TEST REPORT
IEC 61727 2nd ed.
Photovoltaic (PV) systems –
Characteristics of the Utility interface

Report Reference No. .... :	140327083GZU-007
Tested by (name + signature) .... :	Jason Fu
Approved by (name + signature)...... :	Tommy Zhong
Date of issue .... :	30 May 2014
Number of pages	20 pages

Testing Laboratory .... :	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address .... :	Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Testing location / procedure .... :	CBTL ☐ SMT ☐ TMP ☐ TL ☒
Testing location / address .... :	Same as above
Applicant's name .... :	Shenzhen SOFARSOLAR Co., Ltd.
Address .... :	3A-1, Huake Building, East Technology Park, Qiaoxiang Road, Nanshan District, Shenzhen, China

Test specification:

Standard .... :	IEC 61727 2nd ed. 2004-12
Test procedure .... :	Type test for Denmark
Non-standard test method ....:	N/A
Test Report Form No. .... :	IEC61727_2ed_a
TRRF Originator .... :	Intertek
Master TRRF .... :	Dated 2010-08

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Test item description .... :	Grid-connected PV inverter
Trade Mark .... :	SOFAR SOLAR
Manufacturer .... :	Same as applicant
Model/Type reference .... :	Sofar 20000TL-Sx, Sofar 17000TL-Sx, Sofar 15000TL-Sx (x=0-6)

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Ratings DC input................................:	Maximum d.c. input voltage: 1000 V
	Input voltage rang: 250-960 V
	Max. input current: 2×24 A (for Sofar 20000TL-Sx); 2×21 A (for Sofar 17000TL-Sx, Sofar 15000TL-Sx);
	Max. PV Isc: 2×30 A (for Sofar 20000TL-Sx); 2×27 A (for Sofar 17000TL-Sx, Sofar 15000TL-Sx);
Ratings AC Output.............................: ....:	Nominal output voltage: 3/N/PE230V/400V
	Max. output current: 3×29 A (for Sofar 20000TL-Sx); 3×25 A (for Sofar 17000TL-Sx); 3×22 A (for Sofar 15000TL-Sx);
	Nominal frequency: 50 Hz
	Max. output power: 20000 W (for Sofar 20000TL-Sx); 17000 W (for Sofar 17000TL-Sx); 15000 W (for Sofar 15000TL-Sx)
	Ingress protection: IP65
	Operating temperature range: -25～60℃
Software version ....:	V 1.00

Copy of marking plate:

Solar Inverter   **Sofar 20000TL–S3**

Max. DC Input Voltage	1000V
Operating MPPT voltage range	250-960V
Max.Input Current	2*24A
Max. PV Isc	2*30A
Nominal Grid Voltage	3/N/PE,230/400V
Max.Output Currrent	3*29A
Nominal Grid Frequency	50Hz
Max.Output Power	20000W
Power factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25-+60°C
Protective Class	Class I

Manufacturer: shenzhen SOFARSOLAR Co.,Ltd

Made in China

VDE-AR-N4105,RD1699,VDE0126-1-1,G59/3,UTE C15-712-1, C10/11,IEC62116, IEC61727

SC1ES320E39001

Summary of testing:

4.4 DC injection

4.6 Harmonic and waveform distortion

4.7 Power factor

5.2.1 Over/under voltage

5.2.2 Over/under frequency

Test item particulars .... :	
Classification of installation and use .... :	PD III
Supply Connection .... :	TN
.... :	
.... :	

Possible test case verdicts:	
- test case does not apply to the test object .... :	N/A
- test object does meet the requirement .... :	P(Pass)
- test object does not meet the requirement .... :	F(Fail)

Testing... :	
Date of receipt of test item .... :	27 Mar 2014
Date (s) of performance of tests .... :	27 Mar 2014 – 09 May 2014

General remarks:

This report is not valid as a CB Test Report

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"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.

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General product information:

1. Product covered by this report is non-isolated grid-connected PV inverter for connection with low voltage grid.
2. The inverters intended to operate at ambient temperature -25℃ - +60℃ and 250-960 Vdc input, which will be specified in the user manual; The inverters will output full power when operated at 45℃. If operated at higher than 45℃ temperature, the output power derating.

