# QIC-02 Rev D

## ¼ inch Cartridge Tape Drive Intelligent Interface Standard

*Courtesy of:*

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# PROPOSED 1/4 INCH CARTRIDGE TAPE DRIVE

# INTELLIGENT INTERFACE STANDARD

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## 1.0 SCOPE

This document specifies an interface to an intelligent streaming 1/4 inch cartridge tape drive. The specification includes hardware interface, bus timing, commands and status.

## 2.0 DEFINITIONS

block - a group of consecutive bytes transferred as a unit
BOT - beginning of tape marker indicating beginning of tape
bus - a circuit over which data is transmitted
byte - a group of 8 binary bits operated on as a unit
cartridge - a four by six inch enclosure containing 1/4 inch 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 X3.55-1977)
cartridge initialization - an operation which restores normal tension by wind and rewind of the cartridge
continuable - a type of error after which an operation can be continued by issuing another command
command - the portion of an instruction word which specifies the operation to be performed
device - that which is devised, invented, or formed by design; used interchangeably with drive
drive - a device that moves tape past a recording/playback head
early warning - early warning marker indicating the approaching end of permissible recording area
EOT - end of tape marker indicating the end of tape
erase - to remove all magnetically recorded information from the tape
fatal - a type of error which causes an operation to be aborted, operation must be started over
file mark - an identification mark following the last block in a file
load point - load point marker indicating the beginning of the permissible recording area
status - bytes transmitted indicating status of the device
underrun - condition developed when host transmits or receives data at a rate less than that required by the device for streaming operation

## 3.0 INTERFACE

This section describes the proposed 1/4 inch cartridge tape drive interface. Data and commands are transferred to and from the device on an 8 bit bi-directional data bus using asynchronous handshaking techniques to eliminate rigorous timing contraints. Up to four devices are supported on the interface.

### 3.1 INPUT/OUTPUT SIGNAL CONNECTOR AND CABLE

The signal connector on the Device shall be a 50 conductor edge connector. Mating connector 3M type 3415-0001 or equivalent shall be used.

The signal cable shall be a 50 conductor flat ribbon cable. 3M type 3365/50 or equivalent flat cable shall be used.

### 3.2 INTERFACE SIGNAL LEVELS

All signals to the Host shall be standard TTL levels as follows:

| | |
|---|---|
| FALSE, Logic 0 (high) | =2.4 to 5.25 VDC |
| TRUE, Logic 1 (low) | =0 to 0.55 VDC |

All signals to each Device shall be standard TTLlevelsas follows:

| | |
|---|---|
| FALSE, Logic 0 (high) | =2.0 to 5.25 VDC |
| TRUE, Logic 1 (low) | =0 to 0.8 VDC |

Voltages shall be measured at each Device connector. This interface shall support a total cable length of 3 meters maximum.

### 3.3 SIGNAL TERMINATIONS

The standard termination shall be 220 ohms to +5VDC and 330 ohms to GND or Thevenin equivalent. Resistance tolerance shall be +/- 5% maximum. The bi-directional data bus and the four control signals from the Host to the Device shall be terminated at the Device unless daisy-chained in which case the last device on the daisy shall provide terminations. The Host shall terminate the bi-directional data bus and the four control signals from the Devices to the Host at the Host.

### 3.4 SIGNAL LOADING

No signal on the interface shall be loaded by Devices by more than 2.0 mA plus required terminations. No signal on the interface shall be loaded by the Host by more than 2.0 mA plus required terminations.

## 3.5 INPUT/OUTPUT SIGNAL PIN ASSIGNMENTS AND SIGNAL DESCRIPTION

| PIN# | NAME | TO | DESCRIPTION |
|---|---|---|---|
| 02 | NUS- | X | NOT USED - unconnected signal lines |
| 04 | NUS- | X | |
| 06 | NUS- | X | |
| 08 | NUS- | X | |
| 10 | HBP- | B | HOST BUS ODD PARITY - reserved for optional odd bus parity |
| 12 | HB7- | B | HOST BUSBIT7 - most significant bit of 8-bit host bi-directional data bus |
| 14 | HB6- | B | HOST BUS BIT 6 |
| 16 | HB5- | B | HOST BUS BIT 5 |
| 18 | HB4- | B | HOST BUS BIT 4 |
| 20 | HB3- | B | HOST BUS BIT 3 |
| 22 | HB2- | B | HOST BUS BIT 2 |
| 24 | HB1- | B | HOST BUS BIT 1 |
| 26 | HB0- | B | HOST BUS BIT 0 - least significant bit of 8-bit host bi-directional data bus |
| 28 | ONL- | D | ON LINE - host generated control signal which is activated prior to transferring a READ or WRITE command and deactivated to terminate that READ or WRITE command |
| 30 | REQ- | D | REQUEST - host generated control signal which indicates that command data has been placed on the data bus in COMMAND MODE or that status has been taken from the data bus in STATUS INPUT MODE, shall be asserted by host only when RDY- OR EXC- is asserted by device |
| 32 | RST- | D | RESET - causes device initialization to be performed, default selection to device 0, EXCEPTION asserted. |
| 34 | XFR- | D | TRANSFER - host generated control signal which indicates that data has been placed on the data bus in WRITE MODE or that data has been taken from the data bus in READ MODE |
| 36 | ACK- | H | ACKNOWLEDGE - device generated signal which indicates that data has been taken from the data bus in WRITE MODE or that data has been placed on the data bus in READ MODE |

| PIN# | NAME | TO | DESCRIPTION |
|---|---|---|---|
| 38 | RDY- | H | READY - device generated signal which indicates one of the following:<br>(1) data has been taken from the data bus in COMMAND TRANSFER MODE<br>(2) data has been placed on the data bus in STATUS INPUT MODE<br>(3) a BOT, CARTRIDGE INITIALIZATION or ERASE COMMAND is completed following issuance<br>(4) the device is ready to receive the next block or ready to receive a WRITE or WFM Command from the host in WRITE mode<br>(5) a WFM command is completed in WRITE FILE MARK mode<br>(6) the device is ready to transmit the next block to the host or ready to receive a READ or REM command from the host in READ MODE<br>(7) OTHERWISE, device is ready to receive a new command |
| 40 | EXC- | H | EXCEPTION - device generated signal which indicates that an exception condition exists in the device, that host MUST issue STATUS COMMAND and perform a STATUS INPUT to determine cause |
| 42 | DIR- | H | DIRECTION - device generated signal which when false causes host data bus drivers to assert their data bus levels and device data bus drivers to assume high impedence states, when true causes host data bus drivers to assume high impedence states and device data bus drivers to assert their data bus levels |
| 44 | NUS- | X | NOT USED - unconnected signal line |
| 46 | NUS- | X | NOT USED - unconnected signal line |
| 48 | NUS- | X | NOT USED - unconnected signal line |
| 50 | NUS- | X | NOT USED - unconnected signal line |

