



UL 1557

STANDARD FOR SAFETY

Electrically Isolated Semiconductor Devices

UL Standard for Safety for Electrically Isolated Semiconductor Devices, UL 1557

Seventh Edition, Dated December 6, 2022

SUMMARY OF TOPICS:

The Seventh Edition of the Standard for Electrically Isolated Semiconductor Devices, UL 1557 dated December 6, 2022, has been issued to reflect the latest ANSI approval date and to incorporate the following proposal:

- ***Temperature for determining the oven time and temperature for the LTA test***
- ***Requirements for insulating materials***
- ***Insulated case***
- ***Spacings***
- ***Compliance criteria for Limited Thermal Aging (LTA) test***
- ***Miscellaneous revisions to LTA and dielectric tests***

The new requirements are substantially in accordance with Proposal(s) on this subject dated September 30, 2022.

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Standard for Electrically Isolated Semiconductor Devices

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Seventh Edition

December 6, 2022

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The most recent designation of ANSI/UL 1557 as an American National Standard (ANSI) occurred on December 6, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements apply to semiconductor devices of the isolated-mounting type – thyristors, transistors, diodes, and the like, and hybrid modules consisting of combinations of these devices.

1.2 The term isolation, as used in this standard, refers to the isolation of the mounting surface, or surface if there is no dedicated mounting surface, of a device to the electronic circuits within the device.

1.3 These requirements do not apply to snubber and commutation circuits associated with thyristors, transistors or other analog semiconductor devices.

1.4 These requirements cover the isolation performance of thyristors, transistors, diodes, and the like, and their combination in module packages and constructional features that are pertinent to that performance.

1.5 These requirements apply to isolated semiconductors for use as components in products. Compliance of an isolated semiconductor with these requirements does not determine that the semiconductor is acceptable for use as a component of an end product without further investigation. The acceptability of a semiconductor in any particular product depends upon its acceptability for continued use under the conditions that prevail in actual service.

2 Components

2.1 Except as indicated in [2.2](#), a component of a product covered by this Standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

ASTM D5374, *Standard Test Methods for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation*

ASTM D5423, *Standard Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation*

IEC 60068-1, *Environmental Testing – Part 1: General And Guidance*

IEC 60664-1, *Insulation Coordination for Equipment within Low-voltage Supply Systems – Part 1: Principles, Requirements and Tests*

IEC 60664-4, *Insulation Coordination For Equipment Within Low-Voltage Systems – Part 4: Consideration Of High-Frequency Voltage Stress*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 310, *Electrical Quick-Connect Terminals*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

UL 1434, *Thermistor-Type Devices*

5 Glossary

5.1 For the purposes of this Standard, the following definitions apply.

5.2 CASE – The exterior surfaces of the semiconductor device. This may consist of metal or non-metal materials.

5.3 CASE TEMPERATURE – Location on the case where temperatures are specified by the manufacturer.

5.4 ENCAPSULATED MATERIAL – a material that is completely surrounded or covered by a potting or other encapsulating material (e.g. silicone gel).

5.5 FRAME-BASED DEVICES – Semiconductor devices that use a separate material, usually polymeric, to contain the encapsulate of a semiconductor device. This material also serves as at least part of the device case.

5.6 HERMETICAL SEAL – Any material or cover employed to prevent air infiltration, that is, encapsulant.

5.7 INSULATING MATERIAL OPERATING TEMPERATURE – The temperature of the insulating material at the point of maximum electrical field stress for either the discrete semiconductor device or semiconductor power module when operating in accordance with the manufacturer's specifications. See Annex C for examples of areas of highest electrical field strength.

5.8 INSULATING MATERIALS – Any polymeric material in direct contact with live parts, closer than 0.8 mm to live parts, or providing isolation between external as well as internal live parts and the mounting surface of the semiconductor, the surface of the semiconductor not intended for mounting but declared as providing isolation, or between live parts and the surface of the semiconductor when the semiconductor is free-standing (e.g. those mounted to printed wiring board assemblies by their leads).

5.9 ISOLATION VOLTAGE – The maximum withstand potential at 60 Hz between external as well as internal live parts and metal mounting surface of the semiconductor, between live parts and the surface of the semiconductor not intended for mounting if declared, or between live parts and the surface of the semiconductor when the semiconductor is free-standing (e.g. those mounted to printed wiring board assemblies by their leads).

