

# TEST REPORT IEC 62116

## Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters

Report reference number::	SXP-19OC1761FCSHP-3
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Date of issue ...... 2019-05-27

Total number of pages ...... 38

Testing laboratory name ...... Bureau Veritas

**LCIE China Company Limited** 

Address ...... Building 4, No. 518, Xinzhuan

Road, Caohejing Songjiang High-Tech Park, Shanghai,

P.R. China (201612)



Applicant's name.....: SolaX Power Network Technology (Zhe jiang) Co., Ltd.

Address ...... No. 288 Shizhu Road, Tonglu Economic Development Zone,

Dongxing District 311500, Tonglu City, Zhejiang Province, People's

Republic of China

Test specification

Standard.....: IEC 62116:2014

Certificate ...... Certificate of compliance

Test report form number .....: IEC 62116

Master TRF ...... Bureau Veritas Consumer Products Services Germany GmbH

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Test item description ...... Grid-tied photovoltaic inverter

Trademark....:



Model / Type ...... X1-Hybrid-3.0-N-E, X1-Hybrid-3.0-D-E, X1-Hybrid-3.7-N-E, X1-Hybrid-

3.7-D-E, X1-Hybrid-4.6-N-E, X1-Hybrid-4.6-D-E, X1-Hybrid-5.0-N-E,

X1-Hybrid-5.0-D-E, X1-Fit-3.7E,X1-Fit-5.0E



Model / Type:	X1-Hybrid- 3.0-N-E, X1-Hybrid- 3.0-D-E	X1-Hybrid- 3.7-N-E, X1-Hybrid- 3.7-D-E	X1-Hybrid- 4.6-N-E, X1-Hybrid- 4.6-D-E	X1-Hybrid- 5.0-N-E, X1- Hybrid-5.0-D- E	
MPP voltage range [V]:		125-55	50V d.c.		
Max. DC voltage [V]:		600V	d.c.		
Max. DC current [A]:		10/10	A d.c.		
Nominal AC voltage [V]:	230V a.c. 50/60Hz				
Max. Output AC current [A]:	14,4A a.c.	16A a.c.	21A a.c.	21,7A a.c.	
Nomina AC apparent power [VA]:	3000VA	3680VA	4600VA	4999VA	
Battery Voltage Operation Range:	85-400V d.c.				
Max Charge and Discharge Current:		20	)A		
Model / Type:	X1-Fit-3.7E	X1-Fit-5.0E			
Nominal AC voltage [V]:	230\	/ a.c.			
Nominal AC Frequency [Hz]:	50/60Hz				
Max. AC output/intput current [A]:	16 A a.c.	21,7A a.c.			
Nomina AC apparent power [VA]:	3680VA	4999VA			
Battery Voltage Operation Range:	85-400V				
Max Charge and Discharge Current:	20	)A			



. Grid-tied photovoltaic inverter\_V1.1



Testing Location ....:: **Bureau Veritas LCIE China Company Limited** 

Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-Tech Address .....:

Park, Shanghai, P.R.China (201612)

Tested by

**Tony Huang** (name and signature) .....: Test engineer

Approved by

Harvey Wang (name and signature) .....: **Project Manager** 

SolaX Power Network Technology (Zhe jiang) Co., Ltd, Manufacturer's name .....:

No, 288 Shizhu Road, Tonglu Economic Development Zone, Factory address .....:

Dongxing District 311500, Tonglu City, Zhejiang Province, People's

Republic of China

Document History					
Date	Internal reference	Modification / Change / Status	Revision		
2019-05-27	Tony Huang	Initial report was written	0		
Supplementary	information:				

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#### Test items particulars

Equipment mobility.....: Permanent connection

Operating condition .....: Continuous

Class of equipment .....: Class I

Protection against ingress of water..: IP65 according to EN 60529

Mass of equipment [kg] ...... 24kg for X1-Hybrid-3.0-N-E, X1-Hybrid-3.0-D-E, X1-Hybrid-3.7-N-E,

X1-Hybrid-3.7-D-E, X1-Hybrid-4.6-N-E, X1-Hybrid-4.6-D-E, X1-Hybrid-

5.0-N-E, X1-Hybrid-5.0-D-E

23kg for X1-Fit-3.7E,X1-Fit-5.0E

#### Test case verdicts

Test case does not apply

to the test object.....: N/A

Test item does meet

the requirement .....: P(ass)

Test item does not meet

the requirement ...... F(ail)

#### **Testing**

Date of receipt of test item ...... 2018-10-30

Date(s) of performance test ...... 2018-11-14 to 2019-05-16

#### General remarks:

The test result presented in this report relate only to the object(s) tested.

