NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

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2 August 2001 MAS/0959-AIR/7024

STANAG 7024 AIR (EDITION 2) – IMAGERY AIR RECONNAISSANCE TAPE RECORDER STANDARD

References:
a. AC/224-D/887 dated 17 November 1998
b. MAS(AIR)35-AR/7024 dated 10 May 1993 (Edition 1)

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page (iii) is promulgated herewith.

2. The references listed above are to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

4. National staffs are requested to examine page (iii) of the STANAG and, if they have not already done so, advise the Defence Support Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

for Jan H ERIKSEN
Rear Admiral, NONA
Chairman, MAS

Enclosure:
STANAG 7024 (Edition 2)

STANAG No. 7024
(Edition 2)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

MILITARY AGENCY FOR STANDARDIZATION
(MAS)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: IMAGERY AIR RECONNAISSANCE TAPE RECORDER STANDARD

Promulgated on 2 August 2001

Jan H ERIKSEN
Rear Admiral, NONA
Chairman, MAS

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date Entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardisation Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the Custodian. Nations may propose changes at any time to the Custodian where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardisation, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardisation Agreement" (AAP-6).

5. Implementation is "In NATO Standardisation, the fulfilment by a member nation of its obligations as specified in a Standardisation Agreement" (AAP-6).

6. Reservation is "In NATO Standardisation, the stated qualification by a member nation that describes the part of a Standardisation Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION, AND RESERVATIONS

7. Page iii gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the Custodian of its intentions. Page iv (and subsequent) gives details of reservations and proprietary rights that have been stated.

AIM

This document is established to ensure the ability to exchange air reconnaissance sensor recordings and associated auxiliary data within NATO and Allied users, by the use of recording standards for media and recording footprints.

AGREEMENT

Participating nations agree to standardise the magnetic tape media formats for recording of primary reconnaissance data within the airborne environment.

DETAILS OF THE AGREEMENT

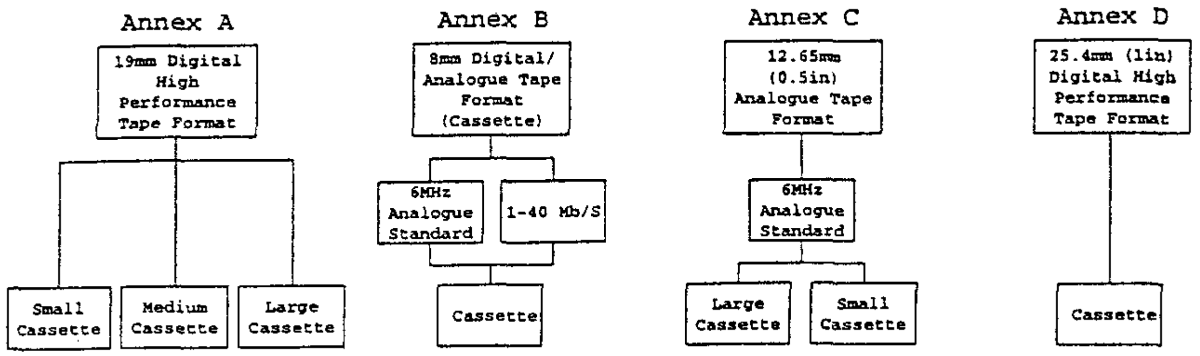
BACKGROUND

Historically, reconnaissance systems have been film based. Now in the era of electro-optical digital (EO), radar reconnaissance sensors and exploitation technology, common/standardised data exchange formats are necessary to assure interoperability between a multiplicity of sensor and exploitation systems. A reconnaissance system will be made up of three subsystems: an air reconnaissance system, a surface exploitation system, and a data transport system. The data transport system is used to transfer sensor and associated auxiliary data from the air reconnaissance system to the surface exploitation system. Standard data formats are the key to this data exchange. In recent and projected reconnaissance systems, the data transport system is a solid state device(SSD)/tape recorder and/or telemetry link. The tape/SSD and/or the data transmission provide the link which carries the information between the air reconnaissance and surface exploitation systems. Standardising this interface will provide interoperability among NATO and Allied reconnaissance systems.

APLICABILITY

This document includes standards to be used as a basis for the development of data tape recording hardware. They provide the basic physical and data format definitions to form generic recording system. In addition to these standards, hardware development for specific systems will require detailed technical specifications for performance and system interface. The standards encompass high and low rate digital recording and analogue video recording formats, as shown in the following diagrams. These requirements are generic in nature, do not limit application of common hardware and allow a wide range of system interfaces to be accommodated. This hardware will meet the operational requirements for data recording on Reconnaissance, Anti Submarine Warfare (ASK) and intelligence gathering platforms. The technology choice for these standards was based on highest storage capacity, volumetric density, bandwidth rates, weight and potential for future growth. These choices permit the application of these standards to a wide range of platforms and missions.

The agreed media standards for recording of reconnaissance data onto tape are listed in the four annexes (A-D) of this STANAG.



PROTECTION OF PROPRIETARY RIGHTS

These annexes are based upon commercial standards, issued by the appropriate companies and international standards bodies, hence the following statement applies :

NATO and member Governments assume no responsibility for possible infringements of any inventions, trade-marks, copyrights, etc. embodied in this STANAG. It is the sole responsibility of anyone using the information to acquire the necessary rights.

IMPLEMENTATION OF THE AGREEMENT

This STANAG is implemented by Nations agreeing to use only the magnetic tape media formats defined within this document for recording of primary imagery/intelligence data to tape for airborne reconnaissance systems.

ANNEXES AND APPENDICES

This document encompasses the standards described in detail in the Annexes. The areas of standardisation are described in general terms in the following paragraphs.

ANNEX A. **"DIGITAL 19mm CASSETTE TAPE RECORDER STANDARD"**

Based on International ID-1 tape cassette standard :

ANSI X3.175.1990 "19-mm Type ID-1 Recorded Instrumentation - Digital Cassette Tape Format"

Part 1 of Annex A is presented as the physical format for high bandwidth digital data recording with references to the format of information on 19mm type ID-1 instrumentation digital cassettes. The dimensions and locations of the helical data and associated annotation tracks are also specified in this annex. The physical characteristics of the cassette are in accordance to the ANSI standard ANSI X3.264:1996 "Unrecorded Helical-Scan Digital Computer Tape Cassette for Information Interchange 19mm (0.748 in)"

Part 2 of Annex A, Logical Reconnaissance Data Format, is defined in STANAG 7023.

ANNEX B **"DIGITAL AND ANALOGUE 8mm CASSETTE TAPE RECORDER STANDARD"**

This standard is based on International 8mm cassette tape format IEC 843:

IEC 843-3 "Helical-scan video tape cassette system using 8mm magnetic tape - 8mm Video, Part 3. High-band specifications for Hi 8"

Part 1 of Annex B is the physical format which will specify minimum performance requirements of Analogue Imagery and Digital data recording, tape track format, cassette tape specifications and the use of azimuth head technique. Applications of this format is to address the needs of aircraft or unmanned air vehicles that have a requirement for commonality interchange and also have a driving requirement for minimum weight, low power use, small size and low cost consideration.

Part 2 of Annex B, Logical Reconnaissance Data Format, is defined in STANAG 7023.

ANNEX C. **"ANALOGUE 12.65mm (HALF-INCH) CASSETTE TAPE RECORDER STANDARD"**

This standard is based on International VHS Analogue video format IEC 774:

IEC 774-3 "Helical-scan video tape cassette system using 12.65mm (0.5in) magnetic tape on type VHS, Part 3. S-VHS"

Part 1 of ANNEX C is the physical format detailing the electrical and mechanical parameters and the necessary characteristics of the S-VHS and S-VHS-C recording format.

Part 2 of ANNEX C, Logical Reconnaissance Data Format, is defined in STANAG 7023.

ANNEX D. **"DIGITAL 25.4mm (1 in) TAPE RECORDER STANDARD"**

Based on the AMPEX DCRsi tape cassette standard :

"25.4mm (1 in) Type DCRsi Recorded Instrumentation-Digital Cartridge Tape Format, Version 1.1 4 June, 1998"

Part 1 of Annex D is presented as the physical format for high bandwidth digital data recording with references to the format of information on 25.4mm (1 in) DCRsi type instrumentation digital cassettes. The dimensions and locations of the transverse scan data and associated annotation tracks are also specified in this annex, along with the mechanical dimensions of the cartridge and magnetic media.

Part 2 of Annex A, Logical Reconnaissance Data Format, is defined in STANAG 7023.

NATO STANDARDISATION AGREEMENT

(STANAG 7024)

IMAGERY AIR RECONNAISSANCE TAPE RECORDER STANDARD

Annexes:

A. Digital 19mm Cassette Tape Recorder Standard

B. Digital and Analogue 8mm Cassette Tape Recorder Standard

C. Analogue 12.65mm Cassette Tape Recorder Standard

D. Digital 25.4 mm (1 in) Cassette Tape Recorder Standard

Related documents:

STANAG 3277: Air Reconnaissance Request/Task Forms

STANAG 3377: Air Reconnaissance Intelligence Report Forms

STANAG 3596: Air Reconnaissance Request and Target Reporting Guide

STANAG 4283: High Density Digital Recording Standard

STANAG 7023: Air Reconnaissance Imagery Data Standard

STANAG 7085: Interoperable Data Links For Imaging Systems

STANAG 4545: NATO Secondary Imagery Format

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ANNEX A

PART 1 PHYSICAL FORMAT

"DIGITAL 19mm CASSETTE TAPE RECORDER STANDARD"

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X3B5 96-196
ANSI ®
2nd Draft proposed revision to X3.175-1990

American National Standard
for Information Systems —

19-mmType ID-1 Recorded Instrumentation — Digital Cassette Tape Format

Secretariat

Computer and Business Equipment Manufacturers Association

Approved December 7, 1989
American National Standards Institute, Inc

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

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Foreword (This Foreword is not part of American National Standard X3 175-1990.)

This standard presents format and recording requirements for 19-mm, helical-scan magnetic tape cassettes to be used for interchange among instrumentation systems, data processing systems, and associated equipment. It is based on SMPTE standards for helical scan tape recording/reproducing systems, some of which are referenced, in order to obtain the broadest possible acceptance.

Requests for interpretation, suggestions for improvement or addenda, or defect reports are welcome. They should be sent to the X3 Secretariat, Computer and Business Equipment Manufacturers Association, 311 First Street, NW, Suite 500, Washington, DC 20001 2178.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Information Processing Systems, X3. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

, Chair
, Vice-Chair
, Administrative Secretary

Page

Contents

American National Standard
for Information Systems -

19-mm Type ID-1 Recorded Instrumentation - Digital Cassette Tape Format

1 Scope and purpose

1.1 Scope

This standard establishes the format of information on 19 mm type ID-1 instrumentation digital cassettes. It specifies the dimensions and locations of the helical data, control, time code, and annotation tracks. It defines the format and recording requirements of the data blocks forming the helical data record containing digital instrumentation and other associated data, and specifies the content, format, and recording method for the control record. This standard also specifies the recording requirements for the longitudinal records contained in the annotation and the time code tracks. The annotation and time-code record formats are not defined. The physical requirements, magnetic requirements, and test methods for the magnetic tape and tape cassette are not specified in this standard, but can be found in the references or in the technical literature. No licenses for patented or copyrighted features are required to implement compliance with this standard. All dimensions given are metric.

1.2 Purpose

The purpose of this standard is to ensure a direct and unique correspondence between user data (as defined in this standard) and the format recorded on tape. In order to ensure data interchange using this standard, it is necessary for interchange parties to agree upon performance levels and source data format. This standard is distinct from a specification in that it delineates a minimum of restrictions consistent with compatibility in media interchange transactions.

1.3 Compliance

An interchange instrumentation tape can be said to comply with this standard if it complies with all the mandatory requirements of this standard. In the text that follows, a mandatory requirement is expressed by the word "shall."

2 Referenced standards and related publication

2.1 Referenced American national standards

This standard is intended for use with the following American National Standards:

ANSI S4.40-1985, Recommended Practice for Digital Audio Engineering — Serial Transmission Format for Linearly Represented Digital Audio Data

ANSI X3.264:1996, Unrecorded Helical-Scan Digital Computer Tape Cassette for Information Interchange 19 mm (0.748 in)

3 Definitions

The following definitions, listed in alphabetic order, and those given in the American National Dictionary for Information Processing, ANSI X3/TR-1-82, apply to this standard:

8/9 coding: The assignment of 9-bit NRZL words to bytes of specific value, in accordance with 5.5.5.

9-bit NRZL word: The immediate result of 8/9 coding.

9-bit symbol: The binary representation of 9 bits of information to be magnetically recorded on tape.

annotation record: The magnetization pattern or associated information recorded into the annotation track.

annotation track: The longitudinal track farthest away from the reference edge of the tape.

ANSI sync word: A waveform as described for Preamble 1 in ANSI S4.40-1985 and as shown in figure 5 of this document, used for data recognition during playback of the control record.

auxiliary data: Optional information of secondary importance.

azimuth: The angular deviation of the mean flux transition line from a line normal to the nominal track centerline.

basic dimension: A fundamental dimension on which the tape record of this standard is based.

bi-phase-mark: The modulation method for the information to be recorded into the control track; also, Manchester Type I.

byte: An ordered string of 8 bits, starting with the least significant and ending with the most significant bit, and representing a numeric value to be acted on as a unit.

byte marker: A means to label bytes during outer coding for error protection so that these bytes can be processed in proper order during inner coding.

codeword digital sum (CDS): The digital sum variation from the beginning to end of a NRZI(1) symbol's waveform. The CDS is calculated assuming that the NRZI(1) waveform starts at a negative level, the binary levels are -1 and +1, and the waveform transitions are centered relative to the corresponding bit cells.

control record: The magnetization pattern or associated information recorded into the control track.

control timing reference point: The center point of the waveform edge in the center of the ANSI sync word.

control track: The longitudinal track between the data area and the time code track.

control track sync tolerance: The maximum allowable longitudinal distance, measured along the reference edge, of the control timing reference point from the intersection of the helical track centerline and the data-area reference line.

data area: An area on tape that is defined by the end points of all possible helical track centerlines.

data area reference line: A line inside the data area parallel to the reference edge at a specified distance from the reference edge.

data area reference point: A point on each helical track's centerline at the boundary between preamble run-up and preamble sync pattern.

data field: A continuous string of bits that is error protected.

data segment: A group of 118 continuous bytes of user data.

digital sum variation (DSV): The running integral of the charge of the NRZI(1) recording waveform including all 9-bit symbols of a sector. The DSV is calculated in accordance with 5.5.5 as the sum of the CDS for all 9-bit symbols of a sector.

error protection: The inclusion into the data field of error check code (bytes) for the purpose of error detection and correction.

helical (data) record: The magnetization pattern or associated information recorded into all possible helical tracks.

helical track: An area on tape, 170 mm long and 45 µm wide, inclined at a small angle to the tape's reference edge, whose centerline lies completely within a helical track tolerance zone.

home track ID: A recorder manufacturer defined field used to identify the scanner head recording the first track of a track set.

inner code: Of two sequential error detection and correction codes, the first encountered on playback from tape.

NRZI(1) modulation: The modulation method defined in 5.5.6, resulting in the NRZI(1) recording waveform to be used for the helical records.

NRZI(1) (recording) waveform: A two level wave form, obtained through NRZI(1) modulation, whose binary representation is a string of NRZI(1) symbols.

NRZI(1) symbol: A 9-bit symbol derived through NRZI(1) modulation of a 9-bit NRZL word.

outer check code: Of two sequential error detection and correction codes, the second encountered on play back from tape.

postamble: The sequence of bits defining the end of a sector.

preamble: The sequence of bits defining the start of a sector.

preamble run-up: The first part of a preamble, containing bit-clock-divided-by-six as the magnetization pattern.

product code arrays: A two dimensional arrangement of bytes, identified by byte markers, as these bytes migrate between outer and inner code error protection processes.

randomization: The method defined in 5.5.4 as prerequisite to 8/9 coding.

reference edge: An equivalent reference edge on the control track side of the tape that is established according to 4.4.5 and may not coincide with the guide edge.

sector: The helical record pertaining to a single helical track.

sector recording tolerance: The maximum allowable distance, along the track centerline, of the data area reference point from the intersection of the track centerline and the data area reference line.

source information: The part of an inner code data field that contains 153 bytes from 153 different outer code data fields; also, the 153 NRZI(1) 9-bit symbols of a sector.

sync block: A part of a sector between preamble and postamble, starting with a sync pattern and followed with an inner code data field.

sync pattern: A magnetization pattern defining the start of each sync block and the postamble or following the preamble run-up.

tape format: The collection and relative position of all possible tracks on tape.

time code track: The longitudinal track closest to the reference edge of the tape.

time code signal: The magnetization pattern or association information recorded into the time code track; also, the longitudinal record where data timing information may be found.

tolerance zones: Narrow zones established to contain completely the track centerlines of six consecutive helical tracks, as defined in 4.8.

track: A narrow, defined area on tape along which a series of magnetic signals may be recorded.

track set: Four consecutive helical tracks of proper azimuth containing four sequential sectors with the same track set ID encoded into their preambles, representing the minimum amount of information recordable or reproducible to/from tape.

track set ID: A common identifier, for four consecutive helical tracks, recorded below the start of these tracks as part of the control record.

user data: Information of primary importance, of which four consecutive portions of 36 108 bytes each are destined for the four consecutive sectors of a track set, in corresponding order.

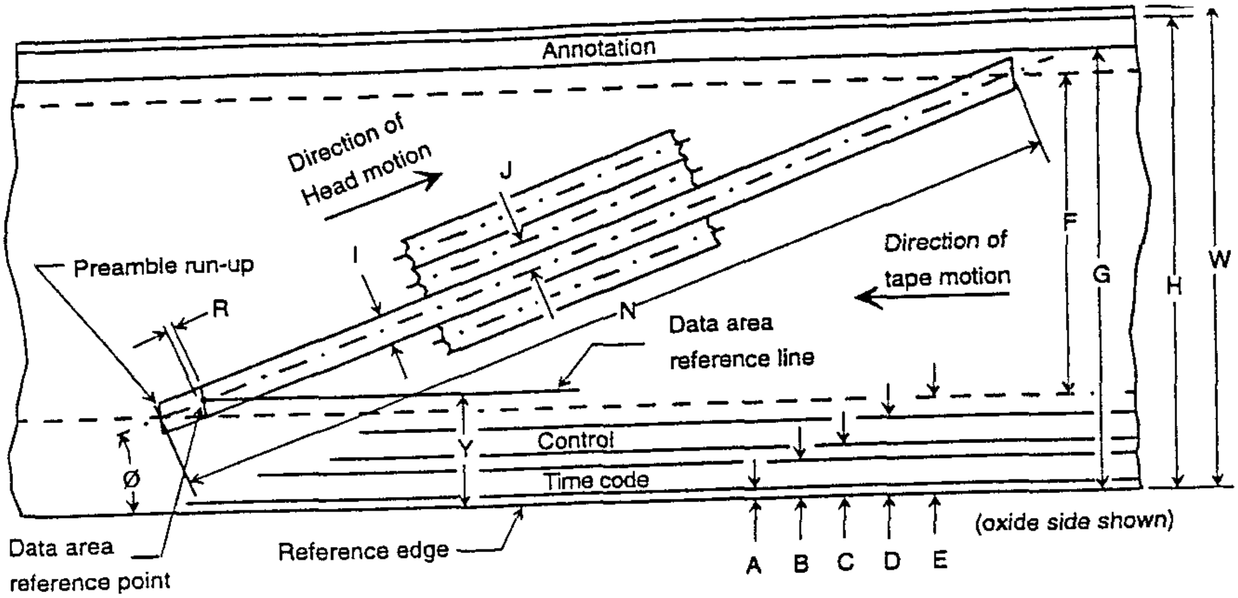

Figure 1 - Location and dimensions of recorded tracks

4 Tape recorded format

4.1 Overview

This section of the standard specifies the dimensions and locations of the helical data, control, time code, and annotation recorded signals for 19 mm type ID-1 helical scan cassettes.

4.2 Purpose

Refer to 1.2.

4.3 Referenced standards

This section of ANSI X3.175-1990 is intended for use in conjunction with ANSI X3.264:1996

4.4 General specifications

4.4.1 Dimensions are in the metric system.

4.4.2 Tests and measurements made on the tape recorded tape to check the requirements of this standard shall be made under the following conditions:

Temperature:	20° C ± 1° C
Relative humidity:	50%, ± 2%
Barometric pressure:	96 kPa ±10 kPa
Tape tension:	0.8 N ± 0.05 N

4.4.3 Conditioning of the tape stock before recording and testing shall be as follows:

Storage conditioning:	Not less than 24 hours
Environmental:	Stabilized to the conditions specified in 4.4.2
Tape tension:	Wound on a reel at a tension of 0.6 to 1.5 N

4.4.4 The reference edge of the tape for dimensions specified in this standard shall be the lower edge as shown in figure 1. The magnetic coating, with the direction of tape travel as shown in figure 1, shall be on the side facing the observer.

4.4.5 All dimensions in the table and figures shall be measured from an equivalent reference edge. The reference edge of the tape is a line through three points on the edge of tape

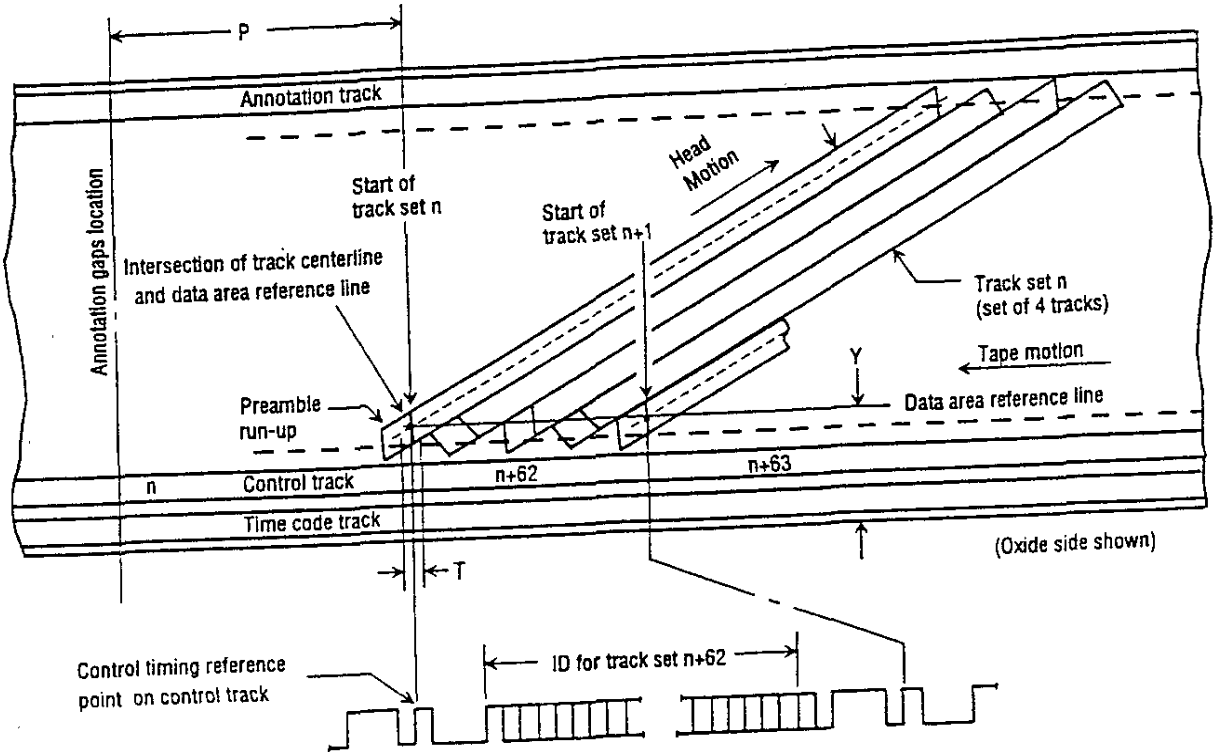

Figure 2 - Location of annotation/time code and 32-bit control word

Table 1 - Recorded track location and dimensions

	Dimensions	Millimeters Nominal	Millimeters Tolerance
A	Time code track lower edge	0.2	±0.1
B	Time code track upper edge	0.7	±0.1
C	Control track lower edge	1.0	±0.1
D	Control track upper edge	1.50	±0.05
E	Data area lower edge	1.80	±0.01
F	Data area width	16.00	±0.03
G	Annotation track lower edge	18.10	±0.15
H	Annotation track upper edge	18.8	±0.2
I	Helical track width	0.045	See 4.6.3
J	Track pitch: basic	0.045	See 4.5 and 4.7.3
N	Helical track total length	170.0	±0.3
P	Annotation/time code head location	118.7	±0.3
R	Sector recording tolerance	0.0	±0.1
T	Control track sync tolerance	0.0	±0.1
Ø	Track angle: arc sin (16/170) basic	5.4005°	See 4.7.1
W	Tape width	19.010	±0.015
Y	Data area reference line: basic	1.8075	

Note: Measurements as shown in table 1 shall be made under the conditions specified in 4.4.2 and 4.4.3.

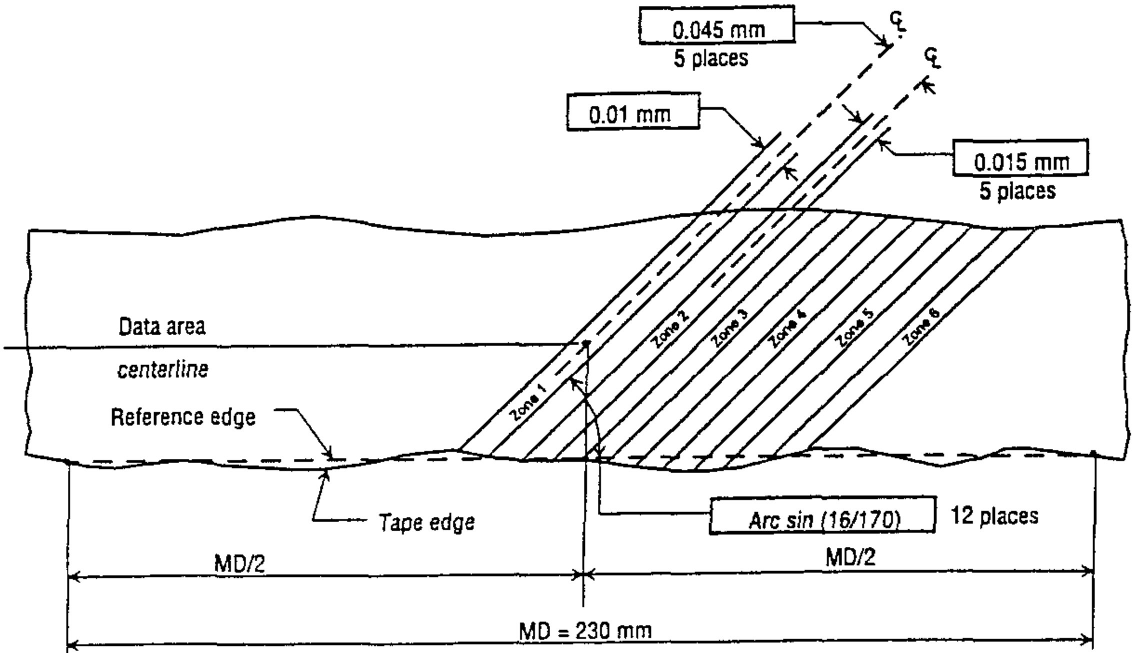

Figure 3 - Location and dimensions of tolerance zones for helical tracks

separated by 115 mm and constrained to lie in one straight line. This constraint may be a physical deformation or an equivalent mathematical transformation. The data area centerline intersects the helical track at a perpendicular to the reference edge through the center point of the reference edge. (see figure 3.) All measurements of the tape edge shall be based on an average over a length of 10 mm.

4.5 Average track pitch

The average track pitch shall be 0.045 mm ± 0.2% averaged over 1000 adjacent helical tracks.

4.6 Track location and dimensions

4.6.1 Track location and dimensions shall be as specified in figures 1 and 2 and table 1.

4.6.2 In recording, all information on the helical track shall be contained within the tolerance specified in table 1 and figure 1.

4.6.3 The helical record head width and position tolerances shall be chosen so as to ensure a minimum track width of 0.040 mm and a maximum overlap of 0.015 mm.

4.7 Relative positions of recorded signals

4.7.1 Annotation and time code track information shall be placed on tape downstream relative to the data area reference point at a distance given as P in figure 2 and table 1.

4.7.2 The data area reference point shall be aligned with the intersection of the track centerline and the data area reference line on every helical track as shown in figures 1 and 2.

4.7.3 The spatial relationship between the control track and helical tracks is specified in figures 1 and 2. The control timing reference point in the control track sync word (ANSI sync word) shall be aligned with the intersection of the helical track centerline and the data area reference line on every four helical tracks as shown in figure 2 and table 1.

4.7.4 The distance between the location of the control track head and the control timing reference edge (see figure 2) corresponding to the data reference point shall not exceed 119.0 mm.

4.7.5 For every recorded helical track set (track set N), there shall exist continuous control track information extending at least from N-127 to N+63, with the track set ID for track set N located relative to the corresponding data area reference point as shown in figure 2. (also, refer to 5.7.)

4.8 Helical recorded track curvature

4.8.1 The centerlines of any six consecutive tracks shall be contained within the pattern of the six tolerance zones established in figure 3.

4.8.2 Each zone shall be defined by two parallel lines which are inclined at an angle equal to arc sin (16 / 170) basic with respect to the tape reference edge.

4.8.3 The centerlines of all zones shall be spaced apart 0.045 mm basic. The width of the first zone shall be 0.010 mm basic. The width of zones 2 through 6 shall be 0.015 mm basic. These zones are established to contain track angle errors, track straightness errors, and track pitch errors.

4.9 Gap azimuth

4.9.1 The azimuth angle of the annotation track, control track, and time code track head gaps used to produce longitudinal records shall be 0° with respect to the perpendicular to the track within a tolerance of ±5 minutes of arc.

4.9.2 The azimuth angle of the head gaps used for the helical tracks shall be ±15° with respect to the perpendicular to the helical track within a tolerance of ±10 minutes of arc. Alternating negative and positive azimuth angles shall result in magnetization patterns on tracks that are inclined relative to the data area reference line by 80.4° for the first and third tracks and 110.4° for the second and fourth tracks of every track set N, as indicated in figure 2.

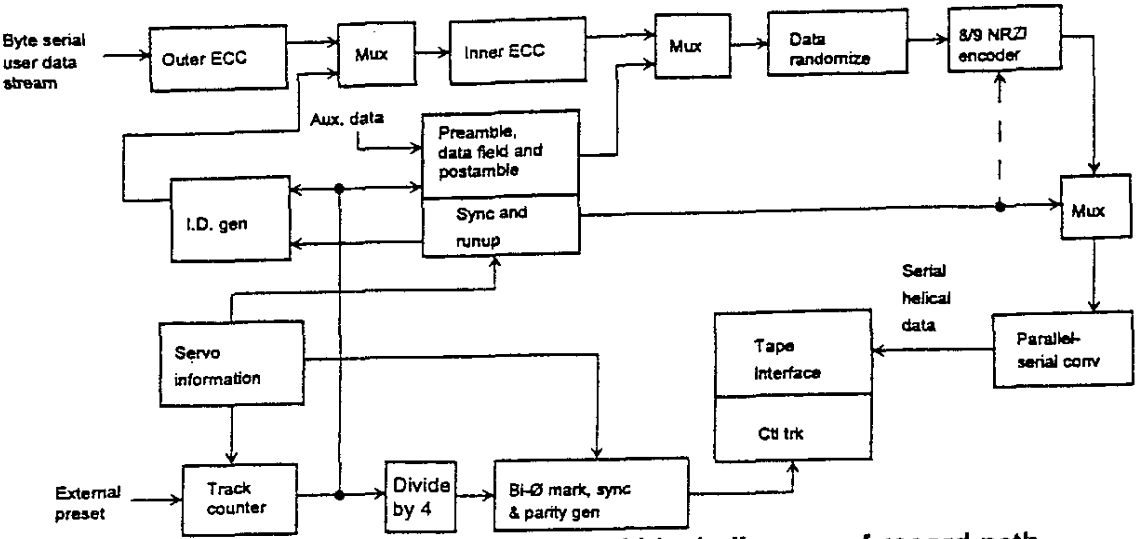

Figure 4 - Digital recorder: conceptual block diagram of record path

5 Helical data and control tracks

5.1 Overview

This section of the standard specifies the content, format, and recording method of the data blocks forming the helical data signals on the tape containing instrumentation digital and other associated data for the 19 mm type ID-1 helical scan cassettes. In addition, the content, format, and recording method of the longitudinal control signals containing tracking information for the scanning head associated with the helical track are specified in 5.7. Track dimensions and locations are specified in section 4. Figure 4 shows a block diagram of the processes involved in the recorder.

5.2 Purpose

Refer to 1.2.

5.3 Referenced standards

This section of ANSI X3.175-1990 is intended for use in conjunction with the following standards:

(1) ANSI S4.40-1985
(2) ANSI X3.264:1996

5.4 Helical track content, format, synchronization, and recording requirements

5.4.1 Labeling conventions

Unless otherwise specified, the following conventions shall apply for section 5:
(1) Values are expressed in 8-bit bytes or 9-bit symbols.
(2) The least significant bit (LSB) is shown to the left-hand side.
(3) The least significant bit is the first one recorded on the track.
(4) The lowest numbered byte is shown left/top and is the first one encountered for error coding / decoding.
(5) The least significant or lowest numbered 9-bit-symbol is the first one recorded on the track.

5.4.2 Introduction

The helical track is compnsed of formatted instrumentation digital data. Data is arranged in one sector per track, as shown in figure 5. The sector (figure 5(a)) is divided into the following elements:

(1) Preamble (figure 5(b)). This element contains a clock run-up sequence, a synchronization (sync) pattern, an identification pattern, and auxiliary data.

(2) Sync blocks (figure 5(c)). This element contains a sync pattern followed by an identification pattern and an information block, both of which are protected by error control.

(3) Postamble (figure 5(d)). This element contains a sync pattern and an identification pattern.

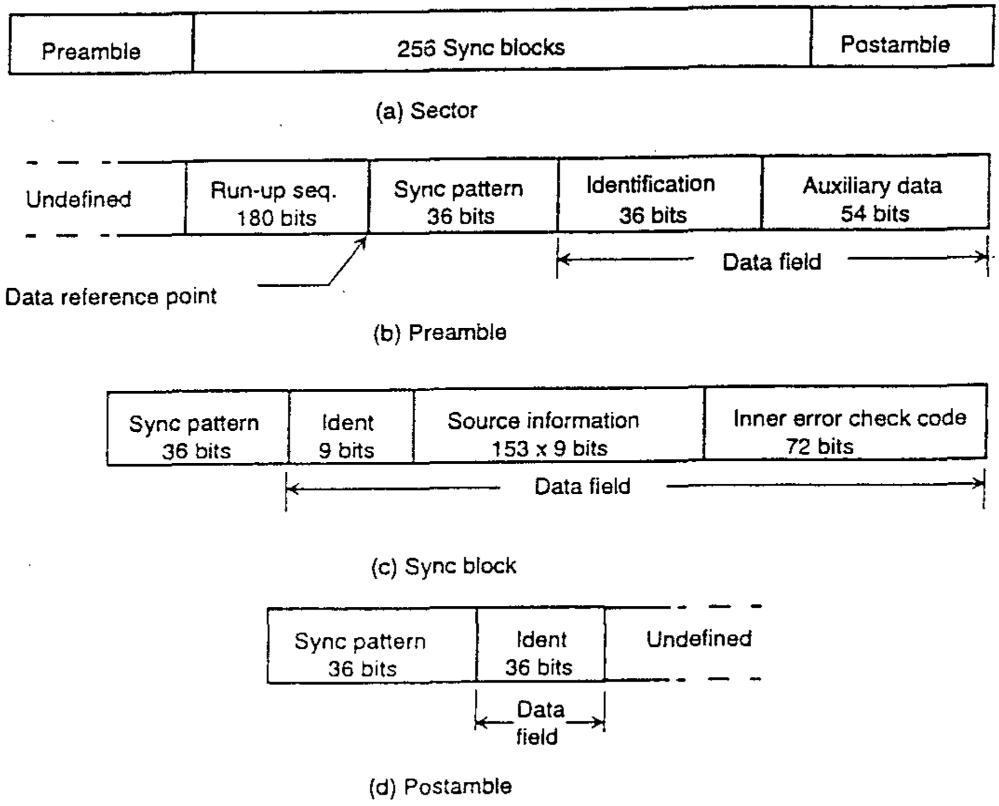

Figure 5 - Sector details

5.4.3 Sector details

5.4.3.1 General

Details of the sector are shown in figure 5(a). All sectors shall contain a preamble, 256 sync blocks, and a postamble, and shall account for a total of 382 842 bits in 42 538 9-bit symbols. A portion of the guard space at the beginning of the sector may contain extended run-up sequence of up to ninety 9-bit symbols in length. Any extended run-up sequence must be added in pairs of run-up 9-bit symbols.

5.4.3.2 Preamble

Details of the preamble are shown in figure 5(b). All sectors shall commence with a preamble composed as follows:

Length	Thirty four 9-bit symbols		
Arrangement	Run-up	Twenty 9-bit symbols	
		Magnetization pattern as follows: LSB 001110001 110001110 . . . 001110001 110001110 MSB (see 5.5.7)	
		See 5.5.5.3 for 8/9 coding implications	
	Sync pattern	Four 9-bit symbols	
		Magnetization pattern as follows: LSB 000011001 111111110 010111000 000001101 MSB (see 5.5.7)	
		See 5.5.5.3 for 8/9 coding implications	
	Data field	Ten 9-bit symbols (see below)	
Data field	Comprises 4 bytes of track identification followed by 6 bytes of auxiliary data, all of which are processed as defined in (d) through (h):		
	(a) Identification	4 bytes created as follows: LSB 11111111 TTSSSSSS SSSSSSSS SSSSSSSS MSB where LSB SS ... S MSB are the 22 least significant bits of the corresponding track set ID on the control track and LSB TT MSB indicates the track position with respect to the corresponding ANSI sync word on the control track (see 5.7) as follows: 0 for track coincident with ANSI sync word 1 for first track after sync word 2 for second track after sync word 3 for track before next sync word	
	(b) Auxiliary data		6 bytes of unspecified content
	(c) Error protection		None
	(d) Randomization		See 5.5.4
	(e) 8/9 coding		See 5.5.5
	(f) NRZI(1) modulation		See 5.5.6
	(g) Magnetization		See 5.5.7
	(h) Record optimization		See 5.5.8

5.4.3.3 Sync Block

Details of the sync block are shown in figure 5(c). All sectors shall contain 256 sync blocks, each composed as follows:

Length	One hundred sixty-six 9-bit symbols	
Arrangement	Sync pattern	Four 9-bit symbols Magnetization pattern as follows: LSB 111100110 000000001 101000111 111110010 MSB (see 5.5.7) See 5.5.5.3 for 8/9 coding implications
	Data field	One hundred sixty two 9-bit symbols (see below)
Data field	Comprises 1 byte of sync block identification and 153 bytes of source information derived according to 5.5.2, both protected by 8 bytes of inner error check code, all of which are processed as defined in (d) through (h):	

(a) Identification	1 byte created as follows: LSB PPPPPPPP MSB where LSB PP . . . P MSB indicates the sync block position within the sector, starting with 0 for the first sync block and ending with 255 for the last sync block
(b) Source Information	153 bytes of row information derived from the product code arrays (see 5.5.2)
(c) Error protection	8 bytes from encoding (a) and (b) with a Reed - Solomon RS(162,154) code (see 5.5.3)
(d) Randomization	See 5.5.4
(e) 8/9 coding	See 5.5.5
(f) NRZI(1) modulation	See 5.5.6
(g) Magnetization	See 5.5.7
(h) Record optimization	See 5.5.8

5.4.3.4 Postamble

Details of the postamble are shown in figure 5(d). All sectors shall terminate with a postamble composed as follows:

Length	Eight 9-bit symbols	
Arrangement	Sync pattern	Four 9-bit symbols Magnetization pattern as follows: LSB 000011001 111111110 010111000 000001101 MSB (see 5.5.7) See 5.5.5.3 for 8/9 coding implications.
	Data field	Four 9-bit symbols (see below)
Data field	Comprises 4 bytes of postamble identification processed as defined in (d) through (h):	
	(a) Identification	4 bytes created as follows: LSB 00000000 TTSSSSSS SSSSSSSS SSSSSSSS MSB where LSB SS . . . S MSB are the 22 least significant bits of the corresponding track set ID on the control track and LSB TT MSB indicates the track position with respect to the corresponding ANSI sync word on the control track (see 5.7) as follows: 0 for track coincident with ANSI sync word 1 for first track after sync word 2 for second track after sync word 3 for track before next sync word
	(b) Information	None or unspecified
	(c) Error protection	None
	(d) Randomization	See 5.5.4
	(e) 8/9 coding	See 5 5.5
	(f) NRZI(1) modulation	See 5.5.6
	(g) Magnetization	See 5.5.7
	(h) Record optimization	See 5.5.8

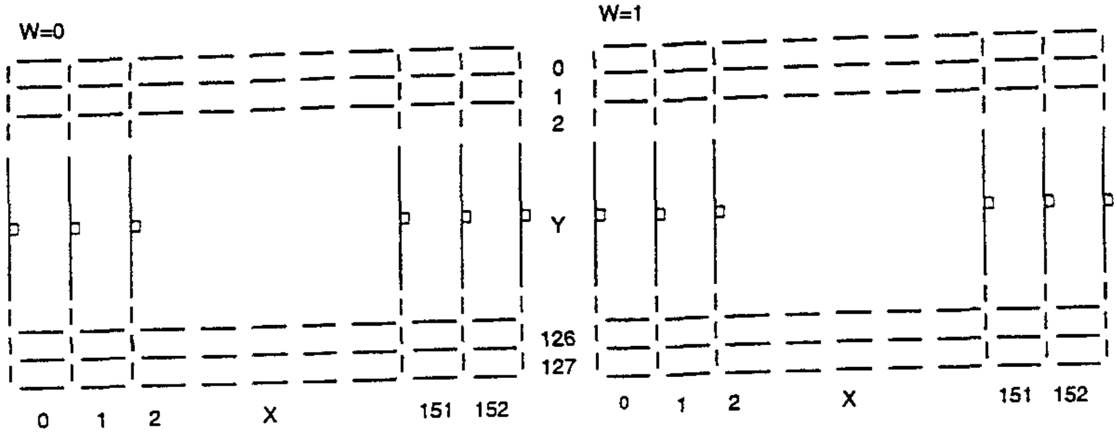

Figure 6 - Two product code arrays

5.5 Sector data field processing

5.5.1 Introduction

Data field processing includes error correction coding of the assembled sync block identification and source information bytes, randomizing of all data fields to minimize undesirable patterns, and 8/9 coding and NRZI(1) modulation to minimize the DC content of the bit string to be recorded on the tape.

5.5.2 Sync block source information

5.5.2.1 General

The source information to be used for inner error correction coding is contained in two product code arrays that are provided through user data processing in accordance with procedures detailed in 5.6.

5.5.2.2 Product code arrays

Details of the two product code arrays are shown in figure 6. Each array contains 128 horizontal rows 153 bytes followed by 8 bytes of inner error code. Each byte has assigned to it a byte marker of the form (W:X:Y).

Array locator W	W has 2 values: 0 for left array 1 for right array
Column locator X	X has 161 values: 0 for first and leftmost column 1 for second column, . . . 160 for last and rightmost column
Row locator Y	Y has 128 values: 0 for first and topmost row 1 for second row, . . . 127 for last and bottommost row

5.5.2.3 Source information byte sequence for sync blocks

Source information and inner error code bytes for each sector shall be assigned to each sync block on the basis of a byte marker (W:X:Y) in the following order:

Sync block 1:	(0:0:0)	(0:1:0)	(0:2:0)	...	(0:159:0)	(0:160:0)
Sync block 2:	(1:0:0)	(1:1:0)	(1:2:0)	...	(1:159:0)	(1:160:0)
Sync block 3:	(0:0:1)	(0:1:1)	(0:2:1)	...	(0:159:1)	(0:160:1)
Sync block 4:	(1:0:1)	(1:1:1)	(1:2:1)	...	(1:159:1)	(1:160:1)
			.			
			.			
Sync block 255:	(0:0:127)	(0:1:127)	(0:2:127)	...	(0:159:127)	(0:160:127)
Sync block 256:	(1:0:127)	(1:1:127)	(1:2:127)	...	(1:159:127)	(1:160:127)

Sync ID 1 Byte	Source information 153 Bytes	Inner error check code 8 Bytes

Figure 7 - Inner code block

5.5.3 Error correction coding for inner check code

5.5.3.1 Data field—inner check code block

The data field of each sync block, defined in 5.4.3.3, is error protected by the following error correction code, referred to as inner code.

Length — 154 bytes total to be encoded, consisting of 1 byte of *sync block identification*, followed by 153 bytes of source information, in accordance with 5.5.2

8 bytes of inner error check code generated as follows:

Protection — Inner code, as follows:

(1) Type — Reed-Solomon RS(162,154)

(2) Galois field — GF(256)

(3) Field generator — $P(X) = X^8 + X^4 + X^3 + X^2 + X^0$

(X^i are place keeping variables in GF(2), the binary field)

(4) Order of use — Leftmost term is "oldest" in time computationally and the first written to tape

(5) Code generator polynomial (in GF 256)) — $G(X) = (X+\alpha^0)(X+\alpha^1)(X+\alpha^2)(X+\alpha^3)(X+\alpha^4)(X+\alpha^5)$
$(X+\alpha^6)(X+\alpha^7)$

where α^1 is a root of $P(x)=0$ given by 02(hex) in GF(256)

(6) Inner error code — $K_7, K_6, K_5, K_4, K_3, K_2, K_1, K_0$ in

$K_7 \times X^7 + K_6 \times X^6 + \ldots + K_1 \times X^1 + K_0 \times X^0$

obtained as the remainder after dividing $X^8 \times D(X)$ by $G(X)$

where $D(X) = I_0 \times X^{153} + B_{152} \times X^{152} + \ldots + B_1 \times X^1 + B_0 \times X^0$

(7) Equation of full code — $C(X) = I_0 \times X^{163} + B_{152} \times X^{160} + B_{151} \times X^{159} + B_{150} \times X^{158}$
$+ \ldots + B_0 \times X^8 + K_7 \times X^7 + K_6 \times X^6 + \ldots + K_1 \times X^1 + K_0 \times X^0$

where i_0 represents the 1 byte of sync block identification, B_{152} through B_0 represent the 153 bytes of sync block source information, and K_7 through K_0 represent the 8 bytes of inner error code (a byte Q_{n+1} is recorded before a byte Q_n)

Table 2 - Inner error check coding examples (hexadecimal notation)

Byte ID	i_0	B_{152}	B_{151}	B_{150}	B_{149}	...	B_1	B_0	K_7	K_6	K_5	K_4	K_3	K_2	K_1	K_0
Pattern 1	00	00	00	00	00		00	01	FF	0B	51	36	EF	AD	C8	18
Pattern 2	00	01	02	03	04		98	99	A1	93	20	86	F9	5B	E7	D0
Pattern 3	CC	CC	CC	CC	CC		CC	CC	24	4B	05	22	ED	70	0C	D9
Timing	First to tape															Last to tape

5.5.3.2 Coding examples for inner check code

An example of three byte patterns in hexadecimal (hex) notation is shown in table 2, where pattern 1 is the impulse function, with the values in the error check code locations representing the expansion of the code generator polynomial.

5.5.4 Randomization

5.5.4.1 All sector data fields (identification, auxiliary data, sourc.- information, and inner error check code) shall be randomized before 8/9 coding (preamble run-up sequence and sync patterns are not randomized.)

5.5.4.2 The randomizing is equivalent to performing the XOR operation between the serial byte stream destined for recording and the serial byte stream generated by the following polynomial function:

$X^8+X^4+X^3+X^2+X^0$ (in GF(2))

The left term shall enter the division computation first. The polynomial is preset to 80(hex) at the end of every sync pattern. This will generate a byte sequence beginning with 80, 38, D2, 81, 49, and so on, hexadecimal bytes in standard notation (most significant bit on left hand side).

5.5.5 8/9 Coding

5.5.5.1 General

8/9 coding includes the mapping of the randomized serial byte stream (according to 5.5.4) into a 9-bit NRZL word stream in such a manner that after the NRZI(1) modulation (according to 5.5.6) of this 9-bit NRZL word stream, a DC free recording waveform is obtained. With this NRZI(1) modulation, one is represented by a transition at the center of a bit cell and zero by the absense of such a transition.

5.5.5.2 Control of Digital Sum Variation(DSV)

In order to effect the DC free encoding of the randomized byte sequence, the channel coding system shall actively maintain an NRZI(1) DSV, calculated from the NRZI(1) symbol codeword digital sum (CDS) listed in Table 3 for each of the allowable 8-bit to 9-bit mappings. This mapping (see table 3) includes both a one-to-one selection of "zero CDS" 9-bit NRZL words and a one-to-two selection of "positive or negative CDS" 9-bit NRZL words. Positive CDS or negative CDS 9-bit NRZL words shall be chosen from table 3 according to the NRZI(1) waveform's DSV and polarity obtained thus far and with the help of table 4. The CDS listed in table 3 assumes a negative NRZI(1) waveform polarity at the end of the previous 9-bit-symbol. When this is true, the next DSV shall be calculated by adding the CDS listed in table 3 to the previously obtained DSV. If the NRZI(1) wave form polarity at the end of the previous 9-bit-symbol is positive, then the next DSV shall be calculated by subtracting the listed CDS from the previous DSV. Each one-to-one selection maintains the DSV by using a 9-bit NRZL word whose NRZI(1) modulation results in a CDS of zero. Table 3 also contains an NRZI(1) waveform polarity inversion indicator for conveniently selecting positive or negative CDS 9-bit NRZL words using table 4. A "Yes" indicates that a polarity inversion across the next NRZI(1) 9-bit symbol will take place as the corresponding 9-bit NRZL word is NRZI(1) modulated.

5.5.5.3 Influence of Preamble Run-Up and Sync Patterns on the DSV

The DSV at the beginning of each track is defined as zero and is not changed by an even number of run-up 9-bit symbols. The nonzero contribution to the DSV by each 36-bit sync pattern, however, shall be included in the calculation of the DSV used as the entry for table 4. Table 5 summarizes the change in DSV effected by preamble run-up and sync patterns.

5.5.6 NRZI(1) Modulation

For magnetic recording, the 9-bit NRZL words shall be converted to NRZI(1) such that each "1" in the NRZL bit stream shall create a transition in the center of the bit cell and each "0" shall create no transition. This NRZI(1) recording waveform shall be provided to the tape by the heads with no additional encoding, randomization, or conversion. However, for purposes of tape magnetization, it is assumed that the NRZI(1) waveform transitions are moved to the beginning of the corresponding bit cells.

5.5.7 Magnetization

For the preamble run-up, sync patterns, and data fields, during the time interval of a recorded bit "1" or of a recorded "+" level of NRZI(1), the polarity of cell flux shall be such that the north pole of the magnetic domain shall point in the direction of head motion. Similarly, during the time interval of a recorded bit "0" or of a recorded "-" level of NRZI(1), the polarity of cell flux shall be such that the south pole of the magnetic domain shall point in the direction of head motion.

5.5.8 Record optimization

5.5.8.1 Second harmonic distortion

The recorded magnetization on tape shall have a second harmonic distortion component that is at least 26 dB below the original signal based on an equivalent flat equalized measurement. This distortion level shall be verified by making measurements on recorded wavelengths approximately equal to 4 times, 8 times, and 16 times the bit length.

5.5.8.2 Residual signal level

If a previously recorded tape is rerecorded with new information, the old data shall be suppressed by at least 26 dB relative to its original level by over-recording or erasing. The measurement shall be made for a worst-case tracking misregistration between new and residual old data, including guard band.

5.5.8.3 Record level optimization

Using either a previously recorded, erased or degaussed tape and a record waveform with rise time and other waveshape characteristics chosen to meet the second harmonic distortion, and residual signal level criteria defined in 5.5.8.1 and 5.5.8.2, the record level shall be chosen to maximize the playback level of a signal component at half the frequency of the recorded data rate. If no clear peak occurs, then the record level shall be set at the lowest level that produces the maximum output level.

Table 3 - Randomized 8-bit byte to 9-bit NRZL word mapping

Randomized byte value (decimal)	Positive CDS selection: 9-bit NRZL word LSB MSB	NRZI(1) symbol CDS	Selection inverts polarity?	Negative CDS selection: 9-bit NRZL word LSB MSB	NRZI(1) symbol CDS	Selection inverts polarity?
0	000100000	+2	Yes	010011100	-1	No
1	001000011	+2	Yes	001000100	-1	No
2	001000110	+2	Yes	001001110	-1	No
3	001001100	+2	Yes	001011010	-1	No
4	001011000	+2	Yes	000100101	-2	Yes
5	001110000	+2	Yes	000101010	-2	Yes
6	010000101	+2	Yes	000101111	-2	Yes
7	010001010	+2	Yes	000110100	-2	Yes
8	010001111	+2	Yes	000111011	-2	Yes
9	010010100	+2	Yes	000111110	-2	Yes
10	010011011	+2	Yes	001001001	-2	Yes
11	010011110	+2	Yes	001010010	-2	Yes
12	010101000	+2	Yes	001010111	-2	Yes
13	010110011	+2	Yes	001011101	-2	Yes
14	010110110	+2	Yes	001100100	-2	Yes
15	010111100	+2	Yes	001101011	-2	Yes
16	011010000	+2	Yes	001101110	-2	Yes
17	011100011	+2	Yes	001110101	-2	Yes
18	011100110	+2	Yes	001111010	-2	Yes
19	011101100	+2	Yes	001111111	-2	Yes
20	011111000	+2	Yes	010010001	-2	Yes
21	100001001	+2	Yes	010100010	-2	Yes
22	100010010	+2	Yes	010100111	-2	Yes
23	100010111	+2	Yes	010101101	-2	Yes
24	100011101	+2	Yes	010111001	-2	Yes
25	100100100	+2	Yes	011000100	-2	Yes
26	100101011	+2	Yes	011001011	-2	Yes
27	100101110	+2	Yes	011001110	-2	Yes
28	100110101	+2	Yes	011010101	-2	Yes
29	100111010	+2	Yes	011011010	-2	Yes
30	100111111	+2	Yes	011011111	-2	Yes
31	101001000	+2	Yes	011101001	-2	Yes
32	101010011	+2	Yes	011110010	-2	Yes
33	101010110	+2	Yes	011110111	-2	Yes
34	101011100	+2	Yes	011111101	-2	Yes
35	101100101	+2	Yes	100100001	-2	Yes
36	101101010	+2	Yes	101000010	-2	Yes
37	101101111	+2	Yes	101000111	-2	Yes
38	101110100	+2	Yes	101001101	-2	Yes
39	101111011	+2	Yes	101011001	-2	Yes
40	101111110	+2	Yes	101110001	-2	Yes
41	110010000	+2	Yes	110000100	-2	Yes

Randomized 8-bit byte to 9-bit NRZL word mapping (continued)

Randomized byte value (decimal)	Positive CDS selection			Negative CDS selection		
	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?
	LSB MSB			LSB MSB		
42	110100011	+2	Yes	110001011	-2	Yes
43	110100110	+2	Yes	110001110	-2	Yes
44	110101100	+2	Yes	110010101	-2	Yes
45	110111000	+2	Yes	110011010	-2	Ycs
46	111000101	+2	Yes	110011111	-2	Yes
47	111001010	+2	Yes	110101001	-2	Yes
48	111001111	+2	Yes	110110010	-2	Yes
49	111010100	+2	Yes	110110111	-2	Yes
50	111011011	+2	Yes	110111101	-2	Yes
51	111011110	+2	Yes	111010001	-2	Yes
52	111101000	+2	Yes	111100010	-2	Yes
53	111110011	+2	Yes	111100111	-2	Yes
54	111110110	+2	Yes	111101101	-2	Yes
55	111111100	+2	Yes	111111001	-2	Yes
56	000010000	0	Yes	000010000	0	Yes
57	000100011	0	Yes	000100011	0	Yes
58	000100110	0	Yes	000100110	0	Yes
59	000101100	0	Yes	000101100	0	Yes
60	000111000	0	Yes	000111000	0	Yes
61	001000101	0	Yes	001000101	0	Yes
62	001001010	0	Yes	001001010	0	Yes
63	001001111	0	Yes	001001111	0	Yes
64	001010100	0	Yes	001010100	0	Yes
65	001011011	0	Yes	001011011	0	Yes
66	001011110	0	Yes	001011110	0	Yes
67	001101000	0	Yes	001101000	0	Yes
68	001110011	0	Yes	001110011	0	Yes
69	001110110	0	Yes	001110110	0	Yes
70	001111100	0	Yes	001111100	0	Yes
71	010001001	0	Yes	010001001	0	Yes
72	010010010	0	Yes	010010010	0	Yes
73	010010111	0	Yes	010010111	0	Yes
74	010011101	0	Yes	010011101	0	Yes
75	010100100	0	Yes	010100100	0	Yes
76	010101011	0	Yes	010101011	0	Yes
77	010101110	0	Yes	010101110	0	Yes
78	010110101	0	Yes	010110101	0	Yes
79	010111010	0	Yes	010111010	0	Yes
80	010111111	0	Yes	010111111	0	Yes
81	011001000	0	Yes	011001000	0	Yes
82	011010011	0	Yes	011010011	0	Yes
83	011010110	0	Yes	011010110	0	Yes
84	011011100	0	Yes	011011100	0	Yes

Randomized 8-bit byte to 9-bit NRZL word mapping (continued)

Randomized byte value (decimal)	Positive CDS selection			Negative CDS selection		
	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?
	LSB MSB			LSB MSB		
85	011100101	0	Yes	011100101	0	Yes
86	011101010	0	Yes	011101010	0	Yes
87	011101111	0	Yes	011101111	0	Yes
88	011110100	0	Yes	011110100	0	Yes
89	011111011	0	Yes	011111011	0	Yes
90	011111110	0	Yes	011111110	0	Yes
91	100010001	0	Yes	100010001	0	Yes
92	100100010	0	Yes	100100010	0	Yes
93	100100111	0	Yes	100100111	0	Yes
94	100101101	0	Yes	100101101	0	Yes
95	100111001	0	Yes	100111001	0	Yes
96	101000100	0	Yes	101000100	0	Yes
97	101001011	0	Yes	101001011	0	Yes
98	101001110	0	Yes	101001110	0	Yes
99	101010101	0	Yes	101010101	0	Yes
100	101011010	0	Yes	101011010	0	Yes
101	101011111	0	Yes	101011111	0	Yes
102	101101001	0	Yes	101101001	0	Yes
103	101110010	0	Yes	101110010	0	Yes
104	101110111	0	Yes	101110111	0	Yes
105	101111101	0	Yes	101111101	0	Yes
106	110001000	0	Yes	110001000	0	Yes
107	110010011	0	Yes	110010011	0	Yes
108	110010110	0	Yes	110010110	0	Yes
109	110011100	0	Yes	110011100	0	Yes
110	110100101	0	Yes	110100101	0	Yes
111	110101010	0	Yes	110101010	0	Yes
112	110101111	0	Yes	110101111	0	Yes
113	110110100	0	Yes	110110100	0	Yes
114	110111011	0	Yes	110111011	0	Yes
115	110111110	0	Yes	110111110	0	Yes
116	111001001	0	Yes	111001001	0	Yes
117	111010010	0	Yes	111010010	0	Yes
118	111010111	0	Yes	111010111	0	Yes
119	111011101	0	Yes	111011101	0	Yes
120	111100100	0	Yes	111100100	0	Yes
121	111101011	0	Yes	111101011	0	Yes
122	111101110	0	Yes	111101110	0	Yes
123	111110101	0	Yes	111110101	0	Yes
124	111111010	0	Yes	111111010	0	Yes
125	111111111	0	Yes	000111001	-1	No
126	000100001	+1	No	001001011	-1	No

Randomized 8-bit byte to 9-bit NRZL word mapping (continued)

Randomized byte value (decimal)	Positive CDS selection			Negative CDS selection		
	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?
	LSB MSB			LSB MSB		
127	001000010	+1	No	001010101	-1	No
128	001000111	+1	No	001011111	-1	No
129	001001101	+1	No	001101001	-1	No
130	001011001	+1	No	001110010	-1	No
131	001110001	+1	No	001110111	-1	No
132	010000100	+1	No	001111101	-1	No
133	010001011	+1	No	010010011	-1	No
134	010001110	+1	No	010010110	-1	No
135	010010101	+1	No	010100101	-1	No
136	010011010	+1	No	010101010	-1	No
137	010011111	+1	No	010101111	-1	No
138	010101001	+1	No	010110100	-1	No
139	010110010	+1	No	010111011	-1	No
140	010111101	+1	No	010111110	-1	No
141	011010001	+1	No	011001001	-1	No
142	011100010	+1	No	011010010	-1	No
143	011100111	+1	No	011010111	-1	No
144	011101101	+1	No	011011101	-1	No
145	011111001	+1	No	011100100	-1	No
146	100001000	+1	No	011101011	-1	No
147	100010011	+1	No	011101110	-1	No
148	100010110	+1	No	011110101	-1	No
149	100011100	+1	No	011111010	-1	No
150	100100101	+1	No	011111111	-1	No
151	100101010	+1	No	100100011	-1	No
152	100101111	+1	No	100100110	-1	No
153	100110100	+1	No	100101100	-1	No
154	100111011	+1	No	101000101	-1	No
155	100111110	+1	No	101001010	-1	No
156	101001001	+1	No	101001111	-1	No
157	101010010	+1	No	101010100	-1	No
158	101010111	+1	No	101011011	-1	No
159	101011101	+1	No	101011110	-1	No
160	101100100	+1	No	101110011	-1	No
161	101101011	+1	No	101110110	-1	No
162	101101110	+1	No	101111100	-1	No
163	101110101	+1	No	110001001	-1	No
164	101111010	+1	No	110010010	-1	No
165	101111111	+1	No	110010111	-1	No
166	110010001	+1	No	110011101	-1	No
167	110100010	+1	No	110100100	-1	No
168	110100111	+1	No	110101011	-1	No

Randomized 8-bit byte to 9-bit NRZL word mapping (continued)

Randomized byte value (decimal)	Positive CDS selection			Negative CDS selection		
	9-bit NRZL word LSB MSB	NRZI(1) symbol CDS	Selection inverts polarity?	9-bit NRZL word LSB MSB	NRZI(1) symbol CDS	Selection inverts polarity?
169	110101101	+1	No	110101110	-1	No
170	110111001	+1	No	110110101	-1	No
171	111000100	+1	No	110111010	-1	No
172	111001011	+1	No	110111111	-1	No
173	111001110	+1	No	111010011	-1	No
174	111010101	+1	No	111010110	-1	No
175	111011010	+1	No	111011100	-1	No
176	111011111	+1	No	111100101	-1	No
177	111101001	+1	No	111101010	-1	No
178	111110010	+1	No	111101111	-1	No
179	111110111	+1	No	111110100	-1	No
180	111111101	+1	No	111111011	-1	No
181	010110111	+1	No	111111110	-1	No
182	001000001	+3	No	001010011	-3	No
183	010000010	+3	No	001010110	-3	No
184	010000111	+3	No	001111011	-3	No
185	010001101	+3	No	001111110	-3	No
186	010011001	+3	No	010100011	-3	No
187	010110001	+3	No	010100110	-3	No
188	011100001	+3	No	011000101	-3	No
189	100000100	+3	No	011001010	-3	No
190	100001011	+3	No	011001111	-3	No
191	100001110	+3	No	011011011	-3	No
192	100010101	+3	No	011011110	-3	No
193	100011010	+3	No	011110011	-3	No
194	100011111	+3	No	011110110	-3	No
195	100101001	+3	No	101000011	-3	No
196	100110010	+3	No	101000110	-3	No
197	100110111	+3	No	101001100	-3	No
198	100111101	+3	No	110000101	-3	No
199	101010001	+3	No	110001010	-3	No
200	101100010	+3	No	110001111	-3	No
201	101100111	+3	No	110010100	-3	No
202	101101101	+3	No	110011011	-3	No
203	101111001	+3	No	110011110	-3	No
204	110100001	+3	No	110110011	-3	No
205	111000010	+3	No	110110110	-3	No
206	111000111	+3	No	110111100	-3	No
207	111001101	+3	No	111100011	-3	No
208	111011001	+3	No	111100110	-3	No
209	111110001	+3	No	111101100	-3	No
210	010000011	+4	Yes	001100101	-3	No

Randomized 8-bit byte to 9-bit NRZL word mapping (continued)

Randomized byte value (decimal)	Positive CDS selection			Negative CDS selection		
	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?	9-bit NRZL word	NRZI(1) symbol CDS	Selection inverts polarity?
	LSB MSB			LSB MSB		
211	010000110	+4	Yes	001101010	-3	No
212	010001100	+4	Yes	001101111	-3	No
213	010011000	+4	Yes	000101001	-4	Yes
214	010110000	+4	Yes	000110010	-4	Yes
215	100000101	+4	Yes	000110111	-4	Yes
216	100001010	+4	Yes	000111101	-4	Yes
217	100001111	+4	Yes	001010001	-4	Yes
218	100010100	+4	Yes	001100010	-4	Yes
219	100011011	+4	Yes	001100111	-4	Yes
220	100011110	+4	Yes	001101101	-4	Yes
221	100101000	+4	Yes	001111001	-4	Yes
222	100110011	+4	Yes	010100001	-4	Yes
223	100110110	+4	Yes	011000010	-4	Yes
224	100111100	+4	Yes	011000111	-4	Yes
225	101010000	+4	Yes	011001101	-4	Yes
226	101100011	+4	Yes	011011001	-4	Yes
227	101100110	+4	Yes	011110001	-4	Yes
228	101101100	+4	Yes	101000001	-4	Yes
229	101111000	+4	Yes	110000010	-4	Yes
230	111000011	+4	Yes	110000111	-4	Yes
231	111000110	+4	Yes	110001101	-4	Yes
232	111001100	+4	Yes	110011001	-4	Yes
233	111011000	+4	Yes	110110001	-4	Yes
234	111110000	+4	Yes	111100001	-4	Yes
235	001000000	+4	Yes	010101100	-3	No
236	011100000	+4	Yes	011010100	-3	No
237	110100000	+4	Yes	011111100	-3	No
238	010000001	+5	No	001100011	-5	No
239	100000010	+5	No	001100110	-5	No
240	100000111	+5	No	001101100	-5	No
241	100001101	+5	No	011000011	-5	No
242	100011001	+5	No	011000110	-5	No
243	100110001	+5	No	110000011	-5	No
244	101100001	+5	No	110000110	-5	No
245	111000001	+5	No	110001100	-5	No
246	010000000	+6	Yes	110000001	-6	Yes
247	100000011	+6	Yes	001100001	-6	Yes
248	100000110	+6	Yes	011000001	-6	Yes
249	100001100	+6	Yes	000110001	-6	Yes
250	100011000	+6	Yes	000110011	-5	No
251	100110000	+6	Yes	000110110	-5	No
252	101100000	+6	Yes	000111100	-5	No
253	111000000	+6	Yes	011001100	-5	No
254	100000001	+7	No	001111000	-5	No
255	100000000	+8	Yes	110011000	-5	No

Table 4 - 9-Bit NRZL word selection

Condition at end of previous NRZI(1) 9-bit symbol		Next 9-bit NRZL word selection	
DSV	Waveform polarity	Positive CDS	Negative CDS
+	+	Chosen	
+	-		Chosen
- or 0	+		Chosen
- or 0	-	Chosen	

Table 5 - DSV calculation using preamble run-up and sync pattern

Pattern	Condition before beginning of pattern		Condition at end of pattern	
	Waveform polarity	DSV	Waveform polarity	DSV
Preamble run-up (180 bits)	None	0	-	0
Preamble sync (36 bits)	-	0	+	-1
Block sync (36 bits)	+	x	-	x+1
	-	x	-	x
Postamble sync (36 bits)	+	x	+	x
	-	x	+	x-1

5.6 User data processing

5.6.1 Introduction

User data processing includes the blocking of user data bytes, their error correction coding, and arrangement in product code arrays prior to sector data field processing (according to 5.5).

