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British Standard Specification for

Safety of data processing equipment

Spécification pour la sécurité du matériel d'informatique

Spezifikation für die Sicherheit von Datenverarbeitungseinrichtungen

British Standards Institution

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Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Foreword

This British Standard has been prepared under the direction of the Office and Information Standards Committee and is based on work carried out by the International Electrotechnical Commission (IEC) in its Technical Committee IEC/TC 74, Safety of data processing equipment and office machines, and specifically on the draft second edition of IEC Publication 435 'Safety of data processing equipment'. That draft was circulated initially as IEC Document 74 (Central Office) 14 dated March 1979 and was supplemented by an amendment, IEC Document 74 (Central Office) 17 dated July 1980. Further proposed amendments were circulated as IEC Document 74 (Central Office) 21 to 26 inclusive dated April 1981.

This British Standard substantially adopts IEC Document 74 (Central Office) 14, 17, 21, 22, 23, 25 and 26 and incorporates, where appropriate, the comments made on them by the UK National Committee. Where the technical requirements in this standard are expected to differ from the published second edition of IEC Publication 435, the differences are listed in appendix J.

IEC Document 74 (Central Office) 24 proposed new requirements for printed circuit boards, and sealed and potted components, but they were not considered to be sufficiently well validated for the UK National Committee to approve. However, it is anticipated that, after further development and testing, requirements for such assemblies will be added to this standard by issue of an amendment.

For ease of future cross-referencing, a list of the clause numbers used in this standard against the numbers of the corresponding clauses in the above IEC documents is included as appendix K. If the numbering of clauses in the second edition of IEC Publication 435, when published, differs from its draft, an amendment to the appendix in this British Standard will be prepared.

The draft second edition of IEC Publication 435 took into consideration the physical size, technical complexity and value of data processing equipment and, whilst incorporating the relevant requirements of IEC Publication 435:1973 (amended in December 1978) it was aimed primarily at enabling designers to realize safety requirements at an early design stage and build them into the equipment. For this reason a new format was considered desirable, and the opportunity was taken to eliminate all requirements that did not fully relate to data processing equipment.

This British Standard is being made available in advance of the second edition of IEC Publication 435 for the following principal reasons.

- (a) The UK National Committee did not approve all the requirements in the draft IEC text, although most of it was acceptable.
- (b) The UK National Committee was anxious to make available, as soon as possible, a standard for safety of data processing equipment, and believed that a British Standard could be finalized appreciably earlier than the date of availability of IEC Publication 435 (second edition), so that manufacturers and purchasers of data processing equipment could use the standard for procurement purposes.
- (c) Having approved, within the UK, further significant proposed amendments to the future second edition of IEC Publication 435, it was opportune to include them in this standard, even though it was recognized that there could be an appreciable delay before their formal adoption by IEC, and publication as separate amendments to the second edition of IEC Publication 435.

Attention is also drawn to PD 6484, to which reference may be found useful.

In this British Standard the parts of the text that contain test specifications (compliance clauses) are indicated by the word 'TEST' at the beginning of the text and the remainder of the text being indented.

For ease of production, some of the figures in IEC Publication 364-3:1977, IEC Publication 435:1973 and Amendment No. 1 (dated December 1978) to IEC Publication 435:1973 have been used in this British Standard. Certain conventions are not identical with those used in British Standards.

Certification. Attention is drawn to the certification facilities described on the inside back cover of this standard.

British Standard Specification for

Safety of data processing equipment

Section one. General

0. Introduction

0.1 Principles of safety as applied to data processing equipment. It is essential for designers to understand the underlying principles of safety requirements in order that they can engineer safe equipment.

The following information is not an alternative to the detailed requirements of this standard, but is intended to provide designers with an appreciation of the principles on which these requirements are based.

0.2 Hazards. This British Standard is intended to prevent injury or damage due to the following hazards:

- (a) electric shock;
- (b) fire;
- (c) energy hazards;
- (d) mechanical and heat hazards;
- (e) radiation hazards;
- (f) chemical hazards.

0.3 Electric shock. Electric shock is caused by current passing through the body. Currents of the order of 1 mA can cause a reaction in persons in good health and may cause indirect danger due to involuntary reaction. Higher currents can have more damaging effects. Voltages up to about 40 V peak or d.c. are not generally regarded as dangerous under dry conditions, but parts that have to be touched or handled should be at earth potential or properly insulated.

There are two types of person who are normally concerned with data processing equipment, the operator and service personnel.

The term 'operator' covers all non-engineering staff, and requirements for their protection assume that they are oblivious to electrical hazards, but do not have suicidal tendencies. Consequently, the requirements provide protection for cleaners and casual visitors as well as the assigned operators.

It is assumed that the service personnel will be reasonably careful in dealing with obvious hazards, but the design should protect them against mishap by the use of shields for hazardous voltage terminals, segregation of protected extra-low and hazardous voltages, and, where appropriate, warning labels. More important, the service engineer should be protected against unexpected hazards.

It is normal to provide two levels of protection for the operator to prevent electric shock arising from faults so that a single fault and its resulting faults, if any, cannot 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.

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 earth conductor and a consequent leakage current hazard. With hand-held equipment this risk is increased, wear on the cord is more likely, and further hazards could arise if the unit were dropped.

The causes and prevention of electric shock are as follows.

Cause	Prevention
Contact with parts normally at hazardous voltage	Prevent operator access to parts at hazardous voltage (or energy levels) by fixed or locked covers, interlocks, etc. Discharge capacitors at hazardous voltages
Breakdown of insulation between parts normally at hazardous voltage and accessible conductive parts	Either connect the accessible conductive parts to earth so that the voltage that can develop is limited to a safe value and the circuit overcurrent protection will disconnect low impedance faults, or use double or reinforced insulation between parts normally at hazardous voltage and accessible conductive parts, so that breakdown to accessible parts is not likely to occur
Breakdown of insulation between parts normally at hazardous voltages and protected extra-low voltage (PELV) circuits, thereby putting accessible parts at hazardous voltage	Segregate parts at hazardous voltage and PELV circuits. Separate by earthed metal screens or double or reinforced insulation. Earth PELV circuits if capable of carrying possible fault currents
Breakdown of insulation guarding parts at hazardous voltage	For parts at hazardous voltage that are accessible to the operator, the insulation should have adequate mechanical and electrical strength to eliminate this danger
Leakage current from parts at hazardous voltage to body of class II equipment. Failure of protective earth connection carrying leakage current. (Leakage current includes current due to RFI filter components connected between parts at hazardous voltage and frame)	Limit leakage current to body to a safe value, or provide high-integrity protective earth connection

0.4 Energy hazards. Shorting between adjacent poles of high current supplies or high capacitance circuits can cause burns or splashing. Even low voltage circuits can be dangerous in this respect. Protect by separation, by shielding or by using safety interlocks.

0.5 Fire. Temperatures that are capable of causing a fire exposure can result from overloads, component failure, insulation breakdown, high resistance or loose connections.

However, fires originating within a unit should not spread beyond the immediate vicinity of the source of the fire nor cause damage to the surroundings of the unit.

NOTE. These design objectives should be met by:

- (a) taking all reasonable steps to avoid high temperatures which might cause ignition;
- (b) controlling the position of combustible materials in relation to possible ignition sources;
- (c) limiting the quantity of combustible materials used;
- (d) ensuring that any combustible materials used have as low a flammability as is practicable;
- (e) using enclosure or barriers if necessary to limit the spread of fire within the equipment;
- (f) using suitable materials for the ultimate enclosures of the equipment.

0.6 Mechanical and heat hazards. Requirements are included to prevent injury due to high temperatures of parts accessible to the operator, to ensure that the equipment is mechanically stable and structurally sound, to avoid the presence of sharp edges and points, and to provide adequate guarding of dangerous moving parts.

0.7 Radiation hazards. Radiation from some equipment can include sonic, radio frequency, infra-red, high intensity visible and coherent lights, ultraviolet, and also ionizing radiation, etc. Requirements should keep operator and service personnel exposures to acceptable levels.

0.8 Chemical hazards. Potential injuries can result from contact with hazardous chemicals, their vapours and fumes. Controls, including appropriate warning labels, are required to limit such contact, as far as is practicable, under normal and abnormal conditions.

