



DEVELOPMENT STANDARD

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Revision J
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COMMAND SET INTERFACE SPECIFICATION
FOR FLEXIBLE DISK CONTROLLER BASED
MINI DATA CARTRIDGE TAPE DRIVES

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I. Revision History

Changes for Revision J:

- Pg. 24: assign Aiwa vendor ID.
- Pg. 7,8,14,17,27,30 : add 4 megabit data rate capability.

Changes for Revision I:

- Pg. 9: tape type 1 may indicate a variable length 550 Oe tape for backwards QIC-80 drive compatibility.
- Pg. 13: cleaning cartridge recognition.
- Pg. 19: calibrated segments may need overridden for QIC-80 compatibility.
- Pg. 24: assign PERTEC vendor ID.

Changes for Revision H:

- Pg. 9: change tape type 3 to indicate any variable length 550 Oe tape.
- Pg. 10: increase stop tape time-out to 8 seconds.
- Pg. 18: require calibrate or set N format segments before entering format mode for any tape type on drives that support these commands.
- Pg. 24: add ComByte vendor ID.
- Pg. 24 update Exabyte format fill character.
- Pg. 33: add application notes 5-7.

Changes for Revision G:

- Add Wide Tape (8mm) support for 550 and 900 Oe media.
 - Pg. 9: Add Wide Tape Bit to Report Tape Status for identifying a wide tape.
 - Pg. 7: Add Wide Tape Increment to Select Format for detecting a wide capable drive.
 - Pg. 9: Add tape type 3 to Report Tape Status for identifying a 400' 550 Oe tape.
 - Pg. 10: Set Seek Head to Track time-out to 15 seconds.
 - Pg. 10: Set Write Reference Bursts time-out to 940 seconds.
 - Pg. 5,17: Allow QIC-40 and QIC-80 drives to support Select Format, Calibrate Tape Length, Report Format Segments, and Set N Format Segments.
- Add support for 425', 550 Oe media.
 - Pg. 9: Report Tape Status tape type 1 indicates either 205' or 425' tape.
 - Pg. 5,17: Allow QIC-40 and QIC-80 drives to support Select Format, Calibrate Tape Length, Report Format Segments, and Set N Format Segments.

Changes for Revision F:

- Adds prefix codes to commands to indicate compatibility in table 2a.
- Documents Vendor Unique codes.
- Adds non-interruptible restriction to Calibrate Tape Length.
- Documents the use of Soft and Phantom selects.
- Warns of command set restrictions.
- Adds new error codes.
- Adds Vendor Make Code list with recommended format filler bytes.
- Adds Application Notes for Step Rate, Non-Standard Servo, Phantom Select on Laptops, and QIC-40 identification.
- Corrects the command argument description.
- Corrects the statement of values for table 2d.
- Adds fast speed in table 2d.
- Restates Extra Length as not standard length.
- Adds not support reports tape format as unknown.
- Documents the argument range of Skip N Segments.
- Include the format as part of the Report Tape.
- Warns of Skip N Segment Extended Arguments if ignored.
- Corrects command ignore range.
- Removes reference to QIC-107 and QIC-115.
- Adds alternative connectors to 34 pin interface.

1.1 Physical/Electrical Interface

The physical and electrical interface for the drive is defined by Subsection I and II. The specifics of connector pin assignments, signal levels, and terminations, etc., are related in these sections.

This first section will specify the timing relationships between the STEP, TRACK ZERO, and INDEX signals directly related to defining the logical command interface. All other electrical requirements for drive selection and interface bus signal qualification will be specified within the subsections for different physical configurations.

1.2 Signal Vocabulary

The following signals comprise the signal vocabulary of the logical command interface.

Signal Name	I/O	Function/Comments
STEP	Input	Transmits command pulse trains to the drive. The number of pulses received designates a numeric command or argument. Pulse train interpretation is controlled by timing. This signal is edge sensitive.
TRACK ZERO	Output	Transmits a response bit back to the host following the execution of a Report command. This signal is level sensitive.
INDEX	Output	Transmits pulses to the host to control read/write operations and to cause time-out interrupts with some of the host operations. This signal is edge sensitive.

Commands and information are communicated between the drive and host by the STEP and TRACK ZERO lines. The host sends commands as a various number of STEP pulses grouped in time as with a floppy disk seek operation. For the host to obtain information from the drive, report commands are issued whereby the drive returns a response bit on the TRACK ZERO line. This bit is identified by the location of the bit within the sequence of report commands where the least significant bit is always sent first. The INDEX pulses, in addition to marking the location of the data segment during the execution of the Logical Forward command, are generated to cue the host that a command related interval has elapsed and further host action is possible.

1.3 Signal Sequencing and Timing

Commands are sent to the drive by creating STEP pulse trains of width T_{STEPW} and at intervals of T_{STEP} via the host. The command code is determined by the number of pulses sent within the train. A retriggerable timer is set for $T_{TIMEOUT}$ and is used to detect the end of a command pulse train. This timer, which can be extended with the alternate time-out command, elapses after subsequent pulses are not received. All commands must be separated by more than the maximum command time-out.

The TRACK ZERO line returns information to the host in response to report commands and at all other times this line should be inactive. The leading edge of the first STEP pulse of a pulse train, received by the drive, causes the TRACK ZERO line to be cleared within T_{CLR} to the inactive state. With the TRACK ZERO line only active after a report command, the tape drive is prevented from being recognized as a diskette drive by a host Diskette Attachment Test (DAT). When the TRACK ZERO line is required to be in a valid state following a report command, this state shall be set within T_{ACK} from the nominal command time-out with the exception of the Report Next Bit command. The Report Next Bit command will assert the TRACK ZERO line within T_{BIT} from the leading edge of the second STEP pulse.

While not in a Read/Write operation, the INDEX line provides timing cues to the host to generate time-out interrupts. For this purpose, the drive may be in one of the following states:

1. **Ready or Idle:**the drive is not executing a command or in motion. The drive may have an error status or no cartridge and still be in the Ready state.
2. **Report in Progress:**the drive is responding to a report command by asserting or clearing the TRACK ZERO line.
3. **Waiting For Argument:**the drive has received a command which requires a numeric argument before execution can occur.

The INDEX will remain inactive within T_{INXOFF} from the leading edge of the first STEP pulse and throughout the reception of a STEP pulse train; otherwise, when the drive is in one of these states, INDEX pulses will be generated within T_{INXON} with a width of T_{INXW} at intervals of T_{INX} . These INDEX pulses can be used to inform the host of the following events:

1. The drive is Ready or Idle following a command execution.
2. The drive has presented a bit on the TRACK ZERO line following a Report command.
3. The drive is ready for a numeric argument if required by a preceding command.

Aside from the states listed above, the drive will not issue INDEX pulses, except as required during the execution of the Logical Forward command.

Note that the INDEX pulse cue mechanism should be supplemented by host time-outs. Some host hardware is known to ignore INDEX pulses in a few modes of operation and not generate interrupts when needed. If time-outs are used as a backup to INDEX pulse synchronization techniques, then the host driver software will continue to function regardless of the hardware limitations.

Table 1: Summary of Timing Parameters

Parameter	Description	Min	Nom	Max	Unit
T_{TIMEOUT}	Command Time-out	2.2	2.5	2.9	ms
	Alt Command Time-out	6.2	6.5	6.9	ms
T_{STEPW}	STEP Pulse Width	1		1100	us
T_{STEP}	STEP Pulse Interval	.9	2.0	2.1	ms
	Alt STEP Pulse Interval	.9	6.0	6.1	ms
T_{INXW}	INDEX Pulse Width	20		1100	us
T_{INX}	Cue INDEX Pulse Interval	2	4	12	ms
T_{INXON}	Time to Issue Cue Indexes			2.5	ms
T_{INXOFF}	Time to Clear Cue Indexes			2.5	ms
T_{ACK}	Time to Report Ack			2.5	ms
T_{BIT}	Time to Report Bit			900	us
T_{CLR}	Time to Clear TRACK ZERO			900	us

1.4 Command Types and Contexts

The command set supports three basic types of commands: report, mode, and motion control. The report commands enable the use of the TRACK ZERO line to report up to sixteen bits using a serial-output approach. The mode commands can select Primary, Format, Verify, and two Diagnostic modes.

1.4.1 Mode Switching Commands

The mode switching commands select a desired operating mode. The drive is initially in the Primary mode after a reset or no cartridge present. Any mode can be entered directly from any other mode. As a safeguard the Diagnostic mode commands must be issued twice in succession or an error will occur. The Diagnostic modes are to be used by the manufacturer only.

