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Revision 5

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Information Technology - BIOS Enhanced Disk Drive Services (EDD)

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Initial revision, document created from NCITS TR-21

Revision 1 - August 23, 1999
Added NCITS standard cover pages, table of contents, etc.

Revision 2 - August 25, 1999
Implemented changes based on meeting review.

- Added forward and membership lists for NCITS and T13
- Removed references to the word new
- Changed references to the word specification to standard
- Changed references to the phrase Technical Report to standard
- Added references to the Normative references section
- Changed many references from drive to device
- Reworked the concept of Physical geometry/addressing to refer to default geometry/addressing
- Changed references in the BIOS section from drive number to refer to BIOS drive number for clarity
- Upgraded the overview to contain a drawing that shows the points of definition that are used later in the document
- Added a conventions section that describes hex and decimal notation
- Updated tables that show ASCII strings to have the actual numeric values
- Changes references from must to shall
- Made formatting changes based on input from the group

Revision 3 - February 18, 2000

- Cleaned up INT13 FN 50 definition to match proof of concept
- Added field to table 4 for specifying the channel number
- Changed ATA and ATAPI entries in table 5 to remove the channel number

Revision 4 - April 6, 2000

- Incorporated changes from meeting held 21-FEB-00 0 25-FEB-00
- Updated Fibre channel to include LUN
- Changed more references from driver to device

Revision 5 - September 29, 2000

- Incorporated changes from E00132r1 (Resolution of letter ballot comments)

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NCITS.**-200x**

American National Standard

For Information Systems -

BIOS Enhanced Disk Drive Services

Secretariat

Information Technology Industry Council

Approved mm dd yy

American National Standards Institute, Inc.

Abstract

This standard describes services currently in use on IA-32 and IA-64 architecture personal computer systems. These services are provided by BIOS firmware to support hard disks up to 16 mega-tera-bytes ($16x10^{18}$). This standard also provides BIOS level services for determining the relationship between BIOS device numbers and the physical mass storage devices attached to the personal computer. The services defined in this standard can be applied to mass storage devices with ATA, ATAPI, SCSI, USB, Fibre Channel, 1394, I_2O, and other interfaces.

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Foreword

(This foreword is not part of American National Standard NCITS.xxx-200x)

In the past, DOS has accessed its mass storage devices using an INT13 programming interface provided by BIOS firmware to higher-level software. This interface was designed in the early 1980's and upgraded in the late 1980's. The maximum theoretical capacity of this API is 8.4 giga-bytes. The INT 13h interface, now known as the legacy INT 13h interface, uses function numbers 1-15h and is Cylinder-Head-Sector (CHS) oriented. An extended INT 13h interface has been created, the purpose of these INT 13h extensions is to:

- Replace CHS addressing with Logical Block Addressing (LBA).
- Remove the current requirement of using interrupt 41h/46h to point at the Fixed Disk Parameter Table information.
- Give the BIOS better control over how this data shall be used.
- Make location and configuration information available to operating systems that do not use the BIOS to access mass storage devices.
- Use data structures that apply to both IA-32 and IA-64 architecture systems.
- Use data structures that can address media capacities for the next 20 years.

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the NCITS Secretariat, Information Technology Industry Council, 1250 I Street NW, Suite 200, Washington, DC 20005-3922.

This standard was processed and approved for submittal to ANSI by National Committee for Information Technology Standardization (NCITS). Committee approval of this standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, NCITS had the following members:
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Jon Haines	Eric Kvamme	Paul Raikunen

Introduction

This standard encompasses the following:

Clause 1 describes the scope.

Clause 2 provides normative references.

Clause 3 provides definitions, abbreviations, and conventions.

Clause 4 is the overview.

Clause 5 is the INT 13h Calling Conventions.

Clause 6 is the INT 13h Function Definitions.

Clause 7 Int 15h removable media eject.

American National Standard
for Information Systems -

Information Technology -
BIOS Enhanced Disk Drive Services (EDD)

1 Scope

This standard assumes that the reader is familiar with the conventional INT 13h interface, the usage of the BIOS Device Parameter Table, and the basic operation of mass storage devices. This standard describes in detail BIOS functions and data structures that are used as an abstraction layer to allow higher-level applications to access mass storage devices in an interface and command-set independent manner. To comply with this standard, higher-level software shall call the INT functions using the data structures described herein; and system firmware shall provide the INT functions and data structures described herein.

The storage industry has increased the capacity and functionality of many types of mass storage devices. This increase in capacitiy and functionality has required the development of a BIOS interface. This standard documents the BIOS interface that is supplied by many BIOS vendors. This standard addresses the following BIOS specific issues:

- BIOS support of devices with a capacity greater than 528 MB. The conventional INT 13h interface has a limit of 528MB;
- The INT 13h interface allows more than two devices to be attached to a system but has no consistent method for storing the additional configuration parameters;
- CHS-independent methods for addressing the devices have been defined. These are device-geometry independent and require a different method of address representation and operation;
- Methods of data transfer continue to be added to ATA devices. Capabilities such as, DMA modes, multi-sector data transfers and Fast PIO are not reported to the operating system;
- Systems require more than two storage devices, and with this requirement comes the requirement to assign the order in which the devices are to be accessed;
- Make location and configuration information available to operating systems that do not use the BIOS to access mass storage devices;
- Provide a linkage between the BIOS device assignments on the operating system device letter assignments;
- Use data structures that apply to both IA-32 and IA-64 architecture systems.

2 Normative References

The following standards contain provisions that, through reference in the text, constitute provisions of this standard. Many of these standards are referenced because they contain the information necessary for describing a method of accessing a device on the specified interface. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

Copies of the following documents can be obtained from ANSI: Approved ANSI standards, approved and draft international and regional standards (ISO, IEC, CEN/CENELEC, ITUT), and approved and draft foreign standards (including BSI, JIS, and DIN). For further information, contact ANSI Customer Service Department at 212-642-4900 (phone), 212-302-1286 (fax) or via the World Wide Web at http://www.ansi.org.

