An American National Standard

IEEE Recommended Practice for Preferred Metric Units for Use in Electrical and Electronics Science and Technology

Sponsor
IEEE Standards Coordinating Committee 14 on Quantities and Units

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An American National Standard

IEEE Recommended Practice for Preferred Metric Units for Use in Electrical and Electronics Science and Technology

1. Purpose

The purpose of this recommended practice is to aid in the selection of metric units so as to promote uniformity in the use of metric units and to limit the number of different metric units that will be used in electrical and electronics science and technology. ANSI/IEEE Std 268-1982, American National Standard Metric Practice, prescribes how metric units are to be used and gives guidance concerning correct metric practice.

Table 1—Multiples and Submultiples of SI Units

Multiplying Factor	Prefix	Letter Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto*	h
10 = 10^{1}	deka*	da
0.1 = 10^{-1}	deci*	d
0.01 = 10^{-2}	centi*	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

*To be avoided where practical. See ANSI/IEEE Std 268-1982 .

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2. Space and Time

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
2.1	plane angle	rad (radian)			Engineering and scientific calculations
				° (degree)	Measurement of angles in surveys, plans, electrical calculations
					(Use of decimal divisions of degrees instead of minutes and seconds is encouraged)
2.2	solid angle	sr (steradian)			Engineering and scientific calculations
2.3	length (width, height, thickness, radius, diameter, depth)	m (meter)	km (kilometer) cm (centimeter mm (millimeter) µm (micrometer) nm (nanometer)		When coverting to SI, the meter generally replaces the yard and foot, the kilometer replaces the mile, the centimeter replaces the inch, and smaller submultiples replace the fractions of an inch. The hectometer, dekameter, and decimeter are used only rarely and are not recommended for general use. In many engineering applications the centimeter is avoided for fear of confusion or of proliferation of different unit multiples. Thus, all dimensions on mechanical engineering drawings are expressed in millimeters; dimensions for construction projects are expressed in meters or millimeters, but not in centimeters.
2.4	area	m^2(square meter)			Area of floors, walls, and small property size
				ha (hectare)	Surveying and land measurement
			km^2 (square kilometer)		Drainage area, watershed, or lake area
			cm^2 (square centimeter)		
			mm^2 (square millimeter)		Cross sectional area of conductors
2.5	volume	m^3 (cubic meter)			All volumes The expression of 10^6 m^3 should be used for volumes of reservoirs
			dm^3 (cubic decimeter)	L (liter)	1 dm^3 = 1 L 1 mL = 1 cm^3
			cm^3 (cubic centimeter)	mL (milliliter)	NOTE: Use of the liter is restricted to volumetric capacity, dry measure, and measure of fluids (both liquid and gases).
			mm^3 (cubic millimeter)	µL (microliter)	

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
2.6	time	s (second)			Preferred unit for all time derivative functions for engineering and scientific measurements and calculations.
			ms (millisecond)		Geophysical measurements, electrical device operating time
			μs (microsecond)		Ultrasonic testing, electrical transients
			ns (nanosecond) ps (picosecond)		Computer and communications technology
				a (year)	Statistics, planning
				month week	Work time, statistics
				d (day) h (hour) min (minute)	Work time, statistics
					NOTE: In engineering measurements and calculations, these non-SI units should be used in time derivative functions only when "second" related quantities become impractical.
2.7	angular velocity	rad/s (radian per second)			Engineering calculations
					NOTE: See also 3.3, rotational frequency
2.8	velocity	m/s (meter per second)			Conveyor speed, wind and water speed, ventilation, hoist speed, crane travel speed, elevator speed, and engineering calculations
			cm/s (centimeter per second)		Tape speeds and recorders
			mm/s (millimeter per second)		Wire feed for welding, chart speeds
				mm/a (millimeter per year)	Wear rates of motor brushes, bearings, etc
				mm/d (millimeter per day)	Chart speeds
				km/h (kilometer per hour)	Vehicle speed, wind speed (meteorological)
2.9	acceleration	m/s^2 (meter per second squared)	mm/s^2 (millimeter per second squared		Mechanical vibrations, engineering calculations
			$\mu m/s^2$ (micrometer per second squared)		
2.10	angular acceleration	rad/s^2 (radian per second squared			Engineering calculations, design, and analysis of machines
					NOTE: See also 3.5, rotational acceleration

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3. Periodic and Related Phenomena

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
3.1	period (See also item 8.1)	s (second)	ms (millisecond)		NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
3.2	frequency (See also item 8.2)	Hz (hertz)	GHz (gigahertz) MHz (megahertz) kHz (kilohertz)		NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
3.3	rotational frequency	s^{-1} (1 per second)		r/s (revolution per second) r/min (revolution per minute)	Not favored Preferred for rotating machine speeds; electrical, hydraulic, or pneumatic tools; automatic control instruments.
3.4	wavelength	m (meter)	cm (centimeter) mm (millimeter) nm (nanometer)		NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice. See also 7.1 and 8.3
3.5	rotational acceleration			r/s^2 (revolution per second squared)	Rotating machinery

4. Mechanics

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.1	mass	kg (kilogram)			Equipment and materials, transport and handling, construction elevator loads
			Mg (megagram)	t (metric ton)	Mass of coal and other bulk materials NOTE: The name *metric ton* may be used as an alternative to *megagram*
			g (gram) mg (milligram)		Mass of small items
4.2	linear density (mass per unit length)	kg/m (kilogram per meter)	g/m (gram per meter) mg/m (milligram per meter)		Mass load on conveyor belt or on a beam Conductor mass per unit length
4.3	area density (mass per unit area)	kg/m^2 (kilogram per square meter)			Mass loads on floor
			g/m^2 (gram per square meter)		Metallic coatings, plating

