IEC 60728-11

Edition 5.0 2023-02

INTERNATIONAL STANDARD

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

IEC 60728-11:2023-02(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 60728-11

Edition 5.0 2023-02

INTERNATIONAL STANDARD

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.060.40

ISBN 978-2-8322-6470-6

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

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

Part 11: Safety

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2016. This edition constitutes a technical revision.

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

a) Replacement of references to IEC 60065 and IEC 60950-1 with references to IEC 62368-1.
b) Addition of subclauses 4.4 to 4.6.
c) Revised definition of class I equipment, class II equipment, main earthing terminal, see 3.1.6, 3.1.8 and 3.1.31.
d) Addition of definitions for harm, hazard, ordinary person, instructed person, skilled person, see 3.1.22, 3.1.23, 3.1.39, 3.1.40 and 3.1.41.

e) Additional requirement to provide details on the equipment installed, see 4.1.

f) Additional mechanical, design and construction requirements, see 4.2.2.

g) Changes to the accessible part requirements, see 4.2.3.

h) The current carrying capacity and dielectric strength of components is now obligatory, see 8.1.3.

i) The assessment of the risk of lightning strike is now obligatory, see Figure 10.

j) Extension of remote feeding voltage on subscriber feeder, see Table 1.

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

Draft	Report on voting
100/3866/FDIS	100/3882/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.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

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 and other deliverables of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television and sound signals and for processing, interfacing and transmitting all kinds of data signals for interactive services using all applicable transmission media. These signals are typically transmitted in networks by frequency-multiplexing techniques.

This includes for instance:

- regional and local broadband cable networks,
- extended satellite and terrestrial television distribution networks and systems,
- individual satellite and terrestrial television receiving systems,

and all kinds of equipment, systems and installations used in such cable networks, distribution and receiving systems.

The extent of this standardization work is from the antennas and/or special signal source inputs to the headend or other interface points to the network up to the terminal input of the customer premises equipment.

The standardization work will consider coexistence with users of the RF spectrum in wired and wireless transmission systems.

The standardization of any user terminals (i.e. tuners, receivers, decoders, multimedia terminals, etc.) as well as of any coaxial, balanced 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 document is intended to provide requirements 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
IEC 60364-4-44:2007/AMD1:2015
IEC 60364-4-44:2007/AMD2:2018

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-54:2011, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*
IEC 60364-5-54:2011/AMD1:2021

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*

IEC 62305-2:2010, *Protection against lightning – Part 2: Risk management*

IEC 62305-3:2010, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62368-1:2018, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62561-1:2017, *Lightning protection system components (LPSC) – Part 1: Requirements for connection components*

IEC 62561-2, *Lightning protection system components (LPSC) – Part 2: Requirements for conductors and earth electrodes*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO/IEC 30129:2015, *Information technology – Telecommunications bonding networks for buildings and other structures*
ISO/IEC 30129:2015/AMD1:2019

EN 50575:2014, *Power, control and communication cables – Cables for general applications in construction works subject to reaction to fire requirements*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp.

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

[SOURCE: IEC 62305-3:2010, 3.6]

3.1.2
amplifier
device to compensate for attenuation

3.1.3
attenuation
ratio of the input power to the output power

Note 1 to entry: The ratio is expressed in decibels.

3.1.4
cable networks
television signals, sound signals and interactive services, regional and local broadband cable networks, extended satellite and terrestrial television distribution networks or systems and individual satellite and terrestrial television receiving systems

Note 1 to entry: These networks and systems can be used in downstream and upstream directions.

3.1.5
CATV network
regional and local broadband cable networks designed to provide sound and television signals as well as signals for interactive services to a regional or local area

Note 1 to entry: Originally defined as Community Antenna Television network.

3.1.6
class I equipment
equipment in which protection against electric shock does not rely on basic insulation only, but that includes a supplementary safeguard in such a way that means are provided for the connection of accessible conductive parts to the protective earthing conductor in the fixed wiring of the installation

Note 1 to entry: For equipment intended for use with a flexible cord or cable, this provision includes a protective conductor as part of the flexible cord or cable.

Note 2 to entry: Class I equipment can be provided with class II construction.

Note 3 to entry: This entry is based on IEC 62368-1:2018, 3.3.15.1.

3.1.7
class II construction
part of an equipment for which protection against electric shock relies upon double insulation or reinforced insulation

Note 1 to entry: This entry is based on IEC 62368-1:2018, 3.3.15.2.

3.1.8
class II equipment
equipment in which protection against electric shock does not rely on basic insulation only, but in which a supplementary safeguard is provided, there being no provision for protective earthing or reliance upon installation conditions

Note 1 to entry: This entry is based on IEC 62368-1:2018, 3.3.15.3.

3.1.9
earthing arrangement
all electrical means involved in the earthing of a system, installation or equipment

Note 1 to entry: Electric connection and devices used for earthing are examples of electrical means.

[SOURCE: IEC 60050-195:2021, 195-02-20, modified – The preferred term "grounding arrangement (US)" has been deleted.]

3.1.10
earthing conductor
conductor forming a conductive path between a conductive part and an earth electrode

EXAMPLE A conductor connected between a main earthing terminal or busbar and an earth electrode.

[SOURCE: IEC 60050-195:2021, 195-02-03, modified – The preferred term "grounding conductor (US)" has been deleted.]

3.1.11
earth electrode
conductive part that is in electric contact with local earth, directly or through an intermediate conductive medium

[SOURCE: IEC 60050-195:2021, 195-02-01, modified – The preferred term "grounding electrode (US)" has been deleted.]

3.1.12
earthing terminal
terminal provided on equipment and intended for the electric connection with the earthing arrangement

[SOURCE: IEC 60050-195:2021, 195-02-31, modified – The preferred term "grounding terminal (US)" has been deleted.]

3.1.13
electric shock
physiological effect resulting from an electric current passing through a human or livestock

[SOURCE: IEC 60050-195:2021, 195-01-04, modified – The specific use <protection against electric shock> has been deleted.]

3.1.14
equipotential bonding
set of electric connections intended to achieve equipotentiality between conductive parts

[SOURCE: IEC 60050-195:2021, 195-01-10]

3.1.15
equipotential bonding bar
busbar which is part of an equipotential bonding system and enables the electric connection of a number of conductors for equipotential bonding purposes

[SOURCE: IEC 60050-826:2022, 826-13-35]

3.1.16
protective bonding conductor
protective conductor provided for protective-equipotential-bonding

[SOURCE: IEC 60050-195:2021, 195-02-10.]

3.1.17
exposed conductive part
conductive part of equipment that can be touched and that is not live under normal conditions, but that can become live when basic insulation fails

[SOURCE: IEC 60050-195:2021, 195-06-10]

3.1.18
extended terrestrial television distribution network or system
distribution network or system designed to provide sound and television signals received by terrestrial receiving antenna to households in one or more buildings

Note 1 to entry: This kind of network or system can possibly be combined with a satellite antenna for the additional reception of TV and/or radio signals via satellite networks.

Note 2 to entry: This kind of network or system can also carry other signals for special transmission systems (e.g. MoCA or Wi-Fi) in the return path direction.

3.1.19
extraneous conductive part
conductive part not forming part of the electrical installation and that is likely to introduce an electric potential, generally the electric potential of a local earth

[SOURCE: IEC 60050-195:2021, 195-06-11]

3.1.20
feeder
transmission path forming part of a cable network

Note 1 to entry: Such a path may consist of a metallic cable, optical fibre, waveguide or any combination of them.

Note 2 to entry: By extension, the term is also applied to paths containing one or more radio links.

3.1.21
galvanic isolator
device providing electrical isolation below a certain frequency range

3.1.22
harm
physical injury or damage to persons, property, and domestic animals

Note 1 to entry: Physical injury or damage to persons also includes health aspects.

Note 2 to entry: This entry is based on ISO/IEC Guide 51:2014, 3.1.

3.1.23
hazard
potential source of harm

Note 1 to entry: The term hazard can be qualified in order to define its origin (e.g. electrical hazard, mechanical hazard) or the nature of the potential harm (e.g. electric shock hazard, cutting hazard, toxic hazard, fire hazard).

Note 2 to entry: This entry is based on ISO/IEC Guide 51:2014, 3.2.

3.1.24
hazardous voltage
electrical condition of an object from which a hazardous touch current (electric shock) could be drawn

[SOURCE: IEC 60065:2014, 2.6.10, modified – The term "hazardous live" has been replaced by "hazardous voltage".]

3.1.25
headend
equipment connected between receiving antennas or other signal sources and the remainder of the cable network, to process the signals to be distributed

3.1.26
home distributor
HD
physical distribution point within a home where cables terminate

Note 1 to entry: This note applies to the French language only.

3.1.27
individual terrestrial television receiving system
system designed to provide sound and television signals received via terrestrial broadcast networks to an individual household

Note 1 to entry: This kind of system can also carry other signals for special transmission systems (e.g. MoCA or Wi-Fi) in the return path direction.

3.1.28
let-go threshold current
value of the maximum electric current through the human body at which that human being can release himself or herself

[SOURCE: IEC 60050-195:2021, 195-03-09.]

3.1.29
lightning protection system
LPS
complete system used to reduce physical damage due to lightning flashes to a structure

Note 1 to entry: It consists of both external and internal lightning protection systems.

[SOURCE: IEC 62305-3:2010, 3.1]

3.1.30
local broadband cable network
network designed to provide sound and television signals as well as signals for interactive services to a local area (e.g. one town or one village)

3.1.31
main earthing terminal
main earthing bar
terminal or busbar that is part of the earthing arrangement of an installation and enabling the electric connection of a number of conductors used for earthing or bonding purposes

[SOURCE: IEC 60050-195:2021, 195-02-33, modified – The preferred terms "main grounding terminal (US)" and "main grounding busbar (US)" have been deleted and, in the term, "busbar" has been abbreviated to "bar".]

3.1.32
MATV network
extended terrestrial television distribution networks or systems designed to provide sound and television signals received by terrestrial receiving antenna to households in one or more buildings

Note 1 to entry: Originally defined as master antenna television network.

Note 2 to entry: This kind of network or system can possibly be combined with a satellite antenna for the additional reception of TV and/or radio signals via satellite networks.

Note 3 to entry: This kind of network or system can also carry other signals for special transmission systems (e.g. MoCA or Wi-Fi) in the return path direction.

3.1.33
metal installation
extended metal items in the structure to be protected which may form a path for lightning current, such as pipework, staircases, elevator guide rails, ventilation, heating and air conditioning ducts, and interconnected reinforcing steel

[SOURCE: IEC 62305-3:2010, 3.18]

3.1.34
multiple-stranded conductor
stranded conductor consisting of a number of groups of wires assembled together in one or more helical layers, the wires in each group being either bunched or stranded

[SOURCE: IEC 60050-461:2008, 461-01-10]

3.1.35
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 1 to entry: Examples of the use of this term include:

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

[SOURCE: IEC 62305-3:2010, 3.15]

3.1.36
network interface unit
NIU
interface between the cable network and the network inside an apartment

Note 1 to entry: The network interface unit can contain an overvoltage protective element and/or a galvanic isolation.

Note 2 to entry: This note applies to the French language only.

3.1.37
neutral conductor
conductor electrically connected to the neutral point and capable of contributing to the distribution of electric energy

[SOURCE: IEC 60050-195:2021, 195-02-06.]

3.1.38
PEN conductor
conductor combining the functions of both a protective earthing conductor and a neutral conductor

[SOURCE: IEC 60050-195:2021, 195-02-12.]

3.1.39
ordinary person
person other than an electrically instructed person and an electrically skilled person

Note 1 to entry: Ordinary persons include not only users of the equipment, but also all persons who may have access to the equipment or who may be in the vicinity of the equipment. Under normal operating conditions or abnormal operating conditions, ordinary persons should not be exposed to parts comprising energy sources capable of causing pain or injury. Under single fault condition, ordinary persons should not be exposed to parts comprising energy sources capable of causing injury.

3.1.40
electrically instructed person
person who has been electrically instructed and trained by an electrically skilled person, or who is supervised by an electrically skilled person, to identify energy sources that may cause pain and to take precautions to avoid unintentional contact with or exposure to those energy sources

Note 1 to entry: Under normal operating conditions, abnormal operating conditions or single fault conditions, electrically instructed persons should not be exposed to parts comprising energy sources capable of causing injury.

3.1.41
electrically skilled person
person who has training or experience in the technology of the equipment, particularly in knowing the various energies and energy magnitudes used in the equipment

Note 1 to entry: Electrically skilled persons are expected to use their training to and experience to recognise energy sources capable of causing pain or injury and to take action for protection from injury from those energies. Electrically skilled persons should also be protected against unintentional contact or exposure to energy sources capable of causing injury.

3.1.42
protective conductor
PE conductor
conductor provided for purposes of electrical safety

[SOURCE: IEC 60050-195:2021, 195-12-09, modified – The term "PE conductor" has been added.]

3.1.43
receiver lead
lead, which connects the system outlet to the subscriber equipment

3.1.44
receiving antenna
device with proper electrical characteristics that intercepts desired signals in the atmosphere and transfers these to the remainder of the cable network

3.1.45
regional broadband cable network
network designed to provide sound and television signals as well as signals for interactive services to a regional area covering several towns and/or villages

3.1.46
remote power feeding voltage
voltage for supplying power to network equipment via the cable network or a separate line

3.1.47
safety distance
minimum distance between two conductive parts within the space to be protected between which no dangerous sparking can occur

3.1.48
SMATV network
extended distribution networks or systems designed to provide sound and television signals received by satellite receiving antenna to households in one or more buildings

Note 1 to entry: Originally defined as satellite master antenna television network.

Note 2 to entry: This kind of network or system can possibly be combined with terrestrial antennas for the additional reception of TV and/or radio signals via terrestrial networks.

Note 3 to entry: This kind of network or system can also carry control signals for satellite switched systems or other signals for special transmission systems (e.g. MoCA or Wi-Fi) in the return path direction.

3.1.49
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 1 to entry: Some forms of this device may be used in the reverse direction for combining signal energy.

3.1.50
spur feeder
feeder to which splitters, subscriber taps or looped system outlets are connected

3.1.51
subscriber equipment
equipment at the subscriber premises such as receivers, tuners, decoders, video recorders, multimedia terminals

3.1.52
subscriber feeder
feeder connecting a subscriber tap to a system outlet or, where the latter is not used, direct to the subscriber equipment.

