



**TEST REPORT  
IEC 61727  
Photovoltaic (PV) systems –  
Characteristics of the utility interface**

**Report Number**..... : GZES191102649903

**Date of issue**..... : 12/ 11 / 2019

**Total number of pages** ..... 22

**Name of Testing Laboratory preparing the Report** ..... : SGS-CSTC Standards Technical Services Co., Ltd.  
Guangzhou Branch

**Applicant's name** ..... : Hitachi Hi-Rel Power Electronics Pvt. Ltd.

**Address**..... : SM 3 & 4, Sanand – II GIDC, Industrial Estate, Boll Village,  
Sanand – 382 110, Gujarat, India.

**Test specification:**

**Standard** ..... : IEC 61727:2004 (Second Edition)

**Test procedure** ..... : Characteristic Examination

**Non-standard test method** ..... : N/A

**Test Report Form No.** ..... : IEC61727A

**Test Report Form(s) Originator** .... : TÜV SÜD Product Service GmbH

**Master TRF** ..... : Dated 2014-11



**Copyright © 2014 IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE System). All rights reserved.**

This publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEE is acknowledged as copyright owner and source of the material. IECEE takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

If this Test Report Form is used by non-IECEE members, the IECEE/IEC logo and the reference to the CB Scheme procedure shall be removed.

**This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.**

**General disclaimer:**

The test results presented in this report relate only to the object tested.

This report shall not be reproduced, except in full, without the written approval of the Issuing CB Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.

<b>Test item description</b> .....	Solar Grid-tied Inverter
<b>Trade Mark</b> .....	
<b>Manufacturer</b> .....	Hitachi Hi-Rel Power Electronics Pvt. Ltd.
<b>Address</b> .....	SM 3 & 4, Sanand – II GIDC, Industrial Estate, Boll Village, Sanand – 382 110, Gujarat, India.
<b>Model/Type reference</b> .....	Hiverter Si-3K-H2, Hiverter Si-3.6K-H2, Hiverter Si-4K-H2, Hiverter Si-4.6K-H2, Hiverter Si-5K-H2, Hiverter Si-6K-H2.
<b>Ratings</b> .....	See model list in Page 7. Serial Number: ZG1ES060H61001 ZH1ES160H9S999 for spot-check test Firmware version: V0.22

<b>Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):</b>		
<b>Test date from 30/10/2017 to 20/11/2017:</b>		
<input checked="" type="checkbox"/>	<b>Testing procedure: TMP/CTF Stage 1:</b>	<b>Shenzhen SOFAR SOLAR Co., Ltd.</b>
<b>Testing location/ address.....</b>		5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China
<b>Tested by (name, function, signature).....</b>		Hugo zhang (Project Engineer)
<b>Approved by (name, function, signature).....</b>		Roger Hu (Technical Reviewer)
<b>Test date: 24/04/2019 and 06/05 2019</b>		
<input checked="" type="checkbox"/>	<b>Testing procedure: TMP/CTF Stage 1:</b>	<b>Shenzhen SOFAR SOLAR Co., Ltd.</b>
<b>Testing location/ address.....</b>		401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen City, Guangdong Province, P.R. China
<b>Tested by (name, function, signature).....</b>		Hugo zhang (Project Engineer)
<b>Approved by (name, function, signature).....</b>		Roger Hu (Technical Reviewer)

<b>List of Attachments (including a total number of pages in each attachment):</b>		
50 Hz		
Attachment #	Description	Pages
Attachment I	Pictures of the EUT and Electrical Schemes	12 pages
Attachment II	Testing Information	5 pages
Attachment II	Graphs and Screenshots of Test Results	15 pages
<b>Summary of testing:</b>		
<p><b>Tests performed (name of test and test clause):</b></p> <p>The equipment has been tested according to the standard: IEC 61727:2004. Testing has been carried out at 50 Hz</p> <p>All applicable tests according to the above specified standard have been carried out.</p> <p>From the result of inspection and tests on the submitted sample, we conclude that it complies with the requirements of the standard.</p> <p><b>Remarks:</b> All the test results are from the report below:</p> <ul style="list-style-type: none"> <li>- IEC 61727:2004 (Second Edition)</li> </ul> <p>Test Report No: 2217 / 1094 – 3 – M1 which was issued by SGS Tecnos, S.A. (Electrical Testing Laboratory) on 06/05/2019</p>	<p><b>Testing location:</b></p> <p>Test data: From 30/10/2017 to 20/11/2017: <b>Shenzhen SOFAR SOLAR Co., Ltd.</b> 5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China</p> <p>Test date: 24/04/2019 and 06/05 2019 <b>Shenzhen SOFAR SOLAR Co., Ltd.</b> 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen City, Guangdong Province, P.R. China (All clauses)</p>	
<b>Summary of compliance with National Differences:</b>		
<p>No National Differences are addressed to this test report</p>		

Copy of marking plate(representative):

<b>HITACHI</b>	
<b>Solar Grid Tied Inverter</b>	
Model No.	Hiverter Si-6K-H2
Max. DC Input Voltage	600V
Operating MPPT Voltage Range	90-580V
Max. Input Current	2x11A
Max. PV Isc	2x13.2A
Nominal Grid Voltage	230V
Max. Output Current	27.3A
Nominal Grid Frequency	50Hz/60Hz
Nominal Output Power	6000W
Max. Output Power	6000VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25 ~+60°C
Protective Class	Class I
 <b>Hitachi Hi-Rel Power Electronics Pvt. Ltd.</b> SM 3 & 4, Sanand - II GIDC, Industrial Estate, Bol Village, Sanand - 382 110, Gujarat, India., www.hitachi-hirel.com	
       	

**Note:**

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation
3. Labels of other models are as the same with Hiverter Si-6K-H2's except the parameters of rating.

<b>Test item particulars</b> .....: Single Phase Inverter	
<b>Classification of installation and use</b> .....: Fixed(permanent connection)	
<b>Supply Connection</b> .....: DC; PV	
.....: AC; Grid connection	
<b>Possible test case verdicts:</b>	
- test case does not apply to the test object..... : N/A	
- test object does meet the requirement..... : P (Pass)	
- test object does not meet the requirement..... : F (Fail)	
<b>Testing</b> .....: CTF Stage 1 procedure	
<b>Date of receipt of test item</b> .....: N/A	
<b>Date (s) of performance of tests</b> .....: From 30/10/2017 to 20/11/2017, 24/04/2019 and 06/05 2019	
<b>General remarks:</b>	
<p>"(See Enclosure #)" refers to additional information appended to the report.          "(See appended table)" refers to a table appended to the report.</p> <p>This document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at <a href="http://www.sgs.com/terms_and_conditions.htm">www.sgs.com/terms_and_conditions.htm</a> and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at <a href="http://www.sgs.com/terms_e-document.htm">www.sgs.com/terms_e-document.htm</a>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.</p> <p><b>Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.</b></p>	
<b>Manufacturer's Declaration per sub-clause 4.2.5 of IEC 61727:</b>	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	<input type="checkbox"/> <b>Yes</b> <input checked="" type="checkbox"/> <b>Not applicable</b>
<b>When differences exist; they shall be identified in the General product information section.</b>	
<b>Name and address of factory (ies) ..... : Dongguan SOFAR SOLAR Co., Ltd.</b>  1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province,P.R. China.	

**General product information:**

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

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

The Solar inverter converts DC voltage into AC voltage.

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

**Equipment Under Testing:**

-Hiverter Si-6K-H2

**Variant models:**

- Hiverter Si-5K-H2
- Hiverter Si-4.6K-H2
- Hiverter Si-4K-H2
- Hiverter Si-3.6K-H2
- Hiverter Si-3K-H2

Product Model	Hiverter Si-3K-H2	Hiverter Si-3.6K-H2	Hiverter Si-4K-H2	Hiverter Si-4.6K-H2	Hiverter Si-5K-H2	Hiverter Si-6K-H2
<b>Input (DC)</b>						
Max.DC Input Power	3500W	4000W	4400W	5000W	5500W	6600W
Max.DC Voltage	600V					
Power Turn on	80V					
Start-up input voltage	120V					
Rated input voltage	360V					
MPPT Voltage Range	90-580V					
Full load DC voltage range	160-520V	180-520V	200-520V	230-520V	250-520V	300-520V
MAX input current per MPPT	11A/11A					
Number of DC inputs	2/2					
<b>Output(AC)</b>						
Max AC Output power	3000VA	3680VA	4000VA	4600VA	5000VA	6000VA
Max AC Output power (PF=1)	3000W	3680W	4000W	4600W	5000W	6000W
Max AC Output Current	13.7A	16.8A	18.2A	21A	22.8A	27.3A
Nominal Grid Voltage	230Vac(Single phase)					
Nominal Frequency	50Hz					
Power factor	1(adjustable+/-0.9)					
Topology	Transformerless					
Operating temperature range	-25°C~60°C					
Degree of protection	IP65					

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

- Same connection system and hardware topology
- Same control algorithm.
- Output power within 2,5 and 2/3 of the EUT or Modular inverters
- Same Firmware Version

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict
<b>4</b>	<b>UTILITY COMPATIBILITY</b>		<b>P</b>
	The quality of power provided by the PV system for the on-site AC loads and for power delivered to the utility is governed by practices and standards on voltage, flicker, frequency, harmonics and power factor.		P
	Deviation from these standards represents out-of-bounds conditions and may require the PV system to sense the deviation and properly disconnect from the utility system.		P
<b>4.1</b>	<b>Voltage, current and frequency</b>		<b>P</b>
	The PV system AC voltage, current and frequency are compatible with the utility system.		P
<b>4.2</b>	<b>Normal voltage operating range</b>		<b>P</b>
	Utility-interconnected PV systems do not normally regulate voltage, they inject current into the utility. Therefore, the voltage operating range for PV inverters is selected as a protection function that responds to abnormal utility conditions, not as a voltage regulation function.		P
<b>4.3</b>	<b>Flicker</b>		<b>P</b>
	The operation of the PV system is not cause voltage flicker in excess of limits stated in the relevant sections of IEC 61000-3-3 for systems less than 16 A or IEC 61000-3-5 for systems with current of 16 A and above.	(see appended table)	P
<b>4.4</b>	<b>DC injection</b>		<b>P</b>
	The PV system is not inject DC current greater than 1 % of the rated inverter output current, into the utility AC interface under any operating condition.	(see appended table)	P
<b>4.5</b>	<b>Normal frequency operating range</b>		<b>P</b>
	The PV system operates in synchronism with the utility system, and within the frequency trip limits defined in 5.2.2.		P
<b>4.6</b>	<b>Harmonics and waveform distortion</b>		<b>P</b>
	Total harmonic current distortion is less than 5 % at rated inverter output. Each individual harmonic is limited to the percentages listed in Table 1.	(see appended table)	P
	Even harmonics in these ranges is less than 25 % of the lower odd harmonic limits listed.		P

IEC 61727: 2004																			
Clause	Requirement + Test	Result - Remark	Verdict																
	<b>Table 1 – Current distortion limits</b> <table border="1"> <thead> <tr> <th>Odd harmonics</th> <th>Distortion limit</th> </tr> </thead> <tbody> <tr> <td>3<sup>rd</sup> through 9<sup>th</sup></td> <td>Less than 4,0 %</td> </tr> <tr> <td>11<sup>th</sup> through 15<sup>th</sup></td> <td>Less than 2,0 %</td> </tr> <tr> <td>17<sup>th</sup> through 21<sup>st</sup></td> <td>Less than 1,5 %</td> </tr> <tr> <td>23<sup>rd</sup> through 33<sup>rd</sup></td> <td>Less than 0,6 %</td> </tr> <tr> <th>Even harmonics</th> <th>Distortion limit</th> </tr> <tr> <td>2<sup>nd</sup> through 8<sup>th</sup></td> <td>Less than 1,0 %</td> </tr> <tr> <td>10<sup>th</sup> through 32<sup>nd</sup></td> <td>Less than 0,5 %</td> </tr> </tbody> </table>		Odd harmonics	Distortion limit	3 <sup>rd</sup> through 9 <sup>th</sup>	Less than 4,0 %	11 <sup>th</sup> through 15 <sup>th</sup>	Less than 2,0 %	17 <sup>th</sup> through 21 <sup>st</sup>	Less than 1,5 %	23 <sup>rd</sup> through 33 <sup>rd</sup>	Less than 0,6 %	Even harmonics	Distortion limit	2 <sup>nd</sup> through 8 <sup>th</sup>	Less than 1,0 %	10 <sup>th</sup> through 32 <sup>nd</sup>	Less than 0,5 %	P
Odd harmonics	Distortion limit																		
3 <sup>rd</sup> through 9 <sup>th</sup>	Less than 4,0 %																		
11 <sup>th</sup> through 15 <sup>th</sup>	Less than 2,0 %																		
17 <sup>th</sup> through 21 <sup>st</sup>	Less than 1,5 %																		
23 <sup>rd</sup> through 33 <sup>rd</sup>	Less than 0,6 %																		
Even harmonics	Distortion limit																		
2 <sup>nd</sup> through 8 <sup>th</sup>	Less than 1,0 %																		
10 <sup>th</sup> through 32 <sup>nd</sup>	Less than 0,5 %																		
4.7	The PV system has a lagging power factor greater than 0,9 when the output is greater than 50 % of the rated inverter output power.	(see appended table)	P																
5	<b>PERSONNEL SAFETY AND EQUIPMENT PROTECTION</b>		P																
	This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.		P																
5.1	<b>Loss of utility voltage</b>		P																
	To prevent islanding, a utility connected PV system ceases to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified time limits.		P																
	A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to fault conditions or the distribution line switched out during maintenance.		P																
5.2	<b>Over/under voltage and frequency</b>		P																
	The abnormal utility conditions of concern are voltage and frequency excursions above or below the values stated in this Clause, and the complete disconnection of the utility, presenting the potential for a distributed resource island.	(see appended table)	P																
5.2.1	<b>Over/under voltage</b>		P																
	When the interface voltage deviates outside the conditions specified in Table 2, the photovoltaic system ceases to energize the utility distribution system. This applies to any phase of a multiphase system.	(see appended table)	P																
	<b>Table 2 – Response to abnormal voltages</b> <table border="1"> <thead> <tr> <th>Voltage (at point of utility connection)</th> <th>Maximum trip time*</th> </tr> </thead> <tbody> <tr> <td><math>V &lt; 0,5 \times V_{nominal}</math></td> <td>0,1 s</td> </tr> <tr> <td><math>50 \% \leq V &lt; 85 \%</math></td> <td>2,0 s</td> </tr> <tr> <td><math>85 \% \leq V \leq 110 \%</math></td> <td>Continuous operation</td> </tr> <tr> <td><math>110 \% &lt; V &lt; 135 \%</math></td> <td>2,0 s</td> </tr> <tr> <td><math>135 \% \leq V</math></td> <td>0,05 s</td> </tr> </tbody> </table> <p>* Trip time refers to the time between the abnormal condition occurring and the inverter ceasing to energize the utility line. The PV system control circuits shall actually remain connected to the utility to allow sensing of utility electrical conditions for use by the "reconnect" feature.</p>		Voltage (at point of utility connection)	Maximum trip time*	$V < 0,5 \times V_{nominal}$	0,1 s	$50 \% \leq V < 85 \%$	2,0 s	$85 \% \leq V \leq 110 \%$	Continuous operation	$110 \% < V < 135 \%$	2,0 s	$135 \% \leq V$	0,05 s	P				
Voltage (at point of utility connection)	Maximum trip time*																		
$V < 0,5 \times V_{nominal}$	0,1 s																		
$50 \% \leq V < 85 \%$	2,0 s																		
$85 \% \leq V \leq 110 \%$	Continuous operation																		
$110 \% < V < 135 \%$	2,0 s																		
$135 \% \leq V$	0,05 s																		
5.2.2	<b>Over/under frequency</b>		P																