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.4	density (mass per unit volume)	kg/m^3 (kilogram per cubic meter)			Mass density of gases, solids or liquids
4.4.1	mass concentration (mass per unit volume)		mg/m^3 (milligram per cubic meter)		Air pollution data
				g/L (gram per liter)	Mass concentrations in liquids
4.4.2	mass per unit energy	kg/J (kilogram per joule)	g/GJ (gram per gigajoule)		Contaminent production related to fuel burning process
4.4.3	relative density	1 (one)			NOTE: The terms *specific weight* and *specific gravity* should be replaced by the term *relative density*. Mercury has a relative density of 13.6, meaning that it is 13.6 times as dense as water. Water is implied as the reference substance unless indicated otherwise. Relative density is a ratio and has no units; it is always just a number.
4.5	momentum	kg·m/s (kilogram meter per second)			
4.6	moment of momentum	$kg·m^2/s$ (kilogram meter squared per second)			
4.7	moment of inertia (See also item 4.13)	$kg·m^2$ (kilogram meter squared)			
4.8	force	N (newton)			
			MN (meganewton)		Reactions on structures
			kN (kilonewton)		Forces in columns, conductor tension, loading on insulators, braces, and struts
			mN (millinewton) μN (micronewton)		Forces of small magnitude
4.8.1	force per unit length	N/m (newton per meter)			Wind loading on conductors
4.9	moment of force, torque	N·m (newton meter)			Engineering calculations, bolt tightening torque, motor torque
			MN·m (meganewton meter)		Bending moments on structures
			kN·m (kilonewton meter)		Bending moments on structures
					NOTE: This unit can result in confusion with the unit for work or energy (see 4.20) which is also newton meter but which in the later case is called the joule. It is important to recognize the difference between torque and energy; the joule should never be used to express torque.

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.10	pressure	Pa (pascal)			Both gauge pressure and absolute pressure are properly expressed in pascals, using SI prefixes as appropriate.
			kPa (kilopascal)		The kilopascal (kPa) is the unit recommended for fluid pressure for almost all fields of use, such as barometric pressure, tire pressure, water pressure, and steam pressure. A notable exception is in air conditioning, where pressure differentials in air ducts are more conveniently measured in pascals (Pa).
4.11	stress	Pa (pascal)			
			MPa(megapascal)		Compressive, tensile, and shear stresses on structures
			N/mm^2 (newton per square millimeter)		1 N/mm^2 = 1 MPa
			kPa (kilopascal)		Static and dynamic stresses in low-strength materials (wood). Dynamic stresses on stator bar packing
4.12	modulus of elasticity	Pa (pascal)			
			MPa (megapascal)		Elastic moduli of structural materials
4.13	second moment of area	m^4 (meter to the fourth power)	cm^4 (centimeter to the fourth power) mm^4 (millimeter to the fourth power)		Properties of structural shapes
4.14	section modulus	m^3 (meter cubed)	cm^3 (centimeter cubed) mm^3 (millimeter cubed)		Properties of structural shapes
4.15	viscosity (dynamic)	Pa·s (pascal second)			NOTE: Use of the centipoise is to be avoided.
			mPa·s (millipascal second)		Hydraulic model studies lubrication 1 mPa·s = 1 cP (centipoise)
4.16	kinematic viscosity	m^2/s (meter squared per second)			NOTE: Use of the centistokes is to be avoided
			mm^2/s (millimeter squared per second)		Hydraulic model studies, lubrication, viscosity of oils and other liquids 1 mm^2/s = 1 cSt (centi-stokes)
4.17	surface tension	N/m (newton per meter)			

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.18	(volume) flow rate	m^3/s cubic meter per second)			River flow rate, pump and pipeline capacity
			dm^3/s (cubic decimeter per second	L/s (liter per second)	Liquid and gas flow rates up to 1000 L/s
			cm^3/s (cubic centimeter per second)	mL/s (milliliter per second)	Pneumatic control and instrument usage, control fluid leakage, oil flow rate in cables
			mm^3/s (cubic millimeter per second	µL/s (microliter per second)	Very low gas leakage rates
					NOTE: Volume flow rate will be used for measure- ments for air flow in ventila- tion and air-conditioning systems and for calculations for the sizing of piping and ducts for all types of liquid and gas flow.
4.19	mass flow rate	kg/s (kilogram per second)	g/s (gram per second)	kg/h (kilogram per hour)	Boiler steam, feed water and associated systems, coal and aggregate handling design and instrumentation.
					NOTE: Mass flow rate will be used for the instrumentation of all liquid flow in nuclear and heavy water in- stallations and for the calculation and instrumentation of flows in such systems as heat transport, boiler feed- water, and steam systems, where changes in pressure and temperature result in substantial changes in volume for a given mass flow rate.
4.20	energy, work (for electric energy, see 6.35)	J (joule)			All mechanical, thermal, and electrical calculations involving energy; studies of energy economics. A very wide range of energy values is encountered in practical applications and SI multiples from picojoule (pJ) to terajoule (TJ) are in common use.
			MJ (megajoule)		Heating, refrigeration, and air conditioning. Thermal energy of process steam. Energy of heating fuels.
4.21	power	W (watt)			All mechanical, thermal, and electrical calculations involving power or energy flow. A very wide range of power values is encountered in practical applications, and SI multiples from picowatt (pW) to gigawatt (GW) are in common use.
4.22	fracture toughness	$Pa{\cdot}m^{1/2}$ (pascal square root meter)			
			$MPa{\cdot}m^{1/2}$ (megapascal square root meter)		Thick section plates, turbine blades, forgings, and pipings

