







<p>TEST REPORT IEC 62116 Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters</p>	
Report Number	2217 / 1094 – 1 – M2(*)
(*)This is a co-report of the report 2217 / 1094 – 1– M1, for detailed information refer to page 8.	
Date of issue	18 / 06 / 2019
Total number of pages.....	14
Name of Testing Laboratory preparing the Report.....	SGS Tecnos, S.A. (Electrical Testing Laboratory)
Applicant's name.....	EVOLVE ENERGY GROUP CO., LIMITED
Address	RM 702, 7/F FU FAI COMM CTR 27 HILLIER ST SHEUNG WAN, HK
Test specification:	
Standard	IEC/EN 62116: 2014 (Second Edition)
Test procedure	Characteristic Examination
Non-standard test method	N/A
Test Report Form No.	IEC62116A
Test Report Form(s) Originator	TÜV SÜD Product Service GmbH
Master TRF.....	Dated 2014-10
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General disclaimer:	
<p>The test results presented in this report relate only to the object tested. This report shall not be reproduced, except in full, without the written approval of the Issuing CB Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.</p>	

Test item description..:	Solar Grid-tied Inverter
Trade Mark.....:	
Manufacturer	EVOLVE ENERGY GROUP CO., LIMITED
Model/Type reference .:	EVVO 6000TLG2
Ratings	DC input: 90-580V, 11/11A. AC output: 230V, 50Hz, 27.3A, 6000VA Serial Number: ZG1ES060H61001 Firmware version: V0.22

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
<input type="checkbox"/>	CB Testing Laboratory:	
Testing location/ address.....:		
<input type="checkbox"/>	Associated CB Testing Laboratory:	
Testing location/ address.....:		
Tested by (name, function, signature).....:		
Approved by (name, function, signature)....:		
<input checked="" type="checkbox"/>	Testing procedure: TMP/CTF Stage 1:	Shenzhen SOFAR SOLAR Co., Ltd.
Testing location/ address.....:		5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China
Tested by (name, function, signature).....:		Roger Hu (Project Engineer) 
Approved by (name, function, signature.....):		Jacobo Tevar (Technical Reviewer)  
<input type="checkbox"/>	Testing procedure: WMT/CTF Stage 2:	
Testing location/ address.....:		
Tested by (name, function, signature).....:		
Witnessed by (name, function, signature) ..:		
Approved by (name, function, signature)....:		
<input type="checkbox"/>	Testing procedure: SMT/CTF Stage 3 or 4:	
Testing location/ address.....:		
Tested by (name, function, signature).....:		
Witnessed by (name, function, signature) ..:		
Approved by (name, function, signature)....:		
Supervised by (name, function, signature):		

50 Hz		
Attachment #	Description	Pages
Attachment I	Pictures of the EUT and Electrical Schemes	12 pages
Attachment II	Graphics of the Test Results	3 pages
Attachment III	Graphics of the Islanding Behavior Detection	18 pages
Attachment IV	Testing Information	4 pages


Summary of testing:

<p>Tests performed (name of test and test clause):</p> <p>All clauses except:</p> <ul style="list-style-type: none"> - Sub-clause d) of the Table 5 of the point 6.1. Voltage and frequency trips shall be adjusted according to National Standards and/or local codes. <p>From the result of inspection and tests performed on the submitted sample we conclude that it complies with the requirements of the Standard.</p> <p>This report is a first issuance for a co-license based on report number 2217 / 1094 – 1– M1, See further information in page 8.</p>	<p>Testing location:</p> <p>Shenzhen SOFAR SOLAR Co., Ltd. 5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China</p>
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Summary of compliance with National Differences:

No National Differences are addressed to this test report

Copy of marking plate (representative):

EVVO Solar Grid-tied Inverter	
Model No:	EVVO 6000TLG2
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90~580V
Max. Input Current	2x11A
Max. PV Isc	2x13.2A
Nominal Grid Voltage	230V
Max. Output Current	27.3A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	6000W
Max. Output Power	6000VA
Power Factor	1 (adjustable +/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~ +60°C
Protection Class	Class I
Inverter Topology	Non-Isolated
Factory - Shenzhen China	
Manufacturer : EVOLVE ENERGY GROUP CO., LIMITED	
Address : RM 702, 7/F FU FAI COMM CTR 27 HILLIER ST SHEUNG WAN, HK	
Global Head Quarters	
371 Sidco Industrial Estate	
Chennai 600098 India	
VDE0126-1-1, G99, EN50438, AS4777, IEC62116, IEC61727	
	

Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation
3. Labels of other models are as the same with EVVO 6000TLG2's except the parameters of rating.

