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Letter symbols to be used in electrical technology —

Part 3: Logarithmic quantities and units

ICS 01.075; 29.020

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee SS/7, General metrology, quantities, units and symbols, upon which the following bodies were represented:

British Measurement and Testing Association

City University

DTI — National Weights and Measures Laboratory

Federation of Small Businesses

Institute of Measurement and Control

Institution of Electrical Engineers

Institution of Mechanical Engineers

National Physical Laboratory

Royal Society of Chemistry

Society of Chemical Industry

Trading Standards Institute

Amendments issued since publication

Amd. No.	Date	Comments

Contents

National foreword

This British Standard reproduces verbatim the English language content of IEC 60027-3:1989, published by International Electrotechnical Commission (IEC). This British Standard is also in agreement with Harmonized Document HD 245.3 S3:2001, which was published by the European Committee for Electrotechnical Standardization (CENELEC).

National annex NA reproduces verbatim Amendment 1 to IEC 60027-3:1989, published March 2000.

IEC 60027 consists of general and specific parts with purely electric character, under the title *Letter symbols to be used in electrical technology*. Only the specific parts with electric character will be published in this series, as the general parts will be harmonized with the ISO 31 series (to form ISO 80000 series) including Part 1. Other parts comprise:

— Part 2: *Telecommunications and electronics*;

— Part 3: *Logarithmic quantities and units*.

This British Standard has been numbered Part 3 to reflect the fact there are other parts in the IEC series.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the HD title page, the HD foreword, pages 3 to 15 and a back cover.

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HARMONIZATION DOCUMENT

DOCUMENT D'HARMONISATION

HARMONISIERUNGSDOKUMENT

HD 245.3 S3

July 2001

ICS 01.060

Supersedes HD 245.3 S2:1991

English version

Letter symbols to be used in electrical technology
Part 3: Logarithmic quantities and units
(IEC 60027-3:1989 + A1:2000)

Symboles littéraux à utiliser en
électrotechnique
Partie 3: Grandeurs et unités
logarithmiques
(CEI 60027-3:1989 + A1:2000)

Formelzeichen für die Elektrotechnik
Teil 3: Logarithmische Größen und
Einheiten
(IEC 60027-3:1989 + A1:2000)

This Harmonization Document was approved by CENELEC on 2001-05-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

Up-to-date lists and bibliographical references concerning such national implementation may be obtained on application to the Central Secretariat or to any CENELEC member.

This Harmonization Document exists in three official versions (English, French, German).

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. HD 245.3 S3:2001 E

Foreword

The text of the International Standard IEC 60027-3:1989 + A1:2000, prepared by IEC TC 25, Quantities and units, and their letter symbols, was submitted to the formal vote and was approved by CENELEC as HD 245.3 S3 on 2001-05-01 without any modification.

This Harmonization Document supersedes HD 245.3 S2:1991.

The following dates were fixed:

— latest date by which the existence of the HD has to be announced at national level	(doa) 2001-10-01
— latest date by which the HD has to be implemented at national level by publication of a harmonized national standard or by endorsement	(dop) 2002-04-01
— latest date by which the national standards conflicting with the HD have to be withdrawn	(dow) 2004-04-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60027-3:1989 + A1:2000 was approved by CENELEC as a Harmonization Document without any modification.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY
Part 3: Logarithmic quantities and units

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by IEC Technical Committee No. 25: Quantities and units, and their letter symbols.

This standard forms the second edition of IEC Publication 27-3 and supersedes the first edition issued in 1974.

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

Six Months' Rule	Reports on Voting
25(CO)93	25(CO)95 and 95A

Full information on the voting for the approval of this standard can be found in the Voting Reports indicated in the above table.

The following IEC publication is quoted in this standard:

Publication No. 50 (702): International Electrotechnical Vocabulary (IEV), Chapter 702: Oscillations, signals and related devices (in preparation).

Other publications quoted:

ISO 31-11 (1978): Mathematical signs and symbols for use in the physical sciences and technology.

ISO 2382-16 (1978): Data processing — Vocabulary — Section 16: Information theory.

LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY

Part 3: Logarithmic quantities and units

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SCOPE AND INTRODUCTION

This standard applies to logarithmic quantities and units.

Quantities that can be expressed as the logarithm of a dimensionless quantity, such as the ratio of two physical quantities of the same kind, can be regarded and treated in different ways. In many cases, differences in principle do not affect the practical treatment.

