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.

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

Revisions of UL Standards for Safety are issued from time to time. A UL Standard for Safety is current only if it incorporates the most recently adopted revisions.

UL provides this Standard ″as is″ without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

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Electronic Standards are intended for on-line use, such as for viewing the requirements of a Standard, conducting a word search, and the like. Only one copy of the Standard may be printed from each single-user version of an electronic Standard. Only one copy of the Standard may be printed for each authorized user of a multiple-user version of an electronic Standard. Because of differences in the computer/software/printer setup used by UL and those of electronic Standards purchasers, the printed copy obtained by a purchaser may not look exactly like the on-line screen view or the printed Standard.

An employee of an organization purchasing a UL Standard can make a copy of the page or pages being viewed for their own fair and/or practical internal use.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the 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.

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

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

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 mm^2 up to 35 mm^2 (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 ±5)°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 ±2)°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
μF	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
2∿	two–phase alternating current
2N∿	two–phase alternating current with neutral
3∿	three–phase alternating current
3N∿	three–phase alternating current with neutral
—▭— A	rated current of the appropriate fuse–link in amperes
—▭— x	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 ⏚

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 ±2.0°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 ±2.0°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 ±2.0°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.

12.4 The tool is operated:

– for the rated operating time for tools for short-time operation;

– on consecutive cycles of operation, until steady thermal conditions are established, for tools for intermittent operation, the ″on″ and ″off″ periods being the rated ″on″ and ″off″ periods;

– until steady thermal conditions are established for all other tools for continuous operation.

12.5 During the test, protective devices shall not operate. The temperature rises shall not exceed the values shown in Table 1, except as allowed by 12.6.

Sealing compound, if any, shall not flow out.

Table 1 – Maximum normal temperature rises

Parts	Temperature rise K	
Windings[1)], if the winding insulation according to IEC 60085 is:		
– class A	75	(65)
– class E	90	(80)
– class B	95	(85)
– class F	115	
– *class H*	140	
– class 200	160	
– class 220	180	
– class 250	210	
Pins of appliance inlets:		
– for hot conditions	95	
– for cold conditions	40	
Ambient of switches, temperature limiters[2)]:		
– without T-marking	30	
– with T-marking	T-25	
Rubber or polyvinyl chloride insulation of internal and external wiring, including supply cords:		
– without temperature rating [3)]	50	
– with temperature rating (T)	T-25	
Cord sheath used as supplementary insulation	35	
Rubber, other than synthetic, used for gaskets or other parts, the deterioration of which could affect safety:		
– when used as supplementary insulation or as reinforced insulation	40	
– in other cases	50	
Lampholders E14 and B15:		
– metal or ceramic type	130	
– insulated type, other than ceramic	90	
– with T-marking	T-25	
Material used as insulation other than that specified for wires and windings[4)]		
– impregnated or varnished textile, paper or press board	70	
– laminates bonded with:		

Table 1 – Maximum normal temperature rises Continued on Next Page

Table 1 – Maximum normal temperature rises Continued

Parts	Temperature rise K	
• melamine-formaldehyde; phenol-formaldehyde or phenol-furfural resins	85	(175)
• urea-formaldehyde resin	65	(150)
– Printed circuit boards bonded with epoxy resin	120	
– moulding of:		
• phenol-formaldehyde with cellulose fillers	85	(175)
• phenol-formaldehyde with mineral fillers	100	(200)
• melamine-formaldehyde	75	(175)
• urea-formaldehyde	65	(150)
– polyester with glass-fibre reinforcement	110	
– silicone rubber	145	
– polytetrafluoroethylene	265	
– pure mica and tightly sintered ceramic material when such materials are used as supplementary insulation or reinforced insulation	400	
– thermoplastic material [5)]	–	
Wood, in general [6)]	65	
Outer surface of capacitors [7)]:		
– with marking of maximum operating temperature (T)	T-25	
– without marking of maximum operating temperature:		
• small ceramic capacitors for radio and television interference suppression	50	
• capacitors complying with IEC 60384-14 or 14.2 or IEC 60065	50	
• other capacitors [7)]	20	
External enclosure of tools without heating elements except handles held in normal use	60	
Handles, knobs, grips and the like which, in normal use, are continuously held:		
– of metal	30	
– of porcelain or vitreous material	40	
– of moulded material, rubber or wood	50	
Handles, knobs, grips and the like which, in normal use, are held for short periods only (e.g. switched):		
– of metal	35	
– of porcelain or vitreous material	45	
– of moulded material, rubber or wood	60	
Parts in contact with oil having a flash-point of t °C	t-50	

[1)] To allow for the fact that the average temperature of windings of universal motors, relays, solenoids, etc., is usually above the temperature at the points on the windings where thermocouples are placed, the figures without parentheses apply when the resistance method is used, and those within parentheses apply when thermocouples are used. For windings of vibrator coils and a.c. motors, the figures without parentheses apply in both cases. For motors constructed so that the circulation of the air between the inside and the outside of the case is prevented, but not necessarily sufficiently enclosed to be called airtight, the temperature rise limits may be increased by 5 K.

[2)] T signifies the maximum operating temperature.

The ambient temperature of switches, thermostats and temperature limiters is the temperature of the air at the hottest point at a distance of 5 mm from the surface of the switch and component concerned.

For the purpose of this test, switches and thermostats marked with individual ratings may be considered as having no marking for the maximum operating temperature, if requested by the tool manufacturer.

Table 1 – Maximum normal temperature rises Continued on Next Page

Table 1 – Maximum normal temperature rises Continued

Parts	Temperature rise K
[3] This limit applies to cables, cords and wires complying with the relevant IEC standards; for others, it may be different. [4] The values in parentheses apply, if the material is used for handles, knobs, grips and the like, and is in contact with hot metal. [5] There is no specific limit for thermoplastic material, which has to withstand the tests of 29.1, for which purpose the temperature rise must be determined. [6] The limit specified concerns the deterioration of wood, and it does not take into account deterioration of surface finishes. [7] There is no limit for the temperature rise of capacitors which are short-circuited in 18.10 If these or other materials are used, they shall not be subjected to temperatures in excess of the thermal capabilities as determined by ageing tests made on the materials themselves. The value of the temperature rise of a winding is calculated from the formula: $\Delta t = (R_2 - R_1/R_1)(k + t_1) - (t_2 - t_1)$ where: Δt is the temperature rise; R_1 is the resistance at the beginning of the test; R_2 is the resistance at the end of the test; k is the equal to 234,5 for copper windings, and 225 for aluminum windings; t_1 is the ambient temperature at the beginning of the test; t_2 is the ambient temperature at the end of the test. At the beginning of the test, the windings are to be at ambient temperature. It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.	

12.6 If the windings are classified according to IEC 60085 and the temperature rise does not exceed the value in Table 1, the following test is not necessary.

Three additional samples are subjected to the following tests.

a) The temperature rise of the windings is determined by the test of 12.2.

b) The samples are then dismantled as far as is possible without damaging any part. Windings are kept for 10 days (240 h) in a heating cabinet, the temperature of which is (80 ± 1) °C in excess of the temperature rise determined according to item 1.

c) After this treatment, the samples are reassembled and no interturn short circuit shall occur.

Interturn short circuits may be detected by means of a winding tester.

d) Immediately afterwards, the samples shall withstand the tests of clause 13 and 15.

e) The samples are then subjected to a humidity treatment as specified in 14.3.

f) After this treatment, they shall again withstand the tests of clause 13 and 15.

Faults which may occur in insulation, which did not show an excessive temperature rise during the test of item 1, are ignored and are repaired, if necessary, in order to complete the tests of this subclause.

12.6DV D1 *Modification: Remove item a) and, in item b), replace "item 1" with "12.3".*

13 Leakage current

13.1 The leakage current shall not be excessive.

Compliance is checked by the following test at a supply voltage equal to 1,06 times rated voltage.

The leakage current test is made with a.c. unless the tool is for d.c. only, in which case the test is not made.

Protective impedance is disconnected from live parts before carrying out the tests.

It is recommended that the tool be supplied through an isolating transformer; otherwise, it must be insulated from earth.

13.2 The leakage current is measured by means of the circuit described in Annex C between any pole of the supply and:

- *accessible metal parts and metal foil with an area not exceeding 20 cm x 10 cm in contact with accessible surfaces of insulating material, connected together. The metal foil has the largest area possible on the surface under test, without exceeding the dimensions specified. If its area is smaller than the surface under test, it is moved so as to test all parts of the surface. The heat dissipation of the tool must, however, not be affected by the metal foil.*

Three-phase tools, which are suitable for single-phase supply, are tested as single-phase tools with the three sections connected in parallel. For single-phase tools and three-phase tools to be tested as single-phase tools, the leakage current is measured with the selector switch shown in Figure 3, in each of the positions 1 and 2, and the switch SI in "on" position.

For three-phase tools not suitable for single-phase supply, the leakage current is measured according to Figure 4 with the switches a, b and c in "on" position. For tools intended to be connected in star connection only, the neutral is not connected.

The leakage current is measured within 5 s after the application of the test voltage and shall not exceed the following values:

– *to accessible metal parts and metal foil:*

- *for class I tools 0,75 mA;*

- *for class II tools 0,25 mA;*

- for class III tools 0,5 mA.

If the tool incorporates one or more capacitors, and is provided with a single-pole switch, the measurements are repeated with the switch in the "off" position.

For tools with heating elements, the total leakage current may be within the limits specified for heating elements, as specified in clause 16 of IEC 60335-1, or for motor-operated tools, whichever is the greater, but the two limits are not added.

13.2DV D2 *Modification: Replace the class I tools item with the following:*

- for class I tools 0,5 mA;

14 Moisture resistance

14.1 The enclosure of the tool shall provide the degree of protection against moisture in accordance with the classification of the tool.

Compliance is checked by the appropriate treatment specified in 14.1.2, with the tool conditions as in 14.1.1.

14.1.1 The tool is not connected to the supply.

Tools are turned continuously through the most unfavourable positions during the test.

Tools with type X attachment are fitted with the lightest permissible type of flexible cord of the smallest cross-sectional area specified in 25.2; other tools are tested as delivered.

Electrical components, covers and other parts which can be removed without the aid of a tool are removed and subjected, if necessary, to the relevant treatment with the main part.

14.1.2 Tools other than IPX0 are subjected to tests of IEC 60529 as follows:

- *IPX1 tools are subjected to the test described in 14.2.1;*
- *IPX2 tools are subjected to the test described in 14.2.2;*
- *IPX3 tools are subjected to the test described in 14.2.3;*
- *IPX4 tools are subjected to the test described in 14.2.4;*
- *IPX5 tools are subjected to the test described in 14.2.5;*
- *IPX6 tools are subjected to the test described in 14.2.6;*

– *IPX7 tools are subjected to the test described in 14.2.7.*

For this last test, the tool is immersed in water containing 1 % NaCl.

Immediately after the appropriate treatment, the tool shall withstand the electric strength test of clause 15, and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage distances and clearances below the values specified in 28.1.

Tools which are not subject to spillage of liquid in normal use are allowed to stand in normal test-room atmosphere for 24 h before being subjected to the test of 14.3.

14.2 Tools subject to spillage of liquid in normal use shall be so constructed that such spillage does not affect their electrical insulation.

Compliance is checked by the following test.

Tools incorporating an appliance inlet are fitted with an appropriate connector and flexible cord; tools with type X attachment are fitted with the lightest permissible type of flexible cord of the smallest cross-sectional area specified in 25.2; other tools are tested as delivered.

Electrical components, covers and other parts which can be removed without the aid of a tool are removed, except those fulfilling the test of 21.23.

The liquid container of the tool is completely filled with water containing approximately 1 % NaCl, and a further quantity, equal to 15 % of the capacity of the container, or 0,25 l, whichever is the greater, is poured in steadily over a period of 1 min.

Immediately after this treatment, the tool shall withstand an electric strength test as specified in clause 15, and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage distances and clearances below the values specified in 28.1.

The tool is allowed to stand in normal test-room atmosphere for 24 h before being subjected to the test of 14.3.

14.3 Tools shall be proof against humid conditions which may occur in normal use.

Compliance is checked by the following humidity test.

Cable entries, if any, are left open; if knock-outs are provided, one of them is opened.

Electrical components, covers, and other parts which can be removed without the aid of a tool are removed and subjected, if necessary, to the humidity test with the main part.

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity of (93 ± 2) %, obtained e.g. by placing in the humidity cabinet a saturated solution of Na_2SO_4 or KNO_3 in water, having a sufficiently large contact surface with the air. The temperature of the air, at all places where samples can be located, is maintained within 1 K of any convenient value t between 20 °C and 30 °C. In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within and, in general, to use a cabinet which is thermally insulated.

Before being placed in the humidity cabinet, the sample is brought to a temperature between t and (t + 4) °C. The tool is considered to be brought to the specified temperature by keeping it at this temperature for at least 4 h before the humidity treatment.

The tool is kept in the cabinet for 48 h.

Immediately after this test, the tool shall withstand the tests of clause 13 at rated voltage or the mean of the rated voltage range with the tool switch 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 ″off″ position.

For three-phase tools not suitable for single-phase supply: a in Figure 4 in the ″on″ position, b and c in ″off″ position.

Then the tool shall withstand the test of clause 15 in the humidity cabinet, or in the room in which the tool was brought to the prescribed temperature after reassembly of those parts which may have been removed.

The leakage current limit values specified in the test of clause 13 are doubled if all controls have an off-position in all poles.

They are also doubled if:

– *the tool has no control other than a thermal cut-out; or*

– *all thermostats and energy regulators do not have an off position; or*

– *the tool has radio interference filters. In that case, the leakage current with the filter disconnected shall not exceed the limits specified.*

However, for class II tools, doubling of the value of 0,25 mA is only allowed if all controls have an ″off″ position.

14.3DV D1 ***Modification: Delete the last three paragraphs beginning with "The leakage current limit values...".***

15 Electric strength

15.1 The electric strength shall be adequate.

Compliance is checked by the tests of 15.2.

Protective impedance is disconnected from live parts before carrying out the tests.

The tests are made on the tools at room temperature and not connected to the supply.

15.2 The insulation is subjected for 1 min to a voltage of substantially sinusoidal waveform, having a frequency of 50 Hz or 60 Hz. The value of the test voltage and the points of application are shown in Table 2, unless otherwise specified.

Accessible parts of insulated material are covered with metal foil.

Table 2 – Test voltages

Points of application of test voltage	Test Voltage (V)		
	Class III tools and construction	Class II tools and construction	Other tools
1. Between live parts and accessible parts separated from live parts by			
– basic insulation only	500	–	1 250
– reinforced insulation	–	3 750	3 750
2. For parts with double insulation, between metal parts separated from live parts by basic insulation only, and			
– live parts	–	1 250	1 250
– accessible parts	–	2 500	2 500
3. Between metal enclosures or covers lined with insulating material and metal foil in contact with the inner surface of the lining, if the distance between live parts and these metal enclosures or covers, measured through the lining, is less than the appropriate clearance as specified in 28.1	–	2 500	1 250
4. Between metal foil in contact with handles, knobs, grips and the like and their shafts, if these shafts can become live in the event of an insulation fault	–	2 500	2 500
5. Between accessible parts and internal diameter of cord guard wrapped with metal foil	–	2 500	1 250
6. Between the point where a winding and a capacitor are connected together, if a resonance voltage *U* occurs between this point and any terminal for external conductors, and			
– accessible parts [1)]	–	–	2 *U* + 1 000
– metal parts separated from live parts by basic insulation only	–	2 *U* + 1 000	–

[1)]The test between the point where a winding and a capacitor are connected together, and accessible parts or metal parts, is only made where the insulation is subjected to the resonance voltage under normal running conditions. Other parts are disconnected, and the capacitor is short-circuited.

Initially, not more than half the prescribed voltage is applied, then it is raised rapidly to the full value.

No flashover or breakdown shall occur during the test.

The high-voltage transformer used for the test must be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

The overcurrent relay must not trip when the output current is less than 100 mA.

Care is taken that the r.m.s. value of the test voltage applied is measured within ±3 %.

Care is taken that the metal foil is so placed that no flashover occurs at the edges or the edges of the insulation.

For class II construction incorporating both reinforced insulation and double insulation, care is taken that the voltage applied to the reinforced insulation does not overstress the basic insulation, or the supplementary insulation.

In cases where basic insulation and supplementary insulation cannot be tested separately, the insulation provided is subjected to the test voltages specified for reinforced insulation.

When testing insulating coatings, the metal foil may be pressed against the insulation by means of a sandbag of such a size that the pressure is about 5 kPa (0,5 N/cm^2). The test may be limited to places where the insulation is likely to be weak, for example where there are sharp metal edges under the insulation.

If practicable, insulating linings are tested separately.

For tools with heating elements incorporated, the test voltages specified in IEC 60335-1 apply to the heating elements only and not to other parts of the tool.

16 Overload protection of transformers and associated circuits

16.1 Tools incorporating circuits supplied from a transformer shall be so constructed that, in the event of short circuits which are likely to occur in normal use, excessive temperatures do not occur in the transformer, or in the circuits associated to the transformer.

NOTE Protection of transformer windings may be, for example, obtained by the inherent impedance of the winding, or by means of fuses, automatic switches, thermal cut-outs or similar devices incorporated in the transformer, or similar devices located inside the tool only accessible with the aid of a tool.

Examples of short-circuits which are likely to occur in normal use are the short-circuiting of bare or inadequately insulated conductors of safety extra-low voltage circuits which are accessible, and the internal short-circuiting of lamp filaments.

A failure of insulation complying with the requirements specified for basic insulation of class I or class II construction is not, for the purpose of this requirement, considered as likely to occur in normal use.

Compliance is checked by applying the most unfavourable short circuit or overload which is likely to occur in normal use, the tool being operated at a voltage equal to 1,06 times, or 0,94 times, rated voltage, whichever is the more unfavourable.

The temperature rise of the insulation of the conductors of safety extra-low voltage circuits is determined, and shall not exceed the relevant value specified in Table 1 by more than 15 K.

The winding temperature of transformers shall not exceed the value specified for windings in 18.9, except for transformers which comply with IEC 61558-1.

17 Endurance

17.1 Tools shall be so constructed that, in extended normal use, there will be no electrical or mechanical failure that might impair compliance with this standard. The insulation shall not be damaged and contacts and connections shall not work loose as a result of heating, vibrations, etc.

Moreover, overload protection devices shall not operate under normal running conditions.

Compliance is checked by the test of 17.2 and, for tools provided with a centrifugal or other starting switch, also by the test of 17.3.

Immediately after these tests, the tool shall withstand an electric strength test as specified in clause 15, the test voltages being, however, reduced to 75 % of the specified values. Connections shall not have worked loose, and there shall be no deterioration impairing safety in normal use.

17.2 The tool is operated intermittently with no load for 24 h of operation at a voltage equal to 1,1 times rated voltage, and then for 24 h at a supply voltage equal to 0,9 times rated voltage.

The tool may be switched on and off by means of a switch other than that incorporated in the tool.

Each cycle of operation comprises an "on" period of 100 s and an "off" period of 20 s, the "off" periods being included in the specified operating time.

The operating period for tools for short-time or intermittent operation is equal to the operating time, if this is limited by the construction of the tool; otherwise, it is in accordance with the prescriptions given in part 2, or with the marking, whichever is the more unfavourable.

During the test, the tool is placed in three different positions, the operating time, at each test voltage, being approximately 8 h for each position.

During this test, replacement of the carbon brushes is allowed, and the tool is oiled and greased as in normal use.

If the temperature rise of any part of the tool exceeds the temperature rise determined during the test of 12.1, forced cooling or rest periods are applied, the rest periods being excluded from the specified operating time.

During these tests, overload protection devices shall not operate.

NOTE The change of position is made to prevent abnormal accumulation of carbon dust in any particular place. Examples for the three positions are horizontal, vertically up and vertically down.

17.3 Tools provided with a centrifugal or other automatic starting switch are started 10 000 times under normal load, and at a voltage equal to 0,9 times rated voltage, the operating cycle being that specified in 17.2.

18 Abnormal operation

18.1 Tools shall be so designed that the risk of fire and mechanical damage impairing safety or the protection against electric shock as a result of abnormal operation is obviated as far as is practicable.

Fuses, thermal cut-outs, overcurrent protection devices or the like, incorporated into the tool, may be used to provide the necessary protection.

Compliance is checked by the following tests of 18.2 to 18.9.

18.2 Tools incorporating heating elements are subjected to the tests of 18.3 and 18.4. Moreover, tools provided with a control limiting the temperature during clause 12 tests unless specifically excluded by part 2, are subjected to the tests of 18.5, and where applicable, to the test of 18.6.

Only one abnormal condition is simulated each time. If more than one of the tests are applicable to the same tool, these tests are made consecutively.

Unless otherwise specified, the tests are continued until a non-self-resetting thermal cut-out operates, or until steady conditions are established. If, during the test, a heating element or an intentionally weak part is permanently open-circuited, the relevant test is repeated on a second sample. This second test shall be terminated in the same way, unless the test is otherwise satisfactorily completed.

An intentionally weak part is a part intended to fail under conditions of abnormal operation so as to prevent the occurrence of a condition which could impair compliance with this standard. Such a part may be a replaceable component, such as a resistor, a capacitor, or a thermal link, or a part of a component to be replaced, such as an inaccessible and non-resettable thermal cut-out incorporated in a motor.

18.3 Tools with heating elements are tested under the conditions specified in clause 12, but with restricted heat dissipation. The supply voltage, determined prior to the test, is that required to provide a power input of 0,85 times the rated power input under normal operation, when steady conditions have been established. This voltage is maintained throughout the test.

The tool is allowed to cool down to approximately room temperature before being subjected to the test of 18.4.

18.4 The test of 18.3 is repeated, but with a supply voltage, determined prior to the test, equal to that required to provide a power input of 1,24 times rated power input under normal operation, when steady conditions have been established. This voltage is maintained throughout the test.

18.5 The tool is tested under the conditions specified in clause 12, under normal operation, the supply voltage being such that the power input is 1,15 times rated power input, but with any control which limits the temperature during the test of clause 12 short-circuited.

If the tool is provided with more than one control, these are short-circuited in turn.

18.6 Unless an all-pole disconnection occurs during the test of 18.5 for class I tools with tubular sheathed and embedded heating elements, but which are not intended to be permanently connected to fixed wiring, the test of 18.5 is repeated, with the controls which limit the temperature during the test of clause 12 not short-circuited, and one end of the element connected to earth. This test is repeated with the polarity of the supply to the tool reversed and with the other end of the element connected to earth.

18.7 The following test is performed with cutting tools, such as sawblades, grinding wheels, etc., removed.

- *Tools incorporating a commutator motor are operated at a voltage equal to 1,3 times rated voltage, or the upper limit of the voltage range, for 1 min at no-load.*

After the tests of 18.2 to 18.7, the safety of the tool shall not have been impaired, in particular windings and connections shall not have worked loose. After the test, the tool need not be capable of further use.

18.8 The following categories of tools incorporating induction motors and:

a) with a starting torque less than the full-load torque; or

b) started by hand; or

c) provided with moving parts which are liable to be jammed, or where the moving parts can be stopped by hand, the motor remaining switched on during this operation;

are connected, starting from cold, to their rated voltage or the upper limit of their rated voltage range with the moving parts locked

- *for 30 s for tools that are operated by hand during use;*
- *for 5 min for tools that are attended during use.*

At the end of the test period specified, or at the instant of operation of fuses, thermal cut-outs, motor protection devices, and the like, the temperature of the windings shall not exceed the values shown in Table 3.

