EUROPEAN STANDARD

NORME **EUROPÉENNE**

EUROPÄISCHE NORM

EN 61029-1

February 2000

ICS 25140.20

Supersedes EN 61029-1:1995

Englishversion

Safety of transportable motor-operated electric tools Part 1: General requirements (IEC 61029-1: 1990, modified)

Sécurité des machines-outils électriques semi-fixes
Partie 1: Règles générales
(CEI 61029-1:1990, modifiée)

Sicherheit transportabler motorbetriebener Elektrowerkzeuge
Teil 1: Allgemeine Anforderungen
(IEC 61029-1 :1990, modifiziert)

This European Standard was approved by CENELEC cn 1998-08-01. CENELEC members are bound tc comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status cf a national Standard without any alteration.

Up-to-date lists and bibliographical references concerning such national Standards may be obtainad cn application tc the Central Secretariat cr tc any CENELEC member.

This European Standard exists in three official versions (English, French, German). Aversion in any other language made by translation under the responsibility cf a CENELEC member into its cwn language and nctified tc the Central Secretariat has the same status as the official versions.

CENELEC members are tha national electrotechnical ccmmittees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Notherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
ComitéEuropéen de Normalisetion Eleotrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B • 1050 Brussels

© 2000 CENELEC • All rights of exploitation in any form and by any means reserved worldwide fcr CENELEC members.

Ref. No. EN 61029-1:2000 E

Foreword

This European Standard has been prepared by the Technical Committee CENELEC TC 61F, Handheld and transportable motor operated electric tools.

The text of the International Standard IEC 61029-1 with CENELEC common modiicattons was submitkd to the formal vok and was approved by CENELEC as EN 61029-1 on 1998-08-01.

The kxt of the common modiications is indicakd by a vertical line in the left margin of the text.

This European Standard supersedes EN 61029-1:1995.

The following dates were fixed:

- latest dak by which the EN has to be implemenkd at national level by pubiication of an identical national skndard or by endorsement (dop) 2000-09-01
- latest dak by which the national skndards confiicting with the EN have to be withdrawn (dow) 2002-09-01

Part 1 of this standard together with related Park 2 gives directly and by reference the complete requiremenk for the specific type of transportable tool defined in the scope.

Other standards to which this European Standard refers are liskd in Annex A This annex iisk the valid edition of these documents at the time of issue of this EN. All reference to these skndards is however to be understood to be a reference to the latest ediion.

This standard is divided into two park:

Part 1 General requirements whii are common to most transportable electric motor operated tools (for the purpose of this standard referred to simply as tools) which could come within the scope of this standard

Part 2 Requiremenk for particukr types of tool which either Supplement or modii the requiremenk given in Part 1 to account for the particukr hazards and characteristics of these specific tools.

This European Standard has been prepared under a mandate given to CENICENELEC by the European Commission and the European Free Trade Association and supports the essential safety requiremenk of the Machinery Directive.

Compliance with the relevant clauses of Part 1 together with a relevant Part 2 of this skndard provides one means of conforming with the essential health and safety requiremenk of the Directive.

A relevant Part 2 is one in which the type of tool or an accessory which is to be used with such a tool is within the scope of that Part 2.

When a relevant Part 2 does not exist, Part 1 can help to estabiish the requiremenk for the tool, but will not by ikeif provide a means of wnforming with the relevant essential health and safety requiremenk of the Machinery Directive.

Waming: Other requiremenk arising from other EC Directives can be applicable to the products falling within the scope of thii skndard.

CEN has proposed standards for industrial machines, which may extend to transportable machines. Although CEN and CENELEC have, where appropriate, used wmmon solutions to provide uniform ievek of prokction, persons using this skndard shouid check the scope of both this and CEN standards to ensure that a correct standard is used. Where necessary, normative reference is made to these standards in the relevant Part 2.

Introduction

This European Standard is divided into two parts:
Part 1: General requirements, wmprising clauses of a general Character.
Part 2: Particular requirements. dealing with particular types of tool.

The requirements in a clause in a Part 2 Supplement or modify the wrresponding clauses in Part 1.

Where the text of a Part 2 indicates an "addition" to or a "replacement" of the relevant requirement, test specification or explanatiw of Part 1, these changes are rnade to the relevant text of Part 1, which then becomes part of the standard. Where no change is necessary, the words "This clause of Part 1 is applicable" are used in the Part 2.

This standard follows the Overall requirements of EN 292-1 and 292-2.

1 Scope

1.1 This standard consists in Part 1 and Part2 and applies to electric motor-operated or rnagneticallydrlven tools. intended for indoor and for outdoor use, which have all the following characteristics:

a) easily moved by one person, simple devices to facilitate transportatlon may be incorporated. e.g. handles, wheels and the like;

b) used in a safe stationary positton with or without fixing. e.g. fast clamping devices, bolting and the like;

c) used under the control of an operator;

d) not intended for wntinuous productlon or productlon line use;

e) intended to be connected to electric supply by a flexible cord and a plug;

f) rnaximum rated voltage not exceeding 250 V single-phase, a.c. or d.c., or 440 V three-phase, a.c.:

g) maximum rated input not exceeding 2600 W, for single-phase a.c. or d.c., and 4000 W for three-phase a.c.

These tools are commonly known as “transportable motor-operated electric tools”, hereinafter referred to, in the text, as tools.

Examples of these tools are: Circular saws, band saws, planen, thicknessers, radial arm saws, spindle moulders, fret saws, jig saws, mitre/chop saws, wood lathes, belt sanden, disc sanden, thicknessers-planen.

shears. wncrete drills, concrete saws, wood shredders, pipe cleaners

1.2 This standard does not apply to

- electrlc motor-operated household and similar electrical appliances according to EN 60335-1;
- hand-held electric motor-operated tools according to EN 50144-1;
- small low voltage transformer operated bench tools intended for model making;
- machines for preparing or pmcessing food;
- tools used in explosive atmospheres;
- additional driving mechanisms required for extemal cooling and dust extraction/collection systems.

2 Definitions

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

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

2.1
rated vottage
voltage (for three-phase supply, the vottage between phases) assigned to the tool by the manufacturer

2.2
rated voltage range
voltage range assigned to the tool by the manufacturer, expressed by its lower and upper limits

2.3
working voltage
maximum voltage to which the part under consideration can be subjected when the tool is operating at its rated voltage and under normal conditions of use

Normal condiions of use include changes of voltage within the tool imposed by likely occurrences such as the Operation of a circuit breaker or the failure of a hmp.

When determining the working voltage. the effect of possible transient voitages on the supply mains is lgnored.

2.4
rated input
input in watts at rated voltage or the mean of the rated vottage range assigned to the tool by the rnanufacturer

2.5
rated current
current at rated voltage or at the mean of the rated vottage range assigned to the tool by the rnanufacturer

NOTE If no current is assigned to ths tool, the rated current for the purpose of thio standard is determined by calculation from the rated input and the rated voltage and/or by measuring the current when the tool is operating at rated voltage under normal load and at normal operating temperature.

2.6
rated frequency
frequency assigned to the tool by the manufacturer

2.7
rated frequency range
frequency range assigned to the tool by the manufacturer, expressed by its lower and upper limits

2.6
rated ndoad speed
no-load Speed at rated vottage or at the upper limit of the rated voltage range, assigned to the tool by the manufacturer

2.9
detachable flexible cord
flexible cord, for supply or other purposes, intended to be connected to the tool by means of a suitable appliance coupler

NOTE Cord sets are covered by EN 60799; appliance couplers for household and similar general purposes by EN 60320-1.

2.10
power supply cord
flexible **cord,** for **supply** purposes, **fixed to,** or assembled with. the **tool** according to one of the following methods:

- **type X attachment:** Method of attachment such that the flexible **cord can** easily **be replaced,** without the aid of special purpose tools, by a flexible **cord** not **requiring** any special preparation;
- **type M attachment:** Method of attachment such that the **flexible cable** or **cord can easily be** replaced, without the aid of spedal purpose **tools,** by a special **cord with,** for **example,** a **moulded-on cord** or **crimped terminations.**

2.11
basic insulation
insulation applied to live parts to provide basic protection against etectric **shock**

NOTE **Basic insulation does not necessarily include insulation used exclusively for functional purposes.**

2.12
supplementary insulation
independent insulation applied in addition **to** the basic insulation, in **order to** ensure protection against electric **shock** in the event of a failure of the basic **insulation**

2.13
double insulation
insulation comprising both basic insulation and supplementary insulation

214
reInforced insulation
single insulation system applied to **live** parts, **which** pmvides a degree of protection against elecbic **shock** equivalent to double insulation **under** the conditions specified in this standard

"Single insulation System" does not imply that the insulation must be one homogeneous **piece.** It may comprise several layers **which cannot** be **tested** singly as supplementary or basic insulaäon.

2.15
class I tool
tool In whii pmtection against electric **shock does** not rely on basic insulation only, but **which** includes an addhional **safety** precaution in such a way that means are providad for the connectton of accessible **conductive parts** to the **protective** (earthing) **conductor** in the **fixed** wiring of the installation in such a way that accessible conductive **parts cannot become** live in the event of a **failure** of the basic insulation

NOTE **Class I tools may have parts with double insulation or reinforced insulation or parts operating at safety extra-low voltage.**

For **tools** intended for use **with** a flexible **cord,** the **provision** includes a pmtective conductor as **part** of the flexible **cord.**

2.16
class II tool
tool in **which** pmtection against **electric shock** does **not** rely on basic **insulation** only, but in **which** additional safety precautions, such as double insulation or reinforced **insulation,** are **provided, there** being no **provision** for pmtective earthing or reliince upon installation wnditions.

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

a) a tool having a durable and substantially wntinuous enclosure of insulating material **which** envelopes all metal **parts,** with the exception of **small parts,** such as nameplates. screws and rivets, **which** are isolated from liie **parts** by insutation at least equivatent to reinforced insulation; such a **tool** is called an insulation-encased **class II tool;**

b) a tool having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulatlon is used, because the application of double insulation is manlfestly impracticable; such a tool ia called a metal-encased class II tool;

c) a tool which is a combination of types a) and b).

2.17
class III tool
tool in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated

2.18
extra-low voltage
Voltage supplied from a source wlthin the tool and, when the tool is operated at its rated voltage, not exceading 42 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V between conductors and neutral, the extra-low voltage circuit being separated from other circuits by basic insulation only.

2.19
safety extra-low voltage (SELV)
nominal voltage not exceeding 42V between conducton and between conductors and earth or, for three-phase supply. not exceeding 24 V between conductors and neutral, the no-load voltage not exceeding 50 V and 29 V respectively.

NOTE 1 When SELV is obtained from the supply mains, it must be through a safety isolating transformer or a convertor with separate Wirdings.

NOTE 2 Tha voltage limits specified are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

Limitations to voltages lower than 50 V a.c. should be specified in the particular standards. especially when direct contact with live parts is involved.

Separation from the mains by protective impedance is excluded.

2.20
safety isolating transformer
transformer the input winding of which is electrically separated from the output windings by an insulation at least equivalent to double insulation or reinforced insulation, and which is designed to supply a distribution circuit, a tool or other equipment at safety extra-low voltage

2.21
normal load
Load to be applied to a tool so that the stress imposed corresponds to that occurring under normal conditions of use, any marking of short-time or intermittent Operation being observed and, unless otherwise specified, heating elements, if any, being operated as in normal use.

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

2.22
rated operating time
operating time assigned to the tool by the manufacturer

2.23
continuous Operation
Operation under normal load for an unlimited period

2.24
short-time Operation
Operation under normal load for a **specified** period, **starting from cold,** the intervals between **each** period of Operation being **sufficient to aliow** the **tool to cool** down approximately **to** mom temperature

2.25
intennittent operation
Operation in a **series** of **specified** identical cycles. **each** cycle being composed of a period of Operation **under** normal load **followed** by a rest period **with** the **tool** running idle or switchad off

2.26
non-detachable part
patt which **can** only be removed with the aid of a **tool**

Where expressions such **as "with** the aid of a **tool"** occur, the word tool means a hand **tool,** for example screwdrivers, **which** may be used **to** oparate a **screw** or other means of fixing.

2.27
detachable part
part which **can** be removed **without** the aid of a **tool.**

2.28
thermal Cut-out
device which, **during** abnormal Operation, **limits** the temperature of a **tool, or** of parts of it, by **automatically** opening the circuit or by reducing the **current,** and which **is** so constructed that its setting **cannot** be **altered** by the **user**

2.29
non-self-resetting thermal cut-out
thermal cut-out which requires resetting by hand, or replacemant of **a part,** in **order** to **restore** the **current**

2.30
creepage distance
shortest path between **two** conductive **parts,** or between a wnductive **part** and the bounding **surface** of the **tool,** measured along the **surface** of the insulating material

2.31
clearance
shortest distance between two wnductive **parts,** or between a wnductive **part** and the bounding **surface** of the tool, measured through air

NOTE **The bounding surface of the tool is the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material.**

2.32
all-pole disconnection
for single-phase a.c. **tools** and for d.c. **tools,** diinnection of **both supply conductors** by a **single switching action or,** for **tools to be** wnnected to more than two supply **conductors,** diinnection of all supply **conductors,** except the **earthed** (grounded) wnductor, by a **single** switching **action**

NOTE **The protective earthing conductor is not a supply conductor.**

2.33
accessible part or accessible surface
part or **surface** which **can** be touched by means of the **standard** test **finger** shown in Figure 1

For accessible metal **parts, it** includes any other metal **part** which is in electrical wntact with such parts.

The term body includes all accessible metal parts, **shafts** of handtes, knobs, **grips** and the like and **metal foil** in **contact** with all **surfaces** of **insulating material;** it **does** not include inaccessible **metal parts.**

2.34
power circuit
circuit which **contains** elecbical equipment **intended** for **generation, transformation, distribution** or **consumption** of **electric energy**

2.35
control **circuit**
auxiliary circuit which **is used** to confrol **electrical** equipment

2.36
confrol device
device, for example **push-buttons, selector** switches, which **is used to** confrol. by hand, the funcfion of **the** tool

3 General **requirement**

Tools **shall** be so designed and **constructed that** in normal **use they** funcfion safely and **cause** no **danger** to persons *or* to the **surroundings,** even in **the** event of such careless use **as** may occur in **normal service.**

The **materials** used for the **construction** of the tool should not introduce addiional **hazards during** the **use** or diiposal of **the tool.**

*In genemi, **compliance is checked** by **carrying** out all the relevant tests.*

4 General **notes on tests**

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

*4.2 **Unless** othenviie **specified,** tests ara **carried** out on a **single** test **sample** as **delivered,** the **said sample***

***voltages,** for both **a.c.** and d.c. and for **different** Speeds, etc., **then more** than one **sample** may ba requirad.*

When testing** a **tool** in **accordance** with* EN 60529 e ***further test ***sample** is **required** when the type of pmtection **concerned** involves a **higher degree** of **severity** than **IP20.***

*Testing of wmponents may **necessitate** the submission of **additional** samples of tha **said** components. When the submisskm of such samples is **necessary,** they should be submitted together with the **tool.***

*4.3 **Unless otherwise specified, tests are carried*** out in the ***order***

order.

4.4 The***tests*** are***carried*** out***with*** the***tool,*** or any movabt***part of*** it, placad in the mo***unfavourable***

ettained *by* any Part *is **limited***

Tools marked with *a rated* ***frequency*** *range* ***other than 50*** *Hz to 60 Hz are tested at the most unfavoumble* ***frequency*** *within the range.*

Tools designed *for more than one rated* ***voltage are tested*** *at the most* ***unfavourable voltage.***

Unless *otherwiie* ***specified, tools designed for one*** *Or* ***more rated voltage ranges are***

by this ***factor, if smaller*** *than 1.*

Where *reference is made to the maximum or* ***minimum*** *rated input, the rated input* ***related to*** *the* ***upper limit*** *or lower* ***limit respectively*** *of the* ***rated voltage*** *range is meant*

When *testing* ***tools*** *for* d.c. ***only,*** *the* ***possible*** *influence of* ***polarity*** *on the opemtion of the* ***tools*** *is* ***taken*** *into consideration.*

If *the* ***tool*** *is dasigned* ***for*** *more than one mted* ***voltage*** *or rated* ***voltage range,*** *it may be* ***necessary*** *to* ***make*** *soma of the tests* at the

running, the ***element*** is tested with or without the motor running, whichever is the ***more*** unfavourabte. ***Heating elements***

applies whether the setting ***can*** be altered by hand or with the ***aid*** of a ***tool;*** if the ***adjusting*** means is not ***accessible without*** the aid of a ***tool,*** this ***subclause***

howaver,

taken into wnsidamtion.

4.13 Tods intended to be opemted at safety extra-low voltage am tested together with their supply transformer if this is normally sold with the tool.

4.14 For the purpose of clauses 8, 15, 23 and 25, parts separated from live parts by double insulation or reinforced insulation

to an earthing terminal and em not sapamted from live parts by *an intermediate metal part*

specified, ff *class I or class II tools have parts operatinn*

electronie circuits, see Annex C.

5 Rating

5.1 The maximum mted voltage is

- *250* V for **single-phase** 2057Tj 0 Tr ET Btool%• ç ?Ï‡ß ¼ 8 444 cm BI /W 1025/H 5 /BPC

- manufacturer's address or wuntry of origin;
- manufacturer's or responsiblc vendor's model or type reference and

l	litres
kg	kilograrns
N/cm^2	newtons per square centimetre
Pa	pascals
h	hours
min	minutes
s	seconds
~	altemating current
3~	three-phase altemating current
3N~	three-phase altamating current with neutral
⎓	direct current
n_0	no-load speed
⧈	class II tools
IPXX	degree of protectlon
min^{-1} or .../min	revolutions or reciprocations per minute

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

The dimensions of the symbol of class II shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square.

The length of the sides of the outer square shall not be 054qø 8 ðð46 Tcnotc 0 ýÿ÷À?ø• øýÿçøùãD [1 0] ETó

marked, iftheir intended operation is obvious.

Manual reset buttons ofthermal cut-outs incorporated in motors are exempt from the requirements of this subclause provided these cannot be mistaken for main controls.

7.9 Marking shall be easily legible and durable.

Marking specified in 7.1 to 7.12 shall be on a main part of the tool in such a way that it is clearly discemible when the tool is ready for use.

