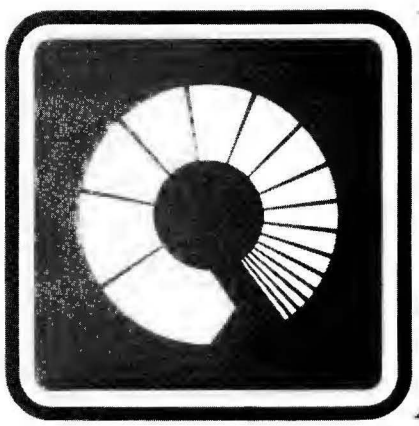
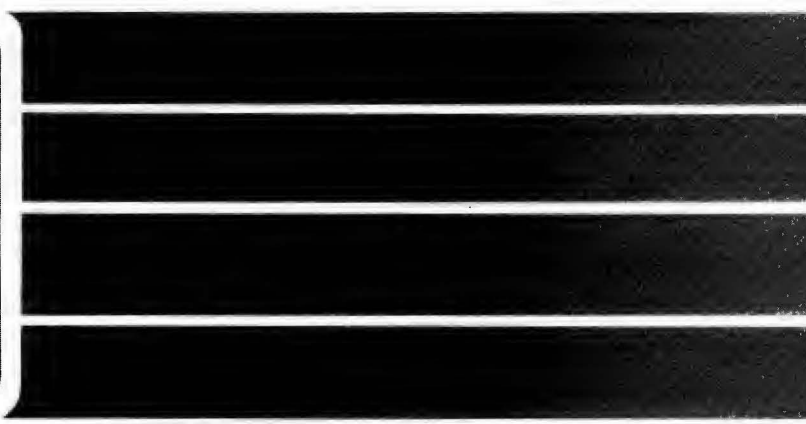
CS/80 INSTRUCTION SET

PROGRAMMING MANUAL





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CS/80 INSTRUCTION SET

PROGRAMMING MANUAL

DESIGNED FOR HP-IB SYSTEMS

HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a computation system.

Printed: APR 1983

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

The increase in capabilities of both host computers and mass storage devices has emphasized the need for efficient channel communications. The instruction set described in this manual increases the efficiency and speed of channel operations between disc drive mass storage devices and their associated host computers.

1-2. SCOPE OF MANUAL

This manual is organized into several sections: Section I, GENERAL INFORMATION provides a general explanation of the operation of a communications model and an overview of the instruction set itself; Section II, DEVICE COMMAND DETAILS provides a detailed explanation of each device command; Section III, TRANSPARENT MESSAGE COMMANDS provides a detailed explanation of each Transparent command; and Section IV, CHANNEL IMPLEMENTATION provides the specific command and message formats required to implement channel communications on the Hewlett-Packard Interface Bus (HP-IB). (HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a computation system.)

1-3. TERMS USED IN THIS MANUAL

Specific terms, abbreviations, and mnemonics used in this manual are listed in the Glossary (refer to Appendix A).

1-4. COMMUNICATIONS SYSTEM MODEL

A communications system contains at least three components: a system host, a communications channel, and one or more peripheral devices. See figure 1-1.

The host controls overall system operation, and initiates and controls communication transactions between system components.

The channel provides the physical communication link between system components. A given channel operates according to a specific set of pre-defined rules (protocol).

A peripheral device performs a specific subsystem function, operates according to a known scheme, recognizes and responds to a given set of operating commands, and requests and participates in communication transactions. A device may include a controller and up to seven units, with each unit containing up to eight volumes.

The following paragraphs describe the CS/80 communication transaction from several standpoints: the device addressing hierarchy, the device structure, the transaction structure, and the transaction messages.

1-5. DEVICE ADDRESSING HIERARCHY

CS/80 assumes a specific hierarchical structure for addressing purposes. That hierarchy in decending order is: device, unit, and volume. See figure 1-1.

A device exists at an addressable port on the channel and may contain a controller and up to seven units.

A unit is a separately addressable entity within a device such as the controller, or a specific storage implementation. Two or more units may share a common controller within a device and are capable of parallel operation. For example, a mass storage device may contain a controller and both a disc drive and a tape drive. In this case, the controller could transfer data from one to the other. A unit may contain up to eight volumes.

A volume is a separately addressable portion of the storage media on a given unit. Volumes are logically separated from each other due to some special attribute such as fixed or removable storage media. The various volumes of a given unit are not capable of parallel operation.

1-6. DEVICE STRUCTURE

As shown in figure 1-1, a CS/80 device consists of the hardware required to perform its function, the processing circuitry necessary to control functional operation, and the interface circuitry that is compatible with the requirements of the channel. The channel interface hardware and the processing circuitry comprise the device controller.

Resident in the device firmware are several modules which control the specific operational aspects of the device.

The channel module intercepts and determines the acceptability of an incoming message and formats an outgoing message to the electrical and protocol requirements of the channel. If more than one unit exists within a device, the channel module directs the incoming message to the proper logical machine module. Channel specific information is removed from the incoming message at this level leaving only device operating information to be passed to the applicable logical machine. Operations occurring at the channel module level are transparent to the functional operation of the device.

The logical machine is responsible for managing input and output data to achieve optimal throughput. The logical machine interprets the incoming commands, controls the device unit operational states, and co-ordinates the flow of data in and out of the unit.

The unit functional control module supervises the operation of the functional hardware of the unit.

The diagnostic module contains the routines for self test. The routines can be called collectively for an overall diagnostic or individually to test specific areas within the device.

The operation controller keeps track of device operation and establishes internal communication links. The controller may be an actual firmware block or distributed among the other firmware modules.

1-7. TRANSACTION STRUCTURE

A transaction is a logically complete operation between a system host and a logical machine within the device. A transaction begins when the channel module accepts a command and ends when a reporting message indicating the pass/fail status of the transaction is accepted by the host.

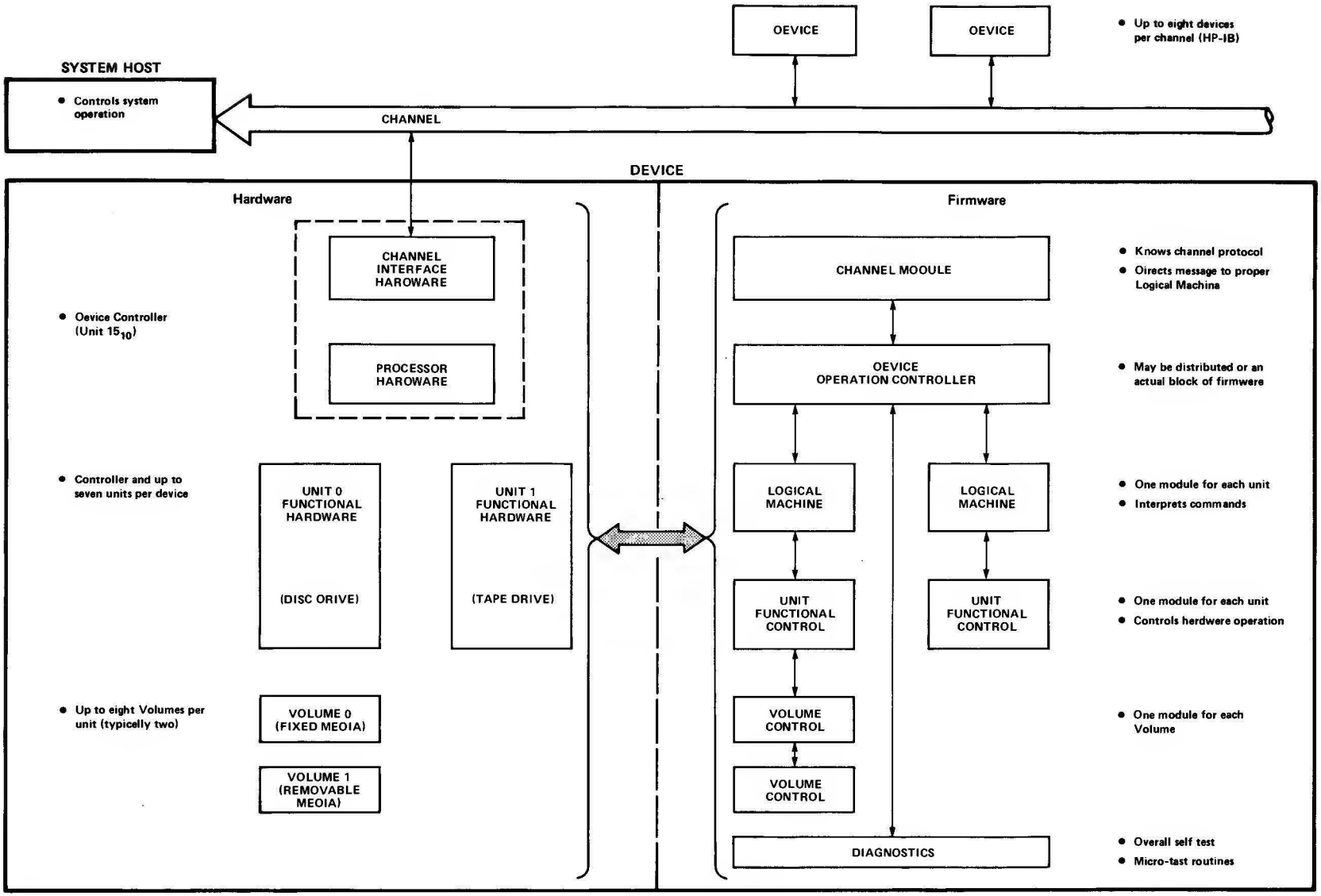


Figure 1-1. Device Model

There are three phases that may occur during each transaction: command, execution, and reporting. Each phase has two aspects to consider: the unit operating state and the corresponding channel activity.

Figure 1-2 illustrates the phases of a transaction and shows the relationship between the unit operating states and the channel activity relative to each phase.

1-8. TRANSACTION MESSAGES

There are three message types that occur in a normal transaction: Command messages which contain the device operating commands; execution messages which transfer data; and reporting messages which contain the one-byte pass/fail status (QSTAT) of the transaction. A fourth message type, transparent, is used to compensate for different types of channels and differences in operating environments.

1-9. COMMAND MESSAGES. Command messages are initiated by a host and always go from the host to a device. The contents of the message may vary in length up to some maximum defined by the device. Except for the Clear and Cancel commands, a command message is valid only if it occurs during the command phase of a transaction.

Command messages contain all device command operation codes (opcodes). There are four categories of device commands: Real Time, Complementary, General Purpose, and Diagnostic. A given command message may contain one or more Complementary command opcodes and/or one command opcode from any of the other three categories. Each opcode may be followed by any associated parameters.

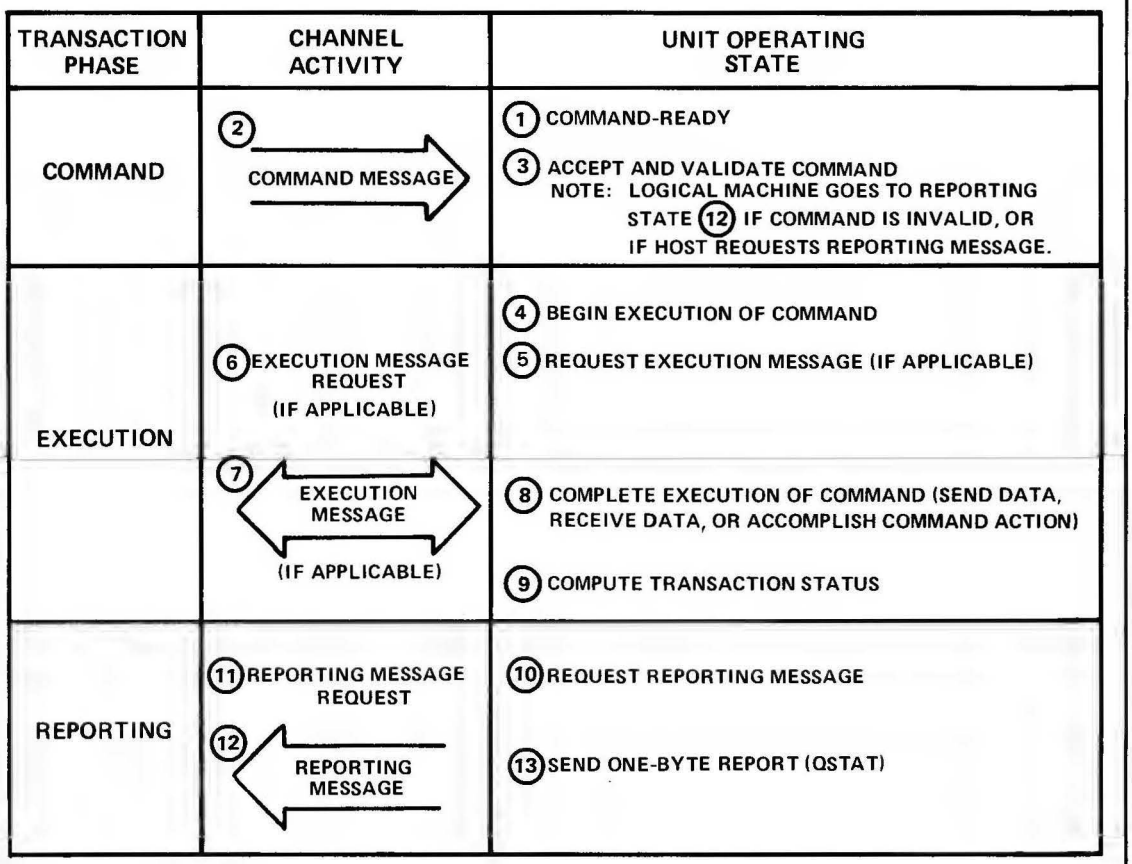
1-10. EXECUTION MESSAGES. Execution messages are initiated by the device unless an execution message has already been established by the host. The direction and significance of the message text depends on the command being executed. Possible execution message contents include read or write data, the detailed status report, or diagnostic information.

Execution messages are valid only during the execution phase of a transaction which started with a command that calls for an execution message. Some operations (e.g., Spare Block) do not include execution messages. The host may cause execution messages to be broken into bursts of smaller messages of uniform length by setting a non-zero burst size (refer to paragraph 2-17). In this case, the device initiates a series of messages which collectively contain the same information as would have been transmitted in one longer message.

1-11. REPORTING MESSAGES. The device initiates reporting messages during the reporting phase of each transaction, during special reporting phases entered for power recovery, or to service internal requests. All reporting messages consist of one byte of status information transmitted from the device to the host. This byte contains the QSTAT pass/fail indication tagged with a message terminator (EOI on HP-IB). The QSTAT byte always reflects the information currently contained in the status report. The only means of clearing the QSTAT byte is by issuing the Request Status command (refer to paragraph 2-35) or the Clear command (refer to paragraph 3-2). The QSTAT byte indicates one of three conditions relating to the current transaction:

(1) Normal Completion. The requested operation was completed without error.

(2) Hard Error. Error information is available. The host must issue a Request Status command to determine complete transaction status.



(1) Logical Machine idle in command-ready state.

(2) Host sends command message.

(3) Logical Machine accepts and verifies command. If command is valid, Logical Machine moves to execution state. If not, Logical Machine moves to reporting state.

(4) Unit begins execution of command.

(5), (6) If command involves data transfer, Logical Machine requests an execution message. If not, unit completes execution (8).

(7) Execution message is established if command involves a data transfer.

(8) Unit completes execution of command. If command involves data transfer, unit sends or receives data through channel module. If not, unit completes action called for in command message.

(9) Logical Machine computes completion status of transaction. Pass/Fail status is set into QSTAT, complete status set into request status.

(10), (11) Logical Machine requests reporting message.

(12) Reporting message is established.

(13) Logical Machine sends one-byte reporting message (QSTAT) indicating Pass/Fail status of transaction. Host must send request status command for complete status report (20 bytes).

5955-2

Figure 1-2. Transaction Structure

(3) Power On. The device has just returned from a power failure or some form of operator intervention (such as removal of the storage media). Any incomplete transactions were aborted and should be repeated. The host must reconfigure any programmable operating parameters because they have returned to their power-on values.

1-12. TRANSPARENT MESSAGES. Transparent messages compensate for different types of channels and differences in operating environments. Transparent messages could be used to support operation in a complex operating environment (i.e., one that involves parallel operations). The discussion of transparent commands in this manual is limited to operation within a simple operating environment.

Transparent messages also include interface specific functions or interface testing. Some device specific messages may be required in order to maintain the integrity of the transaction sequence in specific operating environments. Interface testing includes Read and Write Loopback.

Transparent messages may be initiated by either host or device, and they can be transmitted in either direction. The first byte of the text may be an operating code (opcode) which indicates the purpose of the message. The format of the remainder of the message is a function of the first byte.

1-13. DEVICE OPERATION AND TRANSACTION SEQUENCE RELATIONSHIP

In its idle state, the device is in the command-ready state. When a command message is received, it is buffered, parsed, and validated as defined by the device firmware. (See figure 1-2.) If the command and its parameters are valid, the device enters the execution state and begins to carry out the command. If not, the device enters the reporting state and prepares an error status report. When in the command-ready state, the device can also receive operator inputs (i.e., from front panel switches).

In the execution state, the operation requested by the host is performed. If a data transfer is involved, the device will request an execution message (via the parallel poll on HP-IB) from the host. The execution message is not required for transactions which do not involve a transfer of information. When the requested operation is complete, the device computes the status of the operation, enters the reporting state, prepares the status reports, and requests a reporting message from the host. The device supplies a one-byte status report (QSTAT) to the host as the text of a reporting message.

Figure 1-3 explains the symbols used in the device operating state diagram, figure 1-4.

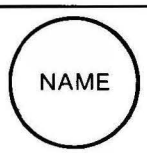
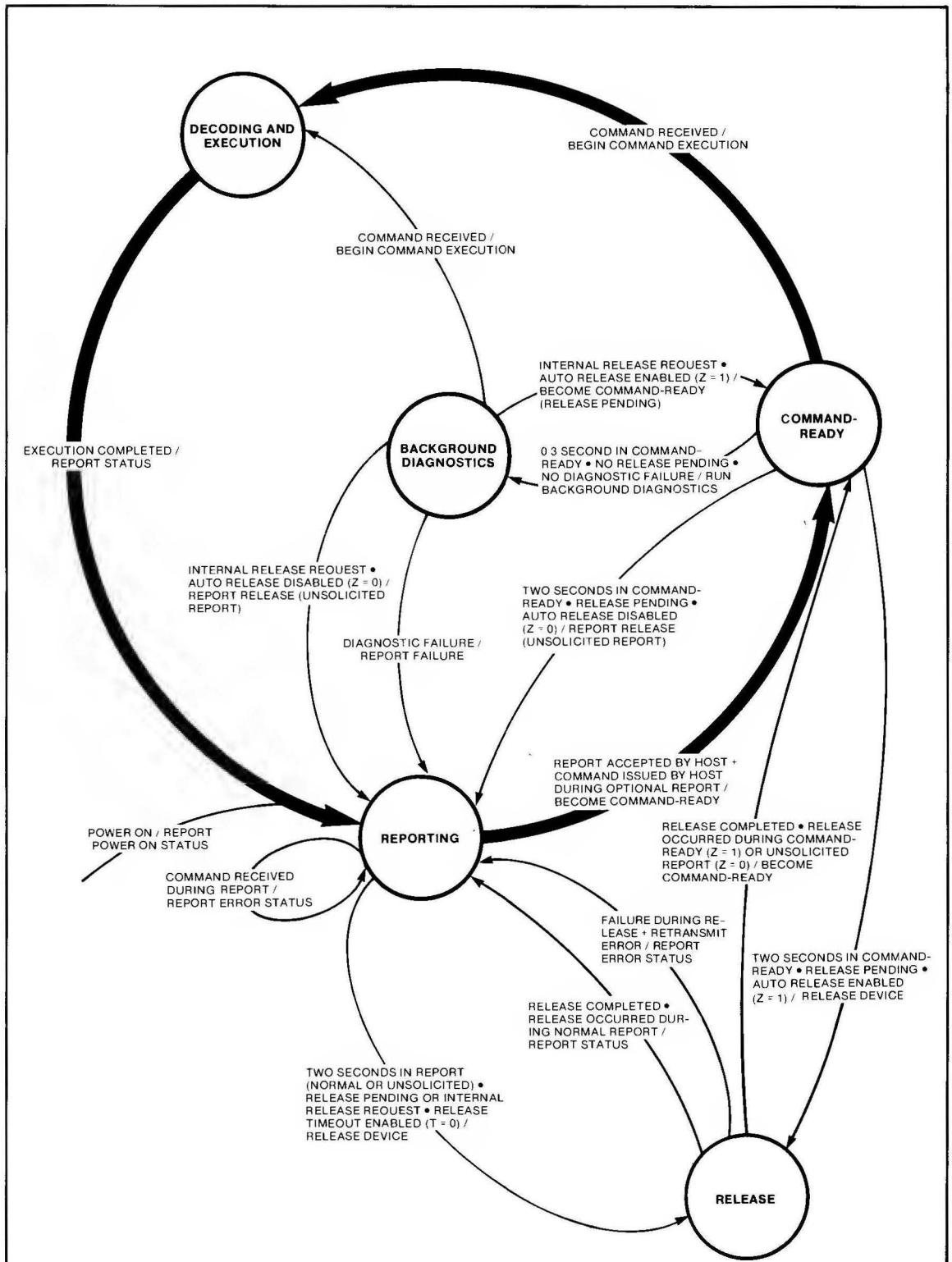
SYMBOL	DESCRIPTION
	STATE SYMBOL. This symbol indicates the current condition a device is in. The symbol contains the name of the state.
INPUT/RESPONSE	INPUT. Occurrence of an event(s) which causes a response.
	RESPONSE. The output caused by a certain input while in a certain state.
	TRANSITION. The path from one state to another or from one state to itself.

Figure 1-3. State Diagram Symbols



NOTES:

1. The "•" symbol indicates that the conditions are logically AND'ed. The "+" symbol indicates that the conditions are logically OR'ed.
2. The darker paths indicate the normal C-E-R transaction sequence.