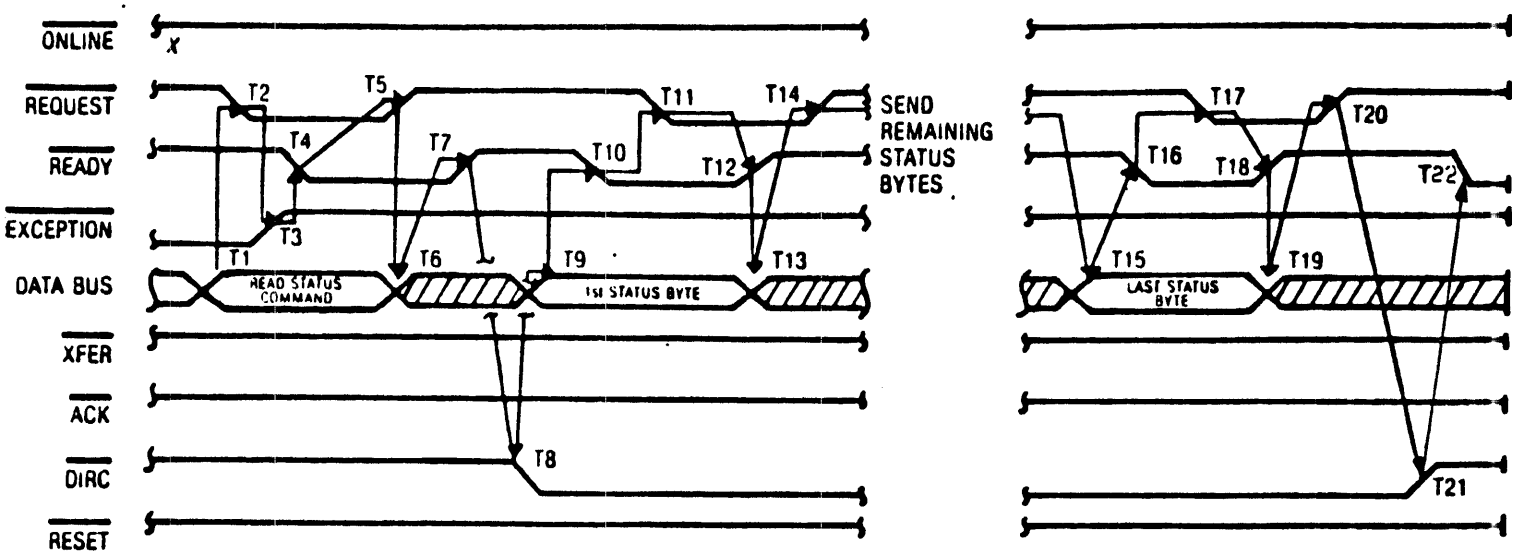
All odd pins shall be connected to signal GND at the Host. The "TO" nomenclature above shall be as follows:

X = UNDEFINED
B = BI-DIRECTIONAL
D = DEVICE
H = HOST

## 3.6 INTERFACE TIMING

Interface signal timing shall be as specified in the following timing diagrams.

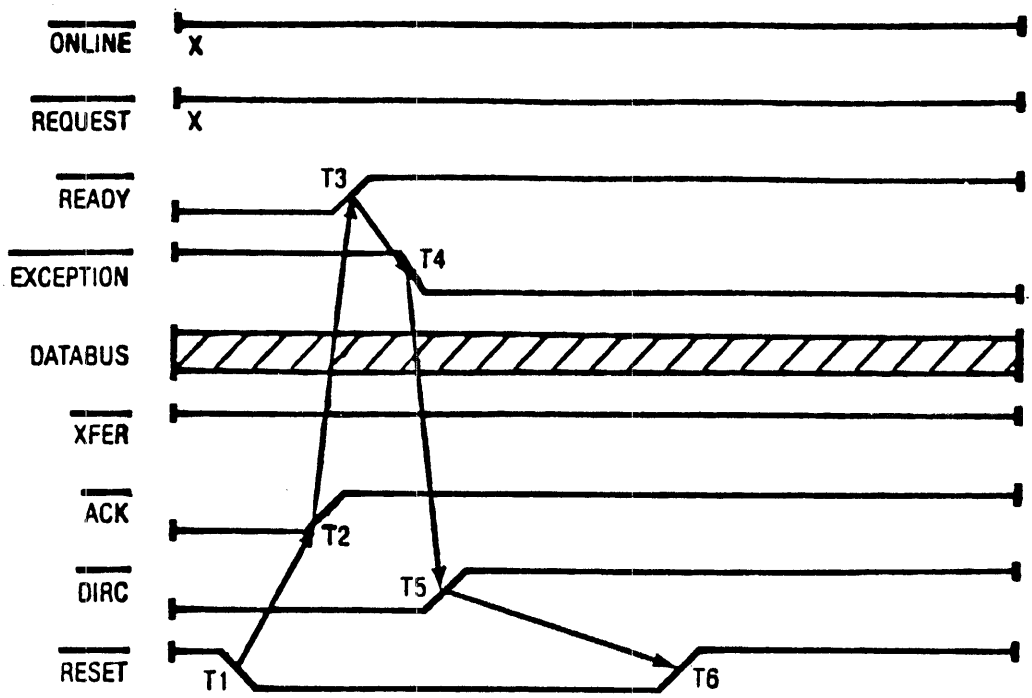
## 3.6.1 READ STATUS COMMAND TIMING




### READ STATUS COMMAND

| ACTIVITY | CRITICAL TIMING |
|---|---|
| T1-HOST COMMAND TO BUS | N/A |
| T2-HOST SETS REQUEST | T1→T2>0 U sec. |
| T3-CONTROLLER RESETS EXCEPTION | T3→T4>10 U sec. |
| T4-CONTROLLER SETS READY | T2→T4>20Usec.(500Usec. Nominal) |
| T5-HOST RESETS REQUEST | T4→T5>0 U sec. |
| T6-BUS DATA INVALID | T4→T6>0 U sec. |
| T7-CONTROLLER RESETS READY | 20<T5→T7<100 U sec. |
| T8-CONTROLLER CHANGES BUS DIRECTION | N/A |
| T9-1ST STATUS BYTE TO BUS | N/A |
| T10-CONTROLLER SETS READY | T7→T10>20 U sec. |
| T11-HOST SETS REQUEST | N/A |
| T12-CONTROLLER RESETS READY | T11→T12< 1 U sec. |
| T13-BUS DATA INVALID | T11→T13>0 U sec. |
| T14-HOST RESETS REQUEST | T11→T14>20 Usec. |
| T15-LAST STATUS BYTE TO BUS | N/A |
| T16-SAME AS T10 | SAME AS T10 |
| T17-SAME AS T11 | SAME AS T11 |
| T18-SAME AS T12 | SAME AS T12 |
| T19-SAME AS T13 | SAME AS T13 |
| T20-SAME AS T14 | SAME AS T14 |
| T21-CONTROLLER CHANGES BUS DIRECTION | N/A |
| T22-CONTROLLER SETS READY | T20→T21 >0 |
| X-DON'T CARE | T21→T22 >0 |

## 3.6.2 RESET TIMING

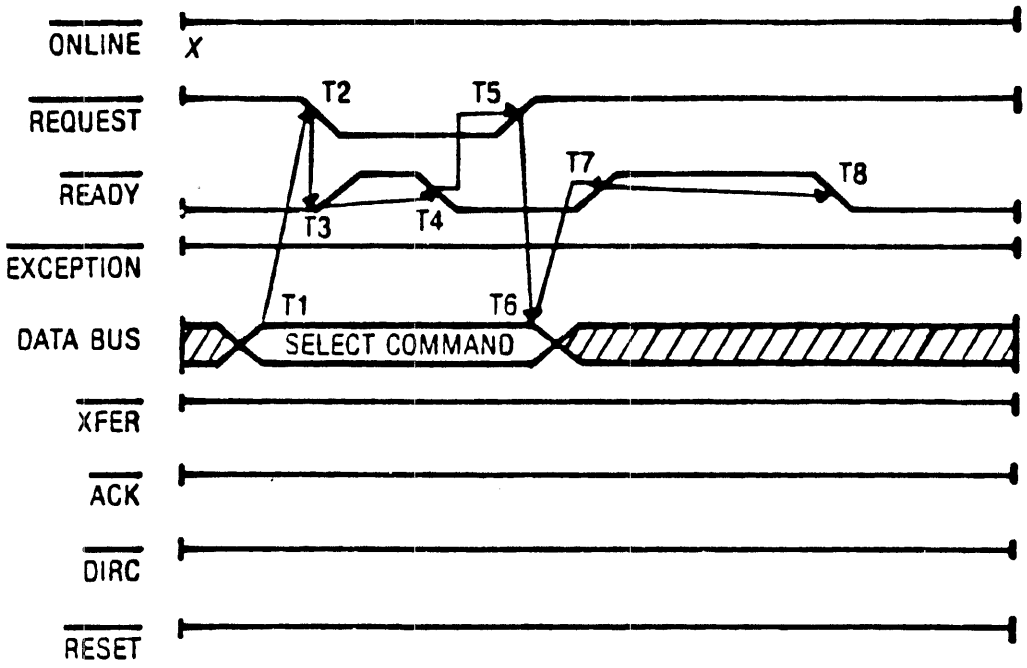



**RESET TIMING**

| ACTIVITY | CRITICAL TIMING |
|---|---|
| T1-HOST ASSERTS $\overline{\text{RESET}}$ | NA |
| T2-CONTROLLER DISABLES $\overline{\text{ACK}}$ | T1→T2<1 U sec. |
| T3-CONTROLLER DISABLES $\overline{\text{READY}}$ | T1→T3<1 U sec. |
| T4-CONTROLLER ASSERTS $\overline{\text{EXCEPTION}}$ | T1→T4<3 U sec. |
| T5-CONTROLLER DISABLES $\overline{\text{DIRC}}$ | T1→T5<3 U sec. |
| T6-HOST DISABLES $\overline{\text{RESET}}$ | T1→T6>25 U sec. |