Self-adhesive labels glued in

b) Operating instructions

1 - Setting and testing.

2 - Tool changing.

3 - Clamping of work.

4 - Limits on ske of work ptece.

5 - General instructions for use.

c) Safety precautions

1 - Precautlons and use of PPE.

2 - Special safety precautions.

3 - Dust extraction.

4 - Guards. security and adjustrnent

5 - General safety instructions.

These shall consist of the following text:

'WARNING ! When using electric tools basic safety precautions should aiways be followed to reduce the rlsk of fire, electric shock and personal injury including the following.

Read all these instructions before attempting to operate this product and save these instructions".

d) Maintenance and servicing

1 - Regular cleaning, maintenance and lubrlcation.

(which shall include the waming "Remove the plug before carrying out any adjustment, servicing or maintenance').

2 - Servicing by manufacturer or agent; list of addresses.

3 - List of user replaceable parts.

4 - Special tools which may be required.

e) Safe Operation

1 - Keep work area clear

- Cluttered areas and benches invite injuries.

2 - Consider work area environment

- Do not expose tools to rain.
- Do not use tools in damp or wet locations.
- Keep work area well lit
- 00 not use tools in the presence of flamrnable liquids or gases.

3 - Guard against electrlc shock

- Avoid body contact with earthed or gmunded surfaces (e.g. pipes, radiators, ranges, refrlgerators).

4 - Keep other persons away

- Do not let persons, especially children, not involved in the work touch the tool or the extension cord and keep them away from the work area.

5 - Store idle tools

- When not in use, tools should be stored in a dry **locked-up place,** out of **reach** of children.

6-Donotforcethetool

- It will do the job **better** and safer at the rate for **which it** was intended.

7 - Use the right tool

- Do not **force small** tools to do ths job of a heavy duty tool.
- Do not use tools for purposes not intended; for example do not use **circular** saws to **cut** tree **limbs** or **logs.**

8 - **Dress properly**

- Do not wear **loose clothing** or jewellery, they **can** be caught in rnoving parts.
- Non-skid footwear **is** recommended when working outdoors.
- Wear protective hair **covering** to contain long hair.

9 - Use protective equipment

- Use **safety glasses.**
- Use **face** or dust mask if working opemtions **create dust.**

10 - Connect dust **extraction** equipment

- **If** the tool is pmvided for the connection of dust **extraction** and **collecting** equipment, ensure these are connected and **properly used.**

1 1 - Do not abuse the **cord**

- Never yank the **cord** to disconnect it from the **socket.** Keep the **cord** away from **heat,** oil and sharp edges.

12 - secura work

- Where possible use **clamps** or a **vice** tc hold the work. It is safer than using your hand.

13 - Do not overreach

- Keep **proper** footing and **balance** at all times.

14 - Maintain tools with **care**

- Keep cutting tools sharp and clean for **better** and safer **performance.**
- Follow **instruction** for lubricating and **changing** accessories.
- Inspect tool **cords periodically** and if darnaged have them repaired by an authorized **service facility.**
- Inspect extension **cords** periodically and **replace if** damaged.
- Keep handles dry. clean and free from oil and grease.

15 - Disconnect tools

- **When** not in use. **before servicing** and when **changing** accessories such as blades, bi and **cutters,** disconnect tools from the power supply.

16 - Remove adjusttng keys and wrenches

- Form the habit of **checking** to see that keys and adjustlng wrenches are removed from the tool before tuming it on.

17 - Avoid unintentional starting

- Ensure **switch** is in **"off" position** when plugging in

18 - Use outdoor extension leads

- When the tool is used outdoors, use only extension cords intended for outdoor use and so marked.

19 - Stay alert

- Watch what you are doing, use common sense and do not operate the tool when you are tired.

20 - Check damaged parts

- Sefore further use of tool, it should be carefully checked to determine that it will operate properly and perform its intended function.
- Check for alignment of moving parts, binding of moving park. breakage of parts, mounting and any other conditions that may affect its Operation.
- A guard or other part that is damaged should be properly repaired or replaced by an authorized Service centre unless otherwise indicated in this instruction manual.
- Have defective switches replaced by an authorized service centre.
- Do not use the tool if the switch does notturn it on and off.

21 - Waming

- The use of any accessory or attachment other than one recommended in this instruction manual may present a risk of personal injury.

22 - Have your tool repaired by a qualified person

- This electric tool complies with the relevant safety rules. Repairs should only be carried out by qualified persons using original spare parts, othenvise this may result in considerable danger to the user.

The following information shall also be given:

- The name and address of the manufacturer;
- The manufacturer's model or type reference;
- A repeat of the safety markings (e.g. maximum speed, capacity, etc.) that are to be marked on the tool;
- An explanation of any symbols or pictograms marked on the tool;
- The mass of the tool including detachable parts.

8 Protection against electric shock

6.1 Tools shall be so constructed and enclosed that there is adequate protection against accidental contact with the liie parts and, for class II tools, with metal parts aeparated from live parts by basic insulation only, even after removal of detachable parts. There shall be. in addiin. adequate pmtection against the risk of contact with basic insulation.

Thii requirement applies to all positions of the tool, when it is connected and operated as in normal use, even after opening of lids and doors, which can be opened without the aid of a tool and removal of detachable parts.

If a manufacturer instructs the user to remove a part during normal operation or user maintenance, that part is regarded as a detachable part even if a tool has to be used for its removal.

The insulating properties of lacquer, enamel, paper, cotton, oxide film on metal parts, beads. sealing wmpound and similar wverings shall not be relied upon to give the required degree of protection against accidental wntact with live parts.

Enclosures shall have no openings giving access to live parts other than openings necessary for the use and working of the tool, and, for class II tools, to parts separated from live parts by basic insulation only.

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

Compliance is checked by inspection and. if necessary, by a test with the fest finger shown in Figure 1.

In addition, apertures in class II and class I tools, other then those in metal parts connected to an earthing terminal or earthing contact, shall be tested with the test pin shown in Figure 2.

After removal of detachable parts, the test finger and the test pin are applied in every possible position, the test finger being applied without appreciable force end the test pin with a force of 10 N.

Apertures pmventing thè enby of the test finger are further tested by means of a straight unjointed test finger of the same dimensions, which is applied with a force of 60 N; if this finger enters, the test with the test finger shown in Figure 1 k repeated, except that the force necessary to push the finger through the aperture is exerted. An electrical contact indicator is used to show contact with live parts.

It shall not be possible to touch bare live parts or live parts protected by lacquer, enamel, paper, cotton, oxide film, sealing compound or similar covering only, with the test finger, nor for class II tools, with the test pin.

For class II tools it shall not be possible to touch metal park seperated from live parts by basic insulation only, with the test finger.

It shall not be possible to touch basic insulation with the fest finger.

NOTE It is recommended that a lamp be used for contact indication and that the voltage used be not less than 40 V.

During introduction or removing of bulbs, direct wntact with live parts of the holder shall be prevented.

8.2 Parts providing protection against electric shock shall have adequate mechanical strength and shall not work loose in normal use.

It shall not be possible to remove the said parts without the aid of a tool.

Compliance is checked by inspection, by manual test and by the tests given in clauses 16 and 19.

8.3 Shafts of operating knobs, handles, levers and the like shall not be live.

Compliance is checked by inspection.

8.4 For tools, other than thosa of class III, handles or knobs of switch-operating means, if of metal, shall either be adequately covered by insulating material or their accessible parts shall be separated from their shafts of fixing by supplementary insulation.

Compliance is checked by inspection.

8.5 For class II tools, capacitors shall not be wnnected to accessible metal parts.

Metal casings of capacitors shall be separated from the accessible metal parts by supplementary insulation,

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

8.6 Tools shall be so designed that. in normal use. there is no risk of elecbic shock from charged capacitors.

Capacitors with a rated capacitance not exceeding 0.1 µF are not wnsidered likely to entail a risk of elecbic shock. In this case the test may be dispensed with.

Compliance is checked by the following test which shall be canfed out ten times:

The tool is operated at rated voltage or et the upper limit of the rated voltage range. The tool switch, if any, is then moved to the "OFF" position and the tool is disconnected from the supply by withdrawing the plug.

One sewnd after disconnection, the voltage between the pins of the plug shall not exceed 34 V.

NOTE Care should be taken that the voltage is measured with an instrument which does not appreciably affect the value to be measured.

9 Starting

9.1 Tools shall start undar all normal voltage conditions which may occur in use.

Centrifugal and other automatic starting switches shall operata reliably and without contact chattering.

Compliance is checked by starting the tool at no load, three times in succession at a voltage equal to 0.85 times rated voltage or the lower limit of the voltaga range, regulating devices, if any, being set as in normal use.

Tools pmvided with a centrifugal or other automatic starting switch shall *be, in addition, started three times in succession at a wltage equal to 1,06 times rated voltage or fhe upper limit of the voltage range. In all cases the tool shall function correctly.*

In accordance *with* 4.5 *the* test *shall* be made at 23 °C ± 2 "C.

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

Compliance is checked by the test of 9.1.

10 Input and current

10.1 The input of the tool at rated voltage and under normal load shall not deviate from the rated input by more than the values given in Table 1.

Table 1 -Input deviation

Rated input W	Deviation
Up to and including 33.3	▯
Over 33,3 up to and including 150	▯
Ovar 150 up to and indudiig 300	+45 W
Over 300	+15%

Compliance is checked by measuring the input of the tool opernfad under normal load at rated voltage or at the mean value of the rated voltage range if the voltage range doas not exceed 10% of its mean value.

For tools marked with a rated voltage range having limits differing by more than 10% of the mean value of the range. the permissible deviations apply for both limits of the mnge.

10.2 If the tool is marked with rated current, the current taken by the tool under normal load shall not exceed the rated current by more than 15%.

Compliance is checked by measuring the current taken by the tool operating under normal load conditions, at rated voltage or at the mean value of the rated voltage mnge, if the voltage range does not exceed 10% of its mean value at ated frequency.

For tools marked with a rated wtfaga range having limits differing by more than 10% of the mean value of the range, the permissible deviations apply for both limits of the range.

11 Heating

11.1 Tools shall not attain excessive temperatures in normal use.

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

11.2 The tool is operated in still air under normal load or under the toqua load necessary to attain rated input or under the loading conditions as specified in Part 2, whichaver causes the higher temperature rise, and at a supply voltage equal to 0.94 times, 1,00 times or 1,06 times rated voltage, whichever is the most unfavourable.

The torque is kept constant at the value recorded when operating at rated voltage, or at the mean of the rated voltage range, under the most unfavourable of the three loading conditions quoted above while the voltage is adjusted to 0,94 or 1,06 times the mted voltage or mean of the rated voltage range.

When applying the torque load necessary to attain rated input, the operating time to be Chosen is that specified for normal load.

11.3 Temperature rises of windings am determined by the resistance method unless the windings am non-uniform or it involves severe complications to make the necessary wnnections for the resistance measurement. In this case, the measurement is mada by thermocouples.

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

In determining the temperatute rises of handles, knobs, grips and the like, consideration is given to all parts whtch are gripped in normal use and, ifof insulating material, to those parts in wntact with hot metal.

The temperatute rise of electrical insulation, other than that of wiidings, is determined on the surface of the insulation, at places whem failure could cause a short-circuit, wntact between live parts and accessible metal parts, bridgtng of insulation or reduction of creepage distances or clearances below the values specified in 27.1.

11.4 The *tool is operated*

- for the rated operating time for tools for short-time Operation;
- on wnsecutiva cycles of Operation, until steady wnditions are established, for tools for intermittent Operation, the "ON" and "OFF" periods being the rated "ON" and "OFF periods;

  until steady wnditions are established for tools for wntinuous Operation.

11.5 *During the test, thermal cut-outs shall not operate. The temperature rises shall not exceed the values shown in Table 2 except as aiiowed by 11.6.*

Sealing compound, if any, shall not flow out.

Table 2 — Temperature rises

Parts	Temperature rise K
Windings[1], and core laminations in contact therewith, if the winding insulation is:	
- *of class A material [2]*	*75 (65)*
- *of class E material [2]*	*90 (80)*
- *of class B material [2]*	*95 (85)*
- *of class F material [2]*	*115*
- *of class H material [2]*	*140*
Ambient of switches and thermostats marked with individual ratings[3]:	
- *without T-marking*	*30*
- *with T-marking*	*T - 25*
Pins of appliance inlets:	
- *for very hot conditions*	*130*
- *for hot conditions*	*95*
- *for cold conditions*	*40*
Rubber or polyvinyl chloride insulation of internal and external wiring including power supply cords:	
- *without T-marking*	*50 [4]*
- *with T-marking*	*T - 25 [5]*
Cord sheaths used as supplementary insulation	*35*
Rubber 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*
Material used as insulation other than for wires and windings [6]:	
- *impregnated or varnished textile, paper or press board*	*70*
- *laminates bonded with:*	
- *melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins*	*85 (175)*
- *urea-formaldehyde resins*	*65 (150)*
- *mouldings of:*	
- *phenol-formaldehyde with cellulose fillers*	*85 (175)*
- *phenol-formaldehyde with mineral fillers*	*100 (200)*
- *melamine-formaldehyde*	*75 (150)*
- *urea-formaldehyde*	*65 (150)*
- *polyester with glass-fibre reinforcement*	*110*
- *silicone rubber*	*145*
- *polytetrafluorethylene*	*265*
- *pure mica and tightly sintered ceramic material, when such products are used as supplementary or reinforced insulation*	*400*
- *thermoplastic material [7]*	-
Wood, in general [8]	*65*
Outer surfaces of capacitors:	
- *with marking of maximum operating temperature (T)*	*T - 25*
- *without marking of maximum operating temperature*	*50*
	20
	60

Table 2 — Temperature rises *(concluded)*

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. of switches):	

) To allow for the fact that the temperature of windings of universal motors, relays, solenoids, etc. measured at points accessible to thermocouples is generally below the average, 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.

[redacted]

Examples of class B material are:
- glass fibre, melamine-formaldehyde and phenol-formaldehyde resins.
Examples of class E material are:
- mouldings with cellulose fillers, cotton fabric laminates and paper laminates, bonded with melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins;
- cross-linked polyester resins, cellulose triacetate films, polyethylene terephthalate films;
- varnished polyethylene terephthalate textile bonded with oil-modified alkyd resin varnish;
- enamels based on polyvinyl formal, polyurethane or epoxy resins.
There is no limit specified for windings insulated with materials other than those of class A, class E, class B or class F, but they shall withstand the test of 11.6.
These tests are always made when the temperature rise of windings or core laminations exceeds 75 K and where there are doubts with regard to the classification of winding insulation.
For totally enclosed motors the temperature rise limits for class A, class E, and class B may be increased by 5 K.
A totally enclosed motor is a motor so constructed 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.

*) *T signifies the maximum operating temperature.*
For the purpose of this test, switches and thermal cut-outs marked with individual ratings may be considered as having no marking in this respect, if requested by the tool manufacturer.

*) *This limit applies to cables, cords and wires complying with the relevant CENELEC standards; for others it may be different.*

*) *This limit will become applicable as soon as there are CENELEC standards for high temperature cables, cords and wires.*

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

*) *There is no specific limit for thermoplastic material which shall withstand the tests of 28.1 or 28.2, for which purpose the temperature rise must be determined.*

*) *The limit is concerned with the deterioration of wood and it does not take into account deterioration of surface finishes.*
If these or other materials are used, they shall not be subjected to temperatures in excess of the thermal capabilities as determined by ageing tests made on the materials themselves.

NOTE The values in the table are based on an ambient temperature not normally exceeding 25 °C but occasionally [redacted]

where:

Δt is the temperature rise in K

R_1 is the resistance at the beginning of the test

R_2 is the resistance at the end of the test

t_1 is the room temperature at the beginning of the test in °C

t_2 is the room temperature at the end of the test in °C

Al the beginning of the test, the windings are to be at room temperature.

It is recommended that tho 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.

11.6 If the tempemtum rise of a winding exceeds the value specified in 11.5, three additional samples are subjacted to the following tests:

1) *The tempemtum rise of the windings is determined by the test of 11.2.*

2) *The samples am then dismantled as far as is possible without damaging any patt. Windings end com laminations am kept for 10 days (240 h) in a heating cabinet, the temperature of which is 80 K ± 1 K in excess of the tempemture rise determined according to item 1).*

3) *After this tmatment the samples am reassembled and no interturn short circuit shall occur.*

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

4) *Immediately afterwards, the samples shall withstand the tests of clause 15.*

5) *The samples am then subjected to a humidity tmatment es specified in 14.2.*

After this treatment, they shall again withstand the tests of clause 15.

6) *Faults which may occur in insulation which dld not show en excessive tempemtum rise during the test of item 1) am ignored and am repaired, if necessary, in order to complete the tests of this subclause.*

Tools are considered not to comply with the requirements of 11.1, if there are more failures than one sample in one of the tests 3) to 5).

If one sample falls in a test, the tests 1) to 5) am repeated on anofher set of three samples, all of which shall then comply with the repeated tests.

12 Leakage current

12.1 The leakage current in normal use shall not be excessive.

Compliance is checked by the test of 12.2, carried out immediately after tha test of 11.2, the tool being operated under the conditions specified in 11.2, but at a supply voltage equal to 1.06 firnes mted voltage.

Three-phase appliances which am also suitable for single-phase supply am tested as single- phase applianoes with the three sections connectad in parallel. The tests are made while the appliance is connected to the supply.

12.2 The leakage current is measured between any pole of the supply and

- accessible metal parts and metal foil with an area not exceeding 20 cm x 10 cm in wntact with accessible surfaces of insulating material. connected together;
- *metal parts of class II tools, sepamted from live parts by basic insulation only.*

The measuring circuit is shown in the following figures:

- for single-phase tools having e rated voltage not exceeding 250 V and for three-phase tools to be tested as single-phase tools:
  - ifof class II, Figure 3;
  - if other than class II, Figura 4;
- for three-phase tools not suitable for single-phase supply:
  - if of class II, Figura 5;
  - if other than class II, Figure 6.

The measuring circuit has a total resistance of 1 750 Ω ± 250 Rand is shunted by a capacitor such that the time wnstant of the circuit is 225 µs ± IJ ps.

