hakel®
THE QUEEN OF POWER

Protection of **PHOTOVOLTAIC SYSTEMS** against **LIGHTNING** and **OVERVOLTAGE**

Surge Protection Device

CHOICE OF SURGE PROTECTION DEVICES FOR PHOTOVOLTAIC APPLICATIONS

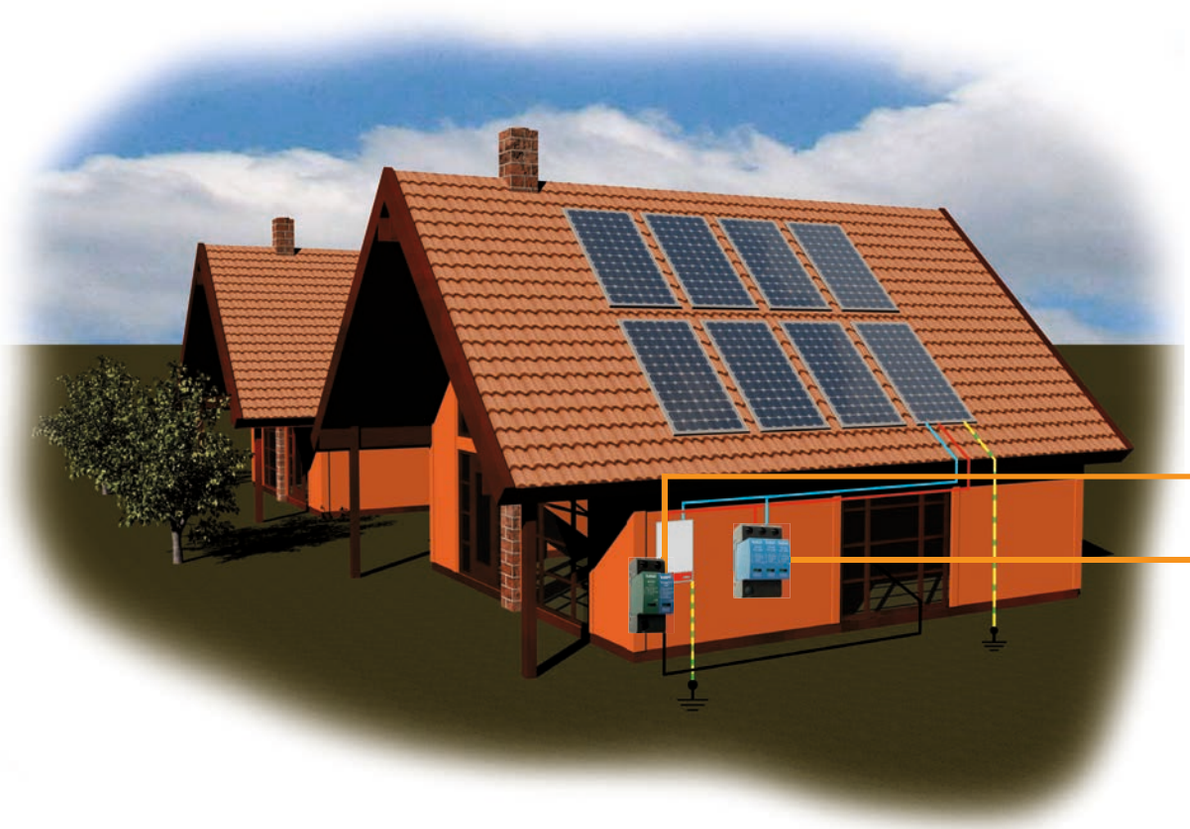
General concept

To achieve complete functionality of a photovoltaic (PV) power plant, whether small, installed on the roof of a family house or large, extending over vast areas, it is necessary to develop a complex project. The project includes correct selection of PV panels and other aspects such as mechanical structure, optimum wiring system (suitable location of components, correct oversizing of the cabling, protective interconnection or network protection) as well as external and internal protection against lightning and overvoltage. The HAKEL Company offers surge protection devices (SPD), which can protect your investment at a fraction of the total purchasing costs.
Before projecting the surge protection devices, it is necessary to become familiar with the particular photovoltaic panels and their connection. This information provides basic data for selection of the SPD. It concerns the maximum open-circuit voltage of the PV panel or the string (a chain of panels connected in a series). Connection of PV panels in a series increases the total DC voltage, which is then converted into AC voltage in inverters. Larger applications can standardly reach 1000 V DC. Open-circuit voltage of the PV panel is determined by intensity of sunrays falling on the panel cells and the temperature. It rises with growing radiation, but it drops with rising temperature.
Another important factor involves application of an external lightning protection system - a lightning rod. The standard ČSN EN 62305 ed.2 on Protection against lightning, Part 1 to 4 defines types of losses, hazards, lightning protection systems, lightning protection levels and the adequate arcing distance. These four lightning protection levels (I to IV) determine parameters of the lightning strikes and the determination is given by the level of hazard.
In principle, there are two situations. In the first case, protection of an object by an external lightning protection system is demanded, but the arcing distance (i.e. the distance between the air-termination network and the PV system) cannot be maintained. Under these conditions, it is necessary to ensure galvanic connection between the air-termination network and the support structure of the PV panels or the PV panel frames. The lightning currents limp (impulse current with the parameter of 10/350 μs) are able to enter the DC circuits; thus it is necessary to install a type 1 surge protection device. HAKEL offers a more suitable solution in the form of combined 1+2 type surge protection devices SPC PV or PIVM PV, which are produced for the voltage of 600 V, 800 V and 1000 V with or without remote signalization. In the second case, there is no demand to equip the protected object by an external lightning protection system, or the arcing distance can be maintained. In this situation, the lightning currents cannot enter the DC circuit and only induced overvoltage is considered (impulse current with the parameter of 8/20 μs), where a type 2 surge protection device is sufficient, e.g. PIIIM PV, which is produced for the voltage of 600 V, 800 V and 1000 V, again with or without remote signalization.
When projecting the surge protection devices, we must consider the AC side as well as the data and communication lines, which are standardly used in a modern PV power station. A PV power station is also threatened from the side of the DC (distribution) network. On this side, the choice of a suitable SPD is much broader and depends on the given application. As a universal surge protector, we recommend a modern SPC25G device, which incorporates all three 1+2+3 types within five meters from the installation point. It features a combination of varistors and a lightning arrester. HAKEL offers several series of surge protection devices for measuring and regulation systems as well as data transfer lines. New types of inverters are usually equipped with interfaces that allow monitoring of the entire systems. The products include various types of interfaces and various voltages for various frequencies and a selectable amount of pairs. As an example, we can recommend the DTE, DTB, HT-DATA or HT-NET PoE 6cat series.
