

Specification for

Safety of information technology equipment, including electrical business equipment

The European Standard EN 60950 : 1992 has the status of a
British Standard

Sécurité des matériels de traitement de
l'information, y compris les matériels de
bureau électriques

Sicherheit von Einrichtungen der
Informationstechnik einschließlich elektrischer
Büromaschinen

UDC 681-3 : 651.2 : 620.1 : 614.8

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Contents

	Page
Cooperating organizations	Inside front cover
National foreword	i
Foreword	2
Text of EN 60950	3
National annex NA (informative) Original IEC text amended by CENELEC common modifications	185
National annex NB (informative) Committees responsible	Inside back cover
National annex NC (informative) Cross-references	Inside back cover
National annex ND (informative) Measuring instrument for earth leakage current test .	2

National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Policy Committee and is the English language version of EN 60950 : 1992 *Safety of information technology equipment, including electrical business equipment, including Amendment A1 and Amendment A2* published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by CENELEC from IEC Publication 950 : 1991 second edition, as amended by Amendment No. 1 : 1992 and Amendment No. 2 : 1993 published by the International Electrotechnical Commission (IEC). It supersedes BS 7002 : 1989.

The foreword of EN 60950 makes reference to the date of withdrawal, dow, of the relevant national standard. In this case the relevant national standard is BS 7002 : 1989, which will cease to be applicable to information technology equipment within the scope of EN 60950 on 1995-03-01. Certification and marks will not be awarded after this date with respect to BS 7002 : 1989. However, such certification and marks, already awarded, may continue to apply to production until 2000-03-01.

The foreword of the EN Amendment A1 makes reference to the 'date of withdrawal (dow) of conflicting national standards' as '1995-03-01'. In this case the conflicting national standard is BS EN 60950 : 1992 but the 'dow' relates only to those parts of the British Standard subject to Amendment No. 1. Certificates and marks will not be awarded after this date with respect to the British Standard not incorporating Amendment No. 1. They will be awarded with respect only to the amended British Standard. However, such certificates and marks already awarded with respect to the British Standard not incorporating Amendment No. 1 may continue to apply for production until 2000-03-01.

The foreword of the EN Amendment A2 makes reference to the 'date of withdrawal (dow) of conflicting national standards' as 1995-03-01. In this case the conflicting national standard is BS EN 60950 : 1992 but the 'dow' relates only to those parts of the British Standard subject to Amendment No. 2. Certificates and marks will not be awarded after this date with respect to the British Standard not incorporating Amendment No. 2. They will be awarded with respect only to the amended British Standard. However, such certificates and marks already awarded with respect to the British Standard not incorporating Amendment No. 2 may continue to apply for production until 2000-03-01.

Annex D of EN 60950/A2 makes reference to the measuring instrument for earth leakage current testing as given in annex D of EN 60950 : 1992 (unamended). For information, the unamended annex D of EN 60950 : 1992 is reproduced in national annex ND.



The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a side line in the margin. Parts of the original IEC text that have been modified by CENELEC have been quoted in national annex NA.

In this standard, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type;*
- notes and other informative matter: in smaller roman type;
- conditions applicable to tables: in small roman type;
- terms that are defined in 1.2: SMALL CAPITALS.

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

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60950/A2

August 1993

UDC 681.3:651.2:620.1:614.8

Descriptors: Information technology equipment, business equipment, personal computer, safety

Amendment A2 to the English version of EN 60950

Safety of information technology equipment,
including electrical business equipment

(IEC 950 : 1991/A2 : 1993, modified)

Sécurité des matériels de traitement de
l'information, y compris les matériels de
bureau électriques
(CEI 950 : 1991/A2 : 1993, modifiée)

Sicherheit von Einrichtungen der
Informationstechnik, einschließlich
elektrischer Büromaschinen
(IEC 950 : 1991/A2 : 1993, modifiziert)

This amendment A2 modifies the European Standard EN 60950 : 1992. It was approved by CENELEC on 6 July 1993. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

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

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

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

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

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

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Foreword

At the request of the 71st Technical Board of CENELEC, the manuscript of amendment 2 to the International Standard IEC 950 : 1991 was submitted to the CENELEC Unique Acceptance Procedure (UAP) in November 1992 for acceptance as a European Standard.

The reference document, with common modifications as prepared by Reporting Secretariat SR 74, was approved by CENELEC as amendment A2 to EN 60950 on 6 July 1993.

The following dates were fixed:

- latest date of publication
of an identical national
standard (dop) 1994-03-01
- latest date of withdrawal
of conflicting national
standards (dow) 1995-03-01

For products which have complied with EN 60950 : 1992 and its amendment A1 : 1993 before 1995-03-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-03-01.

NOTE. The following amendments have been made to annexes ZB and ZC:

Annex ZB – Special national conditions:

A new special national condition for Norway has been allowed for subclauses 2.3.9, 2.9.1 and 5.4.9.

The special national condition for Denmark for subclause 5.4.1 has been deleted.

Annex ZC – A-deviations:

The UK deviation for subclauses 2.8.4 and 2.8.5 has been deleted.

The Norwegian deviation for subclause 5.4.9 has been transferred to annex ZB (Special national conditions) and the one for subclause 6.3 has been deleted.



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60950/A1

January 1993

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Descriptors: Information technology equipment, business equipment, personal computer, safety

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Safety of information technology equipment,
including electrical business equipment

(IEC 950 : 1991/A1 : 1992)

Sécurité des matériels de traitement de
l'information, y compris les matériels de
de bureau électriques
(CEI 950 : 1991/A1 : 1992)

Sicherheit von Einrichtungen der
Informationstechnik, einschließlich
elektrischer Büromaschinen
(IEC 950 : 1991/A1 : 1992)

This amendment A1 modifies the European Standard EN 60950 : 1992. It was approved by CENELEC on 1992-12-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Ref. No. EN 60950 : 1992/A1 : 1993 E



Foreword

At the request of the 71st Technical Board of CENELEC, amendment 1 : 1992 to the International Standard IEC 950 : 1991 was submitted to the CENELEC Unique Acceptance Procedure (UAP) in May 1992 for acceptance as a European Standard.

The text of the International Standard was approved by CENELEC as amendment A1 to EN 60950 on 9 December 1992.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1993-09-01
- latest date of withdrawal of conflicting national standards (dow) 1995-03-01

For products which have complied with EN 60950 : 1992 before 1995-03-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-03-01.

Endorsement notice

The text of amendment 1 : 1992 to the International Standard IEC 950 : 1991 was approved by CENELEC as an amendment to the European Standard without any modification.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60950

August 1992

UDC 681.3 : 651.2 : 620.1 : 614.8

Supersedes EN 60950 : 1988 + amendments

Descriptors: Information technology equipment, business equipment, personal computer, safety

English version

Safety of information technology equipment, including electrical business equipment

(IEC 950 : 1991, modified)

Sécurité des matériels de traitement de l'information, y compris les matériels de bureau électriques
(CEI 950 : 1991, modifiée)

Sicherheit von Einrichtungen der Informationstechnik, einschließlich elektrischer Büromaschinen
(IEC 950 : 1991, modifiziert)

This European Standard was approved by CENELEC on 16 June 1992. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

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

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Foreword

Following a decision taken by the CENELEC Technical Board at their meeting in London on 23 September 1991, the International Publication IEC 950 : 1991 was submitted to the CENELEC Unique Acceptance Procedure (UAP) in October 1991 for acceptance as a European Standard.

The reference document, with common modifications as prepared by Reporting Secretariat SR 74, was approved by CENELEC as EN 60950 on 16 June 1992.

The following dates were fixed:

- latest date of publication of
an identical national
standard (dop) 1993-03-01
- latest date of withdrawal of
conflicting national
standards (dow) 1995-03-01

For products which have complied with EN 60950 : 1988 and its amendments A1 : 1990 and A2 : 1991 before 1995-03-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-03-01.

Annexes designated 'normative' are part of the body of the standard. Annexes designated 'informative' are given only for information. In this standard annexes ZA and ZB are normative and annex ZC is informative.

