IEC 62841-1

Edition 1.0 2014-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electric motor-operated hand-held tools, transportable tools and lawn and garden machinery – Safety – Part 1: General requirements

Outils électroportatifs à moteur, outils portables et machines pour jardins et pelouses – Sécurité – Partie 1: Règles générales

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC MOTOR-OPERATED HAND-HELD TOOLS, TRANSPORTABLE TOOLS AND LAWN AND GARDEN MACHINERY – SAFETY –

Part 1: General requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62841-1 has been prepared by IEC technical committee 116: Safety of motor-operated electric tools.

This standard is scheduled to cancel and replace the fourth edition of IEC 60745-1, published in 2006, the first edition of IEC 61029-1, published in 1990, and the fifth edition of IEC 60335-1, published in 2010, only with respect to requirements concerning lawn and garden machinery. The latter publications remain valid until they are withdrawn. This standard constitutes a technical revision.

This edition includes the following significant technical changes with respect to the fourth edition of IEC 60745-1:

– requirements in various clauses introduced or modified in order to include the requirements for transportable tools and lawn and garden machinery (formerly covered by IEC 61029-1 and IEC 60335-1);

– leakage current test and electric strength test moved from former Clauses 13 and 15 to Annexes C and D;
– former Clauses 29, 30 and 31 renumbered to become Clauses 6, 13 and 15;
– requirements for electronic **safety critical functions** added to Clause 18;
– requirements for switches revised and moved from Annex I to Clause 23;
– clarifications in respect to soft materials (elastomers) added to Clauses 9, 19 and 13;
– test finger in Figure 1 of IEC 60745-1 and test probe in Figure 2 of IEC 60745-1 replaced by references to basic IEC standards;
– requirements for Li-Ion battery systems added to Annexes K and L;
– Annex M removed.

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

FDIS	Report on voting
116/156/FDIS	116/163/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.

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

This Part 1 is to be used in conjunction with the appropriate parts of IEC 62841-2, IEC 62841-3 or IEC 62841-4 which contain clauses that supplement or modify the corresponding clauses in Part 1 to provide the relevant requirements for each type of product.

NOTE 1 In this standard, the following print types are used:

– requirements: in roman type
– *e e / / / / / / e*
– Notes: in smaller roman type

Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and the associated noun are also in bold.

NOTE 2 In Annexes B, K and L, subclauses which are additional to those in the main body of the text are numbered starting from 201.

A list of all parts of the IEC 62841 series, under the general title: *e / / e e e* , can be found on the IEC website.

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

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

NOTE 3 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 36 months from the date of publication.

INTRODUCTION

Individual countries may wish to consider the application of this Part 1 of IEC 62841, so far as is reasonable, to tools not mentioned in an individual part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 and to tools designed on new principles.

Examples of standards dealing with non-safety aspects of **hand-held tools, transportable tools and lawn and garden machinery** are

– standards dealing with EMC aspects;

– standards dealing with environmental aspects.

ELECTRIC MOTOR-OPERATED HAND-HELD TOOLS, TRANSPORTABLE TOOLS AND LAWN AND GARDEN MACHINERY – SAFETY –

Part 1: General requirements

1 Scope

This International Standard deals with the safety of electric motor-operated or magnetically driven:

– **hand-held tools** (IEC 62841-2);
– **transportable tools** (IEC 62841-3);
– **lawn and garden machinery** (IEC 62841-4).

The above listed categories are hereinafter referred to as “tools” or “machines”.

The **rated voltage** is not more than 250 V for single-phase a.c. or d.c. tools, and 480 V for three-phase a.c. tools. The **rated input** is not more than 3 700 W.

The limits for the applicability of this standard for battery tools are given in K.1 and L.1.

This standard deals with the hazards presented by tools which are encountered by all persons in the **normal use** and reasonably foreseeable misuse of the tools.

Tools with electric heating elements are within the scope of this standard.

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. Requirements for such tools that are also operated and/or charged directly from the mains or a non-isolated source are given in Annex L.

Hand-held electric tools, which can be mounted on a support or working stand for use as fixed tools without any alteration of the tool itself, are within the scope of this standard and such combination of a **hand-held tool** and a support is considered to be a **transportable tool** and thus covered by the relevant Part 3.

This standard does not apply to:

– tools intended to be used in the presence of explosive atmosphere (dust, vapour or gas);
– tools used for preparing and processing food;
– tools for medical purposes;

NOTE 1 IEC 60601 series covers a variety of tools for medical purposes.

– tools intended to be used with cosmetics or pharmaceutical products;
– heating tools;

NOTE 2 IEC 60335-2-45 covers a variety of heating tools.

– electric motor-operated household and similar electrical appliances;

NOTE 3 IEC 60335 series covers a variety of electric motor-operated household and similar electrical appliances.

– electrical equipment for industrial machine-tools;

NOTE 4 IEC 60204 series deals with electrical safety of machinery.

– small low voltage transformer operated bench tools intended for model making, e.g. the making of radio controlled model aircraft or cars, etc.

NOTE 5 In the United States of America, the following conditions apply:

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

NOTE 6 In Canada, the following conditions apply:

This standard deals with tools used in non-hazardous locations in accordance with the Canadian Electric Code, Part 1, CSA C22.1, and General Requirements – Canadian Electrical Code, Part II, CAN/CSA-C22.2 No. 0.

2 Normative references

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

IEC 60061, , available at http://std.iec.ch/iec60061

IEC 60065:2001, [1]
Amendment 2:2010
Amendment 1:2005

IEC 60068-2-75:1997,

IEC/TR 60083,

IEC 60085:2007,

IEC 60127 (all parts),

IEC 60227 (all parts),

IEC 60238,

IEC 60245 (all parts),

IEC 60252-1,

IEC 60320 (all parts),

IEC 60320-1,

IEC 60335-1:2010,

1 There exists a consolidated version (Edition 7.2:2011) which includes IEC 60065:2001 and its Amendment 1 (2005) and Amendment 2 (2010).

IEC 60384-14, [illegible]

IEC 60417, [illegible] available at http://www.graphical-symbols.info/graphical-symbols/equipment/db1.nsf/$enHome?OpenForm

IEC 60529:1989, [illegible]
Amendment 1:1999
Amendment 2:2013

IEC 60664-1, [illegible]

IEC 60695-2-11:2000, [illegible]

IEC 60695-2-13:2010, [illegible]

IEC 60695-10-2:2003, [illegible]

IEC 60695-11-10:2013, [illegible]

IEC 60730-1:2010, [illegible]

IEC 60825-1:2007, [illegible]

IEC 60884 (all parts), [illegible]

IEC 60906-1, [illegible]

IEC 60990:1999, [illegible]

IEC 60998-2-1, [illegible]

IEC 60998-2-2, [illegible]

IEC 60999-1:1999, [illegible]

IEC 61000-4-2:2008, [illegible]

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2 There exists a consolidated version (Edition 2.2:2013) which includes IEC 60529:1989 and its Amendment 1 (1999) and Amendment 2 (2013).

IEC 61000-4-3:2006, [illegible] 3
Amendment 1:2007
Amendment 2:2010

IEC 61000-4-4:2012, [illegible]

IEC 61000-4-5:2005, [illegible]

IEC 61000-4-6:2008, [illegible]

IEC 61000-4-11:2004, [illegible]

IEC 61032:1997, [illegible]

IEC 61056-1, [illegible]

IEC 61058-1:2000, [illegible] 4
Amendment 1:2001
Amendment 2:2007

IEC 61210, [illegible]

IEC 61540:1997, [illegible] 5
Amendment 1:1998

IEC 61558-1, [illegible]

IEC 61558-2-4, [illegible]

IEC 61558-2-6, [illegible]

IEC 61558-2-16, [illegible]

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3 There exists a consolidated version (Edition 3.2:2010) which includes IEC 61000-4-3:2006 and its Amendment 1 (2007) and Amendment 2 (2010).

4 There exists a consolidated version (Edition 3.2:2008) which includes IEC 61058-1:2000 and its Amendment 1 (2001) and Amendment 2 (2007).

5 There exists a consolidated version (Edition 1.1:1999) which includes IEC 61540:1997 and its Amendment 1 (2001).

IEC 61951-1, e % e n e e % /n/n' e e % %ne n%n / ee % e % e e e e e n , e e /n' e e / e / / /

IEC 61951-2, e % e n e e % /n/n' e e % %ne n%n / ee % e % e e e e e n , e e /n' e e / e / e n / e

IEC 61960, e % e n e e % /n/n' e e % %ne n%n / ee % e e % e n e e % % e n / /n

IEC 61984, %n e % e e / e e n n e

IEC 62133, e % e n e e % /n/n' e e % %ne n%n / ee % e e e / e e n % % e e e % e n % e / e n % e / /n

IEC 62233, / e e e n / e n% % ee % n e / e % n% en% / n e n // / / / e n % n e % e

IEC 62471, n%% %% / e % / n / e /

IEC/TR 62471-2:2009, n%% %% / e % / n / e / e n e % n / /n' e / e e n e /n' %n n e % / /n e

ISO 1463, / e / n %k e % /n' / e / e n % % /n' n / n e / / % % / e n%

ISO 2178, % / n e / % /n' % / n e / e / e e n % % /n' n / n e / / n e / / e n%

ISO 2768-1, e n e %e n e %e n e % /n e n n' // e n /n / n% /n / / %e n e /n / /n

ISO 3744, % / e e / /n % % n % e e e n % n e e e % n% e % e /n' e % n e e n'/n ee /n' / e n% % n e e n / ee / e % e e e /n' n e

ISO 3864-2, / n / % e %% n e /'n e /'n /n / e % % e e

ISO 3864-3, / n / % e %% n e /'n e /'n /n / e % / n / / % % / e /n e /'n

ISO 4871:1996, % / e /n n e /' /n % n% e e / / /n % e % / n e n e / / e n

ISO 5347 (all parts), / e n% % ne / /n % % / /n n n% /

ISO 5349-1, / e n n / / /n e / e e e n n e /n % % n / n e k % e % n n / / e / /n e / e / e n

ISO 5349-2, / e n n / / /n % / e / e e n n e /n % % n / n e k % e % n n / / e / /n / / / n e % / e / e e n /n n e % e

ISO 7000:2012, / n / / % % e %e / / e n /n e k n n% /

ISO 7010, / n / / % e %% n e /'n e /' e e e /'n

ISO 7574-4, [illegible]

ISO 8041, [illegible]

ISO 9772:2012, [illegible]

ISO 11201, [illegible]

ISO 11203, [illegible]

ISO 12100, [illegible]

ISO 13849-1, [illegible]

ISO 13850, [illegible]

ISO/TR 11690-3, [illegible]

ISO 16063-1, [illegible]

EN 12096, [illegible]

ASTM B 258, [illegible]

UL 969, [illegible]

NOTE 1 In the United States of America, the following normative reference applies:

US, Code of Federal Regulations (CFR) Title 21, [illegible]

NOTE 2 In Canada, the following normative reference applies:

C.R.C., c. 1370, Radiation Emitting Devices Regulations

NOTE 3 In Europe (EN 62841-1), the following normative references apply:

CR 1030-1, [illegible]

EN ISO 11688-1, [illegible]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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”, are used, the word “tool” means a hand tool, for example a screwdriver, which may be used to operate a screw or other fixing means.

3.1

3.10
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

3.11
class II construction
part of a tool for which protection against electric shock relies upon **double insulation** or **reinforced insulation**

3.12
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 voltage**s are not generated

3.13
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 1 to entry: Examples of **clearances** are given in Annex A.

3.14
control device
device used by the user to adjust and/or regulate an electrical or mechanical function of the tool

3.15
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 1 to entry: Examples of **creepage distances** are given in Annex A.

3.16
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 externally accessible brush caps, even if removal requires the use of a tool

Note 1 to entry: A non-detachable part is covered by the requirements of 21.22.

3.17
double insulation
insulation system comprising both **basic insulation** and **supplementary insulation**

3.18
electronic circuit
circuit incorporating at least one **electronic component**

3.19
electronic component
part in which conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor, with the exclusion of neon indicators

Note 1 to entry: Examples of **electronic components** are diodes, transistors, triacs and monolithic integrated circuits. Resistors, capacitors and inductors are not considered **electronic components**.

3.20
explosion
failure that occurs, when an enclosure opens violently and major components are forcibly expelled in a manner that could result in injury

3.21
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

3.22
fixed guard
guard affixed in such a manner (e.g. by screws, nuts, welding) that it can only be opened or removed with the use of tools or by destruction of the affixing means

3.23
guard
physical barrier, designed as part of the tool, to provide protection

3.24
hand-held tool
tool intended to do mechanical work, with or without provisions for mounting on a support, and

3.31
momentary power switch
power switch that does not remain in the “on” position when the actuating device is released

3.32
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

Note 1 to entry: Manual operation also includes operation of the **power switch**.

3.33
non-isolated source
voltage source in which the output is not isolated from the mains supply by means of a **safety isolating transformer**

3.34
normal operation
conditions under which the tool is operated in **normal use** when it is connected to the power supply

3.35
normal use
use of a tool for which it is designed, taking into account the manufacturer’s instructions

3.36
power switch
device that electrically activates the primary function of the tool in the “on” position and deactivates the same function of the tool in its “off” position

3.37
protective device
device, the operation of which prevents a hazardous situation under abnormal operation conditions

3.38
protective impedance
impedance connected between **live parts** and accessible conductive parts, and of value so that the current is limited to a safe value

3.39
rated current
current assigned to the tool by the manufacturer

3.40
rated frequency
frequency assigned to the tool by the manufacturer

3.41
rated frequency range
frequency range assigned to the tool by the manufacturer, expressed by its lower and upper limits

3.42
rated input
input in watts assigned to the tool by the manufacturer

3.52
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**

3.53
supply cord
flexible cord, for supply purposes, which is fixed to the tool

3.54
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

Note 1 to entry: This does not reverse this operation of opening or closing a circuit during the **normal operation** of the tool.

3.55
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, the setting of which cannot be altered by the user

3.56
thermal link
thermal cut-out which operates only once, and then requires partial or complete replacement

3.57
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

3.58
transportable tool
tool that has the following characteristics:

a) intended to be taken to various designated working areas. The tool performs work on the material that is either brought to the tool, the tool is mounted to the workpiece or the tool is placed in proximity of the workpiece;

b) intended to be moved by one or two people, with or without simple devices to facilitate transportation, e.g. handles, wheels and the like;

c) used in a stationary position set up on a bench, table, floor or incorporating a device that performs the function of a bench or table, with or without fixing, e.g. fast clamping devices, bolting and the like, or mounted to the workpiece;

d) used under the control of an operator;

e) either the workpiece or the tool is fed or introduced manually;

f) not intended for continuous production or production line use;

g) if mains operated, supplied with a flexible **supply cord** and plug

3.59
type X attachment
method of attachment of the **supply cord** specified by the manufacturer so that it can easily be replaced

3.60
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

3.61
type Z attachment
method of attachment of the **supply cord** so that it cannot be replaced without breaking or destroying the tool

3.62
user maintenance
maintenance operation(s) which are intended to be carried out by the user in accordance with the instruction manual

3.63
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 with **rated input** or **rated current**

4 General requirements

Tools shall be so constructed that they operate safely so as to cause no danger to persons or surroundings.

Tools that have clearly separate modes of operation shall comply separately with the requirements applicable to each specific mode of operation.

Multifunction tools shall comply separately with the applicable part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 and shall take into account any other hazards due to the combination of functions.

NOTE In Europe (EN 62841-1), the above paragraph is not applicable.

5 General conditions for the tests

5.1

NOTE Annex F shows an example of routine tests.

5.2

electronic circuits

5.3

5.4 ***normal use***

5.5 ***control devices***

5.6

5.7

5.7.1 ***rated frequency*** ***rated frequency*** ***rated frequency range***

5.7.2 ***rated voltage*** ***rated voltage range***

5.7.3 ***rated current*** ***rated current*** ***rated input*** ***rated voltage*** ***rated voltage range***

5.8 ***attachments*** ***attachments***

5.9 ***supply cord***

5.10 ***class I tools*** ***accessible parts*** ***live parts*** ***class II construction***

5.11 ***class I tools*** ***class II tools*** ***safety extra-low voltage*** ***class III tools***

5.12

5.18 [illegible]

5.19 [illegible]

5.20 [illegible]

6 Radiation, toxicity and similar hazards

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

[illegible]

NOTE Previous studies have shown that the level of electromagnetic fields (EMF) emitted by power tools and garden machinery, measured in accordance with IEC 62233, is far below the applicable limits, provided the sole significant source of EMF is the motor, which is typically a universal, DC (with or without brushes), induction or solenoid motor. Therefore, a general measurement in accordance with IEC 62233 was regarded as not necessary.

6.2 If the tool is fitted with a laser to indicate a cutting line or the like, the laser class shall be 2M or lower, according to IEC 60825-1:2007.

In addition, the tool shall be marked with the symbol(s) as required by IEC 60825-1:2007 for the relevant laser class.

[illegible]

6.3 If a tool is fitted with non-coherent light sources, users of tools shall be cautioned as to the risk of potential photo-biological harm, if such harm exists.

Depending on the type of light source, the requirements of 6.3.1, 6.3.2 or 6.3.3 apply.

6.3.1 Visible light indicators (pilot lamps) and Infrared sources used for signalling and communication are considered to have no risk of photo-biological harm and require no marking.

[illegible]

6.3.2 Tools emitting visible light from electroluminescent, incandescent or LED sources are considered to be for short term, non-general light services use where exposure is both incidental and intermittent.

The emitted light is considered to present no reasonable risk or harm, if either

– the light emission at a distance of 200 mm along any direction of the tool is below 500 Lux; or
– the luminance light emission is less than 10 000 cd/m² in the range of visible light; or
– the light source (if not focused by external optics) is in Risk Group 1 or lower evaluated by the methods of IEC 62471; or
– the tool itself is evaluated by the methods of IEC 62471 and found to be in Risk Group 1 or lower.

6.3.3 For light derived by sources other than those mentioned in 6.3.2, the product shall be evaluated by the methods of IEC 62471 and the markings shall be guided by 5.4 of IEC/TR 62471-2:2009.

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**.

7.2 Tools shall have the appropriate degree of protection against harmful ingress of water according to IEC 60529:2013. If a degree other than IPX0 is required this shall be specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

8 Marking and instructions

8.1 Tools shall be marked with rating information as follows:

– **rated voltage**(s) or **rated voltage range**, in volts. Tools for star-delta connection shall be clearly marked with the two **rated voltages** (for example 230 Δ/ 400 Y). A tool that complies with this standard for a voltage range, may also be marked with any single voltage or smaller voltage range within that range;
– symbol for nature of supply, unless the **rated frequency(ies)** or **rated frequency range** is marked. The symbol for nature of supply shall be placed next to the marking for **rated voltage**;
– **rated input**, in watts or **rated current**, in amperes. The **rated input** or **rated current** to be marked on the tool is the total maximum input or current that can be drawn from external 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;
– symbol for **class II construction**, for **class II tools** only;
– IP number according to degree of protection against ingress of water other than IPX0. If the first numeral for the IP numbering is omitted, the omitted numeral shall be replaced by the letter X, for example IPX5.

8.1.1 Tools having a range of rated values such as for voltage and frequency and which can be operated without adjustment throughout the range shall be marked with the lower and upper limits of the range separated by a hyphen.

Example:

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

Tools having different rated values and which have to be adjusted for use of a particular value by the user or installer shall be marked with the different values separated by an oblique stroke. This requirement is also applicable to tools with provision for connection to both single-phase and multi-phase supplies.

Examples:

115/230 V: The tool is only suitable for the marked values.

230/400 V: The tool is only suitable for the voltages values indicated, 230 V being for single-phase operation and 400 V for three-phase operation.

% / n e / ne e /n e /o%

8.1.2 For tools marked with more than one **rated voltage**, a **rated voltage range** or with more than one **rated voltage range**, the **rated input** for each of these voltages 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 upper and lower limits of a **rated voltage range** does not exceed 20 % of the mean value of the range, in which case the marking for **rated input** may be related to the mean value of the range.

% / n e / ne e /n e /o%

8.2 Tools shall be marked with a safety warning in one of the following versions:

– "⚠WARNING – To reduce the risk of injury, user must read instruction manual", or
– symbol M002 of ISO 7010, or
– the appropriate symbol stated in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

If used, the word "WARNING" shall be in capital letters not less than 2,4 mm high and shall not be separated from either the cautionary statement or the symbol ISO 7000-0434A or ISO 7000-0434B (2004-01).

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

If additional symbols are used, they shall be in accordance with ISO 7010 or be designed in accordance with ISO 3864-2 or ISO 3864-3.

Cautionary statements having the same signal word such as "⚠WARNING" may be combined into one paragraph under one signal word. The order of statements shall be markings required by IEC 62841-1, markings required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 and then any optional markings.

% / n e / ne e /n e /o% n / e e / n

8.3 Tools shall be marked with additional information as follows:

– the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact. Country or state, city and postal code (if any) are deemed sufficient for this purpose;

– designation of the tool,
designation of the tool may be achieved by a code that is any combination of letters, numbers or symbols, providing that this code is explained by giving the explicit designation such as “drill”, “planer” etc. in the instructions supplied with the tool;

NOTE 1 An example of such code is “A123-B”.

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 (rpm)

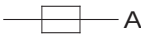
For symbols the following shall be used:

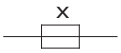
 or d.c. .....[symbol IEC 60417-5031 (2002-10)]
direct current

 or a.c. .....[symbol IEC 60417-5032 (2002-10)]
alternating current

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

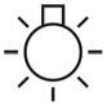
 .....[symbol IEC 60417-5019 (2006-08)]
protective earth

 .....[symbol IEC 60417-5172 (2003-02)]
class II tool

IPXX .....IP symbol

 .....[symbol ISO 7000-0434A or ISO 7000-0434B (2004-01)]
caution

 .....[symbol M002 of ISO 7010]
read the instructions

 .....[symbol IEC 60417-5012 (2002-10)]
lamp

NOTE The rated wattage of the lamp may be indicated in association with this symbol.

 .....[symbol IEC 60417-6041 (2010-08)]
visible radiation, instructional safeguard

Ø .....diameter

Li-Ion .....lithium-ion battery

NiCd .....nickel-cadmium battery

NiMH .....nickel-metal hydride battery

If additional symbols are used, they shall not give rise to misunderstanding and be explained in the instructions.

When other units are used, the units and their symbols shall be those of the international standardized system.

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 terminals are clearly identified.

The earthing conductor is not considered to be a supply conductor. For tools for star-delta connection, the wiring diagram shall show how the windings are to be connected.

8.8 Except for **type Z attachment**, 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 IEC 60417-5019 (2006-08).

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

8.9 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.

8.10 The “off” position of a multi-stable **power switch** shall be indicated; the indication shall be the figure O, as given by symbol IEC 60417-5008 (2002-10). A **momentary power switch** which can be locked in the “on” position is not considered as a multi-stable switch.

