



# UL 60950-1

## STANDARD FOR SAFETY

Information Technology Equipment – Safety – Part  
1: General Requirements

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UL Standard for Safety for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1

Second Edition, Dated March 27, 2007

### **Summary of Topics**

***This revision of ANSI/UL 60950-1 dated May 9, 2019 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.***

***As noted in the Commitment for Amendments statement located on the back side of the title page, UL and CSA are committed to updating this harmonized standard jointly. However, the revision pages dated May 9, 2019 will not be jointly issued by UL and CSA as these revision pages address UL ANSI approval dates only.***

***UL 60950-1 is an adoption of IEC 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements (Second Edition, issued December 2005, including Amendment 1 issued December 2009 and Amendment 2 issued May 2013).***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated February 22, 2019.

In the revisions dated October 14, 2014 pages 177 and 178 have been intentionally deleted from the Standard due to the deletion or relocation of text.

The U.S. Department of Defense (DoD) has adopted UL 1950 on December 21, 1994. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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*Second Edition*  
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Underwriters Laboratories Inc.  
UL 60950-1  
*Second Edition*



**CSA  
Group**



## Information Technology Equipment – Safety – Part 1: General Requirements

March 27, 2007

(Title Page Reprinted: May 9, 2019)

This national standard is based on publication IEC 60950-1, Second Edition (2005), including Amendment 1 (2009) and Amendment 2 (2013).

*Approved by*



**Standards Council of Canada**  
**Conseil canadien des normes**



**ANSI/UL 60950-1-2014 (R2019)**

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**Annex NAF Deleted**

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**PREFACE**

DE

This is the harmonized CSA Group and UL standard for Information Technology Equipment – Safety – Part 1: General Requirements. It is the second edition of CAN/CSA-C22.2 No. 60950-1 and the second edition of UL 60950-1. This harmonized standard has been jointly revised on October 14, 2014. For this purpose, CSA Group and UL are issuing revision pages dated October 14, 2014.

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This harmonized standard is based on IEC Publication 60950-1, second edition, Information Technology Equipment – Safety – Part 1: General Requirements issued 12-2005, as revised by Corrigendum 1 (issued 12-2006), Amendment 1 (issued 12-2009), Amendment 2 (issued 5-2013) and Corrigendum 2 (issued 8-2013). IEC publication 60950-1 is copyrighted by the IEC.

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Previous editions of this standard were designated CAN/CSA-C22.2 No. 950/UL 1950 and CAN/CSA-C22.2 No. 60950/UL 60950, third edition. This standard CAN/CSA-C22.2 No. 60950-1/UL 60950-1, second edition, replaces the previous standard CAN/CSA-C22.2 No. 60950-1/UL 60950-1, first edition. The standard number and edition number have been aligned to correspond with the equivalent IEC 60950-1 standard.

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This harmonized standard was prepared by CSA Group and Underwriters Laboratories Inc. (UL). The efforts and support of representatives of leading industry companies and organizations are gratefully acknowledged.

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This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

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This standard was reviewed by the CSA Subcommittee on Safety of Electronic Equipment within the Field of Audio/Video, Information, and Communication Technology, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

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This Standard has been approved as a National Standard of Canada by the Standards Council of Canada.

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This Standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

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Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

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DE**Level of harmonization**

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This standard adopts the IEC text with national differences. This standard is published as an equivalent standard for CSA Group and UL.

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An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

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All national differences from the IEC text are included in the CSA Group and UL versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ.

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### Interpretations

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The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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National differences have been incorporated into the body of the standard. If national differences necessitate the deletion of IEC 60950-1 text, the IEC 60950-1 text has been retained but has been ~~lined-out~~. Except for tables and figures and annexes, text added as a result of national differences has been underlined. Text added as the Preface is not underlined. DE  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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### INFORMATION TECHNOLOGY EQUIPMENT – SAFETY – Part 1: General Requirements

#### FOREWORD

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**This consolidated version of IEC 60950-1 consists of the second edition (2005) [documents 108/135A/FDIS and 108/147/RVD], its corrigendum 1 (2006), its amendment 1 (2009) [documents 108/350/FDIS and 108/357/RVD] and its corrigendum 1 (2012), and its amendment 2 (2013) [documents 108/507/FDIS and 108/510/RVD]. It bears the edition number 2-2.**

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~~The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2. Additions and deletions are displayed in red, with deletions being struck through.~~

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International Standard IEC 60950-1 has been prepared by IEC technical committee 108: Safety of electronic equipment within the field of audio/video, information technology and communication technology.

IEC 60950-1 includes the basic requirements for the safety of information technology equipment.

Additional parts of IEC 60950-1 will cover specific safety requirements for information technology equipment having limited applications or having special features as follows:

Part 21: Remote feeding (published).

Part 22: Equipment installed outdoors (planned);

Part 23: Large data storage equipment (planned);

Except for notes, all text within a normative figure, or in a box under a normative table, is also normative. Text with a superscript reference is linked to a particular item in the table. Other text in a box under a table applies to the whole table.

Informative annexes and text beginning with the word "NOTE" are not normative. They are provided only to give additional information.

"Country" notes are also informative but call attention to requirements that are normative in those countries.

In this standard, the following print types are used:

- Requirements proper and normative annexes: roman type.
- Compliance statements and test specifications: italic type.
- Notes in the text and in tables: smaller roman type.
- Terms that are defined in 1.2: SMALL CAPITALS.

The numbering system in this standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1.01 means 1.01.

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

- reconfirmed;
- withdrawn;

- replaced by a revised edition; or
- amended.

**IMPORTANT**—The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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## INTRODUCTION

### 0 Principles of safety

The following principles have been adopted by technical committee 108 in the development of this standard.

These principles do not cover performance or functional characteristics of equipment.

Words printed in SMALL CAPITALS are terms that are defined in 1.2 of this standard.

### 0.1 General principles of safety

It is essential that designers understand the underlying principles of safety requirements in order that they can engineer safe equipment.

These principles are not an alternative to the detailed requirements of this standard, but are intended to provide designers with an appreciation of the basis of these requirements. Where the equipment involves technologies, components and materials or methods of construction not specifically covered, the design of the equipment should provide a level of safety not less than those described in these principles of safety.

NOTE The need for additional detailed requirements to cope with a new situation should be brought promptly to the attention of the appropriate committee.

Designers shall take into account not only normal operating conditions of the equipment but also likely fault conditions, consequential faults, foreseeable misuse and external influences such as temperature, altitude, pollution, moisture, overvoltages on the MAINS SUPPLY and overvoltages on a TELECOMMUNICATION NETWORK OR A CABLE DISTRIBUTION SYSTEM. Dimensioning of insulation spacings should take account of possible reductions by manufacturing tolerances, or where deformation could occur due to handling, shock and vibration likely to be encountered during manufacture, transport and normal use.

The following priorities should be observed in determining what design measures to adopt:

- where possible, specify design criteria that will eliminate, reduce or guard against hazards;
- where the above is not practicable because the functioning of the equipment would be impaired, specify the use of protective means independent of the equipment, such as personal protective equipment (which is not specified in this standard);
- where neither of the above measures is practicable, or in addition to those measures, specify the provision of markings and instructions regarding the residual risks.

There are two types of persons whose safety needs to be considered, USERS(or OPERATORS) and SERVICE PERSONS.

USER is the term applied to all persons other than SERVICE PERSONS. Requirements for protection should assume that USERS are not trained to identify hazards, but will not intentionally create a hazardous situation. Consequently, the requirements will provide protection for cleaners and casual visitors as well as the assigned USERS. In general, USERS should not have access to

hazardous parts, and to this end, such parts should only be in SERVICE ACCESS AREAS or in equipment located in RESTRICTED ACCESS LOCATIONS.

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When **USERS** are admitted to **RESTRICTED ACCESS LOCATIONS** they shall be suitably instructed.

**SERVICE PERSONS** are expected to use their training and skill to avoid possible injury to themselves and others due to obvious hazards which exist in **SERVICE ACCESS AREAS** of the equipment or on equipment located in **RESTRICTED ACCESS LOCATIONS**. However, **SERVICE PERSONS** should be protected against unexpected hazards. This can be done by, for example, locating parts that need to be accessible for servicing away from electrical and mechanical hazards, providing shields to avoid accidental contact with hazardous parts, and providing labels or instructions to warn personnel about any residual risk.

Information about potential hazards can be marked on the equipment or provided with the equipment, depending on the likelihood and severity of injury, or made available for **SERVICE PERSONS**. In general, **USERS** shall not be exposed to hazards likely to cause injury, and information provided for **USERS** should primarily aim at avoiding misuse and situations likely to create hazards, such as connection to the wrong power source and replacement of fuses by incorrect types.

**MOVABLE EQUIPMENT** is considered to present a slightly increased risk of shock, due to possible extra strain on the supply cord leading to rupture of the earthing conductor. With **HAND-HELD EQUIPMENT**, this risk is increased; wear on the cord is more likely, and further hazards could arise if the units were dropped. **TRANSPORTABLE EQUIPMENT** introduces a further factor because it can be used and carried in any orientation; if a small metallic object enters an opening in the **ENCLOSURE** it can move around inside the equipment, possibly creating a hazard.

## 0.2 Hazards

Application of a safety standard is intended to reduce the risk of injury or damage due to the following:

- electric shock;
- energy related hazards;
- fire;
- heat related hazards;
- mechanical hazards;
- radiation;
- chemical hazards.

## 0.2.1 Electric shock

Electric shock is due to current passing through the human body. The resulting physiological effects depend on the value and duration of the current and the path it takes through the body. The value of the current depends on the applied voltage, the impedance of the source and the impedance of the body. The body impedance depends in turn on the area of contact, moisture in the area of contact and the applied voltage and frequency. Currents of approximately half a milliampere can cause a reaction in persons in good health and may cause injury indirectly due to involuntary reaction. Higher currents can have more direct effects, such as burn, muscle tetanization leading to inability to let go or to ventricular fibrillation.

Steady state voltages up to 42,4 V peak, or 60 V d.c., are not generally regarded as hazardous under dry conditions for an area of contact equivalent to a human hand. Bare parts which have to be touched or handled should be at earth potential or properly insulated.

Some equipment will be connected to telephone and other external networks. Some TELECOMMUNICATION NETWORKS operate with signals such as voice and ringing superimposed on a steady d.c. supply voltage; the total may exceed the values given above for steady-state voltages. It is common practice for the SERVICE PERSONS of telephone companies to handle parts of such circuits bare-handed. This has not caused serious injury, because of the use of cadenced ringing and because there are limited areas of contact with bare conductors normally handled by SERVICE PERSONS. However, the area of contact of a part accessible to the USER, and the likelihood of the part being touched, should be further limited (for example, by the shape and location of the part).

It is normal to provide two levels of protection for USERS to prevent electric shock. Therefore, the operation of equipment under normal conditions and after a single fault, including any consequential faults, should not create a shock hazard. However, provision of additional protective measures, such as protective earthing or SUPPLEMENTARY INSULATION, is not considered a substitute for, or a relief from, properly designed BASIC INSULATION.

### Harm may result from:

Contact with bare parts normally at HAZARDOUS VOLTAGES.

Breakdown of insulation between parts normally at HAZARDOUS VOLTAGES and accessible conductive parts.

Contact with circuits connected to TELECOMMUNICATION NETWORKS which exceed 42,4 V peak or 60 V d.c.

Breakdown of USER-accessible insulation.

### Examples of measures to reduce risks:

Prevent USER access to parts at HAZARDOUS VOLTAGES by fixed or locked covers, SAFETY INTERLOCKS, etc. Discharge accessible capacitors that are at HAZARDOUS VOLTAGES.

Provide BASIC INSULATION and connect the accessible conductive parts and circuits to earth so that exposure to the voltage which can develop is limited because overcurrent protection will disconnect the parts having low impedance faults within a specified time; or provide a metal screen connected to protective earth between the parts, or provide DOUBLE INSULATION OF REINFORCED INSULATION between the parts, so that breakdown to the accessible part is not likely to occur.

Limit the accessibility and area of contact of such circuits, and separate them from unearthed parts to which access is not limited.

Insulation that is accessible to the USER should have adequate mechanical and electrical strength to reduce the likelihood of contact with HAZARDOUS VOLTAGES.

### Table Continued

**Harm may result from:**

TOUCH CURRENT (leakage current) flowing from parts at HAZARDOUS VOLTAGES to accessible parts, or failure of a protective earthing connection. TOUCH CURRENT may include current due to EMC filter components connected between PRIMARY CIRCUITS and accessible parts.

**Examples of measures to reduce risks:**

Limit TOUCH CURRENT to a specified value, or provide a high integrity protective earthing connection.

#### 0.2.2 Energy related hazards

Injury or fire may result from a short circuit between adjacent poles of high current supplies or high capacitance circuits, causing:

- burns;
- arcing;
- ejection of molten metal.

Even circuits whose voltages are safe to touch may be hazardous in this respect.

Examples of measures to reduce risks include:

- separation;
- shielding;
- provision of SAFETY INTERLOCKS.

#### 0.2.3 Fire

Risk of fire may result from excessive temperatures either under normal operating conditions or due to overload, component failure, insulation breakdown or loose connections. Fires originating within the equipment should not spread beyond the immediate vicinity of the source of the fire, nor cause damage to the surroundings of the equipment.

Examples of measures to reduce risks include:

- providing overcurrent protection;
- using constructional materials having appropriate flammability properties for their purpose;
- selection of parts, components and consumable materials to avoid high temperature which might cause ignition;
- limiting the quantity of combustible materials used;
- shielding or separating combustible materials from likely ignition sources;
- using ENCLOSURES or barriers to limit the spread of fire within the equipment;

- using suitable materials for ENCLOSURES so as to reduce the likelihood of fire spreading from the equipment.

#### 0.2.4 Heat related hazards

Injury may result from high temperatures under normal operating conditions, causing:

- burns due to contact with hot accessible parts;
- degradation of insulation and of safety-critical components;
- ignition of flammable liquids.

Examples of measures to reduce risks include:

- taking steps to avoid high temperature of accessible parts;
- avoiding temperatures above the ignition point of liquids;
- provision of markings to warn USERS where access to hot parts is unavoidable.

#### 0.2.5 Mechanical hazards

Injury may result from:

- sharp edges and corners;
- moving parts which have the potential to cause injury;
- equipment instability;
- flying particles from imploding cathode ray tubes and exploding high pressure lamps.

Examples of measures to reduce risks include:

- rounding of sharp edges and corners;
- guarding;
- provision of SAFETY INTERLOCKS;
- providing sufficient stability to free-standing equipment;
- selecting cathode ray tubes and high pressure lamps that are resistant to implosion and explosion respectively;
- provision of markings to warn USERS where access is unavoidable.

### 0.2.6 Radiation

Injury to USERS and to SERVICE PERSONS may result from some forms of radiation emitted by equipment. Examples are sonic (acoustic), radio frequency, infra-red, ultraviolet and ionizing radiation, and high intensity visible and coherent light (lasers).

Examples of measures to reduce risks include:

- limiting the energy level of potential radiation sources;
- screening radiation sources;
- provision of SAFETY INTERLOCKS;
- provision of markings to warn USERS where exposure to the radiation hazard is unavoidable.

### 0.2.7 Chemical hazards

Injury may result from contact with some chemicals or from inhalation of their vapours and fumes.

Examples of measures to reduce risks include:

- avoiding the use of constructional and consumable materials likely to cause injury by contact or inhalation during intended and normal conditions of use;
- avoiding conditions likely to cause leakage or vaporization;
- provision of markings to warn USERS about the hazards.

### 0.3 Materials and components

Materials and components used in the construction of equipment should be so selected and arranged that they can be expected to perform in a reliable manner for the anticipated life of the equipment without creating a hazard, and would not contribute significantly to the development of a serious fire hazard. Components should be selected so that they remain within their manufacturers' ratings under normal operating conditions, and do not create a hazard under fault conditions.

## INFORMATION TECHNOLOGY EQUIPMENT – SAFETY – Part 1: General Requirements

### 1 General

#### 1.1 Scope

##### 1.1.1 Equipment covered by this standard

**NAA  
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This standard is applicable to mains-powered or battery-powered information technology equipment, including electrical business equipment and associated equipment, with a RATED VOLTAGE not exceeding 600 V and designed to be installed in accordance with the Canadian Electrical Code, Part I, CSA C22.1-12; General Requirements – Canadian Electrical Code, Part II, CSA C22.2 No. 0-10; the National Electrical Code, NFPA 70-2014; and the National Electrical Safety Code, IEEE C2-2012. D1  
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The standard is also applicable to equipment, unless otherwise identified by a marking or instructions, designed to be installed in accordance with Article 645 of the National Electrical Code, ANSI/NFPA 70, and the Standard for the Protection of Information Technology Equipment, NFPA 75-2013. D1  
D1  
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D1

See Annex NAE for examples of and references to regulatory requirements that apply to this equipment. D1  
D1

This standard is also applicable to such information technology equipment:

- designed for use as telecommunication terminal equipment and TELECOMMUNICATION NETWORK infrastructure equipment, regardless of the source of power;
- designed and intended to be connected directly to, or used as infrastructure equipment in, a CABLE DISTRIBUTION SYSTEM, regardless of the source of power;
- designed to use the AC MAINS SUPPLY as a communication transmission medium (see Clause 6, Note 4 and 7.1, Note 4).

This part of IEC 60950 is also applicable to:

- components and subassemblies intended for incorporation in this equipment. Such components and subassemblies need not comply with every requirement of the standard, provided that the complete equipment, incorporating such components and subassemblies, does comply;
- external power supply units intended to supply other equipment within the scope of this part of IEC 60950;
- accessories intended to be used with equipment within the scope of this part of IEC 60950.

NOTE 1 Examples of aspects with which uninstalled components, subassemblies, and accessories may not comply include the marking of the power rating and access to hazardous parts.

NOTE 2 This standard may be applied to the electronic parts of equipment even if that equipment does not wholly fall within its Scope, such as large-scale air conditioning systems, fire detection systems and fire extinguishing systems. Different requirements may be necessary for some applications.

This standard specifies requirements intended to reduce risks of fire, electric shock or injury for the OPERATOR and layman who may come into contact with the equipment and, where specifically stated, for a SERVICE PERSON.

This standard also specifies requirements intended to reduce risks from acoustic outputs at communication receivers and similar devices used for voice telecommunication, regardless of transmission medium (e.g., TELECOMMUNICATION NETWORK, CABLE DISTRIBUTION NETWORK, wireless network). See Annex NAD.

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This standard is intended to reduce such risks with respect to installed equipment, whether it consists of a system of interconnected units or independent units, subject to installing, operating and maintaining the equipment in the manner prescribed by the manufacturer.

Examples of equipment that is in the scope of this standard are:

Generic product type	Specific example of generic type
banking equipment	monetary processing machines including automated teller (cash dispensing) machines (ATM)
data and text processing machines and associated equipment	data preparation equipment, data processing equipment, data storage equipment, personal computers, plotters, printers, scanners, text processing equipment, visual display units
data network equipment	bridges, data circuit terminating equipment, data terminal equipment, routers
electrical and electronic retail equipment	cash registers, point of sale terminals including associated electronic scales
electrical and electronic office machines	calculators, copying machines, dictation equipment, document shredding machines, duplicators, erasers, micrographic office equipment, motor-operated files, paper trimmers (punchers, cutting machines, separators), paper jogging machines, pencil sharpeners, staplers, typewriters
other information technology equipment	photoprinting equipment, public information terminals, multimedia equipment
postage equipment	mail processing machines, postage machines
telecommunication network infrastructure equipment	billing equipment, multiplexers, network powering equipment, network terminating equipment, radio basestations, repeaters, transmission equipment, telecommunication switching equipment
telecommunication terminal equipment	facsimile equipment, key telephone systems, modems, PABXs, pagers, telephone answering machines, telephone sets (wired and wireless)

NOTE 3 The requirements of IEC 60065 may also be used to meet safety requirements for multimedia equipment. See IEC Guide 112, *Guide on the safety of multimedia equipment*.

This list is not intended to be comprehensive, and equipment that is not listed is not necessarily excluded from the scope.

Equipment complying with the relevant requirements in this standard is considered suitable for use with process control equipment, automatic test equipment and similar systems requiring information processing facilities. However, this standard does not include requirements for performance or functional characteristics of equipment.

**1.1.2 Additional requirements**

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NAE**

Requirements additional to those specified in this standard may be necessary for:

- equipment intended for operation in special environments (for example, extremes of temperature; excessive dust, moisture or vibration; flammable gases; and corrosive or explosive atmospheres);
- electromedical applications with physical connections to the patient;
- equipment intended to be used in vehicles, on board ships or aircraft, in tropical countries, or at altitudes greater than 2 000 m;
- equipment intended for use where ingress of water is possible; for guidance on such requirements and on relevant testing, see Annex T.

NOTE Attention is drawn to the fact that authorities of some countries impose additional requirements.

**1.1.3 Exclusions**

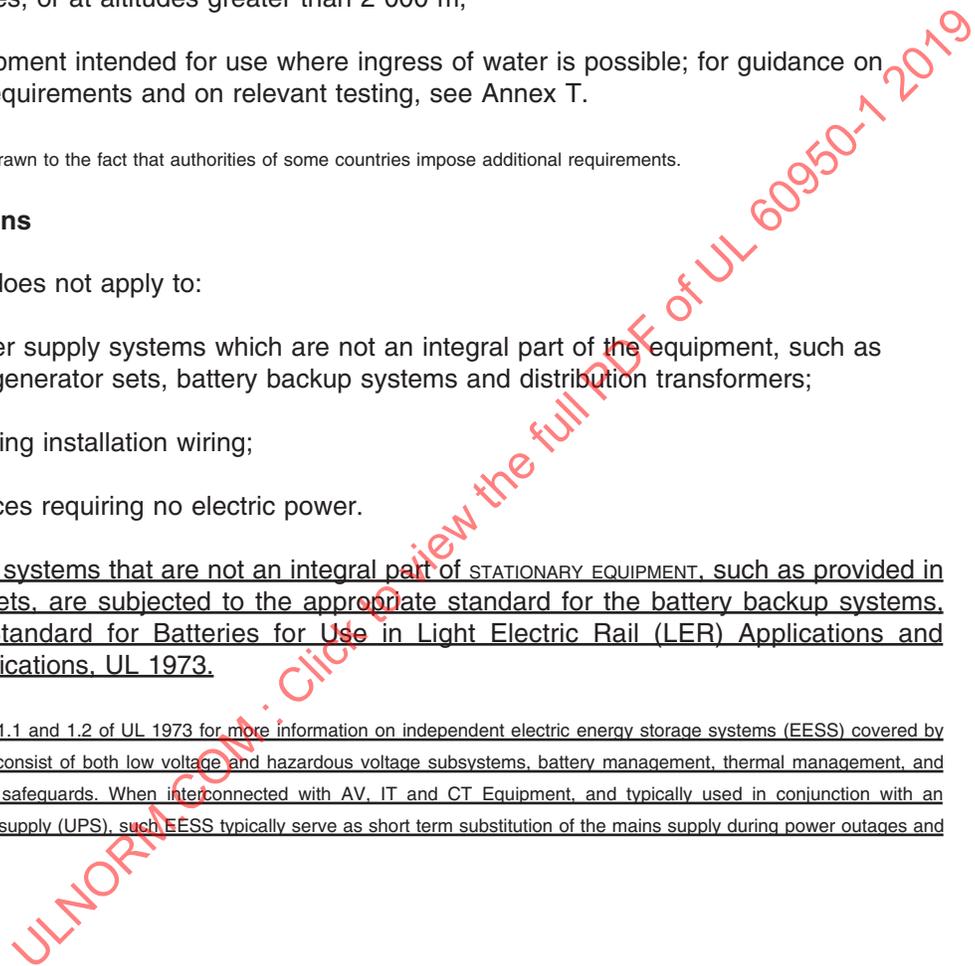
**P. 1  
NAE**

This standard does not apply to:

- power supply systems which are not an integral part of the equipment, such as motor-generator sets, battery backup systems and distribution transformers;
- building installation wiring;
- devices requiring no electric power.

