



# DEVELOPMENT STANDARD

---

QIC-5010-DC  
Revision E  
15 Dec 94

## SERIAL RECORDED MAGNETIC TAPE DATA CARTRIDGE FOR INFORMATION INTERCHANGE

Streaming Mode  
Read-While-Write  
0.250 inch (6.35 mm) Tape  
144 Data Tracks  
Transition Density: 50,800 fpi (2,000 ftpmm)  
Data Density: 67,733 bpi (2,667 bpmm)  
RLL 1,7 Encoding  
Reed-Solomon ECC

Uncompressed Formatted Capacity (with 1,200 feet of 900 Oe tape):  
13 GBytes

**Quarter-Inch  
Cartridge  
Drive Standards, Inc.**

311 East Carrillo Street  
Santa Barbara, California 93101  
Telephone (805) 963-3853  
Fax (805) 962-1541  
[www.qic.org](http://www.qic.org)

---

(See important notices on the following page)

## Important Notices

---

This document is a development standard adopted by Quarter-Inch Cartridge Drive Standards, Inc. (QIC). This document may be revised several times during the development cycle. It is intended solely as a guide for companies interested in developing products which can be compatible with other products developed using this document. QIC makes no representation or warranty regarding this document, and any company using this document shall do so at its sole risk, including specifically the risks that a product developed will not be compatible with any other product or that any particular performance will not be achieved. QIC shall not be liable for any exemplary, incidental, proximate or consequential damages or expenses arising from the use of this document. This development standard defines only one approach to the product. Other approaches may be available in the industry.

This development standard is an authorized and approved publication of QIC. The underlying information and materials contained herein are the exclusive property of QIC but may be referred to and utilized by the general public for any legitimate purpose, particularly in the design and development of quarter-inch tape cartridge drive subsystems. This development standard may be copied in whole or in part *provided* that no revisions, alterations or changes of any kind are made to the materials contained herein. Only QIC has the right and authority to revise or change the material contained in this development standard, and any revisions by any party other than QIC are totally unauthorized and specifically prohibited.

Compliance with this development standard may require use of one or more features covered by proprietary rights (such as features which are the subject of a patent, patent application, copyright, mask work right or trade secret right). By publication of this development standard, no position is taken by QIC with respect to the validity or infringement of any patent or other proprietary right, whether owned by a Member or Associate of QIC, or otherwise. QIC hereby expressly disclaims any liability for infringement of intellectual property rights of others by virtue of the use of this development standard. QIC has not and does not investigate any notices or allegations of infringement prompted by publication of any QIC development standard, nor does QIC undertake a duty to advise users or potential users of QIC development standards of such notices or allegations. QIC hereby expressly advises all users or potential users of this development standard to investigate and analyze any potential infringement situation, seek the advice of intellectual property counsel, and, if indicated, obtain a license under any applicable intellectual property right or take the necessary steps to avoid infringement of any intellectual property right. QIC expressly disclaims any intent to promote infringement of any intellectual property right by virtue of the evolution, adoption, or publication of any QIC development standard.

## Table Of Contents

---

|                                                                    |           |
|--------------------------------------------------------------------|-----------|
| <b>0. Overview of Revision Changes:</b>                            | <b>4</b>  |
| <b>1. SCOPE AND INTRODUCTION</b>                                   | <b>5</b>  |
| 1.1. Scope                                                         | 5         |
| 1.2. Introduction                                                  | 6         |
| <b>2. DEFINITIONS</b>                                              | <b>7</b>  |
| <b>3. REFERENCE EDGE</b>                                           | <b>10</b> |
| <b>4. TRACK GEOMETRY</b>                                           | <b>10</b> |
| 4.1. Physical Tracks                                               | 10        |
| 4.2. Track Width                                                   | 10        |
| 4.3. Servo Tracks                                                  | 10        |
| 4.4. Physical Track Positions                                      | 12        |
| 4.5. Data Tracks                                                   | 13        |
| 4.6. Cartridge Logical Track Layout                                | 13        |
| <b>5. RECORDING</b>                                                | <b>16</b> |
| 5.1. Read While Write Verification                                 | 16        |
| 5.2. Method Of Recording                                           | 16        |
| 5.3. Write Equalization                                            | 16        |
| 5.4. Transition Densities                                          | 18        |
| 5.5. Average Transition Cell Length Variations                     | 18        |
| 5.5.1. Average Transition Cell Length                              | 19        |
| 5.5.2. Long Term Average Transition Cell Length                    | 19        |
| 5.5.3. Medium Term Average Transition Cell Length                  | 19        |
| 5.5.4. Short Term Average Transition Cell Length                   | 19        |
| 5.5.5. Rate of Change of Transition Cell Length                    | 19        |
| 5.5.6. Instantaneous Flux Transition Spacing                       | 20        |
| 5.6. Signal Amplitude Of A Recorded Cartridge For Data Interchange | 20        |
| 5.6.1. Average Signal Amplitude at Nominal Maximum Density         | 21        |
| 5.6.2. Maximum Signal Amplitude                                    | 21        |
| 5.6.3. Minimum Signal Amplitude                                    | 21        |
| 5.7. Recorded Azimuth                                              | 21        |
| 5.8. Overwrite                                                     | 21        |

|                                                     |           |
|-----------------------------------------------------|-----------|
| <b>6. USE OF TRACKS .....</b>                       | <b>22</b> |
| 6.1. Data Tracks.....                               | 22        |
| 6.2. Track Numbering .....                          | 22        |
| 6.3. Track ID .....                                 | 22        |
| 6.4. Minimum/Maximum Distances Even Track Sets..... | 22        |
| 6.5. Minimum/Maximum Distances Odd Track Sets ..... | 22        |
| 6.6. Media Header Position .....                    | 22        |
| 6.7. Tape Slope Considerations.....                 | 24        |
| 6.8. Servo Limitations .....                        | 24        |
| 6.9. Summary Of Requirements .....                  | 24        |
| 6.10. QIC 5010 Media Header Data.....               | 24        |
| <b>7. BYTE AND CODE REQUIREMENTS .....</b>          | <b>26</b> |
| 7.1. Byte Length .....                              | 26        |
| 7.2. Code .....                                     | 26        |
| <b>8. DATA RANDOMIZING AND ENCODING .....</b>       | <b>26</b> |
| 8.1. Data Randomizer .....                          | 26        |
| 8.1.1. Preamble .....                               | 28        |
| 8.1.2. Block Marker.....                            | 28        |
| 8.1.3. Postamble .....                              | 28        |
| 8.2. Data Encoding.....                             | 29        |

## 0. Overview of Revision Changes:

---

- Rev. A    Adopted by the QIC Technical committee on 27 FEB, 1992.
- Editorial changes 5 Aug, 1992 to reflect decision of QIC IDC subcommittee to specify capacity without data compression.
- Rev B    Modified track layout according to QIC 93-18.
- Changed capacity references to 13GB reflect capacity with 1200 Ft tape.
- Removed Cancel Blocks.
- Modified minimum/maximum distances in section "Use of tracks" according to agreed distances.
- Rev C    Modified track pitch and write track width according to QIC 93-100.
- Changed QIC 13GB references to QIC 5010 in both document and ID Frame Format ID.
- Rev D    Defined single channel format version
- Defined Media Header layout and position.
- Rev E    Introduced Track Id blocks according to QIC 94-27 and new tracktables.

# 1. SCOPE AND INTRODUCTION

---

## 1.1. Scope

---

This Standard provides a format and recording standard for a streaming 0.25 inch (6.3 mm) wide, 144 data tracks, 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 capacity of 13,000 GBytes of formatted data on a single cartridge using read-while-write verification and error correction codes.

This Development Standard relies on the following QIC Standards. Compliance with all of the aforementioned standards is a requirement for information interchange.

|          |                                                                                                                                                                                                                                                                                                                    |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| QIC 139  | Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.315 inch (8.0 mm), 75,000 ftpi (2,953 ftpmm), where the following sections will be dealt with in detail: General requirements, definition, tape and cartridge, physical and magnetic requirements, speed requirements, and write enable feature. |
| QIC CRF1 | Common Recording Format Standard which specifies the formatting of data and the Reed-Solomon Error Correcting Code for data retrieval.                                                                                                                                                                             |
| QIC -134 | Recording Head Standard, which specifies the recording head required.                                                                                                                                                                                                                                              |

**CAUTION NOTICE:** Compliance with this Development Standard may require use of one or more proprietary rights (such as features which are the subject of a patent, patent application, copyright, trademark work right or trade secret right). By publication of this Development Standard, no position is taken by QIC with respect to the validity of any patent or other claim of proprietary rights in connection therewith. Persons proposing a feature in this Development Standard which is the subject of a claim of patent rights or other proprietary rights may or may not have notified QIC of such claim. No representation or warranty is made or implied that the filed notice will disclose all patented and proprietary rights that could be the subject of infringement by use of this Development Standard.

