Lightning Protection
Surge Protection
Safety Equipment

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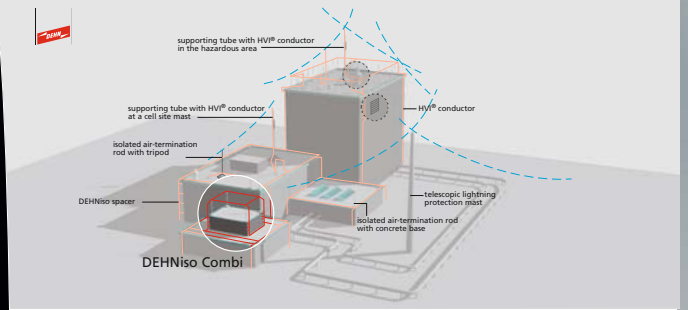
For more information material and services e.g.

- Lightning Protection main catalogue
- DEHNsupport Toolbox
- Lightning Protection Guide
- Appointment with our sales engineer

please visit our homepage:
www.dehn.de “Service“ section

Reliable System Solutions for Isolated Air-Termination Systems.

DS151/E/0810



DEHNiso Combi – modular, versatile and robust.

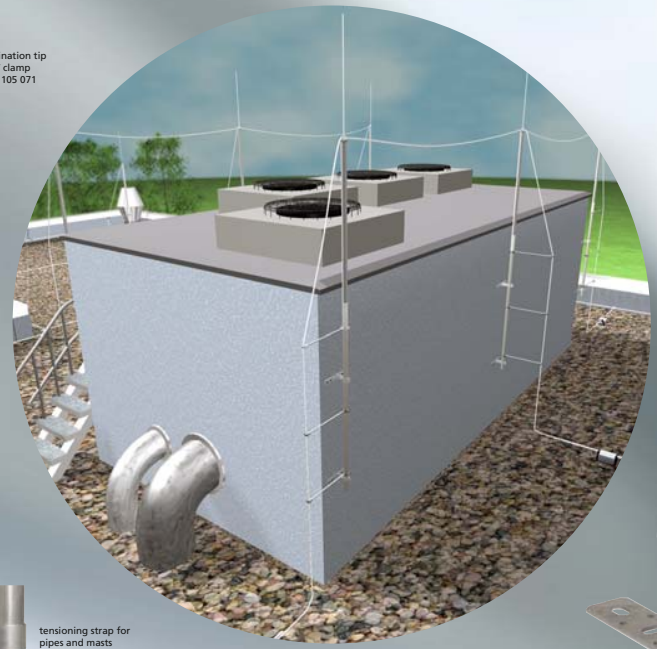
DEHNiso Combi is a practice-oriented, modular and flexible component programme which meets the mechanical and constructive requirements on site. The components of the DEHNiso Combi system allow to use isolated air-termination systems for complex contours of the volume to be protected. Electrical and metal installations protruding above the roof are protected against lightning strokes and coupling of parts of the lightning current into the building is prevented. If the separation distance s is considered, an uncontrolled flashover (sparks) can be prevented and partial lightning currents cannot enter the building/installation. The separation distance can be calculated based on EN 62305-3. The DEHNiso Combi programme allows for installation of the following components:

- Air-termination rods with conical protection zone,
- Four and more air-termination rods with a large protection zone,
- Isolated air-termination systems with tripod.

Pipes or profile systems, walls or corners: the fixing system of the DEHNiso Combi component programme offers solutions for every application.
An insulating piece in the supporting tube and a glass-fibre reinforced plastic spacer bar allow for maintaining the separation distance. Bars come in standard lengths and individually adjustable lengths and are mounted firmly or can be inserted into a fixing socket. A material factor $k_m = 0.7$ is used for determining the separation distance (length of the spacer bar). Besides the standard air-termination rod support, supports for wires are also available.
Tripods with fixed terminals (concrete base) can be used for installing isolated air-termination rods which have to withstand high wind loads. The DEHNiso Combi system allows for easy installation of isolated air-termination systems.

DEHNiso Combi set
Part No. 105 440

air-termination tip
with MV clamp
Part No. 105 071



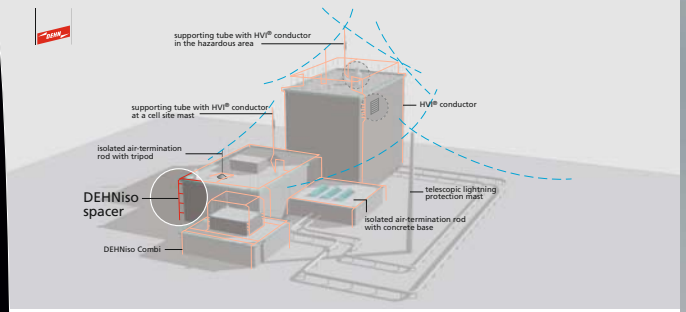
tensioning strap for
pipes and masts
Part No. 105 360

supporting tube
Part No. 105 300

mounting bracket for even
installation locations
Part No. 105 340

For the entire DEHNiso Combi programme and additional technical information, please refer to our Lightning Protection main catalogue and to installation instructions 1475.

DEHNiso Combi

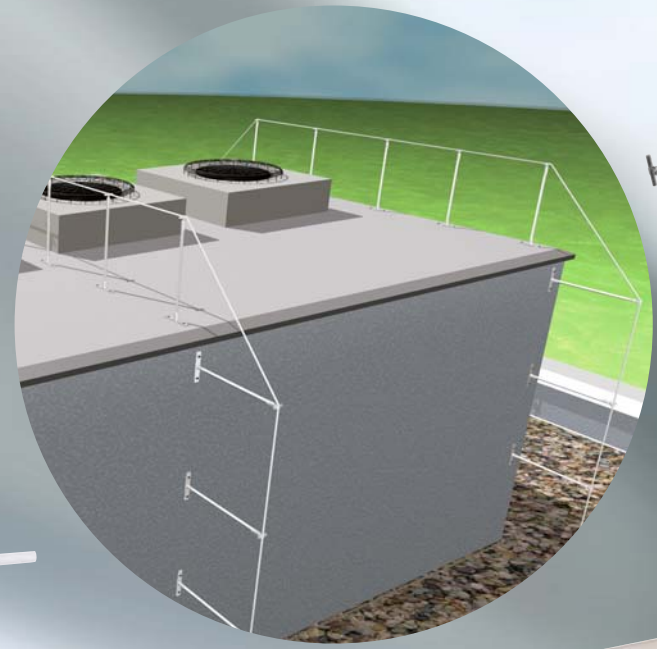


DEHNiso spacer – versatile, durable and elegant.