*X-DON'T CARE*

## 3.6.3 SELECT COMMAND TIMING

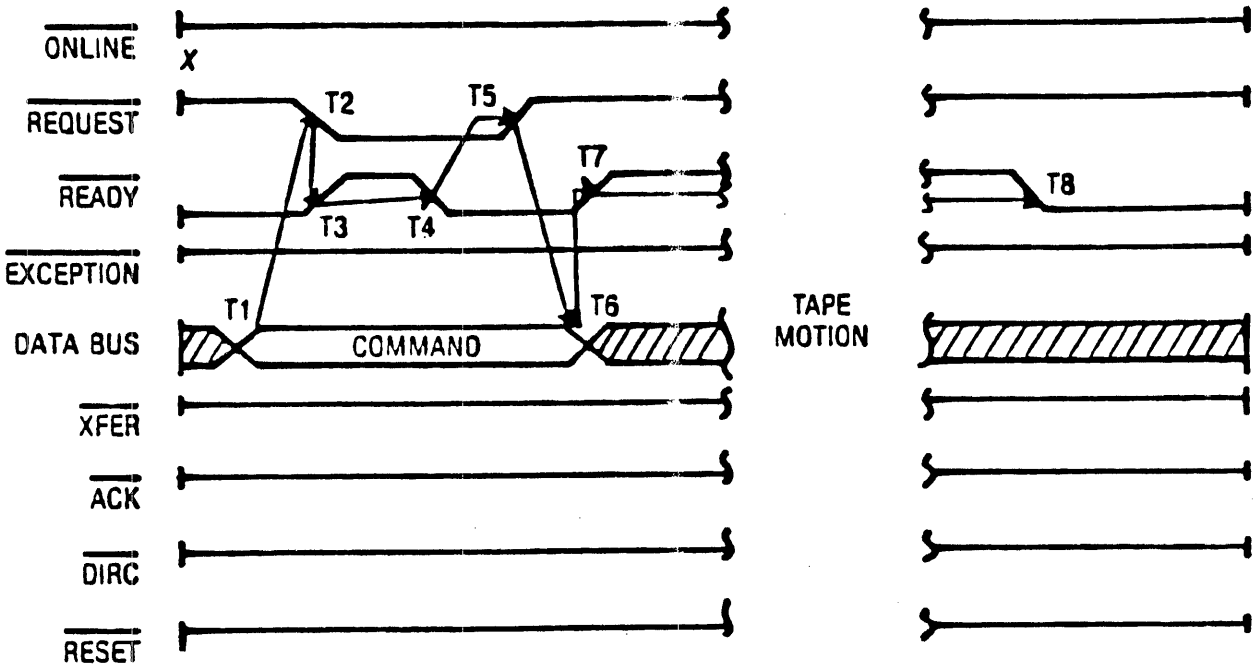



### SELECT COMMAND

| ACTIVITY | CRITICAL TIMING |
|---|---|
| T1-HOST COMMAND TO BUS | N/A |
| T2-HOST SETS REQUEST | T1→T2>Ø U sec. |
| T3-CONTROLLER RESETS READY | T2→T3<1 U sec. |
| T4-CONTROLLER SETS READY | T3→T4> 50 U sec. (500 U sec. nominal) |
| T5-HOST RESETS REQUEST | T4→T5>Ø U sec. |
| T6-BUS DATA INVALID | T4→T6>Ø U sec. |
| T7-CONTROLLER RESETS READY | 20<T5→T7<100 U sec. |
| T8-CONTROLLER SETS READY | T7→T8>20 U sec. |

*X-DON'T CARE*

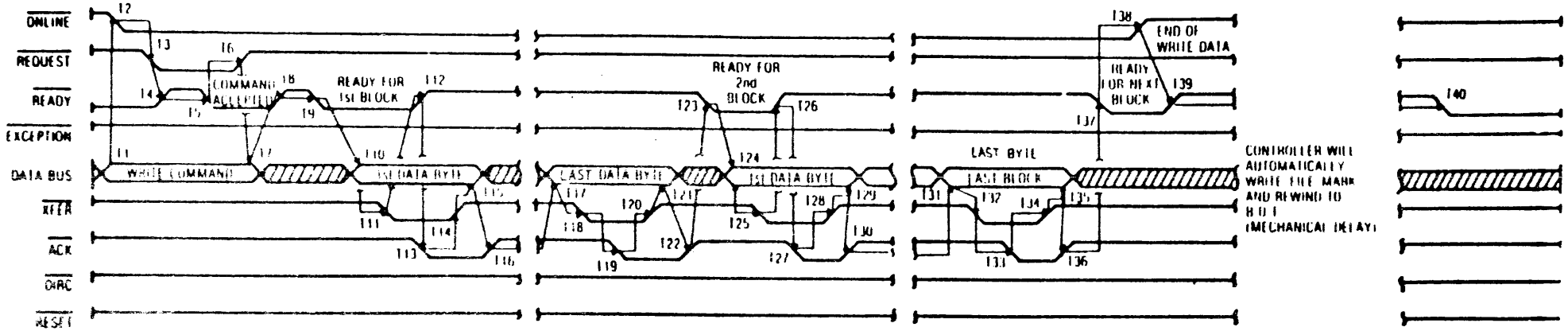
### 3.6.4 BOT, CARTRIDGE INITIALIZATION, OR ERASE TIMING




## BOT, INITIALIZATION OR ERASE COMMAND

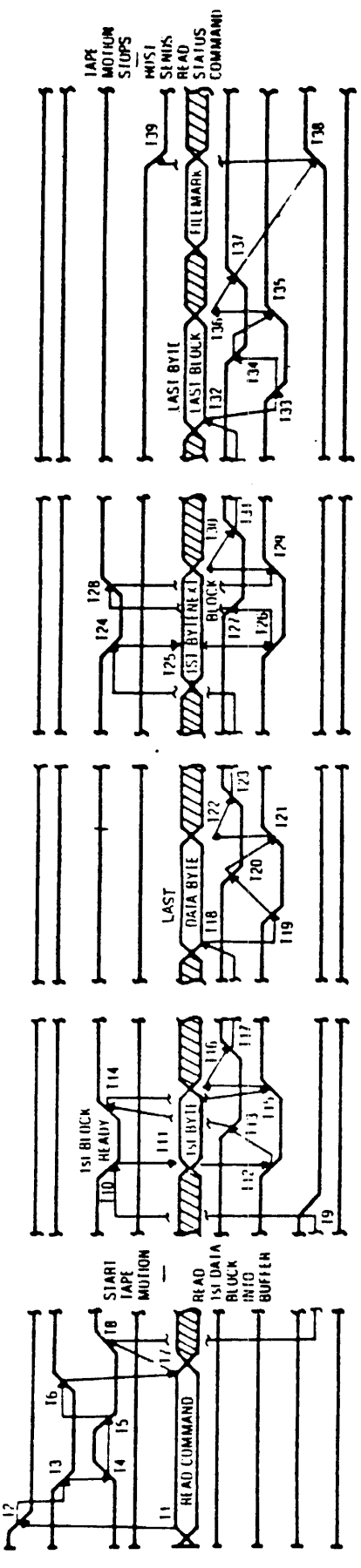
| ACTIVITY | CRITICAL TIMING |
|---|---|
| T1-HOST BUS DATA VALID | N/A |
| T2-HOST SETS REQUEST | T1→T2 = >Ø U sec. |
| T3-CONTROLLER RESETS READY | T2→T3 = < 1 U sec. |
| T4-CONTROLLER SETS READY | T3→T4 > 20 U sec. (500 U sec. nominal) |
| T5-HOST RESETS REQUEST | T4→T5 = >Ø U sec. |
| T6-BUS DATA INVALID | T4→T6 > Ø U sec. |
| T7-CONTROLLER RESETS READY | 20 < T5→T7 < 100 U sec. |
| T8-CONTROLLER SETS READY | T7→T8 = >20 U sec. |