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5. Heat

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
5.1	thermodynamic temperature	K (kelvin)			Thermodynamic calculations, radiative heat transfer measurements, noise temperature in radio receivers. NOTE: The name *degree kelvin* and symbol °K are no longer used.
5.2	Celsius temperature	°C (degree Celsius)			
5.3	temperature interval	K (kelvin) °C (degree Celsius)			
5.4	linear expansion coefficient	K^{-1} (1 per kelvin) $°C^{-1}$ (1 per degree Celsius)			
5.5	heat, quantity of heat	J (joule)	GJ (gigajoule) MJ (megajoule) kJ (kilojoule) μJ (microjoule)		Heat loss calculations, heating, refrigeration, air conditioning Microelectronics
5.6	heat flow rate	W (watt)		MW (megawatt) kW (kilowatt)	Thermodynamic calculations, heating and air conditioning Heat flow calculations
5.6.1	density of heat flow-rate	W/m^2 (watt per square meter)			Heat flow calculations
5.7	radiant intensity	W/sr (watt per steradian)			
5.8	thermal conductivity	W/(m·K) (watt per meter kelvin) W/(m·°C) (watt per meter degree Celsius)			
5.9	thermal insulance	m^2·K/W (square meter kelvin per watt) m^2·°C/W (square meter degree Celsius per watt)			NOTE: Thermal insulance is temperature difference divided by density of heat flow rate.

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
5.10	thermal resistance	K/W (kelvin per watt) °C/W (degree Celsius per watt)			NOTE: Thermal resistance is the temperature difference divided by heat flow rate.
5.11	coefficient of heat transfer	$W/(m^2 \cdot K)$ (watt per square meter kelvin) $W/(mg^2 \cdot °C)$ (watt per square meter degree Celsius)			NOTE: Coefficient of heat transfer is the density of heat flow rate divided by temperature difference.
5.12	heat capacity	J/K (joule per kelvin)	kJ/K (kilojoule per kelvin) kJ/°C (kilojoule per degree Celsius)		
5.13	specific heat capacity	J/(kg·K) (joule per kilogram kelvin)	kJ/(kg·K) (kilojoule per kilogram kelvin) kJ/(kg·°C) (kilojoule per kilogram degree Celsius)		
5.14	entropy	J/K (joule per kelvin)	kJ/K (kilojoule per kelvin)		

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6. Electricity and Magnetism

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.1	electric current	A (ampere)			NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.2	electric charge, quantity of electricity	C (coulomb)			NOTE: Many unit multiples are of electricity used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.3	volume density of charge, charge density	C/m^3 (coulomb per cubic meter)			
6.4	surface density of charge	C/m^2 (coulomb per square meter)			
6.5	electric field strength	V/m (volt per meter)			Antenna field patterns, gradient of electric fields
		N/C (newton per coulomb)	MV/m (megavolt per meter)		Preferred unit for electrical stress in gas, liquid, and solid media
					NOTE: The values of MV/m and kV/mm are numerically equal. Both will be used for convenience.
			kV/mm (kilovolt per millimeter)		Preferred unit for dielectric stress in insulation
			μV/m (microvolt per meter)		Radio noise measurements
					NOTE: Predicted and actual effective field strength (particularly in am broadcasting) is to be expressed as millivolts per meter at one kilometer.
6.6	electrical potential, voltage	V (volt)			NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.7	electric flux density, displacement	C/m^2 (coulomb per square meter)			
6.8	electric flux	C (coulomb)			
6.9	capacitance	F (farad)	μF (microfarad) pF (picofarad)		
6.10	permittivity	F/m (farad per meter)			
6.11	electric polarization	C/m^2 (coulomb per square meter)			
6.12	electric dipole moment	C·m (coulomb meter)			

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.13	current density	A/m^2 (ampere per square meter)	MA/m^2 (megaampere per square meter) A/cm^2 (ampere per square centimeter) A/mm^2 (ampere per square millimeter)		Current density in semiconductors Current density in counductors NOTE: The values of MA/m^2 (megaampere per square meter) and A/mm^2 (ampere per square millimeter) are both numerically equal. Both will be used for convenience.
6.14	linear current density	A/m (ampere per meter)			
6.15	magnetic field strength	A/m (ampere per meter)			Calculation of transformer and reactor characteristics NOTE: Interpret as ampere turns per meter
6.16	magnetomotive force	A (ampere)			NOTE: Often called ampere turns
6.17	magnetic flux density, magnetic induction	T (tesla)	mT (millitesla) μT (microtesla)		
6.18	magnetic flux	Wb (weber)			
6.19	magnetic vector potential	Wb/m (weber per meter)			
6.20	self-inductance, mutual inductance	H (henry)	mH (millihenry) μH (microhenry)		
6.21	permeability	H/m (henry per meter)	mH/m (millihenry per meter)		Self inductance calculations (iron core) Self inductance calculations (air core)
6.22	electromagnetic moment, magnetic moment	$A \cdot m^2$ (ampere meter squared)			
6.23	magnetization	A/m (ampere per meter)			Magnetic circuit calculations
6.24	magnetic polarization	T (tesla)			Magnetic circuit calculations
6.25	magnetic dipole moment	$N \cdot m^2/A$ (newton meter squared per ampere) Wb·m (weber meter)			