0.9 Materials. Materials used in the construction of data processing equipment should be selected and arranged such that they can be expected to perform in a reliable manner without risk of energy hazards or electric shock, and such that they would not contribute significantly to the development of a serious fire hazard.

1. Scope

This British Standard specifies safety requirements for data processing equipment and associated electronic units, data preparation equipment, and data terminal equipment intended to be connected to supply systems with a maximum nominal system voltage of 600 V and designed to be operated continuously under conditions of normal use.

This standard specifies requirements intended to ensure safety for the operator and layman who come into contact with the equipment and, where specifically stated, service personnel.

This standard is intended to ensure the safety of installed equipment, whether such installed equipment consists of a system of interconnected units or independent units, subject to installing and maintaining the equipment in the manner prescribed by the equipment manufacturer.

This standard is applicable to equipment intended for operation in normal office environments or in special data processing rooms.

This standard is intended to cover only the safety aspects of equipment, and does not purport to provide a means for assessing any other characteristics, function or performance of data processing equipment.

NOTE 1. This standard does not cover the following:

- (a) equipment intended for operation whilst exposed to extremes of temperature, excessive dust, dampness, vibration, flammable gases, etc.;
- (b) support equipment such as air-conditioning, fire detection or fire extinguishing systems, power supply systems such as motor generator sets, transformers external to the data processing equipment, or building wiring;
- (c) interface equipment for connection to telecommunication networks, e.g. modems (modulator-demodulator), nor the telecommunication line equipment, except where such equipment is an integral part of the data processing equipment.

NOTE 2. Attention is drawn to the fact that the telecommunications authorities of some countries impose additional requirements relating to the safety of equipment connected to their networks. These concern the protection of those networks against faults in the data processing equipment.

NOTE 3. It is possible for certain types of equipment to be classified either as office machines or as data processing equipment. In such cases, the manufacturer's declaration should be taken into account when deciding whether this standard is applicable (see also 8.2).

NOTE 4. The need for additional detailed requirements to cover a new situation should be brought promptly to the attention of BSI Technical Committee OIS/20.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Definitions

For the purposes of this British Standard the following definitions apply.

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

- 3.1 rated voltage.** The primary power voltage or, for three-phase supply, the phase-to-phase voltage, as declared by the manufacturer.
- 3.2 rated voltage range.** The primary power voltage range as declared by the manufacturer, expressed by its lower and upper values, excluding tolerances.
- 3.3 working voltage.** The voltage to which the part under consideration is subjected when the equipment is operating at its rated voltage under conditions of normal use.
- 3.4 rated current.** The input current of the equipment as declared by the manufacturer.
- 3.5 rated frequency.** The primary power frequency as declared by the manufacturer.
- 3.6 rated frequency range.** The primary power frequency range as declared by the manufacturer, expressed by its lower and upper values, excluding tolerances.
- 3.7 detachable power supply cord.** A flexible cord, for supply purposes, intended to be connected to the equipment by means of a suitable appliance coupler.
- 3.8 non-detachable power supply cord.** A flexible cord, for supply purposes, fixed to or assembled with the equipment.
- 3.9 operational insulation.** Insulation that is applied between live parts of different potential and is necessary for the correct operation of the equipment.
- 3.10 basic insulation.** Insulation that is applied to live parts to provide basic protection against electric shock.
- 3.11 supplementary insulation.** An independent insulation that is applied in addition to basic insulation, in order to ensure protection against electric shock in the event of a failure of the basic insulation.
- 3.12 double insulation.** Insulation that comprises both basic insulation and supplementary insulation.
- 3.13 reinforced insulation.** A single insulation system that is applied to live parts, provides a degree of protection against electric shock and is equivalent to double insulation under the conditions specified in this standard.

NOTE. The term insulation system does not imply that the insulation is to be in one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

- 3.14 class I equipment.** Equipment in which protection against electric shock does not rely on only basic insulation, but which includes an additional safety precaution in that accessible conductive parts are connected to the protective earthing conductor in the fixed wiring of the building installation in such a way that they cannot become live in the event of a failure of the basic insulation.

NOTE. Class I equipment may have parts with double insulation or reinforced insulation, or parts operating at protected extra-low voltage. For equipment intended for use with a flexible cord, this provision includes a protective earthing conductor as part of the flexible cord.

- 3.15 class II equipment.** Equipment in which protection against electric shock does not rely on only basic insulation, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, as there is no provision for protective earthing or reliance upon installation conditions. Such equipment is of one of the following types.

- (a) Equipment that has a durable and substantially continuous enclosure of insulating material that envelops all conductive parts, with the exception of small parts, such as nameplates, screws and rivets, that are isolated from live parts by insulation at least equivalent to reinforced insulation. This type of equipment is called **insulation-encased class II equipment**.

(b) Equipment that has a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used. This type of equipment is called metal-encased class II equipment.

(c) Equipment that is a combination of the types (a) and (b).

NOTE 1. The enclosure of an insulation-encased class II equipment may form a part or the whole of the supplementary insulation or of the reinforced insulation.

NOTE 2. Class II equipment may be provided with a means for maintaining the continuity of protective circuits, provided that such means are within the equipment and are insulated from accessible surfaces according to the requirements of class II, but if equipment with double insulation and/or reinforced insulation throughout has a protective earthing terminal or contact, it is deemed to be of class I construction.

NOTE 3. Class II equipment may have an earth connection for functional purposes.

NOTE 4. Class II equipment may have parts operating at protected extra-low voltage.

3.16 protected extra-low voltage (PELV) circuit. A circuit that is so designed and protected that under normal conditions and under a single fault condition the voltage between any two accessible circuit parts, one of which may be the body or earth, does not exceed a safe value.

NOTE 1. Under normal conditions, the limit is 42.4 V peak or d.c. Under fault conditions higher limits are specified for transient deviations.

NOTE 2. The expression 'PELV circuit' is used in this standard instead of the expression 'SELV circuit', used in IEC Publication 435. This is to avoid confusion with the term 'SELV' used in IEC Publication 364 with a different definition.

3.17 safety isolating transformer (for use in data processing equipment). A transformer in which windings supplying PELV circuits are so isolated from other windings that an insulation breakdown is either unlikely or does not cause a hazardous condition on PELV windings.

3.18 movable equipment. Equipment that is either:

(a) under 18 kg in mass and not fixed; or

(b) has wheels, castors or other means to facilitate movement by the operator, as required to perform its intended use.

3.19 hand-held equipment. Movable equipment that is intended to be held in the hand during normal use.

3.20 stationary equipment. Either fixed equipment or equipment that is intended to be moved from one place to another only when de-energized and by authorized technical personnel.

3.21 fixed equipment. Equipment that is fastened or otherwise secured at a specific location.

3.22 thermostat. A temperature sensing device, the operating temperature of which may be either fixed or adjustable, and that, in normal use, keeps the temperature of the equipment, or parts of it, between certain limits by automatically opening and closing a circuit.

3.23 tool. A screw-driver or any other object that is used to operate a screw, latch or similar fixing means.

3.24 body. All accessible non-energized conductive parts, and metal foil in contact with all accessible surfaces of insulating material.

3.25 clearance. The shortest distance between two conductive parts, or between a conductive part and the bounding surface of the equipment, measured through air.

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

3.26 creepage distance. The 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.

3.27 secondary circuit. A circuit that has no direct connection to primary power and derives its power from a transformer, convertor or equivalent isolation device situated within the equipment.

NOTE. Some solid state devices may provide equivalent isolation.

3.28 operator access area. Any area to which access may be gained without the use of a tool, any area for which the means of access is deliberately provided for the operator, or any area to which access may be gained by fasteners designed for coin operation.

3.29 hazardous voltage. A voltage exceeding 42.4 V peak or d.c., existing in a circuit that does not comply with the requirement for a limited current circuit.

3.30 energy hazard. A hazard that exists at any accessible conductive part of a piece of equipment if a stored energy level of 20 J or more, or an available continuous power level of 240 VA or more at a potential of 2 V or more exists between the accessible conductive part and an adjacent accessible conductive part of different polarity.

NOTE. Above the PELV limit, the protection required against electric shock will also protect against energy hazards.

3.31 data processing equipment. Electrically operated units that, separately or assembled in systems, accumulate, process and store data.