18.9 Tools incorporating three-phase motors are operated, starting from cold,

- *for 30 s, if they are kept switched on by hand or continuously loaded by hand;*
- *or otherwise, for 5 min,*

with one phase disconnected, and under the torque producing normal load.

At the end of the test period specified, or at the instant of operation of fuses, thermal cut-outs, motor protection devices, and the like, the temperature of the windings shall not exceed the values shown in Table 3.

Table 3 – Maximum winding temperature

Protection of windings	Limiting temperature °C							
	Class							
	A	E	B	F	H	200	220	250
Protection by inherent impedance	150	165	175	190	210	230	250	280
Protection by protective devices which operate during the test	200	215	225	240	260	280	300	330

18.10 Tools incorporating electronic devices shall be so designed that, in the event of a failure in the electronic equipment, this shall not result in a hazard.

Compliance is checked by operating the tool for 1 min, at a voltage equal to the rated voltage or the mean value of the voltage range, at no load with the electronic device short-circuited.

The test is then repeated with the electronic device open-circuited.

Following these tests, the tool shall show no damage due to fire, mechanical damage impairing safety and protection against electric shock.

Where the tool incorporates a device for limiting speed should the electronic device fail to operate, the tool is considered to have withstood the test when the said speed-limiting device operates during the test.

18.11 Switches or other devices for motor reversal shall withstand the stresses occurring when the sense of rotation is reversed under running conditions where such a reversal is possible in normal use.

Compliance is checked by the following test.

The tool is operated at a voltage equal to rated voltage, or at the upper limit of the rated voltage range, at no load; the device for reversing the sense of rotation being in such a position that the rotor rotates in one direction at full speed.

The direction of the rotation is then reversed, without the device resting in an intermediate "off" position.

This operation sequence is performed 25 times.

After the test, the switch shall have no electrical or mechanical failure.

18.12 A class I tool employing class II construction (see 5.10) or a class II tool shall be able to operate under extreme overload conditions without impairing protection against electric shock.

Compliance is checked by the following test on a separate sample.

The sample is connected to a minimum 12 kVA circuit. The tool is loaded to 160 % of normal load current for either 15 min or until the tool open-circuits or flame appears. If the tool will not operate at 160 %, the tool is stalled for 15 min or until the tool open-circuits or flame appears. If flames appear, extinguish immediately with CO_2 extinguisher. The leakage current between live parts and accessible parts, measured in accordance with clause 13, is monitored throughout the test and after the test until leakage current has stabilized or decreases. Leakage current shall not exceed 2 mA.

After the tool is cooled to room temperature, an electric strength test per clause 15 is performed between live parts and accessible parts as follows:

– *If a tool does not operate after 15 min, apply a 1 500 V electric strength test.*

– *If a tool operates after 15 min, apply a 2 500 V electric strength test.*

18.12DV D2 *Modification: Add the following paragraph:*

All fuses, thermal cutouts, overload protectors, and the like specified in 18.1 that are accessible to the user without the aid of a tool shall be shorted during the test of 18.12.

19 Mechanical hazards

19.1 Moving and other dangerous parts shall, as far as is compatible with the use and mode of function of the tool, be so arranged or enclosed that, in normal use, adequate protection against injury is provided.

Protective enclosures, covers, guards and the like shall possess adequate mechanical strength for their intended purpose. They shall not be removable without the aid of a tool.

When used as protection of the working element, the guard shall have an easily accessible means of accurate adjustment with the objective of minimizing access to the dangerous parts.

The use and adjustment of a guard shall not create other dangers, for example by reducing or obstructing the operator's view, by transferring heat, or causing other predictable hazards.

All working elements, including special features or attachments intended as part of the tool, shall be secured so that they cannot create dangers during normal use by moving, or being released, out of the normal working constraints of the tool.

NOTE 1 Such dangers might be caused by vibration, reversal of motion, or electric braking.

Compliance is checked by inspection, by the tests of clause 20 and by means of a test using the standard test finger shown in Figure 1. It shall not be possible to touch dangerous moving parts with this finger.

NOTE 2 In some cases, specified in the relevant part 2, a rigid test finger with the same dimensions of the test finger in Figure 1, but without any articulation, is used.

19.2 Accessible parts likely to be touched during normal use shall be free from sharp edges, burrs, flashes and the like.

Compliance is checked by inspection.

19.3 It shall not be possible to reach the moving parts with the provisions for dust collection removed, if any.

Compliance is checked by a test with the rigid finger shown in Figure 1. It shall not be possible to touch dangerous moving parts with the test finger through dust collection openings after the removing of the removable provisions.

19.4 Tools shall have adequate grasping surfaces to ensure safe handling during use.

Compliance is checked by inspection.

19.5 Tools shall be designed and constructed to allow, where necessary, a visual check of the contact of the cutting tool with the work piece.

Compliance is checked by inspection.

20 Mechanical strength

20.1 Tools shall have adequate mechanical strength, and shall be so constructed that they withstand such rough handling as may be expected in normal use.

Compliance is checked by the tests specified in 20.2, 20.3 and 20.4.

Following the tests, the tool shall withstand an electric strength test as specified in clause 15, and shall show no damage which could impair compliance with this standard; in particular, live parts shall not have become accessible, as specified in clause 9.

Damage to the finish, small dents which do not reduce creepage distances or clearances below the values specified in 28.1, or small chips which do not adversely affect protection against shock or moisture are neglected.

The function of mechanical safety devices shall not be impaired thereby.

Cracks not visible to the naked eye and surface cracks in fibre-reinforced mouldings and the like are ignored.

If a decorative cover is backed by an inner cover, a fracture of the decorative cover is neglected when the inner cover withstands the test after removal of the decorative cover.

20.2 Blows are applied to the tool by means of the spring-operated impact test apparatus according to clause 5 of IEC 60068-2-75.

The spring is so adjusted that it causes the hammer to strike with an impact energy as shown in Table 4.

Table 4 – Impact energies

Parts to be tested	Impact energy Nm
Brush caps	0,5 ±0,05
Other parts	1,0 ±0,05

Three blows are applied to every point of the enclosure which is likely to be weak.

Where necessary, blows are also applied to protective devices, handles, levers, knobs and the like.

20.3 A hand-held tool shall withstand being dropped three times on a concrete surface from a height of 1 m. The sample shall be positioned to vary the point of impact.

20.4 Brush holders and their caps shall have adequate mechanical strength.

Compliance is checked by inspection and, in case of doubt, by removing and replacing the brushes 10 times, the torque applied when tightening the cap being as shown in Table 5.

Table 5 – Test torques

Blade width of test screwdriver (mm)	Torque (Nm)
Up to and including 2,8	0,4
over 2,8 up to and including 3,0	0,5
over 3,0 up to and including 4,1	0,6
over 4,1 up to and including 4,7	0,9
over 4,7 up to and including 5,3	1,0
over 5,3 up to and including 6,0	1,25

After this test, the brush holder shall show no damage impairing its further use, the thread, if any, shall not be damaged and the cap shall show no cracks.

The blade width of the test screwdriver must be as large as possible, but must not exceed the length of the recess in the cap. If, however, the thread diameter is smaller than the length of the recess, the blade width must not exceed this said diameter. The torque must not be applied in jerks.

20.4DV.1 D2 *Addition: Add the following clause:*

At the discretion of the manufacturer, a separate sample shall be subjected to a single impact on each handle and each recommended grasping surface. The impacts shall be made from a height of 1 m onto a concrete surface followed by a 1,250 volt ac potential between the grasping surfaces in contact with foil and the output shaft of the tool.

21 Construction

21.1 Tools which can be adjusted to suit different voltages, or to different speeds, shall be so constructed that accidental changing of the setting is unlikely to occur, if such a change might result in a hazard.

Compliance is checked by inspection and by manual test.

21.2 Tools shall be so constructed that accidental changing of the setting of control devices is unlikely to occur.

Compliance is checked by manual test.

21.3 It shall not be possible to remove parts which ensure the required degree of protection against moisture without the aid of a tool.

Compliance is checked by manual test.

21.4 If handles, knobs and the like are used to indicate the position of switches or similar components, it shall not be possible to fix them in a wrong position if this might result in a hazard.

Compliance is checked by inspection and by manual test.

21.5 Replacement of a flexible cable or cord requiring the moving of a switch which acts also as a terminal for external conductors shall be possible without subjecting internal wiring to undue stress; after repositioning the switch, and before reassembling the tool, it shall be possible to verify whether the internal wiring is correctly positioned.

Compliance is checked by inspection and by manual test.

21.6 Wood, cotton, silk, ordinary paper and similar fibrous or hygroscopic material shall not be used as insulation, unless impregnated.

Insulating material is considered to be impregnated if the interstices between the fibres of the material are substantially filled with a suitable insulant.

Compliance is checked by inspection.

21.7 Asbestos shall not be used in the construction of tools.

Compliance is checked by inspection.

21.8 Driving belts shall not be relied upon to provide the required level of insulation.

This requirement does not apply if the tool incorporates a special design of belt which prevents inappropriate replacement.

Compliance is checked by inspection.

21.9 Insulating barriers of class II tools, and parts of class II tools which serve as supplementary insulation or reinforced insulation, and which might be omitted during reassembly after servicing, shall either:

– be fixed in such a way that they cannot be removed without being seriously damaged; or

– be so designed that they cannot be replaced in an incorrect position, and that, if they are omitted, the tool is rendered inoperable or manifestly incomplete.

Compliance is checked by inspection and by manual test.

Servicing includes replacement of components such as supply cords and switches.

This requirement is met if the barrier is so fixed that it can only be removed by breaking or cutting.

Fixing by means of rivets is allowed, provided that these rivets need not be removed when replacing the brushes, capacitors, switches, non-detachable flexible cables and cords and the like.

Fixing by means of an adhesive is only allowed if the mechanical strength of the joint is equal to that of the barrier.

An adequate internal lining of insulation material, or an adequate internal insulating coating on metal enclosures, is considered to be an insulating barrier provided that the coating cannot easily be removed by scraping.

For class II tools, a sleeve on an insulated internal conductor, other than the core of an external flexible cable or cord, is considered to be an adequate insulating barrier, if it can only be removed by breaking or cutting, or if it is clamped at both ends.

Ordinary lacquering on the inside of metal enclosures, varnished cambric, flexible resin-bonded paper, or the like are not considered to be insulating barriers.

21.10 Inside the tool, the sheath (jacket) of a flexible cable or cord shall only be used as supplementary insulation where it is not subject to undue mechanical or thermal stresses.

Compliance is checked by inspection.

21.11 Any assembly gap with a width greater than 0,3 mm in supplementary insulation shall not be coincidental with any such gap in basic insulation, neither shall any such gap in reinforced insulation give direct access to live parts.

Compliance is checked by inspection and measurement.

21.12 Class I tools shall be so constructed that, should any wire, screw, nut, washer, spring or similar part become loose or fall out of position, it cannot become so disposed that accessible metal is made live.

Class II tools or class II constructions shall be so constructed that, should any such part become loose or fall out of position, it cannot become so disposed that creepage distances or clearances over supplementary insulation or reinforced insulation are reduced to less than 50 % of the values specified in 28.1.

Class II tools or class II constructions, other than those of the all-insulated type, shall be provided with insulating barriers between accessible metal and motor parts and other live parts.

For class I tools, this requirement can be met by the provision of barriers, or by fixing the parts adequately, and by providing sufficiently large creepage distances and clearances.

It is not to be expected that two independent parts will become loose or fall out of position at the same time. For electrical connections, spring washers are not considered to be adequate for preventing the loosening of the parts.

Wires are considered as likely to become free from terminals or soldered connections, unless they are held in place near to the terminal or termination, independent of the terminal connection or solder.

Short rigid wires are not regarded as liable to come away from a terminal, if they remain in position when the terminal screw is loosened.

Compliance is checked by inspection, by measurement and by manual test.

21.13 Supplementary insulation and reinforced insulation shall be so designed or protected that they are not likely to be impaired by deposition of dirt, or by dust resulting from wear of parts within the tool, to such an extent that creepage distances or clearance are reduced below the values specified in 28.1.

Ceramic material not tightly sintered and similar materials, and beads alone, shall not be used as supplementary insulation or reinforced insulation.

Parts of natural or synthetic rubber used as supplementary insulation shall be resistant to ageing, or be so arranged and dimensioned that creepage distances are not reduced below the values specified in 28.1, even if cracks occur.

Insulating material in which heating conductors are embedded serves as basic insulation, and shall not be used as reinforced insulation.

Compliance is checked by inspection, by measurement and, for rubber, by the following test.

Parts of rubber are aged at a temperature of (100 ± 2) °C for 70 h. After the test, the samples are examined, and shall show no crack visible to the naked eye.

NOTE In case of doubt with regard to materials other than rubber, special tests may be made.

21.14 Tools shall be so constructed that internal wiring, windings, commutators, slip rings and the like, and insulation in general, are not exposed to oil, grease or similar substances.

If the construction necessitates that insulation be exposed to oil or grease or similar substance, as in gears and the like, the oil or grease or substance shall have adequate insulating properties so that compliance with the standard is not impaired, and shall have no effect on insulation.

Compliance is checked by inspection and by the tests of this standard.

21.15 It shall not be possible to gain access to brushes without the aid of a tool.

Screw-type brush-caps shall be so designed that, when tightening, two surfaces are clamped together.

Brush-holders, which retain the brushes in position by means of a locking device, shall be so designed that the locking does not depend upon the brush-spring tension, if the loosening of the locking device might make accessible metal parts live.

Screw-type brush-caps, which are accessible from the outside of the tool, shall be of insulating material, or be covered with insulating material of adequate mechanical and electrical strength; they shall not project beyond the surrounding surface of the tool.

Compliance is checked by inspection and by manual test, the properties of the insulating material being verified:

– by the tests of 20.2 and 20.4 for screw-type brush-caps which are accessible from the outside of the tool;

– by the tests specified for supplementary insulation for class I tools and class III tools;

– by the tests specified for reinforced insulation for class II tools.

21.16 Tools with water supply shall be either of class III, or designed for use in conjunction with an isolating transformer having a rated output voltage not exceeding 115 V.

Compliance is checked by inspection.

21.16DV D2 *Modification: Replace this clause with the following:*

Tools that utilize a pressurized or non-pressurized liquid system shall be constructed using liquid-handling components that are considered not likely to break or that if broken shall not affect the insulation system.

All metal hoses and reinforced pressure tested hoses rated over twice the pressure encountered in normal use are not considered likely to break. Ordinary garden hose connections are considered likely to be mis-assembled by cross-threading or omission of the washer. Pressure vessels are considered not likely to break if it can be shown that they withstand for one hour twice the pressure encountered in normal use. The requirements of this clause may be met by using shields which will direct the fluid away from electrical components in case of a rupture.

Compliance is checked by the following test on a separate sample:

The tool shall be operated as in normal use and in all operating positions recommended in the instruction manual, with the hose, fitting, or vessel ruptured for a period of one minute. The leakage current of accessible parts shall be measured as described in Clause 13. During the test the leakage current shall not exceed:

2 mA for a Class II tool;

5 mA for a Class I tool.

Following this test, the tool shall meet the test of 13.1 after being allowed to dry for 24 hours at room temperature.

21.17 Switches and reset buttons on non-self-resetting controls shall be so located that accidental operation is unlikely to occur.

Compliance is checked by inspection, and by the following test:

The tool is connected to the power supply, placed in any possible position and dragged across a horizontal surface.

Inadvertent operation of the switch shall not then occur.

21.18 Tools, other than those provided with a flexible shaft, shall be fitted with a mains switch which can be switched off by the user without releasing his grasp on the tool. When a switch has a locking arrangement to lock it in the ON position, the requirement in 21.18 is considered as being met provided the switch unlocks automatically when the trigger or actuating member is actuated.

Compliance is checked by inspection and by manual test.

21.18.1 Where there is a risk associated with continued operation, the switch shall not have any locking device to lock it on the ON position and it shall not remain in the ON position when the trigger is released. This shall be stated in the relevant part 2.

21.18.2 Where there is a risk associated with inadvertent starting, the switch shall have a locking device to lock it on the OFF position. This shall be stated in the relevant part 2.

21.19 Tools shall be so designed that the protection against electric shock is not affected when screws intended for replacement from the outside during routine servicing are replaced by screws having a greater length.

Compliance is checked by inserting longer screws, without appreciable force, after which creepage distances and clearances between live parts and accessible metal parts shall not have been reduced below the values specified in 28.1.

21.20 If the tool is marked with the first numeral of the IP system, the relevant requirements of IEC 60529 shall be fulfilled.

Compliance is checked by making the relevant tests.

21.21 Tools shall be so designed that in normal use there is no risk of electric shock from charged capacitors when touching the pins of the plug. Capacitors, having a rated capacitance less than or equal to 0,1 µF, are not considered to entail a risk of electric shock.

Compliance is checked by the following test, which is made 10 times.

The tool is operated at rated voltage.

The tool switch, if any, is then moved to the "off" position and the tool is disconnected from the supply by means of the plug.

One second after disconnection, the voltage between the pins of the plug is measured with an instrument which does not appreciably affect the value to be measured.

The voltage shall not exceed 34 V.

21.22 Non-detached parts, which provide the necessary degree of protection against electric shock, moisture, or contact with moving parts, shall be fixed in a reliable manner, and shall withstand the mechanical stress occurring in normal use.

Snap-in devices used for fixing such parts shall have an obvious locked position. The fixing properties of snap-in devices used in parts which are likely to be removed during servicing shall not deteriorate.

Compliance is checked by the following tests.

Parts which are likely to be removed during servicing are disassembled and assembled 10 times before the test is carried out.

Servicing includes replacement of the supply cord.

The tool is at room temperature. However, in cases where compliance may be affected by temperature, the test is also carried out immediately after the tool has been operated under the conditions specified in clause 12.

The test is applied to all parts which are likely to be detachable, whether or not they are fixed by screws, rivets, or similar parts.

A force is applied without jerks for 10 s in the most unfavourable direction to those areas of the cover or part which are likely to be weak. The force is as follows:

- *push force 50 N;*
- *pull force*

    a) if the shape of the part is such that the fingertips cannot easily slip off 50 N;

b) if the projection of the part which is gripped is less than 10 mm in the direction of removal 30 N.

The push force is applied by means of a rigid test finger similar in dimensions to the standard test finger shown in Figure 1.

The pull force is applied by a suitable means such as a suction cup, so that the test results are not affected.

While the pull test of a) or b) is being applied, the test fingernail shown in Figure 7 is inserted in any aperture or joint with a force of 10 N. The fingernail is then slid sideways with a force of 10 N; it is not twisted or used as a lever.

If the shape of the part is such that an axial pull is unlikely, no pull force is applied, but the test fingernail shown in Figure 7 is inserted in any aperture or joint with a force of 10 N, and is then pulled for 10 s by means of the loop with a force of 30 N in the direction of removal.

If the cover or part is likely to be subjected to a twisting force, a torque as detailed below is applied at the same time as the pull or push force:

- *for major dimensions up to and including 50 mm 2 Nm;*
- *for major dimensions over 50 mm 4 Nm.*

This torque is also applied when the test fingernail is pulled by means of the loop.

If the projection of the part which is gripped is less than 10 mm, the above torque is reduced to 50 % of the value.

Parts shall not become detached, and they shall remain in the locked position.

21.23 Handles, knobs, grips, levers and the like shall be fixed in a reliable manner so that they will not work loose in normal use, if loosening might result in a hazard.

Compliance is checked by inspection, by manual test, and by trying to remove the handle, knob, grip or lever applying, for 1 min, a 30 N axial force either pushing or pulling.

21.24 Storage hooks and similar devices for flexible cords shall be smooth and well rounded.

Compliance is checked by inspection.

21.25 Current-carrying parts and other parts, the corrosion of which might result in a hazard, shall be resistant to corrosion under normal conditions of use. Stainless steel and similar corrosion-resistant alloys and plated steel are considered to be satisfactory for the purpose of this requirement.

Compliance is checked by verifying that after the tests of clause 18, the relevant parts show no sign of corrosion.

NOTE Examples for causes of corrosion are the incompatibility of materials and effects of heating.

21.26 Direct contact between live parts and thermal insulation shall be effectively prevented, unless such material is non-corrosive, non-hygroscopic, and non-combustible, such as glass-wool.

Compliance is checked by inspection, by the tests of clauses 16 and 17 and, if necessary, by chemical tests or flammability tests.

NOTE Non-impregnated slag-wool is an example of corrosive thermal insulation.

21.26DV D1 ***Modification: Revise the second paragraph by replacing "clauses 16 and 17" with "14.3" and adding "of 29.2" after "flammability tests".***

21.27 Tools other than class II, having parts where reliance is placed upon safety extra-low voltage to provide the necessary degree of protection against electric shock, shall be so designed that the insulation between parts operating at safety extra-low voltage and other live parts complies with the requirements for double insulation or reinforced insulation.

Compliance is checked by the tests specified for double insulation or reinforced insulation.

21.28 Parts separated by protection impedance shall comply with the requirements for double insulation or reinforced insulation.

Compliance is checked by the tests specified for double insulation or reinforced insulation.

21.29 Void

21.30 Shafts of operating knobs, handles, levers and the like shall not be live unless the shaft is not accessible when the knob, handle, lever and the like is removed.

Compliance is checked by inspection and by applying the test finger as specified in 9.2 after removal of the knob, handle, lever, or the like, even with the aid of a tool.

21.31 For constructions other than those of class III, handles, levers and knobs which are held or actuated in normal use shall not become live in the event of an insulation fault. If these handles, levers or knobs are of metal, and if their shafts or fixings are likely to become live in the event of a basic insulation fault, they shall either be adequately covered by insulating material, or their accessible parts shall be separated from their shafts or fixings by insulation.

The covering or insulating material shall comply with the electric strength test in clause 15, Table 2 item 4, but need not be insulation.

Compliance is checked by inspection, and if necessary, by the tests specified for insulation.

21.32 For tools other than those of class III, handles which, in normal use, are continuously held in the hand shall be so constructed that when gripped as in normal use, the operator's hand is not likely to touch metal parts unless they are separated from live parts by double insulation or reinforced insulation.

Compliance is checked by inspection.

21.33 For class II tools, capacitors shall not be connected to accessible metal parts, and their casings, if of metal, shall be separated from accessible metal parts by supplementary insulation.

This requirement does not apply to capacitors complying with the requirements for protective impedance specified in 9.1 and 21.36.

Compliance is checked by inspection and by the tests specified for supplementary insulation.

21.34 Capacitors shall not be connected between the contacts of a thermal cut-out.

Compliance is checked by inspection.

21.35 Lampholders shall be used only for the connection of lamps.

Compliance is checked by inspection.

21.36 Protective impedance shall consist of at least two separate components, the impedance of which is unlikely to change significantly during the lifetime of the tool. If any one of the components is short-circuited or open-circuited, the values specified in 9.1 shall not be exceeded.

Resistors complying with 14.1 of IEC 60065 and capacitors complying with 14.2 of IEC 60065 are considered to comply with this requirement.

Compliance is checked by inspection and by measurement.

21.37 Air-intake openings shall not enable the ingress of foreign bodies that could impair the safety.

Compliance is checked by the following test.

It shall not be possible to insert a steel ball of 6 mm diameter through the air intake opening other than those adjacent to the fan.

22 Internal wiring

22.1 Wireways shall be smooth and free from sharp edges.

Wires shall be protected so that they do not come into contact with burrs, cooling fins, etc., which may cause damage to the insulation of conductors.

