

UL 1047

Isolated Power Systems Equipment



Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Isolated Power Systems Equipment, UL 1047

Fourth Edition, Dated September 30, 2003

Revisions: This Standard contains revisions through and including November 7, 2007.

SUMMARY OF TOPICS

Revision pages for UL 1047 are being issued to reflect the recent reaffirmation of UL 1047 as an American National Standard.

UL Standards for Safety are developed and maintained in the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Due to formatting differences resulting from the use of UL's new electronic publishing system, please note that additional pages (on which no requirements have been changed) may be included in revision pages due to relocation of existing text and reformatting of the Standard.

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revisions dated November 7, 2007 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ulforeword.html>

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

UL's Standards for Safety are copyrighted by UL. Neither a printed copy of a Standard, nor the distribution diskette for a Standard-on-Diskette and the file for the Standard on the distribution diskette should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

UL will attempt to answer support requests concerning electronic versions of its Standards. However, this support service is offered on a reasonable efforts basis only, and UL may not be able to resolve every support request. UL supports the electronic versions of its Standards only if they are used under the conditions and operating systems for which it is intended. UL's support policies may change from time-to-time without notification.

UL reserves the right to change the format, presentation, file types and formats, delivery methods and formats, and the like of both its printed and electronic Standards without prior notice.

Purchasers of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgement (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

If a single-user version electronic Standard was purchased, one copy of this Standard may be stored on the hard disk of a single personal computer, or on a single LAN file-server or the permanent storage device of a multiple-user computer in such a manner that this Standard may only be accessed by one user at a time and for which there is no possibility of multiple concurrent access.

If a multiple-user version electronic Standard was purchased, one copy of the Standard may be stored on a single LAN file-server, or on the permanent storage device of a multiple-user computer, or on an Intranet server. The number of concurrent users shall not exceed the number of users authorized.

Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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 Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

Copyright © 2007 Underwriters Laboratories Inc.

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

Page	Date
1-3	November 7, 2007
4-5	September 30, 2003
6	November 7, 2007
7-54	September 30, 2003
A1-A2	September 30, 2003

No Text on This Page



SEPTEMBER 30, 2003
(Title Page Reprinted: November 7, 2007)



ANSI/UL 1047-2003 (R2007)

1

UL 1047

Standard for Isolated Power Systems Equipment

First Edition – August, 1976
Second Edition – December, 1990
Third Edition – March, 1995

Fourth Edition

September 30, 2003

The most recent designation of UL 1047 as a Reaffirmed American National Standard (ANS) occurred on November 7, 2007. The ANSI approval for this standard does not include the Cover Page, Transmittal Pages, or Title Page.

This ANSI/UL Standard for Safety, which consists of the Fourth Edition including revisions through November 7, 2007, is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI approved standard.

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. 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 <http://csds.ul.com>.

COPYRIGHT © 1976, 2007 UNDERWRITERS LABORATORIES INC.

No Text on This Page



CONTENTS

INTRODUCTION

1 Scope	7
2 Glossary	7
3 General	8
3.1 Components	8
3.2 Units of measurement	9
3.3 Undated reference	9

CONSTRUCTION

4 General	9
5 Enclosure	9
6 Ventilation	10
7 Connections for Wiring Systems	11
8 Corrosion Protection	11
9 Bases – Insulating Material	11
10 Mounting of Parts	12
11 Current-Carrying Parts	15
12 Permanently Connected Equipment	15
13 Field-Wiring Terminals and Leads	15
14 Cord-Connected Equipment	18
14.1 General	18
14.2 Strain relief	18
14.3 Bushings	19
15 X-Ray Equipment	19
16 Wall Modular Units	19
17 Internal Wiring	20
18 Separation of Circuits	21
18.1 Factory installed	21
18.2 Field-installed Class 2	21
19 Field-Wiring Space	22
19.1 General	22
19.2 Wire bending space	22
20 Spacings	25
21 Isolation Transformers	28
22 Line Isolation Monitor	30
23 Overcurrent Protection	30
24 Switches	31
25 Receptacles	31
26 Grounding Jacks and Cord Assemblies	32
27 Reference Grounding Bus	32

PERFORMANCE

28 Regulation	34
29 Temperature	35
30 Leakage Current	38
31 Dielectric Voltage-Withstand	46
32 Stability	47
33 Strength of Insulating Base and Supports	47
34 Abnormal Operation	47
35 Push-Back Relief	48

MANUFACTURING AND PRODUCTION TESTS

36 Production-Line Dielectric Voltage-Withstand	48
37 Production-Line Grounding Continuity	50

RATING

38 Details	50
------------------	----

MARKING

39 Details	50
------------------	----

APPENDIX A

Standards for Components.....	A1
-------------------------------	----

No Text on This Page



This page intentionally left blank.



