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and ANSI Y10.5-1968)

An American National Standard

IEEE Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering

Sponsor
IEEE Standards Coordinating Committee 14, Graphic Symbols and Designations

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Abstract: This standard provides letter symbols to represent various quantities (but not units) used in electrical science and technology. The standard is compatible with IEC Publication 27, Letter Symbols to be Used in Electrical Technology.

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Abstract

This standard provides letter symbols to represent various quantities (but not like) used in electrical science and technology. The standard is compatible with IEC Publication 27, Letter Symbols to be Used in Electrical Technology.

Foreword

(This Foreword is not a part of ANSI/IEEE Std 280-1985, IEEE Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.)

This standard was developed from three separate standards, ASA Z10.5-1949, Letter Symbols for Electrical Quantities, ASA Y10.9-1953, Letter Symbols for Radio, and 57IRE21S1, Letter Symbols and Mathematical Signs. The first edition of this standard was issued as USAS Y10.5-1968 IEEE Std 280-1968, Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering. In the development of this standard the International Electrotechnical Commission Publication 27, Letter Symbols to be Used in Electrical Technology, has been followed closely.

In this revision the following changes and additions have been made:

1) A new section, Scope, has been added.
2) A new section, References has been added.
3) Section 3.2 on typography has been expanded and clarified.
4) Text concerning unit symbols has been expanded and text on the SI system of units added; these now parallel the statements in ANSI/IEEE 268-1982 , American National Standard Metric Practice. All units (for example, temperature, pressure, conductance) have been revised to agree with current SI practice.

Celsius temperature replaces the former terms *temperature* and *customary temperature*

Reciprocal degree Celsius replaces *reciprocal kelvin*

References to *cycle per second* have been deleted

In Table 6, 6.59, Subscripts, Semiconductor Devices, the terms *drain terminal and source terminal* were added.

In Table 8 the values of the physical constants have been revised to agree with current information.

Attention is called to the following related standards:

ANSI Y10.20-1975, Mathematical Signs and Symbols for Use in Physical Science and Technology.

ANSI/IEEE Std 260-1978, IEEE Standard Letter Symbols for Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

ANSI/IEEE Std 268-1982, American National Standard Metric Practice.

When this standard was approved the IEEE Standards Coordinating Committee on Quantities and Units, Subcommittee SCC14.3 on Letter Symbols had the following membership:

Sidney V. Soanes, *Chair*

Bruce B. Barrow	Chester H. Page	Conrad R. Muller

The IEEE Standards Coordinating Committee on Quantities and Units, SCC14 had the following membership:

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An American National Standard

IEEE Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering

1. Scope

This standard covers letter symbols used to represent physical quantities in the field of electrical science and electrical engineering. These symbols are independent of the units (see ANSI/IEEE Std 260-1978 [2][1]) employed or special values assigned. Also included are selected symbols for mathematics and for physical constants.

2. References

When the following American National Standards referred to in this standard are superseded by a revision approved by the American National Standards Institute, the latest vision shall be used.

[1] ANSI Y10.17-1961 (R1973), American National Standard Guide for Selecting Greek Letters Used as Letter Symbols for Engineering Mathematics.

[2] ANSI/IEEE Std 260-1978, IEEE Standard Letter Symbols for Units of Measurement.

[3] ANSI/IEEE Std 268-1982, American National Standard Metric Practice.

3. General Principles of Letter Symbol Standardization

3.1 Letter Symbols

Letter symbols[2] 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, a single letter[3] (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

[1]The numbers in brackets correspond to those of the references in Section 2..

[2]*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, fern in French, and EMK in German. The word *ampere* is sometimes abbreviated amp; the symbol for this unit is A.

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

should appear throughout for the same physical quantity, regardless of the units employed or of special values assigned.

A unit symbol[4] 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.

3.2 Alphabets and Typography

Letter symbols are mainly restricted to the English and Greek alphabets.[5] The type families that are used for text in modern book and journal publishing all include italic (*sloping*) type faces and related roman (*upright*) type 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 shall 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 3.3, last paragraph).

Symbols for physical quantities, mathematical variables, indices, and general functions[6] are printed in italic (*sloping*) type. For example,

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

Symbols for physical units, mathematical constants, specific mathematical functions, operators, and numbers used as indices are printed in roman type. For example,

cm	centimeter
e	base of natural logarithms
sin *x*	sine of *x*
$\mathrm{J}_2(z)$, $\mathrm{J}_n(z)$	Bessel functions
d*x*	differential of *x*

Subscripts and superscripts are governed by the above principles. Those that are letter symbols for quantities or for indices 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,

[4]Formerly 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.
[5]Greek letters that are easily confused with English letters are avoided. See ANSI Y10.17-1961 (1973), [1].
[6]The term *general functions* is used here to contrast with *specific mathematical functions*, for which roman type is to be used.

F	force
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*).

3.3 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 solidus (/) is used in any algebraic term, parentheses shall 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.

3.4 Unit Symbols

Roman type, in general lowercase, is used for unit symbols, except for a very few that use special signs (such as ° 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.[7] As a further exception to the general rule, the symbol L is used for liter to avoid confusion between the lowercase letter 1 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 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 allowed between the numerical value and the unit symbol. For example, write 35 ram, not 35mm, and 2.371 m, not 2.371m. When the quantity is used in an adjectival sense, a hyphen is often used instead 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 °C).

[7]Prefixes are considered separately.

EXAMPLES

A 3-meter pole	The length is 3 meters.
A 35-mm film	The width is 35 min.

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 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 watthour (symbol Wh) if no confusion would result.[8] 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:

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

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

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

but *not* J / mol / K or J / mol·K.

In complicated cases negative powers should be used.[9]

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.

3.5 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'Unitès), which is the name given in 1960 by the General Conference on Weights and Measures (Confèrence Gènèrale des Poids et Measures) 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

[8]It may also be omitted where symbols are separated by an exponent as in $\mathrm{N \cdot m^2 kg^{-2}}$

[9]The notation for products and quotients of unit symbols is intentionally made more explicit than that given in 3.3 for quantity symbols because some unit symbols consist 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:[10]

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 cm *not* 1 mμm

1 pF, *not* μμF

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:

$$1\ \mathrm{cm}^3 = (10^{-2}\ \mathrm{m})^3 = 10^{-6}\ \mathrm{m}^3$$
$$1\ \mathrm{ns}^{-1} = (10^{-9}\ \mathrm{s})^{-1} = 10^{9}\ \mathrm{s}^{-9}$$
$$1\ \mathrm{mm}^2/\mathrm{s} = (10^{-3}\ \mathrm{m})^2/\mathrm{s} = 10^{-6}\mathrm{m}^2/\mathrm{s}$$

For further information concerning metric practice and the SI, refer to ANSI/IEEE Std 268-1982 [3].

