

DEHN protects Photovoltaic Systems

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Reliable power supply thanks to lightning and surge protection



Using the power of the sun

Energy needs are steadily rising throughout the world. However, reserves of fossil fuels are on the wane and the oil and gas production is becoming more and more complex. What alternatives are there? Energy reforms lead the way: The future belongs to renewable energies.

In the future, wind, water, biomass and of course the sun will ensure that the lights do not go out in industrial plants and private households.

In fact, photovoltaics are one of the fastest growing technologies producing green energy. According to the German Solar Industry Association, photovoltaics will account for 10 per cent of the electricity mix by 2020 (about 5 per cent in 2013). On an international level, electricity produced by PV power plants will also offer tremendous growth potential.

The number of photovoltaic systems – both roof-mounted systems and ground-mounted systems such as solar parks – will continue to grow in the long term. This distributed power generation involves major changes of electrical installations. Every PV system installed must be maintained to ensure continuous yield and requires reliable lightning and surge protection to and prevent failure increase the service life of the inverter.

The selection and implementation of lightning and surge protection measures is based on the lightning protection zone concept according to IEC/EN 62305. This standard defines protection zones in which different coordinated protective devices are installed. External lightning protection systems are installed as a result of a risk analysis according to IEC/EN 62305-2 or according to the relevant building code and applicable regulations. A lightning protection system provides protection due to the interaction of

- External lightning protection including air-termination systems, down conductors, and earth-termination system as well as
- Internal lightning protection including lightning equipotential bonding, surge protection and separation distance



DEHN protects roof-mounted systems and solar parks

DEHN is a world-renowned lightning and surge protection expert – also in the field of photovoltaics. We already applied our knowledge of lightning and surge protection when photovoltaic technology was still in its infancy. Thanks to our long-standing experience in the field of photovoltaics, we are able to offer the best products – be it for roof-mounted systems or solar parks. Operators and installers of PV systems can trust that our products always comply with the relevant standards and guidelines. DEHN is thus making a major contribution to reliable power supply, high system availability and sustainable investment protection.





Surge protection protects your investments

Although PV systems are exposed to various external influences, the statistics of insurance companies say that surges are the most frequent cause of damage to PV systems. If the inverter of a PV system is damaged, reinvestment costs may be high. As a consequence, the return on investment is delayed and the break-even point is reached much later. For this reason, smart system operators will choose a protection concept with foresight that is also increasingly required by financial institutions and property insurances. Moreover, long-term profitable installations serve as references for installers and secure follow-up orders.







Lightning protection for roof-mounted systems

Integrated: Planning of PV systems and lightning protection zone concept

Professional planning is indispensable for the safe and reliable operation of PV systems. It must be coordinated with the special requirements of the relevant project and include lightning and surge protection measures right from the planning stage.

Installers of PV and lightning protection systems consider the roof area under different aspects. While installers of lightning protection systems want to maintain the separation distance for the lightning protection system, the aim of installers of PV systems is to optimise the use of space on the roof. This requires close cooperation between those two trades to ensure system protection and the yield of the PV system. State building codes or insurance companies require that a lightning protection system is installed. State building codes call for lightning protection systems in public buildings such as kindergardens, schools or hospitals. However, coordination between roofers / installers of lightning protection systems and installers of photovoltaic systems / electricians is essential not only when constructing a new building, but also when retrofitting roof-mounted systems.

Feasible in practice: Risk analysis by means of DEHN Risk Tool

A risk analysis according to IEC/EN 62305-2 shows whether an external lightning protection system must be installed. To this end, the use of the building and the associated risks are analysed. A risk analysis can be easily performed by means of the globally proven DEHNsupport Toolbox software including the DEHN Risk Tool. The result of this risk analysis forms the basis for a technically and economically sound lightning protection concept.



Isolated and shade-optimised air-termination systems are the ideal lightning protection system for roof-mounted PV systems. They ensure that the separation distance between the down conductor and the PV system is maintained and prevents the injection of partial lightning currents. Shade-optimised air-termination systems do not cast an umbra on the modules, thus securing the yield.

Variable and slim: HVI®Conductors from DEHN

An height adjustable isolated air-termination system with an high-voltage-insulated HVI®Conductor from DEHN is an ideal solution for roof-mounted PV systems. Its unique design allows to maintain separation distances up to 0.90 m in air. Like an installation cable, it can be installed downstream of the sealing end directly next to or below the PV modules, thus ideally using the roof area.