CONTENTS

	Page
INTRODUCTION	8
Clause	
1 General	11
1.1 Scope	11
1.2 Definitions	13
1.2.1 Equipment electrical ratings	14
1.2.2 Operating conditions	14
1.2.3 Equipment mobility	15
1.2.4 Classes of equipment – Protection against electric shock	15
1.2.5 Connection to the supply	16
1.2.6 Enclosures	16
1.2.7 Accessibility	17
1.2.8 Circuit characteristics	17
1.2.9 Insulation	18
1.2.10 Creepage distances and clearances	19
1.2.11 Components	19
1.2.12 Power distribution	20
1.2.13 Flammability	22
1.2.14 Miscellaneous	23
1.3 General requirements	24
1.4 General conditions for tests	24
1.5 Components	27
1.6 Power interface	28
1.7 Marking and instructions	28
1.7.1 Power rating	28
1.7.2 Safety instructions	30
1.7.3 Short duty cycles	30
1.7.4 Mains voltage adjustment	31
1.7.5 Power outlets	31
1.7.6 Fuses	31
1.7.7 Wiring terminals	31
1.7.8 Controls and indicators	32
1.7.9 Isolation of multiple power sources	33
1.7.10 IT power systems	33
1.7.11 Protection in building installation	33
1.7.12 High leakage current	33
1.7.13 Thermostats and other regulating devices	33
1.7.14 Language	33
1.7.15 Durability	33
1.7.16 Removable parts	34
1.7.17 Lithium batteries	34
1.7.18 Operator access with a tool	34

Clause	Page
2 Fundamental design requirements	35
2.1 Protection against electric shock and energy hazards	35
2.2 Insulation	38
2.3 Safety extra-low voltage (SELV) circuits	40
2.4 Limited current circuits	42
2.5 Provisions for protective earthing	43
2.6 Primary power isolation	45
2.7 Overcurrent and earth fault protection in primary circuits	47
2.7.1 Basic requirements	47
2.7.2 Faults not covered in 5.4	47
2.7.3 Short-circuit protection	47
2.7.4 Number and location of protective devices	48
2.7.5 Protection by several devices	49
2.7.6 Warning to service personnel	49
2.8 Safety interlocks	49
2.9 Clearances, creepage distances and distances through insulation	52
2.9.1 General	52
2.9.2 Clearance	53
2.9.3 Creepage distances	57
2.9.4 Distance through insulation	58
2.9.5 Coated printed boards	59
2.9.6 Enclosed and sealed parts	62
2.9.7 Encapsulated parts	63
2.9.8 Component external terminations	63
2.10 Connection to other equipment	64
2.11 Limited power source	64
3 Wiring, connections and supply	66
3.1 General	66
3.2 Connection to primary power	68
3.3 Wiring terminals for external primary power supply conductors	73
4 Physical requirements	77
4.1 Stability and mechanical hazards	77
4.2 Mechanical strength and stress relief	79
4.2.1 General	79
4.2.2 Steady force test, 30 N	79
4.2.3 Steady force test, 250 N	79
4.2.4 Steel ball test	79
4.2.5 Drop test	80
4.2.6 Stress relief test	81
4.2.7 Compliance criteria	81
4.2.8 Mechanical strength of cathode ray tubes	81
4.3 Construction details	81
4.4 Resistance to fire	89
4.4.1 Methods of achieving resistance to fire	89
4.4.2 Minimizing the risk of ignition	89
4.4.3 Flammability of materials and components	89
4.4.4 Materials for enclosures and for decorative parts	91
4.4.5 Conditions for fire enclosures	92
4.4.6 Fire enclosure construction	93
4.4.7 Doors or covers in fire enclosures	95
4.4.8 Flammable liquids	95

Clause	Page
5 Thermal and electrical requirements	97
5.1 Heating	97
5.2 Earth leakage current	99
5.2.1 General	99
5.2.2 Requirements	99
5.2.3 Single-phase equipment	100
5.2.4 Three-phase equipment	101
5.2.5 Equipment with earth leakage current exceeding 3,5 mA	102
5.3 Electric strength	102
5.4 Abnormal operating and fault conditions	106
6 Connection to telecommunication networks	111
6.1 Requirements	111
6.2 TNV circuits and protection against electric shock	111
6.2.1 TNV circuit characteristics and requirements	111
6.2.2 Protection against contact with TNV circuits	113
6.3 Protection of telecommunication network service personnel, and other users of the telecommunication network, from hazards in the equipment	114
6.3.1 Protection from hazardous voltages	114
6.3.2 Use of protective earthing	114
6.3.3 Particular requirements for pluggable equipment type A	114
6.4 Protection of the equipment user from voltages on the telecommunication network	116
6.4.1 Separation from telecommunication network conductors	116
6.4.2 Compliance test	116
Annexes	
A Tests for resistance to heat and fire (normative)	121
A.1 Flammability test for fire enclosures of movable equipment having a total mass exceeding 18 kg, and of stationary equipment	121
A.2 Flammability test for fire enclosures of movable equipment having a total mass not exceeding 18 kg, and for materials located within fire enclosures	122
A.3 High current arcing ignition test	123
A.4 Hot wire ignition test	124
A.5 Hot flaming oil test	125
A.6 Flammability tests for classifying materials V-0, V-1 or V-2	125
A.7 Flammability test for classifying foamed materials HF-1, HF-2 or HBF	127
A.8 Flammability test for classifying materials HB	129
A.9 Flammability test for classifying materials 5V	130
B Motor tests under abnormal conditions (normative)	134
B.1 General requirements	134
B.2 Test conditions	134
B.3 Maximum temperatures	135
B.4 Running overload test	136
B.5 Locked-rotor overload test	136
B.6 Running overload test for d.c. motors in secondary circuits	137
B.7 Locked-rotor overload test for d.c. motors in secondary circuits	138
B.8 Test for motors with capacitors	138
B.9 Test for three-phase motors	139
B.10 Test for series motors	139
C Transformers (normative)	140
C.1 Overload test	140
C.2 Safety isolating transformers	142
C.3 Electric strength requirements	142
D Measuring instrument for earth leakage current test (normative)	146
E Temperature rise of a winding (normative)	146

Annexes

F	Measurement of creepage distances and clearances (normative)	148
G	Earth leakage current for equipment intended to be connected directly to IT power systems (normative)	153
G.1	General	153
G.2	Requirements	153
G.3	Single-phase equipment	154
G.4	Three-phase equipment	155
G.5	Equipment with earth leakage current exceeding 3,5 mA	156
H	Ionizing radiation (normative)	157
J	Table of electrochemical potentials (normative)	158
K	Thermal controls (normative)	159
L	Normal load conditions for some types of electrical business equipment (normative)	161
M	Criteria for telephone ringing signals (normative)	162
N	Impulse test generator (normative)	167
P	Normative references (normative)	168
Q	Bibliography (informative)	169
R	Example of requirements for a quality control programme for unpopulated coated printed boards (informative)	170
S	Procedure for impulse testing (informative)	172
T	Guidance on protection against ingress of water (informative)	174
ZA	Normative references to international publications with their relevant European publications (normative)	176
ZB	Special national conditions (normative)	178
ZC	A-Deviations (informative)	181

Tables

1	Protective devices in single-phase equipment or sub-assemblies	48
2	Protective devices in three-phase equipment	49
3	Minimum clearances for insulation in primary circuits, and between primary and secondary circuits	54
4	Additional clearances for insulation in primary circuits with repetitive peak voltages exceeding the peak value of the mains supply voltage	55
5	Minimum clearances in secondary circuits	56
6	Minimum creepage distances	57
7	Minimum separation distances for coated printed boards	60
8	Limits for inherently limited power sources	65
9	Limits for power sources not inherently limited	65
10	Sizes of cables and conduits, rated current up to 16 A	69
11	Sizes of conductors in power supply cords	70
12	Physical tests on power supply cords	72
13	Range of conductor sizes to be accepted by terminals	75
14	Sizes of terminals for primary power supply conductors	75
15	Size and spacing of holes in metal bottoms of fire enclosures	95
16	Temperature-rise limits - Part 1	98
16	Temperature-rise limits - Part 2	98
17	Maximum earth leakage current	99
18	Test voltages for electric strength tests - Part 1	104
18	Test voltages for electric strength tests - Part 2	105
B.1	Permitted temperature limits for motor windings (except for running overload test)	135
B.2	Permitted temperature limits for running overload tests	136
C.1	Permitted temperature limits for transformer windings	141
C.2	Electric strength tests	143
F.1	Pollution degrees	150
G.1	Maximum earth leakage current for equipment connected to IT power systems	153
J.1	Electrochemical potentials	158
R.1	Rules for sampling and inspection	171
T.1	Extract from IEC 529	175

Figures

1	Example of TN-S power system	20
2	Example of TN-C-S power system	20
3	Example of TN-C power system	21
4	Example of TT power system	21
5	Example of IT power system	21
6	Abrasion resistance test for coating layers	62
7	Impact test using sphere	80
8	Examples of cross-sections of designs of openings preventing vertical access	85
9	Examples of louvre design	86
10	Example of enclosure side opening	87
11	Typical bottom of a fire enclosure for partially enclosed component or assembly	93
12	Baffle plate construction	94
13	Test circuit for earth leakage current on single-phase equipment	101
14	Test circuit for earth leakage current on three-phase equipment	102
15	Maximum voltage after a single fault	113
16	Test probe	114
17	Test for separation between a telecommunication network and earth	115
18	Application points of test voltage	117
19	Test finger	119
20	Test pin	120
21	Ball-pressure apparatus	120
A.1	Circuit for high current arcing test	123
A.2	Test fixture for hot wire ignition test	124
A.3	Test arrangement for flammability test for classifying materials HB	129
A.4	Vertical burning test for classifying materials 5V	133
B.1	Determination of arithmetic average temperature	135
C.1	Determination of arithmetic average temperature	141
C.2	Grades of insulation in transformers	145
D.1	Measuring instrument for earth leakage current test	146
F.1	Narrow groove	148
F.2	Wide groove	148
F.3	V-shaped groove	148
F.4	Rib	149
F.5	Uncemented joint with narrow groove	149
F.6	Uncemented joint with wide groove	149
F.7	Uncemented joint with narrow and wide grooves	149
F.8	Creepage distance under mixed conditions	150
F.9	Divergent groove	150
F.10	Narrow recess	151
F.11	Wide recess	151
F.12	Coating around terminals	152
F.13	Coating over printed wiring	152
G.1	Test circuit for earth leakage current on single-phase equipment for connection to IT power systems ..	154
G.2	Test circuit for earth leakage current on three-phase equipment for connection to IT power systems ..	155
M.1	Definition of ringing period and cadence cycle	163
M.2	I_{TS1} limit curve for cadenced ringing signal	164
M.3	Peak and peak-to-peak currents	164
M.4	Ringing voltage trip criteria	166
N.1	Impulse generating circuit	167
S.1	Waveform on insulation without surge suppressors and no breakdown	172
S.2	Waveforms on insulation during breakdown without surge suppressors	172
S.3	Waveforms on insulation with surge suppressors in operation	173
S.4	Waveform on short-circuited surge suppressor and insulation	173

INTRODUCTION

PRINCIPLES OF SAFETY

General principles

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

The following 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.