1.4.2 Report Commands

The report commands, once entered, must be completed with a series of Report Next Bit commands. Any other commands will cause an error and terminate the report. The report commands, when issued, enters the report subcontext and presents the first bit of the sequence to the TRACK ZERO line.

Note that the first bit of all report commands is Acknowledge, which is always TRUE, indicating that the drive has accepted the report command and assembled the remaining report bits. The host should wait T_{ACK} + nominal T_{TIMEOUT} from the last STEP pulse before reading the bit and issuing the Report Next Bit command. In the event that the drive does not respond with TRUE TRACK ZERO, the host shall consider that a hardware failure has occurred, or that a power-on or soft reset is occurring.

The final bit of all report commands is always TRUE. Once a report command has been entered, any other command except Report Next Bit and Reset will cause an "illegal command in report subcontext" error. The report subcontext will be exited and the Final report bit, normally true, will be false to indicate to the host that an error has occurred. Note that upon presentation of the Final report bit, the report subcontext is exited. The cue indexes will continue and the TRACK ZERO will remain asserted until another command is received by the drive. This command can be Report Next Bit which will be ignored outside the report subcontext but will serve to clear INDEX and TRACK ZERO. This additional command is important for reports made during Logical Forward motion and on host systems which use the TRACK ZERO line to perform a DAT.

The report commands send their responses serially at a rate determined by the host. To avoid ambiguity in interpretation and the possibility of a logical race condition, the data sent by a report command will always represent the latched state of the drive at the time the report command was received, no matter how much time the host consumes in the process of the clocking the status data out of the drive via Report Next Bit commands.

1.4.3 Command Arguments

Some commands require one to three arguments to complete the specification of the command action. An argument is a pulse train limited to a maximum of a 6 bit numeric value. For example, the Select Rate command requires a second STEP pulse train as an argument to specify the data rate. For commands that take one to three consecutive arguments to complete their command, the drive enters a command argument subcontext temporarily, in which case STEP pulses are interpreted as a command argument rather than as command.

The specifications for command arguments are described in Table 2b. The data to be sent as an argument must be converted to a form which avoids issuing a Soft Reset command (a single pulse). This is accomplished by adding 2 to the value and sending the resulting number of pulses. This is called the N+2 form which also makes possible sending the value zero.

1.4.4 Status Required

All commands have a specification detailing the drive status and mode required for their acceptance and execution by the drive. Most typically, the drive must present a Ready status before some commands are accepted. If such commands are issued when the drive is NOT Ready, these commands will be discarded and a "command received when not ready" error will result. In those cases where the execution of a command could otherwise be terminated using a Stop command, an error terminates the command as if a Stop command had been sent. In other cases, the command continues to execute to completion, but the Report Error Code will reflect the illegally sent command. (e.g.: Seek Head to Track). With the exception of the initialization errors, no error overwrites a previous error code. This ensures that initialization and process errors will not be lost.

Many commands will be rejected by the drive if an Error Detected or New Cartridge status is active. The only way to clear this status is to issue a Report Error Code command after the drive indicates ready. Failure to do so will result in a "command received while new cartridge pending"

error or if a previous error is detected then the previous error code will not be over-written. Some commands can only be issued in specific modes. If there is a conflict between the required mode and the mode in effect, a mode error will be generated and the command will not be executed.

2.0 Command List and Descriptions

In the following Table 2a, the numeric command codes are listed, along with a descriptive command name, restricted modes, and required drive status. The basic function and name of the commands do not change in the Primary, Format, and Verify modes; the Diagnostic mode commands are completely manufacturer-dependent. The execution of non-interruptible or high speed commands also restrict the use of some commands until completion and are shown as modes which are only temporary in effect. The illegal mode codes in Table 2a show which of Primary, Format, Verify, Non-Interruptible, and High Speed modes restrict the use of a command while one of these modes is in effect. The required status tabulation defines which Report Drive Status bits determine whether a command will be executed or rejected based on status.

The command codes listed in table 2a have a letter or number prefix. These prefixes indicate the compatibility level of the interface. There are now three Common Command Set, CCS, interfaces with the commands noted as Required, Discretionary, 1 or 2. The level 2 superset includes level 1 to supports the variable length format of the QIC-80, QIC-3010, QIC-3020 drives and 425 ft QIC-80 tapes.

The time-outs listed in Table 2d start at the nominal end of a command time-out except for the Report Next Bit which starts at the leading edge of the second STEP pulse. The expected event is limited by a maximum listed time with specific times calculated from the tape type and data rate.

Table 2a: Common Command Set Restriction Table

Code	Command Name	Illegal Modes	Reqd. Drive Status Bits							
			E	B	R	N	W	C	E	R
R 1	Soft Reset	- - - - -	-	-	-	-	-	-	-	-
R 2	Report Next Bit	- - - - -	-	-	-	-	-	-	-	-
R 3	Pause (n)	- - F N -	-	-	1	0	-	1	0	-
R 4	Micro Step Pause (n)	- - F N -	-	-	1	0	-	1	0	-
R 5	Alternate Command Time-out	- - - - -	-	-	-	-	-	-	-	-
R 6	Report Drive Status	- - - - -	-	-	-	-	-	-	-	-
R 7	Report Error Code	- - - - -	-	-	-	-	-	-	-	1
R 8	Report Drive Configuration	- - - - -	-	-	-	-	-	-	-	-
R 9	Report ROM Version	- - - - -	-	-	-	-	-	-	-	-
R 10	Logical Forward	- - - - -	*	*	1	0	*	1	0	1
R 11	Physical Reverse (h)	- - - - -	-	-	-	0	*	1	0	1
R 12	Physical Forward (h)	- - - - -	-	-	-	0	*	1	0	1
R 13	Seek Head to Track	- - - - -	-	-	1	0	-	1	0	1
R 14	Seek Load Point (n)	- - - - -	-	-	-	0	-	1	0	1
R 15	Enter Format Mode	- - - - -	-	-	-	0	0	1	0	1
R 16	Write Reference Burst (n)	P V - - -	-	-	-	0	0	1	0	1
R 17	Enter Verify Mode	- - - - -	-	-	1	0	-	1	0	1
R 18	Stop Tape (n)	- - - N -	-	-	-	-	-	-	-	-
19-20	reserved									
R 21	Micro Step Head Up	- - F N H	-	-	-	-	-	-	0	-
R 22	Micro Step Head Down	- - F N H	-	-	-	-	-	-	0	-
D 23	Soft Select	- - - - -	-	-	-	-	-	-	-	-
D 24	Soft Deselect	- - - - -	-	-	-	-	-	-	-	-
R 25	Skip N Segments Reverse (n)	- - F N -	-	-	1	0	-	1	0	-
R 26	Skip N Segments Forward (n)	- - F N -	-	-	1	0	-	1	0	-
R 27	Select Rate	- - - - -	-	-	-	-	-	-	0	1
2 27	Select Rate or Format	- - - - -	-	-	-	-	-	-	0	1
D 28	Enter Diag Mode 1									
D 29	Enter Diag Mode 2									
R 30	Enter Primary Mode	- - - - -	-	-	-	-	-	-	-	-
31	Vendor Unique									
R 32	Report Vendor ID	- - - - -	-	-	-	-	-	-	-	-
1 33	Report Tape Status	- - - - -	-	-	-	-	-	1	-	-
1 34	Skip N Segments Extended Reverse (n)	- - F N -	-	-	1	0	-	1	0	-
1 35	Skip N Segments Extended Forward (n)	- - F N -	-	-	1	0	-	1	0	-
2 36	Calibrate Tape Length (n)	- - - - -	-	-	-	0	-	1	0	1
2 37	Report Format Segments	- - - - -	-	-	-	0	-	1	0	1
2 38	Set N Format Segments	- - - - -	-	-	-	0	-	1	0	1
39	reserved									
40-45	Vendor Unique									
D 46	Phantom Select	- - - - -	-	-	-	-	-	-	-	-
D 47	Phantom Deselect	- - - - -	-	-	-	-	-	-	-	-

P=Primary Mode V=Verify Mode F=Format Mode
N=Non-Interruptible Mode H=High Speed Mode
(n)=Non-Interruptible command (h)=High Speed Command
*=Checked in Format Mode
R=Required D=Discretionary 1-2=CCS Compatibility

