TEST REPORT

IEC 61683

Photovoltaic systems – Power conditioners – Procedure for measuring efficiency

Report reference number ..... :	**SXP-18OC1761FCSHP-2**
Date of issue ..... ……..:	2019-05-27
Total number of pages ..... ……..:	40
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 61683:1999; EN 61683:2000; DIN EN 61683:2000
Certificate..... :	**Certificate of compliance**
Test report form number. ..... :	IEC61683
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 – Datasheet of the unit
3. Annex No. 2 – Pictures of the unit
4. Annex No. 3 – Test equipment list

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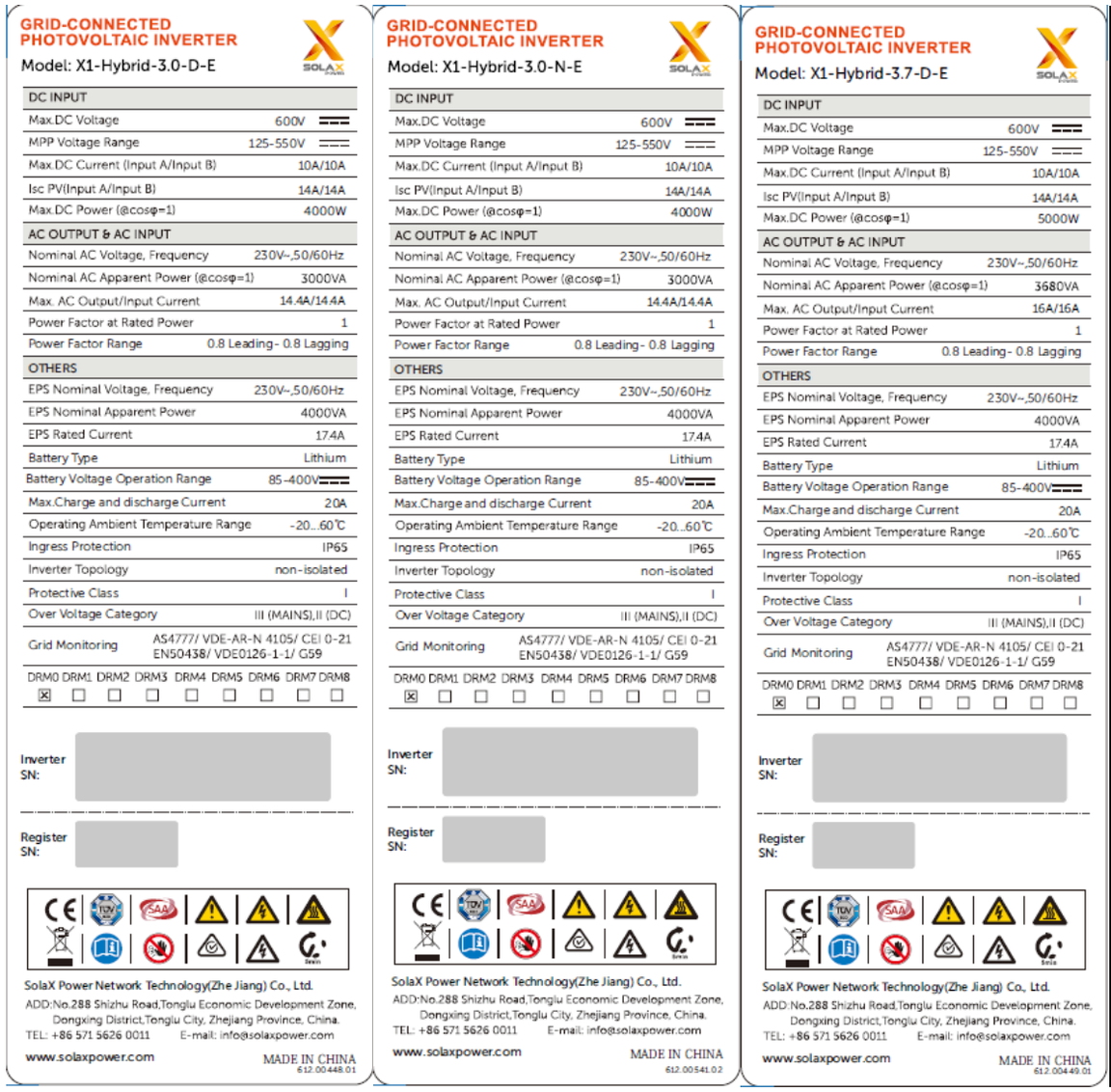

GRID-CONNECTED PHOTOVOLTAIC INVERTER

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:

Register SN:

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612.00448.01

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

DRM0 DRM1 DRM2 DRM3 DRM4 DRM5 DRM6 DRM7 DRM8

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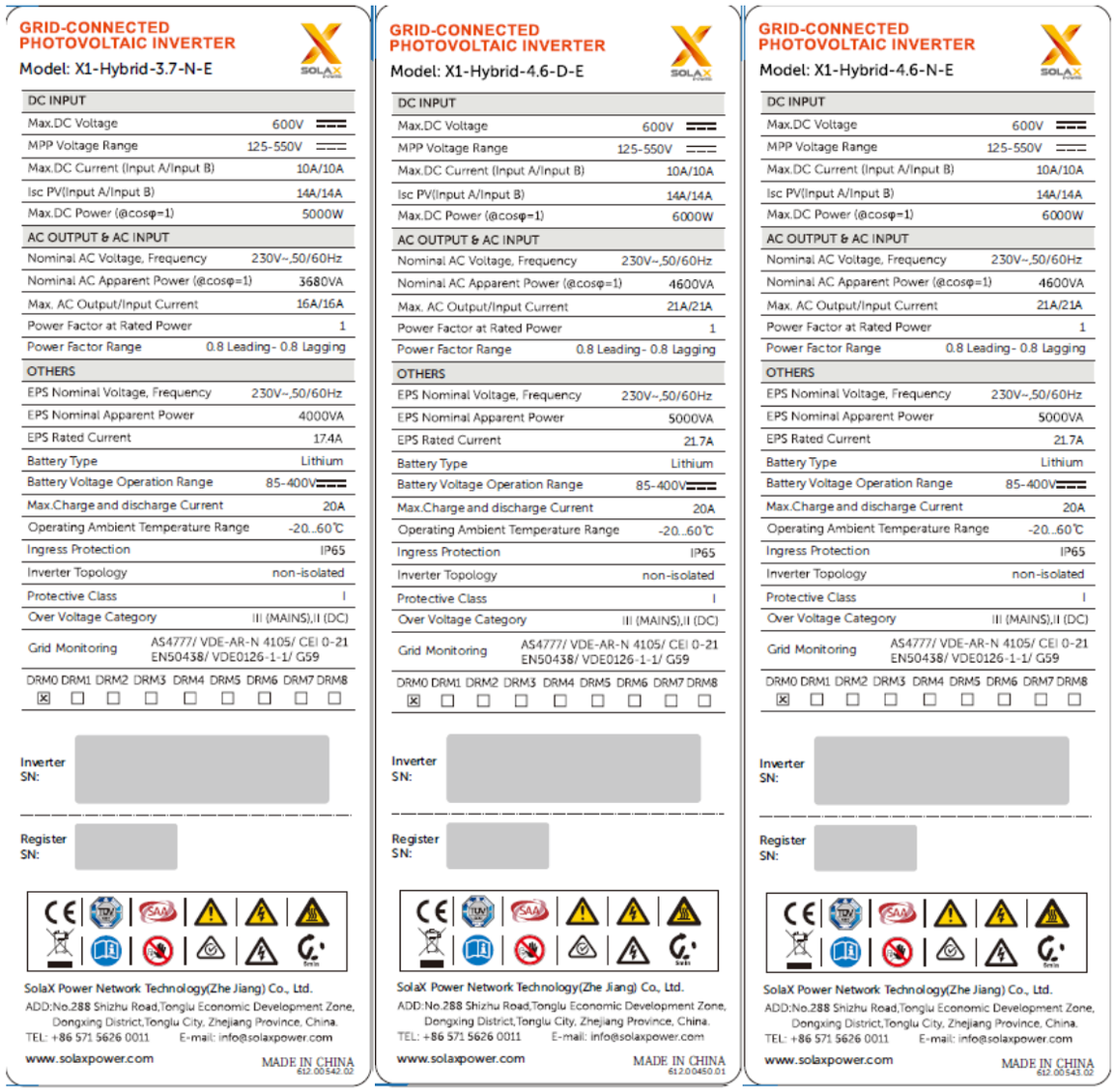

GRID-CONNECTED PHOTOVOLTAIC INVERTER

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

DRM0 DRM1 DRM2 DRM3 DRM4 DRM5 DRM6 DRM7 DRM8

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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

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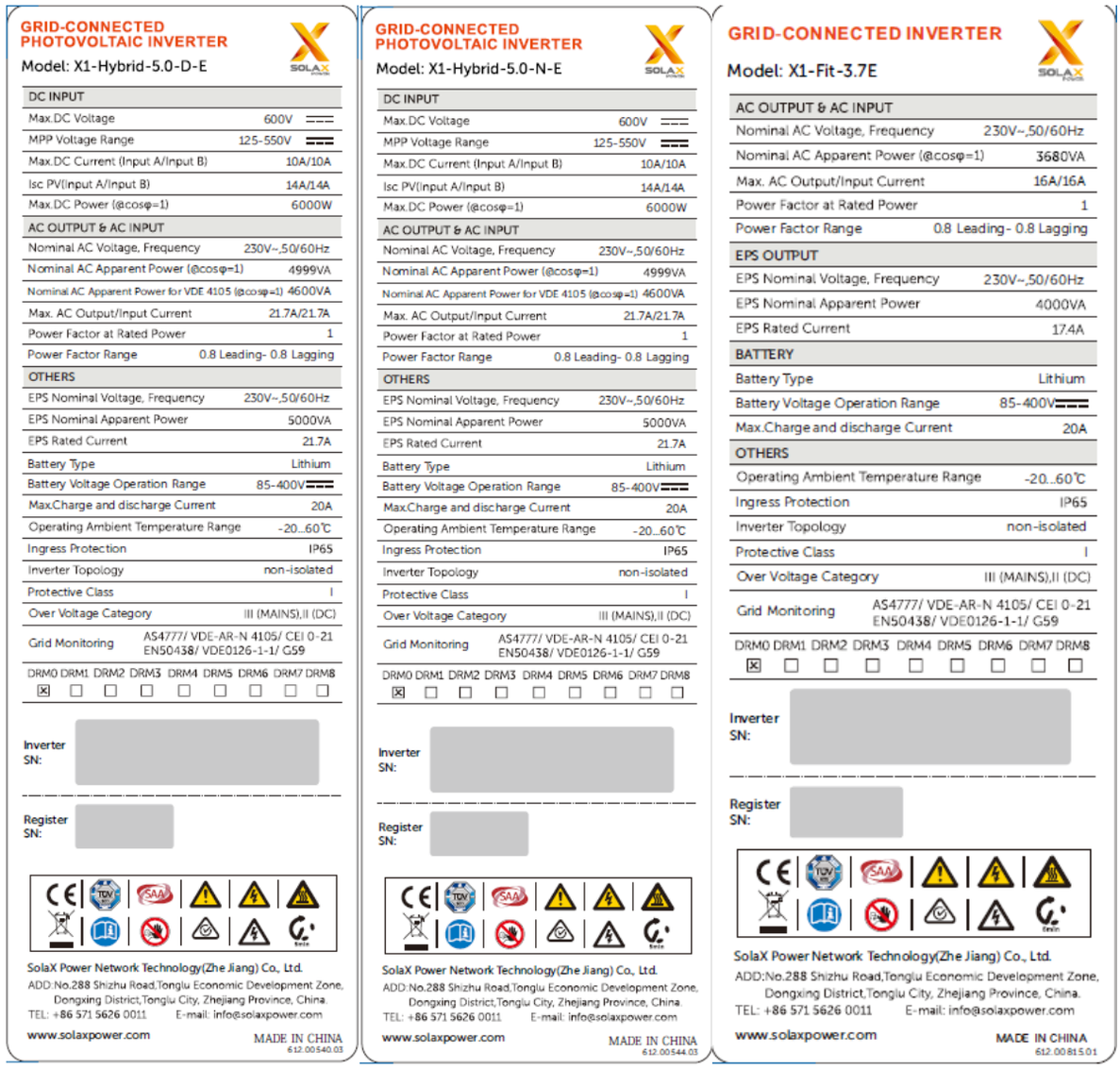