Hazards

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

- Electric shock
- Energy hazards
- Fire
- Mechanical and heat hazards
- Radiation hazards
- Chemical hazards.

Electric shock is due to current passing through the human body. Currents of the order of a milliampere can cause a reaction in persons in good health and may cause indirect danger due to involuntary reaction. Higher currents can have more damaging effects. Voltages up to about 40 V peak, or 60 V d.c., are not generally regarded as dangerous under dry conditions, but parts which have to be touched or handled should be at earth potential or properly insulated.

There are two types of persons who are normally concerned with information technology equipment, OPERATORS and SERVICE PERSONNEL.

"OPERATOR" is the term applied to all other than SERVICE PERSONNEL, and requirements for protection assume that the OPERATOR is oblivious to electrical hazards, but does not act intentionally in the sense of creating a hazard. Consequently, the requirements provide protection for cleaners and casual visitors as well as the assigned OPERATORS.

It is assumed that SERVICE PERSONNEL will be reasonably careful in dealing with obvious hazards, but the design should protect against mishap by use of warning labels, shields for HAZARDOUS VOLTAGE terminals, segregation of SAFETY EXTRA-LOW VOLTAGE CIRCUITS (SELV CIRCUITS) from HAZARDOUS VOLTAGES, etc. More important, SERVICE PERSONNEL should be protected against unexpected hazards.

It is normal to provide two levels of protection for OPERATORS to prevent electric shock caused by a fault. Thus a single fault and its resulting faults will not create a 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 units were dropped.

Electric shock: causes and prevention

Causes:

Contact with parts normally at HAZARDOUS VOLTAGE.

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

Breakdown of insulation between parts normally at HAZARDOUS VOLTAGE and SELV CIRCUITS, thereby putting accessible parts at HAZARDOUS VOLTAGE.

Breakdown of insulation guarding parts at HAZARDOUS VOLTAGE.

Leakage current from parts at HAZARDOUS VOLTAGE to BODY of CLASS II EQUIPMENT. Failure of protective earth connection of CLASS I EQUIPMENT carrying leakage current. (Leakage current includes current due to RFI filter components connected between PRIMARY CIRCUITS and frame.)

Prevention:

Prevent OPERATOR access to parts at HAZARDOUS VOLTAGE by fixed or locked covers, interlocks, etc. Discharge capacitors at HAZARDOUS VOLTAGE.

Either connect the accessible conductive parts to earth so that the voltage which can develop is limited to a safe value and the circuit overcurrent protection will disconnect the parts having low impedance faults; or use DOUBLE or REINFORCED INSULATION between parts normally at HAZARDOUS VOLTAGE and accessible conductive parts, so that breakdown is not likely to occur.

Segregate hazardous and SELV CIRCUITS. Separate by earthed metal screens, or DOUBLE or REINFORCED INSULATION. Earth SELV CIRCUITS if capable of carrying possible fault currents.

For parts at HAZARDOUS VOLTAGE insulation which is accessible to the OPERATOR should have adequate mechanical and electrical strength to eliminate this danger.

Limit leakage current to BODY to a safe value, or provide high integrity protective earth connection.

Energy hazards

Short-circuiting between adjacent poles of high current supplies or high capacitance circuits may cause arcing or ejection of molten metal resulting in burns. Even low voltage circuits may be dangerous in this respect. Protect by separation, by shielding or by using SAFETY INTERLOCKS.

Fire

Temperatures which could cause a fire risk may result from overloads, component failure, insulation breakdown, high resistance or loose connections. However, fires originating within the equipment should not spread beyond the immediate vicinity of the source of the fire or cause damage to the surroundings of the equipment.

These design objectives should be met by:

- taking all reasonable steps to avoid high temperature which might cause ignition,
- controlling the position of combustible materials in relation to possible ignition sources,
- limiting the quantity of combustible materials used,
- ensuring that, if combustible materials are used they have the lowest flammability practicable,
- using ENCLOSURES or barriers, if necessary, to limit the spread of fire within the equipment,
- using suitable materials for the outer ENCLOSURES of the equipment.

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 or interlocking of dangerous moving parts.

Radiation hazards

If equipment emits some forms of radiation, requirements are necessary to keep OPERATOR and SERVICE PERSONNEL exposures to acceptable levels.

The types of radiation that can be encountered are sonic, radio frequency, infra-red, high intensity visible and coherent light, ultraviolet, ionizing, etc.

Chemical hazards

Hazardous chemicals cause injuries and damage through contact with them, their vapours and fumes. Controls including appropriate warning labels are required to limit such contact, as far as practicable, under normal and abnormal conditions.

Materials

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

SAFETY OF INFORMATION TECHNOLOGY EQUIPMENT, INCLUDING ELECTRICAL BUSINESS EQUIPMENT

1 General

1.1 Scope

1.1.1 This standard is applicable to information technology equipment, including electrical business equipment and associated equipment, with a **RATED VOLTAGE** not exceeding 600 V.

This standard is also applicable to such equipment designed and intended to be connected directly to a **TELECOMMUNICATION NETWORK** and forming part of a subscriber's installation, regardless of ownership and of responsibility for installation and maintenance.

This standard specifies requirements intended to ensure safety for the **OPERATOR** and layman who may come into contact with the equipment and, where specifically stated, for **SERVICE PERSONNEL**.

This standard is intended to ensure the safety of 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 which is within the scope of this standard are:

Data and text processing equipment, personal computers, visual display units, data preparation equipment, data terminal equipment, data circuit terminating equipment (e.g. modems), PABXs, key telephone systems, telephone answering machines, facsimile equipment, typewriters, calculators, accounting and book-keeping machines, cash registers, point of sale terminals, paper tape readers and punchers, staplers, duplicators, copying machines, erasers, pencil sharpeners, mail processing machines, document shredding machines, magnetic tape handlers, motor-operated files, dictation equipment, micrographic office equipment, monetary processing machines, electrically operated drawing machines (plotters), paper trimmers (punchers, cutting machines, separators), paper jogging machines, postage machines and teleprinters.

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

- equipment intended for operation while exposed, for example, to extremes of temperature; to excessive dust, moisture, or vibration; to flammable gases; to 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 elevations greater than 2 000 m;
- equipment subject to transient overvoltages exceeding those for Installation Category II according to IEC 664; additional protection might be necessary in the mains supply to the equipment;
- 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 This standard does not apply to:

- support equipment, such as air conditioning, fire detection or fire extinguishing systems; power supply systems, such as motor-generator sets, battery back-up systems and transformers, which are not an integral part of the equipment; building branch wiring;
- duplicating machines, including offset lithographic machines, which are intended primarily for sizes larger than A3 as specified in ISO 216;
- equipment which depends on a TELECOMMUNICATION NETWORK as its only source of electrical power for its operation, and passive devices requiring no source of electrical power.

1.2 Definitions

For the purpose of this 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
Circuit, extra-low voltage (ELV)	1.2.8.4
Circuit, limited current	1.2.8.6
Circuit, primary	1.2.8.1
Circuit, safety extra-low voltage (SELV)	1.2.8.5
Circuit, secondary	1.2.8.2
Circuit, telecommunication network voltage (TNV)	1.2.8.8
Classification, flammability, of materials	1.2.13.1
Clearance	1.2.10.2
Cord, detachable power supply	1.2.5.4
Cord, non-detachable power supply	1.2.5.5
Creepage distance	1.2.10.1
Current, rated	1.2.1.3
Cut-out, thermal	1.2.11.4
Cut-out, thermal, automatic reset	1.2.11.5
Cut-out, thermal, manual reset	1.2.11.6
Enclosure	1.2.6.1
Enclosure, electrical	1.2.6.4
Enclosure, fire	1.2.6.2
Enclosure, mechanical	1.2.6.3
Energy level, hazardous	1.2.8.7
Equipment, Class I	1.2.4.1
Equipment, Class II	1.2.4.2
Equipment, Class III	1.2.4.3
Equipment, direct plug-in	1.2.3.6
Equipment, fixed	1.2.3.4
Equipment, for building-in	1.2.3.5
Equipment, hand-held	1.2.3.2
Equipment, movable	1.2.3.1
Equipment, permanently connected	1.2.5.3
Equipment, pluggable, type A	1.2.5.1
Equipment, pluggable, type B	1.2.5.2
Equipment, stationary	1.2.3.3
Frequency, rated	1.2.1.4
Insulation, basic	1.2.9.2
Insulation, double	1.2.9.4
Insulation, operational	1.2.9.1
Insulation, reinforced	1.2.9.5
Insulation, supplementary	1.2.9.3
Interlock, safety	1.2.7.6
Limit, explosion	1.2.13.10
Limiter, temperature	1.2.11.3
Load, normal	1.2.2.1
Location, restricted access	1.2.7.3
Material, 5V class	1.2.13.5
Material, HB class	1.2.13.8
Material, HBF class foamed	1.2.13.9
Material, HF-1 class foamed	1.2.13.6
Material, HF-2 class foamed	1.2.13.7
Material, V-0 class	1.2.13.2
Material, V-1 class	1.2.13.3
Material, V-2 class	1.2.13.4
Operation, continuous	1.2.2.3

Operation, intermittent	1.2.2.5
Operation, short-time	1.2.2.4
Operator	1.2.14.4
Part, decorative	1.2.6.5
Personnel, service	1.2.14.3
Range, rated frequency	1.2.1.5
Range, rated voltage	1.2.1.2
Surface, bounding	1.2.10.3
System, IT power	1.2.12.3
System, TN power	1.2.12.1
System, TT power	1.2.12.2
Telecommunication network	1.2.14.5
Telecommunication signal	1.2.14.6
Test, type	1.2.14.1
Thermostat	1.2.11.2
Time, rated operating	1.2.2.2
Tool	1.2.7.4
Tracking	1.2.9.7
Transformer, safety isolating	1.2.11.1
Voltage, d.c.	1.2.14.2
Voltage, hazardous	1.2.8.3
Voltage, rated	1.2.1.1
Voltage, working	1.2.9.6

1.2.1 *Equipment electrical ratings*

1.2.1.1 **RATED VOLTAGE:** The primary power voltage (for three-phase supply, the phase-to-phase voltage) as declared by the manufacturer.