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

For single-phase tools having a rated voltage not exceeding 250 V and for three-phase tools to be tested as single-phase tools, the leakage current is measumd with the salector switch shown in Figures 3 and 4, in each of the positions 1 and 2.

For three-phase tools not suitable for single-phase supply, the leakage current is measured with the switches a, b and c, shown in Figures 5 and 6 closed; the measurements am rapeated with each of the switches a, b and c open In turn, the other two switches being closed. For tools intended to be wnnactad in star wnnection only the neutral is not wnnected.

After an operafing time as specified in 11.4, the leakage current shall not exceed the following values:

- for class III tools ..... 0.5 mA
- for class I tools ..... 0,75 mA
- for class II tools ..... 0.25 mA
- to metal parts of class II tools separated from live parts by basic insulation only, if the tool is classified acwrding to degree of protection against moisture as:
  - for tool IPX0 ..... 5,OmA
  - other than IPXO ..... 3.5 mA

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

For tools incorporating heating elements the total leakage current shall ba either within the limits specified abwe or within those specified in EN 60335-1, 13.2, whichever is the greater; the two limits shall not be added.

NOTE Details of a suitable circuit for measuring leakage currents are given in Annex IA.

The measuring arrangement has an accuracy of within 5% for all frequencies in the mnge of 20 Hz to 5 000 Hz.

Where leakage currents excaading 5 mA am measumd in e circuit having a total resistance less than 1600 Ω, the madings am reduced by 5%.

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

The metal foil has the largest ama possible on the surface undar fest, without exceeding the dimensions specified. If its ama is smaller than the surface under test, it is movad so as to tast all parts of the surface; the heat dissipation of the appliance must, howavar, not be affected by the metal foil.

The test with the switch in the "OFF" position is made to verify that capacitors wnnected behind a Single-pole switch do not cause an excassive leakage current.

If the tool incorporates a thermal control which operates during the test of clause 11, the leakage current is measumd immediately befom the control opans the circuit.

13 Environmental requirements

13.1 Dust measurements

If the manufacturer gives information on the dust collection efficiency the effectiveness of the dust collection devices shall be measured in under the following test conditions:

Tests under working condiions, including appropriate rest periods, are canied out in the test cabin (see Figure 11) specifled in EN 1093-3 and measurements of dust emission are made in accordance with that standard.

The test period shall be of one hour duration including all running and rest periods.

The orientation within the cabin shall be such that the passage of dust towards the measuring tunnel is not impeded.

The material to be used for the test shall be appropriate for the intended use of the tool and shall be of the following spechicatlon:

a) Wood - beech with a moisture content of 10 % ± 2 %.

b) Chipboard - to ISO 820 General purpose three layer type. with a density of 500 kg/m^3 to 750 kg/m^3 and a moisture content of 8% ± 2%.

c) Steel - "T" section or round bar according to ISO 630.

Tests shall be canied out at rated voltage and frequency and at maximum speed setting, if any.

The tool bit/cutter/abrasive etc. to be used shall be as specified by the manufacturer for the material to be worked.

The air velocity of externally connected suction and dust collection systems to be as spacified by the manufacturer, or if not specified 20 ms^{-1} ± 2 ms^{-1}. Velocity to be rneasured in the wnnecting tube at the point of wnnection, with the tool wnnected but not running.

The number of tests canied out shall be sufficient to ensure a statistically reliable result, but in all cases not less than two tests shall be canied out

132 Noise mearurements

13.2.1 Noise emission values shall be measured by the test procedure described in 13.2.2 to 13.2.7.

The overall

The rated voltage or the upper limit of the rated voltage range and/or frequency shall be maintainad during the test at the stated values with a tolerance of ± 2%.

The supply voltage of mains powered tools is measured at the plug of the cable or cord supplied, not at the plug of any extension cable or cord.

If required by Patt 2. the rotational speed of tools etc. is measured with instruments having an accuracy of ± 1% of full scale.

13.2.4 Tools are tested under the two operating conditions "no load" and "load".

The measurement under "load" is to be carried out dudng processing of a workpiece or under erdemal mechanical load equivalent to normal Operation.

If the tool is with a bench it is tested with that bench otherwise if it is intended to be used on a bench then it shall be in accordance with the test bench shown in Figure 12.

Care shall be taken that the locatlon of the work piece on its support does not adversely affect the result of the test

Three consecutive tests for no-load or five for toad shall be canied out and the result of the test L_{wa} shall be the arlthmetic mean. rounded off to the nearest decibel, of the three or five tests.

For load conditions the Operator shall use the tool in such a manner as to correspond to normal use.

13.2.5 Measurements shall be carried out in a free field over a reftectlng plane as described in EN ISO 3744.

Fiie microphone positions shall be located 1 m from the centre of the lowest working point of the cutttng or abrading tool. Four positions shall be spaced at regular intervals on a plane passing through the centre and parallel to the reflecttng plane, the fifth position shall be located at a distance of 1 m above the defined plane (See Figure 13).

The tool shall be positioned so that its main axis is at 45" between the microphone position I-4 and 2-3.

Measurements are only valid if the differenca between the background noise and the tool under test is at least 10 dB.

13.2.6 The surface sound pressure level, $\overline{L_p}$, shall be calculated in accordance with the following equation:

$$\overline{L_p} = 10\log\left[\frac{1}{5}\sum_{i=1}^{5}10^{0,1L_{pi}}\right]$$

where:

$\overline{L_p}$ is the A-weighted sound pressure level, in decibels with respect to 20 µPa

L_{pi} is the A-weighted sound pressure level, recorded at the i^{th} microphone location, in decibels wlth respect to 20 µPa

NOTE When the difference of the extreme values of L_{pi} does not exceed 5 dB a simple arithmetic mean of the L_{pi} will not deviate by more than 0.7 dB from tho mol mean square value given in the preceding equation.

13.2.7 The sound power level, L_w shall be calculated in accordance with the following equation:

$$L_w = \overline{L_p} + 10\log S/S_0 = \overline{L_p} + 13 \text{ db}$$

where:

L_w is the A-weighted sound pressure level of the source, in decibels with respect to 1 pW

$\overline{L_p}$ is the surface sound pressure level

S_0 = 1 m²

S = 20 m²

NOTE The emission sound pressure level L_p related to the workplace b assumed to be the surface sound pressure level L_p

13.3 Vibration measurement

13.3.1 The Vibration levels for handarm Vibration shall be measured in accordance with the following test procedure.

It is not intended that the values are used for assessment of human exposure to vibrations. The measurement and assessment of human exposure to hand-transmitted Vibration in the workplace is given in ENV 25349.

13.3.2 Vibrations are rneasured as the acceleration of the handles of the tool under test and shall be expressed as the root-mean-Square (r.m.s.) acceleration, a_h, in metres per second squared.

Weighted acceleratlon values $a_{h,W}$, are obtained by measurement using the weighting filter for handarm Vibration measurements defined in ENV 26041.

13.3.3 A transducer for measuring acceleration (accelerometer), such as a piezo-electric device, shall be used in conjunction with a suitable preampiifier, ENV 26041 shall be consulted for the specification of the measuring equipmant

The total mass of the accelerometer and its mounting shall be not more than 6 g.

Accelerometers shall be mounted in accordance with ISO 5346.

NOTE The measurement of vibration on handles with resilient covers can be accomplished by using a special adaptor between tha hand and the handle. The adaptor may consist of a suitably formed light rigid plate with a suitable mounting arrangement for the accelerometer used. Care should be taken that the mass, size and shape of the adaptor do not significantly influence the signal from tho accelerometer In the frequency range of interest.

It should be noted that if the signal for analysis is of short duration, or its magnitude varies substantially with time. a simple analysis cannot be made. In order to obtain r.m.s. values under these circumstances. it is necessary to use an integrating meter or analyser which is equipped with "linear integration' facilities. It is recommended that 'linear integration" analysis be adopted as tha preferred method. The type of analyser norrnally used for noise analysis can be used only when the signal is relatively steady with tirne or is of sufficient duration.

In such circumstances, the time constant chosen shall be appropriate for the signal duration.

13.3.4 Measurements shall be made in the direction of the handle movement If there is no defined direction then measurements shall be made in all three axes of a basicentric coordinata system.

Measurements shall be carried out at a point half-way along the length of the handles. If the placing of the switch actuator rnakes this impossible then the accelerometer shall be placed as close as possible to the hand between the thumb and the index finger.

13.3.5 Measurements shall be carried out on a new tool additional to that required by other tests.

All speed setting devicas shall be adjusted to the highest figure.

Tools shall be run-in for a period of 5 minutes before starting the test.

13.3.6 The rated voltage or the upper limit of the rated voltage range and/or frequency shall be maintained dudng the test at the stated values with a tolerance Of ± 2%.

The supply voltage of mains powered tools is measured at the plug of the cable or cord supplied. not at the plug of any extension cable or cord.

13.3.7 If required by Part 2, the rotational Speed of tools etc. is measured wlth instruments having an accuracy of ± 1% of full scale.

13.35 Tools are tested under the two operating condiions 'no load" and "load".

Three series of seven consecuttve tests are carried Out using a different Operator for each series. The Operator shall be skilled In the use of the tool under test.

The measurement under "load" is to be carried out during processing of a workpiece or under extemal mechanical load equivalent to normal Operation.

If the tool is with a bench it is tested with that bench otherwise if It is intended to be used on a bench then it shall be in accordance with the test bench shown in Figure 12.

Care shall be taken that the location of work piece on its support does not adversely affect the results of the tests.

NOTE 1 It should be noted that even small differences in size, shape, material. wear, unbalance etc. of the inserted tool (e.g. sawblade grinding wheel, etc.) can alter the vibration intensity considerably.

NOTE 2 The vibrations of the tool can be influenced by the operator, In particular the grip force hu a considerable influence.

13.3.9 The results shall ba in weighted acceleration values.

The upper and lower values of each series of seven tests are disregarded and the value stated shall be the average of the remaining tests.

NOTE It should be noted that the measurement methods given can result In different values being measured in different test locations or with different test equipment.

14 Protection against ingress of foreign bodies and moisture resistance

14.1 Tools which are marked with degree of protection against ingress of forelgn bodies shall possess that degree of protection under working condiions.

Compliance with requirements as specified is checked by tests according to EN 60529.

14.2 Tools with a degree of protectlon providing a higher degree of severity than IPXO shall comply wlth the relevant requirements specified in EN 60529.

Covers and other parts which can be removed without the aid of e tool are mmoved and tested, ff necessary, together with the main part of the tool.

NOTE More detailed test conditions are under consideration.

14.3 Tools shall withstand those effects of humidity which are likely to owur in normal wndllons.

Compliance is checked by the humidity treatment descdbed in this subclause, immediately followed by tests as given in clause 15.

Covers and other parts which can ba removed without the aid of a tool are removed and subjected, if necessary, to the humidity treatment fogether with the main part.

The humidity treatment is carried out in e humidity cabinet containing air with a relative humidity maintained between 91% and 95%. The temperature of the air, at all places where samples can be located, shall be maintained within ± 1 K of any wnvenient value t betwaen 20 °C and 30 °C.

Befora being placed in the humidiiy cabinet the sample is brought to a temperature behveen t °C and (tt4) °C for 24 h.

The sample is kept in the humidity cabinet for

- 2 days (48 h) for tools with degree of protection IPX0;
- 7 days (188 h) for all other tools.

In most cases the sample can be bmught to the temperature spedfiad by keeping it at this temperaturn for at least 4 h before tha humidity treatment.

A relative humidity batwaan 91% and 95% can be obtainad by placing a saturated Solution of sodium sulphate (Na_2SO J or Potassium nitrate (KNO_3) in water, in the humidity cabinat, tha seid solution having a sufficiently large contact surface with the air.

In order to achieve the specified conditions within tha cabinaf it is necessary that constant circulation of the air within the cabinet ia ensured and that, in general, a thermally insulated cabinet ba used.

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

Compliance is checked by tha following test:

Tools pmvidad with an appliance inlet am fitted with an appmpdata connactor and flexible cable or cord.

Other tools am fitted with the lightast permissible type of cable or cord of the smallest cross-sectional area specified in 23.4.

The liquid container of the tool is filled to the top with water and a further quantity, equal to 15% of tha capacity of the Container, is poured in staadily over a period of 1 min.

Immediately following this treatment tha tool shall withstand an electric strangth fest as specified in 15.3.

Inspection shall show that no appreciable quantity of watar has entered the appliance and that there am no traces of water on insulating parts for which minimum creepage distances are specified in 27.1.

The test can be carried out on a separate Sample.

15 Insulation resistance and electric strength

15.1 Tools shall possess adequate insulation resistance and electric strength.

Compliance is checked by tests es specified in 15.2 and 15.3, which am carried out on the cold tool not wnnected to the supply, immediately following the test according to 14.3 in the humidity cabinet or in the room in which the Sample was bmught to the pmscribed temperature, and after reassembly of those parts which may have baen removed.

15.2 The insulation resistance is measurad with a d.c. voltage of appmximatafy 500 V applied, the measurement being made 1 min aftar application of the voltage, haating elements, ff any, being disconnectad.

The insulation msistanca shall be not less than that shown in Table 3.

Table 3 — Insulation resistance

Insulation to be tested	Insulation resistance MΩ
Between live parts and the body:	
- for basic insulation	2
- for reinforced insulation	7
Between live parts and metal parts of class II tools which arc separated from live parts by basic insulation only	2
Between metal parts of class II tools which are separated from live parts by basic insulation only and the body	1

15.3 Immediately after the test of 15.2, the insutation is subjected for 1 min to a voltage of substantially sine-wave form, having a frequency of 50 Hz or 60 Hz. The value of the test vottage and the points of application are shown in Table 4.

Table 4 -Test voltages

Points of application of test voltage	Test voltage V		
	class III tools	class II tools	class I tools
1. Between live parts and parts of the body that are separated from live parts by:			
- basic insulation only	500		1250
- reinforced insulation	–	3 750	3750
2. Between live parts of different polarity	500	1250	1250
3. For parts with double insulation, between metal parts separated from live parts by basic insulation only and:			
- live parts	–	1250	1 250
- the body	–	2 500	2 500
4. Between metal enclosures or covers lined with insulating material and metal foil in contact with the inner surface of the lining, if the distance between live parts and these metal enclosures or covers, measured through the lining, is less than the appropriate clearance as specified in 27.1.	–	2 500	1 250
5. Between metal foil in contact with handles, knobs, grips and the like and their shafts, if these shafts can be live in the event of an insulation fault	–	2 500	2 500
6. Between the body and either metal foil wrapped around the supply flexible cable or cord inside inlet bushings, cord guards, cord anchorages and the like, or a metal rod of the same diameter as the flexible cable or cord, inserted in its place	–	2 500	1 250
7. Between the point where a winding and a capacitor are connected together, if a resonance voltage U occurs between this point and any terminal for external conductors, and:			
- the body	–		2 U + 1 000
- metal parts separated from live parts by basic insulation only	–	2 U + 1 000	

Should separate testing of the basic and supplementary insulation not be possible without disassembling or modifying the tool, a sepi sample is used which is subjected to the test of 14.3 after disassembly or modification.

The test between live parts of different polarity is only made where the necessary disconnections can be made without damaging the tool.

The test is not made between the contacts of switches of micro-gap construction, motor-starting switches, relays, thermostats, thermal cut-outs and the like, or on the insulation of capacitors connected between five parts of different polarity.

Initially, not more than half the prescdbed vottage is applied, then it is raised rapidly tc the full value.

No flashover or breakdown shall occur during the test.

Care is taken that the metal foil is so placed that no flashovar occurs at its edges.

For class II tools incotpcrating both reinfomed insulation and double insulation, care is taken that the wkage applied to the reinforced insulation does not overstress the basic insulation or the wpptementary Matton.

When testing insulating barriers, the metal foil may be pressed against the inwtation by means of a sandbag of such a size that the pressure is about 5 kPa (0.5 N/cm²). The test may be limited tc places where the insulation is likely to be weak, for example where there are sharp edges under the insulation.

If practicable, insulating linings are tested separately.

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

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

16 Endurance

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

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

Complianca is checked by the test of 16.2 and, for tools provided with a centrifugal or other starting switch, also by the tast of 16.3.

Immediately after these tests, the tool shall *withstand an electric stmngth* fest *as specified* in *15.3, the test voltages being howaver, reduced to 75% Of the specified values Connactions shall not have worked loose and there shall be no deterioration impairing safaty in normal use.*

16.2 The tool is opemtad intermittently with no load for 24 h of operation at a voltage equal to 1.1 times mtad voltage and then for 24 h at a supply voitage equal to 0.9 timas rated voltage.

Each cycle of Operation comprises an 'ON' period of 100 s and an "OFF" period of 20 s, the "OFF" period baing included in the specified opemting time.

The opemting period for tools for short-time or intermittent operation is equal to that opernfing time, if this is limited by the construction of the tool; otherwise, it is in accordance with the pmscriptions given in Part 2, or with the markig, whichever is the mom unfavourable.

During the fest, if diffamnt positions of normal use am possible, the test is carried out in the most unfavourable position within the manufacturer's mcommendadposittons of use.

ff tha temperaturn rise of any part of the tool exceeds the temperature rise determined during the test of 11.1, forced cooling or rest periods am applied, the rest periods baing excluded from the specified opemting time.

During these tests, overload protection devices shall not opemte.

NOTE 1 The tool may be switched on and off by means of a switch other than that incorporated in the tool.

NOTE 2 During this test, replacement of the carbon brushes is allowed and the tool is oiled and greased as in normal use.

16.3 Tools provided with a centrifugal or other automatic starting switch am started 10000 times under normal load and at a Vortage *equal to 0,9 times rated voltage, the opemting cycle being that specified in 16.2.*

17 Abnormal Operation

17.1 Tools shall be so designed that the risk of fire, mechanical darnage or electric shock as a result of abnormal or careless Operation is obviated as far as is practicable.

Complianca is checked by the following test, cutting tools like sawblades, grinding wheels, etc. being removed:

Toois incorporating commutator motor am opemtad at a *voitage equal to 1.3 times rated voltage or the upper limit of tha Vortage range for 1 min at no load.*

Following this test windings and connections shall not hava worked loose and the tool shall be fit for further use.