5.6.2 Data ordering to tape

All input data to be recorded in the helical area of the tape shall be recorded track or sector sequentially. Sequentially numbered tracks or sectors shall contain successive data with respect to time. There shall be no intertrack shuffling of data versus time. For example, if track n contains the first 36 108 input data bytes, then track n+1 shall contain the next 36 108 input data bytes, and so forth.

5.6.3 User data structuring

5.6.3.1 General

There are 36 108 sequential bytes of user data destined for one helical track and they are first segmented into 306 consecutive blocks of 118 bytes each. These blocks of user data are then appended with outer error check bytes, and each so-obtained outer-code block is assigned a column in the two product code arrays.

5.6.3.2 *User data segmentation*

Bits or bytes of user data to be recorded onto the helical track are assembled such that the data "oldest" in time is assigned the least significant position in a byte stream. This byte stream is then divided into consecutive blocks of 118 bytes. The 118 byte data segments are outer error correction coded by processing the segment containing the least significant user data byte first. Processed segments become outer-code blocks.

5.6.3.3 Outer code blocks

Details of the outer code block are shown in figure 8. All tracks shall contain 306 outer code blocks, each composed as follows:

Length	128 bytes	
Arrangement	Data field	128 bytes (see below)
Data Field	Comprises 118 bytes of user data protected by 10 bytes of outer error check code:	

(a) Data segment	118 bytes of segmented user data (see 5.6.3.2)
(b) Error protection	10 bytes from encoding (a) above with a Reed-Solomon RS(128,118) code (see 5.6.4)
(c) Destination	see 5.6.5

Data segment 118 Bytes	Outer error check code 10 Bytes

Figure 8 - Outer code block

5.6.4 Error correction coding for outer code

5.6.4.1 Data field—outer code block

Each outer code block, defined in 5.6.3.3, is error-protected by the following error correction code, referred to as outer code.

Length	118 bytes of segmented user data to be encoded 10 bytes of outer error check code generated as follows:
Protection	Outer code, as follows:
(1) Type	Reed-Solomon RS(128,118)
(2) Galois field	GF(256)
(3) Field generator	$P(X) = X^8 + X^4 + X^3 + X^2 + X^0$ (X^i are place keeping variables in GF(2), the binary field)
(4) Order of use	Leftmost term is "oldest" in time computationally and first received for coding or applied to product code arrays
(5) Code generator polynomial (in GF(256))	$G(X) = (X+\alpha^0)(X+\alpha^1)(X+\alpha^2)(x+\alpha^3)(X+\alpha^4)$ $(X+\alpha^5)(X+\alpha^6)(X+\alpha^7)(X+\alpha^8)(X+\alpha^9)$ where α^1 is a root of $P(x)=0$ given by 02(hex) in GF(256)
(6) Outer error code	$K_9, K_8, K_7, K_6, K_5, K_4, K_3, K_2, K_1, K_0$ in $K_9 \times X^9 + K_8 \times X^8 + \ldots + K_1 \times X^1 + K_0 + X^0$ obtained as the remainder after dividing $X^{10} \times D(X)$ by $G(X)$ where $D(X) = B_{117} \times X^{117} + B_{116} \times X^{116} + \ldots + B_1 \times X^1 + B_0 \times X^0$
(7) Equation of full code	$C(X) = B_{117} \times X^{127} + B_{116} \times X^{126} + \ldots + B_1 \times X^{11} + B_0 \times X^{10}$ $+ K_9 \times X^9 + K_8 \times X^8 + \ldots + K_0 \times X^0$ where B_{117} through B_0 represent the 118 bytes of user data, and K_9 through K_0 represent the 10 bytes of outer error code (a byte Q_{n+1} is processed before a byte Q_n)

Table 6 - Outer error check coding examples (hexadecimal notation)

Byte ID	B_{117}	B_{116}	B_{115}	B_{114}	...	B_1	B_0	K_9	K_8	K_7	K_6	K_5	K_4	K_3	K_2	K_1	K_0
Pattern 1	00	00	00	00	...	00	01	D8	C2	9F	6F	C7	5E	5F	71	9D	C1
Pattern 2	00	01	02	03	...	74	75	5B	78	59	23	8A	14	AA	DD	EF	5E
Pattern 3	CC	CC	CC	CC	...	CC	CC	33	32	4A	DD	AE	EB	E7	AF	24	BF
Timing	First processed														Last processed		

5.6.4.2 Coding examples for outer code

An example of three byte patterns in hexadecimal notation is shown in table 6, where pattern 1 is the impulse function, with the values in the error-code locations representing the expansion of the code generator polynomial.

5.6.5 Outer-code block destination

5.6.5.1 General

Although all outer-code blocks are ultimately recorded on tape, it is helpful to visualize them as being arranged into two product-code arrays first, before their bytes are processed as sync block source information (according to 5.4 and 5.5). In order to provide a link between outer-code blocks and sync block source information, the bytes of the outer-code blocks have assigned to them a byte marker in the form (*W:X:Y*). Details of the two product-code arrays are shown in figure 6 and byte markers are defined in 5.5.2.2.

5.6.5.2 Byte marker assignment for outer-code blocks

The bytes of each outer-code block destined for the same track shall be assigned a byte marker (*W:X:Y*) in the following order:

Outer-code block 1:	(0:0:0)	(0:0:1)	(0:0:2)	...	(0:0:126)	(0:0:127)
Outer-code block 2:	(0:1:0)	(0:1:1)	(0:1:2)	...	(0:1:126)	(0:1:127)
Outer-code block 3:	(0:2:0)	(0:2:1)	(0:2:2)	...	(0:2:126)	(0:2:127)
				...		
Outer-code block 153:	(0:152:0)	(0:152:1)	(0:152:2)	...	(0:152:126)	(0:152:127)
Outer-code block 154:	(1:0:0)	(1:0:1)	(1:0:2)	...	(1:0:126)	(1:0:127)
Outer-code block 155:	(1:1:0)	(1:1:1)	(1:1:2)	...	(1:1:126)	(1:1:127)
Outer-code block 156:	(1:2:0)	(1:2:1)	(1:2:2)	...	(1:2:126)	(1:2:127)
				...		
Outer-code block 306:	(1:152:0)	(1:152:1)	(1:152:2)	...	(1:152:126)	(1:152:127)

NOTE: The user data byte marked (0:0:0) is the first user data byte recorded to tape.

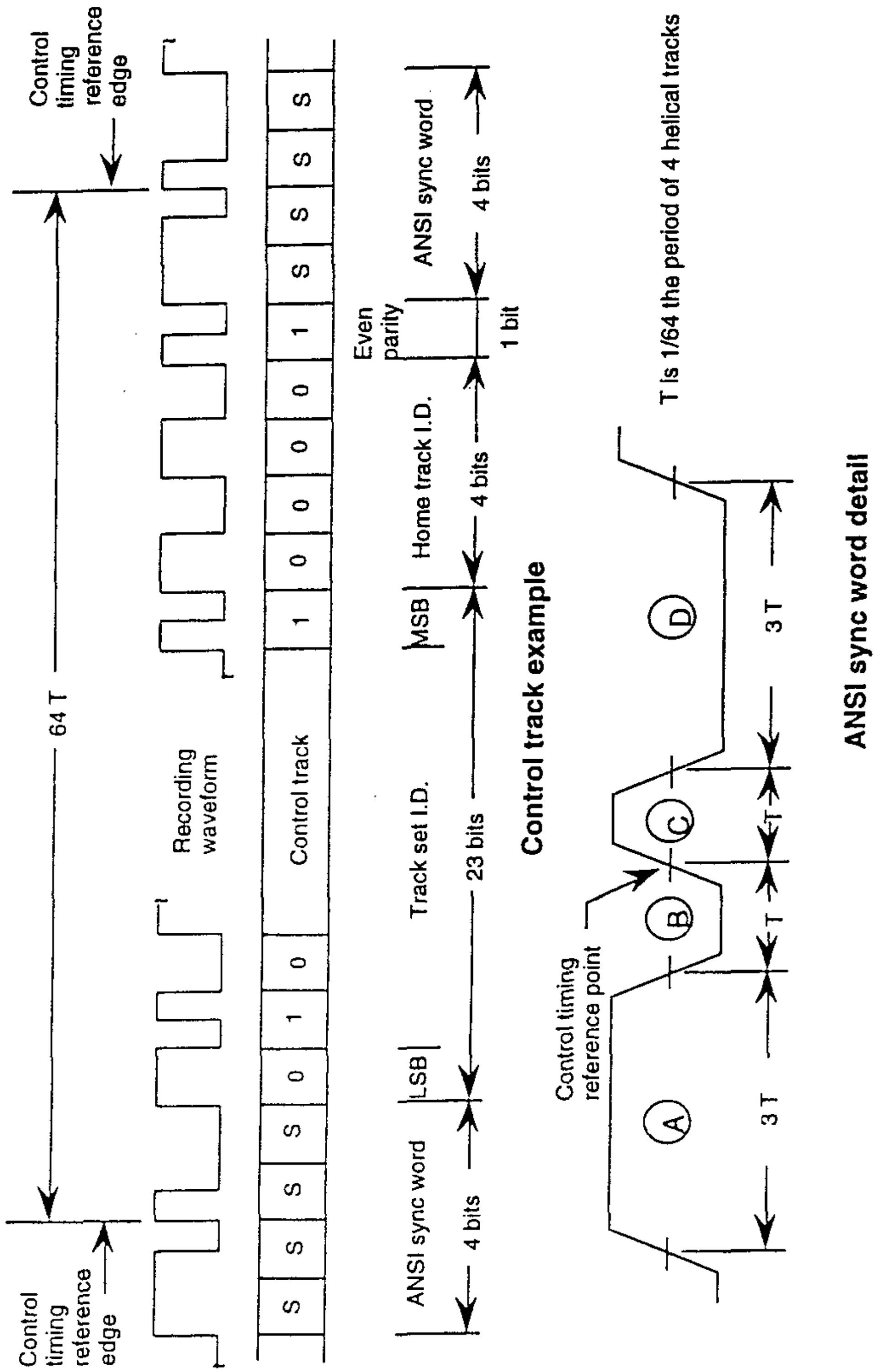

Figure 9 - Recorded control track waveform timing

5.7 Longitudinal control track

5.7.1 Definition

The longitudinal control track shall be a series of 32-bit control words recorded as shown in figure 9. The location of the control track and its positioning relative to the helical track information shall be as defined in section 4.

5.7.2 Control track content

The control record uniquely identifies each set of four consecutive helical tracks with a 23-bit track set ID. The four helical tracks with track set ID equal to 128 shall be the first helical tracks recorded on tape. Every four subsequent tracks shall be identified by a track set ID that is one higher than the previous track set ID. In addition, there is a 4-bit home track ID that may be used to identify the heads of a scanner that were recording the four helical tracks. If the home track ID feature is not used, then the 4-bit field is set to zero.

5.7.3 ANSI sync word

The control track content shall be embedded between two ANSI sync words as shown in figure 9. The center points or center edges of the ANSI sync words provide the control timing reference points or edges, which shall be separated by a pitch distance equivalent to four helical tracks They shall be aligned with the ends of the preamble run-up sequences as shown in figure 2.

5.7.4 Recording method

5.7.4.1 The 23-bit track set ID, 4-bit home track ID, and an even parity bit shall be bi-phase-mark encoded before recording between two ANSI sync words takes place. A transition occurs at every boundary of bit cells and a "1" is represented by a second transition at the center of the bit cell, while a "0" creates no such transition (see figure 9).

5.7.4.2 During time intervals A and C of the ANSI sync word (see figure 9), the polarity of the control track magnetization shall be such that the south pole of the magnetic domain points in the direction of normal tape travel. Similarly, during time intervals B and D, the north pole shall point in the direction of tape travel. The recorded ANSI sync word shall have a half-width of 4T, where T is 1/64 times the period of four helical tracks.

5.7.4.3 The record current rise and fall times shall be less than 0.15T (10 to 90%) and be matched within 0.05T. The peak-to-peak recording current shall maximize the playback signal when using a test signal of period 2T.

6 Annotation and time code tracks

6.1 Overview

This section of the standard specifies the content, format, and modulation method of the longitudinal tracks contained in the annotation and the time code tracks for 19 mm type ID-1 helical scan cassettes. Track dimensions and locations are specified in section 4.

6.2 Purpose

Refer to 1.2.

6.3 Referenced standards

This section of ANSI X3.175-1990 is intended for use in conjunction with ANSI X3.264:1996

6.4 Annotation track

6.4.1 Method of recording

The signals may be recorded using the anhysteretic (AC bias) method or the saturate recording (without bias) method. The bias wavelength shall be sufficiently shorter than (about one fifth of) the shortest signal wavelength supported by a recorder.

6.4.2 Flux level

6.4.2.1 Anhysteretic method

The recorded reference analog level shall correspond to an RMS magnetic short-circuit flux level of 70 nWb / m ± 10 nWb / m of track width at a recorded wavelength of 250 µm.

6.4.2.2 Saturate method

The peak-to-peak recording current shall maximize the playback signal at a recorded wavelength of 10 µm.

6.4.3 Relative position

Annotation record information shall be recorded on the tape at a point relative to the helical track as defined by dimension P in figure 2.

6.4.4 Polarity

An input pulse that is positive going with respect to system ground shall result in a magnetic pattern on the tape with a polarity sequence of south-north-north-south, when recorded in the forward direction of tape motion. During the "south" polarity portions, the magnetization shall be such that the south pole of the magnetic domain points in the direction of tape travel.

6.5 Time code record

6.5.1 Method of recording.

The signals shall be recorded using the anhysteretic (AC bias) recording method.

6.5.2 Flux level.

The recorded peak-to-peak flux shall correspond to an RMS magnetic short circuit flux level of 185 nWb / m ±20 nWb / m of track width.

6.5.3 Relative positions.

Time code track information shall be recorded on tape at a point relative to the helical track as defined by dimension P in figure 2.

6.5.4 Polarity.

An input pulse that is positive going with respect to system ground shall result in a magnetic pattern on the tape with a polarity sequence of south-north-north-south, when recorded in the forward direction of tape motion. During the "south" polarity portions, the magnetization shall be such that the south pole of the magnetic domain points in the direction of tape travel.

7 Annexes

Annex A

(Informative)

Revisions to X3.175-1990

This ANSI Standard was created as a revision to ANSI X3.175-1990 encorporating changes which clarify the intended interpretation of clauses in the document and reflect the actual harware implementations in actual practice which are in conformance with the Standard

The following table identifies the clause, figure or table in the original document subject to change, and describes the change reflected in this document with supportive discussion where appropriate. Only changes of a substantive nature are identified in this annex, not editorial corrections.

Item	Clause/figure/table	Description of change
1	Clauses 2 ,4.3,5.3 Referenced Standards	Delete all references to SMPTE Standards and include reference to ANSI X3.264-1996, Unrecorded Helical-Scan Digital Computer Tape Cassette for Information Interchange 19 mm (0.748 in).
2	Clause 3 Definitions	control timing reference: now reads control timing reference point: The center point of the waveform edge in the center of the ANSI sync word. This change is one of several which clarify the R and T definitions.
3	Clause 3 Definitions	control track sync tolerance: now reads The maximum allowable longitudinal distance, measured along the reference edge, of the control timing reference point from the intersection of the helical track centerline and the data-area reference line. This change is one of several which clarify the R and T definitions.
4	Clause 3 Definitions	data area reference line: now reads A line inside the data area parallel to the reference edge at a specified distance from the reference edge. This change is one of several which clarify the R and T definitions.
5	Clause 3 Definitions	sector recording tolerance: now reads The maximum allowable distance, along the track centerline, of the data area reference point from the intersection of the track centerline and the data area reference line. This change is one of several which clarify the R and T definitions.
6	Clause 4.7.2	Now reads: The data area reference point shall be aligned with the intersection of the track centerline and the data area reference line on every helical track as shown in figure 1 and table 1. This change is one of several which clarify the R and T definitions.

7	Clause 4.7.3	The second sentence: now reads The control timing reference point in the control track sync word (ANSI sync word) shall be aligned with the intersection of the helical track centerline and the data area reference line. This change is one of several which clarify the R and T definitions.
8	Figure 2	Arrow which was label Data area reference point: now is labeled Intersection of track centerline and data area reference line. This change is one of several which clarify the R and T definitions
9	Figure 2	Centerline added to track labeled Start of track set N+1. This change is one of several which clarify the R and T definitions
10	Clause 5.5.6 Modulation	Delete the word "pre-emphasis" from the fourth line. This change allows the option to use record equalization.
11	Clause 5.5.7 Magnetization	Now reads: For the preamble run-up, sync patterns, and data fields, during the time interval of a recorded bit "1" or of a recorded "+" level of NRZI(1), the polarity of cell flux shall be such that the north pole of the magnetic domain shall point in the direction of head motion. Similarly, during the time interval of a recorded bit "0" or of a recorded "-" level of NRZI(1), the polarity of cell flux shall be such that the south pole of the magnetic domain shall point in the direction of head motion. This change correctly defines the magnetization requirements for the different signals in the helical track.
12	Clause 5.5.8.2 Nonlinear intersymbol interference	Delete this paragraph. Requirement not clearly defined nor measurement methods established for this parameter. The referenced ANSI X3B6-TM does not exist at this time.
13	Clause 6.4.1 *Annotation* Method of recording	In the first sentence, "shall" is changed to "may". The second *sentence now reads:* The bias wave length shall be sufficiently shorter than (about one fifth of) the shortest signal wavelength supported by the recorder. This change correctly describes the possible options for the recording method.
14	Clause 6.5.1 *Time code* Method of recording	Delete the second sentence. *The reason for this change is that* 6.4.2.2 *defines optimizing* the saturate method at 10 μm recorded wavelength, which conflicts with 6.5.1 requiring the shortest signal wavelength to be 4.5 μm using a bias wavelength of 1 μm.

ANSI
X3.264-1996
Revision and redesignation of
ANSIX3.264-1996

American National Standard
for Information Technology -

Unrecorded Helical-Scan Digital Computer Tape Cassette for Information Interchange 19 mm (0.748 in) Type D-1

Secretariat
Information Technology Industry Council

Approved February 5, 1996
American National Standards Institute, Inc.

Contents

Foreword

(This foreword is not part of American National Standard X3.264-1996.)

This standard presents the minimum requirements for 19 mm (0.748 in) wide magnetic tape cassette type D-1 to allow parties that comply with these requirements reliably to interchange information. This standard addresses the tape cassette dimensions and tolerances and the properties of the magnetic media.

This standard was developed by Sub-Committee X3B5 for digital magnetic tape. This group consists of experienced and qualified specialists on the recording of digital information on magnetic tape. In the development of this standard, careful consideration was given to current practices, existing equipment and supplies, achieving the broadest possible acceptance, and providing a basis for future improvement in the use of the medium. This standard has three annexes.

This standard is intended to be used with *American National Standard for Information Systems – 19 mm type ID-1 recorded instrumentation – Digital cassette tape format*, ANSI X3.175-1990, developed by ASC X3B6, and was developed in conjunction with a combined unrecorded/recorded standard Helical-scan computer tape cassette for information interchange 19 mm (0.748 in) type DD-1 by ASC X3B5

Requests for interpretation, suggestions for improvement or addenda, or defect reports are welcome. They should be sent to the X3 Secretariat, Information Technology Industry Council, 1250 Eye Street, NW, Washington DC 20005-3922.

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American National Standard for Information Technology –

Unrecorded Helical-Scan Digital Computer Tape Cassette for Information Interchange 19 mm (0.748 in) Type D-1

1 Scope and introduction

1.1 Scope

This standard provides the unrecorded requirements for a computer tape cassette to be used for information interchange between information processing systems. Such a cassette is comprised of two parts:

- a case to provide protection from contaminants and human handling and to facilitate loading/unloading of the cassette by a drive; and
- a magnetic tape of 19 mm (0.748 in) nominal width held inside the case on twin hubs. The tape shall be transported between the hubs for digital recording at a physical density of 2 252 ftpmm (57 200 ftpi).

Information interchange between information processing systems requires the use of this standard in conjunction with a recorded standard.

Additionally, information interchange requires (at a minimum) the utilization of a labeling and file structure and an interchange code as agreed upon by the interchange parties.

It is not within the scope of this standard to describe a recorded format, nor to address standards for labeling and file structure.

1.2 Purpose

The purpose of this standard is to define the requirements and supporting test methods necessary to ensure information interchange at acceptable performance levels. It is distinct from a specification in that it delineates a minimum number of restrictions consistent with compatibility in interchange transactions.

The performance levels contained in this standard represent the minimum acceptable levels of performance for interchange purposes. They, therefore, represent the performance levels that the interchange items should meet or surpass during their useful life and thus define end-of-life criteria for interchange purposes. The performance levels in this standard are not intended to be employed as substitutes for purchase specifications.

Wherever feasible, quantitative performance levels that shall be met or exceeded to comply with this standard are given. In all cases, including those in which quantitative limits for requirements falling within the scope of this standard are not stated but left to agreement between interchange parties, standard test methods and measurement procedures shall be used to determine such limits.

The interchange parties complying with the applicable standards should be able to achieve compatibility without the need for additional exchange of technical information.

1.3 Conformance

A magnetic tape cassette conforms to this standard if it satisfies all mandatory requirements. The tape requirements shall be satisfied throughout the extent of the tape.

1.4 Dimensions

The original dimensions and quantities for all numeric values in this standard are in the International System of Units (SI). Conversions of these units to U.S. Customary engineering units (similar to British Imperial units) and centimeter-gram-second electromagnetic units (cgs emu) have been incorporated in accordance with the procedures described in ANSI/IEEE 268. Units of either of the two measurement systems may be referred to but the two systems should not be intermixed or reconverted. Conversions of toleranced dimensions and quantities in this standard have been performed in accordance with Method A of ANSI/IEEE 268 and ISO 370, *International standard toleranced dimensions – Conversions from millimeters into inches and vice versa*, to maintain the implied correspondence between the accuracy of the original data and the number of significant digits and rounding of the converted values. In the national standards of ISO member bodies, additional rounding may be done to produce "preferred" values. These values should lie within or close to the original tolerances.

2 Normative references

The following standards contain provisions which, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ANSI X3.175-1990, *19 mm type ID-1 recorded instrumentation – Digital cassette tape format*

ANSI/IEEE 268-1982, *American national standard metric practice*

ISO 370:1975, *International standard tolerance dimensions – Conversions from millimeters into inches and vice versa*

SMPTE 224M, *Television digital component recording – 19 mm type D-1 format – Tape record*

SMPTE 225M, *Television digital component recording – 19 mm type D-1 format – Magnetic tape*

SMPTE 226M, *Television digital component recording – 19 mm type D-1 format – Tape cassette*

SMPTE RP-103-1993, *Care, handling, operation and storage of magnetic recording tape for television*

NOTE – Subsequent references to these documents will be by document number only.

3 Definitions

3.1 **average signal amplitude:** The average peak-to-peak value of the signal output of the read head measured over a minimum of 280 000 flux transitions, exclusive of dropouts.

3.2 **back surface:** The surface of the tape opposite the magnetic coating used to record data.

3.3 **basic dimension:** A fundamental dimension on which the tape record of this standard is based.

3.4 **beginning of tape (BOT):** A point denoted by the joining of the leader to the magnetic tape by a splice, when all of the magnetic tape is wound on the supply reel.

3.5 **cleaning cassette:** The cleaning cassette is intended for the periodic maintenance of the tape transport mechanisms that directly contact the tape. The cleaning cassette contains a cleaning tape, attached to the reel hubs via leader and trailer tapes.

3.6 **dropout:** A loss of read signal amplitude below a given threshold.

3.7 **end of tape (EOT):** A point denoted by the joining of the trailer to the magnetic tape by a splice, when all of the magnetic tape is wound on the take-up reel.

3.8 **erase:** To remove all magnetically recorded information from the tape.

3.9 **erasing field:** A magnetic field of sufficient strength to remove the recorded flux transitions from the tape.

3.10 **flux transition spacing:** The distance along a track between successive flux transitions. The spacing is usually expressed as flux transitions per millimeter (ftpmm) or flux transitions per inch (ftpi). (See physical recording density.)

3.11 **leader:** A nonmagnetic length of transparent tape joined to each end of the magnetic tape to provide strength and convenience. At the beginning of the tape, it identifies the storage position of the tape. At the end of the tape, it indicates that the permissible recording area has been exceeded.

3.12 **magnetic tape:** A tape that will accept and retain the magnetic signals intended for input, output, and storage purposes on computers and associated equipment.

3.13 **master standard reference tape:** The tape selected to establish the standard for tape properties essential to data interchange.

NOTE – A master standard reference tape has been established. It has been agreed that Sony Corporation will maintain the master standard reference tape. (See secondary standard reference tape.)

3.14 **physical recording density:** The number of recorded flux transitions per unit length of track, e.g., flux transitions per millimeter (ftpmm) or flux transitions per inch (ftpi).

3.15 **reference edge:** An equivalent reference edge on the control track side of the tape that is established in accordance with 5.4 and may not coincide with the guide edge.

3.16 **reference field:** The typical field of the master standard reference tape.

3.17 **resolution:** The ratio of the average signal amplitude at the physical recording density of 2 252 ftpmm (57 200 ftpi) to that at the physical recording density of 280 ftpmm (7 110 ftpi).

3.18 **secondary standard reference tape:** A tape, the performance of which is known and stated in relation to that of the master standard reference tape.

NOTE – A master standard amplitude reference tape has been established. The Sony Corporation will make available for purchase, secondary standard reference tapes that can be ordered until the year 2005. For information contact:

Sony Corporation, Magnetic Products Group, Major Customer Sales Division,
6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo 141, JAPAN,

Tel: 81-3-5448-3560, Fax: 81-3-5448-7701, Tlx: SONYCORPJ22262

3.19 **standard reference amplitude:** The average peak-to-peak signal amplitude output from the master standard reference tape when it is recorded with the standard reference current. The signal amplitude shall be averaged over at least 280 000 flux transitions. Traceability to the standard reference amplitude reference level is provided by the secondary standard reference tapes.

3.20 **standard reference current:** The current required to produce the reference field.

3.21 **standard reference resolution:** The resolution of the master standard reference tape when it is recorded with the standard reference current.

3.22 **tape cassette centerline:** The centerline of the cassette is defined as a line perpendicular to the prime reference line and located midway between the centers of the two reference holes, see figures 1–3.

3.23 **track:** A narrow, defined area on the tape along which a series of magnetic signals may be recorded.

3.24 **track angle:** The angular deviation, expressed in degrees and minutes of arc calculated from arcsine of (16/170), of the centerline of the recorded track from the equivalent reference edge of the tape.

3.25 **typical field:** In the plot of average signal amplitude against the recording field, i.e. write current, at the physical recording density of 2 252 ftpmm (57 200 ftpi) the minimum field that causes the maximum average signal amplitude.

4 Environmental and safety

4.1 Testing environment

Tests and measurements made on the tape to check the requirements of this standard shall be made under the following conditions unless otherwise specified:

Temperature:	20 °C ± 1 °C (68 °F ± 2 °F); (Ref. SMPTE 224M);
Relative humidity:	50% ± 2%; (Ref. SMPTE 224M, 225M);
Barometric pressure:	96 kPa ± 10 kPa (14 psi ± 1.5 psi);
Tape tension:	0.80 N ± 0.05 N (2.8 ozf ± 0.2 ozf);
Conditioning before testing:	cassette shall be exposed to the test environment for a minimum of 24 hours.

4.2 Operating environment

Cassettes used for data interchange shall be operated under the following conditions:

Temperature:	5 °C to 45 °C (41 °F to 113 °F);
Relative humidity:	20% to 80% non-condensing;
Maximum wet bulb temperature:	26 °C (79 °F).

4.3 Cassette conditioning

For interchange, the cassette shall be conditioned by exposure to the operating environment for a time equal to or greater than the time away from the operating environment (up to a maximum of 24 hours).

Conditioning of the tape stock before recording and testing for compliance to this standard shall be as follows:

Storage conditioning:	not less than 24 hours;
Environmental:	stabilized to the conditions specified in 4.1;
Tape tension:	wound on a reel at a tension of 0.6 N to 1.5 N (2 ozf to 5 ozf).

4.4 Storage environment

Cassettes shall be stored under the following conditions:

Temperature:	5 °C to 32 °C (41 °F to 90 °F)
Relative humidity:	40% to 60%

For environment for transportation refer to annex A.

4.5 Safety

4.5.1 Safeness

The components of the tape and cassette assembly shall not constitute any safety or health hazard when used in the intended manner, or through any foreseeable misuse in an information processing system.

4.5.2 Flammability

Tape or cassette components that will ignite from a match flame, and when so ignited will continue to burn in a still carbon dioxide atmosphere, shall not be used.

4.5.3 Toxicity

Tape or cassette components that may cause bodily harm by contact, inhalation, or ingestion during normal use of the cassette shall not be used.

5 Tape mechanical and electrical properties

5.1 Materials

The tape shall consist of a base film material (oriented polyethylene terephthalate film or its equivalent) coated on one surface with a strong yet flexible layer of ferromagnetic material dispersed in a suitable binder. A back coating material may be used.

5.2 Tape width and tolerance

5.2.1 Requirement

The tape width shall be 19.010 mm ± 0.015 mm (0.7484 in ± 0.0006 in).

5.2.2 Procedure

The tape, covered with a glass plate, shall be measured without tension at a minimum of five different positions along the tape using a calibrated microscope or profile projector having an accuracy of at least 2.5 mm (98 min). Tape width is defined as the average of the five readings.

5.3 Delta width

5.3.1 Requirement

Delta width (width fluctuation) shall not exceed 6 mm (236 min) peak to peak.

5.3.2 Procedure

Measurement of delta width shall be over a tape length of 230 mm (9.06 in).

5.4 Reference edge straightness

Reference edge straightness is the departure of the reference edge of the tape from a straight line along the longitudinal dimension of the tape in the plane of the tape surface.

5.4.1 Requirement

The reference edge straightness maximum deviation is 6 mm (236 min) peak to peak.

5.4.2 Procedure

Edge straightness fluctuation is measured at the edge of a moving tape guided by two guides having contact to the same edge and having a distance of 115 mm (4.5 in). Edge measurements are averaged over 10 mm (0.4 in) lengths and are made at the mid-point between the two guides.

5.5 Tape thickness

Use of tapes with various thicknesses is permitted with the total tape thickness being within the following values:

- nominal 16 mm tape shall have a thickness between 13.5 mm – 16.0 mm (531 min – 630 min);
- nominal 13 mm tape shall have a thickness between 11.0 mm – 13.0 mm (433 min – 512 min).

5.6 Magnetic recording surface coating thickness

The magnetic recording surface coating thickness shall be 2 mm – 3.6 mm (80 min – 140 min). Backcoating surface thickness is not specified.

5.7 Tape length

Each tape cassette shall contain either 16 mm nominal or 13 mm nominal thickness tape and shall be wound to the minimum length as shown in the table below:

Cassette size	16 mm nom	13 mm nom
Small	190 m (623 ft)	225 m (738 ft)
Medium	587 m (1925 ft)	708 m (2322 ft)
Large	1311 m (4300 ft)	1622 m (5322 ft)

The maximum length shall be governed by the outside diameter of the tape pack conforming to figures 4, 5, and 6.

5.8 Discontinuity

There shall be no discontinuities in the tape between the beginning of tape (BOT) and end of tape (EOT) leaders such as those produced by tape splicing or perforations except those caused by leader or trailer attachment.

5.9 Longitudinal curvature

Longitudinal curvature is the departure of the reference edge of the tape from a straight line along the longitudinal dimension of the tape in the plane of the tape surface.

5.9.1 Requirement

Any deviation of the reference edge from a straight line must be gradual and shall not exceed 0.04 mm (0.0016 in) within a 229 mm (9.0 in) span of tape.

5.9.2 Procedure

Measure at a tension of 1.39 N ± 0.28 N (5 ozf ± 1 ozf) in a test fixture equipped with two guides spaced at 229 mm ± 1 mm (9.00 in ± 0.04 in). The two guides shall be spring loaded to position the reference edge of the tape against two edge control surfaces. Measure the maximum deviation of the reference edge of the tape from the line drawn between the two control surfaces.

5.10 Out-of-plane distortions

Out-of-plane distortions are local deformations that cause portions of the tape to deviate from the plane of the surface of the tape. Out-of-plane distortions are most readily observed when the tape is lying on a flat surface under no tension. All visual evidence of out-of-plane distortion shall be removed when the tape is subjected to a uniform tension of 0.6 N ± 0.03 N (2.0 ozf ± 0.01 ozf).

5.11 Leaders, trailers and splices

5.11.1 Leaders and trailers

The cassette shall include leader and trailer tape. When attached to the hub, there shall be a length of 300 mm ± 30 mm (12 in ± 1.2 in) between the splice point and the outside of the cassette shell (see figure 7). The leader/trailer tape material shall be polyester or equivalent having a transmissivity of at least 60% when measured with a 700 nm – 900 nm (7 000 Å – 9 000 Å) light source. When attached to the hub, the leader/trailer tape shall not separate when subjected to a force of 22 N (80 ozf) or less. The width of the leader/trailer tape shall be 19.010 mm ± 0.025 mm (0.748 0 in ± 0.000 6 in). The thickness of the leader/trailer tape shall be 10 mm to 40 mm (390 min to 1 600 min). The break tensile strength of the leader/trailer tape shall be at least 22 N (80 ozf).

5.11.2 Splices

There shall be no splices allowed on magnetic tape between the leader and the trailer except those used to attach the leader and trailer.

The splicing tape shall be of a polyester material which may be with a metal foil backing. The splicing tape width shall be 19.010 mm ± 0.025 mm (0.7484 in ± 0.000 6 in). The splice shall not separate when subjected to a force of 22 N (80 ozf) or less.

5.12 Tape wind

The tape shall be wound on the hubs with the magnetic coating out, and in such a way that during forward read/write operations the tape is unwound in a counterclockwise direction (reel turns clockwise) viewed from the top of the cassette as shown in figures 4, 5, and 6.

5.13 Offset tensile yield force

The force to produce 1% of tangential elongation of the sample (tape or leader/trailer).

5.13.1 Requirement

The offset tensile yield force shall be a minimum of 15 N (54 ozf).

5.13.2 Procedure

Use a static weighting, constant rate-of-separation tester capable of indicating the load to an accuracy of ± 2%. Clamp a specimen of at least 276 mm (11 in) in length, with an initial 200 mm (7.9 in) separation between the jaws. Elongate the specimen at a rate of 100 mm (3.9 in) per minute. The initial tangential slope is extended and read at 1% elongation.

5.14 Inhibitor tape

An inhibitor tape is a tape that degrades the performance of the tape drive or other tapes.

Certain tape characteristics can contribute to poor tape drive performance. Tapes that exhibit these characteristics may not give satisfactory performance, can result in excessive errors and can interfere with the subsequent performance of other tapes.

These characteristics include the following:

- high abrasivity;
- high friction to tape path components;
- poor edge conditions;
- excessive tape wear residual products;
- electro-static charge build-up on the tape or tape path components;
- interlayer slippage;
- transfer of magnetic coating to the back of the next tape layer;

- separation of tape constituents causing deposits that may lead to tape sticking or poor performance of other tapes.

The inherent characteristics of the tape should be such that the tape will not inhibit interchange performance.

5.15 Electrical resistance of the magnetic coating surface and back surface

Electrical resistance is defined as the ohms of the magnetic coating and back surfaces.

5.15.1 Requirement

The resistance for the magnetic surface shall not exceed 10^{13} ohms, but shall be greater than 5×10^{5} ohms. The resistance for the back surface shall not exceed 5×10^{6} ohms.

5.15.2 Procedure

After conditioning to the test environment, position the test piece over two 24-carat gold-plated semicircular electrodes having a radius R = 25.4 mm (1 in) and a finish of at least N4, so that the magnetic coating surface is in contact with each electrode. The electrodes shall be placed parallel to the ground and parallel to each other and spaced d = 25.4 mm (1 in) apart (see figure 8). Apply force of 0.25 N ± 0.012 N (0.9 ozf ± 0.04 ozf) to each end of the test piece. Apply a DC voltage of 500 V ± 10 V across the electrodes and measure the resulting current flow. From this value, determine the electrical resistance.

Repeat for a total of five positions along the test piece and average the five resistance readings.

Repeat the test for the back surface.

NOTE – Neither the specimen nor the insulating surfaces shall be handled with bare fingers. (The use of clean, lint-free gloves is recommended.)

5.16 Layer-to-layer adhesion

Layer-to-layer adhesion refers to that property of a magnetic tape wherein one layer when held in close proximity to the adjacent layer exhibits an adhesive nature and bonds itself to an adjacent layer so that free and smooth separation of the layers is difficult.

5.16.1 Requirement

There shall be no evidence of layer-to-layer adhesion or coating delamination.

5.16.2 Procedure

A 914 mm (36 in) length of tape shall be fastened at one end, magnetic side down, to a 12.7 mm (0.5 in) diameter by a 102 mm (4 in) long stainless steel cylinder with a non-oozing adhesive material. Attach the opposite end of the tape to a 300 gram (10.6 oz) weight. A small strip of double-coated adhesive tape shall be affixed to the magnetic side of the tape 25.4 mm (1 in) above the weight. The tube shall then be slowly and uniformly rotated so that the tape, held in tension by the weight, winds uniformly around the tube into a compact and even roll. The double-coated adhesive tape when wound into the roll acts to secure the end and prevent unwinding when the weight is removed. The tube supporting the weight is then exposed to the following temperature and humidity cycle:

Time (hr)	Temperature	Relative humidity
16 – 18	55° C (130°F)	85% ± 5%
4	55° C (130°F)	10% or less
1 – 2	21.1° C (70°F)	45% ± 5%

To evaluate the tape for adhesion, the end of the roll should be opened and the double-coated adhesive tape removed. The free end of the tape should be released and the outer one or two wraps should spring loose with no adhesion. The free end of the tape should then be held and the cylinder allowed to fall, thereby unwinding the tape. The unwound tape should then be checked for coating delamination with the exception of the last 54 mm (2 in) of tape nearest the cylinder.

5.17 Coating adhesion

Coating adhesion is the force required to separate any part of the coating from the tape base film material.

5.17.1 Requirement

The force required to separate any part of the coating from the tape base film material shall not be less than 1.0 N (3.5 ozf). The force required to separate any part of the back coating from the tape base film material shall not be less than 1.0 N (3.5 ozf).

5.17.2 Procedure

a) Take a sample of the tape approximately 381 mm (15 in) long and scribe a line through the coating across the width of the tape, 127 mm (5 in) from one end;

b) Using double-sided pressure sensitive tape applied to the full width of the sample, attach the sample to a smooth metal plate, with the magnetic coating surface facing the plate;

c) Fold the sample 180 degrees adjacent to, and parallel with the scribed line. Attach the metal plate and the free end of the sample to the jaws of a universal testing machine such that when the jaws are extended the tape is separated. Set the jaw extension rate to 254 mm/min (10 in/min);

d) Note the force at which any part of the coating first separates from the base film material. If the sample separates away from the double-sided pressure sensitive tape before the force exceeds the requirement, an alternative type of double-sided pressure sensitive tape shall be used;

e) Repeat a to d for the back coating, if present.

5.18 Residual elongation

The residual elongation shall be taken as the elongation of a sample over a specified period of time.

5.18.1 Requirement

The residual elongation of the tape shall be no more than 0.1%.

5.18.2 Procedure

Cut a tape length of 1 m (39.4 in) and fasten one end so that the tape hangs freely. Attach a 0.3 N (1 ozf) load to the loose end and measure the length. Attach an additional 10.5 N (37.8 ozf) for 10 minutes. Remove the additional 10.5 N (37.8 ozf), and after 10 minutes measure the change in length from the original. The residual elongation is the change in length expressed as a percentage of the original tape length.

5.19 Tape cupping

The departure across a tape (transverse to motion) from a flat surface is defined as cupping.

5.19.1 Requirement

The departure from a flat surface shall not exceed 0.12 mm (0.005 in) in the tape sample.

5.19.2 Procedure

Cut a 0.9 m (36.0 in) sample of the tape. Condition it to the test environment by hanging it so that the recording surface is freely exposed to the test environment. From the center portion of the acclimated tape sample, cut a sample 25.4 mm (1.0 in) in length. Stand the cut sample on its end in a cylinder, which is at least 25.4 mm (1.0 in) high and has an inside diameter of 19.21 mm ± 0.20 mm (0.756 in ± 0.008 in). With the cylinder standing on an optical comparator, measure the cupping by aligning the edges of the sample to the reticule and determining the distance from the aligned edges to the corresponding surface of the sample at its highest point.

5.20 Light transmission

Light transmission is the measure of the tape's characteristic attenuation in transmission of light through itself.

The magnetic tape shall have a light transmission of less than 5% when measured with a 700 nm – 900 nm (7000 Å – 9000 Å) light source.

6 Magnetic properties

6.1 Magnetic coating

The coating coercivity shall be in the 850 oersted class as measured by a 50 Hz or 60 Hz BH meter. The magnetic particles (pigment) shall be longitudinally oriented.

6.2 Ease of erasure

The maximum peak-to-peak signal amplitude level remaining after subjecting a tape recorded at 170 ftpmm (4 320 ftpi) with the standard reference current to a maximum longitudinal steady field of 2 550 oersteds (202 923 A/m) shall be less than 3% of the average peak-to-peak signal amplitude prior to exposure to the erasing field.

6.3 Average signal amplitude

The average peak-to-peak signal amplitude of the tape under test shall not deviate more than +25% or -10% from the standard reference amplitude. The averaging shall be done over a minimum of 280 000 flux transitions, exclusive of dropouts.

The tape under test and the amplitude reference tape shall be recorded on the same equipment with 2 252 ftpmm (57 200 ftpi) using the standard reference current. The output level shall be measured on the same equipment.

6.4 Resolution

The resolution of the tape under test shall not deviate more than +35% or -15% from that of the standard reference tape.

The tape under test and the reference shall be recorded on the same equipment using the standard reference current. The output amplitudes shall also be measured on the same equipment (see annex B).

6.5 Typical field

The typical field of the tape under test shall not deviate more than +10% or -20% from that of the master standard reference tape.

6.6 Signal dropout

Dropout refers to any read-back signal that falls below a base-to-peak amplitude of less than 35% of the average base-to-peak (one-half of the peak-to-peak) signal obtained from the amplitude reference tape when each tape is recorded at 2 252 ftpmm (57 200 ftpi).

6.6.1 Requirement

The number of rejected regions, not to exceed 25.4 mm (1.0 in) per region is a matter of agreement between interchange parties. For the purpose of evaluation of an unrecorded tape to be used for interchange, an average of one rejected region per 30.5 m (100 ft) of usable track is the recommended limit.

6.6.2 Procedure

This test shall be carried out in the contact condition over the entire tested recording area during a read-while-write operation using the standard reference current. The track spacing shall conform to the recording format for which the cassette is intended to be used in data interchange.

7 Cassette

7.1 General description

The cassette is a coplanar design in three sizes with the tape and hubs completely enclosed by the case, except for the hinged door opening. The drive is via hub couplings which are mechanically connected to external reeling motors. Tape velocity is stabilized by an external capstan. A clear plastic window allows visual monitoring of the tape from the top of the cassette.

7.2 Dimensions

7.2.1 Small cassette

The dimensions of the small cassette are as shown in figures 1, 4, 9, 10, 11, 12, 13, 14, 15, and 23.

7.2.2 Medium cassette

The dimensions of the medium cassette are as shown in figures 2, 5, 12, 13, 15, 16, 17, 18, 23, and 24.

7.2.3 Large cassette

The dimensions of the large cassette are as shown in figures 3, 6, 12, 13, 15, 19, 20, 21, 22, and 23.

7.3 Cassette positioning planes

The cassette is intended to mount in read/write machines in one position only, and cassettes shall have asymmetrical features that can be utilized to prevent engaging the cassette improperly (see figures 9, 16, and 19).

7.3.1 Small cassette

The location of the small cassette positioning planes are as shown in figures 9 and 10.

7.3.2 Medium cassette

The location of the medium cassette positioning planes are as shown in figures 16 and 17.

7.3.3 Large cassette

The location of the large cassette positioning planes are as shown in figures 19 and 20.

7.4 Datum planes

Datum plane Z is determined by datum areas A, B, and C as specified in figures 9, 16, 19, 11, 18, and 21. Datum C need not correspond to a fastener. Datum plane X shall be orthogonal to datum plane Z and shall run through the center of datum hole (A) and datum hole (B) as specified in figures 9, 11, 16, 18, 19, and 21. Datum plane Y shall be orthogonal to both datum plane X and datum plane Z and shall run through the center of datum hole (A) as specified in figures 9, 11, 16, 18, 19, and 21.

7.5 Window and labels

Window and label areas shall be specified as in figures 11, 18, and 21. Labels attached to the cassette shall not extend beyond the external dimensions as shown in figures 11, 18, and 21. Labels shall not interfere with users' or manufacturers' identification holes. Labels shall not interfere with the hub drive and support mechanism.

7.6 Identification holes

There shall be two sets of identification holes, one for the use of the manufacturer and the other for the user. Manufacturers' coding holes, detailed in figures 1, 2, 3, 10, 17, and 20 shall be defined as follows:

7.6.1 Manufacturer holes

7.6.1.1 Media thickness

Manufacturers' holes 1 and 2 shall be used in combination to indicate tape thickness according to the following logic table:

Logic status		
Hole #1	**Hole #2**	**Meaning**
0	0	16 µm tape
0	1	13 µm tape
1	0	Undefined/reserved
1	1	Reserved, cleaning cassette only

NOTE – A '0' in the above tables indicates that the indicator tab is removed or open, denoting an undetected status (0 state) by the recorder/player sensor mechanism.

7.6.1.2 Media coercivity

Manufacturers' holes 3 and 4 shall be used to indicate the coercivity of the magnetic recording tape according to the following logic table:

Logic status		
Hole #1	**Hole #2**	**Meaning**
0	0	Class 850 oe
0	1	Class 1 450 oe
1	0	Undefined/reserved
1	1	Reserved, cleaning cassette only

NOTE – A '0' in the above tables indicates that the indicator tab is removed or open, denoting an undetected status (0 state) by the recorder/player sensor mechanism.

7.6.2 User holes

The user plug mechanism shall withstand an axial force of 0.5 N (1.8 ozf).

The dimensions and location of the users' holes specified in figures 1, 2, and 3 shall be defined as follows:

When a '0' state exists, the user holes shall identify the following conditions:

Hole	Condition
1	Total record lock out (data/auxiliary/time code/control track)
2	Reserved and undefined
3	Reserved and undefined
4	Reserved and undefined

7.7 Reels

The dimension of the reels and the relationship between the reels are specified in figures 12 and 13.

The reels shall be locked automatically when the cassette is removed from the recorder-player. When a small cassette is inserted into a recorder-player, the reels shall be unlocked automatically as specified in figure 14. When a medium or large cassette is inserted into a recorder/player, the reels shall be unlocked automatically as specified in figures 22 and 24. The reels shall be held in position by a reel spring with a force as shown in figures 14, 22, and 24, when the height of the reel table support is 2.0 mm ± 0.2 mm (0.08 in ± 0.01 in) from datum plane Z. The force needed to release the reel lock of the cassette shall be 0.6 N (2.2 ozf) maximum.

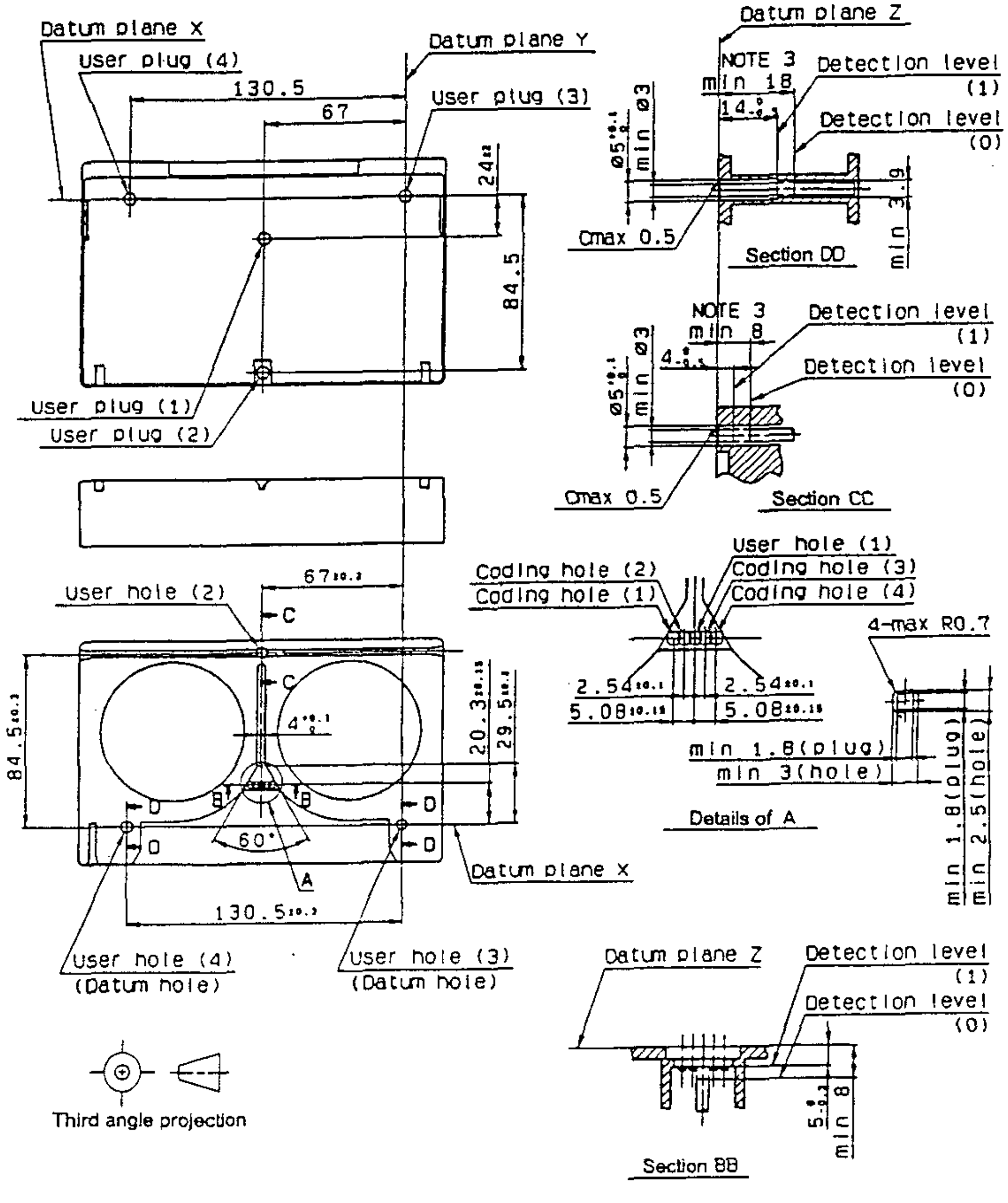
7.8 *Lid-door*

The lid-door shall provide protection to exposed tape by closing and locking automatically upon removal from the recorder-player. The lid-door shall be unlocked and opened by the recorder-player when the cassette is inserted. The minimum space for a loading mechanism is shown in figure 25.

7.9 Locking and opening

The lid-door shall be unlocked by a 0.6 N (2.2 ozf) maximum force being exerted upon the release pin, as specified in figures 10, 14, 22, and 24. The lid-door shall be lifted by the recorder-player to the position shown in figure 15. When the cassette is removed from the recorder-player, the lid-door shall lock automatically. The maximum force to open the lid-door shall be 1.5 N (5.4 ozf).

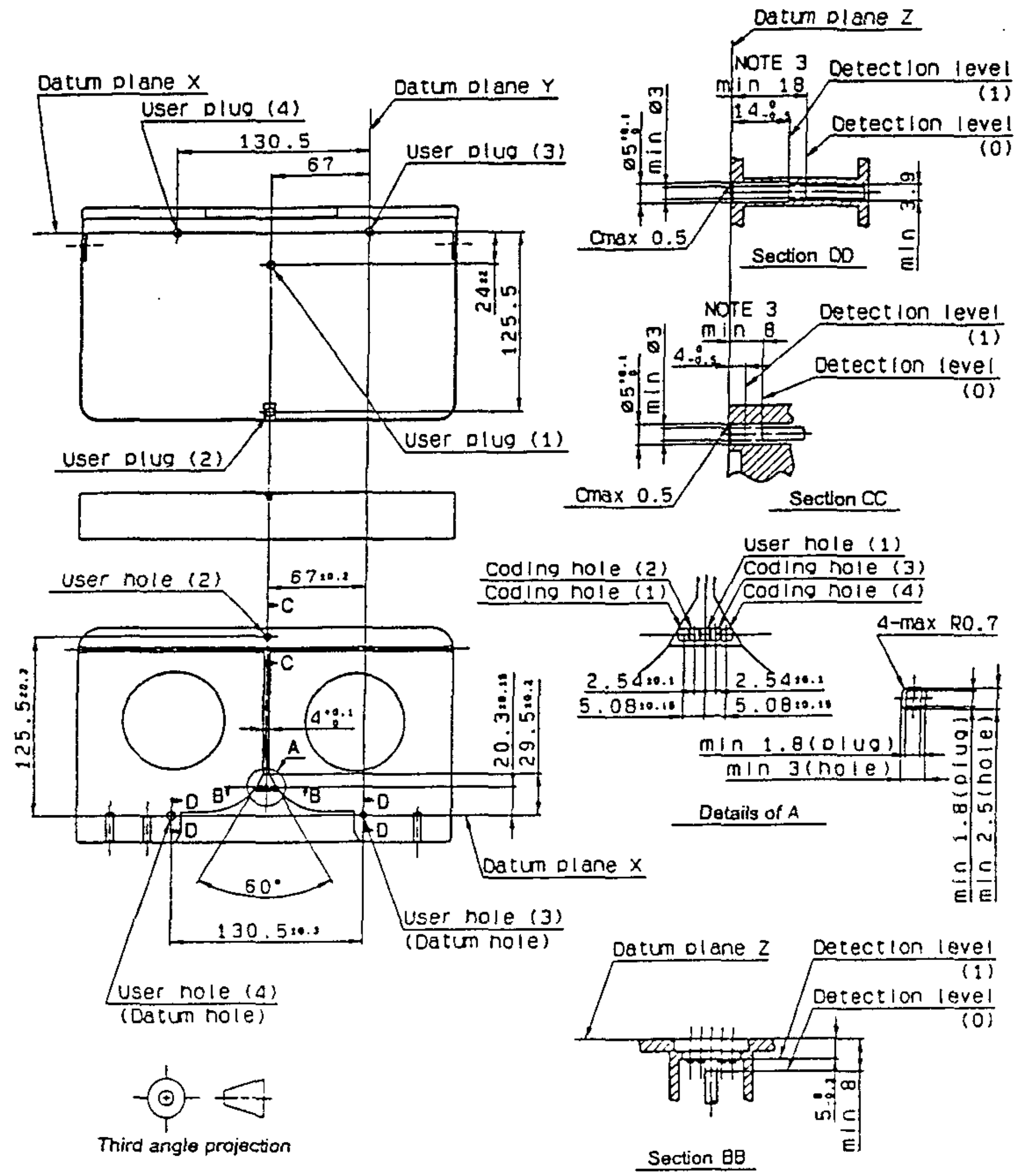
Figures



1 Small cassette coding holes and user holes

Notes:

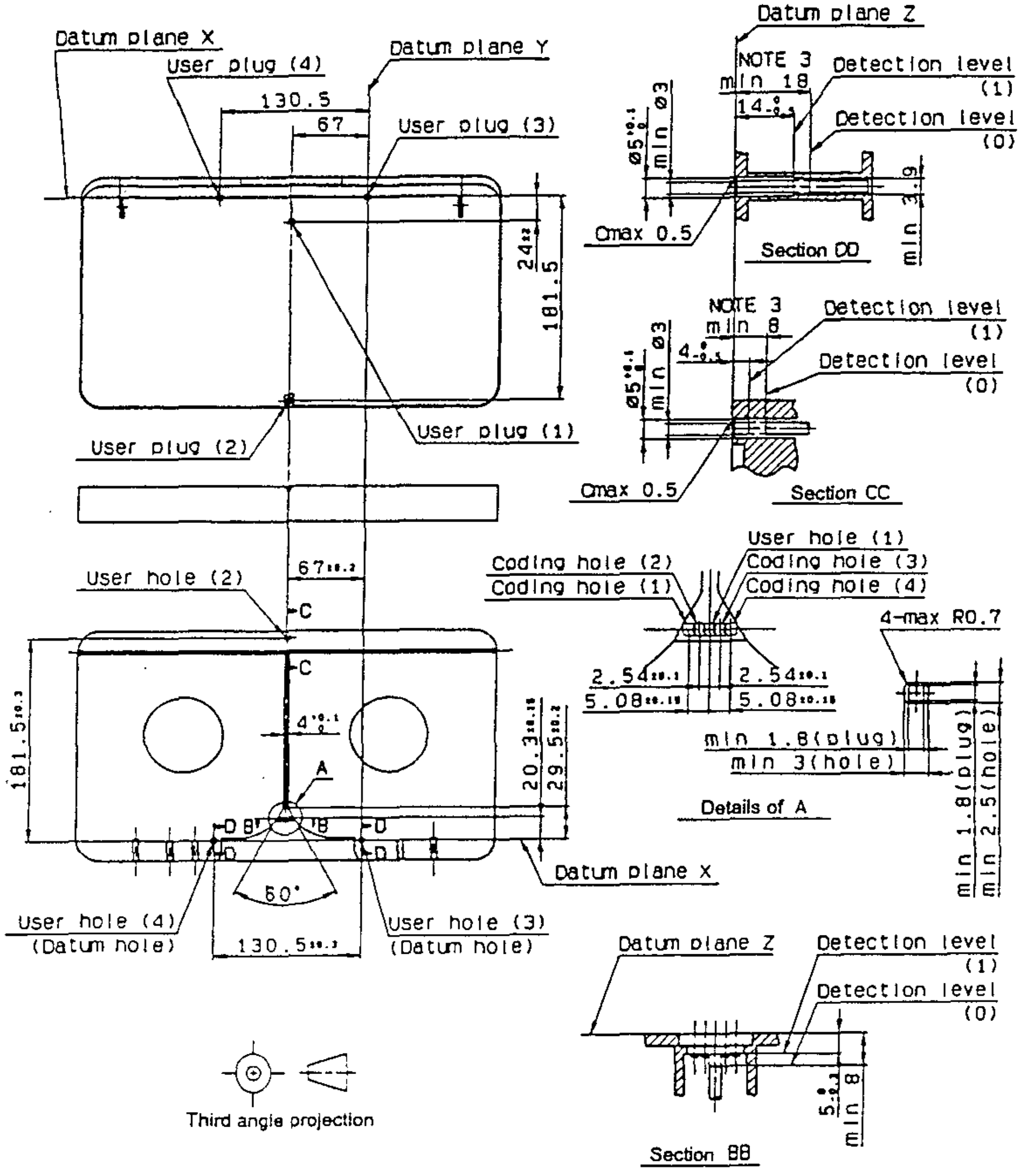
1. The cassette shall be provided with four coding holes (1) to (4) and four user holes (1) to (4). When any plug is removed, the opening shall be shown in detail A. The user plug (1) shall be green.
2. User Holes (3) and (4) on the upper shell shall be opened when user plugs are removed.
3. All cassettes shall be provided with holes as defined by section DD and CC.



2 Medium cassette coding holes and user holes

Notes:

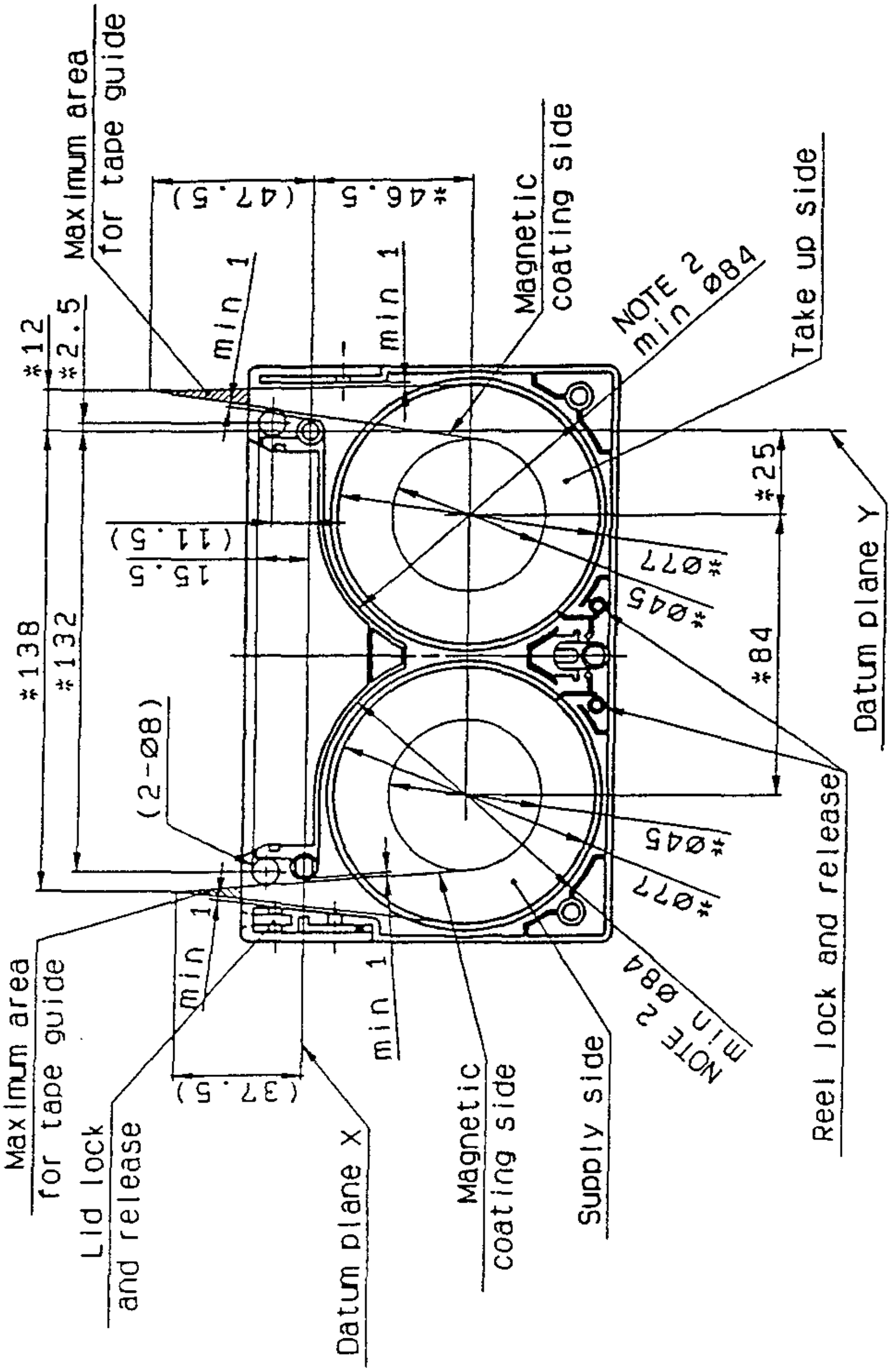
1. The cassette shall be provided with four coding holes (1) to (4) and four user holes (1) to (4). When any plug is removed, the opening shall be shown in detail A. *The user plug (1) shall be green.*
2. User Holes (3) and (4) on the upper shell shall be opened when user plugs are removed.
3. All cassettes shall be provided with holes as defined by section DD and CC.



