

Audio, video and similar electronic apparatus — Safety requirements

ICS 97.020

National foreword

This British Standard is the UK implementation of EN 60065:2002+A12:2011, incorporating amendments A11:2008 and A2:2010 and corrigendum August 2007. It was derived from IEC 60065:2001, incorporating amendments 1:2005, 2:2010, and corrigendum August 2002. It supersedes BS EN 60065:2002+A2:2010 which will be withdrawn on 1 October 2013.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated in the text by **A1** **A1**.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags **C** **C**. Where a common modification has been introduced by amendment, the tags carry the number of the amendment. For example, the common modifications introduced by CENELEC amendment A11 are indicated by **C11** **C11** and A12 by **C12** **C12**.

The start and finish of text introduced by IEC corrigendum August 2002 is indicated by **AC1** **AC1**.

The UK participation in its preparation was entrusted to Technical Committee EPL/108, Safety of electronic equipment within the field of audio/video, information technology and communication technology.

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

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**Audio, video and similar electronic apparatus –
Safety requirements**
(IEC 60065:2001, modified)

Appareils audio, vidéo et appareils
électroniques analogues –
Exigences de sécurité
(CEI 60065:2001, modifiée)

Audio-, Video- und ähnliche elektronische
Geräte –
Sicherheitsanforderungen
(IEC 60065:2001, modifiziert)

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CENELEC

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

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Foreword

Following BT decision D105/051 the text of future edition 7 of the International Standard IEC 60065 (92/85/FDIS), prepared by IEC TC 92, Safety of audio, video and similar electronic equipment, together with common modifications prepared by the Technical Committee CENELEC TC 92, Safety of audio, video and similar electronic equipment, was submitted to the formal vote and was approved by CENELEC as EN 60065 on 2002-03-01.

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The following dates were fixed:

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

Annexes designated "informative" are given for information only.

In this standard, annexes A to K, ZA and ZB are normative; annexes M, N and ZC are informative.

Annexes ZA, ZB and ZC have been added by CENELEC

Foreword to amendment A1

The text of document 108/136/FDIS, future amendment 1 to IEC 60065:2001, prepared by IEC TC 108, Safety of electronic equipment within the field of audio/video, information technology and communication technology, was submitted to the IEC-CENELEC parallel vote.

A draft amendment to EN 60065:2002, prepared by the Technical Committee CENELEC TC 108, Safety of electronic equipment within the fields of audio/video, information technology and communication technology, was submitted to the formal vote.

The two documents together were ratified by CENELEC as amendment A1 to EN 60065:2002 on 2005-12-01.

Annex L of this amendment A1 to EN 60065:2002 supersedes EN 60491:1995.

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Foreword to amendment A11

This amendment to the European Standard EN 60065:2002 was prepared by the Technical Committee CENELEC TC 108X, Safety of electronic equipment within the fields of audio/video, information technology and communication technology.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A11 to EN 60065:2002 on 2008-07-01.

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Clauses, subclauses, notes, tables and figures which are additional to those in IEC 60065 are prefixed "Z".

Foreword to amendment A2

The text of document 108/395/FDIS, future amendment 2 to IEC 60065:2001, prepared by IEC TC 108, Safety of electronic equipment within the field of audio/video, information technology and communication technology, was submitted to the IEC-CENELEC parallel vote.

A draft amendment was prepared by the Technical Committee CENELEC TC 108X, Safety of electronic equipment within the fields of audio/video, information technology and communication technology and was submitted to formal vote.

The combined texts were approved by CENELEC as EN 60065:2002/A2 on 2010-10-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

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Annexes ZA and ZB have been added by CENELEC.

Endorsement notice

The text of amendment 2:2010 to the International Standard IEC 60065:2001 was approved by CENELEC as an amendment to the European Standard with agreed common modifications.

Foreword to amendment A12

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The text of the draft was submitted to the unique acceptance procedure and was approved by CENELEC as amendment A12 to EN 60065:2002 on 2011-01-24.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

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Sub-clauses, tables and figures which are additional to those in IEC 60065 are prefixed “Z”.

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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 A_2 parts that may be touched A_2 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 A_2 caused by a single 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. A_2

Cause

Contacts with parts normally at hazardous voltage.

Breakdown of insulation between parts normally at hazardous voltage and accessible parts.

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.

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.)

Prevention

Prevent access to parts at hazardous voltage by fixed or locked covers, interlocks, etc.
Discharge capacitors at hazardous voltages.

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.

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.

