INTERNATIONAL STANDARD

IEC 60728-11

Second edition
2005-01

Cable networks for television signals, sound signals and interactive services –

**Part 11:
Safety**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 11: Safety

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60728-11 has been prepared by technical area 5: Cable networks for television signals, sound signals and interactive services, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 1997 and its amendment 1 (2000). This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Clause 6, Equipotential bonding and earthing, has been rewritten.
b) Clause 8, Remote power feeding in cable networks, has been rewritten.
c) New informative Annex A: Use of shield wires to protect installations with coaxial cables
d) New informative Annex B: Special conditions using IT power line networks

The text of this standard is based on the following documents:

FDIS	Report on voting
100/847A/FDIS	100/896/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 60728 consists of the following parts, under the general title *Cable networks for television signals, sound signals and interactive services:*

Part 1: Methods of measurement and system performance
Part 2: Electromagnetic compatibility for equipment
Part 3: Active coaxial wideband distribution equipment
Part 4: Passive coaxial wideband distribution equipment
Part 5: Headend equipment
Part 6: Optical equipment
Part 7: Hybrid fibre coax outside plant status monitoring
Part 9: Interfaces of cabled distribution systems for digitally modulated signals
Part 10: System performance of return path
Part 11: Safety (this publication)
Part 12: Electromagnetic compatibility of systems

The following differences exist in some countries.

Clause 6:

- The following parts of the standard cannot be used in areas with an IT power distribution system:
  - Examples of installations inside buildings described in 6.2g) and shown in Figures 3 and 4 cannot be used in areas with an IT-network (Norway).
  - Examples of installations inside buildings described in 6.2i) and shown in Figure 6 should be equipped with a galvanic isolator separating local earth from the cable network distribution lines (Norway).
  - Examples of installations inside buildings described in 6.2.11 and shown in Figure 7 should be equipped with a galvanic isolator separating local earth from the cable network distribution lines (Norway).
  - Subclauses 6.3.4, 6.3.4.1, 6.3.4.2 and 6.3.5 have no relevance for cable networks in areas with an IT power distribution system (Norway).
- Common earthing is not permitted due to electrical earthing conditions (France).

Subclause 6.2:

- Galvanic isolation should withstand a voltage of 1 kV r.m.s. during 1 min (France).
- The equipotential bonding method is not used in Japan (Japan).
- Earthing to gas networks as shown in Figures 3 and 4 is not admitted (Japan, Poland).

Subclause 8.1:

- Remote power feeding voltage shall not exceed 90 V AC r.m.s and the line-powering current shall not exceed 15 A (Japan).

Clause 9:

- The French regulation (arrêté interministériel, 2 April 1991) specifies, among many other parameters, the minimum distance between electric supply wires (isolated and non-isolated, low-voltage and high-voltage) and any other installation (for example, buildings, antennas, telecommunication lines, etc.). The main clauses of this regulation, which concern the cable networks, are Clauses 12, 25, 26, 33, 33bis, 38, 49, 51, 52 and 63. Clause 9 of this standard specifies distances of 10 mm (indoors) and 20 mm (outdoors), and this is not sufficient to cover overhead cables. As an example, the minimum distance between an overhead telecommunication line and an overhead low-voltage (up to 1 kV) electricity supply line should be 1 m (Clause 33). This distance may be reduced under specific conditions (Clauses 51, 52 and 63). This regulation specifies also the minimum distance from high-voltage lines. This distance varies from 1 m to 4 m depending on the voltage, on the isolation of the cable and on the location (built-up area or not) (Clauses 33 and 63) (France).
- For antennas in proximity of voltages up to 7 000 V, the following applies in Japan:

1.	Low voltage:	≤600 V a.c. or ≤750 V d.c.;
	Cable:	≥30 cm distance;
	Isolated wire:	≥60 cm distance.
2.	High voltage:	>600 V a.c. or >750 V d.c.;
	Cable:	≥40 cm distance;
	Isolated wire:	≥80 cm distance.

Clause 10:

- The resistance to the equipotential point is not applied, because the bonding method is not used in Japan. Japanese regulations specify applying the safety terminal. The safety terminal withstands a continuous a.c. test voltage of 1 000 V for a period of not less than 1 min and maintains an insulation resistance of not less than 1,0 MΩ. Installation of a safety terminal at the junction point between the indoor cabling and the feeder cable of the distribution system is shown in Figure 14 (Japan).

Clause 11:

- A lightning protection system is applied in Japan for protection against atmospheric over-voltages and for the elimination of potential differences. In Japan, installation of a lightning protection system is necessary in the case where the topmost height of the construction exceeds 20 m, except in those cases where the construction is inside the safety zone of another lightning protection system (see Figure 15) (Japan).

Subclause 11.1.1:

- An equipotential bonding conductor is not used, because the bonding method is not used in Japan (Japan).

Subclause 11.2.2:

- An earth termination system is not used in Japan. Only a lightning protection system is applied (see Figure 15) (Japan).
- As the conductivity of earth in Finland is lower than what is normal in many other countries, the earthing electrodes in 11.2.2 should be as shown in Figures 16 a), 16 b) or 16 c) (Finland).

- The earthing conductors have the following requirements (Japan):
  a) Conductors for a lightning rod: ≥30 mm^2 Cu.
  b) For an earthing resistance of ≤10 Ω, the diameter has to be at least 2,6 mm Cu.
  c) For an earthing resistance of ≤100 Ω, indoors, the diameter has to be at least 1,6 mm Cu or the cross-sectional area has to be at least 2 mm^2 Cu
  d) For an earthing resistance of ≤100 Ω, outdoors, the diameter has to be at least 2,6 mm Cu or the cross-sectional area has to be at least 5,5 mm^2 Cu.

Subclause 12.2:

- The bending moment of a mast up to 6 m is not applied in Japan. In Japan, the mast shall not be destroyed by the following wind pressures (Japan):
  1. For an antenna height h < 16 m, the wind pressure is $60\sqrt{h}$, in kg per m^2.
  2. For an antenna height $h \geq 16$ m, the wind pressure is $120\sqrt[4]{h}$, in kg per m^2.

Subclause 12.3:

- The required wind pressure value is 700 N/m^2 for buildings up to 30 m (Finland).

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

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

Standards of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for head-end reception, processing and distribution of television signals, sound signals, interactive multimedia signals, interfaces and their associated data signals, using all applicable transmission media.

This includes

– CATV networks;
– MATV networks and SMATV networks;
– individual receiving networks;

and all kinds of equipment, systems and installations installed in such networks.

The extent of this standardization work is from the antennas, special signal source inputs to the head-end or other interface points to the network up to the terminal input.

The standardization of any user terminals (i.e. tuners, receivers, decoders, terminals, etc.) as well as of any coaxial and optical cables and accessories thereof is excluded.

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 11: Safety

1 Scope

This part of IEC 60728 deals with the safety requirements applicable to fixed sited systems and equipment. As far as applicable, it is also valid for mobile and temporarily installed systems, for example, caravans.

Additional requirements may be applied, for example, referring to

- electrical installations of buildings and overhead lines;
- other telecommunication services distribution systems;
- water distribution systems;
- gas distribution systems;
- lightning systems.

This standard is intended to provide specifically for the safety of the system, personnel working on it, subscribers and subscriber equipment. It deals only with safety aspects and is not intended to define a standard for the protection of the equipment used in the system.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60364 (all parts), *Electrical installations of buildings*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

IEC 60825-1:2001, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*

IEC 60825-2:2000, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

IEC 60950-1:2001, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61024-1:1990, *Protection of structures against lightning – Part 1: General principles*

ISO 3864:2002, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs in workplaces and public areas*

EN 50117 (all parts), *Coaxial cables used in cabled distribution networks*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Some terms have been taken from IEC 60050-195 and IEC 60050-826.

3.1.1
amplifier
device to compensate for attenuation

3.1.2
attenuation
decibel ratio of the input power to the output power

3.1.3
cable networks (for television signals, sound signals and interactive services)
general overall term used to define CATV-networks, MATV-networks, SMATV-networks and individual receiving networks; these networks can be used in downstream and upstream directions

3.1.4
CATV network or community antenna television network
network designed to provide sound and television signals as well as signals for interactive services to communities

3.1.5
earthing arrangement
all the electric connections and devices involved in the earthing of a system, an installation and equipment

[IEV 195-02-20]

3.1.6
earthing conductor
protective conductor connecting the main earthing terminal or bar to the earth electrode

[IEV 826-04-07]

3.1.7
earth electrode
conductive part or a group of conductive parts in intimate contact with and providing an electrical connection with earth

[IEV 826-04-02]

3.1.8
earthing terminal
connection point by means of which the earthing or grounding of a conducting part of an equipment is accomplished

3.1.9
electric shock
pathophysiological effect resulting from an electric current passing through a human or animal body

[IEV 826-03-04]

3.1.10
equipotential bonding
electrical connection putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential

[IEV 826-04-09]

3.1.11
equipotential bonding bar
bar to which, for example, extraneous conductive parts (see IEV 826-03-03), metal sheet of electrical power and telecommunication cables and other cables can be bonded

3.1.12
equipotential bonding conductor
protective conductor for ensuring equipotential bonding

[IEV 826-04-10]

3.1.13
feeder
transmission path forming part of a cable network. Such a path may consist of a metallic cable, optical fibre, waveguide or any combination of them. By extension, the term is also applied to paths containing one or more radio links

3.1.14
galvanic isolator
device providing electrical isolation below a certain frequency range.

3.1.15
hazardous voltage
electrical condition of an object from which a hazardous touch current (electric shock) could be drawn

[IEC 60065:2001, definition 2.6.10]

3.1.16
head-end
equipment, which is connected between receiving antennas or other signal sources and the remainder of the cable network, to process the signals to be distributed

3.1.17
individual receiving network
network designed to provide sound and television signals as well as signals for interactive services to an individual household

3.1.18
lightning protection system (LPS)
complete system used to protect a space against the effects of lightning consisting of both external and internal lightning protection systems

NOTE In particular cases, an LPS may consist of an external LPS or an internal LPS only (see IEC 61024-1).

3.1.19
main earthing terminal; main earthing bar
terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors and conductors for functional earthing, if any, to the means of earthing

[IEV 826-04-08]

3.1.20
MATV network or master antenna television network
network designed to provide sound and television signals as well as signals for interactive services to households in one or more buildings

3.1.21
metal installation
extended metal items in the space to be protected which may form a path for lightning current, such as pipe-work, staircases, elevator guide rails, ventilation, heating and air conditioning ducts, and interconnected reinforcing steel

[IEC 61024-1:1990, definition 1.2.18]

3.1.22
"natural" component of an LPS
component which performs a lightning protection function but is not installed specifically for that purpose

NOTE Some examples of the use of this term are as follows:

– "natural" air-termination;
– "natural" down-conductor;
– "natural" earth electrode.

[IEC 61024-1:1990, definition 1.2.17]

3.1.23
network interface unit (NIU)
interface between the cable network and the network inside an apartment

NOTE The network interface unit can contain an over-voltage protective element and/or a galvanic isolation.

3.1.24
neutral conductor (symbol N)
conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy

[IEV 826-01-03]

3.1.25
PEN conductor
earthed conductor combining the functions of both protective conductor and neutral conductor.

NOTE The acronym PEN results from the combination of both symbols PE for the protective conductor and N for the neutral conductor.