The DEHNiso spacer system is a practice-oriented and versatile component programme. This system offers easy and cost-effective solutions for almost every application. The spacer system can be used as static support for isolated air-termination rods (diameter 16 mm). Provided that the separation distance s (material factor k_m = 0.7) is observed, the installation of ring conductors is also possible. Thus, e.g. an air-termination rod (diameter 16 mm) can be directly attached to the structure to be protected via spacers if the separation distance is maintained. The relevant down conductor can also be installed directly at the structure to be protected by means of spacers. Standard lengths up to 1 m with pre-mounted fixing elements and pre-mounted conductor holders and/or rod holders are available. If special lengths are required, spacers can be assembled of 3 m rods and the relevant individual components. Even though projects requirements are versatile, installation vehicles have only limited loading capacities. Therefore, DEHN + SÖHNE does not only offer set solutions but also a modular DEHNiso system.

spacer with twin screw cleat and fixing plate (also suitable for flat structures)
Part No. 106 115

spacer with pipe clamp for fixation at round components
Part No. 106 245



pipe clamp with fixing socket for spacer bar ø 16 mm
Part No. 106 352

angle fixing with clamping bolt for spacer bars ø 16 mm
Part No. 106 321

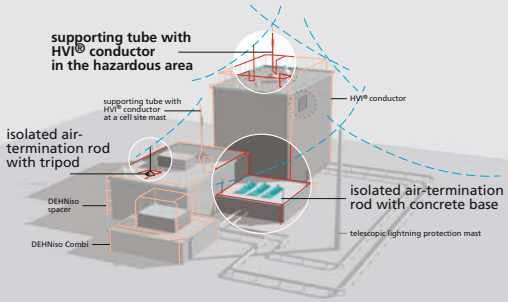
spacer with rod holder
Part No. 106 178

spacer bar (can be cut to length for variable solutions, l = 3 m)
Part No. 106 125

adapter for angled support for robust fixation of air-termination rods
Part No. 106 325

For the entire DEHNiso Combi spacer programme and additional technical information, please refer to our Lightning Protection main catalogue.

DEHNiso spacer



Isolated air-termination rods – easy to install, stable and weight-optimised.

Isolated air-termination rods allow integration of large superstructures into protection zone 0_B without mechanically contacting or drilling installations with roof superstructures, air conditioning systems or fans. Air-termination rods can be inserted into tripods which are positioned on the roof area or on the ground. Stability has to be ensured considering the wind load zones and wind velocities stipulated by the relevant standard. The map shows that approximately 95% of the surface of Germany is covered by wind zones I and II. For this reason, air-termination rods are generally designed for wind zone II. Depending on the occurring loads, it has to be verified separately if isolated air-termination rods can be used in wind zones III and IV.

Zone	Dynamic pressure q [kN/m²]	Wind velocity v [km/h]	Wind force
I	0,8	126,7	12–17
II	1,05	145,1	
III	1,4	161,5	
IV	1,7	184,7	

isolated air-termination rod with braces 6 - 8.5 m
Part No. 105 600 - 105 850

isolated air-termmination rod with tripod 12 m / 14 m
Part No. 105 912 / 105 914

air-termination tip
Part No. 105 071

spacer
Part No. 106 228

DEHNiso Combi supporting tube
Part No. 105 300

isolated air-termination rod available from 4 m to 5.5 m
Part No. 105 400 - 105 550

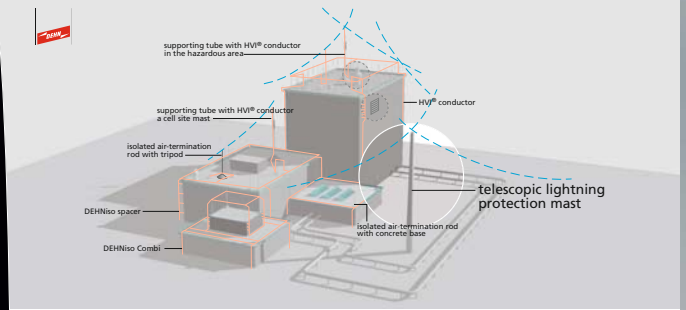
wedged concrete base
Part No. 102 010

base plate for concrete base
Part No. 102 050

tripod for DEHNiso Combi supporting tube
Part No. 105 200

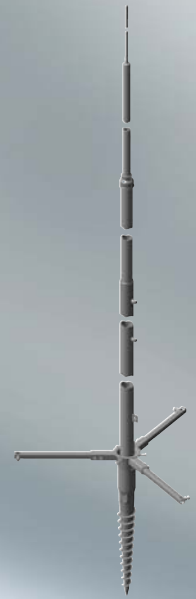
For the complete DEHNiso air-termination rod programme and additional technical information, please refer to our Lightning Protection main catalogue and to installation instructions 1436.

Isolated air-termination rods



DEHN telescopic lightning protection masts – easy to transport, practical and cost-effective.

It is useful to apply the protective angle method to plain buildings. The values of the protective angle depend on the class of LPS and the height of the air-termination rod.
The separation distance s between the air-termination rod and the structure to be protected has to be observed in accordance with EN 62305-3. The telescopic lightning protection masts come in different lengths.