Holes in metal through which insulated wires pass shall be provided with bushings or, unless required otherwise in part 2, shall have smooth, well-rounded edges. A radius of 1,5 mm is considered to be well rounded.

Wiring shall be effectively prevented from coming into contact with moving parts.

Compliance is checked by inspection.

22.2 Internal wiring and electrical connections between different parts of the tool shall be adequately protected or enclosed.

Compliance is checked by inspection.

22.3 Internal wiring shall be either so rigid and so fixed or insulated that, in normal use, creepage distances and clearances cannot be reduced below the values specified in 28.1. The insulation, if any shall be such that it cannot be damaged in normal use.

Compliance is checked by inspection, by measurement, and by manual test.

For insulated internal wiring, it is checked that either their insulation is electrically equivalent to the insulation of the cords complying with IEC 60227 or IEC 60245, or it complies with the following electric strength test.

A voltage of 2 000 V is applied for 15 min between the conductor and metal foil wrapped around the insulation. There shall be no breakdown.

When sleeving is used as supplementary insulation on internal wiring, it shall be retained in position by positive means. A sleeve is considered to be fixed by positive means if it can only be removed by breaking or cutting, or if it is clamped at both ends.

Compliance is checked by inspection and by manual test.

22.3DV DC *Modification: Delete the fourth paragraph and replace the third paragraph with the following:*

Internal wiring shall comply with CSA C22.2 No. 38 or CSA C22.2 No. 75 and UL 44 or UL 83, as applicable.

22.4 Conductors identified by the colour combination green/yellow shall not be connected to terminals other than earthing terminals.

Compliance is checked by inspection.

22.4DV DR *Modification: Replace the first paragraph with the following:*

Conductors identified by the colour green or combination green/yellow shall not be connected to terminals other than earthing terminals.

22.5 Aluminium wires shall not be used for internal wiring. Windings of a motor are not considered as internal wiring.

Compliance is checked by inspection.

NOTE Windings of a motor are not considered as internal wiring.

22.6 Stranded conductors shall not be consolidated by lead-tin soldering where they are subjected to contact pressure, unless the clamping means is so designed that there is no risk of bad contact due to cold flow of the solder.

Consolidation of a stranded conductor by lead-tin soldering is allowed if spring terminals are used; securing the clamping screws alone is not considered adequate.

Soldering of the tip of a stranded conductor is allowed.

Compliance is checked by inspection.

23 Components

23.1 Components shall comply with the safety requirements specified in the relevant IEC standards, as far as they reasonably apply.

If components are marked with their operating characteristics, the conditions under which they are used in the tool shall be in accordance with these markings, unless a specific exception is made.

23.1.1 Capacitors in auxiliary windings of motors shall be marked with their rated voltage and their rated capacitance.

23.1.2 Fixed capacitors for radio interference suppression shall comply with IEC 60384-14.

23.1.3 Small lampholders similar to E10 lampholders shall comply with the requirements for E10 lampholders; they need not accept a lamp with E10 cap complying with the current edition of Standard Sheet 7004-22 of IEC 60061-1.

23.1.4 Isolating transformers and safety isolating transformers shall comply with IEC 61558-1.

23.1.5 Appliance couplers other than those used for IPX0 tools shall comply with IEC 60309. Those used for IPX0 shall comply with IEC 60320.

Where appliance couplers not standardized by IEC are used, the manufacturer shall inform the user in the instructions for use to connect the tool only by means of the appropriate connector specified by the manufacturer.

23.1.6 Automatic controls not complying with IEC 60730-1 shall be tested according to this standard, and additionally, according to 11.3.5 to 11.3.8 and clause 17 of IEC 60730-1. Controls may be tested separately from the tool.

The tests according to IEC 60730-1 are carried out under the conditions occurring in the tool.

For the tests of clause 17 of IEC 60730-1, the number of cycles to be used are:

- *for thermostats, 10 000 cycles of operation;*

- *for temperature limiters, 1 000 cycles of operation;*

- *for self-resetting thermal cut-out, 300 cycles of operation;*

- for non-self-resetting thermal cut-out which is manually reset, 10 cycles of operation.

Automatic controls which comply with the requirements of IEC 60730-1, and which are used in accordance with their marking, are considered to meet the requirements of this standard (the term "marking" includes documentation and declaration as specified in clause 7 of IEC 60730-1).

The tests of clause 17 of IEC 60730-1 are not carried out on automatic controls which operate during clause 12, if the tool meets the requirements of this standard when they are short-circuited.

A specific exception with regard to the testing of thermostats and temperature limiters is made in note 2) of Table 1 of Clause 12.

23.1.7 The testing of components which have to comply with other standards is, in general, carried out separately, according to the relevant standard as follows.

If the component is marked and used in accordance with its marking, it is tested in accordance with its marking, the number of samples being that required by the relevant standard.

In particular, components not mentioned in Table 1 of clause 12 are tested as a part of that tool.

23.1.8 Where no IEC standard exists for the relevant component, or where the component is not marked, or is not used in accordance with its marking, the component is tested under the conditions occurring in the tool, the number of samples being, in general, that required by a similar specification.

23.1.9 For capacitors connected in series with a motor winding, it is verified that, when the tool is operated at a voltage equal to 1,1 times rated voltage and under minimum load, the voltage across the capacitor does not exceed 1,1 times the rated voltage of the capacitor.

23.1.10 Mains switches shall have adequate breaking capacity, and shall be switches for 50 000 cycles of operation.

Compliance is checked by inspection and by the following test.

Mains switches are tested together with the tool at rated voltage or at the upper limit of the rated voltage range of the tool.

The motor is then stalled, and the switch is operated 50 times, each "on" period being not more than 0,5 s, and each "off" period being not less than 10 s.

If, in normal use, an electronic control device switches off the current before opening the main contacts, the number of operations is reduced to five, with the electronic control device short-circuited.

After the test, the switch shall have no electrical or mechanical failure.

Mains switches marked with individual ratings are also tested in accordance with IEC 61058-1.

23.1.11 Switches, which have not been separately tested and found to comply with IEC 61058-1 under the conditions occurring in the tool, shall comply with Annex I.

The test of 17.2.4.4 of IEC 61058-1 is carried out for 50 000 cycles of operation.

Switches intended for operation under no load, and which can be operated only with the aid of a tool, are subjected to the tests of clause 17 of IEC 61058-1. This applies also to such switches operated by hand which are interlocked so that they cannot be operated under load, but switches without that interlock are subjected to the test of 17.2.4.4 for 100 cycles of operation.

The tests of 17.2.4.4 of IEC 61058-1 are not carried out on a switch if the tool meets the requirements of this standard when the switch is short-circuited.

23.2 Tools shall not be fitted with

– switches or automatic controls in flexible cords;

– devices which cause the protection device in the fixed wiring to operate in the event of a fault in the tool;

– thermal cut-outs which can be reset by a soldering operation.

Compliance is checked by inspection.

23.3 Overload protection devices shall be of the non-self-resetting type.

Compliance is checked by inspection.

23.4 Plugs and socket-outlets used as terminal devices for heating elements, and plugs and socket-outlets for extra-low voltage circuits, shall not be interchangeable with plugs and socket-outlets listed in IEC 60884, and with connectors and tool inlets complying with the standard sheets of IEC 60320.

Compliance is checked by inspection

23.5 Motors connected to the supply mains, and having basic insulation which is inadequate for the rated voltage of the tool, shall comply with the requirements of Annex B.

Compliance is checked by the tests of Annex B.

24 Supply connection and external flexible cords

24.1 Tools shall be provided with one of the following means of connection to the supply:

– a supply cord fitted with a plug;

– an appliance inlet having at least the same degree of protection against moisture as required for the tool, and having a locking device preventing inadvertent disconnection;

– a supply cord not exceeding 0,5 m and fixed with an in-line connector (cable coupler) and its mating counterpart. The in-line connector shall have at least the same degree of protection against moisture as required for the tool.

Compliance is checked by inspection and for locking devices with the pull test of 24.14.

24.1DV D2 *Modification: Add the following sentence:*

A supply cord shall be less than 0,5 m or greater than 1,8 m long.

24.2 Supply cords shall be assembled to the tool by one of the following methods:

– type X attachment;

– type Y attachment;

– type Z attachment, only for exchange-type tools, as allowed in part 2.

Supply cords with type X and type Y attachment may be either ordinary flexible cords or special cords and only available from the manufacturer or his service agent. A special cord may also include a part of the tool.

Compliance is checked by inspection and, if necessary, by manual test.

24.3 Plugs shall not be fitted with more than one flexible cord.

Compliance is checked by inspection.

24.4 Supply cords shall be not lighter than:

– ordinary tough rubber sheathed flexible cord (code designation 60245 IEC 53);

– ordinary polyvinyl chloride sheathed flexible cord (code designation 60227 IEC 53).

Polyvinyl chloride insulated flexible cords shall not be used for tools having external metal parts, the temperature rise of which exceeds 75 K during the test of clause 12.

Compliance is checked by inspection and measurement.

If provided with a plug, power supply cords of single-phase tools having a rated current not exceeding 16 A shall be provided with a plug complying with IEC 60884 or IEC 60309.

If plugs complying with IEC 60309 are fitted, the standard sheets to be applied are as follows:

– class I tools	Sheet 2 – I
– class II tool	Sheet 2
– class III tools	Sheet 2 – I

The body of the plug shall be of, or covered with, rubber, polyvinyl chloride or material, having no less mechanical strength.

Power supply cords of single-phase tools, having a rated current exceeding 16 A but not exceeding 63 A, and of multi-phase tools having a rated current not exceeding 63 A, shall be provided with a plug complying with IEC 60309, the standard sheets to be applied being as follows:

– class I tools	Sheet 2 – III according to current
– class II tools	Sheet 2

– class III tools Sheet 2 – III

Two-pole plugs, appliance inlets and connectors for cable couplers and plugs to standard sheet 2 are allowed in class II tools.

24.4DV DR *Modification: Replace 24.4 with the following:*

Supply cords shall be not lighter than Junior Hard service cord in accordance with the National Electrical Code, NFPA 70, and Hard Usage cord in accordance with the Canadian Electric Code, Part 1.

Attachment plugs and cords should be equal to or greater than the rating of the tool.

24.5 Supply cords shall have a nominal cross-sectional area not less than those shown in Table 6.

Table 6 – Minimum cross-sectional area of supply cord

Rated current of the tool A	Nominal cross-sectional area mm^2
Up to and including 6	0,75
Over 6 up to and including 10	1
Over 10 up to and including 16	1,5
Over 16 up to and including 25	2,5
Over 25 up to and including 32	4
Over 32 up to and including 40	6
Over 40 up to and including 63	10

Table 6DV D1 *Replace Table 6 with the following:*

Table 6DV – Minimum cross-sectional area of supply cord

Rated current of the tool A	Nominal cross-sectional area AWG
Up to and including 10	**18**
Over 10 up to and including 13	**16**
Over 13 up to and including 18	**14**
Over 18 up to and including 25	**12**

Compliance is checked by measurement.

24.6 For class I tools, the supply cord shall be provided with a green/yellow core; it shall be connected to the internal earthing terminal of the tool, and to the earthing contact of the plug.

Compliance is checked by inspection.

24.6DV DR *Modification: Replace the first paragraph with the following:*

For class I tools, the supply cord shall be provided with a green or green/yellow core; it shall be connected to the internal earthing terminal of the tool and to the earthing contact of the plug.

24.7 Conductors of supply cords shall not be consolidated by lead-tin soldering where they are subject to contact pressure, unless the clamping means is so designed that there is no risk of a bad contact due to cold flow of the solder.

Compliance is checked by inspection.

The requirement may be met by using spring terminals. Securing the clamping screws alone is not considered adequate.

24.8 For all types of attachment, moulding together the supply cord to the enclosure or part of it shall not affect the insulation of the cord.

Compliance is checked by inspection.

24.9 Inlet openings shall be provided with a bushing, or shall be so constructed that the protective covering of the supply cord can be introduced without risk of damage.

Compliance is checked by inspection and by manual test.

24.10 Inlet bushings shall:

– be so shaped as to prevent damage to the supply cord;

– be reliably fixed;

– not be removable without the aid of a tool.

Compliance is checked by inspection and by manual test.

24.11 At inlet openings, the insulation between the conductor of a supply cord and the enclosure of the tool, if of metal, shall consist of the insulation of the conductor and, in addition, of at least two separate insulations.

A separate insulation shall consist of:

– the sheath of a supply cord at least equivalent to that of a cord complying with IEC 60227 or IEC 60245; or

– a lining or bushing of insulating material complying with the requirements for supplementary insulation.

Compliance is checked by inspection.

24.11DV D1 ***Modification: Delete clause 24.11.***

24.12 Cord guards shall have adequate mechanical strength and shall retain these properties throughout extended normal use.

Compliance is checked by the following test.

The part of the tool comprising the cable entry, fitted with the cord guard and the flexible cable or cord for which the tool is designed, is fixed in the oscillating member of an apparatus similar to that shown in Figure 9. The sample is so mounted that the axis of oscillation is tangential to the outer surface of the part in which the cord guard is secured, and, when the oscillating member is at the middle of its travel, the axis of the cable or cord where it leaves the cord guard is vertical.

A weight, having a mass equal to that of the tool, but not less than 2 kg or more than 6 kg, is attached to the cable or cord.

The oscillating member is moved backwards and forwards through an angle of 90° (45° on either side of the vertical), the number of flexings being 20 000 and the rate of flexing 60 per min. A flexing is one movement, either backwards or forwards. After 10 000 flexings, the sample is turned through 90° about the centre line of the cord guard.

After the test, the cord guard shall not have worked loose, and neither the cord guard nor the flexible cable or cord shall show any damage which could impair compliance with this standard, except that not more than 10 % of the number of strands of each conductor may have been broken.

Immediately after this test, the cord anchorage and the terminal screws are loosened, without removing the conductors of the flexible cable or cord. However, if the cord guard is clamped under the cord anchorage, the cord anchorage is not loosened.

The tool is then lifted by the cord guard, without jerks, over a distance of approximately 500 mm in approximately 1 s, and replaced on a support.

The operation is made 10 times.

During this test, the cord guard shall not slip out of its location.

24.13 Flexible cables or cords of tools shall be protected against excessive bending at the inlet opening of the tool by means of a cord guard of insulating material. Such guards shall not be integral with a power supply cable or cord for type X attachment.

The guards shall be fixed in a reliable manner, and shall be of such a design that they project outside the tool for a distance beyond the inlet opening of at least five times the overall diameter of the cable or cord delivered with the tool.

Compliance is checked by inspection, by measurement and by the following test.

A tool designed for a power supply cord is fitted with a cord guard, the flexible cable or cord being approximately 100 mm longer than the guard.

The tool is so held that the axis of the cord guard, where the cable or cord leaves it, projects upwards at an angle 45° to the horizontal when the cable or cord is free from stress.

A mass equal to 10 D^2 grams is then attached to the free end of the cable or cord. D is the external diameter of the flexible cable supplied with the tool in mm.

If the cord guard is temperature sensitive, the test is made at a temperature of (23 ± 2) °C.

Immediately after the mass has been attached, the curvature of the cable or cord shall nowhere be less than 1,5 D.

24.13DV D1 *Modification: Delete the last sentence of the first paragraph.*

24.14 Tools provided with a supply cord shall have cord anchorages so that the conductors are relieved from strain, including twisting, where they are connected within the tool, and that the insulation of the conductors is protected from abrasion.

It shall not be possible to push the cord into the tool to such an extent that the cord, or internal parts of the tool, could be damaged.

Compliance is checked by inspection, by manual test, and by the following test.

The cord is subjected 25 times to a pull of the value shown in Table 7. The pulls are applied without jerks in the most unfavourable direction each time for 1 s.

Immediately afterwards, the cord, other than that of an automatic cord reel, is subjected for 1 min to a torque of the value shown in Table 7.

Table 7 – Pull and torque value

Mass of tool kg	Pull N	Torque Nm
Up to and including 1	30	0,1
Over 1 up to and including 4	60	0,25
Over 4	100	0,35

During the tests, the cord shall not be damaged.

After the tests, the cord shall not have been longitudinally displaced by more than 2 mm, and the conductors shall not have moved over a distance of more than 1 mm in the terminals, nor shall there be appreciable strain at the connection.

Creepage distances and clearances shall not be reduced below the value specified in 28.1.

For the measurement of the longitudinal displacement, a mark is made on the cord while it is subjected to the pull, at a distance of approximately 2 cm from the cord anchorage or other suitable point, before starting the tests.

After the tests, the displacement of the mark on the cord in relation to the cord anchorage or other point is measured while the cord is subjected to the pull.

24.15 Cord anchorages shall either be so arranged that they are only accessible with the aid of a tool, or be so designed that the cord can only be fitted with the aid of a tool.

Compliance is checked by inspection.

24.16 For type X attachments, cord anchorages shall be so designed or located that:

– replacement of the cord is easily possible;

– it is clear how the relief from strain and the prevention of twisting are to be obtained;

– they are suitable for the different types of cord which may be connected, unless the tool is so designed that only one type of cord can be fitted;

– the cord cannot touch the clamping screws of the cord anchorage, if these screws are accessible, or at least not separate from accessible metal parts by supplementary insulation;

– the cord is not clamped by a metal screw which bears directly on the cord;

– at least one part of the cord anchorage is securely fixed to the tool, unless it is part of the specially prepared cord;

– screws, if any, which have to be operated when replacing the cord, do not serve to fix any other component, unless, when omitted or incorrectly mounted, they render the tool inoperative or clearly incomplete, or unless the parts intended to be fastened by them cannot be removed without the aid of a tool during the replacement of the cord;

– in the case of labyrinths, these labyrinths cannot be bypassed in such a way that the test of 24.14 is not withstood;

– glands shall not be used as cord anchorages for power supply cords;

– for class I tools, they are of insulating material or are provided with an insulating lining, if otherwise an insulation fault on the cord could make accessible metal parts live;

– for class II tools, they are of insulating material, or, if of metal, are insulated from accessible metal parts by insulation complying with the requirements for supplementary insulation.

If, for type X attachment, the cord anchorage comprises one or more clamping member(s) to which pressure is applied by means of one or more nuts engaging with studs, which are securely attached to the tool, the cord anchorage is considered to have one part securely fixed to the tool, even if the clamping member(s) can be removed from the studs.

If, however, the pressure on the clamping member(s) is applied by means of one or more screws engaging either with separate nuts, or with a thread in a part which is integral with the tool, the cord anchorage is not considered to have one part securely fixed to the tool, unless one of the clamping members itself is fixed to the tool, or the surface of the tool is of insulating material and so shaped that it is obvious that surface is one of the clamping member(s) (see Figure 6).

Compliance is checked by inspection, and by the test of 24.14 under the following conditions.

The tests are first made with the lightest permissible type of cord of the smallest cross-sectional area specified in 25.2, and then with the next heavier type of cord of the largest cross-sectional area specified, unless the tool is so designed that only one type of cord can be fitted.

Tools, for which a specially prepared cord is used, are tested with the cord as delivered.

The conductors are introduced into the terminals, the terminal screws, if any, being tightened just sufficiently to prevent the conductors from easily changing their position. The cord anchorage is used in the normal way, the clamping screws, if any, being tightened with a torque equal to two-thirds of that specified in 27.1.

Screws of insulating material bearing directly on the cord are fastened with two-thirds of the torque specified in column I of Table 9; the length of the slot in the screw head being taken as the nominal diameter of the screw.

24.17 For type Y and Z attachments, cord anchorage shall be adequate.

Compliance is checked by the test of 24.14, which is made with the cord as delivered.

24.18 For type X attachment, production methods such as tying the cord into a knot, or tying the ends with string, are not allowed.

Compliance is checked by inspection.

24.19 For type Y and type Z attachments, the insulated conductors of the supply cord shall be insulated from accessible metal parts by insulation complying with the requirements for basic insulation for class I tools, and complying with the requirements for supplementary insulation for class II tools. This insulation shall consist of:

– a separate insulating lining fixed to the cord anchorage;

– a sleeve or grommet fixed to the cord; or

– for class I tools, the sheath of the sheathed cord.

Compliance is checked by inspection.

24.20 The space for the supply cables or the supply cord provided inside, or as a part of the tool for type X attachment:

– shall be so designed as to permit checking, before fitting the cover, if any, that the conductors are correctly connected and positioned;

– shall be so designed that covers, if any, can be fitted without risk of damage to the supply conductors or their insulation;

– shall be so designed that the uninsulated end of the conductor, should it become free from a terminal, cannot come into contact with accessible metal parts, unless the cord is provided with terminations that are unlikely to slip free of the conductor.

Compliance is checked by inspection and, for type X attachment, by an installation test with cables or flexible cords of the largest cross-sectional area specified in 25.2 and by the following additional test.

For pillar terminals where the conductors are not separately clamped at a distance of 30 mm or less from the terminal, and for other terminals with screw clamping, the clamping screws or nuts are loosened in turn. Without removing the conductor from the conductor space, a force of 2 N is applied to the wire in any direction and adjacent to the terminal, screw or stud. The uninsulated end of the conductor shall not then come into contact with accessible metal parts or any other metal part connected thereto.

For pillar terminals, where the conductors are separately clamped at a distance of 30 mm or less from the terminal, the tool is considered to meet the requirement that the uninsulated end of the conductor must not come into contact with accessible metal parts.

24.21 Appliance inlets shall:

– be so located or enclosed that live parts are not accessible during insertion or removal of the connector;

– be so placed that the connector can be inserted without difficulty;

– be so placed that, after insertion of the connector, the tool is not supported by the connector when in any position of normal use on a flat surface.

Compliance is checked by inspection and, with regard to the first requirement, by means of the standard test finger shown in Figure 1, for tool inlets other than those standardized in IEC 60320.

Tools provided with appliance inlets complying with IEC 60320 are considered to comply with the first requirement.

25 Terminals for external conductors

25.1 Tools with type X attachments, except those with specially prepared cord, shall be provided with terminals in which connection is made by means of screws, nuts, or equally effective devices. Screw type terminals in accordance with IEC 60998-2-1, screwless terminals in accordance with IEC 60998-2-2 and clamping units in accordance with IEC 60999-1 are considered to be equally effective devices.

Screws and nuts shall not serve to fix any other component, except that they may also clamp internal conductors, if these are so arranged that they are unlikely to be displaced when fitting the supply conductors.

Compliance is checked by inspection.

For tools with type X attachments, soldered connections may be used for the connection of external conductors, provided that the conductor is so positioned or fixed that reliance is not placed upon the soldering alone to maintain the conductor in position, unless barriers are provided so that creepage distances and clearances between live parts and other metal parts cannot be reduced to less than 50 % of the values specified in 28.1, should the conductor become free at the soldered joint.

For type Y and type Z attachments, soldered, welded, crimped and similar connections may be used for the connection of external conductors; moreover, for class II tools, the conductor shall be so positioned or fixed that reliance is not placed upon the soldering, crimping, or welding alone to maintain the conductor in position, unless barriers are provided so that creepage distances and clearances between live parts and other metal parts cannot be reduced to less than 50 % of the values specified in 28.1, should the conductor become free at the soldered or welded joint, or slip out of the crimped connection.

It is not to be expected that two independent fixings will become loose at the same time.

Conductors connected by soldering are not considered to be adequately fixed, unless they are held in place near to the termination, independently of the solder; but ″hooking in″ before soldering is, in general, considered to be a suitable means for maintaining the conductors of a power supply cord other than a tinsel cord in position, provided the hole through which the conductor is passed is not unduly large.

