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Information Technology - BIOS Enhanced Disk Drive Services – 3 (EDD-3)

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Changed name from EDD-2 to EDD-3 in various places

Filled in CD/DVD boot sections

Added SAS definitions requested by Intel

American National Standard
For Information Systems -

BIOS Enhanced Disk Drive Services – 3

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Approved mm dd yy

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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-terabytes (16×10^{18} bytes). 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, I₂O, and other interfaces. In addition, this standard defines the following:

1. Formatting required to make a CD or DVD bootable
2. INT 13 services used to access devices <8GB
3. addressing information for Infiniband, Serial ATA, Hypertransport, and PCI Express

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Foreword [**Editors Note: Need to update for EDD-3**]

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

DOS accesses 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, upgraded in the late 1980's and upgraded again in the early 1990's. Initially, INT 13 used a cylinder-head-sector interface that was limited to approx. 528MB of disk addressing. Later this same interface was upgraded to support approx. 8.4GB of disk addressing. Finally, extended functions were created that allowed 64 bit disk addressing. At this same time, specifications were created that allowed the CD-ROM to boot using the same INT 13 interface that hard drives used. The Disk and CD/DVD functions have never been fully documented in a standards forum. This standard enables the following capabilities:

- CHS addressing with an 8.4GB limitation
- 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.
- Makes ILocation 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:

[NCITS membership goes here]

Technical Committee T13 on ATA Interfaces, that reviewed this standard, had the following members:

[T13 membership goes here]

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 INT 13h functions limited to 8GB if disk addressing.

Clause 6 is INT 13h functions not limited to 8GB of disk addressing.

Clause 7 is INT 13 function definitions

Clause 8 is INT 15H Removable Media Eject Functions

Clause 9 is CD/DVD Booting

American National Standard
for Information Systems -

Information Technology - **BIOS Enhanced Disk Drive Services – 3 (EDD-3)**

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 capacity 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 defines solutions to the following INT 13h BIOS-specific issues:

- The INT 13h interface has a limit of 528 megabytes (MB);
- 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;
- The INT 13h interface does not define CHS-independent methods for addressing devices. The methods defined by the INT 13h interface are not device-geometry independent. A different method of address representation and operation is needed;
- 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 via the INT 13h interface;
- 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. The INT 13 interface does not provide this capability;
- The INT 13h interface does not make location and configuration information available to operating systems that do not use the BIOS to access mass storage devices;
- The INT 13h interface does not provide a linkage between the BIOS device assignments on the operating system device letter assignments;
- The INT 13h interface does not 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.

INCITS 303-1998 *Fibre Channel Physical and Signaling Interface - 3*
 INCITS 361-2002 *AT Attachment with Packet Interface – 6 (ATA/ATAPI-6)*
 INCITS 325-1998 *Serial Bus Protocol – 2 (SBP-2)*
 INCITS 330-2003 *Reduced Block Commands (RBC)*
 INCITS 351-2001 *SCSI Primary Commands - 2 (SPC-2)*
 INCITS 360-2002 *Multi-Media Commands - 3 (MMC-3)*
 INCITS 363-2002 *BIOS Enhanced Disk Drive Services – 2 (EDD-2)*
 ANSI/IEEE 394:1995 *Extended Unique Identifier, 64-bit (EUI-64)*
 IEEE 1394-1995 *IEEE Standard for a High Performance Serial Bus*
 IEEE 1394a-2000 *IEEE Standard for a High Performance Serial Bus – Amendment 1*
 ISO 9660-1988 *Volume and File Structure of CD-ROM For Information Interchange*

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.

INCITS 1410D *AT Attachment with Packet Interface – 7 (ATA/ATAPI-7)*
 INCITS 1416D *SCSI Primary Commands - 3 (SPC-3)*
 INCITS 1545D *Multi-Media Commands - 4 (MMC-4)*
 IEEE P1394b *Standard for High Performance Serial Bus (High Speed Supplement)*
 INCITS 1467D *Serial Bus Protocol – 3 (SBP-3)*

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
 EI 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

I₂O 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:



3.2.5 CF

The Carry Flag is a bit in the Flags Register in the microprocessor.

3.2.6 CHS

CHS addressing is a method of addressing the contents of a storage device using logical cylinders (C), logical heads (H), and logical sectors (S). This method of addressing allows a maximum C=16,383, H=16, S=63, resulting in a maximum device capacity of 8.4 gigabytes (16,383 * 16 * 63 * 512 bytes per sector ≈ 8.4 gigabytes). . See LBA addressing for another addressing method.