## 1.2. Introduction

---

This Development Standard defines the requirements 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 inter-change transactions. The standard uses a Reed Solomon error correction code to achieve a corrected bit error rate of at least  $10^{-15}$ .

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.

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.

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.

Except as indicated 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:

|                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Bad Block:</b>                      | A block determined to be bad during the Read-While-Write operation, or later during a read operation.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Bit:</b>                            | A single digit in the binary system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Bit Cell:</b>                       | The physical length of a recorded encoded bit along the track. In this standard, the bit cell length must be measured indirectly, by measuring the length of a minimum Transition Cell.                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Block:</b>                          | A group of 512 consecutive data bytes plus additional control bytes recorded as a unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Block Marker:</b>                   | A group of encoded bits following the preamble and marking the start of each block.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>BOT (Beginning of Tape) Marker:</b> | The BOT Marker is a set of two holes punched in the tape. There are four sets of 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 inter-change. |
| <b>Byte:</b>                           | A group of 8 data bits operated on as a unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Cartridge ID:</b>                   | There are six hole positions between BOT1 and BOT2 which identify the cartridge. Reference QIC-121 cartridge type table.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Control Block:</b>                  | A block designated as a Control block. This Standard does not define the use of control blocks nor the contents of the data area of the control block.                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Control Field:</b>                  | A group of 8 bytes recorded before the data area in each block, containing information about block address, track address and block type.                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>CRC (Cyclic Redundancy Check):</b>  | The CRC is a group of 4 bytes recorded at the end of each block of data for the purpose of error detection.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Data Block:</b>                     | A block containing user valid data in its data field.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Data Density:</b>                   | The nominal distribution of recorded data information per unit length of track, usually expressed in bits per inch (bpi) or bits per millimeter (bpm). In this standard, the data density is higher than the transition density.                                                                                                                                                                                                                                                                                                                        |
| <b>DPSI (Defect Per Square Inch):</b>  | The DPSI number specifies the number of defects (using a defined read method) per square inch of tape.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>ECC (Error Correction Code):</b>    | Special drive generated information which may be used to correct bad blocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

|                                    |                                                                                                                                                                                                                                             |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ECC Block:</b>                  | A block containing drive generated ECC data in its data field and part of control field.                                                                                                                                                    |
| <b>Encoding:</b>                   | A method where by a group of data bits is translated into a group of recording bits. In this standard, 2,4 or 8 data bits are translated into 3, 6 or 12 recording bits.                                                                    |
| <b>EOD (End of Data) Marker:</b>   | The EOD marker is used to mark the end of the data area. The marker consists of a minimum of 64K recordings of a 2-byte postamble pattern.                                                                                                  |
| <b>EOT (End of Tape) Marker:</b>   | 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. |
| <b>EW (Early Warning) Marker:</b>  | 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.                                                                                                   |
| <b>File Mark Block:</b>            | A block designated as a File Mark.                                                                                                                                                                                                          |
| <b>Filler Block:</b>               | 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.                                              |
| <b>Flux Transition:</b>            | A point on the magnetic tape which exhibits maximum free space flux density normal to the tape surface.                                                                                                                                     |
| <b>Flux Transition Spacing:</b>    | A distance on the magnetic tape between flux transitions.                                                                                                                                                                                   |
| <b>Frame:</b>                      | A group of 64 blocks forming a complete logical unit.                                                                                                                                                                                       |
| <b>Identifier Block:</b>           | A unique block identifying the type of format being recorded.                                                                                                                                                                               |
| <b>GBytes (GB):</b>                | This standard defines 1 GB to be equal to $10^9$ Bytes.                                                                                                                                                                                     |
| <b>KBytes (KB):</b>                | This standard defines 1 KB to be equal to 1024 bytes.                                                                                                                                                                                       |
| <b>LP (Load Point) Marker:</b>     | 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.                                                                                                 |
| <b>Magnetic Tape Cartridge:</b>    | A cartridge containing 0.25 inch (6.3 mm) or 0.315 inch (8 mm) wide magnetic tape wound on two coplanar hubs with an internal drive belt to transport the tape between the hubs.                                                            |
| <b>Max Rewrites:</b>               | The max. no. of times a block may be rerecorded during Read After Write (RAW) verification..                                                                                                                                                |
| <b>Max Servo Dropout Distance:</b> | The max. legal length of a servo dropout                                                                                                                                                                                                    |
| <b>MBytes (MB):</b>                | This standard defines 1 MB to be equal to $10^6$ bytes.                                                                                                                                                                                     |
| <b>Physical Recording Density:</b> | See transition density.                                                                                                                                                                                                                     |

|                                                          |                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Postamble:</b>                                        | A special sequence of bits recorded at the end of each block.                                                                                                                                                                                                                                          |
| <b>Preamble:</b>                                         | A special sequence of bits recorded at the beginning of each block.                                                                                                                                                                                                                                    |
| <b>Read-After-Write:</b>                                 | A method whereby data being recorded is read and verified on a separate pass as when they are written.                                                                                                                                                                                                 |
| <b>Read-While-Write:</b>                                 | A method where data being recorded is read and verified on the same pass as they are written.                                                                                                                                                                                                          |
| <b>Recorded Azimuth:</b>                                 | The angular deviation, in minutes of arc, of the recorded mean flux transition line from the line normal to the cartridge reference plane.                                                                                                                                                             |
| <b>Reference Tape Cartridge:</b>                         | A tape cartridge selected for a given property for calibrating purposes.                                                                                                                                                                                                                               |
| <b>RLL (Run Length Limited):</b>                         | A data encoding method where data bits are encoded so that certain constraints are met with regard to the maximum and minimum distances between flux transitions.                                                                                                                                      |
| <b>Secondary Reference Tape Cartridge:</b>               | 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.                                                                                                                                          |
| <b>Servo Dropout:</b>                                    | The track following servo signal is outside the tolerances.                                                                                                                                                                                                                                            |
| <b>Signal Amplitude Reference Tape Cartridge:</b>        | A reference cartridge selected as a standard for signal amplitude and reference field.                                                                                                                                                                                                                 |
| <b>Standard Reference Amplitude:</b>                     | The average peak-to-peak signal amplitude output of the Signal Amplitude Reference Cartridge when it is recorded on an TBD measuring system at the maximum flux density specified in this standard.                                                                                                    |
| <b>Streaming:</b>                                        | A method of recording on magnetic tape that maintains continuous tape motion without the requirement to start and stop within an interblock gap.                                                                                                                                                       |
| <b>Track:</b>                                            | A longitudinal area on the tape along which magnetic signals may be serially recorded.                                                                                                                                                                                                                 |
| <b>Track ID:</b>                                         | A prerecorded signal at the beginning of each track required to verify correct track position of the head actuator prior to writing on a track.                                                                                                                                                        |
| <b>Track Set:</b>                                        | A logical collection of N physical tracks which are written or read simultaneously. A track set can be viewed as a logical track that holds N times as much data as a physical track and can transfer data N times as fast as a physical track. A track set may consist of only one track, i.e. N = 1. |
| <b>Transition Cell:</b>                                  | The physical distance between two adjacent flux transition at the maximum recording density.                                                                                                                                                                                                           |
| <b>Transition Density or Physical Recording Density:</b> | The number of recorded flux transitions per unit length of track, usually expressed in flux transitions per inch(ftpi) or flux transitions per millimeter (ftpm). See also Data Density.                                                                                                               |
| <b>Underrun:</b>                                         | A condition developed when the host transmits or receives data at a rate less than required by the device for streaming operation.                                                                                                                                                                     |
| <b>1/4 Inch:</b>                                         | A tape which is 0.25 inches (6.35 mm) wide.                                                                                                                                                                                                                                                            |

### 3. REFERENCE EDGE

---

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

## 4. TRACK GEOMETRY

---

### 4.1. Physical Tracks

---

The physical tracks are used either as servo tracks or as data tracks:

No. of data tracks                      144

No. of servo tracks                      24

The physical track layout is as shown in Figure 4.1

### 4.2. Track Width

---

The width of the recorded track shall be:

$30.5\mu\text{m} \pm 2.0\mu\text{m}$                       ( Ref. QIC 134 )

Read head ETW is  $19\mu\text{m} \pm 1.0\mu\text{m}$ .                      ( Ref. QIC 134 )

Typical Pitch within a servo band is  $33.0\mu\text{m}$  ( Ref. QIC 139 )

### 4.3. Servo Tracks

---

The servo tracks are split into two bands. Each servo band recording will consist of a approx. 12-pitch wide recording at  $F_{\text{servo}}$ . These recordings will have a series of vertical stripes consisting of 12 erased sections, each 1 pitch wide, and separated from each other by approx. 1 pitch. The edges of the top and bottom erased sections are each apr. half pitch from the top and bottom edges, respectively, of the servo recordings. For exact numbers see QIC 139.

