Walk on sunshine.

Our new PV cables SUNCONNECT ensure uninterrupted energy flow, just like the sun's unwavering rise.

Technical details

prysmian

The planet's pathways

PV SOLAR PLANT

Our solar PV cable portfolio consists of a full range of quality solar photovoltaic products, renowned in the field for their easy installation, reliability and longevity attributes and complying with all major international standards.

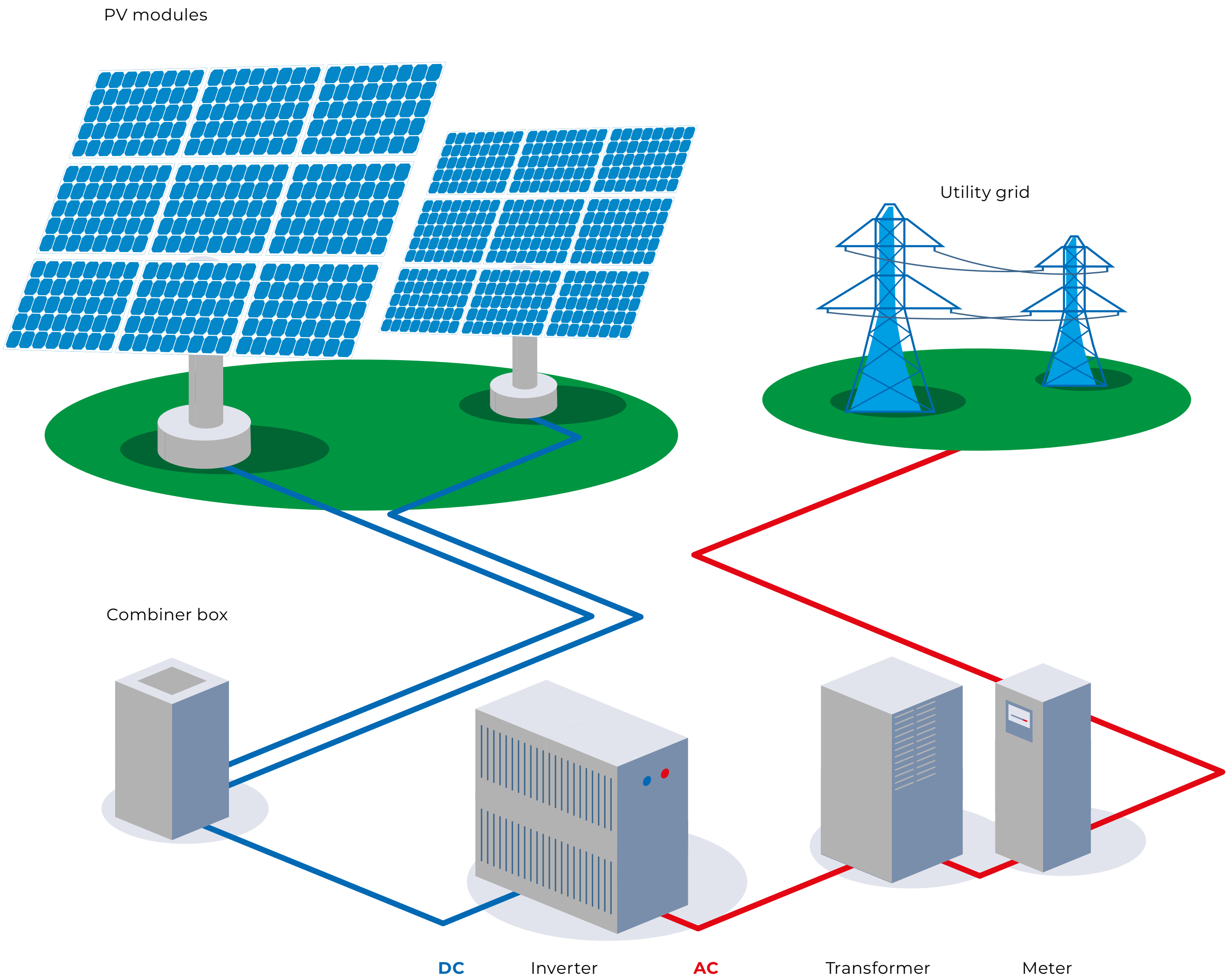

Fig. 1 – PV solar plant.

PV SOLAR PLANT – COMPONENCE

Photovoltaic (PV) cell, commonly called a solar cell, is a nonmechanical device that converts sunlight directly into electricity. PV cells can convert artificial light into electricity. Sunlight is composed of photons, or particles of solar energy. A semiconductor material, usually silicon, is the basis of each individual PV cell.

