

Proposal to Clean up Some CHS and LBA Items for ATA/ATAPI-4

To: T13 Technical committee
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Introduction:

While going through ATA/ATAPI-4 I identified several areas that I thought should be modified in order to have the document be explicit and consistent in regard to CHS and LBA addressing. The following contains the clauses I identified along with my recommended changes.

The format of this revision of this document has been changed significantly from revisions 0 and 1. Revisions 0 and 1 were simply lists of rules. This revision takes those rules and integrates them into several "drop-in" replacements for ATA/ATAPI-4 (based on D1153r14). Sections were taken from the ATA/ATAPI-4 document and modified with "Mark revisions while editing" enabled.

In addition, Revision 1 had the number "16,514,072" in several places. This has been corrected in Revision 2 to be "16,514,064", where required.

Revision 3 contains the updates from the T13 working group meeting of August 20-22, 1997.

- 6.2.2 (b) was corrected to having the requested head value in Word 55.
- All references to combinations of IDENTIFY DEVICE words 57 and 58, and 60 and 61 were changed to be (58:57) and (61:60).
- Item 8.38.8 (e) was changed to be consistent with 8.16.8 (e).
- The second paragraph in 6.2 was modified significantly.
- Minor editorial changes were made.

6.2 Register delivered data transfer command sector addressing

For register delivered data transfer commands all addressing of data sectors recorded on the device's media is by a logical sector address. There is no implied relationship between logical sector addresses and the actual physical location of the data sector on the media.

Devices shall support translations as described below:

- All devices shall support LBA translation.
- If the device's capacity is greater than or equal to one sector and less than or equal to 16,514,064 sectors the device shall support CHS translation.
- If the device's capacity is greater than 16,514,064 sectors, then the device may support CHS translation.
- If a device supports CHS translation, then, following a power-on or hardware reset, the CHS translation enabled by the device shall be known as the default translation.
- If a device supports CHS translation, then a device may allow a host to use the INITIALIZE DEVICE PARAMETERS command to select other CHS translations.

- If a device supports CHS translation, then IDENTIFY DEVICE words 1,3, and 6 shall describe the default translation, and words 53-58 shall describe the current translation.

A CHS address is made up of three fields: the sector **number**, the head number and the cylinder number. Sectors are numbered from 1 to the maximum value allowed by the current CHS translation but shall not exceed 255. Heads are numbered from 0 to the maximum value allowed by the current CHS translation but shall not exceed 15. Cylinders are numbered from 0 to the maximum value allowed by the current CHS translation but cannot exceed 65,535.

When the host selects a CHS translation using the INITIALIZE DEVICE PARAMETERS command, the host requests the number of sectors per logical track and the number of heads per logical cylinder. The device then computes the number of logical cylinders available in requested translation.

A device shall not change the addressing method specified by the command and shall return status information utilizing the addressing method specified for the command.

The host may select either the currently selected CHS translation addressing or LBA addressing on a command-by-command basis by using the LBA bit in the Device/Head register.

The device shall support LBA addressing for all media access commands. The LBA bit of the Device/Head register shall be ignored for commands that do not access the media.

Logical sectors on the device shall be linearly mapped with the first LBA addressed sector (sector 0) being the same sector as the first logical CHS addressed sector (cylinder 0, head 0, sector 1). Irrespective of the logical CHS translation currently in effect, the LBA address of a given logical sector does not change. The following is always true **for LBA numbers less than or equal to 16,514,064 for devices supporting the current CHS translation:**

$$\text{LBA} = ((\text{cylinder} * \text{heads_per_cylinder} + \text{heads}) * \text{sectors_per_track}) + \text{sector} - 1$$

where heads_per_cylinder and sectors_per_track are the current translation values.

