

UL 60745-1

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Hand-Held Motor-Operated Electric Tools – Safety – Part 1: General Requirements

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UL Standard for Safety for Hand-Held Motor-Operated Electric Tools – Safety – Part 1: General Requirements, UL 60745-1

Third Edition, Dated March 26, 2004

Summary of Topics

This is the Third edition of ANSI/UL 60745-1, the Standard for Safety for Hand-Held Motor-Operated Electric Tools – Safety – Part 1: General Requirements and is based on IEC 60745-1, 3.2 edition. UL has purposely skipped the second edition to align with the current edition of the IEC 60745-1 standard.

The new requirements are substantially in accordance with UL's Bulletin(s) on this subject dated July 31, 2002, January 3, 2003, April 7, 2003, and January 16, 2004. The bulletin(s) is now obsolete and may be discarded.

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

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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 preface. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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

Page	Date
1-146.....	March 26, 2004



Canadian Standards Association
CAN/CSA-C22.2 No. 60745-1-04
Second Edition
(IEC 60745-1:2001, MOD)



Underwriters Laboratories Inc.
UL 60745-1
Third Edition

Hand-Held Motor-Operated Electric Tools – Safety – Part 1: General Requirements

March 26, 2004

This national standard is based on publication IEC 60745-1, 3.2 Edition (2003).



ANSI/UL 60745-1-2004

Approved
by
Standards Council
of Canada



Documents

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Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (CSA) and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA or UL at any time. Revisions to this standard will be made only after processing according to the standards development procedures of CSA and UL. CSA and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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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.

The most recent designation of ANSI/UL 60745-1 as an American National Standard (ANSI) occurred on March 10, 2004.

This ANSI/UL Standard for Safety, which consists of the Third edition is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-RTP Standards Department, 12 Laboratory Drive, P.O. Box 13995, Research Triangle Park, NC 27709-3995.

CONTENTS

Preface	6
Foreword (CSA)	8
Foreword (UL)	10
FOREWORD	11
INTRODUCTION	13
1 Scope	14
2 Normative references	15
3 Definitions	20
4 General requirements	24
5 General conditions for the tests	24
6 Void	26
7 Classification	26
8 Marking and instructions	26
9 Protection against access to live parts	38
10 Starting	40
11 Input and current	40
12 Heating	41
13 Leakage current	45
14 Moisture resistance	46
15 Electric strength	49
16 Overload protection of transformers and associated circuits	50
17 Endurance	51
18 Abnormal operation	52
19 Mechanical hazards	56
20 Mechanical strength	57
21 Construction	58
22 Internal wiring	67
23 Components	69
24 Supply connection and external flexible cords	71
25 Terminals for external conductors	80
26 Provision for earthing	83
27 Screws and connections	85
28 Creepage distances, clearances and distances through insulation	88
29 Resistance to heat, fire and tracking	92
30 Resistance to rusting	94
31 Radiation, toxicity and similar hazards	94
 Annex A – (normative) – Measurement of creepage distances and clearances	
A.1 Measurement of creepage distances and clearances	103

Annex B – (normative) – Motors not isolated from the supply mains and having basic insulation not designed for the rated voltage of the tool

B.1 Scope	108
B.9 Protection against access to live parts	108
B.12 Heating	108
B.15 Electric strength	108
B.18 Abnormal operation	108
B.21 Construction	108
B.28 Creepage distances, clearances and distances through insulation	109

Annex C – (normative) – Circuit for measuring leakage currents**Annex D – (normative) – Burning test**

D.1 Burning test	113
------------------------	-----

Annex E – (normative) – Glow-wire test**Annex F – (normative) – Needle-flame test****Annex G – (normative) – Proof tracking test****Annex H – Void****Annex I – (normative) – Switches****Annex J – (informative) – Selection and sequence of the tests of clause 29****Annex K – (normative) – Battery tool and battery packs**

K.1 Scope	120
K.2 Normative references	120
K.3 Definitions	120
K.5 General conditions for the tests	121
K.7 This clause is not applicable.	121
K.8 Marking and instructions	121
K.9 Protection against electric shock	122
K.10 Starting	123
K.11 Input and current	123
K.12 Heating	123
K.13 Leakage current	124
K.14 Moisture resistance	124
K.15 Electric Strength	124

K.16	Overload protection of transformers and associated circuits	125
K.17	Endurance	125
K.18	Abnormal operation	125
K.19	Mechanical Hazards	126
K.20	Mechanical strength	126
K.21	Construction	127
K.22	Internal wiring	128
K.23	Components	128
K.24	Supply connection and external flexible cords	128
K.25	Terminals for external conductors	128
K.26	Provision for earthing	129
K.27	Screws and connections	129
K.28	Creepage distances, clearances and distances through insulation	129
K.29	Resistance to heat, fire and tracking	130

Annex L – (normative) – BATTERY TOOLS AND BATTERY PACKS PROVIDED WITH MAINS CONNECTION OR NON-ISOLATED SOURCES

L.1	Scope	132
L.2	Normative References	132
L.3	Definitions	132
L.5	General conditions for the tests	133
L.7	Classification	133
L.8	Marking and Instructions	133
L.9	Protection against electric shock	135
L.10	Starting	135
L.11	Input and current	135
L.12	Heating	136
L.13	Leakage current	136
L.14	Moisture resistance	136
L.15	Electric strength	136
L.16	Overload protection of transformers and associated circuits	136
L.17	Endurance	136
L.18	Abnormal operation	136
L.19	Mechanical Hazards	137
L.20	Mechanical strength	137
L.21	Construction	138
L.22	Internal wiring	138
L.23	Components	138
L.24	Supply connection and external flexible cords	139
L.25	Terminals for external conductors	139
L.26	Provision for earthing	140
L.28	Creepage distances, clearances and distances through insulation	140
L.29	Resistance to heat, fire and tracking	142

Annex DVL – List of National Differences

Bibliography

Preface

This is the common CSA and UL standard for hand-held motor-operated electric tools. It is the second edition of CAN/CSA-C22.2 No. 60745-1 and the third edition of UL 60745-1. This standard is based on IEC 60745-1, 3.2 edition.

The first edition of this standard was published in 1995 with the designation CAN/CSA-C22.2 No. 745-1/UL 745-1. This standard CAN/CSA-C22.2 No. 60745-1, second edition, and UL 60745-1, third edition, supersedes:

- a) the first edition CAN/CSA-C22.2 No. 745-1/UL 745-1 published in 1995; and
- b) CAN/CSA-C22.2 No. 745-3/UL 745-3 (requirements for battery tools and battery packs are now incorporated into the requirements of CAN/CSA-C22.2 No. 60745-1, second edition, and UL 60745-1, third edition).

The standard number has been aligned to correspond with the equivalent IEC 60745-1 standard. UL has purposely skipped the second edition to align with the current edition of the IEC 60745-1 standard.

This common standard was prepared by the Canadian Standards Association (CSA) and Underwriters Laboratories Inc. (UL).

This standard was reviewed by the CSA Subcommittee on Portable Electric Tools, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

This standard has been approved as a National Standard of Canada by the Standards Council of Canada and has been approved by the American National Standards Institute (ANSI) as an American National Standard.

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.

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.

Where reference is made to a specific number of samples to be tested, the specified number shall be considered a minimum quantity.

Level of harmonization

This standard adopts the IEC text with national differences. This standard is published as an equivalent standard for CSA and UL. An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one literal interpretation has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

CSA Effective Date

The effective date for CSA International will be announced through CSA Informs or a CSA certification notice.

