SN series PV inverter
PID Design

1 Information on this document

This document explains what is PID effect and its negative influnce to the PV panels. Then describes the PID recovery solution of the following inverter models:

- SN series PV inverter

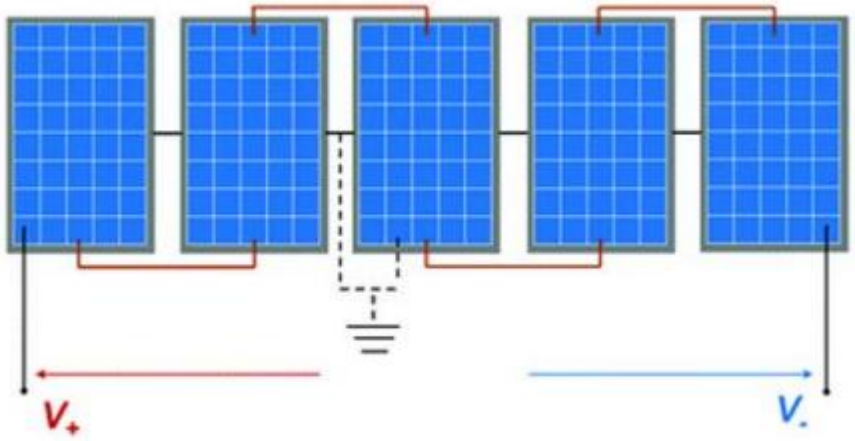
The inverters can support the gird by supplying the reactive power in different ways.

2 What is PID

PID (POTENTIAL INDUCED DEGRADATION) also known as a solar yield killer, is an undesirable performance deterioration induced by the negative potential to ground. It develops internally in the solar modules after a few days or weeks of installation.

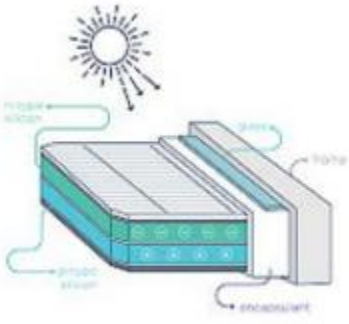
Firstly, to understand PID, you need to know how electricity is generated by a solar panel. A panel consists of several layers and individual photovoltaic cells. The combination of two semiconductor material exchange charges, producing an internal electric field.

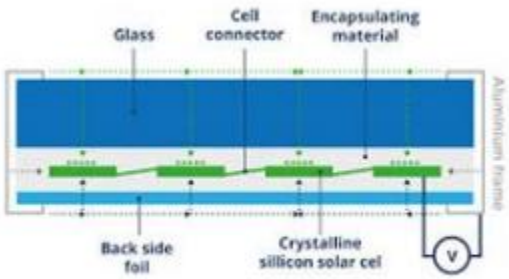
In a solar project, multiple panels connected in an array are called a string. A string has two sides – negative and positive, connected through an inverter which produces AC voltage. If we compare it with the ground, the voltage has a negative and positive potential. The negative potential triggers PID in a solar cell. Usually, photons let electrons flow towards the cell's connector and generate the current.



However, the negative potential attracts positive ions in the cell such as sodium ions which stimulate surface polarization and shunting. The movement usually happens from the glass plate through the encapsulation and the anti-reflective coating to the cell. The electrons then stop flowing and generate electricity which results in a disruption in a junction functionality meaning the decline in the power capacity of the panel.

After a few weeks or months, PID occurs at the entire negative side of the string. The most negative panel loses 30-80% of its yield. PID is contagious, more cells get affected by it over time, it turns the cells black. The speed of PID depends on – the system voltage, humidity levels and cell temperature. It can be reversible or irreversible. Therefore, it has devastating effects on all installation levels of a PV system – financing, operations and economies. The solar investor must address PID effects in the early stage to ensure the PV system works well in its entire life cycle.