[IEV 826-04-06]

3.1.26
protective conductor (symbol PE)
conductor required by some measures for protection against electric shock for electrically connecting any of the following parts:

– exposed conductive parts;
– extraneous conductive parts;
– main earthing terminal;
– earth electrode;
– earthed point of the source or artificial neutral

[IEV 826-04-05]

3.1.27
receiver lead
lead, which connects the system outlet to the subscriber equipment

3.1.28
receiving antenna
device with proper electrical characteristics that intercepts desired signals in the atmosphere and transfers these to the remainder of the cable network

3.1.29
remote power feeding voltage
voltage for supplying power to network equipment via the cable network or a separate line

3.1.30
safety distance
minimum distance between two conductive parts within the space to be protected between which no dangerous sparking can occur

[IEC 61024-1:1990, definition 1.2.23]

3.1.31
SMATV network or satellite master antenna television network
network designed to provide sound and television signals as well as signals for interactive services, received by satellite receiving antenna eventually combined with terrestrial TV and/or radio signals, to households in one or more buildings

3.1.32
splitter (spur unit)
device in which the signal power at the (input) port is divided equally or unequally between two or more (output) ports

NOTE Some forms of this device may be used in the reverse direction for combining signal energy.

3.1.33
spur feeder
feeder to which splitters, subscriber taps or looped system outlets are connected

3.1.34
subscriber equipment
equipment at the subscriber premises such as receivers, tuners, decoders, video recorders, multimedia terminals

3.1.35
subscriber feeder
feeder connecting a subscriber tap to a system outlet or, where the latter is not used, direct to the subscriber equipment

3.1.36
subscriber tap
device for connecting a subscriber feeder to a spur feeder

3.1.37
surge suppressor
device designed to limit the surge voltage between two parts within the space to be protected, such as spark gap, surge diverter or semiconductor device

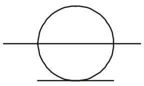
[IEC 61024-1:1990, definition 1.2.24]

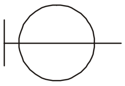
3.1.38
system outlet
device for interconnecting a subscriber feeder and a receiver lead

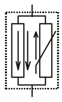
3.1.39
transfer point
interface between the cable network and the building's internal network, each of which may be separately owned and which may contain a voltage-dependent device and/or galvanic isolator

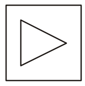
3.2 Symbols

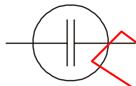
The following graphical symbols are used in the figures of this standard.

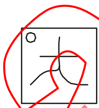

Coaxial conductor
[S00011]


System outlet


Over-voltage protective device


Amplifier
[S01240]


Galvanic isolator


Coaxial over-voltage protective device

3.3 Abbreviations

a.c.	alternating current
AM	amplitude modulation
CATV	community antenna television (network)
d.c.	direct current
IT	isolated earth
LPS	lightning protection system
MATV	master antenna television (network)
N	neutral (conductor)
NIU	network interface unit
PE	protective conductor
PEN	PEN conductor
r.f.	radio frequency
r.m.s	root mean square
SMATV	satellite master antenna television (network)
TV	Television

4 General requirements

4.1 General

The cable network shall be so designed, constructed and installed as to present no danger, either under normal condition or abnormal (any single fault) condition, to subscribers, personnel working on, or externally inspecting, the system, or to any other person, providing particularly

– personal protection against electric shock;
– personal protection against physical injury;
– protection against fire.

For further details, see the IEC 60364 series.

NOTE The above does not apply to skilled persons working on the equipment, who may be exposed to live parts of the equipment by the removal of protective covers.

4.2 Mechanical requirements

All parts of the system shall be so constructed that there is no danger of physical injury from contact with sharp edges or corners.

4.3 Accessible parts

Access to hazardous parts shall not be possible to the general public without first removing a protective cover by use of a tool. IEC 60065 defines accessible parts and test procedures.

4.4 Laser radiation

If equipment embodying laser products is used, special attention shall be paid to radiation safety. Refer to IEC 60825-1 and IEC 60825-2 for requirements and recommendations.

5 Protection against environmental influences

All system parts, taking into account external influences to which they might be exposed, have to be selected and set up in such a way that, when used properly, the effectiveness of the required protective measures is ensured.

NOTE Special measures are required, for example, for protection against corrosive atmosphere, temperature and humidity.

6 Equipotential bonding and earthing

6.1 General requirements

The cable network shall be designed and constructed in accordance with the requirements of the IEC 60364 series so that no hazardous voltages can be present on the outer conductors of any cable or accessible metalwork of any equipment, including passive items. The requirements for the system outlet are specified in Clause 10; the requirements for bonding and lightning protection of antenna systems are given in Clause 11.

These bonding requirements are intended to protect only the cable network and shall not be considered to provide protection against electric shock currents from electrical installations.

Earthing arrangements and protective conductors shall be designed and constructed in accordance with the requirements of IEC 60364-5-54.

Where cable networks are installed outdoors on the same poles as those of the electric supply, a common earthing may be used.

6.2 Equipotential bonding mechanisms

a) In order to prevent potential differences between a cable network and other extraneous conductive parts, which might do harm to persons or cause damage, for example, by arcing, the cable network shall be included in the equipotential bonding system of the building.

NOTE Equipotential bonding between metal installations and electrical systems in and on the building is generally carried out at the equipotential bonding bar of the building. Multiple, meshed equipotential bonding increases its effectiveness.

b) Equipotential bonding can be achieved by means of equipotential bonding conductors, cable shielding or conductive housings or system parts. Heating pipes, water pipes, gas pipes shall not be used because they do not guarantee permanent equipotential bonding efficiency.

c) The equipotential bonding conductors connected to earthing terminals shall be mechanically stable and shall have a minimum cross-sectional area of 4 mm^2 Cu. They shall comply with IEC 60364-5-54.

d) Metallic enclosures for mains-supplied equipment shall be bonded if they are located outside buildings. An example of an equipotential bonding connection is shown in Figure 1.

e) Where direct connection to an earthing system is not suitable because high balancing currents are expected to flow in the outer conductor, for example, in extensive cable networks, special protection shall be provided.

As shown in Figure 2, this protection can be achieved by

– mounting the equipment within a non-metallic enclosure; or

– connecting an over-voltage protective element between the metallic enclosure and the earthing connection that hazardous voltages shall be removed from the outer conductor and accessible metal parts of the system.

The safety sign "Warning about hazardous electrical voltage"  according to sign B.3.6 of ISO 3864 shall be attached to the enclosure.

If balancing currents are expected to exceed the maximum current allowed by the manufacturer of the cable and/or of the cable connectors, a galvanic isolation may be used as described hereafter.

f) Where galvanic isolation is provided between sections of the network, to eliminate balancing currents due to local potential differences, the outer conductors of each isolated section shall be connected to an earthing system.

NOTE 1 Galvanic isolators, in case of improper design, can radiate or pick up inadmissible high-frequency energy. Therefore, compliance with the requirements of IEC 60728-2 should be checked carefully.

NOTE 2 Galvanic isolators can be damaged by over-voltages.

g) The outer conductors of coaxial cables entering or leaving a building shall be included in the equipotential bonding system of the building, either at the equipment or separately. The subscriber feeder cables need not be bonded if a galvanic isolator or fully isolated outlets (see Clause 10) or transfer points each with a galvanic isolation for the inner and the outer conductor are used. Examples are shown in Figures 3, 4 and 5.

h) Where equipotential bonding is not possible and to avoid balancing currents between the cable network and the building installation, a galvanic isolator shall be used. An example is shown in Figure 5.

NOTE 1 Galvanic isolators, in case of improper design, can radiate or pick up inadmissible high-frequency energy. Therefore, compliance with the requirements of IEC 60728-2 should be checked carefully.

NOTE 2 Galvanic isolators can be damaged by over-voltages.

i) When changing or removing equipment or coaxial cable, care shall be taken to avoid hazardous voltages between the interrupted parts (inner and/or outer conductors) by opening the loop caused by leakage currents from subscriber equipment. Provision shall be made to maintain continuity of the outer conductor system while units are changed or removed to avoid electric shock (shock currents). An example is shown in Figure 6. In addition, the inner conductors shall be safeguarded against contact.

j) Every connection of an equipotential bonding conductor or an earthing conductor to an earthing terminal shall be readily accessible and soundly made by the use of crimps, clamps, weld or hard-soldered joints.

k) All metallic enclosures, housings, mounting bays, racks and mains-supplied equipment, shall be provided with an external earthing terminal as shown in Figures 7 and 8 complying with IEC 60065 or IEC 60950-1.

NOTE Line-powered amplifiers, taps, splitters and transfer points should also be fitted with earthing terminals.

l) For antennas, which, according to Clause 11, do not have to be grounded, it is strongly recommended that at least the outer conductor of the coaxial cable connected to the antenna should be included in the equipotential bonding. Furthermore, all interconnected, conductive, accessible parts of the installation should be included in the equipotential bonding. For these connections, either of the following solutions is permitted.

   – Connection to an equipotential bonding terminal by means of a bonding conductor (cross-section ≥ 4 mm^2 Cu).

   – Connection by means of the shielding of the coaxial cable. The d.c. resistance to the nearest point of equipotential bonding (or PE) shall be lower than 5 Ω. The connection of the shield of the coaxial cable to the protective conductor shall only be disconnectable by means of a tool.

6.3 Equipotential bonding in meshed systems

6.3.1 References to other standards

Equipotential bonding shall comply with IEC 60364-5-54, EN 50174-2, EN 50310 and CENELEC R 064-004.

6.3.2 General on a.c. mains

Due to the varying load, locally and versus time, of the individual phases of the a.c. mains supply in a building, high balancing currents can occur in the neutral conductors. The neutral conductor currents are even increased by harmonic currents, which are emitted by certain electric loads like switching power supplies, energy-saving lights, etc.

NOTE For example, the third harmonic currents of the mains frequency in the three phases add linearly in the neutral conductor.

6.3.3 AC power distribution and connection of the protective conductor

In low-voltage installations, different systems are distinguished by the type of earthing connection on the one hand and by the exposed conductive part otherwise (IEC 60364-1 or EN 50310).

a) TN systems

   1) TN-S system: Separate neutral and protective conductors throughout the system connected at the earthing point of the system.

      NOTE No neutral conductor currents flow in the protective conductor.

   2) TN-C system: Neutral and protective functions combined in a single conductor throughout the system.

   3) TN-C-S system: Neutral and protective functions combined in a single conductor in part of the system.

b) TT system: The TT system has 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.

c) IT system: The IT system has all live parts isolated from earth or one point connected to earth through an impedance, the exposed conductive parts of the electrical installation being earthed.

6.3.4 Dangers and malfunction

6.3.4.1 Within buildings

Due to the connecting of the PEN conductor in TN-C and TN-C-S systems to earthed shielding of the cable network, currents can be carried off from the PEN conductor to the cable network and leak away via the cable shielding.

NOTE When connecting equipment of protection class I to mains and simultaneously to the cable network, the connection between the PEN conductor and earthed shielding is established via the protective conductor of the equipment.

In the case of insufficient conductor cross-section of the shield, the currents from the PEN conductor can cause heating and overheating of cables and shieldings (risk of fire).

If the currents flow through non-linear elements (for example, ferrite transformers in taps, splitters, system outlets, etc.) they can cause hum modulation. Coupling loops can also cause hum interference.

Data transmission errors and malfunctions can occur in signalling systems.

6.3.4.2 Between buildings

Due to different currents in N or PEN conductors, the equipotential bonding bars in the individual buildings can carry different potentials which can cause critically high balancing currents to flow through the shielding of the coaxial cables or the shielding of data cables between the buildings.

6.3.5 Measures

a) Equipment of telecommunications and information technology should be connected to a TN-S system.

b) If possible, use equipment of protection class II.

c) When using equipment of protection class I, galvanic isolators should be used in the coaxial connector to avoid PEN conductor currents being carried over.