 $\mathsf{HVI}^{\texttt{e}}\mathsf{Conductor}$ from DEHN: Efficient use and protection of the PV system



Surge protection for roof-mounted systems

Roof-mounted systems with a mounting structure on the roof are most commonly used. Due to their exposed location, roof-mounted systems are particularly prone to direct and indirect lightning strikes. Since the PV system is directly connected to the electrical installation of the building, lightning effects may have serious consequences for the building, devices and persons inside the building. The IEC/EN 62305-2 standard is also used for analysing the risk for roof-mounted systems.

The German supplement 5 of the DIN EN 62305-3 standard and the European CENELEC CLC/TS 50539-12 standard distinguish between three different scenarios of how to install a PV system.

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Building without external lightning protection system

If no external lightning protection system is installed, Supplement 5 of the DIN 62305-3 standard recommends to install a type 2 surge protective device on the d.c. and a.c. side to protect the PV system and to install surge protective devices for the data communication, if any.



Building with external lightning protection system and sufficient separation distance

The PV modules must be located in the protected zone of the isolated air-termination system and the separation distance s must be maintained.



Building with external lightning protection system and insufficient separation distance

If the separation distance s cannot be maintained, for example in case of a metal roof, lightning equipotential bonding must be implemented.



1 *+ 2 d.c. side

DEHNguard® YPV SCI - compact Compact type 2 arrester for the d.c. side surge protection in string inverter systems. Type Part No. DG YPV SCI 600 FM 950 536 DG YPV SCI 1000 FM 950 535 DG YPV SCI 1000 FM 950 535 DEHNcube YPV SCI Prewired type 2 arrester with IP65 degree of type 1 arrester with IP65 degree of type 2 arrester with IP65 degree of type 2 arrester with IP65 degree of type 1 arrester with IP65 degree 0 arrester w

Prewired type 2 arrester with IP65 degree of protection for one MPP tracker (1 M) and two MPP trackers (2 M) can be used up to 1000 V. Accessory: Connecting cable.

Туре	Part No.
DCU YPV SCI 1000 1M	900 910
DCU YPV SCI 1000 2M	900 920
AL DCU Y PV L1000	900 949
AL DCU X PV L1000	900 947

Pluggable, modular type 2 arrester for PV systems

Part No.

952 516

952 515

952 517

952 519

DEHNguard® M YPV SCI

of any size and configuration. For 600 V, 1000 V and 1200 V.

DG M YPV SCI 600 FM

DG M YPV SCI 1000 FM

DG M YPV SCI 1200 FM

DG M PV2 SCI 1000 FM

(for 2 MPPT)



I_{SCPV} = 1000 A

I..... = 1000 A



Туре



* Distance $I_1 > 10 \text{ m} = \text{additional protection at the PV generator}$

DEHNguard[®] M Class II / Type 2 arrester Pluggable, modular surge arrester: High reliability due to "Thermo Dynamic Control" monitoring device. Part No. DG M TNC 275 FM 952 305 DG M TNS 275 FM 952 405 DG M TT 275 FM 952 315

a.c. side (inverter)

DEHNguard® M Class II / Type 2 arrester

Pluggable, modular surge arrester with integrated backup fuse: High reliability due to "Thermo Dynamic С

Control" monitoring device.		
Туре	Part No.	

DG M TNC CI 275 FM	952 309
DG M TNS CI 275 FM	952 406
DG M TT CI 275 FM	952 327

DEHNventil ®	M	
lass I / Type	1 combined	arrester

Pluggable, modular, lightning current carrying combined arrester with spark gap technology and wave breaker function.

Туре	Part No.
DV M TNC 255 FM	951 305
DV M TNS 255 FM	951 405
DV M TT 255 FM	951 315

Class I / Type 1 combined arrester installation by snapping the arrester on Part No. 900 390 WBF

FM = floating	remote signalling contact

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Туре	Part No.	
DSH TNC 255	941 300	State CAP TECHNOLOGY
DSH TNS 255	941 400	[₩] <u>\</u> WBF
DSH TT 255	941 310	A THE BREAKER FUNCT





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Туре

BLITZDUCTOR® XTU

Combined arrester with actiVsense® and Life-Check® technology for protecting two pairs of balanced interfaces (for example RS485). Base part required.