The following categories of tools

3) provided with moving park which ara liable to ba jammad, or where the moving parts can ba stopped by hand, tha motor remaining switched on dudng this Operation, are connected, starting from cold, to their rated voltage or the uppar limit of their rated voltage range with the moving parts locked:

- for 30 s for tools that ara opamtad by hand dudng use;
- for 5 min for tools that ara attandad dudng use.

Tools incorporating three-phase motors am operated, starting from cold, for 30 s, if kapt switched on by hand or continuously loaded by hand, or otherwise for 5 min, with one phasa disconnected and under the toque pmdudng normal load.

At tha end of the tast period specified, or at the instant of operation of fuses, thermal cut-outs, motor pmtaction davicas and tha like, the tampamtura oftha wiidings shall not axcead tha value shown in Tabla 5.

Table 5 — Maximum winding temperatun,

Protection of windings	Limiting temperature °C				
	Class A	Class E	Class B	Class F	Class H
Protection by impedance	150	165	175	190	210
Protection by protection devices which operate during the test	200	215	225	240	260

NOTE Fuses, thermal cut-outs, overcurrent releases or the like, incorporated in the tool, are considered to provide adequate protection against thr risk of fire.

17.2 Tools incorporating electronic control devices shall be so designed that, in the event of a failure in the elecb-onic equipment, it shall not result in a hazard.

Complianca is chackad by operating tha tool for 1 min, et rated voltage or at tha mean value of tha mtad voltage mnga, at no load, with tha electronic control device short-circuited.

The tast is then mpaatad with the electronic control device open-circuited.

Following thasa tests tha

shall withstand stresses occurring when the sense of rotation is reversed under running conditions where such a reversal is possible in normal use.

Complianca is checked by tha following test:

Tha tool is opamtad at a voltage equal to mtad voltage or at the uppar limit of tha mtad voltage mnga, at no load, tha device for reversing the sense of rotation baing in such a position that the mtor mtatas in one direction at full speed.

The diraction of rotation is than ravarsad, without the davica resting in an intarmadiate "OFF" position.

This opamtion saquanca is performed 25 timas.

During tha test, no electrical or machanical failure of tha davica and no buming 'or undue pitting of tha wntacts shall occur.

After tha test, the tool shall show no damage within the maaning of this standard.

18 Stability and mechanical hazards

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

Pmtective enclosures, covers, guards and the like shall possess adequate mechanioal strength for their intended purpose.

Fixed guards shall be used when frequent access is not required and removal of this typa of guard shall only be possible with the aid of a tool. Where more frequent access is required, movable or removable guards shall be provided to enclose the dangerous parts of the tool.

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

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

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

NOTE Such dangers might be caused by vibration, reversal of motion and electric bnking.

Compliance is checked by inspection, by tests according to clause 19 and by means of a test using the standard test finger shown in Figure 1. It shall not be possible to touch dangerous moving parts with this finger.

It shall not be possible to touch dangerous moving parts through dust collection openings after removing any detachable parts of the dust collection system.

Compliance is checked *by* means *of a test using the test finger shown in* Figure 1.

18.2 Tools intended to be used without fixing to the floor or to a table shall have adequate stabilii.

Complianca is *checked by the following test, tools pmvided with en appliance inlet being fitted with an appmpdate connector and flexible cable or cord.*

The tool is piacad with the motor switched off in any normal position of use on a plane inclined at an angle of 10° to the horizontal, the cable or cord resting on the inclined plane in the most unfavourable Position. If, however, the tool is such that, wara it to be tilted through an angle of 10' when standing on a horizontal plane, e part of it not normally in contact with the supporting surfaca would touch the horizontal plane, the tool is placed on a horizontal support and tilted in the most unfavourable direction through an angle of 10°.

Tools pmvided with doors ara tested with the doors open or closed, whichevar is the *mora unfavourable.*

Tools intended to be filled with liquid by the user in normal use ara tested empty or filled with the most unfavourable quantity of water or the racommendad liquid, up to the rated capacity.

The tool shall not overturn.

18.3 Tools shall have adequate stabilily when used under the most onerous condiins of normal use following the manufacturer's instruction.

Compliance is checked by the tests of the relevant Part 2.

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

Compliance is checked by inspecfion.

19 Mechanical strength

19.1 Tools shall possess adequate mechanical strength and shall be so constructed that they withstand such rough handling as is to be expected in normal use.

Complianca is checked by the test specified in 19.2.

Following this test the tool shall withstand en electric strangth test as specified in 15.3 and shall show no darnage within the meaning of this Standard, in particular, live parts shall not hava bacome accessible.

Darnage to the finish, small dents which do not reduce craapaga distances or clearances below the values specified in 27.1, or small chips which do not adversely affect protection against shock or moisture may be disregarded.

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

Cracks not visible to the nekad eya and surface cracks in fibre-reinforced moldings and the like are disregarded.

Where a decomtive cover is back& by an inner cover, a fracture of the decorative cover is disregarded when the inner cover withstands the test after removal of the dacorativa cover.

19.2 Blows ara epplied to the tool by means of the spring-operated impact fest apparatus describad in EN 60068-2-75 (see Figura 7).

The spring is so adjusted that it causes the hammer to strike with an impact energy as shown in the following table, the spring compression being es shown in Teble 6.

Table 6 — Impact energies

Part to be tested	Impact energy Nm	Compression mm
Brush caps	0.5 ± 0.05	20,0
Other parts	1,0 ± 0,05	28,3

The release mechenism springs am so adjusted that they exert just sufficient pressure to kaap the release jaws in the engagad position.

The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft.

The blows are applied by pushing the release cone against the sample in a diraction perpendicular to the surface of the sample at the point to be tested.

The pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then mova to oparate the release machanism and allow the hemmer to strike.

The sample as a whole is rigidly supported and three blows are applied to every point of the enclosure which is likely to be weak.

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

19.3 Brush-holders and their caps shall have adequate mechanical strength.

Complience is chacked by inspection and, in case of doubt, by removing and replacing the brushes ten times, the torque applied when fightaning the cap being es shown in Table 7.

Table 7 -Test torques

Blade width of test screwdriver mm	Torque N m
Up to and including 2,8	0.4
over 2,8 up to and including 3,0	0.8
over 3,0 up to and including 4,1	0,6
over 4,1 up to and including 4,7	0,9
over 4,7 up to and including 5,3	1.0
over 5,3 up to and including 6,0	1.25

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

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

20 Construction

20.1 Tods shall be of class I, class II or class III construction only.

Compliance is ohecked by inspection.

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

Compliance is checked by inspection and by manual test.

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

Compliance is checked by manual test.

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

Compliance is checked by manual test.

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

Compliance is ctmcked by inspection and by manual test.

20.6 Components which may require replacement, such as switches and capacitors, shall ba suitably fitted so as to facilii their replacement.

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

This requirement is wnsidered to be met if the wmponenta form part of an assembly which is itself suitably fitted.

Fixing by means of soldered or crimped wnnections is allowed only tör small resistors, capacitors, inductors and the like, if these components can be suitably fixed by their connecting means. Fixing by means of rivets is not allowed.

Fixing by clamping and fixing by means of suitably shaped casing. such as the provision of a recess which holds the wmponent in position, is allowed..

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

Compliance is chacked by inspection end by manual test.

20.8 Wood, cotton, silk, ordinary paper and similar fibrous or hygmscopic material shall not be used as insulation, unless impregnated or chemically rendered non-fibmus, *for* example: if the interstices between the fibres of the material are substantially filled with a suitable insulant.

Asbestos shall not be used under any circumstances.

Driving belts shall not be relied upon to ensure electrical insulation.

Compliance is *checked by* inspection.

20.9 Reinforced insulation shall only be used when it is manifestly impracticable to pmvide separate basic insulation and supplementary insulation.

Appliance inlets, switches, brush holden and armature coils on shafts are examples where reinforced insulation may ba used.

Compliance is checked by inspection.

20.10 Insulating baniers 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 mutine servicing, shall either

- be fixed in such a way that they cannot be removed without being seriously damaged; or
- be so designed that they cannot be replaced in an incorrect position and that, if they are omitted, the tool is rendered inoperable or manifestty incomplete.

Compliance is checked by inspection and by manual test.

Routine servicing includes replacament of power supply cords, switches and the like.

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

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

An adequate intemal lining of insulating material or an adequate intemal insulating coeting on metal enclosures is wnsidered to be an insulating barrier provided that the coating cannot easily be removed by scraping.

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

Ordinary lacquering on the inside of metal enclosures, vemished cambric, flexible rasin-bonded paper or the like am not wnsidered to ba insulating barriers.

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

Compliance is checked by inspection and measurement.

20.12 Class I tools shall be so constructed that, should *any* wire, screw, nut, washer, spring or simüar part bewme loose or fall out of position, it cannot bscome so diiposed that accessible metal is made live.

Class II tools shall bs so wnstructed that, should any such patt 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 27.1.

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

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

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

It is not to be expected that two independent parts will bawme loose or fell out of position at the same time.

For electrical wnnections, spring washers am *not considered to be adequate for praventing the loosening of the parts.*

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

Short rigid wires are not regarded as liable to wma away from a terminal. ifthey remain in position when the terminal screw is loosenad.

20.13 **Supplementary insulation** and reinforced insulation **shall** be **so** designed or protected that they are not **likely to** be **impaired** by deposition of **dirt,** or by **dust resulting** from waar of **parts** within the **tool,** to such an **extent** that **creepage** distances and clearances are reduced below the values **specified** in 27.1.

Parts of **natural** or **synthetic rubber used as** supplemantary **insulation** in **class II tools shall** be **resistant to** ageing and be so arranged and dimensioned that **creepage** distances and dearances are not raduced below

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

- by the tests of 19.1 and 19.3 for screw-type brush-caps which are accessible from the outside of the tool;
- by the tests spacified for supplementary insulation for class I tools and class III tools;

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

20.16 Radio and television interference suppressors shall be so fitted that they are adequately protected by the tool against mechanical darnage.

Compliance is checked by inspection and by the test of 19.1.

The suppressors may be either within the enclosure of the tool or in a strong casing firmly fixed to the tool.

Care should ba taken, when designing the tool, to allow adaquate space for fitting these suppressors.

20.17 Tools shall be fitted wlth a mains switch.

20.18 Switches shall be so located that accidental operation is unlikely to occur.

Compliance is checked by inspection.

20.19 Tools shall be fitted with a switch or control devica which can be easily actuated, entailing no danger, from the operator's place to stop the machine.

Compiiance is checked by inspection.

20.20 After voltage

21.3 Wireways shall be smooth and free from sharp edges. burrs, flashes and the like which might cause dangerous abrasion of the wiring insulation.

Holes in metal, through which insulated wires pass. shall be provided with bushings or shall have smooth well-rounded edges.

Adequate means shall be pmvided to prevent wiring from coming into wntact with moving parts.

21.4 *In* the case of class II tools adequate means shall be pmvided to prevent direct wntact occurring between the insulation of wiring with basic insulation only and awessible metal parts.

Insulating sleeves may be used to prevent such wntact, pmvided that the sleeves withstand the tests specified for supplementary insulation and that the wnductors or sleeves are not likely to be mislaid or lost during routine servicing and repair.

21.5 Conductors identified by the colour wmbinetion green/yellow shall not be wnneoted to terminals other than earthing terminals.

Compliance with requirements as given in 21.2 to 21.5 is checked by inspection.

21.6 Wiring between different parts of a tool which can move in normal use or during user servicing relative to each other and its electrical wnnections, including those provkting earthing wntinuity shall not be exposed to undue stress.

If flexible metallic tubes are used for the protection of conductors between these parts, such tubes shall not cause darnage to the insulation of the wnductors wntained therein.

Open-coil sptings shall not be used to protect conductors.

If a coiled spring. the turns ofwhich touch one another. is used for this purpose, an adequate insulating lining shall be provided in addltion to the lnsulation of the conductors.

Compliance is checked by inspection and by the following test:

If flexing occurs in normal use the appliance is placed in the normal position of use and is operated et rated voltage or et the upper limit of the reted voltage renge, in accordance with conditions of adequate heat discharge and/or undar normal load.

The moveble pert is moved beckwerds and forwards, so that the wnductor is ßexed through the largest angle permitted by the design.

The number of ßexings for conductors ßexed in normal use is 10 000 and the rate of flexing 30 per min.

After the fest, *the tool shall show no darnage within the meening of this standard and no darnage impairing its further use. In particular, the wiring and its wnnections shall withstand an electric sbength test as specified in 15.3, the* fest *voltage being, however, reduced to f 000 V and epplied between live parts and other metal parts only.*

A *flexing* is *one movement either beckwerds or fonverds.*

The sheeth of e flexible cable or wrd complying with HD 21 or HD 22 is regerded es en edequete insulating lining.

21.7 Where wiring is moved under normal operating wndiions, precautions shall be taken to ensure that a minimum distance of25 mm is kept permanently between moving parts and the wiring.

Where this is not possible means shall be provlded to prevent wntact between the wiring and the moving parts.

Compliance is checked by inspection.

21.6 Aluminium wires shall not be used for intemal wiring.

NOTE Windings of a motor are not considered to be internal wiring.

22 Components

22.1 Components shall comply with the safety requirements specified in the relevant CENELEC standards as far as they reasonably epply.

If wmponents are marked with their operating characteristios, the conditions under which they are used in the tool shall be in accordance with these markings (see note 3 of Table 2).

Capacitors connected in series with a motor winding shall be marked with their rated voltage, in volts, and their rated capacitance. in microfarads.

The testing of wmponents which have to comply with other Standards is, in general, carried out separately, according to the relevant standard as follows:

It is checked that the marking of wmponents marked with individual mtings suits the wnditions which may occur in the tool. The wmponent is then tested in accordance with its marking, the number of samples being that required by the relevant standard. Components not marked with individual mtings are tested under the conditions occurring in the tool, the number of samples being in general, that required by the relevant Standard.

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

Components inwrpomted in the tool am subjected to all the tests of this startdardas part of the tool.

NOTE Compliance with the CENELEC standard for the relevant [illegible]

or at the upper limit of the mted voltage mnge of the tool.

me motor(s) is(are) then stalled and the switch opemted 50 times, each "ON" period lasting no longer than 0,5 s and each "OFF" period lasting at least 10 s.

Whem, in normal use, an electronic control device switches off the current befom opening the main contacts, the number of opemtions is mduced to five, with the electronic control device short-circuited.

During this test no sustained arcing, or undue buming, pitting or welding of contacts shall occur and there shall be no electrical or mechanical failure.

Switches marked with individual mtings am tested in accordance with EN 61058-1.

For series and universal motors, switches not marked with individual ratings are also tested under the conditions occurring in the tool with tha current I_M wrresponding to tha mted input of the tool.

Moreover the current to be used in the bmaking capacity test shall be six times I_M when closing and thme times I_M when opening.

The current used in the normal Operation test shall be five times I_M when closing and I_M when opening.

The power factor is unity p.f. in all cases. The numberof samples is that given in EN 61058-1.

For other motors, switches not marked with individual mtings am tested under the wnditions occurring in the tool as follows:

The currents and their wrresponding power factors during switching-on operations in accordance with wnditions of adequate heat discharge and /or under normal load of the tool are measumd.

The switch may then be tested separately, according to EN 61058-1.

The switching-on current and the corresponding power factor so measured baing used for the breaking capacity test specified in clause 15 of that publication and the current and power factor measured under conditions of adequate heat discharge and/or normal load being used for the normal Operation test specified in clause 16 of thatpubkcation.

22.3 Mains switches shall not be fitted in the flexible cables or cords.

Compliance is checked by inspection.

22.4 Overfoad protection devices shall be of the non-self-resetting type.

Compiiance is checked by inspaction.

22.5 Plugs and appliince inlets for safety extra-low voltage circuits or for frequencies other than 50 Hz or 60 Hz and plugs and connectfons on flexible cables and cords used for an intermediate connection between different parts of a tool shall not be interchangeable with plugs and socket-outlets compiying with IEC 60083. *nor* with connectors and appliance inlets complying with EN 60320-1, whera direct supply of these parts could cause danger to persons or surroundings. or damage to the tool.

Compliance

currents which may occur in the event of an insulation fault

Compliance is checked by the following

and cords

23.1 Tools shall be provided with either a power supply cord with type X or type M attachment or an appliance inlet.

It shall not be easily possible to replace the power supply cord for type M attachment by a cord for type X attachment

If an appliance inlet is used, ft shall be so placed that the connector can be inserted without diiculty.

It shall be so located or enclosed that *no* live parts or none of the pins will be axposed to accidental contact during insertion or removal of a connector.

Compliance is checked by inspection and by means of the test finger shown in Figure 1, or, for appliance inlets, by *means* of *the appropriate* gauges *specified* in EN 60320-1.

23.2 Nondetachable flexible cables and cords shall not ba lighter than: ordinary rubber-sheathed flexible cords (code designation H05RR-F) or ordinary polyvinyl chloride sheathed flexible cords (code designation H05VV-F).

Nondetachable flexible cables or cords of class I tools shall be provided with a core marked green/yellow, which is wnnected to the earthing terminal of the tool and to the earthing wntact of the plug (if fitted).

Complianca is checked by inspection and by measurement.

23.3 If a tool is pmvided with a plug, the plug shall wnform with the raquirements laid down in IEC 60063, EN 60309-1 or EN 60309-2.

23.4 The nominal cross-sectional area of flexible cables or wrds shall be not less than that shown in Table 6.

Table 8 — Minimum cross-sectional area of supply cord

Rated current of tool A	Nominal cross-sectional area mm²
Up to and induding 6	0.75
over 6 up to and induding 10	1
over 10 up to and including 16	1.5
over 16 up to and including 25	2,5
over 25 up to and including 32	4
over 32 up to and including 40	6
over 40 up to and	10

is checked by inspaction.

23.5 Tools pmvided with a power supply wrd shall have cord anchorages such that the wnductors are relieved from strain, induding twisting. where they are connected within the tool, and that their wvering is pmtected from abrasion.

For type X flexible cables or cords, it shall be clear as to how the reliif from strain is to be obtained and *makeshii* methods such as tying the cable or cord into a knot or tying

Cord anchoragas for type X cords shall be so designed that replacement of the flexible cable or cord is easily possible.

