



SLOVENSKI STANDARD
oSIST prEN IEC 60747-15:2023
01-oktober-2023

Polprevodniški elementi - 15. del: Diskretni elementi - Izolirani močnostni polprevodniški elementi

Semiconductor devices - Part 15: Discrete devices - Isolated power semiconductor devices

Halbleiterbauelemente - Einzel-Halbleiterbauelemente - Teil 15: Isolierte Leistungshalbleiter

Dispositifs à semiconducteurs - Partie 15: Dispositifs discrets - Dispositifs de puissance à semiconducteurs isolés

<https://standards.iteh.ai/catalog/standards/sist/81594492-c923-4b42-bcb4-a10647a80db8/osist-pren-iec-60747-15-2023>

Ta slovenski standard je istoveten z: prEN IEC 60747-15:2023

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| 31.080.01 | Polprevodniški elementi (naprave) na splošno | Semiconductor devices in general |
|-----------|--|----------------------------------|

oSIST prEN IEC 60747-15:2023

en



COMMITTEE DRAFT FOR VOTE (CDV)

| | |
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| | |
|--|---|
| IEC SC 47E : DISCRETE SEMICONDUCTOR DEVICES | |
| SECRETARIAT: Korea, Republic of | SECRETARY: Mr Hojun Ryu |
| OF INTEREST TO THE FOLLOWING COMMITTEES: | PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary. |
| FUNCTIONS CONCERNED: <input type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY | |
| <input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING | <input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING |
| <p>Attention IEC-CENELEC parallel voting</p> <p>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.</p> <p>https://standards.iteh.ai/catalog/standards/sist/81594492-c923-4b42-bcb4-47e-iec-60747-15-2023</p> <p>The CENELEC members are invited to vote through the CENELEC online voting system.</p> | |

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TITLE:

Semiconductor devices - Part 15: Discrete devices - Isolated power semiconductor devices

PROPOSED STABILITY DATE: 2029

NOTE FROM TC/SC OFFICERS:

The order of titles is changed for consistency with other IEC 60747 series.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SEMICONDUCTOR DEVICES –

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Part 15: Discrete devices – Isolated power semiconductor devices

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IEC 60747-15 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices. It is an International Standard.

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This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

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

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- a) The intelligent power semiconductor modules (IPM), which was previously excluded from the first and second edition, is now included in this document (Annex C);
- b) The thermal resistance is described for each switch (6.2.4);
- c) Added isolation test between temperature sensor and terminals, in case there is an agreement with the user (6.1.2).

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

| Draft | Report on voting |
|-------------|------------------|
| 47E/XX/FDIS | 47E/XX/RVD |

190

191 Full information on the voting for its approval can be found in the report on voting indicated in
192 the above table.

193 The language used for the development of this International Standard is English.

194 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
195 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
196 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
197 described in greater detail at www.iec.ch/publications.

198 This International Standard is to be used in conjunction with IEC 60747-1:2006 and
199 Amendment 1: 2010.

200 A list of all parts in the IEC 60747 series, published under the general title *Semiconductor*
201 *devices*, can be found on the IEC website.

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

- 205 • reconfirmed,
- 206 • withdrawn,
- 207 • replaced by a revised edition, or
- 208 • amended.

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SEMICONDUCTOR DEVICES –

Part 15: Discrete devices – Isolated power semiconductor devices

216 **1 Scope**

217 This part of IEC 60747 gives the requirements for isolated power semiconductor devices. These
218 requirements are additional to those given in other parts of IEC 60747 for the corresponding
219 non-isolated power devices and parts of IEC 60748 for ICs.

220 **2 Normative references**

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

225 IEC 60270:2015, *High-voltage test techniques – Partial discharge measurements*

226 IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1:*
227 *Principles, requirements and tests*

228 IEC 60721-3-3:2019, *Classification of environmental conditions – Part 3-3: Classification of*
229 *groups of environmental parameters and their severities – Stationary use at weather protected*
230 *locations*

231 IEC 60747-1:2010, *Semiconductor devices – Part 1: General*

<https://standards.iteh.ai/catalog/standards/sist/81594492-c923-4b42-bcb4->

232 IEC 60747-2:2016, *Semiconductor devices – Discrete devices and integrated circuits – Part 2:*
233 *Rectifier diodes*

234 IEC 60747-6:2016, *Semiconductor devices – Part 6: Thyristors*

235 IEC 60747-7:2019, *Semiconductor discrete devices and integrated circuits – Part 7: Bipolar*
236 *transistors*

237 IEC 60747-8:2021, *Semiconductor devices – Part 8: Field-effect transistors*

238 IEC 60747-9:2019, *Semiconductor devices – Discrete devices – Part 9: Insulated-gate bipolar*
239 *transistors (IGBTs)*