DEHN telescopic lightning protection mast with screw-in foundation

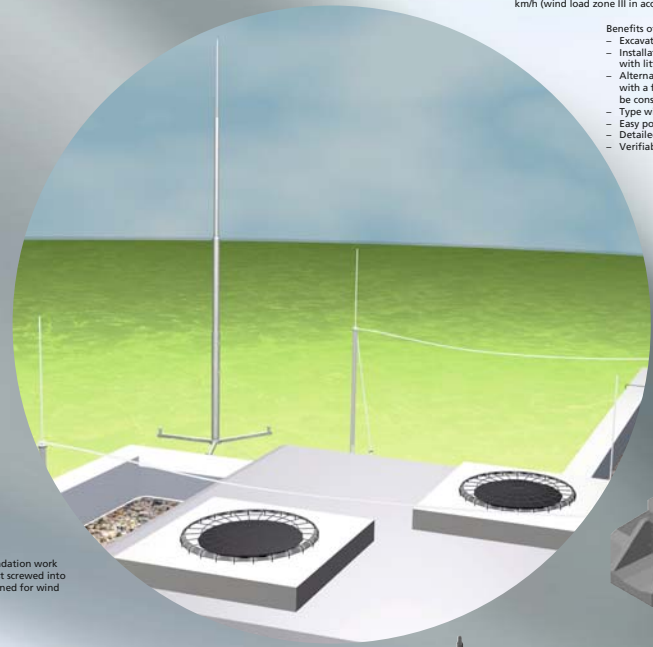
The masts are installed with a screw-in foundation. No digging or foundation work is necessary. Without special preparation the screw-in foundation is just screwed into the ground and fixed additionally with earth rods. The masts are designed for wind velocities up to 145 km/h (wind load zone II according to DIN 4131).

Height above ground from 6 m to 11 m.

Part No. 103 121 - 103 126

For further details, please see also installation instructions No. 1581.

For more technical information, please refer to our Lightning Protection main catalogue.



DEHN telescopic lightning protection mast in a bucket or concrete foundation

The masts are installed on site in a bucket foundation (finished part) or in a concrete foundation with a foundation basket (to be ordered separately).

For more detailed information on the plug-in system, foundation and installation, please refer to our lightning protection catalogue. The masts are dimensioned for wind speeds up to 161 km/h (wind load zone III in accordance with DIN 4131).

Benefits of the air-termination mast system:
- Excavation work can be completed in advance
- Installation on site in a bucket foundation (finished part) with little effort or
- Alternatively installation on site in a concrete foundation with a foundation basket (hardening time of concrete has to be considered for time scheduling and installation)
- Type with flange plate for fast installation
- Easy positioning due to M24 threaded bolt
- Detailed installation instructions
- Verifiable statics (on request)

Max. transport length of 6 m.

Available with a height above ground from 13.35 m to 24.85 m.

Part No. 103 013 - 103 025

For more detailed information, please refer to installation instructions No 1729.

Bucket foundations for telescopic lightning protection masts

Bucket foundation (finished part) for easy installation of telescopic lightning protection masts. No concrete work required on site.

Part No. 103 030 and 103 031

Foundation baskets for concrete foundation on site

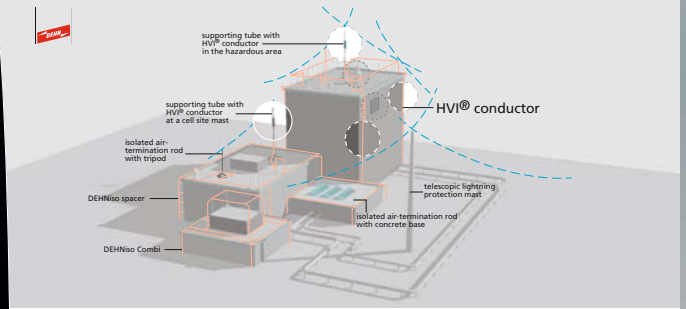
To be encased in concrete, with threaded bolt, compatible with the flange plate of the telescopic lightning protection masts.

Part No. 103 040 and 103 041

Source: AW Elektro Automatisierungstechnik, Stadtlohn / Germany

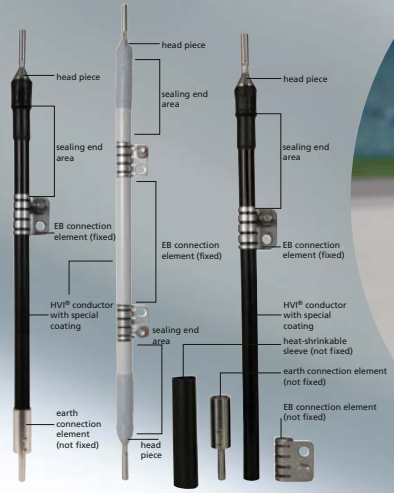
DEHN telescopic lightning protection masts

Source: Bischof Blitzschutz, Weyhe / Germany



DEHNconductor system HVI® conductor – durable, universal, tried and tested.

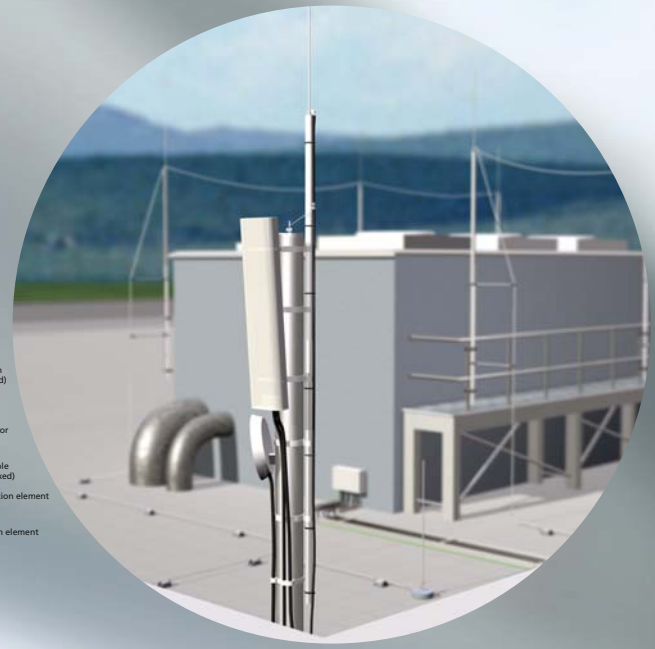
High impulse voltages cause flashovers at the surface of insulating materials if no additional protection measures are taken. This effect is known as creeping flashover. If the creeping discharge inception voltage is exceeded, a surface discharge occurs which may range over a distance of several metres without any problems. In order to avoid creeping discharges, the HVI® conductor is equipped with a special external coating which allows for diverting high lightning impulse voltages to a reference potential. In the sealing end area, the external special coating is connected to the equipotential bonding structure of the building where no parts of the lightning current flow, e.g. at earthed metal roof superstructures in the protection zone of the lightning protection system, at earthed parts of the building construction which are free of lightning currents or at the protective conductor of the low-voltage system. Under certain conditions, the special coating can be connected to parts of the lightning protection system such as air-termination system and other down conductors. For this purpose, it has to be ensured that the calculated separation distance does not exceed 35 cm in air at the contact point. In this case, the special external coating has to be directly connected to the part through which lightning potential flows via an equipotential bonding connection element. The black coaxial HVI® conductor with an outer diameter of 20 mm and the grey coaxial HVI® conductor with an outer diameter of 23 mm consist of a 19 mm² copper wire, a thick-walled, high-voltage-resistant insulation and a weatherproof special external coating. In order to prevent low-energy flashovers due to capacitive displacement currents, the HVI® conductor can be additionally connected to the equipotential bonding structure during conductor installation. These connections do not have to be capable of carrying lightning currents as the capacitive displacement currents have low energy and do not cause dangerous sparking. Extensive measurements show that the HVI® conductor with its high electric strength has an equivalent separation distance of s = 0.75 m (air).