GRID-CONNECTED PHOTOVOLTAIC INVERTER

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

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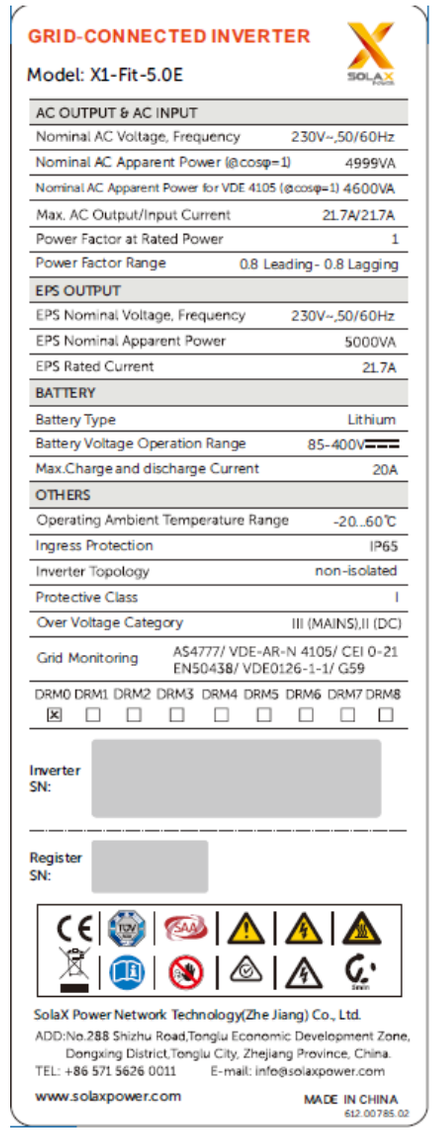

GRID-CONNECTED INVERTER

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
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DRM0	DRM1	DRM2	DRM3	DRM4	DRM5	DRM6	DRM7	DRM8
☒	☐	☐	☐	☐	☐	☐	☐	☐

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612.00785.02

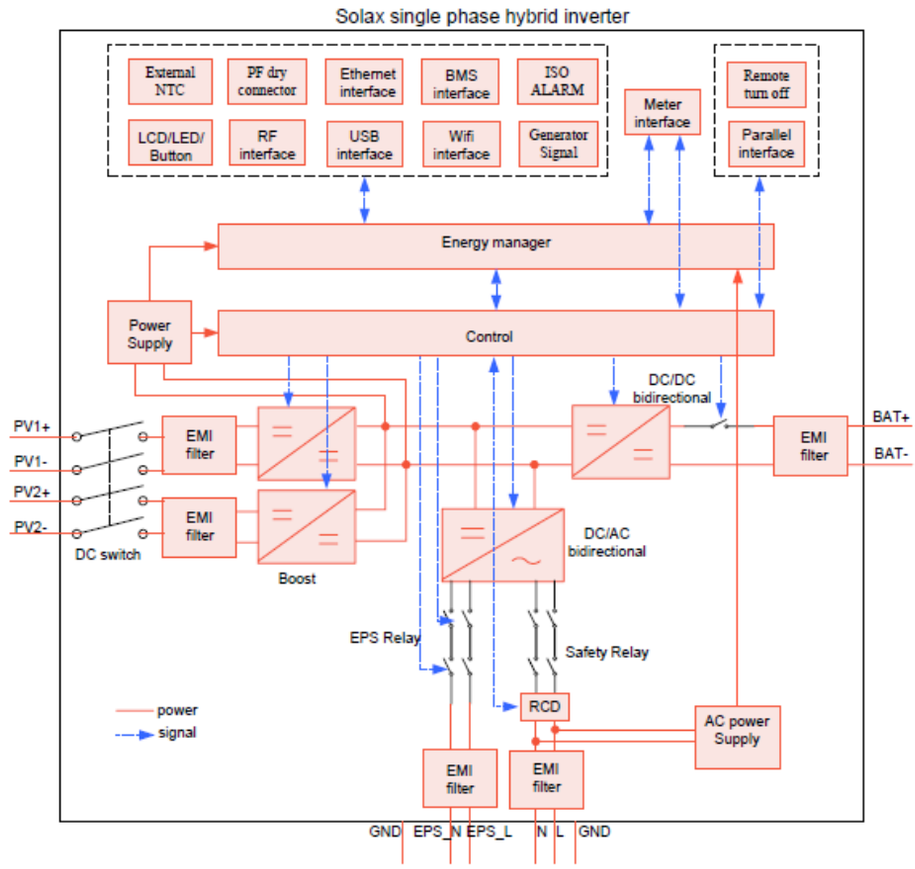
General product information:

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.

