Notation, Symbols and Abbreviations

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Multiplier prefixes

" ≡ " means "by definition the same as"

k ≡ Kilo ≡ 10^3 ≡ 1000
M ≡ Mega ≡ 10^6 ≡ 1000 000
G ≡ Giga ≡ 10^9 ≡ 1000 000 000
T ≡ Tera ≡ 10^{12} ≡ 1000 000 000 000
P ≡ Peta ≡ 10^{15} ≡ 1 000 000 000 000 000

d ≡ deci ≡ 10^{-1} ≡ 1/10
c ≡ centi ≡ 10^{-2} ≡ 1/100
m ≡ milli ≡ 10^{-3} ≡ 1/1000
μ ≡ micro ≡ 10^{-6} ≡ 1/1000 000
n ≡ nano ≡ 10^{-9} ≡ 1/1000 000 000
p ≡ pico ≡ 10^{-12} ≡ 1/1000 000 000 000
f ≡ femto ≡ 10^{-15} ≡ 1/1000 000 000 000 000

The Greek Alphabet

Alpha	A α	Eta	H η	Nu	N ν	Tau	T τ
Beta	B β	Theta	Θ θ	Xi	Ξ ξ	Upsilon	Y υ
Gamma	Γ γ	Iota	I ι	Omicron	O ο	Phi	Φ φ
Delta	Δ δ	Kappa	K κ	Pi	Π π	Chi	X χ
Epsilon	E ε	Lambda	Λ λ	Rho	P ρ	Psi	Ψ ψ
Zeta	Z ζ	Mu	M μ	Sigma	Σ σ	Omega	Ω ω

Fundamental Constants and Relationships

Figure in brackets () after a number is uncertainty in the last digit. " ≡ " means "by definition"

Quantity	Symbol	Definition	Accepted value
Speed of light[1]	c	$= 1/\sqrt{(\mu_0\varepsilon_0)}$	≡ 299 792 458 ±0 metres / second
Permittivity of free space	ε_0		= 8.854187818 × 10^{-12} Farads / metre
Permeability of free space	μ_0		≡ 4π × 10^{-7} Henrys / metre
Impedance of free space	Z_0	$= \sqrt{(\mu_0/\varepsilon_0)}$	= 376.7303134 Ω
Electron charge	q_e		= -1.6021892 × 10^{-19} Coulombs
Planck's constant	h		= 6.62606896(33) × 10^{-34} Joule seconds
Dirac's constant	$\hbar$	$= h/2\pi$	
von Klitzing resistance	R_{vK}	$= h/q_e^2$	= 25812.8056 Ω
Fine-structure constant	α	$= Z_0 /2R_{vK}$	= 7.2973525376(50) × 10^{-3}
Boltzmann's constant	k		1.380662 × 10^{-23} Joules/Kelvin

[1]. c is now defined as 299 792 458 m/s exactly.

Unit Symbols

A	ampere, amp
C	coulomb
dB	decibel ≡ bel/10
F	farad
gauss	≡ 10^{-4} Tesla
H	henry ≡ Wb turns/A
Hz	hertz ≡ cycles per second
J	joule ≡ W s
K	kelvin temperature (ºC + 273.16)
kg	kilogram

m	metre
maxwell	≡ 10^{-8} weber
Oe	Ørsted ≡ 1000 / 4π A turns / m
S	siemens ≡ 1/Ω
s	second
T	tesla ≡ 10^{4} gauss
V	volt
W	watt ≡ J/s
Wb	weber ≡ 10^{8} maxwell
Ω	ohm

Mathematical relations and operators

=	conditionally equal to
≡	equivalent to, equal by definition
→	tends towards
≈	approximately equal to
≠	not equal to
≥	greater than or equal to
>	greater than
>>	much greater than
≤	less than or equal to
<	less than
<<	much less than
//	in parallel with, i.e., **a**//**b** = **ab**/(**a**+**b**)
±	plus or minus

|**x**|	modulus (magnitude) of **x**
'	prime (denotes modified definition)
"	double prime (modified again)
*	complex conjugate
!	factorial[1]
/	divided by, per, over, in units of [2]
×	vector (cross) product, multiplied by
•	scalar (dot) product
√	square root
$\sqrt[3]{}$	cube root
$\sqrt[n]{}$	n^{th} root, n=4, 5, 6 etc.
[ ]	encloses units in dimensional analysis
∞	infinity (of positive real numbers)

[1]. Factorial numbers are defined as follows:

Factorial	0!	1!	2!	3!	4!	n!	(n+1)!
Value	1	1	2×1	3×2×1	4×3×2×1	n(n-1)(n-2)× . . . . . ×1	(n+1)×n!

