

[^{XI}ANNEX

Editorial Information

- XI** Substituted by [Corrigendum to Council Directive 80/181/EEC of 20 December 1979 on the approximation of the laws of the Member States relating to units of measurement and on the repeal of Directive 71/354/EEC \(Official Journal of the European Communities No L 39 of 15 February 1980\)](#).

CHAPTER I

LEGAL UNITS OF MEASUREMENT REFERRED TO IN ARTICLE 1 (a)

1. SI UNITS AND THEIR DECIMAL MULTIPLES AND SUBMULTIPLES

[^{F1}1.1. SI base units

Quantity	Unit	
	Name	Symbol
Time	second	s
Length	metre	m
Mass	kilogram	kg
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Definitions of SI base units:

Unit of time

The second, symbol s, is the SI unit of time. It is defined by taking the fixed numerical value of the caesium frequency $\Delta\nu_{\text{Cs}}$, the unperturbed ground-state hyperfine transition frequency of the caesium 133 atom, to be 9 192 631 770 when expressed in the unit Hz, which is equal to s^{-1} .

Unit of length

The metre, symbol m, is the SI unit of length. It is defined by taking the fixed numerical value of the speed of light in vacuum c to be 299 792 458 when expressed in the unit m/s, where the second is defined in terms of $\Delta\nu_{\text{Cs}}$.

Unit of mass

The kilogram, symbol kg, is the SI unit of mass. It is defined by taking the fixed numerical value of the Planck constant h to be $6,626\,070\,15 \times 10^{-34}$ when expressed in the unit J s, which is equal to $\text{kg m}^2 \text{s}^{-1}$, where the metre and the second are defined in terms of c and $\Delta\nu_{\text{Cs}}$.

Unit of electric current

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The ampere, symbol A, is the SI unit of electric current. It is defined by taking the fixed numerical value of the elementary charge e to be $1,602\ 176\ 634 \times 10^{-19}$ when expressed in the unit C, which is equal to A s, where the second is defined in terms of $\Delta\nu_{\text{Cs}}$.

Unit of thermodynamic temperature

The kelvin, symbol K, is the SI unit of thermodynamic temperature. It is defined by taking the fixed numerical value of the Boltzmann constant k to be $1,380\ 649 \times 10^{-23}$ when expressed in the unit J K^{-1} , which is equal to $\text{kg m}^2 \text{s}^{-2} \text{K}^{-1}$, where the kilogram, metre and second are defined in terms of h , c and $\Delta\nu_{\text{Cs}}$.

Unit of amount of substance

The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly $6,022\ 140\ 76 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, N_{A} , when expressed in the unit mol^{-1} and is called the Avogadro number.

The amount of substance, symbol n , of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.

Unit of luminous intensity

The candela, symbol cd, is the SI unit of luminous intensity in a given direction. It is defined by taking the fixed numerical value of the luminous efficacy of monochromatic radiation of frequency 540×10^{12} Hz, K_{cd} , to be 683 when expressed in the unit lm W^{-1} , which is equal to cd sr W^{-1} , or $\text{cd sr kg}^{-1} \text{m}^{-2} \text{s}^3$, where the kilogram, metre and second are defined in terms of h , c and $\Delta\nu_{\text{Cs}}$.

1.1.1. **Special name and symbol of the SI derived unit of temperature for expressing Celsius temperature**

Quantity	Unit	
	Name	Symbol
Celsius temperature	degree Celsius	°C

Celsius temperature t is defined as the difference $t = T - T_0$ between the two thermodynamic temperatures T and T_0 where $T_0 = 273,15$ K. An interval or difference of temperature may be expressed either in kelvins or in degrees Celsius. The unit ‘degree Celsius’ is equal to the unit ‘kelvin’.]

Textual Amendments

F1 Substituted by [Commission Directive \(EU\) 2019/1258 of 23 July 2019 amending, for the purpose of its adaptation to technical progress, the Annex to Council Directive 80/181/EEC as regards the definitions of SI base units \(Text with EEA relevance\).](#)

[^{F2}1.2. SI derived units]

^{F3}1.2.1. SI supplementary units

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[^{F3}

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Definitions of SI supplementary units:

Unit of plane angle

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Unit of solid angle

Textual Amendments

F3 Deleted by Directive 2009/3/EC of the European Parliament and of the Council of 11 March 2009 amending Council Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement (Text with EEA relevance).

[^{F2}1.2.2. General rule for SI derived units

Units derived coherently from SI base units are given as algebraic expressions in the form of products of powers of the SI base units with a numerical factor equal to 1.

