British Standard

BRITISH STANDARD

BS EN 60065:1998
BS 415:1998

Incorporating Corrigenda Nos. 1 and 2

Audio, video and similar electronic apparatus — Safety requirements

The European Standard EN 60065:1998 has the status of a British Standard

ICS 33.160.01; 97.030

National foreword

This British Standard is the English language version of EN 60065:1998 including Corrigendum June 1999. It was derived by CENELEC from IEC 60065:1998. It supersedes BS EN 60065/BS 415:1994 which will be withdrawn on 2002-08-01.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a sideline in the margin.

The UK participation in its preparation was entrusted to Technical Committee EPL/92, Safety of audio, video and similar electronic equipment, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Cross-references

Attention is drawn to the fact that CEN and CENELEC standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 103 and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments
10393 Corrigendum	December 1998	Corrections to **1.1.1** and **3.1**.
10784 Corrigendum	December 2000	Change to date of withdrawal of conflicting national standards, in EN foreword.

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 November 1998

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60065

August 1998

ICS 97.020

Supersedes EN 60065:1993 + A11:1997
Includes Corrigendum June 1999

Descriptors: Radiocommunication, broadcasting, transmitter, circuit interconnection, interconnection cable, interface, splash-proof electronic equipment

English version

Audio, video and similar electronic apparatus Safety requirements

(IEC 60065:1998, modified)

Appareils audio, vidéo et appareils électroniques analogues
Exigences de sécurité
(CEI 60065:1998, modifiée)

Audio-, Video- und ähnliche elektronische Geräte
Sicherheitsanforderungen
(IEC 60065:1998, modifiziert)

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

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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

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Foreword

The text of document 92/60/FDIS, future edition 6 of IEC 60065, prepared by IEC TC 92, Safety of audio, video and similar electronic equipment, together with the common modifications prepared by the Technical Committee CENELEC TC 92, was submitted to the CENELEC formal vote and was approved by CENELEC as EN 60065 on 1998-08-01.

This European Standard supersedes EN 60065:1993 + corrigenda November 1993 and September 1997 + A11:1997.

The following dates were fixed:

— latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-08-01

— latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-08-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, Annex ZA and Annex ZB are normative and Annex ZC is informative.

Annex ZA, Annex ZB and Annex ZC have been added by CENELEC.

Contents

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Introduction — Principles of safety

General

This introduction is intended to provide an appreciation of the principles on which the requirements of this standard are based. Such an understanding is essential in order that safe apparatus can be designed and manufactured.

The requirements of this standard are intended to provide protection to persons as well as to the surroundings of the apparatus.

Attention is drawn to the principle that the requirements, which are standardized, are the minimum considered necessary to establish a satisfactory level of safety.

Further development in techniques and technologies may entail the need for future modification of this standard.

NOTE The expression "protection to the surroundings of the apparatus" implies that this protection should also include protection of the natural environment in which the apparatus is intended to be used, taking into account the life cycle of the apparatus, i.e. manufacturing, use, maintenance, disposal and possible end-of-life recycling of parts of the apparatus.

Hazards

The application of this standard is intended to prevent injury or damage due to the following hazards:

— electric shock;

— excessive temperatures;

— radiation;

— implosion;

— mechanical hazards;

— fire.

Electric shock

Electric shock is due to current passing through the human body. Currents of the order of a milliampere can cause a reaction in persons in good health and may cause secondary risks due to involuntary reaction. Higher currents can have more damaging effects. Voltages below certain limits are generally regarded as not dangerous under specified conditions. In order to provide protection against the possibility of higher voltages appearing on parts which may be touched or handled, such parts are either earthed or adequately insulated.

For parts which can be touched, two levels of protection are normally provided to prevent electric shock caused by a fault. Thus a single fault and any consequential faults will not create a hazard. The provision of additional protective measures, such as supplementary insulation or protective earthing, is not considered a substitute for, or a relief from, properly designed basic insulation.

Cause	**Prevention**
Contacts with parts normally at hazardous voltage.	Prevent access to parts at hazardous voltage by fixed or locked covers, interlocks, etc. Discharge capacitors at hazardous voltages.
Breakdown of insulation between parts normally at hazardous voltage and accessible parts	Either use double or reinforced insulation between parts normally at hazardous voltages and accessible parts so that breakdown is not likely to occur, or connect accessible conductive parts to protective earth so that the voltage which can develop is limited to a safe value. The insulations shall have adequate mechanical and electrical strength.
Breakdown of insulation between parts normally at hazardous voltage and circuits normally at non-hazardous voltages, thereby putting accessible parts and terminals at hazardous voltage.	Segregate hazardous and non-hazardous voltage circuits either by double or reinforced insulation so that breakdown is not likely to occur, or by a protective earthed screen, or connect the circuit normally at non-hazardous voltage to protective earth, so that the voltage which can develop is limited to a safe value.

Touch current from parts at hazardous voltage through the human body. (Touch current can include current due to RFI filter components connected between mains supply circuits and accessible parts or terminals.)	Limit touch current to a safe value or provide protective earth connection to the accessible parts.

Excessive temperatures

Requirements are included to prevent injury due to excessive temperatures of accessible parts, to prevent damaging of insulation due to excessive internal temperatures, and to prevent mechanical instability due to excessive temperatures developed inside the apparatus.

Radiation

Requirements are included to prevent injury due to excessive energy levels of ionizing and laser radiation, for example by limiting the radiation to non-hazardous values.

Implosion

Requirements are included to prevent injury due to implosion of picture tubes.

Mechanical hazards

Requirements are included to ensure that the apparatus and its parts have adequate mechanical strength and stability, to avoid the presence of sharp edges and to provide guarding or interlocking of dangerous moving parts.

Fire

A fire can result from:

— overloads;

— component failure;

— insulation breakdown;

— bad connections;

— arcing.

Requirements are included to prevent any fire which originates within the apparatus from spreading beyond the immediate vicinity of the source of the fire or from causing damage to the surroundings of the apparatus.

The following preventive measures are recommended:

— the use of suitable components and subassemblies;

— the avoidance of excessive temperatures which might cause ignition under normal or fault conditions;

— the use of measures to eliminate potential ignition sources such as inadequate contacts, bad connections, interruptions;

— the limitation of the quantity of combustible material used;

— the control of the position of combustible materials in relation to potential ignition sources;

— the use of materials with high resistance to fire in the vicinity of potential ignition sources;

— the use of encapsulation or barriers to limit the spread of fire within the apparatus;

— the use of suitable fire retardant materials for the enclosure.

1. General

1.1 Scope

1.1.1 This International Standard applies to electronic apparatus designed to be fed from the MAINS or from a SUPPLY APPARATUS and intended for reception, generation, recording or reproduction respectively of audio, video and associated signals. It also applies to apparatus designed to be used exclusively in combination with the above mentioned apparatus. This standard concerns only safety aspects of the above apparatus; it does not concern other matters, such as style or performance.

For above-mentioned apparatus, which are fed from a supply source other than the MAINS or from a SUPPLY APPARATUS, and which contain a LASER SYSTEM or produce an internal OPERATING VOLTAGE greater than 4 000 V (peak), this standard applies as far as applicable.

NOTE 1 This standard can be used as a guide for the testing of battery operated apparatus.

This standard applies to the above-mentioned apparatus, if it is designed to be connected to the TELECOMMUNICATION NETWORK or similar network, for example by means of an integrated modem.

Some examples of apparatus within the scope of this standard are:

— receiving apparatus and amplifiers for sound and/or vision;

— independent LOAD TRANSDUCERS and SOURCE TRANSDUCERS;

— SUPPLY APPARATUS intended to supply other apparatus covered by the scope of this standard;

— ELECTRONIC MUSICAL INSTRUMENTS, and electronic accessories such as rhythm generators, tone generators, music tuners and the like for use with electronic or non-electronic musical instruments;

— audio and/or video educational apparatus;

— video projectors;

— video cameras and video monitors,

— video games and flipper games;

NOTE 2 Video and flipper games for commercial use are covered by IEC 60335-2-82 [7][1)]

— juke boxes;

— electronic gaming and scoring machines;

NOTE 3 Electronic gaming and scoring machines for commercial use are covered by IEC 60335-2-82 [7]

— teletext equipment;

— record and optical disc players;

— tape and optical disc recorders;

— antenna signal converters and amplifiers;

— antenna positioners;

— Citizen's Band apparatus;

— apparatus for IMAGERY;

— light effect apparatus;

— intercommunication apparatus, using low voltage MAINS as the transmission medium.

1.1.2 This standard applies to apparatus with a RATED SUPPLY VOLTAGE not exceeding:

— 250 V a.c. single phase or d.c. supply;

— 433 V a.c. in the case of apparatus for connection to a supply other than single phase.

1.1.3 This standard applies to apparatus for use at altitudes not exceeding 2 000 m above sea level, primarily in dry locations and in regions with moderate or tropical climates.

For apparatus with protection against splashing water, additional requirements are given in Annex A.

For apparatus to be connected to TELECOMMUNICATION NETWORKS, additional requirements are given in Annex B.

For apparatus intended to be used in vehicles, ships or aircraft, or at altitudes exceeding 2 000 m above sea level, additional requirements may be necessary.

Requirements, additional to those specified in this standard, may be necessary for apparatus intended for special conditions of use.

1.1.4 For apparatus designed to be fed from the MAINS, this standard applies to apparatus intended to be connected to a MAINS supply with transient overvoltages not exceeding overvoltage category II according to IEC 60664-1.

For apparatus subject to transient overvoltages exceeding those for overvoltage category II, additional protection may be necessary in the MAINS supply of the apparatus.

1.1.5 This standard does not apply to the following apparatus, except where this standard is referenced in the relevant standard:

— apparatus falling within the scope of IEC 60950;

— dictation apparatus;

[1)] Figures in square brackets refer to the bibliography given in Annex P.

— projectors not mentioned in **1.1.1**, for example film projectors, slide projectors, overhead projectors, epidiascopes. (See IEC 60335-2-56 [6].)

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60027 (all parts), *Letter symbols to be used in electrical technology.*

IEC 60038:1983, *IEC standard voltages.*

IEC 60068-2-3:1969, *Environmental testing — Part 2: Tests — Test Ca: Damp heat, steady state.*

IEC 60068-2-6:1995, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal).*

IEC 60068-2-32:1975, *Environmental testing — Part 2: Tests — Test Ed: Free fall (Procedure 1).*

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

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

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

IEC 60127 (all parts), *Miniature fuses.*

IEC 60167:1964, *Methods of test for the determination of the insulation resistance of solid insulating materials.*

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

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

IEC 60249-2 (all specifications), *Base materials for printed circuits — Part 2: Specifications.*

IEC 60268-1:1985, *Sound system equipment — Part 1: General.*

IEC 60317 (all parts), *Specifications for particular types of winding wires.*

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

IEC 60335-1:1991, *Safety of household and similar electrical appliances — Part 1: General requirements.*

IEC 60384-1:1982, *Fixed capacitors for use in electronic equipment — Part 1: Generic specification.*

IEC 60384-14:1993, *Fixed capacitors for use in electronic equipment — Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains.*
Amendment 1 (1995)

IEC 60417 (all parts), *Graphical symbols for use on equipment. Index, survey and compilation of single sheets.*

IEC 60454 (all parts), *Specifications for pressure-sensitive adhesive tapes for electrical purposes.*

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

IEC 60536:1976, *Classification of electrical and electronic equipment with regard to protection against electric shock.*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests.*

IEC 60664-3:1992, *Insulation coordination for equipment within low-voltage systems — Part 3: Use of coatings to achieve insulation coordination of printed board assemblies.*

IEC 60691:1993, *Thermal links — Requirements and application guide.*

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

IEC 60707:1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.*

IEC 60730 (all parts), *Automatic electrical controls for household and similar use.*

IEC 60738 (all parts), *Directly heated positive step-function temperature coefficient thermistors.*

IEC 60825-1:1993, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide.*

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

IEC 60885-1:1987, *Electrical test methods for electric cables — Part 1: Electrical tests for cables, cords and wires for voltages up to and including 450/750 V.*

IEC 60906 (all parts), *IEC system of plugs and socket-outlets for household and similar purposes.*

IEC 60950:1991, *Safety of information technology equipment.*

IEC 60990:1990, *Methods of measurement of touch-current and protective conductor current.*

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

IEC 60999:1990, *Connecting devices — Safety requirements for screw-type and screwless-type clamping units for electrical copper conductors.*

IEC 61032:1990, *Test probes to verify protection by enclosures.*

IEC 61058-1:1996, *Switches for appliances — Part 1: General requirements.*

IEC 61149:1995, *Guide for safe handling and operation of mobile radio equipment.*

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters.*

IEC 61293:1994, *Marking of electrical equipment with ratings related to electrical supply — Safety requirements.*

ISO 261:1973, *ISO general purpose metric screw threads — General plan.*

ISO 262:1973, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts.*

ISO 306:1994, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST).*

ISO 7000:1989, *Graphical symbols for use on equipment — Index and synopsis.*

2 Definitions

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

2.1 Definitions in alphabetical order

2.2 Types of apparatus

2.2.1
AUDIO AMPLIFIER

either an independent audio signal amplifying apparatus or the audio signal amplifying part of an apparatus to which this standard applies

2.2.2
ELECTRONIC MUSICAL INSTRUMENT

electronic apparatus such as an electronic organ, electronic piano or music synthesizer that produces music under the control of the player

2.2.3
SUPPLY APPARATUS

apparatus which takes power from the MAINS and from which one or more other apparatus are fed

2.2.4
SUPPLY APPARATUS FOR GENERAL USE

SUPPLY APPARATUS which can be used without special measures not only for the supply of apparatus within the scope of this standard, but also for the supply of other appliances or devices, for example pocket-calculators

2.2.5
SPECIAL SUPPLY APPARATUS

SUPPLY APPARATUS which is designed to be used only for the supply of specified apparatus within the scope of this standard

2.2.6
LASER SYSTEM

LASER in combination with an appropriate laser energy source with or without additional incorporated components (see **3.44** of IEC 60825-1)

2.2.7
LASER

device which can be made to produce or amplify electromagnetic radiation in the wavelength range from 180 nm to 1 mm primarily by the process of controlled stimulated emission (see **3.36** of IEC 60825-1)

2.2.8
IMAGERY

processing, editing, manipulation and/or storing of video signals

2.2.9
REMOTE CONTROL

controlling of an apparatus from a distance, for example mechanically, electrically, acoustically or by means of radiation

2.2.10
PORTABLE APPARATUS

specific apparatus designed to be carried easily BY HAND, the mass of which does not exceed 18 kg

2.2.11
TRANSPORTABLE APPARATUS

apparatus specifically designed to be moved frequently from place to place

2.3 Ratings and electrical values

2.3.1
RATED SUPPLY VOLTAGE

supply voltage or voltage range (for three-phase supply, the line-to-line voltage) for which the manufacturer has designed the apparatus

2.3.2
OPERATING VOLTAGE

highest voltage, non-repetitive transients being disregarded, to which the insulation under consideration is, or can be subjected when the apparatus is operating at its RATED SUPPLY VOLTAGE under normal operating conditions

2.3.3
RIPPLE FREE

d.c. voltage with a r.m.s. value of a ripple content of not more than 10 % of the d.c. component. The maximum peak voltage does not exceed 140 V for a nominal 120 V ripple free d.c. system, and does not exceed 70 V for a nominal 60 V ripple free d.c. system

2.3.4
NON-CLIPPED OUTPUT POWER

sine-wave power dissipated in the RATED LOAD IMPEDANCE, measured at 1 000 Hz at the onset of clipping on either one, or both peaks

in cases where an amplifier is not intended for operation at 1 000 Hz, a test frequency at the peak response shall be used

2.3.5
RATED LOAD IMPEDANCE

resistance, specified by the manufacturer, by which an output circuit should be terminated

2.3.6
RATED CURRENT CONSUMPTION

current consumption of an apparatus operating at its RATED SUPPLY VOLTAGE under normal operating conditions

2.3.7
AVAILABLE POWER

maximum power which can be drawn from the supplying circuit through a resistive load whose value is chosen to maximise the power for more than 2 min when the circuit supplied is disconnected (see Figure 1)

2.4 Supply and external connections

2.4.1
MAINS

power source with a nominal voltage of more than 35 V (peak) a.c or d.c. which is not used solely to supply apparatus specified in **1.1.1**

2.4.2
PERMANENTLY CONNECTED APPARATUS

apparatus which is intended for connection to the MAINS by a connection which cannot be loosened BY HAND

2.4.3
DIRECTLY CONNECTED TO THE MAINS

electrical connection with the MAINS in such a way that a connection to either pole of the MAINS causes in that connection a permanent current equal to or greater than 9 A, protective devices in the apparatus being not short-circuited

NOTE A current of 9 A is chosen as the minimum breaking current of a 6 A fuse.

2.4.4
CONDUCTIVELY CONNECTED TO THE MAINS

electrical connection with the MAINS in such a way that a connection through a resistance of 2 000 Ω to either pole of the MAINS causes in that resistance a permanent current greater than 0,7 mA (peak), the apparatus not being connected to earth

2.4.5
TERMINAL

part of an apparatus by which connection is made to external conductors or other apparatus. It may contain several contacts

2.4.6
PROTECTIVE EARTH TERMINAL

TERMINAL to which parts are connected which must be connected to earth for safety reasons

2.4.7
TELECOMMUNICATION NETWORK

metallically-terminated circuit intended to carry TELECOMMUNICATION SIGNALS for voice, data or other communication. Such networks may be publicly or privately owned. They may be subjected to overvoltages due to atmospheric discharges and power line failures

NOTE It is assumed that adequate measures according to ITU-T Recommendation **K.11** have been taken to reduce the risk that over-voltages presented to apparatus exceed 1,5 kV (peak).

excluded are:

— MAINS systems for supply, transmission and distribution of electrical power, used as telecommunication transmission medium;

— TV distribution systems using cable;

— public or private mobile radio systems;

— radio paging systems.

2.5 Signals, sources, loads

2.5.1
PINK NOISE

NOISE SIGNAL whose energy per unit bandwidth ($\frac{\Delta W}{\Delta f}$) is inversely proportional to frequency

2.5.2
NOISE SIGNAL

stationary random signal having normal probability distribution of instantaneous values. Unless otherwise stated, the mean value is zero

2.5.3
SOURCE TRANSDUCER

apparatus intended to convert the energy of a non electrical signal to electrical energy

NOTE Examples are microphone, image sensor, magnetic reproducing head, laser pick-up.

2.5.4
LOAD TRANSDUCER

apparatus intended to convert the energy of an electrical signal into another form of energy

NOTE Examples are loudspeaker, picture tube, liquid crystal display, magnetic recording head.

2.6 Protection against electric shock, insulations

2.6.1
CLASS I

design in which protection against electric shock does not rely on BASIC INSULATION only, but which includes an additional safety precaution in such a way that means are provided for the connection 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 HAZARDOUS LIVE in the event of a failure of the BASIC INSULATION (see **3.2** of IEC 60536)

NOTE Such a design may have parts of CLASS II.

2.6.2
CLASS II

design in which protection against electric shock does not rely on BASIC INSULATION only, but in which additional safety precautions, such as DOUBLE INSULATION or REINFORCED INSULATION, are provided, there being no provision for protective earthing or reliance upon installation conditions (see **3.3** of IEC 60536)

2.6.3
BASIC INSULATION

insulation applied to HAZARDOUS LIVE parts to provide basic protection against electric shock

NOTE BASIC INSULATION does not necessarily include insulation used exclusively for functional purposes.

2.6.4
DOUBLE INSULATION

insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION (see **2.3** of IEC 60536)

2.6.5
SUPPLEMENTARY INSULATION

independent insulation applied in addition to BASIC INSULATION in order to provide protection against electric shock in the event of a failure of the BASIC INSULATION (see **2.2** of IEC 60536)

2.6.6
REINFORCED INSULATION

single insulation applied to HAZARDOUS LIVE parts which provides a degree of protection against electric shock equivalent to DOUBLE INSULATION

NOTE REINFORCED INSULATION may comprise several layers which cannot be tested singly as BASIC INSULATION or SUPPLEMENTARY INSULATION.

2.6.7
PROTECTIVE SEPARATION

separation between circuits by means of basic and supplementary protection (BASIC INSULATION plus SUPPLEMENTARY INSULATION or plus PROTECTIVE SCREENING) or by an equivalent protective provision, for example REINFORCED INSULATION (see **2.9** of IEC 60536-2)

2.6.8
PROTECTIVE SCREENING

separation from HAZARDOUS LIVE parts by means of an interposed conductive screen, connected to the PROTECTIVE EARTH TERMINAL

2.6.9
TOUCH CURRENT

current which passes through the human body when it touches one or more ACCESSIBLE parts of an apparatus under normal operating or fault conditions

2.6.10
HAZARDOUS LIVE

electrical condition of an object from which a hazardous TOUCH CURRENT (electric shock) could be drawn (see **9.1.1**)

2.6.11
CLEARANCE

shortest distance in air between two conductive parts

2.6.12
CREEPAGE DISTANCE

shortest distance along the surface of an insulating material between two conductive parts

2.7 Components

2.7.1
ISOLATING TRANSFORMER

transformer with PROTECTIVE SEPARATION between the input and output windings

2.7.2
SEPARATING TRANSFORMER

transformer, the input windings of which are separated from the output windings by at least BASIC INSULATION

NOTE Such transformers may have parts meeting the requirements of ISOLATING TRANSFORMERS.

2.7.3
THERMAL RELEASE

device which prevents the maintenance of excessively high temperatures in certain parts of the apparatus by disconnecting these parts from their supply

NOTE PTC-S THERMISTORS (see **2.7.8**) are not THERMAL RELEASES in the sense of this definition.

2.7.4
THERMAL CUT-OUT

THERMAL RELEASE with reset which has no provision for temperature setting by the USER

NOTE A THERMAL CUT-OUT may be of the automatic or of the manual reset type.

2.7.5
THERMAL LINK

THERMAL RELEASE without reset, which operates only once and then requires partial or complete replacement

2.7.6
TRIP-FREE

automatic action, with a reset actuating member, so designed that the automatic action is independent of manipulation or position of the reset mechanism

2.7.7
MICRO-DISCONNECTION

adequate contact separation so as to ensure functional security

NOTE There is a requirement for the dielectric strength of the contact gap but no dimensional requirement.

2.7.8
PTC-S THERMISTOR

thermally sensitive semiconductor resistor, which shows a step-like increase in its resistance when the increasing temperature reaches a specific value. The change of temperature is obtained either by the flow of current through the thermosensitive element, or by a change in the ambient temperature, or by a combination of both

2.7.9
SAFETY INTERLOCK

means either of preventing access to a hazardous area until the hazard is removed or of automatically removing the hazardous condition when access is gained

2.7.10
MANUALLY OPERATED MECHANICAL SWITCH

device operated BY HAND, not incorporating semiconductors, and situated anywhere in the circuit of the apparatus, which can interrupt the intended function, such as sound and/or vision, by moving contacts

NOTE Examples of MANUALLY OPERATED MECHANICAL SWITCHES are single-pole or ALL-POLE MAINS SWITCHES, functional switches and switching systems which for example can be a combination of relays and switches controlling the relays.

2.7.11
ALL-POLE MAINS SWITCH

MANUALLY OPERATED MECHANICAL SWITCH which interrupts all poles of the MAINS supply except the protective earth conductor

2.7.12
PRINTED BOARD

base material cut to size, containing all needed holes and bearing at least one CONDUCTIVE PATTERN

2.7.13
CONDUCTIVE PATTERN

configuration formed by electrically conductive material of a PRINTED BOARD

2.8 Miscellaneous

2.8.1
TYPE TEST

test of one or more specimens made on a certain design to show that the design meets all requirements of this standard

2.8.2
ROUTINE TEST

test to which each specimen is subjected during or after manufacture to ascertain whether it complies with certain criteria

2.8.3
ACCESSIBLE

possibility of touching by the test finger according to IEC 61032, test probe B

NOTE Any ACCESSIBLE area of a non-conductive part is considered as being covered with a conductive layer (see Figure 3 as an example).

2.8.4
BY HAND

operation that does not require the use of any object such as a tool, coin, etc.

2.8.5
SKILLED PERSON

person with relevant education and experience to enable him or her to avoid dangers and to prevent risks which electricity may create

2.8.6
INSTRUCTED PERSON

person adequately advised or supervised by SKILLED PERSONS to enable him or her to avoid dangers and to prevent risks which electricity may create

2.8.7
USER

any person, other than a SKILLED PERSON or an INSTRUCTED PERSON, who may come into contact with the apparatus

2.8.8
STAND-BY

operating condition where the main functions, such as sound and/or vision, are switched-off and where the apparatus is only partly in operation. In this condition, permanent functions, such as a clock, are maintained and it allows the apparatus to be brought into full operation, for example by REMOTE CONTROL or automatically

2.8.9
WOOD-BASED MATERIAL

material in which the main ingredient is machined natural wood, coupled with a binder

NOTE Examples of WOOD-BASED MATERIAL are materials incorporating ground or chipped wood, such as hard fibre board or chip board.

2.8.10
FIRE ENCLOSURE

part of the apparatus intended to minimize the spread of fire or flames from within

2.8.11
POTENTIAL IGNITION SOURCE

possible fault such as a faulty contact or interruption in an electrical connection, including a CONDUCTIVE PATTERN on PRINTED BOARDS, which can start a fire if, under normal operating conditions, the open circuit voltage exceeds 50 V (peak) a.c. or d.c. and the product of this open circuit voltage and the measured current through this possible fault exceeds 15 VA

3 General requirements

3.1 The apparatus shall be so designed and constructed as to present no danger when used for its intended purpose, either in normal operating conditions or under fault conditions, particularly providing protection against:

— hazardous currents passing through the human body (electric shock);

— excessive temperatures;

— hazardous radiations;

— effects of implosion and explosion;

— mechanical instability;

— injury by mechanical parts;

— start and spread of fire;

— exposure to excessive sound pressures from headphones or earphones.

In general, compliance is checked under normal operating conditions and under fault conditions, as specified in **4.2** and **4.3**, by carrying out all the relevant tests specified.

NOTE A new method is under consideration by CENELEC/TC 206.

3.2 Apparatus designed to be fed from the MAINS shall be constructed according to the requirements of CLASS I, or CLASS II apparatus.

4 General test conditions

4.1 Conduct of tests

4.1.1 *Tests according to this standard are TYPE TESTS.*

NOTE For ROUTINE TEST, recommendations are given in Annex N.

4.1.2 *The sample or samples under test shall be representative of the apparatus the USER would receive, or shall be the actual equipment ready for shipment to the USER.*

As an alternative to carrying out tests on the complete apparatus, tests may be carried out separately on circuits, components or subassemblies outside the apparatus, provided that inspection of the apparatus and circuit arrangements ensures that such testing will indicate that the assembled apparatus would conform to the requirements of this standard.

If any such test indicates a likelihood of non-compliance in the complete apparatus, the test shall be repeated in the apparatus.

If a test specified in this standard could be destructive, it is permitted to use a physical model to represent the condition to be evaluated.

NOTE 1 The tests should be carried out in the following order:

— component or material pre-selection;

— component or subassembly bench tests;

— tests where the apparatus is not energized;

— live tests

- under normal operating conditions,
- under abnormal operating conditions,
- involving likely destruction.

NOTE 2 In view of the amount of resources involved in testing and in order to minimize waste, it is recommended that all parties concerned jointly consider the test programme, the test samples and the test sequence.

4.1.3 *Unless otherwise specified, the tests are carried out under normal operating conditions at:*

— *an ambient temperature between 15 °C and 35 °C, and*

— a relative humidity of 75 % maximum.

4.1.4 *Any position of intended use of the apparatus, normal ventilation not being impeded.*

The temperature measurements shall be carried out with the apparatus positioned in accordance with the instructions for use provided by the manufacturer, or, in the absence of instructions, the apparatus shall be positioned 5 cm behind the front edge of an open-fronted wooden test box with 1 cm free space along the sides and top and 5 cm depth behind the apparatus.

Tests on apparatus, intended to be part of an assembly not provided by the apparatus manufacturer, shall be carried out according to the instructions for use provided by the manufacturer, specifically those dealing with the proper ventilation of the apparatus.

4.1.5 *The characteristics of the supply source, except those specified in **4.2.1**, used during the tests shall not appreciably influence the test results.*

Examples of such characteristics are source impedance and waveform.

4.1.6 *Where relevant, a standard signal consisting of PINK NOISE, band-limited by a filter whose response conforms to that given in Figure C.1 in Annex C.*

NOTE If appropriate, the standard signal may be used to modulate a carrier wave.

The output measuring equipment shall indicate true r.m.s. values for crest factors up to at least 3, and the frequency response shall conform to that shown in Annex C.

4.1.7 *The a.c. values given in this standard are r.m.s. values, unless specified otherwise.*

The d.c. values given in this standard are RIPPLE FREE values.

4.2 Normal operating conditions

Normal operating conditions are the most unfavourable combination of the following conditions.

4.2.1 *The apparatus is connected to a supply voltage of 0,9 times or 1,06 times of any RATED SUPPLY VOLTAGE for which the apparatus is designed.*

In case of doubt, tests may also be performed at the value of any RATED SUPPLY VOLTAGE.

For apparatus having a RATED SUPPLY VOLTAGE range not requiring the adjustment of a voltage setting device, the apparatus is connected to a supply voltage of 0,9 times the lower limit or 1,06 times the upper limit of any RATED SUPPLY VOLTAGE range; moreover, the apparatus is connected to any nominal supply voltage within the RATED SUPPLY VOLTAGE range marked on the apparatus.

Any rated supply frequency marked on the apparatus is used.

For a.c./d.c. apparatus, an a.c. or d.c. supply is used.

For d.c. supply any polarity is used, unless this is prevented by the construction of the apparatus.

4.2.2 *Any position of controls which are ACCESSIBLE to the USER for adjustment BY HAND, including REMOTE CONTROLS, excluding voltage setting devices complying with **14.8** and volume controls and tone controls.*

Any cable connected REMOTE CONTROL device, detachable by a connector or a similar device, is connected or not.

A cover, enclosing a LASER SYSTEM, which can be opened BY HAND, is opened fully, opened partly or closed.

4.2.3 *In the case of single-phase supply any earth TERMINAL and any PROTECTIVE EARTH TERMINAL may be connected to either pole of the isolated supply source used during the test.*

In the case of a supply other than single phase any earth TERMINAL and any PROTECTIVE EARTH TERMINAL may be connected to the neutral or to any phase of the isolated supply source used during the test.

4.2.4 *In addition, for an AUDIO AMPLIFIER:*

*a) The apparatus is operated in such a way as to deliver one-eighth of the NON-CLIPPED OUTPUT POWER to the RATED LOAD IMPEDANCE using the standard signal described in **4.1.6** with the tone controls set to their mid position.*

Where the NON-CLIPPED OUTPUT POWER cannot be obtained using the standard signal, one-eighth of the maximum attainable output power is taken.

*When determining whether a part or TERMINAL contact is HAZARDOUS LIVE according to **9.1.1** and **11.1**, at the manufacturer's option the apparatus may also be operated in such a way as to deliver the NON-CLIPPED OUTPUT POWER to the RATED LOAD IMPEDANCE using a sinusoidal signal of 1 000 Hz or another frequency corresponding to the mid-frequency of the relevant amplifier part of the apparatus.*

b) The most unfavourable RATED LOAD IMPEDANCE of any output circuit is connected or not.

c) Organs or similar instruments which have a tone-generator unit are operated with any combination of two bass pedal keys, if any, and ten manual keys depressed, and all stops and tabs which can increase the output power are activated.

*For AUDIO AMPLIFIERS used in an ELECTRONIC MUSICAL INSTRUMENT which does not generate a continuous tone, the standard signal described in **4.1.6** is applied to the signal input TERMINAL or to the appropriate input stage of the AUDIO AMPLIFIER.*

4.2.5 *For apparatus incorporating motors, load conditions for the motor are chosen which may occur during intended use, including stalling BY HAND if this is possible.*

4.2.6 *An apparatus supplying power to other apparatus is loaded to give its rated power or not loaded.*

4.2.7 *A SUPPLY APPARATUS to be used inside apparatus for which it is intended exclusively, is tested within such apparatus after installation according to the manufacturer's instruction for use.*

4.2.8 *In addition for Citizen's Band apparatus, the RATED LOAD IMPEDANCE is connected or not to the antenna TERMINAL or, if applicable, a telescopic antenna extended to any length. The transmitting test conditions are specified in IEC 61149.*

4.2.9 ***Antenna positioners***

4.2.9.1 *In addition for antenna positioners in combination with their control and* SUPPLY APPARATUS*:*

— four consecutive movements from one endstop to the opposite endstop;

— 15 min resting period.

The movements and the resting periods are repeated as many times as necessary for the relevant tests. For temperature measurements the movements and the resting periods are repeated until a steady state of temperature has been reached but not longer than 4 h.

After the last movement period, the 15 min resting period does not apply to the temperature measurements.

4.2.9.2 *In addition, for satellite antenna positioners consisting of a power supply and control unit without a motor drive system, the power supply unit shall be loaded in accordance with the marked output rating and operated with a duty cycle of 5 min on, and 15 min off.*

4.2.10 *Apparatus designed to be supplied exclusively by a* SPECIAL SUPPLY APPARATUS *specified by the manufacturer of the apparatus, shall be tested together with this* SPECIAL SUPPLY APPARATUS*. The supply voltage for the* SPECIAL SUPPLY APPARATUS *is determined in accordance with* ***4.2.1****.*

Where a voltage setting device for the output voltage of the SPECIAL SUPPLY APPARATUS *is provided, it shall be adjusted to the* RATED SUPPLY VOLTAGE *of the apparatus under test.*

4.2.11 *Apparatus, which can be supplied by* SUPPLY APPARATUS FOR GENERAL USE*, shall be supplied by a test power supply according to Table 1 corresponding to the* RATED SUPPLY VOLTAGE *of the apparatus under test. The values of no-load voltage given in Table 1 are subject to the under- and over-voltage provisions specified in* ***4.2.1****.*

Table 1 — Test power supply

RATED SUPPLY VOLTAGE V d.c.	Nominal no-load voltage V d.c.	Internal resistance Ω
1,5	2,25	0,75
3,0	4,50	1,50
4,5	6,75	2,25
6,0	9,00	3,00
7,5	11,25	3,75
9,0	13,50	4,50
12,0	18,00	6,00

NOTE Table 1 provides a standardized set of supply parameters intended to represent those found in SUPPLY APPARATUS FOR GENERAL USE in the range 1,5 V to 12 V and with a rated output current of 1 A.
Supply parameters for voltages > 12 V and output currents > 1 A are under consideration.

4.2.12 *Apparatus intended to be used with optional detachable legs or stands supplied by the manufacturer of the apparatus are tested with or without legs or stands fitted.*

4.3 Fault conditions

For operation under fault conditions, in addition to the normal operating conditions mentioned in ***4.2****, each of the following conditions is applied in turn and, associated with it, those other fault conditions which are a logical consequence.*

NOTE 1 The logical consequences of a fault condition are those which occur when a fault is applied.

Circuits, or parts of a circuit supplied with an open circuit voltage not exceeding 35 V (peak) a.c. or d.c. and not generating voltages above that value, are not considered to present a fire hazard if the current which may be drawn from the supplying circuit for more than 2 min at any load, including short-circuit, is limited to not more than 0,2 A. Such supplied circuits are not subject to fault conditions testing.

An example of a test circuit to measure the voltage and the current is given in Figure 1.