[2]. Dimensions in tables:
In the work of this and other authors you will find tables with headings such as: "Resistance / kΩ" and "Diameter / mm". This significance of this notation is that the numbers in the table, if they have no units written next to them, are just numbers, i.e., they are dimensionless. Thus the heading tells you that the quantity shown has been divided by some unit quantity in order to make it dimensionless, e.g., a resistance of 10 kΩ, divided by kΩ is just the number 10. The slash, often omitted in both writing and pronunciation should, in this context, be read as "***in units of***".

Operators (cont[d])

$\mathbf{1}_x\ \mathbf{1}_y\ \mathbf{1}_z$		Unit vector
∇	Nabla, Del	Vector differential operator. $\nabla \equiv \mathbf{1}_x \partial/\partial x + \mathbf{1}_y \partial/\partial y + \mathbf{1}_z \partial/\partial z$
$\nabla\bullet$	Div	Divergence (scalar)
$\nabla\times$	**Curl**	Curl (vector, therefore bold when written in letters as an operator)
Δ	Delta	$\Delta x \equiv$ "the change in x"
δ	delta	$\delta x \equiv$ "a small or infinitesimal increment in x"
d		Differential operator.
∂	de, dey	partial differential operator. Jacobi's delta. Cursive Cyrillic "dey"
exp		exponentiation operator, $\exp(x) \equiv e^x$
f		(*italic*) function operator; e.g., y = *f*(x)
j		(in **bold**) $\equiv \sqrt{(-1)}$, 90° rotation operator.
ln		Log_e , Naperian logarithm
Π	Pi	product operator
Σ	Sigma	summation operator.
$\int$	long s	Integral operator

Parameter symbols

Note: **Bold typeface** denotes a vector or complex number.

Greek

α	alpha	Temperature coefficient
$\mathit{\alpha}$	*alpha (italic)*	attenuation constant (of a transmission line)
$\mathit{\beta}$	*beta (italic)*	phase constant (of a transmission line)
Γ	Gamma	reflection coefficient.
$\mathit{\gamma}$	*gamma (italic)*	propagation constant
δ	delta	The loss-angle of a reactive impedance. $\delta = 90-\varphi$.
δ_i		Skin depth
$\boldsymbol{\varepsilon}\ \varepsilon$	epsilon	Permittivity. Complex (i.e., includes losses) when bold. $\boldsymbol{\varepsilon} = \varepsilon_0 \boldsymbol{\varepsilon}_r$
ε_0	epsilon nought	Permittivity of free space
$\boldsymbol{\varepsilon}_r\ \varepsilon_r$		Relative permittivity. Dielectric constant.
$\boldsymbol{\eta}\ \eta$	eta	Efficiency, dimensionless transfer function (complex when bold)
Θ	Theta	Internal inductance factor, $L_i = (\mu_{(i)}/8\pi)\ \Theta$
Λ	Lambda	Flux linkage
λ	lambda	Electrical wavelength (i.e., when v is not defined as equal to c). $\lambda \equiv v/f$
λ_0	lambda nought	Free-space wavelength. $\lambda_0 \equiv c/f$
$\mathit{\mu}$	*mu* (*italic*)	parent mean.

μ μ	mu	permeability. Complex (i.e., includes losses) when bold. **μ** = μ_0 $\boldsymbol{\mu}_\mathbf{r}$
μ_0	mu nought	permeability of free space
μ_i		Initial relative permeability of a magnetic material.
$\mu_{(i)}$		Internal permeability (of a conductor)
$\boldsymbol{\mu}_\mathbf{r}$ μ_r		Relative permeability.
ν	*nu (italic)*	the number of degrees of freedom of a data set
Ξ	Xi	AC resistance factor defined such that $R_{ac} = R_{dc}$ Ξ
π	pi	Ratio of circumference to diameter of a circle = 3.14159265.....
ρ	rho	volume resistivity
ρ	*rho* (*italic*)	density, charge density.
σ	sigma	conductivity. σ ≡ 1/ρ
σ	*sigma (italic)*	standard deviation, estimated standard deviation.
σ^2	*sigma* squared	statistical variance
Φ	Phi	Magnetic flux
φ	phi	Phase angle
χ χ	chi	Magnetic susceptibility
χ^2	chi-squared	The normalised square error sum
χ^2/ν	reduced χ^2	χ^2 divided by the number of degrees of freedom in the data
Ψ	Psi	Proximity factor
ψ	psi	Pitch angle (of a helix)
ω	omega	Angular frequency = 2πf [radians / second]