*X-DON'T CARE*




## WRITE DATA COMMAND

| ACTIVITY | CRITICAL TIMING | ACTIVITY | CRITICAL TIMING | ACTIVITY | CRITICAL TIMING |
|---|---|---|---|---|---|
| T1 HOST COMMAND TO BUS | N/A | | | | |
| T2 HOST SETS ONLINE | N/A | T15 BUS DATA INVALID | T13 → T15 > 0 U sec | T28 HOST RESETS XFER | SAME AS T14 |
| T3 HOST SETS REQUEST | T2 → T3 > 0 U sec | T16 CONTROLLER RESETS ACK | 0 < T14 → T16 < 3 U sec | T29 BUS DATA INVALID | SAME AS T15 |
| T4 CONTROLLER RESETS READY | T3 → T4 < 1 U sec | T17 HOST DATA TO BUS | N/A | T30 CONTROLLER RESETS ACK | SAME AS T16 |
| T5 CONTROLLER SETS READY | T4 → T5 > 20 U sec (500 U sec. nominal) | T18 SAME AS T11 | SAME AS T11 | T31 HOST DATA TO BUS | N/A |
| T6 HOST RESETS REQUEST | T5 → T6 > 0 U sec | T19 SAME AS T13 | SAME AS T13 | T32 HOST SETS XFER | SAME AS T18 |
| T7 BUS DATA INVALID | T5 → T7 > 0 U sec | T20 SAME AS T14 | SAME AS T14 | T33 CONTROLLER SETS ACK | SAME AS T19 |
| T8 CONTROLLER RESETS READY | 20 < T6 → T8 < 100 U sec | T21 SAME AS T15 | SAME AS T15 | T34 HOST RESETS XFER | SAME AS T20 |
| T9 CONTROLLER SETS READY | T8 → T9 > 20 U sec | T22 SAME AS T16 | SAME AS T16 | T35 BUS DATA INVALID | N/A |
| T10 HOST DATA TO BUS | N/A | T23 CONTROLLER SETS READY | T22 → T23 > 100 U sec | T36 CONTROLLER RESETS ACK | SAME AS T22 |
| T11 HOST SETS XFER | T10 → T11 > 40 NANO sec | T24 HOST DATA TO BUS | N/A | T37 CONTROLLER SETS READY | SAME AS T23 |
| T12 CONTROLLER RESETS READY | T11 → T12 < 1 U sec. | T25 HOST SETS XFER | SAME AS T11 | T38 HOST RESETS ONLINE | N/A |
| T13 CONTROLLER SETS ACK | 0.5 < T11 → T13 < 100 U sec. | T26 CONTROLLER RESETS READY | SAME AS T12 | T39 CONTROLLER RESETS READY | N/A |
| T14 HOST RESETS XFER | T13 → T14 > 0 U sec | T27 CONTROLLER SETS ACK | SAME AS T13 | T40 CONTROLLER SETS READY | N/A |

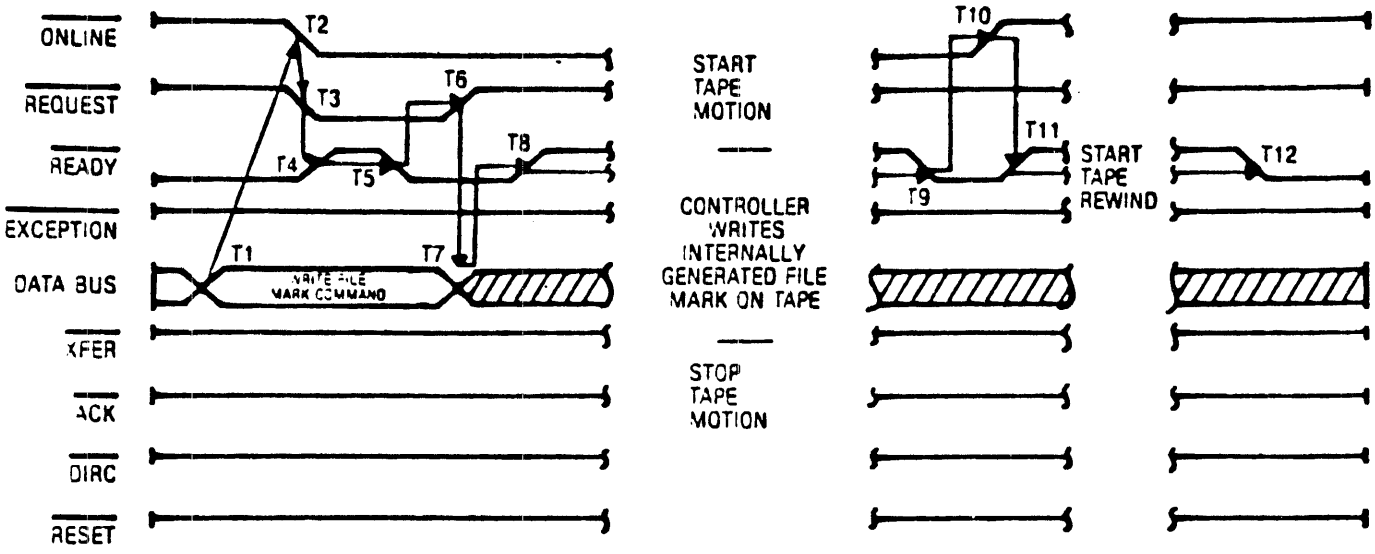



## READ DATA COMMAND

| ACTIVITY | CRITICAL TIMING | ACTIVITY | CRITICAL TIMING | ACTIVITY | CRITICAL TIMING |
|---|---|---|---|---|---|
| T1 HOST COMMAND TO BUS | N/A | T14 CONTROLLER RESETS READY | T13-T14< 1 Usec. | T27 HOST SETS XFER | SAME AS T13 |
| T2 HOST SETS ONLINE | N/A | T15 CONTROLLER RESETS ACK | .5<T13-T15<3 Usec. | T28 CONTROLLER RESETS READY | SAME AS T14 |
| T3 HOST SETS REQUEST | T2 -T13>0 U sec | T16 BUS DATA INVALID | T13-T16>0 U sec | T29 CONTROLLER RESETS ACK | SAME AS T15 |
| T4 CONTROLLER RESETS READY | T3 -T14<1 Usec | T17 HOST RESETS XFER | T15-T17>0 U sec | T30 BUS DATA INVALID | SAME AS T16 |
| T5 CONTROLLER SETS READY | T4 -T5>20Usec.(500Usec.max) | T18 BUS DATA VALID | N/A | T31 HOST RESETS XFER | SAME AS T17 |
| T6 HOST RESETS REQUEST | T5 -T6>0 U sec | T19 CONTROLLER SETS ACK | SAME AS T12 | T32 LAST BYTE TO BUS | N/A |
| T7 BUS DATA INVALID | T5 -T7>0 U sec | T20 HOST SETS XFER | SAME AS T13 | T33 CONTROLLER SETS ACK | SAME AS T12 |
| T8 CONTROLLER RESETS READY | 20<T6 -T8<100 U sec | T21 CONTROLLER RESETS ACK | SAME AS T15 | T34 HOST SETS XFER | SAME AS T13 |
| T9 CONTROLLER CHANGES DIRC | N/A | T22 BUS DATA INVALID | SAME AS T16 | T35 CONTROLLER RESETS ACK | SAME AS T15 |
| T10 1ST DATA BYTE TO BUS | N/A | T23 HOST RESETS XFER | SAME AS T17 | T36 BUS DATA INVALID | SAME AS T16 |
| T11 CONTROLLER SETS READY | N/A | T24 CONTROLLER SETS READY | N/A | T37 HOST RESETS XFER | SAME AS T17 |
| T12 CONTROLLER SETS ACK | T11-T12>-40 NANO sec | T25 1ST BYTE TO BUS | N/A | T38 CONTROLLER SETS EXCEPTION | N/A |
| T13 HOST SETS XFER | T12 -T13>0 U sec | T26 CONTROLLER SETS ACK | SAME AS T12 | T39 CHANGE BUS DIRECTION | N/A |

NOTE: T12 CAN PRECEDE T11 BY 40 NANOSEC.