5955-29

Figure 1-4. Device Operating State Diagram

1-14. POWER-ON SEQUENCE

The following power-on sequence applies to each unit within a device:

- The unit executes an internal diagnostic.
- Results of the diagnostic are stored in the unit's status report.
- The unit enters an interlock reporting state.

The unit will remain in the interlock reporting state until the host accepts the reporting message or issues the Clear command. A Set Unit command will be executed, but if the host sends any other command to the unit, the unit will accept but not execute the command. The resultant reporting message will indicate that the unit is still in the power-on state.

If a power-on diagnostic failure has occurred, the status report will not be cleared by the Clear command. The host will see the diagnostic failure in the first reporting message returned by the failing unit.

All units within a device can be cleared of the power-on status simultaneously by issuing a Clear command address to the device controller (unit 15). A Universal Device Clear or Selected Device Clear will also accomplish this task (refer to paragraphs 3-3 and 3-4).

1-15. BACKGROUND DIAGNOSTICS

To improve the reliability of the device, a set of background diagnostics have been included in the product design. These diagnostics monitor a number of vital functions including the integrity of the controller Read-Only Memory (ROM) and Random Access Memory (RAM). This method of automatic self-testing is capable of detecting errors that might otherwise go undiscovered during real-time operations (i.e., data errors). Background diagnostics are controlled solely by the device and do not require any involvement with the host.

The background diagnostics are initiated 0.3 second after entering the command-ready state, unless a diagnostic failure has occurred or release is pending (see figure 1-4). A release must be dealt with before the background diagnostics can begin. Once begun, the device will continue to run the diagnostics until a failure occurs, an internal request for release is detected, or the host issues a command. A command will cause the device to terminate the background diagnostics and begin execution of the command. This prevents the background diagnostics from interfering with normal channel communications. An internal release request will cause termination of the diagnostics and initiation of the proper release sequence.

If a failure occurs during the background diagnostics, the device:

- Sets the Diagnostic Result bit in the status report.
- Sets a hard error into the QSTAT byte (QSTAT = 1).
- Enters an interlock reporting state.

Once in the interlock reporting state, the device will not execute any commands issued by the host until the diagnostic failure has been reported. The host must accept the reporting message and then issue the Request Status command. This is the only way that the host can clear the status report. The Clear command will not clear a diagnostic failure (refer to paragraph 3-2).

1-16. RELEASE SEQUENCE

Periodically a device will need to go offline in order to respond to an internal requirement such as a front panel request, or an error logging routine, or some other housekeeping process. The release sequence provides the means by which the device can service these internal requirements. The release sequence can be initiated by the host via the Release command (refer to paragraph 2-30) or, if configured properly, the device may be allowed to release itself. The exact manner in which the device handles internal requirements is defined by the host via the Set Release command (refer to paragraph 2-22). Figure 1-4 illustrates the various conditions under which the device can release itself.

When a request for release is pending, the appropriate Release Request bit will be set in each unit's status message. In addition, the number of each unit(s) requesting release will be placed in the parameter field of the status message, providing this field is not needed by a higher priority error. This ensures that the host will see all release requests during the reporting phase (QSTAT = 1). The host can then use the parameter field of the status message to determine which unit(s) are requesting release. The exception to this sequence occurs during automatic release; when automatic release is enabled the device will never request release from the host (refer to paragraph 2-22).

With automatic release enabled and release pending when the command-ready state is entered, the device will wait two seconds before releasing itself. If the host issues a command during this interval it will be executed and the automatic release will not occur. Although the release did not occur, the device will remember the request and the first time the two-second interval elapses without a command from the host the device will release itself.

If release timeout is enabled (refer to paragraph 2-22) and an internal requirement occurs during background diagnostics, the device:

- — terminates the background diagnostics
- — sets the appropriate Release Request bit in the status message
- — goes to the reporting state
- — starts the internal timeout clock
- — requests a reporting message (via parallel poll on HP-IB)

Note: The release timeout cycle is a two-second interval beginning when the device requests a reporting message (via parallel poll on HP-IB).

This sequence puts the device in an unsolicited reporting state, that is, a reporting state that is not part of a transaction. If the host accepts the reporting message, the hard error QSTAT should cause the host to respond with a Request Status command. The status message will alert the host to the request so the host should release the device if possible; if not, the host should issue the Release Denied command. If the host does not respond to the unsolicited report before the timeout clock expires, the device will release itself.

If release timeout is enabled and release is pending when the command-ready state is entered, the procedure is similar to that described in the preceding paragraph; the only exception being a two-second wait in command-ready before going to unsolicited report. During this interval the device will accept commands from the host and, if possible, execute them. If the host issues a command which cannot be executed because it involves a unit requiring release, the command will be terminated and the device will return a status of release required. This informs the host that the release is no longer simply a request and that the command cannot be executed until the device is released and the unit serviced.

Once the device has entered the unsolicited reporting state, commands will no longer be accepted from the host. If the host attempts to send a command, it will fail and a Retransmit error will result. The device will remain in the unsolicited reporting state until the host accepts the reporting message or the timeout clock expires. If the host accepts the reporting message, the device will go to the command-ready state with release pending. If the timeout clock is disabled, the device will remain in unsolicited report until the device accepts the reporting message. The host can clear the release request by issuing the Release Denied command or the Clear command.

When release timeout is enabled, release can also occur during a normal reporting state, that is, a report that occurred as part of a transaction. If the device enters report with release pending and timeout enabled, the host must accept the report within two seconds or release will occur. If the device is in normal report and an internal requirement occurs, the device will begin its two-second wait. The host must accept the report during this interval or the device will release itself.

Once the device has been released and the requirement has been serviced, the device will return in either the reporting or command-ready state: reporting if the release occurred during a normal report or a failure occurred while the device was released; command-ready if the release occurred during an unsolicited report or the command-ready state. Any attempt by the host to communicate with the device while it is released will result in a Retransmit error when the device returns. This informs the host that the attempted transaction failed and should be retried.

1-17. TAPE DRIVE CAPABILITIES

When using the CS/80 Instruction Set in tape drive operation, the user should be aware of certain capabilities possessed by the drive. These capabilities include file marks, character counts, and defect handling.

1-18. FILE MARK

The Write File Mark command (paragraph 2-11) allows the host to write a file mark at the current position of the tape. The host may also use the Set Address command to locate a specific area of the tape where a file mark will be written. The use of file marks is limited to read operations. File marks are not involved in the tape positioning prior to a read, write, or verify command.

Whenever a file mark is encountered in the middle of a data transfer, the transfer is terminated immediately and the End of File (EOF) indication is set into the Request Status message. The controller ends the transfer by sending the terminator byte, "01", tagged with a message terminator (EOI on HP-IB).

If a data transfer ends on the last byte of a file, the EOF indication will not be generated unless the host attempts to read the next data byte. If such an attempt is made, the message terminator byte is sent in a single byte execution message.

1-19. CHARACTER COUNT

During a write operation the device controller will always write a character count in the block header. This count represents the number of data bytes written into the block and is of particular significance when writing a partial block. When a partial block is written, the controller will pad the unused portion of the block with zeros. When that block is read, the controller can now use the character count to determine how much of the block contains valid data.

The character count option is provided for use during read operations. If the character count option is enabled during a read, the controller will skip that portion of a block which does not contain valid data. Only the valid data contained in the block will be sent to the host, after which the tape drive will skip to the next block.

If the character count option is disabled during a read operation, the host must assume the responsibility of keeping track of how much of a partially filled block contains valid data. If this option is enabled, the host is not required to perform this function.

1-20. DEFECT HANDLING

Two sparing methods are provided for defect handling on the tape drive. As different circumstances will require different sparing techniques, the user should be aware of the distinctions between the two methods. Use of skip sparing will optimize defect handling but could result in the loss of needed data. Use of jump sparing increases defect handling time but preserves all user data.

The first method, skip sparing, spares a bad block by substituting the address of the defective block for the address of the next available spare in the sparing table. This will then cause any subsequent data transactions to skip over this block.

Skip sparing results in minimal latency in recovering the spared block, but it alters the address mapping of those blocks beyond the current target address. This results in an effective loss of all data beyond the current target address. Because of the decreased delay in recovering spared blocks, use of the skip method is recommended, however, it should not be used if needed data resides beyond the current target address.

The second sparing method is jump sparing. In this method the bad block is directly replaced by the nearest available spare. Thereafter, all references to the defective block will cause a seek to its spare. This seek results in an average latency of 2.5 seconds to arrive at the spare block and approximately the same amount of time to return to the next sequential block. Although this method is slower in recovering spared blocks, it does not alter the address mapping of other data blocks. Jump sparing should therefore be used when needed data resides beyond the bad block.

A special case arises when a skip spare is asked for but no spare blocks are available beyond the bad block. In this case, a jump spare is substituted for the skip.

When dealing with tape defects, the user should remember that the trade-off between jump and skip sparing is one of time versus loss of data.

Whenever any sparing operation is performed, it is necessary to update the sparing table. This is done before the reporting phase of the transaction that resulted in the sparing. Because updating involves tape movement, the full tape transit time may be required to perform the action.

1-21. TAPE LOADING

When a tape is inserted into the tape drive, a logical load operation must take place before the tape can be accessed. The unit will request release for internal maintenance to accomplish the load operation. If the host denies this release request (via the Release Denied command) the tape will not be loaded until the first operation involving the tape drive occurs.

A tape load operation will also be invoked after a Clear command (providing a tape is inserted in the tape drive). The tape will be loaded the first time an operation involving the tape occurs even if the tape was not previously loaded.

SECTION II
DEVICE COMMAND DETAILS

2-1. INTRODUCTION

The device commands comprise the text portion of the command message. There are four categories of device commands: Real Time, Complementary, General Purpose, and Diagnostic.

2-2. REAL TIME COMMANDS

The Real Time commands (Locate and Read, Locate and Write, Set File Mark) are optimized for execution time. These commands are used most often in host/device transactions. One or more Complementary commands may precede a Real Time command in order to augment the operation of the command.

Real Time commands provide the fastest command response time, and require minimal interaction with the host. Each Real Time command uses a target address which can be specified with the Set Address (Complementary) command in the three-vector address mode or the single-vector address mode (refer to paragraph 2-14).

2-3. COMPLEMENTARY COMMANDS

Each unit within a device has its own set of programmable operating parameters. The values of these parameters define the environment for each operation involving a specific unit. Complementary commands are used to set or update these parameters. The parameters include unit number, data transfer length, burst size, maximum retry time, and Rotational Position Sensing (RPS) window size and location. Table 2-1 shows which Complementary command parameters are used by the Real Time, General Purpose, and Diagnostic commands.

The parameters are initially assigned power-on values (refer to table 2-2). New parameter values for a unit are established by a command message containing *only* Complementary commands. A single command may be used to update multiple parameter values. These new set values are then used in subsequent transactions with that unit. (The one exception to this rule is the target address parameter which is updated by any command that accesses data. Refer to paragraph 2-14 for a detailed explanation of the Set Address command.) A Clear command resets all operating parameters to their power-on values (refer to paragraph 3-2).

Most of a unit's parameter values can also be changed for the duration of a single transaction. This temporary override is accomplished by including the desired Complementary commands in the text of a Real Time, General Purpose or Diagnostic command message. Using Complementary commands in this manner, the host is able to change the parameter values for a single transaction, after which they revert to their previous values. These temporary values are referred to in this manual as *current values.*The Complementary commands must precede the Real Time, General Purpose, or Diagnostic opcodes they accompany.

There are two Complementary commands that do not produce the temporary override described in the preceding paragraph. These are the Set Unit and Set Volume commands. The values specified in these commands remain in effect even if the commands are included in a Real Time, General Purpose, or Diagnostic command.

Table 2-1. Complementary Command Matrix

COMMAND	SET UNIT	SET VOLUME	SET ADDRESS	SET BLOCK DISPLACEMENT	SET LENGTH	SET BURST	SET RPS	SET RETRY TIME	SET STATUS MASK	SET RETURN ADDRESSING MODE	SET RELEASE	SET OPTIONS[1]	NO OP
REAL TIME													
LOCATE AND READ	X	X	X	X	X	X	X	X	X		X	X	
COLD LOAD READ	X	X	X	X	X	X	X	X	X		X	X	
LOCATE AND WRITE	X	X	X	X	X	X	X	X	X		X	X	
WRITE FILE MARK[1]	X	X	X	X				X	X		X	X	
GENERAL PURPOSE													
DESCRIBE	X	X							X		X	X	
INITIALIZE MEDIA	X	X							X		X	X	
SPARE BLOCK	X	X	X	X					X		X	X	
LOCATE AND VERIFY	X	X	X	X	X				X		X	X	
COPY DATA	X	X	X	X	X				X		X	X	
RELEASE	X								X		X	X	
RELEASE DENIED	X								X		X	X	
UNLOAD[1]													
DIAGNOSTIC													
INITIATE UTILITY	X	X	X	X		X			X		X	X	
INITIATE DIAGNOSTIC	X								X		X	X	
REQUEST STATUS	X								X	X	X	X	

NOTE 1: APPLIES TO TAPE DRIVE OPERATIONS ONLY.

Table 2-2. Complementary Command Power-on Values

COMPLEMENTARY COMMAND	POWER-ON VALUE	COMPLEMENTARY COMMAND	POWER-ON VALUE
Set Unit	0	Set Retry Time	device specific
Set Volume	0	Set Status Mask	disabled
Set Address	0, 0, 0	No Op	Not Applicable
Set Length	-1 (full volume)	Set Release	T = 0 Z = 0
Set Burst	disabled	Set Options	device specific
Set RPS	disabled	Set Return Addressing Mode	single vector

Table 2-3 summarizes the Complementary command value definitions as used in this manual.

Except where otherwise noted, all parameters are specified as unsigned binary numbers. The most significant byte is always transferred first.

Table 2-1 provides a summary of the specific Complementary commands that affect the Real Time, General Purpose, and Diagnostic commands.

2-4. GENERAL PURPOSE COMMANDS

This command group includes: the Describe command which allows the host to determine device type and operating characteristics ; commands which maintain or ascertain storage media integrity (Initialize Media, Spare Block, Locate and Verify); the Copy Data command which copies data from one location to another within the same device; and the Release and Release Denied commands.

These commands are not considered "real time" commands and therefore should not be issued by the host unless it is willing to relinquish control of the device for a varying period of time.

2-5. DIAGNOSTIC COMMANDS

Diagnostic commands are intended to assist the host in isolating problems in the device to the replaceable assembly level. Some commands allow protected access to variables or data maintained by the device (such as error information) while others cause tests to be performed on the device or on a specific area of the storage media. Diagnostic commands may be modified by complementary commands (refer to table 2-1).

Table 2-3. Complementary Command Value Summary

VALUE	DESCRIPTION
Power-On	Value initially assigned at power-on or after issuing a Clear command (refer to table 2-2).
Set	The value established by issuing a command message containing *only* Complementary commands. This value remains in effect until changed by another command containing *only* Complementary commands or until a Clear command is issued.
Current	This is a temporary value that is in effect only for the duration of the transaction in which it appears. The Complementary command must be included in a Real Time, General Purpose, or Diagnostic command message to achieve this temporary value. Upon completion of the transaction, the value reverts to the previous set or power-on value.

2-6. QUICK REFERENCE INFORMATION

There are several summary tables located in appendix B. These tables are provided for quick-reference purposes and assume the user has read the detailed information provided for each command. The topical content for each table is as follows:

TABLE	TITLE	TOPICAL CONTENT
B-1	Device Command Summary	Provides the command format and reference paragraph number for each device command.
B-2	Request Status Summary	Shows the complete format of the Request Status command Execution message. The identification and significance of each bit of the status report is explained.
B-3	Possible Errors Summary	Provides a matrix of the possible errors for all device commands.
B-4	Complementary Command Matrix	Shows which Complementary commands affect the Real Time, General Purpose, and Diagnostic commands.
B-5	Complementary Command Power-On Values	Shows the power-on values for all Complementary commands.
B-6	Describe Command Summary	Shows the complete format of the Describe command Execution message.

2-7. DEVICE COMMAND DESCRIPTIONS

The following form is used for each device command description:

FUNCTION:

A brief descriptive statement of the command function.

COMMAND FORMAT:

Note: Table 2-6 and Table B-3 (located in appendix B) provide a summary of the possible errors for all device commands.

DESCRIPTION:

A complete description of the command.

TAPE UNIT OPERATION:

Describes any specific details concerning tape unit operations.

2-8. LOCATE AND READ

FUNCTION:

Locates the data indicated by the target address and transmits it to the host.

COMMAND FORMAT:

<00000000>

DESCRIPTION:

The Locate and Read command is validated during the command phase of the transaction, after which the execution phase may begin.

First the device locates the data indicated by the target address and performs any activity necessary to make it accessible to the user. A failure of any operation up to this point terminates the transaction leaving it in the reporting phase. Once the data is accessible, the device requests an execution message. If RPS (Rotational Position Sensing, a Complementary command) is enabled, the window size and position relative to the target sector are used to determine when to assert and de-assert requests for messages. When an execution message is established, the data transfer may begin.

The length of the total data transfer is the number of bytes specified in a Set Length (Complementary) command included in the message with the Locate and Read command. If Set Length is not specified, the power-on or last set length value is used. If Burst mode is enabled, another link is requested when the next burst is available. (RPS is not effective in the burst mode.)

If a data error is encountered in the course of the transfer, then the device is allowed to attempt correction for an interval specified in the Set Retry Time (Complementary) command. During this interval, the device will execute a predefined set of data recovery routines. If the data is unrecoverable, the device determines its most accurate reconstruction of the data and returns this to the host. The address of the first block of any bad data will be included with the status report returned by a Request Status command. A Locate and Read operation updates the target address as explained in paragraph 2-14.

The transfer always contains the amount of data requested by the host unless the host intervenes or a hardware fault occurs. If a hardware fault occurs, the device will return a single byte (QSTAT = 1) tagged with the message terminator (EOI on HP-IB). The device will continue to return this single byte until the host enters the reporting phase of the transaction.

Note: The term "block" refers to a specific quantity of data, the amount of which is a function of the storage format of a particular mass storage device. For example, a block on a disc drive is a single sector of data, e.g., 256 8-bit bytes. A block on a HP DC600 Tape Cartridge is 1024 8-bit bytes.

TAPE UNIT OPERATION:

- Whenever a file mark is encountered during a read, the data transfer is terminated and an End of File (EOF) indication results (refer to paragraph 1-18).

- If the character count option is enabled, it may be used during read operations. Refer to paragraph 1-19 for an explanation of the character count option.

LOCATE AND READ (continued)

- Concurrent with the reporting phase of a read operation, the device controller will instruct the tape drive to read, but not transmit, the next block of data. This read is performed locally by the tape drive and does not interfere with the normal channel transaction sequence. This feature allows the controller to process sequential read commands without stopping the tape. When attempting to utilize this feature, the maximum time allowed between read commands is critical.

- Attempting to read a block which has never been written will terminate the data transfer with a No Data Found error.

2-9. COLD LOAD READ

FUNCTION:

Used by a host system to bootstrap itself into a higher operating environment from a more primitive state.

COMMAND FORMAT:

<00001010>

DESCRIPTION:

Cold Load Read is part of the following unique channel sequence:

Clear : Wait for message request : Clear : Send Cold Load Read

Note: The Clear command ensures that the device Complementary command parameters are all in the initial (power-on) states, and that the device is in the command-ready state.

The operation of Cold Load Read is identical to that explained in the description for Locate and Read.

LOCATE AND WRITE

2-10. LOCATE AND WRITE

FUNCTION:

Transfers data from the host to storage area beginning at address specified by the target address.

COMMAND FORMAT:

<00000010>

DESCRIPTION:

This command is the only means available to write data from the host onto the device. The opcode is validated during the command phase. If the command is received and decoded correctly, the execution phase commences by locating the area of the media where data is to be written. The address is specified by the Target Address. Using any RPS or burst mode settings, the device determines when it is ready for data, and then requests an execution message. The amount of data bytes defined by the power-on or last set length value are accepted and written to the device. The message ends with a message terminator (EOI on HP-IB).

On a disc drive, the write verifies a block prior to writing on any track, whether the track was reached by an internally or externally generated seek. The write may be aborted by hardware problems, failure to verify at least one block on the correct track, or by some host intervention. If the device internal write process is abnormally terminated, the device will sink data until the execution phase is complete. The reporting phase is used to resynchronize the transaction. A Locate and Write operation updates the target address as explained in paragraph 2-14.

If a partial block is written, the remainder of the block is filled by duplicating the last data byte of the transfer. The Locate and Write command never retains old data in any part of a block.

TAPE UNIT OPERATION:

After completion of a write operation, the tape will be automatically repositioned to a point in front of the next block to be written. This way the seek required in preparation for a sequential write will take place in parallel with the receiving and decoding of the next command.

2-11. WRITE FILE MARK

FUNCTION:

A tape drive command that writes a file mark at the current tape position or any position selected through use of the Set Address command.

COMMAND FORMAT:

<01001001>

DESCRIPTION:

File marks are used only during read operations. When a file mark is encountered during a read operation, the End of File (EOF) indicator is set into the status report. The controller also ends the data transfer by appending the terminator byte, "01", to the data message and tagging it with a message terminator (EOI on HP-IB).

A data transfer which ends on the last byte of a file will not generate an EOF, unless the host attempts to read the next byte. If such an attempt is made, an EOF will immediately occur.

SET UNIT

2-12. SET UNIT

FUNCTION:

Used to specify a specific unit number within a mass storage device.

COMMAND FORMAT:

<0010YYYY>

YYYY = Unit Number (1111 = Device Controller)

DESCRIPTION:

If YYYY = 1111, the command will be directed to the device controller. If this field is not specified, the default will be to the last unit specified. The power-on value is unit 0 so it is never necessary to specify a unit number for a single unit device. An illegal unit number (one that does not reside on the addressed device) produces a Module Addressing status error.