Logarithmic quantities are here treated in a way that makes it possible, for example, to express the attenuation of a certain linear two-terminal network by the equally valid expressions $A = 4,6$ nepers $= 4,0$ bels $= 40$ decibels, where 4,6, 4,0 and 40 are regarded as numerical values and "neper", "bel" and "decibel" as units with specified relationships.

The fact that this standard is based on certain principles and assumptions implies no opinion whether any other principle or assumption is "right" or "wrong". This standard relates to the handling of logarithmic quantities, without regard to their interpretation or specific application.

The fact that only some logarithmic quantities are particularly dealt with here does not imply that other logarithmic quantities do not exist. It is possible that other logarithmic quantities will be particularly dealt with in a later edition or separately.

1. Logarithmic quantities

1.1 *General*

logarithmic quantity

A quantity expressed as the logarithm of the ratio of two quantities of the same kind (two voltages, two powers, two frequencies) or as the logarithm of any dimensionless quantity. For a complete definition of a logarithmic quantity, the base of the logarithm shall be specified.

In the set of logarithmic quantities can also be included quantities which are derivatives of a logarithmic quantity, or quotients of a logarithmic quantity and another quantity. An example of such a derivative is the attenuation coefficient (see Sub-clause 4.3).

The logarithmic quantities particularly dealt with here are transmission path quantities, levels, frequency intervals and decision content.

For transmission path quantities and levels, one must deal with two sets of the quantities to whose ratios the logarithmic quantities correspond, namely field quantities and power quantities.

Field quantity is a quantity such as voltage, current, sound pressure, electric field strength, velocity and charge density, the square of which in linear systems is proportional to power.

Power quantity is power or a quantity directly proportional to power, e.g. energy density, acoustic intensity and luminous intensity.

A field quantity may be expressed by a complex number. In this case, the concept of a logarithmic quantity applies to the logarithm of the modulus and therefore always to a real number.

The logarithmic quantities in this standard are given in a general way, unless specified otherwise. In a given field, logarithmic quantities with narrower definitions can be given. Such quantities can have names corresponding to this, e.g. power level, absolute voltage level, noise level, insertion loss, balance-return loss. Their letter symbols can also correspond to this, e.g. L_E for "field-strength level" and A_{ins} for "insertion loss".

It should further be observed that the value of some logarithmic quantities may be impedance-dependent and that therefore the value of such quantities without adequate information about impedance can be meaningless or misleading.

The definitions for different quantities are followed by simplified definitions after "In short". These simplified definitions are obviously less rigorous than the preceding definitions and in some respects incomplete.

In the definitions, the expression "log" represents a logarithm without a specified base (see ISO 31-11). The following conventions (also ISO 31-11) are used to denote logarithms with different bases:

$$\log_2 x = \text{lb } x$$
$$\log_{10} x = \text{lg } x$$
$$\log_e x = \text{ln } x$$

1.2 Transmission path quantities

A transmission path may be intentional or parasitic and may include reflections, line-discontinuities, etc.

1.2.1 Total quantities

attenuation; loss (of a given transmission path)

A quantity for the property of a transmission path to decrease the strength of a wave passing along it, expressing the property as the logarithm of the ratio of an appropriate value of an input quantity of the wave and the corresponding output quantity value.

In short: log (input/output)

This quantity is applicable to transmission lines, attenuators, pads, filters, reflection points, crosstalk paths, absorbing glass plates, etc.

amplification; gain (of a given transmission path)

A quantity for the property of a transmission path to increase the strength of a wave passing along it, expressing the property as the logarithm of the ratio of an appropriate value of an output quantity of the wave and the corresponding input quantity value.

In short: log (output/input)

This quantity is applicable to amplifiers, amplifying circuits, etc.

gain (relative to a reference transmission path)

A quantity for the property of a transmission path under consideration to make a wave passing along it stronger than it would be if passing along a reference transmission path with the same input, expressing the property as the logarithm of the ratio of an appropriate value of an output quantity of the wave passing along the path under consideration and the corresponding output quantity value of the wave passing along the reference path.

In short: log (output of considered path/output of reference path)

This quantity is applicable to aerials, loudspeakers, microphones, etc. Examples of wave quantities are power intensity, electric field strength, pressure.

1.2.2 Local quantity

attenuation coefficient

A quantity for the property of an infinitesimal part of a continuous transmission path to decrease the strength of a passing wave, expressing the property as the derivative of the attenuation with respect to path length.

