

UL 1577

ISBN 0-7629-0570-0

Optical Isolators

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333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Optical Isolators, UL 1577

Fourth Edition, Dated May 10, 2000

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-14.....	May 10, 2000

MAY 10, 2000

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UL 1577

Standard for Optical Isolators

First Edition – June, 1984
Second Edition – May, 1989
Third Edition – March, 1995

Fourth Edition

May 10, 2000

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

ISBN 0-7629-0570-0

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover optical isolators, also called optical couplers or photocouplers:

- a) Intended to provide unidirectional signal transfer between dielectrically isolated circuits and,
- b) Intended for use in equipment with a supply voltage not exceeding 600 V ac rms or dc.

1.2 These requirements cover the electrical insulation properties of the insulation between the isolated circuits of the optical isolator.

1.3 These requirements also cover double protection optical isolators that are employed in nominal 125 V, 50 or 60 Hz circuits in radio, video, and television equipment, and similar equipment in applications in which breakdown of the optical isolator may result in a risk of fire, electric shock, or injury to persons.

1.4 These requirements do not cover the electrical properties of the separate circuits of the optical isolator.

1.5 These requirements apply to optical isolators for use as components in devices and appliances. Compliance of an optical isolator with these requirements does not indicate that the isolator is acceptable for use as a component of an end product without further investigation.

1.6 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 Glossary

2.1 Dielectric Insulation-Voltage Rating – The maximum voltage-withstand potential between the input and output circuits of the optical isolator.

2.2 Electrically-Insulating Optical Medium – A medium between the photo-emitter and photo-sensor that electrically insulates them from each other but allows the transmission of light from the photo-emitter to the photo-sensor, such as an air space, glass, or the like.

2.3 Insulation, Basic – Insulation applied to live parts to provide basic protection against electric shock.

2.4 Insulation, Double – An insulation comprised of basic insulation and supplementary insulation. A double protection optical isolator has double insulation.

2.5 Insulation, Supplementary – Independent insulation applied in addition to the basic insulation in order to protect against electric shock in the event of a failure of basic insulation.

2.6 Photo-Emitter – A device internal to the optical isolator that generates electromagnetic radiation, such as a light-emitting diode (LED), used to transmit signals to the photo sensor.

2.7 Photo-Sensor – A device internal to the optical isolator that generates an electrical current due to incident light, such as a photo diode or a photo-conductive transducer, used to receive signals from the photo-emitter.

3 Units of Measurement

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

4 References

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.

CONSTRUCTION

5 General

5.1 An optical isolator shall be constructed in compliance with Sections 6 – 9.

6 Corrosion Protection

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

Exception: Encapsulated parts and stainless steel parts need not be provided with plating.

7 Insulating Materials

7.1 An insulating material shall be investigated in accordance with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and shall have a thermal index at least equal to the maximum operating temperature of the insulating material.

Exception: Insulating materials that are encapsulated or hermetically sealed need only be subjected to the tests in Dielectric Voltage-Withstand Test, Section 11 and, if the generic temperature rating of the material is exceeded, to the test switch in Limited Thermal Aging Test, Section 12.

7.2 Materials used to encapsulate devices shall operate within the generic temperature limitations as specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, or shall be tested as outlined in Limited Thermal Aging Test, Section 12.

8 Live Parts

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

Exception: Plated steel and stainless steel may be used for terminals of an optical isolator.

9 Spacings

9.1 The optical isolator's external spacings between input and output circuits shall be based on the end product spacing requirements.

PERFORMANCE

10 General

10.1 Optical isolators shall be tested as described in Sections 11 and 12.

11 Dielectric Voltage-Withstand Test

11.1 Immediately following each of the conditionings indicated in 11.5 – 11.9, each representative optical isolator shall be capable of withstanding without breakdown for 60 seconds a potential equal to the rated dielectric insulation voltage, as specified by the manufacturer, applied between the input and output terminals of the optical isolator. A dc test potential shall be applied to a device having a dc rated dielectric insulation voltage. The value of the potential applied to an ac rated device shall be in volts rms.

11.2 To determine whether a representative optical isolator complies with the requirements in 11.1, the test potential is to be applied as described in 11.4 by means of test equipment having the characteristics outlined in 11.3.

11.3 The test equipment for conducting the Dielectric Voltage-Withstand Test is to have the following features and characteristics:

- a) A means of indicating the test potential,
- b) For an ac rated device, a 40 – 70 Hz test potential that has a sinusoidal waveform.

11.4 The test potential is to be obtained from any convenient source either:

- a) Having a capacity of at least 500 VA, or
- b) If of a lower capacity with the voltmeter connected in the output circuit.

