Appendix A: Symbols and Prefixes

(Appendix A last revised March 2013)

This appendix of the Author's Kit provides recommendations on prefixes, unit symbols and abbreviations, acronyms, and factors for conversion into units of the International System.

Prefixes

Recommended prefixes indicating decimal multiples or submultiples of units and their symbols are as follows:

Multiple	**Prefix**	**Abbreviation**
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	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
10^{-21}	zepto	z
10^{-24}	yocto	y

Avoid using compound prefixes, such as micromicro for pico and kilomega for giga. The abbreviation of a prefix is considered to be combined with the abbreviation/symbol to which it is directly attached, forming with it a new unit symbol, which can be raised to a positive or negative power and which can be combined with other unit abbreviations/symbols to form abbreviations/symbols for compound units. For example:

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

Abbreviations and Symbols

Whenever possible, avoid using abbreviations and symbols in paragraph text; however, when it is deemed necessary to use such, define all but the most common at first use. The following is a recommended list of abbreviations/symbols for some important units, and it also includes other common abbreviations and acronyms that may be used in tables and figures, and, if deemed necessary, in paragraph text. The form of unit abbreviations/ symbols is the same for both singular and plural usage, and they are not followed by a period. The distinction between uppercase and lowercase letters should be carefully observed. When a compound unit is formed by the multiplication of two or more units, its abbreviation/symbol consists of the symbols for the separate units joined by a raised dot, for example, N·m for newton-meter. When a compound unit is formed by division of one unit by another, its abbreviation/symbol consists of the symbols for the separate symbols either separated by solidus (slant) or multiplied using negative powers, for example, m/s or $m \cdot s^{-1}$ for meters per second.

alternating current	ac
American wire gauge	AWG
ampere	A
ampere-hour	Ah
ampere-turn	At
amplitude modulation	AM
antilogarithm	antilog
atomic mass unit (unified)	U
audio frequency	AF
automatic frequency control	AFC
automatic gain control	AGC
automatic volume control	AVC
average	avg
backward-wave oscillator	BWO
bar	bar
barn	b
beat-frequency oscillator	BFO
bel	B
billion electronvolts	GeV
binary coded decimal	BCD
British thermal unit	Btu

calorie	cal
calorie (International Table calorie)	cal_{IT}
calorie (thermochemical calorie)	cal_{th}
candela	cd
candela per square foot	cd/ft^2
candela per square meter	cd/m^2
cathode-ray oscilloscope	CRO
cathode-ray tube	CRT
centimeter	cm
centimeter-gram-second	CGS
circular mil	cmil
continuous wave	CW
coulomb	C
coupling capacitor voltage transformer	ccvt
cubic centimeter	cm^3
cubic foot	ft^3
cubic foot per minute	ft^3/min
cubic foot per second	ft^3/s
cubic inch	in^3
cubic meter	m^3
cubic meter per second	m^3/s
cubic yard	yd^3
curie	Ci
current transformer	Ct
decibel	dB
decibel referred to one milliwatt	dBm
degree (temperature) Celsius	°C
degree (temperature) Fahrenheit	°F
diameter	dia
direct current	dc
double sideband	DSB
electrocardiograph	ECG
electroencephalograph	EEG
electromagnetic compatibility	EMC
electromagnetic unit	EMU
electromotive force	EMF
electronic data processing	EDP
electronvolt	eV
electrostatic unit	ESU
extra high voltage	EHV
extremely high frequency	EHF

extremely low frequency	ELF
farad	F
field-effect transistor	FET
foot	ft
footcandle	fc
footlambert	fL
foot per minute	ft/min
foot per second	ft/s
foot per second squared	ft/s^2
foot poundal	ft·pdl
foot pound-force	ft·lbf
frequency modulation	FM
frequency-shift keying	FSK
gal	Gal
gigaelectronvolt	GeV
gigahertz	GHz
gram	g
henry	H
hertz	Hz
high frequency	HF
high voltage	HV
horsepower	hp
hour	h
inch	in
inch per second	in/s
inductance-capacitance	LC
infrared	IR
inside diameter	ID
intermediate frequency	IF
joule	J
joule per kelvin	J/K
kelvin	K
kiloelectronvolt	keV
kilogram	kg
kilohertz	kHz
kilohm	kΩ
kilojoule	kJ
kilometer	km
kilometer per hour	km/h
kilovar	kvar
kilovolt	kV