The terminals of a component (such as a switch) built into the tool – on the assumption that they comply with the requirements of this clause – may be used as terminals intended for external conductors.

Conductors connected to terminals or terminations by other means are not considered to be adequately fixed, unless an additional fixing is provided near the terminal or termination; this additional fixing, in the case of stranded conductors, clamps both the insulation and the conductor.

Compliance is checked by inspection and by measurement.

25.2 Terminals for type X attachment, except those with specially prepared cords, shall allow the connection of conductors having nominal cross-sectional areas as shown in Table 8, unless the tool is so designed that only one type of cord can be fitted, in which case the terminals shall be suitable for the connection of that cord.

Table 8 – Nominal cross-sectional area of conductors

Rated current of tool A	Nominal cross-sectional area of flexible cables and cords mm^2
Up to and including 6	0,75 and 1
Over 6 up to and including 10	1 and 1,5
Over 10 up to and including 16	1,5 and 2,5
Over 16 up to and including 25	2,5 and 4
Over 25 up to and including 32	4 and 6
Over 32 up to and including 40	6 and 10
Over 40 up to and including 63	10 and 16

Table 8DV D1 ***Modification: Replace Table 8 with the following:***

Table 8DV – Nominal cross-sectional area of conductors

Rated current of the tool A	Nominal cross-sectional area AWG
Up to and including 10	**18**
Over 10 up to and including 13	**16**
Over 13 up to and including 18	**14**
Over 18 up to and including 25	**12**

Compliance is checked by inspection, by measurement and by fitting cables or cords of the smallest and largest cross-sectional areas specified.

Terminals for supply cord shall be suitable for their purpose.

Compliance is checked by inspection and by applying a pull of 5 N to the connection.

After the test, the connections shall show no damage which could impair compliance with this standard.

25.3 For tools with type X attachments, terminals shall be so fixed that, when the clamping means is tightened or loosened, the terminal does not work loose, internal wiring is not subjected to stress, and creepage distances and clearances are not reduced below the values specified in 28.1.

Compliance is checked by inspection, and by the test of 9.6 of IEC 60999-1, the torque applied being, however, equal to two-thirds of the torque specified in Table IV of that standard.

Terminals may be prevented from working loose by fixing with two screws, by fixing with one screw in a recess, so that there is no appreciable play, or by other suitable means.

The requirement for fixation of terminals does not preclude the provision of supply terminals on switches, or similar device in a recess if, after connection of the supply cable, and after re-positioning of the switch or similar device in its recess, it can be verified by inspection that these components and the supply cable are, after re-assembly of the tool, in the correct position.

Covering with sealing compound without other means of locking is not considered to be sufficient. Self-hardening resins may, however, be used to lock terminals which are not subject to torsion in normal use.

25.4 For tools with type X attachments, terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure, and without damage to the conductor.

Compliance is checked by inspection of the terminals and of the conductors after the test of 25.3.

25.5 For tools with type X attachments, except those with specially prepared cords, terminals shall not require special preparation of the conductor in order to effect correct connection, and they shall be so designed or placed that the conductor cannot slip out when clamping screws or nuts are tightened.

Compliance is checked by inspection of the terminals and of the conductors after the test of 25.3.

The term "special preparation of the conductor" covers soldering of the strands, use of cable lugs, formation of eyelets, etc.; but not the reshaping of the conductor before its introduction into the terminal, or the twisting of a stranded conductor to consolidate the end.

Conductors are considered to be damaged if they show deep or sharp indentations.

25.6 Terminals of the pillar type shall be so located that the end of a conductor introduced into the hole is visible, or can pass beyond the threaded hole for a distance at least equal to half the nominal diameter of the screw, or 2,5 mm, whichever is the greater.

Compliance is checked by inspection and by measurement.

25.7 For type X attachments, the terminals shall be clearly recognizable and accessible after opening the tool. All terminals shall be located behind one cover, or one part of the enclosure.

Compliance is checked by inspection.

25.8 Terminal devices shall not be accessible without the aid of a tool, even if their live parts are not accessible.

Compliance is checked by inspection and by manual test.

25.9 Terminal devices of tools with type X attachment shall be so located or shielded that should a wire of a stranded conductor escape when the conductors are fitted, there is no risk of accidental connection between live parts and accessible metal parts and, in the case of class II tools, between live parts and metal parts separated from accessible metal parts by supplementary insulation only.

Compliance is checked by the following test.

An 8 mm length of insulation is removed from the end of a flexible conductor having a nominal cross-sectional area as specified in 24.5.

One wire of the stranded conductor is left free, and the other wires are fully inserted into and clamped in the terminal.

The free wire is bent, without tearing the insulation back, in every possible direction, but without making sharp bends around barriers.

The free wire of a conductor connected to a live terminal shall not touch any metal part which is accessible, or is connected to an accessible metal part or, for class II tools, any metal part which is separated from accessible metal parts by supplementary insulation only. The free wire of a conductor connected to an earthing terminal shall not touch any live part.

26 Provision for earthing

26.1 Accessible metal parts of class I tools, which may become live in the event of an insulation fault, shall be permanently and reliably connected to an earthing terminal or termination within the tool, or to the earthing contact of the tool inlet.

The printed conductors of printed circuit boards shall not be used to provide continuity of the protective earthing circuit.

Earthing terminals and earthing contacts shall not be electrically connected to the neutral terminal.

Class II and class III tools shall have no provision for earthing.

If accessible metal parts are screened from live parts by metal parts which are connected to the earthing terminal or termination, or to the earthing contact, they are not, for the purpose of this requirement, regarded as likely to become live in the event of an insulation fault.

Accessible metal parts, which are separated from live parts by double insulation or by reinforced insulation, are not considered likely to become live in the event of an insulation fault.

Metal parts behind a decorative cover which does not withstand the test of clause 20 are considered to be accessible metal parts.

Compliance is checked by inspection.

26.2 The clamping means of earthing terminals shall be adequately locked against accidental loosening, and it shall not be possible to loosen them without the aid of a tool. Screw clamping terminals complying with clause 25 or screwless terminals in accordance with IEC 60998-2-2 are considered to comply with the requirements of this clause.

For specially prepared cords, terminals complying with IEC 60760 are considered to comply with the requirements of this clause.

Compliance is checked by inspection, by manual test and, for screwless terminals, by the tests specified in IEC 60998-2-2.

26.2DV D1 *Modification: Add the following paragraphs:*

Quick-connect terminals may be used to terminate or interconnect grounding and bonding conductors in sizes 18 – 14 AWG under the following conditions:

a) For wire sizes 18 – 16 AWG, the minimum connector and tab width shall be 2.80 mm (0.110 inch); or

b) For wire sizes 14 AWG, the minimum connector and tab width shall be 6.35 mm (0.250 inch).

Quick-connect tabs shall not be less than 0.8 mm (0.032 inch) thick.

Multipin (friction type) insulated connectors shall not be used in equipment grounding paths unless they are shown to be acceptable for grounding use.

26.3 If detachable parts have an earth connection, this connection shall be made before the current-carrying connections are established when placing the part in position, and the current-carrying connections shall be separated before the earth connection is broken when removing the part.

For tools with supply cords, the arrangement of the terminals, or the length of the conductors between the cord anchorage and the terminals, shall be such that the current-carrying conductors become taut before the earthing conductor, if the cord slips out of the cord anchorage.

Compliance is checked by inspection and by manual test.

26.4 All parts of the earthing terminal intended for the connection of external conductors shall be such that there is no risk of corrosion resulting from contact between these parts and the copper of the earthing conductor, or any other metal in contact with these parts.

Parts which may transmit current in the event of an insulation fault, other than parts of a metal frame or enclosure, shall be of coated or uncoated metal having adequate resistance to corrosion. If such parts are of steel, they shall be provided at the essential areas with an electroplated coating having a thickness of at least 5 µm.

Parts of coated or uncoated metal, which are only intended to provide or to transmit contact pressure, shall be adequately protected against rusting.

Examples of parts which may transmit current in the event of an insulation fault, and parts which are only intended to provide or to transmit contact pressure are shown in Figure 8.

If the body of the earthing terminal is a part of a frame or enclosure of aluminium or aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium or its alloys.

Parts of copper alloys containing at least 58 % copper for parts that are worked cold, and at least 50 % copper for other parts, and parts of stainless steel containing at least 13 % chrome, are considered to be sufficiently resistant to corrosion. Parts subjected to a treatment such as chromate conversion coating are in general not considered to be adequately protected against corrosion, but they may be used to provide or to transmit contact pressure.

The essential areas of steel parts are, in particular, those transmitting current. In evaluating such areas, the thickness of the coating in relation to the shape of the part has to be taken into account. In case of doubt, the thickness of the coating is measured as described in ISO 2178 or in ISO 1463.

Compliance is checked by inspection, by measurement, by manual test, and by the test of 30.1.

26.5 The connection between the earthing terminal or earthing contact, and parts required to be connected thereto, shall be of low resistance.

Compliance is checked by the following test.

A current derived from a source having a no-load voltage not exceeding 12 V (a.c. or d.c.) and equal to 1,5 times rated current of the tool, or 25 A, whichever is the greater, is passed between the earthing terminal or earthing contact, and each of the accessible metal parts in turn.

The voltage drop between the earthing terminal of the tool or the earthing contact of the tool inlet, and the accessible metal part is measured, and the resistance calculated from the current and this voltage drop.

In no case shall the resistance exceed 0,1 Ω.

In case of doubt, the test is carried out until steady conditions have been established.

The resistance of the flexible cord is not included in the resistance measurement.

Care is taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

27 Screws and connections

27.1 Fixings, and electrical connections, the failure of which may impair compliance with this standard, shall withstand the mechanical stresses occurring in normal use.

Screws used for this purpose shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

Such screws, when of insulating material, shall have a nominal diameter of at least 3 mm; they shall not be used for any electrical connection.

Screws transmitting electrical contact pressure shall screw into metal.

Screws shall not be of insulating material if their replacement by a metal screw could impair supplementary insulation or reinforced insulation.

Screws which may be removed when replacing a supply cord having a type X attachment, or when undertaking user maintenance, shall not be of insulating material if their replacement by a metal screw could impair basic insulation.

NOTE Earthing connections are an example for electrical connections.

Compliance is checked by inspection and by the following test.

The screws or nuts are tightened and loosened:

– *10 times for screws in engagement with a thread of insulating material;*

– five times for nuts and other screws.

Screws in engagement with a thread of insulating material are completely removed and reinserted each time.

When testing terminal screws and nuts, a flexible conductor of the largest cross-sectional area specified in 25.2 is placed in the terminal.

The test is made by means of a suitable test screwdriver, spanner, or key applying a torque as shown in Table 9, the appropriate column being:

– for metal screws without heads, if the screw when tightened does not protrude from the hole – I

– for other metal screws and for nuts – II

– for screws of insulating material:

• having a hexagonal head with the dimension across flats exceeding the overall thread diameter; or

• with a cylindrical head and a socket for a key, the socket having a cross-corner dimension exceeding the overall thread diameter; or

• with a head having a slot or cross slots, the length of which exceeds 1,5 times the overall thread diameter – II

– for other screws of insulating material – III

Table 9 – Torque for testing screws and nuts

Nominal diameter of screw	Torque Nm		
mm	I	II	III
Up to and including 2,8	0,2	0,4	0,4
Over 2,8 up to and including 3,0	0,25	0,5	0,5
Over 3,0 up to and including 3,2	0,3	0,6	0,5
Over 3,2 up to and including 3,6	0,4	0,8	0,6
Over 3,6 up to and including 4,1	0,7	1,2	0,6
Over 4,1 up to and including 4,7	0,8	1,8	0,9
Over 4,7 up to and including 5,3	0,8	2,0	1,0
Over 5,3	–	2,5	1,25

The conductor is moved each time the screw or nut is loosened.

During the test, no damage impairing the further use of the fixing or electrical connections shall occur.

The shape of the blade of the test screwdriver is to fit the head of the screw to be tested. The screws and nuts are not to be tightened in jerks.

27.2 Electrical connections shall be so designed that contact pressure is not transmitted through insulating material which is liable to shrink or to distort, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material. Ceramic material is not liable to shrink or to distort.

Compliance is checked by inspection.

27.3 Space-threaded (sheet metal) screws shall not be used for the connection of current-carrying parts, unless they clamp these parts directly in contact with each other, and are provided with a suitable means of locking.

Thread-cutting (self-tapping) screws shall not be used for the electrical connection of current-carrying parts, unless they generate a full-form standard machine screw thread. Such screws shall not, however, be used if they are likely to be operated by the user or installer, unless the thread is formed by a swageing action.

Thread-cutting and space-threaded screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use, and that at least two screws are used for each connection.

Compliance is checked by inspection.

27.4 Screws, which make a mechanical connection between different parts of the tool, shall be secured against loosening, if they also make electrical connections.

This requirement does not apply to screws in the earthing circuit if at least two screws are used for the connection, or if an alternative earthing circuit is provided.

Spring washers and the like may provide satisfactory security. Sealing compound which softens on heating provides satisfactory security only for screw connections not subject to torsion in normal use.

Rivets used for electrical connections shall be secured against loosening if these connections are subject to torsion in normal use. A non-circular shank or an appropriate notch may be sufficient to comply with this requirement.

This requirement does not imply that more than one rivet is necessary for providing earthing continuity.

Compliance is checked by inspection and by manual test.

28 Creepage distances, clearances and distances through insulation

28.1 Creepage distances and clearances shall not be less than the values in millimetres shown in Table 10. The values specified in the table do not apply to cross-over points of motor windings.

If a resonance voltage occurs between the point where a winding and a capacitor are connected together, and metal parts which are separated from live parts by basic insulation only, the creepage distance and clearance shall not be less than the values specified for the value of the voltage imposed by the resonance, these values being increased by 4 mm in the case of reinforced insulation.

Compliance is checked by measurement.

For tools provided with an appliance inlet, the measurements are made with an appropriate connector inserted; for tools with type X attachment, they are made with supply conductors of the largest cross-sectional area specified in 25.2, and also without conductors; for other tools, they are made on the tool as delivered.

For tools provided with belts, the measurements are made with the belts in place, and the devices intended for varying the belt tension adjusted to the most unfavourable position within their range of adjustment, and also with the belts removed.

Movable parts are placed in the most unfavourable position; nuts and screws with non-circular heads are assumed to be tightened in the most unfavourable position.

The clearances between terminals and accessible metal parts are also measured with the screws or nuts unscrewed as far as possible, but the clearances shall then be not less than 50 % of the value shown in Table 10.

Distances through slots or openings in external parts of insulating material are measured to metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test finger of Figure 1, but it is not pressed into openings.

If necessary, a force is applied to any point on bare conductors, other than those of heating elements, to any point on uninsulated metal capillary tubes of thermostats and similar devices, and to the outside of metal enclosures, in an endeavour to reduce the creepage distances and clearances while taking the measurements.

Table 10 – Minimum creepage distances and clearances (in millimetres)

Distances	Class III tools		Other tools					
			Working voltage ≤130 V		Working voltage >130 V and ≤250 V		Working voltage >250 V and ≤440 V	
mm	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
Between live parts of different polarity [1]:								
– if protected against deposition of dirt [2]	1,0	1,0	1,0	1,0	2,0	2,0	2,0	2,0
– if not protected against deposition of dirt	2,0	1,5	2,0	1,5	3,0	2,5	4,0	3,0
– if lacquered or enamelled windings	1,0	1,0	1,5	1,5	2,0	2,0	3,0	3,0
– for positive temperature coefficient (PTC) resistors including their connecting wires, if protected against deposition of moisture or dirt [2]	–	–	1,0	1,0	1,0	1,0	–	–
Between live parts and other metal parts over basic insulation:								
– if protected against deposition of dirt [2]								
• if of ceramic material, pure mica and the like	1,0	1,0	1,0	1,0	2,5 [3]	2,5 [3]	–	–
• if of other material	1,5	1,0	1,5	1,0	3,0	2,5 [3]	–	–
– if not protected against deposition of dirt	2,0	1,5	2,0	1,5	4,0	3,0	–	–
– if the live parts are lacquered or enamelled windings	1,0	1,0	1,5	1,5	2,0	2,0	–	–
– at the end of tubular sheathed-type heating elements	–	–	1,0	1,0	1,0 [5]	1,0 [4]	–	–
Between live parts and other metal parts over reinforced insulation:								
– if the live parts are lacquered or enamelled windings	–	–	6,0	6,0	6,0	6,0	–	–
– for other live parts	–	–	8,0	8,0	8,0	8,0	–	–
Between metal parts separated by supplementary insulation	–	–	4,0	4,0	4,0	4,0	–	–

[1]The clearances specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, and the like, or to the air gap between the current-carrying members of such devices where the clearance varies with the movement of the contacts.

[2]In general, the interior of a tool having a reasonably dust-proof enclosure is considered to be protected against deposition of dirt; provided the tool does not generate dust within itself, hermetic sealing is not required.

[3]If the parts are rigid and located by mouldings, or if the design is such that there is no likelihood of a distance being reduced by distortion or movement of the parts, this value may be reduced to 2,0 mm.

[4]If protected against deposition of dirt.

[5]If over ceramic, pure mica and the like, protected against deposition of dirt.

Table 10DV D1 ***Modification: Replace Row 3 in Table 10 as follows:***

Table 10DV – Minimum creepage distances and clearances (in millimetres)

Between live parts and other metal parts over reinforced insulation:								
– if the live parts are lacquered or enamelled windings	**–**	**–**	**5,0**	**5,0**	**6,0**	**6,0**	**–**	**–**
– for other live parts	**–**	**–**	**8,0**	**5,0**	**8,0**	**8,0**	**–**	**–**

The force is applied by means of the test finger of Figure 1, and has a value of:

– 2 N for bare conductors and for uninsulated capillary tubes of thermostats and similar devices;

– 30 N for enclosures.

The way in which creepage distances and clearances are measured is indicated in Annex A.

If a barrier is interposed, clearances are measured over the barrier or, if the barrier is in two parts with mating surfaces which are not cemented together, through the joint.

For tools having parts with double insulation where there is no metal between basic insulation and supplementary insulation, the measurements are made as though a metal foil were present between the two insulations.

When assessing creepage distances and clearances, the effect of insulating lining of metal enclosures or covers is taken into consideration.

Means provided for fixing the tool to a support are considered to be accessible.

For conductive patterns on printed circuit boards, except at their edges, the values in the table between parts of different potential may be reduced, as long as the peak value of the voltage stress does not exceed:

– 150 V per mm with a minimum distance of 0,2 mm, if protected against the deposition of dirt;

– 100 V per mm with a minimum distance of 0,5 mm, if not protected against the deposition of dirt.

When the limits mentioned above lead to higher values than those of the table, the values of the table apply.

For peak voltages exceeding 50 V, the reduced creepage distances only apply if the Proof Tracking Index (PTI) of the printed circuit board, measured as in Annex G, is greater than 175.

These distances may be reduced further, provided that the tool complies with the requirements of clause 18 when the distances are short-circuited in turn.

Creepage distances and clearances within optocouplers are not measured if the individual insulations are adequately sealed, and if air is excluded between individual layers of the material.

For live parts of different polarity separated by basic insulation only, creepage distances and clearances smaller than those specified in the table are allowed, provided the requirements of clause 18 are met if these creepage distances and clearances are short-circuited in turn.

28.2 The distance through insulation, for working voltages up to and including 250 V, between metal parts shall not be less than 1,0 mm if they are separated by supplementary insulation, and not be less than 2,0 mm if they are separated by reinforced insulation.

This requirement does not apply if the insulation is applied in thin sheet form, other than mica or similar scaly material, and consists:

– for supplementary insulation, of at least two layers, provided that any one of the layers withstands the electric strength test prescribed for supplementary insulation;

– for reinforced insulation, of at least three layers, provided that, when any two of the layers are placed in contact, they withstand the electric strength test prescribed for reinforced insulation.

The test voltage is applied between the outer surfaces of the layer, or of the two layers, as applicable.

Moreover, this requirement does not apply if the supplementary insulation or the reinforced insulation is inaccessible, and meets one of the following conditions:

– the maximum temperature rise determined during the tests of clause 12 does not exceed the permissible value specified in 12.5;

– the insulation, after having been conditioned for seven days (168 h) in a oven maintained at a temperature equal to 50 K greater than the maximum temperature rise determined during the tests of clause 12, withstands an electric strength test as specified in clause 15, this test being made on the insulation both at the temperature occurring in the oven, and at approximately room temperature.

This requirement does not imply that the prescribed distance must be through solid insulation only; it may consist of thickness of solid insulation plus one or more air layers.

Compliance is checked by inspection and by measurement.

For tools having parts with double insulation, where there is no metal between basic insulation and supplementary insulation, the measurements are made as though a metal foil were present between the two insulations.

For optocouplers, the conditioning procedure is carried out at a temperature of 50 K in excess of the maximum temperature rise measured on the optocoupler during the tests of clause 12 and 18, the optocoupler being operated under the most onerous conditions which occur during these tests.

28.2DV D1 *Modification: Delete “exceeding” after “for working voltages” in the first paragraph and add the following paragraph:*

The distance through insulation, for working voltages 50 V up to and including 130 V, between metal parts shall not be less than 1,0 mm if they are separated by supplementary insulation and 1.5 mm if they are separated by reinforced insulation. For reinforced insulation used between windings and accessible metal, the distance through the insulation, for working voltages 50 V up to and including 130 V, shall not be less than 1.0 mm.

29 Resistance to heat, fire and tracking

NOTE Annex J shows the selection and sequence of the tests of this clause.

29DV D1 *Modification: Add the following note:*

NOTE 1DV The tests are not made on parts of ceramic material, insulating parts of motors, such as shaft insulation, end spiders, wedges, commutators, or brush-caps unless otherwise specified in the Part 2.

29.1 External parts of non-metallic material, parts of insulating material supporting live parts, including connections and parts of thermoplastic material providing supplementary insulation or reinforced insulation, the deterioration of which might cause the tool to fail to comply with this standard, shall be sufficiently resistant to heat.

Compliance is checked by subjecting of the relevant parts to a ball-pressure test, which is made by means of the apparatus shown in Figure 5.

Before starting the test, the part is maintained for 24 h in an atmosphere having a temperature between 15 °C and 35 °C, and a relative humidity between 45 % and 75 %.

The part is supported so that its upper surface is horizontal and the spherical part of the apparatus is pressed against this surface with a force of 20 N. The thickness of the part under test shall be at least 2,5 mm.

The required thickness may be obtained by using two or more sections of the part.

The test is made in a heating cabinet at a temperature of (40 ± 2) °C plus the maximum temperature rise determined during the test of clause 12, but it shall be at least:

- *for external parts (75 ± 2) °C;*
- *for parts retaining live parts in position (125 ± 2) °C.*

Before the test is started, the test apparatus is brought to the temperature determined above.

After 1 h, the apparatus is removed and the part is immediately immersed in cold water so that it is cooled to room temperature within 10 s. The diameter of the impression shall not exceed 2 mm.

For coil formers, only those parts which support or retain in position terminals or terminations are subjected to the test.

Unless otherwise specified, parts operating at safety extra-low voltage not exceeding 24 V are not considered to be live parts.

The test is not made on parts of ceramic material.

29.2 Parts of non-metallic material shall be adequately resistant to ignition and to spread of fire.

This requirement does not apply to decorative trims, knobs, and other parts not likely to be ignited or to propagate flames originating from inside the tool.

Compliance is checked by the following test.

Separately moulded specimens of the relevant parts are subjected to the burning test referred to in Annex D.

