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INTERNATIONAL STANDARD

Cable networks for television signals, sound signals and interactive services – Part 11: Safety

colour inside

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

Part 11: Safety

FOREWORD

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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 third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

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

- The list of "differences in some countries" was transferred from the "Foreword" to informative Annex D.
- Some new terms and definitions were added.
- All Figures were reworked among other things concerning equipotential bonding and earthing details and were incorporated in the text at the appropriate places.

- Clause 11 "Protection against atmospheric overvoltages and elimination of potential differences" was completely reworked and re-structured taking into account among other things the provisions and requirements of the IEC 62305 series on "Lightning protection".
- New informative Annex A on "Earth loop impedance" was added.
- New informative Annex C on "Examples of calculation of risk due to lightning" was added.
- Former Annex B on "Special conditions using IT power line networks" was re-worded and incorporated in Annex D as "Difference in Norway".

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

FDIS	Report on voting
100/1679/FDIS	100/1708/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.

The list of all the parts of the IEC 60728 series, under the general title *Cable networks for television signals, sound signals and interactive services,* can be found on the IEC website.

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

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- withdrawn;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

A bilingual version of this publication may be issued at a later date.

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

INTRODUCTION

Standards of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television signals, sound signals and their associated data signals and for processing, interfacing and transmitting all kinds of signals for interactive services 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.

NOTE CATV encompasses the Hybrid Fibre Coaxial (HFC) networks used nowadays to provide telecommunications services, voice, data, audio and video both broadcast and narrowcast.

The extent of this standardization work is from the antennas, special signal source inputs to the headend 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), *Low-voltage electrical installations*

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-5-52, *Electrical installations of buildings – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

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

IEC 60617, *Graphical symbols for diagrams*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

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

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*

IEC 60990, *Methods of measurement of touch current and protective conductor current*

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*

IEC 62305 (all parts), *Protection against lightning*

IEC 62305-2:2006 *Protection against lightning – Part 2: Risk management*

IEC 62305-3:2006, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

ISO 3864-1:2002, *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*

EN 50164-1, *Lightning Protection Components (LPC) – Part 1: Requirements for connection components*

EN 50164-2, *Lightning Protection Components (LPC) – Part 2: Requirements for conductors and earth electrodes*

EN 50174-2, *Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings*

EN 50310, *Application of equipotential bonding and earthing in buildings with information technology equipment*

CENELEC R 064-004, *Electrical installations of buildings – Protection against electromagnetic interference (EMI) in installations of buildings*

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, IEC 60050-826 and IEC 60050-851, with the IEV numbering in square brackets, and from other IEC standards, also referenced to in square brackets.

3.1.1
air termination system
part of an external LPS using metallic elements such as rods, mesh conductors or catenary wires intended to intercept lightning flashes

[IEC 62305-3:2006, 3.6]

3.1.2
amplifier
device to compensate for attenuation

3.1.3
attenuation
decibel ratio of the input power to the output power

3.1.4
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

3.1.5
CATV network or community antenna television network
network designed to provide sound and television signals as well as signals for interactive services to communities

3.1.6
class I equipment
equipment with basic insulation as provision for basic protection and protective bonding as provision for fault protection, in accordance with IEC 61140:2001, 7.1

[IEC 60050-851:2008, 851-15-10]

3.1.7
class II equipment
equipment with basic insulation as provision for basic protection, and supplementary insulation as provision for fault protection, or in which basic and fault protection are provided by reinforced insulation, in accordance with IEC 61140:2001, 7.3

[IEC 60050-851:2008, 851-15-11]

3.1.8
earthing arrangement
all the electric connections and devices involved in the earthing of a system, an installation and equipment

[IEC 60050-195:1998, 195-02-20]

3.1.9
earthing conductor
conductor which provides a conductive path, or part of the conductive path, between a given point in a system or in an installation or in equipment and an earth electrode or an earth-electrode network

NOTE In the electrical installation of a building, the given point is usually the main earthing bar, and the earthing conductor connects this point to the earth electrode or the earth-electrode network.

[IEC 60050-826:2004, 826-13-12]

3.1.10
earth electrode
conductive part, which may be embedded in the soil or in a specific conductive medium, e.g. concrete or coke, in electric contact with the Earth

[IEC 60050-826:2004, 826-13-05]

3.1.11
earthing terminal
terminal provided on equipment or on a device and intended for the electric connection with the earthing arrangement

[IEC 60050-195:1998, 195-02-31]

3.1.12
electric shock
physiological effect resulting from an electric current through a human or animal body

[IEC 60050-826:2004, 826-12-01]

3.1.13
equipotential bonding
provision of electric connections between conductive parts, intended to achieve equipotentiality

[IEC 60050-826:2004, 826-13-19]

3.1.14
equipotential bonding bar
bar which is part of an equipotential bonding system and enables the electric connection of a number of conductors for equipotential bonding purposes

[IEC 60050-826:2004, 826-13-35, modified]

3.1.15
protective bonding conductor
protective conductor provided for protective-equipotential-bonding

[IEC 60050-826:2004, 826-13-24]

3.1.16
exposed conductive part
conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails

[IEC 60050-195:1998, 195-06-10]

3.1.17
extraneous conductive part
conductive part not forming part of the electrical installation and liable to introduce an electric potential, generally the electric potential of a local earth

[IEC 60050-195:1998, 195-06-11]

3.1.18
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

NOTE By extension, the term is also applied to paths containing one or more radio links.

3.1.19
galvanic isolator
device providing electrical isolation below a certain frequency range

3.1.20
hazardous voltage
electrical condition of an object from which a hazardous touch current (electric shock) could be drawn

[IEC 60065:2001, 2.6.10, modified]

3.1.21
headend
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

3.1.22
home distributor
HD
physical distribution point within a home where cables terminate

3.1.23
individual receiving network
network designed to provide sound and television signals as well as signals for interactive services to an individual household

3.1.24
let-go threshold current
maximum value of electric current through the body of a person at which that person can release himself or herself

[IEC 60050-195:1998, 195-03-09]

3.1.25
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.

3.1.26
main earthing terminal
main earthing bar
terminal or bar which is part of the earthing arrangement of an installation and enabling the electric connection of a number of conductors for earthing purposes

[IEC 60050-826:2004, 826-13-15, modified]

3.1.27
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

3.1.28
metal installation
extended metal items in the structure 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 62305-3:2006, 3.18]

3.1.29
natural component of LPS
conductive component installed not specifically for lightning protection which can be used in addition to the LPS or in some cases could provide the function of one or more parts of the LPS

NOTE Examples of the use of this term include:

- natural air-termination;
- natural down-conductor;
- natural earthing electrode.

[IEC 62305-3:2006, 3.15]

3.1.30
network interface unit
NIU
interface between the cable network and the network inside an apartment

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

3.1.31
neutral conductor
identification: **N**
conductor electrically connected to the neutral point and capable of contributing to the distribution of electric energy

[IEC 60050-826:2004, 826-14-07]

3.1.32
PEN conductor
conductor combining the functions of both a protective earthing conductor and a neutral conductor

[IEC 60050-826:2004, 826-13-25]

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

3.1.33
protective conductor
identification: **PE**
conductor provided for purposes of safety, for example protection against electric shock

NOTE In an electrical installation, the conductor identified PE is normally also considered as protective earthing conductor.

[IEC 60050-826:2004, 826-13-22]

3.1.34
receiver lead
lead, which connects the system outlet to the subscriber equipment

3.1.35
receiving antenna
device with proper electrical characteristics that intercepts desired signals in the atmosphere and transfers these to the remainder of the cable network

3.1.36
remote power feeding voltage
voltage for supplying power to network equipment via the cable network or a separate line

3.1.37
safety distance
minimum distance between two conductive parts within the space to be protected between which no dangerous sparking can occur

3.1.38
service person
person having appropriate technical training and experience necessary to be aware of hazards to which that person may be exposed in performing a task and of measures to minimize the risks to that person or other persons

[IEC 60950-1:2005, 1.2.13.5]

3.1.39
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

3.1.40
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.

3.1.41
spur feeder
feeder to which splitters, subscriber taps or looped system outlets are connected

3.1.42
subscriber equipment
equipment at the subscriber premises such as receivers, tuners, decoders, video recorders, multimedia terminals

3.1.43
subscriber feeder
feeder connecting a subscriber tap to a system outlet or, where the latter is not used, direct to the subscriber equipment

3.1.44
subscriber tap
device for connecting a subscriber feeder to a spur feeder

3.1.45
surge protective device
device that is intended to limit transient overvoltages and divert surge currents; it contains at least one non-linear component

3.1.46
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

3.1.47
system outlet
device for interconnecting a subscriber feeder and a receiver lead

3.1.48
(effective) touch voltage
voltage between conductive parts when touched simultaneously by a person or an animal

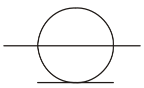
NOTE The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

[IEC 60050-826:2004, 826-11-05]

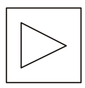
3.1.49
transfer point
interface between the cable network and the building's internal network, each of which may be separately owned and which may contain a voltage-dependent device and/or galvanic isolator

3.2 Symbols

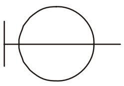
The following graphical symbols are used in the figures of this standard. These symbols are either listed in IEC 60617 or based on symbols defined in IEC 60617.



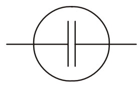
Coaxial conductor
[IEC 60617-S00011
2001-07-01]



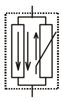
Amplifier
[IEC 60617-S01240
2001-07-01]



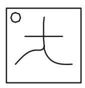
System outlet



Galvanic isolator



Overvoltage protective device



Coaxial overvoltage protective device

3.3 Abbreviations

AC	alternating current
AM	amplitude modulation
ATS	air termination system
CATV	community antenna television (network)
DC	direct current
DTH	direct to home
HD	home distributor
IP	international protection (class)
IT	isolated earth
LNB	low noise block converter
LPS	lightning protection system
LSR	lightning stroke risk
MATV	master antenna television (network)
N	neutral (conductor)
NIU	network interface unit
NTP	Network termination point
PE	protective conductor

PEN	PEN conductor
RCD	residual current device
RF	radio frequency
RMS	root mean square
SMATV	satellite master antenna television (network)
SPD	surge protective device
STB	set top box
TV	television

4 Fundamental 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.

The above does not apply to service persons (according to 3.1.38) 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 or from rotating or moving parts.

4.3 Accessible parts

Access to parts presenting hazardous voltages shall not be possible to the general public without first removing a protective cover by use of a tool or a key. 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. Safety information in the product documentation shall be noted. 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 equipotential 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.

NOTE 1 For requirements in France, see D.1.1

NOTE 2 For requirements in Japan, see D.1.2

6.2 Equipotential bonding mechanisms

All parts belonging to the equipotential bonding mechanisms shall fulfil the following requirements:

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 (e.g. ignition or failure of equipment by arcing), the cable network shall be included in the equipotential bonding system of the building.

   NOTE 1 Equipotential bonding between metal installations and electrical systems in and on the building is generally carried out at the main earthing bar of the building. Multiple, meshed equipotential bonding increases its effectiveness.

b) Equipotential bonding can be achieved by means of protective 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 protective bonding conductors connected to earthing terminals shall be mechanically stable and shall have a minimum cross-sectional area of 2,5 mm^2 Cu (protected) or 4 mm^2 (not protected). They shall comply with IEC 60364-5-54.

d) Metallic enclosures containing mains supplied equipment shall be connected to the main earthing bar regardless if they are located outside or inside of buildings. See examples in Figure 1, in Figure 2 and in Figure 13.

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.

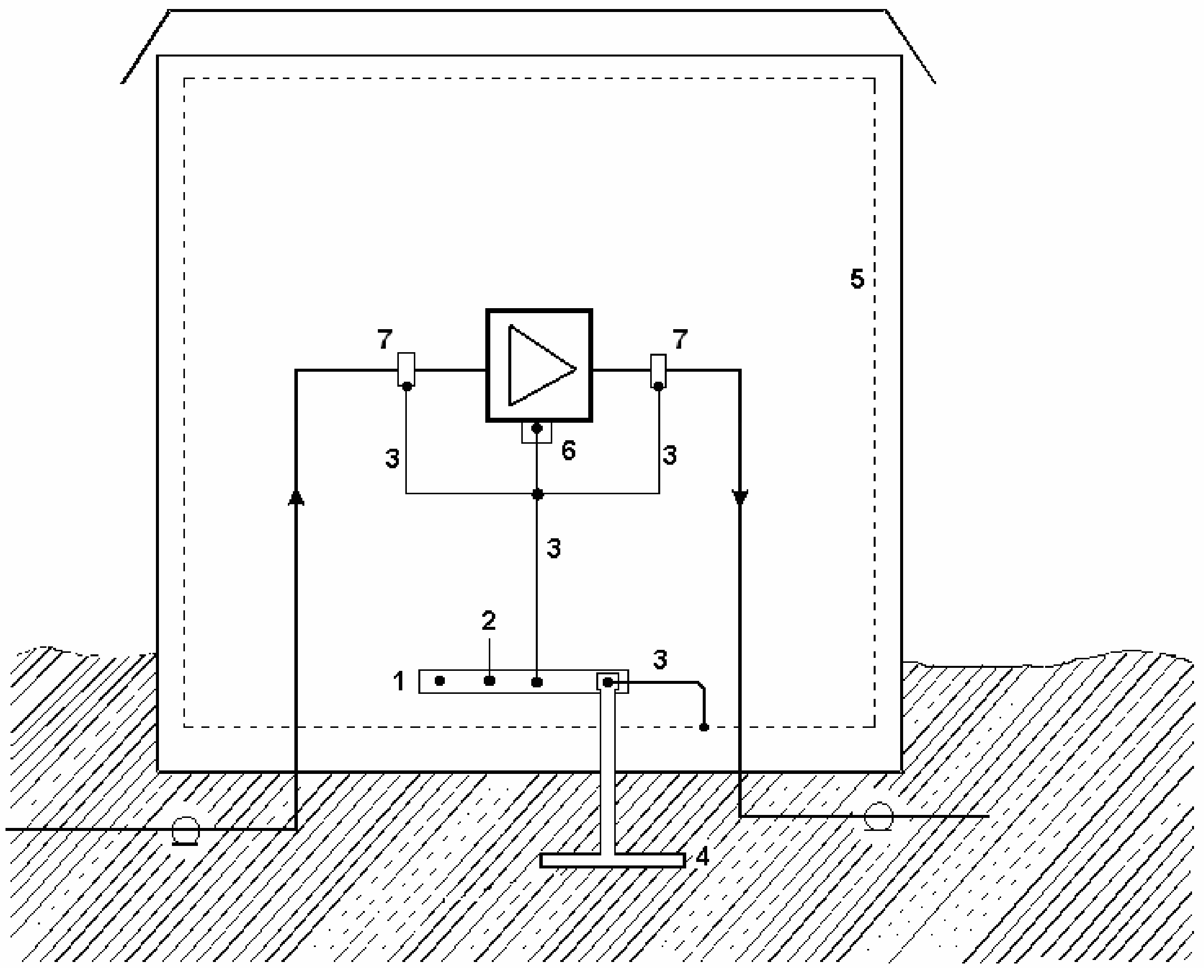
   This protection can be achieved by

   - mounting the equipment within a non-metallic enclosure, or
   - isolating the equipment from a metallic enclosure.

   In both cases an overvoltage protective element shall be connected between the equipment and the main earthing bar as shown in Figure 3.

The safety sign "Warning about hazardous electrical voltage"  according to sign 7.4 of ISO 3864-1:2002 shall be attached to the enclosure.

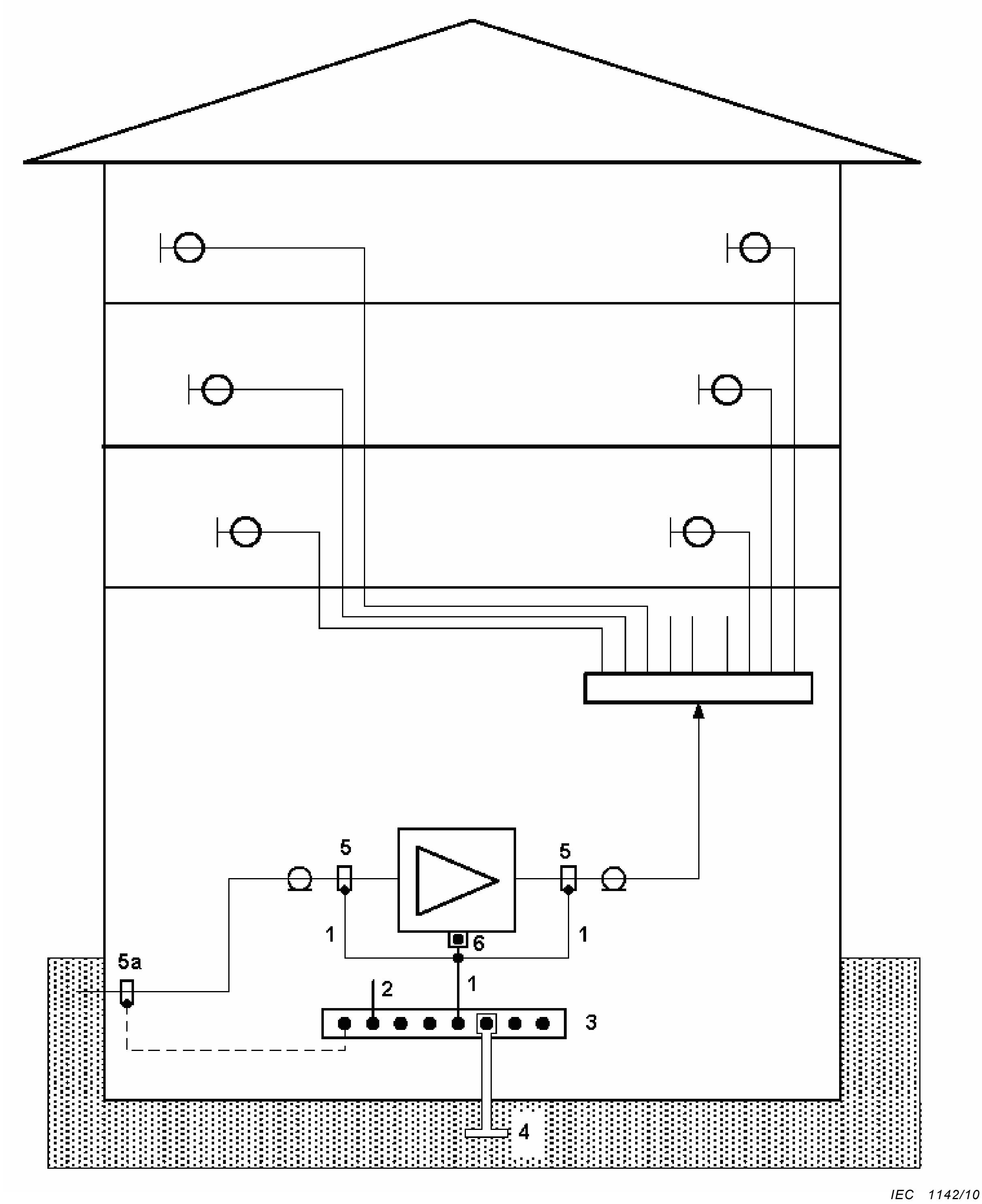
If balancing currents are expected to exceed the maximum current allowed by the manufacturer of the cable and/or of the cable connectors, a galvanic isolation may be used as described hereafter. When installed, it shall not be possible to touch simultaneously both input and output terminals of the isolator.