3 Large cassette coding holes and user holes

Notes:

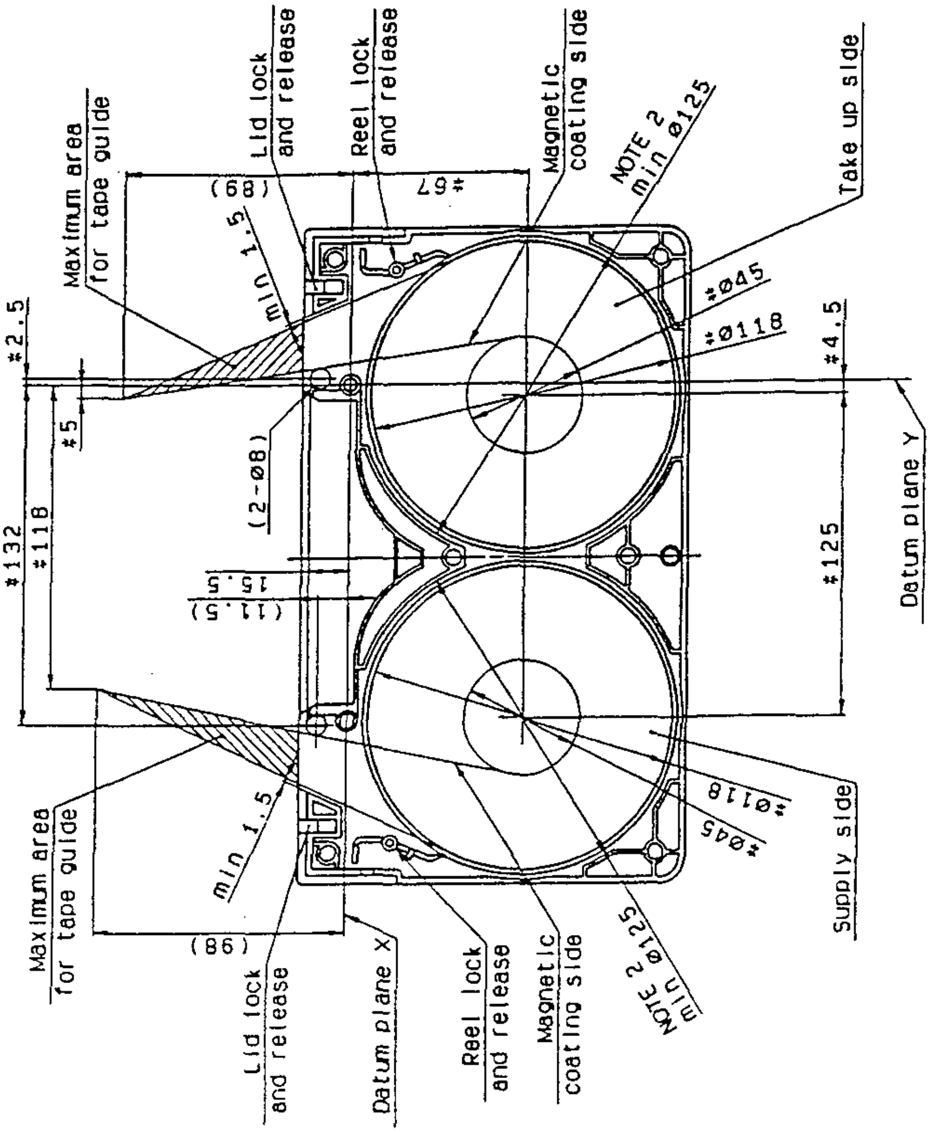
1. The cassette shall be provided with four coding holes (1) to (4) and four user holes (1) to (4).
2. User Holes (3) and (4) on the upper shell shall be opened when user plugs are removed.
3. All cassettes shall be provided with holes as defined by section DD and CC.



4 Internal structure and tape path of small cassette (top view)

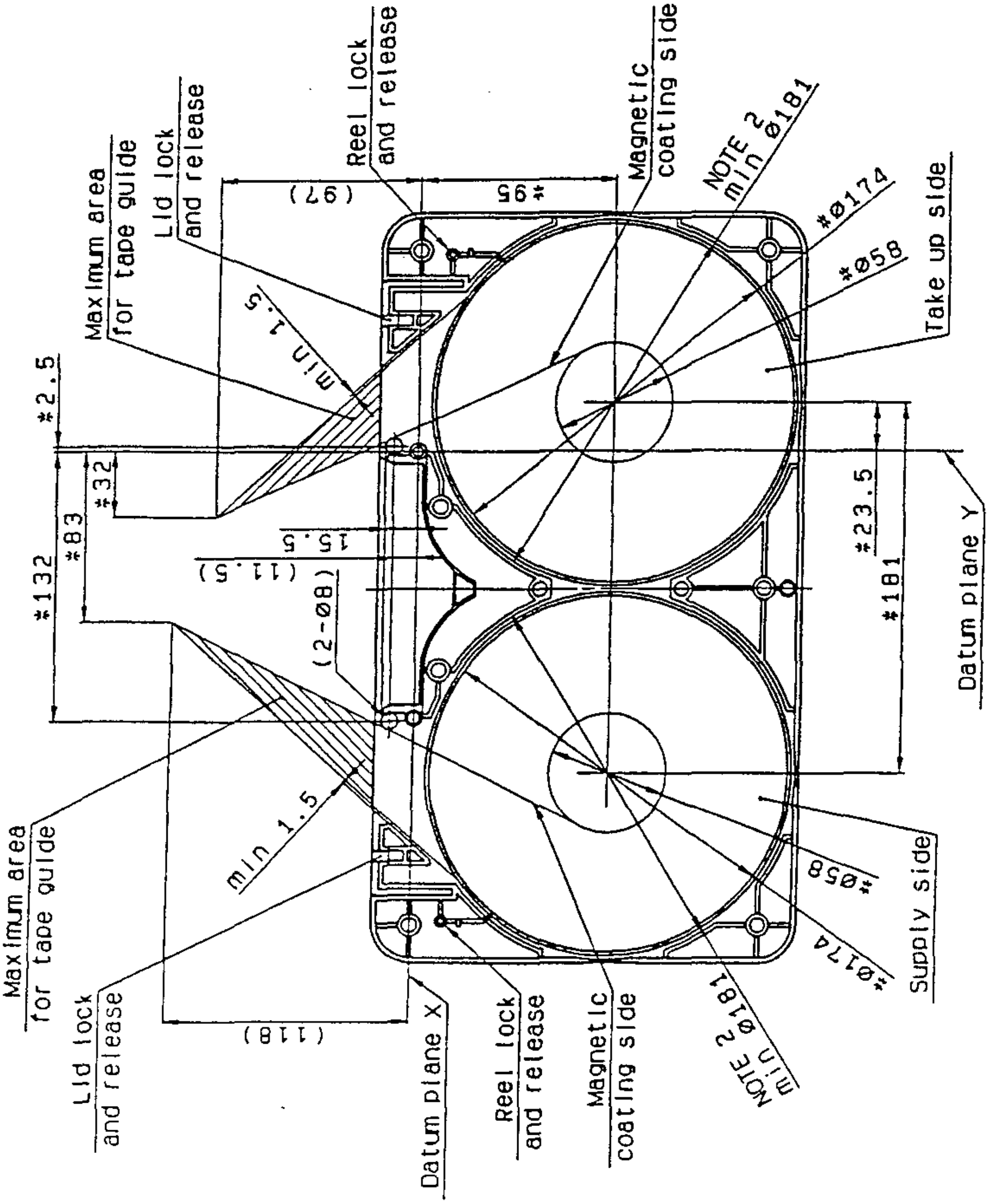
Notes:

1. Dimensions marked with an asterix are nominal values specifying the tape path.
2. Area for the reel.



5 Internal structure and tape path of medium cassette (top view)

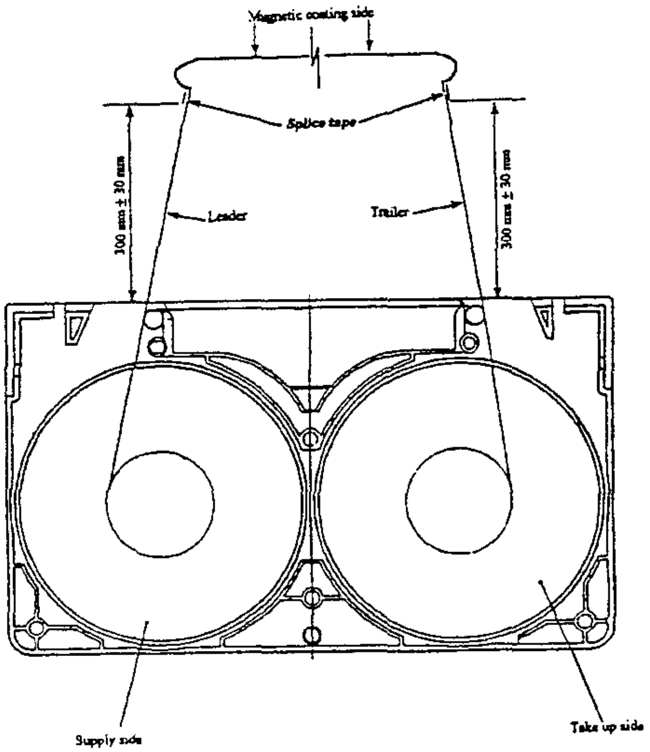
Notes:
1. Dimensions marked with an asterix are nominal values specifying the tape path.
2. Area for the reel.



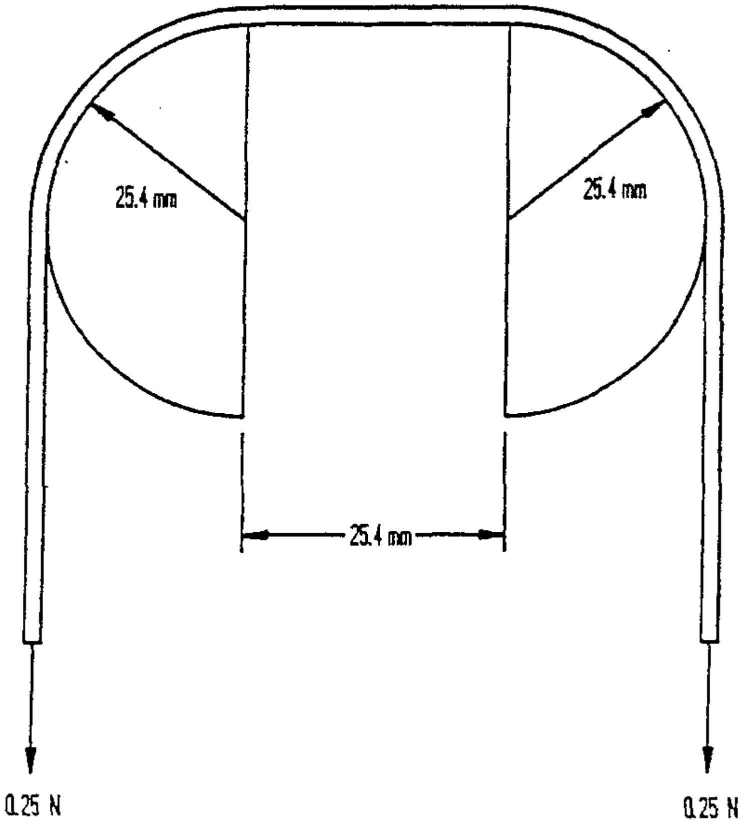
6 Internal structure and tape path of large cassette (top view)

Notes:

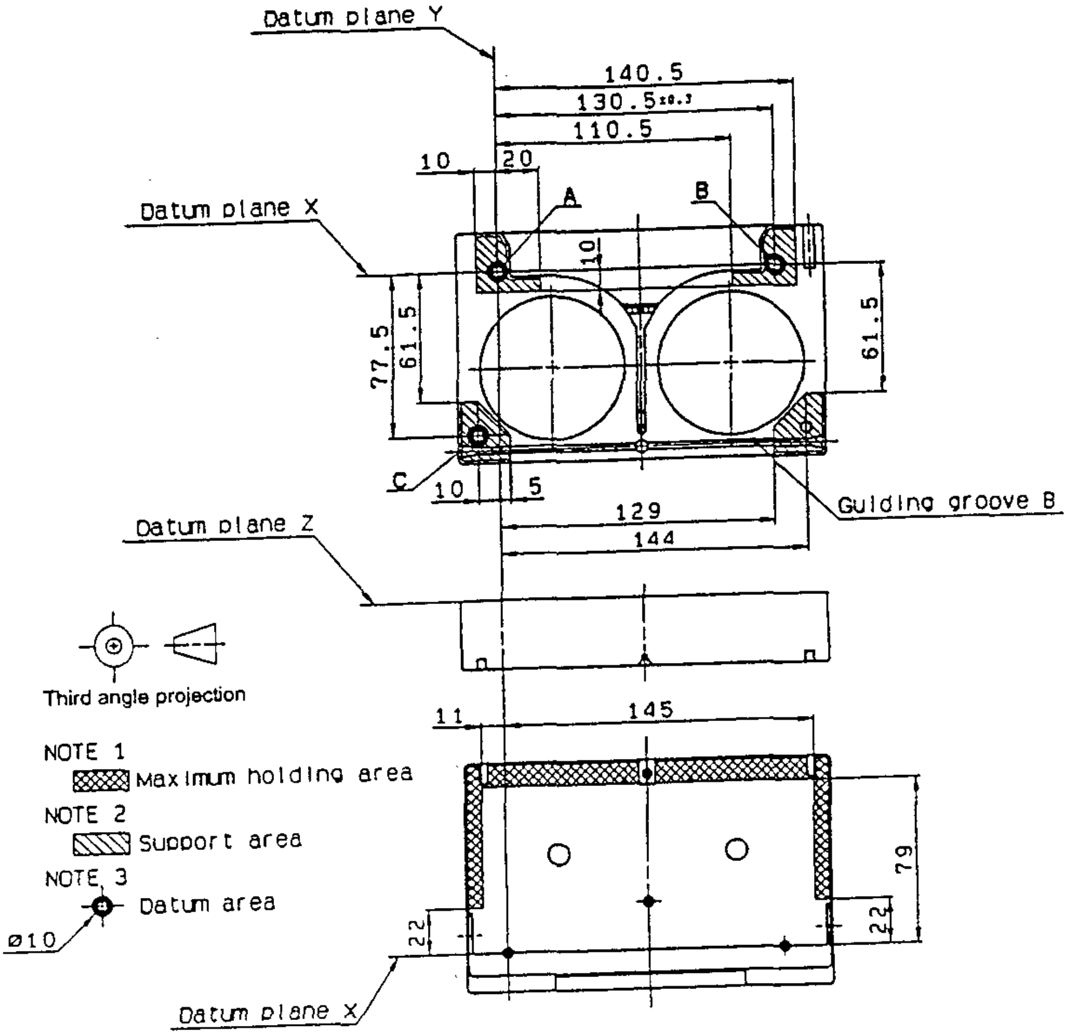
1. Dimensions marked with an asterix are nominal values specifying the tape path.
2. Area for the reel.



7 Leader, trailer, and magnetic tape attachment



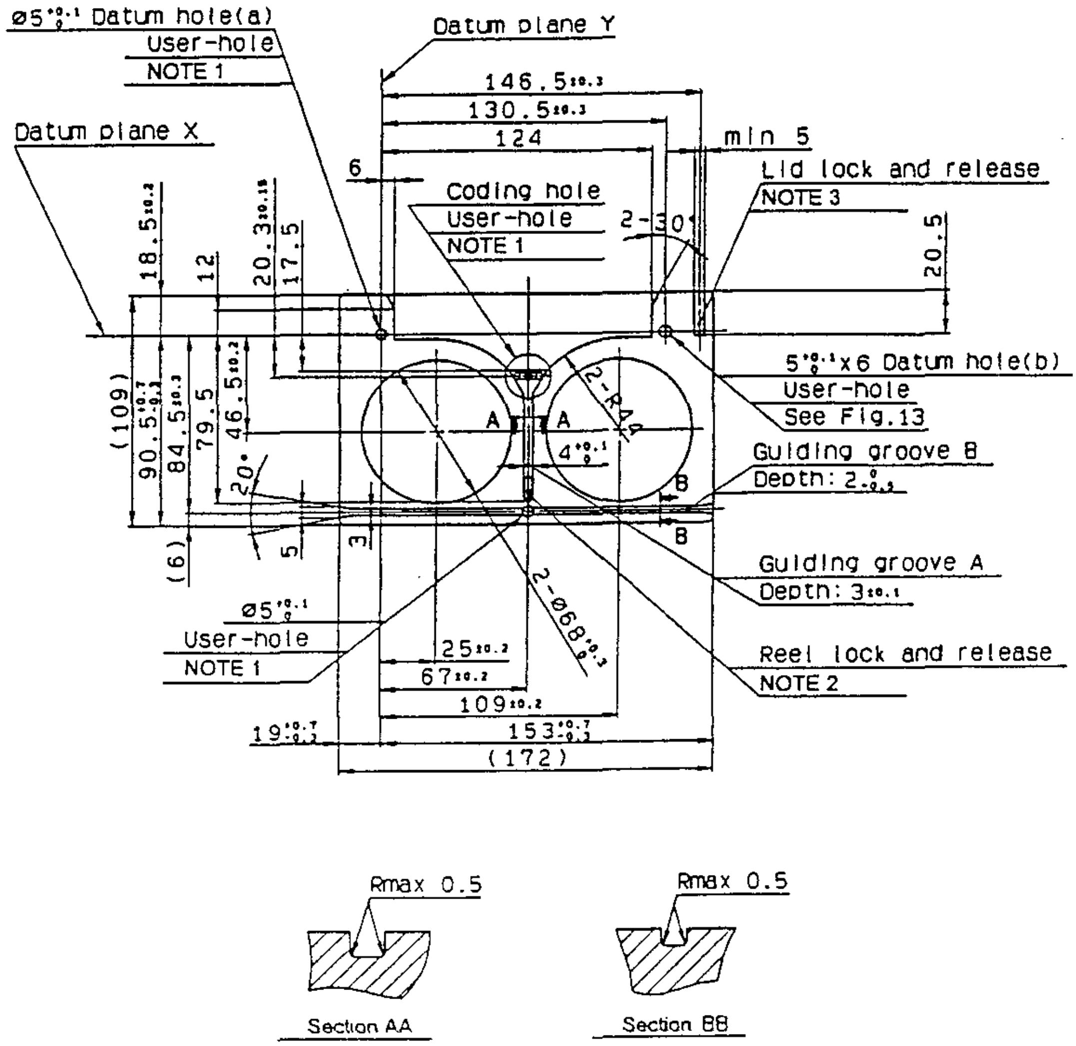
8 Fixture for measuring electrical resistance of tape



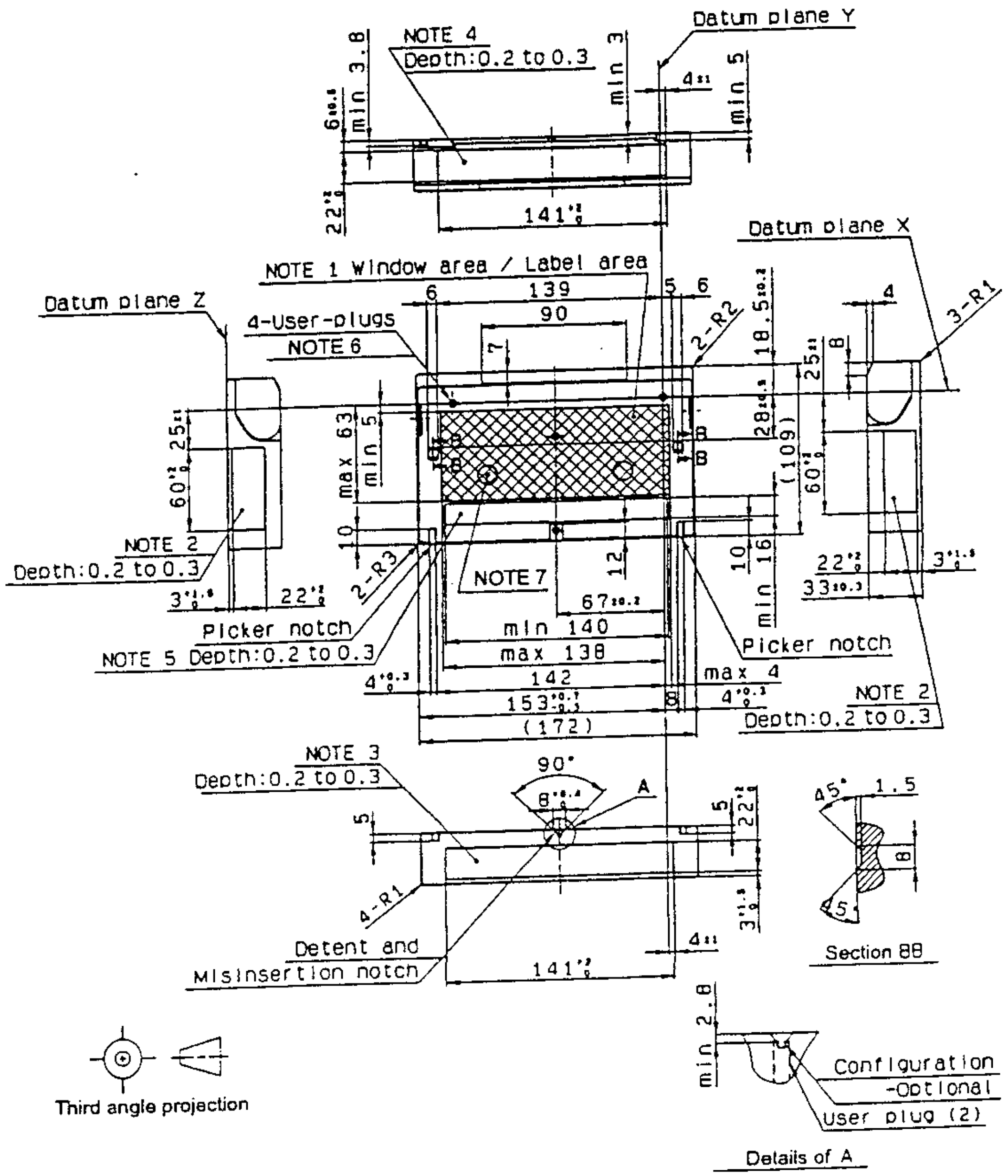
9 **Datum area, support area, and holding area of small cassette**

Notes:

1. The cassette shall be secured by the recorder and/or player unit on the dotted area.
2. The periphery within 1.0 mm from the edge of guiding grove B and from the edge of the cassette shall be removed from the support area.
3. Datum plane Z shall be determined by datum areas A, B, and C.



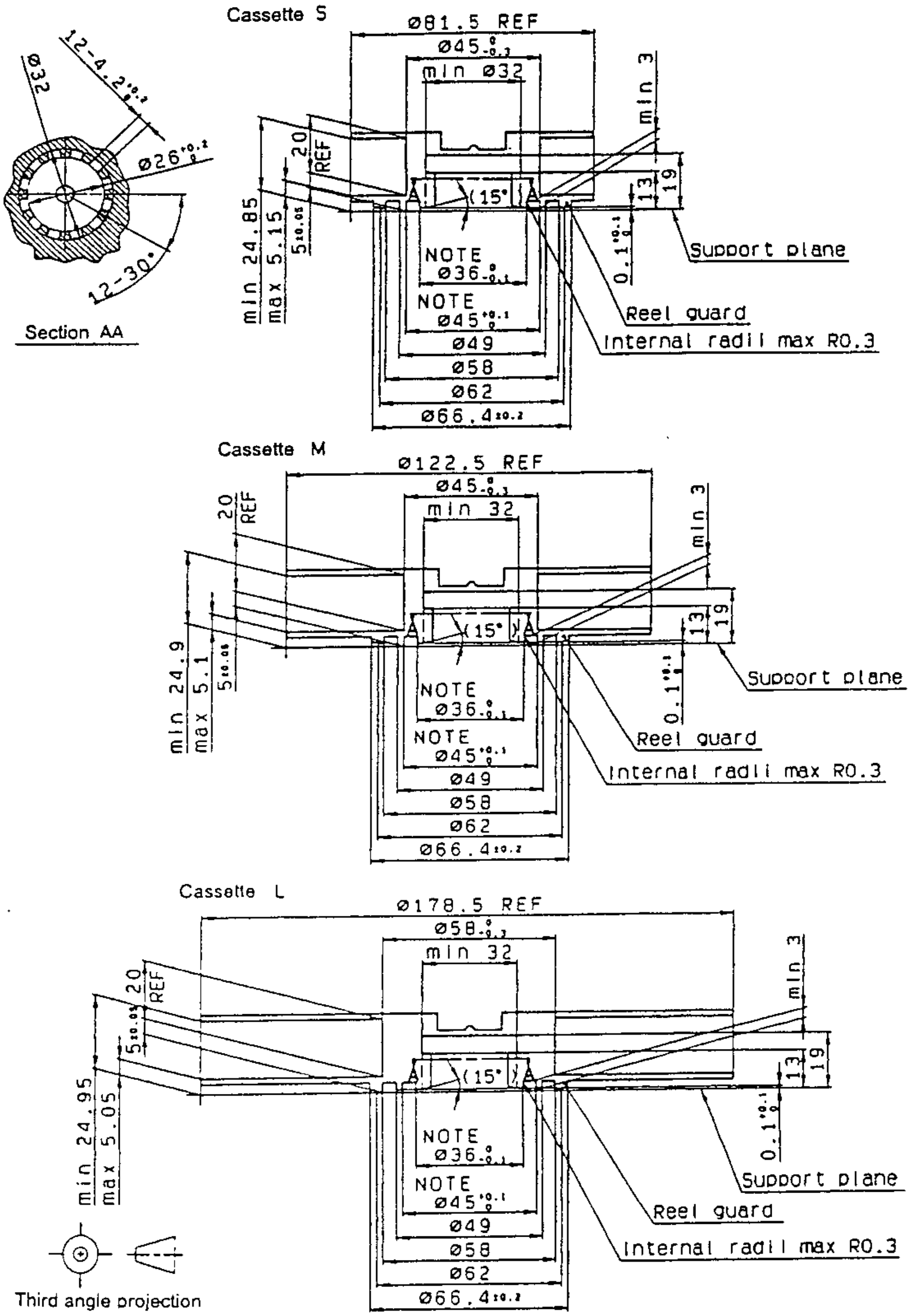
10 Bottom view of small cassette



11 Top and side view of small cassette

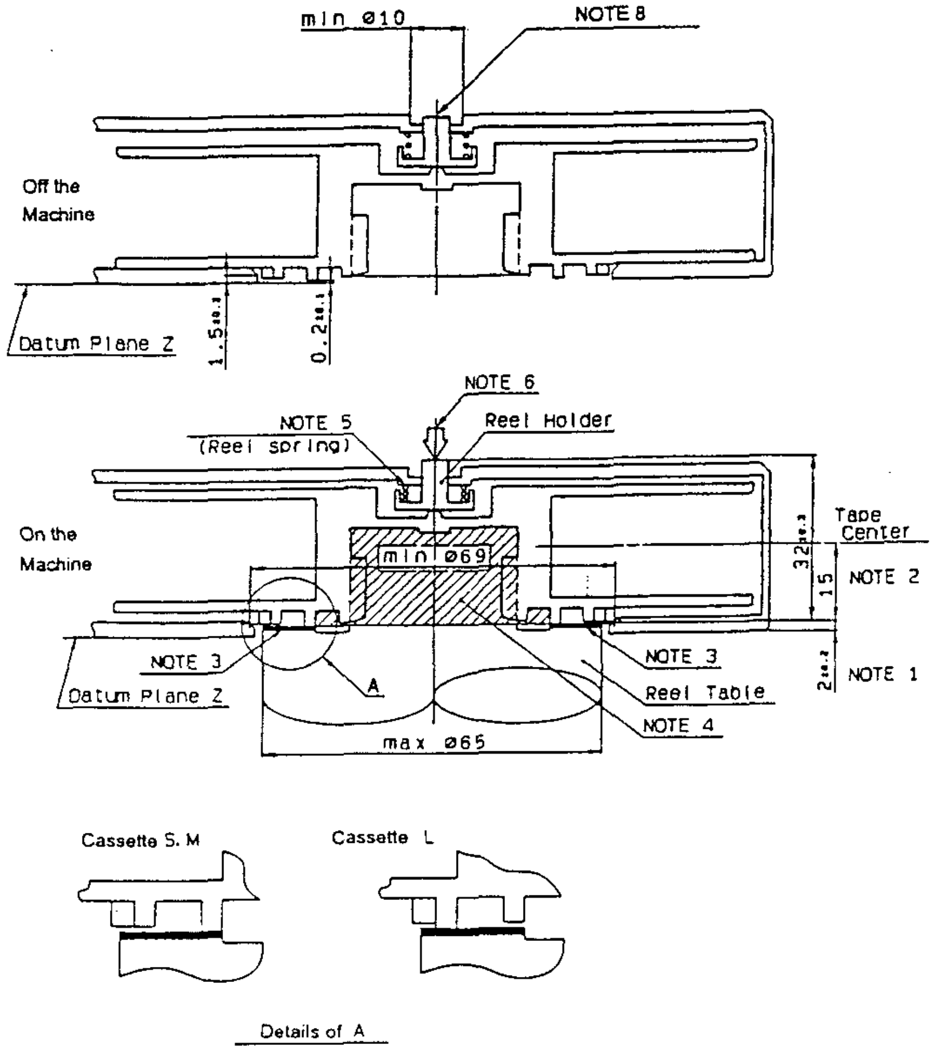
Notes:

1. The crosshatched area is available for the window/labels.
2. Side label may be attached to this recessed area.
3. Rear label may be attached to this recessed area.
4. Lid label may be attached to this recessed area.
5. Top label may be attached to this recessed area.



12 Cassette reel

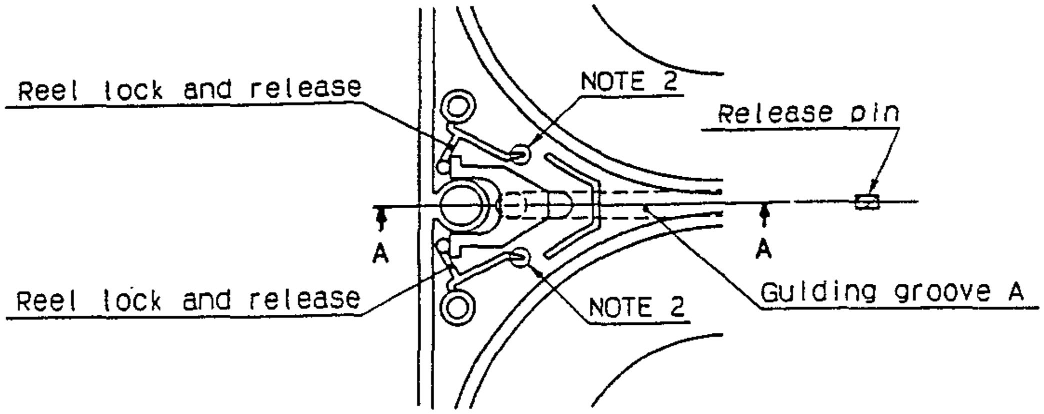
Note: The center of the reel and the reel table shall be positioned on either the 36.0mm +0 - 0.1mm or the 45.0mm + 0.1 - 0mm diameter.

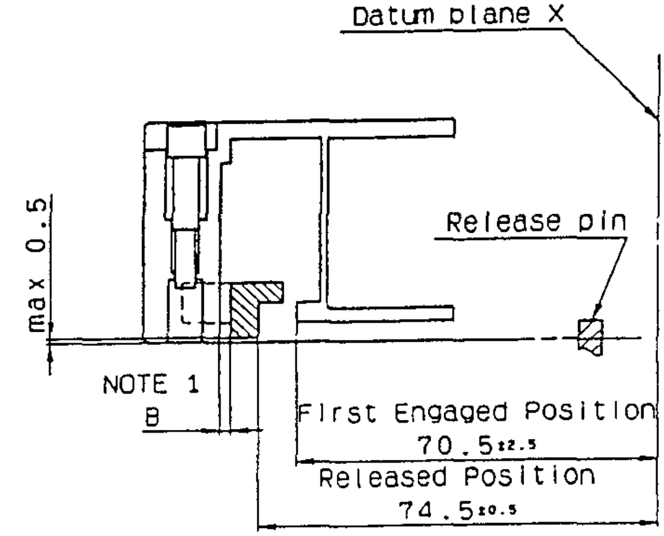


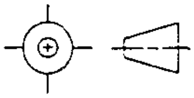
13 Relationship between reel and reel table

Notes:

1. Distance between the support area of the reel table and datum plane Z.
2. Distance between the support area of the reel table and tape center.
3. Support area of the reel table.
4. Hatched area shows the maximum reel table area.
5. Reel spring pressure small cassette 3 - 4 N, medium and large cassette 9 - 11 N.
6. If necessary, more reel spring pressure shall be applied to this portion from the outside.
7. The reel spring structure is at manufacturer's option.







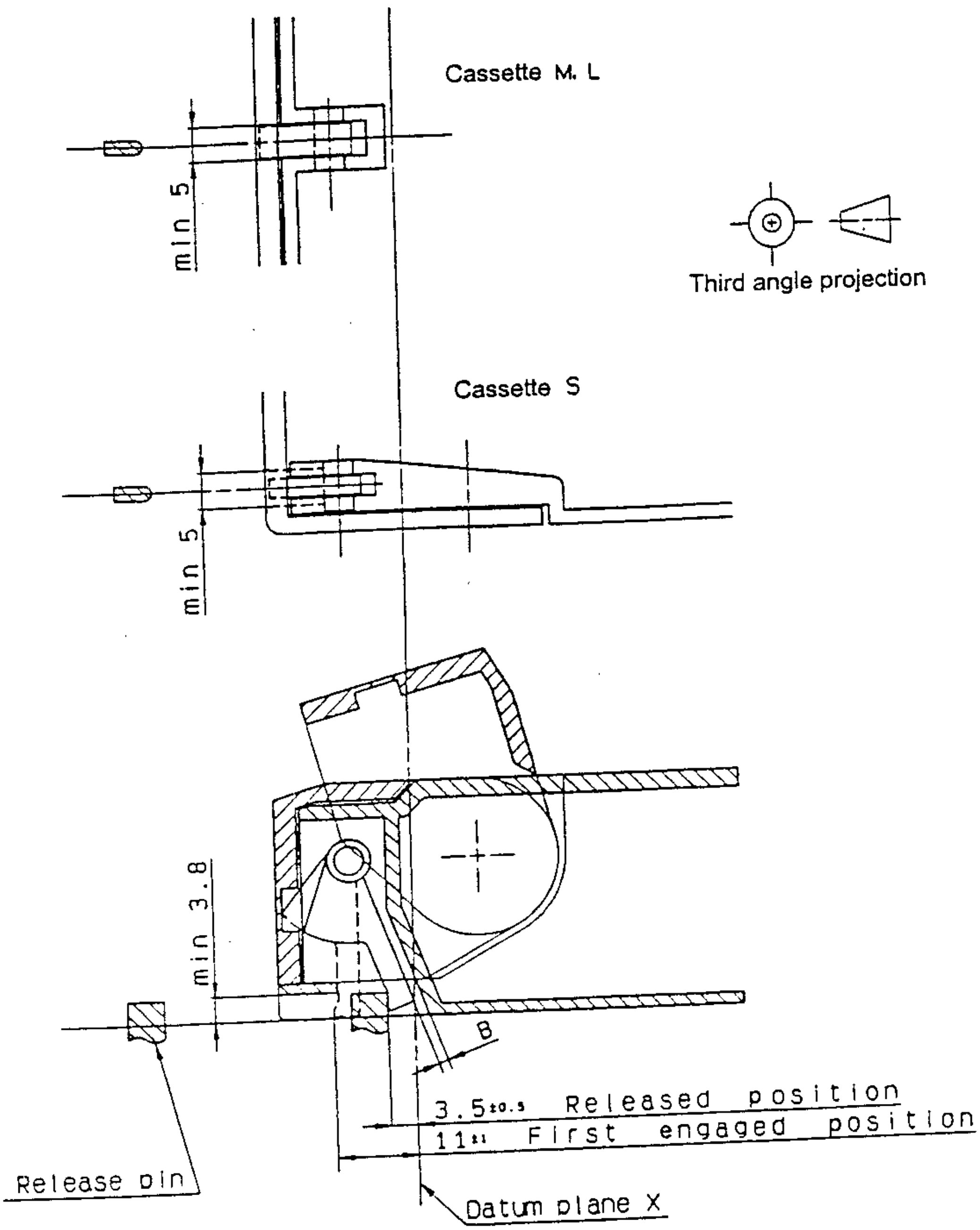
Third angle projection

Section AA

14 Small cassette reel lock and release

Note:

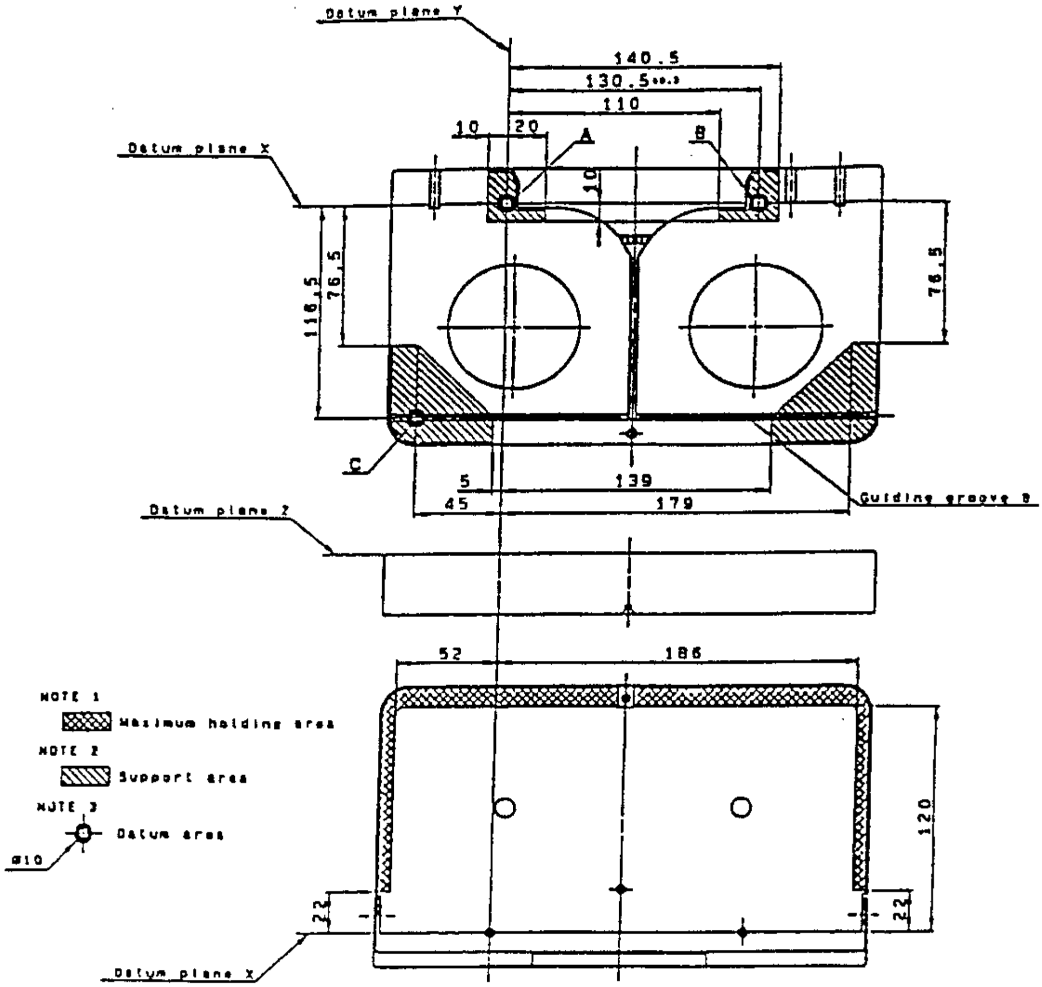
1. Clearance B shall be 0.5 mm at a minimum when the release pin is located 75 mm away from datum plane X.
2. The end of the reel lock shall be outside the reel area 84 mm min in diameter, when the release pin is located 74 mm away from datum plane X.



15 Lid lock and release

Notes:

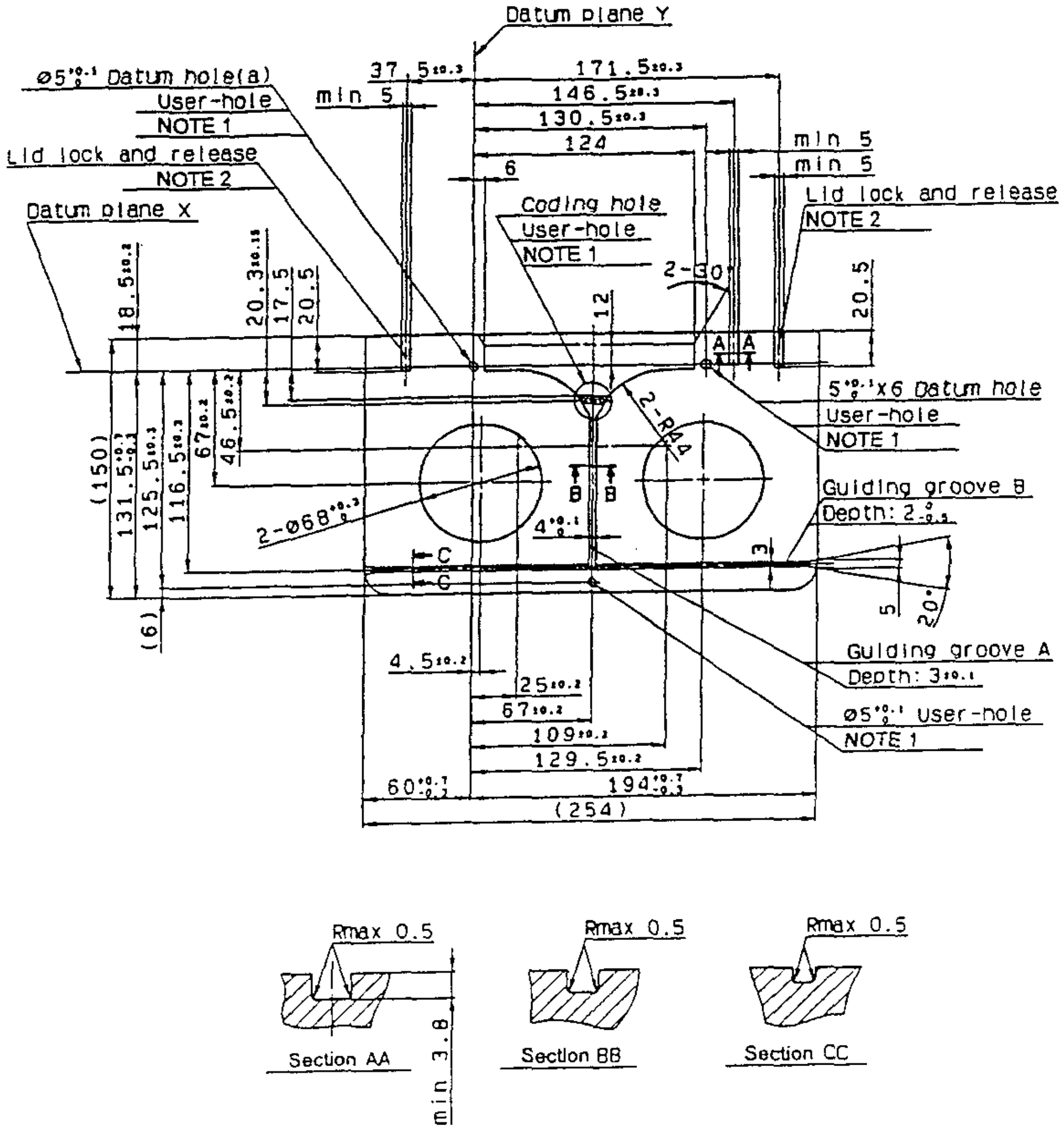
1. Clearance B shall be 0.5 mm at a minimum when the release pin is located 3 mm away from the datum plane X.
2. The lid lock shall be released when the release pin is located 4 mm away from the datum plane X.



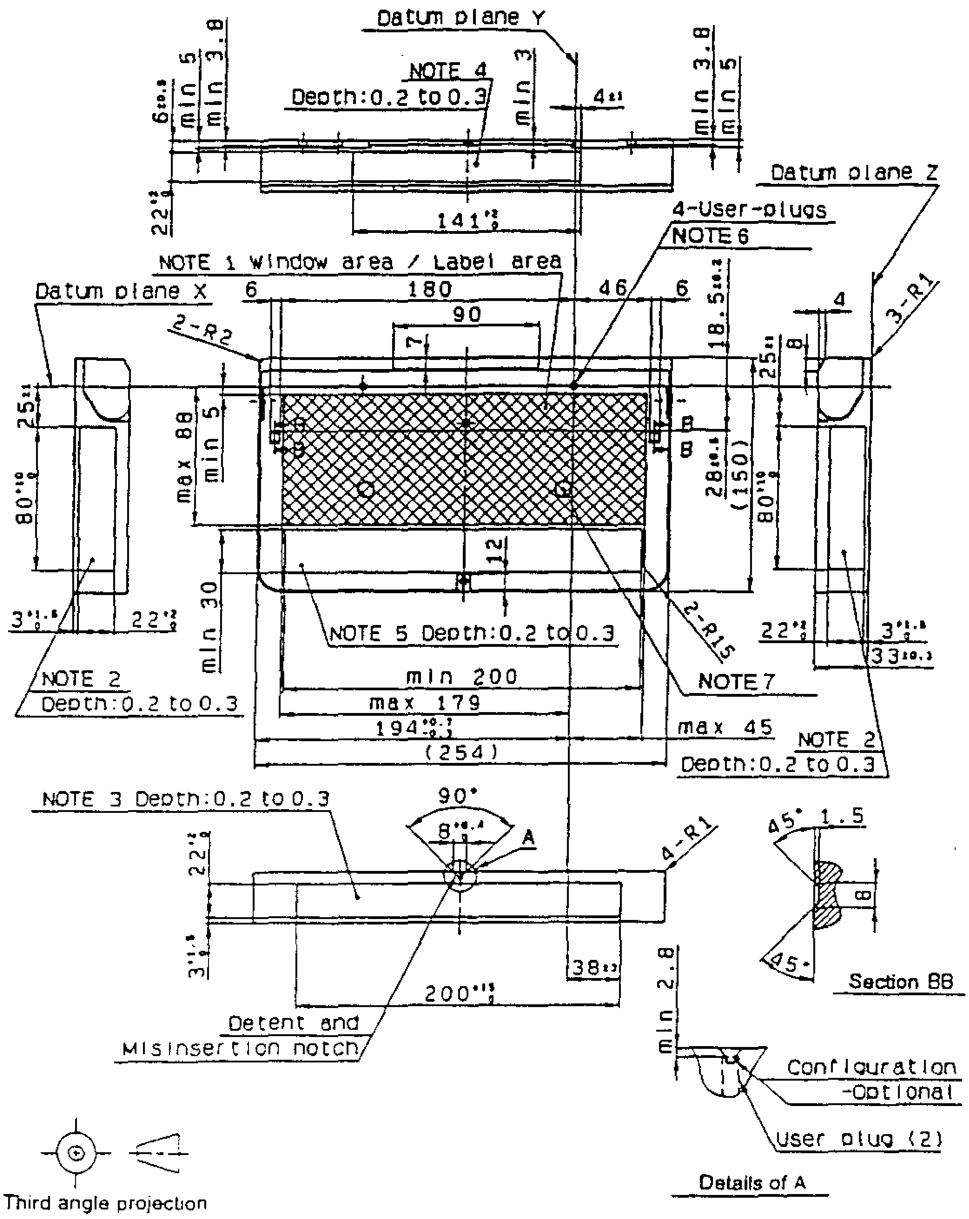
16 Datum area, support area, and holding area of medium cassette

Notes:

1. The cassette shall be secured by the recorder and/or player unit on the dotted area.
2. The periphery within 1.0 mm from the edge of guiding grove B and from the edge of the cassette shall be removed from the support area. The cassette shall be supported by the recorder and/or player unit on the hatched area.
3. Datum plane Z shall be determined by datum areas A, B, and C.



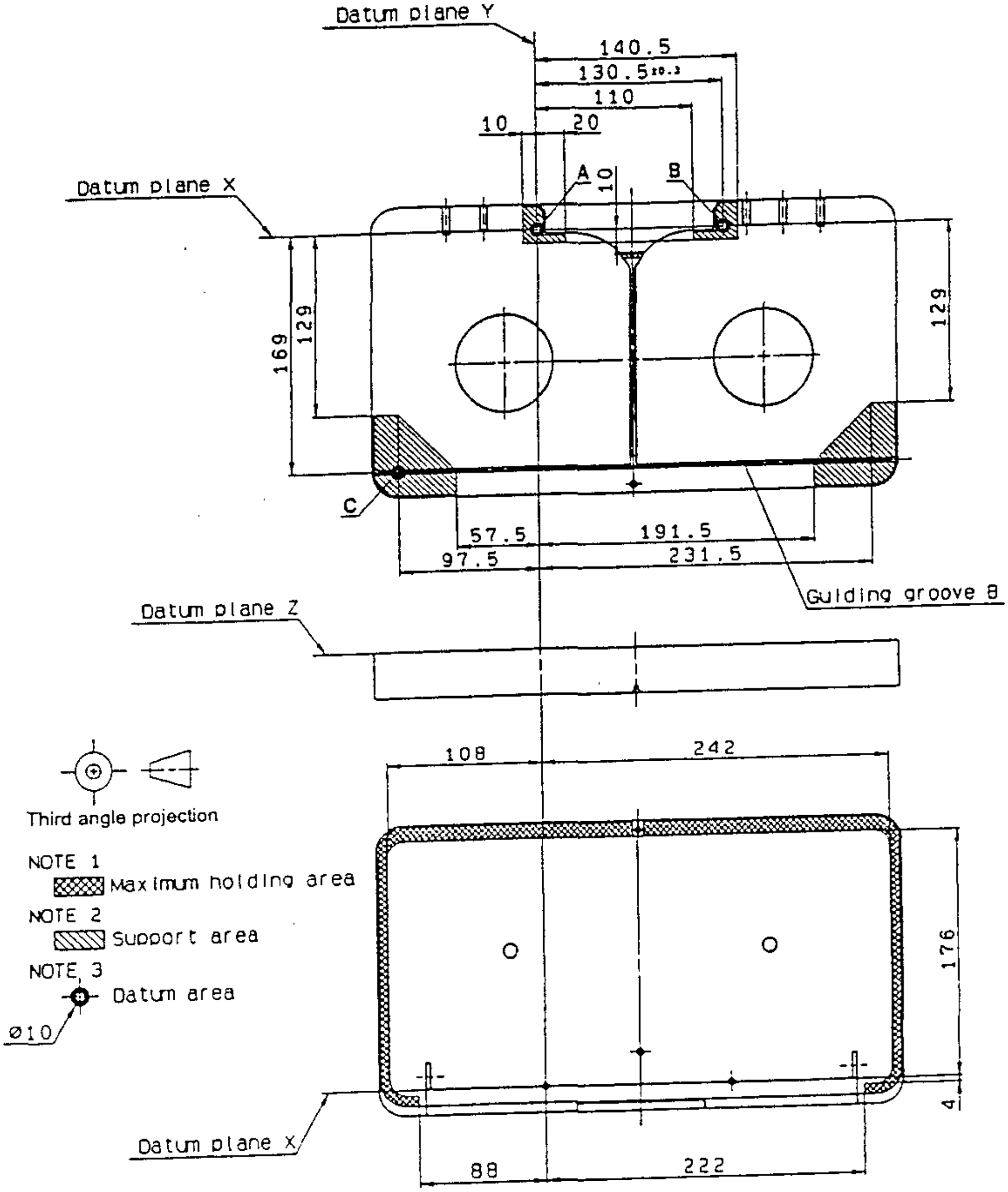
17 Bottom view of medium cassette



18 Top and side view of medium cassette

Notes:

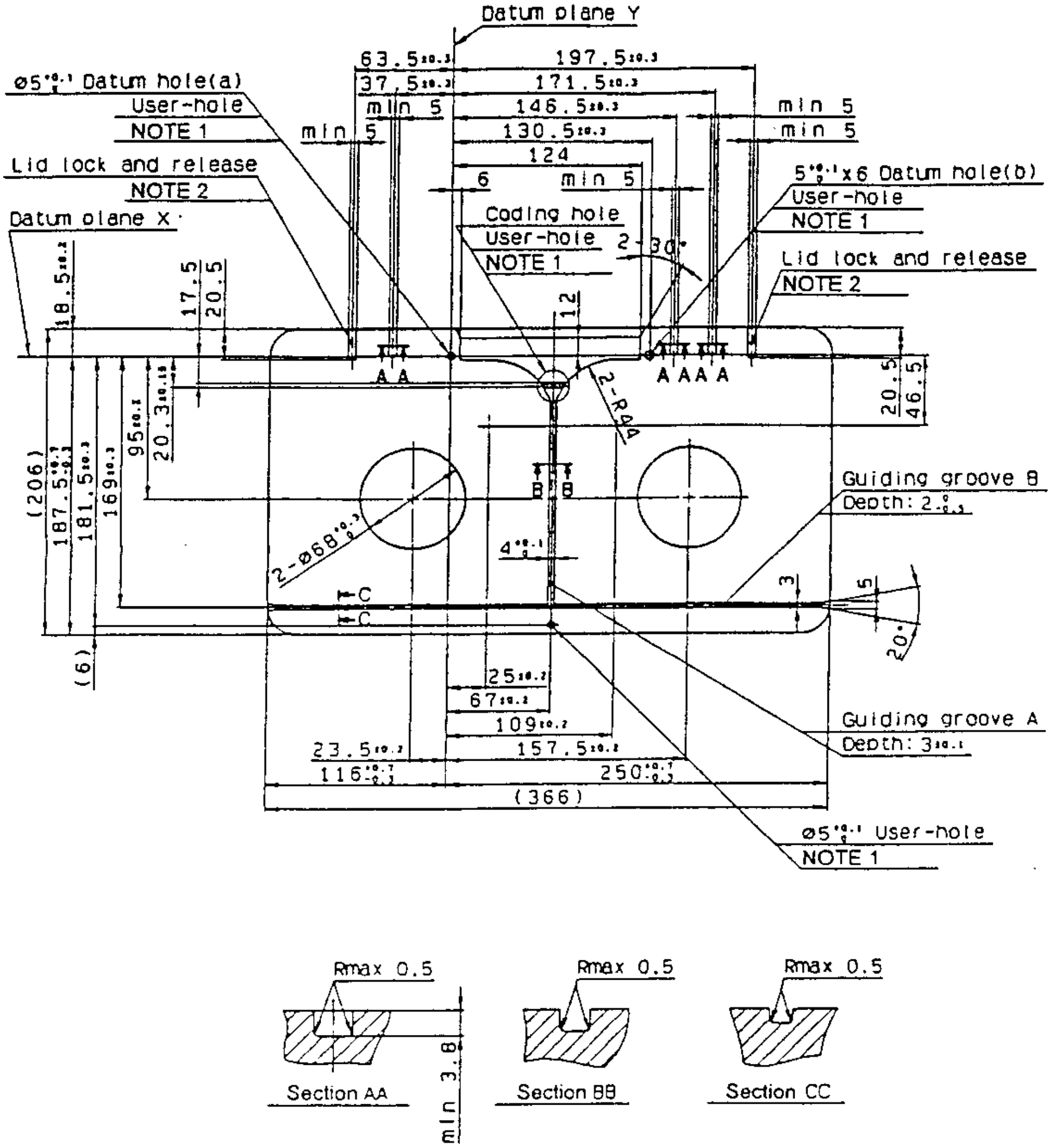
1. The crosshatched area is available for the window/labels.
2. Side label may be attached to this recessed area.
3. Rear label may be attached to this recessed area.
4. Lid label may be attached to this recessed area.
5. Top label may be attached to this recessed area.



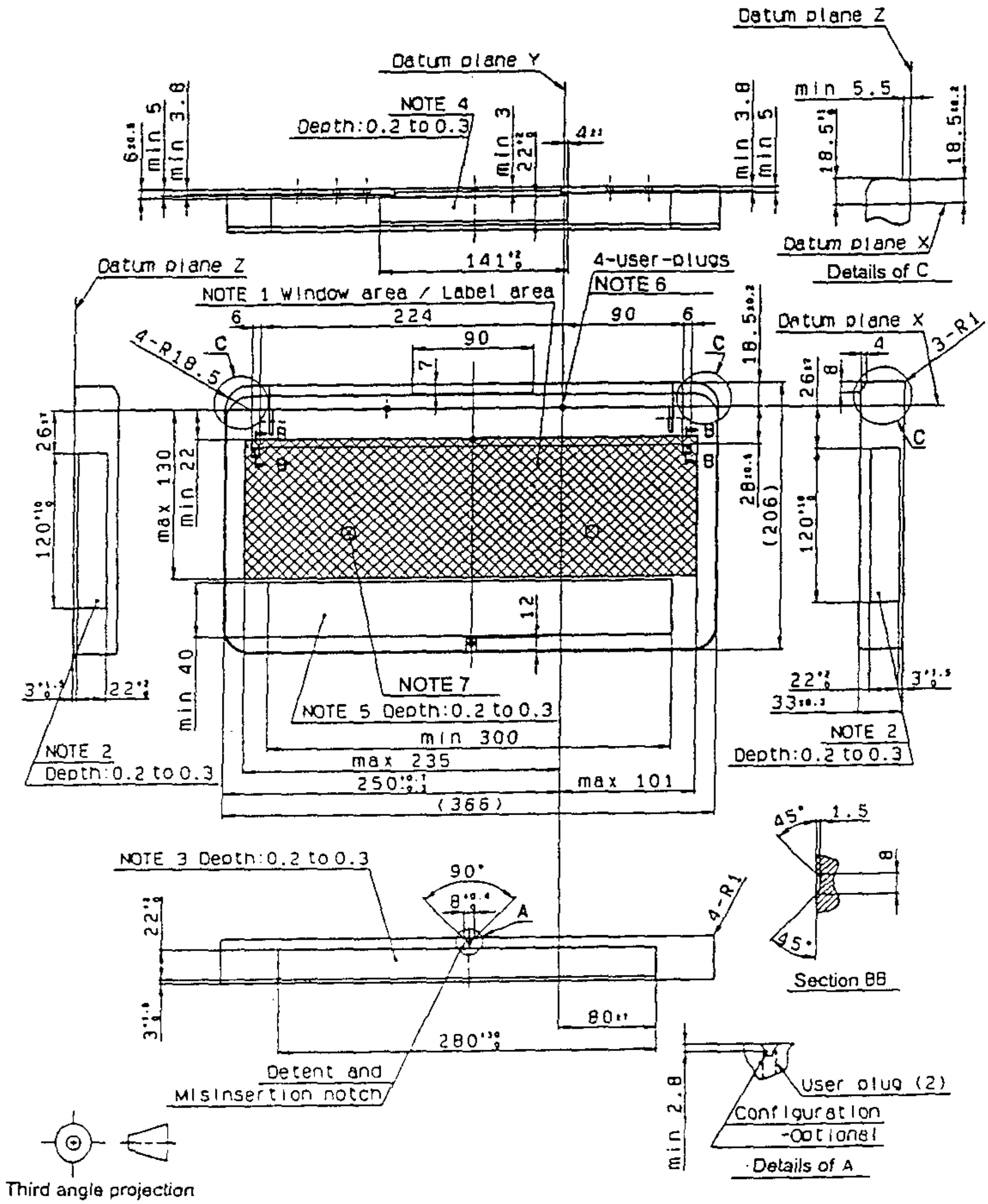
19 Datum area, support area, and holding area of large cassette

Notes:

1. The cassette shall be secured by the recorder and/or player unit on the dotted area.
2. The periphery within 1.0 mm from the edge of guiding grove B and from the edge of the cassette shall be removed from the support area. The cassette shall be supported by the recorder and/or player unit on the hatched area.
3. Datum plane Z shall be determined by datum areas A, B, and C.



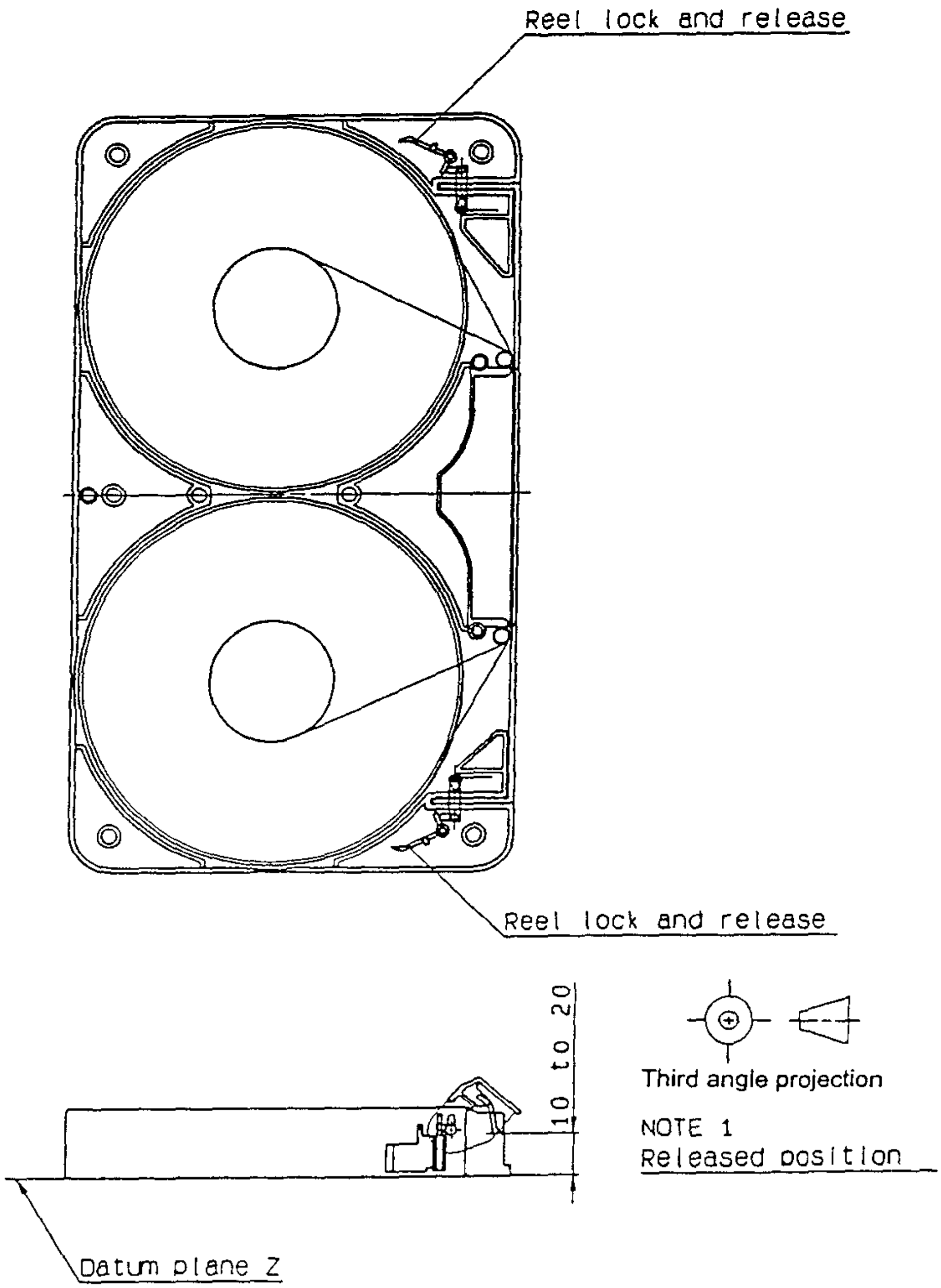
20 Bottom view of large cassette



21 Top and side view of large cassette

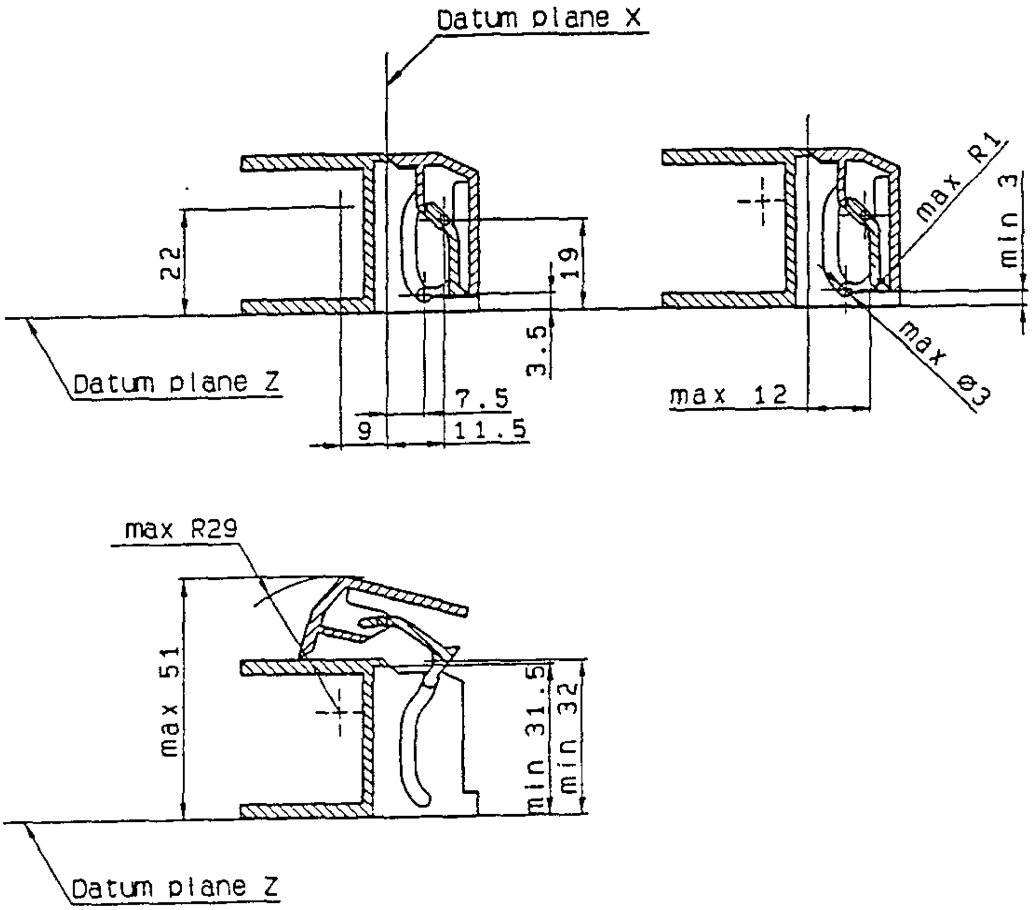
Notes:

1. The crosshatched area is available for the window/labels.
2. Side label may be attached to this recessed area.
3. Rear label may be attached to this recessed area.
4. Lid label may be attached to this recessed area.
5. Top label may be attached to this recessed area.



