IEC 61051-1

Edition 3.0 2018-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Varistors for use in electronic equipment – Part 1: Generic specification

Varistances utilisées dans les équipements électroniques – Partie 1: Spécification générique

IEC 61051-1:2018-10(en-fr)

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COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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VARISTORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 1: Generic specification

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61051-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 2007. This edition constitutes a technical revision.

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

a) 10 new terms and definitions – leaded varistors, surface mount varistors(SMV), electrostatic discharge (ESD), ESD clamping voltage, equivalent rectangular pulse duration, maximum peak current derating characteristic, rated average dissipation power, rated energy, abnormal overvoltage withstanding duration and temperature derating curve – have been added (see 3.6, 3.7, 3.14, 3.15, 3.19, 3.20, 3.23, 3.24, 3.25 and 3.29);
b) General requirements for electrical tests and 7 new test items – clamping voltage, ESD clamping voltage, maximum peak current, rated average dissipation power, rated energy, electrostatic discharge (ESD), robustness of terminations of surface mount varistors – have been added (see 6.5, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16 and 6.17.8);
c) In 6.6, 6.7, 6.8, 6.9.3, 6.23.2, 6.23.4 and 6.26, following test items have been revised:

- Varistor voltage, leakage current and capacitance: more detailed requirements and information have been added;
- Voltage proof – foil method: the space between the edge of the foil and each termination has been changed from 1 mm ~ 1,5 mm to 3 mm ~ 3.5 mm for testing varistors not having axial terminations and the minimum space between the foil and the termination has been changed from 1 mm to 3 mm for testing varistors having axial terminations;
- Climatic sequence – dry heat: the method has been changed from Ba to Bb;
- Climatic sequence – cold: the method has been changed from Aa to Ab;
- Endurance at upper category temperature: the method of "applying test voltages in cycles of 1,5 h on and 0,5 h off" has been changed to the method of applying test voltages continuously throughout the test lasting for 1 000 h;

d) The test items of pulse current, voltage under pulse condition and bump have been deleted from the section of test and measurement procedures;

e) Annex A and the contents referring to the test fixture specified in Annex A have been deleted;

f) All contents related to silicon carbide varistors have been deleted;

g) A new normative annex entitled "Test pulses used in this specification" (Annex B) has been added;

h) A new informative annex entitled "Recommended measurement/test methods for characteristics and parameters for application reference" (Annex C) has been added, in which guidelines of measuring/testing characteristics and parameters for application reference including voltage vs. current characteristic, maximum peak current derating characteristic, thermal resistance and abnormal overvoltage withstanding duration have been given.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
40/2621/FDIS	40/2625/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 61051 series, published under the general title *Varistors for use in electronic equipment*, 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.

VARISTORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 1: Generic specification

1 Scope

This part of IEC 61051 is a generic specification and is applicable to varistors with symmetrical voltage-current characteristics for use in electronic equipment.

It establishes standard terms, inspection procedures and methods of test for use in sectional and detail specifications for quality assessment or any other purpose.

NOTE Detail specifications can be specifications within the IEC system, another specification system linked to IEC, or specified by the manufacturer or user. The drafting of a complete detail specification by IEC technical committee 40, if required, follows the rules described in Annex A.

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 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)*

IEC 60062, *Marking codes for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Tests B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (Sinusoidal)*

IEC 60068-2-13:1983, *Environmental testing – Part 2-13: Tests – Test M: Low air pressure*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*
IEC 60068-2-21:2006/COR1:2012

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12-hour cycle)*

IEC 60068-2-45:1980, *Environmental testing – Part 2-45: Tests – Test XA – Immersion in cleaning solvents*
IEC 60068-2-45:1980/AMD1:1993

IEC 60068-2-58:2015, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-69:2017, *Environmental testing – Part 2-69: Tests – Test Te/Tc: Solderability testing of electronic components and printed boards by the wetting balance (force measurement) method*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60294, *Measurement of the dimensions of a cylindrical component having two axial terminations*

IEC 60617, *Graphical symbols for diagrams*
(available at http://std.iec.ch/iec60617)

IEC 60695-11-5:2016, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60717:2012, *Method for the determination of the space required by capacitors and resistors with unidirectional terminations*

IEC 61000-4-2:2008, *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61193-2, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

IEC 61249-2-7:2002, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

ISO 80000-1:2009, *Quantities and units – Part 1: General*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

3.1
type
group of components having similar design features and the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection

Note 1 to entry: They are generally covered by a single detail specification.