This report must not be reproduced, in part or in full, without the written approval of the issuing testing laboratory.

"(see Annex #)" refers to additional information appended to the report.

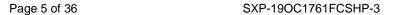
"(see appended table)" refers to a table appended to the report.

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

#### This Test Report consists of the following documents:

- 1. Test Results
- 2. Annex No. 1 Pictures of the unit
- 3. Annex No. 2 Test equipment list

. Grid-tied photovoltaic inverter\_V1.1





#### Copy of marking plate:

## GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-3.0-D-E

OOV	
	==
50V	==
10	A/10A
14	A/14A
4	000W
/~ <u>,</u> 50,	/60Hz
30	000VA
14.4A	/14.4A
	1
0.8 L	agging
/~,50	/60Hz
4	000VA
	17.4A
L	ithium
-400	V <del></del>
	20A
-20	60°C
	IP69
on-is	solated
AINS	),II (DC
05/ C -1/ G!	EI 0-2 59
DRM	7 DRM

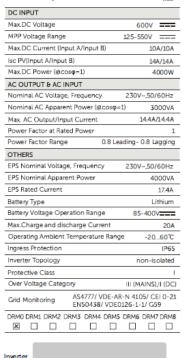


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## GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-3.0-N-E



Inverter SN:

Register SN:



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## GRID-CONNECTED PHOTOVOLTAIC INVERTER

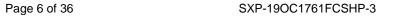
Model: X1-Hybrid-3.7-D-E



Voltage         600V           Itage Range         125-550V           Current (Input A/Input B)         10A/10A           sput A/Input B)         14A/14A           Power (@cosφ=1)         5000W
Current (Input A/Input B)         10A/10A           sput A/Input B)         14A/14A           Power (@cosφ=1)         5000W
put A/Input B) 14A/14A Power (@cosφ=1) 5000W
Power (@cosφ=1) 5000W
PUT & AC INPUT
l AC Voltage, Frequency 230V~,50/60Hz
l AC Apparent Power (@cosφ=1) 3680VA
Output/Input Current 16A/16A
actor at Rated Power
actor Range 0.8 Leading - 0.8 Laggin
i
minal Voltage, Frequency 230V~,50/60Hz
minal Apparent Power 4000VA
ed Current 17.4A
Type Lithium
oltage Operation Range 85-400V
arge and discharge Current 20/
ng Ambient Temperature Range -2060°C
Protection IP6
Topology non-isolated
ve Class
ltage Category III (MAINS),II (DC
nitoring AS4777/ VDE-AR-N 4105/ CEI 0-2 EN50438/ VDE0126-1-1/ G59
RM1 DRM2 DRM3 DRM4 DRM5 DRM6 DRM7 DRM
Itage Category III (MAINS),II (D nitoring AS4777/ VDE-AR-N 4105/ CEI 0- EN50438/ VDE0126-1-1/ G59

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## GRID-CONNECTED PHOTOVOLTAIC INVERTER



#### Model: X1-Hybrid-3.7-N-E

	Found
DC INPUT	
Max.DC Voltage	600V ====
MPP Voltage Range	125-550V ====
Max.DC Current (Input A/Input B)	10A/10A
Isc PV(Input A/Input B)	14A/14A
Max.DC Power (@cosφ=1)	5000W
AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ=	1) 3680VA
Max. AC Output/Input Current	16A/16A
Power Factor at Rated Power	1
Power Factor Range 0.8 Lea	ding- 0.8 Lagging
OTHERS	
EPS Nominal Voltage, Frequency	230V~,50/60Hz
EPS Nominal Apparent Power	4000VA
EPS Rated Current	17.4A
Battery Type	Lithium
Battery Voltage Operation Range	85-400V
Max.Charge and discharge Current	20A
Operating Ambient Temperature Range	e -2060°C
Ingress Protection	IP65
Inverter Topology	non-isolated

Inverter SN:

Over Voltage Category

Grid Monitoring

Registe



DRM0 DRM1 DRM2 DRM3 DRM4 DRM5 DRM6 DRM7 DRM8

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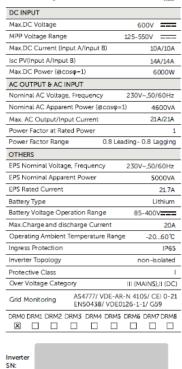
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III (MAINS),II (DC)

AS4777/ VDE-AR-N 4105/ CEI 0-21 EN50438/ VDE0126-1-1/ G59

## GRID-CONNECTED PHOTOVOLTAIC INVERTER





i:

Register SN:



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## GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-4.6-N-E



