TEST REPORT

IEC 61727

Photovoltaic (PV) systems
Characteristics of the utility interface

Report reference number ..... :	**PV190308N051**
Date of issue ..... ::	2019-07-05
Total number of pages ..... ::	39
Testing laboratory name ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China
Applicant's name..... :	**EVOLVE ENERGY GROUP CO., LIMITED**
Address ..... :	RM 702, 7/F FU FAI COMM CTR 27 HILLIER ST SHEUNG WAN, HK
Test specification	
Standard..... :	IEC 61727:2004-12
Certificate..... :	**Certificate of compliance**
Test report form number ..... :	IEC 61727
Master TRF ..... :	Bureau Veritas Consumer Products Services Germany GmbH
Test item description ..... :	**Solar Grid-tied Inverter**
Trademark..... :	EVVO
Model / Type ..... :	EVVO 20000TLG23P, EVVO 25000TLG23P, EVVO 30000TLG23P, EVVO 33000TLG23P

Ratings ..... :	EVVO 20000TLG23P	EVVO 25000TLG23P	EVVO 30000TLG23P	EVVO 33000TLG23P
Input DC voltage range [V]..... :	230-1100			
Full load MPPT DC voltage range [V]:	480-850	460-850	520-850	580-850
Input DC current [A] ..... :	24/24	28/28	30/30	30/30
Output AC voltage [V] ..... :	400V, 3/N/PE, 50Hz			
Output AC current [A]..... :	Max. 32	Max. 40	Max. 48	Max. 53
Output power [VA]..... :	22000	27500	33000	36300

Testing Location ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China
Tested by (name and signature) ..... :	Dora Zhang 
Approved by (name and signature) ..... :	James Huang 
Manufacturer's name ..... :	**EVOLVE ENERGY GROUP CO., LIMITED**
Manufacturer address ..... :	RM 702, 7/F FU FAI COMM CTR 27 HILLIER ST SHEUNG WAN, HK
Factory's name ..... :	**Dongguan SOFAR SOLAR Co.,Ltd.**
Factory address	1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2019-07-05	Dora Zhang	Initial report was written	--
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] ..... :	37

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 ..... :	2018-07-12
Date(s) of performance of test ..... :	2018-07-12 to 2018-08-01

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.

This is a copy test report, the test results refer to the original test report **PV180712N013** issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Aug. 03, 2018.

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

The IEC61727does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

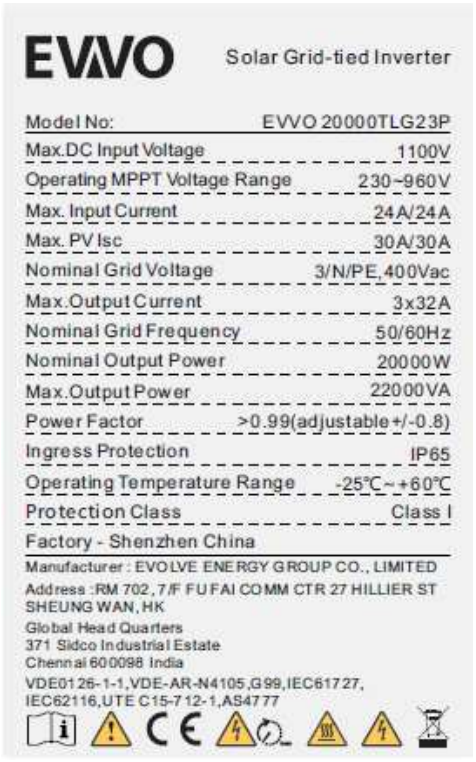
Tolerances on trip values tabel 2 EN 50438:

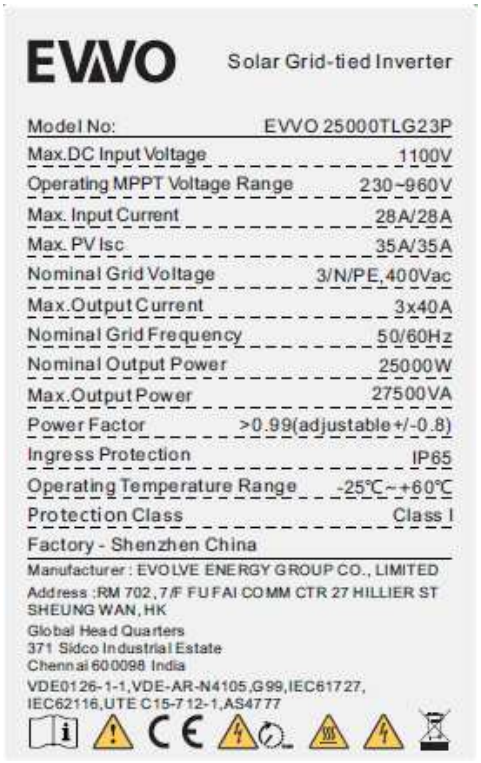
- Voltage: +/- 1% of the nominal voltage;
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

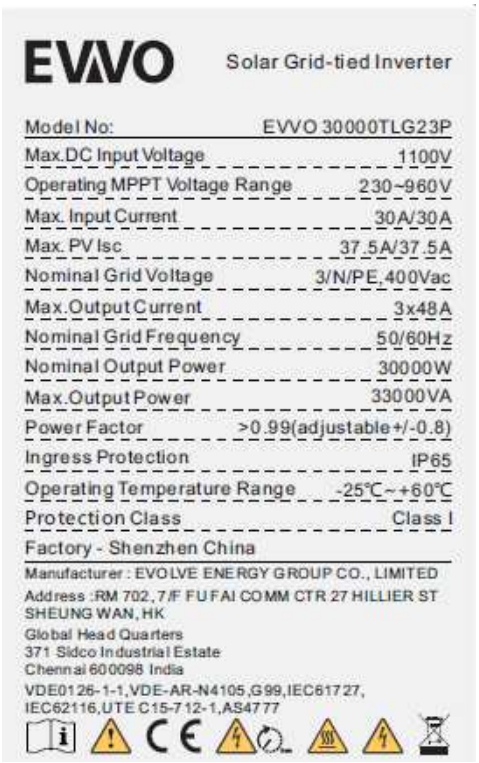
This Test Report consists of the following documents:

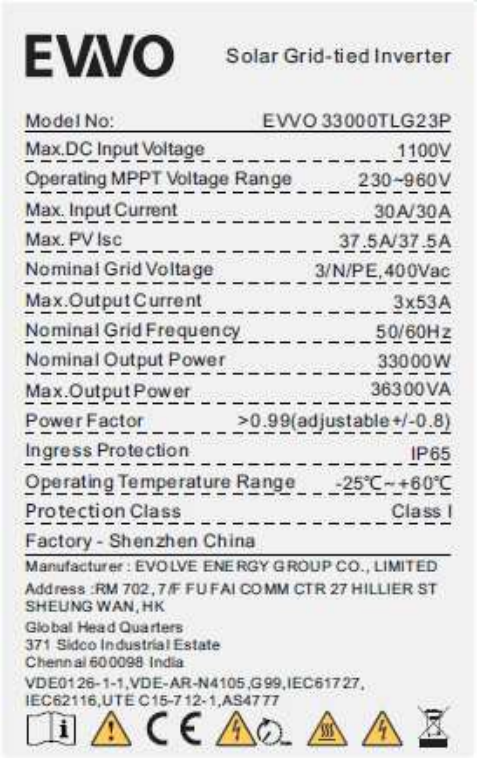
1. Test Results
2. Annex No. 1 – Pictures of the unit
3. Annex No. 2 – Test equipment list

Copy of marking plate:









General product information:

The Solar converter converts DC voltage into AC voltage.
The DC input of Solar converter can be supplied from PV array and Batteries.
The charging current to batteries only from PV array, battery management unit is integrated in External Energy storage.

The Solar converter is a three-phase type.
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.

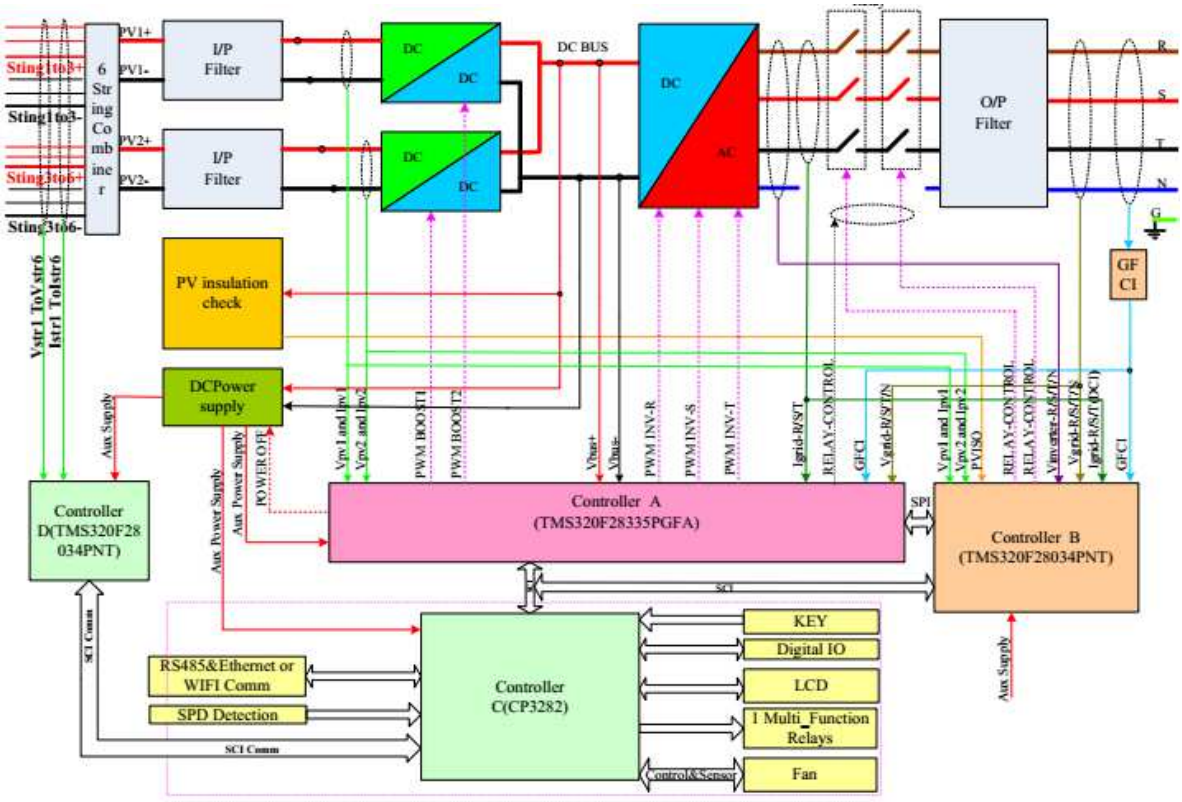


Figure 1-Block diagram

The internal control is redundant built. It consists of Main DSP(UC20) and slave DSP(UC73).

The Main DSP(UC20) can control the relays, measures voltage, and frequency, AC current with injected DC, insulation resistance and residual current, In addition it tests the array insulation resistance and the RCMU circuit before each start up.

The slave DSP(UC73) is using for detect residual current, also can open the relays independently and communicate with Main DSP(UC20).

The unit provides two relays in series on Line conductors. When single-fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before start up. Both controllers(Main DSP(UC20), Slave DSP(UC73) can open the relays.

The product was tested on:

Hardware version: V1.00

Software version: V1.40

Model difference:

The models EVVO 20000TLG23P, EVVO 25000TLG23P, EVVO 30000TLG23P and EVVO 33000TLG23P are almost identical in hardware except the shown in the following table and the output power derated by software.