[10]The use of SI prefixes with US customary units is not recommended, except in the case of the microinch and kilopound-force.

4. Special Principles for Quantity Symbols in Electrical Science and Electrical Engineering

4.1 Phasor Quantities

Phasor quantifies, represented by complex numbers or complex time-varying functions, are extensively used in certain branches of electrical engineering. The following notation and typography are to be used:

	Notation*	Remarks
Complex quantity	Z	$Z = \|Z\| e^{j\phi}$
		$Z = \mathrm{Re}\, Z + \mathrm{j}\, \mathrm{Im}\, Z$
Real part	Re Z, Z'	
Imaginary part	Im Z, Z''	
Conjugate complex quantity	Z^*	$Z^* = \mathrm{Re}\, Z - \mathrm{j}\, \mathrm{Im}\, Z$
Modulus of Z	$\|Z\|$	
Phase of Z, Argument of Z	arg Z	arg $Z = \phi$

*The following alternative notation has been used in electrical power engineering: Complex quantity, $\check{Z}$; Conjugate complex quantity, $\hat{Z}$ Modulus of complex quantity, Z. Further use of this notation for this purpose is not recommended.

4.2 Conventions

4.2.1 Time Varying Quantities

When upper and lowercase type faces are available to resent a time-varying quantity, the lowercase letter may be used for the instantaneous value of the quantity and the uppercase letter may be used as convenient for one of the characterizing values associated with the quantity. For example, *V*, *I*, and *Q* are conventionally used to denote the root-mean-square values of voltage, current, and charge, while ν, *i*, and *q* denote the instantaneous values. For time-varying power, *P* is used to denote the average value, and *p*, the instantaneous power.

When, as an alternative to the above, subscripts are used to denote various values associated with a quantity, the subscripts (for the values indicated) shall conform with the following list:

	Preferred	Reserve
Instantaneous value	i	I
Average value	av	AV
Root-mean-square value*	rms	RMS
Maximum (peak) value	max, m	MAX, M
Minimum (valley, nadir) value	min, n	MIN, N

*The subscript “f” has been adopted by the IEC but is not recommended in this standard.

4.2.2 Internal and External Resistances, etc

When nonideal voltage and current sources are considered with electrical circuits, uppercase symbols (R, C, etc) may be assigned to external circuit elements, and lowercase symbols (r, c, etc) may be assigned to the elements describing the source.

EXAMPLES:

R_L	load resistance
r_a	anode resistance

4.2.3 Quantities Per Unit Volume, Area, or Length

It is recommended that quantities per unit volume, area, or length be represented where practicable by lowercase letters corresponding to the uppercase letters that represent the total quantities, or by the uppercase letter with the subscript v, a, or l, except for those quantities for which this standard gives a specific symbol for the quantity per unit volume, area, or length.

4.2.4 Sequence for Double Subscripts to Multiplying Operators

The sequence of the double subscripts to the multiplying coefficients (mutual impedances, resistances, transconductances, etc) that occur in systems of equations is to be determined as follows. The first subscript in the symbol shall agree with the subscript of the quantity resulting from the multiplication, and the second subscript shall agree with that of the multiplicand.

EXAMPLE: $V_1 = Z_{11}I_1 + Z_{12}I_2 + Z_{13}I_3$

4.2.5 Notation for Symmetrical Components

The symmetrical components of current and voltage in unbalanced polyphase systems are preferably designated by double subscripts. In the standard notation for the symmetrical components of line-to-neutral quantities:

1) The first subscript designates the phase to which the component belongs, and is usually a lowercase letter such as a, b, or c

2) The second subscript is a number that designates the sequence to which the component belongs, the positive-, negative-, and zero-sequence components of a three-phase system designated by 1, 2, and 0, respectively.

Illustration of notation

$$I_a = I_{a1} + I_{a2} + I_{a0}$$

$$I_b = I_{b1} + I_{b2} + I_{b0}$$

$$I_c = I_{c1} + I_{c2} + I_{c0}$$

If symmetrical components of line-to-line quantities are to be represented, two subscripts to designate the phases concerned are preferred, followed by a number to designate the sequence, as for example, E_{bc1}. Use of a single capital-letter subscript to designate the phases is deprecated.

5. Introduction to the Tables

Tables 1 through 7 list quantities grouped in several categories, and give quantity symbols, units based on the International System,[11] and unit symbols. Table 8 lists physical constants, and Table 9 gives some mathematical symbols that are particularly relevant to electrical engineering and science. The quantity symbols in Table 10 are then presented in alphabetical order, so that cross-referencing is easy. The index of this standard includes names that are no longer recommended for quantities, referring the reader to the current names.

Those quantity symbols that are separated by a comma are alternatives on equal standing. Where two symbols for a quantity are separated by three dots (…), the second is a reserve symbol, which is to be used only where there is specific need to avoid a conflict. As a rule the tables do not indicate the vectorial or tensorial character that some of the quantities may have.

[11]The name of the unit is given as a further guide to the definition of the symbol. A quantity shall be represented by the standard letter symbol appearing in the table regardless of the system of units in which the quantity is expressed.

6. Symbols for Quantities

Table 1—Space and Time

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
1.1	angle, plane	$\alpha, \beta, \gamma, \theta, \phi, \psi$	radian	rad	Other Greek letters are permitted where no conflict results.
1.2	angle, solid	Ω, ω	steradian	sr	
1.3	length	l	meter	m	
1.4	breadth, width	b	meter	m	
1.5	height	h	meter	m	
1.6	thickness	d, δ	meter	m	
1.7	radius	r	meter	m	
1.8	diameter	d	meter	m	
1.9	length of path line segment	s	meter	m	
1.10	wavelength	λ	meter	m	
1.11	wave number	$\sigma \ldots \tilde{\nu}$	reciprocal meter	m^{-1}	$\sigma = 1/\lambda$ The symbol $\tilde{\nu}$ is used in spectroscopy.
1.12	circular wave number angular wave number	k	radian per meter	rad/m	$k = 2\pi/\lambda$
1.13	area	$A \ldots S$	square meter	m^2	
1.14	volume	V, v	cubic meter	m^3	
1.15	time	t	second	s	
1.16	period time of one cycle	T	second	s	
1.17	time constant	$\tau \ldots T$	second	s	
1.18	frequency	$f \ldots \nu$	hertz	Hz	The name *cycle per second* is also used for this unit. The symbol for the unit *cycle per second* is c/s; the use of cps as a symbol is deprecated. The symbol f used in circuit theory, sound, and mechanics; ν is used in optics and quantum theory.
1.19	speed of rotation rotation frequency	n	revolution per second	r/s	
1.20	angular frequency	ω	radian per second	rad/s	$\omega = 2\pi f$
1.21	angular velocity	ω	radian per second	rad/s	
1.22	complex (angular) frequency oscillation constant	$p \ldots s$	reciprocal second	s^{-1}	$p = -\delta + j\omega$