Туре	Part No.
BXTU ML4 BD 0-180	920 349
BXT BAS	920 300

6 Equipotential bonding

UNI earthing / saddle clamp

Clamps for integrating the mounting systems of PV systems in the functional equipotential bonding / functional earthing or lightning equipotential bonding.



Type UNI earthing clamp UNI saddle clamp Part No. 540 250 365 250

7 External lightning protection system

Air-termination rod with concrete base

Air-termination rod (1.5 m) tapered from ø 16 mm to 10 mm that reduces the formation of umbras and the wind load.

Wedge-mounted concrete base (17 kg) with adapted base plate, stackable.



Туре	Part No.
Air-termination rod	103 210
Concrete base	102 340

HVI®Conductor

High-voltage-resistant insulated down conductor for maintaining the separation distance from conductive parts according to IEC/EN 62305-3.

One equipotential bonding connection element and one connection element are enclosed.

Туре	Part No.
HVI®Conductor III	819 022





Lightning protection for solar parks

Due to the high investment volumes and the high requirements on the availability of solar parks, the risk of damage posed by a lightning strike must be calculated according to IEC/EN 62305-2. The results must be taken into account for planning and are used for due diligence considerations.

The German guideline "VDS 2010 – Risk-oriented lightning and surge protection" published by the German Insurance Association requires that equipotential bonding is implemented and surge protection measures are taken. The aim is to protect the power plant from lightning damage as well as modules, inverters and monitoring devices from the effects of the electromagnetic impulse.



Layout of a solar park with PV array and operation building

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Air-termination systems, down conductors, earth-termination system

Air-termination systems protect the PV array and operation building in case of direct lightning strikes. The metallic mounting structures on which the module systems are installed can be used to mechanically fix the air-termination rods.

The earth-termination system is intermeshed with mesh sizes from 20 m x 20 m to 40 m x 40 m. All mounting structures must be connected to the earth-termination system. Pile-driven and screw-in foundations ensure connection to the soil. DEHN offers different types of round conductors and strips for connecting the earth-termination system to the PV mounting structures.

The rolling sphere method must be used to determine the quantity and height of the air-termination rods. To this end, at least class of LPL* III is required.







Measures for protecting PV power plants

An efficient lightning protection system for power stations with central inverter, string inverter or a mix of both consists of:

- an air-termination systems
- down conductors
- earth-termination system
- lightning equipotential bonding system

• surge protective devices for the power and data side. These measures must be coordinated with one another. Class II / Type 2 arresters from DEHN provide reliable surge protection. Due to the large cable lengths in the solar park – d.c., a.c., and data cables – high-energy equipotential bonding currents* occur. Class I / Type 1 combined arresters from DEHN withstand this stress, reliably protect all terminal devices and prevent puncture of the cable insulation. All this ensures undisturbed operation for decades.

UNI earthing / saddle clamp	and the second	Туре	Part No.
Clamps for integrating the mounting systems	A STATE	UNI earthing clamp	540 250
of PV systems in the functional equipotential bonding / functional earthing or lightning equipotential bonding.	Costed	UNI saddle clamp	365 250

Angled air-termination tip

Air-termination tip mounted on the substructure protects from direct lightning strikes.

Туре	Part No.
Air-termination tip (separate)	101 010
Air-termination tip including wo saddle clamps	101 110

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DEHNcombo YPV SCI

This compact type 1 and type 2 arrester is a universal solution for roof-mounted and ground-mounted systems. Four modules. For 600 V, 1000 V and 1500 V.



Туре	Part No.
DCB YPV SCI 600 FM	900 065
DCB YPV SCI 1000 FM	900 066
DCB YPV SCI 1500 FM	900 067
$I_{\text{max}} = 1000 \text{ A}$ (without additional	l backup fuse)

Part No.

900 910

900 920

900 949

900 947

fuse)

DEHNcube YPV SCI

Prewired type 2 arrester with IP65 degree of protection for one MPP tracker (1 M) and two MPP trackers (2 M) can be used up to 1000 V. Accessory: Connecting cable.

DEHNguard[®] M(E) YPV SCI

Pluggable, modular type 2 arrester. For 600 V, 1000 V, 1200 V (3 modules) and 1500 V (4.5 modules).



Compact type 2 arrester for the d.c. side surge protection in string inverter systems.



