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Huawei Smart PV Community

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Huawei Smart I-V Curve Diagnosis Tool

Difficulties in Yield Improvement During Daily Maintenance







Solution ? Huawei Smart I-V Curve Diagnosis Function

Item	Huawei String	Central
Solution	Automatic	Manual
Qty. of strings	272	276
Sampling rate	100%	13% (Only 36 strings tested, 3 per DC Box, 12 DC boxes in total)
Preparations and Preforming the I-V curve	 One person to take about 5 mins to connect the computer, and then upload the I-V curve license to SUN2000 inverters One click to start, and it took about 6 mins (for all 272 strings) to complete the scan and receive the comprehensive reports. 	 Two skilled electricians to disconnect and measure PV string one by one. It will take about 8 mins per string. During the process, they sometimes had to stop the test instrument to cool it due the over-heat. Finally, it cost two skilled electricians 288mins (=36 strings*8mins/string) to check only 36 strings
Results	Immediately generated: 0.7% (2/272, abnormal strings were found and the detailed report has been automatically generated.)	Pending on further analysis: Wait for experts to analysis the I-V curve scan data after the tests.



Global Application: Improve O&M efficiency and increase yield







Address: Asia	
Scale: 12MW	
Number: 46080 panels	
Area: 0.16 sq.km	
Grid connect time: 30/6/2016	
Diagnosis string:	1888
Diode short circuit string:	34
Diode short circuit ratio:	1.8 %
String Yield Loss Estimated:	~1.4%
Security: Panel reliability is a	ffected



Smart I-V Curve Diagnosis

ltems	Automatic	Manual Manual	Huawei Advantage
	< 1s for one scan but twice for one strings	< 5s for one scan	
Scan Speed	<10s for one inverter (4 MPPT)	< 1min for one inverter	
	~15min for 100 MW	~2 days for 1MW	More Professional: Accuracy
Scan Resolution	128points	120points	
Scan Accuracy	Voltage/Current ≤0.5%	Voltage/Current ≤1%	
Scan Convenient	Online Operation	Field Operation	
Scan Consistency	More than 200 strings at the same time	String by string at different time	More Convenient: Online
Scan Footprint	All samples	Partial samples	
Analysis & Report	Automatic Analysis and Report	Analysis by Technician	More Intelligent: Automatic
Energy Loss	≈0kWh	100MW Plant, 5% Sampling, 5~7Days Required, >1000kWh lost	More Economic: Less Yields Loss



Smart I-V Curve Diagnosis can Analyze 14+ Faults



No.	Fault	Sort the possible causes of failure	No.	Fault	Sort the possible causes of failure
1	PV string open circuit	PV string breakage/PV string configured by mistake	8	Missing configurations of PV strings	Check whether string information is configured in the system
2	Current mismatch in the PV string	Shade/dust/PV module current inconsistent	9	Excessively lw irradiance	The solar radiation is insufficient (Analyzed the data by HW inverter send)
3	Abnormal PV module output current	Shade/glass breakage/hidden crack	10	Slight current mismatch in the PV string	Dust/slight shade/glass breakage
4	Abnormal PV string voltage	Diode short circuit/PV module invalid/PV module quantity incorrect	11	Excessively low PV string parallel resistance	PID degradation/dust/uneven PV module irradiance
5	Low PV string short-circuit current	Abnormal orientation/dust/PV module degradation	12	Excessively high PV string series resistance	high cable resistance/abnormal internal resistance of the PV module
6	Low PV string power	Abnormal orientation/dust/PV module degradation	13	Abnormal curve near MPP in the PV string	Hotspot/hidden crack/glass breakage
7	No string connected	Check whether PV strings are connected to the inverter	14	Scanning data invalid	Irradiation cause



Fault Impact on Plant Yield

Fault Type	Impact on Yield	DC security risk	Possibility of occurrence
PV string open circuit	100% for each string	The risk of electric shock is in O&M	High
Current mismatch in string (Dust)	3-30% for each string	Severe blockage causes hotspot risks on panels and affects panels reliability within the life cycle	High
Abnormal PV module output current(Breakage)	5% for each string	Energy yield loss, panels reliability risks, and personal safety O&M risk	Very High
Current mismatch in string (Shade)	1-5% for each string	Same with the dust	Very High
Slight current mismatch in string (Slight shade)	1-4% for each string	Maybe there is dust, shade or other problems	Very High
String connection reverse	0.5-0.7% for each string	The risk of electric shock is in O&M	Very Low
Low PV string power(PV module degradation)	3-7% for the whole plant	Panel reliability is affected within the life cycle	Inevitable
Abnormal PV string voltage(Diode short circuit)	1.4% for each string	Panel reliability is affected within the life cycle	High
Abnormal PV string voltage(PV module invalid)	0.5-0.7% for each string	The string information may not be configured successfully in system	Very Low
Low PV string power(Abnormal orientation)	0.5-0.7% for each string	Inherent problems in PV plant design and cause energy yield loss	Very Low
Excessively low PV string parallel resistance(PID)	5-50% for the whole plant	Affecting the service life of the panels.	High Temperature and Humidity Scenario
Abnormal curve near MPP(Hotspot)	0.01% for each panel hotspot	In severe cases, panels are burnt, causing insulation deterioration, accelerating aging, and prolonging the service life of panels	Very High
Excessively high PV string series resistance(High cable resistance)	0.5-5% for the whole plant	There is a fire risk caused by DC arcing.	Low
Abnormal PV module output current(Hidden crack)	Uncertain	The panel causes hot spot risks, and reliability is affected within the life cycle.	Very High
			👐 HUAWEI