Battery backup systems that are not an integral part of STATIONARY EQUIPMENT, such as provided in separate cabinets, are subjected to the appropriate standard for the battery backup systems, such as the Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications, UL 1973. DC  
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NOTE See Figures 1.1 and 1.2 of UL 1973 for more information on independent electric energy storage systems (EESS) covered by UL 1973, which can consist of both low voltage and hazardous voltage subsystems, battery management, thermal management, and related features and safeguards. When interconnected with AV, IT and CT Equipment, and typically used in conjunction with an uninterruptible power supply (UPS), such EESS typically serve as short term substitution of the mains supply during power outages and similar disturbances. DC  
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## 1.2 Definitions

**NAE**

For the purpose of this International Standard the following definitions apply. Where the terms "voltage" and "current" are used, they imply the r.m.s. values, unless otherwise specified.

### Definitions in alphabetical order of nouns

AREA, OPERATOR ACCESS	1.2.7.1
AREA, SERVICE ACCESS	1.2.7.2
BODY	1.2.7.5
CABLE, INTERCONNECTING	1.2.11.6
CABLE DISTRIBUTION SYSTEM	1.2.13.14
CHEESECLOTH	1.2.13.15
CIRCUIT, ELV	1.2.8.7
CIRCUIT, LIMITED CURRENT	1.2.8.9
CIRCUIT, PRIMARY	1.2.8.4
CIRCUIT, SECONDARY	1.2.8.5
CIRCUIT, SELV	1.2.8.8
CIRCUIT, TNV	1.2.8.11
CIRCUIT, TNV-1	1.2.8.12
CIRCUIT, TNV-2	1.2.8.13
CIRCUIT, TNV-3	1.2.8.14
CLEARANCE	1.2.10.1
CONDUCTOR, PROTECTIVE BONDING	1.2.13.11

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VOLTAGE, WORKING	1.2.9.6

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## 1.2.1 Equipment electrical ratings

**1.2.1.1** RATED VOLTAGE: supply voltage from which the equipment is to be operated as declared by the manufacturer

**1.2.1.2** RATED VOLTAGE RANGE: supply voltage range as declared by the manufacturer, expressed by its lower and upper RATED VOLTAGES

**1.2.1.3** RATED CURRENT: input current of the equipment as declared by the manufacturer

**1.2.1.4** RATED FREQUENCY: supply frequency as declared by the manufacturer

**1.2.1.5** RATED FREQUENCY RANGE: supply frequency range as declared by the manufacturer, expressed by its lower and upper RATED FREQUENCIES

## 1.2.2 Operating conditions

**1.2.2.1** NORMAL LOAD: mode of operation, used for testing purposes, which represents as closely as possible the most severe conditions of normal use which can reasonably be expected.

If the conditions of actual use can reasonably be expected to be more severe than the maximum load conditions recommended by the manufacturer, including RATED OPERATING TIME and RATED RESTING TIME, a mode of operation is used that represents these more severe conditions.

NOTE NORMAL LOAD conditions for some types of equipment are given in Annex L.

**1.2.2.2** RATED OPERATING TIME: maximum operating time assigned to the equipment by the manufacturer

**1.2.2.3** RATED RESTING TIME: minimum time, assigned by the manufacturer, during which the equipment is switched off or running idle between periods of RATED OPERATING TIME

## 1.2.3 Equipment mobility

**1.2.3.1** MOVABLE EQUIPMENT: equipment which is either:

- 18 kg or less in mass and not fixed, or
- equipment with wheels, castors or other means to facilitate movement by the OPERATOR as required to perform its intended use.

NOTE MOVABLE EQUIPMENT includes wall-mounted equipment whose mounting means permits removal by an OPERATOR.

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**1.2.3.2** HAND-HELD EQUIPMENT: MOVABLE EQUIPMENT, or a part of any kind of equipment, that is intended to be held in the hand during normal use

**1.2.3.3** TRANSPORTABLE EQUIPMENT: MOVABLE EQUIPMENT that is intended to be routinely carried by a USER

NOTE Examples include laptop and notebook personal computers, pen-based tablet computers, and their portable accessories such as printers and CD-ROM drives.

**1.2.3.4** STATIONARY EQUIPMENT: equipment that is not MOVABLE EQUIPMENT

**1.2.3.5** EQUIPMENT FOR BUILDING-IN: equipment intended to be installed in a prepared recess, such as in a wall, or similar situation

NOTE In general, EQUIPMENT FOR BUILDING-IN does not have an ENCLOSURE on all sides, as some of the sides will be protected after installation.

**1.2.3.6** DIRECT PLUG-IN EQUIPMENT: equipment that is intended to be used without a power supply cord; the mains plug forms an integral part of the equipment ENCLOSURE so that the weight of the equipment is taken by the socket-outlet

## **1.2.4 Classes of equipment – Protection against electric shock**

NOTE Some information technology equipment cannot be identified as conforming to one of the following classes.

**1.2.4.1** CLASS I EQUIPMENT: equipment where protection against electric shock is achieved by

- using BASIC INSULATION and
- providing a means of connection to the PROTECTIVE EARTHING CONDUCTOR in the building wiring those conductive parts that are otherwise capable of assuming HAZARDOUS VOLTAGES if the BASIC INSULATION fails

NOTE CLASS I EQUIPMENT may have parts with DOUBLE INSULATION OR REINFORCED INSULATION.

**1.2.4.2** CLASS II EQUIPMENT: equipment 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 reliance on protective earthing

**1.2.4.3** CLASS III EQUIPMENT: equipment in which protection against electric shock relies upon supply from SELV CIRCUITS and in which HAZARDOUS VOLTAGES are not generated

NOTE For CLASS III EQUIPMENT, although there is no requirement for protection against electric shock, all other requirements of the standard apply.

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## 1.2.5 Connection to the supply

**1.2.5.1** PLUGGABLE EQUIPMENT TYPE A: equipment that is intended for connection to a MAINS supply via a non-industrial plug and socket-outlet or a non-industrial appliance coupler, or both

NOTE 1-15, 2-15, 2-20, 5-15 and 5-20 plugs and outlets as specified in IEC 60083 are considered to be non-industrial within the meaning of this standard.

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**1.2.5.2** PLUGGABLE EQUIPMENT TYPE B: equipment that is intended for connection to a MAINS supply via an industrial plug and socket-outlet or an appliance coupler, or both, complying with IEC 60309 or with a comparable national standard

**1.2.5.3** PLUGGABLE EQUIPMENT: equipment that is either PLUGGABLE EQUIPMENT TYPE A OR PLUGGABLE EQUIPMENT TYPE B

**1.2.5.4** PERMANENTLY CONNECTED EQUIPMENT: equipment that is intended for connection to the building installation wiring using screw terminals or other reliable means

**1.2.5.5** DETACHABLE POWER SUPPLY CORD: flexible cord, for supply purposes, intended to be connected to the equipment by means of a suitable appliance coupler

**1.2.5.6** NON-DETACHABLE POWER SUPPLY CORD: flexible cord, for supply purposes, fixed to or assembled with the equipment

Such a cord may be either:

Ordinary: a flexible cord that can be easily replaced without special preparation of the cord or special TOOLS, or

Special: a flexible cord that is specially prepared, or requires the use of specially designed TOOLS for replacement, or is such that it cannot be replaced without damage to the equipment.

The term "specially prepared" includes provision of an integral cord guard, the use of cable lugs, formation of eyelets, etc., but not the reshaping of the conductor before introduction into a terminal or the twisting of a stranded conductor to consolidate the end.

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## 1.2.6 Enclosures

**1.2.6.1** ENCLOSURE: part of the equipment providing one or more of the functions described in 1.2.6.2, 1.2.6.3 or 1.2.6.4

NOTE One type of ENCLOSURE can be inside another type (for example, an ELECTRICAL ENCLOSURE inside a FIRE ENCLOSURE or a FIRE ENCLOSURE inside an ELECTRICAL ENCLOSURE). Also, a single ENCLOSURE can provide the functions of more than one type (for example, the functions of both an ELECTRICAL ENCLOSURE and a FIRE ENCLOSURE).

**1.2.6.2** FIRE ENCLOSURE: part of the equipment intended to minimize the spread of fire or flames from within

**1.2.6.3** MECHANICAL ENCLOSURE: part of the equipment intended to reduce the risk of injury due to mechanical and other physical hazards

**1.2.6.4** ELECTRICAL ENCLOSURE: part of the equipment intended to limit access to parts that may be at HAZARDOUS VOLTAGES OR HAZARDOUS ENERGY LEVELS or are in TNV CIRCUITS

**1.2.6.5** DECORATIVE PART: part of the equipment, outside the ENCLOSURE, which has no safety function

## 1.2.7 Accessibility

**1.2.7.1** OPERATOR ACCESS AREA: part of the equipment to which, under normal operating conditions, one of the following applies:

- access can be gained without the use of a TOOL;
- the means of access is deliberately provided to the OPERATOR;
- the OPERATOR is instructed to enter regardless of whether or not a TOOL is needed to gain access

The terms "access" and "accessible", unless qualified, relate to OPERATOR ACCESS AREA as defined above.

**1.2.7.2** SERVICE ACCESS AREA: part of the equipment, other than an OPERATOR ACCESS AREA, where it is necessary for SERVICE PERSONS to have access even with the equipment switched on

**1.2.7.3** RESTRICTED ACCESS LOCATION: location for equipment where both of the following apply:

- access can only be gained by SERVICE PERSONS or by USERS who have been instructed about the reasons for the restrictions applied to the location and about any precautions that shall be taken; and
- access is through the use of a TOOL or lock and key, or other means of security, and is controlled by the authority responsible for the location

NOTE The requirements for equipment intended for installation in RESTRICTED ACCESS LOCATIONS are the same as for OPERATOR ACCESS AREAS, except as given in 1.7.14, 2.1.3, 4.5.4, 4.6.2 and 5.1.7.

**1.2.7.4** TOOL: screwdriver or any other object that may be used to operate a screw, latch or similar fixing means

**1.2.7.5** BODY: all accessible conductive parts, shafts of handles, knobs, grips and the like, and metal foil in contact with all accessible surfaces of insulating material

**1.2.7.6** 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

## 1.2.8 Circuits and circuit characteristics

**1.2.8.1** AC MAINS SUPPLY: a.c. power distribution system external to the equipment for supplying power to a.c. powered equipment

These power sources include public or private utilities and, unless otherwise specified in the standard (for example, 1.4.5), equivalent sources such as motor-driven generators and uninterruptible power supplies.

NOTE See Annex V for typical examples of a.c. power distribution systems.

**1.2.8.2** DC MAINS SUPPLY: d.c. power distribution system, with or without batteries, external to the equipment, for supplying power to d.c. powered equipment, excluding the following:

- a d.c. supply providing power over TELECOMMUNICATION NETWORK wiring to remote equipment;
- a limited power source (see 2.5) whose open circuit voltage is less than or equal to 42,4 V d.c.;
- a d.c. supply whose open circuit voltage is greater than 42,4 V d.c. and less than or equal to 60 V d.c., and whose available power output is less than 240 VA

Circuitry connected to a DC MAINS SUPPLY is considered to be a SECONDARY CIRCUIT (for example, an SELV CIRCUIT, a TNV CIRCUIT or a HAZARDOUS VOLTAGE SECONDARY CIRCUIT) in the meaning of this standard.

NOTE 1 See ITU-T Recommendation K.27 for bonding configurations and earthing inside a telecommunication building.

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NOTE 2 See 1.6.1.2

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**1.2.8.3** MAINS SUPPLY: power distribution system that is either an AC MAINS SUPPLY or a DC MAINS SUPPLY

**1.2.8.4** PRIMARY CIRCUIT: circuit that is directly connected to the AC MAINS SUPPLY

It includes, for example, the means for connection to the AC MAINS SUPPLY, the primary windings of transformers, motors and other loading devices.

NOTE Conductive parts of an INTERCONNECTING CABLE may be part of a PRIMARY CIRCUIT as stated in 1.2.11.6.

**1.2.8.5** SECONDARY CIRCUIT: circuit that has no direct connection to a PRIMARY CIRCUIT and derives its power from a transformer, converter or equivalent isolation device, or from a battery

NOTE Conductive parts of an INTERCONNECTING CABLE may be part of a SECONDARY CIRCUIT as stated in 1.2.11.6.

**1.2.8.6** HAZARDOUS VOLTAGE: voltage exceeding 42,4 V peak, or 60 V d.c., existing in a circuit that does not meet the requirements for either a LIMITED CURRENT CIRCUIT or a TNV CIRCUIT

**1.2.8.7** ELV CIRCUIT: SECONDARY CIRCUIT with voltages between any two conductors of the circuit, and between any one such conductor and earth (see 1.4.9), not exceeding 42,4 V peak, or 60 V d.c., under normal operating conditions, which is separated from HAZARDOUS VOLTAGE by BASIC INSULATION, and which neither meets all of the requirements for an SELV CIRCUIT nor meets all of the requirements for a LIMITED CURRENT CIRCUIT

**1.2.8.8** SELV CIRCUIT: SECONDARY CIRCUIT that is so designed and protected that under normal operating conditions and single fault conditions, its voltages do not exceed a safe value

NOTE 1 The limit values of voltages under normal operating conditions and single fault conditions (see 1.4.14) are specified in 2.2. See also Table 1A.

NOTE 2 This definition of an SELV CIRCUIT differs from the term "SELV SYSTEM" as used in IEC 61140.

**1.2.8.9** LIMITED CURRENT CIRCUIT: circuit that is so designed and protected that, under both normal operating conditions and single fault conditions, the current that can be drawn is not hazardous

NOTE The limit values of currents under normal operating conditions and single fault conditions (see 1.4.14) are specified in 2.4.

**1.2.8.10** HAZARDOUS ENERGY LEVEL: available power level of 240 VA or more, having a duration of 60 s or more, or a stored energy level of 20 J or more (for example, from one or more capacitors), at a potential of 2 V or more

**1.2.8.11** TNV CIRCUIT: circuit that is in the equipment and to which the accessible area of contact is limited and that is so designed and protected that, under normal operating conditions and single fault conditions (see 1.4.14), the voltages do not exceed specified limit values

A TNV CIRCUIT is considered to be a SECONDARY CIRCUIT in the meaning of this standard.

NOTE 1 The specified limit values of voltages under normal operating conditions and single fault conditions (see 1.4.14) are given in 2.3.1. Requirements regarding accessibility of TNV CIRCUITS are given in 2.1.1.1.

NOTE 2 Conductive parts of an INTERCONNECTING CABLE may be part of a TNV CIRCUIT as stated in 1.2.11.6.

TNV CIRCUITS are classified as TNV-1 CIRCUITS, TNV-2 CIRCUITS and TNV-3 CIRCUITS as defined in 1.2.8.12, 1.2.8.13 and 1.2.8.14.

NOTE 3 The voltage relationships between SELV and TNV CIRCUITS are shown in Table 1A.

**Table 1A – Voltage ranges of SELV and TNV circuits**

Overvoltages from TELECOMMUNICATION NETWORKS possible?	Overvoltages from CABLE DISTRIBUTION SYSTEMS possible?	Normal operating voltages	
		Within SELV CIRCUIT limits	Exceeding SELV CIRCUIT limits but within TNV CIRCUIT limits
Yes	Yes	TNV-1 CIRCUIT	TNV-3 CIRCUIT
No	Not applicable	SELV CIRCUIT	TNV-2 CIRCUIT

**1.2.8.12** TNV-1 CIRCUIT: TNV CIRCUIT

- whose normal operating voltages do not exceed the limits for an SELV CIRCUIT under normal operating conditions and
- on which overvoltages from TELECOMMUNICATION NETWORKS and CABLE DISTRIBUTION SYSTEMS are possible

**1.2.8.13** TNV-2 CIRCUIT: TNV CIRCUIT

- whose normal operating voltages exceed the limits for an SELV CIRCUIT under normal operating conditions and
- which is not subject to overvoltages from TELECOMMUNICATION NETWORKS

**1.2.8.14** TNV- 3 CIRCUIT: TNV CIRCUIT

- whose normal operating voltages exceed the limits for an SELV CIRCUIT under normal operating conditions and
- on which overvoltages from TELECOMMUNICATION NETWORKS and CABLE DISTRIBUTION SYSTEMS are possible

**1.2.9 Insulation****1.2.9.1** FUNCTIONAL INSULATION: insulation that is necessary only for the correct functioning of the equipment

NOTE FUNCTIONAL INSULATION by definition does not protect against electric shock. It may, however, reduce the likelihood of ignition and fire.

**1.2.9.2** BASIC INSULATION: insulation to provide basic protection against electric shock**1.2.9.3** 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**1.2.9.4** DOUBLE INSULATION: insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION**1.2.9.5** REINFORCED INSULATION: single insulation system that provides a degree of protection against electric shock equivalent to DOUBLE INSULATION under the conditions specified in this standard

NOTE The term "insulation system" does not imply that the insulation has to be in one homogeneous piece. It may comprise several layers that cannot be tested as BASIC INSULATION and SUPPLEMENTARY INSULATION.

**1.2.9.6 WORKING VOLTAGE:** highest voltage to which the insulation or the component under consideration is, or can be, subjected when the equipment is operating under conditions of normal use

Overvoltages that originate outside the equipment are not taken into account.

**1.2.9.7 RMS WORKING VOLTAGE:** r.m.s. value of a WORKING VOLTAGE, including any d.c. component

NOTE For the purpose of determining RMS WORKING VOLTAGES, the rules of 2.10.2.2 apply, and where relevant those of 1.4.8.

**1.2.9.8 PEAK WORKING VOLTAGE:** peak value of a WORKING VOLTAGE, including any d.c. component and any repetitive peak impulses generated in the equipment

Where peak-to-peak ripple exceeds 10 % of the average value, the requirements related to peak or a.c. voltages are applicable.

NOTE For the purpose of determining PEAK WORKING VOLTAGES, the rules of 2.10.2.3 apply, and where relevant those of 1.4.8.

**1.2.9.9 REQUIRED WITHSTAND VOLTAGE:** peak voltage that the insulation under consideration is required to withstand

**1.2.9.10 MAINS TRANSIENT VOLTAGE:** highest peak voltage expected at the power input to the equipment, arising from external transients on the MAINS SUPPLY

**1.2.9.11 TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE:** highest peak voltage expected at the TELECOMMUNICATION NETWORK connection point of the equipment, arising from external transients on the network

NOTE The effect of transients from CABLE DISTRIBUTION SYSTEMS is not taken into account.

## **1.2.10 Properties of insulation**

**1.2.10.1 CLEARANCE:** shortest distance between two conductive parts, or between a conductive part and the BOUNDING SURFACE of the equipment, measured through air

**1.2.10.2 CREEPAGE DISTANCE:** shortest path between two conductive parts, or between a conductive part and the BOUNDING SURFACE of the equipment, measured along the surface of the insulation

**1.2.10.3 BOUNDING SURFACE:** outer surface of the ELECTRICAL ENCLOSURE, considered as though metal foil were pressed into contact with accessible surfaces of insulating material

**1.2.10.4 SOLID INSULATION:** material that provides electrical insulation between two opposite surfaces, not along an outer surface

NOTE The required properties of SOLID INSULATION are specified either as

- the actual minimum distance through the insulation (see 2.10.5.2), or by
- other requirements and tests in this standard instead of a minimum distance.

## 1.2.11 Components

**1.2.11.1 THERMOSTAT:** cycling temperature-sensing control intended to keep a temperature between two particular values under normal operating conditions and that may have provision for setting by the OPERATOR

**1.2.11.2 TEMPERATURE LIMITER:** temperature-sensing control intended to keep a temperature below or above one particular value during normal operating conditions and that may have provision for setting by the OPERATOR

NOTE A TEMPERATURE LIMITER may be of the automatic reset or of the manual reset type.

**1.2.11.3 THERMAL CUT-OUT:** temperature-sensing control intended to operate under abnormal operating conditions and that has no provision for the OPERATOR to change the temperature setting

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

**1.2.11.4 THERMAL CUT-OUT, AUTOMATIC RESET:** THERMAL CUT-OUT that automatically restores the current after the relevant part of the equipment has cooled down sufficiently

**1.2.11.5 THERMAL CUT-OUT, MANUAL RESET:** THERMAL CUT-OUT that requires resetting by hand, or replacement of a part, in order to restore the current

**1.2.11.6 INTERCONNECTING CABLE:** cable used to

- electrically connect an accessory to a unit of information technology equipment,
- interconnect units in a system, or
- connect a unit to a TELECOMMUNICATION NETWORK or to a CABLE DISTRIBUTION SYSTEM

Such a cable may carry any type of circuit from one unit to another.

NOTE A power supply cord for connection to the MAINS SUPPLY is not an INTERCONNECTING CABLE.

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## 1.2.12 Flammability

**1.2.12.1** FLAMMABILITY CLASSIFICATION OF MATERIALS: recognition of the burning behaviour of materials and their ability to extinguish if ignited.

Materials are classified as in 1.2.12.2 to 1.2.12.14 when tested in accordance with IEC 60695-11-10, IEC 60695-11-20, ISO 9772 or ISO 9773.

NOTE 1 When applying the requirements in this standard, HF-1 CLASS FOAMED MATERIAL is regarded as better than HF-2 CLASS, and HF-2 CLASS better than HBF CLASS.

NOTE 2 Similarly, material of 5VA CLASS is regarded as better than 5VB CLASS, 5VB CLASS better than V-0 CLASS, V-0 CLASS better than V-1 CLASS, V-1 CLASS better than V-2 CLASS, V-2 CLASS better than HB40 CLASS and HB40 CLASS better than HB75 CLASS.

NOTE 3 Similarly, MATERIAL OF VTM-0 CLASS is regarded as better than VTM-1 CLASS and VTM-1 CLASS better than VTM-2 CLASS.

NOTE 4 VTM-0 CLASS, VTM-1 CLASS and VTM-2 CLASS MATERIALS are considered to be equivalent to V-0 CLASS, V-1 CLASS and V-2 CLASS MATERIALS, respectively, but only for their flammability properties. Their electrical and mechanical properties are not necessarily equivalent.

NOTE 5 Certain flammability classes are replacing the classes used in earlier editions of this standard. The equivalence of the old and the new classes is shown in Table 1B.

**Table 1B – Equivalence of flammability classes**

Old class	New class	Equivalence
–	5VA (1.2.12.5)	5VA is not required in this standard.
5V	5VB (1.2.12.6)	Materials that pass the tests for class 5V in Clause A.9 of earlier editions of this standard are equivalent to 5VB or better.
HB	HB40 (1.2.12.10)	Samples of materials in a thickness of 3 mm that pass the tests of Clause A.8 in earlier editions of this standard (maximum burning rate 40 mm/min during test) are equivalent to HB40.
	HB75 (1.2.12.11)	Samples of materials in a thickness of less than 3 mm that pass the tests of Clause A.8 in earlier editions of this standard (maximum burning rate 75 mm/min during test) are equivalent to HB75.

