

ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-97

LOCAL AREA NETWORKS SAFETY REQUIREMENTS

September 1985

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European Computer Manufacturers Association
114 Rue du Rhône – 1204 Geneva (Switzerland)

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BRIEF HISTORY

ECMA TC24 started work on Local Area Networks at the beginning of 1981, in cooperation with IEEE 802. It was soon realized that, although the equipment to be connected via Local Area Networks could be designed according to Standard ECMA-57 (Safety Requirements for DPE), the special requirements of the cables interconnecting the equipment were not fully considered in Standard ECMA-57.

ECMA TC24 then asked ECMA TC12 to prepare a document, to be used in conjunction with ECMA-57, describing specific requirements of LAN.

This field was rather new and further experience was needed. For this reason, this document was first published as a Technical Report, ECMA TR/19. Based on comments received and experience gained since then, this revised version of TR/19 is now published as an ECMA Standard. The major differences between the two documents are listed in Appendix F.

Adopted by the General Assembly of ECMA on June 13, 1985, as Standard ECMA-97.

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1. INTRODUCTION

For information systems designed to have interconnect cabling up to a few tens of metres in length and hence installed in a relatively small area, Standard ECMA-57 or IEC Publication 435 fully covers the safety requirements.

With the introduction of Local Area Networks (LAN) which can extend to thousands of metres and hence enter unspecified and uncontrolled environments, other parameters not covered by Standard ECMA-57 or IEC Publication 435 have to be considered.

These parameters, which also relate to experience from existing telecommunications installations, include:

- Different Local Area Network systems, e.g. CSMA/CD, Token Bus, Token Ring, etc.
- Different mains power systems, e.g. distribution at high voltage (> 1000 V), TN-C, TN-S, TT and IT systems.
- Power distribution in high-rise buildings.
- Local Area Networks between buildings.
- Single vs multiple earthing.
- Equipotential bonding.
- Design of DTE interface circuits.
- Environmental restrictions, e.g. flame spread, flammability, smoke and fumes, electrochemical potentials, etc.
- Protective measures against lightning and other transient effects.
- Installation and maintenance requirements.

NOTE 1

Some of the above considerations are still under study.

2. SCOPE

This Standard applies to Local Area Networks (LAN) which consist of trunk cables, medium access units (MAU), medium interface connectors (MIC) and all cabling between the data terminal equipment (DTE) and network components. MAU may be incorporated in DTE.

This standard applies only to LAN whose normal operating voltage does not exceed 25 V ac rms or 60 V dc, and whose trunk cable provides a conductive path between MAU.

Other methods of construction or designs that provide the same level of safety would also be acceptable. As an example, instead of using permanent earthing as described in 6.3.6, a relay could be used to disconnect the trunk cable when the earth connection is unplugged.

Typical configurations of LAN are given in Appendix B, examples of LAN are described in the Standards referenced in 3.

3. REFERENCES

ECMA-57:	Safety Requirements for DPE
ECMA-80:	LAN - CSMA/CD Coaxial Cable System
ECMA-81:	LAN - CSMA/CD Physical Layer
ISO 8802/3	CSMA/CD Access Method and Physical Layer Specifications
ECMA-89:	LAN - Token Ring Technique
ECMA-90:	LAN - Token Bus Technique
ISO 8802/4	Token-Passing Bus Access Method and Physical Layer Specifications

- IEC Publ. 60: High Voltage Test Methods
- IEC Publ. 364: Electrical Installations of Buildings (See Appendices C and D)
- IEC Publ. 384: Capacitors for Radio Interference Suppression
- IEC Publ. 435: Safety of Data Processing Equipment
- IEC Publ. 380: Safety of Electrically Energized Office Machines
- IEC Publ. 65: Safety Requirements for Mains-operated Electronic and related apparatus for Household and Similar General Use
- IEC Publ. 664: Insulation Coordination within Low-voltage Systems including Clearances and Creepage Distances for Equipment.
- IEC Publ. 664A: Insulation Coordination within Low-voltage Systems including Clearances and Creepage Distances for Equipment. First Supplement.

The IEC documents can be obtained from
IEC
1-3 Rue Varembe
CH-1202 GENEVA (Switzerland)

The ISO Standards can be obtained from
ISO Central Secretariat
2 Rue Varembe
CH-1202 GENEVA (Switzerland)

4. DEFINITIONS

4.1 Equipment, Class I

(ECMA-57, 1.2.10; IEC 435, 1.2.14)

Equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in that conductive parts in operator and service access areas are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that the accessible conductive parts cannot become hazardous in the event of a failure of the basic insulation.