The Set Unit opcode must be the first byte of the command message. If the opcode appears elsewhere in the message, an Illegal Opcode error will be reported.

2-13. SET VOLUME

FUNCTION:

Used to specify the desired storage volume of a specific mass storage device.

COMMAND FORMAT:

<01000YYY>

YYY = Volume number

DESCRIPTION:

Where appropriate, fixed and removable storage media are considered as separate volumes. Some devices may have multiple removable volumes. This would be indicated in the Describe (General Purpose) command for that device. Any time Set Address is specified in either the single or three-vector mode, that address will be interpreted for the last volume specified. Therefore, the first sector on each volume has single-vector address 0 and three-vector address 0, 0, 0.

If this field is not included in the command message the default will be to the last volume specified on the selected unit.

The power-on is volume 0. If an illegal volume number is specified (not included on the particular device), a Module Addressing status error is generated.

The Set Volume command applies to the single-vector, three-vector, and Set Block Displacement modes. The Locate and Read, Locate and Write, Verify, Spare Block, and Initialize Media commands all utilize the last specified Set Volume value.

SET ADDRESS

2-14. SET ADDRESS

FUNCTION:

Used to set the value of the target address. Specifies single, or three-vector address mode.

COMMAND FORMAT:

<0001000T> <P1>.....<P6>

6 parameter bytes

T = Address mode: 0 = single-vector, 1 = 3-vector

Single vector format: 6-byte binary number

3-vector format: P1 - P3 = cylinder address

P4 = head address

P5 - P6 = sector address

DESCRIPTION:

The Set Address command is used to set the value of the selected unit's target address. The target address is then used by all other commands accessing data on that unit. The Set Address power-on value is address 0.

Note: The term "block" refers to a specific quantity of data, the amount of which is a function of the storage format of a particular mass storage device. For example, a block on a disc drive is a single sector of data, e.g., 256 8-bit bytes. A block on a HP DC600 Tape Cartridge is 1024 8-bit bytes.

Upon completion of a transaction which uses the target address, the target address will point to the block after the last block accessed during that transaction, whether or not the transaction was successful. The target address can be obtained from the Request Status execution message.

The Target Address is unlike other Complementary parameters in that it is updated by any command which accesses data, and does not revert to a prior value when another accessing command is sent. This allows sequential data accessing.

Three-Vector Address Mode. The 6-byte address specified in a Set Address command is broken into three fields, each of which contains one vector of the three dimensional address. The vectors are three, one, and two bytes in length, respectively. For disc drives, the 3-byte vector indicates cylinder address, the 1-byte vector is the head address, and the 2-byte vector is the sector address. The Set Volume (Complementary) command is used to select the desired volume (fixed/removable). The MSB is transmitted first. The use of the three-vector format must be limited to those devices which support this addressing mode.

Single Vector (Block). The 6-byte address field of the Set Address command is treated as one number. Every addressable unit of storage is located via this 6-byte address. This simplifies device addressing for systems which are not interested in the particular device's configuration. Cylinder, head, and sector addresses on a disc drive are organized into a single vector addressing space such that access to sequential sectors is provided with maximum performance. The mapping of linear addresses into 3-vector addresses is device specific. The three-vector addressing mode is provided to optimize response time. If Set Address is specified in the single vector mode, the device controller will convert it to the 3-vector mode during the decoding of the command. The Set Volume (Complementary) command is used in conjunction with block addressing too.

SET ADDRESS (continued)

If an Address Bounds error occurs during a Set Address command, the target address will be set to zero. The target address is also set to zero any time an End of Volume error occurs.

SET BLOCK DISPLACEMENT

2-15. SET BLOCK DISPLACEMENT

FUNCTION:

Adjusts the target address by the number of blocks indicated in the parameter field.

COMMAND FORMAT:

<00010010> <P1>.....<P6>

6 parameter bytes

Parameter format: 6-byte, signed, two's complement, binary number

DESCRIPTION:

The block displacement parameter is a double precision signed two's complement number which is added to the current target address. The new target address is tested for bounds violation.

The next accessing command will cause a seek to the new target address. This allows random access devices to be accessed in either absolute or relative addressing modes. This capability allows compatibility with sequential device cold load sequences which may use the Set Block Displacement command.

2-16. SET LENGTH

FUNCTION:

Defines the number of bytes in a data transfer.

COMMAND FORMAT:

<00011000> <P1>.....<P4>

4 parameter bytes

Parameter format: 4-byte, unsigned binary number

DESCRIPTION:

The four bytes following the Set Length opcode contain the byte count of the transfer length. If this field is not included in the command message, the transfer length will be determined by the power-on or last set value. A length specification of all 1's (the power-on value) implies a transfer size equal to the selected volume. Volume size is available from the Describe command.

A length specification of all 0's will cause the device to respond to a Real Time command with a Locate only (seek). No data is transferred. A Real Time command executed in this manner does not require an execution message. After this type of seek, no verification of the target block address is performed.

SET BURST

2-17. SET BURST

FUNCTION:

Activates (and de-activates) burst mode.

COMMAND FORMAT:

<0011110T> < P1 >

T = 0 indicates that last burst only is tagged with a message terminator

T = 1 indicates that all bursts are tagged with a message terminator

P1 = Number of 256 byte segments in each burst
(if P1 = all zeros, Burst mode is de-activated)

Note: Message terminator on HP-IB is EOI.

DESCRIPTION:

Set Burst applies only to Real Time commands. Multiple execution messages may be used to accommodate certain timing requirements. The host uses this burst value to define the maximum amount of data to be transferred in any one execution message. The value specified by the Set Length command is then divided by the size of each burst to calculate the number of execution messages expected. The last burst may be shorter than the others.

Burst transfers of 1 to 255 blocks can be specified. The Describe (General Purpose) command gives an indication of the amount of buffering (in blocks) used by the controller for data transfers. If a burst size less than or equal to the buffering available in the device is specified, the device will accept an entire burst of information into buffer RAM at the buffer RAM's speed, and will write to the media at the appropriate time, or will read an entire burst into buffer RAM before transmitting data. This allows optimal channel usage. If the burst size is larger than the buffer RAM available, the timing of each message of a burst transfer will be identical to that of an unbursted data transfer of the same length, except that RPS is not used. This mode of operation allows burst size to be used to satisfy transfer size limits imposed by the channel or host.

If an error occurs during a bursted write operation, the remaining bursts associated with that transaction will be sinked by the device. If an error has occurred during a bursted read operation, the device will return a single byte (QSTAT = 1) tagged with a message terminator (EOI on HP-IB). The device will continue to return this single byte until the host enters the reporting phase of the transaction. The reporting phase is used to resynchronize the transaction sequence after an error.

Set Burst is disabled at power-on.

SET RPS (ROTATIONAL POSITION SENSING)

2-18. SET RPS (ROTATIONAL POSITION SENSING)

FUNCTION:

Sets time-to-target and window-size time intervals for RPS data transfers.

COMMAND FORMAT:

<00111001> < Time 1 > < Time 2 >

Time 1 = time-to-target in hundreds of microseconds
Time 2 = window size in hundreds of microseconds

DESCRIPTION:

Rotational Position Sensing (RPS) is provided to minimize non-productive channel usage while waiting for the device to locate the area at which a transfer will begin. Using this feature, the device will request an execution message containing read or write data only during a period called the RPS window. The window opens at a point in time which precedes the target address by an interval specified as time-to-target, and remains open for a duration specified by window-size. If the host does not respond with an execution message during this window, the execution message request will be removed until the next time the target address becomes accessible. (See figure 2-1.)

The opcode is followed by two parameter bytes:

Time 1 = time-to-target in hundreds of microseconds

Note: If Time 1 = 0, RPS is disabled and the execution message request will occur upon completion of the seek.

Time 2 = window-size in hundreds of microseconds

Note: If Time 1 is NOT = 0 (RPS enabled) and Time 2 = 0, the window will remain open and the execution message request will continue until the host responds with an execution message.

If either of these parameters exceeds the latency time period, it will be treated in the same manner as a zero value.

At power-on, or after a Clear, RPS is disabled.

SET RPS (ROTATIONAL POSITION SENSING) (continued)

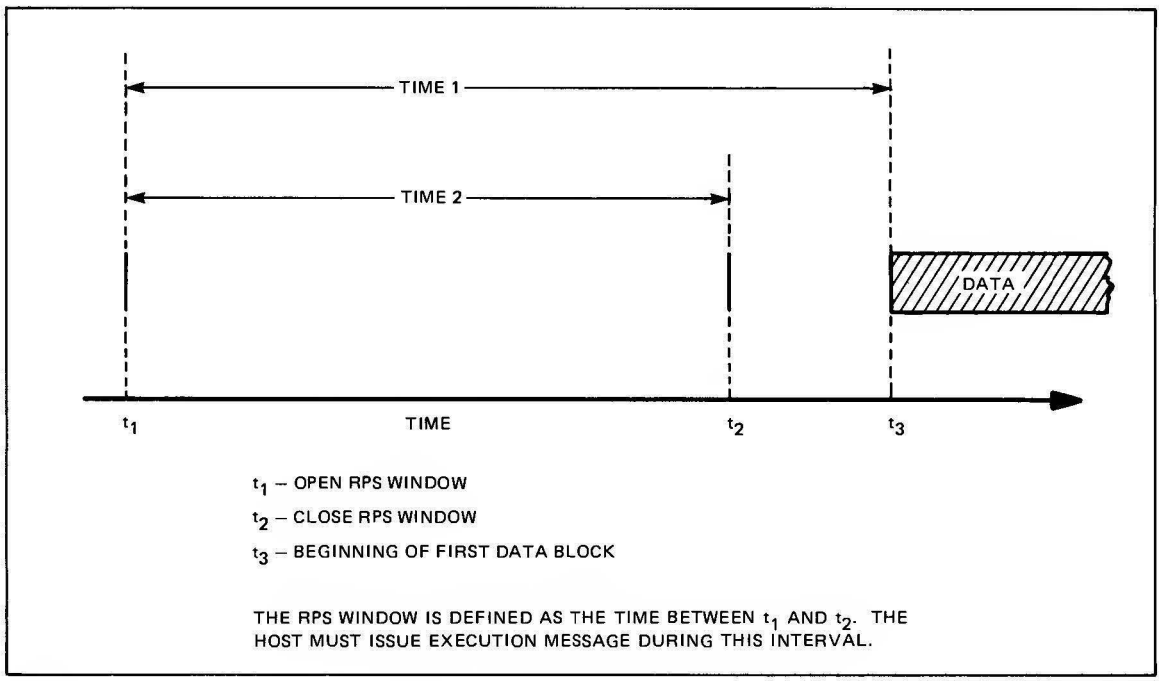


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Figure 2-1. RPS Timing Sequence

2-19. SET RETRY TIME

FUNCTION:

Used to set the amount of time available for read and seek retries.

COMMAND FORMAT:

<00111010> < P1 > < P2 >

P1 - P2 = Retry time in tens of milliseconds (16-bit binary number)

DESCRIPTION:

Retries are attempted after an uncorrectable data error is encountered or when an attempted seek fails. The power-on value is equal to the optimal retry time specified by the Describe (General Purpose) command.

A retry time of 0 causes no read retries to take place. This does not eliminate latencies induced by unrecoverable errors. In general, one latency per read attempt will be observed, once for any unrecoverable error.

In some cases it may be necessary for the device controller to invoke retries in order to meet certain product specifications (i.e., seek error rate). In these situations the controller will impose a minimum allowable retry time. If the current retry time is set below the imposed minimum, it will be forced to the minimum value. No error is generated in the process.

Note: When specifying retry time the host is specifying the maximum delay between any two bytes of a data transfer over the channel. As this is directly related to channel timeout, the maximum retry time should be set to some value less than the defined channel timeout. Using this rule, it is possible that the maximum retry time could be invoked for each block of a data transfer. This situation would imply such a high error rate as to indicate a hardware problem.

SET STATUS MASK

2-20. SET STATUS MASK

FUNCTION:

Allows masking of error conditions reported by the Request Status (Diagnostic) command.

COMMAND FORMAT:

<00111110> <P1>.....<P8>

8 parameter bytes

Parameter format: Bit positions in parameter bytes correspond to error bit positions in the error reporting fields of the status report. Refer to paragraph 2-35.

1 = masked error

DESCRIPTION:

This opcode is followed by 8 bytes containing the status bits to be masked. Each bit position corresponds to an error bit position in the Request Status message. A 'one' in a given bit position will cause that error to be masked. All error conditions except fault errors may be masked. Refer to the Request Status discussions (paragraph 2-35) for bit positions.

If any non-maskable status bits are set, a Parameter Bounds error will result. The power-on value has no error conditions masked.

The masked bits will not be reported by either Request Status or QSTAT. If a status bit is not masked, it reports a hard error (QSTAT = 1) when set. The only exception to this is the Power Fail status bit. This bit reports a power-on status (QSTAT = 2) when set.

2-21. NO OP

FUNCTION:

Causes device to disregard message byte.

COMMAND FORMAT:

<00110100>

DESCRIPTION:

This byte is disregarded if it appears as an opcode in a command message. It may be useful to align messages to word boundaries.

SET RELEASE

2-22. SET RELEASE

FUNCTION:

Used to suppress the release timeout and to enable automatic release.

COMMAND FORMAT:

<00111011> <TZ000000>

T = 1 Suppress release time-out
Z = 1 Release automatically during idle time

DESCRIPTION:

The Set Release command allows the host to define how the device will respond to an internal release request. There are four ways that the device can be configured: The first is with release timeout enabled and automatic release disabled (T = 0, Z = 0). This configuration will impose a two-second limit on the time the device will remain in reporting phase (normal or unsolicited) requesting release. If the two-second interval elapses without any response from the host, the device will release itself. The host can prevent the device from ever releasing itself by disabling both the timeout clock and automatic release (T = 1, Z = 0). In this, the second case, the device will still enter unsolicited reporting phase to request release but will be unable to release itself. A Release command issued by the host is the only way the device can be released when this configuration is used.

The third configuration enables automatic release (T = 1, Z = 1) and allows the device to release itself without requesting release from the host. If release is pending, the device will wait in the command-ready state for two seconds. If no channel activity occurs during this period, the device will release itself. The final configuration also enables automatic release (T = 0, Z = 1) but, with timeout enabled as well, automatic release may occur after two seconds in either command-ready or reporting state.

Note: Masking the Release Request bits in the status message (refer to paragraph 2-20) has the same effect as enabling automatic release (Z = 1).

For most devices the Set Release command must be directed to the device controller (unit 15).

At power-on, or after Clear, the timeout is enabled. The power-on values of T and Z are as follows: T = 0, Z = 0.

2-23. SET OPTIONS

FUNCTION:

Used by the host to set device specific options.

COMMAND FORMAT:

<00111000> <00000VYZ>
P1

P1 = options byte

VYZ for tape unit:

V = 0 Auto sparing disabled (power-on value)
V = 1 Auto sparing enabled

Y = 0 Auto sparing invokes jump sparing (power-on value)
Y = 1 Auto sparing invokes skip sparing

Z = 0 Disable character count (power-on value)
Z = 1 Enable character count

DESCRIPTION:

This command is used by the host to enable or disable predefined capabilities of a specific device.

The power-on value of the options byte is 0.

TAPE UNIT OPERATION:

- The Z-bit in the options byte (P1) enables/disables the character count option. For an explanation of this option, refer to paragraph 1-19.

- When the V-bit is set, defective blocks encountered during a write operation will be automatically spared. This includes blocks with bad keys and those blocks previously written into the error log. Excluded from auto sparing are those blocks that won't be recognized as defective until a read operation is attempted. At that time, the bad block(s) will be entered into the error log and the next time an attempt is made to write the block it will be auto spared. The use of auto sparing allows the host to transfer the responsibility of sparing from itself to the device.

- The Y-bit defines which sparing method will be used. For an explanation of the tape drive sparing methods, refer to paragraph 1-20.

SET RETURN ADDRESSING MODE

2-24. SET RETURN ADDRESSING MODE

FUNCTION:

Allows the host to specify the type of address (single or three-vector) returned in the Request Status message.

COMMAND FORMAT:

<01001000> <00000TTT>

TTT = Addressing mode

000 = single-vector
001 = three-vector

DESCRIPTION:

This command allows the host to specify the type of address (single or three-vector) to be returned in the Request Status message. This allows the host to select either the same address mode defined in the Set Address command or use a different mode. The selection of the type of address returned in the Request Status message is determined by the host and the specific type of device involved, providing the device supports the address mode selected.

The power-on value of the addressing mode is single-vector.

When returning an address, the status message parameter bytes (P1 - P6) are configured as follows:

Single vector format: 6-byte binary number
3-vector format: P1 - P3 = cylinder address
P4 = head address
P5 - P6 = sector address

2-25. DESCRIBE

FUNCTION:

Returns (in an execution message) up to 256 bytes of information concerning device type and characteristics.

COMMAND FORMAT:

<00110101>

DESCRIPTION:

This command provides enough information about the device to allow it to be configured into a system without the host having prior knowledge about this device type. The device will return a maximum of 256 bytes of information in the execution message. Table 2-4 shows the complete format of each field of the Describe command execution message. The last byte of this message will be tagged with a message terminator (EOI on HP-IB), so that fewer than 256 bytes may be transmitted. There are three types of description fields returned: the controller field (5 bytes), the unit field (19 bytes), and the volume field (13 bytes). The format (quantity and sequence) of the description fields returned to the host in an execution message is determined by the unit addressed.

If a selected unit (not the controller) is addressed, the returned sequence format is:

[controller field] [unit field] [volume field]

The controller field is returned once per transaction; the unit field is returned once per transaction and describes the addressed unit; and the volume field is returned once per transaction and describes the currently specified volume.

If the controller unit is addressed, the returned sequence format is:

[controller field] [unit 0 field] [volume 0] [volume 1] . . . etc.
[unit 1 field] [volume 0] [volume 1] . . . etc.
[unit 2 field] . . . etc.
. . . etc.

The controller field is returned once per transaction; the unit 0 field is returned, followed by all the volume fields for that unit; the unit 1 field is returned, followed by all the volume fields for that unit; and so on until all units and volumes within the addressed device have been described.

DESCRIBE (continued)

Table 2-4. Describe Command Summary

CONTROLLER DESCRIPTION FIELD	UNIT DESCRIPTION FIELD [1]	VOLUME DESCRIPTION FIELD [2]
⟨C1⟩------⟨C5⟩ 5-byte field	⟨U1⟩-------⟨U19⟩ 19-byte field	⟨V1⟩-------⟨V13⟩ 13-byte field
C1-C2 = Installed unit byte: 1 bit for each unit. (Unit 0 = LSB) C3-C4 = Maximum instantaneous transfer rate in thousands of bytes per second. C5 = Controller Type 0 = Integrated single-unit controller 1 = Integrated multi-unit controller 2 = Integrated multi-port controller	U1 = Generic Device Type 0 = Fixed disc 1 = Removable disc or combination 2 = Tape U2-U4 = Device number. Represents actual HP product number: XX XX XY (BCD Coded, 2 digits per byte). XXXXX = product number. Y = option. U5-U6 = Number of bytes per block U7 = Number of blocks which can be buffered U8 = Recommended burst size (0 = burst mode not recommended) U9-U10 = Block Time in microseconds (Time is from beginning of one block to beginning of next.) U11-U12 = Continuous average transfer rate for long (full volume) transfer in thousands of bytes per second. U13-U14 = Optimal retry time in 10's of milliseconds. U15-U16 = Access time parameter in 10's of milliseconds. (Maximum time from the end of the command message text to the assertion of parallel poll. Applies to read and write commands only.) U17 = Maximum interleave factor U18 = Fixed volume byte: one bit per volume (set if fixed); Volume 0 = LSB. U19 = Removable volume byte: one bit per volume (set if removable); Volume 0 = LSB.	V1-V3 = Maximum value of cylinder address vector. V4 = Maximum value of head address vector. V5-V6 = Maximum value of sector address vector. V7-V12 = Maximum value of single-vector address. V13 = Current interleave factor.

NOTES:
1. When the controller unit is addressed, the unit field is repeated for each unit within the device.
2. When the controller unit is addressed, the volume field is repeated for each volume within each unit.

2-26. INITIALIZE MEDIA

CAUTION

Execution of the Initialize Media command will destroy all user data on the selected unit. Before executing the Initialize Media command, make certain that the proper unit has been selected. Failure to do so may result in the loss of needed data.

COMMAND FORMAT:

<00110111> <00000CWZ> < P2 >

CWZ = Initialize options

CWZ for disc unit:

000 = initialize selected volume retaining all factory and field spares

001 = initialize selected volume retaining only factory spares

010 = initialize selected volume retaining no spares (for factory or CE use only)

CWZ for tape unit:

C= 0 Run certification utility on tape
C= 1 Inhibit certification utility

W= 0 Every 512th block is allocated as a spare
W= 1 No spares are allocated

Z= 1 Reset sparing table to initial spares as defined by bit W
Z= 0 Rewrite sparing table with no jump spares

P2 = Block interleave byte (binary number). Must be zero for tape operation.

DESCRIPTION:

The initialize options define which spares will be retained during the initialize operation. No previously defined information in the data fields is retained.

Note: The option to initialize retaining no spares (CWZ = 010) is provided for factory or CE use only.

Block interleaving (figure 2-2) allows the transfer rate of a device to be matched most efficiently with that of the host computer connected to it. A host computer cannot always process blocks of data as fast as they are presented by the disc. Often, by the time the host computer is ready for another block, the data head has already passed that particular block on the disc, and a time delay or latency equal to as much as one revolution of the disc is incurred. Block interleaving allows the data to be staggered or interleaved by one or more blocks; access time is delayed only enough to equal that of the host computer. Block interleaving, therefore, reduces inherent latencies which are characteristic of all disc drive memories.

A "0" interleave factor has the same value as a factor of "1". If a block interleave factor greater than the maximum allowable (as specified in the Describe command) is specified, the interleave value defaults to maximum interleave. Different block interleaving factors may exist on different volumes.