Tapes shall be purchased with servo tracks prewritten.

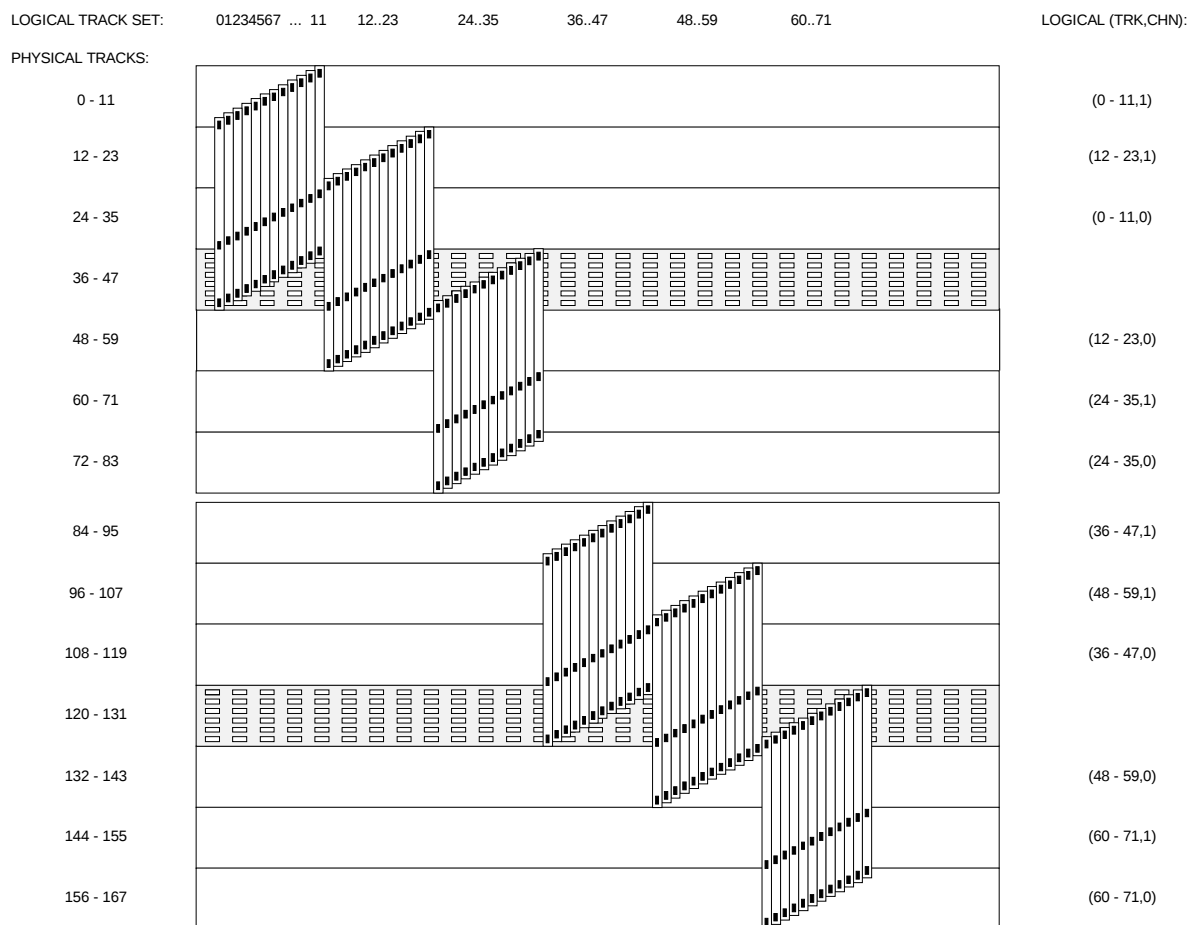


Figure 4.1 Wide Tape Track Locations. Figure shows: physical tracks, servo tracks, data tracks, logical track layout in dual channel mode, and the position of the head. NOTE: All even tracks are written in the forward direction while all odd tracks are written in the reverse direction.

## 4.4. Physical Track Positions

The position of the center line of servo track 18 (physical track 126) is referred to the Reference Edge. The positions of all the other tracks are defined by specifying the distance of their center lines from the center line of servo track 18. Physical tracks are numbered from upper tape edge and downwards.

| Physical Tracks | Reference | Distance from Reference ( $\mu\text{m}$ ) | Tolerance ( $\mu\text{m}$ ) | Note                                                                                                                       |
|-----------------|-----------|-------------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 00 - 11         | S0 - S11  | +1224                                     | $\pm 2.50$                  |                                                                                                                            |
| 12 - 23         | S0 - S11  | +816                                      | $\pm 2.31$                  |                                                                                                                            |
| 24 - 35         | S0 - S11  | +408                                      | $\pm 2.23$                  |                                                                                                                            |
| 36 - 47         | S0 - S11  | 0                                         | 0                           | Servo Tracks. Servo Track 6 shall be located $2907\mu\text{m} \pm 10\mu\text{m}$ above Servo track 18                      |
| 48 - 59         | S0 - S11  | -408                                      | $\pm 2.23$                  |                                                                                                                            |
| 60 - 71         | S0 - S11  | -816                                      | $\pm 2.31$                  |                                                                                                                            |
| 72 - 83         | S0 - S11  | -1224                                     | $\pm 2.50$                  |                                                                                                                            |
|                 |           |                                           |                             | Upper Guardband                                                                                                            |
| 84 - 95         | S12 - S23 | +1224                                     | $\pm 2.50$                  |                                                                                                                            |
| 96 - 107        | S12 - S23 | +816                                      | $\pm 2.31$                  |                                                                                                                            |
| 108 - 119       | S12 - S23 | +408                                      | $\pm 2.23$                  |                                                                                                                            |
| 120 - 131       | S12 - S23 | 0                                         | 0                           | Servo Tracks. Servo track 18 shall be located $1666.4\mu\text{m} \pm 25\mu\text{m}$ above the reference (lower) tape edge. |
| 132 - 143       | S12 - S23 | -408                                      | $\pm 2.23$                  |                                                                                                                            |
| 144 - 155       | S12 - S23 | -816                                      | $\pm 2.31$                  |                                                                                                                            |
| 156 - 167       | S12 - S23 | -1224                                     | $\pm 2.50$                  |                                                                                                                            |

Figure 4.2 Tape Physical Track Locations

## 4.5. Data Tracks

---

Data tracks are grouped into Track Sets. A Track Set can be configured for Single Channel Mode or Dual Channel Mode. In Dual Channel Mode two physical tracks are written in parallel as track sets with each track set consisting of 2 physical tracks. In Single Channel Mode each track set consists of only one physical track. A Tape may only be written entirely in Single Channel or Dual Channel Mode.

The layout shall be as shown in figure 4.3.

## 4.6. Cartridge Logical Track Layout

---

Each head has 3 channels. While any one channel is used as the servo channel, the other two are used one at a time or in parallel as data channels.

If a logical track set consists of two tracks, they are denoted as 0 and 1 and written as (n,0) and (n,1) for a track set n. Track n,0 is written with the bottom data channel and it contains the even frames. Track n,1 is written with the top data channel and it contains the odd frames.