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict
	When the utility frequency deviates outside the specified conditions the photovoltaic system ceases to energize the utility line. The unit does not have to cease to energize if the frequency returns to the normal utility continuous operation condition within the specified trip time.	(see appended table)	P
	When the utility frequency is outside the range of $\pm 1$ Hz, the system ceases to energize the utility line within 0,2 s. The purpose of the allowed range and time delay is to allow continued operation for short-term disturbances and to avoid excessive nuisance tripping in weak-utility system conditions.		P
<b>5.3</b>	<b>Islanding protection</b>		<b>P</b>
	The PV system must cease to energize the utility line within 2 s of loss of utility.	Test according IEC 62116: 2014	P
<b>5.4</b>	<b>Response to utility recovery</b>		<b>P</b>
	Following an out-of-range utility condition that has caused the photovoltaic system to cease energizing, the photovoltaic system is not energize the utility line for 20 s to 5 min after the utility service voltage and frequency have recovered to within the specified ranges.	(see appended table)	P
<b>5.5</b>	<b>Earthing</b>		<b>P</b>
	The utility interface equipment is earthed/grounded in accordance with IEC 60364-7-712.		P
<b>5.6</b>	<b>Short circuit protection</b>		<b>P</b>
	The photovoltaic system has short-circuit protection in accordance with IEC 60364-7-712.		P
<b>5.7</b>	<b>Isolation and switching</b>		<b>P</b>
	A method of isolation and switching is provided in accordance with IEC 60364-7-712.		P

IEC 61727: 2004				
Clause	Requirement + Test	Result - Remark		Verdict
<b>4.3</b>	<b>TABLE: Flicker</b>			<b>P</b>
	<b>Starting</b>	<b>Stopping</b>	<b>Running</b>	
<b>Limit</b>	<b>4%</b>	<b>4%</b>	<b>Pst = 1.0</b>	<b>Plt = 0.65</b>
<b>Sample model</b>	Hiverter Si-6K-H2			
<b>33%Pn</b>				
<b>Test value</b>	0.25	0.10	0.08	0.08
<b>66%Pn</b>				
<b>Test value</b>	0.54	0.15	0.11	0.10
<b>100%Pn</b>				
<b>Test value</b>	0.81	0.14	0.07	0.07
Supplementary information: N/A				

<b>4.4</b>	<b>TABLE: Direct current injection</b>							<b>P</b>	
<b>Rated output current (A)</b>	<b>Ratio of rated output power (VA)</b>	<b>Measured DC output current between terminals (mA)</b>						<b>Isolated transformer ? (Yes/No)</b>	<b>Limit (mA)</b>
		<b>L1-L2</b>	<b>L1-L3</b>	<b>L2-L3</b>	<b>L1-N</b>	<b>L2-N</b>	<b>L3-N</b>		
27.3	25%	--	--	--	29.00	--	--	<b>No</b>	273
27.3	50%	--	--	--	32.00	--	--	<b>No</b>	273
27.3	100%	--	--	--	63.00	--	--	<b>No</b>	273
Supplementary information: N/A									

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

4.6(a)	Table: harmonics and waveform distortion (at 33%Pn)					P
Harmonic	% of fundamental	Limits (% of fundamental)	Harmonic	% of fundamental	Limits (% of fundamental)	
02	0.086	1	03	2.114	4	
04	0.070	1	05	0.94	4	
06	0.027	1	07	0.897	4	
08	0.035	1	09	0.82	4	
10	0.067	0.5	11	0.812	2	
12	0.019	0.5	13	0.778	2	
14	0.051	0.5	15	0.673	2	
16	0.028	0.5	17	0.584	1.5	
18	0.029	0.5	19	0.478	1.5	
20	0.067	0.5	21	0.333	1.5	
22	0.018	0.5	23	0.238	0.6	
24	0.038	0.5	25	0.166	0.6	
26	0.035	0.5	27	0.073	0.6	
28	0.007	0.5	29	0.071	0.6	
30	0.020	0.5	31	0.089	0.6	
32	0.021	0.5	33	0.047	0.6	
THD	3.063	5	--			
Supplementary information:						

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

4.6(b)	Table: harmonics and waveform distortion (at 66%Pn)					P
Harmonic	% of fundamental	Limits (% of fundamental)	Harmonic	% of fundamental	Limits (% of fundamental)	
02	0.116	1	03	1.787	4	
04	0.023	1	05	0.726	4	
06	0.007	1	07	0.704	4	
08	0.017	1	09	0.712	4	
10	0.027	0.5	11	0.645	2	
12	0.009	0.5	13	0.604	2	
14	0.045	0.5	15	0.523	2	
16	0.010	0.5	17	0.441	1.5	
18	0.017	0.5	19	0.358	1.5	
20	0.029	0.5	21	0.244	1.5	
22	0.014	0.5	23	0.193	0.6	
24	0.013	0.5	25	0.131	0.6	
26	0.012	0.5	27	0.074	0.6	
28	0.009	0.5	29	0.090	0.6	
30	0.013	0.5	31	0.061	0.6	
32	0.004	0.5	33	0.060	0.6	
THD	2.507	5	--			
Supplementary information:						

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

4.6(c)	Table: harmonics and waveform distortion (at 100%Pn)					P
Harmonic	% of fundamental	Limits (% of fundamental)	Harmonic	% of fundamental	Limits (% of fundamental)	
02	0.024	1	03	1.725	4	
04	0.041	1	05	0.691	4	
06	0.071	1	07	0.547	4	
08	0.045	1	09	0.540	4	
10	0.053	0.5	11	0.607	2	
12	0.078	0.5	13	0.473	2	
14	0.020	0.5	15	0.398	2	
16	0.038	0.5	17	0.383	1.5	
18	0.048	0.5	19	0.293	1.5	
20	0.016	0.5	21	0.203	1.5	
22	0.046	0.5	23	0.143	0.6	
24	0.026	0.5	25	0.111	0.6	
26	0.011	0.5	27	0.070	0.6	
28	0.016	0.5	29	0.029	0.6	
30	0.033	0.5	31	0.043	0.6	
32	0.021	0.5	33	0.042	0.6	
THD	2.268	5	--			
Supplementary information:						

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

4.6(d)	Table: Spot-check test for harmonics and waveform distortion (at 100%Pn)					P
Harmonic	% of fundamental	Limits (% of fundamental)	Harmonic	% of fundamental	Limits (% of fundamental)	
02	0.065	1	03	1.757	4	
04	0.050	1	05	0.894	4	
06	0.070	1	07	0.277	4	
08	0.067	1	09	0.348	4	
10	0.026	0.5	11	0.374	2	
12	0.089	0.5	13	0.208	2	
14	0.026	0.5	15	0.258	2	
16	0.037	0.5	17	0.261	1.5	
18	0.050	0.5	19	0.161	1.5	
20	0.041	0.5	21	0.127	1.5	
22	0.035	0.5	23	0.108	0.6	
24	0.049	0.5	25	0.114	0.6	
26	0.023	0.5	27	0.021	0.6	
28	0.033	0.5	29	0.007	0.6	
30	0.036	0.5	31	0.018	0.6	
32	0.015	0.5	33	0.057	0.6	
THD	2.125	5	--			
Supplementary information:						

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

4.7	TABLE: Power factor							P
No	Input			Output				Rated output (V.A)
	Voltage (V d.c.)	Current (A d.c.)	Power (W)	Voltage (V a.c.)	Current (A a.c.)	Power (W)	Power factor (+)	
1	362.17	3.45	1248	230.72	5.23	1204	0.998	(20±5)%
2	356.57	5.29	1881	230.96	7.95	1835	0.999	(30±5)%
3	360.74	7.01	2523	231.07	10.67	2464	0.999	(40±5)%
4	354.27	8.87	3134	231.16	13.23	3056	0.999	(50±5)%
5	358.99	10.50	3761	231.32	15.77	3645	0.999	(60±5)%
6	362.77	12.10	4378	231.48	18.32	4239	1.000	(70±5)%
7	362.65	13.81	4994	231.52	20.88	4832	1.000	(80±5)%
8	359.74	15.65	5612	232.29	23.44	5442	1.000	(90±5)%
9	370.73	16.63	6129	232.53	25.74	5983	1.000	(100±5)%
Supplementary information:								
Power factor with “+” indicating leading and “-“ indicating lagging.								

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

<b>4.7(a)</b>	<b>TABLE: Spot-check test for Power factor</b>							<b>P</b>
No	Input			Output				Rated output (V.A)
	Voltage (V d.c.)	Current (A d.c.)	Power (W)	Voltage (V a.c.)	Current (A a.c.)	Power (W)	Power factor (+)	
1	357.61	3.50	1251	230.28	5.25	1200	0.994	(20±5)%
2	358.30	5.23	1875	230.38	7.88	1809	0.997	(30±5)%
3	360.62	6.93	2499	230.48	10.50	2416	0.998	(40±5)%
4	358.91	8.70	3121	230.59	13.12	3020	0.999	(50±5)%
5	355.90	10.51	3742	230.69	15.71	3620	0.999	(60±5)%
6	355.90	12.26	4364	230.79	18.30	4220	0.999	(70±5)%
7	356.50	13.99	4988	230.89	20.89	4820	0.999	(80±5)%
8	365.47	15.27	5579	230.99	23.34	5386	0.999	(90±5)%
9	360.12	17.31	6235	231.09	26.05	6013	0.999	(100±5)%
<p>Supplementary information:</p> <p>Power factor with “+” indicating leading and “-“ indicating lagging.</p>								

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

5.2.1 & 5.4		TABLE: Under-and over-voltage trip settings and reconnection test						P
<b>(1) Under voltage disconnection procedure</b>								
Rated output voltage (V)	Output power (VA)	Required min. voltage (V)	Value of PCE trip settings (V)	Ratio of decreased (V / s)	Interval time (s)	Measured tripped voltage (V)	Measured disconnection time (s)	
50 % $V_n \leq V < 85 \% V_n$								
230	6000	195.5	195	2.3	2	194.80	1.63	
230	6000	155	155	2.3	2	154.78	1.62	
230	6000	117	117	2.3	2	116.83	1.63	
$V < 0,5 \times V_{nominal}$								
230	6000	114	114	2.3	0.1	113.83	0.036	
<b>(2) Under voltage reconnection procedure</b>								
Ratio of voltage rapidly decreased (V / s)			Reconnection voltage (V)		Reconnection time (s)			
0.01			230		72.6			
<b>(3) Over voltage disconnection procedure</b>								
Rated output voltage (V)	Output power (VA)	Required max. voltage (V)	Value of PCE trip settings (V)	Ratio of increased (V / s)	Interval time (s)	Measured tripped voltage (V)	Measured disconnection time (s)	
110 % $V_n < V < 135 \% V_n$								
230	6000	253	255	2.3	0.1	254.83	1.645	
230	6000	282	282	2.3	0.1	281.70	0.036	
230	6000	309	309	2.3	0.1	307.39	0.033	
135 % $V_n \leq V$								
230	6000	312	312	2.3	0.05	311.88	0.0232	
<b>(4) Over voltage reconnection procedure</b>								
Ratio of voltage rapidly decreased (V / s)			Reconnection voltage (V)		Reconnection time (s)			
0.01			230		72.8			
Supplementary information:								
N/A								

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

<b>5.2.2 &amp; 5.4</b>		<b>TABLE: Over/under frequency trip settings and reconnection test</b>						<b>Pass</b>
<b>(1) Under frequency disconnection procedure</b>								
Rated output frequency (Hz)	Output power (VA)	Required min. frequency (Hz)	Value of PCE trip settings (Hz)	Ratio of decreased (Hz / s)	Interval time (s)	Measured tripped frequency (Hz)	Measured disconnection time (s)	
50	6000	49	49	0.1	0.2	48.89	0.157	
<b>(2) Under frequency reconnection procedure</b>								
Ratio of voltage rapidly decreased (V / s)			Reconnection frequency (Hz)		Reconnection time (s)			
0.01			50		72.9			
<b>(3) Over frequency disconnection procedure</b>								
Rated output frequency (Hz)	Output power (VA)	Required max. frequency (Hz)	Value of PCE trip settings (Hz)	Ratio of increased (Hz / s)	Interval time (s)	Measured tripped frequency (Hz)	Measured disconnection time (s)	
50	6000	51	51	0.1	0.2	51.19	0.154	
<b>(4) Over frequency reconnection procedure</b>								
Ratio of voltage rapidly decreased (V / s)			Reconnection frequency (Hz)		Reconnection time (s)			
0.01			50		73.2			
Supplementary information:								
N/A								

IEC 61727: 2004			
Clause	Requirement + Test	Result - Remark	Verdict

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

IEC 61727: 2004									
Clause	Requirement + Test				Result - Remark				Verdict
18	66	66	0	3	108.50	3.93	0.98	335.04	L
19	66	66	0	4	89.50	3.96	1.02	335.99	L
20	66	66	0	5	85.00	3.94	1.01	335.72	L
Test condition C									
21	33	33	0	0	242.00	1.94	0.95	180.54	--
22	33	33	0	-5	156.00	1.95	1.02	180.72	L
23	33	33	0	-4	182.00	1.92	1.03	180.11	L
24	33	33	0	-3	213.00	1.90	1.04	182.98	L
25	33	33	0	-2	195.00	1.95	0.99	183.27	L
26	33	33	0	-1	143.00	1.92	0.98	181.78	L
27	33	33	0	1	199.00	1.92	1.03	181.73	L
28	33	33	0	2	107.50	1.93	1.00	183.98	L
29	33	33	0	3	118.00	1.93	0.95	185.27	L
30	33	33	0	4	121.00	1.94	0.96	182.27	L
31	33	33	0	5	108.25	1.93	0.98	181.78	L
<p>Remark:</p> <p>For test condition A:            If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.</p> <p>For test condition B and C:            If run-on times are still increasing at the 95 % or 105 % points, additional 1 % increments is taken until run-on times begin decreasing.</p>									