240 IEC 60749-5:2017, *Semiconductor devices – Mechanical and climatic test methods – Part 5:*
241 *Steady-state temperature humidity bias life test*

242 IEC 60749-6:2017, *Semiconductor devices – Mechanical and climatic test methods – Part 6:*
243 *Storage at high temperature*

244 IEC 60749-10:2003, *Semiconductor devices – Mechanical and climatic test methods – Part 10:*
245 *Mechanical shock*

246 IEC 60749-12:2017, *Semiconductor devices – Mechanical and climatic test methods – Part 12:*
247 *Vibration, variable frequency*

248 IEC 60749-15:2020, *Semiconductor devices – Mechanical and climatic test methods – Part 15:*
249 *Resistance to soldering temperature for through-hole mounted devices*

250 IEC 60749-21:2011, *Semiconductor devices – Mechanical and climatic test methods – Part 21:*
251 *Solderability*

252 IEC 60749-25:2003, *Semiconductor devices – Mechanical and climatic test methods – Part 25:*
253 *Temperature cycling*

254 IEC 60749-34:2010, *Semiconductor devices – Mechanical and climatic test methods – Part 34:*
255 *Power cycling*

256 **3 Terms and definitions**

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

258 ISO and IEC maintain terminology databases for use in standardization at the following
259 addresses:

- 260 • IEC Electropedia: available at <https://www.electropedia.org/>
- 261 • ISO Online browsing platform: available at <https://www.iso.org/obp>

262 **3.1**

263 **isolated power semiconductor device**

264 semiconductor power device that contains an integral electrical insulator between the cooling
265 surface or base plate and any isolated circuit elements

266 **3.2**

267 **Constituent parts of the isolated power semiconductor device**

268 **3.2.1**

269 **switch**

270 any single component that performs a switching function in a electrical circuit, e.g. diode,
271 thyristor, MOSFET, etc.

272 Note 1 to entry: A switch might be a parallel or series connection of several chips with a single functionality.

273 **3.2.2**

274 **base plate**

275 part of the package having a cooling surface that transfers the heat from inside to outside

276 **3.2.3**

277 **main terminal**

278 terminal having a high potential of the power circuit and carrying the main current. The main
279 terminal can comprise more than one physical connector.

280 **3.2.4**

281 **control terminal**

282 terminal having a low current capability for the purpose of control function, to which the external
283 control signals are applied or from which sensing parameters are taken

284 **3.2.4.1**

285 **high voltage control terminal**

286 terminal electrically connected to an isolated circuit element, but carrying only low current for
287 control function

288 Note 1 to entry: Examples include current shunts and collector sense terminals having the high potential of the main
289 terminals.

290 **3.2.4.2**
 291 **low voltage control terminal**
 292 terminal having a control function and isolated from the high voltage control terminals

293 Note 1 to entry: Examples include the terminals of isolated temperature sensors and isolated gate driver inputs etc.

294 **3.2.5**
 295 **insulation layer**
 296 integrated part of the device case that insulates any part having high potential from the cooling
 297 surface or external heat sink and any isolated circuit element

298 **3.3**
 299 **peak case non-rupture current**
 300 peak current, which will not lead to a rupture of the package, ejecting plasma and massive
 301 particles under specified conditions

302 **3.4**
 303 **thermal interface material**
 304 heat conducting material between base plate and external heat sink

305 **4 Letter symbols**

306 **4.1 General**

307 General letter symbols are defined in Clause 4 of IEC 60747-1:2010.

308 **4.2 Additional subscripts/symbols**

309 p = parasitic

310 t = terminal

311 isol = isolation

312 **4.3 List letter symbols**

313 **4.3.1 Voltages and currents**

| | |
|--------------------------------------|-------------------|
| Terminal current | I_{TRMS} |
| Isolation voltage | V_{isol} |
| Partial discharge inception voltage | V_{i} |
| Partial discharge extinction voltage | V_{e} |
| Isolation leakage current | I_{isol} |

314 **4.3.2 Mechanical symbols**

| | |
|--|-----------------|
| Mounting torque for screws to heat sink | M_{s} |
| Mounting torque for terminal screws | M_{t} |
| Mounting force | F |
| Maximum acceleration in all 3 axis (x, y, z) | a |
| Mass | m |
| Flatness of the case (base-plate) | e_{c} |
| Flatness of the cooling surface (heat sink) | e_{s} |
| Roughness of the case (base plate) | R_{Zc} |
| Roughness of the cooling surface (heat sink) | R_{Zs} |

Thickness of thermal interface material (case - sink) $d_{(c-s)}$

315 4.3.3 Other symbols

Parasitic inductance, effective between terminals and chips (to be specified) L_p
 Parasitic capacitance between terminals and cooling surface (case, base plate, ground) C_p
 Lead resistance between terminal x and internal device connection x' $r_{xx'}$
 Terminal temperature T_t
 Number of power load cycles until failure of a percentage p of a population of devices $N_{fi,p}$

316

317 5 Essential ratings (limiting values) and characteristics

318 5.1 General

319 Isolated power semiconductor devices should be specified as case rated or heat-sink rated
 320 devices. The ratings and characteristics should be quoted at a temperature of 25 °C or another
 321 specified elevated temperature. Requirements for multiple devices having a common
 322 encapsulation are described in 5.12 of IEC 60747-1:2010.

