UL 347A

STANDARD FOR SAFETY

Medium Voltage Power Conversion Equipment

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UL Standard for Safety for Medium Voltage Power Conversion Equipment, UL 347A

Second Edition, Dated January 5, 2021

Summary of Topics

This revision of ANSI/UL 347A dated October 30, 2024 includes replacing withdrawn reference ANSI/ISA MC96.1 with ASTM E230/E230M: 4.2 and 32.2.27.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated September 27, 2024.

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The most recent designation of ANSI/UL 347A as an American National Standard (ANSI) occurred on October 30, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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CONTENTS

INTRODUCTION

1 Scope 7
2 Glossary 7
3 Components 10
4 Referenced Publications 11
5 Units of Measurement 12

RATING

6 General 12

CONSTRUCTION

7 General 12
8 Enclosure 13
8.1 General 13
8.2 Exterior doors, covers, and similar parts of enclosures 13
8.3 Inspection windows 14
8.4 Ventilation openings 14
8.5 Environmental rating related enclosure requirements 15
8.6 Protection against corrosion 15
9 Arrangement of Components 15
10 Guarding and Accessibility of Live Parts 16
11 Grounding and Bonding 16
12 Protective Devices 17
13 Overload Relays 18
14 Isolating Means 18
15 Service Equipment 20
16 Interlocking 20
17 Automatic Restarting 21
18 Internal Wiring 21
19 Voltage Dividers 22
20 Terminals and Connections 23
21 Spacings 24
21.1 General 24
21.2 Circuits connected to the medium voltage line 25
21.3 Circuits isolated from the medium voltage line 26
21.4 Insulating material used as a barrier in lieu of spacings 29
21.5 Clamped insulating joints in lieu of spacings 29
21.6 Voltage dividers and other circuits provided with solid insulation 29
21.7 Spacings for printed wiring boards used in accordance with the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840 29
21.8 Alternate approach for spacings 31
22 Means for Switching 31
23 Capacitors 32
24 Control Circuits 32
25 Bypass Circuits 33
25.1 Bypass contactors rated 15 kV and less 33
25.2 Bypass Circuits Rated Over 15 kV 34
26 Gate Drive Circuits 34
27 Transformers, Reactors, and Voltage Sensing Devices 36

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28 Cord-Connected Programming and Diagnostic Units....36
29 Accessories....36
30 Cooling Systems....36

PERFORMANCE

31 General....38
32 Temperature Test....39
32.1 General....39
32.2 Test conditions....40
33 Dielectric Voltage-Withstand Test....44
33.1 General....44
33.2 Meters....45
33.3 Test procedure....45
34 Switching Capability Test – Isolating Means....46
35 Short Circuit Interruption Test....46
35.1 General requirements....46
35.2 Interruption ratings....47
35.3 Branch circuit short circuit protection requirements....50
36 Impulse Withstand Test....51
36.1 General....51
36.2 Impulse voltage withstand test methods....52
36.3 Evaluation....52
37 Calibration Tests – Overload....53
38 Solid State Motor Protection Tests....53
38.1 Solid state motor overload protection test....53
38.2 Thermal memory retention test (shutdown)....54
38.3 Thermal memory retention test (loss of power)....54
38.4 Speed sensitivity test....54
39 Operation Tests....55
39.1 General....55
39.2 Single phasing....55
39.3 Inoperative blower motor....56
39.4 Clogged filter....56
39.5 Current limiting control....56
39.6 Loss of cooling medium circulation test....56
39.7 Input phase reversal....57
39.8 Acceptance criteria....57
40 Hydrostatic Pressure Test....57
41 Breakdown of Components Test....58
42 Capacitor Discharge Test....60
43 Mechanical Operation and Interlock Integrity Test....60
44 Rod Entry Test....60
45 Mechanical Tests of Viewing Panes....61
46 Accessory Installation Test....61

MARKINGS

47 General....61
48 Overload, Overcurrent, Overtemperature, and Overspeed Protection Markings....65
49 Branch Circuit Short Circuit Protection Markings....65
50 Cautionary Markings....66
51 Instructions and Markings Pertaining to Enclosures....67
51.1 Permanence of marking....67
51.2 Details....67

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52 Instructions and Markings Pertaining to Accessories 67

MANUFACTURING AND PRODUCTION LINE TEST

53 Burn-In and Diagnostic Tests 68

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INTRODUCTION

1 Scope

1.1 These requirements cover enclosed medium voltage power conversion equipment, such as variable frequency controllers, that control and transfer power to motors. These requirements also cover power-supply modules, input/output modules, and electronic assemblies, for use in or with power conversion equipment.

1.2 These requirements cover equipment rated above 1500 volts to 38kV. The equipment may have input ratings greater than 1500 V, output ratings greater than 1500 V, or both.

1.3 These requirements do not cover equipment for use in hazardous locations as defined by the National Electrical Code, NFPA 70.

1.4 These requirements do not cover solid state reduced voltage motor controllers (soft starters). This type of equipment is covered by the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347.