Push-buttons used only for the "off" function shall be indicated by marking the button/position with the figure O and the colour of the button shall be red or black.

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

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

For **transportable tools**, a power switch actuator or its cover shall not have a colour in a combination of yellow and red as specified for an emergency stop in accordance with ISO 13850.

When a flap/cover is provided and covers only the start button, the colour of the flap/cover shall not be black, red or yellow.

When a flap/cover is provided and covers the stop button, such flap/cover shall be red or black.

8.11 **Control devices** 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 for this requirement.

The requirement does not apply to **control devices** provided with an adjusting means, if its fully “on” position is opposite to its “off” position.

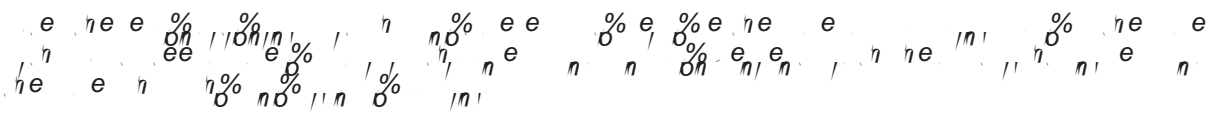
If figures are used for indicating the different positions, the “off” position shall be indicated by the figure O and the other positions shall be indicated by figures reflecting the greater output, input, speed, etc.

The indication for the different positions of the operating means of a **control device** shall be placed on the device itself, or adjacent to the operating means.

8.12 Markings required by the standard shall be legible and durable. Signs shall be in contrast such as colour, texture, or relief, to their background such that the information or instructions provided by the signs are clearly legible when viewed with normal vision from a distance of (500 + 50) mm. Signs need not be in accordance with the blue colour requirements of ISO 3864-2.

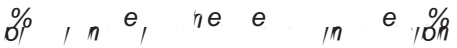
NOTE The designation “n-hexane” is the chemical nomenclature for a “normal” or straight chain hydrocarbon. An example of this petroleum spirit is also known as a certified ACS (American Chemical Society) reagent grade hexane (CAS #110-54-3).

If the marking has an adhesive backing, the adhesive backing shall be durable.



8.13 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.



8.14 An instruction manual and 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. An explanation of the symbols required by this standard and used on the tool shall be provided in either the instruction manual or the safety instructions.

They shall be written in the official language(s) of the country in which the tool is sold.

NOTE In Europe (EN 62841-1), the following additional requirement applies:

The words "Original instructions" shall appear on the language version(s) verified by the manufacturer or his authorised representative. Where no "Original instructions" exist in the official language(s) of the country where the tool is to be used, a translation into that/those language(s) shall be provided by the manufacturer or his authorised representative or by the person bringing the tool into the language area in question. The translations shall bear the words "Translation of the original instructions", and they shall be accompanied by a copy of the "Original instructions".

They shall be legible and contrast with the background.

They shall include the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact. Country or state, city and postal code (if any) are deemed sufficient for this purpose.

They shall include the designation of the tool and series or type as required by 8.3, including description of machine such as “drill”, “planer” etc.

8.14.1

8.14.1.1 General power tool safety warnings

WARNING Read all safety warnings, instructions, illustrations and specifications provided with this power tool.

Save all warnings and instructions for future reference.

1) Work area safety

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

b) **Do not operate power tools in explosive atmospheres, such as in the presence of flammable liquids, gases or dust.**

Keep children and bystanders away while operating a power tool.

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.**

b) **Avoid body contact with earthed or grounded surfaces, such as pipes, radiators, ranges and refrigerators.**

c)

f) **Dress properly. Do not wear loose clothing or jewellery. Keep your hair and clothing away from moving parts.**

g) **If devices are provided for the connection of dust extraction and collection facilities, ensure these are connected and properly used.**

h) **Do not let familiarity gained from frequent use of tools allow you to become complacent and ignore tool safety principles.**

4) Power tool use and care

a) **Do not force the power tool. Use the correct power tool for your application.**

b) **Do not use the power tool if the switch does not turn it on and off.**

c) **Disconnect the plug from the power source and/or remove the battery pack, if detachable, from the power tool before making any adjustments, changing accessories, or storing power tools.**

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.**

e) **Maintain power tools and accessories. Check for misalignment or binding of moving parts, breakage of parts and any other condition that may affect the power tool's operation. If damaged, have the power tool repaired before use.**

The sections of the safety warnings shall be presented in the related topic of the instruction manual.

The instruction manual section titles for IEC 62841-1 warnings shall have a format:

General Power Tool Safety Warnings – [Section subtitle]

Example:

General Power Tool Safety Warnings – Personal Safety

The instruction manual section titles for IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings shall have a format:

[Tool category name] Safety Warnings – [Section subtitle]

Example:

Circular Saw Safety Warnings – Cutting Procedures

If particular IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings do not have a numbered subtitle, then all warnings required by the particular IEC 62841-2, IEC 62841-3 or IEC 62841-4 shall be presented in the given order and the formatting rule above shall be followed without the [**Section subtitle**].

C) Any additional warnings deemed necessary by the manufacturer, shall not be inserted within any of the IEC 62841-1 or IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings. They may be either appended to the section(s) of the IEC 62841-1 or IEC 62841-2, IEC 62841-3 or IEC 62841-4 in accordance with the topic of the safety warnings or located in any other part of the instruction manual.

8.14.1.3 If the safety instructions are separate from the instruction manual, then the following warnings shall be included in the instruction manual. These warnings, if in English, shall be verbatim and in any other official language to be equivalent.

WARNING Read all safety warnings, instructions, illustrations and specifications provided with this power tool. e %%% /n /on / e e% / e /n e e / o / n o e /o /n .

Save all warnings and instructions for future reference.

8.14.2 The instruction manual shall be provided with the following, if appropriate.

a) Instructions for putting into use

1) Setting-up or fixing power tools in a stable position as appropriate for power tools which can be mounted on a support or fixed to a bench or the floor;
2) Assembly;
3) Connection to power supply, cabling, fusing, socket type and earthing requirements;
4) For tools adjustable to different **rated voltages**: instructions, illustrations, or both for changing the voltage. The terminal identification shall be provided if the motor connection has to be altered to operate at a voltage other than that for which it was connected when shipped from the factory;
5) Illustrated description of functions;
6) Limitations on ambient conditions;
7) Fitting and adjusting of **guards** required by 19.1;
8) Information about disassembly and reassembly if applicable for transportation and/or use.

b) Operating instructions

1) Setting and testing;
2) Tool changing;
3) Clamping of the workpiece;

4) Limits on size of workpiece and type of material;
5) General instructions for use;
6) Identification of handle(s) and grasping surface(s) required by 19.4;
7) For tools with electronic speed or load regulators which do not immediately restart the tool after a stalling: a warning that the tool will restart automatically if stalled;
8) For **transportable tools** only: instruction on lifting and transportation.

c) Maintenance and servicing instructions
1) **User maintenance**, such as cleaning, sharpening, lubricating, servicing and/or replacing of parts;
2) Servicing by manufacturer or agent; list of addresses;
3) List of user-replaceable parts and instruction how to replace them;
4) Special tools which may be required;
5) For power tools with **type X attachment**: instruction that, if the **supply cord** of this power tool is damaged, it must be replaced by a specially prepared **supply cord** available through the service organization;
6) For power tools with **type Y attachment**: instruction that, 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**: information that the **supply cord** of this power tool cannot be replaced, and the power tool shall be scrapped.

d) For tools with a **liquid system**, the substance of the following, as appropriate:
1) Instructions for
– the connection to the liquid supply;
– the use of the liquid and the use of **attachments** to comply with 14.3 in order to
– avoid the tool being affected by the liquid;
– the inspection of hoses and other critical parts which could deteriorate;
– the maximum permitted pressure of the liquid supply;
2) For tools provided with an **RCD**
– warning never to use the tool without the **RCD**

3) The vibration total value and its uncertainty measured in accordance with I.3.

When the vibration total value does not exceed 2,5 m/s^2, this shall be stated.

When the vibration total value exceeds 2,5 m/s^2, its value shall be given in the instructions.

4) The following information:

- that the declared vibration total value has been measured in accordance with a standard test method and may be used for comparing one tool with another;
- that the declared vibration total value may also be used in a preliminary assessment of exposure.

5) A warning:

- that the vibration emission during actual use of the power tool can differ from the declared total value depending on the ways in which the tool is used; and
- of the need to identify safety measures to protect the operator that are based on an estimation of exposure in the actual conditions of use (taking account of all parts of the operating cycle such as the times when the tool is switched off and when it is running idle in addition to the trigger time).

8.14.3 If information about the mass or weight of the tool is provided, it shall be the mass specified in 5.17.

[illegible]

9 Protection against access to live parts

9.1 Tools shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts. The requirement applies for all positions of the tool, even after removal of detachable parts and soft materials (elastomers), such as soft grip coverings.

[illegible]

9.2 An **accessible part** is not considered to be live if:

– the part is supplied with **safety extra-low voltage**

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 42,4 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.

[illegible] ***rated voltage*** [illegible]

[illegible]

NOTE Details of a suitable circuit for measuring the current are given in Figure C.3.

9.3 [illegible] ***all-pole disconnection*** [illegible] **live parts** [illegible]

[illegible]

[illegible]

[illegible] **live parts** [illegible] **live parts** [illegible]

NOTE 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**.

9.4 [illegible] ***class II tools*** [illegible] ***class II constructions*** [illegible] ***live parts*** [illegible]

[illegible]

10.2 Tools shall not draw excessive input current during starting that could lead to nuisance operation of facility mains over-current protection devices.

10.3 Tools with a ***rated voltage*** range and a ***control device*** for ***normal use*** shall not draw excessive input current during starting that could lead to nuisance operation of facility mains over-current protection devices.

Compliance is checked by measuring the input current at ± 10 % of the ***rated current*** at the lowest and highest ***rated voltage*** of the range.

11 Input and current

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

For tools with ***accessories*** that are normally used with the tool, the measurement is made with the largest ***accessories*** that are normally used with the tool.

For tools with ***rated voltages*** or a ***rated voltage*** range, the measurement is made at the highest ***rated voltage*** and at the highest ***rated voltage range*** or the ***rated input*** or ***rated current*** that is the least favourable.

12 Heating

12.1 Tools shall not attain excessive temperatures with **rated input** or **rated current**.

Compliance is checked by measuring the temperature rise of the tool after it has been operated under the most severe conditions of normal use at the highest ***rated voltage***.

12.2 For tools with ***rated voltages*** or a ***rated voltage*** range, the most severe conditions of normal use are determined by operating the tool at the highest ***rated voltage*** and at the highest ***rated voltage range*** or the highest ***rated voltage***.

The most severe conditions of normal use are determined by operating the tool under the following conditions, as applicable:

For tools with a ***rated voltage range:*** the following

– at the highest ***rated voltage***, the highest ***rated voltage range*** or the highest ***rated voltage***;

and

– ne e // % ne **rated voltage range** e ne % % % e // e m ne % on / on ne e / on e // e m % e ne % e / m e / e e e n e / m m / e / % e ne % e / ne e / % // e he e // / % ne **rated voltage range**

ne e e e e / e e ne % n % e % ne % % / e e m e e e n e / e e / e m % ne / % % e e e n / e ne % / % e m /

12.2.1 ne % % % % ne ne m / e % e % %

– % % % n **inherent operating cycle,** ne % % / % e e / n % e % e / n n **rated input** % **rated current** / m m / ne / e // / / / e ne

– % % % n **inherent operating cycle** ne % % / % e e / n % e % e / n n **rated input** % **rated current** / m % e // e m / e n % ne % % / % e m / e ne % % / e % e / e % / m

12.3 n / e % / e e // e on / on % ne m / ee e n n % % / e e /

12.3.1 e m / ee e / n e % e e n e ne on / on % e / e m e % / ne n he m % % / % e e % / e e % // e ne **rated voltage**

12.3.2 % % % % / e / n % / % ee % e n / % ne % e m / % ne % eee ne e / e / e % ne % ne n / ee / m e e % / e % ne n % ne ee n % e ee n ne % % e / e % ne % on ne ee

% % % / e e / e % ne n % / % ee n / n e m e % % / % e ne **supply cord** n / e ne % % / m % e on / % ne % / n % n ne e / e e / e % ne % e % ne % / ee / m e ne / % n % e e

12.4 e e e e % ne n n % e % m m / e ee / m e e / m e % n % m / e e on ne e / e % ne % e % n e e

ne e e e / e % ee / m % on % ne n n % m m / ee / m e % ne e % m on / on % e % ne e / % / on % e % / on % **creepage distances** % **clearances** e % ne e / e // m

e e e / e % / m m / e ee / m e ne e / n e / e n % n e ne % e n % on / % % ne / e n % m % e e e e % / on % / % e ne m e / e % % e on n % % ne e / n / e / e n m n / e ne / e / e / n / / e ne / % % e

ee / m m / ne e / e e / e % n e n % / n ne / e on / e on / / e % / n n % / e m on / n % / e **normal use** n / % m m / e / % % e

NOTE 1 If it is necessary to dismantle the tool to position thermocouples, a remeasurement of the **no-load input** is a method 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.

NOTE 3 Thermocouples having wires with a diameter not exceeding 0,3 mm are considered to be fine-wire thermocouples.

12.5 *protective devices*

Table 1 – Maximum normal temperature rises ◄ %

Parts	Temperature rise K	
Windings [a], if the insulation system is		
– class 105	75	(65)
– class 120	90	(80)
Windings [a], if the insulation system according to IEC 60085:2007 is		
– class 130	95	(85)
– class 155	115	
– class 180	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** [b]:		
– without ، -marking	30	
– with ، -marking	، -25	
Rubber or polyvinyl chloride insulation of internal and external wiring, including **supply cords**:		
– without temperature rating [c]	50	
– with temperature rating (،)	، -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 ، -marking	، -25	
Material used as insulation other than that specified for wires and windings [d]		
– 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 [e]	–	

Table 1

Parts	Temperature rise K
Wood, in general [f]	65
Outer surface of capacitors [g]:	
– with marking of maximum operating temperature ( )	-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 60065:2011	50
• other capacitors [g]	20
Parts in contact with oil having a flash-point of °C	-50

[a] 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.

[b] 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.

[c] This limit applies to cables, cords and wires complying with the relevant IEC standards; for others, it may be different. While no limit applies to connectors, it is recognized that these limits for wiring apply to internal wiring at the point where it is terminated in a connector.

[d] The values in parentheses apply, if the material is used for handles, knobs, grips and the like, and is in contact with hot metal.

[e] There is no specific limit for thermoplastic material, which has to withstand the tests of 13.1, for which purpose the temperature rise must be determined.

[f] The limit specified concerns the deterioration of wood, and it does not take into account deterioration of surface finishes.

[g] There is no limit for the temperature rise of capacitors which are short-circuited in 18.6.

If other materials than those mentioned in the table are used, they are not to be subjected to temperatures in excess of their thermal capabilities as determined by ageing tests.

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

$$\Delta = \frac{2 - 1}{1}(k + 1) - (2 - 1)$$

where

Δ is the temperature rise;

$_1$ is the resistance at the beginning of the test;

$_2$ is the resistance at the end of the test;

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

$_1$ is the ambient temperature at the beginning of the test;

$_2$ 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.

Table 2 – Maximum outside surface temperature rises

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 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

12.6 The following tests shall be conducted when the temperature rises of the armature and/or field windings exceed the values in Table 1 or when there is doubt with regards to the temperature classification of the insulation system.

NOTE The use of a growler is one method to detect interturn short circuits.

13 Resistance to heat and fire

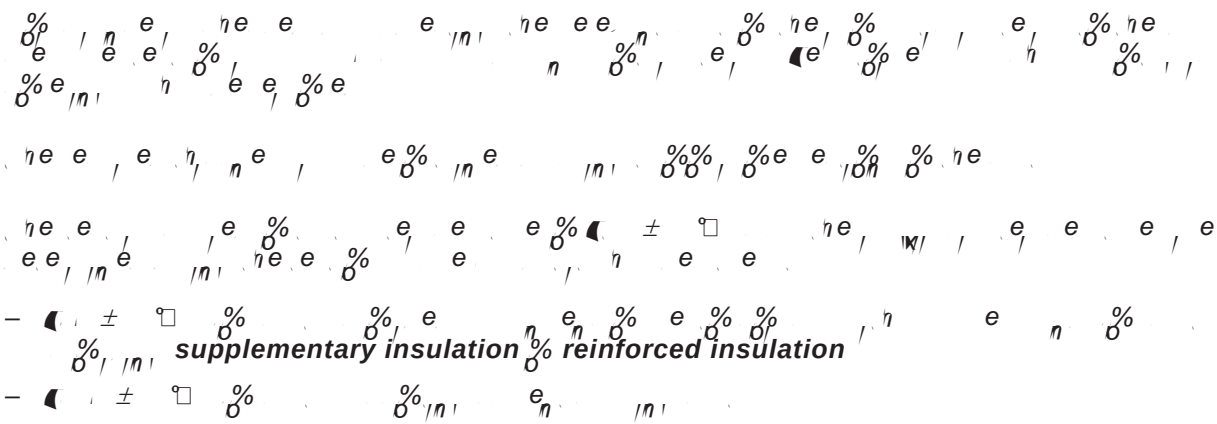
13.1 The following parts shall be sufficiently resistant to distortion due to heat, if this could cause the tool to fail to comply with this standard:

– parts of thermoplastic material provided as an enclosure to comply with Clause 9;
– parts of thermoplastic material supporting current carrying parts;
– parts of thermoplastic material providing **supplementary insulation** or **reinforced insulation**.

For the purpose of 13.1, “supporting” means that the retention of the current carrying part by the insulating material is relied upon to fulfil 28.1. Contact alone does not constitute support.

This requirement does not apply to:

– insulation and sheath of flexible **supply cords** or internal wiring;
– cord guards;
– ceramic materials;
– insulating parts of motors: e.g. shaft insulation, end spiders, slot liners, wedges, commutators.



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

This requirement does not apply to

– internal parts that are more than 13,0 mm from an arcing part such as a commutator, unenclosed switch contacts, and the like;

[illegible]

[illegible]

[illegible] ***rated voltage*** [illegible] ***supply cord*** [illegible] ***class I tools*** [illegible] ***class II tools***

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

[illegible]

14.2.1 [illegible]

[illegible]

[illegible]

14.2.2 [illegible]

– [illegible]
– [illegible]
– [illegible]
– [illegible]
– [illegible]
– [illegible]
– [illegible]

[illegible]

[illegible]

14.3 Liquid systems or spillage of liquid shall not subject the user to an increased risk of electrical shock.

14.4 Liquid systems shall not subject the user to an increased risk of electrical shock by components not capable of withstanding the pressure during operation.

14.5 Residual current devices used to provide protection from shock in the case of failure of the **liquid system** shall comply with IEC 61540:1999 and shall meet the following requirements a) to c):

a) The **RCD** shall disconnect both mains conductors, but not the earth conductor if provided, when the leakage exceeds 10 mA and with a maximum response of 300 ms.

b) The **RCD** shall be reliable for its intended use.

c) The **RCD** shall be installed such that it is unlikely to be removed during use or normal maintenance.

rated voltage ***residual current device*** ***residual current device*** ***supply cord*** ***supply cord*** ***residual current device*** ***Type Y attachment*** ***Type Z attachment*** ***supply cord*** ***interconnection cord***

15 Resistance to rusting

15.1 Ferrous parts used to conduct electricity and those mechanical parts specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 shall be adequately protected against rusting.

16 Overload protection of transformers and associated circuits

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

Examples of short-circuits which are likely to occur 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.

[illegible] ***normal use*** [illegible]

– [illegible] ***rated voltage*** [illegible] ***rated voltage*** [illegible]

– [illegible] ***rated voltage range*** [illegible] ***rated voltage range*** [illegible] ***rated voltage range*** [illegible]

[illegible] ***safety extra-low voltage*** [illegible]

[illegible]

NOTE Protection of transformer windings can 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.

17 Endurance

17.1 Tools shall be so constructed that 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 incorporated in the tool shall not activate under normal running conditions.

[illegible] ***normal use***

17.2 Hand-held tools [illegible] **transportable tools** [illegible]

NOTE 1 Requirements for **lawn and garden machinery** are specified in the relevant part of IEC 62841-4.

[illegible]

Hand-held tools ***rated voltage*** ***rated voltage range*** ***rated voltage*** ***rated voltage range*** ***normal use***

NOTE 2 The change of position is made to prevent abnormal accumulation of carbon dust in any particular place. Examples of the three positions are horizontal, vertically up and vertically down.

Transportable tools ***rated voltage*** ***rated voltage range*** ***rated voltage*** ***rated voltage range*** ***normal use***

17.3 ***rated input*** ***rated current*** ***rated voltage*** ***rated voltage range***

18 Abnormal operation

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

18.1.1 ***live parts*** ***accessible parts***

18.2 [illegible] ***non-self-resetting-thermal cut-outs*** [illegible] ***Electronic circuits*** [illegible] ***safety critical function*** [illegible] ***protective device*** [illegible] ***thermal link*** [illegible] ***thermal cut-out*** [illegible]

18.3 [illegible] ***accessories*** [illegible] ***rated voltage*** [illegible]

18.4 [illegible]

– [illegible]

– [illegible]

[illegible] ***rated voltage*** [illegible] ***rated voltage range*** [illegible] ***rated input*** [illegible] ***rated current*** [illegible] ***thermal cut-outs*** [illegible]

Table 3 – Maximum winding temperature

Class	105	120	130	155	180	200	220	250
Temperature °C	200	215	225	240	260	280	300	330

18.5 Protection against electric shock shall not be impaired when a **class II tool** or a **class I tool** employing **class II construction** (see 5.10) is subjected to running overload conditions.

[illegible] ***lawn and garden machinery*** [illegible]

– [illegible] ***class I tool*** [illegible]

– [illegible]

– [illegible]

lawn and garden machinery

18.5.1 **thermal cut-outs** **protective devices**

electronic circuits **rated current** **safety critical function**

live parts **accessible parts**

rated voltage **rated current**

live parts **accessible parts**

–

–

electronic circuit **safety critical function**

18.5.2

rated voltage

rated current

18.5.3 [illegible]

– [illegible]

– [illegible]

[illegible]

[illegible]

[illegible]

[illegible] ***rated voltage*** [illegible]

- ***hand-held tools***
- [illegible]
- [illegible]

[illegible]

18.5.4 [illegible] ***SCF***

18.6 Electronic circuits shall be so designed and applied so that a fault condition will not render the tool unsafe with regard to electric shock, fire hazard or accessibility to moving parts.

NOTE 1 In general, encapsulation effectively limits the likelihood of the spread of fire within the encapsulated circuit. Electrolytic capacitors often require an unobstructed surface to allow venting under fault conditions.