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
1.23	angular acceleration	α	radian per second squared	rad/s^2	
1.24	velocity	v	meter per second	m/s	
1.25	speed of propagation of electromagnetic waves	c	meter per second	m/s	In vacuum, c_0; see 8.1.
1.26	acceleration (linear)	a	meter per second squared	m/s^2	
1.27	acceleration of free fall gravitational acceleration	g	meter per second squared	m/s^2	Standard value, g_n; see 8.10.
1.28	damping coefficient	δ	neper per second	Np/s	If F is a function of time given by $F = Ae^{-\delta t} \sin (2 \pi t/T)$, then δ is the damping coefficient.
1.29	logarithmic decrement	Λ	(numeric)		$\Lambda = T\delta$, where T and δ are as given in the equation of 1.28.
1.30	attenuation coefficient	α	neper per meter	Np/m	
1.31	phase coefficient	β	radian per meter	rad/m	
1.32	propagation coefficient	γ	reciprocal meter	m^{-1}	$\gamma = \alpha + j\beta$

*Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid a conflict. See Section 5., Introduction to the Tables.

Table 2—Mechanics

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
2.1	mass	m	kilogram	kg	
2.2	(mass) density	ρ	kilogram per cubic meter	kg/m^3	Mass divided by volume
2.3	momentum	p	kilogram meter per second	kg·m/s	
2.4	moment of inertia	I, J	kilogram meter squared	$kg \cdot m^2$	
2.5	second (axial) moment of area	I, I_a	meter to the fourth power	m^4	Quantities 2.5 and 2.6 should be distinguished from 2.4. They have often been given the name "moment of inertia."
2.6	second (polar) moment of area	J, I_p	meter to the fourth power	m^4	
2.7	force	F	newton	N	
2.8	moment of force	M	newton meter	N·m	
2.9	torque	$T \ldots M$	newton meter	N·m	
2.10	pressure	p	pascal	Pa	$1 \text{ Pa} = 1 \text{ N/m}^2$
2.11	normal stress	σ	pascal	Pa	
2.12	shear stress	τ	pascal	Pa	
2.13	stress tensor	σ	pascal	Pa	
2.14	linear strain	$\in$	(numeric)		
2.15	shear strain	γ	(numeric)		
2.16	strain tensor	$\in$	(numeric)		
2.17	volume strain	θ	(numeric)		
2.18	Poisson's ratio	μ, ν	(numeric)		Lateral contraction divided by elongation
2.19	Young's modulus modulus of elasticity	E	pascal	Pa	$E = \sigma/\in$
2.20	shear modulus modulus of rigidity	G	pascal	Pa	$G = \tau/\gamma$
2.21	bulk modulus	K	pascal	Pa	$K = -p/\theta$
2.22	work	W	joule	J	
2.23	energy	E, W	joule	J	U is recommended in thermodynamics for internal energy and for blackbody radiation.
2.24	energy (volume) density	w	joule per cubic meter	J/m^3	
2.25	power	P	watt	W	Rate of energy transfer W = 1 J/s
2.26	efficiency	η	(numeric)		

*Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid a conflict. See Section 5., Introduction to the Tables.

Table 3—Heat

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
3.1	absolute temperature thermodynamic temperature	$T \ldots \Theta$	kelvin	K	In 1967 the CGPM voted to give the name *kelvin* to the SI unit of temperature, which was formerly called *degree Kelvin*, and to assign it the symbol K (without the symbol °).
3.2	Celsius temperature	$t \ldots \theta$	degree Celsius	°C	The symbol °C is printed without space between ° and the letter that follows. The word *centigrade* has been abandoned as the name of a temperature scale. The units of temperature interval or difference are identical on the Kelvin and Celsius scales.
3.3	heat	Q	joule	J	
3.4	internal energy	U	joule	J	
3.5	heat flow rate	$\Phi \ldots q$	watt	W	Heat crossing a surface divided by time.
3.6	temperature coefficient	α	reciprocal degree Celsius	$°C^{-1}$	A temperature coefficient is not completely defined unless the quantity that changes is specified (for example, resistance, length, pressure). The pressure (temperature) coefficient is designated by β; the cubic expansion (temperature) coefficient, by α, β or γ.
3.7	thermal diffusivity	α	square meter per second	m^2/s	
3.8	thermal conductivity	$\lambda \ldots k$	watt per meter degree Celsius	W/(m · °C)	
3.9	thermal conductance	G_θ	watt per degree Celsius	W/°C	
3.10	thermal resistivity	ρ_θ	meter degree Celsius per watt	m · °C/W	
3.11	thermal resistance	R_θ	degree Celsius per watt	°C/W	
3.12	thermal capacitance heat capacity	C_θ	joule per degree Celsius	J/°C	
3.13	thermal impedance	Z_θ	degree Celsius per watt	°C/W	
3.14	specific heat capacity	c	joule per degree Celsius kilogram	J/(°C·kg)	Heat capacity divided by mass
3.15	entropy	S	joule per kelvin	J/K	
3.16	specific entropy	s	joule per kelvin kilogram	J/(K·kg)	Entropy divided by mass
3.17	enthalpy	H	joule	J	

Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid onflict. See Section 5., Introduction to the Tables.