IEC 61683:1999			
Clause/§	**Requirement**	**Remark**	**Verdict**
1	**Scope** (measuring the efficiency of power conditioners used in stand-alone and utility-interactive photovoltaic systems)		
2	**Normative references**		
	IEC 60146-1-1:1991,		
3	**Definitions**		
	3.1 rated output efficiency 3.2 partial output efficiency 3.3 energy efficiency 3.4 efficiency tolerance 3.5 PV array simulator 3.6 no-load loss 3.7 standby loss 3.8 maximum power point tracking (MPPT)		
4	**Efficiency measurement conditions**		**P**
	Efficiency shall be measured under the matrix of conditions as described in the following clauses and table 1. Specific conditions may be excluded by mutual agreement when those conditions are outside the manufacturer's allowable operating range. The resulting data shall be presented in tabular form and may also be presented graphically.	See below.	P
4.1	DC power source for testing		P
	For power conditioners operating with fixed input voltage, the d.c. power source shall be a storage battery or constant voltage power source to maintain the input voltage.	Not such source.	N/A
	For power conditioners that employ maximum power point tracking (MPPT) and shunt-type power conditioners, either a photovoltaic array or a photovoltaic array simulator shall be utilized.	Photovoltaic array simulator used.	P
4.2	Temperature		P
	All measurements are to be made at an ambient temperature of 25 °C ± 2 °C.	25°C ± 2 °C.	P
4.3	Output voltage and frequency		P
	The output voltage and frequency shall be maintained at the manufacturer's stated nominal values.	230V (L-N), 50 Hz	P
4.4	Input voltage		P
	manufacturer's minimum rated input voltage	125Vdc for all model	P

IEC 61683:1999			
Clause/§	**Requirement**	**Remark**	**Verdict**
	the inverter's nominal voltage or the average of its rated input range	360Vdc for all model	P
	90 % of the inverter's maximum input voltage	450Vdc for all model	P
4.5	Ripple and distortion		P
	Record input voltage and current ripple for each measurement	The ripple of the input voltage had no influence on the measurements. (see appended table)	P
4.6	Resistive loads/utility grid		P
	Grid-connected inverters: measure the efficiency for power levels of 10 %, 25 %, 50 %, 75 %, 100 % and 120 %	The efficiency measurement was performed at 10 %, 25 %, 50 %, 75 %, 100 % because the unit does not provide overload function.	P
	Stand-alone inverters: measure the efficiency for power levels of 5 %, 10 %, 25 %, 50 %, 75 %, 100 % and 120 %	No Stand-alone Inverter.	N/A
4.7	Reactive loads	No Stand-alone Inverter.	N/A
	Stand-alone inverters: efficiency with a load which provides a power factor equal to the manufacturer's specified minimum level (or 0,25, whichever is greater) and at power levels of 25 %, 50 % and 100 % of rated VA	No Stand-alone Inverter.	N/A
	Stand-alone inverters: efficiency with power factors of 0,5 and 0,75 (do not go below the manufacturer's specified minimum PF) and power levels of 25 %, 50 %, and 100 % of rated VA	No Stand-alone Inverter.	N/A
4.8	Resistive plus non-linear loads	No Stand-alone Inverter.	N/A
	Stand-alone inverters: efficiency with a fixed non-linear load (total harmonic distortion (THD) = (80 ± 5) %) equal to (25 ± 5) % of the inverter's rated VA plus sufficient resistive load in parallel to achieve a total load of 25 %, 50 % and 100 % of rated VA	No Stand-alone Inverter.	N/A
	Stand-alone inverters: efficiency with a fixed non-linear load equivalent to (50 ± 5) % of the inverter’s rated VA plus sufficient resistive load in parallel to achieve a total load of 50 % and 100 % of rated VA	No Stand-alone Inverter.	N/A
4.9	Complex loads	No Stand-alone Inverter.	N/A
	Stand-alone inverters: efficiency with a fixed non-linear load (THD = (80 ± 5) %) equal to (50 ± 5) % of the inverter's rated VA plus a sufficient reactive load (PF = 0,5) in parallel to achieve a total load of 50 % and 100 % of rated VA.	No Stand-alone Inverter.	N/A

5.	**Efficiency calculations**		**P**
5.1	Rated output efficiency		P

IEC 61683:1999			
Clause/§	**Requirement**	**Remark**	**Verdict**
	Rated output efficiency shall be calculated from measured data as follows: $\eta_R = (P_o / P_i) \times 100$	Applied	P
5.2	Partitial output efficiency		P
	Partial output efficiency shall be calculated from measured data as follows: $\eta_{par} = (P_{op} / P_{ip}) \times 100$	Applied	P
5.3	Energy efficiency		P
	Energy efficiency shall be calculated from measured data as follows: $\eta_E = (W_o / W_i) \times 100$	Applied	P
5.4	Efficiency tolerances		P
	When an efficiency value has been guaranteed, the tolerance of this value shall be within: $-0,2(1-\eta)\eta$ (%)		P

6.	**Efficiency test circuits**		**P**
6.1	Test circuits		P
	See figures 1a and 1b	Figure 1b was used.	P
6.2	Measurement procedure		P
	a) Efficiency is calculated with equation (1) or (2) using measured P_i, P_o or P_{ip}, P_{op}. DC input power P_i, P_{ip} can be measured by wattmeter W_1, or determined by multiplying the d.c. voltmeter V_1 and d.c. ammeter A_1 readings. Output power P_o, P_{op} is measured with wattmeter W_2.	Applied	P
	b) DC input voltage, which is measured by d.c. voltmeter V_1, shall be varied in the defined range where the output current, which is measured with a.c. ammeter A_2, is varied from low output to the rated output.	Applied	P
	c) An average indicating instrument shall be used for the d.c. voltmeter and d.c. ammeter. A true r.m.s. type of indicating instrument shall be used for the a.c. voltmeter and a.c. ammeter. The d.c. wattmeter W_1 shall be a d.c. measuring type. The wattmeter W_2 shall be an a.c. or d.c. measuring type according to the output.	Applied	P
	d) Power factor (PF in per cent) can be measured by a power factor meter PF, or calculated from the readings of V_2, A_2, W_2 and as follows: $PF = (W_2/(V_2 \times A_2)) \times 100$	Applied	P
	e) Each meter may be an analogue type or a digital type. The measurement accuracy shall be better than ± 0,5 % of the full-scale value for each power measured. Digital power instruments for W1 and W2 are also recommended.	Digital measurement devices were used for testing. The accuracy of the measurement devices fulfills the requirements.	P