**1.2.12.2** V-0 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified V-0 according to IEC 60695-11-10

**P.2**

**1.2.12.3** V-1 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified V-1 according to IEC 60695-11-10

**P.2**

**1.2.12.4** V-2 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified V-2 according to IEC 60695-11-10

**P.2**

**1.2.12.5** 5VA CLASS MATERIAL: material tested in the thinnest significant thickness used and classified 5VA according to IEC 60695-11-20

**P.2**

**1.2.12.6** 5VB CLASS MATERIAL: material tested in the thinnest significant thickness used and classified 5VB according to IEC 60695-11-20

**P.2**

- 1.2.12.7** HF-1 CLASS FOAMED MATERIAL: foamed material tested in the thinnest significant thickness used and classified HF-1 according to ISO 9772 **P.2**
- 1.2.12.8** HF-2 CLASS FOAMED MATERIAL: foamed material tested in the thinnest significant thickness used and classified HF-2 according to ISO 9772 **P.2**
- 1.2.12.9** HBF CLASS FOAMED MATERIAL: foamed material tested in the thinnest significant thickness used and classified HBF according to ISO 9772 **P.2**
- 1.2.12.10** HB40 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified HB40 according to IEC 60695-11-10 **P.2**
- 1.2.12.11** HB75 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified HB75 according to IEC 60695-11-10 **P.2**
- 1.2.12.12** VTM-0 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified VTM-0 according to ISO 9773 **P.2**
- 1.2.12.13** VTM-1 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified VTM-1 according to ISO 9773 **P.2**
- 1.2.12.14** VTM-2 CLASS MATERIAL: material tested in the thinnest significant thickness used and classified VTM-2 according to ISO 9773 **P.2**
- 1.2.12.15** EXPLOSION LIMIT: lowest concentration of a combustible material in a mixture containing any of the following: gases, vapours, mists or dusts, in which a flame is able to propagate after removal of the ignition source
- 1.2.13 Miscellaneous**
- 1.2.13.1** TYPE TEST: test on a representative sample with the objective of determining if, as designed and manufactured, it can meet the requirements of this standard
- 1.2.13.2** SAMPLING TEST: test on a number of samples taken at random from a batch
- 1.2.13.3** ROUTINE TEST: test to which each individual sample is subjected during or after manufacture to check if the sample complies with certain criteria
- 1.2.13.4** DC VOLTAGE: average value of a voltage having a peak-to-peak ripple not exceeding 10 % of the average value.
- NOTE Where peak-to-peak ripple exceeds 10 % of the average value, the requirements related to peak voltage are applicable.
- 1.2.13.5** SERVICE PERSON: person having appropriate technical training and experience necessary to be aware of hazards to which that person may be exposed in performing a task and of measures to minimize the risks to that person or other persons
- 1.2.13.6** USER: any person, other than a SERVICE PERSON
- The term USER in this standard is the same as the term OPERATOR and the two terms can be interchanged.
- 1.2.13.7** OPERATOR: see USER (1.2.13.6)

**1.2.13.8 TELECOMMUNICATION NETWORK:** metallically terminated transmission medium intended for communication between equipment that may be located in separate buildings, excluding:

- the mains system for supply, transmission and distribution of electrical power, if used as a telecommunication transmission medium;
- CABLE DISTRIBUTION SYSTEMS;
- SELV CIRCUITS connecting units of information technology equipment

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 either an SELV CIRCUIT or a TNV CIRCUIT. Only the circuits in the equipment 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 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 Integrated Services Digital Network (ISDN);
- a private network with electrical interface characteristics similar to the above.

**1.2.13.9 FUNCTIONAL EARTHING:** earthing of a point in equipment or in a system, which is necessary for a purpose other than safety

**1.2.13.10 PROTECTIVE EARTHING CONDUCTOR:** conductor in the building installation wiring, or in the power supply cord, connecting a main protective earthing terminal in the equipment to an earth point in the building installation

NOTE In some countries, the term "grounding conductor" is used instead of "PROTECTIVE EARTHING CONDUCTOR".

**1.2.13.11 PROTECTIVE BONDING CONDUCTOR:** conductor in the equipment, or a combination of conductive parts in the equipment, connecting a main protective earthing terminal to a part of the equipment that is required to be earthed for safety purposes

**1.2.13.12 TOUCH CURRENT:** electric current through a human body when it touches one or more accessible parts

NOTE TOUCH CURRENT was previously included in the term "leakage current".

**1.2.13.13 PROTECTIVE CONDUCTOR CURRENT:** current flowing through the PROTECTIVE EARTHING CONDUCTOR under normal operating conditions

NOTE PROTECTIVE CONDUCTOR CURRENT was previously included in the term "leakage current".

**1.2.13.14 CABLE DISTRIBUTION SYSTEM:** metallically terminated transmission medium using coaxial cable, mainly intended for transmission of video and/or audio signals between separate buildings or between outdoor antennas and buildings, excluding:

- the mains system for supply, transmission and distribution of electric power, if used as a communication transmission medium;

- TELECOMMUNICATION NETWORKS;
- SELV CIRCUITS connecting units of information technology equipment

NOTE 1 Examples of CABLE DISTRIBUTION SYSTEMS are:

- local area cable networks, community antenna television systems and master antenna television systems providing video and audio signal distribution;
- outdoor antennas including satellite dishes, receiving antennas, and other similar devices.

NOTE 2 CABLE DISTRIBUTION SYSTEMS may be subjected to greater transients than TELECOMMUNICATION NETWORKS(see 7.4.1).

**1.2.13.15** CHEESECLOTH: bleached cotton cloth of approximately 40 g/m<sup>2</sup>

**1.2.13.16** WRAPPING TISSUE: soft and strong, lightweight wrapping paper of grammage generally between 12 g/m<sup>2</sup> and 30 g/m<sup>2</sup>, primarily intended for protective packaging of delicate articles and for gift wrapping

[ISO 4046-4:2002, definition 4.215]

**1.2.13.17** PROTECTIVE CURRENT RATING: rating of an overcurrent protective device that is known or assumed to be in place to protect a circuit

NOTE Rules to determine the value of the PROTECTIVE CURRENT RATING are in 2.6.3.3.

**1.2.13.18** (HOUSEHOLD AND HOME/OFFICE DOCUMENT/MEDIA) SHREDDER: equipment with a plug configuration associated with PLUGGABLE EQUIPMENT TYPE A, or battery operated equipment, designed to shred paper or other forms of media as instructed by the manufacturer

NOTE 1 Examples of other forms of media include but are not limited to digital video disks, compact disks, flash memory, magnetic strip cards, or magnetic disks, or the like.

NOTE 2 HOUSEHOLD AND HOME/OFFICE DOCUMENT/MEDIA SHREDDERS are typically identified as either strip-cut type or cross-cut type. A strip-cut HOUSEHOLD AND HOME/OFFICE DOCUMENT/MEDIA SHREDDER shreds the paper into long strips using a motor-based shredding mechanism. A CROSS-CUT DOCUMENT/MEDIA SHREDDER shreds paper two or more ways into tiny particles, typically using a more powerful motor and more complex shredding mechanism.

NOTE 3 A document/media shredder is considered to be non-household or non-home/office type if the document/media shredder is provided with a plug configuration associated with PLUGGABLE EQUIPMENT TYPE B, or IS PERMANENTLY CONNECTED EQUIPMENT.

### 1.3 General requirements

#### 1.3.1 Application of requirements

The requirements detailed in this standard shall be applied only if safety is involved.

In order to establish whether or not safety is involved, the circuits and construction shall be carefully investigated to take into account the consequences of possible failures.

#### 1.3.2 Equipment design and construction

Equipment shall be so designed and constructed that, under all conditions of normal use and under likely abnormal use or single fault conditions (see 1.4.14), protection is provided to reduce the risk of personal injury from electric shock and other hazards, and against spread of fire originating in the equipment.

*Compliance is checked by inspection and by the relevant tests.*

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### 1.3.3 Supply voltage

Equipment shall be designed to be safe at any supply voltage to which it is intended to be connected.

*Compliance is checked by inspection and by carrying out the relevant tests of this standard using a supply voltage as specified in the corresponding subclause. If the subclause does not specify the supply voltage (explicitly or by reference to 1.4.5), then the value of the RATED VOLTAGE or any value of the RATED VOLTAGE RANGE shall be used.*

### 1.3.4 Constructions not specifically covered

Where the equipment involves technologies and materials or methods of construction not specifically covered in this standard, the equipment shall provide a level of safety not less than that generally afforded by this standard and the principles of safety contained herein.

NOTE The need for additional detailed requirements to cope with a new situation should be brought promptly to the attention of the appropriate committee.

### 1.3.5 Equivalent materials

Where the standard specifies a particular grade of insulation, the use of a better grade of insulation is permitted. Similarly, where the standard requires material of a particular FLAMMABILITY CLASS, the use of a better class is permitted.

### 1.3.6 Orientation during transport and use

Where it is clear that the orientation of use of equipment is likely to have a significant effect on the application of the requirements or the results of tests, all orientations of use permitted in the installation or operating instructions shall be taken into account. For TRANSPORTABLE EQUIPMENT, all orientations of transport and use shall be taken into account.

NOTE The above may apply to 4.1, 4.2, 4.3.8, 4.5, 4.6 and 5.3.

### 1.3.7 Choice of criteria

Where the standard permits a choice between different criteria for compliance, or between different methods or conditions of test, the choice is specified by the manufacturer.

### 1.3.8 Examples mentioned in the standard

Where examples of equipment, parts, methods of construction, design techniques and faults are given in the standard, prefaced by "for example" or "such as", other examples, situations and solutions are not excluded.

### 1.3.9 Conductive liquids

For the electrical requirements of this standard, conductive liquids shall be treated as conductive parts.

## 1.4 General conditions for tests

### 1.4.1 Application of tests

The tests detailed in this standard shall be conducted only if safety is involved.

If it is evident from the design and construction of the equipment that a particular test is not applicable, the test is not made.

Unless otherwise stated, upon conclusion of the tests, the equipment need not be operational.

### 1.4.2 Type tests

Except where otherwise stated, the tests specified in this standard are TYPE TESTS.

### 1.4.3 Test samples

Unless otherwise specified, the sample or samples under test shall be representative of the equipment the USER would receive, or shall be the actual equipment ready for shipment to the USER.

As an alternative to carrying out tests on the complete equipment, tests may be conducted separately on circuits, components or subassemblies outside the equipment, provided that inspection of the equipment and circuit arrangements indicates that the results of such testing will be representative of the results of testing the assembled equipment. If any such test indicates a likelihood of non-conformance in the complete equipment, the test shall be repeated in the equipment.

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

NOTE 1 The tests should be conducted in the following order:

- component or material pre-selection;
- component or subassembly bench tests;
- tests where the equipment is not energized;
- live tests:
  - under normal operating conditions;
  - under abnormal operating conditions;
  - involving likely destruction.

NOTE 2 In view of the 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.

#### 1.4.4 Operating parameters for tests

Except where specific test conditions are stated elsewhere in the standard and where it is clear that there is a significant impact on the results of the test, the tests shall be conducted under the most unfavourable combination within the manufacturer's operating specifications of the following parameters:

- supply voltage (see 1.4.5);
- supply frequency (see 1.4.6);
- operating temperature (see 1.4.12);
- physical location of equipment and position of movable parts;
- operating mode;
- adjustment of THERMOSTATS, regulating devices or similar controls in OPERATOR ACCESS AREAS, which are:
  - adjustable without the use of a TOOL; or
  - adjustable using a means, such as a key or a TOOL deliberately provided for the OPERATOR.
- overcurrent protection devices provided as part of the building installation for protection against overcurrents, short-circuits, and earth faults. (See 1.4.14.)

D1  
D1

#### 1.4.5 Supply voltage for tests

In determining the most unfavourable voltage for the power to energize the equipment under test (EUT), the following variables shall be taken into account:

- multiple RATED VOLTAGES;
- tolerances ON RATED VOLTAGE as specified below;
- extremes of RATED VOLTAGE RANGES.

If the equipment is intended for direct connection to an AC MAINS SUPPLY, the tolerances on RATED VOLTAGE shall be taken as +6 % and -10 %, unless:

- the RATED VOLTAGE is 230 V single-phase or 400 V three-phase, in which case the tolerance shall be taken as +10 % and -10 %; or
- a wider tolerance is declared by the manufacturer, in which case the tolerance shall be taken as this wider value.

If the equipment is intended only for connection to an a.c. mains equivalent source, such as a motor-driven generator or an uninterruptible power supply (see 1.2.8.1), or a source other than a MAINS SUPPLY, the tolerances on RATED VOLTAGE shall be declared by the manufacturer.

If equipment is intended for connection to a DC MAINS SUPPLY, the tolerance shall be taken as +20 % and -15 %, unless declared otherwise by the manufacturer.

When testing equipment designed for d.c. only, the possible influence of polarity shall be taken into account.

#### 1.4.6 Supply frequency for tests

In determining the most unfavourable frequency for the power to energize the EUT, different RATED FREQUENCIES within the RATED FREQUENCY RANGE shall be taken into account (for example, 50 Hz and 60 Hz) but consideration of the tolerance on a RATED FREQUENCY (for example, 50 Hz  $\pm$  0,5 Hz) is not normally necessary.

#### 1.4.7 Electrical measuring instruments

Electrical measuring instruments shall have adequate bandwidth to provide accurate readings, taking into account all components (d.c., AC MAINS SUPPLY frequency, high frequency and harmonic content) of the parameter being measured. If the r.m.s. value is measured, care shall be taken that measuring instruments give true r.m.s. readings of non-sinusoidal waveforms as well as sinusoidal waveforms.

#### 1.4.8 Normal operating voltages

For the purposes of:

- determining WORKING VOLTAGES (see 1.2.9.6); and
- classifying circuits in the equipment as ELV CIRCUITS, SELV CIRCUITS, TNV-1 CIRCUITS, TNV-2 CIRCUITS, TNV-3 CIRCUITS, OR HAZARDOUS VOLTAGE CIRCUITS;

the following voltages shall be considered:

- normal operating voltages generated in the equipment, including repetitive peak voltages such as those associated with switch mode power supplies;
- normal operating voltages generated outside the equipment, including ringing signals received from TELECOMMUNICATION NETWORKS.

For these purposes, unwanted, externally generated, non-repetitive transient voltages (for example, MAINS TRANSIENT VOLTAGES and TELECOMMUNICATION NETWORK TRANSIENT VOLTAGES) induced by power distribution system switching and lightning surges, shall not be considered:

- when determining WORKING VOLTAGES, because such transients have been taken into account in the procedures for determining minimum CLEARANCES (see 2.10.3 and Annex G);
- when classifying circuits in the equipment, except when distinguishing between SELV CIRCUITS and TNV-1 CIRCUITS and between TNV-2 CIRCUITS and TNV-3 CIRCUITS (see 1.2.8.11, Table 1A).

NOTE 1 The effects of unwanted steady-state voltages generated outside the equipment (for example, earth potential differences and voltages induced on TELECOMMUNICATION NETWORKS by electric train systems) are controlled by installation practices or by appropriate isolation in the equipment. Such measures are application dependent and are not dealt with by this standard.

NOTE 2 In Canada and the United States, additional requirements apply for protection against overvoltages (see Clause 6, Note 5).

#### 1.4.9 Measurement of voltage to earth

Where the standard specifies a voltage between a conductive part and earth, all of the following earthed parts are considered:

- the main protective earthing terminal (if any); and
- any other conductive part required to be connected to protective earth (for examples see 2.6.1); and
- any conductive part that is earthed within the equipment for functional reasons.

Parts that will be earthed in the application by connection to other equipment, but are unearthed in the equipment as tested, shall be connected to earth at the point by which the highest voltage is obtained. When measuring a voltage between earth and a conductor in a circuit that will not be earthed in the intended application of the equipment, a non-inductive resistor of  $5\,000\ \Omega \pm 10\%$  shall be connected across the voltage measuring instrument.

Voltage drop in the PROTECTIVE EARTHING CONDUCTOR of the power supply cord, or in an earthed conductor in other external wiring, is not included in the measurements.

#### 1.4.10 Loading configuration of the EUT

In determining the input current (see 1.6.2), and where other test results could be affected, the following variables shall be considered and adjusted to give the most unfavourable results:

- loads due to optional features, offered or provided by the manufacturer for inclusion in or with the EUT;
- loads due to other units of equipment intended by the manufacturer to draw power from the EUT;
- loads that could be connected to any standard supply outlets in OPERATOR ACCESS AREAS on the equipment, up to the value indicated in the marking required by 1.7.5.

It is permitted to use artificial loads to simulate such loads during testing.

#### 1.4.11 Power from a telecommunication network

For the purpose of this standard, the power available from a TELECOMMUNICATION NETWORK is considered to be limited to 15 VA.

#### 1.4.12 Temperature measurement conditions

##### 1.4.12.1 General

Temperatures measured on the EUT shall conform to 1.4.12.2 or 1.4.12.3, as applicable, all temperatures being in degrees Celsius (°C); where

$T$  is the temperature of the given part measured under the prescribed test conditions;

$T_{\max}$  is the maximum temperature specified for compliance with the test;

$T_{\text{amb}}$  is the ambient temperature during test;

$T_{\text{ma}}$  is the maximum ambient temperature permitted by the manufacturer's specification, or 25 °C, whichever is greater.

##### 1.4.12.2 Temperature dependent equipment

For equipment where the amount of heating or cooling is designed to be dependent on temperature (for example, the equipment contains a fan that has a higher speed at a higher temperature), the temperature measurement is made at the least favourable ambient temperature within the manufacturer's specified operating range. In this case:

$T$  shall not exceed  $T_{\max}$ .

NOTE 1 In order to find the highest value of  $T$  for each component, it may be necessary to conduct several tests at different values of  $T_{\text{amb}}$ .

NOTE 2 The least favourable value of  $T_{\text{amb}}$  may be different for different components.

### 1.4.12.3 Non-temperature dependent equipment

For equipment where the amount of heating or cooling is not designed to be dependent on ambient temperature, it is permitted to use the method in 1.4.12.2. Alternatively, the test is performed at any value of  $T_{amb}$  within the manufacturer's specified operating range. In this case:

$$T \text{ shall not exceed } (T_{max} + T_{amb} - T_{ma}).$$

During the test,  $T_{amb}$  should not exceed  $T_{ma}$  unless agreed by all parties involved.

### 1.4.13 Temperature measurement methods

Unless a particular method is specified, the temperatures of windings shall be determined either by the thermocouple method or by the resistance method (see Annex E). The temperatures of parts other than windings shall be determined by the thermocouple method. Any other suitable method of temperature measurement which does not noticeably influence the thermal balance and which achieves an accuracy sufficient to show compliance is also permitted. The choice of and position of temperature sensors shall be made so that they have minimum effect on the temperature of the part under test.

### 1.4.14 Simulated faults and abnormal conditions

Where it is required to apply simulated faults or abnormal operating conditions, these shall be applied in turn and one at a time. Faults which are the direct consequence of a simulated fault or abnormal operating condition are considered to be part of that simulated fault or abnormal operating condition.

When applying simulated faults or abnormal operating conditions, parts, supplies, consumable materials, media and recording materials shall be in place if they are likely to have an effect on the outcome of the test.

When applying simulated faults or abnormal operating conditions, consideration should be given to the overcurrent protection devices provided as part of the building installation for protection against overcurrents, short-circuits, and earth faults. D1  
D1  
D1

For PLUGGABLE EQUIPMENT TYPE A, the protection in the installation shall be taken to be a fuse or circuit breaker rated 20 A. D1  
D1

For PLUGGABLE EQUIPMENT TYPE B, the protection in the installation shall be equal to the rated current of the plug or as specified in the installation instructions. (See 2.7.1.) D1  
D1

Where there is a specific reference to a single fault, the single fault consists of a single failure of any insulation (excluding DOUBLE INSULATION OR REINFORCED INSULATION) or a single failure of any component (excluding components with DOUBLE INSULATION OR REINFORCED INSULATION). The failure of FUNCTIONAL INSULATION is simulated only when required by 5.3.4 c).

The equipment, circuit diagrams and component specifications are examined to determine those fault conditions that might reasonably be expected to occur. Examples include:

- short-circuits and open circuits of semiconductor devices and capacitors;
- faults causing continuous dissipation in resistors designed for intermittent dissipation;

- internal faults in integrated circuits causing excessive dissipation;
- failure of BASIC INSULATION between current-carrying parts of the PRIMARY CIRCUIT and
  - accessible conductive parts;
  - earthed conductive screens (see Clause C.2);
  - parts of SELV CIRCUITS;
  - parts of LIMITED CURRENT CIRCUITS.

#### 1.4.15 Compliance by inspection of relevant data

Where in this standard compliance of materials, components or subassemblies is checked by inspection or by testing of properties, it is permitted to confirm compliance by reviewing any relevant data or previous test results that are available instead of carrying out the specified TYPE TESTS.

### 1.5 Components

#### 1.5.1 General

Where safety is involved, components shall comply with the requirements of this standard or, where specified in a requirements clause, with the safety aspects of the relevant IEC component standards.

NOTE An IEC component standard is considered relevant only if the component in question clearly falls within its scope.

Components and subassemblies that comply with ~~IEC 62368-1~~ CSA/UL 62368-1 are acceptable as part of an equipment covered by this standard without further evaluation other than to give consideration to the appropriate use of the component or subassembly in the end-product. DC

In this standard, certain IEC component standard requirements are replaced by the relevant requirements of component standards listed in Annex P.1. DC  
DC

In this standard, certain requirements (such as flammability tests) are alternatively satisfied by complying with relevant requirements of component standards listed in Annex P.2. DC  
DC

### 1.5.2 Evaluation and testing of components

P. 1  
P. 2

Where use of an IEC component standard is permitted above, evaluation and testing of components shall be conducted as follows:

- a component shall be checked for correct application and use in accordance with its rating;
- a component that has been demonstrated to comply with a standard harmonized with the relevant IEC component standard shall be subjected to the applicable tests of this standard, as part of the equipment, with the exception of those tests that are part of the relevant IEC component standard;
- a component that has not been demonstrated to comply with a relevant standard as above shall be subjected to the applicable tests of this standard, as part of the equipment, and to the applicable tests of the component standard, under the conditions occurring in the equipment; NOTE The applicable

NOTE The applicable test for compliance with a component standard is, in general, conducted separately.

- where components are used in circuits not in accordance with their specified ratings, the components shall be tested under the conditions occurring in the equipment. The number of samples required for test is, in general, the same as required by an equivalent standard.

*Compliance is checked by inspection and by the relevant data or tests.*

### 1.5.3 Thermal controls

*Thermal controls shall be tested in accordance with Annex K.*

### 1.5.4 Transformers

P. 2

Transformers shall comply with the relevant requirements of this standard, including those of Annex C.

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### 1.5.5 Interconnecting cables

P. 1  
P. 2  
NAA  
NAE

INTERCONNECTING CABLES provided as part of the equipment shall comply with the relevant requirements of this standard and shall not present a hazard in the meaning of this standard whether they are detachable or non-detachable.

For INTERCONNECTING CABLES supplied alone (for example, printer cables), it is permitted to apply the requirements of this subclause at the option of the manufacturer.

It is permitted to treat cables, or those parts of cables, that are within an equipment ENCLOSURE either as INTERCONNECTING CABLES or as internal wiring.

INTERCONNECTING CABLES used for external interconnection between parts of equipment or systems shall be constructed of cable acceptable for external use and shall be rated for the application with respect to voltage, current, anticipated temperature, flammability, mechanical serviceability and the like. D1  
D1  
D1  
D1

Cable assemblies with lengths external to the unit not exceeding 3,05 m, coiled or uncoiled, may be constructed of jacketed appliance wiring material, suitable for the maximum voltage, current and temperature, rated VW-1 or FT-1 or better. DC  
DC  
DC

Cable assemblies or wiring with lengths external to the unit not exceeding 3,05 m, coiled or uncoiled, and supplied by a limited power source or CEC/NEC Class 2 source of supply as defined in the Canadian Electrical Code, CSA C22.1 and National Electrical Code, ANSI/NFPA 70, may be constructed of materials rated VW-1 or FT-1 or better with no additional requirements. DC  
DC  
DC  
DC  
DC

*Compliance is checked by inspection.* D1

### 1.5.6 Capacitors bridging insulation

P.2

A capacitor connected between two line conductors in a PRIMARY CIRCUIT, or between one line conductor and the neutral conductor or between the PRIMARY CIRCUIT and protective earth shall comply with one of the subclasses of IEC 60384-14 and shall be used in accordance with its rating. This requirement also applies to a capacitor bridging DOUBLE INSULATION OR REINFORCED INSULATION elsewhere in the equipment. The details of the damp heat, steady state test as specified in 4.12 of IEC 60384-14 shall be as follows:

- Temperature:  $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ;
- Humidity:  $(93 \pm 3)$  % relative humidity;
- Test duration: 21 days.

