Solar power

Lightning and surge protection for photovoltaic systems

PHOENIX CONTACT

Safeguard availability with surge protection from Phoenix Contact

Constructing large photovoltaic ground-mounted systems in the high megawatt range is an investment in the future. The aim is to keep the amortization time as short as possible. This requires a system which guarantees unlimited availability with high performance.

Lightning and surge protection from Phoenix Contact safeguards availability and ensures the yield of the system.

The Zuera II megawatt output solar park near Zaragoza

The Zuera II solar park near Zaragoza has a capacity of 11.5 MW and has been connected to the power grid. It covers an area of more than 30 hectares and generates solar power for over 10,000 inhabitants.
Phoenix Contact was involved in planning together with the system operator and the Spanish company implementing the project.

Contents

Find out more with the web code

You will find web codes throughout this brochure. They consist of a hash symbol followed by a four-digit number combination.

Web code: #1234 (example)

This allows you to access further information on our website quickly.

It couldn't be simpler:
1. Go to the Phoenix Contact website
2. Enter the # and the number combination in the search field
3. Get more information and product versions

#1234 **Search**

Or use the direct link:
phoenixcontact.net/webcode/#1234

Surge protection:
The protective circuit principle

The protective circuit principle defines complete protection against surge voltages. An imaginary circle is drawn around the devices, plants, or systems to be protected.

Surge protective devices that correspond to the nominal data of the relevant power supply or signal type should be installed at all points where cables intersect with this circle. In order to provide objects with consistent protection against conducted surge voltage couplings, the areas of power supply, MCR technology, information technology, and transceiver technology should be taken into consideration.

MCR technology

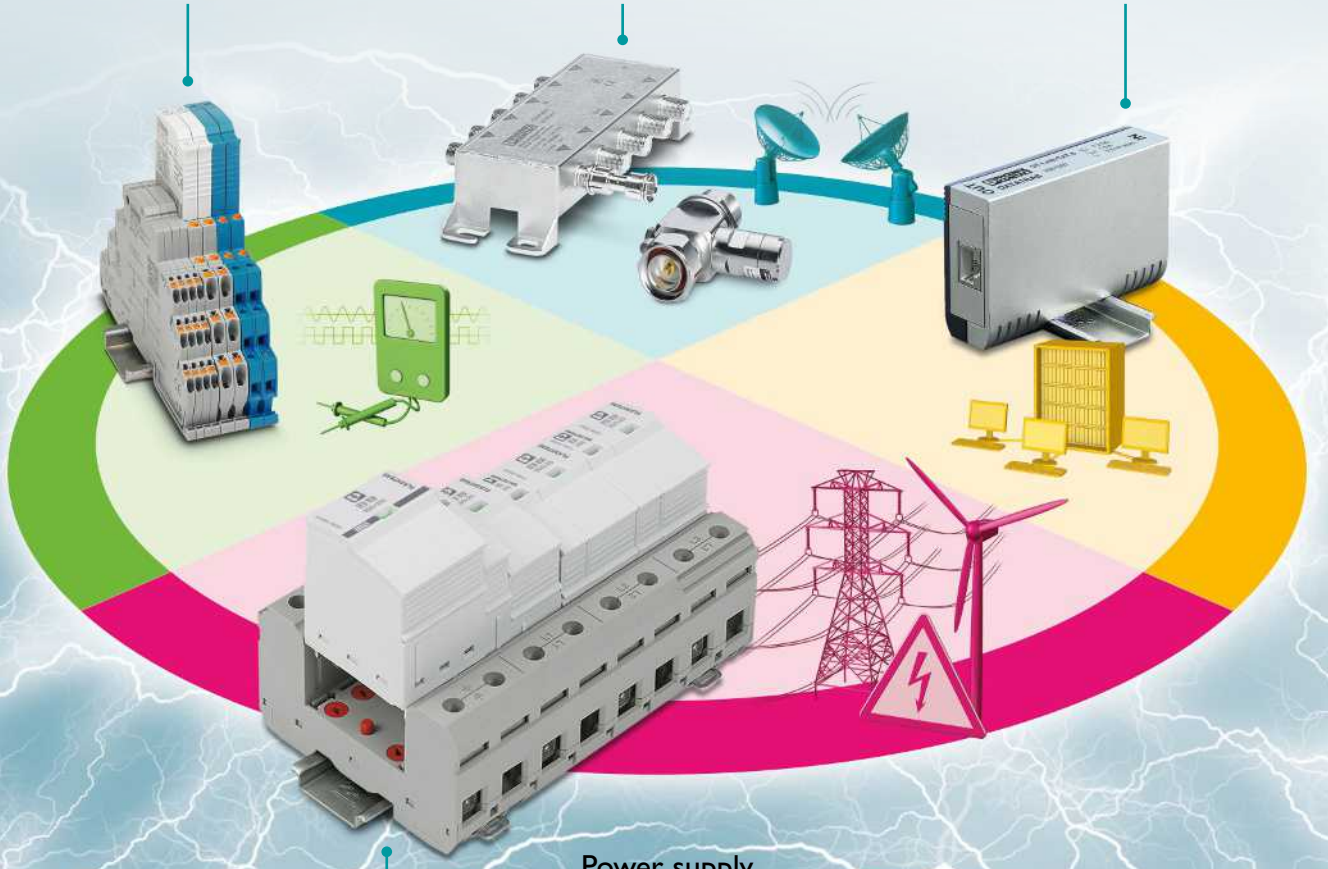
Optimized protective devices are available for the different signal types and measuring principles.

Transceiver technology

So that private operational and cellular communication, as well as satellite or radio systems, still have reception whatever the weather.

Information technology

High-speed protection (CAT6+) for data and communication technology.



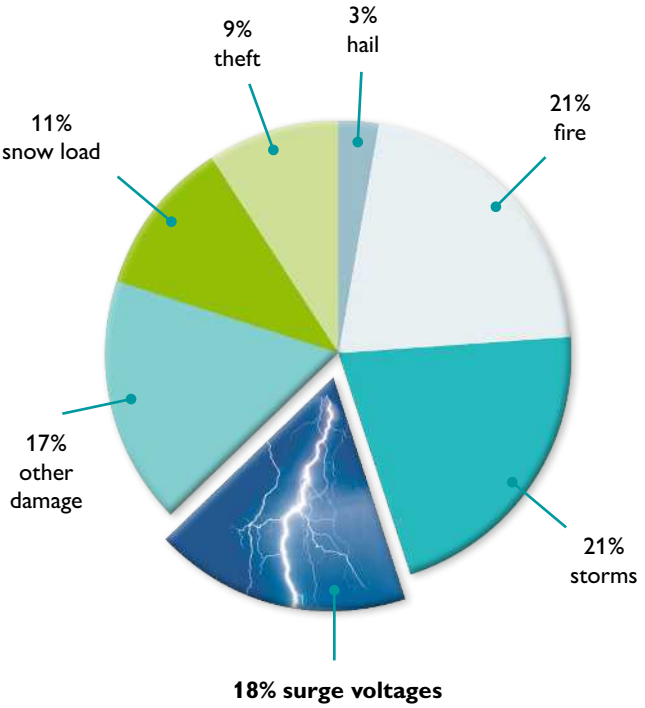
Power supply

Optimally coordinated protective devices for feed-in points, distributors, and terminal devices safeguard the energy supply.