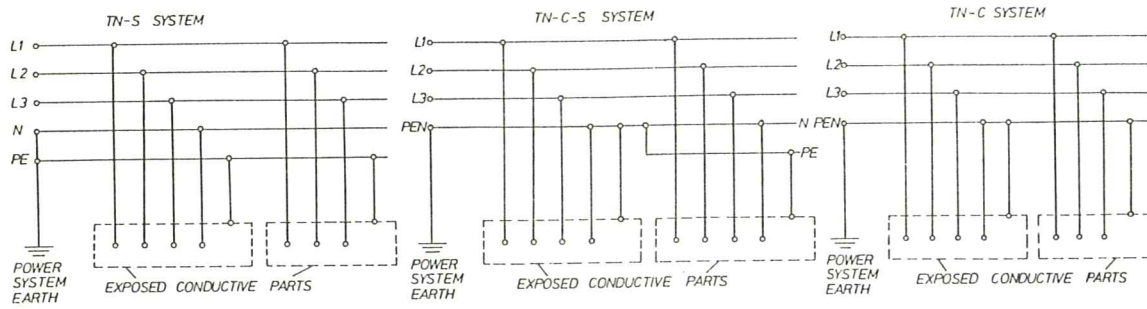
Class I equipment may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

4.2 Power System, TN

(ECMA-57, 1.2.32, IEC 435, 1.2.45)

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 systems are recognized according to the arrangements of neutral and protective earth conductors, as follows:

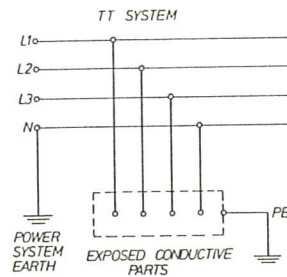
- TN-S system: having separate neutral and protective earth conductors throughout the system;
- TN-C-S system: in which neutral and protective functions are combined in a single conductor in a part of the system;
- TN-C System: in which neutral and protective functions are combined in a single conductor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



4.3 Power System, TT

(ECMA-57, 1.2.33; IEC 435, 1.2.46)

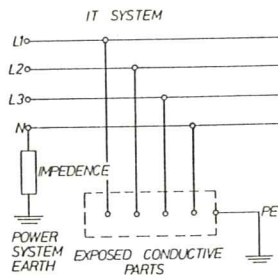
A power distribution system having one point directly earthed, the exposed conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the power system.



4.4 Power System, IT

(ECMA-57, 1.2.34; IEC 435 1.2.47)

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



4.5 Medium Access Unit (MAU)

A junction unit by which a DTE may obtain access to the trunk cable medium.

4.6 Trunk Coupling Unit (TCU)

(ECMA-89, 1.3.22)

A physical device which enables a DTE to connect to a trunk cable. The trunk coupling unit contains the means for inserting the DTE into the ring or, conversely, bypassing the DTE.

NOTE 2

In this Standard TCU and MAU are considered to be equivalent for safety considerations and are referred to as MAU.

4.7 Medium Interface Connector (MIC)

(ECMA-89, 1.3.7)

The connector between the DTE and Trunk Coupling Unit (TCU) at which all transmitted and received signals are specified.

4.8 Data Terminal Equipment (DTE)

(ECMA-80, 1.4.7)

The source and sink for all communication on the network. It includes all equipments attached to the medium, including the means of connection to the cable.

4.9 Situation A

A situation in which a LAN is installed entirely within a zone which has an equipotential bonding conductor according to IEC 364-4-41 clause 413.1.2 and 413.1.6 (see Appendix C)

4.10 Situation B

A situation which does not comply with the definition of Situation A.

4.11 Segment

A LAN or section of LAN whose MAU are connected to each other by conductive trunk cabling, and which is electrically isolated from any other section.

5. DESIGN

The design and installation requirements for the DTE, MAU, cables and other network components shall conform with the requirements stated in Section 6 as appropriate to the installation situation.

In respect of requirements not covered by section 6, DTE shall be designed to ECMA-57, IEC 435, IEC 380 or IEC 65. Active and passive hardware of the network shall be designed to ECMA-57 or IEC 435.

6. REQUIREMENTS

In addition to general requirements (6.1), requirements are classified according to two different mains supply situations, Situation A (6.2) and Situation B (6.3), with additional requirements if cables leave buildings (6.4).

Any single building will normally be Situation A (see Appendix E, E.1).

Multiple buildings will normally be Situation B (see Appendix E, E.4 and E.5). However equipment designed for Situation A may be used in multiple buildings if it can be established that the equipotential bonded zone covers all the buildings (see Appendix E, E.2 and E.3), and also under the conditions described in 6.3.6 or 6.4.5.

If there is doubt about the extent of the equipotentially bonded zone for Situation A in either single buildings or multiple buildings the zone shall be inspected and certified by a qualified Electrical Engineer.