--- End of test report---

# **Attachment I**

**(Pictures of the EUT and Electrical Schemes)**

**1 PICTURES**

**Front**



**Side**



**Connection interface**

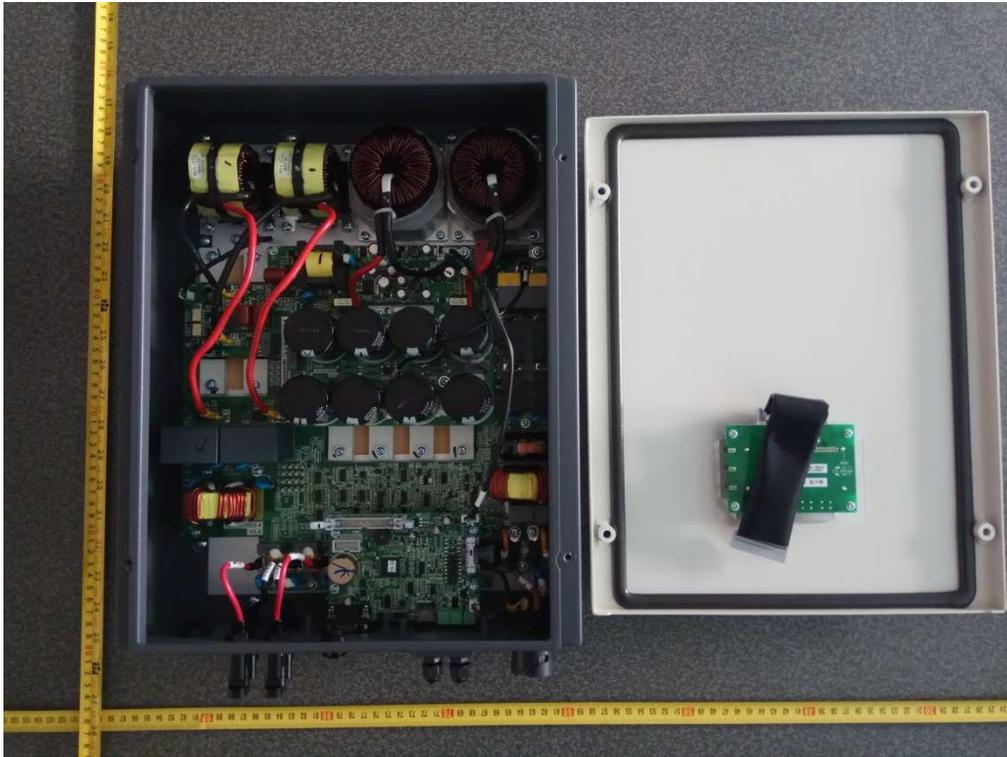


**Back Side**



**IEC 61727:2004**

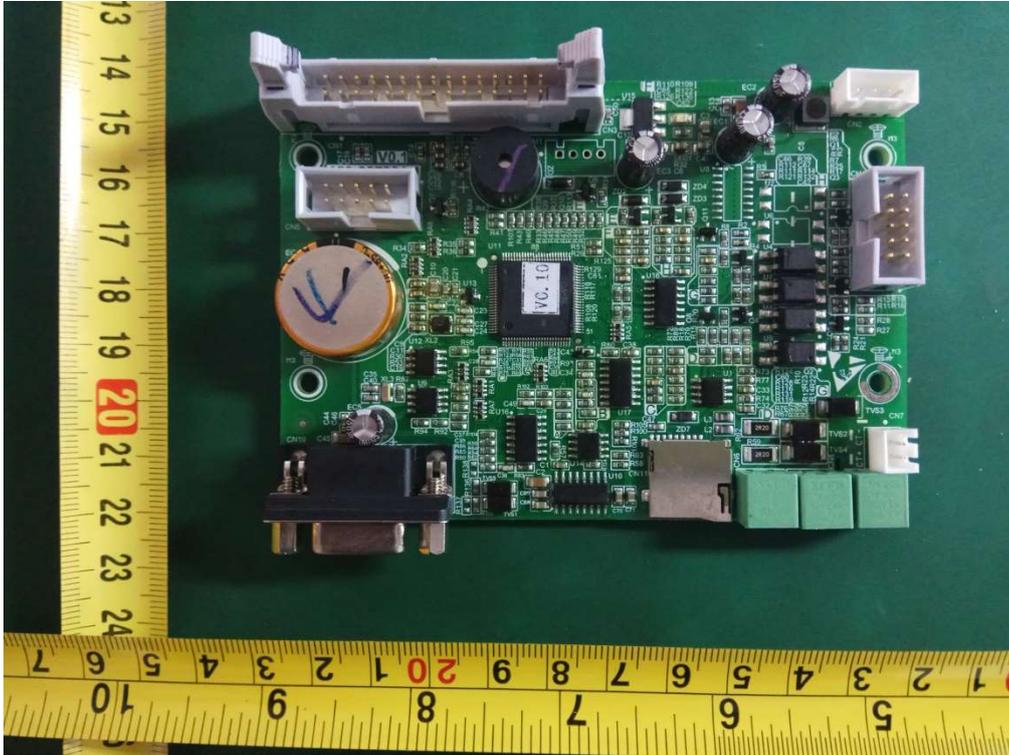
**Internal**



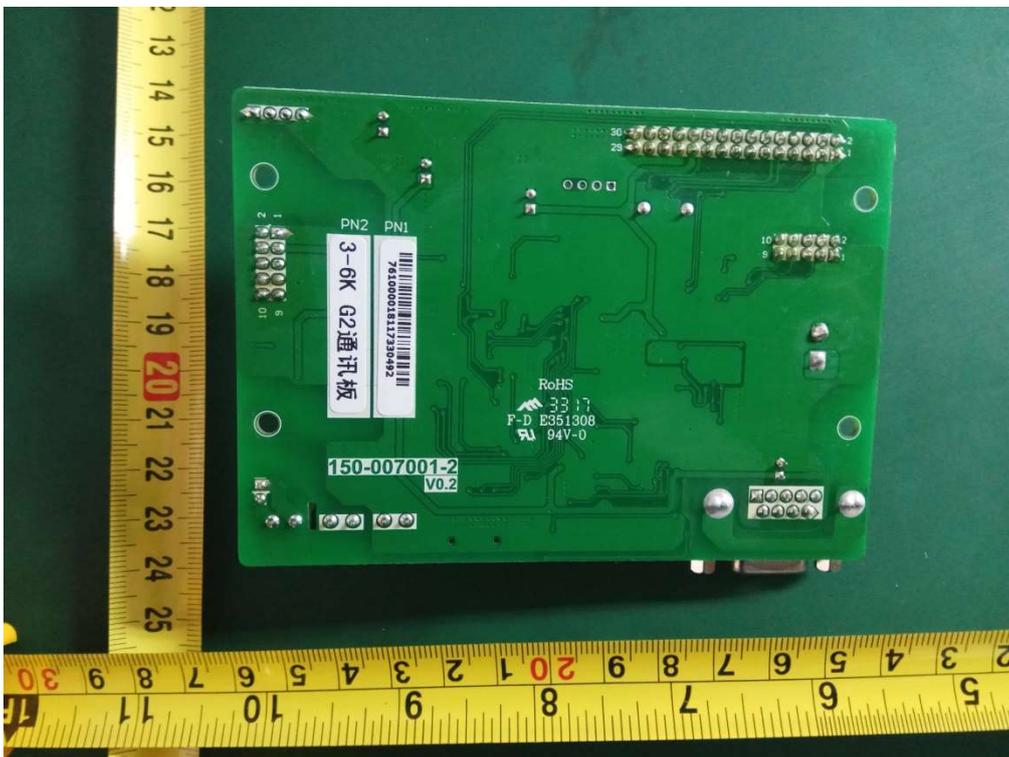
**Internal**



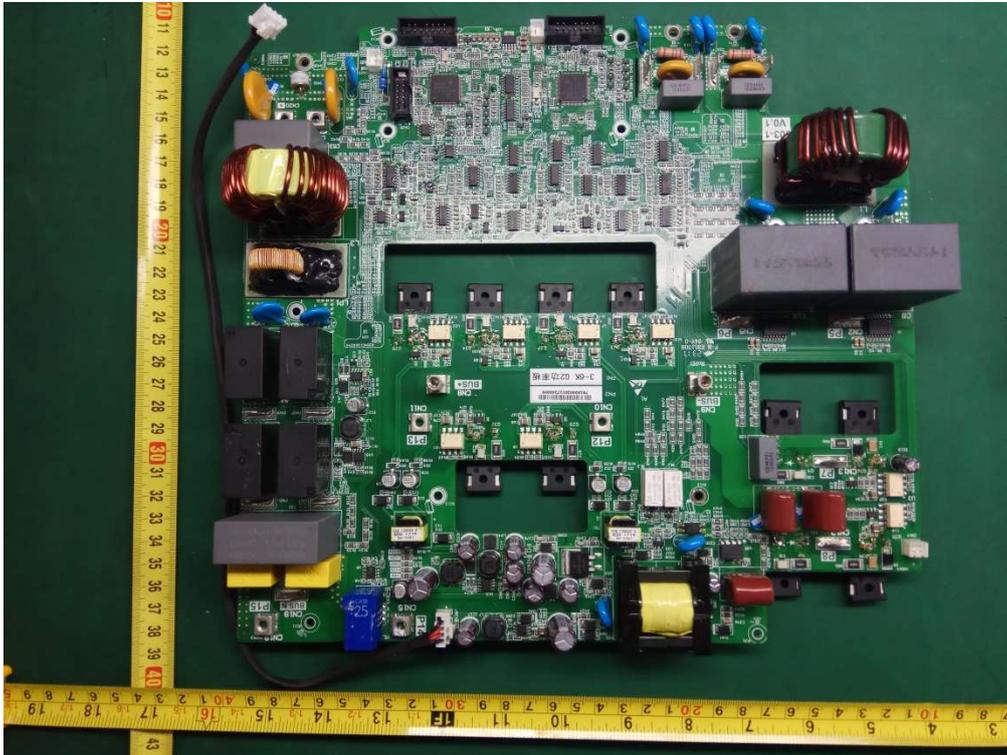
Front side of communication board



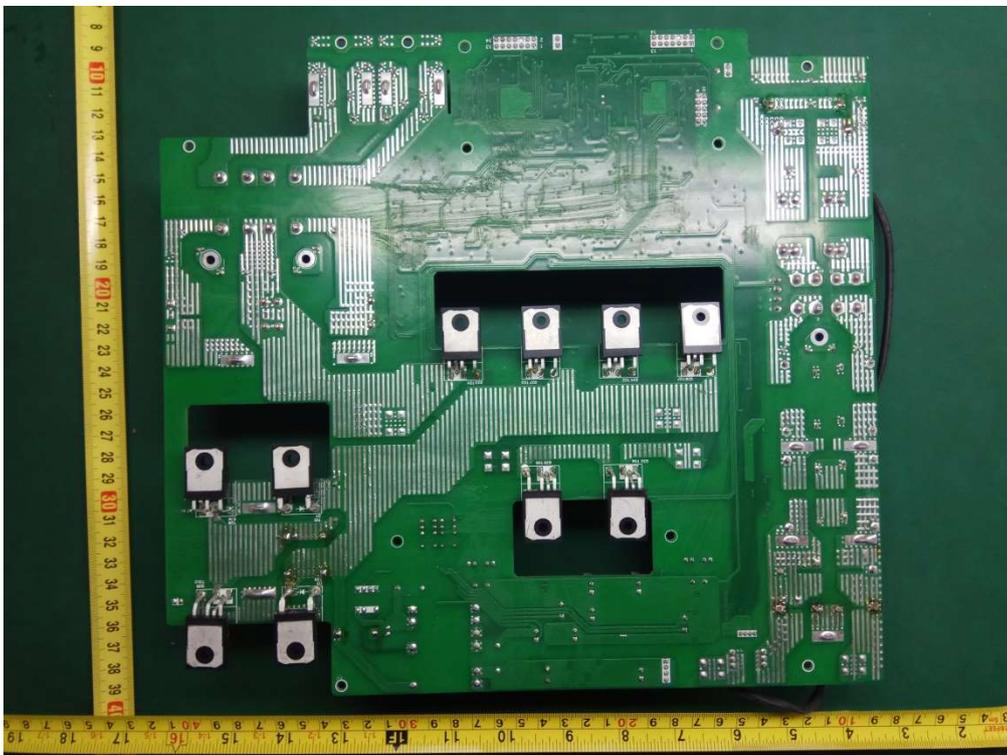
Back side of communication board



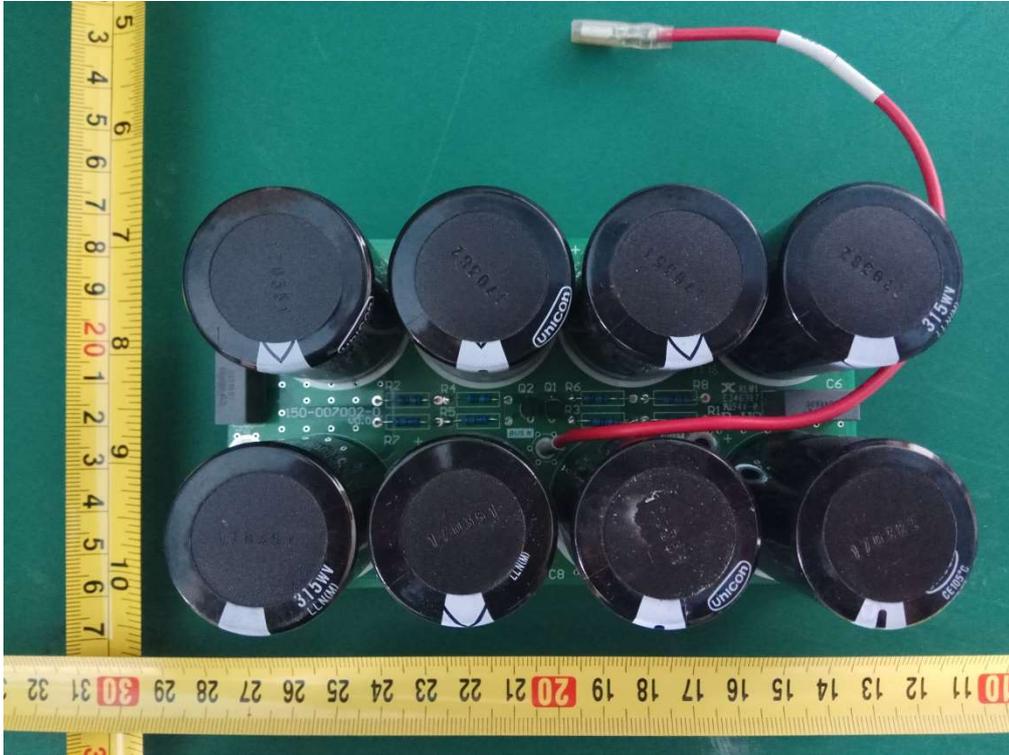
Front side of Main board



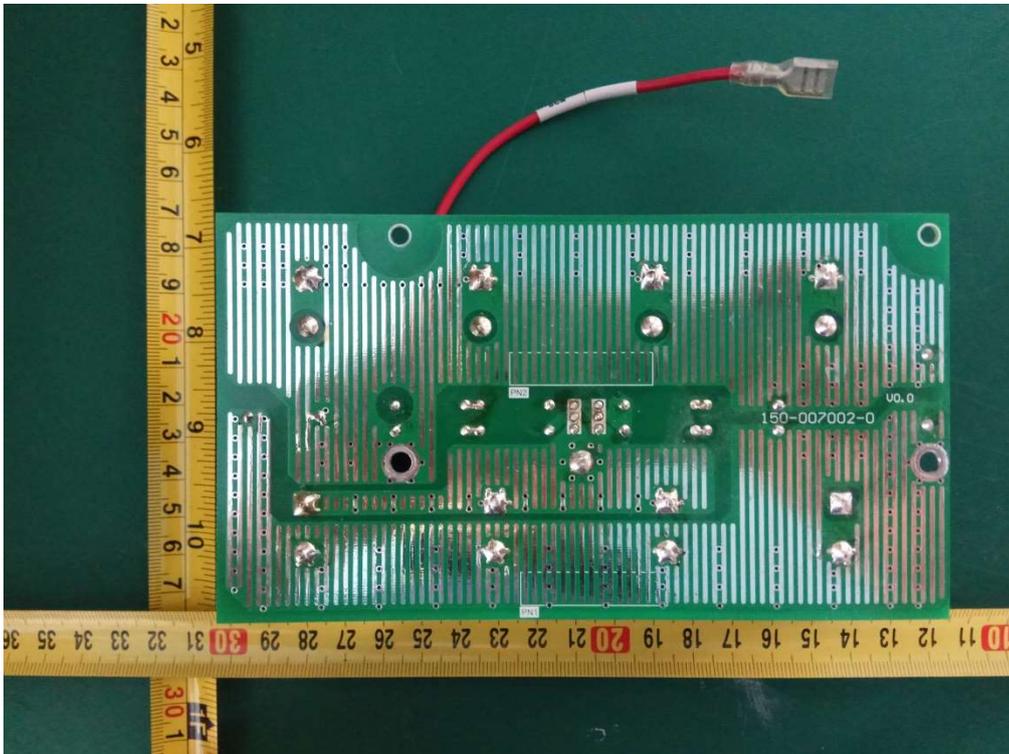
Front side of Main board



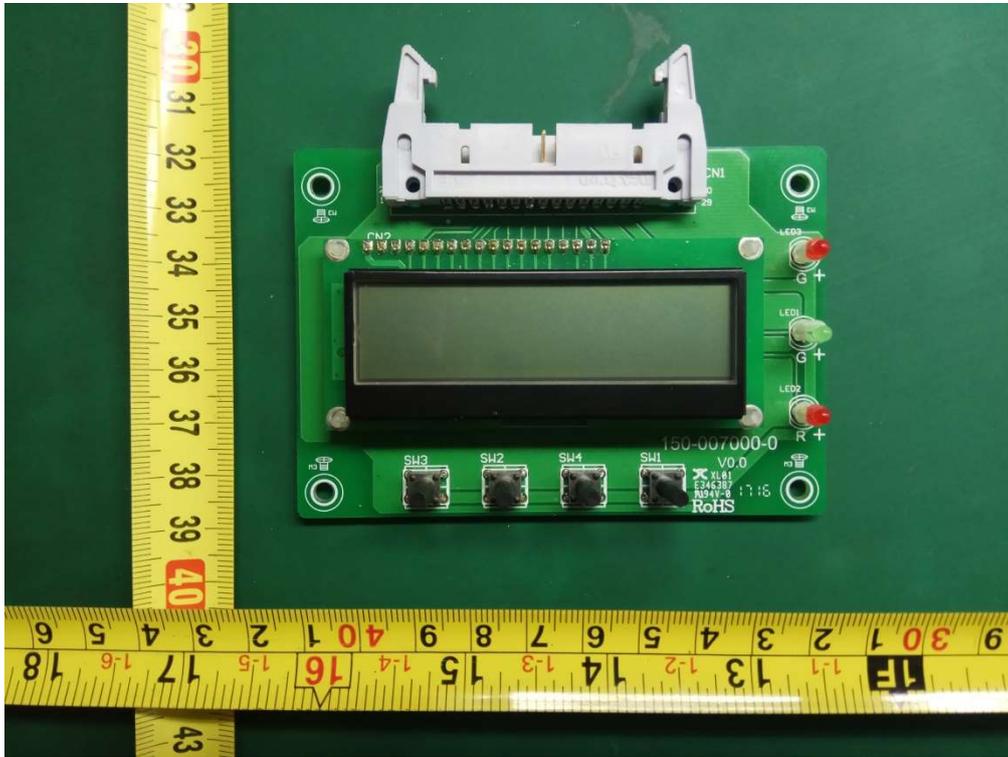
Front side of Bus capacitors board



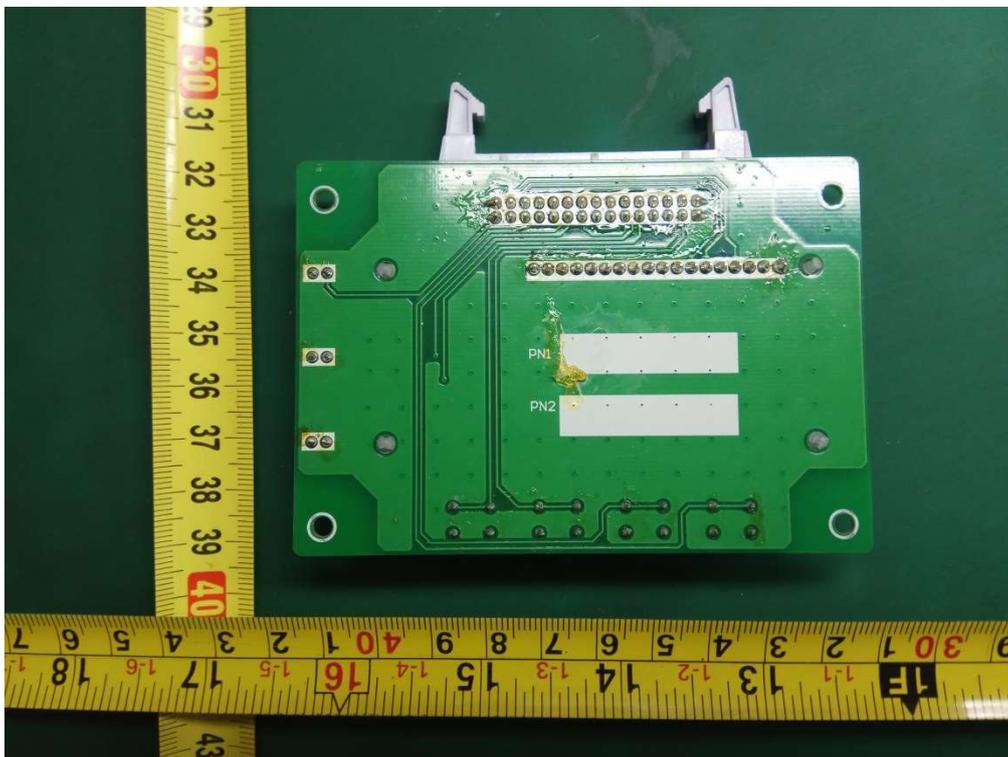
Back side of Bus capacitors board



Front side of display board

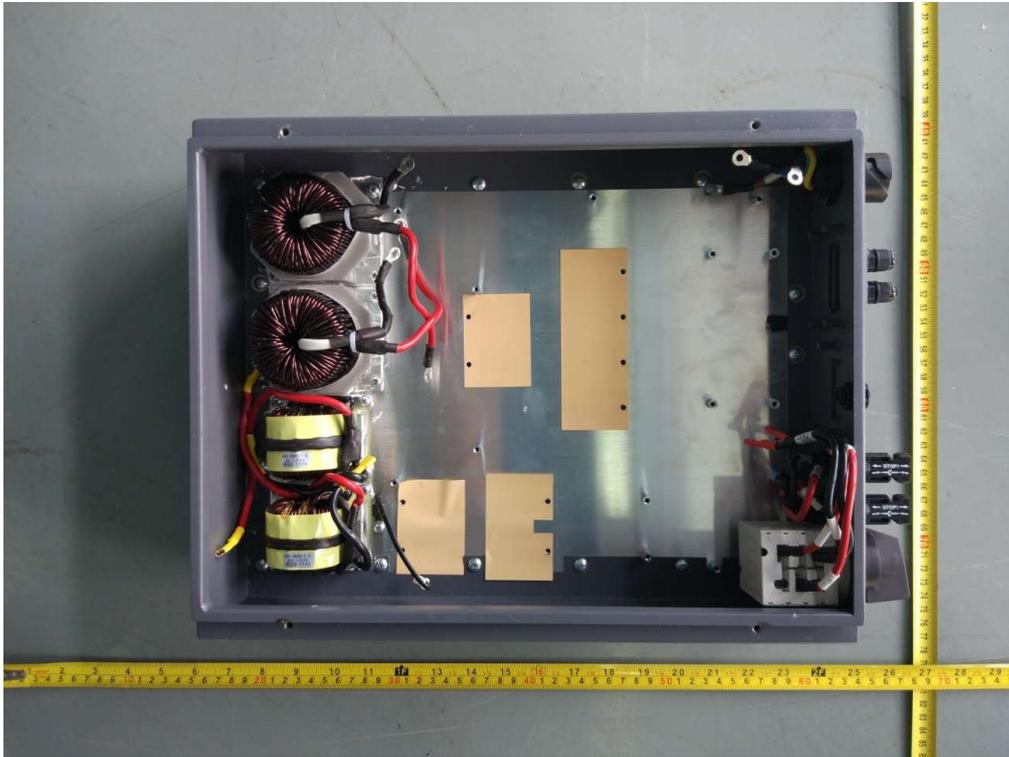


Back side of display board

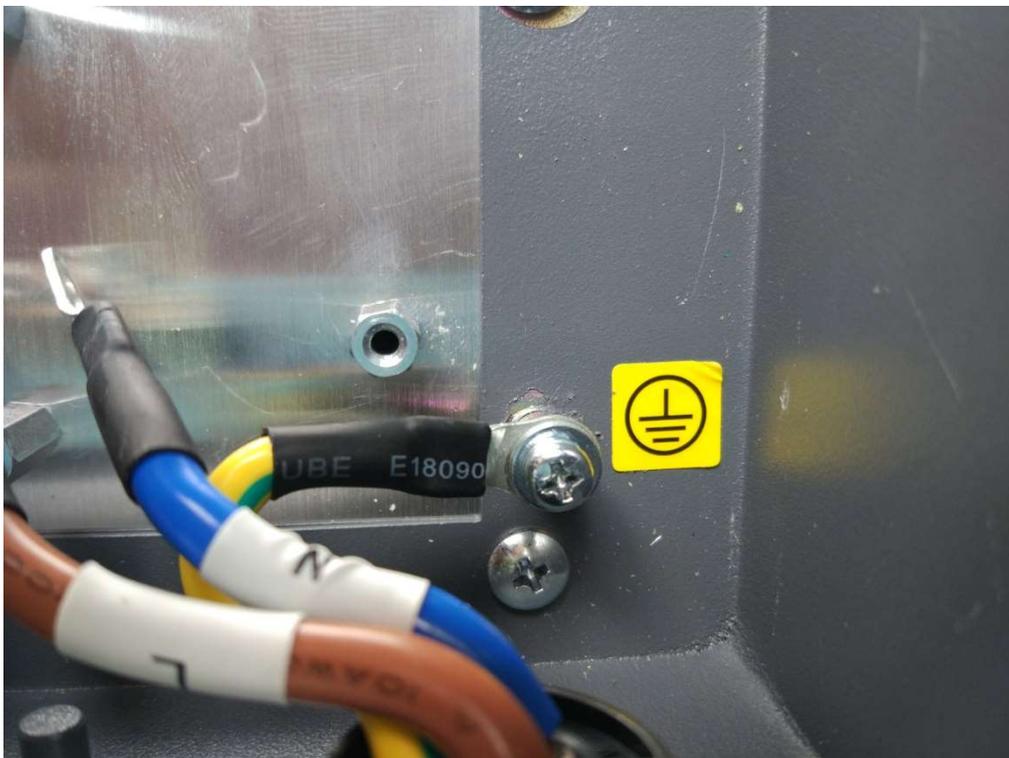


IEC 61727:2004

Removed all PCBAs



Cover

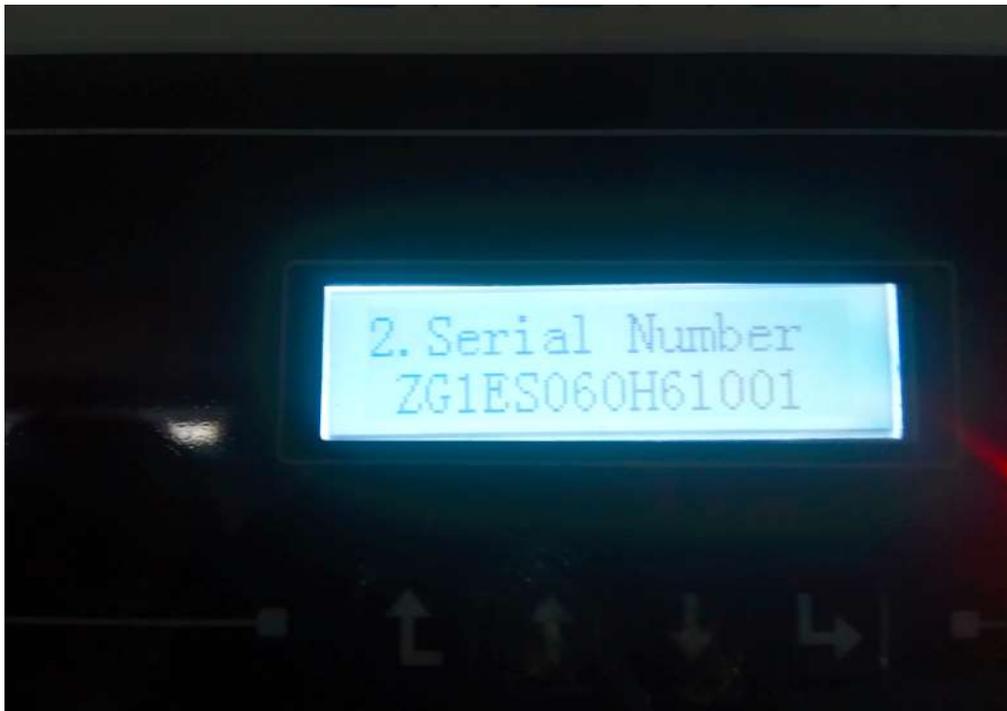


IEC 61727:2004

Software Version



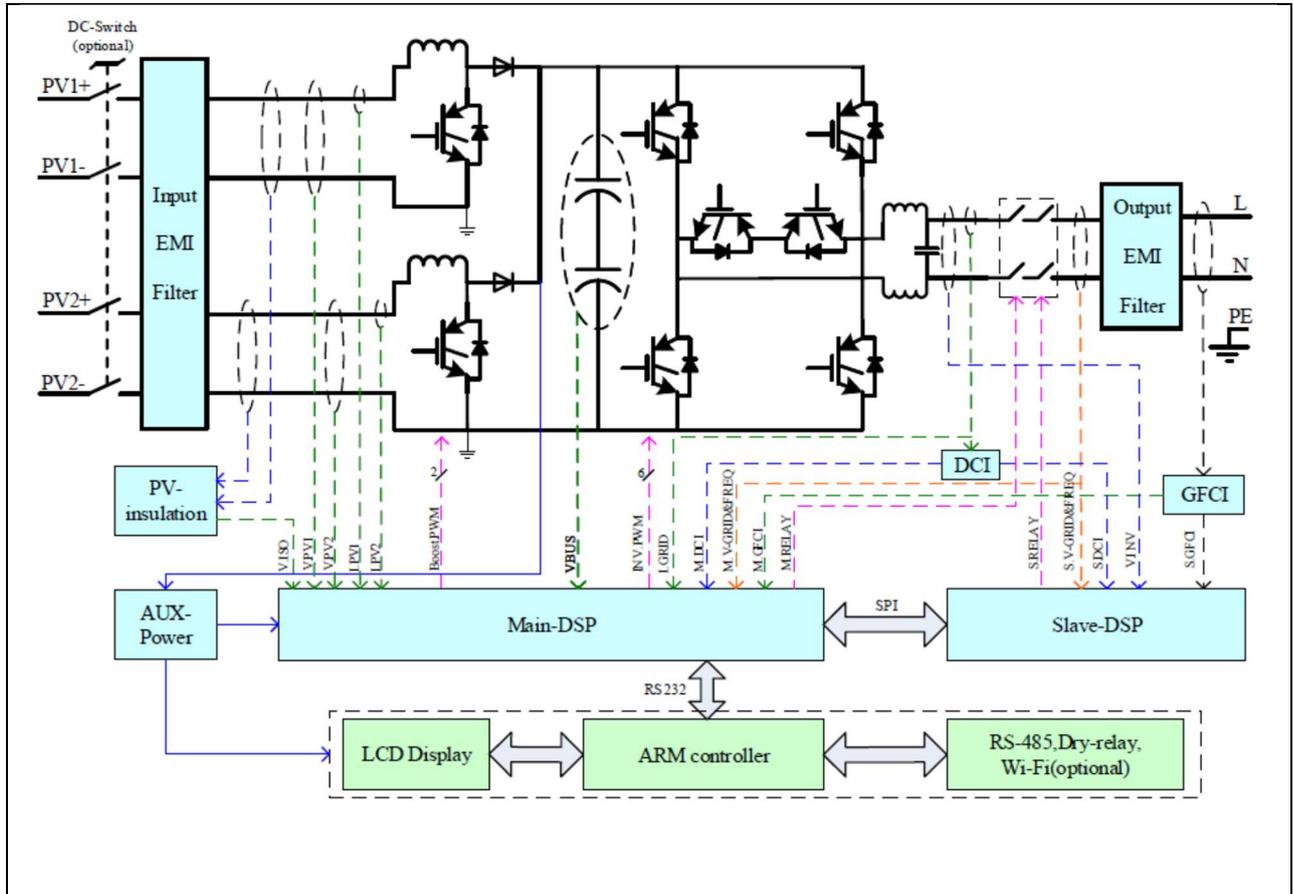
Serial Number of the EUT



**Serial Number of the EUT for spot-check test**



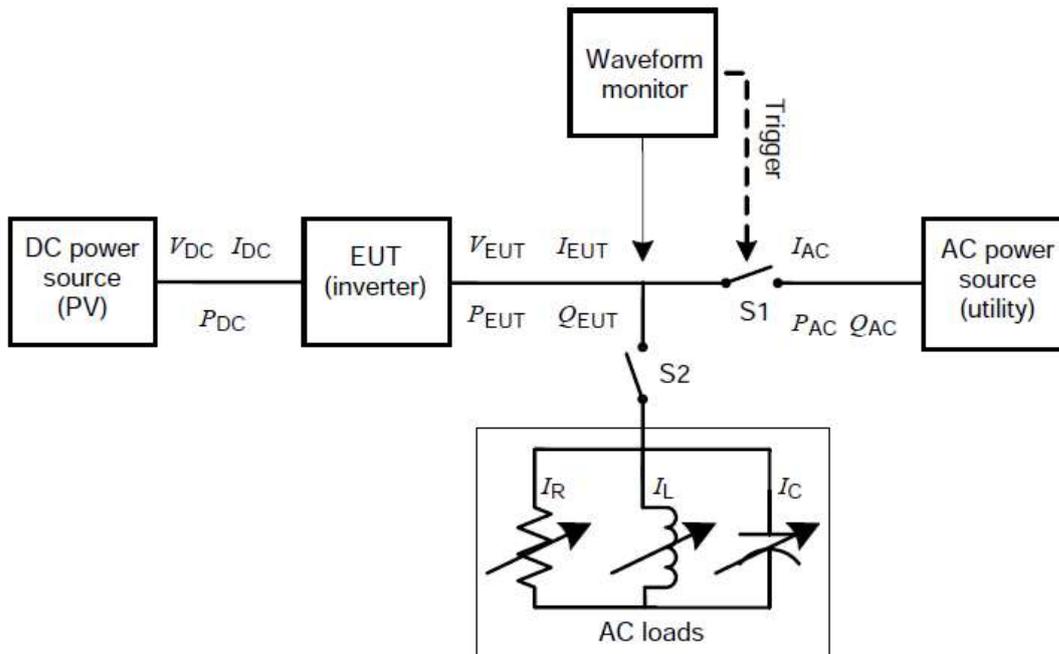
2 ELECTRICAL SCHEMES



## **Attachment II**

**(Testing information)**

## 1 TESTING CIRCUIT



Current and voltage clamps have been connected to the inverter input/output for all the tests.

All the tests and checks have been performed in accordance with the reference standard under testing.

**2 TESTING EQUIPMENT**

No.	Equipment Name	MARK/Model No.	Equipment No.	Equipment calibration due date
1	AC source	Chroma / 61860	--	--
2	PV array simulator	Chroma / 62150H-1000S	--	--
3	Current clamp	FLUKE / i1000s	30413441	2018-02-15
4	Differential probe	Sanhua / SI-9110	111134	2018-02-15
5	Temperature & Humidity meter	VICTOR / VC230A	WS01	2018-09-03
6	Power analyzer	YOKOGAWA / WT 3000	EP-011	2018-08-05
7	Digital oscilloscope	YOKOGAWA/DL 850	EP-001	2018-10-22