NOTE. Acceptance and divulgence of data may or may not be by electronic means.

3.32 flammability classification of materials. The recognition of the ignition and burning resistance characteristics of materials other than metallic or ceramic.

NOTE. For the purposes of this standard, materials are classified as in 3.33 to 3.38 inclusive, when tested in accordance with appendix A.

3.33 material classed V-1. A material that, when tested in accordance with A.6, may flame or glow but will extinguish within the specified period of time, and any glowing particles and/or flaming drops released do not ignite subsequent material.

3.34 material classed V-2. A material that, when tested in accordance with A.6, may flame or glow but will extinguish within the specified period of time, and any glowing particles and/or flaming drops released may ignite surgical cotton.

3.35 foamed plastic classed HF-1. A foamed plastic material that, when tested in accordance with A.7, may flame or glow but will extinguish within the specified period of time, and any flaming or glowing particles or flaming drops released do not ignite surgical cotton.

3.36 foamed plastic classed HF-2. A foamed plastic material that, when tested in accordance with A.7, may flame or glow but will extinguish within the specified period of time, and any flaming or glowing particles or flaming drops released may ignite surgical cotton.

3.37 material classed HB. A material that, when tested in accordance with A.8, burns with the specified maximum burning rate.

3.38 foamed plastic classed HBF. A foamed plastic material that, when tested in accordance with A.7, burns with the specified maximum burning rate.

3.39 enclosure. A construction that protects against contact with hazardous parts, and can be an integral part of a component, a separate part of a component, the outer cabinet or a part of the outer cabinet.

3.40 safety interlock. A means of preventing access to a hazardous area until the hazard is removed, or of automatically removing the hazardous condition when access is gained.

3.41 limited current circuit. A circuit that is so designed and protected that under both normal conditions and a likely fault condition the current that can be drawn is not hazardous (see clause 12).

3.42 thermal cut-out. A device that, during abnormal operation of the equipment, limits the temperature of the equipment, or of parts of it, by automatically opening the circuit or by reducing the current, and is so constructed that its setting cannot be altered by the operator or service personnel.

3.43 primary circuit. All internal circuits that are directly connected to the external supply mains or other equivalent source, such as a motor-generator set that furnishes the electric power. This includes the primary windings of transformers, motors, other loading devices and the means of connection to the supply mains.

3.44 extra low voltage (ELV). A voltage between conductors or between a conductor and earth not exceeding 42.4 V peak or d.c., existing in a secondary circuit that does not comply with the requirements for a PELV circuit nor those for a limited current circuit.

NOTE 1. A voltage not exceeding 42.4 V peak or d.c., existing in a circuit that is conductively connected to a primary circuit, is considered to be a hazardous voltage unless the requirements for a limited current circuit are met.

NOTE 2. Parts in non-PELV circuits that are normally below the ELV limit may assume hazardous voltages under fault conditions.

3.45 TN power systems. A power distribution system that has one point directly earthed and the exposed conductive parts of the installation connected to that point by protective earthing conductors. Three types of TN systems are recognized, according to the arrangement of neutral and protective conductors, as follows:

TN-S system: having separate neutral and protective conductors throughout the system (see figure 1);

TN-C-S system: in which neutral and protective functions are combined in a single conductor in a part of the system (see figure 2);

TN-C system: in which neutral and protective functions are combined in a single conductor throughout the system (see figure 3).

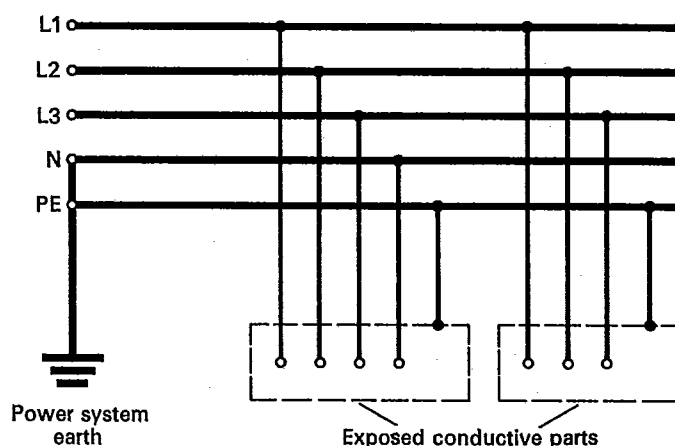


Figure 1. TN-S system

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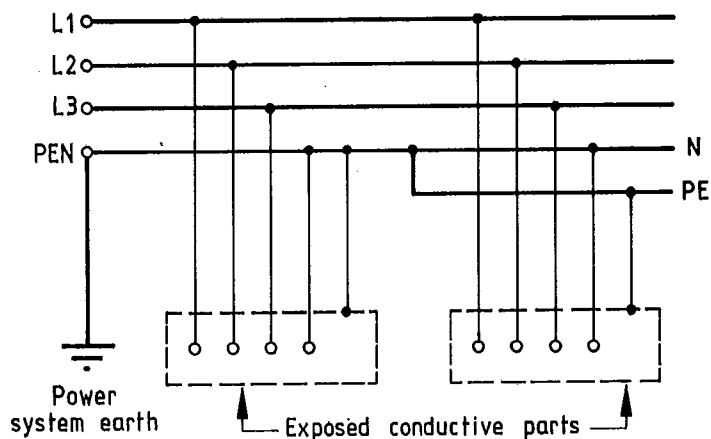


Figure 2. TN-C-S system

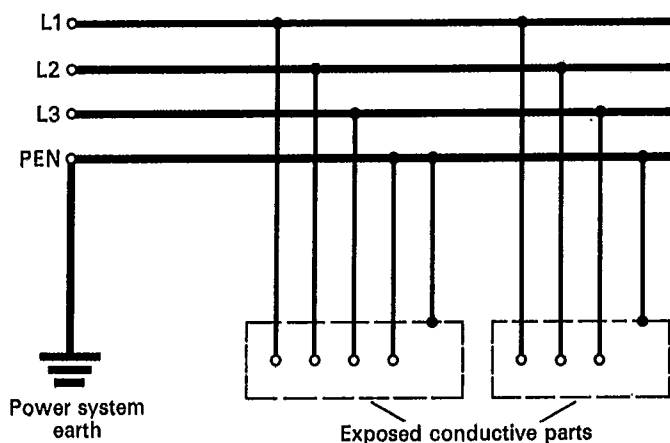


Figure 3. TN-C system

3.46 TT system. A power distribution system that has one point directly earthed and the exposed conductive parts of the electrical installation connected to earth electrodes electrically independent of the earth electrodes of the power system (see figure 4).

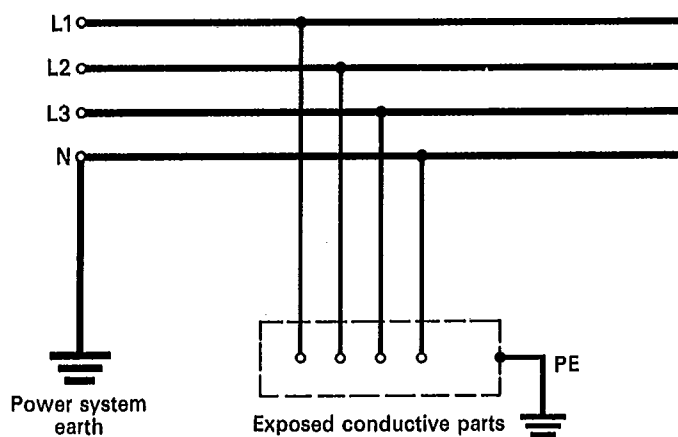


Figure 4. TT system

3.47 IT system. A power distribution system that has no direct connection between live parts and earth and the exposed conductive parts of the electrical installation connected to earth (see figure 5).

3.48 self-resetting thermal cut-out. A thermal cut-out that automatically restores the current after the relevant part of the equipment has cooled down sufficiently.

3.49 non-self-resetting thermal cut-out. A thermal cut-out that requires resetting by hand, or replacement of a part, in order to restore current.