The difference in hardware			
Item	EVVO 20000TLG23P	EVVO 25000TLG23P	EVVO 30000TLG23P / EVVO 33000TLG23P
Number of PV terminal	2+2	3+3	
Number of BUS capacitance	8 capacitors: 550V/110μF 2 capacitors: 1100V/40μF		10 capacitors: 550V/110μF 4 capacitors: 1100V/40μF
INV inductance	785μH	735μH	
BUS board	Not the board	Have the board	
External fan	Not the board	2	3
Relay of output board	6pcs T9VV1K15-12S		3pcs AZSR250-2AE-12D

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4	**General** 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. 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. All power quality parameters (voltage, flicker, frequency, harmonics, and power factor) must be measured at the utility interface/ point of common coupling unless otherwise specified.	Noticed	**P**
4.1	**Voltage, current and frequency** The PV system AC voltage, current and frequency shall be compatible with the utility system.	Derived from tests	**P**
4.2	**Normal voltage operating range** 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.	Derived from tests	**P**
4.3	**Flicker** The operation of the PV system should 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 table 4.3	**P**
4.4	**DC injection** The PV system shall not inject DC current greater than 1 % of the rated inverter output current, into the utility AC interface under any operating condition.	See table 4.4	**P**
4.5	**Normal frequency operating range** The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in 5.2.2.	See table 4.5 and 5.2.2	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4.6	**Harmonics and waveform distortion** Low levels of current and voltage harmonics are desirable; the higher harmonic levels increase the potential for adverse effects on connected equipment. Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads/apparatus, and established utility practice. The PV system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. Total harmonic current distortion shall be less than 5 % at rated inverter output. Each individual harmonic shall be limited to the percentages listed in Table 1. Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed. (see Clause 4.6 Table 1 – Current distortion limits)	See tables 4.6	**P**
4.7	**Power factor** The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50 % of the rated inverter output power.	See table 4.7	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5	**General** This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.	Noticed	**P**
5.1	**Loss of utility voltage** To prevent islanding, a utility connected PV system shall cease to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified time limits. 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. If inverters (single or multiple) have DC SELV input and have accumulated power below 1 kW then no mechanical disconnect (relay) is required.	The loss of utility voltage test report for IEC61727 according to IEC62116 is stored in archive at Bureau Veritas, Project Nr. PV190308N051-1	**P**
5.2	**Over/under voltage and frequency** Abnormal conditions can arise on the utility system that requires a response from the connected photovoltaic system. This response is to ensure the safety of utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system. 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 table 5.2.1 and 5.2.2	**P**
5.2.1	**Over/under voltage** When the interface voltage deviates outside the conditions specified in Table 2, the photovoltaic system shall cease to energize the utility distribution system. This applies to any phase of a multiphase system. All discussions regarding system voltage refer to the local nominal voltage. The system shall sense abnormal voltage and respond. The following conditions should be met, with voltages in RMS and measured at the point of utility connection. (see clause 5.2.1 Table 2 – Response to abnormal voltages) The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping. The unit does not have to cease to energize if the voltage returns to the normal utility continuous operation condition within the specified trip time.	See table 5.2.1	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5.2.2	**Over/under frequency** When the utility frequency deviates outside the specified conditions the photovoltaic system shall cease 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. When the utility frequency is outside the range of ±1 Hz, the system shall cease 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.	See table 5.2.2	**P**
5.3	**Islanding protection** The PV system must cease to energize the utility line within 2 s of loss of utility.	The loss of utility voltage test report for IEC61727 according to IEC62116 is stored in archive at Bureau Veritas, Project Nr. PV190308N051-1	**P**
5.4	**Response to utility recovery** Following an out-of-range utility condition that has caused the photovoltaic system to cease energizing, the photovoltaic system shall 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 table 5.2.1 and 5.2.2	**P**
5.5	**Earthing** The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.6	**Short circuit protection** The photovoltaic system shall have short-circuit protection in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.7	**Isolation and switching** A method of isolation and switching shall be provided in accordance with IEC 60364-7-712.	Stated in the manual.	**P**

Test overview:		
IEC 61727:2004-12		
Clause	**Test**	**Result**
4	Type test:	
4.3	Voltage Fluctuations and Flicker	**P**
4.4	Monitoring of DC-Injection	**P**
4.5	Normal frequency operating range (see 5.2.2 below)	**P**
4.6	Harmonics and waveform distortion	**P**
4.7	Power factor	**P**
5.2.1	Voltage monitoring	**P**
5.2.2	Frequency monitoring	**P**

Test Results

4.3 Voltage fluctuation and flicker			P
inverter >16A			
Limit	dc% = 3.3	P_{st}=1.0	P_{lt}=0.65
Test value	See below		

Test: EVVO 20000TLG23P

No.	dc[%]	dmax[%]	d(t)[ms]	Pst
1	0.06	0.11	0.00	0.11
2	0.00	0.00	0.00	0.11
3	0.00	0.00	0.00	0.11
4	0.00	0.00	0.00	0.11
5	0.01	0.10	0.00	0.11
6	0.00	0.00	0.00	0.11
7	0.00	0.00	0.00	0.11
8	0.00	0.00	0.00	0.11
9	0.00	0.00	0.00	0.11
10	0.00	0.00	0.00	0.11
11	0.00	0.00	0.00	0.11
12	0.00	0.00	0.00	0.11
				Plt
				0.11

Test: EVVO 33000TLG23P

No.	dc[%]	dmax[%]	d(t)[ms]	Pst
1	0.02	0.17	0.00	0.13
2	0.01	0.18	0.00	0.13
3	0.01	0.19	0.00	0.14
4	0.03	0.18	0.00	0.13
5	0.02	0.19	0.00	0.13
6	0.00	0.12	0.00	0.13
7	0.01	0.20	0.00	0.16
8	0.02	0.18	0.00	0.14
9	0.02	0.20	0.00	0.16
10	0.03	0.20	0.00	0.16
11	0.02	0.20	0.00	0.14
12	0.02	0.18	0.00	0.14
				Plt
				0.14

Note:
*The stationary deviance of dc% is more relevant than the dynamic deviance of d_{max} at starting and stopping.

Mains Impedance according EN61000-3-11: **R_{max} = 0.24Ω; jX_{max}= 0.15Ω @50Hz (|Z_{max}| = 0.283/0.4717Ω)**
for single phase inverter use also **R_n = 0.16Ω; jX_n= 0.1Ω**

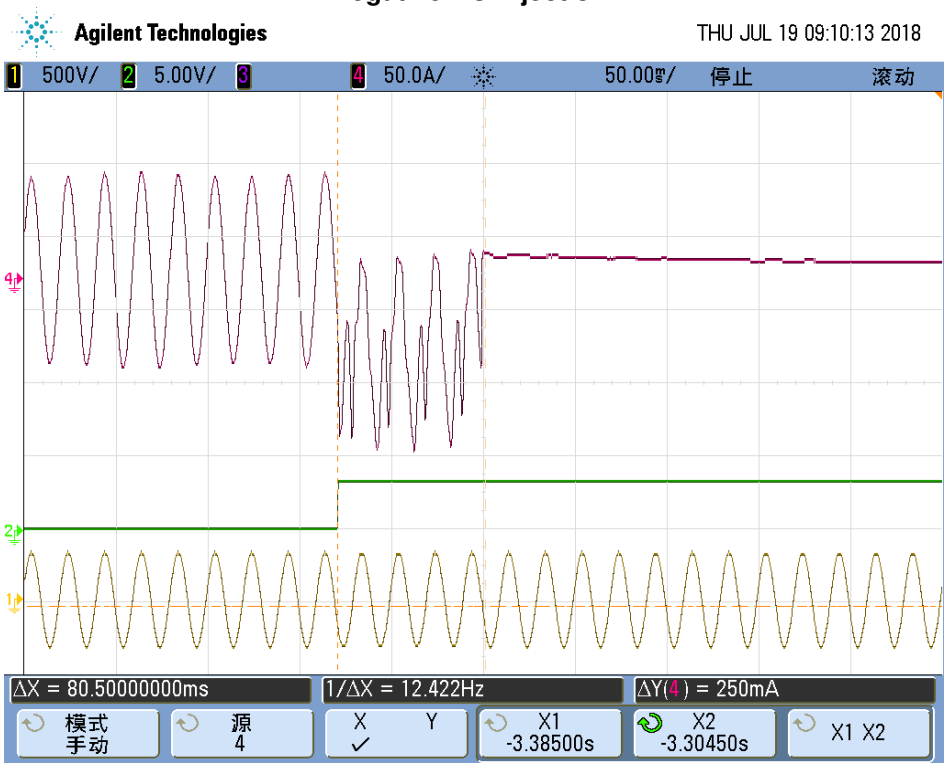
Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:
$Z_{max} = Z_{ref} * 3{,}3\% / d_c(P_n)$

The tests should be based on the limits of the EN 61000-3-11 for more than 16A.

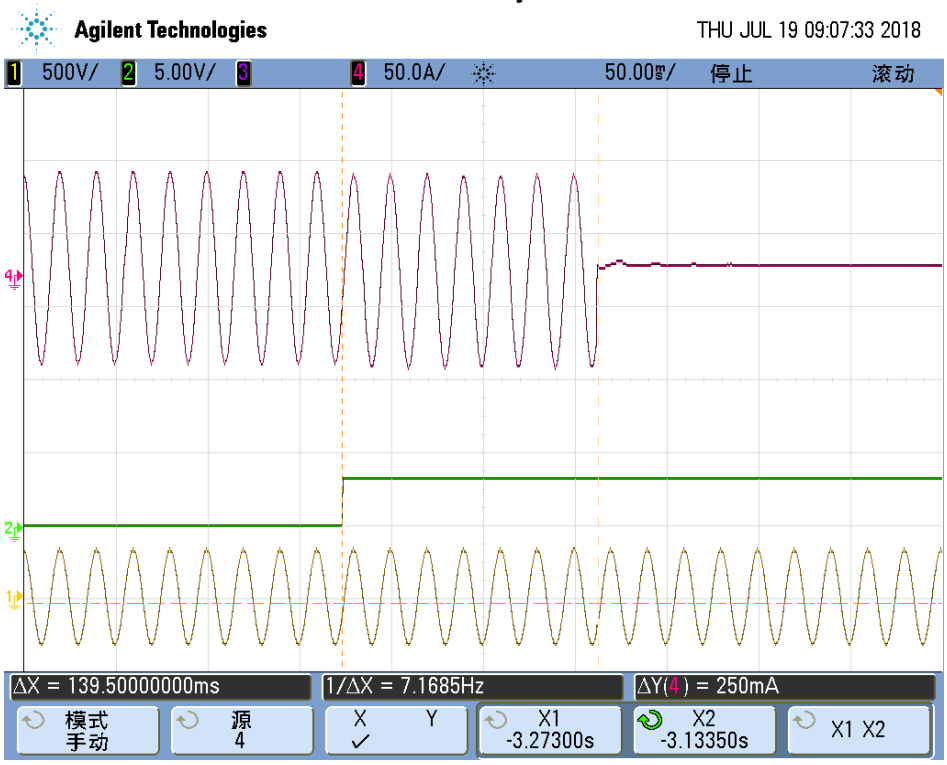
The tests had been performed on the EVVO 33000TLG23P and EVVO 20000TLG23P are valid for the EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.

4.4 Monitoring of DC-Injection				P
Test conditions:	U_N = 400V Uinput = 850V Rated Power: 33kW			
DC Injection [A]	**Limits**	**Trip Time [ms]**	**Trip Time [ms]**	**Trip Time [ms]**
-1.001 A	I_{DC}:>1A than disconnection within 0.2 sec	79	80	77
+1.001 A	I_{DC}:>1A than disconnection within 0.2 sec	120	138	139
Note: A dc-current of 1A is injected, disconnection time of max. 0.2s The tests had been performed on the EVVO 33000TLG23P is valid for the and EVVO 20000TLG23P, EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.				