Smart I-V Curve Activation Procedure



Diagnosis Requirement:

- The cleaning status of the PV modules in one subarray in one diagnosis task must be consistent.
- The irradiance during the diagnosis must be at least 600
 W/m² (minimum irradiance requirement); otherwise, the system terminates the diagnosis automatically.

Diagnosis suggestions:

- You are advised to clean the PV modules before the diagnosis to ensure that the test data reflects the actual status of the PV modules.
- 2. You are advised to perform the diagnosis between 11:00 and 13:00 to avoid shading.



Smart I-V Curve Diagnosis of an Inverter on NetEco

	TI	D -4-11-	
Roan	I no	LIGIAILS	
I COUL		Lo Cala II S	

60KTL(COM1-1)-PV6

Version	∨100	Task time	2017-11-13 16:26:30
Inverter SN	21010735286TGB900003	Inverter version	SUN2000
Ratted capacity of inverter	60kW	Accumulated yield	9613.72KWH
Fill Factor(FF)	0.6039	Degradation Rate	NA
String Voc	1201.4V	String Isc	6.054A
String Vm	937.1V	String Pm	4392.1877Wp



Strings

Export



			10 N 2	110	Test Da	ta							STC Conv	ersion				
omparisc	NO.	Defective type V	Inverter V	String	Voc[V]	Isc[A]	FF	Vm[V]	Im[A]	Vm/Vox	Im/Isc	Pm[Wp]	Pm[Wp]	Voc[V]	Isc[A]	FF	Vmp[V]	Imp[A]
	.1	Alarm02	SUN2000_404	PV1		-	×.	124-3	-	1.00			-	- 87		-	3.40	2.0
	2	Alarm02	SUN2000_404	PV3	-		2	1222	-	-	-		20	- 2	-	-		-
	3	Alarm02	SUN2000_404	PV5	1.5	1.72	10	070	3	0.75		15		23	6	- 52	1000	1.5
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	10	Alarm02	SUN2000_405	PV6	-	-	-	620	-	<u></u>	-	-	-	-	-	-	20	-
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-				100100								010 0000	or or or or				
Description	Detective type	Inverter	ter String	Voc[V]	Isc[A]	FF	Vm[V]	lm[A]	Vm/Voc	Im/Isc	Pm[Wp]	Pm[Wp]	Voc[V]	Isc[A]	FF	Vmp[V]	Imp[A]
best string	Normal	SUN2000_4	PV2	793.90	6.19	0.75	674.80	5.47	0.85	0.88	3692.51	6829.38	918.72	9.53	0.78	773.82	8.83
Medium string	Normal	SUN2000_4	PV4	793.50	5.97	0.75	674.50	5.26	0.85	0.88	3545.85	6560.43	919.76	9.19	0.78	773.14	8.49
Average	1	126	3523	793.67	6.06	0.75	674.63	5.35	0.85	0.88	3608.70	6675.70	919.31	9.34	0.78	773.43	8.63



Smart I-V Curve Report Fault Impact on Plant Yield





Smart I-V Curve Report Overview



Failure Types Ratio

2. Fault Type Analysis

In total, 24 SmartLoggers are scanned in this task, 1149 PV strings are faulty. The distribution is as follows: The common faults are:

1) PV module output current abnormal (shade/glass breakage/hidden crack), Percentage:52.9%

- 2) Current mismatch in the PV string (shade/dust/PV module current inconsistent), Percentage:19.1%
- 3) PV string open circuit (PV string breakage/PV string configured by mistake), Percentage:18.4%

First 3 common faults vs. total faults:90.4%



Failure	Ratio	Cause
PV module output current abnormal	52.9%	Shade, glass breakage or hidden crack
Current mismatch in the PV string	19.1%	Shade, dust or PV module current inconsistent
PV string open circuit	18.4%	PV string breakage or PV string configured by mistake
Abnormal curve near MPP in the PV string	7.6%	Hotspot, hidden crack or glass breakage
PV string voltage abnormal	2.0%	diode short circuit, PV module invalid or PV module quantity incorrect



Smart I-V Curve Test in Asia: Diagnosis & O&M Report





Legend	Quantity	Terenhage	Description
Married 2	370	H. B.	77 string samel
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Transing 18	1	0.38	General curve none 107 in the 77 storing [hateput/hidden setab/glass brokings]



Diagnosis report
Total 3960 strings are
scanned
188 Fault strings are found
Fault rate : <mark>4.7%</mark>

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Plant Scale: 50MW

Plant Location: Asia

Plant Introduction: Mountain, complex terrain, and difficult O&M

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Smart I-V Curve Test in Asia: Diagnosis & O&M Report





Always Available for Highest Yields



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