The HUF 003 device is used for monitoring of parameters on the AC side, where it checks the voltage and frequency and, if the allowable range is exceeded, disconnects the PV power station from the network. In addition, it features a programmable time relay adjusted according to conditions of the distribution or transmission system. As soon as the monitored parameters return to the allowable limits, the PV system needs to remain disconnected for a preset period specified by the network administrator.

Consider the following examples of three basic applications: a small PV power station on the roof of a family house, a mid-size station on the roof of an administrative or industrial building and a large solar park extending over a large plot.

Family house

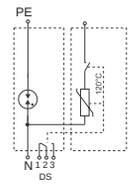
As mentioned in the general concept of surge protection devices for PV systems, the choice of a particular type of device is affected by numerous factors. All HAKEL products for PV applications are adapted to DC 600 V, 800 V and 1000 V. The particular voltage is always selected according to the maximum open-circuit voltage specified by the manufacturer in dependence on the given arrangement of PV panels with a ca 15% reserve. For a family house - a small PV power station, we recommend products of the PIIIM PV series on the DC side (on condition that the family house requires no external protection against lightning or the arcing distance between the air-termination network and the PV system is maintained), or PIVM PV (if an air-termination network is installed at a distance shorter than the arcing distance). As the PIVM PV unit is a 1+2 type combined device (protecting both against partial lightning currents and overvoltage) and the price difference is not great, this product can be used for both options, thus preventing potential human error if the project is not fully observed.
On the AC side, we recommend application of a PIV12,5 device in the building's main distributor. It is manufactured in a fixed and replaceable version PIVM12,5. If the inverter is located in an immediate vicinity of the main distributor, the AC side is protected by a surge protection device of the main distributor. If it is located for example under the roof of the building, it is necessary to repeat installation of a type 2 surge protection device, e.g. the PIII series (again in a fixed or replaceable version) in the sub-distributor usually located next to the inverter. We offer all of the mentioned types of surge protection devices for DC and AC systems also in a remote signal version.
For data and communication lines, we recommend installation of a DIN rail mounted DTE protection device with screw termination or DTB series with screw termination or RF45 connector for structured cabling. It is possible to use a DTB 485 device for a serial busbar with screw attachment. HAKEL also offers a DIN rail mounted HT-NET series with screw termination or RJ45 connectors for the 5 and 6 categories.



PROTECTION OF PHOTOVOLTAIC SYSTEMS AGAINST LIGHTNING AND OVERVOLTAGE

FAMILY HOUSE

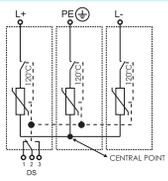
PIVM12,5-275/1+1
PIVM12,5-275 DS/1+1



TYPE 1+2 / CLASS I+II / TN-S / TT / CE

PIVM12,5-275/1+1 **γseries** is a two-pole, metal oxid varistor lightning and surge arrester, combined with gas discharge tube Type 1+2 according to EN 61643-11 and IEC 61643-11. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0 – 1 (according to IEC 1312-1 and EN 62305 ed.2), where they provide the equipotential bonding and discharge of both, the lightning current and the switching surge, which are generated in power supply systems entering the building. The use of the lightning current arresters PIVM12,5-275/1+1 **γseries** is mainly in the power supply lines, which are operated as TN-S and TT systems. The main use of PIVM12,5-275/1+1 **γseries** arrester is in structures of LPL III – IV according to EN 62305 ed.2. The marking **M** specifies a type of construction with removable module. The marking of **DS** specifies a version with remote monitoring.