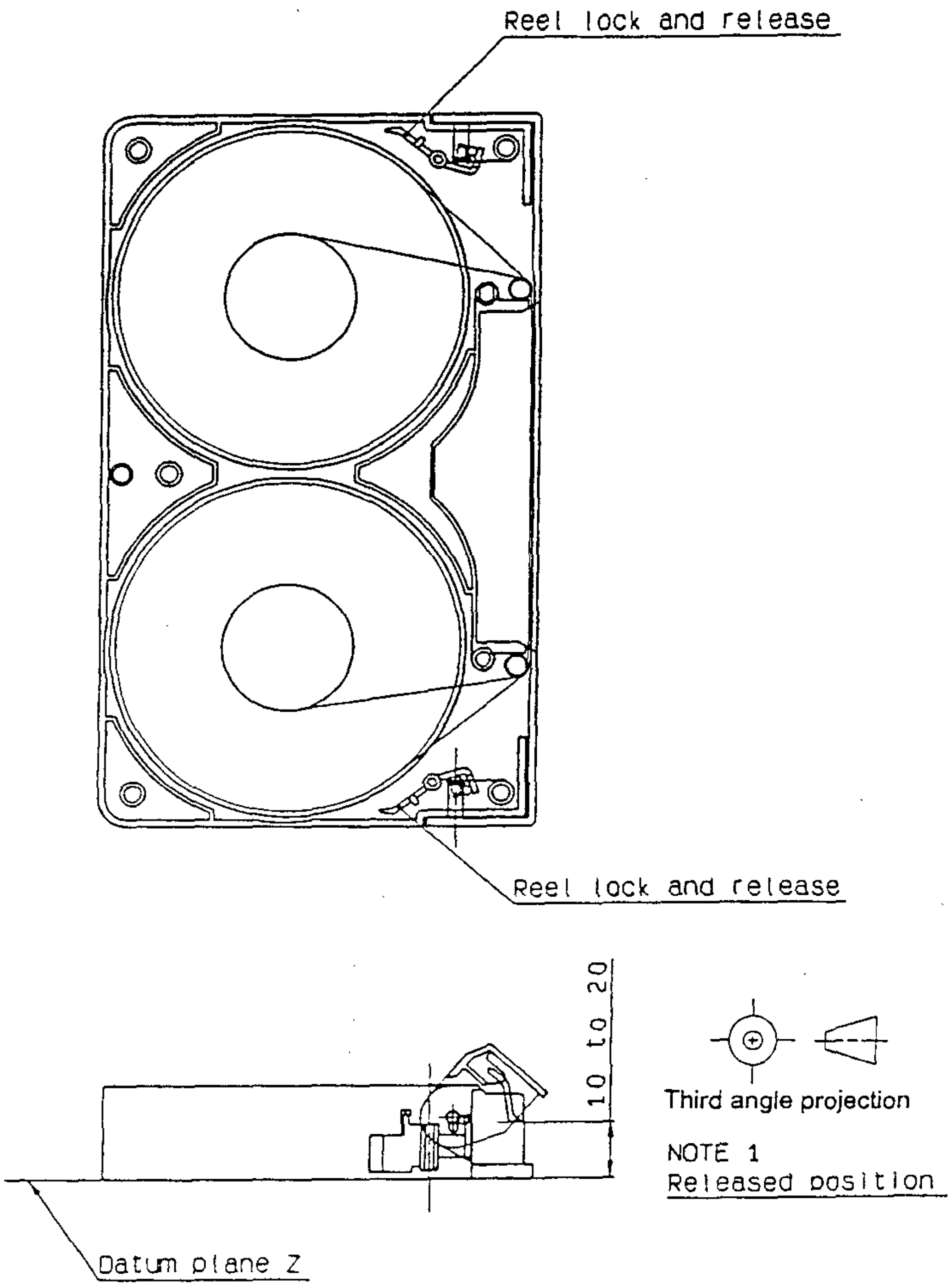
22 Large cassette reel lock and release

Note: The reel lock shall release when the lid is opened 15 mm ± 5 mm above the datum plane Z.



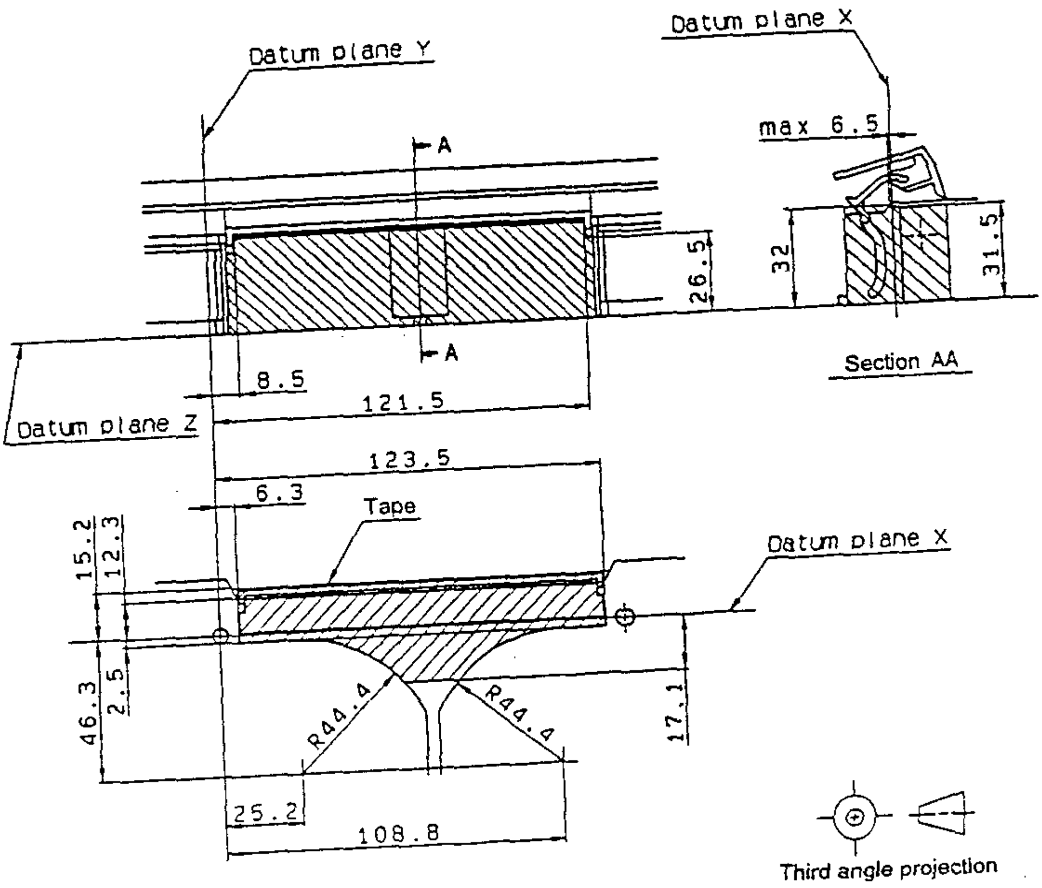
23 Lid structure

Note: Lid shall open to a height of at least 32 mm.



24 Medium cassette reel lock release

Note: The end of the reel lock shall be outside the reel area (0 - 125 mm), when the lid is opened 20 mm above the datum plane Z.



25 Minimum space for loading mechanism

Annex A Recommendations for transportation

(informative)

A.1 Environment

It is recommended that during transportation the cassettes are kept within the following conditions:

A.2 Unrecorded cassette

The packaged, unrecorded media cassette should be capable of withstanding the following environment without damage;

Temperature:	–41 °C to 50 °C (–41 °F to 122 °F);
Relative humidity:	20% – 80%, non-condensing;
Maximum wet bulb temperature:	26 °C (79 °F);
Duration:	10 consecutive days.

There shall be no condensation in or on the cassettes.

NOTE – Interchange parties should exercise caution when storing cassettes at temperatures above 50 °C. Individual cassette history may result in less than satisfactory interchange after storing at temperatures between 50 °C and 66 °C. Storage temperatures should never exceed 66 °C.

A.3 Recorded cassette

The packaged, recorded, tape cassette should be capable of withstanding the following environment without damage:

Temperature:	–41 °C to 45 °C (–41 °F to 113 °F);
Relative humidity:	20% – 80%, non-condensing;
Maximum wet bulb temperature:	26 °C (79 °F);
Duration:	10 consecutive days.

There shall be no condensation in or on the cassettes.

A.4 *Impact loads and vibration*

Compliance with the following recommendations should minimize damage to tape cassettes during transportation:

- avoid mechanical loads that would distort the cassette shape;
- avoid dropping the cassette more than 1 m (39 in);
- cassettes should be fitted into a rigid box containing adequate shock-absorbent material;
- the shipping box must have a clean interior and a construction that provides sealing to prevent the ingress of dirt and water;

- the orientation of the cassettes inside the shipping box should be such that the tape-reel axes are horizontal;
- the shipping box should be clearly marked to indicate its correct orientation.

A.5 Extremes of temperature and humidity

Extreme changes in temperature and humidity should be avoided whenever possible. Whenever a cassette is received after transportation, it should be conditioned in the operating environment (see 4.2) for a period of at least 24 hours. If the user of the cassette knows or suspects that the cassette has been exposed to mechanical shock simultaneously with a drop in temperature exceeding 18 °C (65 °F) tape pack shift may have occurred. In this case, it is recommended that the cassette be conditioned in the operating environment and then be rewound one complete cycle on the tape transport before it is used for data interchange.

A.6 Effects of stray magnetic fields

A nominal spacing of not less than 80 mm (3.15 in) should exist between a recorded cassette and the outer surface of the shipping box to minimize the risk of corruption of the recorded data.

Annex B Secondary reference tape user procedure

(Informative)

B.1 Stabilization of the test system

Switch on the test system and allow a minimum of 1 hour for the temperature of the components to stabilize so that the amplifier gains will remain stable during the following operations.

The test system shall remain switched on until all operations have been completed.

B.2 Procedure for the calibration of the test system

To minimize the use of the secondary standard reference tape, and the risk of damage to it, test the system for correct operation using a tape other than the secondary standard reference tape.

The secondary standard reference tape should never be bulk erased and never be wound at high speed.

Make a complete forward read-while-write pass with the secondary standard reference tape at the physical recording density of 2252 ftpmm (57 200 ftpi) and plot the saturation curve of average peak-to-peak signal amplitude versus write current.

Writing shall commence 31 m (100 ft) after the BOT for the secondary standard reference tape.

Partial passes shall never be made with a secondary standard reference tape.

Rewind the secondary standard reference tape at the normal forward record/playback speed.

Determine from the saturation curve the maximum average signal amplitude and the minimum write current I_1 to produce the maximum average signal amplitude.

I_1 is the current required to produce on the test system the typical field for the particular secondary standard reference tape.

Multiply I_1 by the current calibration factor, C_c, provided with the secondary standard reference tape, to obtain I_2. I_2 is the write current required to produce on the test systems the reference field.

(C_c is the ratio of the write current required of the master system to produce the reference field to the write current required on the master system to produce the particular secondary standard tape's typical field.)

Determine the average peak-to-peak signal amplitude A_1 produced by the secondary standard reference tape at the write current I_2.

Multiply A_1 by the amplitude calibration factor C_a, provided with the secondary standard reference tape, to obtain A_2. A_2 is the standard reference amplitude on the test system. (C_a is the ratio of the standard reference amplitude to the average signal amplitude of the particular secondary standard reference tape at the standard reference current on the master system.)
A_2 is the standard reference amplitude on the test system.

Determine the resolution R_1 of the secondary standard reference tape at the write current I_2.

Multiply R_1 by the resolution calibration factor C_R, provided with the secondary standard reference tape, to obtain R_2. R_2 is the standard reference resolution on the test system. (C_R is the ratio of the standard reference resolution to the resolution of the particular secondary standard reference tape at the standard reference current on the master system.)

The test system may now be calibrated for unrecorded tape evaluation/calibration, ease of erasure, average signal amplitude, resolution, typical field and signal dropout.

B.3 Procedure for calibrating a tertiary tape

The tertiary tape shall be bulk erased prior to use.

Load the tertiary tape and make one forward and one reverse pass at the normal forward record/playback tape speed to re-tension the tape

> NOTE – Some types of tape give a significant rise in the output signal amplitude with usage. If such a type of tape is to be used as a tertiary tape, additional forward and reverse passes shall be made until the rise in signal amplitude is less than 0.05%.

Make a complete forward read-while-write pass, ignoring at least the first 12.5 m (50 ft) of tape where there could be significant change in output with distance along the tape, and plot the saturation curve.

Rewind the tertiary tape at normal forward record/playback speed.

Determine the maximum average signal amplitude.

Determine from the saturation curve the maximum average signal amplitude and the minimum write current I_{11} to produce the maximum average signal amplitude.

The current calibration factor for the tertiary tape relative to the master standard reference tape shall be calculated from the ratio:

$$C_{a} = I_2/I_{11}$$

Determine average peak-to-peak signal amplitude A_{11} at the write current I_2.

The amplitude calibration factor for the tertiary tape relative to the master standard tape shall be calculated from the ratio:

$$C_{A} = A_2/A_{11}$$

Determine the resolution R_{11} at the write current I_2.

The resolution calibration factor for the tertiary tape relative to the master standard reference tape shall be calculated from the ratio:

$$C_{R} = R_2/R_{11}$$

> NOTE – It may be desirable to re-run the secondary standard reference tape at the conclusion of the above operations to verify the stability of the test system. However, the secondary standard reference tape shall not be run more than necessary, since its output signal amplitude may rise with usage.

Annex C Bibliography

(informative)

SMPTE EG 10, *Tape transport geometry parameters for 19 mm type D-1 format for component digital video recording*

ANNEX A

PART 2 LOGICAL RECONNAISSANCE DATA FORMAT

LOGICAL FORMAT IS DEFINED IN STANAG 7023

INTENTIONALLY BLANK

ANNEX B

PART 1 PHYSICAL FORMATS

"DIGITAL AND ANALOGUE 8mm CASSETTE TAPE RECORDER STANDARD"

SECTION 200

ANALOGUE 8mm IMAGERY RECORDING FORMAT

SECTION 201

DIGITAL 8mm DATA RECORDING FORMAT

TABLE OF CONTENTS

1 SCOPE

This standard establishes the format of the data as recorded on the tape, the principal properties of the tape, and the dimensions and physical properties of the cassettes.

1.1 Purpose.

The purpose of this standard is to ensure the ability to exchange imagery data within the appropriate community of users to Standardise the cassettes and the format of the data for 8mm magnetic tape and to ensure that a recording made on one machine can be-replayed on any other machine that conforms to this standard. This standard is intended to reflect the commercial/consumer high-band 8mm video recording standard.

1.2 Applicability.

This standard is a specification requirement for the purchase of magnetic tape recorder/reproducer which record and/or reproduce digital data or analogue imagery data via a rotary helical scan on 8mm tape cassette which conform to the IEC 8mm video standard.

2.0 REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Standards.

The issues of the following documents currently in effect form a part of this standard to the extent specified herein.

MIL-STD-2179(AS)	Helical Digital Recording Format for 19mm Magnetic Tape Cassette Recorder/Reproducer
NATO STANAG 4283	*High Density Digital Recording (HDDR)* Standards ANNEX C AC/141(PG/32)WP/26

2.2 Other publications.

The following documents form a part of this standard to the extent specified herein.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 8mm Video Standard - 843-3

IRIG-RANGE INSTRUMENTATION GROUP (IRIG)

106-86 Telemetry Standards(revised September 1989)AD-A168818
200-89 Time Code Formats AD-A-206580

(Application for copies should be addressed to Secretariat, Range Commanders Council, ATTN: STEWS-SA-R, U.S. Army, White Sands Missile Range, New Mexico, 88002.)

2.3 Order of precedence.
In the event of a conflict between the text of this standard and the text of references cited herein, the text of this standard shall take precedence.

3.0 DEFINITIONS

3.1 8/9 encoding.
A method of encoding whereby an 8-bit data word is | converted to a 9 bit code word in accordance with a conversion table.

3.2 Basic dimensions.
A fundamental dimension to which no tolerance is applied.

3.3 Byte.
A byte consists of eight binary digits.

3.4 Biphase coding.
Biphase Manchester 2 where a "0" is a positive going transition at the renter of the bit cell and a "1" is a negative going transition at the renter of the bit cell. The transitions at the edge of the bit cell are inserted as necessary to make the code orthogonal.

3.5 Channel coding.
The process by which binary information obtained from the digital logic circuits is converted to a waveform suitable for recording on magnetic tape.

3.6 Codeword.
An 8/9 codeword consists of 9 binary digits.

3.7 Codeword Digital Sum (CDS).
The digital sum variation from the beginning to the end of a codeword. CDS is calculated assuming that the codeword polarity begins with a negative level and that the binary levels are +1 and -1 and the transitions are centred in the bit cell.

3.8 Derived dimension.
A derived dimension is obtained from other fundamental dimensions by computation and is given for information purposes only.

3.9 Digital Sum Variation (DSV)
- The running integral of the charge of the binary bit stream which will result in the coded NRZI(1) recording waveform. DSV is calculated assuming the binary levels are +1 and -1.

3.10 Error Correction.
The use of mathematically related check data, recorded with the digital data, to derive the precise location and enable the correction of errors in the digital data.

3.11 Galois field.

A galois field is a finite set of elements denoted by GF (2Q) which consists of 2Q elements. This is a finite field where the operations of addition, subtraction, multiplication and division are closed.

3.12 Helical digital recorder.

A recorder/reproducer based on a video recorder using an 8mm type P-6 or E-6 cassette to record and/or reproduce digital data.

3.13 Identification pattern.

Specific bit patterns used to identify sectors and array rows.

3.14 Inner code block.

An inner code block (horizontal row) consists of 153 bytes of digital data followed by eight bytes of inner code check data for each row of each ECC array.

3.15 Interleaving.

The systematic reordering of data so that originally adjacent bytes are separated, thus reducing the effect of burst errors on the error correcting capability.

3.16 Longitudinal track modulation method.

The modulation method for recording digital data on the longitudinal track shall be Manchester encoding. This method results in a transition occurring at the beginning of every bit period. "One" is represented by a second transition one-half a period from the start of a bit. "Zero" is represented when there is no transition within the bit.

3.17 Non-Return to Zero Inverse, Version 1, NRZI(1).

A coding method where "1" is denoted by a waveform transition in the centre of a bit cell and a "0" is denoted by no change.

3.18 Outer code block.

An outer code block (vertical) consists of 117 bytes of digital data followed by ten bytes of outer code check data.

3.19 Physical beginning of tape (PBOT).

The transition from the tape leader to the opaque area of the splice where the translucent leader tape is joined to the magnetic tape.

3.20 Physical end of tape (PEOT).

The transition from the opaque area of the splice where the translucent trailer tape is joined to the magnetic tape.

3.21 Preamble.

A preamble is a sequential bit pattern recorded at the beginning of each helical track. A preamble consists of a run-up sequence, a sync pattern , an identification pattern, and a secondary run-up sequence.

3.22 <u>Postamble</u>.
A postamble consists of a sync pattern followed by an identification pattern.

3.23 <u>Randomisation</u>.
The reduction of correlation in a serial bit sequence so that it statistically approximates to a random sequence.

3.24 <u>Reference dimension</u>.
A dimension usually without tolerance, used for information purposes as a defined dimension from which other dimensions are measured.

3.25 <u>Run-up sequence</u>.
A run-up sequence consists of a sequential bit pattern chosen to facilitate the synchronisation of data extraction circuits

3.26 <u>Scrambling</u>.
An alternative term for randomisation.

3.27 <u>Track identification pattern</u>.
The sector preamble and postamble identification pattern consists of four consecutive 9 bit symbols which provide unique labelling of each track recorded on tape.

3.28 <u>Sync pattern</u>.
A sync pattern consists of consecutive 9-bit words whose bit pattern is chosen to be unique, compared to data.

3.29 <u>Track positioning signal</u>.
A data sequence or tone recorded on the helical track which is used for alignment of the rotary heads with recorded helical tracks.

3.30 <u>Waveform polarity</u>.
The state of the codeword waveform at any specific time as denoted by "-" when the waveform is low and "+" when the waveform is high.

3.31 <u>Waveform polarity inversion</u>.
The polarity at the end of the codeword waveform that is opposite the polarity at the beginning of the codeword waveform. A waveform polarity inversion is caused by an odd number of "1"s in the nine-bit NRZI codeword.

4.0 GENERAL REQUIREMENTS

4.1 <u>General</u>.
This section covers the general requirements for digital data recordings made on 8mm magnetic tape cassettes.

4.2 Cassettes.

Recorder/reproducers that conform to this standard shall be capable of using 8mm cassettes that conform to the physical dimensions of the cassettes specified in Section 5. The cassettes are based on and are compatible with cassettes defined in the commercial 8mm video standard.

4.3 Magnetic tape.

The magnetic tape used on machines conforming to this standard shall meet the requirements of Mp, Me tape or their equivalents as required by IEC 8mm Video Standard 843 ('87).

4.3.1 Tape reference edge.

The reference edge of the tape for dimensions specified in this standard shall be the lower edge as shown in Specific Recording Formats.

4.4 Performance.

Recorder/reproducer shall record or reproduce analogue imagery or a serial digital bit stream in accordance with the format required herein.

5.0 DETAILED REQUIREMENTS

5.1 Tape mechanical, physical and dimensional requirements,

Tape characteristics are provided herein for reference. These characteristics are meant to be representative of standard commercially available 8mm tape.

5.1.1 Material

The recordable area of the tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent) coated on one side with a strong yet flexible layer of ferromagnetic material dispersed in a suitable binder. The back surface of the tape shall be coated.

5.1.2 Discontinuities.

There shall be no discontinuities in the tape between the physical BOT and the physical EOT. such as those produced by tape splicing or perforations.

5.1.3 Width.

The width of the tape shall be 8.000 mm ± 0.010 mm (0.315 in + 0.0004 in). The width shall be measured across the tape from edge to edge.

5.1.4 Total thickness.

The total thickness of the tape at any point shall be between either 12.0 micrometers to 14.0 micrometers (472.5 microinches and 551.2 microinches) or 10.40 micrometers to 11.4 micrometers (409.5 microinches and 448.8 microinches).

5.1.5 Length.

The minimum tape length between physical BOT and physical EOT shall be 14.72 m (48.24 ft). The maximum tape length shall be 107.5m (352.69 ft.).

5.1.6 Longitudinal curvature.

The departure of the tape edge from a straight line along the longitudinal dimension of the tape in the plane of the tape surface.

5.1.6 Requirement.

The radius of curvature of the edge of the tape shall be as specified in IEC 8mm Standard.

5.1.7 Out-Of-Plane distortions.

Out-of-plane distortions are local deformations that cause portions of the tape to deviate from the plane of the surface of the tape. Out-of-plane distortions are most readily observed when the tape is lying on a flat surface under no tension. All visual evidence of out-of-plane distortion shall be removed when the tape is subjected to a uniform tension as specified in IEC 8mm Standard.

5.1.8 Bezel spring.

The reels shall be held in position in the cassette by a reel spring with a force of 0.4 to 0.8 N (see Figure 1 and 2).

5.1.9 Automatic stop.

When the leader or trailer tape passes behind the light window (see Figure 3 and 4), the recorder and/or player shall stop automatically (for light path, refer to Figure 5).

5.1.10 Dimensions of leader and trailer tape.

The length of the leader and trailer tape shall be 80 + 10mm. (Figure 4) The width of the leader and trailer tape shall be 8 + 0.02 mm. The thickness of the leader and trailer tape shall be sufficient to allow the tape to withstand a tension of 10 N.

5.1.11 Transparency of the leader and trailer tape.

Transparency of the leader and trailer tape shall be 60 percent or more, measured in the same way as the transparency of magnetic tape.

5.1.12 Tape magnetic recording performance.

The magnetic recording performance is defined by the testing requirements given in the following paragraphs.

When performing the tests, the output of the resultant signal shall be measured on the same relative pass for both the reference tape and the tape under test (read while write, or on equipment without read while write capability, on the first forward read pass) on the same equipment.

5.1.13 Test conditions.

The following conditions shall apply to all magnetic recording testing requirements unless otherwise noted:

o Tape condition	pre-record condition
o Tape/head speed	3.759 m/sec (147.99 in Set) ± 0.20%

o Track width	25 micrometers ± 2 micrometers (984 microinches ± 39 microinches)
o Gap azimuth	-10° ± 0.133°
o Gap length	0.30 micrometers ± 0.05 micrometers (12 microinches ± 2.0 microinches)
o Tape tension	0.1170 N ± 0.0098 N (0.423 ozf ± 0.035 ozf)
o Recording current	test recording current.

5.1.14 Dropouts.
A dropout is a loss of read signal amplitude. A dropout exists when the peak to peak amplitude is 25% or less of half the average signal amplitude. When a dropout is detected, a second dropout should not be counted until 28 consecutive dropout free flux transitions are read. If a dropout persists for a distance of 0.038 mm (0.0015 in), another dropout is counted.

The average dropout rate shall be less than one dropout for each 5 x 10^6 flux changes recorded at a linear density of 2126 ftpmm (54,000 ftpi). The average dropout rate is the total number of flux transitions recorded on tape divided by the number of dropouts counted.

5.1.15 Signal amplitude.
The average signal amplitude, exclusive of dropouts, at the physical recording density of 2126 ftpmm (54,000 ftpi) averaged for greater than 3000 flux transitions shall be between 70 percent and 130 percent of the standard reference amplitude.

5.1.17 Narrow-band signal-to-noise.
The narrow band signal-to-noise t ratio is the average read signal power divided by the average integrated (side-band) rms noise power, and is expressed in dB.

5.1.17.1 Requirement.
The NB-SNR shall be equal to greater than 34 dB when normalised to a track width of 25 micrometers (984 microinches). The normalisation factor is dB(25) = dB(W) + 10 log 25/W, where W is the track width used when measuring dB(W).

5.1.18 Cupping.
Cupping is the departure across the width of tape (in the thickness direction) from a flat surface.

5.1.18.1 Requirement.
The departure across the width of tape from a flat surface shall be as specified in IEC 8mm Standard.

5.2 Frictional characteristics of tape.

Is incorporated as a reference.

5.2.1 Coating adhesion requirement.

The force required to peel any part of the coating from the tape base material shall not be less than 0.96 N (0.22 lbf).

5.2.2 Tensile strength.

The measurements shall be in accordance with ISO Recommendation R 527. The length of the test sample shall be 200 mm (7.87 in).
The rate of elongation for all tensile tests shall be 100 mm/min (3.937 in/min) (ISO Recommendation R 527, rate D).

5.2.3 Breaking strength.

The sample shall be loaded until the breaking point of the sample is reached. The force at that point is defined as the breaking strength of the tape.

5.2.3.1 Requirement.

The breaking strength shall be greater than or equal to 17.6 N (3.9 lbf).

5.2.4 Yield strength.

The yield strength is defined as the force necessary to produce 5% elongation of the tape.

5.2.4 Requirement.

The yield strength shall be greater than 4.9 N (1.1 lbf).

5.2.5 Residual elongation.

Measure the initial length of a test sample of approximately 1 m (39 in) with a maximum applied force of 0.20N (0.045 lbf). Apply an additional force per total cross-sectional area of 20.5 N/mm^2 (2973 lbf/in^2) for a period of 10 minutes. Remove the additional force and re-measure the length after 10 minutes.

5.2.5. Requirement.

The residual elongation shall be less than 0.03%.

5.2.6 Electrical resistance of the surface.

Electrical resistance is the resistance of the surface, measured in ohms.

5.2.7 Electrical resistance of coated surfaces.

The electrical resistance of any square area of the recording surface shall be within the range of:

$$10^5 \text{ ohms to } 5 \times 10^{12} \text{ ohms}$$

The electrical resistance of the back-coating shall be less than 9×10^8 ohms.

5.2.8 Inhibitor tape.

An inhibitor tape is any tape that degrades the performance of the tape drive or other tapes. Certain tape characteristics can contribute to poor tape drive performance. Tapes that exhibit these characteristics may not give satisfactory performance, can result in excessive errors and can interfere with the subsequent performance of other tapes.

5.2.8.1 Inhibitor characteristics.

These characteristics include:

- High abrasively
- High friction to tape path components
- Poor edge conditions
- Excessive tape wear residual products
- Electrostatic charge build-up on the tape or tape path components
- Interlayer slippage
- Transfer of recording surface coating to the back of the next tape layer
- Separation of tape constituents causing deposits that may lead to tape sticking or poor performance of other tapes

These parameters are important for interchange; however, definitive tests are not available at this time.

5.2.8.2 Requirement.

The tape shall not be an inhibitor tape.

5.2.9 Transparency.

The transparency of the magnetic tape shall be less than or equal to 5% and the transparency of the leader and trailer tapes shall be greater than or equal to 60% when measured with a 800 - 900 nm wavelength light.

5.3 Cassette (Cartridge) Mechanical, Physical and Dimensional Requirements.

This is only incorporated as a reference.

5.3.1 HDS tape cartridge assembly.

The HDS Tape Cartridge Assembly shall be comprised of two parts:

1. A case to provide protection from contaminants and handling, and to facilitate loading/unloading of the cartridge by a drive, and

2. A magnetic tape of 8.00 mm (0.315 in.) nominal width held inside the case on twin hub, coplanar type reels.

In addition, the cartridge shall contain file-protect, lid and other features to facilitate its use for information interchange. The cartridge is a compact coplanar design with the tape and hubs completely enclosed by the case. All cartridge tolerances and dimensions are found in the Figures. The general configuration of the cartridge shall be as shown in Figure 6 and Figure 7.

5.3.2 Dimensions of the cassette.

The dimensions necessary to permit interchangeability of cartridges shall be in accordance with Figures 6 and 7 of this standard.

5.3.3 Cartridge insertion.

The cartridge is intended to be mounted in read/write machines in only one position. The cartridge shall have asymmetrical features: a channel, recess, and incline as shown in Figures 6 and 7, that can be used to prevent inserting the cartridge improperly.

5.3.4 Datum planes Z. X and Y.

Datum plane Z shall be decided by datum areas A, B, and C, indicated in Figure 8 by hatching. Datum plane X shall be orthogonal to datum plane Z and shall run through the centre of datum hole A and datum hole B as shown in Figure 9 . Datum plane Y shall be orthogonal to both datum plane X and datum plane Z and shall run through the centre of datum hole A as shown in Figure 9.

5.3.5 Tape winding.

The magnetic coating on the tape shall face out of the cartridge. The direction of tape travel is from left to right, i.e. from supply reel to the take-up reel.

5.3.6 Cartridge support areas.

Case support areas are illustrated in Figure 8. Support areas A, B. C and D shall be coplanar with datum areas A, B. and C respectively within ± 0.1 mm (0.0039 in). Support area D shall be coplanar with datum plane Z within ± 0.15 mm (0.0059 in). Support area 0.5 mm (0.0197 in) from the edge of the cartridge shall be removed.

5.3.7 Case dimensions.

The footprint dimensions of the case shall be as shown in Figures 5, 6, and 7.

5.3.8 Cartridge lid.

The cartridge shall contain a lid for protection of the tape during handling, storage and transport. Dimensional requirements for opening the lid are shown in Figures 10 through 12. Lid lock and release requirements are shown in Figures 16 and 17.

The main lid rotates around Pivot A. The auxiliary section slides along the cam and around Pivot B so that neither section extends above a plan maximum 22.3 mm from and parallel to datum plane Z with the lid open (See Figure 12).

Pivot B of the auxiliary section shall be positioned in the sockets inside the main section 10.1 mm from Pivot A of the main section in the X plan direction and 7.0 mm from datum plane Z (see Figure 12). The socket of the main section may be positioned anywhere in the Y direction and anywhere outside plane D in Figure 12, when the lid is closed.

5.3.9 Opening/unlocking force.

The force needed to unlock the reel lock, when applied in the direction shown in Figures 14 and 15, shall not exceed 1 N (0.225 lbf). The force needed to unlock the lid lock, when applied in the direction shown in Figure 16, shall not exceed 0.25 N (0.0562 lbf). The force needed to open the lid, when applied in the direction as shown in Figure 17, shall not exceed 1 N (0.225 lbf).

5.3.10 Accidental erasure protection.

The cartridge shall be provided with a mechanism which allows the user to open and close the accidental erasure protection hole as desired. When the accidental erasure protection hole is open, the recorder/reproducer shall inhibit recording on the cassette. When the accidental erasure hole is closed, it will be possible to record on the cassette. The mechanism shall be constructed so that it can withstand a force of 0.5 N (0.1121 lbf). The accidental erasure protection hole on the upper shell may be either closed or open at the manufacturer's option.

5.3.11 Physical labels.

The back face of the cartridge, opposite the lid, and a portion of the top of the cartridge may be used for labels. The rear surface area provides for readability of the label when it is in a stacked or inserted position. Position and size of the label shall be within the provided depression of the label area as shown in Figure 6.

5.3.12 Drop test.

The cartridge shall be able to withstand the shock incurred from falling 1 m (39 in) onto a concrete floor. For purpose of verifying compliance, the cartridge shall meet the requirements of this standard after being dropped once on a corner and once on a face.

5.3.13 Window.

Part of the reels shall be visible somewhere within the cross-hatched area shown in Figure 6. The window through which a part of the reels can be seen shall not extend beyond the height of the cassette.

5.3.14 Leader and trailer attachment.

The attachment of the leader and trailer tape to the hub shall be capable of withstanding a force of 5N withdrawal force.

5.3.15 Changer grips.

The cartridge shall contain changer grips as shown in Figure 6

5.3.16 Recognition holes.

The cartridge shall be provided with five recognition holes on the lower shell as shown in Figure 2. Recognition hole 1 shall be used for distinguishing between tape types A and B. The closed hole shall signify Type A. The open hole shall signify Type B. Recognition holes 2 and 3 shall be used for distinguishing tape thickness. Hole 2 shall be closed for tape 13 micrometers thick (512 microinches) and open for tape 10 micrometers (394 microinches) thick. The use of hole 3 has not been determined in detail. Use of recognition holes 4 and 5 is under consideration. These holes will remain closed until their use is decided. Recognition holes 1 to 5 on the upper shell may be either open or closed at the manufacturer's option. A closed recognition hole will withstand a force of 0.5 N.

5.3.17 Cartridge name.

The type name shall be used uniformly to identify 8 mm video cartridge:

Type of magnetic tape Television System	Type A	Type B
525 line - 60 field	P6-T	E6-T
625 line - 50 field	P5-T	E5-T

T: Playable time in minutes

5.4 8mm Analogue Data Recording Format.
This format is described in Recording Format 500.

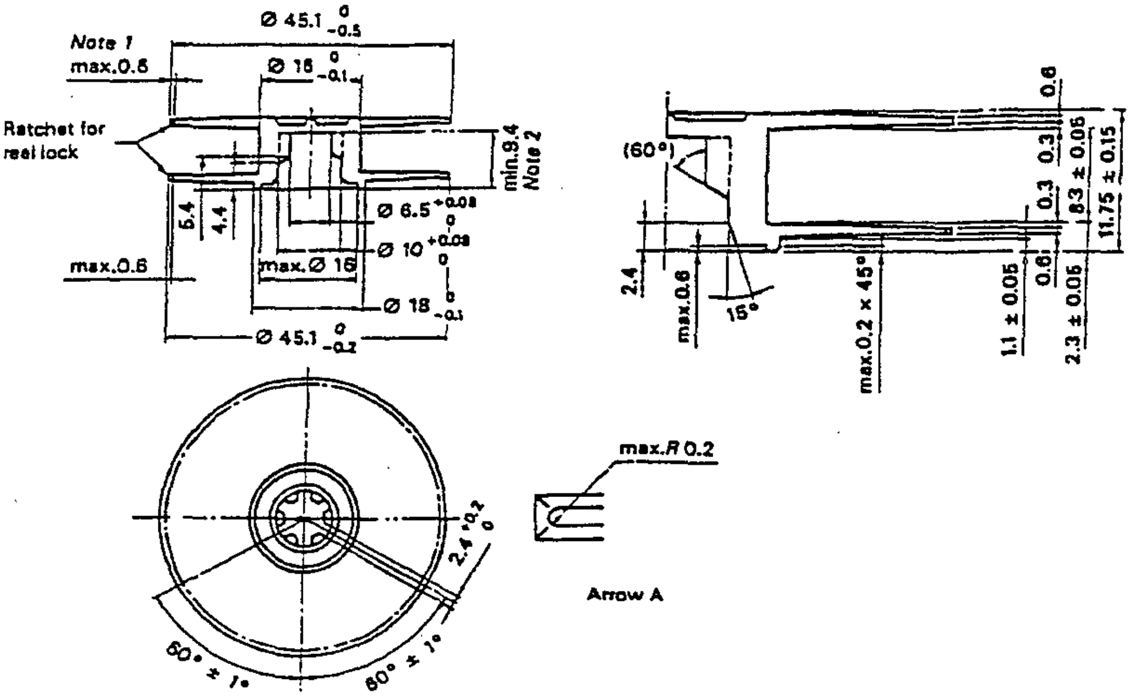
5.5 8mm Digital Data Recording Format.
This format is described in Recording Format 501.

6.0 NOTES

Intended use. This standard is intended to insure the capability to exchange data between members of the various user communities. Data recorded by one recorder shall be capable of being reproduced on any other recorder/reproducer that conforms to this standard. The standard allows the designer of tape transport mechanism to use one of several different combinations of tape scanner diameters and data head arrangements to achieve standard format recording. The designer may make different design choices for different applications provided the format is identical.

Subject term (key word) listing.

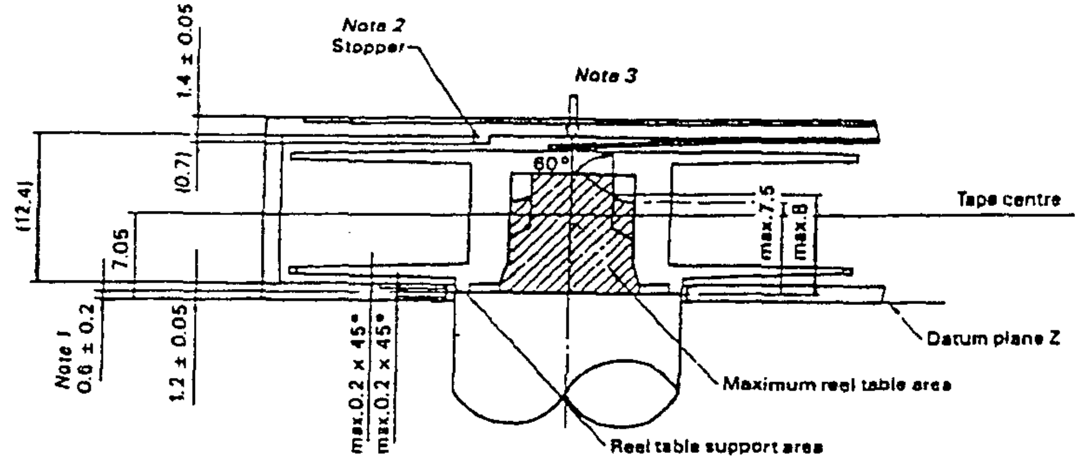
Cassettes, magnetic tape
Magnetic tape
Recording, digital data
Recording, video imagery
Recording, helical
Recording, magnetic tape
Recording, rotary



NOTES

1. - Ratchet for reel lock of the upper part of the reel is at the manufacturer's discretion
2. - Minimum depth 9.4mm of reel deriving hole shall be effective at diameter $6.5^{+0.08}$ mm

FIGURE 1 - Reel of the cassette.



NOTES

1 - Height of reel table.
2 - Stopper to prevent reel from slipping into shell.
3 - Reel spring pressure shall be within 0.4N to 0.8N when the height of the reel table support area is 0.6 ± 0.2mm from datum plane Z.

FIGURE 2 - Relationship between the reel and reel table.

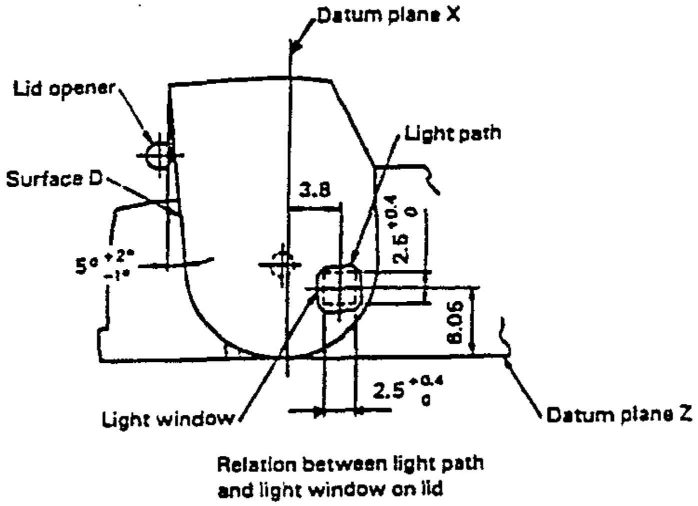


FIGURE 3 - Light path and light window

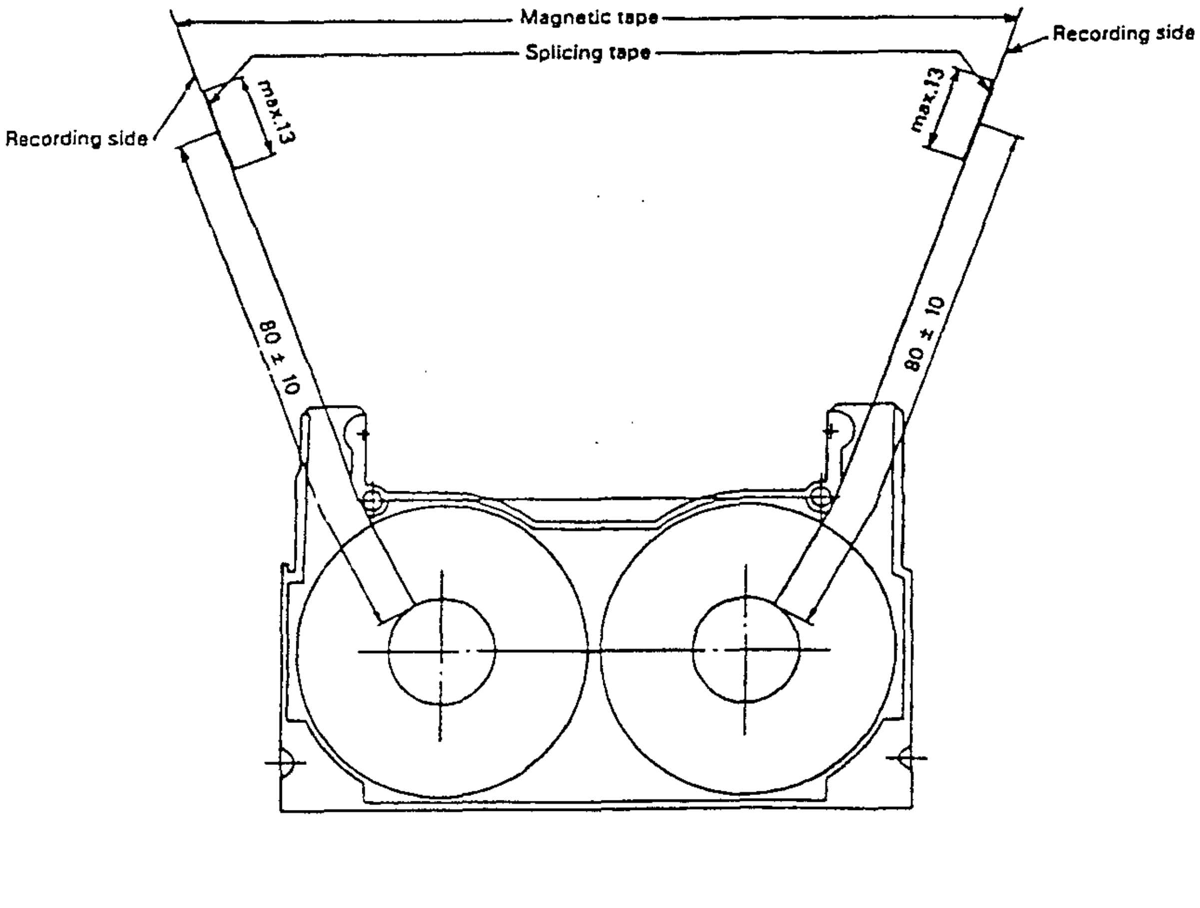
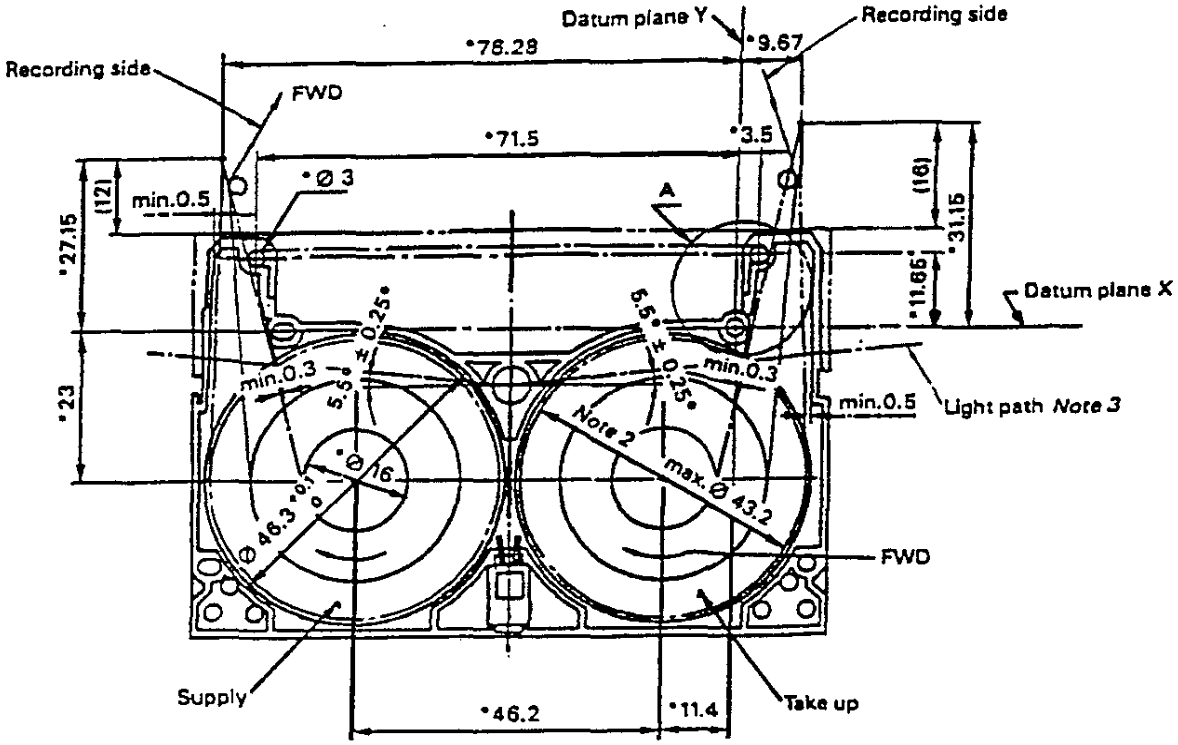
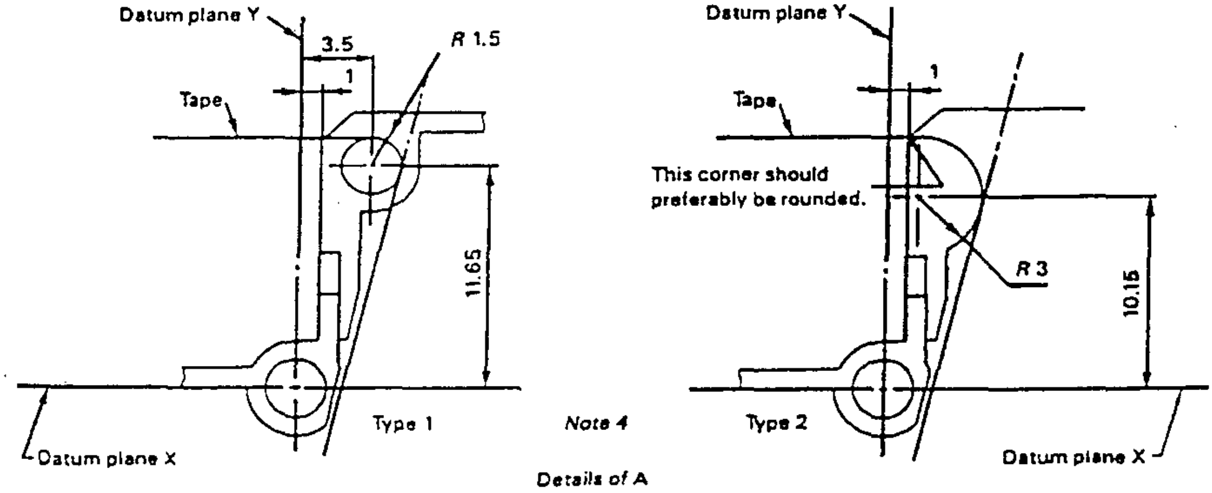


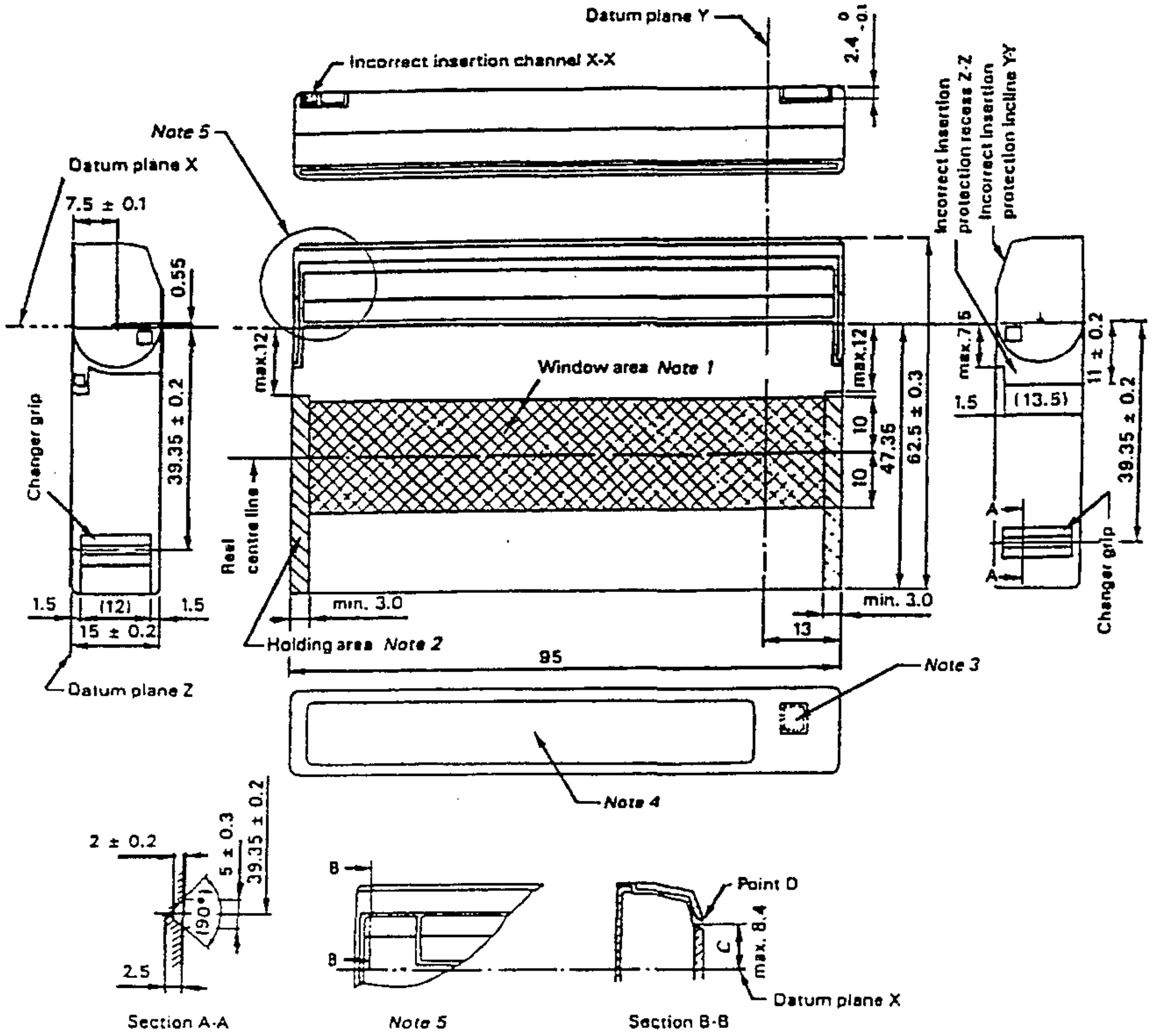
FIGURE 4 - Leader and trailer tape.





NOTES 1. - Dimensions marked with * are nominal values specifying the tape path.
2. - Maximum diameter of wound magnetic tape including leader and trailer tape.
3. - Refer to Figure 3. for height of light path.
4. - Forms Type 1 and Type 2 are possible.

FIGURE 5 - Internal structure, tape path and light path (top view).



NOTES

1 - Some part of this window must be in the cross-hatched area. The window shall not extend beyond the height of the cassette.

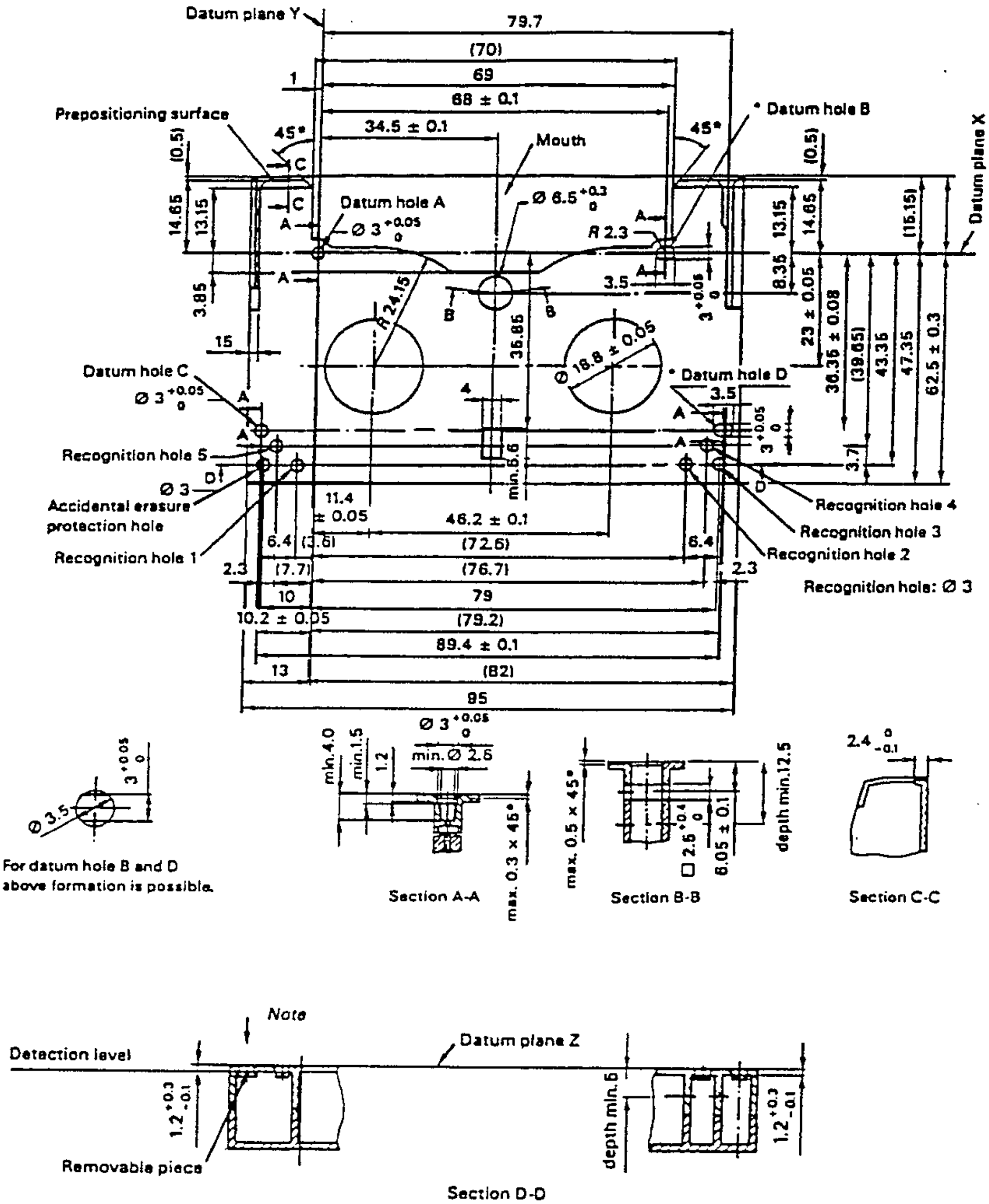
2 - The cassette shall be supported by the recorder and/or player unit in the hatched area.

3 - Indication of accidental erasure protection may be placed in this area at the manufactureer's discretion.

4 - Rear label may be attached in this optional recessed area.

5 - Dimension C shall be no more than 8,4mm from datum plane X as illustrated so that the lid opener does not touch point D on the upper shell when the lid is open.

FIGURE 6. - Appearance of the video cassette (top and side view).



NOTE

1 - The mechanism of accidental erasure protection shall be constructed so that it can withstand a force of 0.5N applied in the direction of the arrow.

FIGURE 7 - Appearance of the video cassette (bottom view).

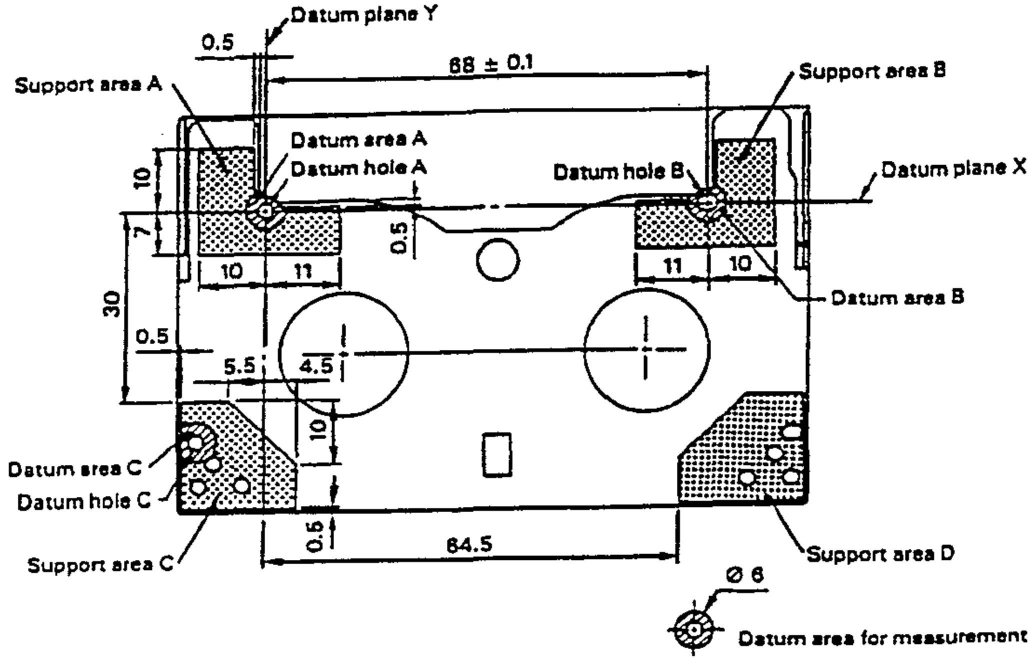
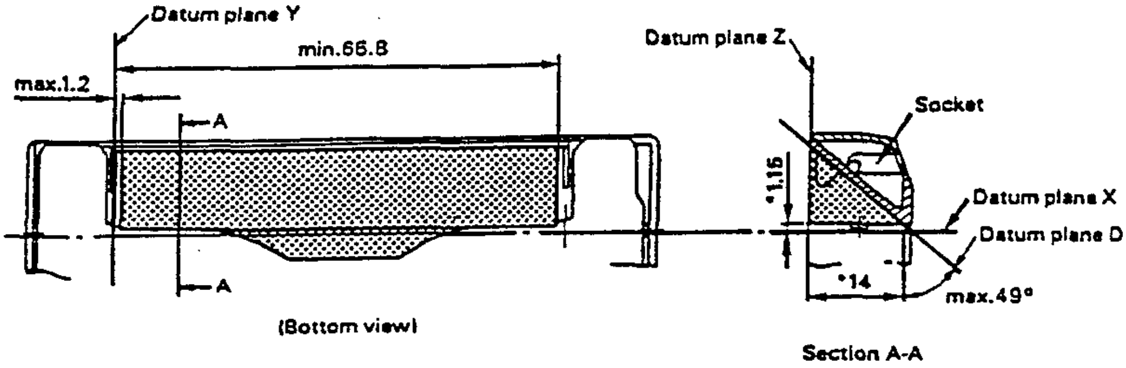


FIGURE 8 - Datum areas and support areas.



Note. – Dimensions marked with * are nominal values.

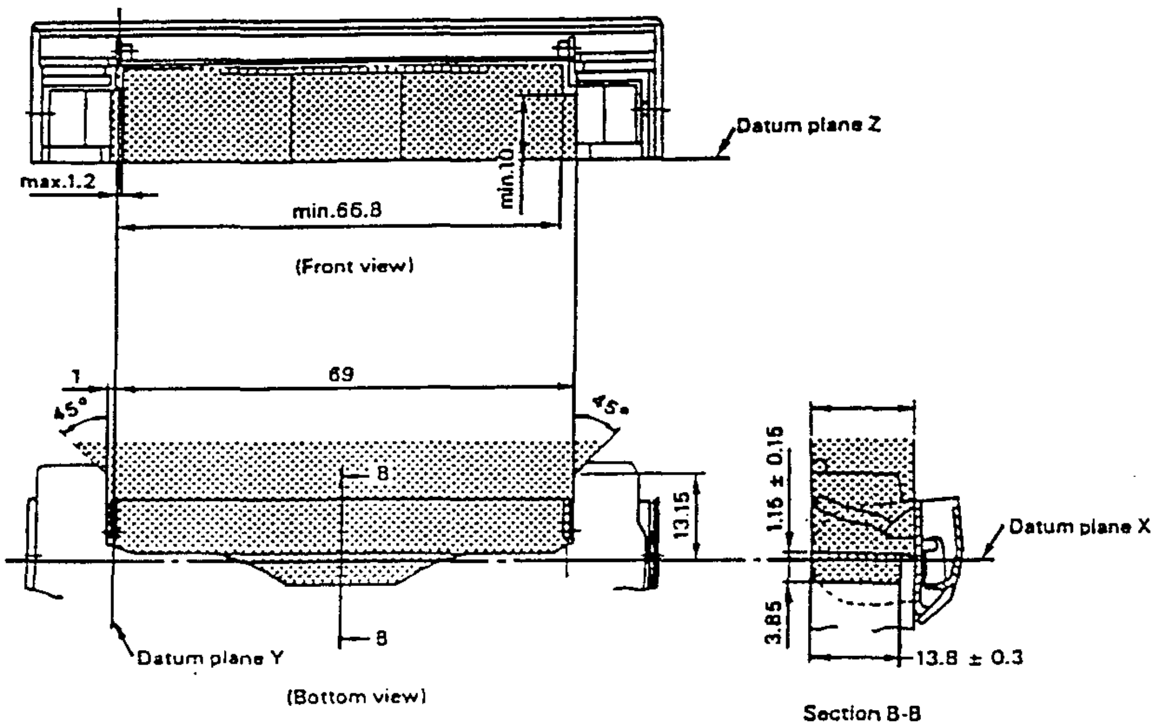


FIGURE 9 - Minimum space for recorder and/or loading mechanism.

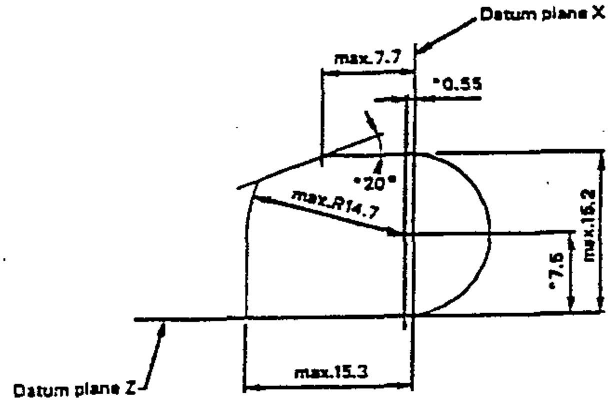


FIGURE 10 - Maximum size of lid (side view).