Surge protection for photovoltaic systems

These are the type of questions you should consider when planning or installing a photovoltaic system:
Does a photovoltaic system on a typical family home need to have lightning protection?
Is it mandatory to equip a public building that has a photovoltaic system with lightning protection?
Is your photovoltaic system automatically included in your household contents or building insurance?
If so: What type of damage is covered? Is it worth signing up for additional photovoltaic insurance?

Due to changes in the DIN VDE 0100-443 and DIN VDE 0100-534 standards, Germany has had a requirement to provide surge protection for new designs and for changes to existing installations since October 1, 2016.
Electricians are obligated to notify their customers about the new requirements.

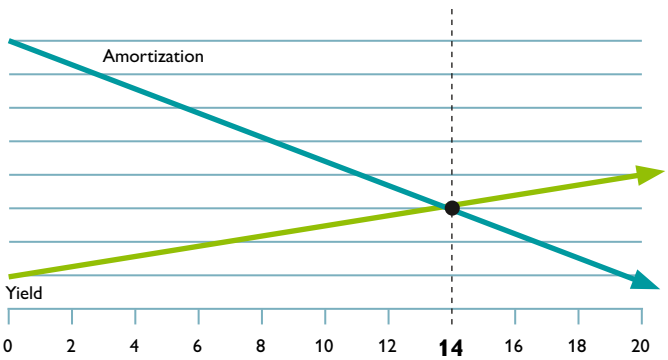


Source: GDV documentation

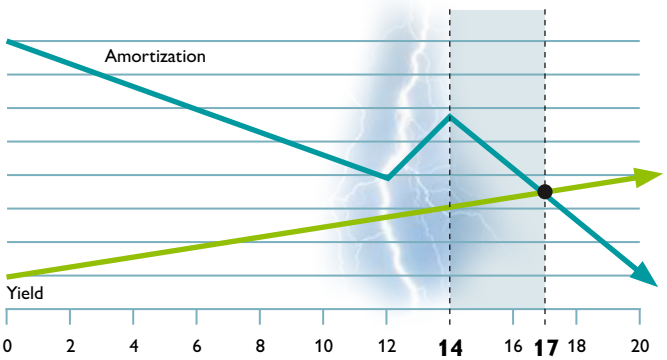
Safeguard amortization of the system with surge protection

An example profitability analysis shows that system failure has a considerable impact on the amortization time of a photovoltaic system. The resulting reinvestment costs can quickly exceed 20% of the actual procurement costs. The logical consequence is that revenue is reduced.
The likelihood of experiencing damage caused by surge voltages and the resulting system failures is constantly on the rise. This applies to both exposed locations as well as other sites faced with the increased prospect of thunderstorms due to climate change. With lightning and surge protection in place, this risk is greatly reduced.

If an effective protection concept is incorporated into the planning phase and installed with the photovoltaic system from the outset, the associated costs are significantly lower than a retrofit solution.