Note 1 to entry: The subscriber feeder can consist of either a coaxial cable, a fibre optic cable or an armoured fibre optic cable.

3.1.53
subscriber tap
device for connecting a subscriber feeder to a spur feeder

3.1.54
surge protective device
device that is intended to limit transient overvoltage and divert surge currents

Note 1 to entry: A surge protective device contains at least one non-linear component.

3.1.55
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

3.1.56
system outlet
device for interconnecting a subscriber feeder and a receiver lead

3.1.57
touch voltage
<effective> voltage between conductive parts when touched simultaneously by a human being or livestock

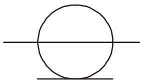
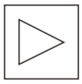
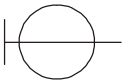
Note 1 to entry: The value of the touch voltage is influenced by the impedance of the human being or the livestock in electric contact with these conductive parts.

[SOURCE: IEC 60050-195:2021, 195-05-11.]

3.1.58
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 document. 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 Abbreviated terms

AC	alternating current
AM	amplitude modulation
ATS	air termination system
CATV	community antenna television (network)
COPD	coaxial overvoltage protective device
DC	direct current
DTH	direct to home
HD	home distributor
FTTH	fibre to the home
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)
MDU	multi dwelling unit
N	neutral (conductor)

NIU	network interface unit
NTP	network termination point
OPD	overvoltage protective device
OTP	optical transfer 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 persons, animals, 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 hazard.

For further details, see IEC 60364-1:2005, IEC 60364-4-44:2007/AMD1:2015, IEC 60364-5-52:2009 and IEC 60364-5-54:2011.

The above does not apply to electrically instructed or electrically skilled persons (according to 3.1.40 or 3.1.41) working on the equipment, who can be exposed to live parts of the equipment by the removal of protective covers. Electrically instructed and electrically skilled persons shall have minimum protection against contact with live parts.

Equipment intended to be installed in a cable network shall be provided with the following information:

a) The name of the manufacturer or supplier, or the brand name or trademark, shall be clearly printed on the electrical equipment or, where that is not practicable, on its packaging. If appropriate, there shall also be marking to identify the date and place of manufacture.

b) Information provided with the equipment shall also include instructions for safe installation (assembly), maintenance, cleaning, operation and storage.

c) Where risks remain despite all the measures adopted, or in the case of potential risks which are not evident, appropriate warnings shall be provided.

d) The essential characteristics, the recognition and observance of which will ensure that equipment will be used safely and in applications for which it was intended and for which it can reasonably be foreseen, shall be marked legibly and indelibly on the equipment or, if this is not possible, in the accompanying instructions for use.

e) Information provided either by marking or in the instructions for use which is essential for the safe use of the equipment shall be easily understandable by the intended user.

4.2 Mechanical requirements

4.2.1 General

To reduce the likelihood of injury resulting from exposure to mechanical hazards, equipment shall be provided with the safeguards specified in IEC 62368-1 and 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.

4.2.2 Equipment design and construction

Equipment shall be so designed and constructed that, under normal operating conditions, abnormal operating conditions and single fault conditions, safeguards are provided to reduce the likelihood of injury or, in the case of fire, property damage.

Parts of equipment that could cause injury shall not be accessible, and accessible parts shall not cause injury.

For an ordinary person or an instructed person, the adjustment of a control shall not defeat an equipment safeguard.

4.2.3 Accessible parts

An accessible part of an equipment is a part that can be touched by a body part. For the purposes of determining an accessible part, a body part is represented by one or more of the specified probes. Accessible equipment parts can include parts behind a door, panel, removable cover, etc. that can be opened without the use of a tool. IEC 62368-1 defines accessible parts and test procedures.

4.3 Radiation

To reduce the likelihood of painful effects and injury resulting from laser, visible, infra-red, ultraviolet, x-ray, and acoustic energy, equipment shall be provided with the safeguards specified in IEC 62368-1.

4.4 Electromagnetic radiation

Exposure to electromagnetic radiation can have an impact on persons working in close proximity to radiation sources. Therefore existing regional or national legislation against EMF to ensure safety at the workplace shall be complied with.

NOTE In Europe, Directive 2013/35/EU applies.

4.5 Thermal protection

To reduce the likelihood of painful effects and injury resulting from thermal burns, equipment shall be provided with the safeguards specified in accordance with IEC 62368-1.

4.6 Safety in case of fire and fire reaction

Consideration shall be given to the materials used with regard to safety in the case of fire and fire reaction. In Europe all cables shall comply with the Construction Product Regulation 305/2011, EN 50575:2014 and in the absence of local or national requirements cables shall meet class E of EN 50575:2014 or better.

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 this document and IEC 62368-1, as appropriate, 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 60364-5-54:2011 and IEC 60364-5-54:2011/AMD1:2021.

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 C.1.1 of Annex C.

NOTE 2 For requirements in Japan, see C.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 (mechanically protected installation) or 4 mm^2 (not protected). They shall comply with IEC 60364-5-54:2011.

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 11 to Figure 17.

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 a surge arrester shall be connected between the equipment and the main earthing bar as shown in Figure 3.

   The impedance of the coaxial cable shall be maintained when installing such a surge arrester.

   The safety sign "Warning about hazardous electrical voltage" ISO 7010-W012:2011-05 shall be attached to the enclosure.

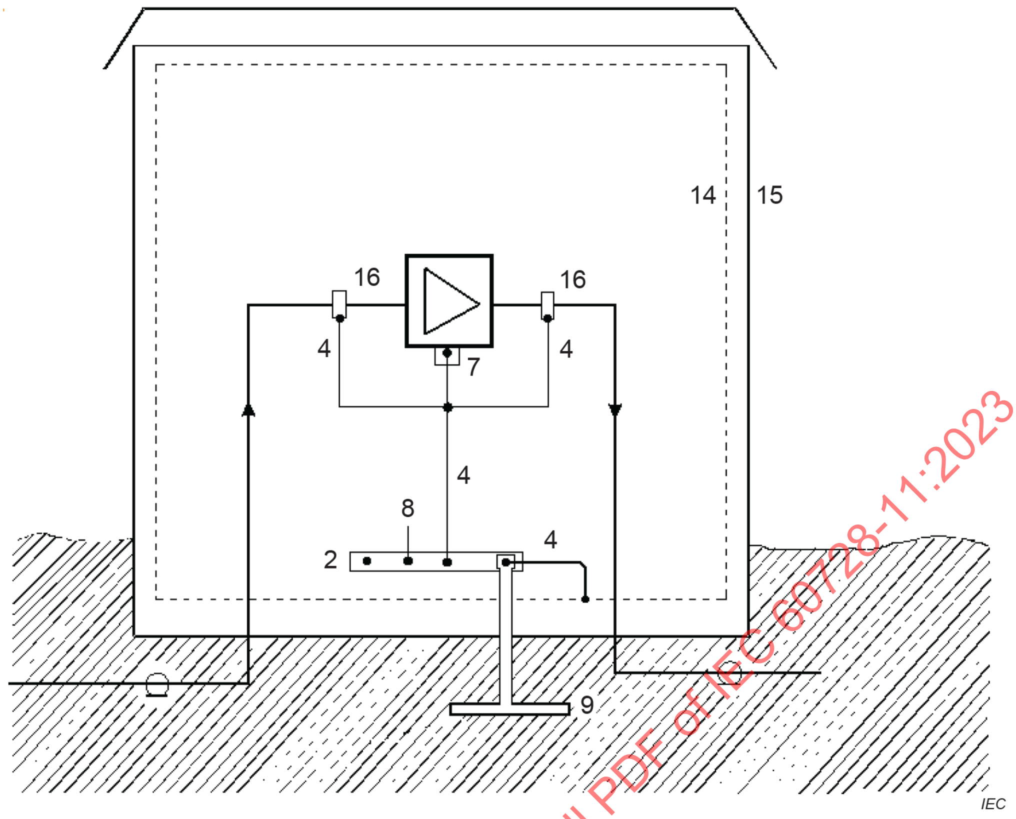
   The maximum balancing current shall be taken into account when selecting the type of cable.

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

NOTE 2 The numbering of equivalent parts in Figure 1 to Figure 19 is unified, where applicable. Therefore the numbering in an individual figure may not be in consecutive order.

NOTE 3 The following Figure 1 to Figure 19 show mains distribution system complying to the TT system.

Figure 1 shows an example of equipotential bonding and earthing of a metal enclosure inside a non-conductive cabinet for outdoor-use.



Key

2 Main earthing bar

4 Protective bonding conductor (minimum cross-section according to 6.2 c)

7 Earthing terminal (see 6.2 j and 6.2 k)

8 Protective conductor (PE)

9 Earth electrode

14 Metallic enclosure (dashed line)

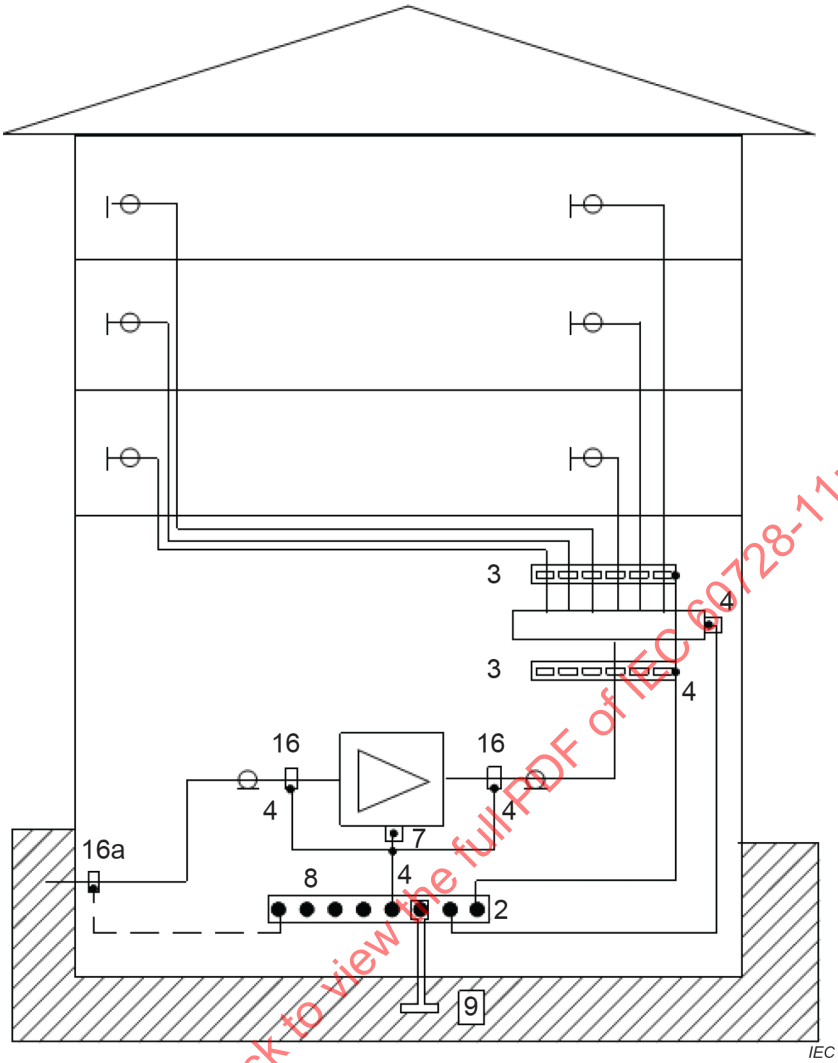
15 Non-metallic enclosure

16 Equipotential bonding clamp [a]

[a] The equipotential bonding bars connecting the outer conductors of the input and output cables of the amplifier with the protective bonding conductors 4 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 (see 6.2 i).

Figure 1 – Example of equipotential bonding and earthing of a metal enclosure inside a non-conductive cabinet for outdoor-use

Figure 2 shows an example of equipotential bonding of an installation in a building.



Key

2 Main earthing bar

3 Equipotential bonding bar [a]

4 Protective bonding conductor (minimum cross-section according to 6.2 c)

7 Earthing terminal (see 6.2 j and 6.2 k)

8 Protective conductor (PE)

9 Earth electrode

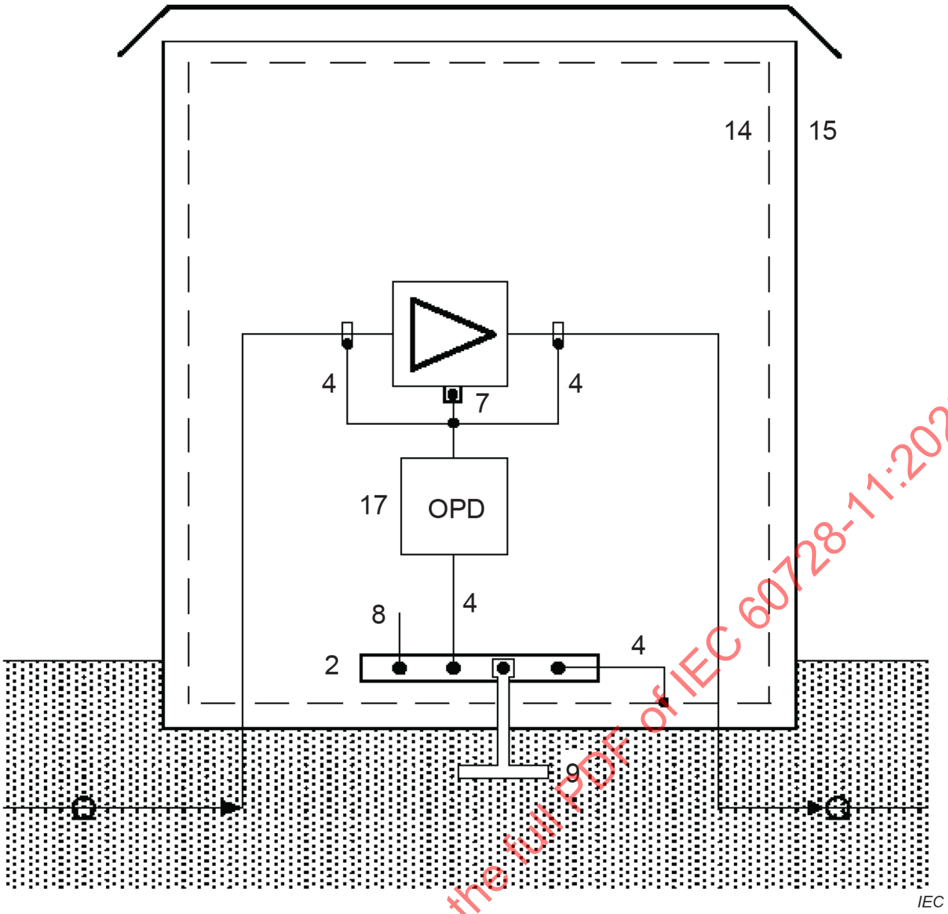
16 Equipotential bonding clamp [a]

16a Equipotential bonding clamp (optional bonding, alternative bonding point for the entering coaxial cable)

[a] The equipotential bonding bars 3 or bonding clamp 16 connecting the outer conductors of the input and output cables of the amplifier with the protective bonding conductors 4 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 (see 6.2 i).