- Refer to figure 4.3.

| PHYSICAL<br>TRACK # | LOGICAL<br>TRACK#<br>SINGLE<br>MODE | LOGICAL<br>TRACK#<br>DUAL<br>MODE | PHYSICAL<br>TRACK # | LOGICAL<br>TRACK #<br>SINGLE<br>MODE | LOGICAL<br>TRACK #<br>DUAL<br>MODE |
|---------------------|-------------------------------------|-----------------------------------|---------------------|--------------------------------------|------------------------------------|
| 0                   | 83                                  | (11,1)                            | 42                  | S6                                   | S6                                 |
| 1                   | 82                                  | (10,1)                            | 43                  | S7                                   | S7                                 |
| 2                   | 81                                  | (9,1)                             | 44                  | S8                                   | S8                                 |
| 3                   | 80                                  | (8,1)                             | 45                  | S9                                   | S9                                 |
| 4                   | 79                                  | (7,1)                             | 46                  | S10                                  | S10                                |
| 5                   | 78                                  | (6,1)                             | 47                  | S11                                  | S11                                |
| 6                   | 77                                  | (5,1)                             | 48                  | 23                                   | (23,0)                             |
| 7                   | 76                                  | (4,1)                             | 49                  | 22                                   | (22,0)                             |
| 8                   | 75                                  | (3,1)                             | 50                  | 21                                   | (21,0)                             |
| 9                   | 74                                  | (2,1)                             | 51                  | 20                                   | (20,0)                             |
| 10                  | 73                                  | (1,1)                             | 52                  | 19                                   | (19,0)                             |
| 11                  | 72                                  | (0,1)                             | 53                  | 18                                   | (18,0)                             |
| 12                  | 95                                  | (23,1)                            | 54                  | 17                                   | (17,0)                             |
| 13                  | 94                                  | (22,1)                            | 55                  | 16                                   | (16,0)                             |
| 14                  | 93                                  | (21,1)                            | 56                  | 15                                   | (15,0)                             |
| 15                  | 92                                  | (20,1)                            | 57                  | 14                                   | (14,0)                             |
| 16                  | 91                                  | (19,1)                            | 58                  | 13                                   | (13,0)                             |
| 17                  | 90                                  | (18,1)                            | 59                  | 12                                   | (12,0)                             |
| 18                  | 89                                  | (17,1)                            | 60                  | 107                                  | (35,1)                             |
| 19                  | 88                                  | (16,1)                            | 61                  | 106                                  | (34,1)                             |
| 20                  | 87                                  | (15,1)                            | 62                  | 105                                  | (33,1)                             |
| 21                  | 86                                  | (14,1)                            | 63                  | 104                                  | (32,1)                             |
| 22                  | 85                                  | (13,1)                            | 64                  | 103                                  | (31,1)                             |
| 23                  | 84                                  | (12,1)                            | 65                  | 102                                  | (30,1)                             |
| 24                  | 11                                  | (11,0)                            | 66                  | 101                                  | (29,1)                             |
| 25                  | 10                                  | (10,0)                            | 67                  | 100                                  | (28,1)                             |
| 26                  | 9                                   | (9,0)                             | 68                  | 99                                   | (27,1)                             |
| 27                  | 8                                   | (8,0)                             | 69                  | 98                                   | (26,1)                             |
| 28                  | 7                                   | (7,0)                             | 70                  | 97                                   | (25,1)                             |
| 29                  | 6                                   | (6,0)                             | 71                  | 96                                   | (24,1)                             |
| 30                  | 5                                   | (5,0)                             | 72                  | 35                                   | (35,0)                             |
| 31                  | 4                                   | (4,0)                             | 73                  | 34                                   | (34,0)                             |
| 32                  | 3                                   | (3,0)                             | 74                  | 33                                   | (33,0)                             |
| 33                  | 2                                   | (2,0)                             | 75                  | 32                                   | (32,0)                             |
| 34                  | 1                                   | (1,0)                             | 76                  | 31                                   | (31,0)                             |
| 35                  | 0                                   | (0,0)                             | 77                  | 30                                   | (30,0)                             |
| 36                  | S0                                  | S0                                | 78                  | 29                                   | (29,0)                             |
| 37                  | S1                                  | S1                                | 79                  | 28                                   | (28,0)                             |
| 38                  | S2                                  | S2                                | 80                  | 27                                   | (27,0)                             |
| 39                  | S3                                  | S3                                | 81                  | 26                                   | (26,0)                             |
| 40                  | S4                                  | S4                                | 82                  | 25                                   | (25,0)                             |
| 41                  | S5                                  | S5                                | 83                  | 24                                   | (24,0)                             |

Figure 4.3A Physical and Logical Track Mapping Upper Servo Band Tracks (Tracks 0 through 83)

| PHYSICAL<br>TRACK # | LOGICAL<br>TRACK#<br>SINGLE<br>MODE | LOGICAL<br>TRACK#<br>DUAL<br>MODE | PHYSICAL<br>TRACK # | LOGICAL<br>TRACK #<br>SINGLE<br>MODE | LOGICAL<br>TRACK #<br>DUAL<br>MODE |
|---------------------|-------------------------------------|-----------------------------------|---------------------|--------------------------------------|------------------------------------|
| 84                  | 119                                 | (47,1)                            | 126                 | S18                                  | S18                                |
| 85                  | 118                                 | (46,1)                            | 127                 | S19                                  | S19                                |
| 86                  | 117                                 | (45,1)                            | 128                 | S20                                  | S20                                |
| 87                  | 116                                 | (44,1)                            | 129                 | S21                                  | S21                                |
| 88                  | 115                                 | (43,1)                            | 130                 | S22                                  | S22                                |
| 89                  | 114                                 | (42,1)                            | 131                 | S23                                  | S23                                |
| 90                  | 113                                 | (41,1)                            | 132                 | 59                                   | (59,0)                             |
| 91                  | 112                                 | (40,1)                            | 133                 | 58                                   | (58,0)                             |
| 92                  | 111                                 | (39,1)                            | 134                 | 57                                   | (57,0)                             |
| 93                  | 110                                 | (38,1)                            | 135                 | 56                                   | (56,0)                             |
| 94                  | 109                                 | (37,1)                            | 136                 | 55                                   | (55,0)                             |
| 95                  | 108                                 | (36,1)                            | 137                 | 54                                   | (54,0)                             |
| 96                  | 131                                 | (59,1)                            | 138                 | 53                                   | (53,0)                             |
| 97                  | 130                                 | (58,1)                            | 139                 | 52                                   | (52,0)                             |
| 98                  | 129                                 | (57,1)                            | 140                 | 51                                   | (51,0)                             |
| 99                  | 128                                 | (56,1)                            | 141                 | 50                                   | (50,0)                             |
| 100                 | 127                                 | (55,1)                            | 142                 | 49                                   | (49,0)                             |
| 101                 | 126                                 | (54,1)                            | 143                 | 48                                   | (48,0)                             |
| 102                 | 125                                 | (53,1)                            | 144                 | 143                                  | (71,1)                             |
| 103                 | 124                                 | (52,1)                            | 145                 | 142                                  | (70,1)                             |
| 104                 | 123                                 | (51,1)                            | 146                 | 141                                  | (69,1)                             |
| 105                 | 122                                 | (50,1)                            | 147                 | 140                                  | (68,1)                             |
| 106                 | 121                                 | (49,1)                            | 148                 | 139                                  | (67,1)                             |
| 107                 | 120                                 | (48,1)                            | 149                 | 138                                  | (66,1)                             |
| 108                 | 47                                  | (47,0)                            | 150                 | 137                                  | (65,1)                             |
| 109                 | 46                                  | (46,0)                            | 151                 | 136                                  | (64,1)                             |
| 110                 | 45                                  | (45,0)                            | 152                 | 135                                  | (63,1)                             |
| 111                 | 44                                  | (44,0)                            | 153                 | 134                                  | (62,1)                             |
| 112                 | 43                                  | (43,0)                            | 154                 | 133                                  | (61,1)                             |
| 113                 | 42                                  | (42,0)                            | 155                 | 132                                  | (60,1)                             |
| 114                 | 41                                  | (41,0)                            | 156                 | 71                                   | (71,0)                             |
| 115                 | 40                                  | (40,0)                            | 157                 | 70                                   | (70,0)                             |
| 116                 | 39                                  | (39,0)                            | 158                 | 69                                   | (69,0)                             |
| 117                 | 38                                  | (38,0)                            | 159                 | 68                                   | (68,0)                             |
| 118                 | 37                                  | (37,0)                            | 160                 | 67                                   | (67,0)                             |
| 119                 | 36                                  | (36,0)                            | 161                 | 66                                   | (66,0)                             |
| 120                 | S12                                 | S12                               | 162                 | 65                                   | (65,0)                             |
| 121                 | S13                                 | S13                               | 163                 | 64                                   | (64,0)                             |
| 122                 | S14                                 | S14                               | 164                 | 63                                   | (63,0)                             |
| 123                 | S15                                 | S15                               | 165                 | 62                                   | (62,0)                             |
| 124                 | S16                                 | S16                               | 166                 | 61                                   | (61,0)                             |
| 125                 | S17                                 | S17                               | 167                 | 60                                   | (60,0)                             |

Figure 4.3B Physical and Logical Track Mapping Lower Servo Band Tracks (Tracks 84 through 167)

## 5. RECORDING

---

### 5.1. Read While Write Verification

---

To achieve the specified error rate this format requires Read While Write (RWW) verification of the data.