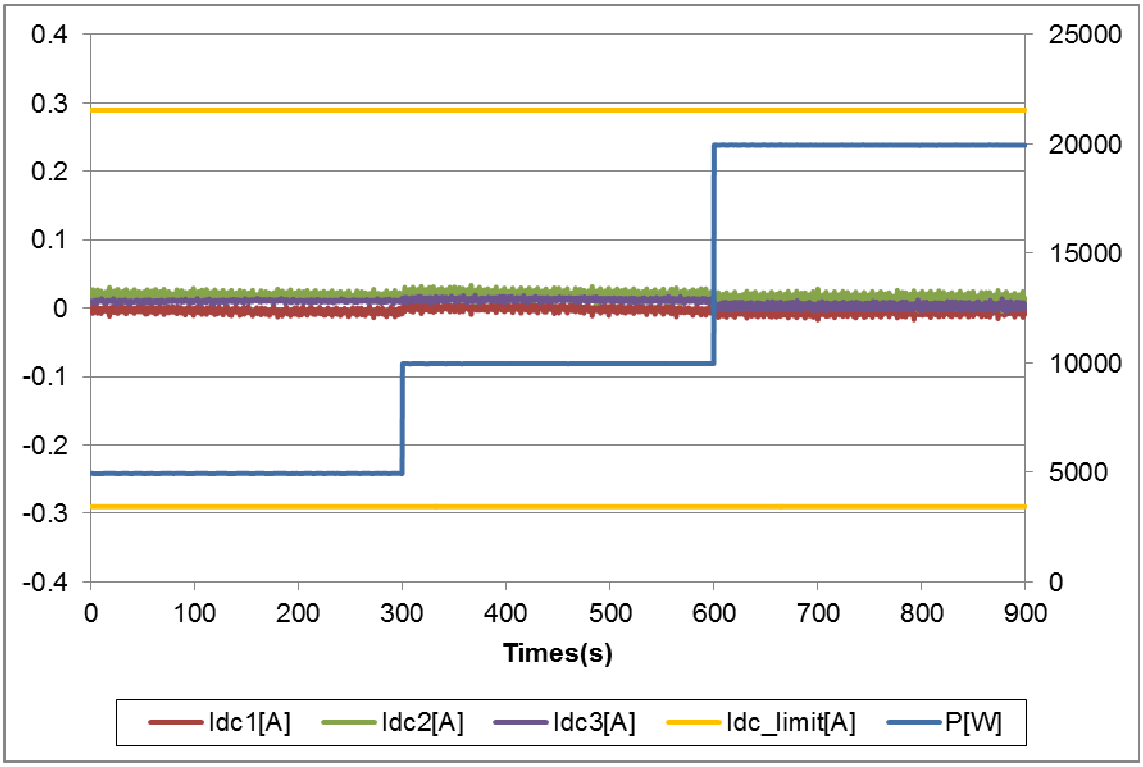
Negative DC-Injection:



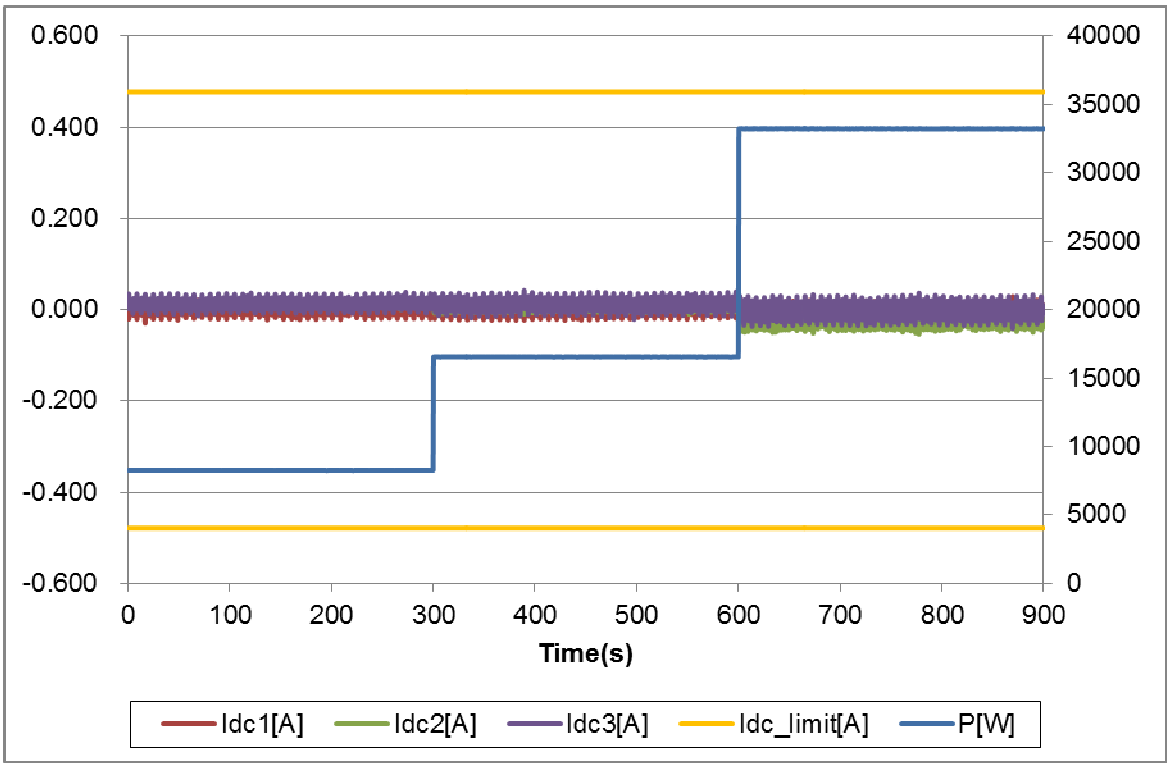
Positive DC-Injection:



4.4 Monitoring of Permanent DC-Injection			P
Slmallest model: EVVO 20000TLG23P			
IEC61727 Limit:	**1% of Inom (290 mA)**		
Output power:	33%	66%	100%
Abs. Max. Test Value:L1	13.8	12.6	16.8
Abs. Ave. Test Value:L1	4.0	0.5	6.5
Abs. Max. Test Value:L2	30.3	33.4	28.1
Abs. Ave. Test Value:L2	18.8	20.2	12.2
Abs. Max. Test Value:L3	14.5	19.2	13.7
Abs. Ave. Test Value:L3	10.5	12.6	3.3



Biggest model: EVVO 33000TLG23P			
IEC61727 Limit:	**1% of Inom (478 mA)**		
Output power:	33%	66%	100%
Abs. Max. Test Value:L1	29.5	23.4	28.9
Abs. Ave. Test Value:L1	1.2	2.7	4.0
Abs. Max. Test Value:L2	23.8	17.7	52.7
Abs. Ave. Test Value:L2	13.0	3.4	29.1
Abs. Max. Test Value:L3	38.7	42.2	40.0
Abs. Ave. Test Value:L3	13.6	11.6	1.7



Note:
The tests had been performed on the EVVO 33000TLG23P and EVVO 20000TLG23P are valid for the EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.

4.6 Harmonic Current Limit Test : EVVO 20000TLG23P — P

Condition	33%Pn	66%Pn	100%Pn
Watts	2238 W	4416 W	6642 W
VA	2245 VA	4420 VA	6646 VA
Vrms	230.05 V	230.21 V	230.56 V
Arms	9.761 A	19.201 A	28.827 A
PF	0.9966	0.9991	0.9993
Frequency	50.00Hz	50.00Hz	50.00Hz
THD50	1.489%	0.886%	0.268%

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	33%Pn	66%Pn	100%Pn	33%Pn	66%Pn	100%Pn		
1st	9.715	19.160	28.801	--	--	--	L1 Phase	--
2nd	0.019	0.024	0.018	0.198	0.122	0.062	L1 Phase	1
3rd	0.045	0.047	0.015	0.460	0.243	0.051	L1 Phase	4
4th	0.015	0.017	0.008	0.154	0.089	0.026	L1 Phase	1
5th	0.089	0.114	0.037	0.911	0.595	0.129	L1 Phase	4
6th	0.009	0.012	0.009	0.091	0.063	0.032	L1 Phase	1
7th	0.054	0.079	0.036	0.553	0.410	0.124	L1 Phase	4
8th	0.005	0.006	0.010	0.056	0.033	0.033	L1 Phase	1
9th	0.030	0.032	0.010	0.304	0.168	0.036	L1 Phase	4
10th	0.006	0.011	0.004	0.062	0.055	0.014	L1 Phase	0.5
11th	0.042	0.049	0.019	0.430	0.254	0.065	L1 Phase	2
12th	0.004	0.006	0.005	0.046	0.030	0.017	L1 Phase	0.5
13th	0.021	0.039	0.010	0.211	0.204	0.034	L1 Phase	2
14th	0.005	0.004	0.004	0.048	0.022	0.014	L1 Phase	0.5
15th	0.008	0.007	0.006	0.085	0.038	0.019	L1 Phase	2
16th	0.004	0.005	0.014	0.044	0.025	0.049	L1 Phase	0.5
17th	0.012	0.021	0.012	0.120	0.107	0.041	L1 Phase	1.5
18th	0.003	0.003	0.003	0.034	0.017	0.012	L1 Phase	0.5
19th	0.022	0.009	0.016	0.227	0.048	0.057	L1 Phase	1.5
20th	0.002	0.003	0.003	0.025	0.016	0.010	L1 Phase	0.5
21th	0.006	0.005	0.007	0.065	0.027	0.026	L1 Phase	1.5
22th	0.002	0.003	0.001	0.022	0.017	0.005	L1 Phase	0.5
23th	0.028	0.005	0.012	0.287	0.025	0.041	L1 Phase	0.6
24th	0.002	0.003	0.002	0.017	0.014	0.006	L1 Phase	0.5
25th	0.020	0.004	0.012	0.206	0.018	0.041	L1 Phase	0.6
26th	0.003	0.002	0.002	0.027	0.011	0.007	L1 Phase	0.5
27th	0.002	0.003	0.004	0.023	0.014	0.013	L1 Phase	0.6
28th	0.003	0.002	0.002	0.027	0.012	0.007	L1 Phase	0.5
29th	0.012	0.005	0.010	0.124	0.026	0.034	L1 Phase	0.6
30th	0.003	0.002	0.002	0.032	0.011	0.006	L1 Phase	0.5
31th	0.005	0.003	0.013	0.053	0.013	0.044	L1 Phase	0.6
32th	0.002	0.003	0.005	0.024	0.014	0.019	L1 Phase	0.5
33th	0.003	0.002	0.003	0.026	0.011	0.012	L1 Phase	0.6

4.6 Harmonic Current Limit Test : EVVO 20000TLG23P — P

Condition	33%Pn	66%Pn	100%Pn
Watts	2221 W	4377 W	6672 W
VA	2227 VA	4381 VA	6676 VA
Vrms	230.07 V	230.19 V	230.61 V
Arms	9.681 A	19.032 A	28.951 A
PF	0.9970	0.9992	0.9993
Frequency	50.00Hz	50.00Hz	50.00Hz
THD50	1.438%	0.861%	0.298%

