

INTERNATIONAL STANDARD

IEC
60745-1

Third edition
2001-12

Hand-held motor-operated electric tools – Safety –

Part 1: General requirements

*Outils électroportatifs à moteur –
Sécurité –*

*Partie 1:
Règles générales*



Reference number
IEC 60745-1:2001(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/catlg-e.htm) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/JP.htm) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch
Tel: +41 22 919 02 11
Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC
60745-1

Third edition
2001-12

Hand-held motor-operated electric tools – Safety –

Part 1: General requirements

*Outils électroportatifs à moteur –
Sécurité –*

*Partie 1:
Règles générales*

© IEC 2001 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission
Telefax: +41 22 919 0300

3, rue de Varembé Geneva, Switzerland
e-mail: inmail@iec.ch IEC web site <http://www.iec.ch>



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE **XD**

For price, see current catalogue

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references.....	7
3 Definitions	9
4 General requirements	15
5 General conditions for the tests.....	15
6 Void.....	17
7 Classification	17
8 Marking and instructions	17
9 Protection against access to live parts	24
10 Starting.....	26
11 Input and current	26
12 Heating.....	26
13 Leakage current.....	30
14 Moisture resistance.....	31
15 Electric strength.....	33
16 Overload protection of transformers and associated circuits	35
17 Endurance	35
18 Abnormal operation.....	36
19 Mechanical hazards	39
20 Mechanical strength.....	40
21 Construction	41
22 Internal wiring.....	48
23 Components.....	49
24 Supply connection and external flexible cords	52
25 Terminals for external conductors	58
26 Provision for earthing.....	61
27 Screws and connections	63
28 Creepage distances, clearances and distances through insulation	65
29 Resistance to heat, fire and tracking	69
30 Resistance to rusting	70
31 Radiation, toxicity and similar hazards.....	71

Annex A (normative) Measurement of creepage distances and clearances.....	79
Annex B (normative) Motors not isolated from the supply mains and having basic insulation not designed for the rated voltage of the tool.....	84
Annex C (normative) Circuit for measuring leakage currents.....	86
Annex D (normative) Burning test.....	88
Annex E (normative) Glow-wire test.....	89
Annex F (normative) Needle-flame test.....	90
Annex G (normative) Proof tracking test.....	91
Annex H Void.....	92
Annex I (normative) Switches.....	93
Annex J (informative) Selection and sequence of the tests of clause 29.....	94
Bibliography.....	95
Figure 1 – Standard test finger.....	72
Figure 2 – Test pin.....	73
Figure 3 – Diagram for leakage current measurement at operating temperature for single-phase connection and three-phase tools suitable for single-phase supply of class II tools.....	73
Figure 4 – Diagram for leakage current measurement at operating temperature for three-phase connection.....	74
Figure 5 – Ball-pressure test apparatus.....	74
Figure 6 – Schematic representation of cord anchorages.....	75
Figure 7 – Test fingernail.....	76
Figure 8 – Examples of parts of earthing terminals.....	77
Figure 9 – Flexing test apparatus.....	78
Figure A.1a – Clearance gap for parallel sided and V-shaped groove.....	80
Figure A.1b – Clearance gap for rib and uncemented joint with groove.....	81
Figure A.1c – Clearance gap for uncemented joint and diverging-sided groove.....	82
Figure A.1d – Clearance gap between wall and screw.....	83
Figure B.1 – Simulation of defects.....	85
Figure C.1 – Circuit for measuring leakage currents.....	87
Table 1 – Maximum normal temperature rises.....	28
Table 2 – Test voltages.....	33
Table 3 – Maximum winding temperature.....	38
Table 4 – Impact energies.....	40
Table 5 – Test torques.....	41
Table 6 – Minimum cross-sectional area of supply cord.....	53
Table 7 – Pull and torque value.....	55
Table 8 – Nominal cross-sectional area of conductors.....	59
Table 9 – Torque for testing screws and nuts.....	64
Table 10 – Minimum creepage distances and clearances (in millimetres).....	66

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 specifications, 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 third edition cancels and replaces the second edition published in 1997 and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
61F/422/FDIS	61F/427/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

Annex J is for information only.

The committee has decided that the contents of this publication will remain unchanged until 2003. 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

The contents of the corrigendum of August 2003 have been included in this copy.

Withdrawn

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 common use 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.

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.

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.

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)

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

IEC 60083:1997, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC*

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

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*

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

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

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

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*

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*

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 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*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 61058-1:2000, *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*

ISO 1463:1982, *Metallic and oxide coatings – Measurement of coating thickness – Microscopical method*

ISO 2178:1982, *Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method*

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 screwdriver or any other object, 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 to which the part under consideration is subjected when the tool is supplied at its rated voltage and operating under normal load. When deducing the working voltage, the effect of transient voltages is ignored

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, 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. The normal load is based on the rated voltage or on the upper limit of the rated voltage range

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

3.3.1

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 without the aid of a special purpose tool provided by the manufacturer. The supply cord may be a specially prepared cord and only available from the manufacturer or its service agent. A specially prepared cord can also include a part of the tool.