UL Effective Date

As of June 1, 2007, all products Listed or Recognized by UL must comply with the requirements in this Standard.

Between March 26, 2004 and June 1, 2007, new product submittals to UL must be evaluated under all requirements in this Standard or, if requested in writing, evaluated under presently effective requirements only. The presently effective requirements are contained in the first edition of UL 745-1.

Alternate constructions, currently Listed to the UL 45, eighth edition, may be evaluated to the first edition of UL 745-1 as referenced in the June 7, 2002 bulletin.

General

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.

National Differences from the text of the International Electrotechnical Commission (IEC) publication 60745-1 (Hand-Held Motor-Operated Electric Tools – Safety – Part 1: General Requirements) are indicated by the following notation:

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 based on **safety practices**. These are differences for IEC requirements that may be acceptable, but adopting the IEC requirements would require considerable retesting or redesign on the manufacturer's part.

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**.

Foreword (CSA)

The Canadian Standards Association (CSA) develops standards under the name Canadian Standards Association, and provides certification and testing under the name CSA International. CSA International provides certification services for manufacturers who, under license from CSA, wish to use the appropriate registered CSA Marks on certain products of their manufacture to indicate conformity with CSA Standards.

CSA Certification for a number of products is provided in the interest of maintaining agreed-upon standards of quality, performance, interchangeability and/or safety, as appropriate. Where applicable, certification may form the basis for acceptance by inspection authorities responsible for enforcement of regulations. Where feasible, programs will be developed for additional products for which certification is desired by producers, consumers, or other interests. In performing its functions in accordance with its objectives, CSA does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of the Association represent its professional judgement given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed.

Products in substantial accord with this Standard but which exhibit a minor difference or a new feature may be deemed to meet the Standard providing the feature or difference is found acceptable utilizing appropriate CSA International Operating Procedures. Products that comply with this Standard shall not be certified if they are found to have additional features which are inconsistent with the intent of this Standard. Products shall not be certifiable if they are discovered to contravene applicable laws or regulations.

Testing techniques, test procedures, and instrumentation frequently must be prescribed by CSA International in addition to the technical requirements contained in Standards of CSA. In addition to markings specified in the Standard, CSA International may require special cautions, markings, and instructions that are not specified by the Standard.

Some tests required by CSA Standards may be inherently hazardous. The Association neither assumes nor accepts any responsibility for any injury or damage that may occur during or as the result of tests, wherever performed, whether performed in whole or in part by the manufacturer or the Association, and whether or not any equipment, facility, or personnel for or in connection with the test is furnished by the manufacturer or the Association.

Manufacturers should note that, in the event of the failure of CSA International to resolve an issue arising from the interpretation of requirements, there is an appeal procedure: the complainant should submit the matter, in writing, to the Secretary of the Canadian Standards Association.

If this Standard is to be used in obtaining CSA Certification please remember, when making application for certification, to request all current Amendments, Bulletins, Notices, and Technical Information Letters that may be applicable and for which there may be a nominal charge. For such information or for further information concerning CSA Certification, please address your inquiry to Applications and Customer Service, CSA International, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3.

No Text on This Page

Foreword (UL)

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HAND-HELD MOTOR-OPERATED ELECTRIC TOOLS – SAFETY – Part 1: General requirements

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

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

International Standard IEC 60745-1 has been prepared by sub-committee 61F: Safety of hand-held motor-operated electric tools, of IEC technical committee 61: Safety of household and similar electrical appliances.

This consolidated version of IEC 60745-1 is based on the third edition (2001) [documents 61 F/422/FDIS and 61 F/427/RVD], its amendment 1 (2002) [documents 61 F/460/FDIS and 61 F/484/RVD], its amendment 2 (2003) [documents 61 F/534/FDIS and 61 F/540/RVD] and the corrigendum of January 2003.

It bears the edition number 3.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A, B, C, D, E, F, G, I, K, and L form an integral part of this standard.

Annex J is for information only.

NOTE In annexes B, K and L, subclauses which are additional to those in the main body of the text are numbered starting from 101.

The committee has decided that the contents of the base publication and its amendments 1 and 2 will remain unchanged until 2006. At this date, the publication will be

- reconfirmed
- withdrawn;
- replaced by a revised edition; or
- amended.

A bilingual version of this publication may be issued at a later date

INTRODUCTION

This part 1 is to be used in conjunction with the appropriate part 2, which contains clauses to supplement or modify the corresponding clauses in part 1 to provide the relevant requirements for each type of product.

Individual countries may wish to consider its application, so far as is reasonable, to tools not mentioned in part 2, and to tools designed on new principles.

If the functions of a tool are covered by the different parts 2 of IEC 60745, the relevant part 2 is applied to each function separately, so far as is reasonable. If applicable, the influence of one function on the other is taken into account.

Normative references to other IEC and ISO standards are given in clause 2.

NOTE In this standard, the following print types are used:

- Requirements: in roman type
- Test specification: in italic type
- Notes: in smaller roman type

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

A product employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intention of the requirements and, if found to be substantially equivalent, may be judged to comply with the standard.

Standards dealing with non-safety aspects of hand-held tools are:

- IEC standards published by TC 59 on methods of measuring performance;
- CISPR 11 and 14 on radio interference suppression;
- IEC 61000-3-2 and IEC 61000-3-3 on electromagnetic compatibility.

HAND-HELD MOTOR-OPERATED ELECTRIC TOOLS – SAFETY –

Part 1: General requirements

1 Scope

1.1 This International Standard deals with the safety of hand-held motor-operated or magnetically driven electric tools, the rated voltage of the tools being not more than 250 V for single-phase a.c. or d.c. tools, and 440 V for three-phase a.c. tools.

So far as is practicable, this standard deals with the common hazards presented by hand-held tools, which are encountered by all persons in the normal use and reasonably foreseeable misuse of the tools.

Tools with an electric heating element are within the scope of this standard. They should also comply with relevant parts of IEC 60335.

Hand-held electric tools, hereinafter referred to as tools, which can be mounted on a support for use as fixed tools without any alteration of the tool itself, are within the scope of this standard. Unless the requirement for such support is given in a relevant part 2, this standard alone will not be sufficient to ensure that the combination of tool and support is adequate.

Requirements for motors not isolated from the supply, and having basic insulation not designed for the rated voltage of the tools, are given in Annex B. Requirements for rechargeable battery- powered motor-operated or magnetically driven tools and the battery packs for such tools are given in Annex K. Those for such tools that are also operated and/or charged directly from the mains or a non-isolated source are given in Annex L.

This standard does not apply to:

- hand-held tools intended to be used in the presence of explosive atmosphere (dust, vapour or gas);
- hand-held tools used for preparing and processing food;
- hand-held tools for medical purposes (IEC 60601);
- heating tools which are covered by IEC 60335-2-45.

For hand-held tools intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary.

For hand-held tools intended to be used in tropical countries, special requirements may be necessary.

NOTE Attention is drawn to the fact that in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities, etc.

1.1DV DR Addition: Add the following paragraph:

This standard deals with tools used in non-hazardous locations in accordance with the National Electrical Code, NFPA 70, and the Canadian Electric Code, Part 1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60745. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60745 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

2DV.1 DC Modification: Add the following sentence:

Where the IEC or ISO normative documents are referenced in this standard, U.S. and Canadian standards shall replace the IEC or ISO documents as specified in the modifications to this clause.