6.1 General Requirements

The following circuits shall be so designed that whether or not they are accessible, they are safe to touch under normal and single fault conditions:

- in the DTE, circuits intended for connection directly or via an MIC to the MAU;
- in the MAU, circuits intended for connection to the trunk cable;
- in the MAU, circuits intended for connection directly or via an MIC to the DTE.

The above requirements apply prior to interconnection of the equipment.

The above requirements are considered to be met by the following circuits:

- An SELV circuit as defined in ECMA-57, IEC 435 or IEC 380;
- An SELV circuit as defined in IEC 364-4-41, not exceeding 25 V rms or 60 V dc. IEC 664 and IEC 664A should be taken into account in designing these circuits;
- A circuit meeting the requirements in IEC 65 for accessible terminals.

NOTE 3

In order to permit various earthing arrangements, circuits connected to the trunk cable may have to be floating if appropriate to the conditions described in 6.3.1.

All Class I equipment and all extraneous metalwork shall be bonded to the principal protective earthing point associated with the incoming mains supply. The electrical installation of the building shall be in accordance with IEC 364.

6.2 Design Requirements for LAN in Situation A

In Situation A, due to the equipotential bonding, differences in earth potential are assumed to be no greater than the maximum prospective touch voltage permitted in IEC 364, clause 41 (see Appendix D).

- 6.2.1 There is no safety requirement to earth the screen, (if any) of the trunk cable. However, where it is earthed for EMC or other reasons it shall be connected to the protective earth of the area served by the LAN. One or more connections may be used. A single connection should be made as close as possible to the main earthing point for the area, to minimize differential voltages.
- 6.2.2 There is no safety requirement for isolation in the MAU between the DTE interface circuits (including the earth circuit, if any) and the trunk cable. However, where such isolation is provided for functional purposes or where a capacitor, which may have any

value, is provided for EMC or other purposes, it should withstand an electric strength test at 500 V rms for 1 minute, in case differences in earth potential occur as described in IEC 364 clause 41 (see Appendix D).

6.2.3 Isolation shall be provided between a LAN segment which is in Situation A and any other LAN, unless both segments are in the same equipotential bonded zone. Such isolation shall withstand the electric strength test for Situation B.

6.2.4 A LAN segment which is in Situation A may be connected to an inter-building section of the trunk cable provided that the protection specified in 6.4 is used.

6.3 Design Requirements for LAN in Situation B

Situation B implies that a LAN segment will bridge two or more separate equipotential bonded zones of the kind described in Situation A, where the continuous and transient potential between the earths of the zones is unknown.

6.3.1 There is no safety requirement to connect the screen (if any) of the trunk cable to earth. However, where this is required for EMC or other reasons it shall be connected to the protective earth of the building by one of the following methods:

- a direct connection from earth to any single point on any one LAN segment; or
- a direct connection from earth to each MAU and at appropriate intervals for EMC purposes on untapped trunk cable, the earthing to be independent of the connection to the DTE; or
- indirectly, by voltage limiting devices which limit the voltage to 1500 V peak or less, between earth and any one or more points on the LAN.

6.3.2 Electrical separation shall be provided in the MAU between the DTE interface circuits and the trunk cable conductors, and between the drop cable screen and the trunk cable screen (if any).

6.3.3 It shall not be possible to touch any metalwork connected to the trunk cable screen or signal conductors with the test finger (ECMA-57 or IEC 435, Fig. 1).

6.3.4 Capacitors connected across safety separation for EMC or other purposes shall be limited in value to 0,01 uF per MAU and shall comply with the requirements of IEC 384-14 for Class Y capacitors tested to 1500 V ac rms for 1 minute.

6.3.5 Insulation provided to comply with the requirements of 6.3.2 or 6.3.3 shall withstand one of the following electric strength tests:

- 1500 V rms at 50 Hz to 60 Hz for 1 minute (see test procedure in ECMA-57 or IEC 435, 5.3.3)
- 2250 V dc for 1 minute (see test procedure in ECMA-57 or IEC 435, 5.3.3)
- 2400 V impulse test in accordance with Appendix A.

NOTE 4

The above test voltages are known from experience to be adequate

for safety. Occasional overvoltages may exceed these values and cause equipment damage and malfunction. To minimise the inconvenience of such a malfunction, which may be permanent and difficult to localise, and may affect the whole LAN, insulation withstanding a higher voltage may be specified. Values corresponding to 2000 V rms have been found to be effective.

