

SLOVENSKI STANDARD

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Sestavni deli za nizkonapetostne naprave za zaščito pred prenapetostnimi udari - 332. del: Izbira in načini uporabe za kovinsko-oksidne varistorje (MOV)

Components for low-voltage surge protection - Part 332: Selection and application principles for metal oxide varistors (MOV)

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Composants de protection contre les surtensions basse tension - Partie 332 : Principes de sélection et d'application pour les varistances à oxyde métallique (MOV)

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Ta slovenski standard je istoveten z: prEN IEC 61643-332:2022

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31.040.20	Potenciometri, spremenljivi upori	Potentiometers, variable resistors

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en



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<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING Attention IEC-CENELEC parallel voting The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

Components for low-voltage surge protection – Part 332: Selection and application principles for metal oxide varistors (MOV)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTION –

Part 332: Selection and application principles for metal oxide varistors
(MOV)

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International Standard IEC 61643 has been prepared by subcommittee 37B: Components for low voltage surge protection, of IEC technical committee 37: Surge arresters.

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/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.

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

- 184 • reconfirmed,
- 185 • withdrawn,
- 186 • replaced by a revised edition, or
- 187 • amended.

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COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTION –

Part 332: Selection and application principles for metal oxide varistors (MOV)

1 Scope

This part of IEC 61643 presents a description, theory of operation, test characteristics, and application principles for MOVs, which are used for applications up to 1 000 V AC or 1 500 V DC in power line, or telecommunication, or signalling circuits. They are designed to protect apparatus or personnel, or both, from high transient voltages.

This specification applies to MOVs having two electrodes and overvoltage protection components with or without disconnectors. This specification also does not apply to mountings and their effect on the MOV's characteristics. Characteristics given apply solely to the MOV mounted only in the ways described for the tests.

This standard specifically discusses the zinc-oxide type of MOVs.

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 60068-1:2013, *Environmental testing – Part 1: General and guidance*
- IEC 60068-2-20:2021, *Environmental testing - Part 2-20: Tests - Test Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*
- IEC 60068-2-21:2021, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*
- IEC 60068-2-78:2012, *Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state*
- IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests*
- IEC 61051-1:2018, *Varistors for use in electronic equipment - Part 1: Generic specification*
- IEC 61051-2:1991/AMD1:2009, *Ammendment 1- Varistors for use in electronic equipment - Part 2: Sectional specification for surge suppression varistors*
- 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 61643-331:2020, *Components for low-voltage surge protection - Part 331: Performance requirements and test methods for metal oxide varistors (MOV)*
- IEC 62368-1:2018, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*

229 3 Terms, definitions, symbols and abbreviated terms

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

- 232 • IEC Electropedia: available at <http://www.electropedia.org/>
- 233 • ISO Online browsing platform: available at <http://www.iso.org/obp>

234

235 3.1 Terms and definitions

236 3.1.1 Ratings

237 3.1.1.1 238 rating

239 either a limiting capability or a limiting condition beyond which damage to the MOV may occur

240 Note 1 to entry: A limiting condition may be either a maximum or a minimum.

241 3.1.1.2 242 nominal discharge current

243 I_n

244 crest value of the current through the MOV having a current waveshape of 8/20

245 [SOURCE: IEC 61643-331:2020, 3.1.1.3]

246 3.1.1.3 247 maximum continuous voltage

248 V_M

249 voltage that may be applied continuously at a specified temperature

250 Note 1 to entry: May also be called U_C or MCOV (Maximum continuous operating voltage).

251 Note 2 to entry: See Figure 1.

252 [SOURCE: IEC 61643-331:2020, 3.1.1.7, modified (addition of "Maximum continuous operating
253 voltage" to Note 1 to entry)]

254 3.1.1.4 255 maximum continuous AC voltage

256 $V_{M(AC)}$

257 value of r.m.s. power frequency voltage (less than 5 % total harmonic distortion) that may be
258 applied continuously at a specified temperature

259 [SOURCE: IEC 61643-331:2020, 3.1.1.8]

260 3.1.1.5 261 maximum continuous DC voltage

262 $V_{M(DC)}$

263 DC voltage that may be applied continuously at a specified temperature

264 [SOURCE: IEC 61643-331:2020, 3.1.1.9]

265 3.1.1.6 266 maximum discharge current

267 I_{max}

268 crest value of a current through the SPD having an 8/20 waveshape and magnitude according
269 to the manufacturers specification.

