DEVELOPMENT STANDARD

QIC-3020-MC
Revision H
20 Mar 96

SERIAL RECORDED MAGNETIC TAPE MINICARTRIDGE FOR INFORMATION INTERCHANGE

Streaming Mode
40 Tracks with 0.250 in. (6.35 mm) Tape
50 Tracks with 0.315 in. (8.0 mm) Tape
Data Density: 44,250 bpi (1,742 bpmm)
MFM Encoded

Uncompressed Formatted Capacity (with 0.250 in. Tape):
680 Mbytes (with 400-foot 900 Oe Minicartridge)
1.7 Gbytes (with 1,000-foot 900 Oe Minicartridge)

Uncompressed Formatted Capacity (with 0.315 in. Tape):
833 Mbytes (with 400-foot 900 Oe Minicartridge)
1.6 Gbytes (with 750-foot 900 Oe Minicartridge)

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(See important notices on the following page)

Important Notices

Revision History

Revision B:

1. Elimination of section 8.1 that defined the need for backwards compliance with the Compression Map Segment. This can be eliminated because backwards compliance with QIC-40 and QIC-80 implies the ability to handle the Compression Map Segment.

2. Section 9 now references the QIC-113 specification for definition of the File Set Logical Format. This was done because the File Set Logical Format is identical for QIC-3010-MC, QIC-3020-MC and QIC-113. Centralization of this information ensures that this vital information is kept consistent.

3. Section 8 details those elements of the volume table entry that are required for QIC-3020-MC compliance.

4. Elimination of the Appendix that described the File Set Directory layout. This is covered by QIC-113.

5. Section 7.2 describes a method for marking all sectors in a given segment as bad.

6. Section 7.2.1 describes how regions of the tape at EOT and BOT should be mapped out so that the hole imprints do not affect error rates. In addition, references to 295 foot tapes were all changed to 300 feet so that the capacity lost due to the hole imprints can be regained.

Revision C:

7. The raw error rate spec was changed to correspond to the stated corrected error rate in section 1.0.

8. The overwrite spec was changed from -30db to -25db in section 3.17.

9. The use of perpindicular mode was clarified during read and write operations in section 5.3.3.

10. The number of tracks mapped out for hole imprints was expanded in section 7.2.1.

Revision D:

11. Include provisions for wide tape (.315 inch or 8mm) allowing for 50 tracks.

Revisionn E:

12. Correct track table in figure 4.1.1.1 for reference burst measurements.

13. Update hole imprint information in Section 7.2.1 for wide tape (.315 inch or 8mm).

Revision F:

14. Addition of 750 foot and 1000 foot cartridge support.

15. Section 8.2, addition of unicode tape name within the volume table.

16. Section 8.3, addition of volume table overflow extension.

Revision G:

17. Addition of 1000 foot, .315” cartridge support.

Revision H:

18. Add format defect, format markout, and grown defect to Definitions section.

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1. SCOPE AND INTRODUCTION

1.1 SCOPE

This standard describes 1) a 680 Megabyte (uncompressed), 40 Track, 44,250 bpi (1,742 bpmm) MFM Encoded,Flexible Disk Controller Compatible Recording Format using a 400 foot 900 Oe, 1/4" (6.35 mm) Mini Data Cartridge Tape or 2) a 833 Megabyte (uncompressed), 50 Track, 44,250 bpi (1,742 bpmm), MFM Encoded, Flexible Disk Controller Compatible Recording Format using a 400 foot 900 Oe, .315 inches (8mm) Mini Data Cartridge Tape or 3) a 1700 Megabyte (uncompressed), 40 Track, 44,250 bpi (1,742 bpmm), MFM Encoded, Flexible Disk Controller Compatible Recording Format using a 1000 foot 900 Oe, 1/4” (6.35mm) Mini Data Cartridge Tape or 4) 1561 Megabyte (uncompressed), 50 Track, 44,250 bpi (1,742 bpmm), MFM Encoded, Flexible Disk Controller Compatible Recording Format using a 750 foot 900 Oe, .315 (8mm) Mini Data Cartridge Tape or 5) 2060 Megabyte (uncompressed), 50 Track, 44,250 bpi (1,742 bpmm), MFM Encoded, Flexible Disk Controller Compatible Recording Format using a 1000 foot 900 Oe, .315 (8mm) Mini Data Cartridge Tape. The standard uses a Reed Solomon error correction code to achieve a corrected error rate of

$$1 \text{ error in } 10^{14} \text{ bits}$$

or less given a raw event error rate of 6.2×10^{-8} bits as provided by requirements in Section 6.1. This format and recording standard for the 0.250 in (6.35 mm) wide or .315 in (8mm) wide magnetic tape cartridge is to be used for information interchange among information processing systems, communications systems and associated equipment. Compliance with the standard for the unrecorded magnetic tape cartridge (ref. ANSI X3B5/85-135, QIC-143, QIC- 144, QIC-148, QIC-162, QIC-165 or QIC-166) is a requirement for information interchange.

1.2 INTRODUCTION

This standard defines the requirements and 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 performance levels contained in this standard represent the minimum acceptable levels of performance for interchange purposes. 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 as substitutes for purchase specifications.

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.

U.S. engineering units are the original dimensions in this standard. Conversions of toleranced dimensions from customary U.S. engineering units (similar to British Imperial Units) to SI units have been done in this standard according to ANSI Z210.1-1976 and ISO 370 Method A, except as noted. 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 in the second preceding paragraph, interchange parties complying with the applicable standards should be able to achieve compatibility without need for additional exchange of technical information.

2. DEFINITIONS

azimuth -	the angular deviation, in minutes of arc, of the mean flux transition line from the line normal to the cartridge reference plane.
BOT -	beginning of tape marker indicating beginning of tape.
bit -	a single digit in the binary number system.
bit cell -	a length of magnetic recording tape within which a flux transistion written at the center signifies a "one" bit and the absence signifies a "zero" bit.
block -	a group of 1024 consecutive bytes transerred as a unit.
byte -	a group of 8 binary bits operated on as a unit.
cartridge -	a 2.406 x 3.188 in (61.11 x 80.98 mm) or a cartridge enclosure 5.00 x 3.188 inches (127 mm x 80.98 mm) width 0.250 inch or 0.315 inch (8 mm) wide magnetic tape wound on two coplanar hubs and driven by an internal belt which is coupled by an internal belt capstan to the external drive (ref. ANSI X3B5/85-135).
cyclical redundancy check -	a two byte code drived from information contained in a data block or ID block used for read check.
cyclical redundancy check failure -	a data error in a sector not detected by the cyclical redundancy check.
data segment -	a segment containing directory and/or file information.
density -	the maximum allowable flux transitions per unit length for a specific recording standard.
early warning -	marker on tape indicating the end of the permissible recording area for even numbered tracks and indicating the start of the permissible recording area for odd numbered tracks.
ECC -	error correction code.
EOT -	end of tape marker indicating the end of tape.
erase -	to remove all magnetically recorded information from the tape.
file -	a logical unit of information.