5.10 JUNCTION TEMPERATURE – The maximum allowable temperature of the semiconductor junction specified by the manufacturer.

5.11 MODULE PACKAGE – An assembly consisting of two or more semiconductor devices.

5.12 MOLDED DEVICES – Non-frame based semiconductor devices or modules whose semiconductor device(s) and additional insulating materials (when used) are encapsulated by being molded into a polymeric material, which also serves as the device case.

5.13 ON-STATE CURRENT – The principle current when the semiconductor is in the ON-state.

5.14 PRESSURE CONTACT SEMICONDUCTOR DEVICE – Semiconductor device where the semiconductor, current carrying metal parts, and insulating materials are stacked and primarily held together using pressure from a spring-type assembly.

5.15 SEMICONDUCTOR DEVICE – Discrete isolated-mounting type electronic device in which the characteristic distinguishing electronic conduction takes place within a semiconductor, examples include thyristors, transistors, and diodes.

5.16 STORAGE TEMPERATURE – Acceptable temperature range at which the semiconductor can be stored, without any power applied, as specified by the manufacturer.

CONSTRUCTION

6 General

6.1 A semiconductor shall be constructed in compliance with Sections [7](#) – [10](#).

6.2 See Annex [A](#) for semiconductor modules that incorporate thermistor type devices.

7 Insulating Materials

7.1 Encapsulants (e.g. silicone gel), encapsulated materials, and materials that are hermetically sealed

7.1.1 Encapsulants (e.g. silicone gel), encapsulated materials, and materials that are hermetically sealed shall be subjected to the Dielectric Voltage-Withstand Test, Section [12](#), and if the generic temperature index of the material is exceeded by the insulating material operating temperature, the Limited Thermal Aging Test, Section [13](#). The generic thermal index shall be in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

7.1.2 When the manufacturer's specified storage temperature exceeds the insulating material operating temperature of a device, the storage temperature shall be considered the insulating material operating temperature for the purpose of these requirements.

7.1.3 The insulating material operating temperature shall be the rated maximum junction temperature, or shall be the highest rated continuous operating junction temperature if the maximum junction temperature is assigned a duration or duty cycle in addition to a continuous rating, for the following devices:

- a) Molded devices that are free-standing (no dedicated mounting surface), see Annex B, [Figure B.1](#) for an example.
- b) Molded devices that are intended to be mounted to a metal surface in such a way that the heat transfer is done via mold, see Annex B, [Figure B.2](#) for an example.
- c) Molded devices or frame-based devices that use an insulated metal substrate for heat transfer, where the insulating material of the insulated metal substrate is a polymeric material (may be ceramic filled or glass filled) or printed wiring board material, see Annex B, [Figure B.3](#) and [Figure B.7](#) (respectively) for examples.
- d) Framed-based pressure contact semiconductor devices, see Annex B, [Figure B.5](#) for an example.

7.1.4 The insulating material operating temperature shall be considered the rated case temperature for molded devices or frame-based devices that use ceramic as an insulating material, see Annex B, [Figure B.4](#), [Figure B.6](#) and [Figure B.8](#) for examples.

7.1.5 The thermal index of ceramic shall be considered unlimited, therefore the insulating material operating temperature of ceramic is not considered.

7.2 Insulating materials other than encapsulants, encapsulated materials, and materials that are hermetically sealed, e.g. case material

NOTE: the following requirements are based on requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.2.1 Insulating materials that are in contact with or less than 0.8 mm (0.031 in) from live parts shall have a CTI in accordance with requirements in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. The CTI for each insulating material shall be specified by the manufacturer. The CTI shall be specified as a performance level category (i.e. 0, 1, 2, 3, or 4) or specified as an ASTM CTI tracking index range corresponding to the PLC (e.g. 175 – 249, which corresponds to PLC 3). See [16.5](#) for specification requirements.

NOTE: UL 840, the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, Section 9.2 gives ASTM CTI tracking index and PLC values.

7.2.2 Insulating materials that are in contact with or less than 0.8 mm (0.031 in) from live parts shall have high current arc resistance to ignition (HAI) in accordance with requirements for in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A and a flammability classification in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The minimum HAI value shall be in accordance with [Table 7.1](#) based on the material flame class rating.