



**BUREAU
VERITAS**

Certificate of compliance

Applicant: Shenzhen SOFARSOLAR Co., Ltd.
3A-1, Huake Building, East Technology Park
Qiaoxiang Road, Nanshan District, Shenzhen
China

Product: Grid-tied photovoltaic (PV) inverter

Model: SOFAR 4000TLM
SOFAR 4600TLM
SOFAR 5000TLM

Use in accordance with regulations:

Automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G59/3 for photovoltaic systems with a single-phase parallel coupling via an inverter in the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter. This serves as a replacement for the disconnection device with isolating function that can access the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G59/3:2013

Recommendation for the Connection of Generating Plant to the Distribution Systems of licensed Distribution Network Operators.

DIN V VDE V 0126-1-1:2006-02 (Functional safety)

Automatic disconnection device between a generator and the public low-voltage grid

The SOFAR 4000TLM, SOFAR 4600TLM and SOFAR 5000TLM are rated >16A per phase and ≤ or 17kW (1 phase). The default values for "Small Power Stations" on the low-voltage grid were verified.

At the time of issue of this certificate the safety concept of an aforementioned representative product corresponds to the valid safety specifications for the specified use in accordance with regulations.

Report number: PVUK140609N058-1-G59/3

Certificate number: U14-0504

Date of issue: 2014-09-26

Certification body

Dieter Zitzmann



Deutsche
Akkreditierungsstelle
D-ZE-12024-01-01

Certification body of Bureau Veritas Consumer Products Services Germany GmbH
Accredited according to EN 45011 - ISO / IEC Guide 65

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. PVUK140609N058-1

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G59/3.

Manufacturer / applicant:	Shenzhen SOFARSOLAR Co., Ltd. 3A-1, Huake Building, East Technology Park Qiaoxiang Road, Nanshan District, Shenzhen China		
Generating Unit technology	Grid-tied photovoltaic inverter		
Rated values	SOFAR 4000TLM	SOFAR 4600TLM	SOFAR 5000TLM
Maximum rated capacity	4,00 kVA	4,60 kVA	5,00 kVA
Rated voltage	230V	230V	230V
Firmware version	V1.00		
Measurement period:	2014-06-09 to 2014-09-18		

Description of the structure of the power generation unit (Figure 1):

The power generation unit is equipped with a PV and line-side EMC filter. The power generation unit has no galvanic isolation between DC input and AC output. Output switch-off is performed with single-fault tolerance based on two series-connected relays in line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