HVI® conductor I
Part No. 819 020

HVI® conductor II
Part No. 819 024

HVI® conductor III
Part No. 819 022



For more technical information, please refer to our Lightning Protection main catalogue and to installation instructions 1566.

spacer for supporting tubes at omnidirectional antennas
Part No. 105 363

HVI® conductor and supporting tube for biogas plants
Part No. 819 750

HVI® conductor in the supporting tube
Part No. 819 320

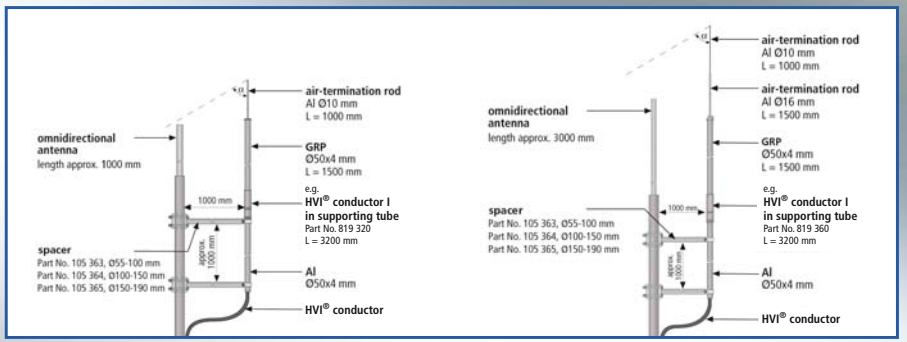
DEHNconductor system HVI® conductor

Product range of the HVI® conductor.

The prewired HVI® conductor I is equipped with a head piece and an earth connection element at delivery. The earth connection element is pre-mounted in its delivery condition. Thus, the length of the HVI® conductor can be adjusted (shortened) on site and the earth connection element can be installed. HVI® conductor I is used e.g. for directly connecting the air-termination system to the earth-termination system of the structure. An equipotential bonding element is firmly attached at the end of the sealing end area for the connection of the HVI® conductor to the equipotential bonding (EB) structure.
At delivery, the prewired HVI® conductor II is equipped with two adjusted head pieces the length of which cannot be changed on site.
The prewired HVI® conductor III is equipped with a fixed sealing end consisting of a head piece and a fixed equipotential bonding element. An additional sealing end at the end of the conductor can be established on site. The components required for this (connection element with heat-shrinkable sleeve and equipotential bonding element) are not fixed at delivery. This allows for adjusting the length of HVI® conductor III on site.
HVI® conductors II and III are used if e.g. several parts of a plant to be protected are not supposed to be connected individually but jointly to the earth-termination system of the structure via a separate ring conductor (consideration of the separation distance).

The HVI® conductor can also be installed in the supporting tube at locations with special architectural requirements.

Isolated air-termination systems for antennas and emitting characteristics / omnidirectional antennas.



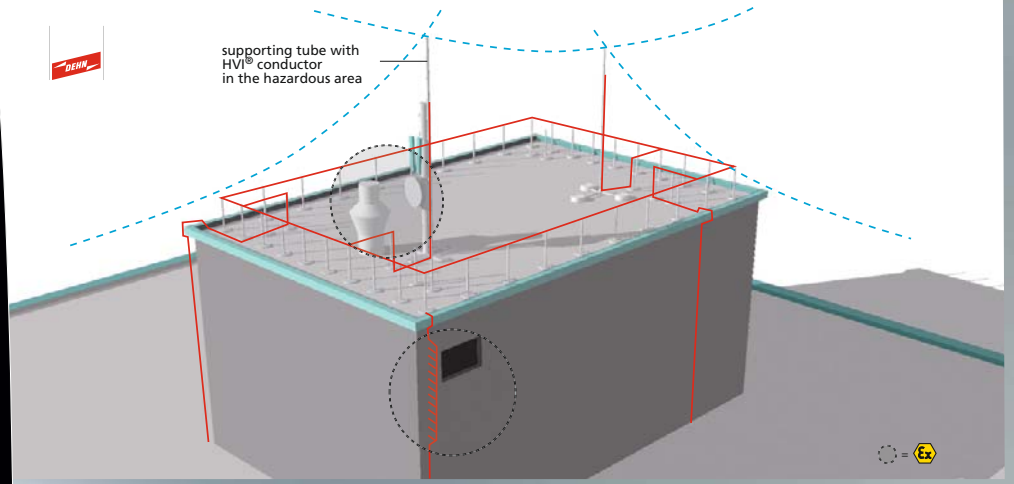
Antennas with 360° emitting characteristics (omnidirectional antennas) are used for different radio applications.
When installing isolated air-termination systems for omnidirectional antennas, it has to be considered that an isolated air-termination rod with a sufficient protective angle covers the antenna to be protected. Furthermore it has to be ensured that a sufficient separation distance is maintained.