Table 2b: Common Command Set Argument Table

Code	Command	Argument(s)								
13	Seek Head to Track	Track+2								
23	Soft Select	20								
25	Skip N Segments Reverse	(N&15)+2, (N/16)+2								
26	Skip N Segments Forward	(N&15)+2, (N/16)+2								
27	Select Rate or Format	<p>N+2 (N=Rate or N=Format)</p> <p>Rate= 0 4 Mbps or 250 Kbps 1 2 Mbps 2 500 Kbps 3 1 Mbps</p> <p>Format = (Tape Format× 4) + Increment</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Tape Format= 1 QIC-40</td> <td style="width: 50%;">Increment = 0 reserved</td> </tr> <tr> <td>2 QIC-80</td> <td>1 Standard</td> </tr> <tr> <td>3 QIC-3020</td> <td>2 reserved</td> </tr> <tr> <td>4 QIC-3010</td> <td>3 Wide Tape (8mm)</td> </tr> </table>	Tape Format= 1 QIC-40	Increment = 0 reserved	2 QIC-80	1 Standard	3 QIC-3020	2 reserved	4 QIC-3010	3 Wide Tape (8mm)
Tape Format= 1 QIC-40	Increment = 0 reserved									
2 QIC-80	1 Standard									
3 QIC-3020	2 reserved									
4 QIC-3010	3 Wide Tape (8mm)									
28	Enter Diag Mode 1	28 (command entered twice)								
29	Enter Diag Mode 2	29 (command entered twice)								
34	Skip N Segments Extended Reverse	(N&15)+2, ((N/16)&15)+2, ((N/256)&15)+2								
35	Skip N Segments Extended Forward	(N&15)+2, ((N/16)&15)+2, ((N/256)&15)+2								
38	Set N Format Segments	(N&15)+2, ((N/16)&15)+2, ((N/256)&15)+2								
46	Phantom Select	N+2 N=Unit Address								

Table 2c: Report Command Response Table

Code	Command Name	Response	Definition	
6	Report Drive Status	0	Drive Ready or Idle	
		1	Error Detected	
		2	Cartridge Present	
		3	Cartridge Write Protected	
		4	New Cartridge	
		5	Cartridge Referenced	
		6	At Physical BOT	
		7	At Physical EOT	
7	Report Error Code	0-7	Error Code	
		8-15	Associated Command	
8	Report Drive Configuration	0	reserved (response = 0)	
		1	Vendor Unique (normally 0)	
		2	Vendor Unique (normally 0)	
		3-4	Rate 4,3 =	00 4 Mbps or 250 Kbps
				01 2 Mbps
				10 500 Kbps
				11 1 Mbps
		5	Vendor Unique (normally 0)	
6	Extra Length Tape Detected			
7	QIC-80 Mode			
9	Report ROM Version	0-6	ROM Version	
		7	ROM BETA indicator	
32	Report Vendor ID	0-15	Vendor Unique ID	

Table 2c: Report Command Response Table continued

33	Report Tape Status	0-3	Tape Format = 0000 Unknown 0001 QIC-40 0010 QIC-80 0011 QIC-3020-MC (500 MB) 0100 QIC-3010-MC (255 MB) 0101-1111 reserved
		4-6	Tape Type = 000 Unknown 001 205 ft. or 425+ ft. 550 Oe 010 307.5 ft. 550 Oe (XL) 011 Variable Length 550 Oe 100 1100 ft. 550 Oe 101 reserved 110 Variable Length 900 Oe 111 reserved
		7	Wide Tape (8mm)
37	Report Format Segments	0-15	Segments/Tape Track

Table 2d: Command Execution Time-out Table

Code	Command Name	Time-out	Event
1	Soft Reset	1	Acknowledge
1	Soft Reset	460	Ready
2	Report Next Bit (from last step)	900 us	Data Assert
3	Pause	16	Ready
4	Micro Step Pause	16	Ready
5	Alternate Command Time-out	0	----
6	Report Drive Status	2.5 ms	Acknowledge
7	Report Error Code	2.5 ms	Acknowledge
8	Report Drive Configuration	2.5 ms	Acknowledge
9	Report ROM Version	2.5 ms	Acknowledge
10	Logical Forward	650 Note 1	Ready
11	Physical Reverse	650 Note 2	Ready
12	Physical Forward	650 Note 2	Ready
13	Seek Head to Track	15	Ready
14	Seek Load Point	670 Note 2	Ready
15	Enter Format Mode	0	----
16	Write Reference Burst	940	Ready
17	Enter Verify Mode	0	----
18	Stop Tape	8	Ready
21	Micro Step Head Up	200 ms	Position
21	Micro Step Head Up	200 ms	Ready
22	Micro Step Head Down	200 ms	Position
22	Micro Step Head Down	200 ms	Ready
23	Soft Select	0	----
24	Soft Deselect	0	----
25	Skip N Segments Reverse	650 Note 2	Ready
26	Skip N Segments Forward	650 Note 2	Ready
27	Select Rate or Format	0	----
28	Enter Diag Mode 1	-	----
29	Enter Diag Mode 2	-	----
30	Enter Primary Mode	0	----
32	Report Vendor ID	2.5 ms	Acknowledge
33	Report Tape Status	2.5 ms	Acknowledge
34	Skip N Segments Extended Reverse	650 Note 2	Ready
35	Skip N Segments Extended Forward	650 Note 2	Ready
36	Calibrate Tape Length	1300 Note 2	Ready
37	Report Format Segments	2.5 ms	Acknowledge
38	Set N Format Segments	0	----
46	Phantom Select	0	----
47	Phantom Deselect	0	----

All times are in seconds unless stated otherwise, and are the maximum times expected for any combination of tape length and tape speed. Other cases may be considered using notes below

Note 1: Tape motion time=tape length/transfer rate tape speed.

Note 2: Tape motion time=tape length/fast seek tape speed.

Typical tape lengths: 205, 295, 307.5, 400 & 425. (feet nominal)

Typical tape speeds possible for data transfer:

22.6, 25, 34, 45.2, 50 and 68. Fast: 68 or higher (inches/sec)

Command Descriptions

(1) **Soft Reset.** A single command pulse in any mode, at any time, and within any subcontext, has the same effect on the tape drive as a power-up sequence; i.e.:

- The Primary mode is selected.
- Any message is terminated.
- The Reset error is set.
- All defaults are restored.
- A new cartridge status will be indicated if present.

If a cartridge is present, an automatic seek to load point can be optionally held until the first Report Drive Status.

The purpose of this command is to reset the drive automatically when the host is reset and the power-up boot procedure on the host performs a Diskette Attachment Test. This test uses 3 ms (or longer) STEP pulses to obtain a possible response on the TRACK ZERO line during a recalibration. Since such a step rate will cause a command recognition time-out to take place after each pulse, such a test will cause the tape drive to reset itself and de-assert the TRACK ZERO signal. This command causes a "Software Initiated Reset" error to be set in the drive.

Both the power-up and the software initiated reset cycles may invoke initialization diagnostic sequences in the controlling firmware of the drive. These sequences, which will vary from one make and model of drive to another, can consume up to 1 second during which the drive will not respond to any command, even the Report Drive Status command.

(2) **Report Next Bit.** Subsequent to any report command, this command causes the next bit (if any) in sequence to be reported on the TRACK ZERO line. For most controllers, this bit will be asserted before a seek complete interrupt is issued which allows the host to read the bit within the interrupt service. If not in a report command subcontext, this command is treated as a no-op and discarded and thus the TRACK ZERO line will be inactive.

(3) **Pause.** This command causes the tape to stop (if in motion), move in the logical reverse direction over the preceding data segments, or until logical BOT is reached, or an error condition is detected, and stop again. Reading and writing are disabled. The drive will remain NOT Ready until all tape motion stops, at which time the Error Detected status should be checked. The host software should ensure that no further motion commands are issued until the Ready status becomes true or such commands will produce an error. This command is not legal in the Format mode.

The number of segments which are backed over during Pause is dependent upon several factors, mostly dealing with motor starting and stopping characteristics, and may vary with different makes and models. Since this command is provided for implementing a retry mechanism, when logical forward motion is resumed, reading will start at least 3 Sector ID fields in the data segment two segments before the location where this command was

received. This requires a minimum of three erase gaps to be traversed during the Pause command and is equal to Skip 2 Segments Reverse.

- (4) Microstep Pause.** This command performs all of the operations of a Pause command (above), and also implements a head microstepping algorithm, for use in off-track recovery retry mechanisms in the host driver software. The drive firmware maintains a "Microstep Pause Cycle Counter". This counter is reset to zero every time the drive performs an explicit or implicit seek to track operation. Subsequent Microstep Pause commands increment the counter modulo three and the head location is controlled by the resulting value, per the following table:

Cycle Counter	Head Position
0	On Track Centerline
1	Track Centerline + 1/8 Track
2	Track Centerline - 1/8 Track

The fractional track offsets are approximated as closely as possible and without accumulation of approximation errors over multiple executions of the command.