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.26	resistance	Ω (ohm)			NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.27	conductance	S (siemens)			Liquids
			MS (megasiemens)		Conductors
			μs (microsiemens)		Insulators
6.28	resistivity	Ω·m (ohm meter)			
			GΩ·m (gigaohm meter)		
			mΩ·m (milliohm meter)		
6.29	conductivity	S/m (siemens per meter)			Conductivity of aqueous solutions and natural water
			MS/m (megasiemens per meter)		Conductivity of metals
			mS/m (millisiemens per meter)		Conductivity of aqueous solutions and natural water
			μS/m (microsiemens per meter)		Demineralized water
6.30	reluctance	H^{-1} (1 per henry)			Magnetic circuit design
6.31	permeance	H (henry)			Magnetic circuit design
6.32	impedance	Ω (ohm)			NOTE: Many unit multiple are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.33	admittance	S (siemens)			Electric circuits and components
			mS (millisiemens)		Electric circuits and components
			μs(microsiemens)		Electric circuits and components
6.34	power				
6.34.1	active power	W(watt)			Appliance rating, dissipation in electronic components
					Power system capability
					Station, machine, line rating
					Appliance rating
					Dissipation in electronic components
					Telecommunications and microelectronics
					NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.34.2	apparent power	VA (voltampere)	MVA (megavoltampere)		Apparent power in substations, generating stations, and ac generators
			kVA (kilovoltampere)		Apparent power in systems, plants, electrical apparatus, and transformer rating
6.34.3	reactive power	var (var)			
			Mvar (megavar)		Reactive power in substations, generating stations, and generators
			kvar (kilovar)		Reactive power in systems, plants, and electrical apparatus
6.35	electric energy	J (joule)			Energy calculations
			GJ (gigajoule)		Energy calculations
			MJ (megajoule)		Energy calculations
			kJ (kilojoule)		Energy calculations
				MWh (megawatthour)	Electrical energy production and consumption
				kWh (kilowatthour)	Electrical energy consumption
6.36	resistance per unit length	Ω/m (ohm per meter)			Soil resistance
			mΩ/m (milliohm per meter) Ω/km (ohm per kilometer)		Resistance of transmission conductors and control cable
					NOTE: The values of mΩ/m and Ω/km are numerically equal. Both will be used for convenience.

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7. Light and Related Electromagnetic Radiations

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
7.1	wavelength	m (meter)			Radio waves, antenna design
			cm (centimeter)		Microwave systems
			μm (micrometer)		Infrared spectroscopy
			nm (nanometer)		Light wavelengths, fiber optics
					See also 3.4 and 8.3.
7.2	radiant energy	J (joule)			Antenna and pulse laser technology
7.3	radiant flux, radiant power	W (watt)			Antenna and continuous wave laser technology
			mW (milliwatt)		Antenna and continuous wave laser technology
7.4	radiant intensity	W/sr (watt per steradian)			
7.5	irradiance	W/m^2 (watt per square meter)			
			kW/m^2 (kilowatt per square meter)		Calculation of solar radiation effect on conductors, water bodies, etc
7.6	luminous intensity	cd (candela)			Lighting calculations
		mcd (millicandela)			Electronic displays, fiber optics, and photodiodes
7.7	luminous flux	lm (lumen)			Lighting calculations
7.8	quantity of light	lm·s (lumen second)			Lighting calculations
7.9	luminance	cd/m^2 (candela per square meter)			Lighting calculations
7.10	luminous exitance	lm/m^2 (lumen per square meter)			Lighting calculations
7.11	illuminance	lx (lux)			Lighting calculations
7.12	light exposure	lx·s (lux second)			Lighting calculations, photography
7.13	luminous efficacy	lm/W (lumen per watt)			Lighting calculations
7.14	attenuation			dB/km (decibel per kilometer)	Fiber optics

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8. Acoustics

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
8.1	period	s (second)	ms (millisecond)		
8.2	frequency (See also item 3.2)	Hz (hertz)	MHz (megahertz) kHz (kilohertz)		Ultrasonic transducers and fault locaters Sound and vibration
8.3	wavelength	m (meter)	mm (millimeter)		Sound and vibration studies Sound and vibration studies See also 3.4 and 7.1
8.4	density (mass density)	kg/m^3 (kilogram per cubic meter)			Sound and vibration studies
8.5	static pressure (instantaneous) sound pressure	Pa (pascal)	μPa (micropascal)		See also 8.14
8.6	sound particle velocity (instantaneous)	ms (meter per second)	mm/s (millimeter per second)		Preferred for characteristics of sound waves
8.7	volume velocity (instantaneous)	m^3/s (cubic meter per second)			Sound studies
8.8	velocity of sound	m/s (meter per second)			Sound and vibration
8.9	sound energy flux, sound power	W (watt)			Sound calculations, ultrasonic testing, and noise studies. A wide range of values is encountered in practical applications, and SI multiples from picowatt (pW) to kilowatt (kW) are in common use.
8.10	sound intensity	W/m^2(watt per square meter)			Sound calculations
8.11	specific acoustic impedance	Pa·s/m (pascal second per meter)			Product of density and velocity in medium

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
8.12	acoustic impedance	$Pa \cdot s/m^3$ (pascal second per cubic meter)			Sonic and ultrasonic testing
8.13	mechanical impedance	N·s/m (newton second per meter)			Sound and vibration studies
8.14	sound pressure level			dB (decibel)	Amplifiers, communications, industrial noise (occupational and environmental) NOTE: If the reference pressure is not clear from the context, it should be explicitly indicated: for example, 12 dB (20/μPa).
8.15	sound power level			dB (decibel)	Sound power output of compressor, ventilating systems, amplifiers, and communication systems. NOTE: When required in an absolute sense, the reference power level should be clearly stated: for example, 20 dB (ref 1 pW)
8.16	equivalent absorption (area of a surface or object)	m^2 (square meter)			Architectural acoustics
8.17	reverberation time	s (second)			Architectural acoustics
8.18	signal gain, attenuation			dB (decibel)	Ultrasonic testing, communications
8.19	sound reduction index, sound transmission loss			dB (decibel)	Amplifier, communications, sound studies

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An American National Standard

IEEE Recommended Practice for Preferred Metric Units for Use in Electrical and Electronics Science and Technology

1. Purpose

The purpose of this recommended practice is to aid in the selection of metric units so as to promote uniformity in the use of metric units and to limit the number of different metric units that will be used in electrical and electronics science and technology. ANSI/IEEE Std 268-1982, American National Standard Metric Practice, prescribes how metric units are to be used and gives guidance concerning correct metric practice.