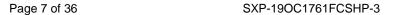
Max.DC Voltage	600V ===
MAX.DC Voltage MPP Voltage Range	
	125-550V ====
Aax.DC Current (Input A/Input B)	10A/10A
sc PV(Input A/Input B)	14A/14A
Max.DC Power (@cosφ=1)	6000W
AC OUTPUT & AC INPUT	2701/ 50/621
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ:	
Max. AC Output/Input Current	21A/21A
Power Factor at Rated Power	1
	eading - 0.8 Lagging
OTHERS	2704 5045211
EPS Nominal Voltage, Frequency	230V~,50/60Hz
EPS Nominal Apparent Power	5000VA
EPS Rated Current	21.7A
Battery Type	Lithium
Battery Voltage Operation Range	85-400V
Max.Charge and discharge Current	20A
Operating Ambient Temperature Rang	
ngress Protection	IP65
nverter Topology	non-isolated
Protective Class	
Over Voltage Category	III (MAINS),II (DC
Grid Monitoring AS4777/ VDE-A EN50438/ VDE	R-N 4105/ CEI 0-2: 0126-1-1/ G59
DRMO DRM1 DRM2 DRM3 DRM4 DRM5	

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#### GRID-CONNECTED PHOTOVOLTAIC INVERTER Model: X1-Hybrid-5.0-D-E DC INPUT Max.DC Voltage MPP Voltage Range 125-550V ==== Max.DC Current (Input A/Input B) Isc PV(Input A/Input B) Max.DC Power (@cosφ=1) AC OUTPUT & AC INPUT

Nominal AC Voltage, Frequency

Power Factor at Rated Power Power Factor Range

EPS Nominal Apparent Power EPS Rated Current

Battery Voltage Operation Range

Max.Charge and discharge Current

Operating Ambient Temperature Range

OTHERS

Battery Type

Ingress Protection

Inverter Topology

Register SN:

Over Voltage Category

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Nominal AC Apparent Power (@cosφ=1) 4999VA Nominal AC Apparent Power for VDE 4105 (@cosφ=1) 4600VA Max. AC Output/Input Current 21.7A/21.7A

EPS Nominal Voltage, Frequency 230V~,50/60Hz

Grid Monitoring AS4777/ VDE-AR-N 4105/ CEI 0-21 EN50438/ VDE0126-1-1/ G59 DRM0 DRM1 DRM2 DRM3 DRM4 DRM5 DRM6 DRM7 DRM8 

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## GRID-CONNECTED PHOTOVOLTAIC INVERTER

600V ====

10A/10A

14A/14A

6000W

21.7A

20A

IP65

Lithium

-20...60°C

non-isolated

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85-400V===

230V~,50/60Hz

0.8 Leading- 0.8 Lagging

Model: X1-Hybrid-5.0-N-E



Max.DC Voltage	600V ====		
MPP Voltage Range	125-550V		
Max.DC Current (Input A/Input B)	10A/10A		
Isc PV(Input A/Input B)	14A/14A		
Max.DC Power (@cosφ=1)	6000W		
AC OUTPUT & AC INPUT			
Nominal AC Voltage, Frequency	230V~,50/60Hz		
Nominal AC Apparent Power (@cosφ-	-1) 4999VA		
Nominal AC Apparent Power for VDE 4105	(@cosφ=1) 4600VA		
Max. AC Output/Input Current	21.7A/21.7A		
Power Factor at Rated Power	1		
Power Factor Range 0.8 Le	ading- 0.8 Lagging		
OTHERS			
EPS Nominal Voltage, Frequency	230V~,50/60Hz		
EPS Nominal Apparent Power	5000VA		
EPS Rated Current	21.7A		
Battery Type	Lithium		
Battery Voltage Operation Range	85-400V====		
Max.Charge and discharge Current	20 <i>A</i>		
Operating Ambient Temperature Rang	ge -2060°C		
Ingress Protection	IP65		
Inverter Topology	non-isolated		
Protective Class			
Over Voltage Category	III (MAINS),II (DO		
Grid Monitoring AS4777/ VDE-AF EN50438/ VDEC	R-N 4105/ CEI 0-21 0126-1-1/ G59		
DRMO DRM1 DRM2 DRM3 DRM4 DRM5	DRM6 DRM7 DRM		

Register SN:



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#### **GRID-CONNECTED INVERTER**