NOTE Cord anchorages may be a part of the mains switch.

Screws, if any, which have to be operated when replacing the power supply cord, shall not serve to fix any other component unless, when omitted or incomctly mounted. they render the tool inoperative or manifestly incomplete or unless the parts which are intended to be fastened by them are not detachable during the replacement of the cord.

Glends shall not be used as cord anchorages for power supply cords.

Complianca is chacked by inspection and by the following tests:

The tool is fitted with a flexible cable or cord and the conductors are introduced into the terminals, the terminal

24 Terminale for extemal conductore

24.1 Tools shall be provided with terminals in whiih connection is made by means of screws, nuts or equally effective devices.

Screws and nuts which clamp extemal wnductors shall have a metric ISO thread. They shall not serve to fix any other component, except that they may also clamp intemal conductors *if* these are *ao* arrangad that they are unlikely to be diiplaced when fitting the supply conductors.

For tools with type X and type M attachments and having a rated input not exceeding 100 W, soldered connections may be used for the connection of extemal 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 such that creepage distances and clearances between live parts and other rnetal parts cannot be reduced to less than 50% of the values specified in *27.1,* should the wnductor break away at the soldered joint.

For the purpose of the requirernents for power supply cords

- it is not to be expected that two independent fixings will become loose at the same time;
- conductors connected by soldering are not wnsidered to be adequately fixed. unless they are held in place near to the termination, independently of the solder, but "hwking in" before soldering is. in general, wnsidered to be a suitable means for maintaining the conductors of a power supply wrd in position, provided the hole through which the wnductor is passed is not unduly large.

The terminals of a wmponent (e.g. a switch) built into the tool - on the assumption that they comply with the requirements of this clause - may be used as terminals intended for extemal conductors.

Switches having wnnecting leads (pig teils) are allowed if the connection point is within the handle or housing and the wrd anchorage of the rnains supply cable meets the requirements of23.5.

24.2 Terminals for type X attachment shall allow the connection of conductors having nominal cross-sectional areas as shown in Table 10.

Table 10 — Conductor cross-sectional areae

Rated current of tool A	Nominal cross-sectional area of flexible cables and cords mm²
Up to and including 6	0.7510 1
over 6 up to and including 10	0,75 to 1.5
over 10 up to and including 16	1 to 2.5
over 16 up to and including 25	1.5 to 4
over 25 up to and including 32	2,5 to 5
over 32 up to and including 40	4 to 10
over 40 up to and including 63	6 to 16

Compliance with the requirements of 24.1 and 24.2 is checked by inspection, by measurement and by fitting cables or cords of the smallest and largest cross-sectional areas specified.

24.3 Terminals and terminations for type M attachment shall be suitable for their purpose.

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

24.4 Terminals shall be so fixed that, when the clarnping means is tightened or lwsened, the terminal does not work loose, intemal wirlng is not subjected to stress, and creepage diinces and clearances are not reduced below the values specified in 27.1.

Compliance is checked by inspection and by measurement after fastening and loosening ten times a conductor of the largest cross-sectional area specified in 24.2, the torque applied being equal to two-thirds of the torque specified in 26.1.

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

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

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

24.5 Terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without darnage to the conductor.

24.6 Terminals of tools having a rated current not exceeding 16 A shall not require special preparatton of the conductor in order to effect correct connection, and they shall be so designed or placed that the conductor cannot slip out when the clamping screws or nuts are tightened.

Compliance with the requirements of 24.5 and 24.6 is checked by inspection of the terminals and of the conductors, after the test of 24.4.

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

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

24.7 Pillar-type terminals shall have dimensions as shown in Table 11, except that the length of the thread in the pillar may be reduced, if the mechanical strength is adequate and at least two full threads are in engagement when a conductor of the smallest cross-sectional area specified in 24.2 is tightly clamped.

Table 11 — Dimensions of pillar-type terminals

Rated current of tool A	Minimum nominal thread diameter mm	Minimum diameter of hole for conductor mm	Minimum length of thread in pillar mm	Maximum difference between diameter of hole and nominal thread diameter mm
up to and including 6	2,5	2.5	1.8	0.5
over 6 up to and including 10	3.0	3.0	2.0	0.6
over 10 up to and including 16	3.5	3.5	2.5	0.6
over 16 up to and including 25	4.0	4.0	3.0	0.6
over 25 up to and including 32	4,0	4.5	3,0	1,0
over 32 up to and including 40	5.0	5.5	4.0	1,3
over 40 up to and including 53	6.0	7.0	4.0	1,5

The length of the threaded part of the terminal screw

If the thread in the pillar is recessed. the length of headed screws must ba increased accordingly.

The part against which the conductor is clamped need not be in one piece with the part carrying the clamping screw.

NOTE The length of the thread in the pillar is measured to the point where the thread is first broken by the hole for the conductor.

24.8 Screw-lype terminals shall have dimensions not less than those shown in Table 12, except that the length of the thread in the screw hole or nut and the length of thread on the screw may be reduced, if the mechanical strength is adequate and at least two full thraads am in engagement when a conductor of the largest cross-sectional area specified in 24.2 is lightly clamped.

If the required length of thread in a terminal screw hole is obtained by plunging, the edge of the extrusion shall be reasonably smooth and the length of thread shall exceed the specified minimum value by at least 0,5 mm. The tength of the axtrusion shall be not more than SO% of the original thickness of the metal, unless the mechanical strength is adequate with a greater length.

If an intermediate part, such as a pressure plate, is used between the head of the screw and the conductor. the length of thread on the screw shall be increased accordingly, but the diimeter of the head of the screw may be reduced by

- 1 mm for mted currents not exceeding 16 A;
- 2 mm for rated currents exceeding 16 A.

Such an intermediate part shall be locked against rotation.

If an intermediate part has more than one screw, screws with the following nominal thread diameter may be used:

- 3,5 mm for rated currents not exceeding 25 A;
- 4,0 mm for rated currents exceeding 25 A.

If the thmad in the scmw hole or nut is recessed. the length of headed screws must be incmased accordingly.

Table 12 — Dimensions of screw-type terminals

Rated current of tool A	Nominal thread diameter mm	bngth of thread on screw mm	Length of	Nominal	Height of
	2.5	4.0			
over 5 up to and including 10	3.0	4.0			
over 10 up to and including 16	3,5	4.0			
over 15 up to and including 25	4.0	5.5			
over 25 up to and including 32	5.0	7.5			
over 32 up to and including 40	5.0	9.0			
over 40 up to and including 63	6,0	10.5			

24.9 Stud-type terminals shall be provided with washers and shall have dimensions as shown in Table 13.

Table 13 — Dimensions of stud-typc terminals

Rated current of tool A	Nominal thread diameter (minimum) mm	Difference between thread diameter and inner diameter of washers (maximum) mm	Difference between thread diameter and outer diameter of washers (minimum) mm
up to and including 6	2.5	0,4	3.5
over 6 up to and including 10	3.0	0,4	4.0
over 10 up to and including 16	3.5	0.4	4.5
over 16 up to and including 25	4.0	0.5	5.0
over 25 up to and including 32	4,0	0,5	5.5

Compliance with tha requirements of 24.7 to 24.9 is chacked by inspection, by measurement and, if necessary, by tha tests of 24.10. A negative deviation of 0,15 mm is allowed for the nominal thread diameter and for the nominal diffarence between diameters of haad and shank of tha screw.

If ona or more of the dimensions required in 24.7 to 24.9 are larger than specified, the othar dimensions naed not be correspondingly increased, but dapattures from tha specified values must not impair the function of the terminal.

24.10 If the length of thread in the pillar, screw hole or nut, or tha length of thread on the screw, is smaller than that shown in the relevant tabla, or if the length of tha extrusion is more than 80% of the original thickness of the metal, Ma mechanical strength of tha terminal is chacked by tha following tests:

Screws and nuts are subjected to the test of 26.1 but with the torque increased to 1.2 times the toqua specified.

After this test, tha terminal shall show no darnage impairing its furthar use.

A conductor is than fastened, as specified in 24.4, once more and, while clamped, is subjected for 1 min to an axial pull, applied without jerks, of the value shown in Table 14.

Table 14 -Axial pull values for conductors

Rated current of tool A	Pull N
Up to and including 6	40
over 6 up to and including 10	50
over 10 up to and including 16	50
over 16 up to and including 25	60
over 25 up to and including 32	so
over 32 up to and including 40	90
over 40 up to and including 63	100

During this test, the conductor shall not move noticeably in the terminal.

24.11 Whare terminals are provided for type X and type M attachments, each terminal shall ba located in proximity to its corresponding terminal, *or* terminals, of diirent polarity and to tha aarthing terminal, if any.

Compliance is chacked by inspection.

24.12 Terminal devices shall not be accessible without the aid of a tool.

Compliance is checked by inspection and by manual test.

24.13 Terminations shall be so designed that the conductor is retained in position independently of the termination, before soldering or welding, so that it cannot slip out should the soldering or welding break.

Complience is checked by inspection.

24.14 Terminals and terminatlons for type X and. when appliible, type M 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, for class II tools. between live parts and metal parts separated from accessible metal parts by suppiementary insulation only.

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

A 8 mm length of inwlation is renwved from the end of a flexible conductor heving e nominal cross-sectional area as specified in 23.4. One wire of the stranded conductor is left free and the other wires are fully inserted into and clamped in the terminals.

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

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

Where the method of connection requires special preparation of the conductor, e.g. soldering, or where a termination is fitted to a type M attachment, e.g. crimping, this preparation is done with one strand left free.

25 Provision for earthing

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

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

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

Compliance is checked by inspection.

If accessible metal parts are screened fmm live parts by metal park which are connected to the earthing terminal or to the earthing contact, they ata not, for the purpose of this requirement, regarded es likely to bewme live in the event of an insulation fault.

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

Metal parts behind a dewretive wver which does not withstand the test of clause 10 em considered to be eccessible metal parts.

25.2 Earthing wnnections shall not be made using screwless terminals.

The clamping means of earthing terminals shall be adequately locked against accidental loosening and tit shall not be possible to loosen them without the aid of a tool.

Complience is checked by inspectlon, by manuel test and by the test of clause 24.

NOTE In general, the designs commonly used for current-carrying terminals, other than some terminals of the pillar type, provide sufficient resiliency to comply with the latter requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

25.3 All parts of the earthing terminal shall be such that there is no risk of conusion resulting from contact between these parts and the wpper of the earthing conductor. or any other metal that is in contact with these parts.

The body of the earthing terminal shall be of brass or other metal no less resistant to corrosion, unless it is a part of the metal frame or enclosure, when the screw or nut shall be of brass. plated steel compiying with clause 29. or other metal no less resistant to wrrosion.

If the body of the earthing terminal is a part of a frame or enclosure of aluminium alloy, precautions shall be taken to avold the risk of wrrosion resulting

screws or nuts.

25.4 For tools with power supply wrds or cables. the arrangemant of the terminals, or the length of the wnductors between the wrd anchorage and the terminals, shall be such that the current-carrying conductors bewme taut before the earthing wnductor if the cable or wrd slips out of the wrd anchorage.

25.5 The wnnection between the earthing terminal or earthing wntact, and parts required to be connected thereto. shall be of low resistance.

Compliance is checked by the following test, during which any inductors for interference suppression ara left in the earthing circuit.

A current of 1,5 times the rated current but not less than 25 A, derived from an a.c. source with a no-Load voltage not exceeding f2 V is passed between the earthing terminal or earthing wntact, and each of the accessible metal parts in turn.

The witage drop behveen the earthing terminal or the earthing wntact of the tool, and the accessible metal part is measured, and *the resistance calculated fmm the current and this voltage dmp.*

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

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

Care is taken that the contact resistance behveen the tip of the measuring pmbe and the metai patt under test doas not influence the test results.

25.6 Terminal screws for earthing wnductors shall not serve any other purpose, e.g. mechanical fixing.

26 Screws and connections

26.1 Screwed wnnections, electrical or otherwise, shall withstand the mechanical Stresses occuning in normal use. Screws transmitting wntact pressure and screws . which are likely to be tightened by the user and have a nominal diameter less than 3 mm shall screw into metal.

Screws shall not be of metal which is soft or liable to creep, such as zinc or pure aluminium.

Screws of insulating material shall have a nominal diametar of at least 3 mm; they shall not be used fix any electrical wnnection.

Screws shall not be of insulating material if their replacement by a metal screw could impair supplementary insulation or reinforced insulation. neither shall screws which may be removed when replacing a power supply wrd or undertaking other routine servicing, be of insulating material if their replacement by a metal screw could impair electrical insulation.

Compliance is checked by inspection and, for screws and nuts transmitting wntact pressure, or which are likely to ba tightened by the user, by the following test.

The screws or nuts are tightened and loosened:

f 0 times for screws in engegement with a thread of insulating material;

5 times for nuts and other screws.

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

When tasting terminal scraws and nuts, a flexible wnductor of the largest cross-sectional aree specified in 24.2 is placed in the terminal.

The tast is made by means of a suitable test screwdriver, spanner or key applying a torque as shown in Table 15, the appropriate column being

- *for metal screws without heads if the screw when tightaned does not protrude from the hole ..... I*
- *forothermetalscmwsandfornuts ..... II*
- *for scraws of insulating material:*
  - *having a hexagonal head with the dimension across flats exceading the overall thread diameter, or*
  - *with the cylindrical head and a socket for a key, the socket having e cmss-wmar dimension exceeding the overall thread diameter,* or
  - *with a head having a slot or cross slots, the* langth *of which axcaeds 1.5 times the overall thread diameter ..... II*
- *for other screws of insulating material ..... III*

Table 15 — Torque values for screwed connections

Nominal diameter of screw mm	Torque N m		
	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	0,6
over 3,2 up to and including 3,6	0,4	0,8	0.8
over 3,6 up to and including 4,1	0.7	1.2	0.8
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 up to and including 6,0		2,5	7.25

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

During the fest, no darnage impairing the further use of the screwad connections shall occur.

Screws or nuts which are likely to be tightenad by the user include terminal scraws or nuts, scraws for fixing covers, Kthey hava to be loosened to open or to remove the cover, screws for fixing handles, knobs, etc.

The shape *of the blade of the tast screwdriver must suit the head of the screw to be tasted. The screws and nuts must not be tightenad in jerks.*

26.2 Screws in engagement with a thread of insulating material **shall have** a length of **engagement** of at least 3 mm plus **one-third** of the nominal screw **diameter** or **8** nun, whichevar **is** the shorter.

Correct intmduction of the scraw into the screw hole or nut **shall** be **ensured.**

This requirement does not apply to brush **caps.**

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

The requirement with regard to correct introdwtion is met if introduction of the screw ifa slenting manner is prevented, for example, by guiding the screw by the part to be fixed, by a recess in the female thread or by the use of a *screw with the leading thread removed.*

26.3 Electrical connectlons shall be so designed that contact pressure is not transmitted through insulating material which is lieble to ehrink or to distort, unless there is sufficient resiliency in the metallic parts to compensate for *any* possible shrlnkage or distortion of the insulating material.

26.4 Spate-threaded (sheet metal) screws shall not be used for the wnnection of current-carrying

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

The force is applied by means of a test finger having a tip as shown in Figure 1 and has a value of

- 2 N for bare conductors and for uninsulated capillaty tubes of thermostats and similar devices;
- 30 N for enclosures.

Table 16 — Crsepage distances and clearances

Distances mm	Class III tools		Other tools					
			Working voltage up to 130 V		Working voltage over 130 up to 250 V		Working voltage over 250 up to 440 V	
	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
Between live parts of different polarity [2]								
- if protected against deposition of dirt	1.0	1.0	1.0	1.0	2.0	2,0	2.0	2,0
- if not protected against deposition of dirt	2.0	1,5	2.0	1.5	3.0	2,5	4.0	3.0
- if lacquered or enamelled windings	1,0	1.0	1.5	1.5	2,0	2.0	2.0	3.0
Between live parts and other metal parts over basic insulation;								
- if protected against deposition of dirt [3]								
- if of ceramic material, pure mica or the like	1.0	1.0	1.0	1.0	2.5 [4]	2.5"	-	-
- if of other material	1.5	1.0	1.5	1.0	3.0	2.5"	-	-
- if not protected gainst deposition of dirt	2.0	1.5	2,0	1,5	4.0	3.0		
- if the live parts are lacquered or enamelled windings	1.0	1.0	1.5	1,5	2.0	2.0		
- at the end of tubular sheathed-type heating elements [5]	-	-	1.0	1.0	1.0	1.0	-	-
Between live parts and other metal parts over reinforced insulation:								
- if the ri parts are lacquered or enamelled windings			6,0	6.0	6.0	6.0		
- for other live parts			8,0	6.0	8,0	6.0	-	
Between metal parts separated by supplementary insulation			4.0	4.0	4.0	4.0		
Between live parts in recesses in the mounting face of the appliance and the surface to which it is fixed	2,0	2.0	6.0	6,0	6.0	6.0		

1) The values specified in these columns do not apply to printed wiring circuits, for which values are under consideration.

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

3) In general, the interior of an appliance having a reasonably dust-proof enclosure is considered to be protected against deposition of dirt, provided the appliance does not generate dust within itself, hermetic sealing is not required.

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

5) These values apply only to class I appliances.

The requirement conceming distancas through insulation batween metal parts does not imply that the prescribed distance must be through solid insulation only; it may consist of a thickness of solid insulation plus one or more air layers.

The requirement conceming the distanca through insulation behveen metal parts does not apply if the insulation is applied in thin sheet form and consists of at least three layers, pmvided that, when two layers am placed in wntact, they withstand the electric strength test prescribed for reinforced insulation, the test vottage being appliad between tha outer surfaces of the two layers.

For live parts of different polarity separatad by basic insulation only, cmepage distances and clearances smaller than those specified in the table are allowed, pmvided the appliance doas not show any defect within the meaning of this standard, if thesa cmepage distances and clearances are short-circuited and the creepage distancas are over insulating material withstanding the test of28.3.

The way in which creepage distances and dearances are measured is indicated in Annex D.