IEC 60061-1:1969,
Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 1: Lamp caps
Supplement A (1969) to amendment 26 (2001)

2DV.2 DC Modification: replace IEC 60061-1 with the following:

**CSA C22.2 No. 43,
Lampholders,
and UL 496,
Edison-Base Lampholders**

IEC 60065:1998,
Audio, video and similar electronic apparatus - Safety requirements

2DV.3 DC Modification: replace IEC 60065 with the following:

**CSA E60065,
Audio, Video and Similar Electronic Apparatus – Safety Requirements,
and UL 60065,
Audio, Video and Similar Electronic Apparatus – Safety Requirements**

IEC 60068-2-75:1997,
Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests

IEC 60085:1984,
Thermal evaluation and classification of electrical insulation

2DV.4 DC Modification: replace IEC 60085 with the following:

**UL 1446,
Systems of Insulating Materials – General**

IEC 60112:1979,
Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions

IEC 60127 (all parts),
Miniature fuses

2DV.5 DC Modification: replace IEC 60127 with the following:

**CSA C22.2 No. 248 series,
Low-Voltage Fuses,
and UL 248 series,
*Low-Voltage Fuses***

IEC 60227 (all parts),
Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V

2DV.6 DC Modification: replace IEC 60277 with the following:

**CSA C22.2 No. 21,
Cord Sets and Power Supply Cords,
CSA C22.2 No. 38,
Thermoset Insulated Wires and Cables,
or CSA C22.2 No. 75,
Thermoplastic-Insulated Wires and Cables,
and UL 44,
Thermoset-Insulated Wires and Cables,
UL 83,
Thermoplastic-Insulated Wires and Cables,
or UL 817,
*Cord Sets and Power-Supply Cords***

IEC 60245 (all parts),
Rubber insulated cables – Rated voltages up to and including 450/750

2DV.7 DC Modification: replace IEC 60245 with the following:

**CSA C22.2 No. 21,
Cord Sets and Power Supply Cords,
CSA C22.2 No. 38,
Thermoset Insulated Wires and Cables,
or CSA C22.2 No. 75,
Thermoplastic-Insulated Wires and Cables,
and UL 44,
Thermoset-Insulated Wires and Cables,
UL 83,
Thermoplastic-Insulated Wires and Cables,
or UL 817,
*Cord Sets and Power-Supply Cords***

IEC 60309 (all parts),
Plugs, socket-outlets and couplers for industrial purposes

2DV.8 DC Modification: replace IEC 60309 with the following:

**CSA C22.2 No. 42,
General Use Receptacles, Attachment Plugs and Similar Wiring Devices,
and UL 498,
Attachment Plugs and Receptacles**

IEC 60320 (all parts),
Appliance couplers for household and similar general purposes

IEC 60335-1:2001,
Safety of household and similar electrical appliances – Part 1: General requirements

2DV.9 DC Modification: replace IEC 60335-1 with the following:

**CSA C22.2 No. 72,
Heater Elements,
or CSA E335-1,
Safety of household and similar electrical appliances – Part 1: General requirements,
and UL 1030,
Sheathed Heating Elements
or UL 60335-1,
Safety of household and similar electrical appliances – Part 1: General requirements,**

IEC 60384-14:1993,
Fixed capacitors for use in electronic equipment - Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

2DV.10 DC Modification: replace IEC 60384-14 with the following:

**CSA C22.2 No. 8,
Electromagnetic Interference (EMI) Filters,
or CSA E384-14,
Fixed Capacitors for Use in Electronic Equipment – Part 14: Blank Detail Specification:
Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the
Supply Mains – Assessment Level D,
and UL 1283,
Electromagnetic Interference Filters**

IEC 60417-DB:2002,
Graphical symbols for use on equipment

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

IEC 60695-2-2:1991,
Fire hazard testing – Part 2: Test methods – Section 2: Needle-flame test

IEC 60695-2-10:2000,
Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure

IEC 60695-2-11:2000, Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products

IEC 60695-2-12:2000,
Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability test method for materials

IEC 60695-2-13:2000,
Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignitability test method for materials

IEC 60707:1999,
Flammability of solid non-metallic materials when exposed to flame sources – List of test methods

IEC 60730-1:1999,
Automatic electrical controls for household and similar use – Part 1: General requirements

IEC 60760:1989,
Flat, quick-connect terminations

2DV.11 DC Modification: replace IEC 60760 with the following:

**CSA C22.2 No. 0.4,
Bonding and Grounding of Electrical Equipment (Protective Grounding),
CSA C22.2 No. 153,
Quick-Connect Terminals,
and UL 310,
Electrical Quick-Connect Terminals**

IEC 60884 (all parts),
Plugs and socket-outlets for household and similar purposes

IEC 60998-2-1:2002,
Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units

IEC 60998-2-2:1991,
Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units

2DV.12 DC Modification: replace IEC 60998-2-2 with the following:

**CSA C22.2 No. 153,
Quick-Connect Terminals,
or CSA C22.2 No. 158,
Terminal Blocks,
and UL 310,
Electrical Quick-Connect Terminals,
or UL 486,
Wire Connectors and Terminals**

IEC 60999-1:1999,

Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)

2DV.13 DC Modification: replace IEC 60999-1 with the following:

**CSA C22.2 No. 153,
Quick-Connect Terminals,
or CSA C22.2 No. 158,
Terminal Blocks,
and UL 310,
Electrical Quick-Connect Terminals,
or UL 486,
Wire Connectors and Terminals**

IEC 61058-1:2000,

Switches for appliances – Part 1: General requirements

2DV.14 DC Modification: replace IEC 61058-1 with the following:

**UL 61058-1,
Switches for appliances – Part 1: General requirements**

IEC 61558-1:1997,

Safety of power transformers, power supply units and similar – Part 1: General requirements and tests

2DV.15 DC Modification: replace IEC 61558 with the following:

**CSA C22.2 No. 107,
General Use Power Supplies,
CSA C22.2 No. 223,
Power Supplies With Extra-Low-Voltage Class 2 Outputs,
or CSA E60335-2-29,
Safety of Household and Similar Electrical Appliances – Part 2: Particular Requirements for
Battery Chargers,
and UL 1012,
Power Units Other Than Class 2,
or UL 1310,
Class 2 Power Units**

ISO 1463:1982,

Metallic and oxide coatings – Measurement of coating thickness – Micro-scopical method

ISO 2178:1982,

Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method

2DV.16 DC Modification: Add the following:

**CSA C22.2 No. 198.1,
Extruded Insulating Tubing,
and UL 224,
Extruded Insulating Tubing**

**CSA C22.2 No. 0.15,
Adhesive Labels,
and UL 969,
Marking and Labeling Systems**

**ASTM D 471,
Standard Test Method for Rubber Property-Effect of Liquids**

3 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1.1 Where the terms voltage and current are used, they imply the r.m.s. values, unless otherwise specified.

3.1.2 Where in this standard the expressions "with the aid of a tool", "without the aid of a tool", and "requires the use of a tool", the word "tool" means a hand tool, for example screwdriver, which may be used to operate a screw or other fixing means.