NOTE 2 Examination of the apparatus and all its circuit diagrams, excluding the internal circuit diagrams of integrated circuits, generally shows the fault conditions which are likely to create a hazard and which need to be applied. These are applied in sequence, in the order which is most convenient.

NOTE 3 When carrying out the examination in note 2, the operating characteristics of integrated circuits are taken into consideration.

NOTE 4 The fault tests are only to be made in the wooden test box mentioned in **4.1.4**, if there is a possibility that this will influence the results.

When a specified fault condition test is carried out, it can cause consequential faults which either interrupt or short-circuit a component. In case of doubt, the fault condition test shall be repeated up to two more times with replacement components in order to check that the same result is always obtained. Should this not be the case, the most unfavourable consequential fault, whether interruption or short circuit, shall be applied together with the specified fault condition.

4.3.1 *Short-circuit across CLEARANCES and CREEPAGE DISTANCES if they are less than the values specified in clause **13** for BASIC and SUPPLEMENTARY INSULATION.*

4.3.2 *Short-circuit across parts of insulating material, the short-circuiting of which might cause an infringement of the requirements regarding protection against electric shock hazard or overheating, with the exception of insulating parts which comply with the requirements of **10.3**.*

NOTE This subclause does not imply a need to short-circuit the insulation between turns of coils.

4.3.3 *Short-circuit, or if applicable, interruption of:*

— heaters of electronic tubes;

— insulation between heaters and cathodes of electronic tubes;

— spacings in electronic tubes, excluding picture tubes;

*— semiconductor devices, one lead at a time interrupted or any two leads connected together in turn [but see **4.3.4** d)].*

NOTE If electronic tubes are so constructed that a short circuit between certain electrodes is highly improbable or even impossible, the electrodes concerned need not be short-circuited.

4.3.4 *Short-circuit or disconnection, whichever is more unfavourable, of resistors, capacitors, windings (for example transformers, degaussing coils), loudspeakers, optocouplers, varistors or non-linear passive components, the short-circuiting or disconnection of which might cause an infringement of the requirements regarding protection against electric shock or overheating.*

These fault conditions do not apply to:

*a) resistors complying with the requirements of **14.1** and, as far as applicable, of **11.2**;*

b) PTC-S THERMISTORS complying with IEC 60738;

*c) capacitors and RC-units complying with the requirements of **14.2**, provided that the voltage at their terminations does not exceed their rated voltage and that their application is in accordance with **8.5** or **8.6**;*

*d) the insulation between the input and output terminations of optocouplers complying with the requirements of **14.11**;*

*e) windings and the insulation of transformers and other windings mentioned in **14.3** complying with the requirements of that subclause.*

4.3.5 *For apparatus containing an AUDIO AMPLIFIER, using the standard signal described in **4.1.6** so as to deliver the most unfavourable output power from zero up to the maximum attainable output power to the RATED LOAD IMPEDANCE or, if applicable, to the most unfavourable load impedance connected to the output TERMINALS including short-circuit and open circuit.*

4.3.6 *Motors are stalled if this is possible during the use of the apparatus by internal or external influences.*

4.3.7 *Motors, relay coils or the like, intended for short-time or intermittent operation, are operated continuously if this can occur during operation of the apparatus.*

4.3.8 *The apparatus is connected simultaneously to alternative types of supply unless this is prevented by the construction.*

4.3.9 *Output TERMINALS of apparatus supplying power to other apparatus, except MAINS socket-outlets DIRECTLY CONNECTED TO THE MAINS, are connected to the most unfavourable load impedance, including short circuit.*

4.3.10 *Each group of ventilation openings that are likely to be covered simultaneously, shall be covered in turn and tested separately.*

Ventilating openings that are likely to be covered simultaneously are:

— openings on top of the apparatus, for example by a newspaper; or

— openings on the sides and the back, excluding the front, for example when pushed into a hanging curtain.

4.3.11 *If it is possible to insert USER replaceable batteries with reversed polarity, the apparatus is tested with one or more batteries with both intended and reversed polarity.*

NOTE CAUTION, there is a danger of explosion when this test is applied.

4.3.12 *For Citizen's Band apparatus, the most unfavourable load impedance including short circuit is connected to the antenna TERMINAL or to the antenna itself, for example a telescopic antenna, when no antenna TERMINAL is provided. The transmitting test conditions are specified in IEC 61149.*

4.3.13 *For PORTABLE APPARATUS to be supplied from an a.c. MAINS and provided with a voltage setting device to be set by the USER, connection to a supply voltage of 250 V a.c., with the MAINS voltage setting device at the most unfavourable position.*

4.3.14 *Apparatus designed to be supplied by a SPECIAL SUPPLY APPARATUS with a voltage setting device for the output voltage, specified by the manufacturer of the apparatus, shall be tested by adjusting this voltage setting device to any output voltage.*

*During this test, **4.2.1** is applied, except that the SPECIAL SUPPLY APPARATUS is fed by its RATED SUPPLY VOLTAGE.*

The test need not be made if the current consumption of the apparatus under test cannot exceed 0,2 A for more than 2 min, for example by the operation of a fuse.

4.3.15 *Apparatus which can be supplied by SUPPLY APPARATUS FOR GENERAL USE shall be tested by using a test power supply as specified in Table 1 step by step upwards, starting with the value one step above the value specified for the RATED SUPPLY VOLTAGE of the apparatus under test.*

This test is not applied to apparatus having a RATED SUPPLY VOLTAGE equal to or higher than the maximum RATED SUPPLY VOLTAGE in Table 1.

*During this test, **4.2.1** is applied, except that the no-load voltages have their nominal values.*

The test need not be made if the current consumption of the apparatus under test cannot exceed 0,2 A for more than 2 min, for example by the operation of a fuse.

5 Marking and instructions

Markings shall be permanent, comprehensible and easily discernible on the apparatus when ready for use.

The information should preferably be on the exterior of the apparatus, excluding the bottom. It is, however, permissible to have it in an area that is easily ACCESSIBLE BY HAND, for example under a lid, or on the exterior of the bottom of a PORTABLE APPARATUS or an apparatus with a mass not exceeding 7 kg, provided that the location of the marking is given in the instructions for use.

Compliance is checked by inspection and by rubbing the marking BY HAND for 15 s with a piece of cloth soaked with water and, at a different place or on a second sample, for 15 s with a piece of cloth soaked with petroleum spirit. After this the marking shall be legible; it shall not be easily possible to remove marking plates and they shall show no curling.

Petroleum spirit, to be used for reference purposes is defined as follows:

The petroleum spirit is an aliphatic solvent hexane having a maximum aromatics content of 0,1 % by volume, a kauri-butanol value of 29, an initial boiling point of approximately 65 °C, a dry-point of approximately 69 °C and a specific mass of approximately 0,7 kg/l.

Letter symbols for quantities and units shall be in accordance with IEC 60027.

Graphical symbols shall be in accordance with IEC 60417 and ISO 7000, as appropriate.

The on-position, and where relevant, the off-position of switches shall be indicated in accordance with **14.6.3**.

Compliance is checked by inspection.

5.1 Identification and supply ratings

The apparatus shall be marked with the following:

a) maker's or responsible vendor's name, trade mark or identification mark;

b) model number or type reference;

c) the symbol for CLASS II, if applicable:  (60417-2-IEC-5172)

d) NOTE Marking for apparatus designed for use in tropical climates is under consideration.

e) Nature of supply:

— a.c. only with the symbol:  (60417-2-IEC-5032)

— d.c. only with the symbol:  (60417-2-IEC-5031)

— a.c. or d.c. with the symbol:  (60417-2-IEC-5033)

— for three-phase systems, reference shall be made to IEC 61293;

f) RATED SUPPLY VOLTAGE or range of the RATED SUPPLY VOLTAGES which can be applied without operating a voltage setting device.

Apparatus which can be set to different RATED SUPPLY VOLTAGES or ranges of RATED SUPPLY VOLTAGES shall be so constructed that the indication of the voltage or range of voltages to which the apparatus is set, is discernible on the apparatus when ready for use;

A solidus shall be used for USER selectable ratings, for example “110/230 V” and a hyphen shall be used for a rating range, for example “110-230 V”;

g) Rated MAINS frequency (or range of frequencies) in hertz, if safety is dependent on the use of the correct MAINS frequency;

h) RATED CURRENT CONSUMPTION or rated power consumption of apparatus which can be supplied by SUPPLY APPARATUS FOR GENERAL USE. As an alternative the information may be given in the instruction manual.

i) Power consumption marking for apparatus intended for connection to an a.c. MAINS supply other than single phase.

NOTE Details for the measurement of the power consumption are under consideration.

Compliance is checked by inspection.

5.2 TERMINALS

TERMINALS shall be marked as follows:

a) The wiring TERMINAL intended for connection of the protective earthing conductor associated with the supply wiring:

 (60417-2-IEC-5019)

This symbol shall not be used for other earthing TERMINALS.

b) TERMINALS which are HAZARDOUS LIVE under normal operating conditions, except TERMINALS for MAINS supply:

 (60417-2-IEC-5036)

c) Output TERMINALS provided for supply of other apparatus except MAINS supply shall be marked with the nominal output voltage and, in addition, the maximum output current, if with the most unfavourable load higher temperature rises than allowed in Table 2 can occur, unless the TERMINALS are marked with the type references of the apparatus which are permitted to be connected.

Socket-outlets providing MAINS power to other apparatus shall be marked with the power or current which may be drawn.

If there is only one TERMINAL provided for supply of other apparatus, the marking may be put on the apparatus at any place, taking into account the first paragraphs of clause **5**.

Compliance is checked by inspection.

5.3 Where in a manufacturer's service documentation, for example in circuit diagrams or lists of components, a symbol is used to indicate that a specific component shall be replaced only by the component specified in that documentation for safety reasons, the following symbol shall be used:

(ISO 7000-0434)

This symbol may also be put adjacent to the relevant component.

This symbol shall not be placed on components.

Compliance is checked by inspection.

5.4 Instructions

When information with regard to safety is required according to this standard, this information shall be given in an instruction for installation or use and supplied with the apparatus. This information shall be given in a language acceptable to the country where the apparatus is intended to be used.

NOTE 1 Reference is made to ISO/IEC Guide 37 [12].

NOTE 2 The following information with regard to safety are recommended to be included as far as applicable:

— minimum distances around the apparatus for sufficient ventilation;

— the ventilation should not be impeded by covering the ventilation openings with items, such as newspapers, table-cloths, curtains, etc.;

— no naked flame sources, such as lighted candles, should be placed on the apparatus;

— attention should be drawn to the environmental aspects of battery disposal;

— the use of apparatus in tropical and/or moderate climates.

5.4.1 In addition, the instructions shall include the following as far as applicable.

a) For MAINS powered apparatus and for apparatus producing internal voltages greater than 35 V (peak) a.c. or d.c., having no protection against splashing water according to Annex A, the instructions for use shall state that the apparatus shall not be exposed to dripping or splashing and that no objects filled with liquids, such as vases, shall be placed on the apparatus.

b) A warning that TERMINALS marked with the symbol according to **5.2** b) are HAZARDOUS LIVE and that the external wiring connected to these TERMINALS requires installation by an INSTRUCTED PERSON or the use of ready-made leads or cords.

c) If an apparatus is provided with a replaceable lithium battery, the following applies:

— if the battery is intended to be replaced by the USER, there shall be a warning close to the battery or in both the instructions for use and the service instructions;

— if the battery is not intended to be replaced by the USER, there shall be a warning close to the battery or in the service instructions.

This warning shall include the following or similar text:

CAUTION
Danger of explosion if battery is incorrectly replaced.
Replace only with the same or equivalent type.

d) Information as required according to **14.6.3**.

Compliance is checked by inspection.

5.4.2 If a PERMANENTLY CONNECTED APPARATUS is not provided with an ALL-POLE MAINS SWITCH according to **14.6.1**, the instructions shall state that an ALL-POLE MAINS SWITCH with a contact separation of at least 3 mm in each pole shall be incorporated in the electrical installation of the building.

6 Hazardous radiations

6.1 Ionizing radiation

Apparatus including a potential source of ionizing radiation shall be so constructed that personal protection against ionizing radiation is provided under normal operating conditions and under fault conditions.

Compliance is checked by measurement under the following conditions.

In addition to the normal operating conditions, all controls adjustable from the outside BY HAND, by any object such as a tool or a coin, and those internal adjustments or pre-sets which are not locked in a reliable manner, are adjusted so as to give maximum radiation whilst maintaining an intelligible picture for 1 h, at the end of which the measurement is made.

NOTE 1 Soldered joints and paint lockings are examples of adequate locking.

The exposure rate at any point outside the apparatus is determined by means of a radiation monitor with an effective area of 10 cm^2, at a distance of 5 cm from the outer surface of the apparatus.

Moreover, the measurement shall be made under fault conditions causing an increase of the high-voltage, provided an intelligible picture is maintained for 1 h, at the end of which the measurement is made.

The exposure rate shall not exceed 36 pA/kg (0,5 mR/h).

NOTE 2 The value is according to ICRP 15, clause **289** [16].

A picture is considered to be intelligible if the following conditions are met:

— a scanning amplitude of at least 70 % of the usable screen width;

— a minimum luminance of 50 cd/m^2 with locked blank raster provided by a test generator;

— a horizontal resolution corresponding to at least 1,5 MHz in the centre, with a similar vertical degradation;

— not more than one flash-over per 5 min.

6.2 Laser radiation

An apparatus containing a LASER SYSTEM shall be so constructed that personal protection against laser radiation is provided under normal operating conditions and under fault conditions.

An apparatus containing a LASER SYSTEM is exempt from all further requirements of this subclause if:

— classification by the manufacturer according to IEC 60825-1, clauses **3**, **8** and **9** shows that the approachable emission level does not exceed class 1 under all conditions of operation, maintenance, service and failure, and

— it does not contain an embedded LASER according to IEC 60825-1.

NOTE 1 Information about the measuring equipment is given in IEC 61040 [8].

NOTE 2 The term "approachable emission level" denotes "ACCESSIBLE EMISSION LIMIT (AEL)" in the sense of IEC 60825-1.

Apparatus shall be classified and labelled in accordance with the approachable emission level measured under fault conditions, except that for apparatus not exceeding class **1**, IEC 60825-1, clause **5** does not apply.

All controls adjustable from the outside BY HAND or any object such as a tool or a coin, and those internal adjustments or pre-sets which are not locked in a reliable manner, are adjusted so as to give maximum radiation.

NOTE 3 Soldered joints and paint locking are examples of adequate locking.

The laser radiation emitted by redirection as mentioned in IEC 60825-1, **3.32** b), shall not be measured for a LASER SYSTEM of class 1.

Compliance is met by satisfying the relevant requirements as specified in IEC 60825-1 with the following modifications and additions:

6.2.1

a) The apparatus shall meet under normal operating conditions, the approachable emission limits of class 1 as specified in IEC 60825-1, Table 1. Time basis of the classification is 100 s.

*Compliance is checked by performing the relevant measurements as specified in IEC 60825-1, **8.2**.*

b) If the apparatus incorporates a LASER SYSTEM which meets, under normal operating conditions, the approachable emission limits of class 1, the requirements mentioned under c) and d) do not apply.

c) Adequate measures shall be taken to prevent the opening of any cover BY HAND giving access to laser radiation in excess of class 1 limits.

Compliance is checked by inspection and measurement.

d) Where safety is dependent on the proper functioning of a mechanical SAFETY INTERLOCK, this interlock shall be fail-safe (in the failure mode the apparatus is rendered inoperative or non hazardous), or shall withstand a switching test of 50 000 cycles of operation with current and voltage applied as under normal operating conditions.

Compliance is checked by inspection or test.

6.2.2

a) When the apparatus is operated under fault conditions as specified in **4.3**, the approachable emission level from the apparatus shall be not higher than class 3A outside the wavelength range of 400 nm to 700 nm and not higher than five times the limit for class 1 within the wavelength range of 400 nm to 700 nm.

NOTE The class 3A limits are as specified in IEC 60825-1, Table 3.

*Compliance is checked by performing the relevant measurements as specified in IEC 60825-1, **8.2***

b) If the apparatus incorporates a LASER SYSTEM which meets, under fault conditions, the approachable emission limits given in **6.2.2** a), the requirements mentioned under c) and d) do not apply.

c) Adequate measures shall be taken to prevent the opening of any cover BY HAND giving access to laser radiation in excess of the limits given in **6.2.2** a).

Compliance is checked by inspection and measurement.

d) Where safety is dependent on the proper functioning of a mechanical SAFETY INTERLOCK, this interlock shall be fail-safe (in the failure mode the apparatus is rendered inoperative or non hazardous), or shall withstand a switching test of 50 000 cycles of operation with current and voltage applied as under normal operating conditions.

Compliance is checked by inspection or test.

7 Heating under normal operating conditions

7.1 General

During intended use, no part of the apparatus shall attain an excessive temperature.

Compliance is checked by measuring the temperature rises under normal operating conditions when a steady state has been attained.

NOTE 1 In general, a steady state is assumed to be attained after 4 h of operation.

Temperature rises are determined:

— in the case of winding wires, by the change in resistance method or any other method giving the average temperature of the winding wires;

NOTE 2 Care should be taken to ensure that during the measurement of the resistance of winding wires, the influence of circuits or loads connected to these winding wires is negligible.

— in other cases, by any suitable method.

Temperature rises shall not exceed the values specified in **7.1.1** to **7.1.5** inclusive.

Protective devices, except THERMAL CUT-OUTS with automatic reset and PTC-S THERMISTORS, affecting the safety of the apparatus shall not operate during the test.

7.1.1 *ACCESSIBLE parts*

The temperature rise of ACCESSIBLE parts shall not exceed the values given in Table 2, item a), "normal operating conditions".

7.1.2 *Parts, other than windings, providing electrical insulation*

The temperature rise of insulating parts, other than windings, providing BASIC, SUPPLEMENTARY, or REINFORCED INSULATION, and of insulating parts, the failure of which would cause an infringement of the requirements of **9.1.1** or a fire hazard, shall not exceed the values given in Table 2, item b) "normal operating conditions", taking into account note 4 of Table 2.

*If an insulating part is used to establish a CLEARANCE or to contribute to a CREEPAGE DISTANCE and its permissible temperature rise is exceeded, then the relevant area of the insulating part is disregarded when compliance with clauses **8** and **11** is checked.*

7.1.3 *Parts acting as a support or a mechanical barrier*

The temperature rise of parts, a mechanical failure of which would cause an infringement of the requirements of **9.1.1**, shall not exceed the value given in Table 2, item c) "normal operating conditions".

7.1.4 ***Windings***

The temperature rise of windings comprising insulation providing protection against electric shock or fire hazard shall not exceed the values given in Table 2, items b) and d) "normal operating conditions".

*If an insulating part is used to establish a CLEARANCE or to contribute to a CREEPAGE DISTANCE and its permissible temperature rise is exceeded, then the relevant area of the insulating part is disregarded when compliance with clauses **8** and **11** is checked.*

NOTE If the insulation is incorporated in a winding in such a way that its temperature rise cannot be measured directly, the temperature is assumed to be the same as that of the winding wire.

7.1.5 ***Parts not subject to a limit under 7.1.1 to 7.1.4 inclusive***

According to the nature of the material, the temperature rise of the part shall not exceed the values given in Table 2, item e) "normal operating conditions".

Table 2 — Permissible temperature rise of parts of the apparatus

Parts of the apparatus	Normal operating conditions K	Fault conditions K
a) *ACCESSIBLE parts*		
Knobs, handles, etc. if		
— metallic	30	65
— non-metallic (note 3)	50	65
Enclosures if		
— metallic (note 2)	40	65
— non-metallic (notes 2 and 3)	60	65
b) *Parts providing electrical insulation (note 4)*		
Supply cords and wiring insulation with		
— polyvinyl chloride or synthetic rubber		
— not under mechanical stress	60	100
— under mechanical stress	45	100
— natural rubber	45	100
Other insulations of:		
— thermoplastic materials (note 5)	(note 6)	(note 6)
— non-impregnated paper	55	70
— non-impregnated cardboard	60	80
— impregnated cotton, silk, paper and textile	70	90
— laminates based on cellulose or textile, bonded with		
— phenol-formaldehyde, melamine-formaldehyde, phenol-furfural or polyester	85	110
— epoxy	120	150
— mouldings of		
— phenol-formaldehyde or phenol-furfural, melamine and melamine phenolic compounds with		
— cellulose fillers	100	130
— mineral fillers	110	150
— thermosetting polyester with mineral fillers	95	150
— alkyd with mineral fillers	95	150
— composite materials of		
— polyester with glass-fibre reinforcement	95	150
— epoxy with glass-fibre reinforcement	100	150
— silicone rubber	145	190
c) *Parts acting as a support or a mechanical barrier including the inside of enclosures (note 4)*		
Wood and WOOD-BASED MATERIALS	60	90
Thermoplastic materials (note 5)	(note 6)	(note 6)
d) *Winding wires (note 4)*		
— insulated with		
— non-impregnated silk, cotton, etc.	55	75
— impregnated silk, cotton, etc.	70	100
— oleoresinous materials	70	135

Table 2 — Permissible temperature rise of parts of the apparatus

Parts of the apparatus	Normal operating conditions K	Fault conditions K
— polyvinyl-formaldehyde or polyurethane resins	85	150
— polyester resins	120	155
— polyesterimide resins	145	180
e) *Other parts*		
These temperature rises apply to parts not covered by items a), b), c) and d):		
Parts of wood and WOOD-BASED MATERIAL	60	140
Lithium batteries	40	50
All other parts, except resistors and parts of metal, glass, ceramic.	200	300

NOTE 1 General conditions applicable to Table 2:

For tropical climates, permissible temperature rises of 10 K less than those specified in this table are required.

The values of the temperature rises are based on a maximum ambient temperature of 35 °C for moderate climates and of 45 °C for tropical climates.

NOTE 2 For areas having no dimension exceeding 5 cm and for heat sinks or metallic parts directly covering heat sinks, without a dimensional restriction, which are not likely to be touched during intended use, temperature rises up to 65 K are allowed under normal operating conditions.

For outside parts of metal which are covered with plastic material, the thickness of which is at least 0,3 mm, a temperature rise which corresponds to the permissible temperature rise of the insulating material is allowed.

NOTE 3 If these temperature rises are higher than those allowed by the class of the relevant insulating material, the nature of the material is the governing factor.

NOTE 4 For the purpose of this standard, the permissible temperature rises are based on service experience in relation to the thermal stability of the materials. The materials quoted are examples. For materials for which higher temperature limits are claimed, and for materials other than those listed, the maximum temperatures should not exceed those which have been proved to be satisfactory, for example in accordance with IEC 60085.

NOTE 5 Natural rubber and synthetic rubbers are not considered as being thermoplastic materials.

NOTE 6 Due to their wide variety, it is not possible to specify permissible temperature rises for thermoplastic materials.

While the matter is under consideration, the following method shall be used:

a) a softening temperature of the material is determined on a separate specimen, under the conditions specified in ISO 306 with a heating rate of 50 K/h and modified as follows:
   — the depth of penetration is 0,1 mm;
   — the total thrust of 10 N is applied before the dial gauge is set to zero or its initial reading noted.

b) the temperature limits to be considered for determining the temperature rises are:
   — under normal operating conditions, a temperature of 10 K below the softening temperature as obtained under item a);
   — under fault conditions, the softening temperature itself.

If the required softening temperature exceeds 120 °C, note 3 shall be taken into account.

7.2 Heat resistance of insulating material

Insulating material supporting parts CONDUCTIVELY CONNECTED TO THE MAINS shall be resistant to heat if, during intended use, these parts carry a steady-state current exceeding 0,2 A and can generate substantial heat due to imperfect contact.

Compliance is checked by subjecting the insulating material to the test specified in Table 2 under item a) of note 6.

The softening temperature of the insulating material shall be at least 150 °C.

In those cases where two groups of conductors, each supported by insulating parts, can be rigidly connected or joined together, for example by plug and socket, only one of the insulating parts need meet the test. Where one of the insulating parts is fixed in the apparatus, this part shall meet the test.

NOTE 1 Examples of parts which can generate substantial heat during intended use are contacts of switches and of voltage setting devices, screw TERMINALS and fuse holders.

NOTE 2 This test need not be performed on parts which are in accordance with a relevant IEC standard.

8 Constructional requirements with regard to the protection against electric shock

8.1 Conductive parts, covered only by lacquer, solvent-based enamel, ordinary paper, untreated textile, oxide films or beads are considered to be bare.

Compliance is checked by inspection.

8.2 The apparatus shall be designed and constructed so that operation BY HAND, like

— changing the setting for the voltage or nature of supply;

— replacing fuse-links and indicator lights;

— handling of drawers etc.,

does not involve a risk of electric shock.

*Compliance is checked by application of the tests of **9.1.1**.*

8.3 The insulation of HAZARDOUS LIVE parts shall not be provided by hygroscopic materials.

Compliance is checked by inspection and, in case of doubt, by the following test.

*A specimen of the material, as specified in IEC 60167, clause **9**, is subjected to a temperature of (40 ± 2) °C, and a relative humidity of 90 % to 95 %, the conditioning period being:*

— 7 days (168 h) for apparatus to be used under tropical conditions;

— 4 days (96 h) for other apparatus.

*Within 1 min after this preconditioning, the specimen shall withstand the tests of **10.3** without the humidity treatment according to **10.2**.*

8.4 The apparatus shall be so constructed that there is no risk of an electric shock from ACCESSIBLE parts or from those parts rendered ACCESSIBLE following the removal BY HAND of a cover.

This requirement applies also to internal parts of battery compartments which become ACCESSIBLE by the removal of a cover when replacing the batteries.

This requirement does not apply to battery compartments inside the apparatus, where the replacement of their batteries by the USER is not intended, for example batteries for memories.

*Compliance is met by satisfying the requirements of **8.5** or **8.6**.*

NOTE Inaccessible contacts of TERMINALS are regarded as ACCESSIBLE parts, unless marked with the symbol according to **5.2** b) or intended to connect the apparatus to the MAINS or to provide MAINS power to other apparatus.

8.5 For CLASS I apparatus, the ACCESSIBLE conductive parts, except for those parts of the apparatus which have DOUBLE or REINFORCED INSULATION (CLASS II construction), shall be separated from HAZARDOUS LIVE parts by BASIC INSULATION meeting the insulation requirements as specified in clause **10** and the requirements for CLEARANCES and CREEPAGE DISTANCES as specified in clause **13**.

This requirement does not apply to insulations whose short-circuiting does not cause any electric shock hazard.

NOTE 1 For example, if one end of a secondary winding of a SEPARATING TRANSFORMER is connected to an ACCESSIBLE conductive part, the other end need not meet any special insulation requirement with regard to the same ACCESSIBLE conductive part.

A resistor bridging BASIC INSULATION shall comply with the requirements as specified in **14.1** a).

NOTE 2 Parts of the apparatus which have DOUBLE or REINFORCED INSULATION (CLASS II construction) may be bridged by a resistor in compliance with the requirements as specified in **14.1** a).

A capacitor or RC-unit bridging BASIC INSULATION between a HAZARDOUS LIVE part and an ACCESSIBLE conductive part connected to the PROTECTIVE EARTH TERMINAL, shall comply with the requirements of **14.2.1** a).

Such resistors, capacitors or RC-units shall be positioned inside the enclosure of the apparatus.

CLASS I apparatus shall be provided with a PROTECTIVE EARTH TERMINAL or contact to which the protective earth contacts of socket-outlets, if any, and ACCESSIBLE conductive parts shall be reliably connected. Such connection is not necessary for those ACCESSIBLE conductive parts which are insulated from HAZARDOUS LIVE parts by DOUBLE or REINFORCED INSULATION (CLASS II construction) or those which are protected from becoming HAZARDOUS LIVE by a conductive part reliably connected to the PROTECTIVE EARTH TERMINAL.

NOTE 3 Examples of such a conductive part are a metal screen in a transformer between the primary and the secondary windings, a metal chassis, etc.

Compliance is checked by inspection.

8.6 For CLASS II apparatus, the ACCESSIBLE parts shall be separated from HAZARDOUS LIVE parts either by DOUBLE INSULATION specified under item a) or by REINFORCED INSULATION specified under item b).

This requirement does not apply to insulations whose short-circuiting does not cause any electric shock hazard.

NOTE 1 For example, if one end of a secondary winding of a SEPARATING TRANSFORMER is connected to an ACCESSIBLE conductive part, the other end need not meet any special insulation requirement with regard to the same ACCESSIBLE conductive part.

A component complying with the requirements of **14.1** a) or **14.3**, except components according to **14.3.4.3**, may bridge BASIC, SUPPLEMENTARY, DOUBLE or REINFORCED INSULATION.

Components according to **14.3.4.3** may bridge BASIC INSULATION only.

BASIC and SUPPLEMENTARY INSULATIONS may each be bridged by a capacitor or RC-unit, having the same rated values, complying with the requirements of **14.2.1** a).

DOUBLE or REINFORCED INSULATION may be bridged by two capacitors or RC-units in series, having the same rated values, each complying with the requirements of **14.2.1** a).

Alternatively DOUBLE or REINFORCED INSULATION may be bridged by a single capacitor or RC-unit complying with the requirements of **14.2.1** b).

NOTE 2 For external insulation, bridging DOUBLE or REINFORCED INSULATION, also see **8.8**.

Such resistors, capacitors or RC-units shall be positioned inside the enclosure of the apparatus.

Compliance is checked by inspection.

a) If ACCESSIBLE parts are separated from HAZARDOUS LIVE parts by BASIC and SUPPLEMENTARY INSULATION, the following shall apply:

Each of these insulations shall comply with the insulation requirements as specified in clause **10** and with the requirements for CLEARANCES and CREEPAGE DISTANCES specified in clause **13**.

Enclosures of wood not complying with the requirements of **8.3** are permitted as SUPPLEMENTARY INSULATION if they withstand the dielectric strength test of **10.3**.

Compliance is checked by inspection and/or measurement.

b) If ACCESSIBLE parts are separated from HAZARDOUS LIVE parts by REINFORCED INSULATION the following shall apply:

The insulation shall comply with the insulation requirements specified in clause **10**. Moreover, it shall comply with the requirements for CLEARANCES and CREEPAGE DISTANCES specified in clause **13**.

NOTE 3 An example of assessment of REINFORCED INSULATION is given in Figure 2.

Compliance is checked by inspection and/or measurement.

8.7 For voltages above 35 V (peak) up to and including 71 V (peak) a.c. or above 60 V d.c. up to and including 120 V d.c. (RIPPLE FREE), measured at the RATED SUPPLY VOLTAGE under normal operating conditions and under fault conditions, in deviation from **8.5** or **8.6** respectively, BASIC INSULATION meeting the requirements of clause **10** and clause **13** is sufficient, between circuits with the voltages above and ACCESSIBLE parts or parts connected to ACCESSIBLE conductive parts.

Circuits with the voltages above shall be separated from HAZARDOUS LIVE parts with higher voltages by DOUBLE or REINFORCED INSULATION according to **8.6** or by an ISOLATING TRANSFORMER according to **14.3.2** (CLASS II construction) or by a conductive part connected to the PROTECTIVE EARTH TERMINAL according to **8.5** or by a transformer according to **14.3.3** (CLASS I construction).

Compliance is checked by inspection.

8.8 BASIC, SUPPLEMENTARY and REINFORCED INSULATION shall each withstand the dielectric strength test as specified in **10.3**.

For DOUBLE INSULATION either the BASIC or the SUPPLEMENTARY INSULATION shall have a thickness of at least 0,4 mm.

REINFORCED INSULATION shall have a minimum thickness of 0,4 mm when not subject to any mechanical stress which, at the temperatures during normal operating conditions and under fault conditions, would be likely to lead to deformation or deterioration of the insulating material.

NOTE Under mechanical stress conditions the thickness may have to be increased to comply with the insulation requirements as specified in clause **10** and the mechanical strength requirements as specified in clause **12**.

The above requirements are not applicable to insulation in thin sheet materials irrespective of their thickness provided that:

— it is used within the enclosure of the apparatus, and

— BASIC or SUPPLEMENTARY INSULATION comprises at least two layers of material, each of which will pass the dielectric strength test specified in **10.3** for BASIC or SUPPLEMENTARY INSULATION, or

— BASIC or SUPPLEMENTARY INSULATION comprises three layers of material for which all combinations of two layers together pass the dielectric strength test specified in **10.3** for BASIC or SUPPLEMENTARY INSULATION, or

— REINFORCED INSULATION comprises at least two layers of material, each of which will pass the dielectric strength test specified in **10.3** for REINFORCED INSULATION, or

— REINFORCED INSULATION comprises three layers of insulation material for which all combinations of two layers together pass the dielectric strength test specified in **10.3** for REINFORCED INSULATION.

There is no requirement for all layers of insulation to be of the same insulating material.

Compliance is checked by inspection and measurement.

8.9 The insulation of internal wiring between HAZARDOUS LIVE conductors in wires or cables and ACCESSIBLE parts, or between HAZARDOUS LIVE parts and conductors in wires or cables connected to ACCESSIBLE conductive parts, shall have a thickness of at least 0,4 mm if made of polyvinyl chloride. Other materials are allowed provided that they withstand the dielectric strength test specified in **10.3** and that their thickness ensures an equivalent mechanical strength, where the construction so requires.

NOTE For example a polytetrafluoroethylene (PTFE) insulation having a thickness of at least 0,24 mm is considered to fulfil this requirement.

Compliance is checked by inspection and measurement.

8.10 In CLASS II apparatus DOUBLE INSULATION shall be provided between

— ACCESSIBLE parts and conductors in wires or cables CONDUCTIVELY CONNECTED TO THE MAINS

and

— conductors in wires or cables connected to ACCESSIBLE conductive parts and parts CONDUCTIVELY CONNECTED TO THE MAINS.

Either the BASIC or the SUPPLEMENTARY INSULATION shall comply with the requirements of **8.9**. The other insulation shall withstand the dielectric strength test specified in **10.3** for BASIC or SUPPLEMENTARY INSULATION.

If DOUBLE INSULATION consists of two layers which cannot be tested separately, it shall withstand the dielectric strength test specified in **10.3** for REINFORCED INSULATION.

The test voltage of **10.3** is applied between the conductor and metal foil wrapped tightly around the insulation of the wire over a length of 10 cm.

In the case of insulating sleeves, the test voltage of **10.3** is applied between a tight-fitting metal rod inserted into the sleeve and a metal foil wrapped tightly around the sleeve over a length of 10 cm.

Compliance is checked by inspection and measurement.

8.11 The construction of the apparatus shall be such that, should any wire become detached, the CLEARANCES and CREEPAGE DISTANCES are not reduced below the values specified in clause **13** by the natural movement of a detached wire. This requirement does not apply if there is no risk of a wire becoming detached.

NOTE 1 It is assumed that not more than one connection will become detached at the same time.

Compliance is checked by inspection and measurement.

NOTE 2 Examples of methods deemed to prevent a wire from becoming detached are:

a) the conductor of the wire is anchored to the tag before soldering, unless breakage close to the soldering place is likely to occur as a result of vibration;

b) wires are twisted together in a reliable manner;

c) wires are fastened together reliably by cable ties, adhesive tapes with thermosetting adhesives according to IEC 60454, sleeves or the like;

d) the conductor of the wire is inserted into a hole in a PRINTED BOARD before soldering, the hole having a diameter slightly greater than that of the conductor, unless breakage close to the PRINTED BOARD is likely to occur as a result of vibration;

e) the conductor of the wire and its insulation, if any, are securely wrapped around the termination by means of a special tool;

f) the conductor of the wire and its insulation, if any, are crimped to the termination by means of a special tool.