file set -	a group of files and their directories.
flux transition -	a point on the magnetic tape which exhibits maximum free space flux density normal to the tape surface.
flux transition spacing -	the distance on the magnetic tape between flux reversals.
format defect -	a sector that is reported as unreadable by the floppy disk controller due to an error in either the data or header region of a sector. Format defects are identified during the certification process verify pass. For reliability purposes, a format defect may result in more than a single format markout. Examples: (1) If a high number of format defects are detected in a single segment, the entire segment may be marked out. (2) If a format defect exists in the sector header, all subsequent sectors in the segment may be chosen for format markouts.
format markout -	a sector that has been marked as unusable in the bad sector map in the tape header. Format markouts are generated as a result of format defects or hole imprints.
grown defect -	a defect which occurs after a tape is formatted. The cause of the defect can be due to interchange, environment, aging, or other factors.
load point -	marker on tape indicating the start of the permissible recording area for even numbered tracks and indicating the end of the permissible recording area for odd numbered tracks.
logical format -	a directory and file structure suitable for information storage and retrieval.
MFM encoding -	a method of encoding data for magnetic recording in which a "one" is represented by a flux transition in the bit cell center and a "zero" by no flux transition. A clock flux transition is written at the end of a bit cell containing a "zero" if the "zero" is followed by a "zero".
magnetic tape -	an oxide coated polyethylene tenthalated base tape capable of accepting and retaining magnetically recorded information.
postamble -	guard information recorded after the data block.
preamble -	synchronization information recorded before the data bloce or ID block.
RS -	refers to Reed Solomon, a method of error correction.
recorded block -	a group of consecutive bits comprising preamble, data address mark, data block. CRC and postamble.
re-direction -	restoration of a file or sub-directory to a directory other than from where it orginated.
reference tape cartridge -	a magnetic tape cartridge selected for a specific property to be used as a

reference.

sector - same as block.

segment - a group of 32 blocks operated on as a unit.

segment number - an integer from 0 to the total number of formatted segments minus one, indicating a specific physical track and segment position.

sync - same as preamble.

streaming - a method of recording on magnetic tape where the tape is continuously moving and data blocks are continuously recorded.

track - a recording strip parallel to the edge of the magnetic tape contaioning recorded information.

underrun - a condition developed when host transmits or receives data at a rate less than that required by the device for streaming operation.

volume table segment - a segment containing the names and storage positions of all file sets placed upon the cartridge.

3. RECORDING

3.1 METHOD

The method of recording shall be Modified Frequency Modulation (MFM) where a "one" (1) is represented by a flux transition in the middle of the bit cell and a "zero" (0) is represented by the absence of flux transition. A clock flux transition is written at the end of a bit cell containing a "zero" followed by a "zero".

3.2 CODE

The code for recording shall consist of an eight (8) bit byte recorded in a bit serial manner, where each bit cell corresponds to a binary digit. The most significant bit of the byte shall be recorded first.

3.3 RECORDING MEDIA

Recorded data for interchange shall be recorded on a 0.25 inch (6.35 mm) or 0.315 inch (8 mm) Mini Data Cartridge with enclosure characteristics conforming to ANSI X3B5/85-135. The media itself shall be 900 Oe and 300 feet in length to 1,100 feet in length.

3.4 TAPE SPEED

The linear speed of the media across the magnetic recording head in the intended application is 22.6 inches (574.04 mm) per second at a 1Mbs transfer rate. Other speeds and compatible transfer rates are possible. Long term speed variation shall be a maximum of:

cartridge	± 1.3
drive	± 1.7%
total product	± 3.0%

Short term speed variation, variations in speed from the long term speed for frequencies of 0 to 1000 Hz, shall be a maximum of

cartridge	± 4.0%
drive	± 2.0%
total product	± 6.1%

3.5 NOMINAL DENSITY

The maximum nominal recording density shall be 44,250 bits per inch (bpi) or 1742 bits per millimeter (bpmm).

3.6 NOMINAL BIT CELL LENGTH

The nominal bit-cell length shall be 22.6 microinches (.574 micrometers).

3.7 AVERAGE BIT CELL LENGTH

The average bit-cell length is the sum of the distances over N bit-cells divided by N.

Any continuously recorded MFM pattern may be used to measure the average bit-cell length.

3.8 LONG TERM AVERAGE BIT CELL LENGTH

The long term average bit-cell length is the average bit-cell length taken over a minimum of 3,000,000 bit-cells.

The long term average bit-cell length shall be within ± 3.0 % of the nominal bit-cell length of 22.6 microinches (.574 micrometers).

3.9 MEDIUM TERM AVERAGE BIT CELL LENGTH

The medium term average bit-cell length is the average bit-cell length taken over a minimum of 36,000 and a maximum of 40,000 bits.

The medium term average bit-cell length shall be within ± 6.1% of the long term average bit-cell length.

3.10 SHORT TERM AVERAGE BIT CELL LENGTH

The short term average bit-cell length is the average bit-cell length taken over 68 bit-cells.

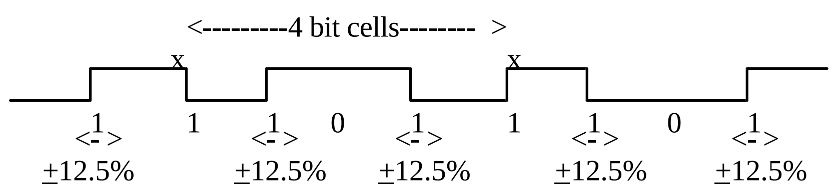
The short term average bit-cell length shall be within ± 2.0% of the medium term average bit-cell length.

3.11 INSTANTANEOUS FLUX TRANSITION SPACING

The instantaneous spacing between flux transitions is influenced by the reading and writing processes, the pattern recorded (pulse-crowding effect) and other factors.

Instantaneous spacings between flux transitions shall satisfy the following conditions.

In a sequence of flux transitions defined by the repetitive flux transition pattern 11101110, the center flux transition of each group of "ones" is called a reference flux transition. The maximum displacement of flux transitions on either side of the reference flux transitions shall not exceed ± 12.5% of the bit cell length averaged over the four bit cells between the reference flux transitions indicated in Figure below.



Note - x indicates reference flux transition

Figure 3.1- Flux Transition Spacing

3.12 SIGNAL AMPLITUDE REFERENCE TAPE CARTRIDGE

A signal amplitude reference tape cartridge is a magnetic tape cartridge selected as a standard for signal amplitude when recorded at 44,250 ftpi (1742 ftpmm).

3.13 MEASUREMENT OF SIGNAL AMPLITUDE

The signal amplitude shall be measured at a point in the read channel where the signal is proportional to the rate of change of voltage from the read head.

3.14 AVERAGE STANDARD REFERENCE AMPLITUDE

The average standard reference amplitude is the peak-to- peak output signal read from the Signal Amplitude Reference Tape Cartridge averaged over a minimum of 40,000 bit-cells.

3.15 AVERAGE SIGNAL AMPLITUDE

The average peak-to-peak signal amplitude of a tape cartridge recorded at 44,250 bpi shall deviate no more than ± 25% from the average standard reference amplitude. Averaging shall be done over a minimum of 40,000 bit-cells.

3.16 SIGNAL DECAY

Signal decay is a measurement of loss in signal amplitude of a recorded tape due to cycling a tape in contact. The tape under test is cycled from BOT to EOT to BOT 55 times. The loss in amplitude from the 5th pass to the 55 pass shall not exceed 15%.

3.17 OVERWRITE AND ERASURE

The overwritten or erased area shall not contain any component of previously recorded information whose amplitude exceeds -25db relative to the amplitude of the newly written data (reference section 3.15).

3.18 AZIMUTH

The angular deviation of the mean bit-cell transition line from a line normal to the magnetic tape cartridge reference base shall be less than 10 minutes of arc.

3.19 WRITE EQUALIZATION METHOD

To minimize the amplitude variation of the recorded signal upon playback, due to the variations in transition spacing on the tape (2:1), some form of write pulse equalization shall be used. This section describes the preferred method of write equalization. Other methods of write equalization may be used provided that the recorded flux characteristics on the tape matches that of the preferred method. Regardless of the method, the recorded signal must also meet the other requirements specified in this section.
Recommended Method:

The width of the inserted pulse shall be 1/6 of the minimum nominal transition period (t_c). The position of the pulses are defined by t_1 and t_2 below. The position of the pulses has been optimized to compensate for phase distortion which occurs during the writing of the transitions. The optimal position is that which forces the shoulders of the low frequency signals to occur at the baseline of the recorded signal.

