



UL 1022

STANDARD FOR SAFETY

Line Isolation Monitors

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



Documents
Document Sharing Hub

UL Standard for Safety for Line Isolation Monitors, UL 1022

Fifth Edition, Dated April 16, 2012

SUMMARY OF TOPICS

The fifth edition of the Standard for Safety for Line Isolation Monitors, UL 1022, has been issued to incorporate the following proposals dated October 28, 2011 and February 17, 2012:

- ***ANSI approval of the Standard for Safety for Line Isolation Monitors, UL 1022.***
- ***Revision to the scope expanding the use of isolated power systems and isolation monitors.***

The revised requirements are substantially in accordance with Proposal(s) on this subject dated October 28, 2011, and February 17, 2012.

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.

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.

Users 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 judgment (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.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

No Text on This Page

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



Documents

Document Sharing Hub

APRIL 16, 2012

1



ANSI/UL 1022-2012

UL 1022

Standard for Line Isolation Monitors

First Edition – March, 1973
Second Edition – July, 1979
Third Edition – March, 1994
Fourth Edition – June, 1998

Fifth Edition

April 16, 2012

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

The most recent designation of ANSI/UL 1022 as an American National Standard (ANSI) occurred on April 16, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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>.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard 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.

COPYRIGHT © 2012 UNDERWRITERS LABORATORIES INC.

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



Documents
Document Sharing Hub

No Text on This Page

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



Documents

Document Sharing Hub

CONTENTS

INTRODUCTION

1 Scope	5
2 General	5
2.1 Components	5
2.2 Units of measurement	6
2.3 Undated references	6
3 Glossary	6
4 Instructions and Drawings	7

CONSTRUCTION

5 Enclosure	7
5.1 General	7
5.2 Cast metal enclosures	8
5.3 Sheet metal enclosures	8
5.4 Nonmetallic enclosures	9
5.5 Ventilating openings	10
5.6 Covers	11
5.7 Glass panels	11
6 Electric Shock	12
7 Corrosion Protection	12
8 Field-Wiring System Connections	13
8.1 General	13
8.2 Equipment grounding connection	14
9 Internal Wiring	14
9.1 General	14
9.2 Wireways	15
9.3 Splices	15
9.4 Barriers	15
9.5 Bushings	15
9.6 Strain relief	16
10 Bonding for Grounding	16
11 Components	17
11.1 Current-carrying parts	17
11.2 Insulating material	18
11.3 Lampholders and lamps	19
11.4 Meters	19
11.5 Printed-wiring boards	19
11.6 Switches	19
11.7 Protective devices	20
11.8 Alarm silencing means	20
11.9 Audible signaling appliance	20
11.10 Mounting of components	20
11.11 Operating components	21
12 Spacings	21
13 Servicing and Maintenance	22

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



Documents
Document Sharing Hub

PERFORMANCE

14	General	23
15	Normal Operation Test	23
16	Sampling Circuit Supervision Test	25
17	Power Input Test	25
18	Leakage Current Measurements Test	25
19	Overvoltage and Undervoltage Test	30
19.1	Voltage operation	30
19.2	Undervoltage operation	30
20	Jarring Test	30
21	Temperature Test	31
22	Overload Test	34
22.1	Monitor	34
22.2	Separately energized circuits	34
23	Endurance Test	35
23.1	Monitor	35
23.2	Devices and separately energized circuits	35
24	Variable Ambient Temperature Test	35
25	Humidity Test	36
26	Electric Shock Current Test	36
27	Transient Tests	40
27.1	General	40
27.2	Externally-induced transients	40
27.3	Internally-induced transients	40
28	Dielectric Voltage-Withstand Test	41
29	Component Failure Test	42
30	Abnormal Operation Test	42
31	Test Switch Operation Test	42

MANUFACTURING AND PRODUCTION TESTS

32	General	42
33	Production-Line Leakage Current Measurements Test	43
34	Production-Line Dielectric Voltage-Withstand Tests	43

MARKING

35	General	44
36	Supplementary	45
36.1	Installation drawing	45
36.2	Operating instructions	46

APPENDIX A

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

INTRODUCTION

1 Scope

1.1 These requirements cover dynamic line isolation monitors and related supplementary indicating units for supervising isolated power-supply circuits in patient care areas of health care facilities, including inhalation-anesthetizing locations in accordance with the National Electrical Code, NFPA 70.

1.2 The detectors and supplementary indicating units are intended to be:

- a) Included as part of an isolated power-supply center for patient care locations of health care facilities; and
- b) Installed in an Other-Than-Hazardous (Classified) Location of a health care facility as defined by the National Electrical Code, NFPA 70.

1.3 These requirements do not cover ground fault circuit interrupters for use on grounded alternating current systems in accordance with the National Electrical Code, NFPA 70.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, 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.