In short: (attenuation over ds)/ds, where ds is an infinitesimal part of the transmission path.

1.3 Levels

level; absolute level

A quantity corresponding to a field quantity or a power quantity under consideration, expressed as the logarithm of the ratio of the quantity under consideration and a specified reference value of that quantity.

The reference value in a given case, e.g. 1 mW shall be known or indicated.

In short: log (considered value of a quantity/specified reference value of the quantity)

level difference; level

The difference between two absolute levels, i.e. a "level" with respect to an unspecified reference value.

In short: log (considered value of a quantity/other considered value of the same quantity)

relative level

The difference between the level of the quantity under consideration and the corresponding level of that quantity at a reference point

In short: log (considered value of a quantity/corresponding value of that quantity at a reference point)

The reference point, which may be real or virtual, shall be known or indicated.

1.4 Frequency interval

frequency interval

A quantity expressing the relationship of two frequencies as the logarithm of the ratio of the higher frequency and the lower frequency.

In short: log (higher frequency/lower frequency)

1.5 Quantities related to information content

decision content (IEV 702-04-17*)

The logarithm of the number of decisions needed to select a given event among a finite number of mutually exclusive events.

In short: log (number of events)

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* International Electrotechnical Vocabulary (IEV). IEC Publication 50(702) (in preparation).

2. Units for logarithmic quantities

It should be observed that a unit for a category of quantities is a quantity of this category chosen for reference. Thus, the unit for attenuation is the logarithm of a particular ratio between the input quantity and the output quantity; this ratio forms the base of the corresponding logarithmic scale.

2.1 *Neper and bel*

2.1.1 The neper and the bel are units for such logarithmic quantities as are expressed as the logarithm of the ratio of the absolute values of two field quantities or of two power quantities.

The use of the neper is usually restricted to theoretical calculations, when this unit is most convenient, whereas in other cases the bel, or more often the submultiple decibel, is usually used.

2.1.2 The bel (B) is the logarithmic reference quantity which for a ratio of two power quantities corresponds to the ratio 10, and for a ratio of two field quantities corresponds to the ratio $\sqrt{10}$.

2.1.3 The neper (Np) is the logarithmic reference quantity which for a ratio of two field quantities corresponds to the ratio e and for a ratio of two power quantities corresponds to the ratio e^2.

2.1.4 The following relations are applicable:

1 neper = 2 lg e bel $\approx$ 0,8686 bel
1 bel = 0,5 ln 10 nepers $\approx$ 1,151 neper

The neper and the bel can be embodied in standards, e.g. for the attenuation of a transmission line, in the form of pads; for light, in the form of absorbing glass plates. A 1-bel standard for attenuation in a transmission line makes the output power 1/10 of the input power and makes the output voltage and current $\sqrt{1/10}$ of the input voltage and current. A 1-neper standard for attenuation in a transmission line makes the output voltage and current 1/e of the input voltage and current and makes the output power $1/e^2$ of the input power.

2.1.5 When coherence with the SI is required, natural logarithms shall be used. Coherent units for the complex ratio of field quantities are the neper (logarithm of the modulus) for the real part and the radian for the imaginary part.

2.2 *Octave and decade*

The octave and the decade are units for frequency intervals.

The octave is the frequency interval which corresponds to the frequency ratio 2.

The decade is the frequency interval which corresponds to the frequency ratio 10.

1 octave = lg 2 decades $\approx$ 0,3010 decade
1 decade = lb 10 octaves $\approx$ 3,322 octaves

2.3 *Shannon, hartley and natural unit of information*

These are units of logarithmic measure of information quantities expressing the decision content, denoted H_0. (ISO 2382-16 [16.03.01].)

The shannon, corresponding to two events, applies to numerical values expressed as binary logarithms. Symbol: Sh.

The hartley, corresponding to 10 events, applies to numerical values expressed as decimal logarithms.

The natural unit of information applies to numerical values expressed as natural logarithms. Abbreviation: NAT.

Example:

For the number of mutually exclusive events equal to 3, then:

H_0 = lb 3 shannon = $\log_2 3$ shannon $\approx$ 1,585 shannon = 1,585 Sh

H_0 = lg 3 hartley = $\log_{10} 3$ hartley $\approx$ 0,477 hartley

H_0 = ln 3 natural unit = $\log_e 3$ natural unit $\approx$ 1,098 natural unit

Hence:

1 hartley = lb 10 shannon $\approx$ 3,322 Sh

1 natural unit of information = lb e shannon $\approx$ 1,443 Sh

2.4 *Multiples of units*

Decimal multiples and submultiples of the above units can be designated by adding the usual prefixes, e.g.:

1 decibel = 0,1 bel;   1 dB = 0,1 B

The decibel is more frequently used than the bel.

