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Series on Technical Communication

Using SI Units

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The SI

An important aspect of technical communication is how we describe the physical world. Engineers have adopted standard ways of characterizing aspects of reality that are relevant to them, and if you wish to communicate with other engineers then you should also abide by these rules. The foundation is provided by the International System of Units (abbreviated as SI, for the French name). The SI defines all of the **quantities** need to describe any measurable characteristic of the physical universe. These quantities have standard names such as **electric current**, **mass**, **volume**, and **luminance**.

Furthermore, the SI defines how we communicate the **amount** of some quantity by specifying the **units** of that quantity. These units are commonly known as the *metric system*. For example, the SI **unit name** for electric current is the **ampere** and the SI unit name for frequency is the **hertz**. Each of these unit names has a corresponding **unit symbol**: the symbol for the ampere is **A** and the symbol for hertz is **Hz**.

It is often the case that we need to describe a very large or very small amount of some quantity. The SI provides prefixes that can be used with the units for this purpose. These prefixes represent integer powers of 10, from 10^{-24} to 10^{24}. As with the SI units, each prefix has a name and a symbol. For example, the prefix that represents 10^{3} is named **kilo** and has the symbol **k**.

Using SI units and prefixes

In written text that doesn't specify an amount of the quantity you should use the unit's name. The unit names are not capitalized except in situations where any other noun would be capitalized, such as the beginning of a sentence.

When describing a **specific amount** of something, use the appropriate **symbols** for the SI unit and prefix. The symbols for unit names that are derived from a person's name are capitalized. Note that the symbol for the unit of time is just the letter 's'. Don't use the letter 'u' as the abbreviation for the micro prefix unless writing a plain text file, such as an email message or program source file.

Remember that the symbols for all prefixes of mega and greater are capitalized. Make sure that you use a lower-case 'm' for milli and an uppercase 'M' for mega, even in handwritten work. Use a lower-case 'k' for kilo so it doesn't look like the symbol for thermodynamic temperature (the kelvin, K).

The unit and prefix symbols are **always** written in an upright (rather than italic or slanted) font. This is particularly important when using these symbols in equations or formulas.

Never mix a symbol for a prefix and the full name of a unit, or vice versa. If you use the symbol for the prefix then use the symbol for the unit as well. Don't write "1 kohm"; instead use "1 kΩ". If you are writing an email or a comment in computer code, "one kilohm" is acceptable.

Don't use exponential notation with SI units; use the appropriate prefix. For example, 3.14×10^{-2} V is wrong, 31.4 mV is correct.

An amount and its unit symbol should be separated by a thin, non-breaking space[1]. Using a non-breaking space will prevent a word processor from splitting a line of text between the amount and the unit symbol. A notable exception to this rule is for plane angles; there is no space before the symbols for degrees, minutes, or seconds.

Units are optional for dimensionless quantities if they are obvious in context. You could say "… the voltage gain is 100 …" or "…the gain is 100 V/V…". If you don't use an SI unit then you can't use an SI prefix, so dimensionless quantities may use exponential notation.

Note that one of the vowels is dropped when we combine kilo and mega with ohm; the correct units are written as kilohm and megohm.

Use a centered dot to separate compound units, particularly if it prevents ambiguity. For example, the SI unit of thermal conductivity is the watt per meter kelvin and the correct abbreviation is W/(m·K). Without the dot the units could be seen as watt per millikelvin (W/mK).

Binary units and prefixes

The correct SI symbols for bit and byte are *bit* and *B*, respectively. There are also defined prefixes that are powers of two instead of powers of ten, so a memory with 2^{10} 8-bit data words would contain 1 KiB (or one kibibyte) of information. The corresponding prefixes for 2^{20} and 2^{30} are mebi and gibi,

[1] The thin non-breaking space is Unicode character U+202F and HTML code

with symbols Mi and Gi. Note that the IEEE standard says that a byte is *usually* eight bits, but the term *octet* is defined as a byte that contains eight bits.

Engineering Format

In general, engineers only use the prefixes that represent powers of 10 that are integer multiples of 3 (e.g. kilo for 10^3, nano for 10^{-9}, tera for 10^{12}). You probably shouldn't use centi, deci, deka, or hecto. You should select a prefix such that the numerical part of the quantity is greater than or equal to 0.1 and strictly less than 1000.

You should understand the difference between a **quantity symbol**, which might be used as a variable in an equation, and a **unit symbol**, which represents one of the defined SI units. Quantity symbols should be italic but unit symbols are always written upright:

$$V_1 = 3.14 \text{ V}$$
$$I_2 = I_1 + 2.7 \text{ A}$$

You may add letters or subscripts to **quantity** symbols (i.e. variables) but you may not add them to **unit** symbols. For example, "...the voltage was 120 Vac…" is incorrect; instead write "...the ac voltage was 120 V…".

There are some situations where a traditional choice of unit may be used even when it is not consistent with the general guidelines. For example, physical dimensions of small objects are usually specified in millimeters and large distances are usually specified in kilometers.

Matters of Style

When groups of values are given together, such as a column in a table, all of the values may use the same unit and prefix (even if the numerical part of the quantity is less than 0.1 or greater than 1000).

Don't use a comma to separate groups of three digits. The preferred style is to use a thin space when there are five or more digits, as in c = 299 792 458 m/s.

For decimal numbers less than one, always use a leading zero to the left of the decimal point. Write 0.2 W instead of .2 W. However, writing this as 200 mW would be preferred in most circumstances.

Don't use vulgar fractions to represent numerical values, except as intermediate steps in a calculation. Unlike mathematicians, engineers usually don't care about exact solutions; we want to easily grasp the relative magnitude of different values. Don't write $\frac{86}{64}$ and $\frac{267}{200}$, write 1.33475 and 1.335.

References

IEEE Std 1541 *IEEE Standard for Prefixes for Binary Multiples*, 2009
IEEE/ASTM SI 10 *American National Standard for Metric Practice*, 2016

NIST Publication 811 *Guide for the Use of the International System of Units*, 2008
ANSI/IEEE Std 945 *IEEE Recommended Practice for Preferred Metric Units for Use in Electrical and Electronics Science and Technology*, 2008
IEEE Std 260.1 *IEEE Standard Letter Symbols for Units of Measurement*, 2010

About this Guide

This guide is part of a series that has been established to provide a repository of information on technical communication for the students and faculty of the Bucknell University Electrical & Computer Engineering Department. Its primary goal is to foster consistent standards applied to the preparation of reports, presentations, and other forms of communication within the ECE curriculum. In effect, the guides in this series constitute official department policy on technical communication.

Although it is important to adhere to standards for graded class work, you should strive to maintain high standards as well in ungraded work and in day-to-day communications with your professors, other students, and professional contacts. You should view every instance of communication as an opportunity to practice your skills so that eventually they become second nature. Fair or not, your colleagues will form opinions of your professional competence based partly on how well you express yourself.