Usual amortization scenario

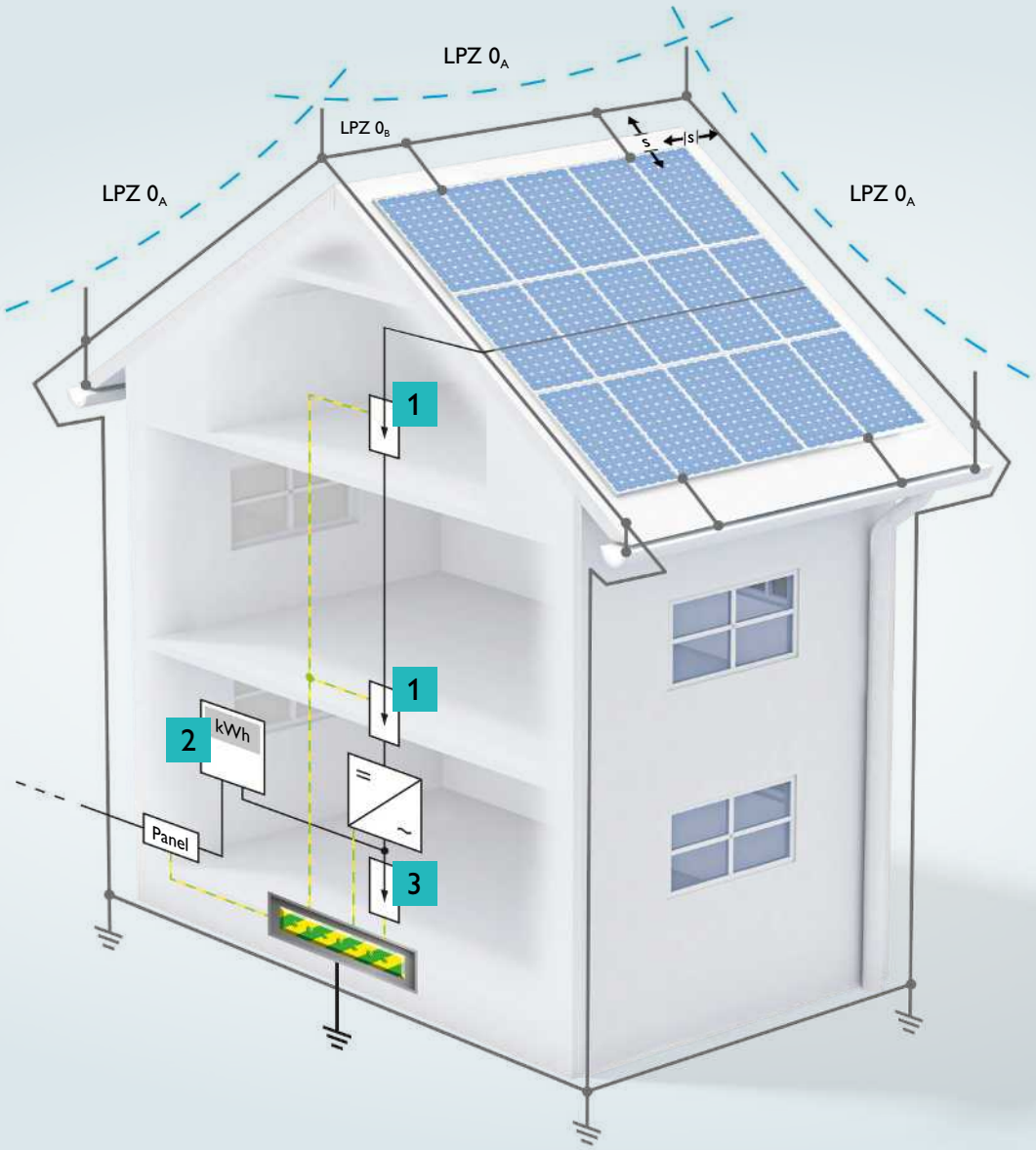


Amortization in the event of damage

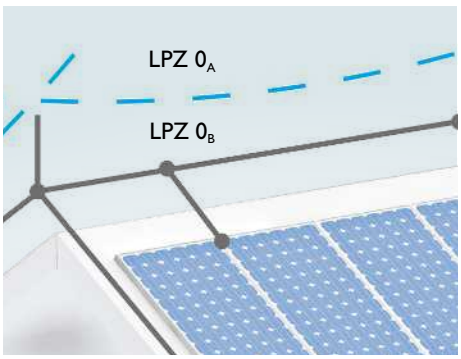
Surge protection for rooftop systems

Surge voltage couplings caused by lightning strikes or switching operations in the power grid can also cause significant damage to parts of a photovoltaic system. The photovoltaic panels on the roof, string combiner boxes (SCB), inverters, and feed-in meters may be at risk.

Installing a photovoltaic system does not increase the risk of the building being struck by lightning. Nevertheless, the photovoltaic system must be incorporated into the existing external lightning protection measures.



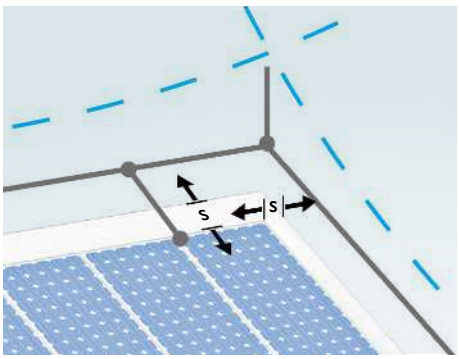
Information and products



PV panels in the protection area

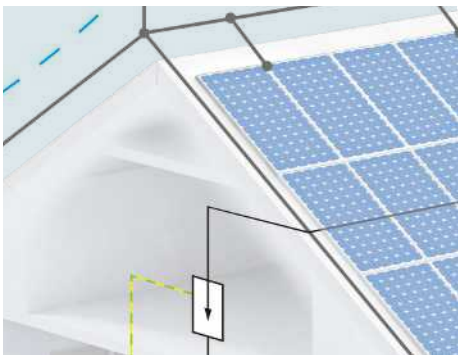
To avoid a direct lightning strike, all photovoltaic panels should be inside the protection zone (rolling sphere model). For photovoltaic systems on buildings, note the following:

- Lightning and surge protection is essential for inverters.
- Include all cables that are connected to the inverter.



Isolation distance "s"

The distance to be maintained between the external lightning protection system and the components of the photovoltaic system. This avoids sparkover that may be caused by fire.



Use in accordance with IEC 61643-32

Without external lightning protection:

- Type 2 before inverter
- Cable length >10 m plus type 2 at building entry point

Isolation distance not observed:

- Cable length <10 m, type 2 before inverter
- Cable length >10 m, type 1 before inverter and at building entry point
- Type 1 AC in main distribution

With external lightning protection, isolation distance observed:

- Type 2 before inverter
- Cable length >10 m plus type 2 at building entry point
- Type 1 AC in main distribution

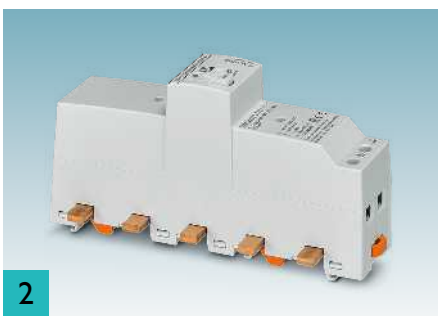
Further information on string combiner boxes for PV rooftop systems:
Simply enter the web code in the search field on our website.