NOTE 2 Examination of the tool and its circuit diagram will reveal the fault conditions which have to be simulated through circuit analysis, so that testing can be limited to those cases which may be expected to give the most unfavourable result.

18.6.1 ηe %%/ ,ση/ση %% e %/ ee n / ne e /e %e // e ση e e/ , e/ , /n n ση %/ e /ση %

η% / / % ***creepage distances*** ***clearances*** e ee % / e % / ee e % / / ηe e / n e e e η n ηe e e // /n e n e ηe ee n / e

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NOTE The verification whether the fuse-link acts as a protecting device is based on the fusing characteristics specified in IEC 60127-3, which also gives the information necessary to calculate the maximum resistance of the fuse-link.

18.7 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.

18.8 Electronic circuits providing safety critical functions

18.8.1 General

Electronic circuits that provide **safety critical functions** shall be

– reliable

and

– not susceptible to loss of **safety critical function** due to exposure to electromagnetic environmental stresses encountered in anticipated environments.

NOTE 1 An example for a safe state is a tool that is inoperable.

Table 4 – Required performance levels

Type and purpose of SCF	Minimum Performance Level (PL)
Power switch – prevent unwanted switch-on	*
Power switch – provide desired switch-off	*
For tools where marking with the direction of rotation is required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4: Provide desired direction of rotation	*
Any electronic control to pass the test of 18.3	*
For tools covered by 19.6: Overspeed prevention to prevent output speed above 130 % of rated (no-load) speed	*
For tools other than those covered by 19.6 or with output speed increases that do not exceed 130 % of rated (no-load) speed: Any speed limiting device	Not a **SCF**
Restart prevention, if required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4	*
Soft start, if required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4	*
Prevent exceeding thermal limits as in Clause 18	*
Prevent self-resetting as required in 23.3	*
* Performance levels are to be specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 or; for tools without a relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, in accordance with ISO 13849-1 using Annex E as a guide.	

NOTE 2 In Europe (EN 62841-1), the footnote in Table 4 reads:

* Performance levels are to be specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

[illegible] ***MTTF*$_d$ [illegible] ***MTTF*$_d$ [illegible]

– [illegible] – ***MTTF*$_d$ – [illegible]

– [illegible] – ***MTTF*$_d$ – [illegible]

– [illegible] – ***MTTF*$_d$ – [illegible]

[illegible] ***safety critical function*** [illegible] ***electronic circuit*** [illegible]

NOTE 3 Annex E provides guidance in applying ISO 13849-1 for **SCF** of products covered by this standard.

NOTE 4 In Europe (EN 62841-1), the above paragraph and NOTE 3 are not applicable.

[illegible] ***safety critical function*** [illegible] ***power switch*** [illegible]

[illegible] **SCF** [illegible] – [illegible]

NOTE 5 The allowance to use microcontrollers and other programmable logic, which are considered as “complex electronic circuits”, for category 1 in accordance with ISO 13849-1, is based upon their fulfilment of the requirements of H.11.12.3 of IEC 60730-1:2010.

[illegible] **SCF** [illegible]

18.8.2 [illegible]

18.8.3 [illegible]

18.8.4 [illegible]

18.8.5 [illegible]

18.8.6 [illegible]

18.8.7 [illegible]

NOTE The dwell time for each frequency is to be sufficient to observe a possible malfunction of the circuit providing a **safety critical function**.

19 Mechanical hazards

19.1 Moving and other dangerous parts of the tool shall, as far as is compatible with the use and working of the tool, be so positioned or enclosed to provide adequate protection against personal injury.

Protective enclosures, covers, **guards** and the like shall have 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, an **adjustable 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 reasonably foreseeable hazards.

[illegible]

19.2 Tools shall have no ragged or sharp edges, other than those necessary for the functioning of the tool, which could create a hazard for the user.

19.3 It shall not be possible to reach dangerous moving parts through dust collection openings with the **detachable parts** or provisions for dust collection removed, if any.

19.4 **Hand-held tools** shall have at least one handle or grasping surface to ensure safe handling during use.

Transportable tools shall be provided with at least one handle, grasping surface or the like to ensure safe transportation.

Lawn and garden machinery shall have adequate grasping surfaces to ensure safe handling during use.

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

19.6 For all tools where the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 requires the tool to be marked with the **rated no-load speed**, the no-load speed of the spindle at **rated voltage** shall not exceed 110 % of the **rated no-load speed**.

19.7 **Transportable tools** and **lawn and garden machinery** intended to be used on a surface such as the floor or a table shall have adequate stability.

19.8 Transportable tools provided with wheels identified in the relevant part of IEC 62841-3 shall have adequate stability during transportation.

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e e n / o ne o e % n e /n /n e n n / e o □ % ne n % % o / on ne e o
ne o % e n o %e ne oo % n n o % / o % e

19.9 If, in accordance with 8.14.2, the user is instructed to remove a **fixed guard**, such as for maintenance, to convert the tool or to change the **accessory**, then the fastenings shall remain attached to the **guard** or to the machinery. If a fastening need not be completely removed for removing the **guard**, it shall be considered as still attached.

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20 Mechanical strength

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

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20.3 *hand-held tools* *lawn and garden machinery* *transportable tools* *lawn and garden machinery*

20.3.1 *hand-held tool* *accessories* *attachment* *attachment* *attachment*

20.3.2 *transportable tool*

guard *guard* *guard* *normal operation*

20.4 Accessible caps of brush holders shall have adequate mechanical strength.

Table 6 – 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	1,25

20.5 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 in accordance with 8.14.2 b) 6), shall have adequate mechanical strength in order to provide insulation between the grasping area

and the output shaft. The relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 specifies if 20.5 does not apply.

[illegible]

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.

[illegible]

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

[illegible]

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.

[illegible]

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.

[illegible]

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.

[illegible]

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.

[illegible]

21.7 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.

[illegible]

21.8 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 **user maintenance**, 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.

[illegible]

[illegible] ***user maintenance***

[illegible]

[illegible] ***class II tools*** [illegible]

21.9 The insulation of the inner conductors of a flexible cable or cord used as wiring within the tool is considered as **basic insulation**. No additional insulation is required in areas of class I construction When these conductors are used in areas of **class II construction**, they shall be insulated from accessible metal parts by any of the following:

– the sheath of the **supply cord** itself, provided this sheath is not exposed to undue thermal stress, clamping against accessible metal or other mechanical stress (e.g. pressure or tension) that could cause damage to the sheath; or

– a sleeve, tubing or barrier complying with the requirements of **supplementary insulation**.

[illegible]

21.10 Air intake of motor enclosures shall not enable the ingress of foreign bodies that could impair safety.

[illegible]

21.11 Class I tools shall be so constructed that, should any wire, screw, nut, washer, spring, brush, brush holder component 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 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.

[illegible]

21.12 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 **clearances** 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**.

Elastomer, natural or synthetic rubber parts used as **supplementary insulation** and/or **reinforced 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**.

[illegible] ***live parts*** [illegible] ***accessible parts***

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

[illegible]

[illegible]

[illegible]

21.13 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.

21.14 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 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; they shall not project beyond the surrounding surface of the tool.

21.15 Tools employing **liquid systems** shall protect the user against the increased risk of shock due to the presence of liquid under faults of the **liquid system**.

Tools employing **liquid systems** shall be either:

– of **class III construction**; or

– of **class I** or **class II construction** and be provided with a **residual current device** and comply with 14.3, 14.4 and 14.5; or

– of **class I** or **class II construction** and be designed for use in combination with an isolating transformer and comply with 14.3 and 14.4.

21.16 For tools having compartments to which access can be gained without the aid of a tool and that are likely to be cleaned in **normal use**, the electrical connections shall be arranged so that they are not subject to pulling during cleaning.

21.17 Tools shall be fitted with a **power switch** to control the motor. The actuating member of this switch shall be easily visible and accessible.

21.17.1 For tools incorporating a switch with a lock-off device, whereby the switch trigger is operated with a squeezing action by closing the fingers towards the palm of the hand, the lock-off system shall be designed to ensure sufficient durability to withstand abuse and environmental conditions to prevent activation of the tool by the switch trigger alone.

21.17.1.1

21.17.1.2

NOTE The above test can be performed in conjunction with 23.1.10.2.

21.17.1.3

Table 7 – Switch trigger force

Trigger type	Force N
Single finger trigger (trigger length < 30 mm)	100
Multi finger trigger (trigger length ≥ 30 mm)	150

21.18 Additional requirements for **power switches** for **hand-held tools** are given in 21.18.1. Additional requirements for **power switches** for **transportable tools** are given in 21.18.2. Additional requirements for **power switches** for **lawn and garden machinery** are given in the relevant part of IEC 62841-4.

21.18.1 For **hand-held tools**, the **power switch** required by 21.17 shall be a **momentary power switch**, with or without a lock-on device, which can be switched on and off by the user without releasing any of the handle(s) or grasping surface(s) required by 19.4.

For **hand-held tools** without a relevant part of IEC 62841-2 and without a substantial risk associated with continued operation, **power switches** other than **momentary power switches** are permitted.

NOTE In Europe (EN 62841-1), the above paragraph is not applicable.

21.18.1.1 When a **momentary power switch** has a separate action to lock it in the "on“ position, the switch shall unlock automatically with a single actuation motion without releasing the grasp on the tool. For tools supplied with more than one switch of which any can be locked on, the lock-on switch(es) shall be within the grasping zone necessary to control the tool, and any one of these switches shall unlock or make ineffective all remaining lock-on devices automatically with a single actuation motion without releasing the grasp on the tool.

Where there is a risk associated with continued locked-on operation as defined by the relevant part of IEC 62841-2, the switch shall not have any locking device to lock it in the “on” position.

21.18.1.2 Where there is a risk associated with inadvertent starting as defined by the relevant part of IEC 62841-2, **power switch** triggers and lock-off devices, if applicable, shall be so located, designed or guarded that inadvertent operation is unlikely to occur.

It shall either not be possible to start the tool when a rigid sphere with a diameter of (100 ± 1) mm is applied to the **power switch** in any direction with a single linear motion;

or

two separate and dissimilar actions shall be necessary before the motor is switched on (e.g. a **power switch** which has to be pushed in before it can be moved laterally to close the contacts to start the motor). It shall not be possible to achieve these two actions with a single grasping motion or a straight line motion.

NOTE In Europe (EN 62841-1), the following additional requirement applies:

Unless **hand-held tools** are equipped with a **momentary power switch**, voltage recovery following an interruption of the supply shall not give rise to a hazard. The relevant part of IEC 62841-2 specifies if this subclause applies and gives specific requirements.

21.18.2 For **transportable tools**, the **power switch** required by 21.17 shall be able to be easily actuated “on” or “off” without any reasonably foreseeable hazard from the operator's position as specified in the instruction manual in accordance with 8.14.2.

21.18.2.1 Unless **transportable tool**s are equipped with a **momentary power switch**, voltage recovery following an interruption of the supply shall not give rise to a hazard. The relevant part of IEC 62841-3 specifies if this subclause applies and gives specific requirements.

21.18.2.2 An “on”/”off” control shall be capable of being turned off by the operator with a single straight-line motion.

When a flap/cover is provided and covers the stop button it shall do so in a way such that pushing the flap actuates the stop.

21.18.2.3 A **power switch** shall be located, designed or guarded so that unintentional movement to the “on” position is unlikely.

It shall either not be possible to start the tool when a rigid sphere with a diameter of (100 ± 1) mm is applied to the **power switch** in any direction with a single linear motion;

or

the **power switch** shall have two separate and dissimilar actions before the motor is switched on (e.g. a **power switch** which has to be pushed in before it can be moved laterally to close the contacts to start the motor). It shall not be possible to achieve these two actions with a single grasping or a straight line motion.

21.18.2.4 A push-pull switch shall be turned off by an inward push.

21.19 Tools shall be so designed that the protection against electric shock is not affected when screws removed during **user maintenance** are incorrectly replaced during reassembly.

21.20 If the tool is marked with the first numeral of the IP system, the relevant requirements of IEC 60529:2013 shall be fulfilled.

21.21 Tools shall be so designed that 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 even if connected to the supply side of the switch. This requirement does not apply to capacitors complying with the requirements for **protective impedance** specified in 9.2 and 21.34.

21.22 Non-detachable parts, which provide the necessary degree of protection against electric shock, moisture, or contact with moving parts, shall either require removal with the aid of a tool or be fixed in a reliable manner.

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 shall not deteriorate.

21.23

accessible metal parts that may become live by the output shaft. These insulating barriers are not to be regarded as **basic insulation**, **supplementary insulation** or **reinforced insulation**.

If a stick type auxiliary handle is provided with such tool, it shall be insulated and be provided with a flange having a height not less than 12 mm above the grasping surface between the grasping area and **accessible parts** that may become live by the output shaft.

The relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 specifies if 21.30 does not apply.

[illegible]

21.31 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 9.2 and 21.34.

21.31

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 the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, 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.

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22.2 Internal wiring shall be either so rigid and so fixed or insulated that **creepage distances** and **clearances** cannot be reduced below the values specified in 28.1.

% / n e / ηe e /n e /on% n ηe e %

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.

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

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

Connections to aluminium windings shall consider the effects of possible corrosion between aluminium and other metals and comply with the requirements of 26.4.

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22.5 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.

% / n e / ηe e /n e /on%

22.6 Different parts of a tool that can move relative to each other

a) in **normal use**,

b) during adjustment operations,

or

c) during **user maintenance**

shall not cause undue stress to electrical connections and internal conductors, including those providing earthing continuity. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them. Open-coil springs shall not be used to protect the wiring. If a coiled spring, the turns of which touch one another, is used for this purpose, there shall be an adequate insulating lining in addition to the insulation of the conductors.

This requirement does not apply to movements of parts with small amplitudes caused by vibration.

NOTE Examples of an adequate insulating lining are flexible cords complying with IEC 60227 or IEC 60245.

23 Components

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

Batteries are not regarded as components, but as part of the tool. They shall comply with the applicable requirements as specified in Annexes K and L.

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 Capacitors for radio interference suppression shall comply with IEC 60384-14.

[illegible]

23.1.3 Small lampholders similar to E10 lampholders shall comply with the requirements for E10 lampholders in IEC 60238. However, they need not accept a lamp with an E10 cap complying with the current edition of Standard Sheet 7004-22 of IEC 60061-1.

[illegible]

23.1.4 Isolating transformers or **safety isolating transformers**, except incorporated transformers as defined in IEC 61558-1, shall comply with IEC 61558-2-4 or IEC 61558-2-6, respectively. Switch mode power supply units and transformers for switch mode power supply units shall comply with IEC 61558-2-16.

[illegible]

Incorporated transformers shall comply with IEC 61558-2-4 or IEC 61558-2-6 except for marking requirements.

[illegible]

23.1.5 Appliance couplers shall either comply with IEC 60320 or 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.

[illegible]

23.1.6 Automatic temperature controls containing electromechanical contacts that cycle in **normal use**, shall have suitable endurance for their intended application.

[illegible]

– [illegible] ***thermostat*** [illegible]

– [illegible] ***temperature limiter*** [illegible]

– [illegible] ***self-resetting thermal cut-out*** [illegible]

– [illegible] ***non self-resetting thermal cut-out*** [illegible]

– [illegible] ***non self-resetting thermal cut-outs*** [illegible]

[illegible]

[illegible] ***thermostats*** [illegible] ***temperature limiters*** [illegible]

23.1.7 [illegible]

[illegible]

23.1.8 [illegible]

[illegible]

23.1.9 [illegible] ***rated voltage*** [illegible]

23.1.10 Switches shall be so constructed that there will be no failure that might impair compliance with this standard.

[illegible]

23.1.10.1 Switches shall be rated and classified as follows.

Power switches shall be rated as follows:

– for a voltage not less than the **rated voltage** of the tool;
– for a current not less than the **rated current** of the tool;
– for a.c., if the tool is rated for a.c.;
– for d.c., if the tool is rated for d.c.

Electronic **power switches** shall, as a minimum, be classified for Continuous Duty in accordance with IEC 61058-1:2008.

Power switches shall further be classified with respect to load:

– switches for motor-operated tools and motor-operated **lawn and garden machinery**: for resistive and motor load in accordance with 7.1.2.2 of IEC 61058-1:2008, if the switch would encounter this load in **normal use**;
– switches for magnetically driven tools and magnetically driven **lawn and garden machinery**: for inductive load in accordance with 7.1.2.8 of IEC 61058-1:2008, if the switch would encounter this load in **normal use**;
– alternatively, switches may be regarded as switches for a declared specific load in accordance with 7.1.2.5 of IEC 61058-1:2008 and may be classified based upon the load conditions encountered in the tool in **normal use**.

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basic insulation

rated current

rated current

power switches

rated voltage

rated current **rated input**

23.1.10.3 The breaking capacity of **power switches** of motor-operated tools and **lawn and garden machinery** shall be adequate.

power switch

23.1.11 Electronic **power switches**, without series mechanical contact separation (air gap), are allowed, provided the requirements of 18.6 and 18.8 are met.

NOTE Electronic **power switches** are considered to provide a **safety critical function**.

23.2 Tools shall not be fitted with

– switches or automatic controls in flexible cords, however **protective devices** such as **RCD**s are allowed;

– devices, except for earthing conductors, which are intended to 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.

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23.3 Protection devices (e.g. overload or over-temperature protection devices) or circuits that switch off the tool shall be of the non-self-resetting type where there is a risk associated with inadvertent starting as specified in the relevant part of IEC 62841-2 (by 21.18.1.2), IEC 62841-3 or IEC 62841-4.

Electronic speed and load regulators are not considered to be protection devices, if they do not switch off the tool but reduce the speed of the tool as a load is applied and increase the speed of the tool when the load is removed. An **RCD** is not considered a protection device.

Resetting a protection device by switching the tool off and on with the **power switch** is considered to be a non-self-resetting action.

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23.4 Plugs and socket-outlets **for extra-low voltage** circuits, and those used as terminal devices for heating elements, shall not be interchangeable with mains plugs and socket-outlets listed in IEC 60884, IEC/TR 60083 or IEC 60906-1 or with connectors and appliance inlets complying with the standard sheets of IEC 60320-1.

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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.

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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** with a minimum length of 1,8 m and with a plug;

– a **supply cord** with a minimum length of 1,8 m and without a plug, the information for connection shall be given in the instructions in accordance with 8.14.2 a);

– an appliance inlet having at least the same degree of protection against moisture as required for the tool;

– a **supply cord** with a length between 0,2 m and 0,5 m and fitted with a plug or other connector having at least the same degree of protection against moisture as required for the tool.

Plugs, connectors and inlets shall be suitable for the ratings of the tool.

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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**, if allowed in the relevant part of IEC 62841-2, IEC 62841-3 or

Supply cords with **type X attachment** shall be specially prepared cords only available from the manufacturer or his service agent. A specially prepared cord may also include a part of the tool.

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

24.4 **Supply cords** shall be not lighter than:

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

NOTE 1 In the United States of America, the following conditions apply:

Supply cords shall be not lighter than Junior Hard service cord in accordance with the National Electrical Code, NFPA 70,

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

NOTE 2 In Canada, the following conditions apply:

Supply cords shall be not lighter than Hard Usage cord in accordance with the Canadian Electrical Code, Part 1.

Attachment plugs and cords shall 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 8.

Table 8 – Minimum cross-sectional area and AWG sizes of supply cords

Rated current of the tool A	Nominal cross-sectional area mm^2	AWG size [a]
Up to and including 6	0,75	18
Over 6 up to and including 10	1	
Over 10 up to and including 12	1,5	17
Over 12 up to and including 13		16
Over 13 up to and including 16		14
Over 16 up to and including 18	2,5	
Over 18 up to and including 25		12
[a] AWG stands for American Wire Gauge as defined in ASTM B 258-02		

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24.6 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.

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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.

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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.

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24.9 Tools provided with a **supply cord** shall be constructed so that the **supply cord** is protected against damage where it enters the tool.

This shall be achieved by either:

– a flexible cord guard; or
– a cord inlet; or
– a bushing.

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24.10 Cord inlets and 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.

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24.11 Tools, other than **transportable tools**, provided with a **supply cord** that is flexed while in operation shall be constructed so that the **supply cord** is protected against excessive flexing where it enters the tool.

NOTE Conductors include earthing conductors.

24.12 Supply cords of tools, other than **transportable tools**, that are flexed while in operation shall be protected against excessive bending at the inlet opening of the tool.

The cord guard, if any, 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.

24.13 Tools provided with a **supply cord** shall have a cord anchorage. The cord anchorage shall relieve conductors from strain, including twisting, at the terminals and protect the insulation of the conductors 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.

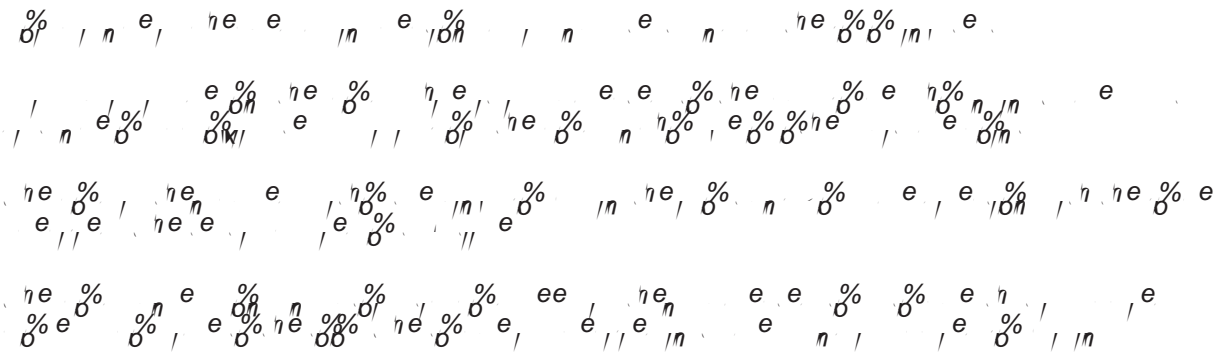
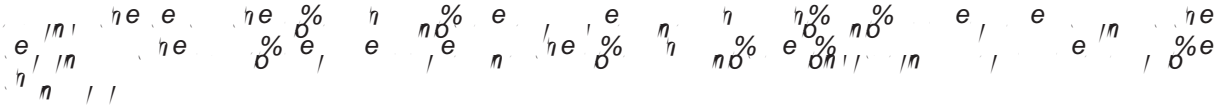


Table 9 – Pull and torque value

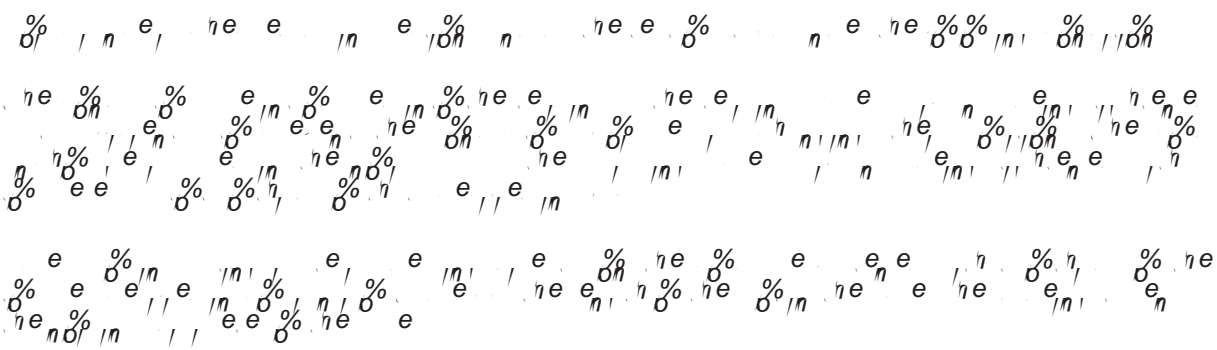
Mass of tool as specified in 5.17 kg	**Pull** N	**Torque** Nm
Up to and including 1	30	0,1
Over 1 up to and including 4	60	0,25
Over 4	100	0,35



24.14 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.