**Equipment for spot-check test**

From	No.	Equipment Name	MARK/Model No.	Equipment No.	Equipment calibration due date
Sofar Solar	1	AC source	Chroma / 61860	--	--
	2	PV array simulator	Chroma / 62150H-1000S	--	--
	3	Current clamp	FLUKE / i1000s	29503223	2020-02-12
	4	Differential probe	Sanhua / SI-9110	111541	2020-02-12
	5	Temperature & Humidity meter	Anymeters / TH101B	201030245220	2020-02-12
	6	Power analyzer	YOKOGAWA / WT 3000	91N610888	2020-02-12
	7	Digital oscilloscope	Agilent / DS05014A	MY50070266	2020-02-12
SGS	8	True RMS Multimeter	Fluke / 289C	GZE012-53	2020/01/24

Items	Specifications
1) PV array simulator	
a) Voltage range	0 – 1000Vdc ( 0.01V step)
b) Current range	0 – 40A ( 0.01A step)
2) AC power source	
a) Output wiring	Three phase
b) Output capacity	100KVA
c) Output voltage	10-300Vrms
d) Output frequency	45-65Hz
e) Voltage stability	± 100ppm/°C
f) Output voltage distortion	0.05% max.
3) Digital meter	
a) Voltage range	0 – 1000Vdc, 0 – 600Vrms
b) Current range	0 – 30A
c) Frequency range ( accuracy)	0.2%
d) Measurement items	Voltage (V)    Current (A)    Active power (W) Reactive power (Var) Volt-ampere (VA) Power factor (PF) Frequency (Hz) Electric energy (Wh)
4) Waveform recorder	
a) Sampling speed	1M/s
b) Recording device	Memory record and USB reading
c) Time accuracy	± 500ppm
5) AC load	
a) Resistive load	Maximum voltage: 300Vrms Current range: 0 – 100A Capacity: 100KW
b) Inductive load	Maximum voltage: 300Vrms Current range: 0 – 100A Capacity: 100KVA
c) Capacitive load	Maximum voltage: 300Vrms Current range: 0 – 100A Capacity: 100KVA

**3 MEASUREMENT UNCERTAINTY**

Voltage measurement uncertainty	$\pm 0.05 \%$
Current measurement uncertainty	$\pm 0.05 \%$
Frequency measurement uncertainty	$\pm 0.001 \text{ Hz}$
Time measurement uncertainty	$\pm 0.001 \text{ s}$
Power measurement uncertainty	$\pm 0.5 \%$
Phase Angle	$\pm 0.1^\circ$
Cos $\phi$	$\pm 0.01\%$