1 millineper = 0,001 neper;   1 mNp = 0,001 Np

3. Numerical values of logarithmic quantities

Physical quantities can be represented as products of numerical values and appropriate units.

For a quantity A with a chosen unit symbolized by $[A]$ and the corresponding numerical value symbolized by $\{A\}$, we have:

$$A = \{A\}[A] \quad \text{or} \quad \{A\} = A/[A]$$

In practice, the choice of units is very restricted and for the logarithmic quantities dealt with here few units beyond those mentioned in Clause 2 are in use.

If for a logarithmic quantity we use this relationship between quantity, numerical value and unit, the numerical value can be obtained as shown in the following example for an attenuation A. The attenuation is assumed to refer to a non-transforming transmission path with the ratio r_f between an input field quantity and the corresponding output quantity and may be represented as:

$$A = \ln r_f \, \mathrm{Np}$$

so that the numerical value of A is ln r_f, when A is measured in nepers. This can be expressed as $\{A\}_{\mathrm{Np}}$ = ln r_f. If we wish to obtain the numerical value of A, when A is measured in bels, i.e. $\{A\}_{\mathrm{B}}$, we shall note that the bel, used with ratios of field quantities, r_f, corresponds to the ratio $\sqrt{10}$.

Thus:

$$\{A\}_{\mathrm{B}} = \frac{A}{[A]} = \frac{A}{1\ \mathrm{B}} = \frac{\lg r_f}{\lg \sqrt{10}} = \frac{\lg r_f}{0,5 \lg 10} = \frac{2 \lg r_f}{\lg 10} =$$

$$2 \lg r_f = 2 \lg e \ln r_f \approx 2 \times 0,4343 \ln r_f = 0,8686 \ln r_f$$

Observe that the numerical value relative to one unit is easily converted to the value appropriate to another unit. This is usually done by means of the relations between units (see Clause 2).

4. Logarithmic quantities with units

It should be observed that, when there is an impedance transformation, it is necessary to distinguish between different but related logarithmic quantities, one referring to the ratio between the power quantities and at least two others to the ratios between the two corresponding field quantities.

In the equations, F denotes a field quantity and P denotes a power quantity, with the corresponding subscripts (F) and (P). (The subscript P without parentheses will be used to indicate active power.) In practical cases, the field quantity F should be replaced by the field quantity of interest, e.g. U for voltage, I for current, E for field strength, p for pressure; the power quantity P should be replaced by the power quantity of interest, e.g. S for apparent power and Φ for radiant flux.

In Sub-clause 4.1, equations are given both for the general case where there may be an impedance transformation and for the case without impedance transformation. Although many different attenuations are given in Sub-clause 4.1, others also exist (e.g. available power attenuation, apparent power attenuation) which can be more or less directly derived from those mentioned.

In Sub-clauses 4.2 to 4.5, equations are given only for the case without impedance transformation, but equations for the general case with impedance transformation can be obtained in the same way as in Sub-clause 4.1.

The equations in Sub-clauses 4.1 and 4.2 refer to transfer from 1 to 2 or to comparison between 2 and 1, with 1 as the basis.

4.1 *Attenuation A*

Power quantity attenuation: $A_{(P)}$.
Field quantity attenuation: $A_{(F)}$.
For transfer from 1 to 2, they can be expressed as:

$$A_{(P)} = \lg \left| \frac{P_1}{P_2} \right| \text{ B} = 10 \lg \left| \frac{P_1}{P_2} \right| \text{ dB} = 0{,}5 \ln \left| \frac{P_1}{P_2} \right| \text{ Np}$$

$$A_{(F)} = 2 \lg \left| \frac{F_1}{F_2} \right| \text{ B} = \ln \left| \frac{F_1}{F_2} \right| \text{ Np}$$

In certain cases, we do not have only one power quantity and one field quantity. For an electric transmission path, we can have two field quantity attenuations, one corresponding to the voltage U and one corresponding to the current I. We can further have one power quantity attenuation corresponding to the apparent power S and one corresponding to the active power P. These attenuations are here denoted:

voltage attenuation: A_U;
current attenuation: A_I;
attenuation of apparent power: A_S;
attenuation of active power: A_P.