Roman

A	Area
A	Vector potential (electromagnetic wave momentum).
A_L	Inductance factor [Henrys per turn-squared]
B	Susceptance. The imaginary part of an admittance.
B	(***italic bold***) Magnetic induction (flux density) vector.
B	(*italic*) Magnetic induction (flux density). *B* = μ *H*
B_C	The susceptance of a capacitance. $B_C = 2\pi fC$
B_L	The susceptance of an inductance. $B_L = -1/(2\pi fL)$
C C	Capacitance. Complex (i.e., includes losses) when bold
c	Velocity of light = 299 792 458 m/s
c	(*italic*) constant of integration
D	Greater diameter. Diameter of a cylinder or solenoid. Denominator.
d	Smaller diameter. Diameter of a wire, etc.
D	(***italic bold***) Electric flux density (vector)
D	(*italic*) Electric flux density. *D* = ε *E*
E	Energy
E	(***italic bold***) Electric field (vector)
E	(*italic*) Electric field strength [Volts / metre]

e	Euler's or Napier's number = 2.7182818.....
F F	Magnetomotive force [Ampere turns]
f	frequency
G	Conductance. The real part of an admittance.
g	Geometric Mean Distance
H	(***italic bold***) Magnetic field (vector)
H	(*italic*) Magnetic field strength [Ampere turns / metre]
h	height
h	Planck's constant. $h = 6.62606896(33) \times 10^{-34}$ Joule seconds
I I	Current phasor, Current.
J J	Current density
k	Coupling factor. Empirical parameter when used with subscript.
k	Boltzmann's constant. $k = 1.380662 \times 10^{-23}$ Joules/Kelvin
L L	Inductance. Complex (i.e., includes losses) when bold.
L'	(L prime) Apparent inductance
ℓ	(*cursive italic l*) length
ℓ"	(ℓ prime) Electrical length, i.e., ℓc/v
M	Mutual inductance
N	The number of turns in a coil. Numerator. A number.
Ñ	(N tilde) Effective number of turns (<N)
n	Refractive index. The number of observations in a data set.
P	Power
P	Poynting vector. Power per unit area.
Q	Quality. The ratio of reactance to resistance of an impedance in series form.
R	Resistance. The real part of an impedance.
r	radius
R_0	The characteristic resistance, or surge resistance, of a transmission line. The real part of $\mathbf{Z}_0$. A reference or standard resistance. The target or design load resistance.
R_r	Radiation Resistance.
S	SWR
S	(*italic*) Reluctance. $S=1/A_L$
T	temperature
t	time
V V	Voltage phasor (bold), Voltage.
v	velocity.
w	width, statistical weight
x	Independent variable, abscissa.
$\bar{x}$	(x bar) sample mean.
X	Reactance
X_0	The characteristic reactance of a lossy transmission line (always negative). The reactance of a standard or reference capacitor
X_C	The reactance of a capacitance. $X_C = -1/(2\pi fC)$

X_L	The reactance of an inductance. $X_L = 2\pi fL$
Y	Admittance. The reciprocal of impedance. $\mathbf{Y} = G + \mathbf{j}B$
y	Dependent variable, ordinate.
Z	Impedance. $\mathbf{Z} = R + \mathbf{j}X$
$\mathbf{Z}_0$	Characteristic impedance of a lossy transmission line. $\mathbf{Z}_0 = R_0 + \mathbf{j}X_0$. (X_0 is negative).
Z_0	The impedance of free space (real for a Lorentzian vacuum, hence not bold). $Z_0 = 376.7303134\ \Omega$

