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Information Technology - Protected Area Run Time Interface Extension Services

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ANSI®
NCITS.**-200x**

American National Standard
for Information Systems -

Protected Area Run Time Interface Extension Services

Secretariat
Information Technology Industry Council

Approved mm dd yy

American National Standards Institute, Inc.

Abstract

This standard specifies a firmware (BIOS) interface for addressing an area of ATA devices that is normally hidden via the SET MAX ADDRESS command. This firmware interface builds on ATA/ATAPI-4 (NCITS 317-1998) to provide services that an operating system may use to address the hidden area in the same manner as a removable media device.

American National Standard

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As of the date of publication of this standard and following calls for the identification of patents that may be required for the implementation of the standard, no such claims have been made.

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Contents Page

Table Page

Foreword

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

Hard disk drives have been returned to system manufacturers in unacceptably large numbers. Analysis of the returned drives by these system manufacturers reveals that the vast majority of returned disk drives are fully functional. Further, a significant percentage of the returned merchandise that did have defects were damaged in shipping. PC Computer System manufacturers are attempting to better support their products by placing information that is normally shipping on an external floppy, CD, or DVD directly on the primary storage device. The vast majority of laptop and desktop computers use ATA hard drives as the primary storage device. This standard defines a method and supporting services for placing data and/or programs on the hard drive in an area that is normally not available to the user.

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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Introduction

This standard encompasses the following:

Clause 1 describes the scope.

Clause 2 provides normative references used within this document.

Clause 3 provides definitions, abbreviations, and conventions used within this document.

Clause 4 describes the overview of the document content.

Clause 5 describes the system initialization requirements.

Clause 6 describes the runtime services

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Information Technology -
Protected Area Run Time Interface Extension Services – PARTIES

1 Scope

This standard describes a BIOS firmware layer that may be used to both place and execute system diagnostics on a protected area of the system hard disk. The purpose of these diagnostics is to accurately determine for both the user and a technical support engineer that the hard drive is functioning correctly. These diagnostics are placed in a protected area of the disk drive because they are less vulnerable to attack from viruses, system software corruption, and the user. The firmware layer described herein may also be used to run DOS based rescue utilities once the drive has been shown to be working by the diagnostics described above. The net effect of these capabilities is that a system may ship with embedded diagnostic and rescue capabilities, these capabilities are known to be reliable by the system manufacturer, and may not be easily corrupted by the user.

The BIOS firmware described in this standard may be implemented for any disk drive that conforms to NCITS 317-1998 (ATA/ATAPI-4) and implements the SET MAX command. The SET MAX command as it is defined in NCITS 317-1998 provides a great deal of security for hiding data on the disk drive. If the system is unable to boot the primary operating system, the area protected by the SET MAX ADDRESS command remains bootable.

All the fields described in this standard are designed to last at least 20 years, given a doubling in capacity each year.

This standard describes a method for the BIOS to do the following:

- Find the start of the reserved area boot code and issue SET MAX ADDRESS command,
- Emulate the reserved area boot code as a bootable floppy.

This standard employs a method that is flexible enough to allow the reserved area boot code to be seen as the primary floppy drive.

Note - This standard only describes BIOS implementations using x86 processor architectures. Some operating systems and applications employ proprietary methods to access floppy and hard drives. The BIOS firmware layer described in this document does not address software that addresses the media in a proprietary manner.

2 Normative References

The following standards contain provisions that, through reference in the text, constitute provisions of this standard. 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.

ATA/ATAPI-4 NCITS 317-1998

BIOS Enhanced Disk Drive Technical Report NCITS TR-21

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.

ATA/ATAPI-5 NCITS 1321D

BIOS Enhanced Disk Drive Services (EDD) NCITS 1386D

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 standard and specifications were also referenced.

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

3 Keyword, 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 device, also known as an IDE device, is a hard drive 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 Boot Device

A Boot Device is any device that shall be initialized prior to loading the O/S. This includes the primary input device (keyboard), the primary output device (display), and the initial program load device (floppy drive, hard drive, etc.)

3.2.5 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

3.2.6 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 for another addressing method.

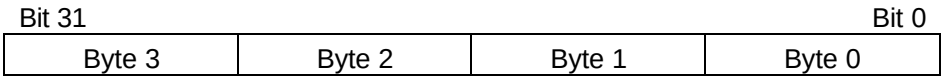
3.2.7 DOS

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

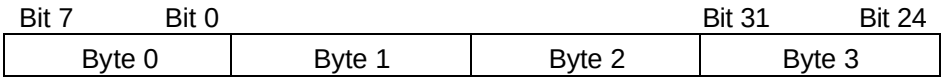
3.2.8 DWord

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:



In Memory:



3.2.9 Host

The Host is the computer system that is controlled by the BIOS.

