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American National Standard
for Information Systems —

AT Attachment with Packet Interface Extension — (ATA/ATAPI-4)

Secretariat
Information Technology Industry Council

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Abstract

This standard specifies the AT Attachment Interface between host systems and storage devices. It provides a common attachment interface for systems manufacturers, system integrators, software suppliers, and suppliers of intelligent storage devices. It includes the Packet Command feature set implemented by devices commonly known as ATAPI devices.

This standard maintains a high degree of compatibility with the AT Attachment-3 Interface (ATA-3), X3.298-1997, and while providing additional functions, is not intended to require changes to presently installed devices or existing software.

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3 Definitions, abbreviations, and conventions

3.1 Definitions and abbreviations

For the purposes of this American National Standard, the following definitions apply:

3.1.1 ATA (AT Attachment): ATA defines the physical, electrical, transport, and command protocols for the internal attachment of storage devices.

3.1.2 ATA-1 device: A device that complies with ANSI X3.221-1994, the AT Attachment Interface for Disk Drives.

3.1.3 ATA-2 device: A device that complies with ANSI X3.279-1996, the AT Attachment Interface with Extensions.

3.1.4 ATA-3 device:A device that complies with ANSI X3.298-1997, the AT Attachment-3 Interface.

3.1.5 ATAPI (AT Attachment Packet Interface) device: A device implementing the Packet Command feature set.

3.1.6 bus release: For devices implementing overlap, the term bus release is the act of clearing both DRQ and BSY to zero before the action requested by the command is completed to allow the host to select the other device.

3.1.7 byte count: The value placed in the Byte Count register by the device to indicate the number of bytes to be transferred under this DRQ assertion when executing a PACKET command.

3.1.8 byte count limit: The value placed in the Byte Count register by the host as input to a PACKET command to indicate the maximum byte count that may be transferred under a single DRQ assertion.

3.1.9 CFA: The CompactFlash Association that created the specification for compact flash memory that uses the ATA interface.

3.1.10 check condition: For devices implementing the PACKET Command feature set, this indicates an exception condition has occurred that needs to be reported to the host.

3.1.11 CHS (cylinder-head-sector): This term defines the addressing of the device as being by cylinder number, head number, and sector number.

3.1.12 command aborted: Command completion with ABRT set to one in the Error register and ERR set to one in the Status register.

3.1.13 command acceptance: A command is considered accepted whenever the currently selected device has its BSY bit equal to zero and the host writes to the Command register. An exception exists for the EXECUTE DEVICE DIAGNOSTIC and DEVICE RESET command (see 8.9).

3.1.14 Command Block registers: Interface registers used for delivering commands to the device or posting status from the device.

3.1.15 command completion: Command completion is the completion by the device of the action requested by the command or the termination of the command with an error, the placing of the appropriate error bits in the Error register, the placing of the appropriate status bits in the Status register, the clearing of both BSY and DRQ to zero, and the asserting of INTRQ if nIEN is cleared to zero and the command protocol specifies that INTRQ be asserted.

3.1.16 command packet: A command packet is a data structure transmitted to the device by a PACKET command that includes the command and command parameters.

3.1.17 Control Block registers: Interface registers used for device control and to post alternate status.

3.1.18 CRC: Cyclical Redundancy Check used for the Ultra DMA protocol to check the validity of the data that has been transferred during the last Ultra DMA burst.

3.1.19 data block: This term describes a unit of data words transferred using PIO data transfer. A data block is transferred between the host and the device as a complete unit. A data block is a sector, except for data blocks of a READ MULTIPLE and WRITE MULTIPLE commands. In the cases of READ MULTIPLE and WRITE MULTIPLE commands, the size of the data block may be changed in multiples of sectors by the SET MULTIPLE MODE command.

3.1.20 device: Device is a storage peripheral. Traditionally, a device on the interface has been a hard disk drive, but any form of storage device may be placed on the interface provided it adheres to this standard.

3.1.21 device selection: A device is selected when the DEV bit of the Device/Head register is equal to the device number assigned to the device by means of a Device 0/Device 1 jumper or switch, or use of the CSEL signal.

3.1.22 DMA (direct memory access): A means of data transfer between device and host memory without host processor intervention.

3.1.23 LBA (logical block address): This term defines the addressing of the device as being by the linear mapping of sectors.

3.1.24 master: In ATA-1, Device 0 has also been referred to as the master. Throughout this document the term Device 0 is used.

3.1.25 native max address: The highest address a device accepts in the factory default condition, which is the highest address that is accepted by the SET MAX ADDRESS command. The capacity defined by native max address may be different in CHS and LBA translations.

3.1.26 overlap: Overlap is a protocol that allows devices that require extended command time to perform a bus release so that commands may be executed by the other device on the bus.

3.1.27 packet delivered command: A command that is delivered to the device using the PACKET command via a command packet that contains the command and the command parameters.

3.1.28 PIO (programmed input/output): A means of accessing device registers. PIO is also used to describe one form of data transfers. PIO data transfers are performed by the host processor utilizing PIO register accesses to the Data register.

3.1.29 queued: Command queuing allows the host to issue concurrent commands to the same device. Only commands included in the Overlapped feature set may be queued.

3.1.30 register delivered command: A command that is delivered to the device by placing the command and all of the parameters for the command in the device Command Block registers.

3.1.31 released: Indicates that a signal is not being driven. For tri-state drivers, this means that the driver is in the high impedance state. For open-collector drivers, the driver is not asserted.

3.1.32 sector: A uniquely addressable set of 256 words (512 bytes).

3.1.33 signature: A unique set of values placed in the Command Block registers by the device to allow the host to distinguish between register delivered command devices and packet delivered command devices.

3.1.34 slave: In ATA-1, Device 1 has also been referred to as the slave. Throughout this document the term Device 1 is used.

3.1.35 SMART: Self-Monitoring, Analysis, and Reporting Technology for prediction of device degradation and/or faults. Throughout this document this is noted as SMART.

3.1.36 Ultra DMA burst: An Ultra DMA burst is defined as the period from an assertion of DMACK- to the subsequent negation of DMACK- when Ultra DMA has been enabled by the host.

3.1.37 unit attention condition: A state that a device implementing the PACKET Command feature set maintains while it has asynchronous status information to report to the host.

3.1.38 unrecoverable error: An unrecoverable error is defined as having occurred at any point when the device sets either the ERR bit or the DF bit to one in the Status register at command completion.

3.1.39 VS (vendor specific): This term is used to describe bits, bytes, fields, and code values that are reserved for vendor specific purposes. These bits, bytes, fields, and code values are not described in this standard, and may vary among vendors. This term is also applied to levels of functionality whose definition is left to the vendor.

NOTE – Industry practice could result in conversion of a Vendor Specific bit, byte, field, or code value into a defined standard value in a future standard.

3.2 Conventions

Lowercase is used for words having the normal English meaning. Certain words and terms used in this American National Standard have a specific meaning beyond the normal English meaning. These words and terms are defined either in clause 3 or in the text where they first appear.

The names of abbreviations, commands, fields, and acronyms used as signal names are in all uppercase (e.g., IDENTIFY DEVICE). Fields containing only one bit are usually referred to as the "name" bit instead of the "name" field. (see 3.2.5 for the naming convention used for naming bits.)

Names of device registers begin with a capital letter (e.g., Cylinder Low register).

3.2.1 Precedence

If there is a conflict between text, figures, and tables, the precedence shall be tables, figures, then text.

3.2.2 Keywords

Several keywords are used to differentiate between different levels of requirements and optionality.

3.2.2.1 expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented.

3.2.2.2 mandatory: A keyword indicating items to be implemented as defined by this standard.

3.2.2.3 may: A keyword that indicates flexibility of choice with no implied preference.

3.2.2.4 obsolete: A keyword used to describe bits, bytes, fields, and code values that no longer have consistent meaning or functionality from one implementation to another. However, some degree of functionality may be required for items designated as “obsolete” to provide for backward compatibility. An

obsolete bit, byte, field, or command shall never be reclaimed for any other use in any future standard. Bits, bytes, fields, and code values that had been designated as “obsolete” in previous standards may have been reclassified as “retired” in this standard based on the definitions herein for “obsolete” and “retired”.

Obsolete commands should not be used by the host. Commands defined as obsolete in previous standards may be command aborted by devices conforming to this standard. However, if a device does not command abort an obsolete command but performs no operation in response to that command, the minimum that is required by the device in response to the command is command completion without performing the action requested by the command and without error indication.

3.2.2.5 optional: A keyword that describes features that are not required by this standard. However, if any optional feature defined by the standard is implemented, it shall be done in the way defined by the standard.

3.2.2.6 retired: A keyword indicating that the designated bits, bytes, fields, and code values that had been defined in previous standards are not defined in this standard and may be reclaimed for other uses in future standards. If retired bits, bytes, fields, or code values are utilized before they are reclaimed, they shall have the meaning or functionality as described in previous standards.

3.2.2.7 reserved: A keyword indicating reserved bits, bytes, words, fields, and code values that are set aside for future standardization. Their use and interpretation may be specified by future extensions to this or other standards. A reserved bit, byte, word, or field shall be set to zero, or in accordance with a future extension to this standard. The recipient shall not check reserved bits, bytes, words, or fields. Receipt of reserved code values in defined fields shall be treated as a command parameter error and reported by returning command aborted.

3.2.2.8 shall: A keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other standard conformant products.

3.2.2.9 should: A keyword indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase “it is recommended”.

3.2.3 Numbering

Numbers that are not immediately followed by a lowercase "b" or "h" are decimal values. Numbers that are immediately followed by a lowercase "b" (e.g., 01b) are binary values. Numbers that are immediately followed by a lowercase "h" (e.g., 3Ah) are hexadecimal values.

3.2.4 Signal conventions

Signal names are shown in all uppercase letters.

All signals are either high active or low active signals. A dash character (-) at the end of a signal name indicates it is a low active signal. A low active signal is true when it is below V_{iL}, and is false when it is above V_{iH}. No dash at the end of a signal name indicates it is a high active signal. A high active signal is true when it is above V_{iH}, and is false when it is below V_{iL}.

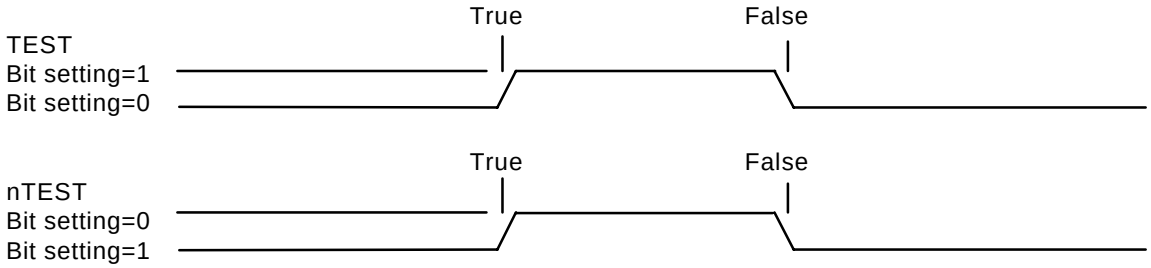
Asserted means that the signal is driven by an active circuit to its true state. Negated means that the signal is driven by an active circuit to its false state. Released means that the signal is not actively driven to any state (see 4.3.1). Some signals have bias circuitry that pull the signal to either a true state or false state when no signal driver is actively asserting or negating the signal.

Control signals that may be used for more than one mutually exclusive functions are identified with their function names separated by a colon (e.g., DIOW-:STOP).

3.2.5 Bit conventions

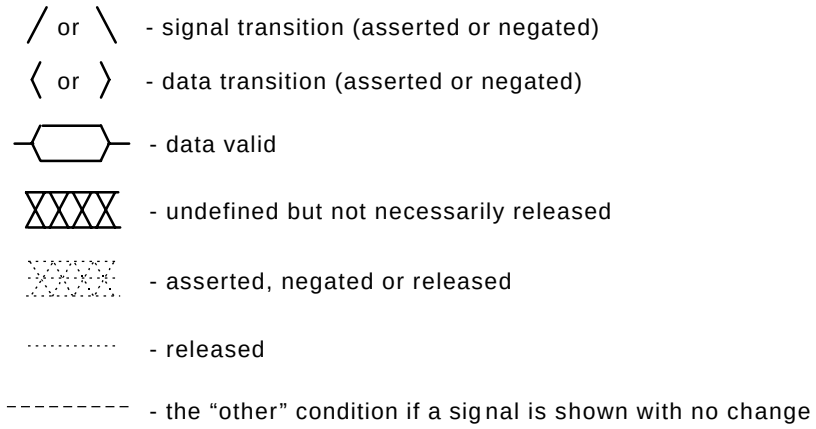
Bit names are shown in all uppercase letters except where a lowercase n precedes a bit name. If there is no preceding n, then when BIT is set to one the meaning of the bit is true, and when BIT is cleared to zero the

meaning of the bit is false. If there is a preceding n, then when nBIT is cleared to zero the meaning of the bit is true and when nBIT is set to one the meaning of the bit is false.



3.2.6 Timing conventions

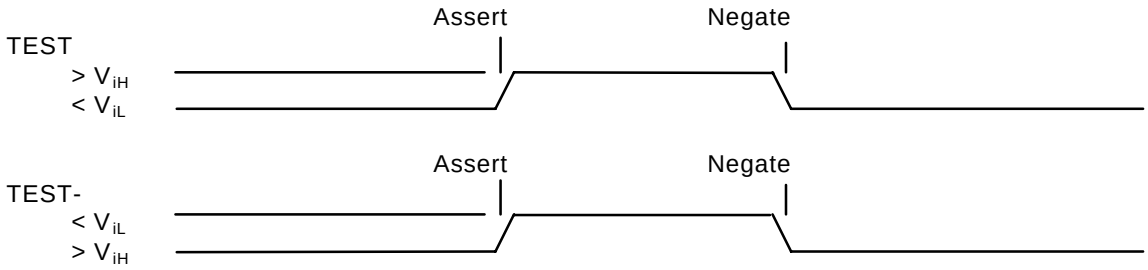
Certain symbols are used in the timing diagrams. These symbols and their respective definitions are listed below.



All signals are shown with the asserted condition facing to the top of the page. The negated condition is shown towards the bottom of the page relative to the asserted condition.

The interface uses a mixture of negative and positive signals for control and data. The terms asserted and negated are used for consistency and are independent of electrical characteristics.

In all timing diagrams, the lower line indicates negated, and the upper line indicates asserted. The following illustrates the representation of a signal named TEST going from negated to asserted and back to negated, based on the polarity of the signal.



3.2.7 Byte ordering for data transfers

Assuming a block of data contains "n" bytes of information, the bytes are labeled Byte(0) through Byte(n-1), where Byte(0) is first byte of the block, and Byte(n-1) is the last byte of the block. Table 1 shows the order the bytes shall be presented in when such a block of data is transferred on the interface (see 8.12.8 and 8.13.8).

Table 1 – **Byte order**

	DD 15	**DD 14**	**DD 13**	**DD 12**	**DD 11**	**DD 10**	**DD 9**	**DD 8**	**DD 7**	**DD 6**	**DD 5**	**DD 4**	**DD 3**	**DD 2**	**DD 1**	**DD 0**
First transfer	Byte (1)								Byte (0)							
Second transfer	Byte (3)								Byte (2)							
.....																
Last transfer	Byte (n-1)								Byte (n-2)							

NOTE – The above description is for data on the interface. Host systems and/or host adapters may cause the order of data, as seen in the memory of the host, to be different.

7.3 Alternate Status register

7.3.1 Address

CS1	CS0	DA2	DA1	DA0
A	N	A	A	N
A = asserted, N = negated				

7.3.2 Direction

This register is read only. If this address is written to by the host, the Device Control register is written.

7.3.3 Access restrictions

When the BSY bit is set to one, the other bits in this register shall not be used. The entire contents of this register are not valid while the device is in Sleep mode.

7.3.4 Effect

Reading this register shall not clear a pending interrupt.

7.3.5 Functional description

This register contains the same information as the Status register in the command block.

See 7.15 for definitions of the bits in this register.

7.4 Command register

7.4.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	A	A	A
A = asserted, N = negated				

7.4.2 Direction

This register is write only. If this address is read by the host, the Status register is read.

7.4.3 Access restrictions

For all commands except DEVICE RESET, this register shall only be written when BSY and DRQ are both equal to zero and DMACK- is not asserted. The contents of this register is not valid while a device is in the Sleep mode. If written when BSY or DRQ is set to one, the results of writing the Command register are indeterminate except for the DEVICE RESET command.

7.4.4 Effect

Command processing begins when this register is written. The content of the Command Block registers become parameters of the command when this register is written. Writing this register clears any pending interrupt condition.

7.4.5 Functional description

This register contains the command code being sent to the device. Command execution begins immediately after this register is written. The executable commands, the command codes, and the necessary parameters for each command are summarized in the tables in informative annex E.

7.4.6 Field/bit description

7	6	5	4	3	2	1	0
Command Code							

7.5 Cylinder High register

7.5.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	A	N	A
A = asserted, N = negated				

7.5.2 Direction

This register is read/write.

7.5.3 Access restrictions

This register shall be written only when both BSY and DRQ are cleared to zero and DMACK- is not asserted. The contents of this register are valid only when BSY is cleared to zero. If this register is written when BSY or DRQ is set to one, the result is indeterminate. The contents of the this register are not valid while a device is in the Sleep mode.

7.5.4 Effect

The content of this register becomes a command parameter when the Command register is written.

7.5.5 Functional description

The content of this register is command dependent (see clause 8).

7.6 Cylinder Low register

7.6.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	A	N	N
A = asserted, N = negated				

7.6.2 Direction

This register is read/write.

7.6.3 Access restrictions

This register shall be written only when both BSY and DRQ are cleared to zero and DMACK- is not asserted. The contents of this register are valid only when BSY is cleared to zero. If this register is written when BSY or DRQ is set to one, the result is indeterminate. The contents of the this register are not valid while a device is in the Sleep mode.

7.6.4 Effect

The content of this register becomes a command parameter when the Command register is written.

7.6.5 Functional description

The content of this register is command dependent (see clause 8).

7.7 Data register

7.7.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	N	N	N
A = asserted, N = negated				

7.7.2 Direction

This register is read/write.

7.7.3 Access restrictions

This register shall be accessed for host PIO data only when DRQ is set to one and DMACK- is not asserted. The contents of the this register are not valid while a device is in the Sleep mode.

7.7.4 Effect

PIO out data transfers are processed by a series of reads to this register, each read transferring the data that follows the previous read. PIO in data transfers are processed by a series of writes to this register, each write transferring the data that follows the previous write. The results of a read during a PIO in or a write during a PIO out are indeterminate.

7.7.5 Functional description

The data register is 16-bits wide.

7.7.6 Field/bit description

15	14	13	12	11	10	9	8
Data(15:8)							

7	6	5	4	3	2	1	0
Data(7:0)							

7.8 Data port

7.8.1 Address

When DMACK- is asserted, CS0- and CS1- shall be negated and transfers shall be 16-bits wide.

CS1	CS0	DA2	DA1	DA0
N	N	X	X	X
A = asserted, N = negated, X = don't care				

7.8.2 Direction

This port is read/write.

7.8.3 Access restrictions

This port shall be accessed for host DMA data transfers only when DMACK- and DMARQ are asserted.

7.8.4 Effect

DMA out data transfers are processed by a series of reads to this port, each read transferring the data that follows the previous read. DMA in data transfers are processed by a series of writes to this port, each write transferring the data that follows the previous write. The results of a read during a DMA in or a write during a DMA out are indeterminate.

7.8.5 Functional description

The data port is 16-bits in width.

7.8.6 Field/bit description

15	14	13	12	11	10	9	8
Data(15:8)							

7	6	5	4	3	2	1	0
Data(7:0)							

7.9 Device Control register

7.9.1 Address

CS1	CS0	DA2	DA1	DA0
A	N	A	A	N
A = asserted, N = negated				

7.9.2 Direction

This register is write only. If this address is read by the host, the Alternate Status register is read.

7.9.3 Access restrictions

This register shall only be written when DMACK- is not asserted.

7.9.4 Effectiveness

The content of this register shall take effect when written.

7.9.5 Functional description

This register allows a host to software reset attached devices and to enable or disable the assertion of the INTRQ signal by a selected device.

7.9.6 Field/bit description

7	6	5	4	3	2	1	0
r	r	r	r	r	SRST	nIEN	0

- Bits 7 through 3 are reserved.
- SRST is the host software reset bit (see 9.3).
- nIEN is the enable bit for the device interrupt to the host. When the nIEN bit is cleared to zero, and the device is selected, INTRQ shall be enabled through a tri-state buffer and shall be asserted r negated by the device as appropriate. When the nIEN bit is set to one, or the device is not selected, the INTRQ signal shall be in a high impedance state.
- Bit 0 shall be cleared to zero.

7.10 Device/Head register

7.10.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	A	A	N
A = asserted, N = negated				

7.10.2 Direction

This register is read/write.

7.10.3 Access restrictions

This register shall be written only when both BSY and DRQ are cleared to zero and DMACK- is not asserted. The contents of this register are valid only when BSY is cleared to zero. If this register is written when BSY or DRQ is set to one, the result is indeterminate. For devices not implementing the DEVICE RESET command, the contents of this register are not valid while a device is in the Sleep mode. For devices implementing the DEVICE RESET command, the contents of this register are valid while the device is in Sleep mode.

7.10.4 Effect

The DEV bit becomes effective when this register is written by the host or the signature is set by the device. All other bits in this register become a command parameter when the Command register is written.

7.10.5 Functional description

Bit 4, DEV, in this register selects the device. Other bits in this register are command dependent (see clause 8).

7.10.6 Field/bit description

7	6	5	4	3	2	1	0
obsolete	#	obsolete	DEV	#	#	#	#

- obsolete - These bits are obsolete.

NOTE – Some hosts set these bits to one. Devices shall ignore these bits.

- # - The content of these bits is command dependent (see clause 8).
- DEV - Device select. Cleared to zero selects Device 0. Set to one selects Device 1.

7.11 Error register

7.11.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	N	N	A
A = asserted, N = negated				

7.11.2 Direction

This register is read only. If this address is written to, the Features register is written.

7.11.3 Access restrictions

The contents of this register shall be valid when BSY and DRQ equal zero and ERR equals one. The contents of this register shall be valid upon completion of power on, or after a hardware or software reset, or after command completion of an EXECUTE DEVICE DIAGNOSTICS or DEVICE RESET command. The contents of this register are not valid while a device is in the Sleep mode.

7.11.4 Effect

None.

7.11.5 Functional description

This register contains status for the current command.

Following a power on, a hardware or software reset (see 9.2), or command completion of an EXECUTE DEVICE DIAGNOSTIC (see 8.9) or DEVICE RESET command (see 8.7), this register contains a diagnostic code .

At command completion of any command except EXECUTE DEVICE DIAGNOSTIC, the contents of this register are valid when the ERR bit is equal to one in the Status register.

7.11.6 Field/bit description

7	6	5	4	3	2	1	0
#	#	#	#	#	ABRT	#	#

- Bit 2 - ABRT (command aborted) is set to one to indicate the requested command has been command aborted because the command code or a command parameter is invalid or some other error has occurred.
- # -The content of this bit is command dependent (see clause 8).

7.12 Features register

7.12.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	N	N	A
A = asserted, N = negated				

7.12.2 Direction

This register is write only. If this address is read by the host, the Error register is read.

7.12.3 Access restrictions

This register shall be written only when BSY and DRQ equal zero and DMACK- is not asserted. If this register is written when BSY or DRQ is set to one, the result is indeterminate.

7.12.4 Effect

The content of this register becomes a command parameter when the Command register is written.

7.12.5 Functional description

The content of this register is command dependent (see clause 8).

7.13 Sector Count register

7.13.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	N	A	N
A = asserted, N = negated				

7.13.2 Direction

This register is read/write.

7.13.3 Access restrictions

This register shall be written only when both BSY and DRQ are zero and DMACK- is not asserted. The contents of this register are valid only when both BSY and DRQ are zero. If this register is written when BSY or DRQ is set to one, the result is indeterminate. The contents of the this register are not valid while a device is in the Sleep mode.

7.13.4 Effect

The content of this register becomes a command parameter when the Command register is written.

7.13.5 Functional description

The content of this register is command dependent (see clause 8).

7.14 Sector Number register

7.14.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	N	A	A
A = asserted, N = negated				

7.14.2 Direction

This register is read/write.

7.14.3 Access restrictions

This register shall be written only when both BSY and DRQ are zero and DMACK- is not asserted. The contents of this register are valid only when both BSY and DRQ are zero. If this register is written when BSY or DRQ is set to one, the result is indeterminate. The contents of the this register are not valid while a device is in the Sleep mode.

7.14.4 Effect

The content of this register becomes a command parameter when the Command register is written.

7.14.5 Functional description

The content of this register is command dependent (see clause 8).

7.15 Status register

7.15.1 Address

CS1	CS0	DA2	DA1	DA0
N	A	A	A	A
A = asserted, N = negated				

7.15.2 Direction

This register is read only. If this address is written to by the host, the Command register is written.

7.15.3 Access restrictions

The contents of this register, except for BSY, shall be ignored when BSY is set equal to one. BSY is valid at all times. The contents of this register are not valid while a device is in the Sleep mode.

7.15.4 Effect

Reading this register when an interrupt is pending causes the interrupt to be cleared (see 5.2.9). The host should not read the Status register when an interrupt is expected as this may clear the interrupt before it can be recognized by the host.

7.15.5 Functional description

This register contains the device status. The contents of this register are updated to reflect the current state of the device and the progress of any command being executed by the device.

7.15.6 Field/bit description

7	6	5	4	3	2	1	0
BSY	DRDY	#	#	DRQ	obsolete	obsolete	ERR

7.15.6.1 BSY (Busy)

BSY is set to one to indicate that the device is busy. After the host has written the Command register the device shall have either the BSY bit set to one, or the DRQ bit set to one, until command completion or the device has performed a bus release for an overlapped command.

The BSY bit shall be set to one by the device:

1) after either the negation of RESET- or the setting of the SRST bit to one in the Device Control register;
2) after writing the Command register if the DRQ bit is not set to one;
3) between blocks of a data transfer during PIO data in commands before the DRQ bit is cleared to zero;
4) after the transfer of a data block during PIO data out commands before the DRQ bit is cleared to zero;
5) during the data transfer of DMA commands either the BSY bit , the DRQ bit, or both shall be set to one;
6) after the command packet is received during the execution of a PACKET command.

NOTE – The BSY bit may be set to one and then cleared to zero so quickly, that host detection of the BSY bit being set to one is not certain.

When BSY is set to one, the device has control of the Command Block Registers and:

1) a write to a Command Block register by the host shall be ignored by the device except for writing DEVICE RESET command;
2) a read from a Command Block register by the host will most likely yield invalid contents except for the BSY bit itself.

The BSY bit shall be cleared to zero by the device:

1) after setting DRQ to one to indicate the device is ready to transfer data;
2) at command completion;
3) upon releasing the bus for an overlapped command;
4) when the device is ready to accept commands that do not require DRDY during a power-on, hardware or software reset.

When BSY is cleared to zero, the host has control of the Command Block registers, the device shall:

1) not set DRQ to one;
2) not change ERR bit;
3) not change the content of any other Command Block register;
4) set the SERV bit to one when ready to continue an overlapped command that has been bus released.

7.15.6.2 DRDY (Device ready)

The DRDY bit shall be cleared to zero by the device:

1) when power-on, hardware, or software reset or DEVICE RESET or EXECUTE DEVICE DIAGNOSTIC commands for devices implementing the PACKET command feature set.

When the DRDY bit is cleared to zero, the device shall accept and attempt to execute as described in clause 8

The DRDY bit shall be set to one by the device:

1) when the device is capable of accepting all commands for devices not implementing the PACKET command feature set;
2) prior to command completion except the DEVICE RESET or EXECUTE DEVICE DIAGNOSTIC command for devices implementing the PACKET feature set.

When the DRDY bit is set to one:

1) the device shall accept and attempt to execute all implemented commands;
2) devices that implement the Power Management feature set shall maintain the DRDY bit equal to one when they are in the Idle or Standby modes.

7.15.6.3 Command dependent

The use of bits marked with # are command dependent (see clause 8). Bit 4 was formerly the DSC (Device Seek Complete) bit.

7.15.6.4 DRQ (Data request)

DRQ indicates that the device is ready to transfer a word of data between the host and the device. After the host has written the Command register the device shall either set the BSY bit to one or the DRQ bit to one, until command completion or the device has performed a bus release for an overlapped command.

The DRQ bit shall be set to one by the device:

1) when BSY is set to one and data is ready for PIO transfer;
2) during the data transfer of DMA commands either the BSY bit , the DRQ bit, or both shall be set to one.

When the DRQ bit is set to one, the host may:

1) transfer data via PIO mode;
2) transfer data via DMA mode if DMARQ and DMACK- are asserted.

The DRQ bit shall be cleared to zero by the device:

1) when the last word of the data transfer occurs;
2) when the last word of the command packet transfer occurs for a PACKET command.

When the DRQ bit is cleared to zero, the host may:

1) transfer data via DMA mode if DMARQ and DMACK- are asserted and BSY is set to one.

7.15.6.5 Obsolete bits

Some bits in this register were defined in previous ATA standards but have been declared obsolete in this standard. These bits are labeled “obsolete”.

7.15.6.6 ERR (Error)

ERR indicates that an error occurred during execution of the previous command. For the PACKET and SERVICE commands, this bit is defined as CHK and indicates that an exception conditions exists.

The ERR bit shall be set to one by the device:

1) when BSY or DRQ is set to one and an error occurs in the executing command.

When the ERR bit is set to one:

1) the bits in the Error register shall be valid;
2) the device shall not change the contents of the following registers until a new command has been accepted, the SRST bit is set to one or RESET- is asserted:
   - Error register;
   - Cylinder High/Low registers;
   - Sector Count register;

- Sector Number register;
- Device/Head register.

The ERR bit shall be cleared to zero by the device:

1) when a new command is written to the Command register;
2) when the SRST bit is set to one;
3) when the RESET- signal is asserted.

When the ERR bit is cleared to zero at the end of a command:

1) the content of the Error register shall be ignored by the host.

8 Command descriptions

Commands are issued to the device by loading the pertinent registers in the command block with the needed parameters and then writing the command code to the Command register.

Each command description in the following clauses contains the following subclauses:

Command code - Indicates the command code for this command.

Feature set - Indicates feature set and if the command is:

- Mandatory - Required to be implemented by devices as specified.
- Optional - Implementation is optional but if implemented shall be implemented as specified.

Protocol - Indicates which protocol is used by the command (see clause 9).

Inputs - Describes the Command Block register data that the host shall supply.

Register	7	6	5	4	3	2	1	0
Features								
Sector Count								
Sector Number								
Cylinder Low								
Cylinder High								
Device/Head								
Command	Command Code							
NOTE – na indicates the content of a bit or field is not applicable to the particular command. obs indicates that the use of this bit is obsolete.								

Normal outputs - Describes the Command Block register data returned by the device at the end of a command.

Register	7	6	5	4	3	2	1	0
Error								
Sector Count								
Sector Number								
Cylinder Low								
Cylinder High								
Device/Head								
Status								
NOTE – na indicates the content of a bit or field is not applicable to the particular command. obs indicates that the use of this bit is obsolete.								

Error outputs - Describes the Command Block register data that shall be returned by the device at command completion with an unrecoverable error.

Register	7	6	5	4	3	2	1	0
Error								
Sector Count								
Sector Number								
Cylinder Low								
Cylinder High								
Device/Head								
Status								
NOTE – na indicates the content of a bit or field is not applicable to the particular command. obs indicates that the use of this bit is obsolete.								

Prerequisites - Any prerequisite commands or conditions that shall be met before the command is issued.

Description - The description of the command function(s).

8.1 CFA ERASE SECTORS

8.1.1 Command code

C0h

8.1.2 Feature set

CFA feature set.

– If the CFA feature set is implemented this command shall be implemented.

This command code is Vendor Specific for devices not implementing the CFA feature Set.

8.1.3 Protocol

Non-data command (see 9.9).

8.1.4 Inputs

The Cylinder Low, Cylinder High, Device/Head, and Sector Number specify the starting sector address to be erased. The Sector Count register specifies the number of sectors to be erased.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	C0h							

Sector Count -
number of sectors to be erased. A value of 00h indicates that 256 sectors are to be erased.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address starting head number or LBA address bits (27:24).

8.1.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	na	na	na	na	na	ERR

Status register

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
ERR shall be cleared to zero.

8.1.6 Error outputs

The device shall return command aborted if the command is not supported. An unrecoverable error encountered during execution of this command results in the termination of the command. The command block registers contain the address of the sector where the first unrecovered error occurred.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	IDNF	na	ABRT	na	MED
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	na	na	na	ERR

Error Register -

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

ABRT shall be set to one if the command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

MED shall be set to one if a media error is detected.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
ERR shall be set to one if an Error register bit is set to one.

8.1.7 Prerequisites

DRDY set equal to one.

8.1.8 Description

This command pre-erases and conditions from 1 to 256 sectors as specified in the Sector Count register. This command should be issued in advance of a CFA WRITE SECTORS WITHOUT ERASE or a CFA WRITE MULTIPLE WITHOUT ERASE command to increase the execution speed of the write operation.

8.2 CFA REQUEST EXTENDED ERROR CODE

8.2.1 Command code

03h

8.2.2 Feature set

CFA feature set.

- If the CFA feature set is implemented this command shall be implemented.

8.2.3 Protocol

Non-data command (see 9.9).

8.2.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Command	03h							

8.2.5 Normal outputs

The extended error code written into the Error register is an 8-bit code. Table 8 defines these values.

Register	7	6	5	4	3	2	1	0
Error	Extended error code							
Sector Count	Vendor specific							
Sector Number	Vendor specific							
Cylinder Low	Vendor specific							
Cylinder High	Vendor specific							
Device/Head	obs	na	obs	DEV	Vendor specific			
Status	BSY	DRDY	na	na	na	na	na	ERR

Error register -

Extended error code.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

May contain additional information.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

ERR shall be cleared to zero.

Table 8 – Extended error codes

Extended error code	Description
00h	No error detected / no additional information
01h	Self test passed
03h	Write / Erase failed
05h	Self test or diagnostic failed
09h	Miscellaneous error
0Bh	Vendor specific
0Ch	Corrupted media format
0D-0Fh	Vendor specific
10h	ID Not Found / ID Error
11h	Uncorrectable ECC error
14h	ID Not Found
18h	Corrected ECC error
1Dh, 1Eh	Vendor specific
1Fh	Data transfer error / command aborted
20h	Invalid command
21h	Invalid address
22-23h	Vendor specific
27h	Write protect violation
2Fh	Address overflow (address too large)
30-34h	Self test or diagnostic failed
35h, 36h	Supply or generated voltage out of tolerance
37h, 3Eh	Self test or diagnostic failed
38h	Corrupted media format
39h	Vendor specific
3Ah	Spare sectors exhausted
3Bh 3Ch, 3Fh	Corrupted media format
3Dh	Vendor specific
All other values	Reserved

8.2.6 Error outputs

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	na	na	na	ERR

Error Register -

ABRT shall be set to one if the command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

ERR shall be set to one if an Error register bit is set to one.

8.2.7 Prerequisites

DRDY set equal to one.

8.2.8 Description

This command provides an extended error code which identifies the cause of an error condition in more detail than is available with Status and Error register values. The CFA REQUEST EXTENDED ERROR CODE command must be issued to the device immediately following the command which ended with an error condition to obtain valid extended error code information.

8.3 CFA TRANSLATE SECTOR

8.3.1 Command code

87h

8.3.2 Feature set

CFA feature set.

– If the CFA feature set is implemented this command shall be implemented.

This command code is Vendor Specific for devices not implementing the CFA feature Set.

8.3.3 Protocol

PIO data in command (see 9.7).

8.3.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	87h							

Sector Number -
sector number or LBA address bits (7:0).
Cylinder Low -
cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address head number or LBA address bits (27:24).

8.3.5 Normal outputs

A 512 byte information table is transferred to the host. Table 9 defines these values.

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	na	na	na	na	na	ERR

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
ERR shall be cleared to zero.

Table 9 – CFA TRANSLATE SECTOR Information

Byte	Description
00h	Cylinder number MSB
01h	Cylinder number LSB
02h	Head number
03h	Sector number
04h	LBA bits (23:16)
05h	LBA bits (15:8)
06h	LBA bits (7:0)
07-12h	Reserved
13h	Sector erased flag (FFh = erased; 00h = not erased)
14-17h	Reserved
18h	Sector write cycles count bits (23:16)
19h	Sector write cycles count bits (15:8)
1Ah	Sector write cycles count bits (7:0)
1B-FFh	Reserved

8.3.6 Error outputs

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	na	na	na	ERR

Error Register -

ABRT shall be set to one if the command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
ERR shall be set to one if an Error register bit is set to one.

8.3.7 Prerequisites

DRDY set equal to one.

8.3.8 Description

This command provides information related to a specific sector. The data indicates the erased or not erased status of the sector, and the number of erase and write cycles performed on that sector. Devices may return zero in fields that do not apply or that are not supported by the device.

8.4 CFA WRITE MULTIPLE WITHOUT ERASE

8.4.1 Command code

CDh

8.4.2 Feature set

CFA feature set.

– If the CFA feature set is implemented this command shall be implemented.

8.4.3 Protocol

PIO data out command (see 9.8).

8.4.4 Inputs

The Cylinder Low, Cylinder High, Device/Head, and Sector Number specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	CDh							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address starting head number or LBA address bits (27:24).

8.4.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	na	na	na	na	na	ERR

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
ERR shall be cleared to zero.

8.4.6 Error outputs

The device shall return command aborted if the command is not supported. An unrecoverable error encountered during execution of this command results in the termination of the command. The command block registers contain the address of the sector where the first unrecovered error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	IDNF	na	ABRT	na	MED
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error Register -

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

ABRT shall be set to one if the command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

MED shall be set to one if a media error is detected

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.4.7 Prerequisites

DRDY set equal to one. If bit 8 of IDENTIFY DEVICE word 59 is equal to zero, a successful SET MULTIPLE MODE command shall precede a CFA WRITE MULTIPLE WITHOUT ERASE command.

8.4.8 Description

This command is similar to the WRITE MULTIPLE command. Interrupts are not generated on every sector, but on the transfer of a block that contains the number of sectors defined by the SET MULTIPLE MODE.

Command execution is identical to the WRITE MULTIPLE operation except that the sectors are written without an implied erase operation. The sectors should be pre-erased by a preceding CFA ERASE SECTORS command.

8.5 CFA WRITE SECTORS WITHOUT ERASE

8.5.1 Command code

38h

8.5.2 Feature set

CFA feature set.

– If the CFA feature set is implemented this command shall be implemented.

8.5.3 Protocol

PIO data out command (see 9.8).

8.5.4 Inputs

The Cylinder Low, Cylinder High, Device/Head, and Sector Number specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	38h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address starting head number or LBA address bits (27:24).

8.5.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	na	na	na	na	na	ERR

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
ERR shall be cleared to zero.

8.5.6 Error outputs

The device shall return command aborted if the command is not supported. An unrecoverable error encountered during execution of this command results in the termination of the command. The command block registers contain the address of the sector where the first unrecovered error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	IDNF	na	ABRT	na	MED
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error Register -

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

ABRT shall be set to one if the command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

MED shall be set to one if a media error is detected

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault h as occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.5.7 Prerequisites

DRDY set equal to one.

8.5.8 Description

This command is similar to the WRITE SECTORS command. Command execution is identical to the WRITE SECTORS operation except that the sectors are written without an implied erase operation. The sectors should be pre-erased by a preceding CFA ERASE SECTORS command.

8.6 CHECK POWER MODE

8.6.1 Command code

E5h

8.6.2 Feature set

Power Management feature set.

- Power Management feature set is mandatory when power management is not implemented by a PACKET power management feature set.
- This command is mandatory when the Power Management feature set is implemented.

8.6.3 Protocol

Non-data command (see 9.9).

8.6.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E5h							

Device/Head register -

DEV shall indicate the selected device.

8.6.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	Result value							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

Device/Head register -

DEV shall indicate the selected device.

Sector Count result value -

00h - device is in Standby mode.
80h - device is in Idle mode.
FFh - device is in Active mode or Idle mode.

8.6.6 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if Power Management feature set is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.6.7 Prerequisites

DRDY set equal to one.

8.6.8 Description

The CHECK POWER MODE command allows the host to determine the current power mode of the device. The CHECK POWER MODE command shall not cause the device to change power or affect the operation of the Standby timer.

8.7 DEVICE RESET

8.7.1 Command code

08h

8.7.2 Feature set

General feature set

- Use prohibited when the PACKET Command feature set is not implemented.
- Mandatory when the PACKET Command feature set is implemented.

8.7.3 Protocol

Device reset (see 9.4).

8.7.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	08h							

Device/Head register -

DEV shall indicate the selected device.

8.7.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	Diagnostic results							
Sector Count	signature							
Sector Number	signature							
Cylinder Low	signature							
Cylinder High	signature							
Device/Head	0	0	0	DEV	0	0	0	0
Status	see 9.4							

Error register -

The diagnostic code as described in 8.9 is placed in this register.

Sector Count, Sector Number, Cylinder low, Cylinder High -

Signature (see 9.1).

Device/Head register -

DEV shall indicate the selected device.

Status register -

see 9.4.

8.7.6 Error outputs

If supported, this command cannot end in an error condition. If this command is not supported and the device has the BSY bit or the DRQ bit set to one when the command is written, the results of this command

are indeterminate. If this command is not supported and the device has the BSY bit and the DRQ bit cleared to zero when the command is written, the device shall respond command aborted.

8.7.7 Prerequisites

This command shall be accepted when BSY or DRQ is set to one, DRDY is cleared to zero, or DMARQ is asserted. This command shall be accepted when in Sleep mode.

8.7.8 Description

The DEVICE RESET command enables the host to reset an individual device without affecting the other device.

8.8 DOWNLOAD MICROCODE

8.8.1 Command code

92h

8.8.2 Feature set

General feature set

- Optional for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.8.3 Protocol

PIO data out (see 9.8).