IEC 1141/10

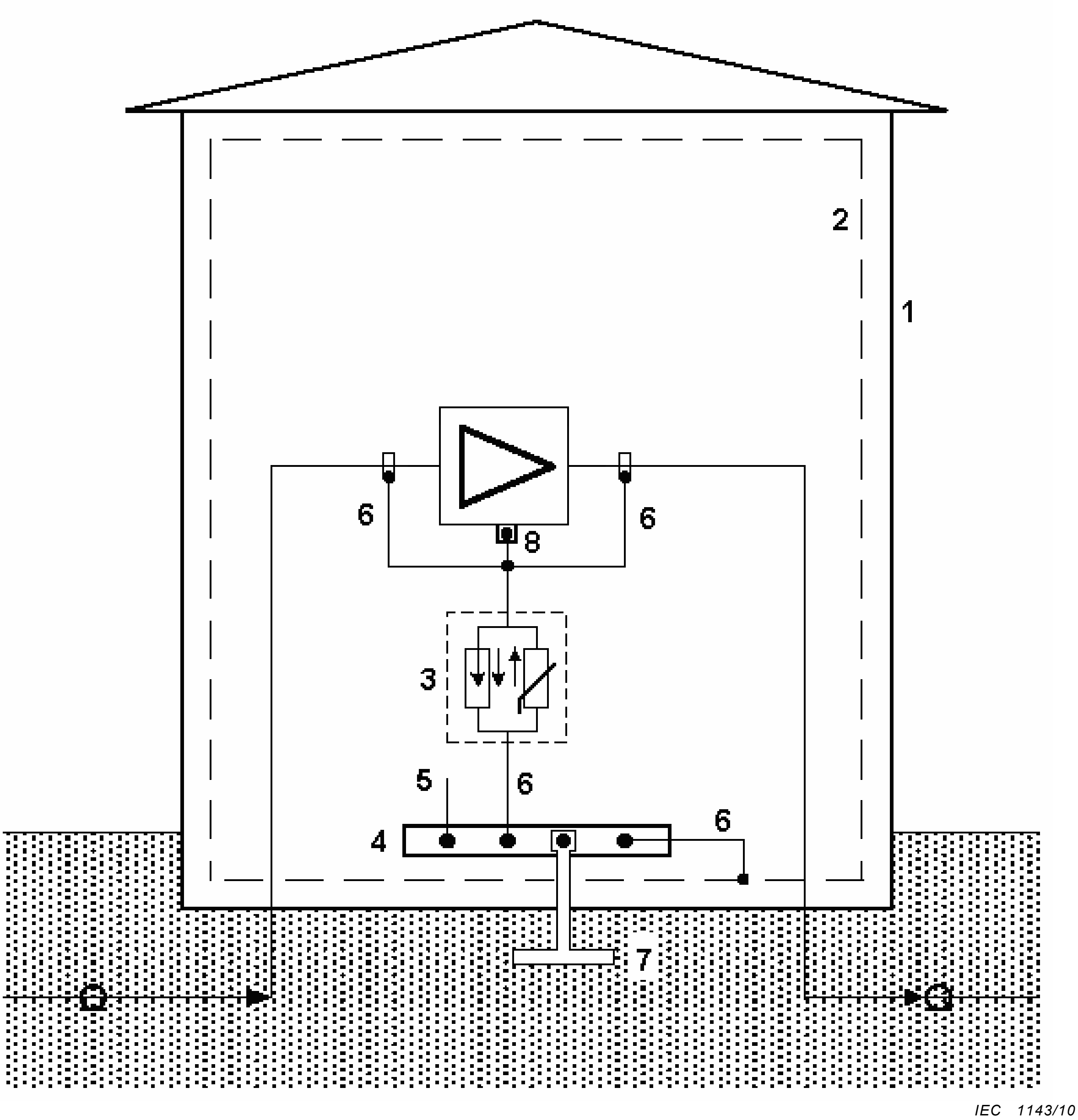
1	Main earthing bar	2	Protective conductor (PE) if required
3	Protective bonding conductor (minimum cross section according to 6.2 c)	4	Earth electrode
5	Metallic enclosure (dashed line)	6	Earthing terminal (see 6.2 j and 6.2 k)
7	Equipotential bonding clamp		

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



1 Protective bonding conductor (minimum cross section according to 6.2 c)	2 Protective conductor (PE) if required
3 Main earthing bar	4 Earth electrode
5 Equipotential bonding clamp	5a Equipotential bonding clamp [optional bonding, alternative bonding point for the entering coaxial cable]
6 Earthing terminal (see 6.2 j and 6.2 k)	

Figure 2 – Example of equipotential bonding



1 Non-metallic enclosure	2 Metallic enclosure (dashed line)
3 Voltage-dependent protective device	4 Main earthing bar
5 Protective conductor (PE) if required	6 Protective bonding conductor (minimum cross section according to 6.2 c)
7 Earth electrode	8 Earthing terminal (see 6.2 j and 6.2 k)

NOTE For details concerning the case of balancing currents, see 6.2 e.

Figure 3 – Example of equipotential bonding and indirect earthing of the amplifier and the cables via a voltage-dependent protective device

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 directly to earth or to earth via an equipotential bonding system.

NOTE 3 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.

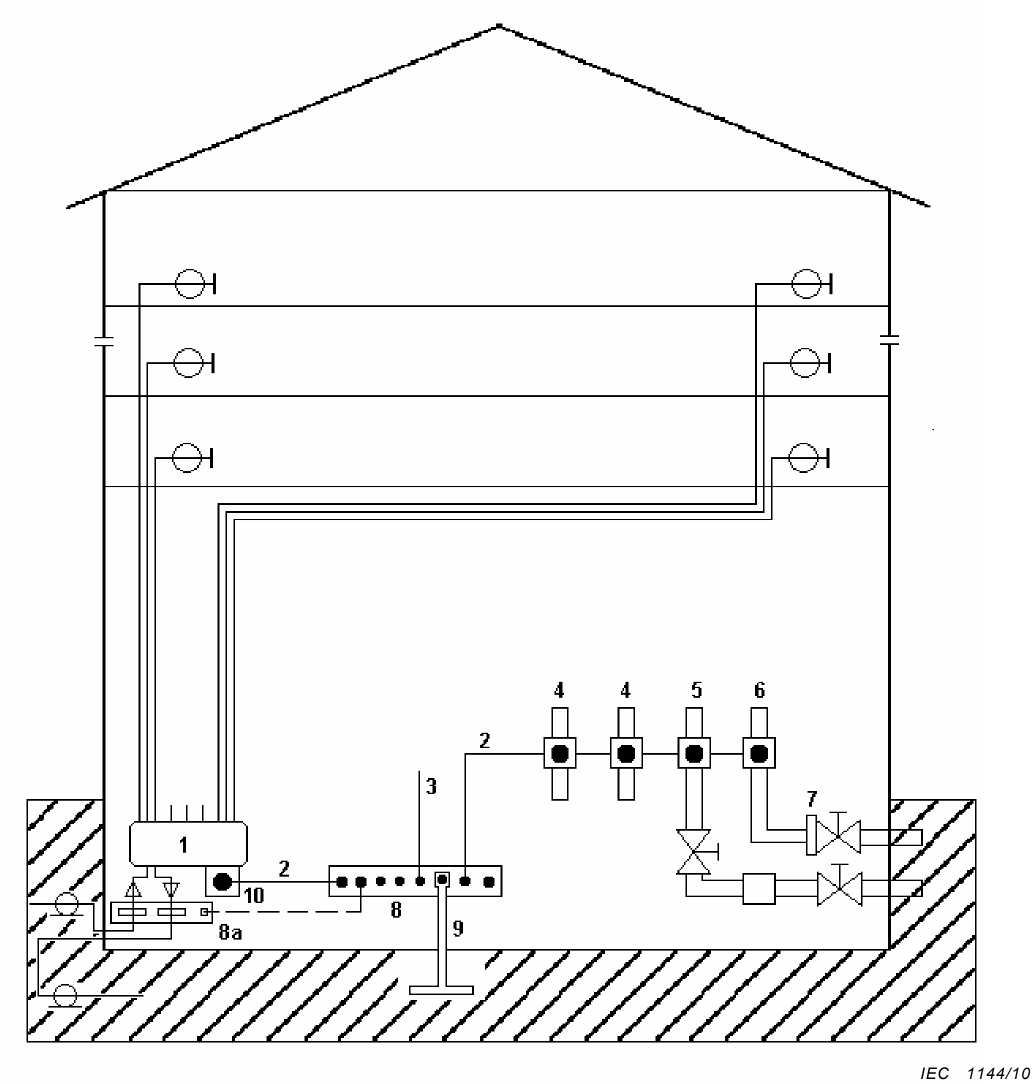
NOTE 4 Galvanic isolators can be damaged by overvoltages.

NOTE 5 For requirements in France, see D.2.1.

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. Examples are shown in Figure 4, in Figure 5 and in Figure 6.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.

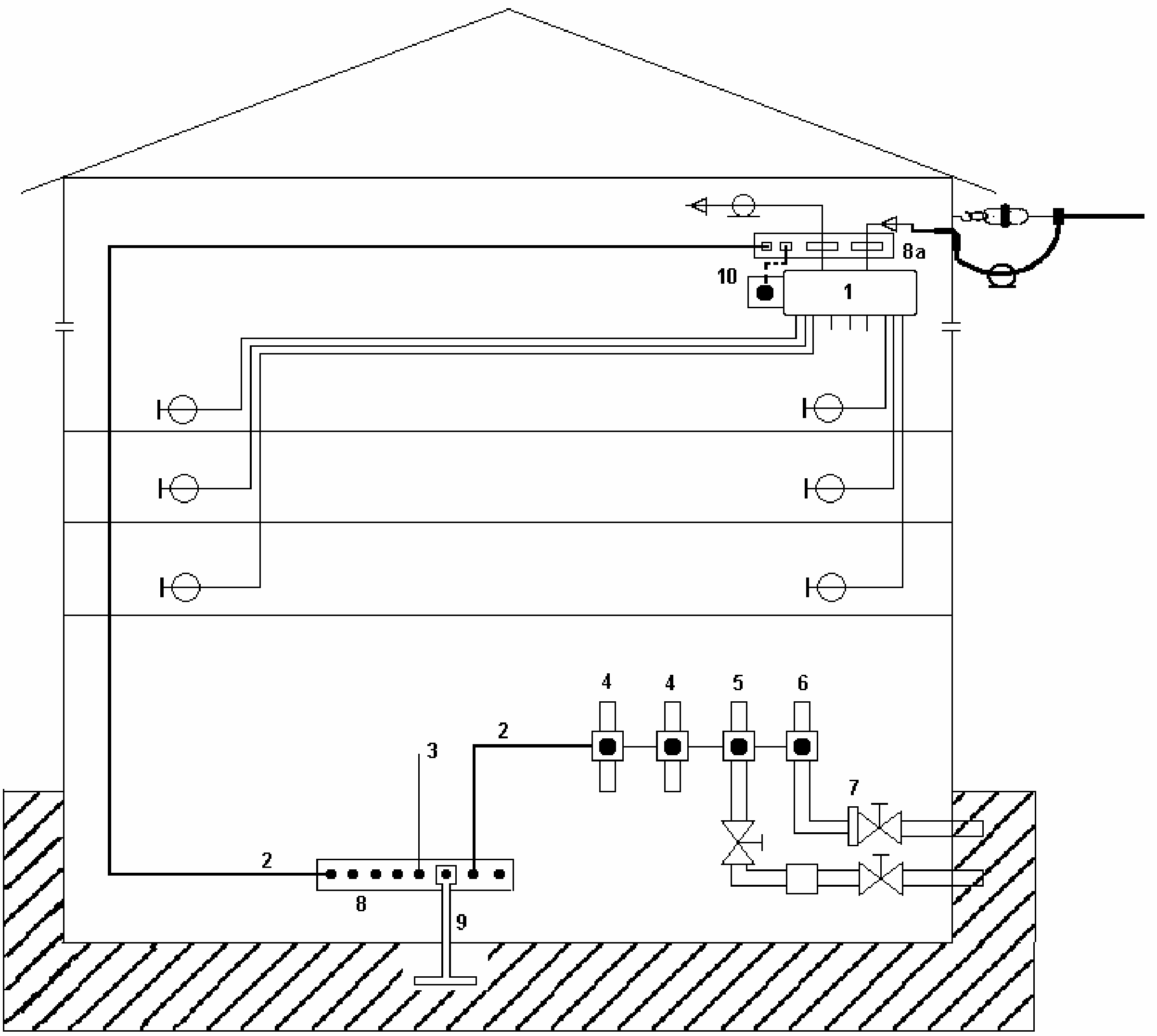
NOTE 6 For requirements in Norway, see D.2.2.

NOTE 7 For requirements in Japan and Poland, see D.2.3.



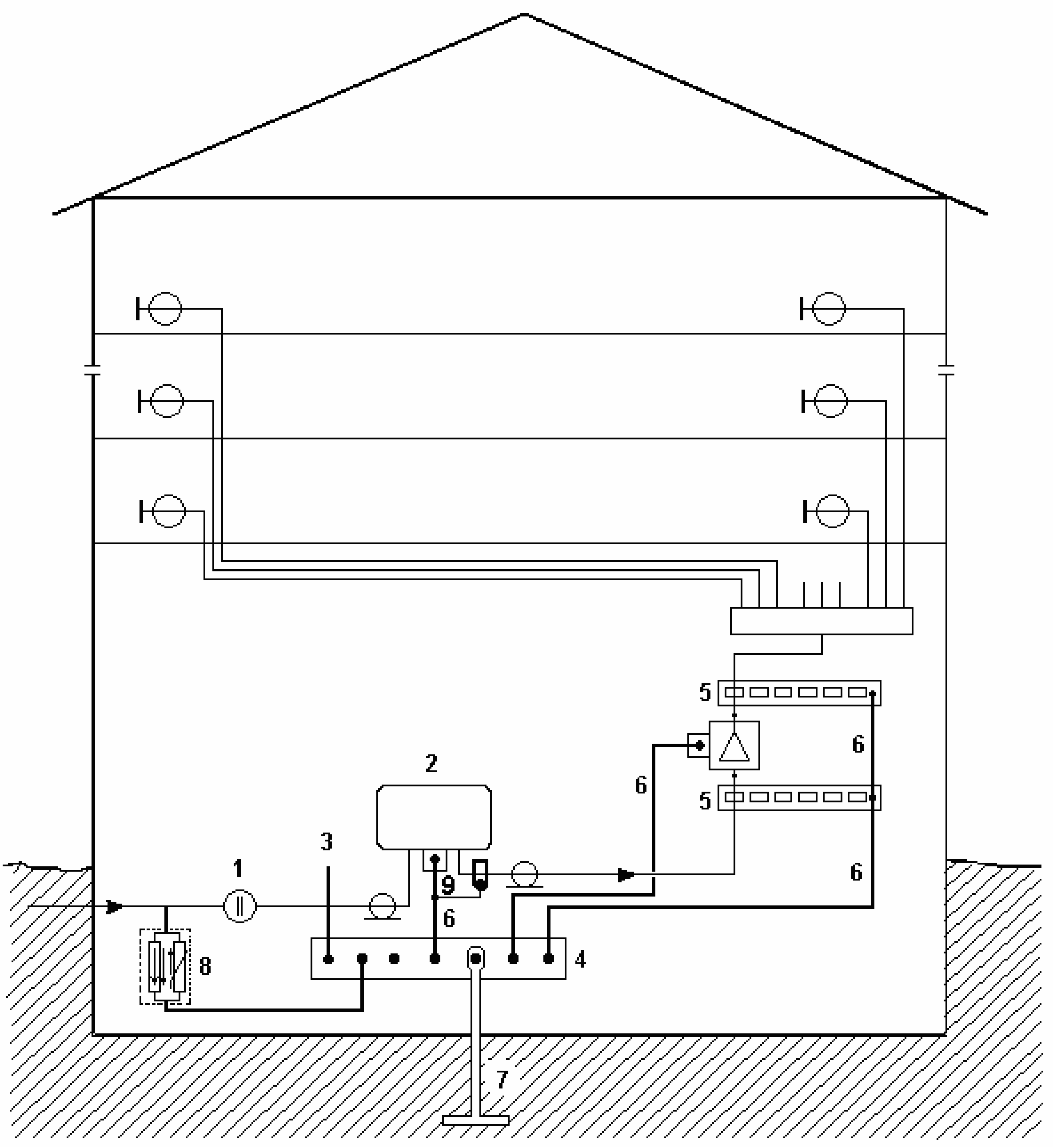
1 Subscriber tap	2 Protective bonding conductor (minimum cross section according to 6.2 c)
3 Protective conductor (PE) if required	4 Heating pipes
5 Water pipe	6 Gas pipe
7 Galvanic isolation	8 Main earthing bar
8a Equipotential bonding bar [optional bonding if the entering and leaving coaxial cables are not included in the equipotential bonding system via the equipment 1]	9 Earth electrode
10 Earthing terminal (see 6.2 j and 6.2 k)	

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



1 Wall-mounted subscriber tap	2 Protective bonding conductor (minimum cross section according to 6.2 c)
3 Protective conductor (PE) if required	4 Heating pipes
5 Water	6 Gas
7 Galvanic isolation	8 Main earthing bar
8a Equipotential bonding bar [optional bonding if the entering coaxial cable is not included in the equipotential bonding system via the equipment 1]	9 Earth electrode
10 Earthing terminal (see 6.2 j and 6.2 k)	

Figure 5 – Example of equipotential bonding and earthing of a building installation (above ground connection)



1	Galvanic isolator	2	Transfer point
3	Protective conductor (PE) if required	4	Main earthing bar
5	Equipotential bonding bar [a]	6	Protective bonding conductor (minimum cross section according to 6.2)
7	Earth electrode	8	Overvoltage protective device (Minimum cross-sectional area of the bonding conductor to main earthing bar (4) 16 mm^2)
9	Earthing terminal (see 6.2 j and 6.2 k)		
[a]	The equipotential bonding bars 5 connecting the outer conductors of the input and output cables of the amplifier with the protective bonding conductors 6 are to ensure safety during equipment replacement. They could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors and may be a temporary installation.		

Figure 6 – Example of equipotential bonding with a galvanic isolated cable entering a building (underground connection)

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 6.

NOTE 8 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 9 Galvanic isolators can be damaged by overvoltages.

i) When changing or removing active or passive equipment (e.g. amplifiers, taps, etc.) 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). Examples are shown in Figure 6 and Figure 7. In addition, the inner conductors shall be safeguarded against contact.

NOTE 10 For requirements in Norway, see D.2.2.

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

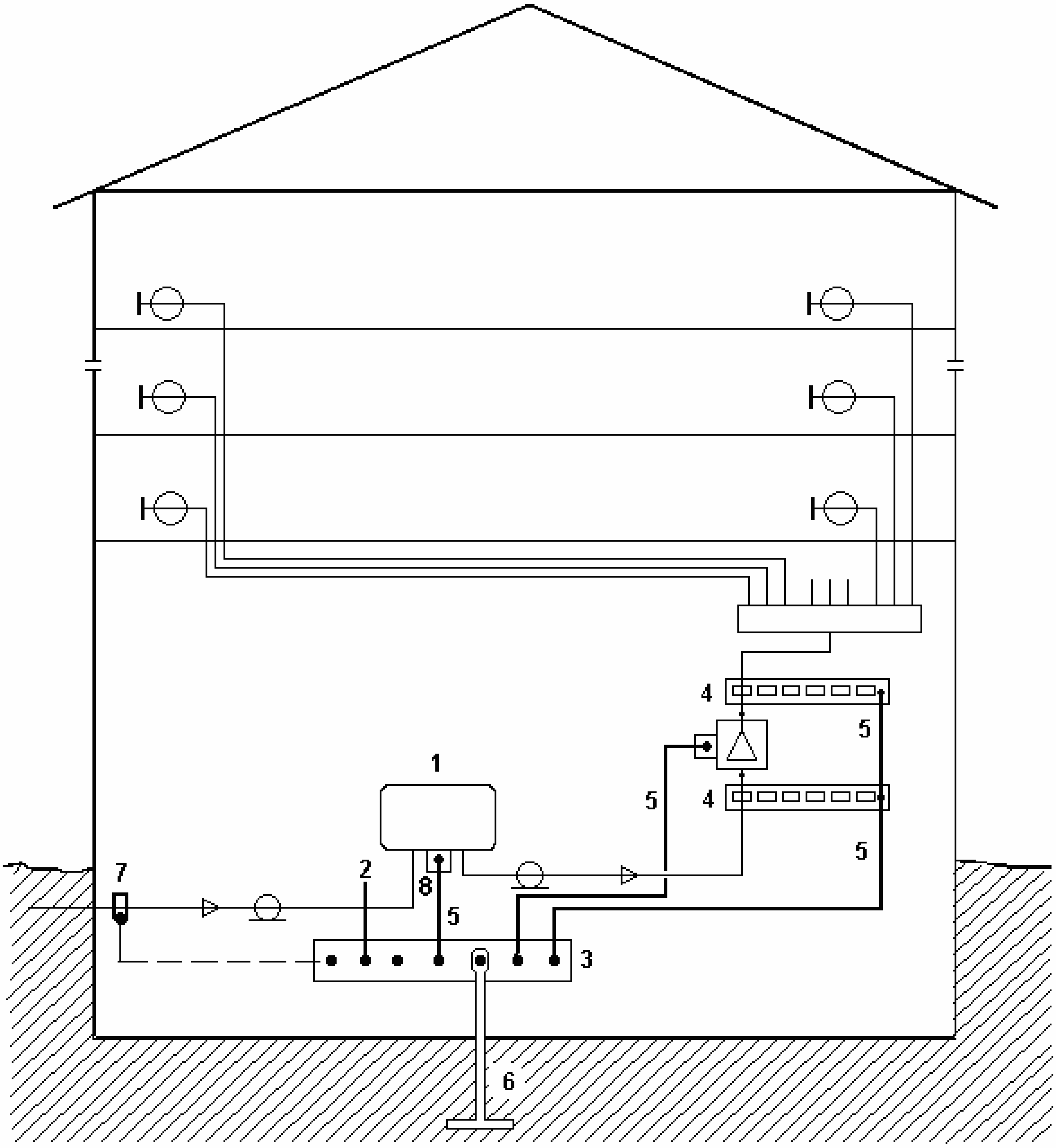
k) All metallic enclosures, housings, mounting bays, racks and mains-supplied equipment, shall be provided with an external earthing terminal complying with IEC 60065 or IEC 60950-1.