Web code: #0920

Surge protection products


1

String combiner box with surge protection type 1/2 DC for one string


2

Type 1/2 surge protection

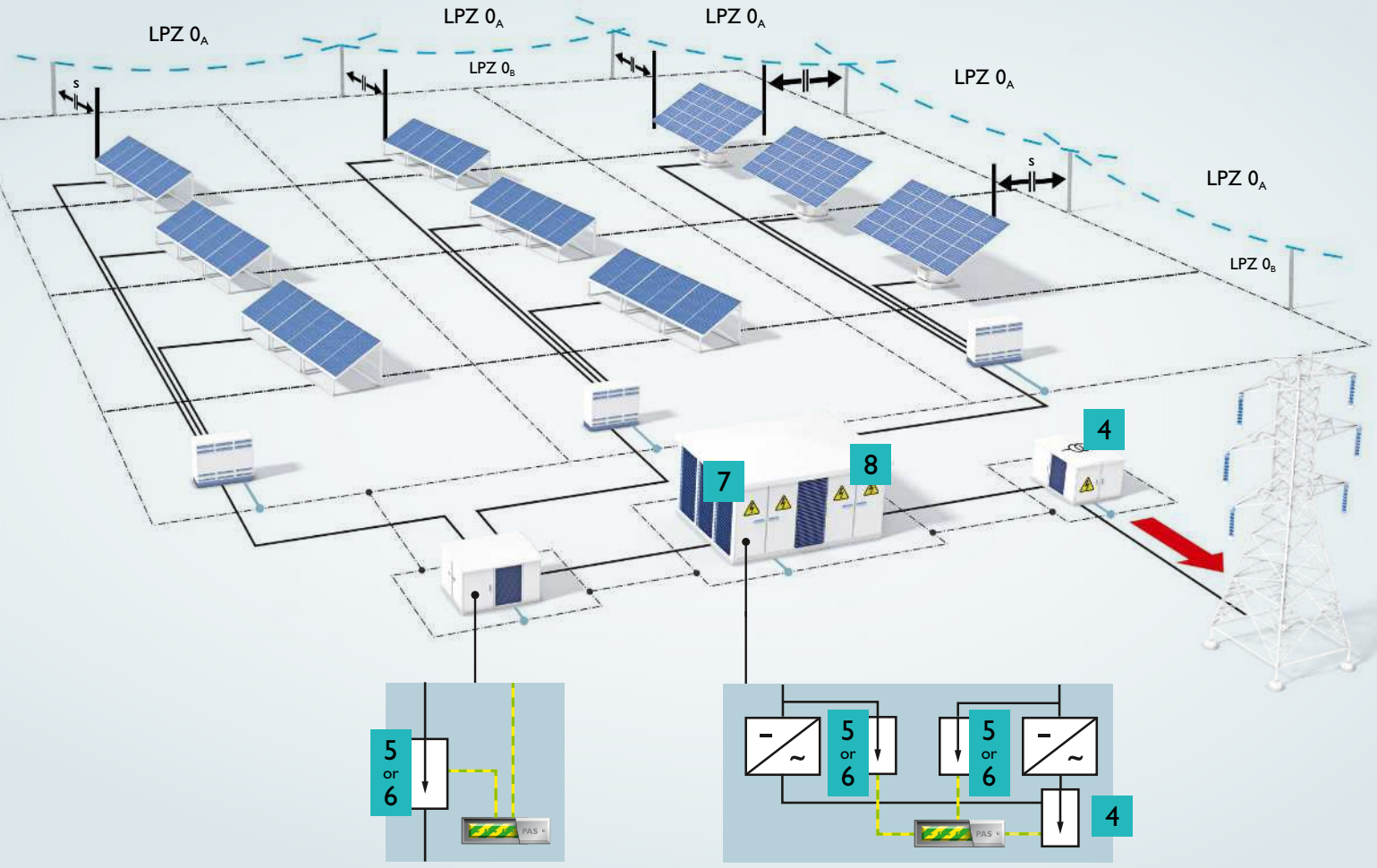

3

Type 2 surge protection

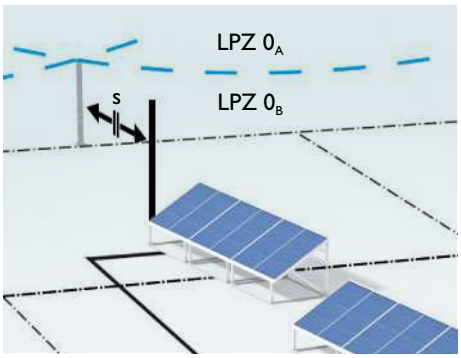
Detailed information about the products used can be found on page 16/17.

Surge protection for ground-mounted systems with centralized inverters

In ground-mounted systems using centralized inverters, the individual strings are grouped in string combiner boxes and connected to the centralized inverter. Ground-mounted systems cover extensive areas and are exposed to dangers such as lightning strikes. Due to long DC cables and meshed grounding systems, there is a danger of lightning currents or transients getting into the devices over these cables and systems. This has to be taken into account when planning the lightning current and surge protection concept.



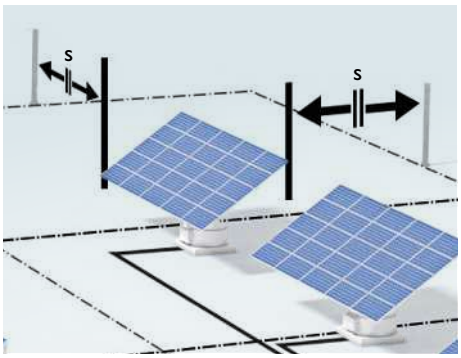
Information and products



PV panels in the protection area

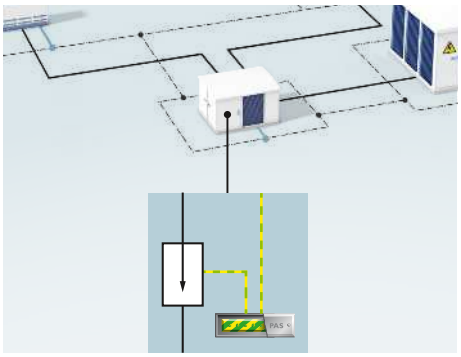
To avoid a direct lightning strike, all photovoltaic panels should be inside the protection zone (rolling sphere model). For ground-mounted systems, note the following:
Use of surge protection with local equipotential bonding:

- On inverters on DC and AC side
- On string combiner boxes
- On all incoming and outgoing cables



Isolation distance “s”

The distance to be maintained between the external lightning protection system and the components of the photovoltaic system. This avoids sparkover that may be caused by fire.

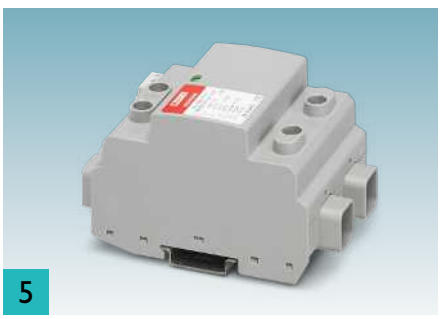


Grounding and equipotential bonding

All metal components must be connected together electro-conductively in order to avoid voltage differences between the individual module fields.

Products for protecting the power supply system and data cables

4 Type 1/2 surge protection



5 Type 1/2 surge protection, one-piece

6 Type 2 surge protection, pluggable

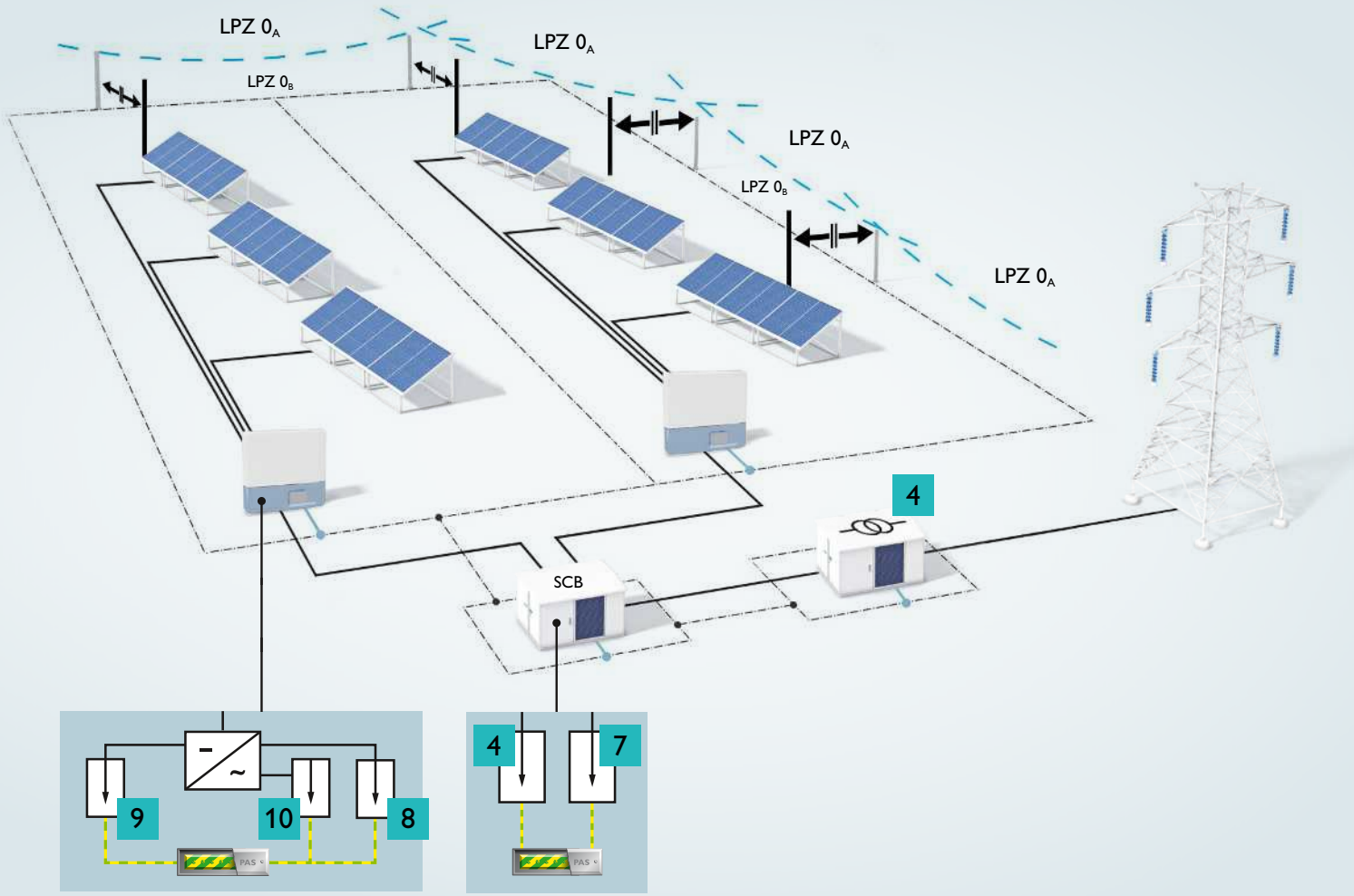
7 Surge protection for information technology