The voltage is to be steadily increased until the required test level is reached and is to be held at that value for one minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

11.5 Six representative optical isolators are to be tested in the as-received condition.

11.6 Six representative optical isolators are to be exposed to the maximum rated junction temperature for 7 hours, before testing.

11.7 Six representative optical isolators are to be exposed to 85 percent relative humidity at $32.0 \pm 2.0^\circ\text{C}$ ($89.6 \pm 3.6^\circ\text{F}$) for 24 hours, before testing.

11.8 Six representative optical isolators are to be exposed to $0.0 \pm 2.0^\circ\text{C}$ ($32.0 \pm 3.6^\circ\text{F}$) for 7 hours, before testing.

11.9 Three representative optical isolators shall be connected to an electrical supply such that the photo-sensor is caused to operate at 150 percent of maximum rated power while the photo-emitter is operated at rated power until temperatures stabilize.

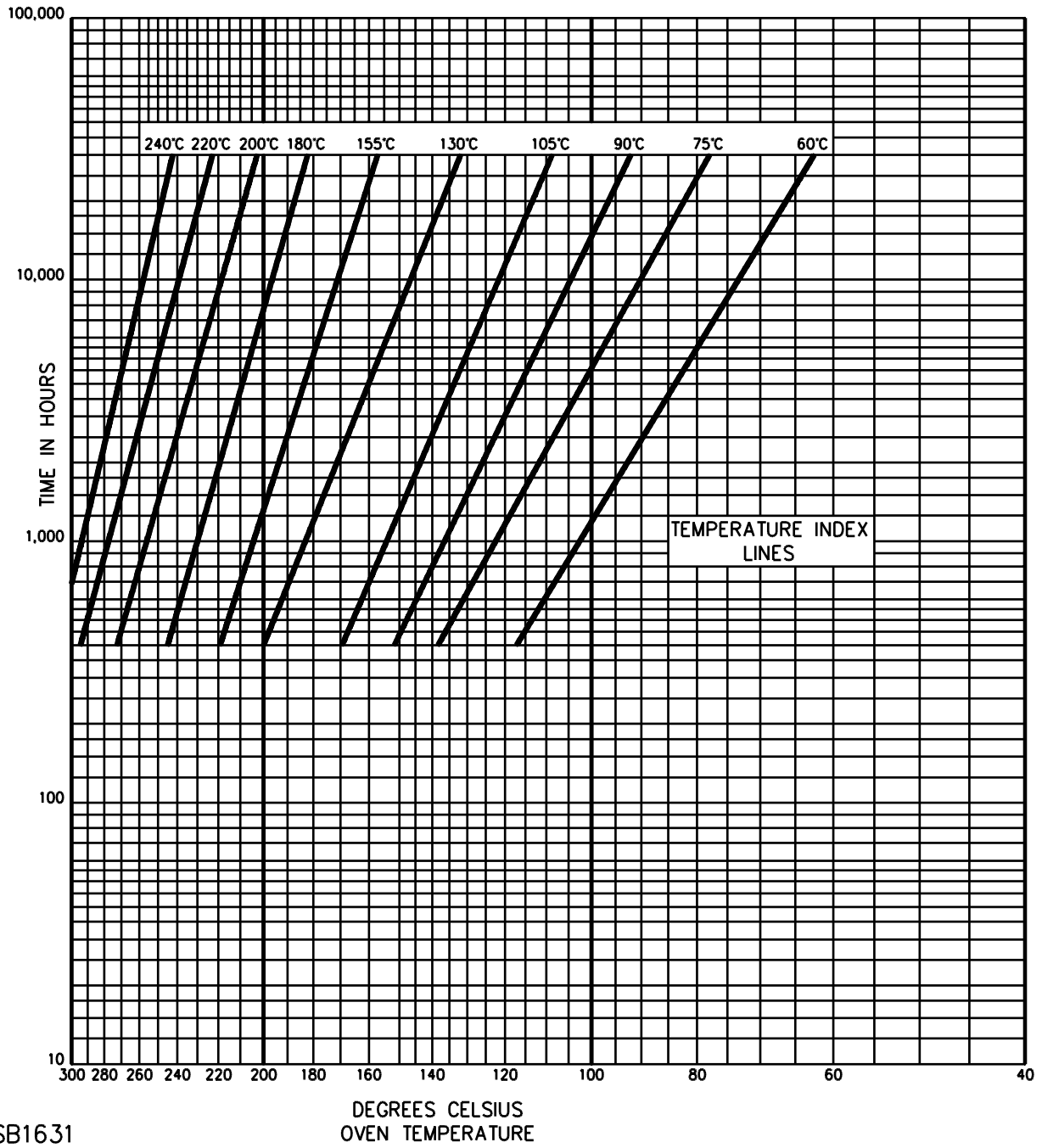
11.10 Separate sets of representative optical isolators are to be used for the various conditions in 11.5 – 11.9.