   NOTE 1 Take care that the inner conductor and shielding of the coaxial cable are electrically isolated.

   NOTE 2 Galvanic isolators, in case of improper design, can radiate or pick up inadmissible high-frequency energy. Therefore, compliance with the requirements of IEC 60728-2 should be checked carefully.

d) To avoid interference according to 6.3.4.2:

   – use relieving equipotential bonding (see IEC 60364-5-54);

   – galvanic isolation at NIU.

7 Mains-supplied equipment

The equipment used in a cable network shall meet the requirements of IEC 60065 or IEC 60950-1. Preferably, equipment of protection class II should be used.

NOTE 1 If different potentials build up between the PE conductor and the equipotential bonding terminal, the balancing currents could produce excessive heat.

NOTE 2 For the application of either standard, IEC Guide 112 applies.

Devices installed outdoors and operated from the mains supply shall be so constructed that the harmful effects of moisture, water, dust, etc. are prevented. Alternatively, they shall be installed in an appropriate drip-proof, splash-proof or watertight enclosure so as to provide the appropriate degree of protection (see IEC 60529).

8 Remote power feeding in cable networks

8.1 Remote power feeding

8.1.1 Maximum allowed voltages

The rated value of the remote powering voltage shall not exceed 65 V a.c. or 120 V d.c. The following conditions must be complied with:

– remote powering shall not extend to the subscriber feeder (for an exception, see 8.2); the necessary isolation shall be provided by equipment according to 8.1.2;

  the remote powering voltage shall only be accessible to skilled persons after removal of equipment covers by means of a tool.

NOTE Direct currents (d.c.) can destroy parts of the system by corrosion.

A true r.m.s reading instrument shall be used to determine this voltage.

8.1.2 General provisions for equipment

The equipment used in a cable network shall meet the requirements of IEC 60065 or IEC 60950-1. For protection against over-voltages in cable networks, see 10.1.

NOTE 1 For the application of either standard, IEC Guide 112 applies.

NOTE 2 A conductive connection between a terminal of the remote supply voltage and the accessible housing of remotely powered equipment is allowed.

The occurrence of hazardous currents shall be prevented by a suitable selection of fuses or by the power supply (for example, power-supply unit with integrated current limitation).

8.1.3 Current-carrying capacity and dielectric strength of the components

The heating caused by operating and short-circuit currents (in case of failure) of the components used shall not cause any danger. Particularly, components like cables, plugs and screw connections shall meet these requirements. With respect to the current-carrying capacity and dielectric strength, only components specified for the maximum current and maximum operating voltage according to Table 1 shall be used, if not specified otherwise by the manufacturer.

Table 1 – Maximum operation voltage and maximum currents for coaxial cables in different cable network applications

Application	Typical diameter of the coaxial cable mm	Maximum operation voltage V		Maximum current A	
		AC	DC	Operation	Permanent short circuit
Drop cable	≤ 10	≤ 24	≤ 34	≤ 0,5	≤ 1,5
Feeder cable	> 10	≤ 65	≤ 120	≤ 7	≤ 15
Trunk cable	> 10	≤ 65	≤ 120	≤ 15	≤ 30
NOTE Specific test conditions for coaxial cables are laid down in the EN 50117 series					

8.2 Remote powering from subscriber premises

Where back-powering to a network or to outdoor equipment such as preamplifiers, low-noise converters, polarizers in antenna installations is incorporated, the system shall comply with the following requirements.

– The maximum voltage applied between the inner and outer conductors of the subscriber feeder shall not exceed 24 V a.c., r.m.s or 34 V d.c.; a true r.m.s reading instrument shall be used to determine the a.c. voltage.

– The equipment shall be so designed and constructed that no dangerous currents can flow under normal operating or single-fault conditions.

– The equipment providing the power shall, if that power is derived from a mains supply, comply with all the relevant clauses of IEC 60065 or IEC 60950-1 as specified in Clause 7.

– Repointing motors and de-icing devices are normally separately fed. Specific requirements
and recommendations are not specified here. Refer to IEC 60065 or IEC 60950-1.

9 Protection against contact and proximity to electric power distribution systems

9.1 General

The risk of hazardous voltages in cable networks due to an accidental contact to electric power lines shall be minimized. These protection requirements are intended, where no local regulations exist, to protect cable networks against potentially hazardous voltages.

9.2 Overhead lines

9.2.1 Overhead lines up to 1 000 V

The distance between any part of the antenna and the antenna support structure and electric power distribution systems shall be not less than 1 m or according to national regulations, if more stringent.

NOTE This value provides sufficient margin that the swinging of the electric power cables need not be taken into account.

9.2.2 Overhead lines above 1 000 V

For phase conductors carrying voltages of more than 1 kV, the distance to any part of an antenna structure shall be at least 3 m or according to national regulations, if more stringent. The cable network shall not cross over in open air any open power-distribution system carrying voltages of more than 1 kV.

9.3 House installations up to 1 000 V

The distance between conductive parts of a cable network and conductive parts, including all support structures, of an electric power-distribution system carrying voltages between 50 V and 1 000 V shall be at least 10 mm when installed inside and 20 mm when installed outside.

These distances may be less only if there is sufficient insulating material, for example, cable with insulating jacket, between the conductors of the two systems, thus guaranteeing that these conductors do not touch each other. For isolation requirements of coaxial cables, see the EN 50117 series.

With respect to common line routing for cable networks and electrical building installations, IEC 60364-5-52 shall be taken into account.

NOTE The installation of a power outlet and a system outlet in a common box is allowed only if the system outlet can be installed in such a way that hazardous live parts of the electric power distribution system cannot be touched by the installer.

10 System outlets and transfer points

10.1 General

The subscriber equipment can be connected to the cable network directly or by means of system outlets and/or transfer points which provide the necessary over-voltage protection.

NOTE Except in the case of fully isolated outlets (see 10.2.1), the protection achieved depends on equipotential bonding of the outer conductor of the subscriber feeder. It should be pointed out that, under certain combinations of fault conditions and when using class I equipment, the outer conductor of the subscriber feeder can act as a protective conductor of the electricity supply with the result that large fault currents may flow for a considerable period of time, depending on the protection provided in the electrical distribution system.

Where system outlets or transfer points are not used, over-voltage protection shall be provided at the output of the subscriber tap.

Where over-voltage protection is provided by means of isolating capacitors or transformers, the isolated conductors, for example, inner conductors shall withstand a continuous d.c. test voltage of 2 120 V for a period of not less than 1 min and maintain an insulation resistance of not less than 3,0 MΩ.

NOTE Compliance with this requirement can be shown to be achieved if the leakage current during the test does not exceed 0,7 mA.

The manufacturer shall design the isolating means in such a way that, under fault conditions of equipment connected to the outlet or transfer point, the a.c. leakage current (50 Hz or 60 Hz) does not exceed 8 mA r.m.s with an applied voltage of 230 V r.m.s.

10.2 System outlet

There are four types of system outlets in common use providing varying degrees of protection against electric shock (shock currents), but also more or less liable to radiate or pick up high-frequency energy.

10.2.1 Fully isolated system outlet

This type of outlet incorporates isolating components in series with both the inner and the outer conductors of the coaxial connections. The isolating components may be either high-voltage capacitors or double-wound transformers.

NOTE Fully isolated system outlets, in case of improper design, can radiate or pick up inadmissible high-frequency energy. Therefore, compliance with the requirements of IEC 60728-2 should be checked carefully.

10.2.2 Semi-isolated system outlet

This type of outlet incorporates an isolating component in series with the inner conductors only of the coaxial connections. If this outlet is used, the protection shall be provided by equipotential bonding of the outer conductor of the subscriber feeder. In this case, the d.c. resistance between the outer conductor of the connection and the nearest network equipotential bonding point shall be less than 5 Ω. The isolating component may be either a high-voltage capacitor or a double-wound transformer.

10.2.3 Non-isolated system outlet with protective element

This type of outlet does not incorporate any series isolation. Protection shall be provided by equipotential bondings as in 10.2.2. A protective element to improve safety (for example, an r.f. coil) shall be connected between the inner and outer conductors of the coaxial connections. The d.c. resistance of this protective element shall be less than 1 Ω. The d.c. resistance between the outer conductor of the coaxial connections and the nearest network equipotential point shall be less than 5 Ω.

10.2.4 Non-isolated system outlet without protective element

This type of outlet incorporates coaxial connector(s) only and does not contain any isolation component or protective element.

NOTE When this type of system outlet is used for back-powering, basic insulation according to IEC 60950-1 should be implemented to prevent the power from reaching other outlets.

The protection shall be provided by equipotential bonding as in 10.2.2.

10.3 Transfer point

This device can also provide varying degrees of protection against electric shock (shock currents), depending on the elements incorporated. The same requirements as for the system outlet are applicable.

NOTE Fully isolated transfer points, in case of improper design, can radiate or pick up inadmissible high-frequency energy. Therefore, compliance with the requirements of IEC 60728-2 should be checked carefully.

11 Protection against atmospheric over-voltages and elimination of potential differences

11.1 General

These protection requirements are intended, where no local regulations exist, to protect antenna systems, including satellite antennas against static atmospheric over-voltages and lightning discharges.

All parts of the outer antenna system shall be so designed that they will withstand a lightning discharge without danger of fire or separation of the outer antenna system or parts thereof from the supporting structure.

These protection requirements shall not be considered as providing protection for buildings or any other structures.

The following cases are excluded:

– antenna systems on buildings which are located at a minimum distance of 2 m below the roof covering or the eaves and less than 1,5 m from the building (see Figure 9);
– antenna systems enclosed within the building structure.

Antennas shall not be installed on buildings having roofs covered with highly flammable materials (for example, thatch, reed-like material, etc.).

Antenna cables and earthing conductors shall not be laid in areas used for the storage of easily ignitable materials, such as hay, straw and similar substances, or in areas in which explosive gases can develop or collect.

AM sound-broadcasting receiving antennas shall incorporate a protective device connected to a bonding conductor.

11.2 Protection of the antenna system

11.2.1 Building equipped with a lightning protection system (LPS)

If the building is equipped with an LPS conforming to IEC 61024-1, the antenna mast, being a metal installation, shall be connected to the building's LPS via the shortest possible path and using an earthing conductor as specified in 11.3.

The outer conductors of all coaxial cables coming from the antennas shall be connected to the mast via an equipotential bonding conductor having a minimum cross-sectional area of 4 mm^2 Cu (see Figure 8).

11.2.2 Building not equipped with an LPS

If the building is not equipped with an LPS conforming to IEC 61024-1, the mast and outer conductors of the coaxial cables shall be earthed as specified in 11.3.

For individual receiving systems or MATV systems confined to one building, where, due to low lightning probability, local regulations allow it, protection against lightning is not necessary but only recommended.

11.3 Earthing and bonding of the antenna system

11.3.1 Earthing and bonding mechanisms

The antenna mast shall be connected to earth via an earthing conductor. The earthing conductor shall be installed straight and vertical such that it can provide the shortest, most direct path to the earthing system. The outer conductors of all coaxial cables coming from the antenna shall be connected to the antenna mast or to the earthing conductor via an equipotential bonding conductor having a minimum cross-section of 4 mm^2 Cu (see Figure 8). The formation of loops shall be avoided.

11.3.2 Earth termination system

The earth termination system shall be provided by one of the following methods as shown in Figure 10:

- connection to the building's lightning protection system;
- connection to the building's earthing system;
- connection to
  - – a minimum of two horizontal earth electrodes of at least 2,5 m length buried in an angle larger than 60°, at least 0,5 m deep and not closer than 1 m to the foundation; or
  - – a vertical or inclined earth electrode of at least 2,5 m length or two vertical earth electrodes of at least 1,5 m length with a spacing of 3 m and not closer than 1 m to the foundation.