Each block may be rerecorded, if necessary, up to a maximum of Max Rewrites times. For this format Max Rewrites is set to 16.

### 5.2. Method Of Recording

---

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

The recording current shall be  $1.15 \times I_{sat} \pm 3\%$  where  $I_{sat}$  is the minimum current providing 95% of the maximum output at 75 000 ftpi.

### 5.3. Write Equalization

---

To minimize problems due to the large transition spacing ratio (4:1), some form of write pulse equalization shall be used. The suppression characteristics of write equalization shall correspond to the curve illustrated in Appendix A to within the range of -6.4 dB to -9.0 dB when measured at  $F_d/4$  or within TBD +/- dB when measured at  $F_d/2$ . This section describes a recommended method. Other methods may be used provided that the recorded flux form on the tape, as defined by the suppression curve, is at least as good as the resulting flux form achieved by using the method described below. Regardless of method, the recorded signal must also meet the other requirements specified in this section.

Recommended method:

For every "zero" other than the first "zero" following a "one", one or more additional write equalization pulses shall be inserted into the waveform as shown in figures 5.1 and 5.2. The center of the inserted pulse shall be exactly as specified in the figures.

The width  $t_w$  of the equalization pulse shall be  $1/6$  of the minimum nominal transition period  $t_c$  ( $\pm 5\%$ ) as shown in figure 5.2.

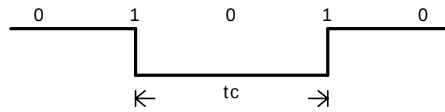


Figure 5.1.1 Pattern ..01010..

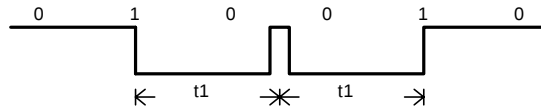


Figure 5.1.2 Pattern ..010010..

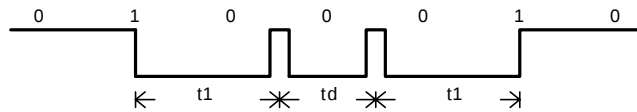


Figure 5.1.3 Pattern ..0100010..

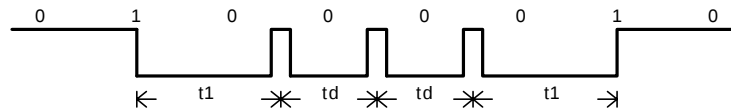


Figure 5.1.4 Pattern ..01000010..

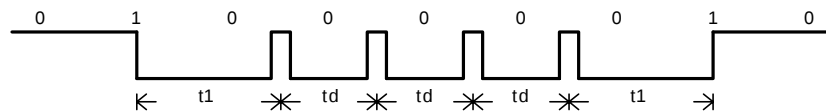


Figure 5.1.5 Pattern ..010000010..

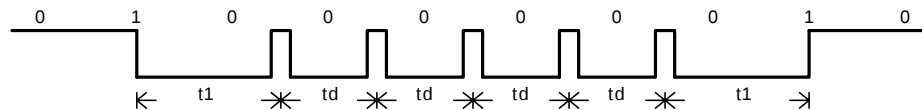


Figure 5.1.6 Pattern ..0100000010..

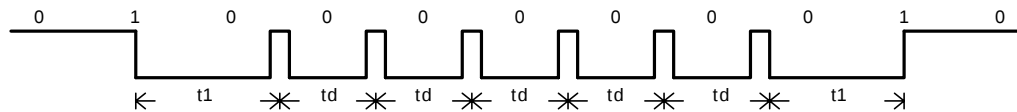


Figure 5.1.7 Pattern ..01000000010..

Figure 5.1 Write Waveforms and Equalization

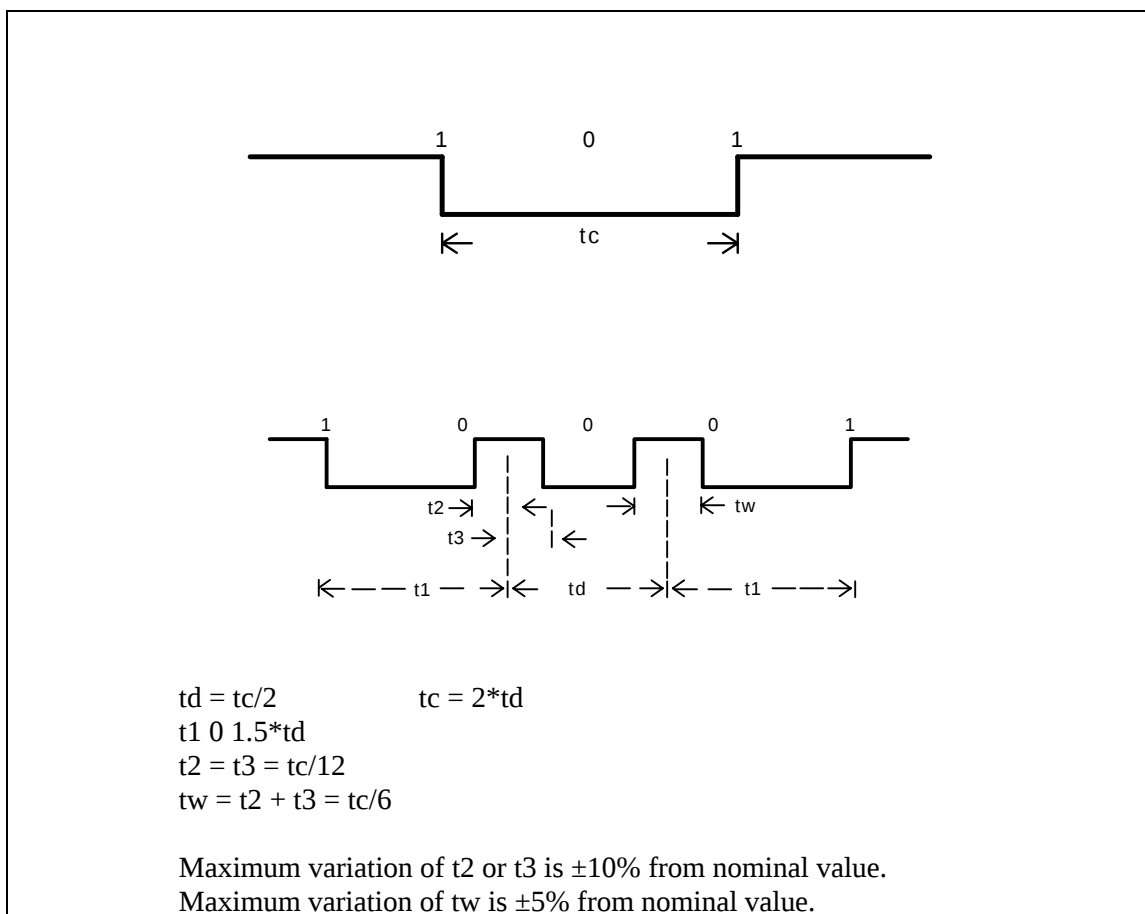


Figure 5.2 Timing Information, Write Equalization

## 5.4. Transition Densities

The nominal maximum transition density shall be 50,800 ftpi (2000 ftpmm). The nominal transition cell length shall be 21.4 micro-inches (0.545  $\mu\text{m}$ ).

With the recording method used in this Standard, seven transition densities may occur on the tape:

50,800 ftpi ( 2000 ftpmm)

33,866 ftpi ( 1333 ftpmm)

25,400 ftpi ( 1000 ftpmm)

20,320 ftpi ( 800 ftpmm)

16,934 ftpi ( 667 ftpmm)

14,514 ftpi ( 571 ftpmm)

12,700 ftpi ( 500 ftpmm)

## 5.5. Average Transition Cell Length Variations

---

### 5.5.1. 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.

### 5.5.2. Long Term Average Transition Cell Length

---

The long term average transition cell length is the average bit cell length taken over a minimum of 2,000,000 transition cells. The long term average transition cell length shall be within +/- 3% of the nominal bit cell length of 13.3 μinch (0.339 μm).

