Units of Measure: Digital and Metric, Decimal and Binary

Units of Measure (Digital and Metric)

1 Byte (B) is defined as the set of bits used to represent 1 character. Commonly: 1 Byte (B) = 8 bits (b). (Byte & bit are best spelled out.) 8 bits can represent 256 different characters. ASCII (ANSI (American National Standards Institute) Standard Code for Information Interchange) (see [http://www.ANSI.org]) uses an 8 bit code to represent 256 characters. 1 ASCII Byte = 8 bits = 1 character 16 bits can be used to represent 65,536 different characters. Unicode uses a 16 bit code to represent 65,536 different characters (some of which are unassigned) to include most of the world's languages in the same, consistent character set. 1 Unicode Byte = 16 bits = 1 character See [http://www.Unicode.org] See also ISO (International Organization for Standardization) for the universal system of measurement known as SI (Système International d'unités). ("ISO" is not an acronym. "ISO" is a word, derived from the Greek isos, meaning "equal", which is the root of the prefix "iso-" that occurs in a host of terms, such as "isometric" (of equal measure or dimensions) and "isonomy" (equality of laws, or of people before the law).) [http://www.ISO.ch]

1 Hertz = 1 cycle per second (e.g. 1 clock cycle in a computer which corresponds roughly to the time required to execute 1 computer instruction. In these terms, a 1 GigaHertz computer executes 1 Billion instructions per second.). A 1,000 cycle per second signal or action is called a 1 KiloHertz signal or action (a 1 KHz signal), each cycle of such a signal is 1 millisecond (ms) long. See BIPM (Bureau International des Poids et Mesures) [http://www.BIPM.fr/enus] for metric units.

1 KiloByte	= 1,000 Bytes	= 1 Thousand Bytes	(KByte)			
1 MegaByte	= 1,000 KBytes	= 1 Million Bytes	(MByte)			
1 GigaByte	= 1,000 MBytes	= 1 Billion Bytes	(GByte)	= 1 Million KiloBytes		
1 TeraByte	= 1,000 GBytes	= 1 Trillion Bytes	(TByte)	= 1 Million MegaBytes	= 1 Billion KiloBytes	
1 PetaByte	= 1,000 TBytes	= 1 Quadrillion Bytes	(PByte)	= 1 Million GigaBytes	= 1 Billion MegaBytes	= 1 Trillion KiloBytes
1 ExaByte	= 1,000 PBytes	= 1 Quintillion Bytes	(EByte)	= 1 Million TeraBytes	= 1 Billion GigaBytes	= 1 Trillion MegaBytes
1 ZettaByte	= 1,000 EBytes	= 1 Sextillion Bytes	(ZByte)	= 1 Million PetaBytes	= 1 Billion TeraBytes	= 1 Trillion GigaBytes
1 YottaByte	= 1,000 ZBytes	= 1 Septillion Bytes	(YByte)	= 1 Million ExaBytes	= 1 Billion PetaBytes	= 1 Trillion TeraBytes

1 KiloHertz	= 1,000 Hertz	= 1 Thousand Hertz	(kHz)	10**+3	1 Kilometer	= 1,000 meters	= 1 Thousand meters	(km)
1 MegaHertz	= 1,000 KHertz	= 1 Million Hertz	(MHz)	10**+6	1 Megameter	= 1,000 Kmeters	= 1 Million meters	(Mm)
1 GigaHertz	= 1,000 MHertz	= 1 Billion Hertz	(GHz)	10**+9	1 Gigameter	= 1,000 Mmeters	= 1 Billion meters	(Gm)
1 TeraHertz	= 1,000 GHertz	= 1 Trillion Hertz	(THz)	10**+12	1 Terameter	= 1,000 Gmeters	= 1 Trillion meters	(Tm)
1 PetaHertz	= 1,000 THertz	= 1 Quadrillion Hertz	(PHz)	10**+15	1 Petameter	= 1,000 Tmeters	= 1 Quadrillion meters	(Pm)
1 ExaHertz	= 1,000 PHertz	= 1 Quintillion Hertz	(EHz)	10**+18	1 Exameter	= 1,000 Pmeters	= 1 Quintillion meters	(Em)
1 ZettaHertz	= 1,000 EHertz	= 1 Sextillion Hertz	(ZHz)	10**+21	1 Zettameter	= 1,000 Emeters	= 1 Sextillion meters	(Zm)
1 YottaHertz	= 1,000 ZHertz	= 1 Septillion Hertz	(YHz)	10**+24	1 Yottameter	= 1,000 Zmeters	= 1 Septillion meters	(Ym)

1 millisecond	= 1 / 1,000 second	= 1 Thousandth second	(ms)	10**-3	1 millimeter	= 1 / 1,000 meter	= 1 Thousandth meter	(mm)
1 microsecond	= 1 / 1,000 millisecond	= 1 Millionth second	(us)	10**-6	1 micrometer	= 1 / 1,000 millimeter	= 1 Millionth meter	(um)
1 nanosecond	= 1 / 1,000 microsecond	= 1 Billionth second	(ns)	10**-9	1 nanometer	= 1 / 1,000 micrometer	= 1 Billionth meter	(nm)
1 picosecond	= 1 / 1,000 nanosecond	= 1 Trillionth second	(ps)	10**-12	1 picometer	= 1 / 1,000 nanometer	= 1 Trillionth meter	(pm)
1 femtosecond	= 1 / 1,000 picosecond	= 1 Quadrillionth second	(fs)	10**-15	1 femtometer	= 1 / 1,000 picometer	= 1 Quadrillionth meter	(fm)
1 attosecond	= 1 / 1,000 femtosecond	= 1 Quintillionth second	(as)	10**-18	1 attometer	= 1 / 1,000 femtometer	= 1 Quintillionth meter	(am)
1 zeptosecond	= 1 / 1,000 attosecond	= 1 Sextillionth second	(zs)	10**-21	1 zeptometer	= 1 / 1,000 attometer	= 1 Sextillionth meter	(zm)
1 yoktosecond	= 1 / 1,000 zeptosecond	= 1 Septillionth second	(ys)	10**-24	1 yoktometer	= 1 / 1,000 zeptometer	= 1 Septillionth meter	(ym)

In the abbreviation for 1 microsecond (us), u is substituted for the symbol for the Greek letter mu.

