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Characteristics of metal oxide varistors for the protection of telecommunication installations

Recommendation ITU-T K.77

ITU-T

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Characteristics of metal oxide varistors for the protection of telecommunication installations

Summary

Recommendation ITU-T K.77 gives the basic requirements to be met by metal oxide varistors (MOVs) for the protection of power circuits and signal circuits of telecommunication installations from surges.

The purpose of this Recommendation is to provide technical guidelines for purchasers and manufacturers of MOVs to ensure their satisfactory operation in the applications for which they are intended.

This Recommendation is intended to be used for the harmonization of existing or future specifications issued by MOV manufactures, telecommunication equipment manufactures, administrations or network operators.

History

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Metal oxide varistors (MOV), electrical characteristics and test methods.

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Introduction

Two types of metal oxide varistor (MOV) may be differentiated by their constructions: leadless surface mounting device (SMD)-type MOVs and leaded disc-type MOVs (including wire-terminations and strap terminations), while by their application fields the MOV may be divided into MOVs for power circuit use and MOVs for signal circuit use. Table 1 gives the applicable test items for various type MOVs.

Recommendation ITU-T K.77

Characteristics of metal oxide varistors for the protection of telecommunication installations

1 Scope

This Recommendation:

- gives the characteristics of metal oxide varistors (MOVs) used in accordance with [b-ITU-T K.11] for the protection of power supply circuits and signal circuits of telecommunication installations against overvoltages;
- does not deal with combinations of MOV with other over voltage protective component such as gas discharge tube (GDT), avalanche breakdown diode (ABD), etc.;
- does not deal with mountings and their effect on MOV characteristics, the characteristics apply to MOV as a component, mounted only in the ways described for the tests;
- does not deal with mechanical dimensions;
- does not deal with quality assurance requirements.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [IEC 60060-1] IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*.
- [IEC 60060-2] IEC 60060-2:2010, *High voltage test techniques – Part 2: Measuring systems*.
- [IEC 60068-1] IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*.
- [IEC 60068-2-1] IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*.
- [IEC 60068-2-2] IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*.
- [IEC 60068-2-6] IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*.
- [IEC 60068-2-13] IEC 60068-2-13:1983, *Environmental testing – Part 2: Tests – Test M: Low air pressure*.
- [IEC 60068-2-14] IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*.
- [IEC 60068-2-20] 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] IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*.

- [IEC 60068-2-27] IEC 60068-2-27:2008, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock.*
- [IEC 60068-2-30] IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle).*
- [IEC 60068-2-45] IEC 60068-2-45:1980, *Environmental testing – Part 2: Tests – Test XA and guidance: Immersion in cleaning solvents.*
- [IEC 60068-2-58] 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] IEC 60068-2-69:2017, *Environmental testing – Part 2-69: Tests – Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method.*
- [IEC 60068-2-78] IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, stead state.*
- [IEC 60099-4] IEC 60099-4:2014, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems.*
- [IEC 60695-11-5] IEC 60695-11-5:2016, *Fire hazard testing – Part 11-5: Test flames – Needle flame test method – Apparatus, confirmatory test arrangement and guidance.*
- [IEC 61000-4-2] IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.*
- [IEC 61000-4-5] IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) Part 4-5: Testing and measurement techniques – Surge immunity test.*
- [IEC 61051-1] IEC 61051-1:2018, *Varistors for use in electronic equipment – Part 1: Generic specification.*
- [IEC 61643-11] IEC 61643-11:2011, *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods.*
- [IEC 61643-21] IEC 61643-21:2000, *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods.*
- [IEC 61643-331] IEC 61643-331:2017, *Components for low-voltage surge protective devices – Part 331: Performance requirements and test methods for metal oxide varistors (MOV).*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 type [IEC 61051-1]: 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.

3.1.2 leaded varistors [IEC 61051-1]: Varistors connected to electric circuits via lead wire, or conductive plate, or screw terminations.

3.1.3 surface mount device (SMD) [b-IEC 60749-20-1]: Plastic-encapsulated surface-mount devices made with moisture-permeable materials.

3.1.4 surface mount varistors (SMV) [IEC 61051-1]: Leadless varistors mounted on electric circuits by use of surface mount technology.

3.1.5 varistor voltage (U_V) [IEC 61051-1]: Voltage, at specified DC current (also named as DC reference current), used as a reference point in the component characteristic.

3.1.6 temperature derating curve [IEC 61051-1]: Graph showing the parameters' derating of varistors with ambient temperature increasing.

3.1.7 abnormal overvoltage withstanding duration [IEC 61051-1]: Time during which the varistor can withstand an abnormal overvoltage across it without irreversible breakdown.

3.1.8 rated average dissipation power (P_M) [IEC 61051-1]: Maximum average dissipation power of repetitive pulses allowed to be applied to the varistors at ambient temperature of 25°C.

3.1.9 rated energy (E_M) [IEC 61051-1]: Maximum pulse energy that the varistor is able to withstand one time when it is exposed to 10/1000 current pulse or 2 ms rectangular wave pulse, at an ambient temperature of 25°C.