If the Cycle Counter value (internal to the drive) is not zero (i.e., the head is currently offset from the nominal track centerline position), and a Seek Track command is received, the drive will nullify the current microstep offset before seeking the head to the new track position. Writing will be disabled while the head is offset from the track centerline.

- (5) Alternate Command Time-out.** This command causes the command time-out interval to be set to the alternate command time-out of 6.5 ms. The new value set will be suitable for step intervals of up to 6 ms per step. Once changed, the alternate command time-out remains in effect until a soft reset or power cycle occurs.

The purpose of this command is to allow the use of Western Digital 179X and 279X controllers. The Alternate Command Time-out is issued by repeatedly issuing Type I Step commands, prematurely terminated by a Force Interrupt Type IV command (to circumvent the minimum step rate), and repeating this at a 2 ms or faster rate. Subsequent commands can then make use of the normal step rate of the controller.

- (6) Report Drive Status.** This command reports eight bits of drive status, as listed in the Report Command Response Table 2c. Each bit definition is described as follows:

Drive Ready- the tape drive is not in motion or otherwise still in the process of executing tape or head motion. Most commands which require head or tape motion may not be issued when this bit is cleared. If such commands are issued, their execution shall be suppressed and an error will result.

Error Detected- the last command was in violation of the Command Restriction table or was completed with an error condition arising, or an asynchronous event led to an error condition such as a power-up or soft reset. This bit **MUST** be cleared by issuing the Report Error Code after the drive is ready. Commands requiring the

Error Detected bit to be cleared will fail. This bit is not valid unless the Drive Ready bit is asserted.

Cartridge Present- this bit always represents the debounced, real time status of the cartridge present microswitch. Most motion commands require cartridge present status before commands can be executed. If this bit is off and the interface write protect signal is off, a cleaning cartridge is present.

Cartridge Write-protected- this bit, when set, indicates that the write-protect feature of the cartridge is activated. Attempts to enter the format mode will fail due to a "cartridge write protected" error. Writing will be inhibited in all cases while write protected. This bit may be active without a cartridge present. If the drive supports the Select Format command, this bit is set when the drive is unable to write at the active or selected format.

New Cartridge- whenever the Cartridge Present status changes from false to true, this bit is internally set. This bit must be cleared using the Report Error Code command, even if no error status is otherwise indicated as pending. Any command requiring this bit to be cleared will fail due to "new cartridge status pending" error if this bit is otherwise set.

Referenced- cleared if no cartridge is present. If since the cartridge insertion, the seek load point algorithms were able to accurately locate valid reference bursts in the load point zone of the tape, this bit is set. It is also set if the last Write Reference Burst command execution was able to complete normally. In all other cases, this bit is cleared. This bit is NOT valid unless Drive Ready is asserted.

At BOT - cleared if no cartridge is present. If the tape is stopped at physical BOT, At BOT will be set, otherwise this bit is cleared. This bit is NOT valid unless Drive Ready is asserted.

At EOT - similar in every respect to At BOT, except this bit indicates that the tape is stopped at physical EOT.

(7) Report Error Code.This report shifts out two eight bit numbers: first the error code (LSB first), then the command code associated with the error (LSB first). A process error returns a command code of zero and an initialization error returns the command code of one. The error code is undefined unless Error Detected and Drive Ready status were returned. Issuing this command clears the Error Detected and New Cartridge status allowing subsequent commands to be initiated.

(8) Report Drive ConfigurationReturns information about the tape drive hardware configuration. See the bit encoding charts in the Report Command Response Table 2c.

The Rate Bits indicate the data transfer rate at which the drive will operate at when given a Logical Forward command. The rate can be changed on those drives which support multiple rates by using the Select Rate command. The coded Rate Bits reported by the

drive may change upon insertion of a cartridge or after a Select Rate command. A Rate value of zero represents either 4 Mbps or 250 Kbps based on the drive type. If the drive supports select format to QIC-3020 tape format, this value represents 4 Mbps, otherwise this value represents 250 Kbps.

The Extra Length Tape Detected bit is set if the drive detects a cartridge that is not a standard length. If this bit is set, then Logical Forward will automatically create an appropriate number of extra segments per track for formatting if the drive is reporting QIC-40 or QIC-80.

For drives complying with QIC-117 revision B and earlier only, the QIC-80/QIC-40 bit indicates the compatibility mode selected by the drive's auto-detect mechanism. During Seek Load Point, the drive will sense the reference bursts on the tape. If the load point zone is formatted per QIC-40, this bit will be cleared, and the drive will emulate a QIC-40 drive for all subsequent operations on that cartridge. Otherwise, the bit is set, and the drive will operate in QIC-80 mode for all subsequent operations. For drives complying with QIC-117 revision C and later, additional information is supplied by the related command Report Tape Status (33), which denotes tape type and tape format.

- (9) Report ROM Version.** Reports the version of the ROM in a manufacturer-dependent way. The "beta" bit is the last of the eight bits (LSB first) shifted out, and is used to distinguish test versions of ROMs before being released.
- (10) Logical Forward.** A FDC read or write can be issued any time after a logical forward in Primary and Verify modes; the drive will initiate forward tape motion if not at logical EOT, and will generate an INDEX pulse for the beginning of the data segment after an erased gap has been encountered on the tape. As some makes and models of drives start quickly, no Report Drive Status commands should be issued after this command and prior to a read/write operation to ensure a segment is not missed during the report.
- In Format Mode, this command will be accepted by the drive only if the tape is at logical BOT and the number of format segments is not zero; otherwise, command execution is suppressed and an error results. Additionally, during Format mode, the drive generates pairs of INDEX pulses, one to mark the beginning of a segment, and one to mark the end, with erased gaps automatically recorded before, between, and after segments. The last erased gap will be extended to the logical EOT. Timings and number of segments generated will be in accordance with the appropriate cartridge format specification.
- The drive will remain NOT Ready until motion stops, at which time the Error Detected status should be checked. This command is terminated when an error is detected, upon reaching logical EOT, or receiving a Stop, Pause, or Skip command.
- (11) Physical Reverse.** If the tape is already at physical BOT, this command is no-op. Otherwise the tape is moved at the highest available speed in the direction of physical BOT. The drive will remain NOT Ready until tape motion stops, at which time the Error detected status should be checked.

If command execution is not terminated by a Stop, Pause or Skip command, the tape will auto stop upon reaching physical BOT or detection of an error condition.

In the Format Mode, the drive will write a pattern over the tape to ensure proper overwrite of the DC erase gaps during subsequent formatting. If this command is not supported by a particular drive it will issue Error 15, Error in Format Mode. The host software drivers will perform this operation only if the reference bursts were detected before a Write Reference Burst operation.

(12) Physical Forward.This command is the same as physical reverse, but operates with the motion toward physical EOT.

(13) Seek Head to Track.This command takes one argument in the N+2 form. The argument is the track number to seek. The track position corresponding to a track number is determined according to the tape format compatibility mode in effect. An error can occur if the track number sent is not valid for the format in effect. The seek may be buffered or performed immediately. If the seek is not buffered, the drive will remain NOT Ready while the seek is being executed. If the head is already positioned to the desired track without any offsets, no head motion takes place and the command is treated as a no-op; otherwise, all offsets will be nullified before positioning.

(14) Seek Load Point.The tape is moved to the BOT area, the reference bursts are scanned (if present) to calibrate the head position to the reference bursts and determine the compatibility mode of the format. This command will not be stopped by any command or error and will continue to completion.

The drive will remain NOT Ready until tape motion stops, at which time the Error Detected status should be checked. The Referenced status will be set if a valid reference burst was detected, the Report Drive Configuration and Tape Status bits will be set or cleared according to the format detected (see commands 8 and 33) and the head will be positioned over track 0. If the format is not supported, Report Tape will indicate unknown tape format.

A Seek Load Point operation will be automatically performed following a cartridge insertion, or, if a cartridge is present, following a power-on or soft reset. The Seek Load Point operation can optionally be delayed until the receipt of a Report Status command which will initiate the operation and report NOT Ready until completion.

(15) Enter Format Mode.This command causes the drive to interpret and execute commands in the Format Mode context. The major difference between Format Mode and Primary Mode is the operation of Pause, Skip, Logical Forward, Physical Forward, and Physical Reverse commands.