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. Type Y attachment may be used either with an ordinary flexible cord or with a special cord

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 applied to live parts to provide basic protection against electric shock. Basic insulation does not necessarily include insulation used exclusively for functional purposes

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

single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard. The term "single insulation system" does not imply that the insulation is one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation

3.4.5

class I tool

tool in which protection against electric shock does not rely on basic 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. For tools intended for use with a flexible cord, this provision includes a protective conductor as part of the flexible cord

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.

Such a tool may be of one of the following types:

- a) a tool having a durable and substantially continuous enclosure of insulating material which envelops all metal parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation; such a tool is called an insulation-encased class II tool;
- b) a tool having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used, because the application of double insulation is manifestly impracticable; such a tool is called a metal-encased class II tool;
- c) a tool which is a combination of the types a) and b).

The enclosure of an insulation-encased class II tool may form a part or the whole of the supplementary insulation or of the reinforced insulation.

If a tool with double insulation and/or reinforced insulation throughout has an earthing terminal or earthing contact, it is considered to be a class I tool

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. Tools intended to be operated at safety extra-low voltage, and having internal circuits which operate at a voltage other than safety extra-low voltage, are not included in the classification, and are subject to additional requirement

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 boundary surface of the tool, measured along the surface of the insulating material

3.4.11

clearance

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

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

nominal 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

NOTE The voltage limits specified are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

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, 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 held by hand or suspended during operation

NOTE Hand-held tools may be provided with a flexible shaft, the motor being either fixed or portable. Hand-held tools may also have provisions for mounting on a support. Hand-held tools include also hand-supported tools (such as paving breakers).

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, 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. It may or may not require manual resetting

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 sufficiently

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**off-position of a switching device**

stable position in which the related circuit is disconnected from the supply mains

NOTE The off-position does not imply an all-pole disconnection.

3.9.3

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

3.9.4

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.

NOTE Parts accessible or not, complying with 9.1, are not considered to be live parts.

3.10.1

electronic component

part in which conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor

NOTE Neon indicators are not considered to be electronic components

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, in normal use and under likely fault conditions in the tool, is limited to a safe value

3.11.1

rated operating time

operating time assigned to the tool by the manufacturer

3.11.2

continuous operation

operation under normal load for an unlimited period

3.11.3

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 room temperature

3.11.4

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

3.11.5

routine servicing

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

3.11.6

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. Attachments include tables to convert hand-held tools to bench mounted types; for example, a router table

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 carelessness that may occur in normal use.

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, the tests of clauses 23 to 27 and of clause 29 may be made on separate samples

Additional samples may be required, for example if the tool is designed for different supply voltages, or if the test of 12.6 has to be made, in this case, three samples of the motor are needed. The testing of components may necessitate the submission of additional samples of these components.

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 setting, if the setting can be altered by the user. Electronic speed control devices are set for the highest speed.

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

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

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

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

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

Tools for a.c. which are not marked with rated frequency, or marked with a frequency range of 50 Hz, 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 voltages within the range.

5.8 When alternative accessories are made available for the tool by its manufacturer, the tool is tested with those accessories 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 accessories 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 accessories, 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. The degrees of protection against harmful ingress of water are given in IEC 60529.

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 of the manufacturer or responsible vendor;
- model or type reference;
- 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;
- manufacturer's address or country of origin;
- 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.

8.2 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.

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.

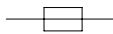
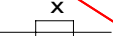
Compliance is checked by inspection.

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 When symbols are used, they shall be as follows:

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
	rated current of the appropriate fuse-link in amperes
	time-lag miniature fuse-link where X is the symbol for the time/current characteristic, as given in IEC 60127
	Protective earth
	class II tool
IPXX	IP symbol

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.

The symbol for class II tools shall be so placed that it will be obvious that it is a part of the technical information, and is unlikely to be confused with any other marking.

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.

NOTE The connector diagram may be that referred to in 8.4.

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.

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.

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 position of a greater output, input, speed, etc., shall be indicated by a higher figure.

An indication of + and – is considered to be sufficient.

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 obvious 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.

The subjects are as follows:

8.12.1 General Safety Instructions. Safety Rules 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

- a) **Keep work area clean and well lit.** *Cluttered and 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 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 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.*

8.12.2 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.

8.14 Markings specified in 8.1 to 8.5 shall be on a main part of the tool.

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.

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 until thermal stabilization. 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 operated time for tools for short-time operation;*
- *on consecutive cycles of operation, until steady conditions are established, for tools for intermittent operation, the "on" and "off" periods being the rated "on" and "off" periods;*
- *until steady conditions are established for 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:	
• 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⁾	–

Table 1 (continued)

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 of 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. switches):	
– 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. 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.	

NOTE 1 The values in the table are based on an ambient temperature not normally exceeding 25 °C, but occasionally reaching 35 °C. However, the temperature rise values specified are based on 25 °C.

NOTE 2 The value of the temperature rise of a winding is calculated from the formula:

$$\Delta t = \frac{R_2 - R_1}{R_1} (k + t_1) - (t_2 - t_1)$$

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 equal to 234,5 for copper windings, and 225 for aluminium windings;

t_1 is the room temperature at the beginning of the test;

t_2 is the room temperature at the end of the test.