The challenge:
large-scale damage caused by approx. 1.5 million lightning strokes in Germany per year

Thunderstorms have always been a fascinating natural phenomenon. However, they also present a risk for man and the environment that should not be underestimated. Especially in July and August, electrical charging differences between clouds or cloud and the earth give rise to thundery fronts. The lightning strokes we perceive mostly consist of a negative current that flows from clouds to the earth. If a building is hit by a lightning strike the lightning current heats up both the impact point and the stonework. This poses a significant fire risk. Every year in Germany, lightning strikes cause damage amounting to several hundred million euros. Lightning protection systems installed professionally and in accordance with the regulations provide effective protection against direct lightning strikes.

The solution:
DIN/VDE-compliant lightning protection from OBO

The task of a lightning protection system is to intercept all lightning strikes entering a building. The lightning current must be intercepted at the impact point, be deflected towards the earth and distributed in the ground. The idea is to prevent thermal, mechanical or electrical effects that cause damage to the building to be protected, or humans through contact or step voltages inside the building.

A lightning protection system comprises:

External lightning protection:

1. **Interception system**
2. **Arrester**
3. **Earthing system**

Internal lightning protection:

4. **Lightning protection equipotential bonding system**
5. **Separating distance**

Principles of external lightning protection: standards, lightning protection classes, test classes and materials

The basis of your activities: Status of standards
Since November 2002, the standard series DIN V VDE V 0185 Parts 1 to 4 have provided the basis for general lightning protection. Standard series 0185 is broken down as described in Table 1. During the planning and installation of lightning protection systems, Part 3 – Protection of Buildings and Humans – is particularly important as it provides a simple description of external lightning protection systems in accordance with the recognised rules of technology.
Is is broken down into the following sections:

- Protection measures
- Lightning protection for special buildings
- Testing and servicing of lightning protection systems and equipment
- Maintenance and checking of lighting protection systems

Section 1	General principles
Section 2	Risk management, assessing the damage risk for buildings
Section 3	Protection of buildings and humans
Section 4	Protection of electrical and electronic systems in buildings

Classification of standard series DIN V VDE V 0185

Lightning protection classes and assignment
Before a lightning protection system is planned, the object to be protected must be assigned to one of four lightning protection classes. Efficiency in lightning protection class I is the highest at 99% and in lightning protection Class IV the lowest at 84% (see Table of hazard parameters). Installing a lightning protection system, e.g. distances from loops, protection profiles, distances from arresters, is more involved for lightning protection Class I systems than for lightning protection Class IV systems.

The required lightning protection class is determined by assessing the damage risk in accordance with DIN V VDE V 0185-2, unless specified in regulations. Directive VdS 2010 (risk-oriented lightning and surge protection, published by Gesamtverband der Deutschen Versicherungswirtschaft e.V., offers an alternative method of determining the lightning protection class (GDV).

Further information can be obtained from www.vds.de, via the OBO Hotline +49 (0) 23 73 / 89 - 15 00 or from www.obo-bettermann.com

Lightning protection class	Lightning current peak value min.	Lightning current peak value max.	Interception probability
I	2.9 kA	200 kA	99%
II	5.4 kA	150 kA	97%
III	10.1 kA	100 kA	91%
IV	15.7 kA	100 kA	84%

Hazard parameters in dependence of lightning protection classes

Application	Lightning protection class recommendation based on Directive VdS 2010
Ex-zones in industry and the chemicals sector	2
Computer centre, military applications, nuclear power stations	1
Museums, schools, hotels with more than 60 beds	3
Hospitals, churches, storage facilities, meeting places accommodating more than 100 to 200 people	3
Administration buildings, sales outlets, office and bank buildings with over 2,000 m2	3
Residential buildings with more than 20 apartments, multi-storey buildings over 22 m high	3
Private houses, offices and sales outlets, administration and bank buildings with less than 2,000 m2	No lightning protection

Lightning protection classes by building type

Material combinations: ++ recommended, O possible, - not recommended

Material	Steel, hot-dip galvanised (FT)	Aluminium (Al)	Copper (Cu)	Stainless steel (VA)
Steel, hot-dip galvanised (FT)	++	O	-	O
Aluminium (Al)	O	++	-	O
Copper (Cu)	-	-	++	O
Stainless steel (VA)	O	O	O	++

Substances and material
The following materials are preferred for use in external lightning protection systems: hot-galvanised steel, stainless steel (VA), copper, aluminium.

Materials: example of round conductor, 8 mm and vario rapid connector, type 249 in steel (FT), steel (VA), copper and aluminium.

