DEVELOPMENT STANDARD

QIC-3040-MC
Revision E
20 Jun 96

SERIAL RECORDED MAGNETIC TAPE MINICARTRIDGE FOR INFORMATION INTERCHANGE

Streaming Mode
Read-While-Write
42 Tracks with 0.250 in. (6.35 mm) Tape
52 Tracks with 0.315 in. (8.0 mm) Tape
Transition Density: 50,800 ftpi (2,000 ftpmm)
Data Density: 40,600 bpi (1,600 bpmm)
GCR 0,2 4,5 Encoding
Reed-Solomon ECC

Uncompressed Formatted Capacity (with 400 feet of 900 Oe tape):
- 840 MBytes (0.250 in. tape)
- 1 GByte (0.315 in. tape)

Uncompressed Formatted Capacity (with 1,000 feet of 900 Oe tape):
- 2.1 GBytes (0.250 in. tape)
- 2.5 GBytes (0.315 in. tape)

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(See important notices on the following page)

Important Notices

Table of Contents:

Figures:

Tables:

Overview of Revision Changes:

Revision A:

This is the first edition of this document. It is based upon QIC-93-105 Rev. B.

Revision B:

This is the second edition of this document. It is based upon QIC-3040 (MC) Rev. A.
The Standard is opened for a range of recording head widths.

Revision C:

This is the third edition of the document. It is based upon QIC-3040 (MC) Rev. B.
The following chapters are changes from Revision B.
Sections 2.38 Pseudo EW (Early Warning), 5.6.2 Security Erase, 6. Use of Tracks, 9.2.8 End of Recorded Area Block, 9.3.2 Preamble, 9.3.7 Postamble, 9.4 Block Rewrites, 9.6 Termination of Write at the end of the last Track and 9.8 Device Directory.

Revision D:

This is the fourth edition of the document. It is based upon QIC-3040 (MC) Rev. C.
The following sections are changed from rev. C.
Sections 9.8.1.2, Definition of the Logical Block Count in a Device Directory Entry field.

Revision E:

This is the fifth edition of the document. It is based upon QIC-3040 (MC) Rev. D.
The following sections are changed from rev. D.
Section 5.6 Erasure and Section 9.8.1.1 The Header Field, Separate Erase bits for the two partitions are included.
Section 6.3 Forward Reference Bursts and 6.9 Summary of Requirements. The end position of all forward reference bursts are now referenced to LP. Text and table is updated.

1.1 Scope

This Standard provides a format and recording standard for a streaming 0.250 inch (6.35 mm), 42 track, or a 0.315 inch (8 mm), 52 track, magnetic tape in a cartridge to be used for information interchange between information processing systems, communication systems and associated equipment utilizing a standard code for information interchange, as agreed upon by the interchange parties. The Standard provides a typical capacity of 840 MBytes of formatted data on a single cartridge with a minimum of 400 feet of 0.250 inch tape using read-while-write verification and error correction codes. The corresponding capacity using a 0.315 inch tape 400 feet is 1.0 GByte (1000 MBytes).

The basis for this standard refers to recording on a 0.250 inch (6.35 mm) magnetic tape cartridge. It complements the proposed American National Standard Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 inch (6.35 mm), 50 800 ftpi (2000 ftpmm), X3B5/90-xxx (or the latest revision), where the following sections are dealt with in detail : general requirements, definition, tape and cartridge, physical and magnetic requirements, speed requirements, and write enable feature. Compliance with the unrecorded standard is a requirement for information interchange. To meet the performance requirements in this standard may require media certification beyond media certified to this ANSI standard.

This standard also describes the use of a tape 0.315 inch Wide tape for the same format. All specifications for the Wide tape format and track layout are based upon the specified format for the 0.250 inch tape. A tape drive designed to meet this format standard shall always be able to read and write both on 0.250 inch tapes as well as on 0.315 inch Wide tapes.

This document explains the standard using a magnetic head with: Write head 0.00700 inch and Read head 0.00300 inch. However, this standard is open for magnetic heads with: Write head; max 0.00700 inch - min 0.00350 inch and Read head; max 0.00300 inch.

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1.2 INTRODUCTION

1.2.1.

This standard defines the requirements of supporting test methods necessary to ensure interchange at acceptable performance levels. It is distinct from a specification in that it delineates a minimum of restrictions consistent with compatibility in interchange transactions. The standard uses a Reed Solomon error correction code to achieve a corrected bit error rate of at least 10^{-14} given a raw error rate of 10^{-8}.

1.2.2

The performance levels contained in this standard represent the minimum acceptable levels of performance for interchange purpose. They therefore represent the performance levels which the interchanged 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 or substituted for purchase specification.

1.2.3

Wherever feasible, quantitative performance levels which must be met or exceeded in order 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 are left to agreement between interchange parties, standard test methods and measurement procedures shall be used to determine such quantities.

1.2.4

US. engineering units are the original dimensions in this standard. Conversions of toleranced dimensions from customary US. engineering units(similar to British Imperial Units) to SI units have been done in this standard according to ANSI/IEEE STD 268-1982 and ISO 370-1975 Method A. Method A should be used for economy unless a requirement for absolute assurance of a fit justifies use of Method B. In the national standards of ISO member nations, additional rounding may be done to produce "preferred" values. These values should lie within or close to the original tolerance ranges.

1.2.5

Except as indicated in 1.2.3 above, interchange parties complying with the applicable standards should be able to achieve compatibility without need for additional exchange of technical information.

2. DEFINITIONS

For the purpose of this standard, the following definitions apply:

2.1 Bad Block.

A block determined to be bad during the Read-While-Write operation, or later during a read operation.

2.2 Bit

A single digit in the binary digit system.

2.3 Bit Cell.

The physical length of a recorded encoded bit along the track.

2.4 Block.

A group of 1024 consecutive data bytes plus additional control bytes recorded as a unit.

2.5 Block Marker.

A group of encoded bits following the preamble and marking the start of each block.

2.6 BOT (Beginning of Tape) Marker.

The BOT Marker is a set of series of holes punched in the tape. There are 6 holes provided, the innermost of which is used for identifying the storage position for the cartridge. The additional sets of holes are used to ensure reliability of detection.

Note: In the storage position, all of the permissible recording area of the tape is wound on the supply hub and is protected by at least one layer of tape not used for recording data. Cartridges to be interchanged shall be rewound to the storage position prior to interchange.

2.7 Byte.

A group of 8 data bits (10 encoded bits) operated upon as a unit.

2.8 Cancel Mark.

A block which may (optionally) be recorded after two consecutive File Marks at End of File. The Cancel Mark acts as a "negative" File Mark so that the second File Mark is reported to the host. Cancel Marks are never reported to host.

2.9 Control Field.

A group of 4 bytes recorded after the data area in each block, containing information about block address, track address and block type.

2.10 Compression Block Group.

A group of compressed data recorded as one variable block on the tape. The Compression Block Group either contains a number of host defined logical fixed blocks or a complete or partial host defined varable logical block. The Compression Block Group also contains a Compression Header recorded at the beginning of the Compression Block Group.

2.11 Compression Header.

A group of 10 bytes recorded as uncompressed data at the beginning of a Compression Block Group. The Header contains specific information related to the Compression Block Group recorded on the tape.

2.12 CRC (Cyclic Redundancy Check).

The CRC is a group of 4 bytes recorded at the end of each block of data for the purpose of error detection.

2.13 Data Block.
A block containing user valid data in its data field.

2.14 Data Density.
The nominal distribution of recorded data information per unit length of track, usually expressed in bits per inch (bpi) or bits per millimeter (bpmm).

2.15 Device Directory.

Data written in a dedicated area of the tape, containing information about End Of Recorded Area position and the connection between Logical and Physical data blocks. The last information is used to increase the performance of Space and Locate operations.

2.16 ECC (Error Correction Code).
Special drive generated information which may be used to correct bad blocks.

2.17 ECC Block.
A block containing drive generated ECC data in its data field and part of control field.

2.18 Encoding.
A method where by a group of data bits is translated into a group of recording bits. In this standard, 4 data bits are translated into 5 encoded bits to be recorded.

2.19 Entry Distance.

The distance in number of physical blocks between the Entry Points on the tape.

2.20 Entry Point.

Physical position on the tape where the Logical Block, Filemark and Setmark counters are written to a Entry Field in the Device Directory.

2.21 EOR Block
The End of Recorded Area Block (EOR-block) is a special block to mark the end of the recorded area. It is overwritten as a part of an append operation.

2.22 EOT (End of Tape) Marker.
The EOT Marker is a single hole punched in the tape to indicate that the usable recording area of the tape has been exceeded, and that the physical end of the tape is approaching. There are three EOT holes to ensure reliable detection.

2.23 EW (Early Warning) Marker.
The EW Marker is a single hole punched in the tape to indicate the approaching end of the usable recording area in the forward direction.

2.24 File Mark Block.
A block designated as a File Mark.

2.25 Filler Block.
A block containing no valid information in its data field. The purpose of this block is to complete a frame in the case that the host cannot fill the whole frame with valid data information.

2.26 Flux Transition.
A point on the magnetic tape which exhibits maximum free space flux density normal to the tape surface.

2.27 Flux Transition Spacing.
A distance on the magnetic tape between flux transitions.

2.28 Frame.
A group of 16 blocks forming a complete logical unit.

2.29 GBytes (GB).
This standard defines 1 GB to be equal to 10^9 bytes (= 1000 MBytes).

2.30 GCR (Group Coded Recording).
A method whereby a group of data bits (in this standard: 4) is translated into a group of recording bits (in this standard: 5) prior to the recording.

2.31 Identifier Block.
A unique block identifying the type of format being recorded.

2.32 LP (Load Point) Marker.
The LP Marker is a single hole punched in the tape to indicate the approaching start of the usable recording area in the forward direction.

2.33 Magnetic Tape Cartridge.
A cartridge containing 0.250 inch (6.350 mm) magnetic tape wound on two coplanar hubs with an internal drive belt to transport the tape between the hubs.

2.34 MBytes (MB).
This standard defines 1 MB to be equal to 10^6 bytes.

2.35 Physical Recording Density.
See transition density.

2.36 Postamble.
A special sequence of bits recorded at the end of each block.

2.37 Preamble.
A special sequence of bits recorded at the beginning of each block.

2.38 Pseudo EW (Early warning)
A logical tape position near the end of the last track. The distance from Pseudo EW to the physical End of Track shall be sufficient to allow the host to terminate a write operation before physical end of Last Track is reached.

2.39 Read-While-Write.
A method where data being recorded is read and verified on the same pass as they are written. Sometimes called Read-After-Write.

2.40 Recorded Azimuth.
The angular deviation, in minutes of arc, of the recorded mean flux transition line from the line normal to the cartridge reference plane.

2.41 Reference Tape Cartridge.
A tape cartridge selected for a given property for calibrating purposes.

2.42 Secondary Reference Tape Cartridge.
A tape cartridge intended for routine calibration purposes, the performance of which is known and stated in relation to that of the Reference Tape Cartridge.

2.43 Signal Amplitude Reference Tape Cartridge.
A reference cartridge selected as a standard for signal amplitude and reference field.

2.44 Standard Reference Amplitude.
The average peak-to-peak signal amplitude output of the Signal Amplitude Reference Cartridge when it is recorded on an NBS measurement system at the maximum flux density specified in this standard.

2.45 Streaming.
A method of recording on magnetic tape that maintains continuous tape motion without the requirement to start and stop within an interblock gap.

2.46 Track.
A longitudinal area on the tape along which a series of magnetic signals may be recorded.

2.47 Transition Cell.
The physical distance between two adjacent flux transition at the maximum recording density.

2.48 Transition Density or Physical Recording Density.
The number of recorded flux transitions per unit length of track, usually expressed in flux transitions per inch (ftpi) or flux transitions per millimeter (ftpmm). See also Data Density.

2.49 Underrun.
A condition developed when the host transmits or receives data at a rate less than required by the device for streaming operation.

3. REFERENCE EDGE

The Reference Edge shall be that edge of the tape which is nearest to the baseplate of the cartridge, Lower Tape Edge.

4. TRACK GEOMETRY

4.1 Track positions

The position of the centerline of the Reference Burst on track 40 is referred to the Reference Edge. The positions of all the other even numbered tracks are defined by specifying the distance of their centerlines from the centerline of the Reference Bursts of track 0 and track 40 for 0.250 inch tape (Reference Bursts of track 0 and track 50 for 0.315 inch Wide tape). The positions of all the odd numbered tracks are defined by specifying the distance of their centerlines from the centerline of the Reference Burst of track 1. The actual (physical) track positioning is described in section 4.7.
Figures 4.2A, 4.2B, 4.3A and 4.3B show the nominal track layout. Tables 4.1A and 4.1B specify the centerline positions of the recorded tracks. Since a recorded track may be partly overwritten later during the write operation of a neighbouring track (see section 4.2), tables 4.1A & 4.1B specify the nominal centerlines for all tracks at the time of writing and the centerlines of the effective tracks during subsequential read operations.

This standard supports Quick File Access (QFA). Track 41 (0.250 inch tape) or track 51 (0.315 inch Wide tape) shall be recorded in the forward direction if the tape is partitioned for QFA. Track 41 (Track 51) shall be recorded in the reverse direction if the tape is not partitioned for QFA. The location of track 41 (track 51) is defined by referring to the centerline of track 1 when QFA is not implemented and to the centerline of track 0 when QFA is implemented. See sections 4.3, 4.4 and 6.3.

4.2 Track width

For a magnetic head with;
Write head width of: 0.00700 ±0.00015 inches (0.17780 ±0.00381 mm) and a
Read head width of: 0.00300 ±0.00015 inches (0.07620 ±0.00381 mm)
the following shall apply:
When writing, nominally 0.00158 inches (0.0402 mm) using 0.250 inch tape, and 0.00139 inches (0.0353 mm) using 0.315 inch Wide tape of each track is overwritten by the next neighbouring track. The recording drive shall have the capability of performing this overwriting process in accordance with the requirements in section 5.7.
When writing, the centerlines of the recording tracks shall be positioned according to tables 4.1A and 4.1B. Likewise, when writing, the centerlines of the Reference Bursts as defined in section 4.3 and the centerlines of the corresponding tracks shall be aligned. The final effective centerline position of a recorded track when the next corresponding neighbouring track has been recorded, will nominally be 0.00079 inches (0.0201 mm) using 0.250 inch tape, and 0.000697 inches (0.0177 mm) using 0.315 inch Wide tape, lower as shown in figure 4.1A and 4.1B. When writing a track, 0.00300 ±0.000150 inches (0.07620 ±0.00381 mm.) of the recorded track shall be verified (Read-While-Write with wide write/narrow read configuration).

4.3 Reference bursts

On tracks 0, 1 and 40 for 0.250 inch tape (tracks 0, 1 and 50 for 0.315 inch Wide tape) Reference Bursts shall be recorded prior to the normal data recording. This is further described in section 6. The Reference Bursts shall be recorded at a nominal frequence of 12500 ftpi (492 ftmm).

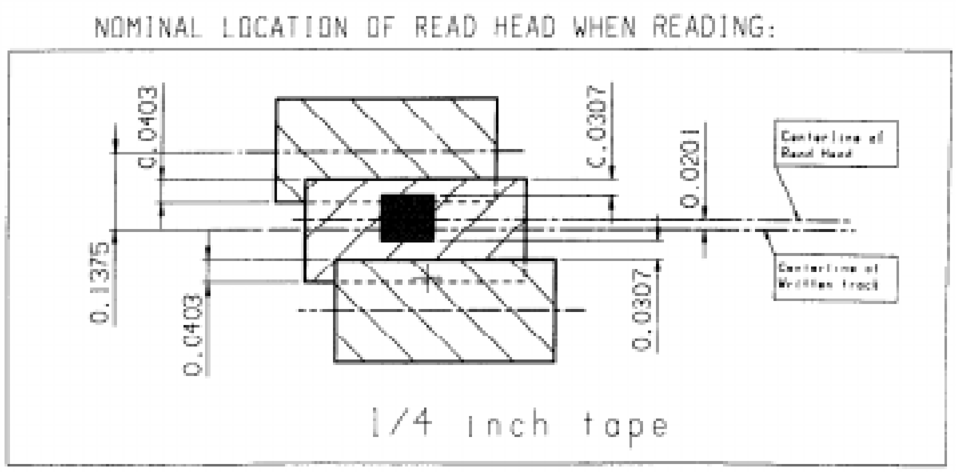


Figure 4.1A Track write operation with overlap, 0.250 inch tape

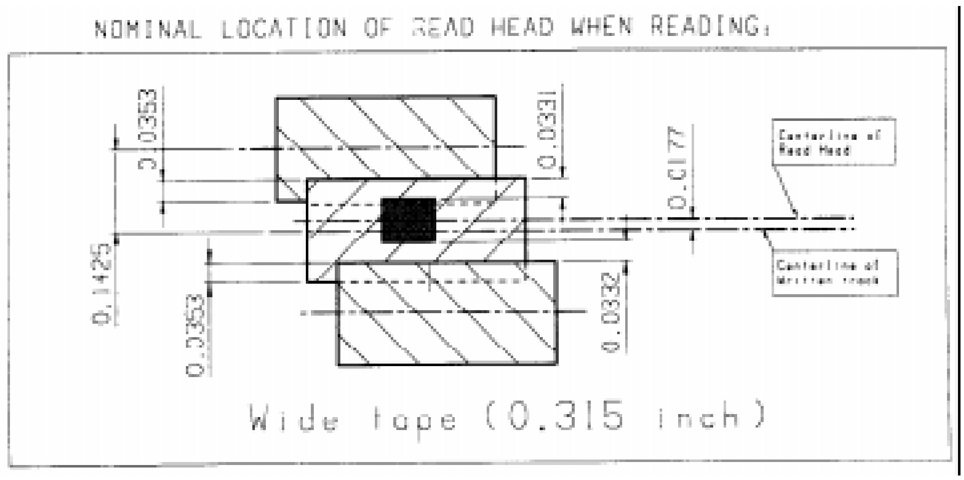


Figure 4.1B Track write operation with overlap, 0.315 inch tape.

4.4 Qick File Access

This standard supports Quick File Access (QFA). Tapes may either be recorded with partition for QFA or not.

With QFA implemented, this standard supports 2 partitions. The data (or default) partition is designated 0. It shall be recorded on all tracks except track 41 (0.250 inch tape) or track 51 (0.315 inch Wide tape). Partition 1 shall be the directory partition and shall be recorded on track 41 (track 51) only. Track 41 (track 51) shall then be recorded in the forward direction.

Tapes not partitioned for QFA shall have track 41 (track 51) recorded in the reverse direction. Partition 1 shall be created through SCSI mode select (FDP).

