

**APLICACIONES
TECNOLÓGICAS**

**LIGHTNING
& EARTHING**



Lightning protection systems in photovoltaic power plants

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Introduction



Photovoltaic power plants are always located in huge and isolated areas or on roofs due to their functions. **They are high-cost equipment and when damaged can cause losses to energy supply, especially if they are connected to the distribution network.** Its operation is controlled by sensitive electronic devices that can be highly damaged by transient surges. Therefore, from the point of view of lightning protection they are high-risks installations.

Aplicaciones Tecnológicas S.A. has all the elements available to achieve the best protection for solar plants: effective lightning rods for capturing lightning, special grounding electrodes for high resistivity soils and a wide range of surge protection devices (SPD) that are able of protecting from data lines connected to electronic devices to the output of transformation centres. Protection must be carefully designed by an expert team as a large number of parameters are involved. Our experience of over 30 years in lightning protection allows us to determine the most convenient solution for each facility.

ESE Lightning air terminals DAT CONTROLER® REMOTE



DAT CONTROLER® REMOTE

The early streamer emission air terminals **DAT CONTROLER® REMOTE** have been tested in official and independent laboratories to obtain the time of advance, which determines its radius of protection and certifies they are capable of withstanding currents from lightning bolts. The early streamer emission air terminals are certified as an AENOR product.

An **ESE lightning rod** is characterized by its response to the approach of lightning, overtaking other elements in its capture within its protection zone and leading it to land safely.

DAT CONTROLER® REMOTE lightning rod uses the environmental electric field as the only power source. It is totally autonomous, maintenance-free and its functioning can be checked at any time. For a greater guarantee, **DAT CONTROLER® REMOTE** lightning rods have been subjected to all necessary tests in official and independent laboratories.

DAT CONTROLER® REMOTE lightning rods installation must be carried out following the 21186 UNE standard: "Lightning Protection with Early Streamer Emission Air Terminals".

With only one single lightning rod it is possible to protect a surface of almost 20.000m² considering Level of Protection 1, which is the most demanding. However, to achieve this protection, lightning rods must be installed at least 6 meters above the solar panels, which can cause a problem with shadows. To minimize it, **it is recommended to place the installation in the perimeter of the solar farm**. This way shadows on photovoltaic panels are avoided as much as possible.

To reduce these shadows, it is recommended to set up the lightning rod on a 10m free standing mast (AT-092C) so it rises above the solar panels.

ESE Lightning air terminals DAT CONTROLER® REMOTE



Protection Radius in meters (Rp)

Protection radius (in meters) at different heights from the lightning rod over the element to be protected are calculated for each of the four levels of protection according to standards UNE 21186:2011, NF C 17-102:2011 and NP 4426:2013.