Туре	Part No.
DG M YPV SCI 600 FM	952 516
DG M YPV SCI 1000 FM	952 515
DG M YPV SCI 1200 FM	952 517
DG ME YPV SCI 1500 FM	952 525
1000 1 (100 1 100 100	

 $I_{SCPV} = 1000 \text{ A}$ (without additional backup fuse)

 $I_{SCPV} = 1000 \text{ A}$ (without additional backup fuse)

SHETY TOO	Туре	Part No.
sci	DG YPV SCI 600 FM	950 536
Recorder Internation	DG YPV SCI 1000 FM	950 535
	$I_{SCPV} = 200 \text{ A}$ (without additional	backup fu

Туре

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DCU YPV SCI 1000 1M

DCU YPV SCI 1000 2M

AL DCU Y PV L1000

AL DCU X PV L1000

DEHNventil[®] M

Multipole, modular, lightning current carrying class I / type 1 spark-gap-based combined arrester with wave breaker function.



Тур	ArtNr.		
DV M TNC 255 FM	951 305		
DV M TNS 255 FM	951 405		
DV M TT 255 FM	951 315		
I _{total} = 100 kA (75 kA)			

DEHNshield[®]

Compact, lightning current carrying class I / type 1 spark-gap-based combined arrester with impulse current parameters adapted to this place of installation.



Тур	ArtNr.
DSH TNC 255	941 300
DSH TNS 255	941 400
DSH TT 255	941 310
_{total} = 50 kA (37.5 kA)	

BLITZDUCTOR® XTU

Combined arrester with actiVsense® technology for protecting one pair, direct or indirect shield earthing. Base part required.



Тур	ArtNr.
BXTU ML2 BD 0-180	920 249
BXT BAS	920 300

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Protection solutions for stand-alone systems

Difficult to access and often far away, stand-alone systems must prove their reliability. Be it earthed or totally insulated, DEHNguard type 2 arresters with their unique SCI technology easily master this task.

DEHNguard[®] S PV SCI (FM)

Single-pole, modular type 2 surge arrester, patented SCI technology prevents fire damage caused by d.c. switching arcs.

DEHNguard[®] M Y PV SCI

Multipole, modular type 2 surge arrester, patented SCI technology prevents fire damage caused by d.c. switching arcs.



ре	Part No.
S PV SCI 150 FM	952 556
S PV SCI 600 FM	952 555

		Туре	Part No.
		DG M YPV SCI 150 FM	952 518
he he he was	SHETY TROUB	DG M YPV SCI 600 FM	952 516
	SCI SCI		





Maximum safety for your service personnel

Safety is the top priority of DEHN safety products for installation and maintenance work. Protect your service personnel during work on roof-mounted systems and solar parks.

Protective gloves

- For arc fault protection according to IEC 61482-1-2
- For protection against thermal risks according to EN 407



Safety helmet for electricians	Туре
Protection of the face and head region,	ESH 100 S Y, yellow
high wearing comfort	
DEHNcare® arc-fault-resistant face shield	Туре

- Anti-mist coating
- Natural colour reproduction
- High light transmittance

PHE III voltage detector

- For nominal voltages up to 30 kV / 50 Hz
- With visual and acoustic indication
- With self-testing element
- For use in indoor and outdoor installations



Туре



Part No. 785 740

Part No.

785 747

767 731

PHE3 10 30 S

TH. It



Innovative products for PV systems

DEHNguard[®]: d.c. arrester with SCI technology for maximum safety and fire protection

SCI stands for **Short Circuit Interruption** and thus for all DEHN surge arresters with three-step d.c. switching devices.

The disconnectors of DEHN surge protective devices (SPDs) ensure disconnection in case of overload. Disconnectors of conventional SPDs are not suited for use in d.c. PV systems. If disconnectors are activated, destruction of the SPD cannot be excluded due to the ignition of a d.c. arc. To prevent this, the disconnector is combined with a bypass path. In case of overload, the disconnector is activated and the d.c. arc is extinguished via the low-impedance bypass path. The fuse in the bypass path interrupts the follow current, thus safely disconnecting the arrester. Thus, the EN 50539-11 standard can be easily fulfilled.

Thanks to their combined disconnection and shortcircuiting device, DEHN arresters with SCI technology provide reliable protection in case of overload and combine efficient surge protection with the most stringent requirements for personal and fire protection.