323 5.2 Ratings (limiting values)

324 5.2.1 Isolation voltage or Isolation test voltage (V_{isol})

325 Maximum RMS or DC value between main terminals and high voltage control terminals at one
 326 side and low voltage control terminals (where appropriate) and base plate at the other side for
 327 a specified time.

328 5.2.2 Peak case non-rupture current (where appropriate)

329 Maximum value for each main terminal that does not cause the bursting of the case or emission
 330 of plasma and particles.

331 5.2.3 Terminal current (I_{tRMS}) (where appropriate),

332 Maximum RMS value of the current through the main terminal under specified conditions at
 333 minimum mounting torque M_t and maximum allowed terminal temperature ($T_{tmax} = T_{stg}$ or T_{tmax}
 334 $\leq T_{vjmax}$).

335 5.2.4 Temperatures

336 5.2.4.1 Solder temperature (T_{sold}) (where appropriate)

337 Maximum solder temperature T_{sold} during solder process over a specified solder processing
 338 time t_{sold} .

339 5.2.4.2 Storage temperature (T_{stg})

340 Minimum and maximum storage temperature.

341 **5.2.5 Mechanical ratings**

342 **5.2.5.1 Mounting torque of screws to heat sink (M_s)**

343 Minimum mounting torque that shall be applied to the fixing screws to the heat sink.

344 **5.2.5.2 Mounting torque of screws to terminals (M_t)**

345 Minimum mounting torque that shall be applied to screwed terminals.

346 **5.2.5.3 Mounting force (F)**

347 Minimum mounting force for pressure mounted devices, fixed by clips, that shall be applied to
348 the isolated pressure contact device.

349 **5.2.5.4 Terminal pull-out force (F_t)**

350 Maximum force.

351 **5.2.5.5 Acceleration (a)**

352 Maximum value along each axis (x, y, z) .

353 **5.2.5.6 Flatness of the heatsink surface (e_s) (where appropriate)**

354 Maximum deviation from flatness for the heatsink surface over the whole mounting area.

355 **5.2.5.7 Roughness of the heatsink surface (R_{ZS}) (where appropriate)**

356 Maximum roughness of the heatsink surface over the whole mounting area.

357 **5.2.6 Climatic ratings (where appropriate)**

358 Limiting values of environmental parameters for the final application as follows.

- 359 – ambient temperature
360 – humidity
361 – speed and pressure of air
362 – irradiation by sun and other heat sources
363 – mechanical active substances
364 – chemically active substances
365 – biological issues

366 shall be described in classes as specified in IEC 60721-3-3:2019, Table 1.

367 **5.3 Characteristics**

368 **5.3.1 Mechanical characteristics**

369 **5.3.1.1 Creepage distance along surface (d_s)**

370 Minimum value of distance along surface of the insulating material of the device between
371 terminals of different potential and to base plate.

372 NOTE 1 IEC 60112:2020 (details to comparative tracking index "CTI") and IEC 60664-1:2020 Subclause 5.2 apply.

373 NOTE 2 Air gaps between plastic surface and grounded metal or between terminals of opposite polarity smaller
374 than 1,0 mm (for pollution degree 2), or 1,5 mm (pollution degree 3) shorten the countable creepage distance

375 considerably (details see 60664-1:2020, examples). This is essential, if dust, moisture or dirt starts to cover the
376 surface and increases the leakage current over surface, which might start burning the plastic encapsulation material.

377 **5.3.1.2 Clearance distance in air (d_a)**

378 Minimum value of distance through air between terminals of different potential of the isolated
379 device and to base plate.

380 NOTE For details, see IEC 60664-1:2020, (Subclause 4.6 and Subclause 5.1) which shows typical examples of
381 various shapes of clearance distances.

382 **5.3.1.3 Mass (m) of the device**

383 Maximum value excluding accessories (mounting hardware).

384 **5.3.1.4 Flatness of the base plate (e_c) (where appropriate)**

385 Maximum and minimum allowed deviation from flatness for the base plate and its direction
386 (convex or concave).

387 **5.3.2 Parasitic inductance (L_p)**

388 Maximum or typical value between the main terminals of each main current path.

389 **5.3.3 Parasitic capacitances (C_p)**

390 Maximum value of parasitic capacitance between the specified main terminal(s) and the cooling
391 surface.

392 **5.3.4 Partial discharge inception voltage (V_{iM} or $V_{i(RMS)}$) (where appropriate)**

393 Minimum peak value V_{iM} or RMS value $V_{i(RMS)}$ between the isolated terminals and the base
394 plate (details, see IEC 60270:2015).

