UL 2367

STANDARD FOR SAFETY

Solid State Overcurrent Protectors

UL Standard for Safety for Solid State Overcurrent Protectors, UL 2367

Second Edition, Dated April 19, 2021

SUMMARY OF TOPICS

This is the Second Edition of ANSI/UL 2367 dated April 19, 2021, which includes several substantive changes to update the requirements.

The requirements are substantially in accordance with Proposal(s) on this subject dated November 6, 2020 and February 12, 2021.

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Standard for Solid State Overcurrent Protectors

First Edition – December, 2009

Second Edition

April 19, 2021

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 2367 as an American National Standard (ANSI) occurred on April 19, 2021. 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 This standard covers solid-state overcurrent protectors. These devices are solid-state switches that limit the output current to a safe level when the output load exceeds the current-limit threshold or when a load-side short-circuit is present. Solid-state overcurrent protectors are intended to be used on the load-side of an isolating transformer, power supply or battery to provide a means of supplementary protection. See Table 1.1 for maximum current and power levels.

Table 1.1
Maximum Current and Power Levels

Output voltage (V_{oc})		Output current (I_{sc})	
V_{ac}	V_{dc}	A	(V × A)
≤ 20	≤ 20	≤ 1000 / V_{oc}	≤ 250
20 ≤ V_{oc} ≤ 30	20 ≤ V_{oc} ≤ 30	≤ 1000 / V_{oc}	≤ 250
–	30 ≤ V_{oc} ≤ 60	≤ 1000 / V_{oc}	≤ 250

1.2 The devices covered by these requirements are integrated circuits, and electrical spacings within the devices are not specified.

1.3 The devices covered by these requirements are entirely electronic in nature and have no means for mechanical operation or reset.

1.4 The terminals of the devices covered by these requirements are for factory wiring only (intended to be mounted on a printed wiring board).

1.5 This Standard also covers devices intended to be used as limited power source current limiters in accordance with UL 62368-1, Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, and UL 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements. These devices limit output currents to values less than the protective current rating of 5 amperes and a maximum output power of 100 VA.

1.6 The devices covered by these requirements limit output currents to values less than the overcurrent protection rating of 5 amperes.

1.7 The devices covered by these requirements have only been evaluated for supplementary overcurrent protection of secondary circuits supplied by the load side of a transformer, power supply or battery and have not been evaluated for branch-circuit protection.

1.8 This Standard may cover devices intended for use in telecommunications applications. However, devices intended for connection to telecommunications networks with outside plant connections should be evaluated in the end-use in accordance with the requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, or the Standard for Secondary Protectors for Communication Circuits, UL 497A, as appropriate.

1.9 This Standard also covers solid-state overcurrent protectors that are identified as providing Class 2 limitations as defined in the National Electrical Code, NFPA 70. See Section 10, Class 2 Limitations per NFPA 70, Article 725.

2 Components

2.1 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.

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

2.3 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:

National Electrical Code, NFPA 70

UL 497A, Secondary Protectors for Communication Circuits

UL 746B, Polymeric Materials – Long Term Property Evaluations

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

UL 1310, Class 2 Power Units

UL 5085-3, Class 2 Transformers

UL 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements

UL 62368-1, Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements

5 Glossary

5.1 For the purpose of this Standard, the following definitions apply:

5.2 AMBIENT TEMPERATURE – The temperature of the surrounding air that comes in contact with the solid-state overcurrent protector.

5.3 ENCAPSULANT – A molding material that is typically cast or injection molded around and is intended to insulate and protect the device. Encapsulated devices do not employ supplementary surrounding shells hence the encapsulant functions as an electrical enclosure.

5.4 EXPOSED PLANT (OUTSIDE PLANT) – Any portion of the telecommunications network subject to accidental contact with or induction from power conductors at a voltage exceeding 300V to ground. This includes circuitry that is intended to be connected to the Public Switched Telephone Network (PST-N), Off-Premises Extension (OPE) lines, and the like.

5.5 MAXIMUM CONTINUOUS CURRENT (CONT. CURRENT) – This designation is the ampere rating for which a protector or family of protectors has been tested for continuous current operation.

5.6 OPERATING AMBIENT TEMPERATURE RANGE – The ambient temperature range for the protector when operating in accordance with the manufacturer's specifications.