Figure 2 – Example of equipotential bonding of a building installation

Figure 3 shows an example of equipotential bonding and indirect earthing of a metal enclosure inside a non-conductive cabinet for outdoor-use.



Key

2	Main earthing bar	4	Protective bonding conductor (minimum cross-section according to 6.2 c)
7	Earthing terminal (see 6.2 j and 6.2 k)	8	Protective conductor (PE)
9	Earth electrode	14	Metallic enclosure (dashed line)
15	Non-metallic enclosure	17	Overvoltage protective device

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

Figure 3 – Example of equipotential bonding and indirect earthing of a metal enclosure inside a non-conductive cabinet for outdoor-use

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.

Improperly designed fully isolated transfer points can radiate or pick up inadmissible high-frequency energy.

NOTE 4 IEC 60728-2 contains relevant requirements.

NOTE 5 Galvanic isolators can be damaged by overvoltage.

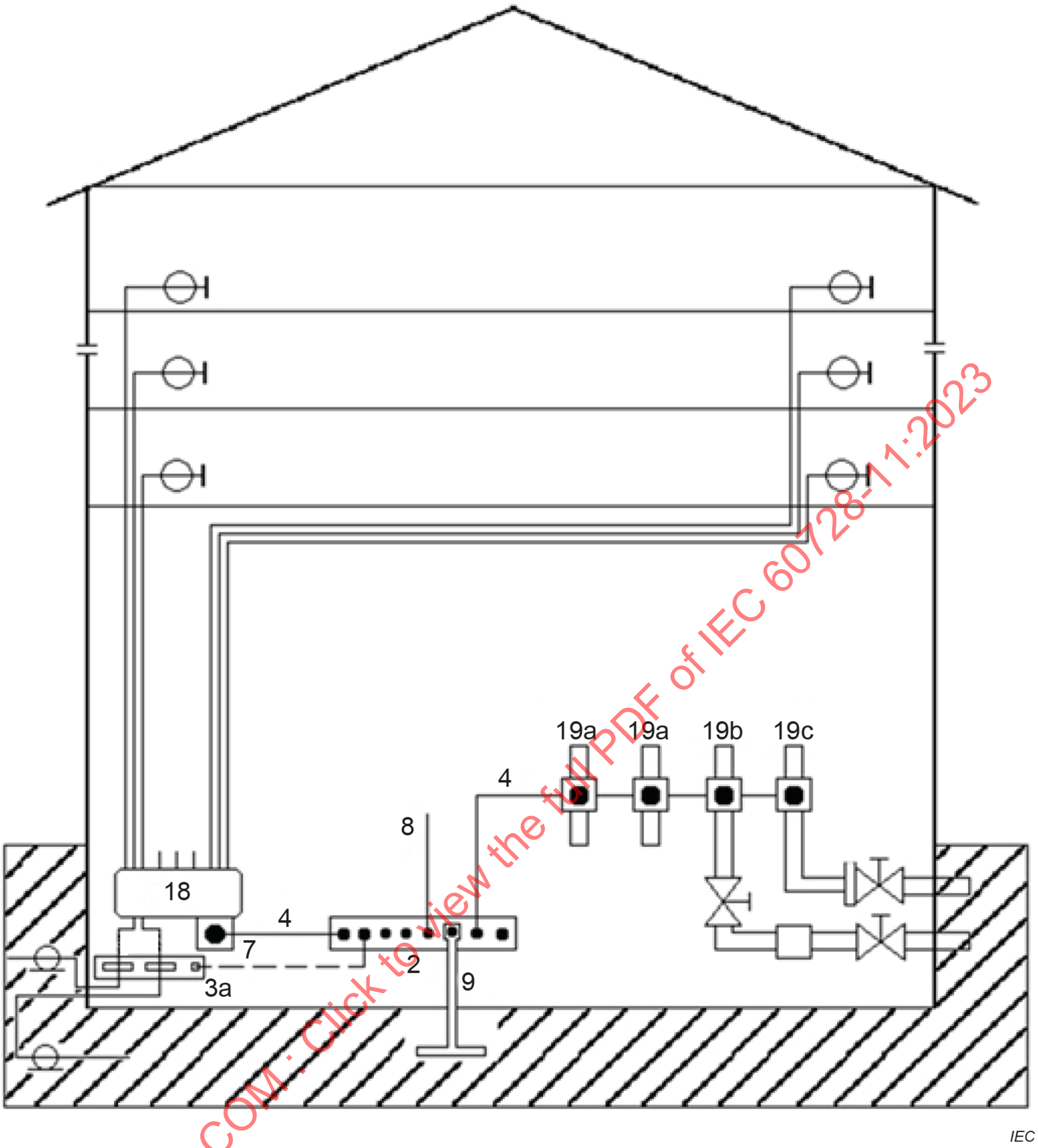
NOTE 6 For requirements in France, see C.2.1.

g) The outer conductor of coaxial cables and armoured optical fibre cables (where the armour is not isolated and insulated) entering or leaving a building and subscriber feeders 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 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 7 For requirements in Norway, see C.2.2.

NOTE 8 For requirements in Japan and Poland, see C.2.3.

Figure 4 shows an example of equipotential bonding and earthing of an installation in a building with underground connection.

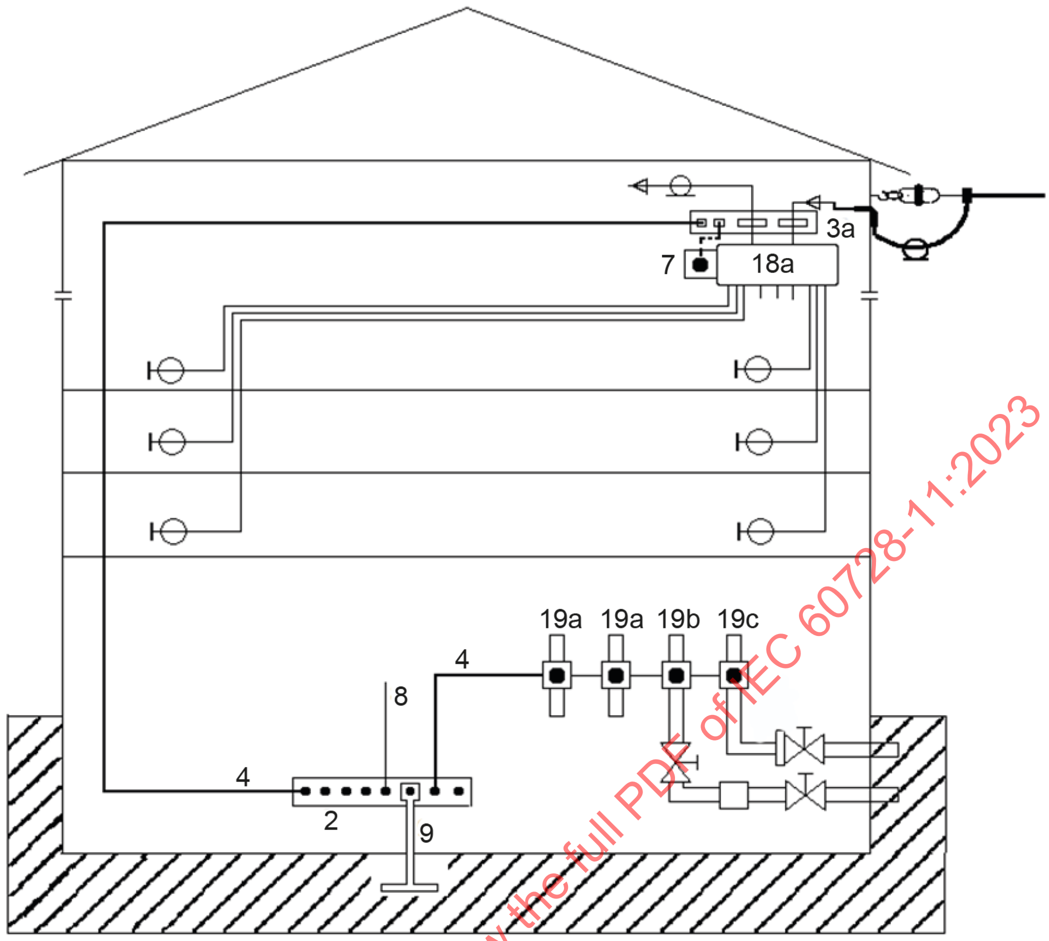


Key

2	Main earthing bar	3a	Equipotential bonding bar (optional bonding if the entering and leaving coaxial cables are not included in the equipotential bonding system via subscriber tap (no. 18))
4	Protective bonding conductor (minimum cross-section according to 6.2 c)	7	Earthing terminal (see 6.2 j and 6.2 k)
8	Protective conductor (PE)	9	Earth electrode
18	Subscriber tap	19a	Heating pipes
19b	Water pipe	19c	Gas pipe

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

Figure 5 shows an example of equipotential bonding and earthing of an installation in a building through above ground connection.

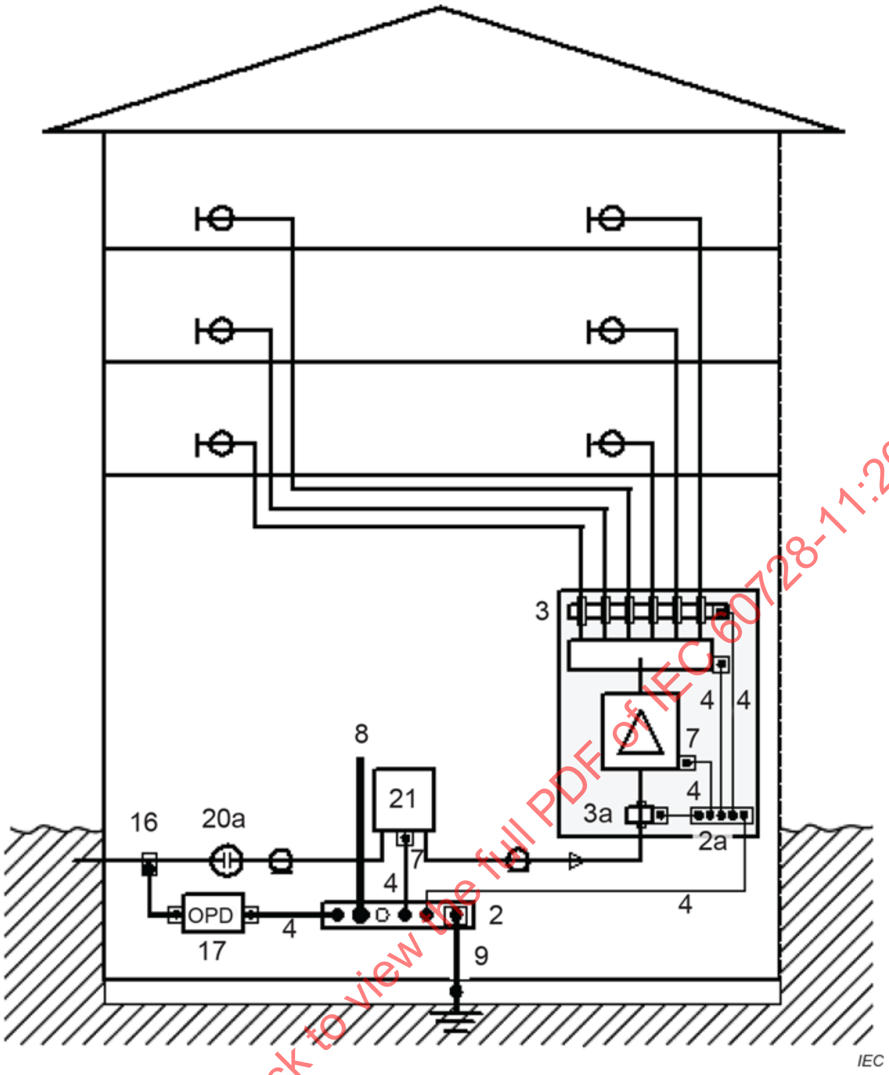


Key

2	Main earthing bar	3a	Equipotential bonding bar (optional bonding if the entering coaxial cables are not included in the equipotential bonding system via wall-mounted subscriber tap (no. 18a))
4	Protective bonding conductor (minimum cross-section according to 6.2 c)	7	Earthing terminal (see 6.2 j and 6.2 k)
8	Protective conductor (PE)	9	Earth electrode
18a	Wall-mounted subscriber tap	19a	Heating pipes
19b	Water pipe	19c	Gas pipe

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

Figure 6 shows an example of equipotential bonding and earthing of a galvanic isolated cable entering a building via an underground connection.



Key

2	Main earthing bar	3	Equipotential bonding bar [a]
4	Protective bonding conductor (minimum cross-section according to 6.2 c)	7	Earthing terminal (see 6.2 j and 6.2 k)
8	Protective conductor (PE)	9	Earth electrode
16	Equipotential bonding clamp [a]	17	Overvoltage protective device (minimum cross-section according to 6.2 c)
20a	Galvanic isolator	21	Transfer point

[a] The equipotential bonding bars 3 or bonding clamp 16 connecting the outer conductors of the input and output cables of the amplifier with the protective bonding conductors 4 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 (see 6.2 i).

The impedance of the coaxial cable shall be maintained when installing such a surge arrester.

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.

Improperly designed fully isolated transfer points can radiate or pick up inadmissible high-frequency energy.

NOTE 9 IEC 60728-2 contains relevant requirements.

NOTE 10 Galvanic isolators can be damaged by overvoltage.

i) When changing or removing active or passive pieces of 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.