If a barrier is interposad and if it is in two parts which are not *cementad together, the* distance *is also measured through thejoint*

If a barrier is interposed, dearances ara measured over the barrier or, if the barrier is in two perts with mating surfaces which am not cementad together, through thejoint

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

Internal wnductors am considemd to be bam conductors unless fheir insulation withstands an electric strengfh *test* made *between the conductor* and *the metal foil* wmpped *mund the insulation, a test voltage* of *2 000 V being appliad for 15 min.*

Wirings am considered to hava basic insulation if they am wrapped with tape and then impregnated, or if they are covered with a layer of self-hardening resin, and if, after the test of 14.2, an electric strength test as specified in 15.3 is withstood, the test voltage being applied *batween the conductors of the winding snd metal foil in contact with the surface of the insulation.*

27.2 **The** distance through insulation, for working **voltages** up to and including 250 **V,** between metal parts, **shall** not be **less** than 1.0 mm if they are separated by **supplementary** insulation, and not be less than 2,0 mm if they are separated by **reinforced** insulation.

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

- for **supplementary** insulation, of at least two layers, provided that at least one of the layers **withstands** the electric strength test **prescribed** for **supplementary** insulation;
- for reinforcad insulation, of at least thrae layers, provided **that,** when **two** of the **layers** are placed in contact, they withstand the electric strength test prascribed for rainforced insulation

the **test voltage** being applied **between** the **outer** surfaces of the layer or of the two layers as **applicable.**

This requirement does not imply that the prescribed distanca **shall** be through solid insulation only; **it may** wnsist of a thickness of solid insulation plus one or more air layers.

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

27.3 For tools having a rated **current** exceeding 25 A, the distance **between** the terminals and metal **enclosures shall be** at least **9,5** mm.

Compliance with the requirements of 27.2 and 27.3 is checked by inspaction and by measurement.

28 Reaistance to heat, fire and tracking

28.1 Extemal parts of insulating material, the deterioration of which might cause the tool to bacome unsafe, shall be sufficiently resistant to heat

Compliance is checked by subjecting enclosures and other extemal park of insulating material to a ball-pressure test by means of the apparatus shown in Figure 8.

The surface of the patt to be tested is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by e force of 20 N.

The test is mede in a heating cabinet at 8 temperature Of 75 °C ± 2 °C or et a temperature which is 40 °C ± 2 °C in excess of the temperaturn rise of the relevant part determined during the test of clause 11, whichever is the higher.

After 1 h, the ball is removed and the diameter of the impression measured. This diameter shall not exceed 2 mm.

The test is not mede on parts of cemmic material.

28.2 Insulating parts retaining live parts in position shall be resistant to abnormal heat and to fire.

Complience is checked by the following test:

A test is made es described in 28.1, but at a temperaturn of 125 °C ± 2 °C or at e temperaturn which is 40 °C ± 2 °C in excess of the temperature rise of the relevant patt determined during the test of clause 11, whichever is the higher.

In addition, the insuleting parts are subjected to a test made with en electrically heated conical mandrel in en appamtus es shown in Figure 9.

The mandrel is inserted into a conicel hole mamed in the patt to be tested in such a way that portions of the conical part of the mandrel of equal length protrude fmm both sides. The sample is pmssed against the mandrel with e force of 12 N. The means by which the force is epplied is then locked to pmvent sny further movement However, if the Sample starts to soften or melt during the fest, e force just sufficient to keep the sample in contact with the mandrel is applied in a horizontal direction.

The mandrel is heated to e temperature of 300 °C in approximately 3 min and is maintained within 10 °C of this value for 2 min. The temperature is measured by means of e thermocouple inside the mandml.

During the period of 5 min, sparks of about 6 mm in length am produced et the upper surface of the sample whem the mandrel protrudes by means of a high-frequency genemtor, the electrodes of which am moved around the mandrel so es to cover the whole area of the sample near the mandrel.

Neither the sample, nor any gases produced during the heating shall be ignited by the sparks.

The tests am not made on parts of cemmic material, insulating parts of commutators or brush-caps and the like, or on coil formem not used as minforced insulation.

28.3 Insulating parts retaining live parts in position and supplementary insulation of metal-encased class II tools shall be of material resistant to tracking, if they are exposed to excessive deposition of moisture or dirt in normal use. unless *the* creepage distances are at least equal to twice the values specified in 27.1.

For materials other than cemmic, complience is checked by the following test:

A flat surface of the part to be tested, if possible et least 15 mm × 15 mm, is placed in the horizontal position.

Two electrodes of platinum or other sufficiently non-corrodible material, with the dimensions shown in Figure 10 em placed on the surface of the sample in the manner shown in this figure, so that the rounded edges em in contact with the sample over their whole length.

The force exerted on the surface by each electrode is about 1 N.

The electrodes em connected to a 50 Hz supply source having e voltage or 175 V of substantially sine-wave form. The total impedence of the circuit when the electrodes am short-circuited is adjusted by means of a variable resistor, so that the current is equal to 1.0 A ± 0,1 A with e power factor behveen 0,9 and 1. An overcurrent relay with e tripping time of at least 0,5 s is included in the circuit.

The surface of the sample is wetted by allowing drops of a sokttion of amnwnium chloride in distilled water to fall centrally between the electrodes. The solution has a volume resistivity of 400 Ω cm at 25 °C, corresponding to a concentration of about 0,1 % The drops have a volume of formula 20 $^{+5}_{0}$ mm³ and fall from a height of 30 mm to 40 mm.

The time interval between one dmp and the next is 30 s ± 5 s.

No flashover or breakdown between electrodes shall occur befora a total of 50 dmps has fallen.

The test is made at three places on the sample.

Care is taken that the electrodes ara clean, correctly shaped and correctly positionad before each test is started.

In case of doubt, the test is repeated, ff necessary On a new Sample.

The test is not made on insulating parts of commutators or brush-caps.

29 Resistance to rusting

Ferrous parts. the rusting of which might cause the tool to become unsafe, shall be adaquataiy protected against rusting.

Compliance is checked by the following test:

All grease is removed fmm the parts to be tested by immersion in carbon tetrachloride or trichlorethane for 10 min.

me parts am then immersed for 10 min in a 10% solution of ammonium chloride in water at a temperature of 20 °C ± 5 °C.

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

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

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

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

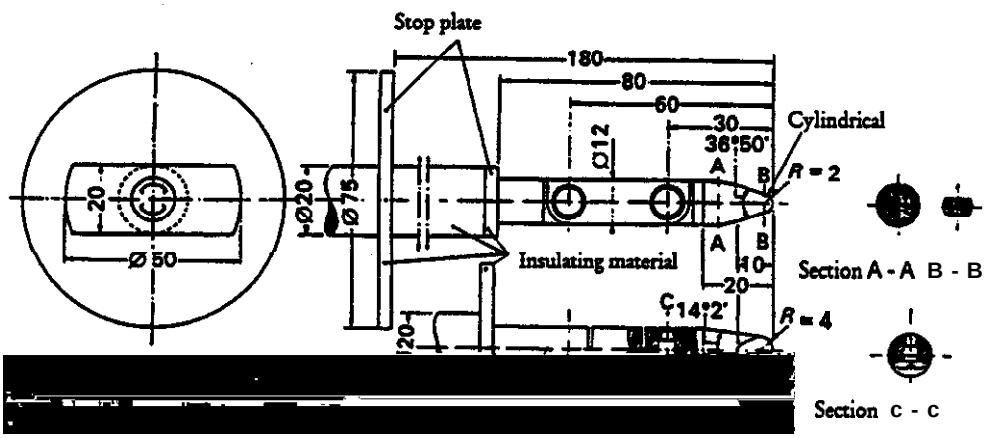
WARNING: When using the liquids specified for the test, adequate precautions must be taken to prevent the inhalation of their vapours.

30 Rediation

Tools shall not emit harmful radiition.

Compliance is checked by test.

A test specification is given in Patt 2.



Dimensions in millimetres

Tolerances:

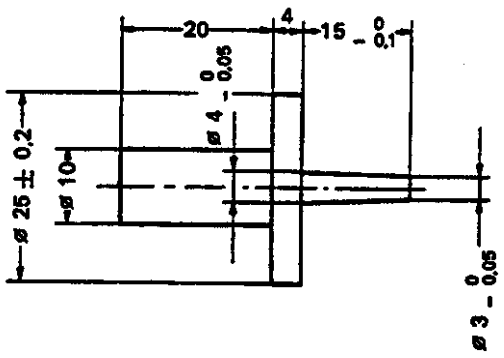
on angles ± 5

on linear dimensions:

less than 25 mm: $^{0}_{-0.05}$

over 25 mm: ± 0.2

Figure 1 — Standard test **finger**



Dimensions in millimetres

Figure 2 — **Test pin**

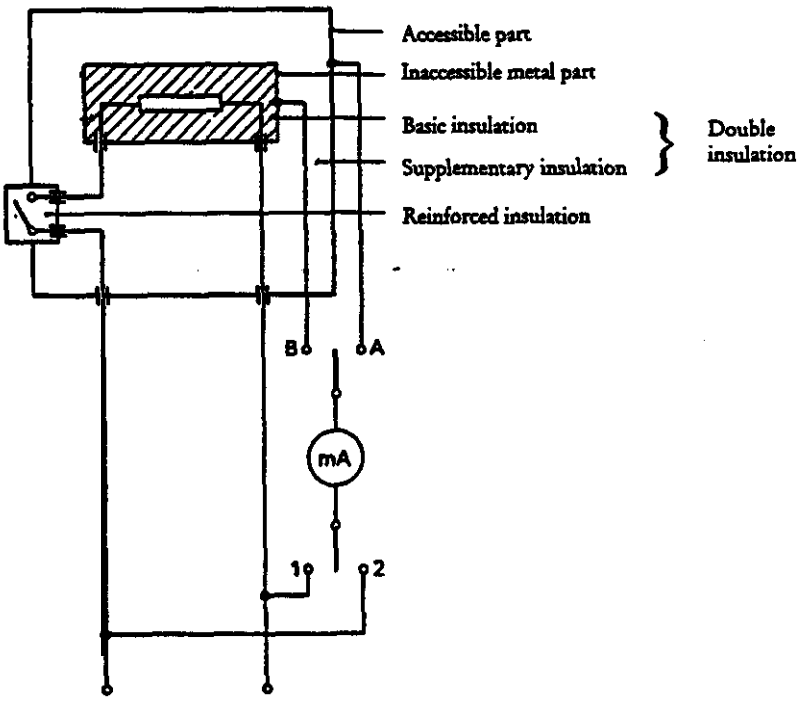


Figure 3 — Diagram for leakage current measurement at operating temperatunt for single-phase connection of class II tools

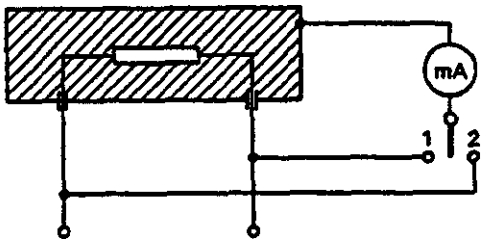


Figure 4 — Diagram for leakage current measurement at opersting tsmperature for single-phase connectlon of tools other than those of class II

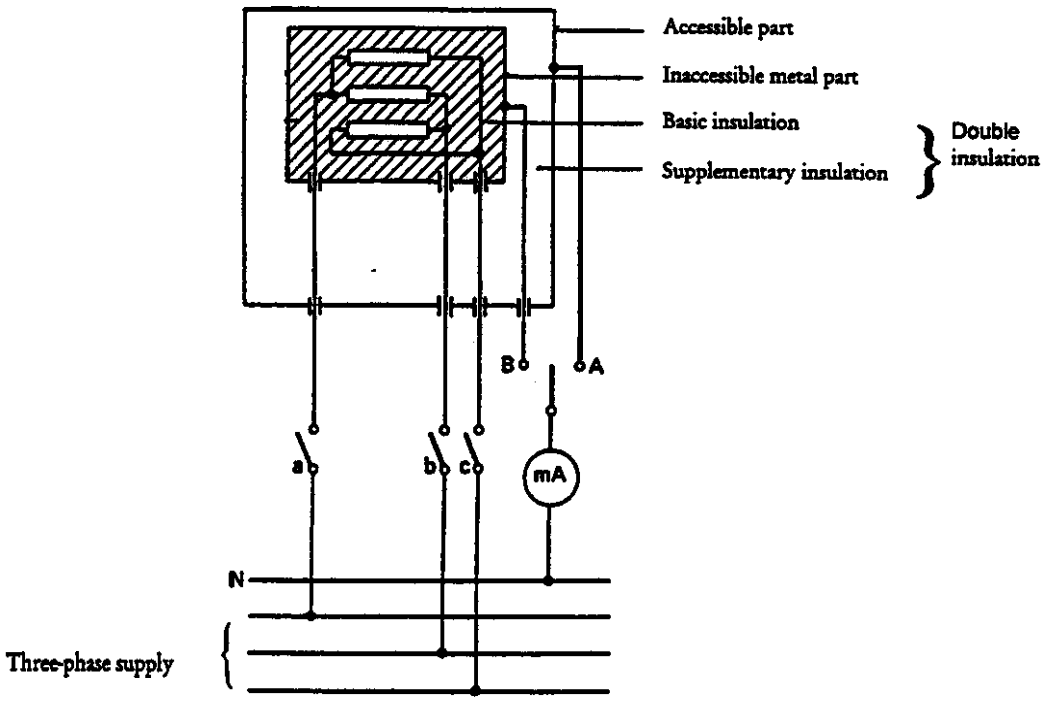


Figure 5 — Diagram for leakage current measurement at operating temperature for three-phase connection of class II toob

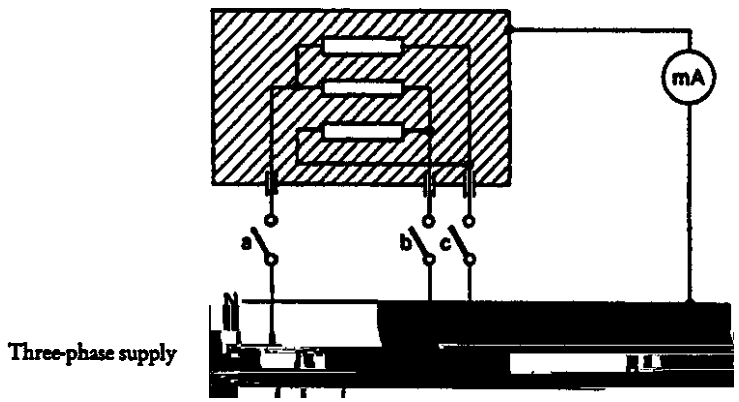


Figure 6 -Diagram for leakage current measurement at operating temperature for three-phase connection of toob other than those of class II