Limit touch current to a safe value or provide a protective earthing 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:

- heat;
- arcing;

caused by

- overloads;
- component failure;
- insulation breakdown;
- bad connections;
- conductor breakage.

Requirements are included that are intended to prevent fire originating 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 prevention of excessive temperature rise that 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. 

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AUDIO, VIDEO AND SIMILAR ELECTRONIC APPARATUS – SAFETY REQUIREMENTS

1 General

1.1 Scope

1.1.1 This International Safety Standard applies to electronic apparatus designed to be fed from the MAINS, from a SUPPLY APPARATUS, from batteries or from REMOTE POWER FEEDING 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 primarily concerns apparatus intended for household and similar general use but which may also be used in places of public assembly such as schools, theatres, places of worship and the workplace. PROFESSIONAL APPARATUS intended for use as described above is also covered unless falling specifically within the scope of other standards.

This standard concerns only safety aspects of the above apparatus; it does not concern other matters, such as style or performance.

This standard applies to the above-mentioned apparatus, if 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;

NOTE 1 Film projectors, slide projectors, overhead projectors are covered by IEC 60335-2-56 [5]¹⁾

- video cameras and video monitors;
- video games and flipper games;

A2 Text deleted **A2**

- juke boxes;
- electronic gaming and scoring machines;

A2 NOTE 2 Video games, flipper games and gaming machines and other amusement games for commercial use are covered by IEC 60335-2-82 [6]. **A2**

1) Figures in square brackets refer to the bibliography.

- 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;
- electronic light effect apparatus;
- apparatus for use in alarm systems;
- intercommunication apparatus, using low voltage MAINS as the transmission medium;
- cable head-end receivers;
- multimedia apparatus;

NOTE 3 The requirements of IEC 60950 may also be used to meet the requirements for safety of multi media apparatus (see also IEC Guide 112 [16])

- professional general use amplifiers, record or disc players, tape players, recorders, and public address systems;
- professional sound/video systems;

A1 – electronic flash apparatus for photographic purposes (see Annex L). **A1**

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.

NOTE See table A.2 of IEC 60664-1.

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.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, 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. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

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

IEC 60038:1983, *IEC standard voltages*

■_{A1} Amendment 1 (1994)

Amendment 2 (1997) ◊_{A1}

■_{A1} IEC 60068-2-78:2001, *Environmental testing – Part 2: Tests – Test Cab: Damp heat, steady state*

IEC 60086-4:2000, *Primary batteries – Part 4: Safety of lithium batteries* ◊_{A1}

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 2)*

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

IEC 60085: ■_{A1} 2004 ◊_{A1}, *Thermal evaluation and classification of electrical insulation*

■_{A2} IEC 60107-1:1997, *Methods of measurement on receivers for television broadcast transmissions – Part 1: General considerations – Measurements at radio and video frequencies* ◊_{A2}

IEC 60112: ■_{A1} 2003 ◊_{A1}, *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 60216 (all parts), *Guide for the determination of thermal endurance properties of electrical 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 60335-1:2001, *Household and similar electrical appliances – Safety – Part 1: General requirements*

■_{A1} Amendment 1 (2004) ◊_{A1}

IEC 60384-1:  1999 , *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*

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

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

 Amendment 1 (1999) 

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

 Amendment 1 (2000)

Amendment 2 (2002) 

IEC 60664-3:  2003 , *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coatings to achieve insulation coordination of printed board assemblies*

IEC 60691:  2002 , *Thermal links – Requirements and application guide*

 IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance* 

 IEC 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

Amendment 1 (2003)¹⁾ 

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

 IEC 60747-5-5:2007, *Semiconductor devices – Discrete devices – Part 5-5: Optoelectronic devices - Photocouplers* 

 IEC 60825-1:2007, *Safety of laser products – Part 1: Equipment classification and requirements* 

IEC 60851-3:1996, *Methods of test for winding wires – Part 3: Mechanical properties*

 Amendment 1 (1997) 

IEC 60851-5:1996, *Methods of test for winding wires – Part 5: Electrical properties*

 Amendment 1 (1997)

Amendment 2 (2004) 

IEC 60851-6:1996, *Methods of test for winding wires – Part 6: Thermal properties*

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 60950:1999, *Safety of information technology equipment*

IEC 60990:1999, *Methods of measurement of touch current and protective conductor current*

¹⁾ A consolidated edition (1.1) exists, including IEC 60695-11-10:1999 and its Amendment 1.

