UL 61800-5-1:2026

(IEC 61800-5-1:2007+A1:2016, MOD)

STANDARD FOR SAFETY

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

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

Second Edition, Dated June 24, 2022

Summary of Topics

This revision of ANSI/UL 61800-5-1 dated July 24, 2026 includes the following changes in requirements:

– Revision of DVD.2.4.4.6.1 – Forced Ventilation in Operator Space

– Type 12 Ventilated Enclosures; DVD.2.1.3.3

– Multiple Sources of Supply; 4.1DV.4, 4.17DV, 5.2.14DV, and 6.6DV

– DC Clearance Requirements; 3.18ADV.1, 3.18ADV.2, 4.3.6.2.1DV.4, 4.3.6.2.3DV, 4.3.6.2.4DV.3, 6.2DV.1.7.

– Fault Testing with DC Sources; 3.16DV, 3.18ADV.1, 3.19DV, 4.3.9DV.1.2, 5.2.3.6.2DV.4.1.16, 5.2.3.6.2.1DV.1.1, 5.2.3.6.2.1DV.1.2, 5.2.3.6.2.1DV.2.1, 5.2.3.6.2.1DV.2.2, 5.2.3.6.2.1DV.2.4, 5.2.3.6.2.1DV.2.5, 5.2.3.6.2.1DV.2.6, 5.2.3.6.2.1DV.2.6.1, 5.2.3.6.2.1DV.2.6.2, 5.2.3.6.2.1DV.2.6.6, 5.2.3.6.2.1DV.2.6.7, 5.2.3.6.2.1DV.2.7, 5.2.3.6.2.1DV.2.8, 5.2.3.6.2.1DV.2.9, 5.2.3.6.2.1DV.3, 5.2.3.6.2.1DV.4, 5.2.3.6.2.1DV.6, 6.2DV.1.7 – 6.2DV.1.9, 6.3.7DV.2.1, 6.3.7DV.2.2, and 6.3.7DV.3.1.

– Withdrawal and replacement of ANSI/ISA MC96.1, Temperature-Measurement Thermocouples; 5.2.3.8DV.2.6

The Second edition of UL 61800-5-1 is an adoption of IEC 61800-5-1, Second Edition, issued by the IEC July 2007 and its amendment 1 issued August 2016. Please note that the National Difference document incorporates all of the U.S. national differences for UL 61800-5-1.

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 12, 2025 and June 5, 2026.

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(IEC 61800-5-1:2007+A1:2016, MOD)

Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy

Second Edition

June 24, 2022

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through July 24, 2026.

The most recent designation of ANSI/UL 61800-5-1 as an American National Standard (ANSI) occurred on July 24, 2026. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

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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Bibliography

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Preface (UL)

This UL Standard is based on IEC Publication 61800-5-1: edition 2.1, Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, as revised by Amendment 1. IEC publication 61800-5-1 is copyrighted by the IEC.

This revision has been issued to satisfy ULSE standards policy.

Efforts have been made to synchronize the UL edition number with that of the corresponding IEC standard with which this standard is harmonized.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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NATIONAL DIFFERENCES

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 61800-5-1, Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy copyright 2016 are indicated by notations (differences) and are presented in bold text.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS – Part 5-1: Safety requirements – Electrical, thermal and energy

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This Consolidated version of IEC 61800-5-1 bears the edition number 2.1. It consists of the second edition (2007-07) [documents 22G/178/FDIS and 22G/181/RVD] and its amendment 1 (2016-08) [documents 22G/338/FDIS and 22G/342/RVD]. The technical content is identical to the base edition and its amendment.

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 61800-5-1 has been prepared by subcommittee 22G: Semiconductor power converters for adjustable speed electric drive systems, of IEC technical committee 22: Power electronic systems and equipment.

This second edition constitutes a technical revision.

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The major areas of change in this edition are the following:

a) addition of alphabetical Table 1 in Clause 3;

b) addition of Table 2 in 4.1 for relevance to PDS/CDM/BDM;

c) addition of Table 4 summary of decisive voltage class requirements;

d) expansion of subclause on protective bonding (4.3.5.3);

e) clarification of distinction between touch current and protective conductor current;

f) revision of section on insulation (now 4.3.6) to include solid insulation;

g) addition of overvoltage categoruies I and II to HV insulation voltage;

h) revision of section on Solid insulation (now 4.3.6.8)

i) addition of high-frequency insulation requirements (4.3.6.9, Annex E);

j) addition of requirements for liquid-cooled PDS (4.4.5);

k) addition of climatic and vibration tests (5.2.6);

l) clarification of voltage test procedure to avoid over-stress of basic insulation (5.2.3.2.3);

m) revision of short-circuit test requirement for large, high-voltage and one-off PDS (now 5.2.3.6);

n) addition of informative Annex B for overvoltage category reduction.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61800 series, published under the general title *Adjustable speed electrical power drive systems*, can be found on the IEC website.