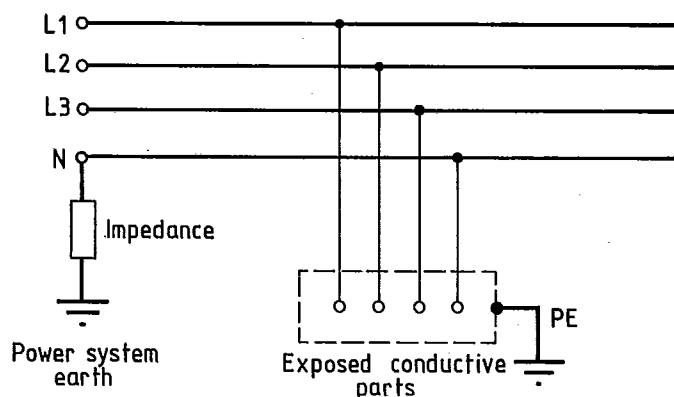


Figure 5. IT system

4. General requirements

- 4.1 For the purposes of this standard the absence or presence of hazards shall be determined by compliance or non-compliance with the requirements of this standard.
- 4.2 Equipment shall be so designed and constructed that, in normal operation and under a likely fault condition, it causes no hazards in accordance with 4.1 to persons or surroundings.
- 4.3 Equipment containing ELV or hazardous voltages shall be class I or class II.
- 4.4 The user shall be provided with sufficient information concerning any condition to ensure that, when used as prescribed by the manufacturer, the equipment will not present a safety or health hazard in accordance with 4.1.

TEST. In general, compliance shall be checked by inspection, by carrying out all the relevant tests or by both inspection and test.

5. General test instructions

- 5.1 The requirements and tests detailed in this standard shall be considered only if safety is involved. If it is evident from the design of the equipment that a particular test is not applicable, the test shall not be made.

TESTS. 5.2 Tests in accordance with this standard are type tests.

- 5.3 Unless otherwise specified, the tests shall be made on a single sample which shall withstand all the relevant tests.

NOTE 1. In view of the large cost involvement in samples, discussion of the test programme with the manufacturer is desirable.

NOTE 2. As an alternative to carrying out tests on the complete equipment, tests may be carried out separately on components and subassemblies, provided that inspection of the equipment and circuit arrangements indicates that such tests will ensure that the assembled equipment complies with the requirements of this standard.

NOTE 3. When it is necessary to employ a destructive test to evaluate the safety of the products, a model representing the condition to be evaluated may be used.

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

- (a) supply voltage;
- (b) supply frequency;
- (c) physical location of equipment and position of movable parts;
- (d) operating mode.

- 5.5 In determining the most unfavourable supply voltage for a test, the following variables shall be considered:

- (a) multiple rated voltages;
- (b) extreme of rated voltage range;
- (c) tolerance on rated voltage as specified by the manufacturer for continuous operation and when no tolerance is specified, it shall be assumed to be $\pm 6\%$.

NOTE. Equipment intended to operate directly from the mains supply should be designed for a minimum supply tolerance of $\pm 6\%$ of rated voltage.

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

- 5.6 In determining the most unfavourable supply frequency for a test, different nominal frequencies within the rated frequency range shall be considered, (e.g. 50 Hz and 60 Hz).

NOTE. Consideration of the tolerance on a rated frequency, (e.g. 50 ± 0.5 Hz) is not normally necessary.

- 5.7 In this standard, maximum temperature rises are specified for compliance with the requirements of certain tests, and the ambient air temperature during the tests need not be controlled, but shall be monitored and recorded. These maximum temperature rises are based on the assumption that the room ambient air temperature

is 25 °C when the equipment is in operation but if the equipment is intended to be operated in a higher room ambient temperature, the specified temperature rises shall be reduced accordingly.

NOTE. Where temperature rises are measured under local ambient conditions of atmospheric pressure and relative humidity, they should be adjusted to allow for adverse limits of pressure, humidity and the effect of partially blocked air filters within the manufacturer's specification.

5.8 Temperature rises of windings shall be determined by the resistance method where practicable (see appendix E). In all other cases, measurement shall be made by the thermocouple or a similar method, using temperature sensors chosen and positioned to have the minimum effect on the temperature of the part under test.

5.9 Equipment for which optional features are offered by the manufacturer shall be tested with those features that give the most unfavourable results, or suitable simulation of these features.

5.10 Equipment containing only protected extra-low voltage circuits shall be tested with the supply device or equivalent.

6. Components

6.1 Where safety is involved, components shall comply with the requirements of this standard and with the safety requirements of the relevant British Standards.

NOTE. In order to establish whether or not safety is involved, a careful investigation of the circuit is recommended, to take into account the consequences of possible failure of components.

This is generally only considered to be necessary for components being used as part of primary circuits or of secondary circuits operating above 42.4 V peak or d.c.

TEST. 6.2

6.2.1 Evaluation and testing of components shall be carried out as specified in 6.2.2 to 6.2.4.

6.2.2 A component certified by a recognized testing authority for compliance with the relevant British Standard shall be checked for correct application and shall be used in accordance with its rating. It 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 British Standard.

6.2.3 A component that is not certified for compliance with a relevant standard as above shall be checked for correct application and use in accordance with its specified rating. It shall be subjected to the applicable tests described in this standard, as part of the equipment, and to the applicable tests described in the relevant component standard, under the conditions occurring in the equipment.

The test for compliance with a relevant component standard shall be carried out separately.

NOTE. The number of test samples is, in general, the same as that required in the component standard.

6.2.4 Where no component standard exists, or where components are used in circuits that are not in accordance with their specified ratings, the components shall be tested under the conditions occurring in the equipment.

NOTE. The number of samples required for test is, in general, the same as that required by an equivalent standard.

6.3 A safety isolating transformer shall be so constructed that a single insulation fault and its consequences will not cause a hazardous voltage to appear on PELV windings.

NOTE 1. This may be achieved by separating the PELV windings from all other windings in accordance with 11.2.

NOTE 2. Appendix C shows examples of the constructional detail that is expected of a transformer designed to comply with these requirements, together with suitable electric strength tests.

6.4 Components that are to be connected to PELV and either to ELV or to a hazardous voltage shall be constructed in accordance with 11.2.

NOTE. An example of such a component would be a relay with different supplies connected to different elements (coils and contacts).

7. Power interface

7.1 The steady state input current of the equipment shall not exceed the rated current by more than 10 % under the most adverse normal operating conditions and at rated voltage.

7.2 The rated voltage of hand-held equipment shall not exceed 250 V.

7.3 Neutral shall be insulated from earth and the body throughout the equipment as if it were a live phase.

7.4 For equipment to be connected to IT power systems (unearthed or impedant neutral), components connected between phase and earth shall be rated at least at the phase-to-phase voltage and components connected between neutral and earth shall be rated at least at the phase-to-neutral voltage.

7.5 Equipment intended to operate directly from the mains supply shall be designed for a minimum supply tolerance of $\pm 6\%$ of the rated voltage.

8. Marking and instructions

8.1 Equipment shall be provided with a power rating plate, the purpose of which is to specify a supply of correct voltage and frequency and of adequate capacity. The power rating plate shall be on a main part of the equipment and easily legible from outside the equipment, if necessary after removal of a cover. The power rating plate shall include the following markings.

(a) The rated voltage(s) or rated voltage range(s), in volts. The voltage range shall have a hyphen (-) between the maximum and minimum rated voltages. When multiple rated voltages or voltage ranges are given, they shall be separated by a solidus (/).

NOTE. Examples of voltage ratings.

(i) A rated voltage range of 220 V - 240 V, means that the equipment is designed to be connected to any supply having a nominal voltage between 220 V and 240 V.

(ii) A multiple rated voltage of 120 V/220 V/240 V, means that equipment is designed to be connected to a supply having a nominal voltage of 120 V or 220 V or 240 V, usually after internal voltage adjustment.

(b) The symbol for nature of supply, for d.c. only in accordance with BS 6217.

(c) The rated frequency or rated frequency range, in hertz, unless the equipment is designed for d.c. only.

(d) The rated current, in 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.

If an equipment is not provided with a means for connection directly to the supply, that equipment need not be marked with the rated current.

The rated current to be marked on the equipment is the total maximum current that can be on circuit at the same time and shall include the combined currents to all equipment in the system that can be supplied through that equipment and operated simultaneously.

(e) The manufacturer's name, trade-mark or identification mark.

(f) The manufacturer's model or type reference.