Model: X1-Fit-3.7E



AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ	=1) 3680VA
Max. AC Output/Input Current	16A/16A
Power Factor at Rated Power	1
Power Factor Range 0.8 Le	eading - 0.8 Lagging
EPS OUTPUT	
EPS Nominal Voltage, Frequency	230V~,50/60Hz
EPS Nominal Apparent Power	4000VA
EPS Rated Current	17.4A
BATTERY	
Battery Type	Lithium
Battery Voltage Operation Range	85-400V
Max.Charge and discharge Current	20A
OTHERS	
Operating Ambient Temperature Ran	ge -2060°C
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	
Over Voltage Category	III (MAINS),II (DC
Grid Monitoring AS4777/ VDE-A EN50438/ VDE	R-N 4105/ CEI 0-2 0126-1-1/ G59
DRM0 DRM1 DRM2 DRM3 DRM4 DRM:	5 DRM6 DRM7 DRM
riverter SN:	
Register SN:	
( <b>(()))</b>	

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odel: X1-Fit-5.0E	SOLAX
AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ=1	) 4999VA
Nominal AC Apparent Power for VDE 4105 (e	accsφ=1) 4600VA
Max. AC Output/Input Current	21.7A/21.7A
Power Factor at Rated Power	1
Power Factor Range 0.8 Lead	ding- 0.8 Lagging
EPS OUTPUT	
EPS Nominal Voltage, Frequency	230V~,50/60Hz
EPS Nominal Apparent Power	5000VA
EPS Rated Current	21.7A
BATTERY	
Battery Type	Lithium
Battery Voltage Operation Range	85-400V===
Max.Charge and discharge Current	20A
OTHERS	
Operating Ambient Temperature Range	-2060°C
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	1
Over Voltage Category	III (MAINS),II (DC)
Grid Monitoring A\$4777/ VDE-AR- EN50438/ VDE013	
DRM0 DRM1 DRM2 DRM3 DRM4 DRM5 I	DRM6 DRM7 DRM8
nverter N: legister N:	
CE	ing) Co., Ltd.
Dongxing District, Tonglu City, Zhejiang TEL: +86 571 5626 0011 E-mail: info@	solaxpower.com

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#### **General product information:**

The Solar Inverter converts DC voltage into AC voltage.

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 will also operate in case of one error.

The PV inverters can also be used with an energy storage system, utilize the advanced power conversion technology IGBT to convert DC to AC.

#### Solax single phase hybrid inverter PF dry ALARM turn off Meter interface LCD/LED/ USB Wifi interface interface Signal interface Energy manager Control Supply DC/DC BAT+ PV1+ ЕМІ PV1 PV2+ EMI DC/AC DC switch EPS R RCD FMI EPS N EPS L

#### **Block diagram**

The internal control is redundant built, It consists of master controller(U2-A) and slave controller(U2-B), the master controller(U2-A) can control relays, measures voltage, frequency, AC current with injected DC, insulation resistance and residual current. The slave controller (U2-B) can control the relays, measures the voltage and frequency. Both controllers communicate with each other.

The voltage and frequency measurement is achieved with resistors in serial which are connected directly to line and neutral. Both controllers get these signals and calculate the data.

The protection device makes up of two in series in each line and netural between inverter and grid .Inverter and back-up load.Back-up load and grid.Communicative coupled AC relays so that the equipment could be effectively separated from utility even any one of relays short circuited or works unnormally.

The controlling section is also redundant built. one master DSP. and one slave DSP. The master DSP carries out the main calculation and driving instructions. Slave DSP is responsible for the redundant relay independently. In case any one of two chips breaks down or runs a wrong program, which result to the loss of protection function, the another chip could indicate the fault and disconnect the equipment immediately.



#### **Hardware Version:**

Model	X1-Hybrid- 3.0-N-E	X1-Hybrid- 3.0-D-E	X1-Hybrid- 3.7-N-E	X1-Hybrid- 3.7-D-E	X1-Hybrid- 4.6-N-E
power board	710.00162.00				
control board	710.70548.00 710.60458.00		710.50458.0 0		
LCD board	710.00177.00				
USB Board	710.00197.00				
EMI Board	710.10218.00				

				ı	
Model	X1-Hybrid-	X1-Hybrid-	X1-Hybrid-	X1-Fit-3.7E	X1-Fit-5.0E
Wodel	4.6-D-E	5.0-N-E	5.0-D-E	Λ1-1 II-3.7 L	A1-FIL-5.0E
power board		710.00162.00			162.00
control board	710.50548.0 0	710.40548.00		710.J0458.0 0	710.E0458.0 0
LCD board	710.00177.00				
USB Board	710.00197.00				
EMI Board	710.10218.00		710.10270.0 0	710.10270.0 0	