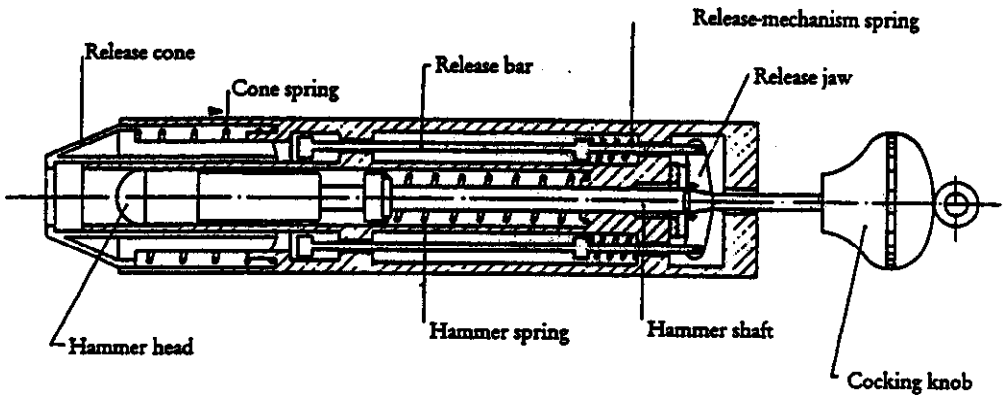


Figura 7 — Impact test apparatus

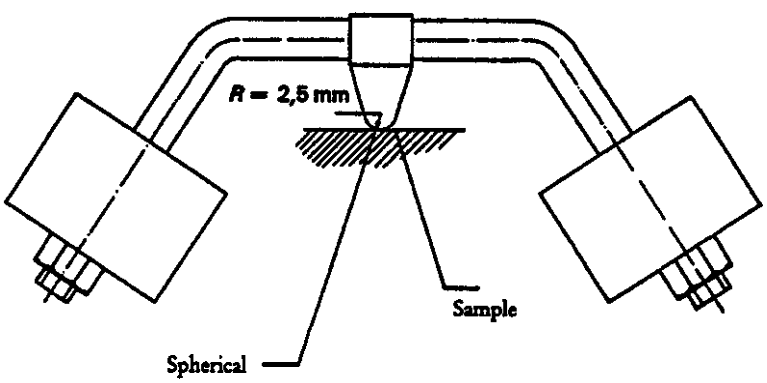


Figure 8 — **Ball-pressure apparatus**

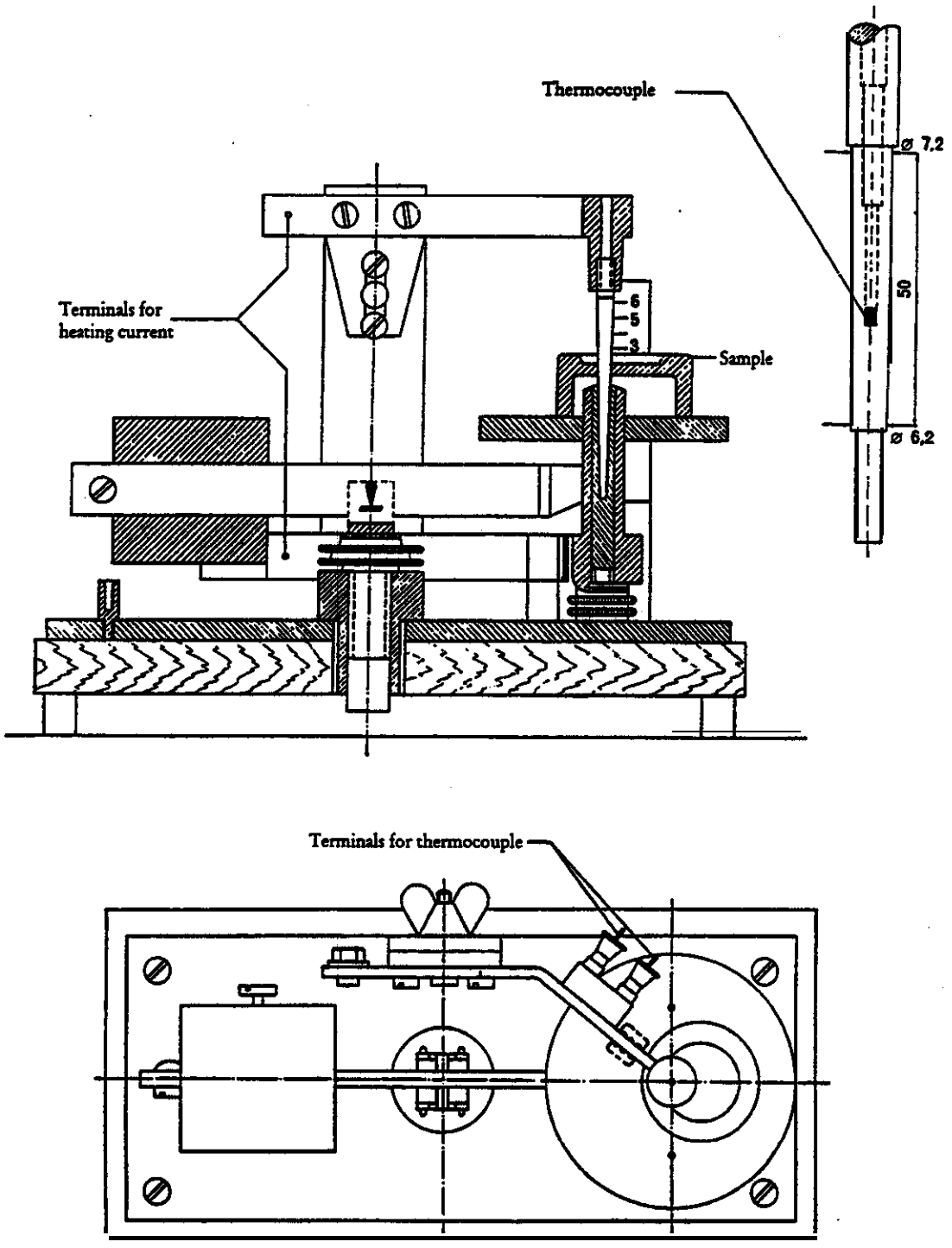
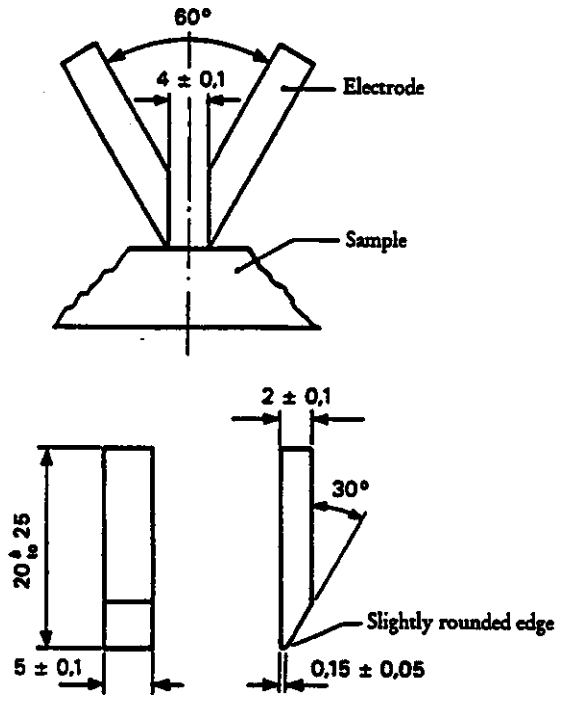
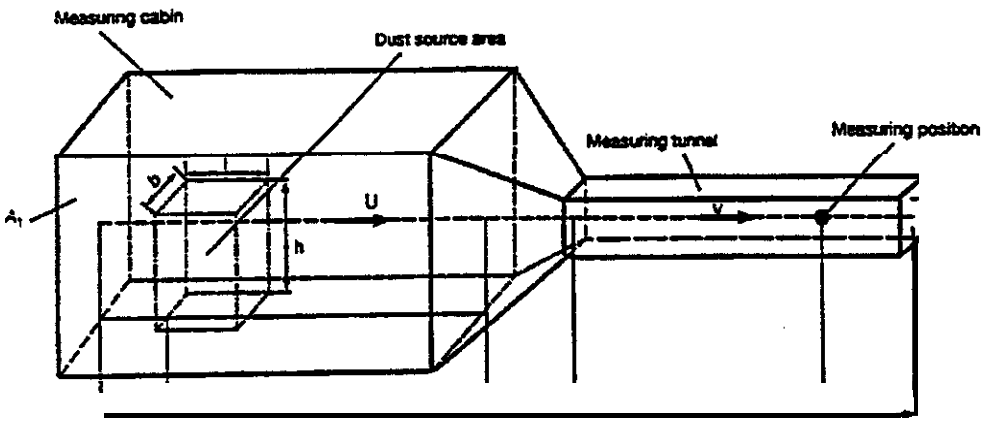
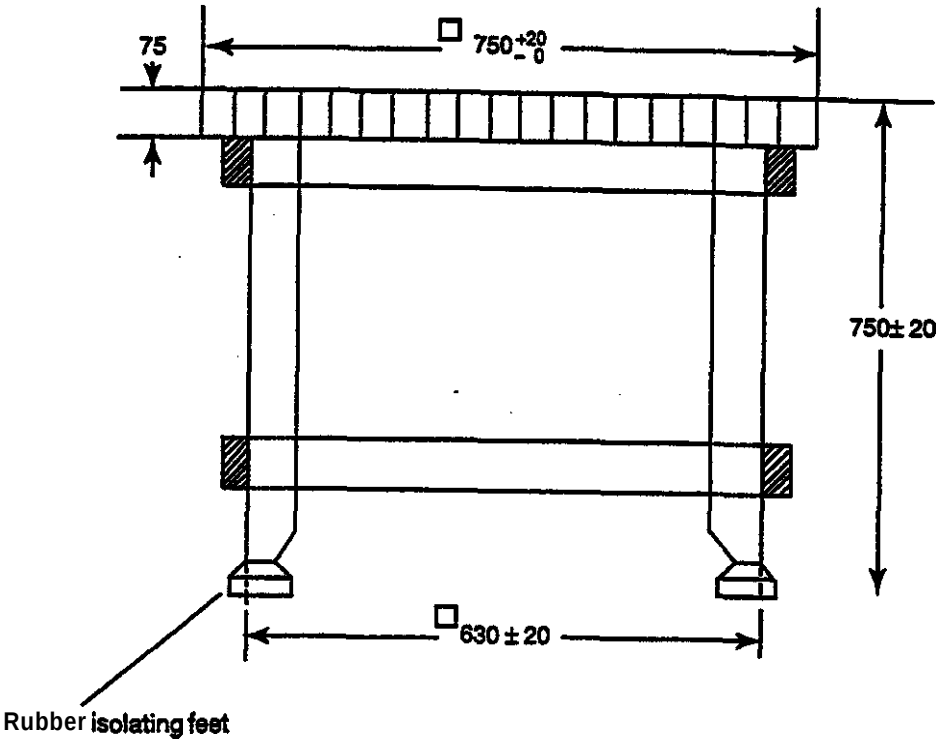


Figure 9 — Hot **mandrel apparatus**


60°
4 ± 0,1
Electrode
Sample
2 ± 0,1
30°
20 to 25
Slightly rounded edge
5 ± 0,1
0,15 ± 0,05


Measuring cabin
Dust source area
Measuring tunnel
Measuring position
U
V
h



Dimensions in millimetres

Material: pine wood 75 x 40 planed, glued and dowelled

Figure 12 -Test bench for dust measurement

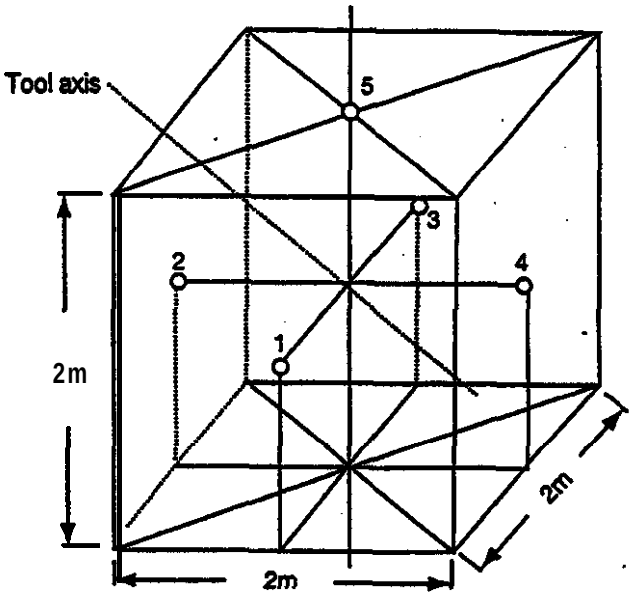


Figure 13 — Microphone for free field measurements over a reflecting plane

Annex A (normative)

Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the pubiications are listed hemafter. For dated references, subsequent amendments to or revisions of any of these pubiications appiy to this European Standard only when inccrporated in it by amendment or revision. For undated references the tatest ediion of the publication referred to applies.

NOTE In this Eureopean Standard, all references are to be regarded as undated references.

Publication	Date	Title
EN 292-1	1991	Safety of rnachinery - Basic concepts. general prtnciples for design Part 1: Basic terminoiogy. methcdoiogy
EN 292-2	1991	Safety of machinery - Basic concepts, general principles for design Part 2: Technical prtnciples and specifications
EN 1093-3	1996	Safety of machinery - Evaluation of the emission of airbome hazardous substances -- Part 3: Emission rate of a specified poilutant - Bench test method using the real pollutant
EN 50144-1	1998	Safety of hand-held electric motor operated tools Part 1: General requirements
EN 60665 + corr. June	1998 1999	Audio, video and similar electronic apparatus - Safety requirements (IEC 60065:1998, mod.)
EN 60068-2-75	1997	Environmental testing -- Part 2-76: Tests - Test Eh: Hammertests (IEC 60068-2-75:1997)
EN 60127-3	1996	Miniature fuses - Part 3: Sub-miniahne fuse-links (IEC 60127-3:1988 + A1:1991 + ccrrigendum Oct. 1994)
EN 60309-1	1999	Plugs, socket-outlets and couplers for industrial purposes Part 1: General requirements (IEC 60309-1: 1999)
EN 60309-2	1999	Plugs, socket-cutiets and couplers for industrial purposes Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories (IEC 60309-2:1999)
EN 60320-1 + A1 + A2	1996 1996 1998	Appliice couplers for household and similar general purposes Part 1: General requirements (IEC 60320-1:1994, mod.: A1:1995 and A2:1996)
EN 60335-1 + corr. Jan. + A l + A11 + A12 + A13 + A14 + A15	1994 1995 1996 1995 1996 1996 1996 2000	Safety of household and similar electrtcai appliances Part 1: General requirements (IEC 6033641991, mod.) (IEC 60335-1:1991/A1:1996, mod.)
EN 60529 + corr. May + A1	1991 1993 2000	Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989 and A1:1999)
EN 60651 + A1	1994 1994	Sound level meters (IEC 60651:1979 and A1:1993)
EN 60799	1996	Electrical accessories -Cord sets and interconnection cord sets (IEC 60799:1998)

EN 61058-1
+ A1

EN ISO 3744

ENV 25349

ENV 26041

HD 21

HD22

HD 566 S1

IEC 60063

IEC 60384-14

ISO 630

ISO 620

ISO 5346

Annex B

fhre samples of the device test which is made at times the current passing through, an 1,1 times the voltage applied to the device wh tool is ope rafed rated voltage or at the u limit of the mte voltage mnge under notm load.

me te is mad with a.c. or d.c. as appropriate, the test with a.c. being made at the power factor detennined when the tool is opemted under normal load.

The device is caused to operate 1 5 times.

After the test, the samples shall show no damage impairing their further use.

8.2 Thermal cut-outs and overload releases shall be so constructed that their setting is not changed appreciably by heating, Vibration, etc. occurring in normal use.

Compliance is checked by inspection during the test of clause 16.

Annex C (normative)

Electronic circuits

C.I Scope

This annex applies to circuits comprising at least one electronic component.

C.2 Definitions

Additional definitions:

C.2.101
electronic components
part in which conduction is achieved principally by electrons moving through a vacuum, gas or semi-conductor

C.2.102
protective impedsnce
impedance connected between live parts and accessible conductive parts, and of a value such that the current, in normal use and under likely fault condiions in the tool, is limited to a safe value

c.4 General notes on tests

Addition:

c.4.1 *All clauses of part 1, as modified in this annex and in the Part 2 for the specific tool, apply to elactmnic circuits.*

Addition:

C.4.2 *The accumulation of stress resulting from successive tests is to be avoidad. It mey ba necessary to replace componenta or to use additional samples.*

NOTE **The number of additional samples should be kept to a minimum by an evaluation of the relevant circuits.**

Additional subclause:

C.4.101 *Care is to be taken that the supply is free from such perturbations from* extemal *sources that can influence the results of the tests.*

C.8 Protection against electric shock

CB.1 The explanation conceming safety extra-low voltage is not applicable.

Addition:

An accessible part is not considered to be live if:

- the part is supplied from a safely isolating transformer, provided that
  - for a.c. the peak value of the voltage does not exceed 42,4 V;
  - for d.c. the voltage does not exceed 42.4 V, or
- the part is separated from live parts by protective impedance.

In the case of protectlve impedance, the current between the part and the supply source shall not excaed 2 mA for d.c. and its peak value shall not exceed 0.7 mA for a.c., and moreover:

- for voltages havfng 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.

Voltages and currents ara measured between tha relevant parts and either pole of the supply source. Discharges are measurad immadiately after the interruption of the supply.

The circuit for measuring the

If a conductor of a printed circuit board becomes open-circuited, the tool is wnsidemd to have withstood the particular test, provided all three of the following wnditions are met:

- *the material of the printed circuit board withstands the buming test of 20.1 of EN 60085;*
- *any loosened wnductor does not reduce the creepage distanoes or dearances between live parts and awessible metal parts below the values specified in clause C.27;*
- *the tool withstands the tests of C. 17.103 with the open-circuited conductor bridged.*

NOTE 1 In general, examination of the tool and its circuit diagram will reveal the fault conditions which have to be simulated, so that testing can be limited to those cases which may be expected to give the most unfavourable result.

NOTE 2 In certain cases, it may be preferable to simulate all fault conditions rather than to analyse the circuit diagram.

NOTE 3 In general, the tests take into account any failure which may arise from perturbations on the mains supply. However, where more than one component may be affected simultaneously it may be necessary to carry out additional tests which are under consideration.

C.17.102 *Fault conditions 1) to 6) specified in C.17.103 am not applied to circuits or parts of circuits where both of the fotlowing wndttions are met:*

- *the electronic circuit is a tow-power circuit as described betow;*
- *the protection agatnst electric shock, fire hazard, mechanicat hazard or dangerous matfunction in other parts of the tool does not rely on* the *correct functioning of the electronic circuit.*

A low-power cirwit is detennined as follows (an exampte is shown in Figure C. 7):

The tool is opemted at rated wttage or at the upper limit of the rated voltage range and a variable resistor, adjusted to its maximum resistance, is wnnected between the point to be investigeted and the opposite pota of the supply source.

The resistance is then decreased until the power wnsumed by the resistor reaches a maximum. Any poiit nearest to the supply and at whtch 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 fmm the supply source than* a low *powerpoint is considered to be a low-power cirwit.*

NOTE 1 The measurements are made from only one

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

NOTE 3 The power consumed by the variable resistor is measured by 8 watt-meter.

C.17.103 *The following fault wnditions am considered and, if necessary, applied one at* a *time. Consequential faults ara taken into wnsideration.*

1) *Short circuit of creepage distances and dearances between live park of different poiadty, if these distances am less than the vaiues specified in clause C.27, unless the relevant part is adequately encapsulated.*
2) *Short circuit between live parts of different polarity across insutation which does not withstand the tests of clause 15.*
3) *Open circuit at the terminals of any wmponent*
4) *Short circuit of capacitors, unless they comply with IEC 60384-14 or 14.2 of EN 80085.*
5) *Short cirwit of eny two terminals of an electronic wmponent, other than integratad circuits.*
6) *Failure of an integmted cirwit In this case the possible hazardous sttuations of the tool are assessed to* [illegible]

mwk

For Simulation of the fault wnditions, the tool is operated under the wndItions specified in clause 11, but at rated vokaga or at the most unfavourable voltage within the rated voltage range.

Whan any of the fault wnditions are simulated, the duration of the test is:

- as specified in 11.4, but only for one operating cycle and only if the fault cannot be recognized by the user, for example, change in temparature;
- as specified in 17.1. if the fault can be recognized by the user, for example, when the motor stops;
- until staady wnditions are astablishad, for cirwits wntinuously wnnected to the supply mains, for example, stand-by circuits.

In each case, the test is ended if interruption of the supply occurs within the tool.

Fault wndition 5) is not appiied batwaen the Wo circuits of an optocoupler.

If the tool incorporates an electronic circuit which operates to ensure wmpliance with clause 17, the relevant test is repeated with a single fault simulated, as indicated in 1) to 6) above.

Fault condition 6) is applied to encapsulated and similar wmponents if the circuit cannot be assessed by other methods.

Positive temperature coefficient resistors (PTC's) are not short-circuited if they are used within their manufacturer's declared spadfication.

C.17.104 If, for any of the fault wnditions specified in C. 17.103, the safety of tha tool depends on the operation of a minlature fuse-link wmplying with EN 60127-3, the test is repeated but with the miniature fuse-link replace by an ammeter.

ff the current measured does not exceed 2,1 times the rated current of the fuse-link, the circuit is not considerad to be adequataly pmtectad and the test is curried out with the fuse-link short-circuited.

If the current measured is at least 2,75 times the rated current of the fuse-link, the circuit is considered to be adequately pmtected.