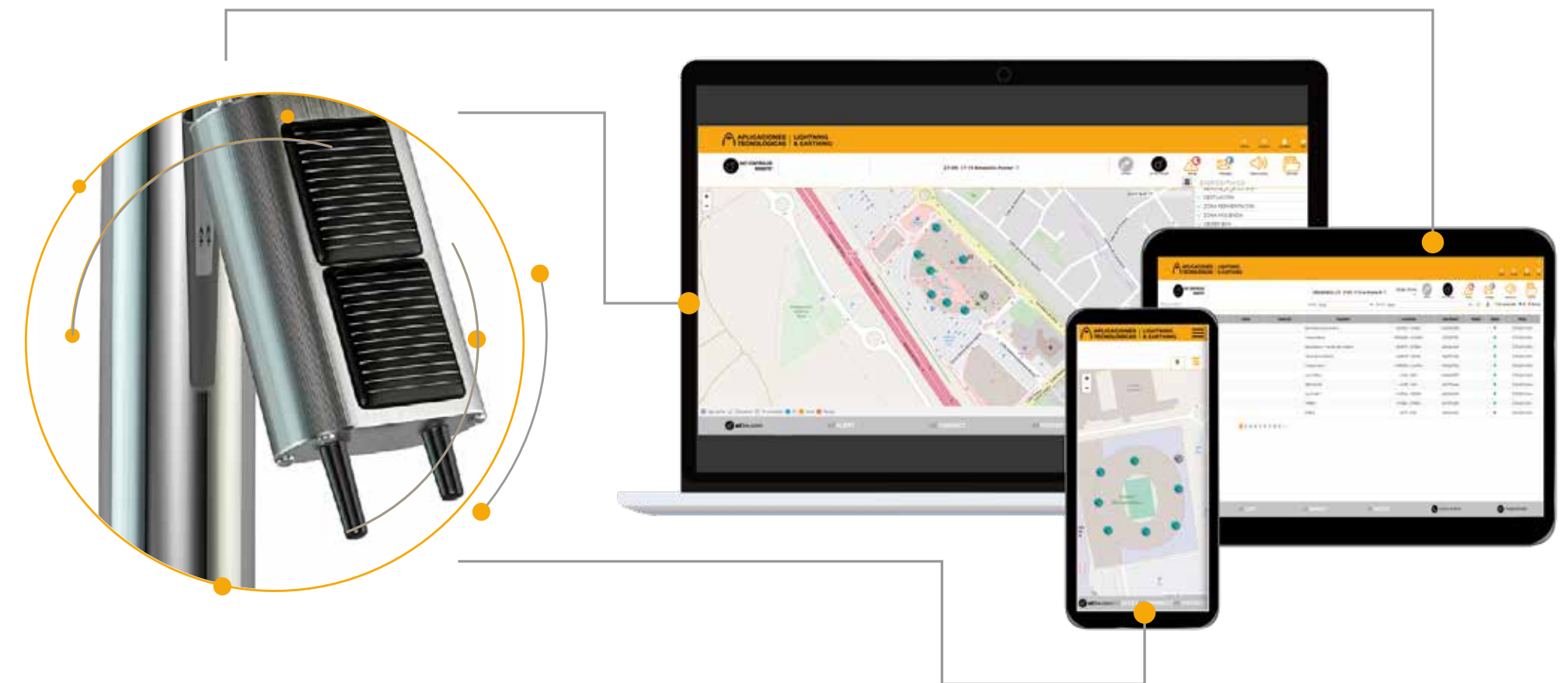
	LEVEL OF PROTECTION I				LEVEL OF PROTECTION II				LEVEL OF PROTECTION III				LEVEL OF PROTECTION IV			
Ref.	AT-2515	AT-2530	AT-2545	AT-2560	AT-2515	AT-2530	AT-2545	AT-2560	AT-2515	AT-2530	AT-2545	AT-2560	AT-2515	AT-2530	AT-2545	AT-2560
h (m) 2	13	19	25	31	15	22	28	35	18	25	32	39	20	28	36	43
4	25	38	51	63	30	44	57	69	36	51	64	78	41	57	72	85
6	32	48	63	79	38	55	71	87	46	64	81	97	52	72	90	107
8	33	49	64	79	39	56	72	87	47	65	82	98	54	73	91	108
10	34	49	64	79	40	57	72	88	49	66	83	99	56	75	92	109
20	35	50	65	80	44	59	74	89	55	71	86	102	63	81	97	113
60	35	50	65	80	45	60	75	90	60	75	90	105	75	90	105	120

h (m): Height of the air terminal over the element to be protected (in metres)

Self-diagnosis and connectivity (IoT)

The REMOTE device allows daily self-test of lightning rod condition without the need to dismantle the lightning rod or the auxiliary lifting equipment.

The result of its self-test is sent to a receiving device (mobile, tablet, computer) by M2M communication. The information can be seen on the portal web along with other personalized notifications, thus facilitating the right preventive and corrective maintenance of the installation and reducing associated costs.





ATLOGGER

Intelligent lightning event counter.

- ✔ It registers the passage of lightning current, amplitude, polarity, date and time of the discharge.
- ✔ Information can be collected on a specific device with USB connection.
- ✔ It stores information of up to 40 events.
- ✔ Data management software is intuitive and easy.
- ✔ Easy installation: does not need interruption of downconductor.

