MAGNETIC PERIPHERALS, INC.
a Control Data Company

INTERFACE SPECIFICATION

FOR IPI-3

INTELLIGENT PERIPHERAL INTERFACE

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MAGNETIC PERIPHERALS INC
a Control Data Company

ENGINEERING SPECIFICATION

TWIN CITIES DISK DIVISION

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INTERFACE SPECIFICATION

FOR

IPI-3 INTELLIGENT PERIPHERAL INTERFACE

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1.0 SCOPE

This document defines the Level 3 Intelligent Peripheral Interface (IPI-3) used on Magnetic Peripherals Inc. Disk Drive Products.

2.0 APPLICABLE DOCUMENTS

SPEC 64731602 - IPI Physical Interface
SPEC xxxxxxxx - IPI Device Specific Command Set for Disk Drives
SPEC xxxxxxxx - IPI Generic Command Set for Tape Drives

3.0 GENERAL DESCRIPTION

3.1 Purpose of this Specification

The purpose of this specification is to facilitate the development and utilization of computer systems within Control Data by providing common logical interface which permits the interconnection of peripherals with diverse characteristics (disks, tapes, printers, terminals etc). It is intended for use with the IPI Physical Interface as separately documented in Specification 64731602.

3.2 Purpose of Logical Interface

The purpose of this interface is to transfer data between connected master, slaves and/or facilities according to the command repertoire. The command repertoire permits varying degrees of device dependent or device independent operation and varying degrees of intelligence to be imbedded in the slave.

3.3 Device Generic - Level 3

This level is oriented to the generic characteristics of devices (disk, tape, printer etc), and typically not the device unique characteristics (e.g. cylinders, heads). The Device Generic commands use a packet structure that provides independence of the command repertoire from the Physical Interface. Some of the Device Generic characteristics are:

1. Operations may be Individual or Queued.

2. The data area is defined by attributes of the slave.

3. The Transfer of data may or may not be timing critical, and is typically buffered.

4. Addressing of data is by Data Block address but Physical Block addresses may be used.

5. Disk Data Block lengths are typically fixed over an addressable data area, and can vary between different addressable areas on the media as well as varying between medias. Tape Data Blocks may vary between any two blocks.

6. Data is normally requested as "perfect" (errors, if any, corrected), or may be requested as "raw" (data errors, if any, are not corrected).

7. Positioning is implicitly requested but may be explicit.

8. Media defect handling is transparent to the master, but may be managed by the master.

9. Error correction is transparent to the master, but may be managed by the master.

10. Error retry is transparent to the master, but may be managed by the master.

These concepts are described relative to their usage in a Device Generic environment. These relationships may be defined differently in other levels of IPI implementation.

3.4 Relationship Of Master, Slave And Facility

A master is an entity which has need for some form of information transfer or storage. The master makes use of slaves and facilities to perform the needed operation. The slave or facility (addressee) to which the master addresses a service request is expected to have sufficient intelligence and capability to perform the requested service.

A slave is subservient to one master per port. The slave provides services to the attached master(s), and is responsible for the control and operation of the facilities (if any) attached to it. The slave may also perform additional functions as it finds necessary.

A facility may be a unit of storage; e.g., disk drives and tape drives; or a unit of functionality; e.g., a communications interface. Facilities are not limited to these devices, or even to being devices. Facilities are defined as having capabilities. A facility may be subservient to one or more slaves.

3.5 Relationship Of Facilities And Partitions

As an option, a slave may allow the subdivision of a facility into partitions. In a facility that is capable of being subdivided, there are two types of subdividing possible that could be supported. The first is ability of the slave to subdivide the facility into a default data partition and up to 7 maintenance partitions.

For disks, the second is the ability of the master to subdivide the default data partition into up to 239 data partitions and up to 8 maintenance partitions.

For tapes, the second is the ability of the slave to define 112 additional partitions and the master to subdivide the default data partition into 127 data partitions and up to 8 maintenanced partitions.

Maintenance partitions are typically used for maintenance purposes, but their use is not restricted thereto, and may be otherwise used for storage of slave and/or facility specific data. Maintenance partitions are not accessed by the master during normal operation, but access by the master is possible via the OPERATING MODE command.

The total area of a facility that is defined by the slave as the default data partition may be used for storage of the master's data. The partitioning and control of the partitions created in the default data area is the responsibility of the master.

The Device Generic command structure is based on message packets which are of variable length. The basic command and response packets are expanded by appending parameters which identify the specific actions to be taken. This provides a powerful tool for providing flexibility for future growth, since the addition of new functions over time should not require major changes to the command repertoire, but add functionality to the existing commands.

The Device Specific (known also as Level 2) command repertoire described in Specification XXXXXXXX uses a different command structure than the Device Generic level. The major objective achieved by being different is the ability to execute timing-critical operations. Because both levels use the same Physical interface it is possible for Device Specific slaves to co-exist on the same daisy chained cable as Device Generic slaves. If the master daisychains Device Specific and Device Generic 3 slaves, this places the requirement on the master to be able to handle both command structures.

Device Generic commands need to be aware of the general device type (i.e. master must know if it is disk or tape), and provide for logical data addressing, buffers, error detection, error retry, error correction etc at the slave. There are no timing-critical dependencies between commands.

3.6 Application Environments

The degree of intelligence provided by the slave varies, and is defined by Attributes described in Equiptment Specifications. The master can either select or respond to, the level of intelligence provided by the slave.

3.7 Control Of Facilities By The Master

The master performs Facility Selection and issues Individual commands. This is a master-oriented environment which typifies the operation of most of today's host system I/O interfaces. The master prioritizes tasks and dispenses them to the various peripherals attached to it in a fashion that optimizes the system performance from the master's perspective.

Since the master controls all activity on the interface it must poll both the slave and facility interrupts in order to maximize the efficiency of data transfers. The master-oriented environment is typified by the following features of the interface:

- Command execution sequenced by the master.
- Individual commands
- Selection to the facility.
- Master polling of both slaves and facilities.
- Bus Control established by the master.
- Command queueing done by the master.

3.8 Shared Control of Facilities

In this environment a slave has functional control of the facilities, but the master has explicit control over some aspects of facility management. Some tasks, such as command queueing may be left to the discretion of the slave, but the master may choose to sequence the flow of data between specific facilities based on its own algorithms.

This environment is typified by the following features of the interface:

- Command execution between facilities sequenced by the master.
- Queued commands.
- Selection to the facility.
- Master polling of both slaves and facilities.
- Bus Control established by the master.
- Command queueing done by the slave.

3.9 Control of Facilities By The Slave

In this environment the slave has functional control of the facilities, and the master has limited control (if any), over facility management. The slave has the intelligence necessary to control operations on behalf of the master.

This is a slave-oriented environment because of the degree of control the slave exercises over system performance and optimization. This environment is typified by the following features of the interface:

- Command execution between facilities sequenced by the slave.
- Queued commands.
- Selection to the slave.
- Master polling of the slave.
- Bus Control established by the master or optionally by the slave.
- Command queueing done by the slave.

4.0 GLOSSARY OF TERMS

The glossary contained in Specification 64732100 is pertinent to this document, but for convenience, some of the terms are repeated here along with new terms needed:

Actual Address - This is the address of the facility which is unique, and is used by the slave to accomplish selection (the interface by which facilities are attached to the slave may or may not be an IPI).

Addressee - This term refers to the slave and/or facility identified by the combination of Slave Address and Facility Address. This term names a partition within a facility.

Attributes - Each slave (or facility) has a level of functionality which can be described by a table that contains entries for characteristics that require definition to the master. The entries are self-defining and are termed attributes.

Burst - The maximum number of octets to be transferred in any one Information Transfer. The transfer of a number of bursts may be implicit within a single command request.

Command - This term refers to a command issued by the master to initiate some specific operation.

Command Address - This term refers to the two octets of Slave Address and Facility Address in the basic command packet which uniquely identifies the addressee (or optionally partition) to which the command is issued.

Data - This term refers to any Information Transfer over the interface not associated with either a command or a response.

Data Block - This term is uniquely defined in this document as meaning the logical representation of data on the media. A Data Block may or may not have a relationship to Physical Blocks; i.e., it may be equal to, less than or greater than Physical Blocks in size. If commands are issued with Data Block addresses to a slave that supports logical addressing, the slave is responsible to correctly locate the physical representation of data by logical address, and present it to the master in Data Blocks.

Extent - A range of contiguous blocks, defined as the count of a number of blocks beginning at a data address (Physical Block or Data Block) within (and limited to) a partition.

Facility Address - This is an octet value in the Command Address which may be an Actual Address, Selection Address, Synonym or Alias. It is used to identify the facility (or partition) to which the command is addressed. Valid values are from 0 to 255.

Housekeeping - This is a procedure required at initial usage of a slave (or facility) because the master must obtain the attributes in order to adapt to or configure, its functionality.

Individual - This term refers to the execution of commands that must be completed before the next command can be issued.

Information Transfer - This term refers to the transferring of octets on the Physical Interface of commands, responses and data that are framed by a Bus Exchange.

Interrupts - This term refers to the ability at the Physical Interface for the slave to advise the master of which types of Response are available in the slave. The slave uses interrupts to initiate assertion of the ATTENTION IN signal.

L-Available (Logically Available) - This condition indicates that the slave can "accept" a command from the master.

L-Busy (Logically Busy) - This condition indicates that the slave can respond to Bus Exchanges but is not capable of "executing" a command from the master.

Level 2 (Device Specific) - This term refers to commands which may be timing critical, that are used to define the execution of device dependent operations. See companion Specification xxxxxxxx.

Level 3 (Device Generic) - This term refers to commands which are not timing critical, and are in an intelligent environment where the slave has functional control (which may or may not be overridden by the master) over the attached facility(s).

Logical Interface - This term refers collectively to all protocols higher than the Physical Interface.

Mandatory - To conform to this specification, all functions described as mandatory must be implemented as defined in this document.

Multiplex - This term defines the ability of a master to intersperse the execution of commands between addressees; or of a slave to intersperse the execution of commands between different facilities; or of a slave to intersperse transfer information in bursts which are less than the requested transfer size.

Operational - The Operational condition indicates that the slave is capable of processing Bus Exchanges.

Optional - This term describes features which are not required by this specification. However, if any feature defined by this specification is implemented, it must be done in the same way as defined by this specification.

P-Available (Physically Available) - The slave is installed and capable of responding to the Physical Interface.

P-Busy (Physically Busy) - The slave is capable of processing Bus Exchanges but not on this port because it is currently selected or reserved to another port.

Partition - This term defines a recording area which may be logically addressed. A partition may be slave defined (e.g data area, CE area, IML area) or may be master defined (e.g. an addressable set of contiguous blocks within the data area). See also Alias.

Physical Block - This term is uniquely defined in this document as meaning the physical representation of data on the media; e.g., sectors or records on disk and blocks or records on tape. It is used to prevent confusion between industry usage of terms.

Physical Interface - This term refers to the mechanical, electrical and bus protocol characteristics specified in Specification 64732100.

Queued - This term refers to the ability of a slave to accept multiple commands per Facility Address from the master and execute them in a sequence according to slave-defined or master-defined algorithms. This term is used to indicate that a slave or facility can execute its intended functions.

Response - This term refers to the response made by a slave to advise the master of the results of a command, or of conditions within the slave.

Selection Address - This is the address used by the master at the Physical Interface to select a slave and/or a facility (this may not be the same as the Actual Address if Synonyms are used).

Synonym - This term describes the ability to re-define the Facility Address of a Facility. There may be more than one synonym to address the same facility.

5.0 LOGICAL INTERFACE CHARACTERISTICS

5.1 Operations

The Logical Interface uses a packet structure to transfer Commands from the master to the slave and Responses from the slave to the master. A Bus Exchange at the Physical Interface requires a Bus Control sequence and its associated Ending Status sequence to frame the Information Transfer of Commands, Responses and data.

The Commands and Responses are of variable length and only a single packet or data is transferred for each Information Transfer.

5.1.1 Commands

Commands are issued by the master to instruct the slave and/or facility to perform an operation. The slave returns a Response when the command has been completed (unless inhibited by the "No Response If Successful" attribute set by the master).

5.1.1.1 Command Types

The command types include:

Control - The Control commands provide for control of the slave and facility(s).

Position - The Position commands cause positioning of the facility.

Transfer Commands - The Transfer commands may cause multiple blocks of data to be transferred between the master and the facility. Before data is actually transferred, the slave activates the Class 2 Interrupt to inform the master that it is ready to transfer data. The complete data transfer may be broken up into several Information Transfers. In a slave with Command Queueing, a Transfer Notification is generated to inform the master of the identity of the command for which the transfer is pending.

Combination Commands - The Combination commands provide for operations between two facilities attached to the same slave, or between two facilities attached to different slaves if Slave-to-Slave Information Transfers are supported at the Physical Interface. An operation between two different slaves requires the designation of a dominant slave and a subservient slave by the master. The dominant slave assumes the role of the master for the purpose of initiating Information Transfers to carry out slave to slave operations.

Diagnostic Commands - The Diagnostic commands provide for maintenance and diagnostic operations between a master and slave or facility. These commands are product specific.

5.1.1.2 Command Stacking

A slave which can accept more than one command is capable of command stacking. The number of commands that may be stacked is defined by the slave's attributes. When a master attempts to send more commands to a slave than can be accepted, rejection occurs at the Physical Interface. Commands that are stacked may be Individual or Queued.

5.1.1.2.1 Individual

The slave can accept only one operation per facility under its control; i.e., a queue of one.

5.1.1.2.2 Queued

The master can have more than one operation per facility concurrently active under control of the slave, and the slave is responsible to execute them. This permits the slave the freedom to optimize the sequence of command execution to enhance performance; e.g., seek ordering algorithms. The master has the ability to override slave optimization via Attributes.

5.1.1.3 Command Execution Order

The order in which commands are executed is controlled by command modifier bits which are common to all commands. Commands which are identified as Chained, Sequential or Ordered cannot be intermixed for a given addressee. The last command of a Chain, Sequence or Order has no encoding of its identity in order to identify it as being the last one - the slave shall be capable of recognizing it as being the last one, rather than treating it as an Individual or Queued command. The execution scenarios possible are:

5.1.1.3.1 Individual/Queued Commands

Commands other than those labelled by modifier bits as Chained, Sequential, Ordered or Priority, are executed in a slave and/or facility dependent order.

5.1.1.3.2 Chained Command

Commands are executed in the order received by the slave (FIFO order); i.e., a sequence of commands (not necessarily stacked) to a single addressee. The addressee is implicitly Reserved as long as any command of the Chain is being executed. If a command in the Chain is unsuccessful, the Chain is terminated and the remaining commands are not executed. The Chained modifier encoding is not set for the last command in a Chain. The slave may multiplex operations for other addressees during execution of the Chain.

5.1.1.3.3 Sequential Command

Commands are executed in the order received by the slave (FIFO order). There may be more than one addressee in a Sequence and the slave may multiplex other operations during execution of the Sequence. If a command in the Sequence is unsuccessful, the Sequence is terminated and the remaining commands are not executed. The Sequential modifier encoding is not set for the last command in a Sequence. There is no implicit Reserve of the addressee beyond the command being executed.

5.1.1.3.4 Ordered Command

Commands are executed in the order received by the slave (FIFO order). There may be more than one addressee in an Order, but the slave shall not multiplex other operations during execution of the Order. If a command in the Order is unsuccessful, the Order is terminated and the remaining commands are not executed. The Ordered modifier encoding is not set for the last command in an Order. There is no implicit Reserve of the addressee beyond the command being executed.

5.1.1.3.5 Priority Command

Priority commands and Priority Chains/Sequences/Orders are indicated by the command modifier bits. Only the first command in a Chain/Sequence?/Order shall be designated as Priority, but the Priority shall apply to the entire Chain/Sequence/Order. A Priority command causes the slave to change the order of execution of stacked commands and also causes changes in interpreting the command packet transmission for each addressee.

When a Priority command packet is received for an addressee, any Chain/Sequence/Order which was in the process of being received shall be ended; i.e., the last packet received is interpreted as the last of the Chain/Sequence/Order regardless of the command modifier settings in that packet. This ending applies regardless of whether the slave is operating in a queued or non-queued environment.

NOTE: This applies only to commands received over the same port.

Priority commands, whether Individual or part of a Chain/Sequence/Order, are executed before non-Priority commands. Priority commands are executed in LIFO (Last In First Out) order. With the exception of individual ABORT commands, the receipt of a Priority command does not affect the operation of any Individual command or commands in a Chain/Sequence/Order except for the possible ending noted previously. When a Priority, Individual ABORT command is received, the slave shall suspend the command executing (if possible), and process the ABORT.

5.1.2 Operation Responses

Each Command has an associated Response packet. Command Completion Response packets contain status which notifies the master whether or not the command was successful and, if not successful, why not. The response is not generated or transferred, if the "No Response If Successful" attribute is set by the master.

Response packets are also generated to notify the master of commands that are ready for data transfer, or for asynchronous events that have occurred in the slave or facility(s).

5.1.2.1 Interrupts

Physical Interface interrupts are used by the slave to request service from the master.

The master may poll any or all of the interrupt classes by setting the appropriate bits in the Request Interrupts octet of the Physical Interface. It is the responsibility of the master to prioritize the interrupts in the event that more than one slave is interrupting.

Optionally, the master may poll the interrupts from the facilities attached to a slave by the Request Facilities Interrupts octet of the Physical Interface if this feature is supported by the slave.

The Physical Interface ATTENTION IN signal is a logical OR of the interrupts from all but the addressee selected on the Physical interface. The interrupts may be enabled and disabled from generating Attention.

The interrupt classes for slaves and facilities are defined in descending order of priority. Slaves shall present interrupts in order of their priority except when the response stack is full of lower order interrupt responses; i.e., if a Class 2 could be presented because data is available in a buffer but the stack is full of Class 1 responses because the master has not requested them, the slave shall not respond to a poll for Class 2 interrupts.

An interrupt is cleared when the condition that caused it to be presented is no longer present.

5.1.2.1.1 Class 3 - Critical Status Pending

This interrupt is used to alert the master to events or conditions existing in a slave or facility which require immediate attention from the master and are not associated with command completion. An Asynchronous response is used to alert the master, and the conditions(s) initiating same are defined by the Major Status, associated Substatus and Extended Substatus (if any).

5.1.2.1.2 Class 2 - Transfer Status Pending

This interrupt is used by slaves to inform the master that data is ready to be transferred. A Transfer Notification to identify the command involved shall be generated by the slave unless the master is selecting facilities and executing Individual commands; or a Paused transfer implies the Transfer Notification.

5.1.2.1.3 Class 1 - Status Pending

This interrupt is used to identify command completion responses, successful or otherwise, of commands issued by the master and of Asynchronous responses which are not critical. The Major Status and associated Substatus, if any, identify either the conditions under which the command terminated or the cause of the Asynchronous response.

An optional use of this interrupt is to report that the slave, which was previously reported Busy during a selection sequence, is no longer Busy. When the interrupt is used in this manner, the master is responsible for recognizing that there is not necessarily a Command Completion or Asynchronous response packet already in the slave. If there is no response packet pending in the slave, the interrupt shall be cleared by a successful selection sequence.

5.1.2.2 Response Types

The response types do not directly correspond to the three interrupt classes. An Asynchronous response may be Class 3 if critical (e.g. power failure warning), or Class 1 if not critical (e.g. transition from Ready to Not Ready).

5.1.2.2.1 Command Completion Response

This response is generated by the slave when a command has completed unless the response has been disabled by Attributes being set to "No Response if Successful Completion."

The Class 1 interrupt is activated to inform the master that a Command Completion Response is available.

5.1.2.2.2 Transfer Notification Response (Optional)

This response is generated by a slave capable of stacking Individual or Queued commands. It is used to identify the command with which the data transfer to follow is associated.

Transfer Notification Responses are not required under the following conditions:

- when commands are Individual, and the command was preceded by a facility selection or,
- for continuation of paused data transfers.

The Class 2 Interrupt is activated to inform the master that a Transfer Notification Response is available.

5.1.2.2.3 Asynchronous Response

This response is generated by the slave to advise the master of an unanticipated event not associated with command completion.

Either the Class 3 or Class 1 Interrupt is activated to inform the master that this response is available (depends on whether or not it is considered critical by the slave).

5.1.2.2.4 Imbedded Data Response (Optional)

This is generated by the slave to send small amounts of data in a parameter field of the response packet. No more than 254 octets can be transferred in this manner.

The objective of this response is to permit peripherals with very low transfer rates and small transfer needs to gather data in a manner that does not interfere with high performance peripherals. This response shall not terminate the command, and many of them can be received in answer to a single command.

The Class 2 Interrupt is activated to inform the master that an Imbedded Data Response is available.

5.1.2.3 Response Handling

When there is more than one response packet to be transferred by the slave, it shall transfer response packets to the master in the order of interrupt priority. Within an interrupt class, the responses shall be presented in order of command completion.

If facility selection precedes the request for a response packet, the slave shall only transfer the highest priority response among those for the selected facility.

The master shall properly handle any response packet which it receives, even if it is not necessarily the response type that it expected.

The master should not attempt to initiate the transfer of a response packet before interrupts indicate the availability of a response ready to transfer. If the slave has no response packet to transfer upon receiving a request for one, it shall terminate the attempted Information Transfer (without transferring any information) and not post the Successful bit in Slave Status.

When a slave which supports Control of Bus at the Physical Interface is given control, it may elect to transfer a response packet or transfer data.

5.1.3 Physical Interface Error Recovery Considerations

Errors detected by the Physical Interface protocol require recovery action be taken via a Device Generic protocol. Recovery procedures depend on the packet type (Command, Data or Response), and on whether or not the error is detected prior to the Slave Status octet being presented.

5.1.3.1 Recovery from Unsuccessful Slave Status Octet

The Slave Status octet contains the Successful Information Transfer bit, which is set to 0 if any errors are detected by the slave prior to transmission of the octet. This includes not posting Successful if the slave recognized bad parity on the Master Status octet.

NOTE: The slave does not change its Slave Status octet contents based on the contents of the Master Status octet.

Following a command transfer, if the Success bit in either the Master or the Slave Status octet is set to 0, the slave shall ignore the command. The master is responsible to retransmit it.

Following a data transfer, if the Success bit in either the Master or the Slave Status octet is set to 0, the slave shall terminate the command in progress. A response indicating the failure shall be generated.

Following a response transfer, if the Success bit in either the Master or the Slave Status octet is set to 0, the slave shall retain the response in its buffer and attempt re-transmittal under the master's control. The slave shall assert the appropriate interrupt upon deselection.

5.1.3.2 Recovery from Bad Parity on the Slave Status Octet

If the master detects a parity error or any other invalid condition on the Slave Status octet, the slave has no way to determine what has happened (as this is presented in the last state before deselection may occur).

Whenever an invalid condition is detected in the Slave Status octet following a command, data or Transfer Notification packet transfer, the master shall use an ABORT command or a selective reset (either Logical Interface Reset or Slave Reset) to force the slave to discontinue execution of the command.

If an invalid condition is detected in the Slave Status octet following a response packet other than Transfer Notification (typically Command Completion), it is the master's responsibility to retry execution of the entire command because the slave is not aware of its failure, and has released the buffer containing the response packet.

NOTE: In the case of a slave which queues commands, the master may have to issue no more until it can match valid responses with all the issued commands in order to identify the one which was unsuccessful.

If an invalid condition is detected in the Slave Status octet following an Asynchronous response packet the master has no way of advising the slave that the Slave Status octet was not received correctly. Master specific recovery procedures may choose whether or not to accept the contents of the Information Transfer. If it is a condition which keeps recurring the slave shall generate another response.

NOTE: Under this circumstance the error recovery action cannot be certain to obtain the same information as was originally presented.

5.2 Operation Sequences

Operation sequences of the logical interface are controlled by the master, since it establishes the Bus Exchanges which transfer information between the master and slave. Optionally, the master may give control of the bus to a slave; actual control of the Information Transfer at the Physical Interface would then be performed by the slave.

The sequence of actions taken to execute operations between master and slave(s) is done as a series of Information Transfers across the Physical Interface. Slave selection and deselection is done as necessary to communicate with the desired addressee.

5.2.1 Slave Procedures

The following procedures are not necessarily supported by every slave. The slave's Attributes indicate which are supported.

Facility Selection and Facility Interrupts - When the slave supports facility selection and interrupts, the master may make use of them to exert control of the facility. The use of the facility interrupts allows the master to determine the facility requiring service and the facility selection allows the master to direct an operation to the desired facility.

Slave Control - When the slave Control of Bus is supported (Bus Acknowledge octet) the master may give control of the subsequent Information Transfer to the slave to allow it to determine whether to transfer a response packet or data. The slave shall not set the Operation Out bits in the Bus Acknowledge octet; i.e., attempt to cause a command to be transferred.

Queued Facility - When the slave's Attributes indicate that a facility can operate in a queued environment, the master may issue more than one command for a facility.

5.2.2 Basic Steps

The basic steps performed by the master in carrying out operations are:

- Transmit Command Packet To Slave
- Poll Interrupts
- Receive Response From Slave
- Transfer Data Between Master and Slave

They are described in the following four sections.

5.2.2.1 Transmit Command Packet To Slave

The master establishes a Bus Exchange to transfer a single Command packet to the selected slave. The number of commands that can be stacked at an addressee is defined in the Attributes.

Commands consist of variable length transfers, and some slaves may terminate the transfer based on the Packet Length defined in the first two octets. If slaves require master termination of transfers, the length of the transfer is decided by the master.

If the Master Status octet in the Ending Status sequence indicates an unsuccessful transfer then the slave shall ignore the received command. There is no response packet generated.

If the Slave Status octet in the Ending Status sequence indicates a successful transfer, the master need not retain the entire command packet.

5.2.2.2 Poll Interrupts

The master polls interrupts to know when to perform data transfers or receive Responses. The polling of a specific interrupt from each of the slaves is performed by the Request Interrupt sequence of the Physical Interface. The presence of an interrupt in any of the slaves is typically provided by the ATTENTION IN signal at the Physical Interface. The master can mask out interrupts by class from setting Attention if it chooses to (via the ATTENTION CONTROL command).

Even if a master has masked out all interrupts from setting Attention, it is still necessary to recognize that unsolicited Attentions could occur; e.g., if an attached slave executed a Power On reset, the mask information would be lost, and an Attention caused by powering on would be generated when its drivers were enabled.

If facility interrupts are supported by the slave, the master may poll facilities attached to a slave after receiving an interrupt from the slave.

NOTE: The slave generates interrupts on behalf of the attached facility(s).

5.2.2.3 Receive Response Packet From Slave

Upon receiving an interrupt from a slave, the master establishes a Bus Exchange to transfer the slave's Response. There is one exception to this when the interrupt is Class 2 and the master is executing in a non-queued environment with facility selection.

The master may give control of the bus to the slave (if this function is supported) so that the slave can decide whether to transfer a response packet or to transfer data.

If the Master Status in the Ending Status sequence indicates a successful transfer, the slave releases the response packet and deactivates the interrupt; otherwise it retains the packet until successfully transferred.

The response packet may indicate: the successful or unsuccessful completion of a command, a notice that data is to be transferred for a particular command, or the occurrence of an asynchronous event.

5.2.2.4 Transfer of Data Between Master and Slave

After receiving a Transfer Notification (or in the exception noted above of a Class 2 interrupt in a non-queued environment with facility selection), the master initiates a Bus Exchange to transfer data to or from the slave as required by the command identified in the response (if the slave is given Control of Bus it sets up the direction of transfer).

The amount of data intended to be transferred is determined by the slave (because it generates SYNC IN at the Physical Interface). Whether or not the ending Master Status indicates a successful input transfer, the slave may release its input data buffer. If the Slave Status indicates a successful output transfer, the master may release its output data buffer.

If the master terminates a data transfer, the characteristics of the slave shall determine whether or not it is an unsuccessful transfer. To a fixed block class of device such as disc, the transfer would be considered unsuccessful unless the transfer was being Paused (optional feature) by the master. To a variable block class of device such as tape, master termination would normally be considered successful, and a short Physical Block would be written.

If not Paused by the master, the Command Completion Response shall identify the termination to the master (whether or not the transfer was succesful) as "Unexpected Master Status" in Machine Exception Substatus.

If the transfer requested by the command was completed successfully, unless overriden by Attributes, the slave shall generate a Class 1 interrupt and a Command Completion Response . If the transfer is unsuccessful, the slave shall generate a Class 1 interrupt and report the appropriate status in the Command Completion Response.

5.2.3 Operation Sequence Examples

The four steps described above can be used in a number of ways, and can best be illustrated by a set of examples executing the same scenario in different implementations. In these examples, the data transfer for Facility 1 requires two transmissions because the slave paused (either unanticipated, or multiplexed) during transfer.

The examples attempt to define only major steps in the flow; e.g., deselection is implicit. To clarify direction of transfer, the terms "transmit" are used for transfers out to the slave, and "receive" is used for transfers in from the slave. The term "recognize" is used for polling because the master has a choice of alternatives when polling (between slaves, facilities and masking).

This example sends Transfer commands to Facilities 0 and 1 on Slave 0.

- Select Slave 0/Facility 0 and transmit Command packet.
- Select Slave 0/Facility 1 and transmit Command packet.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 2 Interrupt from Facility 1.
- Select Slave 0/Facility 1 and perform data transfer until paused by Slave 0.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 2 Interrupt from Facility 0.
- Select Slave 0/Facility 0 and perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 1 Interrupt from Facility 0.
- Select Slave 0/Facility 0 and receive Command Completion Response with "Successful" Status.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 2 Interrupt from Facility 1.
- Select Slave 0/Facility 1 and perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 1 Interrupt from Facility 1.
- Select Slave 0/Facility 1 and receive Command Completion Response with "Successful" Status.

This example sends Transfer commands to Facilities 0 and 1 on Slave 0.

- Select Slave 0/Facility 0 and transmit Command packet.
- Select Slave 0/Facility 1 and transmit Command packet.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 2 Interrupt from Facility 1.
- Select Slave 0/Facility 1 and receive Transfer Notification identifying command.
- Perform data transfer until paused by Slave 0.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 2 Interrupt from Facility 0.
- Select Slave 0/Facility 0 and receive Transfer Notification identifying command.
- Perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 1 Interrupt from Facility 0.
- Select Slave 0/Facility 0 and receive Command Completion Response with "Successful" Status.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 2 Interrupt from Facility 1.
- Select Slave 0/Facility 1 and receive Transfer Notification identifying command.
- Perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Poll Slave 0 and recognize Class 1 Interrupt from Facility 1.
- Select Slave 0/Facility 1 and receive Command Completion Response with "Successful" Status.

NOTE: Applications which implement multiple commands per facility in a non ordered sequence, although not included in this example, require the use of Transfer Notification Packets. This example represents the same scenario as the other examples in this section.

This example sends Transfer commands to Facilities 0 and 1 on Slave 0.

- Select Slave 0 and transmit Command packet for Facility 0.
- Remain selected and transmit Command packet for Facility 1.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Select Slave 0 and receive Transfer Notification identifying command for Facility 1.
- Perform data transfer until paused by Slave 0.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Select Slave 0 and receive Transfer Notification identifying command for Facility 0.
- Perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Select Slave 0 and receive Command Completion Response for Facility 0 with "Successful" Status.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Select Slave 0 and receive Transfer Notification identifying command for Facility 1.
- Perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Select Slave 0 and receive Command Completion Response for Facility 1 with "Successful" Status.

This example sends Transfer commands to Facilities 0 and 1 on Slaves 0 and 1 respectively. This introduces implicit Transfer Notification; i.e., only one data transfer is paused at a slave, so the Transfer Notification can be implied when the transfer is continued.

- Select Slave 0 and transmit Command packet for Facility 0.
- Select Slave 1 and transmit Command packet for Facility 1.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Select Slave 0 and with Bus Control give Control of Bus to slave.
- Receive Bus Acknowledge octet indicating Response (Operation In).
- Receive Transfer Notification identifying command for Facility 1.
- Master sets Bus Control (Data Direction).
- Perform data transfer until paused by Slave 0.
- Poll interrupts and recognize Class 2 Interrupt from Slave 1.
- Select Slave 1 and with Bus Control give Control of Bus to slave.
- Receive Bus Acknowledge octet indicating Response (Operation In).
- Receive Transfer Notification identifying command for Facility 0.
- Master sets Bus Control (Data Direction).
- Perform data transfer until terminated by Slave 1.
- Poll interrupts and recognize Class 2 Interrupt from Slave 0.
- Select Slave 0 and with Bus Control give Control to slave.
- Receive Bus Acknowledge octet with implicit Transfer Notification and Data Direction.
- Perform data transfer until terminated by Slave 0.
- Poll interrupts and recognize Class 1 Interrupt from Slave 0.
- Select Slave 0 and with Bus Control give Control of Bus to slave.

- Receive Bus Acknowledge octet indicating Response (Operation In).

- Receive Command Completion Response for Facility 0 with "Successful" Status.

- Poll interrupts and recognize Class 1 Interrupt from Slave 1.

- Select Slave 1 and with Bus Control give Control of Bus to slave.

- Receive Bus Acknowledge octet indicating Response (Operation In).

- Receive Command Completion Response for Facility 1 with "Successful" Status.

5.3 Multiplexed Data Transfers (Optional)

Different computer system architectures will utilize the IPI, and a wide range of products may be intermixed on a single cable. There are occasions when a transfer may be terminated for either an unanticipated reason or a deliberate event. The interface provides for both to occur via use of the Pause function at the Physical Interface. Command and response packet transfers cannot be paused - only data transfers may be paused and continued.

It is necessary that a master be able to control some of the ways in which different products coexist. One important area is in ensuring equitable use of the bandwidth. A deliberate event to pause a transfer occurs when a master wishes to prevent a particular peripheral from dominating the use of the interface during Information Transfers.

In an application where the master requests large data transfers, it is desirable to be able to predict the use of the interface. The master can accomplish this by multiplexing transfers between addressees on a predictable basis. The master defines (in Attributes) the maximum number of octets to be transferred in any one data transfer (a burst), even though any single command may itself, define considerably more.

A command which requested a 20K data transfer to a slave with a defined 8K maximum burst size would require three data transfers in order to complete. The slave would pause after each 8K burst and complete after the remainder of 4K was transferred.

5.3.1 Physical Interface Pause And Continue (Optional)

The Physical Interface provides the ability to Pause and continue transfers from both master and slave. The master and the slave can use this function to interrupt a continuous data transfer. The slave shall transfer data in bursts no longer than those defined or set in Attributes.

The master cannot indicate any time dependency to the slave, only whether or not the transfer is paused. However, the slave can indicate to the master some idea of the expected time period that the transfer shall be paused. This is done through use of the Time Dependent Operation bit in the Slave Status octet.

The meaning of the bits is as follows:

PAUSE	TIME DEPENDENT OPERATION	
0	0	No Delay
1	0	Short Delay
1	1	Long Delay
0	1	No More Data

If for some reason both the master and slave present the Pause bit in their respective ending status octets, the slave Pause shall override the master Pause.

In the following descriptions the term P/TDO refers to the setting of the Pause and Time Dependent Operation bits in the Slave Status octet.

5.3.2 Slave Pause And Master Continue

The master controls the slaves which receive service. The master shall use Attributes to establish the size of transfer, defined as a burst, to be multiplexed. During data transfers, when the burst defined by the master has been transmitted the slave shall terminate. If information is immediately available to resume transfer with another burst it shall so indicate by P/TDO=00. This condition can only occur on multiplexed burst boundaries.

If a slave Pauses with no information remaining in its buffer to be transferred, but it anticipates only a short delay before information shall be available it sets P/TDO=10. If, however, the delay is expected to exceed the value defined in Attributes it shall set P/TDO=11.

If it is deselected, the slave shall generate a Class 2 interrupt when it has more information to transfer (immediately in the case that P/TDO=00).

When a slave transferring information pauses at the end of a burst, the master may choose to deselect and poll the other slaves, or remain selected and continue the transfer.

To continue a paused data transfer the master shall re-select (if necessary), and transfer resumption may or may not be implicit based on the mode of interface operation.

The slave shall always have a Transfer Notification packet prepared (if they are being used) so that if the master issues a Response request the slave can respond with same.

5.3.2.1 Implicit Continue

If the master is executing Individual commands with Facility Selection it can re-issue the same Bus Control octet as for the initial transfer.

If the master is executing Queued commands to a slave which can have more than one paused transfer, the master has to receive a Transfer Notification to know which one is being continued. To do so, the master may issue the Bus Control octet for a Response, or permit the slave Control of Bus and the slave shall set up the data transfer of a Response.

5.3.2.2 Explicit Continue

If the master is executing Queued commands to a slave but only one transfer can be paused per slave, the master may re-issue the same Bus Control Octet as for the initial data transfer.

Alternatively, the master may provide the slave Control of Bus, and the slave shall respond with the Data, Direction, and Control of Bus Accepted bits set in the Bus Acknowledge octet. The explicit continue prevents a slave which can have more than one paused transfer and has been given Control of Bus, from starting a second paused transfer.

NOTE: The paused slave is locked to the same transfer command until it is either successfully or unsuccessfully completed. It is possible for a master to issue commands or request responses from a paused slave, but based on internal design a slave may or may not be able to comply. The only way in which a master can free a paused slave is to continue the data transfer or abort the transfer command which is Paused.

5.3.3 Slave Control of Pause And Continue

A slave may choose to pause an data transfer due to an unanticipated delay encountered; e.g., re-positioning, error correction. The slave terminates the transfer and sets P/TDO=11. The master can de-select the slave and await a Class 2 interrupt to advise that transfer can be continued.

If the master had de-selected, when the slave is ready to continue the transfer it shall generate a Class 2 interrupt. The master shall re-select and set the Control of Bus bit in the Bus Control octet. If the master did not de-select, it can remain in a loop presenting the Bus Control octet, and being rejected by the slave until the slave is ready to continue.

If the master used the Control of Bus bit, the slave shall set the Data, Direction and Control of Bus Accepted bits in the Bus Acknowledge octet, and transfer shall begin after the master asserts the MASTER OUT signal.

5.3.4 Master Control of Pause And Continue

When a master encounters a temporary interruption, sufficient to stop a data transfer, it shall initiate termination of the transfer, and set the Pause bit in the Master Status octet. The master may choose to de-select or remain selected to the slave.

To continue a Paused data transfer the master shall re-select (if necessary), along with the same settings in the Bus Control octet used for the original command, then assert the MASTER OUT signal to restart the data transfer.

The slave shall not generate a Class 2 interrrupt, but if it encounters any error while Paused, it may generate either a Class 3 or a Class 1 interrrupt.

5.3.5 Uses of Multiplexing

There are three basic uses that are made of multiplexing between addressees.

5.3.5.1 One Paused Transfer per Facility

When Facility Selection is used by the master to issue Individual commands, a slave may have up to 16 concurrent data transfers being multiplexed. It is the master's responsibility to manage the multiplexing of information via selection and re-selection of the facility.

5.3.5.2 One Paused Transfer per Slave

When Slave Selection is used by the master, a slave may be able to multiplex only one transfer (defined by Attributes). Continuing a paused transfer does not require the use of a Transfer Notification (unless enabled by Attributes) as the master can re-issue the same Bus Control octet as for the initial transfer to indicate an implicit Transfer Notification.

5.3.5.3 Multiple Paused Transfers per Slave

When Slave Selection is used by the master, a slave may be able to multiplex more than one transfer. This application requires the use of Transfer Notification packets unless a master remains selected. Upon selection, the slave is required to present a Transfer Notification packet to advise the master which paused data transfer is going to be continued.

5.3.6 Anticipated Pause

The master uses Attributes to advise the slave of the burst size to be transferred during a multiplexed transfer.

After the slave has terminated a burst data transfer it posts Slave Status with Successful and the requisite P/TDO bits.

P/TDO=00 - Immediate Continuation Possible.
On Read, next burst is already buffered and ready to transfer.
On Write, buffer is free to accept next burst from master.

P/TDO=10 - Continuation Possible after Short Delay.
The slave expects a delay of less than the period defined by the master in Attributes.

P/TDO=11 - Continuation Possible after Long Delay.
The slave expects a delay longer than the period defined by the master in Attributes.

P/TDO=01 - No More Data
The entire data transfer is now complete.

The Time Dependent delay posted by the slave is an indication, and not a guarantee, because many factors are involved; e.g., a Short Delay could actually be a long one if an unforeseen error condition occurred.

5.3.6.1 Master Stays Selected

If the master chooses to stay selected to the addressee, it continues by issuing a Bus Control octet with the same settings as on the original. If the slave cannot continue, it shall reject the Bus Control octet, and use encoded Slave Status to advise why.

5.3.6.2 Master Deselects

If the master deselects, the addressee shall assert its Class 2 Interrupt (and Attention if not overridden by ATTENTION CONTROL) when it is capable of continuing the burst transfer.

The actions to be taken are a function of the application (see 5.3.2.1 and 5.3.2.2).

5.3.7 Unanticipated Pauses By The Slave

If the slave encounters a condition which causes interruption of a data transfer (before reaching a burst boundary), it shall terminate the transfer and advise P/TDO=1x in the Slave Status octet (continuation possible after Delay).

NOTE: P/TDO=00 is invalid, because if it could continue immediately it would not have paused in the first place.

The master may choose to remain selected or not. The same actions that are defined above in 5.3.6 for anticipated pauses are followed by the slave and the master in order to continue the transfer.

5.3.8 Unanticipated Pauses By The Master

The master cannot pause more than one data transfer to the slave. The next operation to the same addressee has to be the continuation of the paused data transfer.

If a slave cannot accept a master-initiated Pause it shall set the Not Successful bit in the Slave Status octet.

5.3.9 Multiplexed Transfer Mode Identification

The different ways of multiplexing transfers are defined in Attributes. The following table shows the various combinations:

Who Paused	Who Continued	Attribute Settings ID/Octet/Bit (Pause)	ID (Other)
M	M	6B/4/5	
S	M	6B/5/5, 6B/5/4	66, 67
S	S		6B/2/4, 6B/3/4

5.4 Data Groupings

The basic unit of recorded data is the eight bit octet. Octets are combined to form a Physical Block which is the recording unit on the media, or may be combined to form a Data Block which is the master-defined unit of preference. Data transfer between the slave or facility and the master may be in either Physical Blocks or Data Blocks.

5.4.1 Physical Blocks

The Physical Block size may be preset by the design of the device, determined by the slave, or by the master by means of the appropriate command (FORMAT for disks and OPERATING MODE or ATTRIBUTES for tapes). Once established, the Physical Block size becomes an attribute of the facility until changed by another command. If a Physical Block size has not been established by the master, the default value preset in manufacture shall be used by the facility.

Each Physical Block on disks and on tapes which support the Update function, shall be capable of being written (updated) by a write operation without requiring the master to access or read any adjacent Physical Blocks.

For magnetic disks, this is typically provided by separation of recorded fields. One Physical Block may be updated without reading and rewriting any other Physical Block contained in the physical space. If Physical Blocks are recorded in a field (e.g. sector) without intervening gaps, then an uncorrectable error in one Physical Block may cause a data integrity exposure to one of the other Physical Blocks.

For magnetic tapes, if the Update function is not supported, all data beyond the last write shall be considered invalid.

5.4.2 Data Blocks

The Data Block size may be pre-defined by the slave, or it may be set by the master via the appropriate command (FORMAT or ATTRIBUTES for disks and OPERATING MODE or ATTRIBUTES for tapes). If a Data Block size has not been established by the master,the default value shall be used for the facility.

For disks, a reset or loss of power from the slave or facility shall not cause the Data Block size to change. Once established, the Data Block size remains unchanged until a new FORMAT, ATTRIBUTES, or OPERATING MODE command is issued.

For tapes, a reset or loss of power from a slave or facility may cause the Data Block size to change. The Data Block size may need to be re-established by the master (see product specification).

5.4.3 Extents

An extent is a contiguous number of blocks beginning at a specified starting address. An extent may be as small as one block, or as large as the entire addressable area of a partition (or volume if absolute addresses are used).

Extents are primarily used in association with transfer and positioning commands, however, they are also used to describe master-definable partitions.

5.4.4 Partitions

These are addressable areas on a volume, and may be either slave-defined or master-defined.