3.2.1 rated voltage : voltage assigned to the tool by the manufacturer. For three-phase supply, it is the voltage between phases

3.2.2 rated voltage range : voltage range assigned to the tools by the manufacturer, expressed by its lower and upper limits

3.2.3 working voltage : maximum voltage, without the effect of transient voltages, to which the part under consideration is subjected when the tool is supplied at its rated voltage and operating under normal load

3.2.4 rated input : input in watts assigned to the tool by the manufacturer

3.2.5 rated input range : input range in watts assigned to the tool by the manufacturer, expressed by its lower and upper limits

3.2.6 rated current : current assigned to the tool by the manufacturer. If no current is assigned to the tool, the rated current for the purpose of this standard is the current measured when the tool is under normal load at rated voltage

3.2.7 rated frequency : frequency assigned to the tool by the manufacturer

3.2.8 rated frequency range : frequency range assigned to the tool by the manufacturer, expressed by its lower and upper limits

3.2.9 normal load : load to be applied to a tool at rated voltage or at the upper limit of the rated voltage range, to obtain rated input or rated current, any marking of short-time or intermittent operation being observed and, unless otherwise specified, heating elements, if any, being operated as in normal use

3.2.9.1 no load input / current : highest input or current obtained when a tool is operated at rated voltage and frequency with no external load (work) applied to the accessories packaged with the tool by the manufacturer and adjusted according to manufacturer's instructions, ready for use

3.2.10 rated no-load speed : no-load speed at rated voltage or at the upper limit of the rated voltage range assigned to the tool by the manufacturer

3.2.11 normal use : use of a tool for which it is designed taking into account the manufacturer's instructions

3.3.1 detachable cord : flexible cord, for supply, intended to be connected to the tool by means of a suitable appliance coupler

3.3.2 supply cord : flexible cord, for supply purposes, which is fixed to the tool

3.3.3 type X attachment : method of attachment of the supply cord so that it can easily be replaced

3.3.4 type Y attachment : method of attachment of the supply cord such that any replacement is intended to be made by the manufacturer, its service agent or similar qualified person

3.3.5 type Z attachment : method of attachment of the supply cord so that it cannot be replaced without breaking or destroying the tool

3.4.1 basic insulation : insulation, not necessarily including insulation used for functional purpose, applied to live parts to provide basic protection against electric shock

3.4.2 supplementary insulation : independent insulation applied in addition to the basic insulation, in order to provide protection against electric shock in the event of a failure of the basic insulation

3.4.3 double insulation : insulation system comprising both basic insulation and supplementary insulation

3.4.4 reinforced insulation : insulation of hazardous live parts which provides a degree of protection against electric shock equivalent to double insulation

NOTE Examples for reinforced insulation are a single layer or several layers which cannot be tested singly as basic insulation or supplementary insulation.

3.4.5 class I tool : tool in which protection against electric shock does not rely on basic, double or reinforced insulation only, but which includes an additional safety precaution in that conductive accessible parts are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that conductive accessible parts cannot become live in the event of a failure of the basic insulation. Also considered as class I tools are tools with double insulation and/or reinforced insulation throughout having an earthing terminal or earthing contact

3.4.6 class II tool : tool in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions

3.4.7 class II construction : part of a tool for which protection against electric shock relies upon double insulation or reinforced insulation

3.4.8 class III tool : tool in which protection against electric shock relies on supply at safety extra-low voltage, and in which voltages higher than those of safety extra-low voltages are not generated

3.4.9 class III construction : part of a tool for which protection against electric shock relies upon safety extra-low voltage, and in which voltages higher than those of safety extra-low voltages are not generated

3.4.10 creepage distance : shortest path between two conductive parts, or between a conductive part and the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material, measured along the surface of the insulating material

NOTE Examples for creepage distances are given in Annex A.

3.4.11 clearance : shortest distance between two conductive parts, or between a conductive part and the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material, measured through air

NOTE Examples for clearance distances are given in Annex A.

3.4.12 normal duty conditions of insulating material : where there is virtually no deposition of conductive material and a long period of electrical stress; or a light deposition of conductive material and a short period of electrical stress

3.4.13 severe duty conditions of insulating material : where there is a light deposition of conductive material and a long period of electrical stress; or a heavy deposition of conductive material and a short period of electrical stress

3.4.14 extra-severe duty conditions of insulating material : where there is heavy deposition of conductive material and a long period of electrical stress; or an extra heavy deposition of conductive material and a short period of electrical stress

3.5.1 extra-low voltage : voltage supplied from a source within the tool and, which, when the tool is supplied at rated voltage, does not exceed 50 V between conductors and between conductors and earth

3.5.2 safety extra-low voltage : rated voltage not exceeding 42 V between conductors and between conductors and earth, the no-load voltage not exceeding 50 V. When safety extra-low voltage is obtained from the supply mains, it is to be through a safety isolating transformer or a convertor with separate windings, the insulation of which complies with double or reinforced insulation requirements

3.5.3 safety isolating transformer : transformer, the input winding of which is electrically separated from the output winding by an insulation at least equivalent to double insulation or reinforced insulation, and which is intended to supply a distribution circuit, a tool or other equipment at safety extra-low voltage

3.6.1 hand-held tool (in this standard abbreviated to "tool") : electric motor-operated or magnetically-driven machine intended to do mechanical work, with or without provisions for mounting on a support, and so designed that the motor and the machine form an assembly which can easily be brought to the place of operation, and which is either held or supported by hand or suspended during operation

NOTE Hand-held tools may be provided with a flexible shaft, the motor being either fixed or portable.

3.6.2 exchange type tool : tool which is intended not to be repaired at all, or to be repaired by the manufacturer's service organization only

3.7.1 non-detachable part : part which can only be removed or opened with the aid of a tool, or a part which fulfils the test of 21.22

3.7.2 detachable part : part which can be removed or opened without the aid of a tool, or a part which is removed in accordance with the instruction for use, except user maintenance items, even if removal requires the use of a tool

3.8.1 thermostat : temperature-sensing device, the operating temperature of which may be either fixed or adjustable; and which, during normal operation, keeps the temperature of the controlled part between certain limits by automatically opening and closing a circuit

3.8.2 temperature limiter : temperature-sensing device, the operating temperature of which may be either fixed or adjustable, and which, during normal operation, operates by opening or closing a circuit when the temperature of the controlled part reaches a predetermined value. It does not make the reverse operation during the normal duty cycle of the tool

3.8.3 thermal cut-out : device which, during abnormal operation, limits the temperature of the controlled part by automatically opening the circuit, or by reducing the current, and which is so constructed that its setting cannot be altered by the user

3.8.4 self-resetting thermal cut-out : thermal cut-out which automatically restores the current after the relevant part of the tool has cooled down to a given value

3.8.5 non-self-resetting thermal cut-out : thermal cut-out which requires a manual operation for resetting, or replacement of a part, in order to restore the current

3.8.6 protective device : device the operation of which prevents a hazardous situation under abnormal operation conditions

3.8.7 thermal link : thermal cut-out which operates only once, and then requires partial or complete replacement

3.9.1 all-pole disconnection : disconnection of all supply conductors except the protective earthing (grounding) conductor by a single initiating action

3.9.2 accessible part : part which can be touched by means of the standard test finger in Figure 1, including, for accessible metal parts, any metal part connected to it

3.9.3 live part : any conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor

3.10.1 electronic component : part in which conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor, with the exclusion of neon indicators

3.10.2 electronic circuit : circuit incorporating at least one electronic component

3.10.3 protective impedance : impedance connected between live parts and accessible conductive parts, and of value so that the current is limited to a safe value

3.11.1 rated operating time : operating time assigned to the tool by the manufacturer

3.11.2 short-time operation : operation under normal load for a specified period, starting from cold, the intervals between each period of operation being sufficient to allow the tool to cool down approximately to ambient temperature

3.11.3 intermittent operation : operation in a series of specified identical cycles, each cycle being composed of a period of operation under normal load followed by a rest period with the tool running idle or switched off

3.11.4 routine servicing : periodic servicing which requires tool disassembly as instructed by the instruction manual and performed by authorized service centre

3.11.5 user maintenance : any maintenance operation stated in the instructions for use or marked on the tool which the manufacturer of the tool intends the user to perform

3.12.1 accessory : device that is attached only to the output mechanism of the tool

3.12.2 attachment : device attached to the housing or other component of the tool and which may or may not be attached to the output mechanism and does not modify the normal use of the tool within the scope of this standard

4 General requirements

Tools shall be so constructed that in normal use they function safely so as to cause no danger to persons or surroundings, even in the event of reasonably foreseeable misuse.