The methods under items a) up to and including f) apply to internal wires and the methods under items a) up to and including c) to external flexible cords.

*In case of doubt, the vibration test of **12.1.2** is carried out to verify compliance.*

8.12 Conductors of internal wiring connecting MAINS socket-outlets incorporated in the apparatus to the MAINS TERMINALS either directly or via a MAINS switch shall comply with the cross-sectional area requirements of **16.2**.

Compliance is checked by inspection.

8.13 Windows, lenses, signal lamp covers, etc. shall be fastened by positive means if HAZARDOUS LIVE parts are rendered ACCESSIBLE by their absence.

NOTE Friction only is not regarded as a positive means.

Compliance is checked by inspection and, in case of doubt, by applying a force from the outside of 20 N for 10 s at the most unfavourable place and in the most unfavourable direction.

8.14 Covers which may be subjected to forces during intended use, for example covers supporting TERMINALS (see clause **15**) shall be fastened by positive means if HAZARDOUS LIVE parts are rendered ACCESSIBLE by their absence.

NOTE Friction only is not regarded as a positive means.

Compliance is checked by inspection and, in case of doubt, by applying a force of 50 N for 10 s at the most unfavourable place and in the most unfavourable direction.

*After the tests of **8.13** and **8.14**, the apparatus shall show no damage in the sense of this standard; in particular no HAZARDOUS LIVE parts shall become ACCESSIBLE.*

8.15 Internal wiring of the apparatus, damage to the insulation of which is liable to cause a hazard in the sense of this standard, shall

— be secured so as not to contact parts exceeding the permissible temperature rise for the insulation of the wires as specified in Table 2 when a force of 2 N is applied to any part of the wiring or their surroundings, and

— be so constructed that there is no risk of damage to the insulation of the wires, for example sharp edges, moving parts or pinches, which may come into contact with other parts of the apparatus, when a force of 2 N is applied to any part of the wiring or their surroundings.

Compliance is checked by inspection and measurement.

8.16 Apparatus designed to be supplied exclusively by a SUPPLY APPARATUS specified by the manufacturer of the apparatus, shall be so constructed that the SPECIAL SUPPLY APPARATUS cannot be replaced, without modification, by a SUPPLY APPARATUS FOR GENERAL USE.

NOTE The required non-interchangeability may be obtained for example by special connections.

Compliance is checked by inspection.

9 Electric shock hazard under normal operating conditions

9.1 Testing on the outside

9.1.1 *General*

HAZARDOUS LIVE parts shall not be ACCESSIBLE.

NOTE 1 For interconnection with apparatus under the scope of other standards, circuits should comply with **9.1.1** and, depending upon the construction, with **8.5** or **8.6**.

In addition, when not connected to another apparatus, inaccessible contacts of TERMINALS shall not be HAZARDOUS LIVE, with the following exceptions:

— contacts of signal output TERMINALS, if they have to be HAZARDOUS LIVE for functional reasons, provided the contacts are separated from the supply source as required according to clause **8** for ACCESSIBLE conductive parts.

NOTE 2 Inaccessible input TERMINALS, for example of loudspeakers, are permitted to be HAZARDOUS LIVE when connected to such output TERMINALS.

NOTE 3 For the marking of such output TERMINALS see **5.2** b).

— TERMINALS complying with **15.1.1** provided for connecting the apparatus to the MAINS, socket-outlets and contacts of connecting blocks for providing power to other apparatus.

In order to verify that a part or a contact of a TERMINAL is not HAZARDOUS LIVE, the following measurements are carried out between any two parts or contacts, then between any part or contact and either pole of the supply source used during the test. Discharges shall be measured to the TERMINAL provided for connecting the apparatus to the supply source, immediately after the interruption of the supply.

NOTE 4 For discharges between the poles of the MAINS plug, see **9.1.6**.

The part or contact of a TERMINAL is not HAZARDOUS LIVE if:

a) the open-circuit voltage does not exceed 35 V (peak) a.c. or 60 V d.c.,

or, if a) is not met,

b) the measurement of the TOUCH-CURRENT shall be carried out in accordance with IEC 60990, with the measuring network described in Annex D of this standard.

The TOUCH CURRENT expressed as voltages U_1 and U_2, does not exceed the following values:

— for a.c.: U_1 = 35 V (peak) and U_2 = 0,35 V (peak);

— for d.c.: U_1 = 1,0 V,

NOTE 5 The limit values of U_2 = 0,35 V (peak) for a.c. and U_1 = 1,0 V for d.c. correspond to the values 0,7 mA (peak) a.c. and 2,0 mA d.c.
The limit value U_1 = 35 V (peak) for a.c. corresponds to the value 70 mA (peak) a.c. for frequencies greater than 100 kHz.

and moreover,

c) the discharge does not exceed 45 μC for stored voltages between 60 V and 15 kV, or

d) the energy of discharge does not exceed 350 mJ for stored voltages exceeding 15 kV.

NOTE 6 It is recommended that for apparatus intended to be used in tropical climates, the values given in a) and b) above, be halved.
NOTE 7 To avoid unnecessarily high TOUCH CURRENTS when several apparatus are interconnected, it is recommended that the individual TOUCH CURRENT values are not higher than needed for functional reasons.

In order to determine whether a HAZARDOUS LIVE part is ACCESSIBLE, the jointed test finger according to test probe B of IEC 61032, is pushed against the enclosure or inserted through any openings of the enclosure, including openings in the bottom, without appreciable force.

Through openings, the test finger is applied to any depth that the finger will permit and is rotated or angled before, during and after insertion to any position. If the opening does not allow the entry of the finger, the force on the finger in the straight position is increased to 20 N ± 2 N and the test repeated with the finger in angled position.

Conductive parts, covered only by lacquer, solvent-based enamel, ordinary paper, untreated textile, oxide films or beads are considered to be bare.

For CLASS II constructions, the test probe 13 of IEC 61032 shall not touch HAZARDOUS LIVE parts when applied with a force of 3 N ± 0,3 N in every possible position.

The test probe is not applied to socket-outlets, connectors providing MAINS power, fuse holders and the like.

NOTE 8 For indication of electrical contact a voltage of not less than 40 V and not more than 50 V in series with a suitable lamp may be used.

The above requirements to determine whether a HAZARDOUS LIVE part is ACCESSIBLE apply only to HAZARDOUS LIVE voltages not exceeding 1 000 V a.c. or 1 500 V d.c. For higher voltages, there shall be a CLEARANCE between the part at HAZARDOUS LIVE voltage and the test finger or the test pin as specified in **13.1.1** for BASIC INSULATION (see Figure 3).

9.1.2 *Shafts of operating knobs, handles, levers and the like*

Shafts of operating knobs, handles, levers and the like shall not be HAZARDOUS LIVE.

*Compliance is checked by inspection, in case of doubt by measurement according to **9.1.1**.*

9.1.3 *Openings of the enclosure*

The apparatus shall be so designed that suspended foreign bodies cannot become HAZARDOUS LIVE, when introduced through ventilation or other holes.

Compliance is checked by applying to the holes a metal test pin having a diameter of 4 mm and a length of 100 mm. The test pin is suspended freely from one end, the penetration is limited to the length of the test pin.

The test pin shall not become HAZARDOUS LIVE.

9.1.4 *TERMINALS*

The use of a single-pole plug or a bare wire to make connection with a contact of a TERMINAL for earth or antenna or for audio, video or associated signals, shall not involve the risk of an electric shock.

The test is not applied to TERMINALS marked with the symbol of **5.2** b).

NOTE See also **15.1.2**.

Compliance is checked by the following tests:

Within 25 mm measured from each contact of the TERMINAL, a test pin according to IEC 61032, test probe 16, is applied in every possible position, in case of doubt with a force of 10 N ± 1 N.

Each contact is tested with a straight test probe according to IEC 61032, test probe D, in case of doubt with a force of 1 N ± 0,1 N.

The test probes shall not become HAZARDOUS LIVE.

9.1.5 *Pre-set controls*

If a hole giving access to pre-set controls is marked as such on the enclosure or in the instruction for use, and the setting of this control requires a screwdriver or other tool, the adjustment of the control shall not involve the risk of an electric shock.

Compliance is checked by applying to the opening a test probe according to IEC 61032, test probe C.

The test probe is applied in every possible position, in case of doubt with a force of 10 N ± 1 N.

The test probe shall not become HAZARDOUS LIVE.

9.1.6 *Withdrawal of MAINS plug*

Apparatus intended to be connected to the MAINS by means of a MAINS plug shall be so designed that there is no risk of an electric shock from stored charge on capacitors, when touching the pins or contacts of the plug after its withdrawal from the socket-outlet.

NOTE For the purpose of this subclause, male interconnection couplers and male appliance couplers are regarded as MAINS plugs.

*Compliance is checked by measurement according to **9.1.1** a) or c) or by calculation.*

The MAINS switch, if any, is in the off-position, unless it is more unfavourable in the on-position.

Two seconds after withdrawal of the MAINS plug, the pins or contacts of the plug shall not be HAZARDOUS LIVE.

The test may be repeated up to 10 times to obtain the most unfavourable situation.

If the nominal capacitance across the MAINS poles does not exceed 0,1 µF, no test is conducted.

9.1.7 *Resistance to external forces*

The enclosure of the apparatus shall be sufficiently resistant to external forces.

Compliance is checked by the following tests:

a) by means of a rigid test finger according to IEC 61032, test probe 11, a force of 50 N ± 5 N, directed inwards, is applied for 10 s to different points of the enclosure including openings and textile coverings.

The force shall be so exerted by the tip of the test finger as to avoid wedge or lever action.

During the test the enclosure shall not become HAZARDOUS LIVE, HAZARDOUS LIVE parts shall not become ACCESSIBLE, textile coverings shall not touch HAZARDOUS LIVE parts;

b) by means of a test hook as shown in Figure 4, a force of 20 N ± 2 N, directed outwards, is applied for 10 s at all points where this is possible.

During the test, HAZARDOUS LIVE parts shall not become ACCESSIBLE;

c) external conductive enclosures and conductive parts of an external enclosure shall be subjected for 5 s to a steady force of (250 ± 10) N for floorstanding apparatus or (100 ± 10) N for other apparatus, applied to the enclosure or to a part of the enclosure fitted to the apparatus, by means of a suitable test tool providing contact over a circular plane surface 30 mm in diameter.

NOTE 1 Contacts of TERMINALS are not considered to be a conductive part of the external enclosure.

After the tests, the apparatus shall show no damage in the sense of this standard.

NOTE 2 The apparatus need not be connected to the supply source during the tests.

9.2 Removal of protective covers

A part which becomes ACCESSIBLE by the removal of a cover BY HAND shall not be HAZARDOUS LIVE.

This requirement applies also to internal parts of battery compartments which become ACCESSIBLE by the removal of a cover either BY HAND or with the use of a tool, coin or other object, when replacing the batteries. An exception is made in the case of batteries which are not intended to be replaced by the USER, for example batteries for memories.

*Compliance is checked by application of the tests of **9.1.1**, except that the measurements are made 2 s after removal of the cover.*

NOTE Any part removable BY HAND of a voltage setting device is considered to be a protective cover.

10 Insulation requirements

10.1 Surge test

Insulation between ACCESSIBLE parts or parts connected to them and HAZARDOUS LIVE parts, shall be able to withstand surges due to transients, caused for example by thunderstorms and entering the apparatus through the antenna TERMINAL.

Compliance is checked by the following test:

The insulation between

— TERMINALS for the connection of antenna and MAINS supply TERMINALS,

and between

— MAINS supply TERMINALS and any other TERMINAL in case of apparatus which may be interconnected to other apparatus with antenna TERMINALS,

is subjected to 50 discharges at a maximum rate of 12/min, from a 1 nF capacitor charged to 10 kV in a test circuit, as shown in Figure 5a.

NOTE During this test, the apparatus should not be energized.

*After the test, the tested insulation shall comply with the requirements of **10.3**.*

10.2 Humidity treatment

The safety of the apparatus shall not be impaired by humidity conditions which may occur in the intended use.

*Compliance is checked by the humidity treatment described in this subclause, followed immediately by the tests of **10.3**.*

Cable entries, if any, are left open. If knock-outs are provided, they are opened.

Electrical components, covers and other parts which can be removed BY HAND are removed and subjected, if necessary, to the humidity treatment with the main part.

The humidity treatment is carried out in a humidity chamber containing air with a relative humidity of 93^{+2}_{-3} %.

The temperature of the air, at all places where the apparatus can be located, is maintained at 30^{0}_{-2} °C.

Apparatus intended to be used in tropical climates
are subjected to a temperature of 40^{+2}_{-2} °C and a
relative humidity of 93^{+2}_{-3} %.

Before being placed in the chamber, the apparatus is brought to a temperature between the specified temperature and a 4 K higher temperature.

The apparatus is kept in the chamber for

— 5 days (120 h) for apparatus intended to be used in tropical climates,

— 2 days (48 h) for other apparatus.

NOTE 1 In most cases, the apparatus may be brought to the specified temperature by keeping it at this temperature for at least 4 h before the humidity treatment.

NOTE 2 Some methods of achieving the specified relative humidities are described in IEC 60260 [5].

NOTE 3 The air in the chamber should be stirred and the chamber should be so designed that mist or condensed water will not precipitate on the apparatus.

NOTE 4 During this test, the apparatus should not be energized.

After this treatment, the apparatus shall show no damage in the sense of this standard.

10.3 Insulation resistance and dielectric strength

10.3.1 The insulation of the insulating materials shall be adequate.

*Compliance is checked in accordance with **10.3.2**, and, unless otherwise stated, immediately after the humidity treatment according to **10.2**.*

NOTE In order to facilitate dielectric strength testing, components and subassemblies may be tested separately.

10.3.2 *The insulations listed in Table 3 shall be tested:*

— *for insulation resistance with 500 V d.c.; and*

— *for dielectric strength as follows:*

— insulations stressed with d.c. voltage (RIPPLE FREE) are tested with a d.c. voltage;

— insulations stressed with a.c. voltage are tested with an a.c. voltage at MAINS frequency.

However, where corona, ionization, charge effects or the like may occur, a d.c. test voltage is recommended.

NOTE 1 Where there are capacitors across the insulation under test, it is recommended that d.c. test voltages are used.

Test voltages shall be as specified in Table 3 for the appropriate grade of insulation (BASIC, SUPPLEMENTARY or REINFORCED INSULATION) and for the OPERATING VOLTAGE U across the insulation.

For the purpose of determining the OPERATING VOLTAGE U, the following applies:

— *the apparatus is fed by its RATED SUPPLY VOLTAGE;*

— *in case of a.c. voltages, the true peak value including periodic and non-periodic superimposed pulses with a half value time longer than 50 ns shall be measured;*

— *in case of d.c. voltages, the peak value of any superimposed ripple shall be included;*

— *periodic and non-periodic transients with a half value time up to 50 ns shall be disregarded;*

— *unearthed ACCESSIBLE conductive parts shall be assumed to be connected to an earth TERMINAL or to a PROTECTIVE EARTH TERMINAL or contact;*

— *where a transformer winding or other part is floating, i.e. not connected to a circuit which establishes its potential relative to earth, it shall be assumed to be connected to an earth TERMINAL or to a PROTECTIVE EARTH TERMINAL or contact at the point which results in the highest OPERATING VOLTAGE being obtained;*

— *where DOUBLE INSULATION is used, the OPERATING VOLTAGE across the BASIC INSULATION shall be determined by imagining a short-circuit across the SUPPLEMENTARY INSULATION, and vice versa. For insulation between transformer windings, the short-circuit shall be assumed to take place at the point at which the highest OPERATING VOLTAGE is produced across the other insulation;*

— *for insulations between two transformer windings, the highest voltage between any two points in the two windings shall be used, taking into account external voltages to which the windings may be connected;*

— *for insulations between a transformer winding and another part, the highest voltage between any point of the winding and the other part shall be used.*

The test voltages shall be obtained from a suitable source so designed that, when the output TERMINALS are short-circuited after the test voltage has been adjusted to the appropriate level, the output current is at least 200 mA.

An over-current device shall not trip when the output current is less than 100 mA.

Care shall be taken that the value of the test voltage applied is measured within ± 3 %.

Initially, not more than half of the prescribed test voltage is applied, then it is raised rapidly to the full value which is held for 1 min.

The measurements of the insulation resistance and the dielectric strength tests are made in the humidity chamber, or in the room in which the apparatus was brought to the prescribed temperature, after the reassembly of those parts which may have been removed.

The apparatus is deemed to comply with the requirement, if the insulation resistance measured after 1 min is not less than the values given in Table 3 and no flash-over or breakdown occurs during the dielectric strength test.

When testing enclosures of insulating material, a metal foil is pressed tightly against ACCESSIBLE parts.

For apparatus incorporating both REINFORCED INSULATION and lower grades of insulation, care shall be taken that the voltage applied to the REINFORCED INSULATION does not overstress BASIC or SUPPLEMENTARY INSULATION.

NOTE 2 ACCESSIBLE conductive parts may be connected together during the dielectric strength test.

NOTE 3 An instrument to carry out the dielectric strength test on thin sheets of insulating material is described in Figure 6.

NOTE 4 The test is not made on insulation the short-circuiting of which does not cause any electric shock hazard, for example in the case where one end of a secondary winding of an ISOLATING TRANSFORMER is connected to an ACCESSIBLE conductive part, the other end need not meet any insulation requirement with regard to the same ACCESSIBLE conductive part.

*Resistors, capacitors and RC-units complying with **14.1**, **14.2.1** and **14.2.2** respectively, connected in parallel with the insulations to be tested, are disconnected. Inductors and windings which otherwise would prevent the test from being made, are also disconnected.*

Table 3 — Test voltages for dielectric strength test and values for insulation resistance

Insulation	Insulation resistance	AC test voltage (peak) or d.c. test voltage
1 Between parts of different polarity DIRECTLY CONNECTED TO THE MAINS.	2 MΩ	For rated MAINS voltages ≤ 150 V (r.m.s.) 1 410 V For rated MAINS voltages >150 V (r.m.s.) 2 120 V
2 Between parts separated by BASIC INSULATION or by SUPPLEMENTARY INSULATION.	2 MΩ	Curve A of Figure 7
3 Between parts separated by REINFORCED INSULATION.	4 MΩ	Curve B of Figure 7

NOTE Curves A and B of Figure 7 are defined by the following points:

OPERATING VOLTAGE *U* (peak)	Test voltage (peak)	
	Curve A	Curve B
35 V	707 V	1 410 V
354 V		4 240 V
1 410 V	3 980 V	
10 kV	15 kV	15 kV
> 10 kV	1,5 *U* V	1,5 *U* V

11 Fault conditions

NOTE To check compliance with the requirements of this clause, it may be necessary to repeat the dielectric strength tests. However, it is advisable to identify beforehand all the insulations to be tested with a higher test voltage in order to avoid more than one humidity treatment.

11.1 Electric shock hazard

Protection against electric shock shall still exist when the apparatus is operated under fault conditions.

*Compliance is checked by the tests described in clause **9**, modified as specified below and under fault conditions.*

For contacts of TERMINALS

*— the permissible values of **9.1.1** a) are increased to 70 V (peak) a.c. and 120 V d.c., and*

*— the permissible values of **9.1.1** b) are increased to U_1 = 70 V (peak) and U_2 = 1,4 V (peak) for a.c. and to U_1 = 4 V for d.c.,*

provided that the plugs for antenna and for earth cannot be inserted into the TERMINAL under test.

NOTE It is recommended that for apparatus intended to be used in tropical climates, the values given above be halved.

*If short-circuiting or disconnecting a resistor, a capacitor, an RC-unit, an optocoupler or an inductor causes an infringement of the requirements, the apparatus is still deemed to be satisfactory if the component complies with the relevant requirements of clause **14** (see **4.3.4**).*

*If, during the tests, an insulation mentioned in Table 3 is subjected to a voltage exceeding the voltage occurring under normal operating conditions, and if this increase involves a higher test voltage according to **10.3**, this insulation shall withstand a test for dielectric strength at the higher test voltage, unless the higher voltage is due to the short-circuiting or disconnection of a resistor, a capacitor, an RC-unit, an optocoupler or an inductor complying with the relevant requirements of clause **14**.*

11.2 Heating

When the apparatus is operated under fault conditions, no part shall reach such a temperature that:

— there is a danger of fire to the surroundings of the apparatus;

— safety is impaired by abnormal heat developed in the apparatus.

*Compliance is checked by the tests of **11.2.1**.*

During the tests any flame inside the apparatus shall extinguish within a period of 10 s.

During the test, solder may soften or become fluid as long as the apparatus does not become unsafe within the sense of this standard.

In addition, solder terminations shall not be used as a protective mechanism with the exception of solder which is intended to melt, for example that of THERMAL LINKS.

11.2.1 ***Measurement of temperature rises***

The apparatus is operated under fault conditions and the temperature rises are measured after a steady state has been attained, but not later than after 4 h operation of the apparatus.

*During this period, the apparatus shall meet the requirements of **11.2.2** up to and including **11.2.6**.*

In the case where an applied fault condition results in the interruption of the current before steady state has been reached, the temperature rises are measured immediately after the interruption.

If the temperature is limited by fuses, the following additional test is carried out if necessary in relation to the characteristic of the fuse.

The fuse-link is short-circuited during the test and the current passing through both the fuse-link and the short-circuit link under the relevant fault condition, is measured:

— if this current remains less than 2,1 times the rated current of the fuse-link, the temperatures are measured after a steady state has been attained;

— if this current is either immediately 2,1 times the rated current of the fuse-link or more, or reaches this value after a period of time, equal to the maximum pre-arcing time for the relevant current through the fuse-link under consideration, both the fuse-link and the short-circuit link are removed after an additional time corresponding to the maximum pre-arcing time of the fuse-link under consideration and the temperatures are measured immediately.

If the fuse resistance influences the current of the relevant circuit, the maximum resistance value of the fuse-link shall be taken into account when establishing the value of the current.

NOTE The above test is based on the fusing characteristics specified in IEC 60127, which also gives the information necessary to calculate the maximum resistance value.

In determining the current through the fuse, consideration should be given to the fact that this current may vary as a function of time. It should therefore be measured as soon as possible after switching on, taking into account any delay time for full operation of the circuit under consideration.

*If a temperature rise exceeding the value given in Table 2 is due to short-circuiting an insulation, the apparatus is not deemed to be unsatisfactory, but this insulation shall withstand a dielectric strength test as described in **10.3**.*

*If a temperature rise exceeding the value given in Table 2 is due to short-circuiting or disconnecting a resistor, a capacitor, an RC-unit, an optocoupler or an inductor, the apparatus is deemed to be satisfactory if the component complies with the relevant requirements of clause **14** (see **4.3.4**).*

*If a temperature rise exceeding the value given in Table 2 is due to the disconnection of a resistor, the overload test specified in **14.1** b) is repeated on the resistor mounted in the apparatus, including the connections made by the manufacturer.*

During this test, the connections shall not fail.

11.2.2 ***ACCESSIBLE* parts**

The temperature rise of ACCESSIBLE parts shall not exceed the values given in Table 2, item a), "fault conditions".

11.2.3 ***Parts, other than windings, providing electrical insulation***

The temperature rise of insulating parts, other than windings, the failure of which would cause an infringement of the requirements of **11.1**, **11.2.2**, **11.2.4** and **11.2.6**, shall not exceed the values given in Table 2, item b) "fault conditions", with the following exceptions:

— For PRINTED BOARDS, the temperature rise may exceed, for a maximum period of 5 min, the values given in Table 2, item b) "fault conditions", by not more than 100 K.

— For PRINTED BOARDS withstanding the flame test described in **20.1.3**, the temperature rise may exceed:

a) the values given in Table 2, item b) "fault conditions", by not more than 100 K on one or more small areas providing that the total area does not exceed 2 cm^2 for each fault condition and no electric shock hazard is involved, or

b) for a maximum period of 5 min, the values given in Table 2, item b) "fault conditions", up to the temperature rise value given for "other parts" in Table 2, item e) "fault conditions", on one or more small areas, providing that the total area does not exceed 2 cm^2 for each fault condition and no electric shock hazard is involved.

If a temperature rise value is exceeded and if there is doubt as to whether or not an electric shock hazard exists, a short-circuit is applied between the conductive parts concerned and the tests of ***11.1*** *are repeated.*

If conductors on PRINTED BOARDS are interrupted, peeled or loosened during the test, the apparatus is still deemed to be satisfactory if all of the following conditions are met:

— the PRINTED BOARD complies with ***20.1.3****;*

— the interruption is not a POTENTIAL IGNITION SOURCE;

— the apparatus complies with the requirements of this subclause with the interrupted conductors bridged;

— any peeled or loosened conductor does not reduce the CLEARANCES and CREEPAGE DISTANCES between HAZARDOUS LIVE parts and ACCESSIBLE parts below the values specified in clause ***13****;*

— for CLASS I apparatus the continuity of any protective earth connection is maintained; loosening of such a conductor is not allowed.

11.2.4 ***Parts acting as a support or a mechanical barrier.***

The temperature rise of parts whose mechanical failure may cause an infringement of the requirements of **9.1.1** shall not exceed the values given in Table 2, item c) "fault conditions".

11.2.5 ***Windings***

The temperature rise of windings shall not exceed the values given in Table 2, items b) and d) "fault conditions", with the following exceptions:

— If the temperature is limited due to the operation of replaceable or resettable protective devices, the temperature rises may be exceeded until 2 min after the operation of the device.

In the case of windings providing protection against electric shock or where a fault could result in a fire hazard, the test is carried out three times and the winding is then subjected to the dielectric strength test of ***10.3*** *without the humidity treatment of* ***10.2****, starting within 1 min after the temperature rise measurement.*

No failure is allowed.

— If the temperature is limited due to the operation of an integral non-resettable or a non-replaceable protective device or due to the open circuiting of a winding, the temperature rises may be exceeded but the test shall be carried out three times using new components.

In the case of windings providing protection against electric shock or where a fault could result in a fire hazard, the winding is then in each case subjected to the dielectric strength test of ***10.3*** *without the humidity treatment of* ***10.2****, starting within 1 min after the temperature rise measurement.*

No failure is allowed.

— Higher temperature rises are allowed for windings, provided a failure of their insulation cannot cause an electric shock hazard or a fire hazard and that they are not connected to sources capable of supplying power in excess of 5 W under normal operating conditions.

— If a temperature rise value is exceeded and if there is doubt as to whether or not a hazard exists, the insulation concerned is short-circuited and the tests of **11.1** and **11.2.2** are repeated.

NOTE If the insulation is incorporated in a winding in such a way that its temperature rise cannot be measured directly, the temperature is assumed to be the same as that of the winding wire.

11.2.6 ***Parts not subject to a limit under 11.2.1 to 11.2.5 inclusive***

According to the nature of the material, the temperature rise of the part shall not exceed the values given in Table 2, item e) "fault conditions".

12 Mechanical strength

12.1 Complete apparatus

The apparatus shall have adequate mechanical strength and be so constructed as to withstand such handling as may be expected during intended use.

The apparatus shall be so constructed that short-circuiting of insulations between HAZARDOUS LIVE parts and ACCESSIBLE conductive parts or parts conductively connected to those, for example by unintended loosening of screws, is prevented.

Compliance, except for devices forming a part of the MAINS plug, is checked by the tests of ***12.1.1, 12.1.2*** *and* ***12.1.3****.*

NOTE Devices forming a part of the MAINS plug are subjected to the tests as described in **15.4**.

12.1.1 ***Bump test***

Apparatus with a mass exceeding 7 kg are subjected to the following test:

The apparatus is placed on a horizontal support of wood which is allowed to fall 50 times from a height of 5 cm onto a wooden table.

After the test, the apparatus shall show no damage in the sense of this standard.

12.1.2 ***Vibration test***

TRANSPORTABLE APPARATUS intended to be used for audio amplification of musical instruments, PORTABLE APPARATUS and apparatus having a metal enclosure, are subjected to a vibration endurance conditioning by sweeping, as specified in IEC 60068-2-6.

The apparatus is fastened in its intended positions of use to the vibration-generator by means of straps round the enclosure. The direction of vibration is vertical, and the severity is:

Duration	*30 min*
Amplitude	*0,35 mm*
Frequency range	*10 Hz ... 55 Hz ... 10 Hz*
Sweep rate	*approximately 1 octave/min.*

After the test, the apparatus shall show no damage in the sense of this standard, in particular, no connection or part the loosening of which might impair safety shall have loosened.

12.1.3 ***Impact test***

The apparatus is held firmly against a rigid support and is subjected to three blows from a spring-operated impact hammer according to IEC 60068-2-75, applied with a kinetic energy just before impact of 0,5 J to every point of the exterior that protects HAZARDOUS LIVE parts and is likely to be weak, including drawers in the pulled-out position, handles, levers, switch knobs and the like, by pressing the release cone perpendicularly to the surface.

This test is also made on windows, lenses, signal lamps and their covers, etc., but only if they protrude from the enclosure by more than 5 mm or if the individual projected surface area exceeds 1 cm^2.

After the test, the apparatus shall withstand the dielectric strength test as specified in ***10.3*** *and shall show no damage in the sense of this standard; in particular, HAZARDOUS LIVE parts shall not have become ACCESSIBLE, enclosures shall show no visible cracks and insulating barriers shall not have been damaged.*

NOTE Damage to the finish, small dents which do not reduce CLEARANCES or CREEPAGE DISTANCES below the specified values, cracks which are not visible to the naked eye, surface cracks in fibre-reinforced mouldings and the like are ignored.

12.2 Fixing of actuating elements

Actuating elements, for instance knobs, push-buttons, keys and levers, shall be so constructed and fastened that their use will not impair the protection against electric shock.

Compliance is checked by the following tests.

Fixing screws, if any, are loosened and then tightened with 2/3 of the torque given in Table 12 and finally loosened for 1/4 turn.

The actuating elements are then subjected for 1 min to a torque corresponding to a force of 100 N applied at the periphery, but not more than 1 Nm and, for 1 min, to an axial pull of 100 N. If the mass of the apparatus is less than 10 kg, the pulling force is limited to the value corresponding to the mass of the apparatus but not less than 25 N.

For actuating elements such as push-buttons, keys and the like, on which only a pressure is exerted during intended use and which do not protrude more than 15 mm from the surface of the apparatus, the pulling force is limited to 50 N.

After these tests, the apparatus shall show no damage in the sense of this standard.

12.3 REMOTE CONTROL devices held in hand

Parts of REMOTE CONTROL devices intended to be held in hand and containing HAZARDOUS LIVE parts, shall have adequate mechanical strength and be so constructed as to withstand such handling as may be expected.

Compliance is checked by the following test:

The REMOTE CONTROL device, with its flexible cord, if any, shortened to 10 cm, is tested according to IEC 60068-2-32, procedure 2.

The barrel is rotated 50 times if the mass of the control device is up to 250 g and 25 times if the mass is greater than 250 g.

After the test, the device shall show no damage in the sense of this standard.

Parts of cable-connected REMOTE CONTROL devices, not intended to be held in hand, are tested as a part of the attended apparatus.

12.4 Drawers

Drawers which are intended to be partially pulled out from the apparatus shall have a stop of adequate mechanical strength in order to prevent HAZARDOUS LIVE parts becoming ACCESSIBLE.

Compliance is checked by the following test:

The drawer is pulled out in the intended manner until the stop prevents further movement. A force of 50 N is then applied for 10 s in the most unfavourable direction.

After the test, the apparatus shall show no damage in the sense of this standard; in particular no HAZARDOUS LIVE parts shall become ACCESSIBLE.

12.5 Antenna coaxial sockets mounted on the apparatus

Antenna coaxial sockets mounted on the apparatus and incorporating parts or components which isolate HAZARDOUS LIVE parts from ACCESSIBLE parts, shall be so constructed as to withstand such mechanical stresses as may be expected in the intended use.

Compliance is checked by the following tests, which are made in the order given.

After these tests, the apparatus shall show no damage in the sense of this standard.

Endurance test

A test plug as shown in Figure 8 is inserted and withdrawn from the socket 100 times. Care is to be taken not to damage the socket intentionally during insertion and withdrawal of the test plug.

Impact test

A test plug as shown in Figure 8 is inserted into the socket and three successive blows from the spring-operated hammer according to IEC 60068-2-75 are applied with a kinetic energy just before impact of 0,5 J to the same point on the plug in the most unfavourable direction.

Torque test

A test plug as shown in Figure 8 is inserted into the socket and a force of 50 N is applied for 10 s, without jerks, at right angles to the axis of the plug, the radial direction of the force being so as to stress those parts of the socket which are likely to be weak. The force is determined by using, for example, a spring balance attached by means of the hole in the test plug.

This test is made 10 times.

NOTE When antenna coaxial sockets different from IEC 60169-2 [3] are tested, a corresponding test plug of the same length is used for the tests.

13 CLEARANCES and CREEPAGE DISTANCES

13.1 General

13.1.1 CLEARANCES and CREEPAGE DISTANCES shall be dimensioned in accordance with **13.2**.

The values are the minimum values which shall be applied, except that they may be reduced by 1 mm for BASIC and SUPPLEMENTARY INSULATION and 2 mm for REINFORCED INSULATION if all the following three conditions are met:

— they are not between ACCESSIBLE conductive parts of an enclosure and HAZARDOUS LIVE parts, if they can be reduced by external forces, as specified in **9.1.7**;

— they are maintained by rigid construction;

— their insulation properties are not likely to be significantly affected by any deposition of conductive dust produced inside the apparatus, for example by the carbon brushes of commutator motors.

However, the minimum CLEARANCES and CREEPAGE DISTANCES shall not be reduced below two-thirds of the values given by the curves of Figure 9, taking into account any reduction allowed for wire enamel according to note 6 of Figure 9, with a minimum of 0,5 mm for BASIC INSULATION or SUPPLEMENTARY INSULATION, and with a minimum of 1 mm for REINFORCED INSULATION.

Except for insulation between parts of different polarity DIRECTLY CONNECTED TO THE MAINS, CLEARANCES and CREEPAGE DISTANCES smaller than those specified are allowed but are subject to the requirements of **4.3.1**, **4.3.2** and **11.2**.

The following conditions shall be applied during the assessment for compliance in accordance with **13.2**.

Movable parts shall be placed in the most unfavourable position.

In the determination of CLEARANCES and CREEPAGE DISTANCES between ACCESSIBLE parts and HAZARDOUS LIVE parts, when using the standard test finger, any ACCESSIBLE area of a non-conductive part is considered as being covered with a conductive layer (see Figure 3 as an example).

13.1.2 ***Jointed insulation***

Distances between conductive parts along uncemented joints shall be considered as CLEARANCES and CREEPAGE DISTANCES for which the values of Figure 9 apply.

For reliably cemented joints, complying with the following tests, CLEARANCES and CREEPAGE DISTANCES do not exist. In this case only **8.8** applies.

Compliance is checked by inspection, measurement and test.

For this test, enamelled winding wires, if any, are replaced by uninsulated wires.

The materials are considered to be cemented together, if they withstand the following test:

Three apparatus, components or subassemblies are subjected 10 times to the following temperature cycle:

— 68 h at (X ± 2) °C,

— 1 h at (25 ± 2) °C,

— 2 h at (0 ± 2) °C,

— 1 h at (25 ± 2) °C,

whereby X is the highest temperature measured under normal operating conditions on the apparatus, component or subassembly under consideration plus 10 K with a minimum of 85 °C.