PIVM PV600
PIVM PV600 DS



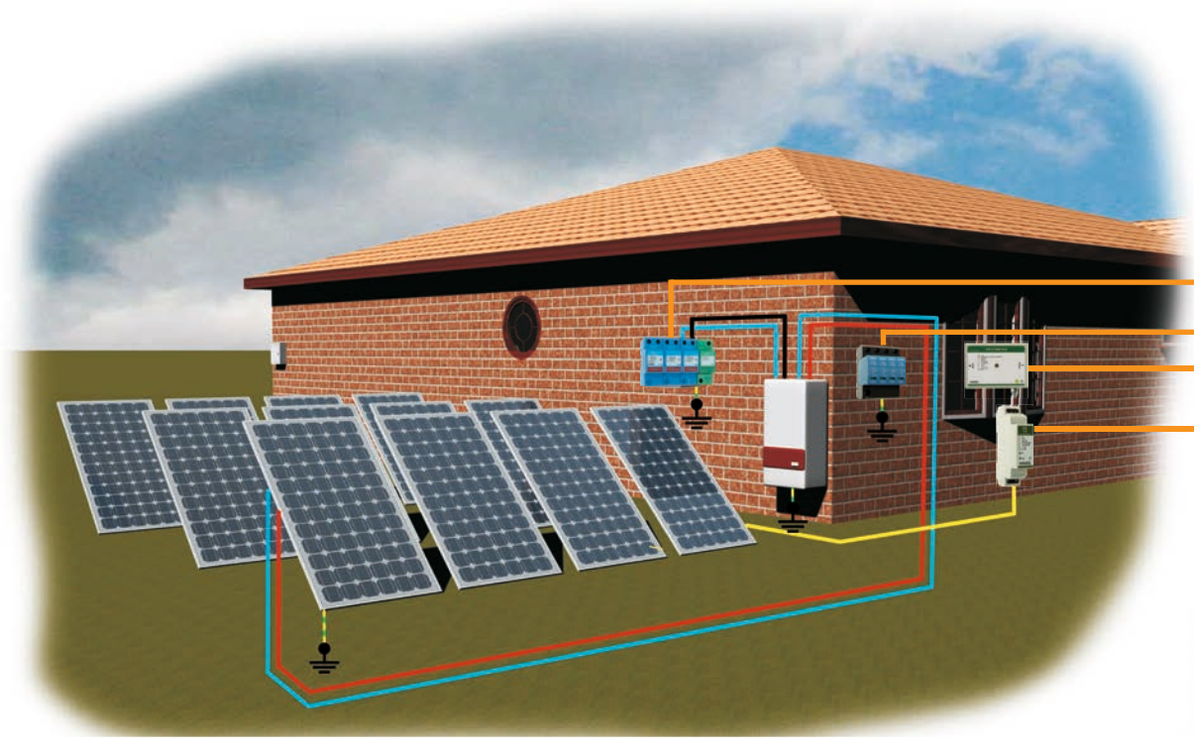
TYPE 1+2 / CLASS I+II / TN-S / TT / CE

PIVM PV is a lightning and surge arrester type 1+2 according to EN 61643-11 and IEC 61643-11 and UTE C 61-740-51. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0-2 (according to IEC 1312-1 and EN 62305) for equipotential bonding of positive and negative busbars of photovoltaic systems and elimination of transient overvoltage that originates during the atmospheric discharges or switching processes. Particular varistor sectors, connected between the terminals L+, L- and PE, are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly visual (discoloration of the signal field) and partly remote monitoring (by potential free change over contacts – only DS types).
The marking **M** specifies a type of construction with removable module.

Type		PIVM12,5-275/1+1 PIVM12,5-275 DS/1+1	PIVM PV 600 PIVM PV 600 DS
Test class according to EN 61643-11 and IEC 61643-11		TYPE 1+2, CLASS I+II	TYPE 1+2, CLASS I+II
Max. continuous operating voltage	U_C	275 V AC / 350 V DC	
Max. continuous operating voltage	U_{CPV}		600 V DC
Open circuit voltage of PV generator	U_{OCSTC}		$U_{OCSTC} < U_{CPV}/1,2 = 500$ V
Short circuit withstand	I_{SCWPV}		100 A
Max. discharge current (8/20)	I_{max}	50 kA	40 kA
Lightning impulse current (10/350) L/N	I_{imp}	12,5 kA	
- charge	Q	6,25 As	
- specific energy	W/R	39 kJ/Ω	
Lightning impulse current (10/350) N/PE	I_{imp}	25 kA	
- charge	Q	12,5 As	
- specific energy	W/R	156 kJ/Ω	
Lightning impulse current (10/350) L/L, L/PE	I_{imp}		7 kA
- charge	Q		3,5 As
- specific energy	W/R		12 kJ/Ω
Total lightning current (10/350)	I_{total}	25 kA	
Nominal discharge current (8/20)	I_n	20 kA	20 kA
Voltage protection level	U_P	< 1,2 kV	< 2,6 kV
Temporary overvoltage (TOV) L/N	U_T	335 V/5 s	
Temporary overvoltage (TOV) N/PE	U_T	1200 V/0,2 s	
Response time L/N	t_A	< 25 ns	
Response time N/PE	t_A	< 100 ns	
Response time L/L, L/PE	t_A		< 25 ns
Max. back-up fuse		160 A gL/gG	
Short-circuit withstand capability	I_p	60 kA_{rms}	
LPZ		0-1	0-2
Protection type		IP20	IP20
Operating temperature range	ϑ	-40°C ... +70 °C	-40°C ... +70 °C
Cross-section of the connected conductors (at tightening moment of clamps 4 Nm)		25 mm² (solid)	25 mm² (solid)
		16 mm² (wire)	16 mm² (wire)
Weight	m	171 g	300 g
Article number			
		16 048	16 070
		16 049	16 071