From a functional point of view, a distance has to be kept between the antenna and the air-termination system, which corresponds to a quarter of the wave length of the radio frequency used. Installation instructions No. 1521 have to be observed.

Units:	
Hz	m
Frequency [F]	Wave length [λ]
100 000	3000
1 000 000	300
10 000 000	30
80×10^6	3.75
100×10^6	3
160×10^6	1.875
900×10^6	0.33
1800×10^6	0.17

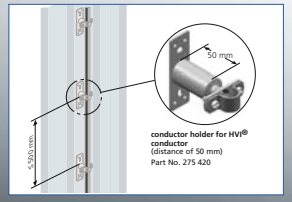
Covered by DEHN spacers for omnidirectional antennas.

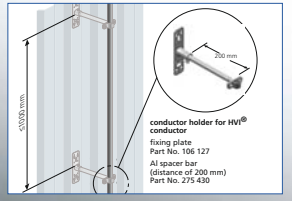
Protection of omnidirectional antennas

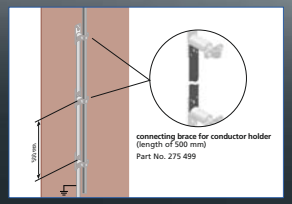


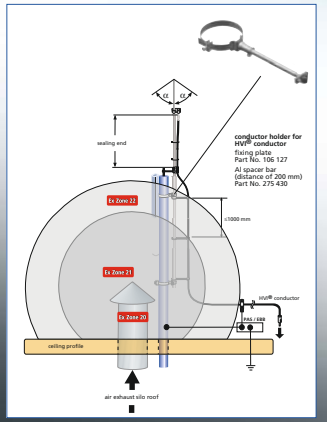
DEHNconductor system HVI® conductor in the hazardous area – approved and certified.

Special measures have to be taken to protect all industrial sectors against explosion in which the processing or transport of combustible substances causes gases, vapours, mist or dusts creating a potentially explosive atmosphere with air. Depending on the probability and duration of the occurrence of potentially explosive atmospheres, the areas of the potentially explosive system are divided into zones which are referred to as hazardous areas. Annex D of EN 62305-3 provides detailed information on lightning protection systems for potentially explosive systems taking into consideration threats posed by direct and indirect lightning strokes, causes of damage, structures to be protected and protection measures to be taken.
Due to the ever increasing complexibility of systems, effective protection in case of lightning strokes and surges becomes more and more important. Legislation e.g. the Landesbauordnungen (German building regulations) and Betriebssicherheitsverordung (German Health and Safety at Work Regulations) calls for lightning protection measures for structures housing potentially explosive facilities such as paint facilities, chemical facilities, large warehouses with combustible liquids and large gas tanks with a high fire risk. The DEHN conductor system allows for the installation of an external lightning protection system in hazardous areas 1 or 2 and 21 or 22. Installation instructions No. 1501 have to be observed.









DEHNconductor system HVI® conductor

No proximities with DEHNcon-H.

Metal and electric superstructures protruding above the roof are particularly exposed lightning striking points. If the external lightning protection system is installed correctly, that is with an isolated air-termination system for these roof superstructures, partial lightning currents do not enter the building.

The new lightning protection standard EN 62305-3 (VDE 0185-305-3), the safety standard for antenna installations EN 60728-11 (VDE 0855-1) as well as supplement 1 of DIN VDE 0845 for surge protection of IT systems call for an isolated lightning protection system or an isolated air-termination system for antenna installations or other installations protruding above the roof.

DEHNcon-H

The variable component system consists of the following components:

- **HVI® conductor light**, a refined insulated down conductor, which is installed in a supporting tube with air-termination tip
- Fixing elements, conductor holders and other accessories

The equivalent separation distance of the HVI® conductor light is $s \leq 0.45$ m (in air) or $s \leq 0.90$ m (solid material).

DEHNcon-H comes with a practice-oriented design since the dimensions of the supporting tubes were reduced. Another benefit of DEHNcon-H is the reduced weight of the total structure. This allows for already existing antenna masts to be retrofitted with DEHNcon-H.

Possible applications are protection against direct lightning strokes into:

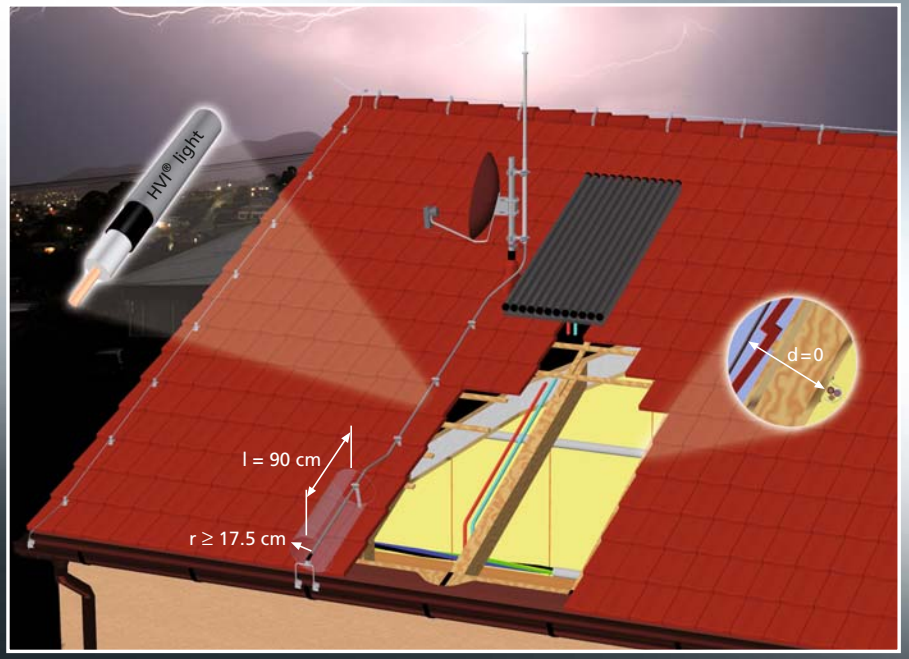
- Antennas (satellite antennas, terrestrial antennas, DVBT receiver installations)
- Photovoltaic and solar thermal systems
- Object surveillance systems

For a complete component overview, please refer to our Lightning Protection main catalogue. For more detailed information on DEHNcon-H, please refer to installation instructions No. 1632.