(g) (For class II equipment only.) The symbol for class II construction, in accordance with BS 6217.

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

When symbols and abbreviations are used, they shall be in accordance with the relevant British Standards.

8.2 Where necessary to ensure that the equipment creates no hazard in accordance with 4.1, the manufacturer shall prepare and have available the necessary instructions for operation, installation, maintenance, transportation and storage.

Where there is doubt about the end use of the equipment, the manufacturer shall clearly state in the instructions, or in a separate manufacturer declaration, that the equipment is intended for data processing use.

NOTE. Maintenance information is normally available only to maintenance personnel.

8.3 For equipment intended for connection to multiple rated voltages or frequencies, the method of adjustment shall be fully covered in the engineering service manual or installation instructions. Unless the means of adjustment is a simple control near the power rating plate 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 plate:

'See installation instructions before connecting the supply.'

8.4 Standard supply outlets in data processing equipment accessible to the operator shall be marked with the maximum permissible load which can be connected to the outlet. This marking shall be placed in the vicinity of the standard supply outlet.

8.5 Where safety is involved, the current rating of fuses shall be indicated. This marking shall be placed on or adjacent to the fixed parts of the fuseholder.

Where fuses with special fusing characteristics are necessary, the type shall also be indicated.

8.6 For class I equipment, terminals intended for the connection of external protective earthing conductors shall be indicated by the symbol $\oplus$, in accordance with BS 6217. This symbol shall not be used for other earthing terminals.

NOTE 1. This applies to terminals for connection of a protective earthing conductor, whether run as an integral part of a power supply cord or with supply conductors in a raceway.

NOTE 2. Because the symbol $\oplus$ has been used widely, not only by manufacturers of data processing equipment but also by manufacturers of components, such as terminal blocks, it is expected that its use will continue for some time.

A terminal intended exclusively for connection of the primary power neutral conductor shall be indicated by the capital letter N.

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

8.7 Unless it is obviously unnecessary, switches and other control devices shall be marked to indicate clearly which function they control.

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

The ON/OFF condition of the power control switch shall be reliably indicated at the operating point. If symbols are used these shall be in accordance with BS 6217.

If figures are used for indicating the different positions, the OFF position shall be indicated by the figure 0 (ZERO) and the position for a greater output, input, speed, cooling effect, etc. shall be indicated by a higher figure.

Markings and indications for switches and other control devices, shall be placed in the vicinity of these components. They shall not be placed on operator-removable parts if these parts can be replaced in such a way that the marking is misleading.

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8.8 Where there is more than one connection supplying hazardous voltage or energy levels to a unit, there shall be a prominent permanent marking close to the service access to the hazardous parts to indicate which disconnect devices isolate each section of the unit and which disconnect device is used to isolate the unit completely.

8.9 The equipment installation instructions shall state whether or not the equipment has been designed, or, when required, needs to be modified, for connection to an IT power system.

8.10 If it is necessary to take special precautions when installing the equipment, details of these shall be given in installation instructions.

NOTE. Special precautions may be necessary, e.g. for connection of the equipment to the supply and the inter-connection of separate units, if any.

For equipment employing PELV circuits, the installation guide and operating handbook shall carry a warning to take care to ensure that the integrity of the PELV system is maintained when interfacing to other parts of equipment takes place.

If equipment is not provided with a disconnect device in accordance with clause 14, the installation instructions shall state that:

- (a) for equipment permanently connected to the primary power supply, an easily accessible disconnect device shall be incorporated in the fixed wiring;
- (b) for equipment connected to the primary power supply by means of a non-detachable flexible cord and a plug, the socket outlet shall be installed near the equipment and shall be easily accessible.

Where operator access to earthed PELV circuits is possible, the installation instructions shall be in accordance with clause 13.

8.11 Instructions and equipment marking related to safety shall be in a language that is acceptable in the country in which the equipment is to be installed.

8.12 Equipment with high leakage current shall carry a warning label in accordance with 28.5 and G.4.

8.13 Marking shall be durable and easily legible.

In considering the durability of the marking, the effect of normal use and cleaning shall be taken into account.

Section two. Safe electrical design

9. Protection against electric shock and energy hazards

9.1 For the purposes of protection against electric shock, live parts shall be classified into the following three groups:

- (a) parts that operate in PELV circuits or in limited current circuits;
- (b) parts that normally operate at hazardous voltages;
- (c) parts that normally operate at ELV and may assume hazardous voltages due to breakdown of basic insulation or the failure of a single component.

NOTE 1. It is the intention of this standard to prevent operator contact with the following:

- (1) bare parts operating at hazardous voltages;
- (2) the operational or basic insulation of such parts;
- (3) bare parts normally operating at ELV.

Operator contact with the following is not prohibited:

- (4) bare parts in PELV circuits;
- (5) bare parts in limited current circuits;
- (6) insulation of parts normally operating at ELV under the conditions specified in 9.2.2.

NOTE 2. Precautions against accidental contact by the service personnel are not required for any secondary circuits that operate at less than 42.4 V peak a.c. or 60 V d.c. including a ripple of not more than 10 %.

9.2

9.2.1 Equipment shall be so constructed that there is adequate protection against accidental contact with parts at ELV or hazardous voltages and, for class II equipment and, where applicable for class I equipment, with unearthed conductive parts separated from parts at hazardous voltages by basic insulation only. This requirement shall apply for all positions of the equipment when it is wired and operated as in normal use, even after removal of operator-detachable parts, except lamps, and with operator access covers open.

NOTE. This requirement precludes the use in operator access areas of fuse types and miniature circuit breakers that are unable to withstand the accessibility test with the test finger (see figure 13).

TEST. Compliance shall be checked by inspection and by a test with the standard test finger. In addition, apertures in class II equipment and apertures in class I equipment, other than those in conductive parts connected to an earthing terminal or earthing contact, shall be tested with the test pin (see figure 14). The test finger and the test pin shall be applied, without appreciable force, in every possible position, except that equipment normally used on the floor and having a mass exceeding 40 kg shall not be tilted.

Testing shall be carried out with access to the equipment limited according to the method of mounting the equipment as detailed by the manufacturer (e.g. wall-mounting, etc.). Apertures preventing the entry of the finger

shall be further tested by means of a straight unjointed version of the test finger which is applied with a force of 30 N. If this finger enters, the test with the test finger (see figure 13) shall be repeated, the finger being pushed through the aperture, if necessary.

NOTE 1. An electrical contact indicator may be used to show contact.

NOTE 2. Where electrical indication of contact is used, care should be taken to ensure that the application of the test does not damage components of electronic circuits.

It shall not be possible to touch the following parts with the test finger:

- (a) bare parts at hazardous voltages;
- (b) the operational or basic insulation of parts or wiring at ELV or hazardous voltages except as permitted by the requirements of 9.2.2.

In addition, for class II equipment, and, where applicable, for class I equipment, it shall not be possible to touch conductive parts separated from parts at ELV or hazardous voltages by only operational or basic insulation with the test finger, nor to touch bare parts at hazardous voltages with the test pin.

Parts at ELV or hazardous voltages, protected only by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compounds other than self-hardening resin, shall be considered to be bare conductive parts.

If components are movable, e.g. for the purpose of belt tensioning, the test with the test finger shall be made with each component in its most unfavourable position within the range of adjustment, the associated parts (such as the belt) being, if necessary, removed for this purpose.

9.2.2 Operator contact with the insulation of internal parts of wiring at ELV shall be prevented unless this insulation is both:

- (a) not subject to damage or stress nor required to be handled by the operator in performing normal operator functions; and
- (b) capable of withstanding the electric strength test for basic insulation at the hazardous voltage.

In addition, the insulation between the ELV and the hazardous voltage shall be capable of withstanding the electric strength test for supplementary insulation at the hazardous voltage.

9.3 There shall be no energy hazard in an operator access area.

TEST. Compliance shall be checked by means of the test bar (see figure 15) applied without appreciable force. It shall not be possible to bridge with this test bar any two parts, one of which may be an earthed conductive part, between which an energy hazard exists.

Clearances behind conductive covers, whether earthed or not, shall be adequate to ensure that no energy hazard arises during the test described in item (b) of clause 22.

9.4 With regard to the electrical requirements of this standard, conducting liquids shall be treated as conductive parts.