However, instead of the burning test, the glow-wire test of Annex E is made at a temperature of 550 °C on corresponding parts of the tool if

- *separately moulded samples are not available;*
- *there is no evidence that the material withstands the burning test;*
- *the separately moulded samples do not withstand the burning test.*

29.3 Insulating material, across which a tracking path may occur, shall have adequate resistance to tracking, taking into account the severity of its duty conditions.

A tracking current may occur

- *between live parts of different polarity;*
- *between live parts and earthed metal parts;*
- *across insulating material of commutators and brush-caps.*

For parts of insulating material used under severe or extra-severe duty conditions, compliance is checked by the proof tracking test referred to in Annex G.

For parts of insulating material used under normal duty conditions, and parts of ceramic material, no tracking test is made.

For parts of insulating material used under severe duty conditions, the test voltage is 175 V. If the specimens do not withstand this test and there is no hazard other than fire, surrounding parts are subjected to the needle-flame test referred to in Annex F.

For parts of insulating material used under extra-severe duty conditions, the test voltage is 250 V. If the specimens do not withstand this test, but withstand the test made with a test voltage of 175 V, and there is no hazard other than fire, surrounding parts are subjected to the needle-flame test referred to in Annex F.

The needle-flame test is made on all parts of non-metallic material positioned within a distance of 50 mm from any place where a tracking path may occur, unless these parts are shielded by a separate barrier or enclosure from that tracking path, in which case the barrier or enclosure is subjected to the needle-flame test.

29.3DV D1 ***Modification: Add the following sentence to the first paragraph:***

All tools shall be considered to be normal duty unless stated in the particular Part 2 standard.

30 Resistance to rusting

30.1 Ferrous parts, the rusting of which might cause the tool to fail to comply with this standard, shall be adequately protected against rusting.

Compliance is checked by the following test.

All grease is removed from the parts to be tested by immersing them in a suitable degreasing agent for 10 min.

The parts are then immersed for 10 min in a 10 % solution of ammonium chloride in water at a temperature of (20 ± 5) °C.

Without drying, but after shaking off any drops, the parts are placed for 10 min in a box containing air saturated with moisture at a temperature of (20 ± 5) °C.

After the parts have been dried for 10 min in a heating cabinet at a temperature of (100 ± 5) °C, their surfaces shall show no signs of rust.

When using the liquids specified for the test, adequate precautions must be taken to prevent the inhalation of their vapours.

Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.

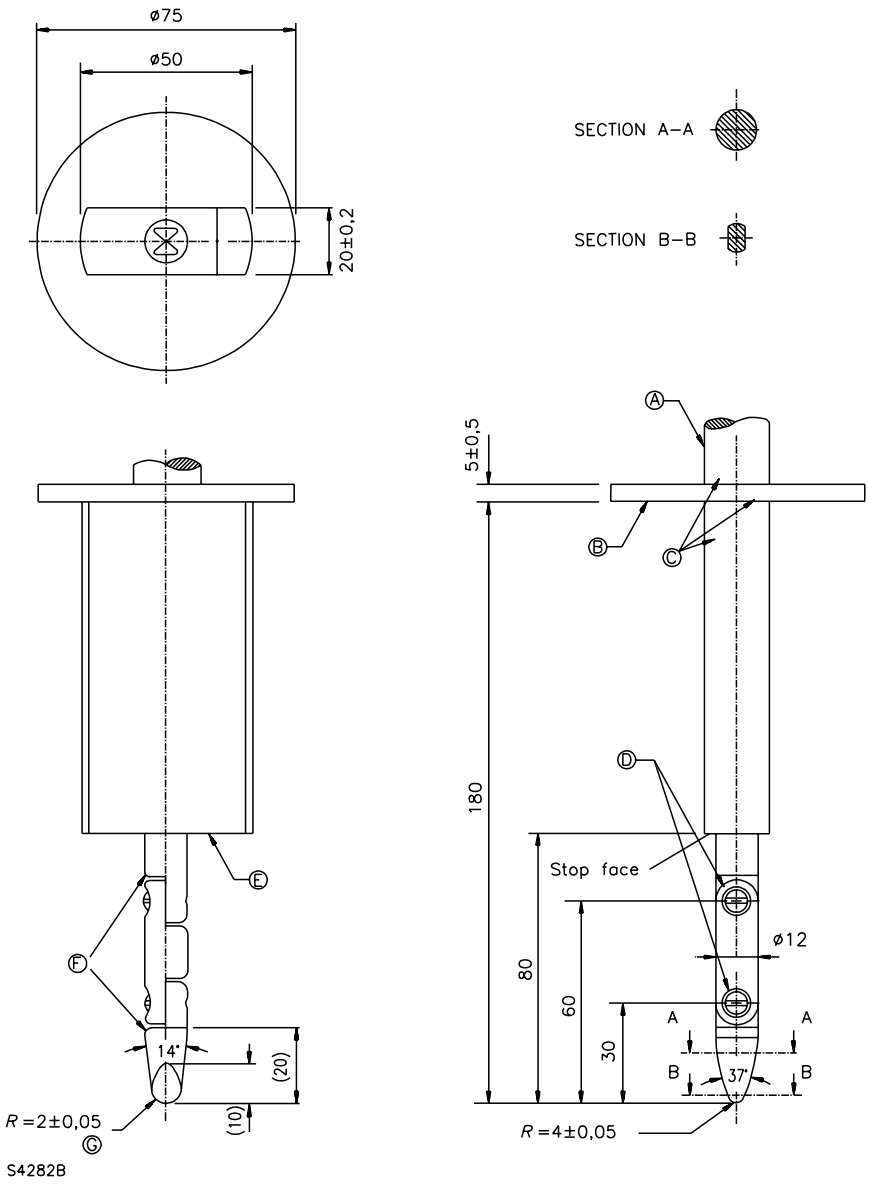
For small helical springs and the like, and for parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are only subjected to the test if there is doubt about the effectiveness of the grease film, and the test is then made without previous removal of the grease.

31 Radiation, toxicity and similar hazards

31.1 Tools shall not emit harmful radiation, or present a toxic or similar hazard.

Compliance is checked by test.

NOTE Test specifications are given in part 2, where necessary.



Material: metal, except where otherwise specified

Linear dimensions in millimetres

Tolerances on dimensions without specific tolerance:
on angles: 0/-10°
on linear dimensions:
up to 25 mm: 0/-0,05
over 25 mm: ±0,2

A = Handle
B = Guard
C = Insulating material
D = Joints
E = Stop face

F = Chamfer all edges
G = Spherical
H = Cylindrical

Both joints shall permit movement in the same plane and the same direction through an angle of 90° with a 0° to +10° tolerance.

Figure 1 – Standard test finger

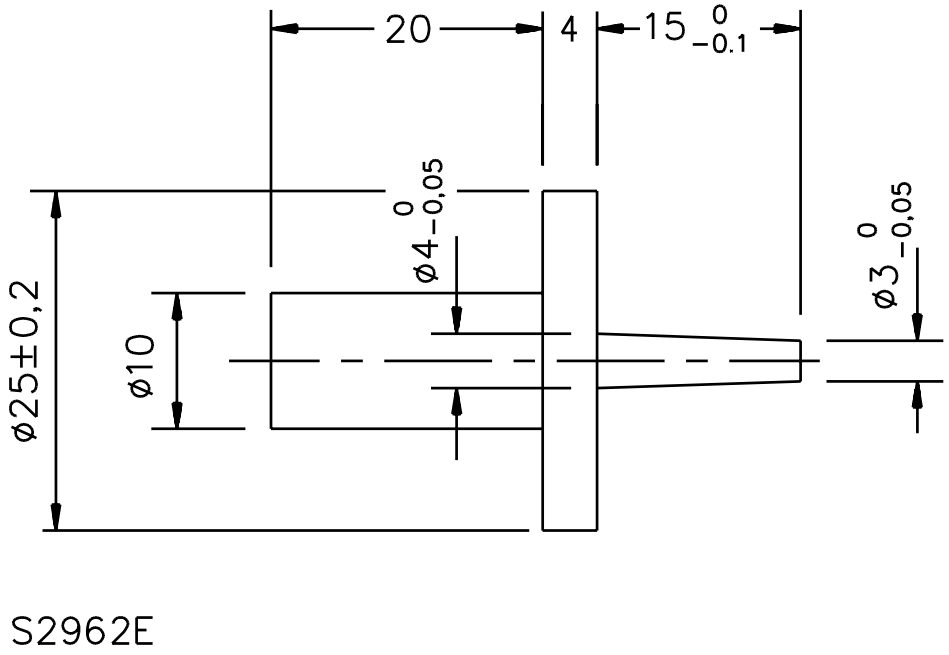
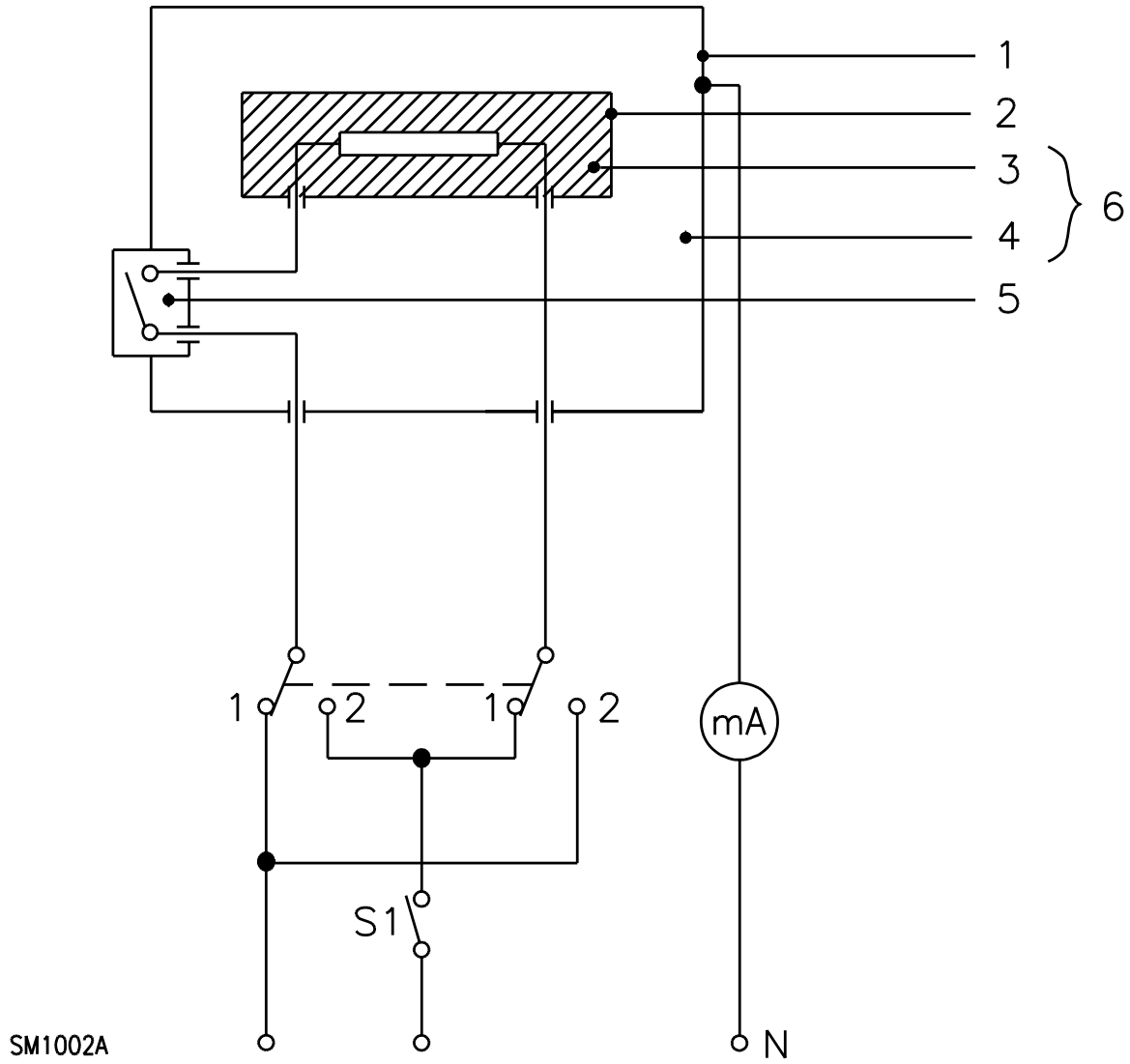


Figure 2 – Test pin



1 Accessible part

2 Inaccessible metal part

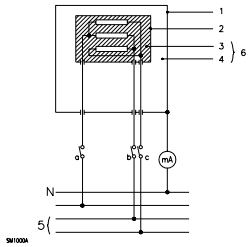
3 Basic insulation

4 Supplementary insulation

5 Reinforced insulation

6 Double insulation

Figure 3 – Diagram for leakage current measurement at operating temperature for single-phase connection and three-phase tools suitable for single-phase supply



1 Accessible part

2 Inaccessible metal part

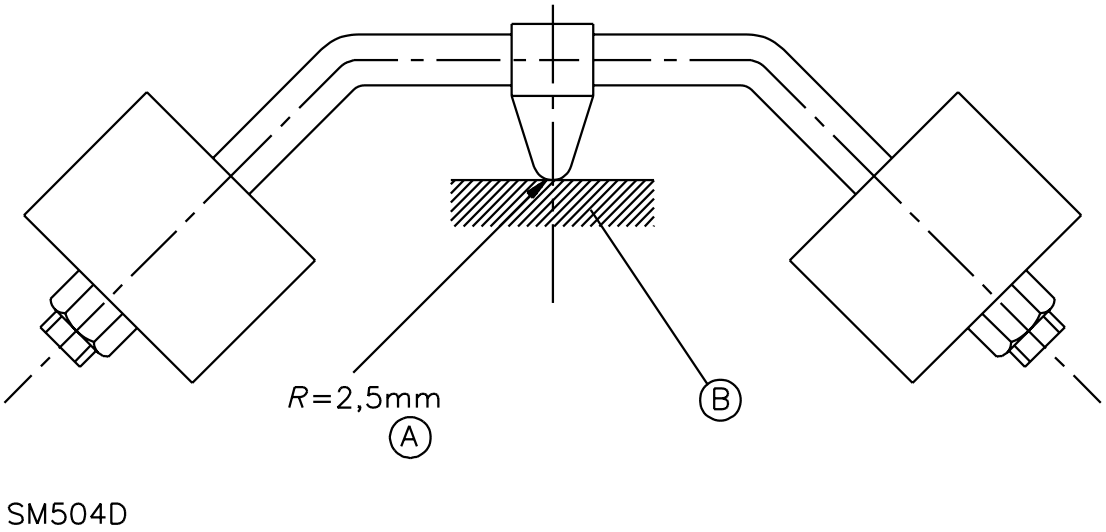
3 Basic insulation

4 Supplementary insulation

5 Reinforced insulation

6 Double insulation

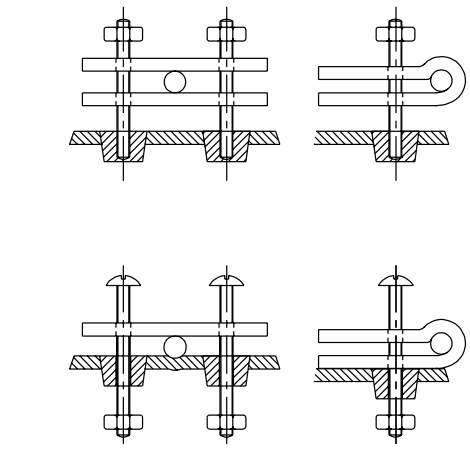
Figure 4 – Diagram for leakage current measurement at operating temperature for three-phase connection



A = Sherical

B = Sample

Figure 5 – Ball-pressure test apparatus



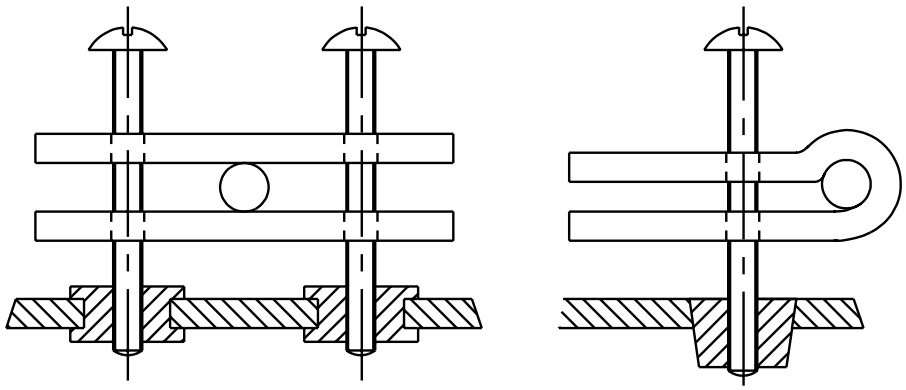
SM1244A

Part of tool of insulating material and so-shaped that it obviously forms part of a cord clamp.

One of the clamping measures is fixed to the tool

Acceptable constructions

(Figure 6 Continued)

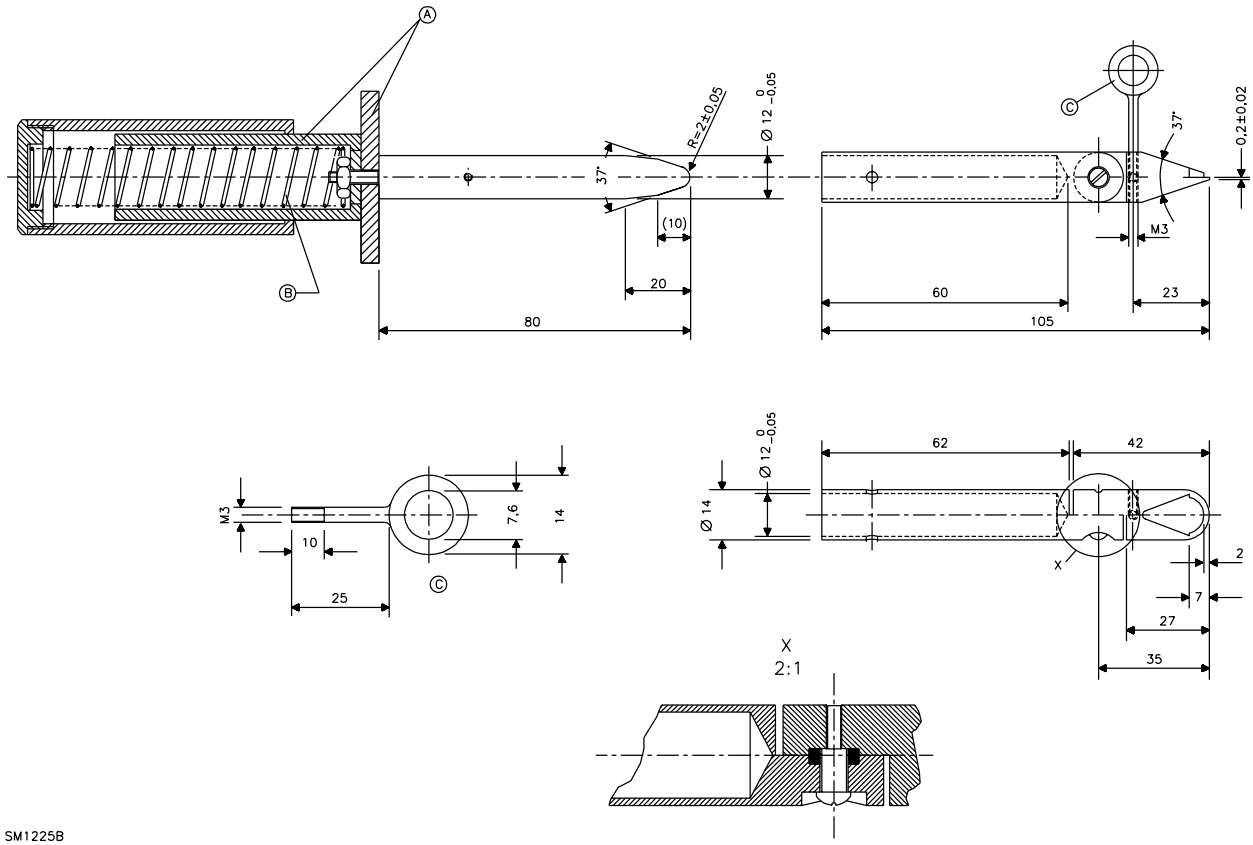


SM1244B

Screws passing though threaded holes in the tool (or screws passing through clearance holes in the tool and secured by nuts) are equally unacceptable