Note: A QFA tape must be partitioned prior to any data recording.

4.5 Implementation techniques

Drives implementing this format shall be designed to use averaging methods to compensate for amplitude modulations and short term tape wander when performing tape edge seek, Reference Burst seek and tape slope compensation operations.

Drives implementing this format shall also be able to micro-step the read head in order to position the head within the recorded track area.

4.6 Explanation to Track tables 4.1A & 4.1B

d40ref (d50ref): Nominal distance from Reference Edge to centerline of Reference Burst on track 40 (50).

d0ref: Nominal distance from the actual centerline position of Reference Burst on track 40 (50) to centerline of Reference Burst on track 0.

d1ref: Nominal distance from the actual centerline position of Reference Burst on track 0 to centerline of Reference Burst on track 1.

d0ref_act: The distance from the actual centerline position (physical position on the tape) of the Reference Burst on track 40 to the actual centerline position of the Reference Burst on track 0.

d1ref_act: The distance from the actual centerline position (physical position on the tape) of the Reference Burst on track 0 to the actual centerline position of the Reference Burst on track 1.

d0-d41 (d0-d51): Nominal distance from the actual centerline position of Reference Burst on track 0 to centerline of data tracks 0 through 41F (51F) for even tracks.
Nominal distance from the actual centerline position of Reference Burst on track 1 to centerline of data tracks 1 through 41R (51R) for odd tracks.

Column A is describing the track centerline positions when writing with a 0.00700 inch Write Head (overlap condition).

NOTE:
For track overlap recording (below 0.00700inch & above 0.00540inch Write head) the table values in Column A must be re-calculated to match the corresponding width of the Write head such that the effective track width will be 0.00540inch.

Column B is describing the track centerline positions when reading.
NOTE:
If there is no overlap during writing (0.00540inch - 0.00350inch Write head) the centerline position described in column B shall be used in both Write and Read operation.

Table 4.1A: Offset = 0,0201 mm (0,000791 inch)
Table 4.1B: Offset = 0,0177 mm (0,000697 inch)

Refer to chapter 4.7 "Actual Track Positioning" for physical position of the tracks on the tape.

4.7 Actual track positioning

Nominal track positions are listed in tables 4.1A (0.250 inch tape) and 4.1B (0.315 inch Wide tape). All even data tracks are referred to Reference Bursts on track 0 and track 40 (track 50 for 0.315 inch Wide tape). All odd data tracks are referred to Reference Burst on track 1. Due to this, the relative physical positioning of the data tracks on the tape will be given by the following formulae:

$$d_{n\_actual} = d_{n\_nominal} \times (d_{0ref\_act} / d_{0ref\_nominal}) \quad \text{for } n=2\text{-}40, \ (n=2\text{-}50))$$

The above formulae is valid for both even and odd tracks.