3.2.7 Conventional and 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 less. 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.

3.2.8 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.

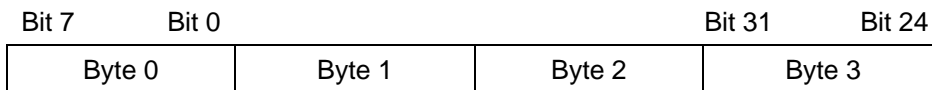
3.2.9 DWord

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

On Paper:



In Memory:



3.2.10 Host

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

3.2.11 IA-32

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

3.2.12 IA-64

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

3.2.13 INT 13h

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

3.2.14 INT 40h

INT 40h is 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.

3.2.15 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.

3.2.16 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 on an ATA device using 28-bit addressing. See CHS for another address method.

3.2.17 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.

3.2.18 NV Memory

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

3.2.19 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.

3.2.20 POST

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

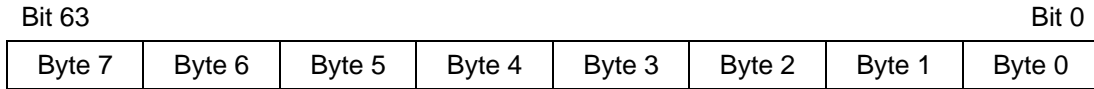
3.2.21 Protected Mode

Intel x86 processors have several modes of main memory addressing. One of these modes is called Protected Mode. In this mode all the system memory can be addressed. Another mode is Real Mode. See section 3.2.23 for the definition of Real Mode.

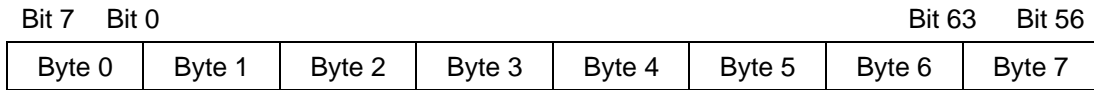
3.2.22 QWord

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

On Paper:



In Memory:



3.2.23 Real 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 called Protected Mode. See section 3.2.21 for the definition of Protected Mode.

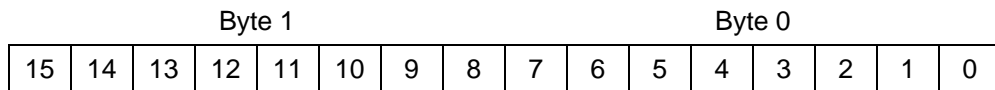
3.2.24 Standard Floppy Drive

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

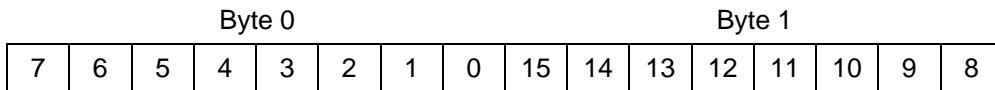
3.2.25 Word

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

On Paper:



In Memory:



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	Example
Binary	nnnb	1001010b
Decimal	nnn	74
Hexadecimal	nnnh	4Ah

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.

3.3.2 Register and CF Contents

The value contained in a register is expressed as "register name = value" (e.g., AH = 01h). The value contained in CF (the Carry Flag) is expressed as "CF = value" (e.g., CF = 1b).

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. The INT 13h interface, now known as the legacy INT 13h interface, uses function numbers 1 through 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, Windows™ NT, Windows™ 2000, and Windows™ XP, 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 when named "A:", "B:", "C:", as well as "D:" and other letters.

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.