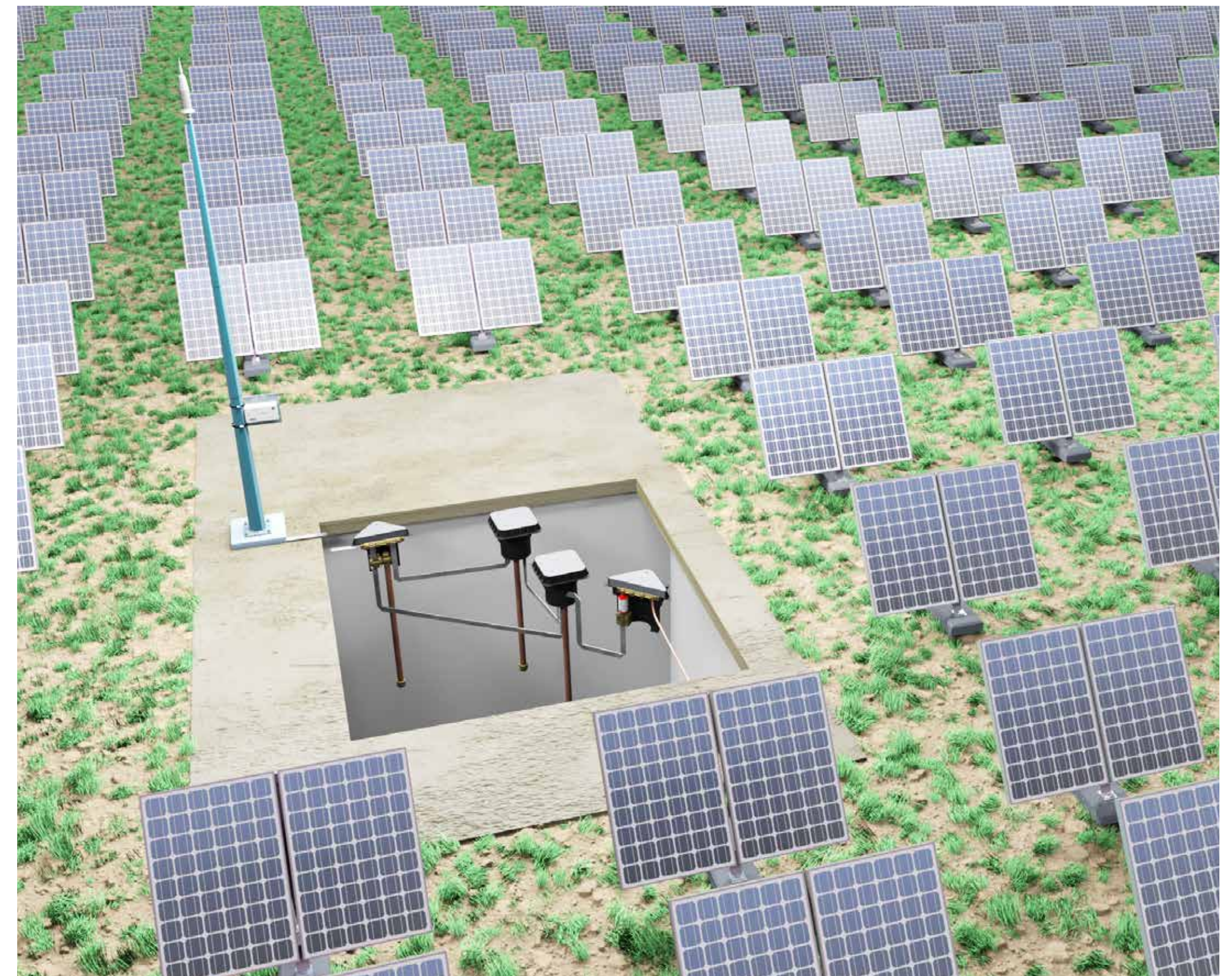


Equipotentialization and earth systems



The earth termination system is important because it serves to stabilize the voltage relative to earth during its normal operation. Therefore, it is common that photovoltaic panels have an adequate earth termination system. It is highly recommended that all earthing systems are united, i.e. there is a general earth network to which each solar panel is connected to. Besides, metal masses (metal fences, enclosures, brackets and equipment cover) should be connected to the ground as established in UNE-EN 61173 standard to achieve equipotentialization of all elements avoiding potential differences and dangerous sparks as much as possible.

The lightning protection system has its own earthing system that will be unified to the general one with a spark gap for earth bonding to keep them separate during the normal functioning of the equipment, eliminating the possibility of causing problems such as electromagnetic noise or corrosion. For the grounding of lightning rods it is preferable to use vertical electrodes about two or three meters long which form a triangle. This is the most suitable configuration for rapidly dissipating lightning, which is pulse current.





Components used in earth systems



AT-010H

250x250x250mm polypropylene earth pit capable of withstanding 5000 kg.



AT-020H

235x40x25mm bonding bar for earth pit.



AT-025H

Ø28x2500mm **APLIROD**® dynamic electrode.



AT-020N

Apliweld Secure+
20 units welding tablets.



AT-050K

Spark gap for earth joint.