3.2.10 Host Protected Area

The area of the disk drive's storage capacity not normally accessible by the user. It starts at the max address + 1 and goes to the address returned by READ NATIVE MAX ADDRESS.

3.2.11 INT 13h

A BIOS interrupt service which provides a protocol independent method for accessing floppy and hard drives.

3.2.12 INT 40h

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

3.2.13 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 the floppy drive or hard drive.

3.2.14 LBA

LBA is a method of addressing a device, which involves using a Logical Block Address. This method of addressing allows a maximum address of 2^{28}-1, or 137.4GB of data. See CHS for another address method.

3.2.15 Max address

The Max address is the last LBA accessible to the end user on the hard disk.

3.2.16 NV Memory

Non-Volatile memory is memory that retains its 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.

3.2.17 O/S

An operating system is the initial program that is loaded from an IPL device when that device is selected for booting.

3.2.18 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.

3.2.19 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.

3.2.20 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

3.2.21 Service Area

An area of the Host Protected Area reserved for a particular BIOS service.

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 most systems shipping today.

3.2.23 System Vendor

Vendor who has access to the Host Protected Area and may create and add code to Service Areas.

3.2.24 Trusted Code

Code that resides in the Host Protected Area that is trusted to operate without corruption of the structure or data in the User or Host Protected Areas.

3.2.25 User Area

The area of the hard disk drive that is available to all users. This area is defined from LBA zero to the max address.

3.2.26 Warm Boot

A Warm Boot is a system re-boot where the system hardware reset is not asserted. A host may initiate a software reset on a device by setting SRST in the Device Control register to one (see ATA/ATAPI-5).

3.2.27 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

4 Overview

The SET MAX ADDRESS command allows the hard drive's storage capacity to be divided into two areas, the User Area and the Host Protected Area (includes the Boot Code Service Area). This standard describes a method for the BIOS to find the max address and then address the Boot Code Service Area as a floppy disk drive. The User Area extends from LBA zero to max address. The Host Protected Area extends from the max address + 1 to the last physical LBA of the device (native max address). The BIOS may use the Host Protected Area to provide a number of services; each service is allocated in its own region of the Host Protected Area. The allocation of these regions shall be under the control of the Boot Engineering Extension Record (BEER) Directory of Services structure. The system normally boots from the User Area. Booting from a Service Area may occur for diagnostic and recovery operations.

When the BIOS boots from a Service Area it puts the system into a Trusted Mode where the whole device is accessible to the Trusted Code (Trusted O/S) loaded by the BIOS. Once the BIOS has initiated the boot process on a Service Area, all accesses to the Service Area are accomplished through INT 13h device 00h (floppy drive emulation). This allows the User Area to remain at its original INT 13h device number, normally device 80h. Any devices that would normally have an ID's of 00h-7Fh shall have their device ID incremented by one.

Before the BIOS initiates a conventional boot, after the completion of the ROM scan and prior to the INT 19h call, it shall issue a SET MAX ADDRESS (non-volatile) command to the device to reset the max address.

5 Initialization Requirements

In order for the BIOS to determine the current Host Protected Area configuration, and the start of the Host Protected Area, a sector is allocated at the physical last sector of the hard disk to provide information about the Host Protected Area. This sector provides the geometry of the User Area, Start of Protected area and Start of reserved area boot code LBA among other things. The first 128 bytes of the sector are the Boot Engineering Extension Record (BEER). Following the BEER entry may be the optional BEER Directory of Services, which is a table with 64 byte entries. The Directory of Services immediately follows the BEER data and may contain up to six entries. The six entries at 64 bytes each plus the 128 BEER bytes compose the 512 bytes in the last sector on the device. IDENTIFY DEVICE data words 60 and 61 are modified by the SETMAX command to indicate the total number of user addressable sectors.

5.1 Diagnostic Service (DS)

One of the basic services to be made available is some form of diagnostic capability. Although there may be a number of diagnostic services available at most one shall be designated as the bootable Diagnostic Service. In some circumstances such as a faulty cable or host bus, accessing a failing device may reduce the chance of data recovery using special procedures. Thus before launching the bootable Diagnostic Service the system should perform the Built In Boot Device Integrity Check (BIBDIC). Once communication and basic device integrity has been established the Diagnostic Service may be launched either directly or indirectly as described below.

5.1.1 Built In Boot Device Integrity Check

The Host BIOS shall have sufficient built in diagnostic code to determine that the basic I/O structure is working (i.e. PIO operation should be possible). The next step is to gain confidence that the storage device is working properly. This basic confidence test should be undertaken using SMART commands.