In general, this principle is achieved by fulfilling the relevant requirements specified in this standard, and compliance is checked by carrying out all the relevant tests.

5 General conditions for the tests

5.1 *Tests according to this standard are type tests.*

5.2 *Unless otherwise specified, the tests are made on a single tool, which shall withstand all the relevant tests. However, any tool requiring modifications to perform the test or disassemble after the test shall be performed on a separate sample.*

The cumulative stress resulting from successive tests on electronic circuits is to be avoided. It may be necessary to replace components or to use additional samples. The number of additional samples should be kept to a minimum by an evaluation of the relevant electronic circuits.

5.3 *Unless otherwise specified, the tests are carried out in the order of the clauses. If it is evident from the construction of the tool that a particular test is not applicable, the test is not made.*

5.4 *The tests are carried out with the tool, or any movable part of it, placed in the most unfavourable position that may occur in normal use.*

5.5 *Tools provided with controls or switching devices are tested with these controls or devices adjusted to their most unfavourable settings, if the setting can be altered by the user. Electronic speed control devices are set for the highest speed.*

If the adjusting means of the control is accessible without the aid of a tool, this subclause applies whether the setting can be altered by hand or with the aid of a tool. If the adjusting means is not accessible without the aid of a tool, and if the setting is not intended to be altered by the user, this subclause does not apply.

Adequate sealing is regarded as preventing alteration of the setting by the user.

5.6 The tests are made in a draught-free location and, in general, at an ambient temperature of $(20 \pm 5)^{\circ}\text{C}$.

If the temperature attained by any part is limited by a temperature sensitive device, or is influenced by the temperature, the room temperature is, in case of doubt, maintained at $(23 \pm 2)^{\circ}\text{C}$.

5.7.1 Tools for a.c. only are tested with a.c. at rated frequency, if marked, and those for a.c./d.c. are tested at the more unfavourable supply.

Tools for a.c. which are not marked with rated frequency, or marked with a frequency range of 50 Hz to 60 Hz, are tested with either 50 Hz or 60 Hz, whichever is the more unfavourable.

5.7.2 Tools having more than one rated voltage are tested on the basis of the most unfavourable voltage.

When it is specified for tools marked with a rated voltage range that the supply voltage is equal to the rated voltage multiplied by a factor, the supply voltage is equal to:

- the upper limit of the rated voltage range multiplied by this factor, if greater than 1;
- the lower limit of the rated voltage range multiplied by this factor, if smaller than 1.

When a factor is not specified, the supply voltage is the most unfavourable within the rated voltage range.

For tools having more than one rated voltage or rated voltage range, it may be necessary to make some of the tests at the minimum, the mean, and the maximum values of the rated voltage, or the rated voltage range, in order to establish the most unfavourable voltage.

5.7.3 For tools marked with a rated voltage range and rated input corresponding to the mean of the rated voltage range, when it is specified that the power input is equal to rated input multiplied by a factor, the input is equal to:

- the calculated input corresponding to the upper limit of the rated voltage range multiplied by this factor, if greater than 1;
- the calculated input corresponding to the lower limit of the rated voltage range multiplied by this factor, if smaller than 1.

When a factor is not specified, the input corresponds to the input at the most unfavourable rated voltage within the range.

5.8 When alternative attachments are made available for the tool by its manufacturer, the tool is tested with those attachments which give the most unfavourable results.

5.9 Unless otherwise specified, tools are tested with the appropriate flexible cord connected to the tool.

5.10 If class I tools have accessible metal parts which are not connected to an earthing terminal or earthing contact, and are not separated from live parts by an intermediate metal part which is connected to an earthing terminal or earthing contact, such parts are checked for compliance with the appropriate requirements specified for class II construction.

If class I tools have accessible non-metallic parts, such parts are checked for compliance with the appropriate requirements specified for class II construction, unless these parts are separated from live parts by an intermediate metal part connected to an earthing terminal or earthing contact.

5.11 *If class I or class II tools have parts operating at safety extra-low voltage, such parts are checked for compliance with the appropriate requirements specified for class III tools.*

5.12 *When testing electronic circuits, the supply is to be free from those perturbations from external sources that can influence the results of the tests.*

5.13 *If, in normal use, the heating element cannot be operated unless the motor is running, the element is tested with the motor running. If the heating element can be operated without the motor running, the element is tested with or without the motor running, whichever is the more unfavourable. Heating elements incorporated in the tool are connected to a separate supply unless otherwise specified.*

5.14 *For attachments performing a function which is within the scope of one of the relevant parts 2, the tests are made in accordance with that part 2.*

For other attachments, the tests are made in accordance with manufacturer's instructions; in the absence of such instructions, the tool is operated continuously at a load at which rated input or rated current is attained.

5.15 *If a torque is to be applied, the method of loading is chosen so as to avoid additional stresses, such as those caused by side thrust. Additional loads necessary for the correct operation of the tool are, however, taken into consideration.*

If a brake is used for applying a load, it must be applied gradually to assure that the starting current does not affect the test. Modification of output means for purpose of loading is permitted for the connection to a brake.

5.16 *Tools intended to be operated at safety extra-low voltage are tested together with their supply transformer, if this is normally sold with the tool.*

6 Void

7 Classification

7.1 Tools shall be of one of the following classes with respect to protection against electric shock:

class I, class II, class III.

Compliance is checked by inspection and by the relevant tests.

7.2 Tools shall have the appropriate degree of protection against harmful ingress of water according to IEC 60529. If a degree other than IPX0 is required this shall be specified in the part 2.

Compliance is checked by inspection and by the relevant tests.

8 Marking and instructions

8.1 Tools shall be marked with:

- rated voltage(s) or rated voltage range(s), in volts. Tools for star-delta connection shall be clearly marked with the two rated voltages (for example 230 Δ / 400 Y);
- symbol for nature of supply, unless the rated frequency is marked;

- rated input, in watts or rated current, in amperes. The rated input or current to be marked on the tool is the total maximum input or current that can be on circuit at the same time. If a tool has alternative components which can be selected by a control device, the rated input or rated current is that corresponding to the highest loading possible;
- name or trade mark or identification mark or company name of the manufacturer or any other person responsible for placing the tool on the market;
- designation of series or type;
- symbol for class II construction, for class II tools only;
- IP number according to degree of protection against ingress of water other than IPX0. The first numeral of the IP number need not be marked on the tool;
- any mandatory mark showing compliance with legislation by reference to this standard.

Compliance is checked by inspection.

Additional markings are allowed, provided they do not give rise to misunderstanding.

If components are marked separately, the marking of the tool and that of the components is to be such that there can be no doubt with regard to the marking of the tool itself.

8.1DV D1 Modification: Add the following items:

- the following statement: **WARNING – To reduce the risk of injury, user must read and understand instruction manual**

The word "Warning" shall be in capital letters not less than 2.4 mm high and shall not be separated from the cautionary statement.

The statement shall be verbatim, except the term "operator's manual" or "user guide" may be used for the term "instruction manual."

- date of manufacture.

The date of manufacture may be a dating period not exceeding any one month. The date of manufacture may be abbreviated or in an established, accepted code or a code affirmed by the manufacturer. The code shall not require reference to the manufacturer's records to determine when the product was manufactured.