Table 4—Radiation and Light

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
4.1	radiant intensity	$I \ldots I_e$	watt per steradian	W/sr	
4.2	radiant power radiant flux	$P, \Phi \ldots \Phi_e$	watt	W	
4.3	radiant energy	$W, Q \ldots Q_e$	joule	J	The symbol U is used for the special case of blackbody radiant energy.
4.4	radiance	$L \ldots L_e$	watt per steradian square meter	$W/(sr \cdot m^2)$	
4.5	radiant exitance	$M \ldots M_e$	watt per square meter	W/m^2	
4.6	irradiance	$E \ldots E_e$	watt per square meter	W/m^2	
4.7	luminous intensity	$I \ldots I_v$	candela	cd	
4.8	luminous flux	$\Phi \ldots \Phi_v$	lumen	lm	
4.9	quantity of light	$Q \ldots Q_v$	lumen second	lm·s	
4.10	luminance	$L \ldots L_v$	candela per square meter	cd/m^2	The name *nit* is sometimes used for this unit.
4.11	luminous exitance	$M \ldots M_v$	lumen per square meter	lm/m^2	
4.12	illuminance illumination	$E \ldots E_v$	lux	lx	$1\ lx = 1\ lm/m^2$
4.13	spectral luminous efficacy	$K(\lambda)$	lumen per watt	lm/W	
4.14	total luminous efficacy	K, K_t	lumen per watt	lm/W	$K = \Phi_v/P$
4.15	refractive index index of refraction	n	(numeric)		
4.16	spectral emissivity	$\in(\lambda)$	(numeric)		
4.17	total emissivity	$\in, \in_t$	(numeric)		
4.18	spectral absorptance	$\alpha(\lambda)$	(numeric)		
4.19	spectral transmittance	$\tau(\lambda)$	(numeric)		
4.20	spectral reflectance	$\rho(\lambda)$	(numeric)		

Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid onflict. See Section 5., Introduction to the Tables.

Table 5—Fields and Circuits

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
5.1	electric charge quantity of electricity	Q	coulomb	C	
5.2	linear density of charge	λ	coulomb per meter	C/m	
5.3	surface density of charge	σ	coulomb per square meter	C/m^2	
5.4	volume density of charge	ρ	coulomb per cubic meter	C/m^3	
5.5	electric field strength	$E \ldots K$	volt per meter	V/m	
5.6	electrostatic potential potential difference	$V \ldots \phi$	volt	V	
5.7	retarded scalar potential	V_r	volt	V	
5.8	voltage electromotive force	$V, E \ldots U$	volt	V	
5.9	electric flux	Ψ	coulomb	C	
5.10	electric flux density (electric) displacement	D	coulomb per square meter	C/m^2	
5.11	capacitivity permittivity absolute permittivity	$\in$	farad per meter	F/m	Of vacuum, $\in_\mathrm{v}$
5.12	relative capacitivity relative permittivity dielectric constant	$\in_{\mathrm{r}, \kappa}$	(numeric)		
5.13	complex relative capacitivity	$\in_\mathrm{r}^*, \kappa^*$	(numeric)		$\in_\mathrm{r}^* = \in_\mathrm{r}' - \mathrm{j}\in_\mathrm{r}''$
	complex relative permittivity				$\in_\mathrm{r}''$ is positive for lossy materials.
	complex dielectric constant				The complex absolute permittivity $\in^*$ is defined in analogous fashion.
5.14	electric susceptibility	$\chi_\mathrm{e} \ldots \in_\mathrm{i}$	(numeric)		$\chi_\mathrm{e} = \in_\mathrm{r} - 1$
5.15	electrization	$E_\mathrm{i} \ldots K_\mathrm{i}$	volt per meter	V/m	$E_\mathrm{i} = (D/\Gamma_\mathrm{e}) - E$
5.16	electric polarization	P	coulomb per square meter	C/m^2	$P = D - \Gamma_\mathrm{e} E$
5.17	electric dipole moment	p	coulomb meter	C·m	
5.18	(electric) current	I	ampere	A	
5.19	current density	$J \ldots S$	ampere per square meter	A/m^2	
5.20	linear current density	$A \ldots \alpha$	ampere per meter	A/m	Current divided by the breadth of the conducting sheet
5.21	magnetic field strength	H	ampere per meter	A/m	
5.22	magnetic (scalar) potential magnetic potential difference	U, U_m	ampere	A	
5.23	magnetomotive force	$F, F_\mathrm{m} \ldots \mathscr{F}$	ampere	A	
5.24	magnetic flux	Φ	weber	Wb	

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
5.25	magnetic flux density magnetic induction	B	tesla	T	$T = Wb/m^2$
5.26	magnetic flux linkage	Λ	weber	Wb	
5.27	(magnetic) vector potential	A	weber per meter	Wb/m	
5.28	retarded (magnetic) vector potential	A_r	weber per meter	Wb/m	
5.29	(magnetic) permeability absolute permeability	μ	henry per meter	H/m	Of vacuum, μ_v
5.30	relative(magnetic) permeability	μ_r	(numeric)		
5.31	initial (relative) permeability	μ_o	(numeric)		
5.32	complex relative permeability	μ_r^*	(numeric)		$\mu_r^* = \mu_r' - j\mu_r''$ μ_r'' is positive for lossy materials. The complex absolute permeability μ^* is defined in analogus fashion.
5.33	magnetic susceptibility	$\chi_m \ldots \mu_i$	(numeric)		$\chi_m = \mu_r - 1$
5.34	reluctivity	ν	meter per henry	m/H	$\nu = 1/\mu$
5.35	magnetization	H_i, M	ampere per meter	A/m	$H_i = (B/\Gamma_m) - H$
5.36	magnetic polarization intrinsic magnetic flux density	J, B_i	tesla	T	$J = B - \Gamma_m H$
5.37	magnetic (area) moment	m	ampere meter squared	$A{\cdot}m^2$	The vector product $\boldsymbol{m} \times \boldsymbol{B}$ is equal to the torque.
5.38	capacitance	C	farad	F	
5.39	elastance	S	reciprocal farad	F^{-1}	$S = 1/C$
5.40	(self) inductance	L	henry	H	
5.41	reciprocal inductance	Γ	reciprocal henry	H^{-1}	
5.42	mutual inductance	L_{ij}, M_{ij}	henry	H	If only a single mutual inductance is involved, M may be used without subscripts.
5.43	coupling coefficient	$k \ldots \kappa$	(numeric)		$k = L_{ij}(L_i L_j)^{1/}{}_2$
5.44	leakage coefficient	σ	(numeric)		$\sigma = 1 - k^2$
5.45	number of turns (in a winding)	N, n	(numeric)		
5.46	number of phases	m	(numeric)		
5.47	turns ratio	$n \ldots n_*$	(numeric)		
5.48	transformer ratio	a	(numeric)		Square root of the ratio of secondary to primary self inductance. Where the coefficient of coupling is high, $a \approx n_*$.
5.49	resistance	R	ohm	Ω	