Additional availability contact information is provided below as needed.

2.1 Approved references

The following approved ANSI standards and technical reports, approved international and regional standards and technical reports (ISO, IEC, CEN/CENELEC, ITUT), may be obtained from the international and regional organizations who control them.

NCITS 317-1998 *AT Attachment with Packet Interface (ATA/ATAPI-4)*

NCITS 325-1998 *Serial Bus Protocol – 2 (SBP-2)*

NCITS 333-1999 *Multi-Media Commands - 2 (MMC-2)*

BSR NCITS 330 *Reduced Block Commands (RBC)*

IEEE 1394-1995 *IEEE Standard for a High Peformance Serial Bus*

IEEE 1394a-2000 *IEEE Standard for a High Performance Serial Bus – Amendment 1*

X3.303 *Fibre Channel Physical and Signaling Interface-3*

X3.301-1997 *SCSI - 3 SPC*

2.2 References under development

At the time of publication, the following referenced standards were still under development. For information on the current status of the document, or regarding availability, contact the relevant standards body or other organization as indicated.

NCITS 1321D *AT Attachment with Packet Interface (ATA/ATAPI-5)*

NCITS 1236D *SCSI Primary Commands - 2 (SPC-2)*

NCITS 1363D *Multi-Media Commands - 3 (MMC-3)*

IEEE P1394b *Standard for High Performance Serial Bus (High Speed Supplement)*

For more information on the current status of the above documents, contact NCITS. To obtain copies of these documents, contact Global Engineering or NCITS.

2.3 Other references

The following standards and specifications were also referenced.

NCITS TR-21 *BIOS Enhanced Disk Drive Technical Report*

BIOS Boot Specification (Compaq, Phoenix and Intel), www.phoenix.com/techs/specs.html

El Torito CD-ROM Boot Specification, www.phoenix.com/techs/specs.html

ATAPI Removable Media BIOS Specification, www.phoenix.com/techs/specs.html

Universal Serial Bus Revision 1.1, www.usb.org/developers

Mass Storage Overview, www.usb.org/developers

I_2O Software Specification v2.0, www.i2osig.org

3 Keywords, Definitions, abbreviations, and conventions

3.1 Keywords

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

3.1.1 Mandatory

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

3.1.2 May

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

3.1.3 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. Describing a feature as optional in the text is done to assist the reader.

3.1.4 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 an error.

3.1.5 Shall

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

3.1.6 Should

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

3.2 Definitions and Abbreviations

For the purposes of this standard, the following definitions apply:

3.2.1 ATA

An AT Attachment (also known as IDE) , is a storage interface that conforms to an ATA standard.

3.2.2 BDA

The BIOS Data Area is an area of reserved memory used by the BIOS and O/S to store data about the system hardware. It is located at memory segment 40h starting with 40h:00h.

3.2.3 BIOS

The Basic Input/Output System is the firmware embedded on a chip located on the computer’s main board. The BIOS executes POST to test and initialize the system components and then loads the O/S. The BIOS also handles the low-level Input/Output to the various peripheral devices connected to the computer.

3.2.4 Byte

A byte is a unit of data that consists of eight bits as described below:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

3.2.5 CHS

CHS addressing: CHS addressing is a method of addressing the contents of a storage device using logical cylinders (C), logical heads (S), and logical sectors (S). This method of addressing allows a maximum C=16383, H=16, S=63, or 8.4GB. See LBA addressing for another addressing method.

3.2.6 Conventional vs enhanced

When a word, term, or phrase is modified by the word “conventional” it refers to the legacy style, or method of operation that is limited to addressing ATA devices that have a 528 MB capacity or below. When a word, term, or phrase is modified by the word “enhanced” it means there is a “conventional” and an “enhanced” method of operation, the “enhanced” method is defined by this standard.

3.2.7 DOS

DOS is a disk operating system that uses the system BIOS as a firmware abstraction layer to access system hardware. Examples of DOS based operating systems include MS-DOS®, DR-DOS®, PC-DOS®, Free DOS, Windows® 3.11, and Windows® 95.

3.2.8 DWord

A DWord (Double Word) is a unit of data that consist of four bytes. This data is usually represented on paper as a series of bits numbered from 31 to 0. Byte 0 of a Dword is stored in the lowest byte address and Byte 3 is stored in the highest byte address.

On Paper:

Bit 31 Bit 0

Byte 3	Byte 2	Byte 1	Byte 0

In Memory:

Bit 7 Bit 0 Bit 31 Bit 24

Byte 0	Byte 1	Byte 2	Byte 3

3.2.9 Host

The Host is the PC that is controlled by the BIOS.

3.2.10 IA-32

IA-32 refers to the Intel Architecture 32-bit wide processor data bus.

3.2.11 IA-64

IA-64 refers to the Intel Architecture 32-bit wide processor data bus.

3.2.12 INT 13h

A BIOS interrupt service that provides a protocol independent method for addressing floppy, hard drive, and other storage devices.

3.2.13 INT 40h

A BIOS interrupt service that provides a protocol independent method for addressing INT 13h devices that have a device number less than or equal to 7Fh.

3.2.14 IPL Device

An Initial Program Load Device is any device in the system that may boot and load an O/S. In standard AT machines, this is normally the floppy drive or hard drive.

3.2.15 LBA

LBA is a method of addressing a device that involves using a Logical Block Address. For example, this method of addressing allows a maximum sector address of 2^{28}-1, or 137.4 GB of data using an ATA device. See CHS for another address method.

3.2.16 Logical Address/Geometry

A logical address or geometry is used to address a device by an application, such as DOS, using the INT 13h interface. INT 13h Fn 8 returns the logical geometry of the device.