kilovoltampere	kVA
kilowatt	kW
kilowatthour	kWh
knot	knot
liter	L
liter per second	L/s
logarithm	log
logarithm, natural	ln
low frequency	LF
lumen	lm
lumen per square foot	lm/ft^2
lumen per square meter	lm/m^2
lumen per watt	lm/W
lumen second	lm·s
lux	lx
magnetohydrodynamics	MHD
magnetomotive force	MMF
medium frequency	MF
megaelectronvolt	MeV
megahertz	MHz
megavolt	MV
megavar	Mvar
megawatt	MW
megohm	MΩ
metal-oxide semiconductor	MOS
meter	m
meter-kilogram-second	MKS
mho	mho
microampere	μA
microbar	μbar
microfarad	μF
microgram	μg
microhenry	μH
micrometer	μm
micrombo	μmho
micron	μm
microsecond	μs
microsiemens	μS
microwatt	μW
mil	mil
mile per hour	mi/h

mile (statute)	mi
milliampere	mA
millibar	mbar
millibarn	mb
milligram	mg
millihenry	mH
milliliter	mL
millimeter	mm
millimeter of mercury, conventional	mmHg
millisecond	ms
millisiemens	mS
millivolt	mV
milliwatt	mW
minute (time)	min
nanoampere	nA
nanofarad	nF
nanometer	nm
nanosecond	ns
nanowatt	nW
nautical mile	nmi
neper	Np
newton	N
newton meter	Nm
newton per square meter	N/m^2
ohm	Ω
ounce (avoirdupois)	oz
outside diameter	OD
pascal	Pa
per unit	pu
phase modulation	PM
picoampere	pA
picocoloumb	pC
picofarad	pF
picosecond	ps
picowatt	pW
pint	pt
pound	lb
poundal	pdl
pound-force	lbf
pound-force foot	lbf·ft
pound-force per square inch	lbf/in^2

pound (force) per square inch	lbf/in^2
power factor	PF
private branch exchange	PBX
pulse-amplitude modulation	PAM
pulse-code modulation	PCM
pulse-count modulation	PCM
pulse-duration modulation	PDM
pulse-position modulation	PPM
pulse-repetition frequency	PRF
pulse-repetition rate	PRR
pulse-time modulation	PTM
pulse-width modulation	PWM
quart	qt
rad	rd
radian	rad
radio frequency	RF
radio-frequency interference	RFI
rem	rem
resistance-capacitance	RC
resistance-inductance-capacitance	RLC
revolution per minute	r/min
revolution per second	r/s
roentgen	R
root-mean-square	rms
second (time)	s
short wave	SW
siemens	S
signal-to-noise ratio	SNR
semiconductor controlled rectifier	SCR
silicon controlled rectifier	SCR
single sideband	SSB
square foot	ft^2
square inch	in^2
square meter	m^2
square yard	yd^2
standing-wave ratio	SWR
steradian	sr
superhigh frequency	SHF
television	TV
television interference	TVI
tesla	T

thin-film transistor	TFT
ton, short	ton
ton, metric	ton
transverse electric	TE
transverse electromagnetic	TEM
transverse magnetic	TM
traveling-wave tube	TWT
ultrahigh frequency	UHF
ultraviolet	UV
(unified) atomic mass unit	u
vacuum-tube voltmeter	VTVM
var	var
variable-frequency oscillator	VFO
very high frequency	VHF
very low frequency	VLF
vestigial sideband	VSB
volt	V
voltage controlled oscillator	VCO
voltage standing-wave ratio	VSWR
voltage transformer	vt
voltampere	VA
volume unit	vu
watt	W
watthour	Wh
watt per steradian	W/sr
watt per steradian square meter	W/(sr m^2)
weber	Wb
yard	yd

Conversion Factors

The following are some factors for conversion into units of the International System.