*Two of the above apparatus, components or subassemblies are then subjected to the relevant dielectric strength test of **10.3**, however, the test voltages are multiplied by 1,6.*

*The remaining apparatus, component or subassembly is subjected to the relevant dielectric strength test of **10.3**, without the humidity treatment of **10.2**, however, the test voltage is multiplied by 1,6.*

The test is performed immediately at the end of the last period at highest temperature during the thermal cycling test.

NOTE The test voltage is higher than the normal test voltage in order to ensure that, if the surfaces are not cemented together, a breakdown occurs.

13.2 CLEARANCES and CREEPAGE DISTANCES: dimensions

CLEARANCES and CREEPAGE DISTANCES shall be dimensioned in accordance with Figure 9 taking into account the relevant conditions specified in the notes under the figure.

The specified CLEARANCES are not applicable to air gaps between the contacts of protective devices, switches of microgap construction and similar components where the CLEARANCE varies with the movement of the contacts.

CLEARANCES and CREEPAGE DISTANCES between parts of different polarity DIRECTLY CONNECTED TO THE MAINS shall have the values given in Figure 9, curve A, taking into account the reduction allowed in **13.1.1** and/or note 6 of Figure 9.

The minimum CLEARANCES and CREEPAGE DISTANCES between conductors, one of which may be CONDUCTIVELY CONNECTED TO THE MAINS, on PRINTED BOARDS complying with the pull-off and peel strength requirements of IEC 60249-2, are given in Figure 10, and for which the following applies:

— these distances only apply as far as overheating is concerned (see **11.2**) to the conductors themselves, but not to mounted components or associated soldered connections;

— coatings of lacquer or the like, except coatings according to IEC 60664-3, are ignored when measuring these distances.

*Compliance is checked by measurement taking into account the figures of Annex E, subject to conditions detailed in **13.1.1**.*

If necessary, forces shall be applied simultaneously to any point on internal parts and to the outside of conductive enclosures, in an endeavour to reduce the CLEARANCE while taking measurements. The forces shall have a value of:

— 2 N for internal parts;

— 30 N for enclosures.

The force shall be applied to the enclosure by means of the rigid test finger according to IEC 61032, test probe 11.

If a CLEARANCE consists of two or more airgaps in series separated by conductive parts, any gap of less than 0,2 mm width is ignored in computing the total distance.

13.3 For apparatus, subassemblies or components, not CONDUCTIVELY CONNECTED TO THE MAINS and which are enclosed, enveloped or hermetically sealed against ingress of dirt and moisture, the minimum internal CLEARANCES and CREEPAGE DISTANCES may be reduced to the values as given in Table 4.

NOTE 1 Examples of such constructions include hermetically sealed metal boxes, adhesive sealed plastic boxes, parts enveloped in a dip coat or by type A coatings according to IEC 60664-3 of PRINTED BOARDS.

NOTE 2 This reduction is only permitted as far as protection against electric shock as well as overheating is concerned.

Compliance is checked by inspection, measurement and by subjecting the apparatus, subassembly or component 10 times to the following temperature cycle:

— 68 h at (Y ± 2) °C,

— 1 h at (25 ± 2) °C,

— 2 h at (0 ± 2) °C,

— 1 h at (25 ± 2) °C,

whereby Y is the highest temperature measured under normal operating conditions of the apparatus, subassembly or component under consideration, with a minimum of 85 °C. In case of transformers, Y is the highest winding temperature measured under normal operating conditions, plus 10 K, with a minimum of 85 °C.

*The apparatus, subassembly or component is then subjected to the dielectric strength test of **10.3**.*

The tests are carried out on three samples.

No failure is allowed.

13.4 The distances between conductive parts internal to apparatus, subassemblies or components which are treated with insulating compound filling all voids, so that CLEARANCES and CREEPAGE DISTANCES do not exist, shall be subject only to the requirements of **8.8**.

NOTE Examples of such treatment include potting, encapsulation and vacuum impregnation.

*Compliance is checked in accordance with **13.3**, taking into account **8.8** together with the following:*

A visual inspection shall show that there are no cracks in the encapsulating, impregnating or other material, that coatings have not loosened or shrunk, and after sectioning the sample, that there are no significant voids in the material.

Table 4 — Minimum CLEARANCES and CREEPAGE DISTANCES (enclosed, enveloped or hermetically sealed constructions)

OPERATING VOLTAGE **up to and including** V (peak) a.c. or V d.c.	**Minimum CLEARANCES and CREEPAGE DISTANCES** mm
35	0,2
45	0,2
56	0,3
70	0,3
90	0,4
110	0,4
140	0,5
180	0,7
225	0,8
280	1,0
360	1,1
450	1,3
560	1,6
700	1,9
900	2,3
1 120	2,6
1 400	3,2
1 800	4,2
2 250	5,6
2 800	7,5
3 600	10,0
4 500	12,5
5 600	16,0
7 000	20,0
9 000	25,0
11 200	32,0
14 000	40,0

NOTE 1 The values are applicable to both BASIC and SUPPLEMENTARY INSULATION.
NOTE 2 The values for REINFORCED INSULATION shall be twice the values in the table.
NOTE 3 A minimum CTI (comparative tracking index) of 100 is required for the insulating materials used. The CTI rating refers to the value obtained in accordance with IEC 60112, solution A.
NOTE 4 Linear interpolation between the nearest two points is allowed, the calculated spacing being rounded to the next higher 0,1 mm increment.

13.5 For type B coated PRINTED BOARDS, insulation between conductors shall comply with the requirements of IEC 60664-3. This applies only to BASIC INSULATION.

NOTE For such PRINTED BOARDS, CLEARANCES and CREEPAGE DISTANCES under the coating do not exist.

14 Components

NOTE 1 Where components are part of a range of values it is usually not necessary to test every value within that range. If this range of values consists of several technologically homogeneous subranges, the samples should be representative of each of these subranges. Moreover, it is recommended, where possible, to make use of the concept of structurally similar components.
NOTE 2 When a certain flammability category according to IEC 60707 is required, reference is made to Annex G with respect to alternative test methods.
NOTE 3 When no flammability requirements are specified in this clause, reference is made to **20.1.1**.

14.1 Resistors

Resistors, the short-circuiting or disconnecting of which would cause an infringement of the requirements for operation under fault conditions (see clause **11**) and resistors bridging contact gaps of MAINS switches, shall have an adequate stable resistance value under overload.

Such resistors shall be positioned inside the enclosure of the apparatus.

Compliance is checked by test a) or test b), carried out on a sample of 10 specimens.

Before test a) or b), the resistance of each specimen is measured and the sample is then subjected to the damp heat test according to IEC 60068-2-3, severity 21 days.

a) For resistors connected between HAZARDOUS LIVE parts and ACCESSIBLE conductive parts and for resistors bridging contact gaps of MAINS switches, the 10 specimens are each subjected to 50 discharges at a maximum rate of 12/min, from a 1 nF capacitor charged to 10 kV in a test circuit as shown in Figure 5a.

After this test, the value of resistance shall not differ more than 20 % from the value measured before the damp heat test.

No failure is allowed.

b) For other resistors, the 10 specimens are each subjected to a voltage of such a value that the current through it is 1,5 times the value measured through a resistor, having a resistance equal to the specified rated value, which is fitted to the apparatus, when operated under fault conditions. During the test the voltage is kept constant.

The value of resistance is measured when steady state is attained and shall not differ more than 20 % from the value measured before the damp heat test.

No failure is allowed.

For resistors connected between HAZARDOUS LIVE parts and ACCESSIBLE conductive parts, the CLEARANCES and CREEPAGE DISTANCES between the terminations shall comply with the requirements of clause **13** for REINFORCED INSULATION.

Resistors with internal end-lead terminations are allowed only if the internal spacings are clearly and precisely defined.

Compliance is checked by measurement and inspection.

14.2 Capacitors and RC-units

Where reference is made to the tests specified in IEC 60384-14, Table II, these tests are supplemented as follows:

The duration of the damp heat steady-state test as specified in IEC 60384-14, subclause **4.12**, shall be 21 days.

NOTE Reference is made to IEC 60384-14:1993, including amendment 1 (1995), irrespective of whether the capacitor or RC-unit is used for electromagnetic interference suppression purposes or not.

14.2.1 Capacitors or RC-units, the short-circuiting or disconnecting of which would cause an infringement of the requirements under fault conditions with regard to electric shock hazard shall:

a) withstand the tests for subclass Y2 or Y4 capacitors or RC-units as specified in IEC 60384-14, Table II.

Subclass Y2 capacitors or RC-units shall be applied for apparatus with rated MAINS voltages > 150 V and ≤ 250 V with respect to earth or neutral respectively.

Subclass Y4 capacitors or RC-units may be applied only for apparatus with rated MAINS voltages ≤ 150 V with respect to earth or neutral respectively.

b) withstand the tests for subclass Y1 or Y2 capacitors or RC-units as specified in IEC 60384-14, Table II.

Subclass Y1 capacitors or RC-units shall be applied for apparatus with rated MAINS voltages > 150 V and ≤ 250 V with respect to earth or neutral respectively.

Subclass Y2 capacitors or RC-units may be applied only for apparatus with rated MAINS voltages ≤ 150 V with respect to earth or neutral respectively.

NOTE For the application of a) and b), reference is made to **8.5** and **8.6**.

Such capacitors or RC-units shall be positioned inside the enclosure of the apparatus.

14.2.2 Capacitors or RC-units having their terminations DIRECTLY CONNECTED TO THE MAINS, shall withstand the tests for subclass X1 or X2 capacitors or RC-units as specified in IEC 60384-14, Table II.

Subclass X1 capacitors or RC-units shall be applied for PERMANENTLY CONNECTED APPARATUS intended for connection to a MAINS with a nominal voltage > 150 V and ≤ 250 V with respect to earth or neutral respectively.

Subclass X2 capacitors or RC-units may be used for all other applications.

NOTE 1 Y2 capacitors or RC-units may be used instead of X1 or X2 capacitors or RC-units.
NOTE 2 Y4 capacitors or RC-units may be used instead of X2 capacitors or RC-units in applications ≤ 150 V.

14.2.3 Capacitors or RC-units in a.c. circuits with MAINS frequency not CONDUCTIVELY CONNECTED TO THE MAINS, the short-circuiting of which would cause an infringement of the requirements with regard to overheating, shall withstand the tests for subclass X2 capacitors or RC-units as specified in IEC 60384-14, Table II.

The characteristics of the capacitors or RC-units shall be appropriate for their function in the apparatus under normal operating conditions.

14.2.4 (Intentionally kept free for future requirements for capacitors or RC-units other than those mentioned in **14.2.1** to **14.2.3**)

14.2.5 Capacitors or RC-units with a volume exceeding 1 750 mm^3 used in circuits where, when the capacitor or RC-unit is short-circuited, the current through the short-circuit exceeds 0,2 A, shall comply with the passive flammability requirements according to IEC 60384-1, subclause **4.38**, flammability category B or better. Capacitors or RC-units with a volume less than 1 750 mm^3 need not meet requirements for passive flammability.

When the distance between POTENTIAL IGNITION SOURCES and capacitors or RC-units with a volume exceeding 1 750 mm^3 does not exceed the values specified in Table 5, then these capacitors or RC-units shall comply with the relevant passive flammability requirements according to IEC 60384-1, subclause **4.38** as specified in Table 5 or better.

Where these capacitors or RC-units are shielded by a barrier meeting the flammability category FV 0 according to IEC 60707 or a barrier made of metal, no requirements shall apply. The barrier shall have dimensions covering at least the areas specified in Table 5 and shown in Figure 13.

These requirements are not applicable to capacitors or RC-units having a metal case. Thin coatings on such a case are ignored.

Table 5 — Flammability category related to distance from POTENTIAL IGNITION SOURCES

Open circuit voltage of the POTENTIAL IGNITION SOURCE	Distance from POTENTIAL IGNITION SOURCES to the capacitor or RC-unit downwards or sideways less than[a] mm	Distance from POTENTIAL IGNITION SOURCES to the capacitor or RC-unit upwards less than[a] mm	Passive flammability category according to IEC 60384-1
> 50V to ≤ 4 000 V (peak) a.c. or d.c.	13	50	B
> 4 kV (peak) a.c. or d.c.	D[b]	D[c]	B

[a] See Figure 13.
[b] Where D is 13 mm or the open-circuit voltage of the POTENTIAL IGNITION SOURCE in kilovolts, whichever is larger.
[c] Where D is 50 mm or the open-circuit voltage of the POTENTIAL IGNITION SOURCE in kilovolts, whichever is larger.

*Compliance is checked according to IEC 60384-1, subclause **4.38**.*

14.3 Inductors and windings

14.3.1 *Marking*

Inductors the failure of which can impair the safety of an apparatus, for example ISOLATING TRANSFORMERS, shall be marked with the manufacturer's name or trade mark and with a type or catalogue reference. The manufacturer's name and the type reference may be replaced by a code number.

Compliance is checked by inspection.

14.3.2 *General*

NOTE 1 Depending on the application in the apparatus attention is drawn to the requirements of **10.1** for the insulation of windings.

ISOLATING TRANSFORMERS shall comply with:

— **14.3.3** and

— **14.3.4.1** or **14.3.4.2** and

— **14.3.5.1** or **14.3.5.2**.

SEPARATING TRANSFORMERS shall comply with:

— **14.3.3** and

— **14.3.4.3** and

— **14.3.5.1** or **14.3.5.2**.

Other windings, for example induction motors where the power is supplied to the stator only, degaussing coils, relay coils, autotransformers, shall comply with **14.3.3.1**, **14.3.5.1** and **14.3.5.2** as far as applicable.

Transformers for switch mode power supplies (SMPS) shall comply with the requirements as for ISOLATING TRANSFORMERS as far as applicable.

NOTE 2 Special requirements for SMPS transformers are under consideration.

Insulating material of inductors and windings, except in thin sheet form, shall comply with **20.1.4**.

14.3.3 *Constructional requirements*

14.3.3.1 *All windings*

CLEARANCES and CREEPAGE DISTANCES shall comply with the requirements of clause **13**.

14.3.3.2 *Designs with more than one winding*

When an insulation barrier consisting of an uncemented pushed-on partition wall is used, CREEPAGE DISTANCES are measured through the joint. If the joint is covered by an adhesive bonding tape in accordance with IEC 60454, one layer of adhesive bonding tape is required on each side of the wall in order to reduce the risk of tape folding over during production.

The input and output windings shall be electrically separated from each other, and the construction shall be such that there is no possibility of any connection between these windings, either directly or indirectly through conductive parts.

In particular, precautions shall be taken to prevent:

— undue displacement of input or output windings, or the turns thereof;

— undue displacement of internal wiring, or wires for external connections;

— undue displacement of parts of windings, or of internal wiring, in the event of rupture of wires, or loosening of connections;

— wires, screws, washers and the like from bridging any part of the insulation between the input and output windings, including the connections of windings, should they loosen or become free.

The last turn of each winding shall be retained in a reliable manner, for example by tape, suitable bonding agent, or retention shall be implied by process technology.

Where cheekless bobbins are used, the end turns of each layer shall be retained in a reliable manner. Each layer can, for example, be interleaved with adequate insulation material projecting beyond the end turns of each layer and, moreover, either

— the windings shall be impregnated with hard-baking or cold-setting material, substantially filling the intervening spaces and effectively sealing-off the end turns, or

— the windings shall be held together by means of insulating material, or

— the windings shall, for example, be fixed by process technology.

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

Where serrated tape is used, the serrated part is disregarded as insulation.

Compliance is checked by inspection.

14.3.4 ***Separation between windings***

14.3.4.1 *Windings of CLASS II construction*

The separation between HAZARDOUS LIVE windings and windings intended to be connected to ACCESSIBLE conductive parts shall consist of DOUBLE or REINFORCED INSULATION according to **8.8**, except that for coil formers and partition walls providing REINFORCED INSULATION a thickness of at least 0,4 mm without additional requirements applies.

Where an intermediate conductive part, for example the iron core, not intended to be connected to ACCESSIBLE conductive parts is located between the relevant windings, the insulation between these windings via the intermediate conductive part shall consist of DOUBLE or REINFORCED INSULATION as mentioned above.

Compliance is checked by inspection and by measurement.

14.3.4.2 *Windings of CLASS I construction*

The separation between HAZARDOUS LIVE windings and windings intended to be connected to ACCESSIBLE parts may consist of BASIC INSULATION plus PROTECTIVE SCREENING only if all of the following conditions are complied with:

— the insulation between HAZARDOUS LIVE windings and the protective screen shall comply with the requirements for BASIC INSULATION according to **8.8** dimensioned for the HAZARDOUS LIVE voltage;

— the insulation between the protective screen and non-HAZARDOUS LIVE windings shall comply with the requirements for dielectric strength according to Table 3, item 2;

— the protective screen intended to be connected to a PROTECTIVE EARTH TERMINAL or contact shall be positioned between the input and output windings in such a way that the screen effectively prevents the input voltage being applied to any output winding in case of an insulation fault;

— the protective screen shall consist of a metal foil or of a wire wound screen extending at least the full width of one of the windings adjacent to the screen. A wire wound screen shall be wound tight without space between the turns;

— the protective screen shall be so arranged that its ends cannot touch each other nor touch simultaneously an iron core, in order to prevent losses due to creation of a shorted winding;

— the protective screen and its lead-out wire shall have a cross-sectional area sufficient to ensure that if a breakdown of insulation should occur, a fusing or interrupting device will open the circuit before the screen or the lead-out wire is destroyed;

— the lead-out wire shall be connected to the protective screen in a reliable manner, for example by soldering, welding, riveting or crimping.

Compliance is checked by inspection and by measurement.

14.3.4.3 *Windings of separating construction*

The separation between HAZARDOUS LIVE windings and windings intended to be connected to parts separated from ACCESSIBLE parts by SUPPLEMENTARY INSULATION only shall consist of at least BASIC INSULATION according to **8.8**.

Compliance is checked by inspection and by measurement.

14.3.5 ***Insulation between HAZARDOUS LIVE parts and ACCESSIBLE parts***

14.3.5.1 *Windings of CLASS II construction*

The insulation between HAZARDOUS LIVE windings and ACCESSIBLE parts or parts intended to be connected to ACCESSIBLE conductive parts, for example the iron core,

and

the insulation between HAZARDOUS LIVE parts, for example the iron core connected to a HAZARDOUS LIVE winding, and windings intended to be connected to ACCESSIBLE conductive parts,

shall consist of DOUBLE or REINFORCED INSULATION according to **8.8**, except that for coil formers and partition walls providing REINFORCED INSULATION a thickness of at least 0,4 mm without additional requirements applies.

Compliance is checked by inspection and measurement.

14.3.5.2 *Windings of CLASS I construction*

The insulation between HAZARDOUS LIVE windings and ACCESSIBLE conductive parts or parts intended to be connected to ACCESSIBLE conductive parts connected to a PROTECTIVE EARTH TERMINAL or contact, for example the iron core,

and

the insulation between HAZARDOUS LIVE parts, for example the iron core connected to a HAZARDOUS LIVE winding, and winding wires or foils of protective screens intended to be connected to a PROTECTIVE EARTH TERMINAL or contact,

shall consist of BASIC INSULATION according to **8.8**.

The winding wires of windings intended to be connected to a PROTECTIVE EARTH TERMINAL or contact shall have a current carrying capacity sufficient to ensure that, if a breakdown of insulation should occur, a fusing or interrupting device will open the circuit before the winding is destroyed.

Compliance is checked by inspection and measurement.

14.4 High voltage components and assemblies

NOTE For high voltage cables reference is made to **20.1.2**.

Components operating at voltages exceeding 4 kV (peak) and spark gaps provided to protect against overvoltages, if not otherwise covered by **20.1.3**, shall not give rise to danger of fire to the surroundings of the apparatus, or to any other hazard within the sense of this standard.

*Compliance is checked by meeting the requirement for category FV1 according to IEC 60707 or by the test of **14.4.1**, in which no failure is allowed.*

14.4.1 ***High voltage transformers and multipliers***

Three specimens of the transformer with one or more high-voltage windings or of the high-voltage multipliers are subjected to the treatment specified under item a), followed by the test specified under item b).

a) Preconditioning

For transformers, a power of 10 W (d.c. or a.c. at MAINS frequency) is initially supplied to the high-voltage winding. This power is sustained for 2 min, after which it is increased by successive steps of 10 W at 2 min intervals to 40 W.

The treatment lasts 8 min or is terminated as soon as interruption of the winding or appreciable splitting of the protective covering occurs.

NOTE 1 Certain transformers are so designed that this preconditioning cannot be carried out. In such cases, only the test of item b) below is applied.

For high-voltage multipliers, a voltage taken from an appropriate high-voltage transformer, is supplied to each specimen, its output circuit being short-circuited.

The input voltage is adjusted so that the short-circuit current is initially (25 ± 5) mA. This is maintained for 30 min or is terminated as soon as any interruption of the circuit or appreciable splitting of the protective covering occurs.

NOTE 2 Where the design of a high-voltage multiplier is such that a short-circuit current of 25 mA cannot be obtained, a preconditioning current is used, which represents the maximum attainable current, determined either by the design of the multiplier or by its conditions of use in a particular apparatus.

b) Flame test

*The specimen is subjected to the flame test of clause **G.1.2**, Annex G.*

14.5 Protective devices

The application of protective devices shall be in accordance with their rated values.

External CLEARANCES and CREEPAGE DISTANCES of protective devices and their connections shall meet the requirements for BASIC INSULATION of clause **13** for the voltage across the device when opened.

Compliance is checked by measurement or calculation.

14.5.1 ***THERMAL RELEASES***

THERMAL RELEASES used in order to prevent the apparatus from becoming unsafe within the sense of this standard shall comply with **14.5.1.1**, **14.5.1.2** or **14.5.1.3** respectively, whichever is applicable.

14.5.1.1 THERMAL CUT-OUTS shall meet one of the following requirements:

a) The THERMAL CUT-OUT when tested as a separate component, shall comply with the requirements and tests of IEC 60730 series as far as applicable.

For the purpose of this standard the following applies:

— the THERMAL CUT-OUT shall be of type 2 action (see IEC 60730-1, subclause **6.4.2**);

— the THERMAL CUT-OUT shall have at least MICRO-DISCONNECTION (type 2B) (see IEC 60730-1, subclauses **6.4.3.2** and **6.9.2**);

— the THERMAL CUT-OUT shall have a TRIP-FREE mechanism in which contacts cannot be prevented from opening against a continuation of a fault (type 2E) (see IEC 60730-1, subclause **6.4.3.5**);

— the number of cycles of automatic action shall be at least

- 3 000 cycles for THERMAL CUT-OUTS with automatic reset used in circuits which are not switched-off when the apparatus is switched-off (see IEC 60730-1, subclause **6.11.8**),
- 300 cycles for THERMAL CUT-OUTS with automatic reset used in circuits which are switched-off together with the apparatus and for THERMAL CUT-OUTS with no automatic reset which can be reset BY HAND from the outside of the apparatus (see IEC 60730-1, subclause **6.11.10**),
- 30 cycles for THERMAL CUT-OUTS with no automatic reset and which cannot be reset BY HAND from the outside of the apparatus (see IEC 60730-1, subclause **6.11.11**);

— the THERMAL CUT-OUT shall be tested as designed for a long period of electrical stress across insulating parts (see IEC 60730-1, subclause **6.14.2**);

— the THERMAL CUT-OUT shall meet the ageing requirements for an intended use of at least 10 000 h (see IEC 60730-1, subclause **6.16.3**);

— with regard to the dielectric strength, the THERMAL CUT-OUT shall meet the requirements of **10.3** of this standard, except across the contact gap, and except between terminations and connecting leads of the contacts, for which IEC 60730-1, subclauses **13.2** to **13.2.4** applies.

The characteristics of the THERMAL CUT-OUT with regard to:

— the ratings of the THERMAL CUT-OUT (see IEC 60730-1, clause **5**);

— the classification of the THERMAL CUT-OUT according to

- nature of supply (see IEC 60730-1, subclause **6.1**),
- type of load to be controlled (see IEC 60730-1, subclause **6.2**),
- degree of protection provided by enclosures against ingress of solid objects and dust (see IEC 60730-1, subclause **6.5.1**),
- degree of protection provided by enclosures against harmful ingress of water (see IEC 60730-1, subclause **6.5.2**),
- pollution situation for which the THERMAL CUT-OUT is suitable (see IEC 60730-1, subclause **6.5.3**),
- maximum ambient temperature limit (see IEC 60730-1, subclause **6.7**);

shall be appropriate for the application in the apparatus under normal operating conditions and under fault conditions.

Compliance is checked according to the test specifications of IEC 60730 series, by inspection and by measurement.

b) The THERMAL CUT-OUT when tested as a part of the apparatus shall:

— have at least MICRO-DISCONNECTION according to IEC 60730-1 withstanding a test voltage according to subclause **13.2** of IEC 60730-1, and

— have a TRIP-FREE mechanism in which contacts cannot be prevented from opening against a continuation of a fault, and

— be aged for 300 h at a temperature corresponding to the ambient temperature of the THERMAL CUT-OUT when the apparatus is operated under normal operating conditions at an ambient temperature of 35 °C (45 °C for apparatus intended for use in tropical climates), and

— be subjected to a number of cycles of automatic action as specified under a) for a THERMAL CUT-OUT tested as a separate component, by establishing the relevant fault conditions.

The test is made on three specimens.

No sustained arcing shall occur during the test.

After the test, the THERMAL CUT-OUT shall show no damage in the sense of this standard. In particular, it shall show no deterioration of its enclosure, no reduction of CLEARANCES and CREEPAGE DISTANCES and no loosening of electrical connections or mechanical fixings.

Compliance is checked by inspection and by the specified tests in the given order.

14.5.1.2 THERMAL LINKS shall meet one of the following requirements:

a) The THERMAL LINK when tested as a separate component, shall comply with the requirements and tests of IEC 60691.

The characteristics of the THERMAL LINK with regard to

— the ambient conditions (see IEC 60691, subclause **6.1**),

— the circuit conditions (see IEC 60691, subclause **6.2**),

— the ratings of the THERMAL LINK [see IEC 60691, subclause **8** b)],

— the suitability for sealing in or use with impregnating fluids or cleaning solvents [see IEC 60691, subclause **8** c)];

shall be appropriate for the application in the apparatus under normal operating conditions and under fault conditions.

The dielectric strength of the THERMAL LINK shall meet the requirements of **10.3** of this standard except across the disconnection (contact parts) and except between terminations and connecting leads of the contacts, for which IEC 60691, subclause **11.3** applies.

Compliance is checked according to the test specifications of IEC 60691, by inspection and measurement.

b) The THERMAL LINK when tested as a part of the apparatus shall be:

— aged for 300 h at a temperature corresponding to the ambient temperature of the THERMAL LINK when the apparatus is operated under normal operating conditions at an ambient temperature of 35 °C (45 °C for apparatus intended for use in tropical climates), and

— subjected to such fault conditions of the apparatus which cause the THERMAL LINK to operate. During the test no sustained arcing and no damage in the sense of this standard shall occur, and

— capable of withstanding two times the voltage across the disconnection and have an insulation resistance of at least 0,2 MΩ, when measured with a voltage equal to two times the voltage across the disconnection.

The test is made 10 times, no failure is allowed.

The THERMAL LINK is replaced, partially or completely, after each test.

NOTE When the THERMAL LINK cannot be replaced partially or completely, the complete component part comprising the THERMAL LINK, for example a transformer, should be replaced.

Compliance is checked by inspection and by the specified tests in the given order.

14.5.1.3 Thermal interrupting devices which are intended to be reset by soldering shall be tested according to **14.5.1.2** b).

However, the interrupting element is not replaced after operation, but reset according to the instructions of the apparatus manufacturer or, in absence of instructions, soldered with standard 60/40 tin/lead solder.

NOTE Examples of interrupting devices which are intended to be reset by soldering, are THERMAL RELEASES, integrated, on power resistors, for example externally.

14.5.2 ***Fuse-links and fuse holders***

14.5.2.1 Fuse-links, DIRECTLY CONNECTED TO THE MAINS, used in order to prevent the apparatus from becoming unsafe within the sense of this standard shall comply with the relevant part of IEC 60127, unless they have a rated current outside the range specified in that standard.

In the latter case, they shall comply with the relevant part of IEC 60127 as far as applicable.

Compliance is checked by inspection.

14.5.2.2 For fuse-links according to IEC 60127, the following marking shall be located on each fuse-holder or close to the fuse-link, in the given order:

— a symbol denoting the relative pre-arcing time/current characteristic;

examples are:

F, denoting quick acting;

T, denoting time lag;

— the rated current in milliamperes for rated currents below 1 A, and in amperes for rated currents of 1 A or more;

— a symbol denoting the breaking capacity of the assigned fuse-link;

examples are:

L, denoting low breaking capacity;

E, denoting enhanced breaking capacity;

H, denoting high breaking capacity.

Examples of marking: T 315 L or T 315 mA L

F 1,25 H or F 1,25 A H

However, it is permissible to locate the marking elsewhere, in or on the apparatus, provided that it is obvious to which fuseholder the marking applies.

The marking requirements apply also if the fuse-links have a rated current outside the range specified in IEC 60127.

Compliance is checked by inspection.

14.5.2.3 Fuse holders, so designed that fuse-links can be connected in parallel in the same circuit, shall not be used.

Compliance is checked by inspection.

14.5.2.4 If HAZARDOUS LIVE parts are rendered ACCESSIBLE during replacement of fusing or interrupting devices, access to such parts shall not be possible BY HAND operation.

Fuse-holders for miniature cartridge fuse-links of the screw-in or bayonet type shall, if removal of the fuse-carrier BY HAND is possible from the outside of the apparatus, be so constructed that HAZARDOUS LIVE parts do not become ACCESSIBLE, either during insertion or removal of the fuse-link, or after the fuse-link has been removed. Fuse holders in compliance with IEC 60127-6 satisfy this requirement.

When the fuse carrier is constructed to hold the fuse-link, the fuse-link is placed in the fuse-carrier during the test.

Compliance is checked by inspection.

14.5.3 ***PTC-S THERMISTORS***

PTC-S THERMISTORS used in order to prevent the apparatus from becoming unsafe within the sense of this standard shall comply with IEC 60738.

*Compliance is checked by inspection and by the tests of **11.2** of this standard.*

For PTC-S THERMISTORS whose power dissipation exceeds 15 W for the rated zero-power resistance at an ambient temperature of 25 °C, the encapsulation or tubing shall comply with the flammability category FV 1 or better according to IEC 60707.

*Compliance is checked according to IEC 60707 or according to clause **G.1.2** of Annex G.*

14.5.4 ***Protective devices not mentioned in 14.5.1, 14.5.2 or 14.5.3***

Such protective devices, for example fusing resistors, fuse-links not standardized in IEC 60127 or miniature circuit breakers, shall have adequate breaking capacity.

For non-resettable protective devices, such as fuse-links, a marking shall be located close to the protective device, so that correct replacement is possible.

*Compliance is checked by inspection and during the tests under fault conditions (see **11.2**).*

The test under fault condition is carried out three times.

No failure is allowed.

14.6 Switches

14.6.1 PERMANENTLY CONNECTED APPARATUS shall be provided with an ALL-POLE MAINS SWITCH, except when the requirement of **5.4.2** is met.

The ALL-POLE MAINS SWITCH shall have a contact separation of at least 3 mm in each pole.

14.6.2 Apparatus, which under normal operating conditions has a power consumption exceeding 15 W and/or employs a peak voltage exceeding 4 kV, shall be provided with a MANUALLY OPERATED MECHANICAL SWITCH.

The switch shall be so connected that, when it is in the off-position, the power consumption of circuits remaining under voltage does not exceed 15 W and/or peak voltages do not exceed 4 kV under normal operating conditions and under fault conditions according to **4.3**.

The switch shall be so placed that it is readily operable by the USER but shall not be fitted in the MAINS flexible cable or cord.

Irrespective of power consumption, no switch is required for apparatus or parts of apparatus having independent functions and not employing voltages exceeding 4 kV (peak) under normal operating conditions, provided that

— they are capable of being switched-on or -off, or both, automatically and without human intervention at the time of switching, for example clock radios, video recorders, apparatus controlled by a data link, or

— they are intended for continuous operation, for example antenna amplifiers, RF converters and modulators, devices forming a part of the MAINS plug.

Compliance is checked by inspection and by measurements.

*The measurements under fault conditions, as specified in **4.3**, are carried out 2 min after the application of a fault.*

14.6.3 On apparatus for which a MANUALLY OPERATED MECHANICAL SWITCH is required according to **14.6.2**, the on-position of the switch shall be indicated.

NOTE The indication of the on-position may be in the form of marking, illumination, audible indication or other suitable means.

Where the indication is in the form of marking, the relevant requirements of clause **5** shall be complied with.

Marking of the off-position by the relevant symbol ◯ (60417-2-IEC-5008) is permitted only for ALL-POLE MAINS SWITCHES.

Where marking, signal lamps or similar means might give the impression that the apparatus is completely switched-off from the MAINS, information which states clearly the correct situation shall be included in the instructions for use. If symbols are used, their meaning shall also be explained.

Compliance is checked by inspection.

14.6.4 Apparatus, which can be brought into operation from a STAND-BY mode and where a MANUALLY OPERATED MECHANICAL SWITCH is required in accordance with **14.6.2**, shall be provided with an indication to show the STAND-BY mode.

NOTE The indication of the STAND-BY mode may be in the form of marking, illumination, audible indication or other suitable means.

No indication is required, if the current consumption of the apparatus in the STAND-BY mode does not exceed 0,7 mA (peak) a.c. or d.c.

Compliance is checked by inspection.

14.6.5 Where resistors, capacitors or RC-units are used for bridging contact gaps of mechanical switches CONDUCTIVELY CONNECTED TO THE MAINS, the components shall comply with **14.1** a) or **14.2.2** respectively.

14.6.6

NOTE Switches controlling currents up to 0,2 A r.m.s. a.c. or d.c. need not meet any specification, provided that the voltage across the open switch contacts does not exceed 35 V (peak) a.c. or 24 V d.c.

MANUALLY OPERATED MECHANICAL SWITCHES controlling currents exceeding 0,2 A r.m.s. a.c. or d.c. shall meet one of the following requirements if the voltage across the open switch contacts exceeds 35 V (peak) a.c. or 24 V d.c.:

a) The switch tested as a separate component, shall comply with the requirements and tests of IEC 61058-1, whereby the following applies:

— the number of operating cycles shall be 10 000; (see IEC 61058-1, subclause **7.1.4.4**);

— the switch shall be suitable for use in a normal pollution situation (see IEC 61058-1, subclause **7.1.6.2**);

— the switch shall be of level 3 regarding the resistance to heat and fire (see IEC 61058-1, subclause **7.1.9.3**);

— for MAINS switches the speed of contact making and breaking shall be independent of the speed of actuation (see IEC 61058-1, subclause **13.1**). Moreover, MAINS switches shall comply with clause **G.1.1** of Annex G.

The characteristics of the switch with regard to:

— ratings of the switch (see IEC 61058-1, clause **6**);

— the classification of the switch according to:

- nature of supply (see IEC 61058-1, subclause **7.1.1**),
- type of load to be controlled by the switch (see IEC 61058-1, subclause **7.1.2**),
- ambient air temperature (see IEC 61058-1, subclause **7.1.3**);

shall be appropriate for the function of the switch under normal operating conditions.

Compliance is checked according to test specifications of IEC 61058-1, by inspection and by measurements.