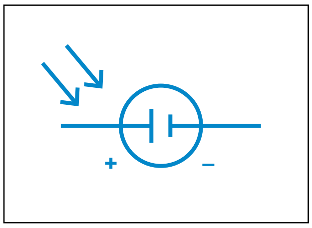

Fig. 2 Symbol of PV Cell

A single PV solar cell can produce an "Open Circuit Voltage" (VOC) of about 0.5 to 0.6 volts at 25 °C (typically around 0.58 V) no matter how large it is. The cell voltage remains constant just if there is sufficient irradiance light from dull to bright sunlight. Open circuit voltage means that the PV cell is not connected to any external load and is not producing any current flow.

Unlike a PV cells voltage, the output DC current (I) does vary in direct relationship to the amount or intensity of the sunlight falling onto the face of the PV cell. Also, I is directly proportional to the cells surface area as the larger the cell the lighter energy enters the cell. Then the more sunlight entering the cell, the more current it produces. PV cells with high current outputs are more desirable, but the higher the current output, the more they will cost.

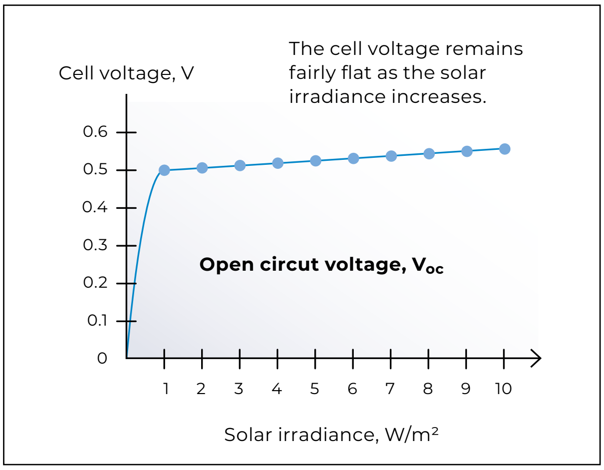

Fig. 3 – PV cell voltage.

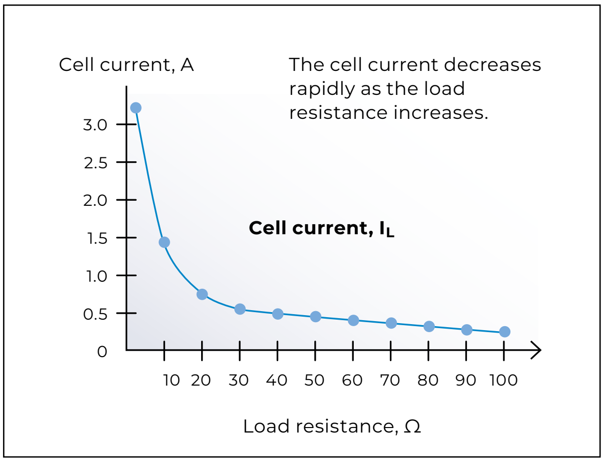

Fig. 4 – PV cell current.