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
5.50	resistivity volume resistivity	ρ	ohm meter	Ω·m	
5.51	conductance	G	siemens	S	$G = \mathrm{Re}\ Y$
5.52	conductivity	γ, σ	siemens per meter	S/m	$\gamma = 1/\rho$ In field theory γ is used for the propagation coefficient necessitating the use of σ for conductivity in this application.
5.53	reluctance	$R, R_m \ldots$	reciprocal henry	H^{-1}	Magnetic potential difference divided by magnetic flux.
5.54	permeance	$P, P_m \ldots$	henry	H	$P_m = 1/R_m$
5.55	impedance	Z	ohm	Ω	$Z = R + jX$
5.56	reactance	X	ohm	Ω	
5.57	capacitive reactance	X_C	ohm	Ω	For a pure capacitance, $X_C = -1/\omega C$
5.58	inductive reactance	X_L	ohm	Ω	For a pure inductance $X_L = \omega L$
5.59	quality factor	Q	(numeric)		$Q = \frac{2\pi\ (\text{peak energy stored})}{(\text{energy dissipated per cycle})}$ For a simple reactor, $Q=\|X\|/R$
5.60	admittance	Y	siemens	S	$Y = 1/Z = G + jB$
5.61	susceptance	B	siemens	S	$B = \mathrm{Im}\ Y$
5.62	loss angle	δ	radian	rad	$\delta = \arctan (R/\|X\|)$
5.63	active power	P	watt	W	
5.64	reactive power	$Q \ldots P_q$	var	var	
5.65	apparent power	$S \ldots P_s$	voltampere	VA	
5.66	power factor	$\cos \phi \ldots F_p$	(numeric)		
5.67	reactive factor	$\sin \phi \ldots F_q$	(numeric)		
5.68	input power	P_i	watt	W	
5.69	output power	P_o	watt	W	
5.70	Poynting vector	S	watt per square meter	W/m^2	
5.71	characteristic impedance surge impedance	Z_o	ohm	Ω	
5.72	intrinsic impedance of a medium	η	ohm	Ω	
5.73	voltage standing-wave ratio	S	(numeric)		

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
5.74	resonance frequency	f_r	hertz	Hz	
5.75	critical frequency cutoff frequency	f_c	hertz	Hz	
5.76	resonance angular frequency	ω_r	radian per second	rad/s	
5.77	critical angular frequency cutoff angular frequency	ω_c	radian per second	rad/s	
5.78	resonance wavelength	λ_r	meter	m	
5.79	critical wavelength cutoff wavelength	λ_c	meter	m	
5.80	wavelength in a guide	λ_g	meter	m	
5.81	hysteresis coefficient	k_h	(numeric)		
5.82	eddy-current coefficient	k_e	(numeric)		
5.83	phase angle phase difference	ϕ, θ	radian	rad	

Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid onflict. See Section 3., Introduction to the Tables.

Table 6—Electronics and Telecommunication

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
6.1	carrier frequency	f_c	hertz	Hz	
6.2	instantaneous frequency	f, f_i	hertz	Hz	
6.3	intermediate frequency	f_i, f_{if}	hertz	Hz	
6.4	modulation frequency	f_m	hertz	Hz	
6.5	pulse repetition frequency	f_p	hertz	Hz	
6.6	frequency deviation	f_d	hertz	Hz	
6.7	Doppler frequency shift	f_D	hertz	Hz	
6.8	pulse duration	t_p	second	s	
6.9	rise time (of a pulse)	t_r	second	s	
6.10	fall time (of a pulse) decay time (of a pulse)	t_f	second	s	
6.11	duty factor pulse duty factor	D	(numeric)		$D = t_p f_p$
6.12	phase propagation time	t_ϕ	second	s	
6.13	group propagation time	t_g	second	s	
6.14	duration of a signal element	τ	second	s	
6.15	signaling speed	$1/\tau$	baud	Bd	
6.16	cathode-heating time	t_k	second	s	
6.17	deionization time	t_d	second	s	
6.18	ionization time	t_i	second	s	
6.19	form factor	k_f	(numeric)		
6.20	peak factor	k_{pk}	(numeric)		
6.21	distortion factor	d	(numeric)		
6.22	modulation factor (AM)	m	(numeric)		
6.23	modulation index (FM)	η	(numeric)		
6.24	signal power	P_s, S	watt	W	
6.25	noise power	P_n, N	watt	W	
6.26	noise-power density	N_0	watt per hertz	W/Hz	
6.27	energy of a signal element	E	joule	J	
6.28	signal-to-noise power ratio†	R, S/N	(numeric)		$R = P_s/P_n$
6.29	elementary signal-to-noise ratio‡	R, R_e	(numeric)		$R_e = E/N_0$
6.30	gain (power)‡	G	(numeric)		
6.31	amplification (current or voltage)‡	A	(numeric)		

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
6.32	noise factor‡ noise figure	F	(numeric)		
6.33	bandwidth	B	hertz	Hz	
6.34	feedback transfer ratio	β	(numeric)		
6.35	critical frequency of an ionized layer	f_c	hertz	Hz	
6.36	plasma frequency	f_n	hertz	Hz	
6.37	ion (number) density	$n^+; n^-$	ion per cubic meter	m^{-3}	
6.38	mobility (of a charge carrier in a medium)	μ	square meter per volt second	$m_2/(V \cdot s)$	
6.39	rate of production of electrons per unit volume	q	electron per cubic meter second	$m^{-3}\ s^{-1}$	
6.40	recombination coefficient	α	cubic meter per second	m^3/s	
6.41	effective attachment coefficient	β	reciprocal second	s^{-1}	
6.42	μ-factor	μ_{ij}	(numeric)		$\mu_{ij} = \lvert\partial \upsilon_i/\partial \upsilon_j\rvert$ where υ_i and υ_j are the voltages of the ith and jth electrodes, and the current to the ith electrode and all electrode voltages other than υ_i and υ_j are held constant.
6.43	amplification factor	μ	(numeric)		The amplification factor is the μ-factor for the anode and control-grid electrodes.
6.44	interelectrode transadmittance	y_{ij}	siemens	S	
6.45	interelectrode transconductance	g_{ij}	siemens	S	The real part of the interelectrode transmittance.
6.46	mutual conductance transconductance	g_m, g_{ag}	siemens	S	The mutual conductance is the control-grid-to-anode conductance.
6.47	conversion transconductance	g_C	siemens	S	Transconductance defined for a heterdodyne conversion transducer.
6.48	plate resistance anode resistance	r_a	ohm	Ω	
6.49	anode dissipation power	P_a	watt	W	
6.50	grid dissipation power	P_g	watt	W	
6.51	saturation current of a cathode	I_s	ampere	A	
6.52	secondary-emission ratio	δ	(numeric)		
6.53	temperature of mercury condensate	T_{Hg}	kelvin	K	
6.54	radiant sensitivity of a photo-tube, dynamic	s	ampere per watt	A/W	