2.1.2 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.

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

2.1.4 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.

2.2 Units of measurement

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

2.3 Undated references

2.3.1 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.

3 Glossary

3.1 For the purpose of this Standard the following definitions apply.

3.2 **FAULT IMPEDANCE** – An impedance that may consist of balanced or unbalanced resistive, capacitive-reactive, or combined resistive-capacitive-reactive loads connected to either or both isolated conductors. See Figure 18.1 for load configurations.

3.3 **HAZARD CURRENT** – The test current that would flow through a low impedance connected between either isolated conductor and ground. Hazard current includes:

- a) **TOTAL HAZARD CURRENT (THC)** – Hazard current with all devices connected, including line isolation monitors,
- b) **MONITOR HAZARD CURRENT (MHC)** – That portion of the total hazard current contributed only by the monitor and remote indicators, and
- c) **FAULT HAZARD CURRENT (FHC)** – That portion of the total hazard current resulting when all devices, except the line isolation monitors, are connected.

3.4 **LINE ISOLATION MONITOR (LIM)** – A test instrument designed to continually check the balanced and unbalanced impedances from each side of an isolated circuit to ground and equipped with a built-in test circuit to exercise an alarm without adding to the hazard current. It initiates a visual and an audible indication when the hazard current exceeds a preset threshold level.

3.5 **REMOTE INDICATOR** – Device connected remotely to the line isolation monitor which provides any one of the following functions; visual signal, audible signal, or both visual and audible signals which supplement the signal provided by the line isolation monitor.

3.6 **VOLTAGE CLASSIFICATION** –

- a) **HIGH-VOLTAGE** – A circuit classified as high-voltage is one having circuit characteristics in excess of those of a low-voltage circuit.
- b) **LOW-VOLTAGE** – A circuit classified as low-voltage is one involving a potential of not more than 30 volts alternating current (42.4 peak) or direct current, and supplied by a primary battery or by a Class 2 transformer or by a combination of transformer and fixed impedance which, as a unit, complies with all the performance requirements for a Class 2 transformer.

4 Instructions and Drawings

4.1 A copy of the operating and installation instructions and related schematic, wiring diagrams, and installation drawings is to be furnished with the sample submitted for investigation to be used as a guide in the examination and test of the unit, and for this purpose is not required to be in final printed form.

4.2 The instructions and drawings shall include such directions and information as deemed by the manufacturer to be adequate for attaining proper installation and maintenance. A description of the circuit functions shall be provided to facilitate understanding of the system operation.

CONSTRUCTION

5 Enclosure

5.1 General

5.1.1 A line isolation monitor enclosure shall be formed and assembled so that it has the strength and rigidity required to resist the abuses to which it is subjected without total or partial collapse resulting in reduction of spacings, loosening or displacement of parts, or other serious defects.

5.1.2 All electrical parts of a line isolation monitor shall be enclosed to provide protection against contact with uninsulated live parts.

5.1.3 A compartment enclosing electrical parts shall not be open to the floor or other support on which the unit rests.

5.1.4 An enclosure for a line isolation monitor shall have provision for connection of metal-clad cable or conduit, or a nonmetallic-enclosed wiring system (for example, nonmetallic sheathed cable) acceptable for the application under the provisions of the National Electrical Code, ANSI/NFPA 70.

Exception No. 1: An enclosure without provision for the connection of metal-clad cable, conduit, or a nonmetallic-enclosed wiring system is not prohibited from being used when there are furnished with it, definite instructions indicating the section(s) of the unit intended to be drilled in the field for the connection(s).

Exception No. 2: A line isolation monitor which is intended to be installed in an overall enclosure with other equipment is not required to have provision for connection of metal-clad cable or conduit.

5.1.5 A line isolation monitor which is to be installed in an overall enclosure shall not be exposed to an ambient temperature exceeding 50°C (122°F).

5.1.6 An enclosure shall have means for mounting which shall be accessible without disassembling any operating part of the unit. Removal of a completely assembled panel or printed wiring board to mount the enclosure is not considered to be disassembly of an operating part.

5.1.7 An enclosure for a line isolation monitor which is intended for recessed (flush) mounting shall not have any openings other than conduit hubs, knockouts, or openings for mounting screws.

5.2 Cast metal enclosures

5.2.1 The thickness of cast metal for an enclosure shall be as indicated in Table 5.1, except that cast metal having a thickness 1/32 inch (0.8 mm) less than that indicated in the Table 5.1 is not prohibited from being used when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape and/or size of the surface is such that equivalent mechanical strength is provided.

5.2.2 When threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or when an equivalent construction is employed, there shall not be less than 3-1/2 nor more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing is capable of being properly attached.