IEC 60998-2-2:  2002 , *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*

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

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61051-2:1991, *Varistors for use in electronic equipment – Part 2: Sectional specification for surge suppression varistors*

IEC 61058-1:  2000 , *Switches for appliances – Part 1: General requirements*

IEC/TR2 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*

IEC 61558-1:1997, *Safety of power transformers, power supply units and similar – Part 1: General requirements and tests* ¹⁾
Amendment 1 (1998)

IEC 61558-2-17:1997, *Safety of power transformers, power supply units and similar – Part 2-17: Particular requirements for transformers for switch mode power supplies*

IEC 61965:  2003 , *Mechanical safety of cathode ray tubes*

IEC 62151:2000, *Safety of equipment electrically connected to a telecommunication network*

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

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*

ITU-T Recommendation K17:1988, *Tests on power-fed repeaters using solid-state devices in order to check the arrangements for protection from external interference*

ITU-T Recommendation K21:1996, *Resistibility of telecommunication equipment installed in customer's premises to overvoltages and overcurrents*

¹⁾ There exists a consolidated edition 1.1 (1998) that includes edition 1.0 and its amendment 1.

2 Definitions

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

2.1 Definitions in alphabetical order

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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 synthesiser that produces music under the control of the USER

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 3.48 of IEC 60825-1:2007) 

2.2.7

LASER

A2 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 3.41 of IEC 60825-1:2007) **A2**

NOTE Devices to which this definition does not apply are Light Emitting Diodes (LEDs) used for displays, infrared remote controls, infrared audio/visual signal transmission and optocouplers.

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

A2 **2.2.10**

PORTABLE APPARATUS

apparatus specifically designed to be carried easily, the mass of which does not exceed 18 kg **A2**

2.2.11

TRANSPORTABLE APPARATUS

apparatus, the mass of which exceeds 18 kg, specifically designed to be moved frequently from place to place

NOTE Examples of TRANSPORTABLE APPARATUS are musical instruments and their associated amplifiers.

2.2.12

PROFESSIONAL APPARATUS

apparatus for use in trades, professions or industries and which is not intended for sale to the general public

NOTE The designation should be specified by the manufacturer.

C12 *Text deleted* **C12**

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

A2 **WORKING 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 **A2**

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)

2.3.8

REQUIRED WITHSTAND VOLTAGE

peak voltage that the insulation under consideration is required to withstand

2.3.9

TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE

highest peak voltage expected at the TELECOMMUNICATION NETWORK connection point of the apparatus, arising from external transients on the network

2.3.10

RATED POWER CONSUMPTION

power in watts consumed in an apparatus operating at its RATED SUPPLY VOLTAGE under normal operating conditions

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 $2\,000\ \Omega$ 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 EARTHING TERMINAL

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

2.4.7

TELECOMMUNICATION NETWORK

metallically-terminated transmission medium intended for communication between apparatus that may be located in separate buildings, excluding

- the MAINS systems for supply, transmission and distribution of electrical power, if used as a telecommunication transmission medium;
- television distribution systems using cable

NOTE 1 The term TELECOMMUNICATION NETWORK is defined in terms of its functionality, not its electrical characteristics. A TELECOMMUNICATION NETWORK is not itself defined as being a TNV CIRCUIT. Only the circuits in apparatus are so classified.

NOTE 2 A TELECOMMUNICATION NETWORK may be

- publicly or privately owned;
- subject to transient overvoltages due to atmospheric discharges and faults in power distribution systems;
- subject to permanent longitudinal (common mode) voltages induced from nearby power lines or electric traction lines.

NOTE 3 Examples of TELECOMMUNICATION NETWORKS are:

- a public switched telephone network;
- a public data network;
- an ISDN network;
- a private network with electrical interface characteristics similar to the above.

2.4.8

REMOTE POWER FEEDING

supply of power to apparatus via a cable network, for example a TELECOMMUNICATION NETWORK or a cable distribution network for antenna signals

2.4.9

TNV CIRCUIT

circuit which is in the apparatus and to which the ACCESSIBLE area of contact is limited (except for a TNV-0 CIRCUIT) and that is so designed and protected that, under normal operating and fault conditions, the voltages do not exceed specified limiting values

A TNV CIRCUIT is considered to be a circuit which is not CONDUCTIVELY CONNECTED TO THE MAINS.

NOTE 1 The specified limiting values of voltages under normal operating and fault conditions are given in annex B. For requirements regarding accessibility of TNV CIRCUITS, see 4.2.2 of IEC 62151.