INITIALIZE MEDIA (continued)

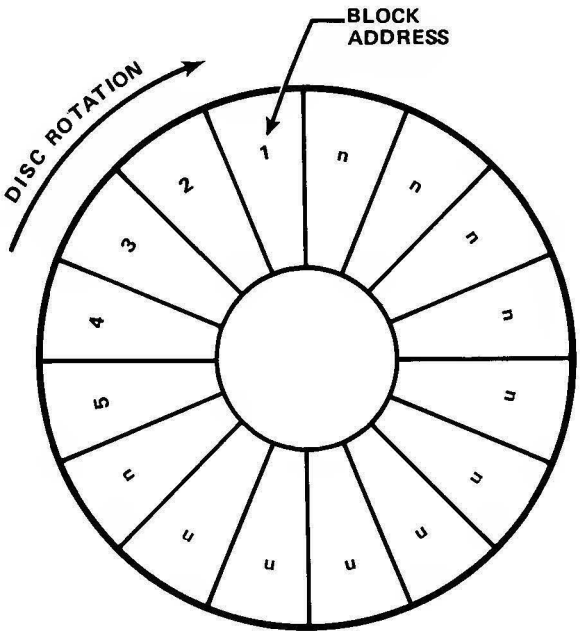
TAPE UNIT OPERATION:

This command will initialize the tape. If bit Z is not set, all existing jump spares are converted to skip spares. This results in the same blocks being spared but without the greater latency associated with jump sparing. If bit Z is set, the spare table is cleared and rewritten to an initial state determined by bit W. When the spare table is cleared, no spares are retained. All defective blocks will have to be rediscovered.

If W-bit is set, a null spare table is written allocating no spares on the tape. Sparing becomes the responsibility of the user, as the controller is left with no resources for it. This option should be used only for compatibility with non Hewlett-Packard systems.

The certification utility is used to verify the integrity of the tape media. When the certification utility is run (C = 0), a spare table is set up on the tape and any defective blocks discovered during the certify routine are automatically spared. If an uncertified tape is loaded, an Uninitialized Media error will result.

INITIALIZE MEDIA (continued)

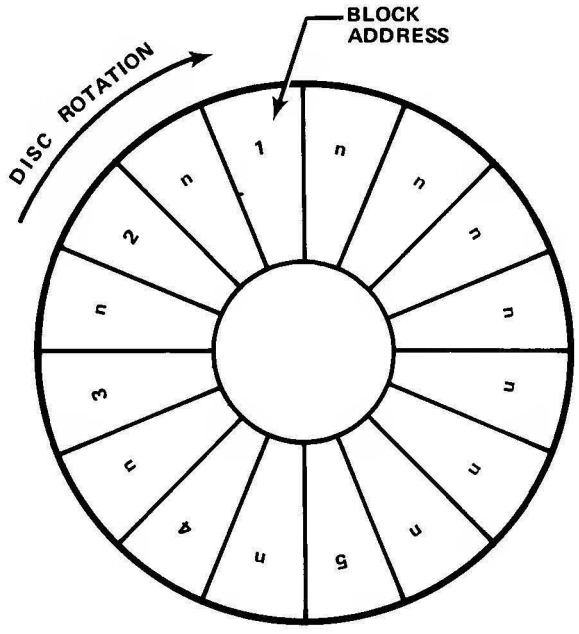


CASE 1

INTERLEAVE = 1

DATA TRANSFER SEQUENCE (BLOCKS 1 - n)

1. The disc drive reads and transmits block 1.
2. The disc drive head is now at block 2 but, because the host is still busy with the first transfer, the drive can not read and transmit the second block.
3. The host finishes accepting block 1 and readies itself for block 2. By this time the drive head has passed the beginning of block 2 and the host will now have to wait for the disc to make a complete revolution back to this block. This induces a latency and degrades system throughput.



CASE 2

INTERLEAVE = 2

DATA TRANSFER SEQUENCE (BLOCKS 1 - n)

1. The disc drive reads and transmits block 1.
2. The host finishes accepting block 1 and readies itself for block 2. Because the blocks are interleaved, the disc drive head is over the intervening block and is approaching block 2.
3. The disc drive head arrives at block 2, and reads and transmits it to the waiting host. By using block interleave to alternate the data blocks, latencies have been reduced and system throughput has been enhanced.

5955-16A

Figure 2-2. Block Interleave

SPARE BLOCK

2-27. SPARE BLOCK

FUNCTION:

Allows the host to give the device permission to become temporarily busy while sparing the block indicated by the target address.

COMMAND FORMAT:

<00000110> <00000S0T>
P1

P1 = Sparing mode byte

S = 0 Skip spare
S = 1 Jump spare

T = 0 Retain data on reformatted track
T = 1 Do not retain data on reformatted track

T must equal 1 for tape operation
S must equal 0 for disc operation

DESCRIPTION:

Once sparing has been initiated in a given area, it must be completed to avoid problems with partial address changes. Under most circumstances, the device will determine the optimum technique for sparing. In some cases, however, the host may specify additional information as to how the sparing operation will be carried out. This is done via the sparing mode byte.

When the host issues a Spare Block command to the disc drive, it is necessary to reformat the entire data track on which the defective block resides. If the option to retain data is specified (T = 0), all data on the track, excluding the defective block, will be retained. If the host does not wish to retain data (T = 1), the sparing operation will be performed but none of the data will be retained. If the host attempts to spare a defective block with the option to retain data and an additional defective block is found on the data track, an Unrecoverable Data error will result. In this case, the host must spare without retaining data.

Following a Spare Block command, the parameter field of the status message will contain information concerning the address and length of the area reformatted by the command. The parameter bytes (P1 - P6) contain the beginning address of the reformatted area and the fault log bytes (P7 - P10) contain the length — in blocks — of the reformatted area.

Note: Because of the information contained in the parameter field of the status message, status should always be requested after a Spare Block command. This will return information about the area affected by the sparing operation and will also clear the status message.

TAPE UNIT OPERATION:

This command instructs the device to spare the current target block using the method indicated by the S bit. A sparing operation requires that the sparing table be updated. Because updating involves tape movement, this command may take the full tape transit time to execute. Refer to paragraph 1-20 for an explanation of sparing methods.

This command does not retain data in the spare block.

2-28. LOCATE AND VERIFY

FUNCTION:

Instructs the device to perform an internal verification of a section of data to ensure that it can be read.

COMMAND FORMAT:

<00000100>

DESCRIPTION:

None of this data is transferred to the host so no execution message is required. The Set Length and Set Address (Complementary) commands are used as described in paragraphs 2-14 and 2-16.

The verification starts at the target address and continues for the amount of data (in bytes) specified in a Set Length (Complementary) command (or the existing set or power-on value). If this byte count length is not an integral multiple of the number of bytes per block the count will be rounded up to verify the entire block, since a block is the smallest unit which can be verified.

During verification all correctable data errors are counted and logged into the error log. Verification will terminate immediately on an unrecoverable data error.

Read retries are not normally attempted during a Locate and Verify. In some cases, however, it may be necessary for the device controller to invoke retries in order to meet certain product specifications (i.e., seek error rate).

TAPE UNIT OPERATION:

- Verify will terminate on an unrecoverable data error unless the bad block has been spared.
- Verify will not terminate on a file mark.
- At the conclusion of a write operation, the host may initiate a verify after resetting the target address to the address in effect at the beginning of the transfer. It is not recommended, however, that such verifies be done on a block-by-block basis as this will result in extremely poor performance and excessive mechanical wear.

COPY DATA

2-29. COPY DATA

FUNCTION:

Copies the amount of data specified by the power-on or last set length value from the specified unit and volume to a selected unit and volume.

COMMAND FORMAT:

<00001000> <0VVV0UUU> <0001000T> < P1 > . . . . . < P6 >

Set Address — 6 parameter bytes

Address of data source

<0XXX0WWW> <0001000T> < P1 > . . . . . < P6 >

Set Address — 6 parameter bytes

Address of data destination

VVV	=	volume number on UUU from which data is copied
UUU	=	unit number of data source
T	=	address mode (0 = single vector, 1 = 3-vector)
XXX	=	volume number on WWW to which data is copied
WWW	=	unit number of data destination

DESCRIPTION:

Copy Data provides a copy function from one unit to another within the same device or from one volume to another within the same unit. If unrecoverable data is read, this data will be copied using the best recovery attempts, but it will not generate an error at the destination. Therefore any errors found in the initial copy will be noted in the status report returned following the Copy Data transaction along with the address of the first error.

The address from which the data is obtained is the address specified after the source unit number. The destination address is specified by the Set Address command located after the destination unit number. The Set Address opcode may indicate any of the addressing modes supported. The parameters of the Set Address command are validated as a normal Set Address.

A full volume transfer is accomplished by setting the length specification (via the Set Length command) to all "1"s. This value implies a transfer size equal to the selected volume. If the target address of the data source is then set to the beginning of the volume (address 0), the entire contents of the volume will be copied. Although this is the normal method of executing a full volume transfer it is not necessary to reset the target address to the beginning of the volume. A full volume transfer can begin anywhere within the selected volume and will copy all data from that point to the end of the volume. If a full volume transfer is executed in this manner, an End of Volume error will *not* be generated when the end of the volume is reached.

The Copy Data command is always directed to the device controller (unit 15). Copying of data from one area to an overlapping area yields an unspecified result which will not cause an error.

If a failure occurs during a Copy Data command, a Cross-Unit error will result. This error will place a list of the failing unit(s) in the parameter field (P1 - P6) of the Request Status message. Using this information, the host can then request status from the failing unit(s) to determine the exact nature of the failure.

COPY DATA (continued)

TAPE UNIT OPERATION:

- The tape unit address must be in block mode.
- End of File (EOF) status is reported and the operation terminated if a file mark is encountered on the tape when it is the source unit.
- If an unwritten block is encountered on the tape when it is the source unit, the operation is terminated with No Data Found status.
- Reaching the end of volume for either unit terminates the operation with an End of Volume status.
- If a bad key is encountered on the tape when it is the destination unit, the operation is terminated unless auto sparing is enabled. During a full volume transfer, auto sparing is enabled using skip sparing.
- If more than one tape is required to perform a full volume transfer to the tape unit, the address of the first disc sector copied to each tape is logged in the maintenance block of that tape. (An example of this is a full volume copy on an HP 7914.)

RELEASE

2-30. RELEASE

FUNCTION:

Used to release the device for a period of time.

COMMAND FORMAT:

"00001110"

DESCRIPTION:

Using the Release command, the host can allow a device to go offline to service an internal requirement. The host is informed of this requirement via the Release Request bits in the status message returned by the device. Once released, the device will service the internal requirement and then return in the reporting state. If the host attempts to communicate with the device while it is released, a Retransmit error will be reported when the device returns.

When the host issues the Release command the device will go offline and service one internal requirement. If more than one release request is present at one time, a separate release sequence will be required to service each request.

2-31. RELEASE DENIED

FUNCTION:

Prohibits the device from releasing itself.

COMMAND FORMAT:

<00001111>

DESCRIPTION:

This command will be issued by the host if the device returns a release request status report and the host does not want the device to be released. By specifically denying the release, the host can keep the device from timing out and releasing itself. The Release Denied command will clear all release requests which are pending when the command is issued. Once release has been denied, the event which initiated the release request must reoccur before the device will issue another request. This may include pushing a button again (e.g., Unload, self-test) or the redetection by the controller of an internal condition (e.g., head alignment, error log maintenance).

For most devices the Release Denied command must be directed to the device controller (unit 15).

UNLOAD

2-32. UNLOAD

COMMAND FORMAT:

<01001010>

DESCRIPTION:

This command is used by the host to unload the tape. The error log is rewritten, if necessary, and the tape is unloaded. Execution of this command may require rewriting logs at both BOT and EOT. Before each log is updated, a release request for internal maintenance will be generated. This means that an Unload command may be followed by as many as two release requests, one for each log. If the logs cannot be rewritten (tape drive failure, tape write protected), the tape will be unloaded without any release requests being generated.

2-33. INITIATE UTILITY

FUNCTION:

Directs the device to perform one utility routine.

COMMAND FORMAT:

<001100XX> < P1> < P2 >.....< P9 >

Up to 8 parameter bytes

XX = execution message qualifier

00 = no execution message
01 = device will receive execution message text
10 = device will send execution message text

P1 = utility number (device specific)

Parameter quantity and content is function of P1.

DESCRIPTION:

The utility number following the Initiate Utility opcode indicates which utility is to be performed. Depending on the utility selected, a predefined number of parameter bytes may be expected to follow the utility number.

INITIATE DIAGNOSTIC

2-34. INITIATE DIAGNOSTIC

FUNCTION:

Directs the device to perform one internally defined diagnostic routine.

COMMAND FORMAT:

<00110011> <P1> <P2> <P3>

3 parameter bytes

P1 - P2 = loop parameter
P3 = diagnostic section number

DESCRIPTION:

This command instructs the device to perform one internally defined diagnostic routine. The Diagnostic Result parameters of the status message will contain information concerning the results of the diagnostic.The Initiate Diagnostic command must be directed to the device controller (unit 15).

Parameter byte P3 (diagnostic section number) defines which internal diagnostic the device will perform. (The value of this parameter is device dependent.) Parameter bytes P1 and P2 (loop) determine how many times the diagnostic will be performed.

2-35. REQUEST STATUS

FUNCTION:

Instructs the device to return (in an execution message) the status report.

COMMAND FORMAT:

<00001101>

DESCRIPTION:

The Request Status command returns a 20-byte status report (in an execution message) indicating the cumulative status of all transactions which have occurred since the status report was last cleared. The status report can only be cleared by executing a Request Status command or a Clear command (refer to paragraph 3-2). The status report consists of a 2-byte identification field, an 8-byte error reporting field, and ten bytes of additional information in the parameter field. Table 2-5 shows the complete format of the status report, and table 2-6 shows the errors that apply to a given command.

The 2-byte identification field contains the volume number, the unit number, and an identification of other units within the device that have status pending.

The 8-byte error reporting field contains four categories: Reject Errors, Fault Errors, Access Errors, and Information Errors. Each category has a 2-byte error field. All error conditions are assigned specific bit positions in one of these fields. The error bit positions correspond to bit positions in the Set Status Mask (Complementary) command parameter field.

The content of the parameter field is dependent on the errors being reported. The parameter field contents are awarded to the error with the highest priority (lowest bit position in the error reporting field). An error that has been masked in a Set Status Mask (Complementary) command will not be reported and will not generate parameters. All address parameters are reported in the format (single or 3-vector) last specified in a Set Return Addressing Mode (Complementary) command. Whenever the 6-byte address field is not being used, either by a status bit which has a parameter or by a Spare Block command, it will contain the current target address. The last four bytes (P7 - P10) of the parameter field will contain device specific fault log information except after a Spare Block command. After a Spare Block command, bytes P1 - P6 contain the address of the area affected by the command and bytes P7 - P10 contain the length of the affected area.

ERROR CATEGORIES

Reject Errors. Includes status bits which indicate a logical error in the host's interaction with the device. Reject errors result from opcode or parameter errors in the command message or message type or length errors in any message. Typically, incorrect programming or channel malfunction is the cause of these errors.

Fault Errors. Indicate device hardware failures or the availability of diagnostic information.

Access Errors. Indicate problems encountered in executing a specific command relating to such factors as device format, media condition, or independent events occurring during a transaction (i.e., operator intervention).

Information Errors. Provide maintenance information to the host. These errors arise from conditions which were not fatal to the operation being performed and do not require immediate host action. In most cases, information errors indicate potential problems or performance irregularities in the device.

REQUEST STATUS (continued)

Table 2-5. Request Status Summary

ERROR REPORTING FIELDS[1]

IDENTIFICATION ERRORS FIELD	REJECT ERRORS FIELD	FAULT ERRORS FIELD[2]
<VVVVUUUU> <SS SS SS SS>	0 7 8 15 <0 0 2 0 0 5 6 7> <8 9 10 0 12 0 0 0>	16 23 24 31 <0 17 0 19 0 0 22 0> <24 0 26 27 28 0 30 31>
VVVV = Volume number **UUUU** = Unit number **SSSSSSSS** = Value of the lowest numbered unit with status pending (all ones if no units have status pending).	**2** = **CHANNEL PARITY ERROR** A channel command was received without odd parity. **5** = **ILLEGAL OPCODE** An unrecognizable opcode was received. **6** = **MODULE ADDRESSING** An illegal volume or unit number was specified for this device. **7** = **ADDRESS BOUNDS** The target address has exceeded the bounds for this device. **8** = **PARAMETER BOUNDS** A parameter (other than unit, volume, or target address) is not allowed for this device. **9** = **ILLEGAL PARAMETER** A parameter field was the wrong length for the opcode preceding it. **10** = **MESSAGE SEQUENCE** The message sequence has been violated. (Error suppressed if any reject or fault errors have occurred prior to sequence error.) **12** = **MESSAGE LENGTH** The total length of the execution message differs from the current default value.	**17** = **CROSS-UNIT[3]** An error has occurred during a Copy Data operation. **19** = **CONTROLLER FAULT** A hardware fault occurred in the controller. **22** = **UNIT FAULT** A hardware fault has occurred in the unit addressed. **24** = **DIAGNOSTIC RESULT[3]** The hardware failed the diagnostic indicated in the parameter field. **26 - 28** = **RELEASE REQUIRED** This command cannot be executed until after release is granted to the device. Device requires release for indicated reason: **26** = **OPERATOR REQUEST** Release required for operator request (e.g., load/unload, restore). **27** = **DIAGNOSTIC REQUEST** Release required for diagnostics initiated from control panel (e.g., HIO, self test). **28** = **INTERNAL MAINTENANCE** Release required for internal maintenance (e.g., head alignment, error log). **30** = **POWER FAIL** The power to the unit failed, a diagnostic destroyed configuration, or a pack was loaded. Device should be reconfigured. **31** = **RETRANSMIT** The preceding transaction should be retried.

Notes:

1. Error bit positions correspond to bit positions in Set Status Mask command. A "1" indicates presence of an error. Unused bit positions musta be zeroes.
2. All Fault Errors are unmaskable.
3. Error uses parameter field.
4. • Parameter field configuration is dependent on reported errors.
   • Highest priority is given to lowest numbered errors.
   • Masked errors relinquish their priority.

REQUEST STATUS (continued)

Table 2-5. Request Status Summary (continued)

ERROR REPORTING FIELDS[1]

ACCESS ERRORS FIELD 32 39 40 47 <32 33 34 35 36 37 00><40 41 0 43 44 0 0 0>	INFORMATION ERRORS FIELD 48 55 56 63 <48 49 50 51 52 0 0 55><0 57 58 59 0 61 0 0>	PARAMETER FIELD[4] <P1>----------<P10>
32 = ILLEGAL PARALLEL OPERATION The requested operation cannot be executed in parallel with some other operation(s) currently in progress. **33 = UNINITIALIZED MEDIA** The host attempted to access unformatted media, or unusable media has been loaded. **34 = NO SPARES AVAILABLE** Spare Block cannot be executed due to lack of spare media. **35 = NOT READY** The selected unit is not ready for access at this time (e.g., heads or media not yet fully loaded). **36 = WRITE PROTECT** The selected volume is write protected. **37 = NO DATA FOUND** A block accessed during a read has not been written. **40 = UNRECOVERABLE DATA OVERFLOW** The previous transaction generated more than 1 unrecoverable data error. The entire transfer should be considered in error. **41 = UNRECOVERABLE DATA**[3] Unrecoverable data at indicated block(s). **43 = END OF FILE** End of file encountered on file structured device. **44 = END OF VOLUME** The host attempted to access across a volume boundary.	**48 - 50 = REQUEST RELEASE**[3] Device requests release for indicated reason: **48 = OPERATOR REQUEST**[3] Release requested for operator request (e.g., load/unload, restore). **49 = DIAGNOSTIC REQUEST**[3] Release request initiated from diagnostic control panel (e.g., HIO, self test). **50 = INTERNAL MAINTENANCE**[3] Release requested for internal maintenance (e.g., head alignment, error log). **51 = MEDIA WEAR** Only one spare track (disc) or one spare block (tape) remaining. **52 = LATENCY INDUCED** A latency was induced during the transfer due to slow transfer rate or seek retry. **55 = AUTO SPARING INVOKED** A defective block has been automatically spared by the device. **57 = RECOVERABLE DATA OVERFLOW** The previous transaction generaged more than 1 recoverable data error. **58 = MARGINAL DATA**[3] Data was recovered, but with difficulty. **59 = RECOVERABLE DATA**[3] A latency was introduced in order to correct a data error. **61 = MAINTENANCE TRACK OVERFLOW**[3] Error and fault log area is full.	No Errors: P1 through P6 indicate new Target Address. The address format, which is used any time P1 through P6 contain address information, is defined by the Set Return Addressing command (refer to paragraph 2-24). No Errors: P7 through P10 contain runtime drive error codes (DERRORS), except after a Spare Block command. The errors are arranged chronologically: P7 contains the most recent of the four errors recorded; P10 contains the oldest of the four recorded. Note: Error codes 40H and CBH will always be followed by a single byte containing fault latch information. After a **Spare Block** command, P1 through P6 contain the beginning address of the reformatted area. (Disc operation only.) After **Spare Block** command, P7 through P10 indicate the length - in blocks - of the reformatted area. The length is a four-byte, unsigned binary number. (Disc operation only.) Error Bit No. 17 **Cross-unit:** P1 through P6 contain the encoded values of each unit which has experienced an error. A byte of all ones indicates no additional units. Error Bit No. 24 **Diagnostic Results:** P1 through P6 contain the following information: P1 = most suspect component P2 = next most suspect component P3 = test error (TERROR) associated with P1 P4 = test error (TERROR) associated with P2 P5 - P6 = not used P7 - P10 contain DERROR information (format described above). Error Bit No. 41 **Unrecoverable Data:** P1 through P6 indicate address of bad block. Error Bit No. 48 - No. 50 **Request Release:** P1 through P6 contain the encoded values of each unit requesting release. A byte of all ones indicates no additional units. Error Bit No. 58 **Marginal Data:** P1 through P6 indicate address of the marginal block. Error Bit No. 59 **Recoverable Data:** P1 through P6 indicate address of recoverable block.

