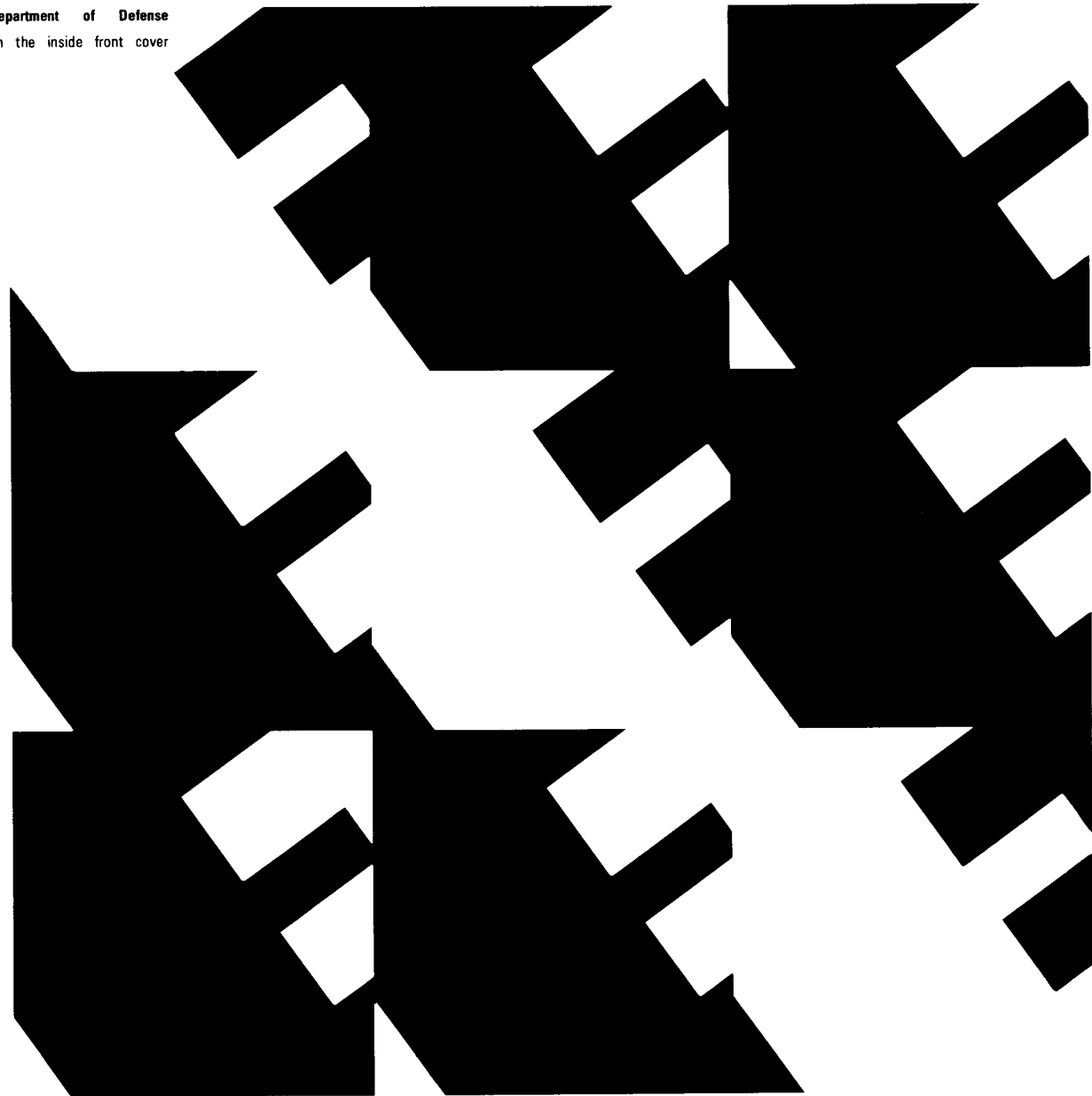


IEEE Standard Letter Symbols for Units of Measurement

(SI Units, Customary Inch-Pound Units, and Certain Other Units)

see acceptance notice of the
Department of Defense
on the inside front cover



ANSI/IEEE Std 260-1978



Published by The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017, USA

December 29, 1978

SH07310

IEEE Std 260-1978
16 June 1978
SUPERSEDING
IEEE Std 260-1977 and
ANSI Y10.19-1969

Acceptance Notice

The above Industry Standardization Document was adopted on 16 June 1978, and is approved for use by the DoD. The indicated industry group has furnished the clearance required by DoD Single Stock Point, Naval Publications and Forms Center, Philadelphia, Pa., 19120, for issue to DoD activities only.