8.8.4 Inputs

The head bits of the Device/Head register shall always be cleared to zero. The Cylinder High and Low registers shall be cleared to zero. The Sector Number and Sector Count registers are used together as a 16-bit sector count value. The Feature register specifies the subcommand code.

Register	7	6	5	4	3	2	1	0
Features	Subcommand code							
Sector Count	Sector count (low order)							
Sector Number	Sector count (high order)							
Cylinder Low	00h							
Cylinder High	00h							
Device/Head	obs	na	obs	DEV	0	0	0	0
Command	92h							

Device/Head register -

DEV shall indicate the selected device.

8.8.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.8.6 Error outputs

The device shall return command aborted if the device does not support this command or did not accept the microcode data. The device shall return command aborted if subcommand code is not a supported value.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if the device does not support this command or did not accept the microcode data. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.8.7 Prerequisites

DRDY set equal to one.

8.8.8 Description

This command enables the host to alter the device's microcode. The data transferred using the DOWNLOAD MICROCODE command is vendor specific.

All transfers shall be an integer multiple of the sector size. The size of the data transfer is determined by the contents of the Sector Number Register and the Sector Count register. The Sector Number Register shall be used to extend the Sector Count register to create a sixteen bit sector count value. The Sector Number Register shall be the most significant eight bits and the Sector Count register shall be the least significant eight bits. A value of zero in both the Sector Number Register and the Sector Count register shall indicate no data is to be transferred. This allows transfer sizes from 0 bytes to 33,553,920 bytes, in 512 byte increments.

The Features register shall be used to determine the effect of the DOWNLOAD MICROCODE command. The values for the Feature Register are:

- 01h - download is for immediate, temporary use.
- 07h - save downloaded code for immediate and future use.

Either or both values may be supported. All other values are reserved.

8.9 EXECUTE DEVICE DIAGNOSTIC

8.9.1 Command code

90h

8.9.2 Feature set

General feature set
- Mandatory for all devices.

8.9.3 Protocol

Device diagnostics (see 9.5).

8.9.4 Inputs

None. The device selection bit in the Device/Head register is ignored.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	na	na	na	na	na
Command	90h							

Device/Head register -
DEV shall indicate the selected device.

8.9.5 Normal outputs

The diagnostic code written into the Error register is an 8-bit code. Table 10 defines these values. The values of the bits in the Error register are not as defined in 7.11.6.

Register	7	6	5	4	3	2	1	0
Error	Diagnostic code							
Sector Count	Signature							
Sector Number	Signature							
Cylinder Low	Signature							
Cylinder High	Signature							
Device/Head	Signature							
Status	see 9.5							

Error register -
Diagnostic code.
Sector Count, Sector number, Cylinder Low, Cylinder High, Device/Head registers -
device signature (see 9.1).
Device/Head register -
DEV shall indicate the selected device.
Status register -
see 9.5.

Table 10 – Diagnostic codes

Code (see note 1)	Description
When this code is in the Device 0 Error register	
01h	Device 0 passed, Device 1 passed or not present
00h, 02h-7Fh	Device 0 failed, Device 1 passed or not present
81h	Device 0 passed, Device 1 failed
80h, 82h-FFh	Device 0 failed, Device 1 failed
When this code is in the Device 1 Error register	
01h	Device 1 passed (see note 2)
00h,02h-7Fh	Device 1 failed (see note 2)

NOTE –
1 Codes other than 01h and 81h may indicate additional information about the failure(s).
2 If Device 1 is not present, the host may see the information from Device 0 even though Device 1 is selected.

8.9.6 Error outputs

Table 10 shows the error information that is returned as a diagnostic code in the Error register.

8.9.7 Prerequisites

This command shall be accepted regardless of the state of DRDY.

8.9.8 Description

This command shall perform the internal diagnostic tests implemented by the device. The DEV bit in the Device/Head register is ignored. Both devices, if present, shall execute this command regardless of which device is selected.

If the host issues an EXECUTE DEVICE DIAGNOSTIC command while a device is in or going to a power management mode except Sleep, then the device shall execute its EXECUTE DEVICE DIAGNOSTIC sequence.

8.10 FLUSH CACHE

8.10.1 Command code

E7h

8.10.2 Feature set

General feature set
- Optional for all devices.

8.10.3 Protocol

Non-data command (see 9.9).

8.10.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E7h							

Device/Head register -
DEV shall indicate the selected device.

8.10.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.10.6 Error outputs

If the command is not supported, the device shall return command aborted. An unrecoverable error encountered during execution of writing data results in the termination of the command and the Command Block registers contain the sector address of the sector where the first unrecoverable error occurred. The

sector is removed from the cache. Subsequent FLUSH CACHE commands continue the process of flushing the cache.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if device does not support this command. ABRT may be set to one if the device is not able to complete the action requested by the command.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of the first unrecoverable error.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.10.7 Prerequisites

DRDY set equal to one.

8.10.8 Description

This command is used by the host to request the device to flush the write cache. If the write cache is to be flushed, all data cached shall be written to the media. The BSY bit shall remain set to one until all data has been successfully written or an error occurs. The device should use all error recovery methods available to ensure the data is written successfully. The flushing of write cache may take several seconds to complete depending upon the amount of data to be flushed and the success of the operation.

NOTE – This command may take longer than 30 s to complete.

8.11 GET MEDIA STATUS

8.11.1 Command code

DAh

8.11.2 Feature set

Removable Media Status Notification feature set

- Mandatory for devices implementing the Removable Media Status Notification feature set.

Removable Media feature set

- Optional for devices implementing the Removable Media feature set.

8.11.3 Protocol

Non-data command (see 9.9).

8.11.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	DAh							

Device/Head register -

DEV shall indicate the selected device.

8.11.5 Normal outputs

Normal outputs are returned if Media Status Notification is disabled or if no bits are set to one in the Error register.

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.11.6 Error outputs

If the device does not support this command, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	WP	MC	na	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if device does not support this command. ABRT may be set to one if the device is not able to complete the action requested by the command.

NM (No Media) shall be set to one if no media is present in the device. This bit shall be set to one for each execution of GET MEDIA STATUS until media is inserted into the device.

MCR (Media Change Request) shall be set to one if the eject button is pressed by the user and detected by the device. The device shall reset this bit after each execution of the GET MEDIA STATUS command and only set the bit again for subsequent eject button presses.

MC (Media Change) shall be set to one when the device detects media has been inserted. The device shall reset this bit after each execution of the GET MEDIA STATUS command and only set the bit again for subsequent media insertions.

WP (Write Protect) shall be set to one for each execution of GET MEDIA STATUS while the media is write protected.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.11.7 Prerequisites

DRDY set equal to one.

8.11.8 Description

This command returns media status bits WP, MC, MCR, and NM, as defined above. When Media Status Notification is disabled this command returns zeros in the WP, MC, MCR, and NM bits.

8.12 IDENTIFY DEVICE

8.12.1 Command code

ECh

8.12.2 Feature set

General feature set
- Mandatory for all devices.
- Devices implementing the PACKET Command feature set (see 8.12.5.2).

8.12.3 Protocol

PIO data in (see 9.7).

8.12.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	ECh							

Device/Head register -

DEV shall indicate the selected device.

8.12.5 Outputs

8.12.5.1 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.12.5.2 Outputs for PACKET Command feature set devices

In response to this command, devices that implement the PACKET Command feature set shall post command aborted and place the PACKET Command feature set signature in the Command Block registers (see 9.1).

8.12.6 Error outputs

Devices not implementing the PACKET Command feature set shall not report an error.

8.12.7 Prerequisites

DRDY set equal to one.

8.12.8 Description

The IDENTIFY DEVICE command enables the host to receive parameter information from the device.

Some devices may have to read the media in order to complete this command.

When the command is issued, the device sets the BSY bit to one, prepares to transfer the 256 words of device identification data to the host, sets the DRQ bit to one, clears the BSY bit to zero, and asserts INTRQ if nIEN is cleared to zero. The host may then transfer the data by reading the Data register. Table 11 defines the arrangement and meaning of the parameter words in the buffer. All reserved bits or words shall be zero.

Some parameters are defined as a 16-bit value. A word that is defined as a 16-bit value places the most significant bit of the value on bit DD15 and the least significant bit on bit DD0.

Some parameters are defined as 32-bit values (e.g., words 57 and 58). Such fields are transferred using two successive word transfers. The device shall first transfer the least significant bits, bits 15 through 0 of the value, on bits DD (15:0) respectively. After the least significant bits have been transferred, the most significant bits, bits 31 through 16 of the value, shall be transferred on DD (15:0) respectively.

Some parameters are defined as a string of ASCII characters. ASCII data fields shall contain only graphic codes (i.e., code values 20h through 7Eh). For the string “Copyright”, the character “C” is the first byte, the character “o” is the 2nd byte, etc. When such fields are transferred, the order of transmission is:

the 1st character (“C”) is on bits DD (15:8) of the first word,
the 2nd character (“o”) is on bits DD (7:0) of the first word,
the 3rd character (“p”) is on bits DD (15:8) of the second word,
the 4th character (“y”) is on bits DD (7:0) of the second word,
etc.

Table 11 – IDENTIFY DEVICE information

Word	F/V	
0		General configuration bit-significant information:
	F	15 0=ATA device
	F	14-8 retired
	F	7 1=removable media device
	F	6 1=not removable controller and/or device
	F	5-1 retired
	F	0 Reserved
1	V	Number of logical cylinders
2	R	Reserved
3	F	Number of logical heads
4-5	X	retired
6	F	Number of logical sectors per logical track
7-9	X	retired
10-19	F	Serial number (20 ASCII characters)
20-21	X	retired
22	F	obsolete
23-26	F	Firmware revision (8 ASCII characters)
27-46	F	Model number (40 ASCII characters)
47	X	15-8 80h
	R	7-0 00h =Reserved
	F	01h-FFh = Maximum number of sectors that shall be transferred per interrupt on READ/WRITE MULTIPLE commands
48	R	Reserved
49		Capabilities
	R	15-14 Reserved for the IDENTIFY PACKET DEVICE command.
	F	13 1=Standby timer values as specified in this standard are supported 0=Standby timer values shall be managed by the device
	R	12 Reserved for the IDENTIFY PACKET DEVICE command.
	F	11 1=IORDY supported 0=IORDY may be supported
	F	10 1=IORDY may be disabled
	R	9 Shall be set to one. Utilized by IDENTIFY PACKET DEVICE command.
	R	8 Shall be set to one. Utilized by IDENTIFY PACKET DEVICE command.
	X	7-0 retired
50	F	Capabilities 15 Shall be cleared to zero. 14 Shall be set to one. 13-1 Reserved. 0 Shall be set to one to indicate a device specific Standby timer value minimum.
51	F	15-8 PIO data transfer mode number
	X	7-0 retired
52	R	retired
53	R	15-3 Reserved
	F	2 1=the fields reported in word 88 are valid 0=the fields reported in word 88 are not valid
	F	1 1=the fields reported in words 64-70 are valid 0=the fields reported in words 64-70 are not valid
	V	0 1=the fields reported in words 54-58 are valid 0=the fields reported in words 54-58 may be valid
54	V	Number of current logical cylinders

(continued)

Table 11 – IDENTIFY DEVICE information *(continued)*

Word	F/V	
55	V	Number of current logical heads
56	V	Number of current logical sectors per track
57-58	V	Current capacity in sectors
59	R	15-9 Reserved
	V	8 1=Multiple sector setting is valid
	V	7-0 xxh=Current setting for number of sectors that shall be transferred per interrupt on R/W Multiple command
60-61	F	Total number of user addressable sectors (LBA mode only)
62	R	retired
63	R	15-11 Reserved
	V	10 1= Multiword DMA mode 2 is selected
		0= Multiword DMA mode 2 is not selected
	V	9 1= Multiword DMA mode 1 is selected
		0= Multiword DMA mode 1 is not selected
	V	8 1= Multiword DMA mode 0 is selected
		0= Multiword DMA mode 0 is not selected
	R	7-3 Reserved
	F	2 1= Multiword DMA mode 2 and below are supported
	F	1 1= Multiword DMA mode 1 and below are supported
	F	0 1= Multiword DMA mode 0 is supported
64	R	15-8 Reserved
	F	7-0 Advanced PIO modes supported
65		Minimum Multiword DMA transfer cycle time per word
	F	15-0 Cycle time in nanoseconds
66		Manufacturer's recommended Multiword DMA transfer cycle time
	F	15-0 Cycle time in nanoseconds
67		Minimum PIO transfer cycle time without flow control
	F	15-0 Cycle time in nanoseconds
68		Minimum PIO transfer cycle time with IORDY flow control
	F	15-0 Cycle time in nanoseconds
69-70	R	Reserved (for future command overlap and queuing)
71-74	R	Reserved for IDENTIFY PACKET DEVICE command.
75	F	Queue depth
		15-5 Reserved
		4-0 Maximum queue depth
76-79	R	Reserved
80	F	Major version number
		0000h or FFFFh = device does not report version
		15 Reserved
		14 Reserved for ATA/ATAPI-14
		13 Reserved for ATA/ATAPI-13
		12 Reserved for ATA/ATAPI-12
		11 Reserved for ATA/ATAPI-11
		10 Reserved for ATA/ATAPI-10
		9 Reserved for ATA/ATAPI-9
		8 Reserved for ATA/ATAPI-8
		7 Reserved for ATA/ATAPI-7
		6 Reserved for ATA/ATAPI-6
		5 Reserved for ATA/ATAPI-5
		4 1=supports ATA/ATAPI-4
		3 1=supports ATA-3
		2 1=supports ATA-2
		1 1=supports ATA-1
		0 Reserved

(continued)

Table 11 – IDENTIFY DEVICE information *(continued)*

Word	F/V	
81	F	Minor version number 0000h or FFFFh=device does not report version 0001h-FFFEh=see 8.12.44
82	F	Command set supported. If words 82 and 83 =0000h or FFFFh command set notification not supported. 15 Obsolete 14 1=NOP command supported 13 1=READ BUFFER command supported 12 1=WRITE BUFFER command supported 11 Obsolete 10 1=Host Protected Area feature set supported 9 1=DEVICE RESET command supported 8 1=SERVICE interrupt supported 7 1=release interrupt supported 6 1=look-ahead supported 5 1=write cache supported 4 1=supports PACKET Command feature set 3 1=supports Power Management feature set 2 1=supports Removable Media feature set 1 1=supports Security Mode feature set 0 1=supports SMART feature set
83	F	Command sets supported. If words 82 and 83 =0000h or FFFFh command set notification not supported. 15 Shall be cleared to zero 14 Shall be set to one 13-5 Reserved 4 1=Removable Media Status Notification feature set supported 3 1=Advanced Power Management feature set supported 2 1=CFA feature set supported 1 1=READ/WRITE DMA QUEUED supported 0 1=DOWNLOAD MICROCODE command supported
84	F	Command set/feature supported extension. If words 82, 83, and 84 = 0000h or FFFFh command set notification extension is not supported. 15 Shall be cleared to zero 14 Shall be set to one 13-0 Reserved
85	V	Command set/feature enabled. If words 85, 86, and 87 = 0000h or FFFFh command set enabled notification is not supported. 15 Obsolete 14 1=NOP command supported 13 1=READ BUFFER command supported 12 1=WRITE BUFFER command supported 11 Obsolete 10 1=Host Protected Area feature set supported 9 1=DEVICE RESET command supported 8 1=SERVICE interrupt enabled 7 1=release interrupt enabled 6 1=look-ahead enabled 5 1=write cache enabled 4 1=supports PACKET Command feature set 3 1=supports Power Management feature set 2 1=supports Removable Media feature set 1 1= Security Mode feature set enabled 0 1= SMART feature set enabled

(continued)

Table 11 – IDENTIFY DEVICE information *(concluded)*

Word	F/V	
86	V	Command set/feature enabled. If words 85, 86, and 87 = 0000h or FFFFh command set enabled notification is not supported. 15-5 Reserved 4 1=Removable Media Status Notification feature set enabled 3 1=Advanced Power Management feature set enabled 2 1=CFA feature set supported 1 1=READ/WRITE DMA QUEUED command supported 0 1=DOWNLOAD MICROCODE command supported
87	V	Command set/feature default. If words 85, 86, and 87 = 0000h or FFFFh command set default notification is not supported. 15 Shall be cleared to zero 14 Shall be set to one 13-0 Reserved
88	R V V V R F F F	15-11 Reserved 10 1=Ultra DMA mode 2 is selected 0=Ultra DMA mode 2 is not selected 9 1=Ultra DMA mode 1 is selected 0=Ultra DMA mode 1 is not selected 8 1=Ultra DMA mode 0 is selected 0=Ultra DMA mode 0 is not selected 7-3 Reserved 2 1=Ultra DMA mode 2 and below are supported 1 1=Ultra DMA mode 1 and below are supported 0 1=Ultra DMA mode 0 is supported
89	F	Time required for security erase unit completion
90	F	Time required for Enhanced security erase completion
91	V	Current advanced power management value
92-126	R	Reserved
127	F	Removable Media Status Notification feature set support 15-2 Reserved 1-0 00=Removable Media Status Notification feature set not supported 01=Removable Media Status Notification feature supported 10=Reserved 11=Reserved
128	V	Security status 15-9 Reserved 8 Security level 0=High, 1=Maximum 7-6 Reserved 5 1=Enhanced security erase supported 4 1=Security count expired 3 1=Security frozen 2 1=Security locked 1 1=Security enabled 0 1=Security supported
129-159	X	Vendor specific
160-255	R	Reserved

Key:
F = the content of the word is fixed and does not change. For removable media devices, these values may change when media is removed or changed.
V = the contents of the word is variable and may change depending on the state of the device or the commands executed by the device.
X = the content of the word is vendor specific and may be fixed or variable.
R = the content of the word is reserved and shall be zero.

8.12.9 Word 0: General configuration

Devices that conform to this standard shall clear bit 15 to zero.

Devices reporting a value of 848Ah in this word shall support the CFA feature set.

8.12.10 Word 1: Number of cylinders

This word contains the number of user-addressable logical cylinders in the default CHS translation (see 6.2).

8.12.11 Word 2: Reserved.

8.12.12 Word 3: Number of logical heads

This word contains the number of user-addressable logical heads per logical cylinder in the default CHS translation (see 6.2).

8.12.13 Word 4-5: Retired.

8.12.14 Word 6: Number of logical sectors per logical track

This word contains the number of user-addressable logical sectors per logical track in the default CHS translation (see 6.2).

8.12.15 Words 7-9: Retired.

8.12.16 Words 10-19: Serial number

This field contains the serial number of the device. The contents of this field is an ASCII character string of twenty bytes. The device shall pad the character string with spaces (20h), if necessary, to ensure that the string is the proper length. The combination of Serial number (words 10-19) and Model number (words 27-46) shall be unique for a given manufacturer.

8.12.17 Word 20-21: Retired.

8.12.18 Word 22: Obsolete.

8.12.19 Word 23-26: Firmware revision

This field contains the firmware revision number of the device. The contents of this field is an ASCII character string of eight bytes. The device shall pad the character string with spaces (20h), if necessary, to ensure that the string is the proper length.

8.12.20 Words 27-46: Model number

This field contains the model number of the device. The contents of this field is an ASCII character string of forty bytes. The device shall pad the character string with spaces (20h), if necessary, to ensure that the string is the proper length. The combination of Serial number (words 10-19) and Model number (words 27-46) shall be unique for a given manufacturer.

8.12.21 Word 47: READ/WRITE MULTIPLE support.

Bits 7-0 of this word define the maximum number of sectors per block that the device supports for READ/WRITE MULTIPLE commands.

8.12.22 Word 48: Reserved.

8.12.23 Word 49-50: Capabilities

Bits 15 and 14 of word 49 are reserved for use in the IDENTIFY PACKET DEVICE command response.

Bit 13 of word 49 is used to determine whether a device utilizes the Standby timer values as defined in this standard. Table 14 specifies the Standby timer values utilized by the device if bit 13 is set to one. If bit 13 is cleared to zero, the timer values shall be vendor specific.

Bit 12 of word 49 is reserved for use in the IDENTIFY PACKET DEVICE command response.

Bit 11 of word 49 is used to determine whether a device supports IORDY. If this bit is set to one, then the device supports IORDY operation. If this bit is zero, the device may support IORDY. This ensures backward compatibility. If a device supports PIO mode 3 or higher, then this bit shall be set to one.

Bit 10 of word 49 is used to indicate a device's ability to enable or disable the use of IORDY. If this bit is set to one, then the device supports the disabling of IORDY. Disabling and enabling of IORDY is accomplished using the SET FEATURES command.

Bits 9 and 8 of word 49 shall be set to one for backward compatibility. These bits are defined for use in the IDENTIFY PACKET DEVICE command response.

Bits 7 through 0 of word 49 are retired.

Bit 15 of word 50 shall be cleared to zero to indicate that the contents of word 50 are valid.

Bit 14 of word 50 shall be set to one to indicate that the contents of word 50 are valid.

Bits 13 through 1 of word 50 are reserved.

Bit 0 of word 50 set to one indicates that the device has a minimum Standby timer value that is device specific.

8.12.24 Word 51: PIO data transfer mode number

The PIO transfer timing for each device falls into modes that have unique parametric timing specifications that are specified in 10.2.2. The value returned in Bits 15-8 shall be 00h for mode 0, 01h for mode 1, or 02h for mode 2. Values 03h through FFh are reserved.

8.12.25 Word 52: Retired

8.12.26 Word 53: Field validity

If bit 0 of word 53 is set to one, the values reported in words 54 through 58 are valid. If this bit is cleared to zero, the values reported in words 54 through 58 may be valid. If bit 1 of word 53 is set to one, the values reported in words 64 through 70 are valid. If this bit is cleared to zero, the values reported in words 64-70 are not valid. Any device that supports PIO mode 3 or above, or supports Multiword DMA mode 1 or above, shall set bit 1 of word 53 to one and support the fields contained in words 64 through 70. If the device supports Ultra DMA and the values reported in word 88 are valid, then bit 2 of word 53 shall be set to one. If the device does not support Ultra DMA and the values reported in word 88 are not valid, then this bit is cleared to zero.

8.12.27 Word 54: Number of current logical cylinders

This field contains the number of user-addressable logical cylinders in the current CHS translation (see 6.2).

8.12.28 Word 55: Number of current logical heads

This field contains the number of user-addressable logical heads per logical cylinder in the current CHS translation (see 6.2).

8.12.29 Word 56: Number of current logical sectors per logical track

This field contains the number of user-addressable logical sectors per logical track in the current CHS translation (see 6.2).

8.12.30 Word (58:57): Current capacity in sectors

This field contains the current capacity in sectors in the current CHS translation (see 6.2).

8.12.31 Word 59: Multiple sector setting

If bit 8 is set to one, bits 7-0 reflect the number of sectors currently set to transfer on a READ/WRITE MULTIPLE command. If word 47 bits 7-0 are zero then word 59 bits 8-0 shall also be zero. This field may default to the preferred value for the device.

8.12.32 Word (61:60): Total number of user addressable sectors

This field contains the total number of user addressable sectors (see 6.2).

8.12.33 Word 62: Retired

8.12.34 Word 63: Multiword DMA transfer

Word 63 indentifies the Multiword DMA transfer modes supported by the device and indicates the mode that is currently selected.

8.12.34.1 Reserved

Bits 15 though 11 of word 63 are reserved.

8.12.34.2 Multiword DMA mode 2 selected

If bit 10 of word 63 is set to one, then Multiword DMA mode 2 is selected. If this bit is cleared to zero, then Multiword DMA mode 2 is not selected. If bit 9 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

8.12.34.3 Multiword DMA mode 1 selected

If bit 9 of word 63 is set to one, then Multiword DMA mode 1 is selected. If this bit is cleared to zero then Multiword DMA mode 1 is not selected. If bit 10 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

8.12.34.4 Multiword DMA mode 0 selected

If bit 8 of word 63 is set to one, then Multiword DMA mode 0 is selected. If this bit is cleared to zero then Multiword DMA mode 0 is not selected. If bit 10 is set to one or if bit 9 is set to one, then this bit shall be cleared to zero.

8.12.34.5 Reserved

Bits 7 through 3 of word 63 are reserved.

8.12.34.6 Multiword DMA mode 2 supported

If bit 2 of word 63 is set to one, then Multiword DMA modes 2 and below are supported. If this bit is cleared to zero, then Multiword DMA mode 2 is not supported. If Multiword DMA mode 2 is supported, then Multiword DMA modes 1 and 0 shall also be supported. If this bit is set to one, bits 1 and 0 shall be set to one.

8.12.34.7 Multiword DMA mode 1 supported

If bit 1 of word 63 is set to one, then Multiword DMA modes 1 and below are supported. If this bit is cleared to zero, then Multiword DMA mode 1 is not supported. If Multiword DMA mode 1 is supported, then Multiword DMA mode 0 shall also be supported. If this bit is set to one, bit 0 shall be set to one.

8.12.34.8 Multiword DMA mode 0 supported

If bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported.

8.12.35 Word 64: PIO transfer modes supported

Bits 7 through 0 of word 64 of the Identify Device parameter information is defined as the advanced PIO data transfer supported field. If this field is supported, bit 1 of word 53 shall be set to one. This field is bit significant. Any number of bits may be set to one in this field by the device to indicate the advanced PIO modes it is capable of supporting.

Of these bits, bits 7 through 2 are Reserved for future advanced PIO modes. Bit 0, if set to one, indicates that the device supports PIO mode 3. Bit 1, if set to one, indicates that the device supports PIO mode 4.

8.12.36 Word 65: Minimum Multiword DMA transfer cycle time per word

Word 65 of the parameter information of the IDENTIFY DEVICE command is defined as the minimum Multiword DMA transfer cycle time per word. This field defines, in nanoseconds, the minimum cycle time that the device supports when performing Multiword DMA transfers on a per word basis.

If this field is supported, bit 1 of word 53 shall be set to one. Any device that supports Multiword DMA mode 1 or above shall support this field, and the value in word 65 shall not be less than the minimum cycle time for the fastest DMA mode supported by the device.

If bit 1 of word 53 is set to one because a device supports a field in words 64-70 other than this field and the device does not support this field, the device shall return a value of zero in this field.

8.12.37 Word 66: Device recommended Multiword DMA cycle time

Word 66 of the parameter information of the IDENTIFY DEVICE command is defined as the device recommended Multiword DMA transfer cycle time. This field defines, in nanoseconds, the minimum cycle time per word during a single sector host transfer while performing a multiple sector READ DMA or WRITE DMA command for any location on the media under nominal conditions. If a host runs at a faster cycle rate by operating at a cycle time of less than this value, the device may negate DMARQ for flow control. The rate at which DMARQ is negated could result in reduced throughput despite the faster cycle rate. Transfer at this rate does not ensure that flow control will not be used, but implies that higher performance may result.

If this field is supported, bit 1 of word 53 shall be set to one. Any device that supports Multiword DMA mode 1 or above shall support this field, and the value in word 66 shall not be less than the value in word 65.

If bit 1 of word 53 is set to one because a device supports a field in words 64-70 other than this field and the device does not support this field, the device shall return a value of zero in this field.

8.12.38 Word 67: Minimum PIO transfer cycle time without flow control

Word 67 of the parameter information of the IDENTIFY DEVICE command is defined as the minimum PIO transfer without flow control cycle time. This field defines, in nanoseconds, the minimum cycle time that, if used by the host, the device guarantees data integrity during the transfer without utilization of flow control.

If this field is supported, Bit 1 of word 53 shall be set to one.

Any device that supports PIO mode 3 or above shall support this field, and the value in word 67 shall not be less than the value reported in word 68.

If bit 1 of word 53 is set to one because a device supports a field in words 64-70 other than this field and the device does not support this field, the device shall return a value of zero in this field.

8.12.39 Word 68: Minimum PIO transfer cycle time with IORDY

Word 68 of the parameter information of the IDENTIFY DEVICE command is defined as the minimum PIO transfer with IORDY flow control cycle time. This field defines, in nanoseconds, the minimum cycle time that the device supports while performing data transfers while utilizing IORDY flow control.

If this field is supported, Bit 1 of word 53 shall be set to one.

Any device that supports PIO mode 3 or above shall support this field, and the value in word 68 shall be the fastest defined PIO mode supported by the device.

If bit 1 of word 53 is set to one because a device supports a field in words 64-70 other than this field and the device does not support this field, the device shall return a value of zero in this field.

8.12.40 Words 69-74: Reserved

8.12.41 Word 75: Queue depth

Bits 4 through 0 of word 75 indicate the maximum queue depth supported by the device. If bit 1 of word 83 is cleared to zero indicating that the device does not support READ/WRITE DMA QUEUED commands, the value in this field shall be 00h. If bit 1 of word 83 is set to one, bits 4 through 0 indicate the maximum queue depth supported. A device may support READ/WRITE DMA QUEUED commands to provide overlap only (i.e., queuing not supported), in this case, bit 1 of word 83 shall be set to one and the queue depth shall be set to 00h.

8.12.42 Words 76-79: Reserved

8.12.43 Word 80: Major version number

If not 0000h or FFFFh, the device claims compliance with the major version(s) as indicated by bits 1 through 4 being equal to one. Values other than 0000h and FFFFh are bit significant. Since ATA standards maintain downward compatibility, it is allowed for a device to set more than one bit.

8.12.44 Word 81: Minor version number

If an implementor claims that the revision of the standard they used to guide their implementation does not need to be reported or if the implementation was based upon a standard prior to the ATA-3 standard, word 81 shall be 0000h or FFFFh.

Table 12 defines the value that may optionally be reported in word 81 to indicate the revision of the standard that guided the implementation.

Table 12 – Minor version number

Value	Minor revision
0001h	ATA (ATA-1) X3T9.2 781D prior to revision 4
0002h	ATA-1 published, ANSI X3.221-1994
0003h	ATA (ATA-1) X3T10 781D revision 4
0004h	ATA-2 published, ANSI X3.279-1996
0005h	ATA-2 X3T10 948D prior to revision 2k
0006h	ATA-3 X3T10 2008D revision 1
0007h	ATA-2 X3T10 948D revision 2k
0008h	ATA-3 X3T10 2008D revision 0
0009h	ATA-2 X3T10 948D revision 3
000Ah	ATA-3 published, ANSI X3.298-199x
000Bh	ATA-3 X3T10 2008D revision 6
000Ch	ATA-3 X3T13 2008D revision 7 and 7a
000Dh	ATA/ATAPI-4 X3T13 1153D revision 6
000Eh	ATA/ATAPI-4 T13 1153D revision 13
000Fh	ATA/ATAPI-4 X3T13 1153D revision 7
0010h	Reserved
0011h	ATA/ATAPI-4 T13 1153D revision 15
0012h-0013h	Reserved
0014h	ATA/ATAPI-4 T13 1153D revision 14
0015h-0016h	Reserved
0017h	ATA/ATAPI-4 T13 1153D revision 17
0018h-FFFFh	Reserved

8.12.45 Words 82-84: Features/command sets supported

Words 82, 83, and 84 shall indicate features/command sets supported. The value 0000h or FFFFh was placed in each of these words by devices prior to ATA-3 and shall be interpreted by the host as meaning that features/command sets supported are not indicated. Bits 1 through 13 of word 83 and bits 0 through 13 of word 84 are reserved. Bit 14 of word 83 and word 84 shall be set to one and bit 15 of word 83 and word 84 shall be cleared to zero to provide indication that the features/command sets supported words are valid.

If bit 0 of word 82 is set to one, the SMART feature set is supported.

If bit 1 of word 82 is set to one, the Security Mode feature set is supported.

If bit 2 of word 82 is set to one, the Removable Media feature set is supported.

If bit 3 of word 82 is set to one, the Power Management feature set is supported.

If bit 4 of word 82 is set to one, the PACKET Command feature set is supported.

If bit 5 of word 82 is set to one, write cache is supported.

If bit 6 of word 82 is set to one, look-ahead is supported.

If bit 7 of word 82 is set to one, release interrupt is supported.

If bit 8 of word 82 is set to one, SERVICE interrupt is supported.

If bit 9 of word 82 is set to one, the DEVICE RESET command is supported.

If bit 10 of word 82 is set to one, the Host Protected Area feature set is supported.

Bit 11 of word 82 is obsolete.

If bit 12 of word 82 is set to one, the device supports the WRITE BUFFER command.

If bit 13 of word 82 is set to one, the device supports the READ BUFFER command.

If bit 14 of word 82 is set to one, the device supports the NOP command.

Bit 15 of word 82 is obsolete.

If bit 0 of word 83 is set to one, the device supports the DOWNLOAD MICROCODE command.

If bit 1 of word 83 is set to one, the device supports the READ DMA QUEUED and WRITE DMA QUEUED commands.

If bit 2 of word 83 is set to one, the device supports the CFA feature set.

If bit 3 of word 83 is set to one, the device supports the Advanced Power Management feature set.

If bit 4 of word 83 is set to one, the device supports the Removable Media Status feature set.

8.12.46 Words 85-87: Features/command sets enabled

Words 85, 86, and 87 shall indicate features/command sets enabled. The value 0000h or FFFFh was placed in each of these words by devices prior to ATA-4 and shall be interpreted by the host as meaning that features/command sets enabled are not indicated. Bits 1 through 15 of word 86 are reserved. Bits 0-13 of word 87 are reserved. Bit 14 of word 87 shall be set to one and bit 15 of word 87 shall be cleared to zero to provide indication that the features/command sets enabled words are valid.

If bit 0 of word 85 is set to one, the SMART feature set has been enabled via the SMART ENABLE OPERATIONS command.

If bit 1 of word 85 is set to one, the Security Mode feature set has been enabled via the SECURITY SET PASSWORD command.

If bit 2 of word 85 is set to one, the Removable Media feature set is supported.

If bit 3 of word 85 is set to one, the Power Management feature set is supported.

If bit 4 of word 85 is set to one, the PACKET Command feature set is supported.

If bit 5 of word 85 is set to one, write cache has been enabled via the SET FEATURES command (see 8.37.9).

If bit 6 of word 85 is set to one, look-ahead has been enabled via the SET FEATURES command (see 8.37.13).

If bit 7 of word 85 is set to one, release interrupt has been enabled via the SET FEATURES command (see 8.37.14).

If bit 8 of word 85 is set to one, SERVICE interrupt has been enabled via the SET FEATURES command (see 8.37.15).

If bit 9 of word 85 is set to one, the DEVICE RESET command is supported.

If bit 10 of word 85 is set to one, the Host Protected Area feature set is supported.

Bit 11 of word 85 is obsolete.

If bit 12 of word 85 is set to one, the device supports the WRITE BUFFER command.

If bit 13 of word 85 is set to one, the device supports the READ BUFFER command.

If bit 14 of word 85 is set to one, the device supports the NOP command.

Bit 15 of word 85 is obsolete.

If bit 0 of word 86 is set to one, the device supports the DOWNLOAD MICROCODE command.

If bit 1 of word 86 is set to one, the device supports the READ DMA QUEUED and WRITE DMA QUEUED commands.

If bit 2 of word 86 is set to one, the device supports the CFA feature set.

If bit 3 of word 86 is set to one, the Advanced Power Management feature set has been enabled via the SET FEATURES command.

If bit 4 of word 86 is set to one, the Removable Media Status feature set has been enabled via the SET FEATURES command.

8.12.47 Word 88: Ultra DMA modes

Only one Ultra DMA mode shall be selected at any time. If an Ultra DMA mode is enabled, no Multiword DMA mode shall be enabled. If a Multiword DMA mode is enabled, no Ultra DMA mode shall be enabled.

8.12.47.1 Reserved

Bits 15 though 11 of word 88 are reserved.

8.12.47.2 Ultra DMA mode 2 selected

If bit 10 of word 88 is set to one, then Ultra DMA mode 2 is selected. If this bit is cleared to zero, then Ultra DMA mode 2 is not selected. If bit 9 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

8.12.47.3 Ultra DMA mode 1 selected

If bit 9 of word 88 is set to one, then Ultra DMA mode 1 is selected. If this bit is cleared to zero then Ultra DMA mode 1 is not selected. If bit 10 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

8.12.47.4 Ultra DMA mode 0 selected

If bit 8 of word 88 is set to one, then Ultra DMA mode 0 is selected. If this bit is cleared to zero then Ultra DMA mode 0 is not selected. If bit 10 is set to one or if bit 9 is set to one, then this bit shall be cleared to zero.

8.12.47.5 Reserved

Bits 7 through 3 of word 88 are reserved.

8.12.47.6 Ultra DMA mode 2 supported

If bit 2 of word 88 is set to one, then Ultra DMA modes 2 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 2 is not supported. If Ultra DMA mode 2 is supported, then Ultra DMA modes 1 and 0 shall also be supported. If this bit is set to one, bits 1 and 0 shall be set to one.

8.12.47.7 Ultra DMA mode 1 supported

If bit 1 of word 88 is set to one, then Ultra DMA modes 1 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 1 is not supported. If Ultra DMA mode 1 is supported, then Ultra DMA mode 0 shall also be supported. If this bit is set to one, bit 0 shall be set to one.

8.12.47.8 Ultra DMA mode 0 supported

If bit 0 of word 88 is set to one, then Ultra DMA mode 0 is supported. If this bit is cleared to zero, then Ultra DMA is not supported.

8.12.48 Word 89: Time required for Security erase unit completion

Word 89 specifies the time required for the SECURITY ERASE UNIT command to complete.

Value	Time
0	Value not specified
1-254	(Value*2) minutes
255	>508 minutes

8.12.49 Word 90: Time required for Enhanced security erase unit completion

Word 90 specifies the time required for the ENHANCED SECURITY ERASE UNIT command to complete.

Value	Time
0	Value not specified
1-254	(Value*2) minutes
255	>508 minutes

8.12.50 Word 91: Advanced power management level value

Bits 7-0 of word 91 contain the current Advanced Power Management level setting.

8.12.51 Words 92-126: Reserved

8.12.52 Word 127: Removable Media Status Notification feature set support

If bit 0 of word 127 is set to one and bit 1 of word 127 is cleared to zero, the device supports the Removable Media Status Notification feature set. Bits 15 through 2 shall be cleared to zero.

8.12.53 Word 128: Security status

Bit 8 of word 128 indicates the security level. If security mode is enabled and the security level is high, bit 8 shall be cleared to zero. If security mode is enabled and the security level is maximum, bit 8 shall be set to one. When security mode is disabled, bit 8 shall be cleared to zero.

Bit 5 of word 128 indicates the Enhanced security erase unit feature is supported. If bit 5 is set to one, the Enhanced security erase unit feature set is supported.

Bit 4 of word 128 indicates that the security count has expired. If bit 4 is set to one, the security count is expired and SECURITY UNLOCK and SECURITY ERASE UNIT are command aborted until a power-on reset or hard reset.

Bit 3 of word 128 indicates security Frozen. If bit 3 is set to one, the security is Frozen.

Bit 2 of word 128 indicates security locked. If bit 2 is set to one, the security is locked.

Bit 1 of word 128 indicates security enabled. If bit 1 is set to one, the security is enabled.

Bit 0 of word 128 indicates the Security Mode feature set supported. If bit 0 is set to one, security is supported.

8.12.54 Words 129-159: Vendor specific.

8.12.55 Words 160-255: Reserved.

8.13 IDENTIFY PACKET DEVICE

8.13.1 Command code

A1h

8.13.2 Feature set

PACKET Command feature set

- Use prohibited for devices not implementing the PACKET Command feature set.
- Mandatory for devices implementing the PACKET Command feature set.

8.13.3 Protocol

PIO data in (see 9.7).

8.13.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	A1h							

Device/Head register -

DEV shall indicate the selected device.

8.13.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.13.6 Error outputs

The device shall return command aborted if the device does not implement this command, otherwise, the device shall not report an error.

8.13.7 Prerequisites

This command shall be accepted regardless of the state of DRDY.

8.13.8 Description

The IDENTIFY PACKET DEVICE command enables the host to receive parameter information from a device that implements the PACKET Command feature set.

Some devices may have to read the media in order to complete this command.

When the command is issued, the device sets the BSY bit to one, prepares to transfer the 256 words of device identification data to the host, sets the DRQ bit to one, clears the BSY bit to zero, and asserts INTRQ if nIEN is cleared to zero. The host may then transfer the data by reading the Data register. Table 13 defines the arrangement and meanings of the parameter words in the buffer. All reserved bits or words shall be zero.

Some parameters are defined as a group of bits. A word that is defined as a set of bits is transmitted with indicated bits on the respective data bus bit (e.g., bit 15 appears on DD15).

Some parameters are defined as a 16-bit value. A word that is defined as a 16-bit value places the most significant bit of the value on bit DD15 and the least significant bit on bit DD0.

Some parameters are defined as 32-bit values (e.g., words 57 and 58). Such fields are transferred using two word transfers. The device shall first transfer the least significant bits, bits 15 through 0 of the value, on bits DD (15:0) respectively. After the least significant bits have been transferred, the most significant bits, bits 31 through 16 of the value, shall be transferred on DD (15:0) respectively.

Some parameters are defined as a string of ASCII characters. For the string “Copyright”, the character “C” is the first byte, the character “o” is the 2nd byte, etc. When such fields are transferred, the order of transmission is:

the 1st character (“C”) is on bits DD (15:8) of the first word,
the 2nd character (“o”) is on bits DD (7:0) of the first word,
the 3rd character (“p”) is on bits DD (15:8) of the second word,
the 4th character (“y”) is on bits DD (7:0) of the second word,
etc.