NOTE 11 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 a bonding terminal or bonding bar by means of an protective bonding conductor (according to 6.2c).
- Connection by means of the shielding of the coaxial cable. The DC resistance to the nearest point of equipotential bonding (or PE) shall be less than or equal to 5 Ω in order that no hazardous touch voltage appears on exposed conductive parts (see also Annex A). The connection of the shield of the coaxial cable to the protective conductor shall only be disconnectable by means of a tool.

NOTE 12 For requirements in Norway, see D.2.2.



1 Transfer point	2 Protective conductor (PE) if required
3 Main earthing bar	4 Equipotential bonding bars [a]
5 Protective bonding conductor (minimum cross section according to 6.2 c)	6 Earth electrode
7 Equipotential bonding clamp (optional bonding if the entering coaxial cable is not included in the equipotential bonding system via the equipment 1)	8 Earthing terminal (see 6.2 j and 6.2 k)
[a] The equipotential bonding bars 4 connecting the outer conductors of the input and output cables of the amplifier with the protective bonding conductors 5 are to ensure safety during equipment replacement. They could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors and may be a temporary installation.	

Figure 7 – Example of maintaining equipotential bonding whilst a unit is removed

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 AC mains

Due to the varying load, locally and versus time, of the individual phases of the AC 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

6.3.3.1 General

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).

6.3.3.2 TN systems

There are three different TN subsystems with the following general characteristics.

a) 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.

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

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

6.3.3.3 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.

NOTE For requirements in Norway concerning IT systems, see Clause D.3.

6.3.3.4 IT system

The IT system is isolated from earth, except that one point may be connected to earth through an impedance or a voltage limiter. The exposed conductive parts of the equipment installation required to be earthed are connected to earth electrodes at the user's premises.

NOTE For requirements in Norway concerning IT systems, see Clause D.3.

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

The following measures are recommended.

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 Care should be taken 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.

   NOTE 3 For requirements in Norway, see D.2.2.
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 Class I equipment is used in a coaxial cable network different potentials can build up between the PE conductor and the equipotential bonding terminal. The occurring 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 of appropriate IP rating 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_{AC} or 120 V_{DC}.

NOTE 1 Direct currents (DC) can destroy parts of the system by corrosion.

A true RMS reading instrument shall be used to determine this voltage.

The following conditions shall 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 service persons and then only by removal of equipment covers by means of a tool.

NOTE 2 For requirements in Japan, see Clause D.4.

8.1.2 General requirements for equipment

The equipment used in a cable network shall meet the requirements of IEC 60065 or IEC 60950-1. For protection against atmospheric overvoltages in cable networks, see 11.1.

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 suitable selection of fuse 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 current and operating voltage according to Table 1 shall be used. Higher values are possible if specified by the manufacturer.

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

Application	Typical diameter of the coaxial cable mm	Maximum allowed operation voltage V		Maximum allowed current A	
		AC_{RMS}	DC	Operation	Permanent short circuit
Drop or Subscriber cable [a]	5 to 10	34	50	2	4
Feeder or Distribution cable	>10	65	120	7	15
Trunk cable	>10	65	120	15	30

[a] Drop or subscriber cable with a diameter <5 mm have to be operated according to the specifications of the manufacturer.

NOTE 1 Specific test conditions for coaxial cables are laid down in the EN 50117 series.

NOTE 2 For back-powering applications these values are reduced according to 8.2.

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 $V_{AC,\ RMS}$, or 34 V_{DC}; a true RMS reading instrument shall be used to determine the AC 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. Reference is made 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.

NOTE For requirements in France, see Clause D.5.

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

NOTE 2 For requirements in Japan, see Clause D.6.

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.

NOTE For requirements in Japan, see Clause D.6.

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 indoors and 20 mm when installed outdoors.

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.

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 terminal equipment can be connected to the cable network directly or preferably by means of a system outlet or transfer point, which provides the necessary overvoltage protection.

NOTE 1 Except in the case of fully isolated outlets (see 10.2.2), 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, overvoltage protection shall be provided at the output of the subscriber tap.

Where overvoltage protection is provided by means of isolating capacitors or transformers, the isolated conductors, for example, inner conductors shall withstand a continuous DC 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 2 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 AC leakage current (50 Hz or 60 Hz) does not exceed 8 mA_{RMS} with an applied voltage of 230 V_{RMS}.

NOTE 3 For requirements in Sweden, see D.7.1.

NOTE 4 For requirements in the UK, see D.7.2.

NOTE 5 For requirements in Norway, see D.2.2.

10.2 System outlet

10.2.1 Types of system outlets

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

10.2.2 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. When installed, it shall not be possible to touch simultaneously both input and output terminals of the isolator.

NOTE 1 In cases where induced voltages resulting from lightning discharges exceed the isolator specification additional over-voltage protection (e.g. surge protecting devices) may be needed.

NOTE 2 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.

10.2.3 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 type of outlet is used, the protection shall be provided by equipotential bonding of the outer conductor of the subscriber feeder. In this case, the DC resistance between the outer conductor and the nearest point of equipotential bonding (or PE) shall be such that no hazardous touch voltage appears on exposed conductive parts (see also Annex A). The isolating component may be either a high-voltage capacitor or a double-wound transformer.

NOTE 1 In 230 V systems a value of the DC resistance ≤5 Ω is used as a good practice.

NOTE 2 For requirements in Japan, see Clause D.8.

10.2.4 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 10.2.3. A protective element to improve safety (for example, an RF coil) shall be connected between the inner and outer conductors of the coaxial connections. The DC resistance of this protective element shall be less than 1 Ω. The DC resistance between the outer conductor and the nearest point of equipotential bonding (or PE) shall be such that no hazardous touch voltage appears on exposed conductive parts (see also Annex A).

NOTE 1 In 230 V systems a value of the DC resistance ≤5 Ω is used as a good practice.

NOTE 2 For requirements in Japan, see Clause D.8.

10.2.5 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 10.2.3.

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 overvoltages and elimination of potential differences

11.1 General

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

The outer antenna system shall be so designed and installed that it will withstand a lightning discharge without danger of fire or separation of the antenna system 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 from these protection requirements on the basis that the increased risk of lightning strike due to the installation of the antenna is negligible:

- 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 external building walls (see Figure 8);
- antenna systems enclosed within the building structure;
- antenna systems serving only a single dwelling installation and the risk of lightning strike is low (see 11.2.3.1).

NOTE For requirements in Germany, see D.10.1

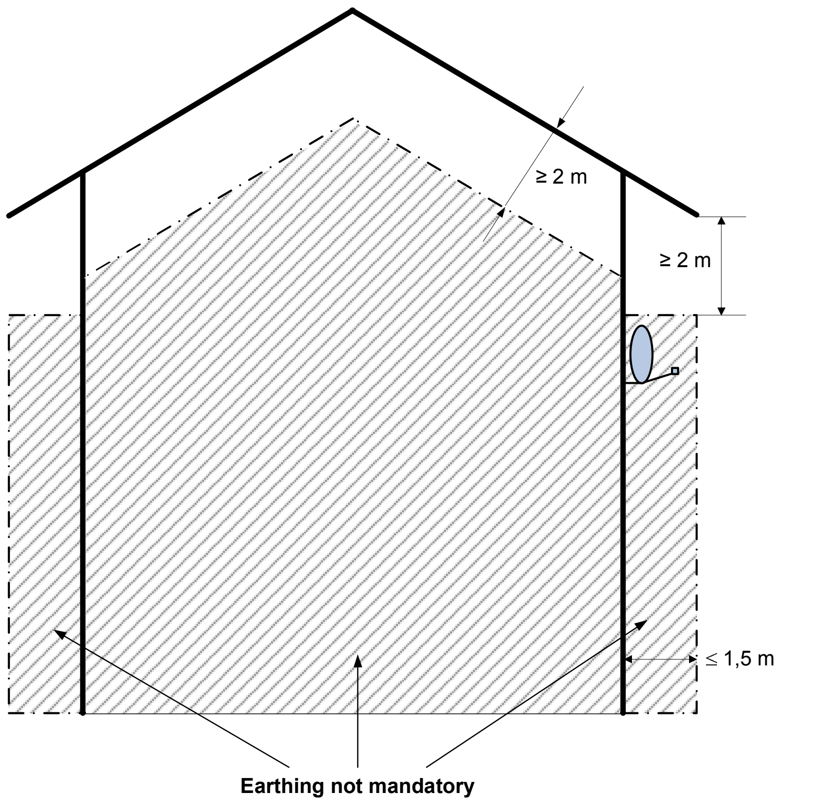
A single dwelling installation is defined as an installation in a single dwelling unit where the summation of the leakage currents of the STBs or home terminals and connected Class II devices does not exceed 3,5 mA_{RMS}. A single Class II device can have a maximum leakage current of 0,25 mA_{RMS} or 0,5 mA_{RMS} for devices covered by IEC 60950-1 and IEC 60065, respectively. The touch current hazard, safe let-go threshold current (defined in IEC 60990) shall be ≤3,5 mA_{RMS} as per the "touch voltage" requirement in IEC 60950-1. The maximum allowable summation of leakage current for connected devices is therefore 3,5 mA_{RMS} before equipotential bonding becomes mandatory.

Antennas shall not be installed on buildings having roofs covered with highly flammable materials (e.g. 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.

For large antenna systems, such as AM broadcasting receiving antennas, it is recommended that an overvoltage protective device to a bonding conductor is incorporated.

The use of shield wires to protect installations with coaxial cables is described in informative Annex B.



NOTE 1 The protected area on the side of buildings is limited up to a height of 45 m (for LPS Class III) due to the possibility of occurring side flashes (see IEC 62305-3).

NOTE 2 For requirements in Japan, see Clause D.9.

Figure 8 – Areas of antenna-outdoor-mounting on buildings, where earthing is not mandatory

11.2 Protection of the antenna system

11.2.1 Selection of appropriate methods for protection of antenna systems

Figure 9 shows a flow chart which serves as decision tree to select the appropriate method for protecting the antenna system under consideration. The decision tree has four outputs which belong to the four solutions for installation of the antenna system, described in Table 2. It is important to distinguish between the responsibilities of the antenna installer (solid line boxes in Figure 9) and the responsibilities of the LPS installer (dashed line boxes in Figure 9).

Table 2 – Solutions for protection of antenna systems against atmospheric overvoltages

Solution	Protection measures	Related standards
1	**Antenna system not directly earthed but connected to an equipotential bonding system**	
1a	In protected area of the building according to Figure 8	This standard
1b	In protected volume of the existing or newly installed LPS; see Figure 10	IEC 62305-3
1c	In protected volume of external isolated ATS; see Figure 11 and Figure 12	IEC 62305
1d	If lightning stroke risk $R \leq$ tolerable risk R_T; see Figure 15	IEC 62305-2
2	**Antenna system directly earthed and connected to an equipotential bonding system**	
	Building without an LPS and no data applicable or available for risk calculation; see Figure 14	This standard
3	**Antenna system connected to an equipotential bonding system and with connection to an LPS**	
	Building with an LPS; antenna mast serves as non-isolated air-termination system (ATS); see Figure 13	IEC 62305 This standard
4	**Antenna system without connection to an equipotential bonding system and not directly earthed**	
	Installation in protected area of a single dwelling unit and for single dwelling installations according to 11.1	This standard
NOTE For installations covered by solution 4, it is nonetheless strongly recommended that the system is equipotential bonded.		

11.2.2 Building equipped with a lightning protection system (LPS)

If the building is already equipped or will be equipped (on the request of the antenna installer) with an LPS conforming to IEC 62305 the best solution for installing an antenna system is to use a protected volume of this LPS (solution 1b in Table 2) as described in the IEC 62305 series of publications. The possibility to use such a protected volume shall be determined by the skilled LPS installer. Figure 10 shows an example of such an installation.

If a protected volume performed by the building LPS is not available, for example due to the size of the antenna system, the use of an external isolated ATS shall be determined next by the LPS installer (solution 1c in Table 2). Figure 11 and Figure 12 show examples of such installations.

If neither of the above mentioned installation principles are possible, 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 11.3.2 (solution 3 in Table 2). In this case the antenna mast may be extended in length to form a non-isolated air termination system and shall fulfil the requirements of 5.2 of IEC 62305-3:2006 for an air-termination system. It is assumed that the antenna system and its mast are able to withstand a lightning stroke.

An example of this kind of installation is shown in Figure 13.

The separation distance S, shown in Figure 10, Figure 11, Figure 12 and Figure 13, between each ATS equipment and the LPS and all LPS connected parts shall meet or exceed the required value (see IEC 62305-3).

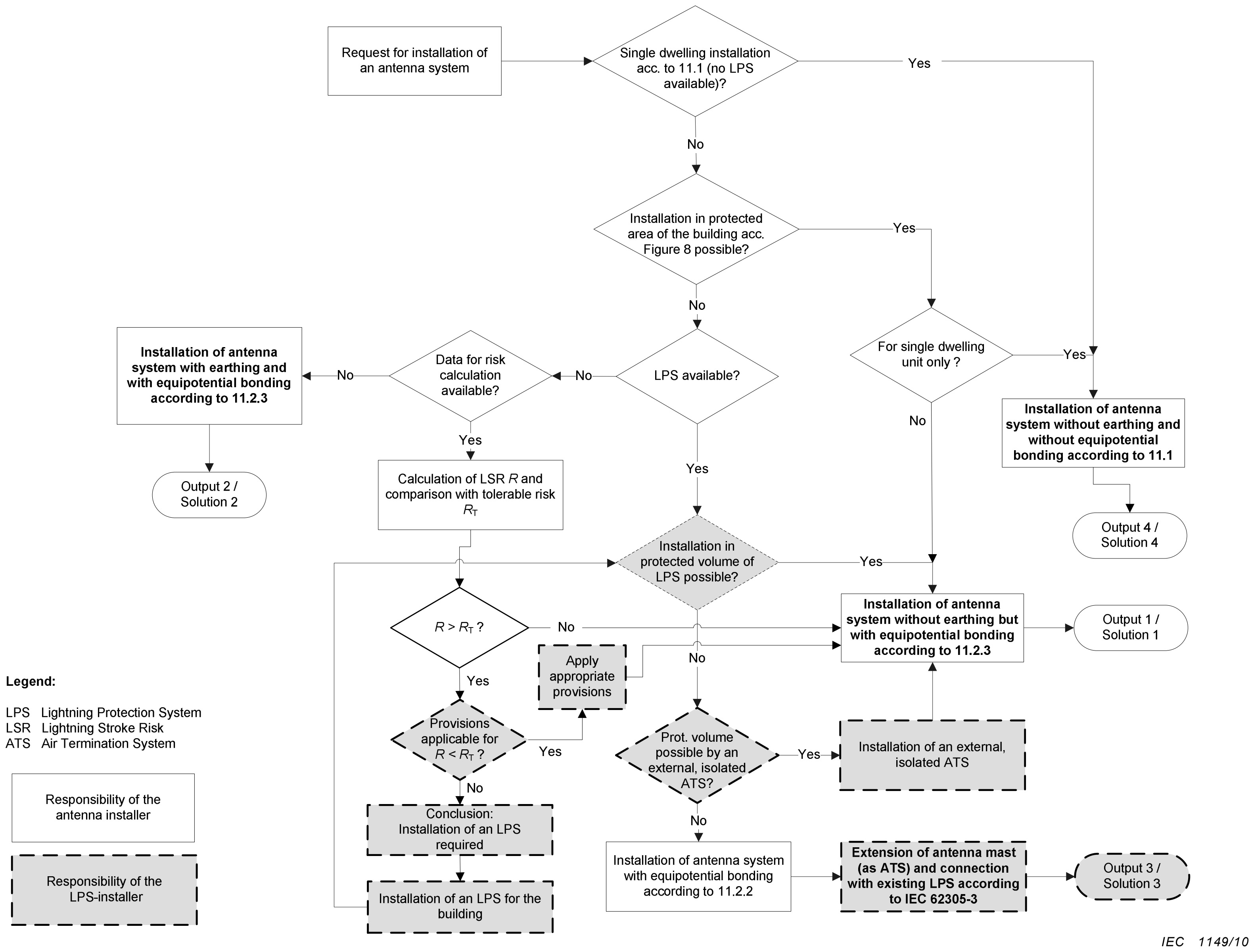
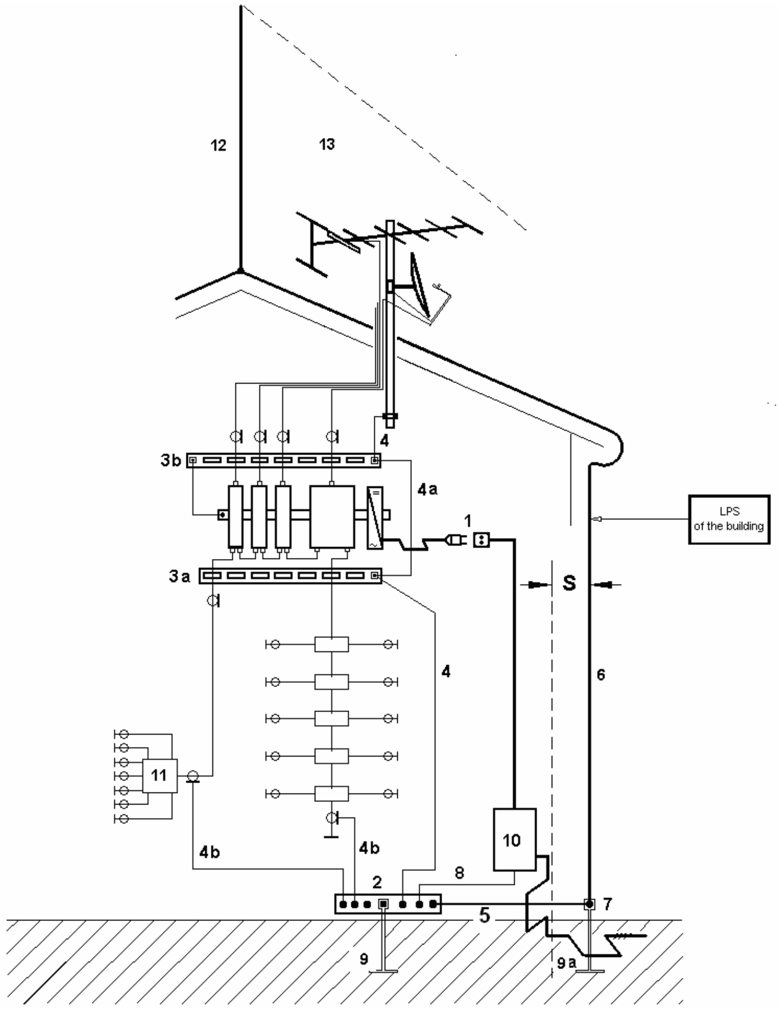


Figure 9 – Flow chart for selection of the appropriate method for protecting the antenna system against atmospheric overvoltages



IEC 1150/10

1	Mains supply	2	Main earthing bar
3a, 3b	Equipotential bonding bars	4, 4a, 4b	Protective bonding conductors (minimum cross section according to 6.2 c)
5	Earth bonding conductor (e.g. ≥ 16 mm^2 Cu) according to 11.3.2	6	External earthing conductor of the buildings LPS (e.g. ≥50 mm^2 Cu, solid round, according to IEC 62305-3)
7	Earth terminal	8	Protective conductor (PE)
9	Foundation earth electrode	9a	LPS earth electrode
10	Mains power distribution box with SPD	11	Home distributor (HD)
12	Interception rod	13	Protected volume by isolated LPS (see IEC 62305-3)
S	Separation distance according to IEC 62305-3		

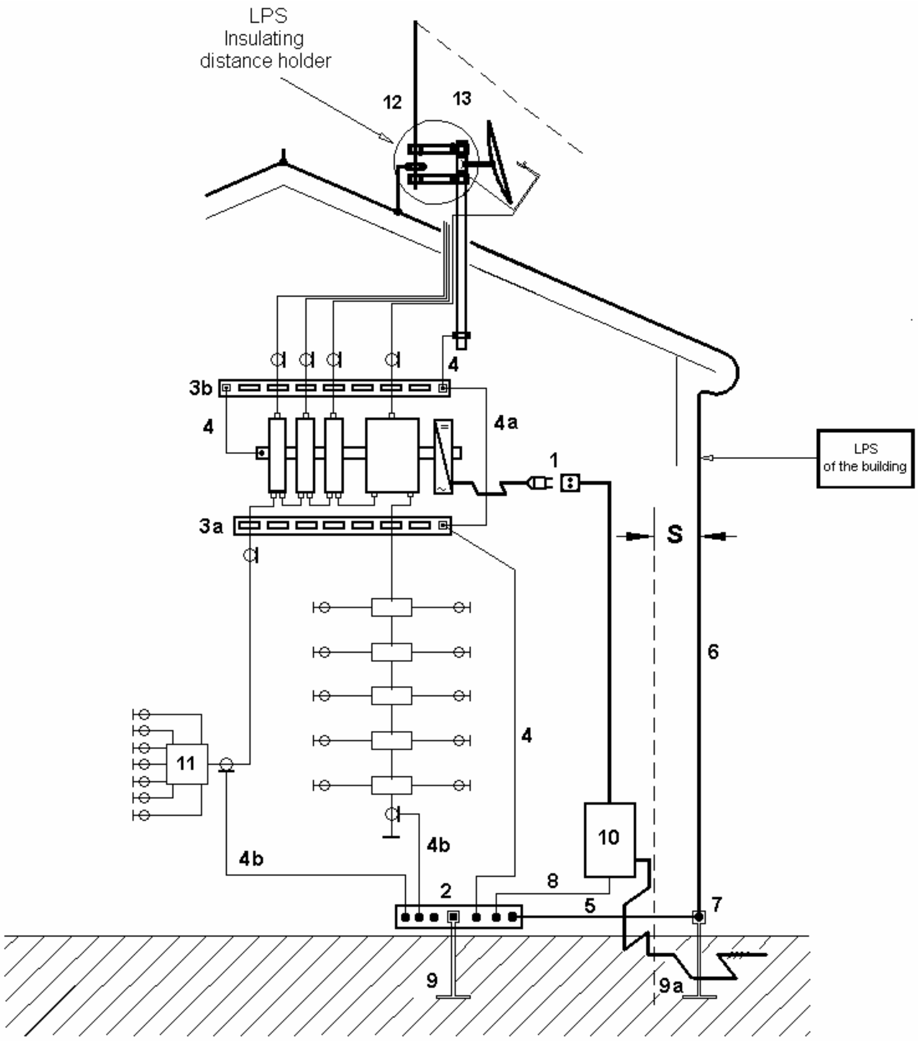
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

NOTE 2 The equipotential bonding bars 3a and 3b could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors.