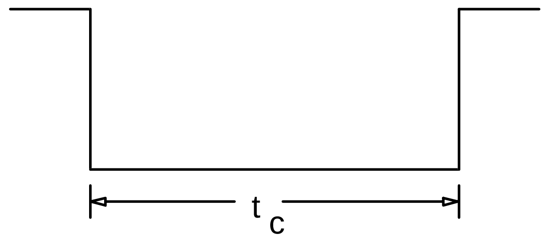


Figure 3.2 MFM Pattern ...0000... or ...1111...

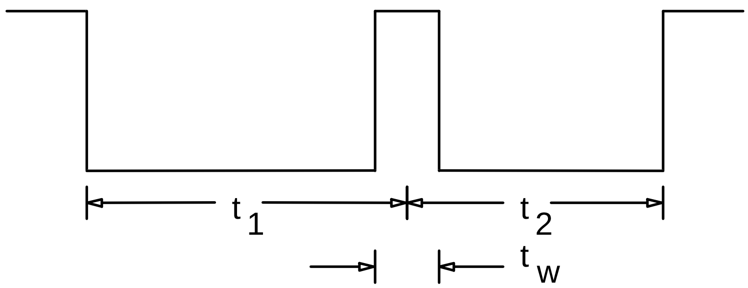


Figure 3.3 MFM Pattern ---100100...

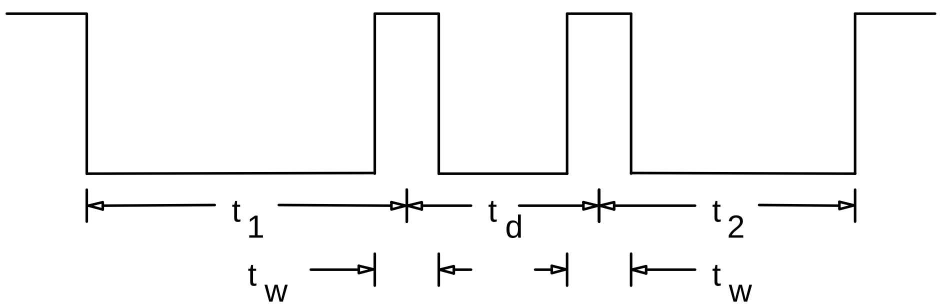


Figure 3.4 MFM Pattern ...10101010...

$t_1 = 0.8333*t_c \pm 10\%$

$t_2 = 0.6667*t_c \pm 10\%$

$t_d = 0.5000*t_c \pm 5\%$

$t_w = 0.1667*t_c \pm 5\%$

t1	The distance from the falling edge of the data transition to the center of the first inserted pulse.
t2	The distance from the center of the inserted pulse to the rising edge of the data transition.
td	The distance from the center of the first inserted pulse to the center of the second inserted pulse.
tw	The width of the inserted pulse.

3.19.1 MEASUREMENT OF THE WRITE EQUALIZATION METHOD

The suppression characteristic of the write equalization shall be verified by comparing the amplitude of the fundamentals of an unequalized 22,125 KFCI signal to an equalized 22,125 KFCI signal using an inductive read head. The suppression characteristic is represented by the following equation:

$$\text{Suppression} = 20 * \log \left((F/2 \text{ write equalized})/(F/2 \text{ unequalized}) \right)_{dB}$$

The suppression characteristics of the write equalization shall correspond to the table below, within $+0.5_{dB}$, -1.0_{dB}.

Fd	0_{dB}
Fd/2	-5.6_{dB} $+.5_{dB}$ - 1.5_{dB}

4. TRACKS

There shall be 40 parallel tracks on .250 in tape and 50 parallel Tracks on 8mm (.315 in) tape. Even tracks shall be recorded in the forward tape direction. Odd tracks shall be recorded in the reverse tape direction.

4.1 TRACK LOCATIONS (.250 in.)

4.1.1 TRACK CENTER LINES (.250 in.)

The track center line locations are shown in Figure below. Even tracks are relative to the center line of a forward reference burst. Odd tracks are relative to the center line of a reverse reference burst offset from the forward reference burst. Track distances above their reference burst are considered positive. Track distances below their reference burst are considered negative. All track position tolerances are ±.0011 inches (±0.0279 mm) relative to their respective positions.

	CL from CL of Reference		
	Track Number	inches	millimeters
	38	.054	1.3716
	36	.048	1.2192
	34	.042	1.0668
	32	.036	.9144
	30	.030	.7620
	28	.024	.6096
	26	.018	.4572
	24	.012	.3048
	22	.006	.1524
Fwd Ref Burst --->	20	.000	.0000
	18	-.006	-.1524
	16	-.012	-.3048
	14	-.018	-.4572
	12	-.024	-.6096
	10	-.030	-.7620
	08	-.036	-.9144
	06	-.042	-.1.0668
	04	-.048	-1.2192
	02	-.054	-1.3716
	00	-.060	-1.5240
	01	.060	1.5240
	03	.054	1.3716
	05	.048	1.2192
	07	.042	1.0668
	09	.036	.9144
	11	.030	.7620
	13	.024	.6096
	15	.018	.4572
	17	.012	.3048
	19	.006	.1524
Rev Ref Burst <---	21	.000	.0000
	23	-.006	-.1524
	25	-.012	-.3048
	27	-.018	-.4572
	29	-.024	-.6096
	31	-.030	-.7620
	33	-.036	-.9144
	35	-.042	-.1.0668
	37	-.048	-1.2192
	39	-.054	-1.3716

Figure 4.1 Track Locations (.250 in.)

4.1.2 FORWARD REFERENCE BURST LOCATION (.250 in.)

The forward reference burst center line shall be located 0.063 ± .0011 inch (1.6002 ± .0279 mm) above the tape center line and written at the BOT end of tape in the forward direction.

4.1.3 REVERSE REFERENCE BURST LOCATION (.250 in)

The reverse reference burst center line shall be located 0.127 ± .0011 inch (3.2258 + .0279 mm) below the forward reference burst center line and written at the BOT end of tape in the reverse direction.

4.2 TRACK LOCATIONS (8mm)

4.2.1 TRACK CENTER LINES (8mm)

The track center line locations are shown in Figure below. Even tracks are relative to the center line of a forward reference burst. Odd tracks are relative to the center line of a reverse reference burst offset from the forward reference burst. Track distances above their reference burst are considered positive. Track distances below their reference burst are considered negative. All track position tolerances are ±.0011 inches (±0.0279 mm) relative to their respective positions.