For disks, each partition is a contiguous range of blocks which begin on a physical boundary (on disks this is typically a cylinder boundary).

For tapes, a partition is defined as a contiguous addressable area. On tapes which are not pre-formatted no extent range is normally possible, and data must be written from the beginning of a partition. If a tape uses pre-formatted addressable areas then a contiguous range of blocks defines a partition.

5.4.4.1 Slave-Defined Partitions

5.4.4.1.1 Data Partition

The slave defines for each facility the addressable data area known as the default data partition which is available to the master for data storage. There is only one default data partition per facility.

For tapes, the slave may define additional data partitions which define storage space in addition to the default data partition.

5.4.4.1.2 Maintenance Partitions

The facility may include space which is dedicated for functions other than user data storage. These may include areas for assignment to describe media defects; diagnostic read and write operations; support functions such as the storage of internal microcode routines; et al. The placement of non-user data storage areas and the algorithms for accessing them are implementation dependent and shall be described in the product specifications.

The slave-defined maintenance areas are available to the master via the OPERATING MODE command.

5.4.2.2 Master-Defined Partitions

5.4.4.2.1 Data Partitions

The master may choose to sub-divide the default data partition into smaller ones.

For disks, each partition other than the default data partition requires that a Partition ID be associated with any commands that address data (this may be implied by an Alias address).

For tapes, once a partition is addressed the slave or facility shall continue processing in that partition until a new partition is chosen by use of a Partition Parameter, or until a volume is demounted (if the partition is on the volume). Subsequent commands after a partition change need not supply a partition ID.

5.4.4.2.2 Maintenance Partitions

The master may have the need to define areas which are excluded from normal data accessing. Up to 8 maintenance partitions may be defined by the master. These are assigned by the slave out of the default data partition.

The master-defined maintenance areas are only accessible via the OPERATING MODE command.

5.4.5 Alternate Data Areas

The slave may map defective Physical Blocks to alternate blocks in order to create a defect free data area for the master. If a Physical Block has been assigned to an alternate data area, it shall be accessible during normal operations in a manner transparent to the master.

5.4.6 Physical Groups

It is possible to organize a disk with variable block sizes (as in IPI-2 Format 2) such that there is more than one Physical Block per identification field. The identification field must be read in order to access any of the Physical Blocks within the Physical Group.

5.5 Media Addressing Definitions

IPI disk transfer commands are multiple block transfers across physical boundaries. The addressee positions itself to the Data Address given in the command packet, locates the block, and begins execution of the command. All read and write transfer operations utilize physical (Physical Block) or logical (Data Block) addresses, unless overridden by the Absolute Addressing modifier in the Data Address parameter. The absolute method of addressing is available for master-specific use when there is a need for device unique addressing mode of operation.

IPI tape transfer commands may be multiple block transfers across physical boundaries. Both explicit positioning (using a Data Address) and implicit positioning are supported. If a Data Address is supplied in the transfer command and the addressee supports explicit positioning for transfer commands, the addressee positions itself to the Data Address in the command packet, and begins execution. Tapes which support implicit positioning will begin execution at the next recorded element following the last operation. The command modifier determines which recorded element is next since direction may be changed between any two commands.

For tapes which support both types of positioning, the presence of a Data Address field in the Command Extent parameter indicates that the master intends explicit positioning, otherwise implicit positioning is used.

5.5.1 Absolute Addressing

Absolute addressing uniquely identifies a location by specifying address values which are implementation dependent (as on disks), or by using Position commands to properly position the media (as on tapes). On tape, positioning would typically be accomplished by using the SPACE BLOCK/FILE MARK command to reach the desired position.

For disks, typical values include cylinder address, head address, and sector address. Cylinder addresses run from 0 to C-1, where C is the number of tracks per disk surface; each possible value represents a particular cylinder. Head addresses run from 0 to H-1, where H is the number of read/write heads on the drive; each possible value represents a particular head. Sector addresses run from 0 to S-1, where S is the number of sectors per track; each possible value represents a definite sector, and the sectors are numbered consecutively.

For tapes, values may include track number, relative block number etc. When used, track numbers are unique. Block numbers run from 0 to n and may be either Physical Block or Data Block values.

Absolute addresses are associated with the media, and references can occur across partition boundaries.

5.5.2 Physical Addressing

Physical addressing uniquely identifies a location by specifying address values which are implementation dependent.

On disks, Physical Blocks use the same format (typically cylinder, head, sector) as Absolute addressing, but the Physical Block address of a given sector may be different from that sector's absolute address. Factors leading to such differences include partitions, multiple Physical Blocks per sector, multiple Physical Blocks per identification field, defect mapping, and interleaving.

Physical Block addresses are associated with the partition, and references cannot occur across partition boundaries.

On tapes, Physical Blocks use the same format as Absolute addressing (Blocks and File Marks), except that positioning may be explicit with Data Address or implicit (no Data Address). Alternatively, the SPACE BLOCK/FILE MARK command is used to reach the desired position on the media.

5.5.3 Logical Addressing

For disks, logical addressing uses Data Block addresses to reference data in partitions, within which all Data Blocks are the same size. Data Blocks in each partition are addressable through a linear address space numbered from 0 to n-1, where n is communicated to the master via Attributes.

For tapes, logical addressing uses Data Block addresses to reference data in partitions. Data Block sizes may vary within a partiton, and are addressable through a linear address space. The Data Block address may be augmented by a track reference to speed positioning which is product specific.

Logical addressing permits the master to use Data Blocks which are a multiple or sub-multiple of Physical Blocks. It is the responsibility of the slave to manage the necessary blocking and unblocking of data, and the slave attributes shall identify whether or not it is capable of providing this function. There are many performance criteria that must be considered when Data Block and Physical Block sizes are different.

Logical Block addresses are associated with the partition, and references cannot occur across partition boundaries.

5.5.4 Media Defect Management Considerations

Media defect avoidance is managed in IPI slaves and facilities using several lists.

The facility manufacturer's defect list is specified by the device level interface. It is used to initialize the slave's Permanent defect list the first time a facility is formatted.

For each facility a slave must retain information which allows it to avoid defective media in real time. The representation and use of this Working set of defects is slave specific. The combined contents of the Working Permanent and Temporary defect lists reflect the condition of the slave's Working set of defects.

Entries in the Permanent defect list cannot be removed by any action of the master defined in the IPI command set. Temporary defect list entries are removed by a FORMAT command with the Initialize modifier set.

A Suspect Permanent and Suspect Temporary defect list are provided to contain the identity of defects between the time when they are identified to the slave via a WRITE DEFECT LIST command, and the actual substitution of replacement media during a FORMAT or REALLOCATE command. Defect list entries are moved from a Suspect list to the corresponding Working defect list at that time.

Defects identified in a Suspect list are still in the master's Data Block addressing space. If automatic reallocation is in effect, the Suspect defect lists are always empty.

Entries can also be added to the Working Temporary defect list by specifying their addresses in defect list parameters to FORMAT or REALLOCATE commands.

Any of the defect lists (Permanent, Temporary, Suspect Permanent and Suspect Temporary) can be read using the Read Defect List command. Only Suspect Permanent and Suspect Temporary defect lists can be created or appended using the Write Defect List command.

The following example is intended to illustrate the condition of the various defect menagement structures in a hypothetical slave which implements all of the available features after the following actions:

- FORMAT the drive for the first time since its manufacture.
- Issue a WRITE DEFECT LIST command with the Permanent modifier set, and a defect list identifying address 5 as defective.

- Execute another FORMAT command.
- Issue a REALLOCATE command identifying addresses 50 and 150 as defective.
- Issue a WRITE DEFECT LIST command with the Temporary modifier set, and a defect list identifying address 10.

MANUFACTURER'S ORIGINAL FACILITY DEFECT LIST:

Defect Address
120
130

SLAVE'S MASTER DEFECT MAP:

Original Address	Perm/ Temp	Working/ Suspect	New Address
5	Perm	Working	200
10	Temp	Suspect	
50	Temp	Working	201
120	Perm	Working	202
130	Perm	Working	203
150	Temp	Working	204

The above by no means describes a complete slave implementation of defect management procedures. The types of addresses indicated are intentionally vague to avoid any assumptions on reallocation technique. In an actual implementation addresses would be expected to be a mixture of Data Block and Absolute addresses.

5.6 Interface Addressing Definitions

5.6.1 Actual Addresses

At the Physical Interface, a facility has an address which is unique, and is used by the slave to accomplish selection. The IPI Physical Interface Facility Selection restricts addressing to 16 facilities. The IPI Device Generic Logical Interface permits addressing of up to 255 facilities.

5.6.2 Selection Addressed

The Level 1 interface defines a selection mechanism which allows selection of a slave or facility. Any one of up to eight slaves on a master, or (optionally) any one of up to 16 facilities on any of the eight slaves may be physically selected. The address used in this method is called the Selection Address. It contains at least a Slave Address, and may or may not contain the address of a facility (which may or may not be a synonym).

5.6.3 Command Addresses

Device Generic commands contain a Slave Address and a Facility Address as part of the basic command packet. The Slave Address in the command packet is compared to the value contained in the Selection Address. It has a valid range of zero through seven, and if not the same, the command is rejected.

If the Level 1 interface utilized slave selection; i.e., there is no facility component in the Selection address, the Facility Address is not compared to the Selection Address. Therefore, the Facility Address can range from zero through 255 (x'FF'). The value of 255 denotes that the command is addressed to the slave, and not a facility.

If the Level 1 interface utilized facility selection, then the Facility Address in the Device Generic command is compared to the address of the facility contained in the Selection Address. In this case, the Facility Address is limited to the range of zero through fifteen. If not the same as the Actual Address or a Synonym, the command is rejected.

5.6.4 Facility Address

The Facility Address is that address contained in the command packet. It may be an Actual Address, a Selection Address, a Synonym, or an Alias address.

5.6.5 Synonym Addresses (Optional)

Without the introduction of Synonyms, a Facility Address of 00-0F would specify a particular physical facility. There are cases when a master would like to utilize a Facility Address to actually reference a different physical facility than would be addressed if the Facility Address in the command were used directly; e.g., if one facility is not operational, it may be advantagous to utilize a different facility in the place of the malfunctioning facility in a way that is transparent to the master's normal operation, thus not impacting operating systems software.

Another situation occurs when the Operating System has pre-defined the characteristics of a device based on its address; e.g., three disks and a tape may have Actual addresses 0, 1, 2 and 3 assigned at the Physical Interface. However, if the host computer's Operating System assigns disk addresses as 0-7 and tape addresses as 8-F, a Synonym address is used to reference the tape by Facility Address 8.

Synonyms can also be used to provide pseudo device-queueing in the Operating System. Many existing Operating Systems do not dispatch more than one I/O request to a device. This is inefficient when the slave to which the devices are attached is capable of optimizing multiple requests to the same device. More than one Synonym address may be assigned to each Actual Address, to overcome the software limitation.

After a Synonym has been set up as equivalent to the Actual address, all Facility Address references thereafter in the command packets may refer to the Synonym as well as the Actual address. The exception to this occurs if an original Actual Address is re-assigned as a Synonym.

Synonym addresses are limited to the range of 00-0F if they are to affect the Physical Interface selection. Synonym addresses may be used in the range 00-FE for Logical Interface addressing.

Synonym addressing is optional, and the Attributes of the slave shall indicate whether or not it is supported. Synonym addressing may be supported by the slave at the Physical Interface (00-0F Selection) only, Logical Interface (00-FE) only, or both. If Synonym addressing is not supported, any attempt to invoke this function shall cause a Command Exception condition.

Support of Synonyms is an option. If supported, a Synonym is used to map a Facility Address to an Actual address. Whether synonyms are supported or not, the initial mapping of Facility Addresses are to Actual addresses in which the same value corresponds to an existing physical facility. Facility Addresses which do not correspond to physical facilities and have not been redefined are invalid.

Synonym addresses are unique from Alias addresses; i.e., the Facility Address can be either a Synonym or an Alias, but not both.

5.6.6 Alias Addresses (Optional)

The use of an Alias allows the Facility Address of a command to be mapped to a data partition within a facility - Aliases cannot be used to address maintenance partitions. If the Facility Address of a command is the address which corresponds to an Alias assignment, that command can not have a partition parameter as a part of the command; i.e., a command may not have two partition parameters, whether explicit or implied. (Exception: Combination Commands may reference multiple facilities, and thus one partition parameter per referenced facility is allowed.)

Partitions permit the master to define more than one addressable data area per physical volume. Reference to these partitions may be made by prefixing every Extent parameter with a Partition parameter, or by assigning an Alias address. The ATTRIBUTES command may be used to assign Alias addresses to each partition. Alias addresses may be assigned in the range of 00-FE.

After Alias addresses have been set up as equivalents to the Partition of a facility (which may be referred to by either an Actual or a Synonym address), all Facility Address references thereafter in the command packets refer to the Partition of that facility. Alias addresses in the range of 00-0F do not affect Physical Interface selection.

Alias addressing is optional, and the Attributes of the slave shall indicate whether or not it is supported. If Alias addressing is not supported, any attempt to invoke this function shall cause a Command Exception condition.

An Alias address maps into a Facility Address and a data partition. The Facility Address that was obtained as a result of an Alias must then be mapped into a physical facility, thus it could be subjected to an existing Synonym or map directly to a physical facility. It cannot go through another Alias definition, as that would result in two implicit partition parameters.

Alias addresses are unique from Synonym addresses; i.e., the Facility Address can be either a Synonym or an Alias, but not both.

5.6.7 Partition Parameters

A partition parameter can be used with a command that references a facility.

For disks, if no partition parameter is supplied, then the default data partition on the facility is assumed (unless the partition parameter is implicit by an Alias).

For tapes, if no partition parameter is supplied the current partition is used.

Partition parameters on the OPERATING MODE command are required for the master to gain access to maintenance partitions.

Partitions are assigned identification numbers. Partition zero is the default data partition. Fifteen partitions (01-0F) are reserved for identifying maintenance partitions. Partitions 10-FE are used for partitioning of the default data partition. Partition identification FF is reserved.

Partition identification numbers are facility specific. The same partition number on different facilities may not necessarily reference the same portion of each facility.

5.6.9 Address Examples

To keep track of the relationship between Synonyms, Aliases and Actual addresses, the slave needs to maintain a table of equivalents. The following table is intended to illustrate how the relationships can be maintained.

Facility Address	Actual or Synonym	Partition ID	
00	00	FF	Actual Address
01	01	FF	Actual Address
02	02	FF	Actual Address
03	03	FF	Actual Address
04	FF	FF	Not attached
05	FF	FF	Not attached
06	FF	FF	Not attached
07	FF	FF	Not attached
08	03	FF	Physical Synonym
09	FF	FF	Not attached
0A	FF	FF	Not attached
0B	FF	FF	Not attached
0C	00	FF	Physical Synonym
0D	01	FF	Physical Synonym
0E	01	FF	Physical Synonym
0F	FF	FF	Not attached
10	00	22	Alias
11	02	25	Alias
12	01	42	Alias
13	08	17	Alias (to a Synonym)
14	01	1A	Alias
15	1B	23	Alias (to a Synonym)
16	FF	FF	Not assigned
17	FF	FF	Not assigned
18	FF	FF	Not assigned
19	02	FF	Logical Synonym
1A	01	FF	Logical Synonym
1B	03	FF	Logical Synonym
1C	00	FF	Logical Synonym
1D	FF	FF	Not assigned
1E	FF	FF	Not assigned
1F	FF	FF	Not assigned

The FF in the second column is used to identify that the facility is not attached (if physical), or not assigned (if logical), and in the third column it identifies that it is not a partition ID reference.

5.7 Slave and Facility Conditions

The manner in which a slave or facility responds to a command is determined by its condition. The condition of a facility is significant only when the slave is in the P-Available condition.

The condition of a slave or facility is affected by its intrinsic as well as its operational characteristics; e.g., a slave capable of command queueing may be L-Available when it is active, whereas a slave which can handle only one command at a time would be Not L-Available when active.

The following figure illustrates the hierarchy of slave conditions.

```
                                  |                    Applies to:
       +--------------------------+
       |                          |
Not P-Available              P-Available                 Port
---------------              -----+-----
                                  |
       +--------------------------+
       |                          |
Not Operational              Operational                 Slave
---------------              -----+-----
                                  |
       +--------------------------+
       |                          |
    P-Busy                    Not P-Busy                 Port
    ------                   -----+----
                                  |
       +--------------------------+
       |                          |
Not L-Available              L-Available                 Port
---------------              -----+-----
                                  |
       +--------------------------+
       |                          |
    L-Busy                    Not L-Busy                 Port
    ------                   -----+----
                                  |
                                  V
```

5.7.1 Interface Conditions

To assist the reading of the following, the terms "accept" and "execute" noted in quotations to emphasize their meaning. All conditions are port relevant except Operational which is applicable to the slave.

5.7.1.1 P-Available

The slave is installed and capable of responding to the Physical Interface. This condition implies that the device is properly cabled and the device is powered on. The P-Available condition is detected at the Physical Interface by responding to the Request Interrupts Sequence with Power On (Bit 3) asserted.

5.7.1.2 Not P-Available

The slave is not installed, is disabled, or is otherwise incapable of responding to the Physical Interface.

5.7.1.3 Operational

This condition qualifies P-Available. The Operational condition indicates that the slave is capable of processing Bus Exchanges and is detected at the Physical Interface if the slave is able to respond to the selection sequence by asserting SLAVE IN, or if the slave asserts Ready (Bit 5) in response to the Request Interrupts Sequence.

5.7.1.4 Not Operational

This condition qualifies P-Available. The slave is unable to respond to a selection sequence. The Not Operational condition is detected at the Physical Interface if the slave does not set Ready (Bit 5) in response to the Request Interrupts Sequence.

NOTE: The slave is capable of providing a response to a command packet directed to a facility which is Not Operational. A non-operational condition at the slave will be detected at the Physical Interface (e.g. lack of response to a selection attempt by the master).

5.7.1.5 P-Busy

This condition qualifies Operational and implies that the slave is capable of processing Bus Exchanges but not on this port because it is currently selected or reserved to another port. The P-Busy condition is detected at the Physical Interface if the slave is able to respond to the selection sequence by asserting SLAVE IN, but does not return its bit significant address, or if the slave asserts Busy (Bit 6) in response to the Request Interrupts Sequence.

5.7.1.6 Not P-Busy

This condition qualifies Operational and indicates that the slave can process Bus Exchanges at this port. Operational is detected if the slave responds to the selection sequence by asserting SLAVE IN and returning its bit significant address, or if the slave does not assert Busy (Bit 6) in response to the Request Interrupts Sequence.

5.7.1.7 L-Available

This condition indicates that the slave can "accept" a command from the master.

5.7.1.8 Not L-Available

This condition indicates that the slave can "execute" a Bus Exchange from the master but cannot "accept" a command.

5.7.1.9 L-Busy

This condition indicates that the slave can respond to Bus Exchanges but is not capable of "executing" a command from the master.

5.7.1.10 Not L-Busy

This condition indicates that the slave can "execute" a command from the master.

5.7.2 General Conditions

5.7.2.1 Active

The addressee has accepted a command and/or has outstanding status.

5.7.2.2 Inactive

The addressee has no commands or status outstanding.

5.7.2.3 Status Pending

The addressee has status (either asynchronous or in response to a command), to send to the master.

5.7.2.4 Reset

The addressee is in an initial condition where it has no cognizance of past events. This condition can come about as a result of an external reset by the master, an internal initialization procedure (e.g. following a power-on sequence) or an unsuccessful internal recovery attempt from a severe error.

5.7.3 Operating Status

Slaves provide predictable status on their ability to process commands, especially during a power-on, either at system start or into an operating environment after maintenance.

A slave which is Not Operational is incapable of processing Bus Exchanges but may be able to communicate what is causing this condition. At the Physical Interface the Request Interrupts octet can be used to obtain Ready status, but Ready has a double meaning.

Within IPI-2, Ready has the connotation that the device is both operational on the interface and ready for data; e.g., if it is a removable media device, the media is mounted. When an IPI-2 slave reports Ready status to a Request Interrupts it is able to process Bus Exchanges (Operational) and can process Data Controls.

Within IPI-3, the conditions Operational and Ready are separated because the slave has no concept of Ready, which is a facility concept. When an IPI-3 slave reports Ready status to a Request Interrupts it is able to process Bus Exchanges (Operational).

There are three Request Interrupts bits which the master can use to build a matrix of information about the attached slaves. Three polls are needed to build the matrix of Power On, Ready and Busy; and the combinations represent the following:

Power	Ready	Busy	Slave Condition
0	x	x	Nothing happening at the slave (Not P-Available)
1	0	1	The slave cannot respond to other than Request Interrupts eg. it is Busy running diagnostics (Not Operational)
1	0	0	The slave can respond to Request Transfer Settings and Request Slave/Facility Interrupts (Not Operational)
1	1	0	The slave is able to process Bus Exchanges (Operational)
1	1	1	The slave can process Bus Exchanges, but is currently Busy and unable to do so on this Port (P-Busy

5.8 Multiple Ports (Optional)

Multiple porting includes both manual and programmed static switching (a single slave or a slave and all of its facilities) and dynamic switching (controlled by the master) between two or more IPI ports.

Two or more IPI physical ports at the slave and/or two or more ports at a facility, Enable/Disable controls and the IPI logical constructs for assigning facilities to a physical port are the minimum configuration for multiple port implementations.

It is assumed that two or more slave ports will be connected to different masters and two or more facility ports will be connected to different slaves, but there is nothing that prevents connection of more than one port to the same master or same slave.

When part of all of the resources of a slave or facility become dedicated to performing tasks for a port, there is an allegiance established between the slave or facility and the port. Unless otherwise stated, a slave or facility can have allegiance to only one port at a time. It is also assumed that data transfers and Response Packets always pass through the port which received the corresponding Command Packet.

5.8.1 Slave Switching

There are many different ways of employing a port switch within a slave; however, as viewed by the master, the slave switches all appear to be either physical or logical.

The following capabilities are represented in the figures:

- the State Machine represents handling all non-selected states.
- the Bus Exchange Logic represents the Bus Control/Ending Status sequence which may or may not include an Information Transfer.
- the Logical Protocol Execution Logic represents decoding and executing command packets and formulating response packets as well as controlling the facilities if they are logically distinct from the slave.
- the Limited Logical Protocol Execution Logic represents decoding and executing command packets and formulating response packets for at least the Priority Reserve command while the slave is implicitly or explicitly reserved to the other port.
- the Full Logical Protocol Execution Logic represents decoding and executing command packets and formulating response packets as well as controlling the facilities if they are logical distinct from the slave.

5.8.1.1 Physical Switch

The Physical switch appears at the Physical Interface. As long as the slave is P-Available it can execute non-selected bus states. When the slave is Not P-Busy, selected bus states can also be executed. When the slave is P-Busy, the master receives a Busy in the Selection sequence.

```
                |                                  |
          +----------+                       +----------+
          |  STATE   |                       |  STATE   |
          | MACHINE  |                       | MACHINE  |
          +----------+                       +----------+
                |                                  |
                +--------o<-----+          o-------+
                                |
                         +-----------+
                         |    BUS    |
                         |  EXCHANGE |
                         |   LOGIC   |
                         +-----------+
                                |
                         +-----------+
                         |  LOGICAL  |
                         |  PROTOCOL |
                         | EXECUTION |
                         |   LOGIC   |
                         +-----------+
                                |
                        +--------------+
                        |  FACILITIES  |
                        |   (IF ANY)   |
                        +--------------+
```

5.8.1.2 Logical Switch

The Logical switch appears at command decode and execution. When a slave is equipped with this switch, the master can select and transfer commands (provided that the slave has room for the packet), responses (if pending) and data (if the slave is ready for a data transfer).

The Logical Busy (L-Busy) state of the slave may never be sensed by the master since the only effect of the L-Busy state is that command packet execution does not proceed for that port. If the master does become aware of the Busy condition, it is through the command buffer(s) becoming full and command packets being rejected with an appropriate setting in the encoded status field of the Slave Status Octet.

```
              |                             |
         +----------+                  +----------+
         |  STATE   |                  |  STATE   |
         | MACHINE  |                  | MACHINE  |
         +----------+                  +----------+
              |                             |
        +------------+                +------------+
        |    BUS     |                |    BUS     |
        |  EXCHANGE  |                |  EXCHANGE  |
        |   LOGIC    |                |   LOGIC    |
        +------------+                +------------+
              |                             |
        +------------+                +------------+
        |  LIMITED   |                |  LIMITED   |
        |  LOGICAL   |                |  LOGICAL   |
        |  PROTOCOL  |                |  PROTOCOL  |
        | EXECUTION  |                | EXECUTION  |
        |   LOGIC    |                |   LOGIC    |
        +------------+                +------------+
              |                             |
              +-------o<----+     o-------+
                            |
                     +------------+
                     |    FULL    |
                     |  LOGICAL   |
                     |  PROTOCOL  |
                     | EXECUTION  |
                     |   LOGIC    |
                     +------------+
                            |
                    +--------------+
                    |  FACILITIES  |
                    |   (IF ANY)   |
                    +--------------+
```

5.8.1.3 Mixed Switch Types

The operation of slaves which employ both Physical and Logical switches is not covered in this document. Mixing the two types of switches at the slave is implementation dependent, and their interaction is not defined.

5.8.2 Facility Switching

There are many ways to implement a facility port switch, but as viewed by the master, there are only two types of facility switches. The first resides within the slave where the slave establishes an allegiance between a facility and a particular slave port. The second switch point resides at a logically, and possibly physically, separate facility which can be switched between two or more slaves.

The slave may report the state of the facility switches to the master in several different ways:

- through the slave's own port switch reporting mechanism; i.e., Physical switch (P-Busy) or Logical switch (Intervention Required Substatus in a Response packet).
- the slave can use the Slave Status Octet in the Bus Exchange.
- the slave can totally mask the facility switch from the master by managing all of the facility switches itself.

In some configurations there may be both a facility switch at the slave and a facility switch at the facility. For most facility operations, the master cannot distinguish between the two types of facility switching but for exceptions such as disabling a facility port and performing resets.

5.8.3 Slave Static Switching

Static switching means that a slave and all of its facilities are made P-Available/Not P-Available at an IPI physical port. This is accomplished by manual controls or the PATH CONTROL command. The Enable/Disable controls alter the connection appearance by making it P-Available on only those ports which are enabled. Static switching is implemented at the Physical Interface.

If a manual port control switch is defined for a port, the port control switch has two positions: Enable and Disable. Any port control switch may independently be set to Enable or Disable; thus any number of ports (including all ports) may be set to Enable or Disable at the same time.

The external form of the port control switch is not specified; e.g., it may be a manually operated switch, or an operator accessible control panel, or a console function. The only requirement is that an operator be able to alter the setting of the port control for a port.

While a slave port is disabled, no signals are received by the slave from that port.

Programmed control of the ports is accomplished by the PATH CONTROL command which provides the capability to Enable and Disable any or all of the ports.

5.8.3.1 Disabling A Slave Port

The manual or orderly command disabling of a slave port takes effect under several circumstances; e.g.:

- the Physical Interface on that port is in the IDLE state,
- the slave port control is set to Disable,
- there are no current or pending commands or responses for any selection address of the port,
- there are no responses pending for the port,
- there are no unterminated Chains, Sequences or Orders for the port and no facilities assigned to the port are active.

A slave port is disabled in an orderly manner either manually or by PATH CONTROL. The slave shall continue to accept requests for the port until all other conditions required for the disabling of the port are satisfied. The acceptance of these requests shall prevent the disabling of the port until the requests are completed. To ensure that the disabling of the port is not delayed indefinitely, the master must stop sending requests and deselect the slave on the port which has its port control switch set to disable.

A slave port can only be disabled in a destructive manner by the PATH CONTROL command. It causes all current or pending commands for the slave port and all non-asynchronous responses to be lost.

5.8.3.2 Enabling A Slave Port

The enabling of a slave port takes effect when its port control is set to Enable and the Physical Interface on that port is in the IDLE state. Any Asynchronous packets to be communicated through a slave port which is disabled shall remain pending until the port becomes enabled or cleared by an appropriate reset. The event of a slave port becoming enabled shall cause an Asynchronous packet to be generated.

Enabling a port shall allow pending Asynchronous packet(s), if any, to be presented to a master. Only the last occurrence of an Asynchronous packet per interrupt class is retained for each addressee unless cleared by an appropriate reset.

5.8.4 Facility Static Switching

Static switching means that a facility is made P-Available/Not P-Available at a slave IPI physical port (either for an individual slave port or for the slave in general) or at the interface between the slave and facility, if present. This is accomplished by manual controls or the PATH CONTROL command.

The Enable/Disable controls alter the connection appearance by making the facility P-Available on only those slave and/or facility ports which are enabled. These controls may operate at the slave or at the facility.

If the manual port control switch is defined for any port, the port control switch has two positions: Enable and Disable. Any port control switch may independently be set to Enable or Disable; thus any number of ports may be set to Enable or Disable at the same time.

The external form of the port control switch is not specified, e.g., it may be a manually operated switch, or an operator accessible control panel, or a console function. The only requirement is that an operator be able to alter the setting of the port control for a port.

While a facility port is disabled, its Not P-Available condition is signaled in either the Slave Status Octet or the Response Packet depending on the slave's logical implementation.

Programmed control of the ports is accomplished by the PATH CONTROL command which provides the capability to Enable and Disable any or all of the ports at both the slave and the logically separate facilities.

5.8.4.1 Disabling a Facility

5.8.4.1.1 Disabling a Facility at a Slave Port

The manual or orderly command disabling of a facility at the slave takes effect when the facility port control for the slave or an individual slave port is set to Disable, the Physical Interface of the slave is not selected on behalf of the facility (Facility Selection), there are no non-stacked, individual or queued commands for the facility on the port which is being Disabled, there are no responses for the facility pending for the port which is being Disabled, and the facility is not active.

When a facility port control at the slave is set to orderly Disable, the slave shall continue to accept requests from the port until all other conditions required for the disabling of the facility for that port are satisfied. The acceptance of these requests shall prevent the disabling of the port until the requests are completed. To ensure that the disabling of the facility is not delayed indefinitely, the master must stop sending requests and deselect the slave on behalf of the facility for the port whose port control switch was set to disable.

5.8.4.1.2 Disabling a Facility at a Facility Port

When the facility's port control is separated from the slave, the facility port disable is determined by the slave/facility logical interface. The slave may or may not be able to continue operation until all pending commands and responses have been processed. If the slave cannot continue, the slave may terminate all commands with an appropriate Response Packet until the orderly termination takes effect. If the slave can continue, the disable takes effect at the same time as if the slave had control of the facility switch.

The destructive disabling of a facility port at the slave or facility, performed only with a PATH CONTROL command, causes all command(s) and non-asynchronous responses for the slave and/or facility port to be lost.

5.8.4.2 Enabling a Facility

5.8.4.2.1 Enabling a Facility at a Slave Port

The enabling of a facility port switch at the slave takes effect when its port control is set to Enable and the Physical Interface is not selected on behalf of the facility. Any Asynchronous packets generated at the slave for a facility which is disabled shall remain pending until the port becomes enabled or are cleared by an appropriate reset. Enabling a facility shall allow pending Asynchronous packet(s), if any, to be presented to a master. Only the last occurrence of an Asynchronous packet per interrupt class shall be retained for each addressee unless cleared by an appropriate reset.

5.8.4.2.2 Enabling a Facility at a Facility Port

The enabling of a facility port switch at a logically separate facility takes effect when the slave/facility interface protocol permits it. The event of a facility port becoming disabled or enabled shall cause the slave to generate an Asynchronous packet for all slave ports at which the facility is enabled.

5.8.5 Slave Dynamic Switching

A slave's dynamic switch can be implemented using either physical or logical switches. In all of these cases, the slave can appear in one of two accessibility modes: Switched or Neutral. Following an internal reset, the slave enters the neutral state.

Interrupts for a port are only presented when the slave is capable of transferring the Response packet associated with the interrupt; however, logical switching does not require the slave to be in the neutral state to transfer response packets.

5.8.5.1 Neutral Mode

In the Neutral Mode the slave has no allegiance to any port. This means that the slave may perform tasks for any port which is enabled.

5.8.5.2 Switched Mode

When a slave enters the Switched Mode, part of the resources of the slave become dedicated to performing operations on behalf of a single port. The slave thus has an allegiance with that port. With the Physical switch, this allegiance is indicated by the other port(s) receiving a P-Busy indication during the selection sequence.

There is not necessarily any indication of what the master can detect with the Logical switch. The master may not be able to determine the cause of the L-Busy condition or a Bus Exchange may be completed which provides Alternate Port Exception Status.

Whenever an attempt to access a slave is rejected because it is switched to another port (whether P-Busy or L-Busy), the slave shall construct an Asynchronous packet for transmission over the requesting port when the condition which caused the access to be rejected no longer exists. While this Asynchronous packet is pending, if a queued slave accepts a command packet at the port or the slave executes an appropriate internal reset, it shall cancel the pending Asynchronous packet. The generation of the Asynchronous packet, but not the associated interrupt, may be suppressed by Attributes.

5.8.5.3 Implicitly Switched

The slave's port switch becomes implicitly switched whenever the slave starts performing operations on behalf of one port to the exclusion of the other port(s). For the Physical switch, this means that one port has accepted a selection to the exclusion of the other port(s). In the Logical switch, this means that command packets are being processed for one port to the exclusion of the other port(s). The allegiance to the port remains as long as the operations continue on behalf of the port. The allegiance ceases when the operation or series of operations on behalf of the port are completed and the slave is either neutral or performing operations for another port.

Another use of the implicit allegiance is the ability of a slave to maintain an allegiance to a port which has a not Busy interrupt pending. In this case, the slave does not return to neutral when the deselection occurs but establishes and maintains an explicit allegiance to the interrupting port for the length of time specified in Attributes.

5.8.5.4 Explicitly Switched

Explicit allegiance of a slave with a Physical switch is controlled solely by Priority Select/Priority Hold mechanisms at the Physical Interface. See the IPI Physical Interface specification 64732100 for details.

Explicit allegiance of the slave's Command Execution port switch is established by the PORT ADDRESS command with the Reserve modifier set. The slave establishes an allegiance to the IPI port over which the command packet was received when the command is executed and the port switch is either neutral or switched to the port over which the packet was received. This is not necessarily immediate in an individual stacked or queued environment.

The allegiance ends when the slave has executed the PORT ADDRESS command with the Release modifier set and the Response Packet is transferred to the master or in a Logical switch is stored in a buffer which can be read by the master regardless of the state of the port switch. The allegiance will also end when the slave returns to the neutral mode for reasons other than a PORT ADDRESS command; e.g., reset.

5.8.6 Facility Dynamic Switch

When the dynamic switch is present in a facility or in a slave on behalf of a facility, it may also appear in either the switched or neutral mode.

Facilities may also be shared between two or more slaves, with different slaves connected to ports of the same facility.

5.8.6.1 Facility Neutral Mode

The slave may communicate on behalf of the facility over any IPI slave port that is enabled.

When an Asynchronous packet (other than one associated with Dynamic Switching) is issued on behalf of a Neutral facility, the packet shall be transmitted over all slave ports that are enabled. The facility condition shall remain as Status Pending until the packet has been transmitted over all ports for which transmission is due.

5.8.6.1.1 Facility Neutral Mode at the Slave Port

Following a slave reset, the facilities affected by the reset become available to all slave ports. The communication over each slave port is subject to the same rules as defined for a single port.

5.8.6.1.2 Facility Neutral Mode at the Facility Port

Following a reset of the facility, it shall enter the neutral mode and become available to all slaves attached to the facility. The communication over each facility port is subject to the same rules as defined for a single port.

5.8.6.2 Facility Switched Mode

When an attempt to access a facility is rejected because the facility is in the Switched mode, the slave shall construct a Command Completion response. An Asynchronous packet shall be transmitted over the requesting port when the condition which caused the access to be rejected no longer exists except if it was caused by a reset. While this Asynchronous packet is pending, a queued slave's acceptance of a command packet for the facility shall cancel the pending Asynchronous packet at the port.

While in the switched mode, parts of the facility become dedicated to the slave which caused the switched mode to be entered. The facility may have an implicit or explicit allegiance to any slave whose port is Enabled.

5.8.6.2.1 Facility Switched Mode at a Slave Port

In the switched mode, the facility is associated with a particular IPI port of the slave.

Because of the various types of port switches at the slave, the slave may or may not be able to respond to Bus Exchanges, Information Transfers or combinations of these on behalf of the addressed facility.

5.8.6.2.2 Facility Switched Mode at a Facility Port

In the switched mode, the facility is associated with a particular port of a facility which is logically separated from the slave.

5.8.6.3 Implicitly Switched Facilities

A facility becomes switched to a slave implicitly when the slave initiates execution of a command addressed to the facility.

If the command packet which established the implicit allegiance specified a chain to another command packet, then the implicit allegiance ends when the last command in the chain of commands for that facility has been completed as described previously.

5.8.6.3.1 Implicitly Switched Facilities at Slave Port

If the command packet that established the implicit allegiance did not specify a chain to another command, the implicit allegiance ends when the Response Packet is prepared to be transferred to the master.

The implicit allegiance may end sooner if the slave and/or facility is returned to the Neutral mode for some other reason; e.g., reset.

Under the circumstances described above, a facility may be Status Pending as viewed from one port of a slave and L-Available as viewed from another.

An Asynchronous packet on behalf of a facility pending at a slave port does not establish an allegiance between the slave port and the facility.

5.8.6.3.2 Implicitly Switched Facility at a Facility Port

If the command packet that established the implicit allegiance did not specify a chain to another command, the implicit allegiance at a logically distinct facility ends when the operation corresponding to the command packet that established the allegiance is completed by the facility, the information necessary to construct the response packet has been made available to the slave and the slave permits the facility to return to Neutral.

The implicit allegiance may end sooner if the facility is returned to the Neutral mode for some other reason; e.g., reset.

Implicit allegiance between the facility and the slave is controlled by the protocols of the slave/facility interface.

5.8.6.4 Explicitly Switched Facilities

Explicit allegiance is established when a PORT ADDRESS command with the Reserve modifier set is executed by the slave to which the facility is attached. The explicit allegiance ends when a PORT ADDRESS command with the Release modifier set is issued by the master and is executed by the slave to which the facility is attached. The master/slave/facility allegiance will continue, however, since the PORT ADDRESS command will establish an implicit allegiance. The allegiance will end as outlined in the implicit allegiance section.

5.8.6.4.1 Explicitly Switched Facilities at a Slave Port

An allegiance is established between the facility and the slave port over which the command packet was transmitted.

5.8.6.4.2 Explicitly Switched Facility at a Facility Port

An allegiance is established between the slave and the facility port over which the slave communicates with the facility when the command is executed.

5.8.7 Multiple Allegiances/Explicit Group Allegiance

Some applications require the concept of a single master/single slave or single master/single slave/single facility relationship being established with implicit and explicit allegiance for all Information Transfers to be expanded for reasons of performance and/or resiliency.

The master/slave or master/slave/facility allegiance is expanded to include the explicit allegiance of a slave or slave/facility to a single master connected to multiple ports of a slave, a single master connected to multiple ports of a facility through two or more slaves, or either of the two previous cases with two or more masters operating in a coherent manner.

The explicit allegiance is established and relinquished with the PORT ADDRESS command just as in the single reserve operations with the exception that a PORT MASK PARAMETER is used to identify the group of port(s) over which further Command Packets will be accepted. In this case, the Data Information Transfers and the Command Completion Response Packets always are returned over the port which received the corresponding Command Packet.

5.8.8 Alternate Port Notification of Changes

Any time that a FORMAT command is completed (successfully or otherwise), an Asynchronous packet shall be sent to all the alternate ports that are enabled, except the one over which the command was received. The Asynchronous packet shall report Format Completed status to advise the attached master(s) that re-initialization procedures may be necessary for continued use of the facility.

Similarly, any time that an ATTRIBUTES command (with Load or Save modifier) is successfully completed, and the Attributes affect anything other than those specific to a single port, an Asynchronous packet shall be sent to all the alternate ports that are enabled, except the one over which the command was received. The Asynchronous packet shall report Attribute Update Completed status to advise the attached master(s) that re-initialization procedures may be necessary for continued use of the port.

5.9 Reset

5.9.1 External Reset

Any external reset in the form of a Master Reset or Selective Reset, received over the Physical Interface, can be presented by the master at any time regardless of the condition of the slave or facilities. It shall not affect facilities that are Switched to another port. The reset shall cause the facilities Switched to the master asserting the reset, to return to Neutral in addition to establishing the reset condition at the facilities.

The Selective Reset octet provides for resetting the Physical Interface, the Logical Interface, or the slave (as at Power On).

Following the reset condition, it is anticipated that the slave and the affected facilities will become Operational.

5.9.2 Internal Reset

When a slave internal reset occurs, an Asynchronous packet is generated indicating the condition of the slave. The status of each facility that is affected by the reset should be broadcast over all ports that are Enabled.

Facility resets associated with an internal reset are handled in a slave dependent manner. It is the slave's responsibility to properly manage the facilities in light of the alternate facility ports, if they exist.

5.10 Bus Octets

The Bus Octets defined in the Physical Interface are used as defined, with the additions described here.

5.10.1 Facility Selection and Request Facility Interrupts Octets

The Facility Selection and Request Facility Interrupt octets are optional. When the facility interrupts are supported by the slave, they provide a means for the master to determine the facility which is interrupting and the class of interrupt. The facility selection provides a means for the master to direct Information Transfers to a specific facility.

5.10.2 Bus Control Octet

The Bus Control octet of the Physical Interface permits Bits 0-5 to be defined according to the Logical Interface level.

Bit 5 - Reserved, set to zero.

Bit 4 - Control of Bus: When Bit 4=0 the master shall control the Bus Exchange, with the Bus Control octet defining the subsequent Information Transfer. When Bit 4=1 the slave is allowed to control the Bus Exchange. If the slave accepts Control of Bus the Bus Acknowledge octet shall define the subsequent Information Transfer (the slave's setting shall override that of the master's).

Bits 3-0 shall be set to zero.

5.10.3 Bus Acknowledge Octet

The Bus Acknowledge octet is optional. When it is supported by the slave, it provides a means for the master to turn control of the bus over to the slave, for determining whether to perform a Response or a data transfer.

Bit 5 - Reserved, set to zero.

Bit 4 - Control of Bus Accepted: When Bit 4=1 the slave shall define the subsequent Information Transfer by setting the appropriate bits in the Bus Acknowledge octet (which shall overrride any setting by the master).

Bits 3→0 shall be set to zero.

NOTE: When Bit 4 of the Bus Control octet is set to 0 (master control of Bus Exchange), the slave shall ensure that Bits 0-7 of the Bus Acknowledge octet are set to zero with correct parity.

5.10.4 Master Status Octet

Bits 5→0 of the Master Status octet are defined as optional in the Physical Interface, and their uses are defined in the slave's Attributes.

5.10.4.1 Bit Definitions

Bit 5 - Pause: When Bit 5=1 the master is informing the slave that there is more information to transfer to complete the just-ended Information Transfer.

Bit 4 - Slave-Slave Operation Completed: When Bit 4=1 the dominant slave is noting that the slave-to-slave Information Transfers have completed. See the IPI Physical Interface specification 64732100.

Bits 3→0 - Encoded Status: When Bits 3→0 of the Master Status octet are defined by Attributes as being Encoded Ending Status, the definitions below apply. The use of some of these values is applicable only when the following optional capabilities of the Physical Interface are supported:

Control of Bus	1011→1101
Double Octet Mode	1111

0000 No Encoded Status

0001→1010 Reserved

1011 Illegal Response Code - the master did not recognize the previously transmitted response packet.

1100 Information Transfer Type Error - the transfer type identified in the Bus Acknowledge octet was incorrect.

1101 Information Transfer Direction Error - the transfer direction identified in the Bus Acknowledge octet was incorrect.