Table 1—Multiples and Submultiples of SI Units

Multiplying Factor	Prefix	Letter Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto*	h
10 = 10^{1}	deka*	da
0.1 = 10^{-1}	deci*	d
0.01 = 10^{-2}	centi*	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

*To be avoided where practical. See ANSI/IEEE Std 268-1982 .

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2. Space and Time

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
2.1	plane angle	rad (radian)			Engineering and scientific calculations
				° (degree)	Measurement of angles in surveys, plans, electrical calculations
					(Use of decimal divisions of degrees instead of minutes and seconds is encouraged)
2.2	solid angle	sr (steradian)			Engineering and scientific calculations
2.3	length (width, height, thickness, radius, diameter, depth)	m (meter)	km (kilometer) cm (centimeter mm (millimeter) µm (micrometer) nm (nanometer)		When coverting to SI, the meter generally replaces the yard and foot, the kilometer replaces the mile, the centimeter replaces the inch, and smaller submultiples replace the fractions of an inch. The hectometer, dekameter, and decimeter are used only rarely and are not recommended for general use. In many engineering applications the centimeter is avoided for fear of confusion or of proliferation of different unit multiples. Thus, all dimensions on mechanical engineering drawings are expressed in millimeters; dimensions for construction projects are expressed in meters or millimeters, but not in centimeters.
2.4	area	m^2(square meter)			Area of floors, walls, and small property size
				ha (hectare)	Surveying and land measurement
			km^2 (square kilometer)		Drainage area, watershed, or lake area
			cm^2 (square centimeter)		
			mm^2 (square millimeter)		Cross sectional area of conductors
2.5	volume	m^3 (cubic meter)			All volumes The expression of 10^6 m^3 should be used for volumes of reservoirs
			dm^3 (cubic decimeter)	L (liter)	1 dm^3 = 1 L 1 mL = 1 cm^3
			cm^3 (cubic centimeter)	mL (milliliter)	NOTE: Use of the liter is restricted to volumetric capacity, dry measure, and measure of fluids (both liquid and gases).
			mm^3 (cubic millimeter)	µL (microliter)	

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
2.6	time	s (second)			Preferred unit for all time derivative functions for engineering and scientific measurements and calculations.
			ms (millisecond)		Geophysical measurements, electrical device operating time
			μs (microsecond)		Ultrasonic testing, electrical transients
			ns (nanosecond) ps (picosecond)		Computer and communications technology
				a (year)	Statistics, planning
				month week	Work time, statistics
				d (day) h (hour) min (minute)	Work time, statistics
					NOTE: In engineering measurements and calculations, these non-SI units should be used in time derivative functions only when "second" related quantities become impractical.
2.7	angular velocity	rad/s (radian per second)			Engineering calculations
					NOTE: See also 3.3, rotational frequency
2.8	velocity	m/s (meter per second)			Conveyor speed, wind and water speed, ventilation, hoist speed, crane travel speed, elevator speed, and engineering calculations
			cm/s (centimeter per second)		Tape speeds and recorders
			mm/s (millimeter per second)		Wire feed for welding, chart speeds
				mm/a (millimeter per year)	Wear rates of motor brushes, bearings, etc
				mm/d (millimeter per day)	Chart speeds
				km/h (kilometer per hour)	Vehicle speed, wind speed (meteorological)
2.9	acceleration	m/s^2 (meter per second squared)	mm/s^2 (millimeter per second squared		Mechanical vibrations, engineering calculations
			$\mu m/s^2$ (micrometer per second squared)		
2.10	angular acceleration	rad/s^2 (radian per second squared			Engineering calculations, design, and analysis of machines
					NOTE: See also 3.5, rotational acceleration

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3. Periodic and Related Phenomena

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
3.1	period (See also item 8.1)	s (second)	ms (millisecond)		NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
3.2	frequency (See also item 8.2)	Hz (hertz)	GHz (gigahertz) MHz (megahertz) kHz (kilohertz)		NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
3.3	rotational frequency	s^{-1} (1 per second)		r/s (revolution per second) r/min (revolution per minute)	Not favored Preferred for rotating machine speeds; electrical, hydraulic, or pneumatic tools; automatic control instruments.
3.4	wavelength	m (meter)	cm (centimeter) mm (millimeter) nm (nanometer)		NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice. See also 7.1 and 8.3
3.5	rotational acceleration			r/s^2 (revolution per second squared)	Rotating machinery

4. Mechanics

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.1	mass	kg (kilogram)			Equipment and materials, transport and handling, construction elevator loads
			Mg (megagram)	t (metric ton)	Mass of coal and other bulk materials NOTE: The name *metric ton* may be used as an alternative to *megagram*
			g (gram) mg (milligram)		Mass of small items
4.2	linear density (mass per unit length)	kg/m (kilogram per meter)	g/m (gram per meter) mg/m (milligram per meter)		Mass load on conveyor belt or on a beam Conductor mass per unit length
4.3	area density (mass per unit area)	kg/m^2 (kilogram per square meter)			Mass loads on floor
			g/m^2 (gram per square meter)		Metallic coatings, plating