1.2.3. SI derived units with special names and symbols

Quantity	Unit		Expression	
	Name	Symbol	In terms of other SI units	In terms of SI base units
Plane angle	radian	rad		$\text{m} \cdot \text{m}^{-1}$
Solid angle	steradian	sr		$\text{m}^2 \cdot \text{m}^{-2}$
Frequency	hertz	Hz		s^{-1}
Force	newton	N		$\text{m} \cdot \text{kg} \cdot \text{s}^{-2}$
Pressure, stress	pascal	Pa	$\text{N} \cdot \text{m}^{-2}$	$\text{m}^{-1} \cdot \text{kg} \cdot \text{s}^{-2}$
Energy, work; quantity of heat	joule	J	$\text{N} \cdot \text{m}$	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2}$
Power ^a , radiant flux	watt	W	$\text{J} \cdot \text{s}^{-1}$	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-3}$
Quantity of electricity, electric charge	coulomb	C		$\text{s} \cdot \text{A}$
Electric potential, potential difference,	volt	V	$\text{W} \cdot \text{A}^{-1}$	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-3} \cdot \text{A}^{-1}$

^a Special names for the unit of power: the name volt-ampere (symbol 'VA') when it is used to express the apparent power of alternating electric current, and var (symbol 'var') when it is used to express reactive electric power. The 'var' is not included in GCPM resolutions.

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electromotive force				
Electric resistance	ohm	Ω	$V \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
Conductance	siemens	S	$A \cdot V^{-1}$	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
Capacitance	farad	F	$C \cdot V^{-1}$	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
Magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
Magnetic flux density	tesla	T	$Wb \cdot m^{-2}$	$kg \cdot s^{-2} \cdot A^{-1}$
Inductance	henry	H	$Wb \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Luminous flux	lumen	lm	$cd \cdot sr$	cd
Illuminance	lux	lx	$lm \cdot m^{-2}$	$m^{-2} \cdot cd$
Activity (of a radionuclide)	becquerel	Bq		s^{-1}
Absorbed dose, specific energy imparted, kerma, absorbed dose index	gray	Gy	$J \cdot kg^{-1}$	$m^2 \cdot s^{-2}$
Dose equivalent	sievert	Sv	$J \cdot kg^{-1}$	$m^2 \cdot s^{-2}$
Catalytic activity	katal	kat		$mol \cdot s^{-1}$

^a Special names for the unit of power: the name volt–ampere (symbol ‘VA’) when it is used to express the apparent power of alternating electric current, and var (symbol ‘var’) when it is used to express reactive electric power. The ‘var’ is not included in GCPM resolutions.

Units derived from SI base units may be expressed in terms of the units listed in Chapter I.

In particular, derived SI units may be expressed by the special names and symbols given in the above table; for example, the SI unit of dynamic viscosity may be expressed as $m^{-1} \cdot kg \cdot s^{-1}$ or $N \cdot s \cdot m^{-2}$ or $Pa \cdot s$.]

Textual Amendments

F2 Substituted by [Directive 2009/3/EC of the European Parliament and of the Council of 11 March 2009 amending Council Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement \(Text with EEA relevance\)](#).

1.3. Prefixes and their symbols used to designate certain decimal multiples and submultiples

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[^{F4}Factor	Prefix	Symbol
10 ²⁴	yotta	Y
10 ²¹	zetta	Z
10 ¹⁸	exa	E
10 ¹⁵	peta	P
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	[^{x2} k]
10 ²	hecto	[^{x2} h]
10 ¹	deca	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
10 ⁻²¹	zepto	z
10 ⁻²⁴	yocto	y]

The names and symbols of the decimal multiples and submultiples of the unit of mass are formed by attaching prefixes to the word 'gram' and their symbols to the symbol 'g'.

Where a derived unit is expressed as a fraction, its decimal multiples and submultiples may be designated by attaching a prefix to units in the numerator or the denominator, or in both these parts.

Compound prefixes, that is to say prefixes formed by the juxtaposition of several of the above prefixes, may not be used.

1.4. Special authorized names and symbols of decimal multiples and submultiples of SI units

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Quantity	Unit		
	Name	Symbol	Value
Volume	litre	l or L ^a	1 l = 1 dm ³ = 10 ⁻³ m ³
Mass	tonne	t	1 t = 1 Mg = 10 ³ kg
Pressure, stress	bar	bar ^b	1 bar = 10 ⁵ Pa

a The two symbols 'l' and 'L' may be used for the litre unit. (Sixteenth CGPM (1979), resolution 6).

b Unit listed in the International Bureau of Weights and Measures booklet as among the units to be permitted temporarily.

Note:

The prefixes and their symbols listed in 1.3 may be used in conjunction with the units and symbols contained in Table 1.4.]