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

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

1.2.1.4 **RATED FREQUENCY:** The primary power frequency as declared by the manufacturer.

1.2.1.5 **RATED FREQUENCY RANGE:** The primary power 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:** The mode of operation which approximates as closely as possible the most severe conditions of normal use in accordance with the manufacturer's operating instructions. However, when the conditions of actual use can obviously be more severe than the maximum load conditions recommended by the manufacturer, a load is used that is representative of the maximum that can be applied.

NORMAL LOAD conditions for some types of electrical business equipment are given in annex L.

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

1.2.2.3 **CONTINUOUS OPERATION:** Operation under NORMAL LOAD for an unlimited period.

1.2.2.4 SHORT-TIME OPERATION: Operation under NORMAL LOAD for a specified period, starting from cold, the intervals after each period of operation being sufficient to allow the equipment to cool down to room temperature.

1.2.2.5 INTERMITTENT OPERATION: Operation in a series of specified identical cycles, each composed of a period of operation under NORMAL LOAD, followed by a rest period with the equipment switched off or running idle.

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.

1.2.3.2 HAND-HELD EQUIPMENT: MOVABLE EQUIPMENT intended to be held in the hand during normal use.

1.2.3.3 STATIONARY EQUIPMENT: Equipment that is not MOVABLE EQUIPMENT.

1.2.3.4 FIXED EQUIPMENT: STATIONARY EQUIPMENT which is fastened or otherwise secured at a specific location.

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

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

- a) using BASIC INSULATION, and also
- b) providing a means of connecting 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.

NOTES

1 CLASS I EQUIPMENT may have parts with DOUBLE INSULATION or REINFORCED INSULATION, or parts operating in SELV CIRCUITS.

2 For equipment intended for use with a power supply cord, this provision includes a protective earthing conductor as part of the cord.

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 provision for protective earthing or reliance upon installation conditions.

NOTE - CLASS II EQUIPMENT may be of one of the following types:

- equipment having a durable and substantially continuous ELECTRICAL ENCLOSURE of insulating material which envelops all conductive parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from parts at HAZARDOUS VOLTAGE by insulation at least equivalent to REINFORCED INSULATION; such equipment is called insulation-encased CLASS II EQUIPMENT;
- equipment having a substantially continuous metallic ELECTRICAL ENCLOSURE, in which DOUBLE OR REINFORCED INSULATION is used throughout; such equipment is called metal-encased CLASS II EQUIPMENT;
- equipment which is a combination of the above two types.

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.

1.2.5 Connection to the supply

1.2.5.1 PLUGGABLE EQUIPMENT TYPE A: Equipment which is intended for connection to the building power supply wiring via non-industrial plugs and socket-outlets or via appliance couplers, or both.

1.2.5.2 PLUGGABLE EQUIPMENT TYPE B: Equipment which is intended for connection to the building power supply wiring via industrial plugs and socket-outlets complying with IEC 309, or with national standards for similar applications.

1.2.5.3 PERMANENTLY CONNECTED EQUIPMENT: Equipment which is intended for connection to the building power supply wiring by screw terminals.

NOTE - See 3.2.2.

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

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

Such a cord may be:

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

Special: A flexible cord which 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 re-shaping of the conductor before introduction into a terminal or the twisting of a stranded conductor to consolidate the end.

1.2.6 Enclosures

1.2.6.1 ENCLOSURE: A 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.

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

1.2.6.3 MECHANICAL ENCLOSURE: A part of the equipment intended to prevent injury due to mechanical and other physical hazards.

1.2.6.4 ELECTRICAL ENCLOSURE: A part of the equipment intended to prevent contact with parts at HAZARDOUS VOLTAGE or HAZARDOUS ENERGY LEVELS.

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

1.2.7 Accessibility

1.2.7.1 OPERATOR ACCESS AREA: An area to which, under normal operating conditions, one of the following applies:

- access can be gained without the use of a TOOL, or
- the means of access is deliberately provided to the OPERATOR, or
- the OPERATOR is instructed to enter regardless of whether or not TOOLS are 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: An area, other than an OPERATOR ACCESS AREA, where it is necessary for service personnel to have access even with the equipment switched on.

1.2.7.3 RESTRICTED ACCESS LOCATION: A room or space where equipment is located, and where either:

- access can only be gained by SERVICE PERSONNEL with the use of a special TOOL or lock and key, or
- access is controlled.

1.2.7.4 TOOL: A screwdriver or any other object which can 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: A 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 Circuit characteristics

1.2.8.1 PRIMARY CIRCUIT: An internal circuit which is directly connected to the external supply mains or other equivalent source (such as a motor-generator set) which supplies the electric power. It includes the primary windings of transformers, motors, other loading devices and the means of connection to the supply mains.

1.2.8.2 SECONDARY CIRCUIT: A circuit which has no direct connection to primary power and derives its power from a transformer, convertor or equivalent isolation device situated within the equipment.

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

1.2.8.4 EXTRA-LOW VOLTAGE (ELV) CIRCUIT: A SECONDARY CIRCUIT with voltages between conductors, and between any conductor and earth, not exceeding 42,4 V peak, or 60 V d.c., under normal operating conditions, which is separated from HAZARDOUS VOLTAGE by at least BASIC INSULATION, and which meets neither all of the requirements for an SELV CIRCUIT nor all of the requirements for a LIMITED CURRENT CIRCUIT.

1.2.8.5 SAFETY EXTRA-LOW VOLTAGE (SELV) CIRCUIT: A SECONDARY CIRCUIT which is so designed and protected that under normal and single fault conditions, the voltage between any two parts of the SELV CIRCUIT or CIRCUITS and, for CLASS I EQUIPMENT, between any one such part and the equipment protective earthing terminal does not exceed a safe value.

NOTES

1 Under normal conditions this limit is either 42,4 V peak, or 60 V d.c. Under fault conditions higher limits are specified in this standard for transient deviation.

2 This definition of an SELV circuit differs from the term SELV as used in IEC 364.

1.2.8.6 LIMITED CURRENT CIRCUIT: A circuit which is so designed and protected that, under both normal conditions and a likely fault condition, the current which can be drawn is not hazardous.

NOTE - The limiting values are specified in 2.4.

1.2.8.7 HAZARDOUS ENERGY LEVEL: 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.

1.2.8.8 TELECOMMUNICATION NETWORK VOLTAGE (TNV) CIRCUIT: A circuit that, under normal operating conditions, carries TELECOMMUNICATION SIGNALS. A TNV circuit is considered to be a secondary circuit in the meaning of 1.2.8.2 of this standard.

1.2.9 Insulation

1.2.9.1 OPERATIONAL INSULATION: Insulation needed for the correct operation of the equipment.

NOTE - OPERATIONAL INSULATION by definition does not protect against electric shock. It may, however, serve to minimize exposure to 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 ensure protection against 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: A single insulation system which 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 which cannot be tested as SUPPLEMENTARY or BASIC INSULATION.

1.2.9.6 WORKING VOLTAGE: The highest voltage to which the insulation under consideration is, or can be, subjected when the equipment is operating at its RATED VOLTAGE under conditions of normal use.

NOTE - See 2.2.7.

1.2.9.7 TRACKING: The progressive formation of conducting paths on the surface of a solid insulating material, due to the combined effects of electric stress and electrolytic contamination on this surface.

1.2.10 Creepage distances and clearances

1.2.10.1 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.

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

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

1.2.11 Components

1.2.11.1 SAFETY ISOLATING TRANSFORMER: A transformer in which windings supplying SELV CIRCUITS are isolated from other windings in such a way that an insulation breakdown either is unlikely or does not cause a hazardous condition on SELV windings.

1.2.11.2 THERMOSTAT: A cycling temperature-sensing control, which is intended to keep a temperature between two particular values under normal operating conditions and which may have provision for setting by the OPERATOR.

1.2.11.3 TEMPERATURE LIMITER: A temperature-sensing control which is intended to keep a temperature below or above one particular value during normal operating conditions and which may have provision for setting by the OPERATOR.

NOTE - A TEMPERATURE LIMITER may be of the automatic reset or of the manual reset type. It does not make the reverse operation during the normal duty cycle of the equipment.