BIBDIC uses the SMART Short Self-Test in Captive Mode to test the device. It may not be possible to always detect if the fault is in the device, the cable, the Host adapter or the Host Bus system.

5.1.2 Recommended BIOS Menu Structure

It is recommended that the BIOS not attempt to address and load the User BIOS Services until requested by user input. This gives the user a chance to choose the diagnostics option first and ensure that the disk system passes the BIBDIC before accessing the device

5.1.3 Recommended Check Sequence

- If SMART capable
  - Issue the SMART ENABLE command
  - Issue the SMART RETURN STATUS command
  - If no response is received then the device, cable, or adapter is faulty and BIBDIC has failed.
  - If an error is received either SMART has been turned off or device has failed.
- Issue the IDENTIFY DEVICE command
  - If the returned information indicates that it is an ATA/ATAPI-5 device check the Checksum word.
  - If there is an error the transfer has failed and the subsystem is faulty, BIBDIC failed.
- If the device supports SMART and supports the SMART EXECUTE OFFLINE IMMEDIATE SHORT SELF-TEST IN CAPTIVE MODE then
  - Initiate the SMART EXECUTE OFFLINE IMMEDIATE SHORT SELF-TEST IN CAPTIVE MODE command. The device shall then instigate internal diagnostic procedures (it is recommended that the user be told to wait as this operation may take up to 2 minutes).
  - If the device fails these tests the BIBDIC has failed.
- If the IDENTIFY DEVICE data indicates that the device does not support the Host Protected Feature Set the BIBDIC has passed.
- If this is a warm boot issue the SET MAX UNLOCK Command (ATA/ATAPI-5 Devices) using the retained password.
- Store the device size data from the IDENTIFY DEVICE word.
- Issue the READ NATIVE MAX ADDRESS command to determine the actual maximum size of the device and compare with the IDENTIFY DEVICE data. This indicates if there is a Host Protected Area currently active, if there is use the SET MAX ADDRESS command (volatile) to the full size of the device.
- Read the last sector of the device, which should contain the BEER record. Validate the BEER record and then search its Directory of Services for the Diagnostic Service requested by the user, launch that service by booting directly or indirectly as indicated in the DS entry.
- The code in that Service Area may then perform more extensive diagnostics and/or recovery processes.

5.2 The Boot Engineering Extension Record (BEER)

The purpose of this structure is to provide non-volitile configuration information about the device. The BEER is a data structure that is stored on the native maximum address of the device. The BEER consists of a mandatory header and one or more optional Directory of Service entries. The BIOS shall use the SET MAX ADDRESS command (non-volatile) to hide this record during the normal boot process. Table 1 shows the BEER header structure. The BEER record shall be accessed using an INT 13h call to the last sector of the device. In some instances the record returned may have been generated by the BIOS or ROM code and not read from surface of the device.

The remainder of this section describes the BEER header structure.

Table 1 - Boot Engineer Extension Record

<table>
<tr><th>Offset</th><th>Type</th><th>Description</th></tr>
<tr><td>0-1</td><td>Word</td><td>Signature = BEEFh</td></tr>
<tr><td>2-3</td><td>Word</td><td>BEER size. Shall be 128.</td></tr>
<tr><td>4-5</td><td>Word</td><td>Capabilities Word
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>8-15</td><td>Reserved</td></tr>
<tr><td>7</td><td>Read Only</td></tr>
<tr><td>6</td><td>Generated Record</td></tr>
<tr><td>5</td><td>Use Reserved Area Boot Code Address</td></tr>
<tr><td>4</td><td>Configuration Time Stamp is valid</td></tr>
<tr><td>3</td><td>Device Supports LBA</td></tr>
<tr><td>2</td><td>Directory of Services is Present</td></tr>
<tr><td>1</td><td>Formatted Geometry Valid</td></tr>
<tr><td>0</td><td>Reported Geometry Valid</td></tr>
</table></td></tr>
<tr><td>6-9</td><td>DWord</td><td>Reported Cylinders</td></tr>
<tr><td>10-13</td><td>DWord</td><td>Reported Heads</td></tr>
<tr><td>14-17</td><td>DWord</td><td>Reported Sectors</td></tr>
<tr><td>18-21</td><td>DWord</td><td>Reported Bytes/Sector</td></tr>
<tr><td>22-29</td><td>QWord</td><td>Reported Sectors/Device</td></tr>
<tr><td>30-33</td><td>DWord</td><td>Formatted Cylinders</td></tr>
<tr><td>34-37</td><td>DWord</td><td>Formatted Heads</td></tr>
<tr><td>38-41</td><td>DWord</td><td>Formatted Sectors</td></tr>
<tr><td>42-45</td><td>DWord</td><td>Formatted Bytes/Sector</td></tr>
<tr><td>46-53</td><td>QWord</td><td>Formatted Sectors/Device</td></tr>
<tr><td>54-55</td><td>Word</td><td>BCD Year</td></tr>
<tr><td>56-57</td><td>Word</td><td>Linear Day</td></tr>
<tr><td>58-61</td><td>DWord</td><td>Configuration Time stamp</td></tr>
<tr><td>62</td><td>Byte</td><td>Reserved shall be 0</td></tr>
<tr><td>63</td><td>Byte</td><td>Device Index</td></tr>
<tr><td>64-71</td><td>QWord</td><td>Host Protected Area Start</td></tr>
<tr><td>72-79</td><td>QWord</td><td>Reserved Area Boot Code Address</td></tr>
<tr><td>80-81</td><td>Word</td><td>Number of entries in the BEER Directory of Services</td></tr>
<tr><td>82-83</td><td>Word</td><td>Length of a BEER Directory of Services Entry</td></tr>
<tr><td>84</td><td>Byte</td><td>Reserved shall be 0</td></tr>
<tr><td>85</td><td>Byte</td><td>Revision of the standard used to generate this record</td></tr>
<tr><td>86-125</td><td>String</td><td>Device Name</td></tr>
<tr><td>126-127</td><td>Word</td><td>16 Bit Checksum</td></tr>
</table>

