IEC 60027-2

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Letter symbols to be used in electrical technology –
Part 2: Telecommunications and electronics

Symboles littéraux à utiliser en électrotechnique –
Partie 2: Télécommunications et électronique

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INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY –

Part 2: Telecommunications and electronics

FOREWORD

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International Standard IEC 60027-2 has been prepared by IEC technical committee 25: Quantities and units.

This fourth edition cancels and replaces the third edition published in 2005. This fourth edition constitutes a technical revision.

This edition includes the following significant changes with respect to the previous edition:

a) former Subclauses 3.8 and 3.9 are cancelled and replaced by IEC 80000-13:2008;
b) former Subclause 3.10, now 4.8, is revised in accordance with IEC 60050-192:2015;
c) former Subclause 3.11, now 4.9, is revised in accordance with IEC 60050-561:2014;
d) former Subclause 3.13, now 4.11, is revised in accordance with ISO 80000-8:2007, IEC 60050-801:1994 and IEC 60050-802:2011;
e) technical and editorial corrections have been carried out, mainly in Subclause 4.1.
f) tables are simplified, mainly by deleting useless columns.

The text of this standard is based on the following documents:

FDIS	Report on voting
25/635/FDIS	25/640/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60027 series, published under the general title *Letter symbols to be used in electrical technology*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY –

Part 2: Telecommunications and electronics

1 Scope

This part of IEC 60027 is applicable to telecommunications and electronics. It gives names and symbols for quantities and their units.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60027-1:1992, *Letter symbols to be used in electrical technology – Part 1: General*
IEC 60027-1:1992/AMD1:1997
IEC 60027-1:1992/AMD2:2005

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Introduction to tables

In this part of IEC 60027, complex quantities are in general denoted by underlining their symbols. However, this does not constitute a compulsory rule in applications (see IEC 60027-1).

To avoid any ambiguity, some quantity names are followed by a specific use, enclosed in angle brackets "<…>" after a comma.

When several symbols are indicated for a given quantity, the first is the preferred symbol and the others are reserve symbols, unless otherwise stated.

When several units are indicated for a given quantity, the first is the coherent SI unit, unless otherwise stated. For logarithmic ratios, the first mentioned unit is the decibel.

For quantities defined as a logarithm of the ratio of two power quantities or two root-power quantities (also known as field quantities), the submultiple decibel (dB) of the bel (B) is generally used, rather than the neper (Np). The bel is not explicitly mentioned in the tables. See IEC 60027-3 and ISO 80000-1:2009, Annex C.

5 Quantities and units

5.1 General concepts

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
101	101-12-02	signal	S s	A signal is any physical phenomenon whose presence, absence or variation is considered as representing information. In general, a signal is a quantity, one or more parameters of which represent information. In this document, S_1 and S_2 are used for input and output signals respectively. See IEC 60027-1 for other suitable subscripts. In cases where the type of signal quantity is known, for example, electric current, voltage, pressure, etc., use the appropriate symbol. With respect to capital and lower-case letters, see IEC 60027-1:1992, 2.1.			The unit depends on the kind of quantity constituting the signal (electric current, voltage, pressure, etc.).
102		signal power	P_s P_sig	"s" (lower case, upright) is used as subscript for "signal". In signal theory, the term "instantaneous power" is by convention used for the square of the instantaneous value of a signal. This square is proportional to a physical power if the signal is a root-power quantity (or field quantity) (see Note 1 to entry of IEC 60050-103:2009, 103-09-05). In a physical system, a signal power is always a physical power.	watt	W	
103		signal level	L L_s L_sig	$L = 10\ \lg\left\|\frac{S}{S_\mathrm{ref}}\right\|\ \mathrm{dB} = \frac{1}{2}\ln\left\|\frac{S}{S_\mathrm{ref}}\right\|\ \mathrm{Np}$ where S and S_ref are two signals of the same kind, S_ref being a reference signal.	decibel neper	dB Np	
104	702-07-04	absolute power level; power level	L_P	$L_P = 10\ \lg\frac{P}{P_\mathrm{ref}}\ \mathrm{dB} = \frac{1}{2}\ln\frac{P}{P_\mathrm{ref}}\ \mathrm{Np}$ where P is a power and P_ref is a reference power.	decibel neper	dB Np	
105	702-07-06	absolute voltage level; voltage level	L_U	$L_U = 20\ \lg\frac{U}{U_\mathrm{ref}}\ \mathrm{dB} = \ln\frac{U}{U_\mathrm{ref}}\ \mathrm{Np}$ where U is a voltage and U_ref is a reference voltage. The synonym "voltage level" may be used only where there is no ambiguity.	decibel neper	dB Np	