NOTE 3 The bonding connection between the headend equipment and the metallic mounting bar is either performed via the metallic equipment enclosure or by an additional protective bonding conductor 4.

NOTE 4 The example refers to Table 2, solution 1b.

Figure 10 – Example of equipotential bonded headends and antennas in a protected volume of the building LPS



1	Mains supply	2	Main earthing terminal
3a, 3b	Equipotential bonding bars	4, 4a, 4b	Protective bonding conductors (minimum cross section according to 6.2c)
5	Earth bonding conductor (e.g. ≥16 mm^2 Cu) according to 11.3.2	6	External earthing conductor of the buildings LPS (e.g. ≥50 mm^2 Cu, solid round, according to IEC 62305-3)
7	Earth terminal	8	Protective conductor (PE)
9	Foundation earth electrode	9a	LPS earth electrode
10	Mains power distribution box with SPD	11	Home distributor (HD)
12	Interception rod	13	Protected volume by isolated LPS (see IEC 62305-3)
S	Separation distance according to IEC 62305-3		

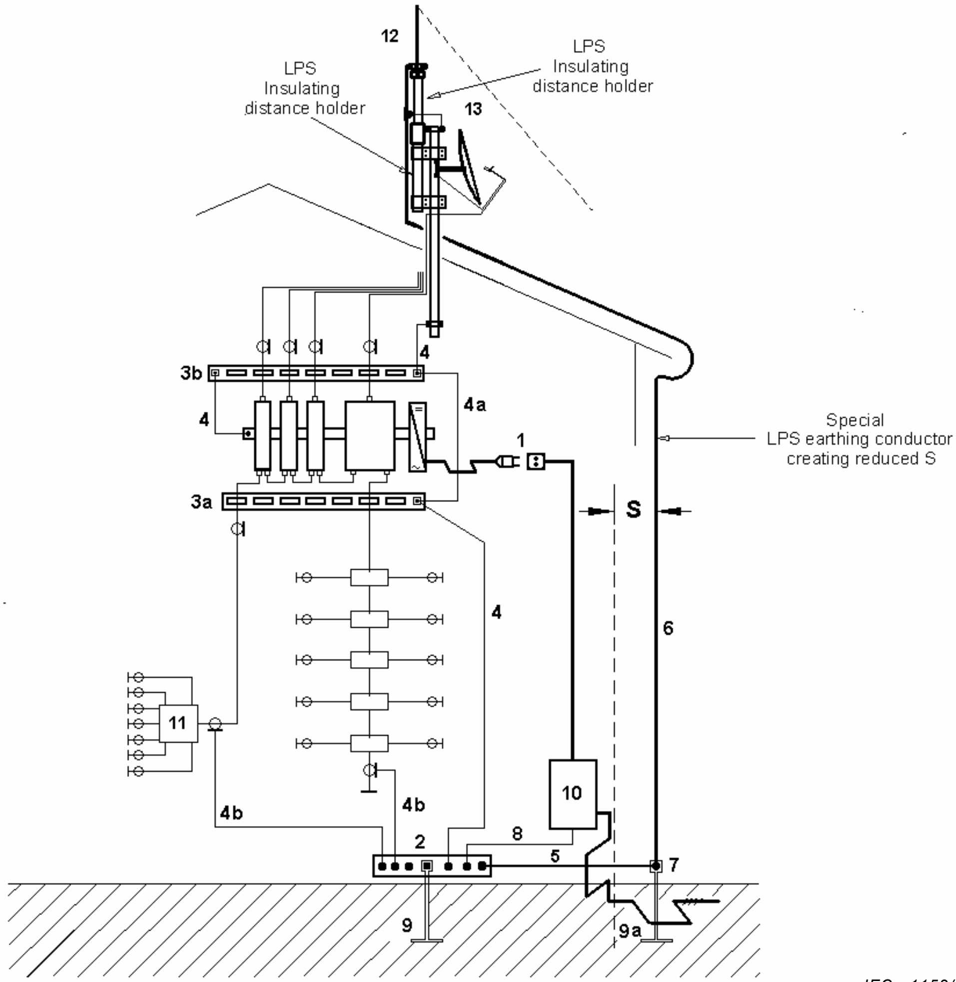
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

NOTE 2 The equipotential bonding bars 3a and 3b could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors.

NOTE 3 The bonding connection between the headend equipment and the metallic mounting bar is either performed via the metallic equipment enclosure or by an additional protective bonding conductor 4.

NOTE 4 The example refers to Table 2, solution 1c.

Figure 11 – Example of equipotential bonded headends and antennas in a protected volume of the building LPS



1	Mains supply	2	Main earthing bar
3a, 3b	Equipotential bonding bars	4, 4a, 4b	Protective bonding conductors (minimum cross section according to 6.2 c)
5	Earth bonding conductor (e.g. ≥ 16 mm^2 Cu) according to 11.3.2	6	External earthing conductor of the buildings LPS (e.g. ≥ 50 mm^2 Cu, solid round, according to IEC 62305-3)
7	Earth terminal	8	Protective conductor (PE)
9	Foundation earth electrode	9a	LPS earth electrode
10	Mains power distribution box with SPD	11	Home distributor (HD)
12	Interception rod	13	Protected volume by isolated LPS (see IEC 62305-3)
S	Separation distance according to IEC 62305-3		

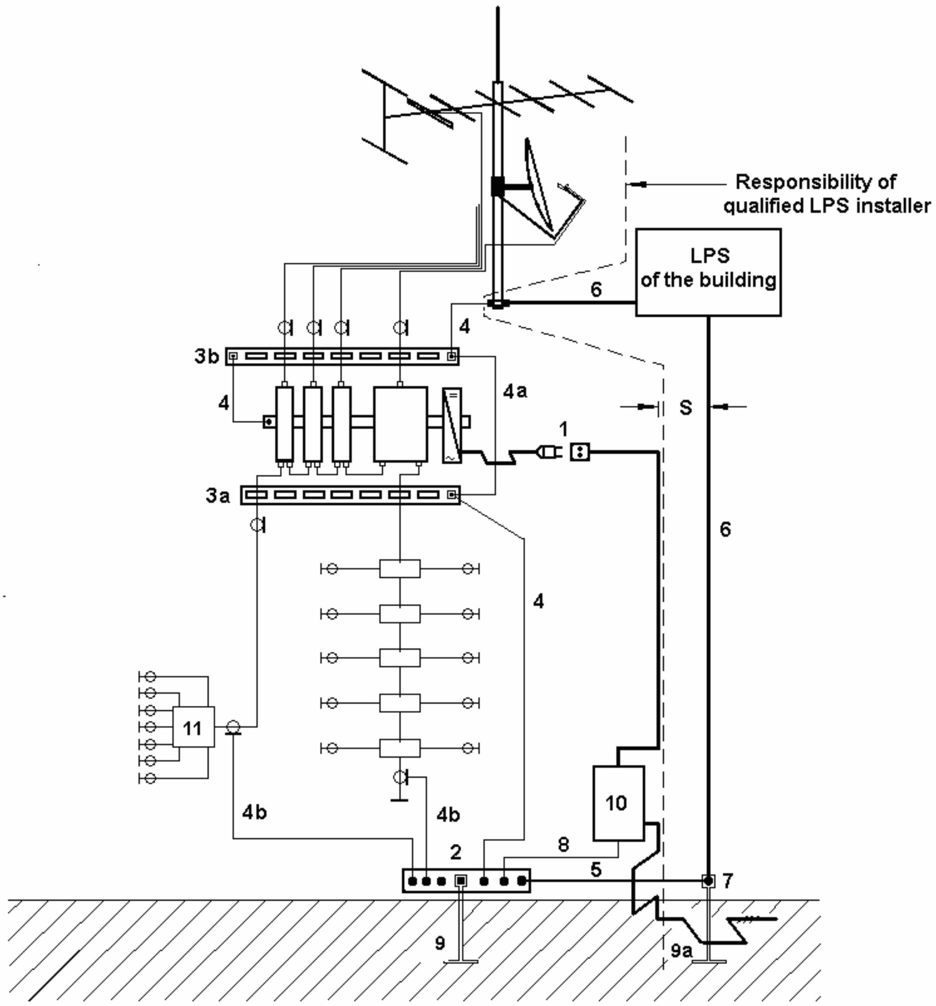
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

NOTE 2 The equipotential bonding bars 3a and 3b could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors.

NOTE 3 The bonding connection between the headend equipment and the metallic mounting bar is either performed via the metallic equipment enclosure or by an additional protective bonding conductor 4.

NOTE 4 The example refers to Table 2, solution 1c.

Figure 12 – Example of equipotential bonded headends and antennas in a protected volume of an external isolated ATS



IEC 1153/10

1	Mains supply	2	Main earthing bar
3a, 3b	Equipotential bonding bars	4, 4a, 4b	Protective bonding conductors (minimum cross section ≥16 mm^2 Cu)
5	Earth bonding conductor (e.g. ≥16 mm^2 Cu) according to 11.3.2	6	External earthing conductor of the buildings LPS (e.g. ≥50 mm^2 Cu, solid round, according to IEC 62305-3)
7	Earth terminal	8	Protective conductor (PE)
9	Foundation earth electrode	9a	LPS earth electrode
10	Mains power distribution box with SPD	11	Home distributor (HD)
S	Separation distance		

NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

NOTE 2 The equipotential bonding bars 3a and 3b could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors.

NOTE 3 The bonding connection between the headend equipment and the metallic mounting bar is either performed via the metallic equipment enclosure or by an additional protective bonding conductor 4.

NOTE 4 The example refers to Table 2, solution 3.

Figure 13 – Example of equipotential bonded antennas (not installed in a protected volume) and headend with direct connection to building LPS

The outer conductors of all coaxial cables coming from the antennas (see Figure 10, Figure 11 Figure 12 and Figure 13) shall be connected to the mast via a protective bonding conductor having a minimum cross-sectional area according to 6.2c.

NOTE 1 To ensure the maintenance of protection of an LPS when an antenna system is installed, the LPS should be inspected according to IEC 62305-3:2006, Clause 7.

NOTE 2 For requirements in Japan, see D.10.2.

11.2.3 Building not equipped with an LPS

11.2.3.1 General

Where the risk due to lightning is less than the tolerable risk according to 11.2.3.2, for individual receiving systems and MATV or SMATV systems confined to one building, protection against lightning is not mandatory unless required by local regulations (but nonetheless strongly recommended). As examples, cases described in 11.2.3.3 to 11.2.3.6 shall be considered as shown in the decision tree of Figure 9 and in Table 2.

For Cases B, C and D the risk assessment of the building with the antenna system shall be performed according to IEC 62305-2; the simplified software (Annex J of IEC 62305-2:2006) should be used as a minimum.

NOTE For requirements in Germany, see D.10.1.

11.2.3.2 Tolerable risk

Identifying the maximum value of the risk which can be tolerated by a building (the „tolerable risk“) is the responsibility of the authority having jurisdiction. If the tolerable risk is not available by local regulations, the risk of the building is taken as indicated in IEC 62305-2:2006, Table 7

loss of human life or permanent injuries	$R_T = 10^{-5}$,
loss of service to the public	$R_T = 10^{-3}$,
loss of cultural heritage	$R_T = 10^{-3}$.

Computer programmes exist within National Standards Bodies for calculation of tolerable risk. Annex J of IEC 62305-2:2006 presents a simplified software for risk assessment for structures. This software can assist installers in order to evaluate the lightning risk R of the complete building including the antenna installation and compare it to the tolerable risk R_T. However, difficult cases should be calculated according to IEC 62305-2.

Examples of calculation of the risk due to lightning using the simplified software for risk assessment for structures described in IEC 62305-2:2006, Annex J are given in Annex C.

11.2.3.3 Case A – Bonding required without LPS

If the building is not equipped with an LPS conforming to IEC 62305, and

- LPS is not mandatory by local authority regulations or
- risk assessment data are not available or not applicable,

the mast and outer conductors of the coaxial cables shall be earthed as specified in 11.3.2. This is shown as output 2/solution 2 in Figure 9 and in Table 2. However, risk assessment is always recommended.

An example of earthing and equipotential bonding according to this solution 2 is shown in Figure 14.

11.2.3.4 Case B – Bonding required without LPS

If the building is not equipped with an LPS conforming to IEC 62305, and

- LPS is not mandatory by local authority regulations or
- the risk of the building with antenna systems due to lightning was calculated (according to 11.2.3.1) and is below or equal the maximum value of risk which can be tolerated,

protection against lightning is not required. This leads to output 1/solution 1 in Figure 9 and is described as solution 1d in Table 2.

NOTE For requirements in Germany, see D.10.1.

An example of antenna system bonding according to this solution 1d is shown in Figure 15. The outer conductors of all coaxial cables coming from the antennas shall be connected to earth via a bonding conductor with a cross-section according to 6.2c.

11.2.3.5 Case C – Lightning protection by risk-reducing measures

If the building is not yet equipped with an LPS conforming to IEC 62305, and the risk of the building with antenna systems due to lightning was calculated (according to 11.2.3.1) and is above the maximum value of risk which can be tolerated, it is possible, according to IEC 62305, to apply additional measures in order to reduce the risk.

These additional measures, to be specified by an LPS installer (or lightning protection expert), are dependent on the causes that have produced the $R > R_T$ condition. These additional measures can be the provision of

- SPD devices, according to IEC 62305-4,
- screening for incoming power line, overhead or underground services,
- fire extinguishers.

If after considering the provision of one or more of these solutions the condition $R < R_T$ can be obtained, this provision shall be applied and then an LPS is not required. This leads to output 1/solution 1 in Figure 9 and is described as solution 1d in Table 2.

NOTE 1 For requirements in Germany, see D.10.1.

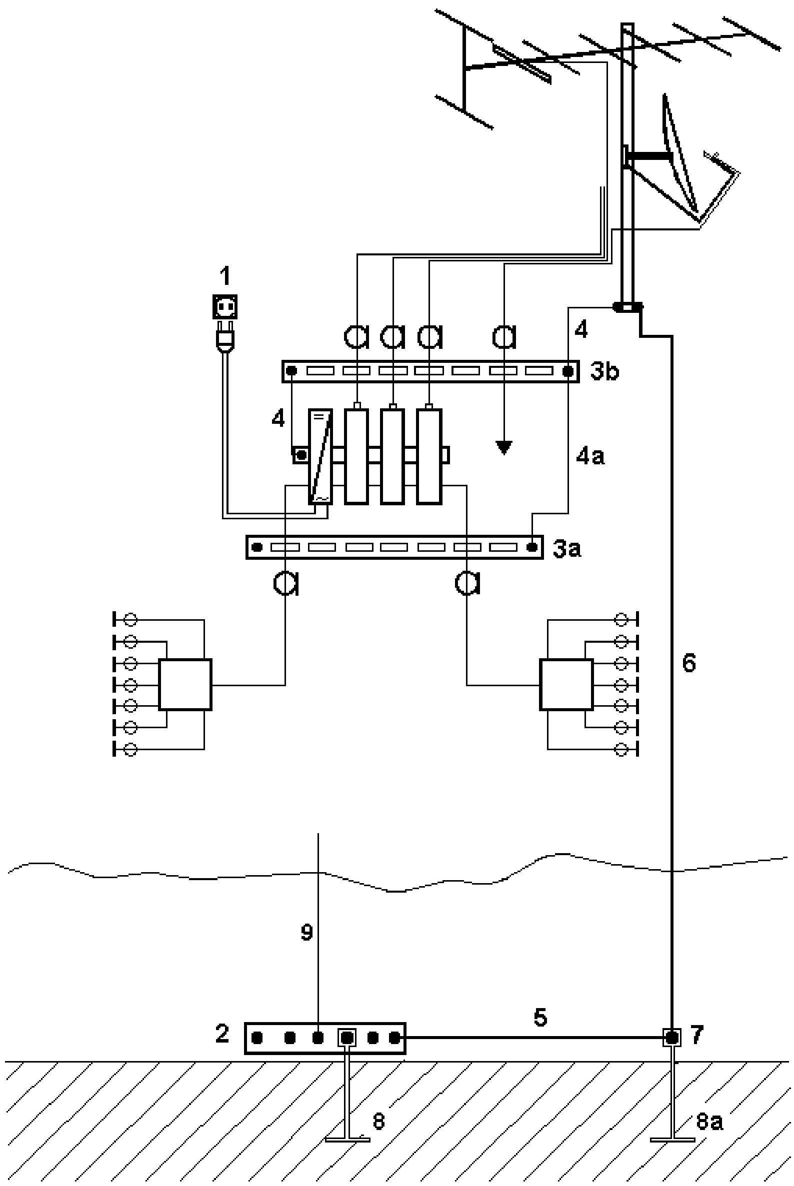
NOTE 2 This may be a more cost effective solution than a provision of an LPS.

11.2.3.6 Case D – LPS required

If after considering the placement of these provisions the condition $R > R_T$ is still valid, the installation of an LPS by a skilled LPS installer is required before installing the antenna system.

After the installation of the LPS the requirements of 11.2.2 apply for the antenna system.

NOTE To ensure the maintenance of protection of an LPS when an antenna system is installed, the LPS should be inspected according to IEC 62305-3:2006, Clause 7.



1	Mains supply	2	Main earthing bar
3a, 3b	Equipotential bonding bars	4, 4a	Protective bonding conductors (see 6.2c)
5	Earth bonding conductor (e.g. ≥16 mm^2 Cu) according to 11.3.2	6	External earthing conductor, (e.g. ≥16 mm^2 Cu, according to 11.3.2)
7	Earthing terminal	8	Foundation earth electrode
8a	Earth electrode	9	Protective conductor (PE) if required

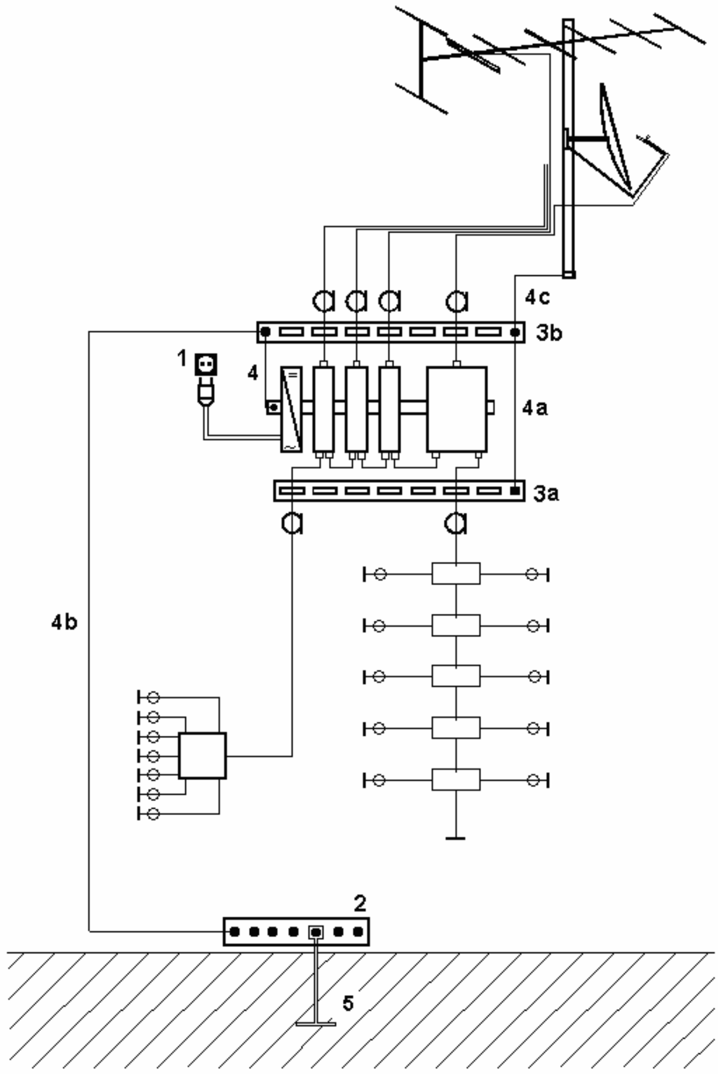
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

NOTE 2 The equipotential bonding bars 3a and 3b could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors.