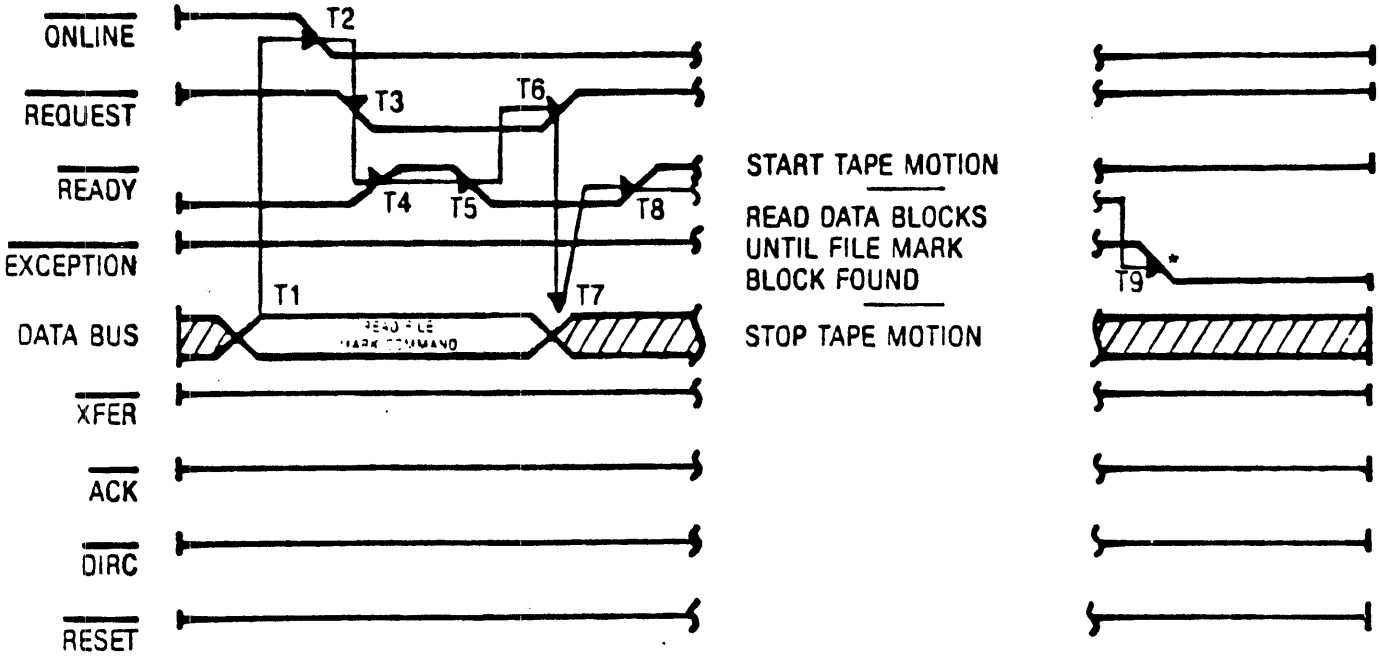
## 3.6.7 WRITE-FILE-MARK TIMING




### WRITE FILE MARK COMMAND

| ACTIVITY | CRITICAL TIMING |
|---|---|
| T1-HOST COMMAND TO BUS | N/A |
| T2-HOST SETS ONLINE | T1→T2>0 U sec. |
| T3-HOST SETS REQUEST | T2→T3>0 U sec. |
| T4-CONTROLLER RESETS READY | T3→T4<1 U sec. |
| T5-CONTROLLER SETS READY | T4→T5>20 Usec. (500 Usec. nominal) |
| T6-HOST RESETS REQUEST | T5→T6>0 U sec. |
| T7-BUS DATA INVALID | T5→T7>0 U sec. |
| T8-CONTROLLER RESETS READY | 20<T6→T8<100 U sec |
| T9-CONTROLLER SETS READY | N/A |
| T10-HOST RESETS ONLINE | T9→T10>0 U sec. |
| T11-CONTROLLER RESETS READY | N/A |
| T12-CONTROLLER SETS READY (AT B.O.T.) | N/A |

## 3.6.8 READ-FILE-MARK TIMING




## READ FILE MARK COMMAND

| ACTIVITY | CRITICAL TIMING |
|---|---|
| T1-HOST COMMAND TO BUS | N/A |
| T2-HOST SETS ONLINE | T1→T2>Ø U sec. |
| T3-HOST SETS REQUEST | T2→T3>Ø U sec. |
| T4-CONTROLLER RESETS READY | T3→T4<1 U sec. |
| T5-CONTROLLER SETS READY | T4→T5>20 Usec. (500 Usec. nominal) |
| T6-HOST RESETS REQUEST | T5→T6>Ø U sec. |
| T7-BUS DATA INVALID | T4→T7>Ø U sec. |
| T8-CONTROLLER RESETS READY | 20<T6→T8<100 U sec. |
| T9-CONTROLLER SETS EXCEPTION | N/A |

**SYSTEM MUST ISSUE READ STATUS COMMAND*

## 4.0 COMMANDS

All device commands are single byte commands as defined in the COMMAND SUMMARY (4.1). Devices shall implement all standard (S) commands in order to meet the minimum requirements of this standard. Optional (O) commands, if implemented, shall be implemented as specified in this standard. Reserved (R) commands are reserved for future use. Vendor unique (V) commands may be used for any purpose. All unimplemented commands shall return illegal command status from a device.

### 4.1 COMMAND SUMMARY

| 7654 3210 | SOR | V(N) | DESCRIPTION |
|---|---|---|---|
| 0000 0000 | | V(1) | |
| 0000 0001 | S | | SELECT DRIVE 1 |
| 0000 0010 | S | | SELECT DRIVE 2 |
| 0000 0011 | | V(1) | |
| 0000 0100 | S | | SELECT DRIVE 3 |
| 0000 0101 | | V(1) | |
| 0000 011X | | V(2) | |
| 0000 1000 | S | | SELECT DRIVE 4 |
| 0000 1001 | | V(1) | |
| 0000 101X | | V(2) | |
| 0000 11XX | | V(4) | |
| 0001 0000 | | V(1) | |
| 0001 0001 | O | | SELECT DRIVE 1, LOCK CARTRIDGE |
| 0001 0010 | O | | SELECT DRIVE 2, LOCK CARTRIDGE |
| 0001 0011 | | V(1) | |
| 0001 0100 | O | | SELECT DRIVE 3, LOCK CARTRIDGE |
| 0001 0101 | | V(1) | |
| 0001 011X | | V(2) | |
| 0001 1000 | O | | SELECT DRIVE 4, LOCK CARTRIDGE |
| 0001 1001 | | V(1) | |
| 0001 101X | | V(2) | |
| 0001 11XX | | V(4) | |
| 0010 0000 | | V(1) | |
| 0010 0001 | S | | POSITION TO BEGINNING OF TAPE |
| 0010 0010 | S | | ERASE THE ENTIRE TAPE |
| 0010 0011 | | V(1) | |
| 0010 0100 | S | | INITIALIZE CARTRIGE |
| 0010 0101 | O | | SELECT AUTO CARTRIDGE INITIALIZATION |
| 0010 011X | | V(2) | |