Administrative and industrial buildings

The basic rules for surge protection devices also apply for this application. If we ignore the voltage, the decisive factor is again the design of the air-termination network. Each administrative or industrial building will most likely have to be equipped with an external surge protection system. Ideally, the PV power plant is positioned in a protective zone of external lightning protection and the minimum arcing distance between the air-termination network and the PV system (between the actual panels or their support structures) is maintained. If the distance of the air-termination network is larger than the arcing distance, we can only consider effect of induced overvoltage and install a type 2 surge protection device, e.g. PIIIM PV. Nonetheless, we still recommend installation of combined 1+2 type surge protection devices, which are able to protect against partial lightning currents as well as potential overvoltage. One of such protection devices is a PIVM PV unit, which is characterized by a replaceable module, but has a slightly lower diverting ability than SPC PV, which has a greater diverting ability and is thus more suitable for larger applications. If the minimum arcing distance cannot be maintained, it is necessary to ensure galvanic connection of a sufficient diameter between all conductive parts of the PV system and the external lightning protection. All of these surge protection devices are installed in sub-distributors on the DC side before the inlet to the inverter. In case of a larger application where the cables are long or if line concentrators are used, it is suitable to repeat the surge protection even in these areas.
The 1+2 type SPC25 device is standardly recommended for the building's main distributor at the AC line entrance. It features doubled varistors for higher safety and can boast an impulse current of 25 kA/pole. The SPC25G unit, a novelty in the field of surge protection, incorporates all three 1+2+3 types and consists of a combination of varistors and a lightning arrester, thus providing multiple benefits. Both of these products will protect the building safely and adequately. In most cases, the inverter will be located off the main distributor, so it will again be necessary to install a surge protection device in the sub-distributor immediately behind the AC outlet. Here we can repeat the 1+2 level surge protection with the PIV12,5 device, which is produced in a fixed and replaceable version PIVM12,5 or just SPD type 2 of the III series (again in a fixed and replaceable version). We offer all of the mentioned types of surge protection devices for DC and AC systems also in a remote signal version.
Each larger PV power station is equipped with data and communication lines, which need to be protected. We recommend installation of DIN rail mounted DTE devices with screw termination or DTB units with screw terminal or RF45 connector for structured cabling. It is possible to use a DTB 485 device for a serial busbar with screw attachment. HAKEL also offers DIN rail mounted HT-NET series with a screw termination or RJ45 connector for the 5 and 6 categories.

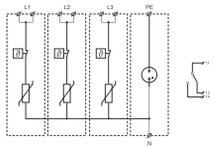


PROTECTION OF PHOTOVOLTAIC SYSTEMS AGAINST LIGHTNING AND OVERVOLTAGE

ADMINISTRATIVE AND INDUSTRIAL BUILDINGS

SPC25/3+1
SPC25 DS/3+1

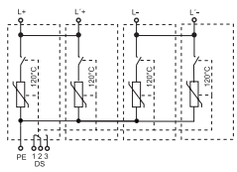
TYPE 1+2 / CLASS I+II / TN-S / TT / CE



SPC25/3+1 is a metal oxid varistor lightning and surge arrester, combined with gas discharge tube Type 1+2 according to EN 61643-11 and IEC 61643-11.These are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0–1 (according to IEC 1312-1 and EN 62305), where they provide the equipotential bonding and discharge of both, the lightning current and the switching surge, which are generated in power supply systems entering the building. The use of the lightning current arresters SPC25/3+1 is mainly in the power supply lines, which are operated as TN-S and TT systems. The main use of SPC25/3+1 arrester is in structures of LPL I – II according to EN 62305 ed.2. Double terminals of the device allow the "V" connection at the maximum current-carrying capacity of 125A.

PIVM PV800
PIVM PV800 DS

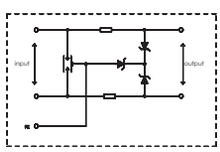
TYPE 1+2 / CLASS I+II / TN-S / TT / CE



PIVM PV are the lightning and surge arresters type 1+2 according to EN 61643-11 and IEC 61643-11 and UTE C 61-740-51. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0-2 (according to IEC 1312-1 and EN 62305) for equipotential bonding of positive and negative busbars of photovoltaic systems and elimination of transient overvoltage that originates during the atmospheric discharges or switching processes. Particular varistor sectors, connected between the terminals L+, L- and PE, are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly visual (discoloration of the signal field) and partly remote monitoring (by potential free change over contacts – only DS types). The marking **M** specifies a type of construction with removable module.

DTE

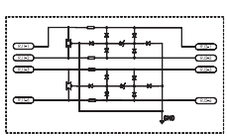
LPZ 1-2-3 / CE



DTE is a complex range of surge protection devices designed for protection of data, communication, measuring and control lines against surge effects. These surge protection devices are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0_A(B) - 1 according to EN 62305. All types provide effective protection of connected equipment against common mode and differential mode surge effects according to IEC 61643-21. The rated load current of individual protected lines I_L < 0,1A. These devices consist of gas discharge tubes, series impedance and transils. The number of protected pairs is optional (1-2). These devices are produced for nominal voltage within the range of 6V-170V. Maximum discharge current is 10kA (8/20). For the protection of telephone lines it is recommended to use a type with nominal voltage U_N=170V (with code mark "T").