Note1: Measurements uncertainties showed in this table are maximum allowable uncertainties. The measurement uncertainties associated with other parameters measured during the tests are in the laboratory at disposal of the solicitant.

## **Attachment III**

**(GRAPHS AND SCREENSHORTS OF TEST RESULTS)**

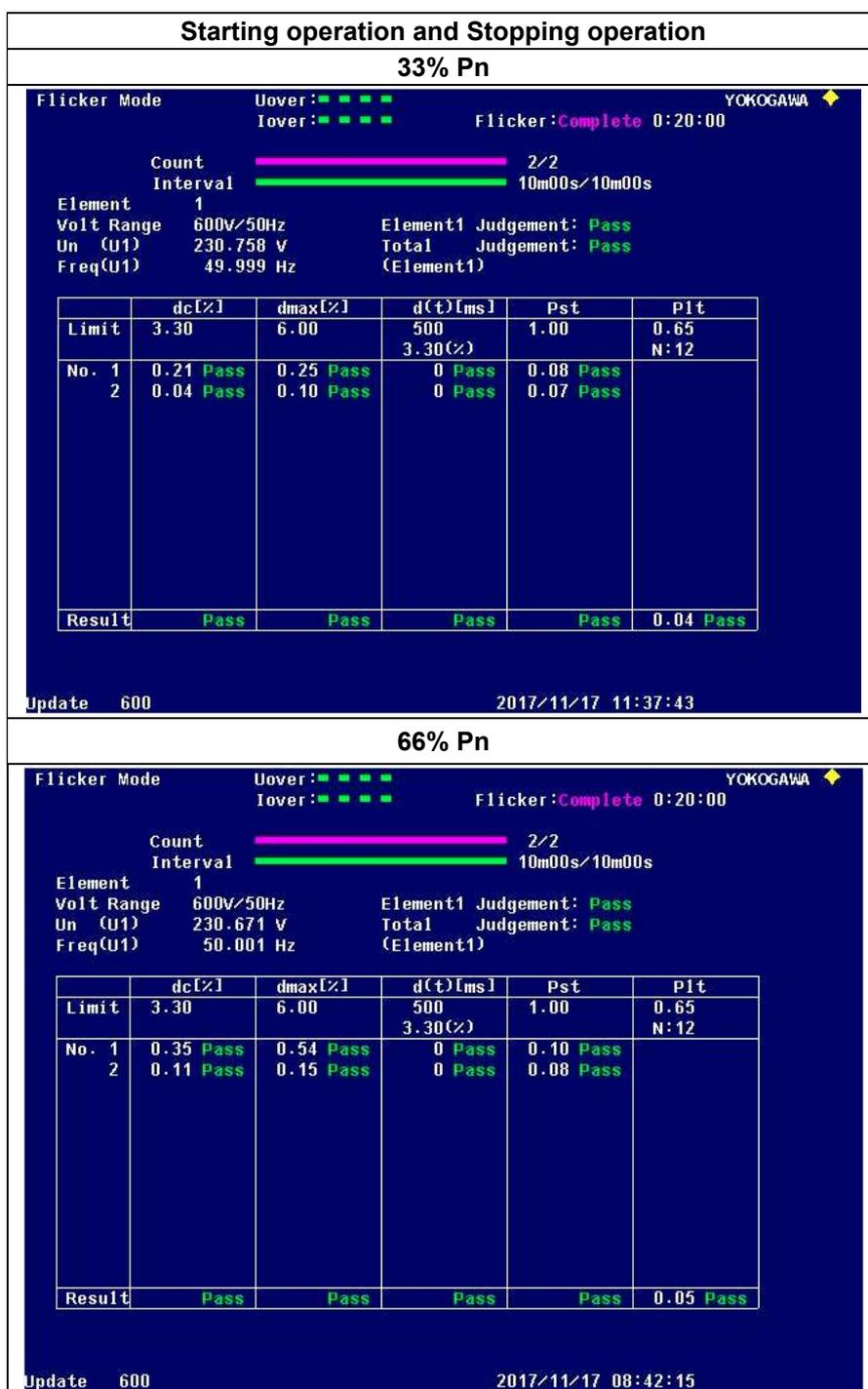
**Flickers**

The measurements of voltage fluctuations have been measured at 33 %, 66% and 100 % of the nominal power value of the inverter.

As it can be seen in the next screenshots, this test has two steps:

- 1.Starting operation
- 2.Stopping operation

The values took of Pst and Plt are the most unfavorable of the two steps.





**IEC 61727:2004**

**66% Pn**

Flicker Mode Uover: ■■■■ Iover: ■■■■ Flicker: **Complete** 2:00:00 YOKOGAWA ◆

Count ██████████ 12/12  
Interval ██████████ 10m00s/10m00s

Element 1  
Volt Range 600V/50Hz Element1 Judgement: **Pass**  
Un (U1) 230.688 V Total Judgement: **Pass**  
Freq(U1) 50.000 Hz (Element1)

	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	6.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.35 <b>Pass</b>	0.54 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
2	0.34 <b>Pass</b>	0.57 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
3	0.35 <b>Pass</b>	0.52 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
4	0.39 <b>Pass</b>	0.53 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
5	0.41 <b>Pass</b>	0.58 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
6	0.34 <b>Pass</b>	0.57 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
7	0.42 <b>Pass</b>	0.56 <b>Pass</b>	0 <b>Pass</b>	0.11 <b>Pass</b>	
8	0.13 <b>Pass</b>	0.16 <b>Pass</b>	0 <b>Pass</b>	0.08 <b>Pass</b>	
9	0.44 <b>Pass</b>	0.60 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
10	0.42 <b>Pass</b>	0.48 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
11	0.35 <b>Pass</b>	0.50 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
12	0.41 <b>Pass</b>	0.52 <b>Pass</b>	0 <b>Pass</b>	0.10 <b>Pass</b>	
Result	<b>Pass</b>	<b>Pass</b>	<b>Pass</b>	<b>Pass</b>	0.10 <b>Pass</b>