9.5 Shafts of operating knobs, handles, levers and the like shall not be at hazardous voltages.

TEST. Compliance shall be checked by inspection.

9.6 Handles, levers and knobs that are held or actuated in normal use shall either be of insulating material or adequately covered by insulating material if the shafts or fixings are likely to acquire hazardous voltages in the event of an insulation fault. This requirement shall not apply to handles, levers and knobs other than those of electrical components, provided they are either reliably connected to an earthing terminal or earthing contact or separated from parts at hazardous voltages by earthed metal.

TEST. Compliance shall be checked by inspection.

9.7 For class II equipment, capacitors operating in non-PELV circuits shall not be connected to accessible conductive parts, and their casings, if conductive, shall be separated from accessible conductive parts by supplementary insulation.

TEST. Compliance shall be checked by inspection and by the tests described for supplementary insulation.

9.8 Equipment intended to be connected to the supply by means of a plug shall be so designed that, in normal use, there is no risk of electric shock from charged capacitors when touching the pins of the plug.

TEST. Compliance shall be checked by the following test, which shall be performed only if the rated capacitance exceeds 0.1 μF . The equipment shall be operated at rated voltage or at the upper limit of the rated voltage range. The equipment ON/OFF switch, if any, is then moved to the OFF position and the equipment disconnected from the supply by means of the plug. One second after disconnection, the voltage between the pins of the plug is measured with an instrument that does not appreciably affect the value to be measured. The test shall be performed ten times. The voltage shall not exceed 34 V peak.

The test shall then be repeated ten times with the equipment switch left ON.

9.9 In areas to which operators have no access but where it is necessary for service personnel to have access for maintenance purposes with the equipment switched on, uninsulated parts operating at more than 42.4 V peak a.c. or 60 V d.c. shall be so located or guarded that unintentional contact with such parts is unlikely during servicing operations involving other parts of the unit.

Uninsulated parts that involve an energy hazard shall be so located or guarded that they are not likely to be contacted simultaneously by conductive materials that might be present during service operations.

NOTE. Required guards should be easily removable and replaceable if removal is necessary to service the protected parts.

TEST. Compliance shall be checked by inspection.

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10. Insulation

10.1 Electrical insulation shall be designed either by using solid or laminated insulating materials having adequate thickness and adequate creepage distances over their surfaces or by using adequate clearances through air or by a combination of the two methods.

10.2 Electrical, thermal and mechanical strength of insulating materials shall be adequate.

10.3 Electric strength shall be assessed in accordance with clause 29 and, when appropriate, creepage distances, clearances and distance through insulation shall be assessed in accordance with clause 17.

NOTE, Insulation in thin layers is considered to have adequate dielectric strength when, for supplementary insulation, at least two layers of material are used one of which will pass the electric strength test for supplementary insulation, and, for reinforced insulation, at least three layers of material are used, two of which will pass the electric strength test for reinforced insulation.

10.4 For the purposes of determining test voltages and the dimensions for a given piece of insulation, two parameters shall be considered.

(a) Application (see 10.5).

(b) Working voltage (see 10.6).

10.5 The application of insulation shall be classified as one of the following:

(a) operational (see 3.9);

(b) basic (see 3.10);

(c) supplementary (see 3.11);

(d) reinforced (see 3.13).

NOTE, Examples of situations where these types of insulation are required are as follows.

(1) *Operational*:

(i) between live parts of different potential;

(ii) between ELV or PELV and earthed conductive parts.

(2) *Basic*:

(i) between parts at hazardous voltage and earthed conductive parts;

(ii) between parts at hazardous voltage and PELV circuits that rely on being earthed for their integrity;

(iii) between primary power conductors and the earthed screen or core of a primary power transformer;

(iv) between ELV complying with the requirements in 9.2.2 and unearthed conductive parts or PELV circuits.

(3) *Supplementary*. Generally, between an accessible part and a part that could become hazardous in the event of failure of basic insulation, e.g.:

(i) between the outer surface of handles, knobs, grips and the like, and their shafts unless earthed;

(ii) between the equipment body and the outer cover of a flexible supply cord on class II equipment, where the cord enters the enclosure;

(iii) between a floating non-PELV secondary circuit and unearthed conductive parts of the body;

(iv) between ELV (other than that complying with the requirements of 9.2.2) and unearthed conductive parts or PELV circuits.

(4) *Reinforced*. Generally, between a non-earthed accessible conductive part and a part at hazardous voltage, e.g.:

(i) between an earthed secondary circuit operating at more than 42.4 V peak or d.c. and a floating PELV circuit;

(ii) between a floating PELV circuit and a primary power part.

10.6 Except for insulation in transformers, where the r.m.s. value of working voltage is used, a sinusoidal a.c. waveform shall be assumed. Where the d.c. value of working voltage is used, allowance shall be made for the peak value of any superimposed ripple.

Where double insulation is used, the same working voltage is applicable to each of the constituent layers of basic and supplementary insulation and shall be taken as the working voltage across the double insulation.

Where a circuit is floating, i.e. not connected in such a way as to establish a potential relative to earth, the working voltage shall be determined by assuming that the floating circuit is to be earthed at the point by which the highest insulation working voltage is obtained.

NOTE, For working voltage in safety isolating transformers see C.2.

10.7 Insulation materials assuring safety shall be suited to the climatic environment in which the equipment is to be used (as specified by the manufacturer).

Natural rubber shall not be used as insulation. Wood, cotton, silk, ordinary paper and similar fibrous or hygroscopic material shall not be used as insulation, unless impregnated. Insulating material shall be considered to be impregnated if the interstices between the fibres of the material are substantially filled with a suitable insulant.

NOTE, Asbestos is considered to be fibrous material for the purposes of this standard.

11. Protected extra-low voltage (PELV) circuits

11.1 In a single PELV circuit or in interconnected PELV circuits, the voltage between any circuit parts or between any circuit part and earth or body shall not exceed 42.4 V peak or d.c. under normal conditions.

11.2

11.2.1 Unless the PELV circuit is protected as specified in 11.4, it shall be separated from parts at ELV or hazardous voltages in accordance with the following requirements, implemented as specified in 11.3.

NOTE. It is necessary to consider the possibility of accidental connection between PELV circuits and parts at hazardous voltages either:

- (a) directly; or
- (b) indirectly through parts or windings that are not at hazardous voltages (consequential hazards).

11.2.2 One of the two following methods of separation between PELV circuits and parts at hazardous voltages shall be employed:

- (a) by insulation having creepage distances, clearances and thickness through insulation complying with the requirements for double insulation or reinforced insulation appropriate to the working voltages involved; or
- (b) by an earthed conductive screen or other earthed conductive parts; insulation between the parts at hazardous voltages and the earthed parts shall comply with the requirements for basic insulation appropriate to the working voltage involved.

The application of each method of separation shall be as shown in figure 6.

Between PELV and:	Separation required
Hazard	Double or reinforced insulation or earthed conductive screen with basic insulation
Consequential hazard	Supplementary insulation at A or B and basic insulation at B or A so that A+B is double insulation; or, basic insulation at A and an earthed conductive screen at B
HAZARD* CONSEQUENTIAL† HAZARD PELV A B	
Any other part	Operational insulation

*Hazards are parts in:

- (a) primary circuits; or
- (b) secondary circuits that are normally operating over 42.4 V peak or d.c. and do not meet the requirements for limited current circuits.

†Consequential hazards are unearthed conductive parts that do not normally separate at over 42.4 V peak or d.c., but are not separated from a hazard by double or reinforced insulation or by an earthed metal screen.

Figure 6. Separation between PELV circuits and parts at hazardous voltages

11.3

11.3.1 Equipment shall be constructed to comply with the requirements 11.3.1.1 to 11.3.1.5 inclusive, except for ELV circuits which shall comply with the requirements of only 11.3.1.1 provided that the design is such that the PELV circuits are protected as specified in 11.4.

11.3.1.1 Where both PELV circuits and parts at hazardous voltage are present in a component or assembly, they shall be separated by double or reinforced insulation or by earthed conductive parts. Creepage distances and clearances between the circuits shall comply with the requirements specified in clause 17 for the appropriate type of insulation.

Where a PELV circuit is protected as specified in 11.4, it may alternatively be separated from parts at hazardous voltage by basic insulation and creepage distances and clearances complying with the requirements for basic insulation.

