

Gigabyte

The **gigabyte** (/ˈɡɪɡəbaɪt, ˈdʒɪɡəbaɪt/^[1]) is a multiple of the unit byte for digital information. The prefix *giga* means 10⁹ in the International System of Units (SI). Therefore, one gigabyte is one billion bytes. The unit symbol for the gigabyte is **GB**.

This definition is used in all contexts of science (especially data science), engineering, business, and many areas of computing, including storage capacities of hard drives, solid state drives, and tapes, as well as data transmission speeds. However, the term is also used in some fields of computer science and information technology to denote 1 073 741 824 (1024³ or 2³⁰) bytes, particularly for sizes of RAM. Thus, prior to 1998, some usage of *gigabyte* has been ambiguous. To resolve this difficulty, IEC 80000-13 clarifies that a *gigabyte* (GB) is 10⁹ bytes and specifies the term *gibibyte* (GiB) to denote 2³⁰ bytes. These differences are still readily seen for example, when a 400 GB drive's capacity is displayed by Microsoft Windows as 372 GB instead of 372 GiB. Analogously, a memory module that is labeled as having the size "1 GB" has one gibibyte (1 GiB) of storage capacity.

In response to litigation over whether the makers of electronic storage devices must conform to Microsoft Windows' use of a binary definition of "GB" instead of the metric/decimal definition, the United States District Court for the Northern District of California rejected that argument, ruling that "the U.S. Congress has deemed the decimal definition of gigabyte to be the 'preferred' one for the purposes of 'U.S. trade and commerce.'"^{[2][3]}

Multiple-byte units

Decimal			Binary		
Value		Metric	Value	IEC	Legacy
1000	kB	kilobyte	1024	KiB	kibibyte KB kilobyte
1000 ²	MB	megabyte	1024 ²	MiB	mebibyte MB megabyte
1000 ³	GB	gigabyte	1024 ³	GiB	gibibyte GB gigabyte
1000 ⁴	TB	terabyte	1024 ⁴	TiB	tebibyte TB terabyte
1000 ⁵	PB	petabyte	1024 ⁵	PiB	pebibyte –
1000 ⁶	EB	exabyte	1024 ⁶	EiB	exbibyte –
1000 ⁷	ZB	zettabyte	1024 ⁷	ZiB	zebibyte –
1000 ⁸	YB	yottabyte	1024 ⁸	YiB	yobibyte –

Orders of magnitude of data

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Definition

The term *gigabyte* has a standard definition of 1000^3 bytes, as well as a discouraged^[2] meaning of 1024^3 bytes. The latter binary usage originated as compromise technical jargon for byte multiples that needed to be expressed in a power of 2, but lacked a convenient name. As 1024 (2^{10}) is approximately 1000 (10^3), roughly corresponding to SI multiples, it was used for binary multiples as well.

In 1998 the International Electrotechnical Commission (IEC) published standards for binary prefixes, requiring that the gigabyte strictly denote 1000^3 bytes and gibibyte denote 1024^3 bytes. By the end of 2007, the IEC Standard had been adopted by the IEEE, EU, and NIST, and in 2009 it was incorporated in the International System of Quantities. Nevertheless, the term gigabyte continues to be widely used with the following two different meanings:



This 2.5 inch hard drive can hold 500 GB (i.e., 500 billion bytes) of data.

Base 10 (decimal)

- 1 GB = 1 000 000 000 bytes (= 1000^3 B = 10^9 B)

Based on powers of 10, this definition uses the prefix giga- as defined in the International System of Units (SI). This is the recommended definition by the International Electrotechnical Commission (IEC).^[4] This definition is used in networking contexts and most storage media, particularly hard drives, flash-based storage,^{[5][6]} and DVDs, and is also consistent with the other uses of the SI prefix in computing, such as CPU clock speeds or measures of performance. The file manager of Mac OS X version 10.6 and later versions are a notable example of this usage in software, which report files sizes in decimal units.^[7]

Base 2 (binary)

- 1 GiB = 1 073 741 824 bytes (= 1024^3 B = 2^{30} B).

The binary definition uses powers of the base 2, as does the architectural principle of binary computers. This usage is widely promulgated by some operating systems, such as Microsoft Windows in reference to computer memory (e.g., RAM). This definition is synonymous with the unambiguous unit gibibyte.

Consumer confusion

Since the first disk drive, the IBM 350, disk drive manufacturers expressed hard drive capacities using decimal prefixes. With the advent of gigabyte-range drive capacities, manufacturers based most consumer hard drive capacities in certain size classes expressed in decimal gigabytes, such as "500 GB". The exact capacity of a given drive model is usually slightly larger than the class designation. Practically all manufacturers of hard disk drives and flash-memory disk devices^{[5][6]} continue to define one gigabyte as 1 000 000 000 bytes, which is displayed on the packaging. Some operating systems such as OS X^[8] express hard drive capacity or file size using decimal multipliers, while others such as Microsoft Windows report size using binary multipliers. This discrepancy causes confusion, as a disk with an advertised capacity of, for example, 400 GB (meaning 400 000 000 000 bytes, equal to 372 GiB) might be reported by the operating system as "372 GB".