Update 3600 2017/11/03 15:23:28

**100% Pn**

Flicker Mode Uover: ■■■■ Iover: ■■■■ Flicker: **Complete** 2:00:00 YOKOGAWA ◆

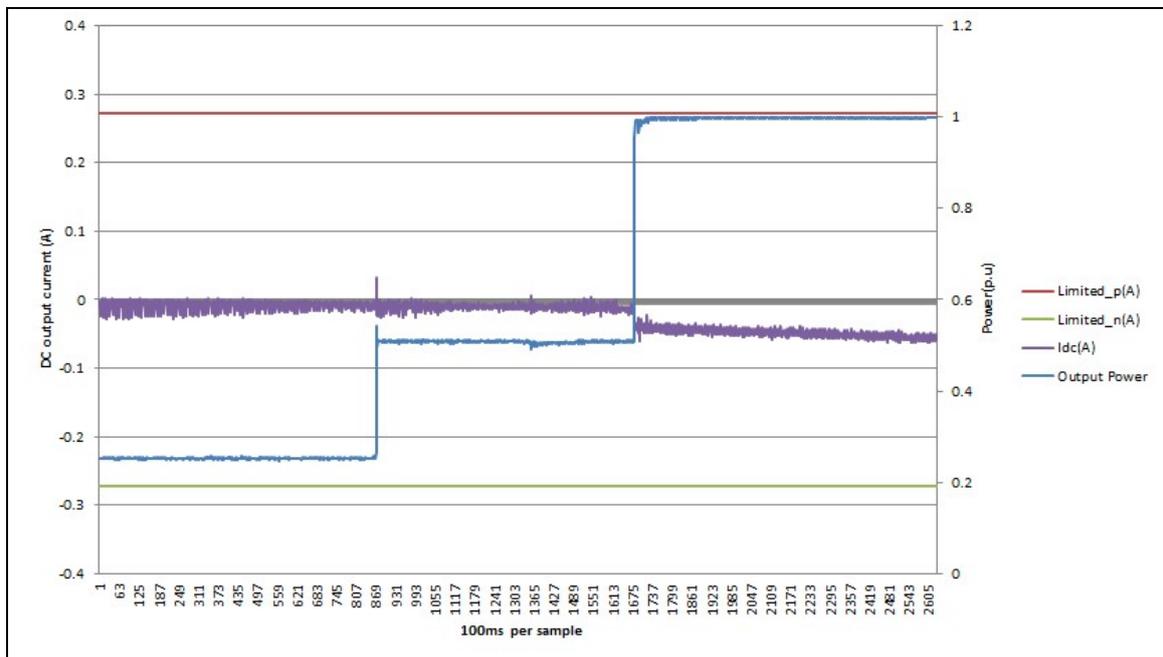
Count ██████████ 12/12  
Interval ██████████ 10m00s/10m00s

Element 1  
Volt Range 600V/50Hz Element1 Judgement: **Pass**  
Un (U1) 231.977 V Total Judgement: **Pass**  
Freq(U1) 49.998 Hz (Element1)

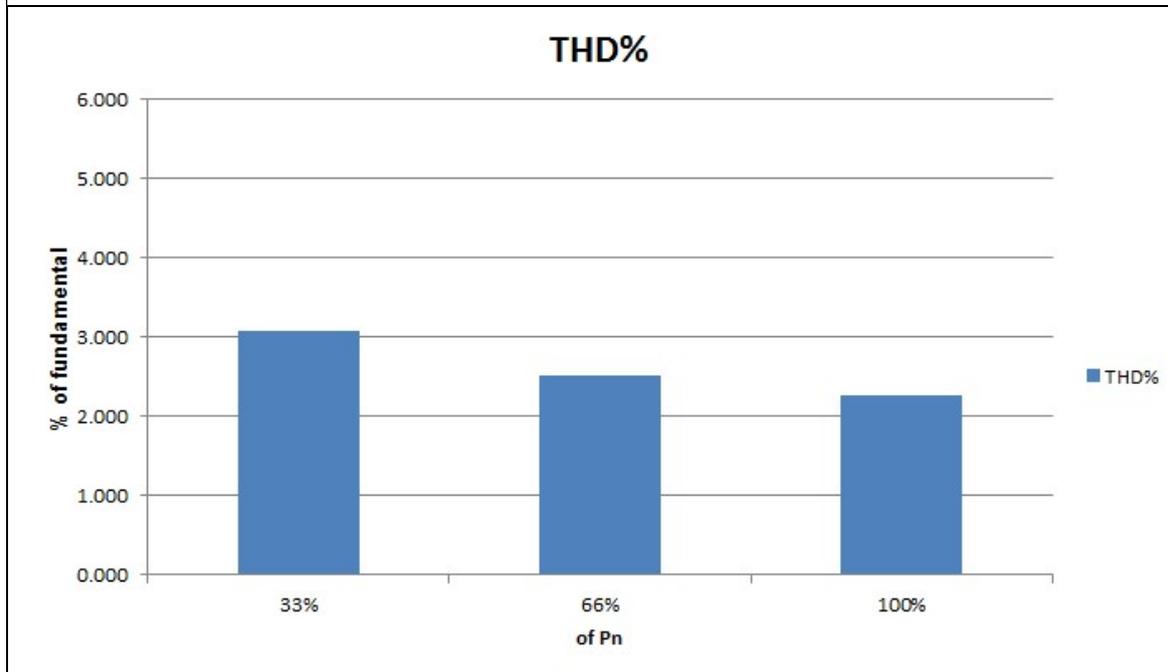
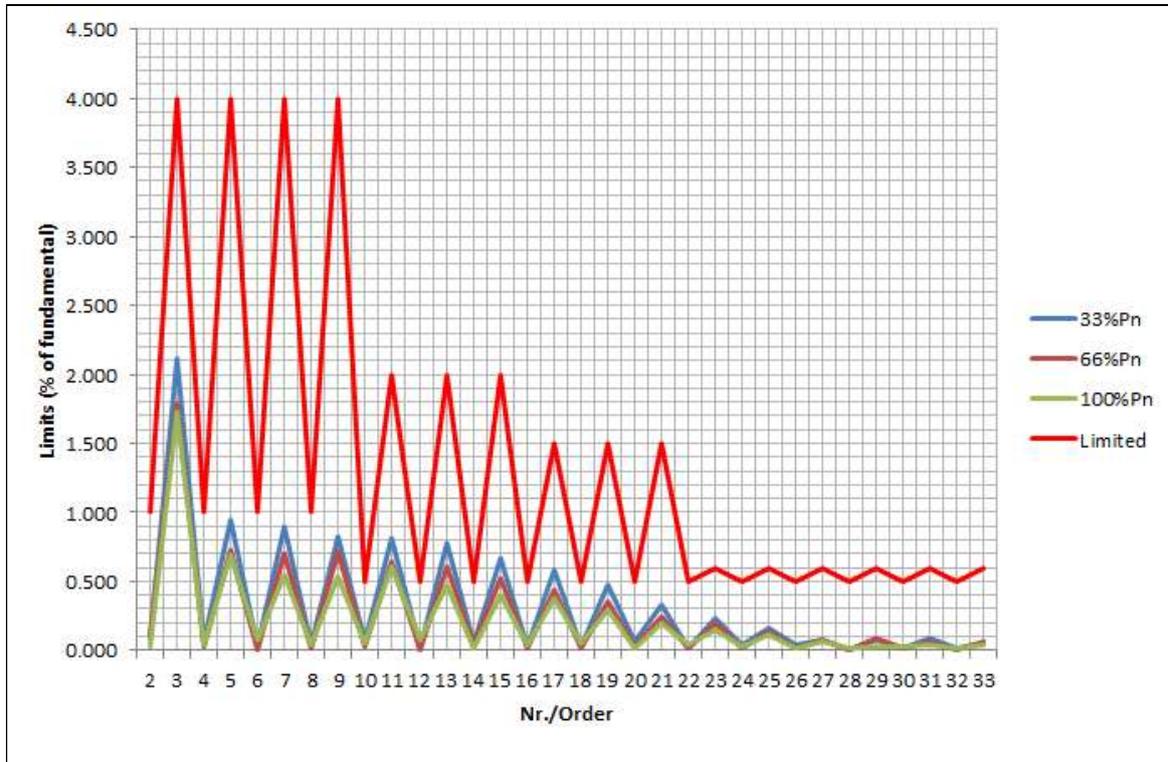
	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	6.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
2	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
3	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
4	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
5	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
6	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
7	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
8	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
9	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
10	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
11	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
12	0.00 <b>Pass</b>	0.00 <b>Pass</b>	0 <b>Pass</b>	0.07 <b>Pass</b>	
Result	<b>Pass</b>	<b>Pass</b>	<b>Pass</b>	<b>Pass</b>	0.07 <b>Pass</b>