1.2.11.4 THERMAL CUT-OUT: A temperature-sensing control intended to operate under abnormal operating conditions and which 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.

1.2.11.5 THERMAL CUT-OUT, AUTOMATIC RESET: A THERMAL CUT-OUT which automatically restores the current after the relevant part of the equipment has cooled down sufficiently.

1.2.11.6 THERMAL CUT-OUT, MANUAL RESET: A THERMAL CUT-OUT which requires resetting by hand, or replacement of a part, in order to restore the current.

1.2.11.7 INTERCONNECTING CABLES: Cables that are external to the equipment and that are used to electrically connect accessories to units of Information Technology Equipment, to interconnect units in a system or to connect units to a TELECOMMUNICATION NETWORK; such cables may carry any type of circuit from one unit to another.

1.2.12 Power distribution

1.2.12.1 TN POWER SYSTEM: A power distribution system having one point directly earthed, the exposed conductive parts of the installation being connected to that point by protective earth conductors. Three types of TN POWER SYSTEMS are recognized according to the arrangement of neutral and protective earth conductors, as follows:

- TN-S system: having separate neutral and protective earth conductors throughout the system;
- TN-C-S system: in which neutral and protective functions are combined in a single conductor in a part of the system;
- TN-C system: in which neutral and protective functions are combined in a single conductor throughout the system.

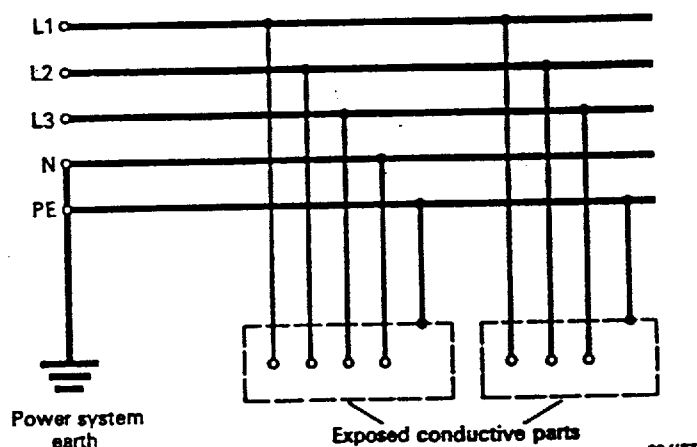


Figure 1 - Example of TN-S power system

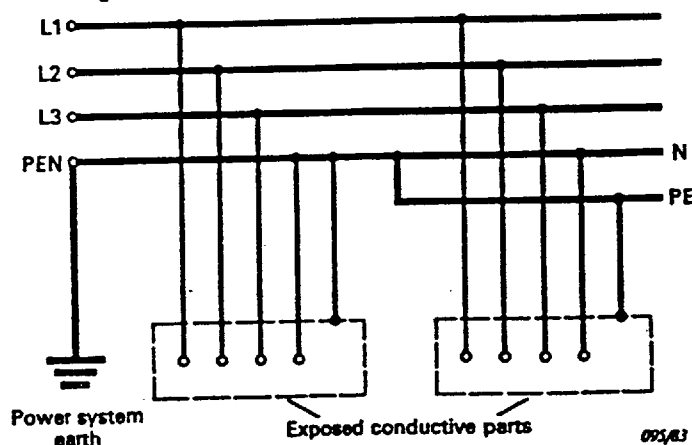


Figure 2 - Example of TN-C-S power system

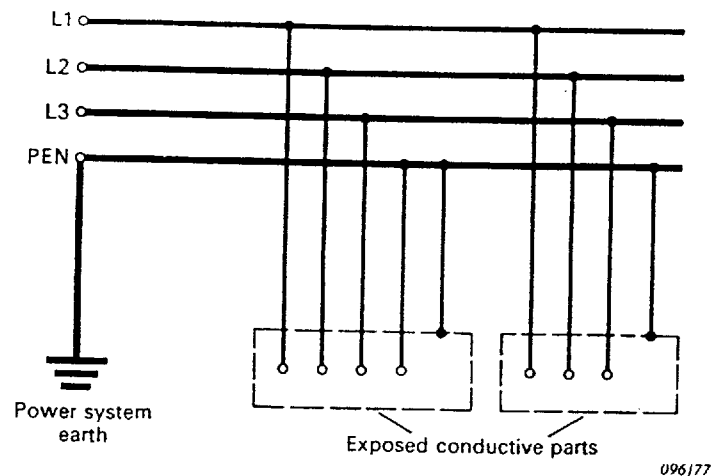


Figure 3 - Example of TN-C power system

1.2.12.2 TT POWER SYSTEM: A power distribution system having one point directly earthed, the exposed conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the power system.

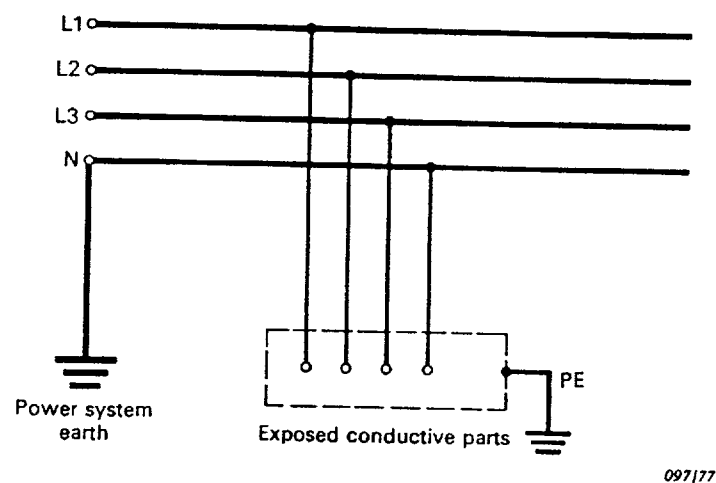


Figure 4 - Example of TT power system

1.2.12.3 IT POWER SYSTEM: A power distribution system having no direct connection to earth, the exposed conductive parts of the electrical installation being earthed.

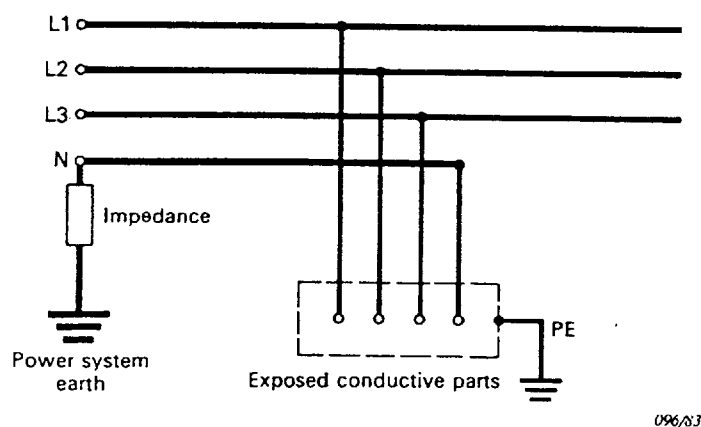


Figure 5 - Example of IT power system

1.2.13 *Flammability*

1.2.13.1 FLAMMABILITY CLASSIFICATION OF MATERIALS: The recognition of the ignition and burning resistance characteristics of materials other than metal or ceramic. Materials are classified as in 1.2.13.2 to 1.2.13.9 when tested in accordance with annex A.

NOTES

1 When applying the requirements in this standard, HF-1 CLASS FOAMED MATERIALS are regarded as better than those of CLASS HF-2, and HF-2 better than HBF.

2 Similarly, other MATERIALS, including rigid (engineering structural) foam of CLASSES 5V or V-0 are regarded as better than those of CLASS V-1, V-1 better than V-2, and V-2 better than HB.

1.2.13.2 V-0 CLASS MATERIAL: A material that, when tested in accordance with clause A.6, may flame or glow but will extinguish in an average period of time not exceeding 5 s; glowing particles or flaming drops released do not ignite surgical cotton.

1.2.13.3 V-1 CLASS MATERIAL: A material that, when tested in accordance with clause A.6, may flame or glow but will extinguish in an average period of time not exceeding 25 s; glowing particles or flaming drops released do not ignite surgical cotton.

1.2.13.4 V-2 CLASS MATERIAL: A material that, when tested in accordance with clause A.6, may flame or glow but will extinguish within an average period of time not exceeding 25 s; glowing particles or flaming drops released may ignite surgical cotton.

1.2.13.5 5V CLASS MATERIAL: A material that, when tested in accordance with clause A.9, may flame or glow but will extinguish within a prescribed period of time; glowing particles or flaming drops released do not ignite surgical cotton.

NOTE - Clause A.9 may be withdrawn as soon as IEC 707 is amended to include flammability Class 5V or its possible substitute.

1.2.13.6 HF-1 CLASS FOAMED MATERIAL: A foamed material that, when tested in accordance with clause A.7, may flame or glow but will extinguish within a prescribed period of time; flaming or glowing particles, or flaming drops released do not ignite surgical cotton.

1.2.13.7 HF-2 CLASS FOAMED MATERIAL: A foamed material that, when tested in accordance with clause A.7, may flame or glow but will extinguish within a prescribed period of time; flaming or glowing particles, or flaming drops released may ignite surgical cotton.

1.2.13.8 HB CLASS MATERIAL: Material that, when tested in accordance with clause A.8, does not exceed a specified maximum burning rate.