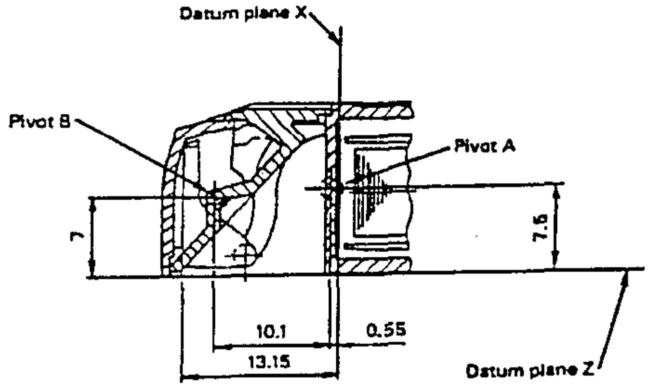


FIGURE 11 - Lid structure.

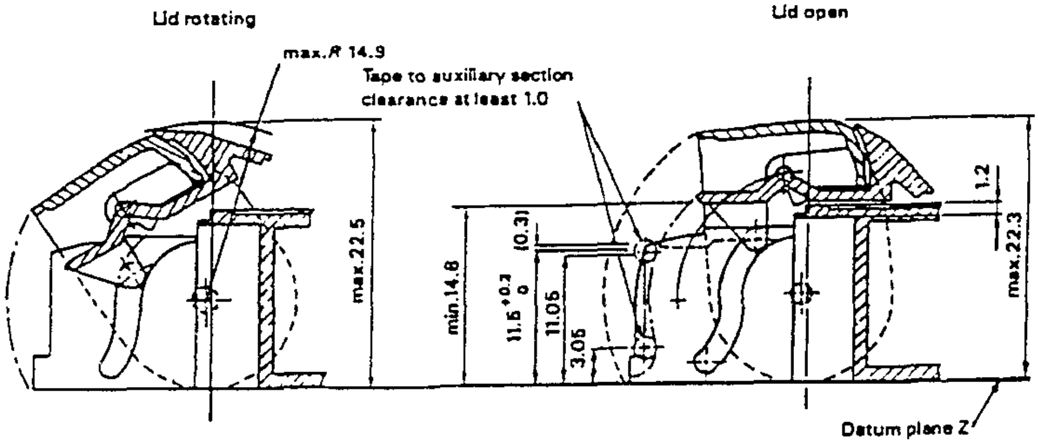
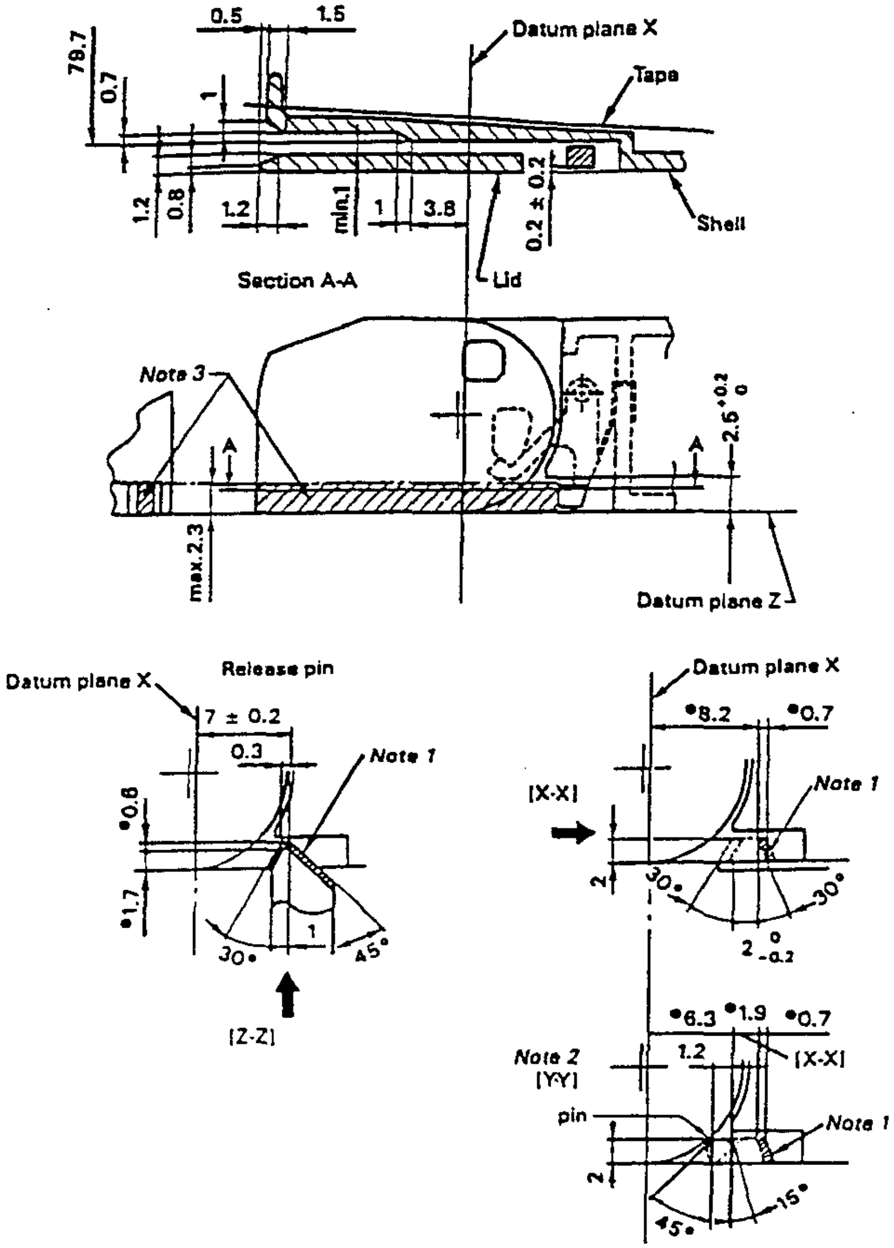


FIGURE 12 - Lid configuration when rotating and when open.



NOTES

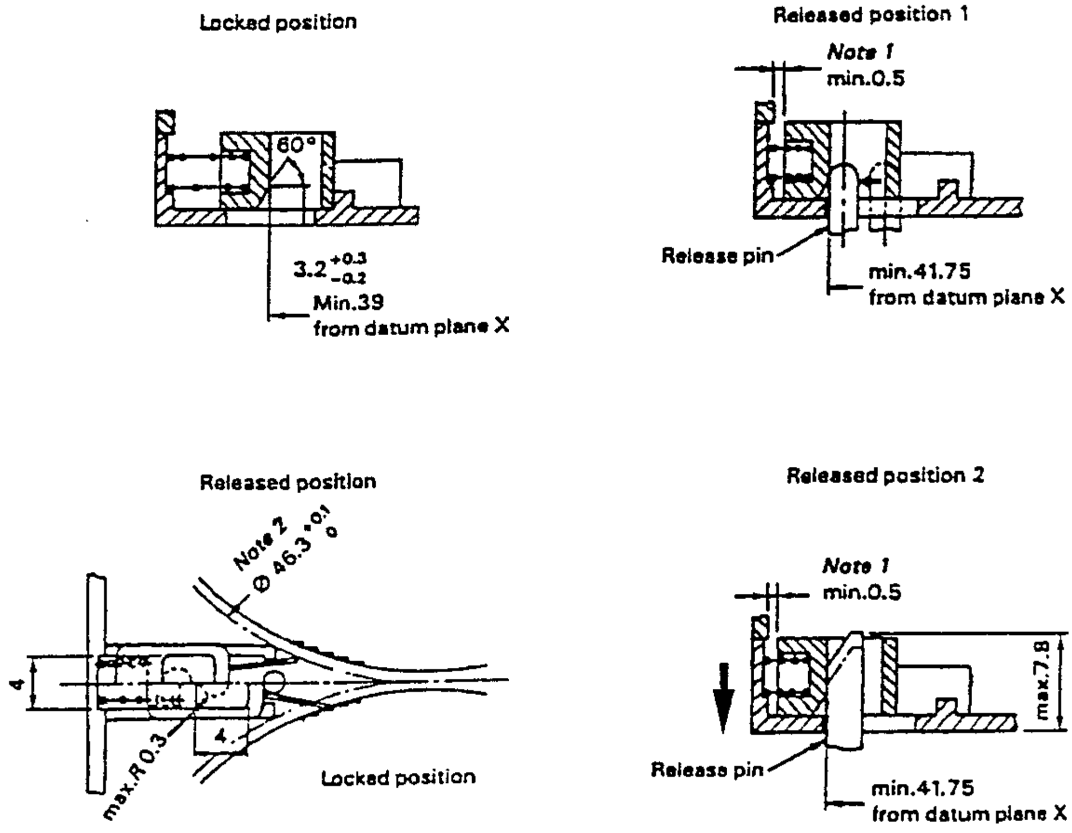
1 - When pin is in the cross-hatched area, lid lock can be released.

2 - Lid lock can be released in Y-Y direction by inserting release pin from the side of cassette and moving to X-X direction.

3 - Lid lock release pin insertion area.

4 - Dimensions marked with * are nominal.

FIGURE 13 - Lid lock and release.



NOTES

1 - Clearance between reel lock and inside of shell shall be minimum 0.5mm when the release pin is located at 41.75mm from datum plane X.

2 - The end of the reel lock shall remain outside the reel area 46.3mm in diameter, when the release pin is located at 41.74mm from datum plane X.

FIGURE 14 - Reel lock and release.

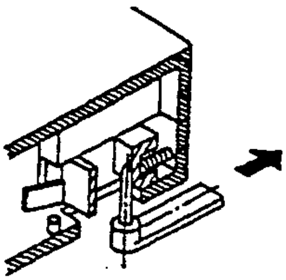


FIGURE 15 - Force needed to unlock the reel lock.

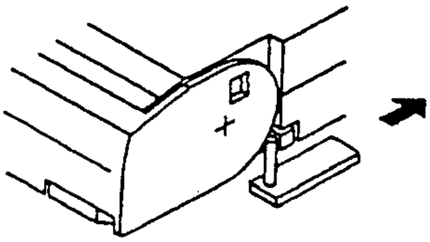


FIGURE 16 - Force needed to unlock the lid lock.

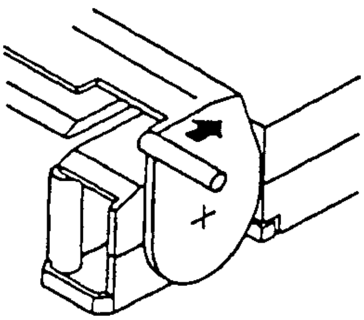


FIGURE 17 - Force needed to open the lid.

ANNEX B

SECTION 200

ANALOGUE 8mm IMAGERY RECORDING FORMAT

TABLE OF CONTENTS

200.0 8mm Analogue Imagery Recording format.

200.1 H band 8mm format.

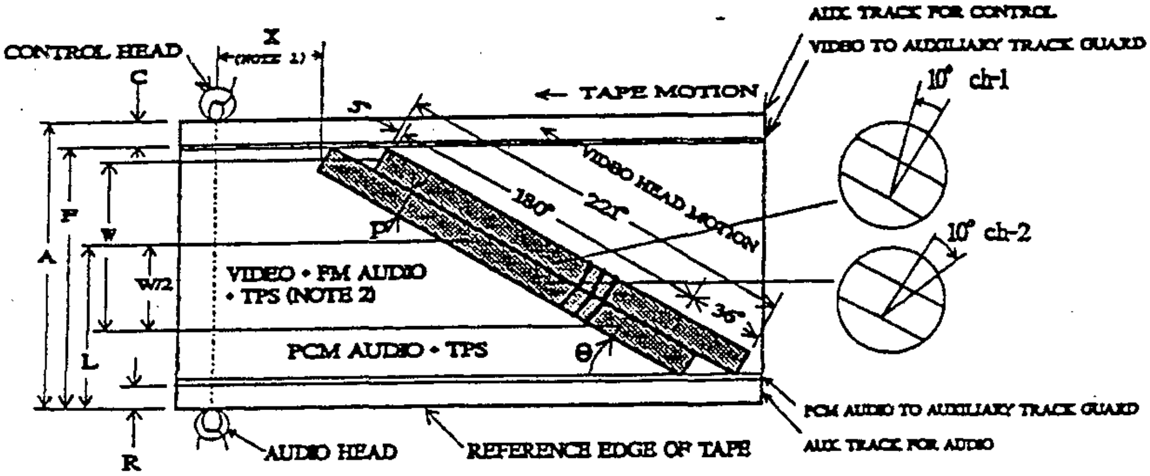
200.1.1 Introduction.

This standard provides the high band specifications of the High-band 8mm video system using 8mm magnetic tapes which is stated in the International Electrotechnical Commission (IEC) Publication 843 ('87). This standard has been specified as an optional standard for the High-band 8mm video system in order to meet the demands to the high quality video pictures. This standard is applicable for both the 525 line - 60 field and 625 line - 50 field television signals.

200.1.2 Object.

The object of this standard is to define electrical and mechanical characteristics of equipment and tapes which will provide for the interchangeability of recorded cassettes. All specifications except for those described in Table I and Figure 1 of this standard are in accordance with the specifications of the 8mm IEC video system.

View Looking into Recorded Side of Tape



Note 1. X shall be measured from the end of the 180° scan of CH-2 to the audio and cue head on the tape.

Note 2. TPS : Tracking pilot signal

FIGURE 1 Record Location

200.1.3 Auxiliary tracks.

Two auxiliary tracks may be provided, as shown in Figure 1, when required by the detailed technical specification.

200.1.3.1 Auxiliary head gap azimuth.

The azimuth angle of the head gaps used to produce Auxiliary track records shall be perpendicular to the track record, plus or minus 5 minutes of arc.

200.1.3.2 Auxiliary head location.

One of the two auxiliary tracks on tape shall always be used as control. The second auxiliary track may be used to record audio, annotation or time code data.

200.1.3.3 Recording method.

When digital data is recorded on the auxiliary tracks, this data shall be recorded using the direct, saturate (no bias) recording method and Manchester coding rules. If voice is used for annotation on one auxiliary track bias shall be used. If analogue time code is recorded on one auxiliary track, IRIG B time code shall be recorded with bias.

200.1.3.4 Flux level.

The recorded peak-to-peak flux shall correspond to a magnetic short circuit flux level of 80 nWb/m for M.P. and 16 nWb/m for tape track width.

200.1.3.5 packing density.

The minimum encoded packing density shall be 5.5 KBPI.

TABLE 1. Record Location and Dimensions

NOTE: All dimensions are in mm.
Where tolerances are not given, the quoted values are nominal.

Item	525 line - 60 field system	625 line - 50 field system
(A) - Tape width	8.0 ± 0.01	8.0 ± 0.01
(P) - Video track pitch	0.0205	0.0344
(L) - Video track centre from reference tape	4.461	4.461
(T) - Video track width	0.205	0.0344
(F) - Auxiliary track reference line	7.4 ± 0.05	7.4 ± 0.05
(C) - Auxiliary track for control	0.6 ± 0.05	0.6 ± 0.05
(R) - Auxiliary track for audio including optional tape edge guard (0.1)	0.6 ± 0.05	0.6 ± 0.05
(γ_0) - Video track angle (tape stopped)	4^0 53′ 06″	4^0 53′ 06″
(γ) - Video track angle (tape running)	4^0 54′ 13.2″	4^0 54′ 58.8″
(W) - Video effective width (180^0)	5.351	5.351
(X) - Position of audio and control head	31 ± 0.24	31 ± 0.24

200.1.3.6 Annotation.

The system specification shall define the data format, data protocol and the interface requirements.

200.1.3.7 Servo control.

The servo control record shall be a series of 32 bits recorded on the control track, as specified in Figure 2, identical to Recording Digital Format 501 and shall allow for identification and location of each two scan set and provide for multiple transport synchronisation.

200.1.3.7.1 Servo sync and ID.

The sync signal shall be four bit periods long and shall be an NRZL signal as defined in Figure 2. The track set ID shall be a 23 bit sequence which will identify each track set. The Home Track Identification shall be a 4-bit sequence which will allow systems with other than two heads per scanner, to use track location data more effectively. The last bit before the next servo sync shall be an even parity bit calculated over the previous 27 bits. When home track ID is not required for a specific application, 0s shall be recorded for this sequence.

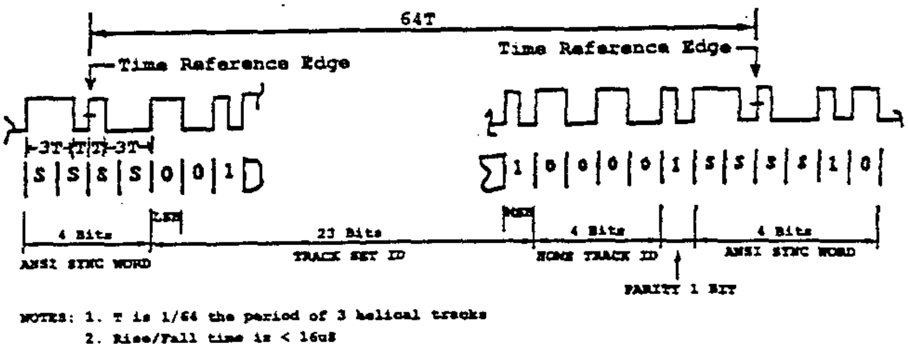


FIGURE 2 Servo Control Record

200.1.3.7.2 Servo reference signals.

Servo control signal for the transport shall be derived from the servo reference on the control track. This signal shall be made up of an ANSI sync word, track set ID, and Home Track Identification. This control track data block shall be repeated with an updated track set ID for each two scan track sets.

200.1.3.7.3 ANSI sync pattern polarity.

During the first bit period of the ANSI sync pattern, the polarity of the control track magnetisation shall be such that the south pole of the magnetic domain points in the direction of normal tape travel. The fourth bit period shall be of opposite polarity.

200.1.3.7. pulse width.

Each bit period of the control track code word shall occupy approximately 7.5 micrometers. Each control track word shall occupy a linear span of tape defined by two helical data tracks as shown in Figure 1.

200.1.3.7.5 Pulse separation.

The centre zero crossing of the control track sync word shall be coincident with the end of the postamble scan of CH-2. Control track sync words are separated by the linear tape span of two helical tracks.

200.1.3.7.6 Relative positions of recorded signals.

The spatial relationship between the centre zero crossing of the sync on the control track record and helical tracks is specified in Figure 1. The reference point is defined by a line parallel to the reference edge of the tape, 7.136 mm basic from the reference edge, intersecting the track centre line at the end of the video track as shown in Figure 1. The distance between the centre-line of the control track head and the reference point shall be in accordance with Table I.

200.1.3.8 Annotation.

If analogue time code is recorded, it shall be IRIG B as specified in IRIG Standard Time Formats, B120 or B123, RCC Document 200-89. When required, time code shall be recorded on the auxiliary annotation track with AC bias. Otherwise, this track can-be used for voice or
other system data.

200.2 definition of tapes for high-band mode.

200.2.1 Reference tape.

High-band 8 mm tapes MP, ME and their equivalents, as specified in IEC 843-3, shall be used for this High-band 8mm video system. A reference tape has been defined for measurements of the recording characteristics of the High-band 8mm tapes. This reference tape is an MP tape numbered RSE-5001 specified in Iec 1105. The reference tape is available from:

Sony corporation, Magnetic Products Group, Major Customer Sales Division 6-7-35 Ritashina, Shinagawa-ku, Tokyo 141, Japan.

Tel: 03-3448-3126 Fax: 03-3447-4378

Tlx:SONYCORPJ 22262

200.2.2 Video characteristics of the tape.

All measurements are to be made in comparison to the reference tape, wherein the reference values are taken as 0 dB.

200.2.2.1 RF optimum recording current.

The RF optimum recording current shall be 1dB ± 1dB at 7 MHz

200.2.2.2 RF output level.

The RF output level shall be:

for luminance	greater than 3 dB at 7MHz for high-band MP tape greater than 5 dB at 7MHz for high-band ME tape, and
for chrominance	greater than ± 0 dB at 0.75 MHz for high-band MP tape greater than - 1 dB at 0.75 MHz for high-band ME tape.

200.2.2.3 RF frequency response D

The RF frequency response D shall be greater than 0 dB.

Note: The playback output levels of the 7 MHz signal and 10 MHz signal which are recorded at the RF reference recording current of the respective frequencies shall be measured. The RF frequency response is defined by "D".

$$D = d - d_0$$

where "d" is the relative value in dB of the playback output level of the 10 MHz signal to that of the 7MHz signal for the tape to be tested and "d_0" is the same for the reference tape.

200.2.2.4 Carrier-to-noise ratio.

The carrier-to-noise ratio shall be

for luminance	greater than 2 dB at 7 MHz for high-band MP tape and greater than 5 dB at 7 MHz for high-band NE tape.
for chrominance	greater than 0 dB at 0.75 MHz both for high-band MP and ME tapes.

200.2.3 Pre-emphasis and clipping.

The luminance signal shall be pre-emphasised through both sub emphasis and main emphasis and clipped prior to frequency modulation. Clipping levels are as shown below. The clipping levels shall be determined independently to the frequency characteristics of emphasised signal. That is, clip is DC clipping.

White clipping level	:	220% measured from sync tip
Dark clipping level	:	90% measured from sync tip

The level from sync tip to peak white is 100%.

200.2.3.1 Main pre-emphasis.
The main pre-emphasis shall be done by using a circuit shown in the Figure 3 or equivalent.

200.2.3.2 Sub pre-emphasis.
The sub pre-emphasis characteristics are in accordance with the 8mm video specification.

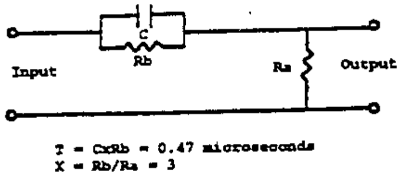


FIGURE 3 Main Pre-Emphasis Circuit

200.2.3.3 Vertical pre-emphasis.
The vertical pre-emphasis is optional and shall be done prior to the sub pre-emphasis and be killed during vertical blanking interval. A typical vertical pre-emphasis block diagram is shown in the Figure 4.

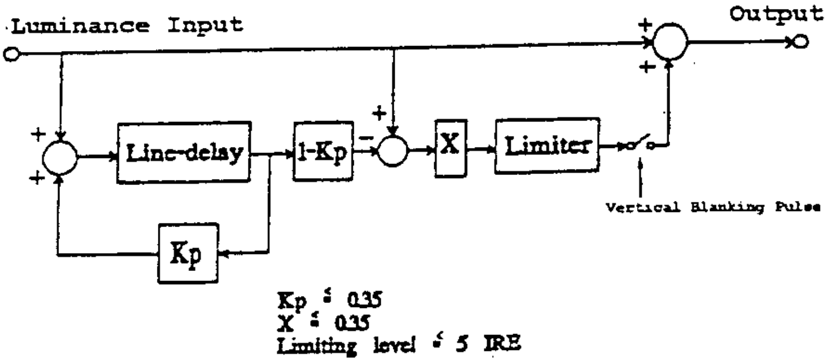


FIGURE 4 A Typical Vertical Pre-Emphasis Block Diagram

200.2.4 Modulation characteristics.
FM carrier frequencies corresponding to reference video levels shall be as follows:

Sync tip level	5.7 MHz I 0.1 MHz
Peak white level	7.7 MHz I 0.5 MHz
Deviation	2.0 MHz I 0.1 MHz

200.2.4.1 Recording current.
The recording current shall be an optimum value at 7 MHz, which is the centre frequency of FM carrier range as defined in 500.2.4.

200.3 Recording of luminance component.

The luminance component of the video signal shall be recorded in accordance with Figure 5 and conform to the requirements of IEC publication 843-3.

200.4 Chrominance component.

When recorded, the chrominance signal shall be recorded in accordance with Figure 5 and the requirements of IEC publication 843-3.

200.5 Optional specifications of FM audio signal recording.

The object of these optional specifications is to define an additional audio carrier so that a stereo or a bilingual mode is possible. All specifications except for those specified below are the same as those specified in the specifications of 8mm video system.

200.5.1 Carrier frequencies.

The centre frequency of main channel and the sub channel shall be 1.50 ± 0.02 MHz and 1.70 ± 0.02 MHz, respectively.

200.5.2 Reference deviation.

The recording reference deviation for the main channel and the sub channel shall be ± 60KHz and ± 30KHz respectively, at reference frequency of 400 Hz.

200.5.3 Maximum deviation.

The maximum deviation for the main channel and the sub channel shall not exceed ± 100KHz and ± 50KHz, respectively.

200.5.4 Recording current.

The recording current of the main channel and the sub channel shall be 13.0 ± 2.0dB and 15.0 ± 2.0dB, respectively, below the level of chrominance signal recording current.

200.5.5 position of matrix.

The matrix for producing (L+R) and (L-R) from (L) and (R) shall be prior to the noise reduction which is defined in the original 8mm video system.

200.5.6 FM audio channel.

Two independent channels may be recorded using the FM audio channels.

200.6 tracking pilot Signals.

To make automatic track finding and dynamic track following possible a tracking pilot signal (TPS) shall be recorded with the FM luminance, down converted chrominance and FM audio signal by frequency multiplexing. The frequency of the TPS and the switching sequence for the video area shall be as shown below.

	(for 525 line - 60 field system)	(for 625 line - 50 field system)
CH1:	with 102544 ± 100Hz (f1)	with 101024 ± 100Hz (f1)
CH2:	with 118951 ± 100Hz (f2)	with 117188 ± 100Hz (f2)
CH1:	with 165210 ± 100Hz (f3)	with 162760 ± 100Hz (f3)
CH2:	with 148689 ± 100Hz (f4)	with 146484 ± 100Hz (f4)
CH1:	with 102544 ± 100Hz (f1)	with 101024 ± 100Hz (f1)
etc.		

Note: The frequencies above can be derived from fosc/58 (f1), fosc/50 (f2), fosc/36 (f3) and fosc/40 (f4) where fosc = 378 fH = 5947552 Hz for the 525 line - 60 field system and 375 fH = 5859375 Hz for the 625 line - 50 field system, but a phase relationship between the horizontal line frequency fH and the TPS frequency is not necessary. The point at which the tracking pilot signals are switched shall be 6 ± 1.5H for the 525 line - 60 field system, and 7 ± 1.8H for the 625 line - 50 field system ahead of the leading edge of the vertical synchronising pulse.

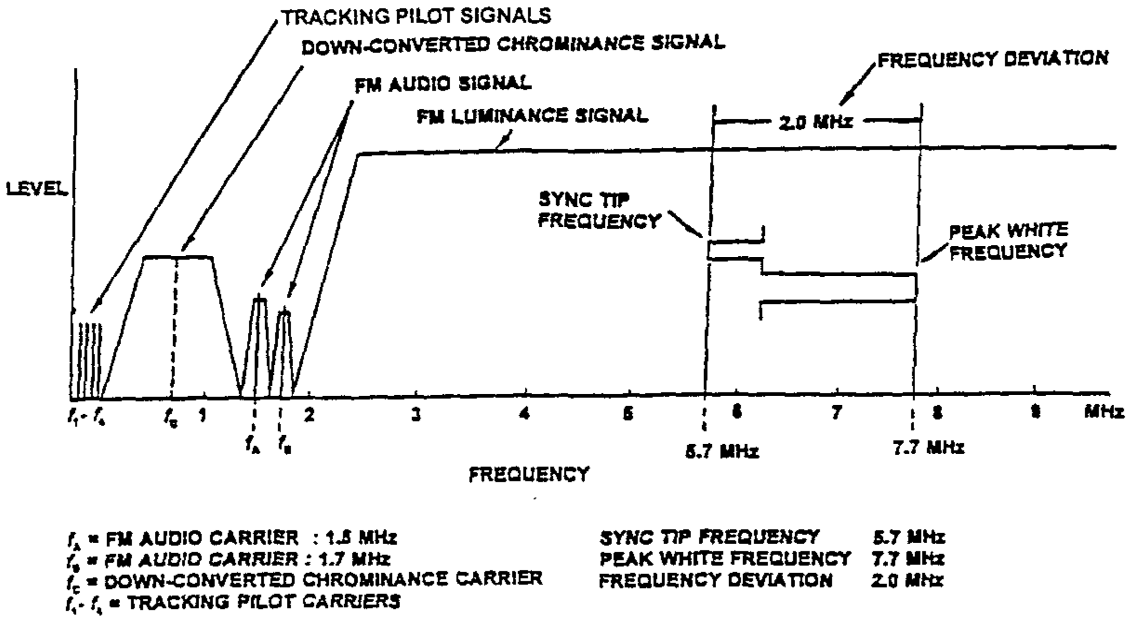


FIGURE 5 Frequency Spectrum Allocation of Recording Signals

200.7 PCM data recording.

When PCM data is recorded, two channels of audio frequency data or one digital 1553 data stream may be recorded.

200.7.1 1553 Option.

When recorded, the 1553 data stream shall be recorded within the existing PCM recording format.

200.7.2 Recording 6 channels of PCM data.

Normally video and one PCM channel is recorded on one helical scan across the tape width. In multi channel PCM recording the helical scan is divided into six individual PCM tracks. when recorded, all six PCM channels shall have the same existing recording format.

200.8 Video tape cassette .

200.8.1 Dimensions of the cassette.

The dimensions necessary to permit interchangeability of cassettes shall be in accordance with Section 5.

200.8.2 Tape winding.

The magnetic coating on the tape shall face out of the cassette. Additional information in Section 5.

200.8.3 Magnetic tape.

Type of magnetic tape		
Television System	Type A	Type B

525 line - 60 field	P6-T	E6-T
625 line - 50 field	P5-T	E5-T

T: Playable time in minutes

200.8.4 Recognition holes.

The normal-band MP tape and the high-band MP and ME tapes are recognised by using hole 1 and 5 as described in the Table II and shown in Figure 6. The definition of the other holes is in accordance with the original 8mm video system.

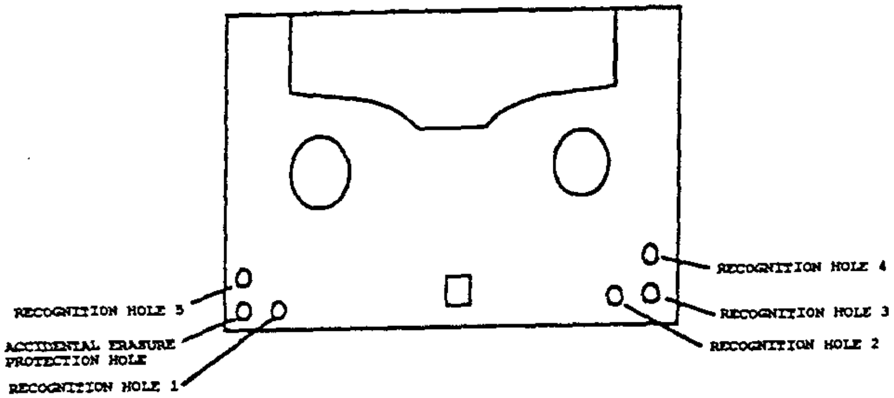


FIGURE 6 ID Holes

	Hole 1	Hole 5
Normal MP	Closed	Closed
High Band MP	Closed	Open
High Band ME	Open	Closed

TABLE II ASSIGNMENT OF ID HOLES

ANNEX B

SECTION 201

DIGITAL 8mm RECORDING FORMAT

Table of Contents

201.0 8mm Digital Data Recording Format

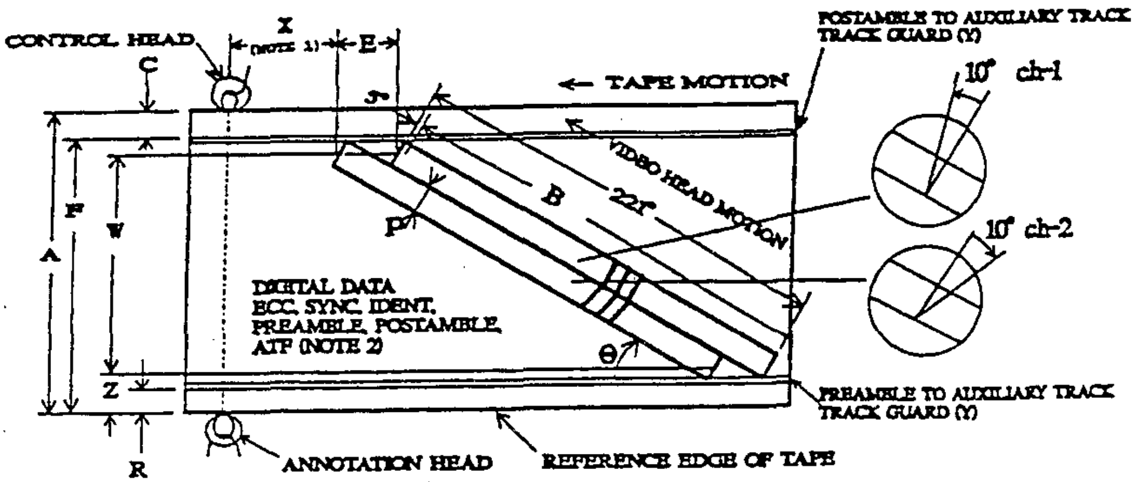
201.1 Tape Record.

Tape recordings shall consist of digital data recorded in helical-scan format. The dimensions and location of the helical track records for 8mm helical-scan digital cassette tape recorder/reproducers shall be as specified herein. An auxiliary data area is available within each scan for annotation data, time code and control information.

201.1.1 Record location and dimensions.

Record locations and dimensions shall be specified in Table I and Figure 1.

Track configuration and dimensions (view on magnetic sensitive side)



Note 1. X shall be measured from the end of the 180° scan of CH-2 to the audio and cue head on the tape.

Note 2. ATF: Automatic track finding

FIGURE 1 Record Location and Dimensions

201.1.2 Bit error rate (BER).

Error correction codes (ECC) shall be employed. The full use of the ECC and taped defined in Section 5 will allow the reproduced BER to be less than 1×10^{-9}. The BER requirement of the detailed technical specification shall apply to data recorded and reproduced on the same machine and also to data recorded on one manufacturer's recorder and reproduced on another manufacturer's reproducer. BER calculations shall exclude up to 2 burst errors per cassette. Each of these burst errors shall not be longer than 1 scan length.

201.1.3 Data rate.

The recorder/reproducer shall record and/or reproduce serial data streams of various data rates. As a minimum, recorder/reproducers shall accommodate any user data rate specified by the detailed technical specification within the range of 1 to 40 megabits per second. Speed changes to accommodate various data rates shall be possible although the data rate will normally remain constant during a recording mission. It shall be possible to select any data rate and maintain the specified packing density and format on tape at any speed. This is the anticipated data rate range for the family of recorders.

201.1.4 Tape speed.

Any tape speed utilised shall at all times result in a recording at the packing density and format specified herein.

201.1.5 Signal flow.

Figure 1 is a conceptual flow diagram of the recording process. It is provided for clarity of data encoding and is not meant to imply a specific hardware implementation.

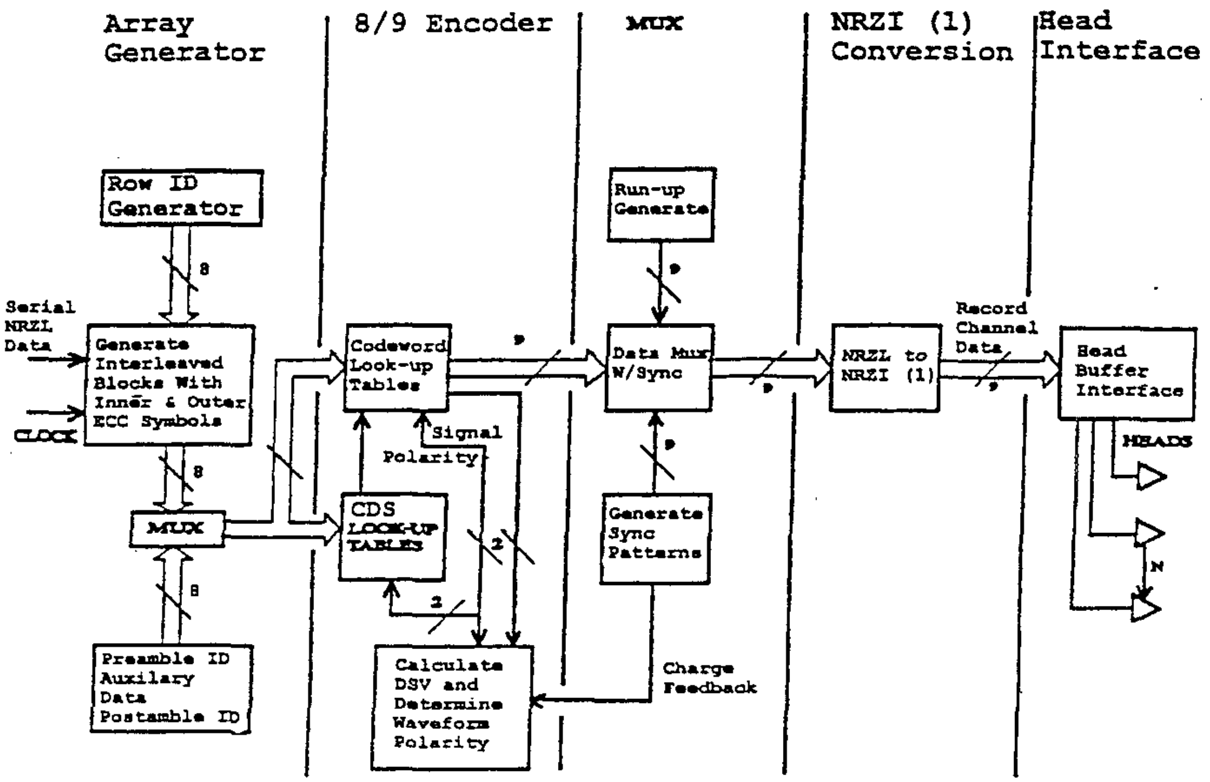


FIGURE 2 Record Process Signal Flow

201.1.6 Input data format.

The input data format shall consist of a serial NRZL bit stream and an in-phase coherent clock. The clock zero crossing jitter shall not exceed + 5% of the bit period about the data zero crossing at any input data rate.

201.2 Longitudinal tracks.

Two longitudinal tracks are defined below and in Figure 2. The control track shall always be recorded. The annotation track is optional.

201.2.1 Longitudinal head gap azimuth.

The azimuth angle of the head gaps used to produce longitudinal track records shall be perpendicular to the track record, plus or minus 5 minutes of arc.

201.2.2 Longitudinal head location.

The longitudinal head(s) for the annotation/time code track and the control track shall be located in a single stack, centred as specified in Figure 1 and Table I. The control track head shall be located + 31.0 mm measured from the end of the helical data scan of CH-2 to the stationary head gap on the tape, using (θ = 4°54'13.2"). The centreline of the longitudinal head stack and the control track head, shall be perpendicular to the reference edge of the tape, plus or minus 5 minutes of arc.

TABLE 1. Record Location and Dimensions

NOTE: All dimensions are in mm.
Where tolerances are not given, the quoted values are nominal.

Item		525 line-60 field system	625 line-50 field system
(A)	Tape width	8.0 ± 0.01	8.0 ± 0.01
(P)	Helical track pitch	0.0205	0.0344
(T)	Helical track width	0.0205	0.0344
(F)	Auxiliary track reference line	7.4 ± 0.05	7.4 ± 0.05
(C)	Auxiliary track for control	0.6 ± 0.05	0.6 ± 0.05
(R)	Auxiliary track for audio	0.6 ± 0.05	0.6 ± 0.05
(θo)	Helical track angle (tape stop)	4° 53' 06"	4° 53' 06"
(θ)	Helical track angle (tape runs)	4° 54' 13.2"	4° 54' 58.8"
(X)	Position of auxiliary and control head	31 ± 0.24	31 ± 0.24
	Azimuth angle of rotary heads	10° (± 8')	10° (± 8')
(B)	Total recorder track length	79.3984	79.3984
(Y)	Track guard	0.1	0.1
(W)	Helical track effective width	6.4455	6.4455
(Z)	Helical track reference point	0.772	0.772
(E)	Longitudinal track pitch	0.239	0.239

201.2.3 Recording method.

Control track data and digital annotation data is recorded on the longitudinal tracks. The direct, saturate (no bias) recording method and Manchester coding rules shall be used. The annotation track may be recorded digitally, with voice, with time code or left unrecorded. If voice is used for annotation on one longitudinal track bias shall be used. If analogue time code is recorded on one longitudinal track, IRIG B time code shall be recorded with bias.

201.2.4 Flux level.

The recorded peak-to-peak flux shall correspond to a magnetic short circuit flux level of 80 nWb/m of track width for MP tape and 16 nWb/m track width for ME tape.

201.2.5 Longitudinal track packing density.

Hardware built to this standard shall be capable of recording and reproducing an encoded packing density for annotation or control track recording of 5.5 KBPI.

201.2.6 Annotation.

The system specification shall define the data 1
format, data protocol and the interface requirements for any annotation data to be recorded on the longitudinal track.

201.2.7 Servo control.

The servo control record shall be a series of 32 bits recorded on the control track, as specified in Figure 3, and shall allow for identification and location of each two scan sets and provide for multiple transport synchronisation.

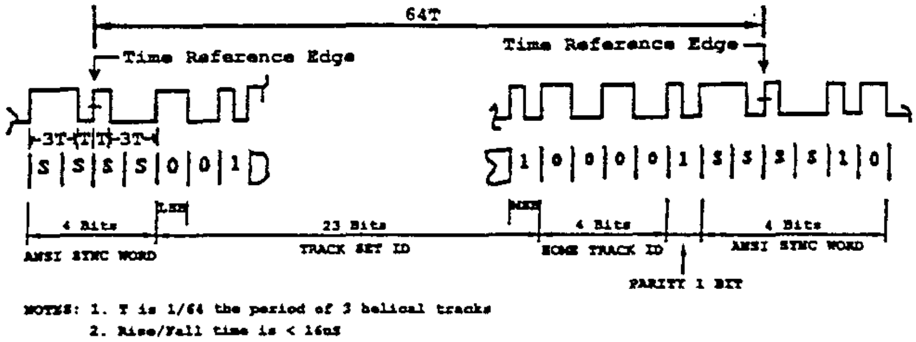


FIGURE 3 Servo Control Record

201.2.7.1 Servo sync and ID.

The sync signal shall be four bit periods long and shall be an NRZL signal as defined in Figure 3. The track set ID shall be a 23 bit sequence which will identify each track set. The Home Track Identification shall be a 4-bit sequence which will allow systems with other than two heads per scanner, to use track location data more effectively. The last bit before the next servo sync shall be an even parity bit calculated over the previous 27 bits. When home track ID is not required for a specific application, 0s shall be recorded for this sequence.

201.2.7.2 Servo reference signals.

Servo control signal for the reproduce transport shall be derived from the servo reference on the control track. This signal shall be made up of an ANSI sync word, track set ID, and Home Track Identification. This control track data block shall be repeated with an updated track set ID for each two scan track sets.

201.2.7.3 ANSI sync pattern polarity.

During the first bit period of the ANSI sync pattern, the polarity of the control track magnetisation shall be such that the south pole of the magnetic domain points in the direction of normal tape travel. The fourth bit period shall be of opposite polarity.

201.2.7.4 Pulse width.

Each bit period of the control track code word shall occupy approximately 7.5 micrometers. Each control track word shall occupy a linear span of tape defined by two helical data tracks as shown in Figure 1.

201.2.7.5 pulse separation.

The centre zero crossing of the control track sync word shall be coincident with the end of the postamble scan of CH-2. Control track sync words are separated by the linear tape span of two helical tracks.

201.2.7.6 Relative positions of recorded signals.

The spatial relationship between the centre zero crossing of the sync on the control track record and helical tracks is specified in Figure 1. The reference point is defined by a line parallel to the reference edge of the tape, 0.772 mm basic from the reference edge, intersecting the track centre line at the end of the preamble as shown in Figure 1. The distance between the centre-line of the control track head and the reference point shall be in accordance with Table 1.

201.2.8 Annotation track.

If analogue time code is recorded, it shall be IRIG B. specified in IRIG Standard Time Formats, B120 or B123, RCC Document 200-70. When required, time code shall be recorded on the longitudinal annotation track with AC bias. Otherwise, this track can be used for voice or other system data.

201.3 Helical record:

The helical track which is defined physically in Figure 1, is recorded with continuous data. This segment of digital data, as defined by Figure 4, shall be recorded on one track, as a continuous serial bit stream and shall contain a complete sequence of the data. The next track written shall contain the next contiguous sequence of a segment of the data, i.e., there shall be no intertrack shuffling of the data. Data is arranged in one track as shown in Figure 4. Each track is divided into the following elements:

a. Margin area unrecorded
b. Run-up sequence, 1,024 bits
c. Preamble including:
   1. Track sync words (4)
   2. Track ident words (4)
   3. Auxiliary data codewords (8)
d. Automatic track finding (14 blocks of 360 bits)
e. Data blocks include:
   1. Row sync words
   2. Row identification words
   3. Main data
   4. Error correction code words
f. Automatic track finding (14 blocks of 360 bits) g. Postamble includes:
   1. Track sync words (4)
   2. Track identification words (4)
h. Margin area unrecorded

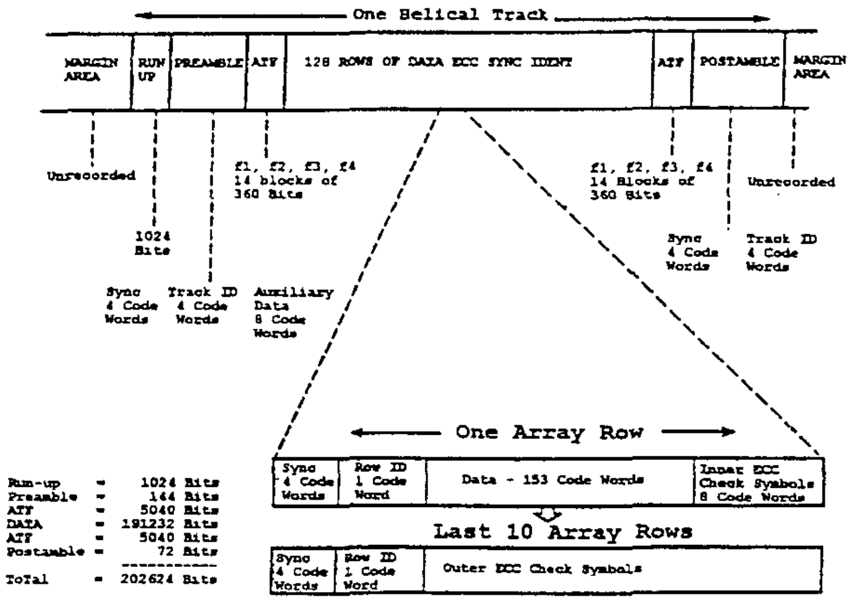
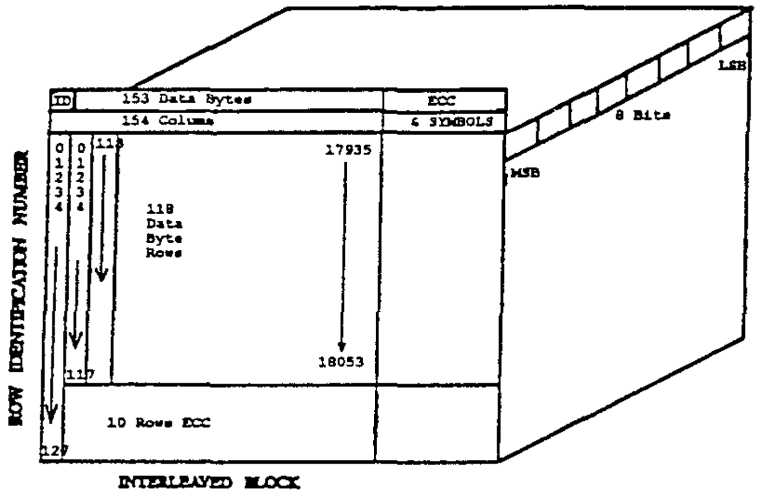


FIGURE 4 Track Details

201.3.1 Array generation.

The data field is formatted in one array as shown in Figure 5. The data array consists of one ID column plus 153 columns by 118 rows. Ten error correcting code symbols are appended to each data column as per Table III. The array is filled by columns. The first I.D. byte is read into the upper left-most column of the array (column 0, row 0). The second I.D. byte is read into the left-most column of the next row of the array (column 0, row 1) etc.. The first column of the array is filled with consecutive row I.D. numbers until the first column is complete. The first data byte is then read into row 0 column 1 of array. The process continues until the first 118 data bytes are read into column 1. The ten error correcting code symbols for column 1 are calculated "on the fly" and then read into column 1, (rows 118 to 127). The 119th data byte is read into column 2 of row 0 of the array and the process of filling column 2 of the array continues in a manner similar to the process used to fill column 0. The process of filling the array by columns continues until the 154th column is filled. When the 154th column of row 0 is filled, the inner ECC symbols are calculated based on the row ID through the 154th column of the row, and appended to that row as per Table II. The error correcting symbols for each subsequent row in the array are calculated and appended in the same manner. When data is transferred to the 8/9 encoder it is read out of the array by interleaved rows.



NOTE: Input data bytes are sequential from 0 through 18053 and are read into the arrays in columns

FIGURE 5 Data and ECC Blocks

201.3.1.1 Channel coding.

The NRZL 8-bit byte stream (contains ECC and data), which is read out of the ECC array, shall be formatted in accordance with the coding rules specified below and incorporate the 8/9 block code conversion described in 501.3.1.2. The preamble, postamble and synchronisation pattern are added as depicted in Figure 4. This data stream shall then be converted from NRZL to NRZI(1) for recording on tape. This data stream conversion is demonstrated by the example given in Figure 6.

201.3.1.2 8/9 code conversion.

In order to properly effect the DC free encoding of data, the channel coding system shall actively maintain a DSV, calculated from the CDS of each 9- bit symbol chosen during the 8 to 9-bit mapping operation. This mapping shall include both a one to one ("0 CDS" 9-bit code word) selection and one to two (+

or - CDS 9-bit word) selection identical to that used in NATO STANAG 4283 ANNEX C and MIL-STD-2179B-Table IV and V of this standard provide 8/9 mapping rules. Each one to two 9-bit word mapping shall be chosen to create a DC free data stream through the choice of the 9-bit word which brings the DSV back to 0. Each one to one 9-bit word mapping maintains the DSV by using a 9-bit word with a CDS of 0. The positive or negative CDS words are chosen from Table IV, based on the DSV and the waveform polarity at the end of the previous word in accordance with Table V. The CDS listed in Table IV assumes a negative waveform polarity at the end of the preceding word. When this is true, the DSV is calculated by adding the CDS listed in Table IV to the previous DSV.

If the waveform polarity at the end of the preceding word is positive, then the DSV is calculated by subtracting the CDS listed in Table IV from the previous DSV. The DSV calculation shall incorporate the CDS of the synchronisation patterns, sector I.D. number and the Auxiliary Data in order to maintain a DC free data stream.

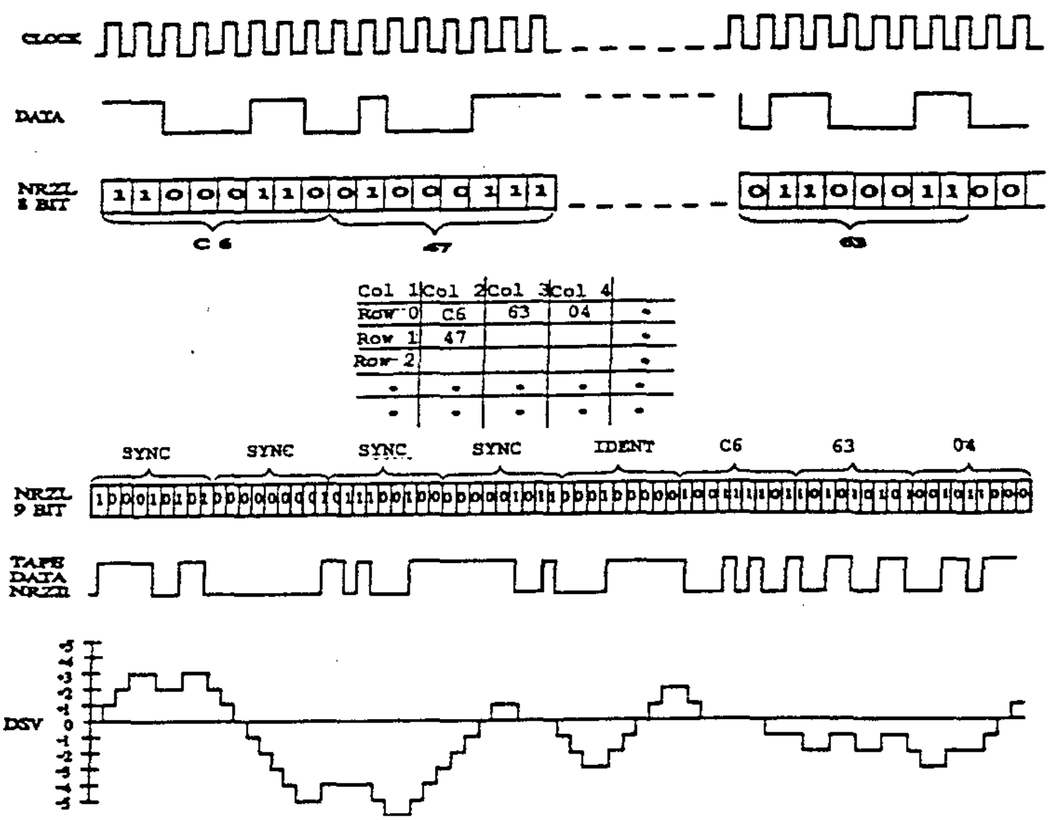


FIGURE 6 Row Synchronisation and Identification

201.3.1.3 Recording waveform.

Figure 2 is a conceptual block diagram of the recording process and is not meant to imply a hardware implementation. Due to the lack of any 0 CDS words in the 9-bit NRZL signal, the waveform recorded shall be NRZI (1). The NRZL waveform shall be converted to NRZI (1) such that each "1" in the data stream shall create a transition in the centre of the bit cell and each "0" shall create no transition. This NRZI (1) data signal shall be provided to the heads with no pre-emphasis, encoding, randomisation, or conversion. A waveform polarity inversion indication is included in Table IV. This is for convenience in determining waveform inversion polarity for any chosen 9-bit word from the table.

201.3.1.4 Read interface.

Due to the wide variation in data rate hardware implementations, the output of the NRZI (1) converter may be buffered for single or multiple heads. A number of heads may be used in order to maintain the physical format on tape. The data's serial nature shall be maintained from track to track.

201.3.1.5 Magnetisation.

During the time interval of a recorded "+" level of NRZI(1), the polarity of data flux shall be such that the north pole of the magnetic domain shall point in the direction of head motion. During the time interval of a recorded "-" level of NRZI(1) the polarity of data flux shall be such that the south pole of the magnetic domain shall point in the direction of head motion. Magnetisation shall bring the tape to saturation at maximum transition density.

201.3.2 Labelling convention.

The most significant bit is written on the left and is the first recorded to tape. The lowest numbered byte is shown at left/top and is the first encountered in the input data stream. Byte values are expressed in hexadecimal notation unless otherwise noted.

201.3.3 Track details.

The track details shall be as shown in Figure 4 and described below.

201.3.3.1 Margin area.

The margin area is provided for head tape contact stabilisation and it is not recorded.

201.3.3.2 Run-up sequence.

The run-up sequence of 1024 bits shall be recorded for clock reference. The magnetisation pattern shall be all ones (1).

201.3.3.3 Track preamble.

Each track shall commence with a preamble sequence recorded after the run-up. Preamble consists of track ID and auxiliary data. It is followed by ATF.

(a) Length	16 codewords	
(b) Arrangement	See Figure 4	
	Sync Pattern	4 codewords
	Ident pattern	4 codewords
	Auxiliary data	8 codewords

201.3.3.4 Automatic track finding (ATF).

Two areas are provided with each track format for automatic track finding. The patterns which repeat every four tracks are shown in Figure 7. Frequencies are derived from the recorded wavelength (2 times bit length) and tape-head speed. The block length is 360 bits with a bit length of 0.372 microns. They use a pilot signal frequency (f1), sync signal frequency (f2), sync signal frequency (f3) and an erase signal frequency (f4). The sync signals differ in four tracks by altering its duration in every frame and its frequency in every track. The pilot signal is positioned for output not to overlap across three successive tracks. The erase signal is used to separate and buffer the other signal frequencies within ATF pattern and from data areas. Note that the signals durations vary from track to track.

The automatic track finding method has the following features:

- Direct detection method
- One pilot detection

- Self clocking signals
- Self home track discriminations
- Analogue method for comparing crosstalk

When the head advances in the direction of the array, the presence of an ATF signal is detected by picking up either the f2 or f3 sync signals. The adjacent pilot signals (f1) on both sides are then immediately compared, and a decision made whether the tracking is correct or not. The f1 signal components use low range frequencies that are not affected by the azimuth setting, so crosstalk can be picked up and detected from both sides. Since this ATF system compares the crosstalk using an analogue method, the processing is different than for other areas. The ATF area is clearly divided into two parts in the track format, this provides error correction signals for track curvature.

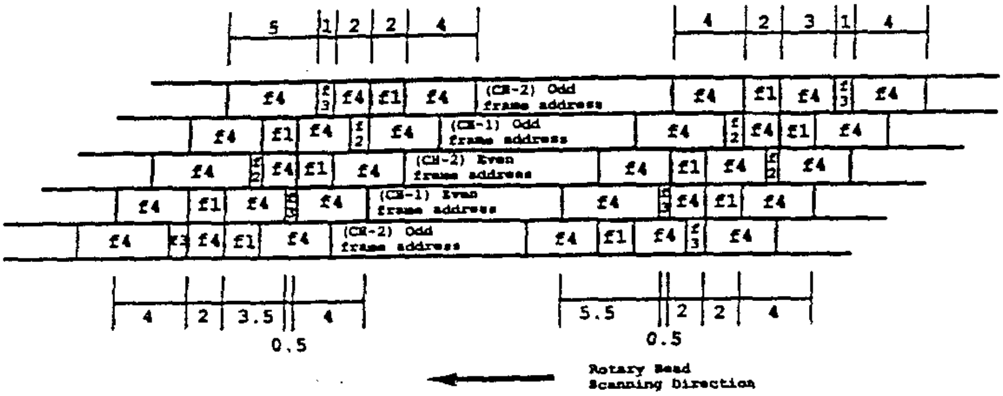


FIGURE 7 Automatic Track Finding Pattern

201.3.3.5 Data field.

This field is used for all data and the associated error correction and identification data.

a. Length -1 array of data bytes; 1 row ID column and 153 columns by 118 rows of user data. Ten error-code check symbols are appended to each column; 8 error-code check symbols are appended to each row.

b. Arrangement -See Figure 4

201.3.3.6 Inner error protection.

Type	Reed - Solomon
Galois Field	8 bits, (GF 2^8)
Field Generator Polynomial	$x^8+x^4+x^3+x^2+x^0$
Order of use	Left most term is significant, "oldest" in time computationally, and first written to tape.
Code Generator Polynomial	$G(x)=(x+\beta^0)(x+\beta^1)(x+\beta^2)(x+\beta^3)(x+\beta^4)(x+\beta^5)(x+\beta^6)(x+\beta^7)$

			MSB	LSB
(in GF (2^8))	where	β^0 =	0000	0001
		β^1 =	0000	0010
		β^2 =	0000	0100

β^3 = 0000 1000
β^4 = 0001 0000
β^5 = 0010 0000
β^6 = 0100 0000
β^7 = 1000 0000

Check Characters	K7, K6, K5, K4, K3, K2, K1, K0 in $K7x^7+K6x^6+K5x^5+K4x^4+K3x^3+K2x^2+K1X^1+K0x^0$ obtained as the remainder after dividing $x^8D(x)$ by $G(x)$ where $D(x)-B152x^{152}+...+B1x^1+B0x^0$
Equation of Full Code	$B153x^{161}+...B0x^8+K7x^7+K6x^6...+K0x^0$

An example of three possible patterns is shown in Table II, where pattern 1 is the impulse function and the values in the check locations represent the expansion of the code generator polynomial. The values are given in hex.

TABLE II. Data Field/Inner Error Protection Patterns

	Data Symbols							Check Symbols							
Symbol Position	0	1	2	..	151	152	153	154	155	156	157	158	159	160	161
Pattern 1	00	00	00	..	00	00	01	FF	0B	51	36	EF	AD	C8	18
Pattern 2	00	01	02	..	97	98	99	A1	93	20	86	F9	5B	B7	D0
Pattern 3	CC	CC	CC	..	CC	CC	CC	24	4B	05	22	ED	70	0C	D9
Symbol Identity	B153	B152	B151	..	B2	B1	B0	K7	K6	K5	K4	K3	K2	K1	K0

201.3.3.7 Outer error protection.

The last ten rows of the array contain the error correction check data associated with each column of 8-bit bytes.

Type - Reed-Solomon	
Galois Field - GF(28)	
Field Generator Polynomial	x8+X4+x3+x2+xo
Order of Use	The left-most term is the most significant, "oldest" in time computationally, and first written to tape.
Code Generator Polynomial	$G(x)=(x+\beta^0)(x+\beta^1)(x+\beta^2)(x+\beta^3)(x+\beta^4)(x+\beta^5)(x+\beta^6)(x+\beta^7)(x+\beta^8)(x+\beta^9)$

where

B^0 - 0000 0001
B^1 - 0000 0010
B^2 - 0000 0100
B^3 - 0000 1000
B^4 - 0001 0000
B^5 - 0010 0000
B^6 - 0100 0000
B^7 - 1000 0000
B^8 - 0001 1101
B^9 - 0011 1010

Check Characters: K9, K8, K7...K1, K0 in $K9x^9+K8x^8+K7x^7+...K1x^1+K0x^0$ obtained as the remainder after dividing $x^{10}D(x)$ by $G(x)$

where: $D(X)=B117X^{117}+B116X^{116}+ \quad +B1x^1+B0X^0$

Equation of Full Code

$$B117x^{127}+B116x^{126}+...+B1x^{11}+B0x^{10}+K9x^9+K8x^8+K7x^7+...+K1x^1+K0x^0$$

Table III shows an example of three possible patterns, where pattern 1 is the impulse function and the values in the check location represent the expansion of the code generator polynomial.

TABLE III. Outer Error Protection Patterns

	Data Symbols					Check Symbols									
Symbol Position	0	1	2	116	117	118	119	120	121	122	123	124	125	126	127
Pattern 1	00	00	00	00	01	D8	C2	9F	6F	C7	5E	5F	71	9D	C1
Pattern 2	00	01	02	74	75	5B	78	59	23	8A	14	AA	DD	EF	5E
Pattern 3	CC	CC	CC	CC	CC	33	32	4A	DD	AE	EB	E7	AF	24	BF
Symbol Identity	B117	B116	B115	B1	B0	K9	K8	K7	K6	K5	K4	K3	K2	K1	K0

201.3.3.8 Automatic Track winding (ATF).

The ATF sequence is recorded as per section 501.3.3.4 and Figure 7.

201.3.3.9 Track postamble

All tracks shall terminate with the postamble sequence.

(a) Length: 8 codewords

(b) Arrangement: See Figure 4

Sync Pattern: 4 codewords (same as preamble)

Ident pattern: 4 codewords (same as preamble)

201.3.3.10 Margin area.

The margin area is provided for head tape contact stabilisation and it is not recorded.

201.3.3.11 Synchronisation patterns.

The synchronisation patterns for the row and track shall be defined below. The NRZI(1) definition implies that "one" is defined as having the polarity of its flux pattern with a north pole pointing in the direction of head travel. A "zero" is defined as having a south pole pointing in the direction of head travel.

201.3.3.12 flow Synchronisation.

The synchronisation pattern in binary for each row of an interleaved block shall consist of four 9 bit words in NRZI(1) as follows:

111100110000000001101000111111110010

The row sync codewords recorded use the NRZL to NRZI encoder and a rule.

The NRZL codewords in hexadecimal are as follows:

@15 001 0E4 00B

Where @ is determined by:

@ - 0 if previous polarity is high
@ - 1 if previous polarity is low

201.3.3.13 Track synchronisation.

The sync pattern in binary, in NRZI(1) for each helical track, is as follows:

000011001111111100101110000000001101

The track sync codeword recorders use the NRZL to NRZI(1) encoder and a simple rule. The NRZL codewords in hexadecimal are as follows:

@15 001 0E4 00B

Where @ is determined by:

@ - 0 if previous polarity is low
@ - 1 if previous polarity is high

This row synchronisation signal CDS/DSV shall be used by the 8/9 encoder when determining the selection of the next 9 bit codeword selected to minimise DSV.

201.3.3.14 Row Identification.

The row identification pattern shall consist of an 8 bit representation of the row number in the interleaved block. Row synchronisation and identification patterns shall be inserted as shown in Figure 5. The row identification pattern shall be included in the calculation of the inner ECC check symbols.

201.4 Helical track geometry.

The helical track geometry is shown in Figure 1 and defined in Table I.

201.4.1 Average track pitch.

The distance, averaged over any group of 1,000 consecutive tracks, between the centreline of any track and the centreline of an adjacent track, measured perpendicular to the track length, shall be between 0.0207 mm and 0.0203 mm. For reference purposes only, its corresponding average longitudinal distance measured parallel to the reference edge of the tape is 0.239 mm nominal.

201.4.1.1 Adjacent track pitch.

The distance between the centrelines of any two adjacent tracks, measured perpendicular to the track length, shall be between 0.019 mm and 0.022 mm, provided however that the specified average track pitch is maintained.

201.4.1.2 Track width.

The width of a written track shall be 20.5 micrometers nominal.

201.4.2 Track straightness.

Either edge of the recorded track shall be contained within two parallel lines 6 micrometers apart.

201.4.3 Track angle.

The track angle shall be as defined in Table I.