INTRODUCTION

1 Scope

1.1 These requirements cover isolated power systems equipment rated 600 Vac or less, intended for installation and use in nonhazardous areas in health care facilities in accordance with the requirements in Article 517 of the National Electrical Code, NFPA 70, and in the Standard for Health Care Facilities, NFPA 99.

1.2 These requirements cover isolated power centers, either cord-connected or permanently wired, consisting of a distribution panel that incorporates an isolation transformer, one or more isolated ungrounded secondary circuits terminating in integrally mounted grounding-type receptacles, a reference grounding bus bar, and line isolation monitor. Isolated power centers may have provision for connection of grounding conductors to remote grounding jacks, the room bonding points, and patient equipment grounding points. A permanently wired isolated power center may also have provision for connection to remote receptacles or indicators.

1.3 These requirements cover convertible system units that facilitate a temporary conversion of the power supply for a power center from a grounded supply to an isolated supply.

1.4 These requirements cover isolated power panelboards that incorporate the same features as permanently wired isolated power centers except that:

- a) They may be supplied from remote isolation transformers, and
- b) The secondary isolated circuits are intended to be connected by conduit to remotely located receptacles.

1.5 These requirements cover wall modular units containing isolated power systems.

1.6 These requirements cover cord-connected isolated power centers, and panels intended to supply x-ray equipment only.

2 Glossary

2.1 For the purpose of this standard the following definitions apply.

2.2 CONVERTIBLE-SYSTEM UNIT – An enclosed assembly incorporating an isolation transformer and line isolation monitor with interconnecting cord assemblies that facilitate temporary conversion of the power supply for a power center from a grounded supply to an isolated supply. The unit is intended for use only with the specific power centers for which it has been designed.

2.3 FIELD-WIRING TERMINAL – A terminal to which a supply or other wire can be connected by an installer in the field is a field-wiring terminal unless a lead is provided as part of a pressure terminal connector, or other means for making the connection is factory-assembled to the wire.

2.4 LINE ISOLATION MONITOR – A test instrument designed to continually check the balanced and unbalanced impedance from each line of an isolated circuit to ground and equipped with a built-in test circuit to actuate an alarm without adding to the leakage current.

2.5 MOMENTARY RATING – A rating based on an operating interval that does not exceed 5 s.

2.6 PATIENT EQUIPMENT GROUNDING POINT – A jack or terminal bus that serves as the collection point for redundant grounding of electric appliances serving a patient vicinity or for grounding other items in order to eliminate electromagnetic interference problems.

2.7 REFERENCE GROUNDING POINT – A terminal bus that is an extension of the equipment grounding bus and is a convenient collection point for grounding all electric appliances, equipment, and exposed conductive surfaces in a patient vicinity.

2.8 ROOM BONDING POINT – A grounding terminal bus that serves as the collection point for grounding exposed metal or conductive building surfaces in a room.

2.9 WALL MODULAR UNIT – A factory-built wall section or sections typically containing various combinations of gas outlets, lighting fixtures, clocks, intercommunication units, and the like for use in, within, or as part of health-care facilities. Only units containing isolated power systems equipment are covered by this standard. Grounded power circuits that are physically segregated and separated may also be included.

3 General

3.1 Components

3.1.1 Except as indicated in 3.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

3.1.2 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.

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

3.1.4 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.

3.2 Units of measurement

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

3.3 Undated reference

3.3.1 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

4 General

4.1 Isolated power systems equipment shall employ materials throughout that are acceptable for the application, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

4.2 A convertible system unit shall be designed to convert a specific power center from a grounded supply to an isolated supply. The specific power center shall consist of overcurrent protection devices, receptacles, grounding jacks and components other than the transformer and line isolation monitor that have been previously permanently installed. Also the grounding conductor from the grounded supply to the distribution panel or modular wall section shall remain continuous and so arranged that it is not interrupted by the converting procedure.

4.3 An enclosure, an opening, a frame, a guard, a knob, a handle, or the like shall not be sufficiently sharp to cause a risk of injury in normal maintenance or use.

4.4 Equipment shall be formed so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts or other serious defects.

5 Enclosure

5.1 The enclosure of isolated power systems equipment shall comply with the Standard for Enclosures for Electrical Equipment, UL 50.

Exception: An enclosure may be ventilated in accordance with Ventilation, Section 6.

5.2 An enclosure cover or door shall be hinged, sliding, or similarly attached so that it cannot be wholly detached without the use of a tool, if it gives access to a fuse or any other overload-protective device the normal functioning of which requires renewal, or if it is necessary to open the cover during normal operation of the device.

6 Ventilation

6.1 A ventilating opening in an enclosure shall be constructed and located so that no flame or molten metal will be emitted during the arcing encountered during the operation of fuses, switches, or circuit breakers.