Table 13 – **IDENTIFY PACKET DEVICE information** *(continued)*

Word	F/V		
0		General configuration bit-significant information:	
	F	15-14	10=ATAPI device 11=reserved
	R	13	reserved
	F	12-8	Field indicates command packet set used by device
	F	7	1=removable media device
	F	6-5	00=Device shall set DRQ to one within 3 ms of receiving PACKET command. 01=Device shall assert INTRQ when DRQ is set to one after receiving PACKET. 10=Device shall set DRQ to one within 50 µs of receiving PACKET command.
	R	4-2	reserved
	F	1-0	11=reserved 00=12 byte command packet 01=16 byte command packet 1x=reserved
1-9	R	Reserved	
10-19	F	Serial number (20 ASCII characters)	
20-22	R	Reserved	
23-26	F	Firmware revision (8 ASCII characters)	
27-46	F	Model number (40 ASCII characters)	
47-48	R	Reserved	
49		Capabilities	
	F	15	1=interleaved DMA supported
	F	14	1=command queuing supported
	F	13	1=overlap operation supported
	F	12	1=ATA software reset required (obsolete)
	F	11	1=IORDY supported
	F	10	1=IORDY may be disabled
	F	9	1=LBA supported
	F	8	1=DMA supported
	X	7-0	Vendor specific
50	R	Reserved	
51	F	15-8	PIO data transfer mode number
	X	7-0	Vendor specific
52	R	Reserved	
53	R	15-3	Reserved
	F	2	1=the fields reported in word 88 are valid 0=the fields reported in word 88 are not valid
	F	1	1=the fields reported in words 64-70 are valid 0=the fields reported in words 64-70 are not valid
	V	0	1=the fields reported in words 54-58 are valid 0=the fields reported in words 54-58 may be valid
54-62	R	Reserved	

(continued)

Table 13 – IDENTIFY PACKET DEVICE information *(continued)*

Word	F/V	
63	R	15-11 Reserved
	V	10 1= Multiword DMA mode 2 is selected
		0= Multiword DMA mode 2 is not selected
	V	9 1= Multiword DMA mode 1 is selected
		0= Multiword DMA mode 1 is not selected
	V	8 1= Multiword DMA mode 0 is selected
		0= Multiword DMA mode 0 is not selected
	R	7-3 Reserved
	F	2 1= Multiword DMA mode 2 and below are supported
	F	1 1= Multiword DMA mode 1 and below are supported
	F	0 1= Multiword DMA mode 0 is supported Multiword DMA mode selected
64	R	15-8 Reserved
	F	7-0 Advanced PIO transfer modes supported
65		Minimum Multiword DMA transfer cycle time per word
	F	15-0 Cycle time in nanoseconds
66		Manufacturer's recommended Multiword DMA transfer cycle time
	F	15-0 Cycle time in nanoseconds
67		Minimum PIO transfer cycle time without flow control
	F	15-0 Cycle time in nanoseconds
68		Minimum PIO transfer cycle time with IORDY flow control
	F	15-0 Cycle time in nanoseconds
69-70	R	Reserved (for future command overlap and queuing)
71	F	Typical time in ns from receipt of PACKET command to bus release.
72	F	Typical time in ns from receipt of SERVICE command to BSY cleared to zero
73-74	R	Reserved
75	F	Queue depth 15-5 Reserved 4-0 Maximum queue depth supported
76-79	R	Reserved
80	F	Major version number 0000h or FFFFh = device does not report version 15 Reserved 14 Reserved for ATA/ATAPI-14 13 Reserved for ATA/ATAPI-13 12 Reserved for ATA/ATAPI-12 11 Reserved for ATA/ATAPI-11 10 Reserved for ATA/ATAPI-10 9 Reserved for ATA/ATAPI-9 8 Reserved for ATA/ATAPI-8 7 Reserved for ATA/ATAPI-7 6 Reserved for ATA/ATAPI-6 5 Reserved for ATA/ATAPI-5 4 1=supports ATA/ATAPI-4 3 1=supports ATA-3 2 1=supports ATA-2 1 1=supports ATA-1 0 Reserved
81	F	Minor version number 0000h or FFFFh=device does not report version 0001h-FFFEh=see 8.12.44

(continued)

Table 13 – IDENTIFY PACKET DEVICE information *(continued)*

Word	F/V	
82	F	Command set supported. If words 82 and 83 =0000h or FFFFh command set notification not supported. 15 Obsolete 14 1=NOP command supported 13 1=READ BUFFER command supported 12 1=WRITE BUFFER command supported 11 Obsolete 10 1=Host Protected Area feature set supported 9 1=DEVICE RESET command supported 8 1=SERVICE interrupt supported 7 1=release interrupt supported 6 1=look-ahead supported 5 1=write cache supported 4 1=supports PACKET Command feature set 3 1=supports Power Management feature set 2 1=supports Removable Media feature set 1 1=supports Security Mode feature set 0 1=supports SMART feature set
83	F	Command sets supported. If words 82 and 83 =0000h or FFFFh command set notification not supported. 15 Shall be cleared to zero 14 Shall be set to one 13-5 Reserved 4 1=Removable Media Status Notification feature set supported 3-1 Reserved 0 1=DOWNLOAD MICROCODE command supported
84	F	Command set/feature supported extension. If words 82, 83, and 84 = 0000h or FFFFh command set notification extension is not supported. 15 Shall be cleared to zero 14 Shall be set to one 13-0 Reserved
85	V	Command set/feature enabled. If words 85, 86, and 87 = 0000h or FFFFh command set enabled notification is not supported. 15 Obsolete 14 1=NOP command supported 13 1=READ BUFFER command supported 12 1=WRITE BUFFER command supported 11 Obsolete 10 1=Host Protected Area feature set supported 9 1=DEVICE RESET command supported 8 1=SERVICE interrupt enabled 7 1=release interrupt enabled 6 1=look-ahead enabled 5 1=write cache enabled 4 1=supports PACKET Command feature set 3 1=supports Power Management feature set 2 1=supports Removable Media feature set 1 1= Security Mode feature set enabled 0 1= SMART feature set enabled

(continued)

Table 13 – IDENTIFY PACKET DEVICE information *(concluded)*

Word	F/V	
86	V	Command set/feature enabled. If words 85, 86, and 87 = 0000h or FFFFh command set enabled notification is not supported. 15-5 Reserved 4 1=Removable Media Status Notification feature set enabled via the SET FEATURES command. 3-1 Reserved 0 1=DOWNLOAD MICROCODE command supported
87	V	Command set/feature default. If words 85, 86, and 87 = 0000h or FFFFh command set default notification is not supported. 15 Shall be cleared to zero 14 Shall be set to one 13-0 Reserved
88	R V V V R F F F	15-11 Reserved 10 1=Ultra DMA mode 2 is selected 0=Ultra DMA mode 2 is not selected 9 1=Ultra DMA mode 1 is selected 0=Ultra DMA mode 1 is not selected 8 1=Ultra DMA mode 0 is selected 0=Ultra DMA mode 0 is not selected 7-3 Reserved 2 1=Ultra DMA mode 2 and below are supported 1 1=Ultra DMA mode 1 and below are supported 0 1=Ultra DMA mode 0 is supported
89-126	R	Reserved
127	F	Removable Media Status Notification feature set support 15-2 Reserved 1-0 00=Removable Media Status Notification feature set not supported 01=Removable Media Status Notification feature set supported 10=Reserved 11=Reserved
128	V	Security status 15-9 Reserved 8 Security level 0=High, 1=Maximum 7-6 Reserved 5 1=Enhanced security erase supported 4 1=Security count expired 3 1=Security frozen 2 1=Security locked 1 1=Security enabled 0 1=Security supported
129-159	X	Vendor specific
160-255	R	Reserved

Key:
F = the content of the word is fixed and does not change. For removable media devices, these values may change when media is removed or changed.
V = the contents of the word is variable and may change depending on the state of the device or the commands executed by the device.
X = the content of the word is vendor specific and may be fixed or variable.
R = the content of the word is reserved and shall be zero.

8.13.9 Word 0: General configuration

Bits 15 and 14 of word 0 indicate the type of device. If bit 15 is cleared to zero the device does not implement the PACKET Command feature set. If bit 15 is set to one and bit 14 is cleared to zero, the device implements the PACKET Command feature set. The value bit 15 and bit 14 both set to one is reserved.

Bits 12 through 8 of word 0 indicate the command packet set implemented by the device. This value follows the peripheral device type value as defined in X3T10/995D, SCSI-3 Primary Commands.

Value	Description
00h	Direct-access device
01h	Sequential-access device
02h	Printer device
03h	Processor device
04h	Write-once device
05h	CD-ROM device
06h	Scanner device
07h	Optical memory device
08h	Medium changer device
09h	Communications device
0A-0Bh	Reserved for ACS IT8
0Ch	Array controller device
0D-1Eh	Reserved
1Fh	Unknown or no device type

Bit 7 if set to one indicates that the device has removable media.

Bits 6 and 5 of word 0 indicates the DRQ response time when a PACKET command is received. A value of 00b indicates a maximum time of 3 ms from receipt of PACKET to the setting of DRQ to one. A value of 01b indicates that INTRQ shall be asserted when DRQ is set to one and that this action will occur within 10 ms of the receipt of PACKET. A value of 10b indicates a maximum time of 50 µs from the receipt of PACKET to the setting of DRQ to one. The value 11b is reserved.

Bits 1 and 0 of word 0 indicate the packet size the device supports. A value of 00b indicates that a 12 byte packet is supported; a value of 01b indicates a 16 byte packet. The values 10b and 11b are reserved.

8.13.10 Words 1-9: Reserved

8.13.11 Words 10-19: Serial number

The use of these words is optional. If not implemented, the content shall be zeros. If implemented, the content shall be as described in words 10-19 of the IDENTIFY DEVICE command (see 8.12.16).

8.13.12 Words 20-22: Reserved

8.13.13 Words 23-26: Firmware revision

Words 23 through 26 shall have the content described for words 23 through 26 of the IDENTIFY DEVICE command.

8.13.14 Words 27-46: Model number

Words 27 through 46 shall have the content described for words 27 through 46 of the IDENTIFY DEVICE command.

8.13.15 Words 47-48: Reserved

8.13.16 Word 49: Capabilities

Bit 15 of word 49 is used to indicated that the device supports interleaved DMA data transfer for overlapped DMA commands.

Bit 14 of word 49 is used to indicated that the device supports command queuing for overlapped commands. If bit 14 is set to one, bit 13 shall be set to one.

Bit 13 of word 49 is used to indicated that the device supports command overlap operation.

Bit 12 of word 49 indicates that the device requires a software reset to reset the device when BSY is set to one. Some devices produced before this standard are unable to process a DEVICE RESET when the BSY bit is set to one. The use of this bit is obsolete.

Bit 11 of word 49 is used to determine whether a device supports IORDY. If this bit is set to one, then the device supports IORDY operation. If this bit is zero, the device may support IORDY. This ensures backward compatibility. If a device supports PIO mode 3 or higher, then this bit shall be set to one.

Bit 10 of word 49 is used to indicate a device's ability to enable or disable the use of IORDY. If this bit is set to one, then the device supports the disabling of IORDY. Disabling and enabling of IORDY is accomplished using the SET FEATURES command.

Bit 9 of word 49 indicates that an LBA translation is supported

Bits 8 of word 49 indicates that DMA is supported.

8.13.17 Word 50: Reserved

8.13.18 Word 51: PIO data transfer mode number

Word 51 shall have the content described for word 51 of the IDENTIFY DEVICE command.

8.13.19 Word 52: Reserved

8.13.20 Word 53: Field validity

Word 53 shall have the content described for word 53 of the IDENTIFY DEVICE command.

8.13.21 Words 54-62: Reserved

8.13.22 Word 63: Multiword DMA transfer

Word 63 shall have the content described for word 63 of the IDENTIFY DEVICE command.

8.13.23 Word 64: PIO transfer mode supported

Word 64 shall have the content described for word 64 of the IDENTIFY DEVICE command.

8.13.24 Word 65: Minimum multiword DMA transfer cycle time per word

Word 65 shall have the content described for word 65 of the IDENTIFY DEVICE command.

8.13.25 Word 66: Device recommended multiword DMA cycle time

Word 66 shall have the content described for word 66 of the IDENTIFY DEVICE command.

8.13.26 Word 67: Minimum PIO transfer cycle time without flow control

Word 67 shall have the content described for word 67 of the IDENTIFY DEVICE command.

8.13.27 Word 68: Minimum PIO transfer cycle time with IORDY

Word 68 shall have the content described for word 68 of the IDENTIFY DEVICE command.

8.13.28 Word 69-70: Reserved

8.13.29 Word 71: PACKET to bus release time

Word 71 shall contain the typical time (99.7 % of the time) in microseconds from the receipt of a PACKET command until the device performs a bus release.

8.13.30 Word 72: SERVICE to bus release time

Word 72 shall contain the typical time (the mean plus three standard deviations) in microseconds from the receipt of a SERVICE command until the device performs a bus release.

8.13.31 Word 73-74: Reserved

8.13.32 Word 75: Queue depth

Bits 4 through 0 of word 75 shall have the content described for word 75 of the IDENTIFY DEVICE command.

8.13.33 Words 76-79: Reserved

8.13.34 Word 80: Major revision number

Word 80 shall have the content described for word 80 of the IDENTIFY DEVICE command.

8.13.35 Word 81: Minor revision number

Word 81 shall have the content described for word 81 of the IDENTIFY DEVICE command.

8.13.36 Words 82-84: Features/command sets supported

Words 82, 83, and 84 shall have the content described for words 82, 83, and 84 of the IDENTIFY DEVICE command.

8.13.37 Words 85-87: Features/command sets enabled

Words 85, 86, and 87 shall have the content described for words 85, 86, and 87 of the IDENTIFY DEVICE command.

8.13.38 Word 88:Ultra DMA modes

Word 88 shall have the content described for word 88 of the IDENTIFY DEVICE command.

8.13.39 Word 89: Time required for Security erase unit completion

Word 89 shall have the content described for word 89 of the IDENTIFY DEVICE command.

8.13.40 Word 90: Time required for Enhanced security erase unit completion

Word 90 shall have the content described for word 90 of the IDENTIFY DEVICE command.

8.13.41 Word 127: Removable Media Status Notification feature set support

Word 127 shall have the content described for word 127 of the IDENTIFY DEVICE command.

8.13.42 Word 128: Security status

Word 128 shall have the content described for word 128 of the IDENTIFY DEVICE command.

8.13.43 Words 129-255: Reserved

8.14 IDLE

8.14.1 Command code

E3h

8.14.2 Feature set

Power Management feature set.

- Power Management feature set is mandatory when power management is not implemented by a PACKET power management feature set.
- This command is mandatory when the Power Management feature set is implemented.

8.14.3 Protocol

Non-data command (see 9.9).

8.14.4 Inputs

Values other than zero in the Sector Count register when the IDLE command is issued shall determine the time period programmed into the Standby timer. Table 14 defines these values.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Timer period value							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E3h							

Device/Head register -

DEV shall indicate the selected device.

Table 14 – Automatic Standby timer periods

Sector Count register contents		Corresponding timeout period
0	(00h)	Timeout disabled
1-240	(01h-F0h)	(value * 5) s
241-251	(F1h-FBh)	((value - 240) * 30) min
252	(FCh)	21 min
253	(FDh)	Period between 8 and 12 hrs
254	(FEh)	Reserved
255	(FFh)	21 min 15 s
NOTE – Times are approximate.		

8.14.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.14.6 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if Power Management feature set is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.14.7 Prerequisites

DRDY set equal to one.

8.14.8 Description

The IDLE command allows the host to place the device in the Idle mode using the Standby timer. INTRQ may be asserted even though the device may not have fully transitioned to Idle mode.

If the Sector Count register is non-zero then the Standby timer shall be enabled. The value in the Sector Count register shall be used to determine the time programmed into the Standby timer (see 6.8). If the Sector Count register is zero then the Standby timer is disabled.

8.15 IDLE IMMEDIATE

8.15.1 Command code

E1h

8.15.2 Feature set

Power Management feature set.

- Power Management feature set is mandatory when power management is not implemented by a PACKET power management feature set.
- This command is mandatory when the Power Management feature set is implemented.

8.15.3 Protocol

Non-data command (see 9.9).

8.15.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E1h							

Device/Head register -

DEV shall indicate the selected device.

8.15.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.15.6 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if Power Management feature set is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.15.7 Prerequisites

DRDY set equal to one.

8.15.8 Description

The IDLE IMMEDIATE command allows the host to immediately place the device in the Idle mode. INTRQ may be asserted even though the device may not have fully transitioned to Idle mode (see 6.8).

8.16 INITIALIZE DEVICE PARAMETERS

8.16.1 Command code

91h

8.16.2 Feature set

General feature set

- Mandatory for devices not implementing the PACKET Command feature set if a CHS translation is supported.
- Not mandatory for devices not implementing the PACKET command feature set if the device capacity is greater then 8 Gbytes and only LBA translation is supported.
- Use prohibited for devices implementing the PACKET Command feature set.

8.16.3 Protocol

Non-data (see 9.9).

8.16.4 Inputs

The Sector Count register specifies the number of logical sectors per logical track, and the Device/Head register specifies the maximum head number.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Logical sectors per logical track							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	Max head			
Command	91h							

Device/Head register -

DEV shall indicate the selected device.

8.16.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	na	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.16.6 Error outputs

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	na	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if the device does not support the requested CHS translation. ABRT may be

set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.16.7 Prerequisites

This command shall be accepted regardless of the state of DRDY.

8.16.8 Description

This command enables the host to set the number of logical sectors per track and the number of logical heads minus 1, per logical cylinder for the current CHS translation mode.

If the capacity of the device is less than 16,514,064 sectors, a device shall support the CHS translation described in words 1, 3, and 6 of the IDENTIFY DEVICE information. Support of other CHS translations is optional.

If the host requests a CHS translation that is not supported by the device, the device shall return command aborted. The device shall also clear bit 0 of word 53 in the IDENTIFY DEVICE data to zero, and the content of words 54, 55, 56, and (58:57) may be zero until a supported translation is requested by the host.

If the requested CHS translation is not supported, the device shall fail all media access commands with an ID Not Found error until a valid CHS translation is established.

After a successful INITIALIZE DEVICE PARAMETERS command the content of all IDENTIFY DEVICE words shall comply with 6.2.1 in addition to the following:

1) The content of words 1, 3, 6, and (61:60) shall be unchanged.
2) The content of word 55 shall equal the (Max head value requested by the host + 1).
3) The content of word 56 shall equal the (Logical sectors per logical track value requested by the host).
4) If the content of word (61:60) is less than or equal to 16,514,064, then word 54 shall equal the whole number result of [[(the content of words (61:60)) ÷ [(the new content of word 55 as determined by the successful INITIALIZE DEVICE PARAMETERS command) * (the new content of word 56 as determined by the successful INITIALIZE DEVICE PARAMETERS command)]], or 65,535 whichever is less.
5) If the content of word (61:60) is greater than 16,514,064, then word 54 shall equal the whole number result of [[(16,514,064) ÷ [(the new content of word 55 as determined by the successful INITIALIZE DEVICE PARAMETERS command) * (the new content of word 56 as determined by the successful INITIALIZE DEVICE PARAMETERS command)]] or 65,535 whichever is less.

6) Words (58:57) shall equal [(the new content of word 54) * (the new content of word 55) * (the new content of word 56)].

8.17 MEDIA EJECT

8.17.1 Command code

EDh

8.17.2 Feature set

Removable Media Status Notification feature set

- Mandatory for devices not implementing the PACKET command feature set and implementing the Removable Media Status Notification feature set.
- Prohibited for devices implementing the PACKET command feature set.

Removable Media feature set

- Mandatory for devices not implementing the PACKET command feature set and implementing the Removable Media feature set.
- Prohibited for devices implementing the PACKET command feature set.

8.17.3 Protocol

Non-data command (see 9.9).

8.17.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	EDh							

Device/Head register -

DEV shall indicate the selected device.

8.17.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.17.6 Error outputs

If the device does not support this command, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	NM	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if device does not support this command. ABRT may be set to one if the device is not able to complete the action requested by the command.

NM (No Media) shall be set to one if no media is present in the device.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.17.7 Prerequisites

DRDY set equal to one.

8.17.8 Description

This command causes any pending operations to complete, spins down the device if needed, unlocks the media if locked, and ejects the media. The device keeps track of only one level of media lock.

8.18 MEDIA LOCK

8.18.1 Command code

DEh

8.18.2 Feature set

Removable Media Status Notification feature set

- Optional for devices not implementing the PACKET command feature set and implementing the Removable Media Status Notification feature set.
- Prohibited for device implementing the PACKET command feature set.

Removable Media feature set

- Mandatory for devices not implementing the PACKET command feature set and implementing the Removable Media feature set.
- Prohibited for devices implementing the PACKET command feature set.

8.18.3 Protocol

Non-data command (see 9.9).

8.18.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	DEh							

Device/Head register -

DEV shall indicate the selected device.

8.18.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.18.6 Error outputs

If the device does not support this command, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if device does not support this command. ABRT may be set to one if the device is not able to complete the action requested by the command.

NM (No Media) shall be set to one if no media is present in the device.

MCR (Media Change Request) shall be set to one if the device is locked and a media change request has been detected by the device.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.18.7 Prerequisites

DRDY set equal to one.

8.18.8 Description

This command can be used to lock the media, if Media Status Notification is disabled. If Media Status Notification is enabled, this command will return good status (no ERR bit in the Status register) and perform no action.

If the media is unlocked and media is present, the media shall be set to the LOCKED state and no Error register bit shall be set to one. The device keeps track of only one level of media lock. Subsequent MEDIA LOCK commands, while the media is in the LOCKED state, do not set additional levels of media locks.

If the media is locked, the status returned shall indicate whether a media change request has been detected by the device. If a media change request has been detected, the MCR bit in the Error register and the ERR bit in the Status register shall be set to one.

When media is in the LOCKED state, the device shall respond to the media change request button, by setting the MCR bit in the Error register and the ERR bit in the Status register to one, until the media LOCKED condition is cleared.

8.19 MEDIA UNLOCK

8.19.1 Command code

DFh

8.19.2 Feature set

Removable Media Status Notification feature set

- Optional for devices not implementing the PACKET command feature set and implementing the Removable Media Status Notification feature set.
- Prohibited for devices implementing the PACKET command feature set.

Removable Media feature set

- Mandatory for devices not implementing the PACKET command feature set and implementing the Removable Media feature set.
- Prohibited for devices implementing the PACKET command feature set.

8.19.3 Protocol

Non-data command (see 9.9).

8.19.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	DFh							

Device/Head register -

DEV shall indicate the selected device.

8.19.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.19.6 Error outputs

If the device does not support this command, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	NM	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if device does not support this command. ABRT may be set to one if the device is not able to complete the action requested by the command.

NM (No Media) shall be set to one if no media is present in the device.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.19.7 Prerequisites

DRDY set equal to one.

8.19.8 Description

This command can be used to unlock the device, if Media Status Notification is disabled. If Media Status Notification is enabled, this command will return good status (no ERR bit in the Status register) and perform no action.

If the media is present, the media shall be set to the UNLOCKED state and no Error register bit shall be set to one. The device keeps track of only one level of media lock. A single MEDIA UNLOCK command unlocks the media.

If a media change request has been detected by the device prior to the issuance of this command, the media shall be ejected at MEDIA UNLOCK command completion.

8.20 NOP

8.20.1 Command code

00h

8.20.2 Feature set

General feature set
- Optional for devices not implementing the PACKET Command feature set.
- Mandatory for devices implementing the PACKET Command feature set.
- Mandatory for devices implementing the Overlapped feature set.

8.20.3 Protocol

Non-data (see 9.9).

8.20.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	Subcommand code							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	00h							

Features register -

Subcommand code	Description	Action
00h	NOP	Return command aborted and abort any outstanding queue.
01h	NOP Auto Poll	Return command aborted and do not abort any outstanding queue.
02h-FFh	Reserved	Return command aborted and do not abort any outstanding queue.

Device/Head register -

DEV shall indicate the selected device.

8.20.5 Normal outputs

This command always fails with an error.

8.20.6 Error outputs

The Command Block registers, other than the Error and Status registers, are not changed by this command. This command always fails with the device returning command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	Initial value							
Sector Number	Initial value							
Cylinder Low	Initial value							
Cylinder High	Initial value							
Device/Head	Initial value							
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one.

Sector Count, Sector Number, Cylinder Low, Cylinder High, Device/Head -

value set by host is not changed.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one.

8.20.7 Prerequisites

DRDY set equal to one.

8.20.8 Description

The device shall respond with command aborted. For devices implementing the Overlapped feature set, subcommand code 00h in the Features register shall abort any outstanding queue. Subcommand codes 01h through FFh in the Features register shall not affect the status of any outstanding queue.

8.21 PACKET

8.21.1 Command code

A0h

8.21.2 Feature set

PACKET Command feature set

- Use prohibited for devices not implementing the PACKET Command feature set.
- Mandatory for devices implementing the PACKET Command feature set.

8.21.3 Protocol

Packet (see 9.11).

8.21.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na	na	na	na	na	na	OVL	DMA
Sector Count	Tag					na		
Sector Number	na							
Byte count low (Cylinder Low)	Byte count limit (7-0)							
Byte count high (Cylinder High)	Byte count limit (15-8)							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	A0h							

Features register -

OVL - This bit is set to one to inform the device that the PACKET command is to be overlapped.

DMA - This bit is set to one to inform the device that the data transfer (not the command packet transfer) associated with this command is via DMA or Ultra DMA mode.

Sector Count register -

Tag - If the device supports command queuing, this field contains the command Tag for the command being delivered. If queuing is not supported, this field is not applicable.

Byte count low and Byte count high registers -

These registers are written by the host with the maximum byte count that is to be transferred in any single DRQ assertion for PIO transfers. The byte count does not apply to the command PACKET transfer. If the PACKET command does not transfer data, the byte count is ignored.

If the PACKET command results in a data transfer:

1) the host shall not set the byte count limit to zero. If the host sets the byte count limit to zero the device shall return command aborted;
2) the value set into the byte count limit shall be even if the total requested data transfer length is greater than the byte count limit;
3) the value set into the byte count limit may be odd if the total requested data transfer length is equal to or less than the byte count limit;
4) the value FFFFh is interpreted by the device as though it were FFFEh.

Device/Head register -

DEV shall indicate the selected device.

8.21.5 Normal outputs

8.21.5.1 Awaiting command

When the device is ready to accept the command packet from the host the register content shall be as shown below.

Register	7	6	5	4	3	2	1	0
Error	na							
Interrupt reason (Sector Count)	Tag					REL	I/O	C/D
Sector Number	na							
Byte count low (Cylinder Low)	Byte count (7:0)							
Byte count high (Cylinder High)	Byte count (15:8)							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DMRD	SERV	DRQ	na	na	CHK

Byte count High/Low - shall reflect the value set by the host when the command was issued.
Interrupt reason register -

Tag - If the device supports command queuing and overlap is enabled, this field contains the command Tag for the command. If the device does not support command queuing or overlap is disabled, this field is not applicable.

REL - Shall be cleared to zero.

I/O - Shall be cleared to zero indicating transfer to the device.

C/D - Shall be set to one indicating the transfer of a command packet.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY - Shall be cleared to zero.

DRDY - na.

DMRD (DMA ready) - Shall be cleared to zero.

SERV (Service) - Shall be set to one if another command is ready to be serviced. If overlap is not supported, this bit is command specific.

DRQ - Shall be set to one.

CHK - Shall be cleared to zero.

8.21.5.2 Data transmission

When the device is ready to transfer data requested by a data transfer command, the device sets the following register content to initiate the data transfer.

Register	7	6	5	4	3	2	1	0
Error	na							
Interrupt reason (Sector Count)	Tag					REL	I/O	C/D
Sector Number	na							
Byte count low (Cylinder Low)	Byte count (7:0)							
Byte count high (Cylinder High)	Byte count (15:8)							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DMRD	SERV	DRQ	na	na	CHK

Byte count High/Low - If the transfer is to be in PIO mode, the byte count of the data to be transferred for this DRQ assertion shall be presented.

Valid byte count values are as follows:

1) the byte count shall be less than or equal to the byte count limit value from the host;
2) the byte count shall not be zero;
3) the byte count shall be less than or equal to FFFEh;
4) the byte count shall be even except for the last transfer of a command;
5) if the byte count is odd, the last valid byte transferred is on DD[7:0] and the data on DD[15:8] is a pad byte of undefined value;
6) if the last transfer of a command has a pad byte, the byte count shall be odd.

Interrupt reason register -

Tag - If the device supports command queuing and overlap is enabled, this field contains the command Tag for the command. If the device does not support command queuing or overlap is disabled, this field is not applicable.

REL - Shall be cleared to zero.

I/O - Shall be cleared to zero if the transfer is to the device. Shall be set to one if the transfer is to the host.

C/D - Shall be cleared to zero indicating the transfer of data.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY - Shall be cleared to zero.

DRDY - na.

DMRD (DMA ready) - Shall be set to one if the transfer is to be a DMA or Ultra DMA transfer and the device supports overlap DMA.

SERV (Service) - Shall be set to one if another command is ready to be serviced. If overlap is not supported, this bit is command specific.

DRQ - Shall be set to one.

CHK - Shall be cleared to zero.

8.21.5.3 Bus release (overlap feature set only)

After receiving the command packet, the device sets BSY to one and clears DRQ to zero. If the command packet requires a data transfer, the OVL bit is set to one, and the device is not prepared to immediately transfer data, the device may perform a bus release by placing the following register content. If the command packet requires a data transfer, the OVL bit is set to one, and the Release interrupt is enabled, the device shall perform a bus release by setting the register content as follows.

Register	7	6	5	4	3	2	1	0
Error	na							
Interrupt reason (Sector Count)	Tag					REL	I/O	C/D
Sector Number	na							
Byte count low (Cylinder Low)	na							
Byte count high (Cylinder High)	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DMRD	SERV	DRQ	na	na	CHK

Byte count High/Low - na.

Interrupt reason register -

Tag - If the device supports command queuing and overlap is enabled, this field contains the command Tag for the command. If the device does not support command queuing or overlap is disabled, this field is not applicable.

REL - Shall be set to one.

I/O - Shall be cleared to zero.

C/D - Shall be cleared to zero.

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY - Shall be cleared to zero indicating bus release.
DRDY - na.
DMRD (DMA ready) - Shall be cleared to zero.
SERV (Service) - Shall be set to one if another command is ready to be serviced. If overlap is not supported, this bit is command specific.
DRQ - Shall cleared to zero.
CHK - Shall be cleared to zero.

8.21.5.4 Service request (overlap feature set only)

When the device is ready to transfer data or complete a command after the command has performed a bus release, the device shall set the SERV bit and not change the state of any other register bit (see 6.6).

8.21.5.5 Successful command completion

When the device has command completion without error, the device sets the following register content.

Register	7	6	5	4	3	2	1	0
Error	na							
Interrupt reason (Sector Count)	Tag					REL	I/O	C/D
Sector Number	na							
Byte count low (Cylinder Low)	na							
Byte count high (Cylinder High)	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DMRD	SERV	DRQ	na	na	CHK

Byte count High/Low -na.
Interrupt reason register -
Tag - If the device supports command queuing and overlap is enabled, this field contains the command Tag for the command. If the device does not support command queuing or overlap is disabled, this field is not applicable.
REL - Shall be cleared to zero.
I/O - Shall be set to one.
C/D - Shall be set to one.
Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY - Shall be cleared to zero indicating command completion.
DRDY - Shall be set to one.
DMRD (DMA ready) - na.
SERV (Service) - Shall be set to one if another command is ready to be serviced. If overlap is not supported, this bit is command specific.
DRQ - Shall be cleared to zero.
CHK - Shall be cleared to zero.

8.21.6 Error outputs

The device shall not terminate the PACKET command with an error before the last byte of the command packet has been written (see 9.11).

Register	7	6	5	4	3	2	1	0
Error	Sense key				na	ABRT	EOM	ILI
Interrupt reason (Sector Count)	Tag					REL	I/O	C/D
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	SERV	DRQ	na	na	CHK

Error register -

Sense Key is a command packet set specific error indication.

ABRT shall be set to one if the requested command has been command aborted because the command code or a command parameter is invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

EOM - the meaning of this bit is command set specific. See the appropriate command set standard for its definition.

ILI - the meaning of this bit is command set specific. See the appropriate command set standard for its definition.

Interrupt reason register -

Tag - If the device supports command queuing and overlap is enabled, this field contains the command Tag for the command. If the device does not support command queuing or overlap is disabled, this field is not applicable.

REL - Shall be cleared to zero.

I/O - Shall be set to one.

C/D - Shall be set to one.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

SERV (Service) - Shall be set to one if another command is ready to be serviced. If overlap is not supported, this bit is command specific.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

CHK shall be set to one if an Error register sense key or code bit is set.

8.21.7 Prerequisites

This command shall be accepted regardless of the state of DRDY.

8.21.8 Description

The PACKET command is used to transfer a device command via a command packet. If the native form of the encapsulated command is shorter than the packet size reported in bits 1 and 0 of word 0 of the IDENTIFY PACKET DEVICE response, the encapsulated command shall begin at byte 0 of the packet. Packet bytes beyond the end of the encapsulated command are reserved.

If the device supports overlap, the OVL bit is set to one in the Features register and the Release interrupt has been disabled via the SET FEATURES command, the device may or may not perform a bus release. If the device is ready for the data transfer, it may begin the transfer immediately as described in the non-overlapped protocol (see 9.11). If the data is not ready, the device may perform a bus release and complete the transfer after the execution of a SERVICE command.

8.22 READ BUFFER

8.22.1 Command code

E4h

8.22.2 Feature set

General feature set
- Optional for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.22.3 Protocol

PIO data in (see 9.7).

8.22.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E4h							

Device/Head register -
DEV shall indicate the selected device.

8.22.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.22.6 Error outputs

The device shall return command aborted if the command is not supported.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.22.7 Prerequisites

DRDY set equal to one. A WRITE BUFFER command shall immediately proceed a READ BUFFER command.

8.22.8 Description

The READ BUFFER command enables the host to read the current contents of the device’s sector buffer.

The READ BUFFER and WRITE BUFFER commands shall be synchronized such that sequential WRITE BUFFER and READ BUFFER commands access the same 512 bytes within the buffer.

8.23 READ DMA

8.23.1 Command code

C8h or C9h

NOTE – The host should not use the C9h value.

8.23.2 Feature set

General feature set
- Mandatory for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.23.3 Protocol

DMA (see 9.10).

8.23.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	C8h or C9h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.23.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.23.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	ICRC	UNC	MC	IDNF	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -
ICRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit is not applicable for Multiword DMA transfers.
UNC shall be set to one if data is uncorrectable
MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.
IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.
MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.
ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.
NM shall be set to one if no media is present in a removable media device.
Sector Number, Cylinder Low, Cylinder High, Device/Head -
shall be written with the address of first unrecoverable error.
Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.23.7 Prerequisites

DRDY set equal to one. The host shall initialize the DMA channel.

8.23.8 Description

The READ DMA command allows the host to read data using the DMA data transfer protocol.

8.24 READ DMA QUEUED

8.24.1 Command code

C7h

8.24.2 Feature set

Overlapped feature set

- Mandatory for devices implementing the Overlapped feature set but not implementing the PACKET command feature set.
- Use prohibited for devices implementing the PACKET command feature set.

8.24.3 Protocol

DMA QUEUED (see 9.12).

8.24.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	Sector Count							
Sector Count	Tag					na	na	na
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	C7h							

Features -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector count -
if the device supports command queuing, bits (7:3) contain the Tag for the command being delivered. If queuing is not supported, this field is not applicable.
Sector number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.24.5 Normal outputs

8.24.5.1 Release

If the device performs a bus release before transferring data for this command, the register content upon performing a bus release shall be as shown below.

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	Tag					REL	I/O	C/D
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	SERV	DRQ	na	na	ERR

Sector Count register -

Tag - If the device supports command queuing, this field shall contain the Tag of the command being bus released. If the device does not support command queuing, this field shall be zeros.

REL bit shall be set to one indicating that the device has bus released an overlap command.

I/O shall be zero.

C/D shall be zero.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating bus release.

DRDY shall be set to one.

SERV (Service) shall be cleared to zero when no other queued command is ready for service. It shall be set to one when another queued command is ready for service. It shall be set to one when the device has prepared this command for service.

DF (Device Fault) shall be cleared to zero

DRQ bit shall be cleared to zero.

ERR bit shall be cleared to zero.

8.24.5.2 Command completion

When the transfer of all requested data has occurred without error, the register content shall be as shown below.

Register	7	6	5	4	3	2	1	0
Error	00h							
Sector Count	Tag					REL	I/O	C/D
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	SERV	DRQ	na	na	ERR

Sector Count register -

Tag - If the device supports command queuing, this field shall contain the Tag of the completed command. If the device does not support command queuing, this field shall be zeros.

REL shall be cleared to zero.

I/O shall be set to one.

C/D shall be set to one.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

SERV (Service) shall be cleared to zero when no other queued command is ready for service. It shall be set to one when another queued command is ready for service.

DF (Device Fault) shall be cleared to zero.

DRQ bit shall be cleared to zero.
ERR bit shall be cleared to zero.

8.24.6 Error outputs

The Sector Count register contains the Tag for this command if the device supports command queuing. The device shall return command aborted if the command is not supported or if the device has not had overlapped interrupt enabled. The device shall return command aborted if the device supports command queuing and the Tag is invalid. An unrecoverable error encountered during the execution of this command results in the termination of the command and the Command Block registers contain the sector where the first unrecoverable error occurred. If a queue existed, the unrecoverable error shall cause the queue to abort.

Register	7	6	5	4	3	2	1	0
Error	ICRC	UNC	MC	IDNF	MCR	ABRT	NM	obs
Sector Count	Tag					REL	I/O	C/D
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	D	Head number or LBA			
Status	BSY	DRDY	DF	SERV	DRQ	na	na	ERR

Error register -

ICRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit is not applicable for Multiword DMA transfers.

UNC shall be set to one if data is uncorrectable.

MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if ABRT is not set to one.

MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.

ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

NM shall be set to one if no media is present in a removable media device.

Sector Count register -

Tag - If the device supports command queuing, this field shall contain the Tag of the completed command. If the device does not support command queuing, this field shall be zeros.

REL shall be cleared to zero.

I/O shall be set to one.

Bit 0 - C/D shall be set to one.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

SERV (Service) shall be cleared to zero when no other queued command is ready for service. It shall be set to one when another queued command is ready for service.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.24.7 Prerequisites

DRDY set to one. The host shall initialize the DMA channel.

8.24.8 Description

This command executes in a similar manner to a READ DMA command. The device may perform a bus release or it may execute the data transfer without performing a bus release if the data is ready to transfer.

8.25 READ MULTIPLE

8.25.1 Command code

C4h

8.25.2 Feature set

General feature set
- Mandatory for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.25.3 Protocol

PIO data in (see 9.7).

8.25.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	C4h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.25.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.25.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	MC	IDNF	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -
UNC shall be set to one if data is uncorrectable.
MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.
IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.
MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.
ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.
NM shall be set to one if no media is present in a removable media device.
Sector Number, Cylinder Low, Cylinder High, Device/Head -
shall be written with the address of first unrecoverable error.
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.25.7 Prerequisites

DRDY set equal to one. If bit 8 of IDENTIFY DEVICE word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall precede a READ MULTIPLE command.

8.25.8 Description

The READ MULTIPLE command performs similarly to the READ SECTOR(S) command. Interrupts are not generated on every sector, but on the transfer of a block that contains the number of sectors defined by a SET MULTIPLE MODE command or the default if no intervening SET MULTIPLE command has been issued. Command execution is identical to the READ SECTOR(S) operation except that the number of

sectors defined by a SET MULTIPLE MODE command are transferred without intervening interrupts. The DRQ bit qualification of the transfer is required only at the start of the data block, not on each sector.

The block count of sectors to be transferred without intervening interrupts is programmed by the SET MULTIPLE MODE command, that shall be executed prior to the READ MULTIPLE command. When the READ MULTIPLE command is issued, the Sector Count register contains the number of sectors (not the number of blocks or the block count) requested.

If the number of requested sectors is not evenly divisible by the block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. The partial block transfer shall be for n sectors, where n = remainder (sector count/ block count).

If the READ MULTIPLE command is received when READ MULTIPLE commands are disabled, the READ MULTIPLE operation shall be rejected with command aborted.

Device errors encountered during READ MULTIPLE commands are posted at the beginning of the block or partial block transfer, but the DRQ bit is still set to one and the data transfer shall take place, including transfer of corrupted data, if any. The contents of the Command Block Registers following the transfer of a data block that had a sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

Subsequent blocks or partial blocks are transferred only if the error was a correctable data error. All other errors cause the command to stop after transfer of the block that contained the error.

8.26 READ NATIVE MAX ADDRESS

8.26.1 Command code

F8h

8.26.2 Feature set

Host Protected Area feature set.

- Mandatory when the Host Protected Area feature set is implemented.
- Use prohibited when Removable feature set is implemented.

8.26.3 Protocol

Non-data command (see 9.9).

8.26.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	LBA	obs	DEV	na			
Command	F8h							

Device/Head -

If LBA is set to one, the maximum address shall be reported as an LBA value.
If LBA is cleared to zero, the maximum address shall be reported as a CHS value.
DEV shall indicate the selected device.

8.26.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	Native max address sector number or LBA							
Cylinder Low	Native max address cylinder low or LBA							
Cylinder High	Native max address cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Native max address head or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Sector Number -

maximum native sector number (IDENTIFY DEVICE word 6) or LBA bits (7:0) for native max address on the device.

Cylinder Low -

maximum native cylinder number low or LBA bits (15:8) for native max address on the device.

Cylinder High -

maximum native cylinder number high or LBA bits (23:16) for native max address on device.

Device/Head -

maximum native head number (IDENTIFY DEVICE word 3 minus one) or LBA bits (27:24) for native max address on the device.

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.26.6 Error outputs

If this command is not supported the device shall return command aborted. The device shall return command aborted if a CHS address is requested and the device does not support a CHS translation.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	na	na	na	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
ERR shall be set to one if an Error register bit is set to one.

8.26.7 Prerequisites

DRDY set equal to one.

8.26.8 Description

This command returns the native maximum address. The native maximum address is the highest address accepted by the device in the factory default condition. The native maximum address is the maximum address that is valid when using the SET MAX ADDRESS command.

8.27 READ SECTOR(S)

8.27.1 Command code

20h or 21h

NOTE – The host should not use the 21h value.

8.27.2 Feature set

General feature set
- Mandatory for all devices.
- PACKET Command feature set devices (see 8.27.5.2).

8.27.3 Protocol

PIO data in (see 9.7).