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.4	density (mass per unit volume)	kg/m^3 (kilogram per cubic meter)			Mass density of gases, solids or liquids
4.4.1	mass concentration (mass per unit volume)		mg/m^3 (milligram per cubic meter)		Air pollution data
				g/L (gram per liter)	Mass concentrations in liquids
4.4.2	mass per unit energy	kg/J (kilogram per joule)	g/GJ (gram per gigajoule)		Contaminent production related to fuel burning process
4.4.3	relative density	1 (one)			NOTE: The terms *specific weight* and *specific gravity* should be replaced by the term *relative density*. Mercury has a relative density of 13.6, meaning that it is 13.6 times as dense as water. Water is implied as the reference substance unless indicated otherwise. Relative density is a ratio and has no units; it is always just a number.
4.5	momentum	kg·m/s (kilogram meter per second)			
4.6	moment of momentum	$kg·m^2/s$ (kilogram meter squared per second)			
4.7	moment of inertia (See also item 4.13)	$kg·m^2$ (kilogram meter squared)			
4.8	force	N (newton)			
			MN (meganewton)		Reactions on structures
			kN (kilonewton)		Forces in columns, conductor tension, loading on insulators, braces, and struts
			mN (millinewton) μN (micronewton)		Forces of small magnitude
4.8.1	force per unit length	N/m (newton per meter)			Wind loading on conductors
4.9	moment of force, torque	N·m (newton meter)			Engineering calculations, bolt tightening torque, motor torque
			MN·m (meganewton meter)		Bending moments on structures
			kN·m (kilonewton meter)		Bending moments on structures
					NOTE: This unit can result in confusion with the unit for work or energy (see 4.20) which is also newton meter but which in the later case is called the joule. It is important to recognize the difference between torque and energy; the joule should never be used to express torque.

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.10	pressure	Pa (pascal)			Both gauge pressure and absolute pressure are properly expressed in pascals, using SI prefixes as appropriate.
			kPa (kilopascal)		The kilopascal (kPa) is the unit recommended for fluid pressure for almost all fields of use, such as barometric pressure, tire pressure, water pressure, and steam pressure. A notable exception is in air conditioning, where pressure differentials in air ducts are more conveniently measured in pascals (Pa).
4.11	stress	Pa (pascal)			
			MPa(megapascal)		Compressive, tensile, and shear stresses on structures
			N/mm^2 (newton per square millimeter)		1 N/mm^2 = 1 MPa
			kPa (kilopascal)		Static and dynamic stresses in low-strength materials (wood). Dynamic stresses on stator bar packing
4.12	modulus of elasticity	Pa (pascal)			
			MPa (megapascal)		Elastic moduli of structural materials
4.13	second moment of area	m^4 (meter to the fourth power)	cm^4 (centimeter to the fourth power) mm^4 (millimeter to the fourth power)		Properties of structural shapes
4.14	section modulus	m^3 (meter cubed)	cm^3 (centimeter cubed) mm^3 (millimeter cubed)		Properties of structural shapes
4.15	viscosity (dynamic)	Pa·s (pascal second)			NOTE: Use of the centipoise is to be avoided.
			mPa·s (millipascal second)		Hydraulic model studies lubrication 1 mPa·s = 1 cP (centipoise)
4.16	kinematic viscosity	m^2/s (meter squared per second)			NOTE: Use of the centistokes is to be avoided
			mm^2/s (millimeter squared per second)		Hydraulic model studies, lubrication, viscosity of oils and other liquids 1 mm^2/s = 1 cSt (centi-stokes)
4.17	surface tension	N/m (newton per meter)			

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
4.18	(volume) flow rate	m^3/s cubic meter per second)			River flow rate, pump and pipeline capacity
			dm^3/s (cubic decimeter per second	L/s (liter per second)	Liquid and gas flow rates up to 1000 L/s
			cm^3/s (cubic centimeter per second)	mL/s (milliliter per second)	Pneumatic control and instrument usage, control fluid leakage, oil flow rate in cables
			mm^3/s (cubic millimeter per second	µL/s (microliter per second)	Very low gas leakage rates
					NOTE: Volume flow rate will be used for measure- ments for air flow in ventila- tion and air-conditioning systems and for calculations for the sizing of piping and ducts for all types of liquid and gas flow.
4.19	mass flow rate	kg/s (kilogram per second)	g/s (gram per second)	kg/h (kilogram per hour)	Boiler steam, feed water and associated systems, coal and aggregate handling design and instrumentation.
					NOTE: Mass flow rate will be used for the instrumentation of all liquid flow in nuclear and heavy water in- stallations and for the calculation and instrumentation of flows in such systems as heat transport, boiler feed- water, and steam systems, where changes in pressure and temperature result in substantial changes in volume for a given mass flow rate.
4.20	energy, work (for electric energy, see 6.35)	J (joule)			All mechanical, thermal, and electrical calculations involving energy; studies of energy economics. A very wide range of energy values is encountered in practical applications and SI multiples from picojoule (pJ) to terajoule (TJ) are in common use.
			MJ (megajoule)		Heating, refrigeration, and air conditioning. Thermal energy of process steam. Energy of heating fuels.
4.21	power	W (watt)			All mechanical, thermal, and electrical calculations involving power or energy flow. A very wide range of power values is encountered in practical applications, and SI multiples from picowatt (pW) to gigawatt (GW) are in common use.
4.22	fracture toughness	$Pa{\cdot}m^{1/2}$ (pascal square root meter)			
			$MPa{\cdot}m^{1/2}$ (megapascal square root meter)		Thick section plates, turbine blades, forgings, and pipings