Terms in *italics* in the text are defined in Clause 3.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• reconfirmed,

• withdrawn,

• replaced by a revised edition, or

• amended.

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DV.1 DE *Modification to replace the eighth paragraph following item (9) of the Foreword:*

Words in SMALL ROMAN CAPS in the text are defined in Clause 3.

DV.2 DE *Modification to add the following:*

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS – Part 5-1: Safety requirements – Electrical, thermal and energy

1 Scope

This part of IEC 61800 specifies requirements for adjustable speed POWER DRIVE SYSTEMS, or their elements, with respect to electrical, thermal and energy safety considerations. It does not cover the driven equipment except for interface requirements. It applies to adjustable speed electric drive systems which include the power conversion, drive control, and motor or motors. Excluded are traction and electric vehicle drives. It applies to d.c. drive systems connected to line voltages up to 1 kV a.c., 50 Hz or 60 Hz and a.c. drive systems with converter input voltages up to 35 kV, 50 Hz or 60 Hz and output voltages up to 35 kV.

Other parts of IEC 61800 cover rating specifications, EMC, functional safety, etc.

The scope of this part of IEC 61800 does not include devices used as component parts of a PDS if they comply with the safety requirements of a relevant product standard for the same environment. For example, motors used in PDS shall comply with the relevant parts of IEC 60034.

Unless specifically stated, the requirements of this International Standard apply to all parts of the PDS, including the CDM/BDM (see Figure 1).

NOTE In some cases, safety requirements of the PDS (for example, protection against direct contact) can necessitate the use of special components and/or additional measures.

1DV.1 D2 *Modification to add the following:*

1DV.1.1 This document is only applicable to the power conversion and drive control equipment, servo drives and integral servo drive/motor combinations.

1DV.1.2 This standard applies to drives with an input rating up to and including 1,5 kV a.c. or d.c.

1DV.1.3 A component of a product covered by this standard shall comply with the requirements for that component. See Annex DVA for a list of additional standards covering components used in the products covered by this standard.

1DV.1.4 The scope includes BDM/CDM/PDS intended for connection to photovoltaic (PV) modules with output voltages not exceeding 1.5 kV DC.

1DV.2 DR *Modification to add the following:*

This equipment is for use in ordinary locations in accordance with Articles 430 and 440 of the National Electrical Code, NFPA 70.

1DV.3 D2 *Modification to add the following:*

Specifications provided in other parts of the 61800 Series of Standards (for example EMC in part 3) apply only on agreement between the manufacturer and the customer.

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2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE This does not mean that compliance is required with all clauses of the referenced documents, but rather that this international standard makes a reference that cannot be understood in the absence of the referenced document.

IEC 60034 (all parts), *Rotating electrical machines*

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60050-111, *International Electrotechnical Vocabulary (IEV) – Chapter 111: Physics and chemistry*

IEC 60050-151, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60050-191, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

IEC 60050-441, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 60050-442, *International Electrotechnical Vocabulary (IEV) – Part 442: Electrical accessories*

IEC 60050-551, *International Electrotechnical Vocabulary (IEV) – Part 551: Power electronics*

IEC 60050-601, *International Electrotechnical Vocabulary (IEV) – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-78, *Environmental testing – Part 78: Tests – Test Cab: Damp heat, steady state*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60204-11, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60309, *Plugs, socket-outlets and couplers for industrial purposes*

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IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:—[1]

IEC 60364-5-54:2002, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*

IEC 60617, *Graphical symbols for diagrams*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*[2]
Amendment 1 (2000)
Amendment 2 (2002)

IEC 60664-3:2003, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coatings to achieve insulation coordination of printed board assemblies*

IEC 60664-4:2005, *Insulation coordination for equipment within low-voltage systems – Part 4: Consideration of high-frequency voltage stress*

IEC 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignitability test method for materials*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test methods*

IEC 60755, *General requirements for residual current operated protective devices*

IEC 60947-4-1:2009, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*
IEC 60947-4-1:2009/AMD1:2012