3.2.17 NV Memory

Non-Volatile memory is memory that retains content even when the power has been shut off. The most common type of NV memory on a PC is the CMOS RAM that is used to store system configuration information.

3.2.18 O/S

An Operating System is a software abstraction layer that provides services that give applications access to system hardware, in a hardware independent fashion. Examples of these services include memory management, multi-threaded task management, file system management, printer management, and screen management.

3.2.19 POST

The Power-On Self-Test is the part of the BIOS that takes control immediately after the computer is turned on. POST initializes the computer hardware so that an O/S may be loaded.

3.2.20 Protect Mode

Intel x86 processors have several modes of main memory addressing. One of these modes is called Real Mode. In this mode, systems can only address the first mega-byte of memory. Another mode is Protect Mode. In this mode all the system memory can be addressed.

3.2.21 QWord

A QWord (Quad Word) is a unit of data that consist of eightbytes. This data is usually represented on paper as a series of bits numbered from 63 to 0. Byte 0 of a Qword is stored in the lowest byte address and Byte 7 is stored in the highest byte address.

On Paper:

Bit 63 Bit 0

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

In Memory:

Bit 7 Bit 0 Bit 63 Bit 57

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

3.2.22 Standard Floppy Drive

The Standard Floppy Drive is the generic term to define the currently used 5.25” floppy drives and the 3.5” floppy drives found in many systems.

3.2.23 Word

A word is a unit of data that consist of two bytes. This data is usually represented on paper as a series of bits numbered from 15 to 0. Byte 0 of a Word is stored in the lower byte address and Byte 1 is stored in the higher byte address.

On Paper:

Byte 1								Byte 0							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

In Memory:

Byte 0								Byte 1							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8

3.3 Conventions

Lowercase is used for words having the normal English meaning. Certain words and terms used in this 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 3.2.6 for the naming convention used for naming bits.)

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

3.3.1 Numeric Notation

Numbers are specified in three different bases throughout this standard: binary (base 2), decimal (base 10), and hexadecimal (base 16). The following notation is used to indicate that base in use:

Base	Notation
Binary	nnnb
Decimal	nnn
Hexadecimal	nnnh

3.3.1.1 Binary

Binary numbers use the digits: 0, 1. An example of a binary number is 0101b, this binary number is 5 decimal or 5h hexadecimal.

3.3.1.2 Decimal

Decimal numbers use the digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. An example of a decimal number is 1024, this is 010000000000b in binary and 400h in hexadecimal

3.3.1.3 Hexadecimal

Hexadecimal numbers use the digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. An example of a hexadecimal number is 1Fh, this is 00011111b in binary and 31 in decimal.

4 Overview

In the past, DOS has accessed its mass storage devices using a BIOS provided INT 13h interface. This interface was designed in the early 1980's and upgraded in the late 1980's. The maximum theoretical capacity of this Applications Program Interface (API) shall be 8.4 GB. TheINT 13h interface, now known as the legacy INT 13h interface, uses function numbers 1-15h and is Cylinder-Head-Sector (CHS) oriented. An extended INT 13h interface has been created, the purpose of these INT 13h extensions shall be to:

- Replace CHS addressing with Logical Block Addressing (LBA).
- Remove the current requirement of using interrupt 41h/46h to point at the Fixed Disk Parameter Table information.
- Give the BIOS better control over how this data is used.
- Make location and configuration information available to operating systems that do not use the BIOS to access mass storage devices.
- Use data structures that apply to both IA-32 and IA-64 architecture systems.
- Use data structures that can address media capacities for the next 20 years.

Many BIOS, Option ROM, and OS vendors have already implemented the functions defined in this document for ATA and SCSI style devices. This standard builds on NCITS TR-21 BIOS Enhanced Disk Drive Technical Report to enable other mass storage technologies, such as 1394, Fibre Channel, and USB.

DOS and other operating systems, such as Windows™ 98 and Windows™ NT, shall gain the capability to consistently provide the same drive letter assignments to the user. The result of this capability shall be that storage devices can be added to an EDD system, and the existing drive letters shall not change.

Data written on media can render the media incompatible with certain drive letters when some drive letter based operating systems are used. Technologies, such as 1394, blur the difference between fixed and removable media. Operating systems shall allow removable media devices to work equally well as A:, B:, C:, as well as D: and above.

One of the important aspects of this standard is to allow a BIOS to describe the physical path to a device. The following diagram shows the basic system components that are referenced by this standard.