DTB 4/100M 5cat

LPZ 2-3 / CE



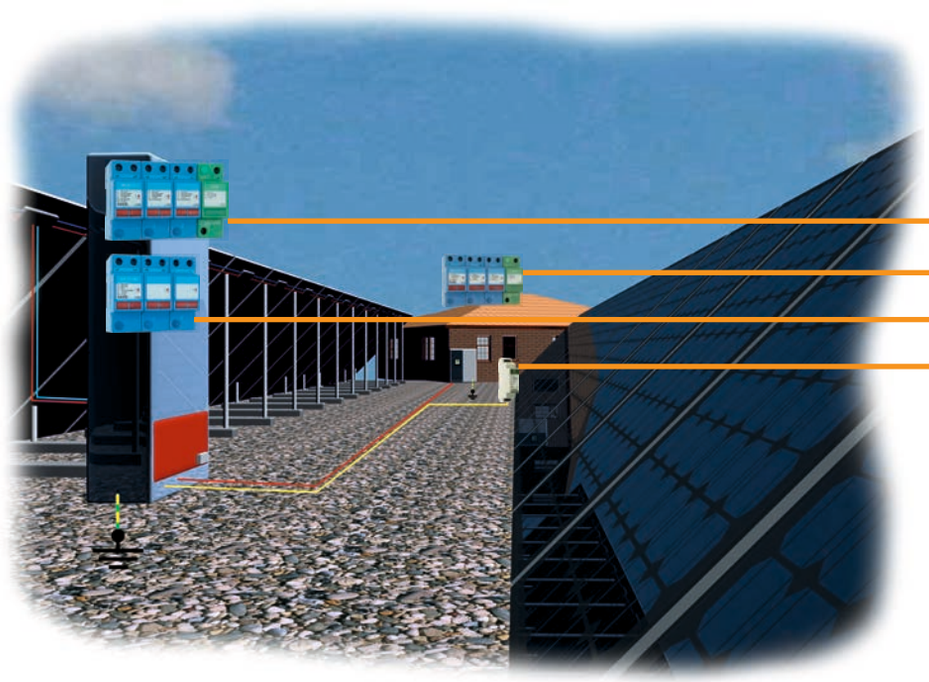
These surge protection devices intended for computer networks are specially designed for securing a faultless data transfer within computer networks category 5. They protect input electronic circuits of network cards against damage caused by surge effects in the Lightning Protection Zones Concept at the boundaries of LPZ $0_{A(B)}$ -1 and higher according to EN 62305. It is recommended to use these protection devices at the input of protected equipment. DTB2/100M 5cat is suitable for mounting on a wall. DTB 2/100M 5cat protects two pairs and DTB 4/100M 5cat protects four pairs of conductors.

Type		SPC25/3+1 SPC25 DS/3+1	PIVM PV 800 PIVM PV 800 DS	DTE 1/6	DTB 4/100M 5cat
Test class according to EN 61643-11 and IEC 61643-11		TYPE 1+2, CLASS I+II	TYPE 1+2, CLASS I+II		
	U_N			6 V	6 V
Max. continuous operating voltage	U_C	275 V AC / 350 V DC		7,2 V	7,2 V
Max. continuous operating voltage	U_{CPV}		800 V DC		
Open circuit voltage of PV generator	U_{OCSTC}		$U_{OCSTC} < U_{CPV}/1,2 = 730$ V		
Short circuit withstand	I_{SCWPV}		100 A		
Max. discharge current (8/20)	I_{max}	50 kA	40 kA	10 kA	
Lightning impulse current (10/350) L/N	I_{imp}	25 kA			
- charge	Q	12,5 As			
- specific energy	W/R	156 kJ/Ω			
Lightning impulse current (10/350) N/PE	I_{imp}	100 kA			
- charge	Q	50 As			
- specific energy	W/R	2500 kJ/Ω			
Lightning impulse current (10/350) L/L, L/PE	I_{imp}		6,5 kA		
- charge	Q		3,25 As		
- specific energy	W/R		10 kJ/Ω		
Total lightning current (10/350)	I_{total}	100 kA			
Nominal discharge current (8/20)	I_n	25 kA	15 kA	1 kA	20 kA
Voltage protection level	U_p	< 1,2 kV	< 3,3 kV	15 V	25 V
Temporary overvoltage (TOV) L/N	U_T	335 V/5 s			
Temporary overvoltage (TOV) N/PE	U_T	1200 V/0,2 s			
Response time L/N	t_A	< 25 ns		30 ns	
Response time N/PE	t_A	< 100 ns			
Response time L/L, L/PE	t_A		< 25 ns		
Data rate				1 Mbit/s	
Max. back-up fuse		250 A gL/gG			
Short-circuit withstand capability	I_p	80 kA_{rms}			
LPZ		0-1	0-2	1-2-3	2-3
Protection type		IP20	IP20	IP20	IP20
Operating temperature range	ϑ	-40°C ... +70 °C	-40°C ... +70 °C	-40°C ... +70 °C	-40°C ... +70 °C
Cross-section of the connected conductors (at tightening moment of clamps 4 Nm)		35 mm² (solid)	25 mm² (solid)	0,25 - 1,5 mm²	
		25 mm² (wire)	16 mm² (wire)		
Weight	m	1125 g	390 g		
Article number		10 732	16 073	41 301	45 109
		10 632	16 074		