11.3.1.2 A means, other than terminal pressure, shall be provided to prevent ring-tongue and similar terminations from pivoting so as to reduce creepage distances and clearances between PELV circuits and parts at ELV or hazardous voltage below the specified minimum values.

11.3.1.3 In multiway plugs and sockets and wherever shorting could otherwise occur, a means shall be provided to prevent contact between parts at hazardous voltage and PELV circuits due to loosening of a terminal or breaking of a wire at a termination.

11.3.1.4 Uninsulated parts at ELV or hazardous voltage shall be covered or shielded or so located as to avoid accidental shorting to PELV circuits, i.e. by tools or test probes.

11.3.1.5 It shall not be possible to mate plugs and sockets in such a way that a PELV circuit is connected to parts at ELV or hazardous voltages.

NOTE. This may be achieved by the design or the location of the connector.

11.3.2 Except where the PELV circuit is protected as specified in 11.4, wiring for PELV circuits shall be separated from wiring at hazardous voltage by one of the following methods:

- (a) permanent separation by barriers, routing or suitable fixing;
- (b) separation by an earthed metallic screen;
- (c) separation by an additional layer of insulation complying with the requirements for supplementary insulation that may be in the form of an insulating sheet over either the PELV wiring or wires over the hazardous voltage wires;
- (d) insulation of all internal wiring to be rated for highest working voltage present (see 18.5);
- (e) insulation on either wiring of PELV circuits, or wiring at hazardous voltage, complying with the requirements for reinforced insulation for the highest voltage present.

11.4 Where the separation between a PELV circuit and parts at hazardous voltage does not comply with the requirements of 11.2, the PELV circuit shall be connected to earth, or provided with another reliable means of protection.

NOTE. Reliable means of protection may be components or circuits such as: fuses, circuit breakers, electronic over-voltage protection and electronic over-current protection.

This protection shall ensure that, in the event of a fault, operator-accessible parts are prevented from exceeding 42.4 V or d.c. for more than 0.2 s, with a limit of 65 V peak or d.c.

11.5 A means shall be provided to ensure that a PELV circuit connected to a winding on a transformer does not acquire hazardous voltage due to breakdown of basic insulation in the transformer.

Either a safety isolating transformer (see 6.3) shall be used or the PELV circuit shall be protected in accordance with 11.4.

11.6 PELV circuits shall not be interconnected with other circuits unless the design is such that protective devices and/or relative impedance and relative current-carrying capacity prevent the PELV circuit exceeding 42.4 V peak or d.c. for more than 0.2 s in the event of any likely insulation or component failure, with a limit of 65 V peak or d.c.

NOTE. Control circuits having working voltages in excess of 42.4 V peak or d.c. between PELV circuits and transformer output windings are classed as other circuits for the purposes of this clause.

11.7 PELV circuits shall not be conductively connected to the primary power supply circuit (including the neutral) within the equipment.

11.8 Where PELV circuits in two pieces of equipment are connected by signal cables, and the equipments are separately connected to different safety earth sources, either:

- (a) each set of PELV circuits shall be connected to its local earth terminal, in which case it may be necessary to include isolating devices (e.g. transformers, relays or opto-isolators) in the signal circuits; or
- (b) where the PELV circuits at one end are isolated from the local earth and are connected to the remote earth, operator access to these circuits shall be prevented.

12. Limited current circuits

12.1 The steady-state current drawn through a non-inductive resistor of 2000 Ω connected between an accessible part of a limited current circuit and either pole of the circuit supply or earth, shall not exceed 0.7 mA peak a.c. or 2 mA d.c. For frequencies above 1 kHz, the limit of 0.7 mA shall be multiplied by the numerical value of the frequency in kHz, but shall not exceed 70 mA peak.

12.2 For accessible parts not exceeding 450 V peak or d.c., the circuit capacity shall not exceed 0.1 μ F.

12.3 For accessible parts not exceeding 15 000 V peak or d.c., the available stored charge shall not exceed 45 μ C.

12.4 For accessible parts exceeding 15 000 V peak or d.c., the available energy shall not exceed 350 mJ.

12.5 Limited current circuits shall be so designed that the limits specified in 12.1 to 12.4 are not exceeded in the event of breakdown of any basic insulation or a single component failure.

Segregation of limited current circuits from circuits at hazardous voltage shall be as specified in 11.2 for PELV circuits.

TEST. Compliance shall be checked by inspection and measurements.

13. Provisions for protective earthing

13.1 Accessible conductive parts, in which a hazardous voltage can develop in the event of a fault in basic insulation, shall be reliably connected to an earthing terminal within the equipment. Such equipment shall be deemed to be class I equipment.

Conductive parts behind a cover that does not comply with the requirements of clause 22 shall be deemed to be accessible.

If accessible parts such as removable covers, detachable conductive parts and insulated conductive parts are not earthed they shall be separated from parts at hazardous voltages by either:

- (a) earthed metal, solid supplementary insulation or reinforced insulation;
- (b) a clearance of not less than 13 mm, in which case the accessible parts shall comply with the requirements of clause 22 and all related parts shall be fixed in such a way that they cannot come into contact with each other due to a failure of fixing or termination or accidental displacement of removable covers.

NOTE. For the purpose of item (b) contact with operational or basic insulation is regarded as physical contact with a part at hazardous voltage.

Class II equipment shall have no provision for protective earthing, except that it may be provided with a means for maintaining the continuity of protective earth circuits to other equipment within the system. If class II equipment has an earth connection for functional purposes, the earth circuit shall be separated from parts at hazardous voltages by double or reinforced insulation.

TEST. Compliance shall be checked by inspection.

13.2 Protective earthing conductors shall not contain switches or fuses.

If a data processing system is made up of a group of class I and class II units, the interconnection of the units shall be such that the earthing connection shall be assured for all class I units irrespective of the arrangement of the units in the system.

Protective earthing conductors may be bare or insulated and, if insulated, the insulation shall be green/yellow except in the case of earthing braids which may use transparent insulation. Earthed conductive parts shall not be electrically connected to the neutral terminal, if any.

Protective earth connections shall not be such that disconnection of a protective earth at one assembly can break the earthing connection to other assemblies, if this can cause a hazard.

If operator detachable parts have an earth connection, this connection shall be made before the current-carrying connections are established when placing the part in position, and the current-carrying connections shall be separated before the earth connection is broken when removing the part.

Protective earth connections shall be so designed that they do not have to be disconnected for servicing, other than for the removal of the part that they serve or where removal of hazardous voltages from that part is accomplished at the same time.

13.3 Protective earthing terminals for fixed supply conductors or for non-detachable power supply cords shall comply with the requirements of clause 20, but screwless terminals shall not be used.

Terminals for the connection of external protective earthing conductors shall not be used to provide earthing continuity between different parts of the equipment. The means of clamping protective earthing terminals shall be adequately locked against accidental loosening and it shall not be possible to loosen them without the aid of a tool.

TEST. Compliance shall be checked by inspection and by manual test.

NOTE. In general, the designs commonly used for current-carrying terminals, other than some terminals of the pillar type, provide sufficient resilience to comply with the requirement that it should not be possible to loosen them without the aid of a tool. For other designs special provisions, such as the use of an adequately resilient part that is not likely to be removed inadvertently, may be necessary.

13.4 The metals in contact at protective earth connections shall not be subject to corrosion due to electro-chemical action in any working, storage or transport environment conditions as specified in the instruction sheets, see 8.2.

The protective earthing terminal shall be resistant to significant corrosion.

NOTE 1. Corrosion resistance may be achieved by a suitable plating or coating process. If the body of the protective earthing terminal is a part of a frame or enclosure of aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between the frame and copper or its alloys.

NOTE 2. Guidance on corrosion at bi-metallic contacts may be found in PD 6484.

TEST. Compliance shall be checked by inspection.

13.5 The connection between the protective earthing terminal or contact, and parts required to be earthed thereto, shall be of low resistance.

TEST. Compliance shall be checked by the following test.

The test current shall be 1.5 times the current capacity of any hazardous voltage circuit at the point where a basic insulation failure would make the earthed conductive part live. The test voltage shall not exceed 12 V and the test current may be either a.c. or d.c. When it is obvious that the earthing contact and associated parts are adequate, a 25 A, 12 V a.c. tester shall be used.