Because light travels about 300 MegaMeters (Mm) in 1 second and has a wavelength of about 400 nm for blue light (about 700 nm for red light), the frequency of light is about 750 THz for blue light, about 430 THz for red light, and about 230 THz for the 1,300 nm light used in fiber optics). This is because speed (e.g.: C, the speed of light, which is a constant) = wavelength X frequency.

1,000 Bytes = 1 KiloByte (exactly 1 Thousand Bytes in common and legal usage) (exactly 1,024 Bytes = 2**10 = 2 to the 10th power in computer terms); 1,000 KBytes = 1 MegaByte (exactly 1 Million Bytes in common and legal usage) (exactly 1,024 KBytes = 1,048,576 Bytes = 2**20 = 2 to the 20th power in computer terms);

For marketing purposes, a given disk can hold more of the smaller commercial units than the larger computer units. For example a disk that contains 770 computer based MegaBytes (1,048,576 Bytes) sounds smaller than a disk that contains 807 of the commercial MegaBytes (1,000,000 Bytes), even though both disks hold exactly the same number of bytes of data. For both marketing purposes, and because of concern about lawsuits, only the commercial terms have been used in commercial descriptions in recent years.

Conversion from computer binary MegaBytes to commercial marketing MegaBytes. (Including the percent by which binary Megabytes are larger than the corresponding marketing MegaBytes.)

1,024 Commercial Bytes	= 1 Computer Based KiloByte	(a difference of 2.4 percent)	1,073,741,824 Commercial Bytes	= 1 Computer Based GigaByte	(a difference of 7.4 percent)
1,048,576 Commercial Bytes	= 1 Computer Based MegaByte	(a difference of 4.9 percent)	1,099,511,627,776 Commercial Bytes	= 1 Computer Based TeraByte	(a difference of 10 percent)

There are 1,048 commercial marketing KiloBytes in a computer based binary MegaByte, but only 1,024 binary KiloBytes in a computer based binary MegaByte.

Computer binary MegaBytes are given in powers of two (2**N) because the address space (size of memory, memory capacity) of a computer is determined by the number (N) of address lines available. A 32 bit computer has 32 address lines, has a 32 bit address space, and can address 2**32 (= 4,294,967,296) Bytes of RAM (Random Access Memory). The capacity of a disk or disc is determined by the number of sectors, tracks, platters, layers, and/or sides. These numbers are not based on powers of 2.

For units of measure, see also: A Dictionary of Units of Measure [http://www.unc.edu/~rowlett/units/index.html]

Powers of 2 (2**N) (Decimal and Binary)

The powers of 2 are included because many of the standard numeric values in document management are set to be equal to a power of two. Often the exponent is also a power of two.

2 = (2** 1)	32 = (2** 5)	512 = (2** 9)	8,192 = (2** 13)	131,072 = (2** 17)	2,097,152 = (2** 21)
4 = (2** 2)	64 = (2** 6)	1,024 = (2** 10)	16,384 = (2** 14)	262,144 = (2** 18)	4,194,304 = (2** 22)
8 = (2** 3)	128 = (2** 7)	2,048 = (2** 11)	32,768 = (2** 15)	524,288 = (2** 19)	8,388,608 = (2** 23)
16 = (2** 4)	256 = (2** 8)	4,096 = (2** 12)	65,536 = (2** 16)	1,048,576 = (2** 20)	16,777,216 = (2** 24)
	4,294,967,296 = (2** 32)	= (2**(((2**2)**2)*2))		18,446,744,073,709,600,000 = (2** 64)	= (2**(((2**2)*2)**2))

Note that the value of 2**64 produced by Microsoft Excel 97, Excel 2000, and Excel 2002 (XP) is approximate, but that those releases of Excel imply that the value of 2**64 that they produce is exact (exactly correct). The correct value for 2**64 is 18,446,744,073,709,551,616 (a difference of 48,384 from the Excel value). The value that these versions of Excel generate for the 64th power of 2 will likely change (be corrected) with the 64 bit release of Microsoft Excel in the 64 bit release of Microsoft Office.

Paper, Trees

1 pulp tree (loblolly pine) = 1/10th cord of wood = 10,000 pages = 1 file cabinet = 4 boxes = 1/2 GigaByte = 1 CD // 1 lumber tree (20 inch (500 mm) diameter, 110 ft (35 m) tall, 50 years old) = 1 cord = 10 pulp trees (8 in. (200 mm) diameter, 50 ft (15 meters) tall, 20 yrs old) = 1 cord = 4 ft x 4 ft x 8 ft = 128 cubic feet (3.5 cubic meters) as stacked for storage (75 cubic feet of wood, 2 cubic meters of wood) = 100,000 pages = 5 GigaBytes See also AFPA (American Forest & Paper Association) [http://www.AFandPA.org]