For all models, if the DC input voltage is higher than 850 Vdc the output power will be derating.
For model Sofar 20000TL-Sx, if the DC input voltage is lower than 430 Vdc, the output power will be derating.
For model Sofar 17000TL-Sx, if the DC input voltage is lower than 420 Vdc, the output power will be derating.
For model Sofar 15000TL-Sx, if the DC input voltage is lower than 370 Vdc, the output power will be derating.
For all models, if the AC output voltage is lower than 230 Vac the output current will be limited to not higher than rated output current.

Model difference:

All the models have identical mechanical and electrical construction except some componnents and some parameter of the software architecture in order to control the max output power. And refer to the following table for detail.

Model	DC Cable Gland	PV connector	DC inside connector	Fuse PCB+ String detection board	DC surge arrester	DC switch	AC switch	AC surge arrester
Sofar 20000TL-S0 Sofar 17000TL-S0 Sofar 15000TL-S0	√		√					
Sofar 20000TL-S1 Sofar 17000TL-S1 Sofar 15000TL-S1	√		√			√		
Sofar 20000TL-S2 Sofar 17000TL-S2 Sofar 15000TL-S2		√	√			√		
Sofar 20000TL-S3 Sofar 17000TL-S3 Sofar 15000TL-S3		√		√		√		
Sofar 20000TL-S4 Sofar 17000TL-S4 Sofar 15000TL-S4		√		√	√	√		
Sofar 20000TL-S5 Sofar 17000TL-S5 Sofar 15000TL-S5		√		√	√	√		√
Sofar 20000TL-S6 Sofar 17000TL-S6 Sofar 15000TL-S6		√		√	√	√	√	√
√ denote incorporating this component								

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Model Sofar 17000TL-Sx similar to Sofar 20000TL-Sx except amount of the DC-link capacitors, different of input and output sampling resistors and different inductance of Boost, invert inductor.

Model Sofar 15000TL-Sx similar to Sofar 17000TL-Sx except amount of the DC-link capacitors, different inductance of Boost, invert inductor and less PV input circuits (including PV terminal, fuse and sampling circuits of fuse).

Model Sofar 20000TL-Sx and Sofar 17000TL-Sx have equipped two external fans.

Model Sofar 15000TL-Sx has equipped one external fan

Unless other special note, the model Sofar 20000TL-S6 selected as representative sample for testing in this report.

Factory information:
Factory: Dongguan dingqiang Machinery & Electric Co., Ltd.

Address: No. 8, Fulong road, Qingxi town, Dongguan city, Guangdong, China

Software setting as following:

Different country can be set on switch SWT3 on communication board, digit "0" represents OFF, digit "1" represents ON

SWITCH 5	SWITCH 4	SWITCH 3	SWITCH 2	SWITCH 1	Country
0	0	1	0	1	Denmark

Clause	Requirement – Test	Result – Remark	Verdict
	IEC 61727:2004		
4	**Utility compatibility**		P
4.1	Rated Utility voltage (V) ....:	3/N/PE230V/400V	P
	Nature of supply...:	3/N/PE230V/400V	P
	Rated frequency (Hz)..:	50Hz	P
	Rated power (W)...:	See markings	P
	Rated current (A) ....:	See markings	P
4.1	**Voltage, current and frequency**		P
4.1	Utility-interconnected Voltage range (V)..................:		P
4.3	**Flicker**		P
	The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC61000-3-3 for systems rated less than 16A		N/A
	The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC61000-3-5 for systems rated more than 16A		P
4.4	**DC injection**		P
	The PV system shall not inject DC current greater than 1% of the rated inverter output current, into the utility AC interface under any operating condition	(see appended table)	P
4.5	**Normal frequency operating range**		P
	The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in §5.2.2	(see appended table) According to requirements of different national codes	P
4.6	**Harmonics and wave form distortion**		P
	The PV system output should have low current-distortion level to ensure that no adverse effects are caused to other equipment connected to the utility system	(see appended table)	P
	THD shall be less than 5% at rated output. Each individual shall be limited to the percentage listed in table 1		P
	Even harmonics in these ranges shall be less than 25% of the lower odd harmonic limits listed		P
4.7	**Power factor**		P