24.15 Cord anchorages shall be so designed or located that:

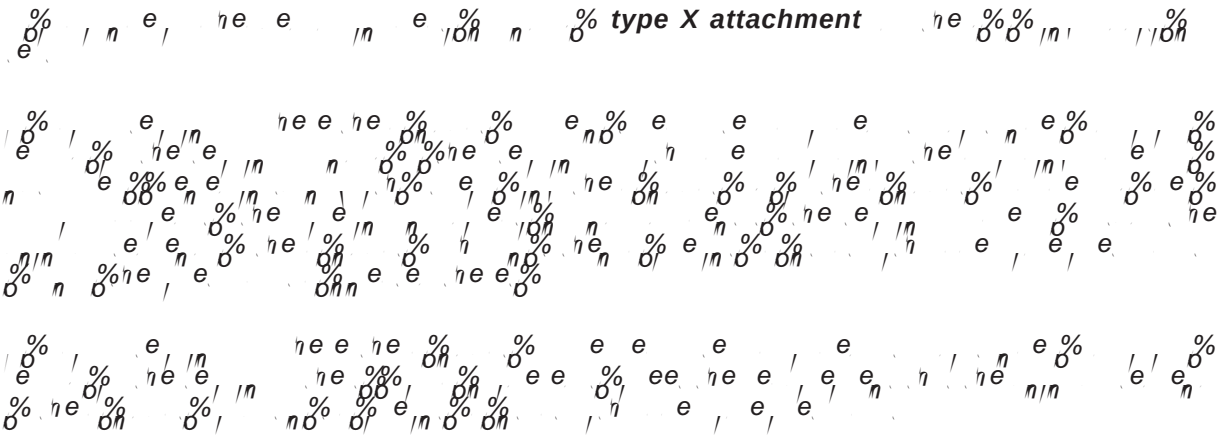
– it is clear how the relief from strain and the prevention of twisting are to be obtained;
– screws, if any, which have to be operated when replacing the cord, do not serve to fix any other component, unless, when omitted or incorrectly mounted, they render the tool inoperative or clearly incomplete, 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 24.13 is not withstood;
– at least one part of the cord anchorage is securely fixed to the tool or to a functional part of the tool such as the switch, terminal block or the like, unless it is part of the specially prepared cord.



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

24.18 The space for 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;
– that covers, if any, can be fitted without risk of damage to the supply conductors or their insulation;
– that the uninsulated end of the conductor, should it become free from a terminal, cannot come into contact with **accessible parts**, unless the cord is provided with terminations that are unlikely to slip free of the conductor.



24.19 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 horizontal flat surface.

[illegible]

24.20 Interconnection cords shall comply with the requirements for the **supply cord**, except that

– the cross-sectional area of the conductors of the cord is determined on the basis of the maximum current carried by the conductor during the test of Clause 12;

– the insulation of the conductor shall be adequate for its **working voltage**;

– the test of 24.11 is restricted to the range of motion of the tool during **normal use**.

NOTE The maximum current carried by the conductor during the test of Clause 12 is not necessarily the **rated current** of the tool.

[illegible]

24.21 Interconnection cords shall not be detachable without the aid of a tool if compliance with this standard is impaired when they are disconnected.

[illegible]

25 Terminals for external conductors

25.1 Tools shall be provided with terminals or equally effective devices for the connection of external conductors. The terminals shall only be accessible with the aid of a tool.

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.

[illegible]

For tools with **type X attachment**, 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 attachment** and **type Z attachment**, 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 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

25.6 For **type X attachment**, 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.

25.7 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.

26 Provision for earthing

26.1 **Accessible 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 tools 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.

Rotating motor components that have metal-to-metal bearing surfaces shall be considered to be electrically bonded to each other through the bearing surfaces for earthing purposes.

Accessible 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.

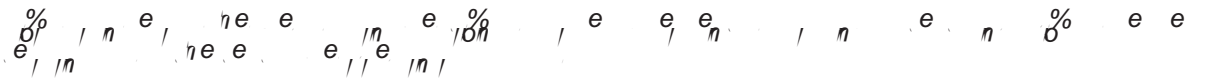
Metal parts behind a decorative cover which does not withstand the test of Clause 20 are considered to be **accessible parts**.

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 26.2.

For specifically prepared cords, terminals complying with IEC 61210 and the specifications in Table 10 are considered to comply with the requirements of 26.2. The connector material of quick connect terminals, if steel, shall comply with the requirements of Clause 15.

Table 10 – Quick-connect terminals for earthing conductors

Nominal cross-sectional area mm^2	AWG wire size	Minimum tab width mm	Minimum tab thickness mm	Connector material
0,75 to 1,0	18	2.8	0.5	Brass or steel
1,5	16	2.8	0.8	Brass or steel
1,5	16	2.8	0.5	Brass
2,5	14	6.35	0.8	Brass or steel



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.

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.

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.

26.5 The connection between the earthing terminal or earthing contact, and earthed metal parts shall be of low resistance.

rated current

27 Screws and connections

27.1 Fixings, and electrical connections, the failure of which may impair compliance with this standard, and connections providing earthing continuity shall withstand mechanical stresses occurring.

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 or connections providing earthing continuity.

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**.

Table 11 – Torque for testing screws and nuts

Nominal diameter of screw mm	Torque Nm		
	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

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.

[illegible]

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, 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.

[illegible]

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.

[illegible]

27.5 Screwless connectors, not intended for disconnection in **normal use**, shall prevent disconnection in **normal use**.

[illegible]

[illegible]

[illegible]

27.5.1 Conductors shall be secured by more than one means or shall not impair safety in the event of detachment.

% ne e ne e % ne %% e

Table 12 – Minimum creepage distances and clearances

Distances	Class III tools		Other tools					
			Working voltage ≤ 130 V		Working voltage > 130 V and ≤ 280 V		Working voltage > 280 V and ≤ 480 V	
	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
Between **live parts** of different polarity [a]:								
– if lacquered or enamelled windings or if protected against deposition of dirt [b]	1,0	1,0	1,0	1,0	2,0	2,0	3,0	3,0
– if not protected against deposition of dirt	2,0 [d]	1,5	2,0 [c]	1,5	3,0 [c]	2,5	8,0 [d]	3,0
Between **live parts** and other metal parts over **basic insulation**:								
– if the **live parts** are lacquered or enamelled windings [e] or if protected against deposition of dirt [b]	–	–	1,0	1,0	2,0	2,0	– [f]	– [f]
– if not protected against deposition of dirt	–	–	2,4 [d]	1,5	4,0 [d]	3,0	– [f]	– [f]
Between **live parts** and other metal parts over **reinforced insulation**:								
– if the **live parts** are lacquered or enamelled windings or protected against deposition of dirt [b]	–	–	5,0	5,0	6,0	6,0	– [f]	– [f]
– for other **live parts** not protected against deposition of dirt	–	–	5,0	5,0	8,0	8,0	– [f]	– [f]
Between metal parts separated by **supplementary insulation**	–	–	2,5	2,5	4,0	4,0	– [f]	– [f]

[a] 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.

[b] 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.

[c] These **creepage distances** are slightly lower than suggested by IEC 60664-1. **Creepage distances** between **live parts** of different polarity (functional insulation) are only associated to fire hazard, not to electric shock hazard. As products in the scope of IEC 62841 are products supervised during **normal use**, lower distances are justified.

[d] These **creepage distances** may be reduced to values in accordance with IEC 60664-1, if the insulation parts are of material group II or lower.

[e] Windings are considered to have **basic insulation** if they are wrapped with tape and then impregnated, or if they are covered with a layer of self-hardening resin, and if, after the test of 14.1, an electric strength test as specified in Clause D.2 is withstood, the test voltage being applied between the conductors of the winding and metal foil in contact with the surface of the insulation.

It is sufficient that the wrapping and impregnation, or the layer of self-hardening resin, cover the windings only at places where it is not possible to obtain the **creepage distance** or **clearance** specified for lacquered or enamelled windings.

[f] The **rated voltage** between a three-phase supply and earth will not be more than 277 V, therefore the column "**Working voltage** > 130 V and ≤ 280 V" will apply. For **working voltage**s greater than 280 V, **creepage distances** and **clearances** shall be determined in accordance with IEC 60664-1, but shall not be lower than the values required in the column "**Working voltage** > 130 V and ≤ 280 V".

thermostats ***creepage distances*** ***clearances***

– ***thermostats***

– ***creepage distances*** ***clearances*** ***double insulation*** ***basic insulation*** ***supplementary insulation***

– ;

– ;

NOTE The above values are equal or larger than the values required by IEC 60664-3.

Creepage darof Cd1es

– For **working voltages** up to and including 280 V, the distance through **reinforced insulation** used between windings and accessible metal shall not be less than 1,0 mm.

The required distance through insulation may be achieved through several thicknesses of solid insulation layers that may have intervening air between the layers such that the sum of the thicknesses of the solid insulation equals the required thickness.

This requirement does not apply, if either a) or b) is fulfilled.

a) The insulation is applied in thin sheet form, other than mica or similar scaly material, and consists:

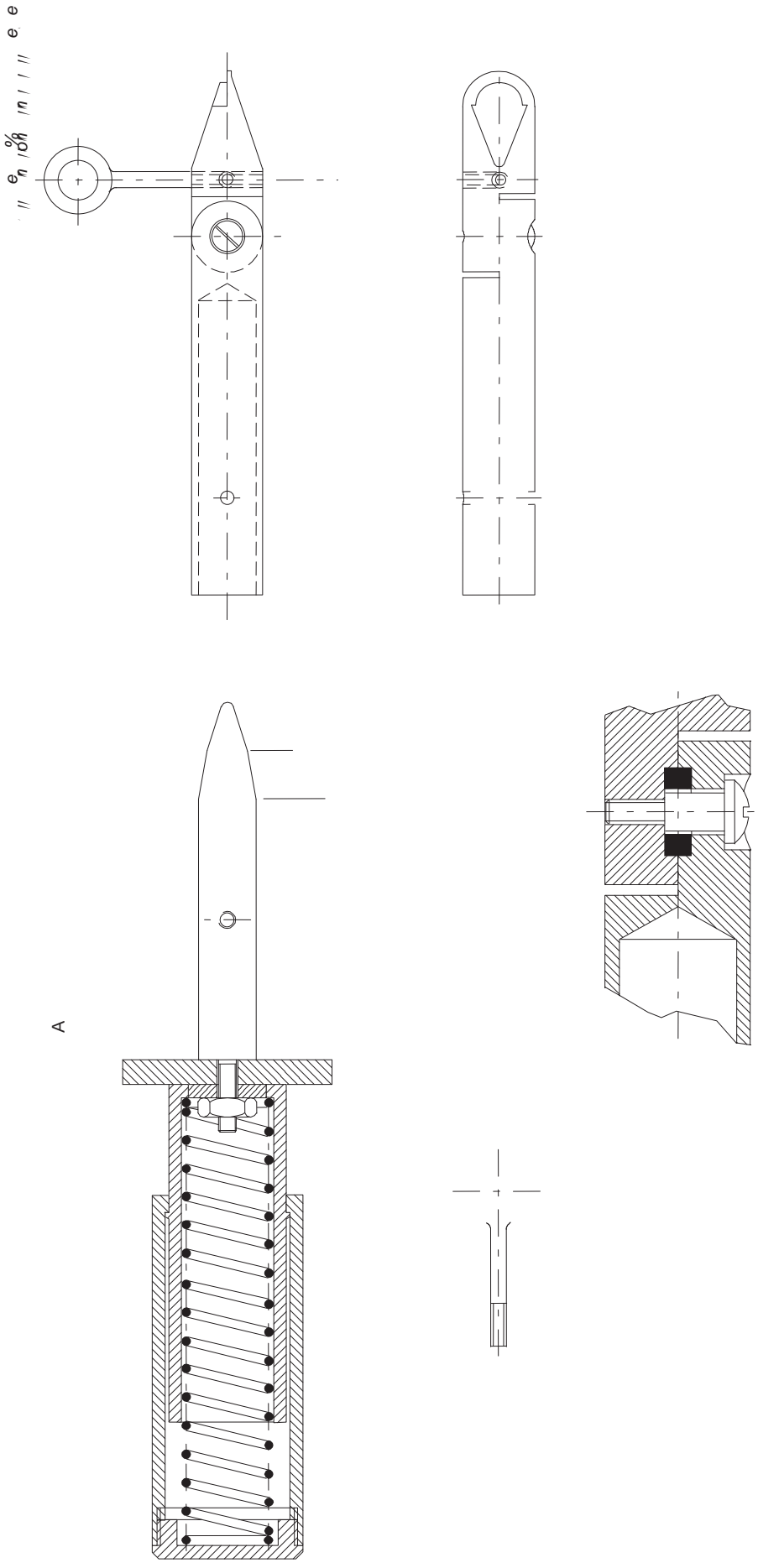
   – for **supplementary insulation**, of at least two layers, provided that any one of the layers withstands the electric strength test prescribed for **supplementary insulation**;

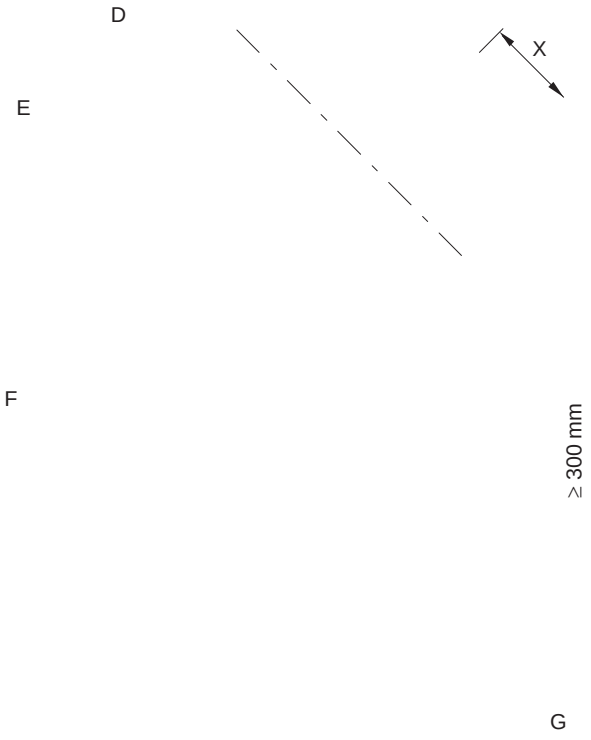
   – for **reinforced insulation**, of at least three layers, provided that, when any two of the layers are placed in contact, they withstand the electric strength test prescribed for **reinforced insulation**.

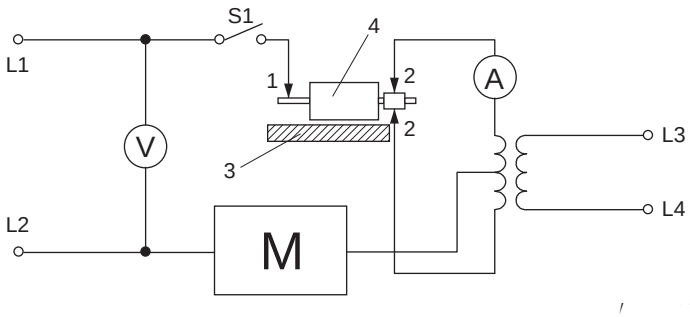
   The test voltage is applied between the outer surfaces of the layer, or of the two layers, as applicable.

b) The **supplementary insulation** or the **reinforced insulation** is inaccessible and meets the following condition:

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


A


D
X
E
F
≥ 300 mm
G



Key

1	shaft contact
2	commutator contacts
3	insulating table
4	armature
L1, L2	voltage supply for leakage current measurement
L3, L4	voltage supply (variable) for armature load current
M	circuit of Figure C.3 for the leakage current meter

Figure 3 – Overload test of a class II armature

Annex A
(normative)

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 Figures A.1 to A.4).

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

[illegible]

– [illegible]

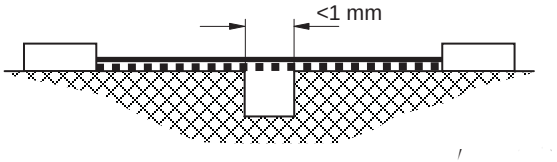
– [illegible]

– [illegible]

– [illegible] ***creepage distance*** [illegible]

– ***creepage distances*** ***clearances*** [illegible]

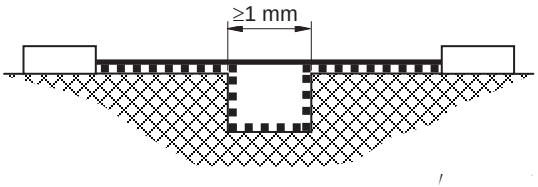
– [illegible] ***clearance***



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

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

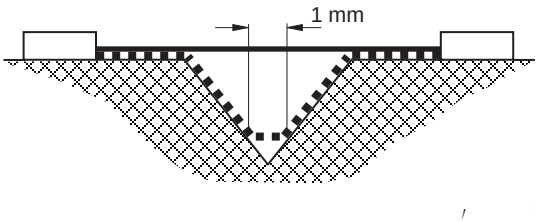
Case 1



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 contour of the groove.

Case 2



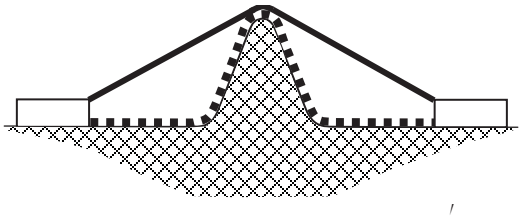
Condition: Path under consideration includes a V-shaped groove with internal angle of less than 80° and with a width greater than 1 mm.

Rule: **Clearance** is the "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 **Creepage distance**

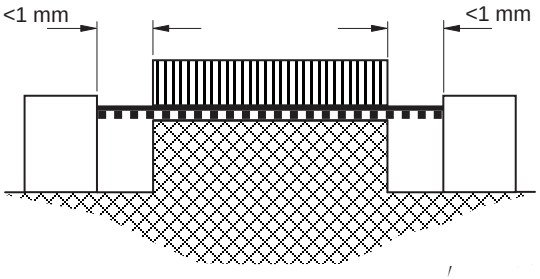
Figure A.1 – Clearance gap for parallel sided and V-shaped groove



Condition: Path under consideration includes a rib.

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

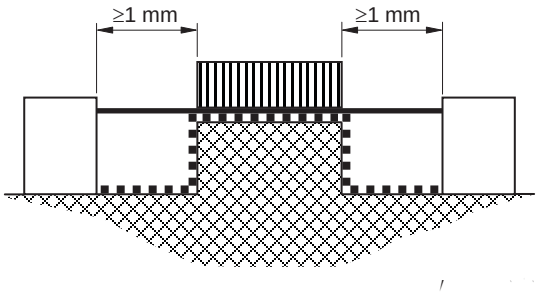
Case 4



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 distance** and **clearance** is the “line of sight” distance shown.

Case 5



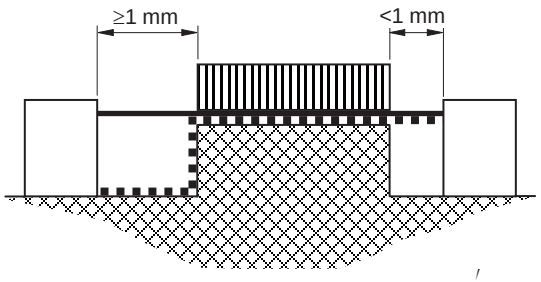
Condition: Path under consideration includes an uncemented joint with grooves equal to or more than 1 mm wide each side.

Rule: **Clearance** is the “line of sight” distance. Creepage path follows the contour of the grooves.

Case 6

Clearance **Creepage distance**

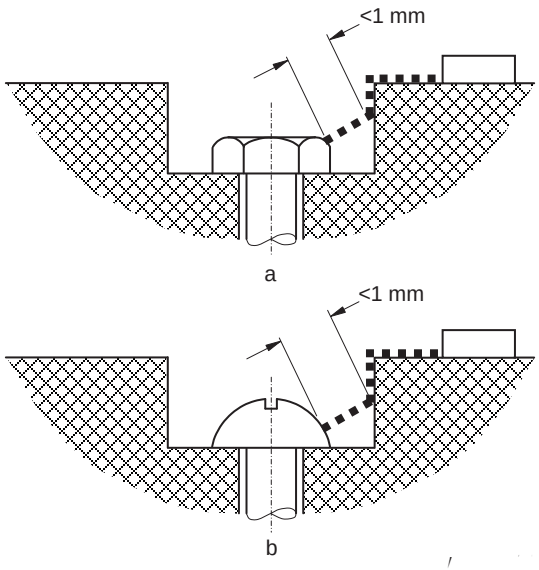
Figure A.2 – Clearance gap for rib and uncemented joint with groove



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

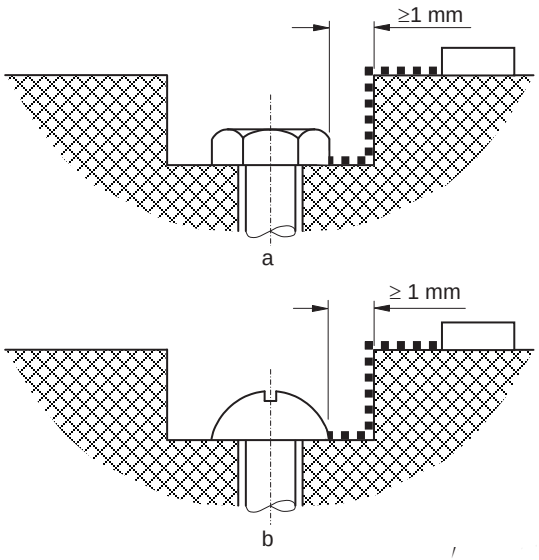
Rule: **Clearance** and creepage path are as shown.

