UL 2097

ISBN 0-7629-1279-0

Reference Standard for Double Insulation Systems for Use in Electronic Equipment

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

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

UL Standard for Safety for Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097

Fourth Edition, Dated December 28, 2006

Summary of Topics

This new edition of UL 2097 is being issued through UL's electronic publishing system to ensure format uniformity between the PDF and HTML versions of the document. While numbering and figure placement, where appropriate, may have been updated, no substantive changes have been incorporated in the document.

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://ulstandardsinfonet.ul.com/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.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

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

Copyright © 2006 Underwriters Laboratories Inc.

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

Page Date

1-28 . . . . . December 28, 2006
A1-A4 . . . . . December 28, 2006
B1-B4 . . . . . December 28, 2006
C1-C2 . . . . . December 28, 2006

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

UL 2097

Reference Standard for Double Insulation Systems for Use in Electronic Equipment

First Edition – June, 1990
Second Edition – May, 1994
Third Edition – February, 1999

Fourth Edition

December 28, 2006

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. 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.

ISBN 0-7629-1279-0

COPYRIGHT © 2006 UNDERWRITERS LABORATORIES INC.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

No Text on This Page

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

CONTENTS

1 Introduction 4
1.1 Scope 4
1.2 General 5
1.3 Glossary 5
1.4 General requirements 8
1.5 General conditions for tests 11
1.6 Markings 12
2 Fundamental Construction Requirements 13
2.1 Protection against electric shock 13
2.2 Insulation 14
2.3 SELV circuits and dead metal parts 17
2.4 Spacings (creepage distances and clearances) 18
2.5 Safety isolating transformers 19
3 Supply 20
3.1 Insulation 20
3.2 Power supply cords 20
4 Physical Requirements 20
4.1 General 20
5 Thermal and Electrical Requirements 21
5.1 Leakage current test 21
5.2 Dielectric voltage-withstand tests 24
5.3 Overload conditioning on safety isolating transformer insulation 25

APPENDIX A Guidelines and Applications for Double Insulation Systems for Electronic Equipment

APPENDIX B Insulation Typically Required Between Parts of Equipment

APPENDIX C International Electrical Symbol

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

1 Introduction

1.1 Scope

1.1.1 These requirements cover double insulation systems intended for use in ungrounded electronic equipment marked ″Double Insulation,″ ″Double Insulated,″ or with the double-insulation symbol intended to be employed in accordance with the National Electrical Code, ANSI/NFPA 70.

1.1.2 These requirements also cover:

a) Equipment required by the end-product standard to be provided with a double insulation system and to be grounded and

b) Double-insulated equipment permitted by the end-product standard to be provided with a non-functional means for grounding.

1.1.3 Equipment marked ″Double Insulation,″ ″Double Insulated,″ or with the double-insulation symbol shall comply with the applicable requirements in this standard and in the standard covering the particular type of equipment – the end-product standard. In cases where the end-product standard contains requirements for double insulation, the end-product standard takes precedence. It is intended that the requirements in this standard be applied to end products marked as described unless the end-product standard specifies different requirements.

1.1.4 These requirements were developed for categories that do not have double insulation requirements, to provide guidance about double insulation systems, and to promote consistent approaches to double insulation. Double insulation requirements for electronic equipment are applicable to the double insulation systems used in products contained in various end-product, component and systems standards. Guidelines and Applications for Double Insulation Systems for Electronic Equipment in Appendix A covers:

a) Level of Protection Provided by Double Insulation,

b) Methods to Address Product-Specific Double Insulation Requirements, and

c) Guidelines for Including Double Insulation Requirements in an End-Product Standard.

1.1.5 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, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements to determine that the level of safety as originally anticipated by the intent of this standard is maintained. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard shall not be judged to comply with this standard. Where appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

1.2 General

1.2.1 Units of measurement

1.2.1.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

1.2.1.2 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

1.2.2 Undated references

1.2.2.1 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.

1.3 Glossary

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

1.3.2 ACCESSIBLE PART OR SURFACE – A part or surface subject to contact by persons under any condition of user operation or user function, including user (or operator)

In a determination of whether a part or surface is accessible to such contact, the criteria specified in the end-product standard are to be applied.