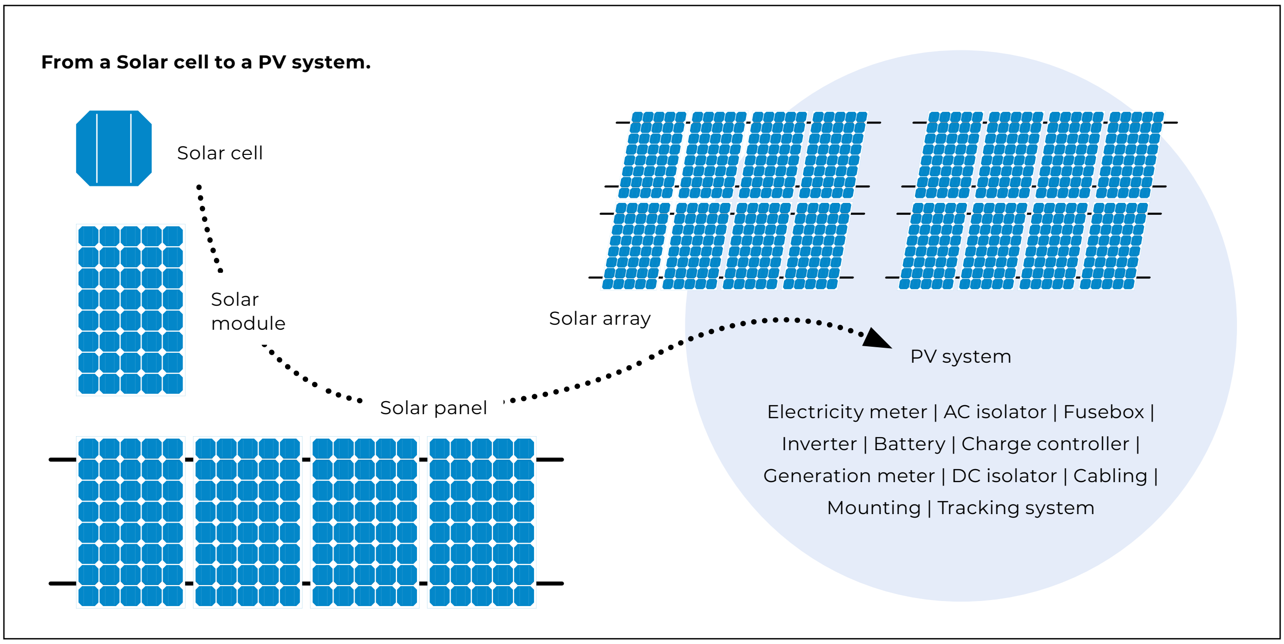

Fig. 5 – PV system.

Photovoltaic (PV) module is a web of PV cells that captures solar power to transform it into sustainable energy. Individual PV cells are connected in two ways:

- in series, when the voltage is added up, and current (amperage) remain the same
- in parallel, when the current (amperage) is added up, and the voltage remain the same.

Photovoltaic (PV) panel is used to produce electricity directly from sunlight. PV panels consist of several individual modules connected in series and parallel, to produce electricity of a desired voltage. PV panels are, inherently, DC devices.

Photovoltaic (PV) array is the complete power-generating unit, consisting of any number of PV panels. The performance of PV modules and arrays are generally rated according to their maximum DC power output (watts) under Standard Test Conditions (STC). To produce AC, they must be used together with an inverter.

Photovoltaic (PV) combiner Box is an electrical distribution box where the DC breakers are housed. Its main purpose is to combine multiple DC inputs from the panels in the system into a single DC output. This output is then connected to a charge controller or inverter, depending on the type of system.

Inverter is a device that converts direct current (DC) electricity, which is what a solar panel generates, to alternating current (AC) electricity, which is used by the electrical grid.

Utility grid is a network of synchronized power providers and consumers that are connected by transmission and distribution lines and operated by one or more control centers "Grid," refers to the transmission system for electricity.

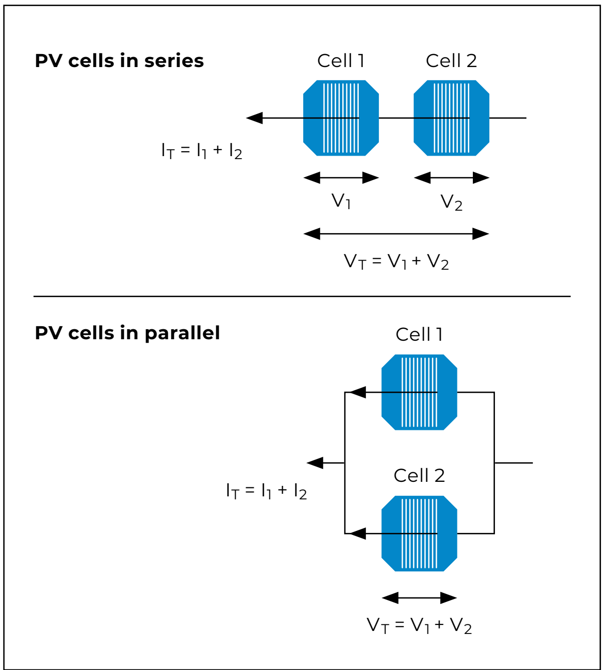

Fig. 6 + 7 – PV cells in series/parallel.

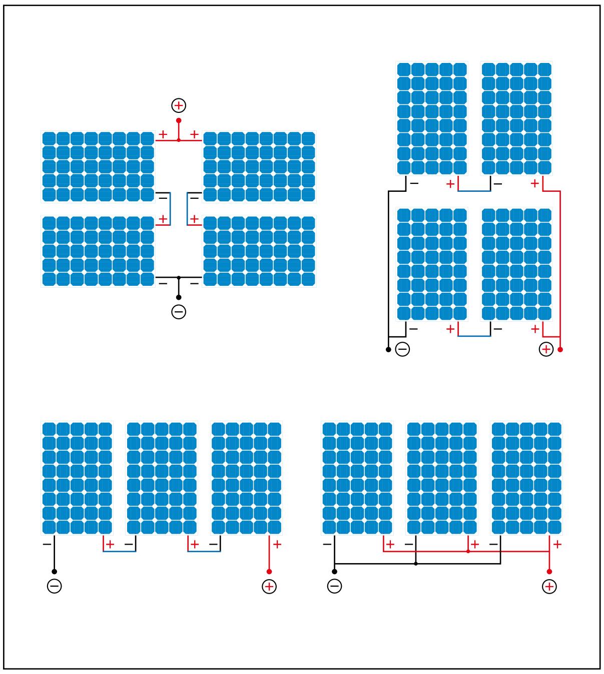

Fig. 8 – PV modules in series and parallel to form PV panels.