8.27.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	20h or 21h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.27.5 Outputs

8.27.5.1 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.27.5.2 Outputs for PACKET Command feature set devices

In response to this command, devices that implement the PACKET Command feature set shall post command aborted and place the PACKET Command feature set signature in the Cylinder High and the Cylinder Low register (see 9.1).

8.27.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	MC	IDNF	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

UNC shall be set to one if data is uncorrectable.

MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.

ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an

address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

NM shall be set to one if no media is present in a removable media device.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.27.7 Prerequisites

DRDY set equal to one.

8.27.8 Description

This command reads from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors. The transfer shall begin at the sector specified in the Sector Number register.

The DRQ bit is always set to one prior to data transfer regardless of the presence or absence of an error condition.

8.28 READ VERIFY SECTOR(S)

8.28.1 Command code

40h or 41h

NOTE – The host should not use the 41h value.

8.28.2 Feature set

General feature set
- Mandatory for all devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.28.3 Protocol

Non-data (see 9.9).

8.28.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	40h or 41h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.28.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.28.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	MC	IDNF	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -
UNC shall be set to one if data is uncorrectable.
MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.
IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.
MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.
ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.
NM shall be set to one if no media is present in a removable media device.
Sector Number, Cylinder Low, Cylinder High, Device/Head -
shall be written with the address of first unrecoverable error.
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.28.7 Prerequisites

DRDY set equal to one.

8.28.8 Description

This command is identical to the READ SECTOR(S) command, except that the DRQ bit is never set to one, and no data is transferred to the host.

8.29 SECURITY DISABLE PASSWORD

8.29.1 Command code

F6h

8.29.2 Feature set

Security Mode feature set.

- Mandatory when the Security Mode feature set is implemented.

8.29.3 Protocol

PIO data out (see 9.8).

8.29.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	F6h							

Device/Head register -

DEV shall indicate the selected device.

8.29.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.29.6 Error outputs

The device shall return command aborted if the command is not supported, the device is in Locked mode, or the device is in Frozen mode.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.29.7 Prerequisites

DRDY set equal to one. Device shall be in Unlocked mode.

8.29.8 Description

The SECURITY DISABLE PASSWORD command requests a transfer of a single sector of data from the host. Table 15 defines the content of this sector of information. If the password selected by word 0 matches the password previously saved by the device, the device disables the Lock mode. This command does not change the Master password that may be reactivated later by setting a User password (see 6.10).

Table 15 – Security password content

Word	Content
0	Control word Bit 0 Identifier 0=compare User password 1=compare Master password Bit 1-15 Reserved
1-16	Password (32 bytes)
17-255	Reserved

8.30 SECURITY ERASE PREPARE

8.30.1 Command code

F3h

8.30.2 Feature set

Security Mode feature set.

- Mandatory when the Security Mode feature set is implemented.

8.30.3 Protocol

Non-data (see 9.9).

8.30.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	F3h							

Device/Head register -

DEV shall indicate the selected device.

8.30.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.30.6 Error outputs

The device shall return command aborted if the command is not supported or the device is in Frozen mode.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported or device is in Frozen mode. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.30.7 Prerequisites

DRDY set equal to one.

8.30.8 Description

The SECURITY ERASE PREPARE command shall be issued immediately before the SECURITY ERASE UNIT command to enable device erasing and unlocking. This command prevents accidental erase of the device.

8.31 SECURITY ERASE UNIT

8.31.1 Command code

F4h

8.31.2 Feature set

Security Mode feature set.

- Mandatory when the Security Mode feature set is implemented.

8.31.3 Protocol

PIO data out (see 9.8).

8.31.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	F4h							

Device/Head register -

DEV shall indicate the selected device.

8.31.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.31.6 Error outputs

The device shall return command aborted if the command is not supported, the device is in Frozen mode, not preceded by a SECURITY ERASE PREPARE command, or if the data area is not successfully overwritten.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported, device is in Frozen mode, not preceded by a SECURITY ERASE PREPARE command, or if the data area is not successfully overwritten. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.31.7 Prerequisites

DRDY set equal to one. This command shall be immediately preceded by a SECURITY ERASE PREPARE command.

8.31.8 Description

This command requests transfer of a single sector of data from the host. Table 16 defines the content of this sector of information. If the password does not match the password previously saved by the device, the device rejects the command with command aborted.

The SECURITY ERASE PREPARE command shall be completed immediately prior to the SECURITY ERASE UNIT command. If the device receives a SECURITY ERASE UNIT command without an immediately prior SECURITY ERASE PREPARE command, the device command aborts the SECURITY ERASE UNIT command.

When normal erase mode is selected, the SECURITY ERASE UNIT command writes binary zeroes to all user data areas. The enhanced erase mode is optional. When enhanced erase mode is selected, the device writes predetermined data patterns to all user data areas. In enhanced mode, all previously written user data is overwritten, including sectors that are no longer in use due to reallocation.

This command disables the device Lock mode, however, the Master password is still stored internally within the device and may be reactivated later when a new User password is set.

Table 16 – SECURITY ERASE UNIT password

Word	Content
0	Control word Bit 0 Identifier 0=compare User password 1=compare Master password Bit 1 Erase mode 0=Normal erase 1=Enhanced erase Bit 2-15 Reserved
1-16	Password (32 bytes)
17-255	Reserved

8.32 SECURITY FREEZE LOCK

8.32.1 Command code

F5h

8.32.2 Feature set

Security Mode feature set.

- Mandatory when the Security Mode feature set is implemented.

8.32.3 Protocol

Non-data (see 9.9).

8.32.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	F5h							

Device/Head register -

DEV shall indicate the selected device.

8.32.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.32.6 Error outputs

The device shall return command aborted if the command is not supported, or the device is in Locked mode.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported or device is in locked mode. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.32.7 Prerequisites

DRDY set equal to one.

8.32.8 Description

The SECURITY FREEZE LOCK command sets the device to Frozen mode. After command completion any other commands that update the device Lock mode are rejected. Frozen mode is disabled by power off or hardware reset. If SECURITY FREEZE LOCK is issued when the device is in Frozen mode, the command executes and the device remains in Frozen mode.

Commands disabled by SECURITY FREEZE LOCK are:

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY DISABLE PASSWORD
- SECURITY ERASE UNIT

8.33 SECURITY SET PASSWORD

8.33.1 Command code

F1h

8.33.2 Feature set

Security Mode feature set.

- Mandatory when the Security Mode feature set is implemented.

8.33.3 Protocol

PIO data out (see 9.8).

8.33.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	F1h							

Device/Head register -

DEV shall indicate the selected device.

8.33.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.33.6 Error outputs

The device shall return command aborted if the command is not supported, the device is in Locked mode, or the device is in Frozen mode.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported, if device is in Frozen mode, or if device is in locked mode. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.33.7 Prerequisites

DRDY set equal to one.

8.33.8 Description

This command requests a transfer of a single sector of data from the host. Table 17 defines the content of this sector of information. The data transferred controls the function of this command. Table 18 defines the interaction of the identifier and security level bits.

Table 17 – SECURITY SET PASSWORD data content

Word	Content		
0	Control word		
	Bit 0	Identifier	0=set User password 1=set Master password
	Bits 1-7	Reserved	
	Bit 8	Security level	0=High 1=Maximum
	Bits 9-15	Reserved	
1-16	Password (32 bytes)		
17-255	Reserved		

Table 18 – Identifier and security level bit interaction

Identifier	Level	Command result
User	High	The password supplied with the command shall be saved as the new User password. The Lock mode shall be enabled from the next power-on or hardware reset. The device shall then be unlocked by either the User password or the previously set Master password.
User	Maximum	The password supplied with the command shall be saved as the new User password. The Lock mode shall be enabled from the next power-on or hardware reset. The device shall then be unlocked by only the User password. The Master password previously set is still stored in the device but shall not be used to unlock the device.
Master	High or Maximum	This combination shall set a Master password but shall not enable or disable the Lock mode. The security level is not changed.

8.34 SECURITY UNLOCK

8.34.1 Command code

F2h

8.34.2 Feature set

Security Mode feature set.

- Mandatory when the Security Mode feature set is implemented.

8.34.3 Protocol

PIO data out (see 9.8).

8.34.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	F2h							

Device/Head register -

DEV shall indicate the selected device.

8.34.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.34.6 Error outputs

The device shall return command aborted if the command is not supported, or the device is in Frozen mode.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported or if device is in Frozen mode. ABRT may

be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.34.7 Prerequisites

DRDY set equal to one.

8.34.8 Description

This command requests transfer of a single sector of data from the host. Table 15 defines the content of this sector of information.

If the Identifier bit is set to Master and the device is in high security level, then the password supplied shall be compared with the stored Master password. If the device is in maximum security level then the unlock shall be rejected.

If the Identifier bit is set to user then the device compares the supplied password with the stored User password.

If the password compare fails then the device returns command aborted to the host and decrements the unlock counter. This counter is initially set to five and is decremented for each password mismatch when SECURITY UNLOCK is issued and the device is locked. When this counter reaches zero then SECURITY UNLOCK and SECURITY ERASE UNIT commands are command aborted until a power-on reset or a hardware reset. SECURITY UNLOCK commands issued when the device is unlocked have no effect on the unlock counter.

8.35 SEEK

8.35.1 Command code

70h

8.35.2 Feature set

General feature set
- Mandatory for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.35.3 Protocol

Non-data (see 9.9).

8.35.4 Inputs

The Cylinder High register, the Cylinder Low register, the head portion of Device/Head register, and the Sector Number register contain the address of a sector that the host may request in a subsequent command.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	70h							

Sector Number -
sector number or LBA address bits (7:0).
Cylinder Low -
cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) head number or LBA address bits (27:24).

8.35.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	DSC	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DSC (Device Seek Complete) shall be set to one concurrent with or after the setting of DRDY to one.

DF (Device Fault) shall be cleared to zero.

DRQ shall be cleared to zero.

ERR shall be cleared to zero.

8.35.6 Error outputs

Some devices may not report IDNF because they do not range check the address values requested by the host.

Register	7	6	5	4	3	2	1	0
Error	na	na	MC	IDNF	MCR	ABRT	NM	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.

ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

NM shall be set to one if no media is present in a removable media device.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.

DRQ shall be cleared to zero.

ERR shall be set to one if an Error register bit is set to one.

8.35.7 Prerequisites

DRDY set equal to one.

8.35.8 Description

This command allows the host to provide advanced notification that particular data may be requested by the host in a subsequent command. DSC shall be set to one concurrent with or after the setting of DRDY to one when updating the Status register for this command.

8.36 SERVICE

8.36.1 Command code

A2h

8.36.2 Feature set

Overlap and Queued feature sets

- Mandatory when the PACKET, Overlapped feature set is implemented.

8.36.3 Protocol

PACKET or READ/WRITE DMA QUEUED (see 9.11 and 9.12).

8.36.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	A2h							

Device/Head register -

DEV shall indicate the selected device.

8.36.5 Outputs

Outputs as a result of a SERVICE command are described in the command description for the command for which SERVICE is being requested.

8.36.6 Prerequisites

The device shall have performed a bus release for a previous overlap PACKET, READ DMA QUEUED, or WRITE DMA QUEUED command and shall have set the SERV bit to one to request the SERVICE command be issued to continue data transfer and/or provide command status (see 8.37.15).

8.36.7 Description

The SERVICE command is used to provide data transfer and/or status of a command that was previously bus released.

8.37 SET FEATURES

8.37.1 Command code

EFh

8.37.2 Feature set

General feature set

- Mandatory for all devices.
- Set transfer mode subcommand is mandatory.
- Enable/disable write cache subcommands are mandatory when a write cache is implemented.
- Enable/Disable Media Status Notification sub commands are mandatory if the Removable Media feature set is implemented.
- All other subcommands are optional.

8.37.3 Protocol

Non-data (see 9.9).

8.37.4 Inputs

Table 19 defines the value of the subcommand in the Feature register. Some subcommands use other registers, such as the Sector Count register to pass additional information to the device.

Register	7	6	5	4	3	2	1	0
Features	Subcommand code							
Sector Count	Subcommand specific							
Sector Number	Subcommand specific							
Cylinder Low	Subcommand specific							
Cylinder High	Subcommand specific							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	EFh							

Device/Head register -

DEV shall indicate the selected device.

8.37.5 Normal outputs

See the subcommand descriptions.

8.37.6 Error outputs

If any subcommand input value is not supported or is invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this subcommand is not supported or if value is invalid. ABRT may be set

to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.37.7 Prerequisites

DRDY shall be set to one.

8.37.8 Description

This command is used by the host to establish parameters that affect the execution of certain device features. Table 19 defines these features.

At power on, or after a hardware reset, the default setting of the functions specified by the subcommands are vendor specific.

Table 19 – SET FEATURES register definitions

Value (see note)	
01h	Retired
02h	Enable write cache
03h	Set transfer mode based on value in Sector Count register. Table 20 defines values.
04h	Obsolete
05h	Enable advanced power management
31h	Disable Media Status Notification
33h	Obsolete
44h	Obsolete
54h	Obsolete
55h	Disable read look-ahead feature
5Dh	Enable release interrupt
5Eh	Enable SERVICE interrupt
66h	Disable reverting to power on defaults
77h	Obsolete
81h	Retired
82h	Disable write cache
84h	Obsolete
85h	Disable advanced power management
88h	Obsolete
95h	Enable Media Status Notification
99h	Obsolete
9Ah	Obsolete
AAh	Enable read look-ahead feature
ABh	Obsolete
BBh	Obsolete
CCh	Enable reverting to power on defaults
DDh	Disable release interrupt
DEh	Disable SERVICE interrupt
NOTE – All values not shown are reserved for future definition.	

8.37.9 Enable/disable write cache

Subcommand codes 02h and 82h allow the host to enable or disable write cache in devices that implement write cache. When the subcommand disable write cache is issued, the device shall initiate the sequence to flush cache to non-volatile memory before command completion (see 8.10).

8.37.10 Set transfer mode

A host selects the transfer mechanism by Set Transfer Mode, subcommand code 03h, and specifying a value in the Sector Count register. The upper 5 bits define the type of transfer and the low order 3 bits encode the mode value. One PIO mode and one DMA mode shall be selected at all times. The host may change the selected modes by the SET FEATURES command.

Table 20 – Transfer mode values

Mode	Bits (7:3)	Bits (2:0)
PIO default mode	00000b	000b
PIO default mode, disable IORDY	00000b	001b
PIO flow control transfer mode	00001b	mode
Retired	00010b	na
Multiword DMA mode	00100b	mode
Ultra DMA mode	01000b	mode
Reserved	10000b	na
mode = transfer mode number		

If a device supports this standard, and receives a SET FEATURES command with a Set Transfer Mode parameter and a Sector Count register value of “00000000b”, it shall set its default PIO mode. If the value is “00000001b” and the device supports disabling of IORDY, then the device shall set its default PIO mode and disable IORDY. A device shall support all PIO modes below the highest mode supported, e.g., if PIO mode 1 is supported PIO mode 0 shall be supported.

Support of IORDY is mandatory when PIO mode 3 or above is the current mode of operation.

Devices reporting support for Multi Word DMA mode 1 shall also support Multi Word DMA mode 0. A device shall support all Multi Word DMA modes below the highest mode supported, e.g., if Multi Word DMA mode 1 is supported Multi Word DMA mode 0 shall be supported.

A device shall support all Ultra DMA modes below the highest mode supported, e.g., if Ultra DMA mode 1 is supported Ultra DMA mode 0 shall be supported.

If an Ultra DMA mode is enabled any previously enabled Multi Word DMA mode shall be disabled by the device. If a Multiword DMA mode is enabled any previously enabled Ultra DMA mode shall be disabled by the device.

8.37.11 Enable/disable advanced power management

Subcommand code 05h allows the host to enable Advanced Power Management. To enable Advanced Power Management, the host writes the Sector Count register with the desired advanced power management level and then executes a SET FEATURES command with subcommand code 05h. The power management level is a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh. Table 21 shows these values.

Table 21 – Advanced power management levels

Level	Sector Count value
Maximum performance	FEh
Intermediate power management levels without Standby	81h-FDh
Minimum power consumption without Standby	80h
Intermediate power management levels with Standby	02h-7Fh
Minimum power consumption with Standby	01h
Reserved	FFh
Reserved	00h

Device performance may increase with increasing power management levels. Device power consumption may increase with increasing power management levels. The power management levels may contain discrete bands. For example, a device may implement one power management method from 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh. Advanced power management levels 80h and higher do not permit the device to spin down to save power.

Subcommand code 85h disables Advanced Power Management. Subcommand 85h may not be implemented on all devices that implement SET FEATURES subcommand 05h.

8.37.12 Enable/disable Media Status Notification

Subcommand code 31h disables Media Status Notification and leaves the media in an unlocked state. If Media Status Notification is disabled when this subcommand is received, the subcommand has no effect.

Subcommand code 95h enables Media Status Notification and clears any previous media lock state. This subcommand returns the device capabilities for media eject, media lock, previous state of Media Status Notification and the current version of Media Status Notification supported in the Cylinder Low and Cylinder High registers as described below.

Register	7	6	5	4	3	2	1	0
Cylinder Low	VER							
Cylinder High	r	r	r	r	r	PEJ	LOCK	PENA

Cylinder Low register -

VER shall contain the Media Status Notification version supported by the device (currently 0x00h)

Cylinder High register -

PENA shall be set to one if Media Status Notification was enabled prior to the receipt of this command,

LOCK shall be set to one if the device is capable of locking the media preventing manual ejection.

PEJ shall be set to one if the device has a power eject mechanism that is capable of physically ejecting the media when a MEDIA EJECT command is sent to the device. This bit must be set to zero if the device only unlocks the media when it receives a MEDIA EJECT command.

r (reserved) shall be cleared to zero.

8.37.13 Enable/disable read look-ahead

Subcommand codes AAh and 55h allow the host to request the device to enable or disable read look-ahead. Error recovery performed by the device is vendor specific.

8.37.14 Enable/disable release interrupt

Subcommand codes 5Dh and DDh allow a host to enable or disable the asserting INTRQ if nIEN is cleared to zero when a device releases the bus for an overlapped PACKET command.

8.37.15 Enable/disable SERVICE interrupt

Subcommand codes 5Eh and DEh allow a host to enable or disable the asserting of an interrupt when DRQ is set to one in response to a SERVICE command.

8.37.16 Enable/disable reverting to defaults

Subcommand codes CCh and 66h allow the host to enable or disable the device from reverting to power on default values. A setting of 66h allows settings that may have been modified since power on to remain at the same setting after a software reset.

8.38 SET MAX ADDRESS

8.38.1 Command code

F9h

8.38.2 Feature set

Host Protected Area feature set.

- Mandatory when the Host Protected Area feature set is implemented.
- Use prohibited when the Removable feature set is implemented.

8.38.3 Protocol

Non-data command (see 9.9).

8.38.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							VV
Sector Number	Native max address sector number or set max LBA							
Cylinder Low	Set max cylinder low or LBA							
Cylinder High	Set max cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Native max address head number or set max LBA			
Command	F9h							

Sector Count -

VV (Value volatile). If bit 0 is set to one, the device shall preserve the maximum values over power-up or hardware reset. If bit 0 is cleared to zero, the device shall revert to the most recent non-volatile maximum address value setting over power-up or hardware reset.

Sector Number -

contains the native max address sector number (IDENTIFY DEVICE word 6) or LBA bits (7:0) value to be set.

Cylinder Low -

contains the maximum cylinder low or LBA bits (15:8) value to be set.

Cylinder High -

contains the maximum cylinder high or LBA bits (23:16) value to be set.

Device/Head -

if LBA is set to one, the maximum address value is an LBA value.
If LBA is cleared to zero, the maximum address value is a CHS value.
DEV shall indicate the selected device.
Bits (3:0) contain the native max address head number (IDENTIFY DEVICE word 3 minus one) or LBA bits (27:24) value to be set.

8.38.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	Native max sector number or max LBA							
Cylinder Low	Max cylinder low or LBA							
Cylinder High	Max cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Native max head or max LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Sector Number -
maximum native sector number or LBA bits (7:0) set on the device.
Cylinder Low -
maximum cylinder number low or LBA bits (15:8) set on the device.
Cylinder High -
maximum cylinder number high or LBA bits (23:16) set on device.
Device/Head -
DEV shall indicate the selected device.
maximum native head number or LBA bits (27:24) set on the device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.38.6 Error outputs

If this command is not supported or the maximum value to be set exceeds the capacity of the device, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	IDNF	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	na	na	na	na	na	ERR

Error register -
ABRT shall be set to one if this command is not supported, maximum value requested exceeds the device capacity, the set max cylinder number is greater than 16,383, or the command is not immediately preceded by a READ NATIVE MAX ADDRESS command. ABRT may be set to one if the device is not able to complete the action requested by the command.
IDNF shall be set to one if the command was the second non-volatile SET MAX ADDRESS command after power on or hardware reset.
Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
ERR shall be set to one if an Error register bit is set to one.

8.38.7 Prerequisites

DRDY set equal to one. A successful READ NATIVE MAX ADDRESS command shall immediately precede a SET MAX ADDRESS command.

8.38.8 Description

This command allows the host to redefine the maximum address of the user-accessible address space in either LBA translation or the current CHS translation. The host may either set a new maximum cylinder number for CHS translation or a new maximum LBA address for LBA translation. After a successful SET MAX ADDRESS command using a new maximum cylinder number value the content of all IDENTIFY DEVICE words shall comply with 6.2.1 in addition to the following:

1) The content of words 3, 6, 55, and 56 are unchanged
2) The content of word 1 shall equal (the new Set max cylinder number + 1) or 16,383, whichever is less
3) The content of words (61:60) shall equal [(the new content of word 1 as determined by the successful SET MAX ADDRESS command) * (the content of word 3) * (the content of word 6)]
4) If the content of words (61:60) as determined by a successful SET MAX ADDRESS command is less than 16,514,064, then the content of word 54 shall be equal to [(the content of words (61:60)) ÷ ((the content of IDENTIFY DEVICE word 55) * (the content of word 56)] or 65,535, whichever is less
5) If the content of word (61:60) as determined by a successful SET MAX ADDRESS command is greater than 16,514,064, then word 54 shall equal the whole number result of [[(16,514,064) ÷ [(the content of word 55) * (the content of word 56)]] or 65,535 whichever is less) The content of words (58:57) shall be equal to [(the new content of word 54 as determined by the successful SET MAX ADDRESS command) * (the content of word 55) * (the content of word 56)]

After a successful SET MAX ADDRESS command using a new maximum LBA address the content of all IDENTIFY DEVICE words shall comply with 6.2.1 in addition to the following:

- The content of words (61:60) shall be equal to the new Maximum LBA address + 1.
- If the content of words (61:60) is greater than 16,514,064 and if the device does not support CHS addressing, then the content of words 1, 3, 6, 54, 55, 56, and (58:57) shall equal zero.

If the device supports CHS addressing:

- The content of words 3, 6, 55, and 56 are unchanged.
- If the new content of words (61:60) is less than 16,514,064, then the content of word 1 shall be equal to [(the new content of words (61:60)) ÷ [(the content of word 3) * (the content of word 6)]] or 65,535, whichever is less.
- If the new content of words (61:60) is greater than or equal to 16,514,064, then the content of word 1 shall be equal to 16,383.
- If the new content of words (61:60) is less than 16,514,064, then the content of word 54 shall be equal to [(the new content of words (61:60)) ÷ [(the content of word 55) * (the content of word 56)]].
- If the new content of words (61:60) is greater than or equal to 16,514,064, then the content of word 54 shall be equal to 16,383.
- Words (58:57) shall be equal to [(the content of word 54) * (the content of word 55) * (the content of word 56).

After successful command completion, all read and write access attempts to addresses greater than specified by the successful SET MAX ADDRESS command shall be rejected with an “ID Not Found” error.

Hosts should not issue more than one non-volatile SET MAX ADDRESS command after a power on or hardware reset. Devices shall report an “ID Not Found” error upon receiving a second non-volatile SET MAX ADDRESS command after a power on or hardware reset.

The contents of IDENTIFY DEVICE words shall not be changed if a SET MAX ADDRESS command fails for any reason.

8.39 SET MULTIPLE MODE

8.39.1 Command code

C6h

8.39.2 Feature set

General feature set
Mandatory for devices not implementing the PACKET Command feature set.
Use prohibited for devices implementing the PACKET Command feature set.

8.39.3 Protocol

Non-data (see 9.9).

8.39.4 Inputs

The Sector Count register contains number of sectors per block to use on all following READ/WRITE MULTIPLE commands. The host shall set Sector Count values equal to 2, 4, 8, 16, 32, 64, or 128.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sectors per block							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	C6h							

Device/Head register -
DEV shall indicate the selected device.

8.39.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -
DEV shall indicate the selected device.
Status register -
BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.39.6 Error outputs

If a block count is not supported, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if the block count is not supported. ABRT may be set to one if the device is

not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.39.7 Prerequisites

DRDY set equal to one.

8.39.8 Description

This command establishes the block count for READ MULTIPLE and WRITE MULTIPLE commands.

Devices shall support the block size specified in the IDENTIFY DEVICE parameter word 47, bits 7 through 0, and may also support smaller values.

Upon receipt of the command, the device checks the Sector Count register. If the Sector Count register contains a valid value and the block count is supported, the value is used for all subsequent READ MULTIPLE and WRITE MULTIPLE commands and their execution is enabled.

8.40 SLEEP

8.40.1 Command code

E6h

8.40.2 Feature set

Power Management feature set.

- Power Management feature set is mandatory when power management is not implemented by a PACKET power management feature set.
- This command is mandatory when the Power Management feature set is implemented.

8.40.3 Protocol

Non-data command (see 9.9).

8.40.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E6h							

Device/Head register -

DEV shall indicate the selected device.

8.40.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.40.6 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if the device does not support the Power Management feature set. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.40.7 Prerequisites

DRDY set equal to one.

8.40.8 Description

This command is the only way to cause the device to enter Sleep mode.

This command causes the device to set the BSY bit to one, prepare to enter Sleep mode, clear the BSY bit to zero and assert INTRQ. The host shall read the Status register in order to clear the interrupt and allow the device to enter Sleep mode. In Sleep mode, the device only responds to the assertion of the RESET signal and the writing of the SRST bit in the Device Control register and releases its driven signal lines. The host shall not attempt to access the Command Block registers while the device is in Sleep mode.

Because some host systems may not read the Status register and clear the interrupt, a device may automatically release INTRQ and enter Sleep mode after a vendor specific time period of not less than 2 s.

The only way to recover from Sleep mode is with a software reset, a hardware reset, or a DEVICE RESET command.

A device shall not power on in Sleep mode nor remain in Sleep mode following a reset sequence.

8.41 SMART

Individual SMART commands are identified by the value placed in the Feature register. Table 22 shows these Feature register values.

Table 22 – SMART Feature register values

Value	Command
00h-CFh	reserved
D0h	SMART READ DATA
D1h	obsolete
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
D3h	SMART SAVE ATTRIBUTE VALUES
D4h	SMART EXECUTE OFF-LINE IMMEDIATE
D5h-D6h	reserved
D7h	obsolete
D8h	SMART ENABLE OPERATIONS
D9h	SMART DISABLE OPERATIONS
DAh	SMART RETURN STATUS
DBh	obsolete
DCh-DFh	reserved
E0h-FFh	vendor specific

8.41.1 SMART DISABLE OPERATIONS

8.41.1.1 Command code

B0h with a Feature register value of D9h.

8.41.1.2 Feature set

SMART feature set.

- Mandatory when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.1.3 Protocol

Non-data command (see 9.9).

8.41.1.4 Inputs

The Features register shall be set to D9h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D9h							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.1.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.1.6 Error outputs

If the device does not support this command, if SMART is not enabled, or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported, if SMART is not enabled, or if input register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.41.1.7 Prerequisites

DRDY set equal to one. SMART enabled.

8.41.1.8 Description

This command disables all SMART capabilities within the device including any and all timer and event count functions related exclusively to this feature. After receipt of this command the device shall disable all SMART operations. SMART data shall no longer be monitored or saved by the device. The state of SMART (either enabled or disabled) shall be preserved by the device across power cycles.

After receipt of this command by the device, all other SMART commands (including SMART DISABLE OPERATIONS commands), with the exception of SMART ENABLE OPERATIONS, are disabled and invalid and shall be command aborted by the device.

8.41.2 SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE

8.41.2.1 Command code

B0h with a Feature register value of D2h.

8.41.2.2 Feature set

SMART feature set.

- Mandatory when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.2.3 Protocol

Non-data command (see 9.9).

8.41.2.4 Inputs

The Features register shall be set to D2h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h. The Sector Count register is set to 00h to disable attribute autosave and a value of F1h is set to enable attribute autosave.

Register	7	6	5	4	3	2	1	0
Features	D2h							
Sector Count	00h or F1h							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.2.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.2.6 Error outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported, if SMART is disabled, or if the input register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.41.2.7 Prerequisites

DRDY set equal to one. SMART enabled.

8.41.2.8 Description

This command enables and disables the optional attribute autosave feature of the device. Depending upon the implementation, this command may either allow the device, after some vendor specified event, to automatically save its updated attribute values to non-volatile memory; or this command may cause the autosave feature to be disabled. The state of the attribute autosave feature (either enabled or disabled) shall be preserved by the device across power cycles.

A value of zero written by the host into the device's Sector Count register before issuing this command shall cause this feature to be disabled. Disabling this feature does not preclude the device from saving SMART data to non-volatile memory during some other normal operation such as during a power-on or power-off sequence or during an error recovery sequence.

A value of F1h written by the host into the device's Sector Count register before issuing this command shall cause this feature to be enabled. Any other meaning of this value or any other non-zero value written by the host into this register before issuing this command may differ from device to device. The meaning of any non-zero value written to this register at this time shall be preserved by the device across power cycles.

If this command is not supported by the device, the device shall return command aborted upon receipt from the host.

During execution of the autosave routine the device shall not set BSY to one nor clear DRDY to zero. If the device receives a command from the host while executing its autosave routine it shall respond to the host within two seconds.

8.41.3 SMART ENABLE OPERATIONS

8.41.3.1 Command code

B0h with a Feature register value of D8h.

8.41.3.2 Feature set

SMART feature set.

- Mandatory when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.3.3 Protocol

Non-data command (see 9.9).

8.41.3.4 Inputs

The Features register shall be set to D8h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D8h							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.3.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.3.6 Error outputs

If the device does not support this command or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported or if the input register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.41.3.7 Prerequisites

DRDY set equal to one.

8.41.3.8 Description

This command enables access to all SMART capabilities within the device. Prior to receipt of this command SMART data are neither monitored nor saved by the device. The state of SMART (either enabled or disabled) shall be preserved by the device across power cycles. Once enabled, the receipt of subsequent SMART ENABLE OPERATIONS commands shall not affect any SMART data or functions.

8.41.4 SMART EXECUTE OFF-LINE IMMEDIATE

8.41.4.1 Command code

B0h with the content of the Features register equal to D4h

8.41.4.2 Feature set

SMART feature set.

- Optional when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.4.3 Protocol

Non-data command (see 9.9).

8.41.4.4 Inputs

The Features register shall be set to D4h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D4h							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na			
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.4.5 Normal Outputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one indicating that the device is capable of receiving any command.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.4.6 Error Outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	IDNF	na	ABRT	na	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

IDNF shall be set to one if SMART data sector's ID field could not be found.

ABRT shall be set to one if this command is not supported, if SMART is not enabled, or if register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one indicating that the device is capable of receiving any command.

DF (Device Fault) shall be set to one indicating that a device fault has occurred.

DRQ shall be cleared to zero indicating that there is no data to be transferred.

ERR shall be set to one if any Error register bit is set to one.

8.41.4.7 Prerequisites

DRDY set to one. SMART enabled.

8.41.4.8 Description

This command causes the device to immediately initiate the optional set of activities that collect SMART data in an off-line mode and then save this data to the device's non-volatile memory.

During execution of its off-line activities the device shall not set BSY nor clear DRDY.

If the device is in the process of performing its set of off-line data collection activities as a result of receiving a SMART EXECUTE OFF-LINE IMMEDIATE command from the host and is interrupted by any new command from the host except a SMART DISABLE OPERATIONS, SMART EXECUTE OFF-LINE IMMEDIATE, or STANDBY IMMEDIATE command, the device shall suspend or abort its off-line data collection activities and service the host within two seconds after receipt of the new command. After servicing the interrupting command from the host the device may immediately re-initiate or resume its off-line data collection activities without any additional commands from the host (see the definition for Bit 2 in the Off-line data collection capability byte in 8.41.5).

If the device is in the process of performing its off-line data collection activities and is interrupted by a STANDBY IMMEDIATE command from the host, the device shall suspend or abort its off-line data collection activities, and service the host within two seconds after receipt of the command. After receiving a new command that causes the device to exit a power saving mode, the device shall initiate or resume off-line data collection activities without any additional commands from the host unless these activities were aborted by the device (see 8.41.5.8).

If the device is in the process of performing its off-line data collection activities and is interrupted by a SMART DISABLE OPERATIONS command from the host, the device shall suspend or abort its off-line data

collection activities and service the host within two seconds after receipt of the command. Upon receipt of the next SMART ENABLE OPERATIONS command the device may, after the next vendor specified event, either re-initiate its off-line data collection activities or resume those activities from where they had been previously suspended.

If the device is in the process of performing its off-line data collection activities and is interrupted by a SMART EXECUTE OFF-LINE IMMEDIATE command from the host, the device shall abort its off-line data collection activities and service the host within two seconds after receipt of the command. The device shall then re-initiate its off-line data collection activities in response to the new EXECUTE OFF-LINE IMMEDIATE command.

8.41.5 SMART READ DATA

8.41.5.1 Command code

B0h with the content of the Features register equal to D0h.

8.41.5.2 Feature set

SMART feature set.

- Optional when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.5.3 Protocol

PIO data in (see 9.7).

8.41.5.4 Inputs

The Features register shall be set to D0h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D0h							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na			
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.5.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one indicating that the device is capable of receiving any command.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.5.6 Error outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	na	IDNF	na	ABRT	na	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

UNC shall be set to one if SMART data is uncorrectable.

IDNF shall be set to one if SMART data sector's ID field could not be found or data structure checksum occurred.

ABRT shall be set to one if this command is not supported, if SMART is not enabled, or if register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one indicating that the device is capable of receiving any command.

DF (Device Fault) shall be set to one indicating that a device fault has occurred.

DRQ shall be cleared to zero indicating that there is no data to be transferred.

ERR shall be set to one if any Error register bit is set to one.

8.41.5.7 Prerequisites

DRDY set to one. SMART enabled.

8.41.5.8 Description

This command returns the Device SMART data structure to the host.

Table 23 defines the 512 bytes that make up the Device SMART data structure. All multi-byte fields shown in this structure follow the byte ordering described in 3.2.7.

Table 23 – Device SMART data structure

Byte	F/V	Descriptions
0-361	X	Vendor specific
362	V	Off-line data collection status
363	X	Vendor specific
364-365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368-369	F	SMART capability
370-385	R	Reserved
386-510	X	Vendor specific
511	V	Data structure checksum

Key:
F=the content of the byte is fixed and does not change.
V=the content of the byte is variable and may change depending on the state of the device or the commands executed by the device.
X=the content of the byte is vendor specific and may be fixed or variable.
R=the content of the byte is reserved and shall be zero.

The value of the off-line data collection status byte defines the current status of the off-line activities of the device. Table 24 lists the values and their respective definitions.

Table 24 – Off-line data collection status byte values

Value	Definition
00h or 80h	Off-line data collection activity was never started.
01h	Reserved
02h or 82h	Off-line data collection activity was completed without error.
03h	Reserved
04h or 84h	Off-line data collection activity was suspended by an interrupting command from host.
05h or 85h	Off-line data collection activity was aborted by an interrupting command from host.
06h or 86h	Off-line data collection activity was aborted by the device with a fatal error.
07h-3Fh	Reserved
40h-7Fh	Vendor specific
81h	Reserved
83h	Reserved
87h-BFh	Reserved
C0h-FFh	Vendor specific

The total time in seconds to complete off-line data collection activity word specifies how many seconds the device requires to complete its sequence of off-line data collection activity. Valid values for this word are from 0001h to FFFFh.

Off-line data collection capability.

The following describes the definition for the off-line data collection capability bits. If the value of all of these bits is equal to zero, then no off-line data collection is implemented by this device.

– Bit 0 (EXECUTE OFF-LINE IMMEDIATE implemented bit) - If the value of this bit equals one, then the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented by this device. If the value of this bit equals zero, then the SMART EXECUTE OFF-LINE IMMEDIATE command is not implemented by this device.

– Bit 1 (vendor specific).

– Bit 2 (abort/restart off-line by host bit) - If the value of this bit equals one, then the device shall abort all off-line data collection activity initiated by an SMART EXECUTE OFF-LINE IMMEDIATE command upon receipt of a new command. Off-line data collection activity must be restarted by a new SMART EXECUTE OFF-LINE IMMEDIATE command from the host. If the value of this bit equals zero, the device shall suspend off-line data collection activity after an interrupting command and resume off-line data collection activity after some vendor-specified event.

– Bits 3-7 (reserved).

SMART capability

The following describes the definition for the SMART capabilities bits. If the value of all of these bits is equal to zero, then automatic saving of SMART data is not implemented by this device.

– Bit 0 (power mode SMART data saving capability bit) - If the value of this bit equals one, the device shall save its SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or immediately upon return to Active or Idle mode from a Standby mode. If the value of this bit equals zero, the device shall not save its SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or immediately upon return to Active or Idle mode from a Standby mode.

– Bit 1 (SMART data autosave after event capability bit) - The value of this bit shall be equal to one for devices complying with this standard.

– Bits 2-15 (reserved).

The data structure checksum is the two's compliment of the result of a simple eight-bit addition of the first 511 bytes in the data structure.

8.41.6 SMART RETURN STATUS

8.41.6.1 Command code

B0h with a Feature register value of DAh.

8.41.6.2 Feature set

SMART feature set.

- Mandatory when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.6.3 Protocol

Non-data command (see 9.9).

8.41.6.4 Inputs

The Features register shall be set to DAh. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	DAh							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.6.5 Normal outputs

If the device has not detected a threshold exceeded condition, the device sets the Cylinder Low register to 4Fh and the Cylinder High register to C2h. If the device has detected a threshold exceeded condition, the device sets the Cylinder Low register to F4h and the Cylinder High register to 2Ch.

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh or F4h							
Cylinder High	C2h or 2Ch							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Cylinder Low -

4Fh if threshold not exceeded, F4h if threshold exceeded.

Cylinder High -

C2h if threshold not exceeded, 2Ch if threshold exceeded.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.6.6 Error outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported, if SMART is disabled, or if the input register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.41.6.7 Prerequisites

DRDY set equal to one. SMART enabled.

8.41.6.8 Description

This command is used to communicate the reliability status of the device to the host at the host's request. If a threshold exceeded condition is not detected by the device, the device shall set the Cylinder Low register to 4Fh and the Cylinder High register to C2h. If a threshold exceeded condition is detected by the device, the device shall set the Cylinder Low register to F4h and the Cylinder High register to 2Ch.

8.41.7 SMART SAVE ATTRIBUTE VALUES

8.41.7.1 Command code

B0h with a Feature register value of D3h.

8.41.7.2 Feature set

SMART feature set.

- Optional and not recommended when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.7.3 Protocol

Non-data command (see 9.9).

8.41.7.4 Inputs

The Features register shall be set to D3h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D3h							
Sector Count	na							
Sector Number	na							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	B0h							

Device/Head register -

DEV shall indicate the selected device.

8.41.7.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.41.7.6 Error outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported, if SMART is disabled, or if the input register values are invalid. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero..
ERR shall be set to one if an Error register bit is set to one.

8.41.7.7 Prerequisites

DRDY set equal to one. SMART enabled.

8.41.7.8 Description

This command causes the device to immediately save any updated attribute values to the device's non-volatile memory regardless of the state of the attribute autosave timer.

8.42 STANDBY

8.42.1 Command code

E2h

8.42.2 Feature set

Power Management feature set.

- Power Management feature set is mandatory when power management is not implemented by a PACKET power management feature set.
- This command is mandatory when the Power Management feature set is implemented.

8.42.3 Protocol

Non-data command (see 9.9).

8.42.4 Inputs

The value in the Sector Count register when the STANDBY command is issued shall determine the time period programmed into the Standby timer. Table 14 defines these values.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Time period value							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E2h							

Device/Head register -

DEV shall indicate the selected device.

8.42.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.42.6 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if the Power Management feature set is not supported. ABRT may be set to

one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.42.7 Prerequisites

DRDY set equal to one.

8.42.8 Description

This command causes the device to enter the Standby mode.

If the Sector Count register is non-zero then the Standby timer shall be enabled. The value in the Sector Count register shall be used to determine the time programmed into the Standby timer (see Table 14).

If the Sector Count register is zero then the Standby timer is disabled.

8.43 STANDBY IMMEDIATE

8.43.1 Command code

E0h

8.43.2 Feature set

Power Management feature set.

- Power Management feature set is mandatory when power management is not implemented by a PACKET power management feature set.
- This command is mandatory when the Power Management feature set is implemented.

8.43.3 Protocol

Non-data command (see 9.9).

8.43.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E0h							

Device/Head register -

DEV shall indicate the selected device.

8.43.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.43.6 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if the Power Management feature set is not supported. ABRT may be set to

one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.43.7 Prerequisites

DRDY set equal to one.

8.43.8 Description

This command causes the device to immediately enter the Standby mode.

8.44 WRITE BUFFER

8.44.1 Command code

E8h

8.44.2 Feature set

General feature set

- Optional for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.44.3 Protocol

PIO data out (see 9.8).

8.44.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Command	E8h							

Device/Head register -

DEV shall indicate the selected device.

8.44.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.44.6 Error outputs

The device shall return command aborted if the command is not supported.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	na	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ABRT shall be set to one if this command is not supported. ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.44.7 Prerequisites

DRDY set equal to one.

8.44.8 Description

This command enables the host to write the contents of one sector in the device's buffer.

The READ BUFFER and WRITE BUFFER commands shall be synchronized within the device such that sequential WRITE BUFFER and READ BUFFER commands access the same 512 bytes within the buffer.

8.45 WRITE DMA

8.45.1 Command code

CAh or CBh

NOTE – The host should not use the CBh value.