1.2.13.9 HBF CLASS FOAMED MATERIAL: A foamed material that, when tested in accordance with clause A.7, does not exceed a specified maximum burning rate.

1.2.13.10 EXPLOSION LIMIT: The 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.

1.2.14 Miscellaneous

1.2.14.1 TYPE TEST: Testing of a representative sample of the equipment with the objective of determining if the equipment, as designed and manufactured, can meet the requirements of this standard.

1.2.14.2 D.C. VOLTAGE: The average value of a voltage (as measured by a moving coil meter) having a peak-to-peak ripple not exceeding 10% of the average value.

NOTE - Where a peak-to-peak ripple exceeds 10% of the average value, the requirements related to peak voltage are applicable.

1.2.14.3 SERVICE PERSONNEL: Persons having appropriate technical training and experience necessary to:

- perform tasks in SERVICE ACCESS AREAS of the equipment, and
- be aware of hazards to which they are exposed in performing a task, and of measures to minimize the danger to themselves or other persons.

1.2.14.4 OPERATOR: Any person, other than SERVICE PERSONNEL.

NOTE - The term "operator" in this standard is the same as the term "user" and the two can be used interchangeably.

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

NOTE - It is assumed that adequate measures according to CCITT Recommendation K.11 have been taken to reduce the risk that the overvoltages presented to the equipment exceed 1,5 kV peak.

Excluded are:

- the mains system for supply, transmission and distribution of electrical power, if used as a telecommunication transmission medium;
- TV distribution systems using cable;
- SELV CIRCUITS connecting units of data processing equipment;
- public or private mobile radio systems;
- radio paging systems.

1.2.14.6 TELECOMMUNICATION SIGNAL: A steady state, varying amplitude, or intermittent voltage or current intended for use on a TELECOMMUNICATION NETWORK.

NOTE - The limiting values are specified in 6.2.1.1.



1.3 General requirements

1.3.1 Equipment shall be so designed and constructed that, under all conditions of normal use and under a likely fault condition, it protects against risk of personal injury from electric shock and other hazards, and against serious fire originating in the equipment, within the meaning of this standard.

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

Unless otherwise specified, compliance is checked by inspection and by carrying out all the relevant tests.

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

1.3.2 Sufficient information shall be provided to the user concerning any condition necessary to ensure that, when used as prescribed by the manufacturer, the equipment will not present a hazard within the meaning of this standard (see 1.7.2).

Compliance is checked by inspection.

1.3.3 Equipment is classified according to its protection from electric shock as:

CLASS I, or
CLASS II, or
CLASS III.

NOTE - Equipment containing ELV CIRCUITS or parts at HAZARDOUS VOLTAGE is Class I or Class II. There are no requirements in this standard for protection against electric shock for CLASS III EQUIPMENT.

1.4 General conditions for tests

1.4.1 The requirements and tests detailed in this standard shall be applied 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 shall not be made.

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 failure of components.

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

1.4.3 Unless otherwise specified in this standard, the tests shall be made on a single sample which shall pass all the relevant tests.

The sample 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 carried out separately on circuits, components or sub-assemblies outside the equipment, provided that inspection of the equipment and circuit arrangements ensures that such testing will indicate that the assembled equipment would conform to the requirements of the standard. 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.

NOTES

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

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

2 In view of the amount of resource 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 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 carried out under the most unfavourable combination within the manufacturer's operating specifications of the following parameters:

- supply voltage,
- supply frequency,
- 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.

1.4.5 In determining the most unfavourable supply voltage for a test, the following variables shall be taken into account:

- multiple RATED VOLTAGES,
- extremes of RATED VOLTAGE RANGES,
- tolerance on RATED VOLTAGE as declared by the manufacturer.

If no tolerance is declared by the manufacturer, it shall be taken as +6% and -10%. If the rated voltage is 230 V single phase or 400 V three phase, the tolerance shall not be less than +10% and -10% (see 1.6.5).

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

1.4.6 In determining the most unfavourable supply frequency for a test, different RATED FREQUENCY within the RATED FREQUENCY RANGE shall be taken into account (e.g. 50 Hz and 60 Hz) but consideration of the tolerance on a RATED FREQUENCY (e.g. 50 Hz $\pm$ 0,5 Hz) is not normally necessary.

1.4.7 Where a maximum temperature ($T_{\max}$) or a maximum temperature rise ($\Delta T_{\max}$) is specified for compliance with tests, it is based on the assumption that the room ambient air temperature will be 25 °C when the equipment is operating. However, the manufacturer may specify a higher ambient air temperature.

It is not necessary to maintain the ambient temperature (T_{amb}) at a specific value during tests, but it shall be monitored and recorded.

Temperatures measured on the equipment shall conform with one of the following conditions, all temperatures being in °C:

if $T_{\max}$ is specified: $(T - T_{\text{amb}}) \leq (T_{\max} - T_{\text{mra}})$

if $\Delta T_{\max}$ is specified: $(T - T_{\text{amb}}) \leq (\Delta T_{\max} + 25 - T_{\text{mra}})$

where:

T = the temperature of the given part measured under the prescribed test conditions, and

T_{mra} = the maximum room ambient temperature permitted by the manufacturer's specification or 25 °C, whichever is greater.

During the test, the room ambient temperature should not exceed T_{mra} unless agreed by all parties involved.

The classification of insulating materials (classes A, E, B, F and H) is in accordance with IEC 85.

1.4.8 Unless a particular method is specified, the temperatures of windings shall be determined either by the thermocouple method or by the resistance method (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.

1.4.9 In determining of the input current, 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 equipment under test;
- loads due to other units of equipment intended by the manufacturer to draw power from the equipment under test;
- loads which 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.

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

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

1.4.12 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 the deliberate fault or abnormal operating condition are considered to be part of that deliberate fault or abnormal operating condition.

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,
 - parts of SELV CIRCUITS,
 - parts of LIMITED CURRENT CIRCUITS.

1.5 Components

1.5.1 Where safety is involved, components shall comply either with the requirements of this standard or with the safety aspects of the relevant IEC component standards.

NOTE 1 - An IEC component standard is considered relevant only if the component in question clearly falls within its scope.

A component which is to be connected to an SELV CIRCUIT and also to an ELV CIRCUIT or to a part at HAZARDOUS VOLTAGE shall comply with the requirements of 2.3.

NOTE 2 - An example of such a component is a relay with different supplies connected to different elements (coils and contacts).

1.5.2 *Evaluation and testing of components shall be carried out as follows:*

– *a component certified by a recognized testing authority for compliance with a standard harmonized with the relevant IEC component standard shall be checked for correct application and use 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 which are part of the relevant IEC component standard;*

– *a component which 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 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 test for compliance with a component standard is, in general, carried out separately. The number of test samples is, in general, the same as that required in the component standard.

– *where no relevant IEC component standard exists, or 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;*

– *thermal controls shall be tested in accordance with annex K.*

1.5.3 Transformers, including SAFETY ISOLATING TRANSFORMERS, shall be of a type suitable for their intended application and shall comply with the relevant requirements of this standard, particularly those of annex C.

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 SELV windings.

1.5.4 High-voltage components operating at peak-to-peak voltages exceeding 4 kV shall either have a flammability CLASS of V-2, or better, or of HF-2 or better, or shall comply with 14.4 of IEC 65: 1985.

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

1.5.6 A capacitor connected between two phase conductors, or between one phase conductor and the neutral conductor of the mains supply, shall be one of the following:

- an X1 capacitor complying with IEC 384-14;
- an X2 capacitor which passes the pulse test of IEC 384-14, 12.11.2, as applied to X1 capacitors, with the test voltage reduced to 2,5 kV;
- an X2 capacitor which passes the endurance test of IEC 384-14, 12.11.2, with the 220 Ω resistor short-circuited (appendix B of IEC 384-14).

1.6 Power interface

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

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

- *where an equipment has one or more RATED VOLTAGE(S), 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.

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

1.6.3 The neutral conductor, if any, shall be insulated from earth and the BODY throughout the equipment as if it were a phase conductor. Components connected between neutral and earth shall be rated for a WORKING VOLTAGE equal to the phase-to-neutral voltage.

1.6.4 For equipment to be connected to IT POWER SYSTEMS, components connected between phase and earth shall be capable of withstanding the stress due to a WORKING VOLTAGE equal to the phase-to-phase voltage. However, capacitors intended to be operated in such applications and complying with IEC 384-14 are permitted if they are rated for the applicable phase-to-neutral voltage.

NOTE - Capacitors meeting IEC 384-14 are endurance tested at 1,7 times the RATED VOLTAGE of the capacitor.

1.6.5 Equipment intended to operate directly from the mains supply shall be designed for a minimum supply tolerance of +6%, -10%. If the rated voltage is 230 V single phase or 400 V three phase, the equipment shall operate safely within a minimum supply tolerance of +10% and -10%.

1.7 *Marking and instructions*

1.7.1 *Power rating*

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 a unit is not provided with a means for direct connection to the supply mains, it need not be marked with any electrical rating, such as its RATED VOLTAGE, RATED CURRENT or RATED FREQUENCY.

For equipment intended to be installed by anyone other than SERVICE PERSONNEL, the marking shall be readily visible either in an OPERATOR ACCESS AREA or shall be located on an outside surface of the equipment. If located on an outside surface of FIXED EQUIPMENT, the marking shall be discernible after the equipment has been installed as in normal use.