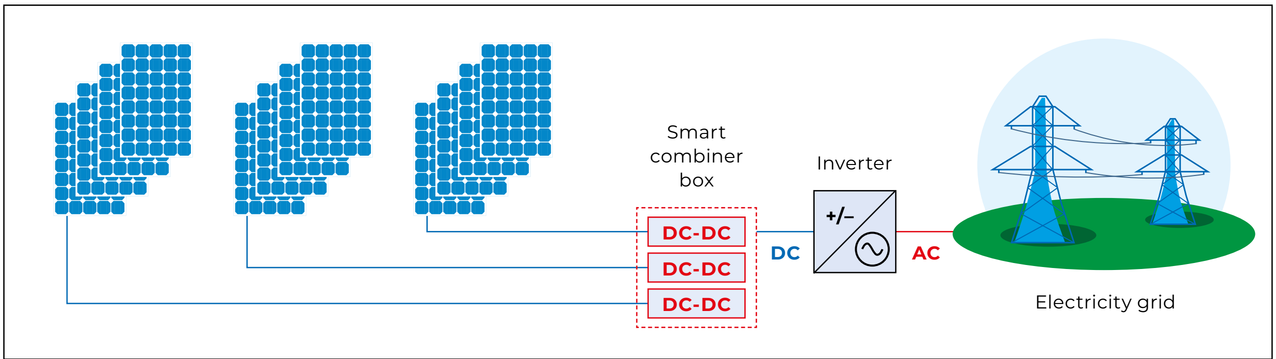

Fig. 9 – PV combiner box.

PV SOLAR PLANT – POTENTIAL INDUCED DEGRADATION (PID)

PID is an undesirable performance deterioration induced by the (-) potential to ground. Is a common phenomenon causing PV panels to lose power generation by up to 80 %. The high potential difference can cause leakage currents to flow from the module frame to the solar cells, which is known to cause PID.

Temperature and humidity are both known to promote PID. However, there is not much one can do about these factors once a system is installed in each location.

Configuration of the PV systems (grounding, module composition, cells type) influence the PID.

System configuration: The voltage potential and sign of the module have an impact on the PID occurrence. It depends on the position of the panel in the array and the system earthing Most of the time, PID is related to a negative voltage potential to earth, the more (-) panel will be the panel at most risk.

Module composition: the chemical composition of glass, encapsulating material or anti-reflective coating, has a considerable impact on the occurrence of PID. For example, the sodium contained in the glass is a cause of PID.

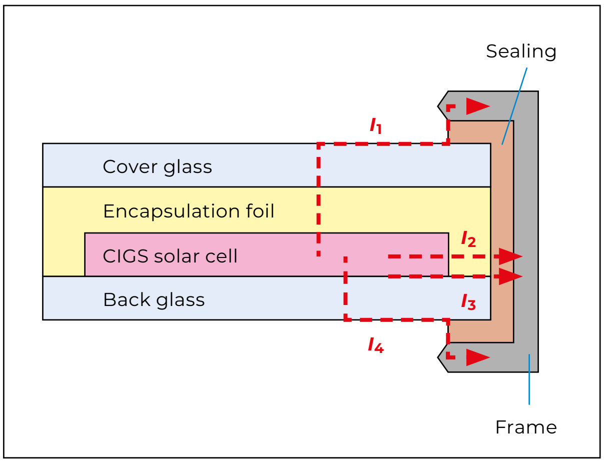

Fig. 10 – Leakage currents in a PV cell.