Roof conductor holder
height of 175 mm
Part No. 202 836

Roof conductor holder
height of 75 mm
Part No. 202 831

Fixing clamp
made of StSt (V2A)
Part No. 105 161



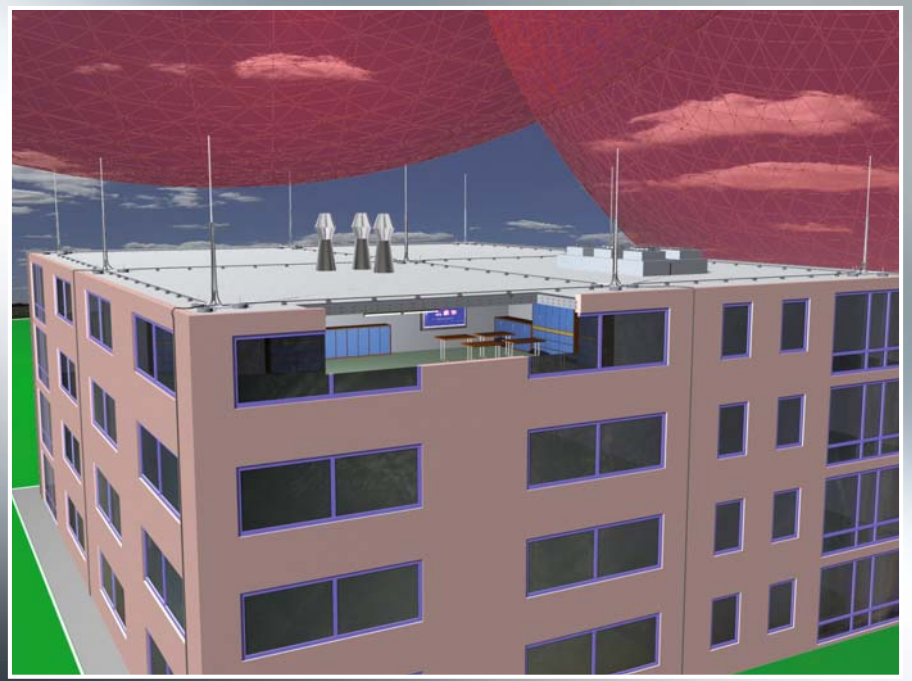
DEHNcon-H

HVI® conductor light.

Nowadays roof areas of industrial and office buildings are often the last installation level. Regardless of the risk of possible lightning strikes, pipes e.g. for ventilation systems, electrical and IT systems are installed on the roof area. All theses systems have electrical links into the building which allow for inducing partial lightning currents. Isolated air-termination systems prevent partial lightning currents from being induced into buildings where they may interfere with or even damage sensitive electrical / electronic equipment.
If bare, non-insulated wires of the air-termination system are directly installed on the roof, the separation distance to electric and metal systems situated underneath the roof area has to be observed according to the state of the art and the current EN 62305-3 lightning protection standard. The separation distance has also to be observed in standard residential buildings with steep roofs. Various conductors, pipes and large metal-coated thermal insulation systems underneath the roofing are located close to the air-termination system and down conductor so that the problem of proximity arises.
Isolated air-termination systems with high-voltage-resistant down conductors, HVI® conductors, provide the solution to this problem.
The air-termination system is installed e.g. conventionally by means of air-termination rods which are mounted on a GRP pipe for insulation/electrical isolation from the roof.

The length of air-termination rods or an arrangement of several air-termination rods is selected in such a way that the protection zone is sufficiently large. If an individual air-termination rod is used, the protection zone is the area formed by the protective angle. If two air-termination rods are used, a tent-shaped protection zone is formed beside the air-termination rods and between these two air-termination rods. If several air-termination rods are arranged, an entire large protection zone is formed underneath the air-termination rods according to the rolling sphere method.
The newly developed HVI® conductor light, an extension of the tried and tested DEHNconductor system, offers various design options for external lightning protection systems. There are also connection types of the HVI® conductors light which require no sealing end for connection to the equipotential bonding element in the connection area. The coupling point at the tripod has to be effected in a defined way so that a functional earth conductor is not required. This allows for easy installation and consequently saves a lot of time.

For a complete component overview, please refer to our Lightning Protection main catalogue. For more detailled information on the HVI® conductor light, please refer to installation instructions No. 1637.



HVI® conductor light

Isolated air-termination systems for protecting roof superstructures considering the separation distances according to standard requirements

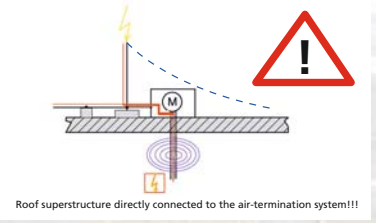
According to the state of the art of lightning protection systems, large roof superstructures should be protected against direct lightning strokes by isolated air-termination systems. Electrical isolation of the lightning protection system from conductive parts of the building construction (metal construction parts, reinforcement, etc.) and isolation with regard to electrical conductors in the building prevent lightning currents from flowing through control and supply lines as well as interference / destruction of sensitive electrical and electronic installations.

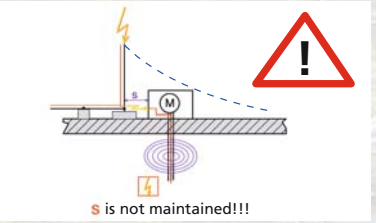
In accordance with the current EN 62305-3 standard, air-termination rods and/or elevated air-termination systems (ring conductors or spanned cables) should be installed taking the calculated separation distance into account in order to protect roof superstructures on buildings against lightning strokes. Three methods can be used for determining the arrangement and position of air-termination systems:

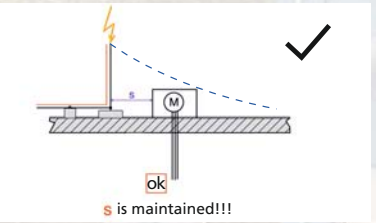
- Rolling sphere method
- Protective angle method
- Mesh method.