12 Limited Thermal Aging Test

12.1 An encapsulating material, as described in 7.2, shall not crack or warp in any of three representative optical isolators when the optical isolators are aged in a full-draft oven at a temperature and time chosen from the graph in Figure 12.1 using the index line that corresponds to the maximum operating temperature of the encapsulating material. After this oven conditioning, all three representative optical isolators shall withstand the rated isolation voltage as described in 11.1 and 11.4.

12.2 The air oven is to be essentially as indicated in the Standard Specification for Forced-Convection Laboratory Ovens for Electrical Insulation, ANSI/ASTM D 2436-68 (R1980). A portion of the air may be recirculated, but a substantial amount of air is to be admitted continuously to maintain an essentially normal air content surrounding the representative optical isolators. The oven is to be adjusted to achieve 100 – 150 complete fresh-air changes per hour. The oven is to maintain the specified temperature $\pm 1.0^{\circ}\text{C}$ ($\pm 1.8^{\circ}\text{F}$).

Figure 12.1
Conditioning time versus oven temperature for temperature index for encapsulating material



SB1631

DOUBLE-PROTECTION OPTICAL ISOLATORS

13 General

13.1 At least 20 representative double-protection optical isolators are required for the tests described in Sections 14 and 15.

14 Discharge Test

14.1 Ten representative optical isolators are to be tested as described in 14.2 and 14.3. As a result of this test:

- a) There shall be no visible evidence of damage to the optical isolator. Discoloration of the optical isolator is not considered to be evidence of damage.
- b) The optical isolator shall comply with the dielectric voltage-withstand tests described in 14.4.

14.2 To determine whether an optical isolator complies with the requirements in 14.1, it is to be subjected to 50 discharges from a 0.0005 microfarad capacitor that has been charged to a potential of 20 kV between the short-circuited input and short circuited output terminals. The interval between successive discharges is to be 5 seconds. The optical isolator may be submerged in an oil bath if arcing occurs over the surface or through air during the test.

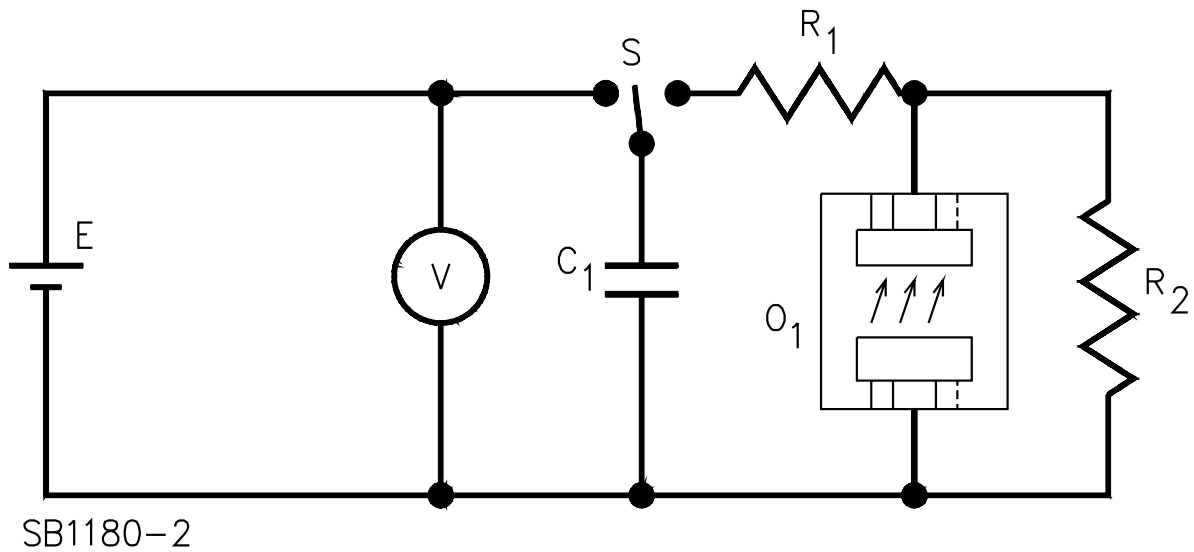
14.3 The circuit to be used in performing the discharge test is illustrated in Figure 14.1.

14.4 To determine whether an optical isolator complies with 14.1(b), the optical isolator shall withstand without breakdown for not less than 1 minute a 3500 V rms sinusoidal potential having a frequency of 60 Hz, applied between:

- a) The input and output terminals of the optical isolator, and
- b) The input and output terminals of the optical isolator connected together and metal foil wrapped closely around the body of the optical isolator. The foil is to be kept at least 1/16 inch (1.6 mm) from the terminals.