If the current measured exceeds 2,1 times the rated current of the fuse-link, but does not exceed 2.75 times the rated current, the fuse-flak is short-circuited and the test is carried out

- for quick-acting fuse-link for the relevant period or for 30 min, whichever is the shorter;
- for time-lag fuses for the relevant period or for 2 min, whichever is the shorter.

NOTE 1 In case of doubt, ths maximum resistance of the fuse-link has to be taken into account when determining the current.

NOTE 2 The verification whether the fuse-link acts as a protecting device is based on the fusing characteristics specified in EN 60127-3, which also gives the information necessary to calculate the maximum resistance of the fuse-link.

NOTE 3 Other fuses are considered as intentionally weak parts in accordance with 17.1.

C.20 Construction

Additional subdauses:

C.20.101 Parts separated by protective impedance shall comply with the requirements for double or reinforced insulation.

C.20.102 Reinforced insulation is allowed for parts separated by a SELV transformer or protective impedance and for parts separated by en optocoupler.

C.20.103 Protective impedance shall wnsist of at least two separate wmponents the impedance of which is unlikely to change significantly during the life time of the tool. If one of the wmponents is short-circuited or open-circuited, the values specified in C.8.1 shall not be exceeded.

Compliance is checked by inspection and by measurement.

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

C.25 Provision for earthing

c.25.1 Addition:

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

C.27 Creepage distances, clearances and distances through insulation

C.27.1 *Addition:*

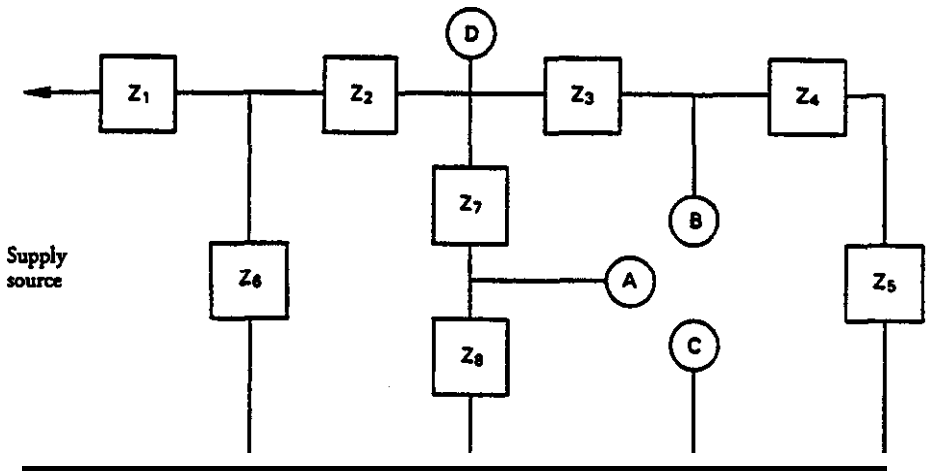
For conductive patterns On printed circuit boards, except at their edges, tha values in tha table batwaen parts of different polarity may ba reduced es long as the peak value oftha voltage stress does not axcead:

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

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

For paak voltages excaadtng 50 V tha reduced craapaga distances only epply if tha Pmof Tracking Index (PTI) oftha printad circuit board is greater **than 175.**

These distances may ba raducad further provided that the tool complies



Annex D (normative)

Measurement of creepage distances and clearances

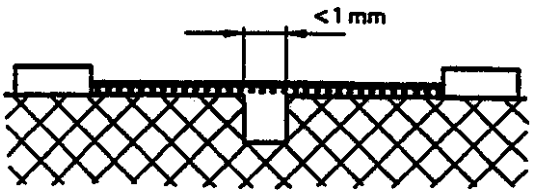
The methods of rnaasuring creepage distances and clearances to be used in intarpreting the requirements of 27.1 are indicatad in Cases 1 to 10 of this annex.

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

The following assumptions are made:

1. *A groove may hava parallel, converging or diverging sides.*
2. *Any gmove having diverging*

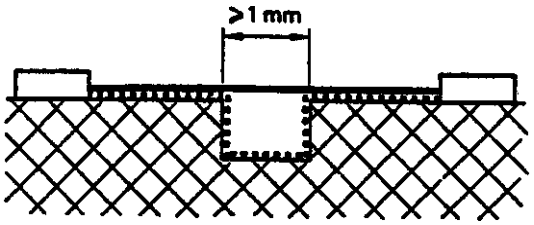
   as an air gap (see case No. 8).
3. *Any wmer including an angle less than 80' is assumed to be bridged with an insulating link of 1 mm width (0.25 mm for dirt-free situations) moved into the most unfavourable position (see case* No. 3).
4. *Where the distance across the top of a groove is f mm (0.25 mm for dirt-free situations) or mom, no craepage distance exists across the air space (see case No. 2).*
5. *A creepaga path is assumed not to exist if them is an air gap as defined in itam 2 above exceeding* 0.25 *mm.*
8. *Creepage distances and clearances measured between parts moving relative to each other am measured whan these parts are in their most unfavourable stationaty*



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

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

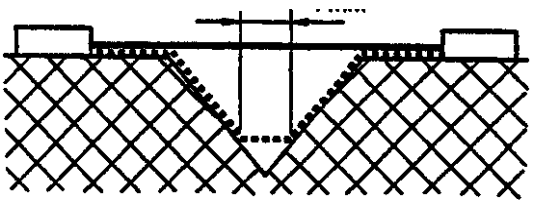
Case No.1



Condition: Path under consideration includes a parallel-sided groove of any depth and with a width equal to or greater than , mm.

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

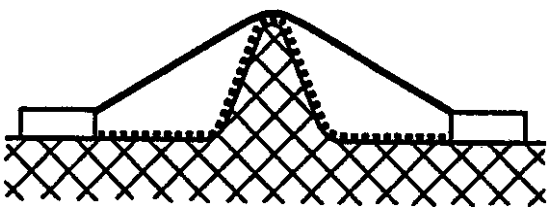
Case No. 2



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

Rule: Clearance k the "line of sight" distance. Creepage path follows the contour of the groove but "short-circuits" the bottom of the groove by 1 mm (0.25 mm for dirt-free situations) link.

Case No. 3



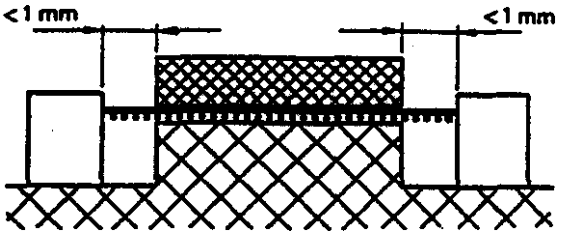
Condition: Path under consideration includes a rib.

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

COMN0.4

Clearance

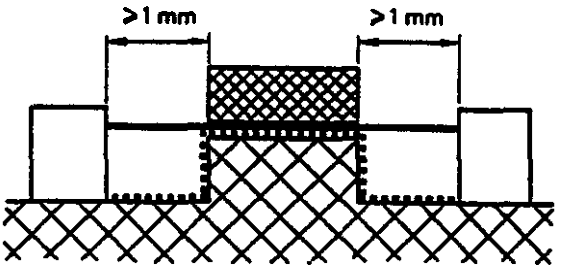
Creepage distance



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

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

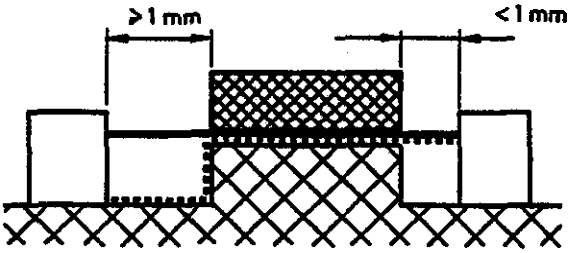
Case No. 5



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

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

Case No. 6



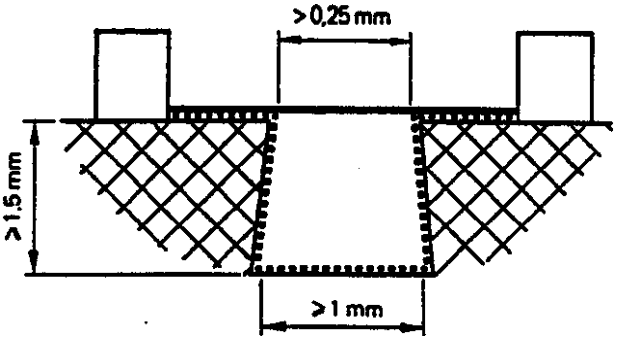
Condition: Path under consideration includes an uncemented joint with a groove on one side less than 1 mm wide and the groove on the other aide equal to or more than 1 mm wide.

Rule: Clearance and creepage path are as shown.

Case No. 7

Clearance

Creepage distance

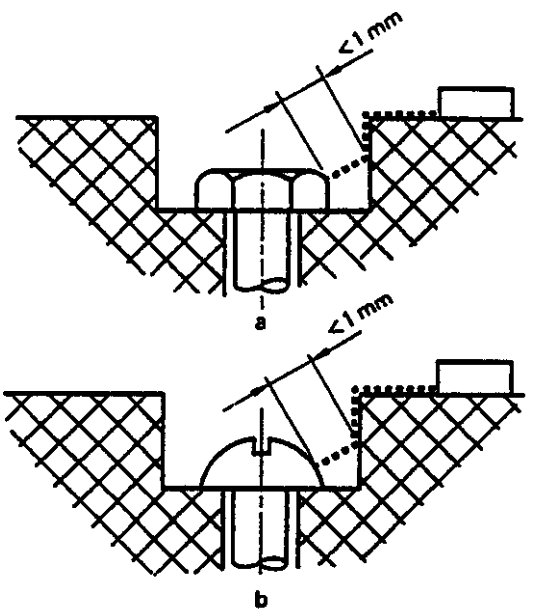


Condition: Path under consideration includes a diverging-sided groove equal to or greater than 1,5 mm deep and greater than 0,25 mm wide at the narrowest parts and equal to or greater than 1 mm at the bottom.

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

Case 3 applies as well to an internal corner if the angle is less than 80°.

Case No. 8

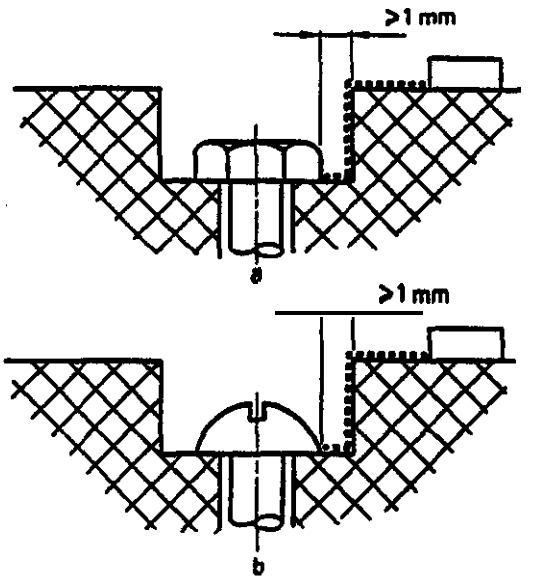


Gap between head of screw and wall of recess too narrow to be taken into account

Case No. 9

Clearance

Creepage distance



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

Case No. 10

. . .* . . . . . Creepage distance

Annex IA (informative)

Circuit for measuring leakage currents

A suitable circuit for measuring leakage currents is shown in Figure IA1.

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

The measuring circuit has a total resistance of 1750 Ω ± 250 Ω and is shunted by a capacitor such that the time constant of the circuit is 225 ps ± 15 µs and has an accuracy within 5% for all frequencies in the range of 20 Hz to 5 000 Hz.

The most sensitive range of the complete instrument must not exceed 1 ,0 mA, higher ranges being obtained by shunting the coil of the meter by non-inductive resistors R_s and simultaneously adjusting the series resistors *RV so as* to maintain the total resistance $R_1 + RV + R_m$ of *the* circuit *et the* value specified.

The basic calibration points. ata sinusoidal frequency of 50 Hz or 60 Hz, are 0.25 mA, 0.5 mA and 0.75 mA.

NOTE 1 The circuit may be protected against overcurrents, but the method chosen must not affect the characteristics of the circuit.

NOTE 2 The resistance R_m is calculated from the voltage dmp measured across the rectifier arrangement at 0.5 mA, the resistance RV being then adjusted so as to give the total resistance of the circuit for each range.

NOTE 3 The measuring arrangement has an accuracy within 5% for all frequencies in the range of 20 Hz to 5 000 Hz.

NOTE 4 Where leakage currents exceeding 5 mA are measured in a circuit having a total resistance less than 1 wo Ω lhe readings are reduced by 5%.

Germanium diodes are used, because these have a lower voltage dmp than other types of diode. thus resulting in a more linear scale; preference is given to gold bonded types. The rating of the diodes must be chosen so as to suit the desired maximum range of the complete instrument; however. this range must not exceed 25 mA, because diodes suitable for higher currents have a high voltage dmp.

It is recommended that the switch be so ananged that it automatically retums to the position giving the highest current range. in order to prevent inadvertent darnage to the instruments.

The capacitor may be made up by selecting capacitors having preferred values and using a series/parallel anangement

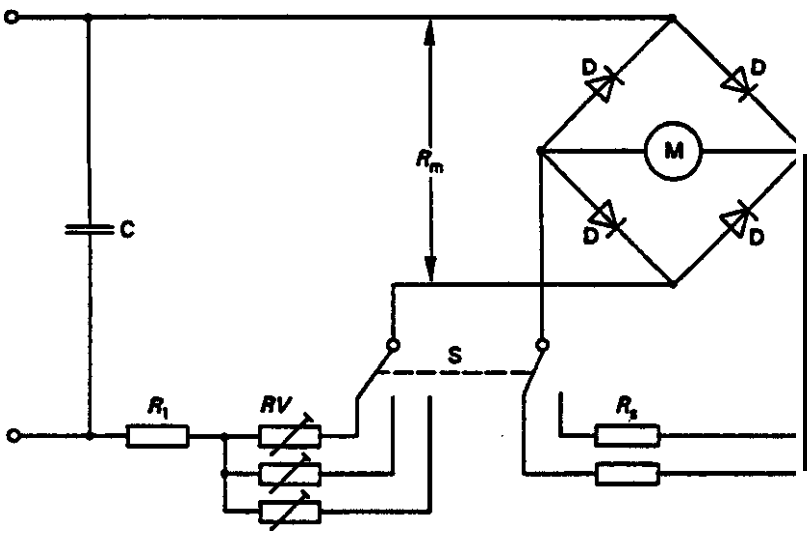


Figure IA.1 — Circuit for measurlng **leakage currents**

Annex ZA (informative)

Rules for routine tests

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

NOTE 1 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 he samples that withstood the tests of this specification. The experience gained by the manufacturer will help to determine the extent of the tests required.

NOTE 2 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.

NOTE 3 For tools covered by a Part 2. additional tests may be necessary.

ZA.1 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 mtation of motors.

ZA.2 Electric strength test

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

A voltage of substantially sine-wave form, having a frequency of 50 Hz and the value shown in Table ZA.1 is immediately applied, for 3 s, between live parts end:

a) accessible metal parts which may become live in the event of an insulation fault or as a result of incorrect assembly;

b) inaccessible metal parts.

Table ZA.1

Application of test voltage	*Test voltage V*		
	Class III tools	*Class II tools*	*Class I tools*
Over basic insulation	*400*	*1000*	*1000*
Over double insulation or reinforced insulation		*2500*	

No flashover or breakdown shall occur during the test.

NOTE 1 The tests of item a) are made on the assembled tool: ths test of item b) is made on the tool, either completely or partially assembled, in thc production line.

NOTE 2 The tests of item a) are made on all tools, the tests of item b) being only made on class II tools.

NOTE 3 The high-voltage transformer used for the tests shall be so designed that when the output; terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

NOTE 4 The overcurrent relay shall trip when the output current exceeds 5 mA.
Care shall be taken that the r.m.s. value of the test voltage is measured and measuring device or other indicator responds to the output voltage of the transformer.
Attention is drawn to the fact that the test described cannot always be used if the tool incorporates d.c. components: in such cases, tests with d.c. may be necessary.
The inherent resistance of the d.c. source shall allow short-circuit current of at least 200 mA.

ZA.3 Earthing continuity test

For class I toois, 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 extemal 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 thii voltage drop.

In no case shall she resistance exceed 0.3 Ω.

This value is applicable to supply cable lengths up to 5 m.

In case of supply cables having lengths exceading 5 m, it is increased by 0.12 Ω for any further cable length of 5 m.

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

Annex ZB (normative)

Special national conditions

Special national condition: National charactertstlc or practice **that cannot** be **changed** even **over** a **long period,** e.g. **climatic** condiions, electric earthing conditttons. **If** it **affects harmonization,** it **forms part** of **the European** Standard or **Harmonization Document.**

For the countries in **which** the relevant apecial national condiions apply these provisions are normative, **for other** countries the are informative.

Clause	Special national condiion
7.13	In **Denmark supply cords** of class **I** transportable tools. whiih are supplied **without** a **plug, shall** be provided with a visible tag containing **the** following **text:**

Vigtigt!

Lederen med **grønn/gul** isolation
må kun tilsluttes en klemme **mærket**

(Important!
The conductor having green/yellow insulation
shall only be connected to a terminal marked **)**

If it is essential for the **safety** of the **tool,** the tag **shall** be pmvided **either** with a wiring **diagram** showing the connectton of the other **conductors** or **with** the **following text:**

For tilslutning af de **øvrige** ledere,
se **medfølgende** installationsvejledning.

(For the connection of the other conductors,
see the enclosed instructions for installation.)

12.5	In **Denmark** socket-outlets for providing power tc other equipment **shall** be in **accordance** with the Danish Heavy Current **Regulations, Section 107-2-D1, standard** sheet DK **1-3a.**
23.3	In Denrnark, for **single-phase class I** tools the plug according **to** IEC 80083 **shall** be **replaced** by a plug **according** to the Danish Heavy Current **Regulations, Section 107-2-D1,** standard sheet DK **2-1a.**
	For **poly-phase** tools with a supply wrd provided with a plug thii plug **shall** wmply with the Danish Heavy Current **Regulations, Section 107-2-D1** or EN **60309-2.**