TNV CIRCUITS are classified as TNV-0, TNV-1, TNV-2 and TNV-3 CIRCUITS as defined in 2.4.10, 2.4.11, 2.4.12, and 2.4.13 respectively.

NOTE 2 The voltage relationships between TNV CIRCUITS are shown in the table below.

Table 1 – Voltage ranges of TNV circuits

Overvoltages from TELECOMMUNICATION NETWORKS possible?	Voltage ranges	
	Within TNV-0 CIRCUIT limits	Exceeding TNV-0 CIRCUIT limits but within TNV CIRCUIT limits
Yes	TNV-1 CIRCUIT	TNV-3 CIRCUIT
No	TNV-0 CIRCUIT	TNV-2 CIRCUIT

2.4.10

TNV-0 CIRCUIT

TNV CIRCUIT:

whose voltages do not exceed a safe value under normal operating conditions and under fault conditions; and

which is not subject to overvoltages from TELECOMMUNICATION NETWORKS

NOTE The limiting values of voltages under normal operating and fault conditions are specified in 9.1.1.1 a) and 11.1 respectively.

2.4.11

TNV-1 CIRCUIT

TNV CIRCUIT:

whose voltages do not exceed the limits for a TNV-0 CIRCUIT under normal operating conditions; and

on which overvoltages from TELECOMMUNICATION NETWORKS are possible

2.4.12

TNV-2 CIRCUIT

TNV CIRCUIT:

whose voltages exceed the limits for a TNV-0 CIRCUIT under normal operating conditions; and

which is not subject to overvoltages from TELECOMMUNICATION NETWORKS

2.4.13

TNV-3 CIRCUIT

TNV CIRCUIT:

whose voltages exceed the limits for a TNV-0 CIRCUIT under normal operating conditions; and

on which overvoltages from TELECOMMUNICATION NETWORKS are possible

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

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

2.6.3

BASIC INSULATION

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

A2 NOTE BASIC INSULATION may also serve as functional insulation. **A2**

2.6.4

DOUBLE INSULATION

insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION

2.6.5

SUPPLEMENTARY INSULATION

independent insulation applied in addition to BASIC INSULATION in order to reduce the risk of electric shock in the event of a failure of the BASIC INSULATION

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

2.6.8

PROTECTIVE SCREENING

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

2.6.9

TOUCH CURRENT

electric current through a human body when it touches one or more ACCESSIBLE parts [IEV 195-05-21, modified]

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 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 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

MAINS SWITCH

MANUALLY OPERATED MECHANICAL SWITCH which interrupts either one pole or all poles of the MAINS, except the protective earthing 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

2.7.14

SPECIAL BATTERY

rechargeable battery or group of rechargeable batteries, identified by battery manufacturer's name and catalogue number, provided with the apparatus or recommended by the manufacturer

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 which can start a fire if the open-circuit voltage measured across an interruption or faulty contact exceeds a value of 50 V (peak) a.c. or d.c. and the product of the peak value of this voltage and the measured r.m.s. current under normal operating conditions exceeds 15 VA.

Such a faulty contact or interruption in an electrical connection includes those which may occur in CONDUCTIVE PATTERNS on PRINTED BOARDS

NOTE An electronic protection circuit may be used to prevent such a fault from becoming a POTENTIAL IGNITION SOURCE.

A₂ 2.8.12

PASSIVE FLAMMABILITY

flammability caused by external heating of the component (for example, by flames) A₂

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.

C₁₂ *Text deleted* C₁₂

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.

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

C₂ 3.21

To protect against excessive current, short-circuits and earth faults in MAINS, protective devices shall be included either as integral parts of the equipment or as parts of the building installation, subject to the following, a), b) and c):

- a) except as detailed in b) and c), protective devices necessary to comply with the requirements of 11 shall be included as parts of the equipment;
- b) for components in series or parallel with the mains input to the equipment such as the supply cord, appliance coupler, r.f.i. filter and switch, short-circuit and earth fault protection may be provided by protective devices in the building installation;
- c) it is permitted for equipment supplied via an industrial mains plug or for PERMANENTLY CONNECTED APPARATUS, to rely on dedicated over current and short-circuit protection in the building installation, provided that the means of protection, e.g. fuses or circuit breakers, is fully specified in the installation instructions.

If reliance is placed on protection in the building installation, the installation instructions shall so state, except that for not via an industrial mains plug or for PERMANENTLY CONNECTED APPARATUS the building installation shall be regarded as providing protection in accordance with the rating of the wall socket outlet. C₂

4 General test conditions

4.1 Conduct of tests

4.1.1 Tests according to this standard are TYPE TESTS.

NOTE For ROUTINE TEST reference is made to EN 50333.