Before applying a temporary solution for equipotential bonding the parts to be disconnected (e.g. the F connector of a disconnected cable) shall maintain continuity to the temporary equipotential bonding link during the complete de-installation/installation process.

NOTE 11 For requirements in Norway, see C.2.2.

j) Every connection of a 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 62368-1.

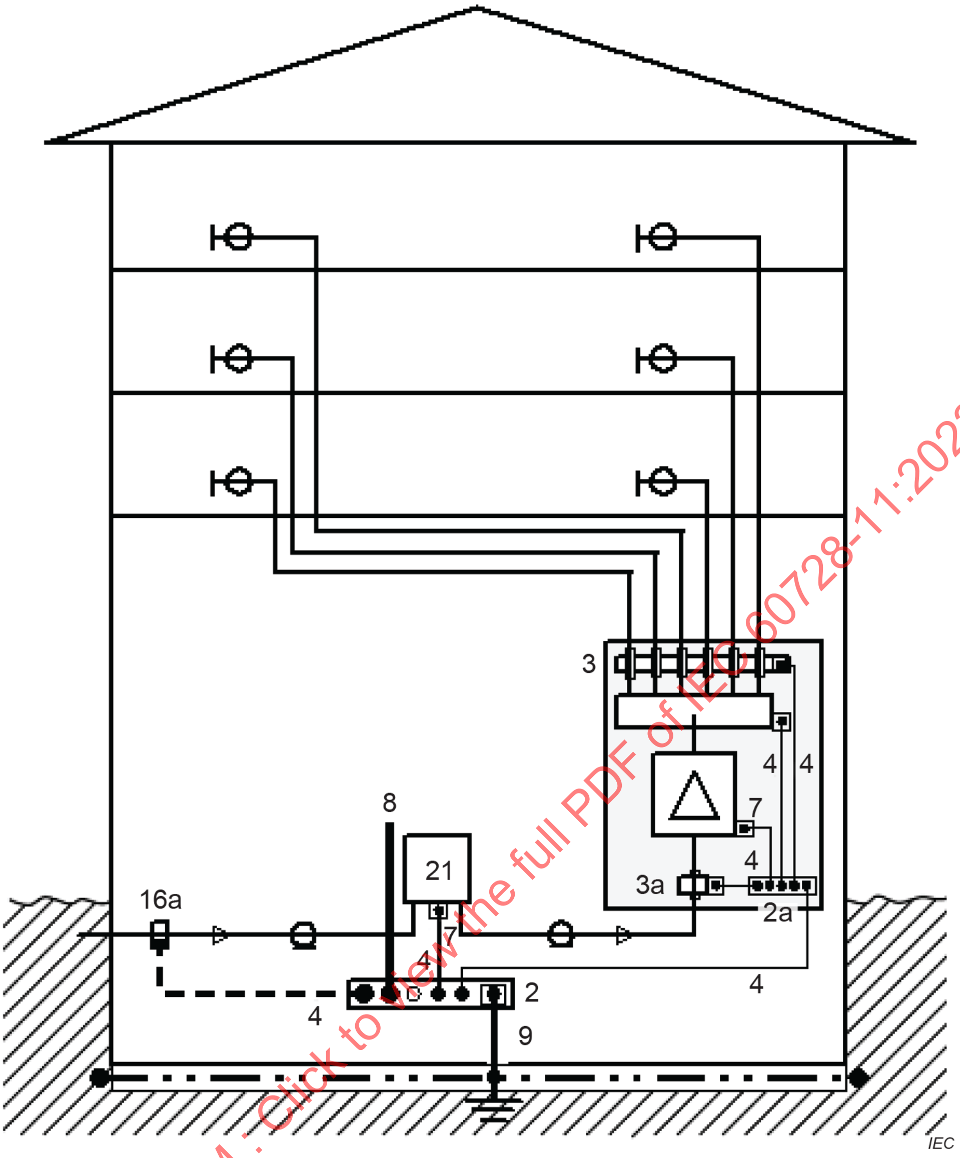
Line-powered amplifiers, taps, splitters and transfer points shall also be fitted with earthing terminals.

l) For antennas, which, in accordance with 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 shall 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 a protective bonding conductor (according to 6.2 c).
- 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 C.2.2.

Figure 7 shows an example of maintaining equipotential bonding whilst a unit is removed.



Key

2	Main earthing bar	3	Equipotential bonding bars [a]
4	Protective bonding conductor (minimum cross-section according to 6.2 c)	7	Earthing terminal (see 6.2 j and 6.2 k)
8	Protective conductor (PE)	9	Earth electrode
16a	Equipotential bonding clamp (optional bonding if the entering coaxial cable is not included in the equipotential bonding system via the transfer point (no. 21))	21	Transfer point

[a] The equipotential bonding bars 3 connecting the outer conductors of the input and output cables of the amplifier with the protective bonding conductors 4 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 (see 6.2 i).

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 the requirements of ISO/IEC 30129:2015/Amd1:2019, Clause 11.

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 60364-1:2005 or ISO/IEC 30129:2015/AMD1:2019).

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.

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 C.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 shielding (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 buildings.

6.3.5 Measures

The following measures are recommended.

a) Equipment of telecommunications and information technology shall 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 shall be used in the coaxial connector to avoid PEN conductor currents being carried over.

   The inner conductor and shielding of the coaxial cable shall be electrically isolated.

   Improperly designed fully isolated transfer points can radiate or pick up inadmissible high-frequency energy.

   NOTE 1 IEC 60728-2 contains relevant requirements.

   NOTE 2 For requirements in Norway, see C.2.2.

d) To avoid interference according to 6.3.4.2:

   - use relieving equipotential bonding (see IEC 60364-5-54:2011);
   - galvanic isolation at NIU.

7 Mains-supplied equipment

The equipment used in a cable network shall meet the requirements of IEC 62368-1.

Equipment with an IP rating of IPX0 in accordance with IEC 60529:1989 shall not be used outdoors.

NOTE Equipment of protection Class II is preferable but 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.

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 90 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 skilled persons and then only by removal of equipment covers by means of a tool.

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

8.1.2 General requirements for equipment

The pieces of equipment used in a cable network shall meet the requirements of IEC 62368-1. For protection against atmospheric overvoltage in cable networks, see 11.1.

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

The occurrence of hazardous currents shall be prevented by a suitable selection of fuses or by the power supply (for example, a 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 coaxial cables specified for the current and operating voltage according to Table 1 shall be used in the absence of specific values provided by the manufacturer.

Table 1 – Maximum allowed operation voltages and maximum recommended currents for coaxial cables

Application	Typical diameter of the coaxial cable	Maximum allowed operation voltage V		Maximum recommended current A	
	mm	AC_{RMS}	DC	Operation	Permanent short circuit
Drop or sub-scriber cable [a]	5 to 10	34	50	2	4
Feeder or distribution cable	>10	90	120	7	15
Trunk cable	>10	90	120	15	30

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.

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

8.2 Remote powering from subscriber premises

Where back-powering to a network or to outdoor equipment such as preamplifiers, low-noise converters, polarizers, transmitters 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. Higher values of remote feeding voltage than 24 V AC, RMS and 34 V DC shall be only allowed if this remote powering voltage shall only be accessible to skilled persons and then only by removal of equipment covers by means of a tool, but in any case shall not exceed 90 V AC or 120 V DC.
- 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 62368-1, 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 62368-1.

9 Segregation distances and protection against indirect contact 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 C.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 C.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 C.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 60364-5-52:2009 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.

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 1 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 2 For requirements in Sweden, see C.7.1.

NOTE 3 For requirements in the UK, see C.7.2.

NOTE 4 For requirements in Norway, see C.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) can be needed.

Improperly designed fully isolated transfer points can radiate or pick up inadmissible high-frequency energy.

NOTE 2 IEC 60728-2 contains relevant requirements.

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 NOTE 1 and 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 C.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 bonding as described 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 NOTE 1 and 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 C.8.

10.2.5 Non-isolated system outlet without protective element

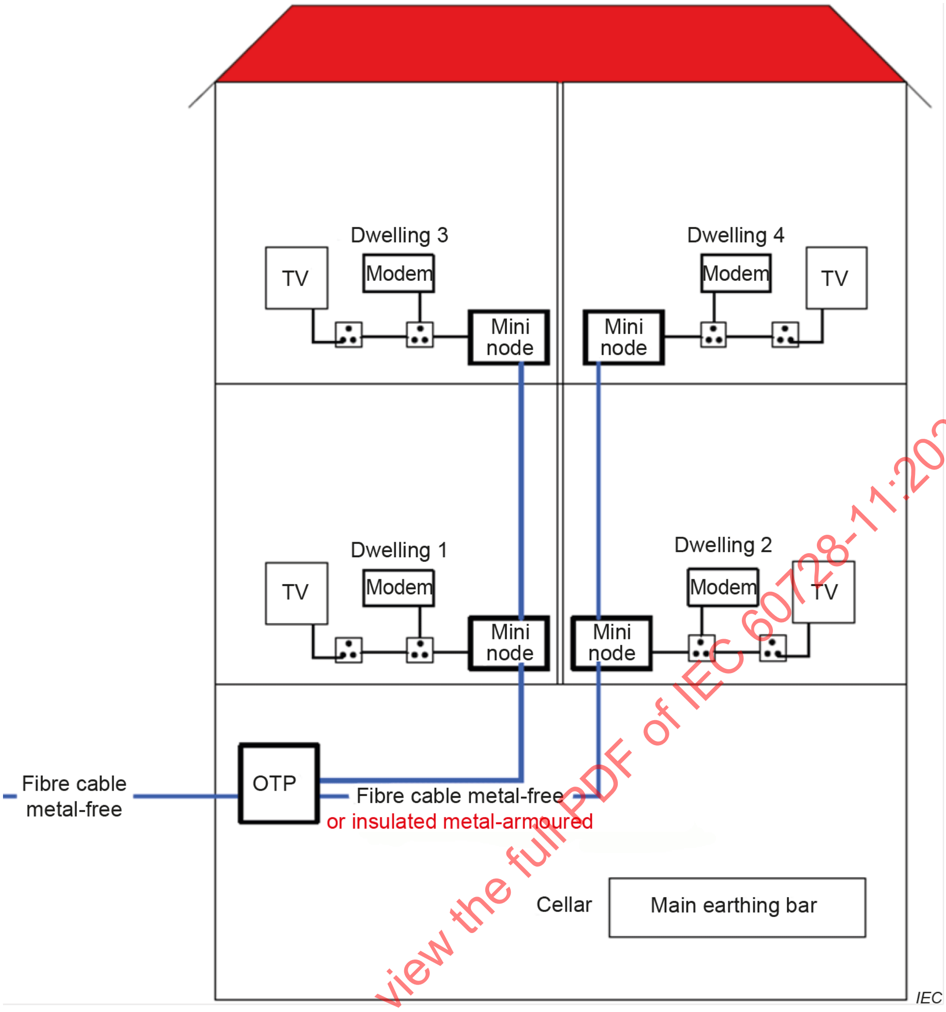
This type of outlet incorporates coaxial connector(s) only and does not contain any isolation component or protective element.

When this type of system outlet is used for back-powering, basic insulation according to IEC 62368-1 shall be implemented to prevent the power from reaching other outlets.

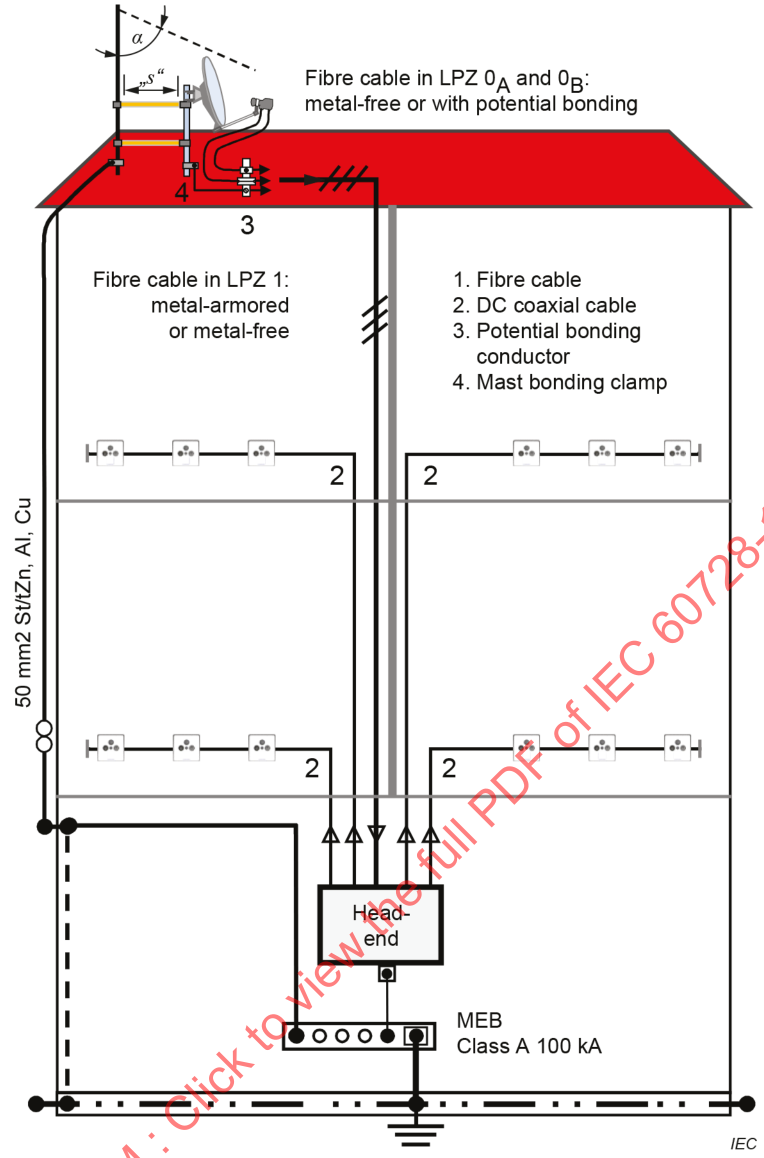
The protection shall be provided by equipotential bonding as described in 10.2.3.