8mm QIC-3020 FORMAT

<table>
<tr><td></td><td></td><td colspan="2">C-L FROM C-L OF REF BURST</td></tr>
<tr><td></td><td>TRACK#</td><td>INCHES</td><td>mm</td></tr>
<tr><td></td><td>48</td><td>0.0720</td><td>1.829</td></tr>
<tr><td></td><td>46</td><td>0.0660</td><td>1.676</td></tr>
<tr><td></td><td>44</td><td>0.0600</td><td>1.524</td></tr>
<tr><td></td><td>42</td><td>0.0540</td><td>1.372</td></tr>
<tr><td></td><td>40</td><td>0.0480</td><td>1.219</td></tr>
<tr><td></td><td>38</td><td>0.0420</td><td>1.067</td></tr>
<tr><td></td><td>36</td><td>0.0360</td><td>0.914</td></tr>
<tr><td></td><td>34</td><td>0.0300</td><td>0.762</td></tr>
<tr><td></td><td>32</td><td>0.0240</td><td>0.610</td></tr>
<tr><td></td><td>30</td><td>0.0180</td><td>0.457</td></tr>
<tr><td></td><td>28</td><td>0.0120</td><td>0.305</td></tr>
<tr><td></td><td>26</td><td>0.0060</td><td>0.152</td></tr>
<tr><td>FWD REF BURST----></td><td>24</td><td>0.0000</td><td>0.000</td></tr>
<tr><td>|</td><td>22</td><td>-0.0060</td><td>-0.152</td></tr>
<tr><td>|</td><td>20</td><td>-0.0120</td><td>-0.305</td></tr>
<tr><td>|</td><td>18</td><td>-0.0180</td><td>-0.457</td></tr>
<tr><td>|</td><td>16</td><td>-0.0240</td><td>-0.610</td></tr>
<tr><td>|</td><td>14</td><td>-0.0300</td><td>-0.762</td></tr>
<tr><td>|</td><td>12</td><td>-0.0360</td><td>-0.914</td></tr>
<tr><td>|</td><td>10</td><td>-0.0420</td><td>-1.067</td></tr>
<tr><td>|</td><td>8</td><td>-0.0480</td><td>-1.219</td></tr>
<tr><td>|</td><td>6</td><td>-0.0540</td><td>-1.372</td></tr>
<tr><td>|</td><td>4</td><td>-0.0600</td><td>-1.524</td></tr>
<tr><td>|</td><td>2</td><td>-0.0660</td><td>-1.676</td></tr>
<tr><td>0.1510</td><td>0</td><td>-0.0720</td><td>-1.829</td></tr>
<tr><td>+/- 0.0011</td><td></td><td></td><td></td></tr>
<tr><td>|</td><td>1</td><td>0.0720</td><td>1.829</td></tr>
<tr><td>|</td><td>3</td><td>0.0660</td><td>1.676</td></tr>
<tr><td>|</td><td>5</td><td>0.0600</td><td>1.524</td></tr>
<tr><td>|</td><td>7</td><td>0.0540</td><td>1.372</td></tr>
<tr><td>|</td><td>9</td><td>0.0480</td><td>1.219</td></tr>
<tr><td>|</td><td>11</td><td>0.0420</td><td>1.067</td></tr>
<tr><td>|</td><td>13</td><td>0.0360</td><td>0.914</td></tr>
<tr><td>|</td><td>15</td><td>0.0300</td><td>0.762</td></tr>
<tr><td>|</td><td>17</td><td>0.0240</td><td>0.610</td></tr>
<tr><td>|</td><td>19</td><td>0.0180</td><td>0.457</td></tr>
<tr><td>|</td><td>21</td><td>0.0120</td><td>0.305</td></tr>
<tr><td>|</td><td>23</td><td>0.0060</td><td>0.152</td></tr>
<tr><td>REV REF BURST<-----</td><td>25</td><td>0.0000</td><td>0.000</td></tr>
<tr><td>|</td><td>27</td><td>-0.0060</td><td>-0.152</td></tr>
<tr><td>|</td><td>29</td><td>-0.0120</td><td>-0.305</td></tr>
<tr><td>|</td><td>31</td><td>-0.0180</td><td>-0.457</td></tr>
<tr><td>|</td><td>33</td><td>-0.0240</td><td>-0.610</td></tr>
<tr><td>|</td><td>35</td><td>-0.0300</td><td>-0.762</td></tr>
<tr><td>|</td><td>37</td><td>-0.0360</td><td>-0.914</td></tr>
<tr><td>0.0810</td><td>39</td><td>-0.0420</td><td>-1.067</td></tr>
<tr><td>+/- 0.0015</td><td>41</td><td>-0.0480</td><td>-1.219</td></tr>
<tr><td>|</td><td>43</td><td>-0.0540</td><td>-1.372</td></tr>
<tr><td>|</td><td>45</td><td>-0.0600</td><td>-1.524</td></tr>
<tr><td>|</td><td>47</td><td>-0.0660</td><td>-1.676</td></tr>
<tr><td>|</td><td>49</td><td>-0.0720</td><td>-1.829</td></tr>
<tr><td>|</td><td></td><td></td><td></td></tr>
<tr><td>LOWER TAPE EDGE</td><td colspan="3">---</td></tr>
</table>

Figure 4.2 Track Locations (8mm)

4.2.2 REVERSE REFERENCE BURST LOCATION (8mm)

The reverse reference burst center line shall be located 0.081 ± .0015 inch (2.0574 ± .0381 mm) above the bottom edge of tape and written at the BOT end of tape in the reverse direction.

4.2.3 FORWARD REFERENCE BURST LOCATION (8mm)

The forward reference burst center line shall be located 0.151 ± .0011 inch (3.8354 + .0279 mm) above the reverse reference burst center line and written at the BOT end of tape in the forward direction.

4.3 TRACK DIMENSIONS

4.3.1 NOMINAL TRACK SPACING

The nominal track spacing shall be 0.006 inch (.1524 mm) between even tracks and between odd tracks. The nominal track spacing between track 00 and track 01 shall be 0.007 inch (.1778 mm).

4.3.2 RECORDING HEAD

The recording head shall be the wide write channel narrow read channel core configuration. The recording heads read and write gaps shall be oriented such that the write gap follows the read gap on even tracks and conversely, the read gap follows the write gap on odd tracks.

The recording track dimensions are as follows:

	inches	**millimeters**
write track width	.006 ± .00008	.1524 ± .0020
read track width	.002 nominal	.0508

The read and write gap centerline alignment must be maintained within ± .00015 inch (.0038 mm).

5. TRACK FORMAT

The tape format consists of three (3) areas: reference burst, beginning gap and recording area.

5.1 REFERENCE BURST

Reference bursts shall be recorded and write equalized at 22,125 frpi between the innermost BOT hole and not more than two inches prior to the LP hole for a minimum distance of 22 in (558.8 mm).The remaining area between the BOT hole and the LP hole shall be completely erased, for all other tracks including between tracks, at format time. The recording format may be discerned from similar formats based on either the reference burst frequency or placement.

5.2 BEGINNING GAP

The beginning gap shall be a minimum of 0.34 in (8.64mm) and a maximum of 1.36 in (34.5 mm) of erased tape between LP and the recording area for even tape tracks. The beginning gap shall be a minimum of 1.5 in (38.1mm) and a maximum of 2.0 in (50.8 mm) between EW and the recording area for odd tape tracks. The area between EOT and EW on odd track locations shall also be erased.

5.3 RECORDING AREA

The recording area of a tape track consists of 429 segments, minimum for a 300 foot tape, separated from each other by 0.226 inches (5.740 mm) ± 9.3% of erased tape. Each segment contains 29 data sectors and 3 ECC sectors for a total of 32 sectors. Each tape track contains 13,504 sectors, minimum for a 300 foot tape. All tape tracks are formatted to the same number of segments and sectors for a given tape.

5.3.1 IDENTIFICATION OF SECTORS

Each sector on the tape shall be uniquely identified by 3 sector identification components: flexible diskside (FSD), flexible disk track (FTK) and flexible disk sector (FSC).

The following table shows the range for the FSD, FTK, FSC, LSN (logical sector number), SEG (logical tape segment), TPT (tape track) and TPS (tape segment relative to start of track).

1 <= FSC <= 128
0 <= FTK <= 254
0 <= FSD <= Variable based on tape length
(e.g. 16 for 300 foot tape with 429 segments/track minimum)

0 <= LSN <= Variable based on tape length
(e.g. 549,119 for 300 foot tape with 429 segments/track minimum)

0 <= SEG <= Variable based on tape length
(e.g. 17,159 for 300 foot tape with 429 segments/track minimum)

0 <= TPS <= Variable based on tape length
(e.g. 428 for 300 foot tape with 429 segments/track minimum)

0 <= TPT <= 39

The first sector on tape track 00 shall have the physical identification vector (FSD,FTK,FSC) = 0,0,1). The following table shows the various relationships between logical sector number (LSN), physical identification vector (FSD,FTK,FSC), logical segment (SEG), tape track (TPT) and segment relative to tape track (TPS).