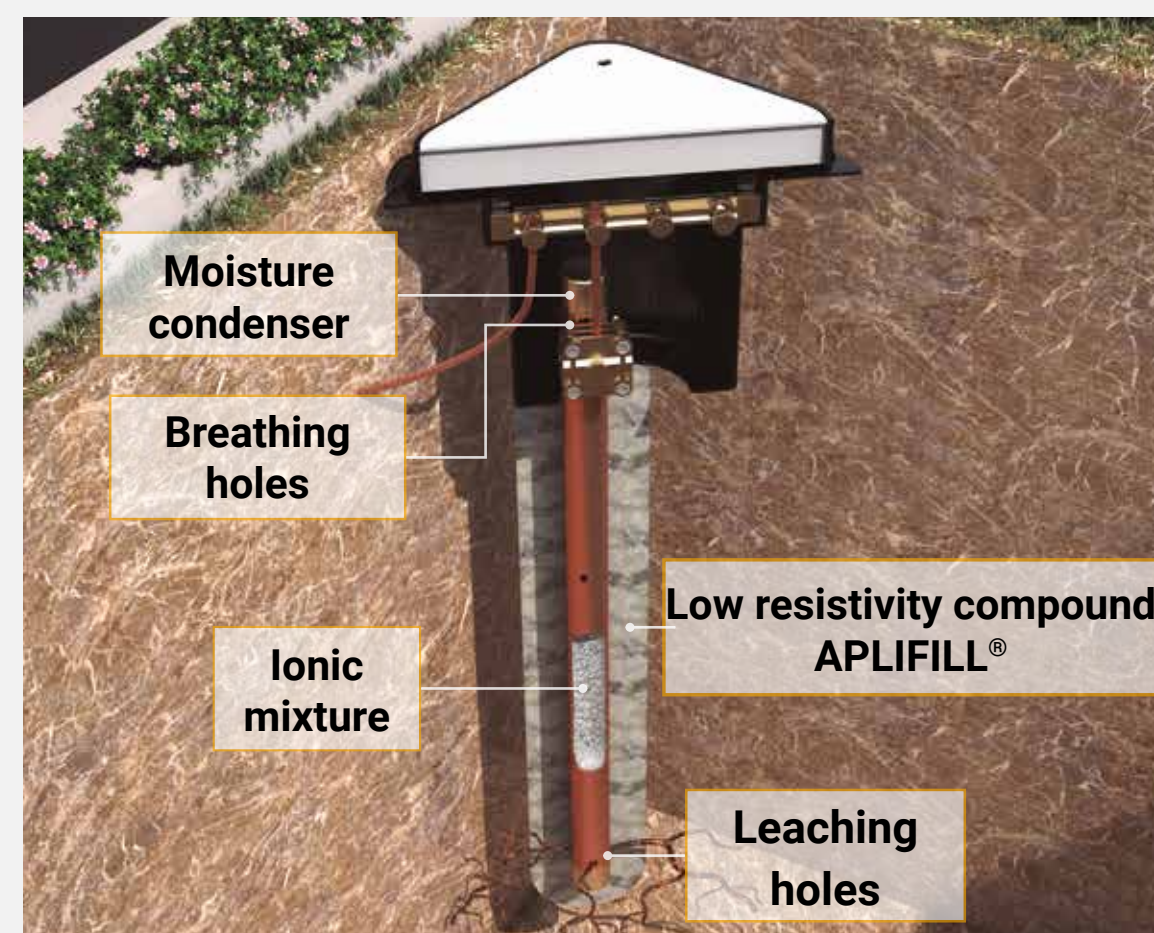
AT-052D

30x2mm tinned copper tape.

AT-025H - APLIROD® dynamic electrodes

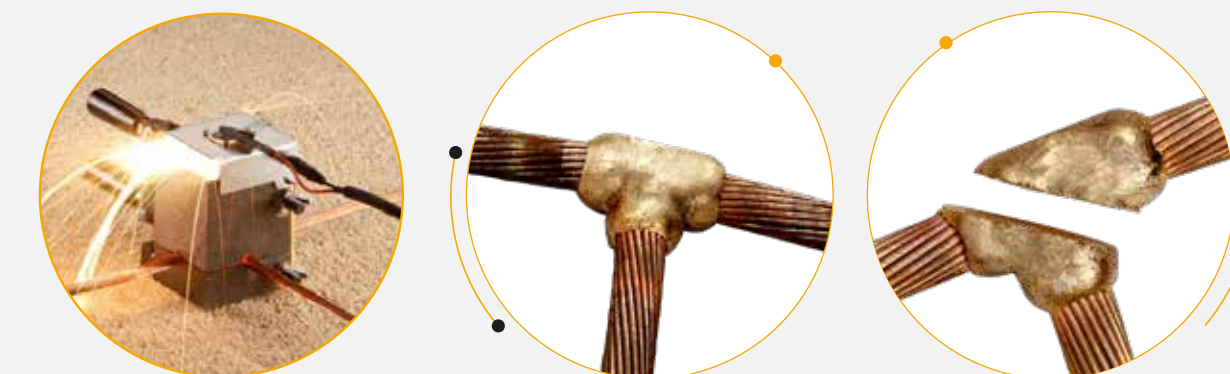
In high-resistivity ground the use of **APLIROD**® dynamic electrodes is recommended. These consist of copper tubes filled with salts that improve the conductivity of the soil over time. Each of the dynamic electrodes must be installed in a registration box so as not to obstruct the breathing holes.

APLIFILL® is gradually mixed with water outside the excavation using a proportion of 1kg of **APLIFILL**® for every 4 litres of water.