Large photovoltaic power stations

External lightning protection systems are not frequently installed in large photovoltaic power stations. Subsequently, usage of the type 2 protection is impossible and it is necessary to use the 1+2 type surge protection device. The systems of large PV power plants incorporate a large central inverter with the output of hundreds of kW or a decentralized system with a larger amount of smaller inverters. The length of cable lines is important not only for elimination of losses, but also for optimization of surge protection. In case of a central inverter, DC cables from individual strings are conducted to line concentrators from which a single DC cable is conducted to the central inverter. Because of the lengths of cables, which can reach hundreds of meters in large PV power stations, and a potential direct lightning strike at the line concentrators or directly the PV panels, it is important to install a 1+2 type surge protection device to all line concentrators even before the entry to the central inverter. We recommend an SPC PV unit with greater diverting ability. In case of a decentralized system, a surge protection device should be installed before each DC inlet to the inverter. We can again use the SPC PV unit. In both cases, we must not forget to interconnect all metal parts with the earthing to equalize the potential.
For the AC side behind outlet from the central inverter, we recommend the SPC25 unit or an innovated SPC25G version. Both of these surge protection devices allow large earth-leakage currents of 25 kA/pole. In case of a decentralized system, it is necessary to install a surge protective device, e.g. SPC12,5, behind each AC outlet from the inverter and repeat the protection by the mentioned SPC25 or SPC25G devices in the main AC distributor. The AC line on the outlet from the central inverter or the main AC distributor is most frequently conducted to a nearby transformer station where the voltage is transformed to HV or VHV and then conducted to an aboveground power line. Because of a higher likelihood of lightning strike directly at the power line, a high-performance type 1 surge protection device must be installed at the transformer station. The HAKEL Company offers its HS50-50 device, which is more than adequate for these applications. It is a spark gap able to divert a lightning pulse current of 50 kA/pole.
To ensure correct operation of a large power station and the maximum efficiency, the PV power station is monitored by modern electronic measurement and regulation systems as well as transfer of data to a control room. Various systems work with various boundaries and HAKEL provides protection of all standardly used systems. Like in the previous applications, we offer only a fraction of products here, but we are able to offer various customized concepts. For structured cables using RJ45 connectors, we recommend installation of DTB or HT-NET devices or DTB 485 for series busbars. For standard data lines, we recommend DIN rail mounted DTE or HT-NET devices with screw termination.

The HAKEL Company is represented in many countries and its qualified staff is prepared to assist you with choosing the right surge protection device for the given application or a technical concept of your particular project. You can also visit our website at www.hakel.com where you can contact our business representatives and find a complete offer of our products, which all conform to the international standard IEC 61643-11:2011.

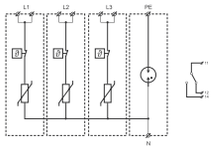


PROTECTION OF PHOTOVOLTAIC SYSTEMS AGAINST LIGHTNING AND OVERVOLTAGE

LARGE PHOTOVOLTAIC POWER STATIONS

SPC12,5/3+1
SPC12,5 DS/3+1

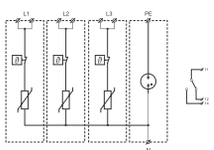
TYPE 1+2 / CLASS I+II / TN-S / TT / CE



SPC12,5/3+1 is a metal oxid varistor lightning and surge arrester, combined with gas discharge tube Type 1+2 according to EN 61643-11 and IEC 61643-11.These are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0–1 (according to IEC 1312-1 and EN 62305), where they provide the equipotential bonding and discharge of both, the lightning current and the switching surge, which are generated in power supply systems entering the building. The use of the lightning current arresters SPC12,5/3+1 is mainly in the power supply lines, which are operated as TN-S and TT systems. The main use of SPC12,5/3+1 arrester is in structures of LPL I – II according to EN 62305 ed.2. Double terminals of the device allow the "V" connection at the maximum current-carrying capacity of 125A.

SPC25/3+1
SPC25 DS/3+1

TYPE 1+2 / CLASS I+II / TN-S / TT / CE

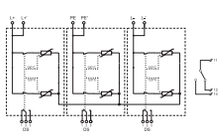


SPC12,5/3+1 is a metal oxid varistor lightning and surge arrester, combined with gas discharge tube Type 1+2 according to EN 61643-11 and IEC 61643-11.These are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0–1 (according to IEC 1312-1 and EN 62305), where they provide the equipotential bonding and discharge of both, the lightning current and the switching surge, which are generated in power supply systems entering the building. The use of the lightning current arresters SPC12,5/3+1 is mainly in the power supply lines, which are operated as TN-S and TT systems. The main use of SPC12,5/3+1 arrester is in structures of LPL III – IV according to EN 62305 ed.2.

Double terminals of the device allow the "V" connection at the maximum current-carrying capacity of 125A.