Unacceptable constructions

Figure 6 – Schematic representation of cord anchorages



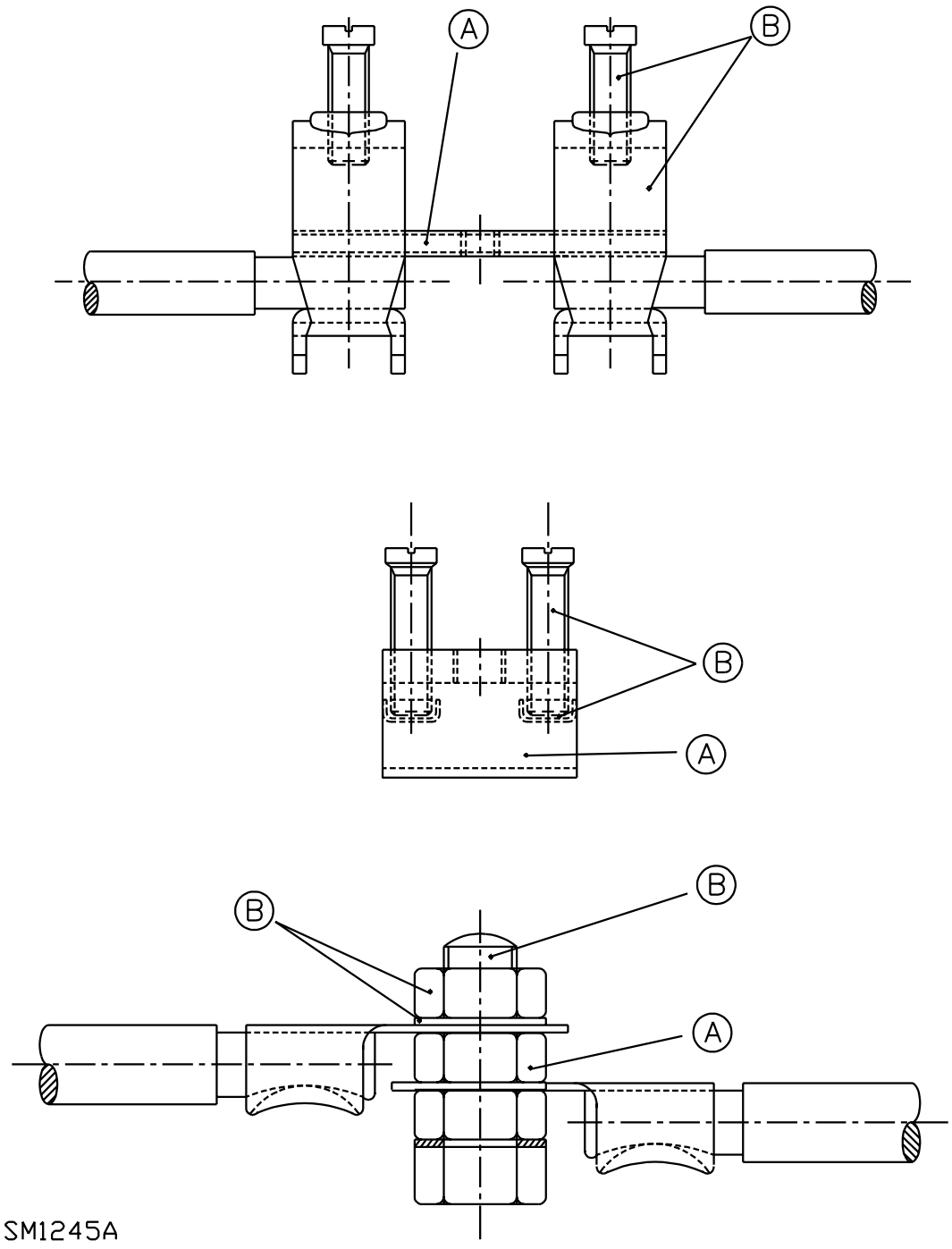
SM1225B

A = Insulating material

B = Spring diameter

C = Loop

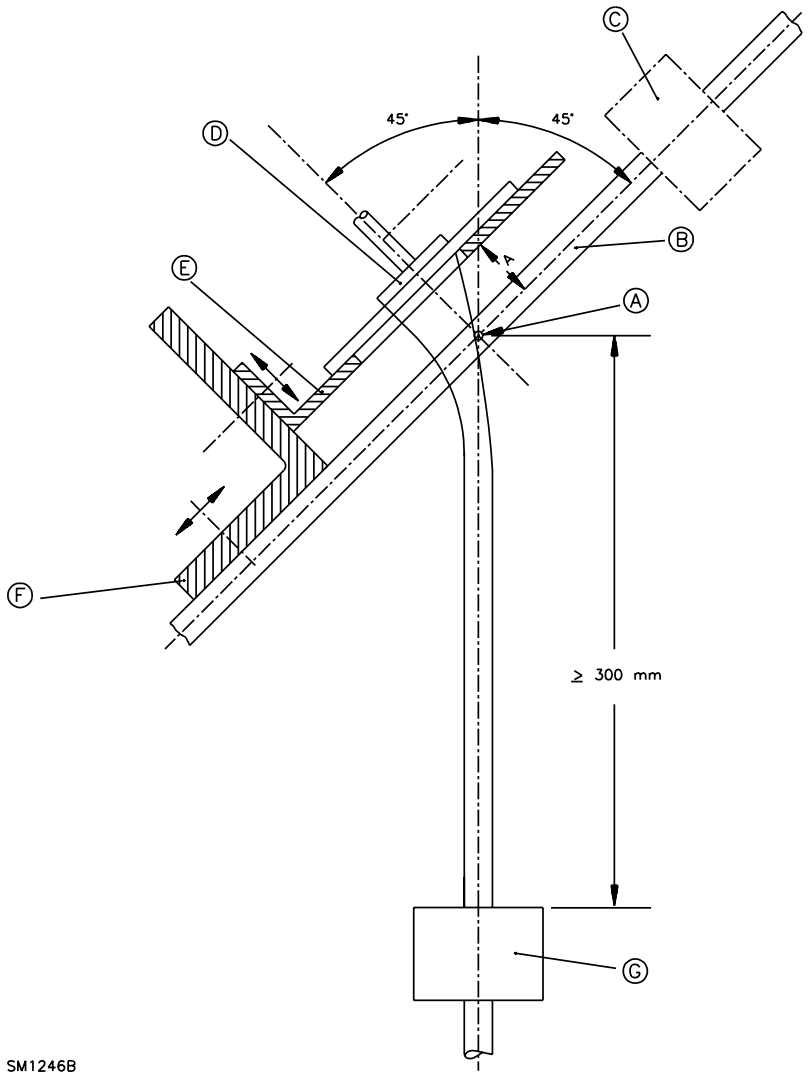
Figure 7 – Test fingernail



A = Part providing earthing continuity

B = Part providing or transmitting contact pressure

Figure 8 – Examples of parts of earthing terminals



A = Axis of oxcillation

B = Oscillating frame

C = Counterweight

D = Sample

E = Adjustable carrier plate

F = Adjustable bracket

G = Load

Figure 9 – Flexing test apparatus

Annex A – (normative) – Measurement of creepage distances and clearances

A.1 Measurement of creepage distances and clearances

The methods of measuring creepage distances and clearances, which are specified in 28.1, are indicated in cases 1 to 10 (see Figure A.1).

These cases do not differentiate between gaps and grooves, or between types of insulation.

The following assumptions are made:

– a groove may have parallel, converging, or diverging sides;

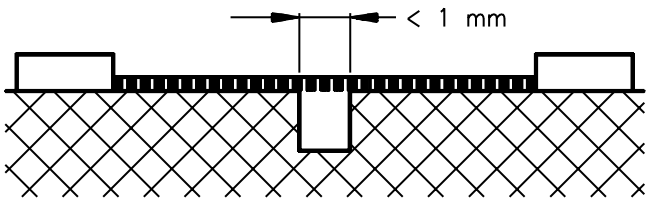
– any groove having diverging sides, a minimum width exceeding 0,25 mm, a depth exceeding 1,5 mm, and a width at the bottom equal to or greater than 1 mm, is regarded as an air gap across which no creepage path exists (case 8);

– any corner including an angle less than 80° is assumed to be bridged with an insulating link of 1 mm width (0,25 mm for dirt-free situations), moved into the most unfavourable position (case 3);

– where the distance over the top of a groove is 1 mm (0,25 mm for dirt-free situations) or more, no creepage distance exists across the air gap (case 2);

– creepage distances and clearances measured between parts moving relative to each other are measured when these parts are placed in their most unfavourable stationary positions;

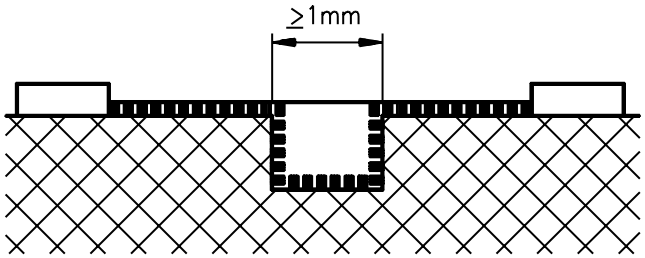
– any air gap less than 1 mm wide (0,25 mm for dirt-free situations) is ignored in computing the total clearance.



Condition: Path under consideration includes a parallel or converging sided groove of any depth with width less than 1 mm.

Rule: Creepage distance and clearance are measured directly across the groove as shown.

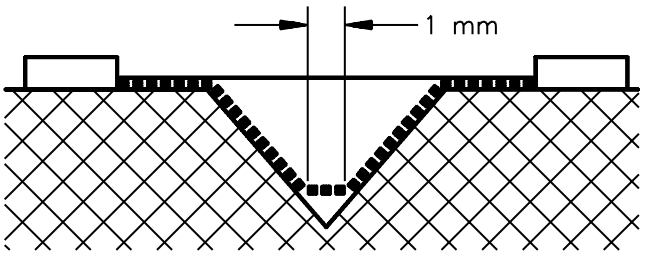
Case 1



Condition: Path under consideration includes a parallel sided groove of any depth equal to or more than 1 mm wide.

Rule: Clearance is the "line of sight" distance. Creepage path follows the cfontour of the groove.

Case 2



Condition: Path under consideration includes a V-shaped groove with internal angle of less than 80° and with a width greater than X mm.

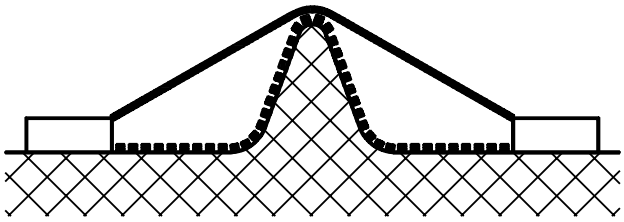
Rule: Clearance is "line of sight" distance. Creepage path follows the contour of the groove but "short circuits" the bottom of the groove by 1 mm link (0,25 mm for dirt-free situations).

Case 3

CLEARANCE

S4621 CREEPAGE DISTANCE

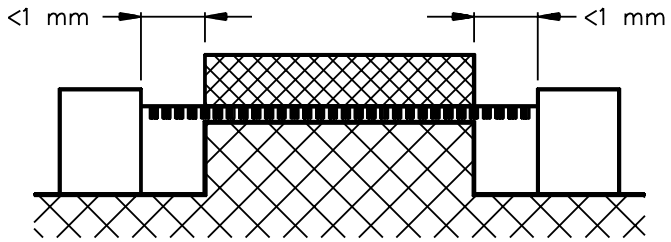
Figure A.1a – Clearance gap for parallel sided and V-shaped groove



Condition: Path under consideration includes a rib.

Rule: Clearance is the shortest direct air path over the top of the rib. Creepage path follows the contour of the rib.

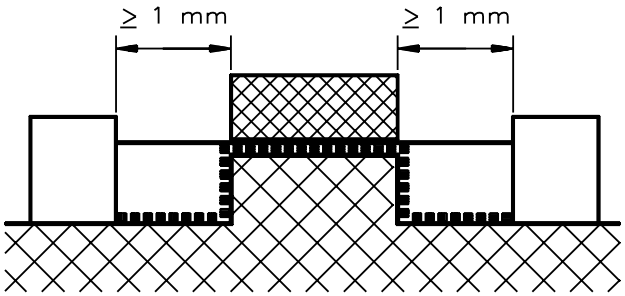
Case 4



Condition: Path under consideration includes an uncemented joint with grooves less than 1 mm wide on either side (0,25 mm for dirt-free situations).

Rule: Creepage and clearance is the "line of sight" distance shown.

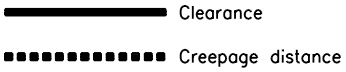
Case 5



Condition: Path under consideration includes an uncemented joint with a groove equal to or more than 1 mm wide each side.

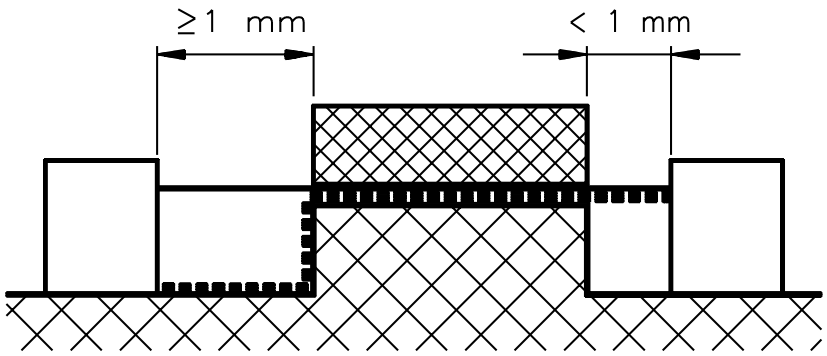
Rule: Clearance is the "line of sight" distance. Creepage path follows the contour of the groove.

Case 6



S4622

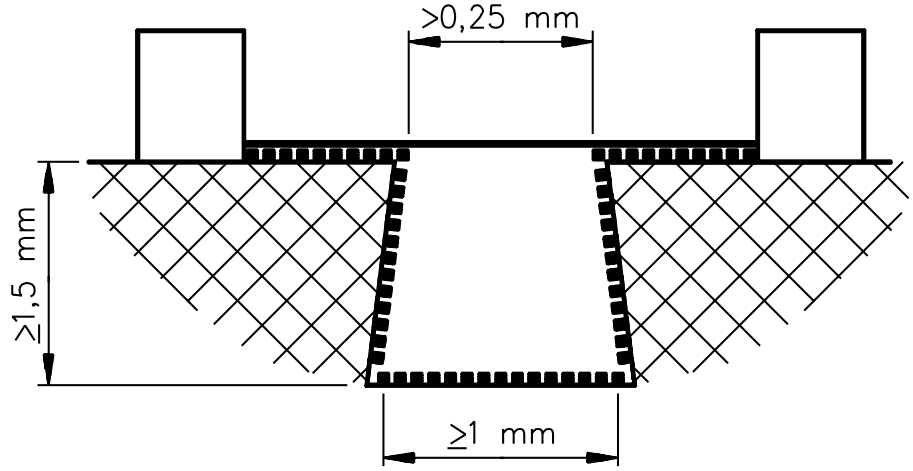
Figure A.1b – Clearance gap for rib and uncemented joint with groove



Condition: Path under consideration includes an uncemented joint with a groove on one side less than 1 mm wide and a groove on the other side equal to or more than 1 mm wide.

Rule: Clearance and creepage path are as shown.

Case 7



Condition: Path under consideration includes a diverging–sided groove equal to or greater than 1,5 mm deep and greater than 0,25 mm wide at the narrowest part and equal to or greater than 1 mm at the bottom.

Rule: Clearance is the "line of sight" distance. Creepage path follows the contour of the groove.

Case 3 also applies to the internal corners if they are less than 80°.

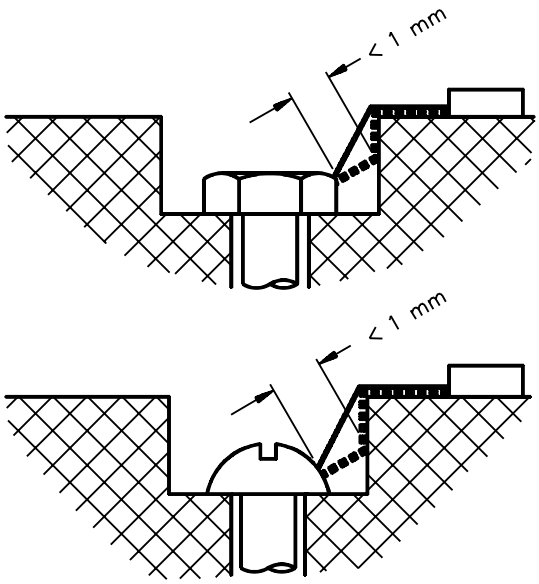
Case 8

Clearance

Creepage distance

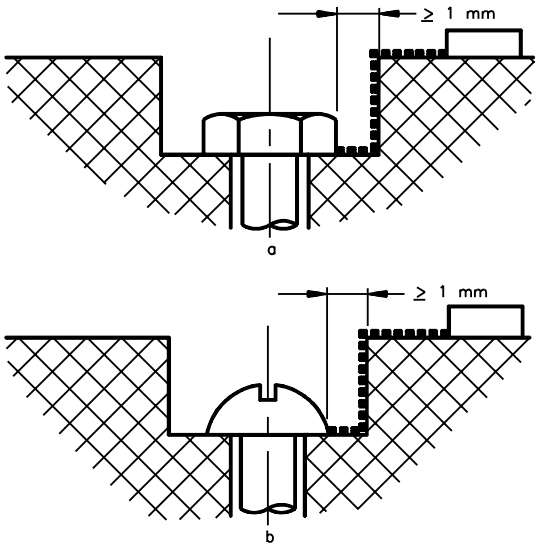
S4623

Figure A.1c – Clearance gap for uncemented joint and diverging-sided groove



Gap between head of screw and wall of recess too narrow to be taken into account.

Case 9



Gap between head of screw and wall of recess wide enough to be taken into account.

Case 10

Clearance

Creepage distance

S4624

Figure A.1d – Clearance gap between wall and screw

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

B.1.1 This annex applies to motors having a working voltage not exceeding 42 V, not isolated from the supply mains, and having basic insulation not designed for the rated voltage of the tool.

All clauses of this standard apply to these motors, unless otherwise specified in this annex.

B.9 Protection against access to live parts

B.9.1 Metal parts of the motor are considered to be bare live parts.

B.12 Heating

B.12.3 The temperature rise of the body of the motor is determined instead of the temperature rise of the windings.

B.12.5 The temperature rise of the body of the motor, where it is in contact with insulating material, shall not exceed the values shown in Table 1 for the relevant insulating material.

B.15 Electric strength

B.15.3 The insulation between live parts of the motor and its other metal parts is not subjected to this test.

B.18 Abnormal operation

B.18.1 The test of 18.7 is not made.

Tools are also subjected to the test of B.18.101.

B.18.101 The tool is operated at rated voltage with each of the following defects:

– short circuit of the terminals of the motor, including any capacitor incorporated in the motor circuit;

– open circuit of the supply to the motor;

– open circuit of any shunt resistor during operation of the motor.

Only one defect is simulated at a time, the tests being made consecutively.

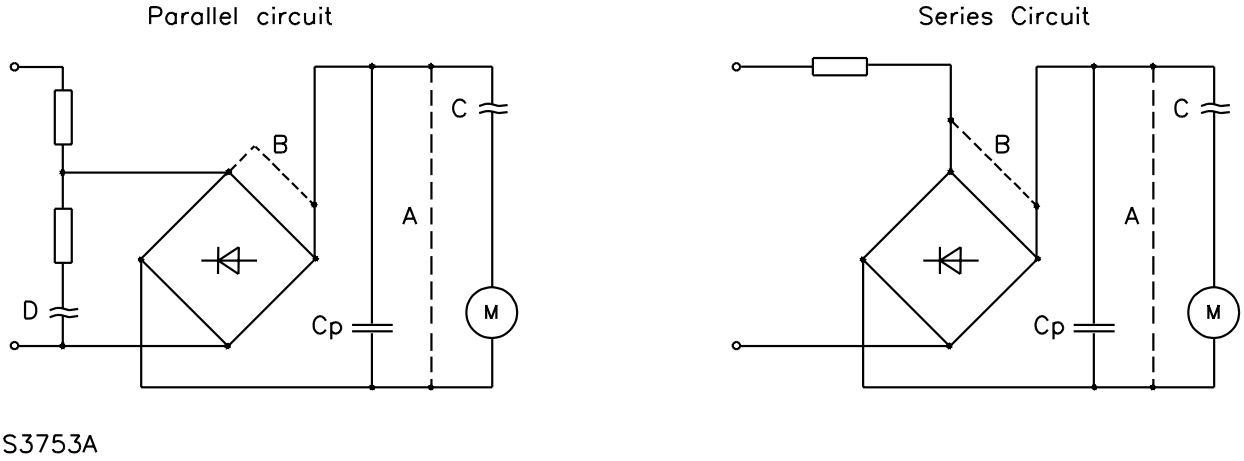
B.21 Construction

B.21.101 For class I tools incorporating a motor supplied by a rectifier circuit, the d.c. circuit shall be insulated from accessible parts of the tool by double insulation or reinforced insulation.

Compliance is checked by the tests specified for double insulation and reinforced insulation.

B.28 Creepage distances, clearances and distances through insulation

B.28.1 The values specified in Table 10 do not apply to distances between live parts of the motor and its other metal parts.



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Components

— original connection

- – - short circuit

≈ open circuit

A short circuit of the terminals of the motor

B open circuit of the shunt resistor

C open circuit of the supply to the motor

Figure B.1 – Simulation of defects

Annex C – (normative) – Circuit for measuring leakage currents

A suitable circuit for measuring leakage currents is shown in Figure C.1.

The circuit comprises a rectifier with germanium diodes D, a moving-coil meter M, resistors and a capacitor C for adjusting the characteristics of the circuit, and a ″make-before-break″ switch S for adjusting the current range of the instrument.

Germanium diodes are used since they have a lower voltage drop than other types of diodes, resulting in a more linear scale, preference being given to gold bonded types. The rating of the diodes has to be chosen to suit the desired maximum range of the complete instrument. However, this range must not exceed 25 mA, since diodes suitable for higher currents have a high voltage drop.

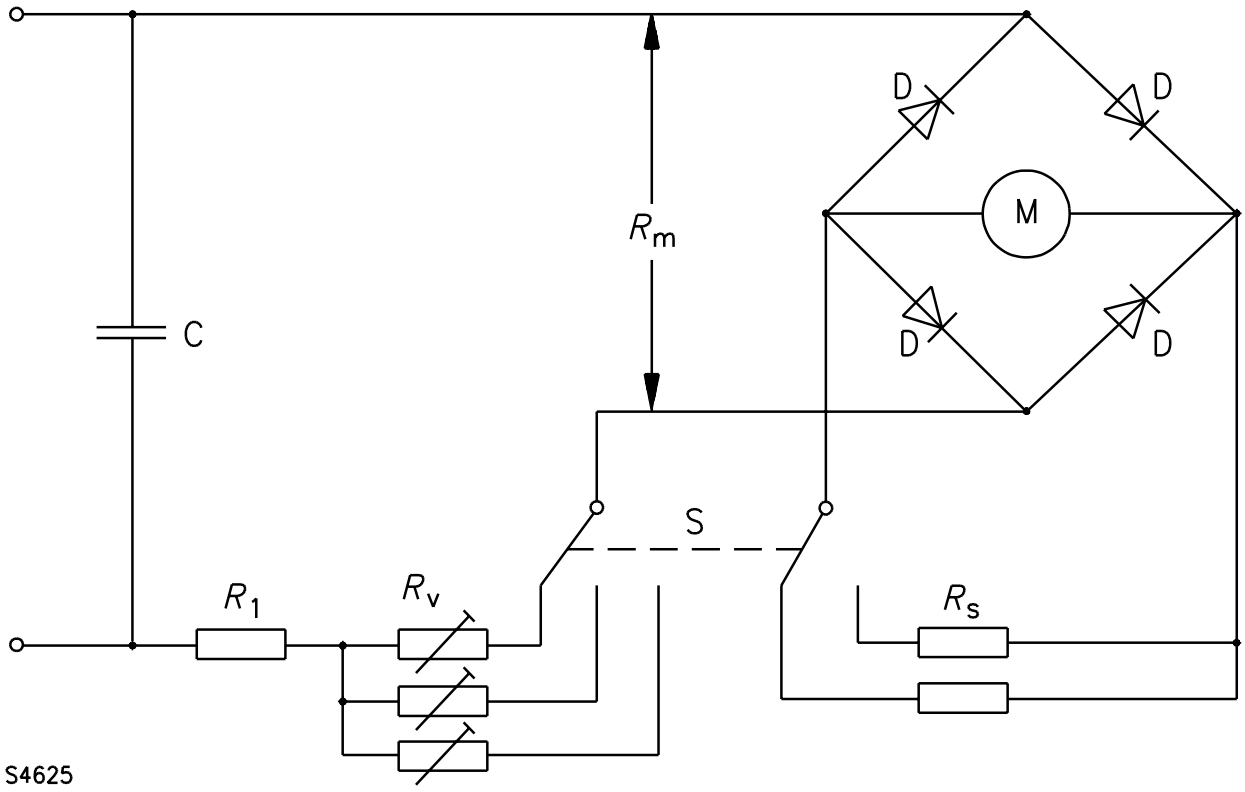
The capacitor may be constructed by selecting capacitors having preferred values and using a series/parallel arrangement.

It is recommended that the switch is arranged so that it automatically returns to the position giving the highest current range, in order to prevent inadvertent damage to the instrument.

The measuring circuit has a total resistance of 1 750 Ω ± 250 Ω, and is shunted by a capacitor so that the time constant of the circuit is 225 µs ± 15 µs. The circuit may be protected against overcurrents, but the method chosen is not to affect the characteristics of the circuit.

The most sensitive range of the complete instrument is not to exceed 1,0 mA, higher ranges being obtained by shunting the coil of the meter by non-inductive resistors R_s and simultaneously adjusting the series resistors R_v so as to maintain the total resistance $R_1 + R_v + R_m$ of the circuit at the value specified. The resistance R_m is calculated from the voltage drop measured across the rectifier arrangement at 0,5 mA, the resistance R_v being then adjusted to give the total resistance of the circuit for each range.