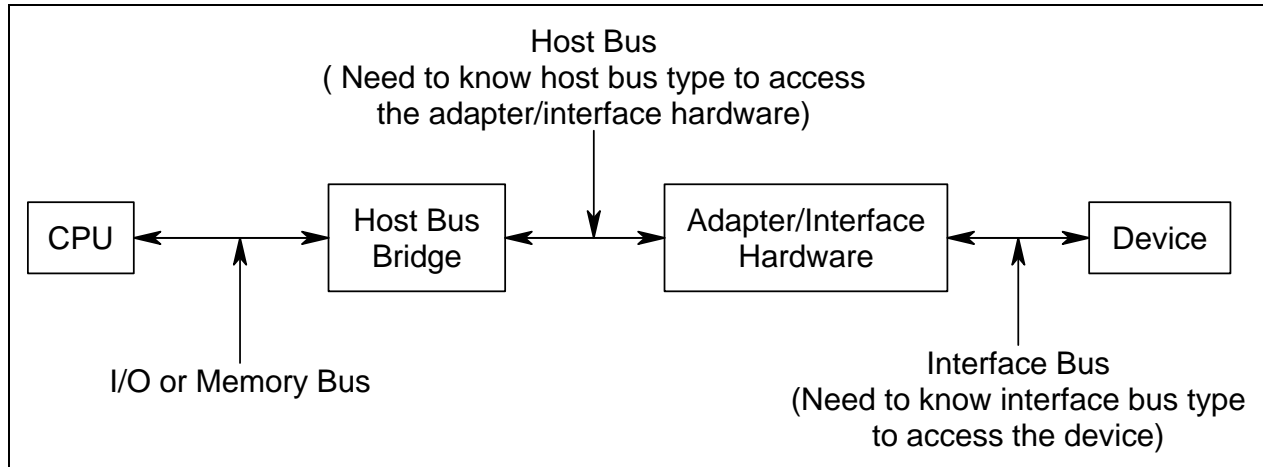


Figure 1 - System Component Diagram

5 <8GB INT 13h Functions (Legacy Functions)

The Legacy INT 13h functions can address a maximum of 8.4GB of device space. Sector sizes shall be exactly 512 bytes. The Legacy INT 13h functions pass all parameters in registers using the following template (see Table 1) unless otherwise specified:

Table 1 – Legacy Register Definitions

Register	Description						
AH	INT 13h function number (Range is 00h -15h)						
AL	Number of sectors to transfer						
CH	Low 8 bits of Cylinder						
CL	<table border="1"> <thead> <tr> <th>Bit</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0-5</td> <td>Sector number. This value is 1 based. 0 is an illegal value.</td> </tr> <tr> <td>6-7</td> <td>High order 2 bits of the cylinder</td> </tr> </tbody> </table>	Bit	Description	0-5	Sector number. This value is 1 based. 0 is an illegal value.	6-7	High order 2 bits of the cylinder
Bit	Description						
0-5	Sector number. This value is 1 based. 0 is an illegal value.						
6-7	High order 2 bits of the cylinder						
DH	Head Number						
DL	<table border="1"> <thead> <tr> <th>Bits</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0-6</td> <td>Drive Number</td> </tr> <tr> <td>7</td> <td>Set to 1 for Fixed media Clear to 0 for removable media</td> </tr> </tbody> </table>	Bits	Description	0-6	Drive Number	7	Set to 1 for Fixed media Clear to 0 for removable media
Bits	Description						
0-6	Drive Number						
7	Set to 1 for Fixed media Clear to 0 for removable media						
ES:BX	Buffer pointer. Commands that move data from the device to memory shall use this pointer as the destination for the data. Commands that move data from memory to the device shall use this pointer as the source for the data to be transferred.						

The following legacy functions shown in Table 2 are documented in this standard:

Table 2 – Legacy Functions Definitions

Function	Description
00h	Reset disk subsystem
01h	Get status of last operation
02h	Read Sectors into memory
03h	Write sectors from memory

04h	Verify sector
08h	Get Drive Parameters
09h	Initialize Controller
0Ah	Read Long
0Bh	Write Long
0Ch	Seek to cylinder
0Eh	Read Buffer
0Fh	Write Buffer
11h	Recalibrate Drive
15h	Get Disk Type
18h	Set Media Type
19h	Park heads
15h	IDENTIFY DEVICE info

6 >8GB INT 13h Functions

The extended INT 13h functions are numbered from 41h through 49h, 4E, and 50h. These functions are 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 through 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.

6.1 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 3 defines the device address packet.

Table 3 - Device Address Packet

Offset	Type	Description
0	Byte	Packet size in bytes. The value in this field shall be 16 (10h) or greater. If the packet size is less than 16 the request shall be rejected with CF = 1b and AH = 01h.
1	Byte	Reserved. The value in this field shall be 00h
2	Byte	Number of blocks to transfer. This field shall contain a maximum value of 127 (7Fh). If a any other value is supplied, the request shall be rejected with CF=1b and AH=01h. 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. The value in this field shall be 00h.
4	DWord	Address of host transfer buffer. This is 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	<p>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:</p> $LBA = (C_1 * H_0 + H_1) * S_0 + S_1 - 1$ <p>Where:</p> <ul style="list-style-type: none"> C₁ = Selected Cylinder Number H₀ = Number of Heads (Maximum Head Number + 1) H₁ = Selected Head Number S₀ = Maximum Sector Number S₁ = Selected Sector Number <p>For ATA compatible devices, with less than or equal to 15,482,880 logical sectors, the H₀ and S₀ values are supplied by words 3 and 6 of the data returned as a result of an IDENTIFY DEVICE command.</p>
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. The value in this field shall be 00h.
NOTE - The options described in table 1 allow a host to use a 7-bit transfer size with a 32-bit 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.		