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5. Heat

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
5.1	thermodynamic temperature	K (kelvin)			Thermodynamic calculations, radiative heat transfer measurements, noise temperature in radio receivers. NOTE: The name *degree kelvin* and symbol °K are no longer used.
5.2	Celsius temperature	°C (degree Celsius)			
5.3	temperature interval	K (kelvin) °C (degree Celsius)			
5.4	linear expansion coefficient	K^{-1} (1 per kelvin) $°C^{-1}$ (1 per degree Celsius)			
5.5	heat, quantity of heat	J (joule)	GJ (gigajoule) MJ (megajoule) kJ (kilojoule) μJ (microjoule)		Heat loss calculations, heating, refrigeration, air conditioning Microelectronics
5.6	heat flow rate	W (watt)		MW (megawatt) kW (kilowatt)	Thermodynamic calculations, heating and air conditioning Heat flow calculations
5.6.1	density of heat flow-rate	W/m^2 (watt per square meter)			Heat flow calculations
5.7	radiant intensity	W/sr (watt per steradian)			
5.8	thermal conductivity	W/(m·K) (watt per meter kelvin) W/(m·°C) (watt per meter degree Celsius)			
5.9	thermal insulance	m^2·K/W (square meter kelvin per watt) m^2·°C/W (square meter degree Celsius per watt)			NOTE: Thermal insulance is temperature difference divided by density of heat flow rate.

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
5.10	thermal resistance	K/W (kelvin per watt) °C/W (degree Celsius per watt)			NOTE: Thermal resistance is the temperature difference divided by heat flow rate.
5.11	coefficient of heat transfer	$W/(m^2 \cdot K)$ (watt per square meter kelvin) $W/(mg^2 \cdot °C)$ (watt per square meter degree Celsius)			NOTE: Coefficient of heat transfer is the density of heat flow rate divided by temperature difference.
5.12	heat capacity	J/K (joule per kelvin)	kJ/K (kilojoule per kelvin) kJ/°C (kilojoule per degree Celsius)		
5.13	specific heat capacity	J/(kg·K) (joule per kilogram kelvin)	kJ/(kg·K) (kilojoule per kilogram kelvin) kJ/(kg·°C) (kilojoule per kilogram degree Celsius)		
5.14	entropy	J/K (joule per kelvin)	kJ/K (kilojoule per kelvin)		

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6. Electricity and Magnetism

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.1	electric current	A (ampere)			NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.2	electric charge, quantity of electricity	C (coulomb)			NOTE: Many unit multiples are of electricity used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.3	volume density of charge, charge density	C/m^3 (coulomb per cubic meter)			
6.4	surface density of charge	C/m^2 (coulomb per square meter)			
6.5	electric field strength	V/m (volt per meter) N/C (newton per coulomb)	 MV/m (megavolt per meter) kV/mm (kilovolt per millimeter) μV/m (microvolt per meter)		Antenna field patterns, gradient of electric fields Preferred unit for electrical stress in gas, liquid, and solid media NOTE: The values of MV/m and kV/mm are numerically equal. Both will be used for convenience. Preferred unit for dielectric stress in insulation Radio noise measurements NOTE: Predicted and actual effective field strength (particularly in am broadcasting) is to be expressed as millivolts per meter at one kilometer.
6.6	electrical potential, voltage	V (volt)			NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.7	electric flux density, displacement	C/m^2 (coulomb per square meter)			
6.8	electric flux	C (coulomb)			
6.9	capacitance	F (farad)	μF (microfarad) pF (picofarad)		
6.10	permittivity	F/m (farad per meter)			
6.11	electric polarization	C/m^2 (coulomb per square meter)			
6.12	electric dipole moment	C·m (coulomb meter)			

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.13	current density	A/m^2 (ampere per square meter)	MA/m^2 (megaampere per square meter) A/cm^2 (ampere per square centimeter) A/mm^2 (ampere per square millimeter)		Current density in semiconductors Current density in counductors NOTE: The values of MA/m^2 (megaampere per square meter) and A/mm^2 (ampere per square millimeter) are both numerically equal. Both will be used for convenience.
6.14	linear current density	A/m (ampere per meter)			
6.15	magnetic field strength	A/m (ampere per meter)			Calculation of transformer and reactor characteristics NOTE: Interpret as ampere turns per meter
6.16	magnetomotive force	A (ampere)			NOTE: Often called ampere turns
6.17	magnetic flux density, magnetic induction	T (tesla)	mT (millitesla) μT (microtesla)		
6.18	magnetic flux	Wb (weber)			
6.19	magnetic vector potential	Wb/m (weber per meter)			
6.20	self-inductance, mutual inductance	H (henry)	mH (millihenry) μH (microhenry)		
6.21	permeability	H/m (henry per meter)	mH/m (millihenry per meter)		Self inductance calculations (iron core) Self inductance calculations (air core)
6.22	electromagnetic moment, magnetic moment	$A \cdot m^2$ (ampere meter squared)			
6.23	magnetization	A/m (ampere per meter)			Magnetic circuit calculations
6.24	magnetic polarization	T (tesla)			Magnetic circuit calculations
6.25	magnetic dipole moment	$N \cdot m^2/A$ (newton meter squared per ampere) Wb·m (weber meter)			

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.26	resistance	Ω (ohm)			NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.27	conductance	S (siemens)			Liquids
			MS (megasiemens)		Conductors
			μs (microsiemens)		Insulators
6.28	resistivity	Ω·m (ohm meter)			
			GΩ·m (gigaohm meter)		
			mΩ·m (milliohm meter)		
6.29	conductivity	S/m (siemens per meter)			Conductivity of aqueous solutions and natural water
			MS/m (megasiemens per meter)		Conductivity of metals
			mS/m (millisiemens per meter)		Conductivity of aqueous solutions and natural water
			μS/m (microsiemens per meter)		Demineralized water
6.30	reluctance	H^{-1} (1 per henry)			Magnetic circuit design
6.31	permeance	H (henry)			Magnetic circuit design
6.32	impedance	Ω (ohm)			NOTE: Many unit multiple are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.
6.33	admittance	S (siemens)			Electric circuits and components
			mS (millisiemens)		Electric circuits and components
			μs(microsiemens)		Electric circuits and components
6.34	power				
6.34.1	active power	W(watt)			Appliance rating, dissipation in electronic components
					Power system capability
					Station, machine, line rating
					Appliance rating
					Dissipation in electronic components
					Telecommunications and microelectronics
					NOTE: Many unit multiples are used for this quantity, as appropriate. The conversion to SI has no effect on current practice.