The basic calibration points, at a sinusoidal frequency of 50 Hz or 60 Hz, are 0,25 mA, 0,5 mA and 0,75 mA.



Components

C shunt capacitor

S current range selector switch

D rectifier circuit diodes

M moving-coil meter

R_m effective meter resistance

R_v series resistance

R_1 fixed resistance

R_a shunt resistor

Figure C.1 – Circuit for measuring leakage currents

Annex D – (normative) – Burning test

D.1 Burning test

The burning test is made in accordance with IEC 60707.

For the purpose of this standard, method FH of IEC 60707 (flame-horizontal specimen), is used.

For the evaluation of the test results, category FH-3 of IEC 60707 applies, the maximum burning rate being 40 mm/min.

If more than one specimen does not withstand the test, the material is rejected.

If one specimen does not withstand the test, the test is repeated on another set of five specimens, all of which shall then withstand the test.

Annex E – (normative) – Glow-wire test

The glow-wire test is made in accordance with IEC 60695-2-10, IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13.

For the purpose of this standard, the following applies.

5 Specified layer

Subclause 5.3 of IEC 60695-2-10 is replaced by:

In cases where burning or glowing particles might fall from the specimen onto an external surface underneath the tool, the test is made with a piece of white pine-wood board, approximately 10 mm thick, and covered with a single layer of tissue paper, positioned at a distance of 200 mm ± 5 mm below the place where the tip of the glow-wire is applied to the specimen. If the tool as a whole is tested, it is placed in its normal position of use above the pine-wood board, which is covered with a single layer of tissue paper. Before starting the test, the board is conditioned as described in clause 7 for the specimen.

11 Observations and measurements

Item 11 c) of IEC 60695-2-11 does not apply.

Annex F – (normative) – Needle-flame test

The needle-flame test is made in accordance with IEC 60695-2-2.

For the purpose of this standard, the following applies.

4 Description of test apparatus

The sixth paragraph of 4.2 is replaced by:

In cases where burning or glowing particles might fall from the specimen onto an external surface underneath the tool, the test is made with a piece of white pine-wood board, approximately 10 mm thick, and covered with a single layer of tissue paper, positioned at a distance of 200 mm ± 5 mm below the place where the test flame is applied to the specimen. If the tool as a whole is tested, it is placed in its normal position of use above the pine-wood board, which is covered with a single layer of tissue paper. Before starting the test, the board is conditioned as described in clause 6 for the specimen.

5 Severities

The duration of application of the test flame is 30 s ± 1 s.

8 Test procedure

8.4 *In the first paragraph, the words "or from any source of ignition accidentally applied" do not apply.*

Replace the last two paragraphs by:

At the beginning of the test, the test flame is applied in such a way that at least the tip of the flame is in contact with the surface of the specimen.

During the application of the test flame, the burner is not to be moved. The test flame is removed immediately after the specified period has elapsed. For examples of test positions, see Figure 1.

Replace the text of 8.5 by:

The test is made on one specimen. If the specimen does not withstand the test, the test is repeated on two further specimens, both of which shall then withstand the test.

10 Evaluation of test results

Add:

When a layer of tissue paper is used, there is to be no ignition of the tissue paper, or scorching of the white pine-wood board; a slight discoloration of the white pine-wood board being neglected.

Annex G – (normative) – Proof tracking test

The proof tracking test is made in accordance with IEC 60112.

For the purpose of this standard, the following applies.

3 Test specimen

The last sentence of the first paragraph does not apply.

5 Test apparatus

The note in 5.1 does not apply.

Note 4 in 5.3 does not apply, and the test solution A described in 5.4 is used.

6 Procedure

The voltage referred to in 6.1 is adjusted to 175 V or 250 V, as appropriate.

Subclause 6.2 does not apply, and the proof tracking test of subclause 6.3 is made five times. For the latter test, notes 2 and 3 of clause 3 also apply.

Annex H – Void

Annex I – (normative) – Switches

Switches which are tested with the tool shall comply with this standard and with the following clauses of IEC 61058-1, as modified.

The tests of IEC 61058-1 are carried out under the conditions occurring in the tool.

Unless otherwise specified, the tests are carried out on the switch incorporated in the tool.

Before being tested in the tool, switches are operated 20 times without load.

8 Marking and documentation

Switches are not required to be marked, except that incorporated switches shall be marked with the manufacturer's name or trade mark and the type reference.

13 Mechanism

This clause is applicable.

NOTE The tests may be carried out on a separate sample.

15 Insulation resistance and dielectric strength

Subclauses 15.1 and 15.2 are not applicable.

Subclause 15.3 is applicable for full disconnection and micro-disconnection.

This test is carried out immediately after the humidity test of 14.3 of IEC 60745-1.

17 Endurance

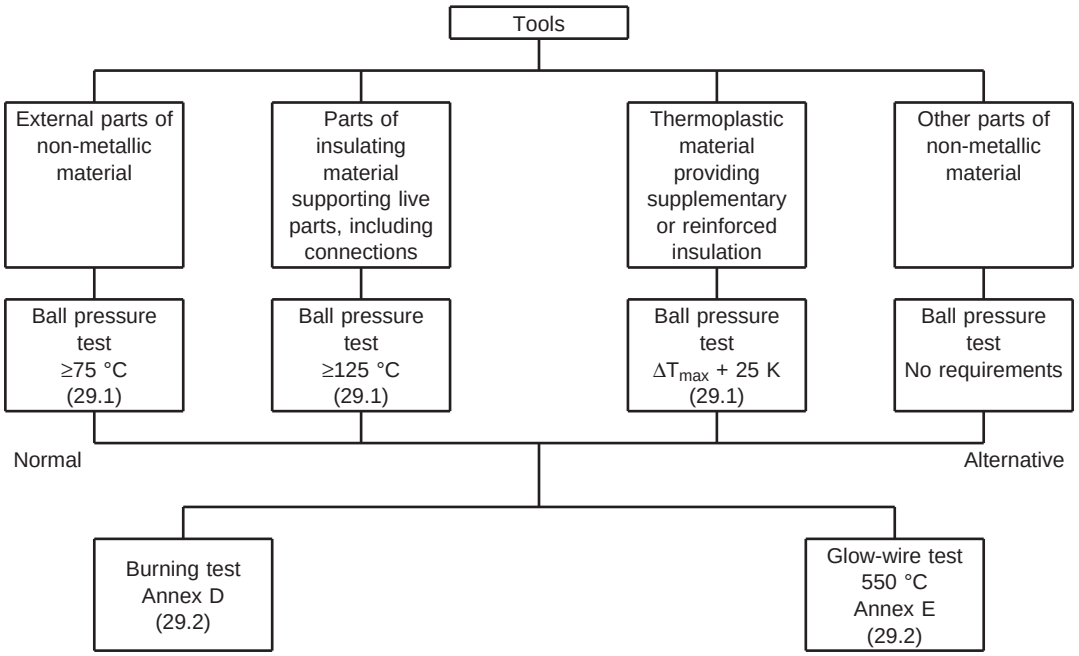
This clause is applicable.

20 Clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies

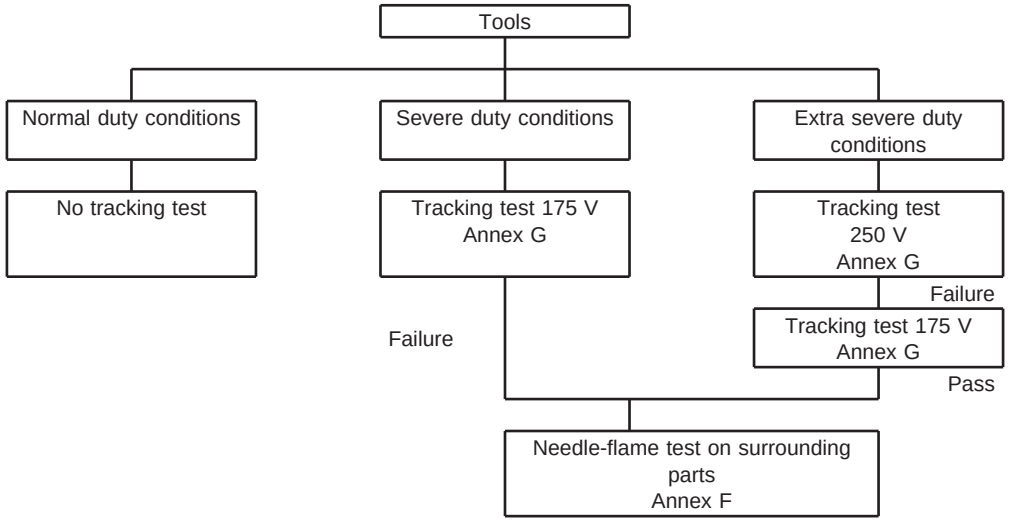
This clause is applicable for creepage distances and clearances for live parts of different potential only, for operational insulation and across full disconnection and micro-disconnection.

Annex J – (informative) – Selection and sequence of the tests of clause 29

Resistance to heat and fire



Resistance to tracking



Annex K – (normative) – Battery tool and battery packs

K.1 Scope

This annex applies to rechargeable battery-powered motor-operated or magnetically driven tools and the battery packs for such tools. This annex applies to tools incorporating detachable, integral and separable battery packs. The maximum rated voltage for tools and battery packs is 75 V d.c.

Battery tools covered by this annex are not considered to be class I, class II, or class III tools and therefore are not required to have basic, supplementary or reinforced insulation. Electric shock hazard is considered to only exist between parts of opposite polarity.

Battery packs for tools covered under this annex intended to be charged by a non-isolated charger shall be evaluated by this annex and standard. When evaluating a battery pack for protection against electric shock, creepage distances, clearances and distances through insulation, the battery pack shall be fitted to the intended charger.

All clauses of this standard apply unless otherwise specified in this annex. If a clause is stated in the annex, the requirements replace the requirements of the standard.

For the purpose of the tools covered by this annex, the term mains switch as it appears in the standard is understood to refer to the power switch of the battery operated tool.

This annex is not intended to apply to tools using general purpose batteries installed by the user and this annex alone will not be sufficient to ensure all hazards are considered for these products' "battery packs".

This annex does not apply to battery chargers which are covered by IEC 60335-2-29.

K.2 Normative references

This clause is applicable except as follows:

Additional normative reference:

IEC 61558–2–6:1997, Safety of power transformers, power supply units and similar – Part 2: Particular requirements for safety isolating transformers for general use

K.3 Definitions

For the purpose of this annex, the following definitions apply.

K.3.101 battery pack : an assembly of one or more cells intended to provide electrical current to the tool which may be supplied in one of the following forms in K.3.101.1 – K.3.101.3.

K.3.101.1 detachable battery pack : a battery pack which is contained in a separate enclosure from the battery tool and is intended to be removed from the tool for charging purposes.

K.3.101.2 integral battery pack : A battery pack which is contained within the battery tool and is not removed from the battery tool for charging purposes. A battery pack that is to be removed from the battery tool for disposal or recycling purposes only is considered to be an integral battery pack.

K.3.101.3 separable battery pack : A battery pack which is contained in a separate enclosure from the battery tool and is connected to the battery tool by a cord.

K.3.102 fully charged battery pack : A battery pack which has been through at least two discharge and charge cycles with an interval of at least two hours after each cycle in accordance with the manufacturer's instructions.

K.3.103 non-isolated source : A voltage source in which the output is not isolated from the mains supply by means of a safety isolating transformer as specified in IEC 61558–1 and IEC 61558–2–6

K.3.104 hazardous voltage : A voltage between parts having an average value exceeding 60 V d.c. or 42,4 V peak when the peak to peak ripple exceeds 10% of the average value.

K.3.105 power switch : power switch that controls the primary operating means of the tool.

K.5 General conditions for the tests

K.5.7.1 This subclause is not applicable.

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

K.5.7.3 This subclause is not applicable.

K.5.10 This subclause is not applicable.

K.5.11 This subclause is not applicable.

K.5.14 This subclause is not applicable.

K.5.15 This subclause is not applicable.

K.5.16 This subclause is not applicable.

K.5.101 Unless otherwise specified, a fully charged battery pack shall be used for each test.

K.5.102 When measuring voltage, the peak value of any superimposed ripple exceeding 10% of the average value shall be included. Transient voltages are ignored, such as the battery voltage such as after the battery pack is removed from the charger.

K.7 This clause is not applicable.

K.8 Marking and instructions

K.8.1 Battery tools and detachable or separable battery packs shall be marked with:

– *rated voltage(s) or rated voltage range(s), in volts;*

– *symbol for nature of supply;*

– *name or trade mark or identification mark of the manufacturer or responsible vendor;*

– *model or type reference;*

– *manufacturer's address or country of origin;*

– *any mandatory mark showing compliance with legislation by reference to this standard.*

Additional markings shall not give rise to misunderstanding.

Compliance is checked by inspection.

K.8.2 This subclause is not applicable.

K.8.5 This subclause is not applicable.

K.8.7 This subclause is not applicable.

K.8.8 This subclause is not applicable.

K.8.12.1 This subclause is applicable except as follows

Item 5) Service, is replaced by the following:

Replacement:

5) Battery tool use and care

a) Ensure the switch is in the off position before inserting battery pack. *Inserting the battery pack into power tools that have the switch on invites accidents.*

b) Recharge only with the charger specified by the manufacturer. *A charger that is suitable for one type of battery pack may create a risk of fire when used with another battery pack.*

c) Use power tools only with specifically designated battery packs. *Use of any other battery packs may create a risk of injury and fire.*

d) When battery pack is not in use, keep it away from other metal objects like paper clips, coins, keys, nails, screws, or other small metal objects that can make a connection from one terminal to another. *Shorting the battery terminals together may cause burns or a fire.*

e) Under abusive conditions, liquid may be ejected from the battery, avoid contact. If contact accidentally occurs, flush with water. If liquid contacts eyes, additionally seek medical help. *Liquid ejected from the battery may cause irritation or burns.*

6) 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.*

K.9 Protection against electric shock

NOTE The title of this clause differs from that of the main standard.

Battery tools and battery packs shall be so constructed and enclosed that there is adequate protection against electric shock.

K.9.1 This subclause is not applicable.

K.9.2 It shall not be possible to have two conductive, simultaneously accessible parts where the voltage between them is hazardous unless they are provided with protective impedance.

In the case of protective impedance the short circuit current between the parts shall not exceed 2 mA for dc or 0,7 mA for ac and there shall not be more than 0,1 µF capacitance directly between the parts.

Compliance for accessibility is checked by applying the test finger of figure 1 to each conductive part.

The test finger of figure 1 is applied without any appreciable force through openings 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 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.

Contact with the test finger is determined with all detachable parts removed and the battery tool operated in any possible position of normal use.

Lamps located behind detachable covers are not removed providing the lamp may be deenergized by means of a user operable plug, battery pack disconnection or a switch.

K.9.3 This subclause is not applicable.

K.9.4 This subclause is not applicable.

K.10 Starting

This clause is not applicable.

K.11 Input and current

This clause is not applicable.

K.12 Heating

K.12.1 Battery tools and battery packs shall not attain excessive temperatures.

Compliance is checked by determining the temperature rise of the various parts under the following conditions:

The tool is operated at no load until maximum temperature is reached or the tool no longer operates due to the battery pack being discharged.

During the test, thermal cut-outs and overload releases shall not operate. The temperature rises shall not exceed the values shown in Table K.1:

Table K.1

Parts	Temperature rise K
External enclosure, except handles held in normal use	60
Handles, knobs, grips, and the like which, in normal use, are continuously held:	
– of metal	30
– of porcelain or vitreous material	40
– of molded material, rubber or wood	50
Handles, knobs, grips, and the like which, in normal use, are held for short periods only (e.g. switches):	
– of metal	35
– of porcelain or vitreous material	45
– of molded material, rubber or wood	60
Parts in contact with oil having a flash point of t° C	t-50

K.12.2 This subclause is not applicable.

K.12.3 This subclause is not applicable.

K.12.4 This subclause is not applicable.

K.12.5 This subclause is not applicable.

K.12.6 This subclause is not applicable.

K.13 Leakage current

This clause is not applicable.

K.14 Moisture resistance

This clause is not applicable.

K.15 Electric Strength

K.15.1 Materials providing insulation from electric shock shall be adequate.

Compliance is checked by subjecting the insulating material for 1 min to 750 volts with a substantially sinusoidal wavefrom having a frequency of 50Hz or 60 Hz. This provision does not exclude the testing of the material as situated within the tool, providing care is taken to ensure that materials not under consideration are not subjected to the test voltage.

This applies only to materials, if they were to fail to insulate, would subject the user to a shock hazard from a hazardous voltage. This test does not apply to materials that provide only a physical barrier to contact. As such, an uninsulated energized part shall be within 1,0 mm of the material surface to be considered for this requirement

K.15.2 This clause is not applicable.

K.16 Overload protection of transformers and associated circuits

This clause is not applicable.

K.17 Endurance

This clause is not applicable.

K.18 Abnormal operation

K.18.1 All tools when operating under battery power and their battery packs shall be so designed that the risk of fire or electric shock as a result of abnormal operation is obviated as far as is practical.

Compliance is checked by the following tests.

The battery tool and battery pack, as is appropriate, are to be placed on a soft wood surface covered by two layers of tissue paper; the battery tool and battery pack are to be covered by one layer of untreated 100% cotton medical gauze. The test is to be conducted until failure or the test sample returns to room temperature. A new sample can be used for each fault listed below. There shall be adequate protection against electric shock as defined in K.9 and no charring or burning of the gauze or tissue paper shall result when a battery tool and battery pack are subjected to any one of the following fault conditions shown below in tests a to f.

Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable.

Thermal cut-outs and thermal overloads may operate during the above tests. In this case, the same test is to be repeated 3 more times, using 3 additional samples. The resistance for the short in items a), b), d), e) and f) shall not exceed 10 mΩ.

a) The terminals of a "detachable" battery pack with exposed terminals are shorted. Battery pack terminals that can be contacted using either figure 1 or figure 2 probes are considered exposed. The means of shorting shall not attain excessive temperatures so as to char or ignite the tissue paper or gauze.

b) The motor terminals are shorted.

c) The motor rotor is locked.

d) A cord provided between the separable battery pack and the battery tool shall be shorted at the point likely to produce the most adverse effects.

e) A cord provided between the tool and the charger shall be shorted at the point likely to produce the most adverse effects.

f) For battery tools a short is introduced between any two uninsulated parts of opposite polarity not in accordance with the spacings given in K.28.

K.18.2 This subclause is not applicable.

K.18.3 This subclause is not applicable.

K.18.4 This subclause is not applicable.

K.18.5 This subclause is not applicable.

K.18.6 This subclause is not applicable.

K.18.7 This subclause is not applicable.

K.18.8 This subclause is not applicable.

K.18.9 This subclause is not applicable.

K.18.12 This subclause is not applicable.

K.19 Mechanical Hazards

K.19.101 If a tool is marked with a direction of movement it shall not be possible to connect a battery pack such that the marking is not correct.

K.20 Mechanical strength

K.20.1 Battery tools and battery packs shall have adequate mechanical strength, and shall be so constructed that they withstand such rough handling as may be expected in normal use.

Compliance is checked by the tests of 20.2 and K.20.3.

Following the test, the battery tool and battery pack shall meet the requirements of K.9, K.19 and either K.18.1 (f) or K.28.1.

K.20.3 A battery tool with its battery pack attached, shall withstand being dropped three times on a concrete surface from a height of 1 m. The sample shall be positioned to vary the point of impact.

For battery tools with detachable or separable battery packs, the test is repeated three more times without the battery pack attached to the tool.

In addition for detachable or separable battery packs the test is repeated three more times on the battery packs separately.

New samples may be used for each series of three drops

K.20.4 This subclause is not applicable.

K.20.4DV.1 D2 *Addition: Add the following clause:*

Insulating material of handles and grasping surfaces, as described in 9.4DV.1 and 9.4DV.2, shall have adequate mechanical strength and shall resist deterioration.

Compliance is checked by the following test:

The sample shall be subjected to a single impact on each handle and each recommended grasping surface. The impact(s) shall be made as described in 20.2 and 20.3, as applicable, followed by a 2,500 volt ac potential between the grasping surfaces in contact with foil and the output shaft of the tool.

K.21 Construction

K.21.5 This subclause is not applicable.

K.21.6 This subclause is not applicable.

K.21.8 This subclause is not applicable.

K.21.9 This subclause is not applicable.

K.21.10 This subclause is not applicable.

K.21.11 This subclause is not applicable.

K.21.12 This subclause is not applicable.

K.21.13 This subclause is not applicable.

K.21.14 This subclause is not applicable.

K.21.15 This subclause is not applicable.

K.21.16 This subclause is not applicable.

K.21.21 This subclause is not applicable.

K.21.25 This subclause is not applicable.

K.21.26 This subclause is not applicable.

K.21.27 This subclause is not applicable.

K.21.28 This subclause is not applicable.

K.21.29 This subclause is not applicable.

K.21.30 This subclause is not applicable.

K.21.31 This subclause is not applicable.

K.21.32 This subclause is not applicable.

K.21.33 This subclause is not applicable.

K.21.34 This subclause is not applicable.

K.21.101 Tools shall not readily accept general purpose batteries (either primary or rechargeable).

Note: Examples of general purpose batteries are AA, C, D, etc.

K.22 Internal wiring

K.22.3 This subclause is applicable only for hazardous voltages.

K.22.4 This subclause is not applicable.

K.23 Components

K.23.1.10 Power switches shall have adequate breaking capacity.

Compliance is checked by subjecting a switch to 50 operations of making and breaking the locked use output spindle current of the fully charged battery operated tool. Each "on" period having a duration of not more than 0,5 s and each "off" period having a duration of at least 10 s.

After this test the power switch shall have no electrical or mechanical failure. If the switch operates properly in the ON and OFF positions at the end of the test, it is considered to have no mechanical or electrical failures.

K.23.1.11 Power switches shall withstand, without excessive wear or other harmful effect, the mechanical, electrical, and thermal stresses occurring in normal use.

Compliance is checked by subjecting a switch to 6 000 cycles of operation making and breaking the current encountered in the fully charged battery tool operated at no-load. The switch is operated at a uniform rate of 30 operations per minute. During the test the switch shall operate correctly. After the test, inspection of the switch shall show, no undue wear, no discrepancy between the position of the operating means and that of the moving contacts, no loosening of electrical or mechanical connections, no seepage of sealing compound.

K.23.5 This subclause is not applicable.

K.24 Supply connection and external flexible cords

This clause is not applicable, except as follows:

K.24.101 For battery tools with separable battery packs, the external flexible cable or cord shall have anchorages such that the conductors are relieved from strain, including twisting, where they are connected within the tool, and protected from abrasion.

Compliance is checked by inspection.

K.25 Terminals for external conductors

This clause is not applicable.

K.26 Provision for earthing

This clause is not applicable.

K.27 Screws and connections

K.27.1 This clause of the standard is applicable except as follows: Paragraph 6 and the accompanying note, which refers to earthing conductors, is not applicable.

K.28 Creepage distances, clearances and distances through insulation

K.28.1 Creepage distances and clearances shall not be less than the values in millimetres shown in Table K.2. The clearances specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, and the like, or to the air gap between the current-carrying members of such devices where the clearances vary with the movement of the contacts. Creepages and clearances also do not apply to the construction of battery cells or the interconnections between cells in a battery pack. The values specified in Table K.2 do not apply to cross-over points of motor windings.

For parts having a hazardous voltage between them, the sum total of the measured distances between each of these parts and their nearest accessible surface shall not be less than 1,5 mm clearance and 2,0 mm creepage.