#### **Software Version:**

Model	X1-Hybrid-3.0-N-E, X1-Hybrid-3.0-D-E, X1-Hybrid-3.7-N-E, X1-Hybrid-3.7-D-E, X1-Hybrid-4.6-N-E, X1-Hybrid-4.6-D-E, X1-Hybrid-5.0-N-E, X1-Hybrid-5.0-D-E, X1-Fit-3.7E,X1-Fit-5.0E
ARM	V2.03
DSP master	V2.07
DSP slave	V2.01

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#### Description of the differences of the models within a series:

Model	R411	R412	R413	R328	R62	DC switch	DC conne ctor
X1-Hybrid- 3.0-N-E	Y	N	N	N	N	N	Y
X1-Hybrid- 3.0-D-E	Y	N	N	N	N	Y	Y
X1-Hybrid- 3.7-N-E	N	Υ	N	N	N	N	Υ
X1-Hybrid- 3.7-D-E	N	Υ	N	N	N	Υ	Y
X1-Hybrid- 4.6-N-E	Y	Y	N	N	N	N	Y
X1-Hybrid- 4.6-D-E	Y	Y	N	N	N	Y	Y
X1-Hybrid- 5.0-N-E	N	N	N	N	N	N	Υ
X1-Hybrid- 5.0-D-E	N	N	N	N	N	Y	Y
X1-Fit-3.7E	N	Y	N	Y	Υ	N	N
X1-Fit-5.0E	N	N	Υ	Υ	Υ	N	N

Note: Y: have N: haven't

#### Note:

#### The product was tested on:

The tests had been performed on model X1-Hybrid-5.0-D-E are valid for model X1-Hybrid-3.0-N-E, X1-Hybrid-3.0-D-E, X1-Hybrid-3.7-N-E, X1-Hybrid-3.7-D-E, X1-Hybrid-4.6-N-E, X1-Hybrid-4.6-D-E, X1-Hybrid-5.0-N-E, X1-Fit-3.7E,X1-Fit-5.0E since it is identical in hardware and just power derated by except for R411, R412, R413, R328, R62, DC Switch, DC Connector.

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#### **Test overview:**

	IEC 62116:2014									
Clause	Clause Test									
	Type test:									
6.1	Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (EUT output = 100%)	Р								
6.1	Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)	Р								
6.1	Load imbalance (reactive load) for test condition C (EUT output = $25 \% - 33 \%$ )	Р								

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## 6.1 Islanding protection

Test circuit and parameters

Parameter	Symbol	Units		
EUT DC Input				
DC voltage	$V_{DC}$	V		
DC Current	I <sub>DC</sub>	A		
DC Power	P <sub>DC</sub>	W		
EUT AC output				
AC voltage	V <sub>EUT</sub>	V		
AC current	I <sub>EUT</sub>	A		
Real power	P <sub>EUT</sub>	W		
Reactive power	$Q_{EUT}$	VAr		
Test Load				
Resistive load current	$I_{R}$	A		
Inductive load current	lι	A		
Capacitive load current	lc	A		
AC (utility) power source				
Utility real power	$P_AC$	W		
Utility reactive power	$Q_AC$	VAr		
Utility current	IAC	Α		

Block diagram test circuit IEC 62116:2014

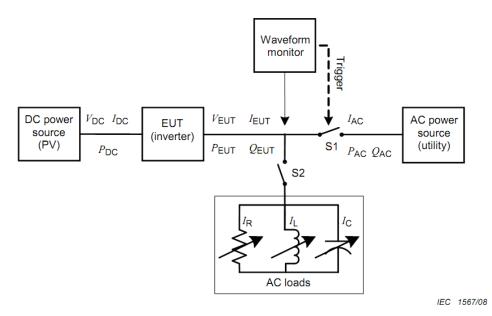


Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)