1110 Reserved

1111 Odd Octet Transfer - the last transfer of a double octet contained only one octet of information (on BUS A).

5.10.4.2 Valid Combinations

The following illustrates the valid combinations of the Master Status octet:

```
+---------------+------------------------------------------
| 7   6   5   4 | 3-0
+---+---+---+---+------------------------------------------
| 0 | 0 | * | * | 1011, 1100, 1101
| 0 | 1 | * | * | 0000, 1011
| 1 | 0 | * | * | 0000, 1111
+---+---+---+---+------------------------------------------
  |   |   |   |   |
  |   |   |   |   +- Valid Master Status Encodings
  |   |   |   |
  |   |   |   +- Slave-Slave Operation Completed
  |   |   +- Pause
  |   +- Bus Parity Error
  +- Successful Information Transfer
```

* indicates the bit setting may be either 0 or 1.

5.10.5 Slave Status Octet

5.10.5.1 Bit Definitions

Bit 5 - Pause: When Bit 5=1 the slave is informing the master that there is more information to transfer to complete the just-ended Information Transfer.

Bit 4 - Time Dependent Operation: When Bit 4=1 the slave is informing the master that the Operation requested in the just-ended Information Transfer will take enough time to complete that deselection may be desirable.

Bits 3→0 - Encoded Slave Status: When Bits 3→0 of the Slave Status octet are defined by Attributes as being Encoded Slave Status, the definitions below apply. The use of some of these values is applicable only when optional capabilities of the Physical Interface are supported:

Facility Selection	0100, 0111
Data Streaming	1001
Double Octet Mode	1111

In some slave implementations it may not be possible to respond with some of the defined status conditions; e.g., a slave may implement a modular design such that it can accept a command into a buffer and post Successful Information Transfer as a complete and separate function from examining the command, and determining that a Bus Control Reject condition exists. In such an implementation, a Response with associated substatus would have to be presented.

0000 No Encoded Status

0001 Bus Control rejected because it conflicts with current Command context, or because there is no response pending.

0010 Bus Control Reject because addressee can accept no more commands; e.g., if only one command can be issued per addressee, that addressee already has an outstanding Command; if more than one command can be issued, the command buffer has overflowed.

0011 Bus Control Reject because an Asynchronous packet which is pending from the addressee must be transmitted before any other Bus Control can be accepted.

0100 Selected Facility Busy.

0101 Bus Control Reject due to outstanding Interrupt(s).

0110 Bus Control Reject due to an unsupported Bus Control; e.g., Response stack is full because Class 1 Interrupts have not been accepted.

0111 Bus Control Reject due to an illegal facility address.

NOTE: This is required because only slave selection can be verified at the Physical Interface.

1000 Command Out Bus Control Reject due to unsupported command packet length

1001 SYNC OUT count not equal to SYNC IN count

1010 Master termination (in some implementations this is an abnormal condition)

1011 Internal Slave Error

1100 Command Out Bus Control Reject due to Intervention Required

1101 Reserved

1110 Reserved

1111 Odd Octet Transfer - the last transfer of a double octet contained only one octet of information (on BUS A).

5.10.5.2 Valid Combinations

The following illustrates the valid combinations of the Slave Status octet:

```
+---------------+------------------------------------------------
| 7   6   5   4 | 3-0
+---+---+---+---+------------------------------------------------
| 0 | 0 | * | * | 0001 through 1100
| 0 | 1 | * | * | 0000, 1111
| 1 | 0 | * | * | 0000, 1111
+---+---+---+---+------------------------------------------------
  |   |   |   |   |
  |   |   |   |   +- Valid Slave Status Encodings
  |   |   |   |
  |   |   |   +- Time Dependent Operation
  |   |   +- Pause
  |   +- Bus Parity Error
  +- Successful Information Transfer
```

* indicates the bit setting may be either 0 or 1.

5.10.6 Request Interrupts Octet

The three interrupt classes, listed in order of descending priority, are defined as follows:

Class 3 - Critical Status Pending
Class 2 - Transfer Pending
Class 1 - Status Pending

See 5.1.2.1 for description of interrupts.

5.10.7 Selective Reset Control Octet

Any Selective Reset, with Bits 0,1 or 2 set, or without any Bits 0-3 set shall cause the slave to enable its drivers/receivers; e.g., to enable a slave which may have been disabled as the result of a preceding MAINT state.

The Selective Reset Control octet of the Physical Interface permits Bits 0-3 to be defined according to the Logical Interface level. The common usage for these bits has been defined as follows:

Bit 0=1 - Physical Interface Reset

The slave shall reset the Physical Interface at the port over which the octet was received, and set the port to neutral. Interface Reset has no effect on any facilities controlled by the slave, and does not reset any explicit reservations or pending Response packets.

Bit 1=1 - Logical Interface Reset

The slave shall reset the Logical Interface at the port over which the octet was received, and set the port to neutral. All slave and facility commands (active and queued), and pending responses from the resetting port shall be reset. All facilities with an allegiance to the reset port, and all neutral facilities shall be reset.

All facilities with an allegiance to the reset port, and all neutral facilities shall be reset with a Logical Interface Reset or equivalent; i.e., alternate port(s) at the facility are not affected. Implicit reservations are reset, but explicit reservations are not affected.

Bit 2=1 - Slave Reset

The slave shall re-initialize as at Power On which means that it shall execute its Initial Microprogram Load procedure (if any) and reset itself to an initial functional condition, with no commands active or responses pending. This typically means that based on slave implementation, all information in the slave will be lost (See 5.9.2).

All facilities with an allegiance to the reset slave, and all neutral facilities shall be reset with a Logical Interface Reset or equivalent; i.e., alternate port(s) at the facility are not affected. Implicit reservations are reset, but explicit reservations are not affected.

NOTE: Facility resets other than Physical Interface Reset and Logical Interface Reset are handled by the ABORT command.

Bit 3=1 - Slave Release

The slave shall release its interface drivers in the same manner as it would upon recognition of the MAINT state. The slave shall not execute a Reset but the drivers are to remain released on the port over which the reset was received until recognition of another reset.

5.11 Attention In Signal

The Device Generic implementation requires that the selected slave not assert ATTENTION IN to indicate the presence of interrupts needing service. It is assumed that the selected slave can use Responses to advise the master of any events that require attention. When a slave is selected, it shall negate its ATTENTION IN signal (if asserted) for the duration of the selection.

5.12 Information Transfers

Information transfers include command packets, reponse packets and data packets.

5.12.1 Packet Transfer Conventions

Packets are transferred between master and slave in either Single Octet Mode or Double Octet Mode. See the IPI Physical Interface specification 64732100.

In Single Octet Mode, command packets and data are transmitted on BUS A, and response packets and data are transmitted on Bus B. In Double Octet Mode, the first octet of every pair of the packet is transmitted on BUS A and the other octet is transmitted on BUS B.

Single Octet Mode Octet Transfer Positions:

```
+---------------+
|  BUS A or B   |
+===============+
|  First Octet  |
+---------------+
|  Next Octet   |
+---------------+
| .......
| Other Octets  |
         .....   |
+----------------+
|  Last Octet   |
+---------------+
```

Double Octet Mode Octet Transfer Positions:

```
+--------------+--------------+
|    BUS A     |    BUS B     |
+==============+==============+
| First Octet  | Second Octet |
+--------------+--------------+
| Third Octet  | Fourth Octet |
+--------------+--------------+
| .......
|        Other   Octets       |
                      ......   |
+--------------+--------------+
| Next   Octet | Last   Octet |
+--------------+--------------+
```

5.12.2 Bit Significance Conventions

In single or double octet mode bit 0 is always the least significant bit of the octet and bit 7 is always the most significant bit of the octet.

Single Octet Mode Bit Positions:

```
+--------+                       +--------+
| BUS A  |                       | BUS B  |
+========+                       +========+
| 7 - 0  |                       | 7 - 0  |
+--------+                       +--------+
| 7 - 0  |                       | 7 - 0  |
+--------+                       +--------+


            +--------+--------+
            | BUS A  | BUS B  |
            +========+========+
            | 7 - 0  | 7 - 0  |
            +--------+--------+
            | 7 - 0  | 7 - 0  |
            +--------+--------+
```

Octets are transmitted on the bus with their least significant bit (the represented bit 0) as bit 0 of the respective bus; i.e., if an octet is transmitted in Single Octet Mode, the least significant bit of the octet is transmitted as bit 0 of BUS A. If a pair of octets is transmitted in Double Octet Mode, the least significant bit of the first octet (as represented in this document) is transmitted as bit 0 of BUS A and the least significant bit of the other octet is transmitted as bit 0 of BUS B.

5.12.3 Octet Significance Conventions

In single and double octet mode formats, the lowest addressed octet of a field is always the most significant octet and the highest addressed octet of a field is the least significant octet.

Single Octet Mode Positions:

BUS A
mso
lso

BUS B
mso
lso

Double Octet Mode Positions:

BUS A	BUS B
mso	
	lso

e.g., a four-octet field followed by a two-octet field is represented as follows:

Octet Positions

BUS A	BUS B
mso	mso-1
lso+1	lso
mso	lso

Bit Positions

BUS A	BUS B
1F-18	17-10
0F-08	07-00
0F-08	07-00

5.12.4 Command And Response Packet Conventions

Defined fields are fixed in position, even though not all may require valid contents for a particular command or response. Optional and/or variable length information is presented via parameters that append to the packet type fields.

Throughout commands, responses and parameters only single octet fields can begin on an odd octet boundary, all other fields always begin on an even octet boundary, and all values are represented as 16 or 32 bit fields (e.g. a one octet field and a value needing only 24 bits are not compressed into four octets, but expressed as a one octet field, a reserved octet, and a four octet field of 32 bits).

5.12.5 Data Transfer Conventions

Data is transferred between master and slave in either Single Octet Mode or Double Octet Mode. In Double Octet Mode the octet on BUS A shall always be considered as being first, and the other octet on BUS B shall be the second.

Due to the difference in ordering of the data fields between different computers there is no definition of either octet significance of data transferred over the interface.

Data is always transferred in the same sequence independent of the host computer's data structure. The ordering difference of the host computer can be of major significance if the slave is required to interpret data, as it will have to be cognizant of the host computer's ordering scheme.

6.0 MESSAGE PACKET STRUCTURE

6.1 Conventions

6.1.1 General Organization

The command and response packets are of variable length and contain a count of the number of octets in the packet in the first octet pair of the packet. The next six octets of the command and response packets are identical in format. Both packet types may or may not have a Parameter list which contains non-structured information.

Fields defined within the basic packet (six octets for commands and eight octets for responses) are fixed in position, even though not all may require valid contents for a particular command or response. Conditional and/or variable information is presented via parameters appended to the basic packets.

6.1.2 Parameters

Parameters are passed as lists in which each parameter defines its length and is self identifying. The parameter list is used to pass specific information in the packet which is relevant to the command or response.

Parameters may contain multiple fields and be up to 254 octets in length. Some commands and responses require no parameters appended to the basic packet, and others may have one or more. The length and format of the parameter list varies depending upon the command or response, as well as the ordering, size, and number of parameters. The slave shall verify that all the parameters required by a specific command are present.

Fields in parameters are required to start on an even octet boundary (even boundary octets are transferred on BUS A in DOM), unless they are the second octet of a pair of single octets. Wherever necessary to maintain this rule, a reserved octet shall be used so that the next field shall begin as an even octet. Only single octets and data strings may be represented in other than octet pairs - all numerical values are represented as 16 bit multiples.

A parameter list may contain more than one parameter of the same type. The parameters shall be treated by the slave in the same sequence as that defined by the master. COPY, SEARCH and COMPARE are examples of commands which can make extensive use of the same parameter type multiple times to specify relatively complex command sequences to be executed by the slave.

6.1.2.1 Parameter Documentation

Parameters are documented throughout as shown below. The @ column is used to identify whether only the master (M), the slave (S), or both (B) can specify the parameter. The Length column contains the legend 'n+1' if the parameter is of variable length, or may be reduced in size. The Octet column represents the range of a particular field. The column X/b defines whether an octet is encoded or bit significant. Hex values are shown from 00-FF and bit significant fields are shown as 0-7. The DEF column is used to show defaults.

```
+-+---+--+-----+---+---+
|@|LTH|ID|OCTET|X/b|DEF|
+-+---+--+-----+---+---+-------------------------------------------
| |   |  |     |   |   |
| |   |  |     |   |   |
| |   |  |     |   |   |
+-+---+--+-----+---+---+-------------------------------------------
```

6.1.2.2 Parameter Length

The Parameter Length shall always begin on a 16 bit boundary; i.e., it shall always be transferred on BUS A of a double octet transfer. It is one octet in size, and the length defined does not include itself.

The value x'00' is a a padding octet in the parameter list which is skipped over and ignored. All masters and slaves that operate with command packets shall be able to handle padding octets, because given the different processors and micro-processors in use, some implementations may only be able to build a parameter list on boundaries other than octets.

Pad octets, if any, required by the Physical Interface shall be ignored; e.g., in Double Octet Mode, the packets transferred across the Physical Interface are a multiple of two octets so the master and the slave shall ignore the remaining octet if the basic packet plus the parameters is not an even number.

A parameter may be reduced in size if fields at the end are not required. An effort has been made to place the fields least likely to be needed at the end of parameters. All parameters which may be reduced in size have their Parameter Length noted as 'n+1' in the tables.

6.1.2.3 Parameter ID

The ID (identification) of each parameter is specific to the command being executed unless it is one of those generic to several commands (see 6.5). The Parameter ID is one octet, permitting up to 255 kinds of parameters per command and associated response. Parameter IDs are assigned as follows:

00	Invalid
01	NOP
02	Continuation of Preceding Parameter
03-0F	Reserved
10-1F	Slave Major Status
20-2F	Facility Major Status
30-4F	Common Parameters
50-9F	Command Parameters
A0-BF	Reserved
C0-CF	Communication Parameters
D0-EF	Product UniqueParameters
F0-FF	Host Adapter Unique Parameters

An ID of x'00' shall be invalid and the command shall be rejected with an Invalid Parameter substatus.

An ID of x'01' shall not be processed but ignored and skipped over in the parameter list.

An ID of x'02' shall identify this parameter as a continuation of the preceding parameter of 254 octets. This ID cannot be used to continue a parameter which was less than 254 octets.

IDs from 10-4F, where assigned, are defined in this section of the document.

IDs from 50-9F, where assigned, are command unique and are defined in the command description sections of this document.

IDs from C0-CF are reserved for the specific use of Communication commands.

IDs from D0-EF are Product Unique and, where assigned, shall be defined by the Equipment Specification.

IDs from F0-FF are reserved for use of the host system for any commands which may be interpreted by the Host Adapter which is responsible for issuing commands over the interface on behalf of the host.

6.1.3 Message Packet Representation In The Document

In Section 3 the packets are shown in a vertical representation which illustrates the physical positioning of fields (see 5.12). Only the Control command packet is illustrated as it would appear on the interface for both SOM and DOM modes. All other packet representations are only in DOM mode because the information is completely repetitive between the two, and DOM representation occupies less space on the page.

The horizontal format used elsewhere in this document is intended to enhance readability, by representing the packets as they would appear in memory.

6.2 Operation Command Packets

Commands to the slave occur as message packets issued to the slave via Information Transfers. There is a limit of one command per Information Transfer.

Every command shall cause the slave to return a response when the command has been completed. The response may be implicit at the Logical Interface if the "No Response if Successful" attribute is set by the master. Response packets contain status which notifies the master whether or not the command was successful and, if not successful, why not.

Commands to the slave may be Control, Position, Transfer (Primary or Other), Combination Transfer, or Diagnostics. The basic command packet is six octets in length. Parameters may be appended to each command, and the size of the parameter list is included in the Packet Length field. The slave is responsible for checking the fields that apply in a command packet for consistency and validity.

6.2.1 Fields In Command Packets

6.2.1.1 Packet Length

Packet Length contains the actual length (it may be odd or even), of the entire packet, including parameters, expressed in octets. Packet Length does not include the two octets of the Packet Length field itself, nor any null octet required by the Physical Interface in DOM. The slave shall use this value to perform a consistency check on the packet received and to determine the presence of parameters on commands which may or may not require parameters.

NOTE: If the Packet Length is used to control a Direct Memory Transfer and not transferred into memory with the packet, some means of recreating it in association with the packet shall be provided.

6.2.1.2 Command Reference Number

The Command Reference Number field contains a value which identifies individual commands from a master. The slave echoes the Command Reference Number in a response packet to identify the associated command. When the slave is capable of queueing multiple commands per addressee, the master is responsible to ensure that all active commands have unique identification.

The Command Reference Number is implicitly qualified by the port over which the command was received. Within the slave, the Command Reference Number, plus the Port ID, plus the Slave and Facility Addresses, forms a unique identification number for each command per addressee per port, and the master may only reuse a Command Reference Number when the command is no longer outstanding; i.e., after receiving the response packet for the command.

6.2.1.3 Slave Address

The Slave Address is a value between x'00-07', and is included in the command packet to assist in slave selection error detection. The slave accepting a command packet shall compare its Slave Address against the the Slave Address field in the command packet. If the command received contains the wrong Slave Address, the slave shall respond with the appropriate error status. For those commands which may be addressed to either the slave or the facility, the code x'FF' in Facility Address shall identify it as slave only.

6.2.1.4 Facility Address

The Facility Address is a value between x'00-FF'. Unlike the Physical Interface, where Facility Address is restricted by the Select octet to the range 00-0F, the Facility Address in a packet has a valid address range of 00-FE.

The Facility Address FF is used to identify the packet as addressed to the slave only.

There are several ways in which Facility Addresses in the range of 00-FE may be used:

Actual - this is the address by which the facility is referenced at the Physical Interface. The address range is limited to 00-0F. The slave shall validate the Facility Address if Facility Selection is being used at the Physical Interface.

Synonym - This is an address declared by the master that refers to the facility by other than the Actual address. A Synonym address is specified in Attributes, and may affect both Physical and Logical selection. If a Synonym is declared in the range of 00-0F, the slave may be capable of responding to the Synonym at Physical Interface Facility Selection as well as at Level 3. If a Synonym is declared in the range of 10-FE it affects only the Logical Interface.

Alias - This is an address defined by the master to refer to a data partition on a facility (which may be referred to by either an Actual or a Synonym address). An Alias address is specified in Attributes, and may be declared in the range of 00-FE. Note, however, that if a Partition is defined in the range of 00-0F it has no effect on Physical Interface selection.

6.2.1.5 Opcode

The Opcode field identifies the purpose of the packet and specifies the operation to be performed. A packet's Opcode implicitly determines the interpretation of any parameters that are present.

The Opcodes are interpreted as follows:

00-0F	Control Commands
10-1F	Transfer Commands
20-2F	Reserved
30-3F	Combination Commands
40-4F	Position Commands
50-6F	Other Transfer Commands
70-7F	Reserved
80-8F	Diagnostic Commands
90-9F	Reserved
A0-BF	Communication Commands
C0-DF	Reserved
E0-EF	Product Unique
F0-FE	Reserved
FF	Asynchronous Response Identifier

6.2.1.6 Modifier Octet

The Modifier Octet is used to express variations in the use or meaning of commands. The Common Modifiers are listed below and defined in Section 2.1.1.3 - they are not required to be supported on every command, but their use is identical on every command where they are supported (defined by slave attributes).

Bit 7 - Reserved

Bit 6=1 - Priority Command

Bit 5	Bit 4	
0	0	Individual or Queued Command
0	1	Chained Command
1	0	Sequential Command
1	1	Ordered Command

The Opcode Modifier bits are not defined the same across all commands, and are defined in each command's description; e.g., there is an Op Code modifier to distinguish whether the command is to treat the Data Address as applying to Data Blocks or Physical Blocks - the same bit position has other meanings on commands which do not require a Data Address.

6.2.1.7 Parameters

The Parameter list is used to pass command specific information to the slave. Each parameter is self-identifying and the list is unordered unless specified as having to appear in a certain sequence. The presence, length and format of the parameters depend on the command. The length of the parameter list shall be included in the Packet Length.

6.2.2 Basic Command Message Packet

The basic command packet is laid out as follows:

SOM Representation:

```
 7                              0
+--------------------------------+
|                        mso     | octet -2
+--      Packet Length         --+
|                        lso     | octet -1
+--------------------------------+
|                        mso     | octet 0
+-- Command Reference Number   --+
|                        lso     | octet 1
+--------------------------------+
|             Opcode             | octet 2
+---------------+----------------+
|Common Modifier|Opcode Modifier| octet 3
+---------------+----------------+
|         Slave Address          | octet 4
+--------------------------------+
|        Facility Address        | octet 5
+--------------------------------+
|                                | octet 6
/           Parameters           /
|                                | octet n
+--------------------------------+
```

If two parameters were present, the first of five octets (Parameter Length + Parameter ID + a three octet field), and the second of three octets (Parameter Length + Parameter ID + a one octet field), it would be a 17-octet transfer, and the parameter list would appear as follows:

```
+--------------------------------+
|    Parameter Length of 04      | octet 6
+--------------------------------+
|         Parameter ID           | octet 7
+--------------------------------+
|                          mso   | octet 8
+---                          ---+
|       First Parameter   mso-1  | octet 9
+---                          ---+
|                          lso   | octet 10
+--------------------------------+
|       Padding of x'00'         | octet 11
+--------------------------------+
|    Parameter Length of 02      | octet 12
+--------------------------------+
|         Parameter ID           | octet 13
+--------------------------------+
|       Second Parameter         | octet 14
+--------------------------------+
```

```
            7       BUS A        0 7      BUS B          0
           +---------------------+---------------------+
octet -2   | mso           Packet Length           lso | octet -1
           +---------------------+---------------------+
octet 0    | mso    Command Reference Number       lso | octet 1
           +---------------------+----------+----------+
octet 2    |       Opcode        | Com Modfr| Op Modfr | octet 3
           +---------------------+----------+----------+
octet 4    |    Slave Address    |  Facility Address   | octet 5
           +---------------------+---------------------+
octet 6    |                                           |
           /                Parameters                 /
           |                                           | octet n
           +-------------------------------------------+
```

If two parameters were present, the first of five octets (Parameter Length + Parameter ID + a three octet field), and the second of three octets (Parameter Length + Parameter ID + a one octet field), it would be an 18-octet transfer, and the parameter list would appear as follows:

	BUS A (7 ... 0)	BUS B (7 ... 0)	
octet 6	Parm Length of 04	Parameter ID	octet 7
octet 8	1st Parm Octet	2nd Parm Octet	octet 9
octet 10	last Parm Octet	Padding of x'00'	octet 11
octet 12	Parm Length of 02	Parameter ID	octet 13
octet 14	1st Parm Octet	Null Octet	octet 15

6.2.3 Command Packet Parameter Requirements

6.2.3.1 Control Command Packet

Control command packets need consist only of the basic packet. There are no required parameters for a control command.

6.2.3.2 Position Command Packet

Unless it is implicit, Position commands require that the Extent parameter be appended to the basic packet.

6.2.3.3 Transfer and Other Transfer Command Packet

Unless it is implicit, Transfer command packets require that the Extent parameter be appended to the basic packet.

6.2.3.4 Combination Transfer Command Packet (Optional)

Combination command packets typically require source and destination Combination Extent Parameters, but not necessarily. The Extent parameters may be either explicit or implicit and are command specific.

6.2.3.5 Diagnostic Command Packet

Diagnostic command packets typically require parameters.

6.2.4 Transferring Parameters As Data

Parameter lists may be transferred as data with Diagnostic commands such as Read/Write Defect List and Read/Write Error Log. The parameters are transferred in as similar a manner as is possible to the way in which data itself is transferred.

The contents of the parameter list may be transferred specifically (by using Parameter ID in appended Request Parameters parameter), or generally (with no specific Parameter ID appended).

When transferred specifically, only one kind of parameter should be transferred as data, since no parameter information is included, and since there is no required ordering of parameters it may be impossible to know what the contents contain.

When transferred generally, the list may contain different kinds of parameters as they are self identifying. Parameter lists that exceed 254 octets use continuation parameters. If parameters are transferred by the slave as data in Data Blocks, the slave shall pad with zeros up to the Data Block size in use.

The master advises the size of the transfer, and if there is a Request Parm Parameter present it must immediately precede the Command Extent used for that purpose.

6.2.4.1 Writing

On writing the master has control of the size of transfer, and uses the Create and Append modifiers.

6.2.4.2 Reading

It is not always possible for the master to predict the size of the parameter list to be transferred when reading. Even when the Request Parm parameter is supported by the slave, the master cannot use it on some commands (e.g. PERFORM DIAGNOSTICS) to find out the length.

The master may issue successive Reads, each containing a Command Extent parameter that identifies the starting address and length to be transferred. The Reads may be Chained or Ordered to prevent intervening commands from being executed while reading parameter data.

Alternatively, the master may request a very high value (as it would to read a tape record of unknown length). The residual of the last Read executed shall define the end of the request information.

Unless requested otherwise by a Request Parms parameter, the slave shall return parameters in a Command Completion response packet if they fit. If they do not fit, the slave shall reject the command as a Missing Parameter, and the master needs to re-issue the command with a Request Parms parameter appended to obtain the information as data.

As an example, if data transfers between master and slave are set up to be transferred in Data Blocks of 512 octets, then the list is transferred in as many Data Blocks of 512 octets as is needed. Data transfers continue until as many Data Blocks as are needed to contain the whole list have been transferred. Full Data Blocks shall be transferred, and any remainder per block shall be padded with zeros.

If transfers are not multiplexed then the slave shall transfer parameter lists up to the limit defined in attributes for data transfers. If the slave contains insufficient buffering or is otherwise unable to transfer the complete list up to the maximum size, then it may use Pause to interrupt the transfer to the master.

If the master needs to limit the size of data transfers, the Count field of the Command Extent parameter may be used to set the number of Data Blocks (or octets depending on the command modifier) to transfer. The maximum transfer size may or may not be less than the length of the parameter list to be transferred. The Address field shall specify the displacement from the beginning of the parameter list.

If more than one transfer is required then the master should issue multiple commands in a Chain or Order. All data transfers shall be of the size identified in the Command Extent, except the last, which shall terminate the Chain or Order and report a residual in the Response Extent.

NOTE: If the master does not know how much data is to be expected it has to issue multiple commands and be prepared to have the Chain or Order terminate when the slave has no more parameters to transfer.

6.2.4.3 Example

On a Read Defect List command the Data Block size is 512 octets and the slave has 44 entries in the defect list. The residual would be of the number of Data Blocks not transferred; i.e., If the command had used the Command Extent parameter with a count of 10, then for both examples the Response Extent would contain 8 as the residual.

General: The packet length specifies the length of the parameter list, not the size of the Data Block.

	Lth	Lth	ID		Lth	ID			
Octet:	0-1	2	3	4-255	256	257	258-509	510	511
Value:	510	253	56	21*entries	253	02	21*entries	00	00

Octet:	0-1	2	3	4-27	28-511
Value:	26	25	02	2*entries	zeros as padding

Slaves may gather parameters as data in a different manner depending on implementation; e.g., some slaves may begin each Data Block with a complete parameter and pad out the remainder if a parameter does not completely fit. Others may choose to concatenate parameters as tightly as possible, with fields divided over different Data Blocks.

The slave is responsible to ensure that the master receives the same information whether there is single or multiple reads i.e if the master requests 4 Data Blocks in a transfer, the last block shall contain the same information as if one Data Block had been requested four times.

Specific: The Request Parm parameter contains the ID 56 and the modifer to transfer Naked Parameters as Data.

Octet:	0-503	504-511
Value:	42*entries	8 octets of 43rd entry

Octet:	0-3	4-15	16-511
Value:	4 octets of 43rd entry	1*entry	zeros as padding

6.3 Operation Response Message Packets

Responses by the slave occur as message packets issued to the master via Information Transfers. There is a limit of one response per Information Transfer.

Responses may advise command completion; be Asynchronous because they are unanticipated events in the slave; or be Transfer Notifications to advise the master of the data transfer about to be initiated.

Response packets contain status to notify the master of the results of a command, or an asynchronous event. The first 6 octets echo the contents of the basic command packet. The next two octets contain the Response Type and Major Status.

Interrupts are used at the Physical Interface to request the master to read any pending Response packet(s). Response packets are not necessarily returned to the master in the order of their completion.

6.3.1 Fields In Response Packets

6.3.1.1 Packet Length

See 6.2.1.1

6.3.1.2 Command Reference Number

This field is echoed from the Command packet.

6.3.1.3 Slave Address

This field is echoed from the Command packet.

6.3.1.4 Facility Address

This field is echoed from the Command packet.

6.3.1.5 Opcode

This field is echoed from the Command packet.

6.3.1.6 Modifier

This field is echoed from the Command packet.

6.3.1.7 Response Type

The Response Type is a 4-bit encoded field (bits 4-7 of octet 7), which identifies the packet being presented by the slave.

- 0 Reserved
- 1 Standard Command Completion Response
  - Control
  - Position
  - Transfer
  - Other Transfer
  - Diagnostic
  - Not Recognized
- 2 Reserved
- 3 Extended Command Completion Response
  - Combination Transfer
- 4 Asynchronous Response
- 5 Transfer Notification
- 6 Imbedded Data Response
- 7-F Reserved

6.3.1.8 Major Status

Major Status is a 12-bit field which tells the master whether the command succeeded or not. All slaves shall return the same status codes for similar situations. The field is bit significant and each Major Status is given a bit code from 0-B (0 corresponds to bit 0 of octet 6, and B corresponds to bit 3 of octet 7). The Major Status categories and their associated Substatus are listed in Section 6.4.

The response parameter list is used to pass response specific data to the master. The presence, length, and format of the parameters are variable. The length of the Parameter field(s) shall be included in the Packet Length. Parameters are self-identifying and are not required to be ordered unless specified as having to appear in a certain sequence.

6.3.2 Basic Response Packet

Basic response packets are laid out as follows:

```
                   7       BUS A        0 7      BUS B         0
                  +--------------------+--------------------+
      octet -2    | mso           Packet Length         lso | octet -1
                  +--------------------+--------------------+
    * octet 0     | mso    Command Reference Number     lso | octet 1 *
                  +--------------------+----------+---------+
    * octet 2     |        Opcode      | Com Modfr| Op Modfr| octet 3 *
                  +--------------------+----------+---------+
    * octet 4     |    Slave Address   |  Facility Address  | octet 5 *
                  +--------------------+--------------------+
      octet 6     |    Major Status    | Resp Type| Maj Stat| octet 7
                  +--------------------+----------+---------+
      octet 8     |                                         |
                  /                Parameters               /
                  |                                         | octet n
                  +-----------------------------------------+
```

* Echoed from command

6.3.3 Response Packet Parameter Requirements

6.3.3.1 Control Response Packet

Control response packets need consist only of the basic packet. There are no required parameters.

6.3.3.2 Position Response Packet

Position response packets need consist only of the basic packet. There are no required parameters.

6.3.3.3 Transfer and Other Transfer Response Packet

Transfer response packets need consist only of the basic packet. When a transfer is Not Successful and the extent is explicit, the slave shall append the Response Extent parameter to the basic packet.

6.3.3.4 Combination Transfer Response Packet (Optional)

Combination response packets may require two Combination Response Extents even if successful. The presence, absence, and number of Combination Response Extents required on success or failure is specific to the command.

6.3.3.5 Diagnostic Response Packet

Diagnostic response packets need consist only of the basic packet. There are no required parameters.

6.3.3.6 Asynchronous Response Packet

Asynchronous response packets typically have Substatus parameter(s) appended to the basic packet. This packet is initiated by the slave to advise the master of an unanticipated event.

If the response is not associated with a previously issued command the Command Reference Number, Opcode and Modifier are not valid. The Opcode shall contain x'FF' and octets 0-1 and 3 shall be ignored. If the slave can associate the response with a previously issued command these fields shall be provided to the master. If the asynchronous event is not associated with a facility, octet 5 shall contain x'FF' to identify it is slave-only.

6.3.3.7 Transfer Notification Packet (Optional)

This packet is initiated by the slave to advise the master that a data transfer is about to be executed. The Command Reference Number is used by the master to identify which transfer command is to be executed. The Major Status field is unused by this packet, and shall be zero.

It is the slave's responsibility to initiate the data transfer when it is ready to do so by issuing a Transfer Notification Response to prepare the master for the subsequent data transfer. The Transfer Notification Response shall have appended to it any master-specific information which may have been associated with the command by the master as a Transfer Notification parameter (See 6.5.1).

The Transfer Notification packet is required unless the master issues Individual commands with Facility Selection, or if the slave and facility are integrated.

The Transfer Notification packet is always required whenever a READ AT FIRST AVAILABLE DATA command is to be executed, because the Read at First Data parameter is appended, which must be provided to the master prior to accepting any data (See 11.2).

6.3.3.8 Imbedded Data Response Packet (Optional)

This packet is used to make small data transfers (typically less than eight octets) in the parameter field attached to the response. Up to 254 octets of data may be appended in this response. More than one Imbedded Data Response packet may be transferred in answer to one command.

6.4 Status

6.4.1 Major Status

Responses may be presented by the slave as the result of a command issued by the master, or may be asynchronous and unexpected as a result of some internal or external condition. Octets 6 and 7 are used to identify the Response Type and the Major Status, and are shown below in a horizontal format by bit position. Substatus is specific to a Major Status category and is listed in tabular form following the definitions.

```
+-------------+-------------+
|    BUS A    |    BUS B    |
+-------------+------+------+
| MAJOR STATUS| RESP | MAJOR|
|    CODE     | TYPE | CODE |
+-------------+------+------+
|   Octet 6   |   Octet 7   |
| 7654   3210 | 7654 | 3210 |
+-------------+------+------+
  ||||   ||||   |  |   ||||
  ||||   ||||   +--+   |||+-  Command Aborted     (Parameter ID 'x8')
  ||||   ||||   |      ||+-  Conditional Success (Parameter ID 'x9')
  ||||   ||||   |      |+-  Incomplete          (Parameter ID 'xA')
  ||||   ||||   |      +-  Successful
  ||||   ||||   |
  ||||   ||||   +- Response Type
  ||||   ||||          0   Reserved
  ||||   ||||          1   Standard Command Completion Response
  ||||   ||||          2   Reserved
  ||||   ||||          3   Extended Command Completion Response
  ||||   ||||          4   Asynchronous Response
  ||||   ||||          5   Transfer Notification
  ||||   ||||          6   Imbedded Data Response
  ||||   ||||          7-F  Reserved
  ||||   ||||
  ||||   |||+-  Reserved                         (Parameter ID 'x0')
  ||||   ||+-  Reserved                          (Parameter ID 'x1')
  ||||   |+-  Product Unique                     (Parameter ID 'x2')
  ||||   +-  Message/Microcode Exception         (Parameter ID 'x3')
  ||||
  |||+-  Intervention Required                   (Parameter ID 'x4')
  ||+-  Alternate Port Exception                 (Parameter ID 'x5')
  |+-  Machine Exception                         (Parameter ID 'x6')
  +-  Command Exception                          (Parameter ID 'x7')
```

NOTE: Parameter ID 'x' = 1 for Slave Major Status
                        = 2 for Facility Major Status

6.4.2 Substatus

There may be more than one Major Status presented (except if Successful). All Major Status categories except Successful have detailed Substatus to identify the specific item that caused its presentation by the slave. This detail is presented in the parameter field which has as its ID in the low order four bits, the encoded value (O-A) of the Major Status code. Status is reported for the addressee on non-Combination commands or for the dominant slave on Combination commands according to the Substatus listed in the table above. If status is presented for Combination command sub-addressees it is supplied in the Combination Response Extent (see 6.5.2).

If Extended Substatus is present (as indicated by parameter length) it complements Substatus. Extended Substatus typically, but not necessarily, further defines conditions identified in Substatus.

6.4.2.1 Intervention Required (ID='x4')

The selected addressee is not able to execute commands, and some intervention is required to make it capable.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	14	01-04			INTERVENTION REQUIRED STATUS
		or	01	7		Not P-Available
		24		6		Not Ready
				5		Not P-Available Transition
				4		Not Ready Transition
				3		Physical Link Failure
				2		Attribute Table may be Corrupted
				1		Addressee Busy
				0		
				to		Reserved
			04	0		
			05- n			EXTENDED SUBSTATUS (if any)

- Not P-Available - the selected addressee is not powered on or is not installed.

- Not Ready - the selected addressee cannot execute its intended functions. The addressees' Not Ready condition may be cleared by operator intervention; e.g., a facility made ready by the mounting of a tape volume on a tape unit.

- Not P-Available Transition - this is presented by the slave to advise the master that a facility has become Not P-Available since the time that a command addressed to it was accepted.

  NOTE: If the transition had occurred before the command packet was accepted, the status would have been Not P-Available.

- Not Ready Transition - this is presented by the slave to advise the master that a facility has dropped ready since the time that a command addressed to it was accepted.

  NOTE: If the transition had occurred before the command packet was accepted, the status would have been Not Ready.

- Physical Link Failure - The slave has detected a catastrophic failure on the external line; e.g., Data Carrier detect Drop on a modem line.

- Attribute Table may be Corrupted - The slave has encountered a condition under which it is possible that the Attributes table has been corrupted, and it is not prepared to continue operation without master intervention.

- Addressee Busy - The command cannot be executed because the addressee has been Busy for a time determined by the Facility Timeout Value specified in Attributes.

6.4.2.2 Alternate Port Exception (ID='x5')

The slave or facility has detected an event from an alternate port.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	15	01-04			ALTERNATE PORT EXCEPTION STATUS
		or	01	7		Priority Reserve Issued
		25		6		Attributes Updated
				5		Initialization Completed
				4		Format Completed
				3		Facility Switched to Another Port
				2-0		Reserved
			02	7		Slave Diagnostic in Process
				6		Slave Diagnostic Terminated
				5		
				to		Reserved
			04	0		
			05- n			EXTENDED SUBSTATUS (if any)

- Priority Reserve Issued - The addressee has been instructed to release allegiance to this port because of a Priority Reserve from an alternate port.
- Attributes Updated - An Attributes command has been issued from an alternate port which has changed the addressee's attributes.
- Initialization Completed - The addressee has completed an initialization procedure which may have affected this port, and was originated by a Reset from an alternate port.
- Format Completed - The addressee has completed a FORMAT command from an alternate port.
- Slave Diagnostic in Progress - The PERFORM SLAVE DIAGNOSTIC command has been issued by an alternate port and is currently in progress.
- Slave Diagnostic Terminated - The slave diagnostic initiated by an alternate port has been completed.
- Facility Switched to Another Port - The slave has determined that the facility is switched to another port.

6.4.2.3 Machine Exception (ID='x6')

Machine Exceptions are the result of a machine condition detected in the slave or an attached facility. Some types of Machine Exceptions are peculiar to an operation; e.g., Data Check exceptions can occur only in connection with operations that transfer data from or to a facility.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	16 or 26	01-04			MACHINE EXCEPTION STATUS
			01	7		Addressee No Longer Busy
				6		P-Available Transition
				5		Ready Transition
				4		Operation Timeout
				3		Physical Interface Check
				2		Slave Initiated Reset
				1		Environmental Error
				0		Power Fail Alert
			02	7		Data Check (on Raw Data)
				6		Uncorrectable Data Check (on Perfect Data)
				5		Fatal Error
				4		Hardware Write Protected
				3		Queue Full
				2 to		Reserved
			03	7		
				6		Read Access Violation
				5		Write Access Violation
				4		Data Overrun
				3		Reallocation Space Exhausted
				2		End of Media detected
				1		End of Extent Detected
				0		Unexpected Master Status
			04	7		Error Log Full
				6		Defect Directory Full
				5		Logical Link Failure
				4		Position Lost
				3-0		Reserved
			05- n			EXTENDED SUBSTATUS (if any)

- Addressee No Longer Busy - The addressee is notifing the master that it is no longer busy.

- P-Available Transition - This is presented asynchronously by the slave to advise the master that a facility which was previously Not P-Available has become P-Available.

- Ready Transition - This is presented asynchronously by the slave to advise the master that a facility which was not previously ready has become Ready.

- Operation Timeout - There has been a failure condition in the addressee which has been detected by an internal timeout mechanism.

- Physical Interface Check - The slave detected a check condition on the Physical Interface; e.g., invalid sequence generation by the "state machine" or parity error on the bus(es)

- Slave Initiated Reset - An internal condition caused the slave to initiate a reset; the master shall assume all outstanding commands and buffer contents are either lost or suspect.

- Environmental Error - Some condition internal or external to the addressee has been detected which may cause a failure condition(s); e.g., temperature sensor alert.

- Power Fail Alert - The slave has detected an impending power failure condition in itself or an attached facility. The Facility Address field of the Response packet shall contain the address of the affected facility, or x'FF' if it is the slave itself.

- Data Check (on Raw Data) - The master has requested raw data and the addresseee has detected a data error.

- Uncorrectable Data Check (on Perfect data) - The slave detected a data error which has persisted after the slave has exhausted any possible recovery actions. On write operations, the malfunction may have caused invalid data to be recorded.

- Fatal Error - The addressee detected an internal machine error that precludes execution or continuation of the current command.

- Hardware Write Protected - An attempt was made to write on a facility that was protected against writing by something physical; e.g., Write Protect Ring for tapes

- Queue Full - The command queue for the addressee is full.

- Read Access Violation - An attempt was made to read on an addressee which had been protected via Access Permits.

- Write Access Violation - An attempt was made to write on an addressee which had been protected via Access Permits.

- Data Overrun - This can occur during direct data transfer, or if the slave has a buffer which was not adequate, and the buffer overran during a read or a write operation.

- Reallocation Space Exhausted - Space required for reallocation of data due to media defects is not available,; i.e., all space assigned for that purpose has been exhausted.

- End of Media Detected - The addressee has detected the end of the media; e.g., the point on tape beyond which the addressee cannot write.

- End of Extent Detected - The addressee has detected the end of the extent; e.g., a File Mark on tape (on disc, end of partition can be detected by a boundary check at command validation and is reported as Command Exception).

- Unexpected Master Status - The slave has received a Master Status at the Physical Interface which does not correlate to the anticipated status, or no status was expected and some was presented by the master.

- Error Log Full - the Error Log capacity has been exceeded.

- Defect Directory Full - the Defect Directory capacity has been exceeded and no more blocks can be re-allocated.

- Logical Link Failure - The addressee has detected a failure on the communications logical link; e.g., failure of the remote entity to respond to the communications protocol.

- Position Lost - The addressee has lost knowledge of its position on the media; e.g., a tape has not completed a block and has no current reference to use to judge its position.

6.4.2.4 Command Exception (ID='x7')

This status code is used to report invalid or incorrect values in both the basic packet and parameter list (if any). A command is also invalid if the packet was too short, or did not contain all the parameters required by the Opcode. This status is normally presented before command initiation but slaves may be unable to detect some invalid values until after performing some part of the command.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	17	01-04			COMMAND EXCEPTION STATUS
		or	01	7		Invalid Packet Length
		27		6		Invalid Command Reference Number
				5		Invalid Slave Address
				4		Invalid Facility Address
				3		Invalid Selection Address
				2		Reserved
				1		Invalid Opcode
				0		Invalid Modifier
			02	7		Reserved
				6		Reserved
				5		Invalid Extent
				4		Reserved
				3		Invalid Parameter(s)
				2		Missing Parameter(s)
				1		Reserved Value Not Equal to Zero
				0		Invalid Combination
			03	7		Not at Initial Position
				6		
				to		Reserved
			04	0		
			05- n			EXTENDED SUBSTATUS (if any)

- Invalid Packet Length - the packet length is invalid; e.g., the length of the parameter list plus the basic packet does not equal the packet length.

- Invalid Command Reference Number - The Command Reference Number is invalid; e.g., it duplicates one in a command that is currently active.

- Invalid Slave Address - the Slave Address in the command packet is invalid; e.g., it does not match the selected slave's address.

- Invalid Facility Address - the Facility Address in the command packet is invalid.

- Invalid Selection Address - the facility selected at the Physical Interface does not match the facility address supplied in the command packet. The slave shall use the Physical Interface address when reporting Class 1 Interrupts to notify the master of the command packet error. The response packet shall contain the same facility address that was contained in the command packet.

- Invalid Opcode - the command packet contained an invalid or unsupported Opcode.

- Invalid Modifier - the Modifier was invalid or is not supported for the Opcode specified.

- Invalid Extent - the Data Address plus the Count specified in an Extent parameter is not valid for the addressee.