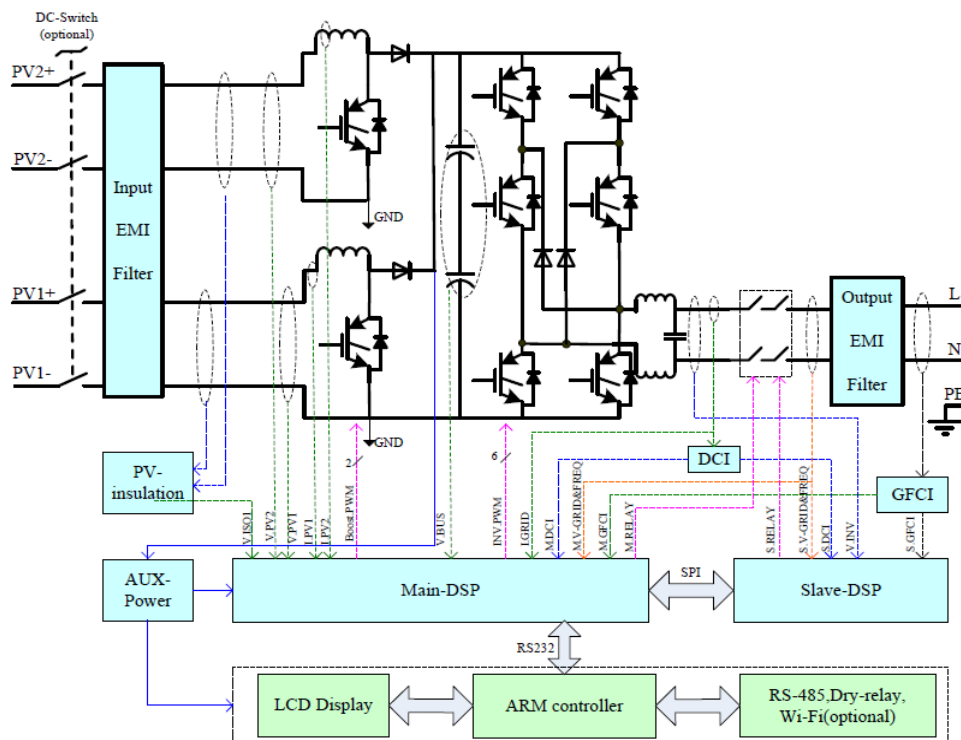


Figure 1 – Schematic structure of the power generation unit

Differences between Generating Units:

The models SOFAR 4000TLM, SOFAR 4600TLM and SOFAR 5000TLM differ in size of the performance-related components (Sine filter, EMC filter, power semiconductor, machine transformer).

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G59/3. Any modification that affects the stated tests must be named by the manufacturer/supplier of the product to ensure that the product meets all requirements of the Engineering Recommendation G59/3.

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. PVUK140609N058-1

Protection. Voltage tests.						
230V grid						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	200,1V	2,5s	201,2V	2,540s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	185,2V	0,533s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	261,7V	1,031s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	273,2V	0,517s	269,7V 0,98s	No trip
					277,7V 0,48s	No trip

Note. For Voltage tests the Voltage required to trip is the setting $\pm 3,45V$. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting $\pm 4V$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Protection. Voltage tests.						
240V grid						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	208,8V	2,5s	210,3V	2,530s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	193,4V	0,516s	196V / 2,48s	No trip
					188V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	273,5V	1,006s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	285,0V	0,520s	281,6V 0,98s	No trip
					289,6V 0,48s	No trip

Note. For Voltage tests the Voltage required to trip is the setting $\pm 3,45V$. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting $\pm 4V$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3 Nr. PVUK140609N058-1

Protection. Frequency tests.						
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20s	47,50Hz	20,034s	47,7Hz / 25s	No trip
U/F stage 2	47Hz	0,5s	47,00Hz	0,584s	47,2Hz / 19,98s	No trip
					46,8Hz / 0,48s	No trip
O/F stage 1	51,5Hz	90s	51,50Hz	90,055s	51,3Hz / 95s	No trip
O/F stage 2	52Hz	0,5s	52,00Hz	0,590s	51,8Hz / 89,98s	No trip
					52,2Hz / 0,48s	No trip

Note. For Frequency Trip tests the Frequency required to trip is the setting $\pm 0,1$ Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The "No-trip tests" need to be carried out at the setting $\pm 0,2$ Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Protection. Loss of Mains.						
BS EN 62116						
SOFAR 4000TLM						
Balancing load on islanded network	33% of -5% Q Test 22	66% of -5% Q Test 12	100% of -5% P Test 5	33% of +5% Q Test 31	66% of +5% Q Test 21	100% of +5% P Test 10
Trip time. Ph1 fuse removed	221ms	218ms	233ms	205ms	186ms	240ms
SOFAR 5000TLM						
Balancing load on islanded network	33% of -5% Q Test 22	66% of -5% Q Test 12	100% of -5% P Test 5	33% of +5% Q Test 31	66% of +5% Q Test 21	100% of +5% P Test 10
Trip time. Ph1 fuse removed	241ms	267ms	245ms	241ms	197ms	242ms

Note for technologies which have a substantial shut down time this can be added to the 0,5 seconds in establishing that the trip occurred in less than 0,5s. Maximum shut down time could therefore be up to 1,0 seconds for these technologies.

Indicate additional shut down time included in above results. (Integrated interface switch)	Type of switching equipment 1: Relay with 20ms Type of switching equipment 2: Relay with 20ms
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Appendix 13.1 Type Testing a Generating Unit

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Nr. PVUK140609N058-1

Protection. Re-connection timer.				
Test should prove that the reconnection sequence starts in no less than 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 10.5.7.1.				
Voltage				
Time delay setting		Measured delay		
20s		79s		
Frequency				
Time delay setting		Measured delay		
20s		80s		
230V grid				
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 196,1V	At 47,4Hz	At 51,6Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection
240V grid				
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 277,6V	At 204,8V	At 47,4Hz	At 51,6Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Protection. Frequency change, Stability test.				
	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49,5Hz	+9 degrees		No trip
Negative Vector Shift	50,5Hz	- 9 degrees		No trip
Positive Frequency drift	49,5Hz	+0,19Hz/sec	51,5Hz	No trip
Negative Frequency drift	50,5Hz	-0,19Hz/sec	47,5Hz	No trip