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	33%Pn	66%Pn	100%Pn	33%Pn	66%Pn	100%Pn		
1st	9.679	19.075	28.928	--	--	--	L2 Phase	--
2nd	0.018	0.015	0.017	0.190	0.081	0.059	L2 Phase	1
3rd	0.036	0.034	0.026	0.367	0.179	0.091	L2 Phase	4
4th	0.014	0.014	0.009	0.144	0.072	0.032	L2 Phase	1
5th	0.083	0.110	0.054	0.852	0.579	0.187	L2 Phase	4
6th	0.010	0.012	0.010	0.106	0.062	0.034	L2 Phase	1
7th	0.058	0.082	0.023	0.602	0.430	0.079	L2 Phase	4
8th	0.006	0.009	0.010	0.067	0.049	0.034	L2 Phase	1
9th	0.028	0.031	0.008	0.285	0.165	0.029	L2 Phase	4
10th	0.006	0.009	0.006	0.063	0.050	0.022	L2 Phase	0.5
11th	0.040	0.045	0.010	0.410	0.238	0.036	L2 Phase	2
12th	0.005	0.007	0.005	0.051	0.039	0.019	L2 Phase	0.5
13th	0.022	0.040	0.013	0.222	0.211	0.045	L2 Phase	2
14th	0.004	0.005	0.007	0.040	0.024	0.025	L2 Phase	0.5
15th	0.008	0.009	0.010	0.079	0.047	0.034	L2 Phase	2
16th	0.004	0.005	0.005	0.044	0.028	0.016	L2 Phase	0.5
17th	0.007	0.020	0.015	0.070	0.104	0.053	L2 Phase	1.5
18th	0.003	0.004	0.005	0.032	0.021	0.017	L2 Phase	0.5
19th	0.021	0.010	0.017	0.222	0.055	0.058	L2 Phase	1.5
20th	0.002	0.004	0.003	0.026	0.018	0.009	L2 Phase	0.5
21th	0.006	0.006	0.007	0.058	0.029	0.023	L2 Phase	1.5
22th	0.003	0.003	0.001	0.027	0.016	0.004	L2 Phase	0.5
23th	0.031	0.004	0.015	0.323	0.021	0.051	L2 Phase	0.6
24th	0.002	0.004	0.001	0.022	0.019	0.005	L2 Phase	0.5
25th	0.019	0.005	0.011	0.198	0.027	0.038	L2 Phase	0.6
26th	0.002	0.002	0.001	0.023	0.013	0.004	L2 Phase	0.5
27th	0.002	0.003	0.005	0.019	0.014	0.016	L2 Phase	0.6
28th	0.003	0.002	0.001	0.031	0.012	0.005	L2 Phase	0.5
29th	0.011	0.004	0.010	0.111	0.023	0.036	L2 Phase	0.6
30th	0.003	0.002	0.001	0.028	0.012	0.003	L2 Phase	0.5
31th	0.007	0.002	0.013	0.069	0.012	0.045	L2 Phase	0.6
32th	0.003	0.002	0.002	0.028	0.009	0.007	L2 Phase	0.5
33th	0.003	0.003	0.003	0.027	0.014	0.010	L2 Phase	0.6

4.6 Harmonic Current Limit Test : EVVO 20000TLG23P — P

Condition	33%Pn	66%Pn	100%Pn
Watts	2225 W	4409 W	6651 W
VA	2232 VA	4412 VA	6656 VA
Vrms	230.02 V	230.20 V	230.69 V
Arms	9.704 A	19.167 A	28.853 A
PF	0.9967	0.9992	0.9993
Frequency	50.00Hz	50.00Hz	50.00Hz
THD50	1.263%	0.650%	0.336%

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	33%Pn	66%Pn	100%Pn	33%Pn	66%Pn	100%Pn		
1st	9.669	19.145	28.828	--	--	--	L3 Phase	--
2nd	0.033	0.031	0.020	0.344	0.161	0.069	L3 Phase	1
3rd	0.069	0.066	0.019	0.712	0.346	0.067	L3 Phase	4
4th	0.020	0.023	0.014	0.203	0.120	0.047	L3 Phase	1
5th	0.025	0.048	0.076	0.258	0.252	0.263	L3 Phase	4
6th	0.014	0.012	0.004	0.148	0.063	0.015	L3 Phase	1
7th	0.017	0.038	0.027	0.173	0.198	0.093	L3 Phase	4
8th	0.008	0.014	0.004	0.087	0.076	0.014	L3 Phase	1
9th	0.052	0.057	0.014	0.537	0.296	0.050	L3 Phase	4
10th	0.007	0.010	0.006	0.074	0.054	0.020	L3 Phase	0.5
11th	0.011	0.019	0.013	0.115	0.098	0.045	L3 Phase	2
12th	0.005	0.006	0.002	0.055	0.033	0.008	L3 Phase	0.5
13th	0.013	0.022	0.007	0.133	0.113	0.024	L3 Phase	2
14th	0.005	0.006	0.005	0.050	0.034	0.019	L3 Phase	0.5
15th	0.016	0.013	0.009	0.166	0.068	0.031	L3 Phase	2
16th	0.003	0.004	0.014	0.032	0.020	0.048	L3 Phase	0.5
17th	0.011	0.012	0.013	0.115	0.064	0.044	L3 Phase	1.5
18th	0.004	0.004	0.003	0.040	0.021	0.009	L3 Phase	0.5
19th	0.016	0.003	0.006	0.165	0.018	0.022	L3 Phase	1.5
20th	0.002	0.003	0.003	0.024	0.016	0.009	L3 Phase	0.5
21th	0.010	0.008	0.006	0.108	0.042	0.022	L3 Phase	1.5
22th	0.002	0.003	0.001	0.023	0.018	0.005	L3 Phase	0.5
23th	0.029	0.007	0.015	0.300	0.036	0.053	L3 Phase	0.6
24th	0.002	0.002	0.001	0.018	0.012	0.004	L3 Phase	0.5
25th	0.018	0.006	0.007	0.190	0.030	0.023	L3 Phase	0.6
26th	0.003	0.002	0.002	0.027	0.008	0.006	L3 Phase	0.5
27th	0.002	0.002	0.002	0.018	0.013	0.006	L3 Phase	0.6
28th	0.002	0.002	0.002	0.022	0.010	0.006	L3 Phase	0.5
29th	0.013	0.005	0.012	0.134	0.024	0.043	L3 Phase	0.6
30th	0.003	0.002	0.001	0.028	0.010	0.003	L3 Phase	0.5
31th	0.007	0.003	0.011	0.069	0.016	0.037	L3 Phase	0.6
32th	0.001	0.003	0.004	0.015	0.013	0.014	L3 Phase	0.5
33th	0.003	0.003	0.002	0.036	0.015	0.007	L3 Phase	0.6

4.6 Harmonic Current Limit Test : EVVO 33000TLG23P — P

Condition	33%Pn	66%Pn	100%Pn
Watts	3483 W	6950 W	10913 W
VA	3488 VA	6953 VA	10917 VA
Vrms	230.14 V	230.32 V	231.07 V
Arms	15.155 A	30.190 A	47.244 A
PF	0.9987	0.9996	0.9997
Frequency	50.00Hz	50.00Hz	50.00Hz
THD50	1.118%	0.570%	0.686%

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	33%Pn	66%Pn	100%Pn	33%Pn	66%Pn	100%Pn		
1st	15.115	30.146	47.244	--	--	--	L1 Phase	--
2nd	0.022	0.025	0.112	0.145	0.081	0.237	L1 Phase	1
3rd	0.047	0.049	0.091	0.309	0.162	0.192	L1 Phase	4
4th	0.016	0.024	0.098	0.104	0.078	0.208	L1 Phase	1
5th	0.109	0.127	0.102	0.721	0.419	0.216	L1 Phase	4
6th	0.006	0.010	0.065	0.041	0.032	0.138	L1 Phase	1
7th	0.074	0.063	0.160	0.486	0.208	0.338	L1 Phase	4
8th	0.008	0.007	0.067	0.054	0.023	0.141	L1 Phase	1
9th	0.034	0.020	0.045	0.228	0.067	0.095	L1 Phase	4
10th	0.005	0.010	0.027	0.033	0.032	0.057	L1 Phase	0.5
11th	0.053	0.030	0.129	0.349	0.100	0.273	L1 Phase	2
12th	0.005	0.006	0.026	0.035	0.021	0.055	L1 Phase	0.5
13th	0.041	0.018	0.097	0.271	0.060	0.205	L1 Phase	2
14th	0.003	0.007	0.024	0.022	0.024	0.051	L1 Phase	0.5
15th	0.008	0.010	0.010	0.054	0.033	0.021	L1 Phase	2
16th	0.003	0.005	0.018	0.023	0.016	0.039	L1 Phase	0.5
17th	0.010	0.033	0.041	0.065	0.110	0.086	L1 Phase	1.5
18th	0.003	0.004	0.018	0.018	0.014	0.037	L1 Phase	0.5
19th	0.005	0.025	0.025	0.036	0.084	0.054	L1 Phase	1.5
20th	0.002	0.002	0.017	0.011	0.008	0.035	L1 Phase	0.5
21th	0.007	0.008	0.006	0.045	0.027	0.012	L1 Phase	1.5
22th	0.003	0.002	0.010	0.018	0.008	0.022	L1 Phase	0.5
23th	0.011	0.020	0.036	0.074	0.066	0.077	L1 Phase	0.6
24th	0.002	0.003	0.005	0.014	0.008	0.010	L1 Phase	0.5
25th	0.011	0.016	0.027	0.074	0.053	0.057	L1 Phase	0.6
26th	0.002	0.003	0.009	0.014	0.009	0.020	L1 Phase	0.5
27th	0.002	0.006	0.005	0.015	0.020	0.011	L1 Phase	0.6
28th	0.002	0.002	0.006	0.016	0.007	0.013	L1 Phase	0.5
29th	0.017	0.010	0.021	0.113	0.034	0.044	L1 Phase	0.6
30th	0.002	0.003	0.005	0.014	0.009	0.012	L1 Phase	0.5
31th	0.016	0.014	0.020	0.103	0.046	0.043	L1 Phase	0.6
32th	0.001	0.002	0.006	0.009	0.008	0.012	L1 Phase	0.5
33th	0.002	0.003	0.006	0.013	0.009	0.013	L1 Phase	0.6

4.6 Harmonic Current Limit Test : EVVO 33000TLG23P — P

Condition	33%Pn	66%Pn	100%Pn
Watts	3454 W	6884 W	10934 W
VA	3458 VA	6888 VA	10937 VA
Vrms	230.12 V	230.31 V	231.05 V
Arms	15.027 A	29.906 A	47.335 A
PF	0.9988	0.9995	0.9998
Frequency	50.00Hz	50.00Hz	50.00Hz
THD50	1.064%	0.556%	0.542%

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	33%Pn	66%Pn	100%Pn	33%Pn	66%Pn	100%Pn		
1st	15.050	30.004	47.328	--	--	--	L2 Phase	--
2nd	0.019	0.018	0.046	0.129	0.060	0.097	L2 Phase	1
3rd	0.036	0.037	0.048	0.241	0.123	0.102	L2 Phase	4
4th	0.015	0.024	0.062	0.100	0.082	0.130	L2 Phase	1
5th	0.103	0.122	0.046	0.687	0.407	0.098	L2 Phase	4
6th	0.009	0.014	0.050	0.057	0.046	0.105	L2 Phase	1
7th	0.069	0.073	0.137	0.459	0.243	0.289	L2 Phase	4
8th	0.011	0.009	0.048	0.075	0.030	0.102	L2 Phase	1
9th	0.027	0.019	0.035	0.177	0.062	0.074	L2 Phase	4
10th	0.005	0.011	0.031	0.032	0.036	0.066	L2 Phase	0.5
11th	0.054	0.021	0.115	0.360	0.069	0.243	L2 Phase	2
12th	0.005	0.005	0.020	0.036	0.017	0.042	L2 Phase	0.5
13th	0.042	0.020	0.099	0.276	0.066	0.210	L2 Phase	2
14th	0.004	0.007	0.008	0.027	0.022	0.018	L2 Phase	0.5
15th	0.009	0.009	0.017	0.059	0.031	0.036	L2 Phase	2
16th	0.002	0.006	0.006	0.015	0.019	0.012	L2 Phase	0.5
17th	0.014	0.032	0.031	0.093	0.106	0.066	L2 Phase	1.5
18th	0.003	0.004	0.019	0.019	0.013	0.040	L2 Phase	0.5
19th	0.007	0.022	0.037	0.045	0.075	0.077	L2 Phase	1.5
20th	0.002	0.002	0.010	0.014	0.008	0.021	L2 Phase	0.5
21th	0.007	0.006	0.007	0.044	0.020	0.015	L2 Phase	1.5
22th	0.003	0.004	0.009	0.018	0.013	0.018	L2 Phase	0.5
23th	0.008	0.021	0.043	0.054	0.070	0.091	L2 Phase	0.6
24th	0.002	0.003	0.005	0.015	0.009	0.011	L2 Phase	0.5
25th	0.012	0.014	0.031	0.078	0.047	0.066	L2 Phase	0.6
26th	0.002	0.002	0.005	0.013	0.007	0.010	L2 Phase	0.5
27th	0.002	0.005	0.003	0.014	0.016	0.007	L2 Phase	0.6
28th	0.003	0.003	0.003	0.017	0.009	0.005	L2 Phase	0.5
29th	0.017	0.013	0.019	0.114	0.042	0.040	L2 Phase	0.6
30th	0.002	0.002	0.006	0.014	0.007	0.014	L2 Phase	0.5
31th	0.015	0.013	0.022	0.102	0.042	0.047	L2 Phase	0.6
32th	0.002	0.002	0.003	0.012	0.007	0.005	L2 Phase	0.5
33th	0.003	0.003	0.005	0.021	0.009	0.010	L2 Phase	0.6