1.3.3 BARRIER – A part providing protection against direct contact.

1.3.4 BASIC INSULATION – The insulation necessary to provide basic protection against the risk of electric shock.

1.3.5 DEAD METAL PART – A metal or other electrically conductive part, accessible or inaccessible, that is not a live part.

1.3.6 DOUBLE INSULATION – An insulation system comprised of both basic insulation and supplementary insulation.

1.3.7 ELV (EXTRA-LOW VOLTAGE) CIRCUIT – A circuit that is constructed and protected so that the voltage between conductors or between a conductor and earth ground does not exceed the limits for risk of electric shock as identified in the end-product standard and that is separated from higher voltage circuits by at least basic insulation, but that does not meet the requirements for an SELV circuit.

For the purposes of these requirements, an ELV circuit may be considered an inaccessible dead metal part.

1.3.8 INSULATION WORKING VOLTAGE – The highest steady-state voltage (transients, including switching transients, are to be disregarded) to which the insulation under consideration is, or can be, subjected under intended operating conditions.

The method for determining the insulation working voltage is described in 2.2.1.5.

1.3.9 LIVE PART – A part that is conductively connected to a circuit that operates at a voltage that exceeds the limits for risk of electric shock as identified in the end-product standard with reference to ground or accessible metal, and in which the available current measured exceeds the current value for accessible parts specified in the end-product standard.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL
Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

1.3.10 OPERATIONAL INSULATION – Insulation that is necessary for the correct operation of the equipment but that is not relied upon for protection against electric shock.

For the purposes of these requirements, parts insulated by operational insulation only are considered to be uninsulated. For example, parts in ELV circuits and live parts, protected only by lacquer, enamel, ordinary paper, cotton, oxide film, beads, or sealing compounds other than self-hardening resin are considered to be uninsulated parts.

Some parts of operational insulation may also serve as basic insulation.

1.3.11 ORDINARY TOOL – A tool considered to be commonly available to the user as described in the end-product standard.

If ordinary tools are not defined in the end-product standard, a flat-bladed or Phillips screwdriver, a nut driver, and pliers will be considered to be ordinary tools.

1.3.12 PRIMARY CIRCUIT – Wiring and components (including the primary windings of transformers, motors, other circuit-loading devices, and the means of connection to the source of supply) that are live parts as described in 1.3.9 and that are conductively connected to:

a) A branch-circuit,

b) An alternating-current or direct-current motor/generator set or inverter installed separately from or included as part of a unit or system, or

c) A battery.

1.3.13 PROTECTIVE IMPEDANCE – A component or assembly of components the impedance, construction, and reliability of which are such that when connected between:

a) Live parts (or parts that may become live in case of a fault) and

b) Accessible conductive parts

it provides protection against risk of electric shock not less than that provided by double insulation.

1.3.14 REINFORCED INSULATION – A single insulation system with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against the risk of electric shock as does double insulation.

The term ″single insulation system″ does not necessitate that the insulation must be in one homogeneous piece. The insulation system may comprise two or more layers that cannot be tested as supplementary or basic insulation.

1.3.15 ROUTINE TEST – A test that is conducted on each piece of equipment during the production process.

1.3.16 SAFETY ISOLATING TRANSFORMER – An isolating transformer in which windings supplying SELV circuits are isolated from windings that present a risk of electric shock by the use of double or reinforced insulation.

1.3.17 SECONDARY CIRCUIT – A circuit that has no conductive connection (other than through a protective impedance) to a primary circuit and that derives its power from an isolating transformer or an equivalent isolation device.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

1.3.18 SELV (SAFETY EXTRA-LOW VOLTAGE) CIRCUIT – A secondary circuit that is constructed and protected so that under intended operating conditions and single fault conditions the voltage between any two accessible parts, one of which may be the unit enclosure or earth ground, does not exceed the limits for risk of electric shock as identified in the end-product standard under intended operating conditions.

Under fault conditions, higher limits are specified in 2.3.2 for transient deviation.

Under intended operating conditions, the SELV circuit voltage limit is the same as that for an ELV circuit; an SELV circuit may be regarded as an ELV circuit with additional protection under fault conditions.

For the purposes of these requirements, an SELV circuit may be viewed as an accessible dead metal part.