- Invalid Parameter(s) - one or more of the parameters in the command packet was invalid. An Invalid Parm parameter shall be used by the slave to clarify the error, unless Invalid Extent is posted for a command with a single extent.

- Missing Parameter(s) - one or more of the parameters required in the command is not present. A Missing Parm parameter shall be used to clarify which one(s) are missing; e.g., a command that requires an Extent does not have it.

- Reserved Value Not Equal to Zero - A reserved value defined by the standard does not contain zero.

- Invalid Combination - The addressee has detected that two valid but mutually exclusive options have been selected by the master; e.g., 7 Track and Phase Encoded options on a tape drive.

- Not at initial Position - The addressee has been instructed to perform an operation that is only valid at its initial position; e.g., a tape may only allow a density change at load point.

6.4.2.5 COMMAND Aborted (ID='x8')

If a command is terminated by an ABORT command, this status code is used in the response packet of the aborted command. Any other commands that may be linked to the one ABORTed are also terminated. A command need not necessarily be aborted explicitly; e.g., a failure in one command of a Chain, Sequence or Order shall cause the remaining commands to be aborted.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	18	01-04			COMMAND ABORTED STATUS
		or	01	7		Command Aborted
		28		6		Command Sequence Terminated
				5		Unexecuted Command from Terminated Sequence
				4		Command Chain Terminated
				3		Unexecuted Command from Terminated Chain
				2		Command Order Terminated
				1		Unexecuted Command from Terminated Order
				0		
				to		Reserved
			04	0		
			05- n			EXTENDED SUBSTATUS (if any)

- Command Aborted - The command this response packet is related to was ABORTed by the master.

- Command Sequence Terminated - Command Sequencing was terminated because this command failed to complete successfully.

- Unexecuted Command from Terminated Sequence - The command related to this response packet was not executed but was terminated because a prior command which was sequenced to it failed to complete successfully.

- Command Chain Terminated - Command Chaining was terminated because this command failed to complete successfully.

- Unexecuted Command from Terminated Chain - The command related to this response packet was not executed but was terminated because a prior command which was chained to it failed to complete successfully.

- Command Order Terminated - Command Ordering was terminated because this command failed to complete successfully.

- Unexecuted Command from Terminated Order - The command related to this response packet was not executed but was terminated because a prior command which was ordered to it failed to complete successfully.

6.4.2.6 Conditional Success (ID='x9')

Substatus detail is in the parameter list. This status is used to advise the master that although the operation completed successfully without Exceptions, there were conditions encountered, or events occurred, or there were changes in slave statistics or parameters, which should be made known to the master; e.g., data retry was needed by the slave, Error Log threshold exceeded.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	19 or 29	01-04			CONDITIONAL SUCCESS
			01	7		Logging Data Appended
				6		Abort Received - no Command Active
				5		Abort Received - Status Pending
				4		Abort Received - Not Operational
				3		Anticipated Error
				2		Anticipated Data Error
				1		Re-allocation Required
				0		Re-allocation Discontinuity (if automatic)
			02	7		Defect Directory Threshold Exceeded
				6		Error Retry Performed
				5		Data Retry Performed
				4		Motion Retry Performed
				3		Data Correction Performed
				2		Soft Error
				1		Release of Unreserved Addressee
				0		Request Diagnostic Control Command
			03	7		Error Log Request
				6		Non-Interchange Volume
				5		Retension Required
				4		End of Media Warning
				3		Statistics Update Requested
				2		Parameter Update requested
				1		Asynchronous Event Occurrence
				0		Master Terminated Transfer
			04	7 to 0		Reserved
			05- n			EXTENDED SUBSTATUS (if any)

- Logging Data Appended - the slave has appended information in this esponse which the slave is advising the master is relevant to be logged. Such information may directly or indirectly be the result of command completion; e.g., laser printers that require regular maintenance based on usage may provide the statistics that indicate maintenance action is desirable - a result of the command in execution at the time a particular usage counter overflowed.

- ABORT Received; No Command Active - an ABORT command was issued to an addressee in the L-Available condition but the referenced command could not be found.

- ABORT Received; Status Pending - an ABORT command was issued to an addressee which has the response status for the referenced command pending; i.e., the command has been completed.

- ABORT received; Not Operational - an ABORT command was issued to a facility which is Not Operational.

- Anticipated Error - The addressee has detected a condition which may result in future error conditions; e.g., on disk seek retries were needed.

- Anticipated Data Error - The addressee has detected a condition which may result in future data errors; e.g., successive retries needed for reading tape or disk data.

- Reallocation Required - The addressee has detected a data error condition which requires reallocation action; e.g., an unrecoverable read error.

- Reallocation Discontinuity - the slave has automatically reallocated a block which contained a data error and the reallocated data is now no longer in close proximity to the blocks previously contiguous to it.

- Defect Directory Threshold Exceeded - the threshold within the addressee's Defect Directory has been exceeded, indicating that there is a limited number of entries remaining for adding more defects.

- Error Retry Performed - The addressee has completed the command but error retry had to be invoked.

  NOTE: Error Retry does not include actions associated with data transfer.

- Data Retry Performed - The addressee has completed the command but data retry had to be invoked; e.g., physical re-read. Data Retry includes all actions associated with the transfer of data.

- Motion Retry Performed - The addressee has completed the command but motion retry had to be invoked.

- Data Correction Performed - The addressee has completed the command but data correction had to be applied.

- Soft Error - the slave detected an internal machine error that did not preclude execution or continuation of the current command.

- Release of an Unreserved Addressee - The addressee has received a release command for which there is no reservation.

- Request Diagnostic Control Command - As a result of executing a diagnostic command which provided more information than can be returned by a Response, the addressee is requesting that the master issue a Diagnostic Read Command.

- Error Log Request - the master is requested to capture the contents of the Error Log (which contains product dependent information) because the threshold has been exceeded. The log action should be performed in addition to any other master action that is specified.

  NOTE: It is not required that all slaves be capable of providing an Error Log, and a master shall not be required to capture same on slaves which provide an Error Log.

- Non-Interchange Volume - The addressee has received a command from the master which would result in creating a volume that may not be readable on another device; e.g., a tape drive may have executed several successive ERASE commands and created a gap which, if increased by another ERASE command, would cause the tape to appear blank when read. This status will continue to be presented until the master initiates a command which does not violate, or compound a violation, to the applicable interchange standard.

- Retension Required - The addressee has successfully completed the operation just completed, but has detected that it is losing tension and requires that a POSITION CONTROL command with the Retension modifier set.

- End of Media Warning - This indicates that the addressee is approaching the end of media; e.g., a tape drive has sensed the EOT (End of Tape) marker.

- Statistics Update Requested - There has been a change in meaningful statistics during the execution of this command, and the master is requested to update its Statistics Table (if any).

- Parameter Update requested - There has been a change in meaningful device parameters during the execution of this command, and the master is requested to update its Statistics Table (if any).

- Asynchronous Event Occurrence - An asychronous event has occurred which may be described further in Extended Status.

- Master Terminated Transfer - the previous Information Transfer which had a Master Termination Parameter, was terminated by the master.

6.4.2.7 Incomplete (ID='xA')

This status is used to advise the master that an otherwise successful command did not complete.

If the the Command Reference Number remains active then the command is one that can be RESUMEd or LINK RESUMEd.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS
S	n+1	1A	01-04			INCOMPLETE STATUS
		or	01	7		Command May Be Resumed
		2A		6		Reserved
				5		COPY Source Space Empty
				4		Response Packet Truncated
				3		Select Subservient Slave
				2-0		Reserved
			02	7		Connect Unsuccessful
				6		Disconnect Unsuccessful
				5		Connect identifier Already Assigned
				4		Link Not Connected
				3-0		Reserved
			03	7		Beginning of Media Detected
				6		End of Media Warning
				5		End of Extent Detected
				4		Block Length Difference
				3		Unrecorded Media
				2		Data Length Difference
				1		Block Not Found
				0		
				to		Reserved
			04	0		
			05- n			EXTENDED SUBSTATUS (if any)

- Command May Be Resumed - The incomplete command remains on the slave's queue, and its Command Reference Number shall remain valid, until the command is resumed or aborted.

  NOTE: The following status may be reported also if they are encountered by the slave during execution of a complex command on behalf of the master; e.g., when executing a COPY command to multiple reel tapes the slave encountered EOT.

- COPY Source Space Empty - The addressee could not find the data on the source space.

- Response Packet Truncated - The maximum Information Transfer Length specified by the attributes was exceeded by the response packet, which was truncated at that size, and the response is considered complete by the slave.

- Select Subservient Slave - the Slave-to-Slave transfer in execution requires that the master select a subservient slave to be used by the dominant slave.

- Connect Unsuccessful - the slave issued a CONNECT command to a facility or logical link but was unable to receive a Connect Acknowledge from the remote host.

- Disconnect Unsuccessful - the slave issued a DISCONNECT command to a facility or logical link but was unable to receive a Disconnect Acknowledge from the remote host.

- Connect Identifier Already Assigned - The master has issued a Conection Identify parameter in the CONNECT command which the slave or facility has found to be already assigned to another logical link.

- Link Not Connected - A frame READ or WRITE was issued to a communications link which was not already established via the CONNECT command.

- Beginning of Media Detected - The addressee has detected the beginning of the media; e.g., a tape which was reading backwards has run out of tape.

- End of Media Warning - The addressee is approaching the end of media; e.g., a tape has sensed the EOT (End of Tape) marker.

- End of Extent Detected - The addresse has detected the end of an extent; e.g., a File Mark on tape.

  NOTE: On disk drives this condition is detected by a boundary check, and reported as Command Exception.

- Block Length Difference - the addressee has detected a block with a length not equal to the currently defined length; e.g., on tape, a block with incorrect length was read.

- Unrecorded Media - The addressee has detected that no data is recorded on the media; e.g., a tape has read a length of tape which exceeds its maximum allowable gap without finding any data.

- Data Length Difference - The addressee has not transferred all the information specified in a transfer command. On a tape writing variable blocks this shall cause a short block to be written.

- Block Not Found - A specified (either implicitly or explicitly) block address could not be found by the addressee; e.g., a tape drive executing a Position Control command where a block numbering sequence error was encountered.

6.4.2.8 Successful

The command was successfully completed, and there are no other Major Status posted. There are no Substatus conditions associated with Successful status.

This status code is used to indicate that a message is being sent in the response, or that a failure related to microcode has occurred.

@	LTH	ID	OCTET	X/b	DEF	SUBSTATUS PARAMETERS	
S	n+1	13	01-04			MESSAGE/MICROCODE	
		or	01	7		Microcode Data Not Accepted	
		23		6		Request Master to IML Slave	
				5		Slave Unable to IML	
				4		Message	*
				3		Microcode Execution Error	
				2		Failure Message	*
				1		Port Disable Pending	
				0		Port Response	
			02	7		Facility Status	
			02	6			
				to		Reserved	
			04	0			
			05- n			EXTENDED SUBSTATUS (if any)	

- Microcode Data Not Accepted - The slave did not accept microcode being loaded.

- Request Master to IML Slave - The slave is unable to IML itself and is requesting the master to assist it by down-line loading of microcode.

- Slave Unable to IML - The slave is unable to IML itself.

- Message - The slave has included a message within Extended Substatus for the master.

- Microcode Execution Error - The slave has encountered an error during execution which is within its own microcode.

- Failure Message - The slave encountered a failure condition which resulted in the identification of a FRU (Field Replaceable Unit). The Extended Substatus contains a message in the following format:

  05-06 FRU Number
  07- n ASCII Text

- Port Disable Pending - The addressee has received a manual or programmed Port Disable command that will take effect when the Disable conditions are met.

- Port Response - A port has executed a Port Response command. Appended after the Message/Microcode Substatus parameter is a Port Mask parameter which identifies the port which issued the command and a Response Information parameter (if any) which identifies the information from the port which issued the command.

- Facility Status - the Extended Substatus which follows includes all of the status provided by the facility; e.g., if it is an IPI-2 device attached then Extended Substatus contains 32 octets of Status and Extended Status of the facility.

  NOTE: This is additional information for the master as it is the responsibility of the slave to map facility status wherever possible to IPI-3 Substatus.

6.4.3 Extended Substatus

Extended Substatus contains slave or facility specific data. The contents for each is defined in the Equipment Specification. If a slave is capable of providing Extended Substatus (which is product unique), and there is pertinent extended status to present, then it is appended to Substatus in the parameter list (unless overrridden by Attributes). The length of the parameter shall implicitly identify if Extended Substatus is present.

These parameters are used on many commands and are grouped here as being common in usage across implementations of the Device Generic command set for different device types.

Under each command description, all parameters associated with the command are listed, except for Transfer Notification parameter, Invalid Parm parameter and Missing Parm parameter. These are not listed because they apply on every command issued, and their repetition serves no useful purpose.

6.5 Common Parameters

These parameters are used on many commands and are grouped here as being common in usage across implementations of the Device Generic command set for different device types.

Under each command description, all parameters associated with the command are listed, except for Transfer Notification parameter, Invalid Parm parameter, and Missing Parm parameter. These are not listed because they apply on every command issued, and their repetition serves no useful purpose.

6.5.1 Transfer Notification Parameter (Optional)

A slave may be capable of accepting multiple data transfer commands, and selecting (via some slave or master defined algorithm), the sequence in which they are to be completed. The Command Reference Number provided in the Transfer Notification Response is the means by which the slave advises which command is about to be executed. If the master provides a Transfer Notification parameter with a command the slave is required to retain the parameter and echo it back to the master as a parameter appended to the Transfer Notification Response (if any).

The parameter contains implementation-dependent information of the master which may be used for a number of different reasons associated with architecture and memory management techniques. One example of the type of information that may be contained in this parameter would be routing information for a system that has virtual memory management.

The contents of this parameter are always echoed back to the master, and may or may not be of any meaning to the slave. If a master and slave are designed to complement each other in a specific configuration, this parameter could contain information such as an algorithm with meaning to the slave to properly sequence the transfer to the master. Such uses of this parameter are not defined in this standard, and it is assumed that the contents of the Transfer Notification parameter are transparent to the slave and echoed back to the master.

It is the slave's responsibility to prepare the master for a subsequent data transfer when it is ready to initiate same, by issuing a Transfer Notification Response packet to the master. The Transfer Notification parameter shall be echoed to the master as part of the response packet.

It is variable in length because it is master-specific information.

@	LTH	ID	OCTET	X/b	DEF	TRANSFER NOTIFICATION PARAMETER
B	n+1	30	01- n			Master Specific Information

6.5.2 Command Extent Parameter

This parameter identifies the extent to be used for those commands that perform positioning or transfer data. Unless specifically permitted by the command, there is a limit of one extent per command.

```
+-+---+--+-----+---+---+
|@|LTH|ID|OCTET|X/b|DEF|     COMMAND EXTENT PARAMETER
+-+---+--+-----+---+---+----------------------------------------
|M|n+1|31|01-04|   |   | Count
| |   |  |05-08|   |   | Data Address
| |   |  |     |   |   |
+-+---+--+-----+---+---+----------------------------------------
```

The interpretation of these fields is dependent upon the selected device type, the specified command, and the opcode modifier bits. The value is an unsigned binary number of either blocks or octets, depending on the modifier used in the command packet.

Count:

The Count is interpreted by Position commands as required. On a Transfer Command, the Count identifies the number of octets or blocks requested.

Data Address:

The Data Address specifies the position on the media. On a Transfer Command this is the point at which to start the data transfer. The Data Address can be expressed in a number of ways depending on the attributes of the slave; e.g.,

- Cylinder, Head and Sector (CCHS) for the Physical Block address of disks.
- Blocks and File Marks for the Physical Block address of tapes.
- Data Block Address for the logical addressing of facilities.

The slave is responsible for performing a boundary check, whenever applicable, on the validity of the extent (Data Address plus Count).

If the Data Address Parameter (see 6.5.11) is used in the parameter list, only the Count field shall be presented.

6.5.3 Response Extent Parameter

This parameter is added to the Response packet for all Position and Transfer commands which required extent information, or did not complete successfully.

@	LTH	ID	OCTET	X/b	DEF	RESPONSE EXTENT PARAMETER
S	n+1	32	01-04			Residual Count
			05-08			Data Address

Residual Count:

This field contains the value remaining to be transferred. The value is an unsigned binary number of either blocks or octets, depending on the units used in the corresponding command packet.

NOTE: If the transfer command ended in an unrecoverable data error and the Data Recovery modifier was On, the Residual Count shall contain the number remaining to be transferred, including the one in error. The data in error was not transferred.

If the transfer command terminated in an unrecoverable data error and the Data Recovery modifier was Off, the Residual Count shall contain the number remaining to be transferred, but not including the one in error. The data in error was transferred.

If the transfer command terminated with a recoverable data error because the Transfer parameter requested Stop on Data Error, and Data Recovery was On, the Residual Count shall contain the number remaining to be transferred but not including the one on which the data was recovered. The data recovered was transferred.

Data Address:

This field contains the address of the next block or octet to be transferred consistent with the setting of the Data Recovery modifier bit. There are considerations associated with the end of media and/or end of extent which affect the ability of the slave to place a valid value in this field; e.g., if status is given for End of Media, or End of Extent the address is not valid.

If the Data Address Parameter (see 6.5.11) is used in the parameter list, only the Count field shall be presented.

6.5.4 Combination Command Extent Parameter (Optional)

All combination commands provide the ability to have one or more extents for the source and destination sub-addressees. The command packet addresses either the slave or a facility. If the addressee is the slave it shall execute the operation on behalf of the master. If the addressee is a facility, all operations are restricted to that facility. Each Combination Extent parameter identifies a sub-addressee and its extents. In the case where a sub-addressee has no address range information (e.g. tape) the Combination Extent parameter contains only octets 00-03. Where there are address ranges to be specified, ordered pairs of fields define the Count and Data Address.

There may be more than one address range within a Combination Extent parameter, and more than one Combination Extent parameter (with different Slave and Facility addresses) may be defined for a source or destination. It is possible for the master to create relatively complex combination commands. As an example, to back up disk files a master may COPY a source file which is spread over more than one extent on more than one facility to a reel of tape on the destination facility.

Not all slaves will offer the full functionality of the combination commands, and their abilities shall be defined in attributes.

@	LTH	ID	OCTET	X/b	DEF	COMBINATION COMMAND EXTENT PARAMETER		
M	n+1	33	01			Slave Address		
			02			Facility Address		
			03			MODIFIERS		
				7		0=Primary(Source) 1=Secondary(Destination)		
				6-4		Reserved		
				3		Direction	0=Forward	1=Reverse
				2		Addressing	0=Data Block	1=Physical Block
				1		Data Recovery	0=On	1=Off
				0		Count	0=Octet	1=Block
			04			Reserved		
			05-08			Count		
			09-0C			Data Address		
			n-7:4			Count	Repeated as many	
			n-3:n			Data Address	times as needed	

Slave Address:

The slave in control of the facility being addressed as source or destination.

Facility Address:

The facility being addressed as source or destination. If the facility is integrated with the slave this field shall be set to x'FF'. The Facility Address shall match the addressee if the addressee is a facility.

Modifiers:

Bit 7 - identifies the parameter as a primary (typically the source), or a secondary (typically the destination) extent.
Bit 3 - establishes the direction of data transfer.
Bit 2 - identifies whether physical or logical addressing is used.
Bit 1 - defines whether or not data recovery is required.
Bit 0 - identifies whether block or octet counts are used.

Count:

If extent information is required, this field is always the first of an ordered pair, and the pair may be repeated as many times as there are extents.

Data Address:

This field is always the second of an ordered pair with the Count. If there are multiple extents to be transferred, the ordered pair is repeated as many times as needed.

NOTE: If the Data Address Parameter (see 6.5.11) is used in the parameter list, the ordered pairing which permits multiple extents cannot be used, and the parameter is truncated at Octet 04, followed by ordered pairs consisting of a Command Extent parameter including only the Count field followed by the Data Address parameter.

6.5.5 Combination Response Extent Parameter (Optional)

The basic response packet contains the Major Status associated with the slave in control of the operation. Following the basic response Substatus, if any, are the Combination Response Extent parameters which belong to the sub-addressee(s). If any Substatus is presented it shall immediately follow the extent to which it applies. The contents of the Major Status and Substatus shall be the same as that defined for all other commands.

@	LTH	ID	OCTET	X/b	DEF	COMBINATION RESPONSE EXTENT PARAMETER
S	n+1	34	01			Slave Address
			02			Facility Address
			03			MODIFIERS
				7		0=Primary(Source) 1=Secondary(Destination)
				6-4		Reserved
				3		Direction 0=Forward 1=Reverse
				2		0=Data Block 1=Physical Block
				1		Data Recovery 0=On 1=Off
				0		Count 0=Octet 1=Block
			04			Reserved
			05-08			Residual Count
			09-0C			Data Address
			0D-0E			Major Status
			0F- n			Substatus if any - Codes x0-xB

Slave Address:

The address of the slave in control of the facility to which the response applies.

Facility Address:

The address of the facility to which the response applies (x'FF' if slave and facility are integrated).

Modifiers:

The contents of this octet are echoed by the slave.

Residual Count:

This field is zero if the extent has been depleted, otherwise it contains the count of the number of octets or blocks remaining in the extent. This field may have a value even if there were no transfer errors; e.g., a COPY command with a larger Destination extent than Source shall have a Destination extent residual.

This field contains the address following the last block of transferred data, but may not contain a valid value if the Residual Count is zero.

If the Data Address parameter (see 6.5.11) was used in the parameter list of the command and the Residual Count is non-zero, this field shall be set to x'FFFFFFFF', and the Data Address parameter shall follow the Combination Response Extent parameter.

Major Status:

This field contains the Response Type and Major Status associated with the sub-addressee. The Major Status associated with the basic response packet belongs to the dominant slave.

NOTE: On a Combination command that fails there may be three sets of Major Status; the dominant slave, the primary sub-addressee, and the secondary sub-addressee.

Substatus:

The Substatus, if any, associated with the addressee (primary or secondary) shall be appended and use the same format as that described in 6.4. Extended Substatus shall also be appended (if any), unless inhibited by Attributes.

6.5.6 Access Key Parameter (Optional)

If the slave provides ACCESS PERMITS to read- or write-protect areas of the media, then every operation which accesses such an area must use the correct access key. See ACCESS PERMITS command.

@	LTH	ID	OCTET	X/b	DEF	ACCESS KEY PARAMETER
M	05	35	01-04			Access Key

The Access Key parameter shall precede the Extents parameter to which it refers. If not present, the assumed partition shall be the default data partition.

6.5.7 Reserved

6.5.8 Reserved

6.5.9 Invalid Parm Parameter

This parameter is used by the slave as a response to identify invalid parameters of the command being initiated.

@	LTH	ID	OCTET	X/b	DEF	INVALID PARM PARAMETER
S	n+1	38	01-02			Displacement of Parameter in error
			03-04			Displacement of field in error
			05: n			Parameter string

The first field is a value which identifies the invalid parameter by its displacement from Octet 0 of the command. A value of x'FFFF' shall be supplied if the slave cannot provide the correct value.

The second value identifies the offset of the field in error within the parameter in error. The parameter string is the parameter in error beginning at the Length field, up to and including the field in error.

6.5.10 Missing Parm Parameter

This parameter is used to identify missing command parameters.

@	LTH	ID	OCTET	X/b	DEF	MISSING PARM PARAMETER
S	n+1	39	01			ID
			n			ID Repeated as many times as needed

If the slave can determine that it was not given a complete set of parameters, but cannot specifically identify which is missing, the parameter shall consist of the Parameter ID and no ID fields.

6.5.11 Data Address Parameter (Optional)

The following parameter is used when the four octets of Data Address in the Extent parameters are insufficient, or if there is a need for the master to use Absolute Addressing. The Absolute Address modifier in the parameter overrides the setting of Bit 2 in the Operation modifier of the command.

@	LTH	ID	OCTET	X/b	DEF	DATA ADDRESS PARAMETER
B	n+1	3A	01	7		Data Block
				6		Physical Block
				5		Absolute Address
				4		Index
				3-0		Product Unique
			02			Reserved
			03- n			Data Address

For some devices (such as optical disk), the master may use "broad" addressing (such as bands), and the slave needs to advise the master of the exact location at which the data shall be placed. On a WRITE command, the slave may append this parameter to the Transfer Notification packet to inform the master of the actual starting position on the media where the data shall be recorded.

6.5.12 Block Size Parameter (Optional)

The following parameter is used when the block size set in the Attributes is to be overridden.

@	LTH	ID	OCTET	X/b	DEF	BLOCK SIZE PARAMETER
B	05	3B	01-04			Block Size

6.5.13 Transfer Parameters

The master may choose from several alternatives in the manner that the slave is to handle a transfer to the recording media. The usage of these alternatives is not typical on every transfer between slave and master, but are a requirement to ensure that certain commands execute according to the master's requirements.

@	LTH	ID	OCTET	X/b	DEF	TRANSFER PARAMETERS
M	02	3C	01	7		Verify
				6		Volume
				5		Certify
				4		Stop on Data Error
				3		
				2		
				1		Compare - use buffer under slave control *
				0		Compare - Master repeat transfer *
						* mutually exclusive parameters

- If the Verify modifier is set the slave shall perform an implied read operation following a write to the media. This may be done to ensure the integrity of the recorded data by using the error detection/error correction code(s) of the device. The verify operation is performed following writing. The facility shall access the block specified by the Data Address. When access is complete the facility shall verify correct access position and shall read data starting with the addressed block. The slave does not transfer data to the master.

During a multiple block verify operation, if access boundaries are encountered, the facility shall perform appropriate access movements and verify block positioning. If a defective block for which an alternate location has been assigned is encountered, the facility shall access the alternate block for verifying and then re-establish the access position for subsequent blocks to be read, if any. Access positioning in all cases is verified.

Recovery from all data errors detected during verifying must be attempted by the slave. If the data error cannot be corrected by the slave, processing of the command shall be terminated with a Machine Exception indicated in Major Status. The cause of the termination shall be indicated in Substatus and Extended Substatus (if applicable). The response packet shall identify the block in error. If the data error is corrected, the facility shall continue the verify operation on the next block; the response packet shall indicate that recovery was employed.

NOTE: The slave actions for error correction are product specific and may or may not include re-writing the block in error, or automatic relocation of the data to an alternate block in the case of a media defect.

- If the Volume modifier is set the slave shall ignore the Command Extent and associate the requested command with an action beginning at the first block, and completing at the last block on the media.

- The Certify modifier applies to the FORMAT command and when set, the slave shall perform whatever actions are necessary to ensure that all recording spaces are free of defects.

- If the Stop on Data Error modifier is set, the slave shall stop data transfer immediately following a block on which some error recovery action had been taken. If a multiple block transfer is in progress, the transfer shall be completed as Conditional Success, and a Response Extent is required, which includes the Residual Count. The master shall have to recognize that a Residual Count greater than zero requires the transfer to be re-requested beginning at that point.

- If one of the Compare modifiers is set, the data previously written by the slave shall be read back and compared. The source of the data comparison shall be either re-transmittal by the master, or from a buffer under the slave's control.

6.5.1.4 Encapsulation Parameter (Optional)

This parameter may be used by the slave or the master to encapsulate information which cannot be passed directly to or from the addressee, and the contents may or may not be structured as an IPI parameter.

@	LTH	ID	OCTET	X/b	DEF	ENCAPSULATION PARAMETER
B	n+1	3D	01- n			Contents to be passed

6.5.15 Partition Parameter (Optional)

There may be more than one addressable area on some addressees. This parameter provides for the identification of these areas, and is used whenever the area that a command is to execute upon is other than the default data partition.

@	LTH	ID	OCTET	X/b	DEF	PARTITION PARAMETER
B	n+1	3E	01			Partition ID
			02			Reserved
			03- n			Product Specific

6.5.15.1 Disk Partitions

The Partition parameter shall precede the Extents parameter to which it refers. If not present, the assumed partition shall be the default data partition.

The allocation of partitions has been made as follows:

```
Slave-defined
  Data Partition
    00     Default Data Partition
  Maintenance Partitions
    01     CE Partition
    02     IML Partition
    03-07  Slave-unique Partitions
Master-defined
  Maintenance Partition
    08-0F  Additional Maintenance Partitions
  Data Partitions
    10-EF  Additional Data Partitions
Specific Usage
    FF     IPI usage; e.g., in Attributes to reference all partitions
           to any command which accesses partitions 01-0F.
```

The CE partition defines the area reserved on the device for the exclusive use of diagnostic and other procedures executed by Customer Engineering.

The IML partition defines the area reserved on the device for exclusive use by the slave and/or facility to execute an Initial Microprogram Load.

6.5.15.2 Tape Partitions

The Partition parameter shall precede the Extents parameter to which it refers. If not present, the assumed partition shall be the current partition. If present, the Partition parameter shall cause a change to the named partition (if required), followed by positioning, and is not required for subsequent operations once a change has been made. The Partition parameter without an Extent parameter in the OPERATING MODE command shall cause the change to occur at the beginning of a partition.

Tapes retain their position within a partition between commands when the partition ID is x'00' or in the range x'10-FE'.

It is not required that position or other attributes information be saved for prior partitions although some designs may provide information concerning position retention and other attributes for prior partitions, or carry over attributes from the prior partition to the new; e.g., recording format or Data Block size (see Equipment Specification).

The allocation of partitions has been made as follows:

```
Group 1
 Slave Defined
    Data Partition
      00      Default Data Partition
    Maintenance Partitions
      01      CE Partition on Storage Volume
      02      IML Partition
      03      CE Partition in Slave or Facility
      04-07   Slave-unique Partitions
 Master Defined
    Maintenance Partitions
      08-0F   Additional Maintenance Partitions

Group 2
 Slave Defined
    Data Partition
      10-7F   Additional Data Partitions (112)
.cp 3
Master Defined
    Data Partition
      80-FE   Additional Data Partitions (127)
Specific Usage
      FF      IPI usage
```

The master must Chain, Sequence, or Order the OPERATING MODES command to any command which accesses a maintenance partition.

The two CE partitions provide for one on the removable volume and one contained in the addressee. The addressee CE partition shall be contained in semi-permanent storage and logically separate from storage used for the Save and Restore of Attributes.

The IML partition provides a capability in the addressee for exclusive use by the slave and/or facility to execute an Initial Microcode Load.

The additional slave-defined data partitions are areas separate from, or in addition to, the default data partition.

The additional master-defined data partitions are allocated from within the default data partition.

6.5.16 Stop On Discontinuity Parameter (Optional)

On some devices it is desirable to be able to identify a discontinuity as being a reason to terminate a transfer. This parameter may be associated with the READ, WRITE and SEARCH transfer commands, or with FORMAT and REPORT DISCONTINUITY. It shall precede the Extent parameter to which it refers.

@	LTH	ID	OCTET	X/b	DEF	STOP ON DISCONTINUITY PARAMETERS
B	n+1	3F	01			DISCONTINUITY TYPE
				7		Cylinders
				6		Tracks
				5		Access Boundary (set by Access Permits)
				4		Discontiguous Defect Re-allocation
				3		Bands
				2		
				to		Reserved
			02	0		Time (Discontinuity Value required)
			03-06			Discontinuity Time (in µs)

Cylinders - discontinuity due to physical cylinder boundary on disk.

Tracks - discontinuity due to physical track boundary on disk.

Access Boundary - discontinuity due to a boundary established by a previously issued Access Permits command.

Discontiguous Defect Re-allocation - discontinuity due to the discontiguous relocation by the slave of a block which included a media defect.

Bands - discontinuity due to the need for a physical motion on optical disk, outside the range of a mirror adjustment.

Time - a modifier set to indicate that the time field is to be used.

Discontinuity Time - a value in microseconds, which if exceeded by the media accessing techniques, is to be considered a discontinuity.

6.5.17 Imbedded Data Parameter (Optional)

This parameter is used for transferring data which has been gathered by an addressee which has limited, low rates of data transfer requirements.

@	LTH	ID	OCTET	X/b	DEF	IMBEDDED DATA PARAMETERS
S	n+1	40	01- n			Data to be transferred

7.0 CONTROL COMMANDS

The commands in this section are used as Control commands.

The abbreviations used in graphical representation of commands and responses in the following sections are:

PKT LTH	Packet Length
REF NO	Command Reference Number
OP CODE	Operation Code
COM MOD	Common Command Modifiers
OP MOD	Op Code Modifiers
SLAV ADDR	Slave Address
FAC ADDR	Facility Address
x	Hexadecimal Value
e	Echoed Value (from Command Packet)
b	Bit Value (identified by position 0-7 or 0-B)

7.1 NOP

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  00  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|   Command  | CODES    |TYPE|CODE|
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The NOP command is a null command that is issued to the slave. The slave shall perform no operation, shall not change its state, and shall return the standard completion response to the master. The slave shall clear any previous status (Section 6.4) when it executes a NOP command, in the same manner as would be done on any other command except READ ADDRESSEE STATUS.

The slave shall ignore any parameters associated with this command. Some masters use command chains or sequences that are modified at the time of dispatch to the slave. The NOP opcode may be used to override execution of commands which have associated parameters.

7.2 Facility Operation

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |     3   | 4  | 5  | 6 through n
+----+----+----+----+----+----+----+-------------
 xxxx xxxx  01  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+-----------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|  Command   | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+-----------+---------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The FACILITY OPERATION command is a "pass through" command that allows a primitive command or a product unique command to be transferred to the slave/facility. The command information is passed in the Encapsulation Parameter appended to the command. The format or content of the encapsulation is slave/facility dependent and is not specified.

Facility Operation Parameters:

```
+-+---+--+-----+---+---+
|@|LTH|ID|OCTET|X/b|DEF|       FACILITY OPERATION PARAMETERS
+-+---+--+-----+---+---+----------------------------------------
|B|n+1|3D|01- n|   |   | ENCAPSULATION PARAMETER
| |   |  |     |   |   |
+-+---+--+-----+---+---+----------------------------------------
```

Encapsulation Parameter:

The contents of this parameter are interpreted directly by the addressee, and may or may not conform to an IPI structure. Unless addressed to the slave, there will usually be no attempt by the slave to parse the encapsulated contents.

7.3 Attributes

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  02  bbbb bbbb  xx   xx
                7654 3210
                     ||||
                     ||||   Bits 0, 1, 3 have encoded meaning of:
                     |||    x'0'=Report
                     ||     x'1'=Initialize    x'2'=Restore
                     |      x'9'=Load          x'A'=Save
```

Response Packet:

```
+-----+------------+---------------------+-----------
|PKT  | Echoed From|    MAJOR STATUS     | PARAMETERS
| LTH |   Command  | CODES    |TYPE|CODE|
|     | 0 1 2 3 4 5|   6      |    7    | 8 through n
+-----+------------+----------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The ATTRIBUTES command allows modification of the slave or facility attributes which are used to tell the master what the addressee's operational characteristics are and to allow them to be examined or modified. The operational characteristics that may be modified in the addressee are implementation dependent.

The operating mode of ATTRIBUTES is determined by the opcode modifier which allows the master to Initialize, Report, Restore, Load, or Save the addressee attributes. The modifiers are mutually exclusive.

NOTE: Bits 0, 1 and 3 (x'1', x'2', and x'8') are encoded.

The information supplied and/or modified by the slave in accordance with the command is specific to the addressee identified by the Slave Address and facility address of the command. Unless a master has prior knowledge, processing of Attributes would begin by analysis of the slave's capabilities and proceed through each attached operational facility.

Report requires the addressee to respond with a list of parameters which detail the attributes requested by the command.

Initialize allows the master to require the addressee to set all of its attributes to their initial values.

NOTE: These may not represent a valid configuration.

Restore allows the restoration of saved attributes. At power on, slaves and facilities shall perform an automatic Restore. If no attributes have been Saved by the master, the Restore values shall be a valid configuration of the Initialize attributes.

Save allows the addressee attributes, including those associated with this command, to be saved prior to power down or removal of the media from a removable media facility.

Load requires the addressee to modify attributes within the addressee (if they are valid).

When the Initialize or Restore modifiers are set, the addressee acts upon all attributes. Similarly, if no parameters are transmitted with the command packet when the Report or Save modifiers are set, the addressee acts upon all attributes.

If the master wishes to be selective about attributes to be affected it shall provide a list of the parameter IDs (via the Request Parm parameter), with the Report, Load, or Save modifiers.

The master and slave either have parameters that are unique to each (so indicated by either M or S in the @ column), or are common to both (indicated by "B" in the @ column). Common parameters are used by the slave to report, and the master to modify. A consistent sequence is necessary to properly manage parameters that are common.

If a master wishes to find out the Initial settings of the slave (rather than the Restored settings), it issues an ATTRIBUTES command with the Initialize modifier set. The slave shall set the Attributes parameters to their initial factory values. The master issues an ATTRIBUTES command with the Report modifier set, to look at the parameter(s) of interest.

The master can change the Attributes parameter(s) by issuing an ATTRIBUTES command with the Load or Save modifier set, and thus instruct the slave to act upon the new values.

If the master does not wish the new values to be kept beyond Power Off, the Load modifier is set.

If the master wishes the new values to be kept beyond power off, and Restored by the slave after power on, the Save modifier is set.

The master can use the Restore modifier to have the slave return to its previously Saved values.

Some of the attributes apply equally to either slave or facility; e.g., number of ports. In the case of an integrated slave and facility both slave and facility apply. For this reason it is impossible to clearly define attributes as belonging to either slave or facility unless the configuration of intended use is known. Therefore, all attributes are shown as being relative to the addressee, even though some may be specifically slave oriented, and others may be specifically facility oriented.

Within the parameters there are sets of octets that may need to be repeated several times to provide all of the information. These repetitive octet sets are noted in the parameter tables.

On facilities which support more than one type of partition, the Partition Parameter shall precede every set of attributes parameters for that partition. In this manner every partition is described by a group of succeeding attributes parameters; e.g., if a disk which has been formatted with one Physical Block size has three partitions, the Size of Disk Physical Blocks parameter would be the same and repeated in every set of parameters succeeding each Partition parameter.

If the Report modifier is set, and a Partition Parameter with an ID of x'FF' is appended to the command, the slave shall respond with information on all of the partitions (with each set of information preceded by a Partition Parameter). On a Report, Load or Save, the absence of a Partition Parameter means the default data partition attributes are to be referenced.

If any fields are not needed in a parameter, the parameter length can be cut short; e.g., on Parameters 53 and 54, a disk with a fixed clock rate and variable rotation speed has a different number of bytes per track on every cylinder so parameters such as the Total Number of Blocks per Cylinder and Total Number of Blocks per Track need not be supplied.

NOTE: There is a need for three types of memory to completely manage Attributes.

To retain all Attributes:

Permanent - contains all of the attributes as defined by the product design. This memory contains the Initial value of Attributes. It is possible that the Initial Attributes are not a valid configuration; e.g., two features which are mutually self-exclusive may be capable of being supported by the slave.

To retain Attributes changed by the master:

Semi-Permanent - at the point of manufacture these values are set to a valid combination of the Initial Attributes. The contents may be replaced by the master performing a Save. The slave uses the contents of this memory to Restore Attributes at power on, or under command of the master when the Restore modifier is set.

Current - after power on the contents are the same as Semi-Permanent memory; i.e., Restored. Individual Attributes may be changed by the master performing either a Load, or a Save with parameters.

Modifiers that permit operations upon individual Attributes are:

Report - the current memory contents are reported to the master. If no parameters are appended the slave responds with all attributes (which can be a very large length). The Request Parms parameter may be used to specifically identify Attributes.

Load - this modifier requires that parameters be appended for Attributes which may be modified. The slave shall replace the contents of the designated parameter(s) in Current memory with the one(s) in the command parameter list (if valid).

Save - if this modifier has associated parameters, the command is executed in the same manner as a Load, then the contents of Current memory are written into Semi-Permanent memory.

Modifiers that operate upon all changeable Attributes:

Initialize - no parameters are accepted. the contents of Permanent memory are written into current memory.

Restore - no parameters are accepted. The contents of Semi-Permanent memory are written into the Current memory.

Save - if no parameters are appended, the contents of Current memory are written into Semi-Permanent memory.

7.3.1 Attributes Parameters 3A, 3E, 50

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
B	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
B	n+1	50				VENDOR ID
			01-10			MPI Identification (ASCII)
			11-18			MPI Model Number (ASCII)
			19-1C			MPI Revision Number (ASCII)
			1D-24			MPI Unique ID
			25-28			MPI Switch Settings
			29- n			MPI Defined Fields

7.3.1.1 Data Address (Common) Parameter

This parameter is used to follow any parameter in which a 32 bit Data Address field is inadequate.

7.3.1.2 Partition (Common) Parameter

This parameter is used to precede the set(s) of facility-dependent parameters to identify which partition is being referred to.

7.3.1.3 Vendor ID Parameter

- MPI Identification (ASCII) - This field contains the addressee ID.
- MPI Model Number (ASCII) - This field contains the model number of the addressee.
- MPI Revision Number (ASCII) - This field contains the current revision number of the addressee.
- MPI Unique ID - This field contains a value which is a unique identification of the slave. If the slave does not provide a unique value, then this field shall be modifiable by the master so as to provide a unique ID value.
- MPI Switch Settings - This field contains the settings of switches that may be field set or modified on the slave.
- MPI Defined Fields - Any fields which the product design chooses to provide.

7.3.2 Attributes Parameters 51→58

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS	
B	05	51	01-04			SIZE OF DISK Data Blocks **	
S	05	52	01-04			SIZE OF DISK Physical Blocks **	
						** If zero, the addressee is not formatted and/or IDs 53 and 54 are invalid	
S	n+1	53				TOTAL NUMBER OF DISk Data Blocks	
			01-04			Total No of Blocks per Partition	
			05-08			Total No of Blocks per Cylinder	
			09-0C			Total No of Blocks per Track	
			0D-10			Data Address	
			n-B:8			Total No of Blocks per Cylinder	repeated as
			n-7:4			Total No of Blocks per Track	many times
			n-3:n			Data Address	as needed
S	n+1	54				TOTAL NUMBER OF DISK Physical Blocks	
			01-04			Total Number of Blocks per Partition	
			05-08			Total Number of Blocks per Cylinder	
			09-0C			Total Number of Blocks per Track	
			0D-10			Data Address	
			n-B:8			Total No of Blocks per Cylinder	repeated as
			n-7:4			Total No of Blocks per Track	many times
			n-3:n			Data Address	as needed
S	n+1	55				Data Block SIZES SUPPORTED	
			01-04			Smallest Block Size Supported	
			05-08			Largest Block Size Supported	
			09-0C			Increment Size	
			n-B:8			Smallest Block Size	repeated as
			n-7:4			Largest Block Size	many times
			n-3:n			Increment Size	as needed
S	n+1	56				Physical Block SIZES SUPPORTED	
			01-04			Smallest Block Size Supported	
			05-08			Largest Block Size Supported	
			09-0C			Increment Size	
			n-B:8			Smallest Block Size	repeated as
			n-7:4			Largest Block Size	many times
			n-3:n			Increment Size	as needed
S	n+1	57				SIZE OF PHYSICAL GROUPS	
			01-02			Number of Physical Blocks per Physical Group	
		58				Reserved	

7.3.2.1 Size of Disk Data Blocks Parameter

This field contains an unsigned binary number specifying the size of the Data Blocks contained within the disk Partition. The master may use this parameter to set the Data Block size of a formatted slave.

7.3.2.2 Size of Disk Physical Blocks Parameter

This field contains an unsigned binary number specifying the size of the Physical Block contained within the disk Partition. Physical Block size is established by the FORMAT command.

7.3.2.3 Total Number of Disk Data Blocks Parameter

- Total Number of Blocks per Partition - an unsigned binary number specifying the number of Data Blocks contained within the disk partition.

- Total Number of Blocks per Cylinder - an unsigned binary number specifying the number of Data Blocks per cylinder.

- Total Number of Blocks per Track - an unsigned binary number specifying the number of Data Blocks per track.

- Data Address - this field contains the starting address of the first block. The first data address shall always be zero. On disks which have a variable number of octets per track, typically within bands or groups of cylinders, to define a partition requires the use of more than one set of fields, so they are repeated as many times as necessary.