*If the switch is a MAINS switch which controls MAINS socket-outlets, the total rated current and the peak surge current of the socket-outlets as specified in **14.6.10** shall be taken into account for the measurement.*

b) The switch tested as part of the apparatus working under normal operating conditions, shall meet the requirements of **14.6.7**, **14.6.10** and **20.1.4**, and moreover:

— switches controlling currents exceeding 0,2 A r.m.s. a.c. or d.c. shall meet the requirements of **14.6.8** and **14.6.9** if the voltage across the open switch contacts exceeds 35 V (peak) a.c. or 24 V d.c.;

— switches controlling currents exceeding 0,2 A r.m.s. a.c. or d.c. shall meet the requirements of **14.6.8** if the voltage across the open switch contacts does not exceed 35 V (peak) a.c. or 24 V d.c.;

— switches controlling currents up to 0,2 A r.m.s. a.c. or d.c. shall meet the requirements of **14.6.9**. if the voltage across the open switch contacts exceeds 35 V (peak) a.c. or 24 V d.c.;

— MAINS switches shall comply with clause **G.1.1** of Annex G.

14.6.7 A switch tested according to **14.6.6** b) shall withstand, without excessive wear or other harmful effects, the electrical, thermal and mechanical stresses that occur during intended use and shall have a mechanism complying with IEC 61058-1, subclause **13.1**, for d.c. switches. Moreover, for MAINS switches the speed of contact making and breaking shall be independent of the speed of actuation.

*Compliance is checked according to IEC 61058-1, subclause **13.1**, and by the following endurance test:*

*The switch is subjected to 10 000 cycles of operation with a sequence according to IEC 61058-1, subclause **17.1.2**, excluding the increased-voltage test at accelerated speed specified in IEC 61058-1, subclause **17.2.4**, and under electrical and thermal conditions given by the normal operating conditions of the apparatus.*

The test is made on three specimens, no failure is allowed.

14.6.8 A switch tested according to **14.6.6** b) shall be so constructed that it does not attain excessive temperatures during intended use. The materials used shall be such that the performance of the switch is not adversely affected by the operation during intended use of the apparatus. In particular, the material and design of the contacts and terminations shall be such that the operation and performance of the switch is not adversely affected by their oxidation or other deterioration.

*Compliance is checked in the on-position under normal operating conditions and according to IEC 61058-1, subclause **16.2.2** d), l) and m), taking into account the total rated current I of MAINS socket-outlets, if any, including the peak surge current according to **14.6.10**.*

The temperature rise at the terminations shall not exceed 55 K during this test.

14.6.9 A switch tested according to **14.6.6** b) shall have adequate dielectric strength.

Compliance is checked by the following tests:

*The switch shall withstand a dielectric strength test as specified in **10.3**, without being previously subjected to the humidity treatment, the test voltage being decreased to 75 % of the corresponding test voltage specified in **10.3**, but not less than 500 V r.m.s. (700 V peak).*

— The test voltage is applied in the on-position between HAZARDOUS LIVE parts and ACCESSIBLE conductive parts or parts which are connected to ACCESSIBLE conductive parts, and in addition between the poles in case of a multipole switch.

— The test voltage is applied in the off-position across each contact gap. During the test, resistors, capacitors and RC-units in parallel to a contact gap may be disconnected.

14.6.10 *If the switch is a MAINS switch which controls MAINS socket-outlets, the endurance test is carried out with an additional load connected to the socket-outlets, consisting of the circuit shown in IEC 61058-1, Figure 9, taking into account IEC 61058-1, Figure 10.*

*The total rated current of the additional load shall correspond to the marking of the socket-outlets, see **5.2** c). The peak surge current of the additional load shall have a value as shown in Table 6.*

Table 6 — Peak surge current

Total rated current of the switch controlled socket-outlets A	Peak surge current A
Up to and including 0,5	20
Over 0,5 up to and including 1,0	50
Over 1,0 up to and including 2,5	100
Over 2,5	150

If the socket-outlets are marked with the currents which may be drawn, these values are chosen for the total rated current of the socket-outlets.

If the socket-outlets are marked with the powers which may be drawn, the total rated current of the socket-outlets is calculated from these values.

After the test, the switch shall show no damage in the sense of this standard. In particular, it shall show no deterioration of its enclosure, no reduction of CLEARANCES and CREEPAGE DISTANCES and no loosening of electrical connections or mechanical fixings.

*Compliance is checked by inspection and by the tests specified in **14.6.8** and/or **14.6.9** in the given order.*

14.7 SAFETY INTERLOCKS

SAFETY INTERLOCKS shall be provided where access BY HAND is possible to areas presenting hazards in the sense of this standard.

For requirements and test specifications reference is made to IEC 60950, subclause **2.8**.

14.8 Voltage setting devices and the like

The apparatus shall be so constructed that changing the setting from one voltage to another or from one nature of supply to another is unlikely to occur accidentally.

Compliance is checked by inspection and by manual test.

NOTE Changing of the setting which necessitates consecutive movements BY HAND is deemed to comply with this requirement.

14.9 Motors

14.9.1 Motors shall be so constructed as to prevent, in prolonged intended use, any electrical or mechanical failure impairing compliance with this standard. The insulation shall not be affected and contacts and connections shall be such that they do not work loose by heating, vibration, etc.

Compliance is checked by the following tests carried out on the apparatus under normal operating conditions.

a) The apparatus is connected to 1,06 times the RATED SUPPLY VOLTAGE and to 0,9 times the RATED SUPPLY VOLTAGE, each time for 48 h. Motors for short-time or intermittent operation are connected for periods in accordance with the operating time if limited by the construction of the apparatus.

In case of short-time operation, suitable cooling intervals are inserted.

NOTE 1 It may be convenient to carry out this test immediately after the test of **7.1**.

b) The motor is started 50 times while the apparatus is connected to 1,06 times the RATED SUPPLY VOLTAGE and 50 times while connected to 0,9 times the RATED SUPPLY VOLTAGE, each period of connection being at least 10 times the period from start to full speed, but not less than 10 s.

The intervals between starts shall be not less than three times the period of connection.

If the apparatus provides for more than one speed, the test is carried out at the most unfavourable speed.

*After these tests, the motor shall withstand the dielectric strength of **10.3**, no connection shall have loosened and there shall be no deterioration impairing the safety.*

NOTE 2 For induction motors with power supplied to the stator only, see also **14.3.2**.

14.9.2 Motors shall be so constructed or mounted that wiring, windings, commutators, slip- rings, insulations, etc., are not adversely affected by oil, grease or other substances to which they are exposed during intended use.

Compliance is checked by inspection.

14.9.3 Moving parts liable to cause personal injury shall be so arranged or enclosed as to provide adequate protection against this danger during intended use. Protective enclosures, guards and the like shall have adequate mechanical strength. They shall not be removable BY HAND.

Compliance is checked by inspection and by manual test.

14.9.4 For motors having phase-shifting capacitors, three-phase motors and series motors, IEC 60950, Annex B, clauses **B.8**, **B.9** and **B.10**, apply additionally.

14.10 Batteries

14.10.1 Batteries shall be so mounted that there is no risk of the accumulation of flammable gases and that the leakage of liquid cannot impair any insulation.

Compliance is checked by inspection.

14.10.2 If it is possible for the USER to replace rechargeable batteries, which can be recharged in the apparatus, by non-rechargeable batteries, special means, such as a separate charging contact on a rechargeable special battery-pack, shall be provided to avoid any current being supplied into the non-rechargeable batteries.

This requirement does not apply to batteries inside the apparatus, the replacement of which by the USER is not intended, for example batteries for memories.

Compliance is checked by inspection.

NOTE Additional requirements regarding the instructions for use are given in **5.4.1**.

14.10.3 Under normal operating conditions and under fault conditions,

— for rechargeable batteries neither the charging current nor the charging time,

— for lithium batteries neither the discharging current nor the reverse current,

shall exceed the permissible values given by the battery manufacturer.

Compliance is checked by measurement.

Lithium batteries shall be removed from the circuit and replaced by a short-circuit when measuring currents.

14.11 Optocouplers

Optocouplers shall comply with the constructional requirements of clause 8.

Internal and external CLEARANCES and CREEPAGE DISTANCES of optocouplers shall comply with **13.1.1**.

NOTE The internal boundaries are not considered to be reliable joints.

15 TERMINALS

15.1 Plugs and sockets

15.1.1 Plugs and appliance couplers for the connection of the apparatus to the MAINS and socket-outlets and interconnection couplers for providing MAINS power to other apparatus shall comply with the relevant IEC standards for plugs and socket-outlets, appliance couplers or interconnection couplers.

Examples of the relevant IEC publications are: IEC 60083 [1], IEC 60320, IEC 60884 and IEC 60906.

MAINS socket-outlets and interconnection couplers mounted on CLASS II apparatus shall only permit connection of other CLASS II apparatus.

MAINS socket-outlets and interconnection couplers mounted on CLASS I apparatus shall either allow connection of CLASS II apparatus only or shall be provided with protective earth contacts which are reliably connected to the PROTECTIVE EARTH TERMINAL or contact of the apparatus.

NOTE 3 For CLASS I apparatus, provision for both kinds of socket-outlets and interconnection couplers is allowed on the same apparatus.

NOTE 4 Socket-outlets allowing only the connection of CLASS II apparatus can be designed, for instance, similar to IEC 60906-1, standard sheets 3-1 or 3-2, or according to IEC 60320-2-2, standard sheets D or H.

Attention is drawn to the fact that a standard is under preparation (presently prEN 50074) for socket-outlets which allow connection of Class II appliances only.

For apparatus with socket-outlets providing MAINS power to other apparatus, measures shall be taken to ensure that plugs or appliance inlets for the connection of the apparatus to the MAINS cannot be overloaded, if the rated current of the plug or appliance connector is less than 16 A.

NOTE 5 Marking of the socket-outlets is not considered to be a suitable measure to prevent overloading.

Internal wiring of socket-outlets providing MAINS power to other apparatus shall have a nominal cross-sectional area as specified in **16.2** for external flexible cords.

*Compliance is checked according to the relevant standards, by inspection and according to **16.2**.*

15.1.2 Connectors other than for connecting MAINS power, shall be so designed that the plug has such a shape that insertion into a MAINS socket-outlet or appliance coupler is unlikely to occur.

NOTE Examples of connectors meeting this requirement are those constructed according to IEC 60130-2, IEC 60130-8, IEC 60130-9 [2], IEC 60169-2 or IEC 60169-3 [3], when used as prescribed. An example of a connector not meeting the requirements of this subclause is the so-called "Banana" plug.

Sockets for audio and video circuits of LOAD TRANSDUCERS indicated with the symbol of **5.2** b) shall be so designed, that a plug for antenna and earth, for audio and video circuits of LOAD TRANSDUCERS and SOURCE TRANSDUCERS and for data and similar circuits which are not indicated with the symbol of **5.2** b), cannot be inserted into them.

Compliance is checked by inspection.

15.1.3 TERMINALS and connectors used in output circuits of SUPPLY APPARATUS, whose output voltage is not a standard nominal MAINS voltage according to IEC 60038, Table I, shall not be compatible with those specified for household and similar general purposes, for example those described in IEC 60083 [1], IEC 60320, IEC 60884, IEC 60906.

Compliance is checked by inspection and by manual tests.

The TERMINAL or connector shall be designed for the loading which may appear under normal operating conditions and during intended use.

Compliance is checked according to IEC 60320 as far as safety is concerned, for instance with regard to shock hazard and heating.

15.2 Provisions for protective earthing

ACCESSIBLE conductive parts of CLASS I apparatus, which might assume a hazardous voltage in the event of a single insulation fault in BASIC INSULATION, and the protective earth contacts of socket-outlets shall be reliably connected to a PROTECTIVE EARTH TERMINAL within the apparatus.

Protective earth circuits shall not contain switches or fuses.

In SUPPLY APPARATUS of CLASS I with non-HAZARDOUS LIVE output voltage, output circuits shall not be connected to the protective earth conductor.

Protective earth conductors may be bare or insulated. If insulated, the insulation shall be green/yellow except in the following two cases:

a) for earthing braids, the insulation shall be either green/yellow or transparent;

b) for internal protective conductors in assemblies such as ribbon cables, busbars, flexible printed wiring, etc., any colour may be used provided that no misinterpretation of the use of the conductor is likely to arise.

Wires identified by the colour combination green/yellow shall be used only for protective earth connections.

For PERMANENTLY CONNECTED APPARATUS and for apparatus provided with a non-detachable flexible cord or cable, a separate PROTECTIVE EARTH TERMINAL shall be used, located adjacent to the MAINS TERMINALS, and shall comply with the requirements of **15.3** and, moreover, shall not serve to fix any other component.

If parts removable BY HAND have a protective earth connection, this connection shall be made before the current-carrying connections are established when placing the part in position, and the current-carrying connections shall be separated before the protective earth connection is interrupted when removing the part.

Conductive parts in contact with protective earth connections shall not be subject to significant corrosion due to electrochemical action. Combinations above the line in Annex F shall be avoided.

The PROTECTIVE EARTH TERMINAL shall be resistant to significant corrosion.

NOTE 1 Corrosion resistance may be achieved by a suitable plating or coating process.

Compliance is checked by inspection and by reference to the table of electro-chemical potentials in Annex F.

The resistance of the connection between the PROTECTIVE EARTH TERMINAL or contact, and parts required to be connected thereto, shall not exceed 0,1 Ω.

Compliance is checked by the following test:

The test shall be carried out for 1 min with a test current of 25 A a.c. or d.c. The test voltage shall not exceed 12 V.

The voltage drop between the PROTECTIVE EARTH TERMINAL or contact and the part to be connected thereto shall be measured and the resistance is calculated from the current and this voltage drop. The resistance of the protective earth conductor of the power supply cord shall not be included in the resistance measurement.

NOTE 3 Care should be taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test result.

15.3 TERMINALS for external flexible cords and for permanent connection to the MAINS supply

15.3.1 PERMANENTLY CONNECTED APPARATUS shall be provided with TERMINALS in which connection is made by means of screws, nuts or equally effective devices, for example screwless type clamping units according to IEC 60998-2-2 or TERMINALS according to IEC 60999.

Compliance is checked by inspection.

For inlet openings, reference is made to IEC 60335-1.

15.3.2 For apparatus with non-detachable MAINS supply cords, the connection of the individual conductors to the internal wiring of the apparatus shall be accomplished by any means that will provide a reliable electrical and mechanical connection, except that the supply conductors and the protective earthing conductor of a non-detachable MAINS cord or cable shall not be soldered directly to the conductors of a PRINTED BOARD.

Soldered, crimped and similar connections may be used for the connection of external conductors. For soldered or crimped connections, barriers shall be provided so that CLEARANCES and CREEPAGE DISTANCES cannot be reduced to less than the values specified in clause **13** should the conductor break away at a soldered joint or slip out of a crimped connection. Alternatively, the conductors shall be positioned or fixed in such a way that reliance is not placed upon the connection alone to maintain the conductors in position.

Compliance is checked by inspection, and, in case of doubt, by applying a pull of 5 N in any direction to the connection.

15.3.3 Screws and nuts which clamp external MAINS supply conductors shall have a thread conforming with ISO 261 or ISO 262, or a thread comparable in pitch and mechanical strength. They shall not serve to fix any other component, except that they may also clamp internal conductors if these are so arranged that they are unlikely to be displaced when fitting the MAINS supply conductors.

NOTE The terminations of a component (for example a switch) built into the apparatus may be used as TERMINALS for the supply of MAINS power to the apparatus, provided that they comply with the requirements of **15.3.1**.

Compliance is checked by inspection.

15.3.4 For the purpose of applying the requirements for MAINS supply cords:

— it is assumed that two independent fixings will not become loose at the same time;

— conductors connected by soldering are not considered to be adequately fixed unless they are held in place near to the termination, independently of the solder. However "hooking-in" before the soldering is, in general, considered to be a suitable means for maintaining the conductors of a MAINS supply cord in position, provided that the hole through which the conductor is passed is not unduly large;

— conductors connected to TERMINALS or terminations by other means are not considered to be adequately fixed unless an additional fixing is provided near to the TERMINAL or termination; this additional fixing may clamp both the insulation and the conductor.

15.3.5 TERMINALS for external flexible cords shall allow the connection of conductors having nominal cross-sectional areas as shown in Table 7.

For rated currents exceeding 16 A, reference is made to IEC 60950, Table 13.

Compliance is checked by inspection, by measurement and by fitting cords of the smallest and largest cross-sectional areas of the appropriate range shown in Table 7.

Table 7 — Nominal cross-sectional area to be accepted by TERMINALS

RATED CURRENT CONSUMPTION of the apparatus[a] A	Nominal cross-sectional area mm^2
Up to and including 3	0,5 to 0,75
Over 3 up to and including 6	0,75 to 1
Over 6 up to and including 10	1 to 1,5
Over 10 up to and including 16	1,5 to 2,5
[a] The RATED CURRENT CONSUMPTION includes currents which can be drawn from socket-outlets providing MAINS power for other apparatus.	

15.3.6 TERMINALS according to **15.3.3** shall have minimum sizes as shown in Table 8.

Stud TERMINALS shall be provided with washers.

For rated currents over 16 A, reference is made to IEC 60950, Table 14.

Compliance is checked by measurement and inspection.

Table 8 — Minimum nominal thread diameter

RATED CURRENT CONSUMPTION of the apparatus[a] A	Minimum nominal thread diameter mm	
	Pillar type or stud type	Screw type
Up to and including 10	3	3,5
Over 10 up to and including 16	3,5	4
[a] The RATED CURRENT CONSUMPTION includes currents which can be drawn from socket-outlets providing MAINS power for other apparatus.		

15.3.7 TERMINALS shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor.

TERMINALS shall be so designed or located that the conductor cannot slip out when the clamping screws or nuts are tightened.

TERMINALS shall be so fixed that, when the means of clamping the conductor is tightened or loosened:

— the TERMINAL itself does not work loose;

— internal wiring is not subjected to stress;

— CLEARANCES and CREEPAGE DISTANCES are not reduced below the values specified in clause **13**.

Compliance is checked by inspection and measurement.

15.3.8 TERMINALS in circuits carrying a current exceeding 0,2 A under normal operation conditions shall be so designed that contact pressure is not transmitted through insulating material other than ceramic, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage of the insulating material.

Compliance is checked by inspection.

15.3.9 For non-detachable MAINS supply cords, each TERMINAL shall be located in proximity to its corresponding TERMINALS of different potential and to the PROTECTIVE EARTH TERMINAL, if any.

Compliance is checked by inspection.

TERMINALS shall be so located, guarded or insulated that, should a strand of a flexible conductor escape when the conductor is fitted, there is no risk of accidental contact between such a strand and:

— ACCESSIBLE conductive parts or conductive parts connected to them;

— conductive parts not connected to the PROTECTIVE EARTH TERMINAL and separated from ACCESSIBLE conductive parts by SUPPLEMENTARY INSULATION only.

Compliance is checked by inspection and, unless a special cord is prepared in such a way as to prevent the escape of strands, by the following test.

An 8 mm length of insulation shall be removed from the end of a flexible conductor having the appropriate nominal cross-sectional area. One wire of the stranded conductor shall be left free and the other wires shall be fully inserted into, and clamped in the TERMINAL.

Without tearing the insulation back, the free wire shall be bent in every possible direction, but without making sharp bends round a guard.

If the conductor is HAZARDOUS LIVE, the free wire shall not touch any conductive part which is ACCESSIBLE or is connected to an ACCESSIBLE conductive part or, in the case of apparatus with DOUBLE INSULATION, any conductive part which is separated from ACCESSIBLE conductive parts by SUPPLEMENTARY INSULATION only.

If the conductor is connected to an earthing TERMINAL, the free wire shall not touch any HAZARDOUS LIVE part.

15.4 Devices forming a part of the MAINS plug

15.4.1 A device provided with pins intended to be introduced into fixed socket-outlets shall not impose undue strain on these socket-outlets.

Compliance is checked by engaging the device, as during intended use, with the socket-outlet of a test apparatus as shown in Figure 11. The balancing arm of the test apparatus pivots about a horizontal axis through the centre lines of the contact tubes of the socket-outlet at a distance of 8 mm behind the engagement face of the socket-outlet.

With the device not in engagement, the balancing arm is in equilibrium, the engagement face of the socket-outlet being in the vertical position.

After the device has been engaged, the torque to be applied to the socket-outlet to maintain its engagement face in the vertical plane is determined by the position of a weight on the balancing arm. The torque shall not exceed 0,25 Nm.

NOTE This test is compatible with the test described in the IEC 60884-1.

15.4.2 The device shall comply with the standards for the dimensions of MAINS plugs.

Compliance is checked by measurement in accordance with the relevant standard.

NOTE The dimensions of some types of MAINS plugs are specified in IEC 60083.

15.4.3 The device shall have adequate mechanical strength.

Compliance is checked by inspection and by the following tests:

a) The device shall be subjected to a drop test.

A sample of the complete device shall be subjected to three impacts that result from being dropped 1 m onto a horizontal surface in positions likely to produce the most adverse results.

The horizontal surface shall consist of hardwood of at least 13 mm thick, mounted on two layers of plywood each 19 mm to 20 mm thick, all supported on a concrete or equivalent non-resilient floor.

After the test, the specimen shall comply with the requirements of this standard, but it need not be operational.

NOTE 1 Small pieces may be broken off, provided that the protection against electric shock is not affected.
NOTE 2 Distortion of pins and damage to the finish and small dents which do not reduce the CLEARANCES or CREEPAGE DISTANCES below the values specified in clause **13**, are neglected.

b) The pins shall not turn when a torque of 0,4 Nm is applied, first in one direction for 1 min and then in the opposite direction for 1 min.

NOTE 3 This test is not carried out if rotation of the pins does not impair safety in the sense of this standard.

c) A pull force as given in Table 9 is applied, without jerks, for 1 min on each pin in turn, in the direction of the longitudinal axis of the pin.

The pull force is applied within a heating cabinet at a temperature of (70 ± 2) °C, 1 h after the device has been placed in the heating cabinet.

After the test, the device is allowed to cool down to ambient temperature, no pin shall have been displaced in the body of the device by more than 1 mm.

Table 9 — Pull force on pins

Ratings of the equivalent plug type	Number of poles	Pull force N
Up to and including 10 A	2	40
130/250 V	3	50
Over 10 A up to and including 16 A	2	50
130/250 V	3	54
Over 10 A up to and including 16 A	3	54
440 V	More than 3	70

For the purpose of this test, protective earth contacts, irrespective of their number, are considered as one pole.

Tests b) and c) are made separately, each with new samples.

16 External flexible cords

16.1 MAINS supply flexible cords shall be of the sheathed type complying with IEC 60227 for PVC cords or according to IEC 60245 for synthetic rubber cords.

Compliance is checked by testing MAINS supply flexible cords in accordance with IEC 60227 or IEC 60245.

Non-detachable flexible cables and cords of CLASS I apparatus shall be provided with a green/yellow core connected to the PROTECTIVE EARTH TERMINAL of the apparatus and, if a plug is provided, to the protective earth contact of the plug.

Compliance is checked by inspection.

NOTE 2 The colour code for cores of flexible MAINS cords is contained in IEC 60173 [4].

16.2 Power supply cord conductors shall have a nominal cross-sectional area not less than those shown in Table 10.

Table 10 — Nominal cross-sectional areas of external flexible cords

RATED CURRENT CONSUMPTION of the apparatus[a] A	Nominal cross-sectional area mm^2
Up to and including 3	0,5[b]
Over 3 up to and including 6	0,75
Over 6 up to and including 10	1
Over 10 up to and including 16	1,5

[a] The RATED CURRENT CONSUMPTION includes currents which can be drawn from the socket-outlets providing MAINS power for other apparatus.

[b] This nominal cross-sectional area is allowed only for CLASS II apparatus and provided that the length of the supply cord, measured between the point where the cord or the cord guard enters the apparatus, and the entry to the plug, does not exceed 2 m.

For higher currents, reference is made to IEC 60950, Table 11.

Compliance is checked by measurement.

16.3

a) Flexible cords, not complying with **16.1**, used as a connection between the apparatus and other apparatus used in combination with it, and comprising HAZARDOUS LIVE conductors, shall have adequate dielectric strength.

*Compliance is checked by applying the dielectric strength test using a sample of approximately 1 m length and by applying the relevant test voltage according to **10.3** for the grade of insulation under consideration as follows:*

*— for insulation of a conductor: by the voltage test method given in IEC 60885-1, subclauses **3.1** and **3.2**;*

— for SUPPLEMENTARY INSULATION, for example sleeving around a group of conductors: between a conductor inserted into the sleeve and metal foil wrapped tightly round the sleeve for a length of at least 100 mm.

NOTE Where a power supply cord, whose insulating properties comply with those of the cord types of **16.1**, is used inside the equipment, either as an extension of the external power supply cord or as an independent cable, its sheath is considered to be adequate SUPPLEMENTARY INSULATION for the purposes of this subclause.

b) Flexible cords not complying with **16.1**, used as connection between the apparatus and other apparatus used in combination with it, and comprising HAZARDOUS LIVE conductors, shall withstand bending and other mechanical stresses occurring during intended use.

*Compliance is checked by the test of IEC 60227-2, subclause **3.1**, except that the Table 11 applies.*

Table 11 — Mass and pulley diameter for stress test

Overall diameter of the flexible cable or cord mm	Mass kg	Pulley diameter mm
Up to and including 6	1,0	60
Over 6 up to and including 12	1,5	120
Over 12 up to and including 20	2,0	180

The carrier moves to and fro 15 000 times (30 000 movements).

*The voltage U between the conductors is the test voltage according to **10.3**.*

*During and after the test, the specimen shall withstand the dielectric strength test specified in **10.3**.*

16.4 Conductors of flexible cords used as a connection between the apparatus and other apparatus used in combination with it shall have a cross-sectional area such that the temperature rise of the insulation under normal operating conditions and under fault conditions is negligible.

Compliance is checked by inspection. In case of doubt, the temperature rises of the insulation are determined under normal operating conditions and under fault conditions. The temperature rises shall not exceed the values given in the appropriate columns of Table 2.

16.5 The apparatus shall allow the external flexible cords, comprising one or more HAZARDOUS LIVE conductors, to be so connected that the connecting points of the conductors are relieved from strain, that the outer covering is protected from abrasion, and that the conductors are prevented from twisting.

Moreover, it shall not be possible to push an external cord back into the apparatus through its aperture if this can impair safety in the sense of this standard.

The method by which the relief from strain and the prevention of twisting is provided shall be clearly seen.

Makeshift methods, such as tying the cord into a knot or tying the cord with a string, are not permitted.

The devices for strain and twist relief shall either be made of insulating material, or have a fixed covering of insulating material other than natural rubber, if an insulation fault of the cord may make ACCESSIBLE conductive parts HAZARDOUS LIVE.

For CLASS I apparatus, the arrangement of the TERMINALS for the MAINS supply flexible cord, or the length of the conductors between the device for strain and twist relief and the TERMINALS, shall be such that the HAZARDOUS LIVE conductors become taut before the conductor connected to the PROTECTIVE EARTH TERMINAL, if the cord slips out of the device for strain and twist relief.

Compliance is checked by inspection and by the following test.

The test is made with the type of flexible cord attached to the apparatus.

The apparatus is fitted with its flexible cord, the device for strain and twist relief being appropriately used. The conductors are introduced into the TERMINALS, and the TERMINAL screws, if any, are slightly tightened, so that the conductors cannot easily change their position.

After this preparation, pushing the cord further into the apparatus shall not be possible or shall cause no hazard in the sense of this standard.

A mark is made on the cord, under strain, near the aperture, and the flexible cord is subjected 100 times to a pull of 40 N for a duration of 1 s each. The pull shall not be applied in jerks.

Immediately afterwards, the cord is subjected for a period of 1 min to a torque of 0,25 Nm.

During the test, the cord shall not be displaced by more than 2 mm, the measurement being made while the cord is still under strain. The ends of the conductors shall not be noticeably displaced in the TERMINALS and no damage to the flexible cord shall be caused by the device for strain and twist relief.

16.6 Apertures for external flexible cords mentioned in **16.5** shall be so constructed that there is no risk of damage to the cord during its introduction or subsequent movement.

NOTE This can be done, for example, by rounding the edges of the aperture or by using an appropriate bushing of insulating material.

Compliance is checked by inspection and by fitting flexible cords.

16.7 TRANSPORTABLE APPARATUS, being musical instruments and their associated amplifiers, shall have an appliance inlet according to IEC 60320-1 for connection to the MAINS by detachable cord sets or shall have a means of stowage to protect the MAINS cord when not in use, for example a compartment, hooks or pegs.

Compliance is checked by inspection.

17 Electrical connections and mechanical fixings

17.1 Screw TERMINALS providing electrical contact and screw fixings which during the life of the apparatus will be loosened and tightened several times shall have adequate strength.

Screws exerting contact pressure and screws with a nominal diameter less than 3 mm which form part of the above-mentioned screw fixings shall screw into a metal nut or a metal insert.

However, screws having a nominal diameter less than 3 mm, which do not exert contact pressure, need not be screwed into metal, provided that the screw fixing withstands the torque specified in Table 12 for screws of 3 mm diameter.

Screw fixings which during the life of the apparatus will be loosened and tightened several times include TERMINAL screws, screws for fixing covers (as far as they must be loosened to open the apparatus), screws for fixing handles, knobs, legs, stands and the like.

Compliance is checked by the following test.

The screws are loosened and then tightened, with a torque according to Table 12:

— 5 times in the case of screws operating in a thread in metal;

— 10 times in the case of screws operating in wood, WOOD-BASED MATERIAL or in a thread in insulating material.

In the latter case, the screws are to be completely removed and reinserted each time.

The screws shall not be tightened in jerks.

After the test, there shall be no deterioration impairing safety in the sense of this standard.

The material in which the screws are inserted is verified by inspection.

Table 12 — Torque to be applied to screws

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

The test is made by means of a suitable test screwdriver, spanner or key, applying a torque as shown in Table 12, the appropriate column being:

- *— for metal screws without heads, if the screw, when tightened, does not protrude from the hole:* ***I***
- *— for other metal screws and for nuts:* ***II***
- *— for screws of insulating material:*
  - *having a hexagonal head with the dimension across flats exceeding the overall thread diameter, or*
  - *with a cylindrical head and a socket for a key, the socket having a dimension across flats not less than 0,83 times the overall thread diameter, or*
  - *with a head having a slot or cross slots, the length of which exceeds 1,5 times the overall thread diameter:* ***II***
- *— for other screws of insulating material:* ***III***

17.2 Means shall be provided to ensure the correct introduction of screws into female threads in non-metallic material, if they will be loosened and tightened several times during the life of the apparatus and contribute to safety in the sense of this standard.

Compliance is checked by inspection and by manual test.

NOTE This requirement is deemed to be met if introduction in a slanting manner is prevented, for example by guiding the screw in the part to be fixed by a recess in the nut or a lead to the screw.

17.3 Screws or other fixing devices intended to fix back covers, bottom covers, legs, stands or the like, shall be captive in order to prevent replacement during servicing by screws or other fixing devices, which might cause a reduction of CLEARANCES or CREEPAGE DISTANCES between ACCESSIBLE conductive parts or parts connected to them and HAZARDOUS LIVE parts below the values given in clause **13**.

Such screws need not be captive if, when replaced by screws having the same nominal diameter and a length of 10 times its nominal diameter, the distances are not less than those stated in clause **13**.

Compliance is checked by inspection and measurement.

17.4 Conductive parts permanently fixed together and carrying a current exceeding 0,2 A across their interface under normal operating conditions shall be secured in such a way that loosening is prevented.

Compliance is checked by inspection and by manual test.

NOTE 1 Sealing by compound or the like provides satisfactory locking only for screw connections not subject to torsion.
NOTE 2 If the fixing consists of more than one screw or rivet, only one of them need be locked.
NOTE 3 For rivets, a non-circular shank or an appropriate notch may be a sufficient guard against rotation.

17.5 Electrical connections in circuits carrying a current exceeding 0,2 A under normal operation conditions shall be so designed that contact pressure is not transmitted through insulating material other than ceramic, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage of the insulating material.

Compliance is checked by inspection.

17.6 Stranded conductors of flexible supply cords carrying a current exceeding 0,2 A under normal operating conditions, which are connected to screw TERMINALS, shall not be consolidated by lead-tin soldering where they are subject to contact pressure, unless the clamping means is so designed that there is no risk of a bad contact due to cold flow of the solder.

Compliance is checked by inspection.

17.7 Cover-fixing devices, which may be operated during the life of the apparatus, shall have adequate mechanical strength, if the failure of such devices would impair safety in the sense of this standard.

The locked and unlocked positions of these devices shall not be ambiguous, and it shall not be possible to unlock the devices inadvertently.

Compliance is checked by inspection, by operating the device and by one of the following tests:

— In the case of devices the operation of which is effected by a combination of rotary and linear movements, the device is locked and unlocked and the torques or forces necessary for this operation are measured. While the device is in the locked position, a torque or force of twice the value necessary to lock the device, with a minimum of 1 Nm or 10 N is applied in the locking direction, unless it is unlocked by a smaller torque or force in the same direction.

This operation is performed 10 times.

The torque or force necessary to unlock the device shall be at least 0,1 Nm or 1 N.

— In the case of covers fixed by means of snap fasteners, the cover is removed and replaced 10 times in the intended way.

*After this test the cover shall still comply with the tests by means of the rigid test finger and the test hook described in **9.1.7** a) and b).*

17.8 Detachable legs or stands supplied by the manufacturer of the apparatus shall be delivered with the relevant fixing means.

Compliance is checked by inspection.

17.9 Internal pluggable connections shall be so designed that unintended loosening is unlikely, if the loosening can impair the safety in the sense of this standard.

Compliance is checked by inspection and in case of doubt by applying a pull of 2 N in any direction to the connection.

NOTE For other internal connections, see **8.11**.

18 Mechanical strength of picture tubes and protection against the effects of implosion

18.1 Picture tubes with a maximum face dimension exceeding 16 cm either shall be intrinsically protected with respect to effects of implosion and to mechanical impact, or the enclosure of the apparatus shall provide adequate protection against the effects of an implosion of the tube.

A non-intrinsically protected picture tube shall be provided with an effective protective screen which cannot be removed BY HAND. If a separate screen of glass is used, it shall not be in contact with the surface of the tube.

Compliance is checked by inspection, by measurement, and by the tests of:

*— **18.2** for intrinsically protected tubes, including those having integral protective screens;*

*— **18.3** for apparatus having non-intrinsically protected tubes.*

NOTE 1 A picture tube is considered to be intrinsically protected with respect to the effects of implosion if, when it is correctly mounted, no additional protection is necessary.
NOTE 2 To facilitate the tests, the tube manufacturer may indicate the most vulnerable area on the tubes to be tested.

18.2 Intrinsically protected picture tubes, including those having integral protective screens

*Each of the tests of **18.2.2** and **18.2.3** is made on six tubes, three of which are tested as received and the others after having been subjected to the ageing process of **18.2.1**.*

No failure is allowed.

*For the tests of **18.2.2** and **18.2.3**, the tubes are mounted in a test cabinet, according to the instructions given by the manufacturer of the tube, the cabinet being placed on a horizontal support at a height of (75 ± 5) cm above the floor.*

Care is taken that, during the tests, the cabinet does not slide on the support.

NOTE The following description of a test cabinet is given as an example:

— the cabinet is made of plywood, with a thickness of about 12 mm for tubes having a maximum face dimension not exceeding 50 cm and of about 19 mm for larger tubes;

— the outside dimensions of the cabinet are approximately 25 % larger than the overall dimensions of the tube;

— the front of the cabinet is provided with an opening closely surrounding the tube when mounted. The back of the cabinet is provided with an opening, 5 cm in diameter, and rests against a wooden bar, about 25 mm high, which is fixed to the support and prevents the cabinet from sliding.