The JEDEC memory standards use **IEEE 100** nomenclature which quote the gigabyte as 1 073 741 824 bytes (2^{30} bytes).^[9]

The difference between units based on decimal and binary prefixes increases as a semi-logarithmic (linear-log) function—for example, the decimal kilobyte value is nearly 98% of the kibibyte, a megabyte is under 96% of a mebibyte, and a gigabyte is just over 93% of a gibibyte value. This means that a 300 GB (279 GiB) hard disk might be indicated variously as "300 GB", "279 GB" or "279 GiB", depending on the operating system. As storage sizes increase and larger units are used, these differences become more pronounced.

US lawsuits

A lawsuit decided in 2019 that arose from alleged breach of contract and other claims over the binary and decimal definitions used for "gigabyte" have ended in favor of the manufacturers, with courts holding that the legal definition of gigabyte or GB is 1 GB = 1,000,000,000 (10^9) bytes (the decimal definition). Specifically, the courts held that "the U.S. Congress has deemed the decimal definition of gigabyte to be the 'preferred' one for the purposes of 'U.S. trade and commerce' The California Legislature has likewise adopted the decimal system for all 'transactions in this state'."^[2]

Earlier lawsuits had ended in settlement with no court ruling on the question, such as a lawsuit against drive manufacturer Western Digital.^{[10][11]} Western Digital settled the challenge and added explicit disclaimers to products that the usable capacity may differ from the advertised capacity.^[10] Seagate was sued on similar grounds and also settled.^{[10][12]}

Other contexts

Because of their physical design, the capacity of modern computer random access memory devices, such as DIMM modules, is always a multiple of a power of 1024. It is thus convenient to use prefixes denoting powers of 1024, known as binary prefixes, in describing them. For example, a memory capacity of 1 073 741 824 bytes is conveniently expressed as 1 GiB rather than as 1.074 GB. The former specification is, however, often quoted as "1 GB" when applied to random access memory.^[13]

Software allocates memory in varying degrees of granularity as needed to fulfill data structure requirements and binary multiples are usually not required. Other computer capacities and rates, like storage hardware size, data transfer rates, clock speeds, operations per second, etc., do not depend on

an inherent base, and are usually presented in decimal units. For example, the manufacturer of a "300 GB" hard drive is claiming a capacity of 300 000 000 000 bytes, not 300×1024^3 (which would be 322 122 547 200) bytes.

Examples of gigabyte-sized storage

- One hour of SDTV video at 2.2 Mbit/s is approximately 1 GB.
- Seven minutes of HDTV video at 19.39 Mbit/s is approximately 1 GB.
- 114 minutes of uncompressed CD-quality audio at 1.4 Mbit/s is approximately 1 GB.
- A single layer DVD+R disc can hold about 4.7 GB.
- A dual-layered DVD+R disc can hold about 8.5 GB.
- A single layer Blu-ray can hold about 25 GB.
- A dual-layered Blu-ray can hold about 50 GB.

Unicode character

The "gigabyte" symbol is encoded by Unicode at code point U+3387 GB SQUARE GB.^[14]

See also

- Orders of magnitude (data)
- Binary prefix

References

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 - "gigabyte" (<https://www.merriam-webster.com/dictionary/gigabyte>). *Merriam-Webster Dictionary*.
2. "Order Granting Motion to Dismiss" (<https://www.courthousenews.com/wp-content/uploads/2020/01/flashdrives.pdf>) (PDF). United States District Court. Retrieved 24 January 2020.
3. See also *Dinan v. SanDisk LLC*, No. 20-15287 (9th Cir. Feb. 11, 2021) https://scholar.google.com/scholar_case?case=16989791406584358656
4. <http://physics.nist.gov/cuu/Units/binary.html> Prefixes for binary multiples
5. SanDisk USB Flash Drive ([http://apac.sandisk.com/Products/Catalog\(1349\)-SanDisk_Extreme_Ducati_Edition_USB_Flash_Drive.aspx](http://apac.sandisk.com/Products/Catalog(1349)-SanDisk_Extreme_Ducati_Edition_USB_Flash_Drive.aspx)) Archived (https://web.archive.org/web/20080513155718/http://apac.sandisk.com/Products/Catalog%281349%29-SanDisk_Extreme_Ducati_Edition_USB_Flash_Drive.aspx) 13 May 2008 at the Wayback Machine "Note: 1 megabyte (MB) = 1 million bytes; 1 gigabyte (GB) = 1 billion bytes."
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External links

- <http://physics.nist.gov/cuu/Units/binary.html>
- <http://www.quinion.com/words/turnsofphrase/tp-kib1.htm>
- https://www.nist.gov/public_affairs/techbeat/tb9903.htm

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