6.2 Removable Media

The distinction between "removable" disks numbered 00h through 7Fh and "fixed" disks numbered 80h through FFh differs from conventional INT 13h functions. Devices numbered 0 through 7Fh are not changed. They follow conventional INT 13h standards for floppy disk operation. Devices numbered 80h through 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:

Return Code	Description
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

6.3 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 = 1b and AH = 01h. There are three subsets defined. At least one of these shall be supported.

NOTE - Conventional INT 13h may be used for media accessing if the Fixed Disk Access Subset is not present.

6.3.1 Fixed Disk Access Subset

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

Function	Code
Check Extensions Present	41h
Extended Read	42h
Extended Write	43h
Verify Sectors	44h
Extended Seek	47h
Get Device Parameters	48h

6.3.2 Device Locking and Ejecting Subset

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

Function	Code
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	na

6.3.3 Enhanced Disk Drive (EDD) Support Subset

These functions provide EDD support as follows:

Function	Code
Check Extensions Present	41h
Get Parameters With EDD Extensions	48h

7 CD/DVD Boot

CD/DVD boot depends on a combination of BIOS functions and media format information. This section documents both.

7.1 CD/DVD BIOS functions

These functions use the same conventions described for the >8GB BIOS functions. There are for capabilities specified:

1. Start Emulation
2. Terminate Emulation
3. Get Directory
4. Boot CD/DVD

7.2 CD/DVD Format

The system BIOS can boot from a CD or DVD only if the format of the media has been predefined. ISO-9660 is a basic CD-ROM file system that has been incorporated into current CD and DVD file system standards. CD/DVD boot uses ISO 9660 as a framework to provide boot capability. ISO 9660 requires that a set of volume descriptors reside on the media starting at sector 10h. For data CD's, there will usually be a "Primary Volume Descriptor" at sector 10h followed by a "Set Terminator" at sector 11h. The "Primary Volume Descriptor" provides a pointer to the directory structures. ISO 9660 has also defined a "Boot Volume Descriptor" (BVS). BIOSes check the BVS to determine if a CD or DVD is bootable. A CD or DVD shall have a BVS at sector 11h on the media. The "Set Terminator" shall reside at sector 12h or higher. ISO 9660 requires that a "Set Terminator" be present. ISO 9660 formatting need not be present for a CD or DVD to be bootable. The only requirement is that a BVS be present at sector 11h.

7.2.1 Boot Volume Descriptor

ISO 9660 does not define the payload for its BVS. EDD-3 provides the necessary formatting to enable bootability. The BIOS shall check the data in the BVS to determine if boot is possible. See Table 4 for the BVS format.

Table 4 – Boot Volume Descriptor

Offset	Type	Description
00h	Byte	0 – Boot Record Indicator
01h-05h	Byte	"CD001" (43h 44h 30h 30h 31h) – ISO-9660 specification identifier
06h	Byte	1 – Version of this descriptor
07h-26h	Byte	"EL TORITO SPECIFICATION" (<i>[Editors Note: add ASCII values]</i>)
27h-46h	Byte	Reserved (shall be 0)
47h-4Ah	DWord	Absolute pointer to first sector of boot catalog
4Ah-7FFh	Byte	Reserved (shall be 0)

8 INT 13h Function Definitions

These function definitions include legacy, extended, and CD/DVD functions. The functions are differentiated by their function numbers and register usage. The extended functions use DS:SI as a pointer to a command packet. The extended functions use ES:BX as a pointer to their transfer buffer. Functions 0-3Fh are legacy functions. Functions 40h-49h are extended functions. Functions 4Ah-4Dh are CD/DVD boot functions. Functions 4Eh-50h

8.1 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 (see Table 5)

carry set
 AH - error code (01h, Invalid Command)

Table 5 - Check Extensions Present Buffer

Bit	Description
0	If the content of this bit is one, then the Fixed disk access subset shall be supported.
1	If the content of this bit is one, then the Device locking and ejecting subset shall be supported.
2	If the content of this bit is one, then the Enhanced disk drive support subset shall be supported.
3	If the content of this bit is one, then the 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. The content of these bits shall be zero.