4.6 Harmonic Current Limit Test : EVVO 33000TLG23P — P

Condition	33%Pn	66%Pn	100%Pn
Watts	3472 W	6953 W	10921 W
VA	3477 VA	6955 VA	10924 VA
Vrms	230.11 V	230.39 V	231.26 V
Arms	15.109 A	30.188 A	47.235 A
PF	0.9988	0.9997	0.9997
Frequency	50.00Hz	50.00Hz	50.00Hz
THD50	0.841%	0.456%	0.648%

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	33%Pn	66%Pn	100%Pn	33%Pn	66%Pn	100%Pn		
1st	15.089	30.174	47.236	--	--	--	L3 Phase	--
2nd	0.032	0.032	0.082	0.210	0.105	0.174	L3 Phase	1
3rd	0.067	0.070	0.077	0.444	0.231	0.164	L3 Phase	4
4th	0.022	0.029	0.102	0.145	0.095	0.216	L3 Phase	1
5th	0.044	0.057	0.096	0.292	0.190	0.202	L3 Phase	4
6th	0.012	0.014	0.043	0.081	0.046	0.091	L3 Phase	1
7th	0.029	0.047	0.157	0.191	0.157	0.333	L3 Phase	4
8th	0.015	0.012	0.041	0.101	0.041	0.086	L3 Phase	1
9th	0.056	0.038	0.028	0.372	0.125	0.060	L3 Phase	4
10th	0.006	0.013	0.022	0.041	0.043	0.046	L3 Phase	0.5
11th	0.024	0.023	0.138	0.156	0.076	0.292	L3 Phase	2
12th	0.005	0.007	0.010	0.035	0.023	0.022	L3 Phase	0.5
13th	0.023	0.029	0.099	0.150	0.096	0.210	L3 Phase	2
14th	0.004	0.009	0.021	0.028	0.029	0.044	L3 Phase	0.5
15th	0.016	0.008	0.009	0.103	0.026	0.020	L3 Phase	2
16th	0.003	0.005	0.015	0.021	0.018	0.031	L3 Phase	0.5
17th	0.008	0.021	0.038	0.053	0.069	0.081	L3 Phase	1.5
18th	0.003	0.004	0.007	0.023	0.012	0.015	L3 Phase	0.5
19th	0.006	0.028	0.033	0.038	0.092	0.071	L3 Phase	1.5
20th	0.002	0.003	0.008	0.016	0.010	0.017	L3 Phase	0.5
21th	0.011	0.006	0.006	0.070	0.019	0.012	L3 Phase	1.5
22th	0.003	0.004	0.011	0.023	0.014	0.023	L3 Phase	0.5
23th	0.008	0.014	0.039	0.053	0.047	0.082	L3 Phase	0.6
24th	0.003	0.003	0.003	0.017	0.009	0.007	L3 Phase	0.5
25th	0.008	0.018	0.029	0.055	0.060	0.061	L3 Phase	0.6
26th	0.002	0.002	0.011	0.016	0.008	0.023	L3 Phase	0.5
27th	0.002	0.006	0.004	0.011	0.021	0.010	L3 Phase	0.6
28th	0.002	0.002	0.005	0.015	0.007	0.011	L3 Phase	0.5
29th	0.016	0.013	0.019	0.108	0.044	0.041	L3 Phase	0.6
30th	0.002	0.003	0.003	0.015	0.009	0.007	L3 Phase	0.5
31th	0.016	0.013	0.023	0.103	0.044	0.048	L3 Phase	0.6
32th	0.002	0.002	0.004	0.013	0.008	0.008	L3 Phase	0.5
33th	0.003	0.003	0.005	0.019	0.009	0.010	L3 Phase	0.6

Note:
The tests had been performed on the EVVO 33000TLG23P and EVVO 20000TLG23P are valid for the EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.

4.7 Power factor					P
Test conditions:	**Biggest model: EVVO 33000TLG23P**				
Output power [kW] / **Test AC voltage [V]**	**~10% 3.290 kW**	**~25% 8.286 kW**	**~50% 16.570 kW**	**~75% 24.715 kW**	**~100% 32.766 kW**
230V	0.9965i	0.9993i	0.9997i	0.9997i	0.9997i
Test conditions:	**Smallest model: EVVO 20000TLG23P**				
Output power [kW] / **Test AC voltage [V]**	**~10% 1.916 kW**	**~25% 4.952 kW**	**~50% 9.980 kW**	**~75% 14.996 kW**	**~100% 19.977 kW**
230V	0.9839i	0.9976i	0.9990i	0.9992i	0.9990i

Note:
*The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50% of the rated inverter output power.

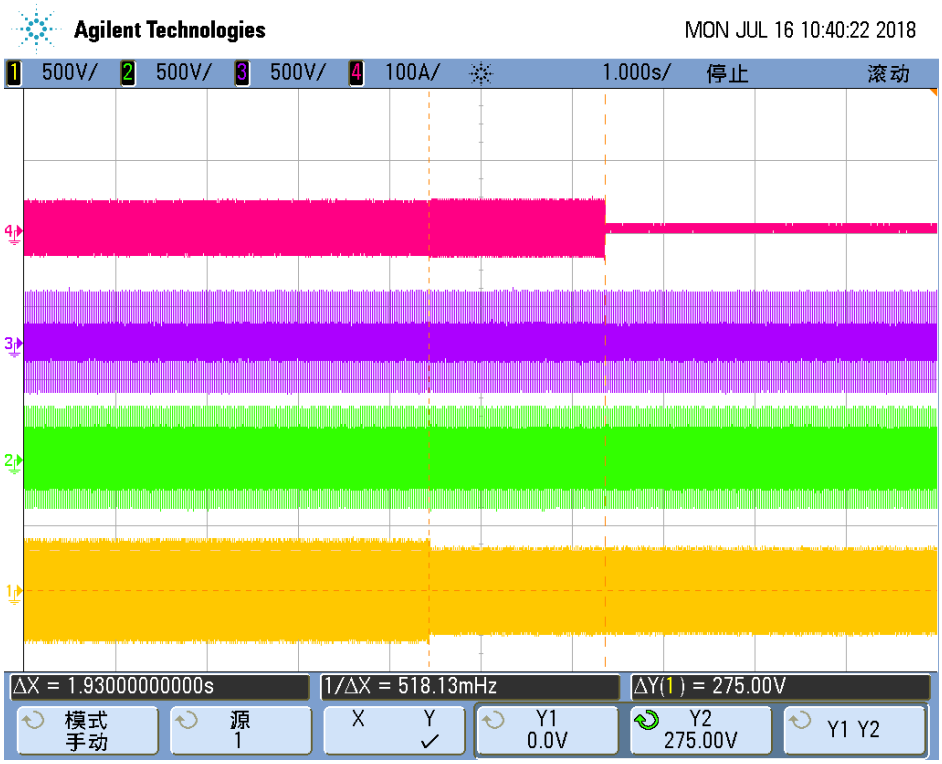
The letter “i” is short for “inductive” and indicates inductive power factor. In case of capacitive power factor the letter “c” is used instead.

The tests had been performed on the EVVO 33000TLG23P and EVVO 20000TLG23P are valid for the EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.

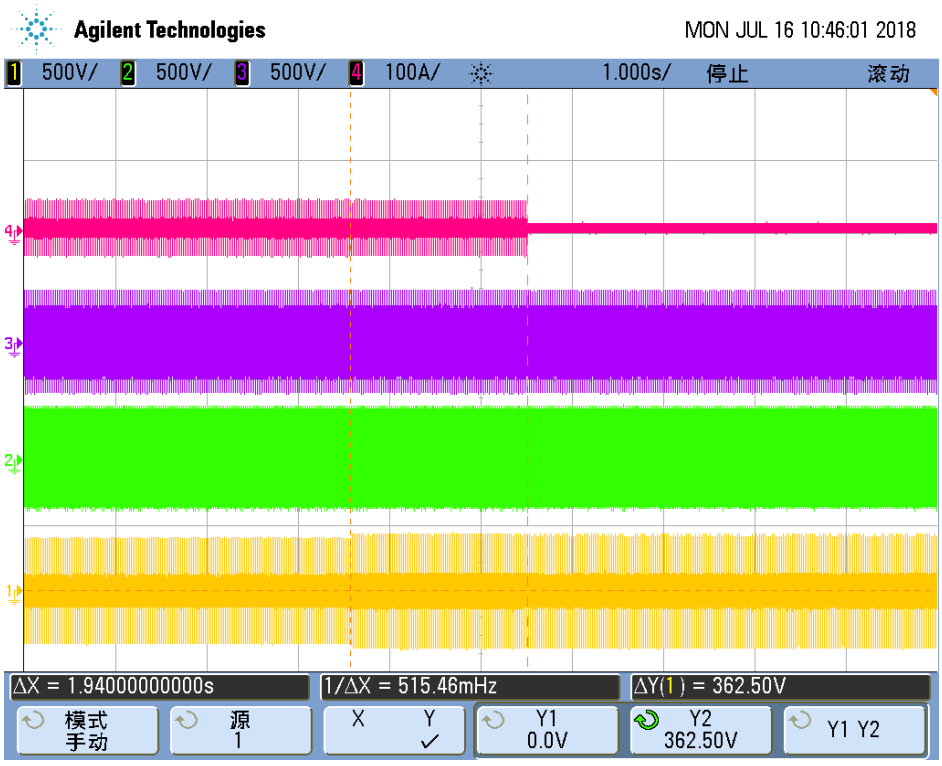
5.2.1 Voltage monitoring									P
IEC 61727: First Level									
Test conditions:	Output power: 16.37kW Frequency: 50Hz								
L1 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time			Voltage	Time			
Limit	**195.5**	**<= 2.0s**			**253.0**	**<= 2.0s**			
Trip value	194.5				254.0				
Disconnection time [ms]	200V to 190V	1.910	1.930	1.900	248V to 258V	1.940	1.920	1.880	
L2 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time			Voltage	Time			
Limit	**195.5**	**<= 2.0s**			**253.0**	**<= 2.0s**			
Trip value	194.5				254.0				
Disconnection time [ms]	200V to 190V	1.930	1.920	1.930	248V to 258V	1.940	1.940	1.900	
L3 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time			Voltage	Time			
Limit	**195.5**	**<= 2.0s**			**253.0**	**<= 2.0s**			
Trip value	194.5				254.0				
Disconnection time [ms]	200V to 190V	1.880	1.900	1.910	248V to 258V	1.900	1.930	1.910	
Reconnection time [s]	20s<t<300s	97			20s<t<300s	98			

IEC 61727: Second Level								
Test conditions:	Output power: 16,37kW Frequency: 50Hz							
L1 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115.0**	**<= 100ms**			**280.0**	**<= 50ms**		
Trip value	113.5				281.0			
Disconnection time [ms]	230V to 110V	77	72	87	230V to 290V	32	42	39
L2 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115.0**	**<= 100ms**			**280.0**	**<= 50ms**		
Trip value	113.5				281.0			
Disconnection time [ms]	230V to 110V	69	75	83	230V to 290V	32	45	43
L3 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115.0**	**<= 100ms**			**280.0**	**<= 50ms**		
Trip value	113.5				281.0			
Disconnection time [ms]	230V to 110V	73	85	88	230V to 290V	46	37	25
Reconnection time [s]	20s<t<300s	97			20s<t<300s	97		
Note: The tests had been performed on the EVVO 33000TLG23P is valid for the EVVO 20000TLG23P, EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.								