Test item particulars	: Single Phase Inverter
Classification of installation and use	: Fixed(permanent connection)
Supply Connection	: DC; PV
.....	: AC; Grid connection
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	: CTF Stage 1 procedure
Date of receipt of test item	: N/A
Date (s) of performance of tests	: From 05/11/2017 to 06/11/2017

General remarks:	
<p>"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report.</p> <p>This document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at www.sgs.com/terms_and_conditions.htm and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at www.sgs.com/terms_e-document.htm. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.</p> <p>Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.</p>	
Manufacturer's Declaration per sub-clause 4.2.5 of IECCE 02:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided :	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> Not applicable
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies) :	Dongguan SOFAR SOLAR Co., Ltd. 1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China.

General product information:

Product covered by this report is grid-connected PV inverter for indoor or outdoor installation. The connection to the DC input and AC output are through connectors. The structure of the unit complied with the IP 65 requirement.

The inverters intended to operate at ambient temperature -25°C - +60°C, which will be specified in the user manual, however, the inverters will output full power when operated at 45°C, if operated at higher than 45°C temperature, the output power would be derate.

The Solar inverter converts DC voltage into AC voltage.

The input and output are protected by varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and a two relays. This assures that the opening of the output circuit can operate in case of one error.

The units are single phase inverter

Equipment Under Testing:

- EVVO 6000TLG2

Variant models:

- EVVO 5000TLG2
- EVVO 4600TLG2
- EVVO 4000TLG2
- EVVO 3600TLG2
- EVVO 3000TLG2

Product Model	EVVO 3000TL G2	EVVO 3600TL G2	EVVO 4000TL G2	EVVO 4600TL G2	EVVO 5000TL G2	EVVO 6000TL G2
Input (DC)						
Max.DC Input Power	3500W	4000W	4400W	5000W	5500W	6600W
Max.DC Voltage	600V					
Power Turn on	80V					
Start-up input voltage	120V					
Rated input voltage	360V					
MPPT Voltage Range	90-580V					
Full load DC voltage range	160-520V	180-520V	200-520V	230-520V	250-520V	300-520V
MAX input current per MPPT	11A/11A					
Number of DC inputs	2/2					
Output(AC)						
Max AC Output power	3000VA	3680VA	4000VA	4600VA	5000VA	6000VA
Max AC Output power (PF=1)	3000W	3680W	4000W	4600W	5000W	6000W
Max AC Output Current	13.7A	16.8A	18.2A	21A	22.8A	27.3A
Nominal Grid Voltage	230Vac(Single phase)					
Nominal Frequency	50Hz					
Power factor	1(adjustable+/-0.9)					

Topology	Transformerless
Operating temperature range	-25-60°C
Degree of protection	IP65

The variants models have been included in this test report without tests because the following features don't change regarding to the tested model:

- Same connection system and hardware topology
- Same control algorithm.
- Output power within 2.5 and 2/3 of the EUT or Modular inverters
- Same Firmware Version

The report nº 2217/1094-1-M1 was modified based on Report No. 2217 / 1094 – 1 with following points:

1. Modified the Applicant address from:
 5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China
 to
 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen City, Guangdong Province, P.R. China

2. Modified the Factory name and address from:
 Shenzhen SOFARSOLAR Co., Ltd.
 5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China
 to
 Dongguan SOFAR SOLAR Co., Ltd.
 1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China.

The report nº 2217 / 1094 – 1 – M2 is a co-report based on Report No. 2217 / 1094 – 1 – M1.

The report is issued including the co-license for EVOLVE ENERGY GROUP CO., LIMITED.
 Models are the same as appearing in the base reports with different denomination and trademark. Editorial changes have been included to change the applicant and trademark references.