LSN = 32640 x FSD + 128 x FTK + (FSC-1)
SEG = 1020 x FSD + 4 x FTK + int((FSC-1)/32)

FSD = SEG / 1020
FTK = (SEG mod 1020) / 4
FSC = (SEG mod 4) x 32 + 1

TPT = SEG / (Variable based on tape length)
(e.g. 429 for 300 foot tape based on 429 segments/track minimum)

TPS = (SEG mod (Variable based on tape length))
(e.g. 429 for 300 foot tape based on 429 segments/track minimum)

5.3.2 SEGMENT FORMATTING

Each segment is formatted as shown below.

# of bytes	hex value	description
SEGMENT HEADER		
80	4E	gap 4A
12	00	sync
3	C2 (note 1)	index addr mark
1	FC (note 2)	index addr mark
50	4E	gap 1
146		total for index

Repeat Below 32 times

# of bytes	hex value	description
TRACK SECTOR ID		
12	00	sync
3	A1 (note 3)	sector id addr mark
1	FE (note 4)	sector id addr mark
1	FTK	floppy track number
1	FSD	floppy side number
1	FSC	floppy sector number
1	03	1024 bytes/sector
2	CRC (note 5)	CRC for trk/sector id
41	4E	gap 2
DATA BLOCK		
12	00	sync
3	A1 (note 3)	data addr mark
1	FB (note 6)	data addr mark
1024	data	data block
2	CRC (note 7)	CRC for data block
SPEED TOLERANCE ± 9.3%		
233	4E	gap 3
DROP OUT GUARD .00272 in (.068885 MM)		
15	4E	gap 3
1353		total for sector

end of repeat

TIMER TOLERANCE ± 0.3%

# of bytes	hex value	description
281	4E	gap 4B (until index)
43,723		nominal total for floppy track segment

note 1 - each hex "C2" in the index address mark shall have a missing clock between bits 3 and 4

```
hex "C2"        1       1       0       0       0       0       1       0
MFM             |       |           |       |       |           |
MFM with        |       |           |               |           |
missing clock
```

hex "FC" completes the index address mark

note 2 - each hex "A1" in the sector address mark, data address mark or deleted
note 3 - data address mark shall have a missing clock between bits 4 and 5

```
hex "A1"        1       0       1       0       0       0       0       1
MFM             |               |           |       |       |           |
MFM with        |               |           |               |           |
missing clock
```

note 4 - hex "FE" completes the sector address mark

note 5 - CRC for the preceding eight (8) bytes generated by the polynomial

$$X^{16} + X^{12} + X^{5} + 1$$

with the accumulating register set to all ones prior to transfer

note 6 - hex "FB" completes the data address mark or a hex "F8" completes the deleted data address mark

note 7 - CRC for the preceding 1028 bytes generated by the polynomial and accumulating register condition defined in note 5

5.3.3 DELAY OF WRITE GATE

To eliminate the possibility of overwriting the track sector ID crc the write gate must be delayed by 8 bytes in the forward direction (even tracks). To accommodate this delay when writing, the floppy controller must be set into perpendicular mode. When reading, the floppy controller should not be in perpendicular mode.

5.4 FORMAT CONTROL

The track format defines recording areas for both even and odd tracks. A precision timer (xtal oscillator based) is required to define recording areas other than those defined by tape holes. Distances shown are converted to time by dividing by 22.6 ips.

5.4.1 VARIABLE FORMAT

Since this format accommodates variable length formatting the exact number of segments per track for a given tape length cannot be guaranteed. The speed variation specification and other format parameters does allow for calculating a minimum number of segments per track. The equation is:

Minimum segments = int(((Tape length * 0.97) - 1.36 + .226))/8.131)

For 300 foot tape: int((3600 * 0.97)-1.36+ .226)/8.131) = 429 segments/track

5.4.2 EVEN TRACK FORMAT

(Reference QIC-143, QIC-144, QIC-148, QIC-162, QIC-165, or QIC-166 for all tape length tolerances)

	in	mm
beginning of tape to BOT hole	12	304.8
BOT hole to BOT hole	12	304.8
BOT hole to BOT hole	27.5	668.3
BOT hole to LP hole	24	609.6 (note 1)
beginning gap	.34 to 1.36	8.64 to 34.5
floppy track segment	7.905	200.8
repeat below n times (n = 428 minimum, 300 foot tape)		
erased gap	.226	5.74
floppy track segment	7.905	200.8
end of repeat		
allowance for +3% speed variation for 300 foot tape		
EW hole to EOT hole		
EOT hole to EOT hole	108	2743.2
EOT hole to EOT hole		
EOT hole to end of tape	24	609.6
	15	364.5
	12	304.8
	12	304.8

note 1 - erased tape except for reference burst on track 20

5.4.3 ODD TRACK FORMAT

(all dimensions nominal unless otherwise stated)

	in	mm
beginning of tape to EOT hole	12	304.8
EOT hole to EOT hole	12	304.8
EOT hole to EOT hole	15	364.5
EOT hole to EW hole	24	609.6 (note 1)
beginning gap	1.5 to 2.0	8.64 to 34.5
floppy track segment	7.905	200.8
repeat below n times (n = 428 minimum, 300 foot tape)		
erased gap	.226	5.74
floppy track segment	7.905	200.8
end of repeat		
allowance for +3% speed variation for 300 foot tape		
LP hole to BOT hole		
BOT hole to BOT hole	108	2743.2
BOT hole to BOT hole		
BOT hole to end of tape	27.5	668.3
	12	304.8
	12	304.8
	12	304.8

note 1 - erased tape except for reference burst on track 21

6. ERROR CONTROL

Hard errors are caused by media defects in the recording area. Two strategies shall be used to defeat hard errors:

(1) elimination of sectors with defects before use and
(2) correction of sectors with hard errors after use.

6.1 ELIMINATION OF SECTORS WITH DEFECTS

Sectors containing media defects shall be excluded from use via the bad sector map (section 7.0).

6.1.1 FORMAT READ CHECK

The cartridge format operation shall include a read check which shall identify all sectors containing media defects of .001 inches (.0254 mm) or greater. Sectors so identified shall be excluded from use via the bad sector map. Based on the recording head of section 4.3.2, a media defect of .001 inches (.0254 mm) implies a 50% threshold referenced to the signal amplitude reference cartridge of section 3.12.

6.1.2 DATA READ CHECK

The cartridge data recording operation may include a read check which shall identify all sectors containing media defects of .002 inches (.0508 mm) or greater. Sectors so identified shall be excluded from use via the bad sector map. Based on the recording head of section 4.3.2, a media defect of .002 inches (.0508 mm) implies a zero (0) threshold referenced to the signal amplitude reference cartridge of section 3.12.

6.2 ERROR CORRECTION

The cartridge data recording operation shall include three (3) sectors of ECC information in each segment which shall be used during the data reading operation to reconstruct sectors in error depending on the format used. The error correction algorithm shall correct errors in each data segment as follows:

(1) correct 3 or less sectors with CRC errors
(2) correct 1 sector with CRC error and 1 sector with CRC failure
(3) correct 1 sector with CRC failure

The error correction algorithm can also detect but not necessarily correct errors in each data segment as follows:

(1) detect 2 sectors with CRC failures
(2) detect 2 sectors with CRC errors and 1 sector with CRC failure

6.2.1 ECC FORMAT

The bytes in a segment are considered to be arranged in a 32 x 1024 matrix, and the parity bytes shall be chosen so that each column of the matrix is an independent Reed-Solomon codeword of redundancy three, with 8-bit characters, as shown in Figure for redundancy three. Note that for redundancy three rows 0 through 28 are data rows and 29 through 31 are parity rows. Data shall be written on the tape row by row, starting with row 0, and within each row (sector) the bytes shall be written starting with column 0.