Title of Document: An American National Standard
IEEE Standard Letter Symbols for
Units of Measurement
(SI Units, Customary Inch-Pound
Units, and Certain Other Units)

Document Number: ANSI/IEEE Std 260-1978

Date of Specific Issue Adopted: 16 June, 1978

Releasing Industry Group: The Institute of Electrical and
Electronic Engineers, Inc

NOTE: The Symbols To Be Used With Limited Character Sets (Section 4) are intended to be used wherever information is to be transmitted or prepared for human use and a complete character set is not available (for example, where messages are sent by teleprinter or information is prepared for computer display). The symbols of Section 4 shall not be used, however, in Military Specifications, Standards, or Handbooks; for such applications a complete character set is required, and the Symbols For General Use (Section 3) shall be used.

Custodians:
Army - AR
Navy - SH
Air Force - 11

Military Coordinating Activity:
Navy - SH

Review activities:
Army - MI
Navy - AS, EC, YD
Air Force - 13, 99

User activity:
Navy - MC

Project Number: MISC-OC22

Certain provisions of this standard are subject of International Standardization Agreement, ABC NAVY STD-28A, Symbols and Abbreviations for Electrical and Electronics Drawings, to which the U.S. Army also subscribes. When reaffirmation, amendment, revision, or cancellation of this standard is proposed which will affect or violate the international agreement concerned, the Military Coordinating Activity will take appropriate reconciliation action through military international standardization channels including departmental standardization offices, if required.

NOTICE: When reaffirmation, amendment, revision, or cancellation of this standard is initially proposed, the cognizant secretariat of the industry standard shall inform the Military Coordinating Activity of the proposed change and request their participation.

An American National Standard

IEEE Standard Letter Symbols for

Units of Measurement

(SI Units, Customary Inch-Pound Units, and
Certain Other Units)

1. General Principles of Letter Symbol Standardization

1.1 Letter Symbols. Letter symbols¹ include symbols for physical quantities (*quantity symbols*) and symbols for the units in which these quantities are measured (*unit symbols*).

A quantity symbol is, in general,² a single letter (for example, *I* for electric current) specified as to general form of type, and modified when appropriate by one or more subscripts or superscripts. In a given work the same letter symbol should appear throughout for the same physical quantity, regardless of the units employed or of special values assigned.

A unit symbol³ is a letter or group of letters (for example, mm for millimeter), or in a few cases a special sign, that may be used in place of the name of a unit.

1.2 Alphabets and Typography. Letter symbols are mainly restricted to the English and Greek

alphabets.⁴ The type families that are used for text in modern book and journal publishing all include italic (*sloping*) type faces and related roman (*upright*) faces. The former are used for quantity symbols, and the latter, for unit symbols — the distinctions are discussed more fully in the following paragraphs. (In the context of this standard, the term *roman* is used simply to mean upright in contrast with sloping and carries no connotation regarding serifs, line widths, or the like.) In situations where roman and italic are not both available, care must be taken to avoid confusion between quantities and units. For example, an underline is frequently used to indicate italic type, and where an underline can be provided, as in manual typewriting, this practice is often helpful.

Unconventional type faces should generally not be used for letter symbols. Script and Old English faces, for example, are not appropriate for unit symbols. Such special faces have seen limited use for quantity symbols, but good modern practice avoids them (see 1.3, last paragraph).

