IEC 61643-341

Edition 2.0 2020-05

INTERNATIONAL STANDARD

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Components for low-voltage surge protection – Part 341: Performance requirements and test circuits for thyristor surge suppressors (TSS)

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IEC 61643-341:2020
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Composants pour parafoudres basse tension – Partie 341: Exigences de performance et circuits d'essai pour parafoudres à thyristor (TSS)

IEC 61643-341:2020-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 31.080.10

ISBN 978-2-8322-8304-2

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COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTION –

Part 341: Performance requirements and test circuits for thyristor surge suppressors (TSS)

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International Standard IEC 61643-341 has been prepared by subcommittee 37B, Components for low-voltage surge protection, of IEC technical committee 37: Surge arresters.

This second edition of IEC 61643-341 cancels and replaces the first edition published in 2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition: Addition of performance values.

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

FDIS	Report on voting
37B/218/FDIS	37B/220/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61643 series, under the general title *Components for low-voltage surge protective devices*, can be found on the IEC website.

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

- reconfirmed;
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COMPONENTS FOR LOW-VOLTAGE SURGE PROTECTION –

Part 341: Performance requirements and test circuits for thyristor surge suppressors (TSS)

1 Scope

This part of IEC 61643 specifies standard test circuits and methods for thyristor surge suppressor (TSS) components. These surge protective components, SPCs, are specially formulated thyristors designed to limit overvoltages and divert surge currents by clamping and switching actions. These SPCs are used in the construction of surge protective devices (SPDs) and equipment used in Information & Communications Technologies (ICT) networks with voltages up to AC 1 000 V and DC 1 500 V. This document is applicable to gated or non-gated TSS components with third quadrant (-v and –i) characteristics of blocking, conducting or switching.

This document contains information on

- terminology;
- letter symbols;
- essential ratings and characteristics;
- rating verification and characteristic measurement;

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This document does not apply to the conventional three-terminal thyristors as covered by IEC 60747-6.

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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 60050-521, *International Electrotechnical Vocabulary – Chapter 521: Semiconductor devices and integrated circuits*

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*

3 Terms, definitions, abbreviated terms and symbols

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 Parametric terms, letter symbols and definitions

Where appropriate, terms, letter symbols and definitions are used from conventional thyristor (IEC 60747-6) and rectifier diode (IEC 60747-2) standards. TSS definitions are the same or similar to conventional thyristor definitions. To avoid the proliferation of terms, the word “thyristor”, as used in the terms of this document, is synonymous with “TSS”.

NOTE 1 IEC 60747-1, clause 2.1.1 Basic letters, states “IEC 60027 recommends the letters V and v only as reserve symbols for voltage; however, in the field of semiconductor devices, they are so widely used that in this publication they are on the same plane as U and u." This document uses the letters V and v for voltage with the letters U and u as alternatives.

NOTE 2 Where several distinctive forms of letter symbol exist, the most commonly used form is given first.

3.2 General terms

3.2.1
information and communications technologies
ICT
group of applications using information and communications (telecommunications) technologies

[SOURCE: ISO/IEC 24704:2004, 3.1.5]

3.2.2
overcurrent
any current having a peak value exceeding the corresponding peak value of maximum steady-state current at normal operating conditions

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[SOURCE: IEC 60664-2-1, ed. 2.0 (2011-01), 3.21, modified by replacing voltage with current]

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3.2.3
overvoltage
any voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

[SOURCE: IEC 60664-2-1, ed. 2.0 (2011-01), 3.21]

3.2.4
surge protective device
SPD
device that restricts the voltage of a designated port or ports, caused by a surge, when it exceeds a predetermined level

Note 1 to entry: Secondary functions may be incorporated, such as a current limiting to restrict a terminal current.

Note 2 to entry: Typically, the protective circuit has at least one non-linear voltage-limiting surge protective component.

Note 3 to entry: An SPD is a complete assembly, having terminals to connect to the circuit conductors.

[SOURCE: IEC 61643-21:2008, 3.8]

3.3 Main terminal ratings

Listed ratings cover the appropriate requirements of the blocking, conducting and switching quadrants.

3.3.1
repetitive peak off-state voltage
V_{DRM}
highest instantaneous value of the off-state voltage, including all repetitive transient voltages, but excluding all non-repetitive transient voltages

[SOURCE: IEC 60747-6:2000, 3.5.12[10][1], modified (removal of NOTE)]

3.3.2
repetitive peak on-state current
I_{TRM}
peak value of the on-state current, including all repetitive transient currents

[SOURCE: IEC 60747-6:2000, 3.6.15[10], modified (removal of Figure)]

3.3.3
surge on-state current
I_{TSM}
on-state current pulse of short duration and specified waveshape, whose application causes or would cause the maximum rated virtual junction temperature to be exceeded, but which is assumed to occur rarely and with a limited number of such occurrences during the service life of the device and to be a consequence of unusual circuit conditions

[SOURCE: IEC 60747-6:2000, 3.6.17[10], modified (removal of "(for example, a fault) (see figure 4)")]

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3.3.4
non-repetitive peak impulse current
I_{PP}
rated maximum value of peak impulse current of specified amplitude and waveshape that may be applied

3.3.5
repetitive peak reverse voltage (of a unidirectional thyristor)
V_{RRM}
highest instantaneous value of the reverse voltage, including all repetitive transient voltages, but excluding all non-repetitive transient voltages

[SOURCE: IEC 60747-6:2000, 3.5.6[10], modified (removal of NOTE)]

3.3.6
non-repetitive surge forward current
I_{FSM}
forward current pulse of short time duration and specified waveshape, whose application causes or would cause the maximum rated junction temperature to be exceeded, but which is assumed to occur rarely and with a limited number of such occurrences during the service life of the device and to be a consequence of unusual circuit conditions (for example a fault)

[SOURCE: IEC 60747-2:2000, 3.3.6[9], modified (original term did not include "non-repetitive")]

3.3.7
repetitive peak forward current (diode)
I_{FRM}
peak value of the forward current including all repetitive transient currents

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1 Numbers in square brackets refer to the bibliography.