5.7 PROTECTIVE CURRENT (PROT. CURRENT) – This designation is the ampere rating for which a protector or family of protectors has been tested for providing overcurrent protection.

5.8 TELECOMMUNICATION (TELEPHONE) NETWORK CIRCUIT – An electrical circuit conductively connected to the telephone company communications facilities.

5.9 TELECOMMUNICATION NETWORK CONNECTIONS (TNC) – Identified as follows:

a) Not intended for use on telecommunication network with outside plant connections.

b) Intended for use on telecommunication network with outside plant connections.

5.10 VOLTAGE RANGE (VOLTS) – This designation is the voltage range for which a protector or family of protectors has been tested. Unless specified otherwise, all voltages are direct current (DC).

CONSTRUCTION

6 General

6.1 A solid-state overcurrent protector shall be constructed in compliance with Sections 7 – 10.

7 Insulating Materials

7.1 Uninsulated live parts involving risk of fire, electric shock, or electrical-energy/high-current levels shall be mounted on porcelain, phenolic-composition, or other material that is intended for the application.

7.2 Thermoplastic materials used for the direct or indirect support of uninsulated live parts involving a risk of fire, electric shock, or electrical-energy/high-current shall comply with the requirements in UL 746C.

7.3 Molded parts shall have the mechanical strength and rigidity to withstand the stresses of actual service.

7.4 Materials used as encapsulants shall operate within their RTI as specified in UL 746B or alternatively shall comply with the Limited Thermal Aging Test, Section 19.

8 Live Parts

8.1 Metal employed for current-carrying parts shall be of stainless steel, silver, gold, copper, nickel, aluminum, an alloy of the same, or an equivalent material.

9 Corrosion Protection

9.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

Exception: Encapsulated parts and stainless steel parts are not required to be provided with plating.

10 Class 2 Limitations per NFPA 70, Article 725

10.1 A solid-state overcurrent protector identified as providing Class 2 limitations shall comply with the output voltage, output current, output power, output loading, and component fault requirements specified in UL 1310, under the maximum voltage and current source capacity to which the protector may be supplied.

10.2 The source to a solid-state overcurrent protector that supplies Class 2 in accordance with 10.1 shall comply with the insulation, spacing, and overload requirements specified in one of the following:

a) UL 1310; or

b) UL 5085-3.

10.3 Following each of the tests specified in 10.1, the solid-state overcurrent protector shall comply with the Calibration Tests of Section 11.

10.4 A solid-state overcurrent protector identified as providing Class 2 limitations shall not exceed the applicable maximum output voltage, current, and power requirements from Table 11.1 during any test condition.

PERFORMANCE

11 Calibration Tests

11.1 A solid state overcurrent protector shall operate in accordance with the parameters shown in Table 11.1 and Table 11.2 and the manufacturer's specifications. There shall be no emission of flame or molten metal from the device during testing or evidence of a risk of fire as determined by the indicator described in 11.2.

Table 11.1
Maximum Acceptable Time for Operation of Protective Device

Output voltage (V_{oc})		Output current (I_{sc}) A	Maximum time for protective device to operate (minutes)
V_{ac}	V_{dc}		
≤ 20	≤ 20	10[a]	2
≤ 20	≤ 20	6.75[b]	60
20 ≤ V_{oc} ≤ 30	20 ≤ V_{oc} ≤ 60	200 / V_{max}[a,c]	2

Table 11.1 Continued on Next Page

Table 11.1 Continued

Output voltage (V_{oc})		Output current (I_{sc}) A	Maximum time for protective device to operate (minutes)
V_{ac}	V_{dc}		
$20 \le V_{oc} \le 30$	$20 \le V_{oc} \le 60$	$135 / V_{max}$ [b,c]	60

[a] The load is to be adjusted continuously to maintain the test current value shown.

[b] After 15 minutes of operation, the load is to be readjusted to return to the output current value shown.

[c] V_{max} is the maximum output voltage regardless of load with rated input.

Table 11.2
Maximum Acceptable Time for Protection Device to Trip

Output voltage (V_{oc})	Rated protective current (A)	Test current, Percent of rated protective current	Maximum trip time (seconds)
≤ 20	≤ 5.0	210	120
> 20	≤ 100 / V_{oc}	210	120

11.2 During the test, the grounding means is to be connected to ground through a 3-ampere non-time-delay fuse and the unit is to be draped with a double layer of cheesecloth conforming to the outline of the unit.