Clause	Requirement – Test	Result – Remark	Verdict
	The PV system shall have a lagging power factor greater than 0.9 when the output is greater than 50% of the rated inverter output power	(see appended table)	P
	Specially designed systems that provide reactive power compensation may operate outside of the limit with utility approval		P
5	**Personnel safety and equipment protection**		P
	The PV system should operate safe and proper		P
	The protection function may be provided as and internal or external device in the system		P
	IEC60364-5-55 or national codes may be applicable		P
5.1	**Loss of Utility**		P
	to prevent islanding, a utility connected PV system shall cease to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified limits	Considered in IEC 62116	P
	A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to a fault condition or the distribution line switched out during maintenance.		P
	If inverters (single or multiple) have DC-SELV input and have accumulated power below 1kW then no mechanical disconnect (relay) is required		N/A
5.2	**Over / under voltage and frequency**		P
	Abnormal conditions can arise on the utility system that require a response from the connected photovoltaic system. This response is to ensure the safety of the utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system		P
5.2.1	**Over / Under voltage**		P
	When the interface voltage deviates outside the conditions specified in table 2, the photovoltaic system shall cease to energize the utility distribution system. this applies to any phase of a multiphase system	(see appended table)	P
	All discussions regarding system voltage refer to the local nominal voltage		P
5.2.2	**Over / Under frequency**		P

Clause	Requirement – Test	Result – Remark	Verdict
	When the utility frequency deviates outside the specific conditions the photovoltaic system shall cease to energize the utility line. When the utility frequency is outside the range of ±1Hz, the system shall cease to energize the utility line within 0.2 s.	(see appended table)	P
5.3	**Islanding protection**		P
	The PV system must cease to energize the utility line within 2 s of loss utility	Considered in IEC 62116	P
5.4	**Response to Utility recovery**		P
	Following an out-of-range utility condition that caused the photovoltaic system to cease energizing, the photovoltaic system shall not energize the utility line for 20 s to 5 min after the utility service voltage and frequency have recovered to within the specified ranges		P
5.5	**Earthing**		N/A
	The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712		N/A
5.6	**Short circuit protection**		N/A
	The photovoltaic system shall have short-circuit protection in accordance with IEC60364-7-712	This short-circuit protection will be considered at the connection to the AC mains	N/A
5.7	**Isolation switching**		N/A
	A method of isolation and switching shall be provided in accordance with IEC 60364-7-712	Should consider in the end use.	N/A

Appendix 1: Test tables

4.4	DC injection	
Rated output load (W)		20000
Rated output current (Arms)		29A/phase
Measured DC current (A)		R: 9.3mA S: 10.6mA T: 17.9mA
DC injection current (%)		R: 0.032% S: 0.037% T: 0.062%
Limit: DC injection current is not greater than 1 % of the rated inverter output current.		

4.3	TABLE: Voltage Fluctuations and Flicker				P
	dc (%)	Dmax (%)	Running		
Limit	3.3	4.0	Pst = 1.0	Plt =0.65	
Test value	1.18	1.30	0.086	0.196	

4.6	Harmonics and wave form distortion			P
Watts		20.02kW		
Vrms		230.28V		
Arms		R: 28.86 S:28.84 T:28.87		
PF		0.9999		
Frequency		50.0Hz		
Harmonics	Harmonic current % of Fundamental			Harmonic Current Limits (%)
	Phase R	Phase S	Phase T	
1st	--	--	--	
2nd	0.125	0.100	0.113	1.0%
3rd	0.085	0.153	0.065	4.0%
4th	0.083	0.070	0.089	1.0%

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Appendix 1: Test tables

5th	0.522	0.554	0.486	4.0%
6th	0.005	0.020	0.018	1.0%
7th	0.619	0.551	0.589	4.0%
8th	0.040	0.045	0.048	1.0%
9th	0.012	0.024	0.044	4.0%
10th	0.025	0.021	0.024	0.5%
11th	0.195	0.194	0.202	2.0%
12th	0.007	0.003	0.006	0.5%
13th	0.174	0.139	0.161	2.0%
14th	0.010	0.008	0.016	0.5%
15th	0.021	0.026	0.040	2.0%
16th	0.005	0.011	0.007	0.5%
17th	0.142	0.143	0.157	1.5%
18th	0.002	0.009	0.008	0.5%
19th	0.124	0.105	0.131	1.5%
20th	0.013	0.011	0.011	0.5%
21st	0.009	0.027	0.027	1.5%
22nd	0.007	0.007	0.001	0.5%
23rd	0.106	0.110	0.128	0.6%
24th	0.008	0.008	0.004	0.5%
25th	0.126	0.104	0.120	0.6%
26th	0.007	0.003	0.006	0.5%
27th	0.004	0.022	0.024	0.6%
28th	0.002	0.003	0.003	0.5%
29th	0.092	0.091	0.114	0.6%
30th	0.005	0.007	0.011	0.5%
31st	0.097	0.083	0.096	0.6%
32nd	0.007	0.010	0.006	0.5%
33rd	0.008	0.032	0.023	0.6%
Note:				