The voltage drop between the earthing terminal or earthing contact and the parts required to be earthed shall be measured and the resistance calculated from the current and this voltage drop. The resistance of the protective earthing conductor of the power supply cord shall not be included in the resistance measurement.

On large equipment where the safety earth connection to a sub-assembly is by means of one core of a multicore cable supplying mains power to that sub-assembly, the resistance of the cable shall not be included in the resistance measurement, provided that the cable is protected by a suitably rated overcurrent device.

In no case shall the resistance exceed 0.1 Ω .

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

13.6 Where operator access to earthed PELV circuits is possible, touch voltages between the PELV circuits and any accessible metalwork in the room (e.g. structural steel, partitions, radiators, other earthed class I equipment etc.) shall be limited. The installation instructions shall require that the body of the data processing equipment, other accessible metalwork in the room, and the safety earth connections of all electrical circuits in the room, shall be conductively connected together, either by separate connections to the building earth, or by bonding within the room, or by a combination of the two methods.

14. Primary power isolation

14.1 A disconnect device shall be provided to disconnect the equipment from the supply for servicing.

This disconnect device shall have a contact separation of at least 3 mm and, when incorporated in the equipment, shall be connected as closely as is practicable to the incoming supply.

Parts remaining live when the disconnect device is switched off shall be shielded to prevent accidental contact by service personnel.

Where a unit or group of units is to be permanently connected to the supply, the disconnect device shall be incorporated in the equipment, unless the equipment is accompanied by installation instructions stating that the disconnect device shall be provided as part of the building installation in accordance with 8.10.

NOTE 1. External disconnect devices will not necessarily be supplied with the equipment.

When an isolating switch is used, it shall not be fitted in a flexible cord.

NOTE 2. The requirements for disconnect devices do not apply to functional switches where other means of isolation are provided.

NOTE 3. Examples of disconnect devices are:

- (a) the plug on the power supply cord of pluggable equipment;
- (b) isolating switches;
- (c) circuit breakers;
- (d) any equivalent device offering a degree of safety equal to the above.

NOTE 4. Requirements for disconnect devices are still under consideration. Devices complying with the requirements of BS 3955 are deemed to comply with the requirements of this standard.

14.2 For single-phase equipment, the disconnect device shall disconnect both poles simultaneously, except that where an earthed neutral can be reliably identified, it need not be disconnected.

NOTE 1. Two examples of cases where a two-pole disconnect device is required are for equipment supplied:

- (a) from an IT power system;
- (b) through a reversible plug (unless the plug is used as a disconnect device).

For three-phase equipment, the disconnect device shall simultaneously disconnect all live poles of the supply.

NOTE 2. The neutral of an IT power system is considered to be a live pole.

If any disconnect device interrupts the neutral, it shall simultaneously interrupt all poles.

14.3 For pluggable equipment, if the plug on the power supply cord is used as the disconnect device, the installation instructions shall comply with the requirements of 8.10.

For class I pluggable equipment, when connecting and disconnecting the supply plug (and the appliance coupler, if any), the protective earthing connection shall be made earlier than the phase connection and shall disconnect later than the phase disconnection.

14.4 Where a group of units having individual pluggable or permanent supply connections is interconnected in such a way that hazardous voltage or energy levels can be transmitted between units, a disconnect device shall be provided to disconnect hazardous parts likely to be contacted while the unit under consideration is being serviced, unless these parts are shielded and marked with appropriate warning labels. In addition, a prominent warning label giving adequate instructions for the removal of all power from the unit shall be provided on each unit.

14.5 Where a unit receives power from more than one source (e.g. different voltages/frequencies or as redundant power), there shall be a prominent marking at each disconnect device giving adequate instructions for the removal of all power from the unit.

When more than one such disconnect device is provided on a unit, all these devices shall be grouped together.

NOTE. It is not necessary that they be in close proximity to one another nor that they be mechanically interconnected.

15. Protection of internal wiring

15.1 All internal wiring, including bus bars and interconnecting cables used in the distribution of primary power shall be protected against excess current and short circuit by suitably rated protection devices.

NOTE 1. Rated protection devices may be included as integral parts of the equipment or as parts of the building installation.

Short runs of wiring not directly involved in the distribution path shall not require protection where it can be shown that no safety hazard is involved (e.g. indicating circuits).

NOTE 2. Devices for overload protection of components may also provide protection of associated wiring. Internal branch circuits may require individual protection depending on reduced wire size and length of conductors.

15.2 For class I equipment, protection devices that protect against earth fault shall be connected in all phase conductors of the supply. If any such device interrupts the neutral conductor, it shall also interrupt all other supply conductors simultaneously. Examples for the supply system most commonly found are given in table 1.

NOTE. Fuses may be used in each pole of the supply to protect a removable single-phase subassembly such as a power supply unit intended to be removed by service personnel from the equipment for repair, provided that the fuses are incorporated in the subassembly and are adequately labelled.

15.3 In situations where earth faults are unlikely, (e.g. class II equipment), the minimum number of protection devices provided in primary power circuits, and their locations, shall be as given in table 2.

15.4 All protective devices that are not capable of breaking the prospective short circuit fault current shall be provided in turn with appropriate short circuit back-up protection.

Table 1. Devices affording protection against earth faults, for class I equipment

Supply system	Number of supply conductors	Minimum number of fuses or circuit breaker poles	Location
Single phase with earthed neutral reliably identified*	2	1	Phase conductor
Other single phase	2	2	Both conductors
three-phase	3	3	All conductors
three-phase earthed neutral	4	3†	All phase conductors
three-phase IT	4	4	All conductors

*Applies also to a single phase supply system with unearthed neutral where location of a protection device in the phase conductor is ensured (see also 15.5).

†Applies only if neutral is the same size as the phase conductor. If the neutral is of smaller size, a four-pole circuit breaker is required, with one pole in each conductor.

Table 2. Devices affording protection against earth faults, for equipment other than class I

Supply system	Number of supply conductors	Minimum number of fuses or circuit breaker poles	Location
Phase-neutral or phase-phase	2	1	Either conductor
three-phase	3	2	Any two conductors
three-phase and neutral	4	3‡	Each phase conductor

‡Applies only if neutral is the same size as the phase conductor. If the neutral is of smaller size, a four-pole circuit breaker is required, with one pole in each conductor.

15.5 If any protection in accordance with clause 15 is obtained from protection devices that are part of the building installation, they shall be specified in the installation instructions.

NOTE. For single phase equipment intended to be connected to standard supply outlets, it is assumed that the building installation provides protection in accordance with the rating of the wall outlet, and appropriate back-up protection.

15.6 Protection systems shall:

- operate automatically at current values that are suitably related to the safe current ratings of the circuits;
- be capable of reliably breaking the maximum fault current that may flow, taking into consideration the back-up protection that is provided or specified;
- be so constructed and positioned that their operation does not cause hazard;
- be so constructed and positioned that their characteristics are not adversely affected by normal operating conditions;
- be mounted as specified if requiring special mounting positions.

NOTE. Two or more protection devices may be combined in one component.

16. Safety interlocks

16.1 Safety interlocks shall be provided where access is required without the use of a tool to areas normally presenting hazards in accordance with 4.1, i.e. in situations where access can be gained by removal of covers, opening of enclosures, or withdrawal of parts of enclosures (doors, casings, lids, covers, etc.).

16.2 Safety interlocks shall be so designed that the hazard will be reduced to an acceptable level before the cover, door, etc. is in any position that will permit contact of the test finger (see figure 13) with hazardous parts as follows.

- For live parts at hazardous voltages, the design shall be such that removal, opening or withdrawal:
 - necessitates previous de-energization of such parts; or
 - initiates automatic disconnection of the supply to such parts.
- After operation of a guard interlock switch where circuit capacitance might otherwise cause a hazardous voltage or energy hazard to persist between accessible live parts a means of discharge shall be provided to ensure that the voltage does not exceed 42.4 V peak or d.c. and the energy level does not exceed 20 J, 5 s after operation of the interlock switch.
- For moving parts, the design shall be such that removal, opening or withdrawal:
 - necessitates previous reduction of movement to a safe level; or
 - initiates automatic reduction of movement to a safe level.