5.2.1 Offset 0-1 (Signature Word)

An initial signature of BEEFh is placed in the sector to indicate BEER data present. If the BIOS or other software scans a portion of the media for BEER, this signature should be tested first.

5.2.2 Offset 2-3 (BEER Size)

The BEER size is the length of BEER in bytes. This is fixed at 128.

5.2.3 Offset 4-5 (Capabilities Word)

This word is a list of bit flags, which confirm the presence of all remaining BEER fields as well as device capabilities.

5.2.3.1 Bit 7 (Read Only)

When this bit is set to one any writes to this sector shall not result in the data being changed. The INT 13h function used may or may not report an error.

5.2.3.2 Bit 6 (Generated Record)

When this bit is one the BEER record does not reside in the device, it is being generated by an outside source such as a BIOS or Option ROM.

5.2.3.3 Bit 5 (Use Reserved Area Boot Code Address)

If set to one and bit 2 (Directory of Services is Present) is set to zero the RABCA is valid. If the system fails to boot from the standard INT19h boot sector and calls INT 18h, then boot from the RABCA should be attempted. The service pointed to by the RABCA becomes the default Diagnostic Service.

5.2.3.4 Bit 4 (Configuration Time Stamp is valid)

Each time the BEER is updated all devices in the system shall have this bit set to one, and a time/date stamp is placed in bytes 54-61. This is one way for software to find new devices and deal with the associated issues. If the BIOS detects a device with a Configuration Time Stamp that is not within current system parameters, this means the system configuration has changed, or the device has been used in a different system. The BIOS may ask the user for a device number assignment, or the BIOS may defer to the operating system to make the drive letter/device assignment. This field is changed during boot when new devices are detected, or when devices are removed from the system. This time stamp is not changed in response to a BEER record update, such as adding or deleting a service area.

5.2.3.5 Bit 3 (Device Supports LBA)

If the device supports LBA, this bit shall be set to 1. When this bit is 1, the reported geometry (found at offset 6-29) may not be supplied. The formatted geometry (found at offset 30-53) shall be supplied if the conventional INT 13h interface addresses the device.

5.2.3.6 Bit 2 (Directory of Services is Present)

If BEER Directory of Services entries are present, this bit is set to one and bytes 80-83 contain valid data. The length of BEER is the product of the values in bytes 80-81 and bytes 82-83 plus the value in bytes 2-3. The first Beer Directory of Service entry starts immediately after the BEER header, where the length of the BEER exceeds the available space on the sector it is continued at the start of the preceding sector.

5.2.3.7 Bit 1 (Formatted Geometry Valid)

If geometry information is supplied in bytes 46-57 then this bit is set to 1. This bit shall only be zero if the conventional INT 13h interface does not support the device. Even if the device only supports LBA, a CHS geometry is still required for compatibility with the INT 13h functions described in this standard.

5.2.3.8 Bit 0 (Reported Geometry Valid)

If geometry information is supplied in bytes 22-33 this bit is set to 1. This geometry is usually derived from the device that accesses the media. If the device does not support CHS, this bit is 0

5.2.4 Offset 6-9 (Reported Cylinders)

On ATA devices the contents of this field matches the contents of IDENTIFY DEVICE word 1. This is the total number of cylinders. The maximum cylinder number is one less because cylinder numbers start at 0.

5.2.5 Offset 10-13 (Reported Heads)

On ATA devices the contents of this field matches the contents of IDENTIFY DEVICE word 3. This is the total number of heads. The maximum head number is one less. Head numbers start at 0.