NOTE 3 The bonding connection between the headend equipment and the metallic mounting bar is either performed via the metallic equipment enclosure or by an additional protective bonding conductor 4.

NOTE 4 The example refers to Table 2, solution 2.

Figure 14 – Example of equipotential bonded headend and earthed antennas (building without LPS)



1	Mains supply	2	Main earthing bar
3a, 3b	Equipotential bonding bars	4, 4a, 4b, 4c	Protective bonding conductors according to 6.2c
5	Foundation earth electrode		

NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

NOTE 2 The equipotential bonding bars 3a and 3b could be either metallic bars for directly fixing and contacting the sheath of the coaxial cables or a block of double sided F connectors.

NOTE 3 The bonding connection between the headend equipment and the metallic mounting bar is either performed via the metallic equipment enclosure or by an additional protective bonding conductor 4.

NOTE 4 The example refers to Table 2, solution 1d.

Figure 15 – Example of bonding for antennas and headend (building without LPS and lightning risk lower than or equal to the tolerable risk)

11.3 Earthing and bonding of the antenna system

11.3.1 Internal protection system

11.3.1.1 General

If the risk due to lightning is greater than the tolerable risk, an internal protection system shall be provided.

The internal protection system is complementary to the external protection system and has the task to avoid dangerous discharges. This system is made of equipotential bonding connections (directly or by means of overvoltage discharge limiters/surge protective devices (SPD)) placed between

- the external protection system,
- the external and internal metallic parts,
- the external and internal electrical circuits.

Overvoltages induced in the coaxial cables of a cable network may generate sparks with fire risk. By use of an internal LPS, dangerous sparking between different parts within a building can be avoided by

- equipotential bonding by connecting the sheath of the network cable and the body of spur feeders at each floor to the next equipotential bonding bar to achieve slender loops of equipotential bonding,
- electrical insulation (IEC 62305-3:2006, 6.1),
- separation distances between the equipment and components of the cable system, other conductive parts of the building and electrical equipment.

The internal protection systems are under the responsibility of the LPS installer and shall comply with the IEC 62305-3:2006, Clause 6.

11.3.1.2 Protection by additional discharge conductors

To achieve a sufficient lightning current capability, the sum of all cable shield cross sections has to result in a value ≥16 mm^2 Cu or ≥25 mm^2 Al. This could be achieved by the installation of additional discharge conductors 4d as shown in Figure 16. To avoid inductive loops between the coaxial cable to be protected and the conductor 4d, it is recommended to lead these conductors parallel and near to the coaxial cable.

Additional discharge conductors serve for protection against fire and sparking in case of lightning discharge or inductive events by nearest lightning discharges.

The surge protection of the inner conductor of a coaxial cable can be achieved by using appropriate equipment. The mounting instructions of the manufacturer have to be considered as well as the above mentioned installation rules.

11.3.2 Earthing conductors

In accordance with EN 50164-1 and EN 50164-2 terminals and wires shall be so designed to withstand lightning currents.

The earthing conductor shall be installed straight and vertical such that it can provide the shortest, most direct path to the earth termination system.

A suitable earthing conductor is a 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 a corrosive behaviour towards each other, shall be used.

Fine-wire conductors shall not be used as earthing conductors. They are only allowed for conductors not carrying lightning currents.

If the earthing conductor can be touched or is installed in a place where persons can be present in high number or for a long period of time, protection against direct contacts shall be required. For this purpose, it is sufficient to install the earthing conductor inside a protective tube (PVC, 3 mm thick).

Natural components can be employed, for example in (see Figure 17):

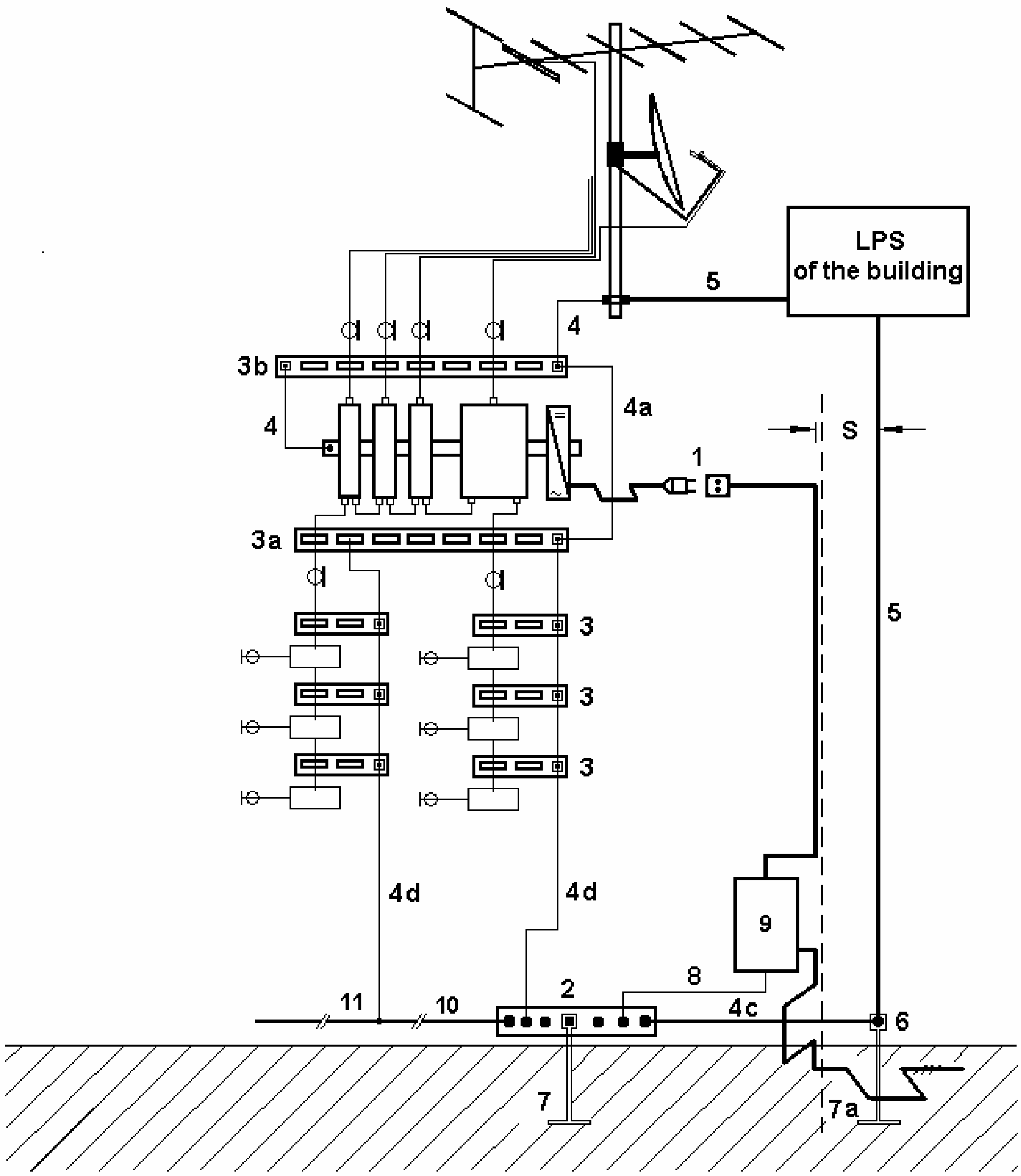
- metallic installations provided that
  - local regulations allow it,
  - the electrical continuity between various parts is made durable,
  - their dimensions are at least equal to those specified for standard earthing conductors;

  NOTE 1 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).

The following components are specifically excluded:

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

NOTE 2 For requirements in Japan, see Clause D.11.



1	Mains supply	2	Main earthing bar
3, 3a, 3b	Equipotential bonding bars	4, 4a,	Protective bonding conductors (e.g. ≥16 mm^2 Cu, solid round, according to IEC 62305-3)
4c	Earth bonding conductor (e.g. ≥16 mm^2 Cu) according to 11.3.2	4d	Additional discharge conductors (e.g. ≥16 mm^2 Cu, solid round, according to IEC 62305-3)
5	External earthing conductor of the buildings LPS (≥50 mm^2 Cu) (see IEC 62305-3)	6	Earthing terminal
7	Foundation earth electrode	7a	Earth electrode of LPS
8	Protective conductor (PE)	9	Mains power distribution box with SPD
10	Inhouse earthing conductor or solid tape conductor, e.g. ring protective bonding conductor (see IEC 62305-3)	11	e.g. terminal, fixed earthing terminal or other reliable equipotential bonding equipment
S Separation distance (see IEC 62305-3)			

Figure 16 – Example of protecting an antenna system (not installed in a protected volume) by additional discharge conductors ($R > R_T$)

11.3.3 Earth termination system

The earth termination system shall be provided by one of the following methods as shown in Figure 17:

- 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.

NOTE 1 For requirements in Japan, see Clause D.12.

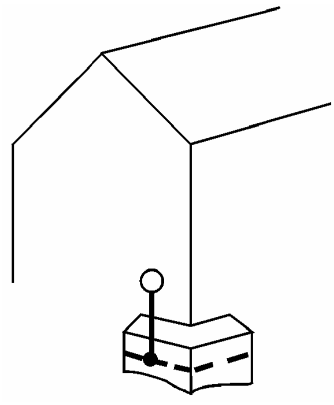


Figure 17a – Conductor in building foundations

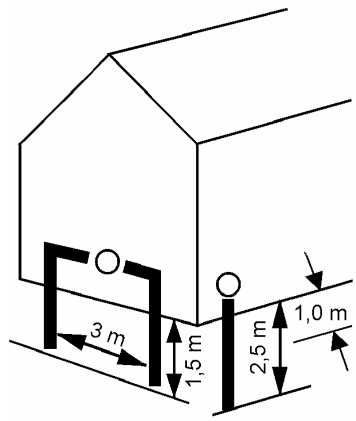


Figure 17b – Steel rod earth electrodes [a]

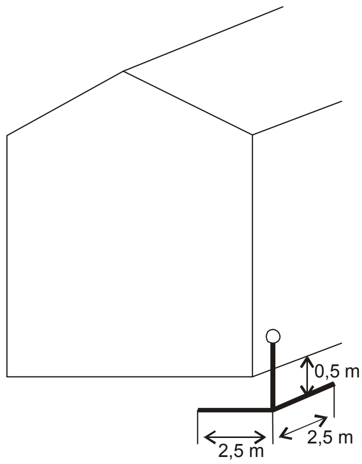


Figure 17c – Steel strip [a]

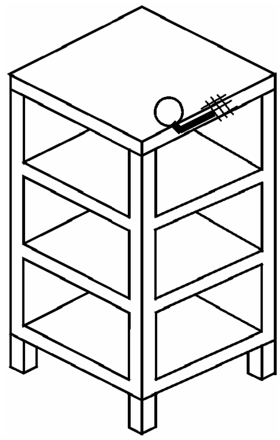


Figure 17d – Structural steelworks

[a] minimum distance 1 m from wall and foundation

Key

○	Earthing terminal	##	Armour / steel construction

Figure 17 – Examples of earthing mechanisms (minimum dimensions)

The minimum cross-sectional area of each earth electrode is 50 mm^2 copper or 90 mm^2 hot-dip galvanized or stainless steel. More details can be found in IEC 60364-5-54.

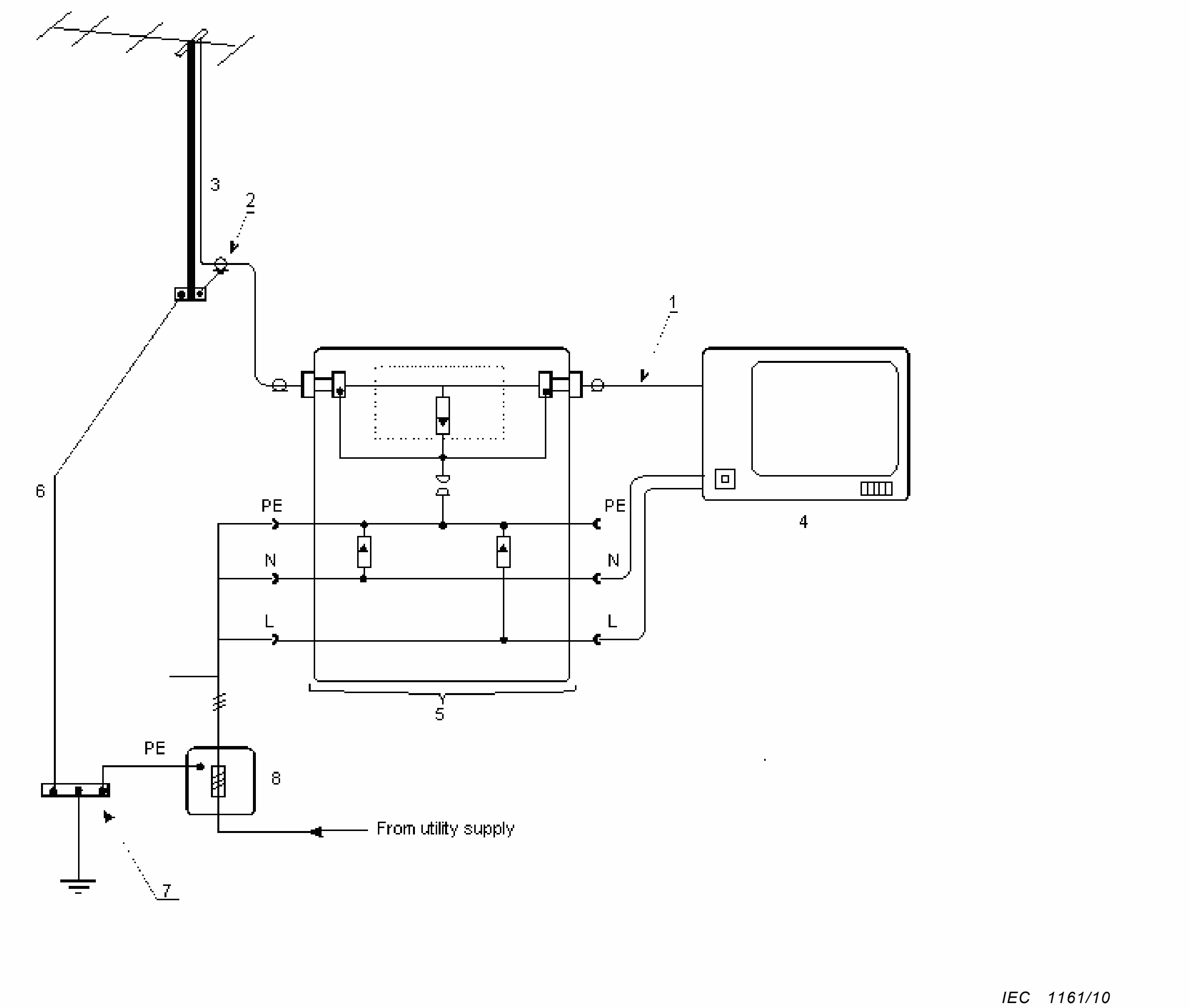
Natural components such as interconnected concrete reinforcing steel or other suitable underground metal structures, incorporated in the building's foundation and whose dimensions comply with the above-mentioned limits, can also be employed.

Other earth termination systems according to IEC 62305-3:2006, 5.4 and E.5.4, are also recommended.

NOTE 2 An earth termination system can also be obtained with a conductor forming a loop external to the perimeter of the structure, grounded at least for its 80 % of length.

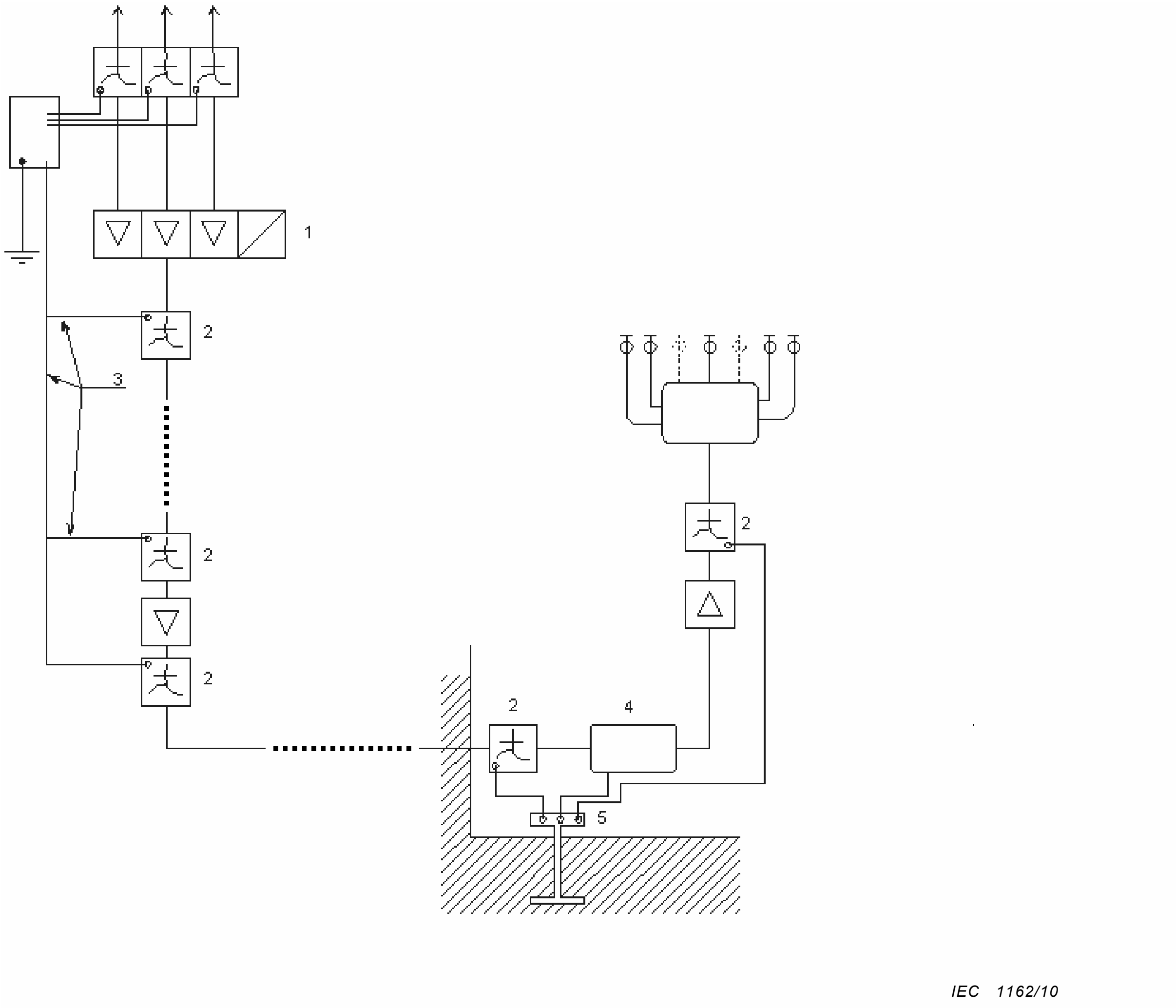
11.4 Overvoltage protection

Induction can introduce high voltages at transfer points, system outlets, at the headend 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 Figure 18 and in Figure 19.



1 Protected part	2 Metallic shield of the coaxial cable connected to the antenna mast (a water-proof solution shall be selected)
3 Coaxial cable	4 Subscriber terminal
5 Overvoltage protective device	6 Earthing conductor
7 Main earthing bar	8 House connection
NOTE These kinds of overvoltage protective devices could be installed also in front of terminal equipment used in multi-dwelling units.	