4.1.2 The sample or samples under test shall be representative of the apparatus the USER would receive, or shall be the actual apparatus 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 apparatus manufacturer, specifically those dealing with proper ventilation.

The apparatus shall also comply with table 3 when tested on an open bench.

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, except battery-operated apparatus, is connected to a supply voltage of 0,9 times or 1,1 times of any RATED SUPPLY VOLTAGE for which the apparatus is designed.*

For battery-operated apparatus a fully charged rechargeable battery or dry batteries in a fresh condition are used.

RATED CURRENT CONSUMPTION and RATED POWER CONSUMPTION are measured at the RATED SUPPLY VOLTAGE.

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 1,1 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.

A1 *Any type of supply for which the apparatus is designed to be used.* **A1**

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 EARTHING 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 EARTHING 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.

As an alternative, where the amplifier function is not adversely affected, a sine wave of 1 kHz or where applicable, another frequency corresponding to the geometric mean of the upper and lower -3 dB response points of the relevant part of the apparatus may be used to supply each channel.

If the result of a measurement performed with a sine wave does not comply with this standard, the measurement with PINK NOISE is decisive.

When determining whether a part or output TERMINAL contact is HAZARDOUS LIVE according to 9.1.1.1 and 11.1, the apparatus shall be operated with a sinusoidal input test signal of 1 kHz or where applicable, another frequency corresponding to the geometric mean of the upper and lower -3 dB response points of the relevant amplifier part of the apparatus, sufficient in amplitude for the apparatus to deliver the NON-CLIPPED OUTPUT POWER into its RATED LOAD IMPEDANCE. Open-circuit output voltage is determined after the load is removed.

- 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.

- d) Where the intended amplifier function depends on phase difference between two channels, there shall be a phase difference of 90° between the signals applied to the two channels.

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 is 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, to 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 2 corresponding to the RATED SUPPLY VOLTAGE of the apparatus under test. The values of no-load voltage given in table 2 are subject to the under- and over-voltage provisions specified in 4.2.1.*

Table 2 – 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 This table 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 ^[A1] one at a time ^[A1] 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.

^[A2] NOTE 2 Examination of the apparatus and all its circuit diagrams, excluding the internal circuit diagrams of integrated circuits, generally shows the fault conditions that are likely to create a hazard and that need to be applied. These are applied in sequence, in the order that is most convenient.

The examination of the apparatus and circuit diagrams indicate the operating conditions under which simulated faults should be applied in order to produce the most unfavourable effects. In most cases, the effects of a simulated fault are most unfavourable if the simulated fault is applied while the apparatus is in full operation.

However, for some parts, the most unfavourable effects may occur if the simulated fault is applied before switching on the apparatus. It is also possible that the most unfavourable effects could occur when a simulated fault is applied when the apparatus is in a STAND-BY condition. ^[A2]

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 no installation instructions are provided and there is a possibility that the test box 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.

^[A1] **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, with the exception of insulation between parts of different polarity DIRECTLY CONNECTED TO THE MAINS.

NOTE For CLEARANCES between parts of different polarity DIRECTLY CONNECTED TO THE MAINS reference is made to 13.1. ^[A1]

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 ^[A1] one pair at a time ^[A1] (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 THERMISTORS complying with IEC 60730-1, clause 15, 17, J15 and J17;
- 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;
- f) surge suppression varistors complying with the requirements of 14.12.

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.

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. MAINS socket outlets shall be loaded with 1,1 times the highest load possible based on over-current protection and the outlet configuration except where the wiring to the socket outlet has the same cross-sectional area as the MAINS cord.

A1 **4.3.10** The top, sides and the back of an apparatus, if such surfaces have ventilation openings, shall be covered one at a time with a piece of card of 200 g/m² density with dimensions not less than each tested surface, covering all openings.

Openings on different surfaces on top of the apparatus (if any) are covered simultaneously by separate pieces of card.

Openings on top of the apparatus, on a surface inclined at an angle greater than 30° and smaller than 60° to the horizontal, from which an obstruction is free to slide, are excluded.

On the back and the sides of the apparatus, the card is attached to the upper edge and allowed to hang freely.

NOTE There is no test for the bottom surface. **A1**

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 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 2 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 2.

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.

4.3.16 *For apparatus with a charging circuit, recharge a fully discharged SPECIAL BATTERY with one cell short-circuited.*

NOTE See also 11.2 and 14.10.3.