1.3.19 SINGLE FAULT CONDITION – A single failure condition that might occur during intended operation of the equipment.

For the purposes of these requirements, single fault conditions include, but are not limited to, the following conditions which, when occurring, reduce the protection against the risk of electric shock:

a) The breakdown of basic insulation;

b) The breakdown of supplementary insulation;

c) The change in the impedance of a component, due to overloading, up to and including short-circuiting or open-circuiting;

d) The open-circuiting of a single electrical connection;

e) The breaking of a wire at a point where the wire is connected by a single fastening means;

f) The overloading of a winding;

g) The movement of a live part, such as a winding wire end turn, where the live part is secured by a single fastening means; and

h) The movement of a dead metal part, such as screws, nuts, and similar parts, if such movement reduces electrical spacings to values below those specified in the requirements.

For the purposes of these requirements, a protective impedance is not considered a component that is likely to open or short circuit under a single fault condition, but individual components within an electronic network functioning as a protective impedance are considered subject to single fault conditions.

1.3.20 SUPPLEMENTARY INSULATION – An independent insulation provided in addition to the basic insulation to provide protection against the risk of electric shock in case of breakdown of the basic insulation.

1.3.21 TYPE TEST – A test that is conducted on a representative sample or samples of the equipment with the objective of determining if the equipment, as constructed and manufactured, complies with the requirements in this standard.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

1.4 General requirements

1.4.1 Equipment shall be constructed so that, under all conditions of intended use and under all specified conditions of user servicing according to the end-product standard, the following shall not be accessible to a user:

a) Any uninsulated live part;

b) Any uninsulated conductive part in an ELV circuit;

c) Any operational or basic insulation of a live part;

d) Any operational insulation of an ELV circuit;

e) Any dead metal part that is insulated from a live part by operational or basic insulation only;

f) Any dead metal part that is insulated from an ELV circuit by operational insulation only.

Equipment shall be constructed so that during and after all single fault conditions applied one at a time, the following shall not be accessible to the user:

a) Any uninsulated live part;

b) Any operational insulation for a live part;

c) Any dead metal part that is insulated from a live part by operational insulation only.

This necessitates that, under single fault conditions, user accessible parts remain insulated from live parts by basic, supplementary, or reinforced insulation, or by a combination of those insulations.

If the end-product standard does not include requirements for the available current for accessible parts, a current limitation of 0.5 mA measured through a 1500-ohm resistor shunted with a 0.15-microfarad capacitor connected from the accessible part to ground or to any other accessible part may be used. This is based on the American National Standard for Leakage Current for Appliances, ANSI C101.1-1986.

Exception: If interlock systems that comply with the requirements for the end product are used, and if the interlock systems de-energize the live parts before the user is able to gain access, basic and operational insulation for the de-energized live parts, dead metal insulated from the de-energized live parts by operational or basic insulation, and the de-energized live parts themselves may be accessible to the user.

If an interlock system is relied upon to reduce the likelihood of user access, the entire interlock system shall be constructed and insulated so that it will continue to provide protection in the intended manner under a single fault condition.

1.4.2 The requirements in 1.4.1 necessitate that one or more of the following methods shall be used, as necessary, to provide protection for the user against a risk of electric shock:

a) Enclosures and, if necessary, barriers that comply with the requirements for the end product and that surround:

1) Live parts in primary and secondary circuits,

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT

2) ELV circuits, and

3) Dead metal that is insulated from live parts by operational or basic insulation.

b) Basic plus supplementary (double) insulation or reinforced insulation between primary and secondary circuit live parts and:

1) Surfaces that are accessible to the user, including dead metal parts and insulation and

2) SELV circuits.

c) Supplementary insulation between parts of an ELV circuit and accessible surfaces, based upon the insulation working voltage of live parts that are insulated from the ELV circuit by basic insulation.

d) An equivalent means of protection, such as a protective impedance.

1.4.3 Unless basic and supplementary insulation are physically separated such that they are not subject to the same deteriorating influences (temperature, contaminants, and the like) to the same degree, as illustrated in Figure 1.4, the combination of basic and supplementary insulation shall be investigated according to requirements for reinforced insulation.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Documents
Document Sharing Hub

Copyright UL
Provided by IHS under license with UL
No reproduction or networking permitted without license from IHS
Full document details: UL 2097 2006

Licensee=North Carolina State Univ/5618801100, User=ranji, hadi
Not for Resale, 07/08/2013 02:49:56 MDT