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Remedying and preventing of Solar plant PID trouble

Shanghai Zhiwei Environmental Technology Co.,Ltd

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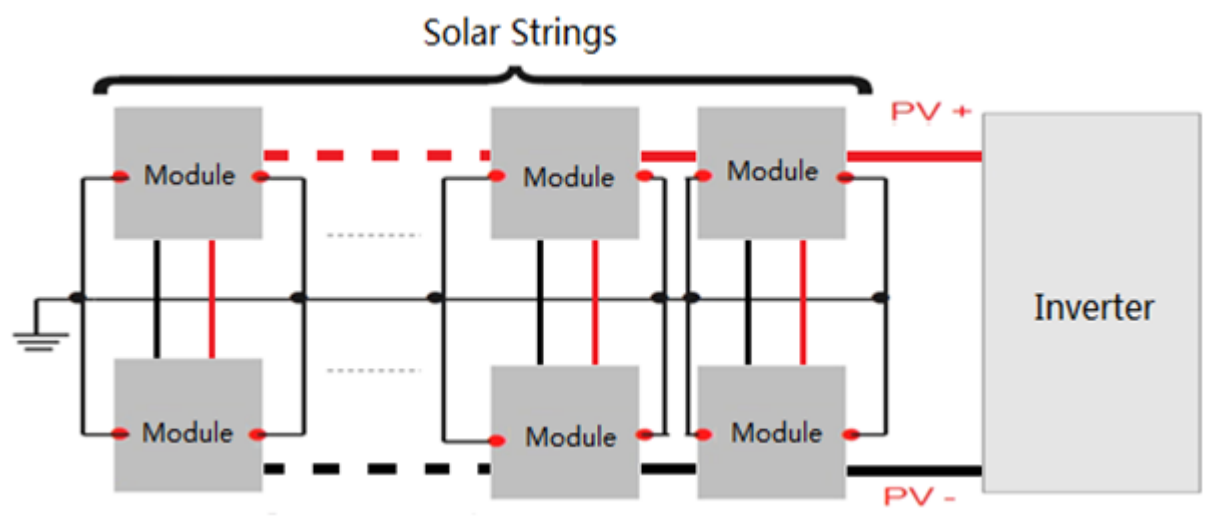
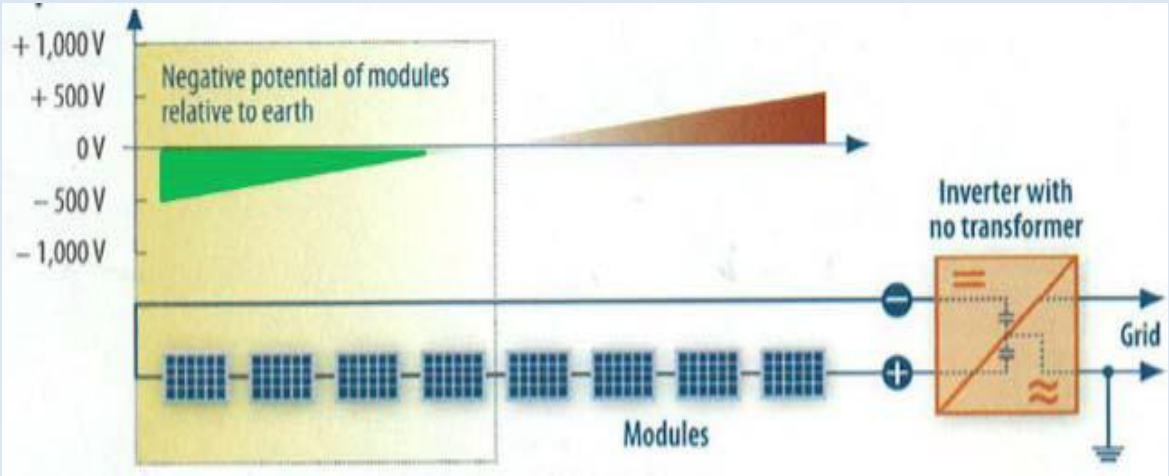
- What is solar plant PID trouble?
- How to remedy and prevent PID trouble?
- Why choose ANTIPID?
- Remedying result of ANTIPID.
- Preventing result of ANTIPID.

What is solar plant PID trouble?

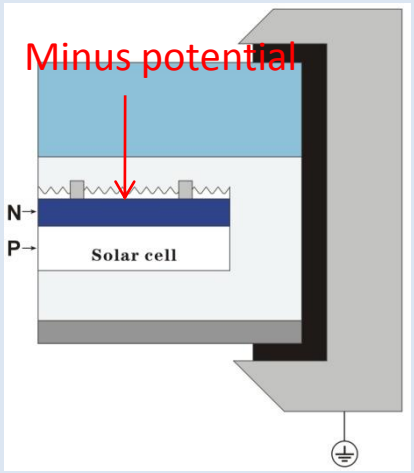


After connected to grid, the voltage of the middle place in the string is 0V to the ground.

Closer to the negative side, the minus voltage is higher to the ground. Closer to the positive side, the plus voltage is higher.

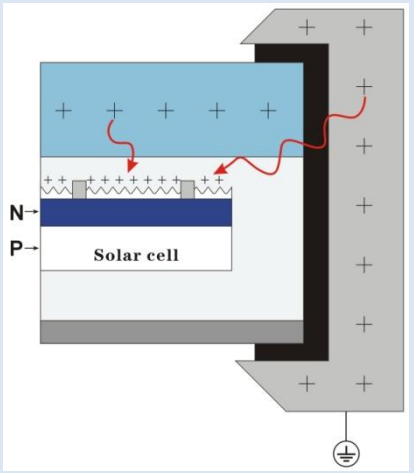


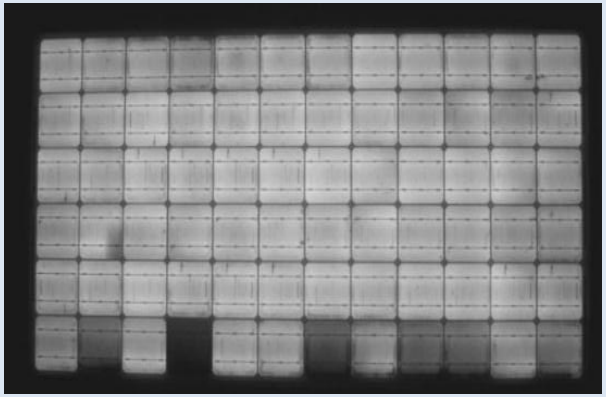
What is solar plant PID trouble?



When the cell potential is negative to the ground, positive charges would accumulate on the cell surface.

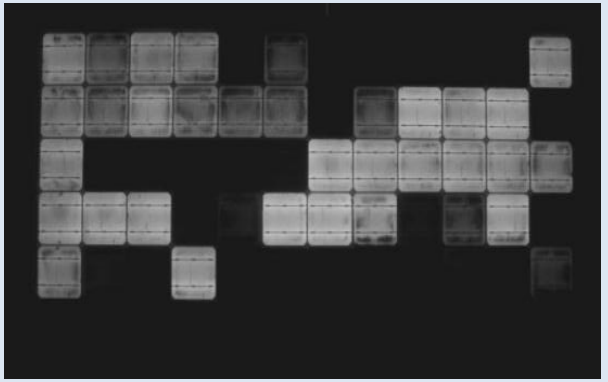
Higher temperature and higher humidity could help the accumulation.





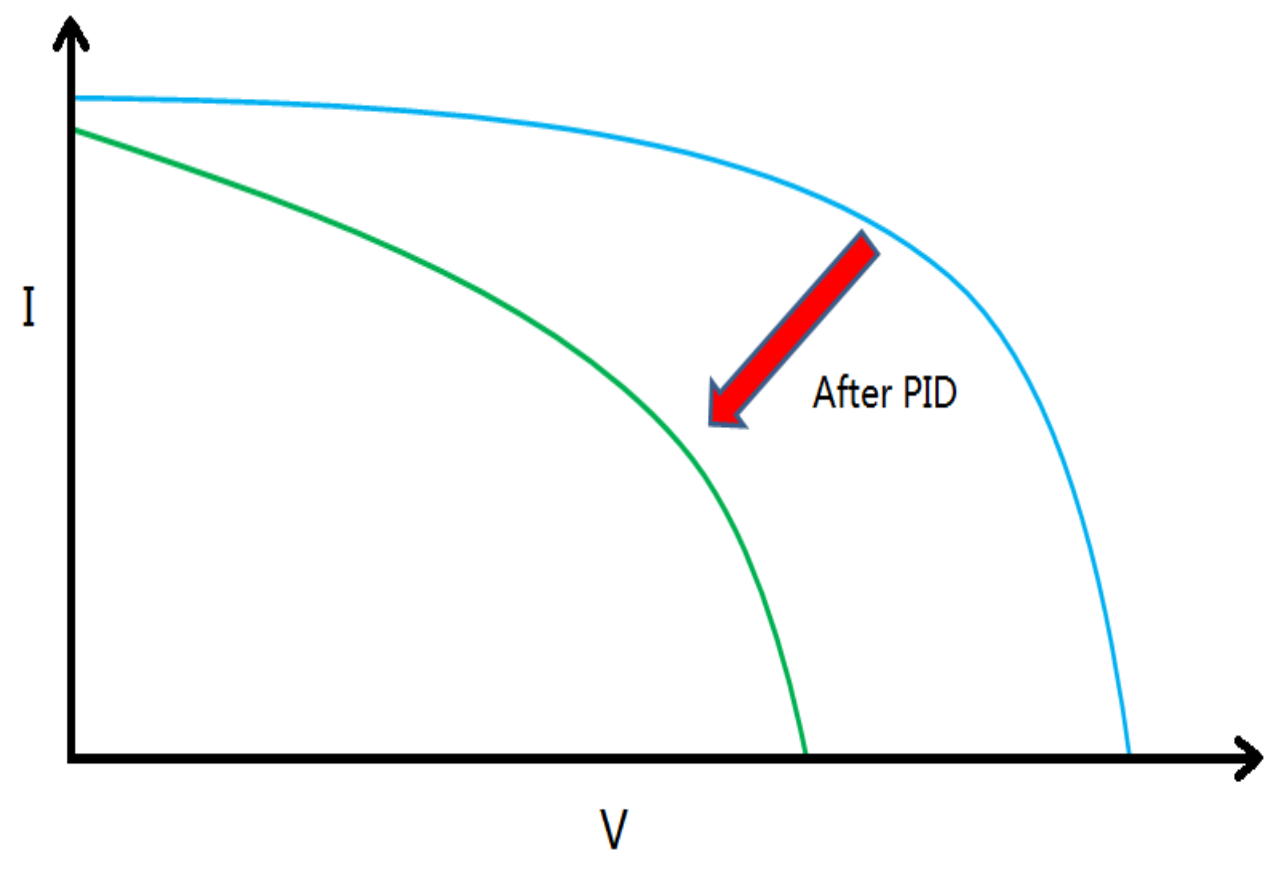
After PID

The electrical properties of panel would degrade. The power could reduce more than 50%.



What is solar plant PID trouble?

PID must happen from the beginning of the plant, seriously or slightly, and become more and more serious along with the electricity production!



How to remedy and prevent PID trouble?

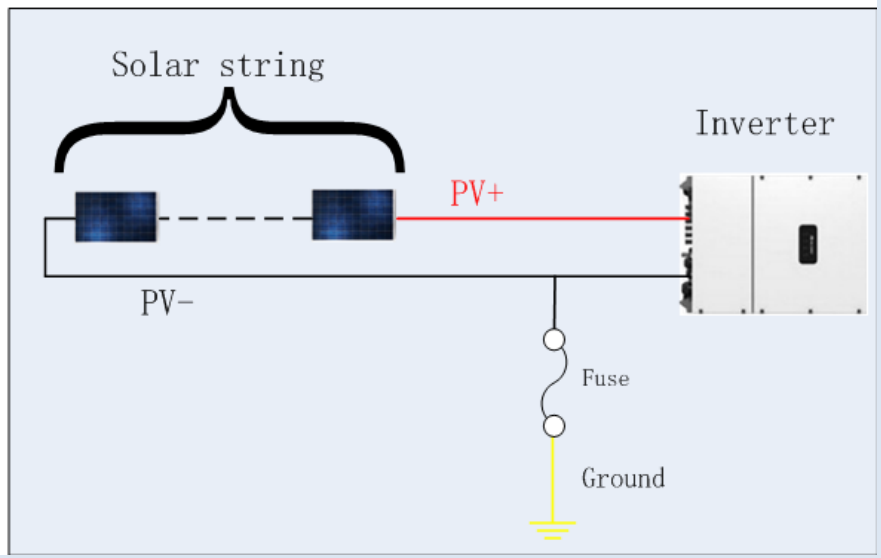
- Remedying and preventing method
  - Wafer
    - Improving silicon wafer quality.
    - Reducing the wafer defect rate.
  - Cell
    - Optimizing cell diffusion process.
    - Optimizing anti-reflection coating process.
  - Module
    - Reducing the porosity of EVA.
    - Improving waterproof of back sheet.
    - Reducing the ions contents of glass.
    - Improving performance of sealant.
  - Solar plant
    - Negative directly grounded (NDG).
    - Negative indirectly grounded (NIG).
    - Negative virtual grounded(NVG).
    - Isolating the modules and the ground.
    - Reverse Voltage application(RV).

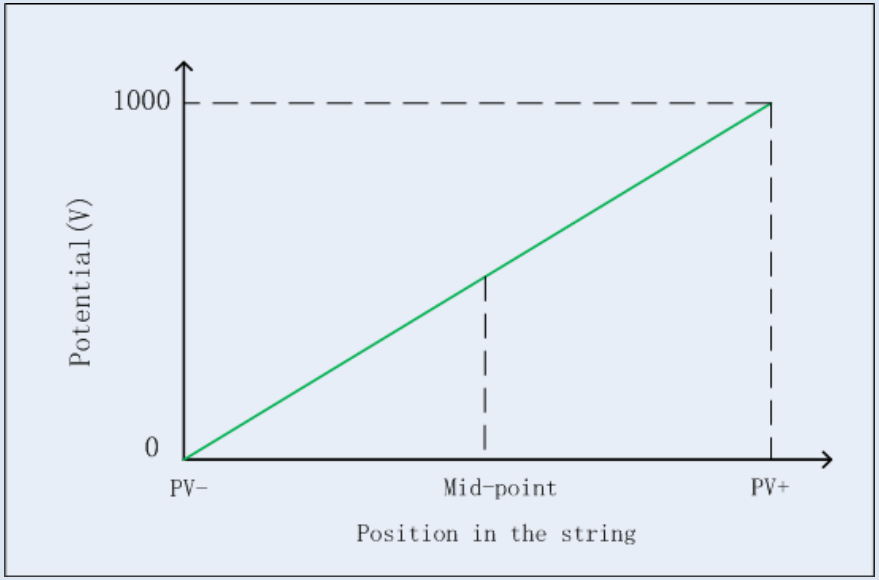
Products methods(Wafer, Cell, Module) can only alleviate PID effect, instead of solving PID completely. Besides, these measures not only reduce the efficiency of solar cells but also increase the cost.

To avoid PID completely, it needs to adopt a method to prevent ions from gathering on the solar cell surface on the plant.

How to remedy and prevent PID trouble?