- 6.3.6 Hardware providing only 500 V isolation as described in 6.2.2 may be used in Situation B provided that circuitry in the MAU intended for connection to the DTE has one pole permanently earthed with a separate conductor having a cross sectional area of not less than 1,5 square mm and not contained in any power cord (see also ECMA-57/IEC 435, subclause 2.5). It should be noted that this arrangement may result in malfunction due to earth loops between MAU and DTE. Uninformed attempts to obtain correct functioning by breaking these loops may create safety hazards. Such earth loops will not occur if the circuits in the DTE intended for connection to the MAU are floating (not earthed).

6.4 Additional Requirements for Cables between Buildings

These requirements apply to LAN with sections of trunk cable between buildings.

Unless the inter-building section of a trunk cable uses fibre optics or other non-conducting technology, the design shall comply with the following requirements. Where connection to protective earth is required, this shall comply with ECMA-57 or IEC 435, 2.5.5.

- 6.4.1 At each point where the inter-building section of the trunk cable enters a building, surge arrestors shall be connected between signal conductors, and from each signal conductor and the cable screen (if any) to protective earth. In the case of a coaxial trunk cable, a single surge arrestor between the outer conductor and protective earth is sufficient. Such surge arrestors shall be so designed and installed that they limit the voltage in the indoor section of the trunk cable to:
- . 400 V peak or less for a segment in Situation A, or
 - . 1500 V peak or less for a segment in Situation B.
- 6.4.2 Where the screen of the trunk cable is directly earthed at a building entry point, no surge arrestor is required between the screen and earth at that point.
- 6.4.3 Where a LAN segment which includes an inter-building section has only one direct earth connection in accordance with 6.3.1, 6.3.2, this should be at one of the building entry points, surge arrestors being used at other building entry points.
- 6.4.4 Where the buildings connected by an inter-building section of trunk cable are in Situation B, the surge arrestors shall be protected from transients due to mains supply faults. Fusible links in the trunk cable may be required.
- In addition:
- . inter-building sections of trunk cable should be installed underground;
 - . earth connections should have as low an inductance as possible.

NOTE 5

Some surge arrestors and fusible links may cause unacceptable degradation of the performance of the signal circuit.

- 6.4.5 Where fusible links are provided in the interbuilding section of trunk cable, and surge arresters or grounding limit the voltage on the indoor section of trunk cable to 400 V peak in accordance with 6.4.1, hardware meeting only 500 V isolation as described in 6.2.2 may be employed whether the buildings so connected are Situation A or B.

7. INSTALLATION

Installation instructions shall be supplied with the trunk cable system and shall call attention to the following points:

- care shall be taken in the installation that there is separation or insulation to IEC 364-4-41 clause 413.2 between mains terminals and the trunk cable, especially where the screen is not connected to earth;
- the situation for which the hardware is designed;
- rules for joining cable segments, with lightning protection where necessary;
- correct earthing of cable screens (6.2.2);
- it is recommended that the cable and power installation procedures be in compliance with IEC Publication 364 or equivalent local installation regulations;
- care shall be taken when installing the trunk cable to avoid damage to the jacket, and situations such as sharp bends and corners which could cause subsequent damage to the jacket, resulting in short-circuits between the screen and local metalwork such as ducting, plumbing and structural metalwork;
- during installation, exposed parts conductively connected to the trunk cable screen shall be insulated to prevent accidental contact with local metalwork;
- it is important to keep accurate and up-to-date records of the network configuration and earthing arrangements so that the requirements can be assured when re-configuration is undertaken;
- where possible, trunk cable runs should not coincide with the paths of lightning conductors;
- trunk cables should preferably be separated from the outside surfaces of buildings, especially roofs;
- earth conductors used as the reference for protection shall be as short as possible and of low inductance (i.e. wide);
- the inductance of the trunk cable entering a building may be

increased by coiling (with spaced turns) to obtain further reduction of pulse current, or other filtering methods employed, such as ferrite rings;

- earth bonding in buildings shall be subjected to inspection and certification by a qualified Electrical Engineer.

8. MAINTENANCE AND NETWORK MODIFICATION

Maintenance instructions and, where relevant, user instructions, shall call attention to the following points, unless the network is specifically designed for user installation. These are concerned with minimizing any risk to maintenance personnel arising from unusual voltages which may occasionally exist on the trunk cable screen when it is earthed at a remote point.

When work (e.g. addition of an MAU, or cable re-routing) is necessary on a trunk cable which has been installed and earthed in accordance with this Standard:

- the work should be carried out by qualified electricians or other suitably trained personnel;
- no work should be undertaken while there is a likelihood of an inter-building section of the cable being struck by lightning;
- prior to work on the cable, a check should be made on the voltage existing between the cable screen and the earth. If it exceeds 30 V rms this indicates an electrical fault which should first be investigated;
- either the screen of the trunk cable should be temporarily earthed locally in two places, one each side of the intended cut or disconnection, or these two places should be joined by a temporary strap, the temporary connection in either case having a current-carrying capacity at least equal to that of the cable screen and being removed after normal continuity is restored;
- personnel should not contact the trunk cable screen and any locally earthed part simultaneously unless the screen has been earthed locally.

