IDEMA®

Document LBA1-03

LBA Count for Disk Drives Standard

1.0 Purpose

The purpose of this standard is to define the required native LBA counts for a given capacity across all Disk manufacturers. This simplifies an aspect of Disk and reduces confusion and compatibility complication in the industry. It is a fact that for many years, each Disk supplier has different LBA count for a given advertised Disk capacity. In addition, each system manufacturer requires different minimum LBA count for a given capacity resulting in LBA counts variations in the industry for each capacity point.

This variation is eliminated by this industry standard. This document shall be used to determine an industry standard LBA count for each advertised capacity. It will also be used by all Disk suppliers and accepted by all system manufacturers. This implementation results in all Disks having the same LBA count for each advertised capacity and system manufacturers will be rest assured with consistent LBA counts across manufacturers.

2.0 Scope

This document supersedes the LBA1-02 document which was intended for only IDE disk drives and applied only to 3.5 inch ATA drives 160GB and greater and 2.5 inch ATA drives 80GB and greater. Legacy capacities are not addressed by this standard to allow system manufacturers to continue to use established LBA counts. At that time, 3.5″ 160GB have been shipping for a while so many system manufacturers have already defined their own LBA counts requirement. Most system manufacturers began to adopt the LBA1-02 implementation at or after 3.5″ 320GB density point.

The scope of this document has been increased to include SATA/SAS Disk drive, SATA/SAS Large Data Sector (4k sector) drives and SAS disk drive whose sector is formatted with T10 PI (Protection Information), a.k.a. DIF (Data Integrity Format). This document defines the algorithm for determining the number of LBAs a disk drive shall have based on the advertised capacity of the drive. The way in which a drive notifies the host of its LBA count is defined in standard documents referenced in section 3.0.

3.0 Reference Documents:

1. AT Attachment 8 – ATA/ATAPI Command Set (ATA8-ACS), (ANSI/INCITS 452:2008)
2. SCSI Block Commands – 2 (SBC-2) (ANSI/INCITS 405:2005)
3. SCSI Block Commands – 3 (SBC-3) (T10/1799-D)
4. SCSI Primary Commands – 3 (SPC-3) (T10/1416-D) (ANSI/INCITS 301-1997)
5. SCSI Primary Commands – 4 (SPC-4) (T10/1731-D)
6. Serial Attached SCSI – 1.1 (SAS-1.1) (T10/1601-D) (ANSI/INCITS
7. 376-2003)
8. Serial Attached SCSI – 2.0 (SAS-2.0) T10 Project/1760-D Rev13 or later

4.0 Equipment

Not applicable

5.0   Test Samples

Not applicable

6.0   LBA counts and Advertised Capacity

Basic LBA count = Advertised Capacity / Sector Size
Basic Capacity = LBA count * Sector Size
IDEMA formula for LBA count and capacity provide 0.02% margin (see Table 1)

<u>For SATA and SAS Disk Drive with 512bytes logical block size:</u>

LBA counts = (97,696,368) + (1,953,504 * (Advertised Capacity in GBytes – 50))
Or
Advertised Capacity (GB) = [(LBA counts – 97,696,368)/1,953,504] + 50

Numbers 97,696,368, 1,953,504 and 50 are constants.

The lower 3 bits of the LBA count are zero (divisable by 8 with a remainder of 0). This is in order to provide a even number of aligned sectors for emulation.

> **Examples:**
> *To advertise a 500GB capacity, the required LBA count is:*
> LBA count = 97696368 + (1953504 * (500 – 50)) = <u>976,773,168</u>
>
> *If a drive has a 585,397,500 LBA count then the advertised capacity is:*
> Advertised Capacity = [(585,397,500 – 97,696,368)/1,953,504] + 50 = <u>300GB</u>

NOTE: Drives less than these capacity points may not comply with this document: 2.5″ SATA 80GB, 3.5″ SATA 160GB, 2.5″/3.5″ SAS 450GB.

<u>For SATA and SAS Disk Drives with a logical block size of 4096 bytes:</u>
The formula is scaled by dividing the first two constants by eight. This results in consistent capacity margin over the basic capacity.

LBA counts = (12,212,046) + (244,188 * (Advertised Capacity in GBytes – 50))
Or
Advertised Capacity (GB) = [(LBA counts – 12,212,046)/244,188] + 50

> **Examples:**
> *To advertise a 500GB capacity (LDS format), the required LBA count is:*
> LBA count = 12,212,046 + (244,188 * (500 – 50)) = <u>122,096,646</u>
>
> *If a LDS drive has a 109,887,246 LBA count, then the advertised capacity is:*
> Advertised Capacity = [(109,887,246 – 12,212,046)/244,188] + 50 = <u>450GB</u>

IDEMA Standard LBA 1-03

Table 1 is an example which shows the additional margin the IDEMA formula in this specification provides over the Exact Capacity. Exact Capacity is defined as: (Advertised Capacity in GB)$*10^9$/512 or 4096.

Table 1:

	Advertised Capacity (GB)	512 byte Sector		4096 byte sector	
		LBA Count	Capacity GB	LBA Count	Capacity GB
IDEMA Capcity example	1000	1953525168	1000.20	244190646	1000.20
Exact Capacity example	1000	1953125000	1000.00	244140625	1000.00
IDEMA % Capacity Margin			0.02%		0.02%

6.2 Common LBA counts with Protection Information enabled

<u>HDDs formatted with T10 PI (Protection Information)</u> have 8 bytes added to the end of each sector. However, the user usable sector size will remain at 512 bytes or 4096 bytes. The 8 bytes of PI will increase the overhead of the disk sector density similar to overhead of ECC bytes in a given sector. Unlike ECC bytes which vary by design, the T10 PI is a fixed 8 bytes to each sector. So, it will be (512+8) on 512 bytes sector and (4096+8) on 4096 bytes sector. Since these 8 bytes are not user usable sectors but are protocol overhead, the number of LBA count on a T10 PI formatted drives must be the same as their non-T10 PI counterparts for the same reported capacity. Therefore a reported capacity of 1000GB will have identical user usable LBA sectors counts in either basic 512 or 4096 bytes formatted with or without T10 PI. HDDs that are not capable of supporting the common LBA count requirement shall be stated on the drive label.

Table 2 is an example which shows that the LBA counts and capacity do not change with or without T10 PI. Exact Capacity is defined as: (Advertised Capacity in GB)$*10^9$/512 or 4096.

Table 2:

	Advertised Capacity (GB)	512 byte Sector without T10 PI support	512 byte Sector with T10 PI support	4096 byte sector without T10 PI Support	4096 byte sector without T10 PI Support
		LBA Count	LBA Count	LBA Count	LBA Count
IDEMA capacity example	1000	1953525168	1953525168	244190646	244190646
Exact Capacity example	1000	1953125000	1953125000	244140625	244140625
IDEMA % Capacity Margin		0.02%	0.02%	0.02%	0.02%

Adding common LBA count to any given drive capacity point requires an additional 1.56% increase in Areal Density.

IDEMA Standard LBA 1-03