(16) Write Reference Burst.This command, valid only in the format mode, causes the drive to format the Load Point Zone of the tape in accordance with the appropriate format specification for the drive or selected format. The Referenced status is set if the operation is successful. This command will not be stopped by any command or error and will

continue to completion. Issuing a Write Reference Burst with a selected format different from that used for a Calibrate Tape Length will zero the number of format segments.

(17) Enter Verify Mode. This command puts the drive into Verify mode, in which special circuitry reduces the read margins to a more stringent value useful for detecting tape media defects. This mode affects only the data stream output from the Logical Forward command, and is used when reading back a tape after a format operation to detect bad sectors.

Some drives require a subsequent Seek Load Point command to allow adjustment of verify thresholds. On such drives, failure to do so will result in a "Warning -- Read Gain Setting Error" when a Logical Forward command is issued.

(18) Stop Tape. This command causes tape motion to stop. The drive remains NOT Ready until tape motion comes to a stop. The Stop command is a no-op if there is no tape in the drive, or if the tape is already stopped. The host software should ensure that no further motion commands are issued until the Ready status becomes true or such a command will cause errors and not be executed.

(21) Microstep Head Up
and

(22) Microstep Head Down This command may be issued with the tape either stopped or in Logical Forward motion. These commands can be used by the host driver software to attempt recovery from suspected off-track conditions which may be inducing excessive read/write errors. If the tape is not moving when issued, the microstep seek may be buffered. The most accurate methods of issuing the Microstep commands and the actual distance will vary between different models and makes. The host should wait at least 200 ms after the command time-out interval has elapsed to allow the drive to step the head, and then let the head settle on the new position. A subsequent Seek Track command will return the head to the nominal track position.

(23) Soft Select. (Optional) This is a command to support a drive selection method. This command is followed by an argument of 20 steps not in the N+2 form. The operation of this command is similar to Phantom Select (46) except only a single tape drive can share the interface and the drive is deselected using Soft Deselect (24) or a Reset command. Drives which do not support this command will report an "Undefined or Reserved Command Code" error.

(24) Soft Deselect. (Optional) This command deselects a drive selected by the Soft Select command. This command will have no effect on the mode or status of the drive except to disable the outputs. Drives which do not support this command may report an "Undefined or Reserved Command Code" error or treat this command as a no-op.

(25) Skip N Segments Reverse. This command requires two arguments which define the relative number of segments to traverse in the logical reverse direction. The number of segments is divided into two 4-bit nibbles. The lower nibble is sent first in the form N+2, followed by the upper nibble also sent in the form N+2. This command is a modified version of the

Pause command and can be used instead of a Pause command to perform a retry in addition to random data accesses.

The drive, upon receipt of the arguments, initiates tape motion at the highest possible speed in the reverse direction and continues to move until the number of segments to move is satisfied, or logical BOT is encountered. The drive uses erased gaps to detect and count the number of segments. The number of gaps traversed is one greater than the number of segments requested in the arguments. A request for 0 segments will cause the tape to traverse a single erased gap. As with the Pause command, the actual number of erased gaps traversed may be greater due to slow motor start and stop times and therefore requires that the Sector ID be read after this command to determine the actual segment location. If the tape is already at the logical BOT, the command will be treated as a no-op.

Some drives may issue error 33 if the number of skip segments exceed the number of format segments.

(26) Skip N Segments Forward. This command is the same as Skip N Segments Reverse, but operates with the motion toward logical EOT.

(27) Select Rate or Format. The command expects an argument in N+2 form. The argument selects the data transfer rate or the Selected Format. Drives made prior to Rev E only support Select Rate.

Selecting data rate 0 selects either 4 Mbps or 250 Kbps based on the drive type. If the drive supports select format to QIC-3020 tape format, this value represents 4 Mbps, otherwise this value represents 250 Kbps.

The format selected by the host before Calibrate Tape Length, Set N Format Segments, and Write Reference Burst is used by the drive to establish the number of segments for variable length tape support and to format the Load Zone in accordance with the appropriate QIC format. It is recommended that host software selects the format before format operations are attempted.

On drives which do not support selectable rate or format, an error status of "Rate or Format Selection Error" will be set. This command should be followed up with Report Drive Configuration to confirm rate selection.

QIC-40 and QIC-80 drives that support Select Format also support Calibrate Tape Length, Report Format Segments, and Set N Format Segments.

(28) Enter Diagnostic Mode 1.
and

(29) Enter Diagnostic Mode 2. These commands are manufacturer dependent. As a safety feature this command must be issued twice in sequence to cause the mode to switch, otherwise an error is set. The diagnostic mode will be exited by issuing an Enter Primary Mode command.

(30) Enter Primary Mode.This command is legal from every command mode and status and always returns the drive to the Primary Mode command context.

(32) Report Vendor ID.This command allows the software to restrict operation or the use of certain commands based on the resulting 16 bit (LSB first) Vendor ID number. This command can also be used by the host to determine the presence of a tape drive during an Tape Attachment Test without inducing tape motion from the auto seek load point. The bits 0-5 define the Model and bits 6-15 define the Make. The Make codes are assigned with the concurrence of the participating standards committee members. The Make code of 0 will be used until assignments are made.

(33) Report Tape Status.Returns information about the type of tape currently in the tape drive and the active format. See bit encoding charts in the Report Command Response Table 2c.

The Tape Format Type bits indicate the compatibility mode selected by the drive's auto-detect mechanism. During Seek Load Point, the drive will sense the reference bursts on the tape.

The Tape Type bits indicate the length and coercivity of the currently installed media.

When the Wide Tape bit is set to one, an 8mm (.315in.) media is installed.

(34) Skip N Segments Extended ReverseThis command is the same as Skip N Segments Reverse (25) except that a third argument is added to extend the skip distance. This command requires three arguments which define the relative number of segments to traverse in the logical reverse direction. The number of segments is divided into three 4-bit nibbles (for a total of 4095 segments). All nibbles are sent in N+2 form and the least significant nibble is sent first. Drives that do not support this command will treat this command as a no-op but the arguments may cause false commands.

(35) Skip N Segments Extended ForwardThis command is the same as Skip N Segments Extended Reverse, but operates with the motion toward logical EOT.

Commands 36, 37 and 38 pertain to drives which support variable length tapes. For all tape types, either a Calibrate Tape Length command or a Set N Format Segments command must be sent prior to entering format mode. A status check must be performed after issuing the enter format mode command. If the above conditions have not been met, the drive shall respond with an error "Illegal Entry into Format Mode".

(36) Calibrate Tape Length.This command causes the drive to determine the number of segments per track that are available on the tape. The number of segments is based on the selected format or the highest capacity format if a Select Format has not been issued.

Tape length is dependent upon several factors, including the physical length of the tape, motor speed, and potentially motor direction. This command should cause the drive to

determine the largest number of segments per track that the tape drive can guarantee for all tracks.

Host software shall override the number of segments calibrated to meet QIC-80 Rev A-K specifications for fixed length 550 Oe tapes. Since tape type 1 of report tape status indicates a fixed or variable length tape, the following algorithm may be used to determine segments per track for compliance:

Segments Calibrated	Override To
1-153	100
154-228	207
229 or more	-

(37) Report Format Segments. This command returns the number of segments per tape track available on the tape, which is a result of the Calibrate Tape Length command. This command will return a value of zero if the calibrate Tape Length command has not been executed since the last drive reset (either power-on reset or soft reset) or since the last new tape condition was detected by the drive.

(38) Set N Format Segments, Arguments. This command sets the number of segments that the drive shall use for generation of index pulses in the format mode.

(46) Phantom Select. (Optional) This is a command to support a drive selection method. This command is followed by an argument to identify the phantom drive being selected. This allows multiple phantom drives to share the same interface. As most systems use a twisted ribbon cable which activate only Drive Select 1 & 2, this method was adopted to allow more than two drives on an interface which supports only two Drive Select signals. To prevent an interface conflict, it is the responsibility of the Host software to ensure all other drives are inactive before issuing a Phantom Select command.

A drive may operate in the phantom mode without the use of this command, in which case, whenever both Drive Select 1 & 2 are inactive, a single phantom drive is selected. Phantom drives using this command are deselected by either a Reset command or Phantom Deselect. Drives which do not support this command will treat this command as a no-op. Host software shall ensure only one drive is selected.

(47) Phantom Deselect. (Optional) This command deselects a phantom drive selected by the Phantom select command. This command will have no effect on the mode or status of the drive except to disable the outputs. Drives which do not support this command will treat this command as a no-op.