8 Surge protection for power and data cables, pluggable

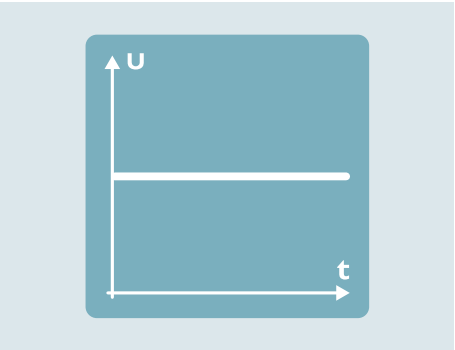
Detailed information about the products used can be found on page 16/17.

Surge protection for ground-mounted systems with string inverters

In ground-mounted systems with a decentralized structure, the individual strings come together right at the string inverter. The DC cables are often kept short; the cables on the AC side are grouped into AC combiner boxes in the field and connected to the transformer. This has to be taken into account when planning the lightning current and surge protection concept.

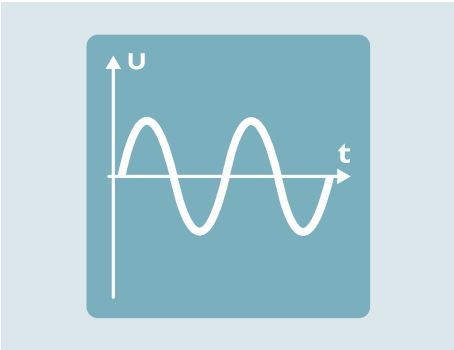


Information and products



Protection of the DC side

Avoid failures on the DC side by using a type 2 surge protective device based on IEC 61643-32.



Protection of the AC side

Cabling on the AC side can amount to 250 m to the transformer. Avoid failures on the AC side by using a type 1/2 surge protective device based on IEC 61643-32.

Protection of data cables

Protect outgoing and incoming communication cables from unexpected pulses from the field. This lets you ensure optimal protection for the PV application.

Products for protecting the power supply system and data cables

4

Type 1/2 surge protection

7

Surge protection for information technology

8

Surge protection for power and data cables, one-piece

9

Base element for the printed-circuit board with type 2 DC surge protection plug

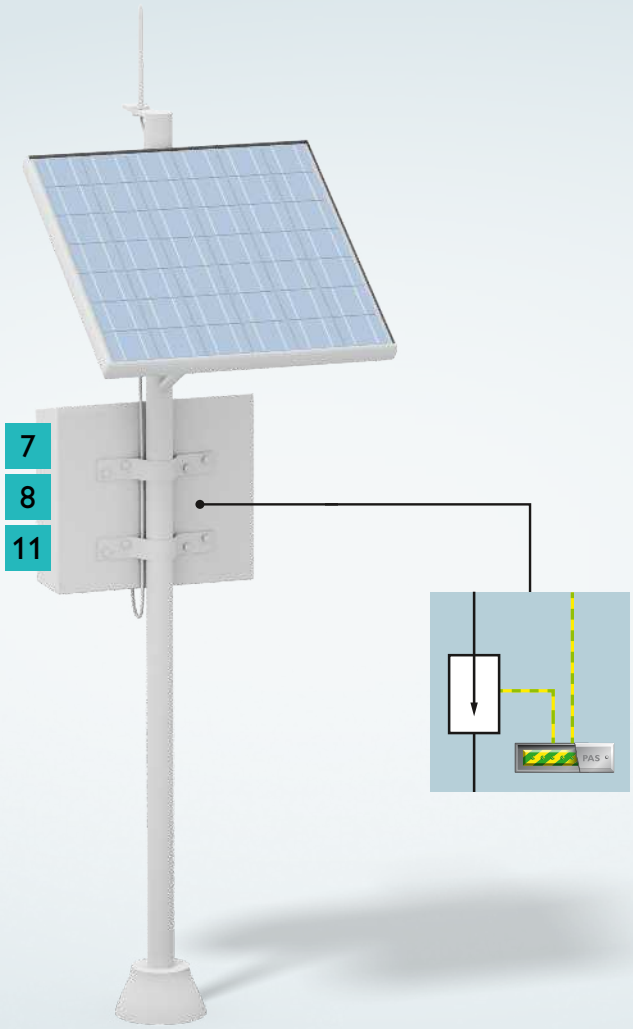
10

Base element for the printed-circuit board with type 1/2 AC surge protection plug

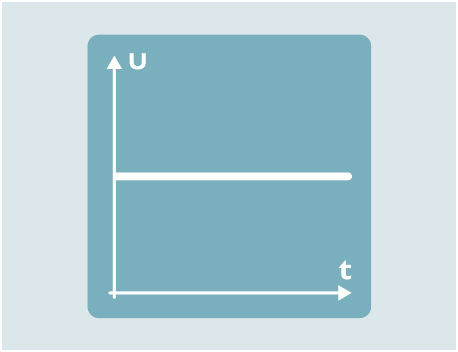
Detailed information about the products used can be found on page 16/17.