Length
1 inch = 2.54 centimeters (exactly)
1 foot = 0.3048 meter (exactly)
1 mile = 1609.3 meters
1 nautical mile = 1852 meters (exactly)
1 micron = 1 micrometer (exactly)
1 angstom = 0.1 nanometer (exactly)

Area
1 square inch = 6.4516 square centimeters (exactly)
1 square foot = 0.092 903 square meter
1 circular mil = 5.0671 x 10^{-4} square millimeter
1 acre = 4046.9 square meters
1 barn = 10^{-28} square meter (exactly)
1 hectare = 10 000 square meters (exactly)

Volume
1 cubic inch = 16.387 cubic centimeters
1 cubic foot = 0.028 317 cubic meter
1 fluid ounce (UK) = 28.413 cubic centimeters
1 fluid ounce (US) = 29.574 cubic centimeters
1 gallon (UK) = 4546.1 cubic centimeters
1 gallon (US) = 3785.4 cubic centimeters
1 barrel (US) (for petroleum; etc) = 0.158 99 cubic meter
1 acre foot = 1233.5 cubic meters
1 liter = 1000 cubic centimeters (exactly)

Speed
1 foot per minute = 5.08 millimeters per second (exactly)
1 mile per hour = 0.44704 meter per second (exactly)
1 knot = 0.514 44 meter per second
1 kilometer per hour = 0.277 78 meter per second

Mass
1 ounce (avoirdupois) = 28.350 grams
1 pound = 0.453 59 kilogram
1 slug = 14.594 kilograms
1 short ton = 907.18 kilograms
1 long ton = 1016.0 kilograms
1 tonne = 1000 kilograms (exactly)

Density
1 pound per cubic foot = 16.018 kilograms per cubic meter
1 pound per cubic inch = 27 680 kilograms per cubic meter

Force
1 poundal = 0.138 25 newton
1 ounce-force = 0.278 01 newton
1 pound-force = 4.4482 newtons

1 kilogram-force = 9.806 65 newtons (exactly)
1 dyne = 10^{-5} newton (exactly)

Pressure
1 poundal per square foot = 1.4882 pascals (newtons per square meter)
1 pound-force per square foot = 47.880 pascals
1 pound-force per square inch = 6894.8 pascals
1 conventional foot of water = 2989.1 pascals
1 conventional millimeter of mercury = 133.32 pascals
1 torr = 133.32 pascals
1 standard atmosphere (760 torr) = 101 325 pascals (exactly)
1 technical atmosphere (1 kgf/cm^2) = 98 066.5 pascals (exactly)
1 bar = 100 000 pascals (exactly)

Energy, Work
1 foot poundal = 0.042 140 joule
1 foot pound-force = 1.3558 joules
1 British thermal unit (thermochemical) = 1054 joules
1 British thermal unit (International Table) = 1055 joules
1 calorie (thermochemical) = 4.184 joules (exactly)
1 calorie (International Table) = 4.1868 joules (exactly)
1 electronvolt = 1.602 x 10^{-19} joule
1 erg = 10^{-7} joule (exactly)

Power
1 foot pound-force per second = 1.3558 watts
1 horsepower (metric) = 735.50 watts
1 horsepower (British) = 745.70 watts
1 horsepower (electrical) = 746 watts (exactly)
1 British thermal unit (International Table) per hour = 0.2931 watt
1 erg per second = 10^{-7} watt (exactly)

Quantities of Light
1 footcandle = 10.764 lux (lumens per square meter)
1 footlambert = 3.4263 candelas per square meter

Quantities of Electricity and Magnetism
1 ESU of current $\simeq$ 3.3356 x 10^{-10} ampere
1 EMU of current = 10 amperes (exactly)
1 ESU of electric potential $\simeq$ 299.79 volts
1 EMU of electric potential = 10^{-8} volt (exactly)

1 ESU of capacitance $\simeq$ 1.1126 x 10^{-12} farad
1 EMU of capacitance = 10^{9} farads (exactly)
1 ESU of inductance $\simeq$ 8.9876 x 10^{11} henrys
1 EMU of inductance = 10^{-9} henry (exactly)
1 ESU of resistance $\simeq$ 8.9876 x 10^{11} ohms
1 EMU of resistance = 10^{-9} ohm (exactly)
1 gilbert $\simeq$ 0.795 77 ampere
1 oersted $\simeq$ 79.577 amperes per meter
1 maxwell = 10^{-8} weber (exactly)
1 gauss = 10^{-4} tesla (exactly)

Note that ESU means electrostatic CGS unit; EMU means electromagnetic CGS unit. In this list, the sign $\simeq$ is to be read “corresponds to.” Since the change from either CGS system to the International System of Units involves a change in quantities, conversion of units by multiplication by a pure number is not, strictly speaking, possible. However, a physical situation which can be described as a “current” of 1 abampere can also be described as a current of 10 amperes.