6.2.1 Definitions and value ranges of IDENTIFY DEVICE words (see 8.12)

- Word 1 shall contain the number of user-addressable logical cylinders in the default CHS translation. If the content of Words (61:60) is less than 16,514,064 then the content of Word 1 shall be greater than or equal to one and less than or equal to 65,535. If the content of Words (61:60) is greater than or equal to 16,514,064 then the content of Word 1 shall be equal to 16,383.
- Word 3 shall contain the number of user-addressable logical heads in the default CHS translation. The content of Word 3 shall be greater than or equal to one and less than or equal to 16. For compatibility with some BIOSs, the content of Word 3 may be equal to 15 if the content of Word 1 is greater than 8192.
- Word 6 shall contain the number of user-addressable logical sectors in the default CHS translation. The content of Word 6 shall be greater than or equal to one and less than or equal to 63.
- [(The content of Word 1) * (the content of Word 3) * (the content of Word 6)] shall be less than or equal to 16,514,064.
- Word 54 shall contain the number of user-addressable logical cylinders in the current CHS translation. The content of Word 54 shall be greater than or equal to one and less than or equal to 65,535. After power-on or after a hardware reset the content of Word 54 shall be equal to the content of Word 1.
- Word 55 shall contain the number of user-addressable logical heads in the current CHS translation. The content of Word 55 shall be greater than or equal to one and less than or equal to 16. After power-on or after a hardware reset the content of Word 55 shall be equal to the content of Word 3.
- Word 56 shall contain the number of user-addressable logical sectors in the current CHS translation. The content of Word 56 should be equal to 63 for compatibility with all BIOSs. However, the content of Word 56 may be greater than or equal to one and less than or equal to 255. At power-on or after a hardware reset the content of Word 56 shall equal the content of Word 6.
- Words (58:57) shall contain the user-addressable capacity in sectors for the current CHS translation. The content of Words (58:57) shall equal [(the content of Word 54) * (the content of Word 55) * (the

content of Word 56)]. The content of Words (58:57) shall be less than or equal to 16,514,064. The content of Words (58:57) shall be less than or equal to the content of Words (61:60).

- i) The content of Words 54, 55, 56 and (58:57) may be affected by the host issuing an INITIALIZE DEVICE PARAMETERS command (see 8.16).
- j) If the content of Words (61:60) is greater than 16,514,064 and if the device does not support CHS addressing, then the content of Words 1, 3, 6, 54, 55, 56, and (58:57) shall equal zero. If the content of Word 1 or Word 3 or Word 6 equals zero, then the content of Words 1, 3, 6, 54, 55, 56, and (58:57) shall equal zero.
- k) Words (61:60) shall contain the total number of user-addressable sectors. The content of Words (61:60) shall be greater than or equal to one and less than or equal to 268,435,456.
- l) The content of Words 1, 54, (58:57), and (61:60) may be affected by the host issuing a SET MAX ADDRESS command (see 8.38).

6.2.2 Addressing constraints and error reporting

- a) Devices may access any address in the current CHS translation if [(the requested cylinder + 1) * (the requested head + 1) * (the requested sector)] is less than or equal to the content of Words (61:60).
- b) Devices may respond with an "ID NOT FOUND" or an "ABORTED COMMAND" error to any command with a CHS address request where one or more of the following are true:
 - The requested cylinder value is greater than [(the content of Word 54) - 1]
 - The requested head value is greater than [(the content of Word 55) - 1]
 - The requested sector value is zero or greater than the content of Word 56
- c) Devices shall respond with an "ID NOT FOUND" or an "ABORTED COMMAND" error to any command with an LBA address request where the requested LBA number is greater than or equal to the content of Words (61:60).

8.12 IDENTIFY DEVICE

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8.12.10 Word 1: Number of default logical cylinders

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

8.12.12 Word 3: Number of default logical heads

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

8.12.14 Word 6: Number of default logical sectors per logical track

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

8.12.27 Word 54: Number of current logical cylinders

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

8.12.28 Word 55: Number of current logical heads

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

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

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

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

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

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

These words contain the total number of user addressable sectors (see 6.2).

8.16 INITIALIZE DEVICE PARAMETERS

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8.16.8 Description

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

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

If the host requests a CHS translation that is not supported by the device, the device shall set the ERR bit to one in the Status register and set the ABRT bit to one in the Error register before clearing the BSY bit to zero in the Status register. The device shall also clear bit 0 of word 53 in the IDENTIFY DEVICE data to zero, and the content of Words 54, 55, 56 and (58:57) may be zero until a supported translation is requested by the host.