### 5.5.3. Medium Term Average Transition Cell Length

---

The medium term average transition cell length is the average transition 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.

### 5.5.4. 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 +/- 2% of the medium term average transition cell length.

### 5.5.5. 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:

$$\text{Rate of Change: } \left| \frac{5(T_1 - T_2)}{4 T_3} \right|$$

Where  $T_1$ ,  $T_2$  and  $T_3$  are the times between flux transitions as shown in figure 5.3. Periods 1 through 5 are contiguous and represent the repetitive encoding pattern 101010 within a data block or in the preamble, and frequency variations are less than 20 kHz.

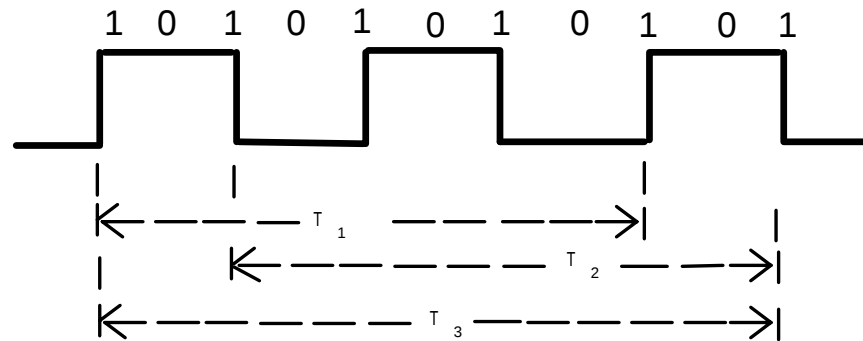


Figure 5.3 Rate of Change Test Pattern

### 5.5.6. 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 ..010101000000010101.., the center flux transition of each group of 010101's is called a reference flux transition. The maximum displacement of flux transitions on either side of the reference flux transitions shall not exceed  $\pm 12.5\%$  of the transition cell length  $d1$  averaged over the six transition cells between the reference flux transitions indicated in the bit pattern in figure 5.4.

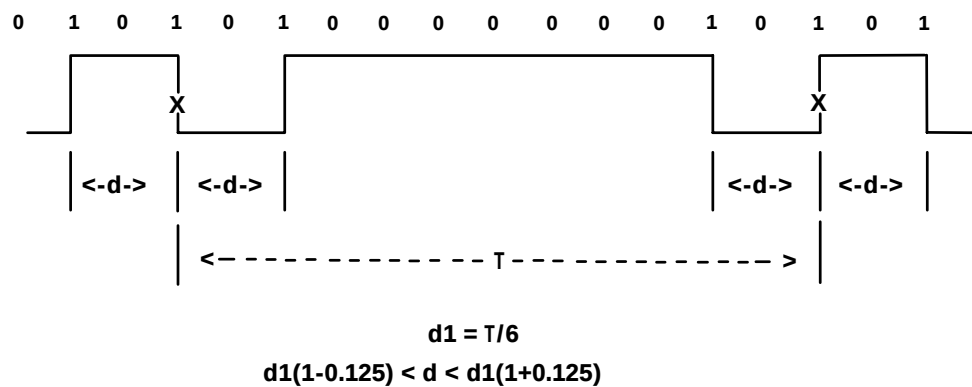


Figure 5.4 Test Pattern for Instantaneous Flux Transition Spacing Test. X denotes a reference flux transition.

## **5.6. 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 specified in 5.5.1 through 5.5.3 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:

### **5.6.1. Average Signal Amplitude at Nominal Maximum Density**

---

At the nominal maximum physical recording density of 50 800 ftpi (2000 ftpmm), the Average Peak-to-Peak Signal Amplitude of any track on the interchange tape shall deviate no more than + 25% or - 25% from the Standard Reference Amplitude recorded at 50 800 ftpi(2000 ftpmm). This averaging shall be made over the central 60 flux transitions of any 64 or more flux transitions recorded at nominal maximum recording density in a block and over at least 600 blocks.

### **5.6.2. 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 twice the Standard Reference Amplitude at 50 800 ftpi (2000 ftpmm).

### **5.6.3. 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 30% of the Standard Reference Amplitude at 50 800 ftpi (2000 ftpmm).

## **5.7. Recorded Azimuth**

---

On any track the angle that a flux transition across the track makes with a line perpendicular to the cartridge reference plane shall not exceed 20 minutes of arc (5.8 mrad).

## **5.8. Overwrite**

---

Overwritten tracks shall not contain any components of previously recorded information whose amplitudes exceed -28 dB relative to the amplitude of the newly recorded data except when an append operation begins between two previously recorded "normal" frames.

## **6. USE OF TRACKS**

---

### **6.1. Data Tracks**

---

Data Tracks may be written two at a time in parallel or one at a time ( ref. Section 4.7 ).

### **6.2. Track Numbering**

---

All even numbered track sets shall be recorded in the forward direction (the direction from the BOT marker to the EOT marker). All odd numbered track sets shall be recorded in the reverse direction (the direction from the EOT marker to the BOT marker).

### **6.3. Track ID**

---

The Track ID is a prerecorded field at the beginning of each track required to verify correct track position of the head actuator prior to writing a data track. The Track ID consists of 64 consecutive recordings of the Track ID block, followed by an Elongated postamble. See QIC-CRF1 for details.

### **6.4. Minimum/Maximum Distances Even Track Sets**

---

On all even numbered track sets (0, 2, ... etc.) the beginning of the preamble of the first Track ID block shall commence a minimum distance of 3 inches (76 mm) and a maximum distance of 4 inches (101 mm) past the LP marker.

When the EW marker is passed, writing may continue up to a point maximum 4 inches (101 mm) in after the EW marker .

### **6.5. Minimum/Maximum Distances Odd Track Sets**

---

On all odd numbered track sets (1, 3, ... etc.) the beginning of the preamble of the first Track ID block (or frame) shall commence a minimum distance of 3 inches (76 mm) and a maximum distance of 4 inches (101 mm) past the EW marker.

When the LP marker is passed, writing may continue up to a point maximum 4 inches (101 mm) after LP marker .

## 6.6. Media Header Position

The Media Header frames are written repeatedly following the Track ID blocks at the beginning of Track Set 0, until the "Media Header End Position" is reached. At this position the high frequency Media Header Postamble follows. The Media Header Postamble is written either to the "Start Partition 0 Position" if writing shall continue, or to the "Media Header Update Position" if only the Media Header should be updated (see Figures 6.1 and 6.2).

The Media Header End Position, Start Partition 0 Position and the Media Header Update Position are:

|                                    |                         |
|------------------------------------|-------------------------|
| Media Header End Position (MHE)    | 136 +/-3 inches from LP |
| Media Header Update Position (MHU) | 143 +/-3 inches from LP |
| Start Partition 0 Position (SP0)   | 150 +/-3 inches from LP |

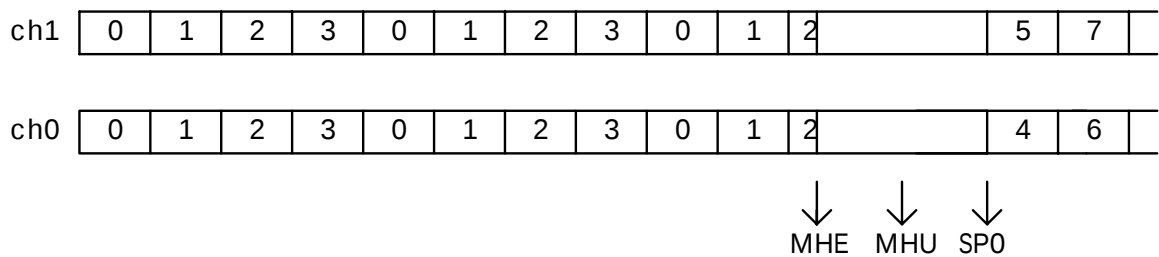


Figure 6.1: Media Header Frames and essential physical positions for dual channel format.