Surge protection for autonomous power supply systems

In rural regions without a local power grid and in developing and emerging countries, hybrid photovoltaic systems are a cost-efficient and environmentally-friendly alternative for generating electricity far from corresponding grids. Due to usually being located in an exposed position, the systems should be equipped with suitable surge protection.

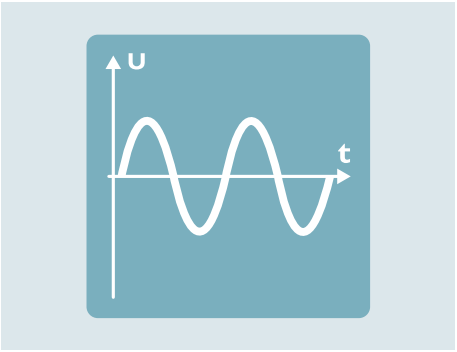


Information and products



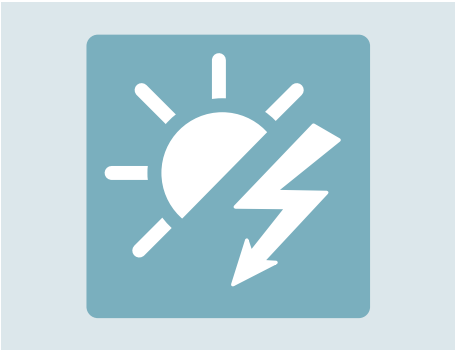
Protection of the DC side

Autonomous systems usually have an isolated design and use a battery for energy storage. Use a type 2 surge protective device on the DC side.



Protection of the AC side

If an autonomous PV system is connected to the low-voltage network, use a type 2 surge protective device on the AC side.



Protection of data cables

In order to protect communication and sensors, take all of the data cables into account in the protection concept.

Examples of autonomous systems

Autonomous power supplies are used for different applications:

- Street lighting
- Cellular communication
- Parking pay and display machines
- Emergency call boxes
- Transportation technology

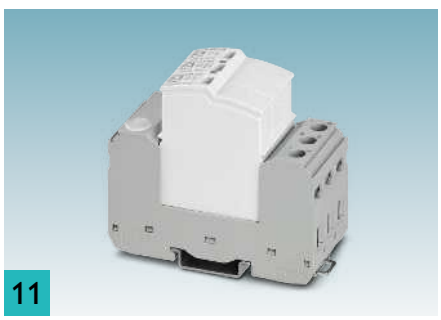
Surge protection products

7

Surge protection for information technology

8

Surge protection for power and data cables, pluggable



11

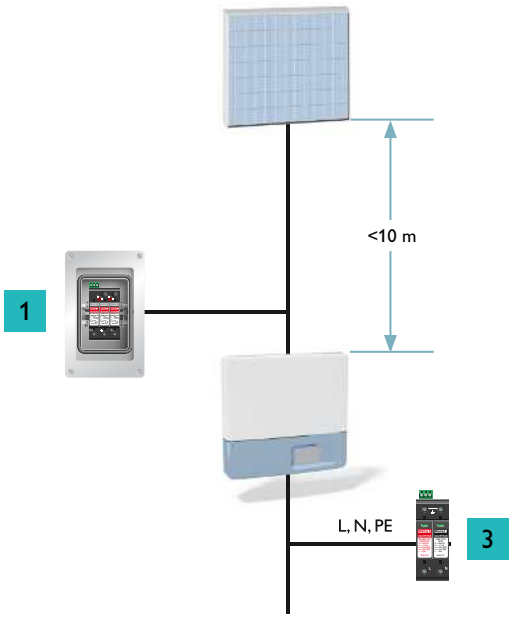
Type 2 surge protection for DC current sources with linear operating characteristics

Detailed information about the products used can be found on page 16/17.

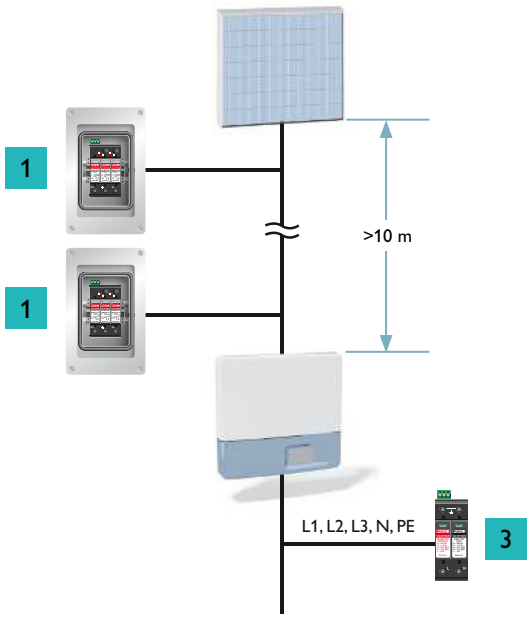
Application examples for protecting photovoltaic systems

Protection for a single-string system

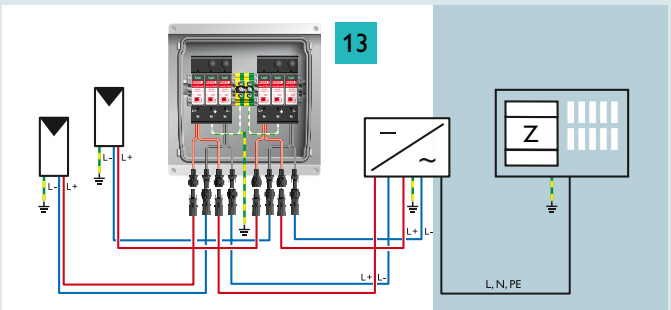
On 1-phase inverters
(<10 m)



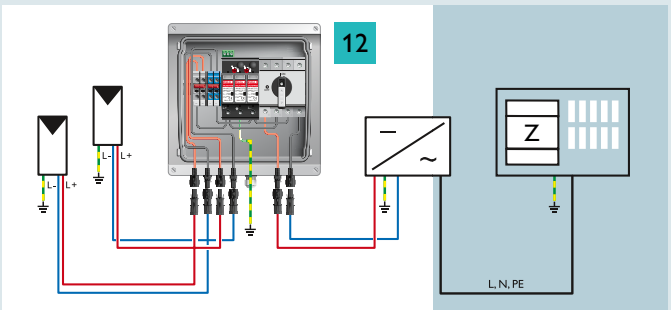
On 1-phase inverters plus protective device
(>10 m)



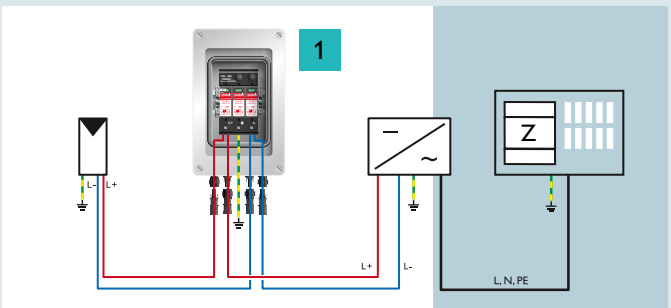
Connection examples for PV sets



Example for the connection of a PV set with two MPP trackers.
L+ and L- are led individually to the inverter.