The minimum cross-sectional area of each earth electrode is 50 mm^2 Cu or 80 mm^2 Fe.

"Natural" components such as interconnected concrete reinforcing steel or other suitable underground metal structures, incorporated in the building's foundation and whose dimensions comply with the above-mentioned limits, can also be employed.

Other earth termination systems according to IEC 61024-1 are also allowed.

11.3.3 Earthing conductors

A suitable earthing conductor is a single solid wire having a minimum cross-sectional area of not less than 16 mm^2 Cu insulated or bare, or 25 mm^2 insulated Al or 50 mm^2 Fe. Only materials, which do not show corrosive behaviour towards each other, shall be used.

"Natural" components can be employed, for example (see Figure 10):

- metallic installations provided that
  - – local regulations allow it;

- the electrical continuity between the various parts is made durable;
- their dimensions are at least equal to those specified for standard earthing conductors;

NOTE According to IEC 60364-5-54, metallic water pipes do generally not meet the requirements as protective conductor.

- the metal framework of the structure;
- the interconnected steel of the structure;
- facade elements, profiled rails and sub-constructions of metal facades, provided that
  - their dimensions comply with the requirements for down conductors and their thickness is not less than 0,5 mm;
  - their electrical continuity in a vertical direction is assured (joints shall be made secure by such means as brazing, welding, crimping, screwing, or bolting) or the distance between the metal parts does not exceed 1 mm and the overlap between two elements is at least 100 cm^2.

The following are specifically excluded:

- protective earth and/or neutral conductors of the electricity supply;
- the outer conductor of any coaxial cable.

11.4 Over-voltage protection

Induction can introduce high voltages at transfer points, system outlets, at the head end of the cable network or at the input of subscriber equipment. Protection can be achieved, for example, by equipotential bonding via surge suppressors. Examples are shown in Figures 11 and 12.

12 Mechanical stability

12.1 General requirements

This standard deals only with the mechanical stability of outdoor antenna systems, including satellite antennas.

All parts of the antenna system shall be so designed that they will withstand the maximum wind forces defined below, without breakage and without any of the components being torn away.

12.2 Bending moment

For antenna systems with masts up to a maximum free length of 6 m, as shown in Figure 13, the bending moment at the fixing point shall not exceed 1 650 Nm. The wind load of the mast shall be included. The fixed part of the mast shall be at least one-sixth of the full length.

NOTE Where the length is greater than 6 m or where it is anticipated that this bending moment will be exceeded or if other fixing methods are used, the services of a qualified person who can guarantee the safety of the structure and/or building should be employed. Local regulations can require that the stability of the specific area where the mast is attached to the building is verified.

12.3 Wind-pressure values

For the purpose of establishing mast loadings, the following values can be used in the absence of specific local regulations.

– If antenna systems are established within 20 m of ground level, the value of p (wind pressure) shall be assumed to be 800 N/m^2 (wind speed 36 m/s or approximately 130 km/h).

– If antenna systems are established higher than 20 m above ground level, the value of p (wind pressure) shall be assumed to be 1 100 N/m^2 (wind speed 42 m/s or approximately 150 km/h).

The wind load on the antenna shall be calculated as follows:

$$W = c\ p\ A$$

where

W is the wind load, in Newtons;

c is the load coefficient;

p is the wind pressure, in Pascals (N/m^2);

A is the component area, in square metres.

The coefficient c to be used is 1,2.

Loading due to snow and ice is not considered.

NOTE Adverse environmental conditions or local regulations may require that a higher or lower wind-pressure value is assumed, for example:

– for a wind speed of 45 m/s (160 km/h), the wind pressure shall be 1,250 N/m^2;

– for a wind speed of 56 m/s (200 km/h), the wind pressure shall be 1,900 N/m^2.

The bending moment at the fixing point shall be calculated as follows:

$$M_b = W_1\ a_1 + W_2\ a_2 + \ldots$$

where

M_b is the bending moment, in Newton metres;

W_1, W_2, . . . is the wind load, in Newtons;

a_1, a_2, . . . is the mast length from the antenna to the fixing point, in metres.

12.4 Mast construction

Where the mast is constructed from steel, the steel shall have a guaranteed extension limit and the maximum loading shall not exceed 90 % of the extension limit (0,9 $B_{0,2}$) so that the mast on being overloaded does not break but only buckles.

The minimum wall thickness of the mast in the fastening area shall be 2 mm.

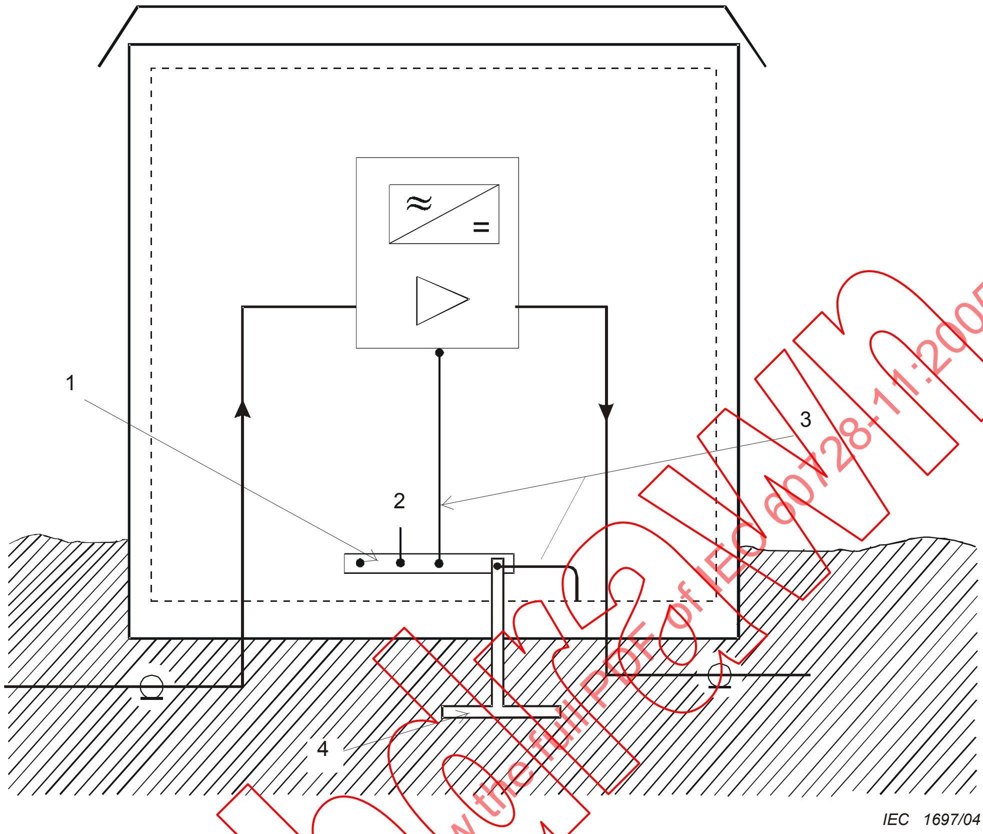
12.5 Data to be published

The antenna manufacturer shall publish the following data for a wind pressure of p = 800 N/m^2:

a) the wind load of the antennas;

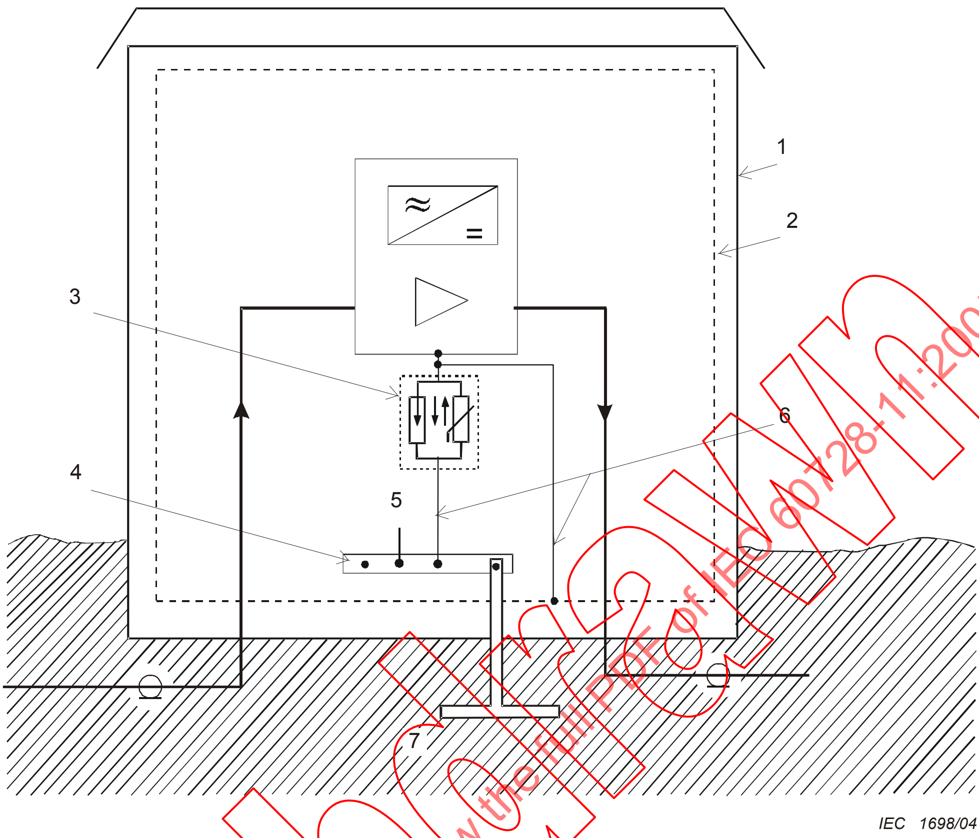
b) the maximum bending moment of the masts at the fixing point.

NOTE To convert the wind pressure of p = 800 N/m^2 to p = 1 100 N/m^2 the factor is 1,37 (1 100 / 800).