IEC 60947-7-1:2002, *Low-voltage switchgear and control gear – Part 7-1: Ancillary equipment –Terminal blocks for copper conductors*

IEC 60947-7-2:2002, *Low-voltage switchgear and controlgear – Part 7-2: Ancillary equipment – Protective conductor terminal blocks for copper conductors*

IEC 60990:1999, *Methods of measurement of touch current and protective conductor current*

IEC 61230, *Live working – Portable equipment for earthing or earthing and short-circuiting*

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IEC 61800-1, *Adjustable speed electrical power drive systems – Part 1: General requirements – Rating specifications for low voltage adjustable speed d.c. power drive systems*

IEC 61800-2, *Adjustable speed electrical power drive systems – Part 2: General requirements – Rating specifications for low voltage adjustable frequency a.c. power drive systems*

IEC 61800-4, *Adjustable speed electrical power drive systems – Part 4: General requirements – Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV*

IEC 62020, *Electrical accessories – Residual current monitors for household and similar uses (RCMs)*

IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

ISO 3864 (all parts), *Graphical symbols – Safety colours and safety signs*

ISO 7000:2004, *Graphical symbols for use on equipment – Index and synopsis*

[1] Under preparation. Stage at the time of publication: IEC DEC 60364-4-41:2016.

[2] There exists a consolidated edition 1.2 (2002) including IEC 60664-1:1992 and its Amendments 1 and 2.

2DV D2 *Modification to add the following:*

See Annex DVA for USA Normative References and Component Standards. See Annex DVB for IEC Normative References that do not apply and for IEC Normative References replaced by USA Standards.

3 Terms and definitions

For the purposes of this international standard, the terms and definitions given in IEC 60050-111, IEC 60050-151, IEC 60050-161, IEC 60050-191, IEC 60050-441, IEC 60050-442, IEC 60050-551, IEC 60050-601, IEC 60664-1, IEC 61800-1, IEC 61800-2, IEC 61800-3 and IEC 61800-4 (some of which are repeated below for convenience), and the following definitions apply.

Table 1 provides an alphabetical cross-reference listing of terms.

Table 1
Alphabetical list of terms

Term	Term number	Term	Term number	Term	Term number
adjacent circuit	3.1	(earth) leakage current	3.16	protective screening	3.31
basic drive module (BDM)	3.2	live part	3.17	protective separation	3.32
basic insulation	3.3	low-voltage PDS	3.18	reinforced insulation	3.33
CDM (complete drive module)	3.4	open-type (product)	3.19	routine test	3.34

Table 1 Continued on Next Page

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Table 1 Continued

Term	Term number	Term	Term number	Term	Term number
closed electrical operating area	3.5	power drive system (PDS)	3.20	safety ELV (SELV) circuit	3.35
commissioning test	3.6	protective ELV (PELV) circuit	3.21	sample test	3.36
decisive voltage class (DVC)	3.7	prospective short-circuit current	3.22	supplementary insulation	3.37
double insulation	3.8	protective bonding	3.23	system voltage	3.38
extra low voltage (ELV)	3.9	protective class 0	3.24	temporary overvoltage	3.39
electrical breakdown	3.10	protective class I	3.25	touch current	3.40
expected lifetime	3.11	protective class II	3.26	type test	3.41
functional insulation	3.12	protective class III	3.27	user terminal	3.42
high-voltage PDS	3.13	protective earthing (PE)	3.28	working voltage	3.43
installation	3.14	protective earthing conductor	3.29	zone of equipotential bonding	3.44
integrated PDS	3.15	protective impedance	3.30		

Table 1DV DE *Modification to add the following terms to Table 1:*

AMBIENT TEMPERATURE	**3.1ADV**
CONTROL CIRCUIT	**3.6ADV**
GROUP INSTALLATION	**3.12ADV**
INSULATED LIVE PART	**3.14ADV**
SLASH VOLTAGE RATING	**3.36ADV**
STRAIGHT VOLTAGE RATING	**3.36BDV**
SURROUNDING AIR TEMPERATURE RATING	**3.37ADV**

3.1
ADJACENT CIRCUIT
circuit having no galvanic connection to the circuit under consideration

NOTE A protective impedance is not considered to be a galvanic connection.

3.1ADV D2 *Addition:*

AMBIENT TEMPERATURE
the temperature of the room or chamber in which the equipment under test is located

3.2
BASIC DRIVE MODULE (BDM)
drive module, consisting of a converter section and a control section for speed, torque, current or voltage, etc. (see Figure 1)

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