5 Marking and instructions

NOTE Additional requirements for marking and instructions are contained in 4.1.4, 4.2.7, 8.19.1, 8.19.2, 9.1.5, 14.3.1, 14.5.1.3, 14.5.2.2, 14.5.4, clause 19 and annex B.

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.

- A₂** As an alternative, it is permitted to use a reagent grade hexane with a minimum of 85 % as n-hexane.

NOTE The designation "n-hexane" is chemical nomenclature for a "normal" or straight chain hydrocarbon. This petroleum spirit may further be identified as a certified ACS (American Chemical Society) reagent grade hexane (CAS# 110-54-3). **A₂**

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.

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:  (IEC 60417-5172)
- d) nature of supply:
 - a.c. only with the symbol:  (IEC 60417-5032)
 - d.c. only with the symbol:  (IEC 60417-5031)
 - a.c. or d.c. with the symbol:  (IEC 60417-5033)
 - for three-phase systems, reference is made to IEC 61293;
- e) 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";
- f) rated MAINS frequency (or range of frequencies) in hertz, if safety is dependent on the use of the correct MAINS frequency;
- g) 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.

The measured consumption at RATED SUPPLY VOLTAGE shall not exceed the marked value by more than 10 %;
- A₂** h) RATED CURRENT CONSUMPTION or RATED POWER CONSUMPTION for apparatus intended for connection to an a.c. MAINS supply.

The measured consumption at RATED SUPPLY VOLTAGE shall not exceed the marked value by more than 10 %.

For RATED CURRENT CONSUMPTION or RATED POWER CONSUMPTION measurements of television sets, the following settings shall apply: **A₂**

- A2** – the ‘three vertical bar signal’ shall be used as defined in 3.2.1.3 of IEC 60107-1:1997; and
- user ACCESSIBLE picture controls shall be adjusted so as to obtain the maximum power consumption; and
 - sound settings shall be as defined in 4.2.4 a) of this standard. **A2**

A1 *Text deleted* **A1**

Compliance is checked by inspection.

C1 NOTE For RATED POWER CONSUMPTION measurements of TVs reference is made to EN 62087. Measurements are done in the ON (play) operating mode. **C1**

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:



(IEC 60417-5019)

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:



(IEC 60417-5036)

- A2** c) Unless the TERMINALS are marked with the type references of the apparatus that are permitted to be connected, output TERMINALS provided for supply of other apparatus except MAINS supply shall be marked with
- the nominal output voltage; and
 - the maximum output current or power, if with the most unfavourable load, temperature rises higher than those allowed in Table 3 for normal operating conditions can occur. **A2**

Compliance is checked by inspection.

A2 5.3 Caution marking

The following markings shall be included as applicable:

- a) 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.

- b) Where a loudspeaker grille, removable from the outside by the use of a tool, coin or other object, is relied on as protective cover (see 9.2), the following marking, or equivalent, shall be visible on the enclosure after removal of the grille:

CAUTION To prevent electric shock hazard, do not connect to mains power supply while grille is removed.
--

Alternatively, the symbol , IEC 60417-5036 (2002) shall be visible after removal of the grille and the caution wording above shall appear in the user instructions, accompanied by the symbol. **A2**

C2 *Text deleted* **C2**

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 [17].

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) A warning that an apparatus with CLASS I construction shall be connected to a MAINS socket outlet with a protective earthing connection.
- e) Instructions to ensure correct and safe installation and interconnection of the apparatus in multimedia systems.
- f) If the apparatus is not tested to the stability requirements of 19.1, 19.2 or 19.3 due to fastening in place, the following or similar text shall be marked on or provided with the apparatus:

WARNING

To prevent injury, this apparatus must be securely attached to the floor/wall
in accordance with the installation instructions.

Compliance is checked by inspection.

-  g) A warning that batteries (battery pack or batteries installed) shall not be exposed to excessive heat such as sunshine, fire or the like.
- h) If the apparatus is provided with a CRT with protective film attached to the faceplate as part of the safety implosion protection system in accordance to IEC 61965, the following warning, or wording with a similar meaning, shall be given in the instructions:

WARNING

The CRT in this apparatus employs a protective film on the face.
This film must not be removed as it serves a safety function and
removal will increase the risk of serious injury. 