Update 3600 2017/11/08 12:55:05

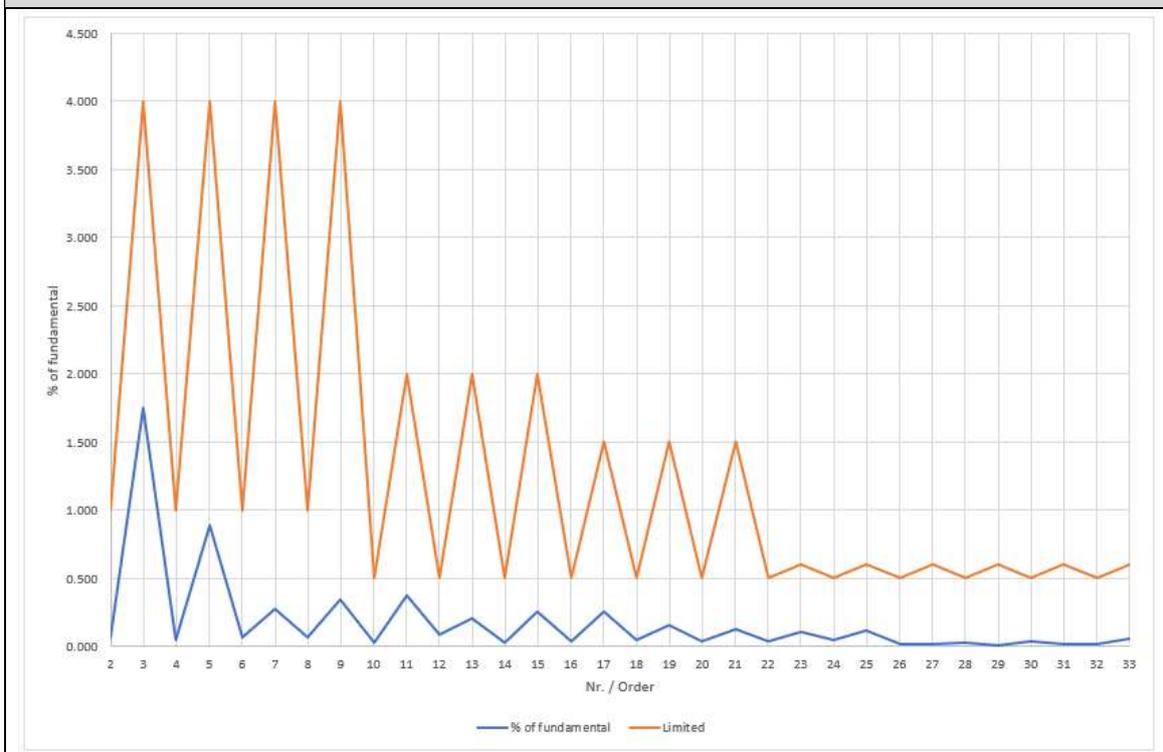
**Direct current injection**



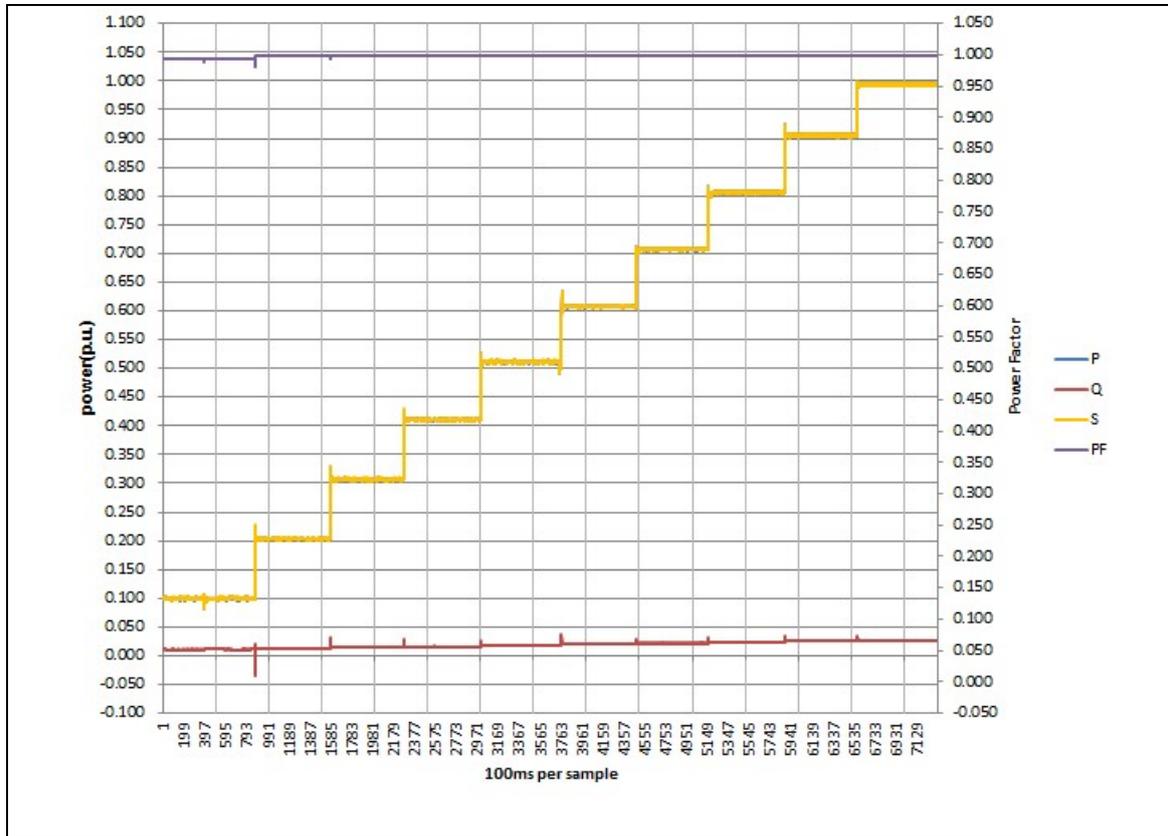
**Harmonics and waveform distortion**



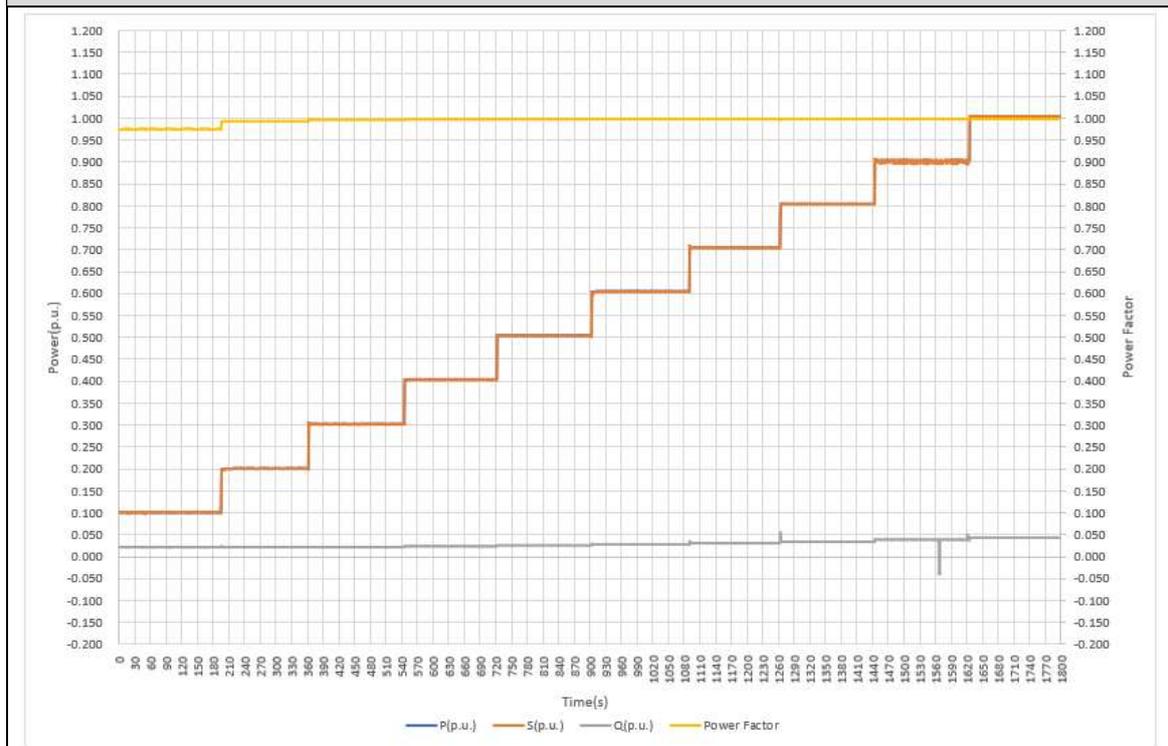
Sopt-check test result



**Power factor**

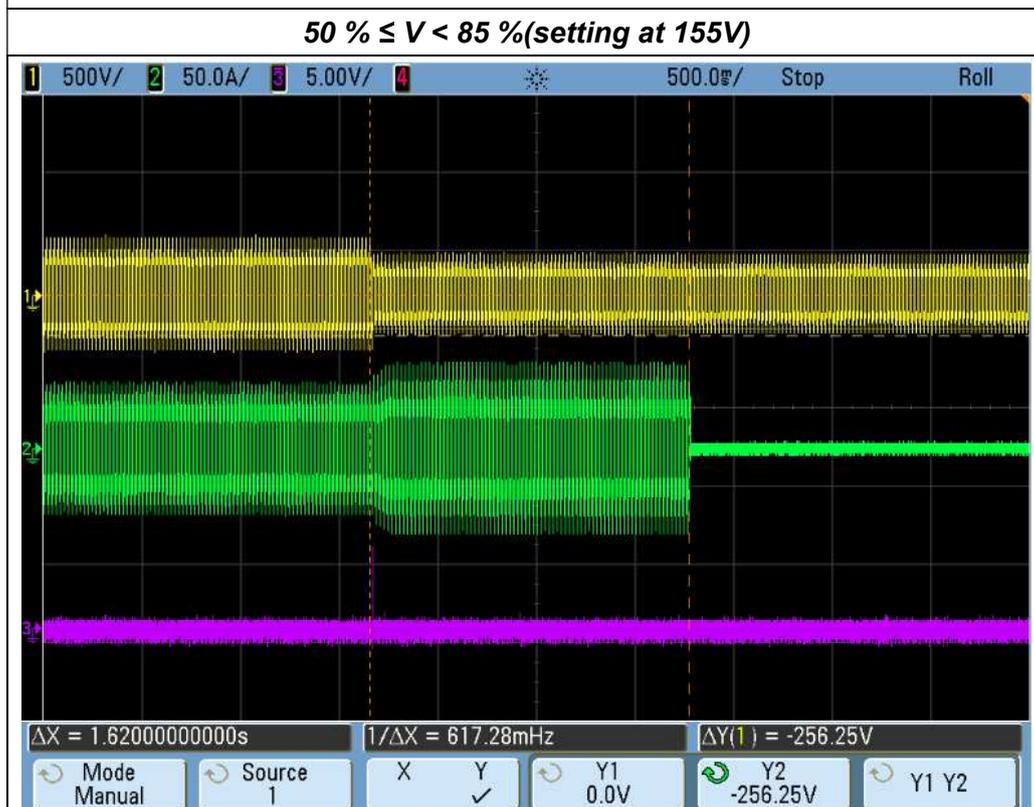
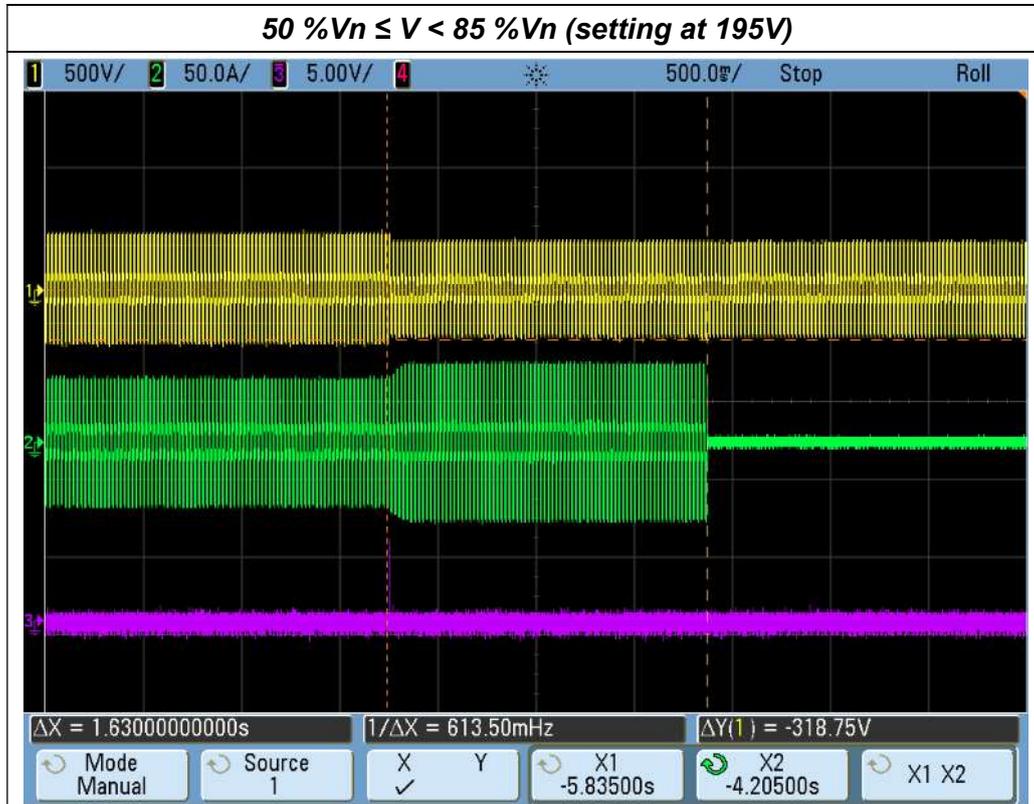