This function shall be used to check for the presence of INT 13h extensions. If CF=1b, the extensions are not supported for the requested device. If CF=0b, BX shall be checked to confirm that it contains the value AA55h indicating that the extensions are present. If BX = 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.

8.2 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 shall 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.

8.3 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 shall transfer sectors from memory to the device. If write with verify is not supported, this function rejects the request with AH = 01h and CF = 1b. 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 00h, 01h, or 02h. This function rejects all other values with AH = 01h and CF = 1b.

8.4 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.

8.5 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 or unlocks removable media in a specific device. All removable media devices numbered 80h and above shall implement this function. If a fixed disk (non-removable device) supports the media locking and ejecting subset, this function shall return with success (i.e., AH = 00h and CF = 0b). There shall be support for 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 shall return with CF = 1b and AH = B0h. If the number of

locks supported value is exceeded on a lock request, this function shall reject the request with CF = 1b and AH = B4h. Locking a device without media present shall be a valid operation. On return from a lock or unlock request, AL shall contain the lock state of the media as maintained by the BIOS. This provides for unlock requests when the lock count is greater than zero. In this case, the media shall remain 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 shall automatically enter an unlocked state.

8.6 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 shall always return with "Volume Not Removable" (i.e., CF = 1 and AH = B2h). An attempt to eject media locked in a device shall return with "Media Locked In Device" (i.e., CF 1 and AH = B1h). 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 "No Media In Device" (i.e., CF = 1b and AH = 31h). 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 shall return with "Valid Eject Request Failed" (i.e., CF = 1b and AH = B5h).

8.7 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 shall initiate a seek operation. The seek may not be complete when this function completes.

8.8 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 6 defines the result buffer. On entry the first word of the result buffer shall be the buffer length in bytes.

Table 6 - Result Buffer

Offset	Type	Description																				
0	Word	The caller shall set this value to the maximum buffer length in bytes. If the length of this buffer is less than 30 bytes, this function shall 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 value of one in a bit indicates that the feature shall be available. A value of zero in a bit indicates the feature shall be not available and shall operate in a manner consistent with the conventional INT 13h interface. <table border="1"> <thead> <tr> <th>Bit</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>DMA boundary errors are handled transparently</td> </tr> <tr> <td>1</td> <td>The geometry returned in bytes 4-15 shall be valid</td> </tr> <tr> <td>2</td> <td>Media shall be removable. Bits 4-6 are not valid if this bit is cleared to zero</td> </tr> <tr> <td>3</td> <td>Device supports write verify</td> </tr> <tr> <td>4</td> <td>Device has media change notification</td> </tr> <tr> <td>5</td> <td>Media shall be lockable</td> </tr> <tr> <td>6</td> <td>Device geometry shall be set to maximum and no media shall be present when this bit is set to one</td> </tr> <tr> <td>7</td> <td>BIOS calls INT13h FN 50h to access the device</td> </tr> <tr> <td>8-15</td> <td>Reserved</td> </tr> </tbody> </table>	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
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. The content of this field shall be one greater than the maximum cylinder number. INT 13h Fn 08h shall be used to find the logical number of cylinders.																				
8	DWord	Number of default heads. The content of this field shall be one greater than the maximum head number. INT 13h Fn 08h shall be used to find the logical number of heads.																				
12	DWord	Number of default sectors per track. The content of this field shall be the same as the maximum sector number because sector addresses are 1 based. INT 13h Fn 08h shall be used to find the logical number of sectors per track.																				
16	QWord	Number of sectors. This shall be one greater than the maximum sector number. If this field is greater than 15,482,880 then word 2, bit 1 shall be cleared to zero.																				
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 set to one. 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. The content of this byte shall be 44h																				
33	Byte	Reserved. The value in this field shall be 00h.																				
34	Word	Reserved. The value in this field shall be 0000h.																				

Offset	Type	Description
36	ASCII	Host bus type, 4 bytes. ASCII data shall be 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 PCI-X PCI-X Bus 50h 43h 49h 58h IBND Infiniband 49h 42h 4Eh 44h XPRS PCI Express 58h 50h 52h 53h HTPT HyperTransport 48h 54h 50h 54h
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 55h 53h 42h 20h 20h 20h 20h 20h 1394 1394 Mass Storage device 31h 33h 39h 34h 20h 20h 20h 20h FIBRE Fibre Channel 46h 49h 42h 52h 45h 20h 20h 20h I ₂ O Intelligent Input/Output 49h 32h 4Fh 20h 20h 20h 20h 20h RAID Redundant Array of Inexpensive Disks (RAID) member 52h 41h 49h 44h 20h 20h 20h 20h SATA Serial ATA 53h 41h 54h 41h 20h 20h 20h 20h SAS Serial Attached SCSI 53h 41h 53h 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. The value in this field shall be 00h.
73	Byte	Checksum for Device Path Information includes the 0BEDDh signature. The content of this field shall be the two's complement of the unsigned sum of offset 30 through 72. The unsigned sum of offset 30 through 73 shall be 0.