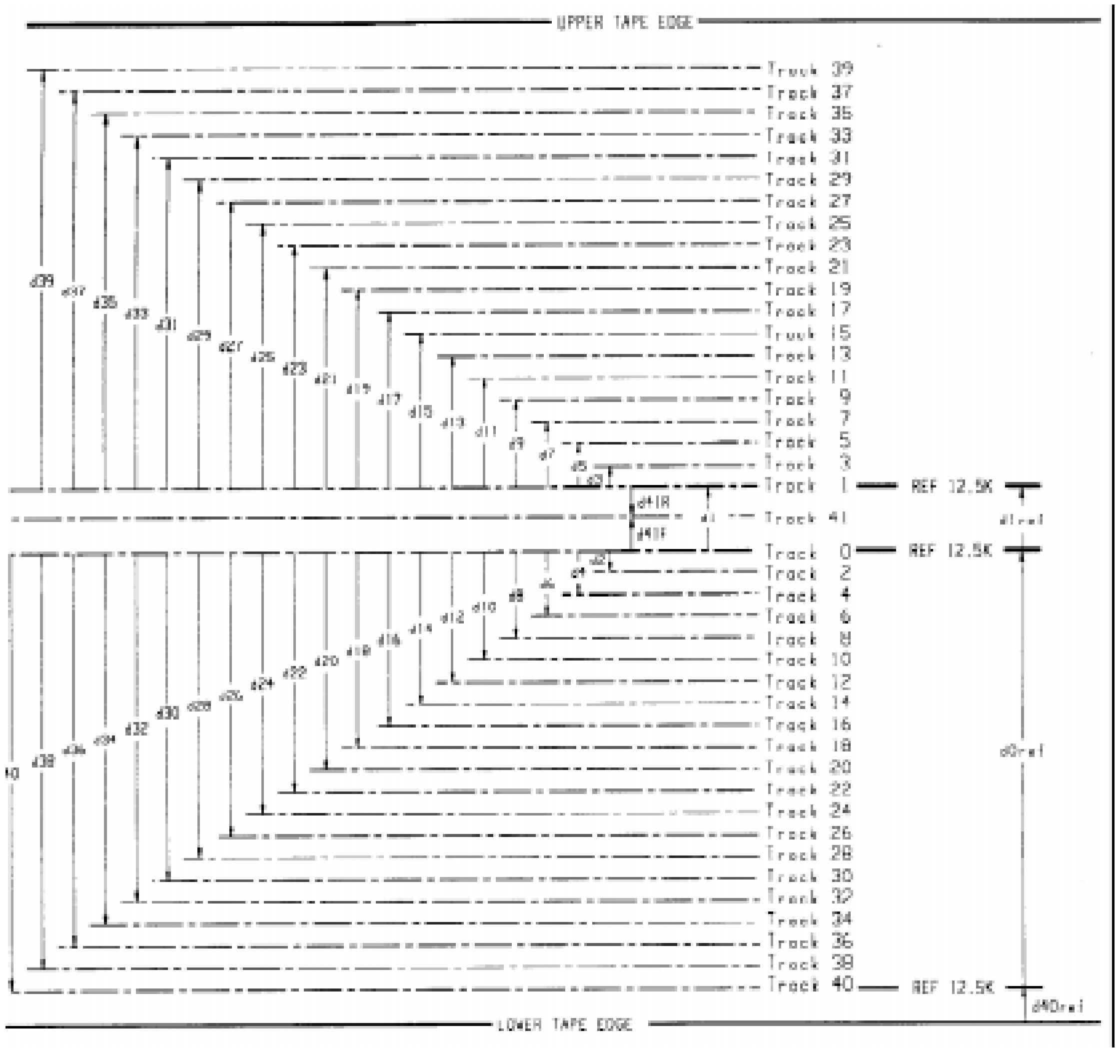


Figure 4.2A. Track Numbering, 0.250 inch tape

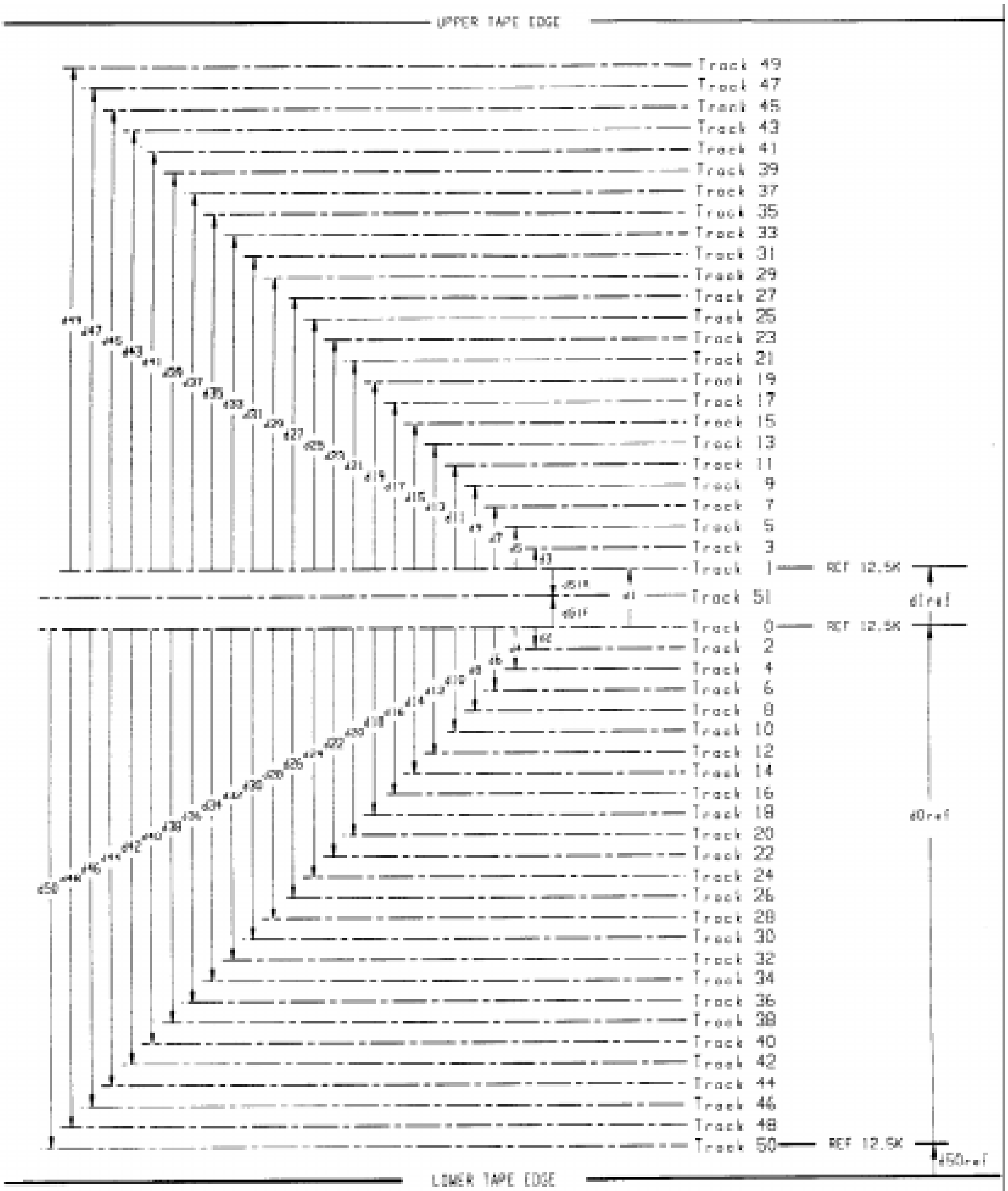


Figure 4.2B. Track Numbering, 0.315 inch Wide tape

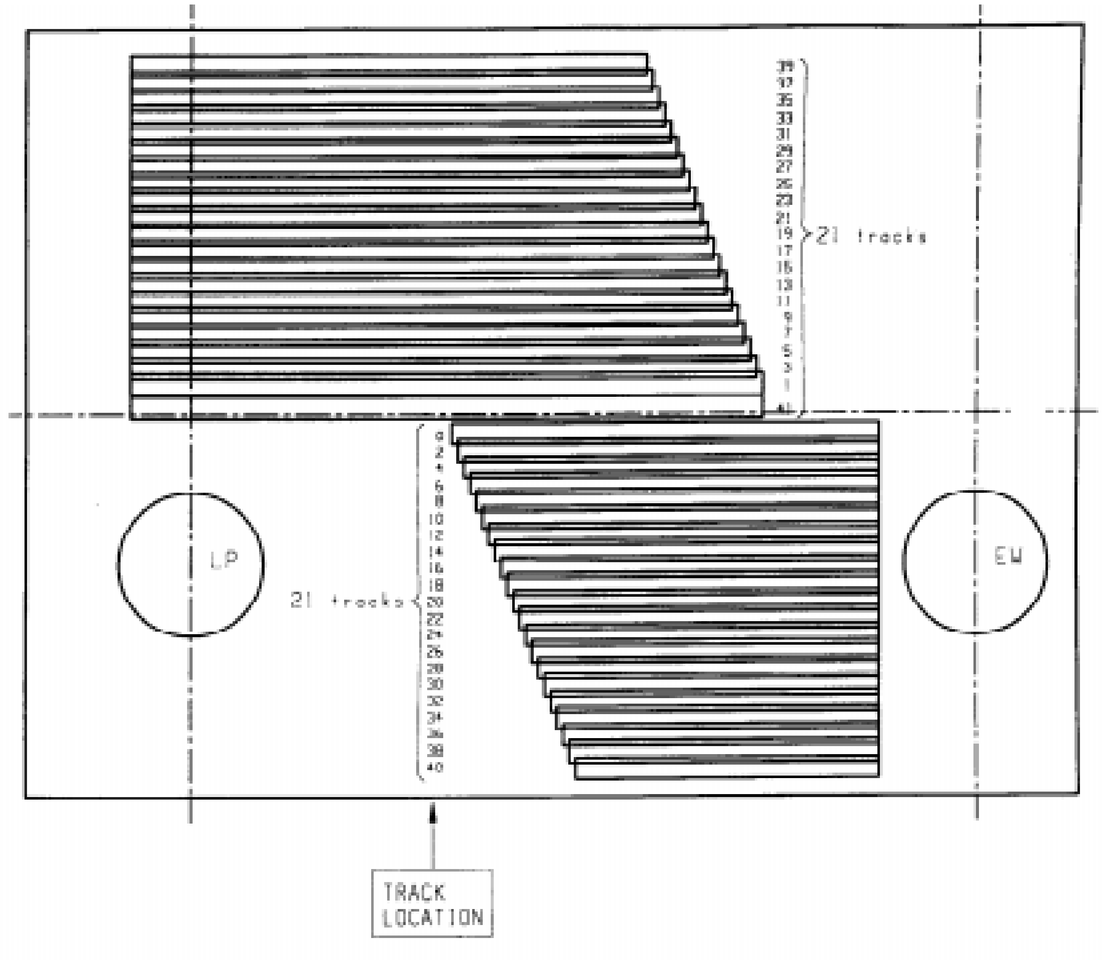


Figure 4.3A Track Layout with track overlapping, 0.250 inch tape

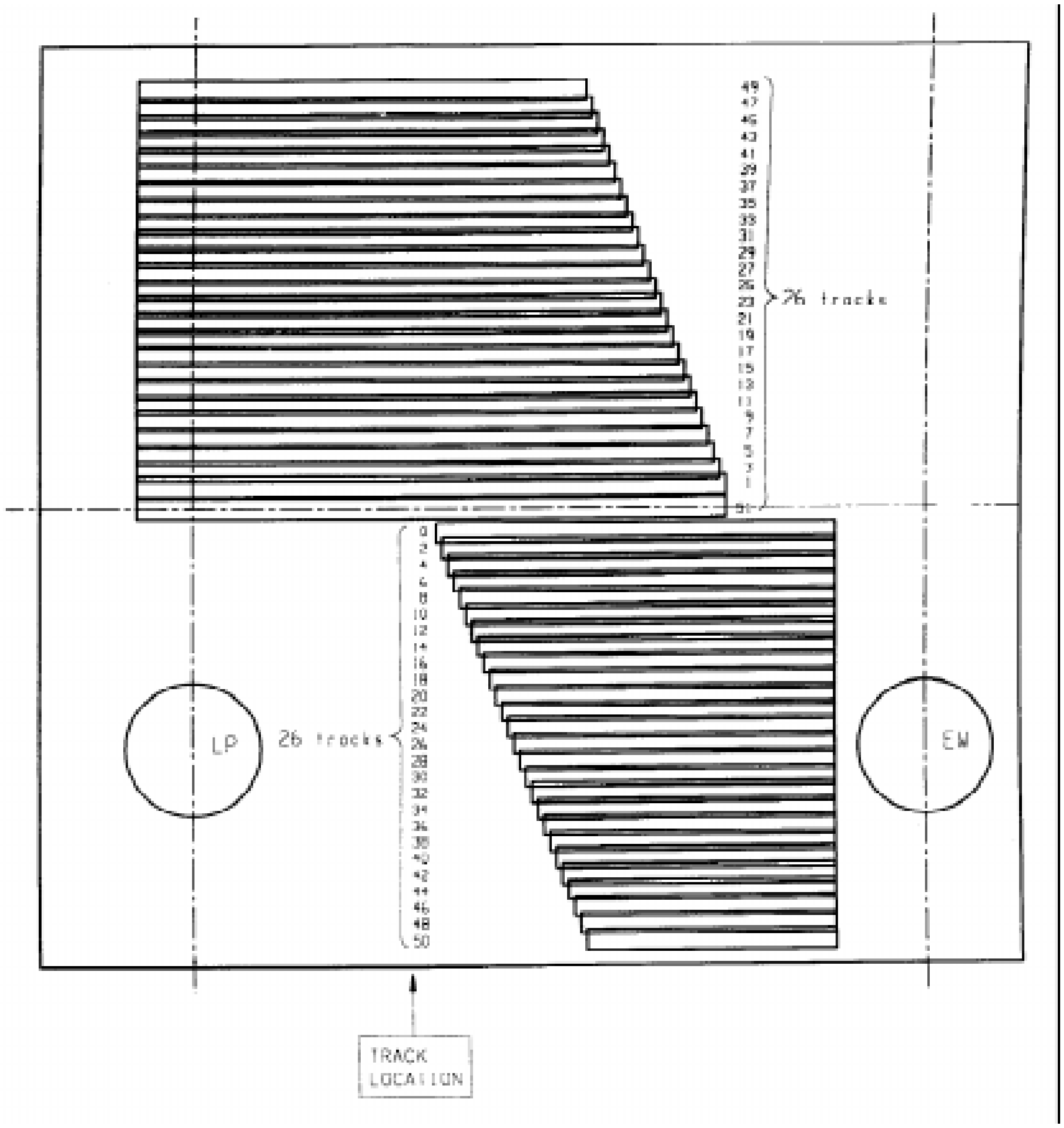


Figure 4.3B Track Layout with track overlapping, 0.315 inch Wide tape

Column A:					**Column B:**			
Center line positions when Writing					Center line positions when Reading (see note)			
	(Millimeters)		(Inches)		(Millimeters)		(Inches)	
d0ref	2,7500	± 0.0400	0.1083	± 0,00157	d0ref	± 0.0400	d0ref	± 0,00157
d0	d0ref_act	± 0.0190	d0ref_act	± 0,00075	d0ref_act + offset	± 0.0190	d0ref_act + offset	± 0.00190
d1ref	0,4000	± 0,0240	0,0157	± 0.00094	d1ref	± 0,0240	d1ref	± 0.00094
d1	d1ref_act	± 0,0190	d1ref_act	± 0.00075	d1ref_act - offset	± 0,0190	d1ref_act - offset	± 0.00075
d2	0,1375	± 0,0190	0,0054	± 0,00075	d2 - offset	± 0,0190	d2 - offset	± 0,00075
d3	0,1375	± 0,0190	0,0054	± 0,00075	d3 - offset	± 0,0190	d3 - offset	± 0,00075
d4	0,2750	± 0,0190	0,0108	± 0,00075	d4 - offset	± 0,0190	d4 - offset	± 0,00075
d5	0,2750	± 0,0190	0,0108	± 0,00075	d5 - offset	± 0,0190	d5 - offset	± 0,00075
d6	0,4125	± 0,0190	0.0162	± 0,00075	d6 - offset	± 0,0190	d6 - offset	± 0,00075
d7	0,4125	± 0,0190	0.0162	± 0,00075	d7 - offset	± 0,0190	d7 - offset	± 0,00075
d8	0,5500	± 0,0190	0.0217	± 0,00075	d8 - offset	± 0,0190	d8 - offset	± 0,00075
d9	0,5500	± 0,0190	0.0217	± 0,00075	d9 - offset	± 0,0190	d9 - offset	± 0,00075
d10	0,6875	± 0,0190	0.0271	± 0,00075	d10 - offset	± 0,0190	d10 - offset	± 0,00075
d11	0,6875	± 0,0190	0.0271	± 0,00075	d11 - offset	± 0,0190	d11 - offset	± 0,00075
d12	0,8250	± 0,0190	0.0325	± 0,00075	d12 - offset	± 0,0190	d12 - offset	± 0,00075
d13	0,8250	± 0,0190	0.0325	± 0,00075	d13 - offset	± 0,0190	d13 - offset	± 0,00075
d14	0,9625	± 0,0190	0.0379	± 0,00075	d14 - offset	± 0,0190	d14 - offset	± 0,00075
d15	0,9625	± 0,0190	0.0379	± 0,00075	d15 - offset	± 0,0190	d15 - offset	± 0,00075
d16	1,1000	± 0,0190	0.0433	± 0,00075	d16 - offset	± 0,0190	d16 - offset	± 0,00075
d17	1,1000	± 0,0190	0.0433	± 0,00075	d17 - offset	± 0,0190	d17 - offset	± 0,00075
d18	1,2375	± 0,0190	0.0487	± 0,00075	d18 - offset	± 0,0190	d18 - offset	± 0,00075
d19	1,2375	± 0,0190	0.0487	± 0,00075	d19 - offset	± 0,0190	d19 - offset	± 0,00075
d20	1,3750	± 0,0190	0.0541	± 0,00075	d20 - offset	± 0,0190	d20 - offset	± 0,00075
d21	1,3750	± 0,0190	0.0541	± 0,00075	d21 - offset	± 0,0190	d21 - offset	± 0,00075
d22	1,5125	± 0,0190	0.0595	± 0,00075	d22 - offset	± 0,0190	d22 - offset	± 0,00075
d23	1,5125	± 0,0190	0.0595	± 0,00075	d23 - offset	± 0,0190	d23 - offset	± 0,00075
d24	1,6500	± 0,0190	0.0650	± 0,00075	d24 - offset	± 0,0190	d24 - offset	± 0,00075
d25	1,6500	± 0,0190	0.0650	± 0,00075	d25 - offset	± 0,0190	d25 - offset	± 0,00075
d26	1,7875	± 0,0190	0.0704	± 0,00075	d26 - offset	± 0,0190	d26 - offset	± 0,00075
d27	1,7875	± 0,0190	0.0704	± 0,00075	d27 - offset	± 0,0190	d27 - offset	± 0,00075
d28	1,9250	± 0,0190	0.0758	± 0,00075	d28 - offset	± 0,0190	d28 - offset	± 0,00075
d29	1,9250	± 0,0190	0.0758	± 0,00075	d29 - offset	± 0,0190	d29 - offset	± 0,00075
d30	2,0625	± 0,0190	0.0812	± 0,00075	d30 - offset	± 0,0190	d30 - offset	± 0,00075
d31	2,0625	± 0,0190	0.0812	± 0,00075	d31 - offset	± 0,0190	d31 - offset	± 0,00075
d32	2,2000	± 0,0190	0.0866	± 0,00075	d32 - offset	± 0,0190	d32 - offset	± 0,00075
d33	2,2000	± 0,0190	0.0866	± 0,00075	d33 - offset	± 0,0190	d33 - offset	± 0,00075
d34	2,3375	± 0,0190	0.0920	± 0,00075	d34 - offset	± 0,0190	d34 - offset	± 0,00075
d35	2,3375	± 0,0190	0.0920	± 0,00075	d35 - offset	± 0,0190	d35 - offset	± 0,00075
d36	2,4750	± 0,0190	0.0974	± 0,00075	d36 - offset	± 0,0190	d36 - offset	± 0,00075
d37	2,4750	± 0,0190	0.0974	± 0,00075	d37 - offset	± 0,0190	d37 - offset	± 0,00075
d38	2,6125	± 0,0190	0.1029	± 0,00075	d38 - offset	± 0,0190	d38 - offset	± 0,00075
d39	2,6125	± 0,0190	0.1029	± 0,00075	d39 - offset	± 0,0190	d39 - offset	± 0,00075
d40	2,7500	± 0,0190	0.1083	± 0,00075	d40 - offset	± 0,0190	d40 - offset	± 0,00075
d40ref	0,2265	± 0,0300	0.0089	± 0,00118	d40ref	± 0,0300	d40ref	± 0,00118
d41F	0,1870	± 0,0190	0.0074	± 0,00075	d41F	± 0,0190	d41F	± 0,00075
d41R	0,1870	± 0,0190	0.0074	± 0,00075	d41R	± 0,0190	d41R	± 0,00075

Table 4.1A. Track positions for 0,250 inch tape.

Refer chapter 4.6 and 4.7 for physical positioning of the Reference Bursts and the Data tracks on the tape.   Note: Offset = 0.0201 mm (0.000791 inch)

Column A:					Column B:			
Centerline positions when Writing					Centerline positions when Reading (see note)			
	(Millimeters)		(Inches)		(Millimeters)		(Inches)	
d0ref	3,5625	± 0,0470	0,1403	± 0,00185	d0ref	± 0,0470	d0ref	± 0,00185
d0	d0ref_act	± 0,0200	d0ref_act	± 0,00079	d0ref_act + offset	± 0,0200	d0ref_act + offset	± 0,00079
d1ref	0,4000	± 0,0240	0,0157	± 0,00094	d1ref	± 0,0240	d1ref	± 0,00094
d1	d1ref_act	± 0,0200	d1ref_act	± 0,00079	d1ref_act - offset	± 0,0200	d1ref_act - offset	± 0,00079
d2	0,1425	± 0,0200	0,0056	± 0,00079	d2 - offset	± 0,0200	d2 - offset	± 0,00079
d3	0,1425	± 0,0200	0,0056	± 0,00079	d3 - offset	± 0,0200	d3 - offset	± 0,00079
d4	0,2850	± 0,0200	0,0112	± 0,00079	d4 - offset	± 0,0200	d4 - offset	± 0,00079
d5	0,2850	± 0,0200	0,0112	± 0,00079	d5 - offset	± 0,0200	d5 - offset	± 0,00079
d6	0,4275	± 0,0200	0,0168	± 0,00079	d6 - offset	± 0,0200	d6 - offset	± 0,00079
d7	0,4275	± 0,0200	0,0168	± 0,00079	d7 - offset	± 0,0200	d7 - offset	± 0,00079
d8	0,5700	± 0,0200	0,0224	± 0,00079	d8 - offset	± 0,0200	d8 - offset	± 0,00079
d9	0,5700	± 0,0200	0,0224	± 0,00079	d9 - offset	± 0,0200	d9 - offset	± 0,00079
d10	0,7125	± 0,0200	0,0281	± 0,00079	d10 - offset	± 0,0200	d10 - offset	± 0,00079
d11	0,7125	± 0,0200	0,0281	± 0,00079	d11 - offset	± 0,0200	d11 - offset	± 0,00079
d12	0,8550	± 0,0200	0,0337	± 0,00079	d12 - offset	± 0,0200	d12 - offset	± 0,00079
d13	0,8550	± 0,0200	0,0337	± 0,00079	d13 - offset	± 0,0200	d13 - offset	± 0,00079
d14	0,9975	± 0,0200	0,0393	± 0,00079	d14 - offset	± 0,0200	d14 - offset	± 0,00079
d15	0,9975	± 0,0200	0,0393	± 0,00079	d15 - offset	± 0,0200	d15 - offset	± 0,00079
d16	1,1400	± 0,0200	0,0449	± 0,00079	d16 - offset	± 0,0200	d16 - offset	± 0,00079
d17	1,1400	± 0,0200	0,0449	± 0,00079	d17 - offset	± 0,0200	d17 - offset	± 0,00079
d18	1,2825	± 0,0200	0,0505	± 0,00079	d18 - offset	± 0,0200	d18 - offset	± 0,00079
d19	1,2825	± 0,0200	0,0505	± 0,00079	d19 - offset	± 0,0200	d19 - offset	± 0,00079
d20	1,4250	± 0,0200	0,0561	± 0,00079	d20 - offset	± 0,0200	d20 - offset	± 0,00079
d21	1,4250	± 0,0200	0,0561	± 0,00079	d21 - offset	± 0,0200	d21 - offset	± 0,00079
d22	1,5675	± 0,0200	0,0617	± 0,00079	d22 - offset	± 0,0200	d22 - offset	± 0,00079
d23	1,5675	± 0,0200	0,0617	± 0,00079	d23 - offset	± 0,0200	d23 - offset	± 0,00079
d24	1,7100	± 0,0200	0,0673	± 0,00079	d24 - offset	± 0,0200	d24 - offset	± 0,00079
d25	1,7100	± 0,0200	0,0673	± 0,00079	d25 - offset	± 0,0200	d25 - offset	± 0,00079
d26	1,8525	± 0,0200	0,0729	± 0,00079	d26 - offset	± 0,0200	d26 - offset	± 0,00079
d27	1,8525	± 0,0200	0,0729	± 0,00079	d27 - offset	± 0,0200	d27 - offset	± 0,00079
d28	1,9950	± 0,0200	0,0785	± 0,00079	d28 - offset	± 0,0200	d28 - offset	± 0,00079
d29	1,9950	± 0,0200	0,0785	± 0,00079	d29 - offset	± 0,0200	d29 - offset	± 0,00079
d30	2,1375	± 0,0200	0,0842	± 0,00079	d30 - offset	± 0,0200	d30 - offset	± 0,00079
d31	2,1375	± 0,0200	0,0842	± 0,00079	d31 - offset	± 0,0200	d31 - offset	± 0,00079
d32	2,2800	± 0,0200	0,0898	± 0,00079	d32 - offset	± 0,0200	d32 - offset	± 0,00079
d33	2,2800	± 0,0200	0,0898	± 0,00079	d33 - offset	± 0,0200	d33 - offset	± 0,00079
d34	2,4225	± 0,0200	0,0954	± 0,00079	d34 - offset	± 0,0200	d34 - offset	± 0,00079
d35	2,4225	± 0,0200	0,0954	± 0,00079	d35 - offset	± 0,0200	d35 - offset	± 0,00079
d36	2,5650	± 0,0200	0,1010	± 0,00079	d36 - offset	± 0,0200	d36 - offset	± 0,00079
d37	2,5650	± 0,0200	0,1010	± 0,00079	d37 - offset	± 0,0200	d37 - offset	± 0,00079
d38	2,7075	± 0,0200	0,1066	± 0,00079	d38 - offset	± 0,0200	d38 - offset	± 0,00079
d39	2,7075	± 0,0200	0,1066	± 0,00079	d39 - offset	± 0,0200	d39 - offset	± 0,00079
d40	2,8500	± 0,0200	0,1122	± 0,00079	d40 - offset	± 0,0200	d40 - offset	± 0,00079
d41	2,8500	± 0,0200	0,1122	± 0,00079	d41 - offset	± 0,0200	d41 - offset	± 0,00079
d42	2,9925	± 0,0200	0,1178	± 0,00079	d42 - offset	± 0,0200	d42 - offset	± 0,00079
d43	2,9925	± 0,0200	0,1178	± 0,00079	d43 - offset	± 0,0200	d43 - offset	± 0,00079
d44	3,1350	± 0,0200	0,1234	± 0,00079	d44 - offset	± 0,0200	d44 - offset	± 0,00079
d45	3,1350	± 0,0200	0,1234	± 0,00079	d45 - offset	± 0,0200	d45 - offset	± 0,00079
d46	3,2775	± 0,0200	0,1290	± 0,00079	d46 - offset	± 0,0200	d46 - offset	± 0,00079
d47	3,2775	± 0,0200	0,1290	± 0,00079	d47 - offset	± 0,0200	d47 - offset	± 0,00079
d48	3,4200	± 0,0200	0,1346	± 0,00079	d48 - offset	± 0,0200	d48 - offset	± 0,00079
d49	3,4200	± 0,0200	0,1346	± 0,00079	d49 - offset	± 0,0200	d49 - offset	± 0,00079
d50	3,5625	± 0,0200	0,1403	± 0,00079	d50 - offset	± 0,0200	d50 - offset	± 0,00079
d50ref	0.2315	± 0,0300	0,0091	± 0,00118	d50ref	± 0,0300	d50ref	± 0,00118
d51F	0.1870	± 0,0200	0,0074	± 0,00079	d51F	± 0,0200	d51F	± 0,00079
d51R	0,1870	± 0,0200	0.0074	± 0,00079	d51R	± 0,0200	d51R	± 0,00079

Table 4.1B. Track positions for 0,315 inch Wide tape.

Refer to chapter 4.6 and 4.7 for physical positioning of the Reference Bursts and Data tracks on the tape. Note: Offset = 0.0177 mm (0.000697 inch)

5. RECORDING

5.1 Method of Recording

The recording method shall be the Non Return to Zero Mark (NRZ1) method where a ONE is represented by a change of direction of longitudinal magnetization.

The recording current shall be 1.15xI_{sat} ± 15% where I_{sat} is the current providing 95% of the maximum output at 2000 ftpmm (50 800 ftpi). The I_{sat} is measured on the non-saturated side of the saturation current curve.

5.2 Transition Densities

The nominal maximum transition density shall be 2000 ftpmm (50 800 ftpi). The nominal transition cell length shall be 0.500 µm (19.7 microinches).

With the recording method used in this Standard, three transition densities may occur:

2000 ftpmm (50 800 ftpi)
1000 ftpmm (25 400 ftpi)
667 ftpmm (16 933 ftpi)

Additionally, the Reference Bursts are recorded at 12 500 ftpi (492 ftpmm).

5.3 Average Transition Cell Length Variations

5.3.1 Average Transition Cell Length

The average transition cell length is the sum of the distances between the flux transitions in n transition cells divided by (n-1). The tests referred to below may be made in any continuously recorded pattern, provided the first and the last transition cell in the pattern each contain a flux transition.

5.3.2 Long Term Average Transition Cell Length

The long term average transition cell length is the average bit cell length taken over a minimum of 2000 000 transition cells. The long term average transition cell length shall be within +/- 3% of the nominal bit cell length of 0.500 µm (19.7 µinch).

5.3.3 Medium Term Average Transition Cell Length

The medium term average transition cell length is the average bit cell length taken over a minimum of 30 000 transition cells and a maximum of 34 000 transition cells. The medium term average transition cell length shall be within +/- 6% of the long term average transition cell length.

5.3.4 Short Term Average Transition Cell Length

The short term average transition cell length is the average transition cell length taken over a minimum of 48 transition cells and a maximum of 64 transition cells. The short term average transition cell length shall be within +/- 6% of the medium term average transition cell length.

5.3.5 Rate of Change of Transition Cell Length.

The rate of change of the transition cell length shall not exceed 0.25 %. The rate of change is given by the following relationship:

$$\text{Rate of Change:} \quad \frac{\left| \frac{T1}{4} - \frac{T2}{4} \right|}{\frac{T3}{5}}$$

Where T1, T2 and T3 are the times between flux transitions as shown in figure 5.1. Periods 1 through 5 are contiguous and represent the repetitive encoding pattern 101010 within a data block, and frequency variations are less than 20 KHz.

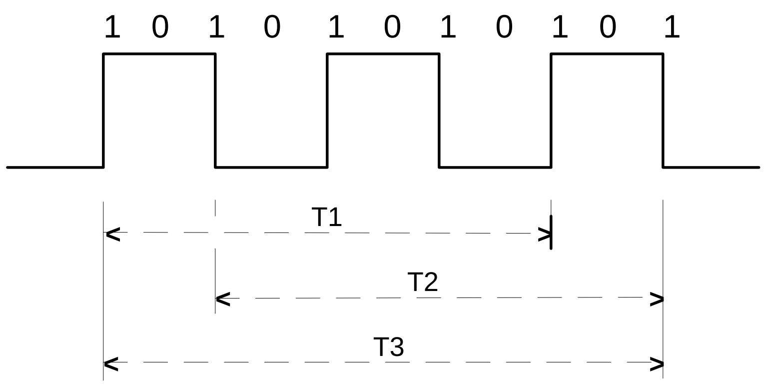


Figure 5.1 Rate of Change Test Pattern

5.3.6 Instantaneous Flux Transition Spacing

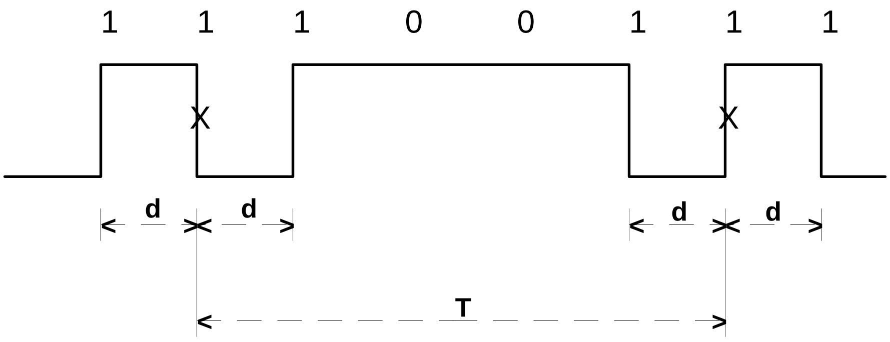
The instantaneous spacing between flux transitions is influenced by the reading and writing process, the pattern recorded (pulse-crowding effect) and other factors. Instantaneous spacing between flux transitions shall satisfy the following conditions:

In a sequence of flux transitions defined by the encoded pattern 11100111, the center flux transition of each group of 111's is called a reference flux transition. The maximum displacement of flux transitions on either side of the reference flux transitions shall not exceed +/- 28% of the transition cell length $\mathbf{d_1}$ averaged over the five transition cells between the reference flux transitions indicated in the bit pattern in figure 5.2.