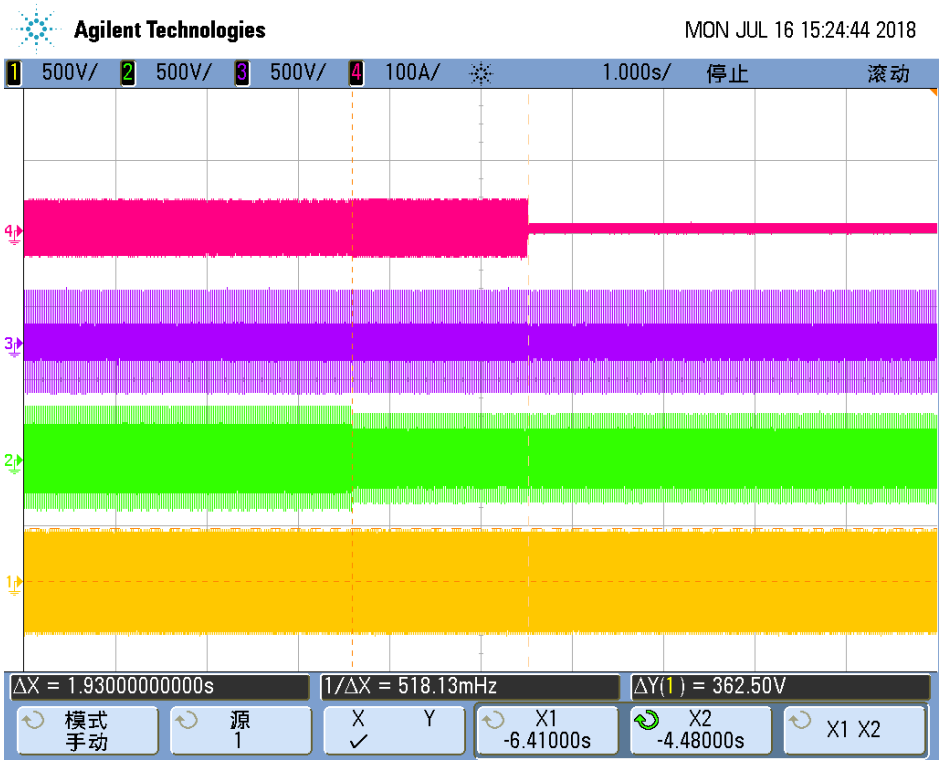
Under Voltage First Level, L1 phase



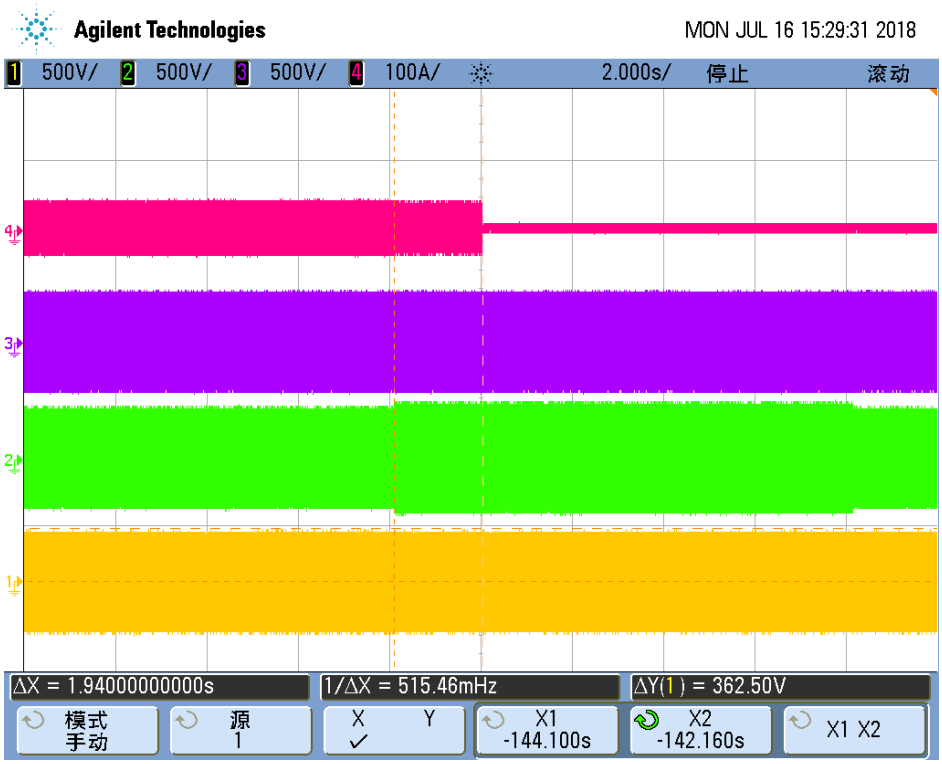
Over voltage First Level, L1 phase



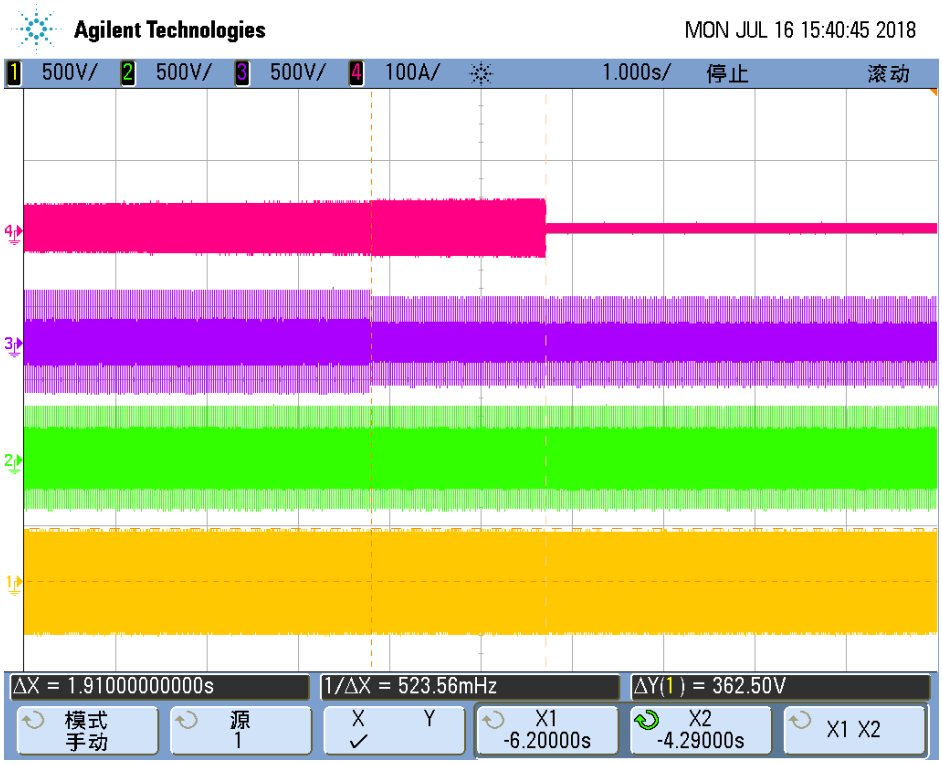
Under Voltage First Level, L2 phase



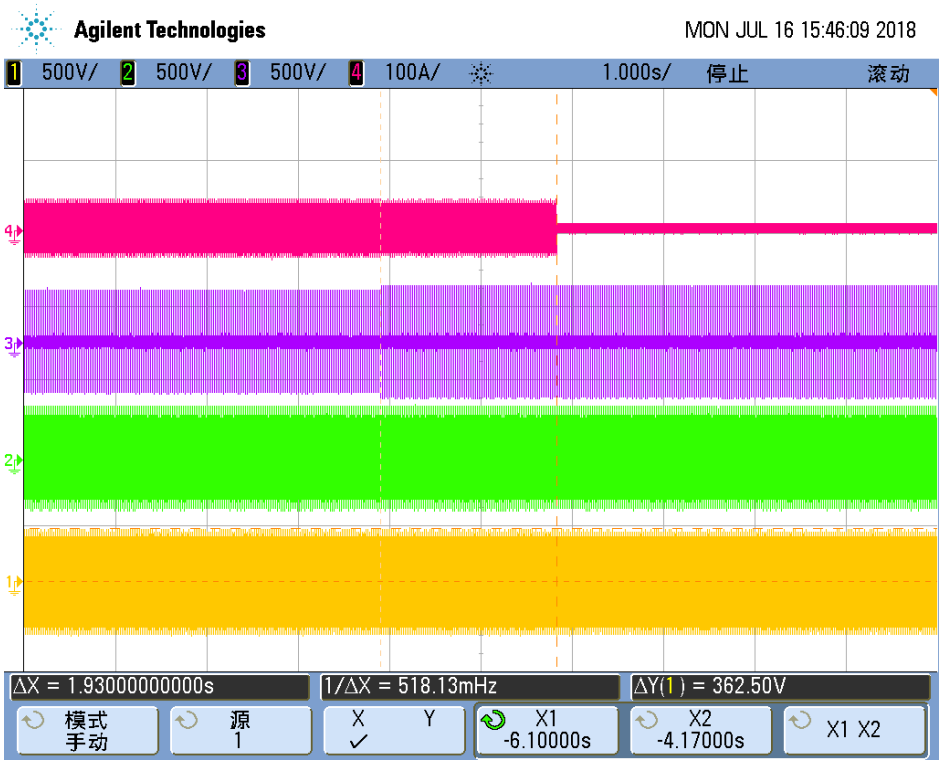
Over voltage First Level, L2 phase



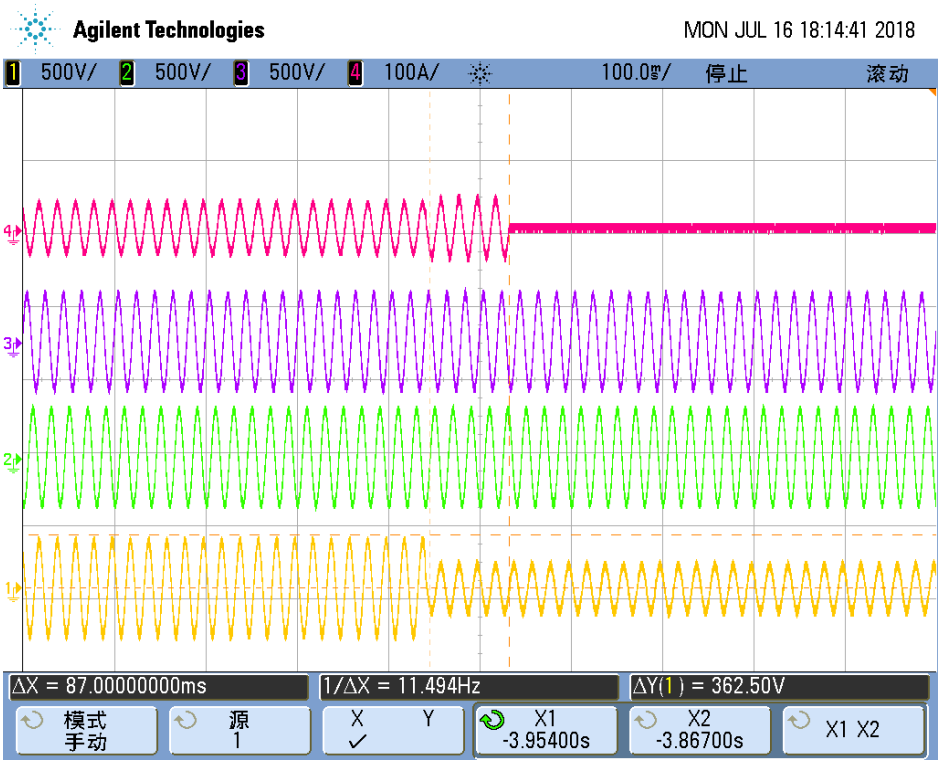
Under Voltage First Level, L3 phase



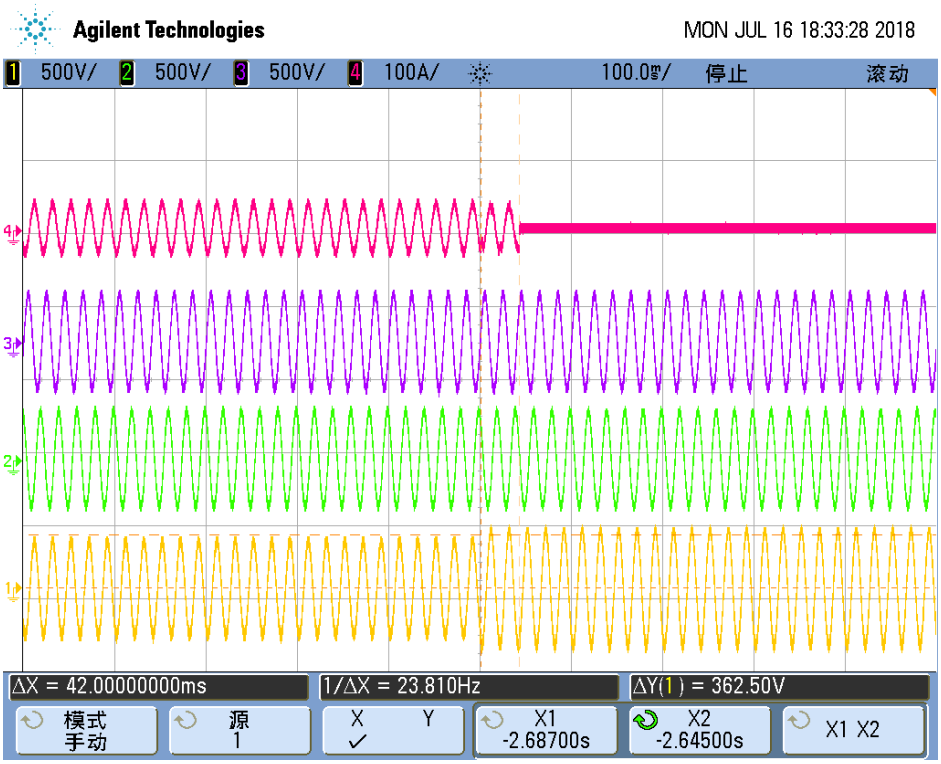
Over voltage First Level, L3 phase



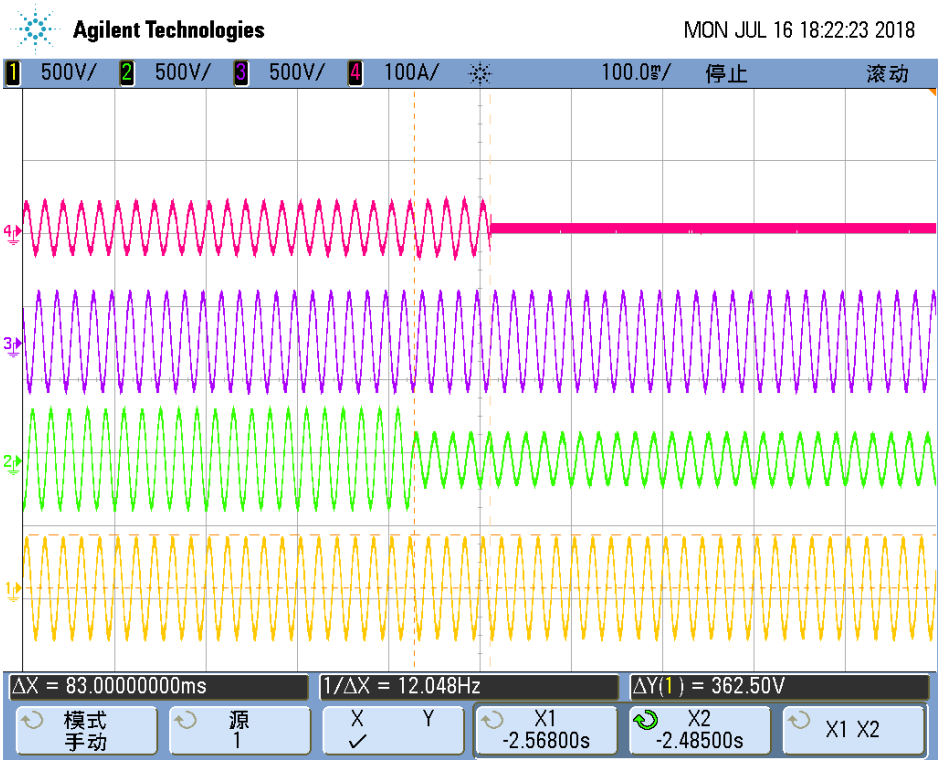
Under Voltage Second Level, L1 phase



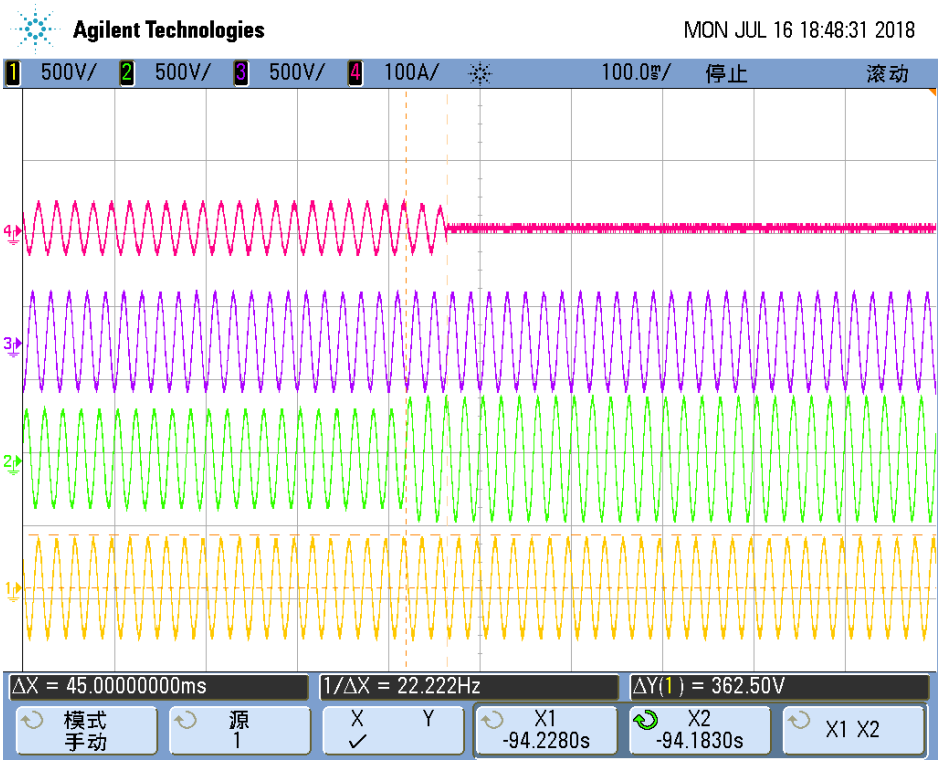
Over voltage Second Level, L1 phase



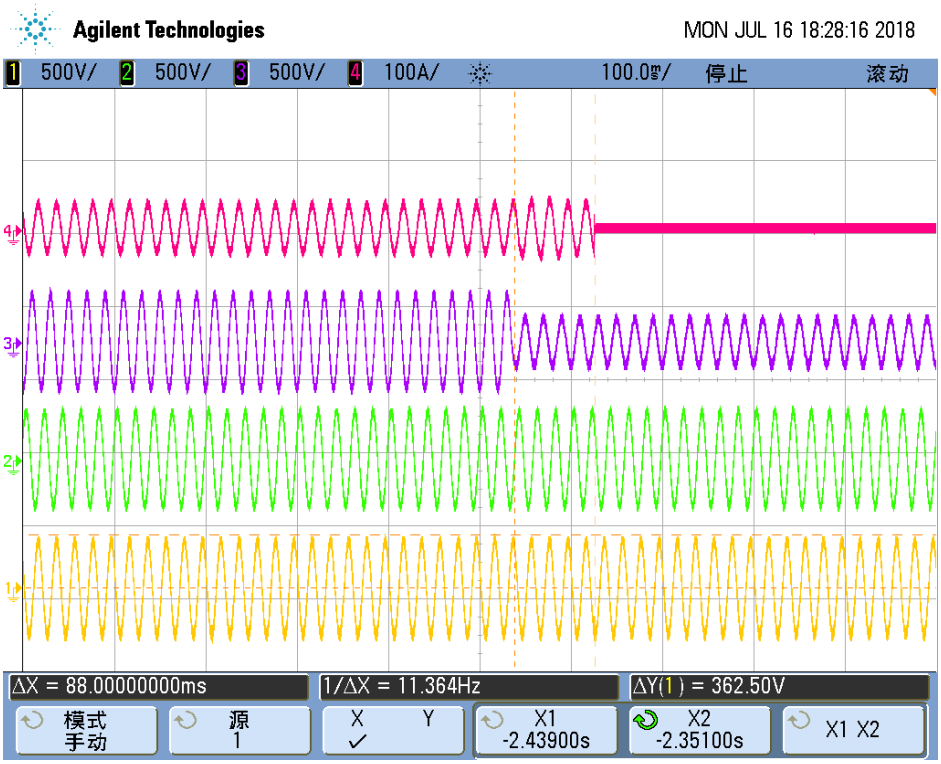
Under Voltage Second Level, L2 phase



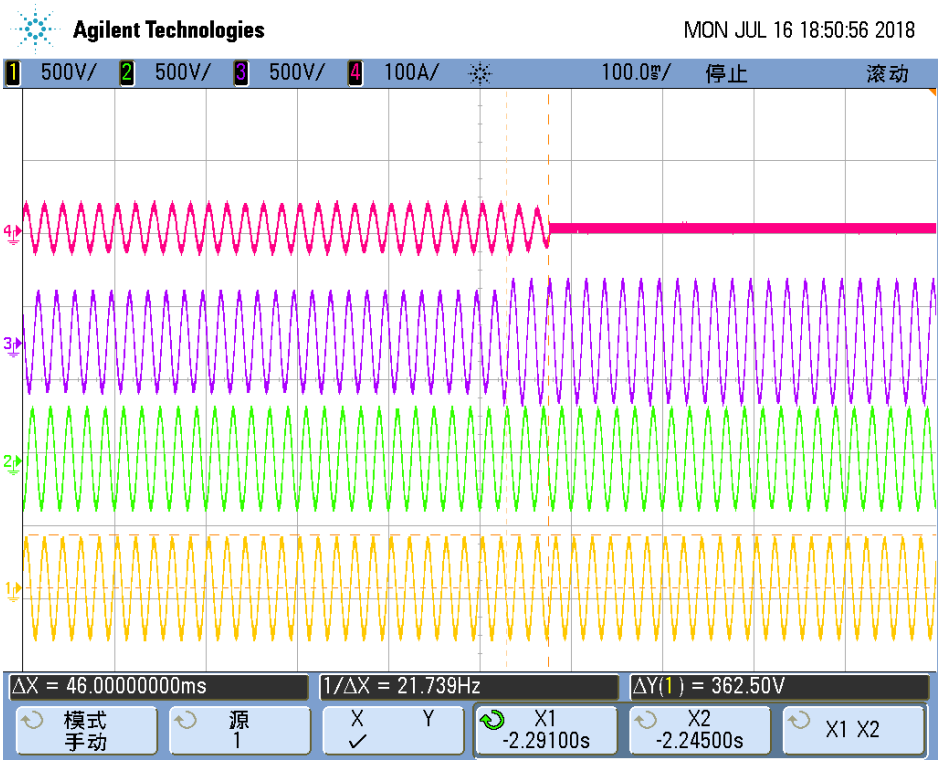
Over voltage Second Level, L2 phase



Under Voltage Second Level, L3 phase



Over voltage Second Level, L3 phase



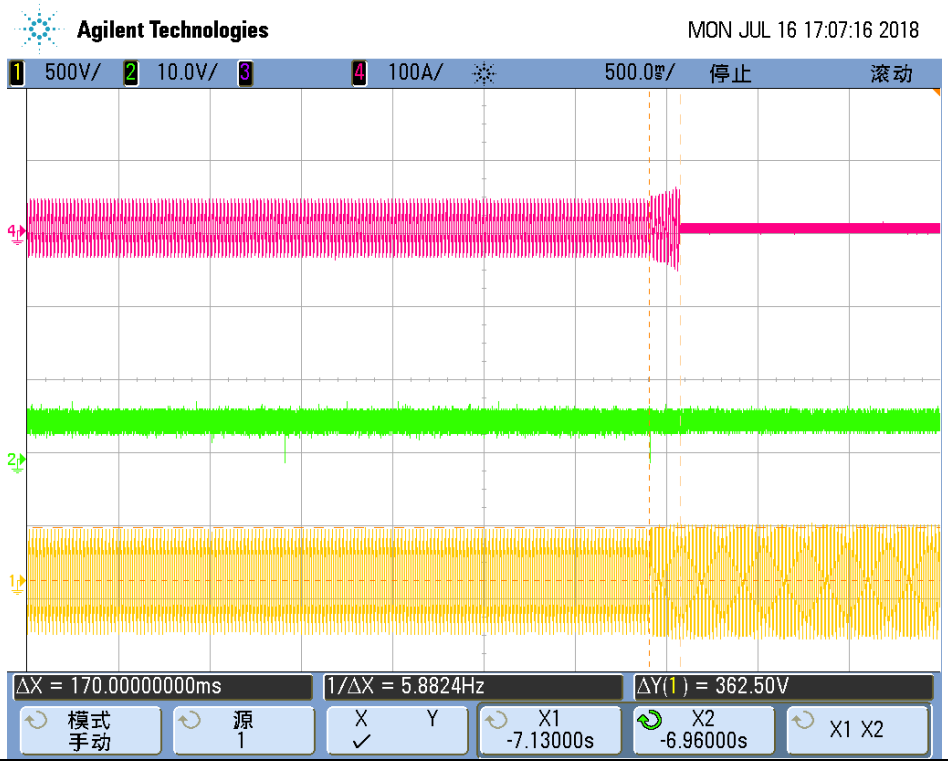
5.2.2 Frequency monitoring	P

IEC 61727

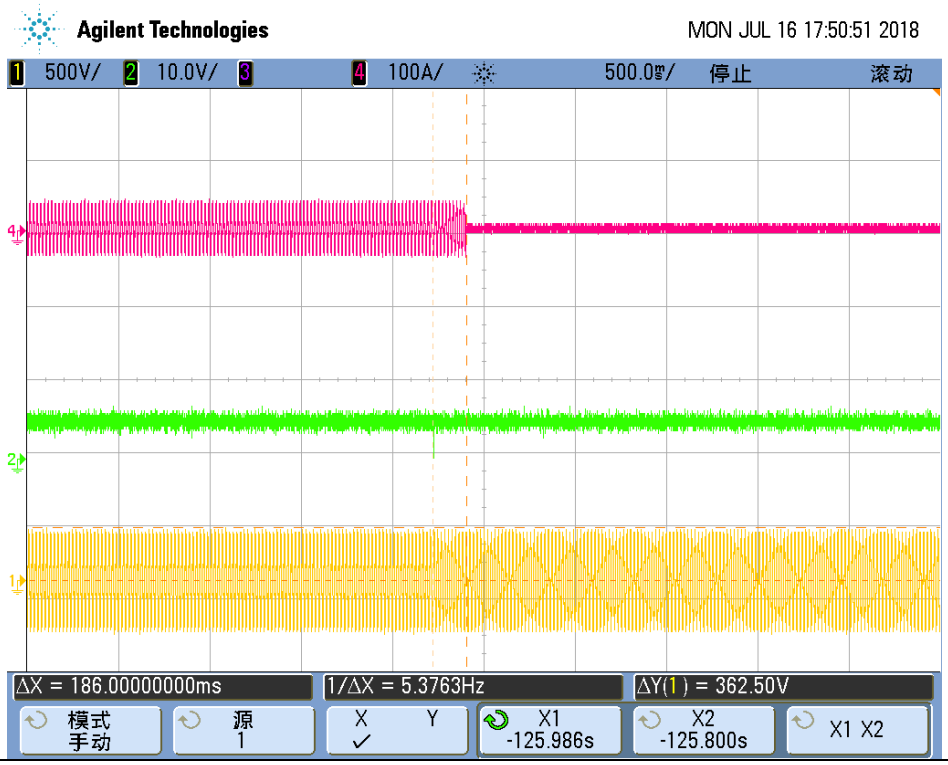
Test conditions:	Any output power level							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N