18.2.1 ***Ageing process***

The ageing process is as follows:

a) Damp heat conditioning:

24 h at (25 ± 2) °C and 90 % to 95 % relative humidity

24 h at (45 ± 2) °C and 75 % to 80 % relative humidity

24 h at (25 ± 2) °C and 90 % to 95 % relative humidity

b) Change of temperature consisting of two cycles, each comprising:

1 h at (+ 20 ± 2) °C

1 h at (– 25 ± 2) °C

1 h at (+ 20 ± 2) °C

1 h at (+ 50 ± 2) °C

NOTE The change of temperature is not intended to cause severe thermal stress on the picture tube, and may be achieved using one or two chambers.

b) Damp heat conditioning as indicated under a).

18.2.2 ***Implosion test***

Cracks are propagated in the envelope of each tube by the following method:

An area on the side or on the face of each tube is scratched (see Figure 12) with a diamond stylus and this place is repeatedly cooled with liquid nitrogen or the like until a fracture occurs. To prevent the cooling liquid from flowing away from the test area, a dam of modelling clay or the like should be used.

After this test, no particles having a mass exceeding 2 g shall have passed a 25 cm high barrier placed on the floor 50 cm from the projection of the front of the tube and no particles shall have passed a similar barrier at 200 cm.

18.2.3 ***Mechanical strength test***

Each tube is subjected to one impact of a hardened steel ball having a Rockwell hardness of at least R62 and a diameter of 40^{+1}_{0} *mm, and which is suspended from a fixed point by means of a string.*

Keeping the string straight, the ball is raised and then allowed to fall onto any place on the face of the tube from a height such that the vertical distance between the ball and the point of impact is:

— 210 cm for tubes having a maximum face dimension exceeding 40 cm;

— 170 cm for other tubes.

The point of impact on the face of the tube shall be at least 20 mm from the border of its useful area.

After this test, no particles having a mass exceeding 10 g shall have passed a 25 cm high barrier, placed on the floor, 150 cm from the projection of the front of the tube.

18.3 Non-intrinsically protected picture tubes

The apparatus, with the picture tube and the protective screen in position, is placed on a horizontal support at a height of (75 ± 5) cm above the floor, or directly on the floor if the apparatus is obviously intended to be positioned on the floor.

The tube is made to implode inside the enclosure of the apparatus by the method described in ***18.2.2****.*

After this test, no particles having a mass exceeding 2 g shall have passed a 25 cm high barrier, placed on the floor, 50 cm from the projection of the front of the apparatus, and no particle shall have passed a similar barrier at 200 cm.

19 Stability and mechanical hazards

Apparatus having a mass exceeding 18 kg shall have adequate stability.

In addition, the stability shall be ensured when legs or stands supplied by the manufacturer are fitted.

Compliance is checked by the tests of ***19.1*** *and* ***19.2****.*

During the tests, the apparatus shall not overbalance.

19.1 *The apparatus is placed in its intended position of use on a plane, inclined at an angle of 10° to the horizontal, and then rotated slowly through an angle of 360° about its normal vertical axis.*

If, however, the apparatus is such that, were it to be tilted through an angle of 10° when standing on a horizontal plane, a part of it not normally in contact with the supporting surface would touch the horizontal plane, the apparatus is placed on a horizontal support and tilted in the most unfavourable direction through an angle of 10°.

NOTE The test on the horizontal support may be necessary, for example, for apparatus provided with small feet, castors or the like.

19.2 *The apparatus is placed in its intended position of use on a non-skid surface that is at an angle not exceeding 1° to the horizontal with lids, flaps, drawers and doors in the most unfavourable position.*

A force of 100 N directed vertically downwards is applied in such a way as to produce the maximum overturning moment, to any point of any horizontal surface, protrusion or recess, provided that the distance of that point to the non-skid surface does not exceed 75 cm.

19.3 Edges or corners, except those required for proper apparatus functioning, shall be smoothed (no abrupt discontinuity) when they could otherwise be hazardous to the USER because of location or application in the apparatus.

Compliance is checked by inspection.

19.4 Glass, with the exception of picture tubes, with a surface area exceeding 0,1 m^2 or with a major dimension exceeding 450 mm, shall not be shattered in a manner likely to result in a skin lacerating injury.

*Compliance is checked by the test of **12.1.3**.*

*If thereby the glass breaks or cracks, an additional test according to **19.4.1** is made on a separate test sample.*

19.4.1 ***Fragmentation test***

The test sample is supported over its whole area and precautions shall be taken to ensure that particles will not be scattered upon fragmentation. Then the test sample is shattered with a centre punch placed approximately 15 mm in from the midpoint of one of the longer edges of the test sample. Within 5 min of fracture, and without using any aid to vision, except spectacles if normally worn, the particles are counted in a square of 50 mm side located approximately at the centre of the area of coarsest fracture and excluding any area within 15 mm of any edge or hole.

The test sample shall fragment in such a way that the number of particles counted in a square of 50 mm side shall not be less than 45.

NOTE A suitable method of counting the particles is to place a square of 50 mm side of transparent material over the test sample and mark a spot of ink as each particle within the square is counted. To count particles at the edges of the square, select any two adjacent sides of the square and count all the particles intersected by these, and exclude all other intersected particles.

20 Resistance to fire

The apparatus shall be so designed that the start and spread of fire is prevented as far as possible, and shall not give rise to danger of fire to the surroundings of the apparatus.

This is achieved as follows:

— by using good engineering practice in design and production of the apparatus to avoid POTENTIAL IGNITION SOURCES,

and

— by using materials of low flammability for internal parts in the vicinity of POTENTIAL IGNITION SOURCES,

and

— by using FIRE ENCLOSURES to limit the spread of fire.

The requirements are considered to be fulfilled, if the apparatus complies with the requirements of **20.1** and **20.2**.

NOTE 1 It is recommended that the quantity of environmentally unfriendly flame retardant materials should be kept as low as possible in order to minimize environmental pollution.

20.1 Electrical components and mechanical parts

Electrical components and mechanical parts with the exception of those in a) and b), shall comply with the requirements of **20.1.1**, **20.1.2**, **20.1.3** and **20.1.4**.

a) Components that are contained in an enclosure having a flammability category of FV 0 according to IEC 60707 and having openings only for the connecting wires filling the openings completely, and for ventilation not exceeding 1 mm in width regardless of length.

b) The following parts which would contribute negligible fuel to a fire:

— small mechanical parts, the mass of which does not exceed 4 g, such as mounting parts, gears, cams, belts and bearings;

— small electrical components, such as capacitors with a volume not exceeding 1 750 mm^3, integrated circuits, transistors and optocoupler packages, if these components are mounted on material of flammability category FV 1 or better according to IEC 60707.

NOTE In considering how to minimize propagation of fire and what "small parts" are, account should be taken of the cumulative effect of small parts adjacent to each other for the possible effect of propagating fire from one part to another.

20.1.1 ***Electrical components***

Electrical components shall comply with the relevant flammability requirement of clause **14**.

Where there are no applicable flammability requirements in clause **14**, the requirements of **20.1.4** apply.

*Compliance is checked by appropriate tests of clause **14** or **20.1.4**.*

20.1.2 ***Internal wiring***

Insulation on wiring shall not contribute to the spread of fire under following conditions:

a) wiring working at voltages exceeding 4 kV (peak) a.c. or d.c., or

b) wiring leaving an internal FIRE ENCLOSURE with the exception of insulation consisting of PVC, TFE, PTFE, FEP or neoprene.

NOTE Reference is made to ISO 1043-1 [14] for the meaning of the abbreviations.

*Compliance is checked by the tests of clause **G.2**, Annex G.*

20.1.3 ***PRINTED BOARDS***

Base material of PRINTED BOARDS, on which the AVAILABLE POWER at a connection exceeds 15 W operating at a voltage exceeding 50 V and equal or less than 400 V (peak) a.c. or d.c. under normal operating conditions, shall be of flammability category FV 1 or better according to IEC 60707, unless the PRINTED BOARDS are protected by an enclosure meeting the flammability category FV 0 according to IEC 60707, or be made of metal, having openings only for connecting wires which fill the openings completely.

Base material of PRINTED BOARDS, on which the AVAILABLE POWER at a connection exceeds 15 W operating at a voltage exceeding 400 V (peak) a.c. or d.c. under normal operating conditions, and base material of PRINTED BOARDS supporting spark gaps which provide protection against overvoltages, shall be of flammability category FV 0 according to IEC 60707, unless the PRINTED BOARDS are contained in a metal enclosure, having openings only for connecting wires which fill the openings completely.

*Compliance is checked for the smallest thickness of PRINTED BOARD used, in accordance with IEC 60707 or of clause **G.1** of Annex G, after a preconditioning of 24 h at a temperature of (125 ± 2) °C in an air-circulating oven and a subsequent cooling period of 4 h at room temperature in a desiccator over anhydrous calcium chloride.*

20.1.4 ***Components and parts not covered by 20.1.1, 20.1.2 and 20.1.3 except FIRE ENCLOSURES***

When the distance between POTENTIAL IGNITION SOURCES and components or parts mentioned in the heading does not exceed the values specified in Table 13, then these components and parts shall comply with the relevant flammability category according to IEC 60707 as specified in Table 13, unless shielded from POTENTIAL IGNITION SOURCES by a barrier made of metal or meeting the flammability category FV 0 according to IEC 60707. The barrier shall have dimensions covering at least the areas specified in Table 13 and shown in Figure 13.

A barrier shall have a distance to a POTENTIAL IGNITION SOURCE of at least 5 mm.

In case of openings in the barrier the requirements shown in Figure 13 apply, unless it is not possible for the needle flame specified in IEC 60695-2-2 to penetrate the barrier.

PRINTED BOARDS carrying POTENTIAL IGNITION SOURCES are not considered to be a barrier for the purpose of this subclause.

POTENTIAL IGNITION SOURCES inside electrical components are not included in this requirement.

Table 13 — Distances to POTENTIAL IGNITION SOURCES

Open circuit voltage of the POTENTIAL IGNITION SOURCE V	**Distance from POTENTIAL IGNITION SOURCES to the components or parts downwards or sideways less than (see Figure 13)** mm	**Distance from POTENTIAL IGNITION SOURCES to the components or parts upwards less than (see Figure 13)** mm	**Flammability category according to IEC 60707**
> 50 to ≤ 400 (peak) a.c. or d.c.	13	50	FH 3-40 mm/min
> 400 to ≤ 4 000 (peak) a.c. or d.c.	13	50	FV 2
> 4 000 (peak) a.c. or d.c.	D[a]	D[b]	FV 1
[a] where D is 13 mm or the open-circuit voltage of the POTENTIAL IGNITION SOURCE in kilovolts, whichever is larger [b] where D is 50 mm or the open-circuit voltage of the POTENTIAL IGNITION SOURCE in kilovolts, whichever is larger			

Wood and WOOD-BASED MATERIAL with a thickness of at least 6 mm is considered to fulfil the FV 1 requirement of this subclause.

*Compliance is checked in accordance with IEC 60707 or clause **G.1** of Annex G for the smallest thickness used, except for flammability category FH 3-40 mm/min, in which case the test is made on test specimens with a thickness of (3 ± 0,2) mm, irrespective of the actual thickness in the apparatus.*

20.2 Fire enclosure

20.2.1 POTENTIAL IGNITION SOURCES with open circuit voltages exceeding 4 kV (peak) a.c. or d.c. under normal operating conditions shall be contained in a FIRE ENCLOSURE which shall comply with the flammability category FV 1 or better according to IEC 60707.

Wood and WOOD-BASED MATERIAL with a thickness of at least 6 mm is considered to fulfil the FV 1 requirement of this subclause.

*Compliance is checked in accordance with IEC 60707 or clause **G.1** of Annex G for the smallest thickness used.*

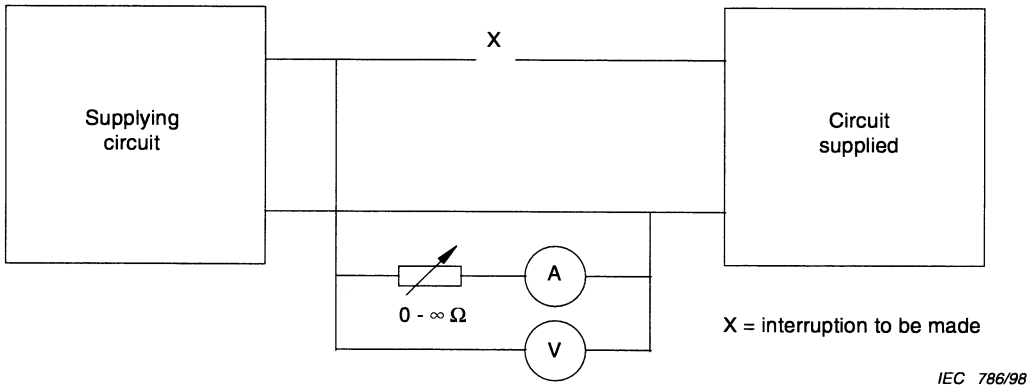
20.2.2 Internal FIRE ENCLOSURES shall not have openings for ventilation exceeding 1 mm in width regardless of length.

Openings for connecting wires shall be filled completely by the wires.

Compliance is checked by inspection and measurement.

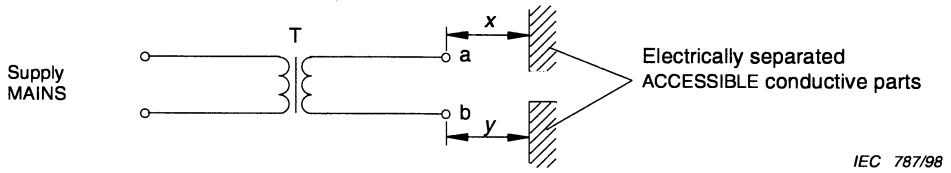
20.2.3 If the requirements of **20.2.1** and **20.2.2** are met by an internal FIRE ENCLOSURE no requirements apply to the outer enclosure of the apparatus or to components or parts adjacent to the internal FIRE ENCLOSURE. Insulation of internal wiring complying with **20.1.2** is considered to be an internal FIRE ENCLOSURE.

Compliance is checked by inspection.



NOTE See **4.3**.

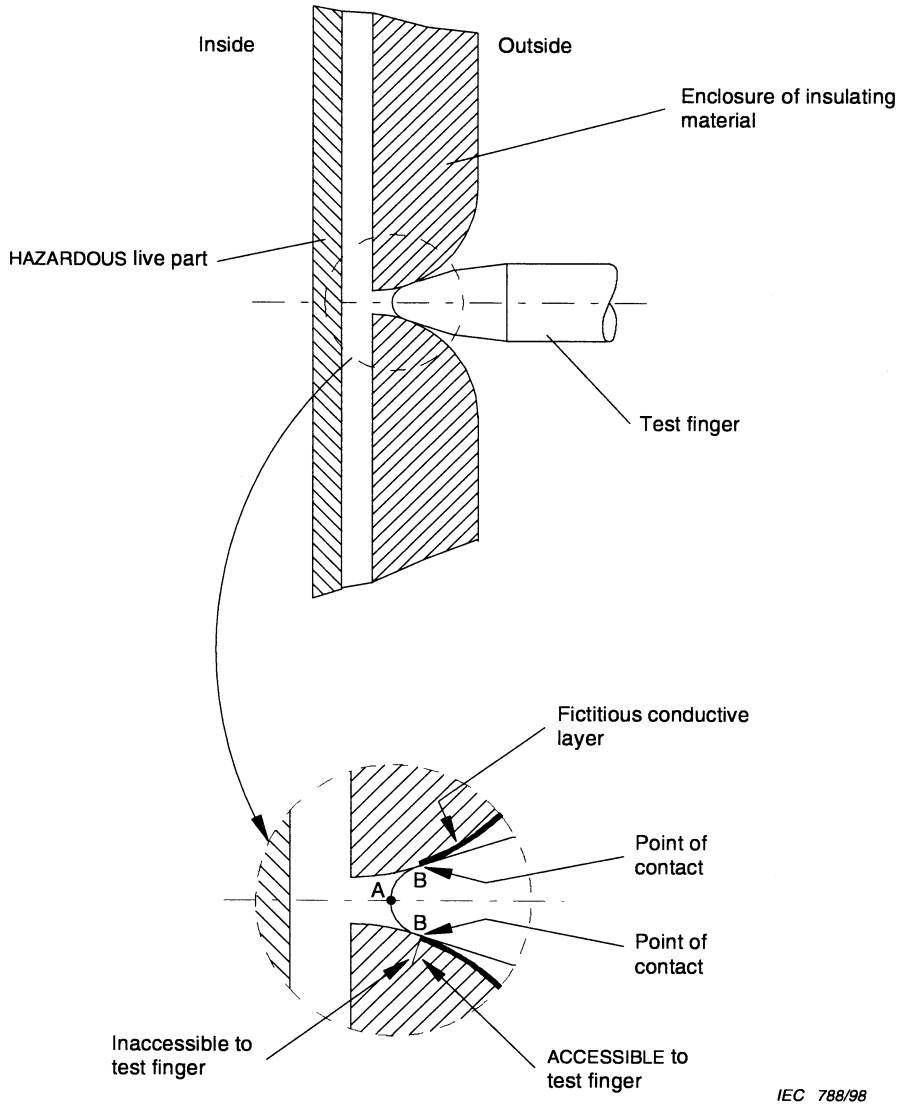
Figure 1 — Test circuit for fault conditions



The diagram shows a SEPARATING TRANSFORMER T, where point a is HAZARDOUS LIVE relative to point b. If a and b are inside the apparatus, the sum of the distances x and y is taken into account for the purpose of checking compliance with **8.6**.

NOTE See **8.6**.

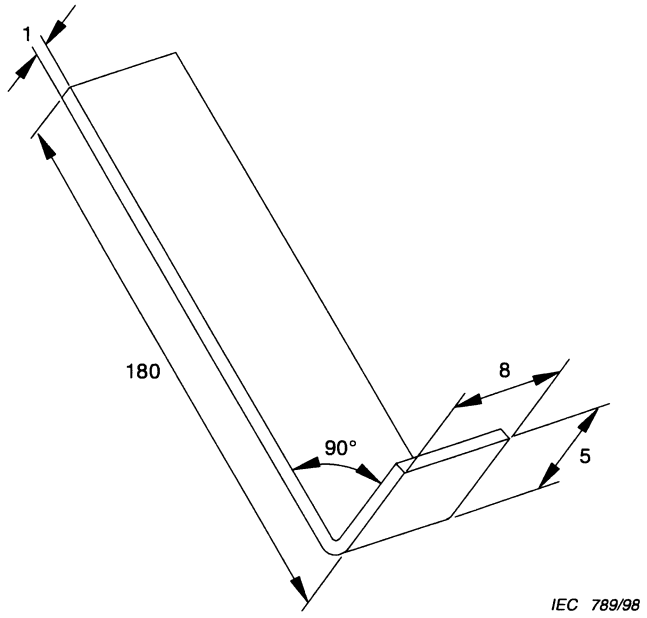
Figure 2 — Example of an assessment of REINFORCED INSULATION



Point A is used for determining accessibility (see **9.1.1**)
Point B is used for measurements of CLEARANCES and CREEPAGE DISTANCES (see clause **13**)

NOTE See **9.1.1** and **13.1.1**.

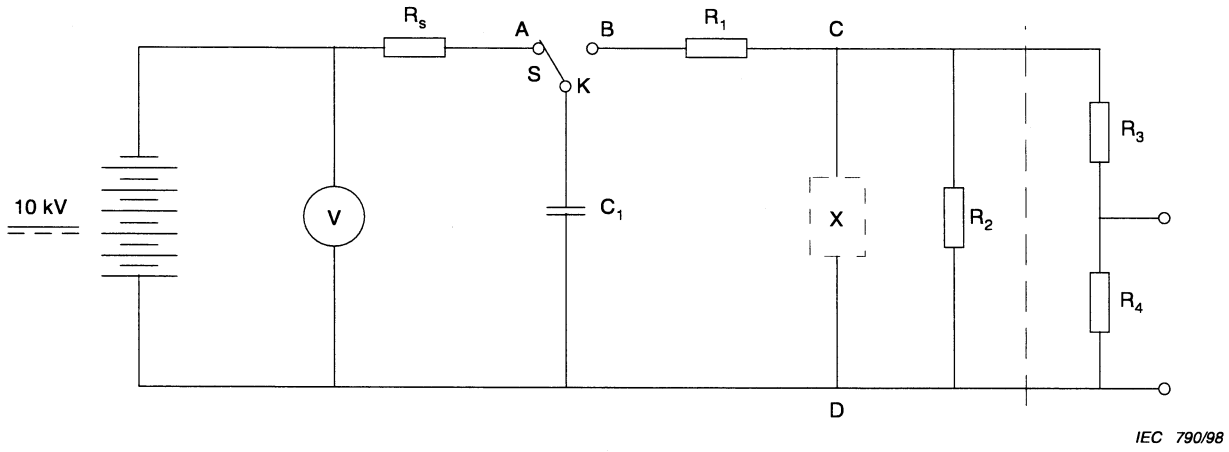
Figure 3 — Example of ACCESSIBLE parts



Dimensions in millimetres

NOTE See **9.1.7**.

Figure 4 — Test hook



C_1 = 1 nF R_1 = 1 KΩ R_2 = 4 MΩ R_3 = 100 MΩ R_4 = 0,1 MΩ R_s = 15 MΩ

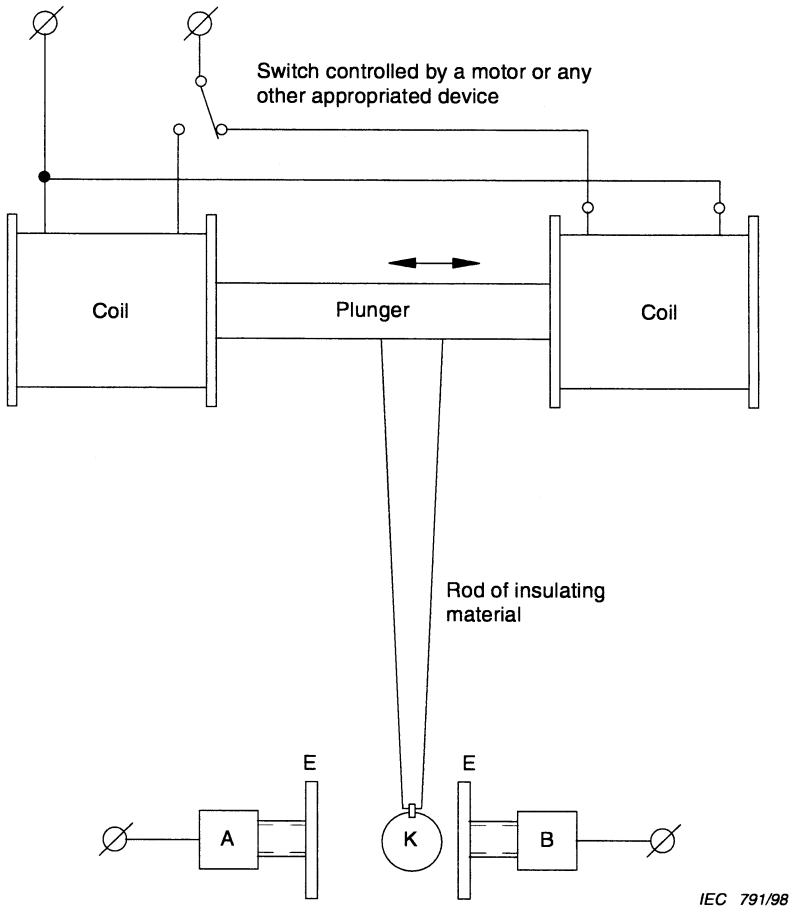
(R_2 is used only when the tests of **14.2** are performed on a component comprising a capacitor only.)

The switch S is a critical part of the circuit. It shall be so designed that as little as possible of the available energy is dissipated in arcing or inadequate insulation. An example of such a switch is given in Figure 5b.

The component X under test is connected to the terminals C and D. Optionally the voltage divider R_3, R_4 may be provided so that an oscilloscope connected across R_4 permits the observation of the voltage waveform across the component under test. This voltage divider is compensated so that the observed waveform corresponds with that across the component under test.

NOTE See **10.1** and **14.1**.

Figure 5a — Surge test — Test circuit



The switch (S in Figure 5a) comprises the following parts:

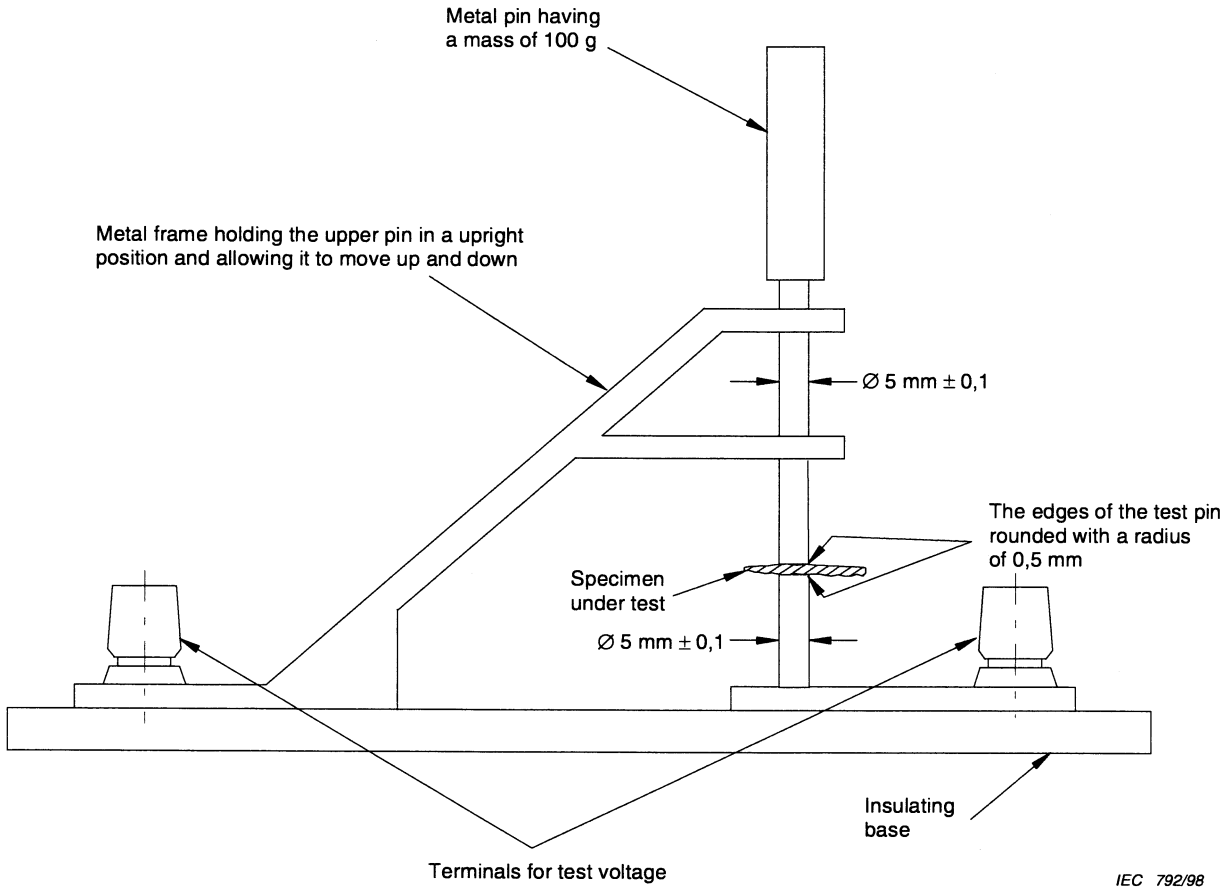
— the brass pillars A and B support circular electrodes E spaced at a distance of 15 mm;

— K is a brass sphere of 7 mm diameter and is supported on a rigid rod of insulating material approximately 150 mm long.

A, B and K are connected as shown in Figure 5a, K by means of a flexible wire

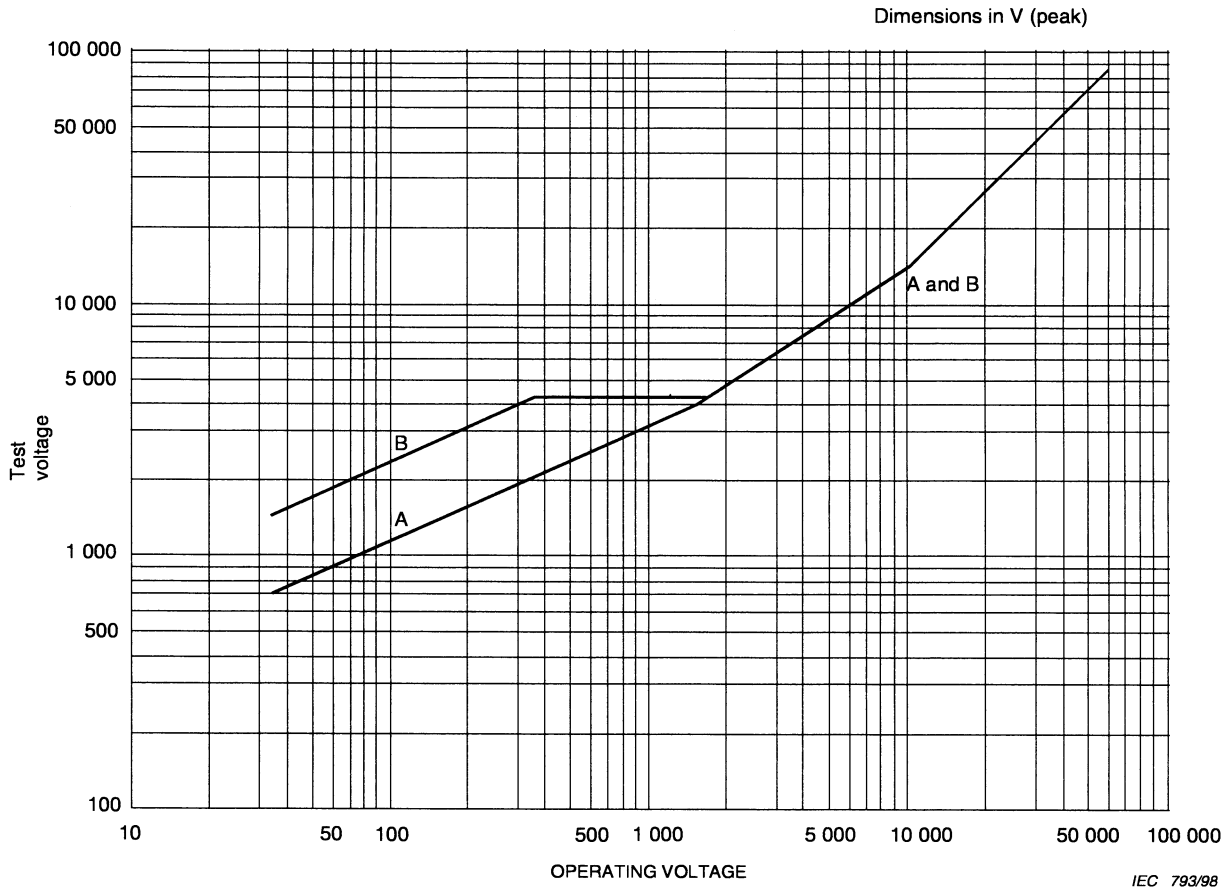
Care shall be taken to avoid bouncing of sphere K.

Figure 5b — Surge test — Example of a switch to be used in the test circuit



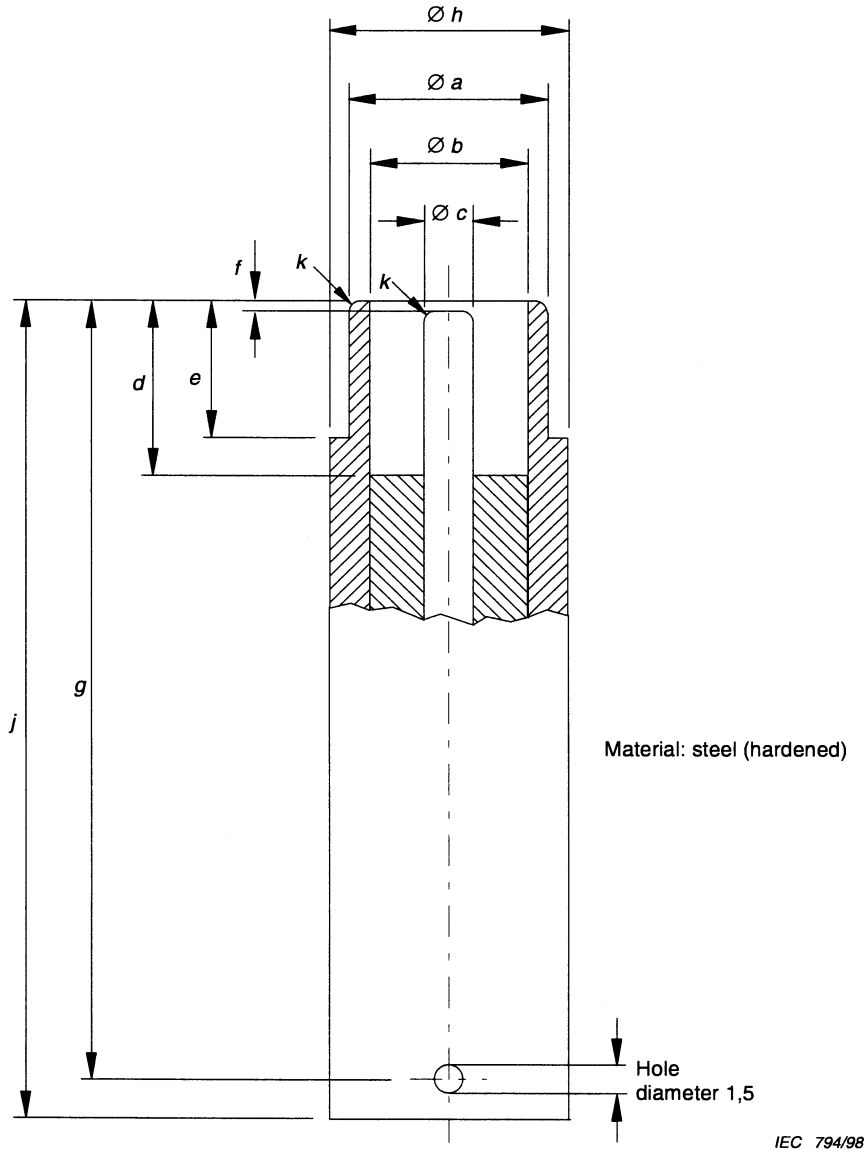
NOTE See **10.3.2**.

Figure 6 — Dielectric strength test instrument



NOTE See **10.3.2** + Table 3.