5.2.6 Offset 14-17 (Reported Sectors)

On ATA devices the contents of this field matches the contents of IDENTIFY DEVICE word 6. This is the total number of sectors per track. The maximum sector number is this number.

5.2.7 Offset 18-21 (Reported Bytes/Sector)

This field is mandatory. On many devices, such as an ATA Hard Drive, this is fixed at 512 bytes. Other devices may use different sizes. For instance, CD-ROM sector sizes may vary from 2048 bytes to greater than 3000 bytes.

5.2.8 Offset 22-29 (Reported Sectors/Device)

This field is mandatory. On ATA devices, the contents of this field matches the contents of IDENTIFY DEVICE words [61:60] if these words are valid. This value shall be greater than or equal to the product of Reported Cylinders (C), Reported Heads (H), and Reported Sectors (S). If the IDENTIFY DEVICE words [61:60] are not valid this field shall be the product of Reported Cylinders (C), Reported Heads (H), and Reported Sectors (S). In the case of an empty removable media device, this shall be the max value the device supports.

5.2.9 Offset 30-33 (Formatted Cylinders)

This shall be the number of cylinders returned by INT 13h FN 08h and/or 48h when the user area is accessed. If conventional INT 13h addresses this device then Formatted Cylinders shall not exceed 1024.

5.2.10 Offset 34-37 (Formatted Heads)

This shall be the number of heads returned by INT 13h FN 08h and/or 48h when the user area is accessed. If conventional INT 13h addresses this device then the number of Formatted Heads does not exceed 256.

5.2.11 Offset 38-41 (Formatted Sectors)

This shall be the number of sectors per track returned by INT 13h FN 08h and/or 48h when the user area is addressed. If conventional INT 13h accesses this device then Formatted Sectors shall not exceed 63.

5.2.12 Offset 42-45 (Formatted Bytes/Sector)

This field is mandatory. On many devices, such as the ATA Hard Drive, this is fixed at 512 bytes. Other devices may use different sizes. For instance, CD-ROM sector sizes may vary from 2048 bytes to greater than 3000 bytes. It is possible for geometric translation to change the sector size. This means the "Formatted Bytes/Sector" may be different than the "Reported Bytes/Sector".

5.2.13 Offset 46-53 (Formatted Sectors/Device)

This field is mandatory. Formatted Sectors/Device is the total number of addressable sectors. If the formatted geometry is valid, Formatted Sectors shall be great than or equal to the space addressed by the geometry.

5.2.14 Offset 54-55 (BCD Year)

This word describes the year in Binary Coded Decimal (BCD) format (yyyy) when the BEER was last updated.

5.2.15 Offset 56-57 (Linear Day)

This word is Linear Calendar date, that is the number of days after December 31st – 1. See section 5.2.14 for a description of the year.

5.2.16 Offset 58-61 (Configuration Time Stamp)

This is the number of seconds past midnight of the date specified in 5.2.14 and 5.2.15 when this record was last updated.

5.2.17 Offset 63 (Device Index)

This field is mandatory. Device Index is the number that INT 13h uses to access the device. Traditionally, mass storage devices have been 80h and above. If this field is FFh, the device number shall be assigned

dynamically.

5.2.18 Offset 64-71 (Host Protected Area Start)

This field specifies the first sector of the Host Protected Area. This is the max address +1

5.2.19 Offset 72-79 (Reserved Area Boot Code Address)

If bit 5 of the Capabilities word at byte 4 is one and bit 2 of the capabilities word is cleared to 0, this field specifies the absolute address of the " Reserved Area Boot Sector". When the Reserved Area Boot Code Address (RABCA) is active, BEER extended INT 19h loads the sector at the supplied address into memory at 0:7C00h. INT 19h shall then jump to 0:7C00h and begin the load process. The whole of the Host Protected Area excluding the BEER is considered to be one service area. The RABCA is within the Service Area.

5.2.20 Offset 80-81 (Number of entries in the BEER Directory of Services)

If bit 2 of the Capabilities word at offset 4 is 1, this field specifies the number of entries in the BEER Directory.

5.2.21 Offset 82-31 (Length of a BEER Directory of Service Entry)

If bit 2 of the Capabilities word at offset 4 is 1, this field specifies the number of bytes in a BEER Directory table entry. This number shall be set to 64.

5.2.22 Offset 85 (Revision of the standard used to generate this record)

This is the PARTIES revision level used to describe the BEER sector. The first BCD digit is the major revision number; the second BCD digit is the minor revision number.

5.2.23 Offset 86-125 (Device Name)

This is a null terminated string that is suitable for display to the user. If the string is 40 characters the null is not present. This string shall only be made up of printable ASCII characters (ASCII 20h-7Eh).