It should be noted that normal operation of the network is liable to be disturbed by these operations.

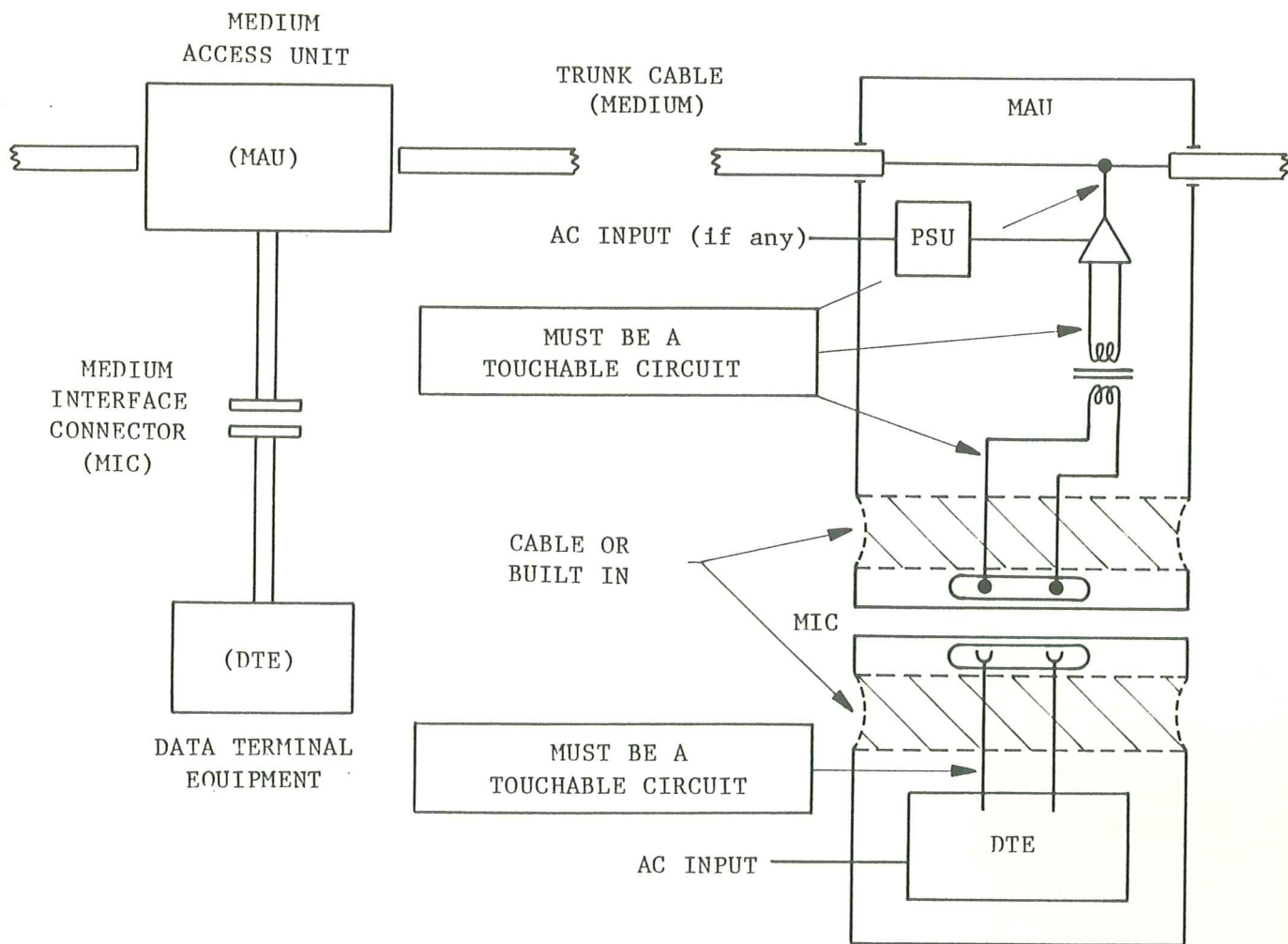
APPENDIX A

IMPULSE TEST

Electric strength test using 10 impulses having the peak voltage specified, applied at intervals of not less than 1 s, the polarity being reversed after each impulse. The waveform shall be 1,2/50 us (see IEC Publication 60). After application of the impulses, the part under test shall have a resistance of at least 2 MOhm, measured at 500 V dc.