6.1 Islanding protection according table 6 - Load imbalance (real, reactive load test condition A (EUT ouput = 100%)						oad) for	Р				
	onditions		Frequency: 50+/-0,1Hz  U <sub>N</sub> =230+/-3Vac  Distortion factor of chokes < 2%  Quality = 1								
	nnection imit				2s	(IEC 6211	16)				
Model:	X1-Hybrid-		T	T		•	T	T	1		
No	P <sub>EUT</sub> 1) [% of EUT rating]	Reactiv e load [% of Q <sub>L</sub> in 6.1.d) 1]	P <sub>AC</sub> <sup>2)</sup> [% of nomina I]	Q <sub>AC</sub> <sup>3)</sup> [% of nomina I]	I <sub>AC</sub> <sup>4)</sup> [A]	P <sub>EUT</sub> [kW]	V <sub>DC</sub> [V]	Q <sub>f</sub> [1]	Run on Time [ms]	Remar ks <sup>5)</sup>	
1	100	100	0	0		5,0	443	1,00	104,1	BL	
2	100	100	-10	-10		5,0	443	0,91	384,1	IB	
3	100	100	-10	-5		5,0	443	0,95	86,1	IB	
4	100	100	-10	0		5,0	443	1,00	239,2	IB	
5	100	100	-10	+5		5,0	443	1,05	146,0	IB	
6	100	100	-10	+10		5,0	443	1,10	154,1	IB	
7	100	100	-5	-10		5,0	443	0,90	88,0	IB	
8	100	100	-5	-5		5,0	443	0,95	156,0	IB	
9	100	100	-5	0	-	5,0	443	1,00	284,0	IB	
10	100	100	-5	+5	-	5,0	443	1,05	164,0	IB	
11	100	100	-5	+10		5,0	443	1,10	156,0	IB	
12	100	100	0	-10		5,0	443	0,90	80,0	IB	
13	100	100	0	-5		5,0	443	0,95	64,0	IB	
14	100	100	0	+5		5,0	443	1,05	168,0	IB	
15	100	100	0	+10		5,0	443	1,10	156,0	IB	
16	100	100	+5	-10		5,0	443	0,90	112,0	IB	
17	100	100	+5	-5		5,0	443	0,95	98,0	IB	
18	100	100	+5	0		5,0	443	1,00	292,0	IB	
19	100	100	+5	+5		5,0	443	1,05	146,0	IB	
20	100	100	+5	+10		5,0	443	1,10	151,0	IB	



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21	100	100	+10	-10	 5,0	443	0,90	134,0	IB
22	100	100	+10	-5	 5,0	443	0,95	162,0	IB
23	100	100	+10	0	 5,0	443	1,00	150,0	IB
24	100	100	+10	+5	 5,0	443	1,05	178,0	IB
25	100	100	+10	+10	 5,0	443	1,10	154,0	IB

Parameter at 0%	L= 33,69 mH	R=10,58 Ω	C_301 01 uE
per phase	L= 33,09 IIII I	11-10,30 22	C=301,01 μF

#### Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

1) P<sub>EUT</sub>: EUT output power

- <sup>2)</sup> P<sub>AC</sub>: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
- <sup>3)</sup> Q<sub>AC</sub>: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
- 4) Fundamental of IAC when RLC is adjusted
- <sup>5)</sup> BL: Balance condition, IB: Imbalance condition.

#### Condition A:

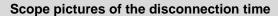
EUT output power PEUT = Maximum 6)

EUT input voltage  $^{6)} = >75\%$  of rated input voltage range

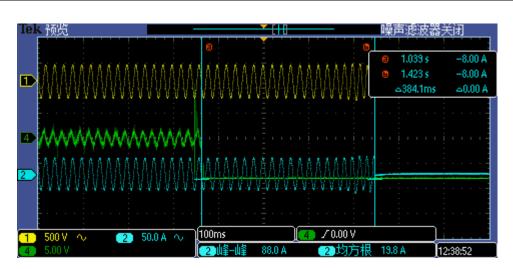
- <sup>6)</sup> Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
- $^{7)}$  Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,75 × (Y X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

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Disconnection at No. 2



Note:

green: EUT current signal for switch S1

blue: EUT output current yellow: Grid voltage signal



Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)						
Test conditions	Frequency: 50+/-0,1Hz U <sub>N</sub> =230+/-3Vac Distortion factor of chokes < 2% Quality =1					
Disconnection limit	2s (IEC 62116)					

Model: X1-Hybrid-5.0-D-E

Wode	Model: X1-Hyprid-5.0-D-E										
No	P <sub>EUT</sub> 1) [% of EUT rating]	Reactive load [% of QL in 6.1.d) 1]	P <sub>AC</sub> <sup>2)</sup> [% of nominal]	Q <sub>AC</sub> <sup>3)</sup> [% of nominal]	I <sub>AC</sub> <sup>4)</sup> [A]	P <sub>EUT</sub> [kW]	V <sub>DC</sub> [V]	Q <sub>f</sub> [1]	Run on Time [ms]	Remark s <sup>5)</sup>	
1	66	66	0	-5		3,3	377	0,95	114,0	IB	
2	66	66	0	-4		3,3	377	0,96	122,0	IB	
3	66	66	0	-3		3,3	377	0,97	101,0	IB	
4	66	66	0	-2		3,3	377	0,98	72,1	IB	
5	66	66	0	-1	-	3,3	377	0,99	132,0	IB	
6	66	66	0	0		3,3	377	1,00	132,0	BL	
7	66	66	0	1		3,3	377	1,01	126,0	IB	
8	66	66	0	2		3,3	377	1,02	92,1	IB	
9	66	66	0	3		3,3	377	1,03	110,0	IB	
10	66	66	0	4		3,3	377	1,04	158,0	IB	
11	66	66	0	5		3,3	377	1,05	122,0	IB	
Par	ameter at 0%	per phase	L= 51,05 mH			R= 16,0	03 Ω		C= 198,67 µF		

#### Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

#### Condition B:

EUT output power  $P_{EUT} = 50 \% - 66 \%$  of maximum

EUT input voltage  $^{6)}$  = 50 % of rated input voltage range, ±10 %

<sup>6)</sup> Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 50 % of range = $X + 0.5 \times (Y - X)$ . Y shall not exceed 0.8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

<sup>1)</sup> PEUT: EUT output power

<sup>&</sup>lt;sup>2)</sup> P<sub>AC</sub>: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

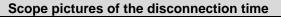
<sup>&</sup>lt;sup>3)</sup> Q<sub>AC</sub>: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

<sup>4)</sup> Fundamental of IAC when RLC is adjusted

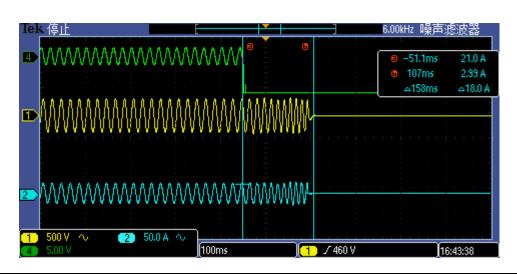
<sup>&</sup>lt;sup>5)</sup> BL: Balance condition, IB: Imbalance condition.

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Disconnection at No. 10



Note:

green: EUT current signal for switch S1

blue: EUT output current yellow: Grid voltage signal

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Load imbalance (reactive load) for test condition C (EUT output = 25 % - 33 %)						
Test conditions	Frequency: $50+/-0,1Hz$ $U_N=230+/-3Vac$ Distortion factor of chokes < $2\%$ Quality =1					
Disconnection limit	2s (IEC 62116)					

Model: X1-Hybrid-5 0-D-F

Mode	Model: X1-Hybrid-5.0-D-E									
No	P <sub>EUT</sub> 1) [% of EUT rating]	Reactive load [% of Q∟ in 6.1.d) 1]	P <sub>AC</sub> <sup>2)</sup> [% of nominal]	Q <sub>AC</sub> <sup>3)</sup> [% of nominal]	I <sub>AC</sub> 4) [A]	P <sub>EUT</sub> [kW]	V <sub>DC</sub> [V]	Q <sub>f</sub> [1]	Run on Time [ms]	Remark s <sup>5)</sup>
1	33	33	0	-5		1,65	210	0,95	166,0	IB
2	33	33	0	-4		1,65	210	0,96	116,0	IB
3	33	33	0	-3		1,65	210	0,97	162,0	IB
4	33	33	0	-2		1,65	210	0,98	158,0	IB
5	33	33	0	-1		1,65	210	0,99	112,0	IB
6	33	33	0	0		1,65	210	1,00	126,0	BL
7	33	33	0	1		1,65	210	1,01	264,0	IB
8	33	33	0	2		1,65	210	1,02	212,0	IB
9	33	33	0	3		1,65	210	1,03	188,0	IB
10	33	33	0	4		1,65	210	1,04	194,0	IB
11	33	33	0	5		1,65	210	1,05	178,0	IB
Par	Parameter at 0% per phase L= 102,1 mH R= 32,06 $\Omega$ C= 99,33 $\mu$ F						3 µF			

Parameter at 0% per phase	L= 102,1 mH	R= 32,06 Ω	C= 99,33 µF
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RLC is adjusted to min. +/-1% of the inverter rated output power

#### Condition B:

EUT output power PEUT = 25 % - 33 % <sup>6)</sup> of maximum

EUT input voltage  $^{7)}$  = <20 % of rated input voltage range

<sup>1)</sup> PEUT: EUT output power

<sup>&</sup>lt;sup>2)</sup> P<sub>AC</sub>: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

<sup>&</sup>lt;sup>3)</sup> Q<sub>AC</sub>: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

<sup>4)</sup> Fundamental of IAC when RLC is adjusted

<sup>&</sup>lt;sup>5)</sup> BL: Balance condition, IB: Imbalance condition.

<sup>&</sup>lt;sup>6)</sup> Or minimum allowable EUT output level if greater than 33 %.