Exception: At the manufacturer's request, a 1000 V potential may be used for (b) in lieu of the 3500 V potential. If this voltage is selected, however, the optical isolator enclosure is considered acceptable for only one level of protection, and the double-protection requirements for the end-use product are to be given further consideration with regards to the optical isolator enclosure.

Figure 14.1
Circuit for discharge test



C1 – 0.0005 microfarad capacitor

O1 – optical isolator under test

R1 – 1000-ohm resistor

R2 – 100 megohm resistor

E – 20 kV direct-current source of supply

S – Switch

V – Direct-current voltmeter

15 Optical Isolator Life Test

15.1 Ten representative optical isolators are to be conditioned as described in 15.2. After the conditioning, the optical isolators shall comply with the following:

- a) The insulation resistance between the input and output terminals of the optical isolator measured at 500 V dc, with a 2-minute electrification time, shall not be less than 500 megohms; and
- b) The optical isolator shall withstand without breakdown the dielectric voltage-withstand test described in 14.4(b).

15.2 The optical isolators are to be conditioned in an air-circulating oven for 1008 hours. The air in the oven is to be maintained at a temperature of $85.0 \pm 3.0^{\circ}\text{C}$ ($185.0 \pm 5.4^{\circ}\text{F}$) and a relative humidity of 50 percent or less. Throughout the conditioning, each optical isolator is to be subjected to a 60 Hz potential of 440 V, except that once each hour the potential is to be doubled for 1/10 second. The potential is to be applied between the short circuited input and short circuited output terminals. A 1-A fuse or other device of acceptable sensitivity is to be connected in the supply circuit to each optical isolator to indicate if breakdown occurs. Clearing of a fuse indicates breakdown of an optical isolator. The optical isolators are to be allowed to cool to room temperature before proceeding with further tests.

MANUFACTURING AND PRODUCTION-LINE TESTS

16 Dielectric Voltage-Withstand Test

16.1 Each optical isolator shall withstand, as a routine production-line test, the application of a potential between the input and output terminals. For an optical isolator having an ac isolation voltage rating, the frequency of the applied potential shall be 40 – 70 Hz. A dc test potential shall be applied for an optical isolator having a dc rated dielectric insulation voltage.

Exception: A dc potential equal to 1.414 times the specified 40 – 70 Hz potential may be used if an ac rated optical isolator has solid state components that may be damaged by an ac potential.

16.2 The production-line test potential shall be the rated dielectric insulation voltage for 60 seconds or 120 percent of the rated dielectric insulation voltage for one second.

Exception: For a double protection optical isolator, the test potential is to be the rated isolation rms voltage or 2500 V, whichever is greater, applied for a minimum of one second.

16.3 The product may be in a heated or unheated condition for the test.

16.4 The test equipment for conducting the dielectric voltage-withstand test is to have the following features and characteristics:

- a) A means of indicating the test potential, in volts rms,
- b) A 40 – 70 Hz test potential that has:
 - 1) A sinusoidal waveform, and
 - 2) A peak value of the waveform that is not to be less than 1.3 and not more than 1.5 times the root-mean-square value.

- c) An automatic reject feature that rejects any unacceptable unit or an audible or visual indicator of electrical breakdown. If the indicator of breakdown is audible or visual, the indicator is to remain active until the test equipment is reset manually.

16.5 If the output of the test-equipment is less than 500 VA, the equipment is to include a voltmeter in the output circuit to indicate the test potential directly.

16.6 If the output of the test-equipment is 500 VA or larger, the test potential may be indicated:

- a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,
- b) By a selector switch marked to indicate the test potential, or
- c) In the case of test equipment that has a single output potential, by a marking in a readily visible location to indicate the test potential. When marking is used without an indicating voltmeter, the equipment is to include a positive means, such as an indicator lamp, to indicate that the manual-reset switch actually resets following a dielectric breakdown.

16.7 Test equipment other than that described in 16.3 – 16.6 may be used if found acceptable to accomplish the intended factory control.

RATINGS

17 General

17.1 An optical isolator shall be provided with a maximum continuous power, a current, and a voltage rating for both the photo-emitter and the photo-sensor circuits.

17.2 A dielectric insulation-voltage rating between the input and output terminals shall be specified in volts rms or dc, as applicable.

17.3 The maximum operating temperature shall be specified.

17.4 Derating specifications related to ambient temperatures shall also be provided.

17.5 Ratings may be expressed in tabular or graphic format.

MARKINGS

18 General

18.1 Each device shall be marked with the manufacturer's name or trademark and model number. This marking shall appear on the device itself or on the smallest shipping carton in which the device was shipped.

18.2 The rating information specified in General, Section 17, shall appear in the manufacturer's specifications for the product.