Symbols for physical quantities, mathematical variables, indexes, and general functions⁵ are printed in italic (*sloping*) type. For example,

<i>A, A</i>	area
<i>e</i>	charge of an electron
<i>x, y, z</i>	Cartesian coordinates
<i>i, j, k, n</i>	indexes
<i>f(x)</i>	function of <i>x</i>

Symbols for physical units, mathematical constants, specific mathematical functions, operators, and numbers used as indexes are printed

¹“Letter symbol” as a technical term does not have the same meaning as either “name” or “abbreviation.” An abbreviation is a letter or a combination of letters (plus sometimes an apostrophe or a full stop) which by convention represents a *word* or a *name* in a particular language; hence an abbreviation may be different in a different language. A symbol represents a *quantity* or a *unit* and is, therefore, independent of language. Example: For electromotive force, the symbol is *E*, whereas the abbreviation is *emf* in English, *fem* in French, and *EMK* in German. The word “ampere” is sometimes abbreviated *amp*; the symbol for this unit is *A*.

²Symbols comprising two letters are sometimes used for numerical transport parameters such as Reynolds number *Re*.

³Formerly it was common to treat unit symbols in the same manner as general abbreviations, but the current recommendations of the International Organization for Standardization (ISO), and of many other international and national bodies concerned with standardization, emphasize the symbolic character of these designations and rigidly prescribe the manner in which they shall be treated. The concept of the unit symbol is therefore adopted in this standard.

⁴Greek letters that are easily confused with English letters are avoided. See American National Standard Guide for Selecting Greek Letters Used as Letter Symbols For Engineering Mathematics, ANSI Y10.17-1961 (R1973).

⁵The term *general functions* is here used to contrast with *specific mathematical functions*, for which roman type is to be used.

in roman type. For example,

cm	centimeter
e	base of natural logarithms
$\sin x$	sine of x
$J_2(z)$, $J_n(z)$	Bessel functions
dx	differential of x

Subscripts and superscripts are governed by the above principles. Those that are letter symbols for quantities or for indexes are printed in italic type, while all others are printed in roman type, for example,

C_p	heat capacity at constant pressure p
a_{ij} , a_{45}	matrix elements
I_i , I_o	input current, output current
x_{av}	average value of x

For indicating the vector character of a quantity, boldface italic type is used. For example,

$\mathbf{F}$	force
$\mathbf{H}$	magnetic field strength

Ordinary italic type is used to represent the magnitude of a vector quantity. It is also commonly used for a vector quantity when there is no need to draw attention to the vector character of the quantity.

When tensor quantities of second or higher order are to be represented by a single letter, sans-serif type should be used (for example, A , B).

1.3 Remarks Concerning Quantity Symbols. Quantity symbols may be used in mathematical expressions in any way consistent with good mathematical usage. The product of two quantities a , b , is indicated by writing ab . The quotient may be indicated by writing

$$\frac{a}{b}, a/b, \text{ or } ab^{-1}$$

If more than one slash (/) is used in any algebraic term, parentheses must be inserted to remove any ambiguity. Thus one may write $(a/b)/c$, or $a/(b/c)$, but not $a/b/c$.

Subscripts and superscripts are widely used with quantity symbols. Several subscripts or superscripts, sometimes separated by commas, may be attached to a single letter. But, so far as logical clarity permits, subscripts and superscripts should not be attached to other subscripts and superscripts. A symbol that has been modified by a superscript should be enclosed in parentheses before an exponent is attached.

Conflicts that occur because different quantities are assigned identical symbols in the same or different standard symbol lists should be resolved in one of the following ways:

(1) By use of a reserve symbol (alternative symbol) if one is listed

(2) By use of a subscript or superscript selected by the author for one or more of the conflicting requirements

(3) By use of uppercase letters as variants for lowercase letters and *vice versa*, but only if no ambiguity results.