Limit	49.00Hz	200ms	200ms	200ms	51.00Hz	200ms	200ms	200ms
Trip value		48.99 Hz	48.99 Hz	48.99 Hz		51.01Hz	51.01Hz	51.01Hz
Disconnection time	49.5Hz to 48.5Hz	159	170	170	50.5Hz to 51.5Hz	158	186	171
Reconnection time	20s<t<300s	96			20s<t<300s	98		

Note:
The tests had been performed on the EVVO 33000TLG23P is valid for the EVVO 20000TLG23P, EVVO 25000TLG23P and EVVO 30000TLG23P, since it is similar in hardware and just power derated by software.

Under Frequency:



Over Frequency:



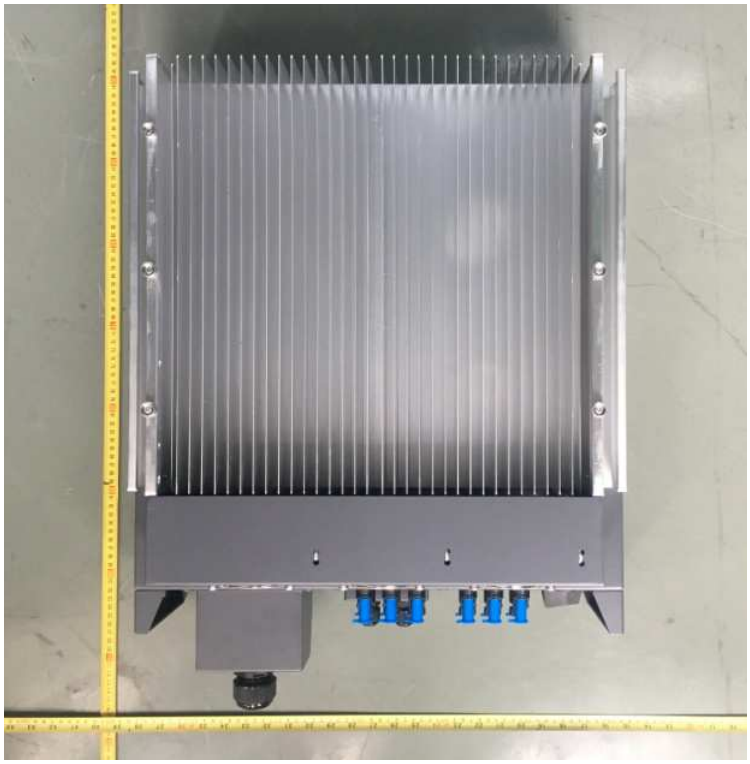
Annex 1

Pictures of the unit
The full pictures refer to PHOTO DOCUMENT
Project No.: 190308N051
Date: 20190705

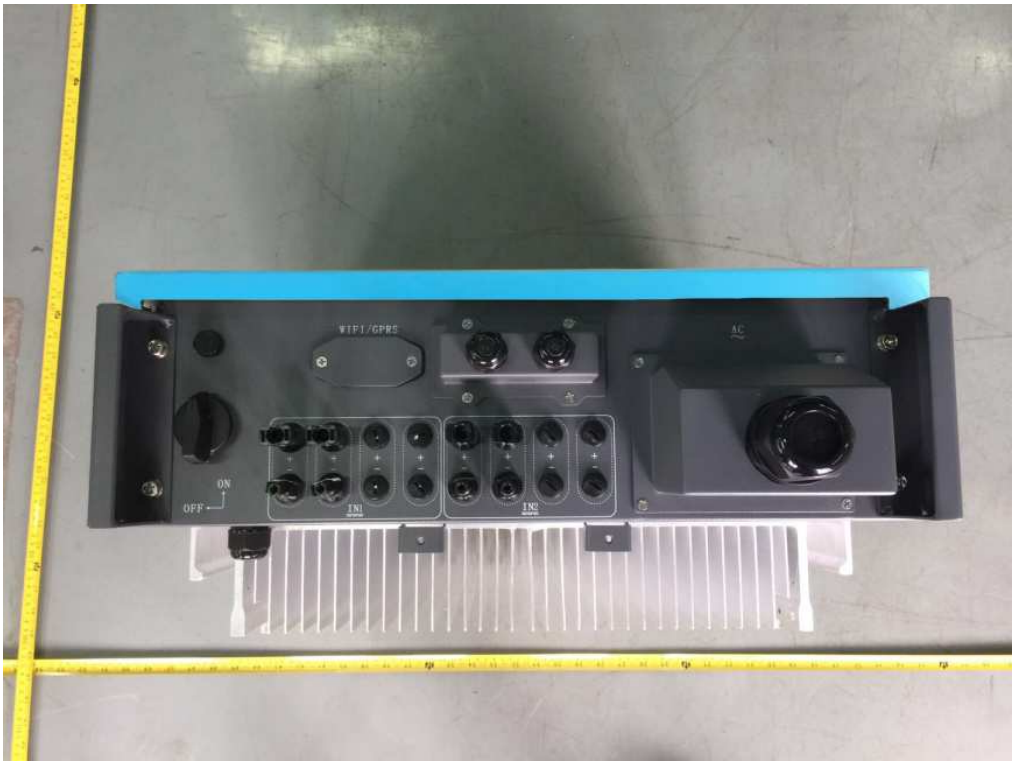
Enclosure front view:

Enclosure rear view: EVVO 20000TLG23P

Enclosure rear view: EVVO 25000TLG23P,EVVO 30000TLG23P, EVVO 33000TLG23P



Enclosure terminal view: EVVO 20000TLG23P



Enclosure terminal view: EVVO 25000TLG23P

Enclosure terminal view: EVVO 30000TLG23P, EVVO 33000TLG23P

Annex 2

Test equipment list

Test location: Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Dates of performance test: 2018-07-12 to 2018-08-01