10.2.6 Fully-isolated system outlet provided by means of a FTTH system

In FTTH installations in a multi-dwelling-unit (MDU) building the individual homes are galvanically separated each from the others if the connections to the individual homes are realised by metal-free or insulated armoured optical fibre cables (Figure 8a), but not (Figure 8b). In the case of (Figure 8a) the metal-free optical fibre cable has the same isolation function as an electrical isolating component applied to the inner and outer conductor of a coaxial cable.



a) MDU building installed with FTTH technology to the home



b) MDU building installed with FTTH technology to the headend

Figure 8 – MDU building installed with FTTH technology

Where fibre cables route outside the zone of protection non-metallic cables shall be used

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

If a metallic sheath is used inside the zone of protection for mechanical protection purposes of fibre cables, galvanic isolation of this sheath in accordance with 10.1 and/or equipotential bonding shall be provided as described in 6.2 f).

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.

Improperly designed fully isolated transfer points can radiate or pick up inadmissible high-frequency energy.

NOTE IEC 60728-2 contains relevant requirements.

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 9);
- antenna systems enclosed within the building structure;
- antenna systems serving only a single dwelling installation and with a low risk to be hit by lightning (see 11.2.3.1).

NOTE 1 For requirements in Germany, see C.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 5 mA RMS. A single Class II device can have a maximum leakage current of 0,5 mA RMS for devices covered by IEC 62368-1:2018. The touch current hazard, safe let-go threshold current as defined in IEC 60990:2016 shall be ≤ 3,5 mA RMS as per the "touch voltage" requirement in IEC 62368-1:2018. 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 systems which are installed remotely from buildings shall be earthed, if outside the protected area of the building LPS.

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.

Figure 9 shows areas of antenna-mounting in or on buildings in cases where earthing is not mandatory.

NOTE 2 The protected area on the side of buildings is limited up to a height of 45 m (for LPS Class III) due to the possible side flashes (see IEC 62305-3).

NOTE 3 For requirements in Japan, see Clause C.9.

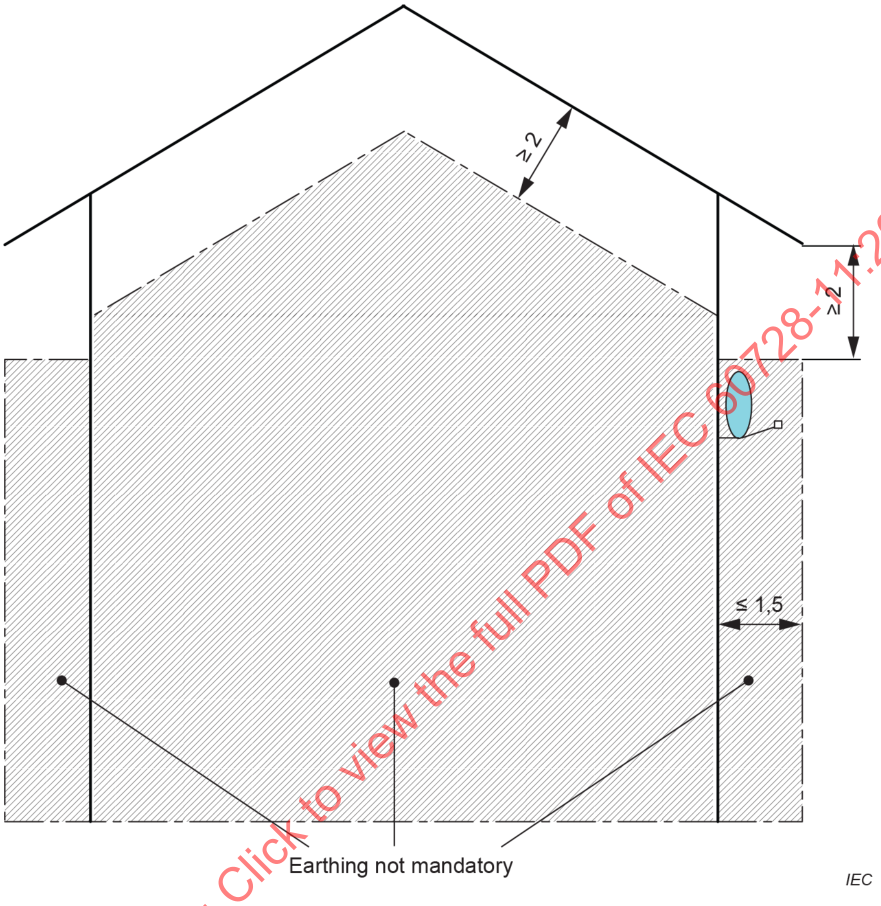


Figure 9 – Areas of antenna-mounting in or on buildings, where earthing is not mandatory

11.2 Protection of the antenna system

11.2.1 Selection of appropriate methods for protection of antenna systems

Figure 10 shows a flow chart which serves as decision tree to select the appropriate method for protecting the antenna system under consideration against atmospheric over voltages. 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 10) and the responsibilities of the LPS installer (dashed line boxes in Figure 10).

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

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 9.	This document
1b	In protected volume of the existing or newly installed LPS, see Figure 11.	IEC 62305-3
1c	In protected volume of external isolated ATS, see Figure 12 and Figure 13	IEC 62305 series
1d	If lightning stroke risk $R \leq$ tolerable risk R_T; see Figure 16	IEC 62305-2:2010
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 15.	This document
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 14	IEC 62305 series This document
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 document
NOTE For installations covered by solution 4, it is nonetheless strongly recommended that the system is equipotentially 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 the IEC 62305 series 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. The antenna system shall not be connected to the LPS systems when installed in the protected volume but shall be separated by the dimension ‘S’ and fitted with type 2 surge arresters on each conductor entering the building. The possibility to use such a protected volume shall be determined by the skilled LPS installer. Figure 11 shows an example of such an installation. Surge arrestors shall be placed as close as possible to the protected equipment.

The distance between equipment cabinets and any external cables located near lightning protection conductor shall be maintained as high as possible in order to reduce the induced voltage.

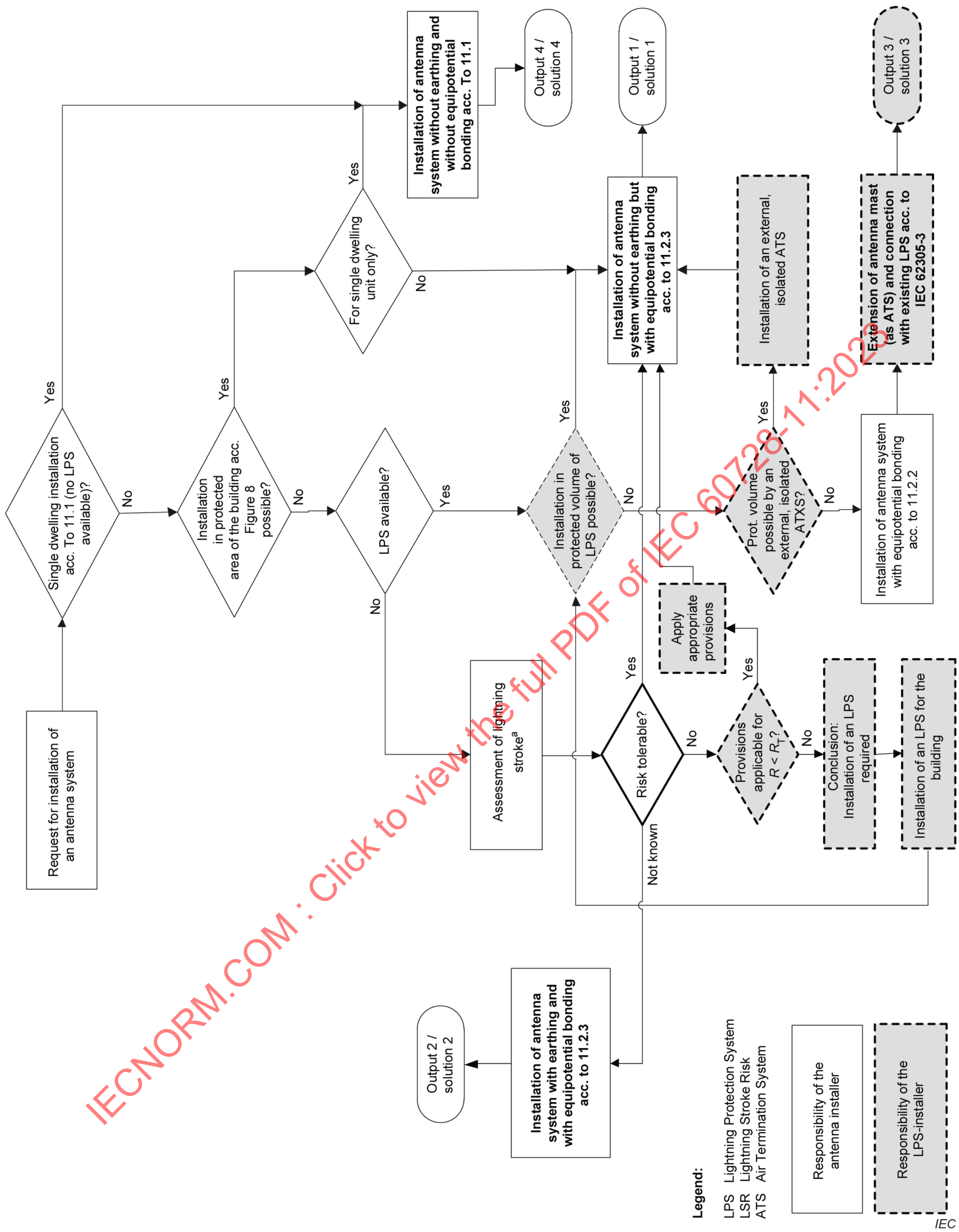
If a protected volume performed by the building LPS is not available, for example due to the size of the antenna system, the use of an external isolated ATS shall be determined by the LPS installer (solution 1c in Table 2). Figure 12 and Figure 13 show examples of such installations.

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). The antenna system connected to the LPS shall be fitted with type 1 followed by a type 3 surge arresters on all conductors entering the building.

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 62305-3:2010 for an air-termination system. The antenna system and its mast shall be able to withstand a lightning stroke and in addition the connection between coaxial cable shields and the mast shall be as short as feasible.

An example of this kind of installation is shown in Figure 14.

The separation distance S, shown in Figure 11, Figure 12, Figure 13 and Figure 14, between each ATS equipment and the LPS and all LPS connected parts shall meet or exceed the required value (see IEC 62305-3:2010).

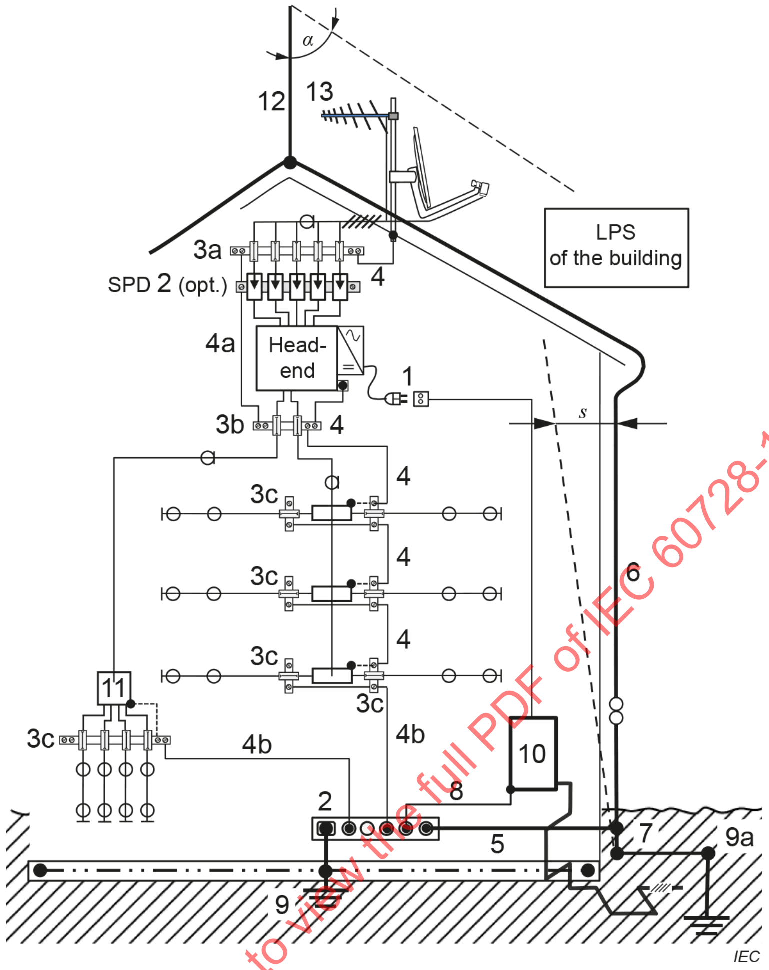


[a] An assessment shall be made of the risk of lightning strike R. If a definitive value of R is known (by calculation using available data) this shall be compared with the tolerable risk R_T to determine whether consideration shall be given to the installation of an LPS or whether to proceed to output 1/solution 1. If it is impossible to determine the value of R (e.g. lack of local data) then local common practice shall be used to determine a solution or, as a minimum, the option output 2 / solution 2 shall be realised.

NOTE It is important to distinguish between the responsibilities of the antenna installer (solid line boxes in Figure 10) and the responsibilities of the LPS installer (dashed line boxes in Figure 10).

Figure 10 – Flow chart for selection of the appropriate method for protecting the antenna system against atmospheric overvoltages

NOTE 1 The numbering of equivalent parts in Figure 11 to Figure 19 is unified, where applicable. Therefore the numbering in an individual figure may not be in consecutive order.