1.4 Remarks Concerning Unit Symbols. Roman type, in general lowercase, is used for unit symbols, except for a very few that use special signs (such as $^{\circ}$ for degree). If, however, the symbol is for a unit whose name is derived from a proper name, uppercase roman type is used for the first letter.⁶ As a further exception to the general rule, the symbol L is used for liter to avoid confusion between the lowercase letter l and the numeral 1. Some additional exceptions arise in the special cases where symbols are joined, as in eV, the symbol for electronvolt, and in mmHg, the symbol for conventional millimeter of mercury, a unit of pressure. The distinction between upper- and lowercase letters should be followed, even if the symbol appears in applications where the other lettering is in uppercase style. The form of unit symbols is the same for both singular and plural, and they are not followed by a period except at the end of a sentence.

In the complete expression for a quantity, a space should be left between the numerical value and the unit symbol. For example, write 35 mm, not 35mm, and 2.371 m, not 2.371m. When the quantity is used in an adjectival sense, a hyphen is often used in lieu of a space between the number and the unit name or between the number and the symbol (except when the first character of the symbol is not a letter, as in $^{\circ}\text{C}$).

Examples:

A 3-meter pole The length is 3 meters.

A 35-mm film The width is 35 mm.

EXCEPTION: No space is left between the numerical value and the symbols for degree, minute, and second of plane angle.

When a compound unit is formed by multiplication of two or more other units, its symbol consists of the symbols for the separate

⁶Prefixes are considered separately.

units joined by a raised dot (for example, N·m for newton meter). The dot may be omitted in the case of familiar compounds such as watt-hour (symbol Wh) if no confusion would result.⁷ Hyphens should not be used in symbols for compound units. Positive and negative exponents may be used with the symbols for units.

When a compound unit is formed by division of one unit by another, its symbol is constructed in one of the following forms:

$$\text{m/s or m} \cdot \text{s}^{-1} \text{ or } \frac{\text{m}}{\text{s}}$$

In simple cases use of the slash is preferred, but in no case should more than one slash, or a slash followed by a product, be used in the same expression unless parentheses are inserted to avoid ambiguity. For example, write:

$$\text{J}/(\text{mol} \cdot \text{K}) \text{ or } \text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \text{ or } (\text{J}/\text{mol})/\text{K}$$

but *not* J/mol/K or J/mol·K.

In complicated cases negative powers should be used.⁸

Letter symbols and mathematical notation should not be mixed with unit names in the same expression. For example, write joules per kilogram or J/kg. Do not write joules/kilogram or joules/kg, or J/kilogram.

1.5 The International System of Units (SI). In this standard some units are identified as SI units. These units belong to the International System of Units (Système International d'Unités), which is the name given in 1960 by the General Conference on Weights and Measures (Conférence Générale des Poids et Mesures) to the coherent system of units based on the following base units and quantities:

Unit	Quantity
meter	length
kilogram	mass
second	time
ampere	electric current
kelvin	thermodynamic temperature
mole	amount of substance
candela	luminous intensity

⁷It may also be omitted where symbols are separated by an exponent as in N·m²kg⁻².

⁸The notation for products and quotients of unit symbols is intentionally made more explicit than that given in 1.3 for quantity symbols because some unit symbols consists of more than one letter.

SI includes as subsystems the MKS system of units, which covers mechanics, and the MKSA system, which covers mechanics and electricity.

The spellings *meter* and *liter* are recommended. This is in accordance with guidance given by the Department of Commerce, which is given the responsibility of interpreting SI for the United States under the Metric Conversion Act of 1975. The variant spellings *metre* and *litre* are also used, especially in British English.

The following prefixes are used to indicate decimal multiples or submultiples of SI units:⁹

Multiple	SI Prefix	Symbol
10 ¹⁸	exa	E
10 ¹⁵	peta	P
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ²	hecto	h
10	deka	da
10 ⁻¹	deci	d
10 ⁻²	centi	c
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p
10 ⁻¹⁵	femto	f
10 ⁻¹⁸	atto	a

Compound prefixes, formed by the juxtaposition of two or more SI prefixes, are not to be used. For example, use

$$1 \text{ nm, not } 1 \text{ m}\mu\text{m}$$

$$1 \text{ pF, not } 1 \mu\mu\text{F}$$

If values are required outside the range covered by the prefixes, they should be expressed using powers of ten applied to the base unit.