3.0 Error Conditions

Any command not supported by the drive which is greater than 32 STEP pulses or an argument out of range will be ignored and, during the report subcontext, the data bit will be repeated when a Report Next Bit command is subsequently received. Only undefined commands less than the Report Vendor ID will cause an "undefined or reserved command code" error. This limit is to

allow the recalibration of the host system without causing any reaction from the drive with the exception of the Report Next Bit command which outputs a 1 on TRACK ZERO. In this case, the recalibration will appear as a valid command and the message will not be terminated with the TRUE Final bit.

Unless the drive supports the Report Tape Status command, host software should not issue the Skip N Segments Extended commands. Unless the drive supports Select Format, host software should not issue Calibrate Tape Length, Report Format Segments, or Set N Format Segments. If a command is rejected then its arguments could induce a false command.

There are two states the tape drive may enter which inhibit further motion commands until the state is cleared: the New Cartridge state and the Error Detected state.

3.1 New Cartridge Status Pending

In the case of the New Cartridge state, any command requiring this status to be cleared will set the "new cartridge status pending" error. A previous error may still be latched which will not allow this error to be indicated; however, the New Cartridge bit will be set in the drive status. This status can be cleared by issuing the Report Drive Status command followed by the Report Error Code Command when the drive indicates Ready. This Report Error Code guarantees that the host will recognize the New Cartridge status before continuing further.

3.2 Power Up and Soft Resets

As a safeguard against loss of context between the tape drive and the host, a power-on or a software-initiated reset will be considered an error condition, and will overwrite any error codes. This error must be cleared before proceeding, ensuring that such occurrences are not overlooked by the host.

3.3 Tape Motion Errors

When an error occurs during the execution of a command (typically a motion command), the command is terminated and the tape is stopped. The Error Detected bit is set, and an appropriate error code is set. Until the Report Error Code command is executed, further motion commands will be inhibited in a fashion similar to that described for the New Cartridge status. Once the Report Error Command is executed after the drive is ready, the Error Detected status is cleared and motion commands will be re-enabled.

3.4 Report Subcontext Errors

During a Report command, the command processor of the drive is in a "report subcontext". If any command other than Report Next Bit is received, the report subcontext will be terminated with an "illegal command during report subcontext" error, the Error Detected bit will be set and the Final report bit, which is normally a "1" at the end of a report sequence, will instead be "0". This will be the first indication to the host that an error has occurred and the status just received is invalid. In

any case most commands will be rejected until the Report Error Code is used to clear the Error Detected status.

3.5 Error Code List

The errors listed below are divided into three classes of errors. Each class associates errors which occur within three different phases of the operation of drive. Within each class the highest priority error is listed first and once an error is detected the remaining errors will not be tested. With the exception of the initialization errors, the error status is never overwritten.

It should be noted that the list below should be supported by all host software; however, it is not required that all drives detect all the errors listed below. Some of these errors may not be appropriate to a particular implementation. Additionally, any manufacturer can "invent" new error codes to be added to the list, with the concurrence of the participating standards committee members.

Error Codes Class and Priority list

Initialization errors:(overwrites previous error)

- (20) Self-Diagnostic Failed (can not be cleared)
- (21) Warning EEPROM Not Initialized, defaults set
- (22) EEPROM Corrupted or Hardware Failure
- (37) Prom Code Missing
- (40) Prom A Checksum Error
- (42) Prom B Checksum Error
- (41) Drive Wakeup Reset Occurred
- (26) Power On Reset Occurred
- (27) Software Reset Occurred

Pre-execution errors:

- (8) Illegal Command in Report Subcontext
- (13) Command Received While New Cartridge Pending
- (14) Command Illegal or Undefined in Primary Mode
- (15) Command Illegal or Undefined in Format Mode
- (16) Command Illegal or Undefined in Verify Mode
- (30) Command Received During Non-Interruptible Process
- (1) Command Received While Drive Not Ready
- (2) Cartridge Not Present or Removed
- (19) Command Illegal When Cartridge Not Referenced
- (5) Cartridge Write Protected
- (6) Undefined or Reserved Command Code
- (7) Illegal Track Address Specified for Seek
- (9) Illegal Entry into a Diagnostic Mode
- (17) Logical Forward Not at Logical BOT or no Format Segments in Format Mode
- (31) Rate or Format Selection error
- (32) Illegal Command While in High Speed Mode
- (33) Illegal Seek Segment Value
- (43) Illegal Entry into Format Mode

Process errors:

- (3) Motor Speed Error (not within 1%)
- (4) Motor Speed Fault (jammed, or gross speed error)
- (10) Broken Tape Detected (based on hole sensor)
- (11) Warning -- Read Gain Setting Error
- (18) Logical EOT Before All Segments Generated
- (23) Motion Time-out Error
- (24) Data Segment Too Long -- Logical Forward or Pause
- (28) Diagnostic Mode 1 Error
- (29) Diagnostic Mode 2 Error
- (34) Invalid Media
- (35) Head Positioning Failure
- (36) Write Reference Burst Failure
- (38) Invalid Format
- (39) EOT/BOT System Failure

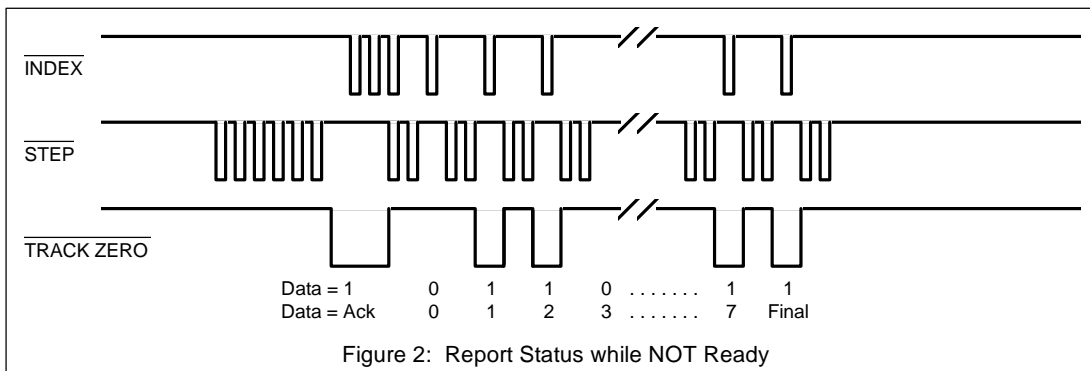
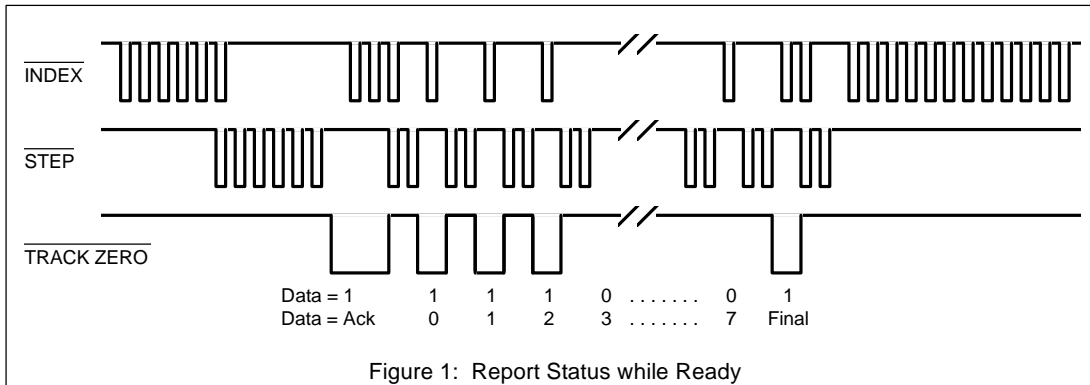
Obsolete errors:

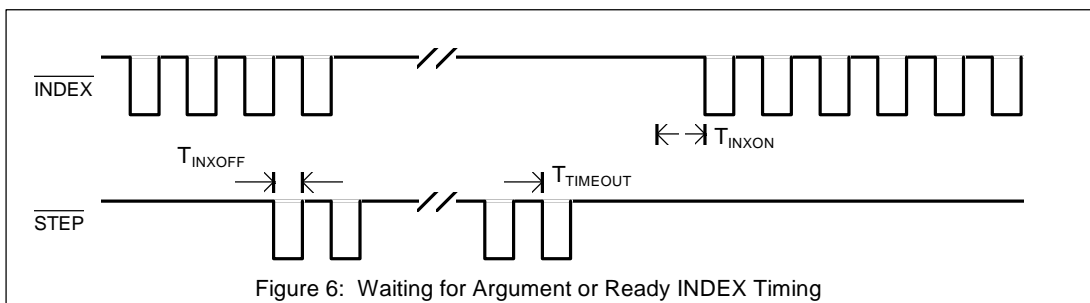
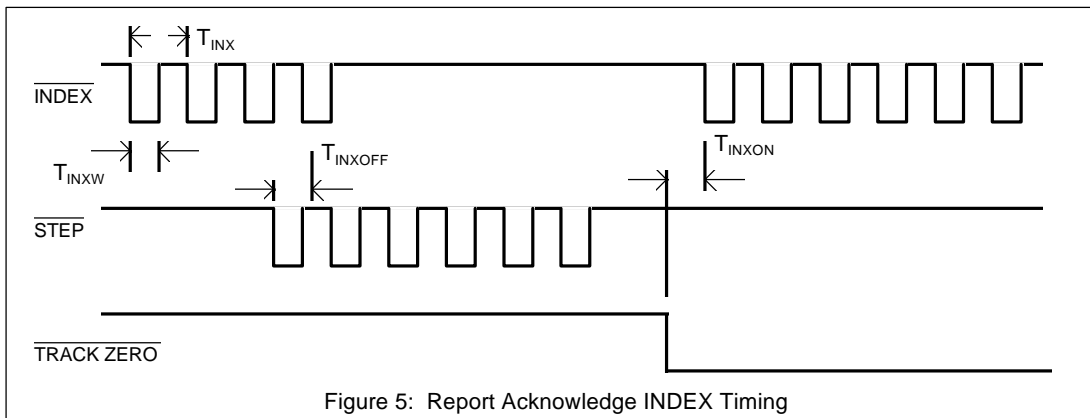
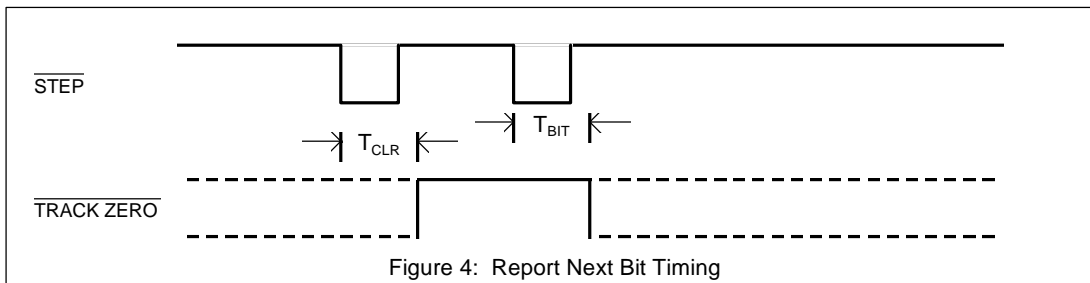
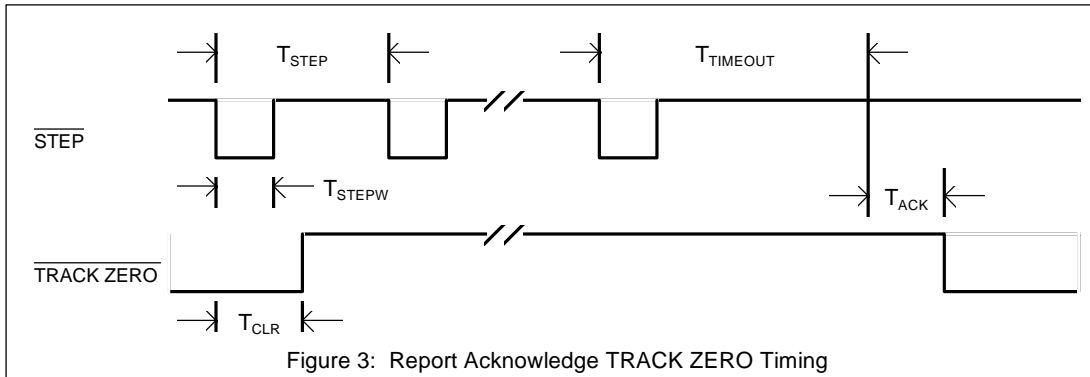
- (12) Command Received While Error Status Pending
- (25) Transmit Overrun

Sequential Error Code List

- (1) Command Received while Drive Not Ready
- (2) Cartridge Not Present or Removed
- (3) Motor Speed Error (not within 1%)
- (4) Motor Speed Fault (jammed, or gross speed error)
- (5) Cartridge Write Protected
- (6) Undefined or Reserved Command Code
- (7) Illegal Track Address Specified for Seek
- (8) Illegal Command in Report Subcontext
- (9) Illegal Entry into a Diagnostic Mode
- (10) Broken Tape Detected (based on hole sensor)
- (11) Warning -- Read Gain Setting Error
- (12) Command Received While Error Status Pending (obs)
- (13) Command Received While New Cartridge Pending
- (14) Command Illegal or Undefined in Primary Mode
- (15) Command Illegal or Undefined in Format Mode
- (16) Command Illegal or Undefined in Verify Mode
- (17) Logical Forward Not at Logical BOT or no Format Segments in Format Mode
- (18) Logical EOT Before All Segments Generated
- (19) Command Illegal When Cartridge Not Referenced
- (20) Self-Diagnostic Failed (cannot be cleared)
- (21) Warning EEPROM Not Initialized, Defaults Set
- (22) EEPROM Corrupted or Hardware Failure
- (23) Motion Time-out Error
- (24) Data Segment Too Long -- Logical Forward or Pause
- (25) Transmit Overrun (obs)
- (26) Power On Reset Occurred
- (27) Software Reset Occurred
- (28) Diagnostic Mode 1 Error
- (29) Diagnostic Mode 2 Error
- (30) Command Received During Non-Interruptible Process
- (31) Rate or Format Selection Error
- (32) Illegal Command While in High Speed Mode
- (33) Illegal Seek Segment Value
- (34) Invalid Media
- (35) Head Positioning Failure
- (36) Write Reference Burst Failure
- (37) Prom Code Missing
- (38) Invalid Format
- (39) EOT/BOT System Failure
- (40) Prom A Checksum Error
- (41) Drive Wakeup Reset Occurred
- (42) Prom B Checksum Error
- (43) Illegal Entry into Format Mode

FIGURES 1-6: COMMAND TIMING





Subsection I Electrical Specifications for 34 pin Open-Collector Configuration

I-1 Scope

The requirements of this interface allow the tape drive to function in place of a standard diskette drive. This interface supports transfer rates of 250 Kbps, 500 Kbps, 1 Mbps, 2 Mbps and 4 Mbps.

I-2 Interface Signals

All interface signals operate at TTL logic levels and are low true. The acceptable voltage levels and the active state are outlined in Table I-a. All drive input signals are terminated only by the last drive on the cable with the exception of the Drive Select lines which are terminated by the corresponding drive. Each drive provides for a termination pack which provides for either 150 ohm to 1 kohm pull-up to +5 volts or 220/330 ohms between +5 volts and ground. Each input signal receiver provides about 800 mV of hysteresis centered about a logic level of 1.2 volts. The drive outputs are all open-collector and can sink 40 mA at the active state. The host provides termination for the drive output signals. The typical receivers and drivers are 74LS14 and 7438. The interface signal assignments are outlined in Table I-b.

I-3 Physical Interface

Either a 34 pin card edge connection for the control signals that will accept an AMP 1-480426-0 equivalent or a double row .025 square posts on .100 centers AMP 1-102847-8 equivalent with Pin 1 clearly marked, preferably to the right as seen from the front. A slot is provided on the card edge between pins 4 and 6 for connector keying. All odd pins are on the same side of the connector and connect to signal ground. The mating cable assembly will provide a 34 conductor AWG #28 ribbon cable which is less than 6 feet in length. The 4 pin DC power connector will accept either an AMP Mate-N-Lok 1-408424-0 or AMP MTA-100 such as AMP 171826-4. The power connector provides for +5 and +12 volt inputs and two power returns. Refer to table I-c for power pin assignments.

I-4 Input Signals

Reduced Write:

This signal is provided an optional termination, otherwise not used.

Drive Select 0-3:

Each Drive Select signal enables or disables the output of the corresponding drive within 10 us. All other control signals are valid only after the drive is selected. (Phantom drives may provide 1 Kohm pull-up to +5 volt for drive selects 1 & 2.)

Motor On:

This signal is provided an optional termination, otherwise not used.

Direction Select:

This signal is provided an optional termination, otherwise not used.

Step:

This signal is used to issue drive commands. The timing of this signal is determined from the leading edge, or the inactive to active state.