Appendix 1: Test tables

4.7	TABLE: Power Factor								P
Output Power (%)	50	60	70	80	90	100			
Output Power Test Value (KW)	3.329	3.997	4.666	5.331	6.000	6.647			
	3.331	3.997	4.663	5.331	5.994	6.644			
	3.338	4.007	4.675	5.342	6.013	6.659			
Vrms (V)	230.1	230.1	230.3	230.4	229.7	230.1			
	230.2	230.2	230.3	230.4	229.7	230.1			
	230.2	230.2	230.3	230.3	229.7	230.0			
Arms (A)	14.621	17.547	20.457	23.363	26.379	29.168			
	14.628	17.550	20.444	23.367	26.369	29.168			
	14.653	17.587	20.496	23.418	26.441	29.232			
Output Power test value (kVA)	3.365	4.038	4.711	5.383	6.059	6.711			
	3.367	4.040	4.709	5.385	6.056	6.711			
	3.373	4.048	4.721	5.394	6.073	6.725			
Power factor Limit lagging	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90			
Power factor	0.9895	0.9898	0.9934	0.9904	0.9902	0.9904			
	0.9894	0.9896	0.9901	0.9901	0.9898	0.9900			
	0.9897	0.9899	0.9903	0.9904	0.9901	0.9903			
Note:									

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Appendix 1: Test tables

5.2.1	TABLE: Over / Under Voltage						P
deviation	Voltage(V)	Measured Tripp Voltage		Maximum trip time	Minimum operate time	Measured trip time	Remark
230V+13%	260	ALL	260.0	0.2s	0.1s	0.180s	P
		R	259.9			0.185s	
		S	259.9			0.186s	
		T	260.0			0.187s	
230V+10%	253	ALL	252.7	40s	39s	39.035s	P
		R	252.8			39.037s	
		S	252.7			39.027s	
		T	252.7			39.029s	
230V-10%	207	ALL	206.7	10s	9s	9.62s	P
		R	206.5			9.64s	
		S	206.7			9.62s	
		T	206.6			9.62	

5.2.2	TABLE: Over / Under frequency trip time					P
deviation	Frequency(Hz)	Maximum trip time	Minimum trip time	Measured trip time		Remark
Over frequency	52.00Hz	0.2s	0.1s	0.182s		P
Under Frequency	47.50Hz	0.2s	0.1s	0.169s		P

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Appendix 2: Photos

Overall view of the unit

Bottom view of the unit

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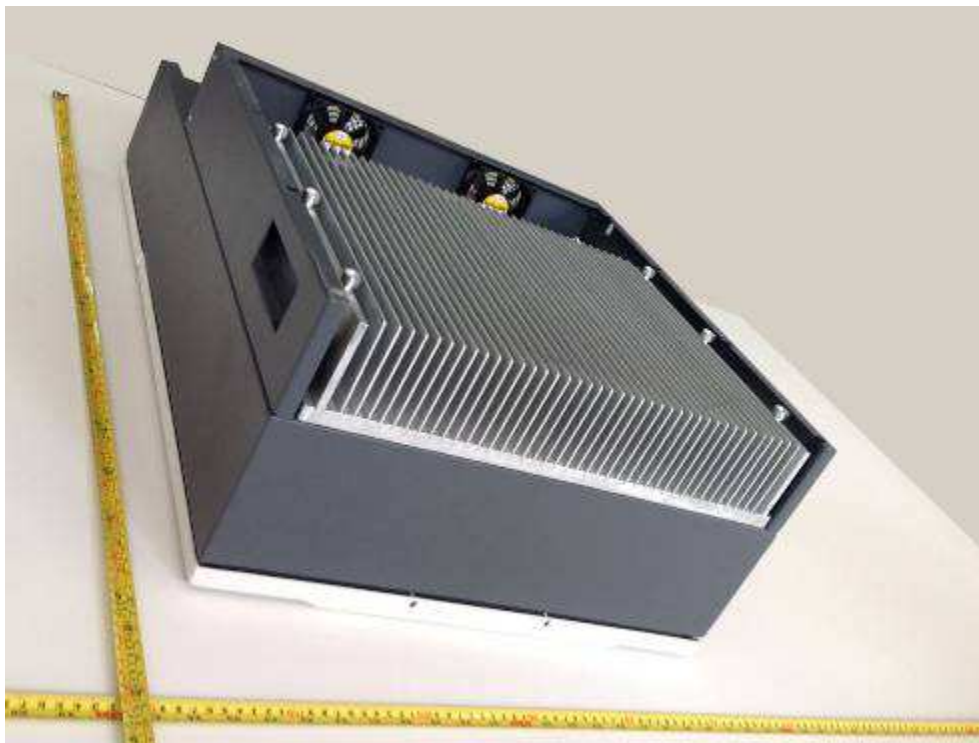
Appendix 2: Photos