Case 7



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**

Figure A.4 – 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 a peak value of 42,4 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.9.2

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

B.12 Heating

B.12.4 [illegible]

B.12.5 [illegible]

B.18 Abnormal operation

B.18.1 The test of 18.3 is not made.

[illegible]

B.18.201 [illegible] ***rated voltage*** [illegible]

– [illegible]
– [illegible]
– [illegible]

[illegible]

B.21 Construction

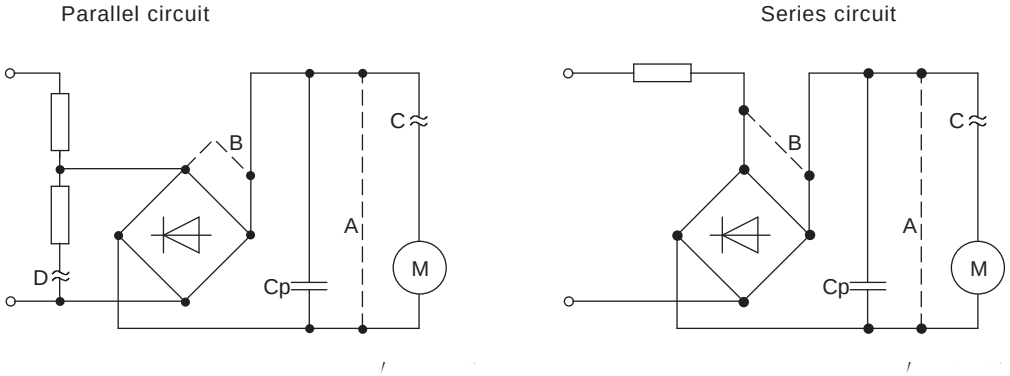
B.21.201 For **class I tools** incorporating a motor supplied by a rectifier circuit, the d.c. circuit shall be insulated from **accessible parts** of the tool by **double insulation** or **reinforced insulation**.

double insulation or **reinforced insulation**.

B.28 Creepage distances, clearances and distances through insulation

B.28.1

The values specified in Table 12 do not apply to distances between **live parts** of the motor and its other metal parts.



Key

——	original connection
– – –	short circuit
≈	open circuit
A	short circuit of the terminals of the motor
B	short circuit of the terminals of the rectifier
C	open circuit of the supply to the motor
D	open circuit of the shunt resistor

Figure B.1 – Simulation of fault conditions

Annex C
(normative)

Leakage current

C.1 General

For battery-operated tools in accordance with Annex L, this annex only applies when the tool is in the configuration where it is directly connected to the mains or to a non-isolated source.

Protective impedance ***live parts***

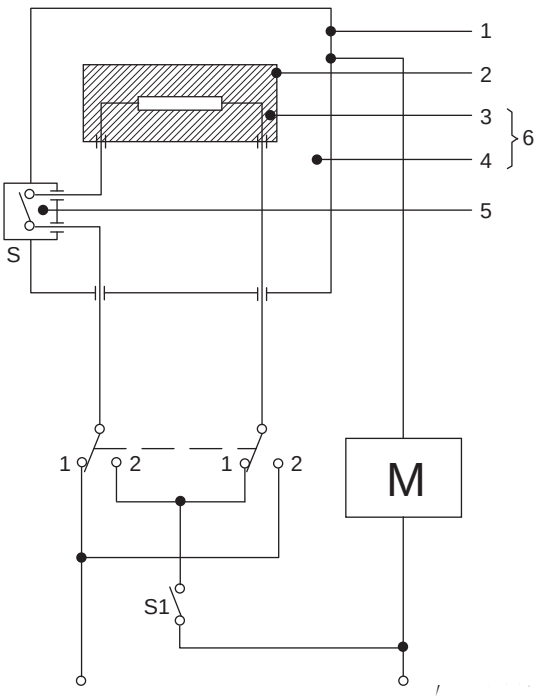
NOTE The weighted touch current is equivalent to MIU (Measurement Indication Units).

– ***class I tools***
– ***class II tools***

C.2 Measurement of a non-operating tool

rated voltage

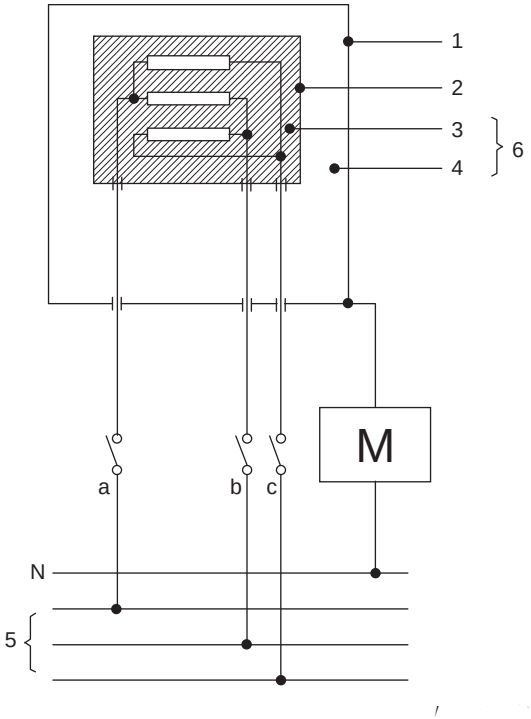
C.3 Measurement of an operating tool



Key

M circuit of Figure C.3 for the leakage current meter
S **power switch** of the product under test
1 **accessible part**
2 inaccessible metal part
3 **basic insulation**
4 **supplementary insulation**
5 **reinforced insulation**
6 **double insulation**

Figure C.1 – Diagram for leakage current measurement for single-phase connection and three-phase tools suitable for single-phase supply



Key

M circuit of Figure C.3 for the leakage current meter

1 **accessible part**

2 inaccessible metal part

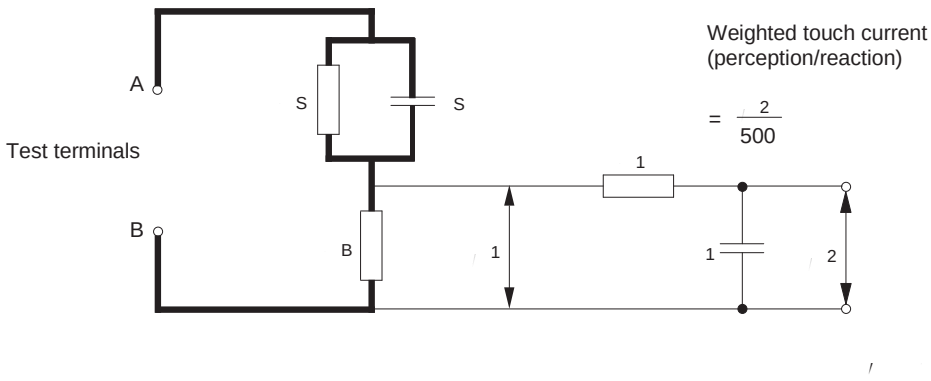
3 **basic insulation**

4 **supplementary insulation**

5 three-phase supply

6 **double insulation**

Figure C.2 – Diagram for leakage current measurement for three-phase connection



S	1 500 Ω	1	10 000 Ω
B	500 Ω	1	0,022 μF
S	0,22 μF		

Figure C.3 – Circuit of the leakage current meter

Annex E
(informative)

Methods of applying ISO 13849-1 to power tools

NOTE In Europe (EN 62841-1), Annex E is not applicable.

E.1 General

ISO 13849-1 provides a simplified method for establishing the associated reliability of a safety critical control function in consideration of the risk of injury associated with its failure. The control function is assigned a Performance Level (PL) which then may be fulfilled with a control system that satisfies both structural requirements and minimum calculated failure rates expressed in **$MTTF_d$** (**Mean Time To Dangerous Failure**).

E.2 Risk assessment

The method of risk assessment used in ISO 13849-1 follows the same general approach as in ISO 12100, where primary consideration is given to the severity of the harm caused by the hazards and the frequency of encountering these hazards. The risk associated with that hazard is then subsequently reduced by consideration of the probability, P, for avoiding the hazard. In ISO 12100, this analysis is carried out using the original, unmitigated hazard followed by all the risk mitigation techniques used to determine the resulting residual risk of the tool with respect to the hazard (and phase of use) under consideration.

When assessing a **safety critical function** (**SCF**), this process is not so clear: In this case, the **safety critical function** may be only one of many elements in the tool design intended to reduce the risk associated with a hazard. The goal then is to establish the change in residual risk associated with the failure of the **SCF** and to determine the remaining residual risk and whether it is still acceptable. This method, taken from ISO 12100, is not well suited to be used in this manner and additional considerations must be taken into account to yield meaningful results. Part of the issue is due to the fact that a binary tree is used to generate one of a discrete number of PLs and this sometimes fails to recognize small differences in risk. While this makes this method easy to use, it introduces some problems in analysis.

E.3 Residual risk analysis

In recognition of the hazards associated with power tools in general, IEC 62841 employs a number of risk mitigation techniques, built into the requirements of the standard, to reduce the risk to an acceptable level. These techniques are often intended to work together, as a system, to achieve the required risk reduction. An electronic control providing an **SCF** is often only one part of this system and its failure, therefore, does not leave the tool without other risk mitigation elements. To assess the effect of the loss of an electronic control function two things are considered:

First, the control function must fulfil a required safety element of the standard. The standard is presumed to have left the tool with an acceptable level of residual risk. Controls whose failure does not increase the risk beyond this already accepted level are not considered to be an **SCF** within this standard.

In addition, there must be a substantial impact on residual risk due to the failure of the **SCF**. To determine this, performance levels can be assessed both with and without the presence of the **SCF**, but with all other risk mitigation in place. It is possible that this will yield the same PL with or without the **SCF**.

If it is recognized that the **SCF** fulfils a required safety function, but the PL remains the same with or without its presence, then in these cases, a minimum level of PL = a is used.

While the method above yields meaningful results under conditions of **normal operation**, there are **SCF**'s that are relied on to protect the user under conditions of reasonably foreseeable misuse or other cases where the risk occurs only under a specific set of unlikely preconditions. An example of this is the case in systems to protect against restart after power interruption, since restart requires the tool to be locked on, plugged in and power interrupted and restored while the user is nearby.

In cases such as these, the unlikelihood associated with the event should dominate the analysis. The method used in ISO 13849-1, however, gives priority to the severity of the hazard (S, F, P) such that, for high severity cases, it would not be possible to assign a severity less than PL = c, because the frequency (F) is analysed second. TC116 concluded that in cases such as these the order of analysis should be reversed (F, S, P) allowing the frequency of exposure to have a higher influence over the outcome.

Performance levels have been assigned in this standard reflecting common cases TC116 has considered. There is a recognition that there may be **SCF**'s in the future not yet contemplated by this standard, and ISO 13849-1 along with this Annex may be used for guidance in setting the appropriate performance level.

E.4 Performance Levels

ISO 13849-1 provides methods for achieving the various performance levels. These solutions generally require certain structures such as dual channel, single channel and single channel with diagnostics. Single and dual channel refer to the functional redundancy of the control. Since the organization of 18.8 and 18.6 in the standard has dual channel designs evaluated before performance levels of other structures are even considered, most of the interest in ISO 13849-1 is focused on single channel designs. While ISO 13849-1 permits diagnostic monitoring of lower reliability single channel systems as an alternative to unmonitored high reliability single channel, there is the concern that these diagnostics are unlikely to be noticed by a power tool operator under use conditions. As a result, the standard generally prohibits these solutions as an alternative to higher reliability designs.

As a result, the single channel designs afforded by this method require increasingly higher $\mathbf{MTTF_d}$ as the PL increases due to increasing risk.

It may be possible that a case could exist where a diagnostic reflecting the unavailability of a **SCF** is present and recognizable well in advance of the operator being exposed to the increased risk. It could be appropriate in this case to consider a structure that provides a diagnostic as a means of achieving the required performance level.

Annex F
(informative)

Rules for routine tests

F.1 General

The tests specified in this annex are intended to reveal, as far as safety is concerned, unacceptable variations in material or manufacture. These production tests do not impair the properties and the reliability of the tool, and should be made by the manufacturer on each tool.

In general, more tests, such as repetition of type tests and sampling tests, have to be made by the manufacturer to ensure that every tool conforms with the samples that withstood the tests of this specification, according to the experience gained by the manufacturer.

The manufacturer may use a test procedure which is better suited to his production arrangements and may make the tests at an appropriate stage during production provided it can be shown that tools which withstand the tests carried out by the manufacturer provide at least the same degree of safety as tools which withstand the tests specified in this annex.

F.2 Correct operation test

The safe operation shall be checked, for example, by electrical measurements, by verifying the functional devices, such as switches and manually-operated controls, and by verifying the direction of rotation of motors.

F.3 Electric strength test

The insulation of the tools shall be checked by the following test.

live parts

class II tools

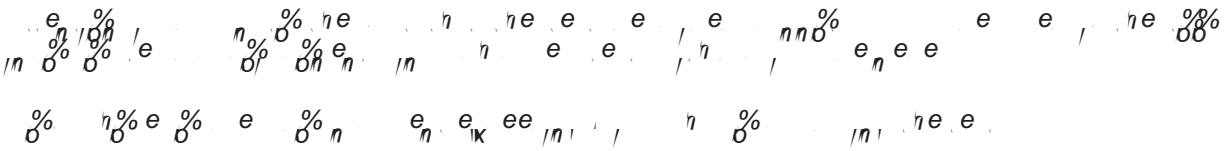


Table F.1 – Test voltages for the electric strength test

Application of test voltage	Minimum test voltage V	
	Class II tools	Class I tools
Over **basic insulation**	1 000	1 000
Over **double insulation** or **reinforced insulation**	2 500	–

F.4 Earthing continuity test

For **class I tools**, a current of at least 10 A, derived from an a.c. source having a no-load voltage not exceeding 12 V, is passed between the earthing terminal or the earthing contact and, in turn, each of the accessible metal parts which need to be earthed for safety reasons.

The voltage drop between the earthing contact of the plug or the external end of an earth continuity conductor or of the appliance 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 0,3 Ω. This value is applicable to **supply cord** lengths up to 5 m. In case of **supply cords** having a length exceeding 5 m it is increased by 0,12 Ω for any further length of 5 m.

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

Annex G

Void

Annex H
(normative)

Determination of a low-power circuit

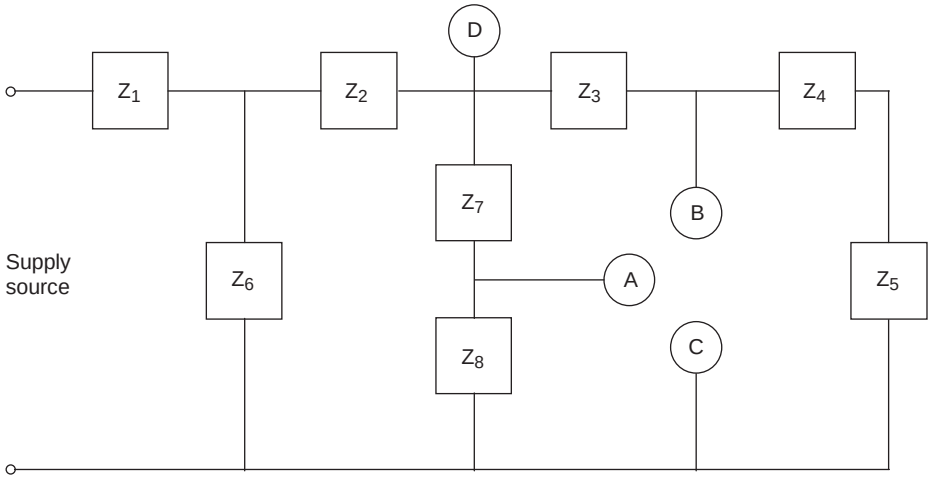
The determination if a circuit qualifies as a low-power circuit is as follows:

The tool is operated at **rated voltage.** A variable resistor, adjusted to its maximum resistance, is connected between the point to be investigated and the opposite pole of the supply source. The resistance is then decreased until the power consumed by the resistor reaches a maximum. Any point closest to the supply at which the maximum power delivered to this resistor does not exceed 15 W at the end of 5 s is called a low power point. The part of the circuit farther from the supply source than a low power point is considered to be a low-power circuit.

The measurements are made from only one pole of the supply source, preferably the one that gives the fewest low power points.

Circuit analysis may be used in lieu of testing to determine the highest power dissipation of circuits.

An example of a low-power circuit is shown in Figure H.1.



When determining the low power points, it is recommended to start with the points close to the supply source.

A and B are points closest to the supply source where the maximum power delivered to external load does not exceed 15 W. These are low-power points.

D is a point farthest from the supply source where the maximum power delivered to external load exceeds 15 W.

Points A and B are separately short-circuited to C.

Figure H.1 – Example of an electronic circuit with low-power points

Annex I
(informative)

Measurement of noise and vibration emissions

NOTE In Europe (EN 62841-1), Annex I is normative.

I.1 Scope

The requirements of this annex apply, if the declaration of noise or vibration emissions is required by national laws or if the manufacturer wishes to declare such emissions.

I.2 Noise test code (grade 2)

NOTE In Europe (EN 62841-1), the following additional requirements apply:

Noise reduction

Noise reduction at tools is an integral part of the design process and shall be achieved by particularly applying measures at source to control noise, see for example EN ISO 11688-1. The success of the applied noise reduction measures is assessed on the basis of the actual noise emission values in relation to other machines of the same type with comparable non acoustical technical data.

The major sound sources of tools are: motor, fan, gear.

I.2.1 General

Noise emission values like the emission sound pressure level L_{pA} and the sound power level L_{WA} shall be measured according to the test procedure described in I.2.2 to I.2.6.

The noise emission may be determined by using the measurements from a machine which has design and technical specifications replicating the machine concerned.

The overall noise can be divided into the pure machine noise and the noise generated from the processed workpiece. Both are influenced by the method of operation; however for percussive tools the noise emission of the workpiece can be dominant. The load conditions for particular tools are therefore specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

NOTE Noise emission values obtained under these measurement conditions will not necessarily be representative for the noise produced under all possible operational conditions of practical use.

I.2.2 Sound power level determination

I.2.2.1 General

The sound power level shall be measured according to ISO 3744, where the acoustic environment, instrumentation, quantities to be measured, quantities to be determined, and the measurement procedure are specified.

The sound power level shall be given as A-weighted sound power level in dB reference 1 pW. The A-weighted sound pressure levels, from which the sound power is to be determined, shall be measured directly, and not calculated from frequency band data. Measurements shall be made in an essentially free field over a reflecting plane.

I.2.2.2 Hand-held power tools

For all **hand-held tool**s, the sound power level shall be determined by using a hemispherical / cylindrical measurement surface according to Figure I.2.

The hemispherical / cylindrical measurement surface is described by a hemisphere standing on a cylindrical pedestal (see Figure I.2). Five microphone positions shall be located 1 m from the geometric centre of the power tool. Four positions shall be spaced at regular intervals on a plane defined as passing through the geometric centre of the power tool and parallel to the reflecting plane; the fifth position shall be located at a distance of 1 m above the geometric centre of the power tool.

The A-weighted sound power level, L_{WA}, shall be calculated, in accordance with of ISO 3744 as follows:

$$L_{WA} = \overline{L_{pA,1m}} + 10\lg\left(\frac{S}{S_0}\right), \text{ in dB} \quad (I.1)$$

with $\overline{L_{pA,1m}}$ determined from

$$\overline{L_{pA,1m}} = 10\lg\left[\frac{1}{5}\sum_{i=1}^{5} 10^{0,1\,L_{pA,i}}\right] - K_{1A} - K_{2A}$$

where

$\overline{L_{pA,1m}}$ is the A-weighted time-averaged 1 meter surface sound pressure level according to ISO 3744;

$L_{pA,i}$ is the A-weighted sound pressure level measured at the i^{th} microphone position, in dB;

K_{1A} is the background noise correction, A-weighted;

K_{2A} is the environmental correction, A-weighted;

S is the area of the measurement surface of Figure I.2, in m^2;

S_0 = 1 m^2.

For the hemispherical / cylindrical measurement surface shown in Figure I.2, the area S of the measurement surface is calculated as follows:

$$S = 2\pi(r^2 + rh), \text{ in } m^2.$$

Where h = 1 m is the height of the distance of the geometrical centre of the power tool above the reflecting plane and r = 1 m is the radius of the hemisphere and of the cylinder which comprise the measurement surface.

Therefore,

$$S = 4\pi\ m^2,$$

so, from equation (I.1)

$$L_{WA} = \overline{L_{pA,1m}} + 11, \text{ in dB.}$$

I.2.2.3 Transportable power tools

For all **transportable tool**s, the sound power level shall be determined by using a cubic measurement surface according to Figure I.3.

Five microphone positions shall be located in the centre of each lateral surface and the top surface of the measurement cubic surface which envelops the source.

The A-weighted sound power level, L_{WA}, shall be calculated, in accordance with ISO 3744 as follows:

$$L_{WA} = \overline{L_{pA,1m}} + 10\lg\left(\frac{S}{S_0}\right), \text{ in dB} \qquad (I.2)$$

with $\overline{L_{pA,1m}}$ determined from

$$\overline{L_{pA,1m}} = 10\lg\left[\frac{1}{5}\sum_{i=1}^{5} 10^{0,1 L'_{pA,i}}\right] - L_{1A} - L_{2A}$$

where

$\overline{L_{pA,1m}}$ is the A-weighted time-averaged 1 meter surface sound pressure level according to ISO 3744;

$L'_{pA,i}$ is the A-weighted sound pressure level measured at the i^{th} microphone position, in dB;

L_{1A} is the background noise correction, A-weighted;

L_{2A} is the environmental correction, A-weighted;

S is the area of the measurement surface of Figure I.3, in m^2;

S_0 = 1 m^2.

For the measurement surface shown in Figure I.3, the area S is calculated as follows:

S = 5 × (2m × 2m) = 20 m^2.

Therefore, from equation (I.2)

$$L_{WA} = \overline{L_{pA,1m}} + 13, \text{ in dB.}$$

I.2.2.4 Lawn and garden machinery

The sound power level of **lawn and garden machinery** shall be determined as specified in the relevant part of IEC 62841-4.

I.2.3 Emission sound pressure level determination

I.2.3.1 Hand-held tools

The A-weighted emission sound pressure level at the work station, L_{pA}, shall be determined in accordance with ISO 11203 as follows:

$$L_{pA} = L_{WA} - K, \text{ in dB}$$

where K = 11, in dB.