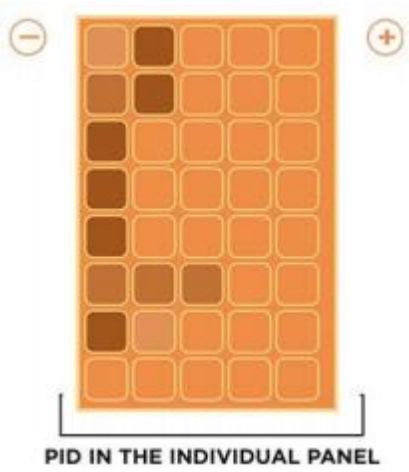




3 Strength of PID effect

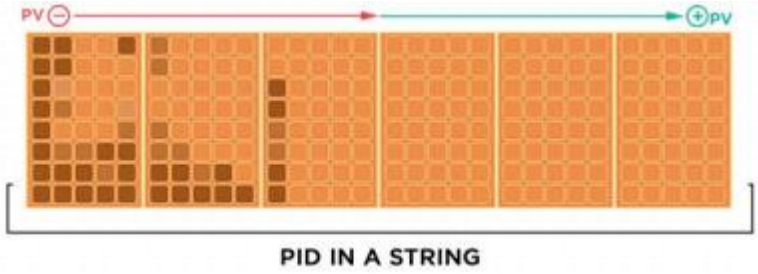
PID effect on individual panels –

The cells located near the aluminium frame are strongly affected by the PID as compared to the cells located in the centre of the modules.



PID effect on a string of panels –

In this case, the panels located on the negative side of the string will have a huge PID impact because the negative potential concerning ground is typically higher at that side.



Factors that determine if a PV system is subject to PID

Module and PV Cells –

The material used while manufacturing the modules plays a significant role. Manufacturers should pay attention to the chemical composition and quality of glass and EVA in which the PV cells are encapsulated. With that, if the cells are too sensitive to negative potential then it suggests that the structure of the cell lacks the quality to withstand the potential. It happens because of the density of the charge carrier of the silicon and the chemical composition of the ARC (Anti-Reflective Coating) layer on the PV cell.

4 The ways to detect PID

There are few ways to detect PID in solar farms:

IV Curve Tracer – the typical test to know if a PV-module is free of PID is to measure its IV (current-voltage) characteristic with an electronic tracer.

EL Imaging – Electroluminescence (EL) is an optical and electrical phenomenon in which a material emits light in response to an electric current/ PID affected modules will appear darker.

Infrared (IR) or **Thermography** – this method uses the fact that PID affected cells have higher temperatures than the neighbor cells free of PID

Statistical mathematical methods – decision on PID existence and its level is made on base of measurements results retrieved from management portal of PV system.

5 Working principle of PID module

Level	Solution for PID	Chances	Risks
Cell	Modification of the emitter	- No constraints for encapsulation material, cover glass, inverters or system grounding.	- PID stability may be insufficient. - Efficiency may be reduced. - Throughput may be reduced.
	Modification of the SiNx antireflection coating	- No constraints for encapsulation material, cover glass, inverters or system grounding.	- PID stability may be insufficient. - Efficiency may be reduced. - Modified SiN deposition Equipment may be needed. - Throughput may be reduced.
Module	Alternative cover glass featuring high volume resistivity	- No constraints for cells, encapsulation material, inverter or system grounding. - Optical performance may be better.	- Cost.
	Alternative encapsulation material featuring high volume resistivity	- No constraints for cells, cover glass, inverters or system grounding.	- Cost. - Optical performance may be worse. - Lamination time may be longer.
System	Grounding of the negative pole of the serially connected modules	- Suited for PID-prone modules.	- Restricted to transformer based inverters or transformer less inverters with inherent grounding. - Inverter topologies featuring higher efficiencies exist.
	Apply a positive voltage between modules and ground for regeneration at night	- Suited for PID-prone modules. - Inverters featuring the highest efficiencies (>> 97%) can be used. - Existing PV systems can be upgraded.	- Additional electrical device needed.
	Micro-inverter	- No constraints for cells, encapsulation material or cover glass. Maybe longer operating life than for central inverters. - MPP tracking of each module.	- Cost. - Inverter efficiency is about 95% at present.