IEC 62116			
Clause	Requirement + Test	Result - Remark	Verdict
4	Testing circuit		
	The testing circuit shown in Figure 1 is employed.		P
	Similar circuits are used for three-phase output.		N/A
	Parameters to be measured are shown in Table 1 and Figure 1. Parameters to be recorded in the test report are discussed in Clause 7.		P
5	Testing equipment		
5.1	Measuring instruments		
	The waveform measurement/capture device is able to record the waveform from the beginning of the islanding test until the EUT ceases to energize the island.	DL 850 oscillograph equipped with memory function Waveform caught from the switch open and the EUT cease to energize	P
	For multi-phase EUT, all phases are monitored.		N/A
	A waveform monitor designed to detect and calculate the run-on time may be used.	See Annex IV for testing equipment information	P
	For multi-phase EUT, the test and measurement equipment is recorded each phase current and each phase-to-neutral or phase-to-phase voltage, as appropriate, to determine fundamental frequency active and reactive power flow over the duration of the test.		N/A
	A sampling rate of 10 kHz or higher is recommended. The minimum measurement accuracy is 1 % or less of rated EUT nominal output voltage and 1 % or less of rated EUT output current	Less than 1% of the rated EUT output current	P
	Current, active power, and reactive power measurements through switch S1 used to determine the circuit balance conditions report the fundamental (50 Hz or 60 Hz) component.		P
5.2	DC power source		
5.2.1	General		
	A PV array or PV array simulator (preferred) may be used. If the EUT can operate in utility-interconnected mode from a storage battery, a DC power source may be used in lieu of a battery as long as the DC power source is not the limiting device as far as the maximum EUT input current is concerned.	Chroma PV simulator used	P
	The DC power source provides voltage and current necessary to meet the testing requirements described in Clause 6.		P
5.2.2	PV array simulator		
	The tests are conducted at the input voltage defined in Table 2 below, and the current is limited to 1,5 times the rated photovoltaic input current, except when specified otherwise by the test requirements.		P
	A PV array simulator is recommended, however, any type of power source may be used if it does not influence the test results.		P
5.2.3	Current and voltage limited DC power supply with series resistance		
			N/A

IEC 62116													
Clause	Requirement + Test	Result - Remark	Verdict										
	A DC power source used as the EUT input source is capable of EUT maximum input power (so as to achieve EUT maximum output power) at minimum and maximum EUT input operating voltage.		N/A										
	The power source provides adjustable current and voltage limit, set to provide the desired short circuit current and open circuit voltage when combined with the series and shunt resistance described below.		N/A										
	<p>A series resistance (and, optionally, a shunt resistance) is selected to provide a fill factor within the range:</p> <p>Output power: Sufficient to provide maximum EUT output power and other levels specified by test conditions of table 5.</p> <p>Response speed: The response time of a simulator to a step in output voltage, due to a 5% load change, results in a settling of the output current to within 10% of its final value in less than 1ms.</p> <p>Stability: Excluding the variations caused by the EUT MPPT, simulator output power remains stable within 2 % of specified power level over the duration of the test: from the point where load balance is achieved until the island condition is cleared or the allowable run-on time is exceeded.</p> <p>Power factor: 0.25 to 0.8</p>		N/A										
5.2.4	PV array		N/A										
	A PV array used as the EUT input source is capable of EUT maximum input power at minimum and maximum EUT input operating voltage.		N/A										
	Testing is limited to times when the irradiance varies by no more than 2 % over the duration of the test as measured by a silicon-type pyranometer or reference device. It may be necessary to adjust the array configuration to achieve the input voltage and power levels prescribed in 6.1.		N/A										
5.3	AC power source												
	<p>The utility grid or other AC power source may be used as long as it meets the conditions specified in Table 4.</p> <p style="text-align: center;">Table 4 – AC power source requirements</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Items</th> <th style="text-align: center;">Conditions</th> </tr> </thead> <tbody> <tr> <td>Voltage</td> <td>Nominal $\pm 2,0$ %</td> </tr> <tr> <td>Voltage THD</td> <td>< 2,5 %</td> </tr> <tr> <td>Frequency</td> <td>Nominal $\pm 0,1$ Hz</td> </tr> <tr> <td>Phase angle distance ¹⁾</td> <td>120 ° \pm 1,5 °</td> </tr> </tbody> </table> <p>¹⁾ Three-phase case only</p>	Items	Conditions	Voltage	Nominal $\pm 2,0$ %	Voltage THD	< 2,5 %	Frequency	Nominal $\pm 0,1$ Hz	Phase angle distance ¹⁾	120 ° \pm 1,5 °	AC power source used meets the conditions specified	P
Items	Conditions												
Voltage	Nominal $\pm 2,0$ %												
Voltage THD	< 2,5 %												
Frequency	Nominal $\pm 0,1$ Hz												
Phase angle distance ¹⁾	120 ° \pm 1,5 °												
5.4	AC loads												