SPC PV 600
SPC PV 600 DS

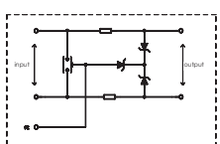
TYPE 1+2 / CLASS I+II / CE



SPC PV is a lightning and surge arrester type 1+2 according to EN 61643-11 and EN 50539. It is designed for protection of positive and negative busbars of photovoltaic systems against the surge effects. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0-2 (according to IEC 1312-1and EN 62305). Particular varistor sectors are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly mechanical (by exserted red signaling target in case of failure) and partly remote monitoring (by potential free change over contacts – only DS types).

DTE

LPZ 1-2-3 / CE



DTE is a complex range of surge protection devices designed for protection of data, communication, measuring and control lines against surge effects. These surge protection devices are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0_A(B) - 1 according to EN 62305. All types provide effective protection of connected equipment against common mode and differential mode surge effects according to IEC 61643-21. The rated load current of individual protected lines I_L < 0,1A. These devices consist of gas discharge tubes, series impedance and transils. The number of protected pairs is optional (1-2). These devices are produced for nominal voltage within the range of 6V-170V. Maximum discharge current is 10kA (8/20). For the protection of telephone lines it is recommended to use a type with nominal voltage U_N=170V (with code mark "T").

Type		SPC12,5/3+1 SPC12,5 DS/3+1	SPC25/3+1 SPC25 DS/3+1	SPC PV 600 SPC PV 600 DS	DTE 1/6
Test class according to EN 61643-11 and IEC 61643-11		TYPE 1+2, CLASS I+II	TYPE 1+2, CLASS I+II		
	U_N				6 V
Max. continuous operating voltage	U_C	275 V AC / 350 V DC	275 V AC / 350 V DC		7,2 V
Max. continuous operating voltage	U_{CPV}			650 V DC	
Open circuit voltage of PV generator	U_{OCSTC}			U_{OCSTC} < U_{CPV}/1,2 = 540 V	
Short circuit withstand	I_{SCWPV}			25 A	
Max. discharge current (8/20)	I_{max}	50 kA	50 kA	10 kA	10 kA
Lightning impulse current (10/350) L/N	I_{imp}	12,5 kA	25 kA		
- charge	Q	6 As	12,5 As		
- specific energy	W/R	36 kJ/Ω	156 kJ/Ω		
Lightning impulse current (10/350) N/PE	I_{imp}	50 kA	100 kA		
- charge	Q	25 As	50 As		
- specific energy	W/R	625 kJ/Ω	2500 kJ/Ω		
Lightning impulse current (10/350) L/L, L/PE	I_{imp}			12,5 kA	
- charge	Q			6 As	
- specific energy	W/R			36 kJ/Ω	
Total lightning current (10/350)	I_{total}	50 kA	100 kA		
Nominal discharge current (8/20)	I_n	25 kA	25 kA	25 kA	1 kA
Voltage protection level	U_p	< 1,2 kV	< 1,2 kV	< 3,1 kV	64 V
Temporary overvoltage (TOV) L/N	U_T	335 V/5 s	335 V/5 s		
Temporary overvoltage (TOV) N/PE	U_T	1200 V/0,2 s	1200 V/0,2 s		
Response time L/N	t_A	< 25 ns	< 25 ns		30 ns
Response time N/PE	t_A	< 100 ns	< 100 ns		
Response time L/L, L/PE	t_A			25 ns	
Data rate					1 Mbit/s
Max. back-up fuse		160 A gL/gG	250 A gL/gG		
Short-circuit withstand capability	I_p	80 kA_{rms}	80 kA_{rms}		
LPZ		0-1	0-1	0-2	1-2-3
Protection type		IP20	IP20	IP20	IP20
Operating temperature range	ϑ	-40°C ... +70 °C	-40°C ... +70 °C	-40°C ... +70 °C	-40°C ... +70 °C
Cross-section of the connected conductors (at tightening moment of clamps 4 Nm)		35 mm^2 (solid) 25 mm^2 (wire)	35 mm^2 (solid) 25 mm^2 (wire)	35 mm^2 (solid) 25 mm^2 (wire)	0,25 - 1,5 mm^2
Weight	m	1130 g	1125 g		
Article number		10 730 10 630	10 732 10 632	10 168 10 068	41 301

PROTECTION OF PHOTOVOLTAIC SYSTEMS AGAINST LIGHTNING AND OVERVOLTAGE

SPC PV 600, SPC PV 800, SPC PV 1000
SPC PV 600 DS, SPC PV 800 DS, SPC PV 1000 DS

SPC PV is a lightning and surge arrester type 1+2 according to EN 61643-11 and EN 50539. It is designed for protection of positive and negative busbars of photovoltaic systems against the surge effects. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0-2 (according to IEC 1312-1and EN 62305). Particular varistor sectors are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly mechanical (by exserted red signaling target in case of failure) and partly remote monitoring (by potential free change over contacts – only DS types).

PIVM PV 600 $\mathcal{V}$series
PIVM PV 600 DS $\mathcal{V}$series

PIVM PV is a lightning and surge arrester type 1+2 according to EN 61643-11 and IEC 61643-11 and UTE C 61-740-51. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0-2 (according to IEC 1312-1 and EN 62305) for equipotential bonding of positive and negative busbars of photovoltaic systems and elimination of transient overvoltage that originates during the atmospheric discharges or switching processes. Particular varistor sectors, connected between the terminals L+, L- and PE, are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly visual (discoloration of the signal field) and partly remote monitoring (by potential free change over contacts – only DS types). The marking M specifies a type of construction with removable module.