5.2.3 When threads for the connection of conduit are tapped part way through a hole in an enclosure wall, there shall be at least 3-1/2 full threads in the metal, and a smooth, rounded inlet hole for the conductors, which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

Table 5.1
Cast-metal enclosures

Use, or dimensions of area involved	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast type,	
	inches	(mm)	inches	(mm)
Area of 24 square inches (154 cm ²) or less and having no dimension greater than 6 inches (152 mm)	1/16	1.6	1/8	3.2
Area greater than 24 square inches or having any dimension greater than 6 inches	3/32	2.4	1/8	3.2
At a threaded conduit hole	1/4	6.4	1/4	6.4
At an unthreaded conduit hole	1/8	3.2	1/8	3.2

5.3 Sheet metal enclosures

5.3.1 The thickness of sheet metal employed for the enclosure of a line isolation monitor shall not be less than indicated in Table 5.2, except that sheet metal of two gage sizes lesser thickness is not prohibited from being used when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape and/or size of the surface is such that adequate mechanical strength is provided.

5.3.2 At any point where conduit or metal-clad cable is to be attached, sheet metal shall be of such thickness or shall be formed or reinforced so that it has the stiffness at least equivalent to that of uncoated flat sheet steel having a minimum thickness of 0.053 inch (1.35 mm) (No.16 MSG).

5.3.3 A plate or plug for an unused conduit opening or other hole in the enclosure shall have a thickness not less than:

- a) 0.014 inch (0.36 mm) for steel or 0.019 inch (0.48 mm) for nonferrous metal for a hole having 1/4 inch (6.4 mm) maximum dimension or
- b) 0.027 inch (0.66 mm) steel or 0.032 inch (0.81 mm) nonferrous metal for a hole having a 1-3/8 inch (34.9 mm) maximum dimension.

5.3.4 A closure for a larger hole shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

5.3.5 A knockout in a sheet metal enclosure shall be reliably secured but shall be capable of being removed without undue deformation of the enclosure.

5.3.6 A knockout shall be provided with a flat surrounding surface adequate for proper seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those indicated in Spacings, Section 12.

Table 5.2
Sheet metal enclosures

Maximum enclosure dimensions				Minimum thickness of sheet metal					
Any linear dimension,		Area of any surface,		Steel				Copper, brass, or aluminum,	
inches	(mm)	inches ²	(cm ²)	Zinc-coated,		Uncoated,		inches	(mm)
				inches	(mm)	inches	(mm)		
12	305	90	581	0.034 [20] ^a	(0.86)	0.032 [20] ^a	(0.81)	0.045 [16] ^a	(1.14)
24	610	360	2322	0.045 [18]	(1.14)	0.042 [18]	(1.07)	0.058 [14]	(1.47)
48	1219	1200	7742	0.056 [16]	(1.42)	0.053 [16]	(1.35)	0.075 [12]	(1.91)
60	1524	1500	9678	0.070 [14]	(1.78)	0.067 [14]	(1.70)	0.095 [10]	(2.41)
Over 60	1524	Over 1500	9678	0.097 [12]	(2.46)	0.093 [12]	(2.36)	0.122 [8]	(3.10)

^a The figures in brackets are the Galvanized Sheet Gage numbers (for zinc-coated steel), the Manufacturers' Standard Gage numbers (for uncoated steel), and the American Wire Gage (B & S) numbers (for a nonferrous metal) which provide the required minimum thickness of metal.

5.4 Nonmetallic enclosures

5.4.1 Nonmetallic material shall not be employed for an enclosure of a line isolation monitor intended to be connected directly to rigid conduit or metal-clad cable. It is not prohibited from being used as an enclosure of a unit intended to be installed in an overall metal enclosure with other equipment, such as in an isolating power panel assembly.

5.4.2 When a nonmetallic enclosure is employed, the continuity of the grounding system shall not rely on the dimensional integrity of the nonmetallic material.

5.4.3 Among the factors taken into consideration when determining the acceptability of a nonmetallic enclosure are:

- a) The mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;

- d) Combustibility and resistance to ignition from electrical sources;
- e) Dielectric strength, insulation resistance, and resistance to arc tracking; and
- f) Resistance to distortion and creeping at temperatures to which the material is subjected under conditions of normal or abnormal usage.

All these factors are to be considered with regard to aging.

5.5 Ventilating openings

5.5.1 Ventilating openings in an enclosure, including perforated holes, louvers, and openings protected by means of wire screening, expanded metal, or perforated covers, shall be of such size or shape that no opening permits passage of a rod having a diameter of 9/64 inch (3.6 mm).

5.5.2 An enclosure housing fuses or any other overload-protective device, and provided with ventilating openings, shall afford adequate protection against the emission of flame or molten metal.