7.3.2.4 Total number of Disk Physical Blocks Parameter

This parameter follows the same format as that for Data Blocks, except that the field contents refer to Physical Blocks and not Data Blocks.

7.3.2.5 Data Block Sizes Supported Parameter

- Smallest Block Size Supported - an unsigned binary number specifying the smallest value of a range of Data Block sizes.

- Largest Block Size Supported - an unsigned binary number specifying the largest value of the range supported.

- Increment Size - an unsigned binary number specifying the increment by which a block can increase from the smallest to the largest size.

There may be more than one range supported, so these fields are repeated as many times as required for the disk. If a block size is fixed the same value is duplicated in the Smallest and Largest fields.

If a disk can be formatted with any block size greater than 256 up to the end of track with 20,160 octets, it would be represented by one set - (256,20160,1). If only two multiples of block size, 512 and 2048, are supported per track two sets would be represented; e.g., (512,17408,512) followed by (2048,18432,2048).

7.3.2.6 Physical Block Sizes Supported Parameter

This parameter follows the same format as that for Data Blocks, except that the field contents refer to Physical Blocks and not Data Blocks.

7.3.2.7 Size of Physical Groups

This parameter contains an unsigned binary value with the count of the number of Physical Blocks in a Physical Group.

7.3.3 Attributes Parameters 59→5A

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	02	59				ATTRIBUTE TABLE CONDITIONS
			01	7		Attributes Table May be Corrupted
				6		Attributes Table Initialized by Master
				5		Attributes Table Restored by Slave
				4		Attributes Table Restored by Master
				3		Attributes Table Loaded by Master
				2		Attributes Table Saved by Master
				0-1		Reserved
B	n+1	5A				PAD WITH FILL CHARACTERS
			01- n			Fill character(s)

7.3.3.1 Attributes Table Conditions Parameter

- Attributes Table May be Corrupted - If a command to change Attributes is initiated this bit is set and all others are set to zero. If the command fails to complete successfully then this bit shall remain set to indicate that there may have been contamination by partial processing. If the command completes successfully this bit is reset to zero and the appropriate bit setting below is posted.

- Attributes Table Initialized by Master - This bit is set by the slave to indicate that the attributes have been set to their initial values by command of the master. If the master attempts to change any attributes after this bit has been set, the slave shall reset this bit indicating that attributes have been changed.

- Attributes Table Restored by Slave - This bit is set by the slave following power on to indicate that the attributes have been restored. If the master attempts to change any attributes after this bit has been set, the slave shall reset this bit indicating that attributes have been changed.

- Attributes Table Restored by Master - This bit is set by the slave to indicate that the attributes have been set to their saved values by command of the master. If the master attempts to change any attributes after this bit has been set, the slave shall reset this bit indicating that attributes have been changed.

- Attributes Table Loaded by Master - This bit is set by the slave to indicate that attributes have been loaded by command of the master. If the master attempts to change any attributes after this bit has been set, the slave shall reset this bit indicating that attributes have been changed.

- Attributes Table Saved by Master - This bit is set by the slave to indicate that attributes have been saved by command of the master. If the master attempts to change any attributes after this bit has been set, the slave shall reset this bit indicating that attributes have been changed.

7.3.3.2 Pad with Fill Characters Parameter

When a situation exists where the slave has to pad data, the slave shall use this field. In the event that the field specified does not fill the entire space to be padded, the slave shall repeat the supplied field until the space is filled.

7.3.4 Attributes Parameters 5B→5D

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS	
B	n+1	5B				DISK PARTITION DEFINITION	
			01			Partition ID	
			02			Facility Address	
			03			Type of Disk	
				7		Non-Removable Disk	
				6		Removable Disk	
				5		Floppy Disk	
				4		Fixed Head Disk	
				3		Moving Head Disk	
				2		Solid State Disk	
				1			
				to		Reserved	
			04	0			
			05-08			Block Count	
			09-0C			Data Block Address	
B	n+1	5C				SYNONYM DEFINITION	
			01			Synonym Address	
			02			Actual Facility Address	
			n- 1			Synonym Address	repeated as many
			n			Actual Facility Address	times as needed
B	n+1	5D				ALIAS DEFINITION	
			01			Alias Address	
			02			Facility Address	
			03			Partition ID	
			04			Reserved	
			n- 3			Alias Address	repeated
			n- 2			Facility Address	as many
			n- 1			Partition ID	times as
			n			Reserved	needed

7.3.4.1 Disk Partition Definition Parameter

The Partition ID identifies the Partition to be defined. The Facility Address (it may be an Actual or Synonym address) defines where the partition is located. The Type of Disk is bit significant and identifies the kind of disk area where the partition is located. The Block Count and Data Address are used to define the extent of the formatted default data area which is to be the partition. This parameter can only be issued to a formatted facility.

7.3.4.2 Synonym Definition Parameter

The parameter list consists of ordered pairs in which the first octet in each pair contains the Synonym address, followed by the absolute Facility Address. Commands issued by the master can use the synonym in the Facility Address field, and the slave shall be responsible to correctly address the actual facility.

7.3.4.3 Alias Definition Parameter

The parameter list consists of three ordered octets in which the first octet contains the Alias address, followed by the Facility Address (which may be a Synonym or an Actual address) and the Partition ID to which it is to refer. The slave shall accept the Alias as a Facility Address to refer to the partition, in lieu of the Partition ID preceding Extent parameters.

7.3.5 Attributes Parameters 5E, 5F

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
B	n+1	5E				MULTI-PORT CHARACTERISTICS
			01-02			Number of Ports
			03			No of stacked cmds allowed at alt'nate port(s)
B	n+1	5F				PHYSICAL DISK CONFIGURATION
			01-04			Number of Cylinders
			05-08			Number of Heads per Cylinder
			09-0C			Number of Fixed Sectors per Revolution *
			0D-10			Absolute Number of Octets per Track
			11-14			Single Cylinder Seek time (µs)
			15-18			Average Cylinder Seek time (µs)
			19-1C			Maximum Cylinder Seek time (µs)
			1D-20			Rotational Period (µs)
			21-24			Head Switch time (µs)
			25-28			Write to Read Recovery Time (µs)
			29-n			Product Specific Data
						* Zero if not fixed

7.3.5.1 Multi-Port Characteristics Parameter

The first field contains the number of ports on the addressee. The second field contains an unsigned binary value of the number of commands that can be stacked at an alternate port before the addressee's alternate port shall report a Busy condition or Command Reject (See 5.10.5) due to the command buffer being full.

If the master wishes to force a single switching point at the addressee it may force the number of commands allowed at alternate ports to zero.

7.3.5.2 Physical Disk Configuration Parameter

This parameter may be used by the master to identify the characteristics of disk drives which are not self-identifying to the slave. It is more typically used by the slave to inform the master of the physical characteristics of the disk(s) attached.

- Number of cylinders - this value specifies the number of data cylinders (including spares) on the addressee.

- Number of Heads per cylinder - This value specifies the number of addressable heads per cylinder for the addressee.

- Number of Fixed Sectors per Revolution - This value specifies the number of fixed sectors (including spares) available on each revolution for the addressee. Sectors between imbedded servo bursts can be configured to contain more than one Physical Block. This value is zero if the disk does not have fixed sectors.

- Absolute Number of Octets per track - This value specifies the number of octets nominally included on each track of the addressee; including gaps, spares, and other overhead allowances.

- Single Cylinder seek time - This value specifies the single cylinder seek time for moving head disk drives.

- Average Cylinder seek time - This value specifies the average cylinder seek time for moving head disk drives, as specified by the equipment specification.

- Maximum Cylinder seek time - This value specifies the maximum cylinder seek time for moving head disk drives.

- Head Switch time - This value specifies the head switch time for multiple head disk drives.

- Rotational Period - This value specifies the rotational period for the addressee; i.e., the time it takes for one disk revolution from index to index.

- Write to Read Recovery Time - This value specifies the time that it takes the disk to become capable of reading data after writing data.

7.3.6 Attributes Parameters 60→63

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	n+1	60				Data Block INTERLEAVE PARAMETER
			01	7		Interleave Factor/Interleave Values
				6-0	0	
			02			Supported
			03			Current
S	09	61				TRANSFER RATE (Octets/second)
			01-04			Effective Transfer Rate
			05-08			Slave's Instantaneous Transfer Rate
S	n+1	62				Physical Block PERFORMANCE CHAR'STICS SUPPORTED
			01			Smallest Physical Block Interleave Factor
			02			Largest Physical Block Interleave Factor
			03			Smallest Head Interleave Factor
			04			Largest Head Interleave Factor
			05			Smallest Cylinder Interleave Factor
			06			Largest Cylinder Interleave Factor
			n-5:4			Physical Block Interleave Factor repeated as
			n-3:2			Head Interleave Factor many times
			n-1:n			Cylinder Interleave Factor as needed
S	n+1	63				CURRENT Physical Block PERFORMANCE SETTINGS
			01			Physical Block Interleave factor
			02			Head Interleave Factor
			03			Cylinder Interleave factor

7.3.6.1 Data Block Interleave Parameter

The first octet is used to identify whether the interleave is established by values unique to the facility, or by factors which are predictable by the master.

When Bit 7=0 the parameter refers to factors which affect transfer rate in a manner that is predictable based upon an algorithm of block interleave factors.

- Supported - this value specifies the maximum interleave factor that can be supported.

- Current - this value specifies the current factor of interleave on the formatted disk. A value of zero or 1 mean the same, that there is no interleave factor; i.e., 1:1.

When Bit 7=1 the parameter refers to values which are device specific, and cannot be calculated without specific knowledge of a pre-existing disk format.

- Supported - this octet identifies the interleave factor values that are defined by the facility. Bit 0 specifies interleave value 0, which is the basic transfer rate capability of the facility, and is always indicated. Bits 1-7 specify interleave values, which are defined by Equipment Specification.

7	Lowest Effective Transfer Rate
1-6	Intermediate Effective Transfer Rates
0	Fastest Effective Transfer Rate

Individual bits 1-7 indicate the ability to cause a reduction in the transfer rate that exceeds the reduction of the immediately preceding bit. Bit 5=1 will cause a greater reduction in the transfer rate than bit 4=1).

- Current - this octet identifies the interleave factor value that is presently established for the facility. Only one bit shall be set in this octet.

7.3.6.2 Transfer Rate Parameter

- Effective Transfer Rate - this value specifies the effective transfer rate of the addressee; e.g., based on the interleave factors used by the slave at formatting. The value is vendor-defined and typically represents a calculation based on the time it takes to transfer one track of data in contiguous block number sequence, which with an interleave factor of greater than zero requires more than one rotation.

- Slave's Instantaneous Transfer Rate - this value specifies the maximum speed at which the slave can transfer from its internal buffer(s).

7.3.6.3 Physical Block Performance Characteristics Supported Parameter

This parameter is provided by the slave to advise the master which interleave factors can be supported when Physical Block formatting is used. The three pairs of octets are repeated if there is more than one range that can be supported.

- Physical Block Interleave Factor - this pair of octets defines the low to high range of interleave factors that can be supported between Physical Blocks.

- Head Interleave Factor - this pair of octets defines the low to high range of interleave factors that can be supported between heads.

- Cylinder Interleave Factor - this pair of octets defines the low to high range of interleave factors that can be supported between cylinders.

If only one factor can be supported the same value is repeated in the smallest and largest field.

7.3.6.4 Current Physical Block Performance Settings Parameter

This parameter is used to advise the master of the current interleave settings of the partition referred to. If no Partition parameter precedes this parameter, the values for the default data partition are provided.

- Physical Block Interleave Factor - this octet defines the current interleave factor in effect between Physical Blocks.

- Head Interleave Factor - this octet defines the current interleave factor in effect between heads.

- Cylinder Interleave Factor - this octet defines the current interleave factor in effect between cylinders.

7.3.7 Attributes Parameters 64→65

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	15	64				PHYSICAL INTERFACE ATTRIBUTES PARAMETER
			01-04			SDE (ns)
			05-08			IRT (ns)
			09-0C			CCD (ns)
			0D-10			SDR (µs)
			11-14			SYD (µs)
S	n+1	65				ADDRESSEE CONFIGURATION PARAMETER
			01-04			Data Buffer Size
			05-08			Command buffer size
			09-0A			Max No of octets in Command Packet
			0B-0C			Max No of octets in Response Packet
			0D			Max No of Access Permit Extents
			0E			Min No of Queued Commands
			0F			Max No of Queued Commands
			10			Size of Command Stack

7.3.7.1 Physical Interface Attributes Parameter

See 5.0 of the IPI Physical Interface specification 64732100 for the definition of these fields which must be supplied at power on.

7.3.7.2 Addressee Configuration Parameter

This parameter is typically relevant only to the slave. However, a slave may have facilities attached which contain their own buffers and capabilities, or the slave may have allocated its own buffering on a dedicated basis amongst the facilities. A simple example would be facilities with integral data buffers for error correction (in which case only the first parameter field is required).

This parameter is intended to provide the master with information that would allow it to maximize performance. If this parameter is relevant to facilities as well as the slave, it is noted in the Slave Configuration parameter (see Facility Configuration Information).

- Data Buffer Size - this value specifies the size (in octets) of the data buffer associated with the addressee.

- Command Buffer Size - this value specifies the size (in octets) of the command buffer associated with the addressee.

- Maximum Number of octets in Command Packet - this value specifies the maximum number of octets the addressee can accept in a command packet.

- Maximum Number of octets in Response Packet - this value specifies the maximum number of octets the addressee can provide in a response packet.

- Maximum Number of Access Permit Extents per Addressee - This value specifies the maximum number of Access Permits Extents allowed per addressee.

- Minimum Number of Queued Commands - Any value greater than zero indicated the minimum number that shall be guaranteed to queue per facility. A value of zero means the slave cannot guarantee any commands for the facility.

- Maximum Number of Queued Commands - A value of zero means that the queue may contain more than the minimum but only as many as the size of the command buffer permits. A value of 1 means that there is no Command Queueing and commands are Individual. Any other value must be greater than or equal to the minimum.

- Size of Command Stack - this value specifies the minimum number of commands that the slave is capable of stacking; e.g., a slave with addressability to 8 facilities and a minimum queue size of 4 per facility may stack 32. If this is an absolute limitation, the value of 32 shall be specified. However, in some implementations the stack may be as large as command buffering and the queueing algorithm permits, and may exceed 32 if commands are small in length. If the size of the stack is variable depending on the sum of command sizes, and it can exceed the calculatable maximum, this field shall be set to x'FF'.

  NOTE: A large number of factors influence the exact degree of stacking and queueing actually available in a slave; e.g., a slave capable of addressing 8 facilities but only 3 are physically attached and operational. If Individual commands are issued, then no more than 3 commands can be stacked. If Queued commands are issued, and there may be up to 4 per facility, the command stack would be 32. However, since only 3 facilities are operational, the effective queue per facility would average above 10 commands. The minimum parameters are what the slave guarantees, and are not intended to be an upper limit.

Another consideration is that commands are variable in length, but the size of the command buffer is typically fixed. In a configuration of 8 facilities with a minimum command queue of 4 and a maximum command size of 256, the command stack would be 32 and the command buffer size would have to be 8,192 octets (32*256). However, if only one command of maximum size can be accepted by the slave; e.g., a COPY, and others are typically less than 64 octets, then the command buffer size need be only 2,240 octets (256+(31*64). Refer to product documentation to determine the methods of buffer management used to maximize performance.

7.3.8 Attributes Parameters 66

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	n+1	66				SLAVE CONFIGURATION (BIT SIGNIFICANT)
			01	7		Facilities may be of Different Classes
				6		Facility-Facility Transfers
				5		Synonym Addressing
				4		Alias Addressing
				3		Odd Octet Transfers
				2		Master Termination of Commands Required
				1		Extended Substatus
				0		Multiplexed Data Transfers
			02	7		Transfer Notification Packets
				6		Imbedded Data Responses
				5		Master-Definable Maintenance Partitions
				4		Facility Configuration Information
				3		Master Throttling of Data Streaming
				2		Multiple Command Extents Accepted
				1		Data Streaming Data Transfers
				0		Interlock Data Transfers
			03	7-0		Reserved
			04			Logical Interface
				7		Level 2
				6		Level 3
				5-0		Reserved

Slave Configuration (Bit Significant) Parameter - There are a large number of features which the slave may be able to support, and this represents a summary of its capabilities.

- The Facilities May be of Different Classes bit is set by the slave if it can support more than one class of facility.

  NOTE: This bit is set even if both classes are not currently attached.

- The Facility-Facility Transfer Capability bit is set by the slave to indicate that it has the capability to transfer data between facilities attached to it without master intervention.

- The Synonym Address bit is set if the slave allows the master to re-define Facility Addresses as Synonyms.

- The Alias Address bit is set if the slave allows the master to re-define Facility Addresses to refer to data partitions by Aliases.

- The Odd Octets Transfer bit is set if the slave supports Double Octet Mode and can transfer odd octets of information.

- The Master Termination of Commands Required bit is set if the slave requires the master to terminate the Information Transfer of commands; i.e., the slave does not dynamically use the Packet Length of the command to generate the necessary number of SYNC INs at the Physical Interface.

- The Extended Substatus bit is set if the slave can provide Extended Substatus. If this capability is available the slave shall also be capable of inhibiting Extended Substatus in responses.

- The Multiplexed Data Transfers bit is set if the slave is capable of multiplexing data transfers; i.e., breaking up a single transfer request into bursts defined as acceptable by the master.

- The Transfer Notification Packets bit is set if the slave has the capability to generate same.

- The Imbedded Data Responses bit is set if the slave has the capability to generate same.

- The Master-Definable Maintenance Partitions bit is set if the slave is capable of allowing the master to define a maintenance partition within the default data partition.

- The Facility Configuration Information bit is set if the slave can provide Addressee Configuration parameters for attached facilities.

- The Master Throttling of Data Streaming bit is set if the slave can support the master throttling a data streaming transfer.

- The Multiple Command Extents Accepted bit is set if the slave is capable of accepting more than one Command Extent on a READ or WRITE command, in order to permit "scatter READ" and "scatter WRITE."

- The Data Streaming Data Transfers bit is set if the slave is capable of Data Streaming data transfers.

  NOTE: in this case the Physical Interface defines operation transfers).

- The Interlocked Data Transfers bit is set if the slave is capable of interlocking data transfers.

  NOTE: in this case the Physical Interface defines operation transfers).

- The Level 2 bit is set if the slave can support Level 2 operations.

- The Level 3 bit shall always be set.

7.3.9 Attributes Parameter 67

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	n+1	67				SLAVE CONFIGURATION (FIELDS)
			01			No of Synonyms Supported per Actual Address
			02			Lowest Synonym Address Supported
			03			Highest Synonym Address Supported
			04			No of Data Partitions Supported per facility
			05			No of Aliases Supported per Partition
			06			Lowest Alias Address Supported
			07			Highest Alias Address Supported
			08			No of concurrent COPY commands supported
			09			Maximimum No of extents Supported
			0A-0F			Reserved
			10- n			Actual Addresses of Facilities Attached

Slave Configuration (Fields) Parameter:

- Number of Synonyms Supported per Actual Address - this value specifies the number of Synonym addresses that can be used to refer to any one Actual address. If the slave cannot support Synonym addressing, this value is 0, and the contents of the next two octets shall be x'FF'.

- Lowest Synonym Address Supported - This value defines the lowest Synonym address supported as a Facility Address (typically 00).

- Highest Synonym Address Supported - This value defines the highest Synonym address suppported as a Facility Address (may be less than or equal to FE).

- Number of Data Partitions Supported per facility - this value specifies the number of partitions that can be supported in the data area of a facility. A value of 1 means that the slave supports only the default data partition.

  NOTE: If the slave also supports Alias Addressing, then a partition may be referred to by an Alias.

- Number of Aliases Supported per Partition - this value specifies the number of Alias addresses that can be used to refer to a Partition. If the slave cannot support Alias addressing, this value is 0, and the contents of the next two octets shall be x'FF'.

- Lowest Alias Address Supported - This value defines the lowest Alias address supported as a Facility Address (typically 10).

- Highest Alias Address Supported - This value defines the highest Alias address supported as a Facility Address (may be less than or equal to FE).

- Number of concurrent COPY commands Supported - This value specifies the number of COPY commands that can be outstanding for the slave.

- Maximum Number of Extents Permitted - this value specifies the maximum number of extents that can be specified on those commands which allow multiple extents to be supplied. If a value of zero is set, it means that the number is as large as can be incorporated in the slave's command buffer - this will vary depending on the size of the command buffer, and the number of other commands already residing in the buffer.

- Actual Addresses of Facilities Attached - This is a string of octets, each of which identifies an attached facility by its Actual Address. The address assignment is not necessarily contiguous for facilities. All facilities attached shall be identified.

  NOTE: Information on facilities that are not powered-up or are otherwise non-functional may not be available via the Facilities Attached parameter.

7.3.10 Attributes Parameter 68

```
+-+---+--+-----+---+---+
|@|LTH|ID|OCTET|X/b|DEF|       ATTRIBUTES PARAMETERS
+-+---+--+-----+---+---+-------------------------------------------
|B|n+1|68|     |   |   | FACILITIES ATTACHED TO SLAVE PARAMETER
| |   |  |   01|   |   | Actual Facility Address
| |   |  |   02|   |   |      Facility Class
| |   |  |     |01 |   | Magnetic Disk
| |   |  |     |02 |   | Optical Disk
| |   |  |     |03 |   | Magnetic Tape
| |   |  |     |04 |   | Communications
| |   |  |   03|   |   |      Facility Type
| |   |  |     |   |   | For Magnetic Disk:
| |   |  |     |  7|   |     Non-Removable Disk
| |   |  |     |  6|   |     Removable Disk
| |   |  |     |  5|   |     Floppy Disk
| |   |  |     |  4|   |     Fixed Head Disk
| |   |  |     |  3|   |     Moving Head Disk
| |   |  |     |  2|   |     Solid State Disk
| |   |  |     |  1|   |
| |   |  |     |to |   |   Reserved
| |   |  |   04|  0|   |
| |   |  | n- 3|   |   | Actual Facility Address        repeated
| |   |  | n- 2|   |   | Facility Class                 as many
| |   |  | n- 1|   |   | Facility Type                  times as
| |   |  |    n|   |   |   Reserved                     needed
| |   |  |     |   |   |
+-+---+--+-----+---+---+-------------------------------------------
```

Facilities Attached to Slave Parameter:

This parameter is addressed only to the slave, and its contents are repeated for as many facilities as there are attached to the slave. It would typically be used by the slave to advise the master of attached facilities. However, when facilities attached are not self-identifying, the master may use this parameter to advise the slave of the attached facility characteristics.

The first octet contains the Actual address of the facility which is typically a device, and the next pair is used to identify the type of facility. The first octet of the pair defines the generic class of device, and the second octet is bit significant to allow reporting of devices which have more than one characteristic; e.g., a disk may have both fixed and moving heads.

7.3.11 Attributes Parameters 69→6A

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
		69				RESERVED
S	n+1	6A				COMMAND SUPPORTED
			01			Op Code Supported
			02			Reserved
			03-04			Common Modifier Mask
			03			Reserved
			04	F-8		Reserved
				7		Priority/Ordered
				6		Priority/Sequential
				5		Priority/Chained
				4		Priority
				3		Ordered
				2		Sequential
				1		Chained
				0		Queued
			05-06			Op Code Modifier Mask
				F-0		Coded According to Modifiers Supported
			07			Parameter ID (first) repeated as many
			n			Parameter ID (last) times as needed

Commands Supported Parameter - This parameter is present for every command supported by the slave.

- Op Code Supported - the value of the supported Op Code is supplied.

- Common Modifier Mask - each bit position represents the encode value of the common modifier bits implemented by the slave for the command; e.g., if a slave does not support Sequential or Ordered on a command, then bit positions 1, 4 and 5 are set to 1 to indicate that Priority and/or Chained are supported in any combination.

- Op Code Modifier Mask - each bit represents the encode value of the Op Code Modifier bits implemented by the slave on a command.

- Parameter ID - This is a list of the IDs of all of the parameters that are supported for the specified op code.

7.3.12 Attributes Parameter 6B

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	n+1	6B				MASKS OF OCTETS SUPPORTED
			01			Selection Octet Mask
				7		1=Facility Selection supported
				4-6	7	Slave Address - Mandatory
				3		1=Change Transfer Mode
				2		1=Change Octet Mode
				1		1=Priority Select
				0		1=Priority Hold
			02			Bus Control Octet Mask
				7	1	Operation/Data - Mandatory
				6	1	Direction - Mandatory
				5		1=Reserved
				4		1=Control of Bus
				0-3		1-F=Reserved
			03			Bus Acknowledge Octet Mask
				7		1=Operation/Data
				6		1=Transfer Direction
				5		1=Reserved
				4		1=Control of Bus Accepted
				0-3		1-F=Reserved
			04			Master Status Octet Mask
				7	1	Successful/Unsuccessful - Mandatory
				6	1	1=Bus Parity Error - Mandatory
				5		1=Pause
				4		1=Slave-Slave Operation Completed
				0-3	F	F=Defined Ending Status - Mandatory
			05			Slave Status Octet Mask
				7	1	Successful/Unsuccessful - Mandatory
				6	1	Bus Parity Error - Mandatory
				5		1=Pause
				4		1=Time Dependent Operation
				0-3	F	F=Defined Ending Status - Mandatory
			06			Request Modifier Octet Mask
				7		1=Facility Interrupts supported
				6	1	Report Busy Status - Mandatory

(continued)

				5	1	Report Ready Status - Mandatory
				4	1	Power Fail Alert - Mandatory
				3	1	Power On Status Request - Mandatory
				0-2	7	Interrupt Class - Mandatory
			07			Selective Reset Control Octet Mask
				4-7	F	Slave Address - Mandatory
				3		1=Slave Release
				2		1=Re-initialize as at Power On
				1		1=Reset Logical Interface
				0		1=Reset Port Physical Interface
			08			Slave Interrupts Octet Mask
				7	0	Reserved
				6	1	Report Busy Status - Mandatory
				5	1	Report Ready Status - Mandatory
				4		1=Priority Hold Status
				3	1	1=Priority Select Status
				0-2	7	Interrupt Class - Mandatory

Masks of Octets Supported Parameter:

- Selection Octet Mask - Bits 4-6 are required for execution over the Physical interface, so the corresponding bits must be set to one. If any of the Bits 7 or 0-3 are set to one it indicates that the slave supports those capabilities at the Physical Interface; e.g., if Bit 7 is set to one, the slave supports the Facility Selection option.

- Bus Control Octet Mask - Bits 6-7 are required for execution over the Physical Interface so must be set to one. If any of the Bits 4-5 are set to one it indicates that the slave supports those capabilities at the Physical Interface. The Generic command set Reserves these bits.

- Bus Acknowledge Octet Mask - support of this octet is optional at the Physical Interface and any bits set to one shall indicate support of this octet.

- Master Status Octet Mask - the setting of any of the Bits 4-6 indicates that the slave supports the options at the Physical Interface; e.g., the Slave-Slave Operation Completed bit is set by the slave to indicate that it has the capability to perform Slave-Slave Information Transfers (see the IPI Physical Interface specification 64732100). Support of defined Ending Status is required, and no other use of these bits may be made.

  NOTE: If no Ending Status codes can be provided '0000' shall be reported in the octet during the Ending Status sequence (see 5.10.4.1).

- Slave Status Octet Mask - Bits 6-7 are required to be set to one, and the setting of the Bits 4-5 indicates that the slave supports these options at the Physical Interface. If Bits 0-3 are set to x'F', it indicates that the Level 3 defined Encoded Ending status is supported. Support of defined Ending Status is required, and no other use of these bits may be made.

  NOTE: If no Ending Status codes can be provided '0000' shall be reported in the octet during the Ending Status sequence (see 5.10.4.1).

- Request Modifier Octet Mask - Bits 0-6 are required to be set to one. If Bit 7 is set to one it indicates that the Facility Interrupts Request option is supported.

- Selective Reset Control Octet Mask - Bits 4-7 are required to be set to one. If Bit 0 is set to one, the slave shall set the condition of the Physical Interface port over which the Selective Reset was received, to Neutral. If Bit 1 is set to one, the slave shall reset its Logical Interface (e.g. microprocessor) upon a Selective Reset. If Bit 2 is set to one, the slave shall be capable of re-initializing to the same conditions as at Power On (information in the slave of a transient or volatile nature would be cleared upon Selective Reset). If Bit 3 is set the slave shall not perform a reset but shall release its drivers.

- Slave Interrupts Octet Mask - if this parameter is not present or contains all zeros then Request Slave Interrupts is not supported by the slave.

7.3.13 Attributes Parameters 6C→6D

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS	
M	n+1	6C				REQUEST PARM PARAMETER	
			01	7		Parameters as Data	*
				6		Parameters in Response	*
				5		Length	*
				4		Naked Parameters as Data	*
				3-0		Reserved	
			02			Parameter ID	Repeated as many
			n			Parameter ID	times as needed
						* mutually exclusive parameters	
S	05	6D				PARM LENGTH PARAMETER	
			01-04			Length of Parameter List	

7.3.13.1 Request Parm Parameter

This parameter is used by the master to request the slave to respond with details on the parameters whose IDs are listed. If no IDs are listed, the slave shall respond with all of the parameters associated with the command.

- When the Parameters as Data bit is set, the slave shall return the requested parameters as data.

- When the Parameters in Response bit is set, the slave shall return the requested parameters appended to the response packet.

- When the Length bit is set, the slave shall return the accumulated length of the requested parameters in the Parm Length parameter of the response packet.

- When the Naked Parameters as Data bit is set, the slave shall return the requested parameter contents as data with no parameter information.

  NOTE: Since there is no parsing information to identify parameters, it is advisable that the master request only one parameter to be returned in this manner, as there is no required order for the slave to return multiple parameters.

7.3.13.2 Parm Length Parameter

This parameter is returned in response to the Request Parm parameter which specified a number of IDs, and requested the slave to advise the accumulated length of same.

7.3.14 Attributes Parameter 6E

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
B	n+1	6E				SLAVE RECONFIGURATION (BIT SIGNIFICANT)
			01	7		Report Conditional Success if Error Retry
				6		Report Conditional Success if Data
				6		Correction
				5		Inhibit Extended Substatus in Response
				4		Physical Selection of Synonyms
				3		Automatic Re-allocation On
				2		Seek Algorithm On
				1		Inhibit Operation Response on Success
				0		Reserved
			02	7		Transfer Notification Packets Required
				6		Inhibit Slave Messages
				5		Inhibit Unanticipated Pauses
				4		Disable All Error Recovery
				3		Log Unexpected Class 1 Events
				2		Discard Class 1 Condition Transitions
				1		Data Streaming Data Transfers
				0		Interlock Data Transfers
			03	7		Response on P-Busy to Not P-Busy Suppressed
				6-0		Reserved

Slave Reconfiguration (Bit Significant) Parameter - The slave may identify in its Initial attributes that it supports a feature; e.g., Automatic Re-Allocation, which may be turned "off" by the master.

- When the Report Conditional Success if Error Retry bit is set to 1, the slave responds with Conditional Success Substatus if an error did not reoccur after retry. When set to 0, if the operation is completed without an error, either initially or upon retry, the slave reports Successful.

- When the Report Conditional Success if Data Correction bit is set to 1, the slave responds with Conditional Success Substatus if a data error was corrected. When set to 0, if the operation is completed without an error, either initially or after correction, the slave reports Successful.

- When the Inhibit Extended Status Response bit is set to 1, the slave does not transmit Extended substatus as part of the response packet.

- When the Physical Selection of Synonyms bit is set to 1, the slave shall recognize Synonyms in the range of 00-0F as Facility Addresses in the Select octet of the Physical Interface.

- The Automatic Reallocation bit is set to 1 by the slave if it automatically reallocates blocks that require excessive retries and/or error correction or are otherwise identified by some optional analog algorithm. This capability should not be confused with defect mapping done during the FORMAT command. If the slave's Initial attributes show that it does not support Automatic Reallocation, and the master sets this bit, the slave shall reject this parameter setting.

- When the Seek Algorithm bit is set to 1, the slave re-orders data access requests in order to minimize seek times (e.g. elevator algorithm). If the slave's Initial attributes show that it does not support Seek Algorithms, and the master sets this bit, the slave shall reject this parameter setting.

- When the Inhibit Operation Response on Success bit is set to 1, the slave neither generates a Class 1 interrupt nor transmits a response packet to the master for a successfully completed command. This bit is generally used for data transfer commands to an unbuffered slave or facility. Response packets are always returned by the slave if the command did not complete sucessfully or if the command required slave/facility initiated recovery. If the slave does not allow the master to overrride the presentation of an Operation Response when a command completes successfully it shall reject this parameter setting.

- When the Transfer Notification Packets Required bit is set to 1, the slave shall provide Transfer Notification packets, even if they are implicit; e.g., Facility Selection with Individual Commands. If the master sets this value to zero in an attempt to override the presentation of Transfer Notification packets where they are required, the slave shall reject this parameter setting.

- When the Inhibit Slave Messages bit is set to 1, the slave shall not generate Message Exceptions.

- When the Inhibit Unanticipated Pauses bit is set, the slave shall not terminate a data transfer except for anticipated pauses (burst boundaries), master pauses (if supported) or interface errors. If the slave can no longer transfer data, it will remain in the XFRRDY state until it can transfer data or an error forces an unsuccessful completion of the data transfer.

- When the Disable All Error Recovery bit is set, the slave shall not invoke any error recovery in the execution of commands. All errors will cause an immediate termination of the command with the error reported in Substatus.

- When the Log Unexpected Class 1 Events is set and there is no ANTICIPATED ACTION command queued, the slave shall record all unexpected Class 1 events (which are normally returned as Asynchronous or Message/Microcode Exception responses), except Condition transitions (P-Available, Not Ready etc), in the Error Log.

If the Error Log fills to the point that Error Log Request or Error Log Full substatus must be reported all unexpected events shall be reported as Class 3 Interrupts to initiate prompt master action.

- When the Discard Class 1 Transitions bit is set the slave shall generate no interrupts or responses when such transitions occur. The master is responsible to determine the condition of a slave or facility by the REPORT ADDRESSEE STATUS or ANTICIPATED ACTION commnads.

- When the Data Streaming Data Transfers bit is set to 1, the slave is required to transmit data in Data Streaming Mode. This setting is not needed unless the Physical Interface is set up for Interlocked mode.

- When the Interlock Data Transfers is set to 1, the slave is required to transmit interlocked data. This setting is not needed unless the Physical Interface is set up for Data Streaming mode.

- When the Response on P-Busy to Not P-Busy Suppressed bit is set, the slave shall generate Class 1 interrupts (but not the associated responses) when notifying the master that the slave is no longer busy after rejecting a selection sequence with a P-Busy response.

7.3.15 Attributes Parameter 6F

@	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
B	n+1	6F				SLAVE RECONFIGURATION (FIELDS)
			01-04			Setting of Time Dependency (µs)
			05-06			Number of Queued Commands
			07-08			Maximum Number of Octets in Command Packet
			09-0A			Maximum Number of Octets in Response Packet
			0B-0C			# of Unanswered SYNC INs during Data
			0B-0C			Streaming
			0D-0E			Max No of Multiplexed Data Transfers
			0F-12			Generate Class 2 Interrupt
			13-16			Burst Size
			17-1A			Data Streaming SYNC timeout (µs)
			1B-1E			Port Release Time (µs)
			1F-22			Facility Timeout (µs)
			23-26			Implicit Release Delay (µs)

Slave Reconfiguration (Fields) Parameter - Fields which are not supported by the slave shall have all bits set to 1; i.e., x'F...F'. If the master wishes to change only one field, all the others shall be set to x'F...F' and the slave shall ignore them; i.e., no existing value for a field shall be changed if the master set x'F...F'

- Setting of Time Dependency - this value specifies the period which, if in the judgment of the slave would be exceeded prior to the start of data transfer, shall cause the slave to set the Time Dependent Operation bit at the Physical Interface on a Paused transfer.

- Number of Queued Commands - this value may be specified by the master to override the slave's setting of the maximum number of commands queued per facility. A master which cannot handle Transfer Notification packets can set this value to one to force commands to be Individual, and the slave shall not present Transfer Notification packets to the master. If this value is greater that one, or the Transfer Notification Packets Required bit is set, the slave shall always present a Transfer Notification response prior to starting a data transfer.

- Maximum Number of Octets in Command Packet - this value specifies the maximum size for command packets.

- Maximum Number of Octets in Response Packet - this value specifies the maximum size for response packets.

- Number of unanswered SYNC IN's during Data Streaming - this value identifies the number of unanswered SYNC IN's the slave transmits before it suspends transmission of SYNC IN's; i.e., if the number of SYNC IN's minus the number of SYNC OUT's is equal to this attribute, the slave shall suspend SYNC IN transmission until SYNC IN's minus SYNC OUT's is less than the maximum difference. See the IPI Physical Interface specification 64732100 for further details.

- Maximum Number of Multiplexed Data Transfers - this value represents the maximum number of data transfers that the slave can multiplex at one time. A value of zero is valid if the slave does not support multiplexed data transfers.

- Generate Class 2 Interrupt - the slave shall initiate a Class 2 Interrupt to indicate data transfer can begin when the value specified is ready to be transferred (In), or can be accepted (Out). The interrupt shall also be generated when the last portion of data to complete the command is ready to be transferred even though the remainder may be less than the value specified.

- Burst Size - this value (in octets) specifies the maximum size of data that a slave shall transfer during any one Information Transfer of data.

  NOTE: The relationship between the buffer size when Class 2 is to be reported and the Burst Size defines the type of buffer management to be used by the slave.

- Data Streaming SYNC timeout - this value specifies the period that the slave shall wait after SYNC OUTs cease from the master, before terminating the Information Transfer. If the value x'FFFFFFFE' is set, the time period shall be the maximum value allowed by the Physical Interface.

- Port Release Time - this value specifies the time period that a slave shall keep a port reserved without any activity following a PORT ADDRESS command, before implicitly releasing it. If a value of x'FFFFFFFE' is set, the time period shall be infinity.

- Facility Timeout - this value specifies the time period that a slave shall wait for a facility to perform an operation before terminating the command. If a value of x'FFFFFFFE' is set, the time period shall be infinity. One use of the timeout is to designate how long a facility may remain busy before the condition is reported to the master.

- Implicit Release Delay - this value specifies the time period that a slave shall wait for a master to respond with a selection sequence after a P-Busy to Not P-Busy interrupt is presented because the master had previously attempted selection. If a value of x'FFFFFFFE' is set, the time period shall be infinity.

  NOTE: If two masters are competing for a port, one may be fast enough to release and then re-select before the other has time to respond, and this value can be set to give the slower master an opportunity to select the slave in such a situation.

7.4 Report Addressee Status

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  03  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Condition
                     |||  Status
                     ||  Port Query
```

Response Packet:

```
+----+-------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS    | PARAMETERS
| LTH|   Command  | CODES    |TYPE|CODE|
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+-------------+----------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

REPORT ADDRESSEE STATUS shall cause the slave to report the condition, status or port mask of the port(s) of the addressee. Execution of this command shall not clear any condition or status in the addressee.

One modifier bit is required for execution of this command, and the bits are mutually exclusive.

- If the Condition modifier is set, the slave shall report the condition (See 5.7) of the addressee for the port(s) specified.

- If the Status modifier is set, the slave shall report the status of the addressee. The response is a Product Unique parameter which includes information about the addressee. One of the uses of this command is to permit a master which has not been available or operational to establish the configuration of operating slaves. Status is device type and implementation dependent. It includes the current status of the addressee; e.g., which side of an optical platter is loaded.

- If the Port Query modifier is set, the slave shall report the addressee port mask(s) for the path over which the command was received. The master can use the Port Mask parameter(s) to find out which port, in a multi-ported slave configuration, it is connected to.

  NOTE: The Port Control command provides the master with the capability of excluding other (presumed defective) masters from using a specific slave. The Port Mask defines the port that the master is connected to so that it can prevent excluding itself from port access.

Report Addressee Status Parameters:

@	LTH	ID	OCTET	X/b	DEF	REPORT ADDRESSEE STATUS PARAMETERS
B	n+1	50				PORT MASK PARAMETER
			01			Slave Address
			02			Facility Address
			03- n			Port Mask
S	n+1	51	01-02			CONDITION
			01	7		Operational
				6		Not Operational
				5		Ready
				4		Not Ready
				3		Facility Switched to Another Port
				2		Port Neutral
				1		L-Available
				0		P-Busy
			02	7		Status Pending
				6		Active
				5		Inactive
				4		P-Available
				3		Not P-Available
				2		Reserved
				1		Reserved
				0		Reserved

Port Mask Parameter:

The first two fields identify the slave or facility it applies to, and the bit(s) set in the mask identify the port(s).

```
+---+---+---+---+---+---+---+---+
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
+---+---+---+---+---+---+---+---+

  0   0   0   0   0   0   1   0    Port 1
```

When the Path Query modifier is set, this parameter identifies the port(s) on the path to the addressee over which the master issued the command.

If the master had appended this parameter to the command, the slave shall repeat this parameter preceding each condition or status in the response for all the elements of the path.

A parameter length of 1 indicates that the command shall be performed for all the installed ports of the addressee.

Condition Parameter:

The two octets are bit significant to advise the master of the conditions within the addressee for the physical port(s) identified by the Port Mask parameter; i.e., the conditions at the Physical Interface as viewed by the master of that interface port.

7.5 Port Address

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  04  bbbb bbbb  xx   xx
                7654 3210
                     ||||  0=Reserve  1=Release
                     |||  Priority Reserve
                     ||  Notify Alternate Port(s) of Priority Reserve
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|   Command  | CODES    |TYPE|CODE|
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The PORT ADDRESS command allows the master to establish explicit allegiances with multiported slaves and/or facilities.

- The Reserve modifier shall cause the addressee to be dedicated to the commanding port. The addressee shall remain reserved until a Release occurs or until another port issues a Priority Reserve or an appropriate reset is issued. Unreserved, multiported addressees shall be implemented to perform an implied reserve when executing a command from the master. Following the execution of the command or Chain,Sequence or Order that caused the implied reserve, the addressee shall perform an implied release and become available to the other port(s).

If the addressee supports command stacking, the addressee may be able to accept commands on one port while executing command(s) at another (this requires that each port of the addressee be capable of stacking commands). The addressee may defer the execution of stacked command(s) until the other port is no longer executing command(s).

If more than one Reserve is issued to an addressee, succeeding Reserves shall be executed as NOPs. Slaves may employ a reserve safety timer to release the addressee if the reserving master does not access the addressee during the safety time limit which is specified by the Attributes. The safety time limit may be overridden by setting its value to infinity in the Attributes.

The Reserve of a facility shall cause it to be dedicated to the commanding port of the slave. However, the slave is not dedicated to the commanding master. When a command is issued to a multiported facility which is not reserved, the slave shall perform an implied reserve on the facility. At the completion of the operation, an implied release is issued to the facility. It is the slave's responsibility to bracket every operation to an unreserved, multiported facility with a reserve and a release function.

- The Release modifier shall cause the addressee to make itself available to its other port(s). The Release complements a previous Reserve of the port. If multiple Reserves had been issued it is not the responsibility of the slave to nest the Reserve/Release pairs to ensure symmetry. The first Release shall cause the addressee to make itself available to the other port(s).

- The Priority Reserve modifier shall not be accepted unless Bit 0=0. This modifier causes immediate switching of the addressee's port, releases any Access Permit ranges that may be active and establishes a Priority Reserve. If the addressee is engaged in a command through another port, it shall terminate the command, and return Priority Reserved status to the other port. Termination may be either "graceful" or immediate, as determined by the slave/facility implementation. The Priority Reserve shall remain in effect until a Release command or an appropriate reset is issued.

Priority Reserve is primarily intended for failure recovery purposes. If the master attached to an unavailable port determines that the master on the active port has failed, the slave/facility(s) can be switched to the operable master through the use of the Priority Reserve command.

If a slave is capable of interpreting commands at an alternate port while reserved, Priority Reserve shall always be accepted unless a port has been excluded by a previous PATH CONTROL command.