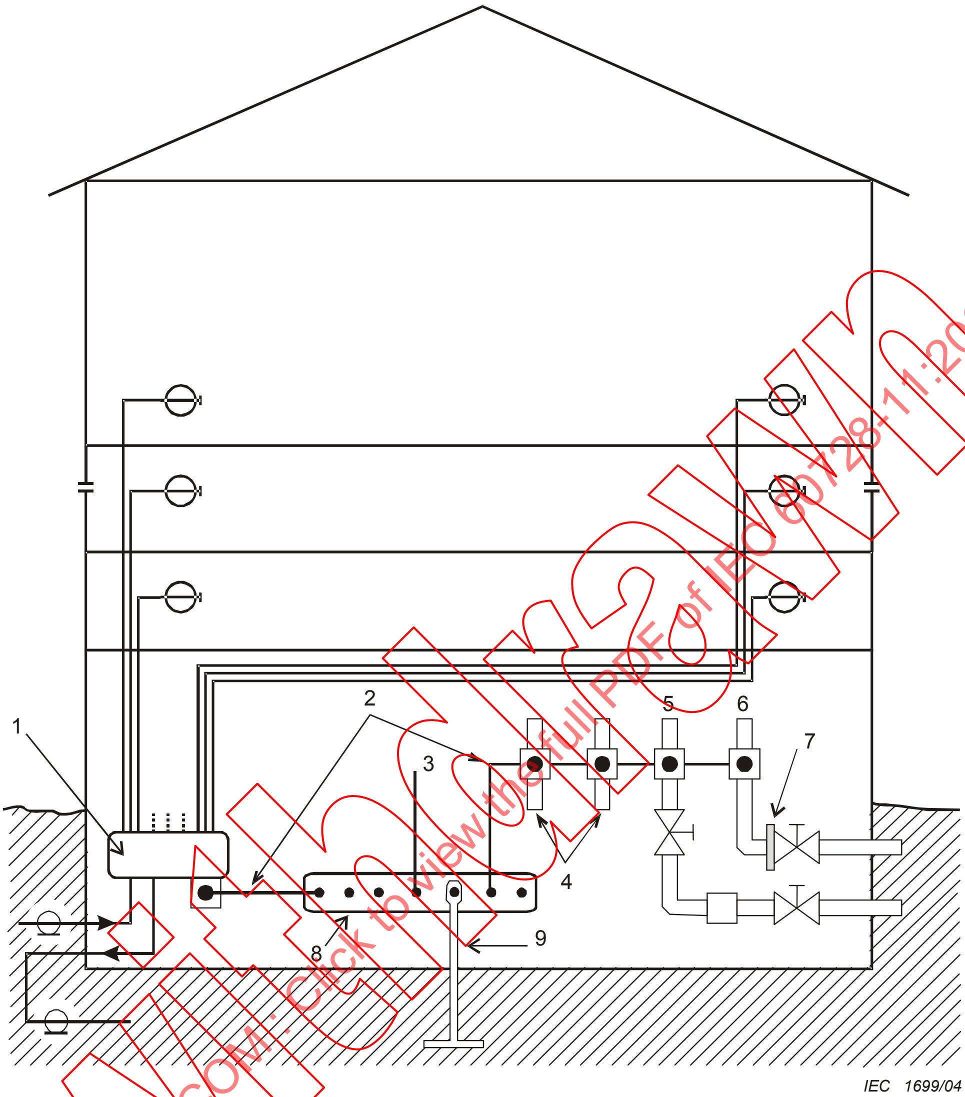
1 Equipotential bonding bar
2 Protective conductor
3 Equipotential bonding conductor
4 Earth electrode

Figure 1 – Example of equipotential bonding and earthing of a metal enclosure



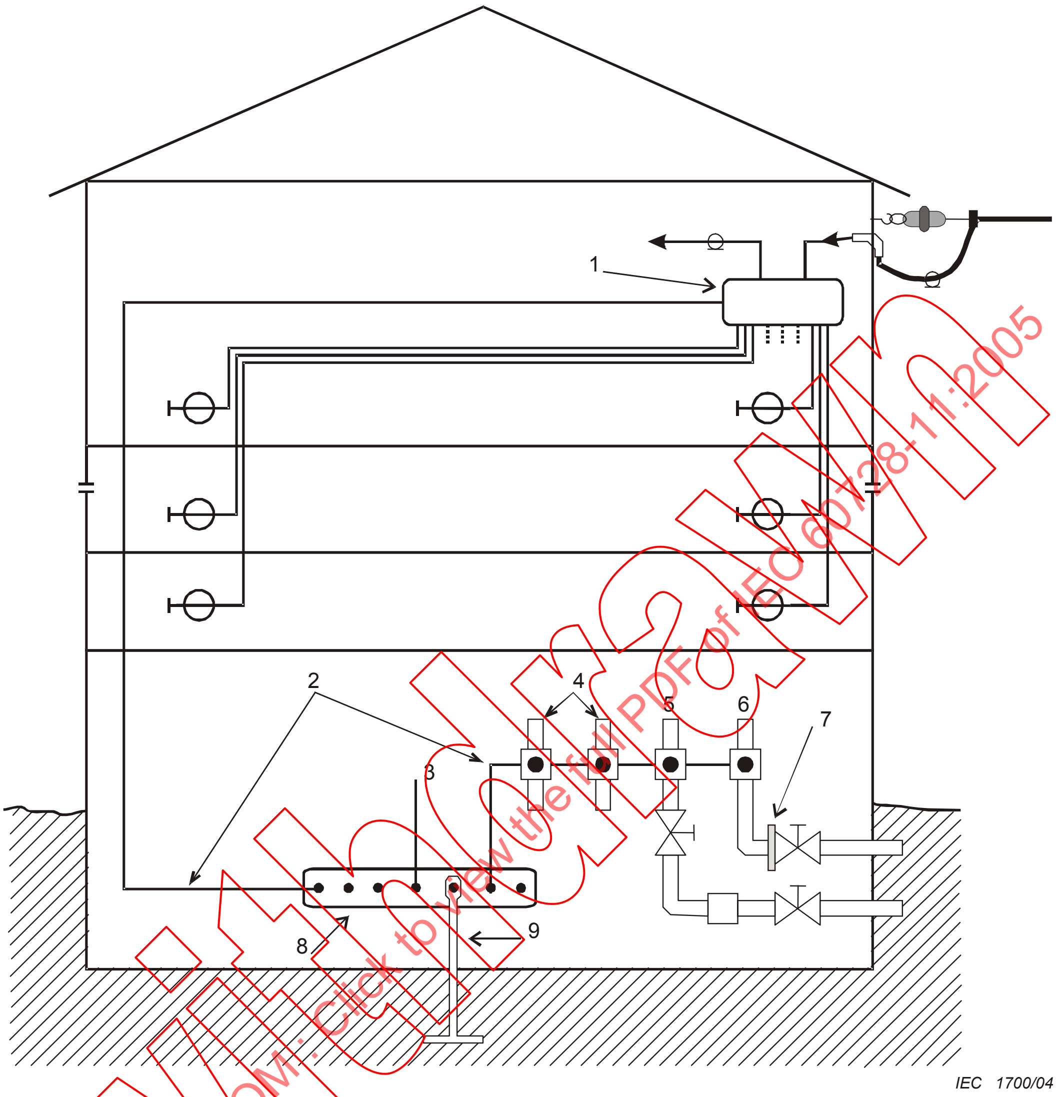
1 Non-metallic enclosure
2 Metallic enclosure
3 Voltage-dependent protective device
4 Equipotential bonding bar
5 Protective conductor
6 Equipotential bonding conductor
7 Earth electrode

Figure 2 – Example of equipotential bonding and indirect earthing of a metal enclosure via a voltage-dependent protective device (in case of balancing currents)



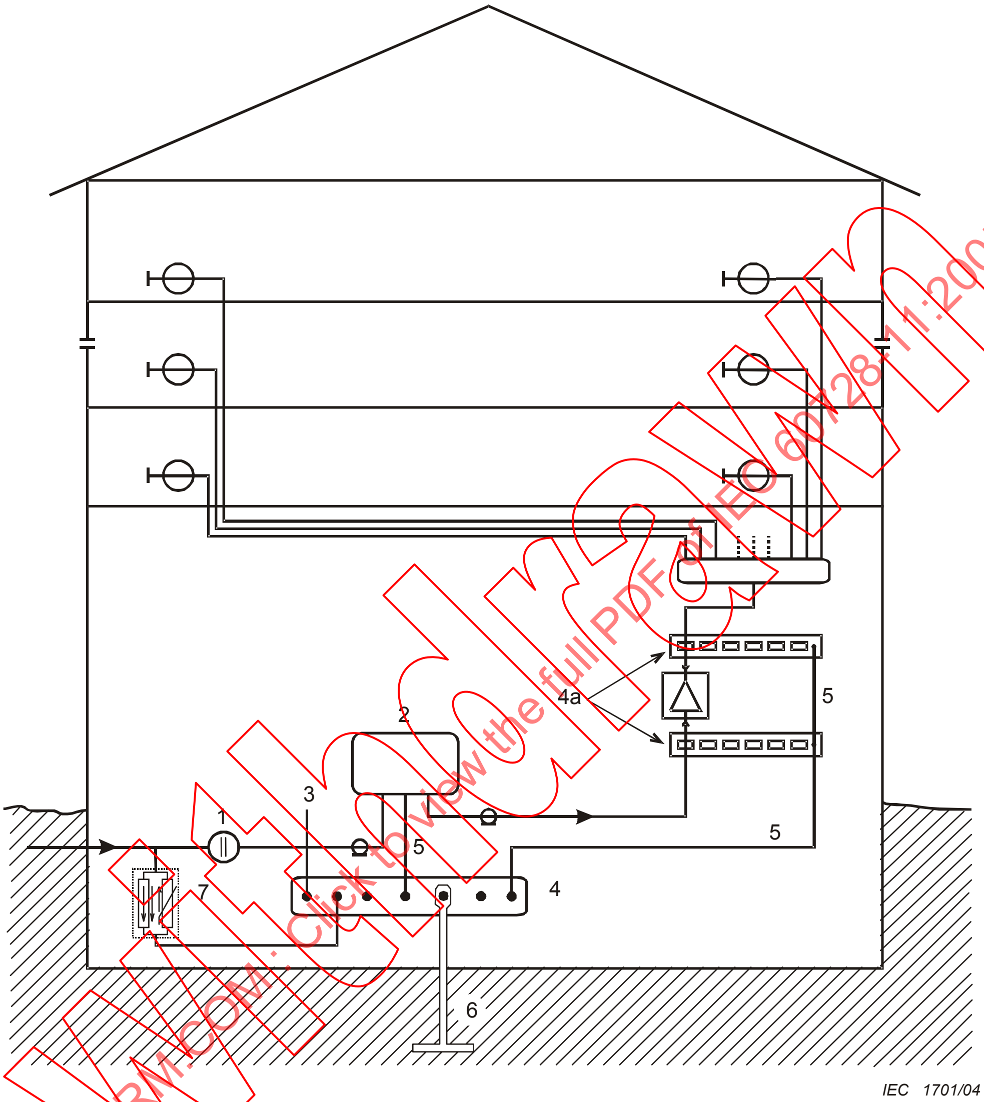
1 Subscriber tap
2 Equipotential bonding conductor
3 Protective conductor
4 Heating pipes
5 Water
6 Gas
7 Galvanic isolation
8 Equipotential bonding bar
9 Earth electrode

Figure 3 – Example of equipotential bonding and earthing of a building installation (underground connection)



1 Wall-mounted subscriber tap
2 Equipotential bonding conductor
3 Protective conductor
4 Heating pipes
5 Water
6 Gas
7 Galvanic isolation
8 Equipotential bonding bar
9 Earth electrode

Figure 4 – Example of equipotential bonding and earthing a building installation (above ground connection)



1 Galvanic isolator

2 Transfer point

3 Protective conductor

4 Equipotential bonding bar

4a Equipotential bonding bar [1]