270 Note 1 to entry: I_{max} is equal to or greater than I_n

271 [SOURCE: IEC 61643-11:2011, 3.1.48]

272 3.1.1.7 273 impulse discharge current for class I test

274 I_{imp}

275 crest value of a discharge current through the SPD with specified charge transfer Q and
276 specified energy W/R in the specified time

277 [SOURCE: definition 3.1.10 of IEC 61643-11:2011]

278 **3.1.1.8**

279 **rated average dissipation power**

280 P_M

281 maximum average dissipation power of repetitive pulses allowed to be applied to the varistors
282 at ambient temperature of 25 °C

283

284 [SOURCE: definition of IEC 61051-1:2018, 3.23]

285 **3.1.2 Characteristics**

286 **3.1.2.1**

287 **characteristics**

288 inherent and measurable properties of an MOV

289 [SOURCE: IEC 61643-331:2020, 3.1.2.1]

290 **3.1.2.2**

291 **standby current**

292 I_D

293 current passing through MOV at maximum continuous voltage V_M

294 Note 1 to entry: The current passing through the MOV at less than V_M is called leakage current

295 [SOURCE: IEC 61643-331:2020, 3.1.2.2]

296 **3.1.2.3**

297 **varistor voltage**

298 V_V

299 voltage across the MOV measured at a specified current (typically 1 mA) for a specific duration

300 Note 1 to entry: The MOV manufacturer specifies the current. Otherwise, 1 mA DC for a duration of 20 to 100 ms
301 is normally used.

302 Note 2 to entry: See Figure 1

303 [SOURCE: IEC 61643-331:2020, 3.1.2.3]

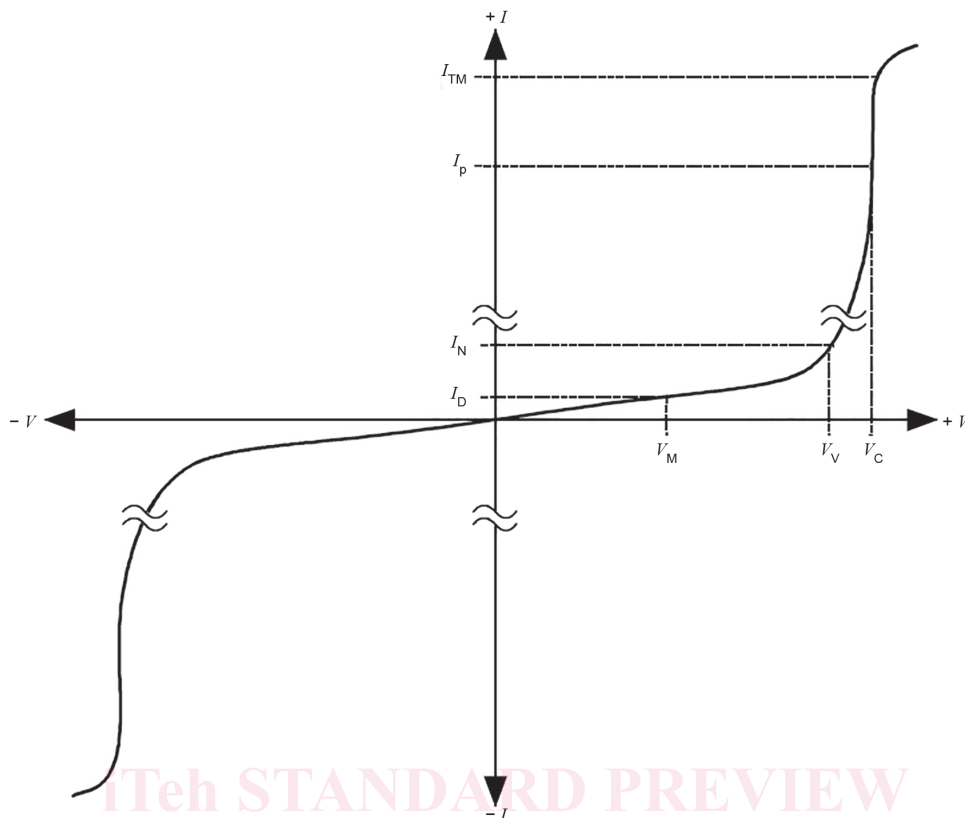


Figure 1 – V - I characteristic of an MOV

304

305

3.1.2.4

Clamping voltage

V_C

peak voltage across the MOV measured under conditions of a specified peak pulse current (I_P) and specified waveform

[SOURCE: IEC 61643-331:2020, 3.1.2.5]

3.1.2.5

Capacitance

C_V

capacitance across the MOV measured at a specified frequency, voltage and time

[SOURCE: IEC 61643-331:2020, 3.1.2.6]

3.1.2.6

metal oxide varistor (MOV)

non-linear resistor made of a sintered mixture of metal oxides whose conductance, at a given temperature, increases rapidly with voltage

Note 1 to entry: This is also known as a voltage dependant resistor (VDR).