- The Notify Alternate Port(s) of Priority Reserve modifier shall cause the slave to advise the other port(s) by Asynchronous Response that this port has been Priority Reserved. This modifier shall only be accepted by the slave if Bit 1=1 and Bit 0=0.

- The Unqualified Reserve modifier shall cause slaves which have the ability to stack and interpret commands at an alternate port to accept this command, whether the slave is Busy or not. This command shall be executed when the slave becomes"un-Busy" in order to connect to the issuing master.

  NOTE: This modifier requires that Bit 0=0 and that the Priority modifier be set. If Bit 1 or Bit 2 is set the command shall be rejected.

7.6 Path Control

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  05  bbbb bbbb  xx   xx
                7654 3210
                     |||| Purge Commands outstanding at Disabled port
                     |||  Path Select
```

Response Packet:

```
+----+-----------+----------------+-----------
|PKT | Echoed From|   MAJOR STATUS  | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|    6    |    7    | 8 through n
+----+-----------+---------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The PATH CONTROL command provides the master the ability to disable (Not P-Available), enable (P-Available), or assign any port(s) of the addressee. The parameter shall be used as a mask to Disable (1) or Enable (0) specific ports on the addressee.

When there are no Operation Modifier bits set the ports shall be disabled in an orderly manner; i.e., after all activity for the port has ceased. The command is completed when all ports referenced in the mask are either enabled or successfully disabled.

Mask Octet Examples:

7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	Enable all ports
0	0	0	0	0	0	1	0	Disable Port 1/Enable Others
0	0	0	0	1	0	0	1	Disable Ports 0 and 3/Enable Others

There may be as many mask octets in the parameter as are needed to define the number of ports addressable (on a switching slave this could be a large number; e.g., 32 ports would require 4 octets). The first port on a slave or facility is represented by bit 0 in the least significant octet and the remaining ports (if any) are represented by contiguous bits in the more significant octets.

- The Purge Commands Outstanding at Disabled Port modifier shall cause the slave to abort all commands currently in the command stack and clear all non-asynchronous responses for the disabled port of the addressee. The port(s) will be disabled regardless of the state of the disabled port. This command may be used to allow a malfunctioning port to be destructively disabled regardless of its current condition.

  NOTE: It is possible for an orderly disable to be executed against a slave port over which the PATH CONTROL command was received. If one is received, the command should be rejected.

- When the Path Select modifer and more than one Port Mask parameter is appended to the command, a group allegiance will be established to the port(s) designated. The group allegiance remains until another PATH CONTROL command with this modifier set and only one Port Mask parameter appended is received, or an appropriate reset is executed. The command has the effect of reserving the addressee to the group of slave and/or facility ports defined in the Port Mask parameters.

While the group allegiance is in effect, implicit and explicit allegiance from within a group work normally. A port excluded from the group allegiance may only gain control of the addressee through the use of Priority Reserve or an appropriate reset.

When the Path Select modifier is not set but more than one slave Port Mask parameter is associated with a facility Port Mask parameter the master is identifying alternate paths which may be used to rout responses. Such a usage demands specific knowledge between the master and attached slaves which may make the design or system dependent.

Path Control Parameters:

@	LTH	ID	OCTET	X/b	DEF	PATH CONTROL PARAMETERS
M	n+1	50				PORT MASK PARAMETER
			01			Slave Address
			02			Facility Address
			03- n			Octet mask(s)

Port Mask Parameter:

This parameter is used to identify the port to be masked. See 7.4.1.1

7.7 Attention Control

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 0006 xxxx  06  bbbb bbbb  xx   xx
                7654 3210
                     ||||
                     ||||     Bits 1, 2 have encoded meaning of:
                     |||         x'0'=Enable x'2'=Disable
                     ||          x'4'=Clear  x'6'=Set
```

Response Packet:

```
+----+------------+--------------------+------------
|PKT | Echoed From|    MAJOR STATUS    | PARAMETERS
| LTH|   Command  | CODES    |TYPE|CODE|
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The ATTENTION IN signal at the Physical Interface is set as a result of interrupts pending in the slave(s). The ATTENTION CONTROL command provides the master with the ability to control generation of the ATTENTION IN signal by the addressee. The modifiers are set in conjunction with the Attention Control Parameter to provide for the enabling, disabling, setting or clearing the interrupt classes within the addressee.

This command does not effect the operation of other ports and does not affect the capability of the master to poll for interrupts at the Physical Interface. At power on, all of the interrupt classes are enabled.

To change how interrupts affect the setting of ATTENTION IN:

Enable allows the selected interrupt(s) to generate attention (e.g. when Interrupt Mask Bit 2 is set, then Class 3 interrupts shall be enabled for causing the ATTENTION IN signal to be asserted).

Disable prevents the selected interrupt(s) from generating attention (e.g. when Interrupt Mask Bit 0 is set, Class 1 interrupts shall not cause the ATTENTION IN signal to be asserted).

To force interrupts themselves to be changed:

Set causes the selected interrupt(s) to be generated internally by the addressee (e.g. when Interrupt Mask Bit 0 is set, then a Class 1 interrupt shall be generated, which shall cause the assertion of the ATTENTION IN signal if Class 1 is Enabled).

Clear causes the selected interrupt(s) to be reset (e.g. when Interrupt Mask Bit 0 is set, then the Class 1 interrupt indication shall be reset within the addressee).

Attention Control Parameters:

@	LTH	ID	OCTET	X/b	DEF	ATTENTION CONTROL PARAMETERS
M	n+1	50	01			INTERRUPTS MASK
				7-3		Reserved
				2		Class 3 Interrrupts (Critical)
				1		Class 2 Interrrupts (Transfer Pending)
				0		Class 1 Interrrupts (Status Pending)

Interrupts Mask Parameter:

This parameter is used to set the mask to either cause or prevent interrupts from having the ATTENTION IN signal be generated.

7.8 Operating Mode

Command Packet:

```
+----+----+----+----+----+----+----+-----------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-----------
 xxxx xxxx  07  bbbb bbbb  xx   xx
                7654 3210
                     ||||
                     |||
                     ||  0=Set  1=Report
```

Response Packet:

```
+----+-----------+-----------------+-----------
|PKT | Echoed From|   MAJOR STATUS  | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+-----------+---------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The OPERATING MODE command allows the master to change slave or facility operating modes dynamically. The parameter field of the command packet defines what action the slave or facility is to take; e.g., those associated with establishing device-unique operating characteristics such as recording density on tape, removal of media etc.

On disks, the master may direct transfer commands to non-primary data spaces such as the CE Partition, IML Partition, etc. Data transfer commands shall be Chained, Sequenced or Ordered to OPERATING MODE with the Partition parameter in order to access the one desired.

Execution of transfer commands in slave-defined areas other than that for data may require different types of response information. The Response Conditions parameter is used to overrride the conditions established by Housekeeping Attributes.

The parameters associated with this command shall remain in effect until a subsequent Chained, Sequenced or Ordered OPERATING MODE command is issued or until the termination of the Chain, Sequence or Order.

Operating Mode Parameters:

@	LTH	ID	OCTET	X/b	DEF	OPERATING MODE PARAMETERS
B	n+1	3E				PARTITION PARAMETER (See 6.5.15)
M	02	50				RESPONSE CONDITIONS
			01	7		Post Conditional Success if Error Retry
				6		Post Conditional Success if Data Correction
				5		Inhibit Operation Response on Success
				4		Inhibit Extended Substatus Response
				0-3		Reserved
M	03	51	01-02			DISK MODES
			01	7		Spin Up
				6		Spin Down
				5		Lock Cartridge
				4		Unlock Cartridge
				3		Load Heads
				2		Unload Heads
				1		Lock Carriage
				0		Rezero
			02	7 to 0		Reserved

Partition (Common) Parameter:

This parameter is used to establish the slave-defined Partition which is to be addressed when it is other than the data partition.

Response Conditions Parameter:
The master can override default attributes by use of this parameter, which has the same meanings as those defined in the Slave Reconfiguration Parameter of the ATTRIBUTES command.

Disk Modes Parameter:

Spin Up - the slave shall cause the disk spindle to be powered up and spinning, and unlock the carriage ready for operation.

Spin Down - the slave shall cause the disk spindle to be powered down.

Lock Cartridge - the slave shall cause the disk cartridge or the cartridge door to be locked, so that a removable disk cartridge cannot be removed by an operator.

Unlock Cartridge - the slave shall cause the disk cartridge or cartridge door to be unlocked, so that a removable cartridge can be removed by an operator.

Load Heads - the slave shall cause the read write heads to be loaded onto the media.

Unload Heads - the slave shall cause the read write heads to be unloaded from the media.

Lock Carriage - the slave shall cause the disk carriage to be locked.

Rezero - shall cause the arm of the addressee to be set to its initial calibrated position.

7.9 Abort

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  08  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Orderly Termination
                     |||  Terminate Command in Progress
                     ||  Terminate All Commands Not in Progress
```

Response Packet:

```
+----+------------+-----------------+-----------
|PKT | Echoed From|   MAJOR STATUS  | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|    6    |    7    | 8 through n
+----+------------+---------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The ABORT command allows a master to terminate all or some of the commands within a slave or issue a Selective Reset to facilities.

Slaves shall be implemented to accept an ABORT command while commands are in progress on attached facilities. This requires that the slave have the ability to process a minimum of one ABORT command even if its command stack is full. This is the only command that this restriction applies to, and only the simplest implementation need be supported when all queues are full.

Since an ABORT is presumed to take precedence over other commands, the Priority Modifier should be set, otherwise it will be managed in the order of the slave's command handler (FIFO or some other algorithm). The ABORT command shall be rejected if no modifiers are set and there are no parameters present.

ABORT allows the master to terminate command(s) in the slave or facility. Unless defined otherwise by the master via parameters, if any command in a Chain, Sequence, or Order is aborted, the remaining commands in the Chain, Sequence or Order shall be terminated. It is the master's responsibility to ensure that no commands in a Chain, Sequence or Order which have not been received by the addressee prior to issuing the ABORT, shall be received following the ABORT.

The Command Reference Number(s) of the command(s) to be terminated are passed as parameters. If no modifiers are set the slave shall terminate all commands which have not been initiated. The response packet(s) for the original command(s) shall identify whether or not the requested command(s) were terminated. The slave issues the Response for the ABORT command only after all of the commands identified in the parameters have been aborted.

- If the Terminate Command in Progress modifier is set the command in execution shall terminate immediately. If a Chain, Sequence or Order of commands is affected, all other associated commands shall be terminated. Results are unpredictable if a command, command sequence or command chain is partially completed at the time it is aborted. The slave shall abort the command in a manner which retains as much data/operational integrity as is practical.

- If the Orderly Termination modifier is set an in-progress command shall be terminated at a point that ensures data integrity. This may or may not require the slave to complete a sequence or chain.

- If the Terminate All Commands Not in Progress modifier is set, all commands not in progress shall be aborted. A command may have been initiated but not be in progress; e.g., a transfer command with an implicit seek which has been completed, but no transfer has begun.

An ABORT command cannot be used to ABORT a previously issued ABORT command.

If a master is terminating commands it issued over the same port, short forms of the parameter list may be used. However, if on a multiported system a different master, or the same master through a different port issues the ABORT, the slave requires the complete routing information of the original command(s). When the aborted command terminates, the port over which it was aborted is advised; i.e., the routing of the ABORT command overrides the original routing.

A master can issue a Selective Reset to a facility if the Facility Reset parameter is appended. The use of this parameter is mutually exclusive with the use of any operation modifiers or other parameters.

Abort Parameters:

@	LTH	ID	OCTET	X/b	DEF	ABORT PARAMETERS	
M	n+1	50				COMMAND REFERENCE NUMBER PARAMETER	
			01-02			Command Reference Number	Repeated as many
			n-1:n			Command Reference Number	times as needed
M	n+1	51				ALTERNATE PORT COMMANDS PARAMETER	
			01-02			Command Reference Number	
			03			Slave Address	
			04			Facility Address	
			05- n			Octet mask(s)	
M	n+1	52				FACILITY ADDRESS PARAMETER	
			01			Facility Address	Repeated as many
			n			Facility Address	times as needed
M	n+1	53				ALTERNATE PORT PARAMETER	
			01			Slave Address	
			02			Facility Address	
			03- n			Octet mask(s)	
M	02	54				FACILITY RESET PARAMETER	
			01	7-4		Reserved	
				3		Release	
				2		Reset as Power On	
				1		Logical Interface Reset	
				0		Physical Interface Reset	

Command Reference Number Parameter:

This parameter is used by the master which originally issued the command(s) to be aborted.

Alternate Port Commands Parameter:

This parameter is issued by a master (which may or may not have issued the original command) for each command to be aborted, over a port other than that from which it was originally received. It is necessary to provide the slave with the complete routing information on the command.

Command Reference Number - this must correspond to that of the command to be aborted.

Slave Address - this shall identify the Slave Address to which the command was originally issued (slaves may have different addresses on different ports).

Facility Address - this shall identify the Facility Address to which the command was originally issued (facilities may have different addresses on different ports).

Octet Mask - this shall identify the port over which the command was originally received.

Facility Address Parameter:

This parameter is used to remove commands queued to Facility Addresses. If there are several commands outstanding to a particular Facility Address, this parameter reduces the burden on the master to identify every Command Reference Number. The slave shall generate a response for each command aborted. This parameter is used as an alternative to Parameter 50.

Alternate Port Parameter:

This parameter is issued by a master (which may or may not have issued the original command) for each command to be aborted, over a port other than that from which it was originally received. It provides the same function as the Facility Address parameter, with the addition of the routing information of Slave Address and port mask over which the command(s) were originally received.

If the Facility Address field is set to x'FF' then all of the commands received by that port shall be aborted. This parameter is used as an alternative to Parameter 51.

Facility Reset Parameter:

When this parameter is appended all of the facility's pending and active commands and pending responses within the slave shall be flushed. Bits 3-0 (see 5.10.7) define the type of reset that the slave shall issue to the facility.

7.10 Access Permits

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  09  bbbb bbbb  xx   xx
                7654 3210
                     ||||        Bits 0, 1, 3 have encoded meaning of:
                     ||||          x'0'=Report
                     |||           x'1'=Initialize   x'2'=Restore
                     ||   0=Data Block   1=Physical Block
                     |             x'9'=Load         x'A'=Save
```

Response Packet:

```
+----+------------+----------------+------------
|PKT | Echoed From|   MAJOR STATUS  | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The ACCESS PERMITS command provides the ability to define multiple extents which may be either read- or write-protected by an Access Key established by the master. The Access Key is set originally by the master to be associated with a defined extent or extents, and specifies the type of protection desired.

Any command that references an extent(s) protected by a previously issued ACCESS PERMITS, must include the Access Key in its parameter list. If the Access Key is not present, or is incorrect, the slave shall terminate with Command Exception (Missing parameter), or Machine Exception (Access Violation) status respectively.

The opcode modifiers allow the master to Initialize, Report, Restore, Load, or Save Access Key information. The modifiers are mutually exclusive; i.e., only one action may be specified by the command modifier.

NOTE: Bits 0, 1 and 3 (x'1', x'2', and x'8') are encoded. Bit 2 (x'4') is used in conjunction to refer to either logical or physical blocks.

Report requires the addressee to respond with a list of the extents currently protected.

Initialize allows the slave to set its protected extents to their default value (typically none will be protected).

Restore allows the restoration of Access Key information that has been Saved.

Save allows the addressee's protected extents, including those associated with this command, to be saved prior to power down or removal of the media from a removable media facility.

Load allows the master to set protected extents within the addressee (if they are valid).

At power on, slaves shall perform an automatic Restore if protected extents have been Saved, otherwise they shall perform an Initialize.

The parameter fields associated with this command allow the protected data areas to be specified as extents, and use bit-significant fields to specify Read or Write Access, and to Invoke or Revoke protection. The maximum number of extents that can be protected is established with the ATTRIBUTES command using the Addressee Configuration parameter.

Protection may be revoked from selected areas by setting the Revoke bit in the parameter field. However, an ACCESS PERMITS command which references any part of a protected area shall be required to define the Access Key for that area. This is necessary to prevent accidental or deliberate revocation, modification or re-modification of access protected address ranges.

In multiport systems that have slaves which share common facilities, it is the responsibility of the master to ensure that appropriate protection is established for all slaves sharing them.

The protection is applied from the port that established the extents, and can be revoked by that port, or other port(s) identified in the original Protection parameter.

In the event that a master fails, or another master attached to a different port has a need to override existing Access Permits, it is possible to re-define allowable access with the PORT ADDRESS command. All of the protected Access Permit ranges associated with an addressee can be released simultaneously by issuing a PORT ADDRESS command with the Priority Reserve bit set in the Opcode Modifier field.

NOTE: The method specified for write and or read protected data is effective in preventing accidental access to address ranges. However, if all users of the system are allowed to issue a Priority Reserve (via a PORT ADDRESS command) then a malicious user can gain access to any data. This problem can be avoided if software restricts the use of the Priority Reserve bit in the PORT ADDRESS command.

Access Permits Parameters:

@	LTH	ID	OCTET	X/b	DEF	ACCESS PERMITS PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	50				PORT MASK PARAMETER
			01			Slave Address
			02			Facility Address
			03- n			Octet mask(s)
M	03	51				ACCESS PROTECTION PARAMETER
			01			Protection Modifiers
				7		Read Access
				6		Write Access
				5		Invoke * mutually
				4		Revoke * exclusive
				0-3		Reserved

Command Extent (Common) Parameter:

This parameter is used to define the extent (or extents if multiple parameters are supplied), which is to be protected by the slave, and is preceded by the Access Key and Access Protection parameters.

Response Extent (Common) Parameter:

This parameter is used to return the extent(s) protected by the Access Key (which was supplied in the command packet).

Access Key (Common) Parameter:

This parameter is used by the master to precede, and thus identify, the extent(s) to be protected, or reported.

Data Address (Common) Parameter:

This parameter is used if the four octets of Data Address in the Extent parameter(s) are insufficient.

Partition (Common) Parameter:

This parameter is used to address other than the default data area, and shall precede the Extent parameter.

Port Mask Parameter:

See 4.4.1.1

The Port Mask is used to establish from which ports the protection is to be applied. Applications of the Port Mask are used as follows:

This Port Only - used to protect the extent(s) on this port only.

This Master Only - used to protect the extent(s) accessible to this master only. It is necessary that the port controls be established to identify which master has access over which port(s). A master may have more than one port of access to a slave.

Other Port(s) Only - used to protect the extent(s) from access by the other port(s) connected to the slave.

Other Master(s) Only - used to protect the extent(s) from access by the other master(s) connected to the slave.

Access Protection Parameter:

Protection Modifiers - these follow the Access Key parameter, and are used to establish what kind of protection is needed for access to the extent:

Read Access permits transfer commands read-only access to the extent when associated with the correct key in their parameter list.

Write Access permits transfer commands both read and write access to the extent when associated with the correct key in their parameter list.

Invoke is used to establish, according to the access modifiers, the protection of the extent(s) with the Access Key.

Revoke is used to cancel, according to the access modifiers, the protection of the extent(s) under the Access Key.

7.11 Resume

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  0A  bbbb bbbb  xx   xx
                7654 3210
```

Response Packet:

```
+----+-----------+-----------------+-----------
|PKT | Echoed From|   MAJOR STATUS   | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+-----------+---------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description

This command allows the master, without reference to the termination address, to resume execution of an operation which was posted as Incomplete by the slave. The slave shall resume from the point at which the command had been suspended in execution, and continue as if there had been no interruption.

RESUME can only be used to re-initiate slave execution of the COPY, COMPARE SLAVE DATA, and COMPARE DATA commands. The response for the RESUME is presented when a command is successfully re-initiated. The re-initiated commands will each present a separate response when they complete.

For example, during a COPY operation from disk to tape, End of Media may have occurred. Incomplete status would have been posted, and the master has to provide for rewind and replacement of the output tape. By issuing RESUME, the master can initiate resumption of the COPY without having to re-issue the COPY with revised disk extents information. The RESUME command thus facilitates the backup/restore operation when multiple backup media are required.

The command to be resumed shall be identified by its Command Reference Number, which is appended as a parameter (the Command Reference Number within the basic command packet is that for the RESUME command itself). If this parameter is missing or incorrect the slave shall terminate with Command Exception status.

If a slave is capable of executing more than one command at a time which can terminate with an Incomplete status, then the parameters listing the Command Reference Number(s) of all those to be restarted shall be supplied as parameters. If a master is resuming commands it issued, only the short form of the parameter list is used.

If on a multiported system a different master, or the same master through a different port issues the RESUME, the slave requires the complete routing information of the original command. When the resumed command terminates, the port over which it was resumed is advised; i.e., the routing of the resumed command overrides the original routing.

Resume Parameters:

@	LTH	ID	OCTET	X/b	DEF	RESUME PARAMETERS
M	n+1	50	01-02			Command Reference Number Repeated as many
			n-1:n			Command Reference Number times as needed
M	n+1	51				ALTERNATE PORT COMMANDS PARAMETER
			01-02			Command Reference Number
			03			Slave Address
			04			Facility Address
			05- n			Octet mask(s)

Command Reference Number Parameter:

This parameter is used by the master which originally issued the command(s) to be resumed.

Alternate Port Commands Parameter:

This parameter is issued by a master (which may or may not have issued the original command) for each command to be resumed, over a port other than that from which it was originally received. It is necessary to provide the slave with the complete routing information on the command.

Command Reference Number - this must correspond to that of the command to be resumed.

Slave Address - this shall identify the Slave Address to which the command was originally issued (slaves may have different addresses on different ports).

Facility Address - this shall identify the Facility Address to which the command was originally issued (facilities may have different addresses on different ports).

Octet Mask - this shall identify the port over which the command was originally received.

7.12 Port Response:

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  OB  bbbb bbbb  xx   xx
                7654 3210
```

Response Packet:

```
+----+------------+------------------+------------
|PKT | Echoed From|   MAJOR STATUS   | PARAMETERS
| LTH|  Command   | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The PORT RESPONSE command allows the master to request that the slave send an Asynchronous response to the port(s) specified by the Port Mask parameter. The response contains Message/Microcode Substatus with the Port Response bit set.

Port Response Parameters:

@	LTH	ID	OCTET	X/b	DEF	PORT RESPONSE PARAMETERS
M	n+1	50				PORT MASK PARAMETER
			01			Slave Address
			02			Facility Address
			03- n			Octet mask(s)
M	n+1	51				RESPONSE INFORMATION PARAMETER
			01- n			Response Information

Port Mask Parameter:

This parameter identifies the addressee port(s) which are to generate a response. If there is no parameter appended the slave shall generate Asynchronous responses over all port(s) other than that over which the command was received. See 7.4.1.1

Response Information Transfer:

This parameter contains the slave independent information which will be contained in the Asynchronous response.

7.13 Anticipated Action

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  OC  bbbb bbbb  xx   xx
                7654 3210
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|    6    |    7    | 8 through n
+----+------------+---------+----+----+-----------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The ANTICIPATED ACTION command is normally issued when the master does not anticipate sending commands to the addressee for an extended period. It is used in conjunction with Attributes set regarding the slave action to be taken with unexpected Class 1 events (Asynchronous or Message/Microcode Exception responses).

This command provides the framework for a Command Completion response to return any unexpected conditions or status to the master. It shall be considered to complete successfully when an unexpected Class 1 event occurs and the Asynchronous or Message/Microcode Exception response shall be appended to the Command Completion Response in the Encapsulation Parameter.

Anticipated Action Parameters:

@	LTH	ID	OCTET	X/b	DEF	ANTICIPATED ACTION PARAMETERS
B	n+1	3D	01- n			ENCAPSULATION PARAMETER
M	n+1	50				EXPECTED CONDITIONS PARAMETER
			01	7		
				to		Reserved
			02	2		
				1		Ready
				0		Not Ready

Expected Conditions Parameter:

This parameter identifies to the slave the conditions that the master expects to be in effect at the addressee when the command is executed. If the expected condition(s) is not met, the slave completes the command immediately with substatus relating to the addressee.

Encapsulation Parameter:

This parameter is used to encapsulate the response packet which had been prepared because of an unexpected Class 1 event.

8.0 POSITION COMMANDS

The commands in this section require the Command Extent parameter unless otherwise noted.

8.1 Position Control

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  41  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet 1=Block
                     |||
                     ||  0=Data Block  1=Physical Block
```

Response Packet:

```
+----+-----------+--------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|  Command   | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |   7     | 8 through n
+----+-----------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The POSITION CONTROL command causes the facility to be positioned according to the Extent parameter Data Address, which may be either logical or physical; e.g., on disk it may be CCHS (cylinder, head, sector).

Position Control Parameters:

@	LTH	ID	OCTET	X/b	DEF	POSITION CONTROL PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Command Extent (Common) Parameter:

This parameter is used to define the Data Address for a disk to be positioned at. The value in the Count field is ignored for disks.

Response Extent (Common) Parameter:

If the command fails, this parameter is used to return the Data Address of the last block accessed prior to failure.

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

This parameter is used if the four octets of Data Address in the Extent parameter(s) is insufficient.

Partition (Common) Parameter:

This parameter is used to address other than the default data area.

8.2 Report Position

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  42  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet 1=Block
                     |||
                     ||  0=Data Block  1=Physical Block
```

Response Packet:

```
+----+-----------+-------------------+------------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+-----------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The REPORT POSITION command instructs the addressee to report its current position. The position is returned in the Data Address field of the Response Extent parameter.

Report Position Parameters:

@	LTH	ID	OCTET	X/b	DEF	REPORT POSITION PARAMETERS
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Response Extent (Common) Parameter:

This parameter is used to return the Data Address of the current position of the disk.

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

8.3 Report Discontinuity

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  44  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet 1=Block
                     |||  0=Search  1=List
                     ||  0=Data Block  1=Physical Block
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The REPORT DISCONTINUITY command is used to provide the master with the location of time dependent discontinuities (e.g., time dependent track change, cylinder change, or reallocated defect) within the range specified in the Command Extent parameter.

The master may set more than one kind of discontinuity in the Stop on Discontinuity Type parameter. In response, the slave shall identify specifically the kind of discontinuity associated with the Data Address of the discontinuity.

- If the Search modifier is set, the command will terminate at the first incident of a specified discontinuity type.

- If the List modifier is set, a list of all the locations within the extent which contain a time-dependent discontinuity shall be presented. If the list is expected to exceed the capacity of a response, then the master has to provide a Request Parms parameter to transfer as data.

The Stop on Discontinuity parameter shall precede the Data Address to which it refers.

Unless errors are encountered this command shall terminate successfully either upon identifying discontinuities within the extent, or if there are none encountered.

Report Discontinuity Parameters:

@	LTH	ID	OCTET	X/b	DEF	REPORT DISCONTINUITY PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
B	07	3F	01- n			STOP ON DISCONTINUITY PARAMETER (See 6.5.16)
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Length *
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID Repeated as many
			n			Parameter ID times as needed
						* mutually exclusive parameters
S	05	6D				PARM LENGTH PARAMETER
			01-04			Length of Parameter List

Command Extent (Common) Parameter:

This parameter is used to define the extent which is to be checked by the slave for discontinuites.

Response Extent (Common) Parameter:

This parameter is used to return the Data Address of the last block accessed prior to a positional discontinuity (e.g. re-allocated block due to defect management) or a transition discontinuity (e.g. cylinder break between two blocks).

The Residual Count shall contain the value of the number of blocks remaining in the requested extent following the discontinuity.

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

Stop on Discontinuity (Common) Parameter:

This parameter is used to identify the type of discontinuity to be reported upon.

Request Parm Parameter:

See 7.3.13.1

Parm Length Parameter:

See 7.3.13.2

9.0 TRANSFER COMMANDS

Transfer commands consist of data transfers which may or may not include multiple blocks within, or crossing physical boundaries. Upon recognizing a transfer command, the slave or facility positions to the Data Address specified in the Command Extent parameter, locates the block, and performs the required action. The command terminates when the amount of data specified by the Count has been transferred, or an error occurs which requires earlier termination. The status provided in the response packet shall identify what actions occurred during the execution of the command.

If a READ command is performed in the reverse direction, the first data octet read is the first data octet transfered to the master.

9.1 Read

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  10  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  Data Recovery  0=On  1=Off
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+----------------------+-------------
|PKT | Echoed From|   MAJOR STATUS       |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7     | 8 through n
+----+------------+----------+----+-----+--------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The READ command transfers data from the addressee to the master starting at the location given in the Data Address of the Command Extent parameter. If positioning is required before the data can be accessed, the slave shall initiate the positioning operation. Refer to the POSITION CONTROL command for details of the positioning operation.

When the Data Recovery modifier is set to On, the slave or facility shall initiate data error recovery to attempt to recover data read with errors. If the error is unrecoverable, data shall be transferred up to the block in error and the command shall terminate. If the recovery attempts are successful, the transfer shall continue until all of the requested data has been transferred.

The response packet and associated parameters (if any), shall indicate the degree of recovery employed, depending on the default established by Attributes, or a preceding OPERATING MODE command.

When the Data Recovery modifier is set to Off (data recovery disabled), the slave or facility shall terminate the command if a data error is detected. The data in error shall be transferred. Recovery from non-data transfer errors are not suppressed by the Data Recovery Off modifier.

When the access is complete the addressee shall verify correct access position and shall read data starting at the Data Address. The addressee shall transfer the number of sequentially addressed octets or blocks specified by the Count.

During a multiple block transfer on disks, if access boundaries are Encountered, the facility shall perform appropriate access movements (unless overridden by a Boundary Gather parameter) and verify block positioning. The required processing such as incrementing to the next Physical Block head switches, seeking to the next cylinder when necessary, and restarting the read operation, shall be handled in a manner that does not require intervention, or explicit instruction, by the master.

If a defective block for which an alternate location has been assigned is encountered, the slave shall access the alternate block for reading, and then re-establish the access position for subsequent blocks to be read, if any. Access positioning shall be verified in all cases.

The slave shall present only valid data to the master if the Data Recovery modifier is set. All recovery from data errors detected during reading shall be attempted by the slave prior to transfer of the data to the master. If the data error is not corrected by the slave, processing of the command shall be terminated with a Machine Exception indicated in Major Status. The cause of the termination shall be indicated in substatus and extended substatus (if applicable).

The slave may permit execution of a "scatter read" if multiple Command Extent parameters are permitted (see Attributes). If multiple extents are accepted, the extents are processed by the slave in the sequence that they were received in the parameter list. Data is transferred to the master in the same manner as if the data was requested using a READ command with a single extent.

Should a command with multiple extents terminate prematurely due to data error or data recovery failure, the Response Extent shall contain the residual count of all non-transferred data within that extent. It is the master's responsibility to ascertain the total residual based on the Response Extent plus any other extents not processed.

A subset of "scatter read" defined as "boundary gather" allows the master to specify the starting address on a track, and have the slave perform an implicit scatter by not changing to the next track, but continuing transfer from the start of the track.

The use of multiple extents and the Skip Mask parameter are mutually exclusive.

9.1.1 Read Parameters - Common

@	LTH	ID	OCTET	X/b	DEF	READ PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	3F	01- n			STOP ON DISCONTINUITY PARAMETER (See 6.5.16)

9.1.1.1 Command Extent (Common) Parameter

The Count specifies the number of blocks (or octets) to be transferred and cannot be zero. A zero value shall cause the command to be terminated with a Command Exception. The Data Address specifies the starting location. If the Data Address is not valid for the addressee, processing shall be terminated with Command Exception.

If the sum of the Data Address and the Count exceeds the number of blocks in the addressable area, processing of the command shall be terminated with Invalid Extent set in the Command Exception status.

9.1.1.2 Response Extent (Common) Parameter

This parameter is used to return the Residual Count of blocks (or octets) remaining in the transfer after it terminated. The Data Address varies depending on which modifiers had been set (see Note under 6.5.3).

9.1.1.3 Access Key (Common) Parameter

See 6.5.6

9.1.1.4 Data Address (Common) Parameter

This parameter is used if the four octets of Data Address in the Extent parameter(s) are insufficient.

9.1.1.5 Partition (Common) Parameter

This parameter is used to address other than the default data area.

9.1.1.6 Stop on Discontinuity (Common) Parameter

This parameter is used to advise the slave under which conditions to terminate a data transfer due to a timing delay due to a discontinuty.

9.1.2 Read Parameters 50-52

@	LTH	ID	OCTET	X/b	DEF	READ PARAMETERS
M	n+1	50				SKIP MASK PARAMETER
			01	7		Reference to Block at Starting Address
				6		Reference to Block at Starting Address+1)
						. . . .
				1		Reference to Block at (Ending Address-1)
			n	0		Reference to Block at Ending Address
M	n+1	51				INFORMATION TRANSFER SIZE OVERRIDE PARAMETER
			01-04			Generate Class 2 Interrupt
			05-08			Burst Size
M	01	52				MASTER TERMINATION PERMITTED PARAMETER
M	01	53				BOUNDARY GATHER PARAMETER

9.1.2.1 Skip Mask Parameter

This parameter alters the action of this command from implicit transfers of consecutive blocks to the selective transfer of blocks under mask control. The parameter consists of a mask up to 32 octets in length. Each bit within the mask corresponds to a sequential Data Block within the Command Extent.

NOTE: The number of 1 bits set in the mask shall equal the number of blocks specified in the Command Extent. Multiples of less than 8 blocks are padded up to a full octet.

Data Blocks are transferred if the corresponding mask bit value is '1', and are skipped if the value is '0'. Bit 7 of the first octet of the mask corresponds to the Data Address in the Command Extent. Succeeding lower order mask bits correspond to numerically higher valued addresses as illustrated in the following figure:

```
+----------+----------+--------   ////   -----------+----------+
| Octet 0  | Octet 1  |                             | Octet n  |
| 76543210 | 76543210 | 765       ////        43210 | 76543210 |
+----------+----------+--------   ////   -----------+----------+
|                                                              |
| <------- Starting Address            Ending Address -------->|
```

9.1.2.2 Information Transfer Size Override Parameter

- Minimum Size of Data Transfers - this value shall override the setting in Attributes for the duration of this command.

- Maximum Size of Multiplexed Data Transfers - this value shall override the setting in Attributes for the duration of this command.

9.1.2.3 Master Termination Permitted Parameter

This parameter allows the master to advise the slave that master termination may occur as a normal condition on this command, which is typically part of a chain. If the master does terminate transfer on a boundary, the slave shall not abort a Chain, Sequence or Order. It will respond with Master Terminated Transfer posted in Conditional Success status, and the Response Extent shall contain the residual count of the transfer.

If termination does not occur on a boundary, the slave shall abort the remaining commands of a Chain, Sequence or Order and post the same status as if this parameter were not present; i.e., Data Length Difference posted in Incomplete Status.

9.1.2.4 Boundary Gather Parameter

This parameter shall immediately precede the Command Extent parameter.

During a multiple block transfer, if an access boundary is encountered the facility shall not perform any access movement, but continue to transfer data until the Count specified has been transferred, or an error occurs which requires earlier termination.

9.2 Read Raw Data

Command Packet:

```
+-----+-----+-----+-----+-----+-----+-----+-------------
|PKT  |REF  | OP  |COM  | OP  |SLAV|FAC |   COMMAND
| LTH|  NO |CODE|  MOD|  MOD|ADDR|ADDR|  PARAMETERS
|     | 0 1|   2 |     3      |  4  |  5  | 6 through n
+-----+-----+-----+----------+-----+-----+--------------
 xxxx xxxx   11   bbbb bbbb   xx    xx
                  7654 3210
                       ||||  Count  0=Octet  1=Block
                       |||  1=Data Recovery Off
                       ||  0=Data Block  1=Physical Block
                       |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+-----+-------------+-------------------+------------
|PKT  | Echoed From|    MAJOR STATUS     |  RESPONSE
| LTH|    Command   | CODES    |TYPE|CODE| PARAMETERS
|     | 0 1 2 3 4 5|    6      |    7     | 8 through n
+-----+-------------+----------+-----+-----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The READ RAW DATA command reads data from the addressee, and transfers it to the master regardless of data errors encountered in the read. An error shall be reported only if the data cannot be transferred because of a condition such as inability to access the block, or an unrecoverable slave or facility error (not associated with data transfer) is encountered.

The Data Recovery modifier shall be set to Off. The command shall be rejected if Bit 1=0.

Read Raw Data Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ RAW DATA PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	3F	01- n			STOP ON DISCONTINUITY PARAMETER (See 6.5.16)

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

Stop on Discontinuity (Common) Parameter:

See 9.1.1.5

9.3 Read Replicated Data

Command Packet:

```
+-----+-----+-----+-----+-----+-----+-----+-----------
|PKT  |REF  | OP  |COM  | OP  |SLAV|FAC  |  COMMAND
| LTH| NO  |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|     | 0 1|  2  |     3     |  4  |  5  | 6 through n
+-----+-----+-----+-----------+-----+-----+-------------
 xxxx xxxx   12   bbbb bbbb   xx    xx
                  7654 3210
                       ||||  1=Block
                       |||  Data Recovery  0=On  1=Off
                       ||  0=Data Block  1=Physical Block
```

Response Packet:

```
+-----+------------+-----------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|     | 0 1 2 3 4 5|   6      |    7    | 8 through n
+-----+------------+----------+-----+-----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The READ REPLICATED DATA command causes the addressee to read one instance of data which was written multiple contiguous times on a track. The intent of this command is to minimize latency in accessing data. The command directs the facility to transfer a string of 'n' blocks from a range of 'm' blocks, beginning at the Data Address in the Command Extent parameter or any block within range 'm' whose address is the sum of the addressed block and an integral multiple of 'n'.

Bit 0 shall be set to 1 for Block transfers only.

The Count field of the Command Extent parameter specifies the 'n' value, and the Range Count parameter defines the number of blocks in the range 'm'.

The facility shall initiate access to one of the repeated instances of 'n' blocks (Extent Count) within the range 'm' (Range Count), so as to minimize the access time to the data. When the access is complete the facility shall verify the correct access position and transfer 'n' blocks (Extent Count).

Read Replicated Data Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ REPLICATED DATA PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	05	50	01-04			RANGE COUNT PARAMETER

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

Range Count Parameter:

This field specifies the number of blocks in the range. The range value shall be non zero. If zero is specified, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. Invalid Parm Parameter shall identify the incorrect parameter.

If the Range Count is less than the Command Extent Count, or if the range is not an integral multiple of the Extent Count, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter indicated in substatus. An Invalid Parm parameter shall indentify the incorrect parameter.

If the sum of the Data Address and the Range Count exceeds the number of blocks in the partition, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter indicated in substatus. Invalid Parm Parameter shall identify the incorrect parameter.

9.4 Search

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+--------------
 xxxx xxxx  18  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  Data Recovery  0=On  1=Off
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward 1=Reverse
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The SEARCH command causes the slave to search and logically compare the data string(s) supplied by the master (as parameters) with stored data. The search starts at the location specified by the Data Address, and continues until either a match is found to that supplied by the master (transfer begins with the block in which the match was found) or the Search Range is exhausted.

If data transfer occurred or the search was unsuccessful, the Response Extent is the same as on other transfer commands. However, if the string is located, but no data transfer was requested (selected by parameter setting), the Response Extent contains the address of the Data Block containing the start of the string, and the Residual Count is unchanged.

The SEARCH command may be parameterized to perform three different types of search operations:

1. A word processing style string search is obtained when one Set String Search Parameter is included in the command packet.

2. A fixed location(s) data processing Key type search is performed when the Set Multiple Key Search Parameter is included.

3. A data base style search can be constructed by the use of multiple Set String Search parameters connected with the Boolean Operator parameter.

   NOTE: The two parameters, Set String Search and Set Multiple Key Search are mutually exclusive and shall never be included in the same command packet.

The data base style search differs from a string search in that rather than searching for a single match condition, the parameters are used to construct a sequence of match conditions which must be met in order for the search to be satisfied. The slave searches for a match to the data model supplied by the master as Search String parameters joined by Boolean Operator parameters. The parameters have to be presented in the correct sequence. A multiple key search is counted or transferred only if the whole expression has been satisified successfully.

9.4.1 Search Parameters 02, 31, 32, 3A, 3E

@	LTH	ID	OCTET	X/b	DEF	SEARCH PARAMETERS
M	01	02	01- n			CONTINUATION OF PRECEDING PARAMETER (3.2.1.7)
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

9.4.1.1 Continuation of Preceding (Common) Parameter

See 6.2.1.7

9.4.1.2 Command Extent (Common) Parameter

The Count specifies the number of blocks (or octets) to be transferred beginning at the first block which contained a match. This field may be set to zero if no data is to be transferred on a successful match. The Data Address specifies the starting location from which the command is to begin the search.

9.4.1.3 Response Extent (Common) Parameter

See 6.5.3

9.4.1.4 Access Key (Common) Parameter

See 6.5.6

9.4.1.5 Data Address (Common) Parameter

See 6.5.11

9.4.1.6 Partition (Common) Parameter

See 6.5.15

9.4.2 SEARCH PARAMETER 50

@	LTH	ID	OCTET	X/b	DEF	SEARCH PARAMETERS
M	n+1	50				SET STRING SEARCH PARAMETER
			01	7		Transfer block(s)/Count number of matches
				6		Reserved
				5		Search Greater Than
				4		Search Equal To
				3		Search Less Than
				2-0		Reserved
			02			Reserved
			03-06			Search Range
			07-0A			Offset into block to begin search
			0B- n			Data string to search against

9.4.2.1 Set String Search Parameter

- Search Condition - this octet specifies the conditions of the search.

When Bit 7=0 data shall be transferred to the master following a successful match condition (the number of octets/blocks to be transferred is specified by the Extent Count).

When Bit 7=1 the slave shall count the number of successful match conditions.

If multiple Set Search String parameters are appended to a command, Bit 7 of each must have the same setting as the first.

Bits 5-3 specify the kind of search operation to be performed. Comparisons between the supplied data string and stored data shall be performed by the slave on an octet by octet basis. The search operators are as follows:

Bits 5-3	Search Operators
000	invalid
001	search less than
010	search equal
011	search less than or equal
100	search greater than
101	search not equal
110	search greater than or equal
111	invalid

- Search Range - this field contains an unsigned binary number specifying a range of blocks, starting from the Data Address, over which to apply the search operation. The range value must be non zero. If zero is specified, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. An Invalid Parm parameter shall identify the incorrect parameter.

- Offset into Block to Begin Search - this field contains an unsigned binary number specifying an offset into the block to begin the search operation. This offset will apply to all subsequent blocks in the Search Range. The value of this parameter must be less than the block length. If the value is greater than, or equal to, the block length, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. Invalid Parm Parameter shall identify the incorrect parameter.

- Data String - this field of variable length (up to 240 octets in length) contains the search argument that will be compared to stored data during the execution of the command.

9.4.3 Search Parameter 51

@	LTH	ID	OCTET	X/b	DEF	SEARCH PARAMETERS
M	03	51				BOOLEAN OPERATOR PARAMETER
			01	7		AND
				6		OR
				5		XOR
				4		NOT
				3		Begin Parentheses
				2		End Parentheses
				1-0		Reserved
			02			Same definition as octet 01

Boolean Operator Parameter:

This octet specifies the Boolean operators that can be used to join any two Set String Search parameters. Only one expression of AND, OR, XOR can be supplied, and NOT can be associated with whichever is set to 1. The parentheses are used to allow correct Boolean expressions to be constructed, and one can be set in combination with any other bit.

If more than two bits are necessary to construct a Boolean expression, the second octet of the parameter is required; e.g., "AND NOT (" would require that bits 7 and 4 be set to 1 in octet 01 and bit 3 in octet 02.

9.4.4 Search Parameter 52

@	LTH	ID	OCTET	X/b	DEF	SEARCH PARAMETERS
M	n+1	52				SET MULTIPLE KEY SEARCH PARAMETER
			01	7	0	Transfer Blocks
				6		Reserved
				5		Search Greater Than
				4		Search Equal To
				3		Search Less Than
				2-0		Reserved
			02			Reserved
			03-06			Search Range
			07-0A			First Key Offset
			0B-0E			Key Offset
			0F-12			Size of Keys - must be the same for all
			13-16			Number of Keys per block
			17- n			Search Key Argument

Set Multiple Key Search Parameter:

- Search Condition - See 9.4.2.1 Search Condition.

  Bit 7 shall always be set equal to zero.

- Search Range - See 9.4.2.1 Search Range.

- First Key Offset - this value specifies an offset into the block to the location of the first Key field where the search operation begins. This offset will apply to all subsequent blocks in the Search Range. The value of this parameter must be less than the block length. If the value is greater than, or equal to, the block length, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. Invalid Parm Parameter shall identify the incorrect parameter.

- Key Offset - this value specifies the offset between all Key fields in the block. The value of this parameter must be non zero and less than the block length. If the value is zero, or greater than, or equal to, the block length, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. An Invalid Parm parameter shall identify the incorrect parameter.

- Size of Keys - this value specifies the size of the Key field (must be the same for all Keys). The value must be non zero and less than the block length. If the value is zero or greater than or equal to the block length, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. An Invalid Parm parameter shall identify the incorrect parameter.

- Number of Keys per Block - this value specifies the number of Key fields in a block, and must be non zero. If the value is zero, processing of the request shall be terminated with a Command Exception indicated in Major Status and Invalid Parameter shall be indicated in substatus. An Invalid Parm Parameter shall identify the incorrect parameter.

- Search Key Argument - This variable length field contains the Search Key Argument that will be compared with the Key fields within the block(s).

NOTE: The following figure illustrates the relationship between all the fields of the Set Multiple Key Search Parameter.