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
6.55	radiant sensitivity of a photo-tube, static	S	ampere per watt	A/W	
6.56	luminous sensitivity of a photo-tube, dynamic	s_v	ampere per lumen	A/lm	
6.57	luminous sensitivity of a photo-tube, static	S_v	ampere per lumen	A/lm	
6.58	Subscripts, Electronic Tubes				
	anode	a			
	cathode	k			
	grid	g			
	heater	h			
	filament (emitting)	f			
	fluorescent screen or target	t			
	external conducting coating	M			
	internal conducting coating	m			
	deflector electrode	*x* or *y*			
	internal shield	s			
	wave-retardation electrode	wr			
	beam-forming plate	bp			
	switch, moving contact	cm			
	switch, fixed contact	cf			
6.59	Subscripts, Semiconductor Devices				
	emitter terminal	E, e			
	base terminal	B, b			
	collector terminal	C, c			
	anode	A, a			
	cathode	K, k			
	control terminal (gate)	G, g			
	drain terminal	D, d			
	junction (general)	J, j			
	source terminal	S, s			

*Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid a conflict. See Section 5., Introduction to the Tables.
†This quantity may be expressed logarithmically in decibels (dB).

Table 7—Machines and Power Engineering

Item	Quantity	Quantity Symbol*	Unit Based on International System	Unit Symbol	Remarks
7.1	synchronous speed (of rotation)	n_1	revolution per second	r/s	
7.2	synchronous angular frequency	ω_1	radian per second	rad/s	
7.3	slip	s	(numeric)		
7.4	number of poles	p, $2p$	(numeric)		The IEC gives p for the number of pairs of poles, although p has been widely used in the US for the number of poles. Where ambiguity may occur, the intended meaning should be indicated.
7.5	pole strength	p … m	weber	Wb	

*Commas separate symbols on equal standing. Where two symbols are separated by three dots the second is a reserve symbol and is to be used only when there is specific need to avoid a conflict. See Section 3., Introduction to the Tables.

Table 8—Symbols for Physical Constants

Item	Name of Constant	Symbol	Value	Remarks
8.1	speed of propagation of electro-magnetic waves in vacuum	c_o	$2.997\,924\,58\ (1.2) \cdot 10^8$ m/s	NOTE (1)
8.2	magnetic constant	Γ_m	$4\pi \cdot 10^{-7}$ H/m	
8.3	electric constant	Γ_e	$8.854\,187\,8\ (1) \cdot 10^{-12}$ F/m	$\Gamma_e = 1/\Gamma_m {c_o}^2$
8.4	elementary charge electronic charge	e	$1.602\,189\,2\ (46) \cdot 10^{-19}$ C	NOTE (1)
8.5	Avogadro constant	N_A	$6.022\,045\ (31) \cdot 10^{23}$ mol^{-1}	NOTE (1)
8.6	Faraday constant	F	$9.648\,456\ (27) \cdot 10^4$ C/mol	NOTE (1)
8.7	Planck constant	h	$6.626\,176\ (36) \cdot 10^{-34}$ J · s	NOTE (1)
		$\hbar$	$1.054\,588\,7\ (57) \cdot 10^{-34}$ J · s	$\hbar = h/2\pi$
8.8	Boltzmann constant	k	$1.380\,662\ (44) \cdot 10^{-23}$ J/K	NOTE (1)
8.9	gravitational constant	G	$6.670\,0\ (41) \cdot 10^{-11}$ N · m^2/kg^2	NOTE (1)
8.10	standard acceleration of free fall	g_n	$9.806\,65$ m/s^2	Defined by the (CGPM) in 1901.

NOTES:
1 — These values are taken from the National Bureau of Standards Dimensions/NBS of January 1974. The numbers in parentheses are the one-standard-deviation uncertainties in the last digits of the quoted value.
2 — Symbols for physical quantities are set in italic type. See Section 3., General Principles of Letter Symbol Standardization.

Table 9—Selected Mathematical Symbols

Item	Name	Symbol	Remarks
9.1	ordinary differential sign	d	
9.2	partial differential sign	∂	
9.3	sign of variation	δ	
9.4	increment sign sign of difference calculus	Δ	
9.5	vector differential operator	∇	
9.6	d'Alembertian operator	❑	
9.7	base of natural logarithms	e, ∈	
9.8	imaginary unit 90° rotative operator	i, j	$i^2 = -1$
9.9	120° rotative operator	a	$a = e^{j2\pi/3}$
9.10	cartesian coordinates	x, y, z	
9.11	unit vector, *x*-axis	**i**	
9.12	unit vector, *y*-axis	**j**	
9.13	unit vector, *z*-axis	**k**	
9.14	cylindrical coordinates	ρ, ϕ, z	$(ds)^2 = (d\rho)^2 + (\rho d\phi)^2 + (dz)^2$
9.15	spherical coordinates	r, θ, ϕ	$(ds)^2 = (dr)^2 + (r \sin \theta d\phi)^2 + (r d\theta)^2$
9.16	real part of	Re	
9.17	imaginary part of	Im	
9.18	natural logarithm of	$\ln, \log_e$	
9.19	common logarithm of	$\log, \log_{10}$	

NOTE — Symbols for mathematical constants and operators are set in roman (upright) type. See Section 3., General Principles of Letter Symbol Standardization.