Figure 7 — Test voltages



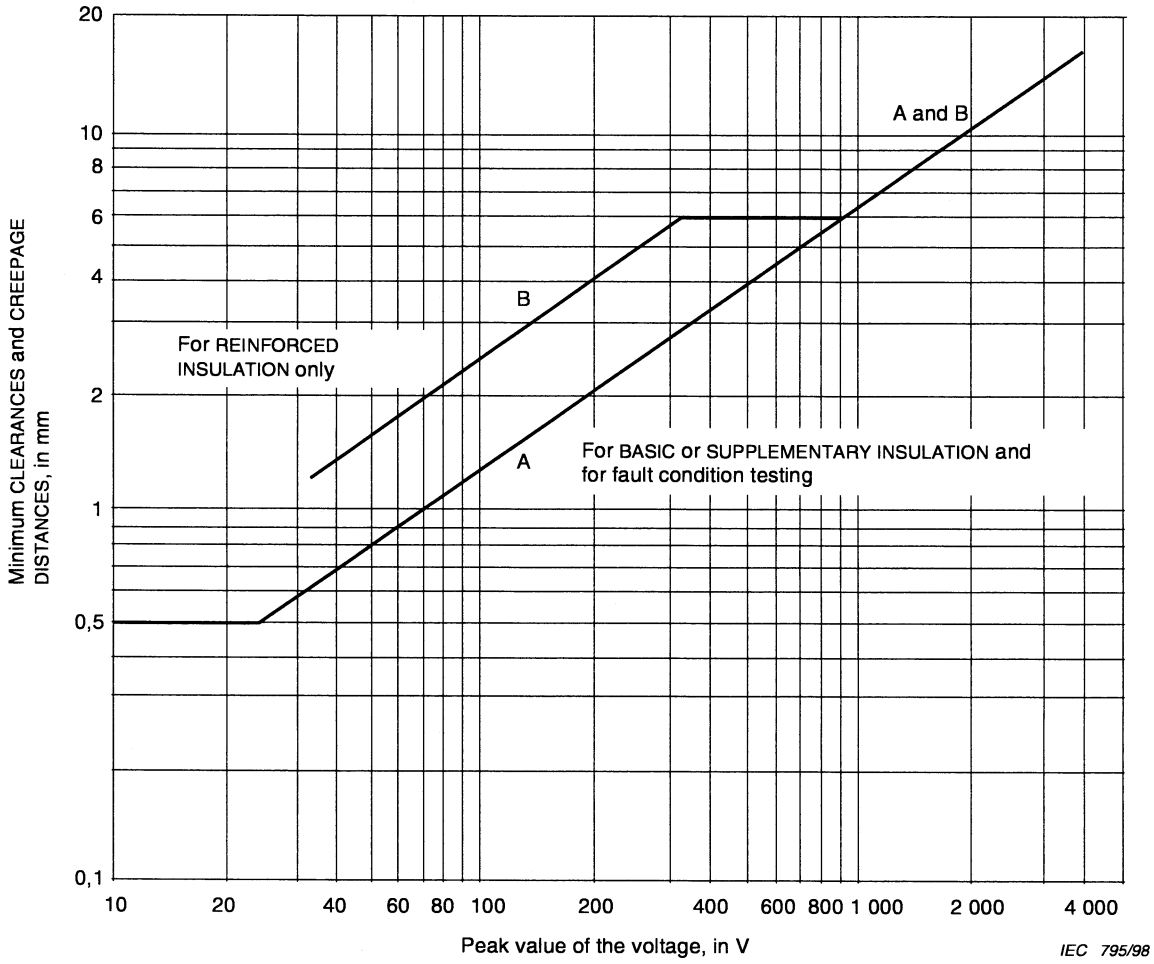
Dimensions in millimetres

a	*b* min.	*c*	*d* min.	*e* min.	*f*	*g*	*h*	*j*	*k* min.
$9{,}576\ ^{0}_{-1}$	8,05	$2{,}438\ ^{0}_{-1}$	9,1	7,112	0,8 ± 0,4	40 ± 0,4	12 ± 0,4	43 ± 0,4	0,3 radii

The mating section of the test plug is in accordance with IEC 60169-2 [3], Figure 7.

NOTE See **12.5**.

Figure 8 — Test plug for mechanical tests on antenna coaxial sockets



NOTE 1 The given values are applicable to BASIC, SUPPLEMENTARY and REINFORCED INSULATION.

NOTE 2 For BASIC, SUPPLEMENTARY and REINFORCED INSULATION, all parts of the circuit CONDUCTIVELY CONNECTED TO THE MAINS are assumed to be at not less than the nominal MAINS voltage with respect to earth.

For parts CONDUCTIVELY CONNECTED TO THE MAINS with voltages in the range of 220 – 250 V (r.m.s.), the values are equal to those related to 354 V peak.

NOTE 3 A voltage across the BASIC INSULATION is determined by short-circuiting the SUPPLEMENTARY INSULATION and vice versa.

NOTE 4 For voltages exceeding 4 000 V (peak) a.c. or d.c., the voltage test according to **10.3** is used to determine whether a CLEARANCE and CREEPAGE DISTANCE shall be short-circuited during the tests under fault condition.

NOTE 5 The graphs are defined by the following:

Curve A: 35 V corresponds to 0,6 mm
354 V corresponds to 3,0 mm

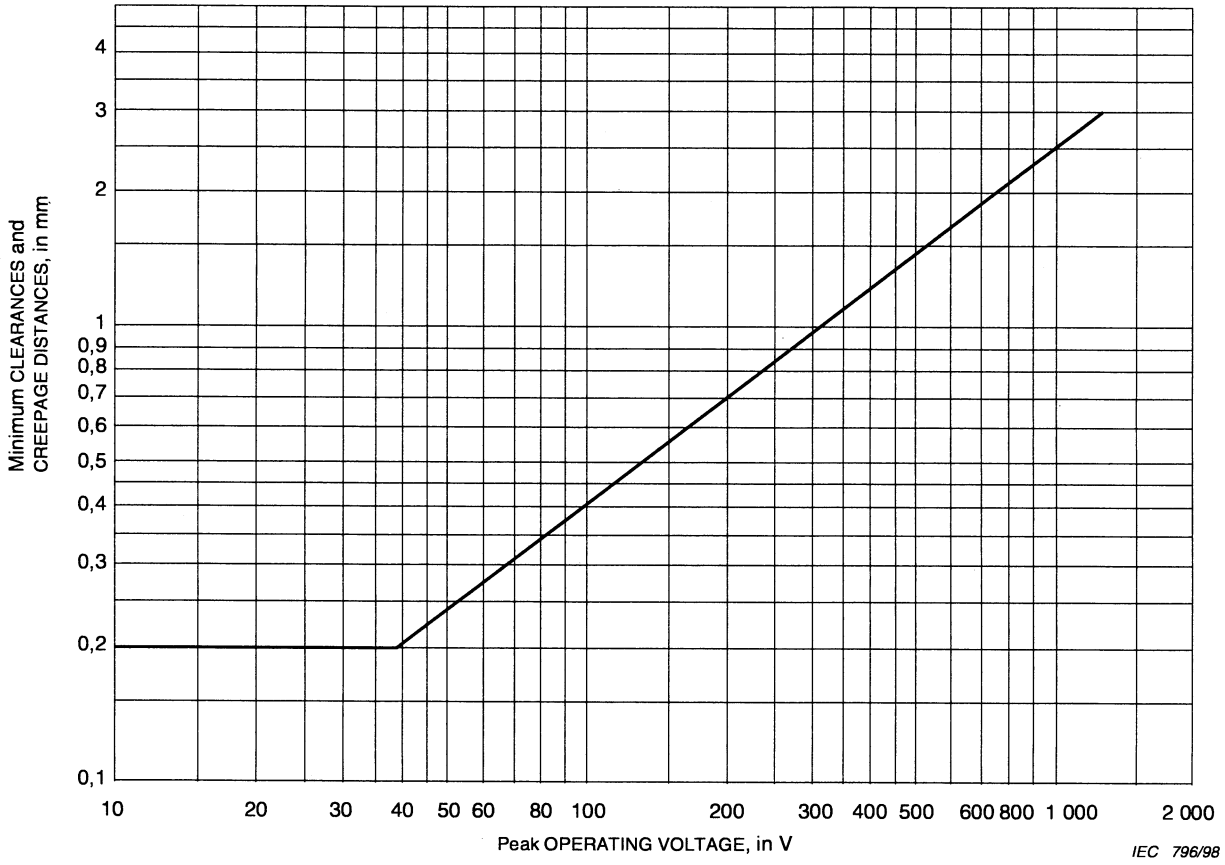
Curve B: 35 V corresponds to 1,2 mm
354 V corresponds to 6,0 mm

NOTE 6 If enamel forms the insulation of a wire and withstands the voltage test prescribed for grade 2 or better of IEC 60317, it is considered to contribute 1 mm to the CLEARANCES and CREEPAGE DISTANCES, with a minimum as specified in **13.1.1**.

NOTE 7 The specified CLEARANCES and CREEPAGE DISTANCES are the minimum actual separations taking into account tolerances in assemblies and piece-parts.

NOTE 8 See clause **13**

Figure 9 — CLEARANCES and CREEPAGE DISTANCES



The curve is defined by the formula:

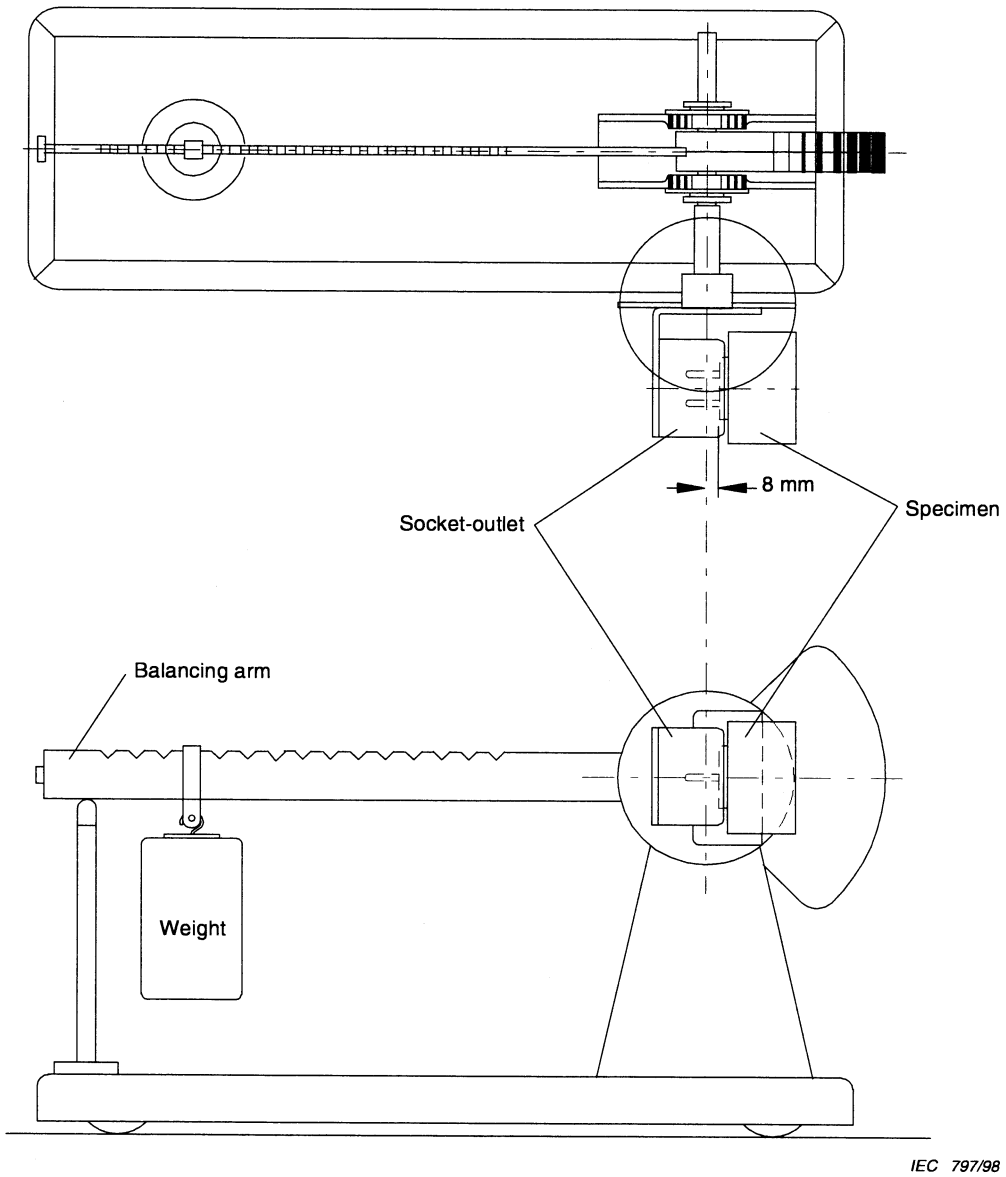
$\log d = 0{,}78 \log (V/300)$

with a minimum of 0,2 mm
d = distance

V = peak voltage (V)

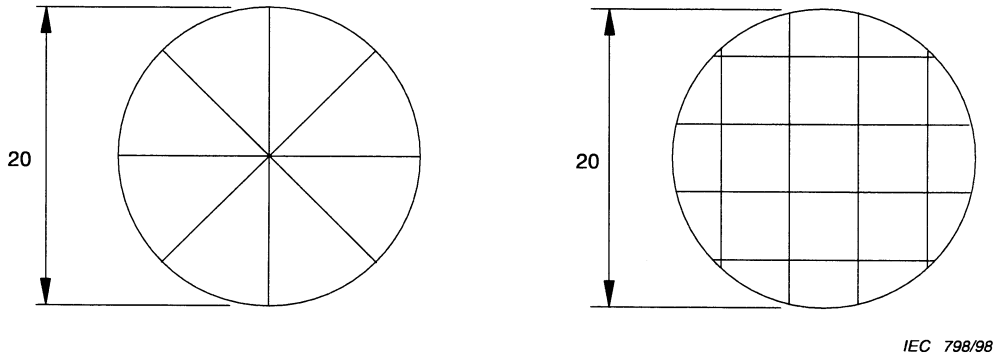
NOTE See **13.2**.

Figure 10 — Minimum CLEARANCES and CREEPAGE DISTANCES on PRINTED BOARDS



NOTE See **15.4.1**.

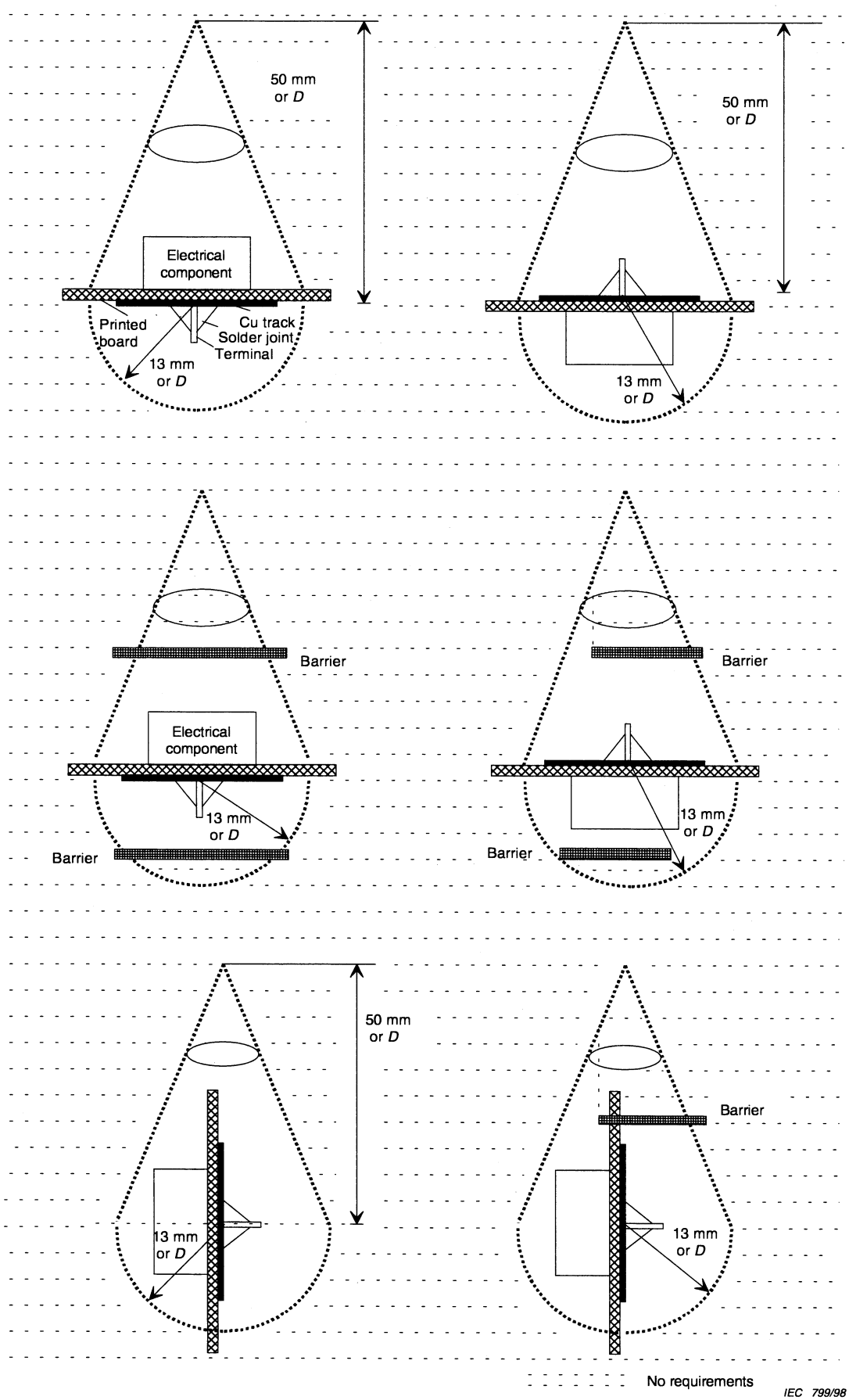
Figure 11 — Test apparatus for devices forming a part of the MAINS plug



Dimensions in millimetres

NOTE See **18.2.2**.

Figure 12 — Scratch patterns for implosion test



NOTE See **20.1.4**.

Figure 13 — Distances from POTENTIAL IGNITION SOURCES

Annex A (normative)
Additional requirements for apparatus with protection against splashing water

The requirements of this standard supplemented or replaced by those contained in this annex, apply to apparatus provided with protection against splashing water.

A.5 Marking and instructions[2)]

*Add the following item after **5.1** i):*

A.5.1 j) *Protection against splashing water*

Apparatus provided with protection against splashing water shall be marked at least with the designation IPX4 in accordance with IEC 60529.

Compliance is checked by inspection.

A.5.4.1 a) Subclause **5.4.1** a) does not apply.

A.10 Insulation requirements

*Modify **10.2** as follows:*

A.10.2 ***Splash and humidity treatment***

A.10.2.1 *Splash treatment*

The enclosure shall provide adequate protection against splashing water.

*Compliance is checked by the treatment specified below, which is made on the apparatus fitted with external flexible cords in accordance with the requirements of clause **16**.*

*The apparatus is subjected to the test described in IEC 60529, subclause **14.2.4**, item a).*

*Immediately after this treatment, the apparatus shall comply with the tests of **10.3** and inspection shall show that water, which may have entered the apparatus, does not cause any damage in the sense of this standard; in particular, there shall be no trace of water on insulations for which CREEPAGE DISTANCES are specified.*

A.10.2.2 *Humidity treatment*

Subclause **10.2** applies, *except that the duration of the test is seven days (168 h).*

Annex B (normative)
Apparatus to be connected to the TELECOMMUNICATION NETWORKS

The requirements of this standard supplemented by those contained in this annex, apply to apparatus within the scope of this standard intended to be connected to TELECOMMUNICATION NETWORKS.

NOTE 1 Attention is drawn to the fact that the telecommunication authorities may impose additional requirements on apparatus to be connected to TELECOMMUNICATION NETWORKS. Those requirements generally concern the protection of the networks as well as the USERS of the apparatus.

B.2 Definitions[2)]

*Add the following two definitions to **2.5**:*

B.2.5.5 *TELECOMMUNICATION SIGNAL*

A steady state, varying amplitude or intermittent voltage or current intended for use on a TELECOMMUNICATION NETWORK.

NOTE The limiting values are specified in IEC 60950, Subclause **6.2.1.1**.

B.2.5.6 *TELECOMMUNICATION NETWORK VOLTAGE (TNV) CIRCUIT*

A circuit that, under normal operating conditions, carries TELECOMMUNICATION SIGNALS.

[2)] The clause numbering of this annex refers to the clauses of this standard.

B.5 Marking and instructions

*Add the following item after **5.4.1** d):*

B.5.4.1 e) Where the separation of TELECOMMUNICATION NETWORK VOLTAGE (TNV) CIRCUITS from other circuits relies on protective earthing of the apparatus, according to **B.8.1** b), the apparatus installation instructions and other relevant literature shall state that the integrity of protective earthing shall be ensured.

B.8 Constructional requirements with regard to protection against electric shock

B.8.1 *Add the following text to **8.1**:*

TELECOMMUNICATION NETWORK VOLTAGE (TNV) CIRCUITS shall be separated from circuits CONDUCTIVELY CONNECTED TO THE MAINS and from HAZARDOUS LIVE parts or circuits as determined in **9.1.1** by one or both of the following methods:

a) by DOUBLE or REINFORCED INSULATION as detailed in **8.6**;

b) by BASIC INSULATION together with PROTECTIVE SCREENING connected to the PROTECTIVE EARTH TERMINAL, as detailed in **8.5**.

For the purpose of **8.5** and **8.6**, the voltage is the sum of the MAINS voltage and the TNV voltage which is assumed to be 135 V (peak) a.c.

B.8.2 Add the following text to ***8.2***:

TNV CIRCUITS shall be separated from circuits other than mentioned in **B.8.1** and from ACCESSIBLE conductive parts by BASIC INSULATION meeting the insulation requirements for CLEARANCES and CREEPAGE DISTANCES as specified in clause **13**, for a voltage which is the sum of the voltage in the circuit and the TNV voltage which is assumed to be 135 V (peak) a.c.

B.9 Electric shock hazard under normal operating conditions

B.9.1.1 *Add the following text to **9.1.1**:*

Contacts of TERMINALS for TNV CIRCUITS which cannot be touched by the test probe Figure B.1, are an additional exemption from the requirement for inaccessible TERMINAL contacts.

B.9.1.4 *Add the following text to **9.1.4**:*

The straight test probe according to IEC 61032, test probe D, is not applied to TNV CIRCUIT TERMINALS.

B.10 Insulation requirements

B.10.1 *Add the following text to **10.1**:*

The insulation between TNV CIRCUIT TERMINALS and

— TERMINALS for the connection of antenna,

— any other TERMINAL in case of apparatus which may be interconnected to other apparatus with antenna TERMINALS

is also subjected to the specified 50 discharges.

B.10.3 *Add the following text to **10.3**:*

The test voltages between TNV CIRCUITS and other parts shall be determined according to the OPERATING VOLTAGES mentioned in **B.8.1**.

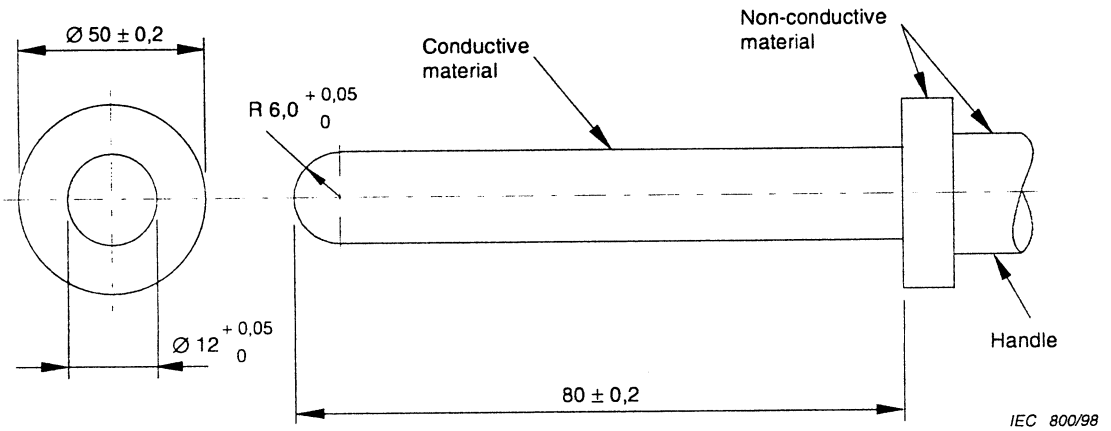
Surge suppressors shall be disconnected during the dielectric strength test.

B.14 Components

Add the following new subclause:

B.14.12 *Surge suppressors*

If surge suppressors are connected between TNV CIRCUITS and other parts of the apparatus, the surge suppressors shall have a nominal d.c. spark-over voltage of at least 1,8 times the rated MAINS voltage of the apparatus.

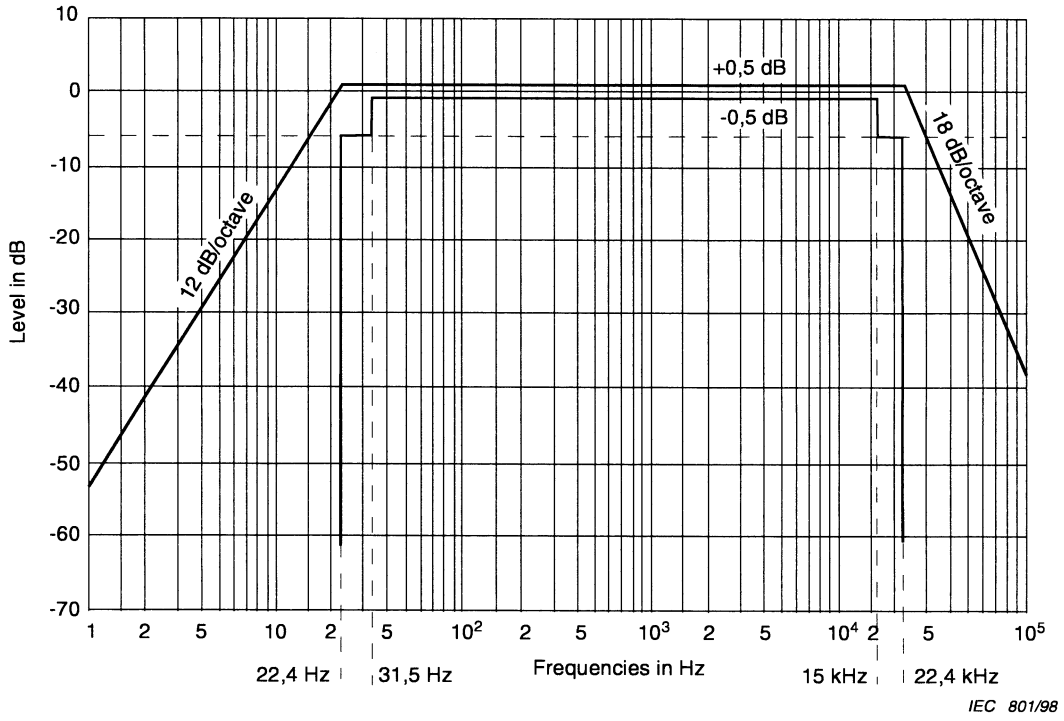


Dimensions in millimetres

NOTE See **B.9.1.1**.

Figure B.1 — Test probe

Annex C (normative)
Band-pass filter for wide-band noise measurement
(Extract of IEC 60268-1)



*Wide-band measurement (see IEC 60268-1, subclause **6.1**)*

The filter shall be a band-pass filter having a frequency response within the limits shown in Figure C.1.

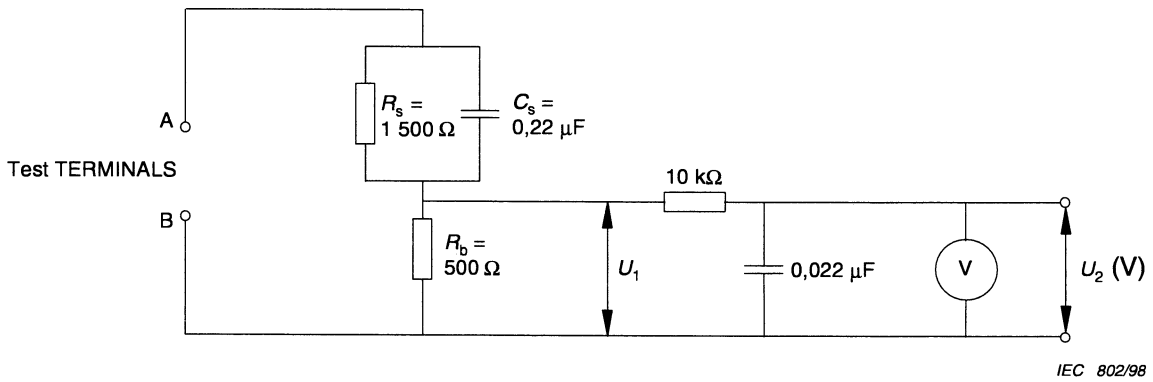
A band-pass filter which has a substantially constant transmission factor between 22,4 Hz and 22,4 kHz, decreasing outside this frequency band at the rates specified for octave-band filters having mid-band frequencies of 31,5 Hz and 16 000 Hz specified in IEC 61260, has a response falling within the limits of this specification.

NOTE 1 Care should be taken when there may be strong signals just above or below the band-limits since in this case the results will depend, to some degree, on the individual frequency response of the filter actually used.

NOTE 2 See **4.1.6**.

Figure C.1 — Band-pass filter for wide-band noise measurement (amplitude/frequency response limits, see below)

Annex D (normative)
Measuring network for TOUCH CURRENTS



Resistance values in ohms (Ω)

V: Voltmeter or oscilloscope
(r.m.s. or peak reading)

Input resistance: ≥ 1 MΩ.

Input capacitance: ≤ 200 pF

Frequency range: 15 Hz to 1 MHz and d.c. respectively

NOTE Appropriate measures should be taken to obtain the correct value in case of non-sinusoidal waveforms.
The measuring instrument is calibrated by comparing the frequency factor of U_2 with the solid line in Figure F.2 of IEC 60990 at various frequencies. A calibration curve is constructed showing the deviation of U_2 from the ideal curve as a function of frequency.

TOUCH CURRENT = U_2/500 (peak value).

NOTE See **9.1.1**.

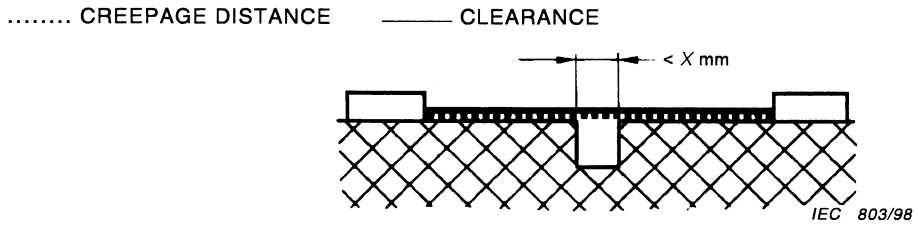
Figure D.1 — Measuring network for TOUCH CURRENTS according to IEC 60990

Annex E (normative)
Measurement of CLEARANCES and CREEPAGE DISTANCES

The methods of measuring and CLEARANCES and CREEPAGE DISTANCES which are specified in Figure E.1 to Figure E.10 are used in interpreting the requirements of this standard.

The minimum value of distance X is 0,25 mm for **13.3** and 1,0 mm for **13.2**.

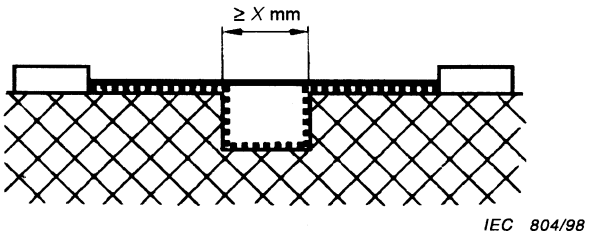
However, if the requirement for the CLEARANCE associated with the concerned CREEPAGE DISTANCE is less than 3,0 mm, the value X is one-third of the specified CLEARANCE, but not less than 0,2 mm.



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

Rule: CLEARANCE and CREEPAGE DISTANCE are measured directly across the groove.

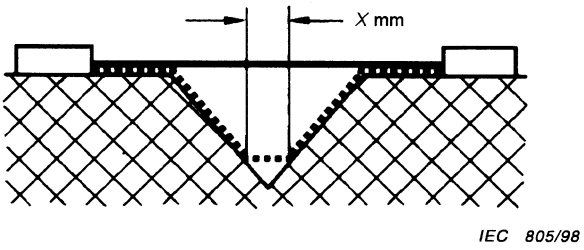
Figure E.1 — Narrow groove



Condition: Path under consideration includes a parallel-sided groove of any depth, and equal to or more than *X* mm wide.

Rule: CLEARANCE is the "line-of-sight" distance, CREEPAGE DISTANCE path follows the contour of the groove.

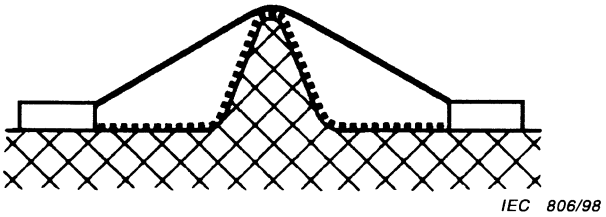
Figure E.2 — Wide groove



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

Rule: CLEARANCE is the "line-of-sight" distance. CREEPAGE DISTANCE path follows the contour of the groove but "short-circuits" the bottom of the groove by 1 mm (**13.2**) respectively 0,25 mm (**13.3**).

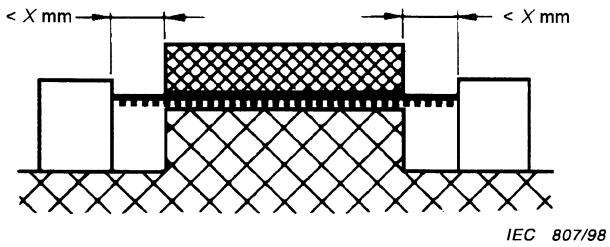
Figure E.3 — V-shaped groove



Condition: Path under consideration includes a rib.

Rule: CLEARANCE is the shortest direct air path over the top of the rib. CREEPAGE DISTANCE path follows the contour of the rib.

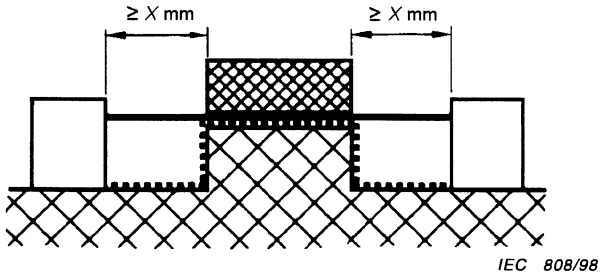
Figure E.4 — Rib



Condition: Path under consideration includes an uncemented joint with grooves less than *X* mm wide on either side.

Rule: CREEPAGE DISTANCE and CLEARANCE path is the "line-of-sight" distance shown.

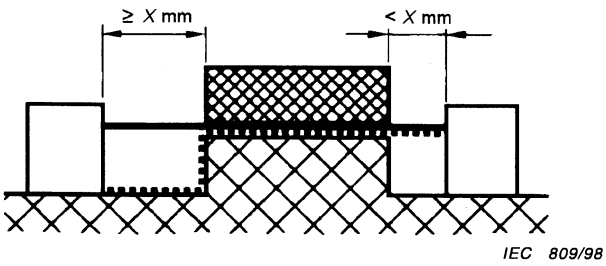
Figure E.5 — Uncemented joint with narrow groove



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

Rule: CLEARANCE is the "line-of-sight" distance. CREEPAGE DISTANCE path follows the contour of the groove.