5.2.24 Offset 126-127 (16 Bit Checksum)

The data structure checksum is the two's complement of the sum of all words from byte offset 0 through byte offset 124. Each word shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 64 words shall be zero.

5.3 BEER Directory of Services Description

BEER Directory of Services is LBA based and is BIOS readable. This eliminates the need for boot code when a system is updated to work with BEER. Each service area is designed to have a string that is suitable for display to a user. This gives the BIOS the ability to present a meaningful name when the user accesses a given service area. The only constraint on the number of directory entries (one per service area) is the size of the media. The four-entry limit of the conventional partition table does not apply to this standard. The remainder of this section describes BEER Directory of Service Entries. Table 2 defines the BEER Directory of Services Entry structure.

Table 2 - BEER Directory of Services Entry

<table>
<tr><th>Offset</th><th>Type</th><th>Description</th></tr>
<tr><td>0</td><td>Byte</td><td>Directory Flags
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7</td><td>Service area is available as B:</td></tr>
<tr><td>6</td><td>Reserved</td></tr>
<tr><td>5</td><td>Diagnostic Service</td></tr>
<tr><td>4</td><td>Service Area is Read Only</td></tr>
<tr><td>3</td><td>This Boot</td></tr>
</table></td></tr>
</table>

Offset	Type	Description
		2 Empty Service Area 1 Hidden Service Area 0 Service Area is bootable as A:
1	Byte	Reserved.
2-9	QWord	Service Area Start
10-17	QWord	Service Area Size
18-21	DWord	Load Sectors
22-25	DWord	Load Address
26-27	Word	Service Area ID
28-59	Byte	ID String
60-61	Word	Reserved
62-63	Word	16 bit Checksum.

5.3.1 Offset 0 (Directory Flags)

The directory flags are a bit map, that enables several different boot options and provide some data security.

5.3.1.1 Bit 7 (Service Area Is Available as B)

When this bit is one the service area shall be visible as drive B:, permitting boot from a normal drive A: diskette or drive C:. This is useful when installing an operating system in the service area. This bit shall be cleared when the service area is bootable.

5.3.1.2 Bit 5 (Diagnostic Service)

This bit shall be set to one when the Service Area contains a Diagnostic Service. In the event that diagnostic services are required the BIOS shall scan the Directory of Service Entries starting at the first entry after the BEER header. The first entry found with both bit 0 and bit 3 set to one shall be chosen as the diagnostic service to boot.

5.3.1.3 Bit 4 (Service Area is Read Only)

When this bit is set to one no data shall be written to this Service Area. This field is intended as a user flag and shall be enforced by the OS as well as the BIOS. It is possible for the user to set this bit to 0, write new data to the service area, and set the bit back to 1.

5.3.1.4 Bit 3 (This Boot)

When this bit is set to one the Service Area has been designated as the boot area. Extended INT 19h chooses this Service Area to boot from instead of the User Area during the normal boot sequence if the user has selected a diagnostic boot.

5.3.1.5 Bit 2 (Empty Service Area)

When this bit is set to one the Service Area has been reserved and is not available for re-use The BIOS shall disregard this Service Area regardless of what other options may be active.

5.3.1.6 Bit 1 (Hidden Service Area)

When this bit is set to one the BIOS shall not present this service area to the user and shall ignore this Service Area. Software shall not expose this Service Area to the user.

5.3.1.7 Bit 0 (Service Area is Bootable)

When this bit is one the service area is a candidate for booting at the users option. If this bit is 0, the BIOS shall not present this service area to the user unless the Service Area Is Available as B: bit is set, see

5.3.1.1.

5.3.2 Offset 2-9 (Service Area Start)

This is the address of the first sector in the Service Area. When the BIOS boots this service area, sectors are loaded starting at this address.

5.3.3 Offset 10-17 (Service Area Size)

This is the number of sectors allocated to the service area.

5.3.4 Offset 18-21 (Load Sectors)

This is the number of sectors the BIOS loads to boot the system.

5.3.5 Offset 22-25 (Load Address)

This is the 64-bit linear host memory address. The conventional address is 31,744 (0:7C00h). BEER Directory of Services allow any address to be specified. If the address is above the 1MB boundary the service area shall have Directory Flags bit 1 set to one. This address is not SEG:OFFSET, it is a 64 bit linear address. This means that A000h:0 is represented as A0000h, or 655,360.

5.3.6 Offset 26-27 (Service Area ID)

The Service Area ID is used to enable Different System Vendor codes to be placed on the Device. The ID shall be the same code allocated to a vendor for the purposes of PCI identification. If the vendor does not have a PCI identification number then this field is cleared to 0. A combination of the vendor ID and the ID string (see 5.3.7) may uniquely identify the source and function of the content of the Host Protected Area. For example, a device manufacturer may place diagnostic code in a service area. The system manufacturer may then add a recovery process to another service area.