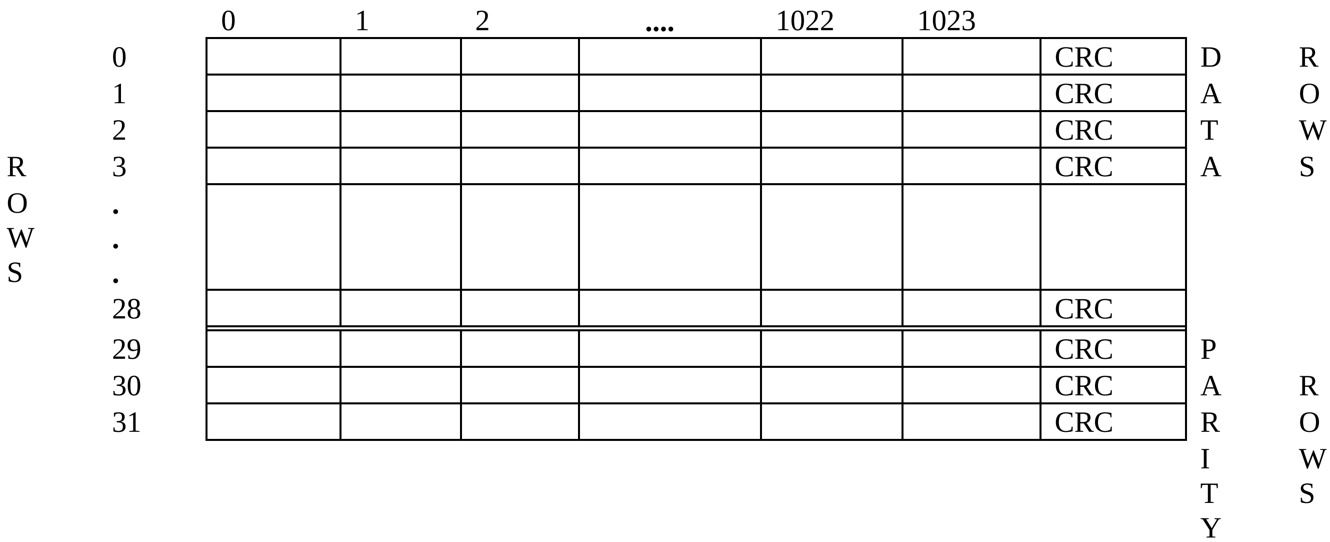


Figure 6.1 ECC Format

See section 6.2.5 for treatment of sectors excluded from use via the bad sector map.

6.2.2 FIELD PRESENTATION

GF(256) is a 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 6.2.

MSB							LSB
a7	a6	a5	a4	a3	a2	a1	a0

Figure 6.2 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:

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

6.2.3 CODE GENERATOR POLYNOMIAL

The generator polynomial for the Reed-Solomon code shall be:

$$g(x) = x^3 + r^{105}x^2 + r^{105}x + 1$$

with r a root of f(x). The hex representation of r^{105} is C0 (decimal 192).

Each column of data contains data bytes, as in Figure , from d_0 to d_{28}. The column's parity bytes d_{29}, d_{30}, and d_{31} shall be chosen such that the polynomial

$$d(x) = \sum_{i=0}^{N} d_i x^i$$

is divisible by g(x), using polynomial division over GF(256), where N = 31 less number of "bad blocks" in the segment.

6.2.4 TEST CODEWORDS

The polynomials defined in the preceding sections shall produce the following test codewords.

	Row #								
	0	:	00	00	00	00	00	00	01
	1	:	00	00	00	00	00	00	02
	2	:	00	00	00	00	00	01	03
	3	:	00	00	00	00	00	C0	04
	4	:	00	00	00	00	00	C0	05
	5	:	00	00	00	00	00	01	06
	6	:	00	00	00	00	00	01	07
	7	:	00	00	00	00	00	00	08
Data	8	:	00	00	00	00	00	67	09
	9	:	00	00	00	00	00	A6	0A
	10	:	00	00	00	00	00	C0	0B
	11	:	00	00	00	00	00	01	0C
	12	:	00	00	00	00	00	00	0D
	13	:	00	00	00	00	00	00	0E
	14	:	00	00	00	00	00	FF	0F
	15	:	00	00	00	00	00	99	10
	16	:	00	00	00	00	00	67	11
	17	:	00	00	00	00	00	01	12
	18	:	00	00	00	00	00	00	13
	19	:	00	00	00	00	00	00	14
	20	:	00	00	00	00	00	00	15
	21	:	00	00	00	00	00	A3	16
	22	:	00	00	00	00	00	5D	17
	23	:	00	00	00	00	00	FF	18
	24	:	00	00	00	00	01	01	19
	25	:	00	00	00	01	00	00	1A
	26	:	00	00	01	00	00	00	1B
	27	:	00	01	00	00	00	00	1C
	28	:	01	00	00	00	00	00	1D
Parity	29	:	C0	67	FF	A3	AD	AD	5D
Parity	30	:	C0	A6	99	5D	0F	0F	FF
Parity	31	:	01	CO	67	FF	A3	A3	A3

Figure 6.3 Test Codewords

6.2.5 EXCLUDED SECTORS

Sectors containing media defects are excluded from use via the bad sector map. The last three non-excluded sectors of a segment shall contain the parity bytes as shown in figure 6 below. The preceding non-excluded sectors of the segment shall contain data. Excluded sectors in the data portion of the segment shall be skipped over as shown in Figure 6.4 below.

```
                     ROW #

                    1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
---------------------------------------------------------------
D D D D D D D D D D D D D B D B D D D D D D D D D D D D D P P P *
D D D D D D D D D D D D D D D D D D D D D D D D D D D P P P     **

D D D D D D D D D D D D D D D D D D D D D D D D D D P B P B P B *
D D D D D D D D D D D D D D D D D D D D D D D D D D P P P       **

D B D D D D D D D D D D D D D D B D D D D P B B B P B B B P B B *
D D D D D D D D D D D D D D D D D D D P P P                     **
```

D = good sector, filled with data
B = bad sector, skipped over
P = good sector, filled with parity
* = segment as it appears on tape
** = segment as it appears in memory

Figure 6.4 Excluded Sectors

7. HEADER SEGMENT

The header segment shall be created in the format operation following the read check. The first defect free segment shall be the header segment. The second defect free segment shall be a duplicate of the header segment. Sectors in segments preceding the first header segment and between the 1st and 2nd header segments shall be recorded with deleted data marks (see note 6 of section 5.3.2). Sectors of the header segment shall be used as follows:

SECTOR(S)	USAGE
0 - 0	Format parameter record
0 - 28	Bad sector map
29 - 31	ECC

7.1 FORMAT PARAMETER RECORD

A cartridge history shall be maintained in the format parameter record. Bytes of word and doubleword fields shall be recorded low to high order.