REQUEST STATUS (continued)

Table 2-6. Possible Errors Summary

COMMAND	REJECT ERRORS								FAULT ERRORS									
	CHANNEL PARITY	ILLEGAL OPCODE	MODULE ADDRESSING	ADDRESS BOUNDS	PARAMETER BOUNDS	ILLEGAL PARAMETER	MESSAGE SEQUENCE	MESSAGE LENGTH	CROSS-UNIT	CONTROLLER FAULT	UNIT FAULT	DIAGNOSTIC RESULT	RELEASE REQUIRED:	• OPERATOR REQUEST	• DIAGNOSTIC REQUEST	• INTERNAL MAINTENANCE	POWER FAIL	RETRANSMIT
REAL TIME																		
LOCATE AND READ	X	X				X	X	X		X	X			X	X	X	X	X
COLD LOAD READ	X	X				X	X	X		X	X			X	X	X	X	X
LOCATE AND WRITE	X	X				X	X	X		X	X			X	X	X	X	X
WRITE FILE MARK[1]	X	X				X	X	X		X	X			X	X	X	X	X
COMPLEMENTARY																		
SET UNIT	X	X	X			X	X	X		X	X			X	X	X	X	X
SET VOLUME	X	X	X			X	X	X		X	X			X	X	X	X	X
SET ADDRESS	X	X		X		X	X	X		X	X			X	X	X	X	X
SET BLOCK DISPLACEMENT	X	X		X		X	X	X		X	X			X	X	X	X	X
SET LENGTH	X	X				X	X	X		X	X			X	X	X	X	X
SET BURST	X	X				X	X	X		X	X			X	X	X	X	X
SET RPS	X	X				X	X	X		X	X			X	X	X	X	X
SET RETRY TIME	X	X				X	X	X		X	X			X	X	X	X	X
SET STATUS MASK	X	X				X	X	X		X	X			X	X	X	X	X
NO OP	X	X				X	X	X		X	X			X	X	X	X	X
SET RELEASE	X	X			X	X	X	X		X	X			X	X	X	X	X
SET OPTIONS[1]	X	X			X	X	X	X		X	X			X	X	X	X	X
SET RETURN ADDRESSING MODE	X	X			X	X	X	X		X	X			X	X	X	X	X
GENERAL PURPOSE																		
DESCRIBE	X	X				X	X	X		X	X			X	X	X	X	X
INITIALIZE MEDIA	X	X			X	X	X	X		X	X			X	X	X	X	X
SPARE BLOCK	X	X				X	X	X		X	X			X	X	X	X	X
LOCATE AND VERIFY	X	X				X	X	X		X	X			X	X	X	X	X
COPY DATA	X	X	X	X		X	X	X	X	X	X			X	X	X	X	X
RELEASE	X	X				X	X	X		X	X	X		X	X	X	X	X
RELEASE DENIED	X	X				X	X	X		X	X			X	X	X	X	X
UNLOAD[1]	X	X				X	X	X		X				X	X	X	X	X
DIAGNOSTIC																		
INITIATE UTILITY	X	X			X	X	X	X		X	X			X	X	X	X	X
INITIATE DIAGNOSTIC	X	X			X	X	X	X		X	X	X		X	X	X	X	X
REQUEST STATUS	X	X				X	X	X		X	X			X	X	X	X	X

NOTE 1: APPLIES TO TAPE DRIVE OPERATIONS ONLY.

REQUEST STATUS (continued)

Table 2-6. Possible Errors Summary (continued)

COMMAND	ACCESS ERRORS									INFORMATION ERRORS										
	ILLEGAL PARALLEL OPERATION	UNINITIALIZED MEDIA[1]	NO SPARES AVAILABLE	NOT READY	WRITE PROTECT[1]	NO DATA FOUND[1]	UNRECOVERABLE DATA OVERFLOW	UNRECOVERABLE DATA	END OF FILE[1]	END OF VOLUME	REQUEST RELEASE:	• OPERATOR REQUEST	• DIAGNOSTIC REQUEST	• INTERNAL MAINTENANCE	MEDIA WEAR	LATENCY INDUCED	AUTO SPARING INVOKED[1]	RECOVERABLE DATA OVERFLOW	MARGINAL DATA	RECOVERABLE DATA	MAINTENANCE TRACK OVERFLOW
REAL TIME																					
LOCATE AND READ	X		X		X	X	X	X	X		X	X	X		X		X	X	X	X	
COLD LOAD READ	X		X		X	X	X	X	X		X	X	X		X		X	X	X	X	
LOCATE AND WRITE	X		X	X		X[1]	X[1]		X		X	X	X		X	X				X	
WRITE FILE MARK[1]			X	X		X	X		X		X	X	X			X		X		X	
COMPLEMENTARY																					
SET UNIT											X	X	X							X	
SET VOLUME											X	X	X							X	
SET ADDRESS											X	X	X							X	
SET BLOCK DISPLACEMENT											X	X	X							X	
SET LENGTH											X	X	X							X	
SET BURST											X	X	X							X	
SET RPS											X	X	X							X	
SET RETRY TIME											X	X	X							X	
SET STATUS MASK											X	X	X							X	
NO OP											X	X	X							X	
SET RELEASE											X	X	X							X	
SET OPTIONS[1]											X	X	X							X	
SET RETURN ADDRESSING MODE											X	X	X							X	
GENERAL PURPOSE																					
DESCRIBE											X	X	X							X	
INITIALIZE MEDIA	X		X	X							X	X	X							X	
SPARE BLOCK	X	X	X	X		X	X				X	X	X					X		X	
LOCATE AND VERIFY	X		X				X		X		X	X	X							X	
COPY DATA	X		X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	
RELEASE											X	X	X							X	
RELEASE DENIED											X	X	X							X	
UNLOAD[1]											X	X	X							X	
DIAGNOSTIC																					
INITIATE UTILITY	X		X	X	X						X	X	X							X	
INITIATE DIAGNOSTIC	X				X						X	X	X							X	
REQUEST STATUS											X	X	X							X	

NOTE 1: APPLIES TO TAPE DRIVE OPERATIONS ONLY.

SECTION III
TRANSPARENT MESSAGE COMMANDS

3-1. INTRODUCTION

The function of transparent commands is to compensate for different types of channels and differences in operating environments. Transparent commands are intercepted by the channel module and modify the normal command-execution-reporting transaction sequence (refer to paragraph 1-6). The transparent commands include the Clear, Cancel, Loopback, and Interface commands. An illegal opcode in a transparent message will generate a Message Sequence error.

CLEAR

3-2. CLEAR

The clear command will cause the device to abort the transaction in process as soon as possible without losing any data. There are three mechanisms available to clear the device: the HP-IB Universal Clear command, the HP-IB Selected Device Clear command, and the Channel Independent Clear. All three commands will cause identical clearing action in a device, unless the Channel Independent Clear is directed to a unit other than the device controller (refer to paragraph 3-5). The Clear command will reset:

— clearable hardware functions

— internal buffers

— channel interface buffers

— Complementary values

— status report, unless the Diagnostic Result status bit is set

— other programmable functions (device dependent)

UNIVERSAL DEVICE CLEAR

3-3. UNIVERSAL DEVICE CLEAR

FUNCTION:

A universal command that forces all devices on the HP-IB to return to a known reset state.

COMMAND FORMAT (HP-IB):

ATN
<P0010100>*

DESCRIPTION:

After the clear operation, the device goes to the reporting state. A reporting message following a Clear command is optional because the device will accept and execute a command if sent. After a Clear command, the host should wait for the device to request a reporting message before sending any other command. This will avoid channel timeouts if there is a delay in processing the Clear command.

There may be some instances where a Clear command occurring during the execution phase may be deferred in order to allow completion of a critical operation.

When the host issues a Clear, the device will:

Note: This sequence does not include any recalibration operations or diagnostic functions.

1. Abort the current operation at the earliest opportunity such that no data corruption can take place.
2. Clear all clearable device or interface conditions currently asserted.
3. Reset all Complementary parameters to their power-on values.
4. Reset status report, unless the Diagnostic Result status bit is set. This includes resetting power-on status.

Note: After the device has reported a diagnostic failure on one unit, the Clear command will clear the status of other units attempting to report the same failure. It is unnecessary for the same failure to be reported more than once.

5. Set QSTAT value to indicate whether or not status should be requested. Note: QSTAT will indicate any diagnostic results in addition to the occurrence of an internal release request.
6. Enter the reporting state.

Note: See section IV for the HP-IB implementation of the Clear command.

*P = Parity Bit for all HP-IB commands

SELECTED DEVICE CLEAR

3-4. SELECTED DEVICE CLEAR

FUNCTION:

An HP-IB channel command that forces only currently addressed devices to return to a known reset state.

COMMAND FORMAT (HP-IB):

ATN	ATN
<P01ADDRS>	<P0000100>

DESCRIPTION:

This command description is identical to the description for the Unversal Device Clear command (refer to paragraph 3-3).

CHANNEL INDEPENDENT CLEAR

3-5. CHANNEL INDEPENDENT CLEAR

FUNCTION:

The recommended clearing mechanism for channels other than HP-IB.

COMMAND FORMAT (HP-IB):

[0010YYYY]<00001000>

YYYY = unit number

DESCRIPTION:

This command can be used by the host to implement a Clear command on channels other than HP-IB. If the unit number specifies the device controller (unit 15), all units associated with that device will be cleared in a manner identical to the Universal Clear command (refer to paragraph 3-3). If the unit number specifies a particular unit within the device, only that unit will be cleared and after the clear operation the specified unit will remain selected.

CANCEL

3-6. CANCEL

FUNCTION:

This command causes graceful termination of the transaction, leaving it in the reporting phase.

COMMAND FORMAT:

[0010YYYY] <00001001>

YYYY = unit number

DESCRIPTION:

The Cancel command suppresses message length errors. The recommended way to terminate a transaction is to terminate the message link, then send the Cancel command.

LOOPBACK

3-7. LOOPBACK

FUNCTION:

Initiates a sequence to test channel integrity.

COMMAND FORMAT:

<0000001T> < P1 > . . . . . < P4 >

Byte Length Parameter (n)

T = 0 Read Loopback Test
T = 1 Write Loopback Test

Note: See section IV for the HP-IB implementation of the Read and Write Loopback tests.

DESCRIPTION:

Loopback is an interface test performed by the channel module consisting of two transparent messages followed by a reporting message. The first transparent message specifies that a read or write loopback operation of n bytes will follow, and the second transparent message contains the test data specified by the first. The host can then progress to the reporting phase without waiting for a poll from the device.

Normally the device remains in the command-ready state during a loopback test and does not request a reporting message. Therefore, unless an error has occurred, a reporting message to retrieve QSTAT is optional and the device will accept and execute a command message following the second transparent message.

If an error occurs during the loopback sequence, the device will enter an interlock reporting state. In this state the device will not execute any commands from the host until the failure has been reported. If the transferred data bytes are not correct, or if the number of bytes transferred is not equal to the number specified in the Loopback command, a Channel Parity error will result.

Internal requests are suppressed once the loopback command is given and re-enabled after completion of the loopback sequence.

The loopback test sequence begins with a hex FF and each byte that follows is equal to its predecessor plus one. Carry is ignored.

HP-IB PARITY CHECKING

3-8. INTERFACE SPECIFIC COMMANDS

These commands are used to set up any channel specific interface parameters or operating conditions.

3-9. HP-IB PARITY CHECKING

FUNCTION:

This command determines whether the device will detect channel command parity errors.

COMMAND FORMAT:

	EOI
<00000001>	<000000SV>

S = 0 Disable SRQ during poll (power-on state)
S = 1 Enable SRQ during poll
V = 0 Parity Checking disabled (power-on state)
V = 1 Parity Checking enabled

Note: See section IV for the HP-IB implementation of the Parity Checking command.

DESCRIPTION:

If Parity Checking is enabled, and a channel command present on the bus does not contain odd parity, the device will NOT accept the command; i.e., Not Data Accepted (NDAC) will remain in the low state. This condition will remain until the host removes Data Valid (DAV) and corrects the channel command parity.

If the S bit is set, the Service Request (SRQ) line will be asserted whenever the device polls.

IDENTIFY

3-10. IDENTIFY

FUNCTION:

Identify is a special-case HP-IB command used by the host at power-on to identify the devices connected to the bus.

COMMAND FORMAT:

Untalk	Secondary with Device Address	Supplied by Device		Unaddress
ATN <P1011111>	ATN <P11ADDRS>	<00000010> ID byte 1	<TTTTTTTT> ID byte 2	ATN <P1011110>

T = Device type code

DESCRIPTION:

Each device returns a two-byte identity code which the host can use to configure itself. All CS/80 devices return the value of 2 (00000010) in ID byte 1, and the product type code in ID byte 2.

Note: The transparent secondary command is not used in this sequence.

SECTION IV
CHANNEL IMPLEMENTATION

4-1. INTRODUCTION

This section provides an overview of the Hewlett-Packard Interface Bus (HP-IB) and discusses the protocol and syntax for bus interactions between the Controller-In-Charge (CIC) and a disc drive mass storage device.

Protocol is defined as the rules for conducting communications on a given channel. Protocol is channel-specific/device-independent and includes the addressing requirements, handshake sequence, bus management operations, and polling techniques on the HP-IB.

Syntax is defined as the systematic arrangement of communication elements (bytes, commands, etc.) to form intelligent messages. Syntax on the HP-IB is device-specific/channel-independent and includes the specific commands used to specify the operational state of a device connected to the HP-IB.

4-2. HP-IB OVERVIEW

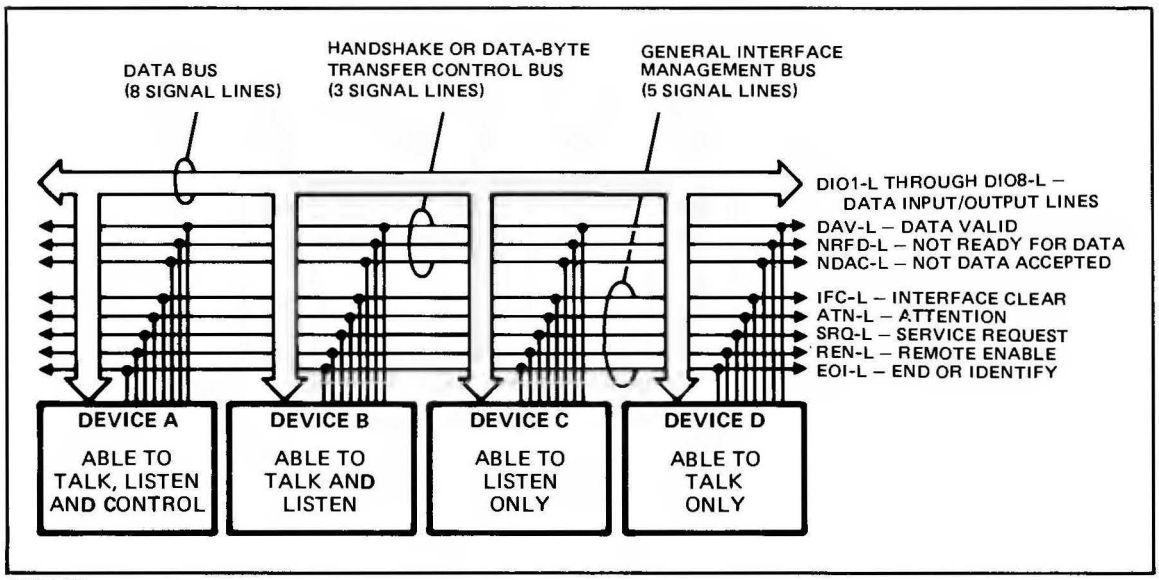
The HP-IB provides a standardized method to connect and transfer information between separate devices. See figure 4-1. HP-IB is the Hewlett-Packard implementation of ANSI/IEEE 488-1978, "IEEE Standard Digital Interface for Programmable Instrumentation".

The HP-IB transfers commands and data between the components of a system on 16 signal lines. The interface functions for each system device are performed within the device so only passive cabling is needed to connect the system. The cables connect all system components in parallel to the signal lines.

The eight Data I/O lines (DIO1 through DIO8) are reserved for the transfer of commands, data, and other messages in a byte-serial, bit-parallel manner. Byte transfer is asynchronous, coordinated by the three-line handshake bus consisting of Data Valid (DAV), Not Ready For Data (NRFD), and Not Data Accepted (NDAC).

Command/data bytes are transmitted over the DIO lines under sequential control of the handshake signals. No step in the handshake sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than the slowest device that is active. This permits several devices on the bus to receive the same message byte concurrently.

Devices connected to the bus may be talkers, listeners, or controllers (see table 4-1). The controller-in-charge (CIC) dictates the role of each of the other devices by setting the Attention (ATN) line true and sending talk or listen address commands on the DIO lines. Addresses are set into a device at the time of system configuration with switches built into the device or by jumpers on a printed circuit board. While ATN is true, all devices must listen to the DIO lines. When ATN is false, only devices that have been addressed will actively send or receive data. Several listeners can be active simultaneously but only one talker can be active at a time. Whenever a talk address is present on the DIO lines (while ATN is true), all other talkers are automatically unaddressed.



5955-3A

Figure 4-1. Hewlett-Packard Interface Bus

The Interface Clear (IFC) signal places all devices on the bus in a known quiescent state. The Remote Enable (REN) signal is used to select between two alternate sources of device programming data such as the front panel or the HP-IB.

In a serial poll system, any active device can set the Service Request (SRQ) signal true. This indicates to the CIC that some device on the bus requires attention.

The End or Identify (EOI) is a talker signal used to indicate the end of a multiple-byte transfer sequence.

In a parallel poll system, when the CIC sets both ATN and EOI true simultaneously, each device requiring attention from the CIC responds by setting the DIO line corresponding to its address true.

Table 4-1. HP-IB Definitions

HP-IB TERM	DEFINITION	CONSIDERATIONS
TALKER	Any device which sends information over the HP-IB.	There can be only one TALKER sending information over the HP-IB at a time.
LISTENER	Any device which receives information over the HP-IB. Some devices can function as LISTENERS or TALKERS.	In a parallel poll system, there can be up to 8 LISTENERS receiving information over the HP-IB at the same time.
CONTROLLER	Any device that has been programmed to manage data flow between the TALKER AND THE LISTENER(s) in addition to being a TALKER and a LISTENER.	The CONTROLLER manages data flow by addressing one device as a TALKER and one or more devices as LISTENERS. There can be only one active CONTROLLER on the HP-IB at any time. The active CONTROLLER is called the CONTROLLER-IN-CHARGE (CIC).
SYSTEM CONTROLLER	Any device that functions as a CONTROLLER and is able to gain absolute control of the HP-IB with the Interface Clear (IFC) signal.	There can be only one SYSTEM CONTROLLER connected to the HP-IB.

4-3. EXPLANATION OF TERMS

The following paragraphs provide explanations of the terms used in this section.

COMMAND. A unit of information transmitted over the channel (HP-IB) relating to a specific operation.

CHANNEL COMMAND. Channel commands are located in the message header (primary I and secondary) and trailer (primary II), and are used to manage operation on the channel itself. Information on the HP-IB data lines is considered a Channel Command when the ATN line is asserted.

DEVICE COMMAND. Device commands are located in the text portion of a command message, and are used to control the operation of a device connected to the channel.

UNIVERSAL COMMAND. A channel command that causes all devices on the bus to perform a predetermined interface function.

PRIMARY COMMAND. The primary I command is a channel command that begins the message sequence. It is located in the message header and contains the command to listen or talk and the address of a particular device. The primary II command is located in the message trailer and unaddresses the device with an unlisten or untalk command.

Table 4-2. Universal Command Formats

UNIVERSAL COMMAND	UNIVERSAL DEVICE CLEAR
ATN <P001CCCC> P = Parity Bit CCCC = Command Code	ATN <P0010100> P = Parity Bit

SECONDARY COMMAND. The secondary command is a channel command located in the message header and sets up the action required of the device in the text of the message.

TEXT. The text of the message can be 1 to n bytes depending on the required action. The required action can be to receive further qualifying information or instructions (such as a device command), to receive write data, to send read or status data, or to perform a specific operation such as a CLEAR.

MESSAGE. A unique sequence of command and text bytes transmitted over the channel during which the communication link between the devices (e.g., CIC and disc drive) remains unbroken.

COMMAND MESSAGE. A single message containing all the information required to address a device and initiate an operation, set up a programmable parameter, or set up for an operation that will be executed by an Execution Message.

EXECUTION MESSAGE. A single message containing all the information required to carry out an operation previously set up with a Command Message.

REPORTING MESSAGE. A single message containing the QSTAT byte. QSTAT indicates the completion status of the previous command.

TRANSACTION. A complete process or operation carried out over the channel. Some transactions are completed with command and reporting messages only and some require a complete command, executing, and reporting sequence. A transaction begins when a command message secondary is accepted by the device and ends when the device accepts the pass/fail reporting message (QSTAT).

4-4. CHANNEL MANAGEMENT TECHNIQUES

The following techniques are used by the CIC to manage the HP-IB: Parallel Poll and Universal Device Clear.

4-5. PARALLEL POLL

The CIC conducts a parallel poll on the HP-IB by asserting ATN and EOI simultaneously. Each peripheral device requiring service can then respond by asserting the DIO line corresponding to its address. The CIC then addresses only the device requiring service. If more than one device requires service, the CIC addresses the device with the highest priority (lowest address) first. Enable Parallel Poll Response (EPPR) and Disable Parallel Poll Response (DPPR) are internal states of the channel module. EPPR occurs when the device requires service from the CIC. DPPR is the opposite state and occurs whenever the device is active (e.g., busy executing a command). A Parallel Poll Response (PPR) from the device will occur if the CIC asserts both ATN and EOI and if the device is in the EPPR state.