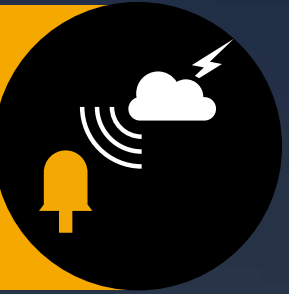


APLIWELD Secure+

It is recommendable that the joints in the earth system are made using exothermic welding since a molecular union is obtained between the conductors which does not.



ATSTORM® preventive protection



ATSTORM®

Preventive protection is complementary to external and surge protection. Having information about the proximity of a storm and taking the adequate measures can avoid special risk situations, but cannot avoid device damage if there is not a good protection system. **Early detection in thunderstorms is interesting for avoiding maintenance operations and placing mobile panels in less risky positions. It is also interesting for connecting autonomous supply systems to avoid lightning striking on electric lines where connected devices could be damaged.**

ATSTORM® thunderstorm detector is the ideal tool for preventive protection for storm effects and atmospheric discharge since it allows to take specific measures with an anticipation of several tens of minutes before imminent risk of a thunderstorm. It safeguards people and equipment from its destructive effects.

The objective of a local thunderstorm detector is to identify the risk of formation or proximity of a thunderstorm with as much anticipation as possible.





ATSTORM®

Maximum efficiency

✓ Detection during all phases of a thunderstorm

We monitor both the electrostatic and electromagnetic fields, enabling the maximum anticipation in the risk of a lightning event.

✓ Fully electronic, with no moving parts

Our equipment does not use moving mechanical parts, preventing blockages, wear and failures.

✓ Operated by specialists through Internet of Things (IoT)

The system is remotely operated, ensuring its proper functioning at all times.

✓ Expert system

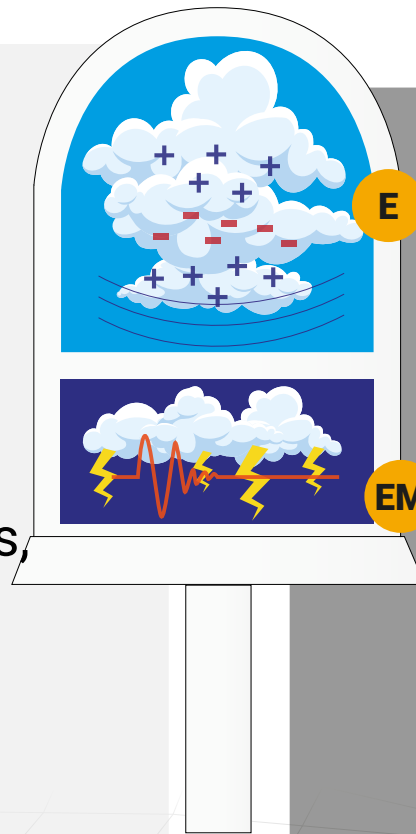
Continuous improvement of its algorithms, increasing their adaptation to the monitored local characteristics.

✓ Risk alerts via multiple channels

Our customers receive the risk alerts through multiple means: smartphone, tablet, private web portal, emails and remote activation of alert devices.

✓ Ad-hoc projects

We study each location and determine the best system configuration in terms of number and positioning of the detection units.