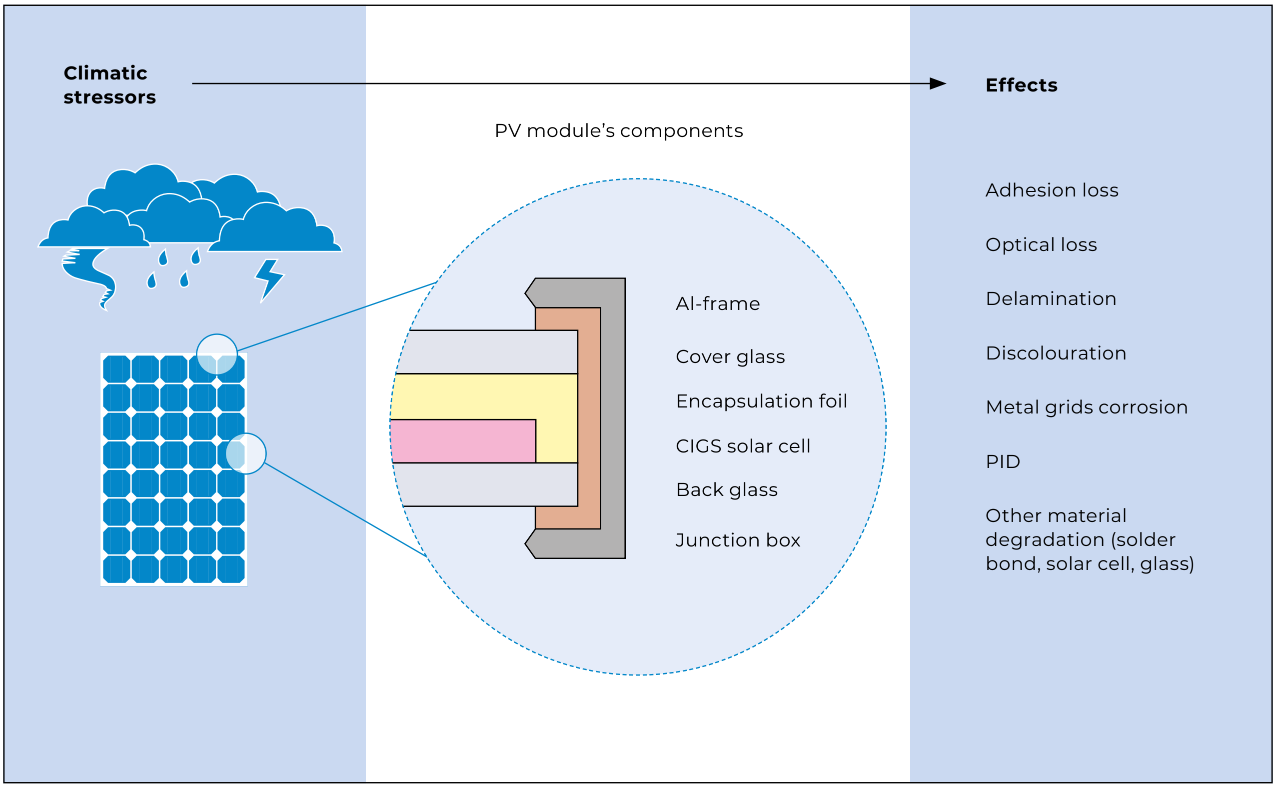

Fig. 11 – Effects of moisture ingress in PV cells.

PID – MAIN MITIGATION ACTIONS

Smart Inverters and/or External Equipment are capable to prevent or to revert this phenomenon, prolonging the lifespan of the PV panels.

- **Transformer PV inverter**

  Conventional inverters are built with an internal transformer that synchronizes the DC voltage with the AC output. If PID has taken place, it can be mitigated by grounding the (-) DC pole on the inverter to avoid (-) voltages on the strings. This works if the inverter allows this operation mode and all the proper design actions associated with this choice is taken. The earthed (-) potential of the modules assures that the (-) pole stays at ground potential, to eliminate the effects of PID.

- **Transformer-less PV inverter with inbuilt charge equalizers**

  Transformer-less (TL) inverters use a computerized multi-step process and electronic components to convert DC to high frequency AC, back to DC, and ultimately to standard-frequency AC. The connection between the grid and the inverter is direct. It nullifies the purpose of (-) pole grounding. There will be chances of short-circuiting of solar cells Therefore, in such inverters, the (-) side is not earthed and becomes a potential danger for PID.

  The PID can be mitigated by Inbuilt Charge Equalizers. If an inverter is not operational during the nighttime, the charge equalizers apply an opposite bias to modules which rules out the reversible type of PID also known as polarization.

- **Transformer-less PV inverter + external anti-PID boxes**

  Anti-PID boxes are installed between the strings and the inverter, and they apply a reverse potential during the nighttime, to polarize all the PV modules affected by the (-) voltage applied by the inverters in the opposite way. Anti-PID boxes work to avoid each string from keeping the same polarization for too much time, to reduce the probability of PID and giving each module the possibility to “recover” the (-) potential suffered during daytime.

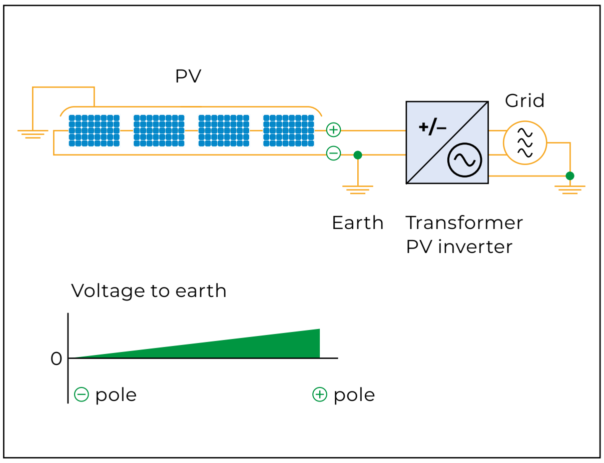

Fig. 12 – Grounding (-) DC pole for Transformer PV inverter.