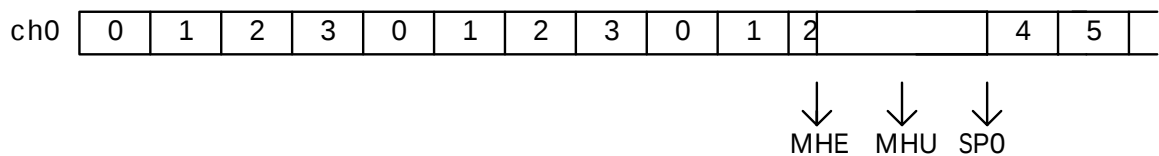


Figure 6.2: Media Header Frames and essential physical positions for single channel format

## 6.7. Tape Slope Considerations

---

Both 3 bump (R-W-R) and 2 bump (WR-RW) heads may be used. To minimize problems when using 3 bump heads, due to tape slope error in the cartridge and offset error between the center lines of the read and the write gap in the head, recording drives should use both read heads to servo, thus effectively centering the write head on the track. When reading, the servo head in the same gap line as the active read heads should be used.

## 6.8. Servo Limitations

---

Due to chock or dropouts in the servo bands it may not be possible to position the head within the tolerances. The QIC-CRF1 standard describes how this should be handled when reading or writing. The maximum legal length of such a servo loss is the Max Servo Dropout Distance.

For this format Max Servo Dropout Distance is set to TBD inches (60 ? ).

## 6.9. Summary Of Requirements

---

TBD - Physical start and length of both servo and data tracks.

*Figure 6.3 TBD*

## 6.10. QIC 5010 Media Header Data

---

Most Media Header Parameters are described in the CRF1 Development Standard. The following format dependent parameters should be set to the values listed below:

| Field                                | Single Ch. Mode  | Dual Ch Mode     |
|--------------------------------------|------------------|------------------|
| Format ID                            | QIC-5010 (ASCII) | QIC-5010 (ASCII) |
| Recording Format Revision (QIC 5010) | A (ASCII)        | A (ASCII)        |
| Frame Format Revision (CRF1)         | I (ASCII) *      | I (ASCII) *      |
| Number of partitions                 | 1-72             | 1-36             |
| No Of Channels:                      | 1                | 2                |
| Start Of Partition Table             | 20               | 20               |
| Start Of Track Table                 | 1042             | 538              |
| Start Of RAT Table                   | 1906             | 970              |
| Partition Table Entry Size           | 14               | 14               |
| Track Table Entry Size               | 6                | 6                |
| Random Access Table Entry Size       | 10               | 10               |
| Track Table Size                     | 17               | 35               |
| Random Access Table Distance         | 4000 (hex)       | 4000 (hex)       |

\* Revision of CRF1 may be higher than indicated.

## 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. DATA RANDOMIZING AND ENCODING

---

Prior to the recording of the data on the tape, the coded characters (see section 7) shall be modified by a special data randomizer circuit (see section 8.1). The randomized information shall then be encoded according to section 8.2 before being recorded on the tape.

Except when otherwise indicated in the description of the tape format, all bytes to be recorded shall be randomized and encoded as described in 8.1 and 8.2.

### 8.1. Data Randomizer

---

In order to reduce problems due to long strings of repetitive data with bad peak shift or amplitude characteristics, a special data randomizer algorithm shall be used on all bytes in the data and control area of each block. This data randomizing process shall take place before the data is encoded according to section 8.2.

Assuming that the data contents is converted into a serial stream prior to being encoded, the data stream shall be "randomized" using the following generator polynomial:

$$g(x) = x^{12} + x^6 + x^4 + x + 1$$

Figure 8.1 shows one method to achieve this randomizer algorithm. It consists of 12 flip-flops (marked x0 to x11) organized into a twelve bit shift register. Exclusive - or gates are inserted in the data stream between register 0 and 1, between 3 and 4 and between 5 and 6. The other inputs to the exclusive-or gates are taken from the output of shift register 11. The serial data stream to be randomized (or "de-randomized" in the case of a read operation) is exclusive-or'ed with the output of register 0.

The randomizer starts with the most significant bit of byte 7 in the Control area and ends up with the least significant bit of byte 511 in the data area.

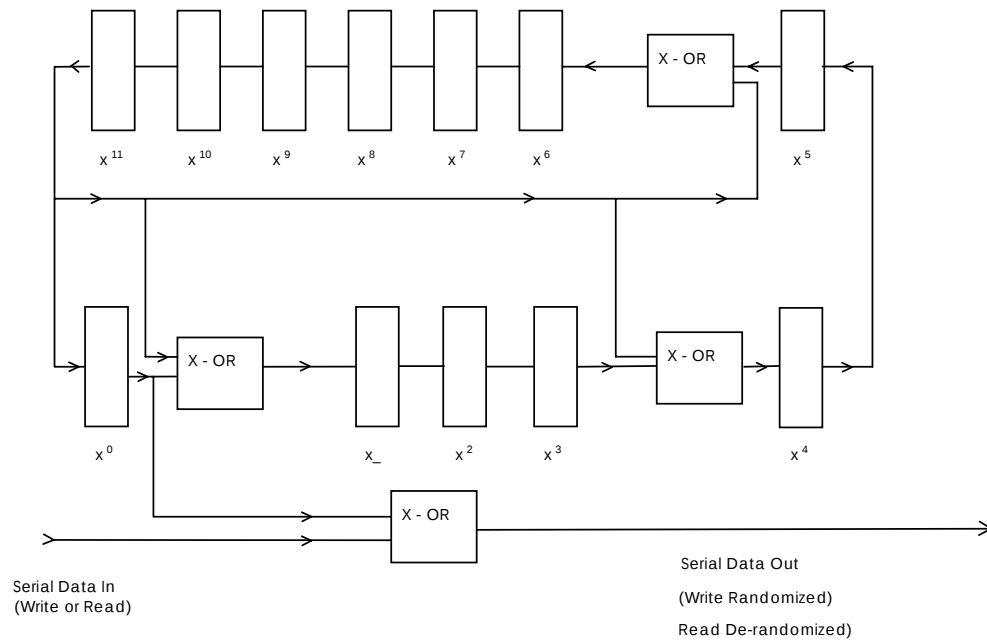


Figure 8.1 Randomizer Circuit

For every data block all 12 bits in the generator shall be set to 1 prior to the randomizer operation.

Note that it is only the data in the 512 bytes data area and the control field that are "randomized" prior to encoding and writing. Preambles, postambles, block markers and CRC bytes shall not be randomized.

### 8.1.1. Preamble

---

The preamble consists of either the fixed Normal Preamble pattern `..010 101 010..` or a combination of the fixed 2-byte Low Frequency Preamble pattern `..010 000 000 100 000 001 000 000 ..` with the fixed Normal pattern. See table 8.2.

The decoding system must be able to distinguish between a preamble and any possible combinations of data patterns.

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

A Normal Preamble shall contain a minimum of 13 and a maximum of 30 bytes of the normal preamble pattern (`..010 101 010 101..`) as described in table 8.2. This preamble shall be recorded at the beginning of every block. It may be preceded by other types of preambles, depending upon the type of block or frame being recorded.

To achieve maximum capacity, it is recommended to use the minimum length of 13 bytes whenever possible.

The Normal Preamble (`..010 101 010..`) 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. The Normal Preamble may be recorded as the only preamble at the beginning of a block or in a combination with other types of preambles.

An Elongated Preamble consists of between 1400 and 1600 recordings of the 2-byte Low Frequency Preamble pattern (`.. 010 000 000 100 000 001 000 000 ..`). It is not recorded alone, but will always be followed by a Normal Preamble. The transition between the Elongated Preamble and the following preamble shall be continuous without any erased or destroyed gaps.

This elongated preamble shall be recorded at the beginning of the first block in a frame which is appended to already existing data on a track, and at the beginning of the first block in a frame after an underrun situation.

The Long Preamble shall contain a minimum of 2400 and a maximum of 3600 recordings of the 2-byte Low Frequency Preamble pattern (`.. 010 000 000 100 000 001 000 000 ..`). It is not recorded alone, but always followed by a Normal Preamble. This preamble shall be recorded at the beginning of the first block on every track, even if this is in the middle of a fixed frame.

### 8.1.2. Block Marker

---

The Block Marker marks the start of a new frame or block. It contains 24 encoded bits : `010 101 010 000 000 100 000 010`, immediately following the Normal Preamble pattern.