NOTE 1 Capacitors that have been subjected to a test duration longer than 21 days are considered to have met the test duration criteria.

The above requirement does not apply to a capacitor connected between a HAZARDOUS VOLTAGE SECONDARY CIRCUIT protective earth, where only BASIC INSULATION is required.

NOTE 2 The test of 5.2.2 still applies between the HAZARDOUS VOLTAGE SECONDARY CIRCUIT and protective earth.

The appropriate capacitor subclass shall be selected from those listed in Table 1C, according to the rules of application in the table.

Table 1C – Capacitor ratings according to IEC 60384-14

Capacitor subclass according to IEC 60384-14	RATED VOLTAGE of the capacitor V r.m.s.	TYPE TEST impulse voltage of the capacitor kV peak	TYPE TEST r.m.s. voltage of the capacitor kV r.m.s.
Y1	Up to and including 500	8	4
Y2	Over 150 up to and including 300	5	1,5
Y4	Up to and including 150	2,5	0,9
X1	Up to and including 760	4 <sup>a</sup>	–
X2	Up to and including 760	2,5 <sup>a</sup>	–

Rules for the application of Table 1C

- Capacitors used to bridge BASIC INSULATION, SUPPLEMENTARY INSULATION or REINFORCED INSULATION shall be class Y except that it is permitted to bridge BASIC INSULATION in a SECONDARY CIRCUIT by a class X capacitor.
- For a single capacitor bridging FUNCTIONAL INSULATION, BASIC INSULATION, SUPPLEMENTARY INSULATION or REINFORCED INSULATION, the voltage rating of the single capacitor shall be at least equal to the RMS WORKING VOLTAGE across the insulation being bridged, determined according to 2.10.2.2.
- For a single capacitor bridging FUNCTIONAL INSULATION, BASIC INSULATION or SUPPLEMENTARY INSULATION,
  - the TYPE TEST impulse test voltage of the single capacitor shall be not less than the peak value of the test voltage (not the r.m.s. voltage) of Table 5B for BASIC INSULATION, or the peak value of the test voltage of Table 5C for BASIC INSULATION, as applicable;
  - the TYPE TEST r.m.s. voltages of the single capacitor shall be not less than the required r.m.s. test voltage of Table 5B for BASIC INSULATION, or the equivalent r.m.s. test voltage (not the peak voltage) of Table 5C for BASIC INSULATION, as applicable
- For a single capacitor bridging DOUBLE INSULATION or REINFORCED INSULATION,
  - the TYPE TEST impulse voltage of the single capacitor shall be not less than the peak value of the test voltage (not the r.m.s. voltage) of Table 5B for REINFORCED INSULATION, or the peak value of the test voltage of Table 5C for REINFORCED INSULATION, as applicable;
  - the TYPE TEST r.m.s. voltage of the single capacitors shall be not less than the required r.m.s. test voltage of Table 5B for REINFORCED INSULATION, or the equivalent r.m.s. test voltage (not the peak voltage) of Table 5C for REINFORCED INSULATION, as applicable;
- It is permitted to use a higher grade capacitor than the one specified, as follows:
  - subclass Y1 if subclass Y2 is specified;
  - subclass Y1 or Y2 if subclass Y4 is specified;
  - subclass Y1 or Y2 if subclass X1 is specified;
  - subclass X1, Y1 or Y2 if subclass X2 is specified.
- It is permitted to use two or more capacitors in series in place of the single capacitor specified, as follows:
  - subclass Y1 or Y2 if subclass Y1 is specified;
  - subclass Y2 or Y4 if subclass Y2 is specified;
  - subclass X1 or X2 if subclass X1 is specified.
- If two or more capacitors are used in series, all of the following apply:
  - under single fault conditions, the voltage on each of the remaining individual capacitors shall not exceed the voltage rating of the relevant individual capacitor;
  - for BASIC INSULATION or SUPPLEMENTARY INSULATION, the sum of the TYPE TEST peak impulse test voltages of all capacitors shall be not less than the peak value of the test voltage (not the r.m.s. voltage) of Table 5B, or the peak value of the test voltage of Table 5C, as applicable;
  - for BASIC INSULATION or SUPPLEMENTARY INSULATION, the sum of the TYPE TEST r.m.s. test voltages of all capacitors shall be not less than the required r.m.s. test voltage of Table 5B, or the equivalent r.m.s. test voltage (not the peak voltage) of Table 5C, as applicable;
  - for REINFORCED INSULATION, the sum of the TYPE TEST peak impulse test voltages of all capacitors shall be not less than the peak value of the test voltage (not the r.m.s. voltage) of Table 5B, or the peak value of the test voltage of Table 5C, as applicable;

**Table 1C – Capacitor ratings according to IEC 60384-14 Continued**

Capacitor subclass according to IEC 60384-14	RATED VOLTAGE of the capacitor V r.m.s.	TYPE TEST impulse voltage of the capacitor kV peak	TYPE TEST r.m.s. voltage of the capacitor kV r.m.s.
– for REINFORCED INSULATION, the sum of the TYPE TEST r.m.s. test voltages of all capacitors shall be not less than the required r.m.s. test voltage of Table 5B, or the equivalent r.m.s. test voltage (not the peak voltage) of Table 5C, as applicable; – they shall comply with the other rules above.			
<sup>a</sup> For capacitance values of more than 1 µF, this test voltage is reduced by a factor equal to $\sqrt{C}$ , where C is the capacitance value in µF.			

Table 1D gives a number of informative examples of the application of capacitors selected in accordance with Table 1C. Other examples are possible.

**Table 1D – Informative examples of application of capacitors**

AC MAINS SUPPLY voltage up to and including V r.m.s.	Overvoltage Category	MAINS TRANSIENT VOLTAGE kV	Bridged insulation	Capacitor type	Number of capacitors	
					Using Table 5B	Using Table 5C
150	II	1,5	B or S	Y2	1	1
	II	1,5	D or R	Y2	2	2
	II	1,5	D or R	Y1	1	1
	II	1,5	F	X2	1	1
	III	2,5	F	X2	–	1
	III	2,5	B or S	Y2	–	2
	III	2,5	D or R	Y1	–	1
	IV	4,0	F	X1	–	1
	IV	4,0	B or S	Y1	–	1
	IV	4,0	B or S	Y2	–	2
250	II	2,5	F	X2	1	1
	III	4,0	F	X1	–	1
300	II	2,5	B or S	Y2	1	2
	II	2,5	D or R	Y1	1	1
	II	2,5	D or R	Y2	2	3
	III	4,0	B or S	Y1	–	1
	III	4,0	B or S	Y2	–	2
	III	4,0	D or R	Y1	–	2
	III	4,0	D or R	Y2	–	4
	IV	6,0	F	X1	–	2
	IV	6,0	B or S	Y1	–	2
	IV	6,0	D or R	Y1	–	3
500	II	4,0	F	X1	1	1
	II	4,0	B or S	Y1	1	1
	II	4,0	D or R	Y1	1	2
	III	6,0	F	X1	–	2
	III	6,0	B or S	Y1	–	2
	III	6,0	D or R	Y1	–	3
	IV	8,0	F	X1	–	2
	IV	8,0	B or S	Y1	–	2

Table 1D – Informative examples of application of capacitors Continued on Next Page

**Table 1D – Informative examples of application of capacitors Continued**

AC MAINS SUPPLY voltage up to and including V r.m.s.	Overvoltage Category	MAINS TRANSIENT VOLTAGE kV	Bridged insulation	Capacitor type	Number of capacitors	
					Using Table 5B	Using Table 5C
	IV	8,0	D or R	Y1	–	3
The values in the table apply to FUNCTIONAL INSULATION (F), BASIC INSULATION (B), SUPPLEMENTARY INSULATION (S), DOUBLE INSULATION (D) and REINFORCED INSULATION (R).						
NOTE Table 5B is used for Overvoltage Categories I and II only.						

If an accessible conductive part or circuit is separated from another part by DOUBLE INSULATION or REINFORCED INSULATION that is bridged by a capacitor or capacitors, the accessible part or circuit shall comply with the requirements for a LIMITED CURRENT CIRCUIT in 2.4. This requirement applies after electric strength testing of the insulation with the bridging capacitor or capacitors in place.

NOTE 3 A circuit is a LIMITED CURRENT CIRCUIT if the current through the bridging components complies with 2.4 and other requirements of 2.4 are met.

*Compliance is checked by inspection and measurement.*

## 1.5.7 Resistors bridging insulation

P.2

### 1.5.7.1 Resistors bridging functional insulation, basic insulation or supplementary insulation

There are no special requirements for resistors bridging FUNCTIONAL INSULATION, BASIC INSULATION or SUPPLEMENTARY INSULATION, but the relevant requirements of 2.10.3 (or Annex G) and 2.10.4 apply, and in some cases those of 2.4.

NOTE In Finland, Norway and Sweden resistors bridging BASIC INSULATION in CLASS I PLUGGABLE EQUIPMENT TYPE A must comply with 1.5.7.1. In addition when a single resistor is used, the resistor must withstand the resistor test in 1.5.7.2.

### 1.5.7.2 Resistors bridging double insulation or reinforced insulation between the a.c. mains supply and other circuits

It is permitted to bridge DOUBLE INSULATION or REINFORCED INSULATION by one resistor or by a group of two or more resistors in series under the following conditions. For conditions applicable to circuits connected to an antenna or coaxial cable, see 1.5.7.3.

The resistor or group of resistors shall comply with the minimum CLEARANCES of 2.10.3 or Annex G and the minimum CREEPAGE DISTANCES of 2.10.4 for REINFORCED INSULATION for the total WORKING VOLTAGE across the resistor or group of resistors. For a group of resistors, see also Figure F.13.

If a single resistor is used, it shall pass the resistor test below.

If a group of resistors is used, the CLEARANCE and CREEPAGE DISTANCE are assessed as if each resistor were short-circuited in turn, unless the group passes the resistor test below.

If an accessible conductive part or circuit is separated from another part by DOUBLE INSULATION or REINFORCED INSULATION that is bridged by a resistor or group of resistors, the accessible part or circuit shall comply with the requirements for a LIMITED CURRENT CIRCUIT in 2.4 between the

accessible conductive part or circuit and earth. If a group of resistors is used, the current measurement in 2.4.2 is made with each resistor short-circuited in turn, unless the group passes the resistor test below. When measuring the LIMITED CURRENT CIRCUIT, the ammeter is placed between the load side of the bridging components and any USER accessible part, including earth.

*Compliance is checked by inspection and measurement and, if specified above, by the following resistor test on ten samples. A sample is a single resistor if used alone, or a group of resistors in series.*

#### *Resistor Test*

*Before the test, the resistance of each sample is measured.*

*The samples are subjected to the damp heat test according to IEC 60068-2-78, with the following details:*

- Temperature:  $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ;*
- Humidity:  $(93 \pm 3)\%$  relative humidity;*
- Test duration: 21 days.*

NOTE Resistors that have been subjected to a test duration longer than 21 days are considered to have met the test duration criteria.

*Each sample is then subjected to ten impulses of alternating polarity, using the impulse test generator reference 2 of Table N.1 The interval between successive impulses is 60 s, and  $U_c$  is equal to the applicable REQUIRED WITHSTAND VOLTAGE.*

*After the test, the resistance of each sample shall not have changed by more than 10 %.*

*No failure is permitted.*

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### 1.5.7.3 Resistors bridging double insulation or reinforced insulation between the a.c. mains supply and circuits connected to an antenna or coaxial cable

The requirements and tests of 1.5.7.2 apply except the impulse test generator is as specified in reference 3 of Table N.1 if the circuit is connected to an antenna or reference 1 of Table N.1 if the circuit is connected to a coaxial cable.

*After the test, the resistance of each sample shall not have changed by more than 20 % and no failure is permitted.*

NOTE If a resistor or a group of resistors is connected between the PRIMARY CIRCUIT and a CABLE DISTRIBUTION SYSTEM, 7.4 also applies.

### 1.5.8 Components in equipment for IT power distribution systems

For equipment to be connected to IT power distribution systems, components connected between line and earth shall be capable of withstanding the stress due to the line-to-line voltage. However, capacitors rated for the applicable line-to-neutral voltage are permitted in such applications if they comply with subclass Y1, Y2 or Y4 of IEC 60384-14.

NOTE 1 The above capacitors are endurance tested at 170 % of the voltage rating of the capacitor.

NOTE 2 In Norway, due to the IT power distribution system used (see Annex V, Figure V.7), capacitors are required to be rated for the applicable line-to-line voltage (230 V).

*Compliance is checked by inspection.*

### 1.5.9 Surge suppressors

P.2

#### 1.5.9.1 General

It is permitted to use any type of surge suppressor, including a voltage dependent resistor (VDR), in a SECONDARY CIRCUIT.

If a surge suppressor is used in a PRIMARY CIRCUIT, it shall be a VDR and it shall comply with Annex Q.

NOTE 1 A VDR is sometimes referred to as a varistor or a metal oxide varistor (MOV). Devices such as gas discharge tubes, carbon blocks and semiconductor devices with non-linear voltage/current characteristics are not considered as VDRs in this standard.

NOTE 2 It is not a requirement of this standard to comply with any particular component standard for surge suppressors used in SECONDARY CIRCUITS. However, attention is drawn to the IEC 61643 series of standards, in particular:

- IEC 61643-21 (surge suppressors in telecommunications application)
- IEC 61643-311 (gas discharge tubes)
- IEC 61643-321 (avalanche breakdown diodes)
- IEC 61643-331 (metal oxide varistors).

*Compliance is checked by inspection and application of Annex Q as appropriate.*

### 1.5.9.2 Protection of VDRs

For protection against

- temporary overvoltages above the maximum continuous voltage,
- thermal overload due to leakage current within the VDR, and
- burning and bursting of the VDR in the event of a short-circuit fault,

an interrupting means having an adequate breaking capacity shall be connected in series with the VDR. This requirement does not apply to a VDR in a LIMITED CURRENT CIRCUIT.

NOTE 1 For temporary overvoltages from the AC MAINS SUPPLY, see IEC 60664-1.

NOTE 2 During the lifetime of a VDR the leakage current increases with the number of switching cycles in the VDR. This leakage current causes a permanent and continuously increasing temperature stress, which can cause the VDR to burn or burst.

*Compliance is checked by inspection and, if necessary to determine that the circuit is a LIMITED CURRENT CIRCUIT, by measurement and test.*

### 1.5.9.3 Bridging of functional insulation by a VDR

It is permitted to bridge FUNCTIONAL INSULATION by a VDR.

*Compliance is checked by inspection.*

### 1.5.9.4 Bridging of basic insulation by a VDR

It is permitted to bridge BASIC INSULATION by a VDR complying with the requirements of Annex Q, with or without a GDT in series, provided that one side of the circuit is earthed in accordance with 2.6.1 a).

Equipment with such a VDR bridging BASIC INSULATION shall be one of the following:

- PLUGGABLE EQUIPMENT TYPE B; OR
- PERMANENTLY CONNECTED EQUIPMENT; OR
- equipment that has provision for a permanently connected PROTECTIVE EARTHING CONDUCTOR and is provided with instructions for the installation of that conductor.

NOTE In Finland, Norway and Sweden, the third dashed item is applicable only to equipment as defined in the Note to 6.1.2.2.

For all other equipment, it is permitted to bridge BASIC INSULATION by a VDR in series with a GDT provided that:

- the VDR complies with the requirements of Annex Q; and
- the GDT complies with:
  - the electric strength test for BASIC INSULATION; and

- the external CLEARANCE and CREEPAGE DISTANCE requirements for BASIC INSULATION.

*Compliance is checked by inspection and, if necessary, by measurement and test.*

#### 1.5.9.5 Bridging of supplementary, double or reinforced insulation by a VDR

It is not permitted to bridge SUPPLEMENTARY INSULATION, DOUBLE INSULATION OR REINFORCED INSULATION by a VDR.

*Compliance is checked by inspection.*

### 1.6 Power interface

**NAE**

#### 1.6.1 AC Power distribution systems

DE

##### 1.6.1.1 AC power distribution systems

DE

AC power distribution systems are classified as TN-C, TN-C-S, TN-S, TT or IT (see Annex V).

##### 1.6.1.2 DC power distribution systems

D2

**NAB  
NAE**

A circuit for connection to the DC MAINS SUPPLY is classified as either a SELV CIRCUIT, TNV-2 CIRCUIT OR HAZARDOUS VOLTAGE CIRCUIT depending on the maximum operating voltage of the supply. This maximum operating voltage shall include consideration of the battery charging "float voltage" associated with the intended supply system, regardless of the marked power rating of the equipment.

D2  
D2  
D2  
D2  
D2

NOTE Equipment marked -60 V d.c. and connected to a DC MAINS SUPPLY may have a maximum operating voltage of up to -75 V d.c. per IEC TR 62102.

D2  
D2

For the purposes of applying insulation requirements only, circuits connected to a DC MAINS SUPPLY shall be treated as indicated below:

D2  
D2

<u>Maximum Operating Voltage of DC MAINS SUPPLY</u>	<u>Classification of Circuit Connected to DC MAINS SUPPLY</u>	
<u>up to 60 V d.c.</u>	<u>SELV</u>	D2
<u>&gt; 60 V up to and including 80 V</u>	<u>TNV-2</u>	D2
<u>&gt; 80 V</u>	<u>HAZARDOUS VOLTAGE</u>	D2

These circuits are not current-limited to TNV CIRCUIT limits when providing power for equipment connected to a DC MAINS SUPPLY but shall be appropriately current-limited when connected to a TELECOMMUNICATION NETWORK.

D2  
D2  
D2

See 3.2.1.2 for additional connection requirements for equipment connected to a DC MAINS SUPPLY.

D2

### 1.6.2 Input current

The steady state input current of the equipment shall not exceed the RATED CURRENT by more than 10 % under NORMAL LOAD.

NOTE See also 1.4.10.

*Compliance is checked by measuring the input current of the equipment at NORMAL LOAD under the following conditions:*

– *where an equipment has more than one RATED VOLTAGE, the input current is measured at each RATED VOLTAGE;*

– *where an equipment has one or more RATED VOLTAGE RANGES, the input current is measured at each end of each RATED VOLTAGE RANGE. Where a single value of RATED CURRENT is marked (see 1.7.1), it is compared with the higher value of input current measured in the associated voltage range. Where two values of RATED CURRENT are marked, separated by a hyphen, they are compared with the two values measured in the associated voltage range.*

*In each case, the readings are taken when the input current has stabilized. If the current varies during the normal operating cycle, the steady-state current is taken as the mean indication of the value, measured on a recording r.m.s. ammeter, during a representative period.*

### 1.6.3 Voltage limit of hand-held equipment

The RATED VOLTAGE of HAND-HELD EQUIPMENT shall not exceed 250 V.

*Compliance is checked by inspection.*

### 1.6.4 Neutral conductor

The neutral conductor, if any, shall be insulated from earth and from the BODY throughout the equipment as if it were a line conductor. Components connected between neutral and earth shall be rated for line-to-neutral voltage (but see also 1.5.8).

*Compliance is checked by inspection.*

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## 1.7 Markings and instructions

NAA

NOTE Additional requirements for markings and instructions are contained in the following subclauses:

2.1.1.2	Battery compartments
2.3.2.3	Protection by earthing
2.6.1	Unearthed parts
2.6.2	FUNCTIONAL EARTHING
2.6.3.4 c)	Bonding conductors
2.6.5.1	Bonding conductors
2.7.1	External protective devices
2.7.6	Neutral fusing
2.10.3.2	Overvoltage Categories
3.2.1.2	DC MAINS SUPPLY
3.3.7	Grouping of wiring terminals
<del>3.4.3</del> 3.4.2	Disconnect devices
3.4.6	Two-pole disconnect devices
3.4.7	Four-pole disconnect devices
3.4.9	Plugs as disconnect devices
3.4.10	Interconnected equipment
3.4.11	Multiple power sources
4.1	Equipment stability
4.2.5	Impact test
4.3.3	Adjustable controls
4.3.5	Plugs and sockets
4.3.13.4	UV radiation
4.3.13.5	Lasers
4.4.2	Hazardous moving parts
4.4.5.2	Fan protection for USERS
4.4.5.3	Fan protection for service persons
4.5.4 Table 4C	Marking of hot parts
4.5.4	Touch temperatures
4.6.2	Equipment on non-combustible floors
4.6.3	Removable doors and covers
5.1.7.1	TOUCH CURRENT exceeding 3,5 mA
5.1.8.2	Summation of TOUCH CURRENTS
6.1.1 and 6.1.2.2	Earthing for a TELECOMMUNICATION NETWORK
7.2 and 7.4.1	Earthing for a CABLE DISTRIBUTION SYSTEM
G.2.1	Equipment in Overvoltage Categories III and IV
DD.2	Maximum shelf load
EE.2	Shredder warning
EE.4	Shredder power disconnection
<u>Annex NAA</u>	

DE

D2

Compliance with each subclause of 1.7 is checked by inspection unless otherwise specified (see 1.7.11).

## 1.7.1 Power rating and identification markings

### 1.7.1.1 Power rating markings

Equipment shall be provided with a power rating marking, the purpose of which is to specify a supply of correct voltage and frequency, and of adequate current-carrying capacity.

If the equipment is not provided with a means for direct connection to a MAINS SUPPLY, it need not be marked with any electrical rating, such as its RATED VOLTAGE, RATED CURRENT OR RATED FREQUENCY.

If the equipment, or a system, has multiple MAINS SUPPLY connections, each individual MAINS SUPPLY electrical rating must be marked, unless they are the same, but the overall equipment or system electrical rating need not be marked. If the multiple MAINS SUPPLY are identical, it is permitted to mark them, for example, as "MAINS SUPPLY electrical rating x N" where N is the number of identical MAINS SUPPLY connections.

For equipment intended to be installed by an OPERATOR, the power rating marking, if required, shall be readily visible in any OPERATOR ACCESS AREA. If a manual voltage selector is not OPERATOR-accessible, the power rating marking shall indicate the RATED VOLTAGE for which the equipment is set during manufacture; a temporary marker is permitted for this purpose. The power rating marking is permitted on any outer surface of the equipment, except the bottom of equipment having a mass exceeding 18 kg.

For STATIONARY EQUIPMENT, the power rating marking shall be visible after the equipment has been installed as in normal use.

For equipment intended to be installed by a SERVICE PERSON, and if the power rating marking is in a SERVICE ACCESS AREA, the location of the permanent marking shall be indicated in the installation instructions or on a readily visible marker on the equipment. It is permitted to use a temporary marker for this purpose.

The power rating marking shall include the following:

- RATED VOLTAGE(S) OR RATED VOLTAGE RANGE(S), in volts;
  - the voltage range shall have a hyphen (-) between the minimum and maximum RATED VOLTAGES and when multiple RATED VOLTAGES OR RATED VOLTAGE RANGES are given, they shall be separated by a solidus (/).

NOTE 1 Some examples of RATED VOLTAGE markings are:

- RATED VOLTAGE RANGE: 220-240 V. This means that the equipment is designed to be connected to an AC MAINS SUPPLY having any voltage between 220 V and 240 V.
- multiple RATED VOLTAGE: 120/230/240 V. This means that the equipment is designed to be connected to an AC MAINS SUPPLY having a voltage of 120 V or 230 V or 240 V, usually after internal adjustment.