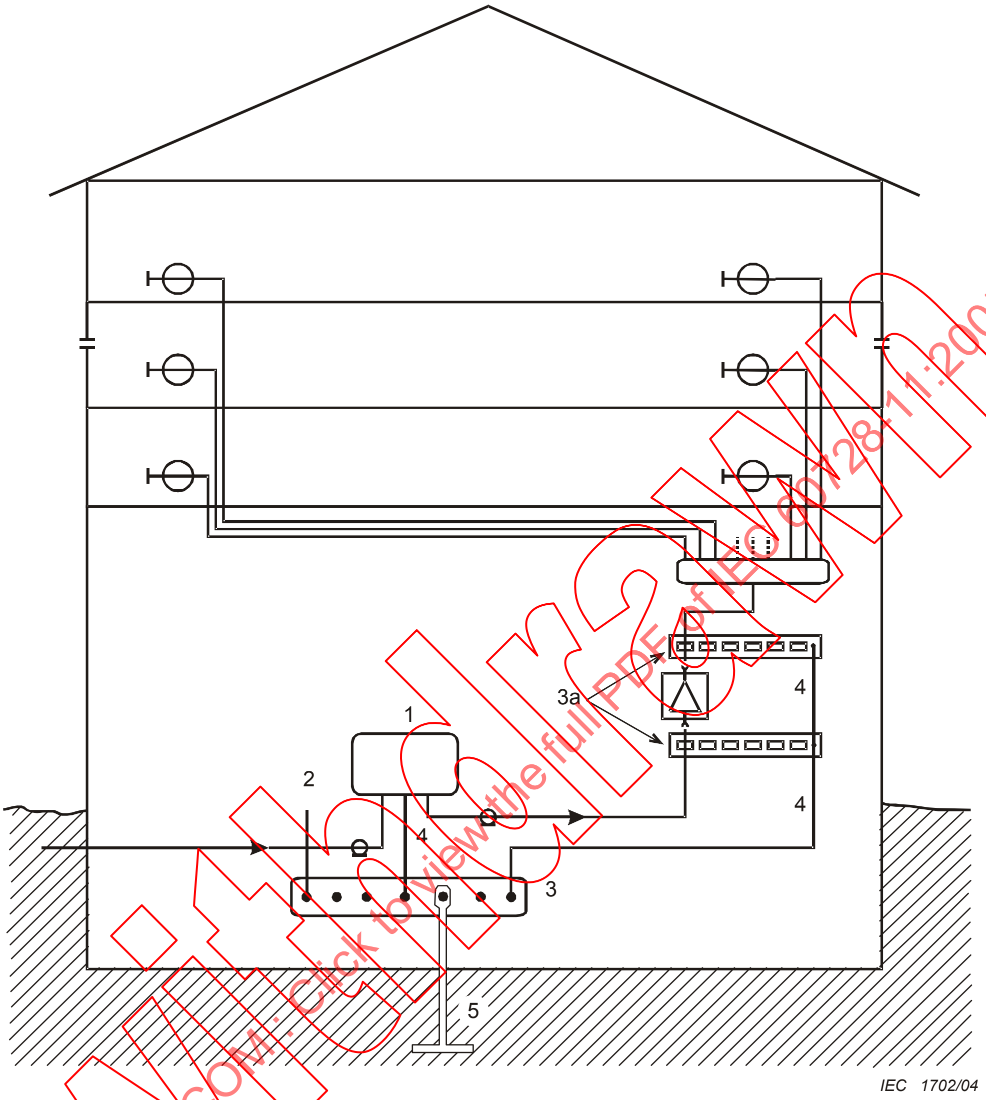
5 Equipotential bonding conductor

6 Earth electrode

7 Over-voltage protective device

[1] The equipotential bonding bars 4a connecting the outer conductors of the input and output cables of the amplifier with the equipotential bonding conductors 5 can be a temporarily installed construction as well.

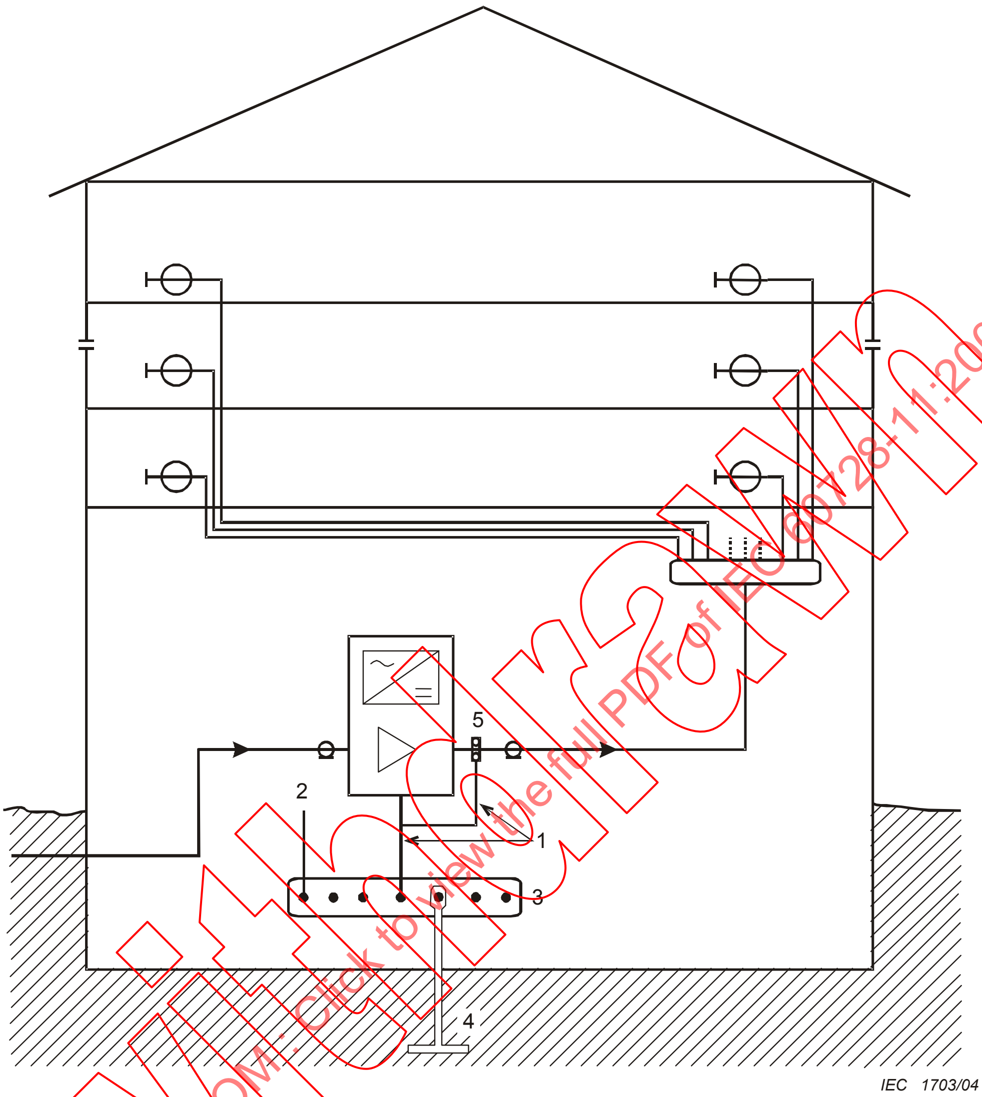
Figure 5 – Example of equipotential bonding with a galvanic isolated cable entering a building (underground connection)



1 Transfer point
2 Protective conductor
3 Equipotential bonding bar
3a Equipotential bonding bar [1)]
4 Equipotential bonding conductor
5 Earth electrode

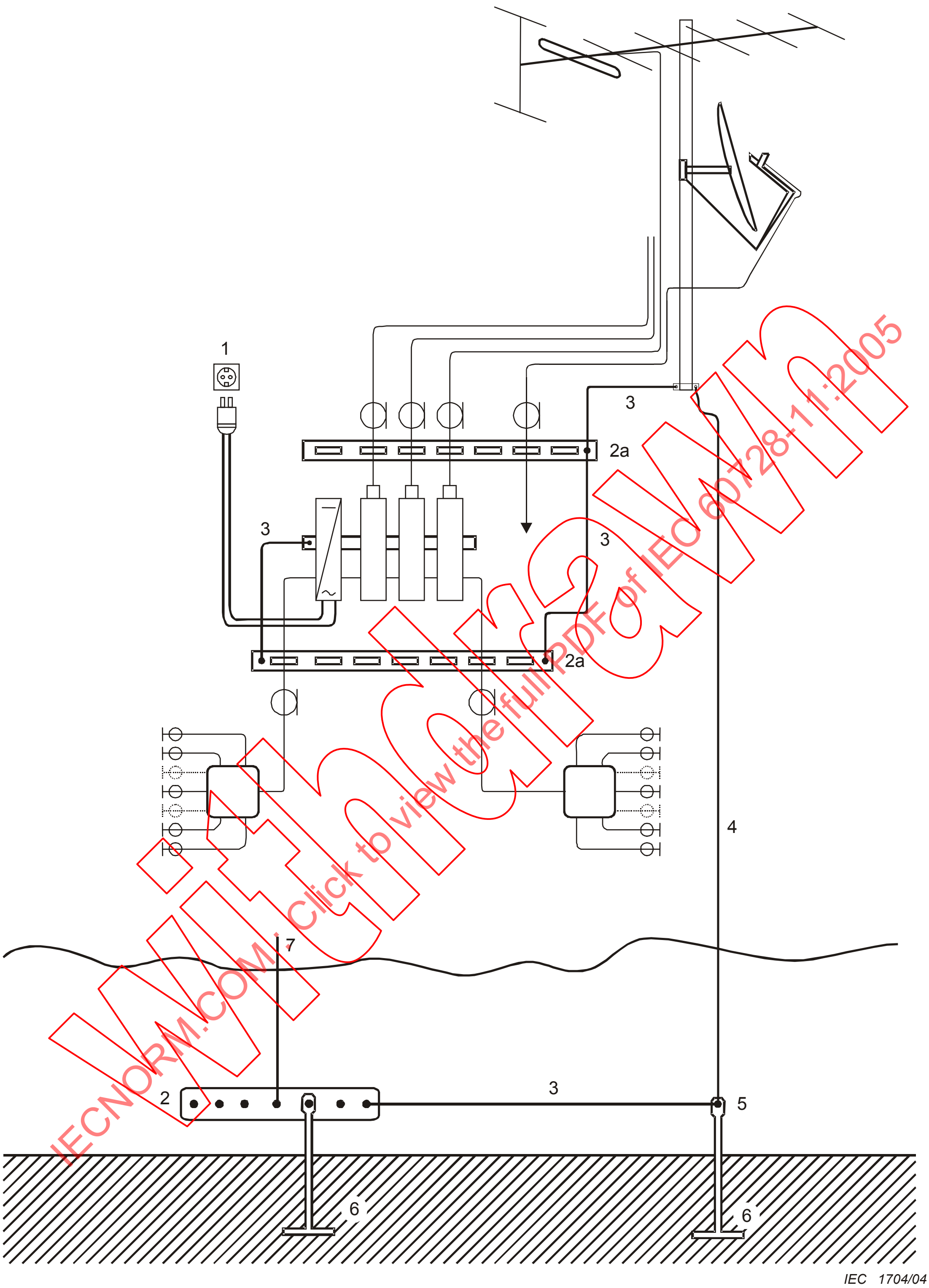
[1)] The equipotential bonding bars 3a connecting the outer conductors of the input and output cables of the amplifier with the equipotential bonding conductors 4 can be a temporarily installed construction as well.

Figure 6 – Example of maintaining of equipotential bonding whilst a unit is removed



1 Equipotential bonding conductor
2 Protective conductor
3 Equipotential bonding bar
4 Earth electrode
5 Equipotential bonding clamp

Figure 7 – Example of external safety equipotential bonding



1 Mains supply, for example, 230 V a.c.

2 Equipotential bonding bar

2a Equipotential bonding bar [1)]

3 Equipotential bonding conductor

4 Earthing conductor

5 Earthing terminal

6 Earth electrode

7 Protective conductor

[1)] The equipotential bonding bars 2a connecting the outer conductors of the input and output cables of the headend with the equipotential bonding conductors 3 can be a temporarily installed construction as well.