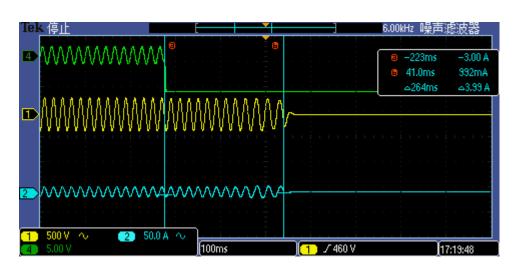
<sup>7)</sup> Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 10 % of range = $X + 0.2 \times (Y - X)$ . Y shall not exceed 0.8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

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### Scope pictures of the disconnection time

#### Disconnection at No. 7



Note:

green: EUT current signal for switch S1

blue: EUT output current yellow: Grid voltage signal



## **Annex 1**

Pictures of the unit

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#### **Enclosure front view for all model**



#### **Enclosure rear view for all model**



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#### **Enclosure left view for all model**



## Enclosure right view for all model



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#### **Enclosure top view for all model**



## Enclosure bottom view for X1-Hybrid-3.0-N-E, X1-Hybrid-3.7-N-E, X1-Hybrid-4.6-N-E, X1-Hybrid-5.0-N-E



. Grid-tied photovoltaic inverter\_V1.1



# Annex 2 Test Equipment list



No,	Equipment	Internal No,	Type/characteristics	Manufacturer	Last Calibration	Due Data
1	Oscilloscope	A4089024SH	P4034B	Tektronix	26/Jul/18	25/Jul/19
2	Oscilloscope	A4089008SH	DPO3014	Tektronix	23/Jan/19	22/Jan/20
3	Oscilloscope	A4089036SH	DL850	YOKOGAWA	29/Aug/18	28/Aug/19
4	High Voltage probe	A4089026SH	P5200A	Tektronix	23/Jan/19	22/Jan/20
5	Voltage probe	A4089004SH	P2220	Tektronix	10/Oct/18	09/Oct/19
6	Current probe	A4089009SH	P6139B	Tektronix	23/Jan/19	22/Jan/20
7	Current probe	A4089013SH	A622	Tektronix	23/Jan/19	22/Jan/20
8	Current probe	A4089037SH	960 30	YOKOGAWA	10/Oct/18	09/Oct/19
9	Current probe	A4089038SH	960 30	YOKOGAWA	10/Oct/18	09/Oct/19
10	Current probe	A4089039SH	960 30	YOKOGAWA	10/Oct/18	09/Oct/19
11	Current probe	A4089017SH	TCP0150	Tektronix	26/Jul/18	25/Jul/19
12	AC power supply	A7040066SH	AFC-31010T	APC	08/Aug/18	31/Jul/20
13	AC power supply	A7040071SH	29/May/68	Chroma	22/Feb/18	21/Feb/20
14	AC power supply	A7040057SH	29/May/68	Chroma	19/Jul/17	18/Jul/19
15	AC power supply	A7040077SH	MX-30	AMETEK	-	-
16	Programmabl e DC source	A7040058SH	62150H-1000S	Chroma	-	-
17	Programmabl e DC source	A7040059SH	62150H-1000S	Chroma	-	-
18	Programmabl e DC source	A7040069SH	62150H-1000S	Chroma	-	-
19	Programmabl e DC source	A7040074SH	62150H-1000S	Chroma	-	-
20	Programmabl e DC source	A7040075SH	62150H-1000S	Chroma	-	-



21	Programmable DC source	A7040076SH	62150H-1000S	Chroma	-	-
22	Programmable DC source	A7040070SH	62150H-1000S	Chroma	-	-
23	Power Analyzer	A1240096SH	WT3000	YOKOGAWA	31/Oct/18	30/Oct/19
24	Power Analyzer	A1240097SH	WT3000	YOKOGAWA	06/May/19	05/May/20
25	Power Analyzer	A1240103SH	LMG500	ZES ZIMMER	26/Jul/18	25/Jul/19
26	Power Analyzer	A1240101SH	WT3000	YOKOGAWA	26/Jul/18	25/Jul/19
27	Anti-isolating test stystem	A7150074SH	ACTL-380SH	qunling	-	-
28	Load cabinet	A7150083SH	WSTF-LDJ60K/300	shanghai wen shun	-	-
29	Load cabinet	A7150084SH	WSTF-LDJ45K/0385	shanghai wen shun	-	-
30	Load cabinet	A7150085SH	WSTF-LDJ45K/0385	shanghai wen shun	-	-
31	Load cabinet	A7150075SH	WSTF-RC25k/0,3D 0,001kVA-25kVA	shanghai wen shun	-	-
32	Temperature recorder	A740037SH	G820	GRAPHIEC	10/Oct/18	09/Oct/19
33	Load cabinet(for flick)	A7150090SH	200Ω , 250V;1200W	shanghai wen shun	-	-
34	Variable resistor	A7150076SH	BX8-67	LingOu	-	-