8.1DV.1 D1 Addition: Add the following clause:

If a nameplate carries a required marking and is on a part that must be removed for normal servicing of the tool, the construction shall be such that the nameplate must be returned to its proper location for the tool to be operable.

A cautionary marking shall be permanent and shall be located on a part permanently attached to the tool or on a part that cannot be removed without impairing the operation or the appearance of the tool.

A fold-over label attached to the power supply cord is acceptable.

Cautionary markings shall be used verbatim as stated. Optional cautionary statements may be added to the markings, as deemed necessary, by the manufacturer. Cautionary statements having the same signal word may be combined into one paragraph under one signal word. The order of statements shall be markings required by Part 1, markings required by the applicable Part 2, and any optional markings.

In cases where the words “danger”, “warning”, and “caution” appear together, the cautionary markings shall be in the order of severity, i.e., “danger, warning, and caution”.

8.2 Tools for short-time operation or intermittent operation shall be marked with rated operating time, or rated operating time and rated resting time respectively, unless the operating time is limited by the construction of the tool.

The marking of short-time operation or intermittent operation shall correspond to normal use.

The marking of intermittent operation shall be such that the rated operating time precedes the rated resting time, both markings being separated by an oblique stroke.

Compliance is checked by inspection.

8.3 The marking of tools intended to be operated without adjustment in a rated range of values (voltage, frequency, etc.) shall be differentiated from those intended to be operated with or without adjustment under different values of the same criteria (voltage, frequency, etc.).

The lower and upper limits of the rated range of values shall be separated by a hyphen (-).

The different rated values shall be separated by an oblique stroke (/).

Examples:

115-230 V: The tool is suitable for any value within the marked range.

115/230 V: The tool is only suitable for the marked values. This will remain as a US national deviation

Compliance is checked by inspection.

8.4 If the tool can be adjusted to suit different rated voltages, the voltage to which the tool is adjusted shall be clearly discernible.

This requirement does not apply to tools for star-delta connection.

For tools where frequent changes in voltage setting are not required, this requirement is considered to be met if the rated voltage to which the tool is adjusted can be determined from a wiring diagram fixed to the tool. The wiring diagram may be on the inside of a cover which has to be removed to connect the supply conductors. It is not to be on a label loosely attached to the tool.

Compliance is checked by inspection.

8.5 For tools marked with more than one rated voltage or with more than one rated voltage range, the rated power input for each of these voltages or ranges shall be marked.

The upper and lower limits of the rated power input shall be marked on the tool so that the relation between input and voltage appears distinctly, unless the difference between the limits of a rated voltage range does not exceed 10 % of the mean value of the range, in which case the marking for rated power input may be related to the mean value of the range.

Compliance is checked by inspection.

8.6 If units or technical data are expressed by symbols, the following symbols shall be used:

V.....	volts
A.....	amperes
Hz.....	hertz
W.....	watts
kW.....	kilowatts
F.....	farads
μ F.....	microfarads
l	litres
g.....	grams
kg	kilograms
bar.....	bars
Pa.....	pascals
h.....	hours
min	minutes
s.....	seconds
n_0	no-load speed

.../min or ...min⁻¹ Revolutions or reciprocations per minute



or d.c. direct current



or a.c. alternating current



.....two-phase alternating current



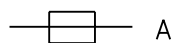
.....two-phase alternating current with neutral



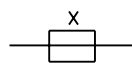
.....three-phase alternating current



.....three-phase alternating current with neutral



.....rated current of the appropriate fuse-link in amperes



.....time-lag miniature fuse-link where X is the symbol for the time/current characteristic, as given in IEC 60127



.....protective earth



.....class II tool

IPXX

.....IP symbol

S4598

If the first numeral for the IP numbering is omitted, the omitted numeral shall be replaced by the letter X, for example IPX5.

The symbol for nature of supply shall be placed next to the marking for rated voltage.

The dimensions for the symbol for class II tools shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square. The length of the sides of the outer square shall not be less than 5 mm, unless the largest dimension of the tool does not exceed 15 cm, in which case the dimensions of the symbol may be reduced, but the length of the sides of the outer square shall not be less than 3 mm.

When other units are used, the units and their symbols shall be those of the international standardized system. Multiple or submultiple units are also allowed.

Additional symbols are allowed, provided they do not give rise to misunderstanding.

Compliance is checked by inspection and measurement.

8.7 Tools to be connected to more than two supply conductors shall be provided with a connection diagram, fixed to the tool, unless the correct mode of connection is obvious.

The correct mode of connection is deemed to be obvious if the terminals for the supply conductors are indicated by arrows pointing towards the terminals. The earthing conductor is not a supply conductor. For tools for star-delta connection, the wiring diagram should show how the windings are to be connected.

Compliance is checked by inspection.

8.8 Except for type Z attachments, terminals shall be indicated as follows:

- Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.
- Earthing terminals shall be indicated by the symbol $\perp$

These indications shall not be placed on screws, removable washers or other parts which might be removed when conductors are being connected.

Compliance is checked by inspection.

8.9 Unless it is obviously unnecessary, switches which may give rise to a hazard when operated shall be marked, or so placed as to indicate clearly which part of the tool they control.

Indications used for this purpose shall, wherever practicable, be comprehensible without a knowledge of languages, national standards, etc.

Compliance is checked by inspection.

8.10 For tools which might cause danger when started unexpectedly, the "off" position of the mains switch shall be indicated, unless this position is obvious; the indication, if required, shall be the figure O, as given by symbol IEC 60417-5008 (DB:2002-10).

The figure O shall not be used for any other indication.

The position of the moving contacts of the mains switch shall correspond to the indications for the different positions of its operating means.

NOTE The figure O may, for example, also be used on a digital programming keyboard.

Compliance is checked by inspection.

8.11 Regulating devices and the like, intended to be adjusted during operation, shall be provided with an indication for the direction of adjustment to increase or to decrease the value of the characteristic being adjusted. An indication of + and - is considered to be sufficient.

The requirement does not apply to regulating devices provided with an adjusting means, if its "fully-on" position is opposite to its "off" position.

If figures are used for indicating the different positions, the "off" position shall be indicated by the figure O and the other position shall be indicated by figures reflecting the greater output, input, speed, etc.

The indication for the different positions of the operating means of a control device need not to be placed on the device itself.

Compliance is checked by inspection.

8.12 An instruction manual and general safety instructions shall be provided with the tool and packaged in such a way that is noticed by the user when the tool is removed from the packaging. The general safety instructions may be separate from the instruction manual. They shall be written in the official language(s) of the country in which the tool is sold.

Instructions shall be legible and contrast with the background.

The instruction manual shall include the name and address of the manufacturer or supplier of branded product and an explanation of the symbols used on the product.

The subjects are as follows:

8.12.1 General Safety Instructions. The Safety Rules specified in this clause, if in English shall be verbatim and in the exact order as given and in any other official language to be equivalent.

Format of General Safety Instructions must differentiate, by font highlighting or similar means, the context of clauses as illustrated below.

The order of the warning statements shall be: as required by part 1, as required by the applicable part 2, and any optional warning statements deemed necessary by the manufacturer.

General Safety Rules

WARNING! Read all instructions Failure to follow all instructions listed below may result in electric shock, fire and/or serious injury. The term "power tool" in all of the warnings listed below refers to your mains-operated (corded) power tool or battery-operated (cordless) power tool.