We obtain:

$$A_U = 2 \lg \left| \frac{U_1}{U_2} \right| \text{ B} = 20 \lg \left| \frac{U_1}{U_2} \right| \text{ dB} = \ln \left| \frac{U_1}{U_2} \right| \text{ Np}$$

$$A_I = 2 \lg \left| \frac{I_1}{I_2} \right| \text{ B} = \ln \left| \frac{I_1}{I_2} \right| \text{ Np}$$

$$A_S = \lg \left| \frac{S_1}{S_2} \right| \text{ B} = 10 \lg \left| \frac{S_1}{S_2} \right| \text{ dB} = 0{,}5 \ln \left| \frac{S_1}{S_2} \right| \text{ Np}$$

$$A_P = \lg \left| \frac{P_1}{P_2} \right| \text{ B} = 0{,}5 \ln \left| \frac{P_1}{P_2} \right| \text{ Np}$$

When $\dfrac{U_1}{I_1} = \dfrac{U_2}{I_2}$, i.e. when there is no impedance-transformation from 1 to 2, we have only one attenuation

$$A = A_{(P)} = A_{(F)} = A_U = A_I = A_S = A_P$$

In the general case with $\dfrac{U_1}{I_1} = Z_1, \dfrac{U_2}{I_2} = Z_2, |U_1 I_1| = |S_1|$ and $|U_2 I_2| = |S_2|$

we obtain:

$$A_S = 0{,}5 (A_U + A_I)$$

$$A_S - A_U = \lg \left| \frac{Z_2}{Z_1} \right| \text{ B} = 0{,}5 \ln \left| \frac{Z_2}{Z_1} \right| \text{ Np}$$

$$A_S - A_I = \lg \left| \frac{Z_1}{Z_2} \right| \text{ B} = 0{,}5 \ln \left| \frac{Z_1}{Z_2} \right| \text{ Np}$$

$$A_U - A_I = 2 \lg \left| \frac{Z_1}{Z_2} \right| \text{ B} = \ln \left| \frac{Z_1}{Z_2} \right| \text{ Np}$$

4.2 Gain G

Power quantity gain: $G_{(P)}$.
Field quantity gain: $G_{(F)}$.

For transfer from 1 to 2 or for comparison between 2 and 1, with 1 as base, they can be expressed as:

$$G_{(P)} = \lg \left| \frac{P_2}{P_1} \right| \text{ B} = 10 \lg \left| \frac{P_2}{P_1} \right| \text{ dB} = 0{,}5 \ln \left| \frac{P_2}{P_1} \right| \text{ Np}$$

$$G_{(F)} = 2 \lg \left| \frac{F_2}{F_1} \right| \text{ B} = \ln \left| \frac{F_2}{F_1} \right| \text{ Np}$$

When there is no impedance transformation

$$G = G_{(P)} = G_{(F)}$$

4.3 Attenuation coefficient α

For a continuous transmission path, $\alpha = \dfrac{dA}{ds}$, where s is path length in the direction of propagation, ds is the length of an infinitesimal part of the path and dA is the corresponding attenuation. If A refers to a certain attenuation, e.g. a voltage attenuation, then α refers to the corresponding attenuation coefficient, i.e. here an attenuation coefficient for voltage. In most cases, when the transmission line does not transform the impedance, the different attenuation coefficients coincide.

Examples of unit: Np/m and B/m.

4.4 Level, absolute level L

Power quantity level: $L_{(P)}$.
Field quantity level: $L_{(F)}$.
When P_{ref} and F_{ref} are reference values, the levels can be expressed as:

$$L_{(P)} = \lg \left|\frac{P}{P_{ref}}\right| B = 10 \lg \left|\frac{P}{P_{ref}}\right| dB = 0.5 \ln \left|\frac{P}{P_{ref}}\right| Np$$

$$L_{(F)} = 2 \lg \left|\frac{F}{F_{ref}}\right| B = \ln \left|\frac{F}{F_{ref}}\right| Np$$

When there is no impedance transformation

$$L = L_{(P)} = L_{(F)}$$

For a field-strength level L_E, where E is the electrical field strength, being a "field quantity", with E_{ref} as reference value, we obtain with units bel and decibel:

$$L_E = 2 \lg \left(\frac{E}{E_{ref}}\right) B = 20 \lg \left(\frac{E}{E_{ref}}\right) dB$$