Markings that are not visible from the outside of the equipment are considered to be in compliance if they are directly visible when opening a door or cover. If the area behind the door or cover is not an OPERATOR ACCESS AREA, a readily visible marker shall be attached to the equipment to indicate clearly the location of the marking. It is permitted to use a temporary marker.

The 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. Where 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 a mains supply having any voltage between 220 V and 240 V.

Multiple RATED VOLTAGE: 120/220/240 V. This means that the equipment is designed to be connected to a mains supply having a voltage of 120 V or 220 V or 240 V, usually after internal adjustment.

- 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 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 the supply mains. 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 2 - Some examples of RATED CURRENT markings are:

- for equipment with multiple RATED VOLTAGES:

120/240 V; 2,4/1,2 A

- for equipment with a RATED VOLTAGE RANGE:

100-240 V; 2,8 A

100-240 V; 2,8-1,1 A

100-120 V; 2,8 A

200-240 V; 1,4 A

- manufacturer's name, trade mark or identification mark,
- manufacturer's model or type reference,
- symbol for class II construction, for CLASS II EQUIPMENT only.

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

Where symbols are used, they shall conform with ISO 7000 or IEC 417 where appropriate symbols exist.

1.7.2 Safety instructions

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

NOTES

- 1 Special precautions may be necessary, for example for connection of the equipment to the supply and for the inter-connection of separate units, if any.
- 2 Where appropriate, installation instructions should include reference to national wiring rules.
- 3 Maintenance information is normally made available only to SERVICE PERSONNEL.

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

When the disconnect device is not incorporated in the equipment (see 2.6.3) or when the plug on the power supply cord is intended to serve as the disconnect device, the installation instructions shall state:

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

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 5 - The present recommended long term exposure limit for ozone is 0,1 ppm (0,2 mg/m³) 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 intended for SHORT-TIME OPERATION or for INTERMITTENT OPERATION shall be marked with RATED OPERATING TIME, or RATED OPERATING TIME and rated resting time respectively, unless the operating time is limited by the construction or by the definition of its NORMAL LOAD.

The marking of SHORT-TIME OPERATION or INTERMITTENT OPERATION shall correspond to normal use.

The marking of INTERMITTENT OPERATION shall be such that the RATED OPERATING TIME precedes the rated resting time, the two markings being separated by a solidus (/).

1.7.4 Mains voltage adjustment

For equipment intended for connection to multiple RATED VOLTAGES or FREQUENCIES, the method of adjustment shall be fully described in the service manual 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

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

Socket-outlets conforming to IEC 83 are examples of standard power supply outlets.

1.7.6 Fuses

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

Where fuses with special fusing characteristics such as time delay 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 (e.g. F1, F2 etc.) to the service documentation which shall contain the relevant instructions.

1.7.7 Wiring terminals

The wiring terminal intended for connection of the protective earthing conductor associated with the supply wiring shall be indicated by the symbol  (IEC 417 No. 5019). This symbol shall not be used for other earthing terminals.

It is not a requirement to mark other terminals for protective earthing conductors, but where such terminals are marked, the symbol  (IEC 417 No. 5017) shall be used.

The following situations are exempt from the above requirements:

- where the terminals for external supply connection are provided on a component (e.g. terminal block) or sub-assembly (e.g. power supply), the symbol  is permitted for the protective earthing terminal instead of  ;
- on sub-assemblies or components, the symbol  is permitted in place of the symbol  provided that it does not give rise to confusion.

This requirement is 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.

Terminals intended exclusively for connection of the primary power neutral conductor, if any, shall be indicated by the capital letter N.

On three-phase equipment, if incorrect phase rotation could cause overheating or other hazard, terminals intended for connection of the primary power phase 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 placed on screws, or other parts which might be removed when conductors are being connected.

1.7.8 Controls and indicators

1.7.8.1 Unless it is obviously unnecessary, indicators, switches and other controls affecting safety shall be identified or placed so as 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.

1.7.8.2 Where safety is involved, colours of controls and indicators shall comply with IEC 73. 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 Where symbols are used on or near controls, for example switches, push buttons, etc., to indicate "ON" and "OFF" conditions, they shall be the line | for "ON" and circle ○ for "OFF" (IEC 417, Nos. 5007 and 5008). For push-push type switches the symbol ⊞ shall be used (IEC 417, No. 5010).

It is permitted to use the symbols ○ and | as OFF and ON markings on any primary power switches, including isolating switches.

A "STAND-BY" condition shall be indicated by the symbol ⊏ (IEC 417, No. 5009).

1.7.8.4 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.

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

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

1.7.9 *Isolation of multiple power sources*

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

1.7.10 *IT power systems*

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

1.7.11 *Protection in building installation*

If PLUGGABLE EQUIPMENT TYPE B or PERMANENTLY CONNECTED EQUIPMENT relies on protective devices in the building installation for protection in accordance with 2.7, the equipment installation instructions shall so state and shall also specify the requirements for short-circuit protection or over-current protection or, where necessary, for both.

1.7.12 *High leakage current*

Equipment in which leakage current exceeding 3,5 mA exists shall carry a warning label as defined in 5.2.5 or clause G.5.

NOTE - Attention is drawn to IEC 364-7-707.

1.7.13 *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.

1.7.14 *Language*

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

NOTE - Documentation intended for use only by SERVICE PERSONNEL is permitted to be in the English language.

1.7.15 *Durability*

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 kauri-butanol 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.

1.7.16 Removable parts

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

1.7.17 Lithium batteries

If an equipment is provided with a replaceable lithium battery, the following applies:

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

This warning shall include the following or similar text:

CAUTION

Danger of explosion if battery is incorrectly replaced.

**Replace only with the same or equivalent type
recommended by the manufacturer.
Dispose of used batteries according
to the manufacturer's instructions.**

1.7.18 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).

2 Fundamental design requirements

2.1 Protection against electric shock and energy hazards

2.1.1 This standard specifies two categories of requirements for protection against electric shock from energized parts. Additional requirements are specified:

- for protection against energy hazards in 2.1.5, and
- for protection against contact with TNV CIRCUITS in 6.2.2.

The two categories of requirements are based on the following principles:

- 1) The OPERATOR is permitted to have access to:
 - bare parts in SELV CIRCUITS;
 - bare parts in LIMITED CURRENT CIRCUITS;
 - insulation of wiring in ELV CIRCUITS under the conditions specified in 2.1.3.
- 2) The OPERATOR shall be prevented from having access to:
 - bare parts of ELV CIRCUITS or of circuits at HAZARDOUS VOLTAGES;
 - OPERATIONAL or BASIC INSULATION of such parts except under the conditions specified in 2.1.3;
 - unearthed conductive parts separated from ELV CIRCUITS or from parts at HAZARDOUS VOLTAGES by OPERATIONAL or BASIC INSULATION only.

2.1.2 Equipment shall be so constructed that there is adequate protection against OPERATOR contact with:

- bare parts of ELV CIRCUITS or bare parts at HAZARDOUS VOLTAGES;
- parts of ELV CIRCUITS or parts at HAZARDOUS VOLTAGES protected only by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compounds other than self-hardening resin;
- OPERATIONAL or BASIC INSULATION of parts or wiring in ELV CIRCUITS or at HAZARDOUS VOLTAGES, except as permitted in 2.1.3;
- unearthed conductive parts separated from ELV CIRCUITS or from parts at HAZARDOUS VOLTAGES by OPERATIONAL or BASIC INSULATION only.

NOTE 1 - See also 6.2.2.

This requirement applies 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 inspection;

- by a test with the test finger, figure 19 (page 239), which shall not contact parts described above when applied to apertures in the ENCLOSURES after removal of OPERATOR detachable parts, including fuseholders, and with OPERATOR access doors and covers open. It is permitted to leave lamps in place for this test. OPERATOR-separable connectors, other than plugs and socket-outlets complying with IEC 83 shall also be tested during disconnection;
- by a test with the test pin, figure 20 (page 241) which shall not contact bare conductive parts at HAZARDOUS VOLTAGES when applied to apertures in an external ELECTRICAL ENCLOSURE. OPERATOR-detachable parts, including fuseholders and lamps, are left in place, and OPERATOR access doors and covers are closed during this test.

The test finger and the test pin 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 by the manufacturer.

Apertures preventing the entry of the test finger, figure 19 (page 239), are further tested by means of a straight unjointed version of the test finger applied with a force of 30 N; if this finger enters, the test with the finger, figure 19 (page 239), is repeated, the finger being pushed through the aperture if necessary.

NOTE 2 - 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.

The above requirements regarding contact with parts at HAZARDOUS VOLTAGE apply only to HAZARDOUS VOLTAGES not exceeding 1 000 V a.c. or 1 500 V d.c. For higher voltages, there shall be a CLEARANCE between the part at HAZARDOUS VOLTAGE and the test finger (figure 19) or the test pin (figure 20), placed in its most unfavourable position. The CLEARANCE shall be as specified in 2.9.2 for BASIC INSULATION, or it shall withstand the relevant electric strength test in 5.3. (See figure F.14, point A).

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.