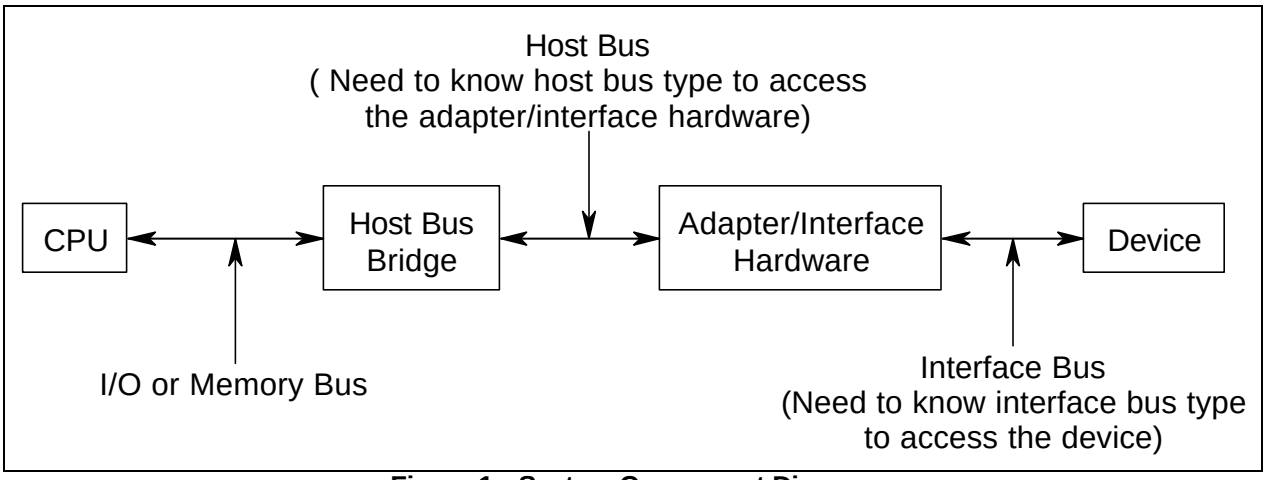

Figure 1 - System Component Diagram

5 INT 13h Calling Conventions

The extended INT 13h functions are numbered from 41h through 49h, 4E, and 50h. These functions are fundamentally different from the legacy INT 13h interface in the following ways:

- Register conventions have been changed to support the passing of data structures;
- All media addressing information shall be passed via a buffer, not registers;
- Flags are used to identify optional capabilities.

The caller shall specify a device number in the DL register when calling functions 41h-48h. This is a logical number that has been assigned to the physical device by system firmware. The physical device addressing information can be retrieved via INT 13h FN 48h. The following registers in IA-32 and IA-64 systems are used: AX, BX, CX, DX, DS, and SI

5.1 Data Structure

The data structure for the INT 13h extensions shall be the device address packet. INT 13h converts addressing information in the device address packet to default parameters appropriate to the media. Table 1 defines the device address packet.

Table 1 - Device Address Packet

Offset	Type	Description
0	Byte	Packet size in bytes. Shall be 16 (10h) or greater. If the packet size is less than 16 the request shall be rejected with CF=1h and AH=01h.
1	Byte	Reserved, shall be 0
2	Byte	Number of blocks to transfer. This field has a maximum value of 127 (7Fh). If a any other value is supplied, the request shall be rejected with CF=1 and AH=01. If this field is set to FFh, then the transfer buffer address shall be found at offset 10h, the number of blocks to transfer shall be found at offset 18h, and the transfer buffer at offset 4 shall be ignored. A block count of 0 means no data shall be transferred.
3	Byte	Reserved, shall be 0.
4	DWord	Address of host transfer buffer. The host buffer that Read/Write operations shall use to transfer the data. This is a 32-bit host address of the form Seg:Offset. If this field is set to FFFFh:FFFFh then the address of the transfer buffer shall be found at offset 10h.
8	QWord	Starting logical block address, on the target device, of the data to be transferred. This is a 64 bit unsigned linear address. If the device supports LBA addressing this value should be passed unmodified. If the device does not support LBA addressing the callee shall convert this LBA to a CHS address using the current geometry in the following formula: $LBA = (C_1 * H_0 + H_1) * S_0 + S_1 - 1$ Where: C_1 = Selected Cylinder Number H_0 = Number of Heads (Maximum Head Number + 1) H_1 = Selected Head Number S_0 = Maximum Sector Number S_1 = Selected Sector Number For ATA compatible devices, with less than or equal to 15,482,880 logical sectors, the H_0 and S_0 values are supplied by WORDS 3 and 6 of the IDENTIFY DEVICE command.
10h	QWord	64 bit unsigned linear address of the host transfer buffer. This is the host buffer that Read/Write operations shall use to transfer the data if the data at offset 4 is set to FFFFh:FFFFh, or the data at offset 2 is set to FFh.
18h	DWord	Total number of blocks to transfer when the data at offset 2 is set to FFh
1Ch	DWord	Reserved, shall be 0.
NOTE - The options described in table 1 allow a host to use a 7 bit transfer size with a 32 or 64 bit memory address for the transfer buffer. Table 1 also allows a 32-bit transfer size in conjunction with a 64-bit address. A 32-bit transfer size shall not be used in conjunction with a 32-bit memory address.		

5.2 Removable media

The distinction between "removable" disks numbered 0-7Fh and "fixed" disks numbered 80h-FFh differs from conventional INT 13h functions. Devices numbered 0-7Fh are not changed, they follow conventional INT 13h standards for floppy disk operation. Devices numbered 80h-FFh include traditional fixed disks, and now also include removable media devices that support media change notification as well as software locking and unlocking capabilities. Functions in this standard support these devices. Return codes defined for the conventional INT 13h interface are vendor specific and may be used. In addition the following return codes support removable media:

- B0h - Media Not Locked In Device;
- B1h - Media Locked In Device;

- B2h - Media Not Removable;
- B3h - Media In Use;
- B4h - Lock Count Exceeded;
- B5h - Valid Eject Request Failed;
- B6h - Media Present but Read Protected.

5.3 INT 13h interface subsets

It shall be permissible for BIOS to support only certain subsets of the INT 13h extensions. These subsets are defined in this standard. If a subset is supported then all functions within that subset shall be supported. The supported subsets shall be determined via the Check Extensions Present function. If a function is not supported and that function is subsequently invoked; then the function rejects the request with CF=1, AH=01h. There are three subsets defined, at least one of these shall be supported.

Note - Conventional INT 13 may be used for media accessing if the Fixed disk access subset is not present

5.3.1 Fixed disk access subset

These functions support basic access to devices using the device address packet structure as follows:

- Check Extensions Present (41h);
- Extended Read (42h);
- Extended Write (43h);
- Verify Sectors (44h);
- Extended Seek (47h);
- Get Device Parameters (48h).

5.3.2 Device locking and ejecting subset

These functions support software control of media locking and ejecting as follows:

- Check Extensions Present (41h);
- Lock/Unlock Media (45h);
- Eject Device (46h);
- Get Device Parameters (48h);
- Get Extended Disk Change Status (49h);
- The Int 15h Removable Media Eject Intercept.