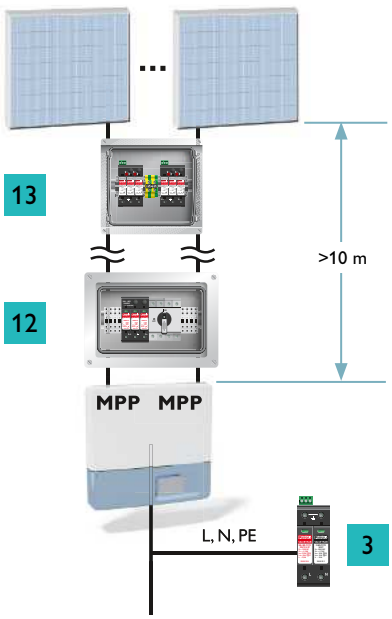
Example for the connection of a two-string PV set with DC switch disconnector.



Example for the connection of a PV set for small systems with a string cable.

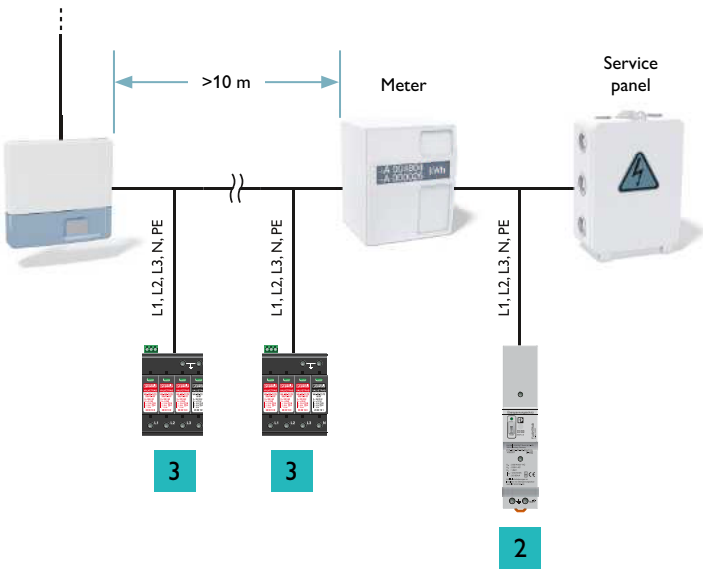
Protection of a multi-string inverter system

On multiple MPP trackers
(MPP = maximum point of power)



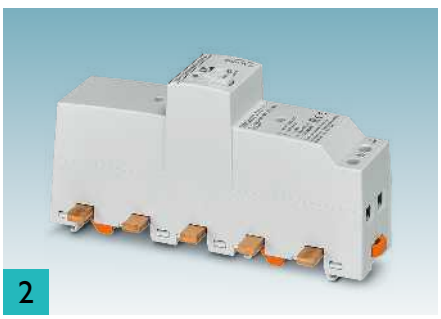
Protection of a 3-phase supply

On bridged inverters
(>10 m)



Surge protection products

String combiner box with surge protection type 1/2 DC for one string



Type 1/2 surge protection

Type 2 surge protection, for 1-phase systems

Type 2 surge protection, for 3-phase systems

String combiner box with surge protection type 1/2 DC for two strings

String combiner box with surge protection type 1/2 DC for two MPP trackers

Product overview

String combiner box with surge protection type 1/2 DC for protecting one string			
1 	Lightning and surge protective device in IP65 housing for protecting single-string photovoltaic systems up to 1,000 V DC, box connection with SUNCLIX plugs.	SOL-SC-1ST-0-DC-1MPPT-1001	2404298
Type 1/2 surge protection for 40 mm DIN rail systems			
2 	Surge protection for residential buildings with external lightning protection or overhead line supply with a discharge capacity of 7.5 kA	FLT-SEC-ZP-3S-255/7,5	1074741
		FLT-SEC-ZP-3C-255/7,5	1074739
	Surge protection for residential buildings with external lightning protection or overhead line supply with a discharge capacity of 12.5 kA	FLT-SEC-ZP-3S-255/12.5	1032207
		FLT-SEC-ZP-3C-255/12,5	1032204
Type 2 AC surge protection			
3 	Second protection stage in the power supply, space-saving protective device, installation location: distributors/post-meter area, minimum protection for the power supply, one module recommended for each distributor	VAL-MS 320/3+1-FM (3-phase)	2859181
		VAL-MS 320/3+1 (3-phase)	2859178
		VAL-MS 320/1+1-FM (1-phase)	2804393
		VAL-MS 320/1+1 (1-phase)	2804380
Type 1/2 AC surge protection			
4 	For 3-phase power supply networks	VAL-MS-T1/T2 335/12.5/3+1-FM	2800183
		VAL-MS-T1/T2 335/12.5/3+1	2800184
	For 1-phase power supply networks	VAL-MS-T1/T2 335/12.5/1+1-FM	2800186
		VAL-MS-T1/T2 335/12.5/1+1	2800187
Type 1/2 DC surge protection, one-piece			
5 	Lightning/surge protective device combination for 2-pos., isolated DC voltage systems with 600/1,000/1,500 V DC, short-circuit proof up to 15 kA, with KEMA approval, with and without floating remote indication contact	VAL-MB-T1/T2 1500 DC-PV/2+V-FM	2905640
		VAL-MB-T1/T2 1500 DC-PV/2+V	2905641
		VAL-MB-T1/T2 1000 DC-PV/2+V-FM	2905638
		VAL-MB-T1/T2 1000 DC-PV/2+V	2905639
		VAL-MB-T1/T2 600 DC-PV/2+V-FM	2906292
		VAL-MB-T1/T2 600 DC-PV/2+V	2906293
Type 1/2 and type 2 DC surge protection			
6 	Lightning/surge protective device combination for 2-pos., isolated DC voltage systems with 600/1,000 V DC, short-circuit proof up to 1,000 A, with KEMA approval, UL-recognized component	VAL-MS-T1/T2 1000 DC-PV/2+V-FM	2801161
		VAL-MS-T1/T2 1000 DC-PV/2+V	2801160
		VAL-MS-T1/T2 600 DC-PV/2+V-FM	2801164
		VAL-MS-T1/T2 600 DC-PV/2+V	2801163
	Surge protective device for 2-pos., isolated DC voltage systems of 600/1,000/1,500 V DC, short-circuit-proof up to 2,000 A, with KEMA approval, UL-recognized component	VAL-MS 1500 DC-PV/2+V-FM	1033725
		VAL-MS 1500 DC-PV/2+V	1033708
		VAL-MS 1000 DC-PV/2+V-FM	2800627
		VAL-MS 1000 DC-PV/2+V	2800628
		VAL-MS 600 DC-PV/2+V-FM	2800641
		VAL-MS 600 DC-PV/2+V	2800642