```
   First      Key
|   Key     | Length   |
|<-Offset->|<-------->|
+----------+----------+------+----------+-------------|
|          |          |      |          |             |
|          |  key 1   |      |  key 2   |             |
+----------+----------+------+----------+-------------+
           |                 |
           |<-Key Offset---->|
|                                                     |
|<-----------------------Block----------------------->|
```

The search action specified in the Search Condition octet shall be repeatedly applied, block by block, between the Search Key Argument and data stored in Key fields within the blocks until either a match occurs or the Search Range has been exhausted.

9.4.5 Search Parameter 53

@	LTH	ID	OCTET	X/b	DEF	SEARCH PARAMETERS
S	n+1	53				REPORT SEARCH PARAMETER
			01			Search Results
				7-6		Reserved
				5		Compared Greater Than
				4		Compared Equal To
				3		Compared Less Than
				2-0		Reserved
			02			Reserved
			03-06			Offset of match into block
			07-0A			Count of blocks transferred/Number of matches
			0B-0E			Data Address of first match

Report Search Parameter:

- Search Results - this octet contains the results of the search operation requested by this command. Meanings of the bits are as follows:

Bits 5-3	Search Results
001	compared less than
010	compared equal
100	compared greater than

The results of a search not equal will be indicated with either the less than or greater than bit setting. The remaining bits in this octet are reserved.

- Offset of Match into Block - this field contains an unsigned binary number specifying the offset into the first block that contained the first octet of the match condition specified by the previous octet.

- Count of Blocks Transferred/Number of Matches - this field contains an unsigned binary number based upon the action requested in the Search Condition octet; i.e., the count of the number of blocks transferred to the master following a match, or a count of the number of matches detected within the Search Range (as per the setting of Bit 7 in the first octet of the parameter that set up the search).

- Data Address of First Match - this field is returned only on a Multiple Key Search and contains the Data Address of the first block that contained the match.

9.5 Write

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  20  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|   MAJOR STATUS    | RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The WRITE command transfers data from the master to the addressee starting at the position specified in the Data Address of the Command Extent parameter. If positioning is required before the data can be accessed, the slave shall initiate the positioning operation. Refer to the POSITION CONTROL command for details of the positioning operation. The mode and direction of the command is specified by the modifier octet.

If multiple Command extents are supported by the slave they shall be processed in the sequence that they were received in the parameter list. Data is transferred to the slave as it was sequential data to be written to a single extent.

Write Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	02	3C				TRANSFER PARAMETER (See 6.5.13)
			01	7		Verify
				6		Volume
				5		Certify
				4		Stop on Data Error
				3-2		Reserved
				1		Compare - Use buffer under slave control
				0		Compare - Master repeat transfer
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	3F	01- n			STOP ON DISCONTINUITY PARAMETER (See 6.5.16)
M	n+1	50	01- n			SKIP MASK PARAMETER
M	n+1	51				INFORMATION TRANSFER SIZE OVERRIDE PARAMETER
			01-04			Generate Class 2 Interrupt
			05-08			Burst Size
M	01	52				MASTER TERMINATION PERMITTED PARAMETER

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Transfer (Common) Parameter:

This parameter is used to specify the actions to be taken by the slave when writing to the media.

See Note at 6.5.13.

Partition (Common) Parameter:

See 6.5.15

Stop on Discontinuity (Common) Parameter:

See 6.5.16

Skip Mask Parameter:

See 9.1.1.6

Information Transfer Size Override Parameter:

See 9.1.1.7

Master Termination Permitted Parameter:

See 9.1.2.3

9.6 Write Pattern

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  21  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet   1=Block
                     |||
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+----------------+------------
|PKT | Echoed From|   MAJOR STATUS  |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The WRITE PATTERN command allows the master to write a data pattern in the extent specified by the Command Extent parameter. If a specific pattern is required by the master it shall be passed as a parameter in the command packet. If the supplied data pattern is less than the number of blocks to be written, the supplied pattern shall be repeated as necessary to fill the blocks. If a Pattern parameter is not supplied, the command is rejected.

Write Pattern Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE PATTERN PARAMETERS
M	01	02	01- n			CONTINUATION OF PRECEDING PARAMETER (3.1.2)
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	02	3C	01			TRANSFER PARAMETERS (See 6.5.13)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	50	01- n			PATTERN PARAMETER

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Transfer (Common) Parameter:

See 6.5.13

Partition (Common) Parameter:

See 6.5.15

Pattern Parameter:

This parameter contains the pattern to be repeated. The length of the pattern cannot exceed the largest command packet size the slave can accept (as set in Attributes).

9.7 Format

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  28  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet  1=Block
                     |||  Inhibit Defect Reallocation
                     ||  0=Data Block  1=Physical Block
                     |  1= Initialize Format
```

Response Packet:

```
+----+-------------+-----------------+------------
|PKT | Echoed From|   MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |   7     | 8 through n
+----+-------------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The master can redefine the slave-defined Default Data Partition of a disk into smaller contiguous Partitions. There can only be one physical format to a Partition. The area to be formatted shall include the slave's allocation for alternate blocks.

The FORMAT command when used with the Initialize Format modifier set establishes a Partition and causes it be formatted. When the modifier is not set, the slave only formats the partition or extent defined by parameters. The formatting operation is slave specific, but the overall result is the establishment of Physical Blocks through the defined Partition.

Typically, but not necessarily, formatting involves rewriting the identification and possibly the data fields of the disk. Some disk drives do not have a simple relationship between Physical Block, track and cylinder addresses and it is the responsibility of the slave to format according to the characteristics of the drives it is controlling.

The Inhibit Defect Reallocation modifier is used to override the avoidance of defects by the slave. The default condition is for the slave to either skip or reallocate defects defined in the parameter list, in addition to those known to the slave by a stored defect list (if any). Defects encountered during the format shall also be skipped or reallocated. The techniques associated with how this is done are the responsibility of the design, and are not defined in this document.

If defect reallocation is not inhibited, entries in the Suspect Permanent and Suspect Temporary defect lists are automaticaly reallocated and moved to the corresponding Working defect list during execution of the FORMAT command.

It may be desirable for some applications to have the track format controlled by the master; e.g., a floppy disk used for media interchange between on specific systems. Other applications are better handled by slave control of the formatting. In addition, some devices may not require defect mapping.

The Initialize Format modifier is used to indicate to the slave that this is an initial formatting of a Partition, rather than an incremental or update formatting. This may require special actions to be taken at the device level; e.g., disks implemented with a Level 2 IPI establish a Format Specification for the Partition, and need to know the difference between an initial and an incremental formatting.

The slave uses the Fill Octet field specified in Attributes as the data to be recorded within Physical Blocks during formatting.

Where a field is not supplied as a parameter value, the slave shall assume values that provide a viable format. The minimum information required by the slave is the Data Block size, as the slave can select all other parameters necessary for formatting. The Data Block size may be implicit if defined in Attributes prior to issuing the FORMAT command, or explicit by use of the Data Block modifier and the Block Size Parameter. If the master is unable to support the maximum transfer rate of the slave the only other essential information would be the Transfer Rate Parameter.

Other use of master-supplied parameters presumes that the master has a knowledge of the disk, and the need to override the slave's selection of parameters in order to achieve a specific desired format.

When the slave is ready to begin the formatting operation, fields associated with the format that are in the addressee s Attribute Table shall have their contents set to zero by the addressee. Following a successful format, the addressee's Attribute Table shall be updated by the addressee to indicate the characteristics of the formatted media.

If a Maintenance Partition (ID x'01-0F') is to be formatted, it is necessary for the FORMAT command to be preceded in a Chain, Sequence or Order by a OPERATING MODE command that specifies which Maintenance Partition is to be formatted. Some disk designs physically compartment the disk into slave-defined Maintenance Partitions (ID x'01-07'); e.g., a CE Cylinder which is provided to allow diagnostics to test read/write functions without affecting user data in the Data Partition(s). Similarly, some masters may choose to define Maintenance Partitions (ID x'08-0F) for system diagnostic purposes.

If more than one partition is to be used on a disk, the slave requires as a minimum, the Count of the number of Blocks or octets in the Partition. If the Data Block modifier is specified the slave shall begin the Partition in previously unformatted data space. If Physical Blocks are specified, the starting Physical Address is required, and must begin on a physical boundary. The master shall precede all other supplied parameters with a Partition Parameter; e.g.,

Partition
Blocksize
Command Extent (Count only if Data Blocks)
(Data Address required if Physical Blocks)
Choice of Interleave Parameters

The burden for managing the implementation of partitions with different formats on the same disk is upon the master. Reference to partitions may be by either the Partition parameter or by Alias addressing.

Interleave Considerations:

The order of blocks as seen by a master during data transfer is always in ascending block number sequence. Interleaving parameters are provided so that the master can request that the order for recording of blocks on disk be in such a manner that blocks with sequentially ascending addresses are not physically contiguous. The effect of this is to reduce the effective transfer rate, though not the instantaneous transfer rate within a block. The degree by which blocks that are adjacent, but not physically contiguous, in the address space may have their transfer rate between the addressee and master effectively reduced is called the interleave factor.

The interleave factor allows an addressee with an effective data rate greater than that of the master, to be attached without incurring a significant performance loss. Non-contiguous physical fields are a commonly implemented technique, although other solutions which provide the same effect may also be used. An interleave factor may be established in manufacture, or it may be set by the master through parameters of the FORMAT command. Once formatted, the interleave factor becomes an attribute of the facility until changed by another FORMAT command. A reset or removal of power from the slave or facility shall not cause the interleave factor to change.

Defect List Considerations:

> If the master wishes to control the management of defects, it may provide defect list parameters for the slave to use in lieu of those known to the slave (by manufacturer's flaw map or slave's own maintained defect list).

If the list of defects supplied by the master exceeds the size of the command packet, then it may be supplied as data. The master is required to provide the information in the same manner as it wants the disk formatted; e.g., if the Block modifier is set, then it applies to both the extent to be formatted and the transfer of parameters as data.

The defect list supplied by the master is treated by the slave as applicable only during the execution of the command, and the slave makes no entries in its own defect lists. Typically, this method of formatting is used in lieu of slave management of defects. If the master wishes the defect list provided to be entered into the slave's defect list, it does so by using the Write Defect List command.

Typically, the master shall be formatting an area smaller than the whole disk, so the master supplies two Command Extent parameters, one for the transfer of parameters as data (See 6.2.4) and the other to define the area to be formatted.

9.7.1 Format Parameters 31, 32, 3A-3F

@	LTH	ID	OCTET	X/b	DEF	FORMAT PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	05	3B	01-04			BLOCK SIZE (See 6.5.12)
M	02	3C	01			TRANSFER PARAMETERS (See 6.5.13)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	3F	01- n			STOP ON DISCONTUITY PARAMETER (See 6.5.16)

9.7.1.1 Command Extent (Common) Parameter

If this parameter is not present, the slave formats the Default Data Partition. If other partitions had been previously defined, the area formatted would be the remaining Default Data Partition, otherwise the entire slave-defined Default Data Partition would be formatted.

If this parameter is present, the Count field establishes the size of the extent to be formatted. When the Initialize Format modifier is set, this also establishes the size of the artition.

If the Data Block and Initialize Format modifiers are set, the Data Address field is not supplied, the partition is described in terms of Data Blocks, and the slave is responsible for allocating the partition into unformatted space of the Default Data Partition.

If the Data Block modifier is set and Initialize Format modifier is not, the Command Extent defines the area to be re-formatted.

If the Physical Block modifier is set, the Data Address field is required, the extent is described in terms of Physical Blocks, and the starting Physical Block address must be on a physical device boundary.

9.7.1.2 Response Extent (Common) Parameter

See 6.5.3

9.7.1.3 Access Key (Common) Parameter

See 6.5.6

9.7.1.4 Data Address (Common) Parameter

See 6.5.11

9.7.1.5 Block Size (Common) Parameter

In the absence of this parameter, the slave shall select a size consistent with the Data Block size defined in Attributes.

If this parameter is present and the Initialize Format modifier is set, it explicitly overrides any block size which may be defined in Attributes. The following actions are performed whether block size is implicit or explicit as long as the Initialize Format modifier is set.

If the Data Block modifier is set, the block size is defined in Data Blocks for the partition, and the slave chooses a Physical Block size which is consistent with the Data Block size, and which optimizes the physical characteristics of the facility. The slave shall reject the FORMAT command with an Invalid Parm substatus if the Data Block size is not supported for the Partition.

If the Physical Block modifier is set, the block size is defined in Physical Blocks for the partition, and the slave checks this against any slave or facility defined constraints; e.g., switch settings, default values, or imbedded servo fixed sector disks. If the values do not match, the FORMAT command shall be rejected with an Invalid Parm Substatus.

9.7.1.6 Transfer (Common) Parameter

See 6.5.13

9.7.1.7 Partition (Common) Parameter

See 6.5.15

9.7.1.8 Stop on Discontinuity (Common) Parameter

Some methods of Physical Block reallocation during formatting can cause discontinuities. The master uses this parameter if it wishes to have the FORMAT command cease executing because of an encountered discontinuity.

See 6.5.16

9.7.2 Format Parameters 50-55

@	LTH	ID	OCTET	X/b	DEF	FORMAT PARAMETERS	
M	03	50	01-02			NUMBER OF Physical Blocks PER TRACK	
M	04	51				Physical Block INTERLEAVE FACTORS	
			01		FF	Cylinder Interleave Factor	
			02		FF	Head Interleave Factor	
			03		FF	Physical Block Interleave Factor	*
M	n+1	52	01-n			Physical Block INTERLEAVE TABLE	*
M	n+1	53				TRANSFER RATE (Octets/second)	*
			01-04			Effective Disk Transfer Rate	
			05-08			Master's Instantaneous Transfer Rate	
M	03	54				Data Block INTERLEAVE PARAMETER	
			01	7	1	Value	
				6-0	0	Reserved	
			02			Data Block Interleave Value	*
M	03	54				Data Block INTERLEAVE PARAMETER	
			01	7	0	Factor	
				6-0	0	Reserved	
			02			Data Block Interleave Factor	*
						* Mutually exclusive parameters	

9.7.2.1 Number of Physical Blocks per Track Parameter

If this parameter is present, the value supplied specifies the number of Physical Blocks per track. If this parameter is not present, the slave determines the number.

9.7.2.2 Physical Block Interleave Factors Parameter

- Cylinder Interleave Factor - this field specifies the number of Physical Blocks delay required between the last Physical Block on the last track of a cylinder, and the first Physical Block in the next cylinder. This delay biases the absolute location of Physical Block 0 to compensate for the rotation of the disk during a single cylinder seek. A value of x'FF' allows the slave to determine the interleaving.

- Head Interleave Factor - this field specifies the number of Physical Blocks offset required between the last Physical Block on a track, and the first Physical Block in the next track. This delay biases the absolute location of Physical Block 0 to compensate for the rotation of the disk during a head switch. A value of x'FF' allows the slave to determine the interleaving.

- Physical Block Interleave Factor - this field is used to adjust the effective transfer rate to and from the disk. It specifies the number of Physical Blocks to be skipped before the next Physical Block is generated. A value of zero causes no skip, and the Physical Blocks are sequentially numbered. A value of x'FF' allows the slave to determine the interleaving. The slave shall generate interleaved Physical Blocks, while accomodating track and cylinder interleaving.

9.7.2.3 Physical Block Interleave Table Parameter

This parameter allows the master to describe the Physical Block interleave structure for a complete track. The number of entries in the table shall be equal to the number of Physical Blocks in a track. The first entry in the table specifies the physical Physical Block number to be given to absolute Physical Block 0 on each track; the second entry gives the physical Physical Block number to be assigned to absolute sector 1; etc. This parameter can be used to achieve a level of software interleaving; e.g., if the operating system software is implemented in block sizes of 1K, but the media is formatted with Physical Block of 512 octets, the table for a simple example of 8 Physical Blocks per track could be constructed as '12563478'.

9.7.2.4 Transfer Rate Parameter

The first field is a value which allows the slave to format the disk in whichever fashion it chooses to achieve an effective data rate equal to or less than that specified. The second field is used by the slave to adjust its internal data flow to match the instantaneous transfer rate to and from the master.

9.7.2.5 Data Block Interleave Parameter

When Bit 7 of the first octet is set to 1, the following octet defines the interleave value to be used in formatting the media:

- The value specifies one of the interleave values defined by the facility. Bit 0 specifies interleave value 0, which is the basic block transfer capability of the facility. Bits 1-7 specify interleave values, which are defined in Equipmemt Specifications. Individual bits 1-7 are set to 1 to cause a reduction in the block transfer rate that exceeds the reduction of the immediately preceding bit; e.g., Bit 5=1 shall cause a greater reduction in the block transfer rate then Bit 4=1). Only one bit may be set.

When Bit 7 of the first octet is set to 0, the following octet specifies the factor to be used in formatting the media:

- The factor is used to adjust the effective rate at which Data Blocks are transferred from the disk. It specifies the number of Data Blocks to be skipped before the next sequential Data Block is generated. A value of zero causes no skip, and a value of x'FF' allows the slave to determine the interleaving.

9.7.3 Format Parameters 56-59

@	LTH	ID	OCTET	X/b	DEF	FORMAT PARAMETERS
M	n+1	56				TRACK DEFECTS LIST
			01-04			Cylinder (first)
			05-06			Track
			07-0A			Octet Offset into track
			0B-0C			Length of defect (in octets)
			n-B:8			Cylinder (last)
			n-7:6			Track
			n-5:2			Octet Offset into track
			n-1:n			Length of defect (in octets)
M	n+1	57				SECTOR DEFECTS LIST
			01-04			Cylinder (first)
			05-06			Track
			07-08			No of Sector after Index
			09-0A			Octet Offset within Sector
			0B-0C			Length of defect (in octets)
			n-B:8			Cylinder (last)
			n-7:6			Track
			n-5:4			No of Sector after Index
			n-3:2			Octet Offset within Sector
			n-1:n			Length of defect (in octets)
M	06	58				HARD DISK FORMATS
			01-02			Number of Alternate Cylinders
			03			Number of On-track Physical Block Spares
M	06	59				FLOPPY FORMATS
			01			Standard Formats
				7-4		Reserved
				3		ANSI 8" SS SD 128 octets/Physical Block
				2		ANSI 8" SS DD 256 octets/Physical Block
				1		ANSI 8" DS DS 256 octets/Physical Block
				0		ANSI 8" DS Quad Density 1024 octets/PhysBlock
			02			Number of Heads
			03-04			Gap Length
			05			Fill Octet

9.7.3.1 Track Defects List Parameter

This parameter allows specifying the location and size of a list of defects by cylinder number, head number, and offset from index by octet location. This parameter is used for disks without fixed sectors.

9.7.3.2 Sector Defects List Parameter

This parameter is used to identify defects in fixed sector disks (e.g. imbedded servo) by their position within the sector, as located by cylinder number, head number and sector number.

9.7.3.3 Hard Disk Formats Parameter

- Number of Alternate Cylinders - This field specifies the number of cylinders to be taken for use in allocating alternate tracks and/or alternate Physical Blocks.

- Number of On-track Physical Block Spares - this field specifies the number of Physical Blocks to be reserved on each track for assigning alternates for those Physical Blocks that contain defects. If this field's value is zero there are no spares, and alternates shall be taken from the Alternate Cylinders. On-track Physical Block spares typically decrease disk capacity but increase performance because the access time penalty associated with defective Physical Blocks mapped to Alternate Cylinders is avoided.

9.7.3.4 Floppy Formats Parameter

Standard Formats - this field is used to identify to which standard format the floppy is to be formatted. If more than one bit is set the parameter is rejected, and if no bits are set the format is non-standard and the remaining parameter fields are required.

Number of Heads - This value specifies the number of heads (i.e. sides) on the floppy to be formatted.

Gap Length - this value specifies the number of octets between Physical Blocks when a floppy disk is to be formatted. It is only used if a non-standard floppy format is to be generated.

9.7.4 Format Parameters 5A, 6C, 6D

@	LTH	ID	OCTET	X/b	DEF	FORMAT PARAMETERS
B	n+1	5A				CELL DEFECT LIST PARAMETER
			01-04			Cylinder (first)
			05-06			Track
			07-08			No of Defective Cells
			09-0C			Offset of Defective Cell #1
			0D- m			Offset of Defective Cell #2 through end
			n -			Cylinder (last)
			n -			Track
			n -			No of Defective Cells
			n -			Offset of Defective Cell #1
			n -			Offset of Defective Cell #2 through end
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Length *
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID Repeated as many
			n			Parameter ID times as needed
						* mutually exclusive parameters

9.7.4.1 Cell Defect List Parameter

This parameter allows specifying the location and size of a list of defects by cylinder number, head number, and offset of cell from index. This parameter is used for disks with variable record sizes (e.g. IPI-2 Format 2). The No of Defective Cells is used to step through the list within each cylinder (4 * No of Defective Cells identifies location of next cylinder's information).

9.7.4.2 Request Parm Parameter

See 7.3.13.1

10.0 COMBINATION COMMANDS

The commands in this section are the most complex commands of the Logical Interface. These commands involve considerations which by their very nature may be device-specific, design-specific, or both. Refer to Equipment Specifications as to their implementation.

Some Combination commands Combination do not require Combination Extents. Command Completions which do not contain a Combination Extent are identified as Transfer Responses (0001), not Combination Responses.

The Combination commands are typically addressed to the slave. However, the command packet may be addressed to a facility. In which case, the Facility Address in each Extent parameter shall be the same as that of the addressee.

On Combination commands which execute as part of a Chain the Source and Destination addressees must be the same as the remainder of the chain.

NOTE: Combination commands do not require the use of the Physical Interface Slave-to-Slave Information Transfers if the facilities are attached to the same slave. Users should be aware that if Physical Interface Slave-to-Slave Information Transfers are to be used, that dedication of the interfaces is required.

It is not intended that Slave-to-Slave Information Transfers execute concurrently with other operations. With Slave-to-Slave Information Transfers the dominant slave must have all of the capabilities of a master such as the handling of unexpected responses, even though it does not have control over selection.

10.1 Copy

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  30  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+------------+-------------------+-------------
|PKT | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|   Command  | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The COPY command allows the transfer of data between slaves (if Slave-to-Slave Information Transfers is supported at the Physical Interface Level 1), or between facilities attached to the slave.

If supported by the slave, multiple extents may be used for both the source and destination. The command requires that at least one source and one destination extent be defined in Combination Extent parameters; additional extents may be supplied and are processed by the slave in the sequence that they were received. The number of combination commands that may be active in a slave at the same time is defined by attributes.

If the two facilities have different block sizes, the transfer length will be expressed in terms of the block size used by the source. The block size of the source will be converted by the slave to the block size of the destination as required. On the write to the last destination block, the destination addressee will perform an "update write" operation i.e if the transfer of the last source block does not fill the destination block, the slave or facility shall not alter the remainder of the destination block.

It is possible for either the source or the destination, and sometimes both, to contain a Residual Count in the response packet; e.g., if the command terminated due to error, or end of tape on a multi-reel file was encountered (see the RESUME command).

Each set of COPY parameters is assumed to refer to an extent on the source and destination facilities. A continuous extent on a disk is equivalent to a span of blocks. COPY parameters may be concatenated so that multiple extents may be transferred via a single command packet. This allows files consisting of multiple non-contiguous extents to be backed up or restored with little overhead in the master.

If, for example, a file is to be restored from a backup tape (which can be treated as one large logically contiguous segment) then the master must know the available storage areas on the destination drive and their lengths. One set of COPY parameters is generated for each logically contiguous area on the destination disk.

An entire disk/tape/floppy may be transferred with a single COPY command by setting the Volume modifier bit in the Transfer parameter. However, unless the two facilities involved in the COPY operation have the same capacity, the transfer will be terminated whenever the lower capacity facility reaches its limit.

The process terminates when one of the following conditions is encountered:

1. The specified extents have been tranferred for all sets of COPY parameters in the packet (nominal termination).

2. A file mark is read from a source tape.

3. The end of tape is found.

4. The source disk is empty; i.e., last block of the source disk has been read and transferred to the destination.

5. The destination disk or tape is full; i.e., last block of the destination disk has been written.

The COPY response packet shall define the completion status if the COPY operation has terminated prematurely (i.e. before all specified data has been transferred), but successfully, it is considered Incomplete and may be resumed from the point of termination with the RESUME command.

In the case of premature termination, the master shall be sent the appropriate response packet defining which facility caused the termination. It is then the master's responsibility to initiate a RESUME command to restart from the point of termination. This mechanism allows the master to prompt the operator for another tape cassette or floppy disk before the operation is continued.

Copy Parameters:

@	LTH	ID	OCTET	X/b	DEF	COPY PARAMETERS	
M	n+1	33				COMBINATION COMMAND EXTENT PARM (See 6.5.4)	
			01			Slave Address	
			02			Facility Address	
			03			Modifiers	
			04			Reserved	
			05-08			Count	
			09-0C			Data Address	
			n-7:4			Count	Repeated as many
			n-3:n			Data Address	times as needed
S	n+1	34				COMBINATION RESPONSE EXTENT PARM (See 6.5.5)	
			01			Slave Address	
			02			Facility Address	
			03			Modifiers	
			04			Reserved	
			05-08			Residual Count	
			09-0C			Data Address	
			0D-0E			Major Status	
			0F- n			Substatus if any - Codes x0-xB	
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)	
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)	
M	02	3C	01			TRANSFER PARAMETERS (See 6.5.13)	
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)	
M	02	50	01			EXTENDED MODIFIERS	
				7		Suppress Automatic Retries	
				6		Transfer If Error	*
				5		Skip Bad Physical Block	
				4		Terminate on Unrecoverable Error	*
				3-0		Reserved	
							* Mutually exclusive modifiers

Combination Command Extent (Common) Parameter:

This parameter is used to identify the extent as being a Source or Destination. The Slave and Facility Addresses are required because the dominant slave responsible for execution of the command may or may not be either the source or the destination.

The modifiers in Bits 0-3 are those that would normally be command modifiers for a READ or WRITE.

Combination Response Extent (Common) Parameter:

This parameter is used to report the Residual Count on the Slave and Facility Source and Destination extents. The Substatus associated with the Source or Destination addressee which was in use at the time the command terminated is also presented.

Access Key (Common) Parameter:

This parameter is used to provide the key which allows access to a protected area.

Data Address (Common) Parameter:

This parameter is used if the four octets of Data Address in the Extent parameter(s) is insufficient.

Transfer (Common) Parameter:

This parameter is used to specify the actions to be taken by the slave when writing to the media.

Partition (Common) Parameter:

This parameter is used to address other than the default data area.

Extended Modifiers Parameter:

This parameter is needed only if the master has a need to override the normal error handling and correction features of the slave, and are associated only with the source. Such a situation can occur when the media source has been physically damaged, or otherwise affected in some way that affects its ability to be read.

- Suppress Automatic Retries - Automatic retries are suppressed when an error is encountered; i.e., the error action will be taken on the first error. Caution: If retries are suppressed then any error will leave a gap in the data on the destination device. Setting this bit makes the COPY operation vulnerable to soft errors. If not set automatic retries will be attempted before any error action is taken.

- Transfer if Error - Physical Blocks containing ECC errors will be transferred with the error intact; e.g., the ECC code is not updated so the error will occur when the destination block is accessed again. It is the responsibility of the master to ensure that the ECC codes of the source and the destination are the same.

If this bit is not set then the ECC will be updated on the destination block and the error will not be detectable on the destination unit.

- Skip Bad Physical Blocks - Physical Blocks that cannot be read correctly shall be ignored; i.e., treat that Physical Block as if it had never been read. The Residual Count is not decremented and the data is not transferred. If not set then the error action is specified by Terminate on Error.

- Terminate on Unrecoverable Error - The COPY operation will be terminated if an unrecoverable error occurs. The appropriate error status will be reported to the master.

10.2 Compare Slave Data

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  31  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   | PARAMETERS
| LTH|   Command  | CODES    |TYPE|CODE|
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The COMPARE SLAVE DATA command compares data on one facility with data on another facility attached to the same slave, or compares two sets of data on the same facility. The data on the source is the reference for the comparison and its Count determines the length of the comparison.

The command terminates when all data has been compared or a data inequality is encountered. If the two facilities have different block sizes, the Count shall be expressed as the number of blocks required for the data on the source. The slave will perform the mapping between the two block sizes.

If the destination data space is smaller than the source, Incomplete status will be posted. The Residual Count of the source can be used to calculate the amount of data actually compared and the Data Addresses will contain the address of the last block compared.

The source and destination can be of multiple extents if parameters are appended to the command packet.

Compare Slave Data Parameters:

@	LTH	ID	OCTET	X/b	DEF	COMPARE SLAVE DATA PARAMETERS
M	n+1	33				COMBINATION COMMAND EXTENT PARM (See 6.5.4)
			01			Slave Address
			02			Facility Address
			03			Modifiers
			04			Reserved
			05-08			Count
			09-0C			Data Address
			n-7:4			Count Repeated as many
			n-3:n			Data Address times as needed
S	n+1	34				COMBINATION RESPONSE EXTENT PARM (See 6.5.5)
			01			Slave Address
			02			Facility Address
			03			Modifiers
			04			Reserved
			05-08			Residual Count
			09-0C			Data Address
			0D-0E			Major Status
			0F- n			Substatus if any - Codes x0-xB
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	02	50	01			EXTENDED MODIFIERS
				7		Suppress Automatic Retries
				6		
				5		
				4		Terminate on Unrecoverable Error

Combination Command Extent (Common) Parameter:

See 6.5.4 and 10.1.1.1

Combination Response Extent (Common) Parameter:

See 6.5.5 and 10.1.1.2

Access Key (Common) Parameter:

See 6.5.6 and 10.1.1.3

Data Address (Common) Parameter:

See 6.5.11 and 10.1.1.4

Partition (Common) Parameter:

See 6.5.15 and 10.1.1.6

Extended Modifiers Parameter:

See 10.1.1.7

10.3 Compare Data

Command Packet:

```
+-----+-----+-----+-----+-----+-----+-----+--------------
|PKT  |REF  | OP  |COM  | OP  |SLAV|FAC  | PARAMETERS
| LTH| NO  |CODE| MOD| MOD|ADDR|ADDR|
|     | 0 1| 2  |     3     | 4  | 5  | 6 through n
+-----+-----+-----+-----------+-----+-----+--------------
 xxxx xxxx  32  bbbb bbbb  xx   xx
```

Response Packet:

```
+-----+-------------+------------------+--------------
|PKT | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|   Command   | CODES   |TYPE|CODE|
|     | 0 1 2 3 4 5|   6     |   7     | 8 through n
+-----+-------------+---------+----+----+--------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The COMPARE DATA command compares data on the facility with data from the master. The Count at the source (master) is defined by the Command Extent parameter, and determines the length of the comparison. The Count shall be expressed as the number of blocks required for the data on the source.

The destination shall be defined by a Combination Extent parameter. The slave will perform any mapping necessary between the data received and the block size at the destination.

The command terminates when all the data to be compared has been received from the master, a data inequality is encountered, or end of extent (Incomplete status) occurs on the destination. The Residual Count in the source's Response Extent parameter can be used to calculate the amount of data actually compared. The Data Address in the destination's Combination Extent response shall contain the address of the last block in which a comparison was made.

Compare Data Parameters:

@	LTH	ID	OCTET	X/b	DEF	COMPARE DATA PARAMETERS
M	05	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
S	05	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
M	n+1	33				COMBINATION COMMAND EXTENT PARM (See 6.5.4)
			01			Slave Address
			02			Facility Address
			03			Modifiers (Bit 7=1)
			04			Reserved
			05-08			Count
			09-OC			Data Address
			n-7:4			Count — Repeated as many
			n-3:n			Data Address — times as needed
S	n+1	34				COMBINATION RESPONSE EXTENT PARM (See 6.5.5)
			01			Slave Address
			02			Facility Address
			03			Modifiers (Bit 7=1)
			04			Reserved
			05-08			Residual Count
			09-OC			Data Address
			OD-OE			Major Status
			OF- n			Substatus if any - Codes xO-xB
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	02	50	01			EXTENDED MODIFIERS
				7		Suppress Automatic Retries
				6		
				5		
				4		Terminate on Unrecoverable Error

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Combination Command Extent (Common) Parameter:

See 6.5.4 and 10.1.1.1

Combination Response Extent (Common) Parameter:

See 6.5.5 and 10.1.1.2

Access Key (Common) Parameter:

See 6.5.6 and 10.1.1.3

Data Address (Common) Parameter:

See 6.5.11 and 10.1.1.4

Partition (Common) Parameter:

See 6.5.15 and 10.1.1.6

Extended Modifiers Parameter:

See 10.1.1.7

10.4 Reallocate

Command Packet:

```
+-----+-----+-----+-----+-----+-----+-----+---------------
|PKT  |REF  | OP  |COM  | OP  |SLAV|FAC  | PARAMETERS
| LTH| NO  |CODE| MOD| MOD|ADDR|ADDR|
|     | 0 1|  2  |     3     |  4  |  5  | 6 through n
+-----+-----+-----+-----+-----+-----+-----+---------------
 xxxx xxxx  33   bbbb bbbb  xx    xx
                 7654 3210
                      ||||  Relocate Data
```

Response Packet:

```
+-----+-------------+-------------------+-------------
|PKT | Echoed From|    MAJOR STATUS    | PARAMETERS
| LTH|   Command   | CODES    |TYPE|CODE|
|     | 0 1 2 3 4 5|    6     |    7     | 8 through n
+-----+-------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The REALLOCATE command causes defective recording area(s) to be re-assigned to replacement recording area(s). The address of the recording area(s) to be reallocated is specified by the Address field within an Extent parameter, in a Defect List parameter, or in a Suspect defect list.

The Data Address is implicitly interpreted by the slave unless the Data Address parameter is used to specify which kind of blocks (logical, physical or absolute) are to be defined.

If the Relocate Data modifier is set, the slave shall copy data from the specified recording area on the facility to a replacement recording area on the same facility. The destination may be explicit as specified by a destination Extent, or implicit if the slave has the capability to automatically manage the alternate area.

The original recording area shall be marked as unusable and the replacement recording area shall be automatically referenced by the facility whenever the original Data Address is accessed.

Slaves may only support this command in a pre-defined mode of operation, in which case only the Command Extent and Response parameters are required to identify the block being re-allocated. In all other cases Combination Extent/Response parameters are required, although if the area of re-assignment is slave-defined only the source extent is necessary as the destination extent is implicit.

The execution of REALLOCATE with no defects specified as appended parameters causes defects listed in either the Suspect Permanent or Suspect Temporary defect lists to be reallocated.

If any defects are specified as appended parameters, then they are the only ones that will be reallocated, and no reference will be made to the Suspect lists.

The location(s) of defective blocks are returned to the command which encountered the defect, and these are the address(s) used for the REALLOCATE command. This command may be used in either Data Block or Physical Block mode. If Data Block reallocation is selected, the slave will determine the Physical Block(s) affected by the defective recording area. The defective recording area and as many additional recording areas as are necessary to accommodate the Data Block will be reallocated.

If the space required to reallocate the specified block is not available (i.e. all space assigned for that purpose has been exhausted), the command shall terminate with Reallocation Space Exhausted status.

NOTE: Some facility technologies may not provide for a master requested reallocation of a data area. Normal completion status in the response packet indicates that the slave executed the command according to its internal algorithm, as specified in the product functional specification.

10.4.1 Reallocate Parameters 31-3E

@	LTH	ID	OCTET	X/b	DEF	REALLOCATE PARAMETERS
M	n+1	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

10.4.1.1 Command Extent (Common) Parameter

See 6.5.2

10.4.1.2 Response Extent (Common) Parameter

See 6.5.3

10.4.1.3 Access Key (Common) Parameter

See 6.5.6 and 10.1.1.3

10.4.1.4 Data Address (Common) Parameter

See 6.5.11 and 10.1.1.4

10.4.1.5 Partition (Common) Parameter

See 6.5.15 and 10.1.1.6

10.4.2 Reallocate Parameters 50, 55

@	LTH	ID	OCTET	X/b	DEF	REALLOCATE PARAMETERS	
M	n+1	50				DEFECT PARAMETER	
			01-04			Octet Offset	
			05-06			Length of Defect (in bits)	
			n-5:2			Octet Offset	Repeated as many
			n-1:n			Length of Defect	times as needed
B	n+1	55				DEFECTIVE DATABLOCK PARAMETER	
			01-02			Size of Datablock Address Fields	
			03-			Address of Defective Data Block	repeated as
			n- :n			Address of Defective Data Block	many times
							needed

10.4.2.1 Defect Parameter

This parameter may be used instead of a source extent, and the defect shall be added to the Defect List.

- The Octet Offset is relative to the location identified in the Data Address parameter (required to precede this parameter).

- The Length of Defect is the size of the defect counted in bits.

10.4.2.2 Defective Data Block Parameter

This parameter is used by the master to supply a list of defects identified by Data Block address to the slave. A master which uses only Data Block addresses has no other reference and presumably these were identified by slave responses following data transfers.

The list shall be processed in such a way that the following sequence of operations can be used to reinstate the pattern of media substitutions which was in place when a previous Temporary defect list was read.

1. Execute an initializing FORMAT without changing the Data Block size to remove Temporary defects.

2. Execute a REALLOCATE command with a Defective Data Block parameter which contains a previously read Temporary defect list in chronological order.

This should be true as long as the Data Block size was not changed, and no Permanent defects were added since the defect list was read.

- Size of Datablock Address Fields - this field specifies the size of the addresses.The field shall be a multiple of 16 bits, and be a minimum of 4 octets.

- Address of Defective Data Block - a list of fields containing the addresses of Data Blocks which contain defects.

10.5 Allocate Restore

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  34  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Relocate Data
```

Response Packet:

```
+----+-------------+-----------------+------------
|PKT | Echoed From |   MAJOR STATUS  | PARAMETERS
| LTH|   Command   | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5 |   6     |    7    | 8 through n
+----+-------------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The ALLOCATE RESTORE command allows a previously re-allocated recording area to be restored and to be marked as usable.

If the Relocate Data modifier is set the data in the allocated replacement recording area shall be restored to the original recording area. The address of the restored recording area shall be removed from the facility's defect list. The address of the previously reallocated recording area is transferred as either data or parameters.

On disks, if a Data Block is contained within a Physical Block, the contents of the replacement Physical Block will be copied to the original Physical Block and the defect linkage shall be cleared. If the Data Block requires several Physical Blocks, the contents of replacement Physical Blocks used by the Data Block will be copied to the original Physical Blocks, and the defect linkage shall be cleared.

This command reverses the effect of the REALLOCATE command. It would typically be used if an error condition within the addressee caused an abnormal number of data re-allocations; e.g., marginal read/write board.

The master is required to effectively mirror the original REALLOCATE command(s) and parameters so that the slave can execute this command successfully. Considerations of interleaving and multiple re-allocations may require that ALLOCATE RESTORE commands be received in the reverse order that the REALLOCATE commands were issued.

10.5.1 Allocate Restore Parameters 31-35, 3A, 3E

@	LTH	ID	OCTET	X/b	DEF	ALLOCATE RESTORE PARAMETERS
M	n+1	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

10.5.1.1 Command Extent (Common) Parameter

See 6.5.2

10.5.1.2 Response Extent (Common) Parameter

See 6.5.3

10.5.1.3 Access Key (Common) Parameter

See 6.5.6 and 10.1.1.3

10.5.1.4 Data Address (Common) Parameter

See 6.5.11 and 10.1.1.4

10.5.1.5 Partition (Common) Parameter

See 6.5.15 and 10.1.1.6

10.5.2 Allocate Restore Parameters 50, 55

@	LTH	ID	OCTET	X/b	DEF	ALLOCATE RESTORE PARAMETERS	
M	n+1	50				DEFECT PARAMETER	
			01-04			Octet Offset	
			05-06			Length of Defect (in bits)	
			n-5:2			Octet Offset	Repeated as many
			n-1:n			Length of Defect	times as needed
B	n+1	55				DEFECTIVE DATABLOCK PARAMETER	
			01-02			Size of Datablock Address Fields	
			03-			Address of Defective Data Block	repeated as
			n- :n			Address of Defective Data Block	many times
							as needed

10.5.2.1 Defect Parameter

This parameter may be used instead of a source extent to remove a defect from the Defect List. See 10.4.1.8 for definition of fields.

10.5.2.2 Defective Data Block Parameter

See 9.7.2.6

10.6 Shadow Read

Command Packet:

```
+-----+-----+-----+-----+-----+-----+-----+--------------
|PKT  |REF  | OP  |COM  | OP  |SLAV|FAC  | PARAMETERS
| LTH| NO  |CODE| MOD| MOD|ADDR|ADDR|
|     | 0 1|  2  |     3     |  4  |  5  | 6 through n
+-----+-----+-----+-----------+-----+-----+--------------
 xxxx xxxx  35   bbbb bbbb  xx    xx
```

Response Packet:

```
+-----+--------------+------------------+-------------
|PKT  | Echoed From|   MAJOR STATUS    | PARAMETERS
| LTH|   Command   | CODES    |TYPE|CODE|
|     | 0 1 2 3 4 5|   6      |    7     | 8 through n
+-----+--------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The SHADOW READ command transfers data from the primary or secondary addressee starting at the location given in the Data Addresses. Whenever a SHADOW READ operation is invoked, the slave shall determine from which addressee the data will be transferred. In a multi-ported environment, the slave shall determine which addressee is available, and initiate the data transfer operation. A slave may also optimise the I/O operation based on optimum head and cylinder geometry.

The command executes in one of two modes depending on whether or not shadowing is on a file basis or by volume.

When executing on a file basis the master shall specify the Count and Data Address for each Extent parameter (the Physical Block sizes may be different for each facility).

When executing on a volume basis only one Count and Data Address need be specified, as the extent on the second facility is a mirror of the first facility.

If there are any Transfer parameters set, they shall apply to both the primary and secondary facilities.

In the event of a data check or other failure on one facility, the slave shall attempt to complete the operation from the other facility. If the command is successfully completed on the second facility, Conditional Success will be posted as the Major Status.

If one of the facilities is not available for the operation, the slave shall complete the command to the available facility, and post Conditional Success as the Major Status.

Shadow Read Parameters:

@	LTH	ID	OCTET	X/b	DEF	SHADOW READ PARAMETERS
M	n+1	33				COMBINATION COMMAND EXTENT PARM (See 6.5.4)
			01			Slave Address
			02			Facility Address
			03			Modifiers
			04			Reserved
			05-08			Count
			09-0C			Data Address
			n-7:4			Count — Repeated as many
			n-3:n			Data Address — times as needed
S	n+1	34				COMBINATION RESPONSE EXTENT PARM (See 6.5.5)
			01			Slave Address
			02			Facility Address
			03			Modifiers
			04			Reserved
			05-08			Residual Count
			09-0C			Data Address
			0D-0E			Major Status
			0F- n			Substatus if any - Codes x0-xB
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	02	3C	01			TRANSFER PARAMETERS (See 6.5.13)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	51				INFORMATION TRANSFER SIZE OVERRIDE PARAMETER
			01-04			Generate Class 2 Interrupt
			05-08			Burst Size
M	01	52				MASTER TERMINATION PERMITTED PARAMETER

Combination Command Extent (Common) Parameter:

Two parameters are required, each a source for the data to be read.