Key

1	Mains supply	2	Main earthing bar
3a, 3b, 3c	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	Earthing terminal	8	Protective conductor (PE)
9	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		

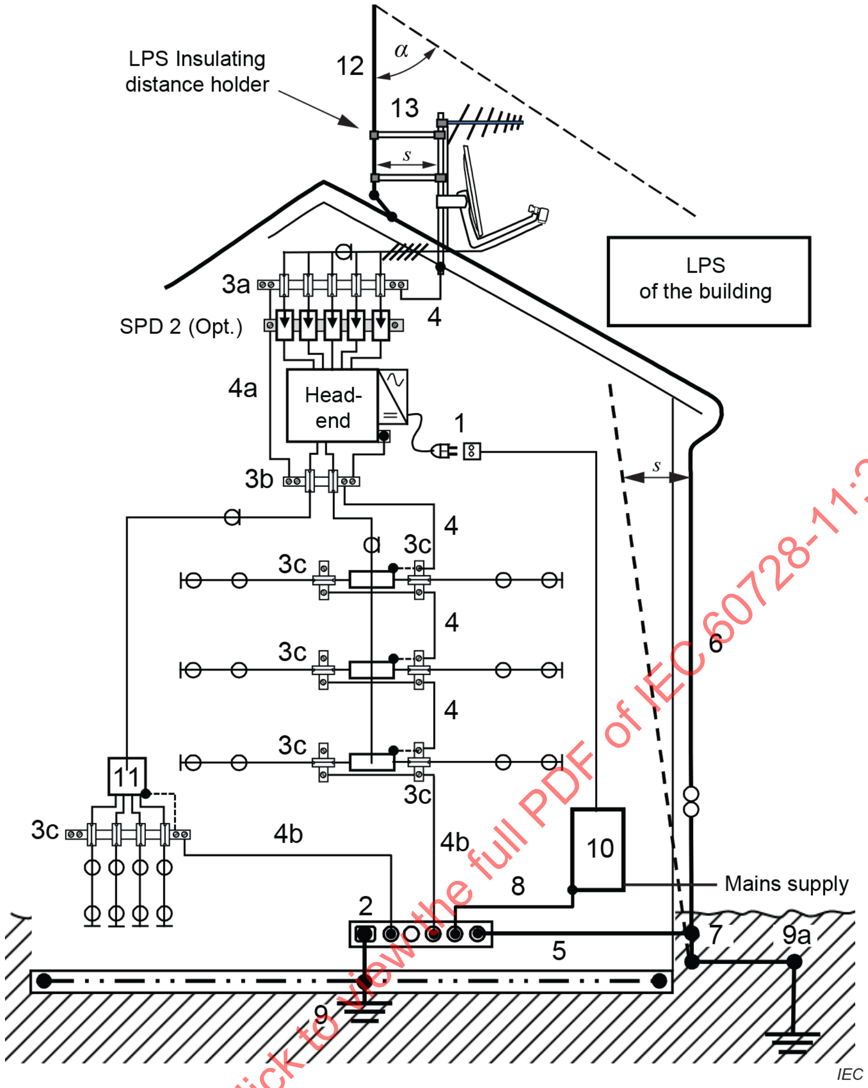
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

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



Key

1	Mains supply	2	Main earthing bar
3a, 3b, 3c	Equipotential bonding bars	4, 4a, 4b	Protective bonding conductors (minimum cross-section according to 6.2 c)
5	Earth bonding conductor (e.g. ≥ 16 mm² Cu) according to 11.3.2	6	External earthing conductor of the buildings LPS (e.g. ≥ 50 mm² Cu, solid round, according to IEC 62305-3:2010, Table 6)
7	Earthing terminal	8	Protective conductor (PE)
9	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		

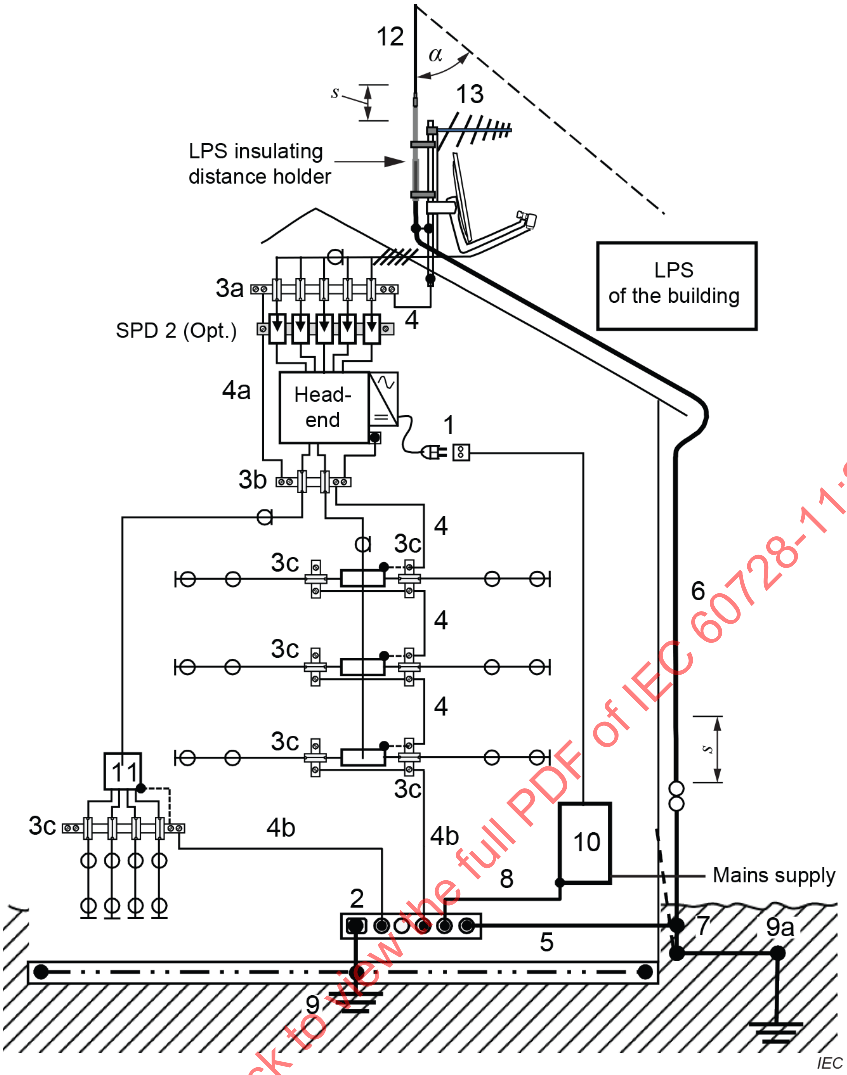
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

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 horizontally isolated ATS



Key

1	Mains supply	2	Main earthing bar
3a, 3b, 3c	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	Earthing terminal	8	Protective conductor (PE)
9	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		

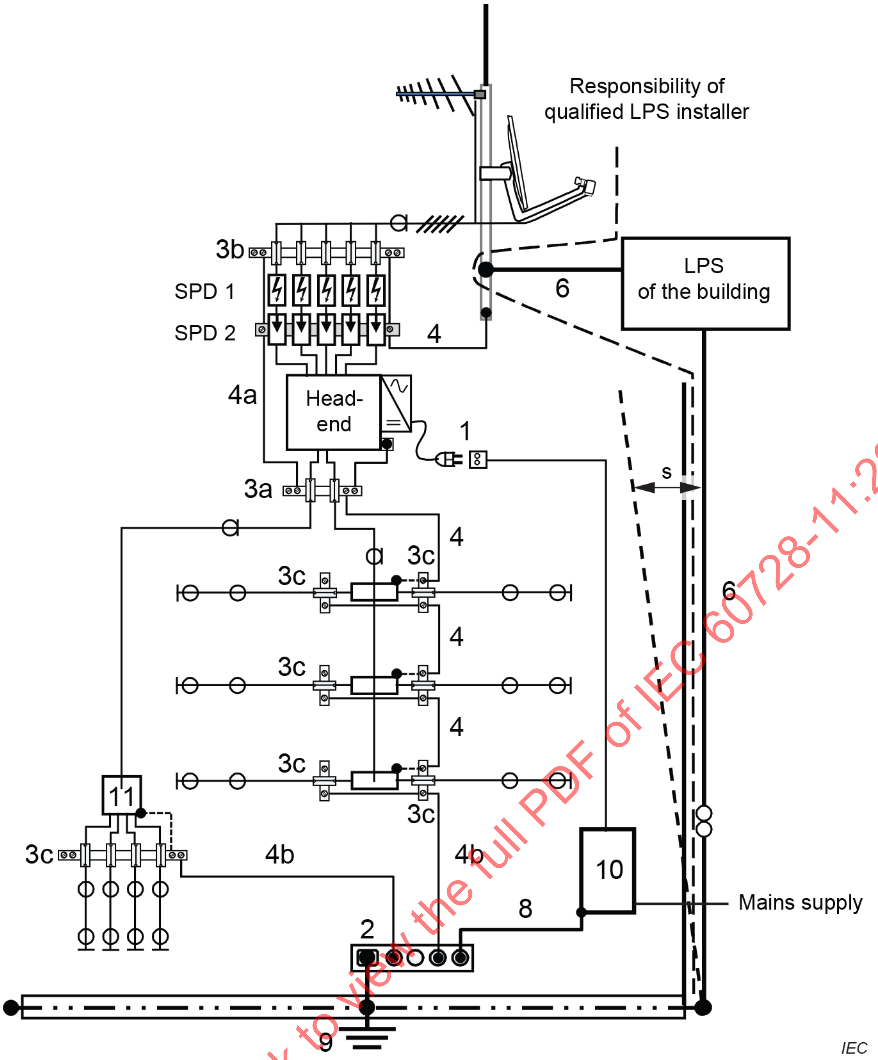
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

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



Key

1	Mains supply	2	Main earthing bar
3a, 3b, 3c	Equipotential bonding bars	4, 4a, 4b	Protective bonding conductors (minimum cross-section according to 6.2 c)
6	External earthing conductor of the building's LPS (e.g. ≥ 50 mm^2 Cu, solid round, according to IEC 62305-3)	8	Protective conductor (PE)
9	Earth electrode	10	Mains power distribution box with SPD
11	Home distributor (HD)		
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 3.

Figure 14 – 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 11, Figure 12, Figure 13 and Figure 14) shall be connected to the mast via a protective bonding conductor having a minimum cross-sectional area in accordance with 6.2 c.

To ensure the maintenance of protection of an LPS when an antenna system is installed, the LPS shall be inspected in accordance with IEC 62305-3:2010, Clause 7.

NOTE 2 For requirements in Japan, see C.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 satellite and/or terrestrial television receiving networks or systems and extended satellite and/or terrestrial television distribution 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 10 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.

NOTE For requirements in Germany, see C.10.1.

11.2.3.2 Tolerable risk

Identifying the maximum value of the risk which can be tolerated in 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 62305-2:2010, Table 4:

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 $R_T = 10^{-4}$.

Computer programmes exist within National Standards Bodies for calculation of the tolerable risk, which 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.

11.2.3.3 Case A – Bonding required without LPS

If the building is not equipped with an LPS conforming to the IEC 62305 series, 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 10 and in Table 2. However, risk assessment is always recommended.

An example of earthing and equipotential bonding according to solution 2 is shown in Figure 15.

11.2.3.4 Case B – Bonding required without LPS

If the building is not equipped with an LPS conforming to the IEC 62305 series, 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 to the maximum value of risk which can be tolerated,

protection against lightning is not required. This leads to output 1/solution 1 in Figure 10 and is described as solution 1d in Table 2.

NOTE For requirements in Germany, see C.10.1.

An example of antenna system bonding according to solution 1d is shown in Figure 16. 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 6.2 c.

11.2.3.5 Case C – Lightning protection by risk-reducing measures

If the building is not yet equipped with an LPS conforming to the IEC 62305 series, 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 the IEC 62305 series, 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 62305-4:2010,
- 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 10 and is described as solution 1d in Table 2.

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

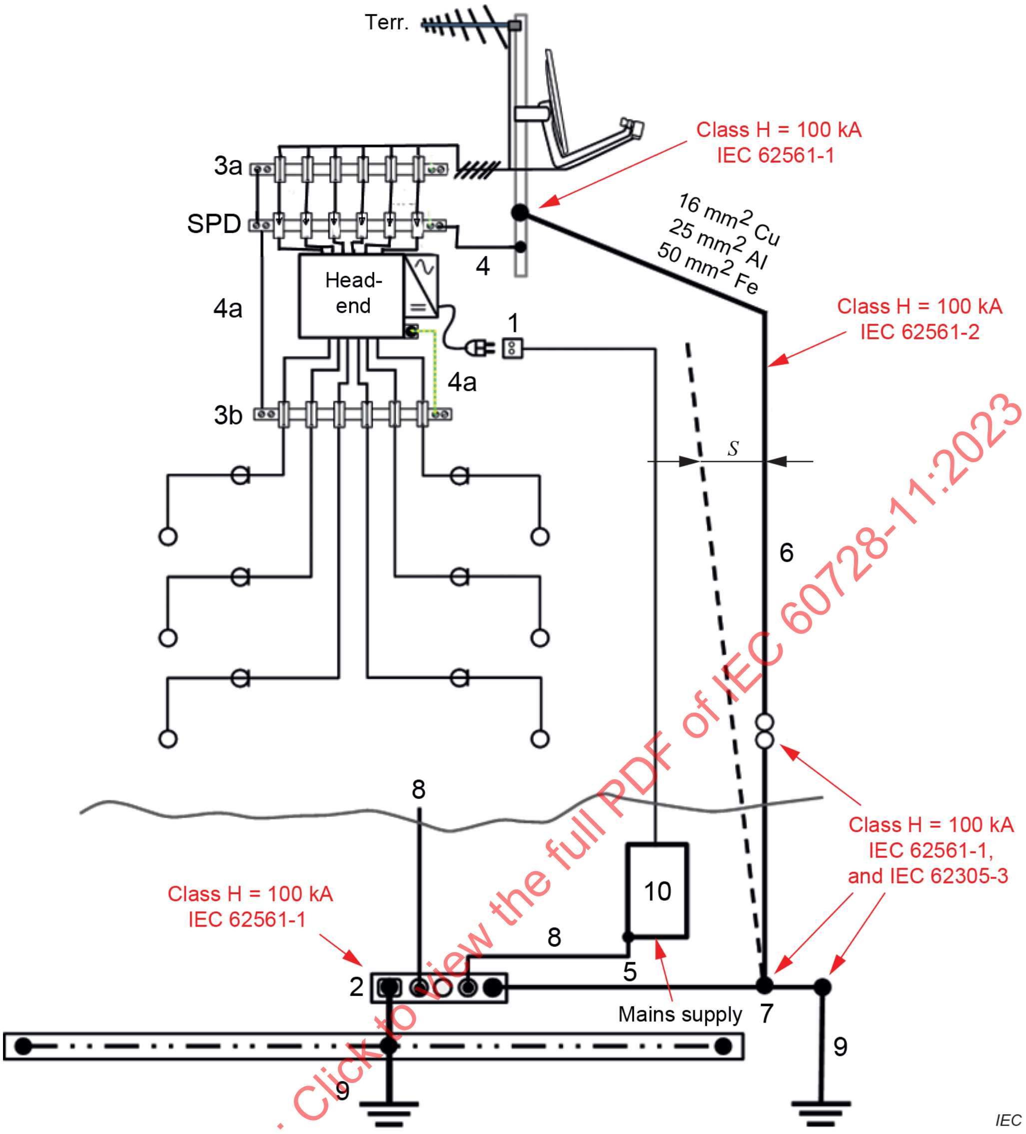
NOTE 2 This may be a more cost effective solution than a provision of an LPS.