Negative directly grounded (NDG) method



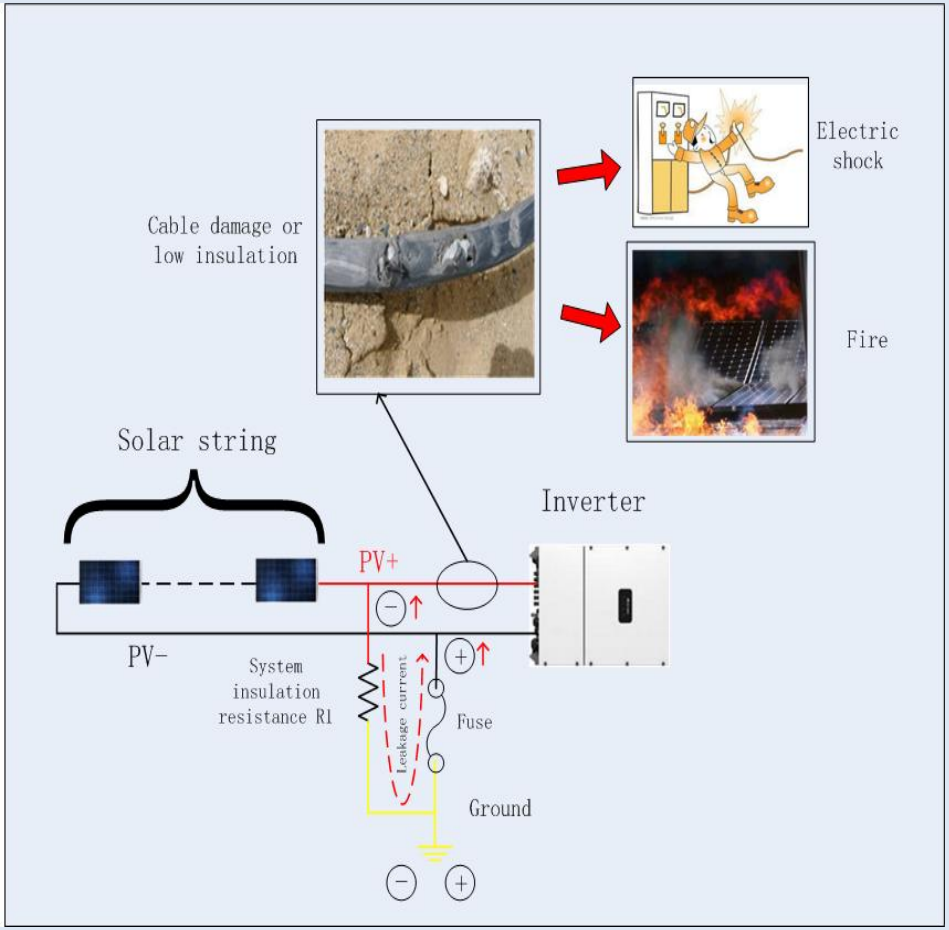


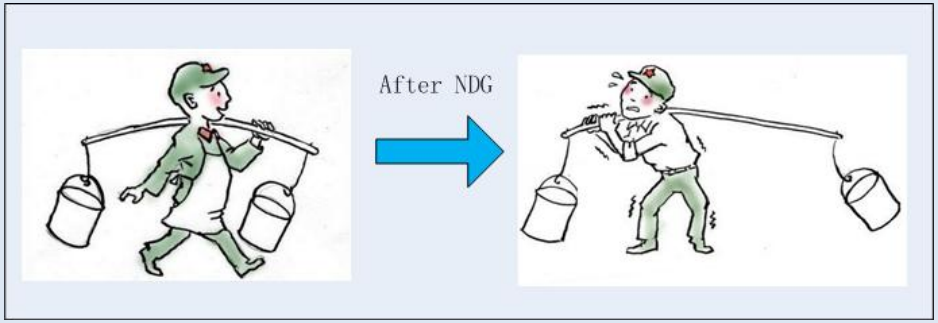
The method is connecting PV- with the ground through Fuse.

After NDG, the voltage potential of every position in the string is above 0V. It can avoid positive ions gathering onto the solar cell surface to prevent PID.

How to remedy and prevent PID trouble?

Disadvantages of NDG





×Fuse is easily damaged, losing anti-PID function;

×The risk of fire;

×The risk of electric shock even to death;

×System voltage withstanding needs to improve;

×Conductor corrosion of the system may happen;

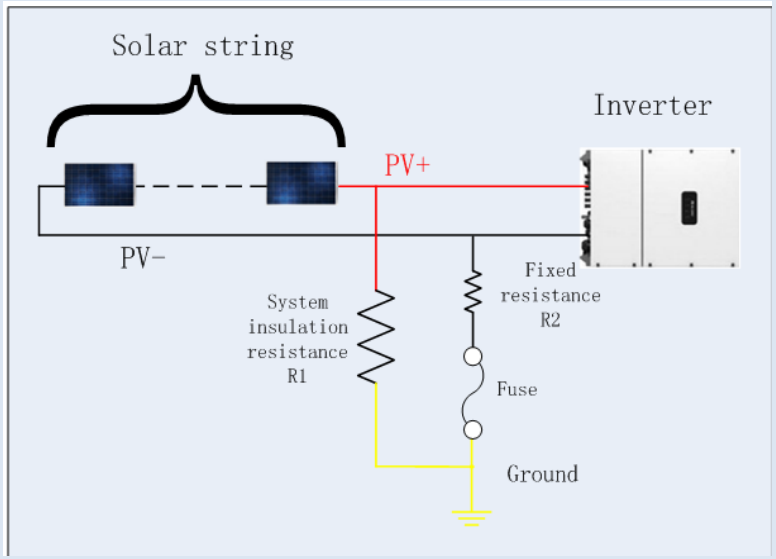
×It can't be applied in PID happened solar plant;

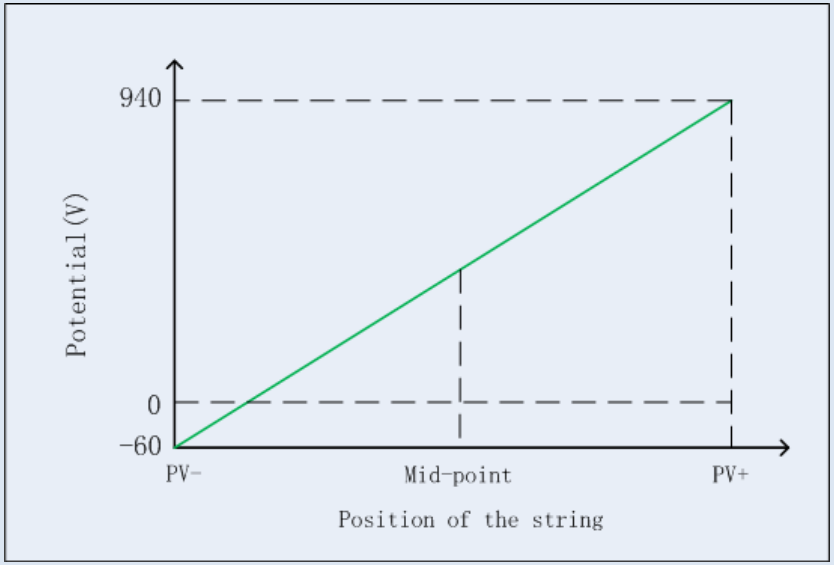
×It can't be applied in solar plant without isolation transformer;

× The insulation monitor besides negative terminal must be applied.

How to remedy and prevent PID trouble?

(Negative Indirectly Grounded) NIG method



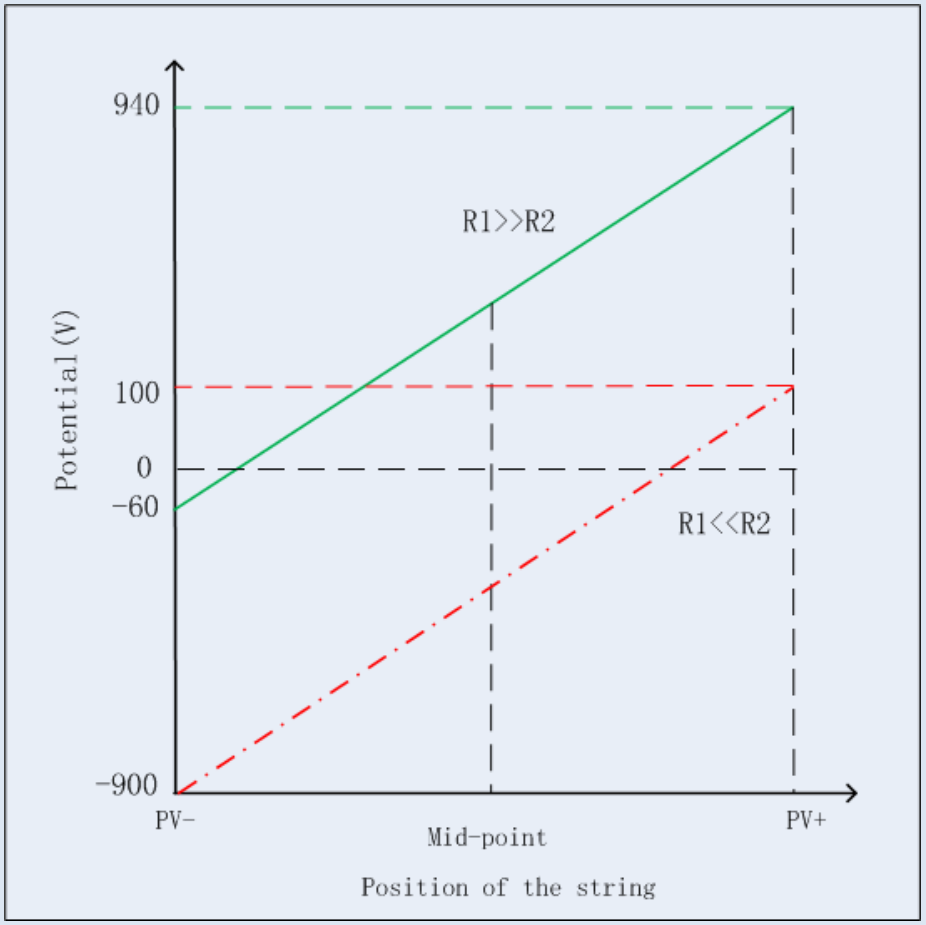


The method is to connect a resistor R2 in series between negative and the earth.

Normally, R2 is far smaller than R1. Then, the voltage potential at PV- is far smaller than that at PV+(taking -60V as an example). So, the PID can be avoided as possible.

How to remedy and prevent PID trouble?

Disadvantages of NIG



× It can't prevent PID completely;

× If R2>>R1, PID may be riskier;

× System voltage withstanding needs to improve;

× The risk of electrical shock even to death;

× Conductor corrosion of the system may happen;

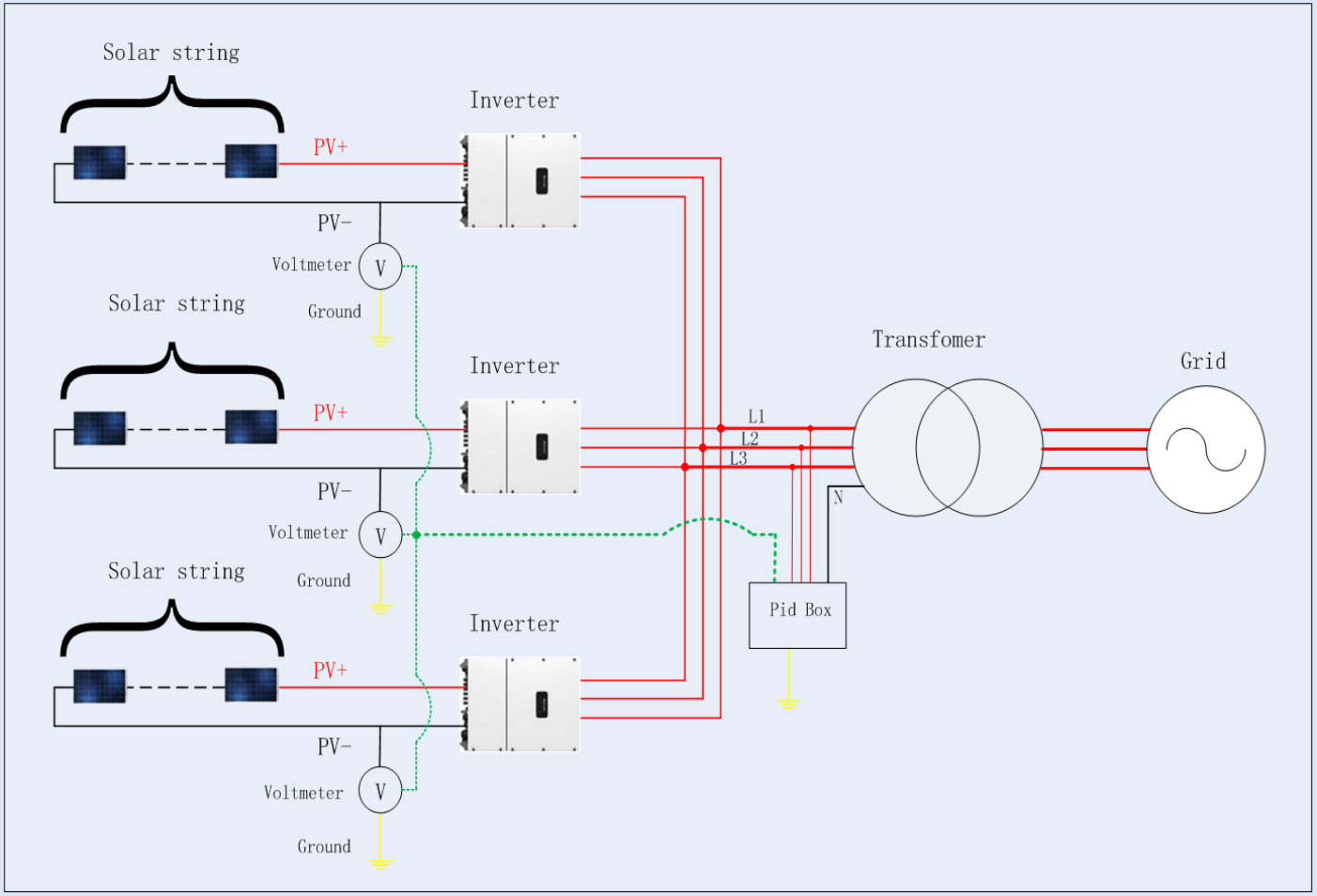
× It can't be applied in PID happened solar plant;

× It can't be applied in solar plant without isolation transformer;

× The insulation monitor besides negative terminal must be applied.

How to remedy and prevent PID trouble?