5.3.3 Enhanced disk drive (EDD) support subset

These functions provide EDD support as follows:

- Check Extensions Present (41h);
- Get Parameters With EDD Extensions (48h);

6 INT 13h Function Definitions

The INT 13h extensions define an API for addressing a variety of mass storage devices up to 2^{64} sectors in size. The expected lifetime of this interface is in excess of 15 years

6.1 Check extensions present

Entry:

AH - 41h
BX - 55AAh
DL - BIOS device number

Exit:

carry clear

AH - Version of extensions = 30h
AL - Internal use only
BX - AA55h
CX - Interface support bit map (seeTable 2)

carry set

AH - error code (01h, Invalid Command)

Table 2 - Check Extensions Present Buffer

Bit	Description
0	1 – Fixed disk access subset
1	1 – Device locking and ejecting subset
2	1 – Enhanced disk drive support subset
3	1 – 64-bit extensions are present. When the 64-bit extensions are present, the fields starting at offset 10h in the Device Address Packet are valid
4-15	Reserved, shall be 0

This function shall be used to check for the presence of INT 13h extensions. If the carry flag is returned set, the extensions are not supported for the requested device. If the carry flag is returned cleared, BX shall be checked for the value AA55h to confirm that the extensions are present. If BX is AA55h, the value of CX shall be checked to determine what subsets of this interface are supported for the requested device. At least one subset shall be supported. The version of the extensions shall be 30h. This indicates that the INT 13h extensions are compliant with this standard.

6.2 Extended Read

Entry:

AH - 42h
DL - BIOS device number
DS:SI - Device address packet

Exit:

carry clear
AH - 0
carry set
AH - error code

This function transfer sectors from the device to memory. In the event of an error, the block count field of the device address packet contains the number of good blocks read before the error occurred.

6.3 Extended Write

Entry:

AH - 43h
AL - 0 or 1, write with verify off
2, write with verify on
DL - BIOS device number
DS:SI - Device address packet

Exit:

carry clear
AH - 0
carry set
AH - error code

This function transfers sectors from memory to the device. If write with verify is not supported, this function rejects the request with AH=01h, CF=1. Fn 48h shall be used to detect if write with verify is supported. In the event of an error, the block count field of the device address packet contains the number of blocks transferred before the error occurred. The calling software should not assume that the data transferred is validly written to the media. AL also contains the values 0, 1, or 2. This function rejects all other values with AH=01h, CF=1.

6.4 Verify Sectors

Entry:

AH - 44h
DL - BIOS device number
DS:SI - Device address packet

Exit:

carry clear
AH - 0
carry set
AH - error code

This function verifies sectors without transferring data between the device and system memory. When an error is reported the block count field of the device address packet shall be filled in with the number of blocks verified before the error occurred.

6.5 Lock/Unlock Media

Entry:

AH - 45h
AL - 0 - Lock media in device
1 - Unlock media in device
2 - Return lock/unlock status
3h-FFh - Invalid
DL - BIOS device number

Exit:

carry clear
AH - 0
AL - 1 if device is locked, 0 if not
carry set
AH - error code.

This function logically locks/unlocks removable media in a specific device. All removable media devices numbered 80h and above require this function. If a fixed disk (non-removable device) supports the media locking and ejecting subset, this function always returns with success, AH=0, CF=0. There shall be support for up to 255 locks per device. A device shall not be unlocked until all locks to that device have been released with unlock commands. Excess unlock calls return with carry set and AH = B0h. If the number of locks supported value is exceeded on a lock request, this function rejects the request with carry set and AH = B4h. Locking a device without media present shall be a valid operation. On return from a lock or unlock request, AL contains the lock state of the media as maintained by the BIOS. This provides for unlock requests when the lock count is greater than 0. In this case, the media remains locked. Any physical locking and unlocking of the media shall be implementation dependent, but the caller may operate on the assumption that locked media cannot be removed without an unlock request. After power-on, or a system reset, all devices automatically enter an unlocked state.

6.6 Eject removable media

Entry:

AH - 46h
AL - 0h
DL - BIOS device number

Exit:

carry clear
AH - 0
carry set
AH - error code

This function shall eject media from the specified device. If a fixed disk (non-removable device) supports the media locking and ejecting interface subset, this function always returns CF=1, AH = B2h, “Volume Not

Removable". An attempt to eject media locked in a device shall return with CF=1, AH = B1h, "Media Locked In Device". This function represents a request to remove media from the selected device. Actual ejection shall be implementation dependent, but system software that issues or observes this function should flush any buffers it is holding. If this function is issued for a device without media the request shall be returned with CF=1, AH = 31h, "No Media In Device". If this call is issued to an unlocked removable media device that has media present, an Int 15h, Fn 52h (removable media eject) shall be issued to determine if eject removable media may proceed with the ejection request. If Int 15h returns an error the ejection request shall be rejected. If the ejection request is accepted, followed by an unrecoverable error, this function returns with CF=1, AH = B5h "Valid Eject Request Failed".

6.7 Extended Seek

Entry:

AH - 47h
DL - BIOS device number
DS:SI - Device address packet

Exit:

carry clear
AH - 0
carry set
AH - error code

This function allows the host to provide advanced notification that particular data may be requested by the host in a subsequent command. This command initiates a seek operation. The seek may not be complete when this function completes.

6.8 Get Device Parameters

Entry:

AH - 48h
DL - BIOS device number
DS:SI - address of result buffer.

Exit:

carry clear
AH - 0
DS:SI - address of result buffer
carry set
AH - error code

This function returns default device parameters. It shall be mandatory regardless of the interface subset that is supported. Table 3 defines the result buffer. On entry the first word of the result buffer shall be the buffer length in bytes.