PIVM PV 800 $\mathcal{V}$series , PIVM PV 1000 $\mathcal{V}$series
PIVM PV 800 DS $\mathcal{V}$series , PIVM PV 1000 DS $\mathcal{V}$series

PIVM PV are the lightning and surge arresters type 1+2 according to EN 61643-11 and IEC 61643-11 and UTE C 61-740-51. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 0-2 (according to IEC 1312-1 and EN 62305) for equipotential bonding of positive and negative busbars of photovoltaic systems and elimination of transient overvoltage that originates during the atmospheric discharges or switching processes. Particular varistor sectors, connected between the terminals L+, L- and PE, are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly visual (discoloration of the signal field) and partly remote monitoring (by potential free change over contacts – only DS types).
The marking M specifies a type of construction with removable module.

PIIIM PV 600 $\mathcal{V}$series, PIIIM PV 800 $\mathcal{V}$series, PIIIM PV 1000 $\mathcal{V}$series
PIIIM PV 600 DS $\mathcal{V}$series, PIIIM PV 800 DS $\mathcal{V}$series, PIIIM PV 1000 DS $\mathcal{V}$series

PIIIM PV are the lightning and surge arresters type 2 according to EN 61643-11 and IEC 61643-11 and UTE C 61-740-51. These arresters are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 1-2 (according to IEC 1312-1 and EN 62305) for equipotential bonding of positive and negative busbars of photovoltaic systems and elimination of transient overvoltage that originates during the atmospheric discharges or switching processes. Particular varistor sectors, connected between the terminals L+, L- and PE, are equipped with internal disconnectors, which are activated when the varistors fail (overheat). Operational status indication of these disconnectors is partly visual (discoloration of the signal field) and partly remote monitoring (by potential free change over contacts – only DS types).
The marking M specifies a type of construction with removable module.

DTE */*

DTE is a complex range of surge protection devices designed for protection of data, communication, measuring and control lines against surge effects. These surge protection devices are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ $0_{A(B)}$ - 1 according to EN 62305. All types provide effective protection of connected equipment against common mode and differential mode surge effects according to IEC 61643-21. The rated load current of individual protected lines I_L < 0,1A.

These devices consist of gas discharge tubes, series impedance and transils. The number of protected pairs is optional (1-2). These devices are produced for nominal voltage within the range of 6V-170V. Maximum discharge current is 10kA (8/20). For the protection of telephone lines it is recommended to use a type with nominal voltage U_N=170V (with code mark "T").

DTB */*/*

DTB, DTB-R is a complex range of surge protection devices designed for protection of data, communication, measuring and control lines against surge effects. These surge protection devices are recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ $0_{A(B)}$ - 1 according to EN 62305. All types provide effective protection of connected equipment against common mode and differential mode surge effects according to IEC 61643-21. The rated load current of individual protected lines I_L < 0,1A.

These devices consist of gas discharge tubes, series impedance and transils. The number of protected pairs is optional (1-4). These devices are produced for nominal voltage within the range of 6V-170V. Maximum discharge current is 10kA (8/20) for type DTB and 2kA (8/20) for DTB-R type. For the protection of telephone lines it is recommended to use DTB type with nominal voltage U_N = 170V (with code mark "T"). The connection of protected lines is carried out by screw terminals for type DTB and by RJ45 connectors for type DTB-R.

HT-DATA 1/* $\mathcal{X}$series
HT-NV 1/*/0,5 $\mathcal{X}$series

Hakel Transmition - Data is designed to protect transmission of information signals and Hakel Transmition-NV to protect links of power supply lines. The casing of this protector is made out of light alloy, which ensures high mechanical and thermal resistance. I_{max}=10kA. It is recommended for use in the Lightning Protection Zones Concept at the boundaries of LPZ 1-2 according to EN 62305.

HT-NET PoE 6cat $\mathcal{X}$series

These surge protection devices intended for computer networks are specially designed for securing a faultless data transfer within computer networks category 6. They protect input electronic circuits of network cards against damage caused by surge effects in the Lightning Protection Zones Concept at the boundaries of LPZ 1-2 according to EN 62305. It is recommended to use these protection devices at the input of protected equipment.

HUF 003 - VOLTAGE & FREQUENCY PROTECTOR

This Voltage & Frequency Protector is recommended for use in AC parts of photovoltaic systems or other types of AC electrical installations. HUF is equipped with switching contact intended for external contactor control. This contact will operate once the HUF gets connected to monitored system after initialization of its internal electronics. Subsequently, HUF device continuously monitors two basic magnitudes (voltage and frequency) of connected AC power system. In case of their deviation from the preseted values the switch contact will open and consequently the external contactor will disconnect the equipment from the monitored AC power system. In this way, it is possible to disconnect all protected equipment from monitored AC power system immediatelly. HUF 003 is suitable for use in three-phase or in one-phase applications since reconfi guration of measuring mode is made automatically by inbuilt microprocessor. The basic working limits of overvoltage / undervoltage / frequency and basic response time are set byproducer.

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