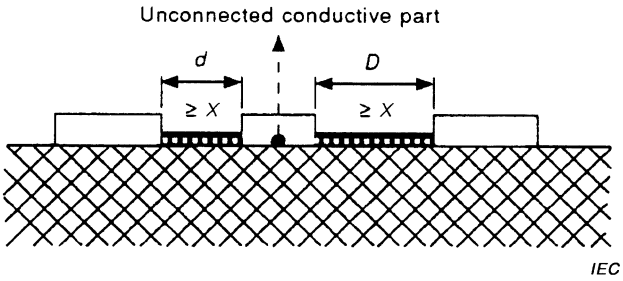
Figure E.6 — Uncemented joint with wide groove



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

Rule: CLEARANCE and CREEPAGE DISTANCE paths are as shown in Figure E.7.

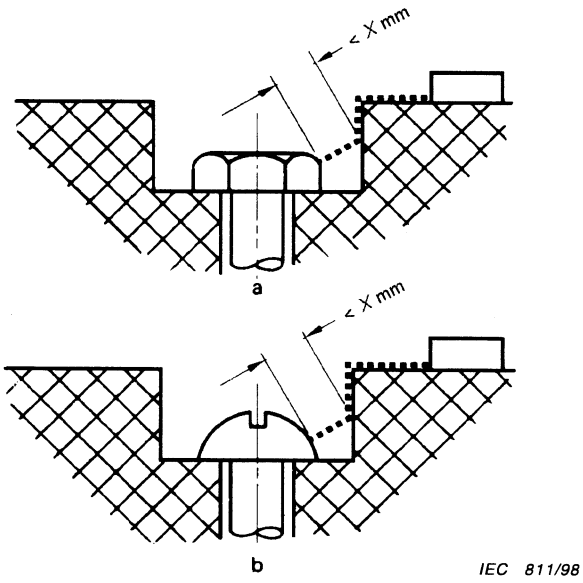
Figure E.7 — Uncemented joint with narrow and wide grooves



Condition: Insulation distance with intervening, unconnected conductive part.

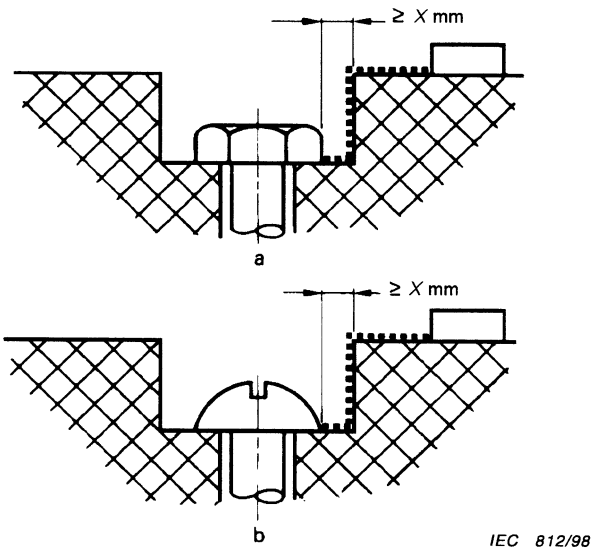
Rule: CLEARANCE is the distance $d + D$, CREEPAGE DISTANCE is also $d + D$. Where the value of d or D is smaller than X it shall be considered as zero.

Figure E.8 — Intervening, unconnected conductive part



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

Figure E.9 — Narrow recess



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

Figure E.10 — Wide recess

Annex F (normative)
Table of electrochemical potentials

Magnesium, magnesium alloys	Zinc, zinc alloys	80 tin/20 zinc on steel, zinc on iron or steel	Aluminium	Cadmium on steel	Aluminium/magnesium alloy	Mild steel	Duralumin	Lead	Chromium on steel, soft solder	Cr on Ni on steel, tin on steel, 12 % Cr stainless steel	High chromium stainless steel	Copper, copper alloys	Silver solder, austenitic stainless steel	Nickel on steel	Silver	Rhodium on silver on copper, silver/gold alloy	Carbon	Gold, platinum	
0	0,5	0,55	0,7	0,8	0,85	0,9	1,0	1,05	1,1	1,15	1,25	1,35	1,4	1,45	1,6	1,65	1,7	1,75	Magnesium, magnesium alloys
	0	0,05	0,2	0,3	0,35	0,4	0,5	0,55	0,6	0,65	0,75	0,85	0,9	0,95	1,1	1,15	1,2	1,25	Zinc, zinc alloys
		0	0,15	0,25	0,3	0,35	0,45	0,5	0,55	0,6	0,7	0,8	0,85	0,9	1,05	1,1	1,15	1,2	80 tin/20 zinc on steel, zinc on iron or steel
			0	0,1	0,15	0,2	0,3	0,35	0,4	0,45	0,55	0,65	0,7	0,75	0,9	0,95	1,0	1,05	Aluminium
				0	0,05	0,1	0,2	0,25	0,3	0,35	0,45	0,55	0,6	0,65	0,8	0,85	0,9	0,95	Cadmium on steel
					0	0,05	0,15	0,2	0,25	0,3	0,4	0,5	0,55	0,6	0,75	0,8	0,85	0,9	Aluminium/magnesium alloy
						0	0,1	0,15	0,2	0,25	0,35	0,45	0,5	0,55	0,7	0,75	0,8	0,85	Mild steel
							0	0,05	0,1	0,15	0,25	0,35	0,4	0,45	0,6	0,65	0,7	0,75	Duralumin
								0	0,05	0,1	0,2	0,3	0,35	0,4	0,55	0,6	0,66	0,7	Lead
									0	0,05	0,15	0,25	0,3	0,35	0,5	0,55	0,6	0,65	Chromium on steel, soft solder
Cr = Chromium Ni = Nickel										0	0,1	0,2	0,25	0,3	0,45	0,5	0,55	0,6	Cr on Ni on steel, tin on steel, 12 % Cr stainless steel
											0	0,1	0,15	0,2	0,35	0,4	0,45	0,5	High chromium stainless steel
												0	0,05	0,1	0,25	0,3	0,35	0,4	Copper, copper alloys
													0	0,05	0,2	0,25	0,3	0,35	Silver solder, austenitic stainless steel
														0	0,15	0,2	0,25	0,3	Nickel on steel
															0	0,05	0,1	0,15	Silver
																0	0,05	0,1	Rhodium on silver on copper, silver/gold alloy
																	0	0,05	Carbon
																		0	Gold, platinum

NOTE 1 Corrosion due to electrochemical action between dissimilar metals which are in contact is minimized if the combined electrochemical potential is below about 0,6 V. In the above table the combined electrochemical potentials are listed for a number of pairs of metals in common use.
NOTE 2 See **15.2**.

Annex G (normative)
Flammability test methods

G.1 *If no test specimens in accordance with IEC 60707, clause **4** are available, the following test methods may be applied.*

The test is made according to IEC 60695-2-2 on three specimens of end products as used in the apparatus.

For the purpose of this standard, the following applies with regard to IEC 60695-2-2:

*Clause **7** — Initial measurements; not applicable*

*Clause **8** — Test procedure*

*— Subclause **8.2***

The first sentence is replaced by the following:

The test specimens are mounted in such a way as to simulate the conditions obtained when installed in the apparatus.

*— Subclause **8.4***

Replace the third paragraph by the following:

The test flame is applied to several points of the specimen, so that all critical areas are tested.

*Clause **9** — Observations and measurements.*

*— Subclause **9.2***

The second paragraph is replaced by the following:

Duration of the burning denotes the time interval from the moment the test flame is removed until any flame has been extinguished.

G.1.1 *If flammability category FV 0 according to IEC 60707 is required, in addition, the following applies with regard to IEC 60695-2-2.*

*Clause **5** — Severities*

The values of duration of application of the test flame are as follows:

The test flame is applied for 10 s. If a self-sustaining flame does not last longer than 15 s, the test flame is applied again for 1 min at the same point or at any other point. If again a self-sustaining flame does not last longer than 15 s, the test flame is then applied for 2 min at the same point or at any other point.

*Clause **10** — Evaluation of test results*

The existing text is replaced by the following:

After the first application of the test flame, the test specimens shall not be consumed completely. After any application of the test flame, the duration of the burning of any specimen shall not exceed 15 s, while the average burning time shall not exceed 10 s. The tissue paper shall not ignite and the board shall not scorch.

G.1.2 *If flammability category FV 1 according to IEC 60707 is required, in addition, the following applies with regard to IEC 60695-2-2.*

Clause 5 — Severities

The values of duration of application of the test flame are as follows:

The test flame is applied for 10 s. If a self-sustaining flame does not last longer than 30 s, the test flame is applied again for 1 min at the same point or at any other point. If again a self-sustaining flame does not last longer than 30 s, the test flame is then applied for 2 min at the same point or at any other point.

*Clause **6** — Preconditioning (only applicable to components of **14.4.1**)*

The existing text is replaced by:

The specimens are stored for 2 h in an oven at a temperature of (100 ± 2) °C.

*Clause **10** — Evaluation of test results*

The existing text is replaced by the following:

After the first application of the test flame, the test specimen shall not be consumed completely. After any application of the test flame, any self-sustaining flame shall extinguish within 30 s. No burning of the tissue paper shall occur and the board shall not scorch.

G.1.3 *If flammability category FV 2 according to IEC 60707 is required, in addition, the following applies with regard to IEC 60695-2-2.*

*Clause **5** — Severities*

The values of duration of application of the test flame are as follows:

The test flame is applied for 10 s. If a self-sustaining flame does not last longer than 30 s, the test flame is applied again for 1 min at the same point or at any other point. If again a self-sustaining flame does not last longer than 30 s, the test flame is then applied for 2 min at the same point or at any other point.

*Clause **10** — Evaluation of test results*

The existing text is replaced by the following:

After the first application of the test flame, the test specimen shall not be consumed completely.

After any application of the test flame, any self-sustaining flame shall extinguish within 30 s.

G.1.4 *If flammability category FH 3-40 mm/min according to IEC 60707 is required, the following applies with regard to IEC 60695-2-2.*

Irrespective of the actual thickness in the apparatus the test is made on test specimens with a thickness of 3 mm.

NOTE Test is under consideration.

G.2 *Compliance of cables and insulation of wires is checked according to IEC 60695-2-2.*

For the purpose of this standard, the following applies with regard to IEC 60695-2-2.

*Clause **5** — Severities*

The values of duration of the application of the test flame are as follows:

- *first specimen: 10 s*
- *second specimen: 60 s*
- *third specimen: 120 s*

*Clause **7** — Initial measurements: not applicable*

*Clause **8** — Test procedure*

*— Add the following to **8.4**:*

The burner is supported so that its axis is in an angle of 45° to the vertical. The cable or wire is held in an angle of 45° to the vertical, its axis being in a vertical plane perpendicular to the vertical plane containing the axis of the burner.

*— Subclause **8.5** is replaced by the following:*

The test is made on three specimens taken from each type of cable or wire as used in the apparatus, for example with additional screening and sleeves.

*Clause **9** — Observations and measurements*

*— Subclause **9.1** does not apply.*

*— Subclause **9.2***

The second paragraph is replaced by the following:

Duration of the burning denotes the time interval from the moment the test flame is removed until any flame has extinguished.

*Clause **10** — Evaluation of the results*

The existing text is replaced by the following:

During the test, any burning of the insulating materials shall be steady and shall not spread appreciably. Any flame shall self-extinguish in 30 s from the removal of the test flame.

Annex N (informative)
ROUTINE TEST

Introduction

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

In general, more tests, such as repetition of TYPE TESTS and sampling tests, have to be made by the manufacturer to ensure that every apparatus is in conformity with the sample that withstood the TYPE TEST of this standard, according to experience gained by the apparatus manufacturer.

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

NOTE Generally, an appropriate quality assurance system should be employed, for example according to the ISO 9000 series [15].

The following rules are given as an example for ROUTINE TEST:

N.1 Tests during the production process

N.1.1 *Correct polarity and connection of components or subassemblies*

If incorrect polarity or connection of components or subassemblies might result in a safety hazard, the correct polarity and connection of these components or subassemblies should be checked by measurement or inspection.

N.1.2 *Correct values of components*

If incorrect values of components might result in a safety hazard, the correct value of these components should be checked by measurement or inspection.

N.1.3 *Protective earth connection of screens and metal barriers*

For CLASS I apparatus with a screen or metal barrier (see **8.5**) between HAZARDOUS LIVE parts and TERMINALS regarded as ACCESSIBLE (see **8.4**) or ACCESSIBLE conductive parts respectively, the continuity of the protective earth connection should be checked as late as possible during the production process between the screen or metal barrier and

— the protective earth contact of the MAINS plug or appliance inlet, or

— the PROTECTIVE EARTH TERMINAL in case of a PERMANENTLY CONNECTED APPARATUS.

The test current applied for 1 s to 4 s should be in the order of 10 A a.c., derived from a source having a no-load voltage not exceeding 12 V.

The measured resistance should not exceed

— 0,1 Ω for apparatus with a detachable power supply cord,

— 0,2 Ω for apparatus with a non-detachable power supply cord.

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

N.1.4 *Correct position of internal wiring*

If incorrect position of internal wiring might impair the safety, the correct position of internal wiring should be checked by inspection.

N.1.5 *Correct fit of internal plug connections*

If incorrect fit of internal plug connections might impair the safety, the correct fit of internal plug connections should be checked by inspection or manual test.

N.1.6 *Safety relevant markings inside the apparatus*

The legibility of markings relevant to safety inside the apparatus, for example with regard to fuse-links, should be checked by inspection.

N.1.7 *Correct mounting of mechanical parts*

If incorrect mounting of mechanical parts might impair the safety, the correct mounting should be checked by inspection or manual test.

N.2 Tests at the end of the production process

The following tests should be made on the apparatus when completely assembled and just before packing.

N.2.1 *Dielectric strength test*

The insulation of the apparatus should be checked by the following tests. In general, these tests are considered to be sufficient.

An a.c. test voltage of substantially sine-wave form, having MAINS frequency, or a d.c. test voltage or a combination of both with a peak value specified in Table N.1, is applied between the MAINS supply TERMINALS connected in parallel and:

— TERMINALS regarded as ACCESSIBLE (see **8.4**), and

— ACCESSIBLE conductive parts respectively,

which may become HAZARDOUS LIVE in the event of an insulation fault as a result of incorrect assembly.

NOTE 1 TERMINALS regarded as ACCESSIBLE and ACCESSIBLE conductive parts may be connected together during the dielectric strength test.

Table N.1 – Test voltage

Application of test voltage	**Test voltage** V (peak) a.c. or d.c.	
	Rated MAINS voltage ≤ 150	**Rated MAINS voltage > 150**
BASIC INSULATION	1 130 (800 r.m.s.)	2 120 (1 500 r.m.s.)
DOUBLE or REINFORCED INSULATION	2 120 (1 500 r.m.s.)	3 540 (2 500 r.m.s.)

Before the test voltage is applied, intimate contact should be made with the specimen.

Initially, not more than half of the prescribed test voltage is applied, then it is raised with a steepness not exceeding 1 560 V/ms to the full value which is held for 1 s to 4 s.

NOTE 2 A steepness of 1 560 V/ms corresponds to the steepness of a sine-wave with a MAINS frequency of 60 Hz.

During the test, MAINS switches and functional switches, if any, CONDUCTIVELY CONNECTED TO THE MAINS, should be in the on-position and it should be secured by suitable means so that the test voltage is completely effective.

No flash-over or breakdown should occur during the test. The test voltage source should be provided with a current sensing (over-current) device which, when activated, gives an indication that the test has been failed. The test voltage source should still deliver the prescribed voltage until current tripping occurs.

NOTE 3 The tripping current should not exceed 100 mA.

NOTE 4 Tripping of the current sensing device is regarded as a flash-over or breakdown.

N.2.2 *Protective earth connection*

For CLASS I apparatus, the continuity of the protective earth connection should be checked between the protective earth contact of the MAINS plug or appliance inlet, or the PROTECTIVE EARTH TERMINAL in case of a PERMANENTLY CONNECTED APPARATUS, and

— the ACCESSIBLE conductive parts, including TERMINALS regarded as ACCESSIBLE (see **8.4**), which should be connected to the PROTECTIVE EARTH TERMINAL, and

— the protective earth contact of socket-outlets respectively, if provided to deliver power to other apparatus.

The test current applied for 1 s to 4 s should be in the order of 10 A a.c., derived from a source having a no-load voltage not exceeding 12 V.

The measured resistance should not exceed

— 0,1 Ω for apparatus with a detachable power supply cord,

— 0,2 Ω for apparatus with a non-detachable power supply cord.

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

N.2.3 *Safety relevant markings on the outside of the apparatus*

The legibility of safety relevant markings on the outside of the apparatus, for example with regard to the supply voltage, should be checked by inspection.

Annex P (informative)
Bibliography

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

[2] IEC 60130 (all parts), *Connectors for frequencies below 3 MHz.*

NOTE IEC 60130-9:1989 + A1:1993 are harmonized as EN 60130-9 (not modified).

[3] IEC 60169 (all parts), *Radio-frequency connectors.*

NOTE Parts 23, 24 and 25 are harmonized as ENs (not modified).

[4] IEC 60173:1964, *Colours of the cores of flexible cables and cords.*

NOTE Harmonized as HD 27 S1:1983 (not modified).

[5] IEC 60260:1968, *Test enclosures of non-injection type for constant relative humidity.*

NOTE Harmonized as HD 98 S1:1977 (not modified).

[6] IEC 60335-2-56:1997 *Safety of household and similar electrical appliances — Part 2: Particular requirements for projectors and similar appliances.*

NOTE Harmonized as EN 60335-2-56:1997 (not modified).

[7] IEC 60335-2-82, — *Safety of household and similar electrical appliances — Part 2: Particular requirements for service machines and amusement machines*[3)].

[8] IEC 61040:1990, *Power and energy measuring detectors, instruments and equipment for laser radiation.*

NOTE Harmonized as EN 61040:1992 (not modified).

[9] IEC Guide 104:1997, *The preparation of safety publications, and the use of basic safety publications and group safety publications.*

[10] IEC Guide 108:1994, *The relationship between technical committees with horizontal functions and product committees and the use of basic publications.*

[11] IEC Guide 109:1995, *Environmental aspects — Inclusion in electrotechnical product standards.*

[12] ISO/IEC Guide 37:1995, *Instructions for use of products of consumer interest.*

[13] ISO/IEC Guide 51:1990, *Guidelines for the inclusion of safety aspects in standards.*

[14] ISO 1043-1:1997, *Plastics — Symbols and abbreviate terms — Part 1: Basic polymers and their special characteristics.*

[15] ISO 9000 (all parts), *Quality management and quality assurance standards.*

[16] ICRP 15:1969, *Protection against ionizing radiations from external sources — Published by the International Commission on Radiological Protection.*

[17] UIT-T Rec. K.11:1993, *Principles of protection against overvoltages and overcurrents.*

[18] IEC 60695 — *Fire hazard testing.*

NOTE Harmonized as EN 60695 series (not modified).

[3)] To be published.

Annex ZA (normative)
Other international publications quoted in this standard with the references of the relevant European publications

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 publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international standard has been modified by common modification, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60027	series	Letter symbols to be used in electrical technology	HD 245	series
IEC 60038 (mod)	1983	Nominal voltages for low-voltage public electricity supply systems	HD 472 S1 + A1	1989 1995
IEC 60068-2-3	1969	Environmental testing Part 2: Tests — Test Ca: Damp heat, steady state	HD 323.2.3 S2[a]	1987
IEC 60068-2-6 + corr. Mar.	1995 1995	Test Fc: Vibration (sinusoidal)	EN 60068-2-6	1995
IEC 60068-2-32	1975	Test Ed: Free fall	EN 60068-2-32[b]	1993
IEC 60068-2-75	1997	Test Eh: Hammer tests	EN 60068-2-75	1997
IEC 60085	1984	Thermal evaluation and classification of electrical insulation	HD 566 S1	1990
IEC 60112	1979	Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions	HD 214 S2	1980
IEC 60127	series	Miniature fuses	EN 60127	series
IEC 60167	1964	Methods of test for the determination of the insulation resistance of solid insulating materials	HD 568 S1	1990
IEC 60227 (mod)	series	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V	HD 21	series
IEC 60245 (mod)	series	Rubber insulated cables of rated voltages up to and including 450/750 V	HD 22	series
IEC 60249-2	series	Base materials for printed circuits Part 2: Specifications	EN 60249-2	series
IEC 60268-1	1985	Sound system equipment Part 1: General	HD 483.1 S2[c]	1989
IEC 60317	series	Specifications for particular types of winding wires	EN 60317	series
IEC 60320 (mod)	series	Appliance couplers for household and similar general purposes	EN 60320	series

[a] HD 323.2.3 S2 includes A1:1984 to IEC 60068-2-3.
[b] EN 60068-2-32 includes A2:1990 to IEC 60068-2-32.
[c] HD 483.1 S2 includes A1:1988 to IEC 60268-1.

Publication	Year	Title	EN/HD	Year
IEC 60335-1 (mod)	1991	Safety of household and similar electrical appliances Part 1: General requirements	EN 60335-1	1994
IEC 60384-1	1982	Fixed capacitors for use in electronic equipment Part 1: Generic specification	EN 130000[a]	1993
IEC 60384-14 A1	1993 1995	Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains	EN 132400[a]	1994
IEC 60417	series	Graphical symbols for use on equipment — Index, survey and compilation of the single sheets	HD 243 S12[b]	1995
IEC 60454	series	Specifications for pressure-sensitive adhesive tapes for electrical purposes	EN 60454	series
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May	1991 1993
IEC 60536	1976	Classification of electrical and electronic equipment with regard to protection against electric shock	HD 366 S1	1977
IEC 60664-1 (mod)	1992	Insulation coordination for equipment within low-voltage systems Part 1: Principles, requirements and tests	HD 625.1 S1 + corr. November	1996 1996
IEC 60664-3	1992	Part 3: Use of coatings to achieve insulation coordination of printed board assemblies	HD 625.3 S1	1997
IEC 60691	1993	Thermal-links — Requirements and application guide	EN 60691[c]	1995
IEC 60695-2-2	1991	Fire hazard testing Part 2: Test methods Section 2: Needle-flame test	EN 60695-2-2	1994
IEC 60707	1981	Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source	HD 441 S1	1983
IEC 60730 (mod)	series	Automatic electrical controls for household and similar use	EN 60730	series
IEC 60738	series	Directly heated positive step-function temperature coefficient thermistors	—	—
IEC 60825-1	1993	Safety of laser products Part 1: Equipment classification, requirements and user's guide	EN 60825-1	1994

[a] Documents are technically equivalent but not identical.
[b] HD 243 S12 is based on IEC 60417:1974 + Supplements A:1974 to M:1994 to IEC 60417.
[c] EN 60691 includes A1:1995 to IEC 60691.

Publication	Year	Title	EN/HD	Year
IEC 60884	series	Plugs and socket-outlets for household and similar purposes	—	—
IEC 60885-1	1987	Electrical test methods for electric cables Part 1: Electrical tests for cables, cords and wires for voltages up to and including 450/750 V	—	—
IEC 60906	series	IEC system of plugs and socket outlets for household and similar purposes	—	—
IEC 60950 (mod)	1991	Safety of information technology equipment	EN 60950 + A11	1992 1997
IEC 60990	1990	Methods of measurement of touch-current and protective conductor current	—	—
IEC 60998-2-2	1991	Connecting devices for low-voltage circuits for household and similar purposes Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units	EN 60998-2-2	1993
IEC 60999-1 (mod) + corr. February	1990 1995	Connecting devices — Safety requirements for screw-type and screwless-type clamping units for electrical copper conductors Part 1: General requirements and particular requirements for conductors from 0,5 mm^2 up to 35 mm^2 (included)	EN 60999-1 + corr. March	1993 1997
IEC 61032	1990[a]	Test probes to verify protection by enclosures	HD 601 S1	1991
IEC 61058-1	1996[b]	Switches for appliances Part 1: General requirements	—	—
IEC 61149	1995	Guide for safe handling and operation of mobile radio equipment	—	—
IEC 61260	1995	Electroacoustics — Octave-band and fractional-octave-band filters	EN 61260	1995
IEC 61293	1994	Marking of electrical equipment with ratings related to electrical supply — Safety requirements	EN 61293	1994
ISO 261	1973	ISO general purpose metric screw threads — General plan	—	—
ISO 262	1973	ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts	—	—

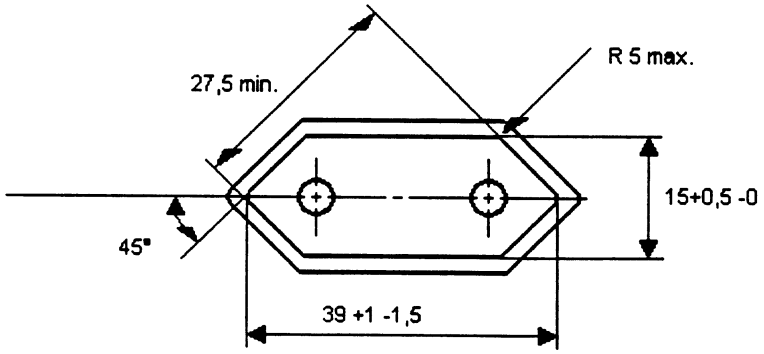
[a] IEC 61032:1997 is harmonized as EN 61032:1998.
[b] IEC 61058-1:1990 is harmonized as EN 61058-1:1992.

Publication	Year	Title	EN/HD	Year
ISO 306	1994	Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)	—	—
ISO 7000	1989	Graphical symbols for use on equipment — Index and synopsis	—	—

Annex ZB (normative)
Special national conditions

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

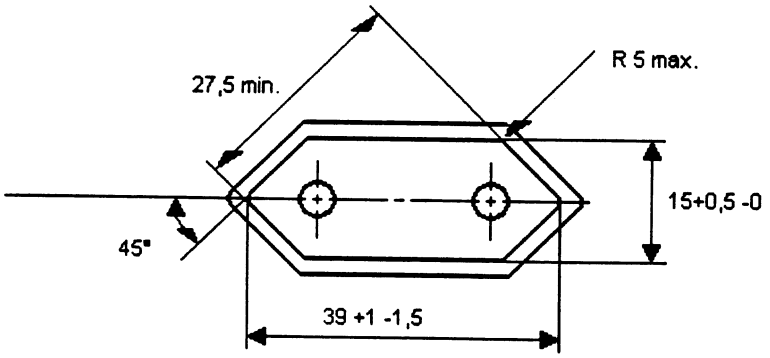
For the countries in which the relevant special national condition apply these provisions are normative, for other countries they are informative.

Clause	Special national condition
	Denmark
2.6.1	The following is added: Certain types of Class I apparatus, see Sub-clause **15.1.1**, may be provided with a plug not establishing earthing continuity when inserted in Danish socket-outlets *Justification:* Heavy Current Regulations, Section 107
	Denmark
15.1.1	To the first paragraph the following is added: In Denmark, supply cords of single phase appliances having a rated current not exceeding 10 A shall be provided with a plug according to the Heavy Current Regulations Section 107-2-D1. Appliances of Class I provided with socket-outlets with earth contact or which are intended to be used in locations where protection against indirect contact is required according to the wiring rules shall be provided with a plug in accordance with standard sheet DK 2-1a. To the second paragraph the following is added: Socket outlets intended for provision power to Class II apparatus with a rated current of 2,5 A shall have the following dimensions:  Dimensions in mm

Clause	Special national condition
	Denmark (continued)
15.1.1 continued	Other dimensions shall be according to IEC 60083, Standard Sheet C 1a for portable socket-outlets. NOTE This Special National Condition will be deleted when prEN 50074 is ratified. To the third paragraph the following is added: Mains socket-outlets with earthing contact shall be in compliance with Heavy Current Regulations Section 107-2-D1, Standard sheet DK 1-3a, DK 1-5a or DK 1-7a *Justification:* Heavy Current Regulations, Section 107
	Ireland
15.1.1	Apparatus which is fitted with a flexible cable or cord shall be provided with a plug in accordance with Statutory Instrument 525.1997, "13A Plugs and Conversion Adapters for Domestic Use Regulations: 1997". *Justification:* S1 525:1997.
	Norway
15.1.1	Mains socket-outlets mounted on Class II apparatus shall comply with the specifications given in CEE Publ. 7 as far as applicable, with the following amendments: § 8 Dimensions a 2,5 A 250 V two-pole socket-outlets for electronic apparatus shall comply with the enclosed Standard Sheet I.

STANDARD SHEET I

2,5 A/250 V SOCKET-OUTLET FOR ELECTRONIC APPLIANCES OF CLASS II



Dimensions in mm

Other dimensions according to CEE Publication 7 Standard Sheet I "Portable Single-Way Socket-Outlets".

Clause	Special national condition
	Norway (continued)
15.1.1 continued	§ 24 Mechanical strength a 2,5 A, 250 V socket-outlets for Class II electronic apparatus are tested as specified in EN 60065, Subclause **12.1.3**. Also the protecting rim shall be tested *Justification:* Act of 24 May 1929 relating to supervision of electrical installation (TEA 1929/FEB 1991). NOTE This Special National Condition will be deleted when prEN 50074 is ratified
	United Kingdom
15.1.1	Apparatus which is fitted with a flexible cable or cord and is designed to be connected to a mains socket conforming to BS 1363 by means of that flexible cable or cord and plug shall be fitted with a "standard plug" in accordance with Statutory Instrument 1768:1994: The Plugs and Sockets etc. (Safety) Regulations 1994, unless exempted by those Regulations. NOTE "Standard plug" is defined in SI 1768:1994 and essentially means an approved plug conforming to BS 1363 or an approved conversion plug. *Justification:* SI 1768:1994
	Norway
B.5.4.1 e)	The following note is added: NOTE In Norway, if separation between the MAINS and a communication system/network, other than public TELECOMMUNICATION NETWORKS, relies upon connection to the safety earth, apparatus shall have a marking stating that it must be connected to an earthed mains socket-outlet. For requirements for the apparatus to be connected to a public TELECOMMUNICATION NETWORK, see **B.8.1** *Justification:* Based on a use in Norway of an IT power distribution system where the neutral is not provided and where wall socket-outlets without earth are used in parts of building installations
	Sweden
B.5.4.1 e)	The following note is added: NOTE In Sweden, if — for apparatus to be connected to the MAINS by means of a plug — the separation between the MAINS and the TELECOMMUNICATION NETWORK, relies upon connection to protective earth, the apparatus shall have a marking stating that it must be connected to an earthed MAINS socket-outlet. The marking text shall be in Swedish and as follows: "Apparaten skall anslutas till jordat uttag." *Justification:* In Sweden, unearthed wall socket-outlets exist in many building installations all over the country.
	Denmark
B.8.1	The following note is added: NOTE In Denmark method b) is permitted only for PERMANENTLY CONNECTED APPARATUS *Justification:* Heavy Current Regulations, Section 107

Clause	Special national condition
	Norway
B.8.1	The following note is added:
	NOTE In Norway, method b) is not permitted. Insulation between parts CONDUCTIVELY CONNECTED TO THE MAINS and parts connected to a public TELECOMMUNICATION NETWORK shall comply with the requirements for DOUBLE or REINFORCED INSULATION.
	Justification: Based on a use in Norway of an IT power distribution system where the neutral is not provided and where wall socket-outlets without earth are used in parts of building installations
	Denmark
B.14.12	The following note is added:
	NOTE In Denmark the use of surge suppressors between the TELECOMMUNICATION NETWORK and conductive ACCESSIBLE parts or TERMINALS which are considered to be ACCESSIBLE, is allowed only for PERMANENTLY CONNECTED APPARATUS.
	Justification: Heavy Current Regulations, Section 107
	Norway
B.14.12	The following note is added:
	NOTE In Norway, for Class I apparatus intended to be connected to the MAINS by means of a plug, surge suppressors may only be connected between TNV circuits and ACCESSIBLE parts if the apparatus has a marking stating that it must be connected to an earthed MAINS socket-outlet.
	Justification: Based on a use in Norway of an IT power distribution system where the neutral is not provided and where wall socket-outlets without earth are used in parts of building installations
	Sweden
B.14.12	The following note is added:
	NOTE In Sweden, for Class I apparatus intended to be connected to the MAINS by means of a plug, surge suppressors may only be connected between TNV circuits and ACCESSIBLE parts if the apparatus has a marking stating that it must be connected to an earthed MAINS socket-outlet. The marking text shall be in Swedish and as follows: "Apparaten skall anslutas till jordat uttag."
	Justification: In Sweden, unearthed wall socket-outlets exist in many building installations all over the country.

Annex ZC (informative)
A-deviations

A-deviation: A national deviation due to regulations, the alteration of which — at least for the time being — is outside the competence of the CEN/CENELEC member.

Clause	National deviation
	Germany
5	The following markings are required: a) In case of intrinsically ionizing radiation safe cathode-ray tubes with accelerating voltages between 20 kV and 30 kV: — On the cathode-ray tube itself the wording: Eigensichere Kathodenstrahlröhre nach Anlage III Röntgenverordnung — Inside the apparatus: the maximum allowed accelerating voltage in kV, and the maximum allowed beam current in mA. — On the outer of the apparatus: a notice in German language that produced X-rays are sufficiently shielded by the intrinsically safe cathode-ray tube. b) In case of approval of the whole TV receiver with an accelerating voltage exceeding 30 kV: — On the outer of the apparatus: the licence number .../.../.../Rö, and the following text: Die in diesem Gerät entstehende Röntgenstrahlung ist ausreichend abgeschirmt. Beschleunigungsspannung. max: ... kV. — Supplied with the apparatus: a copy of the "Zulassungsschein", together with the notices required there. c) In case of TV receivers with accelerating voltages not exceeding 20 kV: Die in diesem Gerät entstehende Röntgenstrahlung ist ausreichend abgeschirmt. Beschleunigungsspannung. max: ... kV. *Justification:* German ministerial decree against ionizing radiation (Röntgenverordnung), dated 1987-01-08.
	Italy
5.1	The following requirements shall be fulfilled: — The power consumption in Watts (W) shall be indicated on TV receivers and in their instruction for use (Measurement according to IEC 107-1) — TV receivers shall be provided with an instruction for use, schematic diagrams and adjustments procedure in Italian language. — Marking for controls and terminals shall be in Italian language. Abbreviation and international symbols are allowed provided that they are explained in the instruction for use. — The ECC manufacturers are bound to issue a conformity declaration according to the above requirements in the instruction manual. The correct statement for conformity to be written in the instruction manual, shall be: Questo apparecchio è fabbricato nella CEE nel rispetto delle disposizioni del D.M. marzo 1992 ed è in particolare conforme alle prescrizioni dell' art. 1 dello stesso D.M.

Clause	National deviation
	— The first importers of TV receivers manufactured outside EEC are bound to submit the TV receivers for previous conformity certification to the Italian Post Ministry (PP.TT). The TV receivers shall have on the back cover the certification number in the following form: D.M. 26/03/1992 xxxxx/xxxxx/S or T or pT S for stereo T for teletext pT for retrofitable teletext *Justification:* Ministerial Decree of 26 March 1992: National rules for television receivers trade. NOTE The ministerial decree above contains additional, but not safety relevant, requirements
	Germany
6.1	For TV receivers an ionizing radiation not exceeding 1μSv/h (microsievert per hour) (= 7,2 pA/kg = 0,1 mR/h) at a distance of 10 cm from the outer surface of the apparatus is required. *Justification:* German ministerial decree against ionizing radiation (Röntgenverordnung), dated 1987-01-08.

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