Table 10—Symbols Listed in Alphabetical Order

Symbol	Item*	Quantity
a	9.9	120° rotative operator
a	1.26	acceleration (linear)
	5.48	transformer ratio
A	1.13	area
	5.20	linear current density
	5.27	(magnetic) vector potential
	6.31	amplification (current or voltage)
A_r	5.28	retarded magnetic vector potential
b	1.4	breadth, width
B	5.25	magnetic flux density magnetic induction
	5.61	susceptance
	6.33	bandwidth
B_i	5.36	magnetic polarization intrinsic magnetic flux density
c	1.25	speed of propagation of electromagnetic waves
	3.14	specific heat capacity
c_o	8.1	speed of propagation of electromagnetic waves in vacuum
C	5.38	capacitance
C_θ	3.12	thermal capacitance heat capacity
d	9.1	ordinary differential sign
d	1.6	thickness
	1.8	diameter
	6.21	distortion factor
D	5.10	electric flux density (electric displacement)
	6.11	duty factor pulse duty factor
e	9.7	base of natural logarithms
e	8.4	elementary charge electronic charge
E	2.19	Young's modulus modulus of elasticity
	2.23	energy
	4.6	irradiance

Symbol	Item*	Quantity
	4.12	illuminance illumination
	5.5	electric field strength
	5.8	voltage
	6.27	energy of a signal element
E_e	4.6	irradiance
E_i	5.15	electrization
E_v	4.12	illuminance illumination
f	1.18	frequency
	6.2	instantaneous frequency
f_c	5.75	critical frequency cutoff frequency
	6.1	carrier frequency
	6.35	critical frequency of an ionized layer
f_d	6.6	frequency deviation
f_D	6.7	Doppler frequency shift
f_i	6.2	instantaneous frequency
	6.3	intermediate frequency
f_{if}	6.3	intermediate frequency
f_m	6.4	modulation frequency
f_n	6.36	plasma frequency
f_p	6.5	pulse repetition frequency
f_r	5.74	resonance frequency
F	2.7	force
	5.23	magnetomotive force
	6.32	noise factor noise figure
	8.6	Faraday constant
F_m	5.23	magnetomotive force
F_p	5.66	power factor
F_q	5.67	reactive factor
$\mathcal{F}$	5.23	magnetomotive force
g	1.27	acceleration of free fall gravitational acceleration
g_{ag}	6.46	mutual conductance transconductance

Symbol	Item*	Quantity
g_C	6.47	conversation transconductance
g_{ij}	6.45	interelectrode transconductance
g_m	6.46	mutual conductance
g_n	8.10	standard acceleration of free fall
G	2.20	shear modulus
	5.51	conductance
	6.30	gain (power)
	8.9	gravitational constant
G_θ	3.9	thermal conductance
h	1.5	height
	8.7	Planck constant
	8.7	Planck constant
H	3.17	enthalpy
	5.21	magnetic field strength
H_i	5.35	magnetization
i	9.8	imaginary unit
i	9.11	unit vector, x-axis
I	2.4	moment of inertia
	2.5	second (axial) moment of area
	4.1	radiant intensity
	4.7	luminous intensity
	5.18	(electric) current
I_a	2.5	second (axial) moment of area
I_e	4.1	radiant intensity
I_p	2.6	second (polar) moment of area
I_s	6.51	saturation current of a cathode
I_v	4.7	luminous intensity
Im	9.17	imaginary part of
j	9.8	imaginary unit
j	9.12	unit-vector, y-axis
J	2.4	moment of inertia
	2.6	second (polar) moment of area
	5.19	current density
	5.36	magnetic polarization
k	1.12	circular wave number

Symbol	Item*	Quantity
	3.8	thermal conductivity
	5.43	coupling coefficient
	8.8	Boltzmann constant
k_e	5.82	eddy-current coefficient
k_f	6.19	form factor
k_h	5.81	hysteresis coefficient
k_{pk}	6.20	peak factor
k	9.13	unit vector, *z*-axis
K	2.21	bulk modulus
	4.13	luminous efficacy
	4.14	total luminous efficacy
	5.5	electric field strength
K_i	5.15	electrization
K_t	4.14	total luminous efficacy
l	1.3	length
ln	9.18	natural logarithm of
log	9.19	common logarithm of
$\log_e$	9.18	natural logarithm of
$\log_{10}$	9.19	common logarithm of
L	4.4	radiance
	4.10	luminance
	5.40	(self) inductance
L_e	4.4	radiance
L_{ij}	5.42	mutual inductance
L_v	4.10	luminance
m	2.1	mass
	5.37	magnetic (area) moment
	5.46	number of phases
	6.22	modulation factor (AM)
	7.5	pole strength
M	2.8	moment of force
	2.9	torque
	4.5	radiant exitance
	4.11	luminous exitance
	5.35	magnetization

Symbol	Item*	Quantity
M_e	4.5	radiant exitance
M_{ij}	5.42	mutual inductance
M_v	4.11	luminous exitance
n	1.19	speed of rotation
	4.15	refractive index
	5.45	number of turns (in a winding)
	5.47	turns ratio
n^+	6.37	ion (number) density
n^-	6.37	ion (number) density
n_1	7.1	synchronous speed (of rotation)
n_*	5.47	turns ratio
N	5.45	number of turns (in a winding)
	6.25	noise power
N_A	8.5	Avogadro constant
N_o	6.26	noise-power density
p	1.22	complex (angular) frequency
	2.3	momentum
	2.10	pressure
	5.17	electric dipole moment
	7.4	number of poles
	7.5	pole strength
P	2.25	power
	4.2	radiant power
	5.16	electric polarization
	5.54	permeance
	5.63	active power
P_a	6.49	anode dissipation power
P_g	6.50	grid dissipation power
P_i	5.68	input power
P_m	5.54	permeance
P_n	6.25	noise power
P_o	5.69	output power
P_q	5.64	reactive power
P_s	5.65	apparent power
	6.24	signal power

Symbol	Item*	Quantity
$\mathcal{P}$	5.54	permeance
q	3.5	heat flow rate
	6.39	rate of production of electrons per unit volume
Q	3.3	heat
	4.3	radiant energy
	4.9	quantity of light
	5.1	electric charge
	5.59	quality factor
	5.64	reactive power
Q_e	4.3	radiant energy
Q_v	4.9	quantity of light
r	1.7	radius
	9.15	spherical coordinate
r_a	6.48	plate resistance
R	5.49	resistance
	5.53	reluctance
	6.28	signal-to-noise power ratio
	6.29	elementary signal-to-noise ratio
R_e	6.29	elementary signal-to- noise ratio
R_m	5.53	reluctance
R_θ	3.11	thermal resistance
$\mathcal{R}$	5.53	reluctance
Re	9.16	real part of
s	1.9	length of path
	1.22	complex (angular) frequency
s	3.16	specific entropy
	6.54	radiant sensitivity of a phototube, dynamic
	7.3	slip
s_v	6.56	luminous sensitivity of a phototube, dynamic
S	1.13	area
	3.15	entropy
	5.19	current density
	5.39	elastance
	5.65	apparent power
	5.70	Poynting vector