SAVE THESE INSTRUCTIONS

1) Work area safety

- a) **Keep work area clean and well lit.** *Cluttered or dark areas invite accidents.*
- b) **Do not operate power tools in explosive atmospheres, such as in the presence of flammable liquids, gases or dust.** *Power tools create sparks which may ignite the dust or fumes.*
- c) **Keep children and bystanders away while operating a power tool.** *Distractions can cause you to lose control*

2) Electrical safety

- a) **Power tool plugs must match the outlet. Never modify the plug in any way. Do not use any adapter plugs with earthed (grounded) power tools.** *Unmodified plugs and matching outlets will reduce risk of electric shock*
- b) **Avoid body contact with earthed or grounded surfaces such as pipes, radiators, ranges and refrigerators.** *There is an increased risk of electric shock if your body is earthed or grounded.*
- c) **Do not expose power tools to rain or wet conditions.** *Water entering a power tool will increase the risk of electric shock*
- d) **Do not abuse the cord. Never use the cord for carrying, pulling or unplugging the power tool. Keep cord away from heat, oil, sharp edges or moving parts.** *Damaged or entangled cords increase the risk of electric shock.*
- e) **When operating a power tool outdoors, use an extension cord suitable for outdoor use.** *Use of a cord suitable for outdoor use reduces the risk of electric shock.*

3) Personal safety

- a) **Stay alert, watch what you are doing and use common sense when operating a power tool. Do not use a power tool while you are tired or under the influence of drugs, alcohol or medication.** *A moment of inattention while operating power tools may result in serious personal injury.*
- b) **Use safety equipment. Always wear eye protection.** *Safety equipment such as dust mask, non-skid safety shoes, hard hat, or hearing protection used for appropriate conditions will reduce personal injuries.*
- c) **Avoid accidental starting. Ensure the switch is in the off-position before plugging in.** *Carrying power tools with your finger on the switch or plugging in power tools that have the switch on invites accidents.*
- d) **Remove any adjusting key or wrench before turning the power tool on.** *A wrench or a key left attached to a rotating part of the power tool may result in personal injury.*
- e) **Do not overreach. Keep proper footing and balance at all times.** *This enables better control of the power tool in unexpected situations.*
- f) **Dress properly. Do not wear loose clothing or jewellery. Keep your hair, clothing and gloves away from moving parts.** *Loose clothes, jewellery or long hair can be caught in moving parts.*
- g) **If devices are provided for the connection of dust extraction and collection facilities, ensure these are connected and properly used.** *Use of these devices can reduce dust-related hazards.*

4) Power tool use and care

- a) **Do not force the power tool. Use the correct power tool for your application.** *The correct power tool will do the job better and safer at the rate for which it was designed.*
- b) **Do not use the power tool if the switch does not turn it on and off.** *Any power tool that cannot be controlled with the switch is dangerous and must be repaired.*
- c) **Disconnect the plug from the power source and/or the battery pack from the power tool before making any adjustments, changing accessories, or storing power tools.** *Such preventive safety measures reduce the risk of starting the power tool accidentally.*
- d) **Store idle power tools out of the reach of children and do not allow persons unfamiliar with the power tool or these instructions to operate the power tool.** *Power tools are dangerous in the hands of untrained users.*
- e) **Maintain power tools. Check for misalignment or binding of moving parts, breakage of parts and any other condition that may affect the power tools operation. If damaged, have the power tool repaired before use.** *Many accidents are caused by poorly maintained power tools.*
- f) **Keep cutting tools sharp and clean.** *Properly maintained cutting tools with sharp cutting edges are less likely to bind and are easier to control.*

g) **Use the power tool, accessories and tool bits etc., in accordance with these instructions and in the manner intended for the particular type of power tool, taking into account the working conditions and the work to be performed. Use of the power tool for operations different from those intended could result in a hazardous situation.**

5) Service

a) **Have your power tool serviced by a qualified repair person using only identical replacement parts. This will ensure that the safety of the power tool is maintained.**

8.12.1DV D1 Modification: Add the following sentence:

– WARNING – To reduce the risk of injury, user must read instruction manual.

8.12.2 Additional information shall be provided, if appropriate.

a) Instructions for putting into use

- 1) Setting-up or fixing power tool in a stable position as appropriate for power tools which can be mounted on a support
- 2) Assembly
- 3) Connection to power supply, cabling, fusing, socket type and earthing requirements
- 4) Illustrated description of functions
- 5) Limitations on ambient conditions
- 6) List of contents

b) Operating instructions

- 1) Setting and testing
- 2) Tool changing
- 3) Clamping of work
- 4) Limits on size of work piece
- 5) General instructions for use

c) Maintenance and servicing

- 1) Regular cleaning, maintenance, and lubrication
- 2) Servicing by manufacturer or agent; list of addresses
- 3) List of user-replaceable parts
- 4) Special tools which may be required

5) For power tools with type X attachment, where a specially prepared cord is needed to replace the cord: if the supply cord of this power tool is damaged, it must be replaced by a specially prepared cord available through the service organization.

6) For power tools with type Y attachment: if the replacement of the supply cord is necessary, this has to be done by the manufacturer or his agent in order to avoid a safety hazard

7) For power tools with type Z attachment: the supply cord of this power tool cannot be replaced, and the power tool shall be scrapped.

8.13 Markings required by the standard shall be easily legible and durable.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After all the tests of this standard, the marking shall be easily legible, it shall not be easily possible to remove marking plates, and they shall show no curling.

In considering the durability of the marking, the effect of normal use is taken into account. Thus, for example, marking by means of paint or enamel other than vitreous enamel on containers that are likely to be cleaned frequently is not considered to be durable.

The petroleum spirit to be used for the test is aliphatic solvent hexane having a maximum aromatics content of 0,1 % by volume, a kauributanol value of 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a specific mass of approximately 0,689 kg/l.

8.13DV D1 Modification: Add the following paragraphs:

Additional tests are required for adhesive labels to test the durability of the adhesive system.

Compliance is checked by inspection and, if the label is not in compliance with C22.2 No. 0.15 and UL 969, the following tests.

After being subjected to the conditions described below, a pressure sensitive label or a label secured by cement or adhesive shall be considered to be of a permanent nature if (1) immediately following removal from each test medium and (2) after being exposed to room temperature for 24 hours following removal from each medium:

- a) Each sample demonstrates good adhesion and the edges are not curled.**
- b) The label resists defacement or removal as demonstrated by scraping across the test panel with a flat steel blade, held at right angles to the test panel. The blade is to be 0,8 mm thick and of any convenient width.**
- c) The printing is legible and is not defaced by rubbing with thumb or finger pressure.**

Label Heating Test

Three samples of the label applied to test surfaces as in the intended application shall be placed for 240 hours in an oven maintained at the temperature specified below.

Maximum Temperature During Temperature Test of Surface to Which Applied °C	Oven Temperature °C
60 or less	87
80 or less	105
100 or less	121
125 or less	150
150 or less	180
Over 150	a

^a A label that is applied to a surface attaining a temperature greater than 150°C, during the temperature test, shall be heated at a temperature representative of the temperatures attained by the appliance during intended use and abnormal use.

Label Immersion Tests

Six samples of the labels applied to text surfaces as in the intended application shall be placed in a controlled atmosphere maintained at $23.0 \pm 2.0^\circ\text{C}$ with a 50 ± 5 percent relative humidity for 24 hours. Three samples shall then be immersed in water and three samples immersed in IRM 903 (Calumet Oil No. 3) as specified in Tests for Rubber Property – Effect of Liquids, ANSI/ASTM D 471-1979, at a temperature of $21.0 \pm 2.0^\circ\text{C}$ for 48 hours in each case.