1.5 These requirements do not cover low voltage power conversion equipment with both input and output voltage ratings of 1500 volts and below. This type of equipment is covered by the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1.

2 Glossary

2.1 For the purpose of this document, the following definitions apply.

2.2 AMBIENT TEMPERATURE – The temperature of the air medium into which the heat of the equipment is dissipated. See 32.1.3.

2.3 BUS – A conductor, or group of conductors, that serve as a common connection for two or more circuits.

2.4 BUS, HORIZONTAL – A bus that extends through a vertical section, that is intended to connect to another vertical section, that may be provided in the future.

2.5 BUS, VERTICAL – A bus that connects one or more controllers in a vertical section together. Where the assembly also contains a horizontal bus, the vertical bus connects the controllers in a vertical section to the horizontal bus.

2.6 BYPASS CIRCUIT – A circuit, typically consisting of a switch or contactor, that when closed, creates an alternate path for current flow in parallel with the circuit being bypassed, allowing the original circuit to be turned off while maintaining current flow to the load.

2.7 CONTACTOR – A two-state (ON-OFF) device for repeatedly establishing and interrupting an electric power circuit.

2.8 CONTACTOR, AIR-GAP – A contactor that introduces a gap (in air) between contacts to interrupt a circuit.

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2.9 CONTACTOR, SOLID-STATE – A contactor that introduces a high impedance to interrupt a circuit. Typical solid-state contactors use silicon controlled rectifiers (SCR) or insulated gate bipolar transistors (IGBT) as the switching device(s).

2.10 CONTACTOR, VACUUM – A contactor that introduces a gap between contacts (located in a vacuum) to interrupt a circuit.

2.11 CONTROL CIRCUIT – A circuit that carries the electric signals directing the performance of a controller, and that does not carry the main power circuit. A control circuit is generally limited to 15 amperes or less.

2.12 CONTROLLER – A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

2.13 COVER – An unhinged portion of an enclosure that covers an opening.

2.14 DOOR – A hinged portion of an enclosure that covers an opening, that is intended to be opened during routine maintenance, operations and adjustments.

2.15 ENCLOSURE – A surrounding case designed to protect:

a) Personnel against injury due to accidental contact with electrical or moving mechanical parts of the enclosed device(s), and

b) Internal device(s) against specified external conditions.

2.16 FAULT CURRENT – A current that results from the loss of insulation between conductors or between a conductor and ground.

2.17 GALVANICALLY ISOLATED SECONDARY CIRCUIT – A circuit having no direct electrical connection to a medium voltage circuit, with isolation between the circuits obtained by the use of transformers or optical isolation.

2.18 INTERLOCK – A device that prevents operation of some other device with which it is directly associated under specific conditions. Interlocks may be electrical, mechanical, or a combination of both.

2.19 INTERLOCK, MECHANICAL – An interlock that performs its function solely by mechanical means.

2.20 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolating source (such as a transformer, optical isolator, voltage divider or electro-mechanical relay) and having no direct connection back to the primary circuit.

2.21 ISOLATING MEANS – A mechanical switching device that provides, in the open position, isolating distance in the main circuit, from the source of power.

2.22 LOW VOLTAGE – Voltage of 1500 V or less.

Note: The National Electrical Code, NFPA 70 defines low voltage to be voltages of 1000 V or less.

2.23 LOW VOLTAGE SECTION (of a voltage divider) – That portion of a voltage divider where a small fraction (no greater than 1500 V total) of the input voltage is present during normal operation.

2.24 MEDIUM VOLTAGE – Voltage greater than 1500 V, up to and including 38 kV.

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Note: National Electrical Code, NFPA 70 defines any voltage above 1000 V as High Voltage.

2.25 OVERCURRENT – Overcurrent is a current in excess of the continuous rated current.

2.26 PANEL, HINGED – A portion of an enclosure that has hinges, but no hand-operable latching system, secured in the closed position by multiple bolts or other hardware requiring a tool other than a key to operate.

Note: Hinged panels are not intended to be opened during normal operation, routine adjustment or simple maintenance operations such as replacement of fuses.

2.27 PHASE LEAST LIKELY TO STRIKE GROUND – A phase that is referenced to ground or by virtue of its position, potential, or both, relative to other phases of the device is defined as less likely than any other phase to strike ground. In a three phase device, this phase is usually the center phase. It is possible for several phases to be equally likely to strike to ground.

2.28 POLLUTION DEGREE 1 – No pollution or only dry, nonconductive pollution occurs. The pollution has no influence.

2.29 POLLUTION DEGREE 2 – Normally, only nonconductive pollution occurs; however, temporary conductivity is expected when equipment is out of operation.

2.30 POLLUTION DEGREE 3 – Conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation that is expected.

2.31 PRIMARY CIRCUIT – A circuit in which the wiring and components are conductively connected to the branch circuit.

2.32 PRIMARY SECTION (of a voltage divider) – That portion of a voltage divider where a large fraction of the input voltage is present during normal operation.