IEC 62116			
Clause	Requirement + Test	Result - Remark	Verdict
	On the AC side of the EUT, variable resistance, capacitance, and inductance are connected in parallel as loads between the EUT and the AC power source. Other sources of load, such as electronic loads, may be used if it can be shown that the source does not cause results that are different than would be obtained with passive resistors, inductors, and capacitors.	Passive loads (variable resistance, capacitance and inductance) have been connected.	P
	All AC loads are rated for and adjustable to all test conditions. The equations for Qf are based upon an ideal parallel RLC circuit. For this reason, non-inductive resistors, low loss (high Qf) inductors, and capacitors with low effective series resistance and effective series inductance are utilized in the test circuit. Iron core inductors, if used, are not exceed a current THD of 2 % when operated at nominal voltage. Load components are conservatively rated for the voltage and power levels expected. Resistor power ratings are chosen so as to minimize thermally-induced drift in esistance values during the course of the test.		P
	Active and reactive power is calculated (using the measurements provided in Table 1) in each of the R, L and C legs of the load so that these parasitic parameters (and parasitics introduced by variacs or autotransformers) are properly accounted for when calculating Qf.		P
6	Test for single or multi-phase inverter		
6.1	Test procedure	(see appended table)	P
	The test uses an RLC load, resonant at the EUT nominal frequency (50 Hz or 60 Hz) and matched to the EUT output power.		P
	For multi-phase EUT, the load is balanced across all phases and the switch S1 as in Figure 1 opens all phases		P
	This test is performed with the EUT conditions as in Table 5, where power and voltage values are given as a percent of EUT full output rating.		P
	a) ..Determine EUT test output power		P
	b) ..Adjusting the DC input source		P
	c) ..Turn off the EUT and open S1		P
	d) ..Adjust the RLC circuit to have $Q_f = 1.0 \pm 0.05$		P
	e) ..Connect the RLC load configured in step d) to the EUT by closing S2		P
	f) ...Open the utility-disconnect switch S1 to initiate the test, Run-on time is recorded.		P

IEC 62116			
Clause	Requirement + Test	Result - Remark	Verdict
	g)..For test condition A, adjust the real load and only one of the reactive load components to each of the load imbalance conditions shown in the shaded portion of table 6. If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.		P
	h) For test condition B and C, adjust the only one reactive load components by approximately 1,0% per test, within a total range of 95% to 105% of the operating point. If run-on times are still increasing at the 95% or 105% points, additional 1% increments have to be taken until run-on times begin decreasing.		P
6.2	Pass/fail criteria		
	An EUT is considered to comply with the requirements for islanding protection when each case of recorded run-on time is less than 2 s or meets the requirements of local codes.	Run-on time is less than 2s in any case	P
7	Documentation		
	At a minimum, the following information is recorded and maintained in the test report.		P
	a) Specifications of EUT. Table 8 provides an example of the type of information that is provided.		P
	b) Measurement results. Table 9 provides an example of the type of information that is provided. Actual measured values is to be recorded.		P
	c) Block diagram of test circuit.		P
	d) Specifications of the test and measurement equipment. Table 10 provides an example of the type of information that is provided.		P
	e) Any test configuration or procedure details such as methods of achieving specified load and EUT output conditions.		P
	f) Any additional information required by the testing laboratory's accreditation.		P
	g) Specify the evaluation criterion from clause 6.2 that was utilized to determine if the product passed or failed the test.		P
Annex A	Islanding as it applies to PV systems(Informative)		--
A.1	General		--
A.2	Impact of distortion on islanding		--
Annex B	Test for independent islanding detection device (relay)(Informative)		--
B.1	Introduction		--
B.2	Testing circuit		--
B.3	Testing equipment		--
B.4	Testing procedure		--
B.5	Documentation		--