11.3 The component or circuit is to be mounted in its intended manner.

11.4 When a range of values for one component or circuit construction is to be evaluated, samples of the minimum, mean, and maximum rating are to be tested. All tests are to be conducted at a 25.0 ±3 °C ambient.

11.5 The operating time and limiting shall be consistent and in accordance with the tolerances specified by the manufacturer's curve of opening time versus current or wattage.

11.6 The manufacturer's operating time curve is to be verified by checking 105 %, 135 %, 210 %, and 300 % of the protective current rating. Five separate component or circuit samples are to be used to check each of the four points.

11.7 The calibration tests are to be conducted on a preset circuit.

11.8 After each of the tests specified in Sections 13 – 18, the Calibration Tests are to be repeated. The results are considered acceptable if the measured operating time characteristics do not exceed the manufacturer's specified parameters by more than 5 percent.

Exception: An open circuit is considered an acceptable result.

12 Temperature Test

12.1 The device shall carry rated maximum continuous current without tripping and the temperature rise during the test shall not exceed the maximum allowable temperature rating of the device or the rating of the insulating materials.

12.2 A sample of the device is to be connected as intended in service to a source with a short circuit current capability of at least 250 A (1000 / V) and a power capacity of at least 250 VA.

12.3 The device is to be energized continuously until constant temperatures are reached on and about the device.

12.4 The temperature test is to be conducted at an ambient temperature within the range of 10 – 40 °C (50 – 104 °F). Where the manufacturer's specified maximum operating ambient temperature is higher than 40 °C (104 °F), the test is instead to be conducted at the manufacturer's specified maximum operating ambient temperature.

12.5 When a test is conducted at an ambient temperature other than 25 °C (77 °F) or other than the maximum operating ambient temperature required in 12.4, an observed temperature shall be corrected as described in 12.6. Neither a corrected temperature nor an observed temperature shall exceed the required values specified in 12.1.

12.6 An observed temperature is to be corrected by addition [if the ambient temperature is lower than 25 °C (77 °F) or the required maximum operating ambient temperature] or subtraction [if the ambient temperature is higher than 25 °C (77 °F) or the required maximum operating ambient temperature] of the difference between 25 °C or the required maximum operating ambient temperature, and the measured ambient temperature.

12.7 When a corrected temperature exceeds the required value specified in 12.1, at the request of the manufacturer, the test may be repeated at an ambient temperature closer to 25 °C (77 °F) or the required maximum operating ambient temperature, whichever is applicable.

12.8 A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5-minute intervals, indicate no further increase.

12.9 Measurement of temperatures shall be by thermocouples. The thermocouples shall be secured by Fuller's earth and waterglass, welding, soldering, or other method that provides thermal contact.

12.10 The thermocouples shall consist of iron and constantan or chromel and alumel wires not larger than 30 AWG (0.05 mm^2).

12.11 An alternative method of temperature measurement may be used when upon investigation it is shown that the alternative method provides equivalent results.

13 Overload Operation Test

13.1 The devices shall be tested according to 13.2 and 13.3 and shall exhibit no appreciable change in the current limiting characteristics from those demonstrated for the as-received samples.

13.2 The input connections of the device are to be connected to a source with a short circuit current capability of at least 250 A (1000 / V) and a power capacity of at least 250 VA.

13.3 The output connections are to be loaded with a resistance value that will result in the device under test conducting at least 150 percent of its rated maximum continuous current until the device opens the circuit. Fifty operations of the device at this current level are to be conducted. One sample is to be cycled with the enable pin and another sample is to be cycled with the power pin.

13.4 Following the Overload Operation Test, the Calibration Tests of Section 11 shall be repeated.

14 Shipping and Storage Test

14.1 The device shall operate as intended following exposure to high and low temperatures representative of shipping and storage likely to be encountered by the end product.

14.2 The device is to be subjected, first to a temperature of 70 °C (158 °F) for a period of 24 hours, cooled to a room temperature of 23 ±3 °C (73 ±5 °F) for at least 1 hour, and then exposed to a temperature of minus 30 °C (minus 22 °F) for at least 3 hours and finally warmed up to room temperature for a minimum of 3 hours.