NOTE 1 This value of K has been determined, during experimental investigations, to be applicable to **hand-held power tools**. The resulting A-weighted emission sound pressure level at the workstation is equivalent to the value of the surface sound pressure level at a distance of 1 m from the power tool. This distance has been chosen to give

satisfactory reproducibility of results, and to permit comparison of the acoustic performance of different **hand-held power tools** which do not, in general, have uniquely defined work stations. Under free field conditions, where it may be required to estimate the emission sound pressure level, $L_{pA,r1}$, at a distance r_1 in m from the geometric centre of the power tool, this can be done by applying the formula:

$$L_{pA,r1} = L_{pA} + 20 \lg\left(\frac{1}{1}\right), \text{ in dB}$$

NOTE 2 At any given position in relation to a particular machine, and for given mounting and operating conditions, the emission sound pressure levels determined by the method of this standard will in general be lower than the directly measured sound pressure levels for the same machine in the typical workroom where it is used. This is due to the influence of sound reflecting surfaces in the workroom compared to the free field conditions of the test specified here. A method of calculating the sound pressure levels in the vicinity of a machine operating alone in a workroom is given in ISO/TR 11690-3. Commonly observed differences are 1 dB to 5 dB, but in extreme cases the difference might be even greater.

If required, the C-weighted peak emission sound pressure level L_{pCpeak} shall be measured at each of the five measurement positions specified in I.2.2. The C-weighted peak emission sound pressure level at the work station is the highest C-weighted peak sound pressure level measured at any of the five microphone positions; no corrections are permitted.

I.2.3.2 Transportable tools

The A-weighted emission sound pressure level at the work station, L_{pA}, shall be determined according to ISO 11201, grade 2. It shall be determined under the same operating conditions as for the determination of the sound power level.

For tools measured under load and run by an operator, the microphone shall be located (0,2 ± 0,02) m to the side of the centre plane of the operator's head, on a line with the eyes, with its axis parallel to the operator's line of view, and on the side where the higher value of the A-weighted sound pressure level is observed.

For tools measured under no-load and without the operator being present, the microphone shall be located at a reference point on the ground plane on which the operator normally stands. If not specified in the relevant part of IEC 62841-3, this reference point shall be located 1 m from the centre of the tool on the side where the operator normally stands. The microphone shall be located directly above the reference point at a height in the range of (1,55 ± 0,075) m.

If required, the C-weighted peak emission sound pressure level L_{pCpeak} shall be measured at the same operator's position as the A-weighted sound pressure level L_{pA}.

I.2.3.3 Lawn and garden machinery

The emission sound pressure level of **lawn and garden machinery** shall be determined as specified in the relevant part of IEC 62841-4.

I.2.4 Installation and mounting conditions of the power tools during noise tests

The installation and mounting conditions shall be the same for the determination of both sound power level and emission sound pressure level at the work station.

The power tool under test shall be new and equipped with **accessories** which affect the acoustic properties, as recommended by the manufacturer. Prior to commencing testing, the power tool (including any required ancillary equipment) shall be set up in a stable condition in accordance with the manufacturer's instructions for safe use.

A **hand-held tool** is held by the operator or suspended in such a way as to correspond to **normal use**, as specified in the relevant part of IEC 62841-2. If the **hand-held tool** is used horizontally, it shall be positioned so that its axis is at 45° between the microphone positions 1 and 4 and 2 and 3 (see Figure I.2); its geometrical centre shall be 1 m above the ground

(reflecting plane). If these requirements are impracticable or the tool is not used horizontally, the adopted positions shall be recorded and described in the test report.

A **transportable tool** shall be so positioned, either placed on the test bench of Figure I.1 or mounted on the accompanying support, that its centre of gravity is located below the top microphone position 5. The tool shall be so oriented that its front edge is parallel to one of the horizontal side edges of the measurement cube of Figure I.3.

Lawn and garden machinery shall be used and positioned as specified in the relevant part of IEC 62841-4.

The operator shall not be positioned directly between any microphone position and the power tool.

I.2.5 Operating conditions

The operating conditions shall be identical for the determination of both sound power level and emission sound pressure level at the work station.

Measurements shall be carried out on a new tool.

Tools are tested under the two operating conditions “no-load” or “load” as appropriate for the type of tool and specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4. Before starting the test, the tool shall be operated under these conditions for a period of at least 1 min.

A measurement under “load” is to be carried out during processing of a workpiece or under external mechanical load equivalent to **normal operation**.

Where tests are required to be carried out on a bench it shall be in accordance with the test bench shown in Figure I.1.

Care shall be taken that the location of the workpiece on its support does not adversely affect the result of the test. If necessary, or when specified in the part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, the workpiece shall be supported on a resilient material (20 ± 1) mm thick compressed to (10 ± 1) mm under the weight of the workpiece.

Three consecutive tests for no-load or five for load shall be carried out and the result of the test $_{/\ WA}$ shall be the arithmetic mean, rounded to the nearest decibel, of the three or five tests.

During measurements, the power tool shall operate under stable conditions. Once the noise emission is steady, the measurement time interval shall be at least 15 s, unless the operating conditions specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 require another time interval. If measurements are to be made in octave or one-third octave frequency bands, the minimum period of observation shall be 30 s for the frequency bands centred on or below 160 Hz, and 15 s for the frequency bands centred on or above 200 Hz.

I.2.6 Measurement uncertainties

The total measurement uncertainty of the noise emission values determined according to this standard is depending on the standard deviation $_{R0}$ given by the applied noise emission measurement method and the uncertainty associated with the instability of the operating and mounting conditions $_{omc}$. The resulting total uncertainty is then calculated from

$$\sigma_{tot} = \sqrt{\sigma_{R0}^2 + \sigma_{omc}^2}$$

$_{R0}$ is about 1,5 dB for the grade 2 measurement methods applied in this noise test code in order to determine the emission sound pressure level or the sound power level.

NOTE 1 $_{tot}$ is referred to as $_{R}$ in ISO 4871:1996.

NOTE 2 In ISO 4871:1996, the expanded measurement uncertainty , in decibels, is calculated from = $_{tot}$, with being the coverage factor.

It depends on the degree of confidence that is desired. For the purpose of comparing the result with a limit value, it is appropriate to apply the coverage factor for a one-sided normal distribution. In that case, the coverage factor = 1,6 corresponds to a 95 % confidence level. Further information is given in ISO 4871:1996. Please note that the expanded measurement uncertainty is referred to as in ISO 4871:1996.

NOTE 3 For machines with a rather constant noise emission, a value of 0,5 dB for $_{omc}$ can apply. In other cases, e.g. a large influence of the material flow into and out of the machine or material flow that varies in an unpredictable manner, it is possible that a value of 2 dB is more appropriate. Methods to determine $_{omc}$ are described in the basic measurement standards. Further guidance for determining the uncertainty of both noise emission values is given in ISO 4871:1996.

I.2.7 Information to be recorded

The information to be recorded covers all of the technical requirements of this noise test code. Any deviations from this noise test code or from the basic standards upon which it is based are to be recorded together with the technical justification for such deviations.

I.2.8 Information to be reported

The information to be included in the test report is at least that which is required to prepare a noise emission declaration or to verify the declared values. Thus as a minimum the following information shall be included:

– reference to this noise test code and to the basic standards used;
– description of the power tool;
– description of the mounting and operating conditions;
– the noise emission values obtained.

It shall be confirmed that all requirements of the noise test code have been fulfilled, or, if this is not the case, any unfulfilled requirements shall be identified. Deviations from the requirements shall be stated and technical justification for the deviations shall be given.

I.2.9 Declaration and verification of noise emission values

The declaration of the noise emission values shall be a dual number according to ISO 4871:1996. It shall declare the noise emission value ($_{pA}$ and $_{WA}$) and the respective uncertainty ($_{pA}$ and $_{WA}$). If required, the C-weighted emission peak sound pressure level $_{pCpeak}$ shall be given.

For a standard deviation of reproducibility of the method $_{R0}$ of 1,5 dB and for a typical standard deviation of production, the values for the uncertainties $_{pA}$ and $_{WA}$ respectively, are expected to be 3 dB.

The noise declaration shall state that the noise emission values have been obtained according to this noise test code. If this statement is not true, the noise declaration shall indicate clearly what the deviations from this standard, and from the basic standards, are.

NOTE If the measured value is the average based on a sample of three power tools that has been properly sampled, then normally is 3 dB. Further guidance on sampling and uncertainty terms is given in ISO 7574-4 and ISO 4871:1996.

Additional noise emission quantities may also be given in the declaration.

If undertaken, the verification shall be performed for a batch of power tools, in accordance with 6.3 of ISO 4871:1996. The verification shall be conducted by using the same mounting, installation and operating conditions as those used for the initial determination of noise emission values.

I.3 Vibration

NOTE In Europe (EN 62841-1), the following additional requirements apply:

Vibration reduction

The vibration at the handles shall be kept as low as possible without unduly affecting the performance and the ergonomics (weight, handling, etc.) of the tool.

In particular vibration shall be reduced by the application of engineering measures as given in CR 1030-1. The success of the applied vibration measures is assessed by comparing the vibration levels for the tool with those for other tools of the same type and with a comparable specification and performance.

I.3.1 Vibration measurement – General

Details for particular types of tools are given in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4. The test code gives all the information necessary to carry out efficiently the determination, declaration and verification of the vibration emission characteristics. It shall allow comparison of test results for different tools.

The vibration total value may be determined by using the measurements from a machine which has design and technical specifications replicating the machine concerned.

EN 12096 gives guidance on how to declare the vibration total values of machinery, and specifies requirements for verification of declared values.

The vibration levels for hand-arm vibration $_{h}$ to be quoted in the user instructions shall be measured in accordance with the following test procedure.

The uncertainty $_{/}$ is provided as an indication of the measured deviation from the mean during the test.

The measurement and assessment of human exposure to hand-transmitted vibration in the workplace is given in ISO 5349-1 and ISO 5349-2.

NOTE The following does not constitute an exhaustive list of possible sources of errors of measurement, but can be considered as a guide to avoid the main errors in measurement:

a) unsuitable mounting or fastening of transducers;

b) inadequate fastening of cables;

c) lack or misadjustment of band-pass filter;

d) not nulling output of amplifiers after mounting of transducers;

e) misalignment of directions of transducers or inappropriate or varying position of the transducers;

f) inappropriate signal conditioning (band-pass, signal-to-noise ratio, overload, etc.);

g) too short duration of measurement;

h) lack of calibration before and after measurement;

i) inappropriate definition of operational conditions;

j) inexperienced operators using inappropriate grip forces;

k) unstable operating conditions, such as fluctuating feed forces and varying motor speed.

Further practical advice on measurement errors is given in ISO 5349-2.

I.3.2 Symbols

In Clause I.3, the following symbols are used:

$a_{hw}(t)$ instantaneous single-axis acceleration value of the frequency-weighted hand-transmitted vibration at time t, in m/s²

a_{hw} root-mean-square (r.m.s.) single-axis acceleration value of the frequency-weighted hand-transmitted vibration, in m/s²

a_{hwx}, a_{hwy}, a_{hwz} values of a_{hw} in m/s², for the axes denoted X, Y and Z respectively

a_{hv} vibration total value of frequency-weighted r.m.s. acceleration, in m/s²; it is the root-sum-of-squares of the a_{hw} values for the three measured axes of vibration

a_h arithmetic mean total vibration value of the measurement results of all runs and operators in m/s², this is the result of the test

R standard deviation of reproducibility

u uncertainty of a_h in m/s²

V coefficient of variation of a test series, defined as the ratio of the standard deviation of a series of measurement values and the mean value of the series:

$$V = \frac{\sigma_{N-1}}{\bar{a}_{hv}}$$

where

$$\sigma_{N-1} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(a_{hvi} - \bar{a}_{hv})^2}$$ is the standard deviation;

$\bar{a}_{hv}$ is the mean vibration total value of the series of 5 measurements in m/s²;

a_{hvi} is the i-th vibration total value of one series of measurements in m/s²;

N is the number of measured values within one series of measurements (here N = 5).

I.3.3 Characterisation of vibration

I.3.3.1 Direction of measurement

Vibration transmitted to the hand is related to the three orthogonal directions X, Y and Z as shown in Figure I.4. For particular types of tools, these directions may be defined in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

I.3.3.2 Location of measurement

Measurements shall be made in three directions at each hand position. All measurements shall be conducted simultaneously.

Measurements shall be carried out as close as possible to the hand between the thumb and the index finger, where an operator normally holds the machine.

If gripping areas are covered by soft surface material, precaution shall be taken to avoid resonance effects of the transducer mounting. If soft surface material is provided in the gripping area it shall be removed or strongly compressed by a transducer mounting clamp or suitable adaptor.

The measurement positions for particular types of tools are specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

When machines are operated with more than one grip or grasping surface, the vibration at the hand positions where an operator normally holds the tool during **normal operation** shall be measured and recorded. If it can be shown that the vibration magnitude at one grip is always dominant, the vibration test code may specify that measurements are made only at that gripping zone.

I.3.3.3 Magnitude of vibration

The quantity used to describe the magnitude of vibration shall be the frequency-weighted acceleration $_{hw}$ in m/s².

Frequency weighting in accordance with ISO 5349-1 shall be used.

The r.m.s. value $_{hw}$ in accordance with this standard is defined as the r.m.s. value of the frequency-weighted acceleration signal $_{hw}(\ )$:

$$_{hw} = \left[\frac{1}{\ } \int_{0}^{\ } {}^{2}_{hw}(\ )\, d\ \right]^{1/2}$$

An integrating device equipped with linear integration facilities shall be used in order to obtain r.m.s. values of signals substantially varying with time.

The measurement time shall be as long as reasonably possible and normally not less than 8 s for hand-transmitted vibration measurements.

If the measurement time of 8 s for individual machines is not possible, e.g. because of short duration of operation (defined in I.3.5.3), this shall be specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

I.3.3.4 Combination of vibration directions

The vibration total value $_{hv}$ is determined from

$$_{hv} = \left[{}^{2}_{hwx} + {}^{2}_{hwy} + {}^{2}_{hwz} \right]^{1\ 2} \qquad \text{(I.3)}$$

where

$_{hwx}$, $_{hwy}$, $_{hwz}$ are the r.m.s. values of the frequency-weighted acceleration in the directions X, Y and Z, respectively.

I.3.4 Instrumentation requirements

I.3.4.1 General

The vibration measurement equipment shall be in accordance with ISO 8041.

Instrumentation for measuring other parameters (e.g. for controlling the working conditions), whose characteristics are not covered by ISO 8041, shall be specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

I.3.4.2 Transducers

I.3.4.2.1 Specification of transducers

The vibration values as specified in I.3.3.3 shall be measured using transducers and other appropriate measurement equipment conforming to ISO 8041.

The total mass of the vibration transducer and its mounting shall not be sufficient to influence the measurement result and shall not be more than 5 g for each direction of measurement.

NOTE Lightweight plastic handles are an example, where heavy transducers may not be suitable. See ISO 5349-2 for further information.

Factors such as the transverse sensitivity (less than 10 %), the ambient temperature range, the typical temperature transient sensitivity and the maximum shock acceleration shall be considered in the selection of transducers.

I.3.4.2.2 Fastening of transducers

Guidance on mounting of transducers is given in ISO 5349-2. The transducer and the mechanical filter, if used, shall be mounted rigidly and on the vibrating surface.

Mechanical filters or other appropriate means may be needed to minimize measurement errors likely to occur when measuring vibration containing impulsive elements, such as occur in percussive tools. For more details, see ISO 5349-2.

NOTE High acceleration in the high-frequency components of the vibration can cause the transducer to generate false signals (e.g. dc shift) in the frequency range of interest because of excitation of the resonance of the transducer itself.

I.3.4.3 Calibration of the measurement chain

The whole measurement system shall be checked both before and after a sequence of measurements using a calibrator which produces a known acceleration at a known frequency.

The transducers shall be calibrated in accordance with ISO 5347 and ISO 16063-1. The whole measurement system shall be checked according to the requirements in ISO 8041.

I.3.5 Testing and operating conditions of the tool

I.3.5.1 General

Measurements shall be carried out on a new tool that is only used for the noise and vibration tests required by this standard.

For mains operated tools: The average voltage during the test shall not deviate from the **rated voltage** or the mean value of the **rated voltage range** by more than ±1 %.

For battery-operated tools: Each operator shall start his series of tests with a fully charged battery.

When the test procedure is not provided in a relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 or there is no relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, the operating conditions and working procedure shall be specified in sufficient detail as to achieve appropriate reproducibility. Test procedures based on a typical real working situation are preferred. The vibration test may simulate a single phase of a task or a working cycle, consisting of a set of operations where the operator is being exposed to vibration.

If for reasons of better reproducibility a simulated work condition is defined, the vibration source shall produce approximately the same magnitude of vibration as that in a typical

working situation. If necessary to provide realistic emission levels, tests shall be carried out under more than one operating condition or set of operating conditions as defined in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

If the tool is equipped with means or devices to reduce the vibration emission in comparable operating conditions, these shall be used, in accordance with the user instructions, during vibration testing. If this requires a deviation from the type test method, this shall be reported and explained in the test report.

During the measurements the hands of the operator shall guide the machine as is necessary by the design of the tool and as specified in the instructions supplied with the machine.

I.3.5.2 Attachment, workpiece and task

The **attachment** or **accessories** to be used with the machine shall be as recommended in the user instruction.

If these **attachments** are of a vibration reduction type, it shall be reported together with the declared vibration value.

Care shall be taken that the location of the workpiece on its support does not affect the results of the test. Details for task and workpiece are given in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

NOTE **E**ven small differences in size, shape, material, wear, unbalance, etc. of the **accessory** can alter the vibration magnitude considerably.

I.3.5.3 Operating conditions

Tools are tested under load only, unless the operating condition no-load is considered as important in practical use (no-load accounts for more than 20 % of the time when tool is switched on). In this case the tool shall be tested under both load and no-load condition, or at a typical work cycle containing load and no-load. The relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 describes the modes of operation and the calculation of the declared emission value.

The machine shall be operated at normal working conditions and working modes according to the user instructions, which shall be maintained for the duration of the test. Those operating conditions shall be used that are representative of the highest vibration values likely to occur at typical and **normal use** of the machine under test. The measurement may be carried out by processing a workpiece or under external mechanical load equivalent to **normal operation**.

Before starting the test, the tool shall be operated under these conditions of at least 1 min to warm it up.

I.3.5.4 Operator

The vibration of the machine is influenced by the operator. The operator shall therefore be skilled and able to operate the machine properly, i.e. he shall be experienced in the use of the tool.

The gripping force shall be as under long term working conditions and not be excessive.

I.3.6 Measurement procedure and validity

I.3.6.1 Reported vibration values

Three series of five consecutive tests shall be carried out using a different operator for each series. If it can be shown that the vibration is not affected by operator characteristics, it is

acceptable to perform all 15 measurements with one operator only. Details are specified in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

The measurements are made in three axes and the results of each direction shall be combined using equation (I.3) to obtain the vibration total value $_{hv}$.

If the coefficient of variation $_{V}$ of the five vibration total values $_{hv}$, recorded for each series, is less than 0,15 or the standard deviation $_{N-1}$ is less than 0,3 m/s^2, the results are accepted (the note in I.3.1 provides information on possible sources of errors of measurement).

The measurement result $_{h}$ shall be determined as the arithmetic mean of vibration total values over the tests and operators.

I.3.6.2 Declaration of the vibration total value

The result $_{h}$ is the basis for the declared value. If values have been obtained for different hand positions, the greatest value shall be the basis for the declaration.

If required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, the work mode description corresponding to the vibration emission shall be stated next to each declared value.

To determine the uncertainty $_{/}$ of the declared value according to EN 12096, the following formula shall be used that takes the standard deviation into account:

$_{/}$ = 1,65 $_{R}$ or $_{/}$ = 1,5 m/s^2, whatever is higher

$$_{R} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(_{hvi} - _{h})^2}$$

with

$_{R}$ = [illegible]$_{R}$);

n = 3 (number of operators);

$_{hvi}$ = average vibration total value of each operator (= result for each operator);

$_{h}$ = average vibration total value of all measurements (= test result).

The vibration value(s) $_{h}$ shall be declared as follows:

Vibration total values (triaxial vector sum) determined according to [number of this standard]:

Work mode description 1 (if required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4)	Vibration emission value a_h = … m/s^2 Uncertainty K = … m/s^2
Work mode description 2 (if required by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4)	Vibration emission value a_h = … m/s^2 Uncertainty K = … m/s^2

I.3.7 Measurement report

The report shall, as a minimum, include the following information:

a) reference to this standard including any relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4;

b) specification of the machine tested (i.e. manufacturer, type and serial number of the machine, etc.);

c) **attachments** or **accessories**;

d) operating and testing conditions (voltage, current, feed force, speed setting, duration and number of test runs, etc.);

e) measuring institution (e.g. laboratory, manufacturer);

f) date of measurement and name of the person responsible for the test;

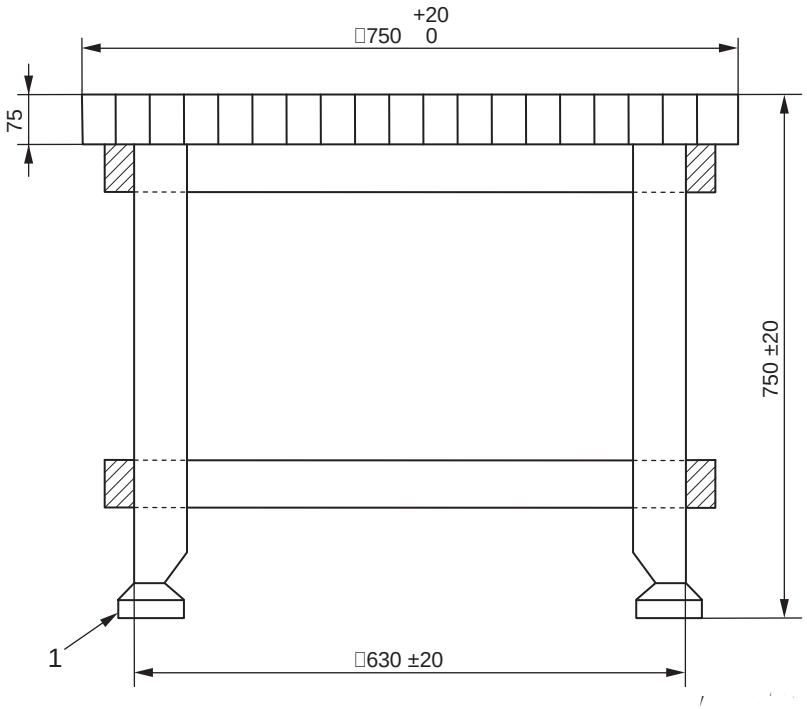
g) instrumentation (transducer mass, filters, integrators, recording system, etc.);

h) position and fastening of transducers, measuring directions and individual vibration values when relevant (e.g. recorded by photos);

i) the arithmetic mean total vibration $_h$, for each operator the total vibration value $_{hv}$ and the three single axis weighted acceleration values $_{hw}$. It is good practice to report all the measured values (i.e. for all axes of vibration, tests and operators);

j) the uncertainty $_f$ of the vibration total value $_h$.

Any deviations from the vibration test code in this standard shall be reported together with the technical justification for such deviations.