Table 3 - Result buffer

Offset	Type	Description
0	Word	The caller sets this value to the maximum buffer length in bytes. If the length of this buffer is less than 30 bytes, this function does not return the pointer to DPT extension. If the buffer length is 30 or greater on entry, it shall be set to 30 on exit. If the buffer length is between 26 and 29, it shall be set to 26 on exit. If the buffer length is less than 26 on entry an error shall be returned.
2	Word	Information Flags. A 1 bit indicates that the feature shall be available; a 0 bit indicates the feature shall be not available and shall operate in a manner consistent with the conventional INT 13h interface. **Bit** — **Description** 0 — DMA boundary errors are handled transparently 1 — The geometry returned in bytes 4-15 shall be valid 2 — Media shall be removable. Bits 4-6 are not valid if this bit is cleared to zero 3 — Device supports write verify 4 — Device has media change notification 5 — Media shall be lockable 6 — Device geometry shall be set to maximum and no media shall be present when this bit is set to one 7 — BIOS calls Int13h FN 50h to access the device 8-15 — Reserved
4	Dword	Number of default cylinders. This shall be 1 greater than the maximum cylinder number. Use INT 13h Fn 08h to find the logical number of cylinders.
8	Dword	Number of default heads. This shall be 1 greater than the maximum head number. Use INT 13h Fn 08h to find the logical number of heads.
12	Dword	Number of default sectors per track. This number shall be the same as the maximum sector number because sector addresses are 1 based. Use INT 13h Fn 08h to find the logical number of sectors per track.
16	Qword	Number of sectors. This shall be 1 greater then the maximum sector number. If this field is greater than 15,482,880 then word 2, bit 1 is cleared to 0.
24	Word	Number of bytes in a sector.
26	Dword	Pointer to the Device Parameter Table Extension (DPTE). This field follows the seg:offset address format. The DPTE shall only be present if INT 13h, Fn 41h, CX register bit 2 is equal to 1. This field points to a temporary buffer that the BIOS may invalidate on subsequent INT 13h calls. A value of FFFFh:FFFFh in this field means that the DPTE is not present. If the length of this result buffer is less than 30, the DPTE shall not be present. This field is only used for legacy INT 13h based systems configured with ATA or ATAPI devices.
30	Word	0BEDDh – Key, indicates presence of Device Path Information
32	Byte	Length of Device Path Information including the key. = 44
33	Byte	Reserved = 0
34	Word	Reserved = 0
36	ASCII	Host bus type, 4 bytes. ASCII data is left justified and padded with the value 20h PCI — PCI Local Bus — 50h 43h 49h 20h ISA — Legacy 16 bit fixed bus — 49h 53h 41h 20h
40	ASCII	Interface type, 8 bytes. ASCII data shall be left justified and padded with the value 20h ATA — ATA/ATAPI compliant device using ATA commands — 41h 54h 41h 20h 20h 20h 20h 20h ATAPI — ATA/ATAPI compliant device using ATAPI commands — 41h 54h 41h 50h 49h 20h 20h 20h SCSI — SCSI compliant device — 53h 43h 53h 49h 20h 20h 20h 20h USB — USB Mass Storage compliant device 1394 — 1394 Mass Storage device

Offset	Type	Description
		FIBRE Fibre Channel 55h 53h 42h 20h 20h 20h 20h 20h I_2O Intelligent Input/Output 31h 33h 39h 34h 20h 20h 20h 20h 46h 49h 42h 52h 45h 20h 20h 20h 49h 32h 4Fh 20h 20h 20h 20h 20h
48	Qword	Interface Path, 8 bytes. See below for format information
56	Double Qword	Device Path. See below for format information.
72	Byte	Reserved = 0
73	Byte	Checksum for Device Path Information includes the 0BEDDh signature. 2's complement of the unsigned sum of offset 30-72. The unsigned sum of offset 30-73 shall be 0.

6.8.1 Interface Path

The Interface Path field at offset 48 allows software external to a system BIOS to locate mass storage device interface chips. The format of this field shall be dependent on the Host Bus type, offset 36-39 of the result buffer. The following formats are currently defined:

Table 4 - Interface Path Definitions

Host Bus Type	Offset	Type	Definition
ISA	48	Word	16 bit base address
	50	Word	Reserved = 0
	52	Dword	Reserved = 0
PCI	48	Byte	Bus
	49	Byte	Slot
	50	Byte	Function
	51	Byte	Channel number. If more than one interface of the same type is in a single Bus, Slot, Function, then the channel number identifies each interface. If there is only one interface, this field shall be cleared to 0. If there are 2 interfaces, such as an ATA Primary and Secondary interface, the primary interface shall be 0, and the secondary interface shall be 1.
	52	Dword	Reserved = 0

6.8.2 Device Path

The Device Path at offset 56 combined with the Interface Path allows software external to a system BIOS to locate a specific mass storage device. The Device Path field provides a path from an interface to a specific device. The format of the Device Path is dependent on the Interface type, offset 40-47. The following formats are defined in this standard:

Table 5 - Device Path Definitions

Interface Type	Offset	Type	Definition
ATA	56	Byte	0 = ATA Device 0, 1 = ATA Device 1
	57	Byte	Reserved = 0
	58	Word	Reserved = 0
	60	Dword	Reserved = 0
	64	Qword	Reserved = 0
ATAPI	56	Byte	0 = ATAPI Device 0, 1 = ATAPI Device 1
	57	Byte	Logical Unit Number
	58	Byte	Reserved = 0
	59	Byte	Reserved = 0
	60	Dword	Reserved = 0
	64	QWord	Reserved = 0
SCSI	56	Word	Physical Unit Number/SCSI ID
	58	Qword	Logical Unit Number
	66	Word	Reserved = 0
	68	Dword	Reserved = 0
USB	56	QWord	64-bit Serial Number as defined in the USB Mass Storage specifications
	64	QWord	Reserved = 0
1394	56	Qword	64-bit Extended Unique Identifier (EUI-64)
	64	QWord	Reserved = 0
FIBRE	56	QWord	64-bit Wordwide Identifier (WWID)
	64	QWord	Logical Unit Number
I_2O	56	QWord	64-bit IdentityTag
	64	QWord	Reserved = 0

6.8.3 Device Parameter Table Extension (DPTE)

The DPTE provides hardware configuration information to applications that bypass INT 13h for addressing an ATA device.