APPENDIX B

TYPICAL CONFIGURATION



APPENDIX C

EQUIPOTENTIAL BONDING

Extract from IEC Publication 364, Chapter 41

413.1.2 Main Equipotential Bonding

In each building, a main equipotential bonding conductor, complying with IEC 364 chapter 54, shall interconnect the following conductive parts:

- main protective conductor;
- main earth-continuity conductor;
- main water pipes;
- main gas pipes;
- risers of central heating and air conditioning systems.

NOTE

The additional interconnection of metallic parts of the building structure and other metal pipework is recommended.

413.1.6 Supplementary Equipotential Bonding

- 413.1.6.1 If, in an installation or part of an installation, the specified conditions for protection against indirect contact, resulting in automatic disconnection of supply, cannot be fulfilled, it is necessary to provide local bonding, known as supplementary equipotential bonding.

NOTE

Supplementary equipotential bonding may involve the entire installation, a part of the installation, an item of apparatus, or a location.

- 413.1.6.2 Supplementary equipotential bonding shall include all simultaneously accessible exposed conductive parts of fixed equipment and extraneous conductive parts, including, where practicable, the main metallic reinforcement of constructional reinforced concrete.

The equipotential system shall be connected to the protective conductors of all equipment including those of socket outlets.

- 413.1.6.3 Supplementary equipotential bonding connection shall be made by protective conductors satisfying the conditions specified in Chapter 54.

413.1.6.4 Where doubt exists regarding the effectiveness of supplementary equipotential bonding, it shall be confirmed that the impedance Z between simultaneously accessible exposed conductive parts and extraneous conductive parts fulfils the following condition:

$$Z \leq U/I_a$$

where:

U = prospective touch voltage limit

I_a = operating current of the protective device in the appropriate disconnecting time stated in IEC 364-4-41, section 413.1.1.

Where fuses are used, it is sufficient to confirm that the condition is fulfilled for the conventional voltage limit U_L and for the current ensuring the operation of the fuse within 5 s.

APPENDIX D

PROSPECTIVE TOUCH VOLTAGE

Extract from IEC Publication 364, Chapter 41

Maximum prospective touch voltage duration

Maximum disconnecting time (s)	Prospective touch voltage	
	a.c., r.m.s. (V)	d.c. (V)
infinite	<50	<120
5	50	120
1	75	140
0,5	90	160
0,2	110	175
0,1	150	200
0,05	220	250
0,03	280	310

Table 41A

NOTE 1

The d.c. column of Table 41A is related to ripple-free d.c., for example from batteries. If the source of supply is rectified a.c. the a.c. column figures would apply. Specific values for rectified a.c. are under consideration.

NOTE 2

The prospective touch voltage on d.c. equipment can be of different waveform from the system voltage and is dependent on the fault circuit parameters.