8.8.1 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, offsets 36 through 39 of the result buffer. The following formats are currently defined:

Table 7 - Interface Path Definitions

Host Bus Type	Offset	Type	Definition
ISA	48	Word	16-bit base address
	50	Word	Reserved. The value in this field shall be 0000h
	52	DWord	Reserved. The value in this field shall be 00000000h
PCI	48	Byte	PCI bus number. Values 00h through FEh shall represent a valid PCI bus. Value FFh shall indicate that this field is not used.
	49	Byte	PCI slot number. Values 00h through FEh shall represent a valid PCI slot. Value FFh shall indicate that this field is not used.
	50	Byte	PCI function number. Values 00h through FEh shall represent a valid PCI function. Value FFh shall indicate that this field is not used.
	51	Byte	Channel number. If more than one interface of the same type is in a single Bus, Slot, Function, then the channel number shall identify each interface. If there is only one interface, the content of this field shall be cleared to zero. If there are two interfaces, such as an ATA Primary and Secondary interface, the primary interface shall be zero, and the secondary interface shall be one. Values 00h through FEh shall represent a valid Channel Number. Value FFh shall indicate that this field is not used
	52	DWord	Reserved. The value in this field shall be 00000000h
PCI-X	48	Byte	PCI-X bus number. Values 00h through FEh shall represent a valid PCI bus. Value FFh shall indicate that this field is not used.
	49	Byte	PCI slot number. Values 00h through FEh shall represent a valid PCI slot. Value FFh shall indicate that this field is not used.
	50	Byte	PCI function number. Values 00h through FEh shall represent a valid PCI function. Value FFh shall indicate that this field is not used.
	51	Byte	Channel number. If more than one interface of the same type is in a single Bus, Slot, Function, then the channel number shall identify each interface. If there is only one interface, the content of this field shall be cleared to zero. If there are two interfaces, such as an ATA Primary and Secondary interface, the primary interface shall be zero, and the secondary interface shall be one. Values 00h through FEh shall represent a valid Channel Number. Value FFh shall indicate that this field is not used
	52	DWord	Reserved. The value in this field shall be 00000000h
Infiniband	48h	Qword	TBD
PCI Express	48h	Qword	TBD
HyperTransport	48h	Qword	TBD

8.8.2 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 at offset 40 through 47 is dependent on the Interface type. The following formats are defined in this standard:

Table 8 - Device Path Definitions

Interface Type	Offset	Type	Definition
ATA	56	Byte	00h = ATA Device 0, 01h = ATA Device 1
	57	Byte	Reserved. The value in this field shall be 00h.
	58	Word	Reserved. The value in this field shall be 0000h.
	60	DWord	Reserved. The value in this field shall be 00000000h.
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.
ATAPI	56	Byte	00h = ATAPI Device 0, 01h = ATAPI Device 1
	57	Byte	Logical Unit Number
	58	Byte	Reserved. The value in this field shall be 00h.
	59	Byte	Reserved. The value in this field shall be 00h.
	60	DWord	Reserved. The value in this field shall be 00000000h.
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.
SCSI	56	Word	Physical Unit Number/SCSI ID
	58	QWord	Logical Unit Number
	66	Word	Reserved. The value in this field shall be 0000h.
	68	DWord	Reserved. The value in this field shall be 00000000h.
USB	56	QWord	64-bit Serial Number as defined in the USB Mass Storage specifications
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.
1394	56	QWord	64-bit Extended Unique Identifier (EUI-64)
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.
FIBRE	56	QWord	64-bit Worldwide Identifier (WWID)
	64	QWord	Logical Unit Number
I ₂ O	56	QWord	64-bit Identity Tag
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.
RAID	56	DWord	RAID array number of which this device is a member
	60	DWord	Reserved. The value in this field shall be 00000000h.
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.