Figure 8 – Example of equipotential bonding antennas and head ends

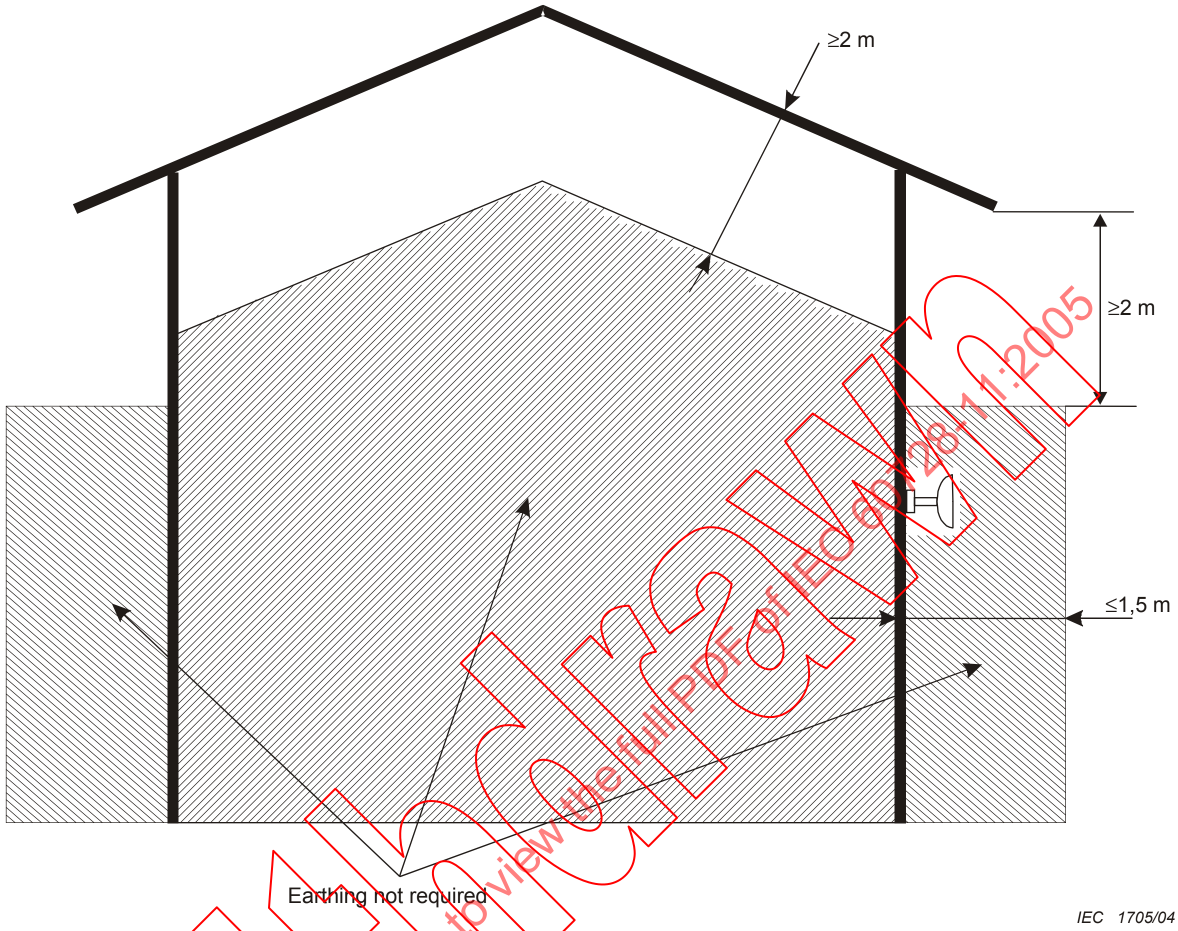
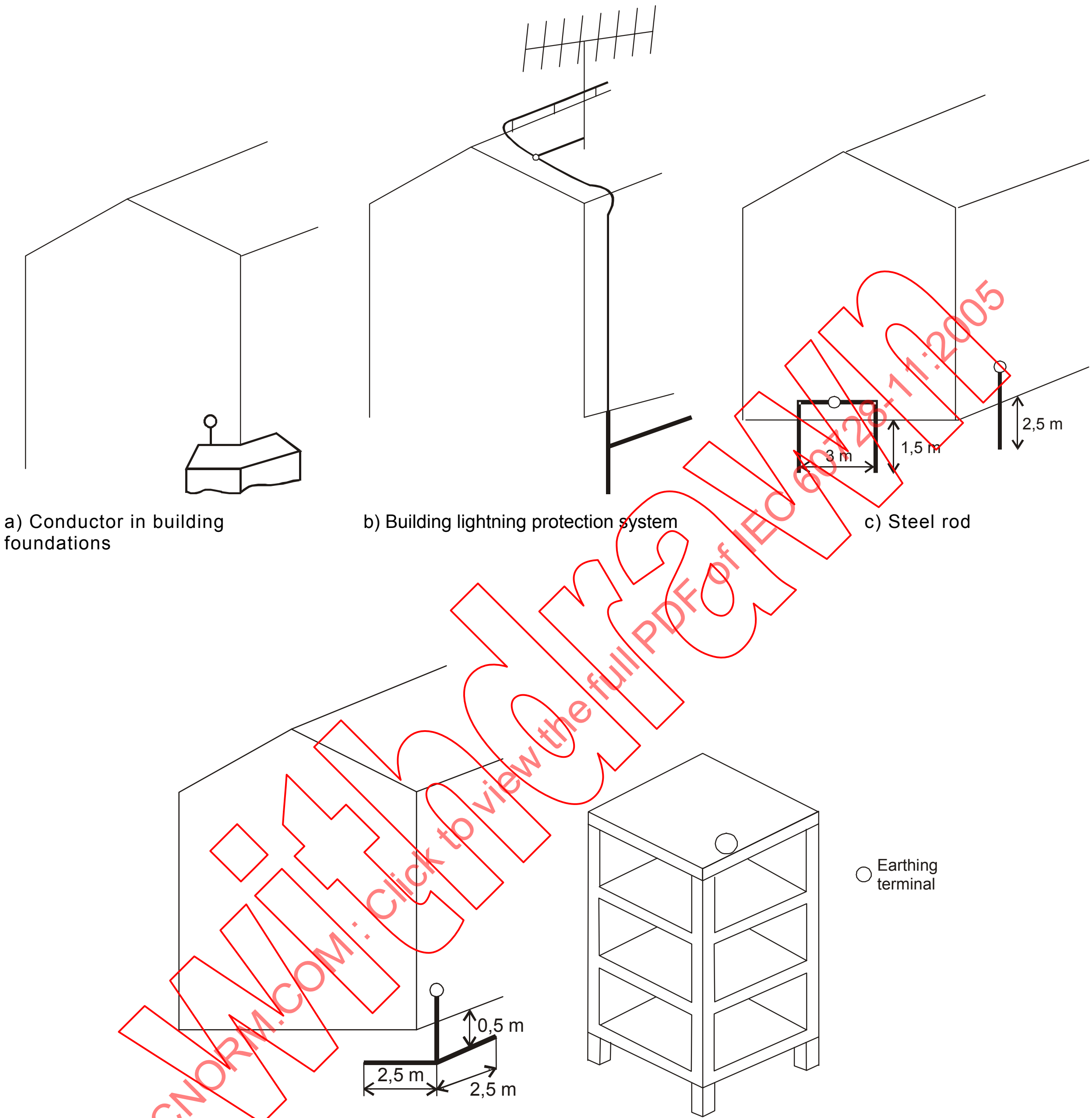


Figure 9 – Example of antenna-outdoor-mounting on buildings, where earthing is not required but recommended