[SOURCE: IEC 61643-331:2020, 3.1.2.7]

3.1.2.7

thermally protected metal oxide varistor

varistor which includes a series non-resettable element that will disconnect the MOV when it is overheated due to excessive dissipation

[SOURCE: IEC 61643-331:2020, 3.1.2.8]

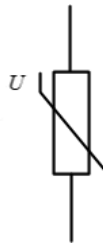
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328 **3.1.2.8**329 **non-linear exponent**330 α

331 a measure of varistor non-linearity between a given current range of (I_1, I_2) , it is expressed as
 332 $\alpha_{12} = \log(I_2 / I_1) / \log(V_2 / V_1)$

333 **3.2 Symbols and abbreviated terms used in this document**

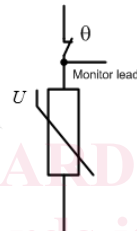
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335

336

Figure 2 – Symbol for an MOV



337

338

Figure 3 – Symbol for a thermally protected MOV

339 Note 1 to entry: IEC 60027 recommends the letters V and v only as reserve symbols for voltage; however, in the field
 340 of MOV components, these are so widely used that in this publication they are preferred to U and u .

341 **3.2.1 Abbreviated terms**

342	ESD	Electrostatic Discharge
343	GDT	Gas Discharge Tube
344	IC	Integrated Circuit
345	IT	Information Technology
346	IT	Isole-Terre (French for Isolated-Earth)
347	MCOV	Maximum Continuous Operating Voltage
348	MOV	Metal Oxide Varistor
349	SMD	Surface Mount Device
350	SMT	Surface Mount Technology
351	SPC	Surge Protective Component
352	SPD	Surge Protective Device
353	TCO	Thermal Cut off
354	TOV	Temporary Overvoltage
355	TN	Terre-Neutral (French for Earth-Neutral)
356	TT	Terre-Terre (French for Earth-Earth)
357	VDR	Voltage Dependent Resistor

358

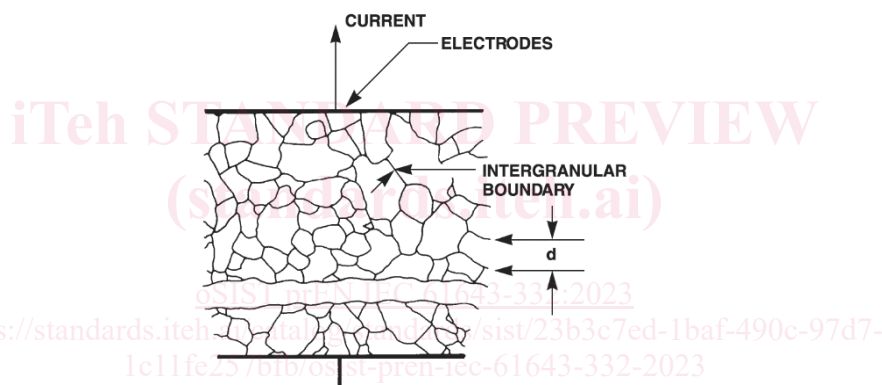
359 4 General

360 Due to the high complexity of the ceramics on which the functioning of the MOV is based, the
 361 performance of the MOV depends on the technology and processes used. Thus the electrical
 362 properties and characteristics (tolerances, impulse withstand capability, etc.) may vary among
 363 manufacturers. The explanations of terms related to electrical properties and characteristics
 364 are described in Annex A.

365 5 Construction

366 Typically, MOVs consist of a round disc-shaped body of sintered zinc-oxide with suitable
 367 additives. Other types in use include rectangular and tubular shapes and multilayer structures.
 368 MOVs have metal particle electrodes consisting of a silver alloy or other metal. The electrodes
 369 may have been applied to the body by screening and sintering or by other processes depending
 370 on the metal used. MOVs also often have wire leads or some other type of termination that may
 371 have been soldered to the electrode.

372 The basic conduction mechanism of MOVs results from semiconductor barriers at the boundary
 373 of the zinc-oxide grains formed during a sintering process. The MOV may be considered a multi-
 374 barrier component with many grains acting in series-parallel combination between the terminals.
 375 A schematic cross-sectional view of a typical MOV is shown in Figure 4.