4-6. UNIVERSAL DEVICE CLEAR

A universal command is a channel command that causes all devices on the HP-IB to perform a predetermined interface function. The Universal Device Clear command clears information stored in the controller unit and places the device in a known reset state. The formats for a Universal command and for a Universal Device Clear command are shown in table 4-2. Section III provides detailed descriptions of the Clear commands.

4-7. MESSAGE STRUCTURE

Each HP-IB message contains three components (see table 4-3): the header, containing address information; the text, containing device operating commands or data being transferred; and the trailer, containing unaddress information. In HP-IB systems using CS/80, the header contains two bytes of information: a primary I command, and a secondary command.

The CIC asserts ATN during primary and secondary commands to distinguish them from text information. The receiving device decodes the information contained in both the primary I and secondary commands to set up for the action to be specified in the text.

Table 4-3. HP-IB Message Structure

HEADER		TEXT	TRAILER
PRIMARY I	**SECONDARY**	**DEVICE COMMAND OR DATA**	**PRIMARY II**
(ATN) <ONE BYTE> - UNIDIRECTIONAL • CIC TO DEVICE - BEGINS MESSAGE • ADDRESSES DEVICE TO LISTEN OR TALK • UNIVERSAL	(ATN) <ONE BYTE> - UNIDIRECTIONAL • CIC TO DEVICE - SET UP DEVICE FOR FURTHER ACTION	<ONE TO n BYTES> - BIDIRECTIONAL - QUALIFYING INSTRUCTIONS TO DEVICE - WRITE DATA TO DEVICE - READ DATA TO CIC - STATUS DATA TO CIC	(ATN) <ONE BYTE> - UNIDIRECTIONAL • CIC TO DEVICE - TERMINATES MESSAGE - UNADDRESSES DEVICE • UNLISTEN • UNTALK

4-8. HEADER/TRAILER FORMATS

The address information contained in the message header consists of the primary and secondary channel commands. The structure of the primary and secondary commands is shown in table 4-4. P is an odd parity bit generated by the CIC. The state of bits 6 and 7 determine whether a command is primary, secondary, or universal. In a primary command, bits 1 through 5 are the device address; in a secondary command, bits 1 through 5 are the modifier field which sets up the receiving device for the particular action to be performed. A receiving device will only respond to the primary I command containing its specific address, but will respond to several authorized secondary commands. The action to be performed in the receiving device is dependent on the information contained in *both* the primary I and secondary commands. Therefore a given secondary can follow different primaries. Each unique primary/secondary combination has its own meaning and will cause a unique action to be performed.

The message trailer contains the primary II command. Bits 1 through 5 are set to 1 which unaddresses all devices on the bus.

Table 4-4. Header/Trailer Formats

MESSAGE HEADER (ADDRESS) COMMANDS		MESSAGE TRAILER (UNADDRESS) COMMAND
PRIMARY I COMMAND	SECONDARY COMMAND	PRIMARY II COMMAND
ATN 8 1 TALK <P10AAAAA> ATN 8 1 LISTEN <P01AAAAA> P = Parity Bit AAAAA = Device Address	ATN 8 1 <P11MMMMM> P = Parity Bit MMMMM = Modifier	ATN 8 1 UNTALK <P1011111> ATN 8 1 UNLISTEN <P0111111>

4-9. TEXT FORMATS

There are only four authorized CS/80 message types: Transparent, Command, Execution, and Reporting. The secondary command (in the message header) identifies the message type. Table 4-5 shows formats for each type of secondary command. The following paragraphs provide descriptions and format information for the text of each type of message.

Table 4-5. Secondary Command Formats

PRIMARY COMMAND TYPE	SECONDARY COMMAND TYPE	SECONDARY COMMAND BREAKDOWN		
		P	COMMAND FIELD	MODIFIER FIELD
Listen or Talk	Transparent	P	1 1	1 0 0 1 0
Listen	Command	P	1 1	0 0 1 0 1
Listen or Talk	Execution	P	1 1	0 1 1 1 0
Talk	Reporting	P	1 1	1 0 0 0 0
		P = Parity bit		

4-10. CONVENTIONS. The following conventions are used throughout this section:

< > Information inside angle brackets is required.

[ ] Information inside brackets is optional and supplied according to program requirements.

n Indicates a number supplied according to program requirements.

4-11. TRANSPARENT MESSAGES. Transparent messages compensate for different types of channels and differences in operating environments. Transparent messages could be used to support operation in a complex operating environment (i.e., one that involves parallel operations). The discussion of transparent commands in this manual is limited to operation within a simple operating environment.

Transparent messages also include interface specific functions or interface testing. Some device specific messages may be required in order to maintain the integrity of the transaction sequence in specific operating environments. Interface testing includes Read and Write Loopback.

Transparent messages may be initiated by either host or device, and they can be transmitted in either direction. The first byte of the text may be an operating code (opcode) which indicates the purpose of the message. The format of the remainder of the message is a function of the first byte.

TEXT FORMAT:

<TTTTTTTT> \< P1 > . . . . . < Pn >/
0 to n bytes

T = Transparent Command Opcode
P = Parameter or Message Information (n determined by T)

4-12. COMMAND MESSAGES. Command messages are initiated by a host and always go from the host to a device. The contents of the message may vary in length up to some maximum defined by the command set. Except for the Clear and Cancel commands, a command message is valid only if it occurs during the command phase of a transaction.

Command messages contain all device command operation codes (opcodes). There are four categories of device commands: Real Time, Complementary, General Purpose, and Diagnostic. A given command message may contain one or more Complementary command opcodes, and/or one command from any of the other three categories. Each opcode may be followed by any associated parameters. Command messages are buffered one at a time, and no command queing is performed. Specific opcodes and message structures are shown in detail in tables 4-6 and 4-7.

TEXT FORMAT:

\[CCCCCCCC] [S] . . . . . [S]/ \<DDDDDDDD> < P > . . . . . < P >/
n bytes 0 to m bytes

May contain 0 or more complementary commands and associated bytes.

C = Complementary Command Opcode
S = Set Value Modification Data (n determined by C)
D = Device Command Opcode
P = Parameter Data (m determined by D)

4-13. EXECUTION MESSAGES. Execution messages are requested by the device (via parallel poll) unless an execution message has already been established by the host. The direction and significance of the message depends on the command being executed. Possible execution message contents include read or write data, or detailed status/diagnostic information.

Execution messages are valid only during the execution phase of a transaction which started with a command that calls for an execution message. Some operations (e.g., Spare Block) do not include execution messages. For the Real Time commands, and the Initiate Utility (Diagnostic) command, the host may cause execution messages to be broken into bursts of smaller messages of uniform length by setting a non-zero burst size (refer to paragraph 2-17). In this case, the device initiates a series of messages which collectively contain the same information as would have been transmitted in one longer message.

TEXT FORMAT:

$$\underbrace{<\text{I1}>.....<\text{In}>}_{\text{n bytes}}$$

I = Transfer Data (n determined by command message)

4-14. REPORTING MESSAGES. The device requests reporting messages (via parallel poll) during the reporting phase of each transaction, and during unsolicited reporting phases entered for power recovery, or to service internal requests (refer to paragraph 1-16). All reporting messages consist of one byte of status information transmitted from the device to the host. This byte contains a QSTAT value tagged with EOI.

TEXT FORMAT:

<000QSTAT>

QSTAT = Completion Status

QSTAT STRUCTURE:

NORMAL COMPLETION = <00000000>

Indicates normal completion of the requested operation.

HARD ERROR = <00000001>

Indicates that error information is available. The host must issue the Request Status command in order to determine what went wrong.

POWER ON = <00000010>

Indicates that the device has just returned from a power failure or some form of operator intervention (such as removal of the storage media). Any incomplete transactions were aborted and should be repeated. The host must reconfigure any programmable operating parameters because they have returned to their power-on values.

4-15. HP-IB MESSAGE STRUCTURES

Table 4-6 shows the HP-IB message structures for the Device commands and table 4-7 shows the HP-IB message structures for the Transparent commands.

Table 4-6. HP-IB Device Command Message Structures

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
LOCATE AND READ	2-8	REAL TIME	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	EOI [0 TO n COMPLEMENTARY COMMANDS] <00000000> TIME DETERMINED BY CURRENT RPS AND BURST VALUES EPPR	ATN <P0111111>
			EXECUTION*	ATN <P10ADDRS>	ATN <P1101110> DPPR	1 TO n BYTES OF READ DATA EOI < >----------<LAST BYTE> EPPR (WHEN EXECUTION COMPLETE)	ATN <P1011111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>
COLD LOAD READ	2-9	REAL TIME	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	EOI [0 TO n COMPLEMENTARY COMMANDS] <00001010> TIME DETERMINED BY CURRENT RPS AND BURST VALUES EPPR	ATN <P0111111>
			EXECUTION*	ATN <P10ADDRS>	ATN <P1101110> DPPR	1 TO n BYTES OF READ DATA EOI < >----------<LAST BYTE> EPPR (WHEN EXECUTION COMPLETE)	ATN <P1011111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

*NO EXECUTION MESSAGE REQUIRED WHEN MESSAGE LENGTH EQUALS ZERO (SET LENGTH = 0).

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
LOCATE AND WRITE	2-10	REAL TIME	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	EOI [0 TO n COMPLEMENTARY COMMANDS] <00000010> TIME DETERMINED BY CURRENT RPS AND BURST VALUES EPPR	ATN <P0111111>
			EXECUTION*	ATN <P01ADDRS>	ATN <P1101110> DPPR	1 TO n BYTES OF WRITE DATA EOI <>----------<LAST BYTE> EPPR (WHEN EXECUTION COMPLETE)	ATN <P0111111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <OSTAT>	ATN <P1011111>
WRITE FILE MARK	2-11	REAL TIME	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	EOI [0 TO n COMPLEMENTARY COMMANDS] <01001001> TIME DETERMINED BY CURRENT RPS AND BURST VALUES EPPR	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

*NO EXECUTION MESSAGE REQUIRED WHEN MESSAGE LENGTH EQUALS ZERO (SET LENGTH = 0).

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET UNIT	2-12	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	EOI <0010YYYY> ↑ EPPR (WHEN UPDATE COMPLETED) YYYY = UNIT NUMBER (1111 = CONTROLLER)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>
SET VOLUME	2-13	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	EOI <01000YYY> ↑ EPPR (WHEN UPDATE COMPLETED) YYY = VOLUME NUMBER	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET ADDRESS	2-14	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101>	6 PARAMETER BYTES EOI <0001000T> <P1> - - - - - - - - - - - - - <P6> DPPR EPPR (WHEN UPDATE COMPLETED) T = ADDRESS MODE (0 = SINGLE VECTOR, 1 = 3-VECTOR SINGLE VECTOR FORMAT: 6-BYTE UNSIGNED BINARY NUMBER 3-VECTOR FORMAT: P1 - P3 = CYLINDER ADDRESS P4 = HEAD ADDRESS P5 - P6 = SECTOR ADDRESS	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <OSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET BLOCK DISPLACEMENT	2-15	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	6 PARAMETER BYTES EOI <00010010> <P1>----------<P6> EPPR (WHEN UPDATE COMPLETED) PARAMETER FORMAT: 6-BYTE, SIGNED, TWO'S COMPLEMENT BINARY NUMBER	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>
SET LENGTH	2-16	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	4 PARAMETER BYTES EOI <00011000> <P1>----------<P4> PARAMETER FORMAT: 4-BYTE BINARY NUMBER EPPR (WHEN UPDATE COMPLETED)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET BURST	2-17	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101>	EOI <0011110T> < P1 > DPPR EPPR (WHEN UPDATE COMPLETED) T = 0 INDICATES THAT LAST BURST ONLY IS TAGGED WITH A MESSAGE TERMINATOR T = 1 INDICATES THAT ALL BURSTS ARE TAGGED WITH A MESSAGE TERMINATOR P1 = NUMBER OF 256-BYTE SEGMENTS IN EACH BURST (IF P1 = ALL ZEROS, BURST MODE IS DEACTIVATED)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET RPS (ROTATIONAL POSITION SENSING)	2-18	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	EOI <00111001> <TIME1> <TIME2> ↑ EPPR (WHEN UPDATE COMPLETED) TIME1 = TIME TO TARGET IN 100'S OF MICROSECONDS TIME2 = WINDOW SIZE IN 100'S OF MICROSECONDS	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>
SET RETRY TIME	2-19	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	EOI <00111010> < P1 >< P2 > ↑ EPPR (WHEN UPDATE COMPLETED) P1 - P2 = RETRY TIME IN 10'S OF MILLISECONDS (16-BIT BINARY NUMBER)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET STATUS MASK	2-20	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	8 PARAMETER BYTES EOI <00111110> <P1> - - - - - - - - - - - - - - - <P8> ↑ EPPR (WHEN UPDATE COMPLETED) PARAMETER FORMAT: 8 BYTES, BIT POSITIONS CORRESPOND TO STATUS REPORT ERROR BIT POSITIONS. REFER TO PARAGRAPH 2-31.	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>
NO OP	2-21	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	EOI <00110100> ↑ EPPR (IF LAST BYTE)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET RELEASE	2-22	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> (DPPR)	EOI <00111011> <TZ000000> (EPPR (WHEN UPDATE COMPLETED)) T = 1 SUPPRESS RELEASE TIME OUT Z = 1 RELEASE AUTOMATICALLY DURING IDLE TIME	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> (DPPR)	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET OPTIONS	2-23	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	EOI <00111000> <00000VYZ> P1 ↑ EPPR (WHEN UPDATE COMPLETED) P1 = OPTIONS BYTE VYZ FOR TAPE UNIT: V = 0 DISABLE AUTO SPARING V = 1 ENABLE AUTO SPARING Y = 0 JUMP SPARE Y = 1 SKIP SPARE Z = 0 DISABLE CHARACTER COUNT Z = 1 ENABLE CHARACTER COUNT	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SET RETURN ADDRESSING MODE	2-24	COMPLE-MENTARY	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	EOI <01001000> <00000TTT> EPPR (WHEN UPDATE COMPLETED) TTT = ADDRESS MODE 000 = SINGLE VECTOR 001 = 3-VECTOR	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>
DESCRIBE	2-25	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	[0 TO n COMPLEMENTARY COMMANDS] EOI <00110101> EPPR	ATN <P0111111>
			EXECUTION	ATN <P10ADDRS>	ATN <P1101110> DPPR	UP TO 256 INFORMATION BYTES <I1> ---- <LAST BYTE> EOI EPPR REFER TO TABLE 2-4 FOR COMPLETE DESCRIBE EXECUTION MESSAGE FORMAT.	ATN <P1011111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
INITIALIZE MEDIA	2-26	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> (DPPR)	[0 TO n COMPLEMENTARY COMMANDS] <00110111> <00000CWZ> < EOI P2 > (EPPR (WHEN INITIALIZING COMPLETED)) CWZ = INITIALIZE OPTIONS CWZ FOR TAPE UNIT: Z = 0 REWRITE SPARING TABLE WITH NO JUMP SPARES. Z = 1 RESET SPARING TABLE TO INITIAL SPARES. W = 0 INITIAL SPARES ARE EVERY 512TH BLOCK WITH TRACK OFFSET. W = 1 INITIAL SPARES ARE NO SPARES. C = 0 RUNS CERTIFICATION UTILITY ON TAPE. C = 1 INHIBITS CERTIFY TEST. MEDIA REMAINS UNINITIALIZED. CWZ FOR DISC UNIT: 000 = RETAIN BOTH FACTORY (PRIMARY) AND FIELD (SECONDARY) SPARES. 001 = RETAIN FACTORY SPARES ONLY. 010 = RETAIN NO SPARES (CE USE ONLY). P2 = BLOCK INTERLEAVE BYTE (BINARY NUMBER) MUST BE 00 FOR TAPE.	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> (DPPR)	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
SPARE BLOCK	2-27	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	[0 TO n COMPLEMENTARY COMMANDS] <00000110> <00000S0T> EOI ↑ EPPR (P1 = <00000S0T>) P1 = SPARING MODE BYTE S = 0 SKIP SPARE S = 1 JUMP SPARE T = 0 RETAIN DATA T = 1 DO NOT RETAIN DATA T MUST EQUAL 1 FOR TAPE OPERATION S MUST EQUAL 0 FOR DISC OPERATION	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>
LOCATE AND VERIFY	2-28	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	[0 TO n COMPLEMENTARY COMMANDS] <00000100> EOI ↑ EPPR	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
COPY DATA	2-29	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> (DPPR)	[0 TO n COMPLEMENTARY COMMANDS] <00001000> <VVV00UUU> SET ADDRESS <0001000T> 6 PARAMETER BYTES <P1>---<P6> (ADDRESS OF DATA SOURCE) <XXX00WWW> SET ADDRESS <0001000T> 6 PARAMETER BYTES <P1>---<P6> EOI (ADDRESS OF DATA DESTINATION) EPPR (WHEN DATA COPY IS COMPLETE) VVV = VOLUME NUMBER ON UUU FROM WHICH DATA IS COPIED; UUU = UNIT NUMBER OF DATA SOURCE; T = ADDRESS MODE (0 = SINGLE VECTOR, 1 = 3-VECTOR); XXX = VOLUME NUMBER ON WWW TO WHICH DATA IS COPIED; WWW = UNIT NUMBER OF DATA DESTINATION	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> (DPPR)	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
RELEASE	2-30	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	[0 TO n COMPLEMENTARY COMMANDS] EOI <00001110> ↑ EPPR (WHEN RELEASE REQUIREMENT IS SATISFIED)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <QSTAT>	ATN <P1011111>
RELEASE DENIED	2-31	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> ↑ DPPR	[0 TO n COMPLEMENTARY COMMANDS] EOI <00001111> ↑ EPPR	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> ↑ DPPR	EOI <OSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
UNLOAD	2-32	GENERAL PURPOSE	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	[0 TO n COMPLEMENTARY COMMANDS] EOI <01001010> EPPR	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>
INITIATE UTILITY (NO EXECUTION MESSAGE)	2-33	DIAG-NOSTIC	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	[0 TO n COMPLEMENTARY COMMANDS] <00110000> <P1> <P2> UP TO 8 PARAMETER BYTES EOI <P9> EPPR (WHEN UTILITY COMPLETED) P1 = UTILITY NUMBER (DEVICE SPECIFIC) PARAMETER QUANTITY AND CONTENT DEPENDENT ON UTILITY (P1)	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR Disable Parallel Poll Response EPPR Enable Parallel Poll Response	PRIMARY II
INITIATE UTILITY (cont) (RECEIVE EXECUTION MESSAGE)	2-33	DIAG-NOSTIC	COMMAND	ATN P01ADDRS	ATN P1100101 DPPR	[0 TO n COMPLEMENTARY COMMANDS] 00110001 P1 P2 ---------- P9 (UP TO 8 PARAMETER BYTES, EOI) P1 UTILITY NUMBER (DEVICE SPECIFIC) PARAMETER QUANTITY AND CONTENT DEPENDENT ON UTILITY (P1) EPPR (WHEN READY TO RECEIVE DATA)	ATN P0111111
			EXECUTION	ATN P01ADDRS	ATN P1101110 DPPR	1 TO n BYTES OF INPUT DATA ----- --------- LAST BYTE (EOI) EPPR (WHEN EXECUTION COMPLETE)	ATN P0111111
			REPORTING	ATN P10ADDRS	ATN P1110000 DPPR	EOI QSTAT	ATN P1011111
INITIATE UTILITY (cont) (SEND EXECUTION MESSAGE)	2-33	DIAG-NOSTIC	COMMAND	ATN P01ADDRS	ATN P1100101 DPPR	[0 TO n COMPLEMENTARY COMMANDS] 00110010 P1 P2 ---------- P9 (UP TO 8 PARAMETER BYTES, EOI) P1 - UTILITY NUMBER (DEVICE SPECIFIC) PARAMETER QUANTITY AND CONTENT DEPENDENT ON UTILITY (P1) EPPR (WHEN READY TO SEND DATA)	ATN P0111111
			EXECUTION	ATN P10ADDRS	ATN P1101110 DPPR	1 TO n BYTES OF OUTPUT DATA ---------- ------- LAST BYTE (EOI) EPPR (WHEN EXECUTION COMPLETE)	ATN P1011111
			REPORTING	ATN P10ADDRS	ATN P1110000 DPPR	EOI QSTAT	ATN P1011111

Table 4-6. HP-IB Device Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
INITIATE DIAGNOSTIC	2-34	DIAG-NOSTIC	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	[0 TO n COMPLEMENTARY COMMANDS] <00110011> 3 PARAMETER BYTES < P1 >< P2 >< P3 > EOI EPPR (WHEN DIAGNOSTIC COMPLETED) P1 - P2 = LOOP PARAMETER P3 = DIAGNOSTIC SECTION NUMBER	ATN <P0111111>
			EXECUTION	NONE	NONE	NO EXECUTION MESSAGE	NONE
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>
REQUEST STATUS	2-35	DIAG-NOSTIC	COMMAND	ATN <P01ADDRS>	ATN <P1100101> DPPR	[0 TO n COMPLEMENTARY COMMANDS] <00001101> EOI EPPR	ATN <P0111111>
			EXECUTION	ATN <P10ADDRS>	ATN <P1101110> DPPR	IDENTIFICATION FIELD <S1><S2> ERROR REPORTING FIELDS <S3>-------<S10> UP TO 10 PARAMETER BYTES <P1>----------<Pn> EOI EPPR REFER TO TABLE 2-5 FOR COMPLETE REQUEST STATUS EXECUTION MESSAGE FORMAT.	ATN <P1011111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>