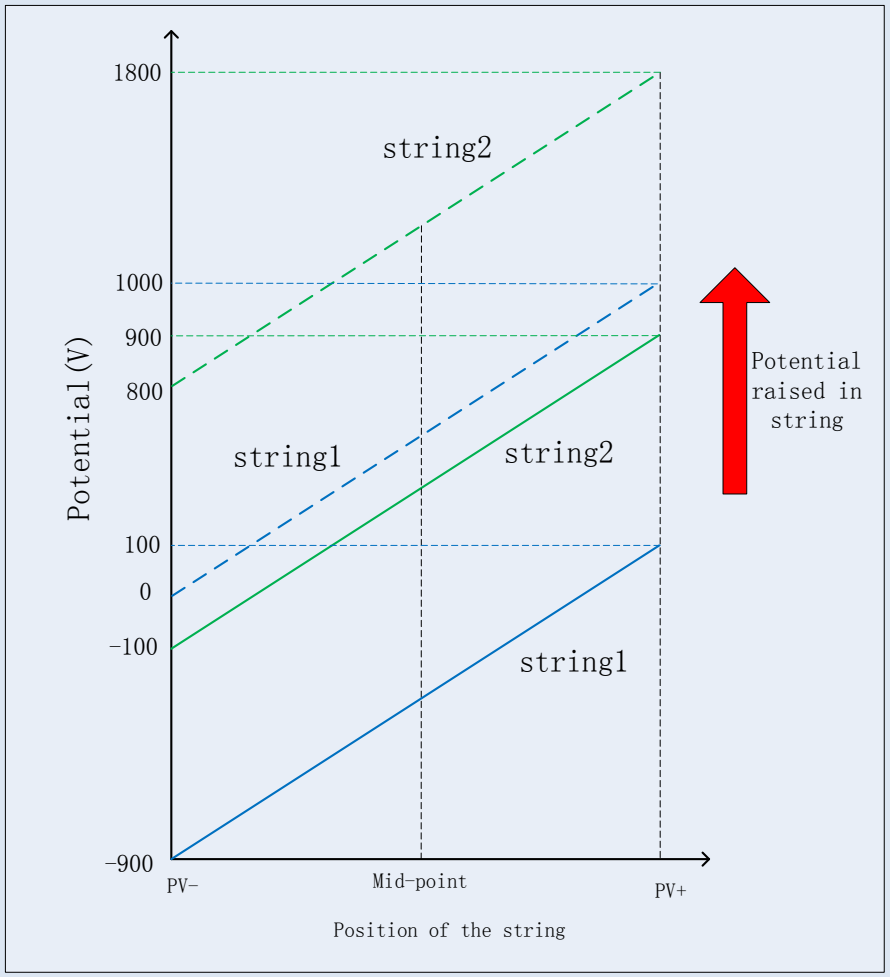
Negative Virtual Grounded (NVG) method



The NVG is to connect the PID box between N point of AC side and the ground. The PID box can obtain the potential of PV- of DC side and adjust the potential of N point to make PV- potential above 0V to avoid PID. NVG could avoid the risks of NDG and NIG.

How to remedy and prevent PID trouble?

Disadvantages of NVG



× System voltage withstanding needs to improve;

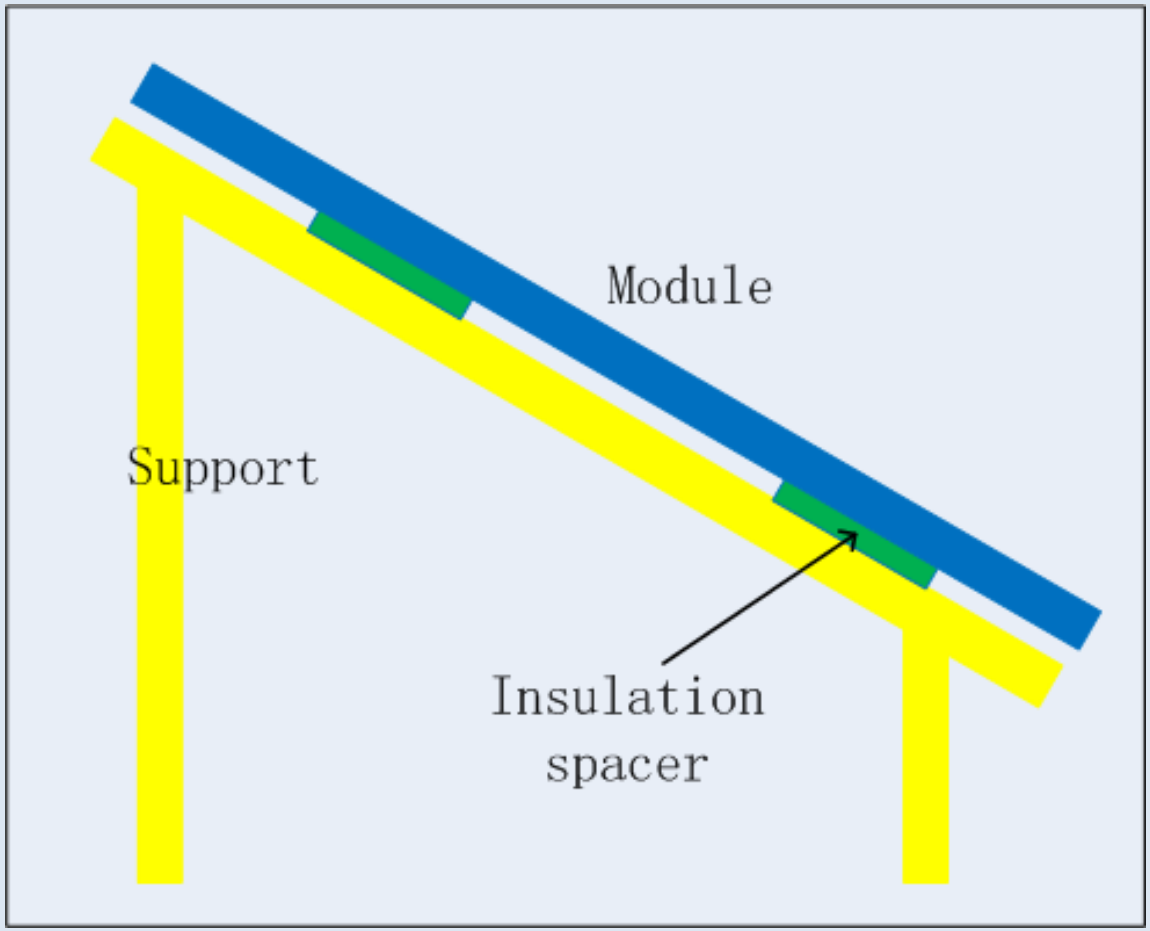
×If applied for several inverters, DC voltage of some inverter may exceed the permit voltage class because of the inconformity of the DC- potentials to the ground between different inverters;

×It can't be applied in PID happened solar plant;

×It can't applied in solar plant without isolation transformer;

How to remedy and prevent PID trouble?

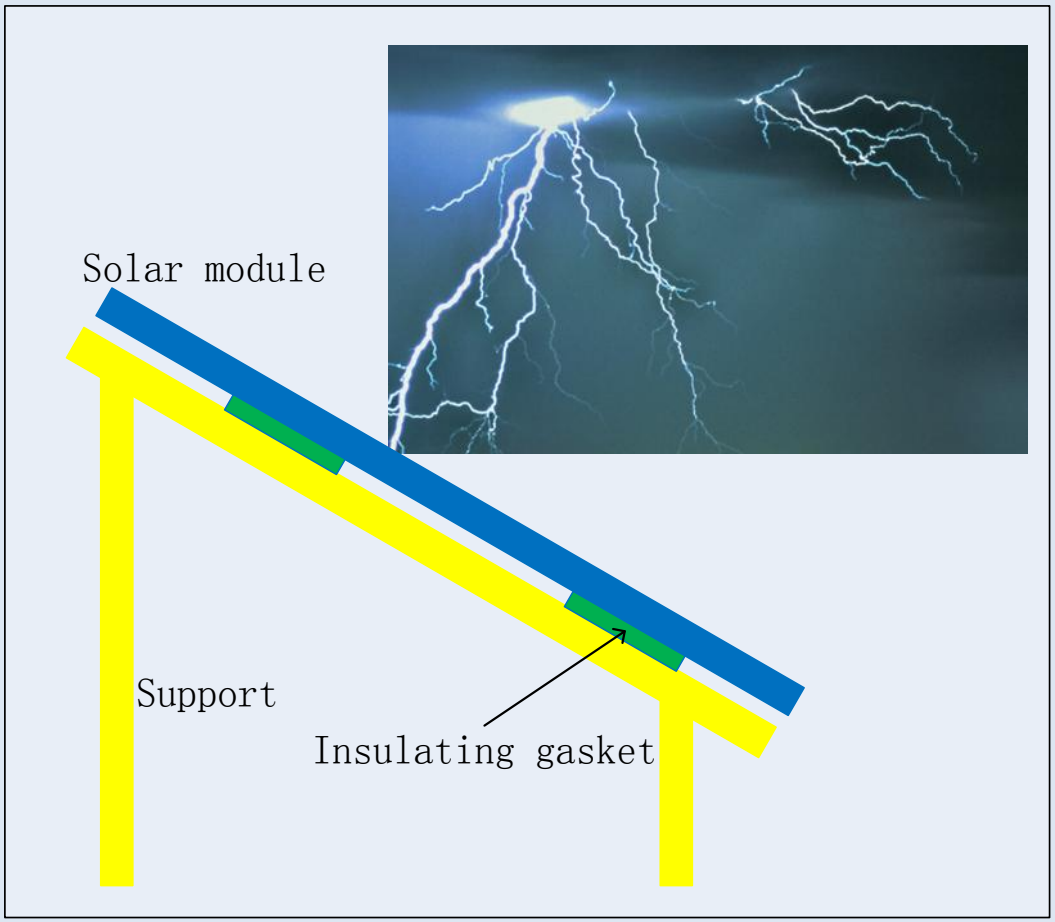
Isolating the module and the ground



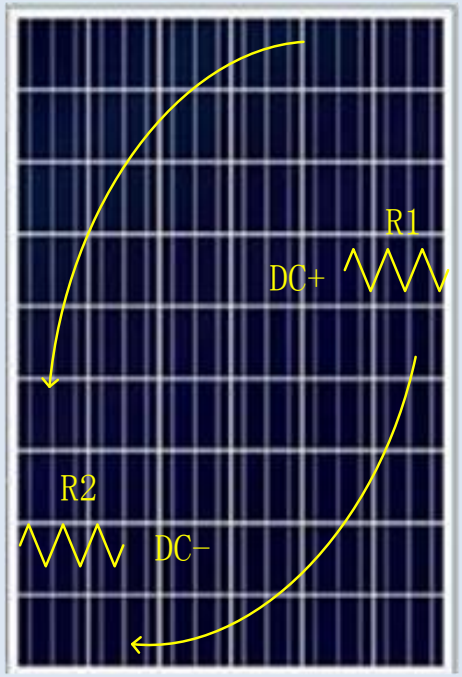
Aging-resistant insulation spacers should be fixed between the frame and the ground(support). There is no fixed voltage between the cell and the ground. So that, the ions cannot accumulate on the surface of the cells. No PID trouble happen.

How to remedy and prevent PID trouble?

Disadvantages of isolating the modules and the ground

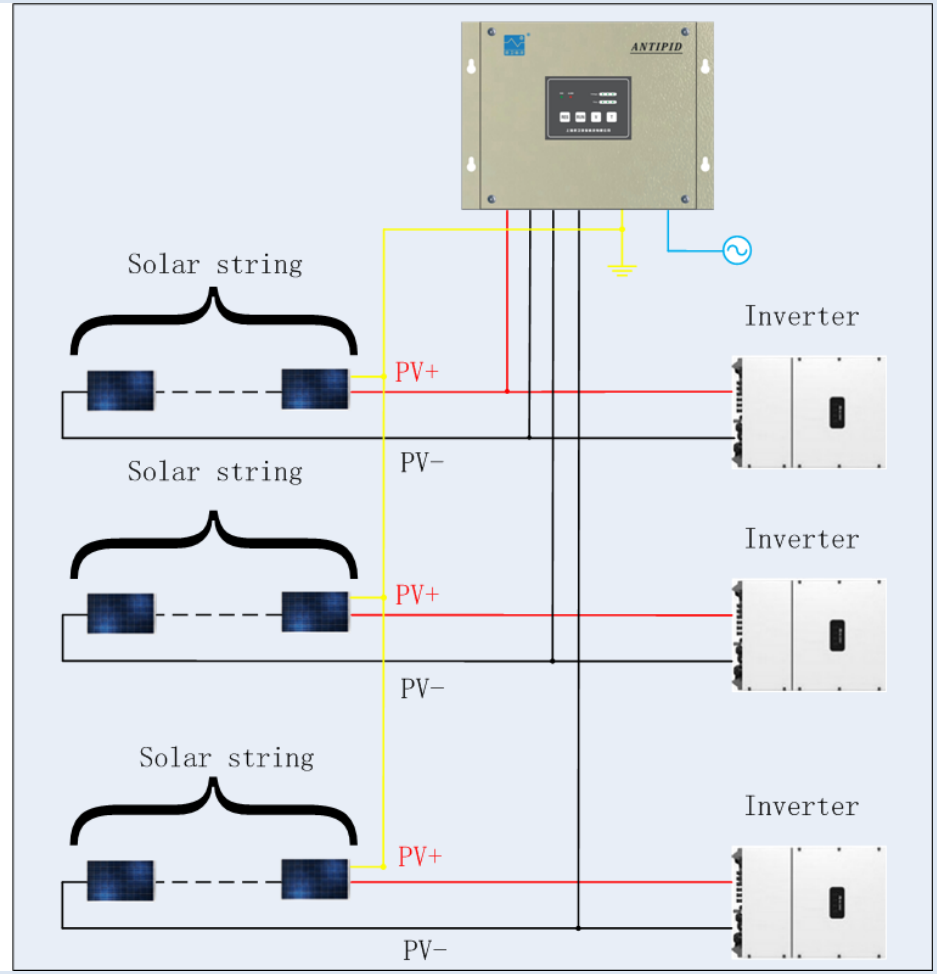


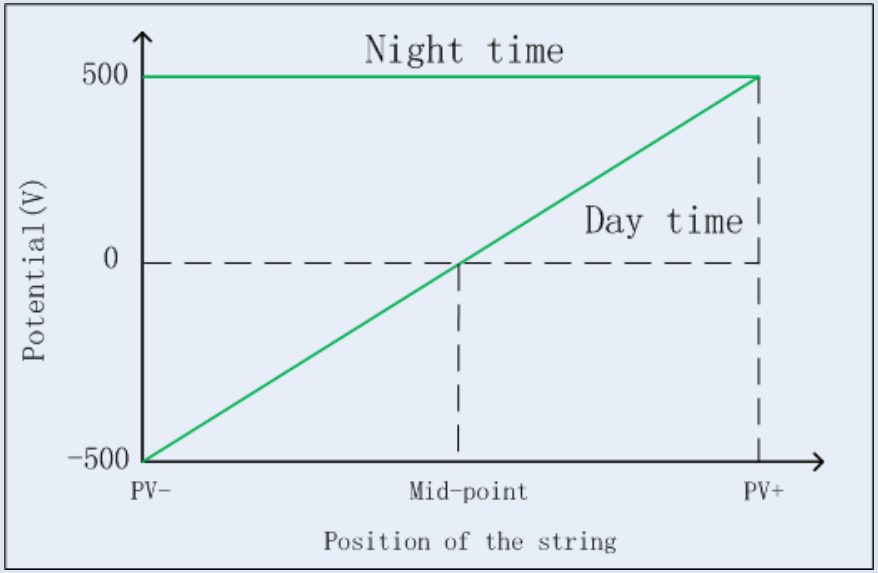
×There is a risk of losing power.
×There is a risk of fire accident.
×There is a risk of electric shock accident.



How to remedy and prevent PID trouble?

Reverse voltage(RV) applied at night time





RV is to add a PID box between the DC side of inverters and ground. Voltage is applied to the string at night to drive the positive ions accumulating on the surface of the cells away to prevent PID trouble.

How to remedy and prevent PID trouble?

Advantages of RV

- ✓ It could be applied for system with or without isolation transformer.
- ✓ It could used for PID prevention in newly built plant and PID recovery for the old plant.
- ✓ There is no electric shock and fire risk.
- ✓ There is no conductor corrosion risk.
- ✓ It need not to improve the voltage withstanding level.
- ✓ It need not any other device for the original system.

