TEST REPORT

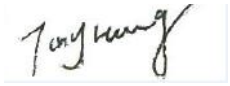
IEC 62116

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

Report reference number .....:	**SXP-19OC1761FCSHP-3**
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

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] ..... :	125-550V 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...:	20A			
Model / Type ..... :	X1-Fit-3.7E	X1-Fit-5.0E		
Nominal AC voltage [V] ..... :	230V 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 :	20A			

Testing Location .....:	**Bureau Veritas LCIE China Company Limited**
Address .....:	Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-Tech Park, Shanghai, P.R.China (201612)
Tested by (name and signature) .....:	Tony Huang Test engineer 
Approved by (name and signature) .....:	Harvey Wang Project Manager
Manufacturer's name .....:	**SolaX Power Network Technology (Zhe jiang) Co., Ltd,**
Factory address .....:	No, 288 Shizhu Road, Tonglu Economic Development Zone, 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:			

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

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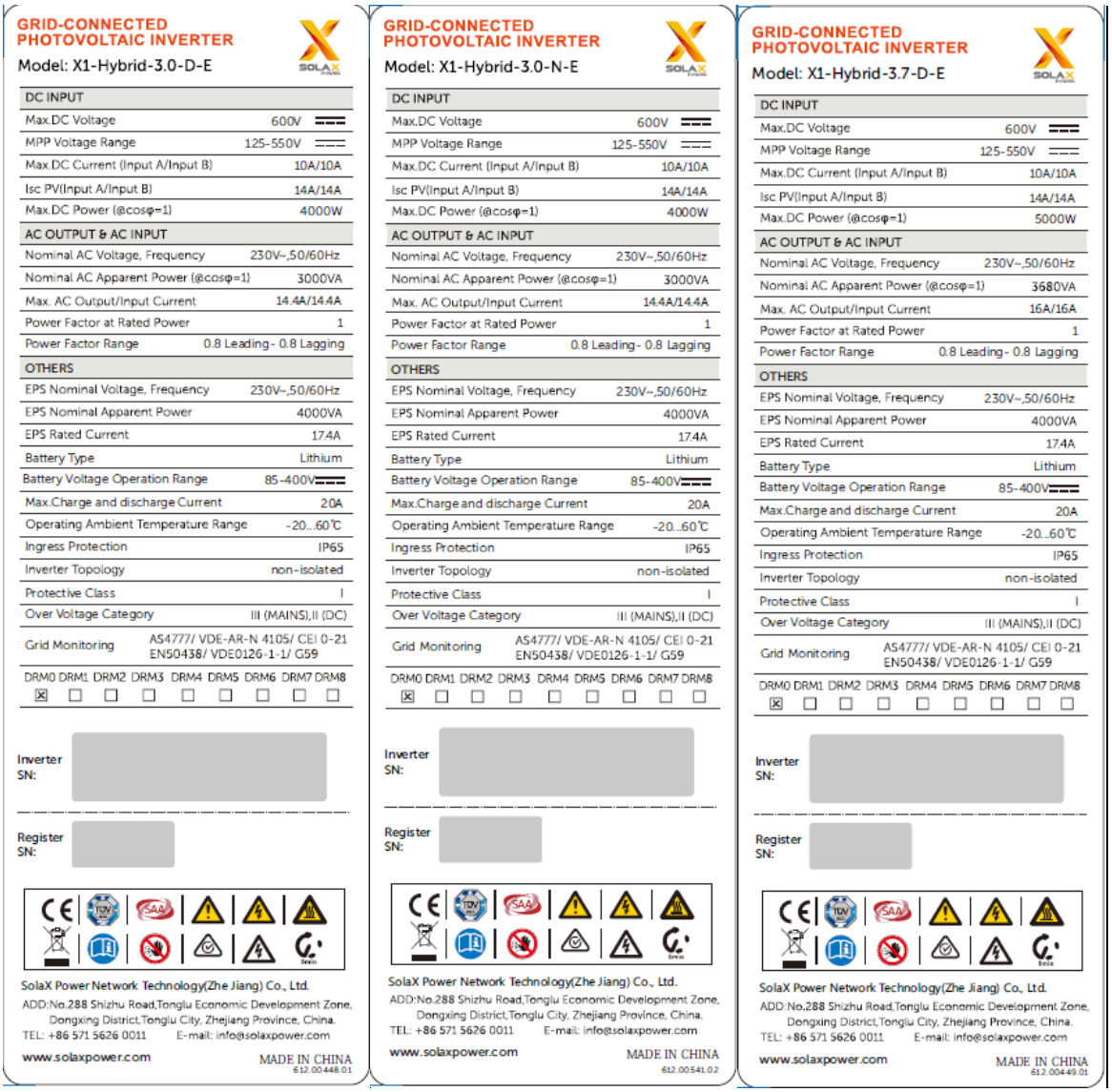

GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-3.0-D-E

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)	4000W
AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ=1)	3000VA
Max. AC Output/Input Current	14.4A/14.4A
Power Factor at Rated Power	1
Power Factor Range	0.8 Leading - 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	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
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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Inverter SN:

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GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-3.0-N-E

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)	4000W
AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ=1)	3000VA
Max. AC Output/Input Current	14.4A/14.4A
Power Factor at Rated Power	1
Power Factor Range	0.8 Leading - 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	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
Grid Monitoring	AS4777/ VDE-AR-N 4105/ CEI 0-21 EN50438/ VDE0126-1-1/ G59

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GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-3.7-D-E

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 Leading - 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	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
Grid Monitoring	AS4777/ VDE-AR-N 4105/ CEI 0-21 EN50438/ VDE0126-1-1/ G59

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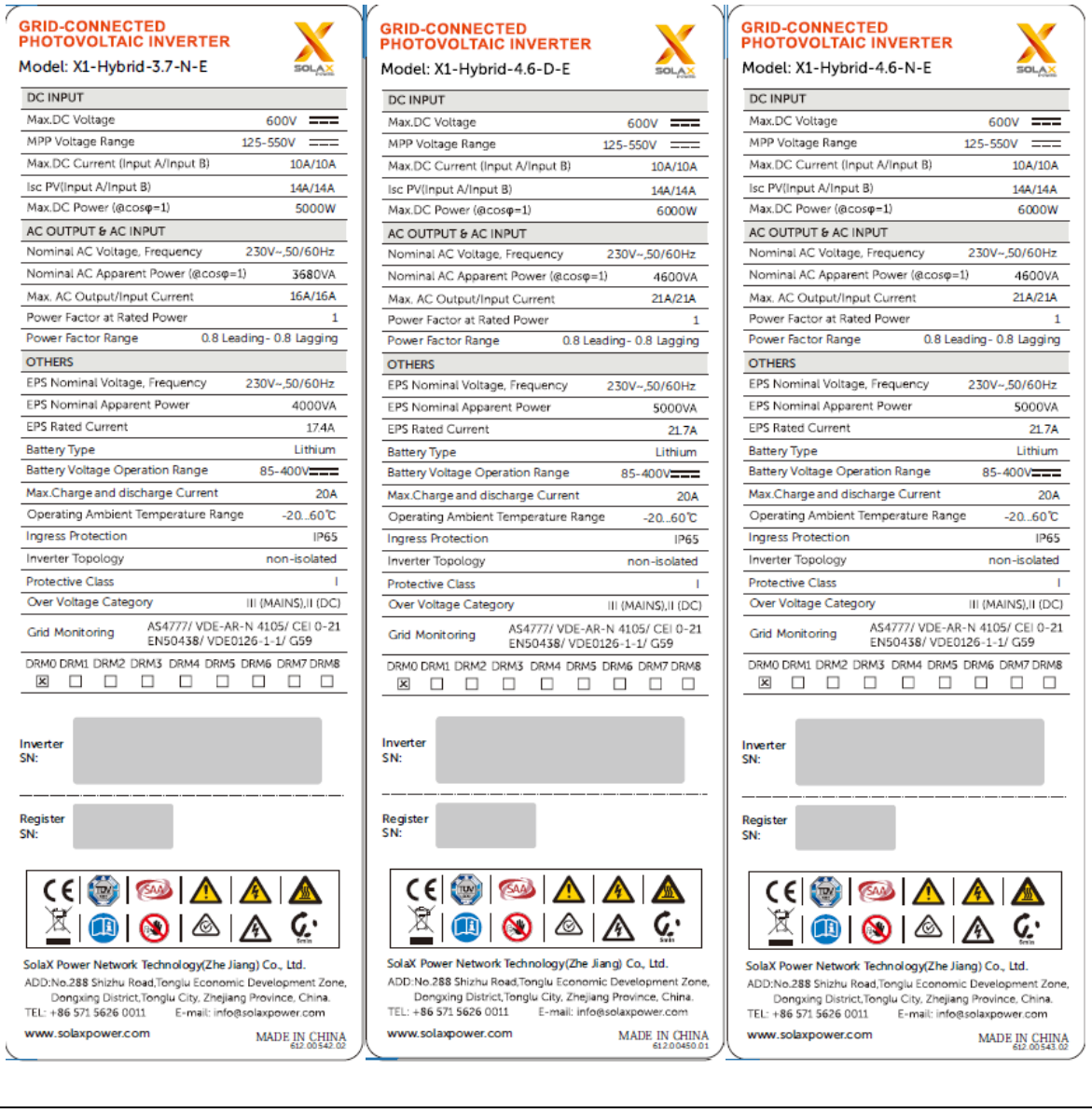

GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-3.7-N-E

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 Leading- 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	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
Grid Monitoring	AS4777/ VDE-AR-N 4105/ CEI 0-21 EN50438/ VDE0126-1-1/ G59

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GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-4.6-D-E

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)	6000W
AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ=1)	4600VA
Max. AC Output/Input Current	21A/21A
Power Factor at Rated Power	1
Power Factor Range	0.8 Leading- 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	20A
Operating Ambient Temperature Range	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
Grid Monitoring	AS4777/ VDE-AR-N 4105/ CEI 0-21 EN50438/ VDE0126-1-1/ G59

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GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-4.6-N-E

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)	6000W
AC OUTPUT & AC INPUT	
Nominal AC Voltage, Frequency	230V~,50/60Hz
Nominal AC Apparent Power (@cosφ=1)	4600VA
Max. AC Output/Input Current	21A/21A
Power Factor at Rated Power	1
Power Factor Range	0.8 Leading- 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	20A
Operating Ambient Temperature Range	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
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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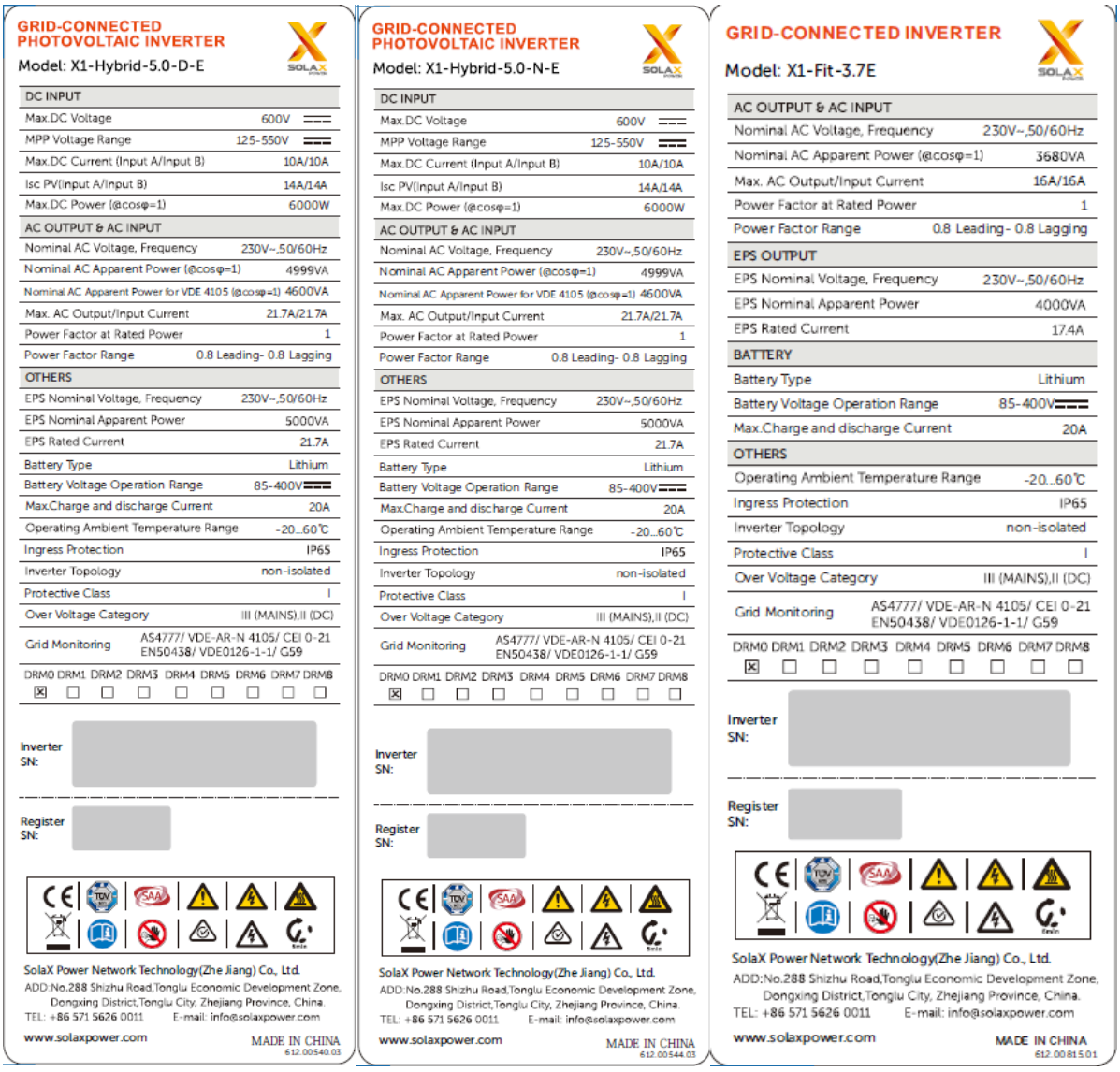

GRID-CONNECTED PHOTOVOLTAIC INVERTER

Model: X1-Hybrid-5.0-D-E

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)	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 Leading- 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	20A
Operating Ambient Temperature Range	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
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

Model: X1-Hybrid-5.0-N-E

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)	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 Leading- 0.8 Lagging
OTHERS	
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EPS Nominal Apparent Power	5000VA
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Battery Type	Lithium
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Ingress Protection	IP65
Inverter Topology	non-isolated
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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 Leading- 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 Range	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
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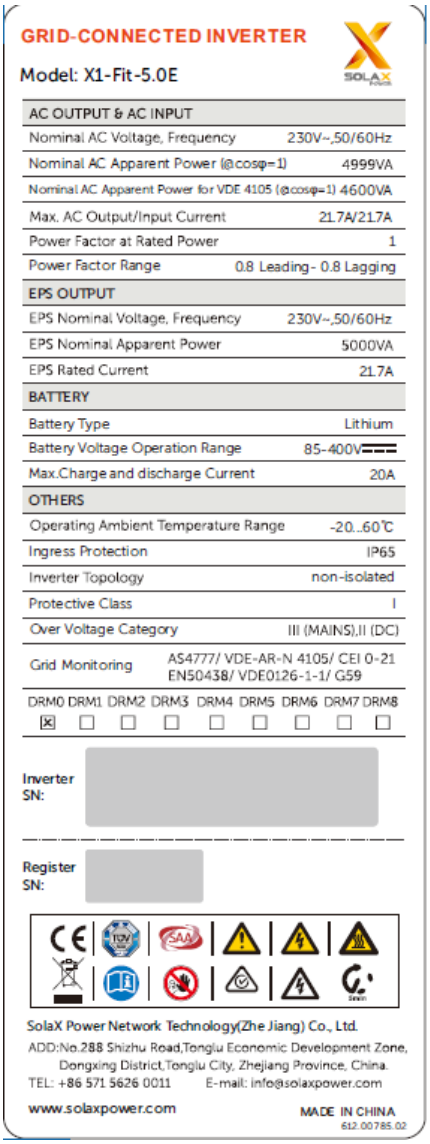

