The NIST Reference on Constants, Units, and Uncertainty

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Prefixes for binary multiples

In December 1998 the International Electrotechnical Commission (IEC), the leading international organization for worldwide standardization in electrotechnology, approved as an IEC International Standard names and symbols for prefixes for binary multiples for use in the fields of data processing and data transmission. The prefixes are as follows:

Prefixes for binary multiples

Factor	Name	Symbol	Origin	Derivation
2^{10}	kibi	Ki	kilobinary: $(2^{10})^1$	kilo: $(10^3)^1$
2^{20}	mebi	Mi	megabinary: $(2^{10})^2$	mega: $(10^3)^2$
2^{30}	gibi	Gi	gigabinary: $(2^{10})^3$	giga: $(10^3)^3$
2^{40}	tebi	Ti	terabinary: $(2^{10})^4$	tera: $(10^3)^4$
2^{50}	pebi	Pi	petabinary: $(2^{10})^5$	peta: $(10^3)^5$
2^{60}	exbi	Ei	exabinary: $(2^{10})^6$	exa: $(10^3)^6$

Examples and comparisons with SI prefixes

one **kibibit**	1 Kibit = 2^{10} bit = **1024 bit**
one **kilobit**	1 kbit = 10^3 bit = **1000 bit**
one **mebibyte**	1 MiB = 2^{20} B = **1 048 576 B**
one **megabyte**	1 MB = 10^6 B = **1 000 000 B**
one **gibibyte**	1 GiB = 2^{30} B = **1 073 741 824 B**
one **gigabyte**	1 GB = 10^9 B = **1 000 000 000 B**

It is suggested that in English, the first syllable of the name of the binary-multiple prefix should be pronounced in the same way as the first syllable of the name of the corresponding SI prefix, and that the second syllable should be pronounced as "bee."

It is important to recognize that the new prefixes for binary multiples are not part of the International System of Units (SI), the modern metric system. However, for ease of understanding and recall, they were derived from the SI prefixes for positive powers of ten. As can be seen from the above table, the name of each new

prefix is derived from the name of the corresponding SI prefix by retaining the first two letters of the name of the SI prefix and adding the letters "bi," which recalls the word "binary." Similarly, the symbol of each new prefix is derived from the symbol of the corresponding SI prefix by adding the letter "i," which again recalls the word "binary." (For consistency with the other prefixes for binary multiples, the symbol Ki is used for 2^{10} rather than ki.)

Official publication

These prefixes for binary multiples, which were developed by IEC Technical Committee (TC) 25, Quantities and units, and their letter symbols, with the strong support of the International Committee for Weights and Measures (CIPM) and the Institute of Electrical and Electronics Engineers (IEEE), were first adopted by the IEC as *Amendment 2 to IEC International Standard IEC 60027-2: Letter symbols to be used in electrical technology - Part 2: Telecommunications and electronics*. The full content of *Amendment 2,* which has a publication date of 1999-01, is reflected in the tables above and the suggestion regarding pronunciation. Subsequently the contents of this Amendment were incorportated in the second edition of IEC 60027-2, which has a publication date of 2000-11 (the first edition was published in 1972). The complete citation for this revised standard is IEC 60027-2, Second edition, 2000-11, *Letter symbols to be used in electrical technology - Part 2: Telecommunications and electronics.*

Historical context*

Once upon a time, computer professionals noticed that 2^{10} was very nearly equal to 1000 and started using the SI prefix "kilo" to mean 1024. That worked well enough for a decade or two because everybody who talked kilobytes knew that the term implied 1024 bytes. But, almost overnight a much more numerous "everybody" bought computers, and the trade computer professionals needed to talk to physicists and engineers and even to ordinary people, most of whom know that a kilometer is 1000 meters and a kilogram is 1000 grams.

Then data storage for gigabytes, and even terabytes, became practical, and the storage devices were not constructed on binary trees, which meant that, for many practical purposes, binary arithmetic was less convenient than decimal arithmetic. The result is that today "everybody" does not "know" what a megabyte is. When discussing computer memory, most manufacturers use megabyte to mean 2^{20} = 1 048 576 bytes, but the manufacturers of computer storage devices usually use the term to mean 1 000 000 bytes. Some designers of local area networks have used megabit per second to mean 1 048 576 bit/s, but all telecommunications engineers use it to mean 10^6 bit/s. And if two definitions of the megabyte are not enough, a third megabyte of 1 024 000 bytes is the megabyte used to format the familiar 90 mm (3 1/2 inch), "1.44 MB" diskette. The confusion is real, as is the potential for incompatibility in standards and in implemented

systems.

Faced with this reality, the IEEE Standards Board decided that IEEE standards will use the conventional, internationally adopted, definitions of the SI prefixes. Mega will mean 1 000 000, except that the base-two definition may be used (if such usage is explicitly pointed out on a case-by-case basis) until such time that prefixes for binary multiples are adopted by an appropriate standards body.

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