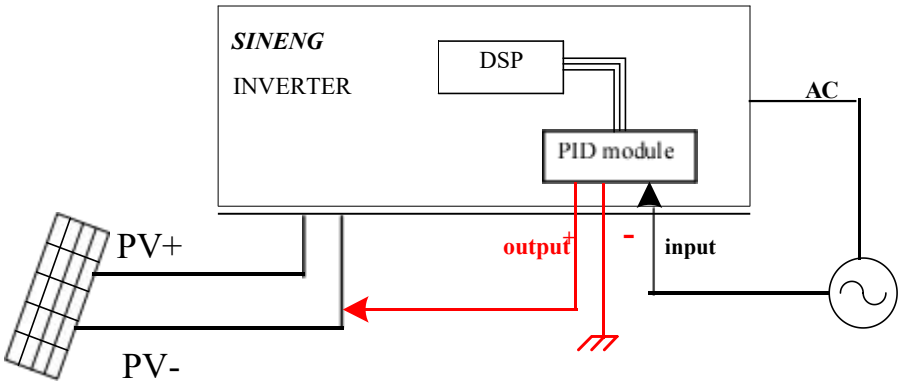
Si-neng inverter adopts the safest and most effective anti-PID solution in the world. Apply a positive voltage between modules and ground for regeneraion at night, when the inverter is working during the day, the internal automatic control switch K1 of the power supply at night is in an off state; the voltage of the battery panel at night drops to 0V, and the night power supply is put into the circuit. When the voltage between the PV negative pole and the ground PE is positive, the ion offset caused by the inverter working can be restored, and the degradation of the panel performance caused by the PID effect can be solved.

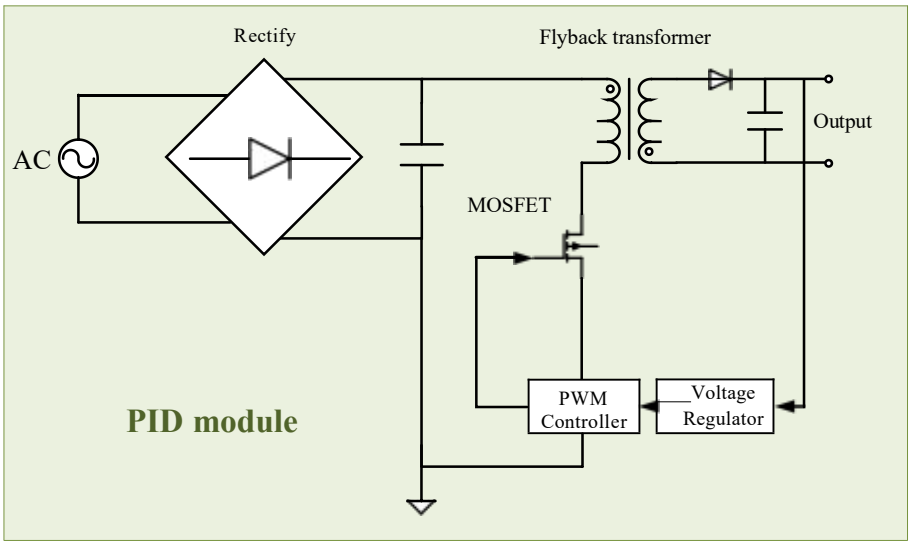
When the light is reduced and the voltage of the PV panel drops sufficiently low, the DC power supply in the inverter stops working and the system enters a sleep state (but at this time the control system can still work because there is AC power supply), and Then the PID module starts to work.

When the light is restored, the DC side power supply in the inverter starts to work, and the system enters the normal working mode. At this time, the PID device is cut off.

Note:If you need take any maintaince job during the evening, you need to disconnect the AC switch.

PID power supply has low output power.





6 The parameters of PID module

Technical index	Specification
AC input	
AC input voltage	220V~1000V
AC input frequency	50Hz/60Hz
DC output	
DC output voltage	500V(max)
Maximum output current	3.3mA