| 7654 | 3210 | SOR | V(N) | DESCRIPTION |
|---|---|---|---|---|
| 0010 | 1XXX | | V(8) | |
| 0011 | XXXX | | V(16) | |
| 0100 | 0000 | S | | WRITE |
| 0100 | 0001 | O | | WRITE WITHOUT UNDERRUNS |
| 0100 | 001X | | V(2) | |
| 0100 | 01XX | | V(4) | |
| 0100 | 1000 | O | | ENTER 6 BYTE PARAMETER BLOCK |
| 0100 | 1001 | | V(1) | |
| 0100 | 101X | | V(2) | |
| 0100 | 11XX | | V(4) | |
| 0101 | XXXX | | V(16) | |
| 0110 | 0000 | S | | WRITE FILE MARK |
| 0110 | 0001 | R | | |
| 0110 | 001X | | V(2) | |
| 0110 | 01XX | | V(4) | |
| 0110 | 1XXX | | V(8) | |
| 0111 | NNNN | O | | WRITE N FILE MARKS |
| 1000 | 0000 | S | | READ |
| 1000 | 0001 | O | | SPACE FORWARD |
| 1000 | 001X | | V(2) | |
| 1000 | 0100 | O | | READ REDUCED TRACK DENSITY |
| 1000 | 0101 | O | | SPACE FORWARD REDUCED DENSITY |
| 1000 | 011X | | V(2) | |
| 1000 | 1000 | O | | READ REVERSE |
| 1000 | 1001 | O | | SPACE REVERSE |
| 1000 | 101X | | V(2) | |
| 1000 | 1100 | O | | READ REVERSE REDUCED TRACK DENSITY |
| 1000 | 1101 | O | | SPACE REVERSE REDUCED TRACK DENSITY |
| 1000 | 111X | | V(2) | |
| 1001 | XXXX | | V(16) | |
| 1010 | 0000 | S | | READ FILE MARK |
| 1010 | 0001 | | V(1) | |
| 1010 | 0010 | | V(1) | |
| 1010 | 0011 | O | | SEEK EOD (END OF DATA) |
| 1010 | 0100 | O | | READ FILE MARK REDUCED TRACK DENSITY |
| 1010 | 0101 | | V(1) | |
| 1010 | 0110 | | V(1) | |
| 1010 | 0111 | O | | SEEK EOD REDUCED TRACK DENSITY |
| 1010 | 1000 | O | | READ FILE MARK REVERSE |
| 1010 | 1001 | | V(1) | |
| 1010 | 101X | | V(2) | |
| 1010 | 1100 | O | | READ FILE MARK REVERSE REDUCED TRACK DENSITY |

| 7654 | 3210 | SOR | V(N) | DESCRIPTION |
|---|---|---|---|---|
| 1010 | 1101 | | V(1) | |
| 1010 | 111X | | V(2) | |
| 1011 | NNNN | O | | READ N FILE MARKS |
| 1100 | 0000 | S | | READ STATUS |
| 1100 | 0001 | O | | READ EXTENDED STATUS 1 |
| 1100 | 0010 | O | | RUN SELF TEST 1 |
| 1100 | 0011 | | V(1) | |
| 1100 | 0100 | O | | READ EXTENDED STATUS 2 |
| 1100 | 0101 | | V(1) | |
| 1100 | 011X | | V(2) | |
| 1100 | 100X | | V(2) | |
| 1100 | 1010 | O | | RUN SELF TEST 2 |
| 1100 | 1011 | | V(1) | |
| 1100 | 11XX | | V(4) | |
| 1101 | XXXX | | V(16) | |
| 1110 | 0000 | O | | READ EXTENDED STATUS 3 |
| 1110 | 0001 | | V(1) | |
| 1110 | 001X | | V(2) | |
| 1110 | 01XX | | V(4) | |
| 1110 | 1XXX | | V(8) | |
| 1111 | XXXX | | V(16) | |

## 4.2 STANDARD COMMAND DESCRIPTIONS

This section describes the standard commands which shall be implemented by all devices.

### 4.2.1 POWER-ON/RESET

The POWER-ON/RESET sequence provides the host with the information on power-on occurrences in the device. It also provides a convenient mechanism for initializing the device during hardware and software debugging of the host interface.

The host applies power to the device or applies a pulse on the device reset line. Device circuitry shall be reset. EXCEPTION shall be asserted. When the power-on reset times out or when the reset pulse terminates, the device initializes operating parameters and defaults to drive 0 for subsequent commands. Each device waits for the host to issue a command. If the command issued was a READ STATUS command, the selected device now executes the command by transferring the six required status bytes, byte 1 (the second byte) bit 0 of which shall be set to indicate that a power-up or a reset occurred.

### 4.2.2 SELECT COMMAND (0000 DRIVE)

The select command selects one of up to four drives. The drive shall remain selected until changed by another SELECT command or RESET (4.2.1).

### 4.2.3 READ STATUS COMMAND (1100 0000)

The READ STATUS command provides host with information about the selected device. The host issues the READ STATUS command. The device transfers the standard six bytes to the host.

### 4.2.4 BOT COMMAND (0010 0001)

The BOT command positions the tape in the cartridge in the selected device to BOT (beginning of tape).

### 4.2.5 INITIALIZATION COMMAND (0010 0100)

The INITIALIZATION command shall be used in accordance with cartridge tape manufacturer's instructions. The INITIALIZATION command moves the tape in the selected device to BOT, then to EOT and then back to BOT.

### 4.2.6 ERASE COMMAND (0010 0010)

The ERASE command completely erases the tape in the selected drive. The ERASE command moves the tape in the selected device to BOT, activates the erase head and moves to EOT, deactivates the erase head and moves the tape back to BOT. The ERASE command also fulfills the requirements of initialization.

### 4.2.7 WRITE COMMAND (0100 0000)

The host asserts ONLINE and issues the WRITE command. The selected device requests and transfers data. The READY line is activated when the device is ready for a data block transfer. When the READY line is active, the host terminates transfer of write data by issuing a WRITE-FILE-MARK command. When the READY line is active, the host alternatively terminates transfer of write data by deactivating ONLINE. Deactivating ONLINE causes a File Mark to be written (if not preceded by a WRITE-FILE-MARK command) and the tape rewound to BOT. Note: A WRITE command following cartridge insertion or RESET shall commence recording at BOT end of tape, otherwise, recording shall commence at the current tape position. Note: if the host starts transfer between blocks before READY is asserted, READY may not be asserted.

When the early warning hole of the last track is detected by the device, the device ceases to transfer additional data blocks from the host. The device terminates the WRITE command and reports END OF MEDIA by means of an EXCEPTION and READ STATUS. Note: the device shall allow the transfer of up to 1024 bytes of data if a WRITE command is issued.

### 4.2.8 READ COMMAND (1000 0000)

The host asserts ONLINE and issues the READ command. The selected device transfers data. The READY line is activated when the device is ready for a data block transfer. The READ command shall be terminated by the device if a file mark is detected. The host is informed by means of an EXCEPTION and a READ STATUS sequence. When READY is asserted, the host may terminate the READ command by deactivating ONLINE. Deactivating ONLINE during READ also causes the tape to be rewound to BOT. When READY is true, the host may alternatively terminate the READ command by issuing a READ-FILE-MARK command. If a READ command is issued, the command is accepted and the drive continues reading. Note: a READ command following cartridge insertion or RESET shall commence at BOT, otherwise the read command commences from the current tape position. Note: if the host starts transfer between blocks before READY is asserted, READY may not be asserted.

### 4.2.9 WRITE-FILE-MARK COMMAND (0110 0000)

The WRITE-FILE-MARK (WFM) command causes a FILE MARK to be written on the tape in the selected drive. Note: a WFM command following cartridge insertion or RESET shall commence recording at BOT end of tape, otherwise, recording shall commence at the current tape position.

### 4.2.10 READ-FILE-MARK COMMAND (1010 0000)

The READ-FILE-MARK (RFM) command causes the tape in the selected drive to be moved to the next FILE MARK. Note: A RFM command following cartridge insertion or RESET shall commence reading at BOT, otherwise, reading shall commence at the current tape position.