201.4.4 Gap azimuth.

The gap azimuth shall be as defined in Table I.

201.4.5 Track positions.

The layout of the tracks and the positions of the recorded tracks are shown on Figure 1. At each end of a recorded track there shall be a Guard Zone which shall extend from the last information written to the auxiliary tracks on the tape. The reference edge of the tape for dimensions specified in this section shall be the lower edge as shown in Figure 1. The magnetic coating, with the direction of tape travel as shown in Figure 1, shall be the side facing the observer.

All dimensions in Figure 1 shall be measured from an equivalent reference edge. The equivalent reference edge is a line through two points on the edge of the tape separated by 100 mm (3.937 in). All tape edge measurements shall be based on an average over a tape edge length of 10 mm (0.4 in).

201.5 Physical format along the length of tape.

The physical format of the recording along the length of the tape is shown in Figure 8. Immediately following the Physical Beginning of Tape (PBOT) shall be the initial erased tape zone which shall immediately precede Logical Beginning of Tape (LBOT). Immediately following the LBOT,, and continuing to Physical End of Tape (PEOT), shall be the recorded area of the tape.

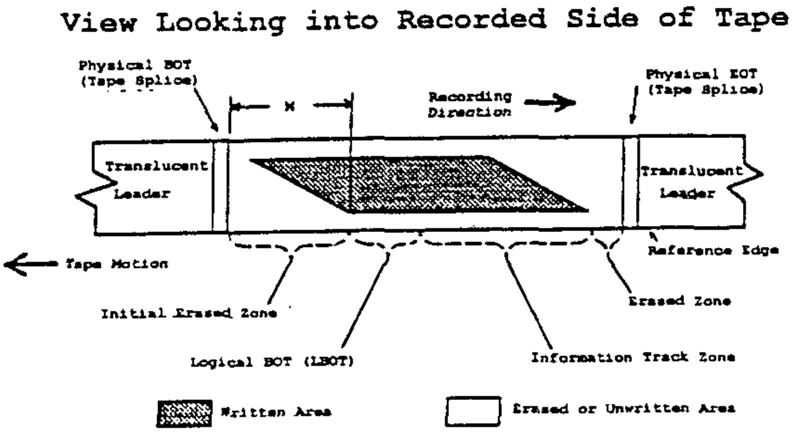


FIGURE 8 Recording Along the Length of the Tape

201.5.1 Physical beginning of tape.

The Physical beginning of tape (PBOT) shall be detected as the transition to the opaque area of the splice where the Leader tape is joined to the magnetic tape.

201.5.2 Initial erased zone.

The length of the Initial erased Zone (M) between the PBOT and the beginning of the LBOT shall be 6 inches.

201.5.3 Logical beginning of tape.

The Logical Beginning of Tape (LBOT) area begins immediately following the Initial Erased Zone and consists of 128 consecutive count-down tracks. Concurrently, the longitudinal servo control track shall write a series of 32 bit records as specified in Figure 3 and shall allow for identification and location of each two scan sets and provide for multiple transport synchronisation.

201.5.4 Erasure.

The tape shall be full-width anhysteretically erased for a distance of 152.4 mm (6 in) (minimum) in the direction of tape motion before the active recording zone on tape. The erasure shall be such that the output read level shall be no greater than 2% of the output level of a non-erased portion of tape.

201.5.5 Physical recording Density.

The physical density of recording shall be:

For all ONEs : 68, 235 bits/in

201.5.6 Mechanical parameters.

See Section 5.

201.6 8/9 Mapping

Mapping is identical to that used in MIL-STD-2179B and NATO STANAG 4283 ANNEX C format. Table IV and Table V is included herein for convenience.

Table IV 8- 9-bit map.

8 - Bit Data (Decimal)	9 - Bit Codeword (Binary) msb lsb	Codeword Digital Sum	Polarity Inversion Y=Yes, N=No
0	000100000	+2	Y
	010011100	-1	N
1	001000011	+2	Y
	001000100	-1	N
2	001000110	+2	Y
	001001110	-1	N
3	001001100	+2	Y
	001011010	-1	N
4	001011000	+2	Y
	000100101	-2	Y
5	001110000	+2	Y
	000101010	-2	Y
6	010000101	+2	Y
	000101111	-2	Y
7	010001010	+2	Y
	000110100	-2	Y
8	010001111	+2	Y
	000111011	-2	Y
9	010010100	+2	Y
	000111110	-2	Y
10	010011011	+2	Y
	001001001	-2	Y
11	010011110	+2	Y
	001010010	-2	Y
12	010101000	+2	Y
	001010111	-2	Y
13	010110011	+2	Y
	001011101	-2	Y
14	010110110	+2	Y
	001100100	-2	Y
15	010111100	+2	Y
	001101011	-2	Y
16	011010000	+2	Y
	001101110	-2	Y
17	011100011	+2	Y
	001110101	-2	Y
18	011100110	+2	Y
	001111010	-2	Y
19	011101100	+2	Y
	001111111	-2	Y
20	011111000	+2	Y
	010010001	-2	Y
21	100001001	+2	Y
	010100010	-2	Y
22	100010010	+2	Y
	010100111	-2	Y
23	100010111	+2	Y
	010101101	-2	Y
24	100011101	+2	Y
	010111001	-2	Y
25	100100100	+2	Y
	011000100	-2	Y
26	100101011	+2	Y
	011001011	-2	Y
27	100101110	+2	z
	011001110	-2	Y
28	100110101	+2	Y
	011010101	-2	Y
29	100111010	+2	Y
	011011010	-2	Y
30	100111111	+2	Y
	011011111	-2	Y
31	101001000	+2	Y
	011101001	-2	Y
32	101010011	+2	Y
	011110010	-2	Y
33	101010110	+2	Y
	011110111	-2	Y
34	101011100	+2	Y
	011111101	-2	Y
35	101100101	+2	Y
	100100001	-2	Y
36	101101010	+2	Y
	101000010	-2	Y
37	101101111	+2	Y
	101000111	-2	Y
38	101110100	+2	Y
	101001101	-2	Y
39	101111011	+2	Y
	101011001	-2	Y
40	101111110	+2	Y
	101110001	-2	Y
41	110010000	+2	Y
	110000100	-2	Y
42	110100011	+2	Y
	110001011	-2	Y
43	110100110	+2	Y
	110001110	-2	Y
44	110101100	+2	Y
	110010101	-2	Y
45	110111000	+2	Y
	110011010	-2	Y
46	111000101	+2	Y
	110011111	-2	Y
47	111001010	+2	Y
	110101001	-2	Y
48	111001111	+2	Y
	110110010	-2	Y
49	111010100	+2	Y
	110110111	-2	Y
50	111011011	+2	Y
	110111101	-2	Y
51	111011110	+2	Y
	111010001	-2	Y
52	111101000	+2	Y
	111100010	-2	Y
53	111110011	+2	Y
	111100111	-2	Y

Table IV 8- to 9-Bit map (continued)

8 - Bit Data (Decimal)	9 - Bit Codeword (Binary)	Codeword Digital Sum	Polarity Inversion Y=Yes, N=No
54	111110110	+2	Y
	111101101	-2	Y
55	111111100	+2	Y
	111111001	-2	Y
56	000010000	0	Y
	000010000	0	Y
57	000100011	0	Y
	000100011	0	Y
58	000100110	0	Y
	000100110	0	Y
59	000101100	0	Y
	000101100	0	Y
60	000111000	0	Y
	000111000	0	Y
61	001000101	0	Y
	001000101	0	Y
62	001001010	0	Y
	001001010	0	Y
63	001001111	0	Y
	001001111	0	Y
64	001010100	0	Y
	001010100	0	Y
65	001011011	0	Y
	001011011	0	Y
66	001011110	0	Y
	001011110	0	Y
67	001101000	0	Y
	001101000	0	Y
68	001110011	0	Y
	001110011	0	Y
69	001110110	0	Y
	001110110	0	Y
70	001111100	0	Y
	001111100	0	Y
71	010001001	0	Y
	010001001	0	Y
72	010010010	0	Y
	010010010	0	Y
73	010010111	0	Y
	010010111	0	Y
74	010011101	0	Y
	010011101	0	Y
75	010100100	0	Y
	010100100	0	Y
76	010101011	0	Y
	010101011	0	Y
77	010101110	0	Y
	010101110	0	Y
78	010110101	0	Y
	010110101	0	Y
79	010111010	0	Y
	010111010	0	Y
80	010111111	0	Y
	010111111	0	Y
81	011001000	0	Y
	011001000	0	Y
82	011010011	0	Y
	011010011	0	Y
83	011010110	0	Y
	011010110	0	Y
84	011011100	0	Y
	011011100	0	Y
85	011100101	0	Y
	011100101	0	Y
86	011101010	0	Y
	011101010	0	Y
87	011101111	0	Y
	011101111	0	Y
88	011110100	0	Y
	011110100	0	Y
89	011111011	0	Y
	011111011	0	Y
90	011111110	0	Y
	011111110	0	Y
91	100010001	0	Y
	100010001	0	Y
92	100100010	0	Y
	100100010	0	Y
93	100100111	0	Y
	100100111	0	Y
94	100101101	0	Y
	100101101	0	Y
95	100111001	0	Y
	100111001	0	Y
96	101000100	0	Y
	101000100	0	Y
97	101001011	0	Y
	101001011	0	Y
98	101001110	0	Y
	101001110	0	Y
99	101010101	0	Y
	101010101	0	Y
100	101011010	0	Y
	101011010	0	Y
101	101011111	0	Y
	101011111	0	Y
102	101101001	0	Y
	101101001	0	Y
103	101110010	0	Y
	101110010	0	Y
104	101110111	0	Y
	101110111	0	Y
105	101111101	0	Y
	101111101	0	Y
106	110001000	0	Y
	110001000	0	Y
107	110010011	0	Y
	110010011	0	Y

Table IV 8- to 9-Bit map (continued)

8-Bit Data (Decimal)	9-Bit Codeword (Binary)	Codeword Digital Sum	Polarity Inversion Y=Yes, N=No
108	110010110	0	Y
	110010110	0	Y
109	110011100	0	Y
	110011100	0	Y
110	110100101	0	Y
	110100101	0	Y
111	110101010	0	Y
	110101010	0	Y
112	110101111	0	Y
	110101111	0	Y
113	110110100	0	Y
	110110100	0	Y
114	110111011	0	Y
	110111011	0	Y
115	110111110	0	Y
	110111110	0	Y
116	111001001	0	Y
	111001001	0	Y
117	111010010	0	Y
	111010010	0	Y
118	111010111	0	Y
	111010111	0	Y
119	111011101	0	Y
	111011101	0	Y
120	111100100	0	Y
	111100100	0	Y
121	111101011	0	Y
	111101011	0	Y
122	111101110	0	Y
	111101110	0	Y
123	111110101	0	Y
	111110101	0	Y
124	111111010	0	Y
	111111010	0	Y
125	111111111	0	Y
	000111001	-1	N
126	000100001	+1	N
	001001011	-1	N
127	001000010	+1	N
	001010101	-1	N
128	001000111	+1	N
	001011111	-1	N
129	001001101	+1	N
	001101001	-1	N
130	001011001	+1	N
	001110010	-1	N
131	001110001	+1	N
	001110111	-1	N
132	010000100	+1	N
	001111101	-1	N
133	010001011	+1	N
	010010011	-1	N
134	010001110	+1	N
	010010110	-1	N
135	010010101	+1	N
	010100101	-1	N
136	010011010	+1	N
	010101010	-1	N
137	010011111	+1	N
	010101111	-1	N
138	010101001	+1	N
	010110100	-1	N
139	010110010	+1	N
	010111011	-1	N
140	010111101	+1	N
	010111110	-1	N
141	011010001	+1	N
	011001001	-1	N
142	011100010	+1	N
	011010010	-1	N
143	011100111	+1	N
	011010111	-1	N
144	011101101	+1	N
	011011101	-1	N
145	011111001	+1	N
	011100100	-1	N
146	100001000	+1	N
	011101011	-1	N
147	100010011	+1	N
	011101110	-1	N
148	100010110	+1	N
	011110101	-1	N
149	100011100	+1	N
	011111010	-1	N
150	100100101	+1	N
	011111111	-1	N
151	100101010	+1	N
	100100011	-1	N
152	100101111	+1	N
	100100110	-1	N
153	100110100	+1	N
	100101100	-1	N
154	100111011	+1	N
	101000101	-1	N
155	100111110	+1	N
	101001010	-1	N
156	101001001	+1	N
	101001111	-1	N
157	101010010	+1	N
	101010100	-1	N
158	101010111	+1	N
	101011011	-1	N
159	101011101	+1	N
	101011110	-1	N
160	101100100	+1	N
	101110011	-1	N
161	101101011	+1	N
	101110110	-1	N

Table IV 8- to 9-Bit map (continued)

8-Bit Data (Decimal)	9-Bit Codeword (Binary)	Codeword Digital Sum	Polarity Inversion Y=Yes, N=No
162	101101110	+1	N
	101111100	-1	N
163	101110101	+1	N
	110001001	-1	N
164	101111010	+1	N
	110010010	-1	N
165	101111111	+1	N
	110010111	-1	N
166	110010001	+1	N
	110011101	-1	N
167	110100010	+1	N
	110100100	-1	N
168	110100111	+1	N
	110101011	-1	N
169	110101101	+1	N
	110101110	-1	N
170	110111001	+1	N
	110110101	-1	N
171	111000100	+1	N
	110111010	-1	N
172	111001011	+1	N
	110111111	-1	N
173	111001110	+1	N
	111010011	-1	N
174	111010101	+1	N
	111010110	-1	N
175	111011010	+1	N
	111011100	-1	N
176	111011111	+1	N
	111100101	-1	N
177	111101001	+1	N
	111101010	-1	N
178	111110010	+1	N
	111101111	-1	N
179	111110111	+1	N
	111110100	-1	N
180	111111101	+1	N
	111111011	-1	N
181	010110111	+1	N
	111111110	-1	N
182	001000001	+3	N
	001010011	-3	N
183	010000010	+3	N
	001010110	-3	N
184	010000111	+3	N
	001111011	-3	N
185	010001101	+3	N
	001111110	-3	N
186	010011001	+3	N
	010100011	-3	N
187	010110001	+3	N
	010100110	-3	N
188	011100001	+3	N
	01100010	-3	N
189	100000100	+3	N
	011001010	-3	N
190	100001011	+3	N
	011001111	-3	N
191	100001110	+3	N
	011011011	-3	N
192	100010101	+3	N
	011011110	-3	N
193	100011010	+3	N
	011110011	-3	N
194	100011111	+3	N
	011110110	-3	N
195	100101001	+3	N
	101000011	-3	N
196	100110010	+3	N
	101000110	-3	N
197	100110111	+3	N
	101001100	-3	N
198	100111101	+3	N
	110000101	-3	N
199	101010001	+3	N
	110001010	-3	N
200	101100010	+3	N
	110001111	-3	N
201	101100111	+3	N
	110010100	-3	N
202	101101101	+3	N
	110011011	-3	N
203	101111001	+3	N
	110011110	-3	N
204	110100001	+3	N
	110110011	-3	N
205	111000010	+3	N
	110110110	-3	N
206	111000111	+3	N
	110111100	-3	N
207	111001101	+3	N
	111100011	-3	N
208	111011001	+3	N
	111100110	-3	N
209	111110001	+3	N
	111101100	-3	N
210	010000011	+4	Y
	001100101	-3	N
211	010000110	+4	Y
	001101010	-3	N
212	010001100	+4	Y
	001101111	-3	N
213	010011000	+4	Y
	000101001	-4	Y
214	010110000	+4	Y
	000110010	-4	Y
215	100000101	+4	Y
	000110111	-4	Y

Table IV 8- to 9-Bit map (continued)

216	100001010	+4	Y
	000111101	-4	Y
217	100001111	+4	Y
	001010001	-4	Y
218	100010100	+4	Y
	001100010	-4	Y
219	100011011	+4	Y
	001100111	-4	Y
220	100011110	+4	Y
	001101101	-4	Y
221	100101000	+4	Y
	001111001	-4	Y
222	100110011	+4	Y
	010100001	-4	Y
223	100110110	+4	Y
	011000010	-4	Y
224	100111100	+4	Y
	011000111	-4	Y
225	101010000	+4	Y
	011001101	-4	Y
226	101100011	+4	Y
	011011001	-4	Y
227	101100110	+4	Y
	011110001	-4	Y
228	101101100	+4	Y
	101000001	-4	Y
229	101111000	+4	Y
	110000010	-4	Y
230	111000011	+4	Y
	110000111	-4	Y
231	111000110	+4	Y
	110001101	-4	Y
232	111001100	+4	Y
	110011001	-4	Y
233	111011000	+4	Y
	110110001	-4	Y
234	111110000	+4	Y
	111100001	-4	Y
235	001000000	+4	Y
	010101100	-3	N
236	011100000	+4	Y
	011010100	-3	N
237	110100000	+4	Y
	011111100	-3	N
238	010000001	+5	N
	001100011	-5	N
239	100000010	+5	N
	001100110	-5	N
240	100000111	+5	N
	001101100	-5	N
241	100001101	+5	N
	011000011	-5	N
242	100011001	+5	N
	011000110	-5	N
243	100110001	+5	N
	110000011	-5	N
244	101100001	+5	N
	110000110	-5	N
245	111000001	+5	N
	110001100	-5	N
246	010000000	+6	Y
	110000001	-6	Y
247	100000011	+6	Y
	001100001	-6	Y
248	100000110	+6	Y
	011000001	-6	Y
249	100001100	+6	Y
	000110001	-6	Y
250	100011000	+6	Y
	000110011	-5	N
251	100110000	+6	Y
	000110110	-5	N
252	101100000	+6	Y
	000111100	-5	N
253	111000000	+6	Y
	011001100	-5	N
254	100000001	+7	N
	001111000	-5	N
255	100000000	+8	Y
	110011000	-5	N

DSV	Waveform Polarity	Positive CDS	Negative CDS
+	+	chosen	
+	-		chosen
- or 0	+		chosen
- or 0	-	chosen	

Table V Code Word Mapping Table

NOTE: Waveform polarity is the position (+ or -) of the waveform at the end of the previous codeword.

ANNEX B

PART 2 LOGICAL RECONNAISSANCE DATA FORMAT

LOGICAL FORMAT IS DEFINED IN STANAG 7023

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ANNEX C

PART 1 PHYSICAL FORMAT

"ANALOGUE 12.65mm CASSETTE TAPE RECORDER STANDARD"

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose.

The purpose of this standard is to ensure the ability to exchange S-VHS analogue video data within the NATO Reconnaissance Community, to Standardise the cassette for 12.65 mm (0.5 in) magnetic tape, and to ensure that a recording made on one machine can be replayed on any other machine that conforms to this standard.

1.2 Scope.

This standard establishes the S-VHS format as recorded on the tape, the principal properties of the tape, and the dimensions and physical properties of the cassette.

1.3 Applicability.

This standard defines requirements for a ground based recorder to replay various S-VHS compatible video formats available from airborne sources.

2.0 REFERENCE DOCUMENTS

2.1 Commercial Standards.

The issue of the following document currently in effect form a part of this standard to the extent specified herein.

IEC 774 - International Electrotechnical Commission Publication 774

2.2 Other Standards.

Inter-Range Instrumentation Group (IRIG)

200-70 IRIG RCC Time Code Standards

3.0 GENERAL REQUIREMENTS

3.1 General.

This section covers the general requirements for analogue data recording made on 12.65 mm (0.5 in) magnetic tape cassettes and is based on IEC 774. The deviations from IEC 774 that enhance this standard to S-VHS are detailed in paragraph 4.

3.1.1 Recorder.

The recorder in replay shall accommodate asynchronous formats, and synchronous 525 line - 60 field NTSC, 625 line -50 field PAL and 625 line - 50 field SECAM standard television formats.

3.1.2 Cassette.

The dimensions of the cassette shall be in accordance with Figures 1 to 18 contained in the IEC Publication 774 - Part 1 "VHS and compact VHS video cassette system".

3.1.2.1 Magnetic Tape.

The magnetic tape shall be S-VHS compatible with a coercivity of 900 Oersted (Oe).

3.1.2.2 Reference Tape.

A reference tape has been defined for measurements of the recording characteristics of S-VHS tapes. This reference tape is numbered SRT-1. The reference tape is available from:

Video Research and Development Labs	Tel: 045-453-1111
Victor Company of Japan Ltd	Fax: 045-453-6140
3-12, Moriyacho, Kanagawa-ku	Tlx: J47753-JVCYHA
Yokohama, 221, Japan	

4.0 DETAILED REQUIREMENTS

4.1 Cassette.

To satisfy this standard the cassette shall have an S-VHS identification hole as shown in Figure 6.

4.2 Recorder.

4.2.1 Track Configuration and Dimensions.

The track configuration and dimensions shall be in accordance with Figure 8 and Table 1.

4.2.2 Low-pass Filter.

The luminance component of the composite video signal shall be separated by a low-pass filter, the attenuation of which shall be greater than 40 dB at the chrominance sub-carrier frequency.

4.2.3 Pre-emphasis and Clipping.

The luminance signal shall be pre-emphasised and clipped prior to frequency modulation. The level from sync tip to peak white is 100% with the following clipping levels:

white clipping level	210% +10%,-5% measured from sync tip
dark clipping level	70% + 10% measured from sync tip

4.2.4 Modulation Characteristics.

The FM carrier frequencies corresponding to reference video levels shall be as shown below. See also Figure 9.

reference peak white level	7.0 MHz + 0.1 MHz
reference sync tip level	5.4 MHz + 0.1 MHz
deviation	1.6 MHz + 0.1 MHz

4.2.5 Recording Level.

The recording current shall have the optimum value at all frequencies within the entire FM carrier range as defined in paragraph 4.2.4.

4.2.6 Signal to Noise Ratio.

The signal to noise ratio shall be at least 45 dB unweighted.

4.2.7 Horizontal Resolution.

The horizontal resolution shall be greater than 400 lines.

4.2.8 FM Helical Audio Tracks.

4.2.8.1 Auxiliary Data.
The auxiliary data, detailed in NATO STANAG 7023, will utilise the high quality FM helical tracks using the S-VHS depth multiplexed system, subject to the provisions specified at para.4.2.9.2

4.2.8.2 Carrier Frequencies.
The left and right hand audio signals shall be frequency modulated onto a 1.4 MHz and a 1.8 MHz carrier respectively (625 line - 50 field), 1.3 MHz and a 1.7 MHz carrier respectively (525 line - 60 field).The operating frequency deviation shall be ± 50 KHz at 400 Hz, with a maximum deviation of ± 150 KHz.

See Figure 9.

	525 line - 60 field	625 line - 50 field
CH - L	1.3 MHz ± 10KHz	1.4 MHz ± 10KHz
CH - R	1.7 MHz ± 10KHz	1.8 MHz ± 10KHz

4.2.8.3 Dynamic Range.
The dynamic range shall exceed 85 dB.

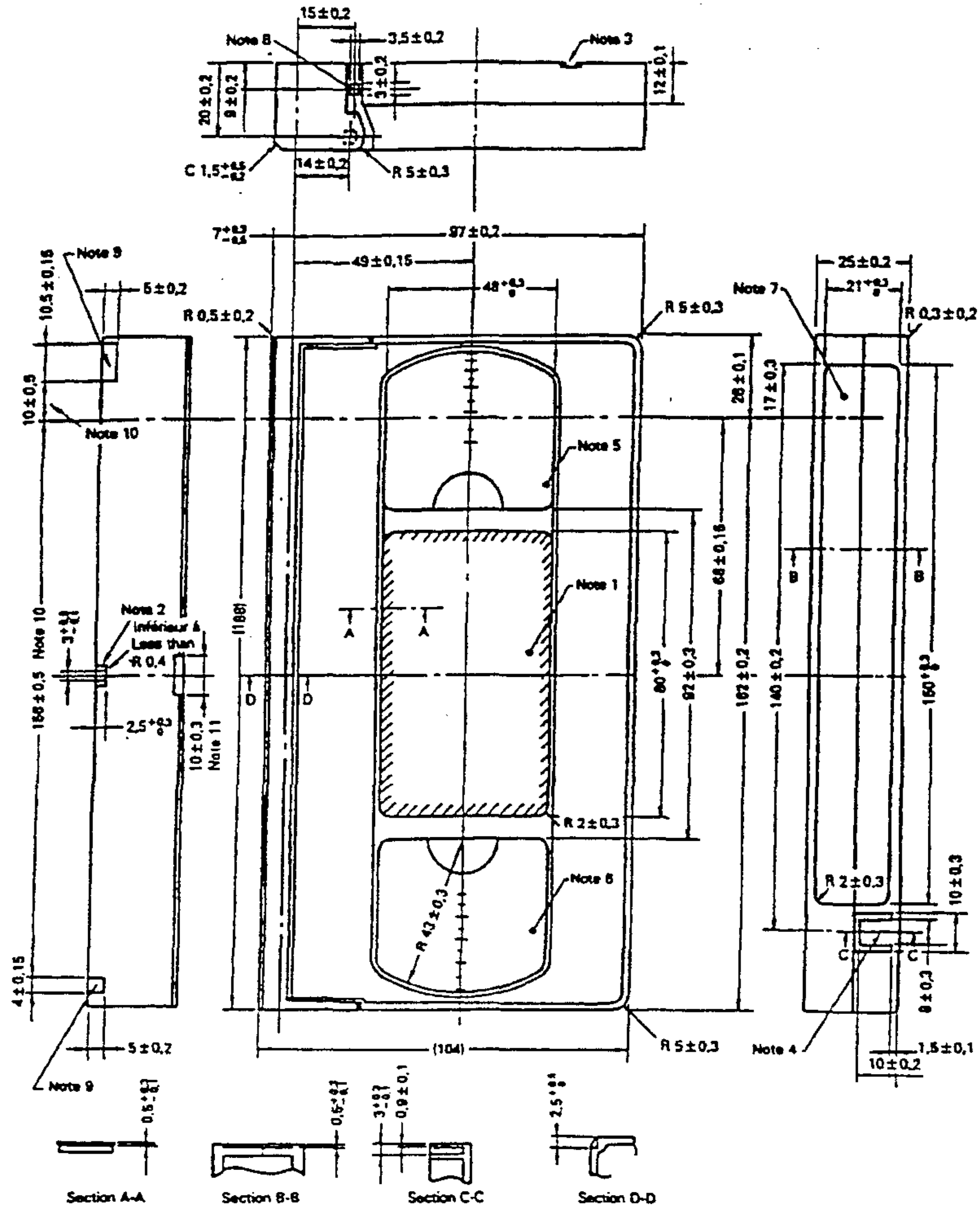
4.2.8.4 Frequency Response.
The frequency response shall be 20Hz to 20KHz

4.2.8.5 Signal to Noise Ratio.
The signal to noise ratio shall be greater than 45 dB.

4.2.9 Longitudinal Audio Tracks.

4.2.9.1 Channel 1 Audio Track.
Channel 1 audio track see Figure 8 will be reserved for cockpit voice recording.

4.2.9.2 Channel 2 Audio Track.
Channel 2 audio track see Figure 8 will be reserved for the recording of a mission time code such as IRIG B and/or mission event markers.



Dimensions in millimetres

FIGURE 1. TOP VIEW OF S-VHS CASSETTE

Figure 1. NOTES:

1 The top label area.

2 Guide grove A to prevent misinsertion.

3 Guide grove B to prevent misinsertion.

4 Break-out lug to prevent accidental erasure.

5 Window for take-up reel.

6 Window for supply reel.

7 Side label area.

8 Unlocking pin for the front cover.

9 Slots for positioning of the cassette.

10 These allowances include slight play of the front cover.

11 This recess is to prevent misinsertion but may not necessarily exist.

Figure 2. NOTES:

1 Reference hole.

2 Hole for the sensor lamp.

3 Hole for the sensor light path.

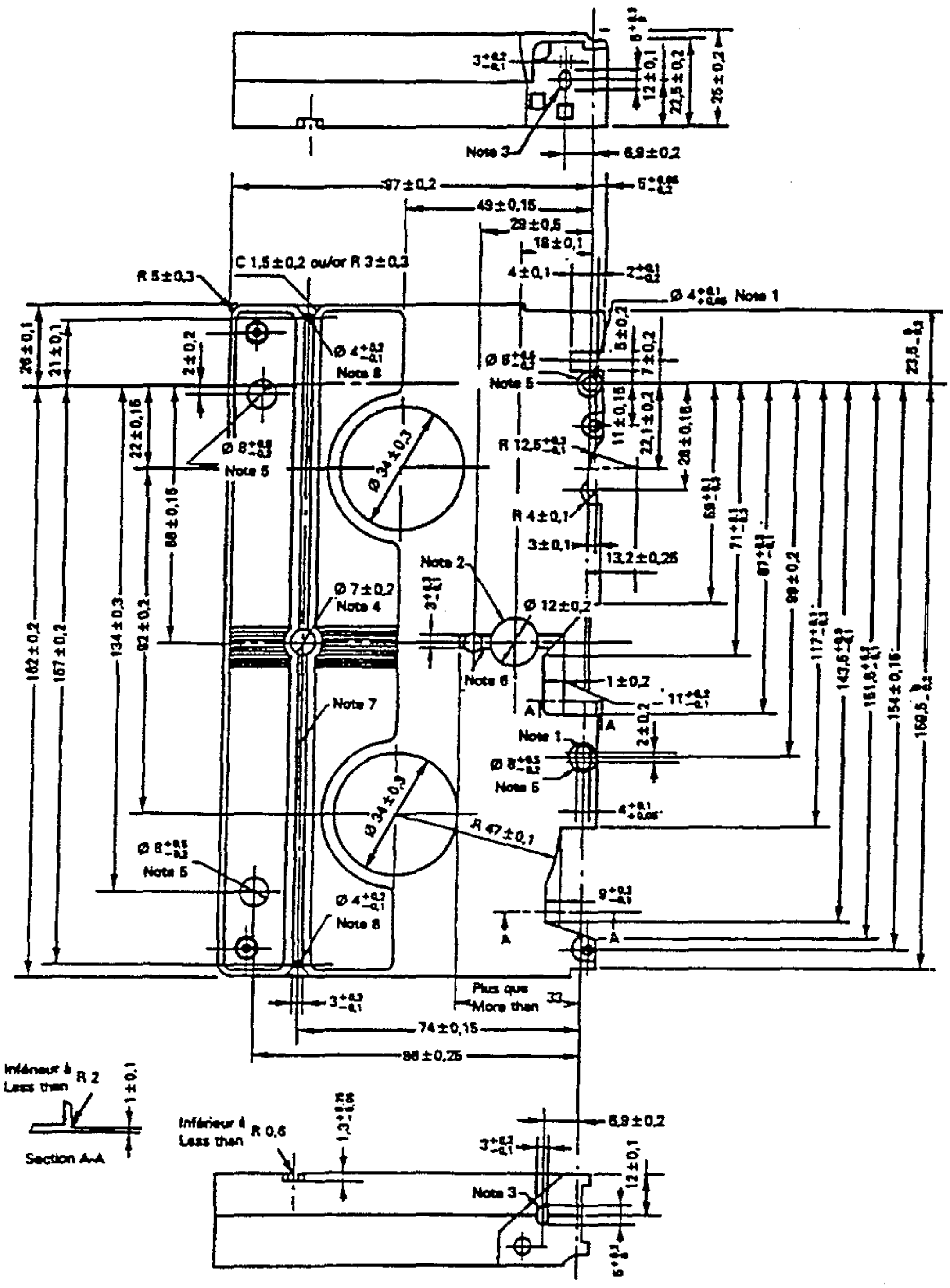
4 Unlocking hole for reel brake.

5 Datum plane.
The flatness of these four datum planes shall be less than 0.2mm.

6 Guide grove A to prevent misinsertion.

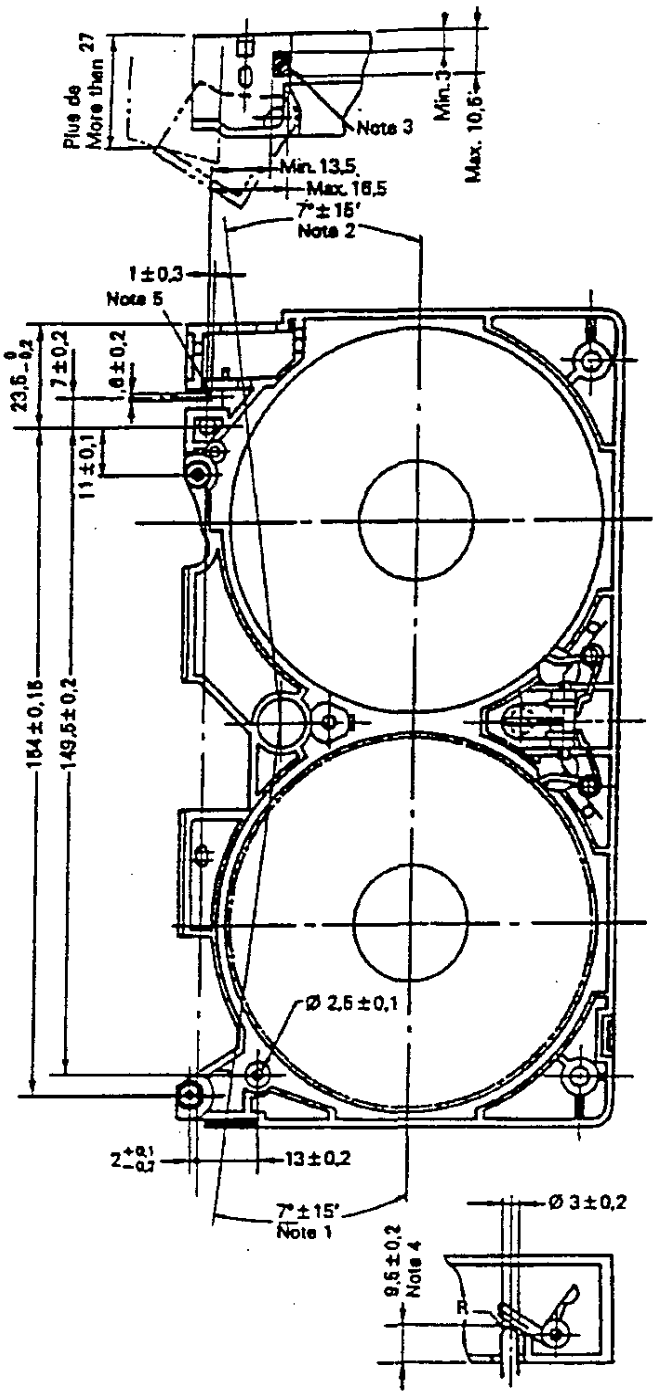
7 Guide grove B to prevent misinsertion.

8 Auxiliary hole position.



Dimensions in millimetres

FIGURE 2. BOTTOM VIEW OF S-VHS CASSETTE



Dimensions in millimetres

FIGURE 3. INNER STRUCTURES

NOTES:

1 Sensor light angle of supply side.

2 Sensor light angle of take-up side.

3 Pushing position of the cover-unlocking device of the recorder.

4 The position of the brake-unlocking pin of the recorder.

5 The position of the lever in the recorder for opening the cassette cover.

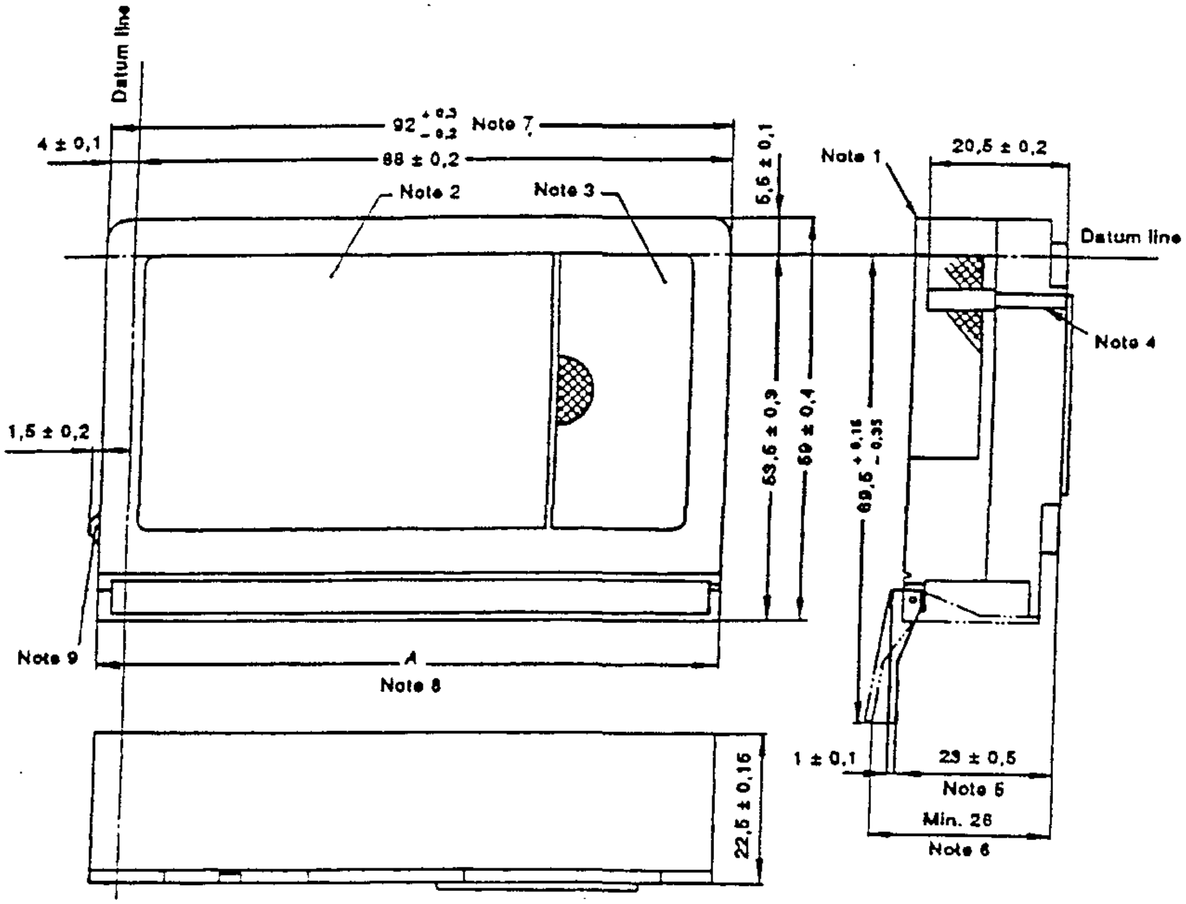


FIGURE 4. COMPLETE COMPACT CASSETTE CASE (VIEW 1)

Dimensions in millimetres

Notes:

1 *All ridges on the cassette body may be less than R 0.5mm or C 0.5mm.*

2 Top label area.

3 Window for supply reel.

4 Guide grove - When the gauge, having dimensions of the grove on the lower case, is inserted into the grove from the bottom, it shall not contact the walls of the corresponding grove in the upper case.

5 The distance is shown when the front cover is in the normal opening position.

6 Maximum value when the front cover is fully opened.

7 92mm ± 0.3mm for the type of front cover without a locking structure.

8 The A length of the front cover shall be smaller than the cassette length by within 0.6mm.

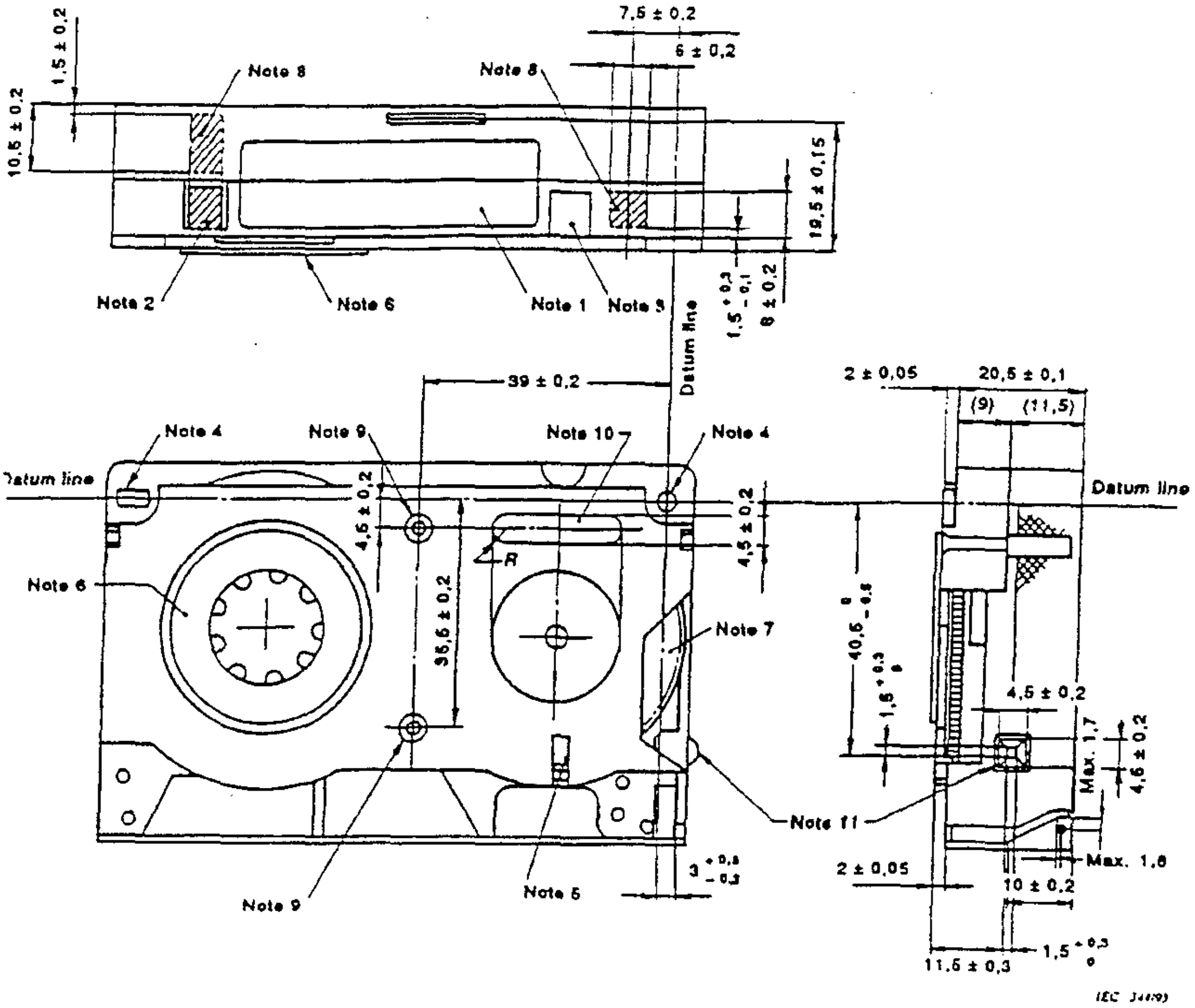


FIGURE 5. COMPLETE COMPACT CASSETTE CASE (VIEW 2)

NOTES:

1 Side label area.

2 Erasure prevention tab area. The depth of the recess shall be 2.5mm

3 Grove corresponding to the unlocking pin for reel brake.

4 Datum holes.

5 Grove to prevent misinsertion.

6 Supply reel.

7 Take-up reel.

8 Auxiliary hole positions. The depth of the recess shall be 2.5mm.

9 Screw locations for securing upper and lower cases.

10 Area for identification. This identification shall not protrude from the lower surface.

11 Front cover unlocking device intended only for the type of front cover with a locking structure.

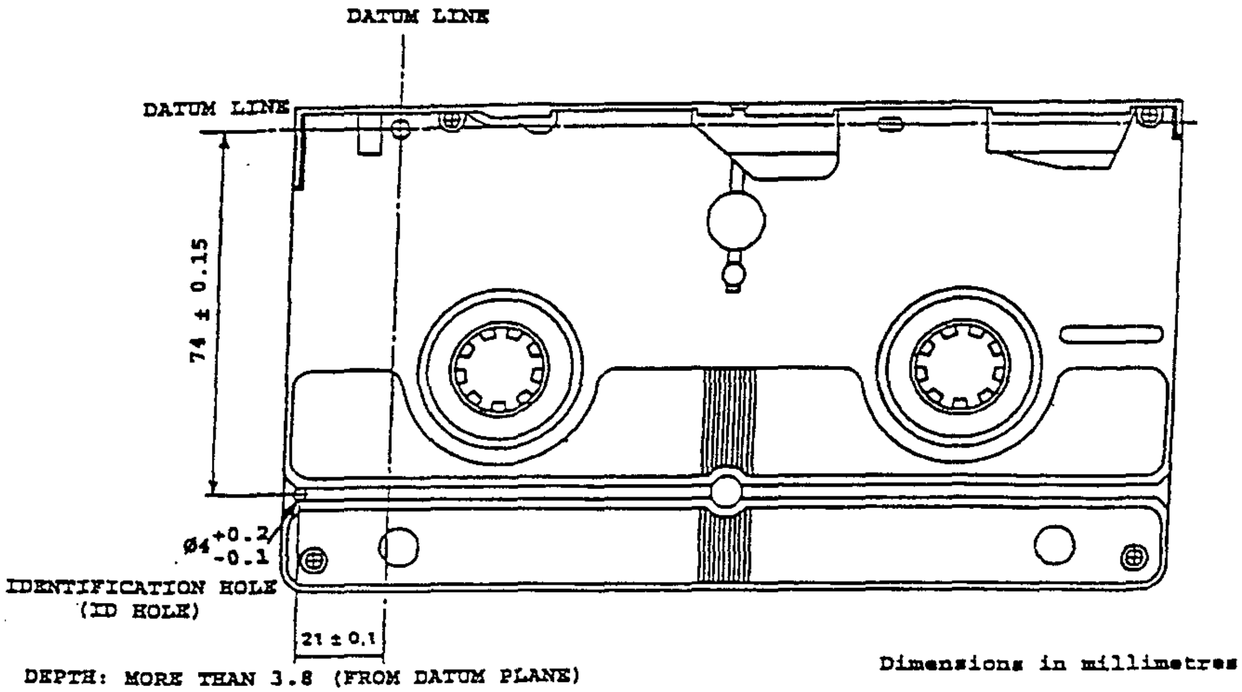


FIGURE 6. S-VHS CASSETTE SHOWING IDENTITY HOLE

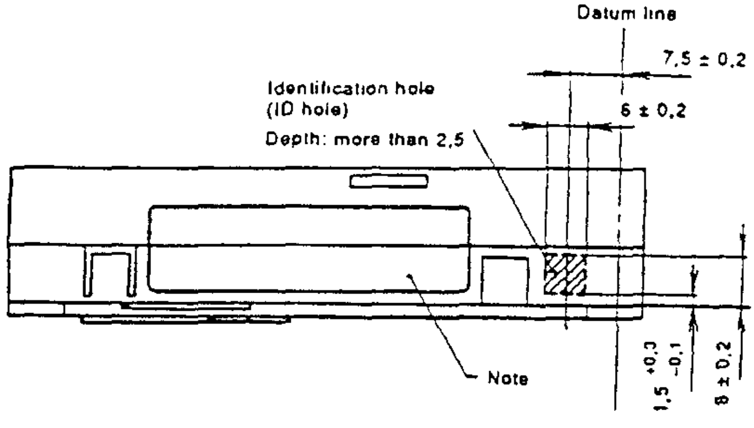
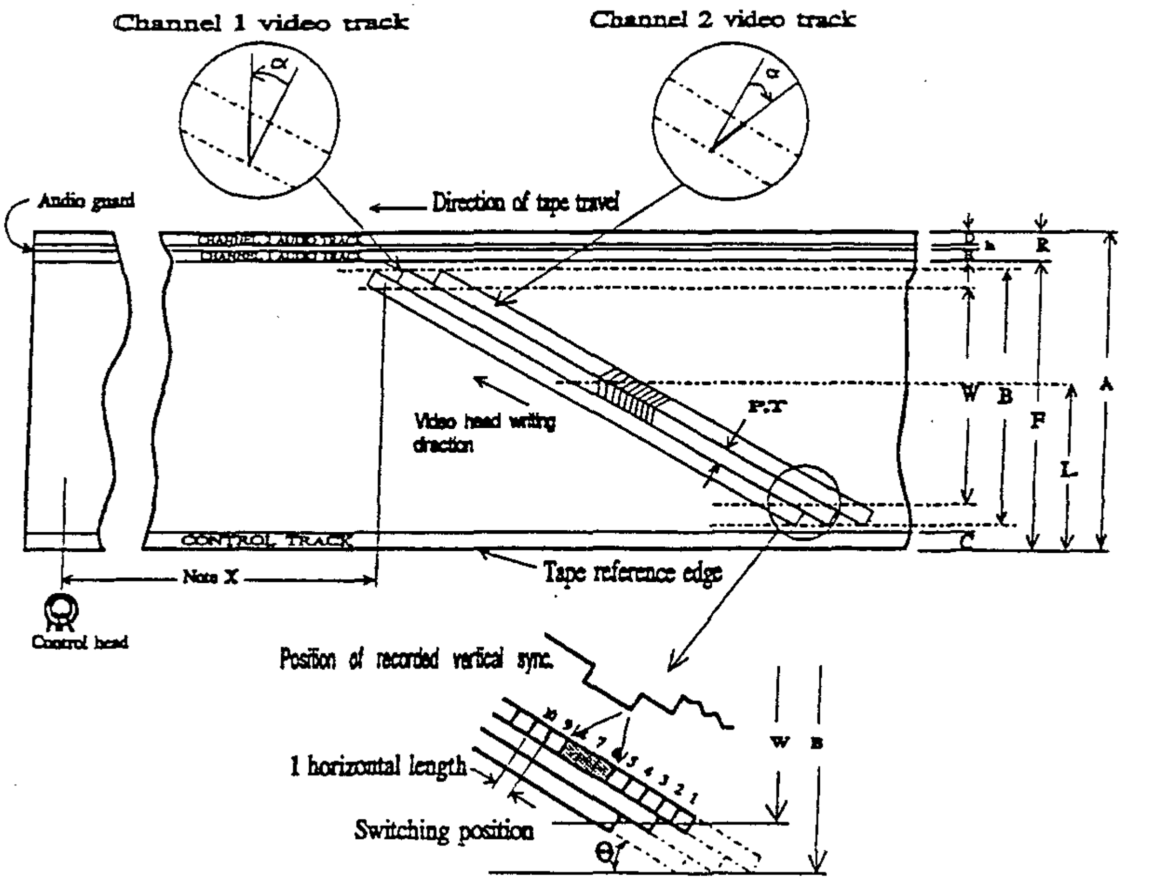


FIGURE 7. COMPACT S-VHS CASSETTE SHOWING IDENTITY HOLE



NOTE : X shall be measured from the end of the 180° scan of channel 2 to the recorded control signal on the tape.

FIGURE 8. TRACK CONFIGURATION AND BASIC DESIGN DIMENSIONS.(VIEW FROM MAGNOSENSITIVE SIDE)

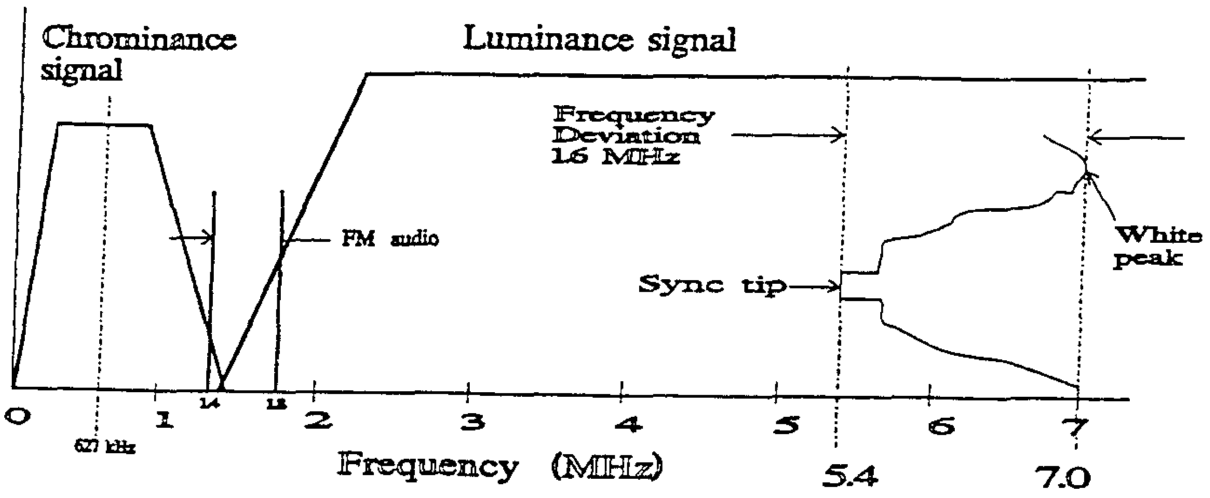


FIGURE 9. S-VHS FREQUENCY SPECTRUM

TABLE 1 Track configuration
see Figure 8.

Dimensions in millimetres

	Item	525 line 60 Hz	625 line 50 Hz
B	Total video width	10.60	10.60
W	Effective video width (180°)	10.07	10.07
L	Video track centre reference edge of the tape	6.2	6.2
P	Video track pitch	0.058	0.049
T	Video track width	0.058	0.049
C	Control track width	0.75 ± 0.1	0.75 ± 0.1
R	Audio track width (monomorphic)	1.0 ± 0.1	1.0 ± 0.1
D	Audio track (channel 2) width (stereophonic - right)	0.35 ± 0.05	0.35 ± 0.05
E	Audio track (channel 1) width (stereophonic - left)	0.35 ± 0.05	0.35 ± 0.05
F	Audio track reference line	11.65 ± 0.05	11.65 ± 0.05
h	Audio to audio track guard band width	0.3 ± 0.05	0.3 ± 0.05
θ	Video track angle	5°58'09.9"	5°57'50.3"
θo	Video track angle (tape stationary)	5°56'07.4"	5°56'07.4"
X	Position of audio and control head	79.244	79.244
α	Video head gap azimuth angle	6° ± 10'	6° ± 10'

ANNEX C

PART 2 LOGICAL RECONNAISSANCE DATA FORMAT

LOGICAL FORMAT IS DEFINED IN STANAG 7023

ANNEX D

PART 1 PHYSICAL FORMAT

"DIGITAL 19mm CASSETTE TAPE RECORDER STANDARD"

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25.4 mm (1 in) Type DCRsi Recorded Instrumentation-Digital Cartridge Tape Format

Version 1.1 .... 4 June, 1998

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Table of Contents:

List of Tables:

List of Figures:

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25.4 mm (1 in) Type DCRsi Recorded Instrumentation Digital Cartridge Tape Format

1 Scope and purpose

1.1 Scope

This standard establishes the format of information on 25.4 mm (1 in) type DCRsi instrumentation digital cartridges. It specifies the dimensions and locations of the transverse scan data and pilot tone track, the control track and the longitudinal data track. It defines the formatting, randomizing, ECC, and other recording requirements of the data blocks forming the transverse data record, containing user data and other associated data and specifies the content, format, and recording method for the control record to ensure that a compliant recorder will be able to reproduce the recorded tape. This standard also specifies the recording requirements for the longitudinal records contained in the longitudinal data tracks. Additionally this standard specifies the pre-record and post-record zones of the transverse scan tracks and the longitudinal data track. The physical requirements, magnetic requirements and test methods for the magnetic tape and tape cartridge are also specified in this standard. All dimensions given are metric with their corresponding U.S. customary engineering units (similar to British Imperial units) shown in parentheses.

> **Note:** It is possible that compliance with this standard may require the use of an invention protected by patent rights. The sponsor of this standard has filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license; however, no warranty is made or implied that this is the only license that may be required to avoid patent infringement in the use of this standard.

1.2 Purpose

The purpose of this standard is to ensure a direct and unique correspondence between user data (as defined in this standard) and the format recorded on tape. In order to ensure data interchange using this standard, it is necessary for interchange parties to agree upon performance levels and source data format. This standard is distinct from a specification in that it delineates a minimum of restrictions consistent with compatability in media and information interchange transactions.

1.3 Compliance

An interchange instrumentation tape can be said to comply with this standard if it complies with all the mandatory requirements of this standard. Any recording made on a machine compliant with this standard shall be interoperable and interchangeable with any recording made on any other recorder also compliant with this standard. In the text that follows, a mandatory requirement is expressed by the word "shall."

2 Referenced standards and related publications

2.1 Referenced American national standards

This standard is intended to be used with the following American national standard:

IRIG-B

2.2 Related publications

The following publications are referenced for informative purposes:

Viterbi Detection of Class IV Partial Response on a Magnetic Recording Channel by Roger W. Wood and David A. Petersen (IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. COM-34, NO. 5, MAY, 1986)

High data rate magnetic recording in a single channel by C. H. Coleman, D. A. Lindholm, D. A. Petersen, and R. Wood (JOURNAL OF THE INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS, VOL. 55, NO. 6, PP. 229-236, JUNE 1985)

Digital Maximum Likelihood Detector for Class IV Partial Response, United States Patent No. 4,504,872. Inventor: David A. Petersen. Date of Patent: March 12, 1985. Assignee: Ampex Corporation, Redwood City, Calif.

3 Definitions

The following definitions, listed in alphabetic order, and those given in the American National Dictionary for Information Processing, ANSI X3/TR-1-82, apply to this standard:

append record: A record made within a single record session in which new data are recorded seamlessly at the end of previously recorded data.

auxiliary data: Optional user information of secondary importance.

azimuth: The angular deviation of the mean flux transition line from a line normal to the nominal track centerline.

basic dimension: A fundamental dimension on which the tape record of this standard is based.

binary: Numbers in binary format are numbers to the base 2 and are shown with a subscript 2. (e.g. Decimal 10 is represented as 1010_2 in binary format.)

bi-phase mark: An encoding method for serial data in which an input bit of "0" is represented by transitions at the output at both edges of the bit-cell period of the input data and an input bit of "1" is represented by transitions at the output at both edges of the bit-cell period and an intermediate transition at the half bit-cell period. The resulting encoded signal is self-clocking and not polarity sensitive.

byte: A contiguous set of 8 bits that are acted on as a unit.

check bytes: Redundant data bytes added to the record data to facilitate error correction on playback.

Class IV partial response: An equalization and detection method allowing improved signal performance for a limited bandwidth record/playback channel.

Class IV partial response precoding: A non-redundant encoding achieved by passing the randomized formatted data through a feedback loop (with modulo-2 addition of feedback to data) including a 2-bit delay.

clock run-down: The sequence of bits at the end of each transverse scan track representing 1/6 the clock frequency of the transverse scan data.

clock run-up: The sequence of bits at the commencement of each transverse scan track representing 1/6 the clock frequency of the transverse scan data.

control record: The magnetization pattern or associated information recorded into the control track.

control track: The longitudinal track farthest from the reference edge of the tape which represents the scanner tachometer signal in record.

ECC (Error correction coding): A method of adding redundant data in the form of parity check bytes to a recorded signal such that the location of errors in the playback data can be identified and the erroneous playback data corrected.

Galois field: A mathematical field containing a finite number of elements in which algebraic operations may be performed. The number of field elements is generally written as an argument in parentheses, e.g. GF(256).

hexadecimal: Numbers in hexadecimal format are numbers to the base 16 and are shown with a subscript 16. (e.g. Decimal 10 is represented as A_{16} in hexadecimal format.)

longitudinal data track: The longitudinal track between the control track and the transverse tracks on the tape. The data recorded are dependent upon the type of record zone.

lsb: The least significant bit of a series of bits forming a byte or word.

LSB: The least significant byte of a series of bytes.

lsn: The least significant nibble of a series of nibbles.

msb: The most significant bit of a series of bits forming a byte or word.

MSB: The most significant byte of a series of bytes.

msn: The most significant nibble of a series of nibbles.

nibble: An ordered string of 4 bits starting with the most significant bit and ending with the least significant bit, representing a numeric value to be acted on as a unit.

pilot: A sine wave signal of relatively low frequency which is added to the transverse track data record signal to facilitate track identification and location on playback.

post-record zone: The third zone of a recording, following the user record zone, in which the SAT data in the transverse scan track and the time code field in the longitudinal data track differ from that in the user record zone.

pre-record zone: The first zone of a recording, preceding the user record zone, in which the SAT data in the transverse scan track and the time code field in the longitudinal data track differ from that in the user record zone.

SAT: The Scan address, Auxiliary data, or Time code (SAT) byte is the last byte of each code-word in a transverse scan track. The SAT byte functionality depends upon its location in the transverse scan track as well as the particular record zone.

scan track sync (STS): The sequence of bits following the run-up sequence on every transverse track.

standard alignment tape: A tape, the performance of which is known and stated in relation to that of the master standard reference tape.

Note: A master standard alignment tape has been established. The Ampex Corporation will make available for purchase, secondary standard alignment tapes (P/N 1294025).

For ordering information contact:

Ampex Corporation
500 Broadway
Redwood City
CA 94063-3199
U.S.A.

time code: A number in binary format (5 bytes) representing the time in milliseconds. A specific implementation may permit time code to be synchronized to IRIG-B time from an external source.

track: A narrow, defined area on tape along which a series of magnetic signals may be recorded.

transverse scan track: A narrow defined area on tape, inclined at a small angle to a line perpendicular to the reference edge of the tape, along which a series of magnetic signals may be recorded.

user record zone: The second zone of a recording, following the pre-record zone and preceding the post-record zone in which user data are recorded.

user record spacing: The spacing between the user record zone of one record session and the user record zone of the next record session.

4 Tape recorded format

4.1 Overview

This section of the standard specifies the physical dimensions and locations of the transverse data, control pilot tone, control and longitudinal data tracks recorded for 25.4 mm (1 in) type DCRsi transverse scan cartridges.

4.2 General specifications

4.2.1 Dimensions

Dimensions are in the metric system. The metric dimensions are derived from U.S. customary engineering units (similar to British Imperial units) which are shown for reference in parentheses.

4.2.2 Test conditions

Tests and measurements made on a recorded tape to check the requirements of this standard shall be made under the following conditions:

Temperature:	20°C ± 1°C (68°F ± 2°F);
Relative humidity:	50% ± 2%;
Barometric pressure:	96 kPa ± 10 kPa (13.93 ± 1.45 psi);
Tape tension:	1.65 N ± 0.25 N (5.9 ± 0.9 ozf).

4.2.3 Tape conditioning

Conditioning of the tape stock before recording and testing shall be as follows:

Storage conditioning:	Not less than 24 hours;
Environmental	Stabilized to the conditions specified in Section 4.2.2 on page 5;
Tape tension:	Wound on a reel at a tension of 1.10 N to 1.65 N (4 ozf to 6 ozf).

4.2.4 Tape reference edge

The reference edge of the tape for dimensions specified in this standard shall be the lower edge as shown in Figure 1 on page 7. The magnetic coating, with the direction of tape travel as shown in Figure 1 on page 7, shall be on the side facing the observer.

4.2.5 Equivalent reference edge

All dimensions in the table and figures shall be measured from an equivalent reference edge with the exception of dimensions I, J, K, and P and azimuth angles γ_1 and γ_2. The equivalent reference edge is a line through three points on the edge of tape separated by 115 mm (4.53 in) and constrained to lie in one straight line. This constraint may be a physical deformation or an equivalent mathematical transformation. Measurements shall be made from the center point of the reference edge.

4.3 Track locations and dimensions

Track locations and dimensions for the format shall be as specified in Figure 1 on page 7 and Table 1 on page 9.

4.4 Relative positions of recorded signals

The relative positions of the transverse scan tracks, the control track, and the longitudinal data track shall be as shown in Figure 2 on page 8 and Table 1 on page 9.

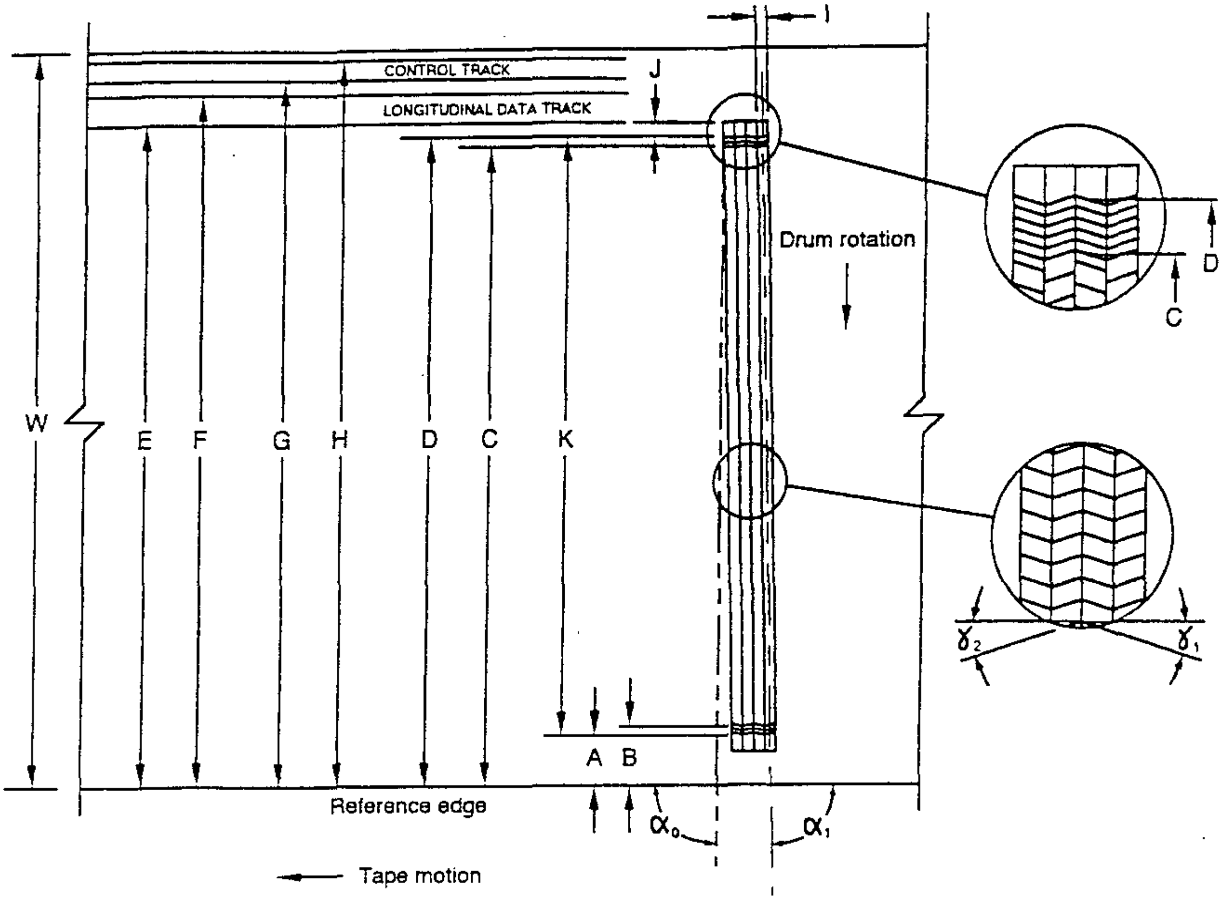
4.5 Gap azimuth

4.5.1 Transverse scan tracks

Azimuth recording shall be utilized in the DCRsi format to obviate the need for guard bands between the transverse scan tracks. Transverse scan tracks recorded with head 1 and other odd-numbered heads shall have a positive azimuth angle (γ_1) and transverse scan tracks recorded with head 2 and other even-numbered heads shall have a negative azimuth angle (γ_2) as shown in Figure 1 on page 7 and Table 1 on page 9. The azimuth angles γ_1 and γ_2 shall be measured at an angle perpendicular to the centerline of the transverse scan tracks. The tolerances for the azimuth angles are shown in Table 1 on page 9.