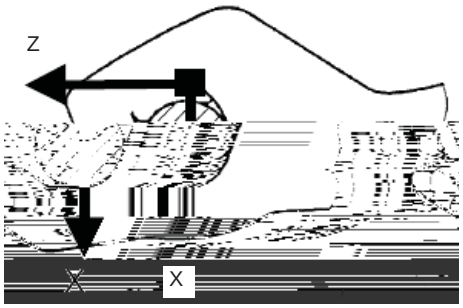


Key

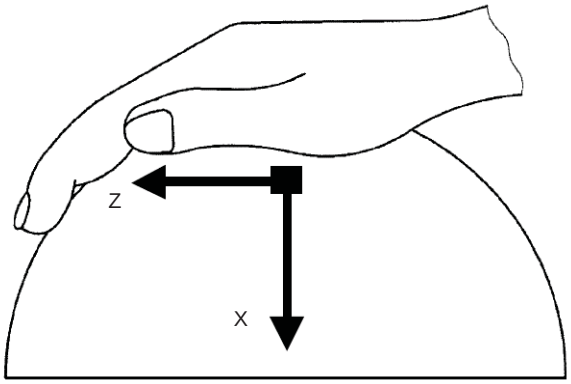
1 rubber isolating feet

Material: pine wood 75 × 40 planed, glued and doweled

Figure I.1 – Test bench



a) Hand grip position – Hand grips around a cylindrical handle



b) Flat palm position – Hand presses down onto a spherical hand grip

Figure I.4 – Directions of vibration measurement

Annex J

Void

Annex K
(normative)

Battery tools and battery packs

K.1 Scope

This annex applies to rechargeable **battery**-powered motor-operated or magnetically driven

– **hand-held tools** (IEC 62841-2);
– **transportable tools** (IEC 62841-3);
– **lawn and garden machinery** (IEC 62841-4);

and the **battery** packs for such tools or machinery. The above listed categories are hereinafter referred to as “tools” or “machines”.

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 tools**, **class II tools**, or **class III tools** and therefore are not required to have basic, **supplementary insulation** or **reinforced insulation**. Electric shock hazard is considered to exist only 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**.

Since **battery** packs for power tools are submitted to different use patterns (such as rough use, high charging and discharging currents) their safety can be evaluated only by this annex and not by using other standards for **battery** packs, such as IEC 62133, unless otherwise indicated in this annex. All relevant requirements of IEC 62133 are addressed in this annex.

When evaluating the risk of **fire** associated with **detachable battery packs**, consideration has been given to the fact that these **battery** packs are unattended energy sources and have been evaluated as such in this standard. Requirements in other standards regarding the risk of **fire** due to the charging of these **detachable battery packs** are therefore considered to be fulfilled.

This annex also addresses requirements covering the use of lithium-ion **cells** employed in **battery systems** in tools. The following is considered within the context of these requirements:

– These requirements address the risk of **fire** or **explosion** of these **batteries** and not any possible hazards associated with toxicity nor potential hazards associated with transportation or disposal.

NOTE 1 IEC 62281 covers the safety aspects of lithium-ion batteries during transport.

– **Battery systems** covered by these requirements are not intended to be serviced by the end user.
– These requirements are intended to provide comprehensive evaluation of a **battery** only if used in products covered by this standard.
– These requirements address the safety of lithium-ion **battery systems** during storage and use including discharge and charge. These requirements are only considered to be supplementary requirements in regards to battery **charger** fire and electric shock.

– These requirements refer to and require parameters supplied in reference to the **cells** that establish conditions for safe use of those **cells**. Those parameters form the basis of acceptance criteria for a number of tests contained herein. This standard does not independently evaluate the safety of **cells**. These parameters, taken as a set, constitute the "**Specified Operating Region**" for a **cell**. There may be several sets of **specified operating region**(s).

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 the safety of battery **chargers** themselves. However, this annex covers the safe functioning of lithium-ion **battery systems**.

NOTE 2 IEC 60335-2-29 covers a variety of **chargers**.

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 main body of the standard unless otherwise specified.

K.3 Terms and definitions

This clause is applicable except as follows:

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

K.3.201
battery system
combination of a lithium-ion **battery**, the **charging system**, the tool and the interfaces between them as existing during operation of the tool or during charging

K.3.202
cell
basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical energy

K.3.203
charger
part or all of the **charging system** contained in a separate enclosure. As a minimum, the **charger** includes some of the power conversion circuitry. Not all **charging systems** include a separate **charger** as in the case where a tool may be charged utilizing a mains **supply cord** or may incorporate a plug for attachment to a mains receptacle

K.3.204
charging system
combination of circuitry intended to charge, balance and/or maintain the state of charge of the **battery**

K.3.205
C_5 rate
current, in amperes, that a **cell** or **battery** can be discharged at for 5 h to the voltage cut-off point specified by the **cell** manufacturer

K.3.206
detachable battery pack
battery which is contained in a separate enclosure from the battery tool and is intended to be removed from the tool for charging purposes

K.3.207
fire
emission of flames from a **battery**

K.3.208
fully charged (battery/cell)
cell or **battery** charged to the maximum state of charge permitted by the **battery charging system** intended for use with the tool

K.3.209
fully discharged (battery/cell)
battery or **cell** that has been discharged at $\mathbf{C_5}$ **rate** until one of the following conditions occurs: discharge terminates due to protective circuitry or the **battery** (or **cell**) reaches a total voltage with an average voltage per cell equal to the end-of-discharge voltage for the cell chemistry being used unless a different end-of-discharge voltage is specified by the manufacturer

Note 1 to entry: The end-of-discharge voltages for common cell chemistries are provided in K.5.210.

K.3.210
general purpose (batteries/cells)
batteries and **cells** available from a variety of manufacturers, through a variety of outlets intended for a variety of different manufacturers' products

Note 1 to entry: 12 V automotive **batteries** and AA, C and D alkaline **cells** are examples of **general purpose**.

K.3.211
hazardous voltage
voltage between parts having an average value exceeding 60 V d.c. or exceeding 42,4 V peak when the peak-to-peak ripple exceeds 10 % of the average value

K.3.212
integral battery
battery which is contained within the battery tool and is not removed from the battery tool for charging purposes

Note 1 to entry: A **battery** that is to be removed from the battery tool for disposal or recycling purposes only is considered to be an **integral battery**.

K.3.213
maximum charging current
highest current that a lithium-ion **cell** is permitted to pass during charging for a specified range of temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

K.3.214
separable battery pack
battery which is contained in a separate enclosure from the battery tool and is connected to the battery tool by a cord

K.3.215
specified operating region
range of permissible operation of lithium-ion **cells**, expressed by **cell** parameter limits

K.3.215.1
specified operating region for charging
conditions for voltage and current during charging in which the lithium-ion **cell** is permitted to operate as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

K.3.216
upper limit charging voltage
highest voltage that a lithium-ion **cell** is permitted to attain during normal charging for a specified range of temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

K.3.217
venting
condition that occurs, when a **cell** releases excessive internal pressure intended by design to preclude **explosion**

K.5 General conditions for the tests

K.5.2

battery

K.5.7 ***rated voltage*** ***fully charged battery***

K.5.10 This subclause is not applicable.

K.5.11 This subclause is not applicable.

K.5.15 This subclause is not applicable.

K.5.16 This subclause is not applicable.

K.5.201 ***battery*** ***charger***

K.5.202 ***cell***

K.5.203 ***fire*** ***explosion*** ***explosions***

K.5.204 ***batteries*** ***batteries*** ***fully discharged***

K.5.205 [illegible] ***cell*** [illegible] ***cell*** [illegible]

K.5.206 [illegible] ***battery*** [illegible]

K.5.207 [illegible] ***fully charged battery*** [illegible] ***charging system*** [illegible] ***fully charged battery*** [illegible]

K.5.208 [illegible] ***battery*** [illegible] ***cell*** [illegible]

K.5.209 [illegible] ***battery*** [illegible] ***cells*** [illegible] ***cell*** [illegible]

K.5.210 [illegible]

– [illegible] ***batteries***
– [illegible] ***batteries***
– [illegible] ***batteries*** [illegible]

K.7 Classification

This clause is not applicable.

K.8 Marking and instructions

K.8.1 This subclause is not applicable.

K.8.3 Battery tools and **detachable battery packs** or **separable battery packs** shall be marked with additional information as follows:

– the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact. Country or state, city and postal code (if any) are deemed sufficient for this purpose;

– designation of series or type,
allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of tool.

NOTE 1 The term “designation of series or type” is also known as model number.

Battery tools shall also be marked with additional information as follows:

– the year of manufacture and a date code identifying at least the month of manufacture;

– designation of the tool,
designation of the tool may be achieved by a code that is any combination of letters, numbers or symbols providing that this code is explained by giving the explicit designation such as “drill”, “planer” etc. in the instructions supplied with the tool;

NOTE 2 An example of such code is “A123-B”.

– for tools manufactured such that its parts are shipped separately for assembly by the end user each part shall be marked with a distinct identification on the part or the package.

Separable and **detachable battery pack**s shall also be marked with additional information as follows:

– the capacity assigned by the manufacturer in Ah or mAh, based on the rated capacity of the **cells** determined in accordance with IEC 61056-1, IEC 61960, IEC 61951-1 and IEC 61951-2, as applicable;

– for alkaline or other non-acid electrolyte **batteries**, the type of **battery** such as Li-Ion, NiCd and NiMH.

NOTE 3 In Canada and the United States of America, the following additional requirements apply.

A battery tool provided with a **detachable battery pack** or a **separable battery pack** shall be marked: "For use only with ___ battery", or the equivalent, where the underlined space is completed with the manufacturer's name or trademark, a catalog number, a series identification, or the equivalent, of the **battery** pack . Alternatively, the statement "See Instruction Manual for Additional Battery Packs" or the equivalent may be employed in addition to at least one **battery** pack referenced by catalog number.

A **detachable battery pack**, a **separable battery pack**, or a **battery** tool provided with an **integral battery** shall be marked "For use only with ___ charger", or the equivalent, where the underlined space is completed with the manufacturer's name or trademark, a catalog number, a series identification, or the equivalent, of the **charger**. Alternatively, the statement "See Instruction Manual for Additional Chargers," or the equivalent may be employed in addition to at least one **charger** referenced by catalog number.

If additional markings are used, they shall not give rise to misunderstanding.

[illegible]

K.8.4 Markings specified in K.8.1, 8.2 and K.8.3 shall not be on a **detachable part** of the tool.

Markings specified in 8.2 shall be clearly discernible from the outside of the tool. Markings specified in K.8.3 shall be visible with any **separable battery pack** or **detachable battery pack** removed. Other markings on the tool may be visible after removal of a cover, if necessary.

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.

[illegible]

K.8.7 This subclause is not applicable.

K.8.8 This subclause is not applicable.

K.8.14.1.1 This subclause is applicable except as follows:

Item 5) Service, is replaced by the following

5) Battery tool use and care

a) **Recharge only with the charger specified by the manufacturer**. [illegible]

b) **Use power tools only with specifically designated battery packs.** [illegible]

c) **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**. [illegible]

d) **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.**

e) **Do not use a battery pack or tool that is damaged or modified.**

f) **Do not expose a battery pack or tool to fire or excessive temperature.**

NOTE The temperature „130 °C“ can be replaced by the temperature „265 °F“.

g) **Follow all charging instructions and do not charge the battery pack or tool outside the temperature range specified in the instructions.**

6) Service

a) **Have your power tool serviced by a qualified repair person using only identical replacement parts.**

b) **Never service damaged battery packs.**

K.8.14.2 This subclause is applicable except as follows:

e) For battery tools:

1) Instructions regarding **battery** charging, information regarding ambient temperature range for tool and **battery** use and storage, and the recommended ambient temperature range for the **charging system** during charging;

2) For a battery-operated tool intended for use with a **detachable battery pack** or a **separable battery pack**: instructions indicating the appropriate **battery** packs for use, such as by a catalog number, series identification or the equivalent;

3) Instructions indicating the appropriate **charger** for use, such as by a catalog number, series identification or the equivalent.

NOTE In Europe (EN 62841-1), the following additional requirement applies:

for battery tools with **integral battery**: instruction, how the **integral battery** can be removed safely from the tool after the tool's end of life, and information about the type of **battery** such as Li-Ion, NiCd and NiMH

K.9 Protection against electric shock

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

K.9.1 Battery tools and **battery** packs shall be so constructed and enclosed that there is adequate protection against electric shock.

K.9.2 This subclause is not applicable.

K.9.3 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 d.c. or 0,7 mA peak for a.c. and there shall not be more than 0,1 μF capacitance directly between the parts.

[illegible]

[illegible] ***detachable parts*** [illegible] ***normal use***

[illegible] ***battery*** [illegible]

K.9.4 This subclause is not applicable.

K.9.5 Materials providing insulation from electric shock shall be adequate.

[illegible] ***hazardous voltage*** [illegible]

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.

[illegible] ***inherent operating cycle*** [illegible] **battery** [illegible]

[illegible] ***protective devices*** [illegible]

K.12.2 to K.12.6 These subclauses are not applicable.

K.12.201 Normal charging of lithium-ion systems

Charging a lithium-ion **battery** under normal conditions shall not exceed the **specified operating region for charging** of the **cell**.

[illegible]

[illegible] ***battery*** [illegible] ***charging system*** [illegible] ***fully discharged battery*** [illegible] ± [illegible]

– [illegible] 0 –5 [illegible]

– [illegible] +5 0 [illegible]

[illegible] ***cells*** [illegible] ***specified operating region for charging*** [illegible]

NOTE 1 The following is an example result of such analysis: the charging current for each branch of a parallel connection would not need to be monitored, if the maximum deliverable current of the **charger** did not exceed the **maximum charging current** of a single **cell**.

[illegible] ***batteries*** [illegible] ***battery*** [illegible] ***fully discharged battery*** [illegible] ***cell*** [illegible]

[illegible] ***normal use*** [illegible]

NOTE 2 Examples are those designs that employ circuitry intended for maintaining balance between **cells** in the **battery** pack. Systems with a small number of **cells** in series may be shown to exhibit limited imbalance in practice, if the product ceases to operate with a **battery** prepared with a smaller initial imbalance.

NOTE 3 An example for a testing is repeated charging and discharging a **battery** in accordance with the manufacturer's instructions until its capacity has decreased to 80 % of the rated capacity, using the imbalance at the end of the test.

K.13 Resistance to heat and fire

K.13.1 Parts of thermoplastic material provided as an enclosure to comply with Clause K.9, the deterioration of which might cause the tool or **battery** pack to fail to comply with this annex, shall be sufficiently resistant to heat.

[illegible]

[illegible]

NOTE In Clause K.12 only outside temperatures are measured. The basic temperature of (40 ± 2) °C has been changed to (55 ± 2) °C representing the typical difference between the inside and outside temperatures of enclosures.

K.13.2 This subclause applies only to the external enclosure enclosing the current-carrying parts of the tool or **battery** pack.

detachable ***separable battery pack*** ***integral battery***

–

–

–

–

K.13.2.201 For **detachable battery pack**s or **separable battery pack**s with external enclosures of polymeric material that enclose current-carrying parts, the material shall be classified at least V according to IEC 60695-11-10:2013, unless the battery pack has been tested in accordance with K.18.1 a).

NOTE The test of K.18.1 a) is mandatory for exposed battery terminals and is an option for battery terminals that are not exposed.

K.14 Moisture resistance

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.

K.18.2 to K.18.5 These subclauses are not applicable.

K.18.8 This subclause does not apply to lithium-ion **charging systems**, since they are covered by K.18.201.

K.18.8.3 to K.18.8.6 These subclauses are not applicable.

K.18.201 Lithium-ion charging systems – abnormal conditions

This subclause applies only to lithium-ion **batteries**.

The **charging system** and **battery** of a lithium-ion system shall be so designed that the risk of **fire** and **explosion** as a result of abnormal operation during charging is obviated as far as is practical.

– **cells** … **upper limit charging voltage** … **charging system** … **battery** … **battery** … **battery system** … **battery** …
– … **cell** …

K.18.202 Lithium-ion battery short circuit

This subclause applies only to lithium-ion **batteries**.

There shall be no risk of **fire** or **explosion** when the main discharge connections of a series configured **integral battery**, **detachable battery pack** or **separable battery pack** are shorted under conditions of extreme imbalance.

… **cells** … **battery fully charged** … **cell fully discharged**

… **detachable battery pack** … **separable battery pack** …

… **integral battery** …

… **battery** … **explosion** … **Venting** … **cells** …

… **thermal cut-outs** **thermal links, temperature limiters** …

… **electronic circuits** … **safety critical function** … – … **temperature limiter** … **temperature limiter** …

K.18.203 Batteries other than lithium-ion – overcharging

Batteries comprised of **cells** other than the lithium-ion type shall withstand abusive overcharging without risk of **fire** or **explosion**.

[illegible]

[illegible] **battery** [illegible] **C_5 rate** [illegible] **battery** [illegible] **explosion** [illegible] **Venting** [illegible] **cell** [illegible]

K.19 Mechanical hazards

K.19.6 For all tools where the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 requires the tool to be marked with the **rated no-load speed**, the no-load speed of the spindle at **rated voltage** shall not exceed 110 % of the **rated no-load speed**.

[illegible]

[illegible] **battery** [illegible] **fully charged battery** [illegible]

K.19.201 It shall not be possible to install a **detachable battery pack** or a **separable battery pack** in reverse polarity.

[illegible]

K.19.202 Lithium-ion enclosure pressure test

This subclause applies only to lithium-ion **batteries**.

An enclosure for lithium-ion **batteries** shall be designed such that it will safely release gasses that may be generated as a result of **venting**.

[illegible] 2 [illegible] **integral battery** [illegible] **detachable battery pack** [illegible] **separable battery pack** [illegible]

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 rough handling that may be expected.

K.20.3.1 **detachable battery pack** **accessories**

detachable battery packs **battery**

attachments **attachment** **attachment** **detachable battery pack** **separable battery pack**

K.20.3.2 **battery** **transportable tool** **detachable battery pack**

guard **guard** **normal operation**

detachable battery packs **separable battery packs** **battery**

detachable battery packs **separable battery packs** **battery**

K.20.4 This subclause is not applicable.

K.21 Construction

K.21.5 This subclause is not applicable.

K.21.6 This subclause is not applicable.

K.21.7 to K.21.15 These subclauses are not applicable.

K.21.17.1.2

K.21.21 This subclause is not applicable.

K.21.25 to K.21.29 These subclauses are not applicable.

K.21.31 to K.21.34 These subclauses are not applicable.

K.21.201 Tools shall not readily accept **general purpose batteries** (either primary or rechargeable) as an energy source for their primary function.

K.21.202 Vents of lithium-ion **cells** shall not be obstructed in such a way as to defeat their operation if **venting** is relied upon for safety.

K.21.203 User accessible interfaces between elements of a lithium-ion **battery system** shall not employ connectors of the following types:

– standard mains inlet connectors, except for mains supply connections;
– barrel connectors with outside diameters of 6,5 mm or less;
– phone plugs with a diameter of 3,5 mm or less.

K.22 Internal wiring

K.22.2 This subclause is applicable only for **hazardous voltages**.

K.22.3 This subclause is not applicable.

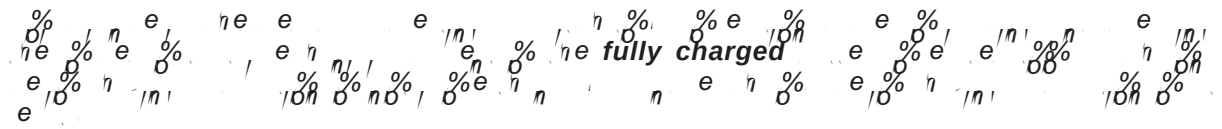
K.22.6

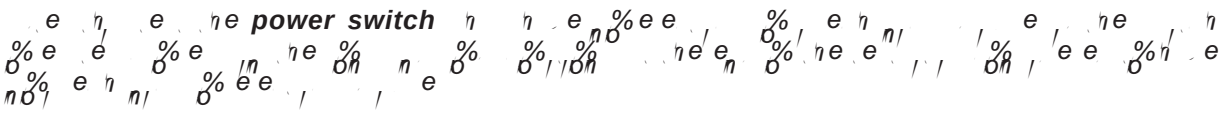
K.23 Components

K.23.1.2 This subclause is not applicable.

K.23.1.9 This subclause is not applicable.

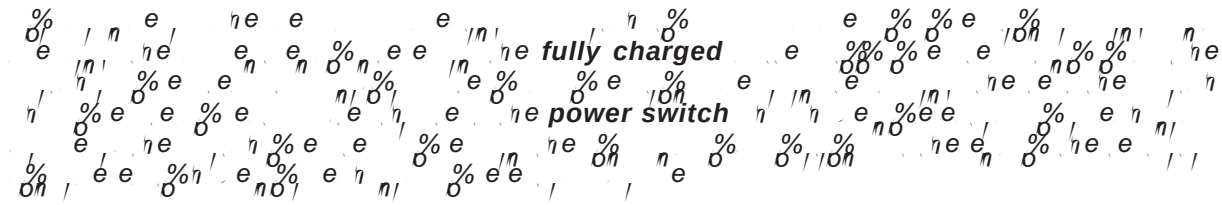
K.23.1.10 **Power switches** shall have adequate breaking capacity.





K.23.1.10.1 to K.23.1.10.3 These subclauses are not applicable.

K.23.1.201 **Power switches** shall withstand, without excessive wear or other harmful effect, the mechanical, electrical, and thermal stresses occurring in the tool.



K.23.5 This subclause is not applicable.

K.23.201 **Cells** employed in tools or **cells** employed in **battery** packs shall comply with IEC 62133.

NOTE The above requirement for testing according to IEC 62133 does not include the **battery** pack itself.

K.23.202 Rechargeable **cells** employed in tools or in **battery** packs shall not be of lithium-metal type.

NOTE Lithium-ion **cells** are not lithium metal **cells**.

K.24 Supply connection and external flexible cords

This clause is not applicable, except as follows:

K.24.201 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.

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 subclause is applicable except as follows: the sixth paragraph and the accompanying note, which refers to earthing connections, are 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.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. **Creepage distances** 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.1 do not apply to cross-over points of motor windings.

The values in Table K1 are equal or larger than the values required by IEC 60664-1, when

– an overvoltage category II;
– a material group III;
– a pollution degree 1 for parts protected against deposition of dirt and for lacquered or enamelled windings;
– a pollution degree 3 for other parts;
– inhomogeneous electric field

are applied.

For parts of different polarity, **clearance** and **creepage distances** less than those given in Table K.1 are acceptable if the shorting of the two parts does not result in the tool starting.

NOTE 1 The risk of **fire** due to spacings below the required values is covered by the requirements of 18.1.