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

### 8.1.3. Postamble

The postamble consists of either the fixed Normal Postamble pattern `..010 101 010 101..` or a combination of this pattern with the Low Frequency Postamble pattern `..010 000 000 100 000 001 000 000 ...` See table 8.2.

The decoding system must be able to distinguish between a postamble and any possible combinations of data patterns.

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

There are two different types of postambles, NORMAL and ELONGATED.

A Normal Postamble shall contain a minimum of 1 and a maximum of 2 bytes of the Normal Postamble pattern (`..010 101 010 101..`) as described in table 8.2. This postamble shall always be recorded at the end of each block. It may be followed by either an Elongated Postamble, or it may be followed by a new preamble.

To achieve maximum capacity, it is recommended to use the minimum length of 1 byte whenever possible.

After writing this postamble, the following preamble or postamble shall be recorded so that there is no phase shift error or transition glitches between the end of the postamble and the beginning of the next preamble/postamble.

An Elongated Postamble consists of between 6600 and 7200 recordings of the 2-byte Low Frequency Preamble pattern (`.. 010 000 000 100 000 001 000 000 ..`). This Elongated Postamble will always follow a Normal Postamble.

The Elongated Postamble shall be recorded at the end of every write operation, or at the end of each track as described in Common Recording Format Standard.:

The Media Header Postamble (`..010 101 010..`) shall be written following the Media Header to either the Media Header Update Position, or to the Start Partition 0 Position See section 6.5

Table 8.1 shows a summary of the use of preambles and postambles for different types of recording situations.

| Recording Type                        | Preamble           | Postamble          |
|---------------------------------------|--------------------|--------------------|
| Normal data block in a fixed frame    | Normal             | Normal             |
| Underrun or write termination         | Normal             | Normal             |
| Append operation + first block in EOD | Elongated + Normal | Normal             |
| First block on a track                | Long + Normal      | Normal             |
| Last block on a track                 | Normal             | Normal + Elongated |
| Media Header Area                     | Normal             | Media Header       |

*Table 8.1 Summary of Preambles/Postambles Recordings*

## 8.2. Data Encoding

Prior to the recording of the data on the tape, the randomized data and control information (plus the non-randomized CRC-bytes) shall be transformed into an encoded bit pattern according to table 8.2 (RLL 1,7 encoding).

For each byte, the most significant two (four) bits shall be encoded first, then the next two (four) and so on.

The most significant data bit is always to the left in table 8.2. The most significant encoded bit is also to the left in the table. When recording, the most significant encoded bit in each byte is recorded first. X denotes an encoded bit which is ONE if the preceding encoded bit was a ZERO, but ZERO if the preceding encoded bit was a ONE.

This encoding method will give a minimum of one "0" and a maximum of seven "0" 's between two ONE's.

| Data Bits                                  | Encoded Bits                          |
|--------------------------------------------|---------------------------------------|
| 01                                         | → X00                                 |
| 10                                         | → 010                                 |
| 11                                         | → X01                                 |
| 0001                                       | → X00 001                             |
| 0010                                       | → X00 000                             |
| 0011                                       | → 010 001                             |
| 0000                                       | → 010 000                             |
| <b>Special Patterns:</b>                   |                                       |
| 1110 1110 (EE hex)                         | → 010 000 001 001 ...                 |
| 1011 1011 (BB hex)                         | → 010 000 001 010 ...                 |
| Normal Preamble, 1 byte repeating          | → 010 101 010 101 ...                 |
| Normal Postamble, 1 byte repeating         | → 010 101 010 101 ...                 |
| Low Frequency Preamble, 2 bytes repeating  | → 010 000 000 100 000 001 000 000 ... |
| Low Frequency Postamble, 2 bytes repeating | → 010 000 000 100 000 001 000 000 ... |

Table 8.2 Encoding table, RLL 1,7 code

### Examples:

| Data pattern |           | Encoded pattern |               |
|--------------|-----------|-----------------|---------------|
| Byte 1       | Byte 2    | Byte 1          | Byte 2        |
| <----->      | <----->   | <----->         | <----->       |
| 0011 0111    | 0010 0001 | → 010001 000101 | 000000 100001 |
| 1000 0000    | 0001 1111 | → 010010 000010 | 000100 101001 |
| 1011 1011    | 1011 1111 | → 010000 001010 | 010101 001001 |
| 1011 1011    | 1011 1001 | → 010100 010000 | 001010 010100 |
| 1110 1011    | 1110 1011 | → X01010 010101 | 001010 010101 |
| 1111 1011    | 1011 1101 | → X01010 000001 | 001001 001000 |

Table 8.2 lists two exceptions to the general encoding rules. Data bit pattern 11101110 (EE hex) and 10111011 (BB hex) shall be encoded following the rules for special patterns. Note that this is not byte related, but should be treated as sliding encoding in steps of two or four bits. Also note that these special patterns are only used for 11101110 (EE hex) and 10111011 (BB hex) respectively. Other patterns, like 11101111 (EF hex) or 10111010 (BA hex) patterns are encoded in the normal way, using the standard Table.

If the two last bits of the last CRC byte ends with 00, two additional bits, 01, shall be added to the 00 bits before encoding. The encoded pattern is then followed by the Normal Postamble as usual.

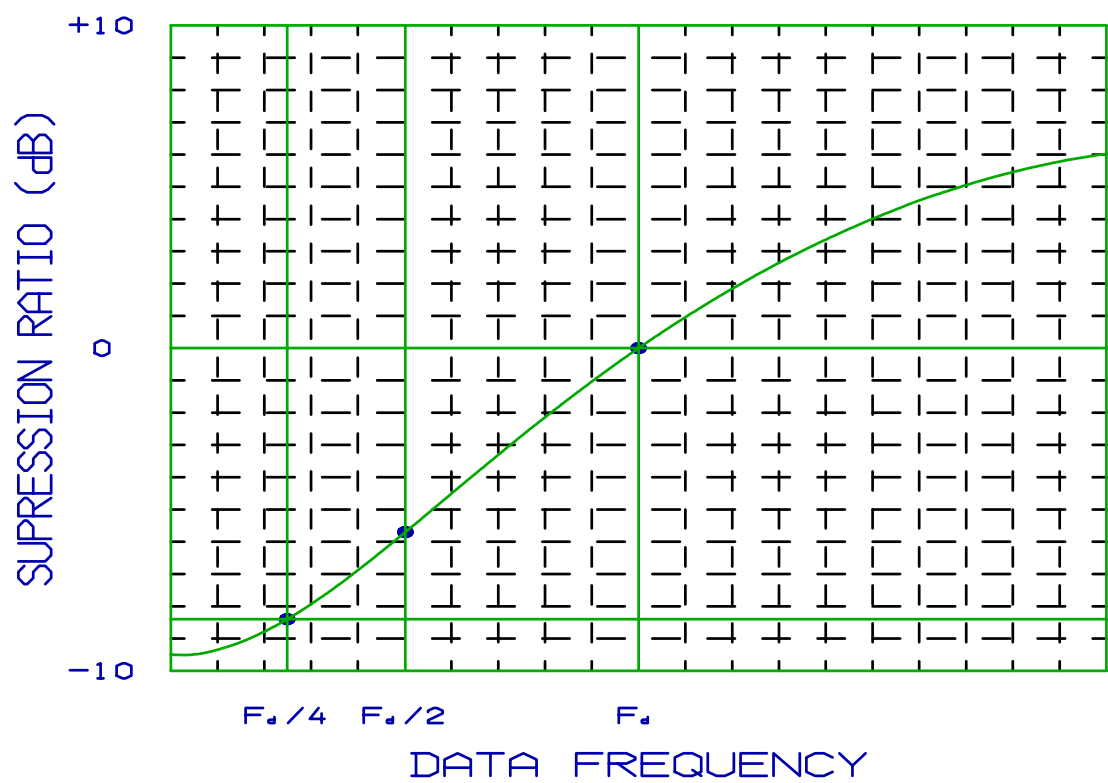
### Example:

|               |                   |            |
|---------------|-------------------|------------|
| Last CRC Byte | Encoded CRC       | Postamble  |
| .. 1001 1100  | 010100 101000 001 | 0101010101 |
|               | ---  Extra bits   |            |

APPENDICES

APPENDIX A.

Write Equalization Suppression Characteristics



| Data Frequency | Suppression |
|----------------|-------------|
| $F_d$          | 0dB         |
| $F_d/2$        | 5.7dB       |
| $F_d/4$        | 8.4dB       |