Note 2 to entry: Components described in several detail specifications may, in some cases, be considered as belonging tothe same type and can therefore be grouped together for approval and quality conformance inspection.

[SOURCE: IEC 60115-1: 2008, 2.2.25, modified – The remark on "single detail specification" has been deleted from the definition and Note 1 to entry and Note 2 to entry have been added.]

3.2
style
subdivision of a type, generally based on dimensional factors that can include several variants, generally of a mechanical order

[SOURCE: IEC 60115-1:2008, 2.2.20]

3.3
varistor
voltage dependent resistor
VDR
component, whose conductance, at a given temperature range, increases rapidly with voltage within a given current range

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: Varistor is graphically symbolized as **Z**.

Note 3 to entry: This property is expressed by either of the following formulae:

$$U = CI^{\beta} \tag{1}$$

or

$$I = AU^{\gamma} \tag{2}$$

where

I is the current flowing through the varistor;

U is the voltage applied across the varistor;

β is the non-linearity current index (see 3.4);

γ is the non-linearity voltage index (see 3.5);

A and C are constants.

3.4
β
non-linearity current index
starting from Formula (1) of 3.3, it is defined by the formula

$$\beta = \frac{I}{U} \times \frac{\mathrm{d}U}{\mathrm{d}I} \tag{3}$$

Note 1 to entry: For the convenience of calculation, the following formula may be used:

$$\beta = \frac{\log_{10}(U_1/U_2)}{\log_{10}(I_1/I_2)} \tag{4}$$

β is always less than 1.

3.5
γ
non-linearity voltage index
reciprocal of non-linearity current index β

Note 1 to entry: γ is always greater than 1.

Note 2 to entry: In varistor industry and literature, the non-linearity voltage index is usually denoted by α rather than γ.

3.6
leaded varistors
varistors connected to electric circuits via lead wire, or conductive plate, or screw terminations

3.7
surface mount varistors
SMV
leadless varistors mounted on electric circuits by use of surface mount technology

3.8
U_{RMS}
maximum continuous AC voltage
maximum AC RMS voltage of a substantially sinusoidal waveform (less than 5 % total harmonic distortion) which can be applied to the component under continuous operating conditions at 25 °C

Note 1 to entry: Full information on derating requirements above 25 °C shall be given in the detail specification.

Note 2 to entry: Normally this voltage value shall be 1,1 times the supply voltage.

Note 3 to entry: Normally the peak value of this voltage shall be equal to or less than the lower limit of varistor voltage tolerance.

3.9
U_{DCM}
maximum continuous DC voltage
maximum DC voltage (with less than 5 % ripple) that can be applied to the component under continuous operating conditions at an ambient temperature of 25 °C

Note 1 to entry: Full information on derating requirements above 25 °C shall be given in the detail specification.

Note 2 to entry: The power loss of varistor at maximum continuous DC voltage shall be approximately the same as that at maximum continuous AC voltage, hence the value of maximum continuous DC voltage is about 1,3 times the maximum continuous AC voltage.

3.10
U_S
supply voltage
voltage by which the system is designated and to which certain operating characteristics of the system are referred

3.11
U_V
varistor voltage
voltage, at specified DC current (also named as DC reference current), used as a reference point in the component characteristic

Note 1 to entry: Unless otherwise specified, the DC reference current is DC 1 mA.

3.12
limiting voltage
peak value of the voltage, which appears at the terminations of the varistor, when a specified current pulse is applied to it

Note 1 to entry: Unless otherwise specified, the voltage peak at the initial instant of the pulse current shall be excluded from the limiting voltage. That voltage peak results from time lag of the resistive current of the varistor due to the charging of the varistor's capacitance.

3.13
U_{CLP}
clamping voltage
limiting voltage under standard atmospheric conditions, when passing an 8/20 class current pulse

SEE: Annex B.

3.14
electrostatic discharge
ESD
<for surface mount electrostatic protective varistors>transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

Note 1 to entry: There are two test methods for electrostatic discharge test:

- Contact discharge method: a method of testing in which the electrode of the ESD pulse generator is held in contact with the SMV, and the discharge is actuated by the discharge switch within the generator.
- Air discharge method: a method of testing in which the electrode of the ESD pulse generator is brought close to the SMV, and the discharge is actuated by a spark to the SMV.