8.45.2 Feature set

General feature set
Mandatory for devices not implementing the PACKET Command feature set.
Use prohibited for devices implementing the PACKET Command feature set.

8.45.3 Protocol

DMA (see 9.10).

8.45.4 Inputs

The Cylinder Low, Cylinder High, Device/Head, and Sector Number specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	CAh or CBh							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.45.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.45.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	ICRC	WP	MC	IDNF	MCR	ABRT	NM	obs
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

ICRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit is not applicable for Multiword DMA transfers.
WP shall be set to one if the media in a removable media device is write protected.
MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.
IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.
MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.
ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.
NM shall be set to one if no media is present in a removable media device.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with address of first unrecoverable error.
DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.45.7 Prerequisites

DRDY set equal to one. The host shall initialize the DMA channel.

8.45.8 Description

The WRITE DMA command allows the host to write data using the DMA data transfer protocol.

8.46 WRITE DMA QUEUED

8.46.1 Command code
CCh

8.46.2 Feature set

Overlapped feature set
- Mandatory for devices implementing the Overlapped feature set but not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.46.3 Protocol
DMA QUEUED (see 9.12).

8.46.4 Inputs

Register	7	6	5	4	3	2	1	0
Features	Sector Count							
Sector Count	Tag					na	na	na
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	CCh							

Features -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector count -
if the device supports command queuing, bits (7:3) contain the Tag for the command being delivered. If queuing is not supported, this field is not applicable.
Sector number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.46.5 Normal outputs

8.46.5.1 Bus release

If the device performs a bus release before transferring data for this command, the register content upon performing a bus release shall be as shown below.

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	Tag					REL	I/O	C/D
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	SERV	DRQ	na	na	ERR

Sector Count register -

Tag - If the device supports command queuing, this field shall contain the Tag of the command being bus released. If the device does not support command queuing, this field shall be zeros.

REL bit shall be set indicating that the device has bus released an overlap command.

I/O shall be cleared to zero.

C/D shall be cleared to zero.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating bus release.

DRDY shall be set to one.

SERV (Service) shall be cleared to zero if no other queued command is ready for service. It shall be set to one when another queued command is ready for service. This bit shall be set to one when the device has prepared this command for service.

DF (Device Fault) shall be cleared to zero.

DRQ bit shall be cleared to zero.

ERR bit shall be cleared to zero.

8.46.5.2 Command completion

When the transfer of all requested data has occurred without error, the register content shall be as shown below.

Register	7	6	5	4	3	2	1	0
Error	00h							
Sector Count	Tag					REL	I/O	C/D
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	SERV	DRQ	na	na	ERR

Sector Count register -

Tag - If the device supports command queuing, this field shall contain the Tag of the completed command. If the device does not support command queuing, this field shall be zeros.

REL shall be cleared to zero.

I/O shall be set to one.

C/D shall be set to one.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one.

SERV (Service) shall be cleared to zero when no other queued command is ready for service. It shall be set to one when another queued command is ready for service.

DF (Device Fault) shall be cleared to zero.
DRQ bit shall be cleared to zero.
ERR bit shall be cleared to zero.

8.46.6 Error outputs

The Sector Count register contains the Tag for this command if the device supports command queuing. The device shall return command aborted if the command is not supported or if the device has not had overlapped interrupt enabled. The device shall return command aborted if the device supports command queuing and the Tag is invalid. An unrecoverable error encountered during the execution of this command results in the termination of the command and the Command Block registers contain the sector where the first unrecoverable error occurred. If a queue existed, the unrecoverable error shall cause the queue to abort. The device may remain BSY for some time when responding to these errors.

Register	7	6	5	4	3	2	1	0
Error	ICRC	WP	MC	IDNF	MCR	ABRT	NM	na
Sector Count	Tag					REL	I/O	C/D
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	SERV	DRQ	na	na	ERR

Error register -

ICRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit is not applicable for Multiword DMA transfers.
WP shall be set to one if the media in a removable media device is write protected.
MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.
IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.
MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.
ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.
NM shall be set to one if no media is present in a removable media device.

Sector Count register -

Tag - If the device supports command queuing, this field shall contain the Tag of the completed command. If the device does not support command queuing, this field shall be zeros.
REL shall be cleared to zero.
I/O shall be set to one.
C/D shall be set to one.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.
DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
SERV (Service) shall be cleared to zero when no other queued command is ready for service. It shall be set to one when another queued command is ready for service.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.46.7 Prerequisites

DRDY set to one. The host shall initialize the DMA channel.

8.46.8 Description

This command executes in a similar manner to a WRITE DMA command. The device may perform a bus release the bus or it may execute the data transfer without performing a bus release if the data is ready to transfer.

If the device performs a bus release, the host shall reselect the device using the SERVICE command.

Once the data transfer is begun, the device shall not perform a bus release until the entire data transfer has been completed.

8.47 WRITE MULTIPLE

8.47.1 Command code

C5h

8.47.2 Feature set

General feature set

- Mandatory for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.47.3 Protocol

PIO data out (see 9.8).

8.47.4 Inputs

The Cylinder Low, Cylinder High, Device/Head, and Sector Number specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	C5h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.47.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.47.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	na	WP	MC	IDNF	MCR	ABRT	NM	na
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

WP shall be set to one if the media in a removable media device is write protected.

MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.

ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

NM shall be set to one if no media is present in a removable media device.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.
DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.47.7 Prerequisites

DRDY set equal to one. If bit 8 of IDENTIFY DEVICE word 59 is equal to zero, a successful SET MULTIPLE MODE command shall proceed a WRITE MULTIPLE command.

8.47.8 Description

This command is similar to the WRITE SECTOR(S) command. Interrupts are not generated on every sector, but on the transfer of a block that contains the number of sectors defined by SET MULTIPLE MODE or the default if no intervening SET MULTIPLE command has been issued.

Command execution is identical to the WRITE SECTOR(S) operation except that the number of sectors defined by the SET MULTIPLE MODE command are transferred without intervening interrupts. The DRQ bit qualification of the transfer is required only at the start of the data block, not on each sector.

The block count of sectors to be transferred without intervening interrupts is the default or programmed by the SET MULTIPLE MODE command, that shall be executed prior to the WRITE MULTIPLE command.

When the WRITE MULTIPLE command is issued, the Sector Count register contains the number of sectors (not the number of blocks or the block count) requested.

If the number of requested sectors is not evenly divisible by the block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. The partial block transfer is for n sectors, where:

n = Remainder (sector count/ block count).

If the WRITE MULTIPLE command is received when WRITE MULTIPLE commands are disabled, the Write Multiple operation shall be rejected with command aborted.

Device errors encountered during WRITE MULTIPLE commands are posted after the attempted device write of the block or partial block transferred. The Write command ends with the sector in error, even if it was in the middle of a block. Subsequent blocks are not transferred in the event of an error.

The contents of the Command Block Registers following the transfer of a data block that had a sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information. Interrupts are generated when the DRQ bit is set to one at the beginning of each block or partial block.

8.48 WRITE SECTOR(S)

8.48.1 Command code

30h or 31h

NOTE – The host should not use the 31h value.

8.48.2 Feature set

General feature set
- Mandatory for devices not implementing the PACKET Command feature set.
- Use prohibited for devices implementing the PACKET Command feature set.

8.48.3 Protocol

PIO data out (see 9.8).

8.48.4 Inputs

The Cylinder Low, Cylinder High, Device/Head, and Sector Number specify the starting sector address to be written. The Sector Count register specifies the number of sectors to be transferred.

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	Sector count							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	LBA	obs	DEV	Head number or LBA			
Command	30h or 31h							

Sector Count -
number of sectors to be transferred. A value of 00h indicates that 256 sectors are to be transferred.
Sector Number -
starting sector number or LBA address bits (7:0).
Cylinder Low -
starting cylinder number bits (7:0) or LBA address bits (15:8).
Cylinder High -
starting cylinder number bits (15:8) or LBA address bits (23:16).
Device/Head -
bit 6 set to one if LBA address, cleared to zero if CHS address.
DEV shall indicate the selected device.
bits (3:0) starting head number or LBA address bits (27:24).

8.48.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Error	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na	na	na	na
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.
DF (Device Fault) shall be cleared to zero.
DRQ shall be cleared to zero.
ERR shall be cleared to zero.

8.48.6 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate.

Register	7	6	5	4	3	2	1	0
Error	na	WP	MC	IDNF	MCR	ABRT	NM	na
Sector Count	na							
Sector Number	Sector number or LBA							
Cylinder Low	Cylinder low or LBA							
Cylinder High	Cylinder high or LBA							
Device/Head	obs	na	obs	DEV	Head number or LBA			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

WP shall be set to one if the media in a removable media device is write protected.

MC shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear its internal media change detected state.

IDNF shall be set to one if a user-accessible address could not be found and after an unsuccessful INITIALIZE DEVICE PARAMETERS command until a valid CHS translation is established (see 8.16.8). IDNF shall be set to one if an address outside of the range of user-accessible addresses is requested if command aborted is not returned.

MCR shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.

ABRT shall be set to one if this command is not supported or if an error, including an ICRC error, has occurred during an Ultra DMA data transfer. ABRT may be set to one if the device is not able to complete the action requested by the command. ABRT shall be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

NM shall be set to one if no media is present in a removable media device.

Sector Number, Cylinder Low, Cylinder High, Device/Head -

shall be written with the address of first unrecoverable error.
DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.
DRDY shall be set to one.

DF (Device Fault) shall be set to one if a device fault has occurred.
DRQ shall be cleared to zero.
ERR shall be set to one if an Error register bit is set to one.

8.48.7 Prerequisites

DRDY set equal to one.

8.48.8 Description

This command writes from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors.

9 Protocol

Commands are grouped into different classes according to the protocols followed for command execution. The command classes with their associated protocols are defined below.

For all commands except DEVICE RESET, the host first checks if the BSY bit is equal to one, and should proceed no further unless and until the BSY bit is equal to zero. For most commands, the host shall also wait for the DRDY bit to be equal to one before proceeding.

Data transfers may be accomplished in more ways than are described below, but these sequences should work with all known implementations of devices.

A device shall maintain either the BSY bit equal to one or the DRQ bit equal to one at all times until command completion. The INTRQ signal is used by the device to signal most, but not all, times when the BSY bit is changed from one to zero during command execution and command completion.

The result of writing to the Command register or a hardware or software reset while the BSY bit is equal to one or the DRQ bit is equal to one may result in data corruption for commands that were queued or in progress at the time.

9.1 Signature and persistence

A device not implementing the PACKET command feature set shall place the signature in the Command Block registers listed below for power on reset, hardware reset, software reset, and the EXECUTE DEVICE DIAGNOSTIC command.

If the device does not implement the PACKET command feature set, the signature shall be:

Sector Count	01h
Sector Number	01h
Cylinder Low	00h
Cylinder High	00h
Device/Head	00h

A device implementing the PACKET command feature set shall place the signature in the Command Block registers listed below for power on reset, hardware reset, software reset, the EXECUTE DEVICE DIAGNOSTIC command, and the DEVICE RESET command. The DEVICE RESET command shall not change the value of the DEV bit when writing the signature into the Device/Head register for a device implementing the PACKET command feature set. If the device implements the PACKET command feature set, the signature is also written in the registers for the IDENTIFY DEVICE and READ SECTOR(S) commands.

If the device implements the PACKET command feature set, the signature shall be:

Sector Count	01h
Sector Number	01h
Cylinder Low	14h
Cylinder High	EBh
Device/Head	00h or 10h

If the PACKET command feature set is implemented by a device, then the signature values written by the device in the Command Block registers following power on reset, hardware reset, software reset, or the DEVICE RESET command shall not be changed by the device until the device receives a command that sets DRDY to one. These commands are a PACKET command or an IDENTIFY PACKET DEVICE command. Writes by the host to the Command Block registers that contain the signature values shall overwrite the signature values and invalidate the signature.

9.2 Power on and hardware resets

This clause describes the algorithm and timing relationships for Device 0 and Device 1 during the processing of power on and hardware resets.

If the host asserts RESET- while a device is in or going to a power management mode, then the device shall execute its hardware reset sequence.

If the host reasserts RESET- before devices have completed executing their power on or hardware reset sequences, then the devices shall restart executing their hardware reset sequence at step (b).

The host should not set the SRST bit to one in the Device Control register or issue a DEVICE RESET command while the BSY bit is set to one in either devices' Status register as a result of executing a power on or hardware reset sequence. If the host sets the SRST bit in the Device Control register to one or issues a DEVICE RESET command before the devices have completed execution of their power on or hardware reset sequences, then the devices shall ignore the software reset or DEVICE RESET command.

A host should issue an IDENTIFY DEVICE and/or IDENTIFY PACKET DEVICE command after a issuing a software reset in order to correctly determine the current status of features implemented by the device(s).

If the device has not determined its device number, the device shall follow the protocol described in steps (a) through (c) of 9.2.1 until the device number is determined.

The host shall not begin polling the Status register until at least 2 ms after RESET- is negated. The host should only interpret bits 6 and 7 of the Status register to determine completion of the reset.

9.2.1 Power on and hardware resets - device 0

The following steps should occur sequentially as listed. Several of the steps may occur concurrently or outside of the listed sequence when explicitly allowed so long as all timing relationships are satisfied, e.g.: Device 0 may continue to sample DASP- after Device 0 has completed its hardware initialization and self-diagnostic testing.

Steps (b) through (o) shall be completed within 31s from negation of RESET- by the host.

a) The host shall assert RESET- for a minimum of 25 μs after power to the device has stabilized within the system's specified tolerance. The device shall not recognize a signal assertion shorter than 20 ns as a valid RESET signal. Devices may respond to any signal assertion greater than 20 ns and shall recognize a signal equal to or greater than 25 us;
b) The device shall release PDIAG-, INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after RESET- is negated;
c) The device shall set the BSY bit to one no later than 400 ns after RESET- is negated;
d) The device shall determine that it is Device 0;
e) The device shall release DASP- no later than 1 ms after RESET- is negated;
f) Steps (b), (c), (d), and (e) shall be completed before continuing;
g) Device 0 shall sample DASP- for assertion by Device 1. Device 0 may sample DASP- at any frequency. This sampling shall not begin until at least 1 ms after RESET- is negated. Device 0 may stop sampling DASP- upon detection of its assertion. The last sample of DASP- by Device 0 shall occur no sooner than 450 ms after RESET- is negated if assertion has not been detected before this time. Device 0 shall not sample DASP- later than 5 s after RESET- is negated;
h) Step (g) shall be completed before executing the following: Device 0 shall store whether or not Device 1 was detected in step (g). This information is needed to process any future software reset or EXECUTE DEVICE DIAGNOSTIC command. This information shall be saved by Device 0 until the next power on or hardware reset;
i) Device 0 should begin performing its hardware initialization and self-diagnostic testing;
j) Device 0 may revert to its default condition (the device's settings may now be in different conditions than they were before RESET- was asserted by the host). All Ultra DMA modes shall be disabled;

k) Step (g) shall be completed before executing the following: if Device 0 did not detect that DASP- was asserted by Device 1 during step (g) (i.e.: Device 1 is not present), then Device 0 shall clear bit 7 to zero in the Error register and go to step (m);
l) Device 0 shall sample PDIAG- for assertion by Device 1. Device 0 may sample PDIAG- at any frequency. This sampling shall not begin until at least 1 ms after RESET- is negated. Device 0 may stop sampling PDIAG- upon detection of its assertion. The last sample of PDIAG- by Device 0 shall occur no sooner than 450 ms after RESET- is negated if assertion has not been detected before this time. Device 0 shall not sample PDIAG- later than 31 s after RESET- is negated;
    1) If Device 0 detects that PDIAG- is asserted within 31 s after RESET- is negated, then Device 0 shall clear bit 7 to zero in the Error register;
    2) If Device 0 does not detect that PDIAG- is asserted within 31 s after RESET- is negated, then Device 0 shall set bit 7 to one in the Error register;
m) If performed, the hardware initialization and self-diagnostic testing initiated in step (i) shall be completed before executing the following: Device 0 shall write its self-diagnostic testing results to bits 6-0 in the Error register. Table 10 defines results values;
n) Device 0 shall set its signature values (see 9.1) and clear SRST in the Device Control register to zero. The effect on the Features register is undefined;
o) Clearing Status register bits:
    1) If the PACKET command feature set is not implemented by Device 0, Device 0 shall clear to zero bits 3, 2, and 0 of the Status register;
    2) If the PACKET command feature set is implemented by Device 0, Device 0 shall clear to zero bits 5, 4, 3, 2, and 0 of the Status register;
p) Clearing BSY:
    1) If the PACKET command feature set is not implemented by Device 0, then steps (h), (j), (k), (l) (as required), (m), and (n) shall be completed before executing the following: Device 0 shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one;
    2) If the PACKET command feature set is implemented by Device 0, then Device 0 shall return its operating modes to their specified initial conditions: MODE SELECT conditions shall be restored to their last saved values if saved values have been established; MODE SELECT conditions for which no values have been saved shall be returned to their default values; then Device 0 shall clear the BSY bit to zero when ready to accept commands;
q) Setting DRDY:
    1) If the PACKET command feature set is not implemented by Device 0, then the DRDY bit shall be set to one within 30 s after the BSY bit has been cleared to zero. Steps (p) (1) and (q) (1) may occur at the same time;
    2) If the PACKET command feature set is implemented by Device 0, then Device 0 shall not set DRDY to one;

9.2.2 Power on and hardware resets - device 1

The following steps should occur sequentially as listed. Several of the steps may occur concurrently or outside of the listed sequence when explicitly allowed so long as all timing relationships are satisfied.

Steps (b) through (m) shall be completed by Device 1 within 30 s from negation of RESET- by the host.

a) The host shall assert RESET- for a minimum of 25 µs after power to the device has stabilized within the system's specified tolerance. The device shall not recognize a signal assertion shorter than 20 ns as a valid RESET signal. Devices may respond to any signal assertion greater than 20 ns and shall recognize a signal equal to or greater than 25 us;
b) The device shall release INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after RESET- is negated;
c) The device shall set the BSY bit to one no later than 400 ns after RESET- is negated;
d) The device shall determine that it is Device 1;
e) Device 1 shall negate PDIAG- no later than 1 ms after RESET- is negated;
f) Steps (b), (c), (d), and (e) shall be completed before continuing;
g) Device 1 shall assert DASP- no later than 400 ms after RESET- is negated:
h) Device 1 should begin performing its hardware initialization and self-diagnostic testing;

i) Device 1 may revert to its default condition (the device's settings may now be in different conditions than they were before the RESET- was asserted by the host). All Ultra DMA modes shall be disabled;
j) If performed, the hardware initialization and self-diagnostic testing initiated in step (h) shall be completed before executing the following: Device 1 shall write its self-diagnostic testing results to the Error register. Table 10 defines the results values;
k) Device 1 shall set its signature values (see 9.1) and clear SRST in the Device Control register to zero. The effect on the Features register is undefined;
l) Clearing Status register bits:
    1) If the PACKET command feature set is not implemented by Device 1, Device 1 shall clear to zero bits 3, 2, and 0 of the Status register;
    2) If the PACKET command feature set is implemented by Device 1, Device 1 shall clear to zero bits 5, 4, 3, 2, and 0 of the Status register;
m) Clearing BSY:
    1) If the PACKET command feature set is not implemented by Device 1, then steps (g), (i), (j), and (k) shall be completed before executing the following: Device 1 shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one;
    2) If the PACKET command feature set is implemented by Device 1, then Device 1 shall return its operating modes to their specified initial conditions: MODE SELECT conditions shall be restored to their last saved values if saved values have been established; MODE SELECT conditions for which no values have been saved shall be returned to their default values; then Device 1 shall clear the BSY bit to zero when ready to accept commands;
n) Step (l) shall be completed before executing the following: If Device 1 passed its self-diagnostic testing, then Device 1 shall assert PDIAG-;
o) Setting DRDY:
    1) If the PACKET command feature set is not implemented by Device 1, then the DRDY bit shall be set to one within 30 s after the BSY bit has been cleared to zero. Steps (m) (1), (n), and (o) (1) may occur at the same time;
    2) If the PACKET command feature set is implemented by Device 1, then Device 1 shall not set DRDY to one;
p) Device 1 shall continue to assert DASP- and PDIAG- until after the first command is received from the host or until at least 31 s after RESET- is negated or until detecting that the host has set the SRST bit to one in the Device Control register, whichever comes first. Device 1 shall release PDIAG- no later than command completion of the next command from the host except for the EXECUTE DEVICE DIAGNOSTIC command.

9.3.1 Software reset - device 0

The following steps should occur sequentially as listed. Several of the steps may occur concurrently or outside of the listed sequence when explicitly allowed so long as all timing relationships are satisfied, e.g., Device 0 may continue to sample PDIAG- after Device 0 has completed writing the specified values to the Sector Count, Sector Number, Cylinder Low, Cylinder High, and Device/Head registers.

Steps (g) through (k) shall be completed within 31 s from Device 0 detecting that the SRST bit is cleared to zero.

a) The host shall set the SRST bit to one in the Device Control register. The host shall not clear the SRST bit to zero until at least 5 µs after setting the bit to one. The host shall not set the SRST bit to one until the bit has been cleared to zero for at least 5 µs;
b) The device shall release PDIAG-, INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after detecting that the SRST bit is equal to one;
c) Device 0 shall set the BSY bit to one no later than 400 ns after detecting that the SRST bit is equal to one;
d) Hardware initialization and self-diagnostic testing:
    1) If the PACKET command feature set is not implemented by the device, the device shall begin performing its hardware and self-diagnostic testing;
    2) If the PACKET command feature set is implemented by the device, the device may begin performing its hardware and self-diagnostic testing and the device is not expected to stop any background device activity (e.g., immediate command (see MMC and MMC2)) that was started prior to the time that the SRST was set to one in step (a);
e) Reverting to default:
    1) If the PACKET command feature set is not implemented by Device 0, then Device 0 may revert to its default condition (the device's settings may now be in different conditions than they were before the SRST bit was set to one by the host). However, the condition of any Ultra DMA mode (either enabled or disabled) shall not be affected by the host setting the SRST bit to one ;
    2) If the PACKET command feature set is implemented by Device 0, then Device 0 shall not revert to its default condition. However, the condition of any Ultra DMA mode (either enabled or disabled) shall not be affected by the host setting the SRST bit to one;
f) Device 0 shall wait for the host to clear the SRST bit to zero before continuing;
g) If Device 0 did not detect that DASP- was asserted by Device 1 during the most recent power cycle or hardware reset, then Device 0 shall clear bit 7 in the Error register to zero and go to step (i);
h) If Device 0 detected that DASP- was asserted by Device 1 during the most recent power cycle or hardware reset, then Device 0 shall sample PDIAG- for assertion by Device 1. Device 0 may sample PDIAG- at any frequency. This sampling shall not begin until at least 1 ms after SRST is cleared to zero. Device 0 may stop sampling PDIAG- upon detection of assertion. Device 0 shall not sample PDIAG- after the first command is received or later than 31 s after SRST is cleared to zero;
    1) If Device 0 detects that PDIAG- is asserted within 31 s after SRST is cleared to zero, then Device 0 shall clear bit 7 to zero in the Error register;
    2) If Device 0 does not detect that PDIAG- is asserted within 31 s after SRST is cleared to zero, then Device 0 shall set bit 7 to one in the Error register;
i) If performed, the hardware initialization and self-diagnostic testing initiated in step (d) shall be completed before executing the following: Device 0 shall write its self-diagnostic testing results to bits 6-0 in the Error register. Table 10 defines the results values;
j) Device 0 shall set its signature values (see 9.1). The effect on the Features register is undefined;
k) Clearing Status register bits:
    1) If the PACKET command feature set is not implemented by Device 0, Device 0 shall clear to zero bits 3, 2, and 0 of the Status register;
    2) If the PACKET command feature set is implemented by Device 0, Device 0 shall clear to zero bits 5, 3, 2, and 0 of the Status register;

l) Clearing BSY:
   1) If the PACKET command feature set is not implemented by Device 0, then Steps (g), (h) (as required), (i) and (j) shall be completed before executing the following: Device 0 shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one.
   2) If the PACKET command feature set is implemented by Device 0, then Device 0 shall return its operating modes to their specified initial conditions: MODE SELECT conditions shall be restored to their last saved values if saved values have been established; MODE SELECT conditions for which no values have been saved shall be returned to their default values; then Device 0 shall clear the BSY bit to zero when ready to accept commands;

m) Setting DRDY:
   1) If the PACKET command feature set is not implemented by Device 0, then the DRDY bit shall be set to one within 30 s after the BSY bit has been cleared to zero. Steps (l) (1) and (m) (1) may occur at the same time;
   2) If the PACKET command feature set is implemented by Device 0, then Device 0 shall not set DRDY to one;

9.3.2 Software reset - device 1

The following steps should occur sequentially as listed. Several of the steps may occur concurrently or outside of the listed sequence when explicitly allowed so long as all timing relationships are satisfied.

Steps (h) through (k) shall be completed within 30 s from Device 1 detecting that the SRST bit is cleared to zero.

a) The host shall set the SRST bit to one in the Device Control register. The host shall not clear the SRST bit to zero until at least 5 µs after setting the bit to one. The host shall not set the SRST bit to one until the bit has been cleared to zero for at least 5 µs;
b) The device shall release INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after detecting that the SRST bit is equal to one;
c) Device 1 shall set the BSY bit to one no later than 400 ns after detecting that the SRST bit is equal to one;
d) Device 1 shall negate PDIAG- no later than 1 ms after detecting that the SRST bit is equal to one;
e) Hardware initialization and self-diagnostic testing:
   1) If the PACKET command feature set is not implemented by the device, the device shall begin performing its hardware and self-diagnostic testing;
   2) If the PACKET command feature set is implemented by the device, the device may begin performing its hardware and self-diagnostic testing and the device is not expected to stop any background device activity (e.g., immediate command (see MMC and MMC2)) that was started prior to the time that the SRST was set to one in step (a);
f) Reverting to default:
   1) If the PACKET command feature set is not implemented by Device 1, then Device 1 may revert to its default condition (the device's settings may now be in different conditions than they were before the SRST bit was set to one by the host). However, the condition of any Ultra DMA mode (either enabled or disabled) shall not be affected by the host setting the SRST bit to one;
   2) If the PACKET command feature set is implemented by Device 1, then Device 1 shall not revert to its default condition. However, the condition of any Ultra DMA mode (either enabled or disabled) shall not be affected by the host setting the SRST bit to one;
g) Device 1 shall wait for the host to clear the SRST bit to zero before continuing;
h) If performed, the hardware initialization and self-diagnostic testing initiated in step (e) shall be completed before executing the following: Device 1 shall write its self-diagnostic testing results to the Error register. Table 10 defines the results values;
i) Device 1 shall set its signature values (see 9.1). The effect on the Features register is undefined;
j) Clearing Status register bits:
   1) If the PACKET command feature set is not implemented by Device 1, Device 1 shall clear to zero bits 3, 2, and 0 of the Status register;
   2) If the PACKET command feature set is implemented by Device 1, Device 1 shall clear to zero bits 5, 3, 2, and 0 of the Status register;

k) Clearing BSY:
   1) If the PACKET command feature set is not implemented by Device 1, then steps (h) and (i) shall be completed before executing the following: Device 1 shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one;
   2) If the PACKET command feature set is implemented by Device 1, then Device 1 shall return its operating modes to their specified initial conditions: MODE SELECT conditions shall be restored to their last saved values if saved values have been established; MODE SELECT conditions for which no values have been saved shall be returned to their default values; then Device 1 shall clear the BSY bit to zero when ready to accept commands;

l) Step (j) shall be completed before executing the following: If Device 1 passed its self-diagnostic testing, then Device 1 shall assert PDIAG-;

m) Setting DRDY:
   1) If the PACKET command feature set is not implemented by Device 1, then the DRDY bit shall be set to one within 30 s after the BSY bit has been cleared to zero. Steps (k) (1), (l), and (m) (1) may occur at the same time;
   2) If the PACKET command feature set is implemented by Device 1, then Device 1 shall not set DRDY to one;

n) Device 1 shall continue to assert PDIAG- until after the first command is received from the host or until at least 31 s after detecting that SRST is cleared to zero or until detecting that the host has set the SRST bit to one in the Device Control register, whichever comes first. Device 1 shall release PDIAG- no later than command completion of the next command from the host except for the EXECUTE DEVICE DIAGNOSTIC command.

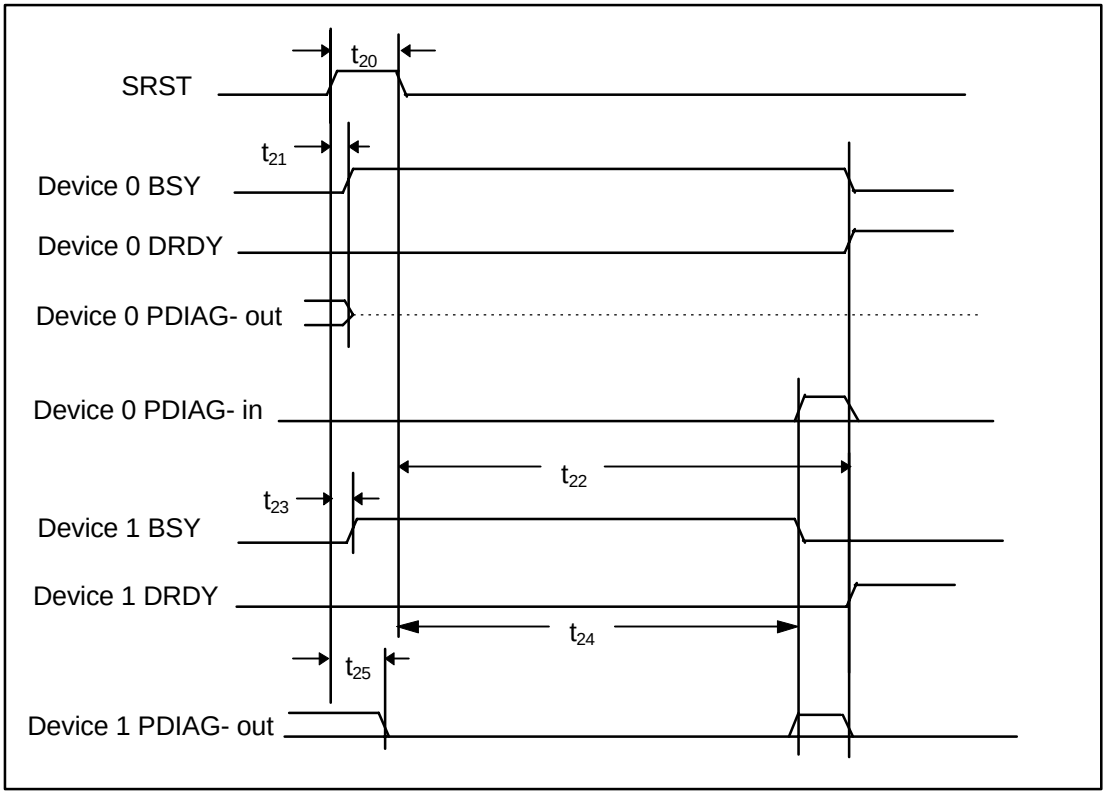


Figure 9 – BSY and DRDY timing for software reset

Table 26 – BSY and DRDY timing for software reset

SRST timing parameters		Min	Max	Note
t_{20}	SRST bit set to one	5 µs		
t_{21}	Device 0 SRST set to one to BSY bit set to one, release PDIAG-		400 ns	
t_{22}	Device 0 SRST cleared to zero to sample of PDIAG-	1 ms	31 s	1
t_{23}	Device 1 SRST set to one to BSY set to one		400 ns	
t_{24}	Device 1 SRST cleared to zero to BSY bit cleared to zero, PDIAG- asserted		30 s	2
t_{25}	Device 1 negate PDIAG- if asserted		1 ms	

NOTES –
1 Device 0 shall sample beginning 1 ms after SRST is cleared to zero. Sampling shall continue until PDIAG- assertion by Device 1 is sensed or 31 s has elapsed indicating Device 1 failed diagnostic.
2 Upon completion of internal diagnostics, Device 1 shall clear BSY to zero, and if diagnostics passed, assert PDIAG-. Internal diagnostics shall complete within 30 s of the SRST being cleared to zero.

9.4 DEVICE RESET protocol

If the host asserts RESET- before the device has completed executing a DEVICE RESET command, then the device shall start executing its hardware reset sequence at step (b).

If the host sets the SRST bit to one before the device has completed executing a DEVICE RESET command, the device shall start executing its software reset sequence at step (b).

The host should not issue a DEVICE RESET command while a DEVICE RESET command is in progress. If the host issues a DEVICE RESET command while a DEVICE RESET command is in progress, the results are indeterminate.

The following steps shall occur sequentially as listed.

Steps (b) through (i) shall be completed within 6 s from the device detecting that the command has been written.

a) The host shall write the DEVICE RESET command in the Command register;
b) The selected device shall release INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after detecting that the command has been written;
c) The device shall set the BSY bit to one no later than 400 ns after detecting that the command has been written;
d) The device should stop execution of any uncompleted command. The device is expected to end background device activity (e.g., immediate commands (see MMC and MMC2));
e) The device should not revert to its default condition. If the device reverts to its default condition, the device shall report a Unit Attention condition to a subsequent PACKET command;
f) The device shall clear bit 7 in the Error register to zero;
g) The device shall set its signature values (see 9.1). The effect on the Features register is undefined;
h) The device shall clear to zero bits 5, 3, 2, and 0 of the Status register;
i) MODE SELECT conditions shall not be altered;
j) The device shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one;
k) The device shall not set DRDY to one.

9.5 EXECUTE DEVICE DIAGNOSTIC protocol

The following steps should occur sequentially as listed. Several of the steps may occur concurrently or outside of the listed sequence so long as all timing relationships are satisfied, e.g.: Device 0 may continue

to sample PDIAG- after Device 0 has completed writing the specified values to the Sector Count, Sector Number, Cylinder Low, Cylinder High, and Device/Head registers.

If the host asserts RESET- before devices have completed executing their EXECUTE DEVICE DIAGNOSTIC sequences, then the devices shall start executing their hardware reset sequence at step (b).

If the host sets the SRST bit in the Device Control register to one before the devices have completed execution of their EXECUTE DEVICE DIAGNOSTIC sequences, then the devices shall start executing their software reset sequences at step (b).

The host shall not begin polling the Status register until at least 2 ms after the EXECUTE DEVICE DIAGNOSTIC command has been issued. The host should only interpret bits 6 and 7 of the Status register to determine command completion.

9.5.1 EXECUTE DEVICE DIAGNOSTIC - Device 0

Device 0 performs the following operations for this command.

Steps (a) through (i) shall be completed within 6 s after the EXECUTE DEVICE DIAGNOSTIC command is received:

a) The device shall release PDIAG-, INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after the EXECUTE DEVICE DIAGNOSTIC command is received;
b) Device 0 shall set the BSY bit to one no later than 400 ns after the EXECUTE DEVICE DIAGNOSTIC command is received;
c) Device 0 should begin performing its self-diagnostic testing;
d) Steps (a), (b), and (c) shall be completed before continuing;
e) If Device 0 did not detect that DASP- was asserted by Device 1 during the most recent power cycle or hardware reset, then Device 0 shall clear bit 7 to zero in the Error register and go to step (g);
f) If Device 0 detected that DASP- was asserted by Device 1 during the most recent power cycle or hardware reset, then Device 0 shall sample PDIAG- for assertion by Device 1. Device 0 may sample PDIAG- at any frequency. This sampling shall not begin until at least 1 ms after the EXECUTE DEVICE DIAGNOSTIC command is received. Device 0 may stop sampling PDIAG- upon detection of assertion. Device 0 shall not sample PDIAG- later than 6 s after the EXECUTE DEVICE DIAGNOSTIC command is received after the next command is received;
    1) If Device 0 detects that PDIAG- is asserted within 6 s after the EXECUTE DEVICE DIAGNOSTIC command is received, then Device 0 shall clear bit 7 to zero in the Error register;
    2) If Device 0 does not detect that PDIAG- is asserted within 6 s after the EXECUTE DEVICE DIAGNOSTIC command is received, then Device 0 shall set bit 7 to one in the Error register;
g) If performed, the self-diagnostic testing initiated in step (c) shall be completed before executing the following: Device 0 shall write its self-diagnostic testing results to bits 6-0 of the Error Register. Table 10 defines the results values;
h) Device 0 shall set its signature values (see 9.1). The effect on the Features register is undefined;
i) Clearing Status register bits:
    1) If the PACKET command feature set is not implemented by Device 0, Device 0 shall clear to zero bits 3, 2, and 0 of the Status register;
    2) If the PACKET command feature set is implemented by Device 0, Device 0 shall clear to zero bits 5, 4, 3, 2, and 0 of the Status register;
j) Clearing BSY:
    1) If the PACKET Command feature set is not implemented by Device 0, then Steps (e), (f) (as required), (g) and (h) shall be completed before executing the following: Device 0 shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one.
    2) If the PACKET Command feature set is implemented by Device 0, then Device 0 shall return its operating modes to their specified initial conditions: MODE SELECT conditions shall be restored to their last saved values if saved values have been established; MODE SELECT conditions for which no values have been saved shall be returned to their default values; then Device 0 shall clear the BSY bit to zero when ready to accept commands;

k) Setting DRDY:
   1) If the PACKET Command feature set is not implemented by Device 0, then the DRDY bit shall be set to one within 30 s after the BSY bit has been cleared to zero. Steps (i) (1) and (j) (1) may occur at the same time;
   2) If the PACKET Command feature set is implemented by Device 0, then Device 0 shall not set DRDY to one;
l) After completing the above steps, Device 0 shall assert INTRQ if nIEN is cleared to zero.

9.5.2 EXECUTE DEVICE DIAGNOSTIC - Device 1

Device 1 performs the following operations for this command.

The following steps should occur sequentially as listed. Several of the steps may occur concurrently or outside of the listed sequence so long as all timing relationships are satisfied.

Steps (a) through (i) shall be completed within 5 s after the EXECUTE DEVICE DIAGNOSTIC command is received:

a) The device shall release INTRQ, IORDY, DMARQ, and DD(15:0) no later than 400 ns after the EXECUTE DEVICE DIAGNOSTIC command is received;
b) Device 1 shall set the BSY bit to one no later than 400 ns after the EXECUTE DEVICE DIAGNOSTIC command is received;
c) Device 1 shall negate PDIAG- no later than 1 ms after the EXECUTE DEVICE DIAGNOSTIC command is received;
d) Device 1 should initiate performance of its self-diagnostic testing;
e) Steps (a), (b), (c), and (d) shall be completed before continuing.
f) If performed, the self-diagnostic testing initiated in step (d) shall be completed before executing the following: Device 1 shall write its self-diagnostic testing results to the Error register. Table 10 defines the results values;
g) Device 1 shall set its signature values (see 9.1). The effect on the Features register is undefined;
h) Clearing Status register bits:
   1) If the PACKET command feature set is not implemented by Device 1, Device 1 shall clear to zero bits 3, 2, and 0 of the Status register;
   2) If the PACKET command feature set is implemented by Device 1, Device 1 shall clear to zero bits 5, 4, 3, 2, and 0 of the Status register;
i) Clearing BSY:
   1) If the PACKET Command feature set is not implemented by Device 1, then steps (f) and (g) shall be completed, , before executing the following: Device 1 shall clear the BSY bit to zero when ready to accept commands that do not require the DRDY bit to be equal to one;
   2) If the PACKET Command feature set is implemented by Device 1, then Device 1 shall return its operating modes to their specified initial conditions: MODE SELECT conditions shall be restored to their last saved values if saved values have been established; MODE SELECT conditions for which no values have been saved shall be returned to their default values; then Device 1 shall clear the BSY bit to zero when ready to accept commands;
j) Step (h) shall be completed before executing the following: If Device 1 passed its self-diagnostic testing during step (d), then Device 1 shall assert PDIAG-;
k) Setting DRDY:
   1) If the PACKET Command feature set is not implemented by Device 1, then the DRDY bit shall be set to one within 30 s after the BSY bit has been cleared to zero. Steps (h) (1), (i), and (j) (1) may occur at the same time;
   2) If the PACKET Command feature set is implemented by Device 1, then Device 1 shall not set DRDY to one;
l) Device 1 shall continue to assert PDIAG- until after the first command is received from the host or until 31 s after the EXECUTE DEVICE DIAGNOSTIC command is received or until detecting that the host has set the SRST bit to one in the Device Control register, whichever comes first. Device 1 shall release PDIAG- no later than command completion of the next command from the host except for the EXECUTE DEVICE DIAGNOSTIC command.