The mesh size, the radius of the rolling sphere and the protective angle depend on the class of LPS. The rolling sphere method as universal design method should be used particularly for geometrically complicated applications. A risk analysis in accordance with EN 62305-2 has to be carried out to determine the class of LPS. When using the protective angle method, the protective angle of an air-termination system depends on the selected class of LPS of the lightning protection system and the height of the air-termination system above the area to be protected.

We recommend to use the DEHN Distance Tool software for the calculation of the separation distance.



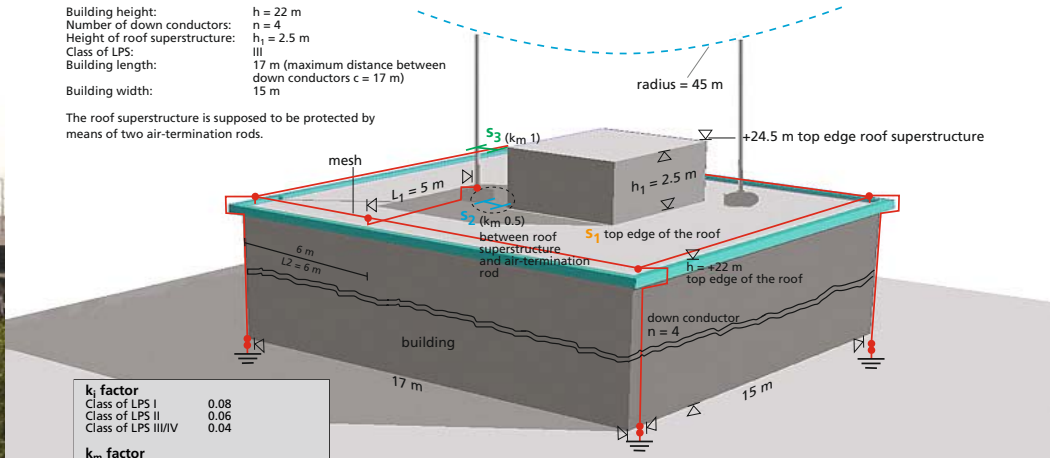




Building data

Building height: h = 22 m
Number of down conductors: n = 4
Height of roof superstructure: h_1 = 2.5 m
Class of LPS: III
Building length: 17 m (maximum distance between down conductors c = 17 m)
Building width: 15 m

The roof superstructure is supposed to be protected by means of two air-termination rods.



k_i factor

Class of LPS I	0.08
Class of LPS II	0.06
Class of LPS III/IV	0.04

k_m factor

1.0 = air
0.5 = solid material
0.7 = GRP DEHNiso spacer/DEHNiso Combi

Design procedure

POSSIBILITY 1: Manual calculation of the separation distance

Step 1:
Determine the length of the air-termination rod via the protective angle method or rolling sphere method.

Step 2:
Calculate the separation distance to determine the position of the air-termination rod.

Legend:
n = total number of down conductors
c = maximum distance between one down conductor and the next
h = distance (or height) between ring conductors
k_c = partitioning coefficient

1. Calculation k_c (building):

$$k_c = \frac{1}{2 \cdot n} + 0.1 + 0.2 \cdot \sqrt[3]{\frac{c}{h}}$$

$$k_c = \frac{1}{2 \cdot 4} + 0.1 + 0.2 \cdot \sqrt[3]{\frac{17}{22}} = 0.41$$

2. Calculation of s_1 top edge of the roof (side strike):

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

$$s_1 = 0.04 \cdot \frac{0.41}{0.5} \cdot 22 = 0.72\ m$$

3. Calculation of s_2 between the base point of the air-termination rod and the roof superstructure (k_m 0.5):

$$s_{2\,(L1)} = \frac{k_i}{k_m} \cdot (k_{c_1} \cdot L_1{}^* + k_{c_2} \cdot L_2 + k_{c_3} \cdot L_{3(h)})$$

$$s_{2\,(L1)} = \frac{0.04}{0.5} \cdot (1 \cdot 5\ m + 0.5 \cdot 6\ m + 0.25 \cdot 22\ m)$$

$$s_{2\,(km\ 0.5)} = 1.08\ m$$

Note: $L_1{}^*_{base}$ = 5 m length of the connecting line from the base to the next node

4. Calculation of s_3 between the top edge of the roof superstructure and the air-termination rod (k_m 1):

$$s_{3\,(km\ 1)} = \frac{k_i}{k_m} \cdot (k_{c_1} \cdot L'_1{}^* + k_{c_2} \cdot L_2 + k_{c_3} \cdot L_{3(h)})$$

$$s_{3\,(km\ 1)} = \frac{0.04}{1} \cdot (1 \cdot 7.5\ m + 0.5 \cdot 6\ m + 0.25 \cdot 22\ m)$$

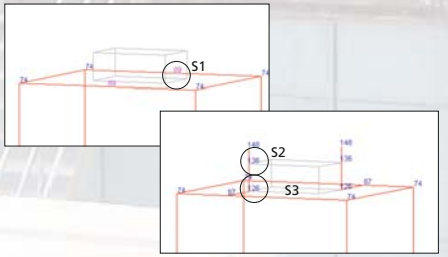
$$s_{3\,(km\ 1)} = 0.64\ m$$

Note: $L_1{}^*_{roof\ superstructure}$ = 7.5 m length of the air-termination rod from the point of proximity to the next node

Application of the division rule: 5. Comparison of $s_{2\,(km\ 0.5)}$ with $s_{3\,(km\ 1)}$

$$s_{2\,(km\ 0.5)} = 1.08\ m \geq s_{3\,(km\ 1)} = 0.64$$

POSSIBILITY 2: Calculation of the separation distance by means of DEHN Distance Tool



1. + 2. Calculation of s_1 top edge of the roof (lightning strike into the middle of the metal capping)
Calculation with "solid material (k_m 0.5)":
$s_{1max.}$ = 0.89 m

3. Calculation of s_2 between the base point of the air-termination rod and the roof superstructure
Calculation with "solid material (k_m 0.5)":
s_2 = 1.26 m