See 6.5.4 and 10.1.1.1

Combination Response Extent (Common) Parameter:

See 6.5.5 and 10.1.1.2

Access Key (Common) Parameter:

See 6.5.6 and 10.1.1.3

Data Address (Common) Parameter:

See 6.5.11 and 10.1.1.4

Partition (Common) Parameter:

See 6.5.15 and 10.1.1.7

Information Transfer Size Override Parameter:

See 9.1.2.2

Master Termination Permitted Parameter:

See 9.1.2.3

10.7 Shadow Write

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  36  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+-------------+-------------------+-------------
|PKT | Echoed From|    MAJOR STATUS   | PARAMETERS
| LTH|   Command   | CODES   |TYPE|CODE|
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+-------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The SHADOW WRITE command transfers data from the master to both the primary and secondary addressee's, starting at the location given in the respective Data Addresses. The data transfer operation shall take place first to whichever facility, primary or secondary, records a position complete.

The command executes in one of two modes depending on whether or not shadowing is on a file basis or by volume.

When executing on a file basis the master shall specify the Count and Data Address for each Extent parameter (the Physical Block sizes may be different for each facility).

When executing on a volume basis only one Count and Data Address need be specified, as the extent on the second facility is a mirror of the first facility.

If there are any Transfer parameters set, they shall apply to both the primary and secondary facilities.

During execution, if one of the facilities should encounter a failure on one facility, the slave shall complete operation to the other facility, and post Conditional Success in the Major Status of the addressee (the cause of failure in the facility shall be identified in the Substatus of the associated Combination Response packet). It is the master's responsibility to manage the procedures necessary to recover from the loss of a single facility.

Shadow Write Parameters:

@	LTH	ID	OCTET	X/b	DEF	SHADOW WRITE PARAMETERS	
M	n+1	33				COMBINATION COMMAND EXTENT PARM (See 6.5.4)	
			01			Slave Address	
			02			Facility Address	
			03			Modifiers	
			04			Reserved	
			05-08			Count	
			09-0C			Data Address	
			n-7:4			Count	Repeated as many
			n-3:n			Data Address	times as needed
S	n+1	34				COMBINATION RESPONSE EXTENT PARM (See 6.5.5)	
			01			Slave Address	
			02			Facility Address	
			03			Modifiers	
			04			Reserved	
			05-08			Residual Count	
			09-0C			Data Address	
			0D-0E			Major Status	
			0F- n			Substatus if any - Codes x0-xB	
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)	
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)	
M	02	3C	01			TRANSFER PARAMETERS (See 6.5.13)	
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)	
M	n+1	51				INFORMATION TRANSFER SIZE OVERRIDE PARAMETER	
			01-04			Generate Class 2 Interrupt	
			05-08			Burst Size	
M	01	52				MASTER TERMINATION PERMITTED PARAMETER	

Combination Command Extent (Common) Parameter:

Two parameters are required, each a destination for the data to be written.

See 6.5.4 and 10.1.1.1

Combination Response Extent (Common) Parameter:

See 6.5.5 and 10.1.1.2

Access Key (Common) Parameter:

See 6.5.6 and 10.1.1.3

Data Address (Common) Parameter:

See 6.5.11 and 10.1.1.4

Transfer (Common) Parameter:

See 6.5.13 and 10.1.1.5

Partition (Common) Parameter:

See 6.5.15 and 10.1.1.6

Information Transfer Size Override Parameter:

See 9.1.2.2

Master Termination Permitted Parameter:

See 9.1.2.3

10.8 Shadow Restore

Command Packet:

```
+----+----+----+----+----+----+----+-------------
|PKT |REF | OP |COM | OP |SLAV|FAC | PARAMETERS
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR|
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  37  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+-------------+------------------+-------------
|PKT | Echoed From|    MAJOR STATUS   | PARAMETERS
| LTH|   Command  | CODES    |TYPE|CODE|
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+-------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0011 bbbb
                   7654 3210      3210
```

Description:

The SHADOW RESTORE command is a recovery command which transfers data from the primary addressee to the master starting at the location given in the data address. The specified data shall be echoed (written) to the secondary facility, starting at the Data Address specified for same.

The effect of this is similar to that of a facility to facility COPY, plus transfer to the master in parallel of all data being copied. If there are any Transfer parameters set, they shall apply to the secondary facility only.

If any failures occur on the secondary facility, the operation shall terminate with Machine Exception status reported for the failing facility.

Shadow Restor Parameters:

```
+-+---+--+-----+---+---+
|@|LTH|ID|OCTET|X/b|DEF|       SHADOW RESTORE PARAMETERS
+-+---+--+-----+---+---+----------------------------------------
|M|n+1|33|     |   |   | COMBINATION COMMAND EXTENT PARM (See 6.5.4)
| |   |  |   01|   |   | Slave Address
| |   |  |   02|   |   | Facility Address
| |   |  |   03|   |   | Modifiers
| |   |  |   04|   |   | Reserved
| |   |  |05-08|   |   | Count
| |   |  |09-0C|   |   | Data Address
| |   |  |n-7:4|   |   | Count                      Repeated as many
| |   |  |n-3:n|   |   | Data Address               times as needed
| |   |  |     |   |   |
|S|n+1|34|     |   |   | COMBINATION RESPONSE EXTENT PARM (See 6.5.5)
| |   |  |   01|   |   | Slave Address
| |   |  |   02|   |   | Facility Address
| |   |  |   03|   |   | Modifiers
| |   |  |   04|   |   | Reserved
| |   |  |05-08|   |   | Residual Count
| |   |  |09-0C|   |   | Data Address
| |   |  |0D-0E|   |   | Major Status
| |   |  |0F- n|   |   | Substatus if any - Codes x0-xB
| |   |  |     |   |   |
|M|05 |35|01-04|   |   | ACCESS KEY PARAMETER (See 6.5.6)
| |   |  |     |   |   |
|B|n+1|3A|01- n|   |   | DATA ADDRESS PARAMETER (See 6.5.11)
| |   |  |     |   |   |
|M|02 |3C|   01|   |   | TRANSFER PARAMETERS (See 6.5.13)
| |   |  |     |   |   |
|M|n+1|3E|01- n|   |   | PARTITION PARAMETER (See 6.5.15)
| |   |  |     |   |   |
+-+---+--+-----+---+---+----------------------------------------
```

Combination Command Extent (Common) Parameter:

See 6.5.4 and 7.1.1.1

Combination Response Extent (Common) Parameter:

See 6.5.5 and 7.1.1.2

Access Key (Common) Parameter:

See 6.5.6 and 7.1.1.3

Data Address (Common) Parameter:

See 6.5.11 and 7.1.1.4

Transfer (Common) Parameter:

See 6.5.13 and 7.1.1.5

Partition (Common) Parameter:

See 6.5.15 and 7.1.1.6

11.0 OTHER TRANSFER COMMANDS

The data transfer commands in this section are used for specific functions other than typical read and write activity. In many situations these commands may be used to complement diagnostics. These commands by their very nature are device-specific. Refer to Equipment Specifications as to their implementation.

11.1 Read Verify

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  50  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  High Margin
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+------------------+------------
|PKT | Echoed From|   MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |  7      | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The READ VERIFY command reads data from the addressee and verifies that the data is correct as determined by the slave or facility's error detection/correction scheme. Data is not transferred to the master.

When used with disk, this command is used to verify that a number of blocks on the disk is formatted properly. Every identification field and Physical Block on each track within the extent is read and the CRC/ECC is checked. If an error is detected, the operation is terminated and the Data Address in the Response Extent parameter identifies the block contains the error.

If the High Margins modifier is set the slave shall (where the capability is provided within the facility), control the circuits within the facility to operate under marginal conditions.

If the Volume modifier in the parameters is set, the slave shall verify the entire volume.

@	LTH	ID	OCTET	X/b	DEF	READ VERIFY PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A				DATA ADDRESS PARAMETER (See 6.5.11)
M	02	3C	01- n			TRANSFER PARAMETERS (See 6.5.13)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Transfer (Common) Parameter:

See 6.5.13

Partition (Common) Parameter:

See 6.5.15

11.2 Read at First Available Data

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  51  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet 1=Block
                     |||  Data Recovery 0=On  1=Off
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+----------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0010 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The READ AT FIRST AVAILABLE DATA command shall access the currently selected track and transfer data starting at the first available block. The address of the first block encountered is provided in the Read at First Data parameter appended to the the Transfer Notification packet which precedes the transfer of the data.

The data from the first block in the extent shall follow the transfer of the last block in the extent. The transfer shall continue until the Count has been exhausted.

If Physical Block transfers are specified in the Command Extent parameter, the Count shall be equal to one track of data. The facility shall not perform a track or cylinder change during the transfer.

If Data Block transfers are specified, the addressee shall transfer all blocks within the extent, from point of beginning transfer to end of extent, then beginning of extent to the block prior to the first transferred.

If the Block Size parameter is supplied, the slave shall use the specified block size only for the duration of the command execution.

The master does not know from which address the first data will be transferred so the slave appends the Read at First Data parameter to the Transfer Notification Response (which is required for execution of this command), and to the response packet.

The master is responsible for making the necessary corrections (if any) in the sequence of data in order to compensate for its improper order. READ AT FIRST AVAILABLE DATA is intended to provide improved performance but it must be recognized that due to the addressee's and the master's overhead in order to execute this command, some operations may perform slower than if the data was read normally. For this reason, the extent should normally be restricted to a physical track or cylinder.

Read At First Available Data Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ AT FIRST AVAILABLE DATA PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	3F	01- n			STOP ON DISCONTINUITY PARAMETER (See 6.5.16)
S	09	50				READ AT FIRST DATA
			01-04			Count from Beginning
			05-08			Starting Data Address
M	n+1	51				INFORMATION TRANSFER SIZE OVERRIDE PARAMETER
			01-04			Generate Class 2 Interrupt
			05-08			Burst Size

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

Stop on Discontinuity Parameter:

See 9.1.1.16

Read at First Data Parameter:

Count from Beginning - this value specifies the displacement into the extent where the transfer begins.

Starting Data Address - this field identifies the address within the extent from which the slave shall begin transferring data.

11.2.1.8 Information Transfer Size Override Parameter

See 9.1.2.2

11.3 Read From Buffer

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |   COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  52  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The READ FROM BUFFER command transfers the contents of the addressee's buffer to the master beginning at the octet offset contained in the Data Address field of the Command Extent parameter. The Count specifies the number of octets that are to be transferred to the master.

READ FROM BUFFER may be used in conjunction with WRITE TO BUFFER to test the addressee's data buffer. To ensure that the contents of the buffer from the WRITE TO BUFFER command are the same as can be read, the master has to Order their execution to be certain that a command queueing slave did not use the buffer when overlapping command executions.

The addressee shall transfer the specified number of octets from the buffer to the master.

The buffer to be used is identified in the Buffer Address parameter. One of the following buffers may be used.

1. The "generic" buffer. This is the buffer which the slave normally makes visible to the master and may be in either the slave or the addressee.

2. The slave buffer. This buffer is always contained in the slave.

3. The facility buffer. This buffer is always in the facility.

Read From Buffer Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ FROM BUFFER PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	03	50	01			BUFFER ADDRESS PARAMETER
				7		Generic *
				6		Slave *
				5		Facility *
				4-0		Reserved
			02	7		Port Command Stack *
				6		Slave Command Stack *
				5		Slave Data Buffer *
				4-0		Reserved
						* mutually exclusive

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Transfer (Common) Parameter:

See 6.5.15

Buffer Address Parameter:

The first octet identifies which buffer is to be used.

Bit 7=1 - the buffer utilized by the slave is to be used.

Bit 6=1 - the slave buffer is to be used. If none is present this parameter shall be rejected.

Bit 5=1 - the facility buffer is to be used. If none is present, this parameter shall be rejected.

The second octet may be used to identify, which of the buffers (if any), within the slave are to be addressed. It is possible for a slave to use several buffers in an implementation.

11.4 Read Facility Data to Buffer

Command Packet:

```
+----+----+----+----+----+----+----+-----------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  53  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  Data Recovery  0=On  1=Off
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+----------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The READ FACILITY DATA TO BUFFER command is similar to a READ command except that data is transferred to a specified buffer rather than to the master. The transfer size shall be less than or equal to the length of the destination buffer.

Read Facility Data to Buffer Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ FACILITY DATA TO BUFFER PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	03	50	01-02			BUFFER ADDRESS PARAMETER

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Transfer (Common) Parameter:

See 6.5.15

Buffer Address Parameter:

See 8.3.1.6

11.5 Read Physical Data and ECC

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |   COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  54  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  0=ECC  1=Syndrome
                     ||
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+--------------------+------------
|PKT | Echoed From|    MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The READ PHYSICAL DATA AND ECC command reads data beginning at the Physical Block specified by the Data Address field in the Command Extent parameter. The error detection/correction information read with the data is appended and transfered with the data. The data is checked for errors and, if errors are detected, Substatus is reported in the response packet.

The ECC information returned with the data may be either the recorded ECC information or may be the syndrome, as specified by the modifier octet.

Operation of this command shall be limited to the Physical Block protected by the ECC.

Read Physical Data and Ecc Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ PHYSICAL DATA AND ECC PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.6 Read Physical Header

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  55  bbbb bbbb  xx   xx
                7654 3210
                     ||||
                     |||  Data Recovery 0=On 1=Off
                     ||
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

On disks the READ PHYSICAL HEADER command causes the identification field(s) to be read from the Physical Block specified by the Data Address field in the Command Extent parameter. The Count shall not be greater than the number of Physical Blocks on a track.

Read Physical Header Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ PHYSICAL HEADER PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.7 Read IPL

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  56  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+------------+--------------------+-----------
|PKT | Echoed From|    MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

Read IPL (Initial Program Load) causes the first block of IPL data to be transferred to the master. Typically, receipt of the Read IPL command shall cause the slave to access the first block of the IPL area on the addressed facility. When the access is complete the addressee shall verify correct access position and shall transfer one or more blocks of data to the master.

11.7.1 Read IPL Parameters

@	LTH	ID	OCTET	X/b	DEF	READ IPL PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

See 6.5.2

Command Extent (Common) Parameter

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.8 Read Physical Heder and ECC

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+----+----+----+----+-------------
 xxxx xxxx  58  bbbb bbbb  xx   xx
                7654 3210
                     ||||
                     |||  0=ECC  1=Syndrome
                     ||
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

On disks the READ PHYSICAL HEADER command causes the identification field(s) to be read from the Physical Block specified by the Data Address field in the Command Extent parameter. The Count shall not be greater than the number of Physical Blocks on a track.

The ECC (or may be CRC) information returned with the header may be either the recorded ECC information or may be the syndrome, as specified by the modifier octet.

Read Physical Header and ECC Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ PHYSICAL HEADER AND ECC PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.9 Write to Buffer

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |   COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  62  bbbb bbbb  xx   xx
```

Response Packet:

```
+----+-----------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |  7      | 8 through n
+----+-----------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The WRITE TO BUFFER command transfers data from the master to the designated addressee buffer beginning at the octet offset contained in the Data Address field of the Command Extent parameter. The Count specifies the number of octets that are to be transferred, which must be equal to or less than the size of the destination buffer.

The WRITE TO BUFFER command may be used in conjunction with the READ FROM BUFFER command to test the addressee's data buffer. The addressee shall transfer the specifed number of octets from the master to its buffer.

Write to Buffer Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE TO BUFFER PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	02	50	01			BUFFER ADDRESS
				7		Generic *
				6		Slave *
				5		Facility *
				4-0		Reserved * mutually exclusive

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

Buffer Address Partition:

See 8.3.1.5

11.10 Write Buffer to Facility

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  63  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The WRITE BUFFER TO FACILITY command is similar to a WRITE command except that the data is written from the addressee's buffer. Data shall not be transferred from the master. The Count shall be less than or equal to the length of the specified buffer.

The source buffer for the write is defined by the Buffer Address parameter and is identical to the buffer addressing options available in the READ FACILITY DATA TO BUFFER command.

Write Buffer to Facility Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE BUFFER TO FACILITY PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	02	3C	01			TRANSFER PARAMETERS (See 6.5.13)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	02	50	01			BUFFER ADDRESS
				7		Generic *
				6		Slave *
				5		Facility *
				4-0		Reserved * mutually exclusive

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

Buffer Address Partition:

See 8.3.1.5

11.11 Write Physical Data and ECC

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  64  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||
                     ||
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    | RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |   7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The WRITE PHYSICAL DATA AND ECC command writes data and associated error detection/correction code information on the facility beginning at the Physical Block specified by the Data Address field in the Command Extent parameter.

Write Physical Data And ECC Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE PHYSICAL DATA AND ECC PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.12 Write Physical Header

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  65  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet 1=Block
                     |||
                     ||
                     |  Direction 0=Forward 1=Reverse
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The WRITE PHYSICAL HEADER command writes the identification field(s) which are transferred as data starting at the Physical Block specified by the Data Address field in the Command Extent parameter for the extent defined by the Count.

Write Physical Header Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE PHYSICAL HEADER PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.13 Load Slave IML

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+----+----+----+----+-------------
 xxxx xxxx  66  bbbb bbbb  xx   xx
                7654 3210
                     ||||    Bits 0-2 have encoded meaning of
                     |||     x'0'=Load       x'1'=Reload
                     ||      x'2'=Report     x'4'=Store
```

Response Packet:

```
+----+-----------+-----------------+-----------
|PKT | Echoed From|   MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |   7     | 8 through n
+----+-----------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

LOAD SLAVE IML causes the slave to act upon its initial Microcode Load according to the opcode modifiers. The slave shall perform the requested operation on/to its microcode area then perform any necessary checks on the data as specified in the product specification.

On successful Load (x'0') or Reload (x'1'), the slave will become ready for use with the new microcode set in place.

The opcode modifier defines whether the master wishes to Load (x'0'), Reload (x'1'), Report (x'2'), or Store (x'4') the addressee IML area. The modifiers are mutually exclusive; i.e., only one action may be specified by the command modifier.

Load causes the slave to transfer an Initial Microcode Load (IML) from the master. The slave shall load the data (as specified in the product specification) into its microcode area, perform its checks on the data and become ready for use. Load IML will not update the IML partition on any attached media. The Load may only be addressed to the slave.

Execution of the following requires either:

- the Set Operating Mode command chained to the Load Slave IML command or
- the Partition parameter appended to the command packet.

Reload allows the master to request the addressee to read its Initial Microcode from the appropriate area in the IML partition.

Report requests the addressee to respond with an information transfer containing the contents of the addressee IML area. If the addressee is the slave, the source of the data will be the RAM/ROM area where the current microcode is executing. If the address is a facility, the data represents the IML partition of the attached facility.

Store causes the addressee to load its currently executing Microcode into the appropriate area in the IML partition of a facility. This command allows updates of the slave's Module's microcode to be written to the facility.

NOTE: The Command Completion response sent to the master by the slave for this command should be transferred only after the newly loaded microcode has been successfully initialized and is operational.

Load Slave IML Parameters:

@	LTH	ID	OCTET	X/b	DEF	LOAD SLAVE IML PARAMETERS
M	05	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
M	05	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Count

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

11.14 Erase

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |   COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  67  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet  1=Block
                     |||
                     ||  0=Data Block  1=Physical Block
                     |  Direction  0=Forward  1=Reverse
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The ERASE command writes through all addressable recording spaces of the addresses specified in the command packet. The data and identification fields in the recording spaces operated on by the ERASE command shall be unformatted and unrecognizable as a result of the command.

Erase Parameters:

@	LTH	ID	OCTET	X/b	DEF	ERASE PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

Command Extent (Common) Parameters:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

11.15 Write Physical Header

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |   COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  68  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count 0=Octet 1=Block
                     |||
                     ||
                     |  Direction 0=Forward 1=Reverse
```

Response Packet:

```
+----+-----------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+-----------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The Direction modifier is not applicable to disk.

The WRITE PHYSICAL HEADER command writes the identification field(s) starting at the Physical Block specified by the Data Address field in the Command Extent parameter for the extent defined by the Count.

Write Physical Header And ECC Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE PHYSICAL HEADER AND ECC PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	05	35	01-04			ACCESS KEY PARAMETER (See 6.5.6)
B	n+1	3A	01- n			DATA ADDRESS PARAMETER (See 6.5.11)
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Access Key (Common) Parameter:

See 6.5.6

Data Address (Common) Parameter:

See 6.5.11

Partition (Common) Parameter:

See 6.5.15

12.0 DIAGNOSTIC COMMANDS

The commands in this section are the maintenance and diagnostic commands of the Logical Interface. These commands by their very nature are either device-specific. Refer to Equipment Specifications as to their implementation.

The commands in this section may require that parameters be transferred as data (because they are too big to transfer as parameters. See 6.2.4). The master shall set the Count field of the Command Extents parameter to the limit to be transferred.

12.1 Perform Slave Diagnostics

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  80  bbbb bbbb  xx   xx
                7654 3210
                     |||| Count  0=Octet  1=Block
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|    6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The PERFORM SLAVE DIAGNOSTICS command causes the specified self-contained slave diagnostic to be executed. Results from the slave diagnostic are slave unique, and may be returned to the master as data.

Perform Slave Diagnostic Parameters:

@	LTH	ID	OCTET	X/b	DEF	PERFORM SLAVE DIAGNOSTIC PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	03	50	01-02			Diagnostic Number (design specific)
M	n+1	51	01- n			Diagnostic function list (design specific)
M	n+1	52	01-02			Diagnostic Action Code (design specific)
			03- n			Diagnostic parameters (design specific)
M	n+1	53	01- n			Command parameters unique to the product
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Reserved
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID — Repeated as many
			n			Parameter ID — times as needed
						* mutually exclusive parameters

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Diagnostic Number Parameter:

This parameter supplies a number which is of specific meaning, as one of a list of documented diagnostics.

Diagnostic Function List Parameter:

This parameter supplies a list of functions to be performed as specified in product documentation.

This parameter supplies an action code and a list of parameters associated with it.

Product Unique Parameter:

The field or fields, if any, in this parameter shall be specified in the Equipment Specification.

Request Parm Parameter:

See 7.3.13.1

12.2 Perform Facility Diagnostics

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  81  bbbb bbbb  xx   xx
                7654 3210
                     |||| Count  0=Octet  1=Block
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The PERFORM FACILITY DIAGNOSTICS command shall cause the specified self-contained facility diagnostic to be executed. Results from the facility diagnostic are facility-unique and may be returned to the master as data.

This command is valid only if the the device(s) attached to a slave are capable of executing diagnostics that provide information to the master.

Perform Facility Diagnostics Parameters:

@	LTH	ID	OCTET	X/b	DEF	PERFORM FACILITY DIAGNOSTIC PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	03	50	01-02			Diagnostic Number (design specific)
M	n+1	51	01- n			Diagnostic function list (design specific)
M	n+1	52	01-02			Diagnostic Action Code (design specific)
			03- n			Diagnostic parameters (design specific)
M	n+1	53	01- n			Command parameters unique to the product
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Reserved
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID Repeated as many
			n			Parameter ID times as needed
						* mutually exclusive parameters

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Diagnostic Number Parameter:

See 9.1.3.1

Diagnostic Function List Parameter:

See 9.1.3.4

Diagnostic Action Code Parameter:

See 9.1.3.5

See 9.1.3.6

Request Parm Parameter:

See 7.3.13.1

12.3 Read Defect List

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  82  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet   1=Block
                     |||  0=Permanent    1=Temporary
                     ||  0=Working      1=Suspect
                     |  0=Sequential   1=Chronological
```

Response Packet:

```
+----+------------+-------------------+-----------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The READ DEFECT LIST command transfers the Working Permanent, Working Temporary, Suspect Permanent or Suspect Temporary media defect list as specified by the modifier octet, for the partition defined in the Partition parameter.

The media defect list may be returned as data, although it consists of the parameter list containing the requested information. Media defect information is kept in a variety of ways by different designs, and the parameter format provides a common method of communicating the information.

To obtain defect information on areas other than the Data Partition, it is necessary to precede this command in a Chain, Sequence or Order with a OPERATING MODE command that identifies the required partition.

- The Permanent or Temporary modifier identifies the Suspect list to be used.

- The Working or Suspect modifier identifies the Suspect list to be used.

- The Sequential modifier indicates that the requested defect list entries are to be returned in order of ascending address. The chronological modifier indicates that the requested defect list entries are to be returned in the order in which media replacements occurred.

Chronological defect lists have several special characteristics. For uses of the ALLOCATE RESTORE command which must operate on defects in reverse chronological order, this list provides that order. If a REALLOCATE command is being used to restore a slave's Working set of defects, the chronological list provides the order of reallocations which will restore the current condition. Duplicate entries may appear in chronological defect lists to indicate multiple defects in the same block over a period of time.

12.3.1 Read Defect List Parameters

@	LTH	ID	OCTET	X/b	DEF	READ DEFECT LIST PARAMETERS	
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)	
			01-04			Count	
			05-08			Data Address	
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)	
			01-04			Residual Count	
			05-08			Data Address	
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)	
B	n+1	55				DEFECTIVE DATABLOCK PARAMETER	
			01-02			Size of Data Block Address Fields	
			03-			Address of Defective Data Block	(first)
			n- :n			Address of Defective Data Block	(last)
B	n+1	56				TRACK DEFECTS LIST PARAMETER	
			01-04			Cylinder	(first)
			05-06			Track	
			07-0A			Octet Offset into track	
			0B-0C			Length of defect (in octets)	
			n-B:8			Cylinder	(last)
			n-7:6			Track	
			n-5:2			Octet Offset into track	
			n-1:n			Length of defect (in octets)	
B	n+1	57				SECTOR DEFECTS LIST PARAMETER	
			01-04			Cylinder	(first)
			05-06			Track	
			07-08			Number of Sector after Index	
			09-0A			Octet Offset within Sector	
			0B-0C			Length of defect (in octets)	
			n-B:8			Cylinder	(last)
			n-7:6			Track	
			n-5:4			Number of Sector after Index	
			n-3:2			Octet Offset within Sector	
			n-1:n			Length of defect (in octets)	

12.3.1.1 Command Extent (Common) Parameters

See 6.5.2

12.3.1.2 Response Extent (Common) Parameter

See 6.5.3

12.3.1.3 Partition (Common) Parameter

See 6.5.15

12.3.1.4 Defective Data Block Parameter

This parameter may be returned as data to indicate Data Blocks which currently contain defective media, or Data Blocks which have been affected by defect reallocation. This depends on which list is read, and design specific defect management algorithms. See 10.4.2.2.

12.3.1.5 Track Defects List Parameter

See 9.7.3.1

12.3.1.6 Sector Defects List Parameter

See 9.7.3.2

12.3.2 Read Defect List Parameters

@	LTH	ID	OCTET	X/b	DEF	READ DEFECT LIST PARAMETERS
B	07	58				VARIABLE SIZE SECTORS PARAMETER
			01-02			Size of Cells at Index Gap
			03-04			Cell Size
			05-06			No of Cells Reserved per Track to Skip Flaws
			07-08			No of Cells to Skip per Flaw
B	n+1	5A				CELL DEFECT LIST PARAMETER
			01-04			Cylinder (first)
			05-06			Track
			07-08			No of Defective Cells
			09-0C			Offset of Defective Cell #1
			0D- m			Offset of Defective Cell #2 through end
			n -			Cylinder (last)
			n -			Track
			n -			No of Defective Cells
			n -			Offset of Defective Cell #1
			n -			Offset of Defective Cell #2 through end
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Length *
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID — Repeated as many
			n			Parameter ID — times as needed
						* mutually exclusive parameters
S	05	6D				PARM LENGTH PARAMETER
			01-04			Length of Parameter List

12.3.2.1 Variable Size Sectors Parameter

This parameter immediately precedes the first Track Defects List parameter. The first value defines the Number of Cells at the Index Gap, and the second defines the number of octets in a regular cell. The third field contains the number of cells reserved per track for skipping flaws.

12.3.2.2 Cell Defect List Parameter

See 9.7.4.1

12.3.2.3 Request Parm Parameter

See 7.3.13.1

12.3.2.4 Parm Length Parameter

See 7.3.13.2

12.4 Write Defect List

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  83  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  0=Permanent  1=Temporary
                     ||  Clear Defect List
                     |  0=Append  1=Create
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|   MAJOR STATUS    |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The WRITE DEFECT LIST command transfers addresses of Permanent or Temporary defects, as determined by the modifier byte, to the Suspect Permanent or Suspect Temporary defect list for the partition defined in the Partition parameter (if any), or by a preceding OPERATING MODE command (if any) in a Chain, Sequence or Order.

WRITE DEFECT LIST does not cause the slave to begin any reallocation of data.

The location and format of the defect list are slave or facility dependent. The media defect list may be transferred as data. The Request Parms parameter shall identify if the list is to be transferred as data, and if it is to be a general transfer or be specific containing only the contents of the parameter.

Entries in the Suspect defect list do not cause media replacement until the next FORMAT or REALLOCATE command.

- The Permanent or Temporary modifier identifies the Suspect list to be used.

- The Clear Defect List modifier is used to clear the entire list of all entries. It allows the master to force the slave to reference the manufacturer's initial list of flaws when a succeeding FORMAT command is issued.

- The Create or Append modifier is used to break up a long parameter list into multiple smaller ones that can be transferred to the slave. The Create clears any existing information in the addressee's Suspect defect list as identified by the modifier.

If the Create modifier is set, the old Suspect list is replaced by the list transferred with this command. Otherwise the transferred defect list shall be appended to the existing Suspect defect list.

To supply defect information for areas other than the Data Partition, it is necessary to precede this command in a Chain, Sequence or Order with an OPERATING MODE command that identifies the required partition.

It is recommended that the defect list(s) be kept with the media to which they are applicable. In the case of removable media this implies that the list(s) need to be recorded on the media.

12.4.1 Write Defect List Parameters

@	LTH	ID	OCTET	X/b	DEF	WRITE DEFECT LIST PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	n+1	3E	01- n			PARTITION PARAMETER (See 6.5.15)
M	n+1	55				DEFECTIVE DATABLOCK PARAMETER
			01-02			Size of Data Block Address Fields
			03-			Address of Defective Data Block (first)
			n- :n			Address of Defective Data Block (last)
M	n+1	56				TRACK DEFECTS LIST PARAMETER
			01-04			Cylinder (first)
			05-06			Track
			07-0A			Octet Offset into track
			0B-0C			Length of defect (in octets)
			n-B:8			Cylinder (last)
			n-7:6			Track
			n-5:2			Octet Offset into track
			n-1:n			Length of defect (in octets)
M	n+1	57				SECTOR DEFECTS LIST PARAMETER
			01-04			Cylinder (first)
			05-06			Track
			07-08			Number of Sector after Index
			09-0C			Octet Offset within Sector
			0D-0E			Length of defect (in octets)
			n-D:A			Cylinder (last)
			n-9:8			Track
			n-7:6			Number of Sector after Index
			n-5:2			Octet Offset within Sector
			n-1:n			Length of defect (in octets)

12.4.1.1 Command Extent (Common) Parameter

See 6.5.2

12.4.1.2 Response Extent (Common) Parameter

See 6.5.3

12.4.1.3 Partition (Common) Parameter

See 6.5.15

12.4.1.4 Defective Data Block Parameter

This parameter contains a list of Data Block addresses which are to be placed in a defect list. See 10.4.2.2.

12.4.1.5 Track Defects List Parameter

See 9.7.3.1

12.4.1.6 Sector Defects List Parameter

See 9.7.3.2

12.4.2 Write Defect List Parameters

@	LTH	ID	OCTET	X/b	DEF	WRITE DEFECT LIST PARAMETERS
B	07	58				VARIABLE SIZE SECTORS PARAMETER
			01-02			Size of Cells at Index Gap
			03-04			Cell Size
			05-06			Number of Cells Reserved per Track to Skip Flaws
			07-08			Number of Cells to Skip per Flaw
B	n+1	5A				CELL DEFECT LIST PARAMETER
			01-04			Cylinder (first)
			05-06			Track
			07-08			Number of Defective Cells
			09-0C			Offset of Defective Cell #1
			0D- m			Offset of Defective Cell #2 through end
			n -			Cylinder (last)
			n -			Track
			n -			Number of Defective Cells
			n -			Offset of Defective Cell #1
			n -			Offset of Defective Cell #2 through end
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Reserved
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID — Repeated as many
			n			Parameter ID — times as needed
						* mutually exclusive parameters

12.4.2.1 Variable Size Sectors Parameter

See 9.3.2.1

12.4.2.2 Cell Defects List Parameter

See 9.7.4.1

12.4.2.3 Request Parm Parameter

See 7.3.13.1

12.5 Read Error Log

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  84  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||  Clear Error Log
```

Response Packet:

```
+----+-----------+-----------------+------------
|PKT | Echoed From|   MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+-----------+---------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The READ ERROR LOG command provides a method for the master to request statistics of usage and/or error information from the addressee because it transfers the recorded error log data from the addressee. The error log contents and format are slave or facility specific.

The error log contents may be returned as data containing the parameter list with the requested information. The error log data may be maintained automatically by the slave, maintained under direct control of the master, or by a combination of both.

If the addressee does not automatically clear error and usage counters after the successful completion of the command the master must specifically do so by using the Clear Error Log modifier. If the addressee does automatically clear the error log after successful completion of the command, the clearing of the log shall be inhibited when the Clear Error Log modifier is set.

Read Error Log Parameters:

@	LTH	ID	OCTET	X/b	DEF	READ ERROR LOG PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
S	n+1	50	01- n			Product Specific Error Log data
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Length *
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID Repeated as many
			n			Parameter ID times as needed
						* mutually exclusive parameters
S	05	6D				PARM LENGTH PARAMETER
			01-04			Length of Parameter List

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Error Log Parameter:

The field or fields in this parameter shall be defined in the product documentation.

Request Parm Parameter:

See 7.3.13.1

Parm Length Parameter:

See 7.3.13.2

12.6 Write Error Log

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |  COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1| 2  |    3    | 4  | 5  | 6 through n
+----+----+----+---------+----+----+------------
 xxxx xxxx  85  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
                     |||
                     ||
                     |  0=Append  1=Create
```

Response Packet:

```
+----+-----------+-----------------+------------
|PKT | Echoed From|   MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES   |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6     |    7    | 8 through n
+----+-----------+---------+----+----+------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

The WRITE ERROR LOG command transfers error log data to the addressee. The error log contents and format are slave or facility specific and may be transferred as data although it consists of the parameter list containing the required information to be logged.

The Create clears any existing information in the addressee's error log, and resets any usage or error counters to zero.

Write Error Log Parameters:

@	LTH	ID	OCTET	X/b	DEF	WRITE ERROR LOG PARAMETERS
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)
			01-04			Count
			05-08			Data Address
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)
			01-04			Residual Count
			05-08			Data Address
M	n+1	50	01- n			Product Specific Error Log Data
M	n+1	6C				REQUEST PARM PARAMETER
			01	7		Parameters as Data *
				6		Parameters in Response *
				5		Reserved
				4		Naked Parameters as Data *
				3-0		Reserved
			02			Parameter ID — Repeated as many
			n			Parameter ID — times as needed
						* mutually exclusive parameters

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Error Log Parameter:

See 9.5.1.3

Request Parm Parameter:

See 7.3.13.1

12.7 Diagnostic Control

Command Packet:

```
+----+----+----+----+----+----+----+------------
|PKT |REF | OP |COM | OP |SLAV|FAC |   COMMAND
| LTH| NO |CODE| MOD| MOD|ADDR|ADDR| PARAMETERS
|    | 0 1|  2 |    3    |  4 |  5 | 6 through n
+----+----+----+---------+----+----+-------------
 xxxx xxxx  90  bbbb bbbb  xx   xx
                7654 3210
                     ||||  Count  0=Octet  1=Block
```

Response Packet:

```
+----+------------+-------------------+------------
|PKT | Echoed From|    MAJOR STATUS   |  RESPONSE
| LTH|   Command  | CODES    |TYPE|CODE| PARAMETERS
|    | 0 1 2 3 4 5|   6      |    7    | 8 through n
+----+------------+----------+----+----+-------------
 xxxx eeeeeeeeeeee bbbb bbbb 0001 bbbb
                   7654 3210      3210
```

Description:

If there are no parameters the DIAGNOSTIC CONTROL command causes the slave to transfer any diagnostic results currently in the slave as data.

The DIAGNOSTIC CONTROL command allows the master to load either a slave or a facility diagnostic. The diagnostic is transferred to the slave as data. Following loading, the selected slave or facility shall execute the supplied diagnostic. The slave shall execute according to the list. The parameters may result in transfers to or from the master, and depending on the diagnostic sequences, both may occur during execution of this single command.

Results from the loaded diagnostic may be returned to the master as data. The parameters contained in the command packet and the results returned must be defined in each product's functional specification.

This command may be used to read and write ID fields, read and write data fields of sectors whose ID fields were damaged, and other facility type specific operations.

Diagnostic Control Parameters:

@	LTH	ID	OCTET	X/b	DEF	DIAGNOSTIC CONTROL PARAMETERS	
M	09	31				COMMAND EXTENT PARAMETER (See 6.5.2)	
			01-04			Count	
			05-08			Data Address	
S	n+1	32				RESPONSE EXTENT PARAMETER (See 6.5.3)	
			01-04			Residual Count	
			05-08			Data Address	
M	03	50	01-02			Diagnostic Number (design specific)	
M	n+1	51	01- n			Diagnostic function list (design specific)	
M	n+1	52	01-02			Diagnostic Action Code (design specific)	
			03- n			Diagnostic parameters (design specific)	
M	n+1	53	01- n			Command parameters unique to the product	
M	n+1	6C				REQUEST PARM PARAMETER	
			01	7		Parameters as Data	*
				6		Parameters in Response	*
				5		Reserved	
				4		Naked Parameters as Data	*
				3-0		Reserved	
			02			Parameter ID	Repeated as many
			n			Parameter ID	times as needed
							* mutually exclusive parameters

Command Extent (Common) Parameter:

See 6.5.2

Response Extent (Common) Parameter:

See 6.5.3

Diagnostic Number Parameter:

See 9.1.3.1

Diagnostic Function List Parameter:

See 9.1.3.4

Diagnostic Action Code Parameter:

See 9.1.3.5

Product Unique Parameter:

See 9.1.3.6

Request Parm Parameter:

See 7.3.13.1

13.0 COMMAND SUMMARY

13.1 Control Commands

OP	COMMAND	OPCODE MODIFIERS
00	NOP	None
01	FACILITY OPERATION	None
02	ATTRIBUTES	x'0' - Report x'1' - Initialize x'2' - Restore x'9' - Load x'A' - Save
03	REPORT ADDRESSEE STATUS	0 - Condition 1 - Status 2 - Port Query
04	PORT ADDRESS	0 - Reserve/Release 1 - Priority Reserve 2 - Notify Alternate Ports of Priority Reserve
05	PATH CONTROL	0 - Purge Commands Outstanding at Excluded Port 1 - Path Select
06	ATTENTION CONTROL	x'0' - Enable x'2' - Disable x'4' - Clear x'6' - Set
07	OPERATING MODE	2 - Report/Set
08	ABORT	0 - Orderly Termination 1 - Terminate Command In Progress 2 - Terminate All Commands Not In Progress

(continued)

OP	COMMAND	OPCODE MODIFIERS
09	ACCESS PERMITS	x'0' - Report x'1' - Initialize x'2' - Restore x'9' - Load x'A' - Save 2 - Data Block/Physical Block
0A	RESUME	None
0B	PORT RESPONSE	None
0C	ANTICIPATED ACTION	None

13.2 Position Commands

OP	COMMAND	OPCODE MODIFIERS
41	POSITION CONTROL	0 - Octet/Block Count 2 - Data Block/Physical Block
42	REPORT POSITION	0 - Octet/Block Count 2 - Data Block/Physical Block
44	REPORT DISCONTINUITY	0 - Octet/Block Count 1 - Search/List 2 - Data Block/Physical Block

13.3 Transfer Commands

OP	COMMAND	OPCODE MODIFIERS
10	READ	0 - Octet/Block Count 1 - Data Recovery On/Off 2 - Data Block/Physical Block 3 - Forward/Reverse
11	READ RAW DATA	0 - Octet/Block Count 1 - Data Recovery=1 (Off) 2 - Data Block/Physical Block 3 - Forward/Reverse
12	READ REPLICATED DATA	0 - Count=1 (Block) 1 - Data Recovery On/Off 2 - Data Block/Physical Block
18	SEARCH	0 - Octet/Block Count 1 - Data Recovery On/Off 2 - Data Block/Physical Block 3 - Forward/Reverse
20	WRITE	0 - Octet/Block Count 2 - Data Block/Physical Block 3 - Forward/Reverse
21	WRITE PATTERN	0 - Octet/Block Count 2 - Data Block/Physical Block 3 - Forward/Reverse
28	FORMAT	0 - Octet/Block Count 1 - Inhibit Defect Reallocation 2 - Data Block/Physical Block 3 - Initialize Format

13.4 Combination Commands

OP	COMMAND	OPCODE MODIFIERS
30	COPY	None
31	COMPARE SLAVE DATA	None
32	COMPARE DATA	None
33	REALLOCATE	0 - Relocate Data
34	ALLOCATE RESTORE	0 - Relocate Data
35	SHADOW READ	None
36	SHADOW WRITE	None
37	SHADOW RESTORE	None

13.5 Other Transfer Commands

OP	COMMAND	OPCODE MODIFIERS
50	READ VERIFY	0 - Octet/Block Count 1 - High Margin 2 - Data Block/Physical Block 3 - Forward/Reverse
51	READ AT FIRST AVAILABLE DATA	0 - Octet/Block Count 1 - Data Recovery On/Off 2 - Data Block/Physical Block 3 - Forward/Reverse
52	READ FROM BUFFER	None
53	READ FACILITY DATA TO BUFFER	0 - Octet/Block Count 1 - Data Recovery On/Off 2 - Data Block/Physical Block 3 - Forward/Reverse
54	READ PHYSICAL DATA AND ECC	0 - Octet/Block Count 1 - ECC/Syndrome 3 - Forward/Reverse
55	READ PHYSICAL HEADER	1 - Data Recovery On/Off 3 - Forward/Reverse
56	READ IPL	None
58	READ PHYSICAL HEADER & ECC	1 - ECC/Syndrome 3 - Forward/Reverse

OP	COMMAND	OPCODE MODIFIERS
62	WRITE TO BUFFER	None
63	WRITE BUFFER TO FACILITY	0 - Octet/Block Count 2 - Data Block/Physical Block 3 - Forward/Reverse
64	WRITE PHYSICAL DATA AND ECC	0 - Octet/Block Count 3 - Forward/Reverse
65	WRITE PHYSICAL HEADER	0 - Octet/Block Count 3 - Forward/Reverse
66	LOAD SLAVE IML	x'0' - Load x'1' - Reload x'2' - Report x'4' - Store
67	ERASE	0 - Octet/Block Count 2 - Data Block/Physical Block 3 - Forward/Reverse
68	WRITE PHYSICAL HEADER & ECC	0 - Octet/Block Count 3 - Forward/Reverse

13.6 Diagnostic Commands

OP	COMMAND	OPCODE MODIFIERS
80	PERFORM SLAVE DIAG	0 - Octet/Block Count
81	PERFORM FACILITY DIAG	0 - Octet/Block Count
82	READ DEFECT LIST	0 - Octet/Block Count 1 - Permanent/Temporary 2 - Working/Suspect 3 - Sequential/Chronological
83	WRITE DEFECT LIST	0 - Octet/Block Count 1 - Permanent/Temporary 2 - Clear Defect List 3 - Append/Create
84	READ ERROR LOG	0 - Octet/Block Count 1 - Clear Error Log
85	WRITE ERROR LOG	0 - Octet/Block Count 3 - Append/Create
90	DIAGNOSTIC CONTROL	0 - Octet/Block Count