Electrostatic field sensor

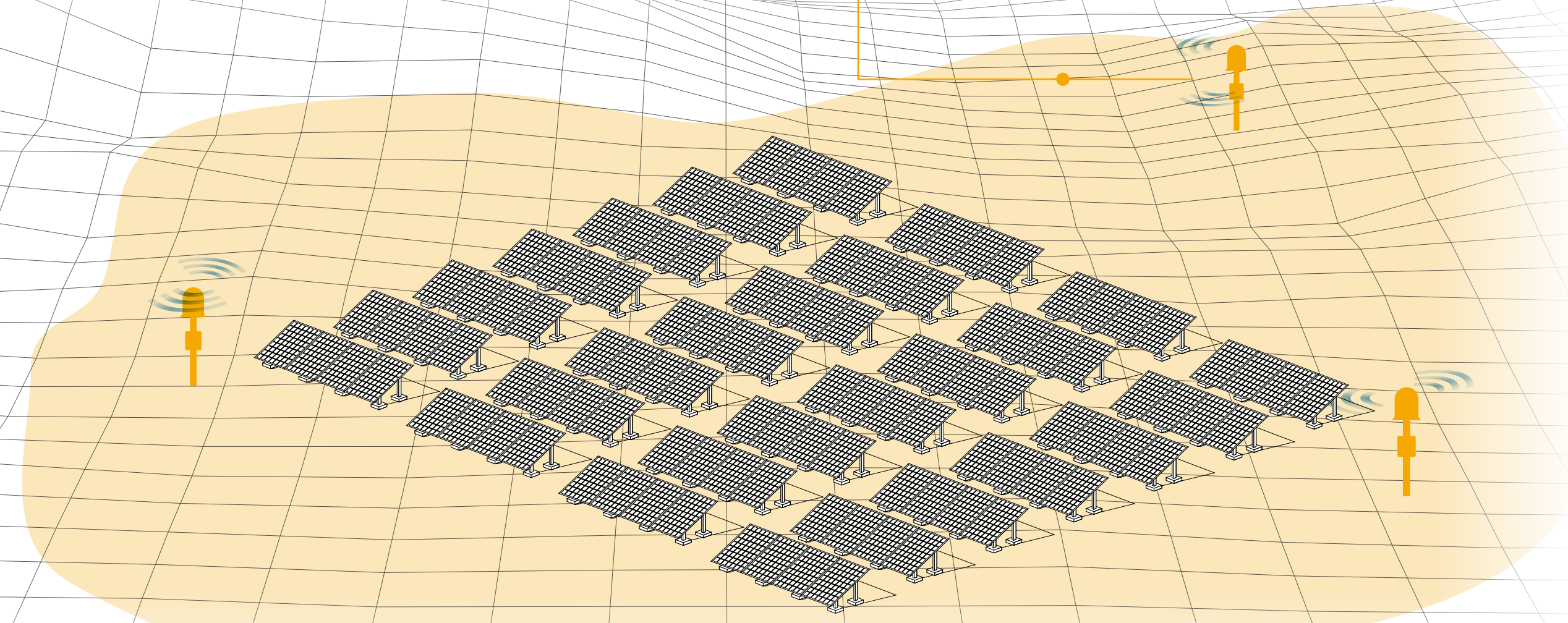
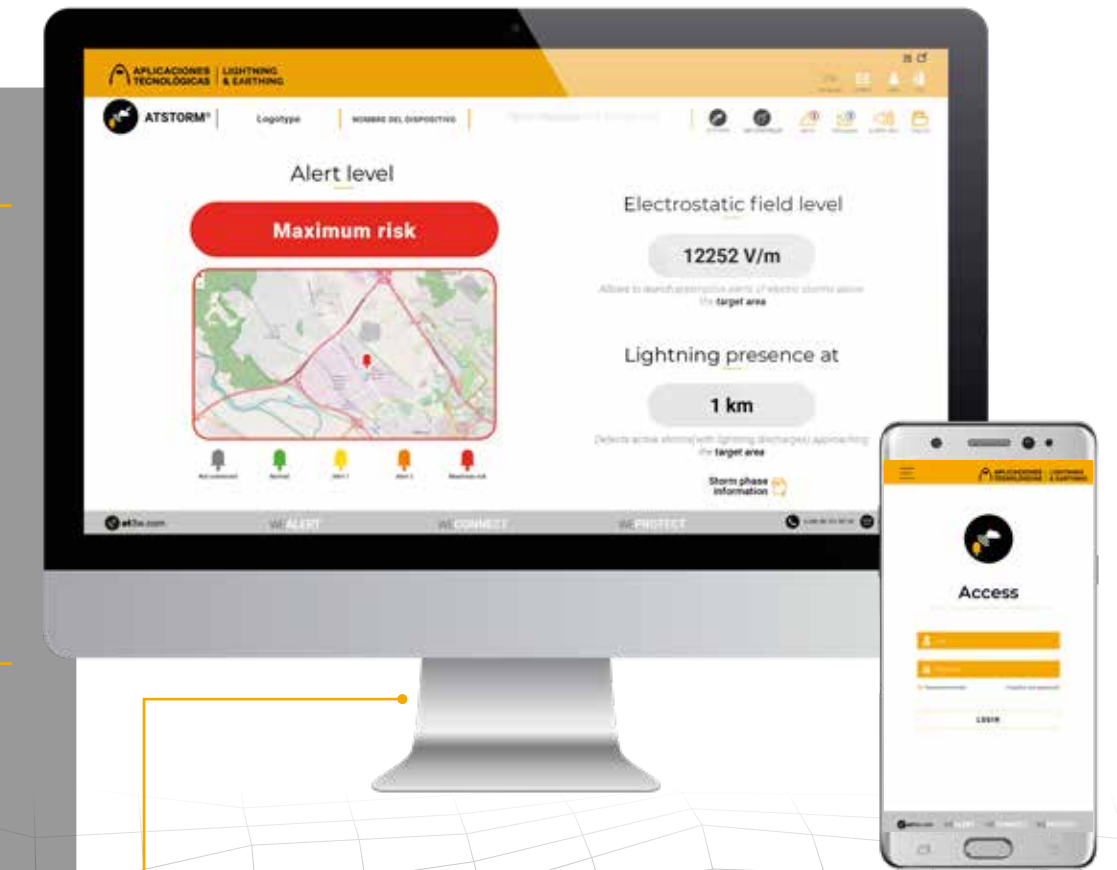
Detection of thunderstorms forming over the target area by monitoring the increase in electrostatic field:

- Tens of minutes for EARLY ALERT WARNINGS

Electromagnetic field sensor

Detection of lightning in active thunderstorms approaching the target area:

- 40km / 24,85mi radius



Surge Protection



Electromagnetic fields caused by lightning can affect the lines and the equipment, even if there is a lightning protection system that intercepts direct strikes. Cloud-to-cloud lightning and nearby lightning strikes (up to 1 km distance) cause transitory surges capable of damaging equipment. **Protection against surges of photovoltaic plants is custom-designed for every installation in order to protect photovoltaic cells and all the integrated elements as much as possible.**

If the photovoltaic plant is protected with lightning rods, panels are in an external zone but safe from direct strikes. If there is no external lightning protection it will be necessary to install surge protectors capable to support direct strike effects. Therefore, protectors will be different for each case.

On the other hand, for the protection of electric installations we must distinguish the cases in which generated energy is for self-consumption from those in which it is used for selling to an electric company through a transformation center.



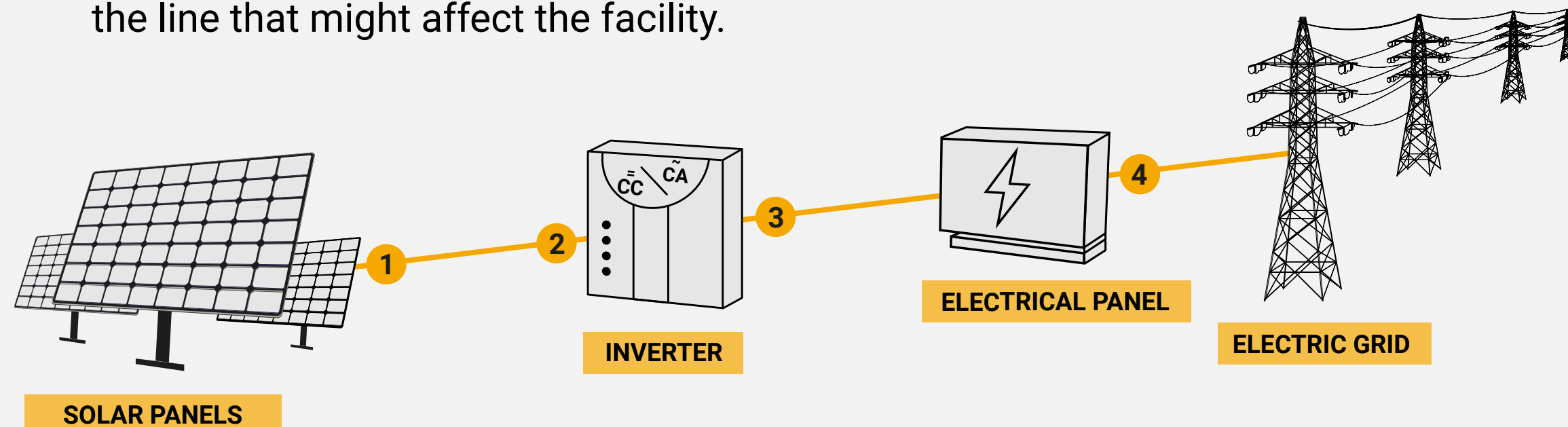
Surge Protection



Protection scheme for surges in photovoltaic power plants

- 1 If the distance between the panels and the inverter is less than 10m, no protector will be installed at this point because there would be no coordination with the next one. If the distance between the panels and the inverter is more than 10m:
 - ✓ If there is no air terminal, protectors of high current capacity must be installed (**ATSHOCK**).
 - ✓ If there are air terminals, **ATVOLT** protectors will be installed (or **ATSUB** in case the currents on the panel are over 3A).
- 2 Customized **ATPV** protector for every facility.
- 3 **ATSUB** protector.
- 4 If the energy generated is for self-supply a protector from the **ATCOVER** series will be placed in the distribution board of the building to prevent high residual voltage.

If the energy generated is to be sold to the electric company through a transformation centre, an **ATSHOCK** protector will be installed to prevent surges in the line that might affect the facility.



Components used for surge protection



ATPV series

Custom-designed protective enclosure of photovoltaic plant with the most adequate protectors for photovoltaic cells and invertors of each installation.



ATVOLT series

Protection for DC supply lines in modules with coordinated protection for a pair of wires. Capable of withstanding a peak current of 20kA per pole with a 8/20 μ s wave and a residual voltage of less than twice the rated nominal voltage.