## 4.3 OPTIONAL COMMAND DESCRIPTIONS

This section describes optional commands which if implemented shall be implemented as specified.

### 4.3.1 SELECT DRIVE, LOCK CARTRIDGE (0001 DRIVE)

This command is identical in function to the SELECT DRIVE command and additionally provides a soft (light) and/or hard lock on the cartridge. Execution of the SELECT command (0000 drive) or RESET unlocks the cartridge.

### 4.3.2 SELECT AUTO CARTRIDGE INITIALIZATION COMMAND (0010 0101)

This command will instruct the drive to perform a cartridge initialization each time a new cartridge is inserted. The drive will perform this operation for every cartridge insertion until the drive is reset or power is turned off.

### 4.3.3 WRITE WITHOUT UNDERRUNS COMMAND (0100 0001)

This command instructs the drive not to stop tape movement when a buffer underrun situation (no data available from the host) occurs in write mode. The drive will then proceed by writing an elongated preamble and/or redundant blocks until either the end of track is reached or data becomes available.

### 4.3.4 ENTER 6 BYTE PARAMETER BLOCK COMMAND (0100 1000)

This command shall be used to enter information to the drive which allows drive operation to be configured remotely. Its use is not restricted and allows a method of implementing additional functions not covered in the specific command set. The 6 byte parameter block shall be transferred as a 6 byte write data block.

### 4.3.5 WRITE N FILE MARKS COMMAND (0111 NNNN)

This command is identical in function to the WRITE FILE MARK command (0110 0000) except that the number of file marks written is determined by the binary value of NNNN. A value of NNNN=0 shall cause no operation to be performed.

### 4.3.6 SPACE FORWARD COMMAND (1000 0001)

This command moves the tape forward over the subsequent block. No data is transferred to the host.

### 4.3.7 READ REDUCED TRACK DENSITY COMMAND (1000 0100)

This command instructs the drive to perform the read operation on tapes with reduced track density.

### 4.3.8 SPACE FORWARD REDUCED TRACK DENSITY COMMAND (1000 0101)

This command instructs the drive to perform the space forward operation on tapes with reduced track density.

### 4.3.9 READ REVERSE COMMAND (1000 1000)

This command is identical in function to the READ command (1000 0000) except that tape motion is logically reversed. The byte transfer sequence is in the order read. If the command is issued at beginning of media, an exception will result.

### 4.3.10 SPACE REVERSE COMMAND (1000 1001)

This command moves the tape in reverse over the subsequent block. No data is transferred to the host. If the command is issued at beginning of media, an exception will result.

#### 4.3.11 READ REVERSE REDUCED TRACK DENSITY COMMAND (1000 1100)

This command instructs the drive to perform the read reverse operation on tapes with reduced track density.

#### 4.3.12 SPACE REVERSE REDUCED TRACK DENSITY COMMAND (1000 1101)

This command instructs the drive to perform the space reverse operation of tapes with reduced track density.

#### 4.3.13 SEEK END OF RECORDED DATA COMMAND (1010 0011)

This command instructs the drive to seek the end of recorded data. New data may then be appended to already existing data on the tape by issuing a write command.

#### 4.3.14 READ FILE MARK REDUCED TRACK DENSITY COMMAND (1010 0100)

This command instructs the drive to perform the read file mark operation on tapes with reduced track density.

#### 4.3.15 SEEK END OF RECORDED DATA REDUCED TRACK DENSITY (1010 0111)

This command instructs the drive to perform the seek end of recorded data operation on tapes with reduced track density.

#### 4.3.16 READ FILE MARK REVERSE COMMAND (1010 1000)

This command is identical in function to the READ FILE MARK command except that the tape is moved in the logically reverse direction. If this command is issued at beginning of tape, an exception shall result.

#### 4.3.17 READ FILE MARK REVERSE COMMAND REDUCED TRACK DENSITY (1010 1100)

This command instructs the drive to perform the read file mark reverse operation on tapes with reduced track density. If this command is issued at beginning of tape, an exception shall result.

#### 4.3.18 READ N FILE MARKS COMMAND (1011 NNNN)

This command is identical in function to the READ FILE MARK command (1010 0000) except that number of file marks read is the binary value of NNNN. A value of NNNN=0 shall cause no operation to be performed.

### 4.3.19 READ EXTENDED STATUS 1 COMMAND (1100 0001)

This command instructs the drive to transfer the first 6 status bytes from the extended status register. These bytes are numbered from 6 to 11. The table below shows the use of these bytes for different kinds of operations.

| Status Byte Number | 0 Select Command | 1 Position Command | 2 Write Command | 3 Write File Mark Command | 4 Read Command | 5 Read File Mark Command | 6 Self Test Command |
|---|---|---|---|---|---|---|---|
| 6 | Not used | Not used | Not used | Last File Mark Number | Not used | Last File Mark Number | Not used |
| 7 | Not used | Not used | Number of Good Blocks MSB | Not used | Number of Good Blocks MSB | Not used | Not used |
| 8 | Not used | Not used | Number of Good Blocks | Not used | Number of Good Blocks | Not used | Not used |
| 9 | Not used | Not used | Number of Good Blocks LSB | Not used | Number of Good Blocks LSB | Not used | Not used |
| 10 | Not used | Not used | Remaining Data Blocks In Buffer | Not used | Not used | Not used | Not used |
| 11 | Not used | Not used | Not used | Not used | Not used | Not used | Not used |

### 4.3.20 RUN SELF TEST 1 COMMAND (1100 0010)

This command instructs the drive to perform different kinds of selftest operations. The particular types of selftest operations performed are vendor unique. SELF TEST 1 does not allow writing on the cartridge in the permissible recording area. The result of the tests is given as a code which is available in status register 3. The code is vendor unique except that 0001 0001 always means selftest OK. A 0000 0000 result indicates that a selftest operation may not have been performed.

### 4.3.21 READ EXTENDED STATUS 2 COMMAND (1100 0100)

This command instructs the drive to transfer the following 6 status bytes:

```
0     current read file       MSB.
1     current read file       LSB.
2     current write file      MSB.
3     current write file      LSB.
4     diagnostic error code     .
5     track number              .
```

### 4.3.22 RUN SELF TEST 2 COMMAND (1100 1010)

This command is identical in function to the RUN SELF TEST 1 COMMAND (1100 0010) except that SELF TEST 2 allows writing on the cartridge in the permissible recording area. Note: user data will be destroyed.

### 4.3.23 READ EXTENDED STATUS 3 COMMAND (1110 0000)

The READ EXTENDED STATUS 3 command provides host with information for fault isolation of the selected device. The host issues the READ EXTENDED STATUS 3 command. The device transfers 64 bytes of vendor unique status information to the host.

## 5.0 STANDARD STATUS DESCRIPTION

ALL DEVICE STATUS shall be contained in 6 byte groups as defined in the STATUS BYTE SUMMARY (5.1).

## 5.1 STATUS BYTE SUMMARY

| BYTE 0 | BYTE 1 | EXS | DESCRIPTION |
|---|---|---|---|
| BIT 76543210 | 76543210 | | |
| \|\|\|\|\|\|\|\| | \|\|\|\|\|\|\|+--------- | POR | power on/reset occurred |
| \|\|\|\|\|\|\|\| | \|\|\|\|\|\|+---------- | RES | reserved for end of recorded media |
| \|\|\|\|\|\|\|\| | \|\|\|\|\+---------- | RES | reserved for bus parity error |
| \|\|\|\|\|\|\|\| | \|\|\|\+---------- | BOM | beginning of media |
| \|\|\|\|\|\|\|\| | \|\|\+---------- | MBD | marginal block detected |
| \|\|\|\|\|\|\|\| | \|\+---------- | NDT | no data detected |
| \|\|\|\|\|\|\|\| | \+---------- | ILL | illegal command |
| \|\|\|\|\|\|\|\| | +---------- | ST1 | status byte 1 bits |
| \|\|\|\|\|\|\|\| | | | |
| \|\|\|\|\|\|\|+---------- | | FIL | file mark detected |
| \|\|\|\|\|\|+---------- | | BNL | bad block not located |
| \|\|\|\|\+---------- | | UDA | unrecoverable data error |
| \|\|\|\+---------- | | EOM | end of media |
| \|\|\+---------- | | WRP | write protected cartridge |
| \|\+---------- | | USL | unselected drive |
| \+---------- | | CNI | cartridge not in place |
| +---------- | | STO | status byte 0 bits |
| BYTE 2 | BYTE 3 | DEC | data error counter |
| BYTE 4 | BYTE 5 | URC | underrun counter |

## 5.2 STATUS BYTE DESCRIPTION

Bytes 0 and 1 contain exception status (EXS) to define the reason that the device asserted EXCEPTION. A description of each status bit follows:

STATUS BYTE 1

BIT 0: POR - The power on reset bit is set after the host asserts RESET or when the controller is powered up. The bit is reset by a Read Status Sequence.