IEC 61683:1999			
Clause/§	**Requirement**	**Remark**	**Verdict**
	f) An MPPT dynamically adjusts the input voltage so as to maximize the output power. In principle, the monitoring equipment shall sample all of the electrical parameters, such as input voltage and current, output power and current, within the update period of the MPPT. If the MPPT and input source (PV array or PV array simulator) interact in such a way that the input voltage varies by less than 5 %, then averaging of readings is acceptable. The averaging period shall be 30 s or longer.	The dynamic MPPT was deactivated, the 60s average was used anyway.	P

7.	**Loss measurement**		**P**
7.1	No-load loss		P
	Stand-alone inverters: reading of d.c. input voltage, output voltage and frequency is given with meters V_1, V_2 and F respectively in figure 1a, and shall be adjusted to the rated values.	No Stand-alone inverter.	N/A
	Utility-interactive inverters: reading of d.c. input voltmeter V_1, a.c. output voltmeter V_2 and frequency meter F in figure 1b shall be adjusted to meet the specified voltages and frequency.		P
7.2	Standby loss		P
	Stand-alone inverters: Consumption of utility power when the power conditioner is not operating but is under standby condition.	No Stand-alone inverter.	P
	Utility-interactive inverters: consumption from the d.c. source when the power conditioner is not operating but is under standby condition.		P

Annex A	**Power conditioner description (informative)**		**P**
	A power conditioner is defined in IEC 61277	Figure A.2	P

Annex B	**Power efficiency and conversion factor (informative)**		**P**
	There are two types of efficiencies shown in IEC 60146-2; one is a power efficiency, the other is a conversion factor. Power efficiency is defined as the ratio of active output power and active input power. Conversion factor is the ratio between output and input fundamental power levels.	Power efficiency used.	P

Annex C	**Weighted-average energy efficiency (informative)**		**P**
	The energy of a power conditioner depends on both the irradiance profile and the load profile. The energy efficiency of a power conditioner shall be calculated by the ratio of the output to the input energy actually measured over a certain period		P

IEC 61683:1999			
Clause/§	**Requirement**	**Remark**	**Verdict**
C.1	η_{WT} of power conditioner for utility-interactive PV systems	X1-Hybrid-3.0-D-E 96,46% X1-Hybrid-3.7-D-E 96,53% X1-Hybrid-4.6-D-E 96,36% X1-Hybrid-5.0-D-E 98,50%	P
	Utility-interactive PV systems, which have no storage and for which reverse-power flow is accepted, are described. In this case, d.c. power generated by the PV array is supplied direct into the power conditioner (PC). Almost all of the input power to the PC is converted to a.c. power. A part of it is dissipated as the PC loss.		P
C.2	η_{WT} of power conditioner for stand-alone PV systems		N/A
	In stand-alone PV systems with a storage subsystem, power generated from the PV array is stored and stabilized by the batteries. DC power is converted into regulated d.c. power or constant-voltage and constant-frequency a.c. power by a power conditioner (PC) and supplied to the load. In this case, some fraction of the generated power is dissipated as a loss in the batteries and power conditioner.	No Stand-alone inverter.	N/A

Annex D	**Derivation of efficiency tolerance in table 2 (informative)**		**P**

4.5 Input ripple and distortion						**P**
Model: X1-Hybrid-5.0-D-E						
Ripple voltage(V) (Vp-p)		Power Level				
		10%	25%	50%	75%	100%
		0,50kW	1,25kW	2,50kW	3,75kW	5kW
V_{min}	250	1,12	1,64	2,60	2,30	3,20
$V_{nominal}$	360	4,60	6,80	10,90	6,70	6,10
$V_{max (90\% MPPT)}$	500	1,90	1,50	1,80	2,70	3,20
Ripple current(A) (Ap-p)		Power Level				
		10%	25%	50%	75%	100%
		0,50kW	1,25kW	2,50kW	3,75kW	5kW
V_{min}	250	0,06	0,11	0,45	0,64	1,15
$V_{nominal}$	360	0,88	1,49	1,90	0,52	0,65
$V_{max (90\% MPPT)}$	500	0,04	0,10	0,16	0,40	0,50

4. Efficiency measurement conditions test results						P
Model: X1-Hybrid-5.0-D-E		Temperature 25°C				
Input voltage (Vdc)		Power Level				
		10%	25%	50%	75%	100%
		0,50kW	1,25kW	2,50kW	3,75kW	5kW
V_{min}	250	91,50	93,01	92,98	94,28	94,69
$V_{nominal}$	360	93,89	95,97	96,41	96,18	95,78
$V_{max\ (90\%\ MPPT)}$	500	90,88	95,05	96,12	96,14	95,88