Abbreviations and acronyms

ABS	Acrylonitrile-butadiene-styrene copolymer
AC	Alternating current
ACA	Asymptotically-correct approximation
A-D	Analog to Digital
Ae	Antenna
AFC	Automatic frequency control
Ag	Silver (Argentum)
AGC	Automatic Gain Control.
AGM	Arithmetico-geometric mean
Al	Aluminium, Aluminum
ALC	Automatic Level Control
AM	Amplitude modulation
AMU	Antenna matching unit.
Ar	Argon (noble gas. A is sometines used in old documents)
ATU	Antenna tuning unit
AVC	Automatic volume control
B+ B-	Battery (DC power)
BWO	Backward-wave oscillator
ca.	circa (i.e., in the region of, approximately)
Cd	Cadmium (metal, toxic substance)
cf.	confer (i.e., compare with)
Co	Cobalt
CRAB	Capacitor ratio-arm bridge
Cu	Copper (Cuprum)
CVS	Capacitive voltage-sampling
D-A	Digital to Analog
DC	Direct current
DF	Direction finder
DFM	Digital frequency meter
DMM	Digital multi-meter
DUT	Device under test

DVM	Digital Voltmeter.
EHT	Extra-high tension (i.e., very-high voltage)
EMC	Electromagnetic compatibility
EMF	Electromotive force (the voltage produced by a generator).
ERP	Effective radiated power
ESD	Estimated Standard Deviation (can also stand for electrostatic discharge).
ESL	Equivalent series inductance
ESR	Equivalent series resistance
ETFE	Ethylene-tetrafluoroethylene (Tefzel)
Fe	Iron (ferrum)
FET	Field-efect transistor
FM	Frequency modulation
FSD	Full-scale deflection (of a meter)
Ge	Germanium
GDO	Grid-dip oscillator
GMD	Geometric Mean Distance
Goof	Goodness of fit (scalar composite error function)
Gnd	Ground, Earth, Mass, Chassis, 0V
H_2S	World War II 10cm airborne radar system (named after the song 'Home sweet home').
He	Helium
HF	High-frequency. Frequency in the 1.6 to 30MHz (short-wave) range.
Hg	Mercury (hygrarium, quicksilver)
HT	High-tension (i.e., high voltage)
HV	High voltage
IF	Intermediate frequency
IFT	Intermediate-frequency transformer
IR	infra-red
Kr	Krypton (noble gas)
LF	Low frequency
LNA	Low-noise amplifier
MDB	Magnitude-Difference Bridge
MEK	Methyl-ethyl-ketone (butanone, CH_3-CO-C_2H_5), an industrial solvent.
ML	Modified Lorentzian function (e.g., the electrical resonance curve)
Mn	Manganese
MMF	Magnetomotive force
Ne	Neon (noble gas)
Ni	Nickel
PAD	Pico-Amp diode (low reverse-leakage diode)
Pb	Lead (Plumbum)
PC	Polycarbonate
PD	Potential difference
PE	Polyethylene, Polythene

PET	Polyethylene terephthalate (polyester)
PF	Power-factor
PP	Polypropylene
PS	Polystyrene
PSU	Power-supply unit
PTFE	Polytetrafluoro ethylene (Teflon)
PVC	Polyvinyl chloride
QSL	Quasi-static limit
radar	RAdio Direction And Range (nowadays often written lower-case).
RF	Radio frequency
RFC	Radio-frequency choke
RMS	square-Root of the Mean of Squares
RVS	Resistive voltage-sampling
RX	Receiver
Si	Silicon
Sn	Tin (Stannum)
SMPS	Switched-mode power supply
SRBF	Synthetic-resin-bonded fabric
SRBP	Synthetic-resin-bonded paper
SRF	self-resonance frequency
SS	stainless steel
SWR	Standing Wave Ratio
TCA	Thick-conductor approximation
TED	Truncated exponential decay
TL	Transmission-line
TP	Test point
TRAB	Transformer ratio-arm bridge
TVS	Transformer voltage-sampling
TWT	Travelling-wave tube
TX	Transmitter
UHF	ultra-high frequency (> 300MHz. Upper limit definition is variable, but ≤ 3GHz)
uPVC	un-plasticised PVC
UV	ultraviolet
VHF	very-high frequency (30 - 300MHz)
VCA	Voltage-controlled amplifier
VCF	Voltage-controlled filter
VCO	Voltage-controlled oscillator
+Ve	Positive
-Ve	Negative
VFO	Variable-frequency oscillator
x	(prefix) trans
Xe	Xenon (noble gas)

xtal	crystal (humorously derived from Xmas ≡ Christmas)
Z	Impedance
Zn	Zinc (metal)