ATSUB series

Single-phase protector capable of withstanding currents of tens of kiloamperes with 8/20 μ s wave and with residual voltages between 1 and 2kV. Different models available.



ATSHOCK series

Single-phase protector capable of withstanding a peak current of 50kA per pole and 10/350 μ s wave with a residual voltage under 4kV.



ATCOVER series

Protector both in common mode and differential mode. Capable of withstanding a peak current of 30kA per pole and 8/20 μ s wave with a residual voltage under 900V. Includes visual warning and connection for remote warning.



**LOCAL STORM
DETECTION**



**AIR TERMINALS
AND ACCESSORIES**



EARTHING



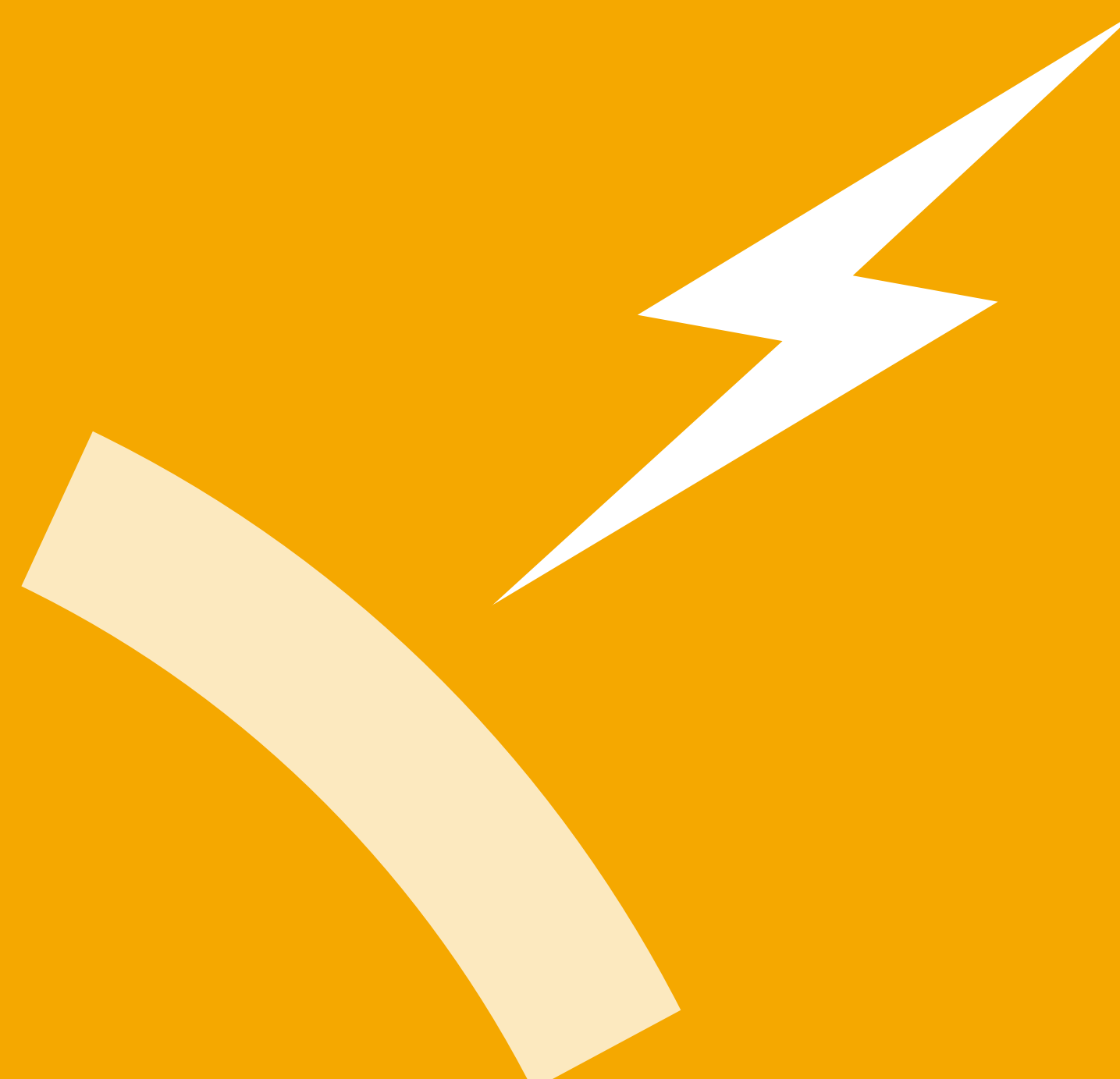
**EXOTHERMIC
WELDING**



**TRANSIENT
OVERVOLTAGES**




**PERMANENT
OVERVOLTAGES**



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