4. Calculation of s_3 between the air-termination rod and the top edge of the roof superstructure
Calculation with "air (k_m 1)":
s_3 = 1.36 m / 2
s_3 = 0.68 m

DEHNsupport Toolbox software available on www.dehn.de

ROLLING SPHERE

Distance between the air-termination rods in m	Class of LPS I radius 20 sag in m	Class of LPS II radius 30 sag in m	Class of LPS III radius 45 sag in m	Class of LPS IV radius 60 sag in m
1	0.01	0.00	0.00	0.00
2	0.03	0.02	0.01	0.01
3	0.06	0.04	0.03	0.02
4	0.10	0.07	0.04	0.03
5	0.16	0.10	0.07	0.05
6	0.23	0.15	0.10	0.08
7	0.31	0.20	0.14	0.10
8	0.40	0.27	0.18	0.13
9	0.51	0.34	0.23	0.17
10	0.64	0.42	0.28	0.21
11	0.77	0.51	0.34	0.25
12	0.92	0.61	0.40	0.30
13	1.09	0.71	0.47	0.35
14	1.27	0.83	0.55	0.41
15	1.46	0.95	0.63	0.47
16	1.67	1.09	0.72	0.54
17	1.90	1.23	0.81	0.61
18	2.14	1.38	0.91	0.68
19	2.40	1.54	1.01	0.76
20	2.68	1.72	1.13	0.84
21	2.98	1.90	1.24	0.93
22	3.30	2.09	1.37	1.02
23	3.64	2.29	1.49	1.11
24	4.00	2.50	1.63	1.21
25	4.39	2.73	1.77	1.32
26	4.80	2.96	1.92	1.43
27	5.24	3.21	2.07	1.54
28	5.72	3.47	2.23	1.68
29	6.23	3.74	2.40	1.78
30	6.77	4.02	2.57	1.91
31	7.36	4.31	2.75	2.04
32	8.00	4.62	2.94	2.17
33	8.70	4.95	3.13	2.31
34	9.46	5.28	3.33	2.46
35	10.32	5.63	3.54	2.61
36	11.28	6.00	3.76	2.76
37	12.40	6.38	3.98	2.92
38	13.76	6.78	4.21	3.09
39	15.56	7.20	4.44	3.26
40	20.00	7.64	4.69	3.43
41		8.10	4.94	3.61
42		8.58	5.20	3.80
43		9.08	5.47	3.98
44		9.60	5.74	4.18
45		10.16	6.03	4.38
46		10.74	6.32	4.58
47		11.35	6.62	4.79
48		12.00	6.93	5.01
49		12.69	7.25	5.23
50		13.42	7.58	5.46
51		14.20	7.92	5.69
52		15.03	8.27	5.93
53		15.94	8.63	6.17
54		16.92	9.00	6.42
55		18.01	9.38	6.67
56		19.23	9.77	6.93
57		20.63	10.18	7.20
58		22.32	10.59	7.47
59		24.55	11.02	7.75
60		30.00	11.46	8.04

Table 3: Sag of the rolling sphere depends on the distance between two air-termination rods and the class of LPS

PROTECTIVE ANGLE

Height of the air-termination rod h in m	Class of LPS I Angle α	Distance a in m	Class of LPS II Angle α	Distance a in m	Class of LPS III Angle α	Distance a in m	Class of LPS IV Angle α	Distance a in m
1	71	2.90	74	3.49	77	4.33	79	5.14
2	71	5.81	74	6.97	77	8.66	79	10.29
3	66	6.74	71	8.71	74	10.46	76	12.03
4	62	7.52	68	9.90	72	12.31	74	13.95
5	59	8.32	65	10.72	70	13.74	72	15.39
6	56	8.90	62	11.28	68	14.85	71	17.43
7	53	9.29	60	12.12	66	15.72	69	18.24
8	50	9.53	58	12.80	64	16.40	68	19.80
9	48	10.00	56	13.34	62	16.93	66	20.21
10	45	10.00	54	13.76	61	18.04	65	21.45
11	43	10.26	52	14.08	59	18.31	64	22.55
12	40	10.07	50	14.30	58	19.20	62	22.57
13	38	10.16	49	14.95	57	20.02	61	23.45
14	36	10.17	47	15.01	55	19.99	60	24.25
15	34	10.12	45	15.00	54	20.65	59	24.96
16	32	10.00	44	15.45	53	21.23	58	25.61
17	30	9.81	42	15.31	51	20.99	57	26.18
18	27	9.17	40	15.10	50	21.45	56	26.69
19	25	8.86	39	15.39	49	21.86	55	27.13
20	23	8.49	37	15.07	48	22.21	54	27.53
21			36	15.26	47	22.52	53	27.87
22			35	15.40	46	22.78	52	28.16
23			36	16.71	47	24.66	53	30.52
24			32	15.00	44	23.18	50	28.60
25			30	14.43	43	23.31	49	28.76
26			29	14.41	41	22.60	49	29.91
27			27	13.76	40	22.66	48	29.99
28			26	13.66	39	22.67	47	30.03
29			25	13.52	38	22.66	46	30.03
30			23	12.73	37	22.61	45	30.00
31					36	22.52	44	29.94
32					35	22.41	44	30.90
33					35	23.11	43	30.77
34					34	22.93	42	30.61
35					33	22.73	41	30.43
36					32	22.50	40	30.21
37					31	22.23	40	31.05
38					30	21.94	39	30.77
39					29	21.62	38	30.47
40					28	21.27	37	30.14
41					27	20.89	37	30.90
42					26	20.48	36	30.51
43					25	20.05	35	30.11
44					24	19.59	35	30.81
45					23	19.10	34	30.35
46							33	29.87
47							32	29.37
48							32	29.99
49							31	29.44
50							30	28.87
51							30	29.44
52							29	28.82
53							28	28.18
54							27	27.51
55							27	28.02
56							26	27.31
57							25	26.58
58							25	27.05
59							24	26.27
60							23	25.47

Values ≙ Lightning Protection Guide, 2nd edition, Table 5.1.1.4 (page 55)

Table 2: Assignment of the height of the air-termination rod h to the protective angle α and distance a depending on the class of LPS