Interface Type	Offset	Type	Definition
SATA	56	Byte	00h = SATA Device 0, 01h = SATA Device 1
	57	Byte	Reserved. The value in this field shall be 00h.
	58	Word	Reserved. The value in this field shall be 0000h.
	60	DWord	Reserved. The value in this field shall be 00000000h.
	64	QWord	Reserved. The value in this field shall be 0000000000000000h.
SAS	56	QWord	64-bit SAS address
	64	QWord	Logical Unit Number

8.8.3 Device Parameter Table Extension (DPTE)

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

Table 9 - Device parameter table extension

Offset	Type	Description
0-1	Word	I/O port base address
2-3	Word	Control port address
4	Byte	Device 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 cleared to zero
12-13	Word	Reserved, shall be cleared to zero
14	Byte	11h, version level of this table.
15	Byte	Checksum, 2's complement of the 8 bit unsigned sum of bytes 0-14

8.8.3.1 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.

8.8.3.2 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.

8.8.3.3 Offset 4 - head prefix

The upper four bits of this byte shall be logically ORed with the head number, or upper four 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. The LBA addressing bit is set for each disk access and shall not be used to determine the LBA capability of the system. See the LBA translation enabled bit described in section 8.8.3.9.5 for system LBA capability.

8.8.3.4 Offset 5 - BIOS use only

BIOS use only.

8.8.3.5 Offset 6 - IRQ number

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

8.8.3.6 Offset 7 - READ/WRITE MULTIPLE command block count

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

8.8.3.7 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 shall specify the DMA mode in the upper four bits, as per the definition in ATA-5 or later, and the DMA Channel in the lower four bits. ATA channels that support PCI DMA bus mastering shall set the DMA channel to zero. 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.

8.8.3.8 Offset 9 - PIO type

If the BIOS has configured the system to perform PIO data transfers other than mode 0, this field shall specify the PIO mode as per the definition in ATA-5 or later.

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

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

8.8.3.9.1 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.

8.8.3.9.2 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 cleared to zero, then the DMA Channel/DMA Type field shall be ignored.

8.8.3.9.3 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.

8.8.3.9.4 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. See section 8.8.3.9.10 to determine the method of geometry translation.

8.8.3.9.5 Bit 4 - LBA translation

If the system is configured for LBA type addressing, this bit shall be set to one and the Extended INT 13h interface (Fn 41h through 48h) shall pass LBA values directly to the device. The conventional INT 13h interface shall ignore this bit and shall use 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).

8.8.3.9.6 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.

8.8.3.9.7 Bit 6 - ATAPI device

If this ATA device implements the PACKET command feature set (ATAPI) as defined in ATA/ATAPI-5, this bit shall be set to one.

8.8.3.9.8 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.

8.8.3.9.9 Bit 8 - ATAPI device uses command packet interrupt

If bit 6 is cleared to zero, then this field shall be ignored and shall be zero. 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 set to one, 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.

8.8.3.9.10 Bits 9-10 - translation type

If bit 3 is cleared to zero then this field shall be ignored and shall be zero. If bit 3 is set to one then this field identifies the geometric translation shown in Table 10 .

Table 10 - Translation Type

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

8.8.3.9.11 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 cleared to zero, then the DMA Channel/DMA Type field shall be ignored.

8.8.3.9.12 Bits 12-15 - Reserved

Shall be cleared to zero.

8.8.3.10 Offset 12-13 - Reserved

Shall be cleared to zero.

8.8.3.11 Offset 14 - table revision

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

8.8.3.12 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 zero.

8.9 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 CF = 1b, the media may not have been changed. The media change notification may be activated by 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 shall return with success, AH = 00h, CF = 0b. This function shall clear the media change notification on exit.

8.10 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 11 - 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.
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 00h. If the host adapter only supports the setting on an ATA channel basis, AL shall be set to 01h. Once this function has been invoked, all subsequent INT 13h device-access functions shall use the mode specified by this invocation. This means that if “DMA Maximum” is enabled, INT 13h Fn 02h shall read 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 shall return with CF = 1b and AH = 01h

8.11 Send Packet Command

Entry:

- AH - 50h
- AL – D7h
- DL - BIOS device Number
- ES:SI – Pointer to formatted command packet, (see Table 12).

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 12 - 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 may 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 shall determine the size of a packet with payload information defined in SBP-2.

8.11.1 Packet Sending Service (PSS) For SCSI Command Data Block's (CDB)

The purpose of this interface is to allow an application to send SCSI CDB's using BIOS INT 13h calls to a device, regardless of the bus on which the device resides. This interface is currently defined for ATAPI, SCSI, 1394, and USB devices. Future buses that use SCSI CDB's may also adopt this mechanism for transporting commands

This interface shall not retry any operation. If an error occurs either in command format, or operation of the device, an error shall be returned by INT 13h. The application may choose to retry a command by issuing it again.