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyzer
	A7040020DG	Chroma	61512	61512000438	
	A7040006DG	AC Power	ACST-S-33045T	C311120140	
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
	A7040021DG	Chroma	62150H-1000S	62150EF00609	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	
Resistive load cabinet	A7150030DG	Shenzhen Weihuaer	//	//	
	A7150029DG	Shenzhen Weihuaer	//	//	
Inductive load cabinet	A7180005DG	Shenzhen Weihuaer	//	//	
Power Analyzer	A4080002DG	YOKOGAWA	WT3000	91M210852	Jan. 12, 2018
Digital Phosphor Oscilloscope	A4089003DG	Tektronix	DPO4104B	C010624	Oct. 25, 2017
ScopeCorder	A4089017DG	YOKOGAWA	DL850-H-HC	91N726247	Sep. 01, 2017
Isolation voltage probe	A4089008DG	Tektronix	TPP1000	C008230	Dec. 06, 2017
	A4089009DG	Tektronix	TPP1000	C008231	Dec. 06, 2017
	A4089010DG	Tektronix	TPP1000	C008228	Dec. 06, 2017
	A4089011DG	Tektronix	TPP1000	C008229	Dec. 06, 2017
Current transducer	A1060007DG	YOKOGAWA	CT200	1130700012	Nov. 15, 2017
	A1060008DG	YOKOGAWA	CT200	1130700017	Nov. 15, 2017
	A1060009DG	YOKOGAWA	CT200	1130700019	Nov. 15, 2017
	A1060010DG	YOKOGAWA	CT200	1130700016	Nov. 15, 2017