If $E = 1$ pV/m and $E_{ref} = 1$ nV/m

$$L_E = 2 \lg \left(\frac{1\ pV/m}{1\ nV/m}\right) B = 2 \lg 10^{-3} B = 2(-3) B = -6 B = -60 dB$$

4.5 Relative level L_r

Without impedance transformation, we obtain:

$$L_r = \ln \left|\frac{F}{F_0}\right| Np = 0.5 \ln \left|\frac{P}{P_0}\right| Np = \lg \left|\frac{P}{P_0}\right| B = 2 \lg \left|\frac{F}{F_0}\right| B$$

where F_0 and P_0 are values at a reference point. The reference point, which may be real or virtual, shall be known or indicated.

For cases with impedance transformation, compare Sub-clauses 4.1, 4.2 and 4.4.

4.6 Frequency interval

The frequency interval is here denoted by x

$$x = \text{lb}\left(\frac{f_2}{f_1}\right)\text{octave} = \text{lg}\left(\frac{f_2}{f_1}\right)\text{decade}$$

where f_1 is the lower and f_2 the higher frequency of the interval.

5. Notation for expressing the reference of a level

A level representing a quantity x with a reference quantity x_{ref} may be indicated by:

$$L_x(\text{re } x_{ref}) \quad \text{or by} \quad L_{x/x_{ref}}$$

Examples:

The statement that a certain sound pressure level is 15 dB above the level corresponding to a reference pressure of 20 µPa can be written as:

$$L_p(\text{re } 20\,\mu\text{Pa}) = 15\,\text{dB} \quad \text{or as} \quad L_{p/20\,\mu\text{Pa}} = 15\,\text{dB}$$

The statement that the level of a current is 10 Np below 1 A can be written as:

$$L_I(\text{re } 1\,\text{A}) = -10\,\text{Np}$$

The statement that a certain power level is 7 dB above 1 mW can be written as:

$$L_P(\text{re } 1\,\text{mW}) = 7\,\text{dB}$$

The statement that a certain electric field strength is 50 dB above 1 µV/m can be written as:

$$L_E(\text{re } 1\,\mu\text{V/m}) = 50\,\text{dB}$$

In presenting data, particularly in tabular form or in graphical symbols, a condensed notation is often needed for identifying the reference value. Then the following condensed form, illustrated by application to the above examples, may be used:

15 dB (20 µPa)
− 10 Np (1 A)
7 dB (1 mW)
50 dB (1 µV/m)

A "1" in the expression of a reference quantity is sometimes omitted. This is not recommended in cases where confusion may occur.

When a constant level reference is used repeatedly in a given context and explained in the text, it may be omitted.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This Harmonization Document incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Harmonization Document only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE   When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-702	1992	International electrotechnical vocabulary - Chapter 702: Oscillations, signals and related devices	-	-
ISO 31-11	1978	Mathematical signs and symbol for use in the physical sciences and technology	-	-
ISO 2382-16	1996	Information technology - Vocabulary Part 16: Information theory	-	-

National annex NA (normative) Amendment 1 to International Standard IEC 60027-3:1989

National annex NA reproduces verbatim the text of Amendment 1 to International Standard IEC 60027-3:1989, published 1 March 2000

FOREWORD

This amendment has been prepared by IEC technical committee 25: Quantities and units, and their letter symbols.

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

FDIS	Report on voting
25/232/FDIS	25/233/RVD

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2002. At this date, the publication will be

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

Page 11

Replace the existing subclause 1.5 by the following new subclause:

1.5 Quantities related to information

decision content (IEV 702-04-20 and ISO/IEC 2382-16.03.01[*])

The logarithm of the number of events in a finite set of mutually exclusive events

$$H_0 = \log_a n$$

where n is the number of events.

In short: $\log_a$ (number of events)

NOTE The number of single decisions needed to select a specific event out of a finite set of mutually exclusive events equals the smallest integer which is greater than or equal to the decision content expressed with the base a of the logarithm being equal to the number of possible choices at each decision. This is applicable when a is a positive integer greater than 1.

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[*] IEC 60050(702):1992, *International Electrotechnical Vocabulary (IEV) – Chapter 702: Oscillations, signals and related devices;*
ISO/IEC 2382-16:1996, *Information technology – Vocabulary – Part 16: Information theory.*

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