- if equipment is to be connected to both line conductors and to the neutral conductor of a single-phase, three-wire power distribution system, the power rating marking shall give the line-to-neutral voltage and the line-to-line voltage, separated by a solidus (/), with the added notation "Three wires plus protective earth", "3W + PE" or equivalent;

NOTE 2 Some examples of the above system rating markings are:

- 120/240 V; 3 wire + PE;
- 120/240 V; 3W + ⊕ (60417-1-IEC-5019);

100/200 V; 2W + N + PE;  
100-120/200-240 V; 2W + N + PE.

- symbol for nature of supply, for d.c. only;
- RATED FREQUENCY OR RATED FREQUENCY RANGE, in hertz, unless the equipment is designed for d.c. only;
- RATED CURRENT, in milliamperes or amperes;
  - for equipment with multiple RATED VOLTAGES, the corresponding RATED CURRENTS shall be marked such that the different current ratings are separated by a solidus (/) and the relation between RATED VOLTAGE and associated RATED CURRENT appears distinctly;
  - equipment with a RATED VOLTAGE RANGE shall be marked with either the maximum RATED CURRENT or with the current range;
  - the power rating marking for RATED CURRENT of a group of units having a single supply connection shall be placed on the unit which is directly connected to a MAINS SUPPLY. The RATED CURRENT marked on that unit shall be the total maximum current that can be on circuit at the same time and shall include the combined currents to all units in the group that can be supplied simultaneously through the unit and that can be operated simultaneously.

NOTE 3 Some examples of RATED CURRENT markings are:

- for equipment with multiple RATED VOLTAGES;
  - 120/240 V; 2,4/1,2 A;
  - 100-120/200-240 V; 2,4/1,2 A;
- for equipment with a RATED VOLTAGE RANGE:
  - 100-240 V; 2,8 A;
  - 100-240 V; 2,8-1,4 A
  - 100-120 V; 2,8 A
  - 200-240 V; 1,4 A

It is recognized that in some regions it is customary to use a point (.) as a decimal marker instead of a comma.

Additional markings are permitted, provided that they do not give rise to misunderstanding.

Where symbols are used, they shall conform to ISO 7000 or IEC 60417 where appropriate symbols exist.

### 1.7.1.2 Identification markings

Equipment shall be provided by the following identification markings:

- manufacturer's name or trade-mark or identification mark;
- manufacturer's model identification or type reference;
- symbol  $\square$ , IEC 60417-5172 (DB:2003-02), for the identification of CLASS II EQUIPMENT only, except where this is forbidden by 2.6.2.

Additional identification markings are permitted, provided that they do not give rise to misunderstanding.

These identification markings shall be readily visible in any OPERATOR ACCESS AREA, except that they shall not be located on the bottom of equipment having a mass exceeding 18 kg. For STATIONARY EQUIPMENT, the identification markings shall be visible after the equipment has been installed as in normal use.

### 1.7.1.3 Use of graphical symbols

Graphical symbols placed on the equipment, whether required by this standard or not, shall be in accordance with IEC 60417 or ISO 3864-2 or ISO 7000, if available. In the absence of suitable symbols, the manufacturer may design specific graphical symbols.

Symbols placed on the equipment shall be explained in the user manual.

## 1.7.2 Safety instructions and marking

### 1.7.2.1 General

Sufficient information shall be provided to the USER concerning any condition necessary to ensure that, when used as prescribed by the manufacturer, the equipment is unlikely to present a hazard within the meaning of this standard.

If it is necessary to take special precautions to avoid the introduction of hazards when operating, installing, servicing, transporting or storing equipment, the necessary instructions shall be made available.

NOTE 1 Special precautions may be necessary, for example, for connection of the equipment to the supply and for the interconnection of separate units, if any.

NOTE 2 Where appropriate, installation instructions should include reference to national wiring rules.

NOTE 3 In many countries, instructions and equipment marking related to safety are required to be in a language that is acceptable in the country in which the equipment is to be installed. Servicing instructions are normally made available only to SERVICE PERSONS and are generally acceptable in the English language only.

NOTE 4 In Germany, safety-related information, even for SERVICE PERSONS, has to be in the German language.

NOTE 5 In Canada, the instructions and markings should be in French and English.

NOTE 6 In Finland, Norway and Sweden, CLASS I PLUGGABLE EQUIPMENT TYPE A intended for connection to other equipment or a network, must, if safety relies on connection to protective earth or if surge suppressors are connected between the network terminals and accessible parts, have a marking stating that the equipment must be connected to an earthed mains socket-outlet.

The operating instructions, and the installation instructions for PLUGGABLE EQUIPMENT intended for USER installation, shall be made available to the USER.

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### 1.7.2.2 Disconnect devices

Where the disconnect device is not incorporated in the equipment (see 3.4.3) or where the plug on the power supply cord is intended to serve as the disconnect device, the installation instructions shall state that:

- for PERMANENTLY CONNECTED EQUIPMENT, a readily accessible disconnect device shall be incorporated external to the equipment;
- for PLUGGABLE EQUIPMENT, the socket-outlet shall be installed near the equipment and shall be easily accessible.

### 1.7.2.3 Overcurrent protective devices

For PLUGGABLE EQUIPMENT TYPE B OR PERMANENTLY CONNECTED EQUIPMENT, the installation instructions shall specify the maximum rating of an overcurrent protective device to be provided external to the equipment, unless there are appropriate overcurrent protective devices in the equipment [see also 2.6.3.3 b)].

NOTE The specified maximum rating may not be one of the protective device ratings available in the country of installation. Allowance should be made for the use of a device with a smaller rating that will still be adequate for the equipment RATED CURRENT plus any necessary allowance for inrush current.

### 1.7.2.4 IT power distribution systems

If the equipment has been designed or, when required, modified for connection to an IT power distribution system, the equipment installation instructions shall so state.

### 1.7.2.5 Operator access with a tool

If a TOOL is necessary to gain access to an OPERATOR ACCESS AREA, either all other compartments within that area containing a hazard shall be inaccessible to the OPERATOR by the use of the same TOOL, or such compartments shall be marked to discourage OPERATOR ACCESS.

An acceptable marking for an electric shock hazard is ⚡ (ISO 3864, No. 5036).

### 1.7.2.6 Ozone

For equipment that may produce ozone, the installation and operating instructions shall refer to the need to take precautions to ensure that the concentration of ozone is limited to a safe value.

NOTE The present recommended long term exposure limit for ozone is  $0,1 \times 10^{-6}$  ( $0,2 \text{ mg/m}^3$ ) calculated as an 8 h time-weighted average concentration. It should be noted that ozone is heavier than air.

### 1.7.3 Short duty cycles

Equipment not intended for continuous operation shall be marked with its RATED OPERATING TIME, and RATED RESTING TIME unless the operating time is limited by the construction.

The marking of RATED OPERATING TIME shall correspond to normal use.

The marking of the RATED OPERATING TIME shall precede the marking of the RATED RESTING TIME (if given), the two markings being separated by a solidus (/).

### 1.7.4 Supply voltage adjustment

NAA

For equipment intended for connection to multiple RATED VOLTAGES OR FREQUENCIES, the method of adjustment shall be fully described in the servicing or installation instructions.

Unless the means of adjustment is a simple control near the power rating marking, and the setting of this control is obvious by inspection, the following instruction or a similar one shall appear in or near the power rating marking:

**SEE INSTALLATION INSTRUCTIONS BEFORE CONNECTING TO THE SUPPLY**

### 1.7.5 Power outlets on the equipment

If any standard power supply outlet in the equipment is accessible to the OPERATOR, a marking shall be placed in the vicinity of the outlet to show the maximum load that is permitted to be connected to it.

Socket-outlets conforming to IEC 60083 are examples of standard power supply outlets.

## 1.7.6 Fuse identification

**NAA**

Marking shall be located adjacent to each fuse or fuseholder, or on the fuseholder, or in another location provided that it is obvious to which fuse the marking applies, giving the fuse current rating and, where fuses of different voltage rating value could be fitted, the fuse voltage rating.

Where fuses with special fusing characteristics such as time delay or breaking capacity are necessary, the type shall also be indicated.

For fuses not located in OPERATOR ACCESS AREAS and for soldered-in fuses located in OPERATOR ACCESS AREAS, it is permitted to provide an unambiguous cross-reference (for example, F1, F2, etc.) to the servicing instructions that shall contain the relevant information.

NOTE See 2.7.6 regarding other warnings to SERVICE PERSONS.

## 1.7.7 Wiring terminals

**NAA  
NAE  
NAE**

### 1.7.7.1 Protective earthing and bonding terminals

A wiring terminal intended for connection of a PROTECTIVE EARTHING CONDUCTOR shall be indicated by the symbol  $\oplus$ , IEC 60417-5019 (DB:2002-10). This symbol shall not be used for other earthing terminals, except that the symbol may also be used to identify the separate protective earthing terminal specified in 5.1.7.1.

It is not a requirement to mark terminals for PROTECTIVE BONDING CONDUCTORS, but where such terminals are marked, the symbol  $\equiv$  (IEC 60417-5017 (DB:2002-10)) shall be used.

The following situations are exempt from the above requirements:

- where terminals for the connection of a supply are provided on a component (for example, a terminal block) or subassembly (for example, a power supply unit), the symbol  $\equiv$  is permitted for the protective earthing terminal instead of  $\oplus$ ;
- on subassemblies or components, the symbol  $\oplus$  is permitted in place of the symbol  $\equiv$  provided that it does not give rise to confusion.

These symbols shall not be located on screws, or other parts that might be removed when conductors are being connected.

These requirements are applicable to terminals for connection of a PROTECTIVE EARTHING CONDUCTOR whether run as an integral part of a power supply cord or with supply conductors.

### 1.7.7.2 Terminals for a.c. mains supply conductors

For PERMANENTLY CONNECTED EQUIPMENT and equipment with ordinary NON-DETACHABLE POWER SUPPLY CORDS:

- terminals intended exclusively for connection of the AC MAINS SUPPLY neutral conductor, if any, shall be indicated by the capital letter N; and
- on three-phase equipment, if incorrect phase rotation could cause overheating or other hazard, terminals intended for connection of the AC MAINS SUPPLY line conductors shall be marked in such a way that, in conjunction with any installation instructions, the sequence of phase rotation is unambiguous.

These indications shall not be located on screws, or other parts that might be removed when conductors are being connected.

### 1.7.7.3 Terminals for d.c. mains supply conductors

**NAB  
NAE**

For PERMANENTLY CONNECTED EQUIPMENT and equipment with ordinary NON-DETACHABLE POWER SUPPLY CORDS, terminals intended exclusively for connection of a DC MAINS SUPPLY shall be marked to indicate polarity.

If a single terminal is provided, both as a main protective earthing terminal in the equipment and for the connection to one pole of the DC MAINS SUPPLY, it shall be marked as specified in 1.7.7.1, in addition to polarity marking.

These indications shall not be located on screws or other parts which might be removed when conductors are being connected.

## 1.7.8 Controls and indicators

### 1.7.8.1 Identification, location and marking

Unless it is obviously unnecessary, indicators, switches and other controls affecting safety shall be identified or located so as to indicate clearly which function they control.

Markings and indications for switches and other controls shall be located either:

- on or adjacent to the switch or control, or
- elsewhere, provided that it is obvious to which switch or control the marking applies.

Indications used for this purpose shall, wherever practicable, be comprehensible without a knowledge of languages, national standards, etc.

### 1.7.8.2 Colours

Where safety is involved, colours of controls and indicators shall comply with IEC 60073. Where colours are used for functional controls or indicators, any colour, including red, is permitted provided that it is clear that safety is not involved.

### 1.7.8.3 Symbols

Where symbols are used on or near controls (for example switches and push buttons), to indicate "ON" and "OFF" conditions, they shall be the line I for "ON" and circle ○ for "OFF" (IEC 60417-5007 (DB:2002-10)) and IEC 60417-5008 (DB:2002-10). For push-push type switches the symbol ⊕ shall be used (IEC 60417-5010 (DB:2002-10)).

It is permitted to use the symbols ○ and I to indicate the "OFF" and "ON" positions of any primary or secondary power switches, including isolating switches.

A "STAND-BY" condition shall be indicated by the symbol ⊖ (IEC 60417-5009 (DB:2002-10)).

### 1.7.8.4 Markings using figures

If figures are used for indicating different positions of any control, the "OFF" position shall be indicated by the figure 0 (zero) and higher figures shall be used to indicate greater output, input, etc.

### 1.7.9 Isolation of multiple power sources

Where there is more than one connection supplying HAZARDOUS VOLTAGES OR HAZARDOUS ENERGY LEVELS to equipment, a prominent marking, located close to the entry point provided for a SERVICE PERSON to gain access to the hazardous parts, shall be provided to indicate which disconnect device or devices isolate the equipment completely and which disconnect devices can be used to isolate each section of the equipment.

### 1.7.10 Thermostats and other regulating devices

THERMOSTATS and similar regulating devices intended to be adjusted during installation or in normal use shall be provided with an indication for the direction of adjustment to increase or decrease the value of the characteristic being adjusted. Indication by the symbols + and – is permitted.

### 1.7.11 Durability

**P.2**

Any marking required by this standard shall be durable and legible. In considering the durability of the marking, the effect of normal use shall be taken into account.

*Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit. After this test, the marking shall be legible; it shall not be possible to remove marking plates easily and they shall show no curling.*

*The petroleum spirit to be used for the test is aliphatic solvent hexane having a maximum aromatics content of 0,1 % by volume, a kauributenol value of 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a mass per unit volume of approximately 0,7 kg/l.*

*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).

### 1.7.12 Removable parts

Marking required by this standard shall not be placed on removable parts that can be replaced in such a way that the marking would become misleading.

### 1.7.13 Replaceable batteries

**NAA**

If an equipment is provided with a replaceable battery, and if replacement by an incorrect type could result in an explosion (for example, with some lithium batteries), the following applies:

- if the battery is placed in an OPERATOR ACCESS AREA, there shall be a marking close to the battery or a statement in both the operating and the servicing instructions;
- if the battery is placed elsewhere in the equipment, there shall be a marking close to the battery or a statement in the servicing instructions.

This marking or statement shall include the following or similar text:

#### **CAUTION**

**RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE.**

**DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS**

### 1.7.14 Equipment for restricted access locations

For equipment intended only for installation in a RESTRICTED ACCESS LOCATION, the installation instructions shall contain a statement to this effect.

## 2 Protection from hazards

### 2.1 Protection from electric shock and energy hazards

#### 2.1.1 Protection in operator access areas

This subclause specifies requirements for protection against electric shock from energized parts based on the principle that the OPERATOR is permitted to have access to:

- bare parts of SELV CIRCUITS; and
- bare parts of LIMITED CURRENT CIRCUITS; and
- TNV CIRCUITS under the conditions specified in 2.1.1.1.

Access to other energized parts, and to their insulation, is restricted as specified in 2.1.1.1.

Additional requirements are specified in 2.1.1.5 and 2.1.1.8 for protection against energy hazards.

##### 2.1.1.1 Access to energized parts

The equipment shall be so constructed that in OPERATOR ACCESS AREAS there is adequate protection against contact with:

- bare parts of ELV CIRCUITS; and
- bare parts at HAZARDOUS VOLTAGES; and
- SOLID INSULATION providing FUNCTIONAL INSULATION or BASIC INSULATION of parts or wiring in ELV CIRCUITS, except as permitted in 2.1.1.3; and
- SOLID INSULATION providing FUNCTIONAL INSULATION or BASIC INSULATION of parts or wiring at HAZARDOUS VOLTAGES; and

NOTE 1 FUNCTIONAL INSULATION includes, but is not limited to, insulation, such as lacquer, solvent-based enamel, ordinary paper, cotton and oxide film, or displaceable insulation such as beads and sealing compounds other than self-hardening resin.

- unearthed conductive parts separated from ELV CIRCUITS or from parts at HAZARDOUS VOLTAGES by FUNCTIONAL INSULATION OR BASIC INSULATION only; and
- bare parts of TNV CIRCUITS, except that access is permitted to:

- bare conductive parts in the interior of equipment that are normally protected against contact by a cover intended for occasional removal by the OPERATOR, such as for the installation of accessories, provided that the installation instructions include directions for the disconnection of the TNV CIRCUIT connector before removing the cover;

D3  
D3  
D3  
D3  
D3

- contacts of connectors that cannot be touched by the test probe, (Figure 2C);
- bare conductive parts in the interior of a battery compartment that complies with 2.1.1.2;
- bare conductive parts of TNV-1 CIRCUITS that have any point connected in accordance with 2.6.1 d) to a protective earthing terminal;
- bare conductive parts of connectors in TNV-1 CIRCUITS that are separated from unearthed accessible conductive parts of the equipment in accordance with 6.2.1.

NOTE 2 A typical application is the shell for a coaxial connector.

NOTE 3 Access to TNV-1 CIRCUITS and TNV-3 CIRCUITS via other circuits is also restricted by 6.2.1 in some cases.

Unrestricted access is permitted to LIMITED CURRENT CIRCUITS.

These requirements apply for all positions of the equipment when it is wired and operated as in normal use.

Protection shall be achieved by insulation or by guarding or by the use of interlocks.

*Compliance is checked by all of the following.*

a) *Inspection.*

b) *A test with the test finger, Figure 2A, which shall not contact parts described above when applied to openings in the ENCLOSURES after removal of parts that can be detached by an OPERATOR, including fuseholders, and with OPERATOR access doors and covers open. It is permitted to leave lamps in place for this test. Connectors that can be separated by an OPERATOR, other than those complying with IEC 60083, IEC 60309, IEC 60320, IEC 60906-1 or IEC 60906-2, shall also be tested during disconnection.*

c) *A test with the test pin, Figure 2B, which shall not contact bare parts at HAZARDOUS VOLTAGES when applied to openings in an external ELECTRICAL ENCLOSURE. Parts that can be detached by an OPERATOR, including fuseholders and lamps, are left in place, and OPERATOR access doors and covers are closed during this test.*

d) *A test with the test probe, Figure 2C, where appropriate.*

*The test finger, the test pin and the test probe are applied as above, without appreciable force, in every possible position, except that floor-standing equipment having a mass exceeding 40 kg is not tilted.*

*Equipment intended for building-in or rack-mounting, or for incorporation in larger equipment, is tested with access to the equipment limited according to the method of mounting detailed in the installation instructions.*

Openings preventing the entry of the test finger, test b) above, are further tested by means of a straight unjointed version of the test finger applied with a force of 30 N. If the unjointed finger enters, test b) is repeated except that the finger is pushed through the opening using any necessary force up to 30 N.

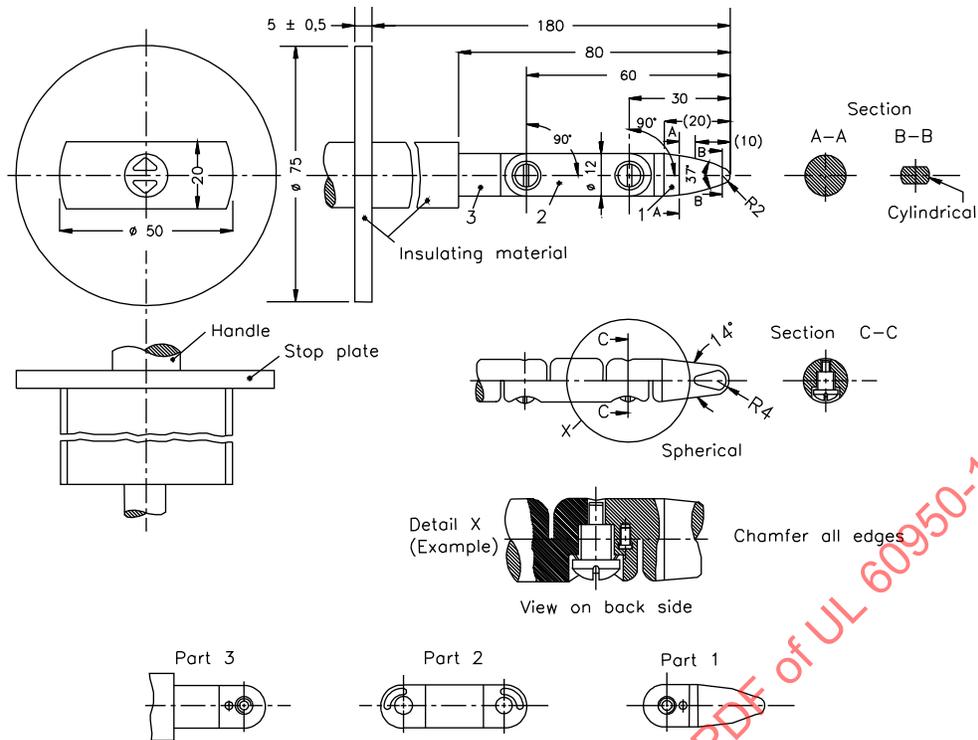
NOTE 4 If an electrical contact indicator is used to show contact, care should be taken to ensure that the application of the test does not damage components of electronic circuits.

Where contact between the test tool and the part is not permitted in the above tests, there is no requirement for a minimum air gap for voltages not exceeding 1 000 V a.c. or 1 500 V d.c. For higher voltages, there shall be an air gap between the part at HAZARDOUS VOLTAGE and the test finger, Figure 2A, or the test pin, Figure 2B, placed in its most unfavourable position. This air gap, see Figure 2D, shall either

- have a minimum length equal to the minimum CLEARANCE for BASIC INSULATION specified in 2.10.3 (or Annex G), or
- shall withstand the relevant electric strength test in 5.2.2.

If components are movable, for instance, for the purpose of belt tensioning, the test with the test finger is made with each component in its most unfavourable position within the range of adjustment, the belt being removed, if necessary, for this purpose.

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Linear dimensions in millimetres

SM471D

Tolerances on dimensions without specific tolerances:

– 14° and 37° angles:	$\pm 15'$
– on radii:	$\pm 0,1 \text{ mm}$
– on linear dimensions:	
$\leq 15 \text{ mm}$ :	0
$> 15 \text{ mm} \leq 25 \text{ mm}$ :	$\pm 0,1 \text{ mm}$
$> 25 \text{ mm}$ :	$\pm 0,3 \text{ mm}$

Material of finger: heat-treated steel, for example.

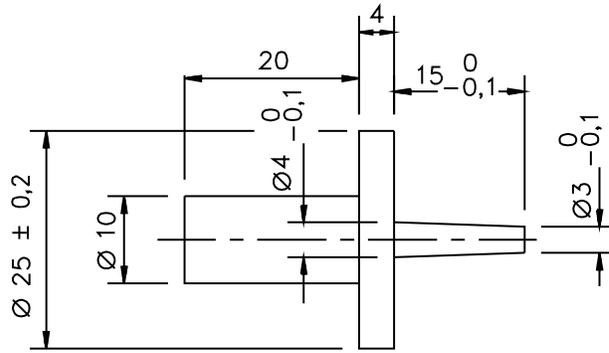
Both joints of this finger can be bent through an angle of 90° (+10°, 0°) but in one and the same direction only.

NOTE 1 Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to 90°. For this reason, dimensions and tolerances of these details are not given in the drawing. The actual design must ensure a 90° bending angle with a 0° to +10° tolerance.

NOTE 2 Dimensions in parentheses are for information only.

NOTE 3 The test finger is taken from Figure 2, test probe B of IEC 61032. In some cases, the tolerances are different.