Surge protection for information technology				
7		Surge protection in accordance with Class EA, for Ethernet up to 10 Gbps (incl. PoE), token ring, ISDN S0	DT-LAN-CAT.6+	2881007
		Intermediate plug with surge protection for analog and digital telecommunication interfaces, analog telephony, ADSL/T-DSL, ISDN U	DT-TELE-RJ45	2882925
		D-SUB 9 intermediate plug with surge protection for RS 485 interfaces, RS-485 (PROFIBUS)	DT-UFB-485/BS	2920612
Surge protection for data cables				
8		HF protective circuit for three signal wires	TTC-6P-3-HF-F-M-12DC-UT-I Pluggable	2906786
			TTC-6-3-HF-F-M-12DC-UT One-piece	2906769
Surge protection for printed-circuit boards				
		Base element for direct mounting on the PCB for products 9 and 10	VAL-MS-BE-PCB-FM	1035864
9		Type 2 plug for DC applications	VAL-MS 1500DC-PV-ST	1033727
10		Type 1/2 plug for AC applications	VAL-MS-T1/T2 335/12,5 ST	2800190
		Type 2 surge protective device for direct mounting on the PCB	PRT-PV-1000	2908900
			PRT-PV-P-1500/20-550	1013424
			PRT-PV-P-1500/20-680	1026507
Type 2 surge protection for DC current sources with linear operating characteristics				
11		Type 2 DC surge protection, 48 V DC	VAL-SEC-T2-2+F-48DC-FM	1033786
		Type 2 DC surge protection, 120 V DC	VAL-SEC-T2-2+F-120DC-FM	1033788
		Type 2 DC surge protection, 220 V DC	VAL-SEC-T2-2+F-220DC-FM	1033789
		Type 2 DC surge protection, 380 V DC	VAL-SEC-T2-2+F-380DC-FM	1033790
String combiner box with surge protection type 1/2 DC for protecting two strings				
12		String combiner box for photovoltaic systems up to 1,000 V DC for connecting 1x 2 strings. With surge protection, DC switch disconnector, and SUNCLIX DC connector for the input and output side.	SOL-SC-2ST-0-DC-1MPPT-1101	2404297
String combiner box with surge protection type 1/2 DC for protecting two MPP trackers				
13		Lightning current and surge protection for the DC side with two MPP trackers up to 1,000 V DC, box connection with SUNCLIX plugs.	SOL-SC-1ST-0-DC-2MPPT	2404299

We demand top quality

Through its highly qualified personnel, Phoenix Contact is actively engaged in the work of national and international standards bodies. This means that changes to standards can be incorporated into the development process for new products in a timely manner. A high-current laboratory with an area of approx. 1,300 m² is available for the testing that accompanies the development and to provide proof of performance prior to applications for approval. Powerful testing technology which is specially tuned to the requirements is essential for modern and forward-looking product development.

Standard-compliant tests in the pulse and high-current laboratory

Equipment for powerful testing

The testing equipment is able to generate surge currents and surge voltages with different pulse shapes. Even power supply frequency short-circuit currents and DC currents can be generated, by means of the finely adjustable voltage.
One special feature of the laboratory is that the high-performance power supply system can be coupled with surge current generators. This enables a realistic environment to be created for testing surge protective devices.

Direct current testing technology

The DC testing system functions autonomously and consists of a high-performance DC source as well as a special pulse current generator. This generator is set up to precisely meet the requirements in the field of direct current testing technology.
The system offers the option of coupling power pulse currents (8/20 µs) into the DC system. Among other tests, this system permits tests in accordance with IEC 64643-11, "Requirements and tests for surge protective devices for use in photovoltaic systems".

Standards and approvals

The requirements and tests for surge protective devices for use in photovoltaic installations are defined in part 11 of the IEC 64643-11 standard.
The standard describes low-voltage surge protective devices and surge protective devices for specific applications including DC voltage.
The surge protective devices are approved and certified by recognized companies with respect to their safety for harmless use in different applications.

Special features of the DC voltage side

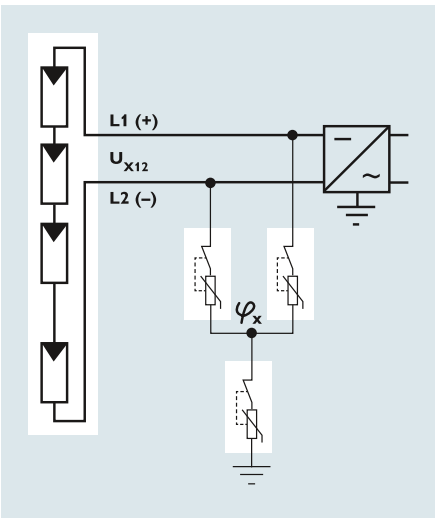
The parameters on the DC side of photovoltaic systems differ substantially from those on the AC side. High system DC voltages are generated and a photovoltaic generator is operated close to its short-circuit current. Fuse mechanisms that are typically used for AC applications, such as backup fuses, are not used here. Therefore, special tests are required for the surge protective devices used on the DC side of photovoltaic systems.

End-of-life test
Over time, surge currents can overload the surge protective device. This type of load is simulated when developing surge protective devices for photovoltaic systems. The nominal discharge current is applied to the protective devices 20 times. After the test, the test objects must have the same protective effect as new surge protective devices without a load.

Then, safe activation of the internal thermal separation device is checked. In this process, the protective device is purposefully overloaded. The constant current of the generator creates an electric arc. The disconnecting device must disconnect this electric arc automatically before the housing heats up to an impermissible temperature. This eliminates the risk of a fire.

Surge protective devices in a Y-circuit can permanently withstand the voltage load in the case of ground faults on the system side.

Due to these special features of the DC side, surge protective devices that have been specifically developed for photovoltaic systems must be used.



Y-circuit for protecting the DC side of a photovoltaic system

Open communication with customers and partners worldwide

Phoenix Contact is a global market leader based in Germany. We are known for producing forward-thinking products and solutions for the comprehensive electrification, networking, and automation of all sectors of the economy and infrastructure. With a global network, we maintain close relationships with our customers, something we believe is essential for our common success.

You can find your local partner at

phoenixcontact.com

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