5.5.3 The average thickness of perforated sheet metal and sheet metal employed for expanded-metal mesh shall not be less than:

- a) 0.042 inch (1.07 mm), 0.046 inch (1.14 mm) if zinc coated, when the mesh openings or perforations are $1/2$ inch² (323 mm²) or less in area and
- b) 0.080 inch (2.04 mm), 0.084 inch (2.14 mm) if zinc coated, for larger openings.

Exception: When the indentation of a guard or enclosure wall does not alter the clearance between uninsulated live parts and grounded metal and affect performance adversely or reduce spacings below the minimum value given under Spacings, Section 12, 0.021 inch (0.53 mm) expanded metal mesh [0.024 inch (0.59 mm) if zinc coated] is not prohibited from being used, when the exposed mesh on any one side or surface of the device so protected has an area of not more than 72 inches² (464 mm²) and no dimension greater than 12 inches (305 mm), or when the width of an opening so protected is not greater than 3-1/2 inches (90 mm).

5.5.4 The wires of a screen shall not be smaller than No. 16 AWG (1.3 mm diameter) and the screen openings shall not be greater than 1/8 inch (3.2 mm) square in area.

5.6 Covers

5.6.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached when it provides ready access to fuses or any other overcurrent protective device, the intended protective functioning of which require renewal, or when it is required to open the cover in connection with the normal operation of the unit.

5.6.2 With reference to 5.6.1, normal operation is considered to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit which requires such action in connection with its intended performance.

5.6.3 A hinged cover is not required when it is not necessary to open the cover in connection with normal operation of the unit, and the only fuse(s) enclosed is for protection of portions of internal circuits against damage resulting from a fault. The following or equivalent marking shall be indicated on the outer surface of the cover provided: "CAUTION – CIRCUIT FUSE(S) INSIDE – DISCONNECT POWER-SUPPLY PRIOR TO SERVICING. "

5.6.4 When a hinged cover is required, it shall be provided with a latch, screw, or catch to hold it closed. The hinged cover of a unit intended to be installed where it is accessible to other than authorized personnel shall be provided with a key lock or with a screw requiring a tool for removal.

5.6.5 An unhinged cover shall be securely held in place by screws or the equivalent.

5.7 Glass panels

5.7.1 A glass panel covering an observation opening, other than a meter cover, shall be securely held in place so that it cannot be readily displaced in service and shall provide adequate mechanical protection for the enclosed parts. The thickness of the glass panel shall not be less than that indicated in Table 5.3.

Table 5.3
Thickness of glass covers

Maximum size of opening				Minimum thickness of glass,	
Length or width,		Area,		inches	(mm)
inches	(mm)	inches ²	(cm ²)		
4	102	16	103	1/16	1.6
12	305	144	927	1/8	3.2
Over 12	305	Over 144	927	a	

^a 1/8 inch (3.2 mm) or more, depending upon the size, shape, and mounting of the glass panel.

5.7.2 A glass panel for an opening having an area of more than 144 square inches (927 cm²), or having any dimension greater than 12 inches (305 mm), shall be supported by a continuous flange not less than 3/16 inch (4.8 mm) deep along all four edges of the panel.

5.7.3 A transparent material other than glass, employed as a cover over an opening in an enclosure, shall have mechanical strength equivalent to that of glass, not introduce a risk of fire, distort, nor become less transparent at the temperature to which it is subjected under all conditions of intended use.

6 Electric Shock

6.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See Electric Shock Current Test, Section 26.

6.2 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The resistance of the conductive connection shall not exceed 5.2 megohms. The wattage rating shall be at least 1/2 watts, and the conductive connection shall be effective with the power switch in either the on or off position.

Exception: The conductive connection is not required to be provided when:

- a) Such a connection is established in the event of electrical breakdown of the antenna isolating means;*
- b) The breakdown does not result in a risk of electric shock; and*
- c) In a construction employing an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 megohms.*

6.3 The maximum value of 5.2 megohms specified in 6.2 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance is acceptable. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors is not prohibited from being rated a minimum of 1/4 watt.

6.4 The insertion in any socket of any vacuum tube or its glass or metal equivalent of like designation used in the product shall not result in a risk of electric shock.

7 Corrosion Protection

7.1 Except as indicated in 7.2, iron and steel parts, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

Exception: The requirement does not apply to:

- a) Bearings, and the like, where such protection is impracticable or*
- b) Minor parts, such as washers, screws, bolts, and the like, when corrosion of such unprotected parts does not result in a risk of fire, electric shock, or injury to persons, or impair the operation of the unit.*

7.2 The requirement of 7.1 applies to all enclosing cases of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation depends. Parts made of stainless steel, properly polished or treated, when required, do not require additional protection against corrosion. Bearing surfaces shall be of such material and construction as to resist binding due to corrosion.