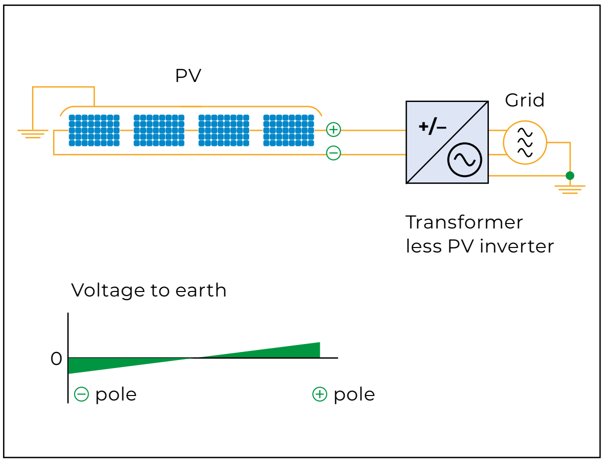

Fig. 13 – Transformer-less PV inverter with inbuilt charge equalizer.

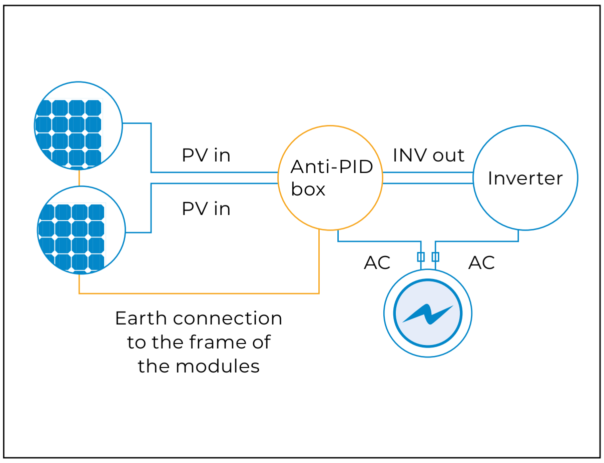

Fig. 14 – External anti-PID box.

PID – OTHER MITIGATION ACTIONS

Use of materials less susceptible to PID, for solar panels, as: coatings, encapsulants, cover glass.

- **Anti-Reflective Coating (ARC)**

  Applying an anti-reflective coating to the surface of solar panels can help to prevent PID by reducing the amount of light that is reflected off the panel and back onto the solar cells.

- **PID-resistant materials**

  Developing materials that are less susceptible to PID, such as those with a high resistance to electrical current or a lower surface area, could help to reduce the effects of this phenomenon.

- **Bypass diodes**

  Installing bypass diodes in solar panels can help to redirect the flow of electrical current around cells that are experiencing PID, reducing the overall impact on the panel's performance. Bypass diodes, usually Schottky diodes, are placed on sub-strings of a PV panel, for example one diode per 10 or 20 PV cells.

- **Improved manufacturing processes**

  Developing better manufacturing processes for solar panels could help to reduce the occurrence of PID by ensuring that panels are built to withstand the effects of this phenomenon.

- **PID-resistant encapsulants**

  Using encapsulants that are less prone to degradation from PID, such as those with a higher resistance to electrical current or a lower surface area, could help to prolong the lifespan of solar panels.

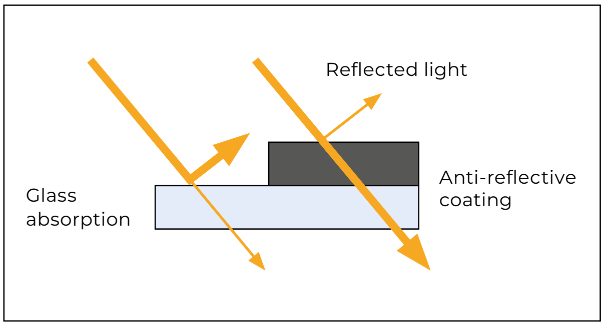

Fig. 15 – Anti-reflective coating of a PV cell.