SECTOR 0 OFFSET(S)	USAGE
0 - 3	Header segment signature string. Used to verify that the header segment has been correctly found. Must be set to hex '55 AA 55 AA' by format.
4	Format code. Identifies logical structure of tape. Hex '04' = variable length format. Hex '06' = tapes with > 65535 segments (e.g. 1000’, .315”)
5	Unused, set to zero.
6 - 7	Word: Format code = ‘04h’: segment number of header segment. Format code = ‘06h’: unused, set to zero.
8 - 9	Word: Format code = ‘04h’: segment number of duplicate header segment. Format code = ‘06h’: unused, set to zero.
10 -11	Word: Format code = ‘04h’: first logical area data segment. Format code = ‘06h’: unused, set to zero.
12 -13	Word: Format code = ‘04h’: last logical area data segment. Format code = ‘06h’: unused, set to zero.
14 -17	Doubleword: date and time of most recent format. The bits are encoded as follows: 31-25: Year-1970 (0-127 = 1970-2097) 24- 0: Month, day, hour, minute and second. Let MO=month (0-11), DY=day (0-30), HR=hour (0-23), MN=minute (0-59) and SC=second (0-59). Stored here is: SC+60*(MN+60*(HR+24*(DY+31*MO)))
18 - 21	Doubleword: date and time of most recent write or format to cartridge. The bits are encoded as in offset 14 - 17.
22 - 23	Unused, set to zero.
24 - 25	Word: Tape segments per tape track - Variable length dependent.
26	Byte: Tape tracks per cartridge - 40 (.250 inch), 50 (8mm)

SECTOR 0 OFFSET(S)	USAGE
27	Byte: Maximum floppy side - Variable length dependent
28	Byte: Maximum floppy track - 254
29	Byte: Maximum floppy sector - 128
30 - 73	Tape name. Any ASCII string, left justified and space filled.
74 - 77	Doubleword: date and time that the tape name was written. The bits are encoded as in offset 14 - 17.
78 -127	Unused, set to zero.
128	Re-format error flag. = FF if any of the remaining fields were lost due to tape error during re-format, else = 00.
129	Unused, set to zero.
130 - 133	Doubleword: Number of segments written, formatted or verified throughout life of tape.
134 - 137	Unused, set to zero.
138 - 141	Doubleword: date and time of initial tape format. The bits are encoded as follows: 31-25: Year-1970 (0-127 = 1970-2097) 24- 0: Month, day, hour, minute and second. Let MO=month (0-11), DY=day (0-30), HR=hour (0-23), MN=minute (0-59) and SC=second (0-59). Stored here is: SC+60*(MN+60*(HR+24*(DY+31*MO)))
142 - 143	Word: format count. Number of times tape has been formatted.
144 - 145	Unused, set to zero.
146 - 189	Original manufacturer name/code. For pre-formatted tapes, this field holds a manufacturer identification string. All zero if tape not pre-formatted.
190 - 233	Original manufacturer lot code. For pre-formatted tapes, this field holds tape lot numbering information. All zero if tape not pre-formatted.
234 - 237	Doubleword: Format code = ‘04h’: unused, set to zero. Format code = ‘06h’: segment number of header segment.

SECTOR 0 OFFSET(S)	USAGE
238 - 241	Doubleword: Format code = '04h': unused, set to zero. Format code = '06h': segment number of duplicate header segment.
242 - 245	Doubleword: Format code = '04h': unused, set to zero. Format code = '06h': first logical area data segment.
246 - 249	Doubleword: Format code = '04h': unused, set to zero. Format code = '06h': last logical area data segment.
250 - 255	Unused, set to zero.
256	Start of Bad Sector Map

7.2 BAD SECTOR MAP

The bad sector map shall be a list of 3-byte structures that defines each bad sector on the tape or all sectors in a segment as bad. This list is organized in ascending order so that as each bad sector is encountered during the format verify process, it is added to the next available structure location. This format allows a total of 314,016 sectors to be marked bad and can address up to 16,777,215 sectors.

Each 3 byte structure is viewed as an array of bytes from least significant byte to most significant byte, which can be converted to a double word representation of the logical sector number. Sector numbering starts with one (1) so that a zero entry can be interpreted as the end of the list. If the high order bit of the most significant byte is set then this indicates that the logical sector indicated (must be the first sector in the segment) and the next 31 sectors are marked as bad. For example, the following byte string would indicate 6 bad sectors with logical sector numbers of 0, 45,999, 4321, 500231 and 1001203:

0x01,0x00,0x00,0x2e,0x00,0x00,0xe8,0x03,0x00,0xe2,0x10,0x00,0x08,0xa2,0x07,0xf4,
0x46,0x0f,0x00,0x00,0x00

7.2.1 BAD SECTORS AND HOLE IMPRINTS

Data located on certain tracks within 4 segments of either EOT or BOT are prone to increased error rates due to hole imprints. For 0.250 in. tape these tracks are 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25 and 27. For 0.315 in. tape, these tracks are 17, 19, 21, 23, 25, 27, 29, 31, 33, 35 and 37. Therefore, these regions shall be mapped as bad at format time and entered into the bad sector map by indicating that all sectors within the identified segments are bad. For example, if a cartridge with 0.250 in. tape formats to 220 segments per track the following entries shall be made in the bad sector map for the hole imprints on track 9:

0xc1,0xe3,0x81,0xe1,0xe3,0x81,0x01,0xe4,0x81,0x21,0xe4,0x81,0xc1,0x17,0x82,
0xe1,0x17,0x82,0x01,0x18,0x82,0x21,0x18,0x82

Entries for tracks other than 9 shall be made in a similar fashion.

8. VOLUME TABLE SEGMENT

The volume table segment shall be created in the format operation following creation of the header segment as an all "zeroes" segment. The volume table shall be stored in the first segment of the logical area.

The volume table will contain an entry for each file set stored on the cartridge. The entry capacity of the table is determined by the amount of usable sectors within the segment it is stored upon. Each entry within the table shall be 128 bytes long.

Tapes with a format code of ‘04h’ will use the volume table format described below. Tapes with a format code of ‘06h’ will use the volume table described in QIC-113, section 5.

The first 4 bytes of a used entry shall hold the uppercase ASCII string "VTBL" as a signature. Following all used entries, *the end of the volume table shall be indicated by an entry with an undefined signature*. If the first table slot contains no signature, the cartridge is empty. If the last slot contains a signature, the cartridge is full.

It shall be required that each successive volume table entry allocate a segment range beyond any currently in use. Thus the ending segment number of the final table entry acts as a starting point for further allocation.

The volume table entry for supplementary cartridges in a multi-cartridge file set shall be required to be identical to that of the initial cartridge, except for the following fields:

Offset(s)	4-7:	Starting, ending segment numbers.
	56:	Multiple cartridge bit (bit 1).
	57:	Multi-cartridge sequence number.
	58-83:	Vendor extension data.

All character strings shall be left-justified and blank filled. Blank - Hex 20. All other character codes are permitted, and system specific.

Each volume table entry shall be formatted as follows (Word and Doubleword bytes are stored low to high order).

OFFSET(S)	USAGE
0 - 3	Volume entry signature. Must equal the ASCII uppercase string "VTBL" for all used entries.
4 - 5	Starting segment number. Word: Number of first segment within the range allocated to this volume entry (for this cartridge).
6 - 7	Ending segment number. Word: Number of last segment within the range allocated to this volume entry (for this cartridge).
8 - 51	Volume entry description string. May be any string of ASCII text. "First byte zero if none specified".
52 - 55	Volume entry storage date and time. Doubleword, the bits are encoded as follows: 31-25: Year-1970 (0-127 = 1970-2097) 24- 0: Month, day, hour, minute and second. Let MO=month (0-11), DY=day (0-30), HR=hour (0-23), MN=minute (0-59) and SC=second (0-59). Stored here is: SC+60*(MN+60*(HR+24*(DY+31*MO)))
56	Volume flags. Low order bit is zero: 0: Vendor specific volume bit. Set if remainder of volume entry is vendor specific. Only this bit and the previous bytes (0-55) are defined. If this bit is set the volume is not QIC-3020-MC compliant. 1: Multiple cartridge bit. Set if this file set spans to another cartridge. 2: Non-verification bit. Set if file set was written without verification. 3: Re-direction inhibit. Set if file set re-direction is disallowed. 4 Compressed data segment spanning 5: Directory last bit. Indicates that File Set Directory Section follows File Set Data Section. Always set if providing extended OS support. 6-7: Reserved, set to zero.
57	Multi-cartridge sequence number. Verifies a correct multiple cartridge loading sequence. Initial cartridge= 1, next cartridge= 2, etc. Can be greater than 1 only in the first volume table entry written.
58 - 83	Vendor extension data. Reserved for unique vendor extensions to the volume entry. If used, should be combined with a signature to insure recognition of valid data only. Ability to read or write this field is not required for QIC-3020-MC compliance,
84 - 91	File set password. First byte zero if none specified. Otherwise, may be any ASCII string. Controls file set read access only.