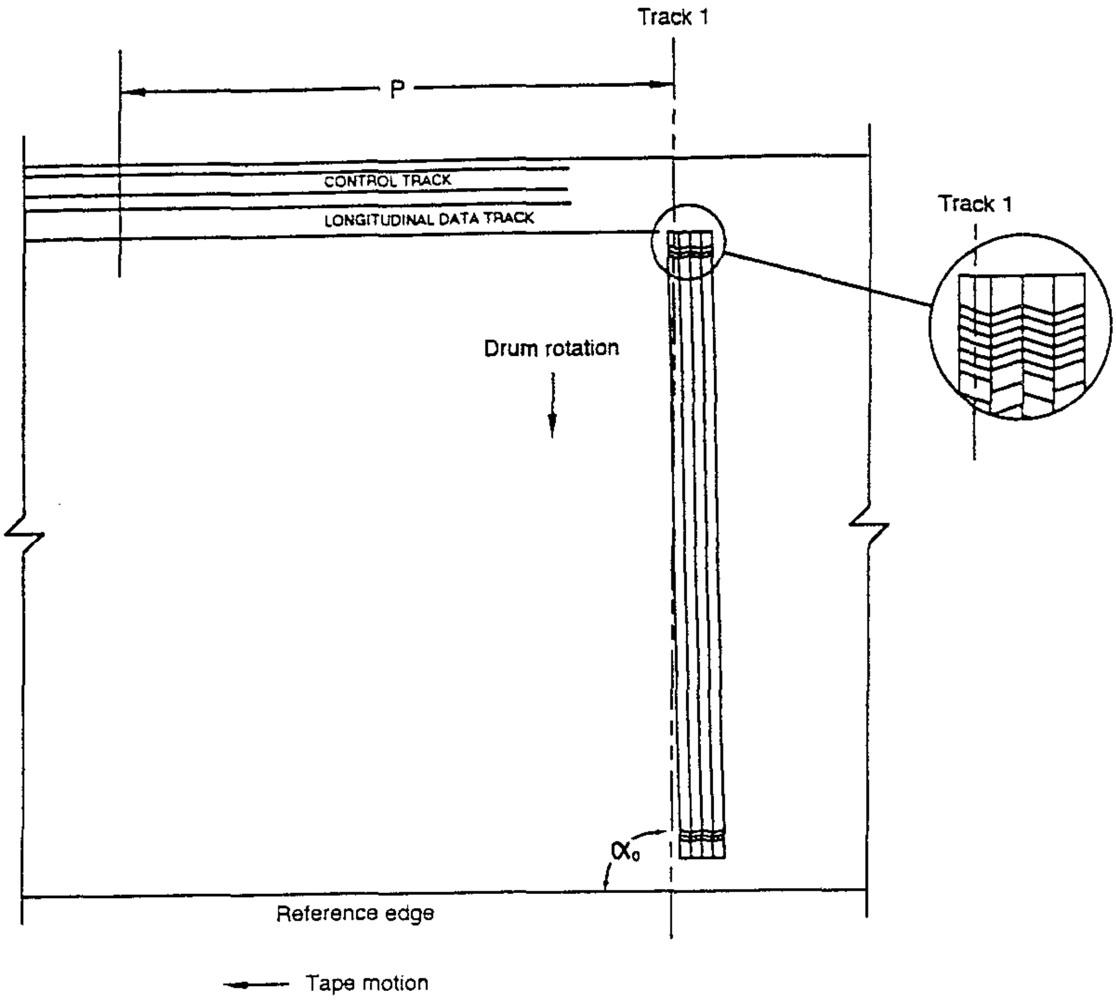
4.5.2 Control track and longitudinal data track

The azimuth angle of the control track and longitudinal data track head gaps used to produce longitudinal records shall be 0° with respect to the perpendicular to the track within a tolerance of ±0.033°.



Notes:
1. See Table 1 on page 9 for dimensions.
2. Dimensions A, B, C, and D are measured at the center of the transverse scan track width.

Figure 1 – Location and dimensions of recorded tracks



Notes:
1. *See Table 1 on page 9 for dimensions.*

Figure 2 – Location of longitudinal data and control track record

Table 1 – Recorded track location and dimensions

Dim	Location	Nominal dimensions and tolerances
A	Clock run-down, bottom edge	1.524 ±0.025 mm (0.060 ±0.001in)
B	Clock run-down, top edge	1.676 ±0.025 mm (0.066 ±0.001in)
C	Clock run-up, bottom edge	22.530 ±0.025 mm (0.887 ±0.001in)
D	Clock run-up, top edge	22.682 ±0.025 mm (0.893 ±0.001in)
E	Longitudinal data track, bottom edge	22.962 ±0.063 mm (0.904 ±0.0025 in)
F	Longitudinal data track, top edge	23.724 ±0.063 mm (0.934 ±0.0025 in)
G	Control track, bottom edge	24.740 ±0.063 mm (0.974 ±0.0025 in)
H	Control track, top edge	25.248 ±0.063 mm (0.994 ±0.0025 in)
I	Track pitch	0.043625 mm (0.001715 in) basic
J	Record current turn-on zone	0.28 mm (0.011 in) derived
K	Transverse scan track length (D - A)	21.158 mm (0.833 in) derived
P	Longitudinal data/control head location	81.966 ±0.45 mm (3.227 ±0.018 in)
W	Tape Width	25.349 ±0.050 mm (0.998 ±0.002 in)
α_0	Scanning angle	90°
α_1	Transverse scan track angle	89.920° ±0.012°
γ_1	Azimuth angle (positive)	15.000° ±0.132°
γ_2	Azimuth angle (negative)	15.000° ±0.132°

5 Usable tape length, record zones and inter-record zone

5.1 Overview

This section of the standard defines the usable tape length. It also defines the record zones created for a normal record session and the inter-record zone when there are multiple record sessions on the same tape.

5.2 Usable tape length

The length of the leaders and the length of the usable tape is dependent on the physical length of tape spooled on a cartridge and the thickness of the tape. The length of tape on a given reel is calculated from the pack radius (R) and the tape thickness (Th) as follows:

$$Length = \frac{\{\pi \times [R^2 - (R_{hub})^2]\} \div Th}{1000} \text{ meters}$$

where the hub radius (R_{hub}) is 20.383 mm (0.8025 in).

There are five positions of the tape which are defined in the sequence in which they occur, namely, Beginning-of-Tape (BOT), Virtual BOT, Near EOT, Record EOT, and End-of-Tape (EOT).

The usable length of tape is the length of tape between the Virtual BOT and the Record EOT.

5.2.1 Beginning-of-Tape (BOT)

The Beginning-of-Tape (BOT) is defined as the position of the tape in which the radius of the tape pack on the takeup reel is 21.989 mm (0.8657 in). The BOT represents a DO-NOT-CROSS line.

5.2.2 Virtual BOT

The Virtual BOT is defined as the position of the tape in which the radius of the tape pack on the takeup reel is 22.222 mm (0.8749 in). The Virtual BOT is the point at which record address zero is located.

5.2.3 Near EOT

The Near EOT is defined as the position of the tape in which the radius of the tape pack on the supply reel is 24.709 mm (0.9728 in). The Near EOT is used to warn the user that the record session is about to be terminated.

5.2.4 Record EOT

The Record EOT is defined as the position of the tape in which the radius of the tape pack on the supply reel is 23.223 mm (0.9143 in). The Record EOT is the position that a record session will be automatically terminated.

5.2.5 End-of-Tape (EOT)

The End-of-Tape (EOT) is defined as the position of the tape in which the radius of the tape pack on the supply reel is 21.989 mm (0.8657 in). The EOT represents a DO-NOT-CROSS line.

5.3 Record zones and inter-record zone

Each normal record session shall record three zones on tape, namely, a pre-record zone, a user record zone, and a post-record zone. Both the transverse scan tracks and longitudinal data tracks utilize pre-record and post-record zones in addition to the user record zone. User data is only recorded in the user record zone. During a single record session data are appended transparently to any records made previously during the session and no additional pre-record and post-record zones are used. When there are multiple record sessions, the space between the end of the post-record zone of one record session and the start of the pre-record zone of the next record session is the inter-record zone. Details of the implementation of the pre-record and post-record zones are given in Section 6.5 on page 23 and Section 6.6 on page 25 for the transverse scan tracks and Section 7.13 on page 39 and Section 7.14 on page 39 for the longitudinal data tracks. Figure 3 on page 11 shows the sequence of a typical record session and Table 2 on page 11 shows the pre-record zone and post-record zone spacings as a function of number of transverse scan tracks.

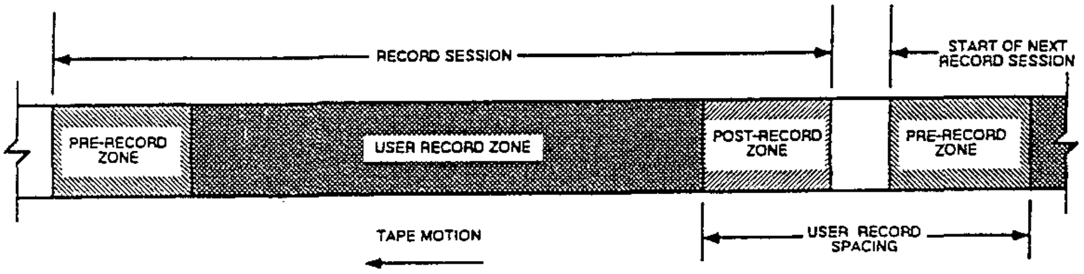


Figure 3 – Record zones

Table 2 – Record zone spacing

Write format type number	Number of transverse scan tracks			
	Pre-record zone	User record zone	Post-record zone	User record spacing
1 & 2	2,801	user defined	2,955	7,000
3, 4, & 5	3,996	user defined	2,955	10,000

The write format type numbers are described in Section 7.10 on page 37 and Annex B.

Note: Equipment designers should be aware that the use of write format type numbers 1 and 2 is not recommended for new equipment designs. This is to ensure that the user record spacing is maintained at 10,000 transverse scan tracks on all new recordings. However, reproduce equipment shall have the capability to operate satisfactorily when the recorded tape's user record spacing is either 10,000 or 7,000 transverse scan tracks.

5.3.1 Pre-record zone

The pre-record zone has a duration of 3,996 transverse scans. The pre-record zone is further subdivided into two areas having different zone flags inserted into the SAT data. The zone flag is set to D_{16} but changes to E_{16} when the scan count is 64_{16} before the start of user record.

5.3.2 User record zone

The user record zone is the zone in which the end user can record continuous and seamless data. Its duration is determined by the user.

5.3.3 Post record zone

The post-record zone has a duration of 2,955 transverse scans.

5.3.4 User record spacing

The user record spacing is the number of transverse scans between the end of the user record in one session and the start of the user record of the following record session. A user record session can only commence at a point on the tape where there is a valid scan track address. The only exception to this is at the start of recording on a bulk-erased or new tape when the scan track address is zero. All subsequent record sessions have the same user record spacing of 10,000 transverse scans as shown in Table 2 on page 11 and include 2,995 transverse scans for the post-record session of the last record session and 3,996 transverse scans for the pre-record zone of the new record session.

5.3.5 Insert and crash recording

If a record scan track address is specified at a location on tape where there is an existing recording that recording will be erased from the address specified and the user record zone will start at a point which maintains the user record spacing. Although the original recording will not have a normal post-record zone prior to the new recording, playback of the original recording up to the address specified for the new recording shall be permitted. If the new recording is inserted within an existing recording there shall be an erased gap of at least 7.62 cm (3 in) between the end of the new recording's post-record zone and the start of data of the original recording. Crash recording shall also be permitted when there is a valid scan track address and the same conditions then apply as for an inserted recording.

6 Transverse scan data, pilot tone, and control track

6.1 Overview

This section of the standard specifies the content, format, and recording method of the user record zone data blocks forming the transverse scan data signals on the tape containing instrumentation digital and other associated data for the 25.4 mm (1 in) type DCRsi transverse scan tape cartridges. The pilot tone added to the transverse scan data is specified in Section 6.8 on page 27. In addition, the content, format, and recording method of the control signals containing tracking information for the transverse scan heads associated with the transverse tracks are specified in Section 6.10 on page 29. Track dimensions and locations are specified in Figure 1 on page 7 and Table 1 on page 9. Figure 4 on page 13 shows a block diagram of the processes involved in a recorder. Details of the differences in the transverse scan data track for the pre-record zone and the post-record zone are described in Section 6.5 on page 23 and Section 6.6 on page 25 respectively.

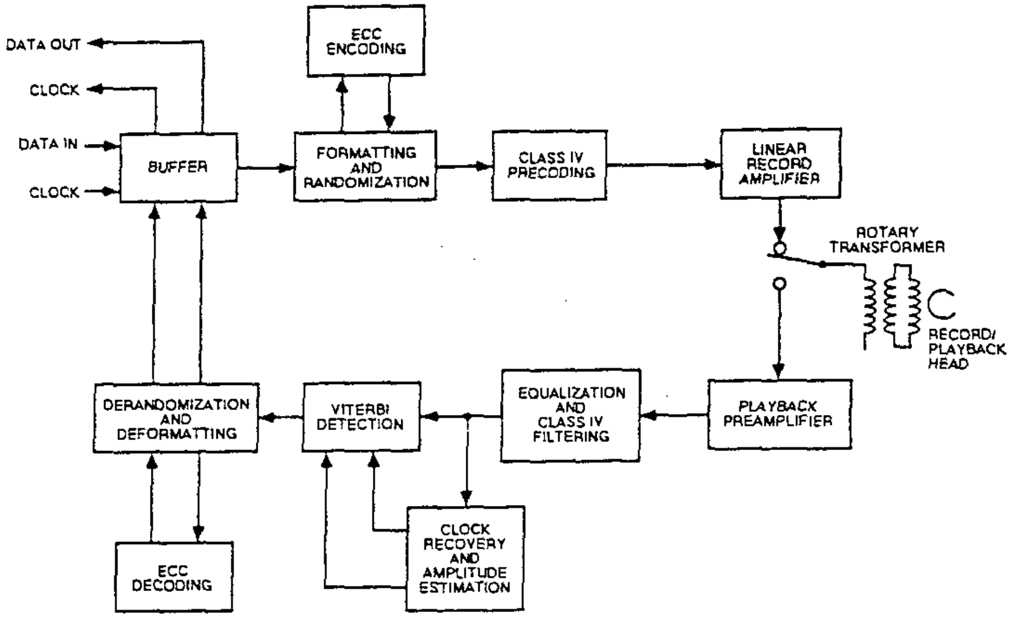


Figure 4 – Block diagram of typical signal processing

6.2 Transverse scan track data, format, synchronization, and recording requirements

6.2.1 Labeling conventions

Unless otherwise specified, the following conventions shall apply for Section 6:

(1) Values are expressed in 8-bit bytes

(2) The most significant bit (msb) is shown on the left-hand side.

(3) The most significant bit is the first bit recorded on the track.

6.2.2 Introduction

The transverse scan track is comprised of formatted digital data. The data are arranged in one scan per track as shown in Figure 5 on page 15. The transverse scan track is divided into the following elements:

(1) Clock run-up, 37 bytes

(2) Scan track sync, 16 bytes

(3) ECC codewords (blocks), 18 blocks of 265 bytes/block

(4) Clock run-down, 37 bytes

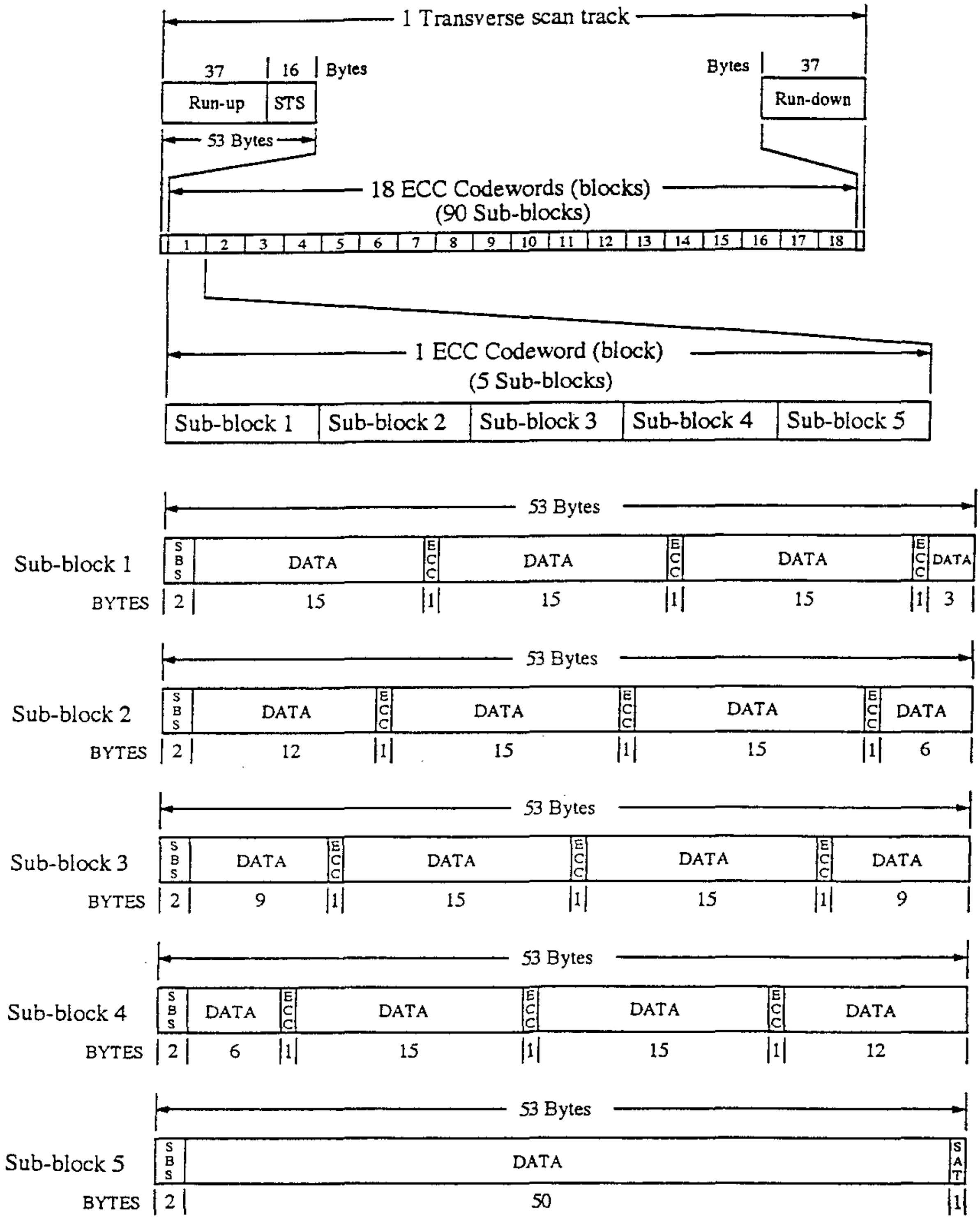


Figure 5 – Transverse scan track data format

6.2.3 Transverse scan track details

6.2.3.1 General

Details of the transverse scan track data format are shown in Figure 5 on page 15. All scan tracks shall contain a run-up, a scan track sync, and 18 ECC codewords or blocks.

6.2.3.2 Clock run-up

This element of the transverse scan track contains a clock run-up sequence of 37 bytes representing a frequency of one sixth (1/6) the clock frequency of the transverse scan data. Its location in the transverse scan track is shown in Figure 5 on page 15. The run-up pattern is therefore the sequence 111000_2 repeated 49 times with 11_2 appended to complete the 37 bytes. The following sequence, shown in both binary and hexadecimal formats, results:

Binary:

11100011 10001110 00111000 11100011 10001110 00111000
11100011 10001110 00111000 11100011 10001110 00111000
11100011 10001110 00111000 11100011 10001110 00111000
11100011 10001110 00111000 11100011 10001110 00111000
11100011 10001110 00111000 11100011 10001110 00111000
11100011 10001110 00111000 11100011 10001110 00111000
11100011_2

Hexadecimal:

E3 8E 38 E3 8E 38 E3 8E 38 E3 8E 38 E3 8E 38 E3 8E 38 E3 8E 38
E3 8E 38 E3 8E 38 E3 8E 38 E3 8E 38 E3 8E 38 $E3_{16}$

6.2.3.3 Scan track sync (STS)

This element of the transverse scan track shall contain a synchronizing pattern sequence of 16 bytes. The sequence is shown below in both hexadecimal and binary formats:

Hexadecimal:

90 B8 34 09 FC 55 E6 51 18 7B EB 53 67 6E 92 $C6_{16}$

Binary:

10010000 10111000 00110100 00001001
11111100 01010101 11100110 01010001
00011000 01111011 11101011 01010011
01100111 01101110 10010010 11000110_2

The location of the scan track sync in the transverse scan track format is shown in Figure 5 on page 15.

6.2.3.4 ECC codewords (blocks)

This element of the transverse scan track contains 18 ECC codewords (blocks) each comprising 5 sub-blocks of 53 bytes resulting in a total of 265 bytes per block as shown in Figure 5 on page 15. The formatting of the codewords (blocks) into the 5 sub-blocks is shown in Table 3 on page 18. Sub-blocks 1 - 4 contain sub-block sync (SBS), user data, and ECC check bytes. Sub-block 5 contains only sub-bock sync (SBS), user data and 1 Scan track address, Auxiliary data, or Time code (SAT) byte. The user data are not shuffled.

6.2.3.4.1 Sub-Block Sync (SBS)

The first two bytes of each sub-block, within the ECC codeword (block), shall comprise the synchronizing signal $1BE2_{16}$.

6.2.3.4.2 Scan track address, Auxiliary data, or Time code (SAT)

The last byte of each codeword (block) is the Scan address, Aux data, or Time code (SAT) byte according to the location of the codeword (block) within the transverse scan track. There are therefore 18 SAT data bytes in each transverse scan track as shown in Table 4 on page 19.

6.2.3.4.2.1 Scan track address - user record zone

The scan track address is a unique 3-byte (24-bit) number on the recorded tape indicating the number of scan tracks recorded. The scan track address is zero at the start of the user record zone of the first record session. This address is also mapped into the longitudinal data track block as coarse scan address (16 bits) F0 through F15 and fine scan address (8 bits) K0 through K7.

6.2.3.4.2.2 Auxiliary data - user record zone

User's auxiliary data, which is data separate from the user data, are recorded in the SAT bytes of the even-numbered codewords 2 through 18, with the most significant byte in codeword 2 and the least significant byte in codeword 18 as shown in Table 4 on page 19. Because the SAT byte occurs only once for every 242 user data bytes in a codeword (block) and only 9 out of 18 codewords have an auxiliary data SAT byte, the maximum data rate for the auxiliary data is 1/484 times the rate of the user's high speed data clock.

6.2.3.4.2.3 Time code - user record zone

The time code is a 40-bit number representing the count of elapsed time in increments of 1 millisecond. This count shall be set to zero at the start of record on a blank tape or synchronized to IRIG-B time code. This time code is also mapped into the longitudinal data track block as coarse time code (32 bits) H0 through H31 and fine time code (8 bits) J0 through J7.

Table 3 – Formatting of ECC codewords (blocks)

	Byte No.	Length (bytes)	Description
Sub-block #1	1-2	2	Sub-block sync
	1-2	15	Data
	3-17	1	ECC check byte
	18	15	Data
	19-34	1	ECC check byte
	35-49	15	Data
	50	1	ECC check byte
	51-53	3	Data
Sub-block #2	54-55	2	Sub-block sync
	56-67	12	Data
	68	1	ECC check byte
	69-83	15	Data
	84	1	ECC check byte
	85-99	15	Data
	100	1	ECC check byte
	101-106	6	Data
Sub-block #3	107-108	2	Sub-block sync
	109-117	9	Data
	118	1	ECC check byte
	119-133	15	Data
	134	1	ECC check byte
	135-149	15	Data
	150	1	ECC check byte
	151-159	9	Data
Sub-block #4	160-161	2	Sub-block sync
	162-167	6	Data
	168	1	ECC check byte
	169-183	15	Data
	184	1	ECC check byte
	185-199	15	Data
	200	1	ECC check byte
	201-212	12	Data

Table 3 – Formatting of ECC codewords (blocks) [Continued]

	Byte No.	Length (bytes)	Description
Sub-block #5	213-214	2	Sub-block sync
	215-264	50	Data
	265	1	SAT data

Table 4 – Location of SAT data within each transverse scan track

Odd code-word	SAT description	Even code-word	SAT description
1	Scan track address 2 (MSB)	2	Auxiliary data 8 (MSB)
3	Scan track address 1	4	Auxiliary data 7
5	Scan track address 0 (LSB)	6	Auxiliary data 6
7	Time code 4 (MSB)	8	Auxiliary data 5
9	Time code 3	10	Auxiliary data 4
11	Time code 2	12	Auxiliary data 3
13	Time code 1	14	Auxiliary data 2
15	Time code 0 (LSB)	16	Auxiliary data 1
17	Reserved	18	Auxiliary data 0 (LSB)

Note: Scan track is equivalent to "transverse scan track"

6.2.3.5 Clock run-down

The clock run-down, and any subsequent sync and data, recorded at the end of a transverse scan track, as shown in Figure 1 on page 7 and Table 1 on page 9, is identical to the clock run-up, sync, and data of the following transverse scan track and represents a period of overlap recording. The clock run-down (37 bytes) is identical to the clock run-up described in Section 6.2.3.2 on page 16.

6.3 ECC encoding

The error correction code (ECC) shall be a Reed-Solomon (85,81) code interleaved to depth 3618 operating in the Galois field GF(256).

The field generator polynomial is $x^8 + x^4 + x^3 + x^2 + 1$

where x^i are place keeping variables in GF(2), the binary field.

The generator polynomial of the code in GF(256) is

$$G(x) = (x + 1)(x + a)(x + a^2)(x + a^3)$$

where a is given by 02_{16} in GF(256).

The parity bytes K_3, K_2, K_1, and K_0 are given by the equation below:

$$K(x) = x^4D(x) \bmod G(x) = K_3x^3 + K_2x^2 + K_1x + K_0$$

where K(x) is the residue of $x^4D(x)$ divided by G(x) and where the data polynomial D(x) is defined as follows:

$$D(x) = D_{80}x^{80} + D_{79}x^{79} + \ldots\ldots + D_3x^3 + D_2x^2 + D_1x + D_0$$

and the codeword polynomial is given by the following equation:

$$C(x) = x^4D(x) + K(x)$$

$$= D_{80}x^{84} + D_{79}x^{83} + \ldots\ldots + D_1x^5 + D_0x^4 + K_3x^3 + K_2x^2 + K_1x + K_0$$

6.4 Record data randomization

The data and ECC bytes within the 18 ECC codewords (blocks) comprising the transverse scan are randomized prior to final formatting and the insertion of the run-up and scan sync. Randomization consists of modulo-2 addition of the 51 bytes of data and ECC in each 53-byte sub-block with the output of a pseudorandom sequence generator (PRSG). The first 2 bytes of the sub-block consisting of the sub-block sync are not randomized. The algorithm of the pseudorandom sequence generator, including a print statement outputting the results to a file, is shown below:

```
#include <stdio.h>
/*
 * DCRsi Randomizer - Pseudorandom Sequence Generator
 * This program generates the randomizer byte sequence
 */

main ()
{
     int cur_bit[8];              /* Bits in current byte*/
     int pre_bit[8];              /* Bits in previous byte*/
     int cur_byte[51]             /* Current byte array*/
     int count;                   /* Byte counter*/
     FILE *hex, *fopen();

     /* Initialize the first byte to hex "FD" */

     cur_bit[0] = 1;
     cur_bit[1] = 0;
     cur_bit[2] = 1;
     cur_bit[3] = 1;
```

```
cur_bit[4] = 1;
cur_bit[5] = 1;
cur_bit[6] = 1;
cur_bit[7] = 1;

cur_byte[0] = 0xfd;
/* Generate byte sequence */

for (count = 1; count <= 50; count++)
{

/* Copy current bits to previous bits */

pre_bit[0] = cur_bit[0];
pre_bit[1] = cur_bit[1];
pre_bit[2] = cur_bit[2];
pre_bit[3] = cur_bit[3];
pre_bit[4] = cur_bit[4];
pre_bit[5] = cur_bit[5];
pre_bit[6] = cur_bit[6];
pre_bit[7] = cur_bit[7];

/* Calculate new current bits from previous bits */

cur_bit[0] = pre_bit[0] ^ pre_bit[1] ^ pre_bit[3];
cur_bit[1] = pre_bit[1] ^ pre_bit[2] ^ pre_bit[4];
cur_bit[2] = pre_bit[2] ^ pre_bit[3] ^ pre_bit[5];
cur_bit[3] = pre_bit[3] ^ pre_bit[4] ^ pre_bit[6];
cur_bit[4] = pre_bit[4] ^ pre_bit[5] ^ pre_bit[7];
cur_bit[5] = pre_bit[0] ^ pre_bit[3] ^ pre_bit[5];
cur_bit[6] = pre_bit[1] ^ pre_bit[4] ^ pre_bit[6];
cur_bit[7] = pre_bit[2] ^ pre_bit[5] ^ pre_bit[7];

/* Generate current byte from current bits */

cur_byte[count] =          (cur_bit[0] << 0
                           |cur_bit[1] << 1
                           |cur_bit[2] << 2
                           |cur_bit[3] << 3
                           |cur_bit[4] << 4
                           |cur_bit[5] << 5
                           |cur_bit[6] << 6
                           |cur_bit[7] << 7);

}
```

```
/* Write byte sequence to File "rand.h" */

hex = fopen ("rand.h","w");

for (count = 0; count <= 51; count++)
{
fprintf(hex, "%x          %x\n", cur_byte[count], count);
}

fclose(hex);

exit(0);

}
```

The pseudorandom sequence generator is seeded such that its output has the value FD_{16} when coincident with the third byte of each sub-block.

The 51-byte sequence from the pseudorandom sequence generator with corresponding sub-block byte numbers is shown in Table 5 on page 22.

Table 5 – Pseudorandom sequence generator (51 bytes)

Sub-block byte no.	PRSG number (hex)	Sub-block byte no.	PRSG number (hex)	Sub-block byte no.	PRSG number (hex)	Sub-block byte no.	PRSG number (hex)
3	*FD*	16	*FE*	29	*7F*	42	*BF*
4	*BC*	17	*DE*	30	*6F*	43	*B7*
5	*D5*	18	*6A*	31	*35*	44	*9A*
6	*25*	19	*92*	32	*49*	45	*A4*
7	*13*	20	*89*	33	*44*	46	*A2*
8	*38*	21	*9C*	34	*CE*	47	*67*
9	*C3*	22	*61*	35	*30*	48	*18*
10	*BA*	23	*DD*	36	*EE*	49	*77*
11	*10*	24	*08*	37	*84*	50	*42*
12	*5A*	25	*2D*	38	*16*	51	*0B*
13	*7C*	26	*3E*	39	*9F*	52	*4F*
14	*0D*	27	*06*	40	*03*	53	*81*
15	*8A*	28	*C5*	41	*62*	–	–

6.5 Transverse scan track pre-record zone

The pre-record zone is the area recorded on tape preceding the user record zone. The transverse scan track pre-record zone consists of 3996 transverse scan tracks in which the SAT byte at the end of each ECC codeword (block) is different from that during the user record zone. This is shown in Table 6 on page 23.

Table 6 – SAT data for pre-record zone

Odd code-word	SAT description	Even code-word	SAT description
1	Zone flag & count msn	2	Set to $A5_{16}$
3	Count lsn & STA msn	4	Set to $A5_{16}$
5	STA LSB	6	Set to $A5_{16}$
7	Set to 00_{16}	8	Set to $A5_{16}$
9	Scan track address 2 (MSB)	10	Set to $A5_{16}$
11	Scan track address 1	12	Set to $A5_{16}$
13	Scan track address 0 (LSB)	14	Set to $A5_{16}$
15	Set to 00_{16}	16	Set to $A5_{16}$
17	Check sum	18	Set to $A5_{16}$

The pre-record zone is identified by a zone flag, either D_{16} or E_{16} inserted in nibble 5 (the msn of scan address 2 in the user record zone SAT) as show in Table 7 on page 23. The zone flag is initially set to D_{16} but changes to E_{16} for the last 100 (64_{16}) scan counts. The scan track address is incremented from a number, representing the user record start scan track address minus 3996, to the user record start scan track address at which time the user record zone commences. For the initial record session on each tape the scan track address in the pre-record zone represents a negative value.

Table 7 – SAT of codewords 1, 3, and 5 for pre-record zone

Codeword 1 SAT		Codeword 3 SAT		Codeword 5 SAT	
msn	lsn	msn	lsn	msn	lsn
Zone flag	**Scan count**		**Scan track address**		
nibble	**msn**	**lsn**	**msn**	**mid nibble**	**lsn**
D_{16}	Set to 00_{16}		12 LS bits of scan track address		
E_{16}	Count down 64_{16} to 00_{16}		12 LS bits of scan track address		

6.5.1 Codeword 1 SAT byte

Codeword 1 SAT byte contains the zone flag in its msn and the count msn in its lsn as shown in Table 7 on page 23. At the start of the pre-record zone the zone flag is set to D_{16} and the count msn is set to 0_{16}. When the scan track address reaches 100 scans prior to the start of the user record zone the scan count is set to 64_{16} and the zone flag is changed to E_{16}. The scan count then counts down until the count is 00_{16} at which time the user record zone is reached.

6.5.2 Codeword 3 SAT byte

Codeword 3 SAT byte contains the scan count lsn in its msn and the scan track address bits 11 - 8 in its lsn as shown in Table 7 on page 23. Scan track address bits 11 - 8 are identical to those bits of the 24-bit scan track address. In the first record on a blank tape the scan track address is negative and the location of record *is determined by the beginning of tape* (BOT). The scan count lsn is initially set to 0_{16} as for codeword 1 SAT byte and follows the same rules as outlined in Section 6.5.1 on page 24.

6.5.3 Codeword 5 SAT byte

Codeword 5 SAT byte contains the scan track address bits 7 - 4 in its msn and the scan track address bits 3 - 0 in its lsn as shown in Table 7 on page 23. Scan track address bits 7 - 0 are identical to those bits of the 24-bit scan track address. In the first record on a blank tape the scan track numbers are negative and the location of record is determined by the beginning of tape (BOT).

6.5.4 Codeword 7 SAT byte

Codeword 7 SAT byte is set to 00_{16}.

6.5.5 Codeword 9 SAT byte

Codeword 9 SAT byte is the MSB of the 24-bit scan track address recorded in the Codeword 1 SAT byte in the user record zone.

6.5.6 Codeword 11 SAT byte

Codeword 11 SAT byte is the middle byte (bits 15 - 8) of the 24-bit scan track address recorded in the Codeword 3 SAT byte in the user record zone. During the pre-record zone, the 4 least significant bits (bits 11 - 8) of the middle byte of the 24-bit scan track address are duplicated in the codeword 3 SAT byte.

6.5.7 Codeword 13 SAT byte

Codeword 13 SAT byte is the LSB of the 24-bit scan track address recorded in the Codeword 5 SAT byte in the user record zone. During the pre-record zone, the LSB (bits 7 - 0) of the 24-bit scan track address is duplicated in the codeword 5 SAT byte.

6.5.8 Codeword 15 SAT byte

Codeword 15 SAT byte is set to 00_{16}.

6.5.9 Codeword 17 SAT byte

Codeword 17 SAT byte is the check sum for the odd-numbered codeword SAT bytes 1 through 15.

6.5.10 Codewords 2, 4, 6, 8,10, 12, 14, 16, and 18 SAT bytes

Even-numbered codeword SAT bytes are all set to $A5_{16}$ and replace the auxiliary data bytes in the user record zone.

6.6 Transverse scan track post-record zone

The post-record zone of the transverse scan track is the area recorded on tape following the user record zone. The post-record zone consists of 2955 transverse scan tracks in which the SAT byte at the end of each ECC codeword (block) is different from that during the user record zone. This is shown in Table 8 on page 25:

Table 8 – SAT data for post-record zone

Odd Code-word	SAT Description	Odd Code-word	SAT Description
1	Zone flag & scan count msn	2	Set to $A5_{16}$
3	Scan count lsn & STA msn	4	Set to $A5_{16}$
5	STA LSB	6	Set to $A5_{16}$
7	Set to 00_{16}	8	Set to $A5_{16}$
9	Scan track address 2 (MSB)	10	Set to $A5_{16}$
11	Scan track address 1	12	Set to $A5_{16}$
13	Scan track address 0 (LSB)	14	Set to $A5_{16}$
15	Set to 00_{16}	16	Set to $A5_{16}$
17	Check sum	18	Set to $A5_{16}$

The post-record zone is identified by a zone flag F_{16} inserted in nibble 5 (the msn of scan address 2 in the user record zone SAT) as shown in Table 9 on page 25. The scan track address is incremented from 0 to 2955 at which time the record session is terminated.

Table 9 – SAT of codewords 1, 3, and 5 for post-record zone

Codeword 1 SAT		Codeword 3 SAT		Codeword 5 SAT	
msn	lsn	msn	lsn	msn	lsn
Zone flag	Scan count		Scan track address		
nibble	msn	lsn	msn	mid nibble	lsn
F_{16}	Set to 00_{16}		12 LS bits of scan track address		

6.6.1 Codeword 1 SAT byte

Codeword 1 SAT byte contains the zone flag in its msn and the count msn in its lsn as shown in Table 9 on page 25. At the start of the post-record zone the zone flag is set to F_{16}. During the post-record zone the scan count msn is set to 0_{16} and remains at that value.

6.6.2 Codeword 3 SAT byte

Codeword 3 SAT byte contains the count lsn in its msn and the scan track address bits 11 - 8 in its lsn as shown in Table 9 on page 25. Scan track address bits 11 - 8 are identical to those bits of the 24-bit scan track address. During the post-record zone the scan count lsn is set to 0_{16} and remains at that value.

6.6.3 Codeword 5 SAT byte

Codeword 5 SAT byte contains the scan track address bits 7 - 4 in its msn and the scan track address bits 3 - 0 in its lsn as shown in Table 9 on page 25. Scan track address bits 7 - 0 are identical to those bits of the 24-bit scan track address.

6.6.4 Codeword 7 SAT byte

Codeword 7 SAT byte is set to 00_{16}.

6.6.5 Codeword 9 SAT byte

Codeword 9 SAT byte is the MSB of the 24-bit scan track address recorded in the Codeword 1 SAT byte in the user record zone.

6.6.6 Codeword 11 SAT byte

Codeword 11 SAT byte is the middle byte (bits 15 - 8) of the 24-bit scan track address recorded in the Codeword 3 SAT byte in the user record zone. During the post-record zone, the 4 least significant bits (bits 11 - 8) of the middle byte of the 24-bit scan track address are duplicated in the codeword 3 SAT byte.

6.6.7 Codeword 13 SAT byte

Codeword 13 SAT byte is the LSB of the 24-bit scan track address recorded in the Codeword 5 SAT byte in the user record zone. During the post-record zone, the LSB (bits 7 - 0) of the 24-bit scan track address is duplicated in the codeword 5 SAT byte.

6.6.8 Codeword 15 SAT byte

Codeword 15 SAT byte is set to 00_{16}

6.6.9 Codeword 17 SAT byte

Codeword 17 SAT byte is the check sum for the odd-numbered codeword SAT bytes 1 through 15.

6.6.10 Codewords 2, 4, 6, 8,10, 12, 14, 16, and 18 SAT bytes

Even-numbered codeword SAT bytes are all set to $A5_{16}$ and replace the auxiliary data bytes in the user record zone.

6.7 Record data precoding

Randomized formatted record data shall be Class IV partial response precoded. The precoder shall have an impulse response of:

$$1/(1 \oplus D^2)$$

This is functionally shown in Figure 6 on page 27, where the blocks marked "D" are single bit delay elements and the symbol "⊕" represents modulo-2 addition of the formatted and randomized data in signal and the 2-bit-period delayed precoded record data out signal.

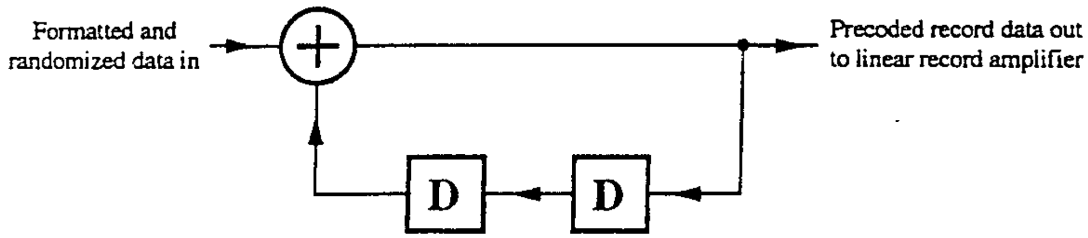


Figure 6 – Record data precoding

6.8 Pilot

6.8.1 Pilot frequency

A pilot of frequency fp shall be linearly added to the formatted and precoded transverse scan record data prior to recording on tape, where fp is determined by the relationship:

$$fp = (91 \times \text{Scanner speed in rps} \times 5) / 1000 \text{ kHz}$$

6.8.2 Pilot amplitude

The pilot shall have a peak-to-peak amplitude of 7% of the formatted and precoded transverse scan data record signal prior to recording on tape.

6.8.3 Pilot phase

In record, the phase of the pilot relative to the start of runup for head 1 shall be +6.0° ±5.0° and referred to the record leakage flux. This phase relationship is shown in Figure 7 on page 27:

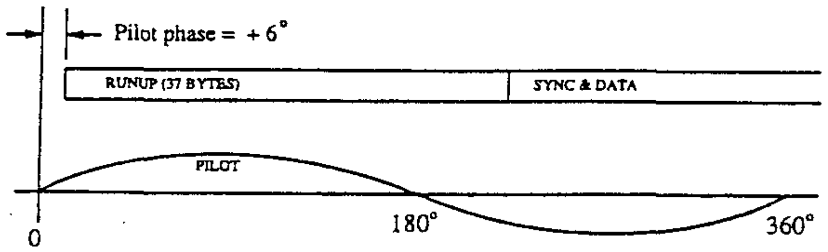


Figure 7 – Pilot phase in record

6.9 Magnetization

6.9.1 Polarity

The recorder shall operate in reproduce without regard to the polarity of data flux during record on the transverse tracks, however it shall be dependent upon the pilot phase.

6.9.2 Record equalization

The record equalization shall be adjusted to minimize the non-linear intersymbol interference of the record channel by minimizing the ripple, at the sample points on the spectral response characteristic for Class IV partial response, of the playback of a recorded 127-bit pseudorandom number sequence. The Class IV partial response pulse spectrum, as measured at the output of the playback equalizer, previously adjusted with a standard alignment tape, is shown in Figure 8 on page 28.

6.9.3 Record current level

The optimum record current shall be at that level which produces a maximum output on playback, at the frequency that is 3/4 of the Nyquist frequency, of a recorded 127-bit pseudorandom number sequence. Refer to Figure 8 on page 28. Optimization of the record current level should be done using either a previously recorded, erased or degaussed tape.

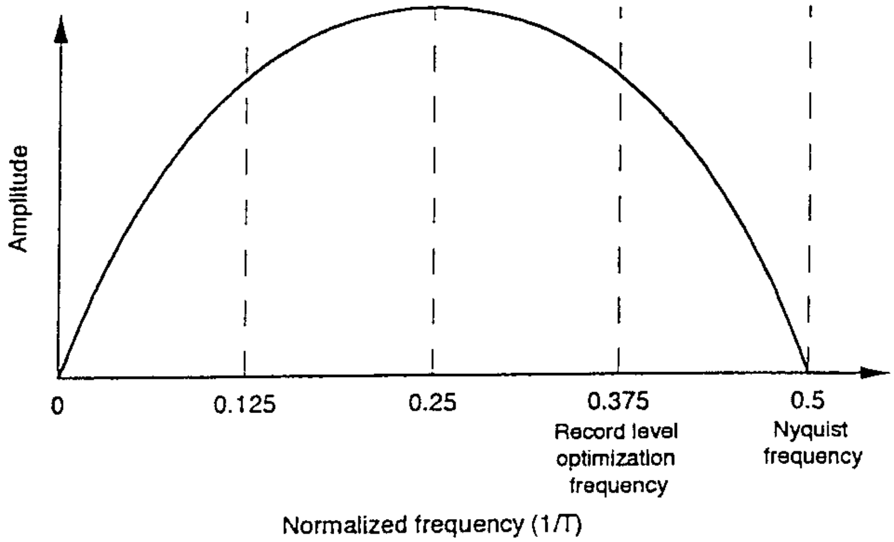


Figure 8 – Class IV partial response pulse spectrum

6.10 Control track

6.10.1 Record method

The control track shall be recorded using the saturate record (no bias) method.

6.10.2 Signal

The control track servo reference signal, at the time of recording, shall be a series of square waves representing the scanner tachometer signal. The period of the control track square wave signal shall be 1000 ÷ (scanner rps) milliseconds.

6.10.3 Flux polarity

During the time interval A of the record, the polarity of the recorded flux, immediately following the positive transition of the control track signal, shall be such that the south pole of the magnetic domains point in the direction of normal tape motion. During time interval B, immediately following the negative transition of the control track signal, the north pole shall be similarly orientated. The negative-to-positive transition of the control track signal shall occur at the midpoint of the head 1 record RF signal as shown in Figure 9 on page 29.

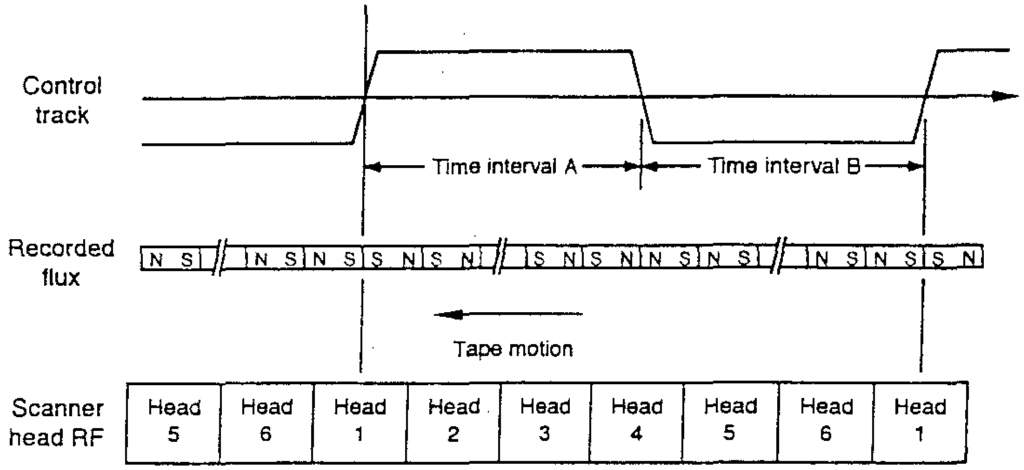


Figure 9 – Control track signal and phasing

6.10.4 Flux level

The peak recorded flux level shall be greater than 145 nWb/m of the track width.

6.10.5 Position

The control track shall be recorded on the tape at a point relative to the transverse scan track as defined by dimension P in Figure 2 on page 8.

7 Longitudinal data track

This section of the standard specifies the content, format, and modulation method of the longitudinal data track for DCRsi digital instrumentation cartridges. Track dimensions and locations are specified in Figure 1 on page 7 and Table 1 on page 9. Details of the longitudinal data track block for the user record zone are shown in Figure 10 on page 31. Each block shall be comprised of 48 incremental motion sub-blocks or 24 search blocks. A search block is therefore comprised of 2 incremental motion sub-blocks as shown in Figure 10 on page 31. Each incremental motion sub-block shall contain 12 bytes and each search block 24 bytes. The 24 bytes (192 bits) of each search block are used for the synchronization and messages shown in Table 10 on page 32. The bit period of the longitudinal data track shall be equal to the period of 2 transverse scan tracks. Details of the differences in the longitudinal data track block for the pre-record zone and the post-record zone are described in Section 7.13 on page 39 and Section 7.14 on page 39 respectively.

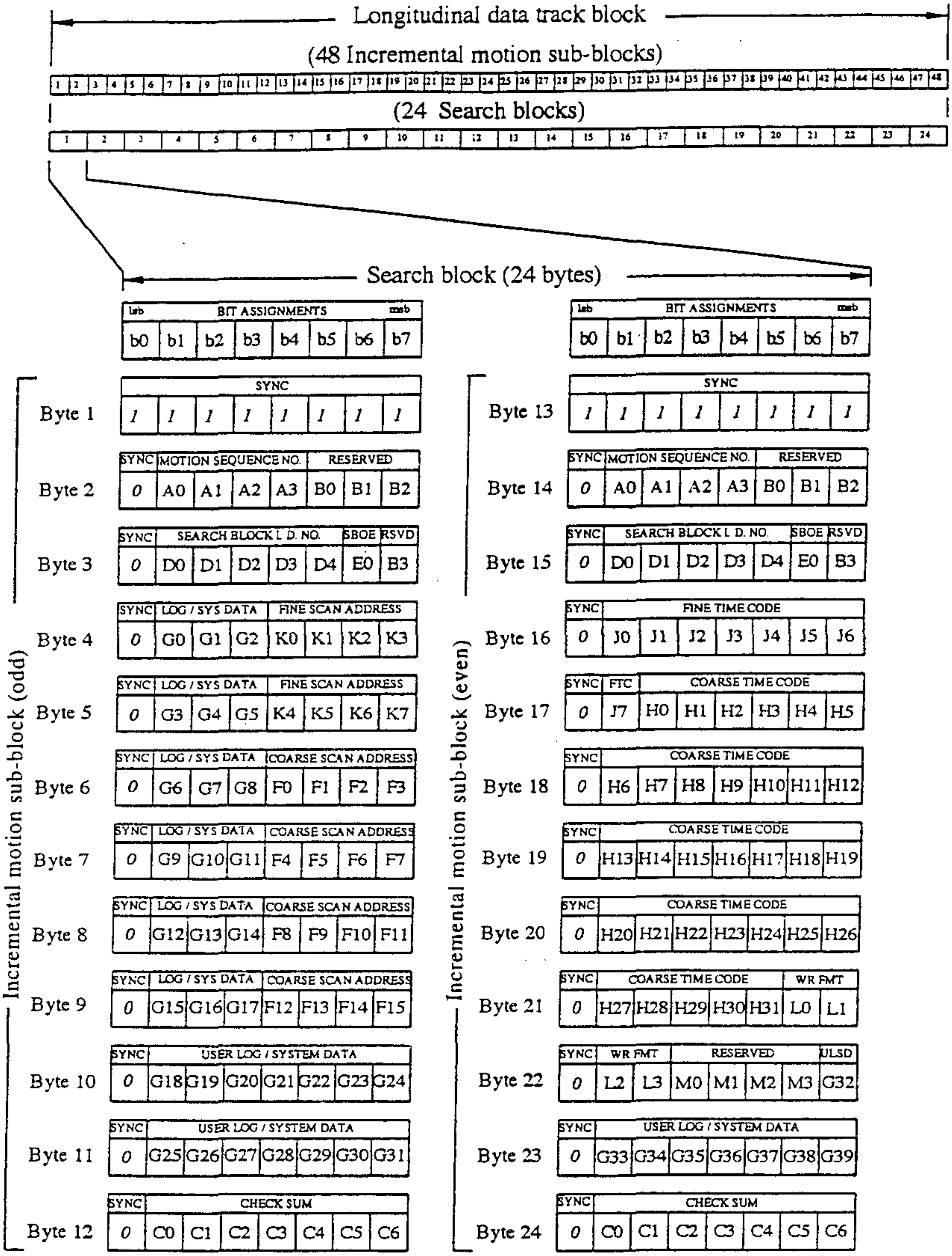


Figure 10 – Longitudinal data track block

Table 10 – Search block synchronization and messages

Message	Length	Occurrence
Synchronization	19 bits	Incremental motion block
Motion sequence number	4 bits	Incremental motion block
Search block I.D. number	5 bits	Incremental motion block
Sub-block number	1 bit	Incremental motion block
User log data	800 bits	Longitudinal data block
System data	160 bits	Longitudinal data block
Coarse scan address	16 bits	Search block
Fine scan address	8 bits	Search block
Coarse time code	32 bits	Search block
Fine time code	8 bits	Search block
Check sum	7 bits	Incremental motion block
Reserved	4 bits	Incremental motion block
Reserved	8 bits	Search block

7.1 Synchronization

The search blocks shall be synchronized by setting byte 1 and byte 13 to FF_{16} and bit 0 of the remaining 22 bytes of the search block to 0_2 as shown in Table 11 on page 32 and Figure 10 on page 31.

Table 11 – Synchronization

Search block byte number	lsb			Bit assignments				msb	Value
	b0	b1	b2	b3	b4	b5	b6	b7	
1, 13	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	All bits set to *1*
2 – 12, 14 – 24	*0*	*	*	*	*	*	*	*	Bit b0 set to *0*

7.2 Motion sequence number

The motion sequence number (A0 – A3) shall be a 4-bit count, 0 - 15, incremented at each incremental motion sub-block to facilitate playback of append recordings. At the start of a record session, the motion sequence number shall be set to 0 for the first incremental motion sub-block in the user record zone. At the start of an append record, the motion sequence number shall increment by one from that of the last sub-block prior to the append record. The motion sequence number shall be inserted in byte 2 and byte 14 of the search block as shown in Table 12 on page 33 and Figure 10 on page 31.

Table 12 – Motion sequence number

Search block byte number	lsb	Bit assignments						msb	Range of values (hex)
	b0	b1	b2	b3	b4	b5	b6	b7	
2, 14	*0*	A0	A1	A2	A3	*	*	*	*0 - F*

7.3 Search block identification number

The search block identification number (D0 – D4) shall be a 5-bit count, 0 – 23, incremented at each search block boundary. The count shall be set to zero for the first and second incremental motion sub-blocks at the start of each longitudinal data block. The search block identification number shall be inserted in byte 3 and byte 15 of the search block as shown in Table 13 on page 33 and Figure 10 on page 31.

Table 13 – Search block identification number

Search block byte number	lsb	Bit assignments						msb	Range of values (hex)
	b0	b1	b2	b3	b4	b5	b6	b7	
3, 15	*0*	D0	D1	D2	D3	D4	*	*	*00 - 17*

7.4 Sub-block odd/even (SBOE)

The sub-block odd/even bit (E0) shall be set to indicate whether the motion sub-block number is either even or odd with 0 indicating an odd sub-block and 1 indicating an even sub-block. This bit shall be set in byte 3 and byte15 of the search block as shown in Table 14 on page 33 and Figure 10 on page 31.

Table 14 – Sub-block number

Search block byte number	lsb	Bit assignments						msb	Value
	b0	b1	b2	b3	b4	b5	b6	b7	
3	*0*	*	*	*	*	*	*0*	*	bit b6 set to *0*
15	*0*	*	*	*	*	*	*1*	*	bit b6 set to *1*

7.5 User log/system data (ULSD)

The user log/system data shall comprise 960 bits (120 bytes) per longitudinal data block consisting of 800 bits (100 bytes) of user log data and 160 bits (20 bytes) of system data as detailed in Section 7.5.1 on page 34 and Section 7.5.2 on page 35 respectively. There are therefore 40 user log/system data bits per search block identified as bits G0 – G39.

7.5.1 User log data

The user log data shall be of length 100 bytes per longitudinal data block or 5 bytes (40 bits) for each of the 20 search blocks 3 through 22. The first 5 user log data bytes shall be inserted into search block number 3 and subsequent groups of 5-byte sequences inserted into subsequent search blocks as shown in Table 15 on page 34.

Table 15 – Distribution of user log data in longitudinal data block

User log data byte number	Search block number	User log data byte number	Search block number
1 - 5	3	51 - 55	13
6 - 10	4	56 - 60	14
11 - 15	5	61 - 65	15
16 - 20	6	66 - 70	16
21 - 25	7	71 - 75	17
26 - 30	8	76 - 80	18
31 - 35	9	81 - 85	19
36 - 40	10	86 - 90	20
41 - 45	11	91 - 95	21
46 - 50	12	96 - 100	22

The 5 bytes (40 bits) of user log data (d0 - d39) shall be inserted into bytes 4 - 11, 22, and 23 of the appropriate search blocks as shown in Table 16 on page 34.

Table 16 – User log data in search blocks 3 - 22

Search block byte number	lsb	Bit assignments						msb	User log data
	b0	b1	b2	b3	b4	b5	b6	b7	
4	*0*	G0	G1	G2	*	*	*	*	d0 - d2
5	*0*	G3	G4	G5	*	*	*	*	d3 - d5
6	*0*	G6	G7	G8	*	*	*	*	d6 - d8
7	*0*	G9	G10	G11	*	*	*	*	d9 - d11
8	*0*	G12	G13	G14	*	*	*	*	d12 - d14
9	*0*	G15	G16	G17	*	*	*	*	d15 - d17
10	*0*	G18	G19	G20	G21	G22	G23	G24	d18 - d24
11	*0*	G25	G26	G27	G28	G29	G30	G31	d25 - d31
22	*0*	*	*	*	*	*	*	G32	d32
23	*0*	G33	G34	G35	G36	G37	G38	G39	d33 - d39

7.5.2 System data

The system data shall be of length 20 bytes per longitudinal data block or 5 bytes (40 bits) for search blocks 1, 2, 23, and 24. The first 5 system data bytes shall be inserted into search block number 1 and subsequent groups of 5-byte sequences inserted into the search blocks 2, 23, and 24 as shown in Table 17 on page 35.

Table 17 – Distribution of system data in longitudinal data block

System data byte number	Search block number
1 - 5	1
6 - 10	2
11 - 15	23
16 - 20	24

The 5 bytes (40 bits) of system data (d0 - d39) shall be inserted into bytes 4 - 11, 22, and 23 of each search block as shown in Table 18 on page 35 and Figure 10 on page 31.

Table 18 – System data in search blocks 1, 2, 23, & 24

Search block byte number	lsb			Bit assignments				msb	System data
	b0	b1	b2	b3	b4	b5	b6	b7	
4	*0*	G0	G1	G2	*	*	*	*	d0 - d2
5	*0*	G3	G4	G5	*	*	*	*	d3 - d5
6	*0*	G6	G7	G8	*	*	*	*	d6 - d8
7	*0*	G9	G10	G11	*	*	*	*	d9 - d11
8	*0*	G12	G13	G14	*	*	*	*	d12 - d14
9	*0*	G15	G16	G17	*	*	*	*	d15 - d17
10	*0*	G18	G19	G20	G21	G22	G23	G24	d18 - d24
11	*0*	G25	G26	G27	G28	G29	G30	G31	d25 - d31
22	*0*	*	*	*	*	*	*	G32	d32
23	*0*	G33	G34	G35	G36	G37	G38	G39	d33 - d39

7.6 Coarse scan address

The coarse scan address (F0 – F15) shall be the upper 2 bytes (4 nibbles) of a 24-bit count representing the number of scan tracks recorded on tape. This count shall be reset to zero at the start of record on a blank tape. In an append record the count shall increment from the last scan address of the previous record. The 2 upper bytes of the scan address shall be inserted into bytes 6 - 9 of the search block as shown in Table 19 on page 36 and Figure 10 on page 31.

Table 19 – Coarse scan address

Search block byte number	lsb	Bit assignments						msb	Range of values (hex)
	b0	b1	b2	b3	b4	b5	b6	b7	
6	*0*	*	*	*	F0	F1	F2	F3	*0 - F* (lsn)
7	*0*	*	*	*	F4	F5	F6	F7	*0 - F*
8	*0*	*	*	*	F8	F9	F10	F11	*0 - F*
9	*0*	*	*	*	F12	F13	F14	F15	*0 - F* (msn)

7.7 Fine scan address

The fine scan address (K0 – K7) shall be the lower byte (2 nibbles) of a 24-bit count representing the number of scan tracks recorded on tape. This count shall be reset to zero at the start of record on a blank tape. In an append record the count shall increment from the last valid count obtained during playback. The lower byte of the scan address shall be inserted into bytes 4 and 5 of the search block as shown in Table 20 on page 36.

Table 20 – Fine scan address

Search block byte number	lsb	Bit assignments						msb	Range of values (hex)
	b0	b1	b2	b3	b4	b5	b6	b7	
4	*0*	*	*	*	K0	K1	K2	K3	*0 - F* (lsn)
5	*0*	*	*	*	K4	K5	K6	K7	*0 - F* (msn)

7.8 Coarse time code (CTC)

The coarse time code (H0 – H31) shall be the upper 4 bytes (32 bits) of a 40-bit count representing elapsed time in increments of 1 millisecond. This count shall be reset to zero at the start of record on a tape or synchronized to IRIG time code. The 4 upper bytes of the time code shall represent elapsed time in increments of 0.125 seconds and shall be inserted into bytes 17 - 21 of the search block as shown in Table 21 on page 37 and Figure 10 on page 31.

Table 21 – Coarse time code

Search block byte number	lsb		Bit assignments					msb	Range of values (hex)
	b0	b1	b2	b3	b4	b5	b6	b7	
17	*0*	*	H0	H1	H2	H3	H4	H5	(ls 6 bits)
18	*0*	H6	H7	H8	H9	H10	H11	H12	
19	*0*	H13	H14	H15	H16	H17	H18	H19	*0 - FFFFFFFF*
20	*0*	H20	H21	H22	H23	H24	H25	H26	
21	*0*	H27	H28	H29	H30	H31	*	*	(ms 5 bits)

7.9 Fine time code (FTC)

The fine time code (J0 – J7) shall be the lower byte (8 bits) of a 40-bit count representing elapsed time in increments of 1 millisecond. This count shall be reset to zero at the start of record on a blank tape or synchronized to IRIG time code. The lower byte of the time code shall represent elapsed time in increments of 1 milliseconds and shall be inserted into bytes 16 and 17 of the search block as shown in Table 22 on page 37 and Figure 10 on page 31. The fine time code count is 0 - 124 representing a maximum count of 125 milliseconds or 1/8 of a second. The msb (J7) of the fine time code shall be set to zero.

Table 22 – Fine time code

Search block byte number	lsb		Bit assignments					msb	Range of values (hex)
	b0	b1	b2	b3	b4	b5	b6	b7	
16	*0*	J0	J1	J2	J3	J4	J5	J6	*0 - 7C*
17	*0*	J7	*	*	*	*	*	*	J7 = *0*

7.10 Write format

The write format (L0 – L3) shall be a 4-bit number indicating the type number of the machine which made the record. The two least-significant bits, L0 and L1, are inserted into bits b6 and b7 respectively of search block byte number 21 and the two most-significant bits, L2 and L3, are inserted into bits b1 and b2 respectively of search block byte number 22 as shown in Table 23 on page 38.

Table 23 – Write format

Search block byte number	lsb			Bit assignments				msb	Occurrence
	b0	b1	b2	b3	b4	b5	b6	b7	
21	*0*	*	*	*	*	*	L0	L1	Search block
22	*0*	L2	L3	*	*	*	*	*	Search block

The type number of the machine shall be set as shown in Table 24 on page 38. Refer also to Annex B.

Table 24 – Type numbers

Type	L0	L1	L2	L3
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0

7.11 Check sum (CS)

The check sum (C0 – C6) shall be calculated as the 7 msb's (bits 1 - 7) of the 8-bit sum of bytes 2 though 11 for odd-numbered incremental motion blocks and of bytes 14 through 23 for even-numbered incremental motion blocks. If bit 7 (msb) of the check sum is 1 then the check sum shall be complemented. Bit 0 of the 8-bit sum shall be discarded. The resulting 7-bit check sums shall be inserted in bytes 12 and 24 for the odd-numbered and even-numbered incremental motion blocks respectively as shown in Table 25 on page 38 and Figure 10 on page 31.

Table 25 – Check sum

Search block byte number	lsb			Bit assignments				msb	Remarks
	b0	b1	b2	b3	b4	b5	b6	b7	
12	*0*	C0	C1	C 2	C 3	C 4	C 5	C 6	if CS msb = *0*
	0	$\underline{C0}$	$\underline{C1}$	$\underline{C2}$	$\underline{C3}$	$\underline{C4}$	$\underline{C5}$	$\underline{C6}$	if CS msb = *1*
24	*0*	C0	C1	C 2	C 3	C 4	C 5	C 6	if CS msb = *0*
	0	$\underline{C0}$	$\underline{C1}$	$\underline{C2}$	$\underline{C3}$	$\underline{C4}$	$\underline{C5}$	$\underline{C6}$	if CS msb = *1*

7.12 Reserved bits (RSVD)

A total of 12 bits per search block shall be reserved as shown in Table 26 on page 39. Reserved bits B0 – B3 occur at the incremental motion sub-block rate whereas reserved bits M0 – M3 occur at the search block rate.