Figure 18 – Example of an overvoltage protective device for single dwelling unit



1 Headend	2 Coaxial overvoltage protective device
3 Protective bonding conductor	4 Transfer point
5 Main earthing bar	

Figure 19 – Example of application of a coaxial overvoltage protective device for multiple dwelling unit

12 Mechanical stability

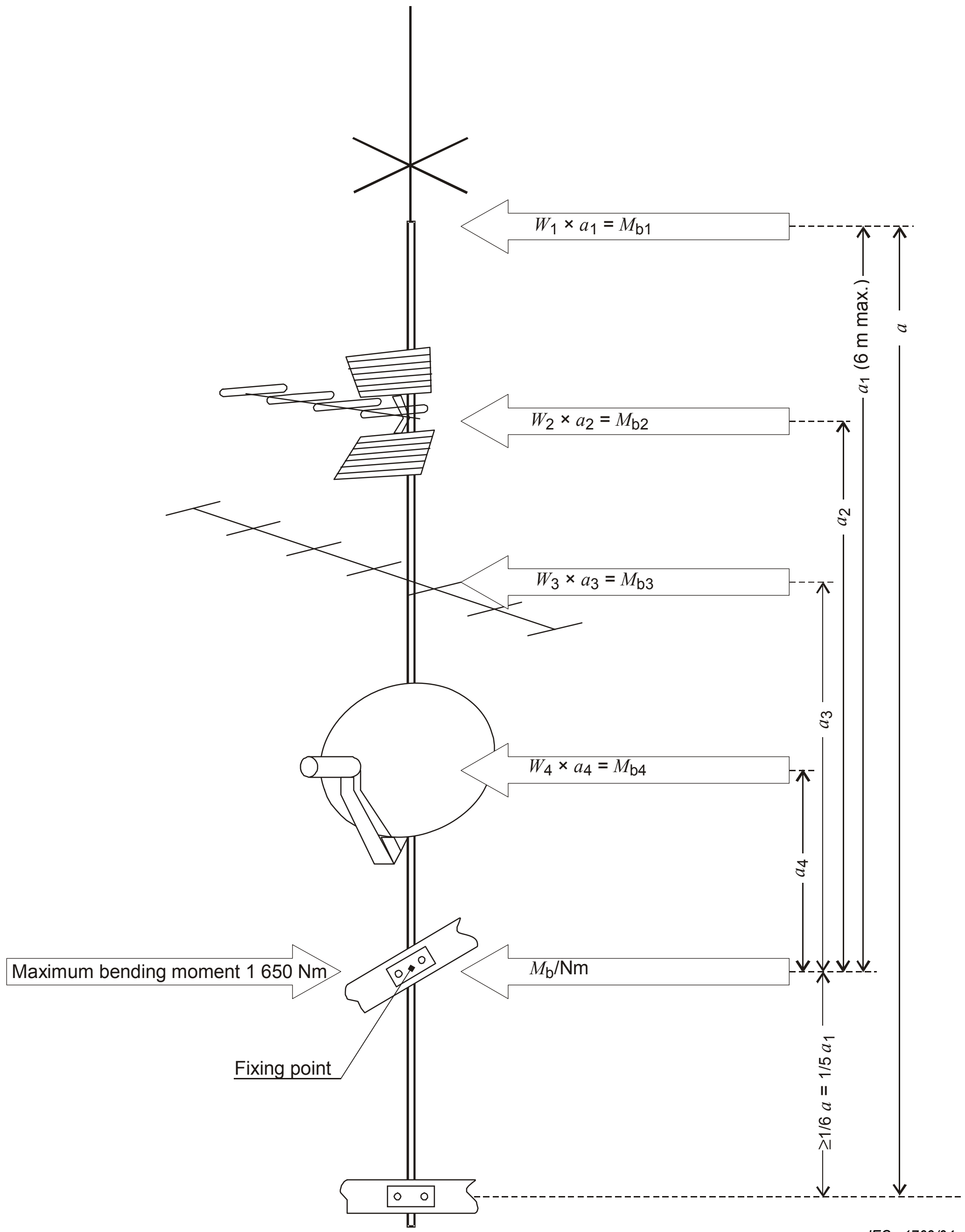
12.1 General requirements

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 20, 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.



Key

a_i distance of antenna number i from the fixing point of the mast

M_{bi} bending moment of antenna number i

M_b sum of bending moments of all i antennas and of the mast

W_i wind load of antenna number i

NOTE 1 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.

NOTE 2 For requirements in Japan, see Clause D.13.

Figure 20 – Example of bending moment of an antenna mast

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).

NOTE 1 For requirements in Finland, see Clause D.14.

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

$$W = c\,p\,A$$

where

W is the wind load, in Newton;

c is the load coefficient;

p is the wind pressure, in Pascal (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 2 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;

$W_1, W_2, \ldots$ is the wind load, in Newton;

$a_1, a_2, \ldots$ 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 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 (derived from 1 100 / 800).

Annex A
(informative)

Earth loop impedance

A.1 General

The earthing and equipotential bonding of systems and equipment performs two vital roles. Firstly, it provides a path for static and leakage currents to discharge safely and thus avoids the build-up of dangerous voltages between equipment and earth potential. The second role is more critical in that it provides protection for subscribers, personnel working on, or externally inspecting, the system or any other person in the case of a fault condition in the equipment that would otherwise result in dangerous voltage appearing on exposed surfaces.

A.2 Earthing for fault conditions

It is not, in general, the role of the cable network to provide safety earthing for equipment. By definition, Class II equipment cannot introduce earth faults and Class I equipment is protected by its own earthing connection: fault current should therefore not flow through a cable network system. There are instances, however, when a common earth electrode is used (for example a street cabinet such as is shown in Figure 1) and the onus is on the cable system installer to ensure that adequate protection exists.

The overriding requirement for safety earthing is that the impedance of the fault path is small enough so that sufficient current flows in the event of a fault to ensure that any protective device, such as a fuse or circuit breaker, will operate before any dangerous shock can occur.

The maximum value of loop impedance Z_{max} can be calculated from Ohms Law

$$Z_{\mathrm{max}} = \frac{U}{I_{\mathrm{f}}}$$

where

U is the supply voltage to the equipment operating under fault condition and

I_{f} is the resultant fault current required to cause operation of the protective disconnection device.

The value of I_{f} depends upon the type and operating characteristics of the protective device and the required disconnection time. The latter may vary depending upon local electrical code regulations but typically may have two values. In the United Kingdom, for instance, a value of 0,4 s is specified for portable equipment connected via a system outlet (where the equipment could be tightly grasped) and 5 s for fixed equipment where lighter physical contact is more likely. Having defined the required disconnection time the value of I_{f} can be obtained from the published time/current characteristic of the protective device.

The value of U is normally considered constant but care shall be taken to ensure that the calculation takes into account any voltage reduction or ‘droop’ caused by the excessive currents flowing under fault condition.

Note that U is often the supply voltage leading to significantly different values of Z_{max} in different parts of the world; Z_{max} will be less than half the value in a 110 V system compared with one fed by 230 V.

In some cases it may be impossible to achieve the necessary earth loop impedance when using conventional fusing and a residual current device (RCD) may have to be incorporated in the system supply.

A.3 Earthing to protect against hazardous touch voltage

Equipotential bonding is designed to avoid dangerous potential differences occurring between exposed conducting parts of any equipment or services (e.g. water pipes) within the installation. In addition to the equipotential bonding requirement there is also a need to ensure that the whole bonded structure does not have a significant potential above that of the local earth. This may be caused by the build-up of static due to atmospheric conditions or the inherent leakage that can occur from Class II powered equipment. The earth loop resistance is therefore a vital factor in ensuring that no hazardous touch voltage exists for the bonded structure.

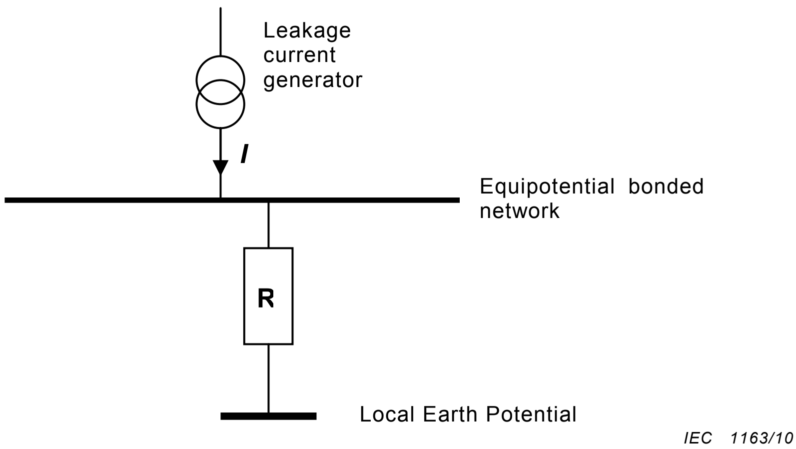


Figure A.1 – Systematic of earth loop resistance

If a general case, as shown in Figure A.1, is considered the touch voltage of the equipotential bonded network should be less than 45 V. If a design value of 35 V is assumed then the maximum value of *R*, the earth loop impedance is 10 kΩ for a leakage current of 3,5 mA. This is easily achievable by any of the methods detailed in 11.3.3. Generally, values of this magnitude can also be considered to be effective against the build up of static load due to atmospheric disturbances.

Note that a single Class II device may have a maximum inherent leakage current of 0,25 mA_{RMS} or 0,5 mA_{RMS} for devices covered by IEC 60950-1 and IEC 60065, respectively and, whilst equipotential bonding is not obligatory, it is still recommended. The touch current hazard, safe let-go threshold current (see Clause A.4) shall be less than 3,5 mA_{RMS} as defined in IEC 60950-1 and, therefore, the maximum summation of leakage current for connected Class II devices must not exceed 3,5 mA_{RMS}, otherwise equipotential bonding is mandatory. For methods of measurement see IEC 60065 and IEC 60950-1.

However, in a large cable network, composed of many Class II pieces of equipment (amplifiers, set-top boxes, television sets and video recorders all contributing to the total leakage current) the requirement on maximum earth loop impedance may become significantly more difficult to meet. With 1 000 connected pieces of equipment (possibly 0,5 A total leakage), the earth loop impedance shall be less than 70 Ω. It must be emphasised that this example applies only to the cumulative inherent leakage of Class II devices and not to fault currents as discussed in Clause A.2.

A.4 Temporary safety measures

Where a system comprises Class II equipment and is not equipotential bonded an induced voltage can be present on the screen of the coaxial cable (see Clause A.3). Even with an equipotential bonded system care shall be taken when installing and servicing the system to ensure that bonding continuity is maintained. In general, the risks to service persons may be minimised by the temporary use of a functional earth between the screen and the earthing arrangement of the electrical installation.

Two levels of reaction to voltages present on exposed metalwork may be considered.

a) The touch hazard reaction (defined in IEC 60990) occurs for leakage currents greater than 0,25 mA and may induce momentary muscle reflex. Whilst not likely to cause medium to long term physiological problems, the initial loss of control is particularly important when the service person is working in an exposed position, for example working at height, off a ladder under wet conditions, etc. The risk can be minimised by provision of a functional earth to lower the induced voltage on any exposed metalwork. Service persons working on such an installation should either

   - satisfy themselves of the continuity of a local mains earth and then use that earth connection to minimise any induced voltage that may be found on the antenna installation by making a temporary bond,
   - isolate from the mains supply all devices connected and interconnected with the antenna installation such that there is no possibility of the presence of an induced voltage and no touch currents;
   - apply a functional earth to the system as detailed below.

b) The touch current hazard (safe let-go threshold current) defined in IEC 60990 is the level at which it may not be possible for an exposed person to remove or let go contact with the exposed voltage hazard. The maximum touch current below the safe let-go threshold current is taken as 3,5 mA_{RMS} as defined in IEC 60950-1. For simple installations where equipotential bonding is not present, the number of interconnected items of Class II equipment should be limited so that the aggregate leakage current does not exceed 3,5 mA_{RMS}.

   For installation and servicing of installations the service person should either

   - functionally earth the distribution amplifier and / or each of the coaxial cables at a central location,
   - functionally earth one of the coaxial cables at a convenient location providing that there is a low impedance path from the cable chosen to all other cables in the installation,
   - ensure that any temporary bonding arrangements (for instance those shown in Figure 10 to Figure 15 and explained in NOTE 1) are present and in use.

A functional earth may be connected to the earth of an electrical supply radial (including a lighting circuit), a ring final circuit or directly from a building main earth terminal. In any case, for robustness, the minimum cross sectional area of this temporary conductor should be not less than 1,5 mm^2 but preferably 2,5 mm^2 and should be sheathed.

Where part of the functional earth path relies on the connector of a coaxial cable that connector should be terminated in a permanent and robust manner.

Before starting the installation, installers should satisfy themselves of the continuity of a local mains earth.

Annex B
(informative)

Use of shield wires to protect installations with coaxial cables

B.1 General

Cabinets containing amplifiers and/or other coaxial equipment are often widely spread in the terrain. In areas with high specific earth resistance between such installations, special protecting measures shall be taken due to the possibility of exposure to lightning. Shield wires, steel tubes etc. shall be considered for the protection of coaxial cables.

This will protect coaxial cables against both direct lightning strokes and disruptive discharges from nearby underground installations, metallic structures, tree roots, etc.

B.2 Soil quality determines shield-wiring necessity

Shield wires should be used when the specific electrical resistance ρ of the soil in which the cables are buried in is as specified (see also Table B.1):

ρ < 100 Ωm — No shield wire is necessary

ρ = 100 to 1 000 Ωm — One shield wire is necessary

ρ = 1 000 to 3 000 Ωm — Either cables with wire armouring or two shield wires are necessary

ρ > 3 000 Ωm — Cables laid in iron pipes are necessary

Shield wires are laid out parallel to, about 30 cm above or possibly alongside the cable.

Table B.1 – Conductivity of different types of soil

Type of soil and water	Typical specific resistance values Ωm	Limit of specific resistance value Ωm
Sea water	2	0,1 to 10
Clay	40	8 to 70
Subsoil water	50	10 to 150
Mixture of clay and sand	100	4 to 300
Shale, sandstone, etc.	120	10 to 1000
Moist clay soil, turf	150	5 to 250
Fresh water	250	100 to 400
Sand	2 000	200 to 3 000
Moraine gravel	3 000	40 to 10 000
Granite	25 000	10 000 to 50 000
Ice/frozen soil	100 000	10 000 to 10^6

B.3 Protective measures against direct lightning strikes on under ground cables

Shield wires generally consist of galvanised steel wire with a diameter of 8 mm. Other materials or diameters are also possible, for example in the area of corrosion protection.

Lightning protected cable is generally a telecom cable with a semi-conductive plastic sheath in combination with a metal screen.

Steel tubes generally consist of galvanised steel. It should be assumed that interruptions at cable collars are kept as short as possible. The interruption should be bridged by either a closed metal jacket or at least three shield wires by a cage arrangement, each with an offset of 120° to the others.

Lightning protection cable ducts are generally armoured concrete ducts, or electric conductive metallic ducts.

The values in Table B.2 give an overview over typical level of protection based on type of protection means, K_p = 1 representing none protection.

Table B.2 – Protection factors (K_p) of protection measures against direct lightning strokes for buried cables

Protection means	K_p
One shield wire	0,6
Two shield wires	0,4
Lightning protection duct	0,1
Lightning protective cable	0,02
Steel tube	0,01

If a more accurate level of protection is desired or required, the level of protection can be calculated by the following equation:

$$K_p = \frac{\lg \frac{r_{12}}{r_{22}}}{\lg \frac{r_1^2}{r_{11} \cdot r_{22}}}$$

where (see Figure B.1)

r_{11} is the mean radius of the sheath,

r_{12} is the distance between their axes,

r_{22} is the radius of the shield wire.

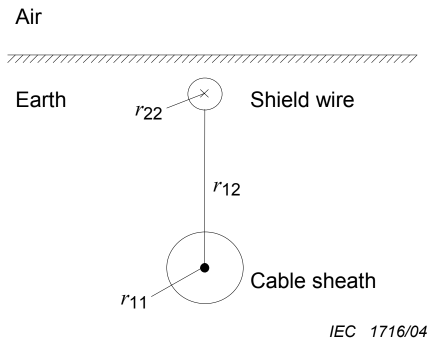


Figure B.1 – Principle of single shield wire

The equation for the protection factor using two shield wires is the following:

$$K_p = \frac{\lg \dfrac{r'_{12}}{r'_{22}}}{\lg \dfrac{r'^2_{12}}{r'_{11} \cdot r'_{22}}} \qquad r_{12} > (2 \cdot r_{11} \cdot h)^{0,5} = r'_{11}$$

where (see Figure B.2)

r'_{12} is the distance between the axis of the cable and one of the shield wires,

r_{11} is the mean radius of the sheath,

$r'_{11} = (2 \cdot r_{11} \cdot h)^{0,5}$,

$r'_{22} = (2 \cdot r_{22} \cdot h' \cdot b \cdot b')^{0,25}$,

r_{22} is the radius of the shield wire,

h is the buried depth of the cable,

h' is the buried depth of the shield wire,

b is the distance between the shield wires,

b' is the distance between one shield wire and the image of the other one with respect to the air-soil interface.

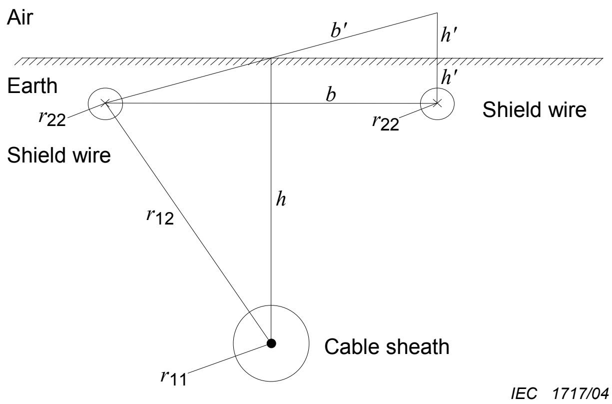


Figure B.2 – Principle of two shield wires

Annex C
(informative)

Examples of calculation of risk due to lightning

C.1 General

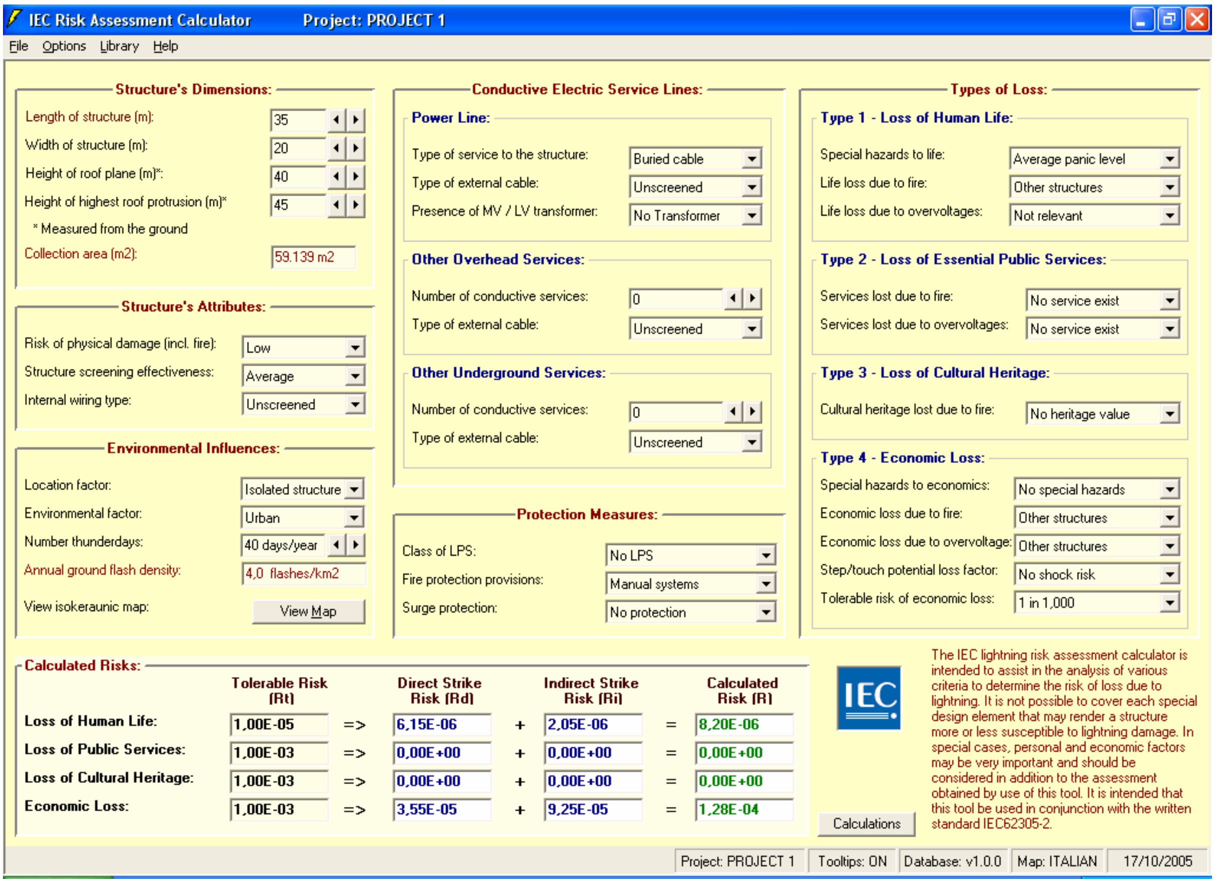
The examples presented are referred to MATV/SMATV antenna installations, using the simplified software described in Annex J of IEC 62305-2:2006 and showing the settings of the main parameters.