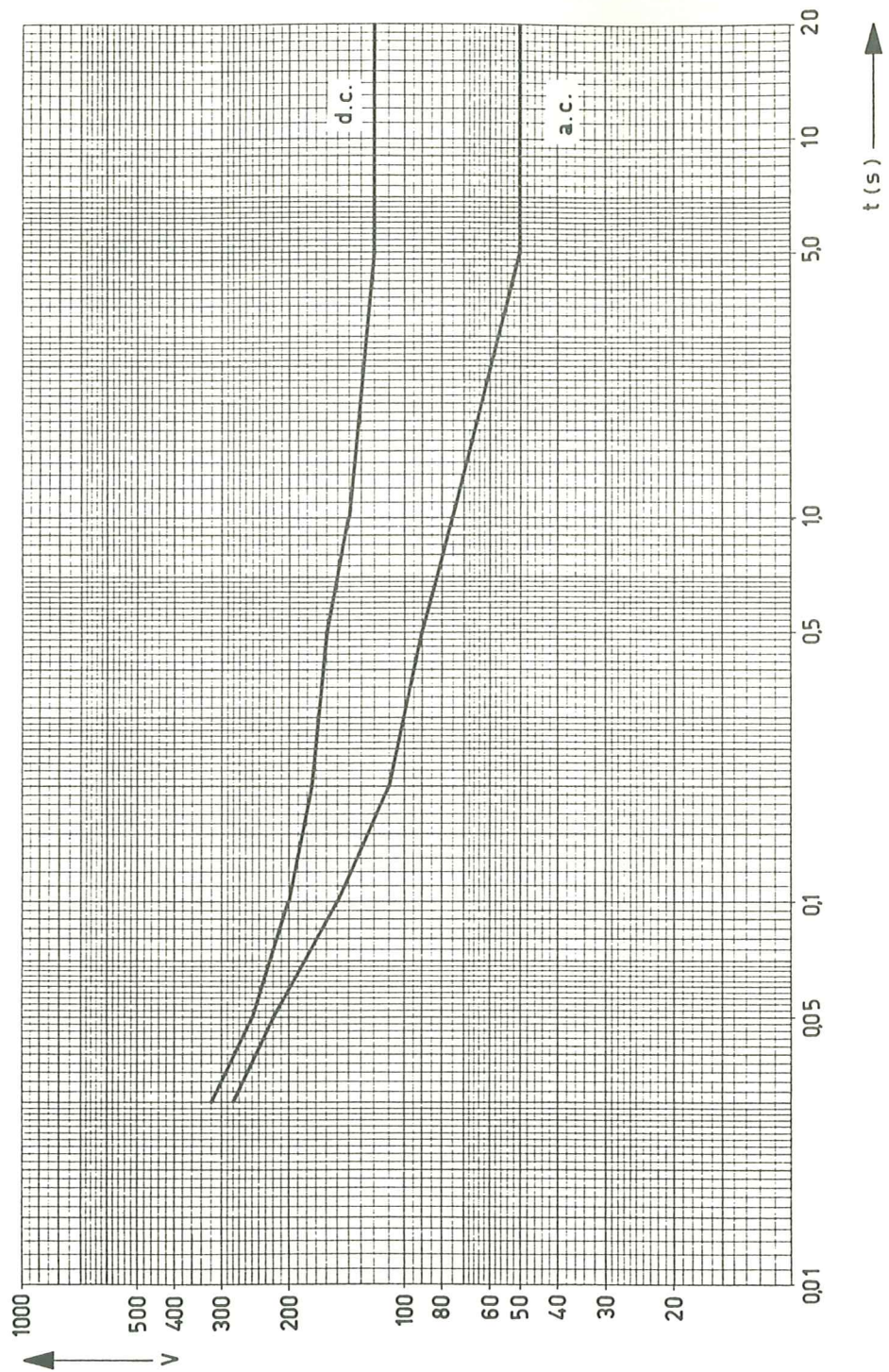
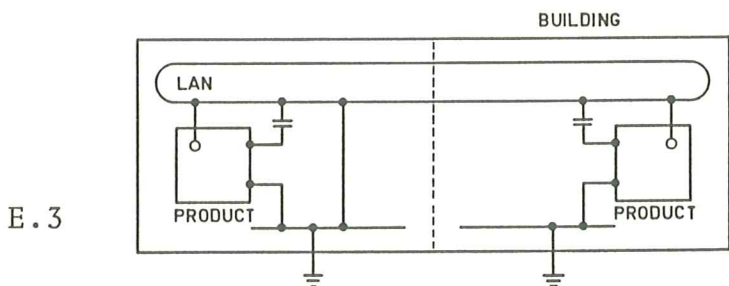
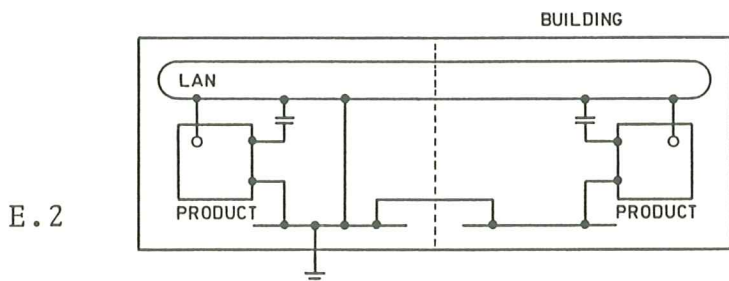
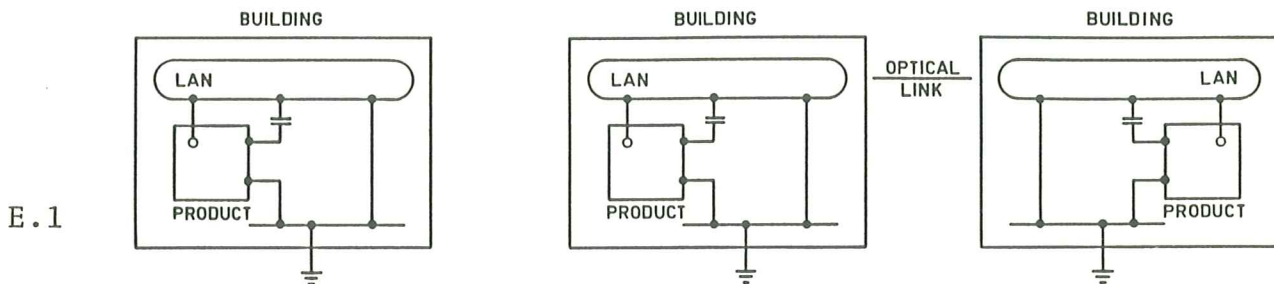


Fig. 41B - Maximum prospective touch voltage duration curves according to table 41A