GRID-CONNECTED INVERTER

Model: X1-Fit-5.0E

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 Leading - 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	-20...60℃
Ingress Protection	IP65
Inverter Topology	non-isolated
Protective Class	I
Over Voltage Category	III (MAINS),II (DC)
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DRM0	DRM1	DRM2	DRM3	DRM4	DRM5	DRM6	DRM7	DRM8
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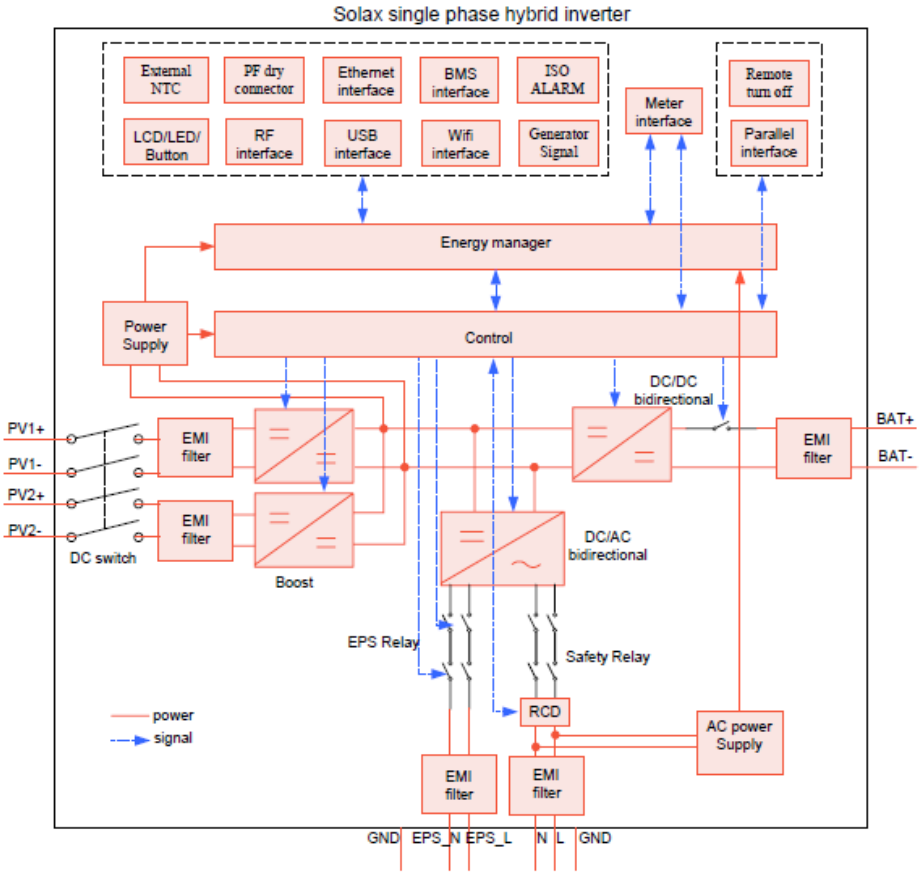
General product information:

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.