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.

To ensure the maintenance of protection of an LPS when an antenna system is installed, the LPS should be inspected according to IEC 62305-3:2010, Clause 7.



Key

1	Mains supply	2	Main earthing bar
3a, 3b	Equipotential bonding bars	4, 4a	Protective bonding conductors (see 6.2 c)
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	Protective conductor (PE)
9	Earth electrode	S	Separation distance according to IEC 62305-3

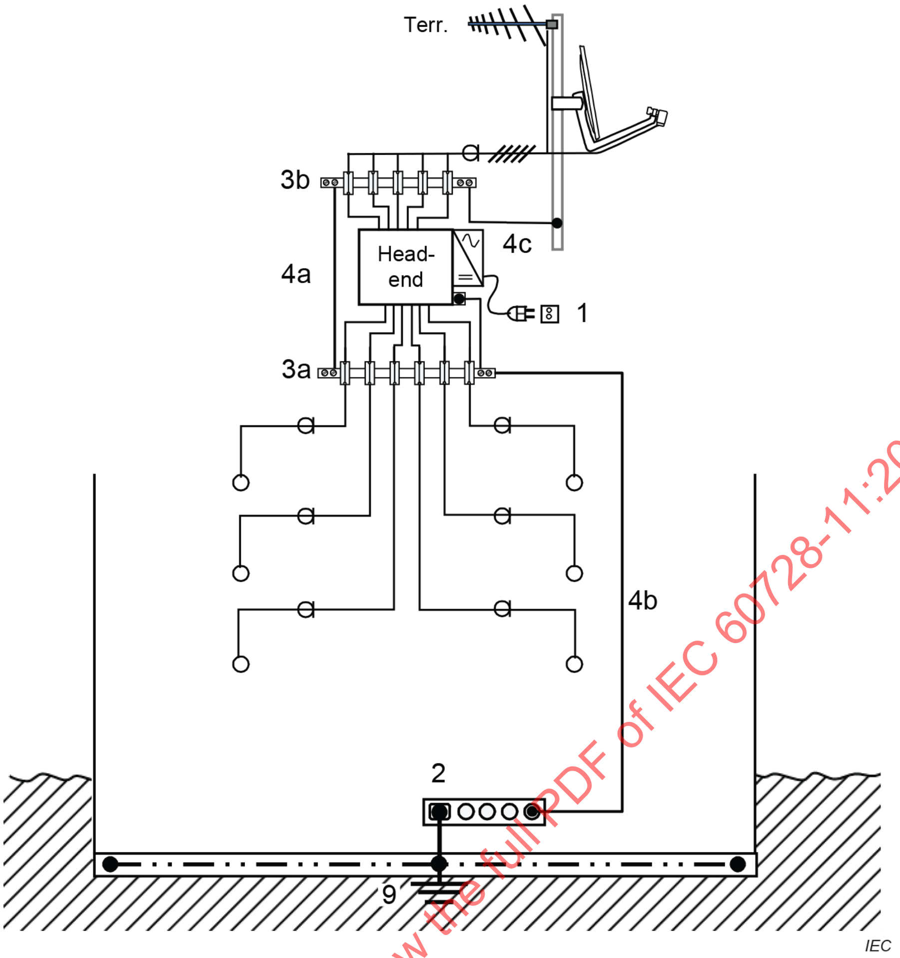
NOTE 1 The equipotential bonding bar 3a connecting the outer conductors of the output cables of the headend with the protective bonding conductor 4a can be a temporary installation to ensure safety during equipment replacement.

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 2.

Figure 15 – Example of equipotential bonded headend and earthed antennas (building without LPS)



Key

1	Mains supply	2	Main earthing bar
3 a, 3b	Equipotential bonding bars	4a, 4b, 4c	Protective bonding conductors according to 6.2c
9	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 16 – 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:

- external and internal metallic parts,
- 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 62305-3:2010, 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 62305-3:2010, Clause 6.

11.3.1.2 Protection by additional bonding conductors

To achieve a sufficient bonding current capability, the sum of all cable shield cross-sections has to result in a value according to 6.2 c). This can be achieved by the installation of additional bonding conductors 4d as shown in Figure 17. 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 bonding conductors serve for protection against fire and sparking caused by inductive events due to 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

Terminal and wires shall be designed to withstand lightning currents of 100 kA in accordance with IEC 62561-1:2017, Class H, and IEC 62561-2. The earthing conductor shall be installed straight and as vertical as possible such that it can provide the shortest, most direct path to the earth termination system (i.e. horizontal routing shall occur preferably on ground level).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 are not corrosive between each other, shall be used.

If multi-strand conductors are used the capability for carrying lightning currents shall be ensured.

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

Existing components can be employed, for example in Figure 18:

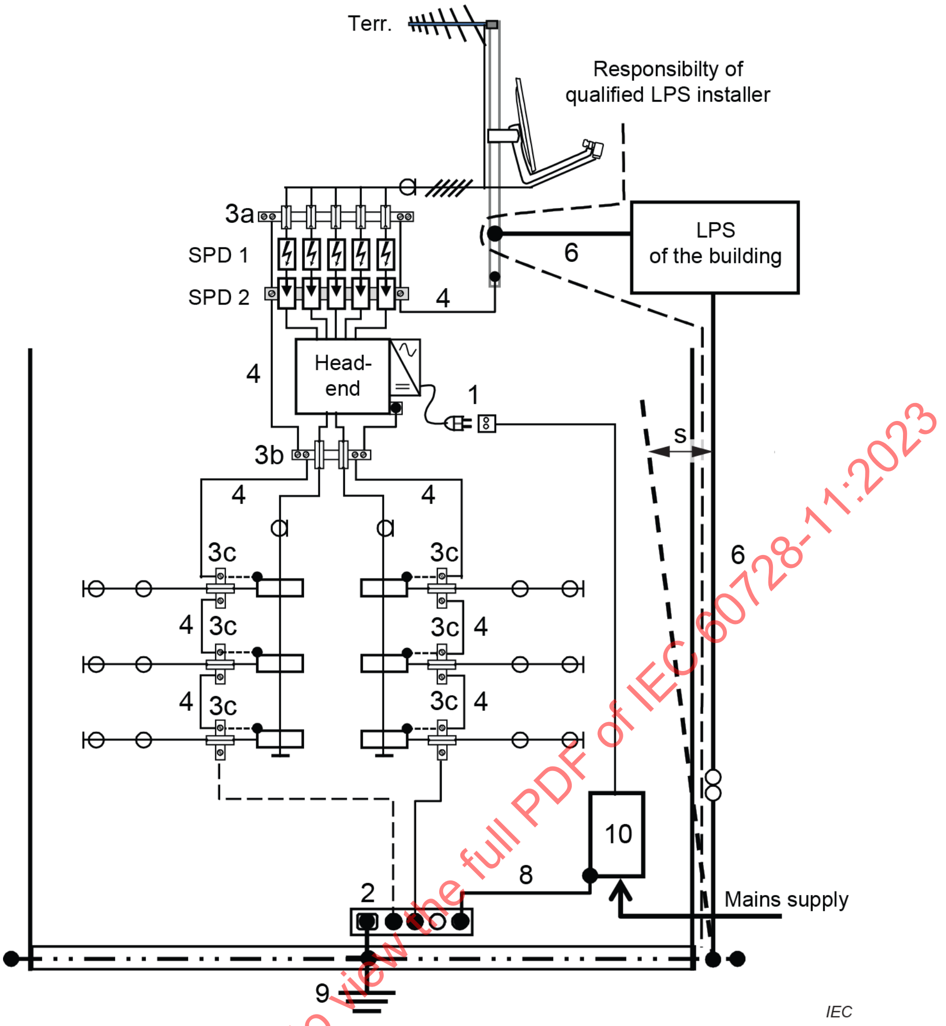
- metallic installations provided that:
  - – local regulations allow it,
  - – the electrical continuity between various parts is made durable,
  - – their dimensions are at least equal to those specified for standard earthing conductors;

  NOTE 1 According to IEC 60364-5-54:2011 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 C.11.



Key

1	Mains supply	2	Main earthing bar
3a, 3b, 3c	Equipotential bonding bars	4	Protective bonding conductors (minimum cross-section according to 6.2 c)
6	External earthing conductor of the buildings LPS (e.g. ≥ 50 mm^2 Cu) (see IEC 62305-3)	8	Protective conductor (PE)
9	Earth electrode	10	Mains power distribution box with SPD
S	Separation distance according to IEC 62305-3		

Figure 17 – Example of protecting an antenna system (not installed in a protected volume) by additional bonding 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 18:

- 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° or one earth electrode of at least 5m length, at least 0,5 m deep under the earth's surface and not closer than 1 m to the foundation (Figure 18c), 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, at least 0,5 m deep under the earth's surface and not closer than 1 m to the foundation (Figure 18b).