 Text deleted 

Ⓒ₂ Text deleted Ⓒ₂

5.4.2 With regard to devices for disconnection from the MAINS, instructions shall state that

- a) where the MAINS plug or an appliance coupler is used as the disconnect device, the disconnect device shall remain readily operable;
- b) where an all-pole MAINS SWITCH is used as the disconnect device, the location on the apparatus and the function of the switch shall be described, and the switch shall remain readily operable;
- c) for PERMANENTLY CONNECTED APPARATUS provided neither with an all-pole MAINS SWITCH nor an all-pole circuit breaker, the installation shall be carried out in accordance with all applicable installation rules.

Where marking, signal lamps or similar means might give the impression that the apparatus is completely disconnected from the MAINS, information that states clearly the correct situation shall be included. If symbols are used, their meaning shall also be explained.

Marking of the off-position by the relevant symbol according to IEC 60417-5008 or according to IEC 60417-5010 is permitted only for an all-pole MAINS SWITCH which interrupts all poles of the MAINS supply except the protective earthing conductor.

Compliance is checked by inspection.

6 Hazardous radiations

Ⓒ₁₁ 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 dose-rate is determined by means of a radiation monitor with an effective area of 10 cm², at any point 10 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. Ⓒ₁₁

[C₁₁] *The dose-rate shall not exceed 1 μSv/h (0,1 mR/h) taking account of the background level.*

NOTE 2 These values appear in Directive 96/29/Euratom of 13th May 1996.

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/m² 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 flashover per 5 min.* **[C₁₁]**

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 [10].

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, 5.2 of IEC 60825-1, 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.

[A₂] The laser radiation emitted by redirection as mentioned in IEC 60825-1:2007, 3.37 b), shall not be measured for a LASER SYSTEM of class 1. **[A₂]**

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.

[A₂] *Compliance is checked by performing the relevant measurements as specified in IEC 60825-1:2007, 9.2. **[A₂]***

- 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 3R 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 3R 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.

Any single protective device or component of a protective circuit operating during the test shall be defeated, except for

- a) THERMAL CUT-OUTS with automatic reset complying with 14.5.1,*
- b) PTC THERMISTORS complying with 14.5.3.*

Consequently, if continuous operation of an AUDIO AMPLIFIER is not possible, the amplifier shall also be operated at the maximum possible signal level permitting continuous operation.

7.1.1 ACCESSIBLE parts

The temperature rise of ACCESSIBLE parts shall not exceed the values given in table 3, 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 3, item b) "Normal operating conditions", taking into account condition d) of table 3.

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 3, 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 3, 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 3, item e), "Normal operating conditions".

Table 3 – Permissible temperature rise of parts of the apparatus

Parts of the apparatus	Δ_2 Normal operating conditions ^a K	Fault conditions ^a K Δ_2
a) <i>ACCESSIBLE parts</i> Knobs, handles, etc. if – metallic – non-metallic ^c Enclosures if – Δ_1 metallic ^b Δ_1 – non-metallic ^{b + c}	30 50 40 60	65 65 65 65
b) <i>Parts providing electrical insulation^d</i> Supply cords and wiring insulation with – polyvinyl chloride or synthetic rubber – not under mechanical stress – under mechanical stress – natural rubber Other insulations of: – thermoplastic materials ^e – non-impregnated paper – non-impregnated cardboard – impregnated cotton, silk, paper and textile – laminates based on cellulose or textile, bonded with – phenol-formaldehyde, melamine-formaldehyde, phenol-furfural or polyester – epoxy – mouldings of – phenol-formaldehyde or phenol-furfural, melamine and melamine phenolic compounds with – cellulose fillers – mineral fillers – thermosetting polyester with mineral fillers – alkyd with mineral fillers – composite materials of – polyester with glass-fibre reinforcement – epoxy with glass-fibre reinforcement – silicone rubber	60 45 45 f) 55 60 70 85 120 100 110 95 95 95 100 100 145	100 100 100 f) 70 80 90 110 150 130 150 150 150 150 150 190
c) <i>Parts acting as a support or a mechanical barrier including the inside of enclosures^d</i> Wood and WOOD-BASED MATERIALS Thermoplastic materials ^e Other materials	60 f) d)	90 f) d)
d) <i>Winding wires^{d + g}</i> – insulated with – non-impregnated silk, cotton, etc. – impregnated silk, cotton, etc. – oleoresinous materials – polyvinyl-formaldehyde or polyurethane resins – polyester resins – polyesterimide resins	55 70 70 85 120 145	75 100 135 150 155 180
e) <i>Other parts</i> These temperature rises apply to parts not covered by items a), b), c) and d): Parts of wood and WOOD-BASED MATERIAL Lithium batteries Resistors and parts of metal, glass, ceramic, etc. All other parts	60 Δ_1 40 ^{h)} No limit 200	140 50 ⁱ⁾ Δ_1 No limit 300

For conditions see the following page.