Table 4-7. HP-IB Transparent Command Message Structures

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
UNIVERSAL DEVICE CLEAR (HP-IB COMMAND)	3-2, 3-3	TRANS-PARENT	UNIVERSAL COMMAND	NONE	NONE	ATN <P0010100> ↑EPPR (WHEN CLEAR OPERATION COMPLETE)	NONE
			OPTIONAL REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR ↑	EOI <OSTAT>	ATN <P1011111>
SELECTED DEVICE CLEAR (HP-IB COMMAND)	3-2, 3-4	TRANS-PARENT	TRANS-PARENT COMMAND	ATN <P01ADDRS>	NONE	ATN <P0000100> ↑EPPR (WHEN CLEAR OPERATION COMPLETE)	ATN <P0111111>
			OPTIONAL REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR ↑	EOI <OSTAT>	ATN <P1011111>
CHANNEL INDEPENDENT CLEAR	3-2, 3-5	TRANS-PARENT	TRANS-PARENT COMMAND	ATN <P01ADDRS>	ATN <P1110010> DPPR ↑	EOI [0010YYYY] <00001000> ↑EPPR (WHEN CLEAR OPERATION COMPLETE) YYYY = UNIT NUMBER (1111 = CONTROLLER)	ATN <P0111111>
			OPTIONAL REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR ↑	EOI <OSTAT>	ATN <P1011111>
CANCEL	3-6	TRANS-PARENT	TRANS-PARENT COMMAND	ATN <P01ADDRS>	ATN <P1110010> DPPR ↑	EOI [0010YYYY] <00001001> ↑EPPR (WHEN CANCEL OPERATION COMPLETE) YYYY = UNIT NUMBER (1111 = CONTROLLER)	ATN <P0111111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR ↑	EOI <QSTAT>	ATN <P1011111>

Table 4-7. HP-IB Transparent Command Message Structures (continued)

COMMAND NAME	SEE PARA.	CATEGORY	MESSAGE TYPE	MESSAGE FORMAT			
				HEADER		TEXT	TRAILER
				PRIMARY I	SECONDARY	DPPR = Disable Parallel Poll Response EPPR = Enable Parallel Poll Response	PRIMARY II
LOOPBACK (READ LOOPBACK)	3-7	TRANS-PARENT	TRANS-PARENT COMMAND	ATN <P01ADDRS>	ATN <P1110010> DPPR	EOI <00000010><P1>----------<P4> BYTE LENGTH PARAMETER (n) PARAMETER = NUMBER OF BYTES IN LOOPBACK TEST	ATN <P0111111>
			TRANS-PARENT EXECUTION	ATN <P10ADDRS>	ATN <P1110010> DPPR	READ LOOPBACK DATA (n BYTES LONG) EOI < >----------<LAST BYTE>	ATN <P1011111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR	EOI <QSTAT>	ATN <P1011111>
(WRITE LOOPBACK)			TRANS-PARENT COMMAND	ATN <P01ADDRS>	ATN <P1110010> DPPR	EOI <00000011><P1>----------<P4> BYTE LENGTH PARAMETER (n) PARAMETER = NUMBER OF BYTES IN LOOPBACK TEST	ATN <P0111111>
			TRANS-PARENT EXECUTION	ATN <P01ADDRS>	ATN <P1110010> DPPR	WRITE LOOPBACK DATA (n BYTES LONG) EOI < >----------<LAST BYTE>	ATN <P0111111>
			REPORTING	ATN <P10ADDRS>	ATN <P1110000> DPPR		ATN <P1011111>
HP-IB PARITY CHECKING	3-9	TRANS-PARENT	TRANS-PARENT COMMAND	ATN <P01ADDRS>	ATN <P1110010> DPPR	EOI <00000001> <000000SV> V = PARITY CHECK BIT 0 = DISABLED (POWER-ON STATE) 1 = ENABLED S = 0 DISABLE SRQ DURING POLL (POWER-ON STATE) S = 1 ENABLE SRQ DURING POLL	ATN <P0111111>
IDENTIFY	3-10	TRANS-PARENT	TRANS-PARENT COMMAND	ATN <P1011111>	ATN <P11ADDRS> DPPR	<00000010> <TTTTTTTT> T = DEVICE TYPE CODE ID BYTE 1 ID BYTE 2 NOTE: TWO ID BYTES SUPPLIED BY DEVICE	ATN <P1011110>

APPENDIX A
GLOSSARY

BEGINNING OF TAPE (BOT). The physical beginning of the tape media.

BURST. A message which represents a portion of a larger logical message which has been broken apart for transmission over a channel, and which will be reassembled later.

COMMAND MESSAGE. A message which contains one or more commands, with each command containing instructions to perform an operation or set up a programmable parameter.

DEVICE. A unit of system hardware which performs a specified function, and which is accessed only via a channel port. A device usually contains the I/O hardware and firmware required to communicate over the channel.

END OF TAPE (EOT). The physical end of the tape media.

ERROR LOG. A log of the block(s) that have been found to be defective but have not been spared. Once spared, the address of the bad block will be transferred to the sparing table.

EXECUTION MESSAGE. A message containing read or write data, or status or diagnostic information which is exchanged between the host and device during the execution phase of a transaction.

HOST. The controlling computer with which a given device is associated.

INDIVISIBLE. A type of operation which is not allowed to be interrupted or suspended for reasons involving device integrity.

INITIATE, INITIATION (of a message). The origination of a signal which will cause a message to occur.

INTERNAL REQUEST. Any event other than power failure which will cause a device to initiate a message out of turn.

KEY. A permanently formatted tape address header. Each data block is preceded by a key which contains block address data. Keys are written by the tape manufacturer and cannot be altered by the user. Defective keys can be detected during write operations.

LATENCY. Suspension of an operation for some period of time.

LINK (message). A message link is the hardware path over which a message travels. A given link may share hardware with other potential links, therefore a message link may be established only when all of the hardware necessary for a given message exchange has been allocated to the devices involved.

MESSAGE. A unit of information exchanged over a given channel during which the message link remains unbroken.

PARSING. Breaking down of a command string into individual elements (i.e., command opcode and parameters).

QSTAT. A completion code indicating the success or failure of the preceding transaction.

REPORTING MESSAGE. A message containing the QSTAT code for the preceding transaction. Availability of the reporting message is a required part of every transaction.

REQUEST SERVICE. A general term for the process by which a device informs the host that some action is required by the host.

ROTATIONAL POSITION SENSING (RPS). A method of timing the assertion of service requests in an effort to synchronize channel activity with disc rotation.

SINK/SOURCE (a message). To sink a message is to accept a message from the channel, and discard it without executing it. To source a message is to send a single byte tagged with the message terminator (EOI on HP-IB) over the channel. A sink/source is usually an error recovery operation.

SPARING TABLE. The table containing the addresses of all spare blocks. These addresses are inaccessible to the host. The sparing table is updated after each sparing operation.

TAPE TRANSIT TIME. The time required to go from BOT to EOT or from EOT to BOT. This time is dependent upon the particular tape media in use.

TRANSACTION. A command, and the execution and reporting messages associated with it; a logically complete operation encompassing several messages.

TRANSACTION SEQUENCE. The allowable sequence of messages which can occur during a transaction.

TRANSPARENT MESSAGE. A message passed over the channel, but intercepted by the channel handling firmware modules. Transparent message commands compensate for the operating differences between channels and between operating environment.

UNIT. A separately addressable storage entity with associated control routines which may share a device interface port with other units.

UNSOLICITED REPORT. A reporting state that is not associated with a transaction. Unsolicited report occurs any time an idle device needs to inform the host of some internal event, for example, a release request.

APPENDIX B
QUICK REFERENCE TABLES

Tables B-2 through B-6 are duplicates of those found in the text portion of the CS/80 Reference Manual. These tables are provided for quick-reference purposes and assume the user has read the detailed information provided for each command. The topical content for each table is as follows:

TABLE	TITLE	TOPICAL CONTENT
B-1	Device Command Summary	Provides the command format and reference paragraph number for each device command.
B-2	Request Status Summary	Shows the complete format of the Request Status command Execution message. The identification and significance of each bit of the status report is explained.
B-3	Possible Errors Summary	Provides a matrix of the possible errors for all device commands.
B-4	Complementary Command Matrix	Shows which Complementary commands affect the Real Time, General Purpose, and Diagnostic commands.
B-5	Complementary Command Power-On Values	Shows the power-on values for all Complementary commands.
B-6	Describe Command Summary	Shows the complete format of the Describe command Execution message.

Table B-1. Device Command Summary

COMMAND	OPCODE FORMAT					COMMAND FORMAT	FUNCTION
	BINARY	HEX	OCTAL	ASCII	DECIMAL		
LOCATE AND READ (REAL TIME)	<00000000>	00	000	NULL	0	NO VARIABLES OR PARAMETERS	LOCATES DATA INDICATED BY TARGET ADDRESS AND TRANSMITS DATA TO HOST. (PARAGRAPH 2-8)
LOCATE AND WRITE (REAL TIME)	<00000010>	02	002	STX	2	NO VARIABLES OR PARAMETERS	TRANSFERS DATA FROM HOST TO STORAGE AREA BEGINNING AT ADDRESS SPECIFIED BY TARGET ADDRESS. (PARAGRAPH 2-10)
LOCATE AND VERIFY (GENERAL PURPOSE)	<00000100>	04	005	EOT	4	NO VARIABLES OR PARAMETERS	INSTRUCTS DEVICE TO PERFORM AN INTERNAL VERIFICATION OF A SECTION OF DATA TO ENSURE THAT IT CAN BE READ. (PARAGRAPH 2-28)
SPARE BLOCK (GENERAL PURPOSE)	<00000110>	06	006	ACK	6	<00000110> <00000S0T> (P1) P1 = SPARING MODE BYTE S = 0 SKIP SPARE S = 1 JUMP SPARE T = 0 RETAIN DATA T = 1 DO NOT RETAIN DATA T MUST EQUAL 1 FOR TAPE OPERATION S MUST EQUAL 0 FOR DISC OPERATION	ALLOWS HOST TO GIVE DEVICE PERMISSION TO BECOME TEMPORARILY BUSY WHILE SPARING BLOCK INDICATED BY TARGET ADDRESS. (PARAGRAPH 2-27)
COPY DATA (GENERAL PURPOSE)	<00001000>	08	010	BS	8	<00001000> <0VVV0UUU> <0001000T> <P1>-------<P6> SET ADDRESS; 6-BYTE PARAMETER ADDRESS OF DATA SOURCE <0XXX0WWW> <0001000T> <P1>-------<P6> SET ADDRESS; 6-BYTE PARAMETER ADDRESS OF DATA DESTINATION VVV = VOLUME NUMBER ON UUU FROM WHICH DATA IS COPIED UUU = UNIT NUMBER OF DATA SOURCE T = ADDRESS MODE (0 = SINGLE VECTOR, 1 = 3-VECTOR) XXX = VOLUME NUMBER ON WWW TO WHICH DATA IS COPIED WWW = UNIT NUMBER OF DATA DESTINATION T = ADDRESS MODE (0 = SINGLE VECTOR, 1 = 3-VECTOR)	COPIES AMOUNT OF DATA SPECIFIED BY LENGTH (DEFAULT VALUE, OR COMPLEMENTARY COMMAND VALUE) FROM THE SPECIFIED UNIT AND VOLUME TO A SELECTED UNIT AND VOLUME. (PARAGRAPH 2-29)

Table B-1. Device Command Summary (continued)

COMMAND	OPCODE FORMAT					COMMAND FORMAT	FUNCTION
	BINARY	HEX	OCTAL	ASCII	DECIMAL		
COLD LOAD READ (REAL TIME)	<00001010>	0A	012	LF	10	NO VARIABLES OR PARAMETERS	USED BY HOST SYSTEM TO BOOTSTRAP ITSELF INTO A HIGHER OPERATING ENVIRONMENT FROM A MORE PRIMITIVE STATE. (PARAGRAPH 2-9)
REQUEST STATUS (DIAGNOSTIC)	<00001101>	0D	015	CR	13	NO VARIABLES OR PARAMETERS	INSTRUCTS DEVICE TO RETURN (IN AN EXECUTION MESSAGE) THE STATUS OF THE LAST TRANSACTION. (PARAGRAPH 2-35)
RELEASE (GENERAL PURPOSE)	<00001110>	0E	016	SO	14	NO VARIABLES OR PARAMETERS	USED TO RELEASE DEVICE FOR A PERIOD OF TIME. (PARAGRAPH 2-30)
RELEASE DENIED (GENERAL PURPOSE)	<00001111>	0F	017	SI	15	NO VARIABLES OR PARAMETERS	PROHIBITS DEVICE FROM RELEASING ITSELF. (PARAGRAPH 2-31)
SET ADDRESS (COMPLEMENTARY)	<00010000> <00010001>	10 11	020 021	DLE DC1	16 17	<0001000T> < P1 > - - - - - - - - - - - - < P6 > 6-BYTE PARAMETER T = ADDRESS MODE (0 = SINGLE VECTOR, 1 = 3-VECTOR) SINGLE VECTOR FORMAT: 6-BYTE BINARY NUMBER 3-VECTOR FORMAT: P1 - P3 = CYLINDER ADDRESS P4 = HEAD ADDRESS P5 - P6 = SECTOR ADDRESS	USED TO SET VALUE OF TARGET ADDRESS. SPECIFIES SINGLE- OR THREE-VECTOR ADDRESS MODE. (PARAGRAPH 2-14)
SET BLOCK DISPLACEMENT (COMPLEMENTARY)	<00010010>	12	022	DC2	18	<00010010> < P1 > - - - - - - - - - - - - < P6 > 6-BYTE PARAMETER PARAMETER FORMAT: 6-BYTE, SIGNED, TWO'S COMPLEMENT, BINARY NUMBER	ADJUSTS TARGET ADDRESS BY NUMBER OF BLOCKS INDICATED BY PARAMETER FIELD. (PARAGRAPH 2-15)
SET LENGTH (COMPLEMENTARY)	<00011000>	18	030	CAN	24	<00011000> < P1 > - - - - - - - - - - - - < P4 > 4-BYTE PARAMETER PARAMETER FORMAT: 4-BYTE, UNSIGNED BINARY NUMBER	DEFINES THE NUMBER OF BYTES IN A DATA TRANSFER. (PARAGRAPH 2-16)

Table B-1. Device Command Summary (continued)

COMMAND	OPCODE FORMAT					COMMAND FORMAT	FUNCTION
	BINARY	HEX	OCTAL	ASCII	DECIMAL		
SET UNIT (COMPLEMENTARY)	<00100000> <00100001> <00100010> <00100011> <00100100> <00100101> <00100110> <00100111> <00101000> <00101001> <00101010> <00101011> <00101100> <00101101> <00101110> <00101111>	20 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F	040 041 042 043 044 045 046 047 050 051 052 053 054 055 056 057	space ! " # $ % & ' (apostrophe) ( ) * (asterisk) + , (comma) - . /	32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	<0010YYYY> YYYY = UNIT NUMBER (1111 = DEVICE CONTROLLER)	USED TO SPECIFY A SPECIFIC UNIT NUMBER WITHIN A MASS STORAGE DEVICE. (PARAGRAPH 2-12)
INITIATE UTILITY (DIAGNOSTIC)	<00110000> <00110001> <00110010>	30 31 32	060 061 062	0 1 2	48 49 50	<001100XX>< P1 >< P2>----------<P9> UP TO 8-BYTE PARAMETER XX = EXECUTION MESSAGE QUALIFIER 00 = NO EXECUTION MESSAGE 01 = DEVICE WILL RECEIVE EXECUTION MESSAGE TEXT 10 = DEVICE WILL SEND EXECUTION MESSAGE TEXT P1 = UTILITY NUMBER (DEVICE SPECIFIC) PARAMETER QUANTITY AND CONTENT IS FUNCTION OF P1.	DIRECTS DEVICE TO PERFORM ONE UTILITY ROUTINE. (PARAGRAPH 2-33)
INITIATE DIAGNOSTIC (DIAGNOSTIC)	<00110011>	33	063	3	51	<00110011>< P1 >< P2 >< P3 > 3-BYTE PARAMETER P1 - P2 = LOOP PARAMETER P3 = DIAGNOSTIC SECTION NUMBER	DIRECTS DEVICE TO PERFORM ONE INTERNALLY DEFINED DIAGNOSTIC ROUTINE. (PARAGRAPH 2-34)
NO OP (COMPLEMENTARY)	<00110100>	34	064	4	52	NO VARIABLES OR PARAMETERS	CAUSES DEVICE TO DISREGARD MESSAGE BYTE. (PARAGRAPH 2-21)
DESCRIBE (GENERAL PURPOSE)	<00110101>	35	065	5	53	NO VARIABLES OR PARAMETERS	DIRECTS DEVICE TO RETURN INFORMATION ABOUT ITSELF. (PARAGRAPH 2-25)

Table B-1. Device Command Summary (continued)

COMMAND	OPCODE FORMAT					COMMAND FORMAT	FUNCTION
	BINARY	HEX	OCTAL	ASCII	DECIMAL		
INITIALIZE MEDIA (GENERAL PURPOSE)	<00110111>	37	067	7	55	<00110111><00000CWZ>< P2 > CWZ = INITIALIZE OPTIONS CWZ FOR TAPE UNIT Z = 0 REWRITE SPARING TABLE WITH NO JUMP SPARES Z = 1 RESET SPARING TABLE TO INITIAL SPARES W = 0 INITIAL SPARES ARE EVERY 512TH BLOCK WITH TRACK OFFSET W = 1 INITIAL SPARES ARE NO SPARES C = 0 RUNS CERTIFICATION UTILITY ON TAPE C = 1 INHIBITS CERTIFY TEST (MEDIA REMAINS UNINITIALIZED) CWZ FOR DISC UNIT 000 = RETAIN BOTH FACTORY (PRIMARY) AND FIELD (SECONDARY) SPARES 001 = RETAIN FACTORY SPARES ONLY 010 = RETAIN NO SPARES (CE USE ONLY) P2 = BLOCK INTERLEAVE BYTE (BINARY NUMBER) MUST BE 00 FOR TAPE	USED TO INITIALIZE ALL OF THE DATA FIELDS OF THE DEFINED MEDIA AREA (CURRENT UNIT NUMBER AND VOLUME). (PARAGRAPH 2-26)
SET OPTIONS (COMPLEMENTARY)	<00111000>	38	070	8	56	<00111000><00000VYZ> └──P1──┘ P1 = OPTION BYTE VYZ FOR TAPE UNIT V = 0 DISABLE AUTO SPARING V = 1 ENABLE AUTO SPARING Y = 0 JUMP SPARE Y = 1 SKIP SPARE Z = 0 DISABLE CHARACTER COUNT Z = 1 ENABLE CHARACTER COUNT	USED TO SET DEVICE SPECIFIC OPTIONS. (PARAGRAPH 2-23)
SET RPS (COMPLEMENTARY)	<00111001>	39	071	9	57	<00111001>< TIME 1 >< TIME 2 > TIME 1 = TIME-TO-TARGET IN HUNDREDS OF MICROSECONDS TIME 2 = WINDOW-SIZE IN HUNDREDS OF MICROSECONDS	SETS TIME-TO-TARGET AND WINDOW-SIZE TIME INTERVALS FOR RPS DATA TRANSFERS. (PARAGRAPH 2-18)
SET RETRY TIME (COMPLEMENTARY)	<00111010>	3A	072	:	58	<00111010>< P1 >< P2 > P1 - P2 = RETRY TIME IN TENS OF MILLISECONDS (16 BIT BINARY NUMBER)	USED TO SET AMOUNT OF TIME AVAILABLE FOR READ AND SEEK RETRIES. (PARAGRAPH 2-19)

Table B-1. Device Command Summary (continued)

COMMAND	OPCODE FORMAT					COMMAND FORMAT	FUNCTION
	BINARY	HEX	OCTAL	ASCII	DECIMAL		
SET RELEASE (COMPLEMENTARY)	<00111011>	38	073	;	59	<00111011><TZ000000> T = 1 SUPPRESS RELEASE TIME-OUT Z = 1 RELEASE AUTOMATICALLY DURING IDLE TIME	USED TO SUPPRESS RELEASE TIME-OUT AND TO ENABLE AUTOMATIC RELEASE. (PARAGRAPH 2-22)
SET BURST (COMPLEMENTARY)	<00111100> <00111101>	3C 3D	074 075	< =	60 61	<0011110T>< P1 > T = 0 INDICATES THAT LAST BURST ONLY IS TAGGED WITH A MESSAGE TERMINATOR (EOI ON HP-IB). T = 1 INDICATES THAT ALL BURSTS ARE TAGGED WITH A MESSAGE TERMINATOR. P1 = NUMBER OF 256-BYTE SEGMENTS IN EACH BURST (IF P1 = ALL ZEROES, BURST MODE IS DEACTIVATED).	ACTIVATES AND DEACTIVATES BURST MODE. (PARAGRAPH 2-17)
SET STATUS MASK (COMPLEMENTARY)	<00111110>	3E	076	>	62	<00111110> < P1 > - - - - - - - - - - - - < P8 > 8-BYTE PARAMETER PARAMETER FORMAT: BIT POSITIONS IN PARAMETER BYTES CORRESPOND TO STATUS REPORT ERROR BIT POSITIONS. REFER TO PARAGRAPH 2-35 IN CS/80 REFERENCE MANUAL. 1 = MASKED ERROR	ALLOWS MASKING OF ERROR CONDITIONS REPORTED BY REQUEST STATUS (DIAGNOSTIC) COMMAND. (PARAGRAPH 2-20)
SET VOLUME (COMPLEMENTARY)	<01000000> <01000001> <01000010> <01000011> <01000100> <01000101> <01000110> <01000111>	40 41 42 43 44 45 46 47	100 101 102 103 104 105 106 107	@ A B C D E F G	64 65 66 67 68 69 70 71	<01000YYY> YYY = VOLUME NUMBER	USED TO SPECIFY DESIRED STORAGE VOLUME OF A SPECIFIED STORAGE DEVICE. (PARAGRAPH 2-13)
SET RETURN ADDRESSING MODE (COMPLEMENTARY)	<01001000>	48	110	H	72	<01001000><00000TTT> TTT = ADDRESSING MODE 000 = SINGLE VECTOR 001 = 3-VECTOR	USED BY HOST TO SPECIFY TYPE OF ADDRESS (SINGLE- OR THREE-VECTOR) TO BE RETURNED IN REQUEST STATUS EXECUTION MESSAGE. (PARAGRAPH 2-24)

Table B-1. Device Command Summary (continued)

COMMAND	OPCODE FORMAT					COMMAND FORMAT	FUNCTION
	BINARY	HEX	OCTAL	ASCII	DECIMAL		
WRITE FILE MARK (REAL TIME)	<01001001>	49	111	I	73	NO VARIABLES OR PARAMETERS	WRITES A FILE MARK AT THE CURRENT POSITION OF THE TAPE. (PARAGRAPH 2-11)
UNLOAD (GENERAL PURPOSE)	<01001010>	4A	112	J	74	NO VARIABLES OR PARAMETERS	USED TO UNLOAD THE TAPE. (PARAGRAPH 2-32)

Table B-2. Request Status Summary

ERROR REPORTING FIELDS[1]

IDENTIFICATION FIELD	REJECT ERRORS FIELD	FAULT ERRORS FIELD[2]
<VVVVUUUU> <SS SS SS SS>	0 7 8 15 <0 0 2 0 0 5 6 7> <8 9 10 0 12 0 0 0>	16 23 24 31 <0 17 0 19 0 0 22 0> <24 0 26 27 28 0 30 31>
VVVV = Volume number **UUUU** = Unit number **SSSSSSSS** = Value of the lowest numbered unit with status pending (all ones if no units have status pending).	**2** = **CHANNEL PARITY ERROR** A channel command was received without odd parity. **5** = **ILLEGAL OPCODE** An unrecognizable opcode was received. **6** = **MODULE ADDRESSING** An illegal volume or unit number was specified for this device. **7** = **ADDRESS BOUNDS** The target address has exceeded the bounds for this device. **8** = **PARAMETER BOUNDS** A parameter (other than unit, volume, or target address) is not allowed for this device. **9** = **ILLEGAL PARAMETER** A parameter field was the wrong length for the opcode preceding it. **10** = **MESSAGE SEQUENCE** The message sequence has been violated. (Error suppressed if any reject or fault errors have occurred prior to sequence error.) **12** = **MESSAGE LENGTH** The total length of the execution message differs from the current default value.	**17** = **CROSS-UNIT[3]** An error has occurred during a Copy Data operation. **19** = **CONTROLLER FAULT** A hardware fault occurred in the controller. **22** = **UNIT FAULT** A hardware fault has occurred in the unit addressed. **24** = **DIAGNOSTIC RESULT[3]** The hardware failed the diagnostic indicated in the parameter field. **26 - 28** = **RELEASE REQUIRED** This command cannot be executed until after release is granted to the device. Device requires release for indicated reason: **26** = **OPERATOR REQUEST** Release required for operator request (e.g., load/unload, restore). **27** = **DIAGNOSTIC REQUEST** Release required for diagnostics initiated from control panel (e.g., HIO, self test). **28** = **INTERNAL MAINTENANCE** Release required for internal maintenance (e.g., head alignment, error log). **30** = **POWER FAIL** The power to the unit failed, a diagnostic destroyed configuration, or a pack was loaded. Device should be reconfigured. **31** = **RETRANSMIT** The preceding transaction should be retried.