Item number	Quantity				Units		
	Entry number in IEC 60050	**Name**	**Symbol**	**Definition and remarks**	**Name**	**Symbol**	**Remarks**
106	702-07-05	relative power level	$L_{r,x}$ L_r	$L_{r,x} = L_{P,x} - L_{P,0}$ where $L_{P,x}$ and $L_{P,0}$ are the absolute power levels (104) at the measuring point and at a reference point, respectively.	decibel neper	dB Np	
107	702-08-03	noise	N n S_n s_n	A noise is any variable physical phenomenon, generally a quantity, apparently not conveying information and which can be superimposed on, or combined with, a wanted signal. Concerning upper and lower-case letters, see IEC 60027-1:1992, 2.1. "n" (lower case, upright) is used as subscript for "noise". In cases where the type of noise quantity is known, use the appropriate symbol (for example, I, i for electric current) with n as subscript (e.g. I_n, i_n).			The unit depends on the kind of quantity constituting the noise (electric current, voltage, pressure, etc.).
108	103-09-05	power spectral density, <for a signal or noise>	$w(f)$	$P = \int_0^\infty w(f)\,\mathrm{d}f$ where f is the frequency and P is the total power. In signal theory, the term "instantaneous power" is by convention used for the square of the instantaneous value of a signal or noise. This square is proportional to a physical power if the signal or the noise is a root-power (or field quantity). See Note 1 to entry of 103-09-05 in IEC 60050-103:2009. In a physical system, the power spectral density is always a physical power spectral density.	watt per hertz	W/Hz	
109		power spectral density of white noise	N_0	The power spectral density (108) is frequency-independent: $w(f) = N_0$	watt per hertz	W/Hz	
110	702-08-51	equivalent noise voltage	U_n	Applies to a one-port network. U_n is an RMS voltage.	volt	V	

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
111	702-08-52	equivalent noise resistance; noise resistance	R_{eq} R_n	Applies to a one-port network. $R_{eq} = \frac{U_n^2}{4kT_{ref}\,\Delta f}$ where U_n is the equivalent noise voltage (110), k is the Boltzmann constant, T_{ref} is a reference temperature and Δf is the frequency bandwidth (154) considered. The synonym "noise resistance" may be used only where there is no ambiguity.	ohm	Ω	
112	702-08-54	spot noise temperature	$T(f)$	Applies to a one-port network. f is frequency.	kelvin	K	
113	702-08-55	mean noise temperature	$\overline{T}$	Applies to a one-port network.	kelvin	K	
114	702-08-56	equivalent spot noise temperature	$T_{eq}(f)$	Applies to a two-port network. f is frequency.	kelvin	K	
115	702-08-58	mean equivalent noise temperature; mean noise temperature	$\overline{T}_{eq}$	Applies to a two-port network. The synonym "mean noise temperature" may be used only where there is no ambiguity.	kelvin	K	
116	702-08-57	spot noise factor	$F(f)$	Applies to a two-port network. The noise factor is the ratio of the exchangeable power spectral density (108) of output noise to the power spectral density that would be present at the output if the only source of noise were input thermal noise at a reference temperature T_{ref}: $F(f) = 1 + \frac{T_{eq}(f)}{T_{ref}}$ where $T_{eq}(f)$ is the equivalent spot noise temperature (114). For exchangeable power, see IEC 60050-702:1992, 702-07-11.	one	1	