BIT 1: RES - Reserved

BIT 2: RES - Reserved

BIT 3: BOM - Beginning of Media bit is set whenever the cartridge is logically at beginning of tape, track 0. The bit is reset when the tape moves away from beginning of tape. This is the only bit in this byte that does not set EXCEPTION when it goes true, nor is it reset by the Read Status Sequence. This bit is reset when the tape moves away from the logical end of media or a RESET occurs.

BIT 4: MBD - Marginal Block Detected bit is set when the device determines that a data block is marginal. This bit is reset by a Read Status Sequence.

BIT 5: NDT - No Data Detected bit is set when an unrecoverable data error occurs due to lack of recorded data. Absence of recorded data is the failure to detect a data block within a controller time-out. This bit is reset by a Read Status Sequence.

BIT 6: ILL - Illegal Command bit is set if any of the following occurs. The bit is reset by a Read Status Sequence.

a. SELECT command is issued with no drives or more than one drive indicated.

b. ONLINE not asserted when a WRITE, WRITE FILE MARK, READ or READ FILE MARK command is issued.

c. A command other than WRITE or WRITE FILE MARK is issued during the execution of a Write Data Sequence.

d. A command other than READ or READ FILE MARK is issued during the execution of a Read Data Sequence.

e. A drive is deselected by another SELECT command when the cartridge in the currently selected drive is not at beginning of tape, track 0.

f. Any unimplemented command is issued.

BIT 7: ST1 - Status byte 1 bit is set if any other bit in Status byte 1 is set.

STATUS BYTE 0

BIT 0: FIL - File Mark Detected bit is set when a File Mark is detected during a Read Data or Read File Mark Sequence. The bit is reset by a Read Status Sequence.

BIT 1: BNL - Block in error Not Located bit is set when an unrecoverable read error occurs and the controller can not confirm that the last block transmitted was the block in error. The bit is reset by a Read Status Sequence.

BIT 2: UDA - Unrecoverable Data bit is set when the controller experiences a hard error during read or write operations. The bit is reset by a Read Status Sequence.

BIT 3: EOM - End of Media bit is set when the logical early warning hole of the last track is detected during a write operation. This bit will remain set as long as the drive is at logical end of media. The EOM bit will not be reset by a Read Status Sequence.

BIT 4: WRP - Write Protected bit is set if the cartridge write protect plug is set in the file protect "safe" position. Operator must change the write protect plug position before the status bit will reset.

BIT 5: USL - Drive Unselected bit is set if the selected drive is not physically connected or is not receiving power. Operator must correct the condition before the status bit will reset.

BIT 6: CNI - Cartridge not in Place bit is set if a cartridge is not fully inserted into the drive. Operator must correct the condition before the status bit will reset.

BIT 7: STO - Status Byte 0 bit is set if any other bit in Status Byte 0 is set.

Refer to EXCEPTION STATUS SUMMARY and EXCEPTION STATUS DESCRIPTION for further explanation.

Bytes 2 and 3 contain the data error counter (DEC) which accumulates the number of blocks rewritten for WRITE operations and the number of soft read errors during READ operations. These bytes shall be cleared by a Read Status Sequence.

Bytes 4 and 5 contain the underrun counter (URC) which accumulates the number of times that streaming was interrupted because host failed to maintain minimum through-put rate. These bytes shall be cleared by a Read Status Sequence.

## 5.3 EXCEPTION STATUS SUMMARY

| | BYTE 0 | BYTE 1 | DESCRIPTION |
|---|---|---|---|
| | 76543210 | 76543210 | |
| 1. | 110X0000 | 00000000 | ------- No cartridge |
| 2. | 11110000 | 00000000 | ------- No drive |
| 3. | 10010000 | X000X000 | ------- Write Protected |
| 4. | 10001000 | 00000000 | ------- End of Media |
| 5. | 100X0100 | 10001000 | ------- Read or Write abort |
| 6. | 100X0100 | 00000000 | ------- Read error, bad block xfer |
| 7. | 100X0110 | 00000000 | ------- Read error, filler block xfer |
| 8. | 100X0110 | 10100000 | ------- Read error, no data |
| 9. | 100X1110 | 10100000 | ------- Read error, no data & EOM |
| 10. | 100X0110 | 101X1XX0 | ------- Read error, no data & BOM |
| 11. | 100X0001 | 00000000 | ------- Read a filemark |
| 12. | XXXX0000 | 1100X000 | ------- Illegal command |
| 13. | XXXX0000 | 1000X001 | ------- Power on/reset |
| 14. | 100X0001 | 00010000 | ------- Marginal block detected |

NOTE: X denotes "could be either 0 or 1" condition

## 5.4 EXCEPTION STATUS DESCRIPTION

1. NO CARTRIDGE - Selected drive did not contain a cartridge when BOT, RET, ERASE, WRITE, WFM, READ or RFM was issued or cartridge was removed while the drive is selected. FATAL.

2. NO DRIVE - Selected drive was not present when BOT, RET, ERASE, WRITE, WFM, READ or RFM was issued. FATAL.

3. WRITE PROTECTED - Selected drive contained write protected (safe) cartridge when ERASE, WRITE or WFM was issued. FATAL.

4. END OF MEDIA - Tape has passed the logical early warning hole of the last track during WRITE command, CONTINUABLE.

5. READ OR WRITE ABORT - The maximum limit of same block rewrites occurred during a WRITE or WFM command or unrecoverable reposition error occurred during a WRITE, WFM, READ or RFM command. Tape has returned to BOT. FATAL.

6. READ ERROR, BAD BLOCK XFER - The maximum limit of same block retries failed to recover block without CRC error, last block transferred contained data from the erroneous data block for off line reconstruction. CONTINUABLE.

7. READ ERROR, FILLER BLOCK XFER - The maximum limit of same block retries failed to recover block without CRC error, last block transferred contained filler data to keep total block count correct. CONTINUABLE.

8. READ ERROR, NO DATA - No recorded data found on tape. CONTINUABLE.

9. READ ERROR, NO DATA AND EOM - The maximum limit of same block retries failed to recover the next or subsequent blocks and the logical end of tape holes on the last track were encountered. CONTINUABLE.

10. READ ERROR, NO DATA & BOM - During a reverse motion command, the maximum limit of same block retries failed to recover the next or subsequent blocks and the logical beginning of tape holes on the first track were encountered. CONTINUABLE.

11. FILEMARK READ - A filemark block was read during a READ or RFM command. CONTINUABLE.

12. ILLEGAL COMMAND - One of the following events occurred:

    a. Attempt to select other than one drive.
    b. Attempt to change drive selection when tape has been moved away from BOT by a read or write operation.
    c. Attempt to BOT, INITIALIZE CARTRIDGE, or ERASE simultaneously.
    d. Attempt to WRITE, WFM, READ or RFM with ONLINE off.
    e. Attempt to issue a command other than WRITE or WFM during a WRITE command. FATAL.
    f. Attempt to issue a command other than READ or RFM during a READ command. FATAL.
    g. Attempt to issue any command not implemented.

13. POWER ON/RESET - A power on reset or a reset by the host has occurred - FATAL.

14. MARGINAL BLOCK DETECTED - A marginal data block was detected by the device. CONTINUABLE.