Symbol	Item*	Quantity
	5.73	voltage standing-wave ratio
	6.24	signal power
	6.55	radiant sensitivity of a phototube, static
S_v	6.57	luminous sensitivity of a phototube, static
t	1.15	time
	3.2	Celcius temperature
t_d	6.17	deionization time
t_f	6.10	fall time (of a pulse) (decay time (of a pulse)
t_g	6.13	group propagation time
t_i	6.18	ionization time
t_k	6.16	cathode-heating time
t_p	6.8	pulse duration
t_r	6.9	rise time (of a pulse)
t_ϕ	6.12	phase propagation time
T	1.16	period time of one cycle
	1.17	time constant
	2.9	torque
	3.1	absolute temperature thermodynamic temperature
T_{Hg}	6.53	temperature of mercury condensate
U	3.4	internal energy
	5.8	voltage electromotive force
	5.22	magnetic (scalar) potential magnetic potential difference
U_m	5.22	magnetic (scalar) potential magnetic potential difference
v	1.14	volume
	1.24	velocity
V	1.14	volume
	5.6	electrostatic potential potential difference
	5.8	voltage electromotive force
V_r	5.7	retarded scalar potential
w	2.24	energy (volume) density

Symbol	Item*	Quantity
W	2.22	work
	2.23	energy
	4.3	radiant energy
x	9.10	Cartesian coordinate
X	5.56	reactance
X_{C}	5.57	capacitive reactance
X_L	5.58	inductive reactance
y	9.10	Cartesian coordinate
y_{ij}	6.44	interelectrode transadmittance
Y	5.60	admittance
z	9.10	Cartesian coordinate
	9.14	cylindrical coordinate
Z	5.55	impedance
Z_{o}	5.71	characteristic impedance surge impedance
Z_{θ}	3.13	thermal impedance
α	1.1	angle, plane
	1.23	angular accelaration
	1.30	attenuation coefficient
	3.6	temperature coefficient
	3.7	thermal diffusivity
	4.18	spectral absorptance
	5.20	linear current density
	6.40	recombination coefficient
β	1.1	angle, plane
	1.31	phase coefficient
	6.34	feedback transfer ratio
	6.41	effective attachment coefficient
γ	1.1	angle, plane
	1.32	propagation coefficient
	2.15	shear strain
	5.52	conductivity
Γ	5.41	reciprocal inductance
Γ_{e}	8.3	electric constant
Γ_m	8.2	magnetic constant

Symbol	Item*	Quantity
δ	1.6	thickness
	1.28	damping coefficient
	5.61	loss angle
	6.51	secondary-emission ratio
	9.3	sign of variation
∂	9.2	partial differential sign
Δ	9.4	increment sign sign of difference calculus
$\in$	2.14	linear strain
	4.16	spectral emissivity
	4.17	total emissivity
	5.11	capacitivity permittivity absolute permittivity
	9.7	base of natural logarithms
$\in$	2.16	strain tensor
$\in_i$	5.14	electric susceptibility
$\in_r$	5.12	relative capacitivity relative permittivity dielectric constant
$\in_r^*$	5.13	complex relative capacitivity complex relative permittivity complex dielectric constant
$\in_t$	4.17	total emissivity
$\in_\upsilon$	5.11	capacitivity permittivity absolute permittivity
η	2.26	efficiency
	5.72	intrinsic impedance of a medium
	6.23	modulation index (FM)
θ	1.1	angle, plane
	2.17	volume strain
	3.2	Celcius temperature
	5.83	phase angle phase difference
	9.15	spherical coordinate
Θ	3.1	absolute temperature thermodynamic temperature

Symbol	Item*	Quantity
κ	5.12	relative capacitivity relative permittivity dielectric constant
	5.43	coupling coefficient
κ^*	5.13	complex relative capacitivity complex relative permittivity complex dielectric constant
λ	1.10	wavelength
	3.8	thermal conductivity
	5.2	linear density of charge
λ_c	5.79	critical wavelength cutoff wavelength
λ_g	5.80	wavelength in a guide
λ_r	5.78	resonance wavelength
Λ	1.29	logarithmic decrement
	5.26	magnetic flux linkage
μ	2.18	Poisson's ratio
	5.29	(magnetic) permeability absolute permeability
	6.38	mobility (of a charge carrier in a medium)
	6.43	amplification factor
μ_i	5.33	magnetic susceptibility
μ_{ij}	6.42	μ-factor
μ_o	5.31	initial (relative) permeability
μ_r	5.30	relative (magnetic) permeability
μ_r^*	5.32	complex relative permeability
μ_v	5.29	(magnetic) permeability absolute permeability
ν	1.18	frequency
	2.18	Poisson's ratio
	5.34	reluctivity
	1.11	wave number
ρ	2.2	(mass) density
	4.20	spectral reflectance
	5.4	volume density of charge
	5.50	resistivity volume resistivity

Symbol	Item[*]	Quantity
	9.14	cylindrical coordinate
ρ_θ	3.10	thermal resistivity
σ	1.11	wave number
	2.11	normal stress
	5.3	surface density of charge
σ	5.44	leakage coefficient
	5.52	conductivity
σ	2.13	stress tensor
τ	1.17	time constant
	2.12	shear stress
	4.19	spectral transmittance
	6.14	duration of a signal element
$1/\tau$	6.15	signaling speed
ϕ	1.1	angle, plane
	5.6	electrostatic potential potential difference
ϕ	5.83	phase angle phase difference
	9.14	cylindrical coordinate
	9.15	spherical coordinate
Φ	3.5	heat flow rate
	4.2	radiant power radiant flux
	4.8	luminous flux
	5.24	magnetic flux
Φ_e	4.2	radiant power radiant flux
Φ_v	4.8	luminous flux
χ_e	5.14	electric susceptibility
χ_m	5.33	magnetic susceptibility
ψ	1.1	angle, plane

Symbol	Item*	Quantity
Ψ	5.9	electric flux
ω	5.9	angle, solid
	1.20	angular frequency
	1.21	angular velocity
ω_c	5.77	critical angular frequency
ω_1	7.2	synchronous angular frequency
ω_r	5.76	resonance angular frequency
Ω	1.2	angle, solid
∇	9.5	vector differential operator
❑	9.6	d'Alembertian operator

*Numbers refer to items in Tables 1 through 9.