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

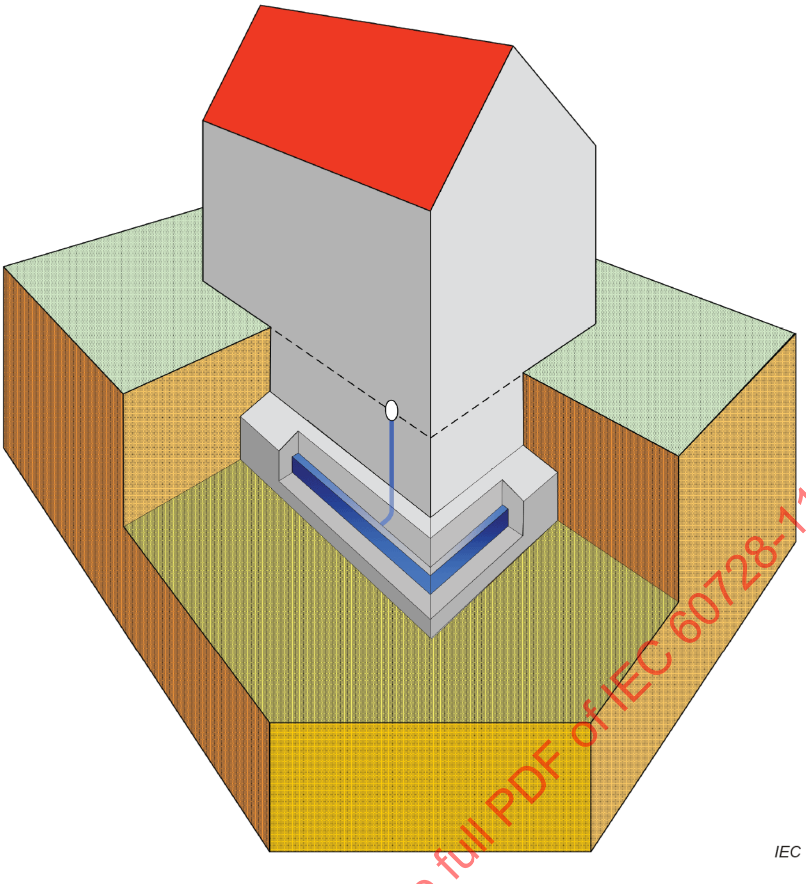


Figure 18a – Conductor in building foundations

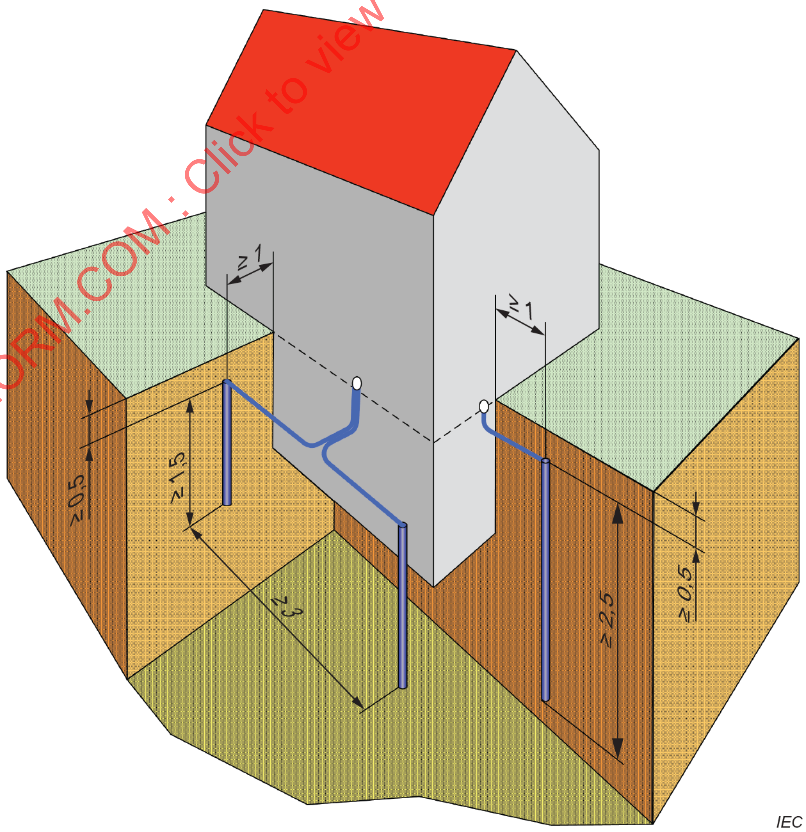


Figure 18b – Minimum dimensions of steel rod earth electrodes

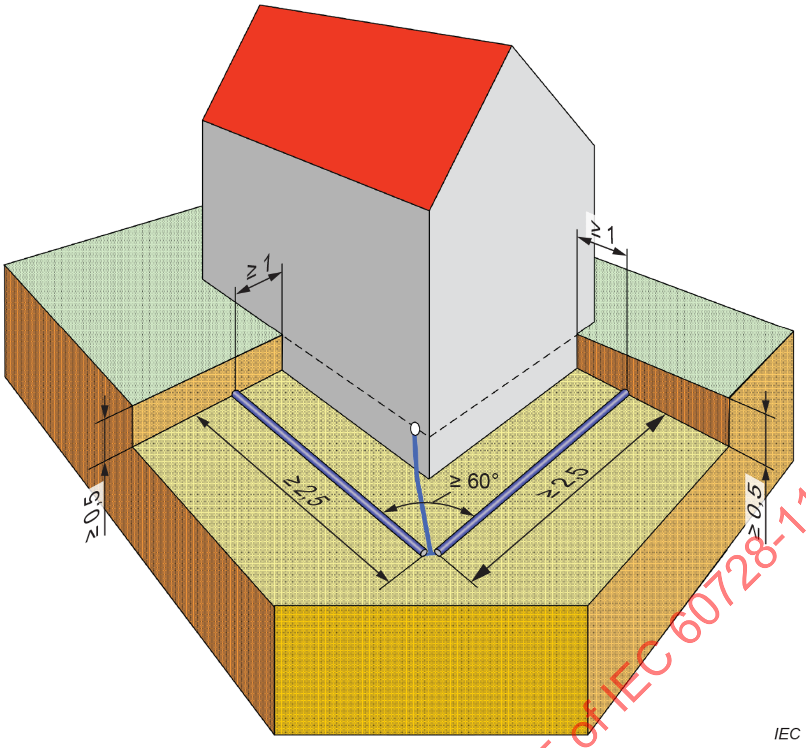


Figure 18c – Minimum dimensions of steel strip

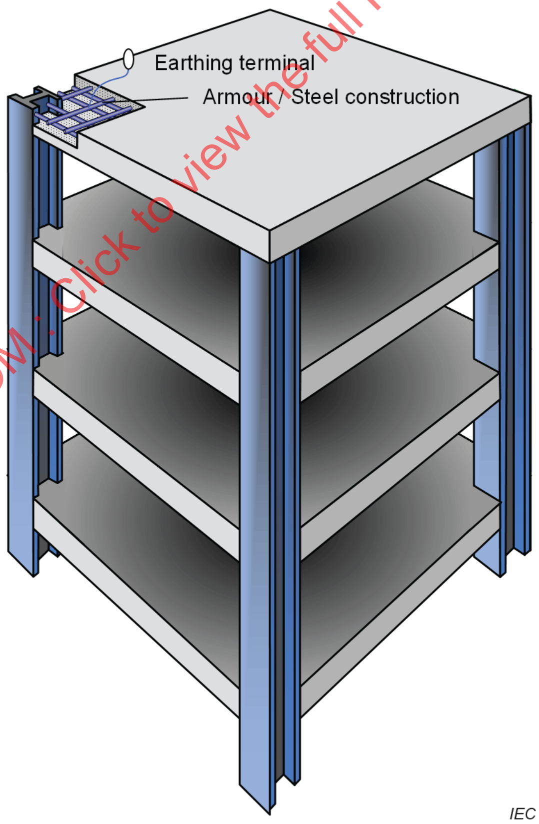


Figure 18d – Structural steel work

Figure 18 – Examples of earthing mechanisms

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 60364-5-54:2011.

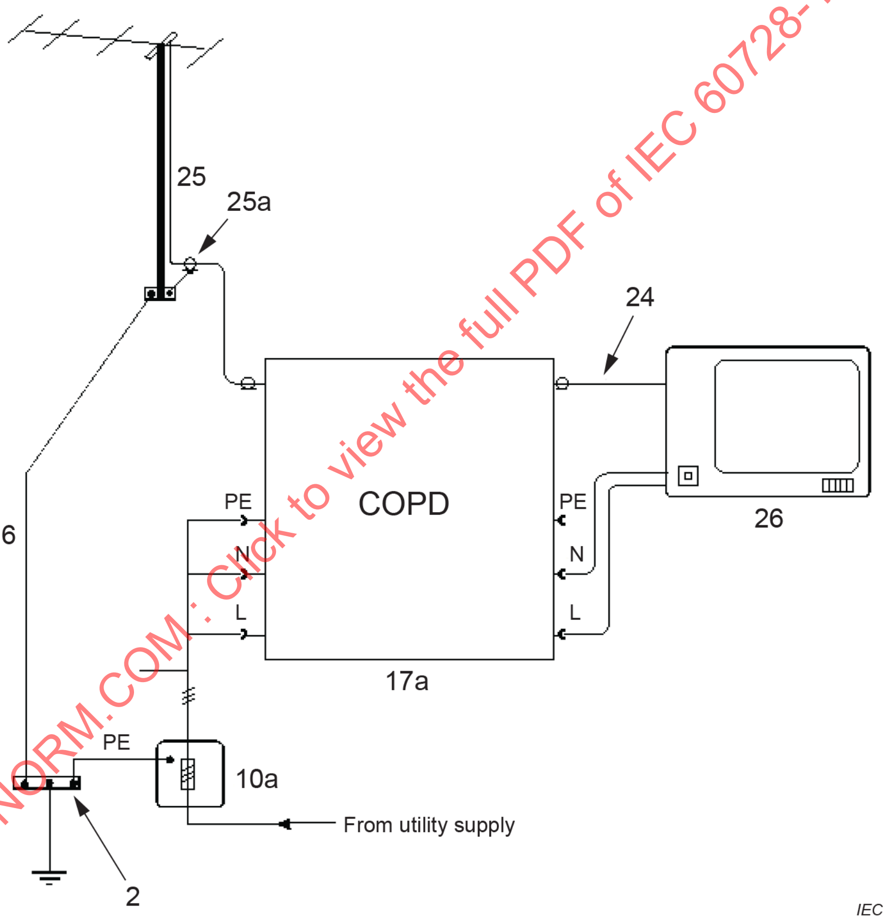
Natural components such as interconnected concrete reinforcing steel or other suitable underground metal structures, incorporated in the building's foundation and whose dimensions comply with the above-mentioned limits, can also be employed.

Other earth termination systems according to IEC 62305-3:2010, 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. An example of an overvoltage protective device for a single dwelling unit is shown in Figure 19.



Key

2	Main earthing bar	6	Earthing conductor
10a	House connection box	17a	Coaxial overvoltage protective device
24	Protected part	25	Coaxial cable
25a	Metallic shield of the coaxial cable connected to the antenna mast (a water-proof solution shall be selected)	26	Subscriber terminal

NOTE These kinds of overvoltage protective devices could be installed also in front of terminal equipment used in multi-dwelling units.

Figure 19 – Example of an overvoltage protective device for single dwelling unit

12 Mechanical stability

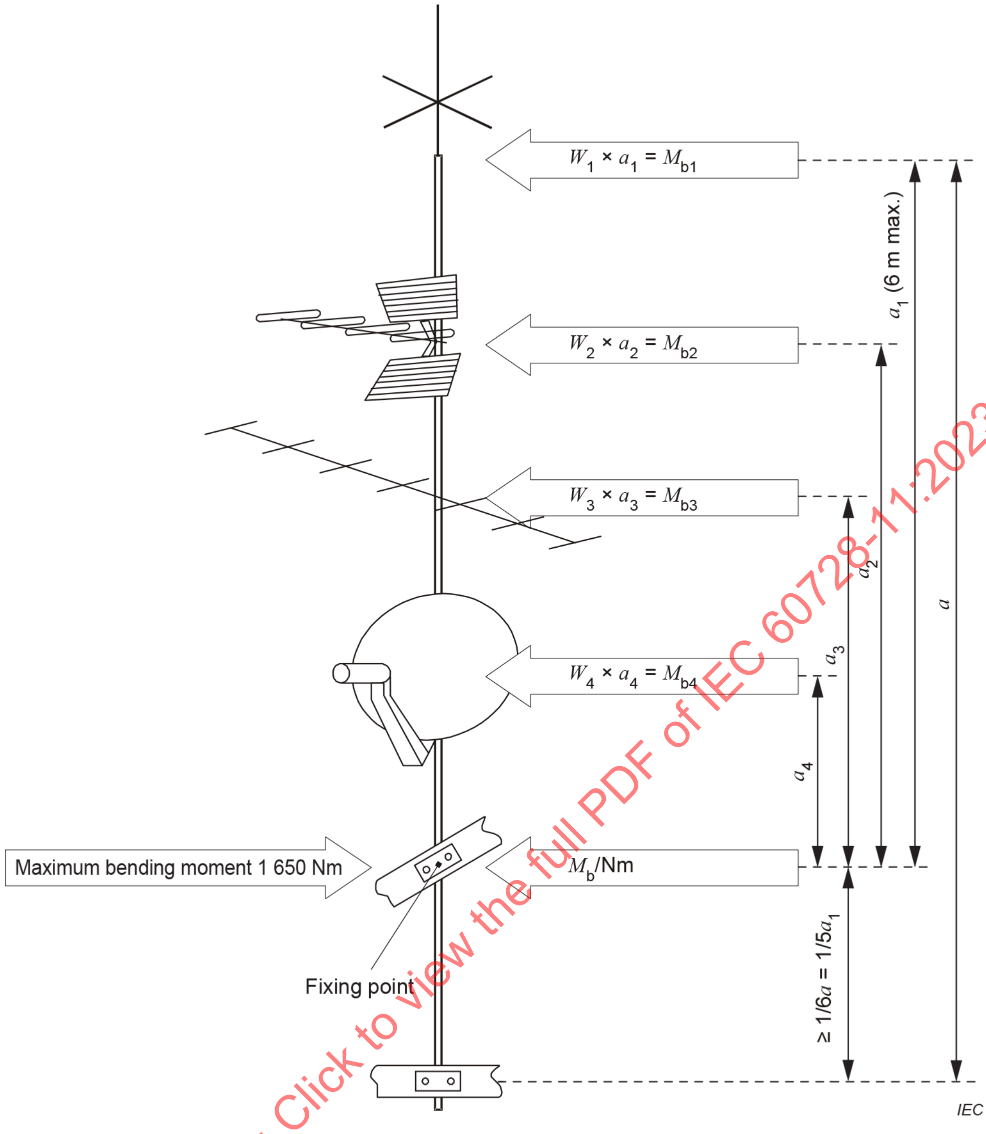
12.1 General requirements

This document 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 the example 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

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 For requirements in Japan, see Clause C.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 C.14.

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

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

where

W is the wind load, in newtons;

c is the load coefficient;

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

A is the component area, in square metres.

The coefficient c to be used is 1,2.

Loading due to snow and ice is not considered.

NOTE 2 Adverse environmental conditions or local regulations may require that a higher or lower wind-pressure value be 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:

$$M_\mathrm{b} = W_1\,a_1 + W_2\,a_2 + \ldots$$

where

M_b is the bending moment, in newton metres;

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

$a_1, a_2, \ldots$ 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
(normative)

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 Ohm's law:

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

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, as shown in Figure A.1, is therefore a vital factor in ensuring that no hazardous touch voltage exists for the bonded structure.

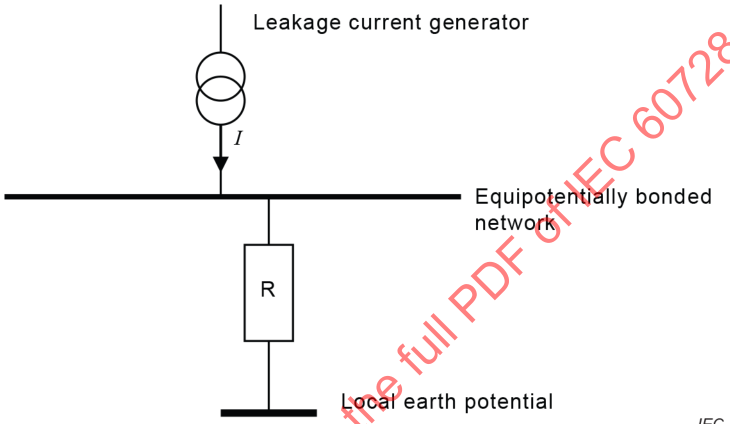


Figure A.1 – Systematic of earth loop resistance

If a general case, as shown in Figure A.1, is considered the touch voltage of the equipotentially bonded network shall 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 touch current of 0,5 mA RMS for devices covered, 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 5 mA RMS as defined in IEC 62368-1 and, therefore, the maximum summation of touch currents for connected Class II devices shall not exceed 5 mA RMS, otherwise equipotential bonding is mandatory. For methods of measurement, see IEC 60990.

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 is 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 equipotentially bonded an induced voltage can be present on the screen of the coaxial cable (see Clause A.3). Even with an equipotentially bonded system care shall be taken when installing and servicing the system to ensure that bonding continuity is maintained. In general, the risks to skilled 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.

– The touch hazard reaction (defined in IEC 60990:2016) 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 skilled 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. Skilled persons working on such an installation shall 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, or
  - 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; or
  - apply a functional earth to the system as detailed below.

The touch current hazard (safe let-go threshold current) defined in IEC 60990:2016 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 60479-1. For simple installations where equipotential bonding is not present, the number of interconnected items of Class II equipment shall be limited so that the aggregate leakage current does not exceed 3,5 mA RMS.

Note that the leakage current values given in IEC 60990:2016 and IEC 60479-1 are defined for persons. It is assumed that these figures are also applicable to animals.

For installation and servicing of installations the skilled person shall either:

- functionally earth the distribution amplifier and / or each of the coaxial cables at a central location, or
- 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, or
- ensure that any temporary bonding arrangements (for instance those shown in Figure 11 to Figure 16 and explained in NOTE 1 of these Figures) 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 shall 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 Ωm to 1 000 Ωm	One shield wire is necessary
ρ	= 1 000 Ωm 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 1 000
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 underground 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 a typical protection level based on each type of protection, K_p = 1 signifies no 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 formula:

$$K_p = \frac{\lg \frac{r_{12}}{r_{22}}}{\lg \frac{r_{12}^{\;2}}{r_{11} \times r_{22}}}$$

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.

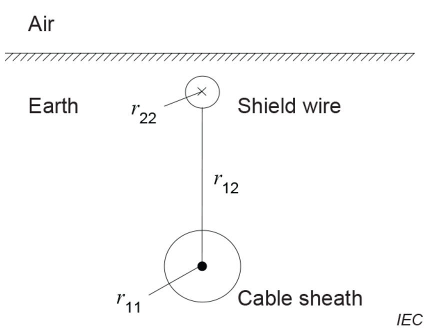


Figure B.1 – Principle of single shield wire