Table 26 – Reserved bits

Search block byte number	lsb			Bit assignments				msb	Occurrence
	b0	b1	b2	b3	b4	b5	b6	b7	
2, 14	*0*	*	*	*	*	B0	B1	B2	Sub-block
3, 15	*0*	*	*	*	*	*	*	B3	Sub-block
22	*0*	*	*	M0	M1	M2	M3	*	Search block

7.13 Longitudinal data track – pre-record zone

The pre-record zone is the area recorded on tape preceding the user record zone. The longitudinal data track pre-record zone data are mapped similarly to that for data in the user record zone with the exception of the 5 bytes of time code. In the user record zone the time code (40 bits) is configured as 4 bytes (32 bits, H0 - H31) of coarse time code (CTC) and 1 byte (8 bits, J0 - J7) of fine time code (FTC). In the pre-record zone, mapping for these 5 bytes is dependent upon the longitudinal write format data which are imbedded in each search block and specify the machine type as shown in Section 7.10 on page 37. There are two possible mappings of the time code field as shown in Table 27 on page 39. In all cases the most significant nibble of the coarse time code field is set to the appropriate zone flag D_{16} or E_{16} as specified for the transverse scan track pre-record zone. In Type 1, the coarse time code bytes are set to 00_{16}, whereas in Types 2 – 5, the 24-bit start-of-user-record scan track address is mapped into the 3 least significant bytes of the coarse time code.

Table 27 – Time code field mapping – pre-record zone

Write format type	CTC byte 4 (hex)	CTC byte 3 (hex)	CTC byte 2 (hex)	CTC byte 1 (hex)	FTC 1 byte (hex)
Type 1	*D0*	*00*	*00*	*00*	*00*
	E0	*00*	*00*	*00*	*00*
Types 2 – 5	*D0*	24-bit start-of-user-record scan address			*00*
	E0	24-bit start-of-user-record scan address			*00*

7.14 Longitudinal data track – post-record zone

The post-record zone is the area recorded on tape following the user record zone. The longitudinal data track post-record zone data are mapped similarly to that for data in the user record zone with the exception of the 5 bytes of time code. In the user record zone the time code (40 bits) is configured as 4 bytes (32 bits, H0 - H31) of coarse time code (CTC) and 1 byte (8 bits, J0 - J7) of fine time code (FTC). In the post-record zone, mapping for these 5 bytes is dependent upon the longitudinal write format data which are imbedded in each search block and specify the machine type as shown in Section 7.10 on page 37. There are therefore two possible mappings of the time code field as shown in Table 28 on page 40. In both cases the most significant nibble of the coarse time code field is set to the zone flag F_{16}. In Type 1, the coarse time code bytes are set to 00_{16}, whereas in Types 2 – 5, the 24-bit end-of-user-record scan track address is mapped into the 3 least significant bytes of the coarse time code.

Table 28 – Time code field mapping – post-record zone

Write format type	CTC byte 4 (hex)	CTC byte 3 (hex)	CTC byte 2 (hex)	CTC byte 1 (hex)	FTC 1 byte (hex)
Type 1	*F0*	*00*	*00*	*00*	*00*
Types 2 – 5	*F0*	24-bit end-of-user-record scan address			*00*

7.15 Record data sequence

Formatted longitudinal data shall be output to the bi-phase mark encoder in the sequence shown in Figure 10 on page 31 where search block 1, byte 1, is the first recorded to tape. For each byte in the sequence the least significant bit shall be recorded first.

7.16 Method of encoding

The formatted longitudinal data shall be bi-phase mark encoded prior to recording on tape.

7.17 Method of recording

Data are recorded using the saturate record (no bias) method.

7.18 Flux level

7.18.1 Saturate record method

The peak-to-peak recording current shall maximize the playback signal at a recorded wavelength of 87.3 µm (0.0034 in).

7.19 Relative position

Longitudinal data track information shall be recorded on the tape at a point relative to the transverse scan track as defined by dimension P in Figure 2 on page 8 and Table 1 on page 9.

8 Magnetic tape

8.1 Overview

This section of the standard specifies the principal properties of the magnetic tape used for the DCRsi instrumentation digital cartridge tape format.

8.2 Measurement environment

8.2.1 Dimensions

Dimensions are in the metric system.

8.2.2 Atmospheric conditions

Tests and measurements made on magnetic tape to check the requirements of this standard shall be made under the following atmospheric conditions unless otherwise stated:

Temperature:	20°C ± 1°C (68°F ± 2°F);
Relative humidity:	50% ± 2%;
Barometric pressure:	96 kPa ± 10 kPa (13.93 ± 1.45 psi).

8.2.3 Tape stock conditioning

Conditioning of the tape stock before recording and testing shall be as follows:

Storage conditioning:	Not less than 24 hours;
Environmental:	Stabilized to the conditions specified in Section 8.2.2 on page 41;
Tape tension:	Wound on a reel at a nominal tension of 2.8 N (10.07 ozf).

8.3 Tape specification

8.3.1 Basefilm

The basefilm material shall be polyester or equivalent.

8.3.2 Width

The tape width shall be 25.349 ± 0.050 mm (0.998 ± 0.002 in)

8.3.2.1 The tape, covered with a glass plate shall be measured without tension at a minimum of five (5) equally-spaced positions over any random 30 cm (11.8 in) length of the tape using a calibrated microscope or profile projector having an accuracy of at least 2.5 µm (98.4 µin). Tape width is defined as the average of the five (5) readings.

8.3.3 Delta width

Delta width (width fluctuation) shall be measured over 30 cm (11.8 in) and will be determined by the difference in the maximum width found minus the minimum width found. This variation shall be less than 0.100 mm (0.0039 in).

8.3.3.1 Longitudinal curvature. The tape longitudinal curvature shall not exceed 100 µm peak-to-valley.

8.3.3.2 The tape shall be measured with a uniform tensile force of 2.1 N (7.5 ozf) over a length of 30 cm (11.8 in) using a calibrated microscope or profile projector having an accuracy of at least 2.5 µm (98.4 µin).

8.3.4 Tape thickness

The tape thickness shall be between 18.5 µm (0.728×10^{-3} in) and 22.5 µm (0.886×10^{-3} in).

8.3.4.1 The polyester base film thickness shall be between 13.75 µm (0.541×10^{-3} in) and 16.75 µm (0.659×10^{-3} in).

8.3.4.2 The oxide coating thickness shall be between 4.25 µm (0.167×10^{-3} in) and 5.5 µm (0.216×10^{-3} in).

8.3.4.3 The back coating thickness shall be between 0.5 µm (0.019×10^{-3} in) and 1.1 µm (0.043×10^{-3} in).

8.3.5 Out-of-plane distortions

Out of plane distortions are local deformations that cause portions of the tape to deviate from the plane of the surface of the tape. Out-of-plane distortions are most readily observed when the tape is lying on a flat surface under no tension. All visual evidence of out-of-plane distortion shall be removed when the tape is subjected to a uniform tension of 0.8 N ± 0.04 N (2.9 ozf ± 0.01 ozf).

8.3.6 Leaders and trailers

The cartridge shall not include leader and trailer tape.

8.3.7 Splices

No splices shall be allowed on the magnetic tape.

8.3.8 Elongation yield strength

Yield strength shall be greater than 37.8 N (8.5 lbf).

8.3.8.1 The force to produce 5% tangential elongation of a 200 mm (7.875 in) test sample with a pull rate of 20 mm (0.787 in) per minute shall be used to confirm the elongation yield strength.

8.3.8.2 The initial tangential slope is extended and read at 5% elongation.

8.3.9 Magnetic coating

The magnetic tape used should have a coating of cobalt doped gamma-ferric oxide magnetic particles or equivalent.

8.3.9.1 The coating coercivity in the transverse direction shall be a class 700 oersted coating, as measured by a 50 or 60 Hz BH meter.

8.3.9.2 The coating retentivity in the transverse direction shall be 900 to 1100 gauss, as measured by a 50 or 60 Hz BH meter.

8.3.9.3 The magnetic particles shall be transversely orientated.

8.3.9.4 The backcoat should provide electrical conductance sufficient to prevent static accumulation of particulate matter.

8.3.10 Surface resistivity of the magnetic and back coatings

Surface resistivity is determined by measuring the surface resistance between two electrodes forming opposite sides of a square. Surface resistivity values are reported in ohms per square (ohms/square).

8.3.10.1 The surface resistivity of the magnetic coating shall not exceed 1×10^{12} ohms/square.

8.3.10.2 The surface resistivity of the back coating shall not exceed 1×10^{8} ohms/square.

8.3.10.3 The surface resistivity of the magnetic coating and back coatings shall be measured as follows. After conditioning the tape sample to be measured to the test environment (24 hours minimum) position it over two 24-carat gold plated semicircular electrodes having a radius of 24.4 mm (1 in) and a finish of at least N4, so that the surface to be measured is in contact with each electrode. The electrodes shall be placed parallel to the ground, parallel to each other, and have their flat surfaces spaced 25.4 mm (1in) apart. Apply a force of 0.25 N ±0.012 N (0.9 ozf ±0.04 ozf) to each end of the test piece. Apply a DC voltage of 500v ±10v across the electrodes and measure the resulting current flow. From this value calculate the electrical resistance and hence the surface resistivity.

Repeat the measurement for a total of five positions along the tape sample and average the five resistance readings.

NOTE – Neither the tape sample nor the insulating surfaces shall be handled with bare fingers. (The use of clean, lint-free gloves is recommended).

8.3.11 Coating adhesion

Coating adhesion is the force required to separate any part of the coating from the tape base film material.

8.3.11.1 The force required to separate any part of the magnetic coating from the tape base film material shall not be less than 1.0 N (3.5 ozf).

8.3.11.2 The force required to separate any part of the back coating from the tape base film material shall not be less than 1.0 N (3.5 ozf).

8.3.11.3 The coating adhesion of the magnetic coating and back coating surfaces shall be measured as follows.

8.3.11.3.1 Take a sample of the tape approximately 381 mm (15 in) long and scribe a line through the coating across the width of the tape, 127 mm (5 in) from one end.

8.3.11.3.2 Using double-sided pressure sensitive tape applied to the full width of the sample, attach the sample to a smooth metal plate, with the coating surface to be tested facing the plate.

8.3.11.3.3 Fold the sample 180 degrees adjacent to and parallel with the scribed line. Attach the metal plate and the free end of the tape sample to the jaws of a universal testing machine such that when the jaws are extended the tape is separated. Set the jaw extension rate to 254 mm/min (10 in/min).

8.3.11.3.4 Note the force at which any part of the coating first separates from the base film material. If the sample separates away from the double-sided pressure sensitive tape before the force exceeds the requirement, an alternative type of double-sided pressure sensitive tape should be used.

8.3.12 Tape cupping

Tape cupping is defined as the departure across a tape (transverse to motion) from a flat surface.

8.3.12.1 The tape cupping shall not exceed 1.27 mm (0.05 in).

8.3.12.2 Tape cupping shall be measured as follows. Cut a 1m (39 in) length of tape and condition it to the test environment for a minimum of 24 hours. Cut a 0.3 m (11.8 in) segment from the approximate center of the tape specimen and mount it, magnetic coating side up, onto a flat surface with 1.67 N (6 ozf) of tension in the direction of normal tape motion. With an optical comparator, measure the distance to the highest point of the tape sample from the reference flat surface

8.4 Record/reproduce characteristics

8.4.1 Ease of erasure

The erasure characteristics of the magnetic tape shall be such that, when a 60 Hz alternating field of 2000 Gauss is applied to a recorded tape, its recorded signal level shall be reduced by at least 60 dB. The recorded tape to be tested shall have been recorded with the record level adjusted to the standard record level.

8.4.2 Average signal amplitude uniformity

The ratio of the maximum RMS level of the wide band (RF) output to minimum RF output shall not exceed 2 dB when measured from the beginning-of-tape (BOT) to the end-of-tape (EOT) within the playable length of the tape.

9 Tape Cartridge

9.1 Scope

This section of the standard specifies dimensions, tolerances, and functionality for the cartridge.

9.2 Measurements

9.2.1 Atmospheric conditions

Tests and measurements on cartridge parameters shall be made under the following atmospheric conditions:

Temperature:	20°C ±1°C (68°F ±2°F);
Relative humidity:	50% ±2%;
Stabilization time:	24 hours.

9.2.2 Dimensions

Dimensions shall be as specified in the figures and tables.

9.2.3 Tolerances

General tolerances for dimensions, except those for which tolerances are otherwise specified, shall be as shown in Table 29 on page 45.

Table 29 – Mechanical tolerances

From mm	To mm	Tolerances mm
0	4	±0.2
4	16	±0.3
16	63	±0.4
63	250	±0.5
250		±0.7

9.3 General specifications

9.3.1 Identification

The cartridge shall be identified as DCRsi.

9.3.2 Material

The cartridge shall be molded from a flame retardant material that shall be sufficiently rugged and wear resistant to withstand normal operating and non-operating use conditions, which are understood to include shipping environments (see Annex A).

9.3.3 Corrosion resistance

Any metal parts of the cartridge shall be made of a corrosion resistant material or be finished so as to resist corrosion.

9.3.4 Window

The cartridge shall have a clear window on the front face of the cartridge that will allow observation of the tape pack position and reel motion within the assembled cartridge.

9.3.5 Minimum tape length

The minimum oxide coated tape length for a fully loaded cartridge shall be 526 m (1725 ft). This includes any additional length necessary to secure the tape to the reels.

9.3.6 Minimum tape wrap on reels

A minimum of twelve (12) wraps of tape shall be wound onto the take-up reel. Likewise, a minimum of twelve (12) wraps of tape shall be left on the supply reel at the end of recording.

9.3.7 Magnetic coating surface

The magnetic coating on the tape shall face out of the cartridge as shown in Figure 11 on page 49.

9.4 Operating environment

Cartridges used for data interchange shall operate under the following conditions:

Temperature:	4°C to 50°C (39°F to 122°F);
Relative humidity:	20% to 80%, non-condensing;
Maximum wet bulb temperature:	26°C (79°F).

9.5 Cartridge conditioning prior to operational use

For interchange, the cartridge shall be conditioned by exposure to the operating environment for a time equal to or greater than the time away from the operating environment (up to a maximum of 24 hours}.

Conditioning of the tape stock prior to operational use shall be as follows:

Storage conditioning:	not less than 24 hours;
Environmental:	stabilized to within ±5°C (±9°F) of the operational environment as specified in Section 9.4 on page 46 but not to exceed the specifications therein;
Tape tension:	wound on a reel at a tension of 1.1 N to 1.65 N (4.5 ozf to 6 ozf).

9.6 Storage environment

Cartridges shall be stored under the following conditions:

Temperature: 4°C to 32°C (39°F to 90°F);

Relative humidity: 40% to 60%.

For the environment for transportation refer to Annex A

9.7 Safety

9.7.1 Safeness

The components of the tape and cartridge assembly shall not constitute any safety or health hazard when used in the intended manner, or through any foreseeable misuse in an information processing system.

9.7.2 Flammability

Tape or cartridge components that will ignite from a match flame, and when so ignited will continue to burn in a still carbon dioxide atmosphere, shall not be used.

9.7.3 Toxicity

Tape or cartridge components that may cause bodily harm by contact, inhalation, or ingestion during normal use of the cartridge shall not be used

9.8 Datum planes

9.8.1 Datum plane Z

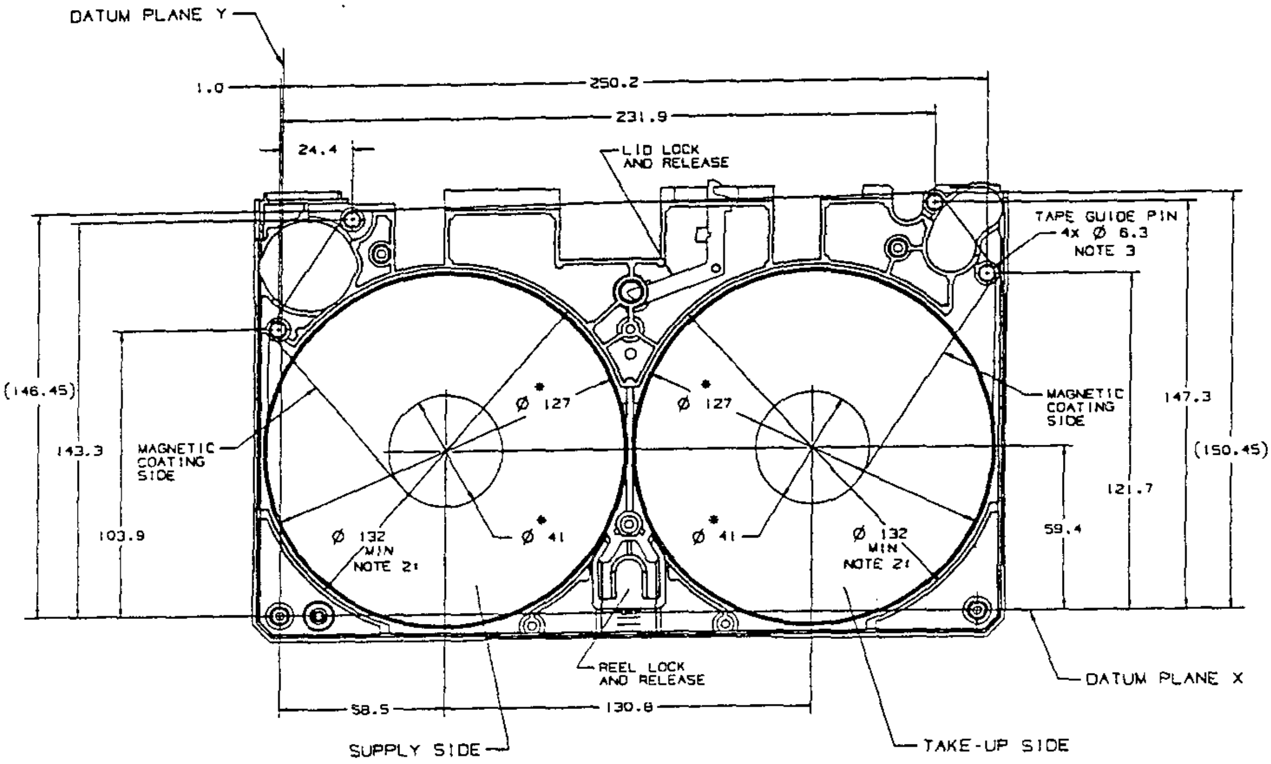
Datum plane Z is determined by datum areas 1, 2, and 3 as specified in Figure 12 on page 50.

9.8.2 Datum plane X

Datum plane X shall be orthogonal to datum plane Z and shall run through the center of datum hole "A" and datum hole "B" as specified in Figure 13 on page 51.

9.8.3 Datum plane Y

Datum plane Y shall be orthogonal to both datum plane X and datum plane Z and shall run through the center of datum hole "A" as specified in Figure 13 on page 51.

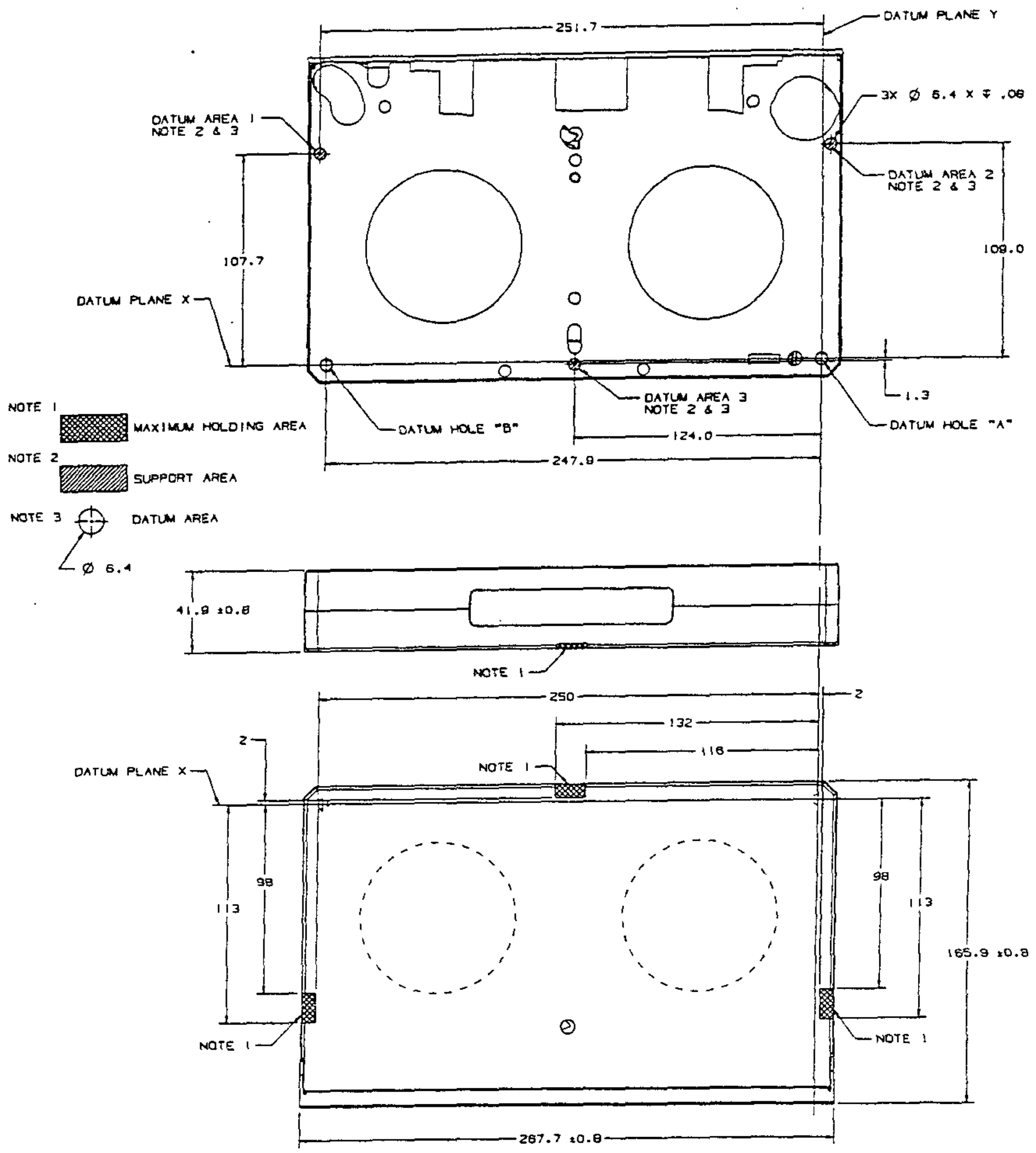


Dimensions in millimeters

Notes:

1. Dimensions with an asterisk are nominal values specifying the tape path.
2. Area for the reel.
3. The perpendicularity of the tape guide pins shall be within 0.127 mm (0.005 in) with respect to datum plane Z.

Figure 11 – Internal structure and tape path of cartridge

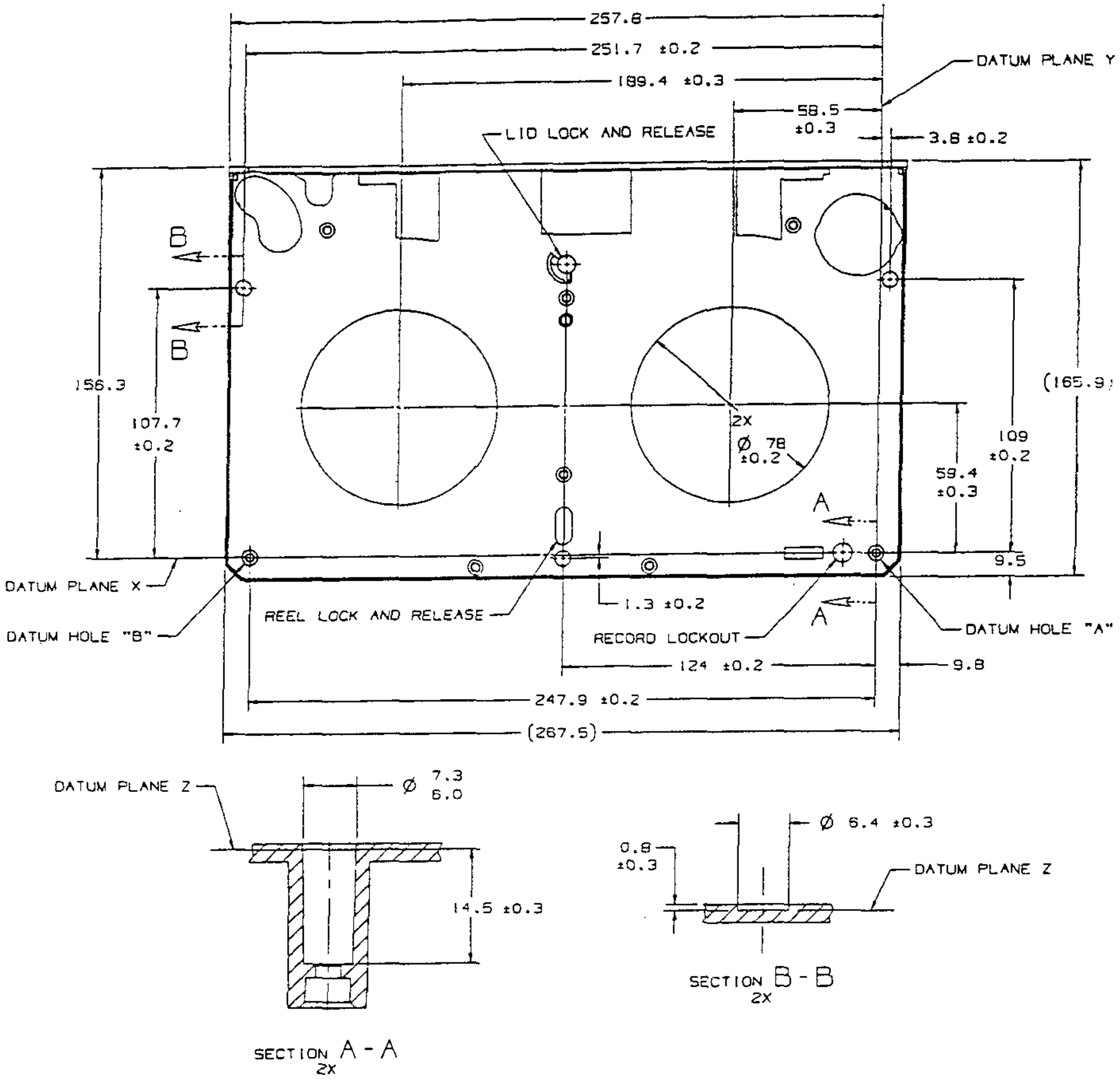


Dimensions in millimeters

Notes:

1. The cartridge shall be secured by the recorder and/or player unit on the crosshatched area.
2. The cartridge shall be supported by the recorder and/or player on the shaded area.
3. The datum plane Z shall be determined by datum areas 1, 2, and 3.

Figure 12 – Datum area, support area, and holding area



Dimensions in millimeters

Figure 13 – Bottom view of cartridge

9.9 Windows and labels

9.9.1 Window and label areas

Window and label areas shall be as specified in Figure 14 on page 53.

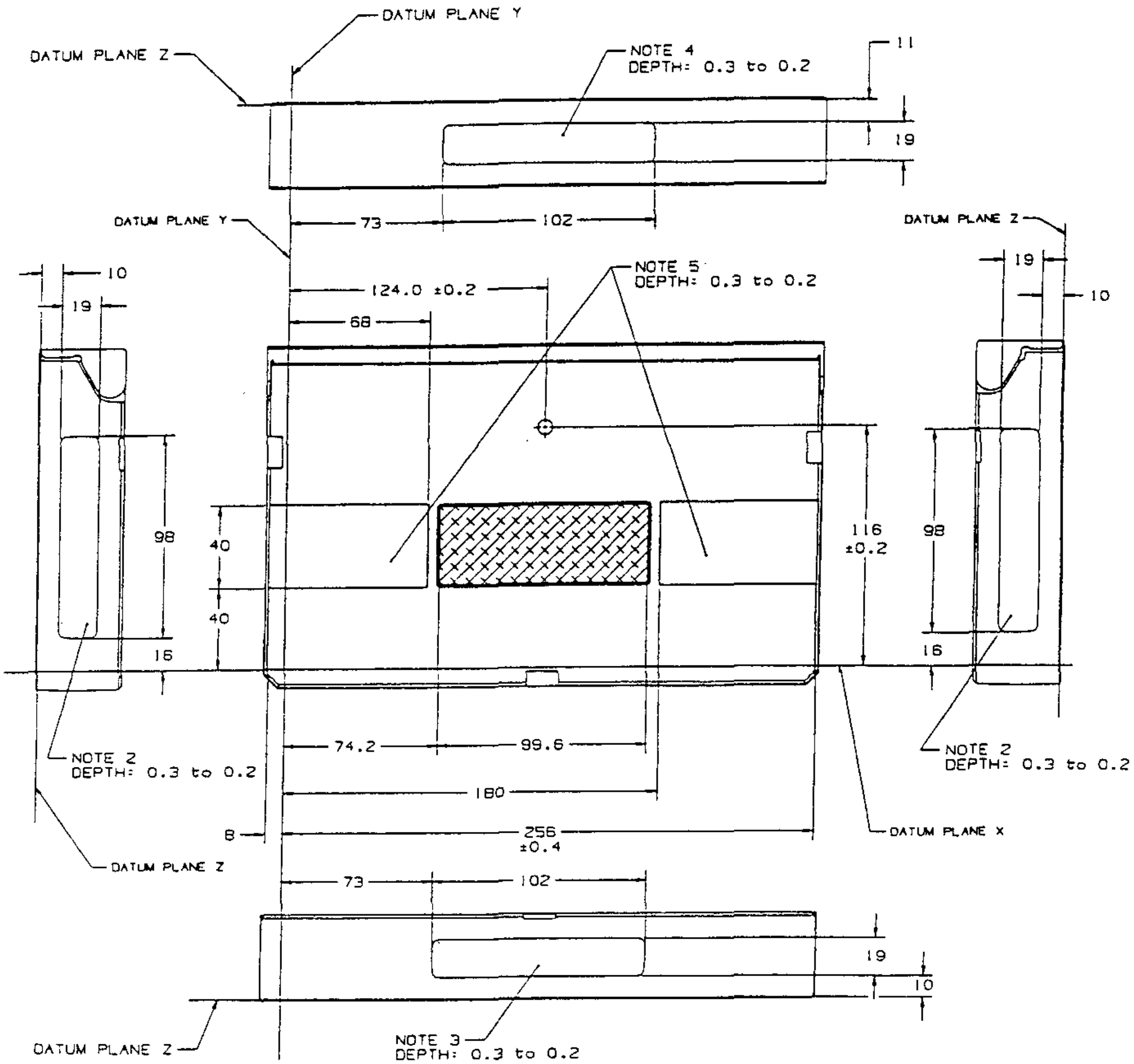
9.9.2 Label attachment area

Labels attached to the cartridge shall not extend beyond the external dimensions shown in Figure 14 on page 53.

9.9.3 Label clearances

9.9.3.1 Labels shall not interfere with user or datum holes.

9.9.3.2 Labels shall not interfere with the hub drive and support area.



Dimensions in millimeters

Notes:
1. Crosshatched area is available for window.
2. Side label may be attached to this recessed area.
3. Rear label may be attached to this recessed area.
4. Lid label may be attached to this recessed area.
5. Top label may be attached to this recessed area.

Figure 14 – Top and side of cartridge

9.10 Record lockout plug

9.10.1 Dimension and location

The dimension and location of the record lockout plug shall be as specified in Figure 15 on page 55.

9.10.2 Detent

The record lockout plug shall be detented such that when rotated there are two detent positions 180° apart indicating record lockout or record enabled.

9.10.3 Setting identification

The record lockout plug shall include an arrowhead as shown in Figure 15 on page 55 to identify its setting.

9.10.4 Settings

The setting of the record lockout pin as shown in Figure 15 on page 55 shall indicate the SAFE or record lockout position. Rotation of the plug through 180° from the position indicated in Figure 15 on page 55 shall enable recording.

9.10.5 Retention

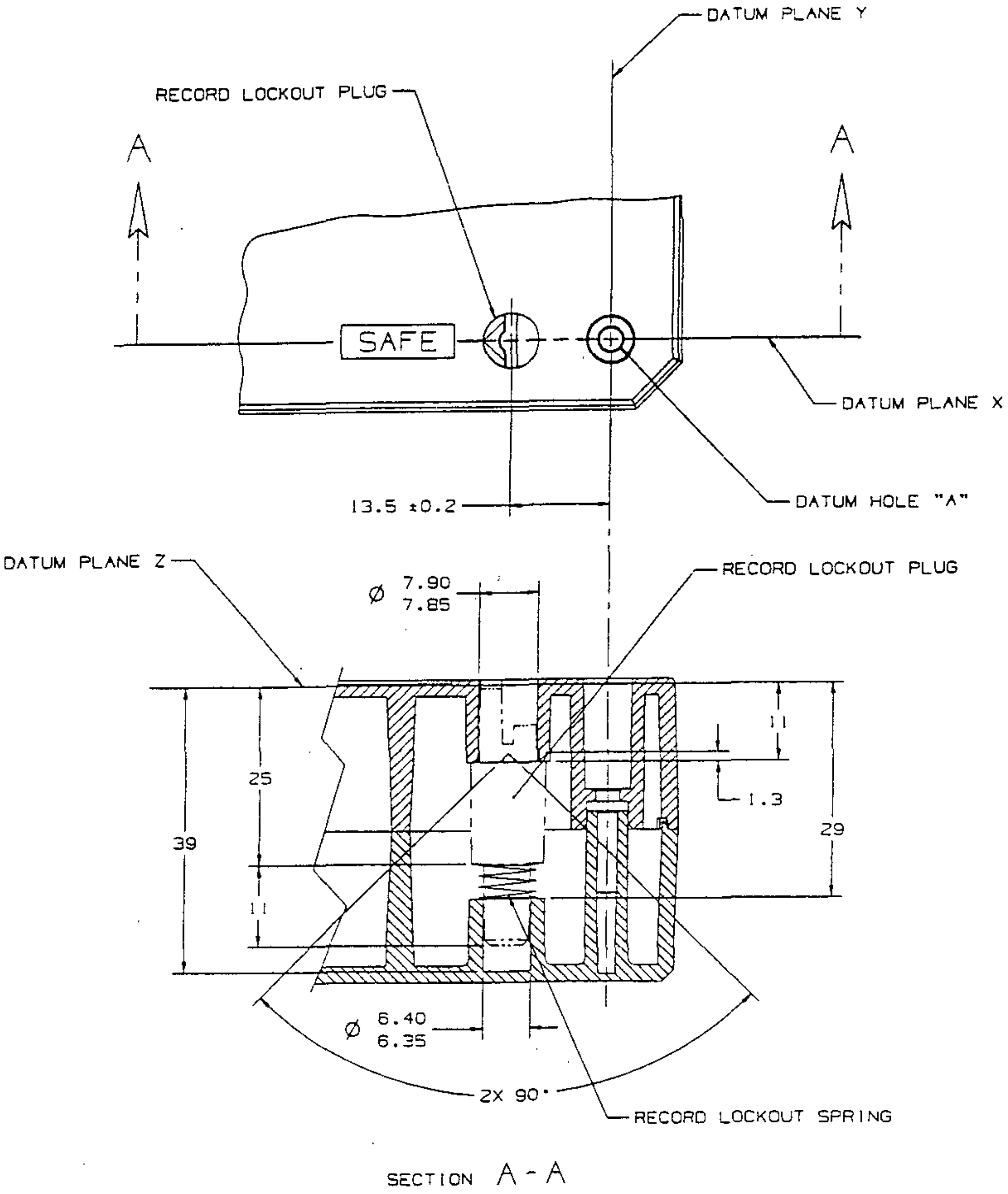
The record lockout plug shall be spring loaded to retain the plug in its selected position.

9.10.6 Maximum axial force

The record lockout plug shall be capable of withstanding an axial force of 0.5 N (1.8 ozf).

9.10.7 Color

The record lockout plug shall be manufactured of red plastic for easy identification.



Dimensions in millimeters

Figure 15 – Record lockout plug

9.11 Reels

9.11.1 Reel dimensions and reel to reel table relationships

The dimensions of the reels and the relationship between the reels and reel tables are specified in Figure 16 on page 57 and Figure 17 on page 58.

9.11.2 Reel locking

The reels shall be locked automatically when the cartridge is removed from the recorder/player.

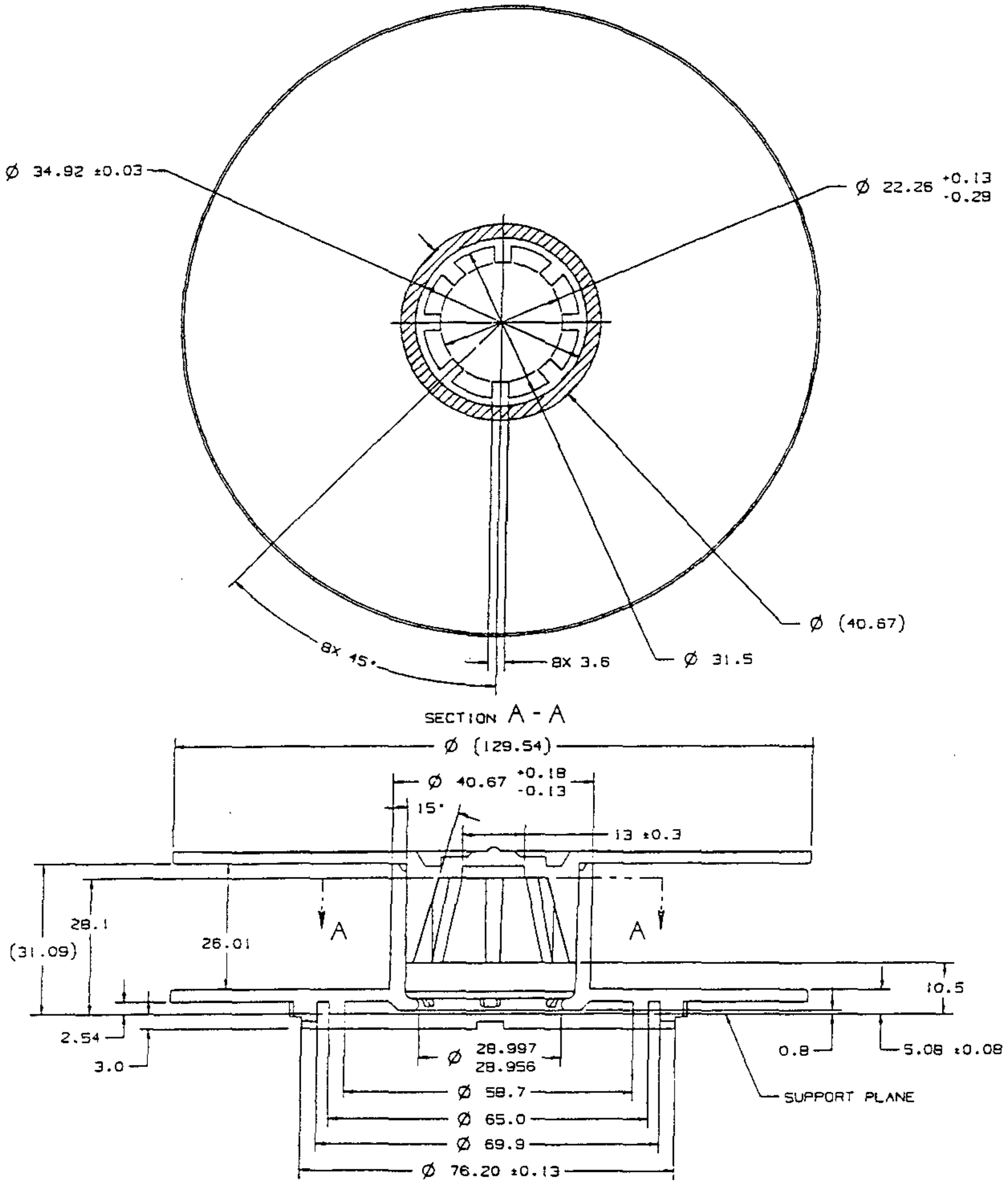
9.11.3 Reel unlocking

When a cartridge is inserted into a recorder/player, the reels shall be unlocked automatically as specified in Figure 18 on page 59.

9.11.3.1 The force needed to release the reel lock of the cartridge shall be 0.5 N ±0.1 N (1.8 ozf ±0.4 ozf).

9.11.4 Reel lock mechanism spring

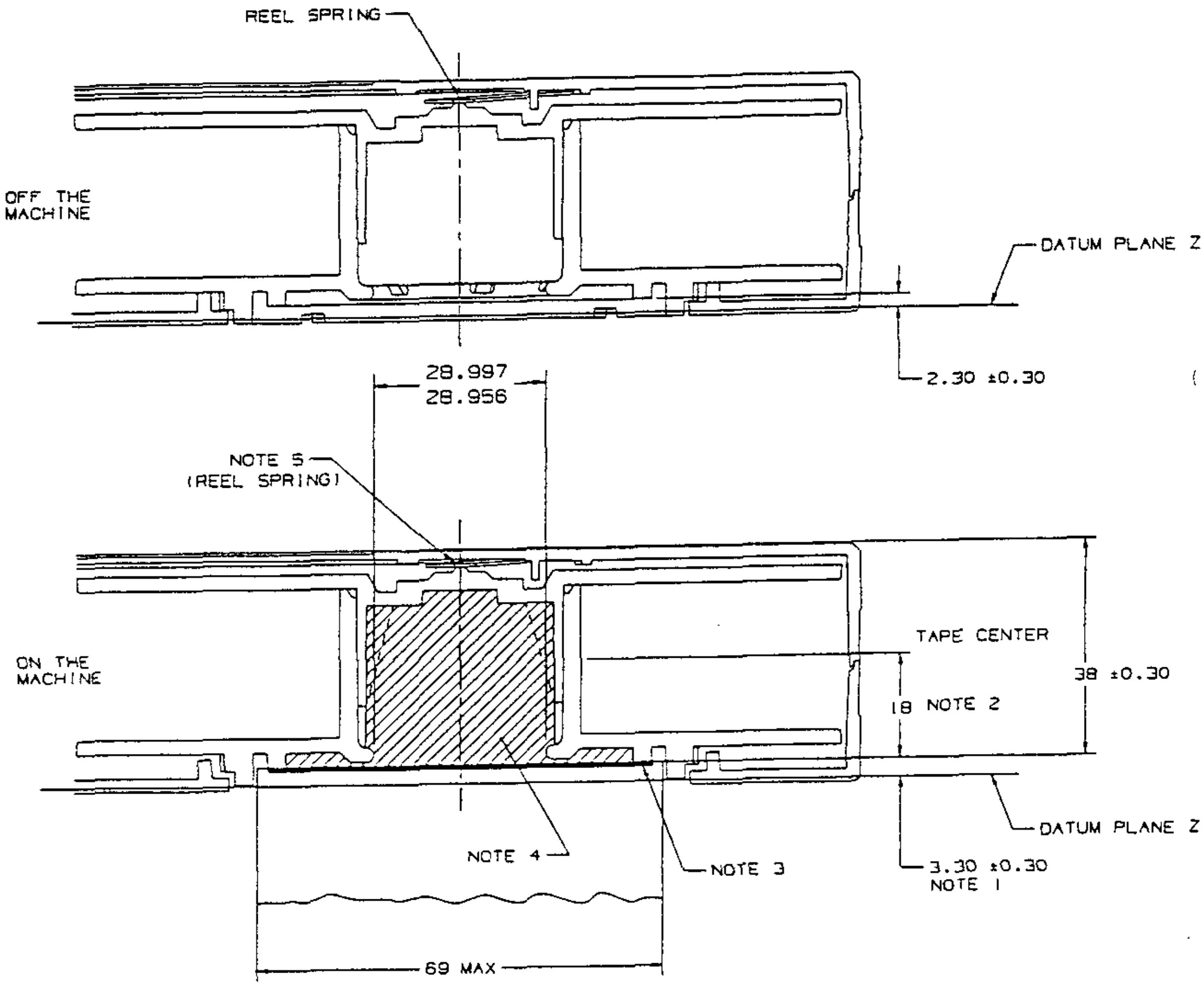
The reel lock and release mechanism shall be held in position by a spring with a force of 10 - 22 N (36 - 79 ozf).



Dimensions in millimeters

Note:
1. The center of the reel and reel table shall be positioned on Ø 28.997/28.956 and support plane.

Figure 16 – Cartridge reel

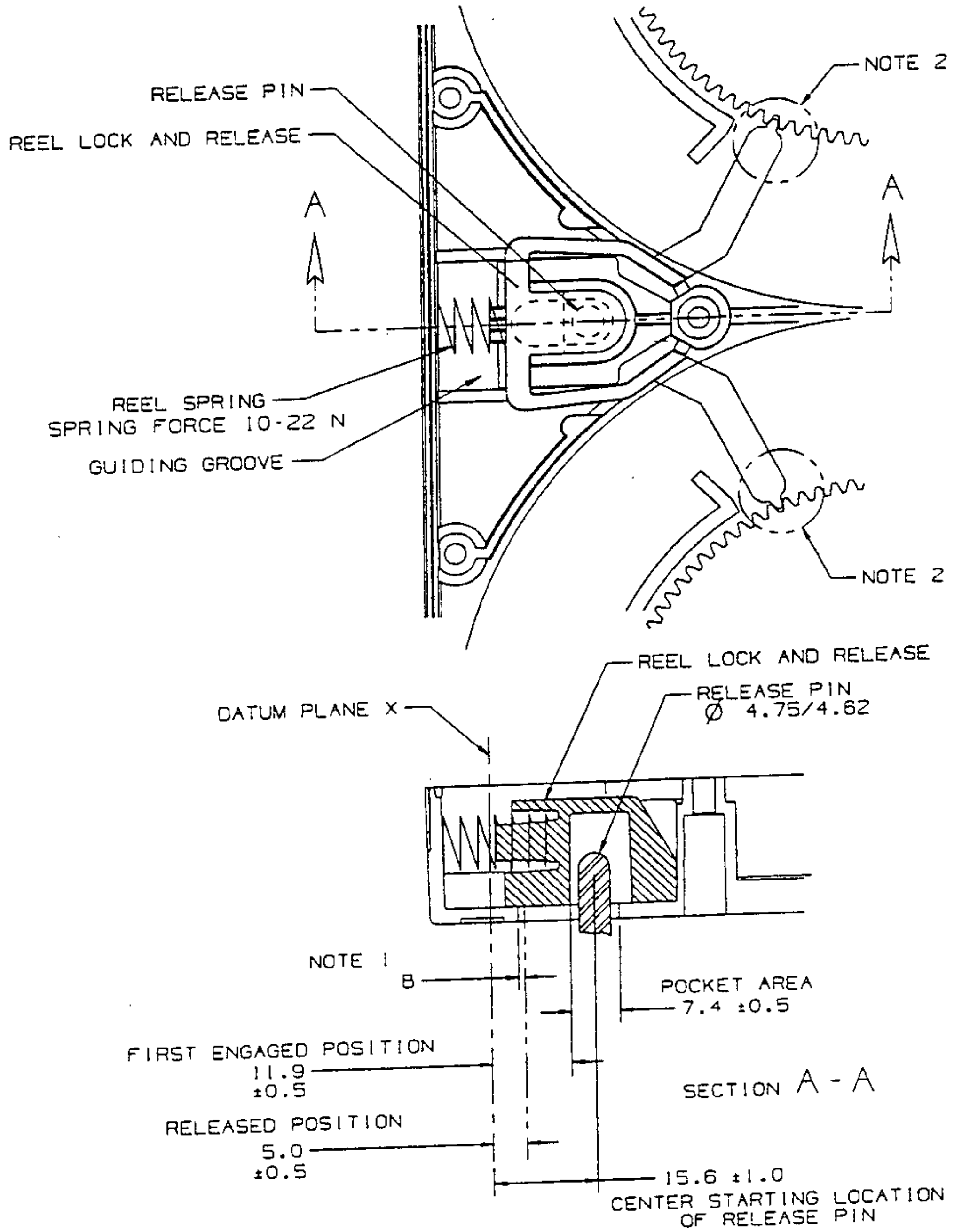


Dimensions in millimeters

Notes:

1. Distance between the support area of the reel table and datum plane Z.
2. Distance between the support area of the reel table and tape center.
3. Support area of the reel table.
4. Hatched area shows the maximum reel table area.
5. Reel spring pressure shall measure 3 - 6 N (10.8 - 21.6 ozf).
6. The reel spring structure is at manufacturer's option.

Figure 17 – Relationship between reel and reel table



Dimensions in millimeters

Notes:

1. Clearance "B" shall be 0.46 mm (0.018 in) when the release pin is located 4.5 mm (0.177 in) away from datum plane X.
2. The end of the reel lock shall be outside the reel area 84 mm (3.307 in) in diameter, when the release pin is located 5.5 mm (0.217 in) away from datum plane X.

Figure 18 – Cartridge reel lock and release

9.12 Lid

9.12.1 Lid unlocking

The lid shall be unlocked and opened by the recorder and/or player when the cartridge is inserted into the recorder.

9.12.2 Lid unlocking force

The lid shall be unlocked by a force of 0.5 N ±0.1 N (1.8 ozf ±0.4 ozf) force being exerted upon the release pin, as specified in Figure 19 on page 61 and Figure 20 on page 62.

9.12.3 Lid opening

The lid when open shall not exceed 52 mm (2.05 in) with respect to datum plane Z, as specified in Figure 21 on page 63.

9.12.4 Lid locking

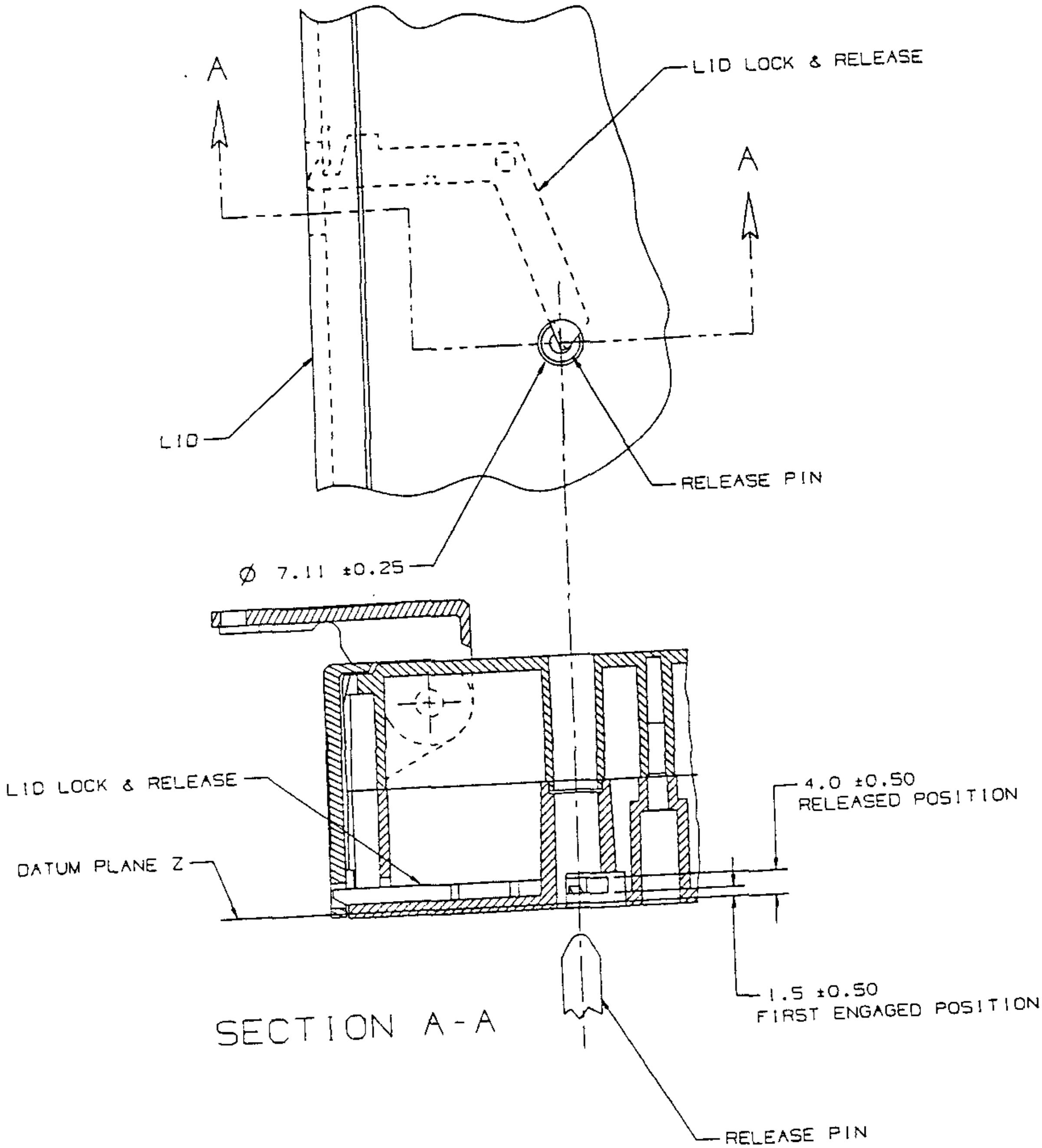
When the cartridge is removed from the recorder and/or player, the lid shall lock automatically.

9.12.5 Maximum force to open lid

The maximum force required to open the lid shall be 1.5 N (5.4 ozf) up to the 37.5 mm (1.67 in) minimum height defined in Figure 21 on page 63.

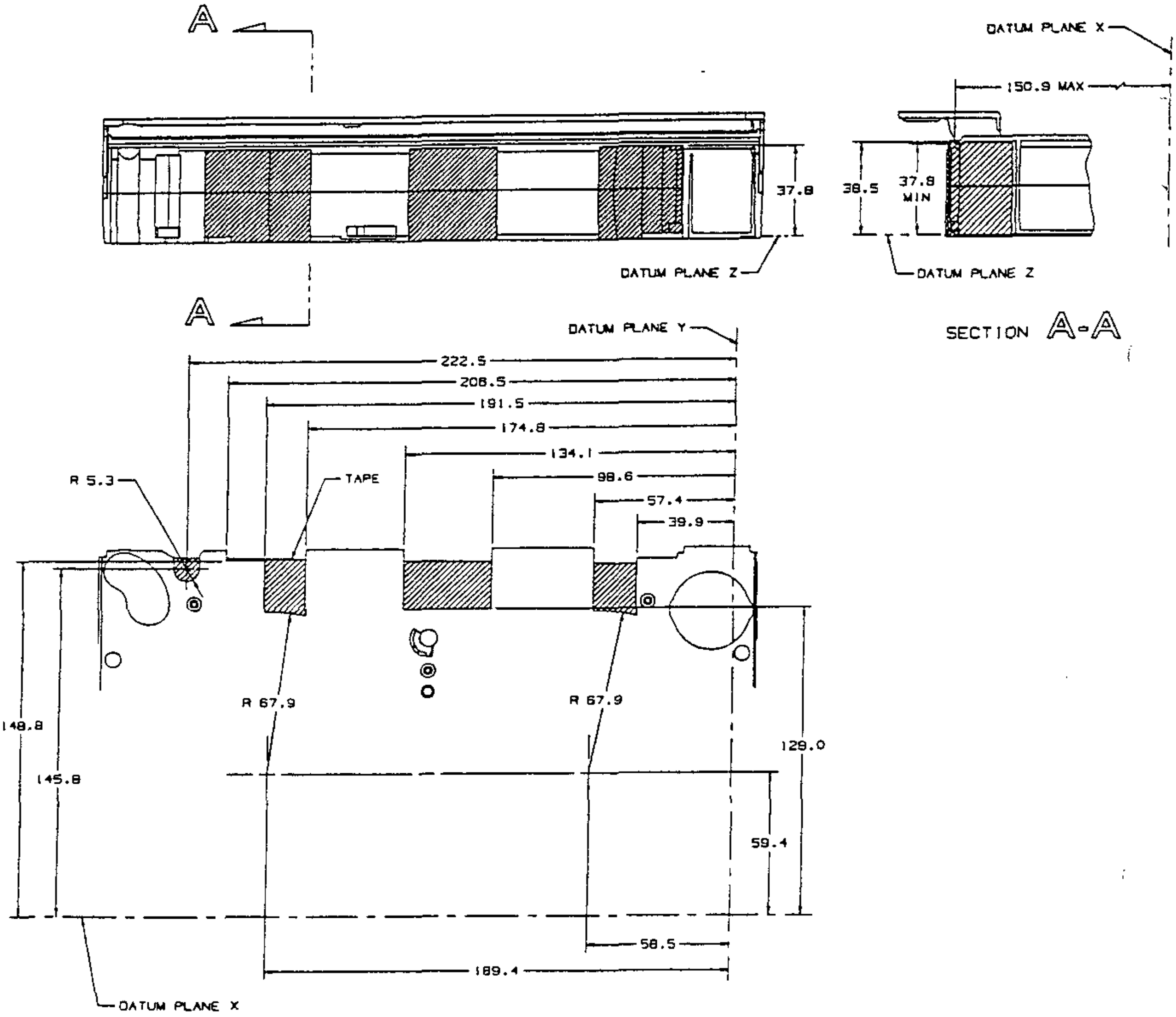
9.12.6 Direction of force to open lid

The force required to open the lid shall be applied at 90° ±5° to the datum plane Z at the lower edge of the lid, reference Figure 21 on page 63.



Dimensions in millimeters

Figure 19 – Lid lock and release

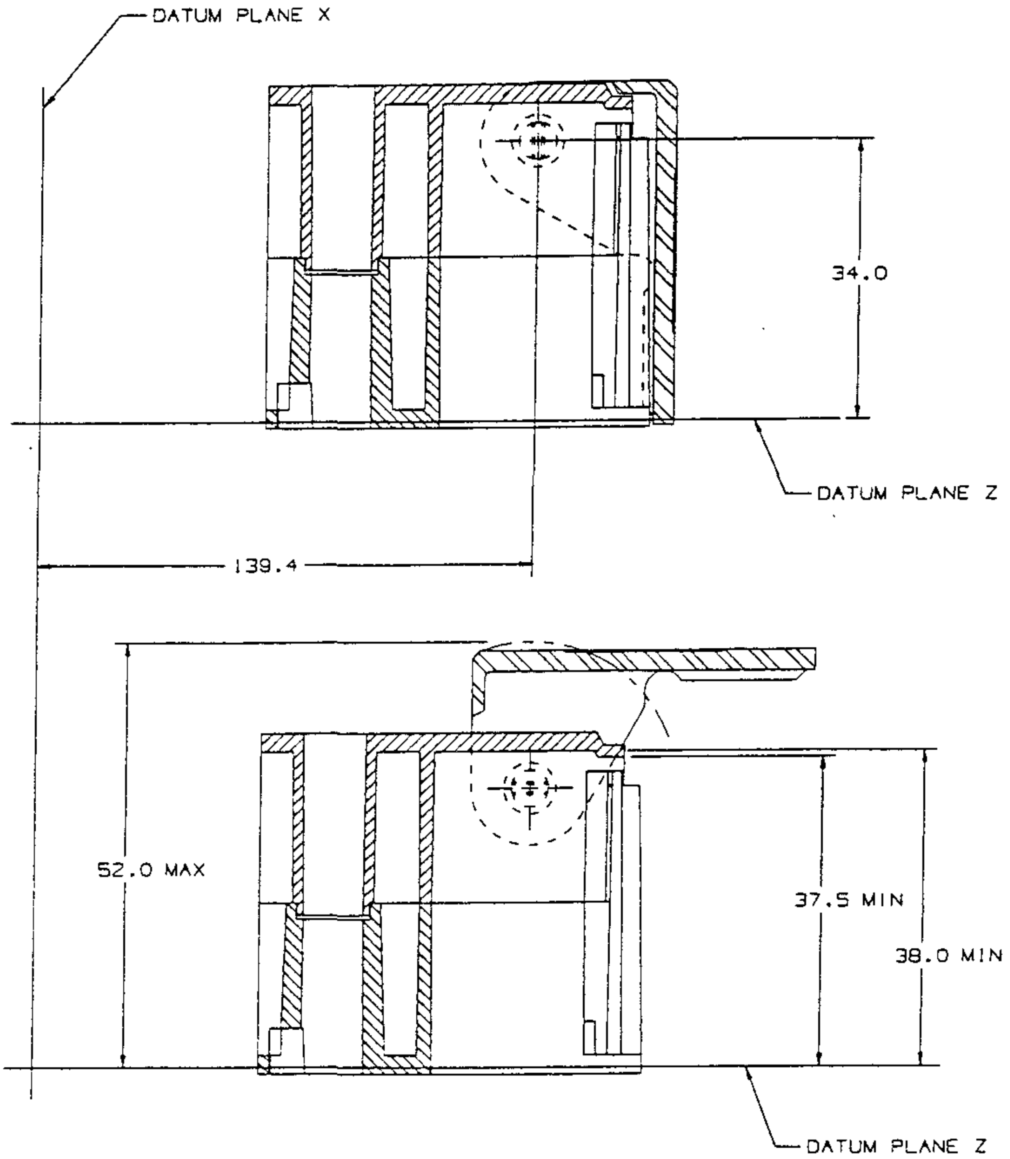


Dimensions in millimeters

Note:

1. The shaded area represents an interference-free space for threading.

Figure 20 – Space for transport loading mechanism



Dimensions in millimeters

Note:
1. Lid shall open to a height of at least 38 mm (1.5 in).

Figure 21 – Lid structure

Annex A
(informative)

Recommendations for tape cartridge transportation

A.1 Environment

It is recommended that during transportation the cartridges are kept within the following conditions:

A.2 Unrecorded cartridge

The packaged, unrecorded media cartridge should be capable of withstanding the following environment without damage:

Temperature:	-57°C to 55°C (-70°F to 130°F);
Relative humidity:	5% to 80%, non-condensing;
Maximum wet bulb temperature	26°C (79°F);
Duration:	10 consecutive days.

There shall be no condensation in or on the cartridges.

Note - Interchange parties should exercise caution when storing cartridges at temperatures above 50°C. Individual cartridge history may result in less than satisfactory interchange after storing at temperatures between 55°C (130°F) and 68°C (154°F). Storage temperatures should never exceed 68°C (154°F).

A.3 Recorded cartridge

The packaged, recorded, tape cartridge should be capable of withstanding the following environment without damage:

Temperature:	-57°C to 50°C (-70°F to 122°F);
Relative humidity:	5% to 80%, non-condensing;
Maximum wet bulb temperature	26°C (79°F);
Duration:	10 consecutive days.

There shall be no condensation in or on the cartridges.

A.4 Impact loads and vibration

Compliance with the following recommendations should minimize damage to tape cartridges during transportation:

- avoid mechanical loads that would distort the cartridge shape:
- avoid dropping the cartridge more than 1 m (39 in):
- cartridges should be fitted into a rigid box containing adequate shock-absorbent material:

- the shipping box must have a clean interior and a construction that provides sealing to prevent the ingress of dirt and water:
- the orientation of the cartridges inside the shipping box should be such that the tape-reel axes are horizontal:
- the shipping box should be clearly marked to indicate its correct orientation.

A.5 Extremes of temperature and humidity

Extreme changes in temperature and humidity should be avoided whenever possible. Whenever a cartridge is received after transportation, it should be conditioned in the operating environment (see Section 9.4 on page 46) for a period of at least 24 hours. If the user of the cartridge knows or suspects that the cartridge has been exposed to mechanical shock simultaneously with a drop in temperature exceeding 18°C (65°F) tape pack shift may have occurred. In this case, it is recom-mended that the cartridge be conditioned in the operating environment and then rewound one com-plete cycle on the tape transport before it is used for data interchange.

A.6 Effects of stray magnetic fields

Stray field strengths of more than 500A/m on recorded magnetic tape should be avoided. This may be realistically achieved by maintaining a minimum of 50 mm (2 in) of nonmagnetic spacing ma-terial around the recorded cartridge, from the cartridge surface to the outer surface of the shipping container.

Annex B
(informative)

DCRsi model characteristics

Table 1 lists the characteristics of various types of DCRsi Instrumentation Recorder as implemented by Ampex Corporation. Equipment designers should be aware of the existence of slight variations in implementation which should be considered in new equipment designs.

Table 1 – Model characteristics

Characteristic	Type 1	Type 2	Type 3	Type 4	Type 5
Ampex name or model no.	DCRsi Classic	DCRsi 107	DCRsi 240	DCRsi 75	DCRsi 120
User data rate (Mbits/sec)	107	107	240	75	120
No. of record/play channels	1	1	2	1	1
Channel data rate (Mbits/sec)	118.557	118.557	134.000	118.557	134.000
No. of heads	6	6	12	6	6
Tape speed (cm/s) (in/s)	13.404 (5.277)	13.404 (5.277)	30.302 (11.93)	13.404 (5.277)	15.151 (5.965)
Scanner rotational speed (rps)	512	512	578	512	578
User record session spacing (No. of transverse scans)	7,000	7,000	10,000	10,000	10,000
Pre-record zone (No. of transverse scans)	2,801	2,801	3,996	3,996	3,996
Post-record zone (No. of transverse scans)	2,955	2,955	2,955	2,955	2,955
Maximum transverse scan auxiliary data rate (Kbits/sec)	221	221	499.5	155	249.7

ANNEX D

PART 2 LOGICAL RECONNAISSANCE DATA FORMAT

LOGICAL FORMAT IS DEFINED IN STANAG 7023

INTENTIONALLY BLANK