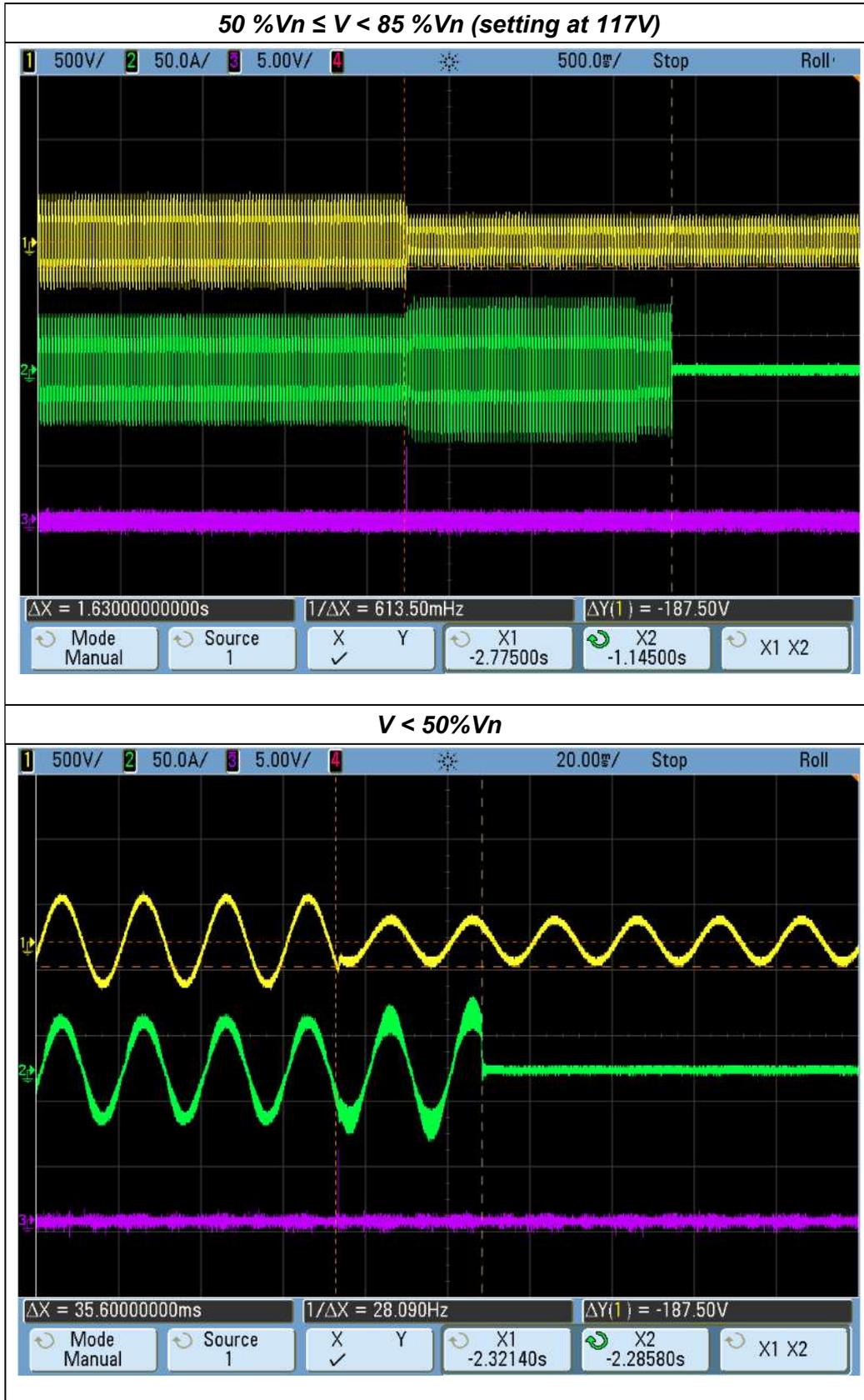
**Sopt-check test result**

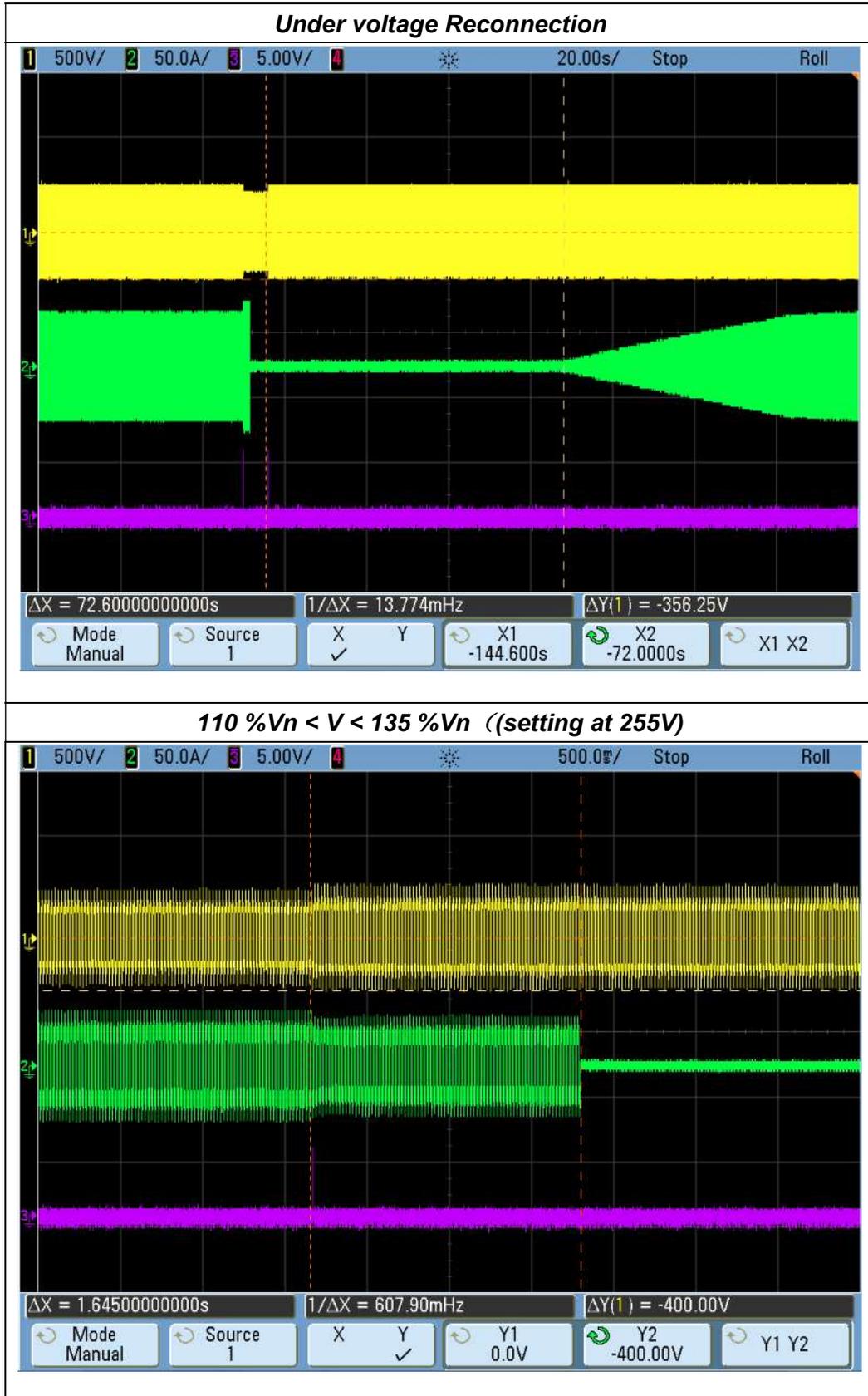


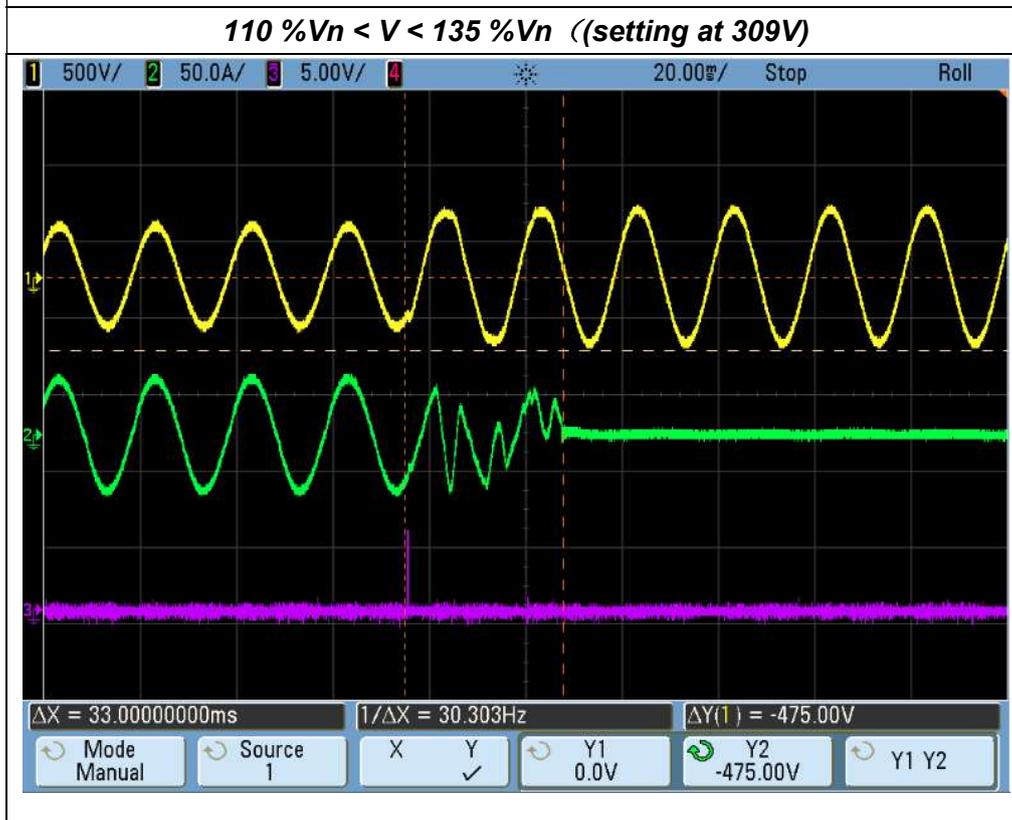
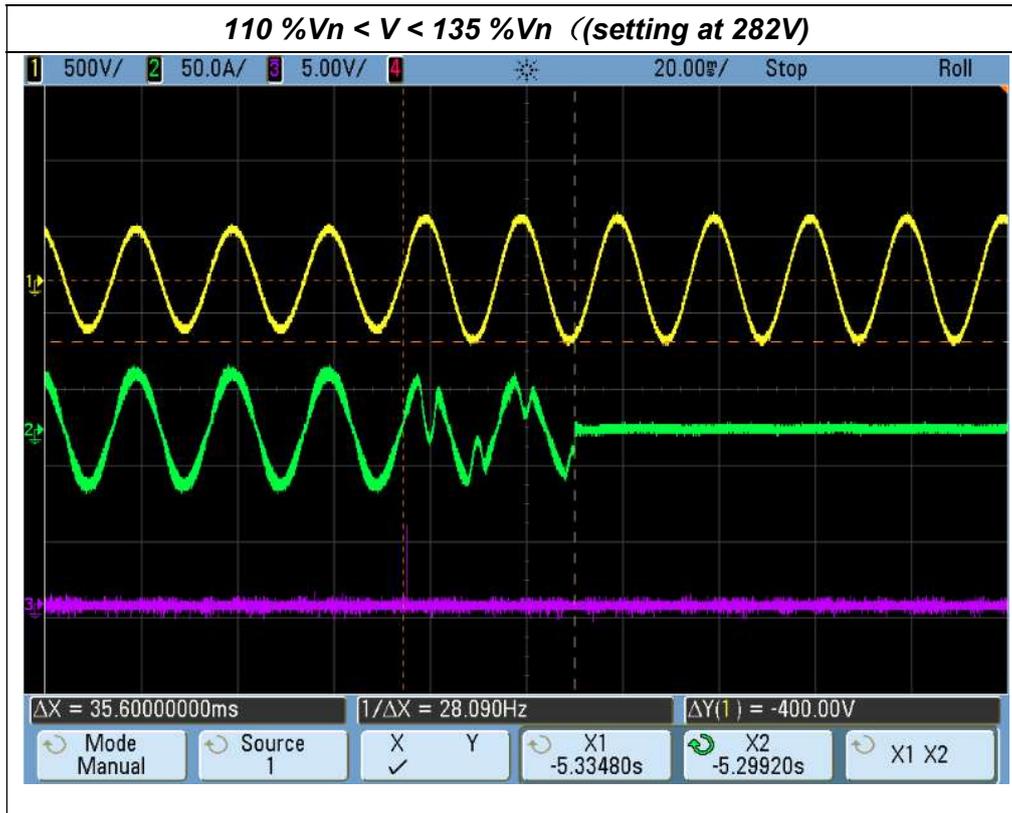
***Under-and over-voltage trip settings and reconnection test***

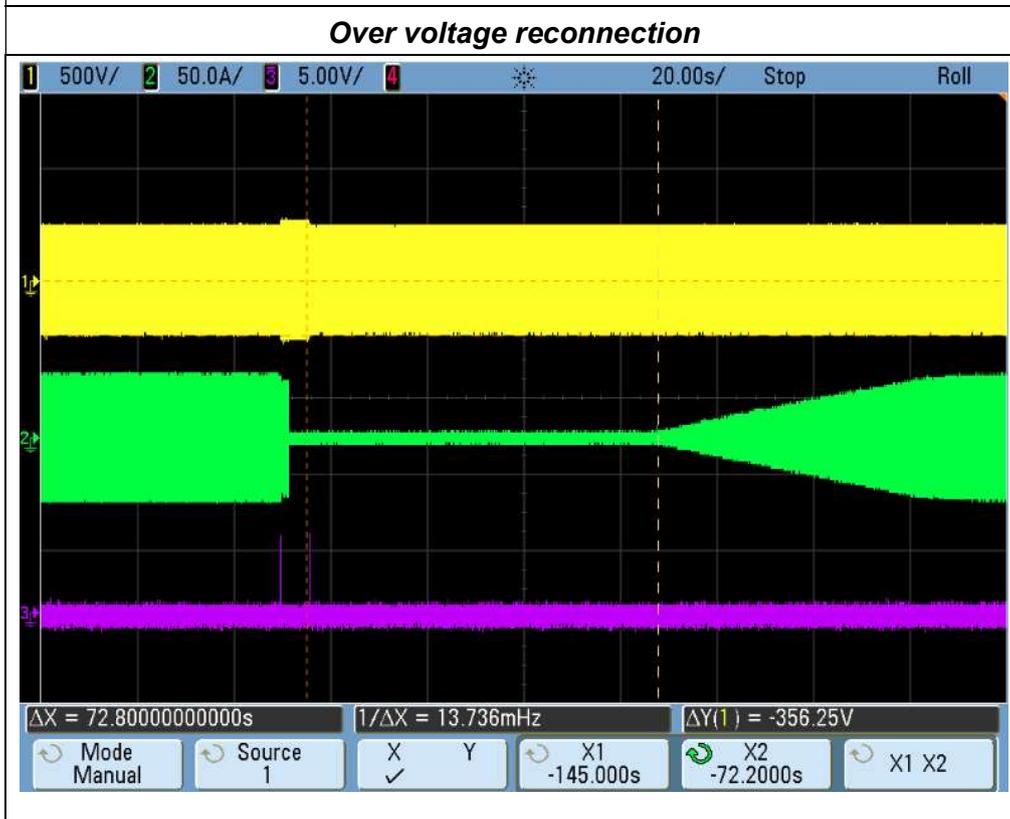
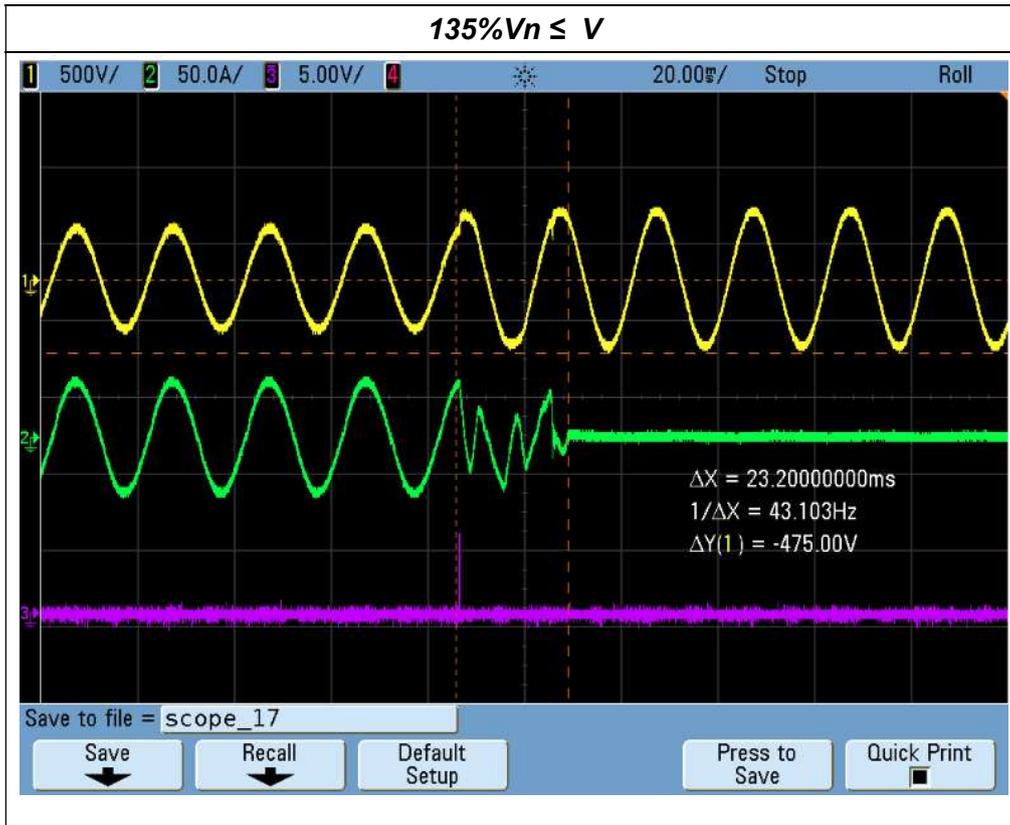
Ch1: Output Voltage Ch2: Output Current Ch3: Trip signal





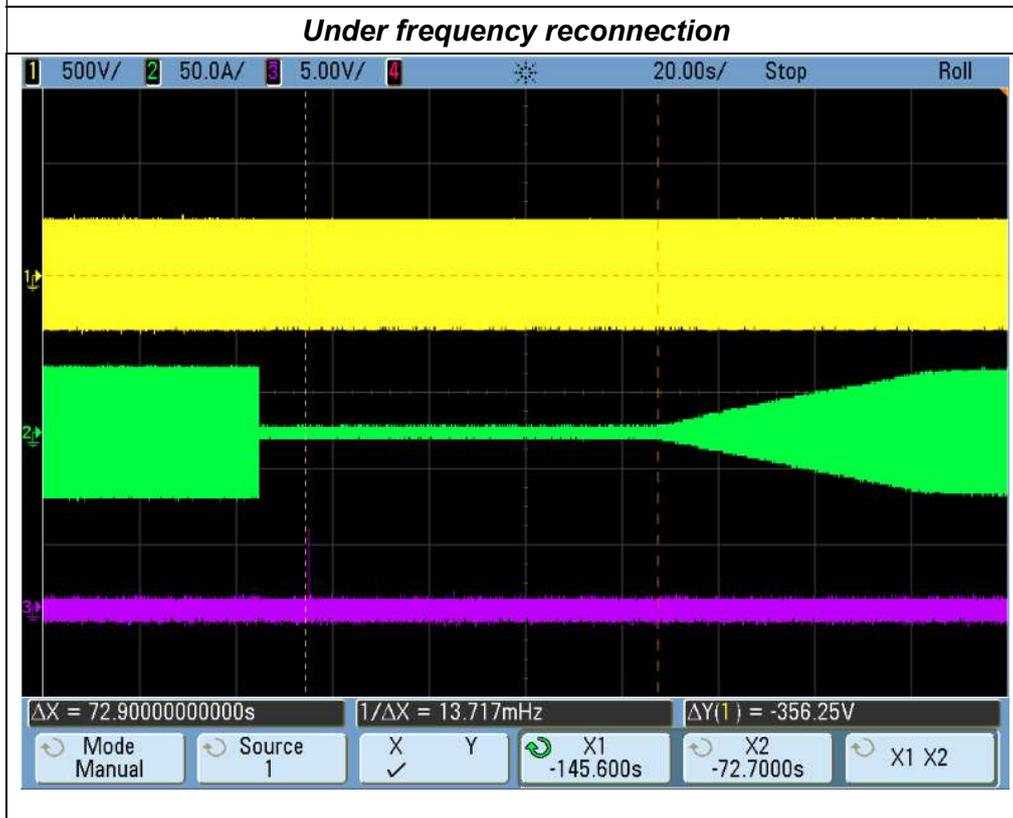
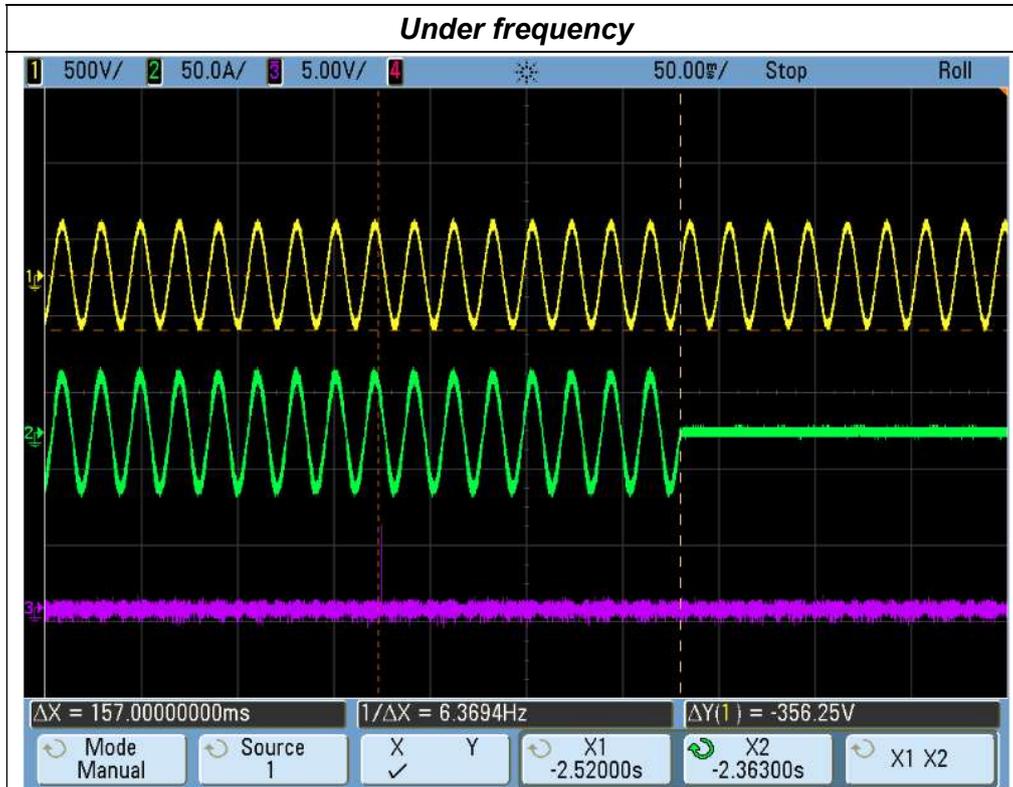






**Over/under frequency trip settings and reconnection test**

Ch1: Output Voltage Ch2: Output Current Ch3: Trip signal



IEC 61727:2004