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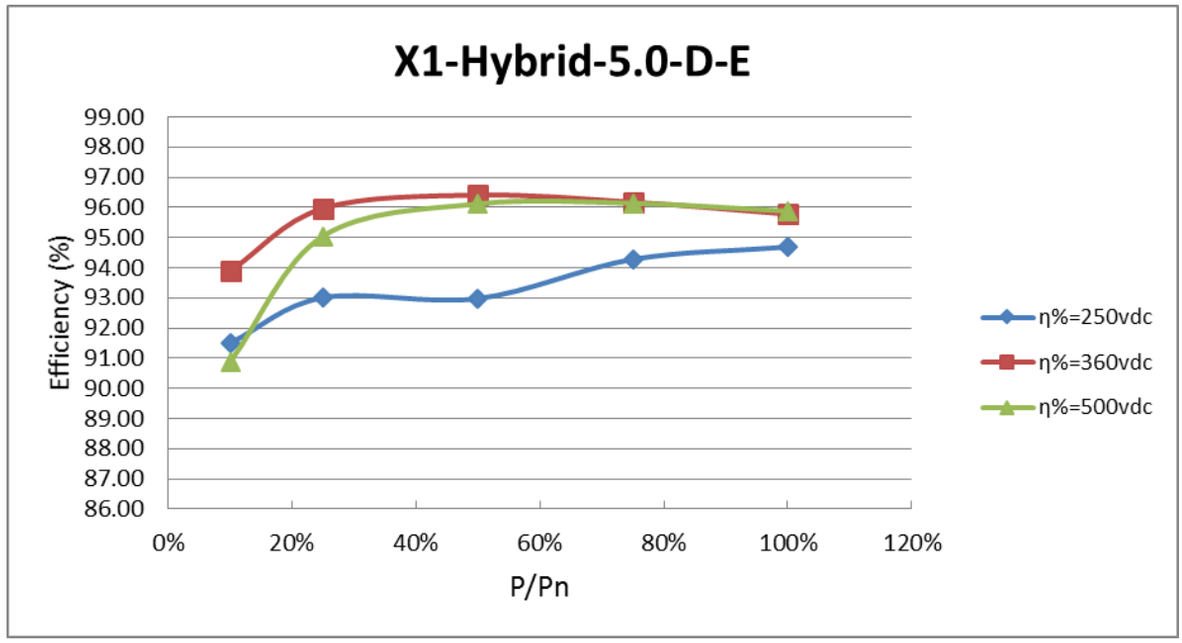

Internal power consumption via auxilary input in standby : 0,5W (Input: 0V, 0A; Output: 230V, 2,17mA)

Internal power consumption via auxilary input at maximum output power : 1,4W

4,5 Input ripple and distortion						**P**
Model: X1-Hybrid-4.6-D-E						
Ripple voltage(V) (Vp-p)		Power Level				
		10%	25%	50%	75%	100%
		0,46kW	1,15kW	2,30kW	3,45kW	4,60kW
V_{min}	230	1,10	1,54	1,80	3,40	2,80
$V_{nominal}$	360	1,50	2,10	3,50	4,30	6,20
$V_{max\ (90\%\ MPPT)}$	500	1,40	2,07	2,20	2,80	3,10
Ripple current(A) (Ap-p)		Power Level				
		10%	25%	50%	75%	100%
		0,46kW	1,15kW	2,30kW	3,45kW	4,60kW
V_{min}	230	0,05	0,08	0,30	0,56	0,96
$V_{nominal}$	360	0,03	0,10	0,18	0,47	0,64
$V_{max\ (90\%\ MPPT)}$	500	0,03	0,08	0,14	0,34	0,44

4, Efficiency measurement conditions test results						P
Model: X1-Hybrid-4.6-D-E		Temperature 25°C				
Input voltage (Vdc)		Power Level				
		10%	25%	50%	75%	100%
		0,46kW	1,15kW	2,30kW	3,45kW	4,60kW
V_{min}	230	91,18	93,04	92,68	94,34	94,47
$V_{nominal}$	360	93,41	95,84	96,36	96,08	95,93
$V_{max\ (90\%\ MPPT)}$	500	90,16	94,71	96,00	96,18	95,93

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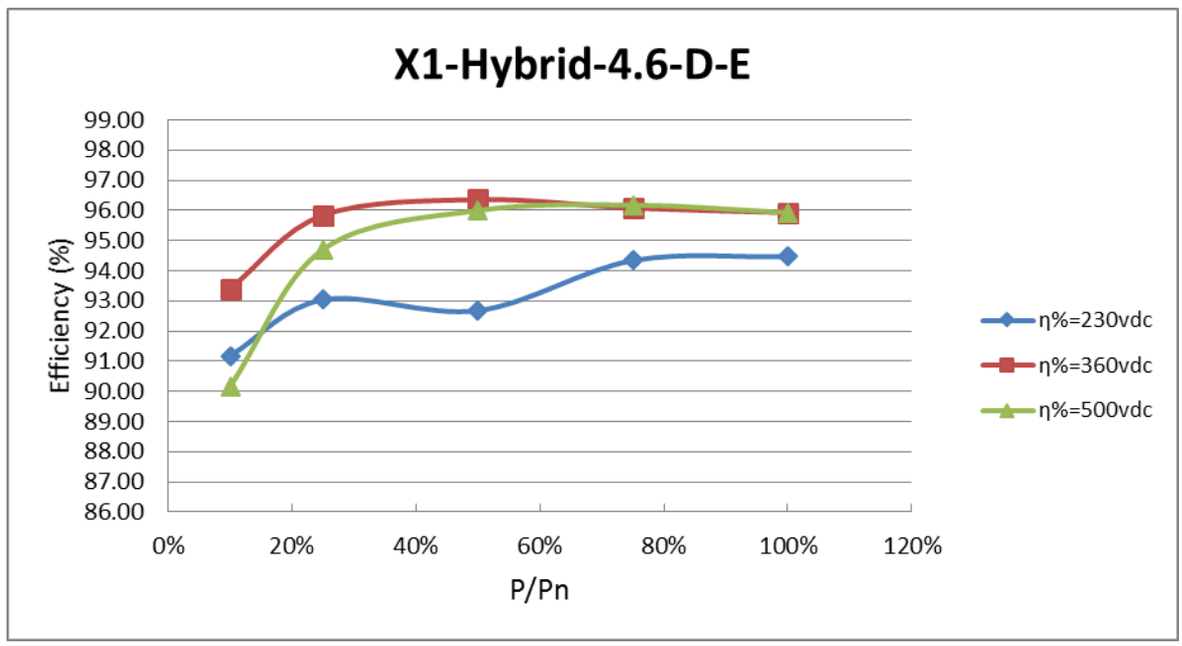