**Figure 2A – Test finger**



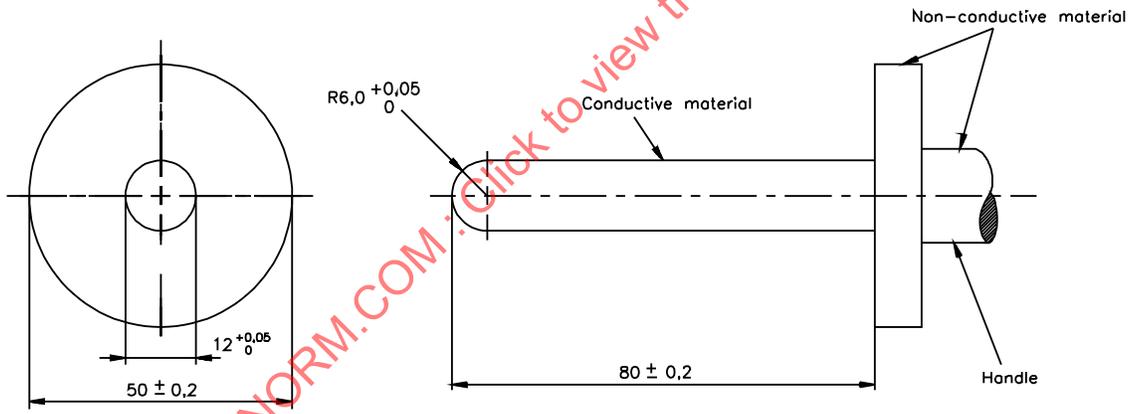
*Dimensions in millimetres*

S2962D

The handle dimensions ( $\text{Ø } 10$  and 20) are not critical.

NOTE The test pin dimensions are those given in Figure 9, test probe 13 of IEC 61032. In some cases the tolerances are different.

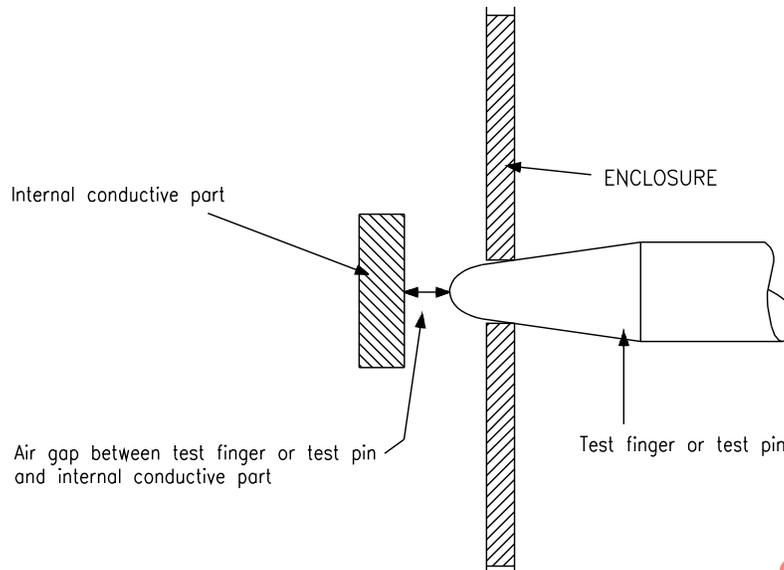
**Figure 2B – Test pin**



*Dimensions in millimetres*

SM430E

**Figure 2C – Test probe**



There is no requirement for a minimum air gap between the test finger or test pin and the internal conductive part for voltages up to 1 000 V a.c. and 1 500 V d.c.  
S4930

**Figure 2D – Accessibility of internal conductive parts**

### 2.1.1.2 Battery compartments

Access by an OPERATOR to bare conductive parts of TNV CIRCUITS within a battery compartment in the equipment is permitted if all of the following conditions are met:

- the compartment has a door that requires a deliberate technique to open, such as the use of a TOOL or latching device; and
- the TNV CIRCUIT is not accessible when the door is closed; and
- there is a marking next to the door, or on the door if the door is secured to the equipment, with instructions for protection of the USER once the door is opened.

Information stating that the telephone cord is to be disconnected prior to opening the door is an example of an acceptable instruction.

*Compliance is checked by inspection.*

### 2.1.1.3 Access to ELV wiring

Insulation of internal wiring in an ELV CIRCUIT is permitted to be accessible to an OPERATOR provided that:

- a) the insulation meets the requirements for SUPPLEMENTARY INSULATION detailed in 3.1.4; or
- b) all of the following apply:
  - the wiring does not need to be handled by the OPERATOR and is so placed that the OPERATOR is unlikely to pull on it, or is so fixed that the connecting points are relieved from strain; and
  - the wiring is routed and fixed so as not to touch unearthed accessible conductive parts; and
  - the insulation passes the electric strength test of 5.2.2 for SUPPLEMENTARY INSULATION; and
  - the distance through the insulation is not less than that given in Table 2A.

**Table 2A – Distance through insulation of internal wiring**

WORKING VOLTAGE (in case of failure of BASIC INSULATION)		Minimum distance through insulation mm
V peak or d.c.	V r.m.s. (sinusoidal)	
Over 71 up to and including 350	Over 50 up to and including 250	0,17
Over 350	Over 250	0,31

*Compliance is checked by inspection and measurement, and by the test of 5.2.2.*

### 2.1.1.4 Access to hazardous voltage circuit wiring

Where the insulation of internal wiring at HAZARDOUS VOLTAGE is accessible to an OPERATOR, or is not routed and fixed to prevent it from touching unearthed accessible conductive parts, it shall meet the requirements of 3.1.4 for DOUBLE INSULATION OR REINFORCED INSULATION.

*Compliance is checked by inspection and measurement and, if necessary, by test.*

### 2.1.1.5 Energy hazards

There shall be no risk of injury due to an energy hazard in an OPERATOR ACCESS AREA.

*Compliance is checked by inspection and measurement and, if necessary, by tests.*

- a) *A risk of injury due to an energy hazard exists if it is likely that two or more bare parts (one of which may be earthed) between which a HAZARDOUS ENERGY LEVEL exists, will be bridged by a metallic object.*
- b) *The likelihood of bridging the parts under consideration is determined by means of the test finger, Figure 2A (see 2.1.1.1), in a straight position. It shall not be possible to bridge the parts with this test finger, applied without appreciable force.*
- c) *The existence of a HAZARDOUS ENERGY LEVEL is determined as follows:*
  - 1) *with the equipment operating under normal operating conditions, a variable resistive load is connected to the parts under consideration and adjusted to obtain a level of 240 VA. Further adjustment is made, if necessary, to maintain 240 VA for a period of 60 s. If the voltage is 2 V or more, the output power is at a HAZARDOUS ENERGY LEVEL, unless an overcurrent protective device opens during the above test, or for any other reason the power cannot be maintained at 240 VA for 60 s;*
  - 2) *the stored energy in a capacitor is at a HAZARDOUS ENERGY LEVEL if the voltage, U, is 2 V or more, and the stored energy, E, calculated from the following equation, is 20 J or more:*

$$E = 0,5 CU^2 \times 10^{-6}$$

Where

*E is the energy, in joules (J);*

*C is the capacitance, in microfarads ( $\mu\text{F}$ );*

*U is the measured voltage on the capacitor, in volts (V).*

### 2.1.1.6 Manual controls

Conductive shafts of operating knobs, handles, levers and the like in OPERATOR ACCESS AREAS shall not be connected to parts at HAZARDOUS VOLTAGES, to ELV CIRCUITS or to TNV CIRCUITS.

In addition, conductive operating knobs, handles, levers and the like which are manually moved in normal use and that are earthed only through a pivot or bearing, shall either:

- be separated from parts at HAZARDOUS VOLTAGES by DOUBLE INSULATION or REINFORCED INSULATION; or
- have their accessible parts covered by SUPPLEMENTARY INSULATION for a HAZARDOUS VOLTAGE and by BASIC INSULATION for a TNV CIRCUIT.

*Compliance is checked by inspection and measurement, and by the applicable electric strength tests of 5.2.2.*

### 2.1.1.7 Discharge of capacitors in equipment

Equipment shall be so designed that, at an OPERATOR-accessible external point of disconnection of a MAINS SUPPLY, the risk of electric shock from stored charge on capacitors connected in the equipment is reduced. No test for shock hazard is required unless the nominal voltage of the MAINS SUPPLY exceeds 42,4 V peak or 60 V d.c.

*Compliance is checked by inspection of the equipment and relevant circuit diagrams, taking into account the possibility of disconnection of the supply with any on/off switch in either position.*

*Equipment is considered to comply if any capacitor having a marked or nominal capacitance exceeding 0,1  $\mu\text{F}$  and in circuits connected to the MAINS SUPPLY has a means of discharge resulting in a time constant not exceeding:*

- 1 s for PLUGGABLE EQUIPMENT TYPE A, and
- 10 s for PLUGGABLE EQUIPMENT TYPE B

*The relevant time constant is the product of the effective capacitance in microfarads and the effective discharge resistance in megohms. If it is difficult to determine the effective capacitance and resistance values, a measurement of voltage decay at the point of external disconnection can be used. When conducting the voltage decay measurement, the measurement is either made with, or referred to, an instrument having an input impedance consisting of a resistance of  $100\text{ M}\Omega \pm 5\text{ M}\Omega$  in parallel with an input capacitance of 25 pF or less.*

NOTE During an interval equal to one time constant, the voltage will have decayed to 37 % of its original value.

### 2.1.1.8 Energy hazards – d.c. mains supplies

Equipment shall be so designed that at an OPERATOR-accessible external point of disconnection of a DC MAINS SUPPLY, either

- there is no HAZARDOUS ENERGY LEVEL (for example, due to stored charge on a capacitor or a battery in the equipment, or to a redundant DC MAINS SUPPLY for backup), or
- the HAZARDOUS ENERGY LEVEL is removed within 2 s of the disconnection.

External points of disconnection include the plugs of PLUGGABLE EQUIPMENT and isolating switches external to the equipment.

*Compliance is checked by inspection of the equipment and relevant circuit diagrams, taking into account the possibility of disconnection of the supply with any on/off switch in either position.*

*If necessary, the existence of a HAZARDOUS ENERGY LEVEL is determined as follows:*

**a) Capacitor connected to the DC MAINS SUPPLY**

*A test is conducted when the equipment is operating normally. The DC MAINS SUPPLY is then disconnected and the voltage across the capacitor (U) is measured 2 s after disconnection.*

*The stored energy is calculated from the following formula:*

$$E = 0,5 CU^2 \times 10^{-6}$$

*where*

*E is the energy, in joules (J);*

*C is the capacitance, in microfarads ( $\mu\text{F}$ );*

*U is the measured voltage on the capacitor, in volts (V).*

*A HAZARDOUS ENERGY LEVEL exists if the voltage, U, is 2 V or more, and the stored energy, E, is 20 J or more.*

**b) Internal battery connected to the DC MAINS SUPPLY**

*A test is conducted with the DC MAINS SUPPLY disconnected and a variable resistive load connected to the input terminals where the DC MAINS SUPPLY is normally connected. The EUT is operated from its internal battery. The variable load is adjusted so that it draws 240 VA. Further adjustment is made, if necessary, to maintain 240 VA for a period of 60 s.*

*If U is more than 2 V, the output power is at a HAZARDOUS ENERGY LEVEL unless an overcurrent protective device opens during the above test, or for any other reason the power cannot be maintained at 240 VA for a period of 60 s.*

*If the output power is at a HAZARDOUS ENERGY LEVEL, a further test is conducted with the variable load disconnected and the EUT operated from the DC MAINS SUPPLY.*

*The supply is disconnected and the energy level at the input terminals, 2 s after disconnection, shall not be a HAZARDOUS ENERGY LEVEL.*

NOTE It is assumed that it will be possible to bridge the parts accidentally external to the equipment. There is no test to determine the likelihood of bridging the parts.

### 2.1.1.9 Audio amplifiers in information technology equipment

Accessible circuits, terminals and parts of audio amplifiers and associated circuits shall comply with either

- 2.1.1.1 of this standard, or
- 9.1.1 of IEC 60065.

*Compliance is checked by inspection and, if necessary, by the tests of 9.1.1 of IEC 60065, during which the audio amplifiers are operated in accordance with 4.2.4 of IEC 60065.*

### 2.1.2 Protection in service access areas

In a SERVICE ACCESS AREA, the following requirements apply.

The requirements of 2.1.1.7 apply to all types of equipment and for PERMANENTLY CONNECTED EQUIPMENT, the time constant limit is 10 s. In addition, the requirements of 2.1.1.8 apply.

Bare parts at HAZARDOUS VOLTAGES shall be located or guarded so that unintentional contact with such parts is unlikely during service operations involving other parts of the equipment.

Bare parts at HAZARDOUS VOLTAGE shall be located or guarded so that accidental shorting to SELV CIRCUITS or to TNV CIRCUITS (for example, by TOOLS or test probes used by a SERVICE PERSON) is unlikely.

No requirement is specified regarding access to ELV CIRCUITS or to TNV CIRCUITS. However, bare parts that present a HAZARDOUS ENERGY LEVEL shall be located or guarded so that unintentional bridging by conductive materials that might be present is unlikely during service operations involving other parts of the equipment.

Any guards required for compliance with 2.1.2 shall be easily removable and replaceable if removal is necessary for servicing.

*Compliance is checked by inspection and measurement. In deciding whether or not unintentional contact is likely, account is taken of the way a SERVICE PERSON needs to gain access past, or near to, the bare parts in order to service other parts. For determination of a HAZARDOUS ENERGY LEVEL see 2.1.1.5 c).*

### 2.1.3 Protection in restricted access locations

For equipment to be installed in a RESTRICTED ACCESS LOCATION, the requirements for OPERATOR ACCESS AREAS apply, except as permitted in the following four paragraphs.

In general, the requirements of 2.1.1.7 and 2.1.1.8 apply except that they do not apply to PERMANENTLY CONNECTED EQUIPMENT. However, appropriate markings and instructions shall be provided for protection against energy hazards if a HAZARDOUS ENERGY LEVEL exists.

If a SECONDARY CIRCUIT at HAZARDOUS VOLTAGE is used to supply a ringing signal generator that complies with 2.3.1 b), contact with bare parts of the circuit is permitted with the test finger, Figure 2A (see 2.1.1.1). However, such parts shall be so located or guarded that unintentional contact is unlikely.

Bare parts that present a HAZARDOUS ENERGY LEVEL shall be located or guarded so that unintentional bridging by conductive materials that might be present is unlikely.

No requirement is specified regarding contact with bare parts of TNV-1 CIRCUITS, TNV-2 CIRCUITS and TNV-3 CIRCUITS.

*Compliance is checked by inspection and measurement. In deciding whether or not unintentional contact is likely, account is taken of the need to gain access past, or near to, the bare parts. For determination of a HAZARDOUS ENERGY LEVEL see 2.1.1.5 c).*

## 2.2 SELV circuits

### 2.2.1 General requirements

SELV CIRCUITS shall exhibit voltages that are safe to touch both under normal operating conditions and after a single fault (see 1.4.14). If no external load is applied to the SELV CIRCUIT (open circuit), the voltage limits of 2.2.2 and 2.2.3 shall not be exceeded.

*Compliance with 2.2.1 to 2.2.4 is checked by inspection and relevant tests.*

### 2.2.2 Voltages under normal conditions

In a single SELV CIRCUIT or in interconnected SELV CIRCUITS, the voltage between any two conductors of the SELV CIRCUIT or CIRCUITS, and between any one such conductor and earth (see 1.4.9), shall not exceed 42,4 V peak, or 60 V d.c., under normal operating conditions.

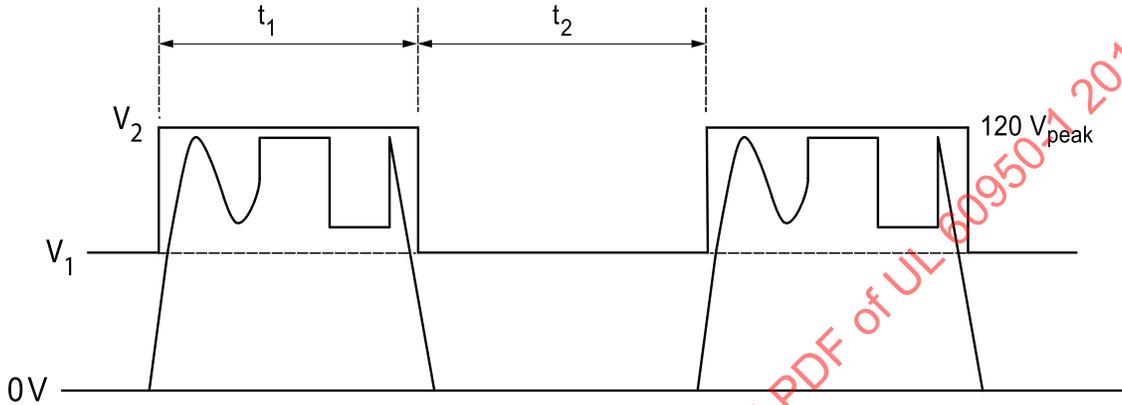
NOTE 1 A circuit that meets the above requirements, but that is subject to overvoltages from a TELECOMMUNICATION NETWORK or a CABLE DISTRIBUTION SYSTEM, is a TNV-1 CIRCUIT.

NOTE 2 For normal conditions, the SELV CIRCUIT voltage limit is the same for an ELV CIRCUIT; an SELV CIRCUIT may be regarded as an ELV CIRCUIT with additional protection under fault conditions.

**2.2.3 Voltages under fault conditions**

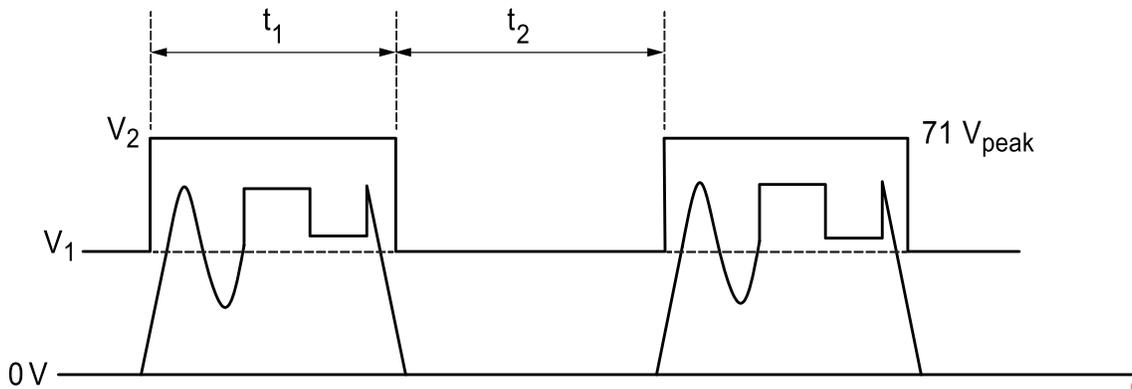
Except as permitted in 2.3.2.1 b), in the event of a single fault (see 1.4.14), the voltages between any two conductors of the SELV CIRCUIT OR CIRCUITS and between any one such conductor and earth (see 1.4.9) shall not exceed 42,4 V peak, or 60 V d.c. ( $V_1$  in Figure 2E.1 and Figure 2E.2) for longer than 200 ms. Moreover, the voltage shall not exceed 71 V peak or  $120 V_{peak}$  ( $V_2$  in Figure 2E.1 and Figure 2E.2).

NOTE In Canada and the United States, the exception mentioned in 2.3.2.1 b) is not permitted.



su1636

**Figure 2E.1 – Voltages in SELV circuits under single fault conditions for a single pulse above  $V_1$**



su1637

**Figure 2E.2 – Voltages in SELV circuits under single fault conditions for multiple pulses above  $V_1$**

For voltages having a repetitive nature after a fault (for example, from power supplies in “hiccup” mode), additional pulses exceeding  $V_1$  (but not exceeding  $V_2$ ) are permitted under the following conditions:

- if  $t_1 \leq 20$  ms,  $t_2$  shall be greater than 1 s;
- if  $t_1 > 20$  ms,  $t_2$  shall be greater than 3 s; and
- $t_1$  shall not exceed 200 ms.

A limit of  $120 V_{\text{peak}}$  applies if the pulse goes above  $V_1$  only once during time  $t_1$ , for example see Figure 2E.1.

A limit of  $71 V_{\text{peak}}$  applies if the pulse goes above  $V_1$  more than once during time  $t_1$ , for example see Figure 2E.2.

Except as permitted in 2.2.4, an SELV CIRCUIT shall be separated from a part at a HAZARDOUS VOLTAGE by one or more of the constructions specified in 2.9.4.

It is permitted for some parts of a circuit (for example, a transformer-rectifier circuit) to comply with all of the requirements for SELV CIRCUITS and to be OPERATOR-accessible, while other parts of the same circuit do not comply with all of the requirements for SELV CIRCUITS and are therefore not permitted to be OPERATOR-accessible.

## 2.2.4 Connection of SELV circuits to other circuits

An SELV CIRCUIT is permitted to be connected to other circuits provided that, when the SELV CIRCUIT is so connected, all of the following conditions are met:

- except as permitted by 1.5.7 and 2.4.3, the SELV CIRCUIT is separated by BASIC INSULATION from any PRIMARY CIRCUIT (including the neutral) within the equipment; and
- the SELV CIRCUIT meets the limits of 2.2.2 under normal operating conditions; and
- except as specified in 2.3.2.1 b), the SELV CIRCUIT meets the limits of 2.2.3 in the event of a single fault (see 1.4.14) in the SELV CIRCUIT or in the SECONDARY CIRCUIT to which the SELV CIRCUIT is connected.

If an SELV CIRCUIT is connected to one or more other circuits, the SELV CIRCUIT is that part which complies with the requirements of 2.2.2 and 2.2.3.

If an SELV CIRCUIT obtains its supply conductively from a SECONDARY CIRCUIT which is separated from a HAZARDOUS VOLTAGE circuit by either:

- DOUBLE INSULATION OR REINFORCED INSULATION; OR
- an earthed conductive screen that is separated from the HAZARDOUS VOLTAGE circuit by BASIC INSULATION,

the SELV CIRCUIT shall be considered as being separated from the HAZARDOUS VOLTAGE circuit by the same method.

NOTE For requirements in Norway, see 1.7.2.1 Note 6, 6.1.2.1 Note 2 and 6.1.2.2 Note.

If an SELV CIRCUIT is derived from a HAZARDOUS VOLTAGE SECONDARY CIRCUIT, and the HAZARDOUS VOLTAGE SECONDARY CIRCUIT is separated from the PRIMARY CIRCUIT by DOUBLE INSULATION OR REINFORCED INSULATION, the SELV CIRCUIT shall remain within the limits given in 2.2.3 under single fault conditions (see 1.4.14). In such a case, the short-circuiting of the insulation in a transformer that provides the separation between the HAZARDOUS VOLTAGE SECONDARY CIRCUIT and the SELV CIRCUIT is considered to be a single fault, for the purpose of applying the single fault conditions, provided the insulation in the transformer passes an electrical strength test for BASIC INSULATION in accordance with 5.2.2.