Notes:

1. Error bit positions correspond to bit positions in Set Status Mask command. A "1" indicates presence of an error. Unused bit positions must be zeroes.
2. All Fault Errors are unmaskable.
3. Error uses parameter field.
4. • Parameter field configuration is dependent on reported errors.
   • Highest priority is given to lowest numbered errors.
   • Masked errors relinquish their priority.

Table B-2. Request Status Summary (continued)

ERROR REPORTING FIELDS[1]

ACCESS ERRORS FIELD	INFORMATION ERRORS FIELD	PARAMETER FIELD[4]
32 39 40 47 <32 33 34 35 36 37 00><40 41 0 43 44 0 0 0>	48 55 56 63 <48 49 50 51 52 0 0 55><0 57 58 59 0 61 0 0>	<P1>----------<P10>
32 = ILLEGAL PARALLEL OPERATION The requested operation cannot be executed in parallel with some other operation(s) currently in progress. **33 = UNINITIALIZED MEDIA** The host attempted to access unformatted media, or unusable media has been loaded. **34 = NO SPARES AVAILABLE** Spare Block cannot be executed due to lack of spare media. **35 = NOT READY** The selected unit is not ready for access at this time (e.g., heads or media not yet fully loaded). **36 = WRITE PROTECT** The selected volume is write protected. **37 = NO DATA FOUND** A block accessed during a read has not been written. **40 = UNRECOVERABLE DATA OVERFLOW** The previous transaction generated more than 1 unrecoverable data error. The entire transfer should be considered in error. **41 = UNRECOVERABLE DATA[3]** Unrecoverable data at indicated block(s). **43 = END OF FILE** End of file encountered on file structured device. **44 = END OF VOLUME** The host attempted to access across a volume boundary.	**48 - 50 = REQUEST RELEASE[3]** Device requests release for indicated reason: **48 = OPERATOR REQUEST[3]** Release requested for operator request (e.g., load/unload, restore). **49 = DIAGNOSTIC REQUEST[3]** Release request initiated from diagnostic control panel (e.g., HIO, self test). **50 = INTERNAL MAINTENANCE[3]** Release requested for internal maintenance (e.g., head alignment, error log). **51 = MEDIA WEAR** Only one spare track (disc) or one spare block (tape) remaining. **52 = LATENCY INDUCED** A latency was induced during the transfer due to slow transfer rate or seek retry. **55 = AUTO SPARING INVOKED** A defective block has been automatically spared by the device. **57 = RECOVERABLE DATA OVERFLOW** The previous transaction generaged more than 1 recoverable data error. **58 = MARGINAL DATA[3]** Data was recovered, but with difficulty. **59 = RECOVERABLE DATA[3]** A latency was introduced in order to correct a data error. **61 = MAINTENANCE TRACK OVERFLOW** Error and fault log area is full.	No Errors: P1 through P6 indicate new Target Address. The address format, which is used any time P1 through P6 contain address information, is defined by the Set Return Addressing command (refer to paragraph 2-24). No Errors: P7 through P10 contain run-time drive error codes (DERRORS), except after a Spare Block command. The errors are arranged chronologically: P7 contains the most recent of the four errors recorded; P10 contains the oldest of the four recorded. Note: Error codes 40H and CBH will always be followed by a single byte containing fault latch information. After a **Spare Block** command, P1 through P6 contain the beginning address of the reformatted area. The address format is described above. (Disc operation only.) After a **Spare Block** command, P1 through P6 contain the beginning address of the reformatted area. (Disc operation only.) Error Bit No. 17 **Cross-unit:** P1 through P6 contain the encoded values of each unit which has experienced an error. A byte of all ones indicates no additional units. Error Bit No. 24 **Diagnostic Results:** P1 through P6 contain the following information: P1 = most suspect component P2 = next most suspect component P3 = test error (TERROR) associated with P1 P4 = test error (TERROR) associated with P2 P5 - P6 = not used P7 - P10 contain DERROR information (format described above). Error Bit No. 41 **Unrecoverable Data:** P1 through P6 indicate address of bad block. Error Bit No. 48 - No. 50 **Request Release:** P1 through P6 contain the encoded values of each unit requesting release. A byte of all ones indicates no additional units. Error Bit No. 58 **Marginal Data:** P1 through P6 indicate address of the marginal block. Error Bit No. 59 **Recoverable Data:** P1 through P6 indicate address of recoverable block.

Table B-3. Possible Errors Summary

COMMAND	REJECT ERRORS									FAULT ERRORS									
	CHANNEL PARITY	ILLEGAL OPCODE	MODULE ADDRESSING	ADDRESS BOUNDS	PARAMETER BOUNDS	ILLEGAL PARAMETER	MESSAGE SEQUENCE	MESSAGE LENGTH	CROSS-UNIT	CONTROLLER FAULT	UNIT FAULT	DIAGNOSTIC RESULT	RELEASE REQUIRED:	• OPERATOR REQUEST	• DIAGNOSTIC REQUEST	• INTERNAL MAINTENANCE	POWER FAIL	RETRANSMIT
REAL TIME																		
LOCATE AND READ	X	X				X	X	X		X	X			X	X	X	X	X
COLD LOAD READ	X	X				X	X	X		X	X			X	X	X	X	X
LOCATE AND WRITE	X	X				X	X	X		X	X			X	X	X	X	X
WRITE FILE MARK[1]	X	X				X	X	X		X	X			X	X	X	X	X
COMPLEMENTARY																		
SET UNIT	X	X	X			X	X	X		X	X			X	X	X	X	X
SET VOLUME	X	X	X			X	X	X		X	X			X	X	X	X	X
SET ADDRESS	X	X		X		X	X	X		X	X			X	X	X	X	X
SET BLOCK DISPLACEMENT	X	X		X		X	X	X		X	X			X	X	X	X	X
SET LENGTH	X	X				X	X	X		X	X			X	X	X	X	X
SET BURST	X	X				X	X	X		X	X			X	X	X	X	X
SET RPS	X	X				X	X	X		X	X			X	X	X	X	X
SET RETRY TIME	X	X				X	X	X		X	X			X	X	X	X	X
SET STATUS MASK	X	X				X	X	X		X	X			X	X	X	X	X
NO OP	X	X				X	X	X		X	X			X	X	X	X	X
SET RELEASE	X	X			X	X	X	X		X	X			X	X	X	X	X
SET OPTIONS[1]	X	X			X	X	X	X		X	X			X	X	X	X	X
SET RETURN ADDRESSING MODE	X	X			X	X	X	X		X	X			X	X	X	X	X
GENERAL PURPOSE																		
DESCRIBE	X	X				X	X	X		X	X			X	X	X	X	X
INITIALIZE MEDIA	X	X			X	X	X	X		X	X			X	X	X	X	X
SPARE BLOCK	X	X				X	X	X		X	X			X	X	X	X	X
LOCATE AND VERIFY	X	X				X	X	X		X	X			X	X	X	X	X
COPY DATA	X	X	X	X		X	X	X	X	X	X			X	X	X	X	X
RELEASE	X	X				X	X	X		X	X	X		X	X	X	X	X
RELEASE DENIED	X	X				X	X	X		X	X			X	X	X	X	X
UNLOAD[1]	X	X				X	X	X		X				X	X	X	X	X
DIAGNOSTIC																		
INITIATE UTILITY	X	X			X	X	X	X		X	X			X	X	X	X	X
INITIATE DIAGNOSTIC	X	X			X	X	X	X		X	X	X		X	X	X	X	X
REQUEST STATUS	X	X				X	X	X		X	X			X	X	X	X	X

NOTE 1: APPLIES TO TAPE DRIVE OPERATIONS ONLY.

Table B-3. Possible Errors Summary (continued)

COMMAND	ACCESS ERRORS										INFORMATION ERRORS									
	ILLEGAL PARALLEL OPERATION	UNINITIALIZED MEDIA[1]	NO SPARES AVAILABLE	NOT READY	WRITE PROTECT[1]	NO DATA FOUND[1]	UNRECOVERABLE DATA OVERFLOW	UNRECOVERABLE DATA	END OF FILE[1]	END OF VOLUME	REQUEST RELEASE: • OPERATOR REQUEST	• DIAGNOSTIC REQUEST	• INTERNAL MAINTENANCE	MEDIA WEAR	LATENCY INDUCED	AUTO SPARING INVOKED[1]	RECOVERABLE DATA OVERFLOW	MARGINAL DATA	RECOVERABLE DATA	MAINTENANCE TRACK OVERFLOW
REAL TIME																				
LOCATE AND READ	X		X		X	X	X	X	X		X	X	X		X		X	X	X	X
COLD LOAD READ	X		X		X	X	X	X	X		X	X	X		X		X	X	X	X
LOCATE AND WRITE	X		X	X		X[1]	X[1]		X		X	X	X		X	X				X
WRITE FILE MARK[1]			X	X		X	X		X		X	X	X			X		X		X
COMPLEMENTARY																				
SET UNIT											X	X	X							X
SET VOLUME											X	X	X							X
SET ADDRESS											X	X	X							X
SET BLOCK DISPLACEMENT											X	X	X							X
SET LENGTH											X	X	X							X
SET BURST											X	X	X							X
SET RPS											X	X	X							X
SET RETRY TIME											X	X	X							X
SET STATUS MASK											X	X	X							X
NO OP											X	X	X							X
SET RELEASE											X	X	X							X
SET OPTIONS[1]											X	X	X							X
SET RETURN ADDRESSING MODE											X	X	X							X
GENERAL PURPOSE																				
DESCRIBE											X	X	X							X
INITIALIZE MEDIA	X		X	X							X	X	X							X
SPARE BLOCK	X	X	X	X		X	X				X	X	X					X		X
LOCATE AND VERIFY	X		X				X			X	X	X	X							X
COPY DATA	X		X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X
RELEASE											X	X	X							X
RELEASE DENIED											X	X	X							X
UNLOAD[1]											X	X	X							X
DIAGNOSTIC																				
INITIATE UTILITY	X		X	X	X						X	X	X							X
INITIATE DIAGNOSTIC	X				X						X	X	X							X
REQUEST STATUS											X	X	X							X

NOTE 1: APPLIES TO TAPE DRIVE OPERATIONS ONLY.

Table B-4. Complementary Command Matrix

COMMAND	COMPLEMENTARY												
	SET UNIT	SET VOLUME	SET ADDRESS	SET BLOCK DISPLACEMENT	SET LENGTH	SET BURST	SET RPS	SET RETRY TIME	SET STATUS MASK	SET RETURN ADDRESSING MODE	SET RELEASE	SET OPTIONS[1]	NO OP
REAL TIME													
LOCATE AND READ	X	X	X	X	X	X	X	X	X		X	X	
COLD LOAD READ	X	X	X	X	X	X	X	X	X		X	X	
LOCATE AND WRITE	X	X	X	X	X	X	X	X	X		X	X	
WRITE FILE MARK[1]	X	X	X	X				X	X		X	X	
GENERAL PURPOSE													
DESCRIBE	X	X							X		X	X	
INITIALIZE MEDIA	X	X							X		X	X	
SPARE BLOCK	X	X	X	X					X		X	X	
LOCATE AND VERIFY	X	X	X	X	X				X		X	X	
COPY DATA	X	X	X	X	X				X		X	X	
RELEASE	X								X		X	X	
RELEASE DENIED	X								X		X	X	
UNLOAD[1]													
DIAGNOSTIC													
INITIATE UTILITY	X	X	X	X		X			X		X	X	
INITIATE DIAGNOSTIC	X								X		X	X	
REQUEST STATUS	X								X	X	X	X	

NOTE 1: APPLIES TO TAPE DRIVE OPERATIONS ONLY.

Table B-5. Complementary Command Power-on Values

COMPLEMENTARY COMMAND	POWER-ON VALUE	COMPLEMENTARY COMMAND	POWER-ON VALUE
Set Unit	0	Set Retry Time	device specific
Set Volume	0	Set Status Mask	disabled
Set Address	0, 0, 0	No Op	Not Applicable
Set Length	-1 (full volume)	Set Release	T = 0 Z = 0
Set Burst	disable	Set Options	device specific
Set RPS	disabled	Set Return Addressing Mode	single vector

Table B-6. Describe Command Summary

CONTROLLER DESCRIPTION FIELD	UNIT DESCRIPTION FIELD [1]	VOLUME DESCRIPTION FIELD [2]
⟨C1⟩-----⟨C5⟩ 5-byte field	⟨U1⟩------⟨U19⟩ 19-byte field	⟨V1⟩------⟨V13⟩ 13-byte field
C1-C2 = Installed unit byte: 1 bit for each unit. (Unit 0 = LSB) C3-C4 = Maximum instantaneous transfer rate in thousands of bytes per second. C5 = Controller Type 0 = Integrated single-unit controller 1 = Integrated multi-unit controller 2 = Integrated multi-port controller	U1 = Generic Device Type 0 = Fixed disc 1 = Removable disc or combination 2 = Tape U2-U4 = Device number. Represents actual HP product number: XX XX XY (BCD Coded, 2 digits per byte). XXXXX = product number. Y = option. U5-U6 = Number of bytes per block U7 = Number of blocks which can be buffered U8 = Recommended burst size (0 = burst mode not recommended) U9-U10 = Block Time in microseconds (Time is from beginning of one block to beginning of next.) U11-U12 = Continuous average transfer rate for long (full volume) transfer in thousands of bytes per second. U13-U14 = Optimal retry time in 10's of milliseconds. U15-U16 = Access time parameter in 10's of milliseconds. (Maximum time from the end of the command message text to the assertion of parallel poll. Applies to read and write commands only.) U17 = Maximum interleave factor U18 = Fixed volume byte: one bit per volume (set if fixed); Volume 0 = LSB. U19 = Removable volume byte: one bit per volume (set if removable); Volume 0 = LSB.	V1-V3 = Maximum value of cylinder address vector. V4 = Maximum value of head address vector. V5-V6 = Maximum value of sector address vector. V7-V12 = Maximum value of single-vector address. V13 = Current interleave factor.

NOTES:
1. When the controller unit is addressed, the unit field is repeated for each unit within the device.
2. When the controller unit is addressed, the volume field is repeated for each volume within each unit.

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24 Residency Rd.
***BANGALORE** 560 025*
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Telex. 0845-430
Cable: BLUESTAR
A,CH,CM,CS,E

Blue Star Ltd.
Band Box House
Prabhadevi
***BOMBAY** 400 025*
Tel: 422-3101
Telex: 011-3751
Cable: BLUESTAR
A,M

Blue Star Ltd.
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
***BOMBAY** 400 025*
Tel: 422-6155
Telex: 011-4093
Cable: FROSTBLUE
A,CH,CM,CS,E,M

Blue Star Ltd.
Kalyan, 19 Vishwas Colony
*Alkapuri, **BORODA**, 390 005*
Tel: 65235
Cable: BLUE STAR
A

Blue Star Ltd.
7 Hare Street
***CALCUTTA** 700 001*
Tel: 12-01-31
Telex: 021-7655
Cable: BLUESTAR
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Blue Star Ltd.
133 Kodambakkam High Road
***MADRAS** 600 034*
Tel: 82057
Telex: 041-379
Cable: BLUESTAR
A,M

Blue Star Ltd.
Bhandari House, 7th/8th Floors
91 Nehru Place
***NEW DELHI** 110 024*
Tel: 682547
Telex: 031-2463
Cable. BLUESTAR
A,CH,CM,CS,E,M

Blue Star Ltd.
15/16:C Wellesley Rd.
***PUNE** 411 011*
Tel: 22775
Cable: BLUE STAR
A

Blue Star Ltd.
2-2-47/1108 Bolarum Rd.
***SECUNDERABAD** 500 003*
Tel: 72057
Telex: 0155-459
Cable: BLUEFROST
A,E

Blue Star Ltd.
T.C. 7/603 Poornima
Maruthankuzhi
***TRIVANDRUM** 695 013*
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Telex: 0884-259
Cable: BLUESTAR
E

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BERCA Indonesia P.T.
P.O.Box 496/JKT.
Jl. Abdul Muis 62
JAKARTA
Tel: 373009
Telex: 46748 BERSAL IA
Cable: BERSAL JAKARTA
P

BERCA Indonesia P.T.
Wisma Antara Bldg., 17th floor
JAKARTA
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BERCA Indonesia P.T.
P.O. Box 174/SBY.
Jl. Kutei No. 11
SURABAYA
Tel: 68172
Telex: 31146 BERSAL SB
Cable: BERSAL-SURABAYA
A*,E,M,P

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Hewlett-Packard Trading S.A.
Service Operation
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Telex: 212-455 HEPAIRAQ IK
CH,CS

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Hewlett-Packard Ireland Ltd.
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Telex: 30439
A,CH,CM,CS,E,M,P

Cardiac Services Ltd.
Kilmore Road
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***DUBLIN** 5*
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M

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P.D. Box 1270
JERUSALEM 91000
16, Ohaliav St.
JERUSALEM 94467
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Telex: 25231 AB/PAKRD IL
A

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A,E,M

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Telex: 3289 BROKER MB MUSCAT
P

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Arranged Alphabetically by Country

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Telex: 3274 BAHWAN MB

PAKISTAN

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1-8, Street 43
Sector F-8/1
ISLAMABAD
Tel: 26875
Cable: FEMUS Rawalpindi
A,E,M

Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
KARACHI 0302
Tel: 511027, 512927
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi
*A,E,M,P**

PANAMA

Electrónico Balboa, S.A.
Calle Samuel Lewis, Ed. Alfa
Apartado 4929
PANAMA 5
Tel: 64-2700
Telex: 3483 ELECTRON PG
A,CM,E,M,P
Foto Internacional, S.A.
Colon Free Zone
Apartado 2068
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Tel: 45-2333
Telex: B626 IMPORT PG
P

PERU

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Los Flamencos 145, San Isidro
Casilla 1030
LIMA 1
Tel: 41-4325, 41-3703
Telex: Pub. Booth 25306
A,CM,E,M,P

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The Online Advanced Systems Corporation
Rico House, Amorsolo Cor. Herrera Street
Legaspi Village, Makati
P.O. Box 1510
Metro ***MANILA***
Tel: 85-35-81, 85-94-81, 85-32-21
Telex: 3274 ONLINE
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Electronic Specialists and Proponents Inc.
690-8 Epifanio de los Santos Avenue
Cubao, ***QUEZON CITY***
P.O. Box 2649 Manila
Tel: 98-96-81, 98-96-82, 98-96-83
Telex: 40018, 42000 ITT GLOBE MACKAY BOOTH
P

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Mundinter
Intercambio Mundial de Comércio S.a.r.l
P.O. Box 2761
Av. Antonio Augusto de Aguiar 138
P-LISBON
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M

Soquimica
Av. da Liberdade, 220-2
1298 ***LISBON*** *Codex*
Tel: 56 21 81/2/3
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Telectra-Empresa Técnica de Equipmentos Eléctricos S.a.r.l.
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P.O. Box 4747
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Telex: 11216 ITIKAL SY
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E

Middle East Electronics
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