[SOURCE: IEC 60747-2:2000, 3.3.4[9]]

3.3.8
critical rate of rise of on-state current
di_T/dt_{cr}
highest value of the rate of rise of on-state current that a thyristor can withstand without deleterious effect

[SOURCE: IEC 60747-6:2000, 3.6.23[10]]

3.4 Main terminal characteristics

3.4.1
off-state voltage
V_D
anode, principal, or thyristor voltage when the thyristor is in the off state

[SOURCE: IEC 60747-6:2000, 3.5.9[10]]

3.4.2
off-state current
I_D
anode, principal, or thyristor current when the thyristor is in the off state

[SOURCE: IEC 60747-6:2000, 3.6.26[10]]

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3.4.3
peak off-state current
I_{DRM}
maximum (peak) value of off-state current that results from the application of the repetitive peak off-state voltage, V_{DRM}

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3.4.4
breakover voltage
$V_{(BO)}$
voltage at the breakover point

[SOURCE: IEC 60747-6:2000, 3.5.1[10]]

3.4.5
holding current
I_H
minimum anode, principal, or thyristor current that will maintain the thyristor in the on state

[SOURCE: IEC 60747-6:2000, 3.6.25[10]]

3.4.6
off-state capacitance
C_o, C_J
differential capacitance at the specified terminals in the off-state measured at specified frequency, f, amplitude, V_d and DC bias, V_D

3.4.7
repetitive peak reverse current
I_{RRM}
maximum (peak) value of reverse current that results from the application of the repetitive peak reverse voltage, V_{RRM}

3.4.8
forward recovery voltage (diode)
V_{FRM}
varying voltage occurring during the forward recovery time after instantaneous switching from zero or a specified reverse voltage to a specified forward current

[SOURCE: IEC 60747-2:2000, 3.2.3[9]]

3.5 Additional and derived parameters

The following derived and measured parameters may be necessary or useful for comparison, certain applications or statistical process controls.

3.5.1
breakover current
$I_{(BO)}$
anode, principal, or thyristor current at the breakover point

[SOURCE: IEC 60747-6:2000, 3.6.1[10]]

3.5.2
on-state voltage
V_T
anode, principal, or thyristor voltage when the thyristor is in the on state

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[SOURCE: IEC 60747-6:2000, 3.5.8[10]]

3.5.3
on-state current
I_T
anode, principal, or thyristor current when the thyristor is in the on state

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[SOURCE: IEC 60747-6:2000, 3.6.9[10]]

3.5.4
forward voltage (diode)
V_F
voltage across the terminals which results from the flow of current in the forward direction

[SOURCE: IEC 60747-2:2000, 3.2.1[9]]

3.5.5
forward current (diode)
I_F
current through the device in the forward conducting state

3.6 Temperature related parameters

All the semiconductor related TSS parameters are temperature dependent. The need for temperature dependence information can often be removed by specifying that a parameter's maximum or minimum value should be valid over the intended operating temperature range. Some common temperature related terms are shown hereafter.

3.6.1
variation of holding current with temperature
change in holding current, I_H, with changes in temperature and shown as a graph

3.6.2
temperature derating
derating with temperature above a specified base temperature, expressed as a percentage, such as may be applied to peak pulse current

3.6.3
thermal resistance
R_{thJL}, R_{thJC}, R_{thJA} ($R_{\theta JL}$, $R_{\theta JC}$, $R_{\theta JA}$)
effective temperature rise per unit power dissipation of a designated junction, above the temperature of a stated external reference point (lead, case or ambient) under conditions of thermal equilibrium

Note 1 to entry: Thermal resistance is usually expressed as K/W with °C/W as an alternative.

3.6.4
transient thermal impedance
$Z_{thJL(t)}$, $Z_{thJC(t)}$, $Z_{thJA(t)}$ ($Z_{\theta JL(t)}$, $Z_{\theta JC(t)}$, $Z_{\theta JA(t)}$)
change in the difference between the virtual junction temperature and the temperature of a specified reference point or region (lead, case, or ambient) at the end of a time interval, divided by the step function change in power dissipation at the beginning of the same time interval which causes the change of temperature difference

Note 1 to entry: Thermal impedance is usually expressed as K/W with °C/W as an alternative.

Note 2 to entry: It is the thermal impedance of the junction under conditions of change and is generally given in the form of a curve as a function of the duration of an applied power pulse.

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3.6.5
(virtual) junction temperature
T_J, T_{VJ}
theoretical temperature representing the temperature of the junction(s) calculated on the basis of a simplified model of the thermal and electrical behaviour of the device

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Note 1 to entry: The term “virtual-junction temperature” is particularly applicable to multijunction semiconductors and is used to denote the temperature of the active semiconductor element when required in specifications and test methods. The term “junction temperature”, T_J, is used interchangeably with the term “virtual junction temperature”, T_{VJ}, in this standard.

3.6.6
maximum junction temperature
T_{JM}
maximum value of permissible junction temperature, due to self-heating, which a TSS can withstand without degradation

3.6.7
storage temperature range
T_{stgmin} to T_{stgmax}
temperature range over which the device can be stored without any voltage applied

3.7 Gate terminal parameters

3.7.1
gate trigger current
I_{GT}
lowest gate current required to switch a device from the off-state to the on-state

3.7.2
gate trigger voltage
V_{GT}
gate voltage required to produce the gate trigger current, I_{GT}