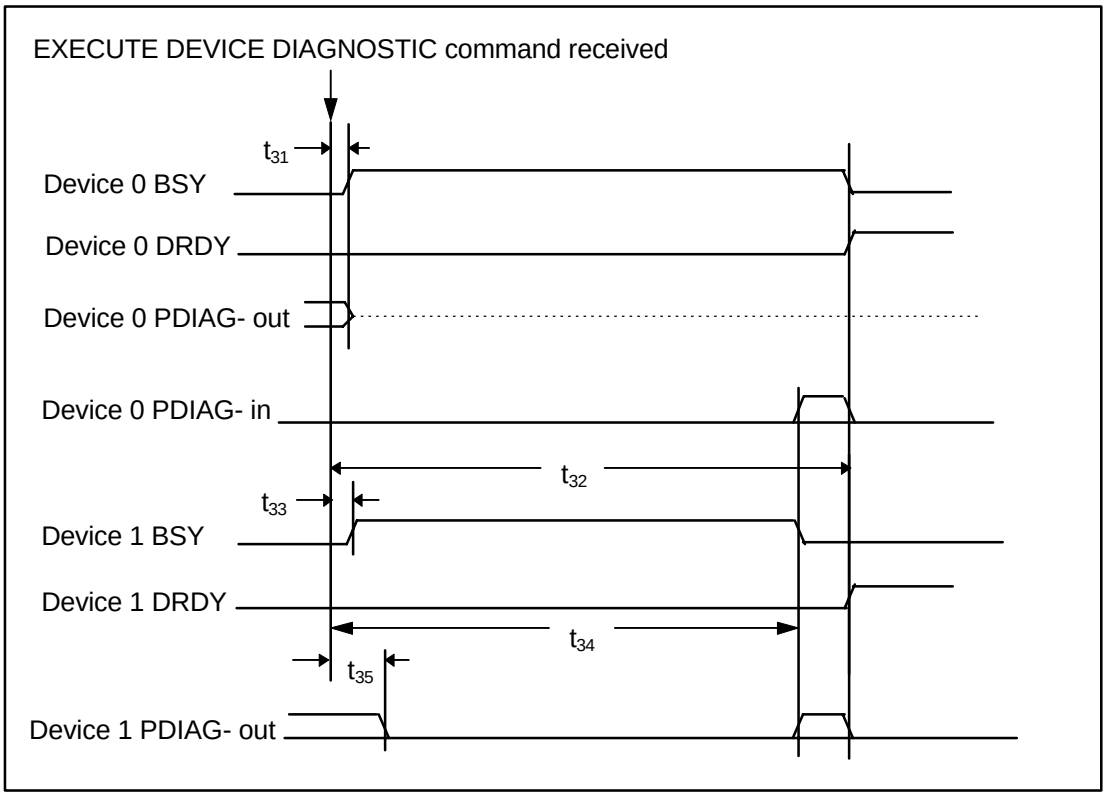


Figure 10 – **BSY and DRDY timing for diagnostic command**

Table 27 – **BSY and DRDY timing for diagnostic command**

EXECUTE DEVICE DIAGNOSTIC timing parameters		**Min**	**Max**	**Note**
t_{31}	Device 0 command received to BSY bit set to one, release PDIAG-		400 ns	
t_{32}	Device 0 command received to sample of PDIAG-	1 ms	6 s	1
t_{33}	Device 1 command received to BSY set to one		400 ns	
t_{34}	Device 1 command received to BSY bit cleared to zero, PDIAG- asserted		5 s	2
t_{35}	Device 1 negate PDIAG- if asserted		1 ms	

NOTES –
1 Device 0 shall sample beginning 1 ms after receipt of the command. Sampling shall continue until PDIAG- assertion by Device 1 is sensed or 6 s has elapsed indicating Device 1 failed diagnostic.
2 Upon completion of internal diagnostics, Device 1 shall clear BSY to zero, and if diagnostics passed, assert PDIAG-. Internal diagnostics shall complete within 5 s of the receipt of the command.

9.6 Device selection protocol

Before issuing any command to a device except the DEVICE RESET command, the host shall insure that the selected device is no longer busy, select the desired device, and insure that it is ready to accept a command. Figure 11 describes the protocol for device selection.

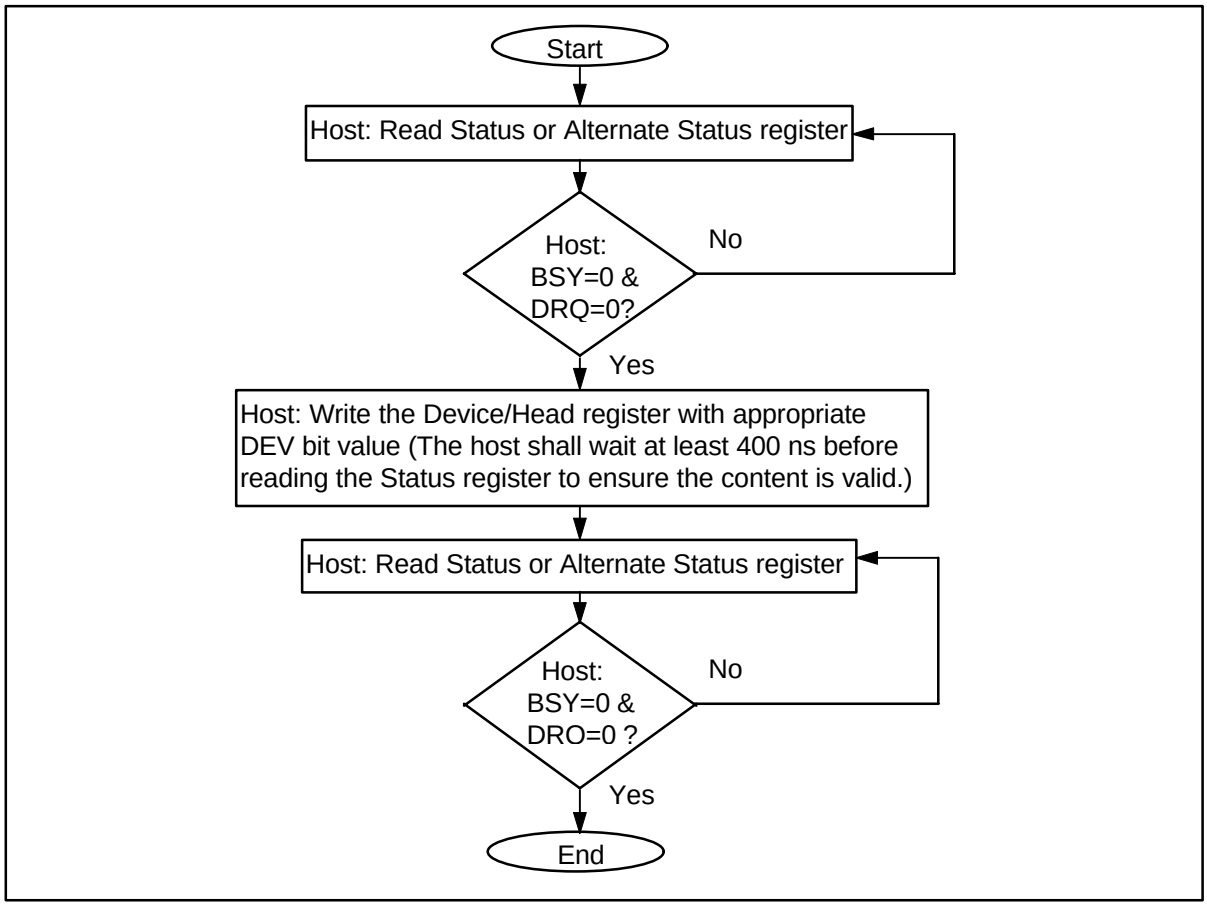


Figure 11 – **Device selection protocol**

9.7 PIO data in command protocol

This class includes:

- CFA TRANSLATE SECTOR
- IDENTIFY DEVICE
- IDENTIFY PACKET DEVICE
- READ BUFFER
- READ MULTIPLE
- READ SECTOR(S)
- SMART READ DATA

Execution of this class of command includes the transfer of one or more blocks of data from the device to the host. Figure 12 describes the protocol of a PIO data in command. This description does not include all possible error conditions.

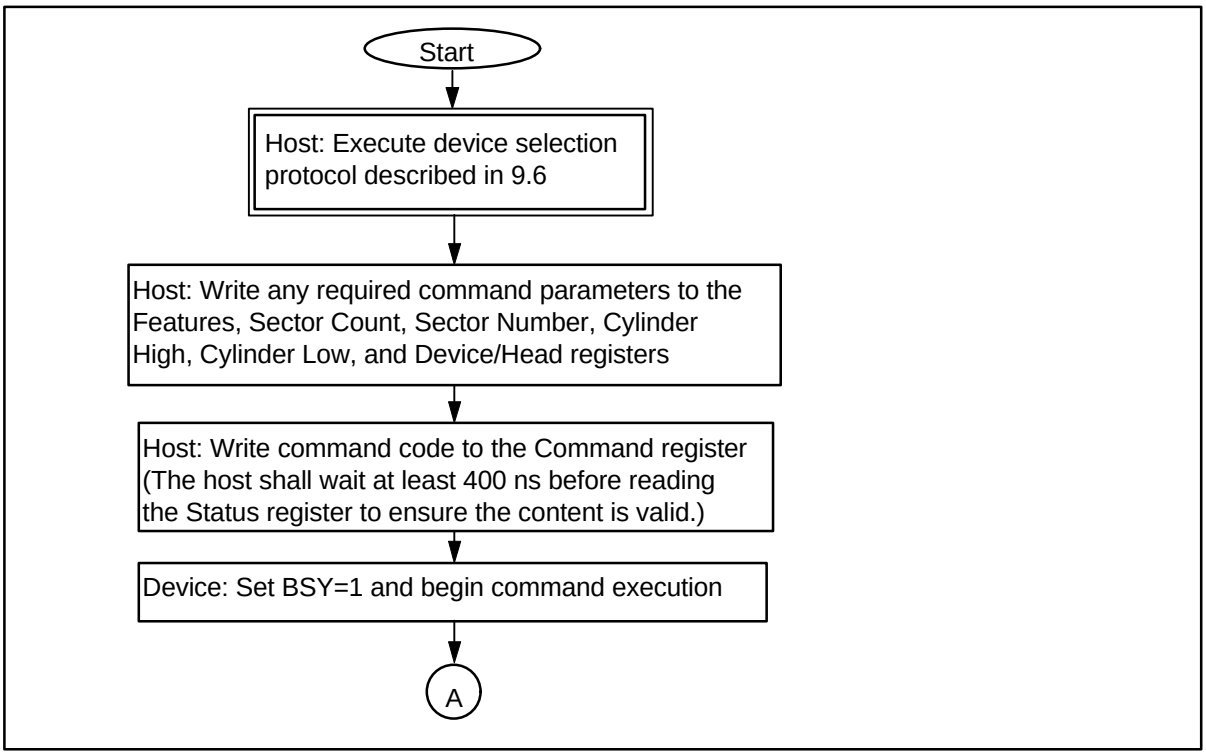


Figure 12 – **PIO data in command protocol** *(continued)*

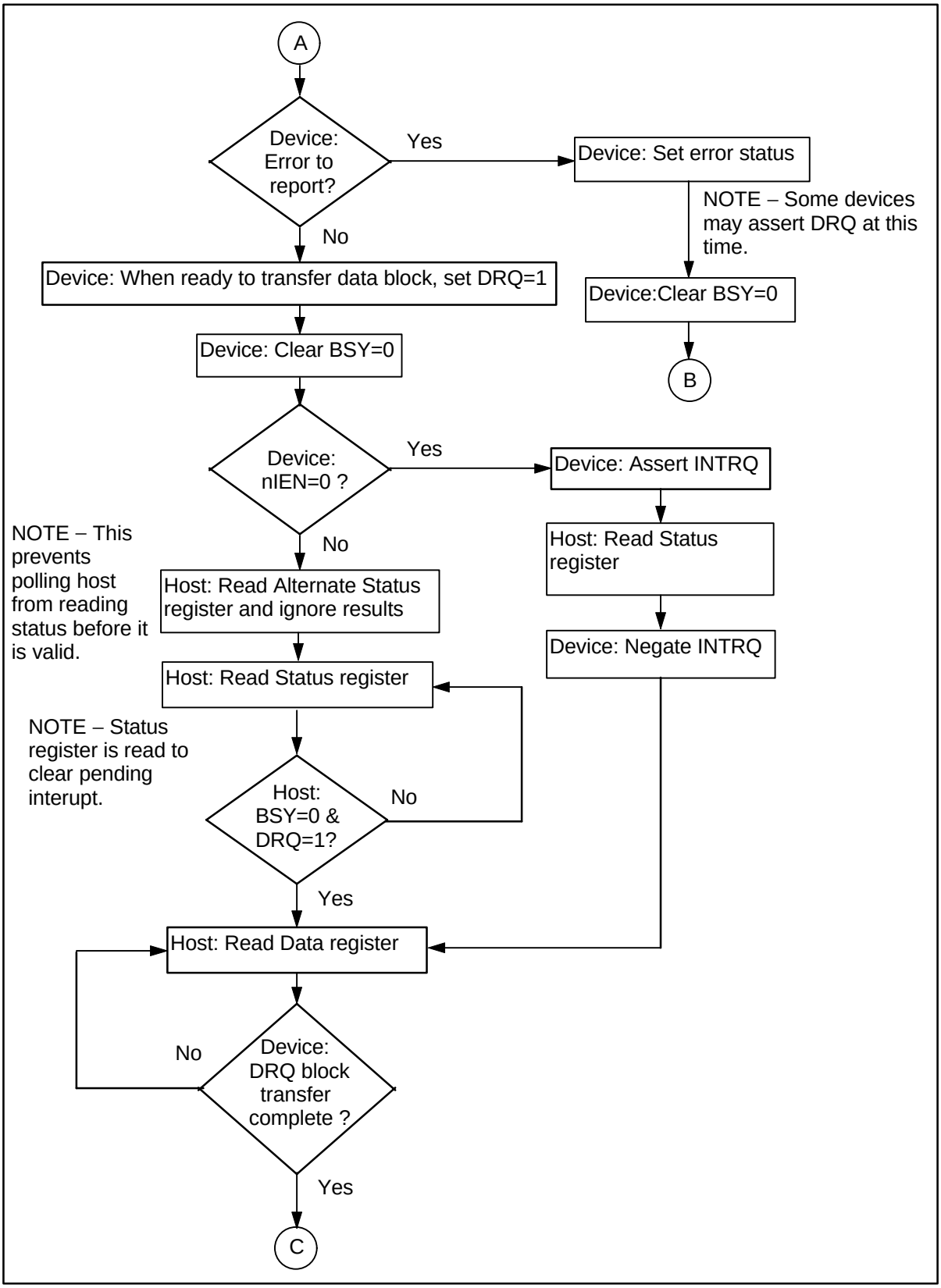


Figure 12 – **PIO data in command protocol** *(continued)*

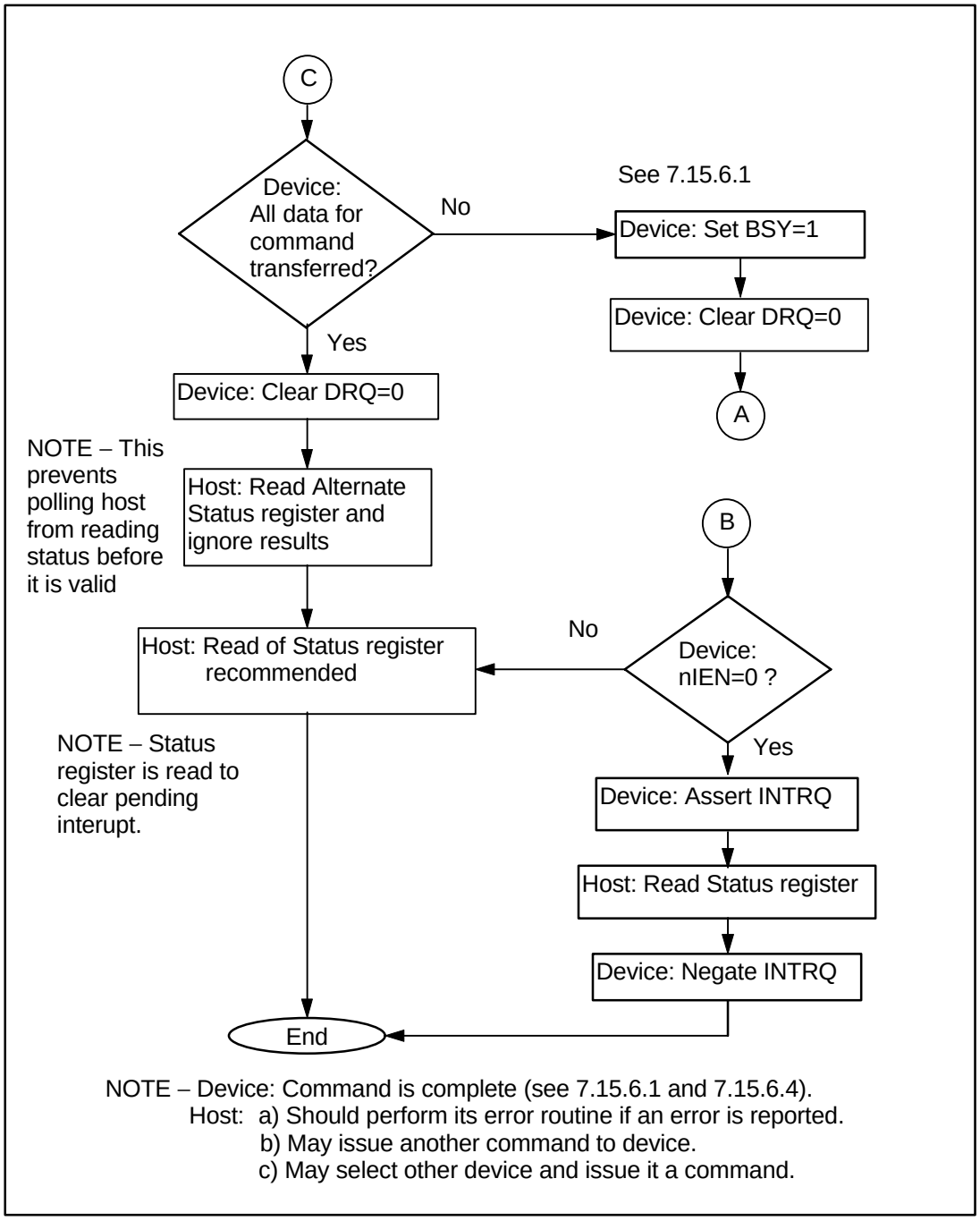


Figure 12 – PIO data in command protocol *(concluded)*

9.8 PIO data out command protocol

This class includes:

- CFA WRITE MULTIPLE WITHOUT ERASE
- CFA WRITE SECTORS WITHOUT ERASE
- DOWNLOAD MICROCODE
- SECURITY DISABLE PASSWORD
- SECURITY ERASE UNIT
- SECURITY SET PASSWORD
- SECURITY UNLOCK
- WRITE BUFFER
- WRITE MULTIPLE
- WRITE SECTOR(S)

Execution of this class of command includes the transfer of one or more blocks of data from the host to the device. Figure 13 describes the protocol of a PIO data out command. This description does not include all possible error conditions.

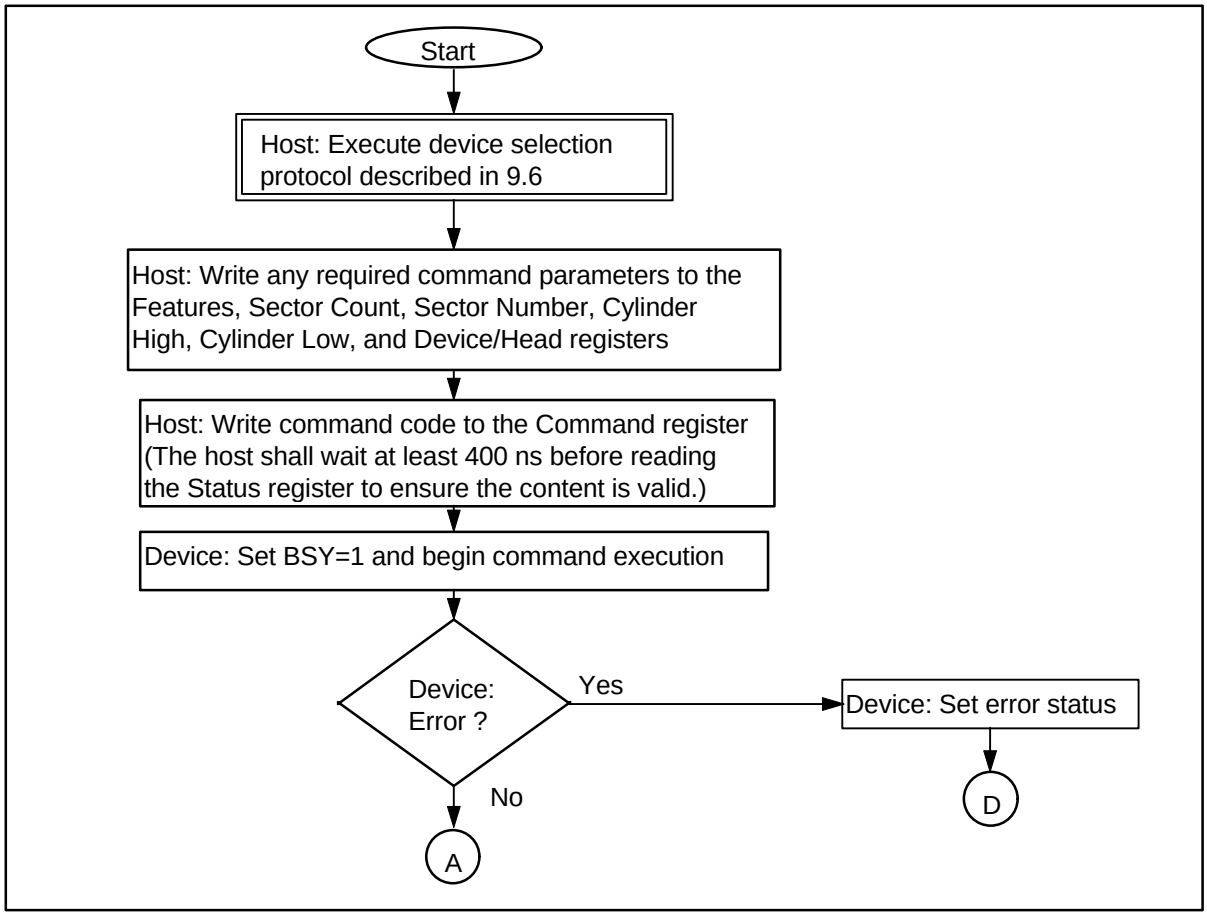


Figure 13 – **PIO data out command protocol** *(continued)*

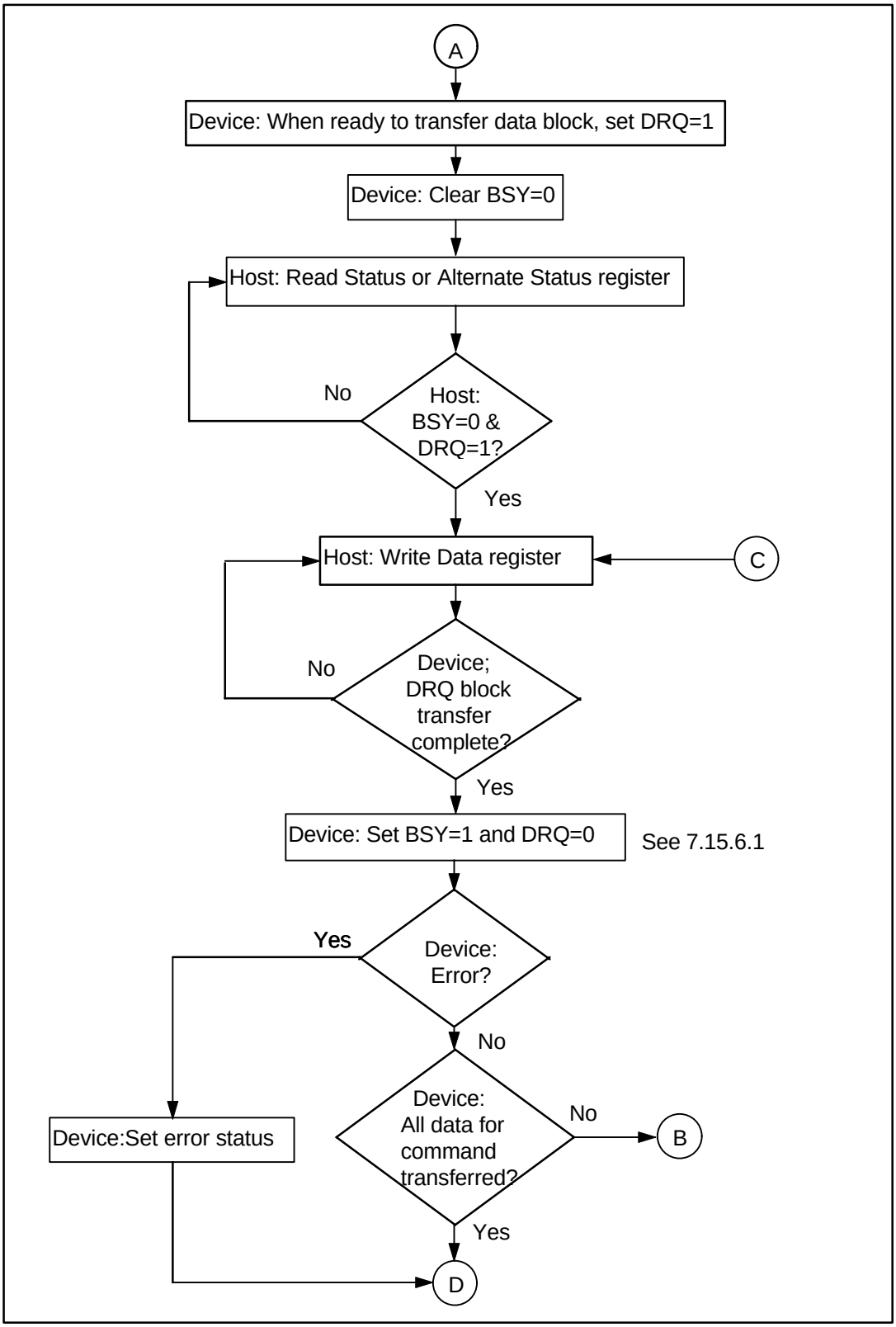


Figure 13 – PIO data out command protocol *(continued)*

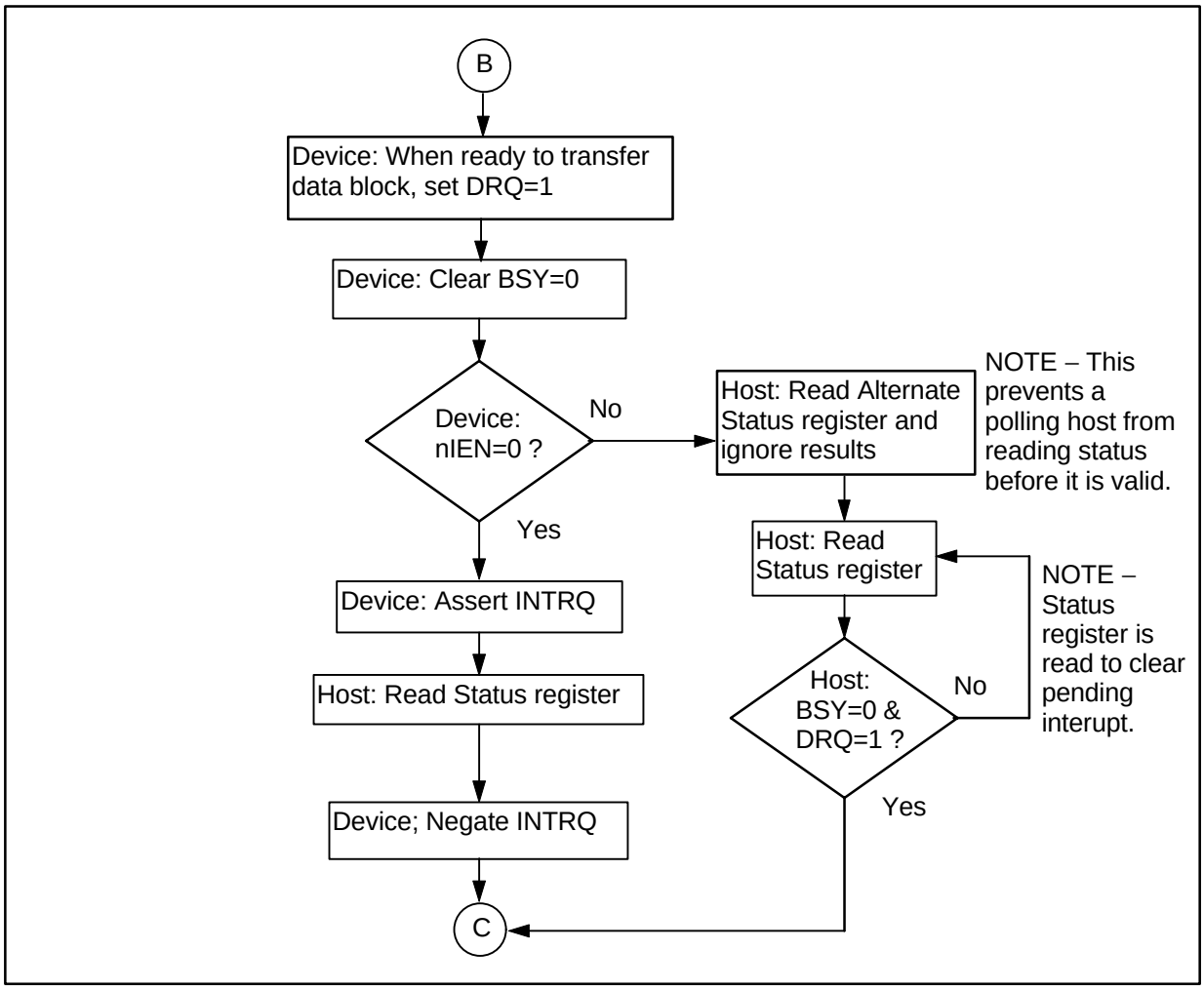


Figure 13 – **PIO data out command protocol** *(continued)*

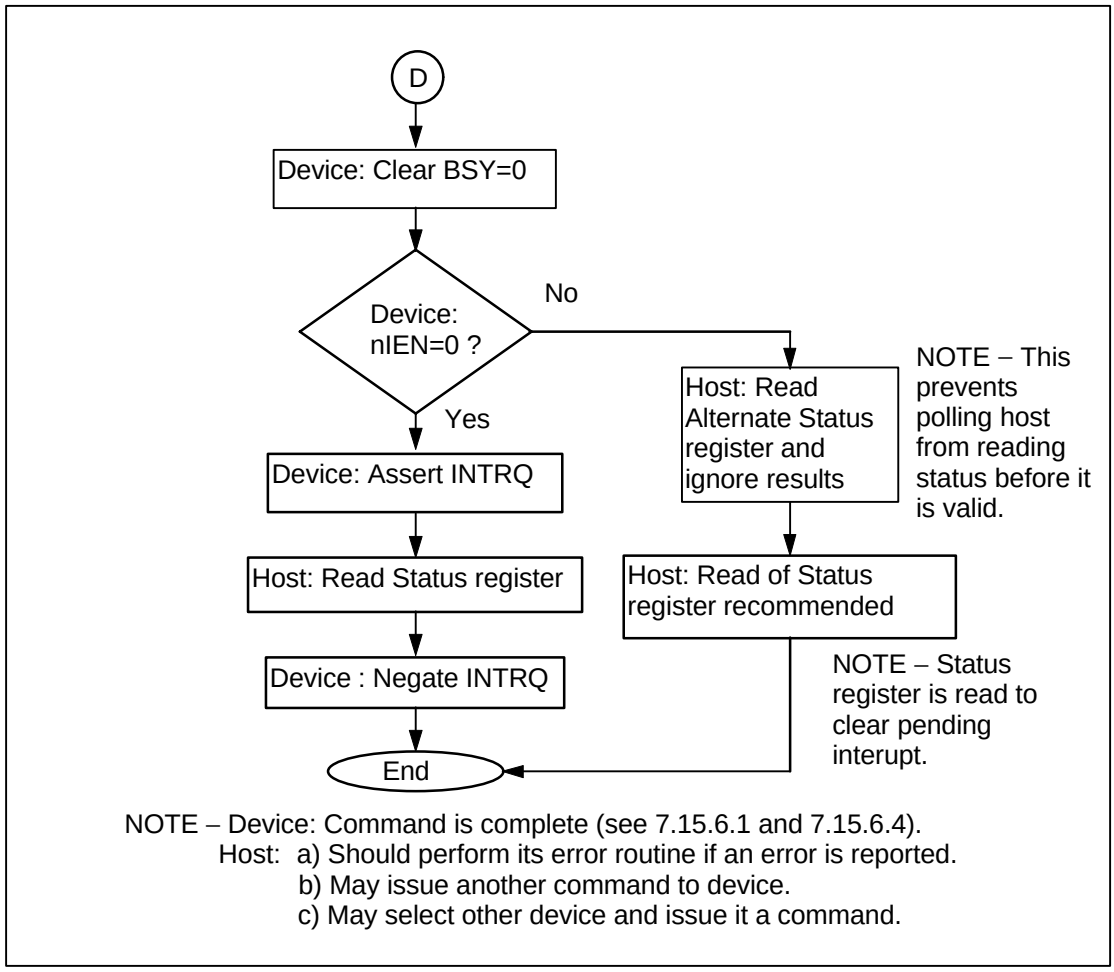


Figure 13 – PIO data out command protocol *(concluded)*

9.9 Non-data command protocol

This class includes:

- CFA ERASE SECTORS
- CFA REQUEST EXTENDED ERROR CODE
- CHECK POWER MODE
- FLUSH CACHE
- GET MEDIA STATUS
- IDLE
- IDLE IMMEDIATE
- INITIALIZE DEVICE PARAMETERS
- MEDIA EJECT
- MEDIA LOCK
- MEDIA UNLOCK
- NOP
- READ NATIVE MAX ADDRESS
- READ VERIFY SECTOR(S)
- SECURITY ERASE PREPARE
- SECURITY FREEZE LOCK
- SEEK
- SET FEATURES
- SET MAX ADDRESS
- SET MULTIPLE MODE
- SLEEP
- SMART DISABLE OPERATION
- SMART ENABLE/DISABLE AUTOSAVE
- SMART ENABLE OPERATION
- SMART EXECUTE OFFLINE IMMEDIATE
- SMART RETURN STATUS
- STANDBY
- STANDBY IMMEDIATE

Execution of these commands involves no data transfer. Figure 14 describes the protocol of a no data transfer command. This description does not include all possible error conditions.

See the NOP command description in 0 and the SLEEP command description in 8.40 for additional protocol requirements.

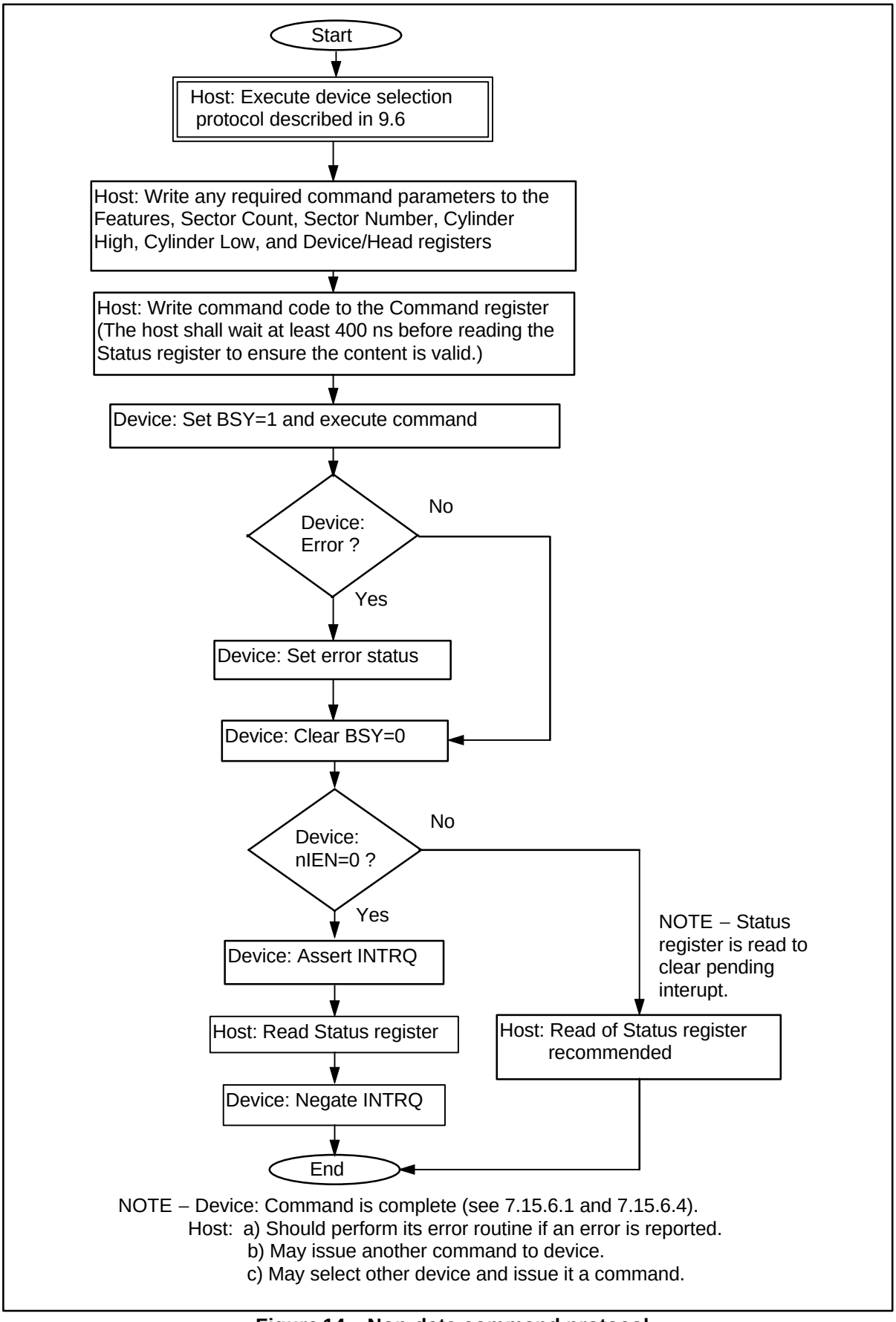


Figure 14 – Non-data command protocol

9.10 DMA command protocol

This class comprises:

- READ DMA
- WRITE DMA

Data transfers using DMA commands differ in two ways from PIO transfers:

1) data transfers are performed using the DMA channel;

2) A Single interrupt is issued at command completion.

Initiation of the DMA transfer commands is identical to the READ SECTOR(S) or WRITE SECTOR(S) commands except that the host initializes the DMA channel prior to issuing the command.

The interrupt handler for DMA transfers is different in that no intermediate sector interrupts are issued on multi-sector commands.

Figure 15 describes the protocol of a DMA command..

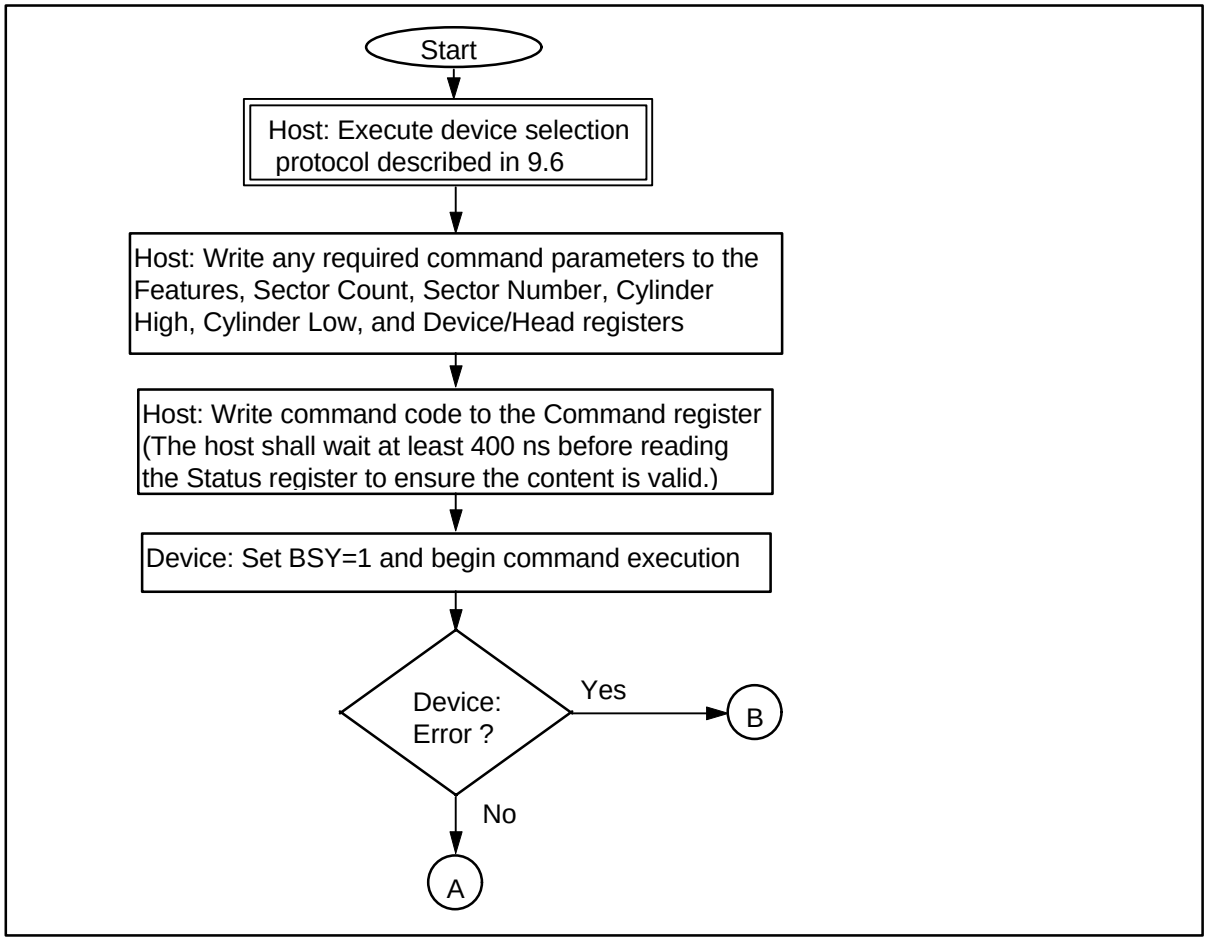
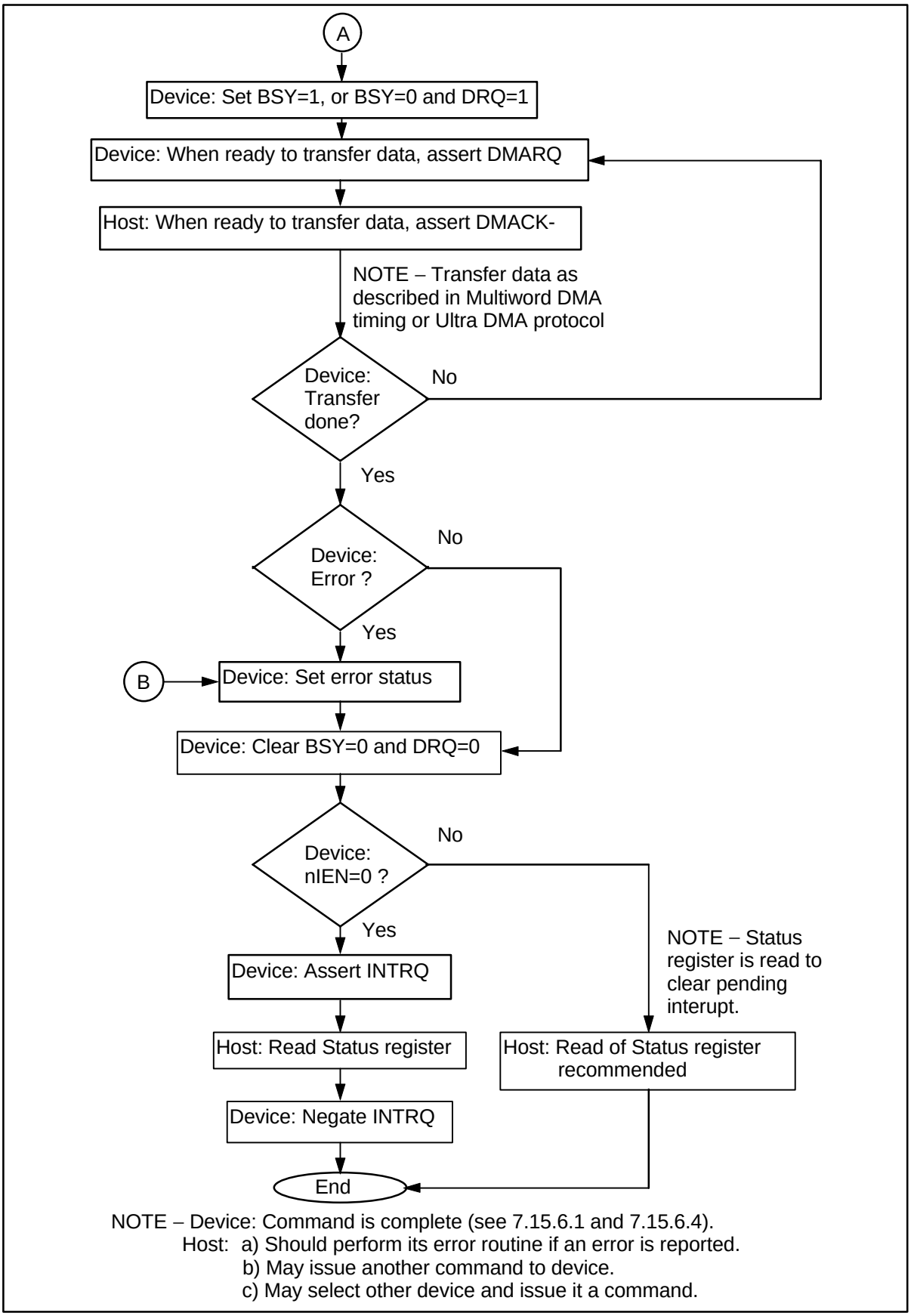


Figure 15 – DMA command protocol *(continued)*



NOTE – Device: Command is complete (see 7.15.6.1 and 7.15.6.4).
Host: a) Should perform its error routine if an error is reported.
b) May issue another command to device.
c) May select other device and issue it a command.