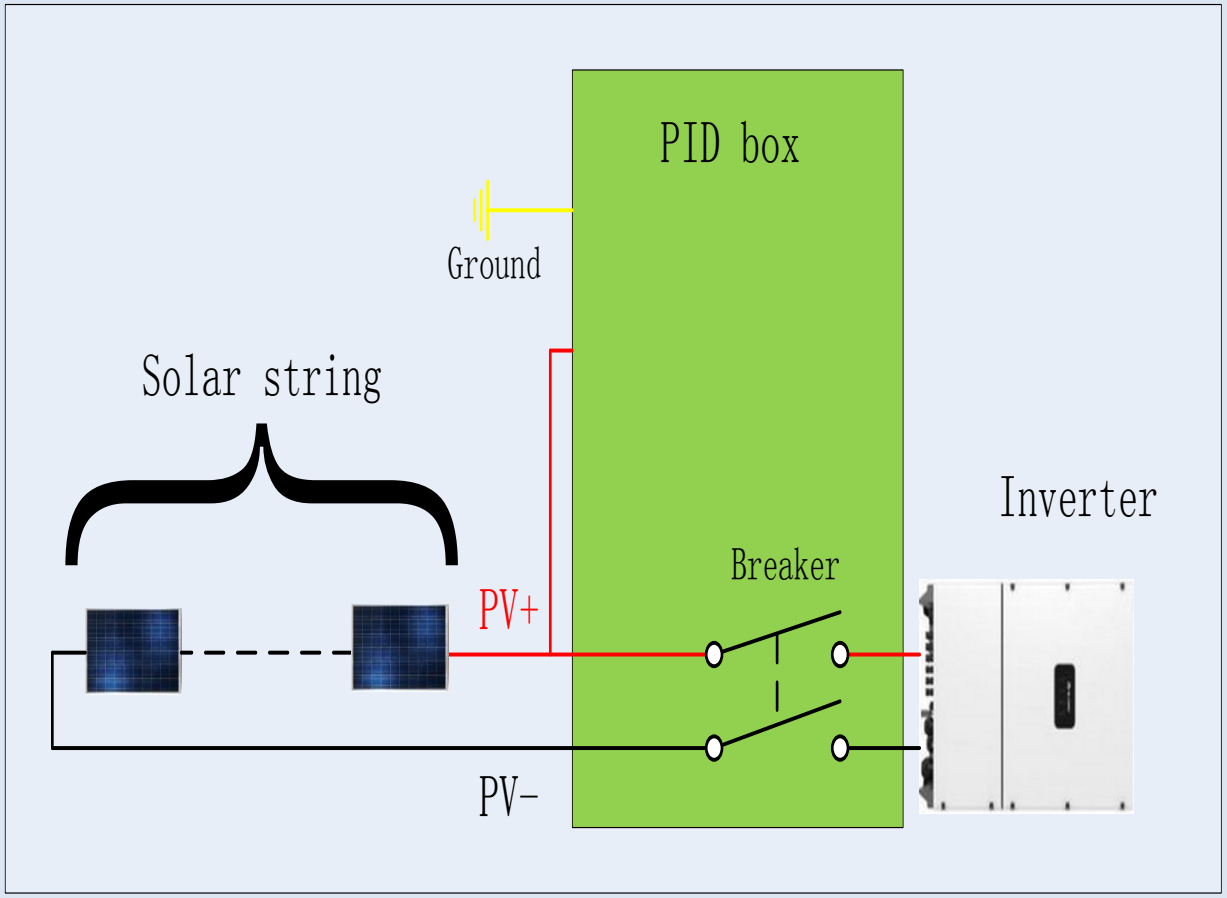
How to remedy and prevent PID trouble?

Different RV methods

- RV methods
  - Series connecting technology
  - Parallel connecting technology
    - Apply voltage between PV+ and the ground
    - Apply voltage between PV- and the ground

How to remedy and prevent PID trouble?

Series connecting technology



The series connecting technology is installing the PID box between the string and the inverters with circuit breakers.

The breaker opens at night and the PID box will emit voltage between the cells and the ground.

The breaker closes at the daytime and the inverter can generate power normally.

How to remedy and prevent PID trouble?

Advantages and disadvantages

Advantage

✓Series connecting technology doesn't apply voltage on the inverter.

Disadvantage

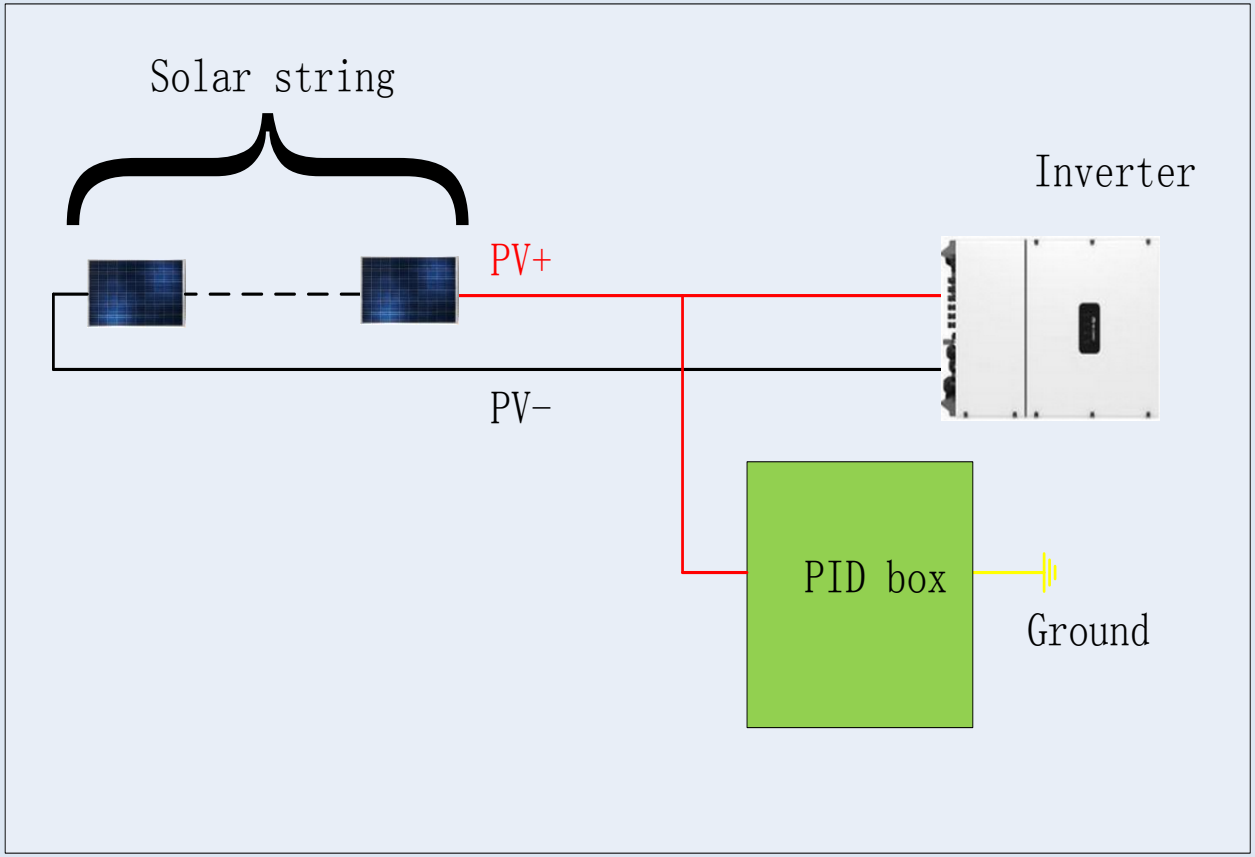
×If the PID box fails, the solar power can't generate.

×Each circuit breaker can only be connected with one MPPT.

How to remedy and prevent PID trouble?

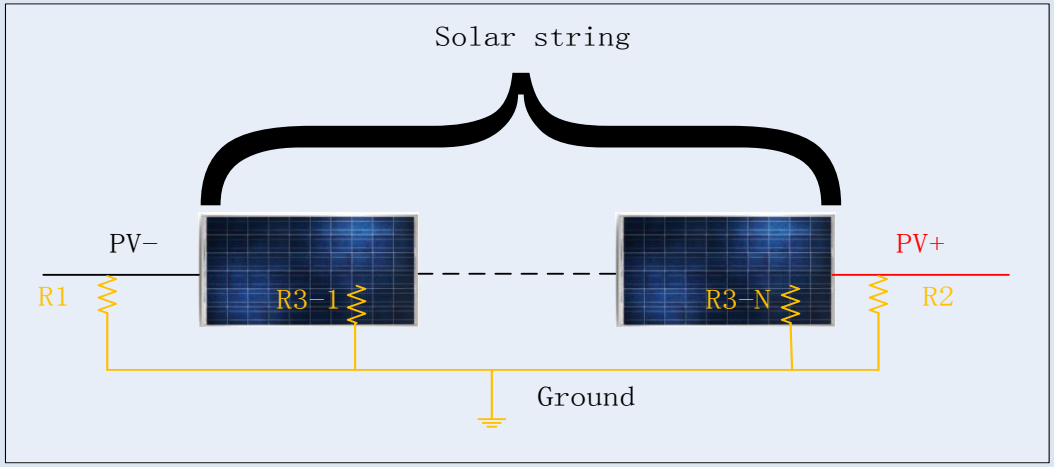
Parallel connecting technology

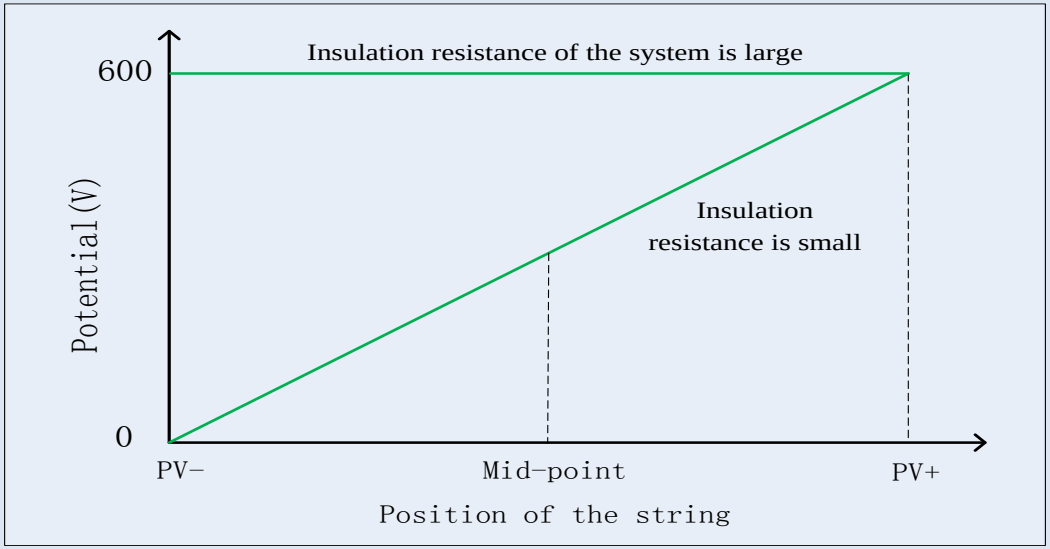
Apply voltage between PV+ and earth



Installing PID box between PV+ and the ground to emit voltage at night time. There is no risk of influence production even if PID box fails.

How to remedy and prevent PID trouble?

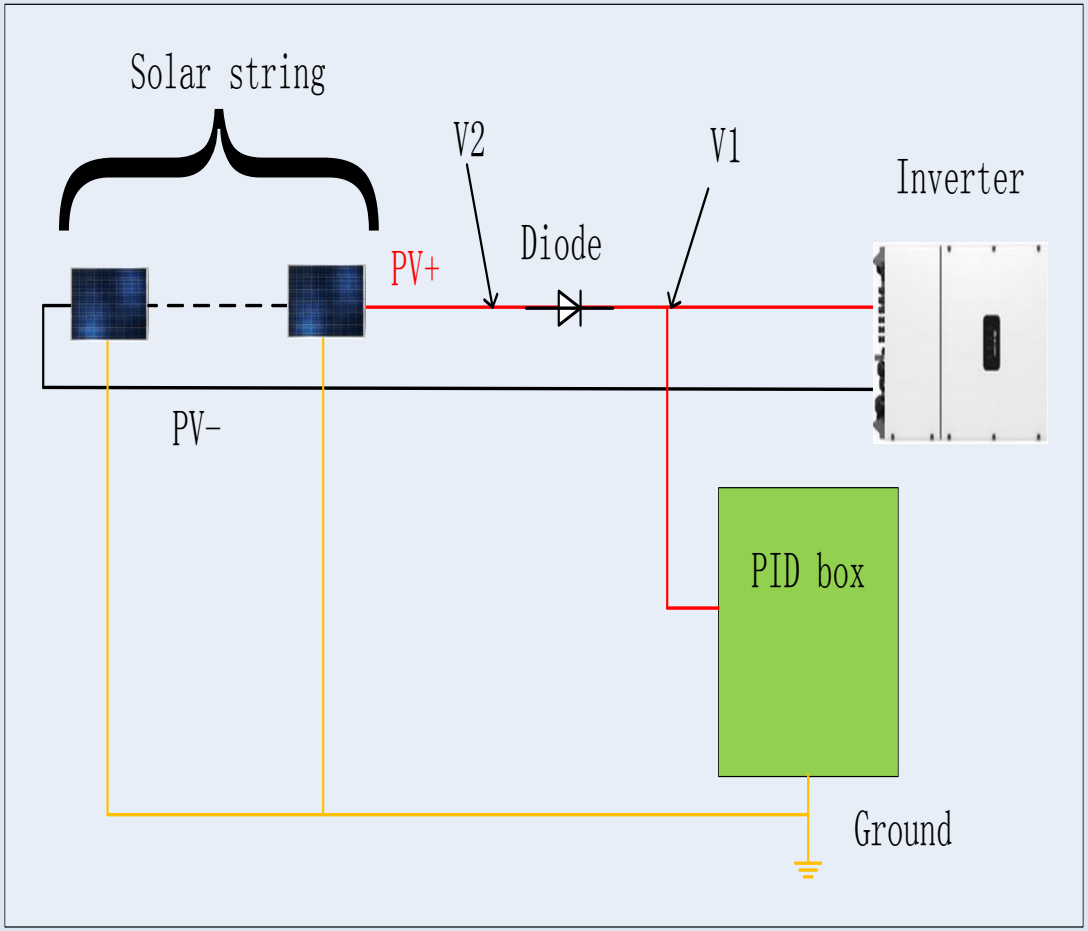




Disadvantages of applying voltage between PV+ and the ground

If R1, R2, R3-1 ～ R3-N are low, the closer to the PV-, the smaller the potential is, probably close to 0, presenting poor effect in PID remedying and preventing.