Corrosion
A risk of corrosion occurs especially when joining different material types. Therefore, no copper parts may be installed above galvanised surfaces or above aluminium parts as copper particles worn away by rain or other environmental influences can penetrate the galvanised surface. In addition, a galvanic element occurs, which accelerates corrosion of the contact surface. As you can see from the example below, the copper connection on the steel water pipe is corroded and could become detached. If two different materials that are not recommended need to be joined, bi-metal connectors can be used. The example below shows the use of bi-metal connectors on a copper gutter to which an aluminium round conductor is attached. Points at increased risk of corrosion, such as insertion points into the concrete or soil, must be corrosion-protected. A suitable coating is to be applied as corrosion protection to connection points in the ground. Aluminium must not be placed directly (without a distance) on, in or under plaster, mortar or concrete or in the ground – the potential consequences of doing so are shown in our example, below right.
In the "Material combinations" table, possible metal combinations are evaluated with regard to contact corrosion in air.

Incorrect installation
Corroded connection caused by different material types

Correct installation
with bi-metal connector (Al/copper)

Incorrect installation
Corroded aluminium conductor caused by open installation on the wall

Principles of external lightning protection
Testing of lightning protection systems, tested components

Testing of lightning protection systems
Lightning protection systems should, even after the acceptance test, be checked at regular intervals to ensure correct functioning, establish any faults and carry out any necessary repairs. The test involves checking the technical documentation and inspecting and measuring the lightning protection system. The table shows the time intervals between the repeat tests.

Lightning protection class	Interval between the complete tests	Interval between the visual tests of buildings
I	2 years	1 year
II	4 years	2 years
III, IV	6 years	3 years

Time intervals between repeat tests

Measuring the earth resistance

Measuring surge arresters

- Checking all records and documentation, including compliance with the standards.
- General condition of interception and arrester equipment and all connecting components (no loose connections), check feed-through resistors.
- Checking the earthing system and the earthing resistors including transitions and connections.
- Checking internal lightning protection, including surge arresters and fuses.
- General corrosion status.
- Reliability of fastening the lines of the LPS and its components.
- Documentation of all modifications and upgrades to LPS and modifications to buildings.

The testing and servicing activities should be carried out on the basis of the standard and the technical principles of DIN V VDE V 0185 Part 3-3. The following points must be observed: the tests also comprise checking the internal lightning protection system. This includes checkking the lightning protection equipotential bonding and the connected lightning and surge arresters.

A test report or test log is used to record the testing and servicing of lightning protection systems and must be updated or recreated at each test/service.

Test class	Tested with	Application
H	3x I_{imp} 100 kA (10/350)	Interception system
N	3 x I_{imp} 50 kA (10/350)	Several arresters,over which the lightning current can split (min. 2 arresters)

Test classes of connecting components

Connections (tested lightning protection components)
Previously, components for lightning protection systems were specified by the standard series DIN 48801 to DIN 48852, whereby the focus was on component measurements. In August 1999, EN 50164-1 (DIN/VDE 0185 Part 201) came into force and provided the basis for testing connecting components. After a conditioning phase lasting ten days, the components are impacted with three lightning strikes.

Principles of external lightning protection
Separating distance

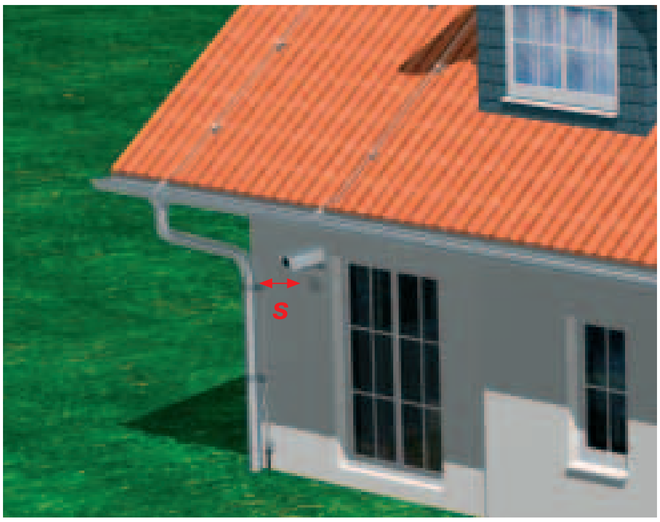
All metallic parts of a building and electrically-powered equipment and their supply cables must be integrated into the lightning protection system. This measure is required to avoid dangerous sparking between both interception system and arrester and also the metallic building parts and electrical equipment.

Separating distance
If there is an adequate distance between the conductor passing from the lightning current and the metallic building parts, the risk of sparking is practically non-existent. This distance is described as the separating distance (s). Page 121 describes how this separating distance is calculated.