NOTE Figure K.1 provides clarification on the measurement method.

Compliance is checked by measurement.

The way in which creepage distances and clearances are measured is indicated in annex A.

NOTE The risk of fire due to spacings below the required values is covered by the requirements of 18.1.

Table K.2 – Minimum creepage distances and clearances between parts of opposite polarity

millimetres

≤15V		>15V and ≤32V		>32V	
Creepage Distance	**Clearance**	**Creepage distance**	**Clearance**	**Creepage distance**	**Clearance**
–	0,8	–	1,5	2,0	1,5

Distances through slots or openings in external parts of insulating material are measured to the metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test finger of Figure 1, but is not pressed into openings.

The sum total of distances measured between parts operating at hazardous voltage and accessible surfaces is determined by measuring the distance from each part to the accessible surface. The distances are to be added together to determine the sum total. See Figure K.1.

For the purpose of this determination, one of the distances shall be 1,0 mm or greater. See annex A, cases 1 to 10.

If necessary, a force is applied to any point on bare conductors and to the outside of metal enclosures, in an endeavour to reduce the creepage distances and clearances while taking the measurements.

The force is applied by means of a test finger having a tip as shown in Figure 1 and has a value of:

- *2 N for bare conductors;*
- *30 N for enclosures.*

If a barrier is interposed, and if it is in two parts which are not cemented together, the creepage distance is also measured through the joint.

If a barrier is interposed, clearances are measured over the barrier or, if the barrier is in two parts with mating surfaces which are not cemented together, through the joint.

When assessing creepage distances and clearances, the effect of insulating lining of metal enclosures or covers is taken into consideration.

Means provided for fixing the tool to a support are considered to be accessible.

K.28.2 This subclause is not applicable.

K.29 Resistance to heat, fire and tracking

K.29.1 External parts of non-metallic material, the deterioration of which might cause the tool or battery pack to fail to comply with this annex, shall be sufficiently resistant to heat.

Compliance is checked by subjecting of the relevant parts to a ball-pressure test, which is made by means of the apparatus shown in figure 5.

Before starting the test the part is maintained for 24 h in an atmosphere having a temperature between 15°C and 35°C, and a relative humidity between 45% and 75%.

The part is supported so that its upper surface is horizontal and the spherical part of the apparatus is pressed against this surface with a force of 20 N. The thickness of the part under test shall be at least 2,5 mm. The required thickness may be obtained by using two or more sections of the part.

The test is made in a heating cabinet at a temperature of (40 ± 2) °C plus the maximum temperature rise determined during the test of K.12, but it shall be at least:

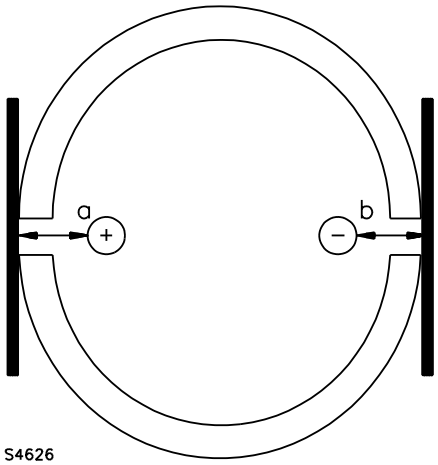
– *for external parts (75 ± 2) °C;*

Before the test is started, the test apparatus is brought to the temperature determined above.

After 1 h, the apparatus is removed and the part is immediately immersed in cold water so that it is cooled to room temperature within 10 s. The diameter of the impression shall not exceed 2 mm. The test is not made on parts of ceramic material.

K.29.2 This clause applies only to the external enclosure enclosing the current carrying part of the tool or battery pack.

K.29.3 This subclause is not applicable.



Dimension a – distance from positive bare conductive part to the external surface as defined by foil stretched across the openings.

Dimension b – distance from negative bare conductive part to the external surface as defined by foil stretched across the openings.

a + b is the sum total as defined in clause K.28.1.

Figure K.1 – Measurement of clearances

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

L.1 Scope

This annex applies to rechargeable battery-powered motor-operated or magnetically driven tools and the battery packs for such tools that are also operated and/or charged directly from the mains or a non-isolated source, including tools provided with integral battery chargers. This annex applies to tools incorporating detachable, integral and separable battery packs. The maximum rated voltages for tools are 250 V single phase a.c. or d.c. mains source and 75 V d.c. battery source. The maximum rated voltage for battery packs is 75 V d.c.

Battery packs for tools covered under this annex intended to be charged by a non-isolated charger shall be evaluated by this annex and standard. When evaluating a battery pack for protection against electric shock, creepage distances, clearances and distances through insulation, the battery pack shall be fitted to the intended charger.

All clauses of this standard apply unless otherwise specified in this annex. If a clause is stated in the annex, the requirements replace the requirements of the standard.

For the purpose of the tools covered by this annex, the term mains switch as it appears in the standard is understood to refer to the power switch of the battery-operated tool.

This annex is not intended to apply to tools using general purpose batteries installed by the user and this annex alone will not be sufficient to ensure all hazards are considered for these products.

This annex does not apply to battery chargers which are covered by IEC 60335-2-29.

L.2 Normative References

This clause is applicable except as follows:

Additional normative reference:

IEC 61558–2–6:1997, Safety of power transformers, power supply units and similar – Part 2: Particular requirements for safety isolating transformers for general use

L.3 Definitions

For the purpose of this annex, the following definitions apply:

L.3.101 battery pack : assembly of one or more cells intended to provide electrical current to the tool

L.3.101.1 detachable battery pack : a battery pack which is contained in a separate enclosure from the battery tool and is intended to be removed from the tool for charging purposes.

L.3.101.2 integral battery pack : A battery pack which is contained within the battery tool and is not removed from the battery tool for charging purposes. A battery pack that is to be removed from the battery tool for disposal or recycling purposes only is considered to be an integral battery pack.

L.3.101.3 separable battery pack : A battery pack which is contained in a separate enclosure from the battery tool and is connected to the battery tool by a cord.

L.3.102 fully charged battery pack : A battery pack which has been through at least two discharge and charge cycles with an interval of at least two hours after each cycle in accordance with the manufacturer's instructions.

L.3.103 non-isolated source : A voltage source in which the output is not isolated from the mains supply by means of a safety isolating transformer as specified

L.3.104 hazardous voltage : A voltage between parts having an average value exceeding 60 V d.c. or 42,4 V peak when the peak to peak ripple exceeds 10% of the average value.

L.3.105 power switch : power switch that controls the primary operating means of the tool.

L.3.106 interconnecting cord : external flexible cord provided as part of a complete tool for purposes other than connection to the supply mains

NOTE A remote hand-held switching device, an external interconnection between two parts of a tool and a cord connecting an accessory to the tool or to a separate signalling circuit are examples of interconnecting cords.

L.5 General conditions for the tests

L.5.101 Unless otherwise specified, a fully charged battery pack shall be used for each test.

L.5.102 When measuring voltage, the peak value of any superimposed ripple exceeding 10% of the average value shall be included. Transient voltages are ignored, such as a temporary increase above nominal, such as after the battery pack is removed from the charger.

L.7 Classification

L.7.1 This clause applies except that class III tools are not considered in this annex.

L.8 Marking and Instructions

L.8.1 The first paragraph of this clause is replaced by the following:

Non-isolated sources that can supply a tool or tools that can be supplied directly from the mains shall be marked with the following. In the case of tools supplied directly from the mains, these markings shall include those for both mains and battery operation:

– rated voltage(s) or rated voltage range(s), in volts;

– symbol for nature of supply;

– rated input, in watts, or rated current in amperes,

– name or trade mark or identification mark of the manufacturer or responsible vendor;

– model or type reference;

– symbol for class II construction, for class II tools only;

– manufacturer's address or country of origin;

– any mandatory mark showing compliance with legislation by reference to this standard.

Compliance is checked by inspection.

L.8.1.101 Tools, other than those that can be supplied directly from the mains, and detachable or separable battery packs shall be marked with:

– rated voltage(s) or rated voltage range(s), in volts;

– symbol for nature of supply;

– name or trade mark or identification mark of the manufacturer or responsible vendor;

– model or type reference.

– manufacturer's address or country of origin;

– any mandatory mark showing compliance with legislation by reference to this standard.

Additional markings shall not give rise to misunderstanding.

Compliance is checked by inspection.

L.8.12.1 This clause is applicable except as follows

Item 5) Service, is replaced by the following:

5) Battery tool use and care

a) Ensure the switch is in the off position before inserting battery pack. *Inserting the battery pack into power tools that have the switch on invites accidents.*

b) Recharge only with the charger specified by the manufacturer. *A charger that is suitable for one type of battery pack may create a risk of fire when used with another battery pack.*

c) Use power tools only with specifically designated battery packs. *Use of any other battery packs may create a risk of injury and fire.*

d) When battery pack is not in use, keep it away from other metal objects like paper clips, coins, keys, nails, screws, or other small metal objects that can make a connection from one terminal to another. *Shorting the battery terminals together may cause burns or a fire.*

e) Under abusive conditions, liquid may be ejected from the battery, avoid contact. If contact accidentally occurs, flush with water. If liquid contacts eyes, additionally seek medical help. *Liquid ejected from the battery may cause irritation or burns.*

6) 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.*

L.9 Protection against electric shock

NOTE The title of this clause differs from that of the main standard.

The requirements of 9.1 through 9.4 apply for all conditions along with the following addition:

L.9 *Addition*

Tools covered by this annex and their battery packs shall be so constructed and enclosed that there is adequate protection against electric shock.

The clause of the standard applies to tools when they are connected to the mains or are supplied by a non-isolated source. During the evaluation in this condition, battery packs are to be connected to the tool in the normal fashion. The tool is also evaluated with the battery pack removed if such removal can be accomplished without the use of a tool.

L.9.101 For battery packs which may be disconnected from the tool and tools operated under battery power it shall not be possible to have two conductive, simultaneously accessible parts where the voltage between them is hazardous unless they are provided with protective impedance.

In the case of protective impedance the short circuit current between the parts shall not exceed 2 mA for dc or 0,7 mA for ac and there shall not be more than 0,1 µF capacitance directly between the parts.

Compliance for accessibility is checked by applying the test finger of figure 1 to each conductive part.

The test finger of figure 1 is applied without any appreciable force through openings 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 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.

Contact with the test finger is determined with all detachable parts removed and the battery tool operated in any possible position of normal use.

Lamps located behind detachable covers are not removed providing the lamp may be deenergized by means of a user operable plug, battery pack disconnection or a switch.

L.10 Starting

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.11 Input and current

This clause only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source. In the case of tools that can also charge the battery while performing their intended function, the test is conducted while charging a previously discharged battery pack.

L.12 Heating

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source. In the case of tools that can also charge the battery pack while performing their intended function, they are tested with the charger connected and are operated at no load until the tool stops operating due to the battery pack discharged or thermal stabilization is achieved, whichever occurs first. The test is repeated allowing the battery pack to charge while the tool is not operating.

L.13 Leakage current

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.14 Moisture resistance

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.15 Electric strength

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source. Care shall be taken that the premature failure of electronic devices does not prevent the application of the test voltage across insulation. If this is the case, electronic devices may be bypassed to enable the test to be conducted.

L.16 Overload protection of transformers and associated circuits

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.17 Endurance

This clause applies to tools capable of continuous operation when they are supplied directly from the mains or a non-isolated source. For tools that are not capable of continuous, operation, they shall be operated under battery power for the duration of the test but shall be evaluated for electric strength with their charger connected.

L.18 Abnormal operation

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.18.101 All tools when operating only under battery power and their battery packs shall be so designed that the risk of fire or electric shock as a result of abnormal operation is obviated as far as is practical.

Compliance is checked by the following tests.

The battery tool and battery pack, as is appropriate, are to be placed on a soft wood surface covered by two layers of tissue paper; the battery tool and battery pack are to be covered by one layer of untreated 100% cotton medical gauze. The test is to be conducted until failure or the test sample returns to room temperature. A new sample can be used for each fault listed below. There shall be adequate protection against electric shock as defined in L.9 and L.13 and no charring or burning of the gauze or tissue paper shall result when a battery tool and battery pack are subjected to any one of the following fault conditions shown below in tests a) to f).

Charring is defined as a blackening of the gauze caused by combustion. Discolouration of the gauze caused by smoke is acceptable.

Thermal cut-outs and thermal overloads may operate during the above tests. In this case, the same test is to be repeated 3 more times, using 3 additional samples. The resistance for the short in items a), b), d), e) and f) shall not exceed 10 mΩ.

a) The terminals of a "detachable" battery pack with exposed terminals are shorted. Battery pack terminals that can be contacted using either figure 1 or figure 2 probes are considered exposed. The means of shorting shall not attain excessive temperatures so as to char or ignite the tissue paper or gauze.

b) The motor terminals are shorted.

c) The motor rotor is locked.

d) A cord provided between the separable battery pack and the battery tool shall be shorted at the point likely to produce the most adverse effects.

e) A cord provided between the tool and the charger shall be shorted at the point likely to produce the most adverse effects.

f) For battery tools a short is introduced between any two uninsulated parts of opposite polarity not in accordance with the spacings given in L.28.101.

L.19 Mechanical Hazards

L.19.101 If a tool is marked with a direction of movement it shall not be possible to connect a battery pack such that the marking is not correct.

L.20 Mechanical strength

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.20.4DV.1 D2 *Addition: Add the following clause:*

Insulating material of handles and grasping surfaces, as described in 9.4DV.1 and 9.4DV.2, shall have adequate mechanical strength and shall resist deterioration.

Compliance is checked by the following test:

The sample shall be subjected to a single impact on each handle and each recommended grasping surface. The impact(s) shall be made as described in 20.2 and 20.3, as applicable, followed by a 2,500 volt ac potential between the grasping surfaces in contact with foil and the output shaft of the tool.

L.20.101 With the battery connected, battery tools and battery packs shall have adequate mechanical strength, and shall be so constructed that they withstand such rough handling as may be expected in normal use.

A battery tool with its battery pack attached, shall withstand being dropped three times on a concrete surface from a height of 1 m. The sample shall be positioned to vary the point of impact.

For battery tools with detachable or separable battery packs, the test is repeated three more times without the battery pack attached to the tool.

In addition for detachable or separable battery packs the test is repeated three more times on the battery packs separately.

New samples may be used for each series of three drops.

Following the test, the battery tool and battery pack shall meet the requirements of L.9, L.19, L.28.1 and either L.18.101 (f) or L.28.101.

L.21 Construction

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.22 Internal wiring

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.23 Components

L.23.1.10 The subclause of the standard applies only to tools capable of performing their intended operation when connected to the mains or a non-isolated source for those switches that control the primary operating means of the tool.

L.23.1.10.101 Switches, other than those of tools described in L.23.1.10, that control the primary operating means of the tool shall have adequate breaking capacity.

Compliance is checked by subjecting a switch to 50 operations of making and breaking the locked use output spindle current of the fully charged battery operated tool. Each "on" period having a duration of not more than 0,5 s and each "off" period having a duration of at least 10 s.

After this test the power switch shall have no electrical or mechanical failure. If the switch operates properly in the ON and OFF positions at the end of the test, it is considered to have no mechanical or electrical failures.

L.23.1.11 The subclause of the standard applies only to tools capable of performing their intended operation when connected to the mains or a non-isolated source for those switches that control the primary operating means of the tool.

L.23.1.11.101 Switches, other than those described in L.23.1.10, that control the primary operating means of the tool shall withstand, without excessive wear or other harmful effect, the mechanical, electrical, and thermal stresses occurring in normal use.

Compliance is checked by subjecting a switch to 6 000 cycles of operation making and breaking the current encountered in the fully charged battery tool operated at no-load. The switch is operated at a uniform rate of 30 operations per minute. During the test the switch shall operate correctly. After the test, inspection of the switch shall show, no undue wear, no discrepancy between the position of the operating means and that of the moving contacts, no loosening of electrical or mechanical connections, no seepage of sealing compound.

L.24 Supply connection and external flexible cords

L.24.1 This subclause also applies to a flexible cord between a non-isolated power source and the tool.

L.24.3 This subclause also applies to a flexible cord between a non-isolated power source and the tool.

L.24.4 This subclause applies except a flexible cord provided between a non-isolated power source and the tool shall not be provided with a plug that can be connected directly to the mains.

L.24.5 This subclause does not apply to a flexible cord provided between a non-isolated power source and the tool.

L.24.21 This subclause applies except a flexible cord provided between a non-isolated power source and the tool shall not be provided with an appliance inlet that can be connected directly to the mains.

L.24.101 For battery tools with separable battery packs, the external flexible cable or cord shall have anchorages such that the conductors are relieved from strain, including twisting, where they are connected within the tool, and protected from abrasion.

Compliance is checked by inspection.

L.25 Terminals for external conductors

This clause does not apply to interconnecting cords.

L.26 Provision for earthing

This clause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

L.28 Creepage distances, clearances and distances through insulation

The clause of the standard is applicable except as follows:

L.28.1 Addition:

This subclause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source. During the evaluation in this condition, battery packs are to be connected to the tool. The tool is also evaluated with the battery pack removed if such removal can be accomplished without the use of a tool.

L.28.101

Creepage distances and clearances shall not be less than values in millimetres shown in Table L.1. The clearances specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, and the like, or to the air gap between the current-carrying members of such devices where the clearances vary with the movement of the contacts. Creepages and clearances also do not apply to the construction of battery cells or the interconnections between cells in a battery pack. The values specified in Table L.1 do not apply to cross-over points of motor windings.

For parts having a hazardous voltage between them, the sum total of the measured distances between each of these parts and their nearest accessible surface shall not be less than 1,5 mm clearance and 2,0 mm creepage.

NOTE Figure L.1 provides clarification on the measurement method.

Compliance is checked by measurement.

The way in which creepage distances and clearances are measured is indicated in annex A.

For parts of different polarity, clearance and creepage distances less than those given in Table L.1 are acceptable if the shorting of the two parts does not result in the tool starting.

NOTE The risk of fire due to spacings below the required values is covered by the requirements of 18.1.

Table L.1 – Minimum creepage distances and clearances between parts of opposite polarity

millimetres

≤15V		>15V and ≤32V		>32V	
Creepage Distance	**Clearance**	**Creepage distance**	**Clearance**	**Creepage distance**	**Clearance**
–	0,8	–	1,5	2,0	1,5

Distances through slots or openings in external parts of insulating material are measured to metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test finger of Figure 1, but is not pressed into openings.

The sum total of distances measured between parts operating at hazardous voltage and accessible surfaces is determined by measuring the distance from each part to the accessible surface. The distances are to be added together to determine the sum total. See Figure L.1. For the purpose of this determination, one of the distances shall be 1,0 mm or greater. See annex A, cases 1 to 10.

If necessary, a force is applied to any point on bare conductors and to the outside of metal enclosures, in an endeavour to reduce the creepage distances and clearances while taking the measurements.

The force is applied by means of a test finger having a tip as shown in Figure 1 and has a value of:

- *2 N for bare conductors;*
- *30 N for enclosures.*

If a barrier is interposed, and if it is in two parts which are not cemented together, the creepage distance is also measured through the joint.

If a barrier is interposed, clearances are measured over the barrier or, if the barrier is in two parts with mating surfaces which are not cemented together, through the joint.

When assessing creepage distances and clearances, the effect of insulating lining of metal enclosures or covers is taken into consideration.

Means provided for fixing the tool to a support are considered to be accessible.

L.29 Resistance to heat, fire and tracking

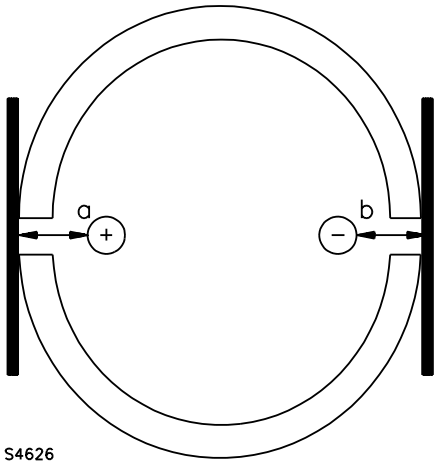
The clause of the standard is applicable except as follows:

L.29.1 Addition:

This subclause only applies when the tool is in the configuration where it is directly connected to the mains or a non-isolated source.

In the case of tools that can charge the battery while performing their intended function, the battery pack shall be evaluated with the charger connected to the mains and with a battery in a condition that results in the most unfavourable temperatures.

In addition, tools capable of charging the battery and may also be capable of performing its intended operation must also be evaluated with battery power alone if this may create temperatures that are more unfavourable. For the purposes of this clause, a part that is energized only by a battery source is not to be considered live.



Dimension a – distance from positive bare conductive part to the external surface as defined by foil stretched across the openings.

Dimension b – distance from negative bare conductive part to the external surface as defined by foil stretched across the openings.

a + b is the sum total as defined in clause L.28.101

Figure L.1 – Measurement of clearances

Annex DVL – List of National Differences

Annex DVL DE *Addition: Add the following Annex:*

Reference	National Difference Type
1.1DV	DR Addition
2DV.1	DC Modification
2DV.2	DC Modification
2DV.3	DC Modification
2DV.4	DC Modification
2DV.5	DC Modification
2DV.6	DC Modification
2DV.7	DC Modification
2DV.8	DC Modification
2DV.9	DC Modification
2DV.10	DC Modification
2DV.11	DC Modification
2DV.12	DC Modification
2DV.13	DC Modification
2DV.14	DC Modification
2DV.15	DC Modification
2DV.16	DC Modification
8.1DV	D1 Modification
8.1DV.1	D1 Addition
8.12.1DV	D1 Modification: Addition to 8.12.1
8.13DV	D1 Modification
9.4DV.1	D2 Addition of 9.4DV.1
9.4DV.2	D1 Addition of 9.4DV.2
12.6DV	D1 Modification to 12.6
13.2DV	D2 Modification
14.3DV	D1 Modification of 14.3
18.12DV	D2 Modification
20.4DV.1	D2 Addition of 20.4DV.1
21.16DV	D2 Modification
21.26DV	D1 Modification of second paragraph in 21.26
22.3DV	DC Modification: Replace the fourth paragraph
22.4DV	DR Modification: Replace the first paragraph
24.1DV	D2 Modification
24.4DV	DR Modification
Table 6DV	D1 Replace Table 6
24.6DV	DR Modification: Replace the first paragraph
24.11DV	D1 Modification: Delete paragraph 24.11
24.13DV	D1 Modification to first paragraph
Table 8DV	D1 Modification: Replace Table 8
26.2DV	D1 Modification
Table 10DV	D1 Modification: Replace Row 3 in Table 10
28.2DV	D1 Modification
29DV	D1 Modification
29.3DV	D1 Modification of first paragraph
K.20.4DV.1	D2 Addition of K.20.4DV.1

Table Continued on Next Page

Table Continued

Reference	National Difference Type
L.20.4DV.1	D2 Addition of L.20.4DV.1
Annex DVL	DE Addition

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IEC 60335-2-45: 1996, Safety of household and similar electrical appliances – Part 2: Particular requirements for portable heating tools and similar appliances

IEC 60601 (all parts), Medical electrical equipment

IEC 61000-3-2: 2000, Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase)

IEC 61000-3-3: 1994, Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤16 A

CISPR 11: 1999, Industrial, scientific and medical (ISM) radio-frequency equipment – Electro-magnetic disturbance characteristics – Limits and methods of measurement

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CISPR 14-2: 1997, Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: Immunity – Product family standard

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