C.2 Examples

C.2.1 Example No. 1

The first example (Figure C.1) considers a structure (building for offices or apartment house) placed in an urban environment where the number of days with thunderstorms per year is 40 (the maximum estimated value in Italy), being isolated, and having the following dimensions:

- length: 35 m,
- width: 20 m
- total height: 45 m with the antenna.



NOTE This template is presented in Annex J of IEC 62305-2:2006. *IEC 1164/10*

Figure C.1 – Template for calculation of the risk due to lightning (Example No. 1)

The structure's attribute concerning the physical damage is set to "Low", considering the structure made with low use of combustible material (timber). The other parameters influencing the indirect strike risk are those concerning the power line that is assumed to be buried and unscreened.

The parameters concerning the loss of human life are set at an average value. If different conditions apply, they shall be suitably evaluated by the designer of the LPS or by the responsible person of the antenna system installation.

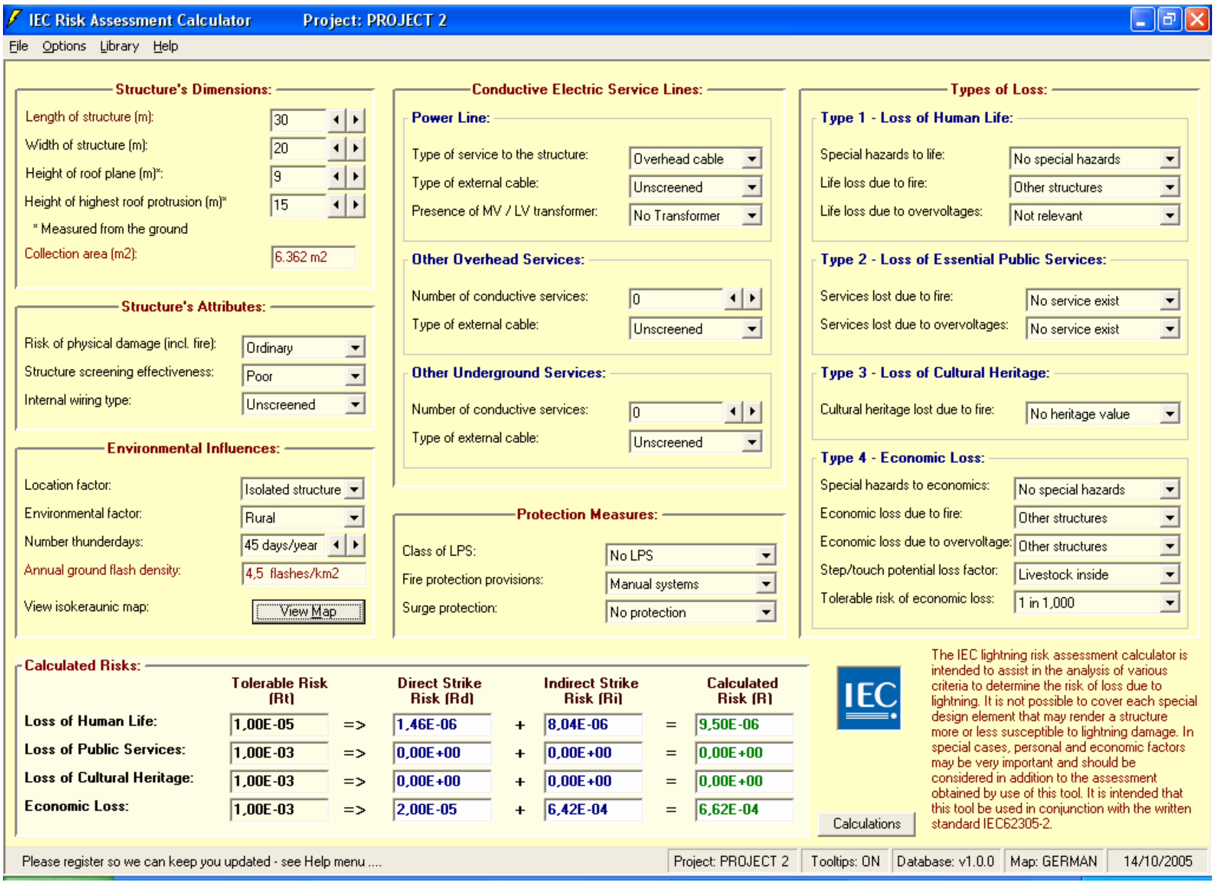
This first example shows that the protection against lightning is not required, because the calculated risk R = 8,20·E-6 is lower than the tolerable risk R_T = 1·E-05. The value of R is shown in green colour (it would become red if higher than the tolerable risk). Therefore only equipotential bonding is necessary, as stated in 11.2.3 and shown in Figure 15. The tolerable risk R_T can be set at different values than those indicated in the IEC 62305-2, if this is required by local regulations.

NOTE It should be noted that the same structure (building) would have a risk due to lightning lower than the tolerable risk R_T = 1·E-05 also if it is located in other countries such as Germany (where the maximum estimated number of days with thunderstorms per year is 45, giving a risk value R = 9,22 E-6) or France (where the maximum estimated number of days with thunderstorms per year is 44, giving a risk value R = 9,02 E-6).

C.2.2 Example No. 2

The second example (Figure C.2) considers a structure placed in a rural environment where the number of days with thunderstorms per year is 45 (the maximum estimated value in Germany), being isolated, and having the following dimensions

- length 30 m,
- width 20 m
- total height: 15 m with the antenna.



IEC 1165/10

NOTE This template is presented in Annex J of IEC 62305-2:2006.

Figure C.2 – Template for calculation of the risk due to lightning (Example No. 2)

The structure's attribute concerning the physical damage is set to "Ordinary", considering the structure made of predominant combustible material (e.g. timber). The other parameters influencing the indirect strike risk are those concerning the power line that is assumed to be provided with an unscreened overhead cable (worst case).

The parameters concerning the loss of human life are here set at "no special hazards" because the height of the structure and the number of people present are considered low. If different conditions apply, they shall be suitably evaluated by the designer of the LPS or by the responsible person of the antenna installation.

This second example shows that the protection against lightning is not required because the calculated risk (R = 9,50·E-6) is lower than the tolerable risk (R_T = 1·E-05). The value of R is shown in green colour. Therefore only equipotential bonding is necessary, as stated in 11.2.3 and shown in Figure 15. The tolerable risk R_T can be set at different values than those indicated in the IEC 62305-2, if this is required by local regulations.

NOTE The direct strike risk (R_d = 1,46 E-6) is much lower than the indirect strike risk (R_i = 8,04 E-6), mainly due to the overhead cable for power distribution.

Annex D
(informative)

The following differences exist in some countries

D.1 Subclause 6.1

D.1.1 France

Common earthing is not permitted due to electrical earthing conditions.

D.1.2 Japan

The equipotential bonding method is not used in Japan.

D.2 Subclause 6.2

D.2.1 France

Galvanic isolation should withstand a voltage of 1 kV $_{RMS}$ during 1 min.

D.2.2 Norway

The following parts of the standard are not applicable due to Special National Conditions:

- For new and rebuilt coaxial electronic communication networks the outer conductor of the coaxial cable leading into a building shall be galvanically isolated from the outer conductor of the coaxial cable inside the building;
- Examples of installations inside buildings described in 6.2g, 6.2i, 6.2l and shown in Figure 2, Figure 4, Figure 5 and Figure 7 shall be equipped with a galvanic isolator separating local earth from the cable network distribution lines;
- Galvanic isolators shall withstand the following requirements:

  Applying a 50 Hz AC voltage of 300 V $_{RMS}$ between the input and the output of the outer conductor of the galvanic isolator for a period of not less than 20 min, the leakage current shall not exceed 8 mA RMS. Applying a continues DC voltage of 2 120 V between the input and the output of the outer conductor of the galvanic isolator for a period of not less than 1 min, the leakage current shall not exceed 0,7 mA.

  It shall not be possible to touch metallic parts of the galvanic isolator when connected.

D.2.3 Japan and Poland

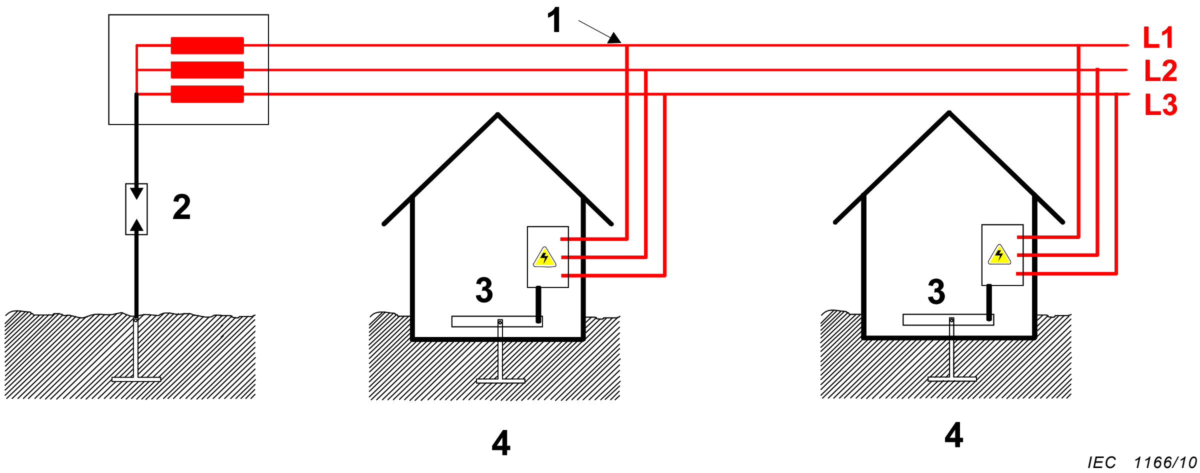
Earthing to gas networks as shown in Figure 4 and in Figure 5 is not permitted.

D.3 Subclause 6.3 – Norway

D.3.1 Justification

In most parts of Norway, the AC mains power are built as an IT- or TT-network with a line-to-line voltage of 230 V (see Figure D.1).

These types of networks have no N-conductor, and the AC mains power is supplied to the equipment from two of the three line conductors (IEC 60950-1:2005, Annex V).



1 AC power distribution, IT system, line-to-line voltage 230 V	**2** Voltage limiter
3 Equipotential bonding bar	**4** Earth electrode

Figure D.1 – IT power distribution system in Norway

For a cable network covering an area with this type of power supply networks, special initiative should be taken to ensure that safety in the cable network is maintained. The following equipotential bonding arrangements described will provide necessary safety in such a network.

D.3.2 Equipotential bonding mechanism for cable networks

D.3.2.1 Installations in the vicinity of transformer stations

Any earth electrode in a cable network shall preferably be located at a minimum distance of 20 m from the nearest earth electrode in a high-power transformer station (high to mains voltage) (see Figure D.2 and ITU-T K.8 or EN 50174-3).

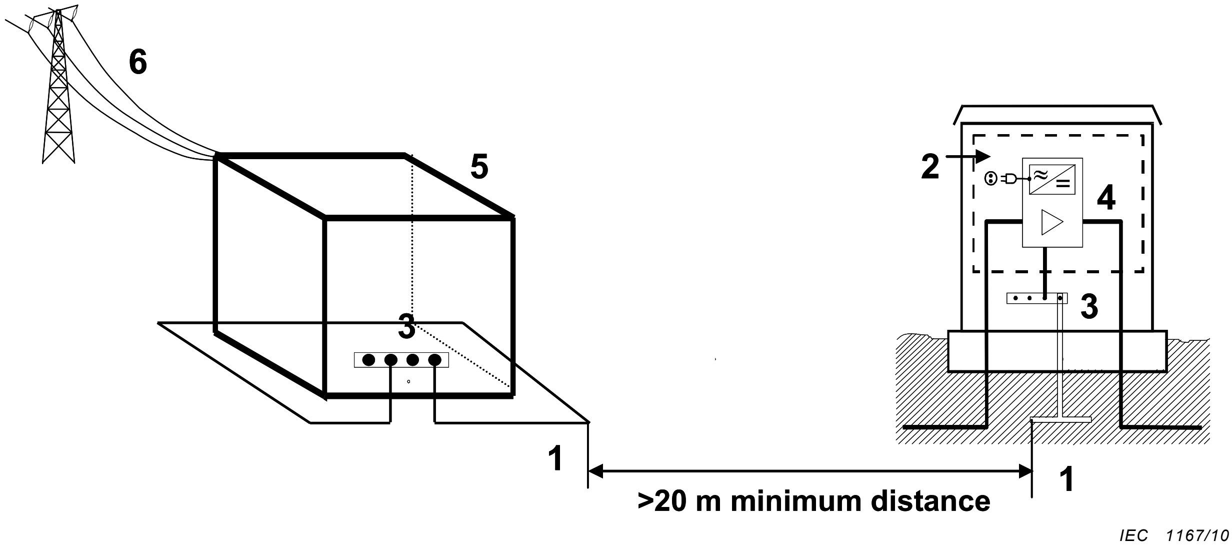
If the above-mentioned distance is less than 20 m, all equipment in the cable network shall be electrically isolated from local earth by mounting the equipment within a non-metallic enclosure, as shown in Figure D.3. Mains powered equipment with local power feeding should not be used in this case.

Before any work on the installation is started, measurements shall be carried out to reveal if there are any hazardous voltages between local earth and the earth for the cable network.

The safety sign "Warning about hazardous electrical voltage"  according to sign 7.4 of ISO 3864-1:2002 shall be attached to the non-metallic enclosure.

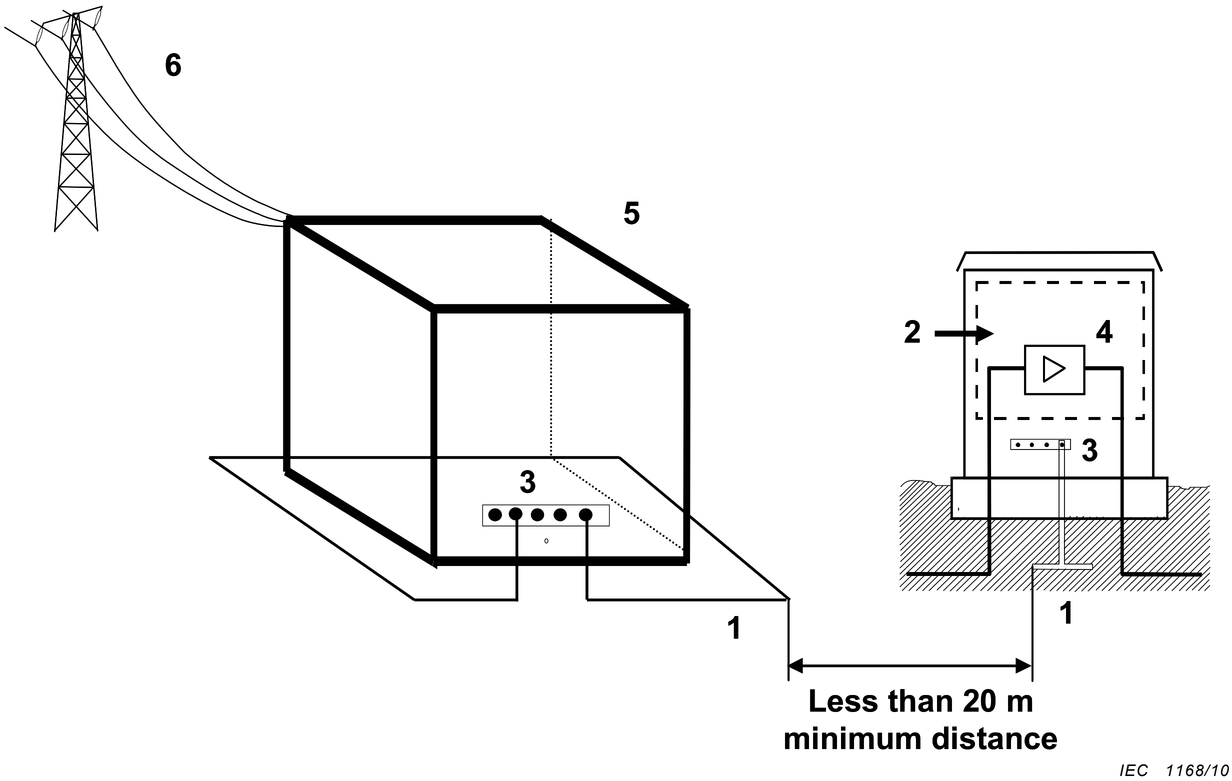
D.3.2.2 Cabinets for cable networks located near cabinets/installations for mains

Cabinets for cable networks placed together with cabinets for mains power distributions should preferably be placed at a minimum of 2 m apart. If the distance is closer than 2 m, a common earth electrode between the cabinets shall be used. Examples of such installations are shown in Figure D.4, Figure D.5, Figure D.6 and Figure D.7.



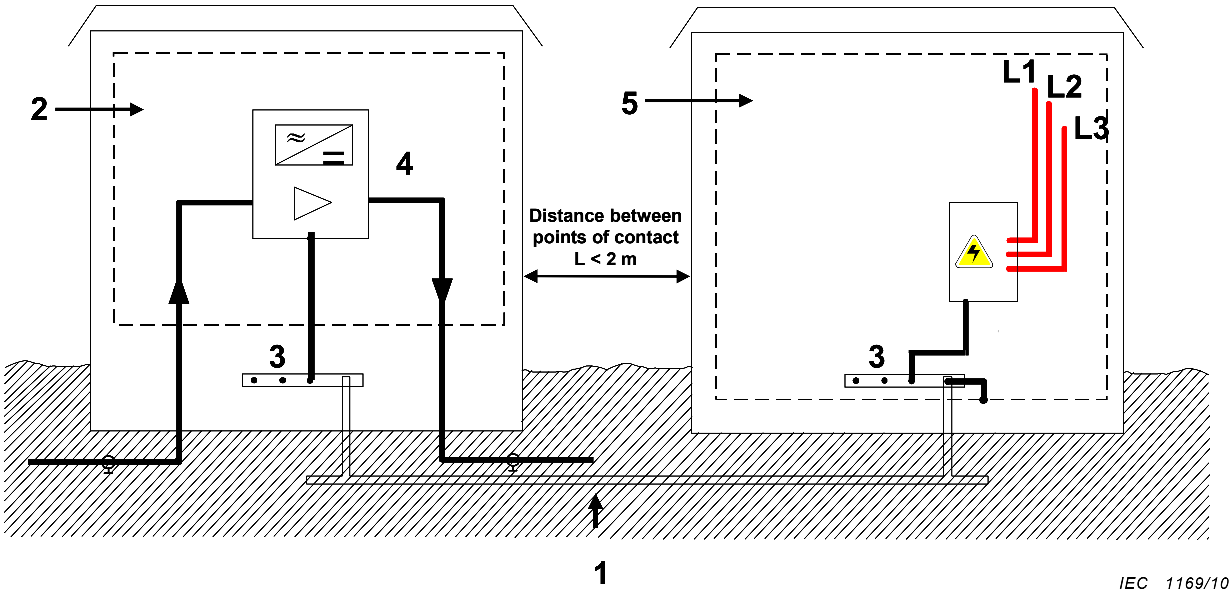
1 Earth electrode	2 Non-metallic enclosure
3 Equipotential bonding bar	4 Mains supplied equipment
5 Transforming station	6 High-voltage power transmission system

Figure D.2 – Example of installations located farther than 20 m away from a transforming station