Appendix 13.1 Type Testing a Generating Unit

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Nr. PVUK140609N058-1

Power Quality. Harmonics.						
SOFAR 4000TLM						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 2,0 kW		100% of rated output 4,0 kW			
Harmonic	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,019	0,19	0,029	0,16	8%	8%
3rd	0,166	1,70	0,262	1,50	21,6%	N/A
4th	0,015	0,15	0,030	0,17	4%	4%
5th	0,043	0,44	0,066	0,38	10,7%	10,7%
6th	0,009	0,10	0,025	0,14	2,67%	2,67%
7th	0,041	0,42	0,048	0,27	7,2%	7,2%
8th	0,007	0,07	0,013	0,07	2%	2%
9th	0,043	0,44	0,044	0,25	3,8%	N/A
10th	0,007	0,08	0,024	0,14	1,6%	1,6%
11th	0,045	0,46	0,076	0,44	3,1%	3,1%
12th	0,007	0,07	0,018	0,10	1,33%	1,33%
13th	0,045	0,47	0,057	0,33	2%	2%
14th	0,006	0,06	0,014	0,08	N/A	N/A
15th	0,043	0,44	0,040	0,23	N/A	N/A
16th	0,005	0,05	0,018	0,10	N/A	N/A
17th	0,038	0,39	0,055	0,31	N/A	N/A
18th	0,004	0,05	0,010	0,06	N/A	N/A
19th	0,034	0,35	0,047	0,27	N/A	N/A
20th	0,005	0,05	0,012	0,07	N/A	N/A
21th	0,030	0,31	0,032	0,18	N/A	N/A
22th	0,004	0,04	0,011	0,06	N/A	N/A
23th	0,025	0,25	0,030	0,17	N/A	N/A
24th	0,003	0,03	0,008	0,05	N/A	N/A
25th	0,021	0,22	0,030	0,17	N/A	N/A
26th	0,003	0,03	0,013	0,08	N/A	N/A
27th	0,017	0,17	0,024	0,14	N/A	N/A
28th	0,003	0,03	0,007	0,04	N/A	N/A
29th	0,014	0,15	0,018	0,10	N/A	N/A
30th	0,003	0,03	0,009	0,05	N/A	N/A
31th	0,012	0,12	0,015	0,09	N/A	N/A
32th	0,003	0,03	0,008	0,05	N/A	N/A
33th	0,010	0,10	0,010	0,06	N/A	N/A
34th	0,003	0,03	0,005	0,03	N/A	N/A
35th	0,009	0,09	0,008	0,05	N/A	N/A
36th	0,002	0,03	0,007	0,04	N/A	N/A
37th	0,008	0,08	0,009	0,05	N/A	N/A
38th	0,002	0,02	0,005	0,03	N/A	N/A
39th	0,007	0,07	0,006	0,03	N/A	N/A
40th	0,002	0,02	0,005	0,03	N/A	N/A
THD ₄₀	0,23%		0,10%		23%	13%
PWHD	0,41%		0,17%		23%	22%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. PVUK140609N058-1