Components with direct connection to the lightning protection system
A separating distance does not have to be observed in buildings with cross-connected, reinforced walls and roofs or with cross-connected metal facades and metal roofs. Metallic components with no conductive lead into the building to be protected and whose distance to the conductor of the external lightning protection system is less than one metre, must be connected directly to the lightning protection system. These include, although are not limited to, metallic railings, doors, pipes (with non-flammable and/or explosive content), facade elements, etc.

Situation	Solution
Metallic structures such as railings, windows, doors, pipes (with non-flammable and/or explosive content) or facade elements, **without conductive lead** into the building.	Connecting the lightning protection system with the metallic components.
Air-conditioning system, photovoltaic systems, electrical sensors/actuators or metallic vent pipes **with conductive lead** into the building.	Insulation by separating distance (see also examples on this double page).

Incorrect installation
Non-observed separating distance s – connection via isolating spark gaps is no longer permitted, the illumination must be set in the interception zone of an interception rod.



Correctly observed separating distance s between arrester equipment and surveillance camera

Calculating the separating distance

The distance is calculated using the following formula:

$$s = k_i \frac{k_c}{k_m} L(m)$$

Step 1:
Calculate the value of the coefficient k_i

k_i is dependent on the selected protection class of the lightning protection system.

Protection class	k_i
I	0.1
II	0.075
III, IV	0.05

Step 2:
Calculate the value of the coefficient k_c

(simplified system) k_c is dependent on the lightning current that flows into the arresters.

Number of arresters *n*	Approximate values k_c	Detailed values (precise values are contained in DIN V VDE V 0185 Part 3)
1	1	1
2	0.66	1 ... 0.5
4 and more	0.44	0.5 ... 1/*n*

Step 3:
Calculate the value of the coefficient k_m

k_m is dependent on the material of the electrical insulation.

Material	k_m
Air	1
Concrete, tiles	0.5

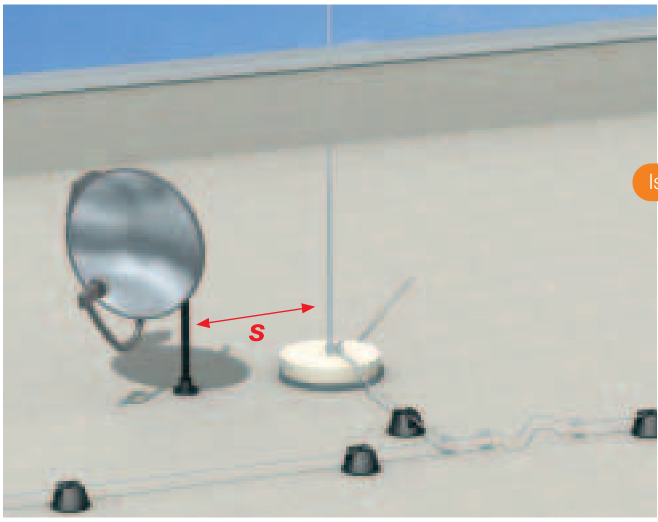
Step 4:
Calculate the value *L*

L is the vertical distance from the point at which the separating distance s is to be calculated up to the closest point of the equipotential bonding.

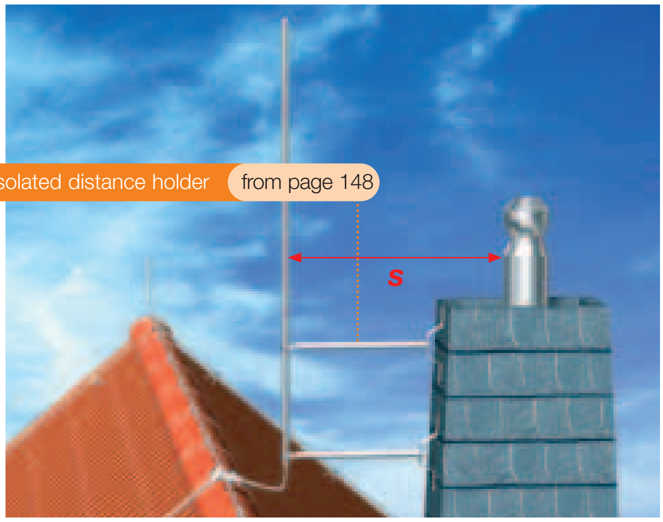
An example:

- Building with more than 4 arresters
- Lightning protection Class III
- Maximum distance*L* = 10 m high
- k_i = 0.05 m
- k_m = concrete, tiles= 0.5

- **Separating distance = 0.44 m**



Correctly observed separating distance s between interception system and SAT system



Correctly observed separating distance s between intercepting system and stainless steel chimney