Table 3 (continued)

Conditions applicable to table 3

- ^a 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.
- Where the temperatures are thermostatically limited by a THERMAL CUT-OUT with automatic reset or a PTC THERMISTOR, the measured temperature on the part shall not exceed 35 °C plus the permitted rise of table 3.
- ^b For parts not likely to be touched during intended use, temperature rises up to 65 K are allowed under normal operating conditions. The wooden test box of 4.1.4 shall not be used when evaluating access to parts likely to be touched. The following parts are considered not likely to be touched:
- rear and bottom panels, except those incorporating switches or controls handled during normal use,
 - external heatsinks and metallic parts directly covering external heatsinks, except those on surfaces incorporating switches or controls handled during normal use,
 - parts of the top surface which are more than 30 mm below the general plane of the top surface.
- 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.
- ^c 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.
- ^d 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 shall not exceed those which have been proved to be satisfactory, for example in accordance with IEC 60085.
- ^e Natural rubber and synthetic rubbers are not considered as being thermoplastic materials.
- ^f Due to their wide variety, it is not possible to specify a generic permissible temperature rise for thermoplastic materials. In order to determine the softening temperature of a specific thermoplastic material, the softening temperature as determined by the test B50 of ISO 306 shall be used. If the material is not known or if the actual temperature of the parts exceeds the softening temperature, the test described under 1) shall be used.
- 1) the softening temperature of the material is determined on a separate specimen, under the conditions specified in ISO 306 with a heating rate of 50 °C/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.
 - 2) 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;
 - under fault conditions, the softening temperature itself.
- If the required softening temperature exceeds 120 °C, condition ^c shall be taken into account.
- ^g For switch mode transformers temperature rises may be measured with a thermocouple placed as close as practicable to the winding. The permitted temperature rise shall be 10 K less than that given in table 3.
- ^h) Lithium batteries shall meet the permissible temperature rise, unless such batteries comply with the applicable electrical tests of 6.2.2.1 or 6.2.2.2 of IEC 60086-4.
- ⁱ) Lithium batteries shall meet the permissible temperature rise, unless such batteries comply with all electrical tests of 6.3.2 of IEC 60086-4. ^{A1}

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 3, condition f.

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 operations BY HAND, such as

- 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 also 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 EARTHING 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 EARTHING TERMINAL or contact to which the protective earthing 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 EARTHING 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 Void.

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.

For requirements for insulated winding wires for use without additional interleaved insulation, see 8.17.

A1 For test specifications of non-separable thin sheet insulation, see 8.22.

NOTE The purpose of the tests in 8.22 is to ensure that the material has adequate strength to resist damage when hidden in inner layers of insulation. Therefore, the tests are not applied to insulation in two layers. The tests are also not applied to SUPPLEMENTARY INSULATION. **A1**

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.

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

8.12 Void.

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 3 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 by 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.

8.17 Requirements for insulated winding wires for use without additional interleaved insulation

Insulated winding wires of wound components, the insulation of which is providing BASIC, SUPPLEMENTARY, REINFORCED OR DOUBLE INSULATION shall meet the following requirements:

- where the insulation on the winding wire is used to provide BASIC, SUPPLEMENTARY or REINFORCED INSULATION in a wound component, the insulated wire shall comply with annex H;
- the minimum number of constructional layers applied to the conductor or conductors shall be as follows:
 - for BASIC INSULATION: two wrapped layers or one extruded layer;
 - for SUPPLEMENTARY INSULATION: two layers, wrapped or extruded;
 - for REINFORCED INSULATION: three layers, wrapped or extruded.
- where more than one constructional layer is specified above, it is permitted for the total number of layers to be on one conductor or shared between the two conductors;
- the insulated winding wires that are adjacent to each other are considered to be separated by DOUBLE INSULATION if the insulation of each conductor is rated for the $\overline{A_2}$ WORKING VOLTAGE; $\overline{A_2}$
- if the wire is insulated with two or more spirally wrapped layers of tape, the overlap of layers shall be adequate to ensure continued overlap during manufacture of the wound component. Layers of tape shall be sealed if CREEPAGE DISTANCES between layers, as wrapped, do not fulfil clause 13 of this standard;

NOTE 1 For wires insulated by an extrusion process, sealing is inherent to the process.