6.2 Unless the opening is remote from the arcing part, the requirement in 6.1 necessitates the interposing of a noncombustible barrier between a ventilating opening and a possible source of arcing such as a switch, fuse, and the like.

6.3 The barrier shall be of such dimensions and located so that straight lines drawn from any arcing part past the edge of the barrier will define an area at the plane of the opening 1/4 in (6.4 mm) beyond the edges of the opening.

6.4 A sheet-steel barrier shall not be less than 0.053 in (1.35 mm) thick if uncoated and not less than 0.056 in (1.42 mm) thick if galvanized.

Exception: A steel barrier may be of lesser thickness provided its strength and rigidity is not less than that of a flat sheet of steel of the specified thickness having the same dimensions as the barrier.

6.5 The thickness of a nonmetallic barrier may be less than 1/4 in (6.4 mm) if the barrier is located so that it will not be subject to mechanical abuse during installation and is located and supported so that it will have the necessary mechanical strength and rigidity.

6.6 A ventilating opening in an enclosure shall have such size or shape, or shall be covered by screening or by an expanded, perforated, or louvered metal panel so that a test rod of the diameter specified in 6.7 will not enter the opening.

6.7 The test rod mentioned in 6.6 shall be 33/64 inch (13.2 mm) in diameter if the plane of the opening is less than 4 in (102 mm) from an uninsulated live part, or 49/64 inch (19.4 mm) in diameter if the plane of the opening is 4 in or more from such part.

6.8 The size, shape, and location of a screened opening shall be such as not to unduly weaken the overall enclosure.

6.9 The area of a ventilating opening in an enclosure shall not exceed 80 in².

6.10 The wires of a screen required to protect a ventilating opening shall not be smaller than No. 16 AWG (1.3 mm²) if the screen openings are 1/2 in² or less in area, and not smaller than No. 12 AWG (3.3 mm²) for larger screen openings. A supplementary screen of smaller openings may be additionally provided. The supplementary screen is not to be considered in the evaluation of the ventilating opening screen.

6.11 Perforated sheet steel and sheet steel employed for expanded-metal mesh shall not be less than 0.042 in (1.07 mm) thick if uncoated, or 0.045 in (1.14 mm) if galvanized if the mesh openings or perforations are 1/2 in² or less in area, and shall not be less than 0.080 in (2.03 mm) thick if uncoated, or 0.084 in (2.13 mm) thick if galvanized for larger openings.

Exception: Where the indentation of a guard or enclosure cannot alter the clearance between uninsulated live parts and grounded metal so as to affect performance adversely or reduce spacings below the minimum values given in Table 20.1, perforated sheet steel and sheet steel employed as expanded metal-mesh not less than 0.020 in (0.51 mm) thick if uncoated, or if galvanized 0.023 in (0.58 mm) thick may be used.

6.12 A grill construction complying with the intent of the requirements in 6.11 may be accepted if it has been found to be suitable for the particular application.

6.13 The length of ventilating louvers in an enclosure shall not exceed 12 in (305 mm).

6.14 A separate louvered panel that is riveted or welded in place over a ventilating opening in the enclosure may be of not less than 0.032 in (0.81 mm) thick if uncoated and not less than 0.034 in (0.86 mm) thick if galvanized sheet steel.

6.15 A ventilating opening in the top of the enclosure shall be covered by a hood or protective shield spaced above the opening to prevent the entry of foreign material.

7 Connections for Wiring Systems

7.1 Knockouts provided in the enclosure shall be of the proper size; and shall be so located that the installation of bushings will not result in spacings between live parts and bushings of less than the minimum requirements specified in Table 20.1. At least two of the knockouts shall be sized to accommodate the largest size wiring which could be used in the installation of the panel.

8 Corrosion Protection

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

8.2 The requirement of 8.1 applies to all enclosing cases whether of sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend. It does not apply to bearings, laminations, and the like, if the failure of such unprotected parts would not be likely to result in a hazardous condition or in the equipment's operation being affected adversely. Parts made of stainless steel of the type having inherent resistance to corrosion (properly polished or treated, if necessary) do not require additional protection against corrosion. Bearing surfaces should be of such materials and design to ensure against binding due to corrosion.

9 Bases – Insulating Material

9.1 A base for mounting uninsulated live parts shall be strong, not easily ignited, moisture-resistant and insulating. The base shall be of such material that it will withstand the most severe conditions likely to be met in service.

9.2 Ordinary fiber, rubber, and so-called hot-molded shellac and tar compositions are not acceptable for the mounting of uninsulated live metal.

9.3 Insulating material including barriers between parts of opposite polarity and material that may be subject to the influence of the arc formed by the opening of contacts shall be suitable for the particular application.