PV connector (Sofar 20000TL-Sx and Sofar 17000TL-Sx has 3×2 pairs)
(Sofar 15000TL-Sx and Sofar 10000TL-Sx has 2×2 pairs)

Terminals view of the unit (for models "-S2" to "-S6")

Terminals view of the unit (without AC switch)

Appendix 2: Photos

Terminals view of the unit for model Sofar 10000TL-Sx

DC Cable Gland

Terminals view of the unit (for models "-S0" to "-S1")

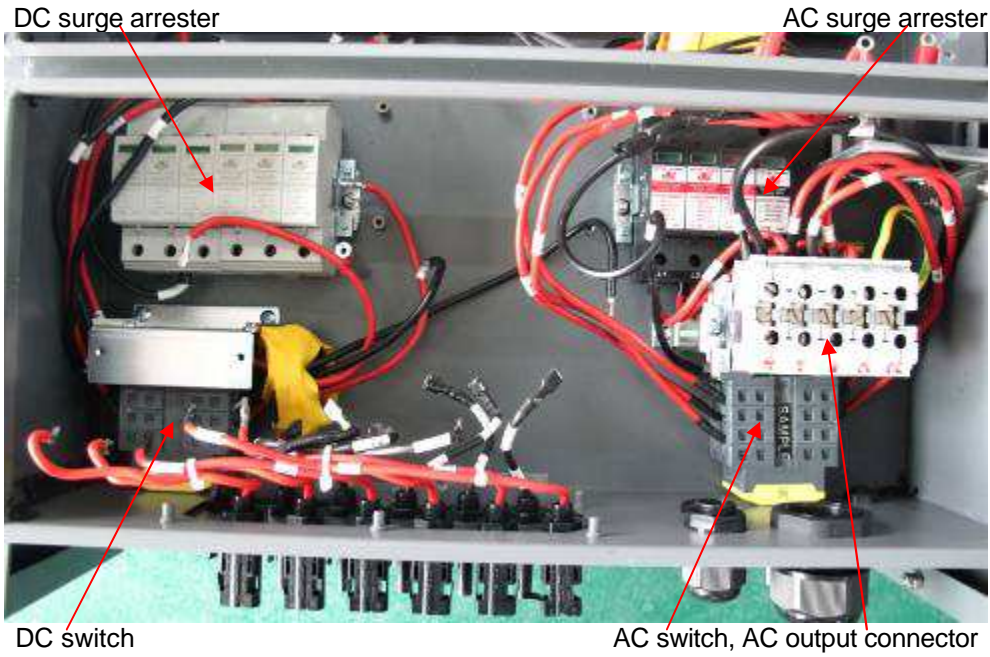Code: IEC61727_a / Effective Date: 18 Nov 2011