Internal power consumption via auxilary input in standby : 0,5W (Input: 0V, 0A; Output: 230V, 2,17mA)

Internal power consumption via auxilary input at maximum output power : 1,2W

4,5 Input ripple and distortion						**P**
Model: X1-Hybrid-3.7-D-E						
Ripple voltage(V) (Vp-p)		Power Level				
		10%	25%	50%	75%	100%
		0,37kW	0,92kW	1,84kW	2,76kW	3,7kW
V_{min}	190	1,12	1,60	2,60	2,90	2,60
$V_{nominal}$	360	2,30	2,60	2,80	3,60	4,50
$V_{max\ (90\%\ MPPT)}$	500	1,10	1,50	1,60	2,50	3,60
Ripple current(A) (Ap-p)		Power Level				
		10%	25%	50%	75%	100%
		0,37kW	0,92kW	1,84kW	2,76kW	3,7kW
V_{min}	190	0,04	0,09	0,81	0,50	1,02
$V_{nominal}$	360	0,04	0,08	0,15	0,39	0,49
$V_{max\ (90\%\ MPPT)}$	500	0,02	0,06	0,12	0,22	0,36

4, Efficiency measurement conditions test results						P
Model: X1-Hybrid-3.7-D-E		Temperature 25°C				
Input voltage (Vdc)		Power Level				
		10%	25%	50%	75%	100%
		0,37kW	0,92kW	1,84kW	2,76kW	3,7kW
V_{min}	190	90,20	92,81	93,04	93,79	94,31
$V_{nominal}$	360	92,52	95,51	96,22	96,53	95,87
$V_{max\ (90\%\ MPPT)}$	500	88,47	93,84	95,66	96,15	96,14

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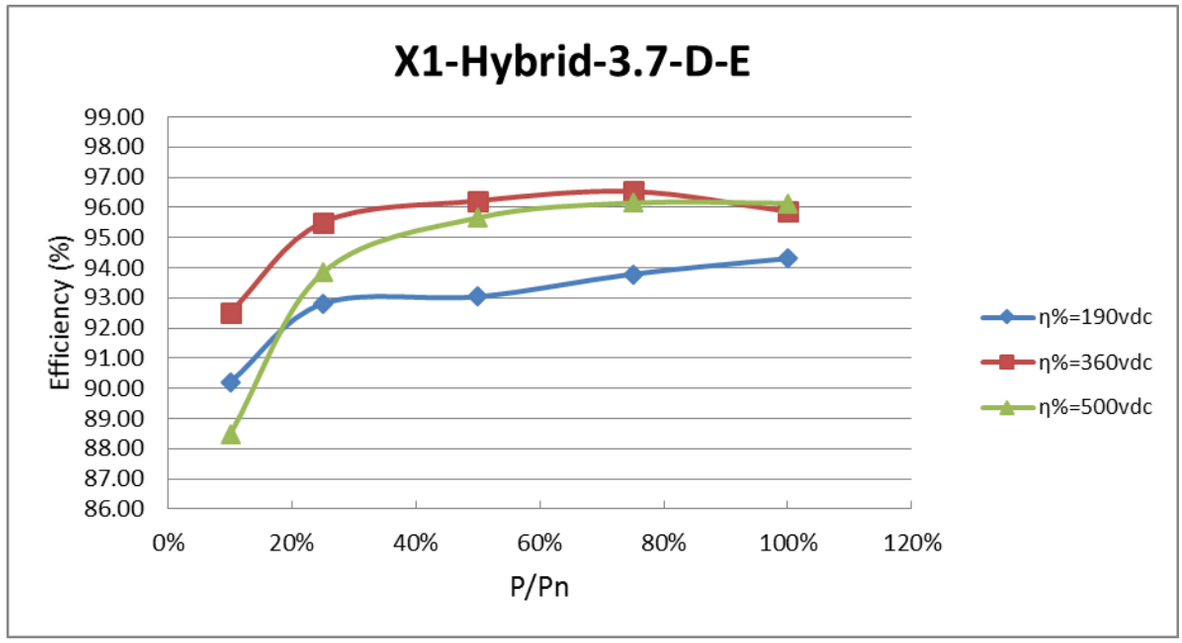

Internal power consumption via auxilary input in standby : 0,5W (Input: 0V, 0A; Output: 230V, 2,17mA)

Internal power consumption via auxilary input at maximum output power : 1,2W

4,5 Input ripple and distortion						**P**
Model: X1-Hybrid-3.0-D-E						
Ripple voltage(V) (Vp-p)		Power Level				
		10%	25%	50%	75%	100%
		0,30 kW	0,75kW	1,50kW	2,25kW	3,0kW
V_{min}	150	1,08	1,19	1,50	3,30	2,90
$V_{nominal}$	360	1,40	1,70	2,40	4,00	3,50
$V_{max\ (90\%\ MPPT)}$	500	1,20	1,10	1,60	2,00	2,20
Ripple current(A) (Ap-p)		Power Level				
		10%	25%	50%	75%	100%
		0,30 kW	0,75kW	1,50kW	2,25kW	3,0kW
V_{min}	150	0,04	0,09	0,41	0,83	0,95
$V_{nominal}$	360	0,02	0,05	0,12	0,24	0,38
$V_{max\ (90\%\ MPPT)}$	500	0,02	0,03	0,09	0,18	0,25

4, Efficiency measurement conditions test results						P
Model: X1-Hybrid-3.0-D-E		Temperature 25°C				
Input voltage (Vdc)		Power Level				
		10%	25%	50%	75%	100%
		0,30 kW	0,75kW	1,50kW	2,25kW	3,0kW
V_{min}	150	89,42	92,94	93,85	93,72	93,44
$V_{nominal}$	360	90,60	95,07	96,03	96,34	96,46
$V_{max\ (90\%\ MPPT)}$	500	88,68	92,87	95,40	95,91	96,17