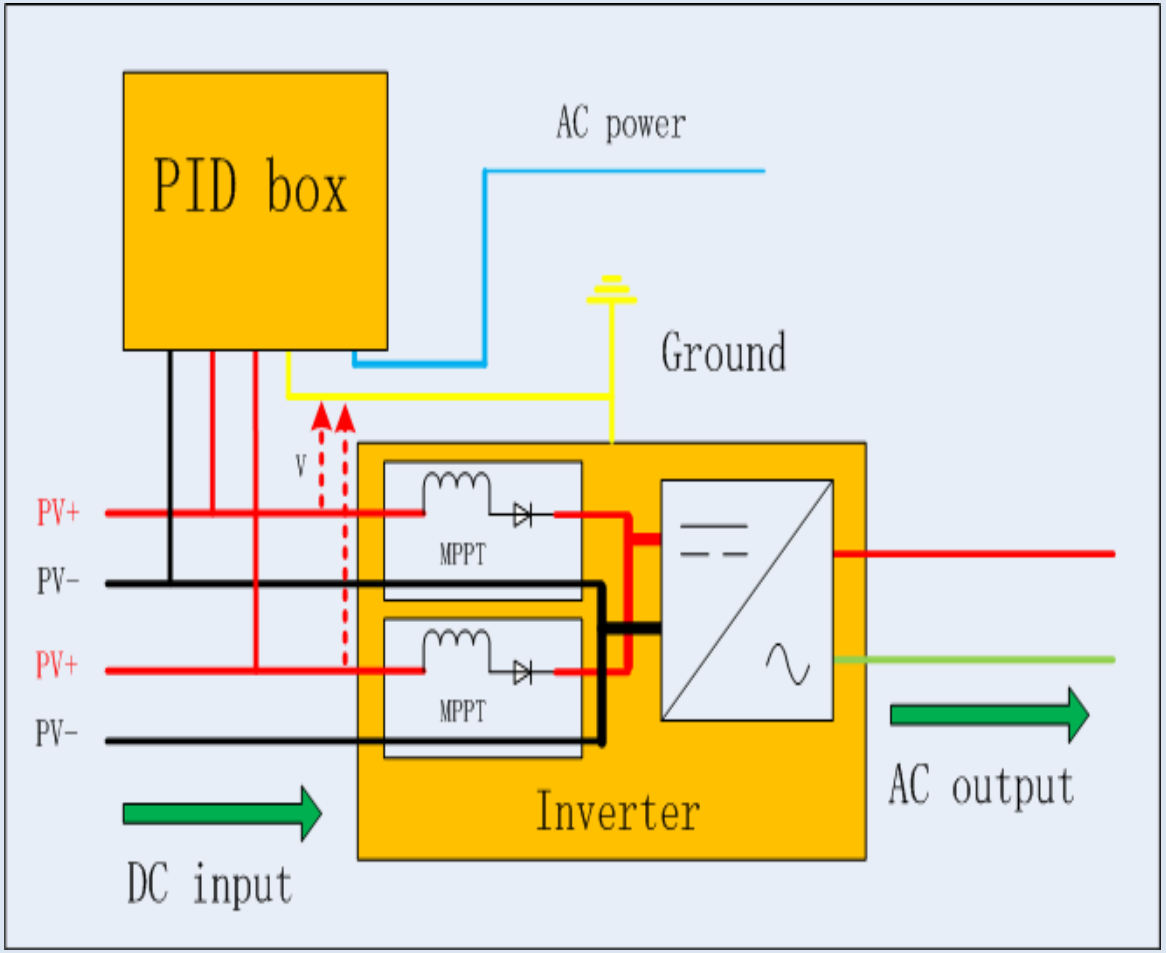
How to remedy and prevent PID trouble?



Disadvantages of applying voltage between PV+ and the ground

When there are diodes in the string, most of the voltage between the PV+ and the ground will be consumed on the diode and the voltage in the PV string is very low.
If the reverse voltage of the diode is larger than V1, the voltage of V2 is nearly 0.
there will be no effect on PID remedying and preventing.

How to remedy and prevent PID trouble?



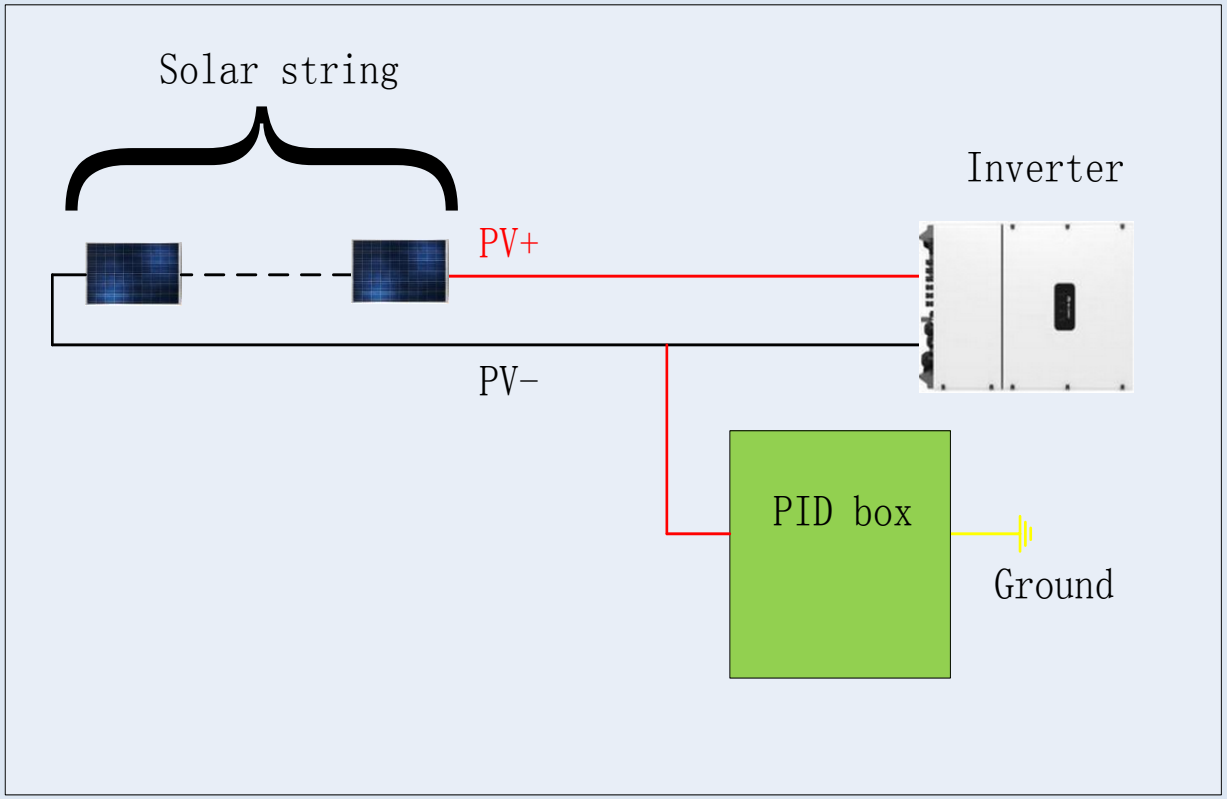
Disadvantages of applying voltage between PV+ and the ground

As to the inverters with multiple MPPTs, each positive side of MPPT is separated. If the voltage is applied between the PV+ and ground, each channel of PID box can only be connected with one MPPT.

Taking two MPPT inverters as an example, two channels or two PID boxes must be connected for anti-PID.

How to remedy and prevent PID trouble?

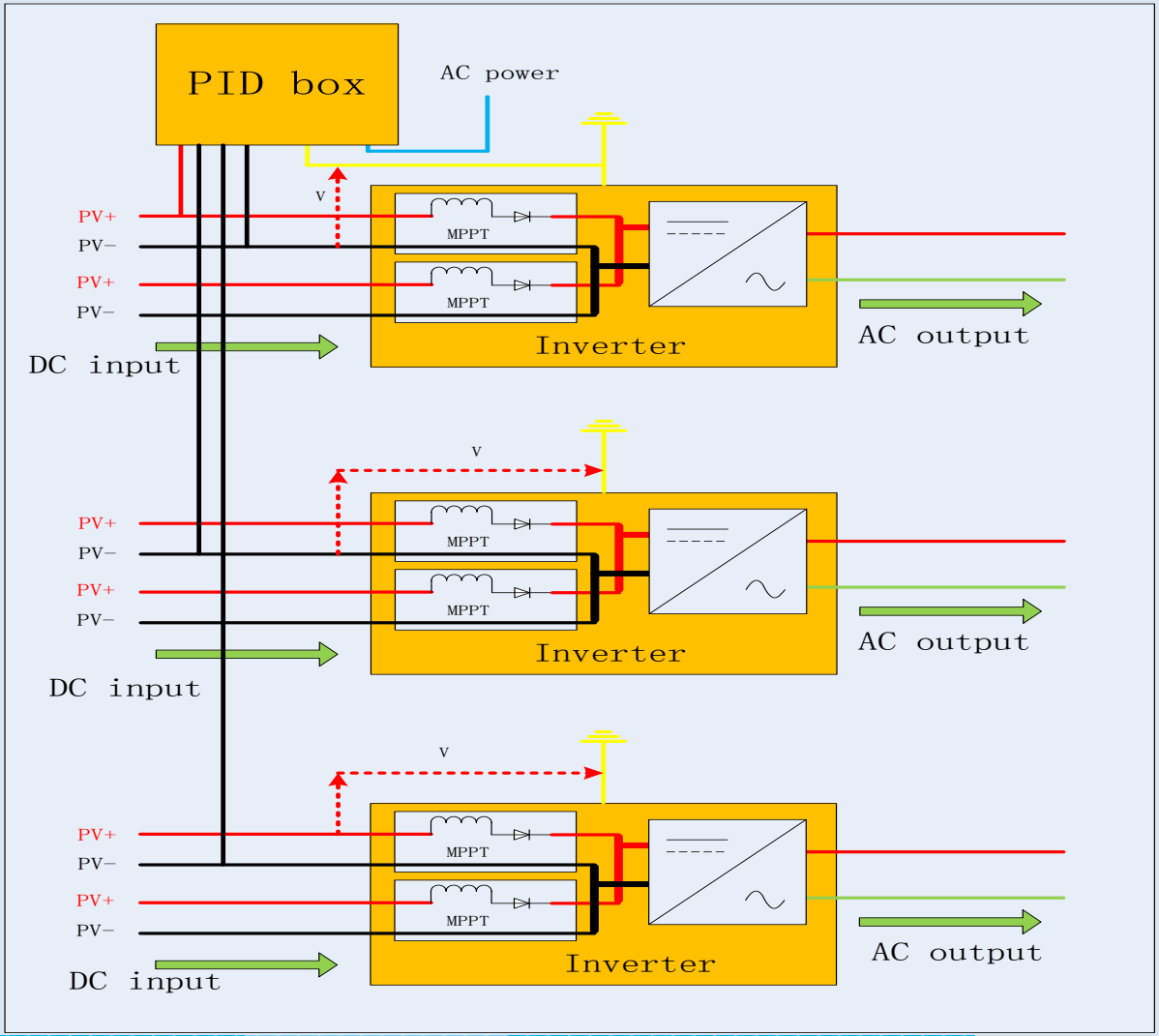
Parallel connecting technology
Apply voltage between PV- and the ground



Installing PID box between PV- and the ground to emit voltage at night time.
There is no risk of influence production even if PID box fails. Appling voltage between the PV- and ground remedy and prevent the PID trouble more effectively even if the insulation resistance of the system is low.
The remedying and preventing effect will keep same even there is reverse diode in the circuit.

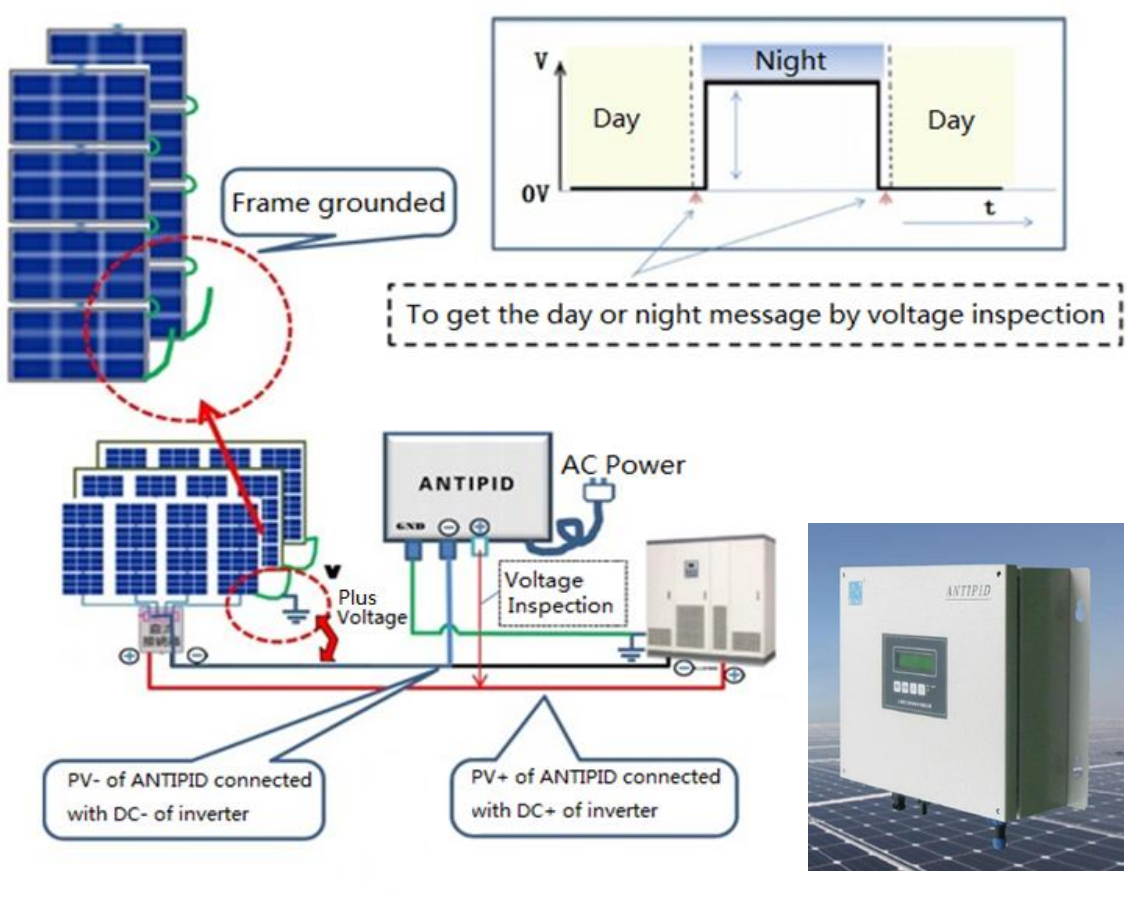
How to remedy and prevent PID trouble?

As the PV- of multiple MPPTs in one inverters are connected with each other, one inverter only need one channel and one PID box with several channels could be connected with several inverters.



Why choose ANTIPID?

ANTIPID, invented by Zealwe Technology Co., Ltd., is the most professional solar plant PID remedying and preventing device.



- ✓ Used in new plant for PID preventing and existing plant for PID remedying;
- ✓ Used in system with transformer or without transformer;
- ✓ No need to improve the voltage withstanding level;
- ✓ No need to add extra insulation monitor;
- ✓ No negative influence in electric production;
- ✓ One device could be used for several inverters;
- ✓ Could be controlled by PV voltage and clock automatically;
- ✓ Could be controlled by remote communication.

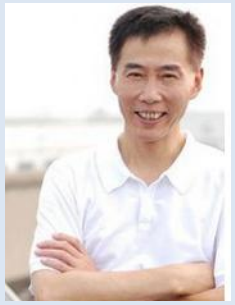
Why choose ANTIPID?

Different anti-PID method.