6.1 Table: tested condition and run-on time									P
No.	P _{EUT} (% of EUT rating)	Reactive load (% of normal)	P _{AC}	Q _{AC}	Run-on time(ms)	P _{EUT} (kW)	Actual Q _r	V _{DC} (d.c.V)	Which load is selected to be adjusted (R or L)
Test condition A									
1	100	100	0	0	238.00	5.98	1.02	520.23	--
2	100	100	-5	-5	152.00	5.96	0.98	529.78	R/L
3	100	100	-5	0	166.00	5.97	0.99	523.17	R
4	100	100	-5	+5	77.00	5.99	0.98	521.17	R/L
5	100	100	0	-5	180.00	5.94	0.99	521.17	L
6	100	100	0	+5	88.00	5.91	1.01	521.17	L
7	100	100	+5	-5	156.00	5.97	1.02	520.17	R/L
8	100	100	+5	0	177.00	5.93	1.05	522.11	R
9	100	100	+5	+5	76.00	5.97	0.99	522.72	R/L
10	100	100	-10	+10	--	--	--	--	/
11	100	100	-5	+10	--	--	--	--	/
12	100	100	0	+10	--	--	--	--	/
13	100	100	+10	+10	--	--	--	--	/
14	100	100	+10	+5	--	--	--	--	/
15	100	100	+10	0	--	--	--	--	/
16	100	100	+10	-5	--	--	--	--	/
17	100	100	+10	-10	--	--	--	--	/
18	100	100	+5	-10	--	--	--	--	/
19	100	100	0	-10	--	--	--	--	/
20	100	100	-5	-10	--	--	--	--	/
21	100	100	-10	-10	--	--	--	--	/
22	100	100	-10	-5	--	--	--	--	/
23	100	100	-10	0	--	--	--	--	/
24	100	100	-10	+5	--	--	--	--	/
Test condition B									
10	66	66	0	0	209.00	3.93	1.04	335.17	--
11	66	66	0	-5	131.25	3.95	0.99	335.12	L
12	66	66	0	-4	138.00	3.93	1.01	335.78	L
13	66	66	0	-3	198.00	3.93	1.04	335.12	L
14	66	66	0	-2	228.00	3.94	1.05	335.17	L
15	66	66	0	-1	271.00	3.92	1.03	335.18	L
16	66	66	0	1	192.00	3.94	0.98	335.17	L
17	66	66	0	2	100.50	3.92	0.99	335.17	L
18	66	66	0	3	108.50	3.93	0.98	335.04	L

19	66	66	0	4	89.50	3.96	1.02	335.99	L
20	66	66	0	5	85.00	3.94	1.01	335.72	L
Test condition C									
21	33	33	0	0	242.00	1.94	0.95	180.54	--
22	33	33	0	-5	156.00	1.95	1.02	180.72	L
23	33	33	0	-4	182.00	1.92	1.03	180.11	L
24	33	33	0	-3	213.00	1.90	1.04	182.98	L
25	33	33	0	-2	195.00	1.95	0.99	183.27	L
26	33	33	0	-1	143.00	1.92	0.98	181.78	L
27	33	33	0	1	199.00	1.92	1.03	181.73	L
28	33	33	0	2	107.50	1.93	1.00	183.98	L
29	33	33	0	3	118.00	1.93	0.95	185.27	L
30	33	33	0	4	121.00	1.94	0.96	182.27	L
31	33	33	0	5	108.25	1.93	0.98	181.78	L

Remark:

For test condition A:

If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.

For test condition B and C:

If run-on times are still increasing at the 95 % or 105 % points, additional 1 % increments is taken until run-on times begin decreasing.

--- End of test report---