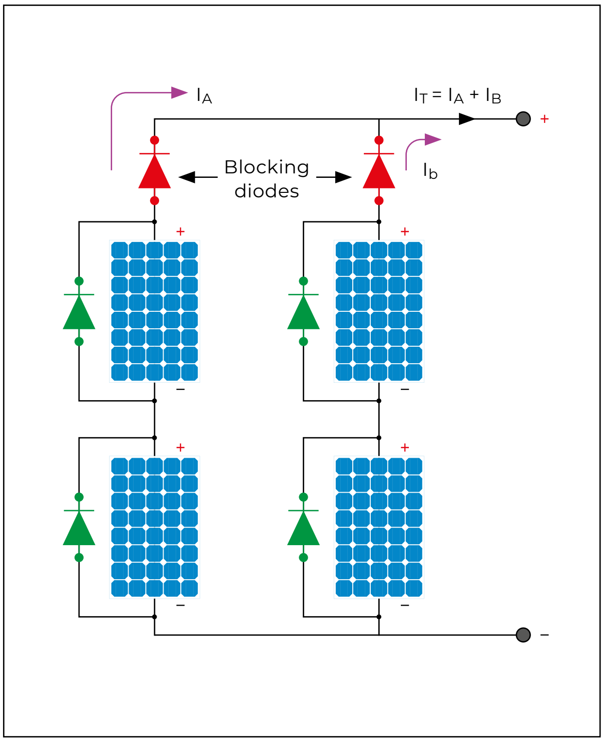

Fig. 16 – Bypass diodes.

PRYSMIAN "SUNCONNECT" CABLES (N)A2XY-J(O)

Application

SUNCONNECT is a new brand of cables, manufactured by Prysmian, designed for their use in PV solar plants. Typically, the maximum voltage of the PV systems is either 600V, for residential systems, or 1000 V (or 1500 V), for utility-scale systems

SUNCONNECT are power cables with aluminium conductors, XLPE insulation and PVC outer sheath, designed for 1.8/3(3.6) kV AC | 1.5/1.5(1.8) kV DC. They are for fixed indoor / outdoor electrical installations, laying in ground, in open air, in concrete, in cable ducts, and in water, where mechanical protection is not required during installation and operation, and where the PVC outer sheath is not attacked by corrosive agents. In case of corrosive ground, extra protection for the cables is requested. SUNCONNECT cables connect PV panels, Combiner Boxes, Inverters, and the Utility Grid.

Features

- Designed for AC | DC applications
- High dielectric strength given by cross-linked polyethylene insulation
- Lead-free materials
- Flame-retardant according to IEC 60332-1 series of standards
- Withstand high temperatures and UV-exposure
- Work with the new smart inverters & related external equipment, and withstand the reverse potential applied during night-time to the panels (see fig. 10, page 5).

SUNCONNECT (N)A2XY-J/O	
Brand	SUNCONNECT
Type description	(N)A2XY-J/O
Standard	IEC 60502-1
Conductor	Aluminium
Insulation	Cross-linked polyethylene (XLPE)
Sheath	Polyvinyl Chloride (PVC)
Rated voltage Uo/U	1.8/3 kV AC | 1.5/1.5 kV DC
Max. operating voltage Um	AC: 3.6 kV DC: 1.8 kV
Min. laying temperature	-5 °C (on cable surface)
Min. service temperature	-40 ˚C (fixed and protected installations)
Max. operating temperature	90 °C
Short circuit temperature	250 °C
Flame performance	IEC 60332-1 series of standards

Link Web catalogue:
https://ro-catalogue.prysmiangroup.com/s/#/category/a1q7S000000IhviQAC/subcategory/a1q7S000000IhvnQAC

Thickness of XLPE insulation, as per IEC 60502-1

Nom. cross section (mm²)	Nom. thickness of insulation at rated voltage Uo/U (Um)	
	0.6/1 (1.2) kV and 1/1 (1.2) kV	1.8/3 (3.6) kV
25 to 35	0.9	2.0
50	1.0	2.0
70 to 95	1.1	2.0
120	1.2	2.0
150	1.4	2.0
185	1.6	2.0
240	1.7	2.0
300	1.8	2.0
400	2.0	2.0
500	2.2	2.2
630	2.4	2.4
800	2.6	2.6
1000	2.8	2.8

CURRENT CARRYING CAPACITY (CCC)

Direct in ground or in buried ducts (A)					
Cross section (mm²)	Direct in ground				In buried ducts
	Single core*	2 conductors	Single core	Multi-core	Multi-core
25	177	-	114	112	101
35	212	-	136	135	122
50	252	-	162	158	142
70	310	-	199	196	176
95	372	-	238	234	211
120	425	323	272	268	242
150	476	361	305	300	270
185	541	408	347	342	308
240	631	476	404	398	359
300	716	537	457	457	412
400	825	616	525	529	477
500	952	699	601	609	549

Ground temperature 20 °C, depth of laying 0.7 m, soil thermal resistivity 1.0 K.m/W.
* Rated current for cables in DC systems with return conductor far away.