Label Standard Atmosphere Test

Three samples of the label applied to test surfaces as in the intended application shall be placed for 72 hours in a controlled atmosphere maintained at $23.0 \pm 2.0^\circ\text{C}$ with a 50 ± 5 percent relative humidity.

After all the tests of this standard, the marking shall be easily legible; it shall not be easily possible to remove marking plates and they shall show no curling.

8.14 Markings specified in 8.1 to 8.5 shall be on a main part of the tool. Markings specified in 8.1, 8.2, 8.3 and 8.5 shall be placed together.

Markings on the tool shall be clearly discernible from the outside of the tool, but after removal of a cover, if necessary. It shall be possible to remove or open this cover without the aid of a tool.

Indications for switches and controls shall be placed on or in the vicinity of these components; they shall not be placed on parts which can be repositioned, or positioned in such a way that the marking is misleading.

Compliance is checked by inspection.

8.15 If compliance with this standard depends upon the operation of a replaceable thermal link or fuse-link, the reference number or other means for identifying the link shall be marked on the link, or in a place that it is clearly visible after the link has failed, when the tool has been dismantled to the extent necessary for replacing the link.

This requirement does not apply to links which can only be replaced together with a part of the tool.

Compliance is checked by inspection.

9 Protection against access to live parts

Tools shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts.

Compliance is checked by inspection, and by the tests of 9.2 to 9.4, as applicable.

9.1 An accessible part is not considered to be live if:

- the part is supplied with safety extra-low voltage, provided that
 - for a.c., the peak value of the voltage does not exceed 42 V;
 - for d.c., the voltage does not exceed 42 V;

or

- the part is separated from live parts by protective impedance.

In the case of protective impedance, the current between the part and the supply source shall not exceed 2 mA for d.c., and its peak value shall not exceed 0,7 mA for a.c., and moreover:

- for voltages having a peak value over 42 V up to and including 450 V, the capacitance shall not exceed 0,1 μF ;
- for voltages having a peak value over 450 V up to and including 15 kV, the discharge shall not exceed 45 μC .

Compliance is checked by operating the tool at rated voltage. Voltages and currents are measured between the relevant parts and either pole of the supply source. Discharges are measured immediately after the interruption of the supply.

9.2 The requirement of 9.1 applies for all positions of the tool when it is operated as in normal use, even after removal of detachable parts.

Lamps located behind a detachable cover are not removed, provided the tool can be isolated from the supply by means of a plug or an all-pole switch. However, during insertion or removal of lamps which are located behind a detachable cover, protection against contact with live parts of the lamp cap shall be ensured.

This excludes the use of screw type fuses and screw-type miniature circuit breakers which are accessible without the aid of a tool.

The test finger of Figure 1 is applied without appreciable force, the tool being in every possible position.

Through openings, the test finger is applied to any depth that the finger will permit, and it is rotated or angled before, during, and after insertion to any position.

If the opening does not allow the entry of the finger, the force on the finger in the straight position is increased to 20 N and the test with the finger bent repeated.

It shall not be possible to touch with the test finger live parts or live parts protected only by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compound.

Lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, beads and sealing compound, except self-hardening resins, are not considered to give the required protection against contact with live parts.

9.3 For openings in class II tools or class II constructions, except for those giving access to lamp caps or live parts in socket-outlets of class I tools, the test pin of Figure 2 is applied without appreciable force. It shall not be possible to touch live parts with the test pin.

9.4 In addition, class II tools and class II constructions shall be so constructed and enclosed that there is adequate protection against accidental contact with basic insulation, and metal parts separated from live parts by basic insulation only.

Parts which are not separated from live parts by double insulation or reinforced insulation shall not be accessible.

Compliance is checked by inspection and by applying the test finger of Figure 1.

This requirement applies for all positions of the tool when it is operated as in normal use, even after removal of detachable parts.

9.4DV.1 D2 Addition: Add the following clause:

For tools other than those of Class III, handles or grasping areas, which as specified in the instruction manual shall be so constructed that they are separated from live parts by double or reinforced insulation.

Compliance is checked by inspection.

9.4DV.2 D1 Addition: Add the following clause:

For all tools that are likely to cut into concealed wiring or their own cord, handles and grasping surfaces, as specified in the instruction manual, shall be formed of insulating material or, when of metal, either they shall be adequately covered by insulating material or their accessible parts shall be separated from dead metal parts that can become live at the output shaft. These insulating barriers shall not be regarded as basic, supplementary, or reinforced insulation.

An insulated, stick type auxiliary handle shall be provided with a flange having a height not less than 6 mm above the grasping surface between the grasping area and accessible, non-insulated parts.

Compliance is checked by the tests of 20.4DV.1.

10 Starting

10.1 Motors shall start under all normal voltage conditions which may occur in use.

Compliance is checked by operating the tool with no load 10 times at a voltage equal to 0,85 times rated voltage, regulating devices, if any, being set as in normal use.

In all cases, the tool shall function safely and correctly.

10.2 Centrifugal and other automatic starting switches shall operate reliably, and without contact chattering.

Tools provided with a centrifugal or other automatic starting switch are, in addition, operated 10 times at a voltage equal to 1,1 times rated voltage. The interval between consecutive starts is made sufficiently long to prevent undue heating.

In all cases, the tool shall function safely and correctly.

10.3 Overload protection devices shall not operate under normal starting conditions.

The tests of 10.1 and 10.2 check compliance with this requirement.

11 Input and current

11.1 The rated power input or rated current shall be at least 110 % of the measured no-load input or current.

For tools marked with one or more rated voltage ranges, the test is made at both the upper and lower limits of the ranges, unless the marking or the rated power input is related to the mean value of the relevant voltage range, in which case the test is made at a voltage equal to the mean value of that range.

Compliance is checked by measuring the power input or current of the tool when stabilized while all circuits which can operate simultaneously are in operation.

12 Heating

12.1 Tools shall not attain excessive temperatures under normal load.

Compliance is checked by determining the temperature rise of the various parts under the conditions specified in 12.2 to 12.5 immediately followed by the test of clause 13 with the tool in the "on" position and under the following conditions:

For single-phase tools and for three-phase tools to be tested as single-phase tools:

S1 of Figure 3 in the "on" position.

For three-phase tools not suitable for single-phase supply:

a, b and c in Figure 4 in the "on" position.

For heating elements, the measurements are repeated with each of the switches a, b and c open in turn, the other two switches being closed.

12.2 The tool is operated in still air under normal load. While the torque is maintained, the voltage is then adjusted to 0,94 times the rated voltage or 1,06 times the rated voltage, or the mean of the rated voltage range, whichever is the most unfavourable.

Heating elements, if any, are operated under the conditions specified in clause 11 of IEC 60335-1, when the tool is operated at a voltage equal to 1,06 times rated voltage.

12.3 Temperature rises, other than those of windings, are determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test.

The temperature rise of electrical insulation, other than that of windings, is determined on the surface of insulation, at places where failure could cause a short circuit, contact between live parts and accessible metal parts, bridging of insulation, or reduction of creepage distances or clearances below the values specified in 28.1.

Temperature rises of windings are determined by the resistance method, unless the windings are non-uniform, or the method involves severe complications to make the necessary connections for the resistance measurement. In that case, the measurement is made by thermocouples.

Such temperature rises are determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test.

In determining the temperature rises of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use, and, if of insulating material, to those parts in contact with hot metal.

NOTE 1 If it is necessary to dismantle the tool to position thermocouples, the power input is measured again to check that the tool has been correctly reassembled.

NOTE 2 The point of separation of the cores of a multicore cord is an example of a place where thermocouples are positioned.