5.4 Signal Amplitude of a Recorded Cartridge for Data Interchange

When performing the tests described below, the output or resultant signal shall be measured on the same pass for both the Standard Amplitude Reference Cartridge and the tape under test. If possible, the measurements shall be performed during the write pass; if not during the first read pass after the write pass. The same equipment shall be used for all measurements. The signal amplitude shall be measured at a point in the read channel where the signal is proportional to the rate of change of the flux induced in the head.

After writing, the cartridge shall meet the following requirements:



$$d_1 = T/5$$

$$d_1(1-0.28) < d < d_1(1+0.28)$$

Figure 5.2 Test Pattern for Instantaneous Flux Transitions Spacing Test.
X denotes reference flux transitions.

5.4.1 Average Signal Amplitude at nominal maximum Density

At the nominal maximum physical recording density 2000 ftpmm (50 800 ftpi), the Average Peak-to- Peak Signal Amplitude of any track on the interchange tape shall deviate no more than + 50% or - 35% from the Standard Reference Amplitude recorded at 2000 ftpmm (50 800 ftpi). This averaging shall be made over the central 100 flux transitions of any 120 or more flux transitions recorded at nominal maximum density in a block and over at least 400 blocks.

5.4.2 Maximum Signal Amplitude

When interchanged, a tape shall not contain, in the valid information area, any flux transitions where the peak-to-peak signal amplitude is more than three times the Standard Reference Amplitude at 2000 ftpmm (50 800 ftpi).

5.4.3 Minimum Signal Amplitude

When interchanged, a tape shall not contain, in its valid information area, any flux transitions where the peak-to-peak signal amplitude is less than 25% of the Standard Reference Amplitude at 2000 ftpmm (50 800 ftpi).

5.5 Recorded Azimuth

On any track the angle that a flux transition across the track makes with a line perpendicular to the Reference B-plane of the cartridge shall not exceed 7 minutes of an arc (2.04 mrad).

5.6 Erasure

To erase the tape, overwrite shall be used. Two modes of erase shall be implemented, logical erase and security erase.

5.6.1 Logical erase

The ERASE, ERASE P0 and ERASE P1 bits in the Device Directory shall all be set to 1. This indicates that the tape is logically erased. It is possible to un-erase the tape by clearing these bits.

No data in any partition shall be overwritten. No data in the Device Directory shall be updated except for the Erase-bits.

The ERASE bit shall be cleared and the Device Directory shall be updated when data is written from BOT on any partition. The ERASE P0 and the ERASE P1 bits shall be cleared when data is written from BOT on the respective partition.

5.6.2 Security erase

All tracks on all partitions on the tape shall be overwritten using normal data recording with a random data pattern.

The Reference Tracks shall not be overwritten.

The Device Directory shall be updated to indicate that EOD is located at BOT and there is only one partition. The Erase-bits shall all be set to 1 to indicate that the tape is erased.

See layout for Device Directory in section 9.8.1.

5.7 Overwrite

During write operation, the preceding track may be partly overwritten as defined in section 4.2. This overwriting process shall be performed so that the signal level of the preceding track area being overwritten is reduced with at least 24 dB.

If writing occur on a previously recorded tape, each track shall be overwritten so that the previous recording on the track is reduced with at least 24 dB.

6. USE OF TRACKS

6.1. Data Tracks

Each track shall be a data track and shall be written serially, one track at a time.

6.2 Track Numbering

All even numbered tracks shall be recorded in the forward direction (the direction from the BOT marker to the EOT marker). All odd numbered tracks shall be recorded in the reverse direction (the direction from the EOT marker to the BOT marker). If the Quick File Access option is implemented, track 41/51 shall be recorded in the forward direction.

6.3 Forward Reference Bursts

On tracks 0 and 40 for 0.250 inch tape (tracks 0 and 50 for 0.315 inch Wide tape), the Forward Reference Bursts shall start a minimum of 0 inches (0 mm) and a maximum of 1 inch (25.4 mm) from the BOT2-marker and end a minimum of 0inches (0 mm) and a maximum of 1 inch (25.4 mm) in front of LP.
Enclosing the Forward Reference Bursts there shall be a belt with a recording frequency of 50 800 ftpi (2000 ftpmm). The belt shall be 0.00542 inches (0.1376 mm) above and below the Reference Bursts on tracks 0 and 40 for 0.250 inch tape. For the Reference Burst on track 40 ensure that the lower part of the belt reaches the Reference Edge.
The belt shall be 0.00562 inches (0.1426 mm) above and below the Reference Bursts on tracks 0 and 50 for 0.315 inch Wide tape. For the Reference Burst on track 50 ensure that the lower part of the belt reaches the Reference Edge.

See figures 6.1A & 6.1B, and 6.2A & 6.2B.

Note: When searching the reference burst on track 0 make sure to terminate the search enough in front of the LP-marker to avoid conflict with any data written on the last track.

6.4 Reverse Reference Burst

On track 1 a Reverse Reference Burst shall be recorded between LP and the BOT3-marker. The Reverse Reference Burst and the Forward Reference Bursts shall be recorded prior to data recording. The Reverse Reference Burst shall be recorded while the tape is moving in reverse direction. The Reverse Reference Burst shall be recorded using a recording frequency of 12 500 ftpi (492 ftpmm).
The Reverse Reference Burst shall start a minimum of 6 inches (152.4 mm) and a maximum of 7 inches (177.8 mm) after the LP marker (measured in direction towards the BOT holes), and shall terminate a minimum of 2 inches (50.8 mm) and a maximum of 4 inches (101.6 mm) passed the BOT2 marker.
Enclosing the Reverse Reference Burst there shall be a belt with a recording frequency of 50 800 ftpi (2000 ftpmm). The belt shall be 0.00542 inches (0.1376 mm) above and below the Reference Burst for 0.250 inch tape.
The belt shall be 0.00562 inches (0.1426 mm) above and below the Reference Burst for 0.315 inch Wide tape.

See figures 6.1A & 6.1B, and 6.2A & 6.2B.

6.5 Minimum/Maximum Distances, Even Tracks

On all even numbered tracks (0,2,...etc.) the beginning of the Long preamble of the first data block (or frame) shall commence a minimum distance of 1 inch (25.4 mm) and a maximum distance of 2 inches (50.8 mm) past the LP marker.

If QFA is implemented, track 41 [42 track recording] / 51 [52 track recording] shall also be recoreded in the Forward direction in the same way as any even numbered track.

On all even numbered tracks, no data shall be recorded closer than 0.3 inches (7.5 mm) to the EW marker. The maximum distance from valid data to the EW marker shall be 2 inches (50.8 mm). When recorded in the Forward direction, track 41[42 track recording] / 51 [52 track recording] shall also meet this requirement.

After the data, a Long Postamble shall be recorded on all even numbered tracks.

See figures 6.1A & 6.1B, and 6.2A & 6.2B.

6.6 Minimum/Maximum Distances, Odd Tracks

On all odd numbered tracks (1,3,...etc.) the beginning of the preamble of the first data block (or frame) shall commence a minimum distance of 2 inches (50.8 mm) and a maximum distance of 3 inches (76.2 mm) past the EW marker.

On all odd numbered tracks (except track 41[42 track recording] / 51 [52 track recording] when QFA is implemented) the valid data area shall terminate at most a distance of 4 inches (101.6 mm) and at least a distance of 2 inches (50.8 mm) passed the LP marker. When track 41[42 track recording] / 51 [52 track recording] is recoreded in the Reverse direction (QFA not implemented), it shall also meet this requirement.

After the data, a Long Postamble shall be recorded on all odd numbered tracks.

See figures 6.1A & 6.1B, and 6.2A & 6.2B.

6.7 Drive Working Area (DWA)

DWA is a dedicated area between BOT3 and the LP markers to be used by the tape drive for specific test operations during write mode. The area shall be centered around tracks 11 and 28 with a total width of 0.01783 inches (0.4528 mm) for 42-track recording, and centered around tracks 11 and 40 with a total width of 0.01822 inches (0.4628 mm) for 52-track recording.
On track 11 (reverse direction) DWA shall start a minimum distance of 6 inches (152.4 mm) and a maximum distance of 7 inches (177.8mm) from the LP marker and end a maximum distance of 4 inches (101,6 mm) from the BOT2 marker.

On track 28 [42 track recording] / 40 [52 track recording] (forward direction) DWA shall start a minimum of 0 inches (0 mm) from the BOT2 marker and end a minimum distance of 0.1 inches (2.5 mm) in front of the LP marker.

See figures 6.1A & 6.1B, and 6.2A & 6.2B.

6.8 Minimum/Maximum Distances, Device Directory.

The Device Directory shall be written on 2 tracks between LP and BOT3. The tracks are 34 and 19 (42 track recording), and tracks 10 and 29 (52 track recording).

For both 42 and 52 track recording, the Device Directory shall be written in the logical forward direction (from BOT3 to LP on even tracks and from LP to BOT3 on odd tracks.). The recording on the even tracks shall start a minimum of 0 inches (0 mm) and a maximum of 1 inch (25.4 mm) from the BOT2 marker. The tracks shall end a maximum of 1 inch (25.4 mm) and a minimum of 0,1 inches (2,5 mm) in front of the LP marker in the recording direction.

The recording on the odd tracks shall start a minimum of 6 inches (152,4 mm) and a maximum of 7 inches (177,8 mm) on the BOT side of the LP marker. The tracks shall end a maximum of 4 inches (101.6 mm) and a minimum of 2 inches (50.8 mm) passed the BOT2 marker in the recording direction.

See figures 6.1A & 6.1B, and 6.2A & 6.2B.

6.9 Summary of requirements

Table 6.1 and figures 6.1A & 6.1B, and 6.2A & 6.2B on the next pages summarize the requirements in sections 6.1 to 6.8.

	Minimum	Maximum	Description.
D1	0" (0mm)	1" (25,4mm)	BOT2 to start of Reference Bursts, DWA and Device Directory on even tracks.
D2	0" (0mm)	1" (25,4mm)	End of Reference Bursts , DWA and Device Directory to LP on even tracks.
D3	1" (25,4mm)	2" (50,8mm)	LP to start of valid data (start of Long Preamble) on all even tracks.
D4	0,3" (7,5mm)	2" (50,8mm)	End of valid data (start of Long Postamble) to EW on all even tracks.
D5	2" (50,8mm)	3" (76,2mm)	EW to start of valid data (start of Long Preamble) on all odd tracks
D6	2" (50.8mm)	4" (101,6mm)	LP to end of valid data (start of Long Postamble) on all odd tracks.
D7	6" (152,4mm)	7" (177,8mm)	LP to start of Reference Burst on track 1, DWA and Device Directory on odd tracks..
D8	4" (101,6)	5" (127,0mm)	Long Postamble length (Refer to 9.3.7).
D9	2" (50.8mm)	4" (101,6mm)	BOT2 to end of Reference Burst on track 1, DWA and Device Directory on odd tracks.

Table 6.1 Summary of Requirements for Use of Tracks.

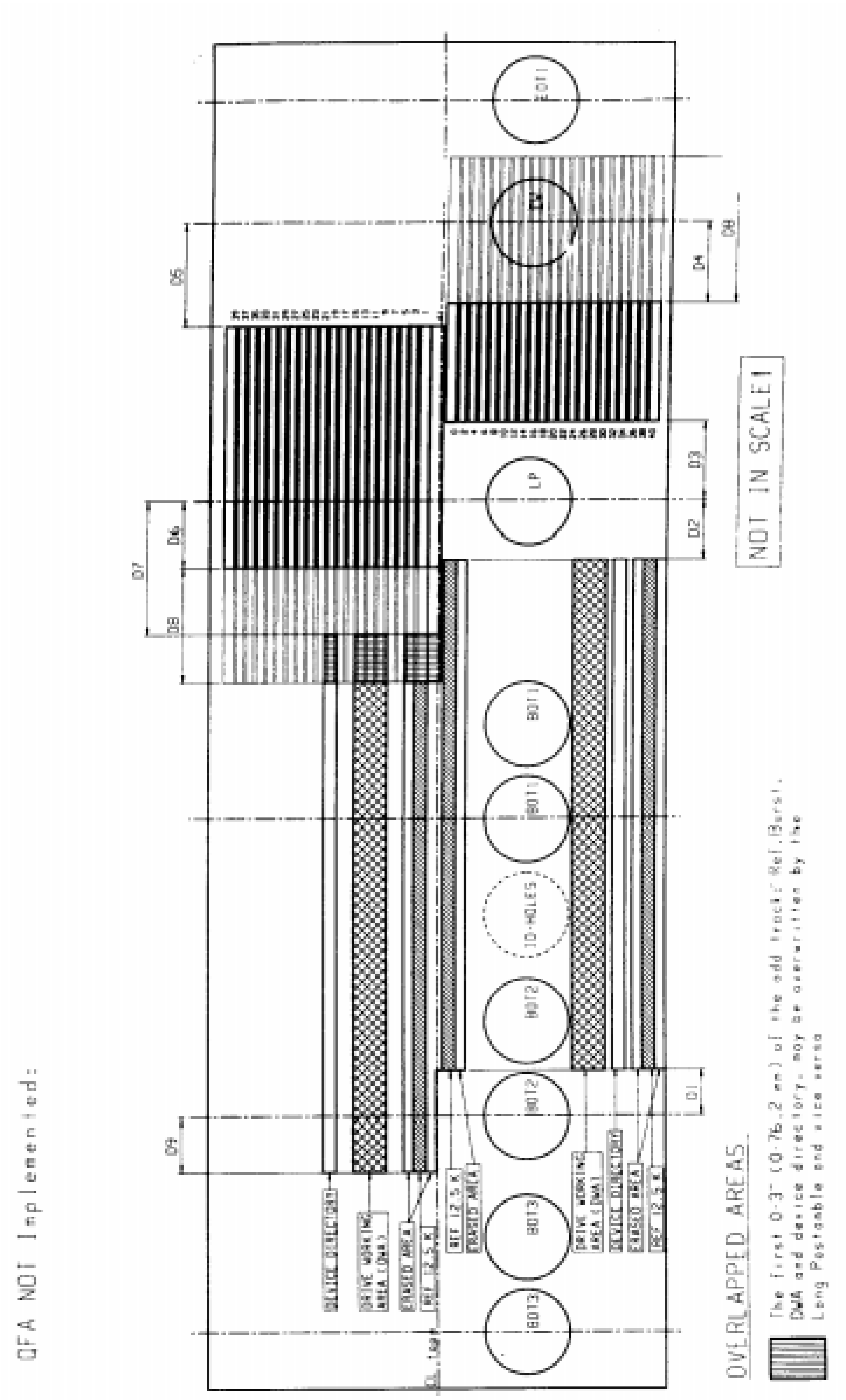


Figure 6.1A. Requirements for Use of Tracks, 0.250 inch tape.
QFA <u>not</u> implemented.

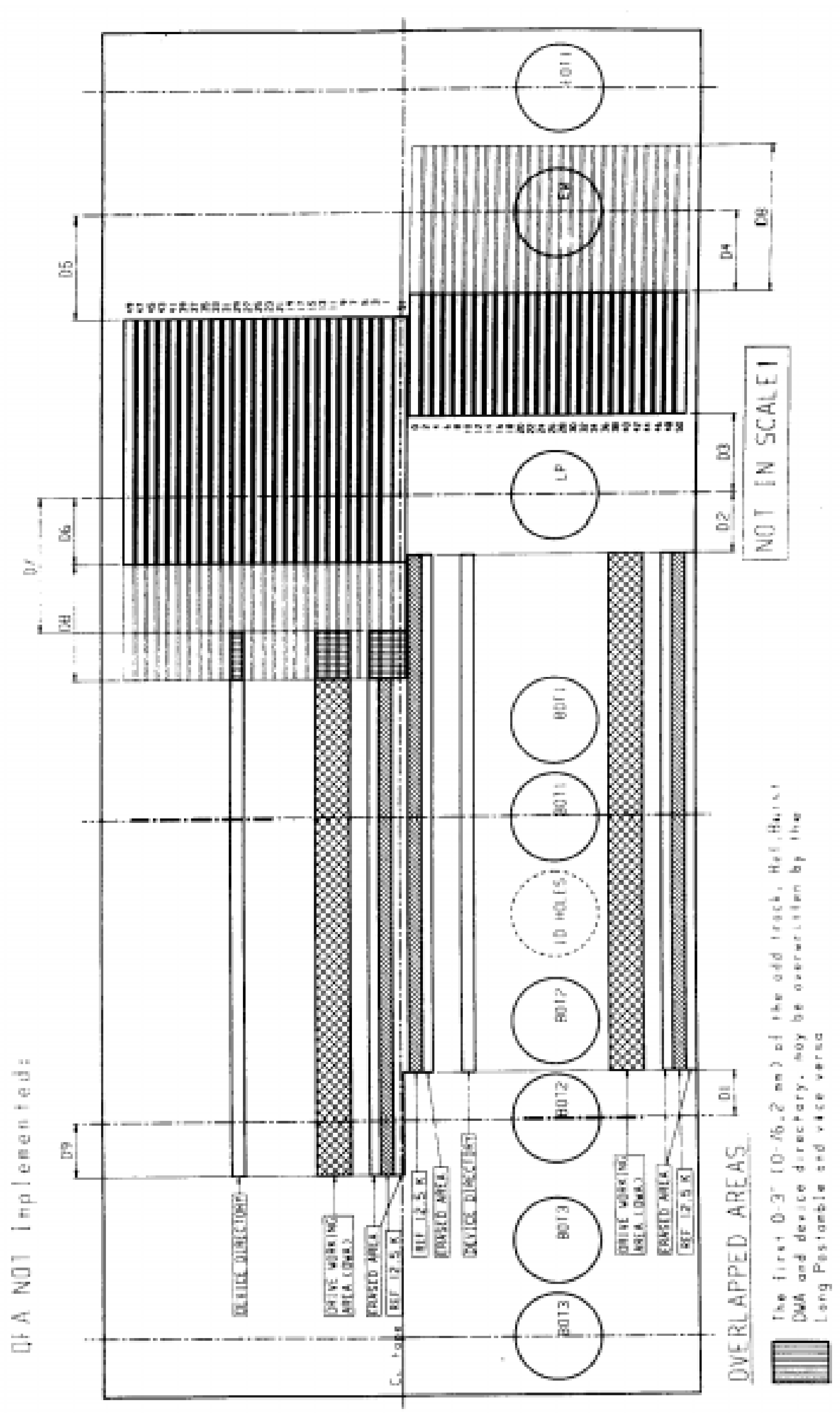


Figure 6.1B. Requirements for Use of Tracks, Wide tape (0.315 inch).
QFA <u>not</u> implemented.