Table K.1 – Minimum creepage distances and clearances between parts of opposite polarity

Working voltage ≤ 15 V		Working voltage > 15 V and ≤ 32 V		Working voltage > 32 V	
Creepage distance	**Clearance**	**Creepage distance**	**Clearance**	**Creepage distance**	**Clearance**
0,8 [a]	0,8	1,5	1,5	2,0 [a]	1,5

[a] These **creepage distances** are slightly lower than suggested by IEC 60664-1. **Creepage distances** between **live parts** of different polarity (functional insulation) are only associated to fire hazard, not to electric shock hazard. As products in the scope of IEC 62841 are products supervised during **normal use**, lower distances are justified.

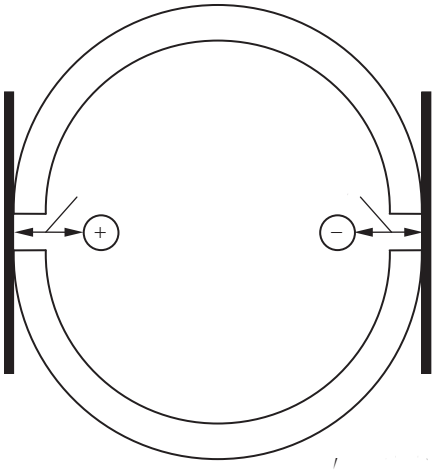
For parts having a **hazardous voltage** between them, the sum total of the measured distances between each of these parts and their nearest accessible surface shall not be less than 1,5 mm **clearance** and 2,0 mm **creepage distance**.

NOTE 2 Figure K.1 provides clarification on the measurement method.

creepage distances **clearances** **hazardous voltage**

creepage distances **clearances**

K.28.2 This subclause is not applicable.



Dimension = distance from positive bare conductive part to the external surface as defined by foil stretched across the openings.

Dimension = distance from negative bare conductive part to the external surface as defined by foil stretched across the openings.

\+ is the sum total as defined in 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

– **hand-held tools** (IEC 62841-2);
– **transportable tools** (IEC 62841-3);
– **lawn and garden machinery** (IEC 62841-4);

and the **battery** packs for such tools or machinery that are also operated and/or charged directly from the mains or a **non-isolated source**, including tools provided with integral battery **chargers**. The above listed categories are hereinafter referred to as “tools” or “machines”.

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**.

Since **battery** packs for power tools are submitted to different use patterns (such as rough use, high charging and discharging currents) their safety can be evaluated only by this annex and not by using other standards for **battery** packs, such as IEC 62133, unless otherwise indicated in this annex. All relevant requirements of IEC 62133 are addressed in this annex.

When evaluating the risk of **fire** associated with **detachable battery packs**, consideration has been given to the fact that these **battery** packs are unattended energy sources and have been evaluated as such in this standard. Requirements in other standards regarding the risk of **fire** due to the charging of these **detachable battery packs** are therefore considered to be fulfilled.

This annex also addresses requirements covering the use of lithium-ion **cells** employed in **battery systems** in tools. The following is considered within the context of these requirements:

– These requirements address the risk of **fire** or **explosion** of these **batteries** and not any possible hazards associated with toxicity nor potential hazards associated with transportation or disposal.

NOTE 1 IEC 62281 covers the safety aspects of lithium-ion batteries during transport.

– **Battery systems** covered by these requirements are not intended to be serviced by the end user.
– These requirements are intended to provide comprehensive evaluation of a **battery** only if used in products covered by this standard.
– These requirements address the safety of lithium-ion **battery systems** during storage and use including discharge and charge. These requirements are only considered to be supplementary requirements in regards to battery **charger** fire and electric shock.
– These requirements refer to and require parameters supplied in reference to the **cells** that establish conditions for safe use of those **cells**. Those parameters form the basis of acceptance criteria for a number of tests contained herein. This standard does not

independently evaluate the safety of **cells**. These parameters, taken as a set, constitute the "**Specified Operating Region**" for a **cell**. There may be several sets of **specified operating region**(s).

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 the safety of battery **chargers** themselves. However, this annex covers the safe functioning of lithium-ion **battery systems**.

NOTE 2 IEC 60335-2-29 covers a variety of **chargers**.

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 main body of the standard unless otherwise specified.

L.3 Terms and definitions

This clause is applicable except as follows:

For the purpose of this annex, the following additional definitions apply:

L.3.201
battery system
combination of a lithium-ion **battery**, the **charging system**, the tool and the interfaces between them as existing during operation of the tool or during charging

L.3.202
cell
basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical energy

L.3.203
charger
part or all of the **charging system** contained in a separate enclosure. As a minimum, the **charger** includes some of the power conversion circuitry. Not all **charging systems** include a separate **charger** as in the case where a tool may be charged utilizing a mains **supply cord** or may incorporate a plug for attachment to a mains receptacle

L.3.204
charging system
combination of circuitry intended to charge, balance and/or maintain the state of charge of the **battery**

L.3.205
C_5 rate
current, in amperes, that a **cell** or **battery** can be discharged at for 5 h to the voltage cut-off point specified by the **cell** manufacturer

L.3.206
detachable battery pack
battery which is contained in a separate enclosure from the battery tool and is intended to be removed from the tool for charging purposes

L.3.207
fire
emission of flames from a **battery**

L.3.208
fully charged (battery/cell)
cell or **battery** charged to the maximum state of charge permitted by the **battery charging system** intended for use with the tool

L.3.209
fully discharged (battery/cell)
battery or **cell** that has been discharged at $\mathbf{C_5}$ **rate** until one of the following conditions occurs: discharge terminates due to protective circuitry or the **battery** (or **cell**) reaches a total voltage with an average voltage per cell equal to the end-of-discharge voltage for the cell chemistry being used unless a different end-of-discharge voltage is specified by the manufacturer

Note 1 to entry: The end-of-discharge voltages for common cell chemistries are provided in L.5.210.

L.3.210
general purpose (battery/cell)
batteries and **cells** available from a variety of manufacturers, through a variety of outlets intended for a variety of different manufacturers' products

Note 1 to entry: 12 V automotive **batteries** and AA, C and D alkaline **cells** are examples of **general purpose**.

L.3.211
hazardous voltage
voltage between parts having an average value exceeding 60 V d.c. or exceeding 42,4 V peak

L.3.216
upper limit charging voltage
highest voltage that a lithium-ion **cell** is permitted to attain during normal charging for a specified range of temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133

L.3.217
venting
condition that occurs, when a **cell** releases excessive internal pressure intended by design to preclude **explosion**

L.5 General conditions for the tests

L.5.2

L.5.7.2 Unless otherwise specified, tests to be done at **rated voltage** are done with a **fully charged battery**.

L.5.201

L.5.202

L.5.203

L.5.204

L.5.205

L.5.206

L.5.209 % ***battery*** e ,, n ηe e ηe e / e / e n / e e % e e % ***cells*** ηe e η e e e /n / e ***cell*** % η%e e n / ή e / e e /n / ηe / o n o % η , e% on /n / e ***cell*** /o % % on /n / ηe e

L.5.210 ηe e n o % / η , e o % , e % o o / on e ηe / / e e

– e % o n / e / / / o n / e / e η / e ***batteries***
– e % o e / ***batteries***
– e % η / / / on ***batteries*** n e ηe / n e e / / e / e e n o % , e

L.7 Classification

L.7.1 This subclause applies except that **class III tools** are not considered in this annex.

L.8 Marking and instructions

L.8.1 **Non-isolated sources** that can supply a tool, or tools that can be supplied directly from the mains, shall be marked with the following:

– **rated voltage**(s) or **rated voltage range**(s), in volts;
– symbol for nature of supply, unless the **rated frequency(ies)** or **rated frequency range** is marked. The symbol for nature of supply shall be placed next to the marking for **rated voltage**;
– **rated input**, in watts, or **rated current** in amperes;
– symbol for **class II construction**, for **class II tools** only.

% / n e / ηe e /n e /on

L.8.3 Tools and **detachable battery packs** or **separable battery packs** shall be marked with additional information as follows:

– the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact. Country or state, city and postal code (if any) are deemed sufficient for this purpose;
– designation of series or type,
allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of tool.

NOTE 1 The term “designation of series or type” is also known as model number.

Tools shall also be marked with additional information as follows:

– the year of manufacture and a date code of identifying at least the month of manufacture;
– designation of the tool:
designation of the tool may be achieved by a code that is any combination of letters, numbers or symbols providing that this code is explained by giving the explicit designation such as “drill”, “planer” etc. in the instructions supplied with the tool;

NOTE 2 An example of such code is “A123-B”.

– for tools manufactured such that its parts are shipped separately for assembly by the end user each part shall be marked with a distinct identification on the part or the package.

Separable and **detachable battery packs** shall also be marked with additional information as follows:

– the capacity assigned by the manufacturer in Ah or mAh, based on the rated capacity of the cells determined in accordance with IEC 61056-1, IEC 61960, IEC 61951-1 and IEC 61951-2, as applicable;

– for alkaline or other non-acid electrolyte **batteries**, the type of **battery** such as Li-Ion, NiCd and NiMH.

If additional markings are used, they shall not give rise to misunderstanding.

[illegible]

L.8.4 Markings specified in L.8.1, 8.2 and L.8.3 shall not be on a **detachable part** of the tool.

Markings specified in 8.2 shall be clearly discernible from the outside of the tool. Markings specified in L.8.3 shall be visible with any **separable battery pack** or **detachable battery pack** removed. Other markings on the tool may be visible after removal of a cover, if necessary.

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.

[illegible]

L.8.14.1.1 This subclause is applicable except as follows:

Item 5) Service, is replaced by the following

5) Battery tool use and care

a) **Recharge only with the charger specified by the manufacturer.** [illegible]

b) **Use power tools only with specifically designated battery packs.** [illegible]

c) **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.** [illegible]

d) **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.** [illegible]

e) **Do not use a battery pack or tool that is damaged or modified.** [illegible]

f) **Do not expose a battery pack or tool to fire or excessive temperature.** [illegible]

NOTE The temperature „130 °C“ can be replaced by the temperature „265 °F“.

g) **Follow all charging instructions and do not charge the battery pack or tool outside the temperature range specified in the instructions.** [illegible]

6) Service

a) **Have your power tool serviced by a qualified repair person using only identical replacement parts.** [illegible]

b) **Never service damaged battery packs.** [illegible]

L.8.14.2 This subclause is applicable except as follows:

e) For battery tools:

1) Instructions regarding **battery** charging, information regarding ambient temperature range for tool and **battery** use and storage, and the recommended ambient temperature range for the charging system during charging;

2) For a **battery**-operated tool intended for use with a **detachable battery pack** or a **separable battery pack**: instructions indicating the appropriate **battery** packs for use, such as by a catalog number, series identification or the equivalent;

3) Instructions indicating the appropriate **charger** for use, such as by a catalog number, series identification or the equivalent.

NOTE In Europe (EN 62841-1), the following additional requirement applies:

for battery tools with **integral battery**: instruction, how the **integral battery** can be removed safely from the tool after the tool's end of life, and information about the type of **battery** such as Li-Ion, NiCd and NiMH

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:

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.9.201 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 d.c. or 0,7 mA peak for a.c. and there shall not be more than 0,1 µF capacitance directly between the parts.

detachable parts **normal use**

[illegible] **battery** [illegible]

L.10 Starting

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**.

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 to a **non-isolated source**. In the case of tools that can also charge the **battery** 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** being discharged or until thermal stabilization is achieved, whichever occurs first. The test is repeated, allowing the **battery** to charge while the tool is not operating.

L.12.201 Normal charging of lithium-ion systems

Charging a lithium-ion **battery** under normal conditions shall not exceed the **specified operating region for charging** of the **cell**.

[illegible] ***charging system*** [illegible] ***fully discharged battery*** [illegible]

– [illegible] $^{0}_{-5}$

– [illegible] $^{+5}_{-0}$

[illegible] ***cells*** [illegible]

NOTE 2 Examples are those designs that employ circuitry intended for maintaining balance between **cells** in the **battery** pack. Systems with a small number of **cells** in series may be shown to exhibit limited imbalance in practice, if the product ceases to operate with a **battery** prepared with a smaller initial imbalance.

NOTE 3 An example for a testing is repeated charging and discharging a **battery** in accordance with the manufacturer's instructions until its capacity has decreased to 80 % of the rated capacity, using the imbalance at the end of the test.

L.13 Resistance to heat and fire

This clause is applicable except as follows:

L.13.1

This subclause 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 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 which may also be capable of performing its intended operation shall also be evaluated with **battery** power alone if this may create temperatures that are more unfavourable. For the purposes of L.13.1, a part that is energized only by a **battery** source is not to be considered live.

L.13.2

detachable battery pack ***separable battery pack*** ***integral battery***

–

–

–

–

L.14 Moisture resistance

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**.

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 to a **non-isolated source**.

L.17 Endurance

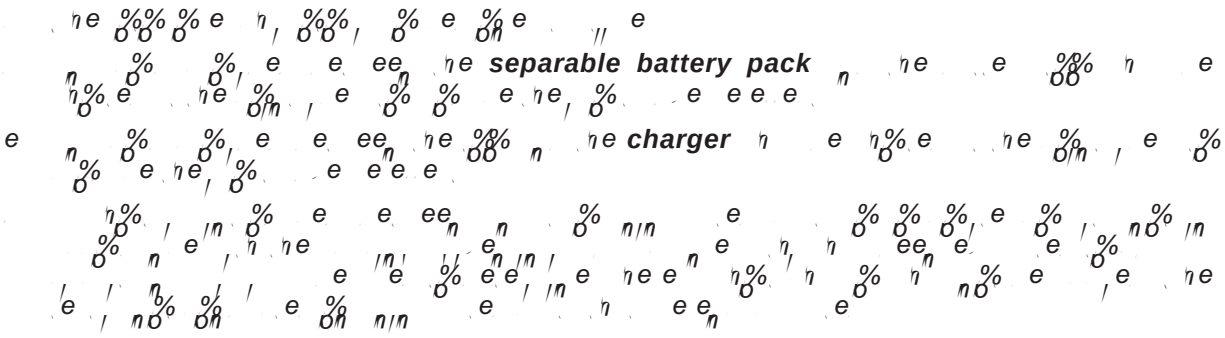
This clause applies to tools capable of continuous operation when they are supplied directly from the mains or from a **non-isolated source**. Tools that are not capable of continuous operation shall be operated under **battery** power for the duration of the test but shall be evaluated for electric strength with their **charger** connected.

L.18 Abnormal operation

This clause, except L.18.8 and L.18.201 to L.18.204, only applies when the tool is in the configuration where it is directly connected to the mains or to a **non-isolated source**.

L.18.8 This subclause does not apply to lithium-ion **charging systems**, since they are covered by L.18.202.

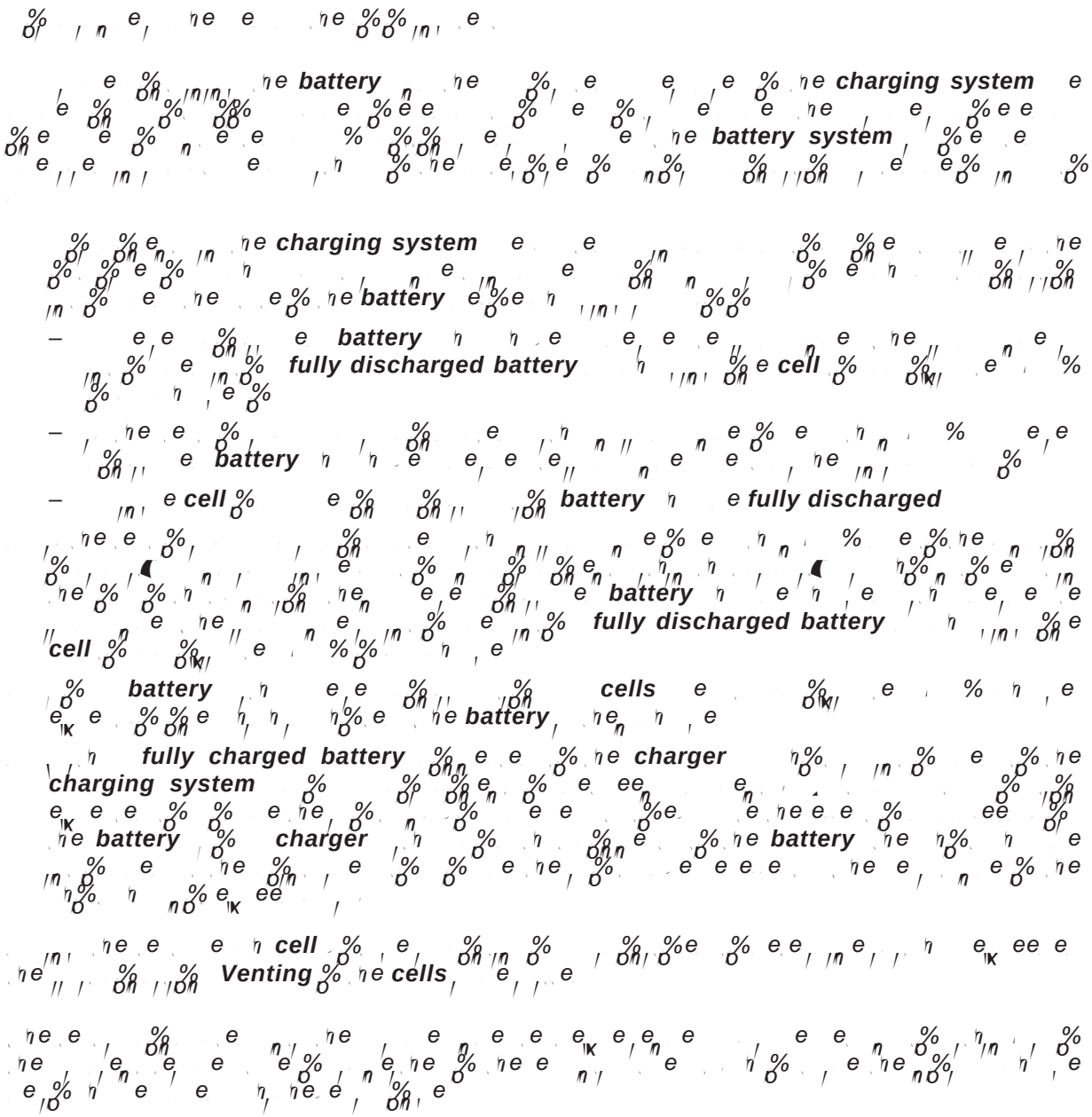
L.18.201 All tools when operating only under **battery** power and their **battery** packs shall be so designed that the risk of **fire** or electric shock as a result of abnormal operation is obviated as far as is practical.



L.18.202 Lithium-ion charging systems – abnormal conditions

This subclause applies only to lithium-ion **batteries**.

The **charging system** and **battery** of a lithium-ion system shall be so designed that the risk of **fire** and **explosion** as a result of abnormal operation during charging is obviated as far as is practical.



L.18.203 Lithium-ion battery short circuit

This subclause applies only to lithium-ion **batteries**.

There shall be no risk of **fire** or **explosion** when the main discharge connections of a series configured **integral battery**, **detachable battery pack** or **separable battery pack** are shorted under conditions of extreme imbalance.

L.18.204 Batteries other than lithium-ion – overcharging

Batteries comprised of **cells** other than the lithium-ion type shall withstand abusive overcharging without risk of **fire** or **explosion**.

L.19 Mechanical hazards

L.19.201 It shall not be possible to install a **detachable battery pack** or a **separable battery pack** in reverse polarity.

L.19.202 Lithium-ion enclosure pressure test

This subclause applies only to lithium-ion **batteries**.

An enclosure for lithium-ion **batteries** shall be designed such that it will safely release gasses that may be generated as a result of **venting**.

L.20 Mechanical strength

This clause, except L.20.201 and L.20.202, only applies when the tool is in the configuration where it is directly connected to the mains or to a **non-isolated source**.

L.20.201 With the **battery** connected, battery tools and **battery** packs shall have adequate mechanical strength, and shall be so constructed that they withstand rough handling that may be expected.

L.20.202 **L.20.202.1** **detachable battery pack** **detachable battery packs** **battery** **accessories** **attachment** **detachable battery pack** **separable battery pack**

L.20.202.2 **battery** **transportable tool** **detachable battery pack** **guard** **guard** **normal operation** **detachable battery packs** **separable battery packs** **battery** **detachable battery packs** **separable battery packs** **battery**

L.21 Construction

This clause, except L.21.201 and L.21.202, only applies when the tool is in the configuration where it is directly connected to the mains or to a **non-isolated source**.

L.21.201 Tools shall not readily accept **general purpose batteries** (either primary or rechargeable) as an energy source for their primary function.

[illegible]

L.21.202 Vents of lithium-ion **cells** shall not be obstructed in such a way as to defeat their operation if **venting** is relied upon for safety.

[illegible]

L.21.203 User accessible interfaces between elements of a lithium-ion **battery system** shall not employ connectors of the following types:

– standard mains inlet connectors, except for mains supply connections;
– barrel connectors with outside diameters of 6,5 mm or less;
– phone plugs with a diameter of 3,5 mm or less.

[illegible]

L.22 Internal wiring

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**.

L.23 Components

L.23.1.10 This subclause applies only to **power switches** of tools capable of performing their intended operation when connected to the mains or to a **non-isolated source**.

L.23.1.10.201 **Power switches**, other than those of tools described in L.23.1.10, shall have adequate breaking capacity.

[illegible]

[illegible]

L.23.201 **Cells** employed in tools or cells employed in **battery** packs shall comply with IEC 62133.

NOTE The above requirement for testing according to IEC 62133 does not include the **battery** pack itself.

L.23.202 Rechargeable **cells** employed in tools or in **battery** packs shall not be of lithium-metal type.

[illegible]

NOTE Lithium-ion **cell**s are not lithium metal **cells**.

L.24 Supply connection and external flexible cords

L.24.1 This subclause also applies to a flexible cord between a **non-isolated source** and the tool.

L.24.3 This subclause also applies to a flexible cord between a **non-isolated source** and the tool.

L.24.4 This subclause applies, except a flexible cord provided between a **non-isolated 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 source** and the tool.

L.24.20 This subclause applies, except a flexible cord provided between a **non-isolated source** and the tool shall not be provided with an appliance inlet that can be connected directly to the mains.

L.24.201 For battery tools with **separable battery packs**

L.28.1 %

This subclause only applies when the tool is in the configuration where it is directly connected to the mains or to 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.

Between parts of opposite polarity that are live during charging, the **creepage distances** and **clearance**

Dimension = distance from positive bare conductive part to the external surface as defined by foil stretched across the openings.

Dimension = distance from negative bare conductive part to the external surface as defined by foil stretched across the openings.

\+ is the sum total as defined in L.28.201.

Figure L.1 – Measurement of clearances

Bibliography

IEC 60127-3,

IEC 60204 (all parts),

IEC 60335 (all parts),

IEC 60335-2-29,

IEC 60335-2-45,

IEC 60601 (all parts),

IEC 60664-3,

IEC 62281,