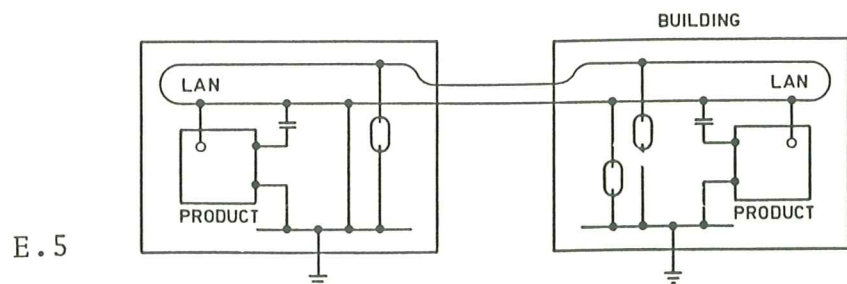
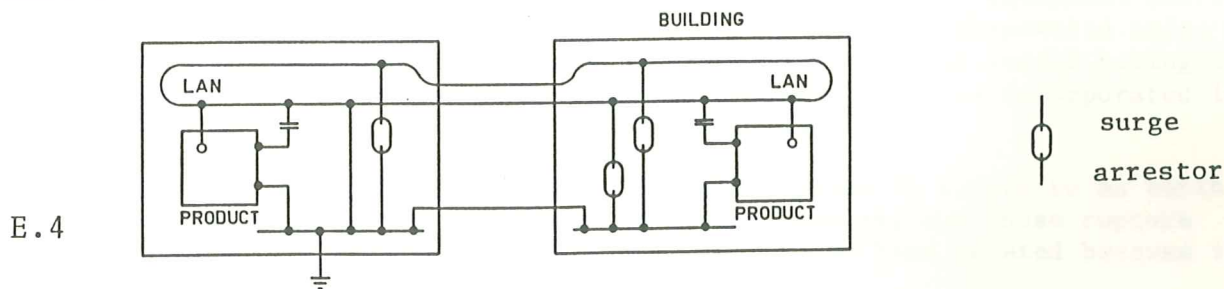
APPENDIX E

EXAMPLES OF SITUATIONS IN AND AROUND BUILDINGS

SITUATION A



SITUATION B



APPENDIX F

DIFFERENCES BETWEEN THIS STANDARD AND ECMA TR/19

- F.1 Scope (section 2) limited to LAN which have an extra-low operating voltage, because the use of a mains circuit to carry encoded messages, although could be called a LAN, has not been covered. Also limited to LAN which have conductive trunk cables, because eg. a fibre optic trunk cable would eliminate most of the requirements.
- F.2 A minimum number of references is now made to other documents except for information. Several definitions from other standards are copied in, complete. However, several references are still made to IEC 364, parts of which are reproduced in new appendices C and D. The impulse test voltage from IEC SC28A has been corrected but is still understood to be provisional.
- F.3 Situation A has been re-defined in terms of equipotential bonding, which is more fundamental than the existing definition in 6.1. All other situations are B. In most cases, a single building is A and multiple buildings are B, a new Appendix E illustrates these possibilities.
- F.4 In section 5, the prerequisite that equipment should conform with ECMA-57 has been moderated to permit the DTE (only) to conform with IEC 65 or 380 or 435.
- F.5 In section 6.1, instead of requiring the use of SELV circuits (as defined in ECMA-57), any circuit considered to be safe to touch according to one of several IEC standards is now acceptable. In addition to the DTE circuits, the requirement now includes circuits presented by the MAU to the DTE, and those presented by the MAU to the trunk cable. These requirements would be satisfied by equipment meeting the present TR19, provided that the MAU is not a mains-powered unit; the new requirements allow the possibility of the MAU itself having a mains input, and also clarify the case when the MAU is incorporated in the DTE.
- F.6 In TR19, 6.2.2, Note 3 has been deleted because it refers to an earth connection which is not there for safety reasons, and whose rupture would not degrade safety. In 6.3.1, Note 4 has been deleted because it is redundant.
- F.7 In 6.3.1 of this standard, earthing at MAU is required to be direct, not relying on a DTE being connected, otherwise the MAU could present unsafe touch voltages derived from another point in the LAN.
- F.8 Much hardware exists with isolation suitable for Situation A, and two scenarios have been identified where such hardware can be used in Situation B. One (6.3.6) is if the equipment is earthed in a particular way. Some malfunctioning which may occur due to possible multiple earths make this a less preferred option, especially where the

DTE design cannot be controlled. The other is if over-voltages which may occur in Situation B are suitably attenuated (6.4.5) by surge arrestors.

F.9 In 6.4.1 the effectiveness of a single surge arrestor for a coaxial trunk cable is recognized.