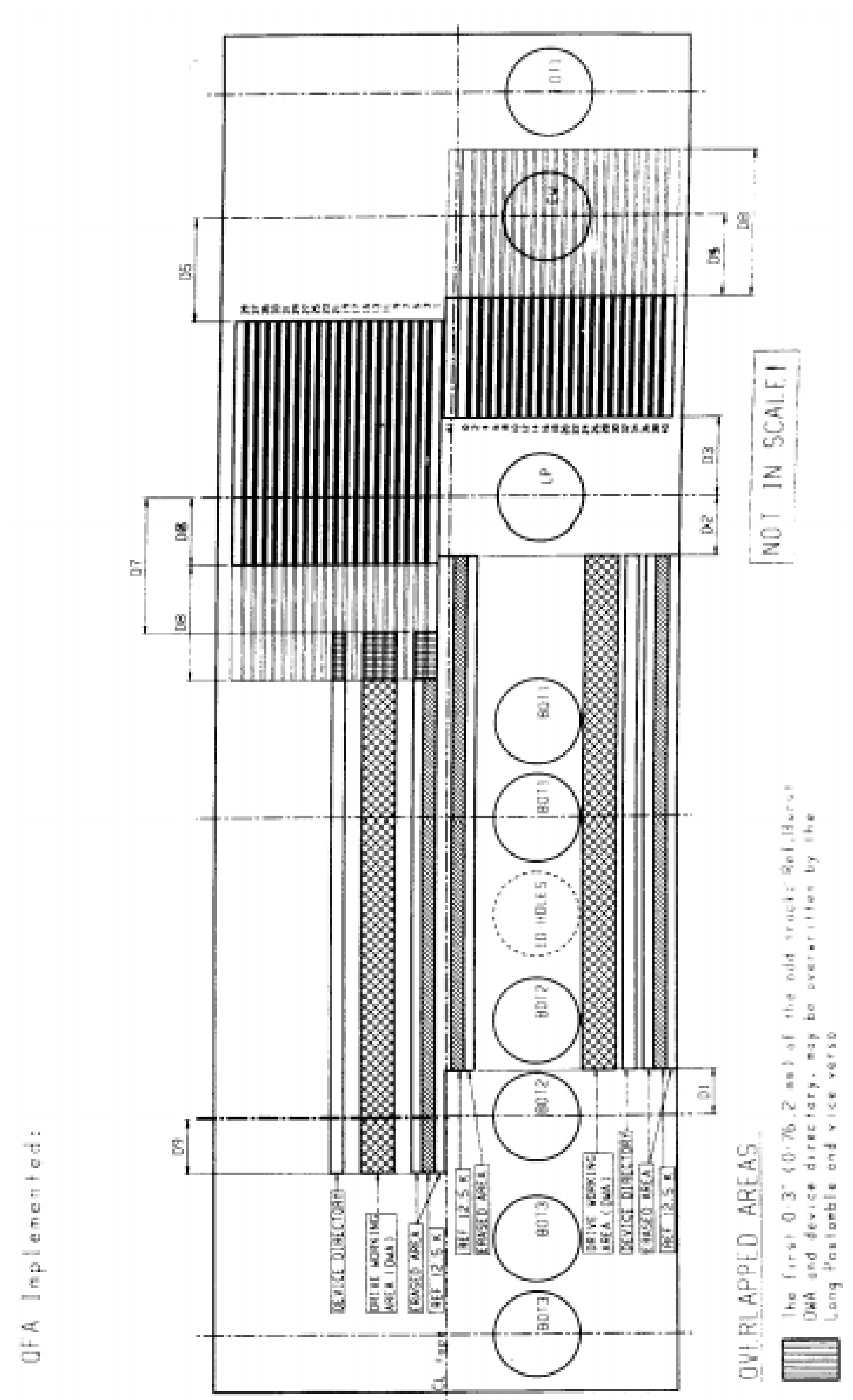


Figure 6.2A. Requirements for Use of Tracks, 0.250 inch tape.
QFA implemented.

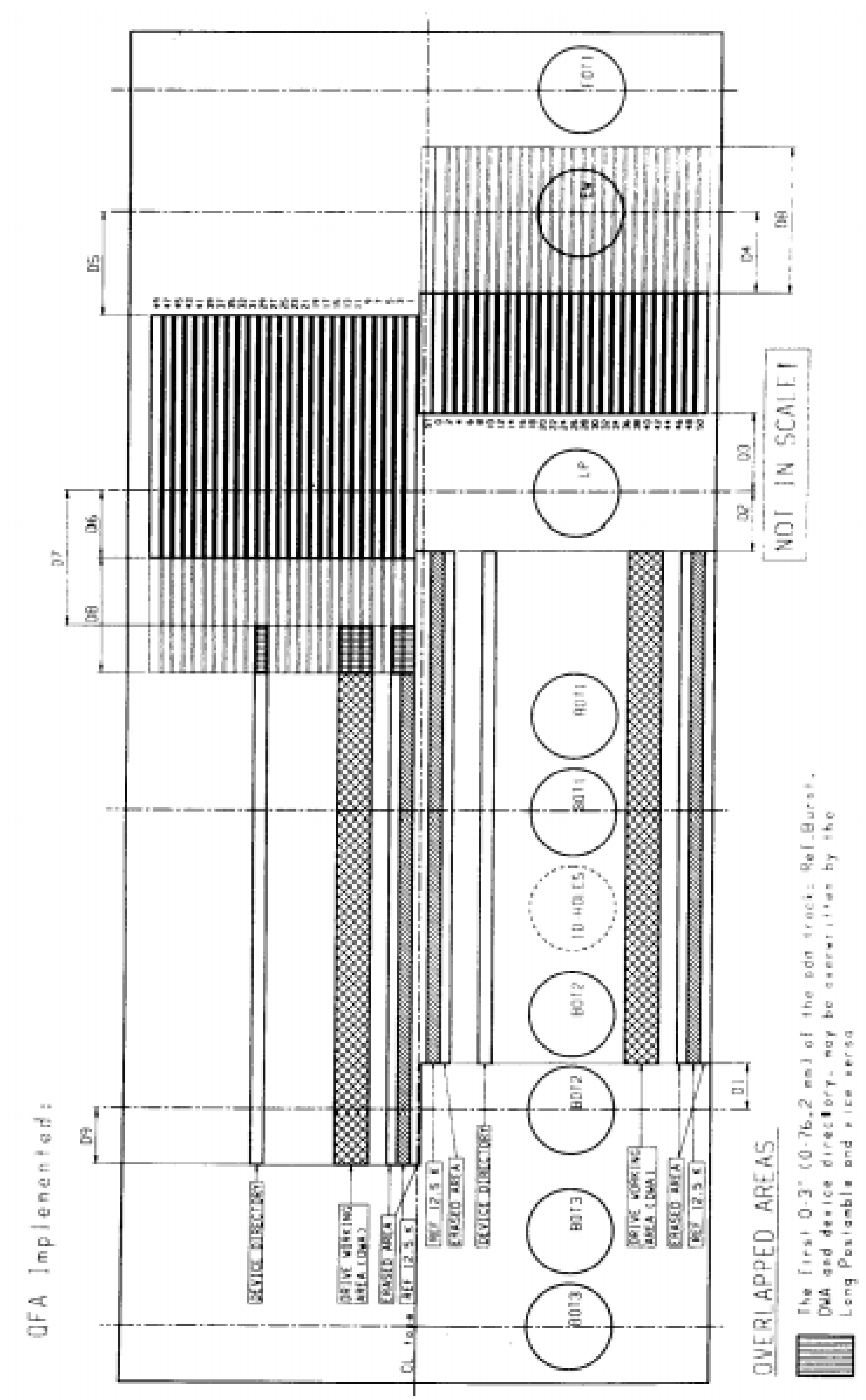


Figure 6.2B. Requirements for Use of Tracks, Wide tape (0.315 inch). QFA implemented

7. BYTE AND CODE REQUIREMENTS

7.1 Byte Length

The data shall be in eight-bit bytes. The 8 bits in each byte are numbered b0 to b7, b7 being the most significant bit.

7.2 Code

Bits b0 to b6 correspond to the 7 least significant bit assignments specified in the American National Standard Code for Information Interchange (ASCII), ANSI X3.4 - 1986. To comply with this standard, bit 7 shall always be set to Zero and the seven bits b0 through b6 shall represent ASCII characters.

Upon agreement between the interchange parties, other coded character sets may be used. Bit 7 may then be a Zero or a One depending upon the character standards used.

8. TRANSFORMING OF CODED CHARACTERS PRIOR TO RECORDING

Prior to the recording of the data on the tape, the coded character representation as described in section 7 shall be transformed into a encoded bit pattern according to table 8.1 (GCR 4,5 code). Unless otherwise indicated in the description of the tape format, all bytes to be recorded shall be transformed using this table prior to the recording. The encoded information shall then be recorded as described in section 6.

Each 8-bit byte shall be split into two groups of four consecutive bits, one group containing the four most-significant bits (b7 to b4) and one group containing the four least-significant bits (b3 to b0). Each 4-bit group shall then be transformed into a 5-bit group according to table 8.1.

For each encoded byte, the most significant bit shall be recorded first. Consequently, the 5-bit group corresponding to data bits b7 to b4 shall be recorded first, starting with encoded bit e4. When this group is recorded the least significant group corresponding to data bits b3 to b0 shall follow, again starting with encoded bit e4.

The most significant data bit is always to the left in the table. This encoding will give a minimum of zero and a maximum of two "0" 's between two ONE's.

Data Bits				Encoded Bits				
b7	b6	b5	b4					
b3	b2	b1	b0	e4	e3	e2	e1	e0
0	0	0	0	1	1	0	0	1
0	0	0	1	1	1	0	1	1
0	0	1	0	1	0	0	1	0
0	0	1	1	1	0	0	1	1
0	1	0	0	1	1	1	0	1
0	1	0	1	1	0	1	0	1
0	1	1	0	1	0	1	1	0
0	1	1	1	1	0	1	1	1
1	0	0	0	1	1	0	1	0
1	0	0	1	0	1	0	0	1
1	0	1	0	0	1	0	1	0
1	0	1	1	0	1	0	1	1
1	1	0	0	1	1	1	1	0
1	1	0	1	0	1	1	0	1
1	1	1	0	0	1	1	1	0
1	1	1	1	0	1	1	1	1

Table 8.1. Encoding Table.

9. TRACK FORMAT

9.1 FRAMES

9.1.1 General Information

Each track is divided into frames as shown in figure 9.1. Each frame contains 16 blocks (data blocks, information blocks (File Marks, identifier or filler blocks, EOR blocks) or ECC blocks). Each block is numbered sequentially, starting with 0 for the first block on track 0, and then incremented by one for each new block, regardless of track number. Frames are numbered indirectly, by using the 16 most significant bits of the Block Address.

Frame N	Frame N+1	Frame N+2	Frame N+3	Frame N+4	Frame N+5	Frame N+6

Figure 9.1. General Track Layout.

The frame operation is controlled by the recording drive and the whole frame system shall be invisible from the host side. The purpose for the use of frames is to control the error correction operation.

Once recorded, a frame shall not be overwritten or partly erased by new frames. A frame which cannot be completed on one track shall be completed at the beginning of the next track.

The number of blocks within a frame is always fixed. Each frame shall contain 14 Data/Information Blocks and two ECC (Error Correction Control) blocks plus any rewritten bad blocks.

Each block contains 1024 data or information bytes.

The first frame contains only QIC-3040 Identifier Blocks (plus the two ECC blocks).

9.1.2 Frame Layout.

The general layout of a frame is shown in figure 9.2.

Data Block 0	Data Block 1	....	Data Block 12	Data Block 13	ECC Block 14	ECC Block 15

Figure 9.2. General Frame Layout.

Any block determined as bad during the Read-While-Write verification is rewritten immediately at the end of the second following block. See section 9.4.

9.2 BLOCK TYPES

There are 8 different types of blocks:

Data Block
ECC Block
Cancel Block (option)
Identifier Block
File Mark Block
Set Mark Block
EOR Block
Filler Block

Information in the Control Field determines the type of block being recorded. See tables 9.5A and 9.5B.

The Data Field of the blocks contains always 1024 bytes, although the number of valid data bytes in the block may be less than 1024. See section 9.5.
Information about how many user data bytes that are available in each data block is recorded in the Control Field of the block.

9.2.1 Data Block

The Data Block contains user data. A full Data Block contains 1024 bytes, but variable data blocks may contain from 1 to 1023 valid data bytes (see section 9.5).

9.2.2 QIC-3040 Identifier Block

The IDENTIFIER Block is generated by the drive only. All 14 Data/ Information blocks in frame 0 (the ID frame) are QIC-3040 Identifier blocks. The Identifier blocks are generally invisible to the host system, but contain information in the data area which may be transferred to the host by special commands.

This Standard specifies the use of the first 9 Identifier blocks as follows:

(In this section, several references are made to QIC-121. However, this Standard does not require that a drive shall be fully compatible with QIC-121).

9.2.2.1 Identifier Block 0

The contents of the first block in the ID frame (Identifier Block 0) is not specified except for the first 16 bytes. These bytes shall contain the following information:

The first 8 bytes shall contain the KEY that determine whether the information in the next 8 blocks meet this specification or not. These 8 bytes shall contain the ASCII code for the characters "QIC-3040" as shown in figure 9.3.

The next 8 bytes shall identify the WRITING DRIVE MANUFACTURER in accordance with table J-1 of the X3T9-2 SCSI-2 VENDOR IDENTIFICATION list.

The complete layout for block 0 of the ID frame is shown in figure 9.4.

	BYTES							
	0	1	2	3	4	5	6	7
ASCII char.	Q	I	C	-	3	0	4	0
Hex. Value	51	49	43	2D	33	30	34	30

Figure 9.3. Layout of first 8 bytes of Block 0 in ID frame.

First 8 Bytes	Next 8 Bytes	1008 Bytes
KEY	Manufacturers ID	Not Defined

Figure 9.4. Layout of Block 0 in ID frame.

9.2.2.2 Identifier Block 1

The first 512 bytes of the data area of Identifier block 1 shall contain Inquiry Data exactly as it would be reported by the drive in response to an Inquiry command. The Inquiry Data shall at least include the Standard Inquiry Data List, located from byte 0 of the data area up to maximum byte 511. The remaining 512 bytes of the data area in this block may be utilized by each vendor. The use of these bytes is not a part of this standard.

The format of the Inquiry Data recorded in the first 512 bytes of the block shall be as specified in table 9.1. Unused bytes (that is unused bytes covered by the Additional Length field) shall be filled with the ASCII code for the blank character.

The Peripheral Device Type shall always be set to 01_{hex}. The RMB bit shall be set to one. For further information, see QIC-121.

Byte #	Bits 7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB	Reserved						
2	ISO Version		ECMA Version			ANSI-Approved Version		
3	AENC	TrmIQP	Reserved		Response Data Format			
4	Additional Length (n-4)							
5	Reserved							
6	Reserved							
7	RelAdr	WBus 32	WBus 16	Sync	Linked	Res.	CmdQue	SftRe
8 . . 15	(MSB) . . (LSB) Vendor Identification							
16 . . 31	(MSB) . . (LSB) Product Identification							
32 . . 35	(MSB) . . (LSB) Product Revision Level							
36 . . 55	(MSB) . . (LSB) Vendor Specific							
56 . . 95	(MSB) . . (LSB) Reserved							
96 . . 511	Vendor-Specific Parameter Bytes							

Table 9.1 Inquiry Data Format

9.2.2.3 Identifier Block 2

The data area of Identifier block 2 shall contain MODE SENSE data. It shall be set up as if an implicit MODE SENSE command has been executed where the returned data is moved into the first 512 bytes of the data area of Identifier block 2 (and not to the SCSI bus as usual). This data shall be formatted as shown in figure 9.5.

Byte 0: Header List
Block Descriptor List
Page Descriptor Lists in ascending order of Page Code
Last 512 Data Bytes Unspecified

Figure 9.5. Layout of Identifier Block 2.

Only the first 512 bytes of the data area of Identifier Block 2 are allocated for mode sense data. Unused portion of this area shall be filled with blank characters. The remaining 512 bytes of the data area are unspecified.

<u>Header List</u>

This is the standard MODE SENSE Header List from IC-121 and shown in table 9.2. Note that the first part of the Header List (the Mode Sense Data Length) is set to specify the total length of the following sense data including all Page Descriptor Lists. The Medium Type field shall indicate the current cartridge type. The Write Protect (WP) bit shall be set to zero. The Speed field shall be set to zero. The Block Descriptor Length shall be set to 8 to indicate that a single Block Descriptor List follows next. See QIC-121 table 7-61 for further details.

	Bits							
Byte #	7	6	5	4	3	2	1	0
0	Mode Sense Data Length							
1	Medium Type							
2	WP	Buffered Mode			Speed			
3	Block Descriptor Length							

Table 9.2. Header List

Block Descriptor List

This is the standard MODE SENSE Block Descriptor List shown in table 9.3. The Density Code shall be set to 23_{hex} to indicate that the current tape format is QIC-3040. See QIC-121 table 7-63 for further details.

	Bits							
Byte #	7	6	5	4	3	2	1	0
0	Density Code							
1 . 3	(MSB) . Number of Blocks (LSB)							
4	Reserved							
5 . 7	(MSB) . Block Length (LSB)							

Table 9.3. Block Descriptor List

Page Descriptor Lists

The various Page Descriptor Lists supported by the device follows in ascending order of page code. They shall be formatted according to table 9.4. See QIC-121 table 7-64 for further details.

	Bits							
Byte #	7	6	5	4	3	2	1	0
0	PS	Reserv.	Page Code					
1	Page Length							
2 → n	Mode Parameters							

Table 9.4. Page Descriptor List.

9.2.2.4 Identifier Blocks 3 and 4

The data area of block 3 and 4 are reserved for additional mode data. Only the first 512 bytes of each block may contain valid information.

9.2.2.5 Identifier Block 5

The data area of Identifier block 5 shall be reserved for Vital Product Data. If Vital Product Data are recorded this block shall at least include the Supported Vital Product Data Page. See figure 9.6 This page shall start at byte 0 in the data area of Identifier block 5 and may be followed by other VPD pages in ascending order of Page Code. A maximum of 512 bytes can be allocated for VPD data. Unused bytes shall be filled with blank characters. The remaining 512 bytes are unspecified. The format of the Vital Product Data pages shall be as specified in QIC-121 (tables 7-76 and 7-77 and related text).