This PSS shall provide transport specific wrappers and modify the CDB where necessary with bus specific information. If the secondary bus is a hot-plug bus such as 1394 or USB, the PSS shall insert device addresses or EUI-64 as necessary. In the event that a device address changes due to a bus reset or re-enumeration, the PSS shall connect with the device without generating an error.

8.11.1.1 Formatted Protocol Specific Data

Table 13 defines the format of the data passed in ES:SI (See 8.11) to INT 13h Fn 50h.

Table 13 - Formatted Protocol Specific Data

Offset	Type	Description
0	Word	Packet length in bytes including this word
2	Byte	Information flags Bits 6-7 = Data direction. 00 = No data exchanged with device (command only) 01 = Receive data from device 10 = Send data to device 11 = Reset Interface. Bits 0-5 = Reserved.
3	Byte	Bytes in command packet, or zero if no command is to be sent.
4	DWord	Pointer to command packet. This field follows the seg:offset address format. This field is ignored if offset 3 is zero.
8	DWord	Number of bytes to transfer following command complete. Shall be a multiple of the sector size of the media, as returned by Function 48h. If the data direction bits in Flags do not indicate a send or receive data command, then this field shall be ignored. Otherwise, if this value shall be zero, then a 0-byte transfer shall occur.
10h	DWord	Pointer to the start of the data stream to transfer. This field follows the seg:offset address format.
14	Word	Access timeout. Maximum time in milliseconds to wait for command start. Command start includes sending the command to the devices and waiting for the first data byte to transfer. If this field contains the value of 0000h, an 80h error shall result
16	Word	Sector timeout increment. The PSS shall divide the amount of data transferred by the sector size, round up, multiply by this value, and add to the Access Timeout (offset 14), the maximum result is limited to FFFFh. This shall be the total timeout for the specified CDB. This value shall be ignored for command-only and bus-reset calls.

8.11.1.2 Output Parameters

The following output parameters, see Table 14, match the parameters defined in 8.11. No other return parameters are necessary for this transport.

Table 14 – Output Parameters

OUT	Description														
AL	Undefined														
AH	<table border="1" data-bbox="332 457 1300 947"> <thead> <tr> <th data-bbox="332 457 501 506">Value</th> <th data-bbox="501 457 1300 506">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="332 506 501 554">00h</td> <td data-bbox="501 506 1300 554">No Error</td> </tr> <tr> <td data-bbox="332 554 501 602">01h</td> <td data-bbox="501 554 1300 602">AX=50D7h not implemented</td> </tr> <tr> <td data-bbox="332 602 501 743">80h</td> <td data-bbox="501 602 1300 743">A condition has occurred which prevented successful command completion. This may be due to a busy device, a timeout, a bus reset, short packet, or other event. The host should issue a Request-Sense-type command in the required protocol.</td> </tr> <tr> <td data-bbox="332 743 501 821">97h</td> <td data-bbox="501 743 1300 821">There is no support for the indicated logical drive, although Function 50D7h is recognized.</td> </tr> <tr> <td data-bbox="332 821 501 869">C3h</td> <td data-bbox="501 821 1300 869">PSSP is too short.</td> </tr> <tr> <td data-bbox="332 869 501 947">Remaining Values</td> <td data-bbox="501 869 1300 947">Reserved</td> </tr> </tbody> </table>	Value	Description	00h	No Error	01h	AX=50D7h not implemented	80h	A condition has occurred which prevented successful command completion. This may be due to a busy device, a timeout, a bus reset, short packet, or other event. The host should issue a Request-Sense-type command in the required protocol.	97h	There is no support for the indicated logical drive, although Function 50D7h is recognized.	C3h	PSSP is too short.	Remaining Values	Reserved
Value	Description														
00h	No Error														
01h	AX=50D7h not implemented														
80h	A condition has occurred which prevented successful command completion. This may be due to a busy device, a timeout, a bus reset, short packet, or other event. The host should issue a Request-Sense-type command in the required protocol.														
97h	There is no support for the indicated logical drive, although Function 50D7h is recognized.														
C3h	PSSP is too short.														
Remaining Values	Reserved														
All other registers	Preserved														
Carry flag	0 if AH is cleared to zero 1 if AH is 1through FFh.														

9 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.

A user may press an eject button or use a software command to request that a particular media be ejected. By default the INT15h handler returns with ejection accepted status. A disk cache program may hook this INT15h call and return acceptance or rejection based on the state of its buffers for this disk. This function may also be used by operating system software as a media change request.