Figure 15 – DMA command protocol *(concluded)*

9.11 PACKET command protocol

This class comprises:

- PACKET
- SERVICE

The use of the PACKET command includes two different protocols. Figure 16 describes the use of the PACKET command for non data transfer and PIO data transfer commands. Figure 17 describes DMA transfer commands.

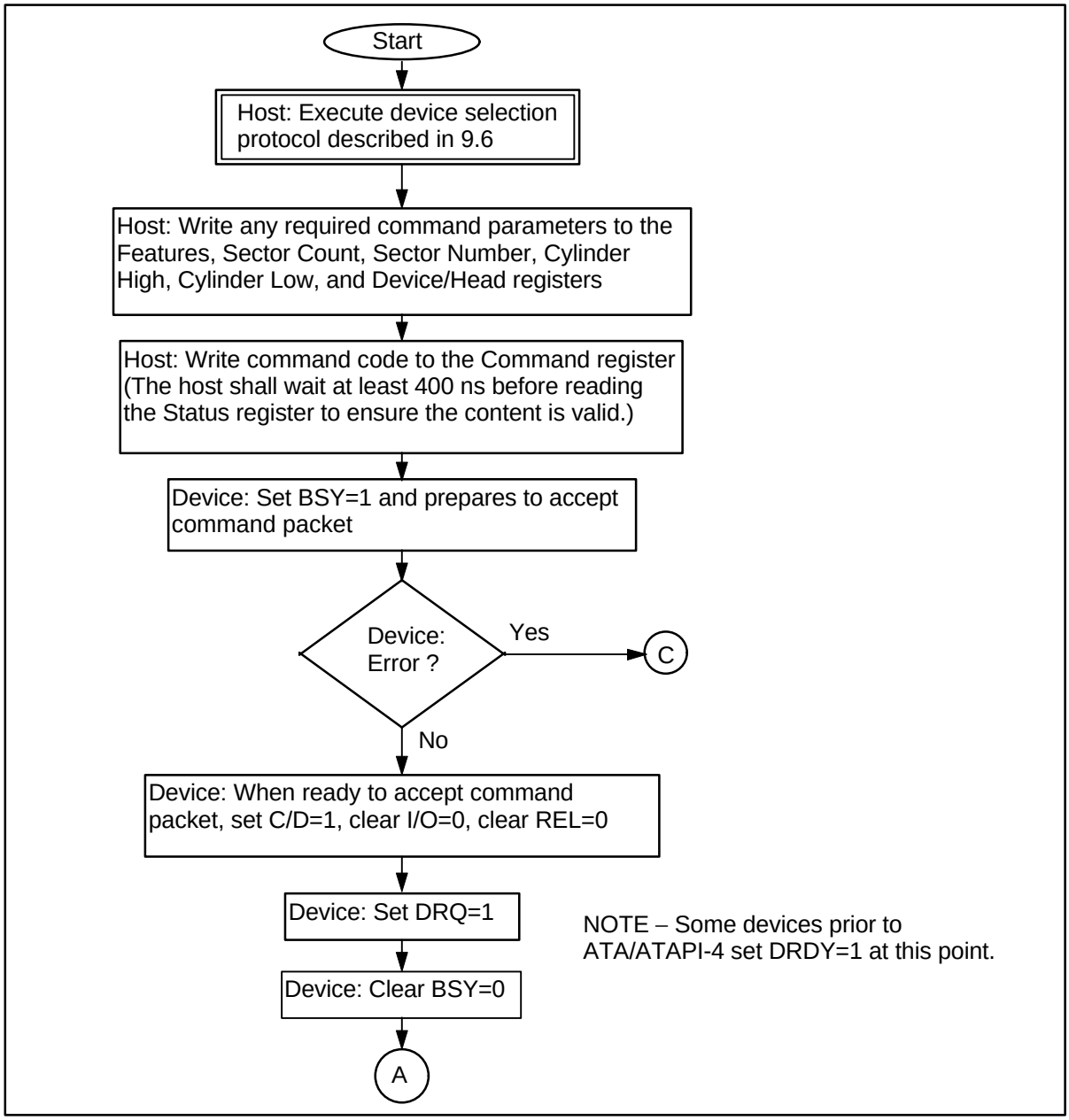


Figure 16 – PACKET non-data and PIO data command protocol *(continued)*

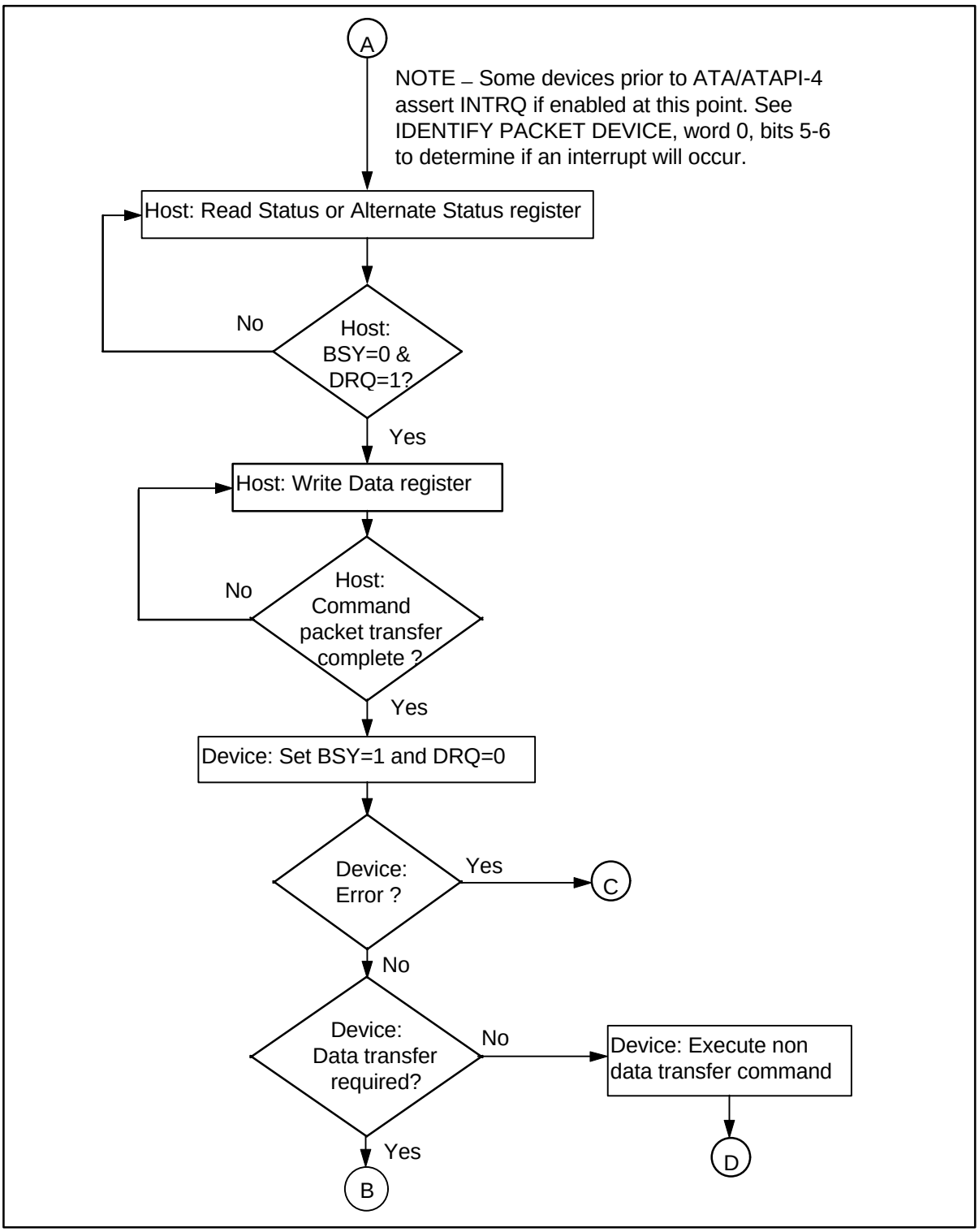


Figure 16 – **PACKET non-data and PIO data command protocol** *(continued)*

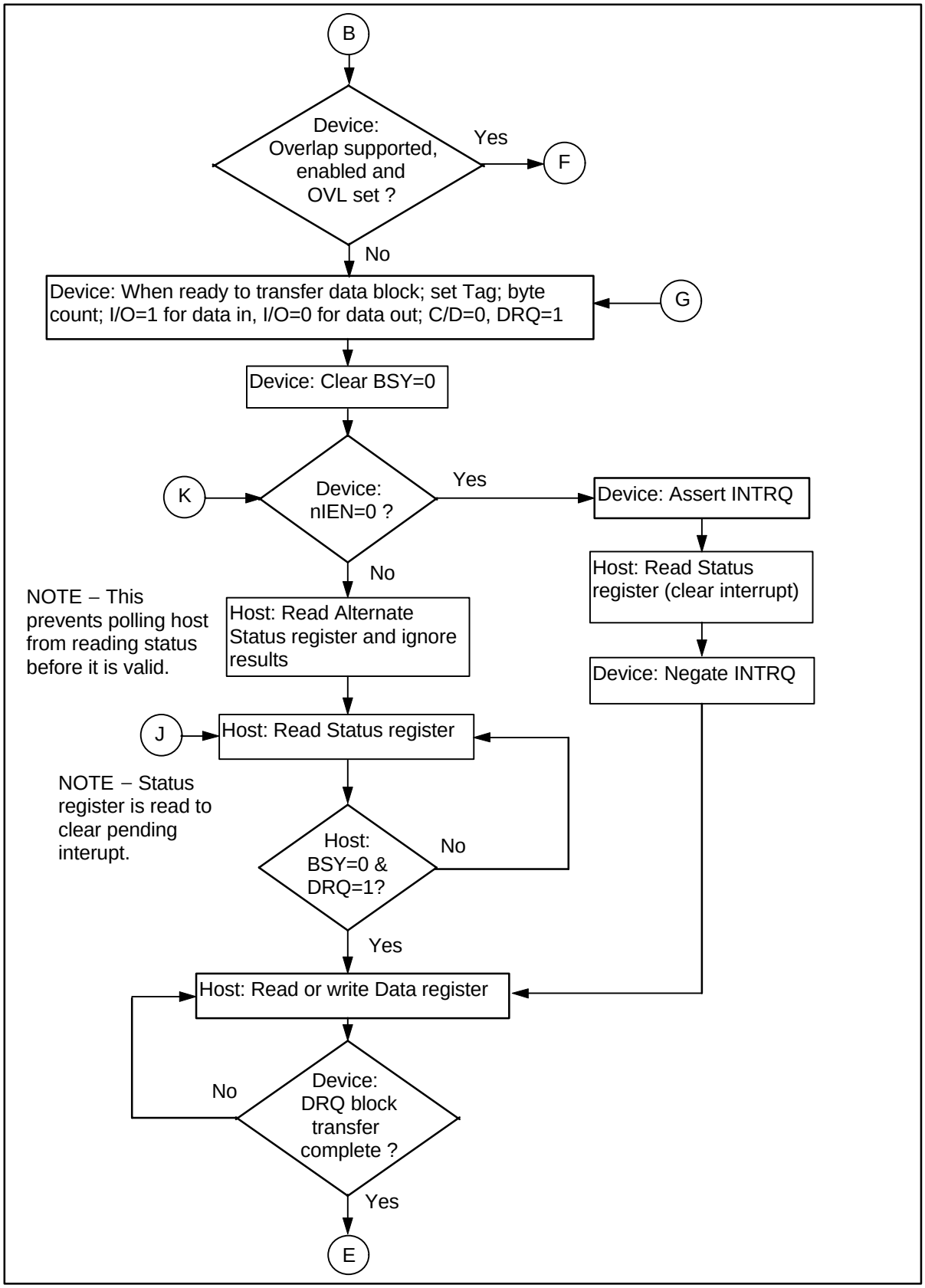


Figure 16 – PACKET non-data and PIO data command protocol *(continued)*

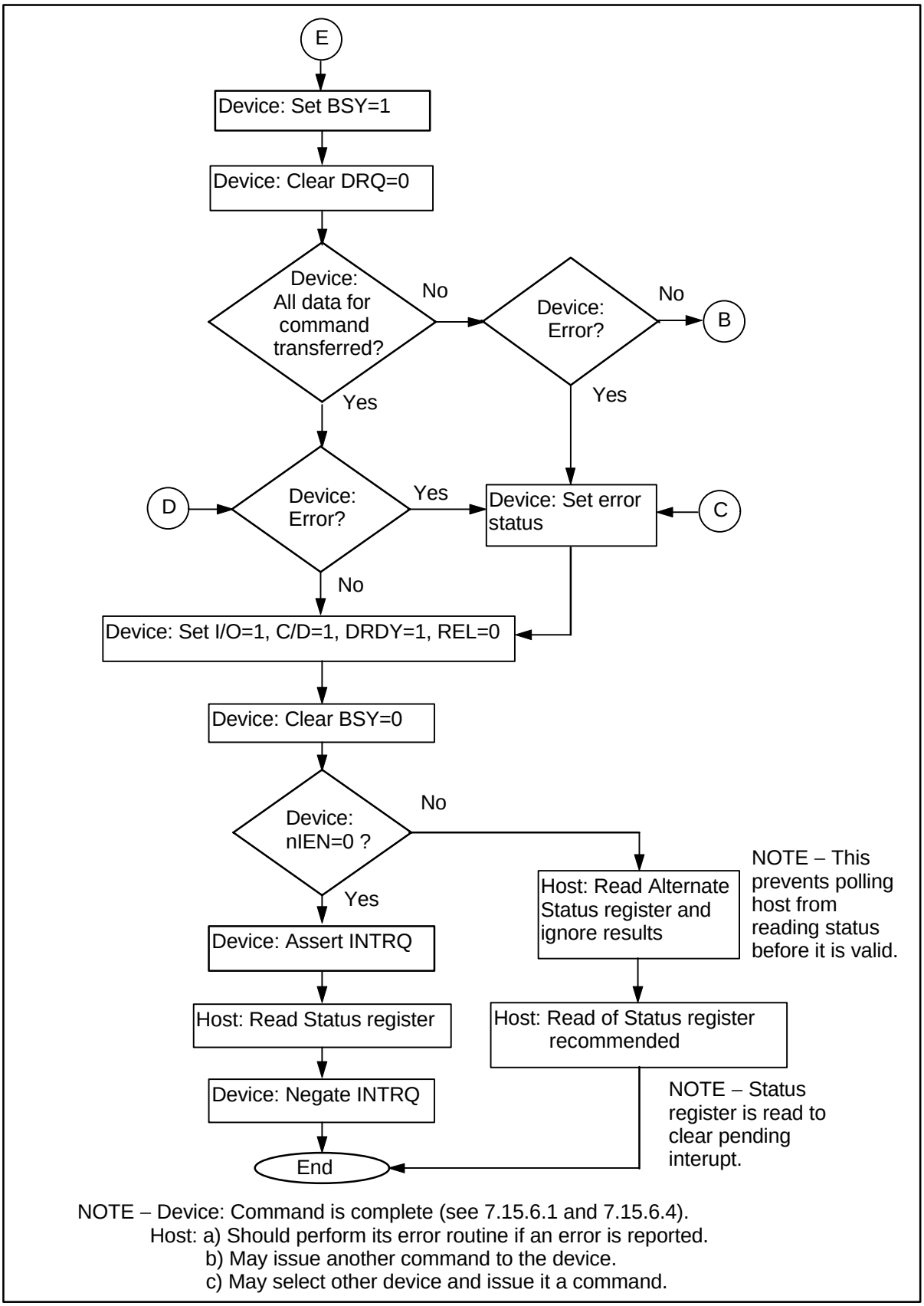


Figure 16 – PACKET non-data and PIO data command protocol *(continued)*

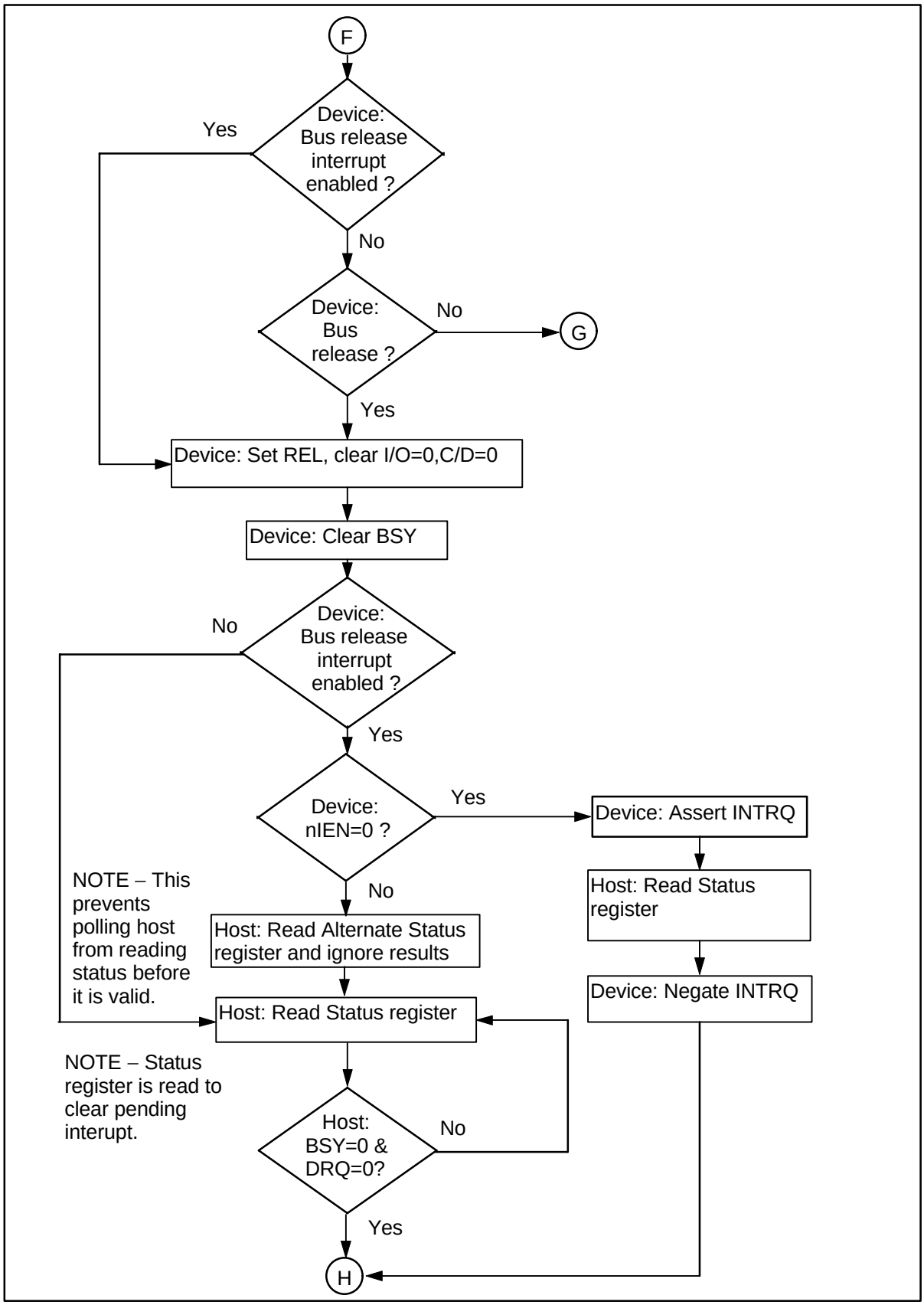


Figure 16 – PACKET non-data and PIO data command protocol *(continued)*

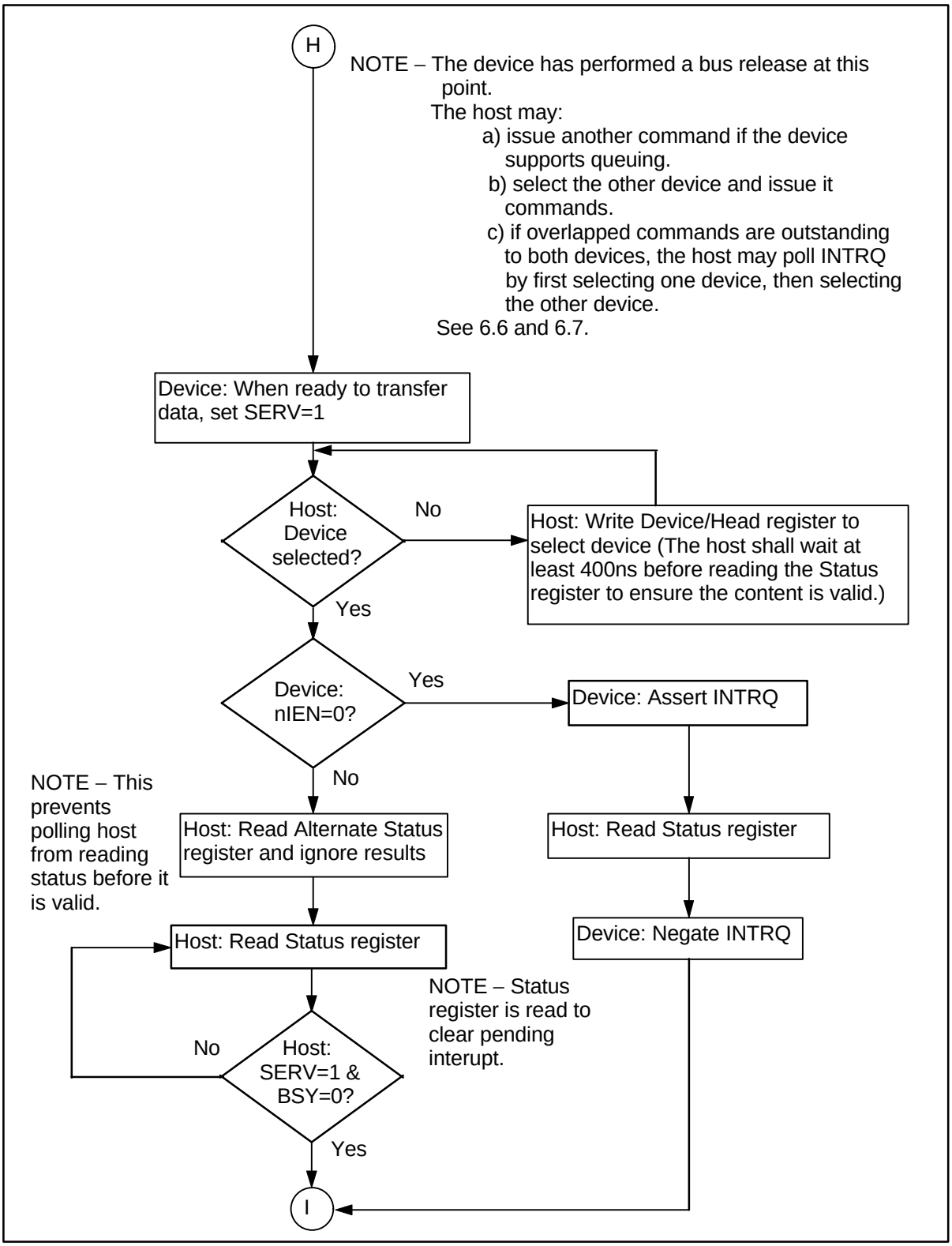


Figure 16 – PACKET non-data and PIO data command protocol *(continued)*

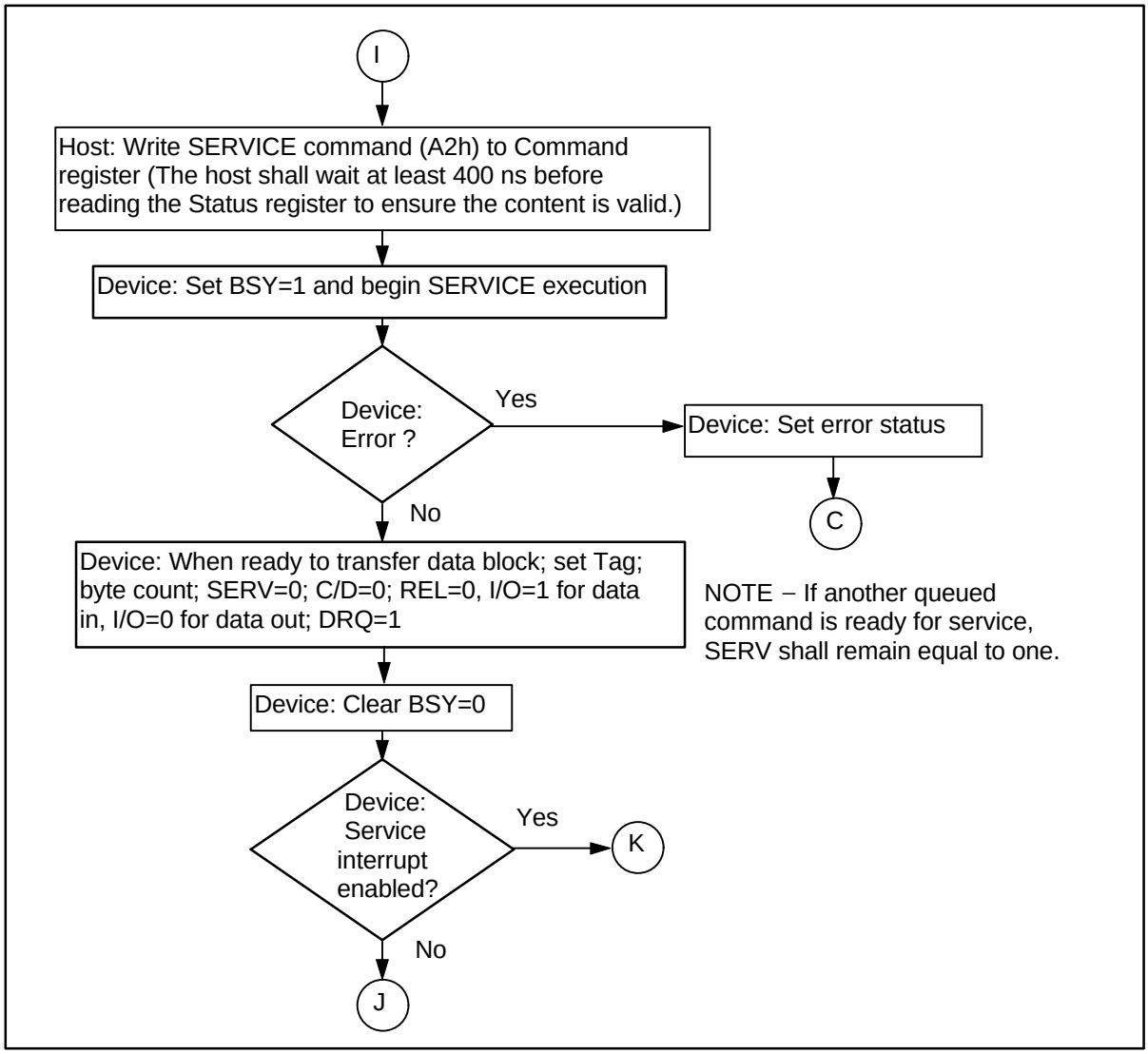


Figure 16 – PACKET non-data and PIO data command protocol *(concluded)*

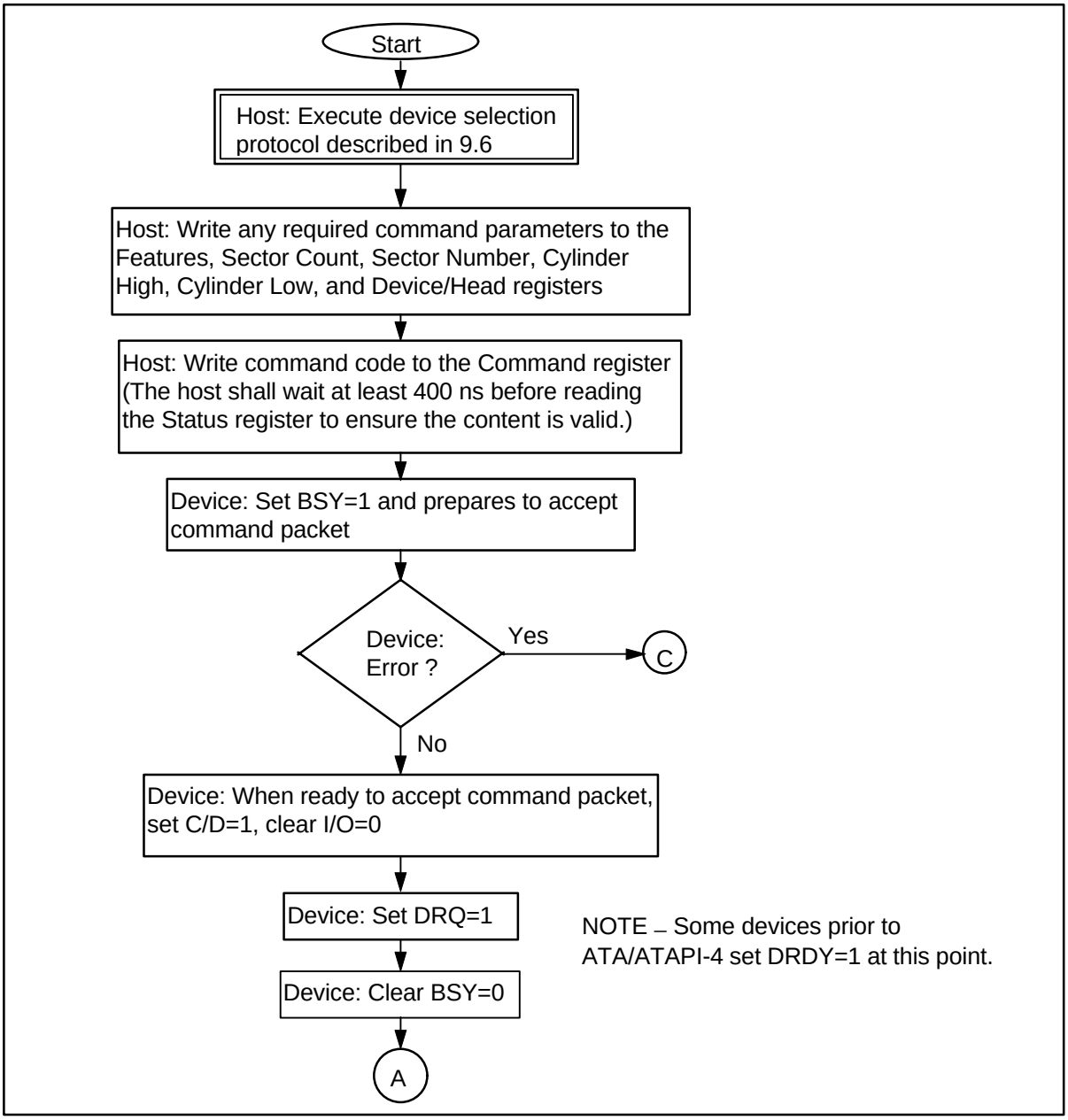


Figure 17 – PACKET DMA command protocol *(continued)*

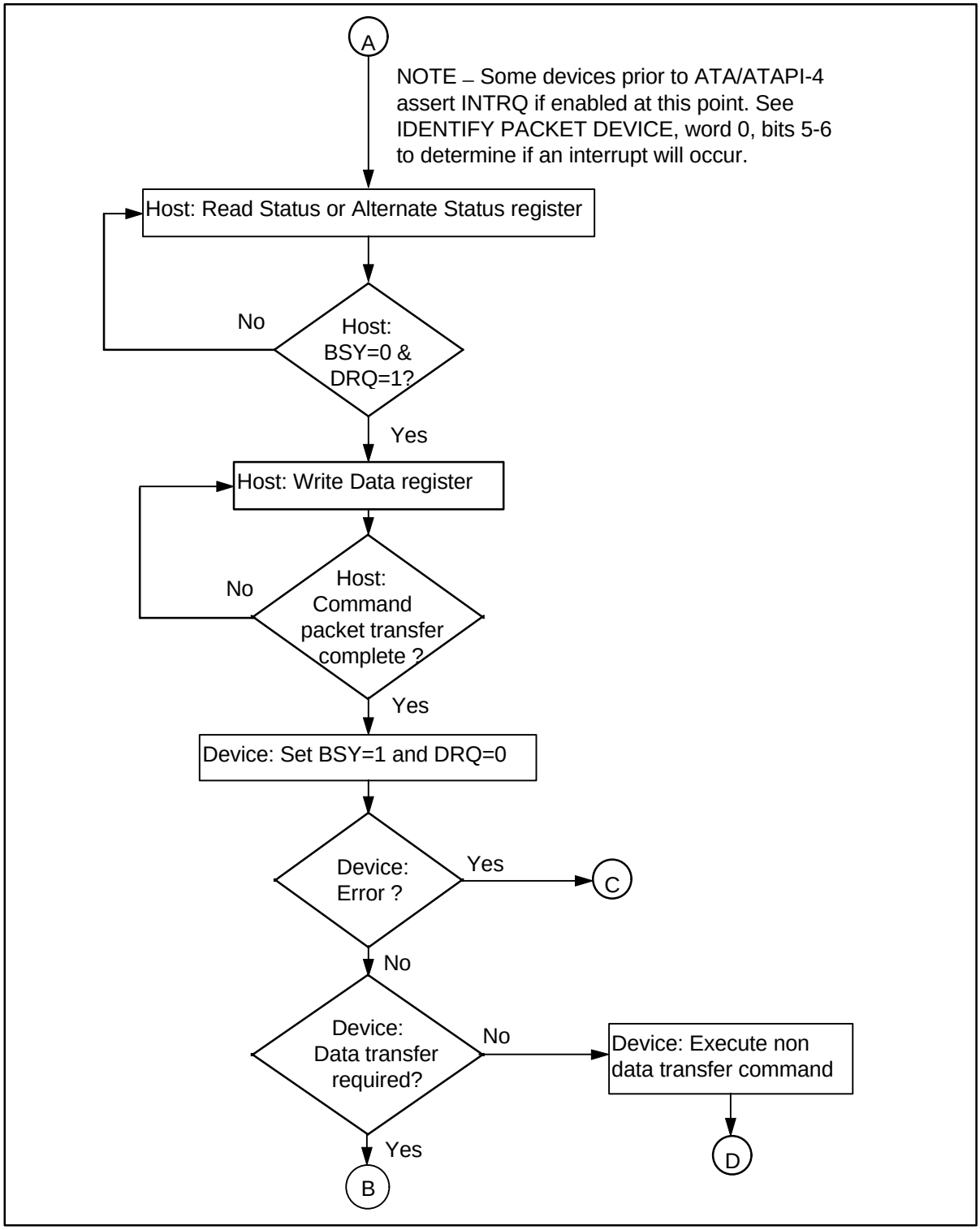


Figure 17 – PACKET DMA command protocol *(continued)*

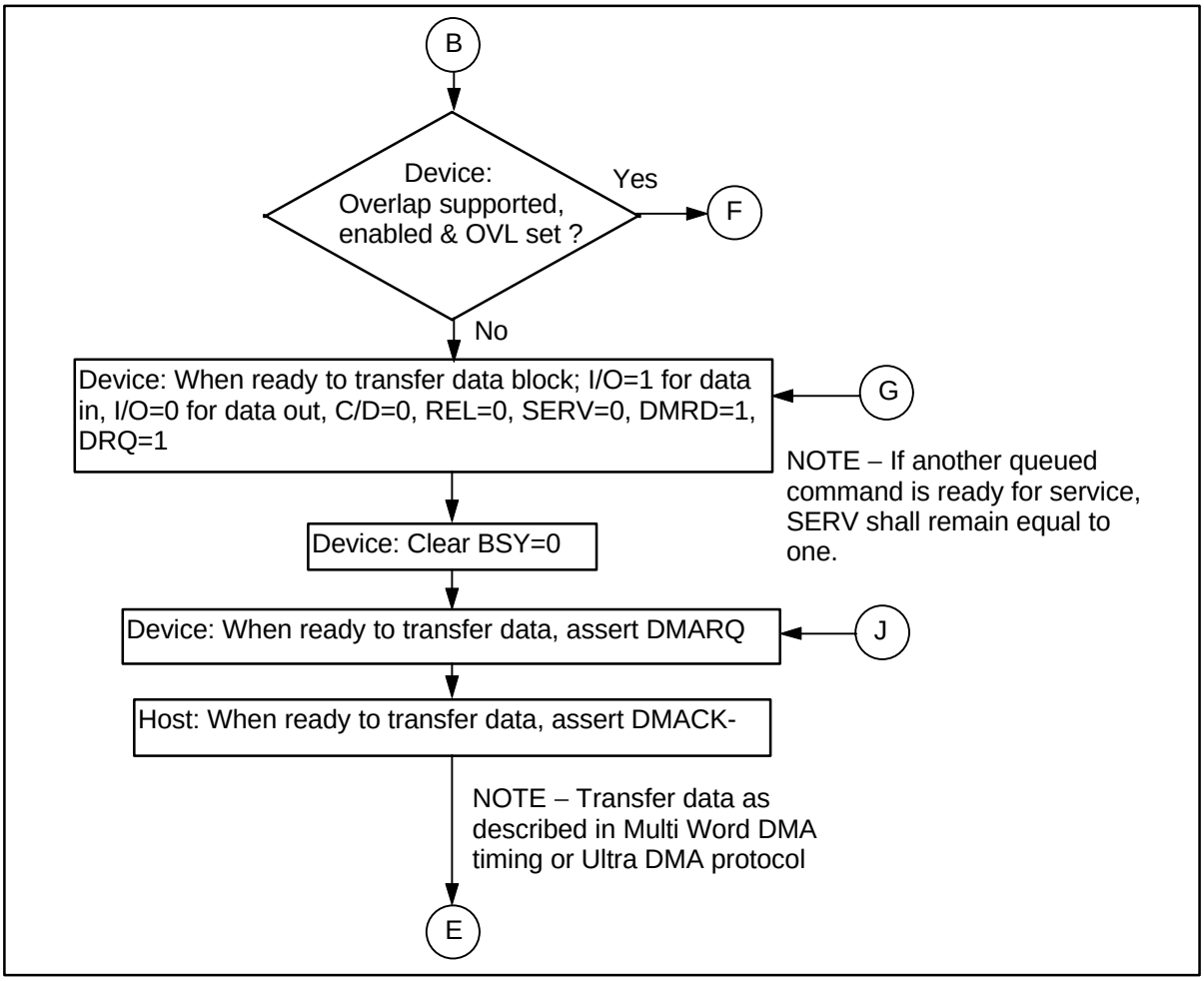
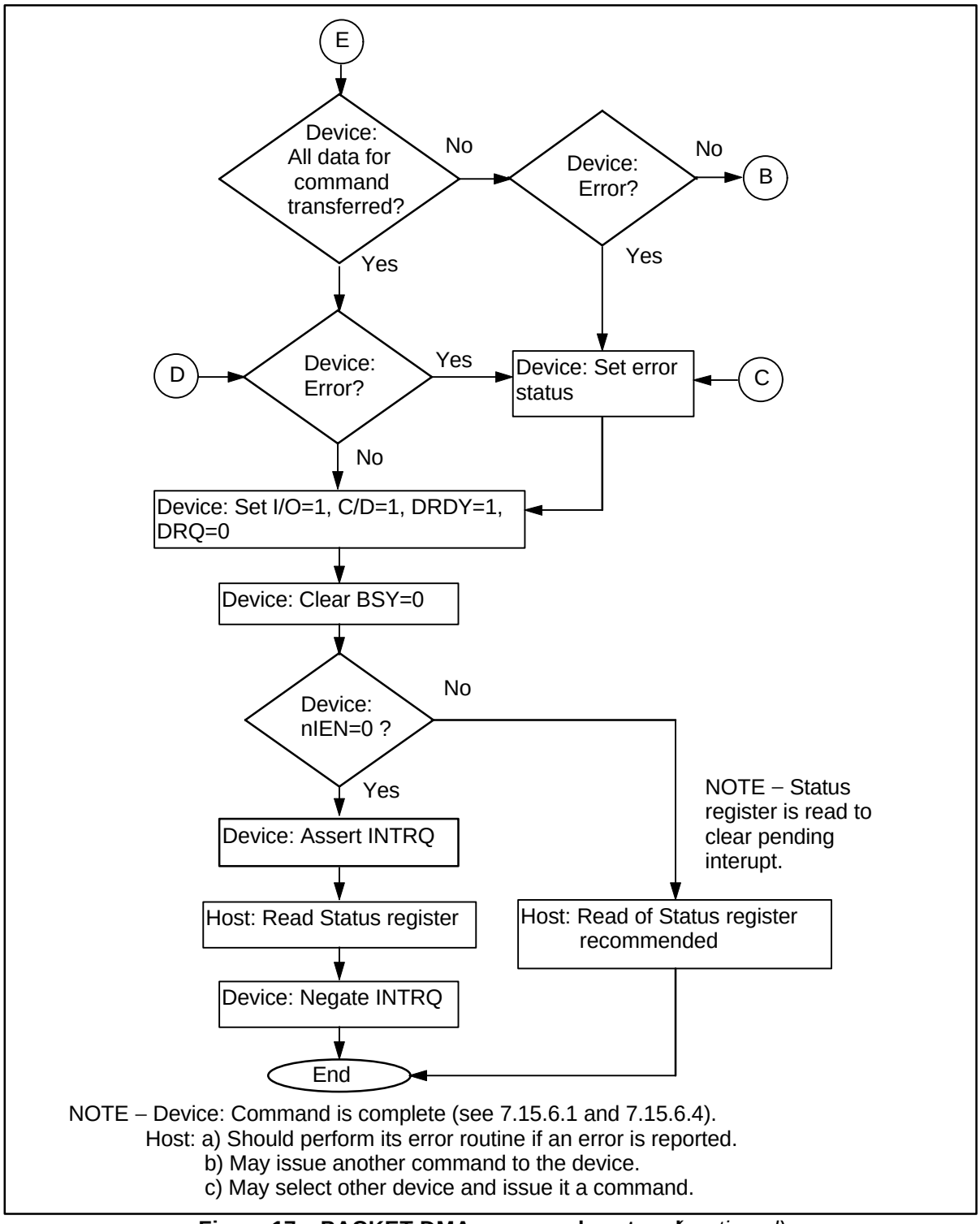


Figure 17 – **PACKET DMA command protocol** *(continued)*



NOTE – Device: Command is complete (see 7.15.6.1 and 7.15.6.4).
Host: a) Should perform its error routine if an error is reported.
b) May issue another command to the device.
c) May select other device and issue it a command.