Byte 0: Summary of Supported Pages (VPD Identifier 00h)
Vital Product Data Pages in ascending order of Page Code
Last 512 Data Bytes Unspecified

Figure 9.6. Layout of Identifier Block 5.

If any Vital Product Data is included the first VPD page shall be the Supported Product Data Page (VPD Page Code 00h). This page holds a list of VPD Page Codes for the VPD pages to follow. The format of this page is specified in table 7-76 in QIC-121.

Vital Product Data Pages

Vital Product Data Pages are appended in ascending order of VPD code. The format of these pages shall be as specified in QIC-121.

9.2.2.6 Identifier Blocks 6, 7 and 8

The data area of blocks 6, 7 and 8 shall be reserved for diagnostic data at the discretion of the drive manufacturer.

The contents of Identifier blocks 9 - 13 is not specified.

9.2.2.7 Reading Out Identifier Block Information

See Appendix A for a description of how the data in the ID frame may be transferred to the host.

9.2.3 File Mark Block

The File Mark Block is a block designated as a File Mark. Normally, the Data Area of a File Mark block contains no valid information, however, it may optionally be used for special host File Mark information. This is not specified in this Standard.

9.2.4 Filler Block

A filler block contains no valid information in the data area.

9.2.5 ECC Block

The ECC Block contains error correction parity bytes which may be used during a subsequent read operation where one or more data blocks cannot be read correctly.

9.2.6 Setmark Block

The Setmark Block is a block designated as a Setmark (see QIC-121 for a logical definition). Normally, the data area of a Setmark contains no valid information, however, it may optionally be used for special host File Mark information. This use is not specified in this standard.

9.2.7 Cancel Mark Block (Optional)

The Cancel Mark Block is a block designated as a Cancel Mark. The Cancel Mark may only be recorded (appended) logically directly after *two logically consecutive File Marks at End of Recorded Area (End of File)*. Logically it operates as a "negative" File Mark; i.e. One File Mark followed by one Cancel Mark is zero (File Mark not reported).

Prior to the recording of the Cancel Mark, the drive shall verify that the two File Marks are recorded consecutively (from a logical point of view), that they both are valid and that they are recorded at End of Recorded Area (End of File). Only one Cancel Mark (with rewrites if required) shall be recorded in conjunction with these two File Marks.

A recorded tape may contain several groups of two File Marks and one Cancel Mark as a combination, however each of these Cancel Marks shall have been recorded in an independent append operation, meeting the requirements above.

Cancel Marks shall never be reported to the host.

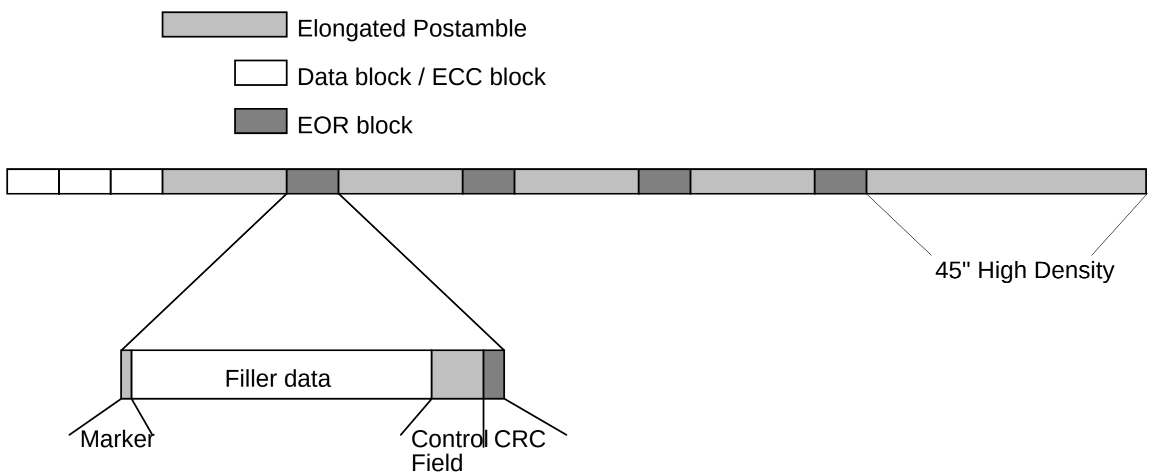
Physically, Filler blocks may be recorded between the File Marks and the Cancel Mark or between the File Marks or both. See also Appendix B.

Cancel Blocks are optional in this Standard. Drives that has not implemented this feature shall ignore all cancel marks completely.

9.2.8 End Of Recorded Area Block (EOR-Block)

At the end of any write operation, a group of special blocks named EOR-Blocks (End Of Recorded Area Blocks) shall be recorded. The operation is as follows:

The write operation is completed by writing the last frame containing the data transferred from the host. If necessary, filler blocks are added to complete the frame in the normal way. Then, at the end of the frame, an elongated postamble is recorded followed by a group of *five EOR-blocks.* An elongated postamble is recorded directly after each of the first four EOR blocks. The last EOR block is followed by 45" of High Density Recording. (50800ftpi/2000ftpmm). See figure 9.7. If End of Track is encountered while writing the High Density, additional 45" of High Density recording shall be written from the start of the next track.



Preamble:	Normal		
Marker:	Standard QIC GCR marker 1111100111		
Filler data: (Data Area):	1024 bytes with random values.		
Control Field:	Control Byte 0	:	0E hex
	Track addr.	:	00 hex
	Block no.	:	Next block number to be recorded
CRC:	32 bits normal CRC character		
Postamble:	Normal		

Figure 9.7 EOR-Blocks

Each EOR Block is recorded in the same way as all the other blocks specified in this Standard. The preamble shall be a Normal Preamble. The Block Marker shall be the normal Block Marker specified in 9.3.3 Control Byte 3 shall have a value of 0E $_{hex}$. Track address shall be set to 00. All EOR blocks in the group shall have the same physical block number. This block number shall be the next following ***data*** block number in the normal block numbering sequence.

Each EOR block shall be verified as good. If required, more EOR blocks shall be recorded to ensure that 5 EOR blocks verified as "good" have been recorded. The verification shall be done during the writing of the elongated postamble after each EOR block.

The write operation is terminated after the writing of the fifth good EOR block followed by the specified elongated postamble or high density recording. No filler blocks or ECC blocks shall be recorded when this group of 5 EOR blocks is recorded.

During append operations, data shall be appended in the area of the elongated postamble following the last complete data frame as shown in figure 9.8 and also described in section 9.6. The nominal append point shall be measured from the end of the frame and follow the specifications given in section 9.6.

When appending data, all the EOR blocks are overwritten from the Append point.

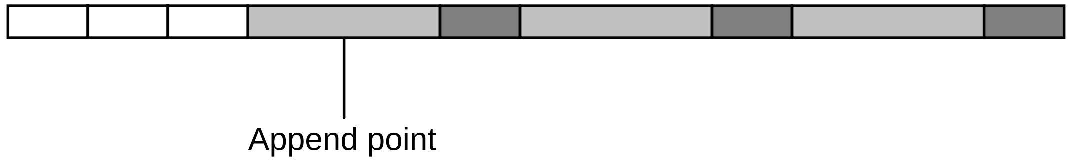


Figure 9.8 Append operation in the EOR area.

9.3 BLOCK FORMAT

9.3.1 General Layout

All blocks have the same basic layout as shown in Figure 9.9:

Preamble	Block Marker	Data Field	Control Field	CRC	Post-amble

Figure 9.9. Layout of a block

All sections of a block are recorded continuously without any erased gaps between the sections. All blocks within a frame are also always recorded continuously without any erased interblock gaps. Frames are also recorded continuously, except during append operations. During this operation, a short area with erased or damaged recording may occur between the end of the postamble of one frame and the preamble of the next frame due to the write current turn on time. This area shall always be shorter than the length of the recording of one byte of data.

9.3.2 Preamble

The preamble consists of a fixed pattern of all ONE's recorded at the highest nominal frequency. The length of the preamble varies, but the contents is always the same: ...11111111111..... The preamble shall be used to synchronize the phase locked loop or a similar circuit to the frequency and the phase of the data signal. It shall also be used to measure the average signal amplitude.
To achieve maximum capacity it is recommended to use the minimum specified preamble length wherever feasible.

There are three different types of preamble: NORMAL, ELONGATED and LONG.

A **Normal** Preamble shall contain a minimum of 485 and a maximum of 700 transitions recorded at the highest nominal frequency (50 800 ftpi/2000 ftpmm). This preamble shall be recorded at the beginning of each block, except for the first block in a frame append operation.

An **Elongated** Preamble shall contain a minimum of 8800 and a maximum of 13 600 transitions recorded at the highest nominal frequency (50 800 ftpi/2000 fpmm). It shall be recorded at the beginning of the first block in a frame which is appended to already existing data on a track and the first block in a frame after an underrun situation. It shall also be recorded at the beginning of the first block following a block which is purposely truncated due to a rewrite operation (see section 9.4).

An **Long** Preamble shall contain a minimum of 203 200 and a maximum of 254 000 transitions recorded at the highest nominal frequency (50 800 ftpi/2000 ftpmm). This preamble shall be recorded at the beginning of the first block on every track, even if the block is in the middle of a frame.

9.3.3 Block Marker

The Block Marker marks the start of a new frame or block. It contains 10 encoded bits in a unique pattern not found in any data field:

11111 00111

The left bit is the most significant bit, recorded first.

9.3.4 Data Field

The Data Field contains 1024 bytes of data, encoded according to the rules in section 8. The contents of the data field depends upon the type of block being recorded:

* Data Block:	All 1024 bytes are available for user data.
* QIC-3040 Identifier Block	May contain valid host or vendor unique information in its data field. See 9.2.2.
* File Mark/Setmark Block:	Contains no valid information in its data field. May contain vendor unique information.
* Filler Block:	Contains no valid data.
* Cancel Mark Block	Contains no valid data.
* ECC Block:	Contains error correction characters generated by the drive.
* EOR Block:	Contains no valid data.

9.3.5 Control Field

All blocks have 4 bytes in their control field, as shown in figure 9.10. Control bytes 0-2 are always used for address and track information, regardless of block type, while the use of control byte 3 depends upon the block type being recorded.

Control Byte 3	Control Byte 2	Control Byte 1	Control Byte 0

Figure 9.10. Layout of Control Field.

Byte 3 is recorded first followed by Control Byte 2 and so on. All bytes are encoded according to the rules given in section 8.

Figure 9.11 shows the layout of Control Byte 3.

Control Byte 3 Bits							
7	6	5	4	3	2	1	0
X	Part of Physical Block Address. 3 Most Significant Bits			Block Type			

Figure 9.11. Layout of Control Byte 3.

Bits 6, 5 and 4 of Control Byte 3 are used as the three most significant bits in the Physical Block Address. Bit 6 is the most significant bit of the address.

Bit 7 of Control Byte 3 may either be set to 0 (permanently) or optionally used to indicate blocks recorded past Logical Early Warning. When set to 1, Early Warning condition is indicated. When set to 0, the absence of Early Warning condition is indicated. This is an optional feature. Drives which do not implement this feature shall always set this bit to zero.

The four least significant bits of Control Byte 3 is used to indicate the type of block being recorded. The coding of these four bits is shown in table 9.5. All combinations of the four control bits 0-3 not specified in table 9.5 are reserved. Drives meeting this Standard shall ignore (skip) all reserved combinations in order to minimize compatibility problems with future updates of this Standard. Variable blocks are treated in detail in section 9.5.

Control Byte 3 is the only control byte covered by ECC protection.

The layout of Control Bytes 0-2 is shown in figure 9.12.

Except for the 4 most significant bits of control byte 2, the other 20 bits are a part of the physical block address as specified in figures 9.12. The Physical Block Address consists of 23 bits. The three most significant bits are recorded in Control Byte 3 (see figure 9.11), the 20 other bits of the address are recorded as shown in figure 9.12.

This block address is independent of block type and track numbers. It starts with 00000_{Hex} for the first block on track 0, and is incremented by one for each new block being recorded.

Rewritten blocks keep their original block number. The block numbering is not reset at the start of a new track.

Control Byte 3 Bits 3 2 1 0	Block Type	Comments
0 0 0 0	*Full Data Block End Variable Host Block*	This block contains 1024 bytes of valid data. A variable host block containing an integer number of 1024 bytes of data (1024, 2048, 3078 etc.) ends with this block.
0 0 0 1	*Full Data Block Partial Variable Host Block*	This block contains 1024 bytes of valid data. This block and the next valid block on the tape are part of a variable host block.
0 0 1 0	*Full Data Block QIC-02 Compatible*	This block contains 1024 bytes of valid data, which consists of two host data blocks (each containing 512 data bytes).
0 1 0 0	*Variable Data Block 1- 255 data bytes. End Variable Host Block.*	This block contains from 1 to 255 bytes of valid data. A host variable block ends with this block if the rest number of data bytes in the host block is between 1 and 255 (see section 9.5)
0 1 0 1	*Variable Data Block 256 - 511 data bytes. End Variable Host Block.*	This block contains from 256 to 511 bytes of valid data. A host variable block ends with this block if the rest number of data bytes in the host block is between 255 and 511 (see section 9.5)
0 1 1 0	*Variable Data Block 512 - 767 data bytes. End Variable Host Block.*	This block contains from 512 to 767 bytes of valid data. A host variable block ends with this block if the rest number of data bytes in the host block is between 512 and 767 (see section 9.5)
0 1 1 1	*Variable Data Block 768 - 1023 data bytes. End Variable Host Block.*	This block contains from 768 to 1023 bytes of valid data. A host variable block ends with this block if the rest number of data bytes in the host block is between 768 and 1023 (see section 9.5)
1 0 0 0	*File Mark*	No valid information in data area.
1 0 0 1	*Filler Block*	No valid information in data area.
1 0 1 0	*QIC-3040 Identifier Block*	May contain valid information in data area.
1 1 0 0	*Setmark*	No valid information in data area.
1 1 1 0	*EOR Block*	No valid information in data area.
1 1 1 1	*Cancel Mark*	Optional Block. No valid information in data area.

Table 9.5. Encoding of Block Type Control Bits.

The four most significant bits of control byte 2 contains a track address. This track address is the physical track number as specified in section 4 divided by 2. Thus tracks 0 and 1 both have track address 0, tracks 2 and 3 have address 1 and so on. This track address always follows the physical track number. If a frame cannot be completed at the end of tracks 1, 3, 5 etc., the track address must be incremented by one before writing the remaining blocks in the frame on the next track.

The track number system will wrap around and start with 0000 again at track 32. The drive shall utilize the total physical block number (23 bits) to distinguish between tracks from 0 through 31 and tracks from 32 and up.

Control Bytes 0-3 are encoded according to the rules in section 8. Byte 3 is recorded first, followed by byte 2 and so on. The most significant encoded bit in each byte is recorded first.

Control Byte 2		Control Byte 1	Control Byte 0
Bits 7 6 5 4	Bits 3 2 1 0	Bits 7 6 5 4 3 2 1 0	Bits 7 6 5 4 3 2 1 0
Track Address	Part of Physical Address (20 Least Significant bits)		

Figure 9.12. Layout of Control Bytes 0-2.

9.3.6 CRC Field

The CRC (Cyclic Redundancy Check) field consists of 4 bytes calculated over the whole data block area and control field area, starting with the most significant bit of byte 0 in the Data Field and ending with the least significant bit of Control Byte 0 in the Control Field. All calculations are done prior to the data encoding. All 32 bits in the CRC character shall be set to ONE prior to the start of the CRC calculation. The generating polynomial shall be:

$$x^{32} + x^{28} + x^{26} + x^{19} + x^{17} + x^{10} + x^{6} + x^{2} + 1$$

The four bytes shall be encoded according to the rules in section 8 prior to the recording. The most significant byte shall be recorded first.

9.3.7 Postamble

The postamble consists of a fixed pattern of all ONE's recorded at the highest nominal frequency. The length of the postamble varies, but the contents is always the same:

...11111111111.....

The Postamble is recorded at the end of each block following the CRC bytes.

There are three different types of postambles:

NORMAL, ELONGATED and LONG.

A **Normal** Postamble shall contain a minimum of 10 and a maximum of 20 flux transitions recorded at the nominal maximum flux density of 50 800 ftpi (2000 ftpmm). This postamble shall be recorded at the end of each block, except for the last block in frame when an underrun situation has occurred.
After writing this normal postamble, the following preamble shall be recorded so that there is no phase shift or transition glitches between the end of this postamble and the beginning of the next preamble.

An **Elongated** Postamble shall contain a minimum of 14 500 and a maximum of 19 800 flux transitions recorded at the nominal highest flux density of 50 800 ftpi (2000 ftpmm). This postamble shall be recorded at the end of the block if an underrun situation has occurred, or at the end of the last block in a recording. It shall also be recorded at the end of every EOR block.

A **Long** Postamble shall contain a minimum of 203 200 and a maximum of 254 000 transitions recorded at the highest nominal frequency (50 800 ftpi/2000 ftpmm). The Long Postamble shall be recorded after the last block at the end of every track, even if the last block is in the middle of a frame.

9.4 BLOCK REWRITES

Any block determined to be bad during the read-while-write verify operation shall be re-recorded immediately after the following or in the second following block.

Each block may be re-recorded up to 16 times after the previous block has been determined good. Figure 9.13 shows typical formats resulting from rewrite operations.

If the rewrite limit is exceded, the write operation shall be terminated and 45" of High Density recording ("Erase tape") shall be appended. If Track End is encountered while writing High Density, additional 45" of High Density recording shall be appended on the next track.

Blocks being rewritten shall be identical to the original blocks with the same block address, data contents etc. The only thing which may be changed is the track address if the rewriting takes place on the next (even) track. During read operation, two or more good blocks with the same block address may therefore be detected by the drive. Should this happen, the drive shall use the data contents of any of these valid blocks.

When a block (N) is determined bad, the rewrite operation shall be performed as follows:

> If the drive is writing block N+1 when block N is determined bad, block N+1 shall be completed (but not verified) before the drive rewrites block N followed by block N+1 and so on.

If the drive is writing block N+2 when block N is determined bad, block N+2 shall either be truncated (by writing a block with less than 1024 data bytes) or written with a bad CRC in order to ensure that the block can never be read as "good". Then block N is rewritten followed by N+1, N+2 and so on.
If block N+2 was truncated, the rewritten block N shall be preceded by en elongated preamble.