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### 2.3 TNV circuits

#### 2.3.1 Limits

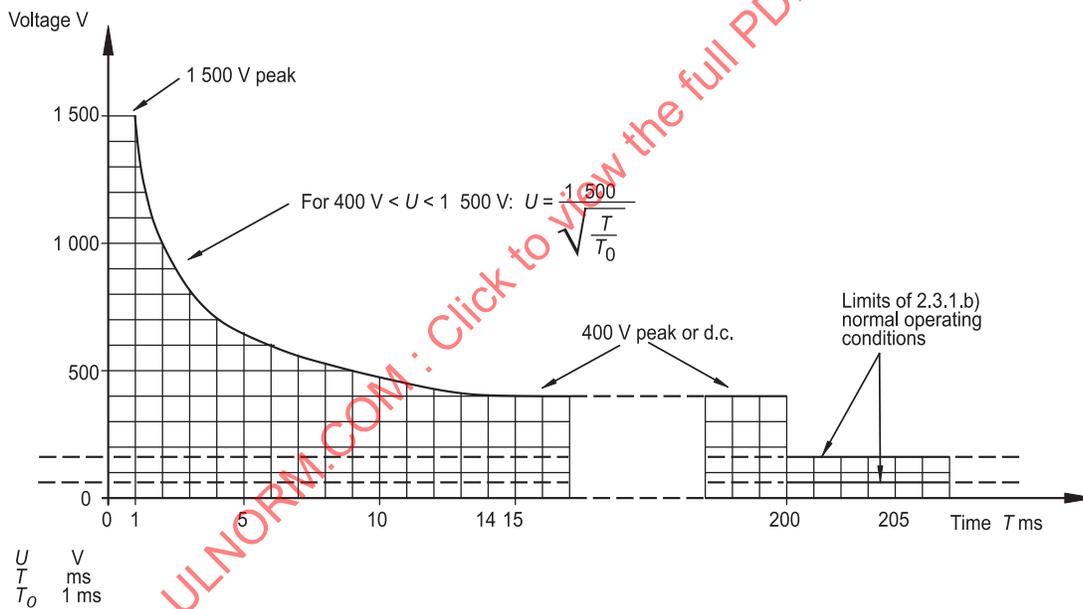
In a single TNV CIRCUIT or interconnected TNV CIRCUITS, the voltage between any two conductors of the TNV CIRCUIT or CIRCUITS and between any one such conductor and earth (see 1.4.9) shall comply with the following.

a) TNV-1 CIRCUITS

The voltages do not exceed the following:

- the voltage limits in 2.2.2 for an SELV CIRCUIT under normal operating conditions;
- the voltage limits of Figure 2F measured across a  $5\,000\ \Omega \pm 2\%$  resistor in the event of a single fault (see 1.4.14) within the equipment.

NOTE 1 In the event of a single insulation or component failure, the limit after 200 ms is the limit in 2.3.1 b) for a TNV-2 CIRCUIT or TNV-3 CIRCUIT for normal operating conditions.



SM429D

Figure 2F – Maximum voltages permitted after a single fault

b) TNV-2 CIRCUITS and TNV-3 CIRCUITS

Except as permitted in 1.6.1.2, the voltages exceed the limits in 2.2.2 for an SELV CIRCUIT but do not exceed the following: D2

- when telephone ringing signals are present, voltages such that the signal complies with the criteria of either Clause M.2 or Clause M.3;
- when other telephone signals are present, voltages such that the signal complies with the criteria of Clause M.4; D2  
D2
- when telephone ringing signals or other telephone signals are not present: D2
  - a combination of voltages, a.c. and d.c., such that under normal operating conditions:

$$\frac{U_{ac}}{71} + \frac{U_{dc}}{120} \leq 1$$

and for voltages exceeding 42.4 V peak or 60 V d.c., the current flowing through any resistance 2 000 ohms or greater connected across the voltage source with other loads disconnected does not exceed 7.1 mA peak or 30 mA d.c. D2  
D2  
D2  
D2

where

$U_{ac}$  is the peak value of the a.c. voltage (V) at any frequency;

$U_{dc}$  is the value of the DC VOLTAGE (V).

NOTE 2 When  $U_{dc}$  is zero,  $U_{ac}$  can be up to 71 V peak.

NOTE 3 When  $U_{ac}$  is zero,  $U_{dc}$  can be up to 120 V.

and

- the voltage limits of Figure 2F measured across a  $5\,000\ \Omega \pm 2\%$  resistor in the event of a single fault (see 1.4.14) within the equipment, except the limits after 200 ms specified in Figure 2F are replaced by the limits of M.3.1.4. D2  
D2

*Compliance is checked by inspection and measurement.*

NOTE 4 Telegraph and teletypewriter signals may be present on existing TELECOMMUNICATION NETWORKS. However, these signals are considered to be obsolescent and their characteristics are not considered in this standard.

## 2.3.2 Separation of TNV circuits from other circuits and from accessible parts

NOTE In Finland, Norway and Sweden, there are additional requirements for the insulation. See 6.1.2.1 Note 2 and 6.1.2.2 Note.

### 2.3.2.1 General requirements

NOTE 1 See also 6.1.2, 6.2 and 7.3.

SELV-CIRCUITS, TNV-1 CIRCUITS and accessible conductive parts shall be separated from TNV-2 CIRCUITS and TNV-3 CIRCUITS in such a way that in the event of a single fault (see 1.4.14) both of the following conditions are met:

- a) the voltages of TNV-1 CIRCUITS do not exceed the limits of Figure 2F; and
- b) the voltages of the SELV CIRCUITS and accessible conductive parts do not exceed the limits specified in 2.3.1 b) for TNV-2 CIRCUITS and TNV-3 CIRCUITS under normal operating conditions 2.2.3.

D2  
D2

NOTE 2 In Canada and the United States, in the event of a single fault as described above, the limits of 2.2.3 apply to SELV CIRCUITS and to accessible conductive parts.

NOTE 3 Under normal operating conditions, the limits of 2.2.2 always apply to each SELV CIRCUIT and accessible conductive part.

NOTE 4 The limits of 2.3.1 always apply to each TNV CIRCUIT.

At the choice of the manufacturer, it is permitted to treat a TNV-1 CIRCUIT or a TNV-2 CIRCUIT as a TNV-3 CIRCUIT. In this case, the TNV-1 CIRCUIT or TNV-2 CIRCUIT shall meet all the separation requirements for a TNV-3 CIRCUIT.

One of the methods specified in 2.3.2.2, 2.3.2.3, 2.3.2.4 and 2.10.5.13 shall be used.

*Compliance is checked as specified in 2.3.2.2, 2.3.2.3, 2.3.2.4 or 2.10.5.13.*

### 2.3.2.2 Protection by basic insulation

The requirements of 2.3.2.1 are met if the parts are separated by BASIC INSULATION.

*Compliance is checked by inspection, measurement and electric strength testing of the BASIC INSULATION and if necessary by simulation of failures of components and the BASIC INSULATION (see 1.4.14). However, if it is clear from a study of the circuit diagrams that the specified limits of 2.3.1 b) will not be exceeded, failure of components and the BASIC INSULATION need not be simulated.*

NOTE 1 The test of 2.3.5 is not required.

NOTE 2 Where BASIC INSULATION is provided and 6.2.1 also applies to this insulation, the test voltage prescribed in 6.2.2 is in most cases higher than that for BASIC INSULATION.

### 2.3.2.3 Protection by earthing

The requirements of 2.3.2.1 are considered to be met if the SELV CIRCUIT, TNV-1 CIRCUIT or accessible conductive part is connected to the main protective earthing terminal in accordance with 2.6.1 c) or d); and one of the following, a), b), c) or d) applies.

- a) For PLUGGABLE EQUIPMENT, a separate protective earthing terminal is provided in addition to the main protective earthing terminal, if any (see 2.6.4.1). The installation instructions shall specify that this separate protective earthing terminal be permanently connected to earth.
- b) For PLUGGABLE EQUIPMENT TYPE B, having connections to TELECOMMUNICATION NETWORKS OR TO CABLE DISTRIBUTION SYSTEMS that are all pluggable, a marking on the equipment and a statement in the installation instructions shall be provided. These shall specify that the USER is to disconnect all TELECOMMUNICATION NETWORK connectors and CABLE DISTRIBUTION SYSTEM connectors before disconnecting the POWER SUPPLY CORD.
- c) For PLUGGABLE EQUIPMENT TYPE A, the requirements of b) above apply, and in addition the installation instructions shall specify that it be installed by a SERVICE PERSON and connected to a socket-outlet with a protective earthing contact.
- d) For PERMANENTLY CONNECTED EQUIPMENT there is no additional requirement.

NOTE If earthing is provided that is not in accordance with a), b), c) or d), see 2.3.2.4.

*Compliance is checked by inspection and if necessary by simulation of failures of components and insulation such as are likely to occur in the equipment (see 1.4.14). The voltage limits specified in 2.3.2.1 shall be met.*

*Additionally, the test of 2.3.5 shall be conducted if the TNV-2 CIRCUIT OR TNV-3 CIRCUIT is intended to receive signals or power that are generated externally during normal operation (for example, in a TELECOMMUNICATION NETWORK). Single faults are not simulated while conducting the test of 2.3.5.*

*Prior to the above tests, insulation that does not meet the requirements for BASIC INSULATION is short-circuited. However, if simulation of failures would be more severe if conducted without short-circuiting the insulation, the test is conducted without short-circuiting.*

### 2.3.2.4 Protection by other constructions

Other constructions are permitted if they ensure that the voltage limits specified in 2.3.2.1 are met, but do not rely on BASIC INSULATION or earthing, or by separation as specified in 2.10.5.13.

*Compliance is checked by simulation of failures of components and insulation such as are likely to occur in the equipment (see 1.4.14).*

*If earthing is provided that is not in accordance with 2.3.2.3 a), b), c) or d), the tests are conducted with the EUT not connected to earth. The voltage limits specified in 2.3.2.1 shall be met.*

*Additionally, the test of 2.3.5 shall be conducted if the TNV-2 CIRCUIT OR TNV-3 CIRCUIT is intended to receive signals or power that are generated externally during normal operation (for example, in a TELECOMMUNICATION NETWORK). Single faults are not simulated while conducting the test of 2.3.5.*

*Prior to the above tests, insulation that does not meet the requirements for BASIC INSULATION is short-circuited. However, if simulation of failures would be more severe if conducted without short-circuiting the insulation, the test is conducted without short-circuiting.*

### 2.3.3 Separation from hazardous voltages

Except as permitted in 2.3.4, a TNV CIRCUIT shall be separated from circuits at HAZARDOUS VOLTAGE by one or more of the constructions specified in 2.9.4.

*Compliance is checked by inspection and measurement.*

### 2.3.4 Connection of TNV circuits to other circuits

Except as permitted in 1.5.7, a TNV CIRCUIT is permitted to be connected to other circuits, provided that it is separated by BASIC INSULATION from any PRIMARY CIRCUIT (including the neutral) within the equipment.

NOTE 1 The limits of 2.3.1 always apply to TNV CIRCUITS.

If a TNV CIRCUIT is connected to one or more other circuits, the TNV CIRCUIT is that part which complies with 2.3.1.

If a TNV CIRCUIT obtains its supply conductively from a SECONDARY CIRCUIT which is separated from a HAZARDOUS VOLTAGE circuit by:

- DOUBLE INSULATION OR REINFORCED INSULATION; OR
- the use of an earthed conductive screen that is separated from a HAZARDOUS VOLTAGE circuit by BASIC INSULATION;

the TNV CIRCUIT shall be considered as being separated from the HAZARDOUS VOLTAGE circuit by the same method.

If a TNV CIRCUIT is derived from a HAZARDOUS VOLTAGE SECONDARY CIRCUIT, and the HAZARDOUS VOLTAGE SECONDARY CIRCUIT is separated from the PRIMARY CIRCUIT by DOUBLE INSULATION OR REINFORCED INSULATION, the TNV CIRCUIT shall remain within the limits given in 2.3.1 under single fault conditions (see 1.4.14). In such a case, the short-circuiting of the insulation in a transformer that provides the

separation between the HAZARDOUS VOLTAGE SECONDARY CIRCUIT and the TNV CIRCUIT is considered to be a single fault, for the purpose of applying the single fault conditions, provided the insulation in the transformer passes an electrical strength test for BASIC INSULATION in accordance with 5.2.2.

*Compliance is checked by inspection, and by simulation of single faults (see 1.4.14) such as are likely to occur in the equipment. No such simulated fault shall cause the voltage across a 5 000  $\Omega \pm 2\%$  resistor, connected between any two conductors of the TNV CIRCUIT or between one such conductor and earth, to fall outside the shaded area of Figure 2F (see 2.3.1). Observation is continued until stable conditions have existed for at least 5 s.*

NOTE 2 For requirements in Norway, see 1.7.2.1 Note 6, 6.1.2.1 Note 2 and 6.1.2.2 Note.

### 2.3.5 Test for operating voltages generated externally

*This test is only conducted if specified in 2.3.2.3 or 2.3.2.4.*

*A test generator specified by the manufacturer is used, representing the maximum normal operating voltage expected to be received from the external source. In the absence of such a specification, a test generator is used that provides 120 V  $\pm 2$  V a.c. at 50 Hz or 60 Hz and has an internal impedance of 1 200  $\Omega \pm 2\%$ .*

NOTE The above test generator is not intended to represent the actual voltages on the TELECOMMUNICATION NETWORK but to stress the circuit of the EUT in a repeatable manner.

*The test generator is connected between the TELECOMMUNICATION NETWORK terminals of the equipment. One pole of the test generator is also connected to the earthing terminal of the equipment (see Figure 2G). The test voltage is applied for a maximum of 30 min. If it is clear that no further deterioration will take place, the test is terminated earlier.*

*During the test, the SELV CIRCUIT, TNV-1 CIRCUIT or accessible conductive part shall continue to comply with 2.2.2.*

*The test is repeated after reversing the connections to the TELECOMMUNICATION NETWORK terminals of the equipment.*

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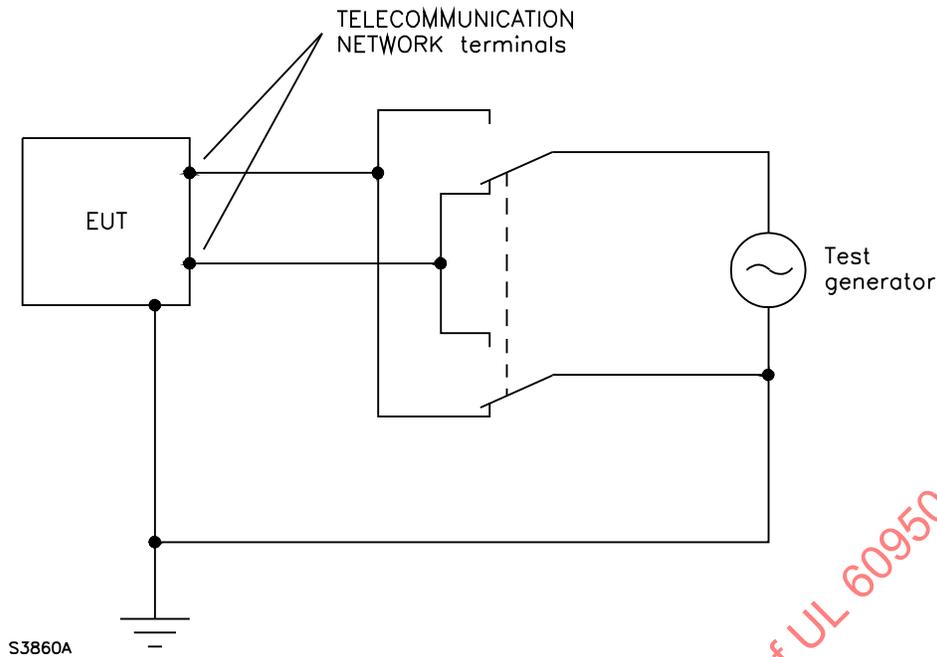


Figure 2G – Test generator

## 2.4 Limited current circuits

### 2.4.1 General requirements

LIMITED CURRENT CIRCUITS shall be so designed that the limits specified in 2.4.2 are not exceeded under normal operating conditions and in the event of a single failure within the equipment (see 1.4.14 and 1.5.7).

Except as permitted in 2.4.3, segregation of accessible parts of LIMITED CURRENT CIRCUITS from other circuits shall be as described in 2.2 for SELV CIRCUITS.

*Compliance with 2.4.1 to 2.4.3 is checked by inspection, measurement and, when necessary, by test.*

NOTE 1 An accessible conductive part or circuit separated from another part by DOUBLE INSULATION or REINFORCED INSULATION that is bridged by a resistor or group of resistors is treated as a LIMITED CURRENT CIRCUIT (see 1.5.7).

NOTE 2 A LIMITED CURRENT CIRCUIT may be derived from either a PRIMARY CIRCUIT or SECONDARY CIRCUIT.

## 2.4.2 Limit values

For frequencies not exceeding 1 kHz, the steady-state current drawn through a non-inductive resistor of  $2\ 000\ \Omega \pm 10\ \%$  connected between any two parts of a LIMITED CURRENT CIRCUIT, or between any such part and earth (see 1.4.9), shall not exceed 0,7 mA peak, or 2 mA d.c.

For frequencies above 1 kHz, the limit of 0,7 mA is multiplied by the value of the frequency in kilohertz but shall not exceed 70 mA peak.

Alternatively, it is permitted to use the measuring instruments of Annex D instead of the non-inductive resistor of  $2\ 000\ \Omega \pm 10\ \%$  mentioned above.

When using the measuring instrument of Figure D.1, the voltage,  $U_2$ , is measured and the current is calculated by dividing the measured voltage,  $U_2$ , by 500. The calculated value shall not exceed 0,7 mA peak.

NOTE 1 If one side of the LIMITED CURRENT CIRCUIT has a conductive connection to earth, point B of the measuring instrument of Figure D.1 should be connected to that side.

When using the measuring instrument of Figure D.2, the measured value of the current shall not exceed 0,7 mA peak.

For parts not exceeding 450 V peak or d.c., the circuit capacitance shall not exceed 0,1  $\mu\text{F}$ .

For parts whose voltage,  $U$ , exceeds 0,45 kV peak or d.c., but does not exceed 15 kV peak or d.c., the circuit capacitance shall not exceed  $45/U$  nF, where  $U$  is expressed in kilovolts.

NOTE 2 The limit of  $45/U$  corresponds to an available stored charge of 45  $\mu\text{C}$ .

For parts whose voltage,  $U$ , exceeds 15 kV peak or d.c., the circuit capacitance shall not exceed  $700/U^2$  nF, where  $U$  is expressed in kilovolts.

NOTE 3 The limit of  $700/U^2$  corresponds to an available energy of 350 mJ.

## 2.4.3 Connection of limited current circuits to other circuits

LIMITED CURRENT CIRCUITS are permitted to be supplied from or connected to other circuits, provided that the following conditions are met:

- the LIMITED CURRENT CIRCUIT meets the limits of 2.4.2 under normal operating conditions;
- the LIMITED CURRENT CIRCUIT continues to meet the limits of 2.4.2 in the event of a single failure of any component or insulation in the LIMITED CURRENT CIRCUIT, or of any component or insulation in the other circuit to which it is connected.

If a LIMITED CURRENT CIRCUIT is connected to one or more other circuits, the LIMITED CURRENT CIRCUIT is that part which complies with the requirements of 2.4.1.

## 2.5 Limited power sources

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A limited power source shall comply with one of the following, a), b, c) or d):

- a) the output is inherently limited in compliance with Table 2B; or
- b) a linear or non-linear impedance limits the output in compliance with Table 2B. If a positive temperature coefficient device is used, it shall:
  - pass the tests specified in IEC 60730-1, Clauses 15, 17, J.15 and J.17; or
  - meet the requirements in IEC 60730-1 for a device for Type 2.AL action;
- c) a regulating network, or an integrated circuit (IC) current limiter, limits the output in compliance with Table 2B, both with and without a simulated single fault (see 1.4.14) in the regulating network or the IC current limiter (open circuit or short circuit). A single fault between the input and output is not conducted if the IC current limiter meets a suitable test program as given in Annex CC;
- d) an overcurrent protective device is used and the output is limited in compliance with Table 2C.

Where an overcurrent protective device is used, it shall be a fuse or a non-adjustable, non-autoreset, electromechanical device.

A limited power source operated from an AC MAINS SUPPLY, or a battery-operated limited power source that is recharged from an AC MAINS SUPPLY while supplying the load, shall incorporate an isolating transformer.

*Compliance is checked by inspection and measurement and, where appropriate, by examination of the manufacturer's data for batteries. Batteries shall be fully charged when conducting the measurements for  $U_{oc}$  and  $I_{sc}$  according to Tables 2B and 2C.*

*The non-capacitive load referred to in Tables 2B and 2C is adjusted to give the maximum measured value of  $I_{sc}$  or S.*

*Simulated faults in a regulating network, required according to item c) above, are applied under the above maximum measured values of  $I_{sc}$  or S.*

**Table 2B – Limits for power sources without an overcurrent protective device**

Output voltage <sup>a</sup> ( $U_{oc}$ )		Output current <sup>b d</sup> ( $I_{sc}$ ) A	Apparent power <sup>c d</sup> (S) VA
V a.c.	V d.c.		
≤ 30	≤ 30	≤ 8,0	≤ 100
–	$30 < U_{oc} \leq 60$	≤ $150/U_{oc}$	≤ 100

<sup>a</sup>  $U_{oc}$ : Output voltage measured in accordance with 1.4.5 with all load circuits disconnected. Voltages are for substantially sinusoidal a.c. and ripple free d.c. For non-sinusoidal a.c. and d.c. with ripple greater than 10 % of the peak, the peak voltage shall not exceed 42,4 V.

<sup>b</sup>  $I_{sc}$ : Maximum output current with any non-capacitive load, including a short-circuit.

<sup>c</sup> S(VA): Maximum output VA with any non-capacitive load.

<sup>d</sup> Measurement of  $I_{sc}$  and S are made 5 s after application of the load if protection is by an electronic circuit and 60 s for a positive temperature coefficient device or in other cases.

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**Table 2C – Limits for power sources with an overcurrent protective device**

Output voltage <sup>a</sup>		Output current <sup>b d</sup>	Apparent power <sup>c d</sup>	Current rating of overcurrent protective device <sup>e</sup>
$(U_{oc})$				
V a.c.	V d.c.	$(I_{sc})$ A	(S) VA	A
≤ 20	≤ 20	≤ 1 000/ $U_{oc}$	≤ 250	≤ 5,0
20 < $U_{oc}$ ≤ 30	20 < $U_{oc}$ ≤ 30			≤ 100/ $U_{oc}$
–	30 < $U_{oc}$ ≤ 60			≤ 100/ $U_{oc}$

a)  $U_{oc}$ : Output voltage measured in accordance with 1.4.5 with all load circuits disconnected. Voltages are for substantially sinusoidal a.c. and ripple free d.c. For non-sinusoidal a.c. and for d.c. with ripple greater than 10 % of the peak, the peak voltage shall not exceed 42,4 V.

b)  $I_{sc}$ : Maximum output current with any non-capacitive load, including a short-circuit, measured 60 s after application of the load.

c) S (VA): Maximum output VA with any non-capacitive load measured 60 s after application of the load.

d) Current limiting impedances remain in the circuit during measurement, but overcurrent protective devices are bypassed.

NOTE The reason for making measurements with overcurrent protective devices bypassed is to determine the amount of energy that is available to cause possible overheating during the operating time of the overcurrent protective devices.

e) The current ratings of overcurrent protective devices are based on fuses and circuit-breakers that break the circuit within 120 s with a current equal to 210 % of the current rating specified in the table.

## 2.6 Provisions for earthing and bonding

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NOTE For additional requirements with regard to earthing of equipment to be connected to TELECOMMUNICATION NETWORKS, see 2.3.2.3, 2.3.2.4, 2.3.3, 2.3.4, 6.1.1 and 6.1.2; and for CABLE DISTRIBUTION SYSTEMS, see 7.2 and 7.4.1.

### 2.6.1 Protective earthing

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The following parts of equipment shall be reliably connected to the main protective earthing terminal of the equipment.

- Accessible conductive parts that might assume a HAZARDOUS VOLTAGE in the event of a single fault (see 1.4.14).
- Parts to be earthed as required by 2.9.4 d) or e).
- SELV CIRCUITS, TNV CIRCUITS and accessible conductive parts required to be earthed by 2.3.2.3 or 2.3.2.4, if the power source is not a TELECOMMUNICATION NETWORK or a CABLE DISTRIBUTION SYSTEM.
- SELV CIRCUITS, TNV CIRCUITS and accessible conductive parts required to be earthed by 2.3.2.3, if the power source is a TELECOMMUNICATION NETWORK or a CABLE DISTRIBUTION SYSTEM.
- Circuits, transformer screens and components (such as surge suppressors) that could not assume a HAZARDOUS VOLTAGE in the event of a single fault (see 1.4.14) but are required to be earthed in order to reduce transients that might affect insulation (for example, see 6.2.1 and 7.4.1).

f) SELV CIRCUITS and TNV CIRCUITS that are required to be earthed in order to reduce or eliminate TOUCH CURRENT to a TELECOMMUNICATION NETWORK OR a CABLE DISTRIBUTION SYSTEM(see 5.1.8.1).