2.33 PROTECTION, OVERLOAD – A protective device or circuit that detects excessive current, (not necessarily short-circuit current) and functions to cause interruption or limitation of the flow of current through the protected device or circuit.

2.34 PROTECTION, OVERVOLTAGE – A protective device or circuit that detects excessive voltage and functions to interrupt power or reduce voltage to the protected device or circuit.

2.35 RATING – A designated limit of operating characteristics based on definite conditions. Operating characteristics such as current, voltage, frequency, and other characteristics comprise the rating.

2.36 RELAY, OVERLOAD – A relay that functions at a predetermined value of overcurrent to provide a signal or to result in disconnection of the load from the power supply, or both. An overload relay is intended to protect the motor branch circuit conductors, the motor control apparatus, and the motor against overcurrent. It does not necessarily protect itself.

2.37 REVERSING – Reversing is a control function that provides for changing operation of the controlled motor from one direction to the other.

2.38 ROUTINE MAINTENANCE – Maintenance that involves simple tasks such as changing of filters, adjustment of controls, replacement of fuses, or resetting of protective functions or devices. Routine maintenance does not include repair or replacement of components other than fuses or filters.

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2.39 SOLID STATE MOTOR OVERLOAD PROTECTION – Circuitry integral to the power conversion equipment that acts to protect a motor under overload conditions by reducing current flow to the motor output terminals. This protection is typically achieved through an algorithm based on the I^2t of the current to the motor. The protection circuitry is usually comprised of hardware, firmware and software components.

2.40 SOLID STATE SHORT CIRCUIT PROTECTION – Circuitry integral to power conversion equipment that acts to suspend current flow to the motor output terminals upon sensing a preset or predetermined condition such as a rapid rate of change in output current or bus voltage. The protection circuitry may be comprised of hardware, firmware and software components.

2.41 SWITCH, ISOLATING – A switching device intended for isolating an electric circuit from the source of power. It does not have an interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

2.42 SWITCH, LOAD BREAK – A switch that has an interrupting rating equal to or greater than the circuit that it controls, and is intended for control of the particular load type to which it is connected.

2.43 TRIP CURRENT – Current above rated output motor current at which the motor overload protection circuitry will function. May be provided as a percent of motor current or as an actual stated current value. Typical values are 125 percent of full load motor current or less.

2.44 VOLTAGE DIVIDER – A combination of components intended to produce an output voltage that is a fraction of the voltage input to the combination.

3 Components

3.1 Other than where specifically referenced in this standard, or as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

3.3 An unevaluated component, such as a capacitor, resistor, or inductor, is not required to comply with a specific requirement when the system incorporating the component complies with the requirement.

3.4 A low voltage subassembly located in low voltage circuitry, that is both physically and electrically isolated by a transformer, electromechanical relay, or other isolation device, from medium voltage equipment shall be investigated in accordance with the Standard for Industrial Control Panels, UL 508A. Any protection circuitry shall be evaluated with the controller to the requirements of this standard.

3.5 Printed wiring boards shall be suitable for direct support of live parts in accordance with the Standard for Printed Wiring Boards, UL 796.

3.6 Metal oxide surge arrestors connected to the medium voltage line shall comply with IEEE C62.11 or IEC 60099-4 and shall have voltage ratings no less than the maximum voltage at which the arrestor is applied.

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4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

ANSI Z535 Series, *Safety Alerting Standards*

ASTM E230/E230M, *Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

IEC 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy*

IEEE 4, *Techniques for High Voltage Testing*

IEEE C37.09, *Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*

NFPA 70, *National Electrical Code*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 248 Series, Fuses

UL 347, *Medium Voltage AC Contactors, Controllers, and Control Centers*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 508, *Industrial Control Equipment*

UL 508A, *Industrial Control Panels*

UL 746C, *Polymeric Materials – Use In Electrical Equipment Evaluations*

UL 796, *Printed Wiring Boards*

UL 810, *Capacitors*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

UL 969, *Marking and Labeling Systems*

UL 1077, *Supplementary Protectors for Use in Electrical Equipment*

UL 1562, *Transformers, Distribution, Dry-Type – Over 600 Volts*

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

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UL 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy*

5 Units of Measurement

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

RATING

6 General

6.1 Power conversion equipment shall be rated according to:

a) Input.

1) Voltage.

2) Maximum current.

3) Number of phases.

4) Frequency.

b) Output.

1) Voltage.

2) Full load current or maximum horsepower.

3) Number of phases.

4) Base frequency and frequency range (applies only to alternating current outputs).

6.2 Power conversion equipment shall also be rated with the following:

a) Short circuit current rating.

b) Maximum voltage.

c) Control voltage.

d) Impulse test voltage (expressed in kilovolts).

e) Dielectric withstand voltage.

6.3 Ratings of equipment covered by this standard are based on normal service conditions as defined in Section 2.1 of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347. Section 2.2 of UL 347 provides additional guidance when equipment is used in special service conditions.

CONSTRUCTION

7 General

7.1 Equipment covered by these requirements shall be constructed as to provide for compliance with the rules for installation and use of such equipment as given in the National Electrical Code, NFPA 70.

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