A:

N-1	N X	N+1	N+2 Z	N	N+1	N+2	N+3	N+4	N+5

B:

N-1	N X	N+1	N+2 Z	N X	N+1	N+2 Z	N	N+1	N+2

C:

N-1	N X	N+1	N X	N+1	N+2 Z	N	N+1	N+2	N+3

D:

N	N+1	N+2	N+2	N+2	N+2	N+2	N+2	N+3	N+4

Figure 9.13. Examples of possible format layout variations due to block rewrite operations. X denotes a bad block. Z denotes a bad block either due to a purposely recorded incorrect CRC value, or to a purposely truncated block. Figure 9.11D shows format after forced streaming operation.

A correct block N shall be followed, not necessarily immediately, by a correct block N+1. When counting the number of rewrites for a block N+1, only those following a verified block N shall be counted.

This rewrite scheme is independent of frames. Therefore, the writing of the first blocks in the next frame may begin before the last block in the previous frame has been completely verified.

It is allowed to rewrite consecutive blocks with the same block number as shown in figure 9.13D (forced streaming). This may be done to prevent termination of a streaming operation due to an underrun situation. The forced streaming mode shall always be performed with the last block and terminated when the next block is available or at the end of file or end of track.

9.5 FIXED AND VARIABLE BLOCKS

This standard allows for the recording of both fixed and variable host blocks. The physical blocks recorded on the tape contain always 1024 data bytes, however, some of these data bytes may not be valid in every block.

9.5.1 Fixed Host Blocks, 1024 Data Bytes

In this case, the host block size is the same as the size of the physical recorded block. The lower nibble of Control Byte 3 will be set to 0_{Hex} and all data bytes in the recorded block are valid.

9.5.2 Fixed Host Blocks, QIC-02 Compatible

In this case, the physical recorded block contains 1024 valid data bytes, however, it is transferred to the host as **two** data blocks containing 512 data bytes each in order to be compatible with the QIC-02 interface specification. The lower nibble of Control Byte 3 will be set to 2_{Hex}.

9.5.3 Variable Host Blocks, < 1024 Data Bytes

In this case, the physical recorded data block contains less than 1024 valid data bytes. The layout of the data field is shown in figure 9.14.

Data Field 1024 Bytes		
Valid Data Bytes	Filler Bytes Unspecified	Valid Data Counter (Byte 1023)

Figure 9.14. Layout of Data Field, Physical Variable Data Blocks.

The number of valid data bytes are specified by bits 0 and 1 in Control Byte 3 (see table 9.5) and the value of the last byte in the data field, byte 1023. This byte contains a number from 1 to FF_{Hex} (255_{Dec}) depending upon the number of valid data bytes. The

valid data bytes are always recorded first in the data field, then come filler bytes (no value specified in this standard) and finally as the last byte the Valid Byte Counter.

A variable block containing 392 bytes of valid data will therefore be recorded with the lower nibble of Control Byte 3 set to 5_{Hex} and byte 1023 of the data

field set to 88_{Hex} (136_{Dec}).

9.5.4 Variable Host Blocks, > 1024 Data Bytes

In this case, the host block is recorded as one or more Full Data Block, Partial Host

Block (the lower nibble of Control Byte 3 = 1_{Hex}) plus either one Variable Block (lower

nibble of Control Byte 3 = either 4_{Hex}, 5_{Hex}, 6_{Hex} or 7_{Hex}) or one Full Data Block, End

Variable Host Block (lower nibble of Control Byte 3 = 0_{Hex}.

The number of remaining valid data bytes in the variable host block when all the full data blocks have been recorded, determines the size of the variable block.

<u>Example 1:</u>

Variable host block size is 4096 bytes. This will be recorded as shown in figure 9.15.

Variable Host Block, 4096 Data Bytes			
Block No. N	**Block No. N+1**	**Block No. N+2**	**Block No. N+3**
Full Data Block Partial Variable Host Block Control Byte 3 is x 1_{Hex}	Full Data Block Partial Variable Host Block Control Byte 3 is x 1_{Hex}	Full Data Block Partial Variable Host Block Control Byte 3 is x 1_{Hex}	Full Data Block End Variable Host Block Control Byte 3 is x 0_{Hex}

Figure 9.15. Variable Host Block, 4096 Bytes.

Example 2:

Variable host block size is 2051 bytes. This will be recorded as shown in figure 9.16.

Variable Host Block, 2051 Data Bytes		
Block No. N	**Block No. N+1**	**Block No. N+2**
Full Data Block Partial Variable Host Block Control Byte 3 is x 1_{Hex}	Full Data Block Partial Variable Host Block Control Byte 3 is x 1_{Hex}	Full Data Block End Variable Host Block Control Byte 3 is x 4_{Hex} Last byte in data field is x 3_{Hex} (2051 - 1024 - 1024 = 3)

Figure 9.16. Variable Host Block, 2051 Data Bytes.

Example 3:

Variable host block size is 1673 bytes. This will be recorded as shown in figure 9.17.

Variable Host Block, 1673 Data Bytes	
Block No. N+1	**Block No. N+1**
Full Data Block Partial Variable Host Block Control Byte 3 is x 1_{Hex}	Full Data Block End Variable Host Block Control Byte 3 is x 6_{Hex} Last byte in data field is x 89_{Hex} (= $137_{Decimal}$) (1673 - 1024 - 256 -256 = 137)

Figure 9.17. Variable Host Block, 1673 Data Bytes.

NOTE
When writing compressed data, each Compression Block Group is recorded as one variable block. The actual length of the variable block will depend on the compression ratio.

9.6. TERMINATION OF WRITE AT END OF THE LAST TRACK

If data is written to physical end of the last track (EW/LP), the write operation shall be terminated as specified in section 6.5 and 6.6. The current frame shall not be completed and no EOD blocks shall be appended. If any of the blocks written after End of Last Track is detected as bad, no rewrites shall be performed.

Note:
A tape written to physical End of Last Track will most likely be incorrectly terminated and data written passed the EW (LP) marker may be lost or unreadable. Drives writing and reading this format will implement a Pseudo EW position in front of the physical EW (LP) on the last track. This is done to give room for proper data termination before physical End of Last Track. It is the host's responsibility to terminate written data properly if this Pseudo EW position is reached during a write operation.

9.7. APPEND OPERATION

The last block recorded on the tape is always terminated with an Elongated Postamble (see section 9.3.7). If new data shall be appended to the already existing data on the tape, the first new block shall be recorded with an Elongated Preamble (see section 9.3.2). The append operation shall be performed so that the postamble of the previous block and the preamble of the new block overlaps as shown in figure 9.18. The recording in the overlap area may not be readable by the drive.

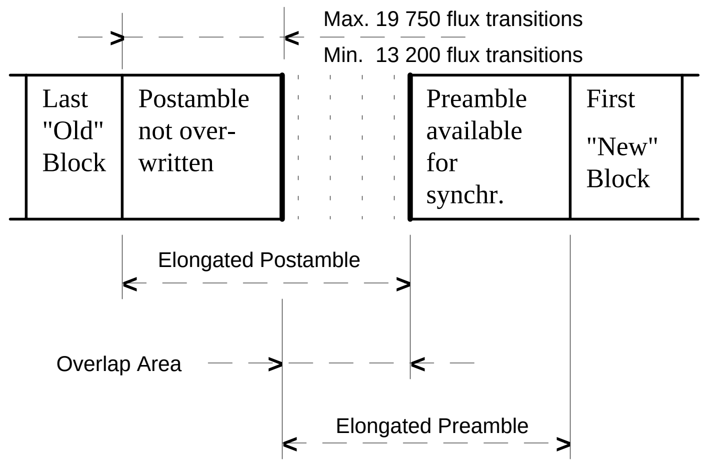


Figure 9.18. Postamble/Preamble overlap during append operations.

A minimum of 13 200 flux transitions and a maximum of 19 750 flux transitions of the previously recorded postamble shall remain intact (not overwritten) when the preamble for the next block is recorded. The overlap area will then have a minimum length equivalent to 50 flux transitions and a maximum length equivalent to 6600 flux transitions. The minimum available preamble area for synchronization will be 2200 flux transitions.

9.8 DEVICE DIRECTORY.

Refer to chapter 6.8, for Maximum/Minimum distances for the Device Directory

9.8.1 Device Directory Content.

The Device Directory shall consist of a 32 byte Header and up to 1788 Entry Fields of 8 bytes. (14.336 bytes, 14K). One Entry Field is added to the Device Directory for each Entry Point on the tape. The first Entry Field after the Header corresponds to a physical block number equal to the Entry Distance. The last entry field in the Device Directory holds entry information for EOD, (EOD Entry). A tape with valid reference tracks shall always have a Device Directory even when no data is written. The Device Directory shall always hold a minimum of a header and the EOD Entry Field for BOT.

9.8.1.1 The Header Field.

Byte	Bit7	6	5	4	3	2	1	0
0	Device Directory ID String.							
1								
2								
3								
4								
5								
6								
7	Revision							
8	Track Number for EOD, Partition 0							
9	MSB							
10	Block number for last written block, Partition 0							
11								LSB
12	Track Number for EOD, Partition 1							
13	MSB							
14	Block number for last written block, Partition 1							
15								LSB
16	MSB							
17	Number of Entry Fields							LSB
18	MSB							
19	Number of Blocks pr. Track							
20								LSB
21	MSB	Entry distance						
22								LSB
23	ERASE P1	ERASE P0	IGNORE			PSEW1	PSEW0	ERASE
24	Width of Write Head							
25	Width of Read Head.							
26	Functionallity information							
27	IGNORE							
28								
29								
30								
31								

Figure 9.19 Layout of the Device Directory Header Field

These bytes are defined as follows:

ID String.	These 7 bytes holds the ASCII - String "QIC DIR"

	BYTES						
	0	1	2	3	4	5	6
ASCII - String	Q	I	C		D	I	R
Hex value	51	49	43	20	44	49	52

Revision.	This is the Device Directory Revision number. The number is a binary number starting from 0. The revision should be incremented when and only when the layout of **the Device Directory** is changed. Current value is 3.
Track number for EOD. Partition 0.	Contains the track number where EOD is located in the Data Partition. (Partition 0)
Last written block. Partition 0.	The value in this field shall be the last written block number, EOD blocks excluded, on the partition. If a write operation is terminated with a hard write error this is the block number for the bad block.
Track number for EOD. Partition 1.	Contains the track number where EOD is located in the Directory Partition. (Partition 1) If the tape is Written with a Single Partition, this value shall be set to 0.
Last written block. Partition 1.	The value in this field shall be the last written block number, EOD blocks excluded, on the partition. If a write operation is terminated with a hard write error this is the block number for the bad block. If the tape is Written with a Single Partition, this value shall be set to 000000H.
Number of Entry Fields.	The total number of Entry Fields in the Device Directory. The minimum value is 1. (There is always a minimum of an EOD Entry in the Directory) The maximum value is 1788 Decimal (06FCH)
Number of Blocks per Track	This is the average number of physical blocks per track. If the number of blocks per track is unknown (Less than 1 track written) the value shall be set to FFFFFFH.
Entry Distance	Holds the distance in number of physical blocks between the Entry Points on the tape. In the current revision of the Device Directory the Entry Point Distance is always set to 0800H. The first Entry Point is at the physical Block number equal to the Entry Distance.
PSEW0	This bit shall be set if a tape is written passed Pseudo EW on the last track. on partition 0.(See section 9.6)
PSEW1	This bit shall be set if a tape is written passed Pseudo EW on partition 1.(See section 9.6)

Table continues on next page.

ERASE	This bit is set to indicate that the tape is Erased. See section 5.6. The bit is initially set to "0" (Not Erased).
ERASE P0	This bit shall be set when the ERASE bit is set to indicate that Partition 0 is erased. The bit is cleared when data is written from BOT on Partition 0 on an erased tape. The bit is initially set to “0” (Not Erased). See section 5.6.
ERASE P1	This bit shall be set when the ERASE bit is set to indicate that Partition 1 is erased. The bit is cleared when data is written from BOT on Partition 1 on an erased tape. The bit is initially set to “0” (Not Erased). See section 5.6.
Write Head Width	This byte shall hold the width of the Write Head for the drive that wrote the Reference tracks. The width is measured in micro-meter.
Read Head Width	This byte shall hold the width of the Read Head for the drive that wrote the Reference tracks. The width is measured in micro-meter.
Functionality information	This byte is a Boolean Array. BIT 0 = "1" if the drive that wrote the Reference tracks used Read while Write. BIT 1 to BIT 7 IGNORE
IGNORE	Bits and Bytes marked IGNORE are reserved for future use. These bytes shall be written with 00H and be ignored during directory Read by drives implementing this version of the Device Directory.

9.8.1.2 The Entry Field

Each Entry Field contains 8 byte of data.

Byte	Bit7	6	5	4	3	2	1	0
0	MSB							
1				LOGICAL BLOCK COUNT				
2								LSB
3	MSB							
4				FILEMARK COUNT				
5								LSB
6	MSB							
7				SETMARK COUNT				LSB

Figure 9.20 Layout of the Entry Field,

LOGICAL BLOCK COUNT	For standard uncompressed data, this field contains the Logical Block Count up to the current Entry Point. The logical block at the entry point is not included in the count. If Data Compression is included and the Entry Point falls within a Compression Block Group, all the Logical Blocks in the Compression Block Group, are included in the count. This applies both to compressed fixed and variable blocks. It also applies if one variable block, because of its size, is compressed into multiple Compression Block Groups. Filemarks are not counted as Logical Blocks.
FILEMARK COUNT	Contains the Filemark Count up to the current Entry Point. If a Entry Point falls on a Filemark Block, the Filemark is not included in the count.
SETMARK COUNT	Contains the Setmark Count up to the current Entry Point. If a Entry Point falls on a Setmark Block, the Setmark is not included in the count.

9.8.2 Writing the Device Directory

The Device Directory data shall be written as one normal 14K variable block. Except for a special rewrite scheme, the variable block shall be written in the same way as a normal Data Frame with ECC. The Device Directory frame shall be presided by a Long Preamble and shall be terminated with a normal EOD block sequence followed by high density recording (50.800 ftpi) until the end of the Device Directory track. The Device Directory Data shall be written starting with the Header in the first block in the frame.

Two identical copies of the Device Directory shall be written. One copy is written on each of the two Device Directory tracks. The physical blocks shall be numbered from 00000H and up and the track information shall be the same as for the corresponding data track. On each track each physical data- and ECC block shall be written a minimum of 8 times. The normal rewrite scheme shall be disabled.

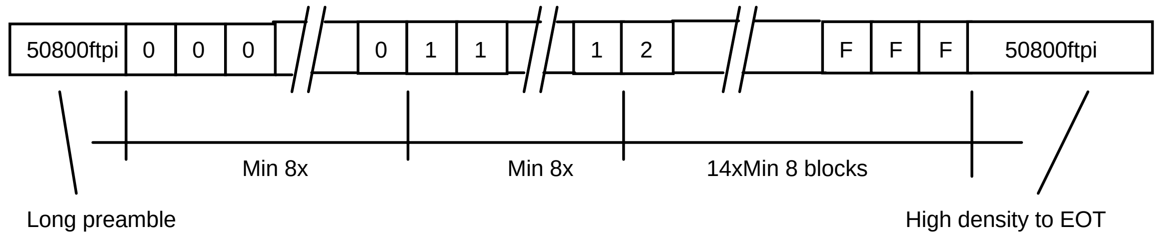


Figure 9.21: Track layout for Device Directory tracks.

9.9 DATA COMPRESSION

This Standard supports data compression as an optional feature. More than one method of data compression may be employed.

It is not a requirement in this Standard that the drive must support data compression to be compatible with the Standard. The Standard is designed such that drives that do support the general QIC-3040 and QIC-121 Standards but do not support data compression will be able to retrieve compressed data and transfer it to the host.

The rules for data compression are set forth below. The user should also refer to the QIC-121 for additional information.

9.9.1 General Rules

The data on the directory partition of a QFA tape shall not be compressed.

Only the data area in the data blocks may contain compressed data. All other information is uncompressed. Other blocks and tape marks shall be uncompressed.

If compression is enabled, all data blocks within current partition shall be grouped into Compression Block Groups (except the directory partition, which shall be written uncompressed).

9.9.2 Compression Block Group

Compressed data will be grouped into Compression Block Groups. The Compression Block Group shall contain a ten bytes Compression Header as described below. The first data byte following the Compression Header is the beginning of compression and the last byte is the end of compressed data. The Compression Block Group shall be limited to 32 K (32768) bytes of uncompressed data. Each Compression Block Group shall be written to the tape as one variable logical block.

9.9.3 Data Compression with Fixed or Same Sized Blocks

When writing in fixed block mode, a number of same sized blocks may be grouped, compressed and recorded as one Compression Block Group on the tape.

9.9.4 Data Compression with Variable Blocks

When writing in variable block mode, each write data command is recorded as one or more Compression Block Groups. Variable blocks having a transfer length greater than 32 K (32768) bytes shall be diveded into multiple Compression Block Groups. Each Compression Block Group shall not contain data from more than one write command.

9.9.5 Compression Header

The Compression Header consist of 10 bytes of uncompressed data placed at the beginning of each Compression Block Group. It shall be the first 10 bytes in the data field representing the Compression Block Group. These 10 bytes shall be uncompressed with the following layout:

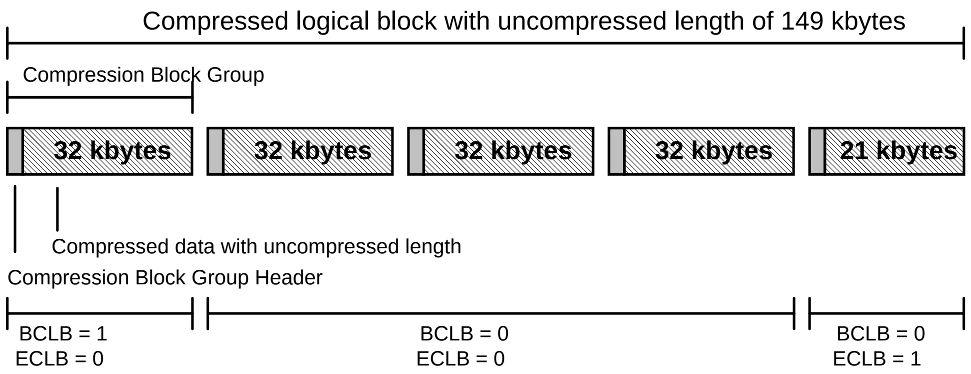
Byte 0	UCMP	BCLB	ECLB	Header length
Byte 1	QIC compression algorithm ID			
Byte 2	Uncompressed logical block length MSB			
Byte 3	Uncompressed logical block length LSB			
Byte 4	Uncompressed logical block quantity MSB			
Byte 5	Uncompressed logical block quantity LSB			
Byte 6	Logical block number MSB			
Byte 7	Logical block number NMSB			
Byte 8	Logical block number NLSB			
Byte 9	Logical block number LSB			

UCMP (bit 7)	**Uncompressed.** This bit will indicate that the data in the Compression Block Group is uncompressed. **NOTE:** This bit will be set if the DCE-bit (Data Compression Enable) is set and the 'Compression Algorithm'-field is set to zero in the MODE SELECT, Data Compression Parameter Page.
BCLB (bit 6)	**Beginning of Compression Logical Block.** This bit is set if the Compression Block Group is the first or the only Compression Block Group in the Compressed Logical Block.
ECLB (bit 5)	**End of Compression Logical Block.** This bit is set if the Compression Block Group is the last or the only Compression Block Group in the Compressed Logical Block.
Header Length (bits 4 to 0)	**The size of the header.** This field will always be 0Ah.
QIC Compression Algorithm	**The registered compression algorithm identifier.** Refer to QIC-121 for additional details.
Uncompressed Logical Block Length	Contains the size in bytes of the host defined (fixed) logical blocks in the Compression Block Group, or the transfer length in bytes of the host variable block.
Uncompressed Logical Block Quantity	Contains the number of host blocks compressed and recorded on the tape as one compressed variable block. This number is '1' if the host operates with variable blocks. Hence, the number '1' may also indicate that one, and only one, fixed block resides in the Compression Block Group.
Logical Block Number	Contains the logical address of the first block in the Compression Block Group. If a logical block is represented by multiple Compression Block Groups, The Logical Block Number will be the same for all the Compression Block Groups which represent the logical block.