Item	Voltage applied between the PV- and ground(ANTIPID)	Voltage applied between the PV+ and ground(other company1)	Series connection(other company2)
Connection mode	Parallel connection with the power generating system	Parallel connection with the power generating system	Series connection with the power generating system
Scope of one channel	One inverter	One MPPT	One MPPT
Direction of voltage application	Voltage applied between the PV- and ground	Voltage applied between the PV+ and ground	Break the string and inverter and apply voltage to the string
Parameter setting	Set the parameter on the operation panel	Open the cover and set	Unable to set
On-site monitoring	Monitor the voltage, output voltage, time, operating state and alarm status of components	Operating state	Unable to monitor
Control mode	PV voltage, clock and remote control information	PV voltage	PV voltage

Why choose ANTIPID?

Professional team



Dr. Jiang Haijiang

Awarded two Doctor degree from NUAA(China) and FUB(Belgium)

As senior engineer in USA Controllde Power Co, USA Eaton Airspace, Shanghai aviation electrical appliance. Developed EPS, SSPC, solar inverter, S-MPPT,ANTIPID and other equipment.

Dr. Yu Huacong

Awarded Doctor degree from SJTU(China)

Professor-level engineer. Member of SAC/TC90, evaluation expert of Shanghai special fund, Changzhou 4th "Dragon city outstanding person plan" leading person. Worked in Linyang, Suntech and Hanenergy on developing solar cell and module product, solar system integration. Participated in drawing up 2 national standards,2 provincial standards. Achieved 6 invention patents, 22 utility patents.

Dr. Liu Zhigang

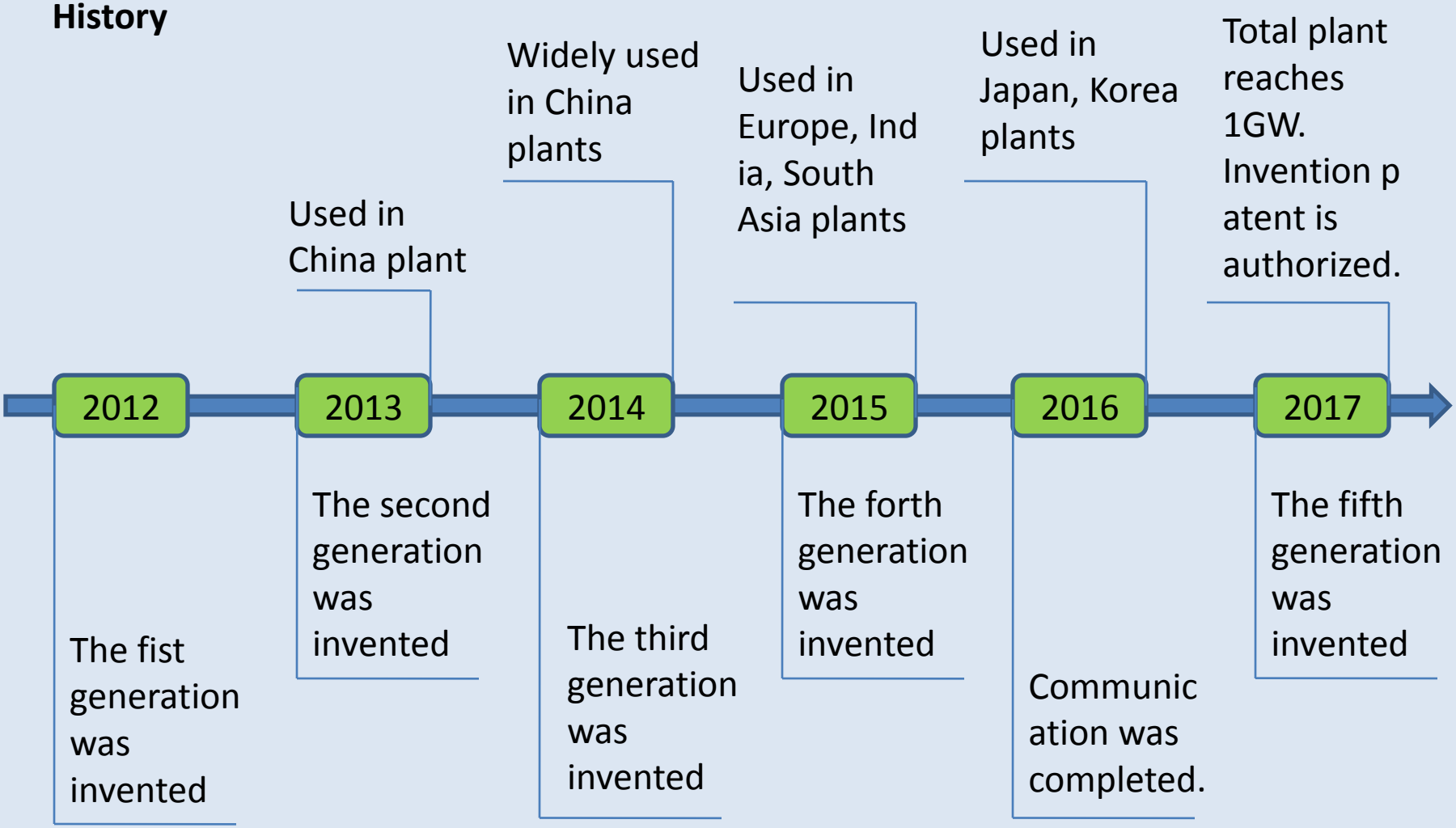
Awarded Doctor degree from SJTU(China)

Worked in Eging PV. Achieved Changzhou wuyi labour award, Jiangsu wuyi labour award, 8 invention patents, 20 utility patents. Majored in solar cell and solar plant product test, quality control and performance improving.

Why choose ANTIPID?

ANTIPID has a history from 2012 and has been installed in 1GW solar plant.

History



Why choose ANTIPID?

There are 1 invention patent and 2 utility patents.


发 明 专 利 证 书

局长
申长雨


证书号第4332336号

实用新型专利证书

实用新型名称：在线式太阳能电站PID恢复系统

发 明 人：刘志刚

专 利 号：ZL 2015 2 0092667.9

专利申请日：2015年02月07日

专 利 权 人：上海质卫环保科技有限公司

授权公告日：2015年05月27日

局长
申长雨


证书号第5213992号

实用新型专利证书

实用新型名称：太阳能电站组串最功率优化器

发 明 人：刘志刚;殷大明;黄文忠

专 利 号：ZL 2015 2 1085982.5

专利申请日：2015年12月22日

专 利 权 人：上海质卫环保科技有限公司

授权公告日：2016年05月18日

局长
申长雨

Why choose ANTIPID?

There are 3 software copyrights.

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计算机软件著作权登记证书

证书号：软著登字第1276351号

软件名称：质卫光伏功率优化设备软件 V2.0

著作权人：上海质卫环保科技有限公司

开发完成日期：2016年04月08日

首次发表日期：2016年04月18日

权利取得方式：原始取得

权利范围：全部权利

登记号：2016SR097734

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著作权人：上海质卫环保科技有限公司

开发完成日期：2017年02月15日

首次发表日期：2017年02月15日

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软件名称：质卫光伏检测设备控制软件 V2.0

著作权人：上海质卫环保科技有限公司

开发完成日期：2016年04月08日

首次发表日期：2016年04月18日

权利取得方式：原始取得

权利范围：全部权利

登记号：2016SR099156

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No. 01036618

Why choose ANTIPID?

ANTIPID has achieved CE certification， ISO9001 certification and a trademark.

SGS

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ee.shanghai@sgs.com

VERIFICATION OF COMPLIANCE

Verification No.:	SHEM140500097501MDC
Applicant:	Shanghai zhiwei Environmental Technology Co., Ltd
Address of Applicant:	No.60 Zhong Hui Road, Minhang District, Shanghai City, China
Product Description:	PID Recovery System
Model No.:	ANTIPID

Sufficient samples of the product have been tested and found to be in conformity with

Test Standard:	EN 61000-6-4:2007/A1:2011
	EN 61000-6-2:2005

as shown in the

Test Report Number(s):	SHEM140500097501

This verification of EMC Compliance has been granted to the applicant based on the results of the tests, performed by laboratory of SGS-CSTC Standards Technical Services Co., Ltd. on the sample of the above-mentioned product in accordance with the provisions of the relevant specific standards and Directive 2004/108/EC. The CE mark as shown below can be used under the responsibility of the manufacturer, after completion of an EC Declaration of Conformity and compliance with all relevant EC Directives.

CE

Tony Wu
ESE Section Manager
SGS-CSTC (Shanghai) Co., Ltd.

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sira
CERTIFICATION

QUALITY MANAGEMENT SYSTEM CERTIFICATE

This is to Certify that the QUALITY MANAGEMENT SYSTEM of

SHANGHAI ZHIWEI ENVIRONMENTAL TECHNOLOGY CO., LTD.

Registered Address:Room 101, Building 20, No. 60 Zhonghui Road, Minhang District, Shanghai, China

Business Address:Building 17, No. 60 Zhonghui Road, Minhang District, Shanghai, China

has been assessed by Sira Certification Service and found to comply with

GB/T19001-2008 idt ISO9001:2008

for the

R&D, manufacture and sales of solar PV testing equipment

Certificate No:	150129
Organization Code:	596457270
Initial Certification:	6 February 2015
Date of Issue/Reissue:	6 February 2015
Certificate Expiry:	3 February 2018

On behalf of SCS

UKAS
IAF

Recertification Date: 3 February 2018

This certificate is subject to the company maintaining its system to the required standards, which will be monitored by Sira. The use of this Certificate and the Sira Certification Mark are subject to the Regulations Applicable to Holders of Sira Certificates. This certificate is provided by Shanghai Sira Quality Certification Co., LTD; the certificate information is available on the CNCA official website: http://www.cnca.gov.cn

Sira Certification Service

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商标注册证

第 1638951 号

ANTIPID

注册人 上海[illegible]科技有限公司

注册人地址 上海市[illegible]

注册日期 2016年11月21日 有效期至 2026年11月20日

局长 刘俊臣

发证机关 国家工商行政管理总局商标局

Why choose ANTIPID?

ANTIPID was produced by very professional persons and should endure most strictly function inspection and aging test before delivery.

Why choose ANTIPID?

ANTIPID has been widely used in 1GW solar plants around the world.

Why choose ANTIPID?

ANTIPID has been widely used in all kinds of solar plant structure.







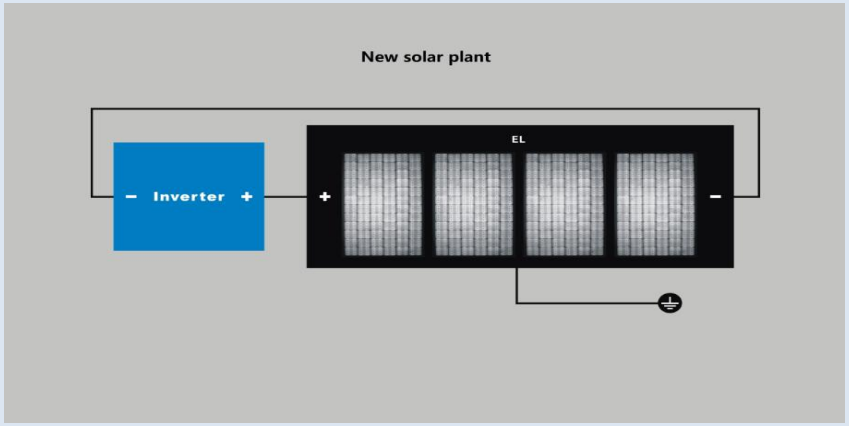


Why choose ANTIPID?

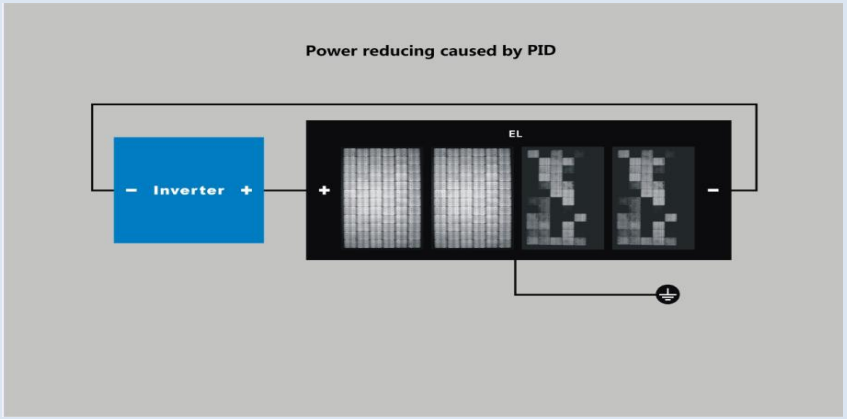
ANTIPID has matched well with more than 30 kinds of inverters.

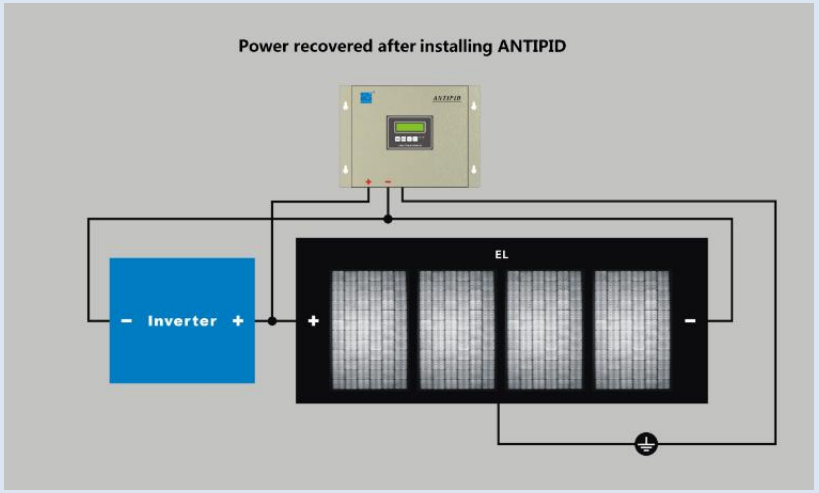
SUPPLIER	TYPE	SUPPLIER	TYPE
powerone	PG1060/ PVI-27.6 OUTD	AVIC	X04-020TL-CN
kaco	Powador 48.0 TL3 Park	TBEA	TC500KH
Vensys	Vensys 1500	Kostal	PIKO19.2
Schneider	Xantrex GT 250 E	Platinum	Diehl AKO R3
HYUNDAI	HPC-250-HL	SIEMENS	SINVERT PVM200
Bonfiglioli	RPS TL 0280	Sineng	EP-0500-A
SMA	Sunny tripower 17000TL	Winline	Ylssl-630
Huawei	Sun2000-KTL	NARI	NST500K
Xuji	GBL500	Great wall	PVSO500
Kunlan	Solartec 20000	Omron	KP55m-J4/ KP55K2/ KP44M-J4
Sungrow	SG500MX/SG30KTL-M	GS YUASA	LBSG-10-T3
Samil power	SolarOcean 500TL	GP Tech	PV500S2
Growatt	Growatt 3300TL3	Soleil	660TLH
Emerson	SSL500	NISSIN	SPM250
FIRST-SECOND	GSG-500KTT-LV	Soleaf	DSP 33200K
CSR	GTI 500	FUJI	PV1750-3/500
KSTAR	GLS 500K	SolarMax	660 TS-SV

Remedying result of ANTIPID.