Table 6 - Device parameter table extension

Offset	Type	Description
0-1	Word	I/O port base address
2-3	Word	Control port address
4	Byte	DEVICE/HEAD register bit 0-3 0 bit 4 ATA DEV bit bit 5 1 bit 6 LBA enable (1 = enabled) bit 7 1
5	Byte	BIOS Vendor Specific.
6	Byte	IRQ information bits 0-3 IRQ for this device bits 4-7 0
7	Byte	Block count for ATA READ/WRITE MULTIPLE commands
8	Byte	DMA information bits 0-3 DMA channel bits 4-7 DMA type
9	Byte	PIO information bits 0-3 PIO type bits 4-7 0
10-11	Word	BIOS selected hardware specific option flags bit 0 Fast PIO accessing enabled bit 1 DMA accessing enabled bit 2 ATA READ/WRITE MULTIPLE accessing enabled bit 3 CHS translation enabled bit 4 LBA translation enabled bit 5 Removable media bit 6 ATAPI device bit 7 32-bit transfer mode bit 8 ATAPI device uses command packet interrupt bits 9-10 Translation type bit 11 Ultra DMA accessing enabled bits 12-15 Reserved, shall be 0
12-13	Word	Reserved, shall be 0
14	Byte	11h, version level of this table.
15	Byte	Checksum, 2's complement of the 8 bit unsigned sum of bytes 0-14

6.8.3.1 Offset 0-1 - I/O port base

This word is the 16-bit address in I/O space of the data register in the ATA Command Block. Any application that provides a proprietary interface to the device may use this base address.

6.8.3.2 Offset 2-3 - control port base

This word is the 16-bit address in I/O space of the device control register. Any application that provides a proprietary interface to the device may use this address.

6.8.3.3 Offset 4 - head prefix

The upper nibble of this byte shall be logically ORed with the head number, or upper 4 bits of the LBA, each time the disk is addressed. It contains the ATA DEV bit and the LBA addressing bits that are preset, and makes these functions transparent to any software using this extension.

6.8.3.4 Offset 5 - Internal use only

For BIOS use only.

6.8.3.5 Offset 6 - IRQ number

Each ATA channel requires an assigned Interrupt number. This byte identifies which IRQ is used by this device's channel.

6.8.3.6 Offset 7 - READ/WRITE MULTIPLE command block count

If the device was configured to use the READ/WRITE MULTIPLE command, then this field contains the block size of the transfer, in sectors, used by the BIOS.

6.8.3.7 Offset 8 - DMA channel/Multiword DMA Type

If the BIOS has configured the system to perform multiword DMA data transfers in place of PIO transfers, this field specifies the DMA mode in the upper nibble, as per the ATA-2 or later definition, and the DMA Channel in the lower nibble. ATA channels that support PCI DMA bus mastering shall set the DMA channel to 0. Note that the DMA Type field does not follow the format of the data returned by the device. The value of the DMA mode shall not be limited to two.

6.8.3.8 Offset 9 - PIO type

If the BIOS has configured the system to perform PIO data transfers other than mode 0, this field specifies the PIO mode as per the ATA-2 or later definition.

6.8.3.9 Offset 10-11 - BIOS selected hardware specific option flags

These bytes specify the current hardware options enabled by the BIOS. They have a bit for each of the options listed below.

6.8.3.9.1 Bit 0 - fast PIO

If the system is configured for a PIO mode greater than 0, this bit shall be set to one and byte 9 (PIO Type) shall be used to configure the system. If this bit is cleared to zero, the PIO-Type field shall be ignored.

6.8.3.9.2 Bit 1 - fast DMA

If the system is configured for DMA, this bit shall be set to one and byte 8 (DMA Channel/DMA Type) should be used to configure the system. If this bit and bit 11, section 3.5.9.11, are 0, then the DMA Channel/DMA Type field shall be ignored.

6.8.3.9.3 Bit 2 - ATA READ/WRITE MULTIPLE

If the system is configured for multi-sector transfers, this bit shall be set to one and byte 7 (sector count) specifies the number of sectors used for each data transfer. If block PIO is disabled, ignore the block count field.

6.8.3.9.4 Bit 3 - CHS translation

If the device reports more than 1024 cylinders in the IDENTIFY DEVICE command data, this bit shall be set to one.

6.8.3.9.5 Bit 4 - LBA translation

If the system is configured for LBA type addressing, this bit shall be set to one. When LBA translation is on, the Extended INT 13h interface (Fn 41h-48h) pass LBA values directly to the device. The conventional INT 13h interface ignores this bit and always uses CHS. LBA-type addressing shall be available on devices with less than 1024 cylinders, and therefore bit 3 (CHS translation) shall be independent from bit 4 (LBA translation).

6.8.3.9.6 Bit 5 - removable media

If the device supports removable media, this bit shall be set to one and the extended INT 13h device locking and ejecting subset shall also be supported.

6.8.3.9.7 Bit 6 - ATAPI device

If this ATA device implements the PACKET command feature set (ATAPI) as defined in ATA/ATAPI-4, this bit shall be set to one.

6.8.3.9.8 Bit 7 - 32-bit transfer mode

If the BIOS has configured the host adapter to perform 32-bit wide data transfers, this bit shall be set to one.