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Appendix 2: Photos

Internal view of the unit

Internal view of the unit

Appendix 2: Photos

DC surge arrester   AC surge arrester

DC switch   AC switch, AC output connector

Internal view of the unit

DC inside connector   AC output connector

Internal view of the unit

Appendix 2: Photos

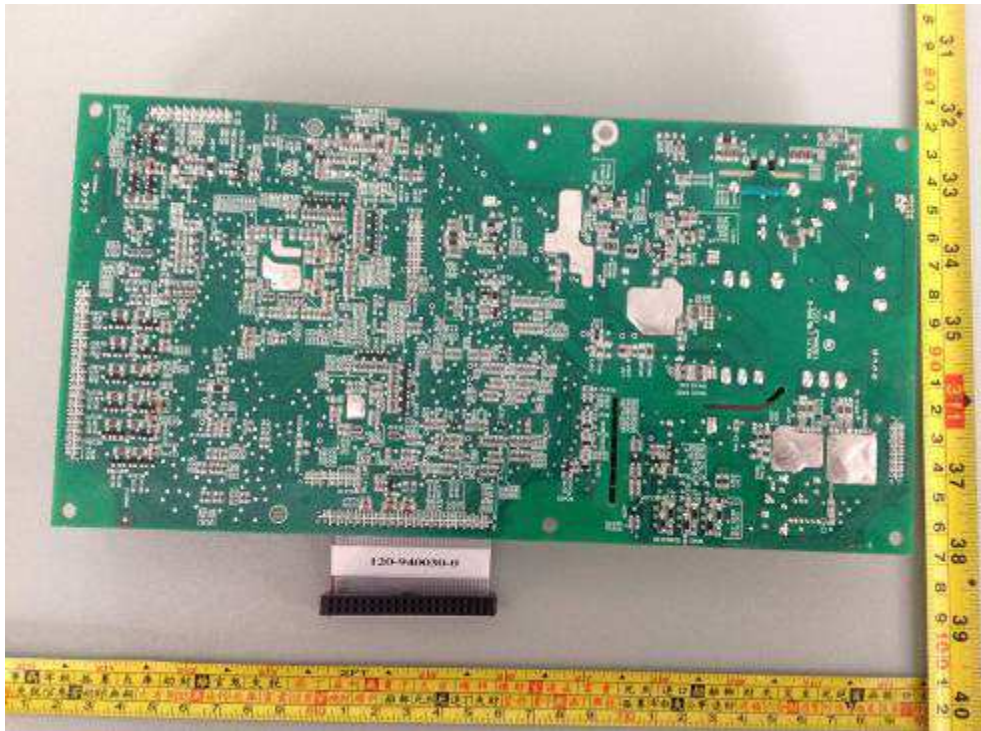Input board, Control board, Output board
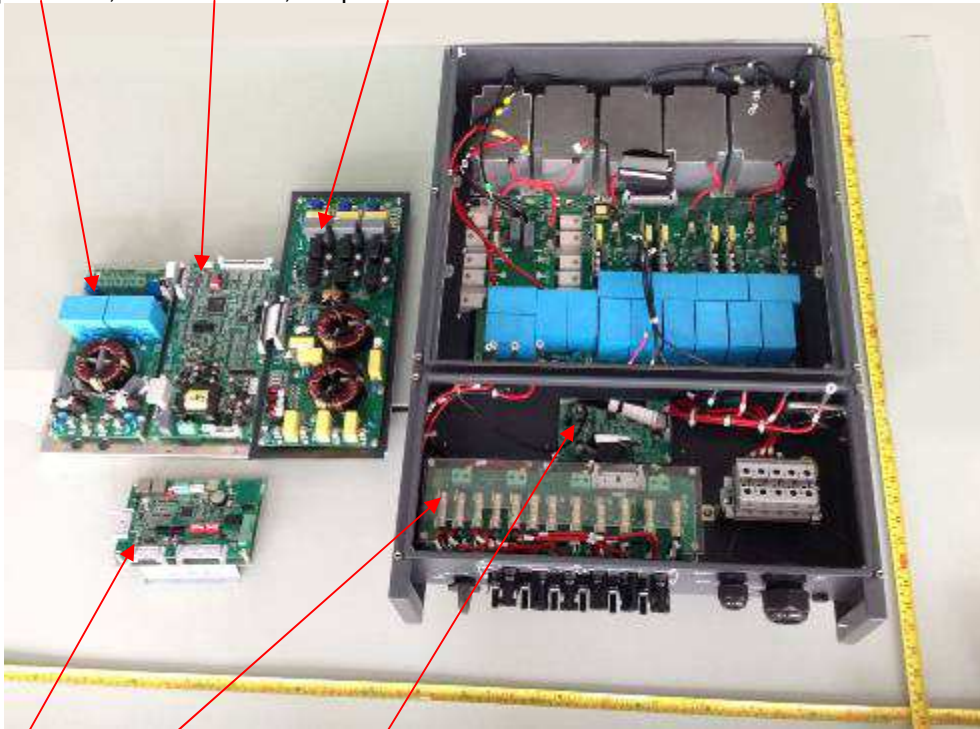
COM board, Fuse board, String detection board
Internal view of the unit

Front view of the control board

Appendix 2: Photos

Bottom view of the control board