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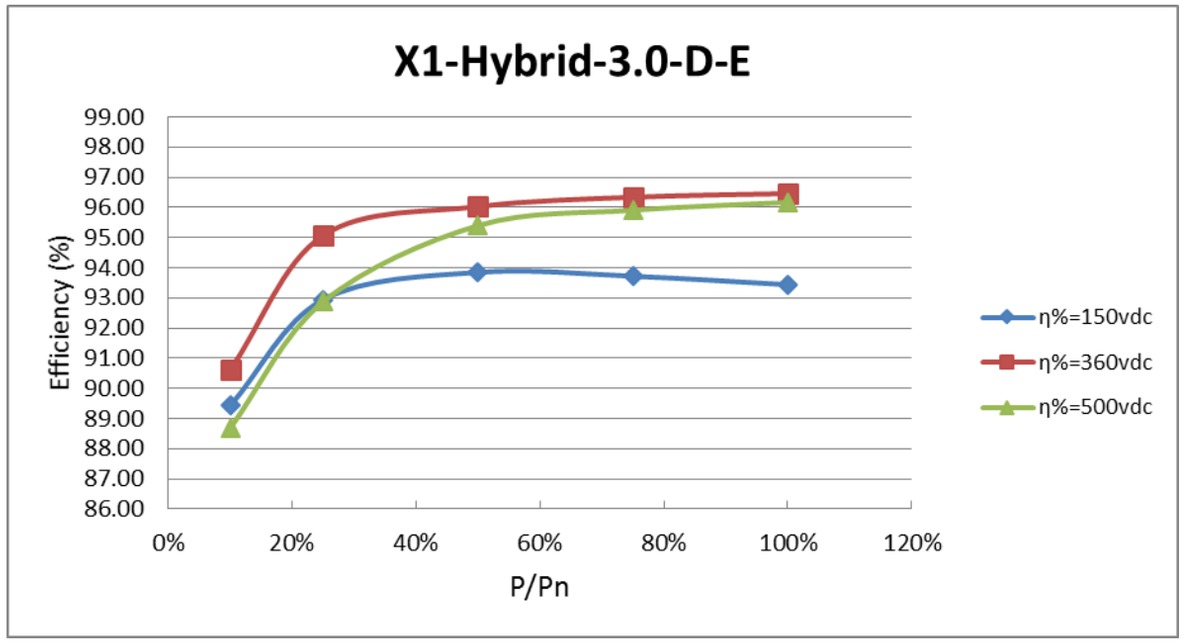


Internal power consumption via auxilary input in standby : 0,5W (Input: 0V, 0A; Output: 230V, 2,17mA)

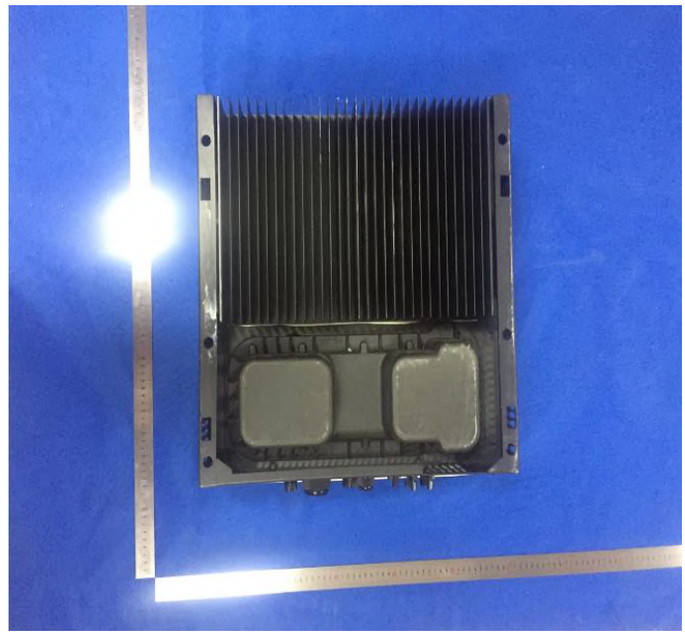
Internal power consumption via auxilary input at maximum output power : 1,2W

Annex 1

Pictures of the unit

Enclosure front view for all model

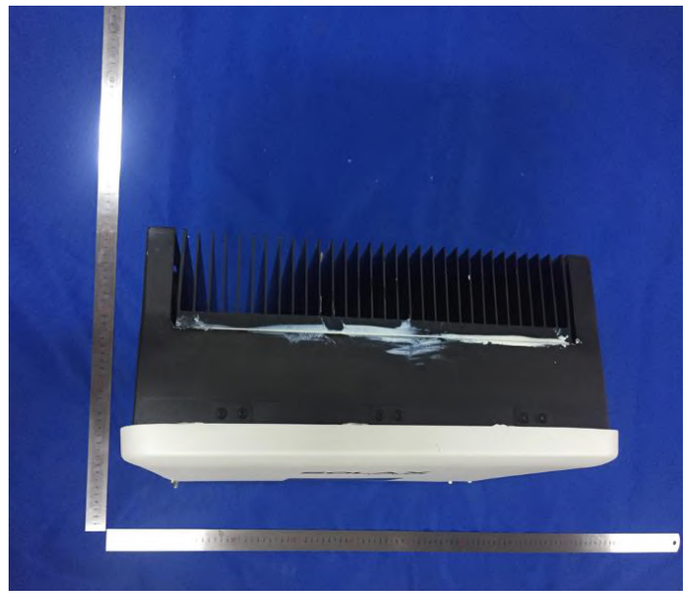
Enclosure rear view for all model



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

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

Enclosure bottom view for X1-Fit-3.7E,X1-Fit-5.0E

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	-	-