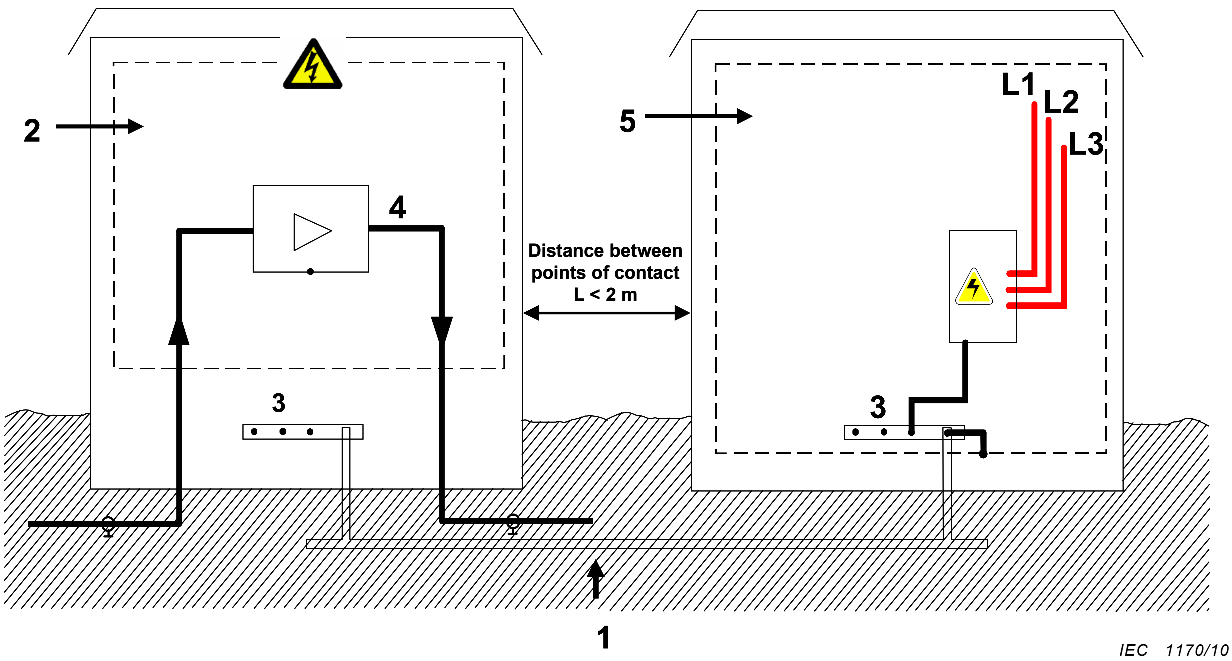
1 Earth electrode	2 Non-metallic enclosure
3 Equipotential bonding bar	4 Remotely supplied equipment
5 Transforming station	6 High-voltage power transmission system

Figure D.3 – Example of installations located closer than 20m from a transforming station



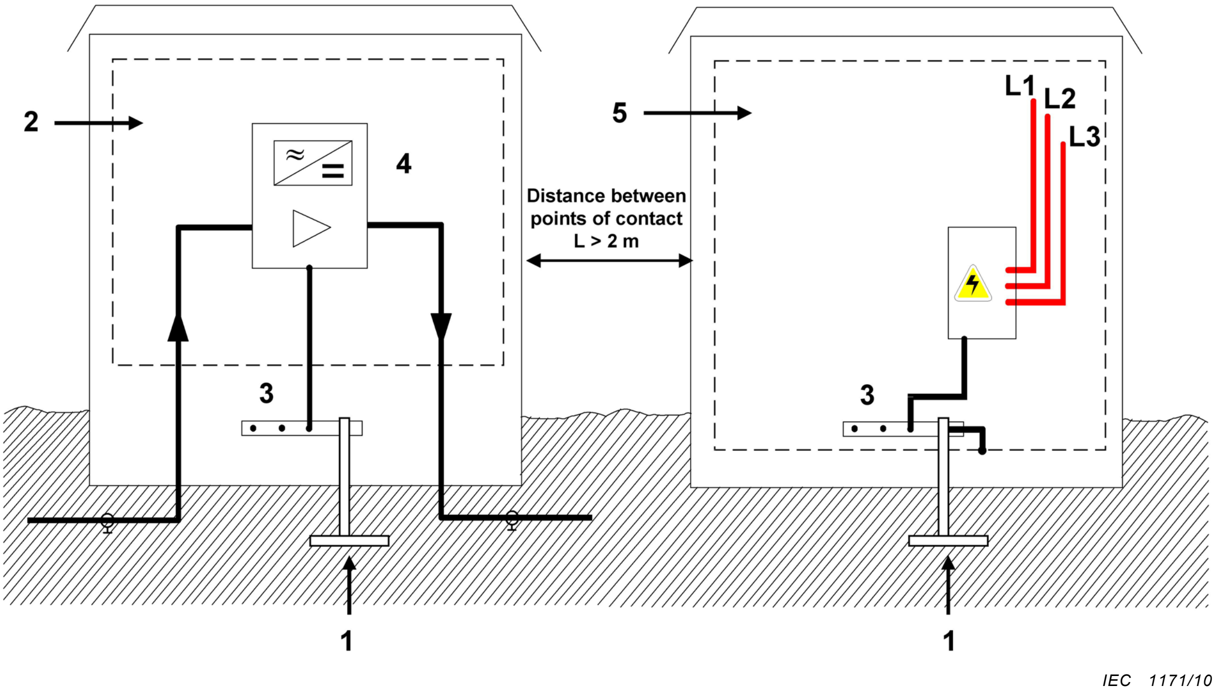
1 Common earth electrode	2 Non-metallic enclosure
3 Equipotential bonding bar	4 Mains supplied equipment
5 Metallic enclosure	

Figure D.4 – Example of cabinets for cable network with locally fed equipment and mains placed less than 2 m apart



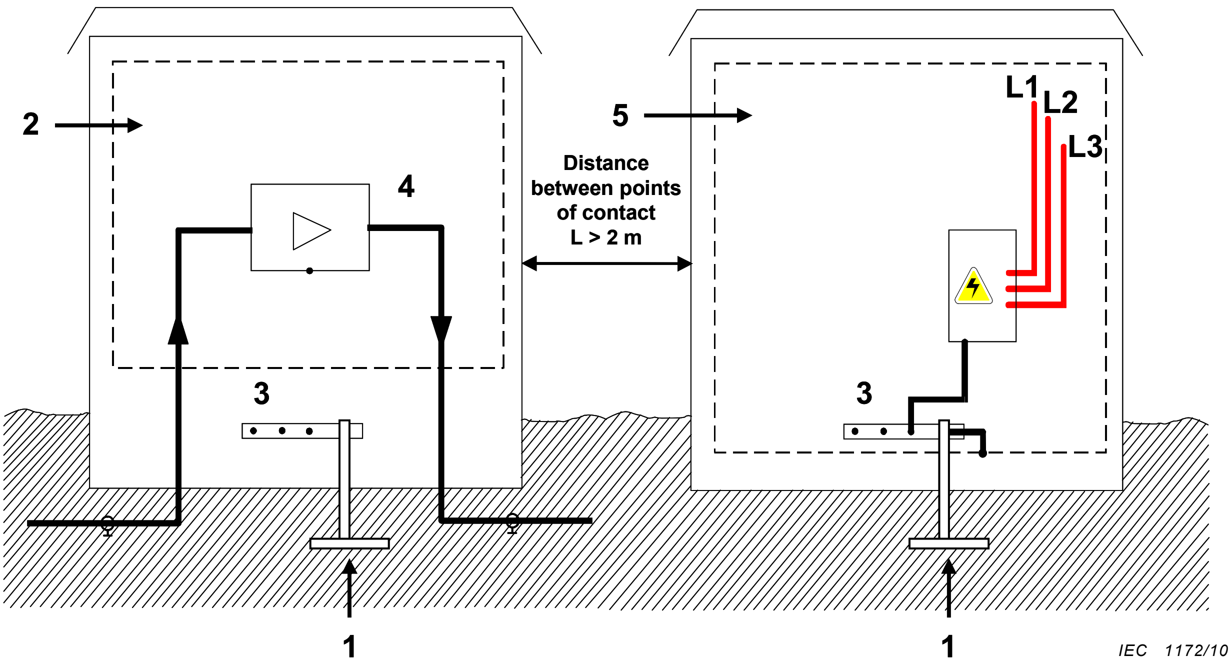
1 Common earth electrode	2 Non-metallic enclosure
3 Equipotential bonding bar	4 Remotely supplied equipment
5 Metallic enclosure	

Figure D.5 – Example of cabinets for cable network with remotely fed equipment and mains placed less than 2 m apart



1 Earth electrode	2 Non-metallic enclosure
3 Equipotential bonding bar	4 Mains supplied equipment
5 Metallic enclosure	

Figure D.6 – Example of cabinets for cable network with locally fed equipment and mains placed more than 2 m apart

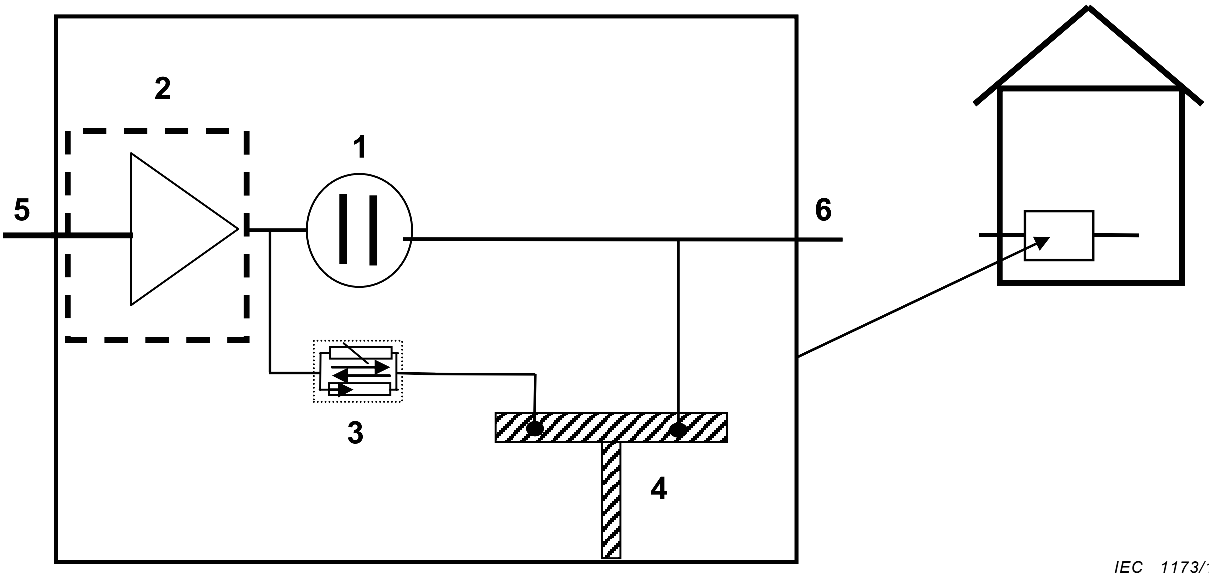


1 Earth electrode	2 Non-metallic enclosure
3 Equipotential bonding bar	4 Remotely supplied equipment
5 Metallic enclosure	

Figure D.7 – Example of cabinets for cable network with remotely fed equipment and mains placed more than 2m apart

D.3.3 Use of galvanic isolation in a cable network with remote power-feeding

When using galvanic isolation in cable networks with remote power feeding, the amplifier shall be placed in front of the galvanic isolator as shown in Figure D.8.



1 Galvanic isolator	2 Non-metallic enclosure
3 Voltage dependent protection device	4 Common earth electrode
5 CATV system	6 House internal cable-TV network

Figure D.8 – Example of an installation placing the amplifier in front of the galvanic isolator

A voltage dependent protective device is recommended in order to protect the galvanic isolator from transient voltages.

The amplifier shall be electrically isolated from the local electrical earth. In case the amplifier is mounted close to either local electrical earth or installations connected to local electrical earth, the amplifier shall be placed in such a way that it is not possible to physically touch both the amplifier and the installation without having to remove a cover or other safety arrangements. The covers and amplifiers shall be labelled with the safety sign given under D.3.2.1. The covers used shall be designed in such a way that they can only be removed using a key or a special tool.

D.3.4 Use of voltage dependent protective device in a cable network

Network, property and health shall be protected against failure in isolation between infrastructures with different levels of voltage and other unwanted high voltages caused by any kind of high voltage distribution networks or atmospheric discharges.

Depending on the voltages time span, all voltages with local earth as a reference shall be limited according to following values:

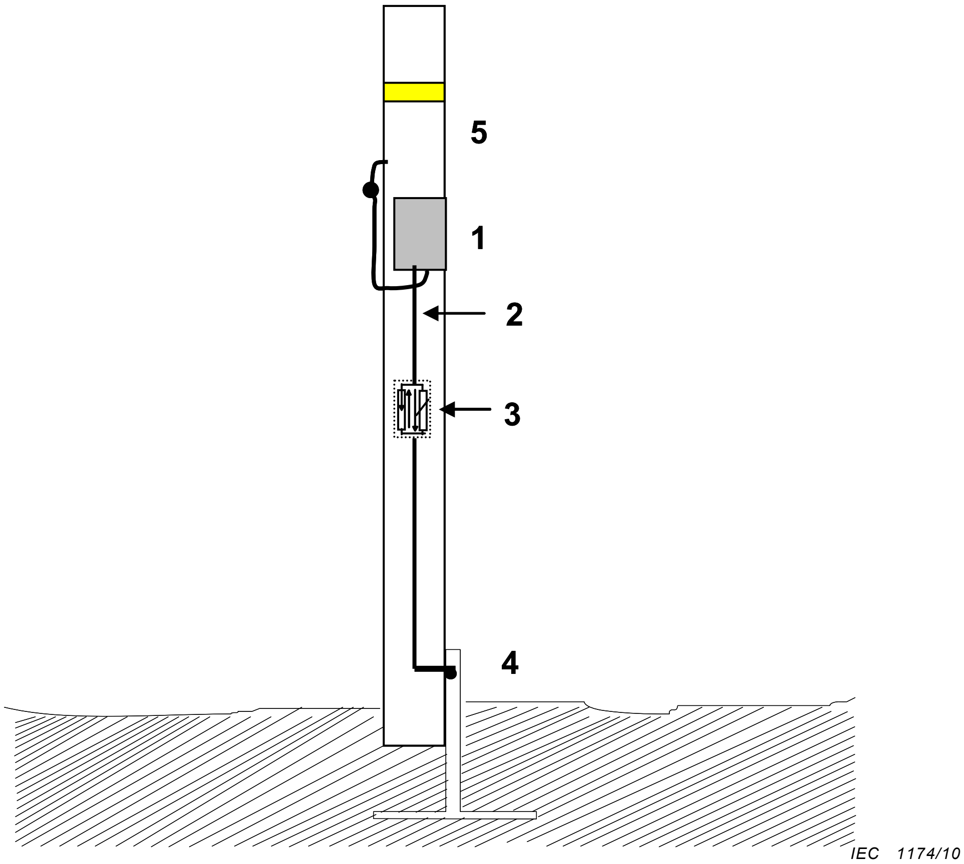
0 ms to 200 ms	1 030 V
201 ms to 350 ms	780 V
351 ms to 500 ms	650 V
501 ms to 1 000 ms	430 V
1 001 ms to 2 000 ms	300 V
2 001 ms to 3 000 ms	250 V

3 001 ms to 5 000 ms	200 V
5 001 ms to 10 000 ms	150 V
More than 10 000 ms	60 V

In Norway, network installations with no mains supplied equipment are usually installed isolated from local earth due to difficult ground conditions. When calculations show that the voltage level will rise above 650 V, measures shall be taken to reduce the voltage level. This can be done by connecting a voltage dependent device between the network installation and local earth. The voltage dependent device must not connect the installations to local earth in case of a short circuit in mains power.

This implies a safe threshold voltage of 420 V.

Examples of protections using a voltage depending device are shown in Figure 3 and Figure D.9.



1 Amplifier / passive equipment	2 Equipotential bonding conductor
3 Voltage dependent protection device	4 Common earth electrode
5 Pylon	

Figure D.9 – Example of protection using a voltage depending device on network installations on poles

D.4 Subclause 8.1.1 – Japan

Remote power feeding voltage shall not exceed 90 $V_{AC,\ RMS}$ and the line-powering current shall not exceed 15 A.

D.5 Subclause 9.1 – France

The French regulation (arrêté interministériel, 2 Avril 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).

D.6 Subclause 9.2 – Japan

For antennas in proximity of voltages up to 7 000 V, the following applies in Japan:

Low voltage:	**$\leq$600 V $_{AC}$ or $\leq$750 V $_{DC}$;**
Cable:	$\geq$30 cm distance;
Isolated wire:	$\geq$60 cm distance.
High voltage:	**$>$600 V $_{AC}$ or $>$750 V $_{DC}$;**
Cable:	$\geq$40 cm distance;
Isolated wire:	$\geq$80 cm distance.

D.7 Subclause 10.1

D.7.1 Sweden

In Sweden there is a common agreement to use fully isolated system outlets according to 10.2.2 or a galvanic insulation in the transfer point in Cable Television Networks.

D.7.2 UK

In the UK the use of fully isolated system outlets is obligatory under the terms of the cable operating licence.

D.8 Subclause 10.2 – Japan

The resistance to the equipotential point is not applied, because the bonding method is not used in Japan. Japanese regulations specify the application of the safety terminal. The safety terminal withstands a continuous AC 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 D.10.

D.9 Subclause 11.1 – Japan

A lightning protection system is applied in Japan for protection against atmospheric overvoltages 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 D.11).

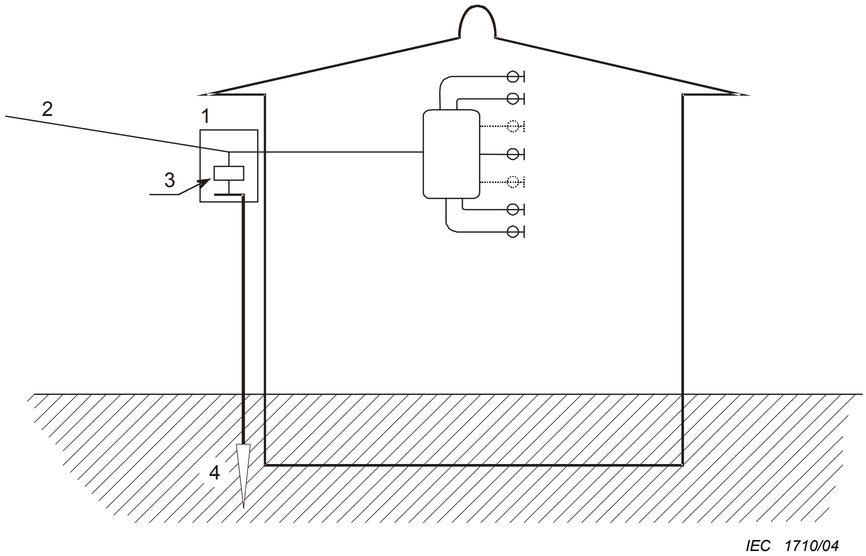
D.10 Subclause 11.2

D.10.1 Germany

In Germany no local regulations exist concerning the exemption for individual receiving systems, MATV or SMATV systems.

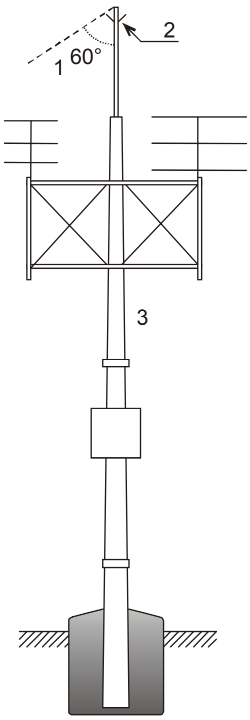
D.10.2 Japan

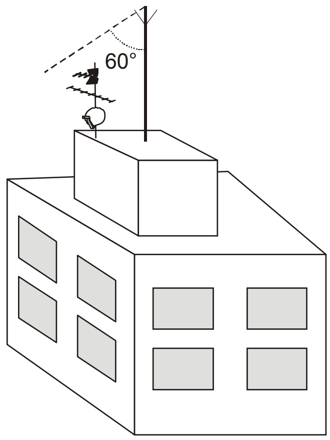
A protective bonding conductor is not used, because the bonding method is not used in Japan.



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

Figure D.10 – Example of the installation of a safety terminal in Japan





1 Safety zone	2 Lightning rod
3 Mast	

Figure D.11a – Mast **Figure D.11b – Building**

Figure D.11 – Examples of installation of a lightning protection system in Japan

D.11 Subclause 11.3.2 – Japan

In Japan the earthing conductors have the following requirements:

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.

D.12 Subclause 11.3.3 – Japan

An earth termination system is not used in Japan. Only a lightning protection system is applied (see Figure D.11).

D.13 Subclause 12.2 – Japan

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:

a) for an antenna height $h < 16$ m, the wind pressure is $60\sqrt{h}$, in kg per m^2;

b) for an antenna height $h \geq 16$ m, the wind pressure is $120\sqrt[4]{h}$, in kg per m^2.

D.14 Subclause 12.3 – Finland

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

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ITU-T K.8, *Separation in the soil between telecommunication cables and earthing system of power facilities*

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