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 utitlity 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 funciton. 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		710.50458.00
LCD board	710.00177.00				
USB Board	710.00197.00				
EMI Board	710.10218.00				

Model	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
power board	710.00162.00			710.10162.00	
control board	710.50548.00	710.40548.00		710.J0458.00	710.E0458.00
LCD board	710.00177.00				
USB Board	710.00197.00				
EMI Board	710.10218.00			710.10270.00	710.10270.00

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

Description of the differences of the models within a series:

Model	R411	R412	R413	R328	R62	DC switch	DC connector
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	Y	N	N	N	N	Y
X1-Hybrid-3.7-D-E	N	Y	N	N	N	Y	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	Y
X1-Hybrid-5.0-D-E	N	N	N	N	N	Y	Y
X1-Fit-3.7E	N	Y	N	Y	Y	N	N
X1-Fit-5.0E	N	N	Y	Y	Y	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.

Test overview:

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

6.1 Islanding protection

Test circuit and parameters

Parameter	Symbol	Units
EUT DC Input		
DC voltage	V_{DC}	V
DC Current	I_{DC}	A
DC Power	P_{DC}	W
EUT AC output		
AC voltage	V_{EUT}	V
AC current	I_{EUT}	A
Real power	P_{EUT}	W
Reactive power	Q_{EUT}	VAr
Test Load		
Resistive load current	I_R	A
Inductive load current	I_L	A
Capacitive load current	I_C	A
AC (utility) power source		
Utility real power	P_{AC}	W
Utility reactive power	Q_{AC}	VAr
Utility current	I_{AC}	A

Block diagram test circuit IEC 62116:2014

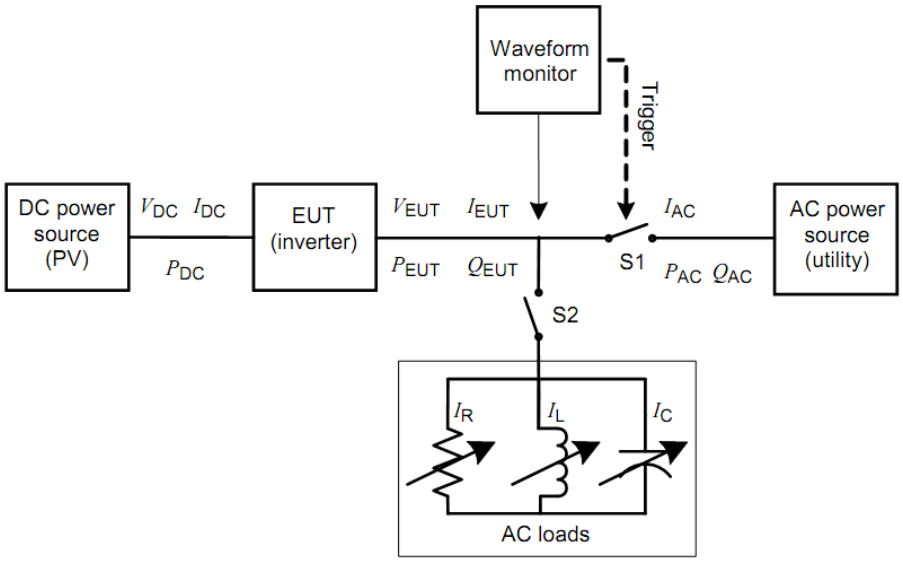


Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)

6.1 Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%)	**P**

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-E

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks 5)
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