Power Quality. Harmonics.						
SOFAR 5000TLM						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 2,5 kW		100% of rated output 5,0 kW			
Harmonic	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	Limit in BS EN61000-3-12 in %	
					1 phase	3 phase
2nd	0,025	0,21	0,050	0,23	8%	8%
3rd	0,179	1,50	0,287	1,34	21,6%	N/A
4th	0,018	0,15	0,041	0,19	4%	4%
5th	0,049	0,41	0,074	0,34	10,7%	10,7%
6th	0,012	0,10	0,029	0,14	2,67%	2,67%
7th	0,048	0,40	0,057	0,26	7,2%	7,2%
8th	0,009	0,08	0,022	0,10	2%	2%
9th	0,048	0,40	0,051	0,24	3,8%	N/A
10th	0,008	0,07	0,034	0,16	1,6%	1,6%
11th	0,051	0,42	0,089	0,42	3,1%	3,1%
12th	0,008	0,07	0,021	0,10	1,33%	1,33%
13th	0,055	0,46	0,072	0,33	2%	2%
14th	0,007	0,06	0,017	0,08	N/A	N/A
15th	0,052	0,43	0,047	0,22	N/A	N/A
16th	0,007	0,06	0,018	0,08	N/A	N/A
17th	0,047	0,39	0,065	0,30	N/A	N/A
18th	0,006	0,05	0,011	0,05	N/A	N/A
19th	0,042	0,35	0,065	0,30	N/A	N/A
20th	0,006	0,05	0,017	0,08	N/A	N/A
21th	0,039	0,32	0,040	0,19	N/A	N/A
22th	0,006	0,05	0,011	0,05	N/A	N/A
23th	0,035	0,29	0,041	0,19	N/A	N/A
24th	0,007	0,05	0,014	0,06	N/A	N/A
25th	0,030	0,25	0,043	0,20	N/A	N/A
26th	0,005	0,04	0,014	0,07	N/A	N/A
27th	0,027	0,22	0,029	0,14	N/A	N/A
28th	0,004	0,04	0,009	0,04	N/A	N/A
29th	0,021	0,17	0,025	0,12	N/A	N/A
30th	0,005	0,04	0,016	0,07	N/A	N/A
31th	0,019	0,16	0,025	0,12	N/A	N/A
32th	0,004	0,03	0,015	0,07	N/A	N/A
33th	0,018	0,15	0,018	0,08	N/A	N/A
34th	0,004	0,03	0,012	0,05	N/A	N/A
35th	0,014	0,12	0,016	0,08	N/A	N/A
36th	0,006	0,05	0,012	0,06	N/A	N/A
37th	0,012	0,10	0,016	0,07	N/A	N/A
38th	0,004	0,03	0,008	0,04	N/A	N/A
39th	0,011	0,09	0,011	0,05	N/A	N/A
40th	0,004	0,03	0,008	0,04	N/A	N/A
THD ₄₀	0,17%		0,08%		23%	13%
PWHD	0,37%		0,15%		23%	22%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. PVUK140609N058-1

Power Quality. Power factor.				
230V grid				
SOFAR 4000TLM				
	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.
Measured value	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	
SOFAR 5000TLM				
	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.
Measured value	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	
240V grid				
SOFAR 4000TLM				
	225,6V	240V	264V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.
Measured value	0,999	0,999	0,998	
Limit	>0,95	>0,95	>0,95	
SOFAR 5000TLM				
	225,6V	240V	264V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.
Measured value	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. PVUK140609N058-1

Power Quality. Voltage fluctuation and Flicker.								
SOFAR 4000TLM								
	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	0,27	0,14	0,00	0,27	0,14	0,00	0,26	0,26
Normalised to standard impedance	0,27	0,14	0,00	0,27	0,14	0,00	0,26	0,26
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65
SOFAR 5000TLM								
	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	0,10	0,08	0,00	0,10	0,08	0,00	0,13	0,13
Normalised to standard impedance	0,10	0,08	0,00	0,10	0,08	0,00	0,13	0,13
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65
Test impedance	R	0,24* 0,4^		Ω	XI		0,15* 0,25	Ω
Standard impedance	R	0,24* 0,4^		Ω	XI		0,15* 0,25^	Ω

Power Quality. DC injection.			
Test level power	10%	55%	100%
SOFAR 4000TLM			
Recorded value	24,4 mA	26,2 mA	26,5 mA
As % of rated AC current	0,14 %	0,15 %	0,15 %
Limit	0,25 %	0,25 %	0,25 %
SOFAR 5000TLM			
Recorded value	26,0 mA	29,7 mA	33,6 mA
As % of rated AC current	0,12 %	0,14 %	0,15 %
Limit	0,25%	0,25%	0,25%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. PVUK140609N058-1

Fault level Contribution.					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	40,2	22,2
Initial Value of aperiodic current	A	N/A	100ms	31,4	22,6
Initial symmetrical short-circuit current*	I_k	N/A	250ms	30,0	22,7
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	29,4	22,7
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,545	In seconds

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the Generating Unit terminals.
* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.

Self Monitoring – Solid state switching.	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the Generating Unit, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
Note. Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open.	