5.3.7 Offset 28-59 (ID String)

The ID string is a null terminated ASCII string, which is displayed to the user by the BIOS, OS or other software as the name of the service area. If the string is 22 characters the null is not present.

5.3.8 Offset 62-63 (16 Bit Checksum)

The data structure checksum is the two's complement of the sum of all words from byte offset 0 through byte offset 60. Each word shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 32 words shall be zero.

6 Runtime Services

The Runtime Services described in the following sections are defined for the purposes of providing an emulated device by the BIOS. Runtime services provided by a system BIOS for operating mass storage devices are beyond the scope of this standard (see BIOS Enhanced Disk Drive Services (EDD) T13/1386D).

6.1 INT 13h Dispatcher

Runtime support for the services running within a Service Area shall be achieved by hooking the INT 13h BIOS interrupt service. This gives the handler access to all commands issued to the BIOS disk subsystem. The handler shall also hook INT 40h to gain access to the floppy subsystem. The following INT 13h functions are defined to show how each function shall respond when reporting a floppy drive.

6.2 Reset

In	Description
AH	00h

DL	Device number
Out	**Description**
AH	00h
Carry Flag	Clear

The Reset function shall always return success, while issuing no commands to the device

6.3 Get Status

In	Description
AH	01h
Out	**Description**
AL	Status of last command executed

Return the status of the last INT 13h/40h function call.

6.4 Read Sectors

In	Description
AH	02h
AL	Number of sectors to read
CH	Lower eight bits of the number of cylinder number
CL	Bits <5,0> Sectors number, Bits <7,6> Most significant bits of the cylinder number
DH	Head
DL	Device
ES:BX	Start address of the buffer to fill
Out	**Description**
AH	Status of command executed
AL	Number of sectors read
ES:BX	Filled buffer
Carry Flag	Set if error

The Read Sectors function transfers data from the Boot Code Area on the device to a buffer supplied by the caller.

Change Address from CHS to LBA using the following formula:

$$LBA = (C_1 * H_0 + H_1) * S_0 + S_1 - 1 + BCA$$

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
BCA = Boot Code Address

6.5 Write Sectors

In	Description
AH	03h
AL	Number of sectors to write
CH	Lower eight bits of the cylinder number
CL	Bits <5,0> Sector number, Bits <7,6> Top two bits of he cylinder number
DH	Head
DL	Device
ES:BX	Start of the buffer to write
Out	**Description**
AH	Status of command executed
AL	Number of sectors written
Carry Flag	Set if error

The Write Sectors function transfers data from a buffer to the Boot Code Area on the device.

Change Address from CHS to LBA using the following formula:

$$LBA = (C_1 * H_0 + H_1) * S_0 + S_1 - 1 + BCA$$

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
BCA = Boot Code Address

6.6 Verify Sectors

In	Description
AH	04h
AL	Number of sectors to verify
CH	Lower eight bits of the cylinder number
CL	Bits <5,0> sector number, Bits <7,6> Top two bits of the cylinder number
DH	Head
DL	Device
Out	**Description**
AH	00h
AL	Number of sectors verified
Carry Flag	Clear

The Verify Sectors function causes the device to check all the sectors in the specified range. If the device is unable to read one or more of the sectors without error, this function returns carry set.

6.7 Format Track

In	Description
AH	05h
AL	Number of sectors to create on this track
CH	Track
CL	Sector
DH	Head
DL	Device
ES:BX	Array of 4-byte address fields
Byte 0	Track
Byte 1	Head
Byte 2	Sector
Byte 3	Bytes per sector 0=128, 1=256, 2=512, 3=1024
Out	**Description**
AH	Status of command executed
Carry Flag	Set if error

The Format Track function shall always return success, while issuing no commands to the device

6.8 Get Device Parameters

In	Description
AH	08h
DL	Device
Out	**Description**
AH	Status of command executed
BL	Device Type: 10h
DL	Number of INT 40h devices
DH	Maximum value for head number
CL	Maximum value for sector number (bits <0,5>)
CH	Maximum value for cylinder number
ES:DI	Pointer to device parameter table
Carry Flag	Clear

The Get Device Parameters function returns a device type of 10h. This informs the caller that the media does not conform to conventional floppy standards.

6.9 Get Current Device Parameters

In	Description
AH	15h
DL	Device
Out	**Description**
AH	02=Change detection supported

Get Current Device Parameters always returns Change Detection Support for the Service Area.