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
6.34.2	apparent power	VA (voltampere)	MVA (megavoltampere)		Apparent power in substations, generating stations, and ac generators
			kVA (kilovoltampere)		Apparent power in systems, plants, electrical apparatus, and transformer rating
6.34.3	reactive power	var (var)			
			Mvar (megavar)		Reactive power in substations, generating stations, and generators
			kvar (kilovar)		Reactive power in systems, plants, and electrical apparatus
6.35	electric energy	J (joule)			Energy calculations
			GJ (gigajoule)		Energy calculations
			MJ (megajoule)		Energy calculations
			kJ (kilojoule)		Energy calculations
				MWh (megawatthour)	Electrical energy production and consumption
				kWh (kilowatthour)	Electrical energy consumption
6.36	resistance per unit length	Ω/m (ohm per meter)			Soil resistance
			mΩ/m (milliohm per meter) Ω/km (ohm per kilometer)		Resistance of transmission conductors and control cable
					NOTE: The values of mΩ/m and Ω/km are numerically equal. Both will be used for convenience.

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7. Light and Related Electromagnetic Radiations

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
7.1	wavelength	m (meter)			Radio waves, antenna design
			cm (centimeter)		Microwave systems
			μm (micrometer)		Infrared spectroscopy
			nm (nanometer)		Light wavelengths, fiber optics
					See also 3.4 and 8.3.
7.2	radiant energy	J (joule)			Antenna and pulse laser technology
7.3	radiant flux, radiant power	W (watt)			Antenna and continuous wave laser technology
			mW (milliwatt)		Antenna and continuous wave laser technology
7.4	radiant intensity	W/sr (watt per steradian)			
7.5	irradiance	W/m^2 (watt per square meter)			
			kW/m^2 (kilowatt per square meter)		Calculation of solar radiation effect on conductors, water bodies, etc
7.6	luminous intensity	cd (candela)			Lighting calculations
		mcd (millicandela)			Electronic displays, fiber optics, and photodiodes
7.7	luminous flux	lm (lumen)			Lighting calculations
7.8	quantity of light	lm·s (lumen second)			Lighting calculations
7.9	luminance	cd/m^2 (candela per square meter)			Lighting calculations
7.10	luminous exitance	lm/m^2 (lumen per square meter)			Lighting calculations
7.11	illuminance	lx (lux)			Lighting calculations
7.12	light exposure	lx·s (lux second)			Lighting calculations, photography
7.13	luminous efficacy	lm/W (lumen per watt)			Lighting calculations
7.14	attenuation			dB/km (decibel per kilometer)	Fiber optics

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8. Acoustics

Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
8.1	period	s (second)	ms (millisecond)		
8.2	frequency (See also item 3.2)	Hz (hertz)	MHz (megahertz) kHz (kilohertz)		Ultrasonic transducers and fault locaters Sound and vibration
8.3	wavelength	m (meter)	mm (millimeter)		Sound and vibration studies Sound and vibration studies See also 3.4 and 7.1
8.4	density (mass density)	kg/m^3 (kilogram per cubic meter)			Sound and vibration studies
8.5	static pressure (instantaneous) sound pressure	Pa (pascal)	μPa (micropascal)		See also 8.14
8.6	sound particle velocity (instantaneous)	ms (meter per second)	mm/s (millimeter per second)		Preferred for characteristics of sound waves
8.7	volume velocity (instantaneous)	m^3/s (cubic meter per second)			Sound studies
8.8	velocity of sound	m/s (meter per second)			Sound and vibration
8.9	sound energy flux, sound power	W (watt)			Sound calculations, ultrasonic testing, and noise studies. A wide range of values is encountered in practical applications, and SI multiples from picowatt (pW) to kilowatt (kW) are in common use.
8.10	sound intensity	W/m^2(watt per square meter)			Sound calculations
8.11	specific acoustic impedance	Pa·s/m (pascal second per meter)			Product of density and velocity in medium

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Item	Quantity	SI Symbol (Unit)	Preferred Multiples of the SI Units	Other Units Permitted for Use with SI	Typical and Recommended Applications and Explanatory Notes
8.12	acoustic impedance	$Pa \cdot s/m^3$ (pascal second per cubic meter)			Sonic and ultrasonic testing
8.13	mechanical impedance	N·s/m (newton second per meter)			Sound and vibration studies
8.14	sound pressure level			dB (decibel)	Amplifiers, communications, industrial noise (occupational and environmental) NOTE: If the reference pressure is not clear from the context, it should be explicitly indicated: for example, 12 dB (20/μPa).
8.15	sound power level			dB (decibel)	Sound power output of compressor, ventilating systems, amplifiers, and communication systems. NOTE: When required in an absolute sense, the reference power level should be clearly stated: for example, 20 dB (ref 1 pW)
8.16	equivalent absorption (area of a surface or object)	m^2 (square meter)			Architectural acoustics
8.17	reverberation time	s (second)			Architectural acoustics
8.18	signal gain, attenuation			dB (decibel)	Ultrasonic testing, communications
8.19	sound reduction index, sound transmission loss			dB (decibel)	Amplifier, communications, sound studies

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