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
117	702-08-57	spot noise figure	$F_n(f)$	$F_n(f) = 10 \lg F(f)$ dB $= \frac{1}{2} \ln F(f)$ Np where $F(f)$ is the spot noise factor (116). In English, "noise factor" is generally used for the arithmetic expression and "noise figure" is used for the logarithmic expression. See IEC 60050-702:1992, 702-08-57, Note 2. In French, "facteur de bruit" is generally used in both cases.	decibel neper	dB Np	
118	702-08-59	mean noise factor; noise factor	$\overline{F}$	Applies to a two-port network. $\overline{F} = 1 + \frac{\overline{T}_{eq}}{T_{ref}}$ where $\overline{T}_{eq}$ is the mean equivalent noise temperature (115) and T_{ref} is a reference temperature. The synonym "noise factor" may be used only where there is no ambiguity.	one	1	
119	702-08-59	mean noise figure; noise figure	$\overline{F}_n$	$\overline{F}_n = 10 \lg \overline{F}$ dB $= \frac{1}{2} \ln \overline{F}$ Np where $\overline{F}$ is the mean noise factor (118). In English, "noise factor" is generally used for the arithmetic expression and "noise figure" is used for the logarithmic expression. See IEC 60050-702:1992, 702-08-59, Note 2. In French, "facteur de bruit" is generally used in both cases and the adjective "logarithmique" is omitted in practice. The synonym "noise figure" may be used only where there is no ambiguity.	decibel neper	dB Np	
120	702-08-61	signal-to-noise ratio; SNR	k_{SN}	Signal power (102) divided by noise power. In practice, the symbol S/N is generally used.	one	1	

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
121	702-08-61	signal-to-noise logarithmic ratio	K_{SN}	$K_{SN} = 10 \lg k_{SN}$ dB $= \frac{1}{2} \ln k_{SN}$ Np where k_{SN} is the signal-to-noise ratio (120). In practice, the term "signal-to-noise ratio" and the symbol S/N are generally used.	decibel neper	dB Np	
122	103-07-17	growth coefficient	σ	Example: $u(t) = \hat{u}\,e^{\sigma t} \sin \omega t$ where $u(t)$ is a sinusoidal function of time t, with angular frequency ω and amplitude $\hat{u}$.	decibel per second neper per second	dB/s Np/s	
123	103-05-24	damping coefficient	δ	$\delta = -\sigma$ where σ is the growth coefficient (122).	decibel per second neper per second	dB/s Np/s	
124	103-07-16	complex angular frequency; complex frequency	$\underline{s}$ $\underline{p}$	$\underline{s} = \sigma + j\omega = -\delta + j\omega$ where ω is the angular frequency, σ is the growth coefficient (122) and δ is the damping coefficient (123).	second to the power of minus one	s^{-1}	Special units are only used when the real and imaginary parts are treated separately.

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
125	131-15-20	transfer function	$\underline{H}$ $\underline{T}$	$\underline{H}(\underline{s}) = \frac{\underline{S}_2(\underline{s})}{\underline{S}_1(\underline{s})}$ where $\underline{S}_1$ and $\underline{S}_2$, respectively, are the complex representations of the input and output signals, respectively, as functions of the complex angular frequency $\underline{s}$ (124). The complex quantities are generally the Laplace transforms of the time-varying quantities: $\underline{H} = \frac{\mathrm{L}s_2(t)}{\mathrm{L}s_1(t)}$ where $\mathrm{L}s_1(t)$ and $\mathrm{L}s_2(t)$ are the Laplace transforms of the signals $s_1(t)$ and $s_2(t)$ and t is time.			The unit of the quantity $\underline{H}$ is the quotient of the unit of $s_2(t)$ by the unit of $s_1(t)$.
126		transfer gain	$G(\omega)$	$G(\omega) = \lvert H(\mathrm{j}\omega)\rvert$ where $H(\sigma + \mathrm{j}\omega)$ is the transfer function (125).			The unit is the same as for $\underline{H}$.
127		transfer attenuation	$A(\omega)$	$A(\omega) = 1/G(\omega)$ where $G(\omega)$ is the transfer gain (126).			The unit is the reciprocal of the unit of $\underline{H}$.
128		transfer exponent	$\underline{\Gamma}$	If the transfer function $\underline{H}$ (125) is of dimension one (see IEC 60050-112:2010, 112-01-13): $\underline{H}(\mathrm{j}\omega) = G(\omega)\exp[-\mathrm{j}B(\omega)] = \exp[\underline{\Gamma}(\omega)]$ $\underline{\Gamma} = A - \mathrm{j}B$ (see 129 and 130). See also image transfer coefficient (IEC 60050-131:2002, 131-15-25).	one	1	Special units are only used when the real and imaginary parts are treated separately.
129		logarithmic transfer attenuation	A	$A = 20\,(\lg\,\mathrm{e})\,\mathrm{Re}\,(\underline{\Gamma})\ \mathrm{dB} = \mathrm{Re}\,(\underline{\Gamma})\ \mathrm{Np}$ where $\underline{\Gamma}$ is the transfer exponent (128) and e is the base of the natural logarithm. In practice, "transfer attenuation" is used.	decibel neper	dB Np	