Derating factors for laying in ground or buried ducts = f (soil temp)															
Temperature (°C):	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Derating factors	1.07	1.04	**1.00**	0.96	0.93	0.89	0.85	0.80	0.76	0.71	0.65	0.60	0.53	0.46	0.38

Current carrying capacity – in air (A)							
Cross section (mm²)	Single core*	Multi-core	Single core				
25	136	102	121	106	107	138	122
35	166	126	150	130	135	172	153
50	205	149	184	161	165	210	188
70	260	191	237	204	215	271	244
95	321	234	289	252	264	332	300
120	376	273	337	295	308	387	351
150	431	311	389	339	358	448	408
185	501	360	447	395	413	515	470
240	600	427	530	472	492	611	561
300	696	507	613	547	571	708	652
400	821	600	–	643	–	–	–
500	971	695	–	754	–	–	–
500	971	695	–	754	–	–	–

Temperature open air installation: 30 °C.
* Rated current for cables in DC systems with return conductor far away.

Derating factors for laying in air = f (air temp)															
Temperature (°C):	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Derating factors	1.15	1.12	1.08	1.04	**1.00**	0.96	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41

installation

General information

The following instructions are intended to guide the direct burial in ground of SUNCONNECT (N)A2XY-J/O cables, for photovoltaic application. These cables cannot be installed under any given ground conditions, and the characteristics of the soil and few protection measures shall be considered, to prevent damages to the cables, and thus guarantee a long lifetime in operation.

General conditions for installation	
Installation	**In ground / in buried ducts / in air**
Min. bending radius during installation	15 x D single core | 12 x D multi-cores
Max. pulling force during installation	≤ 30 N/mm²
Test after installation	Max. 3 kV DC for PVC sheath
External influences (IEC 60364-5-51): – Presence of water – Presence of corrosive or polluting substances – Mechanical shock – Vibrations – Presence of flora – Presence of fauna – Solar and UV radiation	Withstanding to below conditions: AD7: possibility of intermittent, partial, or total covering by water (immersion) AF2: medium severity AG2: standard industrial conditions AH2: standard industrial conditions AK1: no hazard AL1: no hazard AN2: medium severity

For stronger conditions, special protections shall be applied to the cables for each case, in agreement with cables manufacturer.

Means to upgrade conditions for installation	
Installation	**In ground / in buried ducts / in air**
Presence of water	AD8: cables permanently and totally covered by water (submersion) – using special protection or PE sheath
Presence of corrosive or polluting substances	AF3: intermittent, accidental – using protection against corrosion, as tapes, paints, or grease
Mechanical shock	AG3: high severity – selected location and/or using reinforced mechanical protection
Vibrations	AH3: high severity – using special arrangements or flexible conductors
Presence of flora	AK2: hazard – using special installation, as closed types of installation: conduit or cable ducting, or trunking
Presence of fauna	AL2: hazard – using special installation, as selected location and/or reinforced mechanical protection
Solar and UV radiation	AN3: high – using special protections (shields)

Installation in ground

The following instructions are intended to guide the direct burial in ground of SUNCONNECT (N)A2XY-J/O cables, for photovoltaic application. These cables cannot be installed under any given ground conditions, and the characteristics of the soil and few protection measures shall be considered, to prevent damages to the cables, and thus guarantee a long lifetime in operation.

General information

- When the cables are buried directly in ground, the soil conditions shall be considered
- In case of corrosive ground, extra protections for the cables are requested. PVC is resistant to many alcohols, fats, oils, and aromatic free petrol. It is also resistant to most common corroding agents including inorganic acids, alkalis, and salts. PVC shall not be used with esters, ketones, ethers and aromatic or chlorinated hydrocarbons
- In case of high probability of lightning strike, additional protection measures are highly recommended

Laying

- The trench bottom must be made of the original or subsequently compacted soil and must be free of stones
- Before laying the cable, a layer of approx. 5 cm shall be first filled with sand or fine-grained soil
- The min. laying depth must be 0.7 m
- The burial depth can be disregarded in special cases, i.e., due to localized obstacles or if the ground conditions create significant impediments. When the minimum depth of 0.7 m is not met, the cable shall be especially protected (i.e., cable ducts)
- The laying of underground cables longitudinally under driveways is permitted only in exceptional cases when cables shall be protected with cable ducts or pipes. The inner diameter of cable ducts and pipes shall be min 1.5 x D
- The laying of the cables shall be done manually. The aid of mechanical feeders (cable pulling machines) is not allowed
- After laying the cables, an additional layer of stone-free material (ground and sand) shall be piled up, covering at least 5 cm above the cables, and gently compacted
- To avoid damages, the buried cables shall be protected with additional covering, such as cable protective hood or plates
- To fill up the cable trench, it shall be used material free of components which could chemically or mechanically be harmful for the cables
- A mechanical compacting of the cables trench is not allowed

The planet's pathways

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