Figure 17 – PACKET DMA command protocol *(continued)*

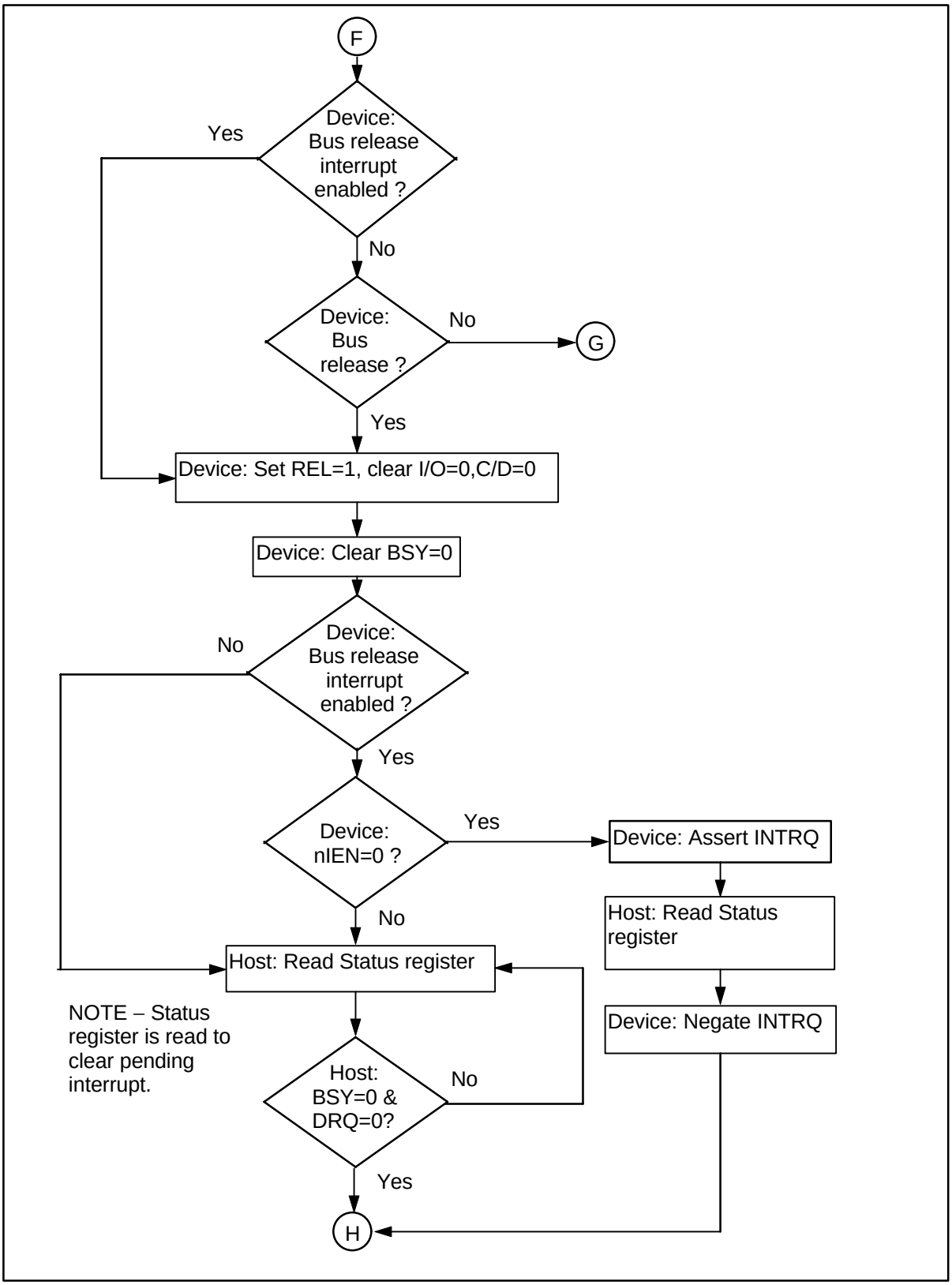


Figure 17 – **PACKET DMA command protocol** *(continued)*

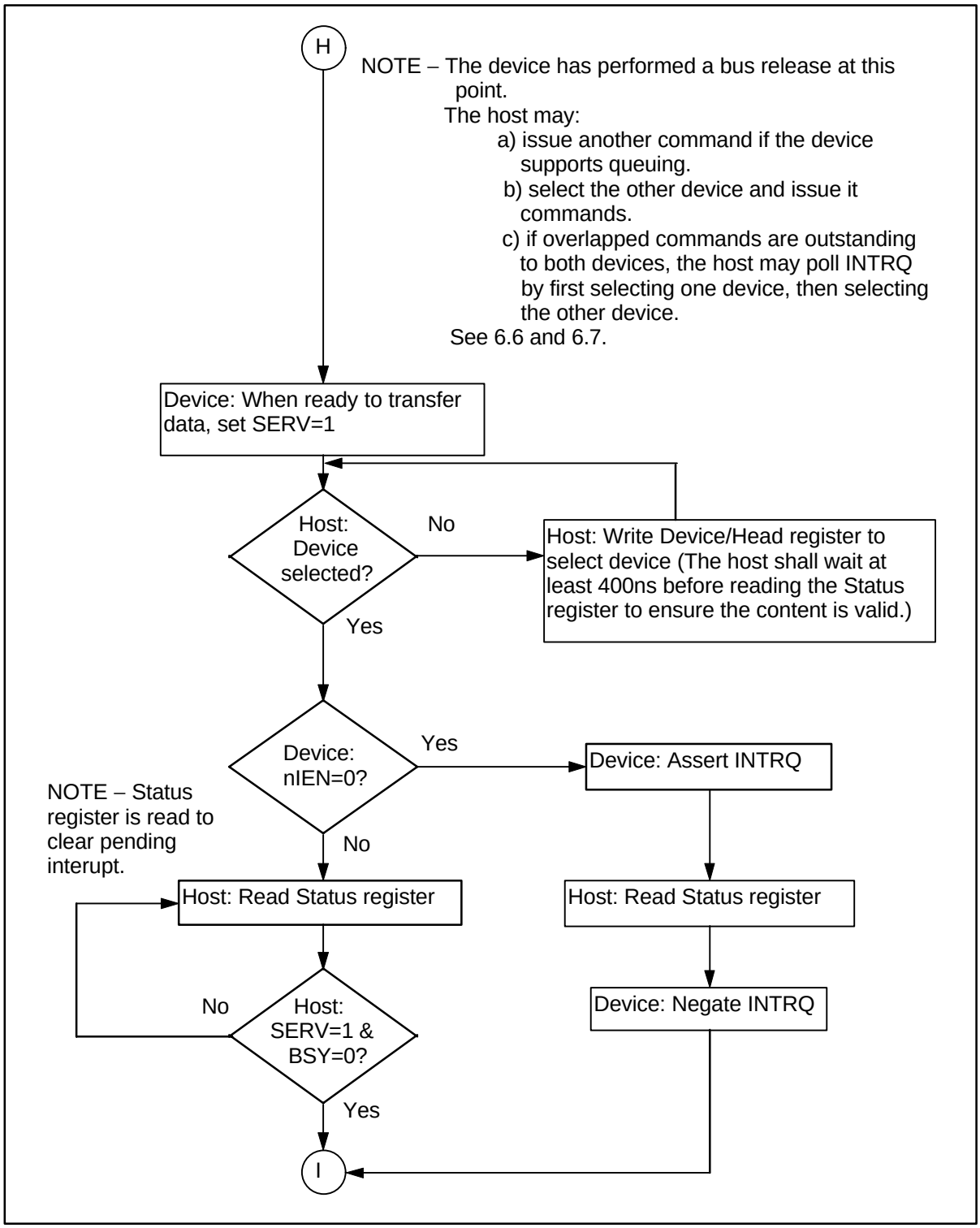


Figure 17 – PACKET DMA command protocol *(continued)*

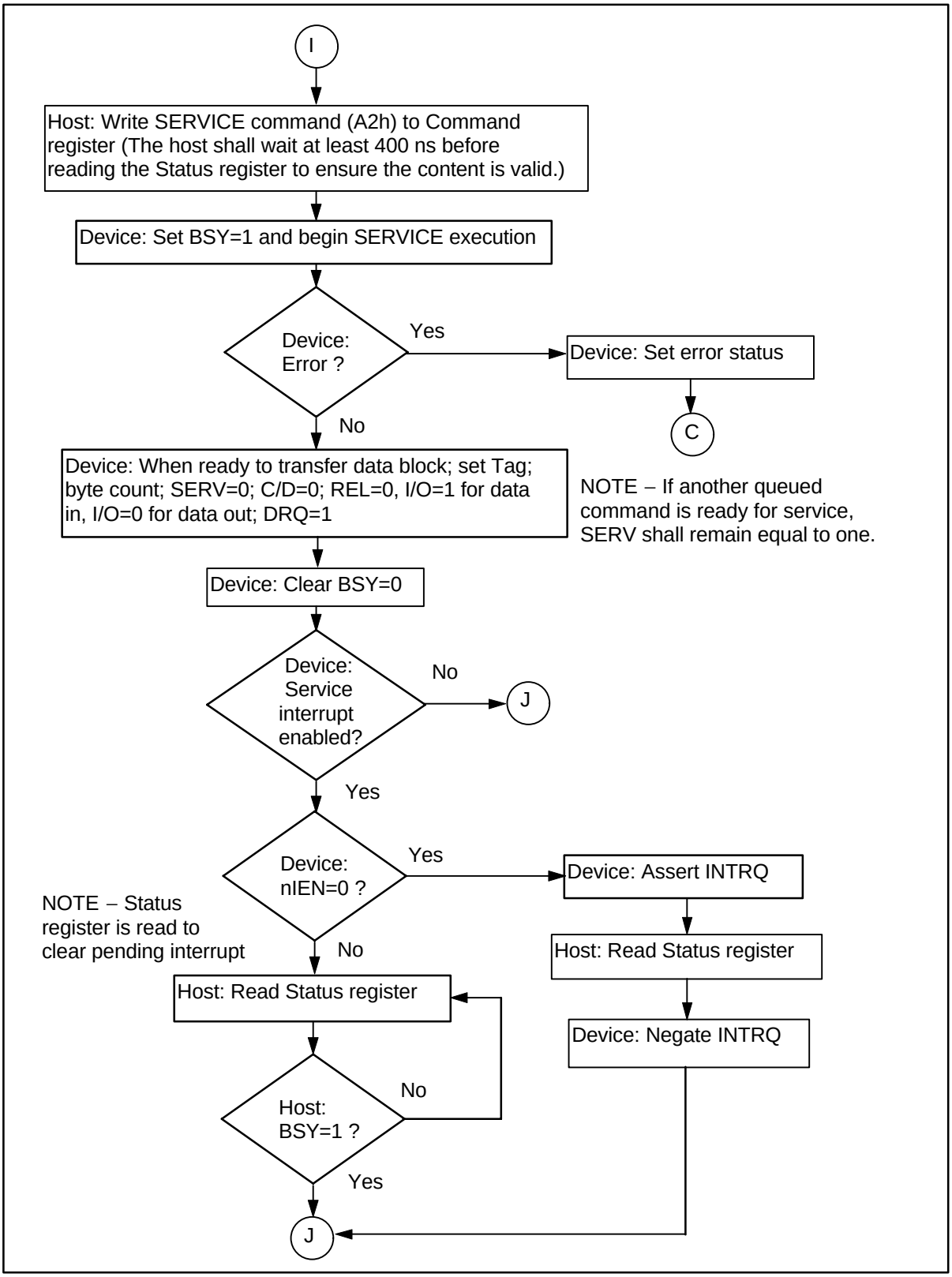


Figure 17 – PACKET DMA command protocol *(concluded)*

9.12 READ/WRITE DMA QUEUED command protocol

This class includes:

- READ DMA QUEUED
- SERVICE
- WRITE DMA QUEUED

Figure 18 describes the execution of a READ DMA QUEUED or WRITE DMA QUEUED command.

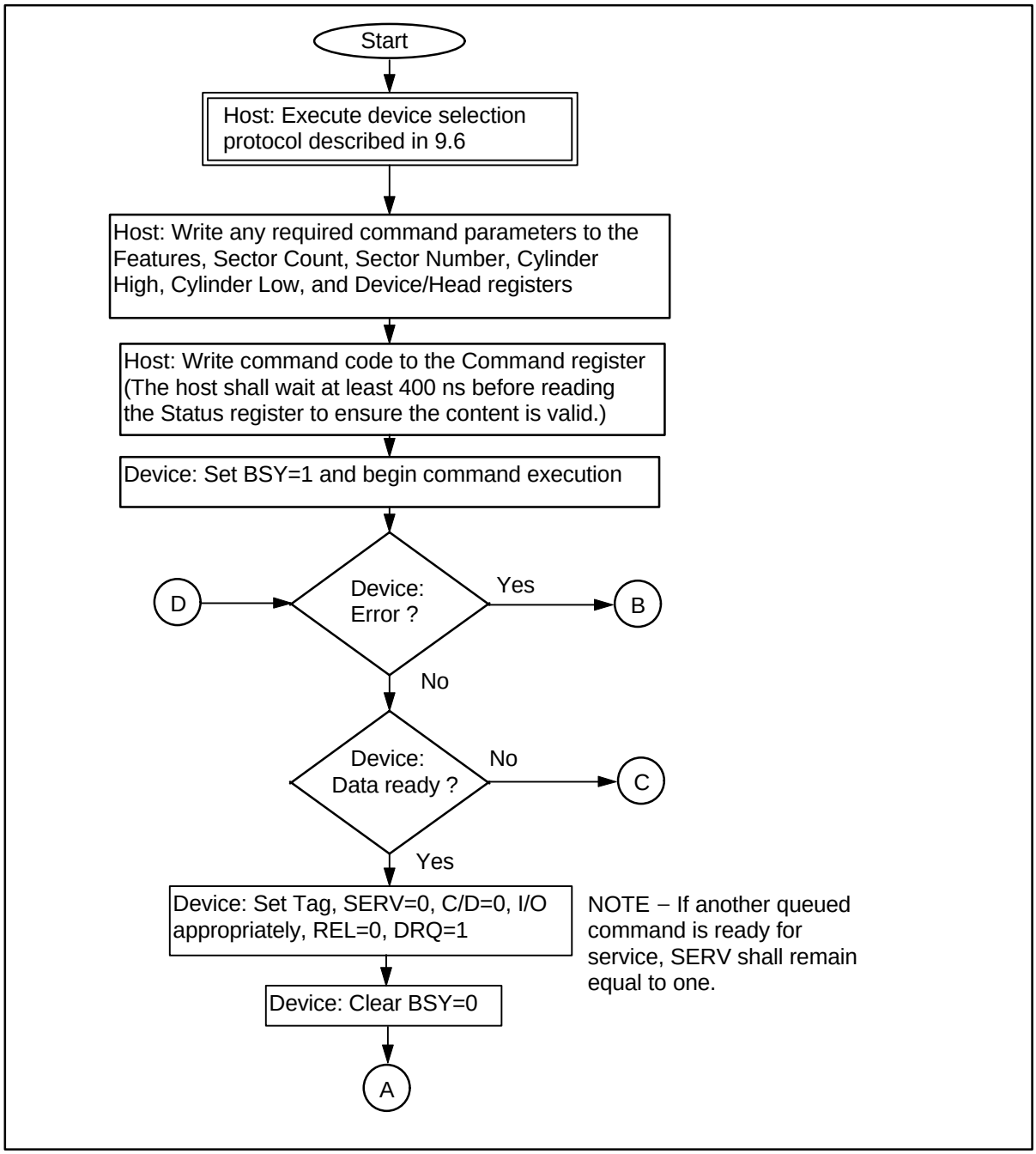


Figure 18 – READ/WRITE DMA QUEUED command protocol *(continued)*

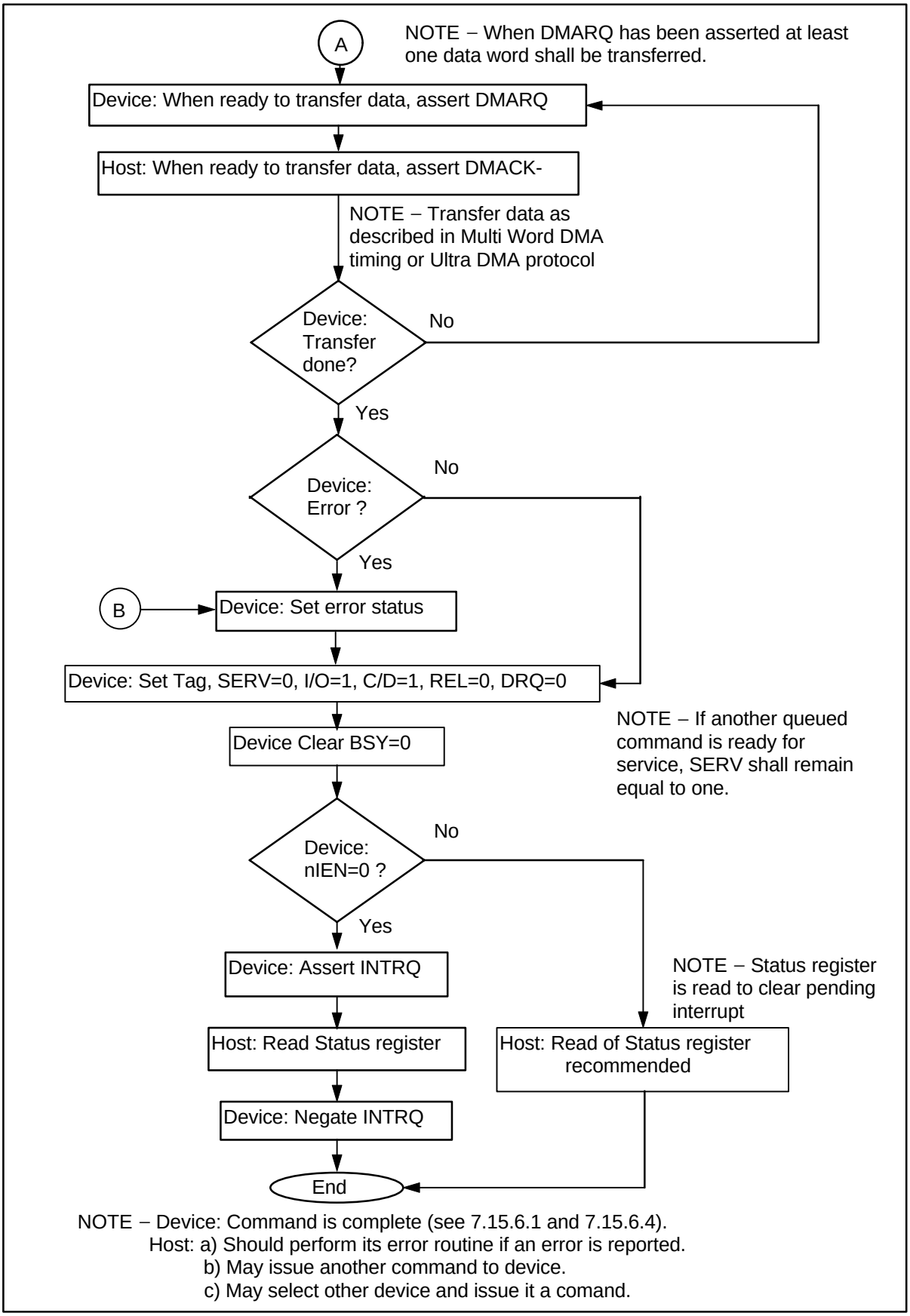


Figure 18 – READ/WRITE DMA QUEUED command protocol *(continued)*

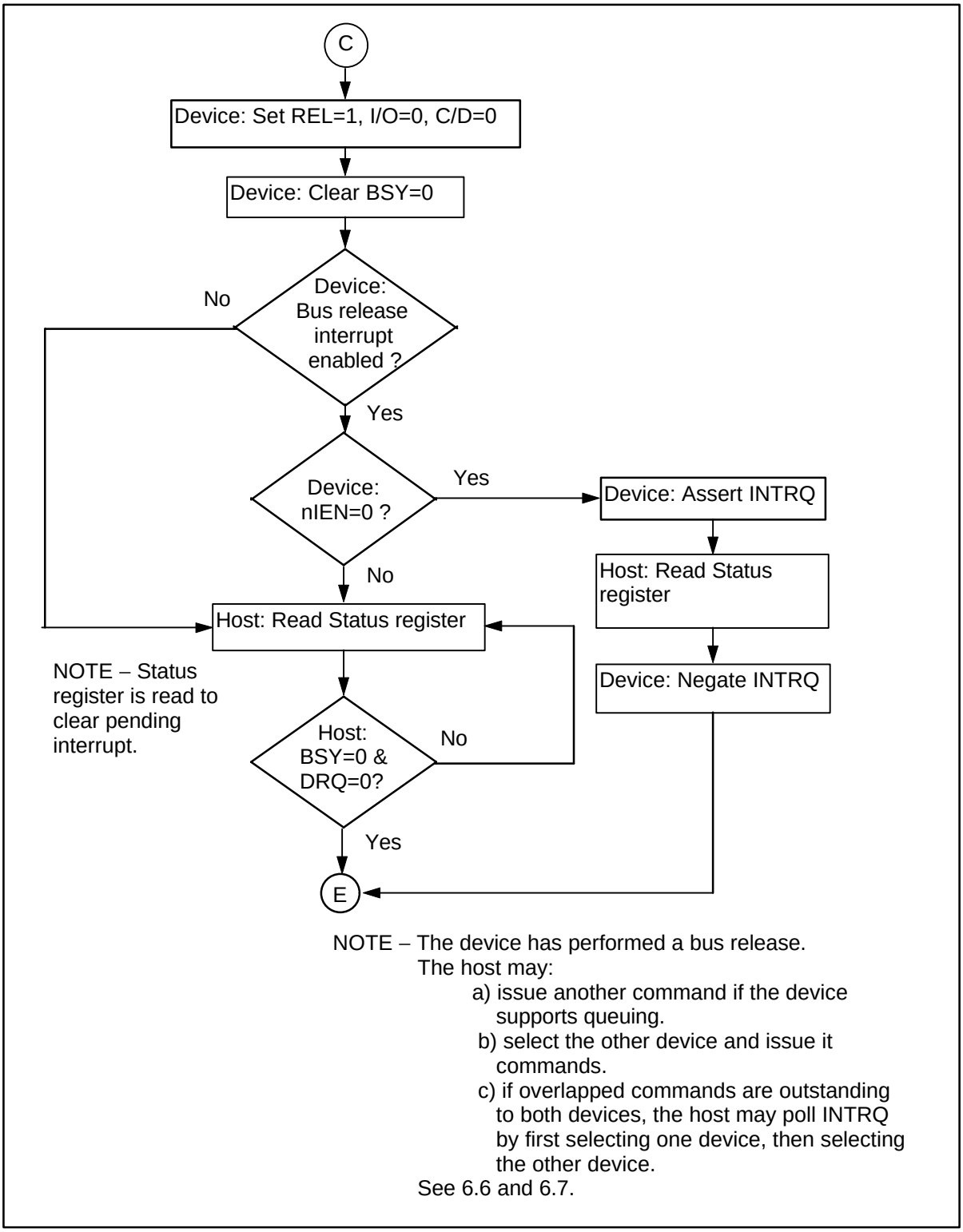


Figure 18 – READ/WRITE DMA QUEUED command protocol *(continued)*

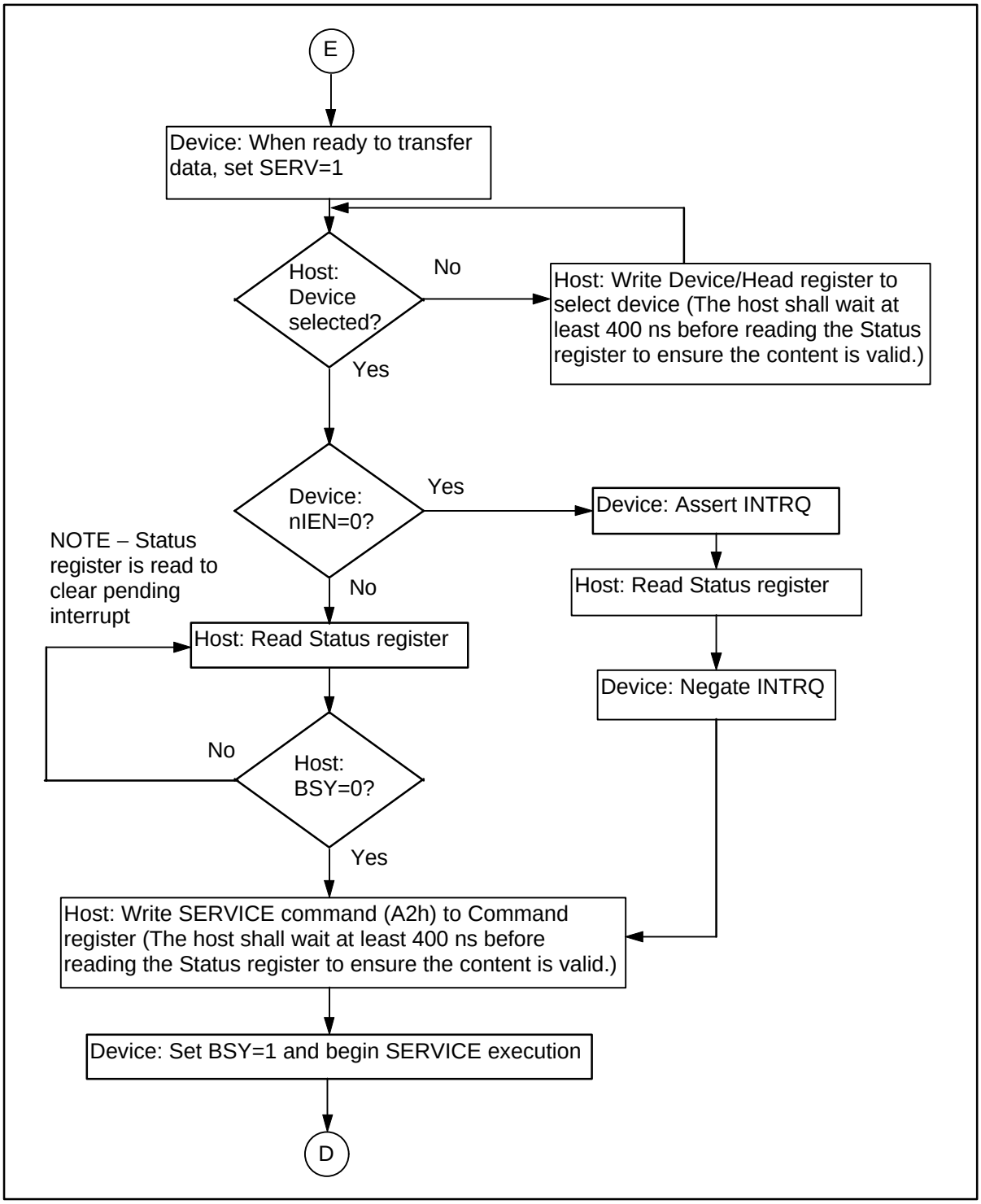


Figure 18 – READ/WRITE DMA QUEUED command protocol *(concluded)*

Annex E
(informative)
Command set summary

The following four tables are provided to facilitate the understanding of the command set. Table E.1 provides information on which command codes are currently defined. Table E.2 provides a list of all of the commands in order of command code. Table E.3 provides a summary of all commands with the protocol, required use, command code, and registers used for each. Table E.4 shows the status and error bits used by each command.

Table E.1 – Command matrix

	x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	xA	xB	xC	xD	xE	xF
0x	C	R	R	C*	R	R	R	R	C*	R	R	R	R	R	R	R
1x	O	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*
2x	C	C	O*	O*	R	R	R	R	R	R	R	R	R	R	R	R
3x	C	C	O*	O*	R	R	R	R	C*	R	R	R	O*	R	R	R
4x	C	C	R	R	R	R	R	R	R	R	R	R	R	R	R	R
5x	O*	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
6x	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
7x	C	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*
8x	V	V	V	V	V	V	V	F*	V	V	V	V	V	V	V	V
9x	C	C	C	R	E*	E*	E*	E*	E*	E*	V	R	R	R	R	R
Ax	C*	C*	C*	R	R	R	R	R	R	R	R	R	R	R	R	R
Bx	C	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Cx	F*	V	V	V	C	C	C	C*	C	C	C	C	C*	C*	R	R
Dx	R	R	R	R	R	R	R	R	R	R	C*	E*	E*	E*	C*	C*
Ex	C	C	C	C	C	C	C	C*	C	E*	R	R	C*	C*	O*	C
Fx	V	C	C	C	C	C	C	V	C	C*	V	V	V	V	V	V

Key:
C = a defined command, R = Reserved, undefined in current specifications, V = Vendor specific commands
O = Obsolete, E=a retired command, F=If the device does not implement the CFA feature set, this command code is Vendor specific, * indicates that the definition of this command has changed from ATA-3, X3.298-1997.

Table E.2 – Commands sorted by command value

Command name	Command code
NOP	00h
CFA REQUEST EXTENDED ERROR CODE	03h
DEVICE RESET	08h
READ SECTOR(S)	20h-21h
WRITE SECTOR(S)	30h-31h
CFA WRITE SECTORS WITHOUT ERASE	38h
READ VERIFY SECTOR(S)	40h-41h
SEEK	70h
CFA TRANSLATE SECTOR	87h
EXECUTE DEVICE DIAGNOSTIC	90h
INITIALIZE DEVICE PARAMETERS	91h
DOWNLOAD MICROCODE	92h
PACKET	A0h
IDENTIFY PACKET DEVICE	A1h
SERVICE	A2h
SMART	B0h
CFA ERASE SECTORS	C0h
READ MULTIPLE	C4h
WRITE MULTIPLE	C5h
SET MULTIPLE MODE	C6h
READ DMA QUEUED	C7h
READ DMA	C8h-C9h
WRITE DMA	CAh-CBh
WRITE DMA QUEUED	CCh
CFA WRITE MULTIPLE WITHOUT ERASE	CDh
GET MEDIA STATUS	DAh
MEDIA LOCK	DEh
MEDIA UNLOCK	DFh
STANDBY IMMEDIATE	E0h
IDLE IMMEDIATE	E1h
STANDBY	E2h
IDLE	E3h
READ BUFFER	E4h
CHECK POWER MODE	E5h
SLEEP	E6h
FLUSH CACHE	E7h
WRITE BUFFER	E8h
IDENTIFY DEVICE	ECh
MEDIA EJECT	EDh
SET FEATURES	EFh
SECURITY SET PASSWORD	F1h
SECURITY UNLOCK	F2h
SECURITY ERASE PREPARE	F3h
SECURITY ERASE UNIT	F4h
SECURITY FREEZE LOCK	F5h
SECURITY DISABLE PASSWORD	F6h
READ NATIVE MAX ADDRESS	F8h
SET MAX ADDRESS	F9h

Table E.3 – Command codes and parameters

proto	Command	typ	PKT fea	Command code	Parameters used				
					FR	SC	SN	CY	DH
ND	CFA ERASE SECTORS	O	N	C0h		y	y	y	y
ND	CFA REQUEST EXTENDED ERROR	O	N	03h					D
PI	CFA TRANSLATE SECTOR	O	N	87h			y	y	y
PO	CFA WRITE MULTIPLE W/OUT ERASE	O	N	CDh		y	y	y	y
PO	CFA WRITE SECTORS W/OUT ERASE	O	N	38h		y	y	y	y
ND	CHECK POWER MODE	M	M	E5h		y			D
DR	DEVICE RESET	O	M	08h					D
PO	DOWNLOAD MICROCODE	O	N	92h	y	y	y	y	D
DD	EXECUTE DEVICE DIAGNOSTIC	M	M	90h					D*
ND	FLUSH CACHE	O	O	E7h		y	y	y	y
ND	GET MEDIA STATUS	O	O	DAh					D
PI	IDENTIFY DEVICE	M	N	ECh					D
PI	IDENTIFY PACKET DEVICE	N	M	A1h					
ND	IDLE	M	O	E3h		y			D
ND	IDLE IMMEDIATE	M	M	E1h					D
ND	INITIALIZE DEVICE PARAMETERS	M	N	91h		y			y
ND	MEDIA EJECT	O	O	EDh					D
ND	MEDIA LOCK	O	O	DEh					D
ND	MEDIA UNLOCK	O	O	DFh					D
ND	NOP	O	M	00h					D
P	PACKET	N	M	A0h	y	y	y	y	D
PI	READ BUFFER	O	N	E4h					D
DM	READ DMA	M	N	C8h C9h		y	y	y	y
DMO	READ DMA QUEUED	O	N	C7h	y	y	y	y	y
PI	READ MULTIPLE	M	N	C4h		y	y	y	y
ND	READ NATIVE MAX ADDRESS	O	N	F8h					D
PI	READ SECTOR(S)	M	N	20h 21h		y	y	y	y
ND	READ VERIFY SECTOR(S)	M	N	40h 41h		y	y	y	y
PO	SECURITY DISABLE PASSWORD	O	O	F6h					D
ND	SECURITY ERASE PREPARE	O	O	F3h					D
PO	SECURITY ERASE UNIT	O	O	F4h					D
ND	SECURITY FREEZE	O	O	F5					D
PO	SECURITY SET PASSWORD	O	O	F1H					D
PO	SECURITY UNLOCK	O	O	F2h					D
ND	SEEK	M	N	70h			y	y	y
P	SERVICE	N	O	A2h		y	y	y	D
ND	SET FEATURES	M	M	EFh	y				D
ND	SET MAX ADDRESS	O	N	F9h		y	y	y	y
ND	SET MULTIPLE MODE	M	N	C6h		y			D
ND	SLEEP	M	M	E6h					D
ND	SMART DISABLE OPERATIONS	O	O	B0h	y			y	D
ND	SMART ENABLE/DISABLE AUTOSAVE	O	O	B0h	y	y		y	D
ND	SMART ENABLE OPERATIONS	O	O	B0h	y			y	D
ND	SMART EXECUTE OFF_LINE	O	O	B0h	y			y	D
PI	SMART READ DATA	O	O	B0h	y			y	D
ND	SMART RETURN STATUS	O	O	B0h	y			y	D
ND	STANDBY	M	O	E2h		y			D
ND	STANDBY IMMEDIATE	M	M	E0h					D

(continued)

Table E.3 – Command codes and parameters *(concluded)*

proto	Command	typ	PKT fea	Command code	Parameters used				
					FR	SC	SN	CY	DH
PO	WRITE BUFFER	O	N	E8h					D
DM	WRITE DMA	M	N	CAh CBh		y	y	y	y
DMO	WRITE DMA QUEUED	O	N	CCh	y	y	y	y	y
PO	WRITE MULTIPLE	M	N	C5h		y	y	y	y
PO	WRITE SECTOR(S)	M	N	30h 31h		y	y	y	y
VS	Vendor specific	V	V	9Ah,C0h-C3h,8xh, F0h,F7h, FAh-FFh					
-	Reserved: all remaining codes	R	R						

Key:
DM = DMA command ND = Non-data command PI = PIO data in command
PO = PIO data out command VS = Vendor specific command O = Optional P=PACKET command
DR = DEVICE RESET protocol DD = EXECUTE DEVICE DIAGNOSTIC protocol
DMO = Overlapped/queued DMA
typ=Command type PKT fea=Command type when PACKET Command feature set implemented
M = Mandatory R = Reserved N=Not to be used V = Vendor specific implementation
CY = Cylinder registers SC = Sector Count register DH = Device/Head register
SN = Sector Number register FR = Features register (see command descriptions for use)
y = the register contains a valid parameter for this command. For the Device/Head register, y means both the device and head parameters are used.
D = only the device parameter is valid and not the head parameter.
d = the device parameter is valid, the usage of the head parameter vendor specific.
D* = Addressed to device 0 but both devices execute it.

Table E.4 – I/O port functions and selection addresses except PACKET and SERVICE commands

Addresses					Functions	
CS0-	**CS1-**	**DA2**	**DA1**	**DA0**	**Read (DIOR-)**	**Write (DIOW-)**
N	N	x	x	x	Data bus high impedance	Not used
					Control block registers	
N	A	N	x	x	Data bus high impedance	Not used
N	A	A	N	x	Data bus high impedance	Not used
N	A	A	A	N	Alternate Status	Device Control
N	A	A	A	A	obsolete(see note)	Not used
					Command block registers	
A	N	N	N	N	Data	Data
A	N	N	N	A	Error	Features
A	N	N	A	N	Sector Count	Sector Count
A	N	N	A	A	Sector Number	Sector Number
A	N	A	N	N	Cylinder Low	Cylinder Low
A	N	A	N	A	Cylinder High	Cylinder High
A	N	A	A	N	Device/Head	Device/Head
A	N	A	A	A	Status	Command
A	A	x	x	x	Invalid address	Invalid address

Key:
A = signal asserted, N = signal negated, x = don't care
NOTE – This register is obsolete. It is recommended that a device not respond to a read of this address.

Table E.5 – I/O port functions and selection addresses for PACKET and SERVICE commands

Addresses					Functions	
CS0-	**CS1-**	**DA2**	**DA1**	**DA0**	**Read (DIOR-)**	**Write (DIOW-)**
N	N	x	x	x	Data bus high impedance	Not used
					Control block registers	
N	A	N	x	x	Data bus high impedance	Not used
N	A	A	N	x	Data bus high impedance	Not used
N	A	A	A	N	Alternate Status	Device Control
N	A	A	A	A	obsolete(see note)	Not used
					Command block registers	
A	N	N	N	N	Data	Data
A	N	N	N	A	Error	Features
A	N	N	A	N	Interrupt reason	
A	N	N	A	A		
A	N	A	N	N	Byte count low	Byte count low
A	N	A	N	A	Byte count high	Byte count high
A	N	A	A	N	Device select	Device select
A	N	A	A	A	Status	Command
A	A	x	x	x	Invalid address	Invalid address

Key:
A = signal asserted, N = signal negated, x = don't care
NOTE – This register is obsolete. A device should not respond to a read of this address.

Annex F
(informative)
Command packet format example

Table F.1 is an example of the command packet for most PACKET commands.

Table F.1 – Command packet

Byte	7	6	5	4	3	2	1	0
0	Operation code							
1	reserved			reserved				
2	(MSB)							
3	Logical block address (if required)							
4								
5								(LSB)
6	reserved							
7-8	(MSB)		Transfer length (if required) or Parameter list length (if required) or Allocation length (if required)					(LSB)
9	reserved							
10	reserved							
11	reserved							