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

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

- a) The content of words 1, 3, 6, and (61:60) shall be unchanged
- b) The content of word 55 shall equal the (Max head value requested by the host + 1)
- c) The content of word 56 shall equal the (Logical sectors per logical track value requested by the host)
- d) If the content of word (61:60) is less than or equal to 16,514,064, then word 54 shall equal the whole number result of $[(\text{the content of words (61:60)}) \div [(\text{the new content of word 55 as determined by the successful INITIALIZE DEVICE PARAMETERS command}) * (\text{the new content of word 56 as determined by the successful INITIALIZE DEVICE PARAMETERS command})]]$, or 65,535 whichever is less
- e) If the content of word (61:60) is greater than 16,514,064, then word 54 shall equal the whole number result of $[(16,514,064) \div [(\text{the new content of word 55 as determined by the successful INITIALIZE DEVICE PARAMETERS command}) * (\text{the new content of word 56 as determined by the successful INITIALIZE DEVICE PARAMETERS command})]]$ or 65,535 whichever is less
- f) Words (58:57) shall equal $[(\text{the new content of word 54}) * (\text{the new content of word 55}) * (\text{the new content of word 56})]$

8.26 READ NATIVE MAX ADDRESS

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8.26.5 Normal outputs

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Sector Number -

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

Cylinder Low -

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

Cylinder High -

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

Device/Head -

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

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero when the command is complete

DRDY shall be set to one

DF (Device Fault) shall be cleared to zero

DRQ shall be cleared to zero

ERR shall be cleared to zero

8.38 SET MAX ADDRESS

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8.3.6 Error outputs

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Error register -

ABRT shall be set to one if this command not supported or maximum value requested exceeds the device capacity or the Set max cylinder number is greater than 16,383.

IDNF shall be set to one if the command was the second non-volatile SET MAX ADDRESS command after power on or hardware reset.

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8.38.8 Description

This command allows the host to redefine the maximum address of the user-accessible address space in either LBA translation or the current CHS translation. The host may either set a new maximum cylinder number for CHS translation or a new maximum LBA address for LBA translation. After a successful SET MAX ADDRESS command using a new maximum cylinder number value the content of all IDENTIFY DEVICE words shall comply with 6.2.1 in addition to the following :

- a) The content of words 3, 6, 55 and 56 are unchanged
- b) The content of word 1 shall equal (the new Set max cylinder number + 1) or 16,383, whichever is less
- c) The content of words (61:60) shall equal [(the new content of word 1 as determined by the successful SET MAX ADDRESS command) * (the content of word 3) * (the content of word 6)]
- d) If the content of words (61:60) as determined by a successful SET MAX ADDRESS command is less than 16,514,064, then the content of word 54 shall be equal to [(the content of words (61:60)) ÷ ((the content of IDENTIFY DEVICE word 55) * (the content of word 56))] or 65,535, whichever is less
- e) If the content of word (61:60) as determined by a successful SET MAX ADDRESS command is greater than 16,514,064, then word 54 shall equal the whole number result of [[(16,514,064) ÷ [(the content of word 55) * (the content of word 56)]]] or 65,535 whichever is lessf) The content of words (58:57) shall be equal to [(the new content of word 54 as determined by the successful SET MAX ADDRESS command) * (the content of word 55) * (the content of word 56)]

After a successful SET MAX ADDRESS command using a new maximum LBA address the content of all IDENTIFY DEVICE words shall comply with 6.2.1 in addition to the following :

- The content of words (61:60) shall be equal to the new Maximum LBA address + 1

- If the content of Words (61:60) is greater than 16,514,064 and if the device does not support CHS addressing, then the content of Words 1, 3, 6, 54, 55, 56, and (58:57) shall equal zero.

If the device supports CHS addressing:

- The content of words 3, 6, 55 and 56 are unchanged
- If the new content of words (61:60) is less than 16,514,064, then the content of word 1 shall be equal to $[(\text{the new content of words (61:60)}) \div [(\text{the content of word 3}) * (\text{the content of word 6})]]$ or 65,535, whichever is less
- If the new content of words (61:60) is greater than or equal to 16,514,064, then the content of word 1 shall be equal to 16,383
- If the new content of words (61:60) is less than 16,514,064, then the content of word 54 shall be equal to $[(\text{the new content of words (61:60)}) \div [(\text{the content of word 55}) * (\text{the content of word 56})]]$
- If the new content of words (61:60) is greater than or equal to 16,514,064, then the content of word 54 shall be equal to 16,383
- Words (58:57) shall be equal to $[(\text{the content of word 54}) * (\text{the content of word 55}) * (\text{the content of word 56})]$

After successful completion of this command, all read and write access attempts to addresses greater than specified by the successful SET MAX ADDRESS command shall be rejected with an "ID Not Found" error.

Hosts should not issue more than one non-volatile SET MAX ADDRESS command after a power on or hardware reset. Devices shall report an "ID Not Found" error upon receiving a second non-volatile SET MAX ADDRESS command after a power on or hardware reset.

The contents of IDENTIFY DEVICE words shall not be changed if a SET MAX ADDRESS command fails for any reason.