Switching phases of the d.c. switching device (SCI)



HVI[®]Conductor: Patented solution for external lightning protection systems that allows to maintain the separation distance

Due to their exposed location, photovoltaic systems are particularly at risk. To prevent flashover and that lightning currents are flow in the structure, they must be protected in case of a lightning strike without compromising the need for the required separation distance. A conventional lightning protection system does not always allow to maintain the required separation distances. Isolated air-termination systems in conjunction with the high-voltage-resistant HVI®Conductor developed by DEHN are ideally suited for this purpose. Due to its unique design with a special semiconductive sheath, the HVI®Conductor allows to maintain an equivalent separation distance. Thus, HVI®Conductors may contact other conductive parts such as electrical lines directly downstream of the sealing end without causing flashover.



DEHN UNI earthing clamp: Universal connection

Installation guidelines require earthing and lightning equipotential bonding and recommend the following for the connection of the mounting system:

- Connection with 6 or 16 mm² Cu at the mounting structure*
- Connection of the equipotential bonding conductor to the main earthing busbar of the building at ground level

Corrosion-resistant DEHN UNI earthing clamps are ideally suited for integrating mounting systems into the lightning equipotential bonding system and for functional earthing. The stainless steel contact plate allows to connect different conductor materials (copper, aluminium and steel) to common mounting systems that are, for example, made of aluminium. The lightning current carrying clamp (EN 50164-1) allows easy and fast connection of the profiles and ensures permanent and reliable electrical contact.

* without external lightning protection: separation distance ok: separation distance not ok: min. 6 mm² Cu conductor min. 6 mm² Cu conductor min. 16 mm² Cu conductor





Practical tests in the DEHN test laboratory

Testing of switching operations in PV systems

Our test laboratory is equipped with a direct current source and a PV simulator. Our customers use our laboratory, for example, to test the lightning current carrying capability of PV mounting systems. Impulse current tests on inverters are also carried out on request in our laboratory. Profit from our knowledge to optimise your protection solutions in the field of photovoltaics.

Devices and components for PV systems must be adapted to meet their special requirements. Especially the operating performance of devices which ensure the protection and switching functions must be verified in laboratory simulations. The laboratory tests should be performed under real operating conditions.

Since conventional d.c. sources are not suitable for exactly simulating the behaviour of PV systems, we have developed a PV simulator. Due to its dynamic i/u characteristic, this simulator allows to realistically simulate switching operations in PV systems.

The PV simulator is an efficient test circuit for testing overcurrent protective devices, mechanical switching devices and surge protective devices under realistic conditions.

Testing of lightning protection components

Metal lightning protection components (clamps, conductors, air-termination rods or earth electrodes) which are exposed to all weather conditions must be subjected to artificial ageing by the manufacturer. The aim is to verify the actual suitability for outdoor use.

Artificial ageing and testing of metal components are performed in two steps: In a first step, the metal components are subjected to a salt mist treatment and a humid sulphurous atmosphere treatment. This is followed by a lightning current test.



"PV simulator for simulation of switching operations in PV systems" (DS192)

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DEHN arresters with SCI technology protect PV systems all over the world

Throughout the world, DEHN arresters with SCI technology protect PV systems in the gigawatt range from interruption and failure caused by lightning currents and surges under different climatic conditions. DEHN arresters with SCI technology comply with international product standards. They withstand extreme climatic conditions and can thus be used in any climate zone. As a leading manufacturer of lightning and surge protection for PV systems, we have been setting trends in this industry for more than two decades. The DEHN sales team in Germany, 19 international subsidiaries and offices as well as sales partners support PV projects on site – in more than 70 countries worldwide.

Examples of PV systems protected by DEHN arresters with SCI technology representing a selection of some hundred thousand systems worldwide:

- 2,5 MW_p PV solar power plant from Meridionale Impianti in Palermo, Italy
- 3 MW_p PV solar power plant in Yongam, Korea
- 20 MW_p Dongtai PV solar power plant, Dongtai City, Jiangsu Province, China
- Systems with inverters from ABB Ltd, Zurich, Switzerland
- Systems with inverters from SMA Solar Technology AG, Niestetal, Germany
- Systems with inverters from Power One, Terranuova Bracciolini, Italy
- Systems with inverters from Solectria Renewables LCC, Lawrence, Massachusetts, USA



Surge Protection Lightning Protection Safety Equipment DEHN protects. DEHN + SÖHNE GmbH + Co.KG. Hans-Dehn-Str. 1 Postfach 1640 92306 Neumarkt Germany Tel. +49 9181 906-0 Fax +49 9181 906-1100 info@dehn.de www.dehn-international.com



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