An exponent attached to a symbol containing a prefix indicates that the multiple or submultiple of the unit (the unit with its prefix) is raised to the power expressed by the exponent. For example:

$$1 \text{ cm}^3 = (10^{-2} \text{ m})^3 = 10^{-6} \text{ m}^3$$

$$1 \text{ ns}^{-1} = (10^{-9} \text{ s})^{-1} = 10^9 \text{ s}^{-1}$$

$$1 \text{ mm}^2/\text{s} = (10^{-3} \text{ m})^2/\text{s} = 10^{-6} \text{ m}^2/\text{s}$$

For further information concerning metric practice and the SI, refer to American National Standard Metric Practice, (ANSI/IEEE Std 268-1976), ANSI Z210.1-1976.

⁹The use of SI prefixes with U.S. customary units is not recommended, except in the case of the microinch and kilopound-force.

2. Introduction to Standard Letter Symbols for Units of Measurement

2.1 Scope. This standard covers symbols for units only. It does not include abbreviations for technical terms, nor does it cover symbols for physical quantities.

The symbols given in this standard are intended for all applications, including use in text and equations, in graphs and diagrams, and on panels, labels, and nameplates.

2.2 Usage. The use of unit symbols in place of full names of the units is frequently desirable where space is restricted. Their use presupposes that the reader will find them intelligible. If there is any doubt that the reader will not understand a symbol, the name of the unit should be written in full. When an unfamiliar unit symbol is first used in text, it should be followed by its name in parentheses or the name should be given with the symbol in parentheses; the symbol may be used alone thereafter. Explanatory notes or keys should be included where appropriate on drawings and in tabular matter.

2.3 List of Symbols. Symbols for units are listed alphabetically by name of unit. The list is intended to be reasonably complete but could not possibly include all units in current use.

Obsolescent units, such as apothecaries' weights, and units used almost exclusively in narrow fields of commerce, such as the bushel and hundredweight, have been omitted. Many compound symbols and many illustrations of the use of the SI prefixes are included. Other combined forms may easily be constructed according to the principles set forth in 1.4.

Attachment of letters to a unit symbol as a means of giving information about the *quantity* under consideration is incorrect. Thus MWe for "megawatts electrical (power)," Vac for "volts ac," and kJt for "kilojoules thermal (energy)" are not acceptable. For this reason, no attempt should be made to construct SI equivalents of the abbreviations "psia" and "psig," so often used to distinguish between absolute and gage pressure.

If the context leaves any doubt as to which is meant, the word *pressure* must be qualified appropriately. For example:

"...at a gage pressure of 13 kPa"

or

"...at an absolute pressure of 13 kPa"

When space limitations make it necessary to juxtapose information about the quantity being measured with the unit name or unit symbol, such information must be separated from the unit symbol by a space, or by a comma followed with a space, or the equivalent. Thus the following examples are appropriate for use on nameplates, gage scale plates, table headings, graph labels, etc:

rating - 115 V ac
kPa, gage
kPa (abs)

On the other hand, letters may be attached to a unit symbol where needed to properly identify the *unit* involved. In such symbols as inHg, mmHg, and ftH₂O, the suffixes are needed to identify the units, which are units of pressure, not of length. Similarly, it is proper to write Btu_{IT}, cal_{th}, gal_{US}, etc, to distinguish from the related but different units Btu₆₀, cal₁₅, gal_{UK}, etc.

The distinction between uppercase and lowercase letters shown in the list is part of the standardization of the symbol, following international rules. Changing the letter case changes the symbol and violates this standard. There are situations in which the standard symbols cannot be used, for example, when the printing equipment has no provision for Greek letters, or for lowercase letters. These situations are discussed in Section 4.

2.4 Abbreviations. A list of abbreviations used in the standard follows:

CGPM	Conférence Générale des Poids et Mesures (General Conference on Weights and Measures)
CGS	centimeter-gram-second
CIPM	Comité International des Poids et Mesures (International Committee for Weights and Measures)
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MKS	meter-kilogram-second
MKSA	meter-kilogram-second-ampere
SI	Système International d'Unités (International System of Units)