Write Data:

This signal is used to cause a flux transition for each leading edge or inactive to active state. This signal is enabled only when Write Enable is active. Write data shall have precompensation of 41.67 ns at 1 Mbps, 125 ns at 500 Kbps and 250 ns at 250 Kbps. Exceptions to this are that QIC-3010-MC and QIC-3020-MC formats shall have no write precompensation (i.e. 0 ns) in the write data from the controller to the drive.

Write Enable:

This signal enables the operation of Write Data for a write operation. The Drive Select signal should be active during the entire operation of this signal. This signal will be active 100 ns before and after any Write Data transitions.

Side Select:

This signal is provided an optional termination, otherwise not used.

I-5 Output Signals

Index:

The leading edge or inactive to active state of this signal marks the location of Data Segments and cues the host system for control operations while idle or waiting for commands. During Read/Write operations this signal will become active within 8 flux transitions on the tape following the detection of at least a 50% duration of an erased gap.

Track Zero:

Provides drive information following a report command.

Write Protect:

Indicates the Record tab on the tape cartridge is not set in the record position.

Read Data:

A 150 ns +/- 25% pulse is provided for each flux transition detected on the tape during a Logical Forward command. The timing of this signal is determined from the leading edge or the inactive to active state.

Diskette Change:

Not Connected.

Table I-a Interface Logic Levels

Level	Voltage Range
inactive	2.5 to 5.25
active	0 to 0.4

Table I-b Interface Pin Assignments

Pin	I/O	Signal Name
2	I	Reduced Write
4	-	Reserved
6	I	Drive Select 3
8	O	Index
10	I	Drive Select 0
12	I	Drive Select 1
14	I	Drive Select 2
16	I	Motor On
18	I	Direction
20	I	Step
22	I	Write Data
24	I	Write Enable
26	O	Track Zero
28	O	Write Protect
30	O	Read Data
32	I	Side Select
34	O	Diskette Change

Table I-c Power Pin Assignments

Pin	Signal Name
1	+12 DC Volts
2	+12 Return
3	+5 Return
4	+5 DC Volts

Subsection II Electrical Specifications for 40 pin Tri-State Configuration

II-1 Scope

The requirements of this interface allow the tape drive to function in place of a standard diskette drive. This interface supports transfer rates of 250 Kbps, 500 Kbps, 1 Mbps, 2 Mbps and 4 Mbps.

II-2 Interface Signals

All interface signals operate at TTL logic levels and are low true. The acceptable voltage levels and the active state are outlined in Table II-a. Signal termination is not required; however, all drive input signals may be terminated only by the last drive on the cable with the exception of the Drive Select lines which may be terminated by the corresponding drive. Each drive may provide for an optional termination pack which provides for 4.7 kohm pull-up to +5 volts. Each input signal receiver provides about 650 mV of hysteresis centered about a logic level of 1.3 volts and has a maximum capacitance of 10 pF. The drive outputs are all LS-compatible Tri-State and can sink 4.0 mA at the active state. The typical receivers and drivers are 74HCT14 and 74HCT367. The interface signal assignments are outlined in Table II-b.

II-3 Physical Interface

The 40 pin card edge connection for the control and power signals will accept an AMP 583717-5 or equivalent. A slot is provided on the card edge between pins 34 and 36 for connector keying. All odd pins are on the same side of the connector and are connected to ground except pin 3 which is left open. The mating cable assembly will provide a 40 conductor AWG #28 ribbon cable which is less than 3 feet in length.

II-4 Input Signals

High Density:

This signal may be provided an optional termination, otherwise not used.

Drive Select 0-3:

Each Drive Select signal enables or disables the output of the corresponding drive within 10 us. All other control signals are valid only after the drive is selected. (Phantom drives may provide 10 Kohm pull-up to +5 volt for drive selects 1 & 2.)

Motor On:

This signal may be provided an optional termination, otherwise not used.

Direction Select:

This signal may be provided an optional termination, otherwise not used.

Step:

This signal is used to issue drive commands. The timing of this signal is determined from the leading edge or the inactive to active state.

Write Data:

This signal is used to cause a flux transition for each leading edge or inactive to active state. This signal is enabled only when Write Enable is active. Write data shall have precompensation of 41.67 ns at 1 Mbps, 125 ns at 500 Kbps and 250 ns at 250 Kbps. Exceptions to this are that QIC-3010-MC and QIC-3020-MC formats shall have no write precompensation (i.e. 0 ns) in the write data from the controller to the drive.

Write Enable:

This signal enables the operation of Write Data for a write operation. The Drive Select signal should be active during the entire operation of this signal. This signal will be active 100 ns before and after any Write Data transitions.

Side Select:

This signal may be provided an optional termination, otherwise not used.

II-5 Output Signals

Index:

The leading edge or inactive to active state of this signal marks the location of Data Segments and cues the host system for control operations while idle or waiting for commands. During Read/Write operations this signal will become active within 8 flux transitions on the tape following the detection of at least a 50% duration of an erased gap.

Track Zero:

Provides drive information following a report command.

Write Protect:

Indicates the Record tab on the tape cartridge is not set in the record position.

Read Data:

A 150 ns +/- 25% pulse is provided for each flux transition detected on the tape during a Logical Forward command. The timing of this signal is determined from the leading edge or the inactive to active state.

Diskette Change:

Not Connected.

Table II-a Interface Logic Levels

Level	Voltage Range
inactive input	2.0 to 5.25
active input	0 to 0.8
inactive output	3.7 to 5.25
active output	0 to 0.4

Table II-b Interface Pin Assignments

Pin	I/O	Signal Name
2	I	Reduced Write
4	-	Reserved
6	I	Drive Select 3
8	O	Index
10	I	Drive Select 0
12	I	Drive Select 1
14	I	Drive Select 2
16	I	Motor On
18	I	Direction
20	I	Step
22	I	Write Data
24	I	Write Enable
26	O	Track Zero
28	O	Write Protect
30	O	Read Data
32	I	Side Select
34	O	Diskette Change
36	-	Frame Ground
38	O	+5 DC Volts
40	I	+12 DC Volts

Application Notes

Note 1 Step Rate.

The original maximum step rate was 1 milli-second but many drives are unable to support this rate. It is strongly recommended that third party software operates at a 2 milli-second step rate.

Note 2 Vendor Unique Non-Standard Servo Tape Adaptation.

There are older servo tape formats which do not conform to the QIC standard that can be read with special software. The Vendor Unique drives report the presence of these tapes on two bits in the Report Drive Configuration. Bit 1 is set if these non-standard formats are detected. Bit 2 is set if this non-standard format is the lower capacity version in which case both bits will be set.

Should the drive detect these non-standard tapes, then the QIC-80 bit of this report will be cleared. Drives may not be equipped to follow the servo and, as such, a micro-step hunt of no more than 12 micro-steps above or below the track position should be used to stay over data. These tapes should be treated as Read Only and a Report Tape Status, if supported, will return "Unknown" as a tape format after a Seek Load Point operation with the Reference bit set.

Note 3 Phantom Selection on some Laptop computers.

Some of these computers require a non-existent drive B to be selected for the interface to operate. On most interfaces, both floppy drives are disabled with the clearing of the Motor Enable signal.

Note 4 QIC-40 Identification.

On drives below CCS-1 compatibility, when a QIC-40 tape is reported, the user may be asked to remove the tape to determine the type of drive. If the drive does not support CCS-1 and the Report Drive Configuration indicates a QIC-80 cartridge, then the host software can assume the drive is QIC-80.

Note 5 Detecting Wide Tape (8mm) capable drives

Issue a select format to a supported density with increment=3 instead of 1. If report drive status does not present an error status, the drive is wide capable.

Note 6 Determining if the inserted tape is readable, writeable, and/or formattable.

READABLE: The tape is readable if referenced is on for drives that do not support report tape status. For drives that do support report tape status, the tape is readable if referenced is on and either the report tape status format is non zero or bits 1 and 2 of the report drive configuration are on.

WRITEABLE: Issue a select format to the tape format from report tape status followed by report drive status. The tape is writeable if the write protect bit in report drive status is off .

FORMATTABLE: Issue a select format to the desired format. If drive accepts the select format and the write protect bit from report drive status is 0, the tape can be formatted at the given format.

Note 7 Segments per track considerations when formatting.

For drives supporting variable length 550 Oe media, the number of segments per track must be set using the Calibrate Tape Length command or the Set N Segments command prior to entering format mode for all tape types. The number of segments per track for 205 ft. and 307.5 ft. cartridges must be set to QIC-80 specification values to ensure specification compatibility. Drives which do not support variable length 550 Oe media must return an invalid command error upon attempted execution of either a Calibrate Tape Length command or a Set N Segments command.