6.8.3.9.9 Bit 8 - ATAPI device uses command packet interrupt

If bit 6 is cleared to zero, then this field shall be ignored and shall be 0. If bit 6 is set to one, this bit indicates how the ATAPI devices signals it is ready to receive a packet command. When this bit is 1, it indicates that the ATAPI device returns an interrupt, and sets DRQ, when it is ready for a packet. When this bit is cleared to zero, it indicates that the ATAPI device sets DRQ, without an interrupt, when it is ready for a packet.

6.8.3.9.10 Bits 9-10 - translation type

If bit 3 is zero then this field shall be ignored and shall be 0. If bit 3 is 1 then this field identifies the geometric translation shown in Table 7 .

Table 7 - Translation type

Bits 9-10	Description
00	Bit-shift translation
01	LBA assisted translation
10	Reserved
11	Vendor specific translation

6.8.3.9.11 Bit 11 - Ultra DMA

If the system is configured for Ultra DMA, this bit shall be set to one and byte 8 (DMA Channel/DMA Type) should be used to configure the system. If this bit and bit 1, (Bit 1 - fast DMA, section 6.8.3.9.2) are 0, then the DMA Channel/DMA Type field shall be ignored.

6.8.3.9.12 Bits 12-15 - Reserved

Shall be set to 0.

6.8.3.10 Offset 12-13 - Reserved

Shall be set to 0.

6.8.3.11 Offset 14 - table revision

The table version shall be set to 11h indicating compliance with this standard.

6.8.3.12 Offset 15 - checksum

This shall be the two's complement of the 8-bit unsigned sum of bytes 0 through 14. Adding bytes 0 through 15 shall in all cases produce an 8-bit result of 0.

6.9 Get extended media change status

Entry:

AH - 49h
DL - BIOS device number

Exit:

carry clear
AH - 00, change-line inactive
carry set
AH - 06, change-line active

This function returns media change status. If it returns with carry flag set, the media has not necessarily been changed; the media change notification may be activated by simply unlocking and locking the device door without removing the media. This function corresponds to INT 13h Fn 16h, but explicitly allows any device number to be passed in. If a non-removable device supports the Device Locking and Ejecting interface subset, this function always returns with success, AH=0h, CF=0h. This function clears the media change notification on exit.

6.10 Set hardware configuration

Entry:

AH - 4Eh
AL - Hardware configuration sub-function (See Table 8)
DL - BIOS device number.

Exit:

carry clear
AH - 0
AL - 0 if command was safe
1 if other devices are affected
carry set
AH - error code

Table 8 - Hardware configuration sub-functions

AL	Sub-function description
0h	Enable prefetch
1h	Disable prefetch
2h	Set maximum PIO transfer mode.
3h	Set PIO mode 0. Clear to the minimum PIO transfer rate.
4h	Return to default PIO transfer mode. Return the system to the PIO mode enabled by the BIOS setup utility.
5h	Enable INT 13h DMA maximum mode. Set the maximum rate allowed by both the host adapter and the device.
6h	Disable INT 13h DMA

The purpose of this function is to allow non-hardware-specific software to configure host adapter and devices for optimal operation. ATA channels may have two devices attached, but this function operates on a single-device

basis. This shall be accommodated by the value that is returned in AL. If the host adapter supports the requested sub-function on a device basis, AL shall be cleared to zero. If the host adapter only supports the setting on an ATA channel basis, AL shall be set to one. Once this function has been invoked, all subsequent INT 13h device-access functions use the mode specified by this invocation. This means that if "DMA Maximum" is enabled, INT 13h Fn 02h reads from the device using DMA transfers. The DMA/PIO selections are mutually exclusive. When "DMA Maximum" is enabled, "PIO Maximum" shall be disabled. If the requested mode change is not supported this function returns with CF=1 and AH=1

6.11 Send Packet Command

Entry:

AH - 50h
AL – D7h
DL - BIOS device Number
ES:SI – Pointer to formatted command packet, (see Table 13).

Exit:

carry clear
AH - 0
carry set
AH - error code
01 – Function not implemented
80h – Command failed to complete
97h – Subfunction D7h not supported for this device
C3h – Formatted Command Packet is too short

Table 9 - Formatted Command Packet

Offset	Type	Description
0	Word	Length of this record in bytes
2-n	Byte	Formatted protocol specific data

This function defines a service that the system BIOS shall call for sending data to and from a packet oriented device. The BIOS shall provide this service before the OS is loaded. When an operating system takes control of the device controller it takes the hook for this service to provide a seamless transfer of control from the BIOS to the operating system. This service allows several BIOS level services to continue functioning, even after the OS has taken control of the device controller, for example:

- The INT 13h mass storage interface
- Power Management
- Suspend to disk

The BIOS is a single threaded, master device. This means that the BIOS shall not process asynchronous requests from other devices. The BIOS shall send commands to devices and wait for responses. This means that the operating system can take control of the serial interface with no hand-off information from the system BIOS. The operating system shall reconfigure the interface and hook the service described above. The system BIOS may provide INT 13h Fn 50h for the 1394, USB, and any other packet oriented bus.

The format of the packet shall be determined by the requirements of the target bus and is beyond the scope of this document. In the case of USB, the packet format shall be determined by the USB specification. In the case of 1394, IEEE 1394-1995 determines the size of a packet with payload information defined in SBP-2.

7 Int 15h removable media eject

Entry:

AH - 52h
DL - BIOS device number

Exit:

carry clear

AH - 0, ejection may proceed

carry set

AH - error code, B1h or B3h, ejection is rejected

This function shall be called by the BIOS in response to a software request (INT 13h, AH=46h, Eject Device) to eject media from a removable media device.

Typically a user will press an eject button or use a software command to request that a particular media be ejected. By default the Int 15h handler returns with ejection accepted status. A disk cache program could hook this Int 15h call and return acceptance or rejection based on the state of its buffers for this disk. It may also be used by operating system software as a media change request.