The total number of uncompressed bytes within one Compression Block Group is given by multipling the 'Uncompressed Logical Block Length' and the 'Uncompressed Logical Block Quantity'.

When writing and reading compressed data, the Compression Block Groups are not visible for the user. The Compression Header will not be transferred to the host during decompression. If a tape which contains compressed data is read on a drive without data decompression, the complete Compression Block Group with the Compression Header *and* the compressed data will be transferred to the host. The host must then use the information in the Compression Header to decompress the data.

Example:



9.9.6 Configuration of drive for datacompression

According to QIC-121 MODEpage 0Fh shall be used to select compression or decompression algorithm. The user should refer to QIC-121 for more details. As a reference, Appendix C shows the proposed implementation of this compression page.

10. ERROR CORRECTION

The ECC blocks at the end of each frame may be used during the data read operation to reconstruct blocks in error. The error correction system makes it possible to correct 2 blocks with CRC errors within each frame.

10.1 Error Correction Matrix Format

A frame contains 16 blocks, 14 data blocks and two ECC parity blocks. Each block contains 1024 data bytes and 1 Control Byte (Control Byte 3) which are covered by ECC control.
The bytes in ECC frame are considered to be arranged in 16 blocks (rows) by 1025 bytes as shown in figure 10.2. The ECC parity bytes shall be chosen so that each column of the matrix forms an independent Reed-Solomon codeword of redundancy two, with 8-bit characters, as shown in figures 10.2.

10.2 Field Representation

GF(256) is the field consisting of 256 elements. Each field element "a" has the form

$$a = a_7x^7 + a_6x^6 + a_5x^5 + a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0.$$

where each a_i is either 0 or 1. A field element "a" shall be represented by a byte as shown in figure 10.1.

MSB LSB

a7	a6	a5	a4	a3	a2	a1	a0

Figure 10.1. Bit Numbering Convention

Field math operations (addition, multiplication, division) are defined to be polynomial math modulo an irreducible binary polynomial of degree eight, f(x), where binary addition is the logical exclusive-or operation and binary multiplication is the AND operation. The irreducible polynomial used to generate the field GF(256) shall be:

$$f(x) = x^8 + x^7 + x^2 + x + 1 .$$

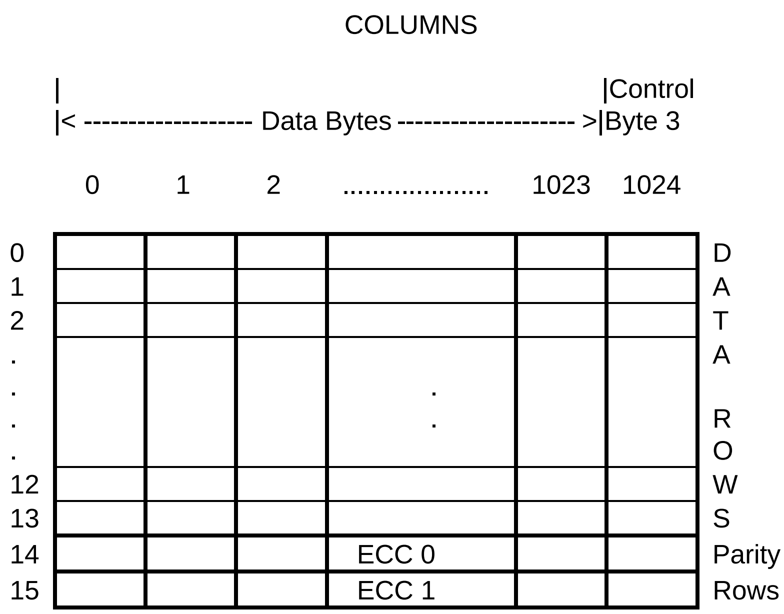


Figure 10.2. ECC Frame Format

10.3 Code Generator Polynomial

The generator polynomial for the Reed-Solomon code is of the form

$$g(x) = x^2 + ax + b,$$

where a and b are field elements. However, a and b are not arbitrary. They must be chosen so that the roots of g(x) over the field are consecutive powers of a primitive element of the field (e.g. a root of f(x)).

There are eight roots of f(x) in GF(256), so let r be one of them. Then g(x) will have the form:

$$g(x) = (x + r^0)(x + r^1) = (x+1)(x+2) = x^2 + 3x + 2$$

with r=2.

To encode a column of data, label the data bytes in a given column by their row number, as in figure 10.2, from d_0 to d_{13}. Encoding a frame shall be accomplished as follows. In a frame, each column contains data bytes d_0 to d_{15}, numbered as in figure 10.2. The parity bytes d_{14} and d_{15} in each column shall be chosen so that the polynomial

$$d(x) = \sum_{i=0}^{15} d_{15-i} x^i$$

(Σ = SUM)

is divisible by g(x), using polynomial division over the field GF(256). In practice, encoding is done by taking the remainder using a linear feedback shift register.

10.4 Example Codewords

The following columns of bytes are codewords for the polynomials defined in the preceding sections, using hex notation for the field elements.

Row						
0 :	00	00	00	00	00	00
...						
11 :	00	00	00	00	00	00
12 :	00	00	01	02	04	07
13 :	01	10	00	04	08	0C
14 :	03	30	07	02	04	01
15 :	02	20	06	04	08	0A

Table 10.1. Example of Codewords.

APPENDIX A.

The data found in the Identifier blocks 1, 2 and 5 may optionally be transferred to the Initiator by using the INQUIRY and MODE SENSE commands.

Inquiry Data

When the Identifier Frame of a QIC-3040 have been read the Inquiry data from command with RIB (Read Information Block) bit set to one. The INQUIRY command shall then transfer Inquiry data and VPD data as usual except that the data returned is taken from the Identifier Frame of the tape and not from the device itself.

The RIB bit is located in bit 7 byte 5 of the INQUIRY command descriptor block.

If no Identifier Frame have been read (from the currently inserted tape), then an INQUIRY command with the RIB bit set to one shall be terminated with CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST with the ASC byte = 14 hex and ASCQ byte = 00 to indicate RECORDED ENTITY NOT FOUND.

Mode Sense Data

When the Identifier Frame of a QIC-3040 tape have been read the mode sense data from Identifier block 2 can be transferred to the Initiator by using a the MODE SENSE command with RIB (Read Information Block) bit set to one. The MODE SENSE command shall then transfer mode sense data as usual except that the data returned is taken from the Identifier Frame of the tape and not from the device itself.

The RIB bit is located in bit 7 byte 5 of the MODE SENSE command descriptor block.

When the RIB bit is set to one the PC (Page Control) field of the MODE SENSE command shall be ignored.

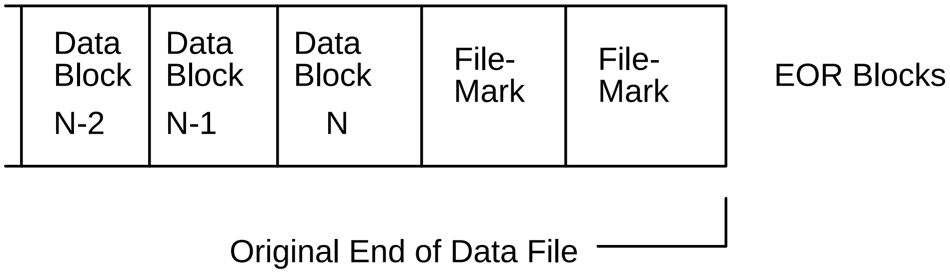
If no Identifier Frame have been read (from the currently inserted tape), then a MODE SENSE command with the RIB bit set to one shall be terminated with CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST with the ASC byte = 14 hex and ASCQ = 00 to indicate RECORDED ENTITY NOT FOUND.

APPENDIX B

Cancel Mark (option)

Many tape control systems developed for 1/2" 9-track tape drives used the principle of writing two File Marks at the end of last file recorded on the tape to indicate end of data. When appending data on such tapes, the second File Mark is first erased to remove the end of data indicator. This is shown in figure B-1.

First Write Operation:



Same Area after Append Operation:
Physical and Logical Layout:

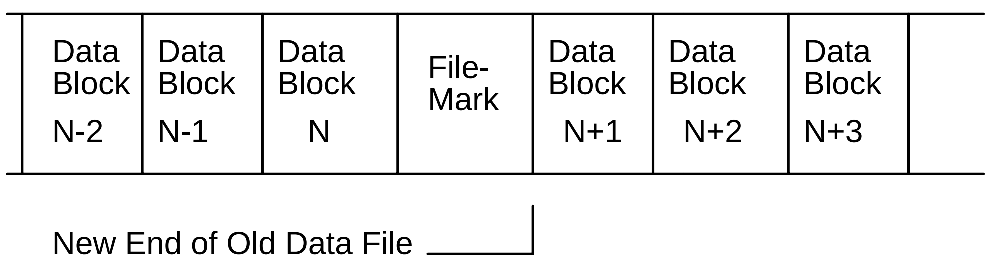


Figure B-1. Append operations, ½" tape formats.

A QIC-3040 compatible tape drive cannot perform this operation as overwrite is not specified in the format standard. The Cancel Mark option offers the same flexibility without any overwrite requirements. This optional feature makes it possible for QIC-3040 compatible drives to better emulate a ½" tape drive system.

The Cancel Mark block acts as a "negative" File Mark. When a Cancel Block follows directly after two consecutive File Marks, the drive when reading the tape shall logically ignore the last File Mark and the companion Cancel Mark.

Except in the case of "killing" the last File Mark as described above, the Cancel Mark has no other function and shall never be reported back to the host.

Figure B-2 shows the use of the Cancel Mark.

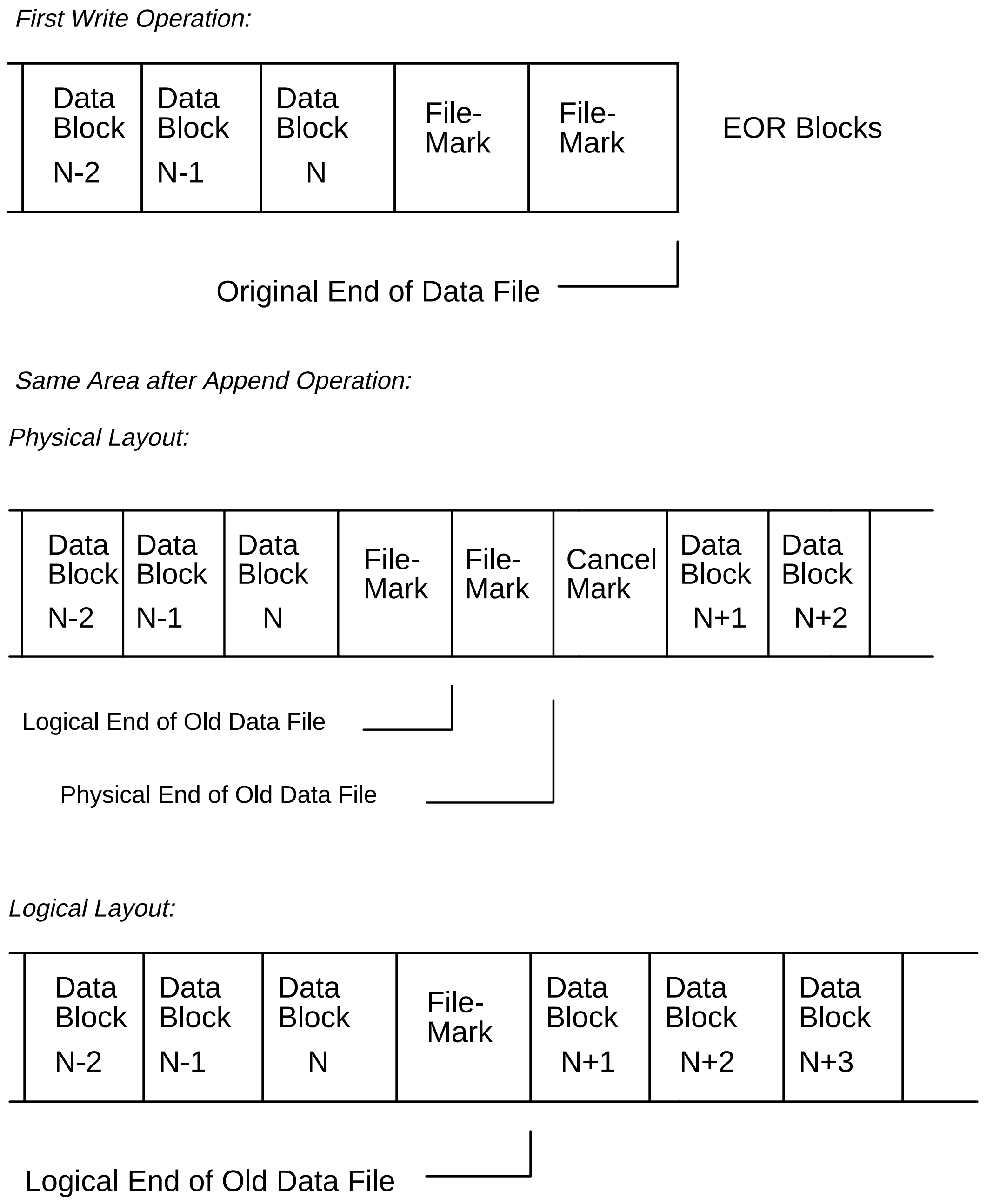


Figure B-2. Append operations with optional Cancel Mark.

The Cancel Mark shall always be appended as the *logically* first block after the *second* consecutive File Mark. It is not allowed to write a Cancel Mark unless the two *logically* preceding blocks are File Mark Blocks. The drive must also verify both File Marks as "good", and it must also verify that the two File Marks are at the End-of-Recorded Area before a Cancel Mark may be appended.

No Cancel Marks shall be recorded if the preceding File Mark group consists of *three* or more *logically* consecutive File Marks.

(Filler Blocks are acceptable, either after the two File Marks or between the two File Marks or both, as they in this tape format are *logically* non-existent. Therefore, a drive may terminate a write operation with two consecutive File Marks and one or more Filler Blocks and still according to this Standard start an append operation later by first writing a Cancel Mark after the last Filler Block).

Only *one* Cancel Mark is allowed for each group of two consecutive File Marks, however, the Cancel Mark may be rerecorded several times in order to meet the read-while-write verification requirements.

The data area of the Cancel Mark Block contains no valid data according to this Standard.

This optional feature may be activated by emulating a ½" command sequence used to overwrite the last File Mark at EOR (EOF) as follows:

Space to EOR (End of Recorded Area)
Space Reverse one File Mark
Write Data

It is also possible to implement this feature via the SCSI bus using the Mode Select command. For SCSI-I and SCSI-II, the following command may be used:

SCSI-I:
Vendor Unique Page,
Byte 13,
Bit 2 (named EOWR).

SCSI-II:
Miscellaneous Parameter Page
Page Code 20
Byte 08,
Bit 4 (named EOWR)

EOWR = Enable Overwrite

Appendix C

Data Compression Page

(MODE page 0Fh)

BYTE	BIT7	6	5	4	3	2	1	0
0	PS	R	Page Code (0Fh)					
1	Parameter Length (0Eh)							
2	DCE	DCC	Reserved					
3	DDE	RED		Reserved				
4	(MSB)							
5	Compression Algorithm							
6								
7								(LSB)
8	(MSB)							
9	Decompression Algorithm							
10								
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

PS	The Parameter Savable (PS) bit MUST be set to zero
DCE	A data compression enable (DCE) bit of one indicates that the data compression is to be enabled. When this bit is set, data sent to the device by the initiator shall be processed using the selected compression algorithm before beeing written to the medium. A DCE bit of zero indicates that data compression is disabled - Legal values are numbers in the range 0..1 - The default (foctory programmed) value is 1.
DCC	A data compression capable (DCC) bit of one indicates that the device supports data compression and can process data sent to it for transferral to the medium using the selected compression algorithm. A DCC bit of zero indicates that the device does not support data compression. This bit is not changeable.
DDE	A data decompression enable (DDE) bit of one indicates that data decompression is to be enabled. A DDE of zero indicates that data decompression is disabled. - Legal values are numbers in the range 0..1 - The default (factory programmed) value is 1.
RED	The report exception on decompression (RED) field indicates the device's response to certain boundaries it detects in the data on the medium. Possible boundaries are 1) transition between compressed and decompressed data 2) between decompressed and compressed data 3) change in compression algorithm. Since none of these boundaries are legal, the RED field shall be set to 2 indicating that the Drive will return with CHECK CONDITION status when a boundary is found. (Data is regarded as compressed as long as they are organized into Compression Block Groups, even if the actual data field is not compressed) This field must be set to 2.
Compression Algorithm	The compression algorithm field indicates the compression algorithm the Drive will use to process the data sent to it by the initiator when the DCE bit is one. Supported Algorithm is the ALDC Data Compression Algorithm with identifier value ??h. - Legal values are 0 and ??h - The default (factory programmed) value is TBDh.
Decompression Algorithm	The decompression algorithm field indicates the decompression algorithm the Drive will use during decompression of data encountered on the medium. - Legal values are 0 and ??h - The default (factory programmed) value is TBDh.