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
130		phase change; phase shift	B φ	$B(\omega) = \text{Im}(\underline{\Gamma}) = -\arg \underline{H}(\text{j}\omega)$ where $\underline{H}(\sigma + \text{j}\omega)$ is the transfer function (125) and $\underline{\Gamma}$ is the transfer exponent (128).	radian degree	rad °	$1° = \frac{\pi}{180}$ rad
131		voltage attenuation factor	a_U	$a_U = \frac{U_1}{U_2}$ where U_1 and U_1 are two voltages. Subscripts 1 and 2 can for example designate the input port and the output port, respectively, of a two-port network. The inverse of the voltage attenuation factor is the voltage gain factor (133). In practice, "voltage attenuation" is used.	one	1	
132		logarithmic voltage attenuation	A_U	$A_U = 20 \lg a_U$ dB $= \ln a_U$ Np where a_U is voltage attenuation factor (131). When the logarithmic voltage attenuation is negative, its absolute value is the logarithmic voltage gain (134). In practice, "voltage attenuation" is used.	decibel neper	dB Np	
133		voltage gain factor	g_U	$g_U = \frac{U_2}{U_1}$ where U_1 and U_1 are two voltages. Subscripts 1 and 2 can, for example, designate the input port and the output port, respectively, of a two-port network. The inverse of the voltage gain factor is the voltage attenuation factor (131). In practice, "voltage gain" is used.	one	1	
134		logarithmic voltage gain	G_U	$G_U = 20 \lg g_U$ dB $= \ln g_U$ Np where g_U is the voltage gain factor (133). When the logarithmic voltage gain is negative, its absolute value is the logarithmic voltage attenuation (132). In practice, "voltage gain" is used.	decibel neper	dB Np	

Item number	Quantity				Units		
	Entry number in IEC 60050	Name	Symbol	Definition and remarks	Name	Symbol	Remarks
135	702-02-10	power loss factor; power attenuation factor	a_P	Use subscript S instead of P in the case of apparent powers. $a_P = \frac{P_1}{P_2}$ Subscripts 1 and 2 are used to designate the power of a signal at two points, for example, input and output of a two-port network, or the power of a signal in two specified conditions, for example, for defining insertion attenuation or insertion loss (IEC 60050-131:2002, 131-15-30). The inverse of the power loss factor is the power gain factor (137). In practice, "power loss" or "power attenuation" are used.	one	1	
136	702-02-10	logarithmic power loss; logarithmic power attenuation; loss; attenuation	A_P	Use subscript S instead of P in the case of apparent powers. $A_P = 10 \lg a_P \text{ dB} = \frac{1}{2} \ln a_P \text{ Np}$ where a_P is the power loss factor (135). When the logarithmic power loss is negative, its absolute value is the logarithmic power gain (138). In practice, "logarithmic" is omitted in the terms.	decibel neper	dB Np	
137	702-02-11	power gain factor; gain factor	g_P	Use subscript S instead of P in the case of apparent powers. $g_P = \frac{P_2}{P_1}$ Subscripts 1 and 2 are used to designate the power of a signal at two points, for example, input and output of a two-port network, or the power of a signal in two specified conditions, for example, for defining available power gain (IEC 60050-702:1992, 702-07-12). The inverse of the power gain factor is the power loss factor (135). In practice, "factor" is omitted in the terms.	one	1	