14.3 Following the Shipping and Storage Test, the Calibration Tests of Section 11 shall be repeated.

15 Thermal Cycling Test

15.1 Devices are to undergo 10 cycles of temperature variation between 0 and 49 °C (32 and 120 °F) while unenergized.

15.2 The transfer time from one extreme to the other is to be a maximum of 5 minutes, and there is to be a period of not less than 10 minutes at each temperature level after the mass of the test sample has reached the specified temperature. Each cycle is to start at one test condition, change to the other extreme, and return to the original test condition. After 10 cycles, the device is to be stabilized at the normal test ambient temperature before operation.

15.3 Each device is to undergo the Calibration Tests of Section 11 once at each of the temperature extremes and again at the conclusion of the Thermal Cycling Test. Devices that acceptably complete the Calibration Tests at the conclusion of the Thermal Cycling Test but fail to acceptably complete the Calibration Tests at either or both temperature extremes are to be designated as not acceptable for outdoor use.

16 Endurance Test

16.1 A sample of the device shall be subjected to endurance testing as indicated in Table 16.1. A new sample may be used for each of the endurance cycles. The input connections of the device are to be connected to a source with a short circuit current capability of at least 250 A (1000/V) and a power capacity of at least 250 VA.

Table 16.1
Conditions for Endurance Test

Test No.	Initial condition	Cycle procedure[d]	Number of cycles	Ambient temperature[a]
1[b]	Power on with output loaded to maximum rated, enable pin off	Enable pin On / Enable pin Off	10000	25 °C ±2 °C
2	Power on with output open-circuited	Short Output / Open Output	50	T_{min}
3	Power on with output open-circuited	Short Output / Open Output	50	T_{max}
4	Output short-circuited, power to circuit off	Power On / Power Off	50	T_{min}
5	Output short-circuited, power to circuit off	Power On / Power Off	50	T_{max}

Table 16.1 Continued on Next Page

Table 16.1 Continued

Test No.	Initial condition	Cycle procedure[d]	Number of cycles	Ambient temperature[a]
6	Power on, circuit loaded to maximum rated load	Short Output / Remove Short	50	T_{min}
7	Power on, circuit loaded to maximum rated load	Short Output / Remove Short	50	T_{max}
8	Power off, output open-circuited	Power On / Short Output / Power Off / Power On / Remove Short / Power Off	50	T_{min}
9	Power off, output open-circuited	Power On / Short Output / Power Off / Power On / Remove Short / Power Off	50	T_{max}
10[c]	Power on with output short-circuited, enable pin off	Enable pin On/Off	50	T_{min}
11[c]	Power on with output short-circuited, enable pin off	Enable pin On/Off	50	T_{max}

[a] T_{min} – Not more than manufacturer's specified minimum operating ambient temperature, but not more than minus 30 °C.

T_{max} – Not less than manufacturer's specified maximum operating ambient temperature, but not less than 70 °C.

[b] If the device does not have an Enable pin, the Power is to be cycled.

[c] Not required for devices without an Enable pin.

[d] For Test 1 – Each cycle consists of operating the sample for 1 second with current and 1 second without current.

For Tests 2 – 11, Each cycle consists of operating the sample until it trips, followed by resetting it within 1 second of tripping. When sample operation does not allow for reset within 1 second, the reset time shall be as close as possible to 1 second.

16.2 Following the Endurance Test, the Calibration Tests of Section 11 are to be repeated.

16.3 The sample is to be conditioned for a minimum of 3 hours at the specified ambient temperature before testing.

17 Abnormal Test

17.1 The solid-state protector shall be evaluated for conditions imposed by the supply circuit that might have an effect on the limiting circuit performance. The conditions shall include 1/2 wave rectification, high (110 % maximum rated voltage) and low (85 % minimum rated voltage) voltage conditions due to failure of a regulator and similar conditions. The condition is imposed with the input connections of the device connected to a source with a short circuit current capability of at least 250 A (1000/V) and a power capacity of at least 250 VA. At the conclusion of this abnormal test, the Endurance Tests 2, 4, 6, and 8 per Table 16.1 shall be repeated, except that the ambient temperature shall be 25 °C ±2 °C. The Calibration Tests of Section 11 shall not be repeated after these tests.

18 Long Term Abnormal Test

18.1 After subjecting the device to the test procedures in 18.2, the device shall perform its intended function. The output current shall not display any significant change and there shall be no manifestation of a fire hazard as determined by the indicator described in 18.2.