9.4 A live screw head or nut on the underside of an insulating base shall be reliably prevented from loosening and shall be adequately insulated or spaced from the mounting surface. This may be accomplished by:

- a) Countersinking such parts not less than 1/8 inch (3.2 mm) in the clear and then covering them with a waterproof, insulating sealing compound that does not soften at a temperature 15°C (27°F) higher than its normal operating temperature in the device, and not less than 90°C (194°F) in any case; or

b) Reliably securing such parts and insulating them from the mounting surface by means of a barrier, or the equivalent, or by means of through-air or over-surface spacings not less than the minimum values specified in Table 20.1.

9.5 With reference to 9.4, a lock washer, properly applied, is acceptable as a means of preventing the loosening of a screw or nut.

9.6 With reference to 9.4(a), determination of the softening point of a sealing compound is to be made in accordance with the American Society for Testing and Materials Standard Test for Softening Point by Ring and Ball Apparatus, ASTM E28-1967.

10 Mounting of Parts

10.1 All parts shall be securely mounted in position and prevented from loosening or turning if such motion may affect adversely the normal performance of the equipment, or may increase the risk of fire, shock, and injury to persons incident to the operation of the equipment.

10.2 Uninsulated live metal parts shall be secured to their supporting surfaces so that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings to less than those indicated in Table 20.1. The security of contact assemblies shall be such as to ensure the continued alignment of contacts. See also 13.9.

10.3 With reference to 10.1 and 10.2, friction between surfaces is not acceptable as a means to prevent turning, loosening, or shifting of a part; but a suitable lock washer, properly applied, may be accepted.

10.4 The wiring of an electrical component mounted on a door or hinged cover shall be factory installed using suitable pressure wire connectors, at each end, that comply with the Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors, UL 486A and the Standard for Wire Connectors for Use With Aluminum Conductors, UL 486B. There shall be no provision for connection of field wiring.

Exception No. 1: Quick-connect terminals may be used for signal lights, buzzers or switches, if clamps or the equivalent are provided where necessary to prevent stress on the terminations.

Exception No. 2: Provision may be made for field-installation of clocks, timers, or lighting fixtures by means of plugs and receptacles.

10.5 Wires connected to a component mounted on a door or hinged cover shall:

- a) Not be larger than No. 12 AWG (3.3 mm²),
- b) Be stranded,
- c) Have at least 1/32 in (0.79 mm) thick insulation, and
- d) Be cabled or routed so as to avoid being damaged during opening and closing of the door or hinged cover.

Exception No. 1: A bundle or cable of not more than 12 wires, in addition to the bonding wire mentioned in 10.6, may contain No. 10 AWG (5.3 mm²) wires.

Exception No. 2: A bundle or cable of not more than 4 wires, in addition to the bonding wire mentioned in 10.6, may contain No. 10 AWG wires.

10.6 A door or hinged cover on which electrical components are mounted shall be bonded to the box with a wire not smaller than No. 10 AWG (5.3 mm²).

10.7 Electrical parts of a component mounted on a cover shall be located or enclosed so that with the cover open, persons are protected against unintentional contact with uninsulated live parts.

Exception: Live parts may be accessible if the voltage involved is 42.4 V peak or less or if the available current measured through a 1500 Ω noninductive resistor is 0.5 mA or less.

10.8 Not more than six receptacles and six grounding jacks shall be mounted on a single cover of a remote assembly.

10.9 Receptacles and grounding jacks mounted on a cover of a remote assembly shall be factory wired to pressure wire terminals in the remote assembly box.

Exception No. 1: Factory wiring is not required if:

- a) Not more than six devices (receptacles, grounding jacks and signal lights) are provided,*
- b) The field installed wires do not exceed six No. 12 AWG (3.3 mm²) plus one grounding conductor,*
- c) It is not necessary to remove the devices from the cover in order to do the wiring, and*
- d) The assembly is not intended for wiring other than that associated with the receptacles and jacks.*

Exception No. 2: A single grounding wire may be field wired if no reference grounding bus is provided in the remote assembly box.

10.10 Factory wiring of receptacles and grounding jacks mounted on a cover of a remote assembly shall be stranded and shall have at least 1/32-in (0.79-mm) thick insulation.

10.11 The enclosure of a remote assembly shall have a depth that accommodates the reinstallation of the cover after wiring is completed without forcing conductors against parts mounted on the cover. Parts mounted in the box such as wire terminating means shall be located so that wires connected to parts on the cover are not forced against such parts after the cover is reinstalled.

10.12 The cover of a remote assembly that is intended to be field wired shall have suitable means for its support during field wiring so that the cover assembly does not hang completely on the connected wires. This may be accomplished by the use of hinges, by instructions and design to permit hanging the cover from the lower box cover screws, or the equivalent.

10.13 If parts are held together by screws, a metal threaded part shall have no fewer than two full, clean-cut threads engaged. If the screw does not extend all the way through a threaded part, the taper or lead and the first full thread are to be disregarded in a determination of the number of threads engaged.