

LIGHTNING PROTECTION FOR PHOTOVOLTAIC PLANTS



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"The cost of the equipment is high and their damage is detrimental to power supply..."

Photovoltaic (PV) plants are always, due to their nature, in wide and isolated extensions or over building roofs. The cost of the equipment is high and their damage is detrimental to power supply, especially if they are connected to the distribution network. Their working is controlled by sensitive electronic equipment that may be severely affected by transient overvoltages. Therefore, they are high risk installations for lightning protection.

Aplicaciones Tecnológicas, S.A. supplies all the elements for achieving the best protection for photovoltaic plants: efficient air terminals for lightning interception, special electrodes for the earth termination system and a wide range of surge protective devices (SPD), able to protect from the data lines connected to the electronic equipment to the outputs connected to the power station. The protection has to be carefully designed by a team of experts since many parameters are involved. Our experience of over 20 years in lightning protection allows us to ascertain the best solution for each installation.

LIGHTNING PROTECTION

DAT CONTROLER[®] PLUS EARLY STREAMER EMISSION AIR TERMINAL

DAT CONTROLER[®] PLUS Early Streamer Emission (ESE) Air Terminals have been tested in official independent laboratories in order to obtain their advance time, for establishing their protection radius, and to certify that they are able to withstand lightning currents. DC+ ESE Air Terminals have AENOR product certification.

Considering Level I (the most exigent), a single air terminal can protect a surface of approximately 20.000m². However, for achieving this protection air terminals have to be installed 6 meters over the solar cells so they may cause a problem of shadows. In order to minimize it, it is recommended to install the air terminals around the photovoltaic plant perimeter. In this way shadows on solar cells are avoided as much as possible.

For a better performance it is recommended to place the air terminal on the 10m self-standing masts supplied by Aplicaciones Tecnológicas, S.A. (AT-10C) then the air terminals reach a sufficient height over the solar cells.

An Early Streamer Emission (ESE) air terminal is characterized by its response to lightning approach, going ahead any other element within its protection area and thus driving lightning current to earth through a safe path.

DAT CONTROLER[®] PLUS employs the atmospheric electric field as its only power supply. It is fully autonomous, maintenance-free and its performance can be verified at any moment

The installation of DAT CONTROLER[®] PLUS air terminals shall be made according to the relevant standards (UNE 21186/NF C 17-102)

DAT CONTROLER[®] PLUS radii of protection (in meters) for h = 5m

	DC+15	DC+30	DC+45	DC+60
Level 1 according to UNE-EN62305 Level I according to UNE21186	32	48	63	79
Level 2 according to UNE-EN62305	37	55	71	86
Level 3 according to UNE-EN62305 Level II according to UNE21186	45	63	81	97
Level 4 according to UNE-EN62305 Level III according to UNE21186	51	72	90	107

h: height of the air terminal over the surface to be protected



EQUIPOTENTIALIZATION AND EARTH TERMINATION SYSTEM

Earthing is essential for stabilizing the voltage of the equipment with respect to the ground during its normal operation. It is therefore usual the solar cells have a good earthing system. It is highly recommendable to bond all the earthings, that is, that a general earthing network exists where all solar cells are connected. Besides, metallic masses (frames, fenders, supports and covers) should be also connected to the earthing according to UNE-EN 61173 in order to achieve the equipotentialization of all the elements thus avoiding differences of potential and dangerous sparks.



The lightning protection system should have its own earthing that will be bonded to the main one with an isolating spark gap according to UNE-EN 50164-3. Then they remain separated during the normal working of the equipment thus avoiding electromagnetic noise or corrosion. For the lightning protection earthing it is preferable to use vertical electrodes, 2 to 3 meters long, forming a triangle since this is the most adequate configuration for dispersing the impulsional current of lightning as fast as possible.

EARTHING SYSTEM COMPONENTS



Dynamic electrode
APLIROD, vertical,
Ø28x2500 mm.

AT-025H



Isolating spark gap
for earth joint.
Ip(10/350µs) of
100kA.

AT-050K



Polypropylene
inspection pit,
250x250x250 mm,
able to withstand
5000 kg.

AT-010H



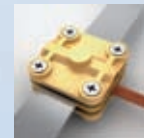
Brass bonding bar
for equipotentializa-
tion and testing. To
be place inside an
inspection pit.
Connector for
Ø8-10mm and/or
30x2mm tape.

AT-020H



30x2mm tinned-
copper tape.

AT-052D



Brass clamp for
straight, cross, "T"
and parallel
connection for
Ø8-10mm and/or
30x2mm tape.

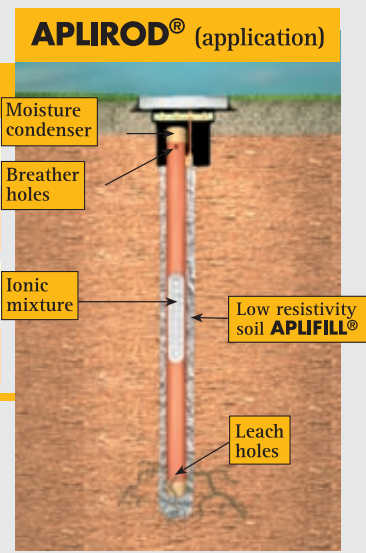
AT-020F

DYNAMIC ELECTRODE AT-025H – APLIROD®

In high resistivity soils it is recommended the use of dynamic electrodes APLIROD®. They are copper pipes filled with salts that improve the conductivity of the soil along the time. Each electrode should be installed inside an inspection pit for avoiding the obstruction of the breathing holes.

The compound APLIFILL® should be mixed gradually with water outside the excavation. The proportion should be 8 litres water per 1kg APLIFIL®.