3.1.10 category temperature range [IEC 61051-1]: Range of ambient temperatures defined by the temperature limits of its appropriate climatic category for which the varistor is designed to operate continuously.

3.1.11 upper category temperature [IEC 61051-1]: Maximum ambient temperature for which a varistor has been designed to operate continuously.

3.1.12 lower category temperature [IEC 61051-1]: Minimum ambient temperature at which a varistor has been designed to operate continuously.

3.1.13 electrostatic discharge (ESD) [IEC 61051-1]: (for surface mount electrostatic protective varistors) Transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact.

3.1.14 ESD clamping voltage [IEC 61051-1]: (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.

3.1.15 equivalent rectangular pulse duration (τ) [IEC 61051-1]: Normalized unidirectional pulse duration that is equal to the ratio of area of the pulse wave to the pulse peak.

3.1.16 isolation voltage (U_{ISO}) [IEC 61051-1]: (insulated varistors) maximum peak voltage that can be applied under continuous operating conditions between the varistor terminations and any conducting mounting surface.

3.1.17 capacitance (C_V) [IEC 61643-331]: Capacitance across the MOV measured at a specified frequency, voltage and time.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 style (based on IEC 61051-1): Subdivision of a type, generally based on dimensional factors and the voltage gradient that may include several variants, generally of a mechanical order.

3.2.2 clamping voltage (U_{cla}): Highest peak voltage value among the population when the nominal discharge current (I_n) to be applied to the MOV.

NOTE – For an individual MOV, peak voltages shall be measured in two directions, and the larger value of the two is considered as the clamping voltage of this MOV.

SOURCE: IEC 61643-11:2011, clause 3.1.15 modified: "SPD" has been changed as "MOV", "impulses of specified waveshape and amplitude" has been changed as "nominal discharge current".

3.2.3 maximum impulse voltage (U_{max}): Highest peak voltage value among the population when the maximum impulse current (I_{max}) to be applied to the MOV. U_{max} is used for clearance determination.

SOURCE: IEC 61643-11:2011. 3.1.47, modified: the original expression was "highest measured voltage during surge applications according 8.3.3 for clearance determination".

3.2.4 leakage current (I_L): Current passing through the MOV with the maximum continuous operating voltage U_M applied on it, and measured at a specified temperature. It is DC current under $U_{M(DC)}$, or RMS value of the current under $U_{M(AC)}$ or $U_{M(SP)}$.

NOTE – Some manufacturers test DC leakage current under $0.75U_V$ or $0.83U_V$, where U_V refers to practical varistor voltage of the tested unit.

SOURCE: IEC 61051-1: 2018, clause 3.17, revised.

3.2.5 maximum continuous operating voltage (U_M): Maximum voltage which can be applied continuously on MOV at a temperature of 25°C. It may be DC voltage (with ripple less than 5%) $U_{M(DC)}$, or AC voltage in rms value (total harmonic less than 5% $U_{M(AC)}$), or specified waveform voltage in rms value $U_{M(SP)}$.

NOTE 1 – Manufacturer's data sheet specified that $U_{M(AC)} \approx 0.7U_N$, $U_{M(DC)} \approx 1.3U_{M(AC)}$, provided the tolerance of varistor voltage is $\pm 10\%$, where U_N refers to nominal varistor voltage.

NOTE 2 – U_M is not a measurable parameter, its conformity is verified by service life test under U_M and maximum operation temperature.

SOURCE: combined IEC 61051-1: 2018, clause 3.8 and 3.9.

3.2.6 maximum discharge current (I_{max}): Crest value of a current through the MOV for once, having an 8/20 waveshape and magnitude according to the manufacturers specification. I_{max} is equal to or greater than I_n .

SOURCE: IEC 61643-11:2011, clause 3.1.48, modified: "SPD" has been changed as "MOV", adding a remark "for once", and "equal to or" deleted

3.2.7 metal oxide varistor (MOV): Non-linear resistor made of a sintered mixture of zinc oxide and other metal oxides whose resistance (R), at a given temperature, decreases rapidly with current (I), and increases with current rate (dI/dt), i.e. $R = f(I, dI/dt)$.

NOTE – This property is expressed by either 2-order polynomial formula (1) or power law formula (2):

$$U = 10^{A_0} \times I^B \quad (1)$$

$$\text{or } U = a + b \times I^c \quad (2)$$

where:

$$B = 1 + A_1 + A_2 \times \lg I$$

I is the applied current flowing through the MOV;

U is the voltage developed across the MOV;

A_0, A_1, A_2 are 2-order polynomial formula constants;

a, b, c : are power law formula constants.

SOURCE: IEC 61643-331

3.2.8 nominal discharge current (I_n): The crest value of impulse current with 8/20 waveform that is intended for clamping voltage measurement.

NOTE – The I_n specified by the most manufacturers is (1500~2000)A/cm², and the test current used for clamping (limiting) voltage measurement which are specified by previous manufacturer's data sheets is (30~50)A/cm².

SOURCE: IEC 61643-11: 2011, clause 3.1.9, revised.