a) Conductor in building foundations

b) Building lightning protection system

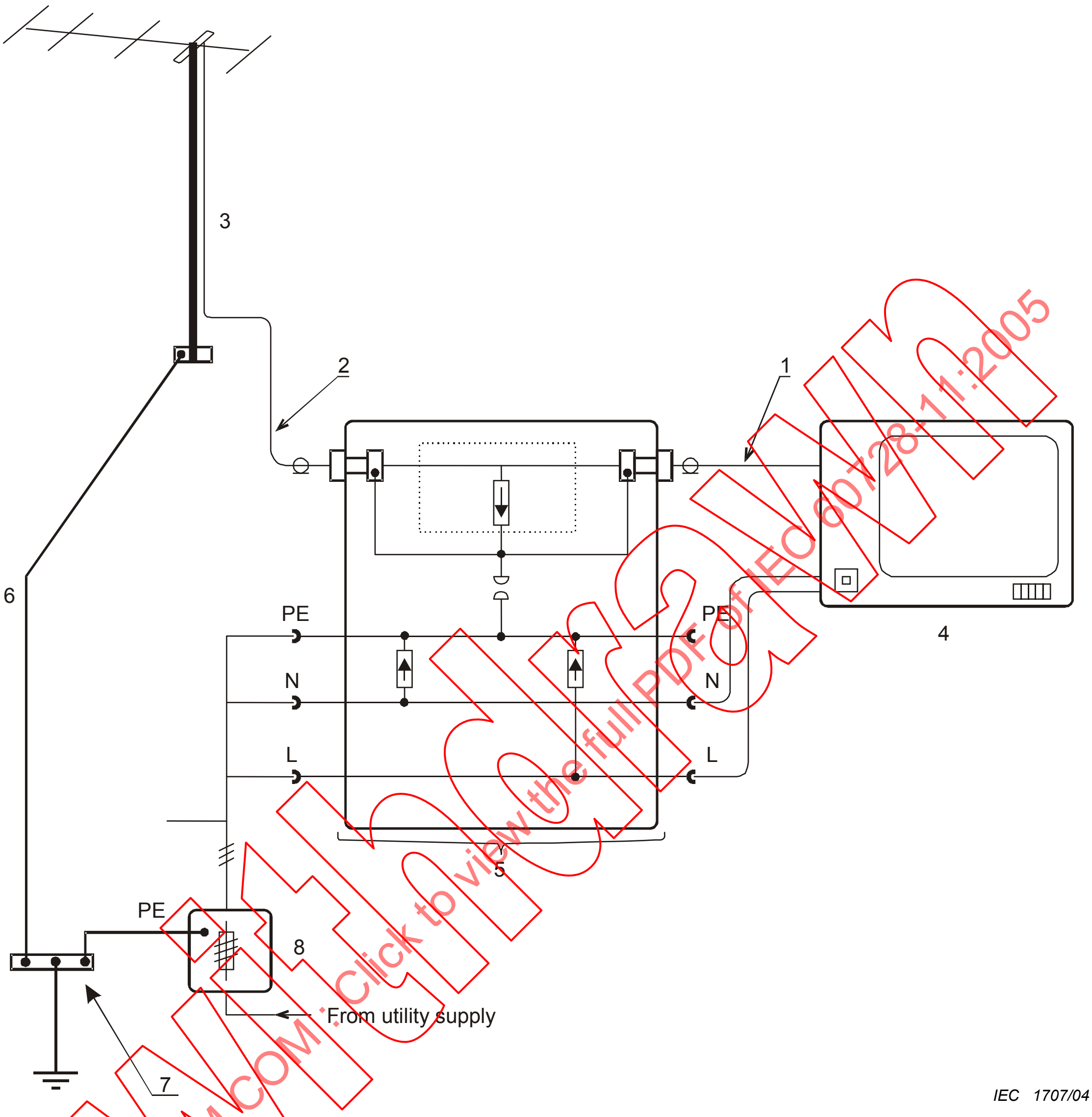
c) Steel rod

d) Steel strip

e) Structural steelworks

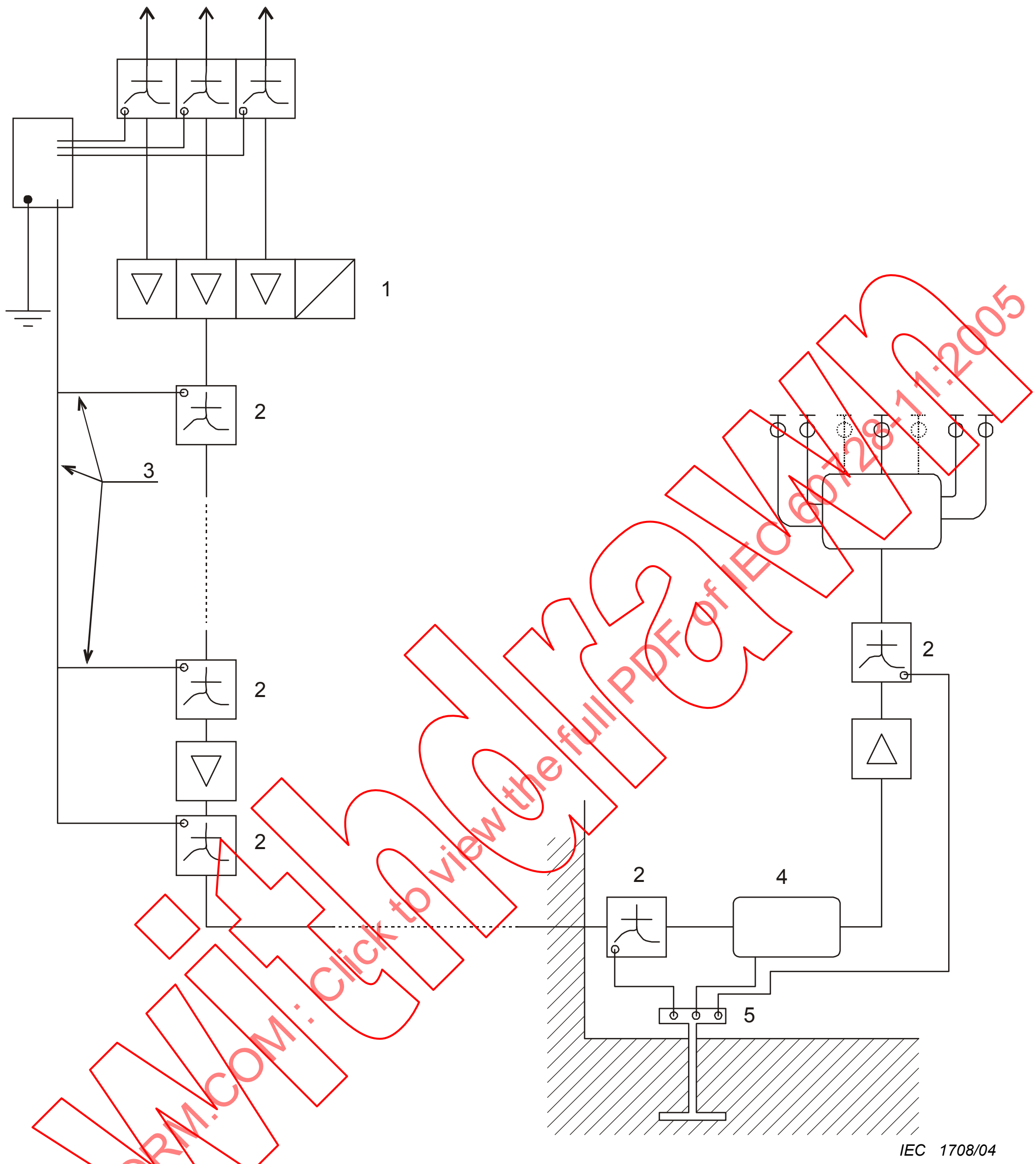
IEC 1706/04

Figure 10 – Examples of earthing mechanisms



1 Protected part
2 Unprotected part
3 Coaxial cable
4 Subscriber terminal
5 Over-voltage protective device
6 Earthing conductor
7 Equipotential bonding bar
8 House connection

Figure 11 – Example of an over-voltage protective device



1 Head end
2 Coaxial over-voltage protective device
3 Earthing
4 Transfer point
5 Equipotential bonding bar

Figure 12 – Example of application of a coaxial over-voltage protective device

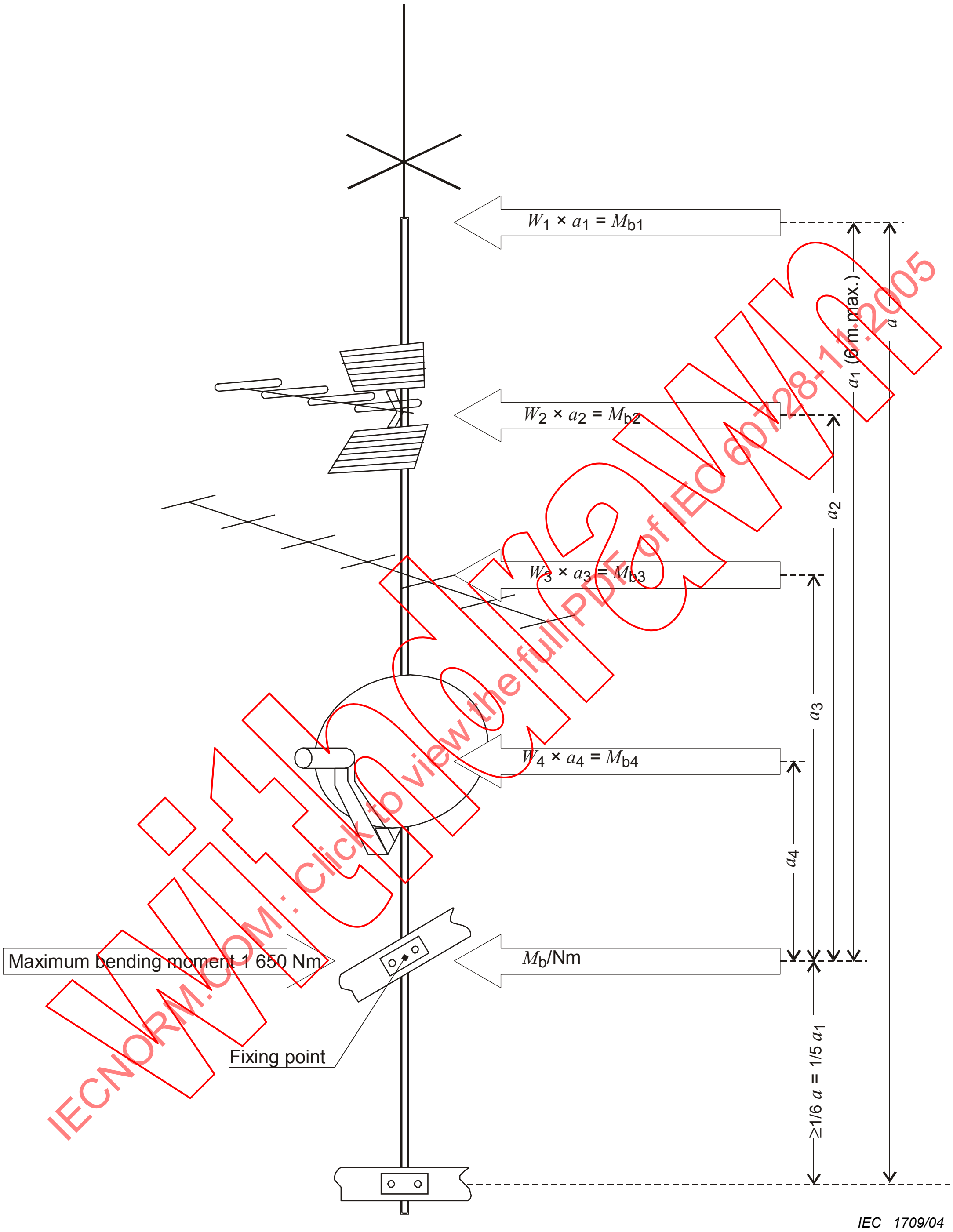
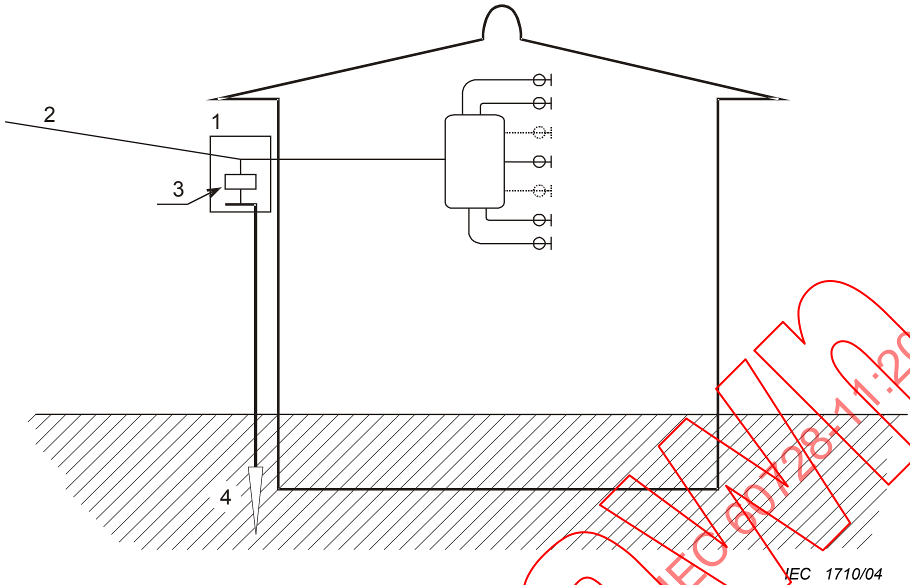
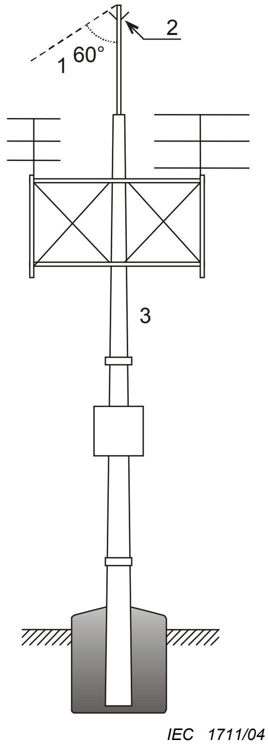


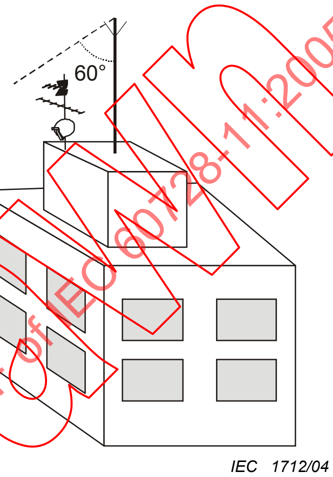
Figure 13 – Example of bending moment of an antenna mast



1 Safety terminal
2 Feeder cable
3 Protective device
4 Earthing conductor

Figure 14 – Example of the installation of a safety terminal in Japan





1 Safety zone

2 Lightning rod

3 Mast

Figure 15a – Mast

Figure 15b – Building

Figure 15 – Examples of installation of a lightning protection system in Japan

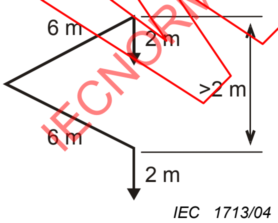


Figure 16 a

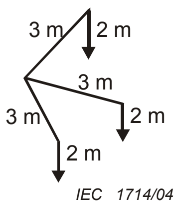


Figure 16 b

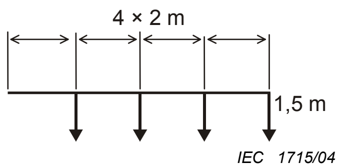


Figure 16 c

Figure 16 – Examples of earth electrodes in Finland