OFFSET(S)	USAGE
92 - 95	Directory section size. Doubleword: Area of the file set image reserved for the directory table. The table shall not be required to fill this area completely.
96 - 103	Data section size. Quadword: Total size (in bytes) of the file set data section. Includes all cartridges of multicartridge volumes unless the Directory Last bit (bit 5 of byte 56) is set, in which case this number reflects the sum of the File Data Section sizes up through this cartridge only.
104- 105	OS version number. First byte is operating system major version number, second is minor. If undefined, these bytes shall be zero. This version number is associated with the OS Type field (Offset 121). (e.g. If the OS Type field is 4, this field will contain the version of Novell that the backup was made from.). If the version is 3.12 the first byte would be a 3, and the second byte would be a 12 (decimal).
106- 121	Source drive volume label. First byte zero if none specified. Otherwise, may be any ASCII string.
122	Logical device file set originated from. If undefined, this byte shall be zero.
123	Reserved, set to zero.
124	Byte: Compression method used. See QIC-123 for definition. 0-5: Compression code field (3FH indicate vendor specific Only a code of 01H is allowed for QIC-3020-MC compliance.). 6: Always 0 7: Set to one if compression is used
125	Format & OS Type. Identifies whether volume data area is formatted in Basic DOS or Extended format. If extended format is used, also indicates operating system volume data originated from. The OS type is informational only, the important feature about this field is that if its value is NOT 1, extended format is used. 0 = Unknown 1 = DOS (Required for QIC-3020-MC compliance) 2 = Unix 3 = OS/2 4 = Novell NetWare 5 = Windows NT 6 = DOS extended format (long file names)
126- 127	Reserved, set to zero.

8.1 VOLUME TABLE EXTENSION

Volume table entries may be extended to support features such as unicode volume names and passwords by appending to them an extended entry. These extension entries will be identified by the ASCII signature "XTBL" and should be preserved even if the contents are ignored by software that does not support the extended information. Volume table extensions are required for extended OS support when unicode is used. A volume table extension is logically paired with the volume table entry that immediately precedes the volume table extension.

Offset	***Description***
0 - 3	Extended volume entry signature. Must equal the ASCII uppercase string "XTBL".
4 - 91	Volume Name (Unicode)
92 - 107	Volume Password (Unicode)
108 - 127	Reserved (set to 0)

8.2 VOLUME TABLE EXTENSION FOR UNICODE TAPE NAMES

Unicode tape names may be implemented through the use of a Unicode Tape ID entry, “UTID”. Only one UTID entry may be made within the volume table and it shall be used as the tape’s name if present.

Offset	***Description***
0 - 3	Volume entry signature. Must equal the ASCII uppercase string “UTID”.
4 - 91	Unicode Tape Name (left justified and space filled)
92 - 127	Reserved (set to 0)

8.3 VOLUME TABLE OVERFLOW EXTENSION

Since QIC-3010 has a finite volume table size, the volume table may be extended into another segment using an Extended Volume Table Entry, “EXVT”. This entry shall be used to allocate a previously unused tape segment for the purpose of extending the volume table segment. This 128 byte entry shall be the last entry within the segment containing this portion of the volume table.

Offset	***Description***
0 - 3	Volume entry signature. Must equal the ASCII uppercase string “EXVT”.
4 - 5	Parent Segment Number. Word: Number of segment containing this entry.
6 - 7	Child Segment Number. Word: Number of next segment to extend the parent volume table (for this cartridge).
8 - 127	Reserved (set to 0)

9. FILE SET LOGICAL FORMAT

The File Set Logical Format for QIC-3020-MC is defined in QIC-113 revision C and beyond. QIC-3020-MC compliance requires the implementation of the DOS file system logical format defined in QIC-113 for basic interchange. There are a number of operating systems that are supported in QIC-113 besides the base DOS format, QIC-113 identifies those portions of the specification that are required for compliance.

APPENDIX A

RECORDING SPECIFICATION SUMMARY

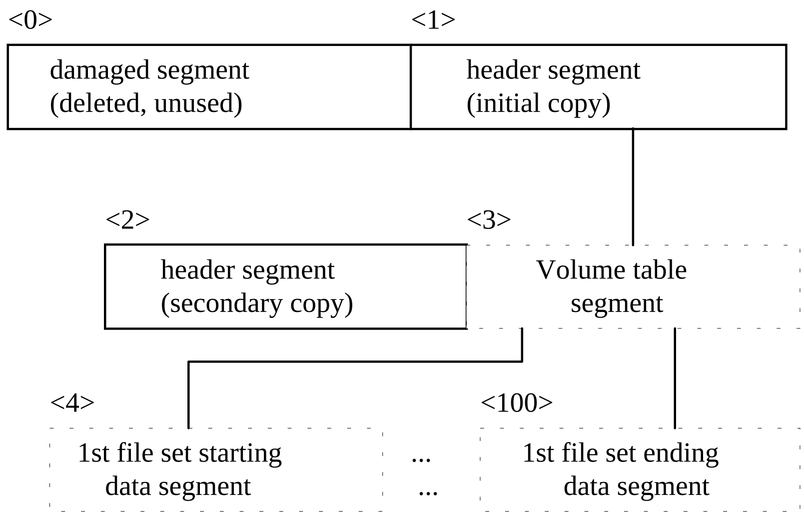
Values for 300 foot and 1100 foot tapes are provided as examples only. Other tape lengths may offer different capacities.

CAPACITY (Bytes before ECC)	**300 foot tape**	**1100 foot tape**
unformatted/cart (min)	773,262,307	2,847,341,475
formatted/cart (min)	562,298,880	2,063,073,280
formatted/tape track (min)	14,057,472	51,576,832
formatted/segment (min)	32,768	32,768
formatted/sector	1,024	1,024
CAPACITY (Bytes after ECC)		
unformatted/cart (min)	773,262,307	2,847,341,475
formatted/cart (min)	509,583,360	1,869,660,160
formatted/tape track (min)	12,739,584	46,741,504
formatted/segment (min)	29,696	29,696
formatted/sector	1,024	1,024
FORMAT		
tape trks/cart	40	40
segments/tape track (min)	429	1,574
data sectors/segment	29	29
ECC sectors/segment	3	3
bytes/sector	1,024	1,024
bits/inch	44,250	44,250
tape tracks/inch	155.6	155.6
encode method	MFM	MFM
SECTOR ADDRESSING		
sectors/cartridge (min)	549,120	2,014,720
sectors/side	32,512	32,512
sectors/tape track (min)	13,728	50,368
sectors/floppy track	128	128
SIDE	(0:16)	(0:61)
TRACK	(0:254)	(0:254)
SECTOR	(1:128)	(1:128)

APPENDIX B

EXAMPLE OF LOGICAL CARTRIDGE LAYOUT

In the example below, each box represents a tape segment. The corresponding segment numbers appear above within angle brackets. Segments enclosed by equal signs (=) are generated during the format operation. Those enclosed in dashes (-) reside in the logical data region.



The only impact the segments (<0> to <2>) have on the logical format is that they define the range of segment numbers the logical area will occupy. In this example, the starting segment of this area is <3>. This initial segment shall always hold the volume table. The ending logical area segment is not shown. A single file set is pictured, with its starting <4> and ending <100> segment numbers pointed to by the volume table. This simplified volume table has only a single entry; however, it is likely to find many such entries within the table. Each entry would designate its own (higher numbered) range of segments.