376

377 **Figure 4 – Schematic depiction of microstructure of MOV**

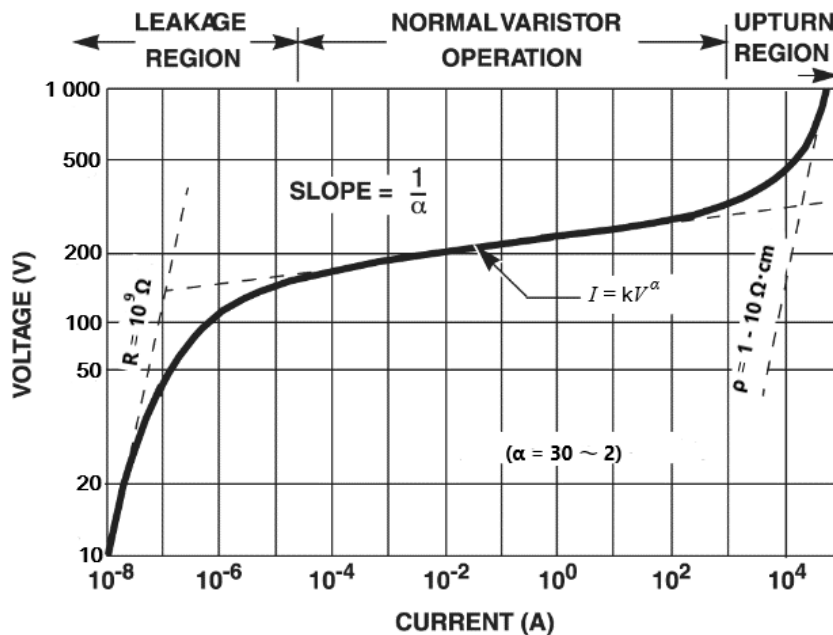
378 6 Function

379 6.1 Theory of operation

380 MOVs have the property of maintaining a relatively small voltage change across their terminals
 381 while the surge current flowing through them varies over several decades. This non-linear action
 382 allows them to divert the current of a surge when connected in shunt across the line, and hold
 383 the voltage across the line to values that protect the equipment connected to that line. Since
 384 the voltage across the MOV is held at some level higher than the normal circuit voltage (but still
 385 protecting) while surge current flows, there will be energy dissipated in the MOV during its surge
 386 diversion function.

387 The MOV material consists of zinc-oxide grains separated by a thin intergranular material.
 388 Bismuth oxide and other metal oxides comprise the boundary between grains, and these form
 389 semiconducting barriers with the grains. A fundamental property of the material is that the
 390 voltage drop across a single interface between the grains is nearly constant, and is independent
 391 of the grain size. Figure 5 shows a typical $V-I$ characteristic of an MOV in one direction of
 392 conduction, and the opposite direction would be similar.

393 The voltage and current values of the curve in Figure 5 were measured by using DC current
 394 when the current being less than 10^{-2} A, or by using 8/20 current when the current being greater
 395 than 100 A.



396

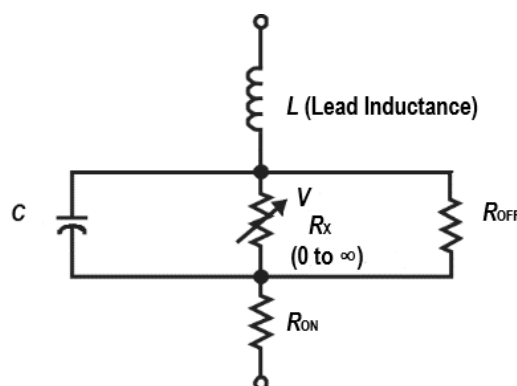
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Figure 5 – Typical varistor V - I curve plotted log-log scale

398 The electrical behaviour of an MOV can be understood by reference to the V - I characteristic of
399 Fig.5 and the equivalent circuit components of Fig.6 as follows:

- 400 1) Leakage Region: When the voltage across the MOV is below its varistor voltage (V_V),
401 the non-linear resistance R_x approaches a high ohmic state and can be disregarded,
402 hence the parallel resistance R_{off} , is the prevailing component. In the example of Fig. 6,
403 R_{off} is such a high value that the MOV is essentially in a nearly open-circuit state.
- 404 2) Normal Varistor Operation Region: The non-linear resistance R_x becomes so small that
405 it is much lower than the linear leakage resistance R_{off} , so that the R_{off} is ignored but R_x
406 remains larger than R_{on} . The variable resistance R_x takes on continuously decreasing
407 values, according to the power law relating current and voltage. During this region,
408 current increases in several orders of magnitude as V_V remains rather constant.
- 409 3) Upturn Region: At large currents, the series resistance R_{on} becomes a significant part of
410 the total device resistance, causing an upturn with the value of R_{on} as an asymptote. The
411 MOV is essentially in a short-circuit state during this region.

412 The parametric values given in Figure 5 and Figure 6 are shown for illustration purposes only.



413

414

Figure 6 – MOV equivalent circuit model

415 Under AC or signal operating conditions as well as under surge conditions the reactive
416 components (L and C) of Figure 6 may significantly affect the behaviour of the MOV. The parallel
417 capacitance C can pass a current that may be larger than the DC standby current. The series
418 inductance L , resulting from the leads can increase the voltage appearing across the component