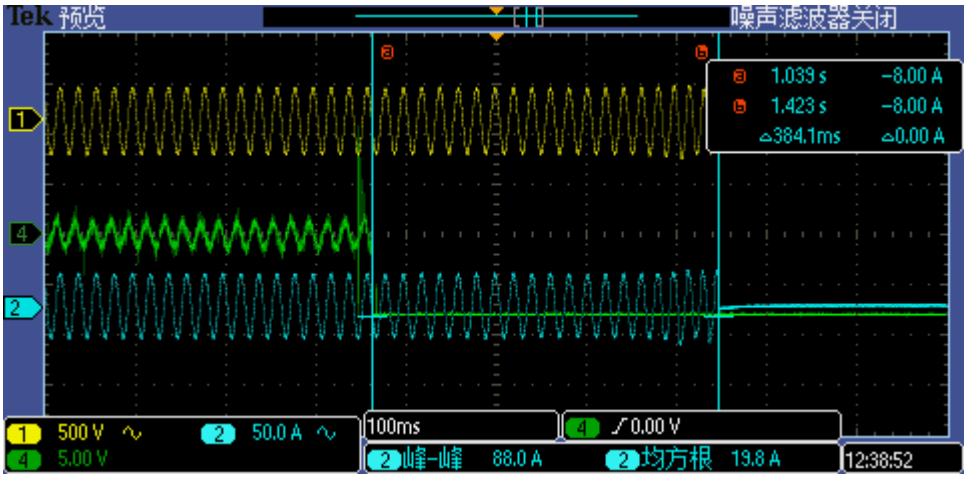
21	100	100	+10	-10	--	5,0	443	0,90	134,0	IB
22	100	100	+10	-5	--	5,0	443	0,95	162,0	IB
23	100	100	+10	0	--	5,0	443	1,00	150,0	IB
24	100	100	+10	+5	--	5,0	443	1,05	178,0	IB
25	100	100	+10	+10	--	5,0	443	1,10	154,0	IB

Parameter at 0% per phase	L= 33,69 mH	R=10,58 Ω	C=301,01 μF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
[1] P_{EUT}: EUT output power
[2] P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
[3] Q_{AC}: 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 I_{AC} when RLC is adjusted
[5] BL: Balance condition, IB: Imbalance condition.

Condition A:
EUT output power PEUT = Maximum [6]
EUT input voltage [6] = >75% of rated input voltage range

[6] 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.

Scope pictures of the disconnection time
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 %)	**P**

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-E

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks 5)
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

Parameter at 0% per phase	L= 51,05 mH	R= 16,03 Ω	C= 198,67 µF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: 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 I_{AC} when RLC is adjusted
5) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power P_{EUT} = 50 % – 66 % of maximum
EUT input voltage 6) = 50 % of rated input voltage range, ±10 %
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 50 % of range =X + 0,5 × (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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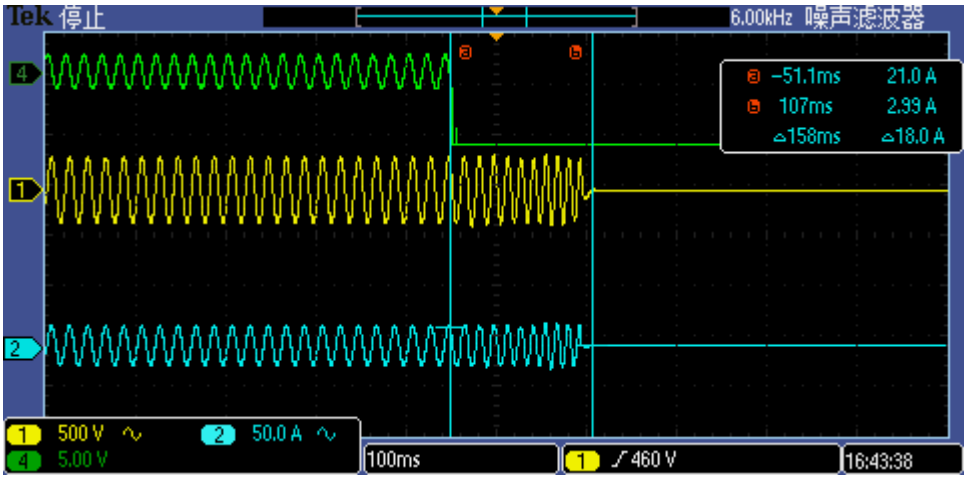
Scope pictures of the disconnection time
Disconnection at No. 10

Note: green: EUT current signal for switch S1 blue: EUT output current yellow: Grid voltage signal

Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)	**P**

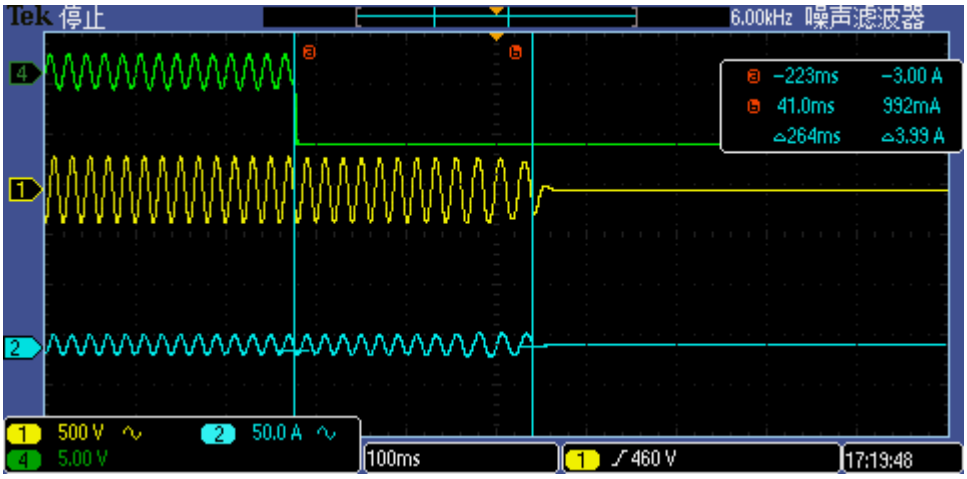
Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	2s (IEC 62116)

Model: X1-Hybrid-5.0-D-E

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks 5)
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

Parameter at 0% per phase	L= 102,1 mH	R= 32,06 Ω	C= 99,33 µF

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: 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 I_{AC} when RLC is adjusted
5) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power PEUT = 25 % – 33 % 6) of maximum
EUT input voltage 7) = <20 % of rated input voltage range
6) Or minimum allowable EUT output level if greater than 33 %.
7) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 10 % of range =X + 0,2 × (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.

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

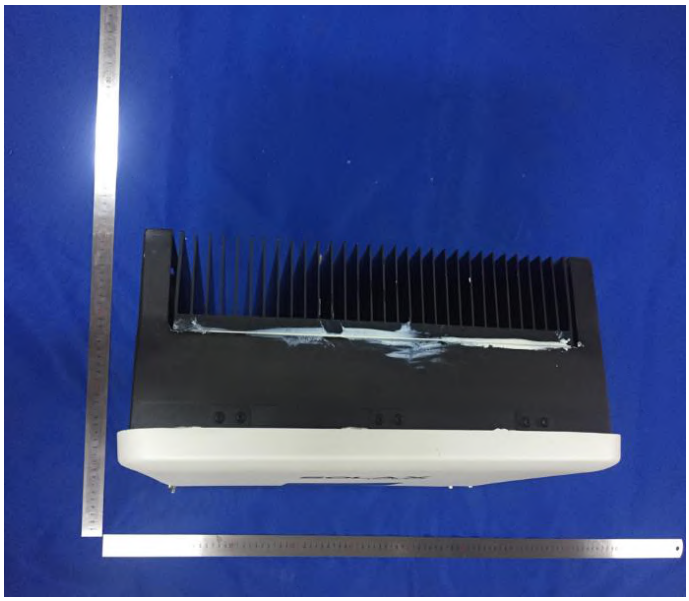
Enclosure front view for all model

Enclosure rear view for all model

Enclosure left view for all model

Enclosure right view for all model

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

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	Programmable DC source	A7040058SH	62150H-1000S	Chroma	-	-
17	Programmable DC source	A7040059SH	62150H-1000S	Chroma	-	-
18	Programmable DC source	A7040069SH	62150H-1000S	Chroma	-	-
19	Programmable DC source	A7040074SH	62150H-1000S	Chroma	-	-
20	Programmable 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	-	-