2.1.3 Where the insulation of internal wiring in an ELV CIRCUIT is accessible to an OPERATOR, this wiring shall:

- not be subject to damage or to stress;
- not need to be handled by the OPERATOR;
- be routed and fixed so as not to touch unearthed accessible conductive parts;
- have distance through insulation not less than 0,17 mm for voltage over 50 V r.m.s. (71 V peak or d.c.) and up to 250 V r.m.s. (350 V peak or d.c.) and not less than 0,31 mm for voltage over 250 V r.m.s. (350 V peak or d.c.) where the voltages referred to are the maximum occurring across the insulation in case of failure of BASIC INSULATION;
- withstand on its insulation an electric strength test with a voltage specified for SUPPLEMENTARY INSULATION (see 5.3). The test voltage shall be related to the voltage which occurs across the insulation in case of failure of BASIC INSULATION.

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

2.1.4 In SERVICE ACCESS AREAS, bare parts operating at more than 42,4 V peak, or 60 V d.c., and which are not connected to LIMITED CURRENT CIRCUITS shall be so located or guarded that unintentional contact with such parts is unlikely during servicing operations involving other parts of the equipment.

In deciding whether or not unintentional contact with bare parts would be likely, account shall be taken of the way SERVICE PERSONNEL need to gain access past, or near to, the bare parts in order to service other parts.

NOTE - Precautions against unintentional contact by SERVICE PERSONNEL are not required for any SECONDARY CIRCUITS, including ELV CIRCUITS, that operate at less than 42,4 V peak, or 60 V d.c. (see 1.2.14.2).

Bare parts that involve an energy hazard (see 2.1.5) shall be located, enclosed, guarded or provided with a barrier to take into account the possibility of unintentional bridging by conductive materials that might be present during service operations.

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

Compliance is checked by inspection.

2.1.5 There shall be no energy hazard in OPERATOR ACCESS AREAS.

Compliance is checked by means of the test finger, figure 19 (page 239), in a straight position, applied without appreciable force. It shall not be possible to bridge with this test finger two bare parts, one of which may be an earthed conductive part, between which a HAZARDOUS ENERGY LEVEL exists.

2.1.6 CLEARANCES behind earthed or unearthed conductive ENCLOSURES shall not be reduced to a level that would result in an energy hazard arising during the relevant tests of 4.2 involving a force of 250 N, in equipment to which this test is applicable.

2.1.7 Shafts of operating knobs, handles, levers and the like shall not be connected to a circuit at HAZARDOUS VOLTAGE nor to an ELV CIRCUIT.

Compliance is checked by inspection.

2.1.8 Conductive handles, levers, control knobs and the like which are manually moved in normal use and which are earthed only through a pivot or bearing shall be either:

- separated from HAZARDOUS VOLTAGES within the component or elsewhere by CREEP-AGE DISTANCES and CLEARANCES of DOUBLE or REINFORCED INSULATION, or
- covered by SUPPLEMENTARY INSULATION over accessible parts.

Compliance is checked by inspection and by the applicable electric strength tests of 5.1.2.

2.1.9 Conductive casings of capacitors operating in ELV CIRCUITS or circuits at HAZARDOUS VOLTAGES shall not be connected to unearthed conductive parts in OPERATOR ACCESS AREAS and shall be separated from these parts by SUPPLEMENTARY INSULATION or earthed metal.

Compliance is checked by inspection and, where necessary, by the applicable tests of 2.9 and 5.3.2.

2.1.10 Equipment shall be so designed that at an external point of disconnection of the mains supply, there is no risk of electric shock from stored charge on capacitors connected to the mains circuit.

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

Equipment is considered to comply if any capacitor having a marked or nominal capacitance exceeding 0,1 μ F and connected to the external mains circuit has a means of discharge resulting in a time-constant not exceeding:

- 1 s for PLUGGABLE EQUIPMENT TYPE A;
- 10 s for PERMANENTLY CONNECTED EQUIPMENT and 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 can be used. During an interval equal to one time-constant the voltage will have decayed to 37% of its original value.

2.2 Insulation

2.2.1 Electrical insulation shall be achieved by provision of either one of the following, or a combination of the two:

- solid or laminated insulating materials having adequate thickness and adequate CREEPAGE DISTANCES over their surfaces;
- adequate CLEARANCES through air.

2.2.2 The choice and application of insulating materials shall take into account the needs for electrical, thermal and mechanical strength, frequency of the WORKING VOLTAGE, and the working environment (temperature, pressure, humidity and pollution).

Neither natural rubber nor materials containing asbestos shall be used as insulation.

Hygroscopic material shall not be used as insulation.

Compliance is checked by inspection and by evaluation of the data for the material. If such data is not available, the hygroscopic nature of an insulating material is determined by subjecting the component or sub-assembly employing the insulation in question to the humidity treatment of 2.2.3.

The insulation is then subjected to the electric strength test of 5.3.2 or clause C.3, as appropriate, while still in the humidity cabinet or in the room in which the samples were brought to the prescribed temperature.

2.2.3 Where required by 2.2.2 or 2.9.6, humidity treatment is carried out for 48 h in a cabinet or room containing air with a relative humidity of 91% to 95%. The temperature of the air, at all places where samples can be located, is maintained within 1 °C of any convenient value t between 20 °C and 30 °C such that condensation does not occur. During this treatment the component or sub-assembly is not energized.

Before the humidity treatment the sample is brought to a temperature between t °C and $(t + 4)$ °C.

2.2.4 Insulation in equipment shall comply with the applicable electric strength requirements of 5.3, with the CREEPAGE DISTANCE, CLEARANCE and distance through insulation requirements of 2.9, and with the heating requirements of 5.1.

2.2.5 For the purpose of determining the test voltages, CREEPAGE DISTANCES, CLEARANCES and distance through insulation for a given piece of insulation, two parameters shall be considered:

- application (see 2.2.6);
- WORKING VOLTAGE (see 2.2.7).

2.2.6 Application of INSULATION shall be considered to be OPERATIONAL, BASIC, SUPPLEMENTARY, REINFORCED or DOUBLE.

Where DOUBLE INSULATION is used, ELV CIRCUITS or unearthed conductive parts are permitted between the two layers provided that the overall level of insulation is maintained.

For DOUBLE INSULATION it is permitted to interchange the basic and supplementary layers.

NOTE - Some examples of situations where these types of insulation are required are as follows:

OPERATIONAL:

- between parts of different potential;
- between an ELV CIRCUIT or an SELV CIRCUIT and an earthed conductive part.

BASIC:

- between a part at HAZARDOUS VOLTAGE and an earthed conductive part.;
- between a part at HAZARDOUS VOLTAGE and an SELV CIRCUIT which relies on being earthed for its integrity;
- between a primary power conductor and the earthed screen or core of a primary power transformer;
- as an element of DOUBLE INSULATION.

SUPPLEMENTARY:

- generally, between an accessible conductive part and a part which could assume a HAZARDOUS VOLTAGE in the event of a failure of BASIC INSULATION, for example:
 - between the outer surface of a handle, a knob, a grip and the like, and its shaft unless the shaft is earthed,
 - between the equipment BODY and the surface of a flexible supply cord where the cord enters metal-encased CLASS II EQUIPMENT,
 - between an ELV CIRCUIT and an unearthed conductive part of the BODY.

– as an element of DOUBLE INSULATION.

DOUBLE OR REINFORCED:

- generally, between a PRIMARY CIRCUIT and
 - an unearthed accessible conductive part, or
 - a floating SELV CIRCUIT, or
 - a TNV CIRCUIT.

2.2.7 For the purpose of determining WORKING VOLTAGE (see also 1.4.11):

- if the d.c. value is used, the peak value of any superimposed ripple shall be included;
- non-repetitive transients (due, for example, to atmospheric disturbances) shall be disregarded;
- the voltage of an ELV CIRCUIT or SELV CIRCUIT is regarded as zero for determination of CLEARANCES and electric strength test voltages. However, the voltage of an ELV CIRCUIT or SELV CIRCUIT shall be taken into account for determination of CREEPAGE DISTANCES;
- unearthed accessible conductive parts shall be assumed to be earthed;
- where a transformer winding or other part is floating, i.e. not connected to a circuit which establishes its potential relative to earth, it shall be assumed to be earthed at the point by which the highest WORKING VOLTAGE is obtained;
- where DOUBLE INSULATION is used, the WORKING VOLTAGE across the BASIC INSULATION shall be determined by imagining a short circuit across the SUPPLEMENTARY INSULATION, and vice versa. For insulation between transformer windings, the short circuit shall be assumed to take place at the point by which the highest WORKING VOLTAGE is produced in the other insulation;
- for insulation between two transformer windings, the highest voltage between any two points in the two windings shall be used, taking into account external voltages to which the windings may be connected;
- for insulation between a transformer winding and another part, the highest voltage between any point on the winding and the other part shall be used;
- nominal values of mains supply voltage shall be used.

2.3 Safety extra-low voltage (SELV) circuits

2.3.1 SELV CIRCUITS shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as breakdown of a layer of BASIC INSULATION or failure of a single component.

2.3.2 In a single SELV CIRCUIT or in interconnected SELV CIRCUITS, the voltage between any two parts of the SELV CIRCUIT or CIRCUITS and, for CLASS I EQUIPMENT, between any one such part and the equipment protective earthing terminal, shall not exceed 42,4 V peak, or 60 V d.c., under normal operating conditions.

2.3.3 In the event of a single failure of BASIC or SUPPLEMENTARY INSULATION, or of a component (excluding components with DOUBLE or REINFORCED INSULATION), the voltages in accessible parts of a SELV CIRCUIT shall not exceed 42,4 V peak, or 60 V d.c., for longer than 0,2 s. Moreover, a limit of 71 V peak, or 120 V d.c., shall not be exceeded.