NOTE Parts a), b) and c) are likely to carry fault currents intended to operate overcurrent protective devices. Parts d), e) and f) carry other currents.

In SERVICE ACCESS AREAS, where conductive parts, such as motor frames, electronic chassis, etc., might assume a HAZARDOUS VOLTAGE in the event of a single fault (see 1.4.14), either these conductive parts shall be connected to the main protective earthing terminal or, if this is impossible or impracticable, a suitable marking shall indicate to a SERVICE PERSON that such parts are not earthed and should be checked for HAZARDOUS VOLTAGE before being touched.

*Compliance is checked by inspection and, where appropriate, by the test specified in 2.6.3.*

## 2.6.2 Functional earthing

If FUNCTIONAL EARTHING of accessible conductive parts is necessary, all of the following apply to the FUNCTIONAL EARTHING circuit:

– the FUNCTIONAL EARTHING circuit shall be separated from parts at HAZARDOUS VOLTAGES in the equipment by either:

- DOUBLE INSULATION OR REINFORCED INSULATION; OR
- a protectively earthed screen or another protectively earthed conductive part, separated from parts at HAZARDOUS VOLTAGES by at least BASIC INSULATION; and

– it is permitted to connect the FUNCTIONAL EARTHING circuit to a protective earth terminal or to a PROTECTIVE BONDING CONDUCTOR; and

– ~~wiring terminals to be used only for FUNCTIONAL EARTHING shall not be marked by the symbol  $\perp$  (60417-IEC-5017) or by the symbol  $\oplus$  (60417-IEC-5019), except that, where a wiring terminal is provided on a component (for example, a terminal block) or subassembly, the symbol  $\perp$  is permitted; and~~

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DI  
DI

NOTE ~~Other markings such as one of the symbols,  $\perp$  (IEC 60417-5018 (DB:2002-10)) or  $\perp$  (IEC 60417-5020 (DB:2002-10)), if appropriate, are permitted.~~

DI  
DI

– wiring terminals to be used only for the connection of FUNCTIONAL EARTHING shall be marked by the symbol  $\perp$  (IEC 60417-5020:2002-10). These terminals shall not be marked with the symbol  $\perp$  (60417-IEC-5017), or with the symbol  $\oplus$  (60417-IEC-5019). However, these symbols may be used for a wiring terminal provided on a component (for example, a terminal block) or subassembly; and

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DI

– for internal FUNCTIONAL EARTHING conductors, the colour combination green-and-yellow shall not be used except in multipurpose preassembled components (for example, multi-conductor cables or EMC filters).

For equipment having a power supply cord where a conductor with green-and-yellow insulation is used only to provide a FUNCTIONAL EARTHING connection:

- the equipment shall not be marked with the symbol , IEC 60417-5172 (2003-02);  
and
- ~~the equipment may be marked with:~~ DI
  - ~~the symbol , IEC 60417-5018 (2011-07); or~~ DI
  - ~~the symbol , IEC 60417-6092 (2011-10).~~ DI
- the equipment shall be marked with the symbol , IEC 60417-6092 (2011-10). DI

These symbols shall not be used for CLASS I EQUIPMENT.

There are no requirements other than those in 3.1.9 regarding the termination of this FUNCTIONAL EARTHING conductor at the equipment end.

*Compliance is checked by inspection.*

### 2.6.3 Protective earthing conductors and protective bonding conductors

#### 2.6.3.1 General

PROTECTIVE EARTHING CONDUCTORS and PROTECTIVE BONDING CONDUCTORS shall have sufficient current-carrying capacity.

The requirements of 2.6.3.2, 2.6.3.3 and 2.6.3.4 apply to PROTECTIVE EARTHING CONDUCTORS and PROTECTIVE BONDING CONDUCTORS provided to comply with 2.6.1 a), b) and c).

For PROTECTIVE EARTHING CONDUCTORS and PROTECTIVE BONDING CONDUCTORS provided to comply with 2.6.1 d), the requirements and test of 2.6.3.4 e) apply.

For PROTECTIVE EARTHING CONDUCTORS and PROTECTIVE BONDING CONDUCTORS provided to comply with 2.6.1 e) and 2.6.1 f), and for FUNCTIONAL EARTHING conductors, the current-carrying capacity shall be adequate for the actual current under normal operating conditions, in accordance with 3.1.1, that is the conductors are not required to carry fault currents to earth.

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### 2.6.3.2 Size of protective earthing conductors

PROTECTIVE EARTHING CONDUCTORS in power supply cords supplied with the equipment shall comply with the minimum conductor sizes in Table 3B (see 3.2.5).

*Compliance is checked by inspection and measurement.*

### 2.6.3.3 Size of protective bonding conductors

**NAE**

PROTECTIVE BONDING CONDUCTORS shall comply with one of the following:

- the minimum conductor sizes in Table 3B (see 3.2.5); or
- the requirements of 2.6.3.4 and also, if the PROTECTIVE CURRENT RATING of the circuit is more than 16 20 A, with the minimum conductor sizes in Table 2D; or
- for components only, be not smaller than the conductors supplying power to the component.

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The PROTECTIVE CURRENT RATING of the circuit (used in Table 2D and in the test of 2.6.3.4) depends on the provision and location of overcurrent protective devices. It shall be taken as the smallest of a) or b) or c), as applicable.

a) For PLUGGABLE EQUIPMENT TYPE A, the PROTECTIVE CURRENT RATING is the rating of an overcurrent protective device provided external to the equipment (for example, in the building wiring, in the mains plug or in an equipment rack) to protect the equipment, with a minimum of 16 A.

NOTE 1 In most countries, 16 A is considered to be suitable as the PROTECTIVE CURRENT RATING of the circuit.

NOTE 2 In Canada and United States, the PROTECTIVE CURRENT RATING of the circuit is taken as 20 A.

NOTE 3 In the United Kingdom, the current rating of the circuit shall be taken as 13 A, not 16 A.

b) For PLUGGABLE EQUIPMENT TYPE B and PERMANENTLY CONNECTED EQUIPMENT (see 2.7.1), the PROTECTIVE CURRENT RATING is the maximum rating of the overcurrent protective device specified in the equipment installation instructions to be provided external to the equipment (see 1.7.2.3).

c) For any of the above equipment, the PROTECTIVE CURRENT RATING is the rating of an overcurrent protective device, if provided in or as part of the equipment, that protects the circuit or part required to be earthed.

*Compliance is checked by inspection and measurement.*

Table 2D – Minimum size of protective bonding conductors

PROTECTIVE CURRENT RATING of the circuit under consideration  Up to and including A	Minimum conductor sizes	
	Cross-sectional area	AWG or kcmil
	mm <sup>2</sup>	(cross-sectional area in mm <sup>2</sup> )
20	Size not specified	Size not specified
25	1,5	14 (2)
32	2,5	12 (3)
40	4,0	10 (5)
63	6,0	8 (8)
80	10	6 (13)
100	16	4 (21)
125	25	2 (33)
160	35	1 (42)
190	50	0 (53)
230	70	000 (85)
260	95	0000 (107)
300	120	250 kcmil (126)
340	150	300 kcmil (152)
400	185	400 kcmil (202)
460	240	500 kcmil (253)

NOTE AWG and kcmil sizes are provided for information only. The associated cross-sectional areas have been rounded to show significant figures only. AWG refers to the American Wire Gage and the term "cmil" refers to circular mils where 1 circular mil is the area of a circle having a diameter of 1 mil (one thousandth of an inch). These terms are commonly used to designate wire sizes in North America.

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### 2.6.3.4 Resistance of earthing conductors and their terminations

Earthing conductors and their terminations shall not have excessive resistance.

PROTECTIVE EARTHING CONDUCTORS are considered to comply without test.

PROTECTIVE BONDING CONDUCTORS that meet the minimum conductor sizes in Table 3B (see 3.2.5) throughout their length and whose terminals all meet the minimum sizes in Table 3E (see 3.3.5) are considered to comply without test.

PROTECTIVE BONDING CONDUCTORS and their terminals of non-standard constructions, such as printed wiring protective traces, shall also be evaluated in accordance with the Limited Short-Circuit Test in CSA C22.2 No. 0.4, Bonding of Electrical Equipment. PROTECTIVE BONDING CONDUCTORS that can be determined to meet the equivalent of the minimum conductor sizes in Table 2D and are provided with terminals not more than one size smaller than the sizes in Table 3E (see 3.3.5) shall be considered to comply without test.

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D1

NOTE Short-circuit values for d.c. equipment and systems are under consideration.

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*Compliance is checked by inspection, measurement and, for PROTECTIVE BONDING CONDUCTORS that do not meet the minimum conductor sizes in Table 3B (see 3.2.5) throughout their length or whose terminals do not all meet the minimum sizes in Table 3E (see 3.3.5), by the following test.*

*The voltage drop in a PROTECTIVE BONDING CONDUCTOR is measured after conducting the test current for the time period specified below. The test current can be either a.c. or d.c. and the test voltage shall not exceed 12 V. The measurement is made between the main protective earthing terminal and the point in the equipment that is required by 2.6.1 to be earthed. The resistance of the PROTECTIVE EARTHING CONDUCTOR is not included in the measurement. However, if the PROTECTIVE EARTHING CONDUCTOR is supplied with the equipment, it is permitted to include the conductor in the test circuit but the measurement of the voltage drop is made only from the main protective earthing terminal to the part required to be earthed.*

*On equipment where the protective earth connection to a subassembly or to a separate unit is by means of one core of a multicore cable that also supplies mains power to that subassembly or unit, the resistance of the PROTECTIVE BONDING CONDUCTOR in that cable is not included in the measurement. However, this option is only permitted if the cable is protected by a suitably rated protective device which takes into account the size of the conductor.*

*If the protection of an SELV CIRCUIT or a TNV CIRCUIT is achieved by earthing the protected circuit itself in accordance with 2.9.4 e), the resistance and the voltage drop limits apply between the earthed side of the protected circuit and the main protective earthing terminal.*

*If the circuit is protected by earthing the winding of a transformer supplying the protected circuit, the resistance and the voltage drop limits apply between the unearthed side of the winding and the main protective earthing terminal. The BASIC INSULATION between the primary and secondary windings is not subjected to the single fault testing required by 5.3.7 and 1.4.14.*

*Care is taken that the contact resistance between the tip of the measuring probe and the conductive part under test does not influence the test results.*

*The test current, duration of the test and test results are as follows:*

a) For equipment powered from a MAINS SUPPLY, if the PROTECTIVE CURRENT RATING of the circuit under test (see 2.6.3.3) is 16 A or less, the test current is 200 % of the PROTECTIVE CURRENT RATING applied for 120 s.

The resistance of the PROTECTIVE BONDING CONDUCTOR, calculated from the voltage drop, shall not exceed 0,1  $\Omega$ . After the test, the PROTECTIVE BONDING CONDUCTOR shall not be damaged.

b) For equipment powered from an AC MAINS SUPPLY, if the PROTECTIVE CURRENT RATING of the circuit under test exceeds 16 A, the test current is 200 % of the PROTECTIVE CURRENT RATING and the duration of the test is as shown in Table 2E.

**Table 2E – Test duration, a.c. mains supplies**

PROTECTIVE CURRENT RATING of the circuit ( $I_{pc}$ ) A	Duration of the test min
$\leq 30$	2
$30 < I_{pc} \leq 60$	4
$60 < I_{pc} \leq 100$	6
$100 < I_{pc} \leq 200$	8
$> 200$	10

The voltage drop in the PROTECTIVE BONDING CONDUCTOR shall not exceed 2,5 V. After the test the PROTECTIVE BONDING CONDUCTOR shall not be damaged.

c) As an alternative to b) above, the tests are based on the time-current characteristic of the overcurrent protective device that limits the fault current in the PROTECTIVE BONDING CONDUCTOR. This device is either one provided in the EUT or specified in the installation instructions to be provided external to the equipment. The tests are conducted at 200 % of the PROTECTIVE CURRENT RATING, for the duration corresponding to 200 % on the time-current characteristic. If the duration for 200 % is not given, the nearest point on the time-current characteristic is used.

The voltage drop in the PROTECTIVE BONDING CONDUCTOR shall not exceed 2,5 V. After the test the PROTECTIVE BONDING CONDUCTOR shall not be damaged.

d) For equipment powered from a DC MAINS SUPPLY, if the PROTECTIVE CURRENT RATING of the circuit under test exceeds 16 A, the test current and duration are as specified by the manufacturer.

The voltage drop in the PROTECTIVE BONDING CONDUCTOR shall not exceed 2,5 V. After the test the PROTECTIVE BONDING CONDUCTOR shall not be damaged.

e) For PROTECTIVE BONDING CONDUCTORS provided to comply with 2.6.1 d), the test current is 150 % of the maximum current available under normal operating conditions from the TELECOMMUNICATION NETWORK OR CABLE DISTRIBUTION SYSTEM (if known) with a minimum of 2 A, applied for 120 s. The voltage drop in the PROTECTIVE BONDING CONDUCTOR shall not exceed 2,5 V.

### 2.6.3.5 Colour of insulation

The insulation of the PROTECTIVE EARTHING CONDUCTOR in a power supply cord supplied with the equipment shall be green-and-yellow.

If a PROTECTIVE BONDING CONDUCTOR is insulated, the insulation shall be green-and-yellow except in the following two cases:

- for an earthing braid, the insulation shall be either green-and-yellow or transparent;
- for a PROTECTIVE BONDING CONDUCTOR in assemblies such as ribbon cables, busbars, printed wiring, etc., any colour is permitted provided that no misinterpretation of the use of the conductor is likely to arise.

Except as permitted in 2.6.2, the colour combination green-and-yellow shall be used only to identify PROTECTIVE EARTHING CONDUCTORS and PROTECTIVE BONDING CONDUCTORS.

*Compliance is checked by inspection.*

## 2.6.4 Terminals

### 2.6.4.1 General

The requirements of 2.6.4.2 and 2.6.4.3 apply only to protective earthing terminals provided to comply with 2.6.1 a), b) and c).

NOTE For additional requirements concerning terminals, see 3.3.

For protective earthing provided to comply with 2.6.1 d), e) and f), it is sufficient for the terminals to comply with 3.3.

### 2.6.4.2 Protective earthing and bonding terminals

**NAE**

Equipment required to have protective earthing shall have a main protective earthing terminal. For equipment with a DETACHABLE POWER SUPPLY CORD, the earthing terminal in the appliance inlet is regarded as the main protective earthing terminal.

If equipment is provided with more than one supply connection (for example, with different voltages or frequencies or as backup power), it is permitted to have a main protective earthing terminal associated with each supply connection. In such a case, the terminals shall be sized according to the rating of the associated supply input.

Terminals shall be designed to resist accidental loosening of the conductor. In general, the designs commonly used for current-carrying terminals, other than some terminals of the pillar type, provide sufficient resilience to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, shall be used.

Except as noted below, all pillar, stud or screw type protective earthing and protective bonding terminals shall comply with the minimum size requirements of Table 3E (see 3.3.5).

Where a terminal for a PROTECTIVE BONDING CONDUCTOR does not comply with Table 3E (see 3.3.5), the test of 2.6.3.4 shall be applied to the PROTECTIVE BONDING CONDUCTOR path in which the terminal is used.

The main protective earthing terminal for PERMANENTLY CONNECTED EQUIPMENT shall be

- located so that it is readily accessible while making the supply connections; and
- provided with factory installed pillar terminals, studs, screws, bolts or similar terminals, together with the necessary fixing hardware, if a PROTECTIVE EARTHING CONDUCTOR larger than 7 mm<sup>2</sup> (3 mm diameter) is required.

*Compliance is checked by inspection and measurement.*

#### **2.6.4.3 Separation of the protective earthing conductor from protective bonding conductors**

Separate wiring terminals, which may be on the same busbar, shall be provided, one for the PROTECTIVE EARTHING CONDUCTOR, or one for each PROTECTIVE EARTHING CONDUCTOR if more than one is provided, and one or more for PROTECTIVE BONDING CONDUCTORS.

However, it is permitted to provide a single wiring terminal of the screw or stud type in PERMANENTLY CONNECTED EQUIPMENT having a NON-DETACHABLE POWER SUPPLY CORD, and in PLUGGABLE EQUIPMENT having a special NON-DETACHABLE POWER SUPPLY CORD, provided that the wiring termination of the PROTECTIVE EARTHING CONDUCTOR is separated by a nut from that of the PROTECTIVE BONDING CONDUCTORS. The order of stacking of the terminations of the PROTECTIVE EARTHING CONDUCTOR and the PROTECTIVE BONDING CONDUCTORS is not specified.

It is also permitted to provide a single wiring terminal in equipment with an appliance inlet.

*Compliance is checked by inspection.*

### **2.6.5 Integrity of protective earthing**

#### **2.6.5.1 Interconnection of equipment**

In a system of interconnected equipment, the protective earthing connection shall be ensured for all equipment requiring a protective earthing connection, regardless of the arrangement of equipment in the system.

Equipment that contains a PROTECTIVE BONDING CONDUCTOR to maintain continuity of protective earthing circuits to other equipment in the system, shall not be marked with the symbol □ (IEC 60417-5172 (DB:2003-02)).

Such equipment shall also provide power to the other equipment in the system (see 2.6.5.3).

*Compliance is checked by inspection.*

### 2.6.5.2 Components in protective earthing conductors and protective bonding conductors

PROTECTIVE EARTHING CONDUCTORS and PROTECTIVE BONDING CONDUCTORS shall not contain switches or overcurrent protective devices.

*Compliance is checked by inspection.*

### 2.6.5.3 Disconnection of protective earth

Protective earthing connections shall be such that disconnection of a protective earth at one point in a unit or a system does not break the protective earthing connection to other parts or units in a system, unless the relevant hazard is removed at the same time.

*Compliance is checked by inspection.*

### 2.6.5.4 Parts that can be removed by an operator

Protective earthing connections shall make earlier and break later than the supply connections in each of the following:

- the connector of a part that can be removed by an OPERATOR;
- a plug on a power supply cord;
- an appliance coupler.

*Compliance is checked by inspection.*

### 2.6.5.5 Parts removed during servicing

Protective earthing connections shall be so designed that they do not have to be disconnected for servicing other than for the removal of the part which they protect unless the relevant hazard is removed at the same time.

*Compliance is checked by inspection.*

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### 2.6.5.6 Corrosion resistance

Conductive parts in contact at protective earthing and protective bonding terminals and connections shall not be subject to significant corrosion due to electrochemical action in any working, storage or transport environment conditions as specified in the instructions supplied with the equipment. Combinations above the line in Annex J shall be avoided. Corrosion resistance can be achieved by a suitable plating or coating process.

*Compliance is checked by inspection and by reference to the table of electrochemical potentials (Annex J).*

### 2.6.5.7 Screws for protective bonding

**NAE**

NOTE The following requirements are additional to those in 3.1.6.

Self-tapping (thread-cutting and thread-forming) and spaced thread (sheet metal) screws are permitted to provide protective bonding but it shall not be necessary to disturb the connection during servicing.

In any case, the thickness of the metal part at the point where a screw is threaded into it shall be not less than twice the pitch of the screw thread. It is permitted to use local extrusion of a metal part to increase the effective thickness.

At least two screws shall be used for each connection. However, it is permitted to use a single self-tapping screw provided that the thickness of the metal part at the point where the screw is threaded into it is a minimum of 0,9 mm for a screw of the thread-forming type and 1,6 mm for a screw of the thread-cutting type.

*Compliance is checked by inspection.*

### 2.6.5.8 Reliance on telecommunication network or cable distribution system

Protective earthing shall not rely on a TELECOMMUNICATION NETWORK OR A CABLE DISTRIBUTION SYSTEM.

*Compliance is checked by inspection.*

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## 2.7 Overcurrent and earth fault protection in primary circuits

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### 2.7.1 Basic requirements

Protection in PRIMARY CIRCUITS against overcurrents, short-circuits and earth faults shall be provided, either as an integral part of the equipment or as part of the building installation.

If PLUGGABLE EQUIPMENT TYPE B OR PERMANENTLY CONNECTED EQUIPMENT relies on protective devices external to the equipment for protection, the equipment installation instructions shall so state and shall also specify the requirements for short-circuit protection or overcurrent protection or, where necessary, for both.

NOTE In the member countries of CENELEC and in China, the protective devices necessary to comply with the requirements of 5.3 must, with certain exceptions, be included as part of the equipment.

*Compliance is checked by inspection.*

### 2.7.2 Faults not simulated in 5.3.7

Protection against faults not covered in 5.3.7 (for example, short-circuits to protective earth from wiring in a PRIMARY CIRCUIT) need not be fitted as an integral part of the equipment.

*Compliance is checked by inspection.*

### 2.7.3 Short-circuit backup protection

Unless appropriate short-circuit backup protection is provided, protective devices shall have adequate breaking (rupturing) capacity to interrupt the maximum fault current (including short-circuit current) which can flow.

For PERMANENTLY CONNECTED EQUIPMENT OR PLUGGABLE EQUIPMENT TYPE B, it is permitted for short-circuit backup protection to be in the building installation.

For PLUGGABLE EQUIPMENT TYPE A, the building installation is considered as providing short-circuit backup protection.

NOTE If fuses complying with IEC 60127 are used in PRIMARY CIRCUITS, they should have high breaking capacity (1 500 A) if the prospective short-circuit current exceeds 35 A or ten times the current rating of the fuse, whichever is greater.

*Compliance is checked by inspection and by the tests of 5.3.*

## 2.7.4 Number and location of protective devices

Protective systems or devices in PRIMARY CIRCUITS shall be in such a number and located so as to detect and to interrupt the overcurrent flowing in any possible fault current path (for example, line-to-line, line-to-neutral, line to protective earth conductor or line to PROTECTIVE BONDING CONDUCTOR).

No protection is required against earth faults in equipment that either:

- has no connection to earth; or
- has DOUBLE INSULATION OR REINFORCED INSULATION between the PRIMARY CIRCUIT and all parts connected to earth.

NOTE 1 Where DOUBLE INSULATION OR REINFORCED INSULATION is provided, a short-circuit to earth would be considered to be two faults.

In a supply using more than one line conductor to a load, if a protective device interrupts the neutral conductor, it shall also interrupt all other supply conductors. Single pole protective devices, therefore, shall not be used in such cases.

*Compliance is checked by inspection and, where necessary, by simulation of single fault conditions (see 1.4.14).*

NOTE 2 For protective devices that are an integral part of the equipment, examples of the number and location of fuses or circuit-breaker poles necessary to provide fault current interruption in commonly encountered supply systems are given in informative Table 2F for single-phase equipment or subassemblies and in informative Table 2G for three-phase equipment. The examples are not necessarily valid for protective devices external to the equipment.

**Table 2F – Informative examples of protective devices in single-phase equipment or subassemblies**

Equipment supply connections	Protection against	Minimum number of fuses or circuit-breaker poles	Location
Case A: Equipment to be connected to power distribution systems with earthed neutral reliably identified, except for case C below.	Earth faults	1	Line conductor
	Overcurrent	1	Either of the two conductors
Case B: Equipment to be connected to any supply, including IT power distribution systems and supplies with reversible plugs, except for case C below.	Earth faults	2	Both conductors
	Overcurrent	1	Either of the two conductors
Case C: Equipment to be connected to three-wire power distribution systems with earthed neutral reliably identified.	Earth faults	2	Each line conductor
	Overcurrent	2	Each line conductor