[SOURCE: IEC 60050-161, 161-01-22, modified – Note 1 to entry has been added.]

3.15
ESD clamping voltage
<for surface mount electrostatic varistors> peak voltage developed across the varistor terminations measured at 30 ns after initiation of pulse of 30 A/8 kV defined in Table 3 and Figure 2 of IEC 61000-4-2:2008

SEE: Annex B

3.16
U_{ISO}
isolation voltage
<insulated varistors> maximum peak voltage that can be applied under continuous operating conditions between the varistor terminations and any conducting mounting surface

3.17
I_L
leakage current
current passing through the varistor at the maximum DC voltage and at a temperature of 25 °C or at any other specified temperature

3.18
I_{Pm}
maximum peak current
maximum current per pulse that can be passed by a varistor at an ambient temperature of 25 °C, for a given number of pulses

3.19
τ
equivalent rectangular pulse duration
normalized unidirectional pulse duration that is equal to the ratio of area of the pulse wave to the pulse peak

3.20
maximum peak current derating characteristic
characteristic curve or mathematical formula expressing maximum peak current I_{Pm} derating with increasing equivalent rectangular pulse duration τ and repetitive pulse number n that can be applied to the varistor at ambient temperature 25 °C

3.21
I_{CLS}
class current
peak value of current, which is 1/10 of the maximum peak current for 100 pulses for the 8/20 current pulse with a time interval of 30 s

SEE: Annex B

3.22
pulse or impulse
unidirectional wave of voltage or current without appreciable oscillations

SEE: Annex B

Note 1 to entry: In IEC 60060-2, the word "impulse" is used; however, for this specification, only the word "pulse" is used.

3.23
P_M
rated average dissipation power
maximum average dissipation power of repetitive pulses allowed to be applied to the varistors at ambient temperature of 25 °C

3.24
E_M
rated energy
maximum pulse energy that the varistor is able to withstand one time when it is exposed to 10/1 000 current pulse or 2 ms rectangular wave pulse, at an ambient temperature of 25 °C

SEE: Annex B

3.25
abnormal overvoltage withstanding duration
time during which the varistor can withstand an abnormal overvoltage across it without irreversible breakdown

3.26
category temperature range
range of ambient temperatures defined by the temperature limits of its appropriate climatic category for which the varistor is designed to operate continuously

3.27
upper category temperature
maximum ambient temperature for which a varistor has been designed to operate continuously

[SOURCE: IEC 60115-1: 2008, 2.2.26, modified – "Resistor" in the definition has been replaced by "varistor", "at that portion of the rated dissipation which is indicated in the category dissipation" has been deleted from the definition, and the notes to entry have been deleted.]

3.28
lower category temperature
minimum ambient temperature at which a varistor has been designed to operate continuously

[SOURCE: IEC 60115-1:2008, 2.2.12, modified – "Resistor" in the definition has been replaced by "varistor", and the Note to entry has been deleted.]

3.29
temperature derating curve
graph showing the parameters' derating of varistors with ambient temperature increasing

Note 1 to entry: The parameters include, but are not limited to, maximum continuous AC and/or DC voltage, rated average dissipation power. Their derating curves are usually given in the detail specification.

3.30
thermal resistance
ratio between the temperature rise of the element of the varistor above the ambient temperature and the applied power

3.31
combination pulse
pulse with voltage waveform of 1,2/50 and current waveform of 8/20, which is expressed by "peak voltage/peak current"

SEE: Annex B

4 Technical data

4.1 Units, symbols and terminology

Units, graphical symbols, letter symbols and terminology shall, whenever possible, be taken from the following publications:

- the IEC 60027 series;
- the IEC 60050 series;
- IEC 60617;
- ISO 80000-1.

When further items are required, they shall be derived in accordance with the principles of the documents listed above.

4.2 Preferred values and characteristics

Each sectional specification shall prescribe the preferred values appropriate to the subfamily, covered by that sectional specification.

4.3 Marking

4.3.1 General

The information given in the marking is normally selected from the following list; the relative importance of each item being indicated by its position in the list:

a) maximum continuous AC voltage or nominal varistor voltage;
b) date of manufacture;
c) number of the detail specification and style reference;
d) manufacturer's name or trade mark.