AT-025H	
External Diameter	28mm
Length	2,5m (vertical)
Drilling	Ø40mm x 3m.
Filling	0,5kg of APLIFILL®.



PREVENTIVE PROTECTION

Preventive protection is complementary to the external and overvoltage protection. Information about the proximity of a lightning storm and all the measures that can be taken may prevent hazardous situations but cannot avoid the damage that this storm will cause to the equipment if there is no proper lightning protection system. Early detection of lightning storms is interesting, for example, to avoid maintenance operations, to fix mobile panels in the least risky position or to connect autonomous supply systems thus protecting the equipment from lightning strikes on the incoming electric lines.

ATSTORM® the storm detector is the perfect tool for preventive protection against the effects of storms and atmospheric discharges since it allows a time in advance of several 10's minutes for taking specific measures when the risk of a lightning storm is imminent, thus keeping the people and the equipment safe from its destructive effects.

The sensor is equipped with the new patented FCES technology (Field-Controlled Electrometric Sensor) where all the components are electronic.

Alarm levels are configurable so it is easily adapted to the user necessities. The typical levels, recommended by Aplicaciones Tecnológicas, S.A., are also implemented in the equipment as predetermined values.



AT- STORM® is provided with a software that, when installed in a PC connected to the interface, allows to keep the data from the electric field (every second, during remarkable events, etc.) thus obtaining a historic that can be analyzed later.

When the risk of lightning strike is high or when a given alarm level is reached, then ATSTORM® can be programmed for executing the different automatic actions that will reduce potential damages:

- Send an SMS.
- Activate a sonorous and/or visual alarm.
- Connect UPS and generators.
- Disconnect sensitive equipment.



MAIN ADVANTAGES OF AT- STORM®

- Local detection by electric field measurement.
- Detection of all the storm formation stages.
- Entirely electronic. No mobile parts. This makes the sensor very robust, free of special maintenances due to obstruction by dust, insects, ice...
- No need of height calibration previous to every placement.
- The lightning storm is foreseen several 10's minutes before happening.
- Reliable working in adverse conditions.

PROTECTION AGAINST OVERVOLTAGES

Electromagnetic fields caused by lightning may affect the lines and therefore the equipment even if there is an external lightning protection system that intercepts direct lightning strikes. Cloud-to-cloud lightning and nearby strikes (up to 1km around) cause also transient overvoltages able to damage the equipment.

Surge protection of photovoltaic plants is particularly designed for each installation in order to achieve the maximum protection of solar cells and any other integrated element.

If the photovoltaic plant is protected with an external lightning protection system then all cells are in the open air but safe from direct impacts. In case there is no external lightning protection system then the surge protective devices to be installed should be able to withstand the effects of direct strikes. Hence the protectors to be used in each case are different.

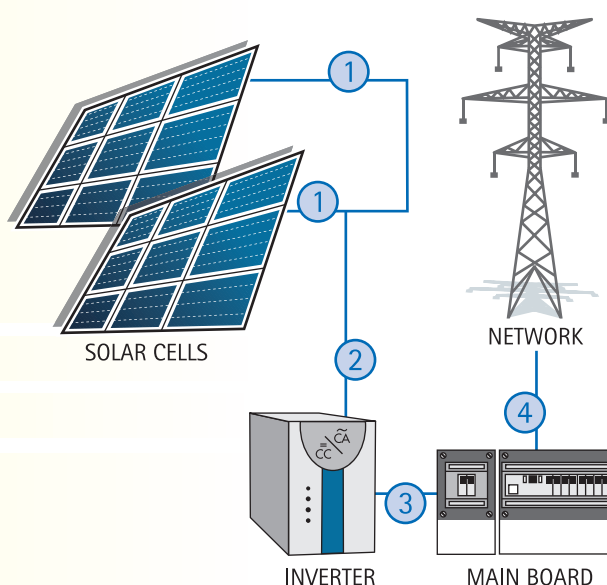
On another side, for the protection of the power supply installation 2 cases should be considered separately: when the generated energy is for self-supply or to be sold to an electric company through a power station.

- 1 If the distance between the solar cells and the inverter is lower than 10m then no SPD can be installed in this point because there would be no coordination with the following protector.
If the distance between the solar cells and the inverter is larger than 10m:
 - If there is no air termination system then SPDs with a high current withstanding capacity (ATSHOCK) should be installed.
 - If there is an air termination system then ALVOLT (or ATSUB in case the current per panel is higher than 8A) will be installed.

- 2 ATPV protector, custom-designed for each installation.

- 3 ATSUB Protector.

- 4 - If the generated energy is for self-consumption, then ATCOVER protector has to be installed in the building mains board in order to avoid high residual voltages.
- If the generated energy will be sold to the electric company through a power station then ATSHOCK protector has to be installed in order to avoid the line overvoltages to affect the installation.



OVERVOLTAGE PROTECTION COMPONENTS



ATPV Series
Protection box specifically designed for the photovoltaic plant with the most accurate protectors for the inverter and solar cells in each installation.



ATVOLT Series
DC Power Supply protector in modules containing coordinated protection for one pair of lines. Able to withstand 20kA peak current (8/20μs wave) letting a residual voltage lower than twice the nominal voltage value.



ATSUB Series
Single-phase protector, able to withstand 10's kA peak current (8/20μs wave). Residual voltages between 1 and 2kV. Several models available.



ATSHOCKL Series
Single-phase protector, able to withstand 100kA peak current (10/350μs wave) through each pole letting a residual voltage lower than 4kV.



ATCOVER Series
Surge Protector both common and differential protection, able to withstand a peak current of 30kA per pole with 8/20μs wave letting a residual voltage lower than 900V. With light alarm and remote control connection.



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