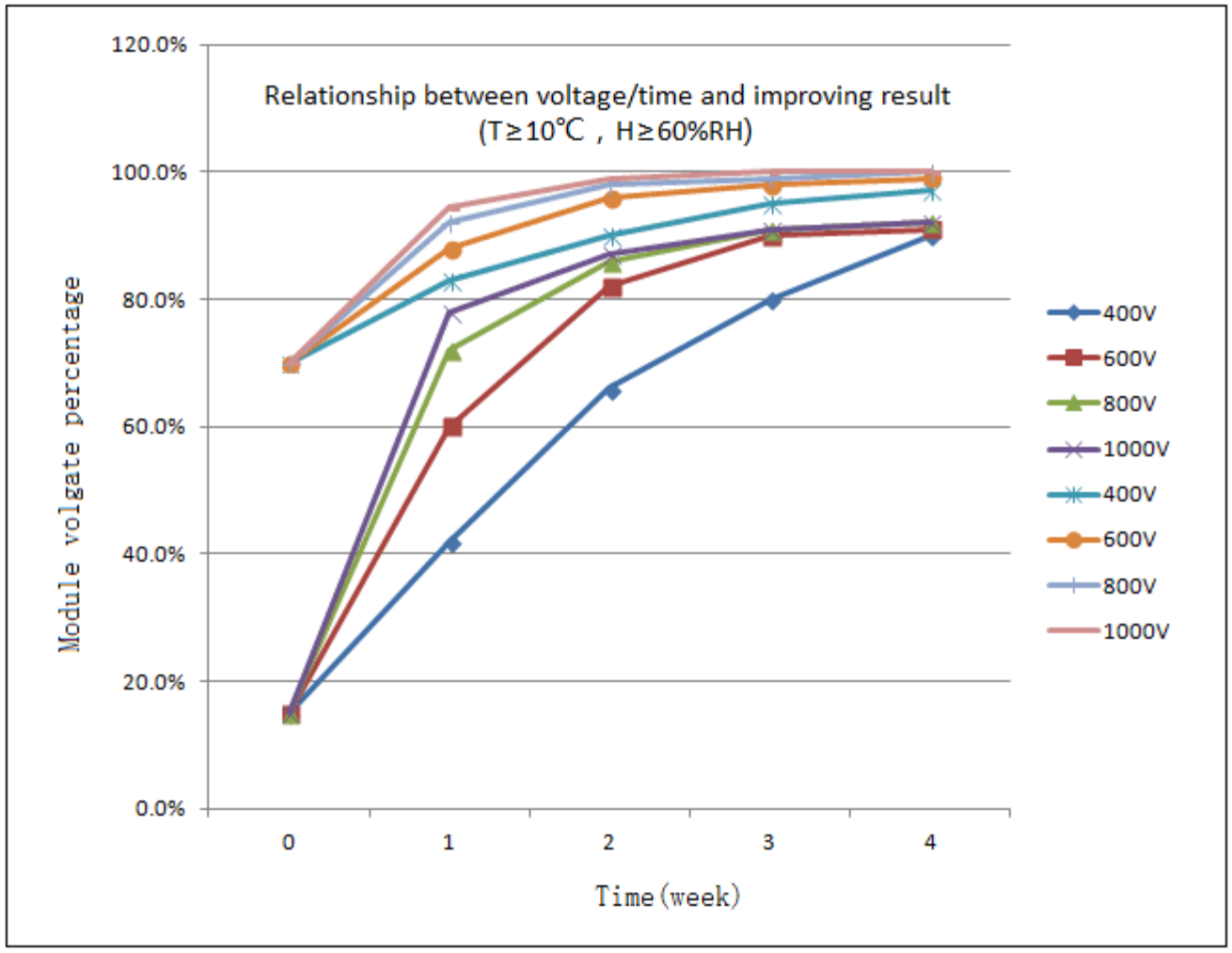


After some months, power of solar plant may be reduced caused by PID trouble. ANTIPID could be used to improve the degradation to more than 90% of initial power.





Remedying result of ANTIPID.



Module voltage could be improved

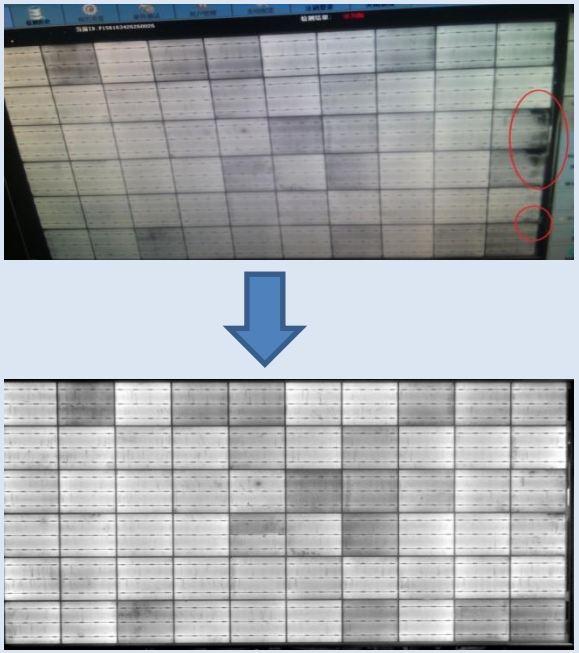
Experientially, if the voltage of the module has decreased to 15%, it could be improved back to about 90%. If the voltage of the module has decreased to 70% , it could be improved to almost 100%.

The temperature is required larger than 10 ℃ and the humidity is required larger than 60%.

Remedying result of ANTIPID.

Voltage of negative side panel is obviously lower than that of positive side. The voltage could be improved to more than 90% after remedied by ANTIPID.

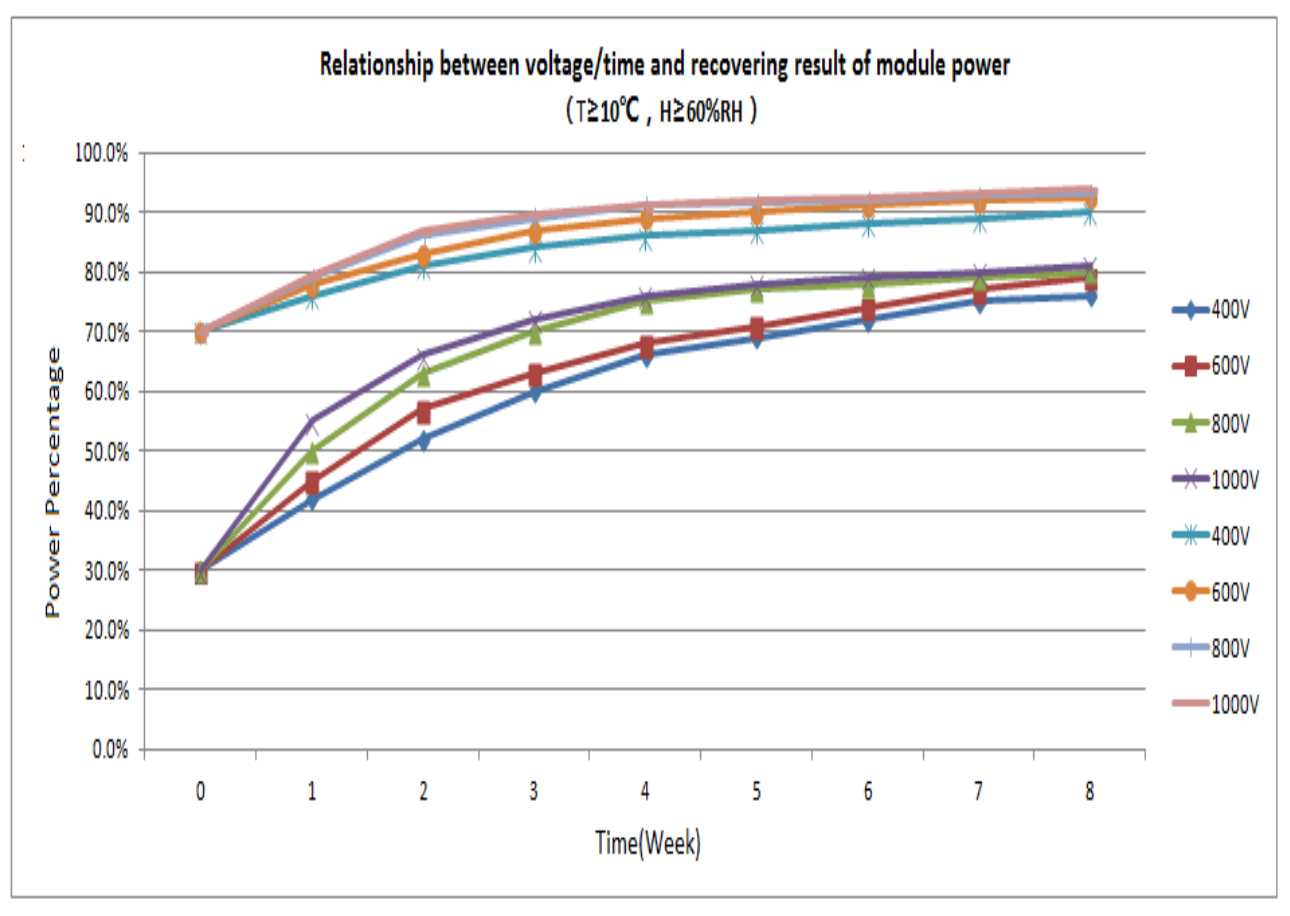
Module number（Beginning from negative side）	Before installing (V)	After installing (V)
1	18.95	36
2	21.41	37
3	21.15	37
4	25.27	37
18	35.08	37
19	34.9	37
20	35.9	38
21	35.15	39



Black spot disappeared after recovery(EL).

Remedying result of ANTIPID.

Module Power could be improved

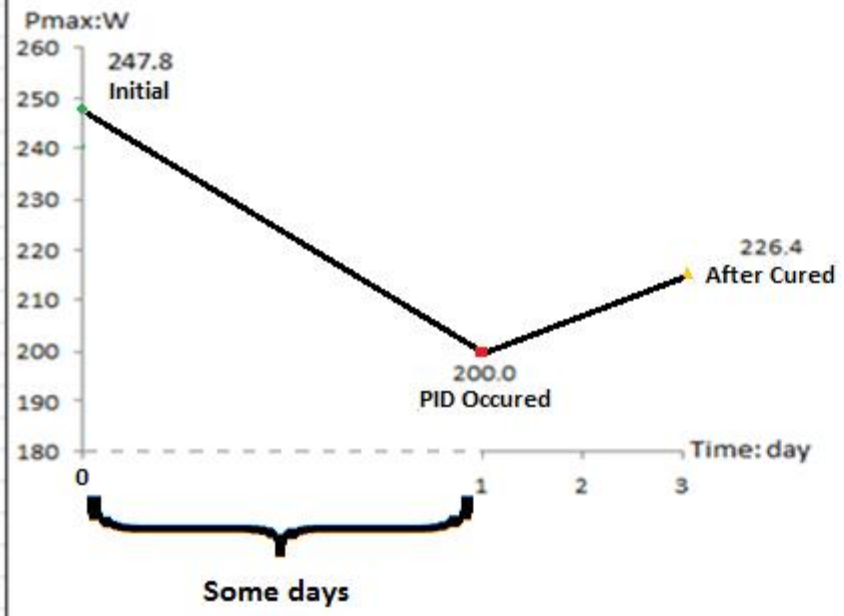


Experientially, if the power of the module has decreased to 30%, it could be improved to about 80%. If the power of the module has decreased to 70%, it could be improved up to more than 90%. The temperature is required larger than 10℃ and the humidity is required larger than 60%.

Remedying result of ANTIPID.

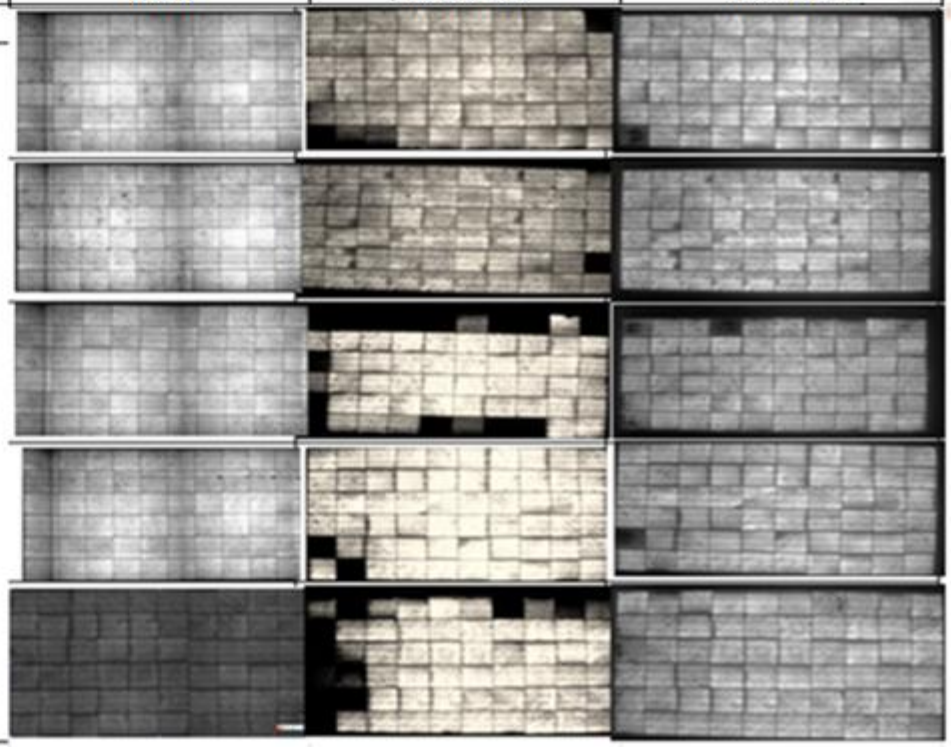
After 3 days remedied by ANTIPID, panel power improved to more than 30%.