395 **5.3.5 Partial discharge extinction voltage (V_{eM} or $V_{e(RMS)}$) (where appropriate)**

396 Minimum peak value V_{eM} or RMS value $V_{e(RMS)}$ between the isolated terminals and the base
397 plate (for details, see IEC 60270:2015).

398 **5.3.6 Thermal resistances**

399 **5.3.6.1 Thermal resistance junction to case for case rated devices ($R_{th(j-c)X}$)**

400 Maximum value of thermal resistance junction to a specified reference point at the case (base
401 plate) per switch "X" (for example of the diode (D), thyristor (T), IGBT (I) or MOSFET (M)).

402 **5.3.6.2 Thermal resistance case to heat sink ($R_{th(c-s)}$) (where appropriate)**

403 Maximum or typical value of thermal resistance between two specified points at the case and
404 at the heat sink of the case rated device ("module"), when the case is mounted according to
405 manufacturer's mounting instructions.

406 **5.3.6.3 Thermal resistance case to heat sink per switch ($R_{th(c-s)X}$) (where 407 appropriate)**

408 Maximum or typical value of thermal resistance between the two specified points of the case
409 and the heat sink of the switch "X" (for example of the diode (D), thyristor (T), IGBT (I) or
410 MOSFET (M)) of the isolated case rated devices ("module"), when the case is mounted
411 according to the manufacturer's mounting instructions.

412 **5.3.6.4 Thermal resistance junction to heat sink for heat sink rated devices ($R_{th(j-s)x}$)**

413 Maximum or typical value of thermal resistance junction to a specified point at the heat sink
414 per switch "X" (for example of the diode (D), thyristor (T), IGBT (I) or MOSFET (M)), when the
415 device is mounted according to the manufacturer's mounting instructions.

416 **5.3.6.5 Thermal resistance junction to sensor ($R_{th(j-r)}$) (where appropriate)**

417 Value of thermal resistance junction to an integrated temperature sensor, when the device is
418 mounted according to the manufacturer's mounting instructions.

419 NOTE The position of this thermal resistance should be shown in the thermal resistance equivalent circuit.

420 **5.3.7 Transient thermal impedance (Z_{th})**

421 Thermal impedance as a function of the time elapsed after a step change of power dissipation
422 for each thermal resistance specified in Subclause 5.3.6 and shall be specified in one of the
423 following ways.

424 **6 Measurement methods**

425 **6.1 Verification of isolation voltage rating**

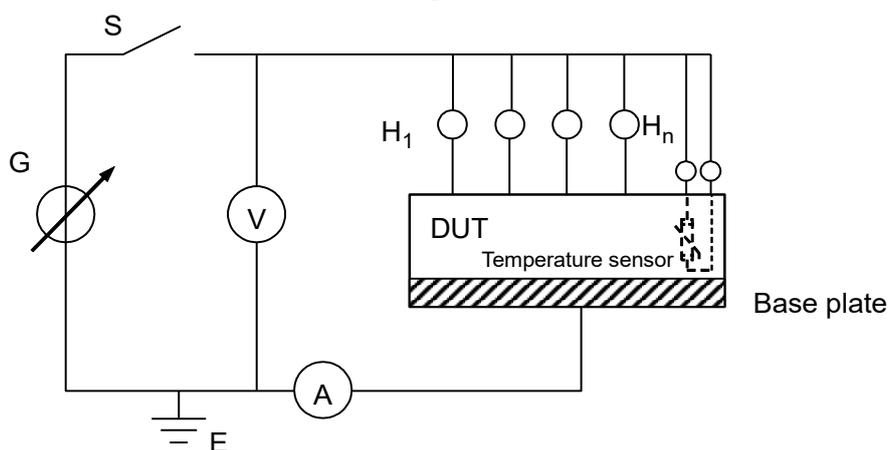
426 **6.1.1 Verification of isolation voltage rating between terminals and base plate (V_{isol})**

427 – **Purpose**

428 Proof of the ability of the isolated power device to withstand the rated isolation voltage.

429 – **Circuit diagram**

430 See Figure 1 below.



431

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432 **Figure 1 – Basic circuit diagram for isolation breakdown withstand**
433 **voltage test ("high pot test") with V_{isol}**

434 – **Circuit description and requirements**

435 DUT = Device under test

436 G = voltage source with high impedance, capable to supply V_{isol}

437 S = main switch

438 V = voltmeter for V_{isol}