6.10 Get Device Change Status

In	Description
AH	16h
DL	Device
Out	**Description**
AH	00=No disk change, 06=Disk has changed

Since this is a hard disk and a floppy drive is being emulated, this function shall always return 0.

6.11 Set Device Type

In	Description
AH	17h
AL	Disk Type 00 - reserved 01 - 48-tpi media, DD drive 02 - 48-tpi media, HD drive 03 - 96-tpi media, HD drive 04 - 135-tpi media
DL	Device
Out	**Description**
N/A	No information passed on exit

The Set Device Type function shall always return success, while issuing no commands to the device

6.12 Set Media Type for Format

In	Description
AH	18h
CH	Lower eight bits of number of tracks
CL	Bits <5,0> Sectors per Track, Bits <7,6> Top two bits of number of tracks
DL	Device
Out	**Description**
AH	00=Requested combination supported 0C=Not supported or device type unknown 80=No media present
ES:DI	Disk parameter table

The Set Media Type for Format command shall return 00h, requested combination supported if the parameters in CH and CL fit within the Service Area. Otherwise, return Carry set, AH = 0Ch.

6.13 Sense Media Type

In	Description
AH	20h
DL	Device
Out	**Description**
AL	Media Type: 10h=Other Media Device
AH	Media present: 00h=Media present
Carry flag	Clear

Always return AL = 10h and AH=0

6.14 Check Extensions Present

In	Description
AH	41h
BX	55AAh
DL	Device
Out	**Description**
AL	Internal Use, not preserved
AH	21h, Major version of these extensions
BX	AA55h
CX	Interface Support Bit map
Carry flag	Clear if INT 13h, FN 41h supported

Interface Support Bit map

Bit	Description
3-15	Reserved
2	EDD Support
1	Device Locking and Ejecting
0	Extended access functions

The Check Extensions Present function notifies the caller that Extended device support is preset. See BIOS Enhanced Disk Drive Services (EDD) T13/1386D for a full definition. If CX is set to zero on return then INT 13h FN 48h is the only function that shall be supported

6.15 Get Device Parameters

In	Description
AH	48h
DL	Device
DS:SI	Address of result buffer. See Table 3 for data format
Out	**Description**
AH	Status of command executed
DS:SI	Result Buffer
Carry flag	Set if error

This function is mandatory regardless of the interface subset that is supported. The geometry returned by Get Device Parameters is the same as was reported by function 08h and reflects the size of the service area.

Table 3 - Result Buffer

<table>
<tr><th>Offset</th><th>Type</th><th>Description</th></tr>
<tr><td>0</td><td>Word</td><td>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.</td></tr>
<tr><td>2</td><td>Word</td><td>Information Flags
In the following table, a bit set to one indicates that the feature is available; a bit cleared to zero indicates the feature is not available and shall operate in a manner consistent with the conventional INT 13h interface.
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>DMA boundary errors are handled transparently</td></tr>
<tr><td>1</td><td>The geometry supplied in bytes 4-15 is valid</td></tr>
<tr><td>2</td><td>Device is removable</td></tr>
<tr><td>3</td><td>Device supports write with verify</td></tr>
<tr><td>4</td><td>Device has change line support (bit 2 shall be set to one)</td></tr>
<tr><td>5</td><td>Device is lockable (bit 2 shall be set to one).</td></tr>
<tr><td>6</td><td>Device geometry is set to maximum, no media is present (bit 2 shall be set to one). This bit is turned off when media is present in a removable media device.</td></tr>
<tr><td>7-15</td><td>Reserved, shall be 0</td></tr>
</table></td></tr>
<tr><td>4</td><td>Double Word</td><td>Number of physical cylinders. This is one greater than the maximum cylinder number. Use INT 13h Fn 08h to find the logical number of cylinders.</td></tr>
<tr><td>8</td><td>Double Word</td><td>Number of physical heads. This is one greater than the maximum head number. Use INT 13h Fn 08h to find the logical number of heads.</td></tr>
<tr><td>12</td><td>Double Word</td><td>Number of physical sectors per track. This number is the same as the maximum sector number for any given track because sector addresses are one based. Use INT 13h Fn 08h to find the logical number of sectors per track.</td></tr>
<tr><td>16</td><td>Quad Word</td><td>Number of physical sectors in the Service Area.</td></tr>
<tr><td>24</td><td>Word</td><td>Number of bytes in a sector.</td></tr>
<tr><td>26</td><td>Double Word</td><td>Pointer to Enhanced Disk Drive (EDD) configuration parameters. This field is only present if INT 13h, Fn 41h, CX register bit 2 is enabled. This field points to a temporary buffer that the BIOS may re-use on subsequent INT 13h calls. A value of FFFFh:FFFFh in this field means that the pointer is invalid.</td></tr>
</table>