Average power(5pcs modules)(W)		
Initial	PID Occured	After Cured
247.8	200.0	226.4



EL Pictures

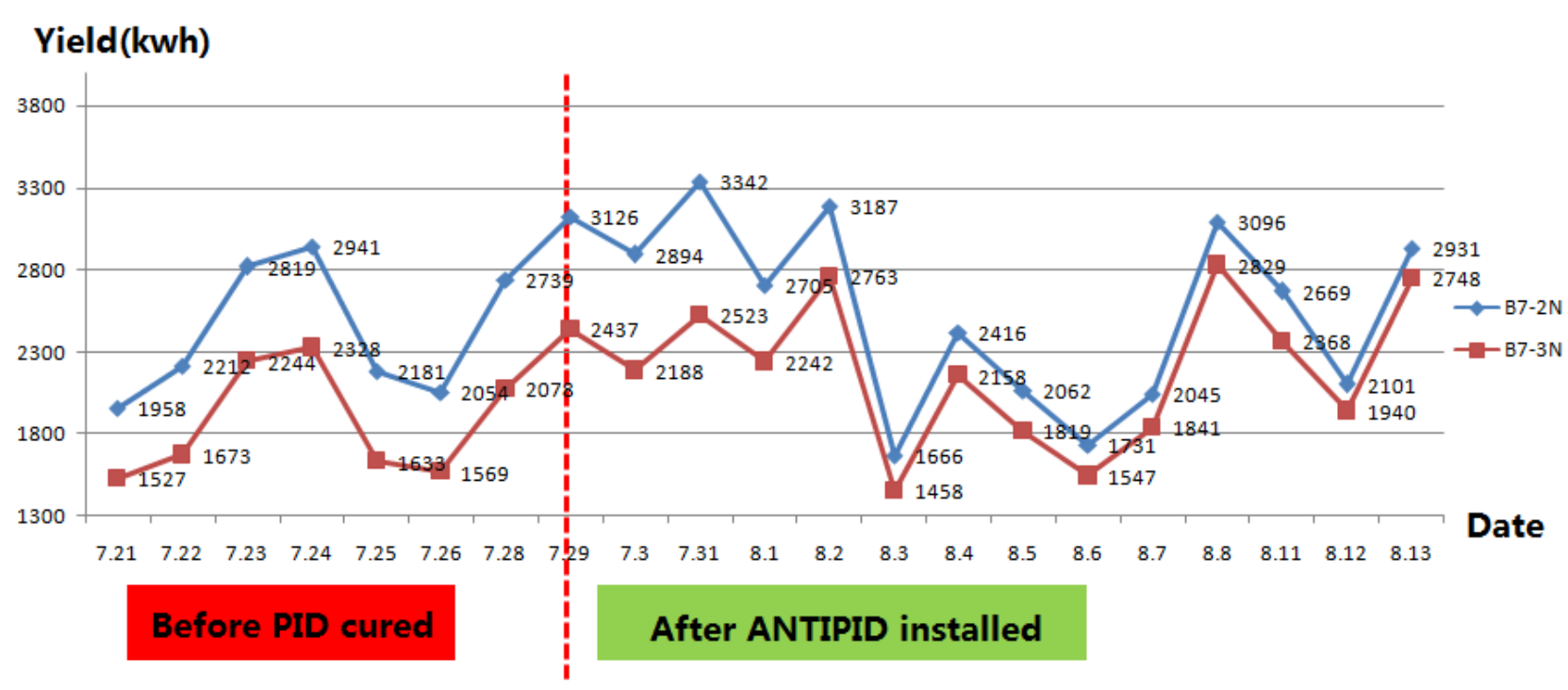
Initial	PID Occured	After Cured



Remedying result of ANTIPID.

Production could be improved.

The power production ratio of B7-3N (with ANTIPID) and B7-2N (without ANTIPID) is improved from 77% to 94%, about 14%!



If 1MW solar plant could produce 1100000KWH every year, the power could improve at least 110000KWH every year.

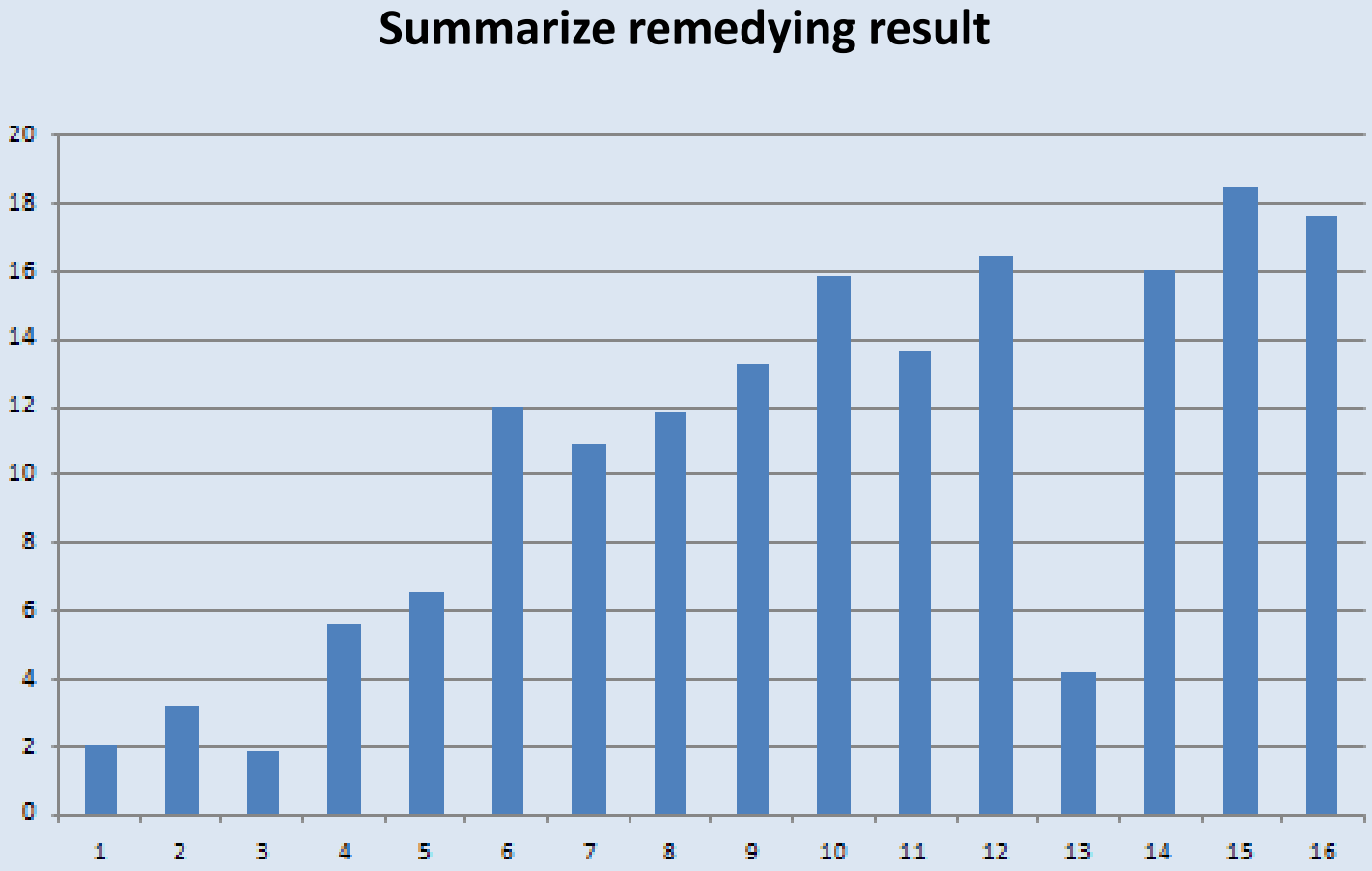
Remedying result of ANTIPID.

Typical Reference of Yield Improving

Project region	Capacity (MW)	Annual Yield (MKWH)	Annual yield after PID cured (MKWH)	Improving (%)
China · Jiangsu	20	24	26.88	12.2%
India · Gujarat	20	32	33.92	6%
Japan · Kumamoto	2.5	2.25	2.4525	9%
Korea · Pusan	10	10	10.85	8.5%
Germany · Leipzig	1	0.8	0.904	13%

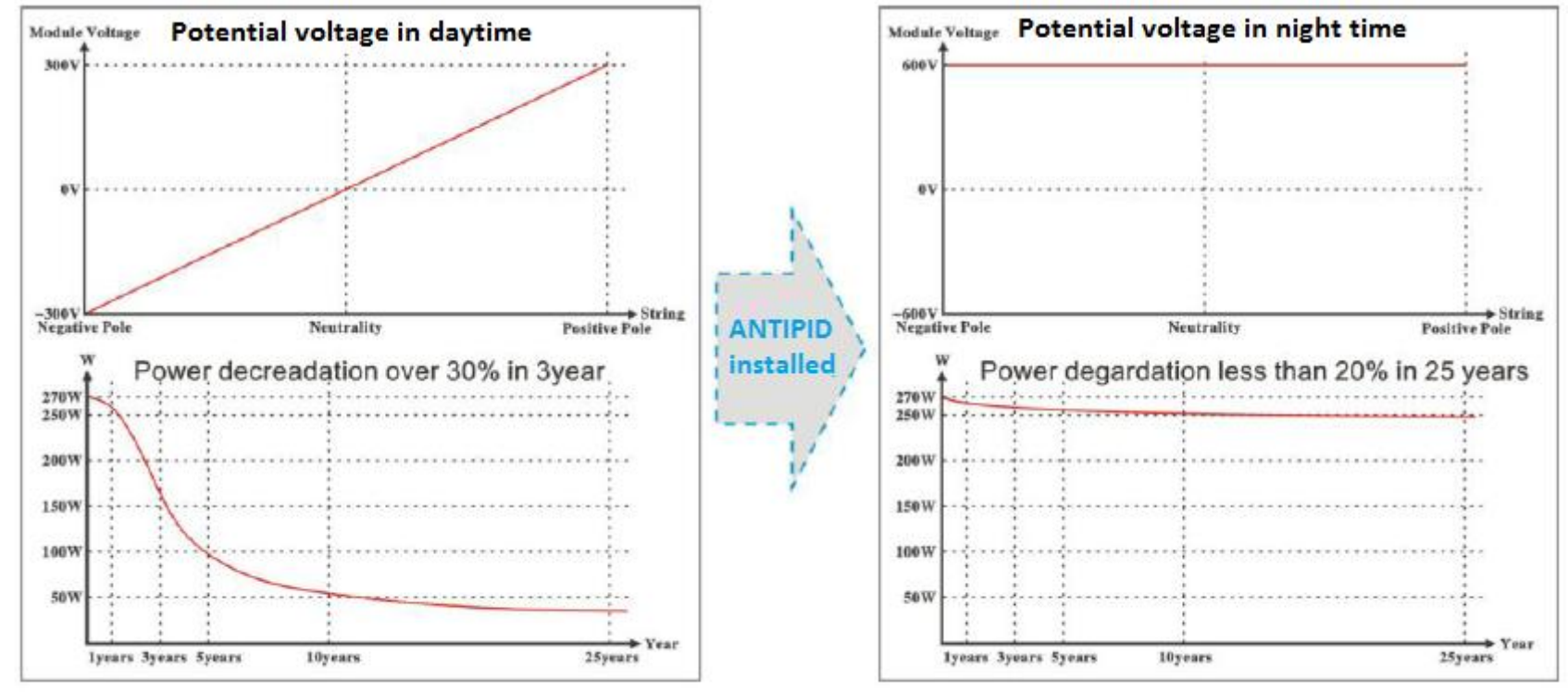
Remedying result of ANTIPID.

Collect the data of 16 solar plants. The best improving rate is 18.4% and the average is 10.56%.

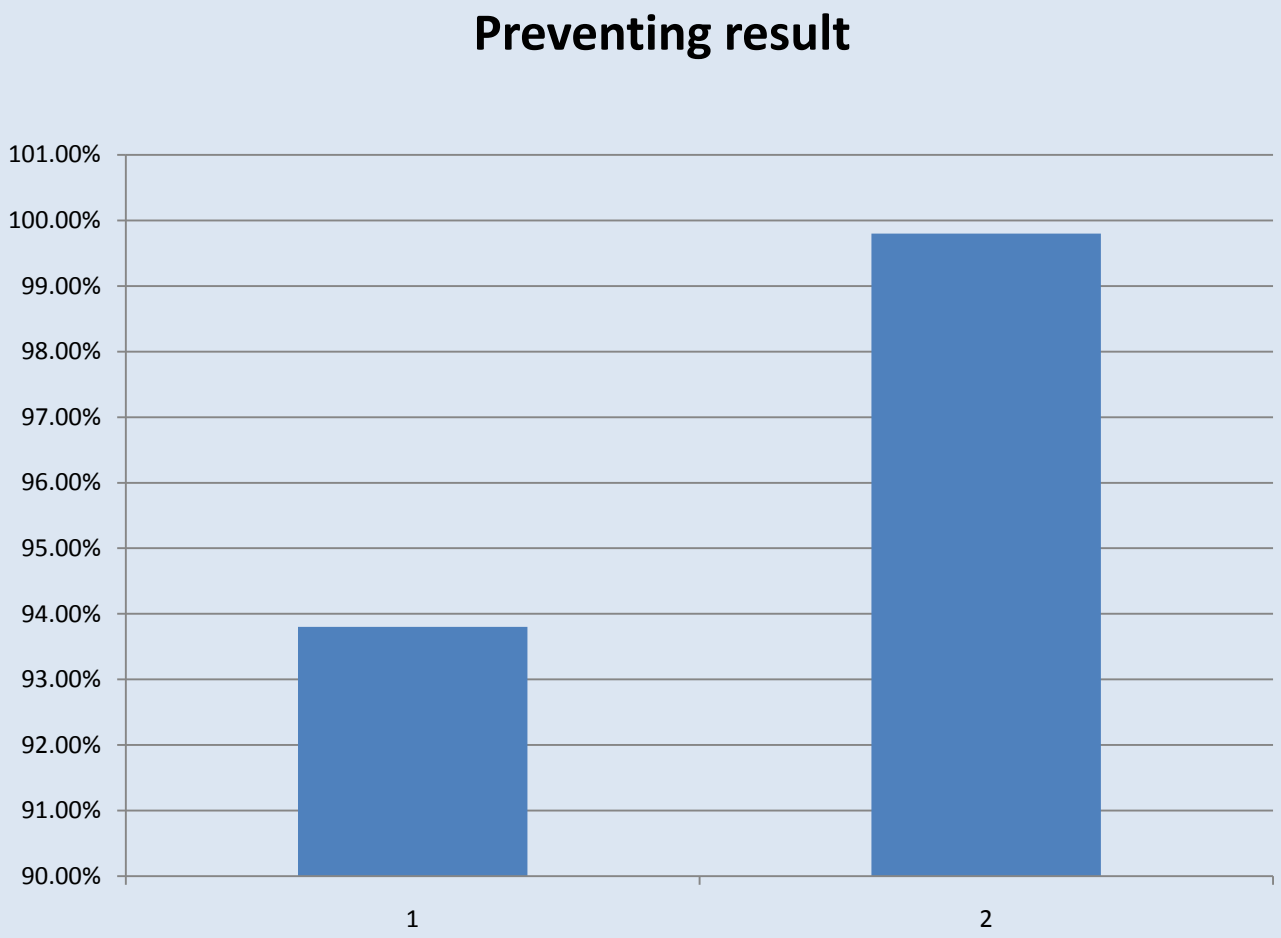


Preventing result of ANTIPID.

If there is no ANTIPID in the plant, the power of the module maybe decrease more than 70% in 3 years. If ANTIPID is applied from the beginning, PID could be prevented completely. The degradation will be less than 20% in 25 years.



Preventing result of ANTIPID.



The 2# inverter was installed with ANTIPID from the beginning and there is no ANTIPID on 1# inverter. After one year, the yield of 1# inverter decrease more 6% than that of 2#.

Summarize

- ✓ PID is an unavoidable trouble in solar plant. As the running time grown, PID trouble become worse and worse.
- ✓ Applying RV at night has advantages compared with NDG, NIG, NVG, isolating modules and the ground.
- ✓ Applying voltage between PV- and the ground has advantages compared with applying voltage series connecting, applying voltage between PV+ and the ground.
- ✓ ANTIPID has 1 invention patent, 2 utility model patents, 3 software copyrights, 1 trademark, a CE certification and an ISO9001 certification.
- ✓ ANTIPID has been widely used in 1GW solar plant in the world and compatible well with almost all kinds of famous brand inverters in the world. It fits for all kinds of inverter structure.
- ✓ ANTIPID could improve the voltage of solar module up to 100% of initial value.
- ✓ ANTIPID could improve the power of solar module up to more than 90% of the initial value.
- ✓ ANTIPID could significantly improve the yield of solar plant, and increase profit of solar plant owner.
- ✓ ANTIPID could prevent PID trouble from the beginning.
- ✓ ANTIPID is the most professional device to remedy and prevent PID of solar plant.

Hope to have a good cooperation with you!

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