TEST REPORT

IEC 61727

Photovoltaic (PV) systems
Characteristics of the utility interface

Report reference number ..... :	**PV190627N026**
Date of issue ..... ::	2019-07-23
Total number of pages ..... ::	51
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 EN 61727:1995 DIN EN 61727:1996
Certificate..... :	**Certificate of compliance**
Test report form number ..... :	IEC 61727
Master TRF ..... :	Bureau Veritas Consumer Products Services Germany GmbH
Test item description ..... :	**PV Grid inverter**
Trademark..... :	EVVO
Model / Type ..... :	**EVVO 50000TL3P, EVVO 60000TL3P, EVVO 70000TL3P-HV**

Ratings ..... :	**EVVO 50000TL3P**	**EVVO 60000TL3P**	**EVVO 70000TL3P-HV**
Full load MPP DC voltage range [V] :	600-800		700-800
Input DC voltage range [V]..... :	250-950, Max. 1000		
Input DC current [A] ..... :	Max. 40/30/30	Max. 40/40/40	
Output AC voltage [V] ..... :	3~/N/PE, 230/400Vac, 50Hz		3~/PE, 480Vac, 50Hz
Output AC current [A]..... :	Max. 80	Max. 90	
Nominal output power [W]..... :	50000	60000	70000
Max. output power [VA]..... :	50000	60000	75000

Testing Location ..... :	**Shenzhen Academy of Metrology & Quality Inspection**
Address ..... :	No. 4 Tongfa Rd.,Nanshan, Shenzhen, China
Tested by (name and signature) ..... :	Dora Zhang 
Approved by (name and signature) ..... :	James Huang 
Manufacturer's name ..... :	**EVOLVE ENERGY GROUP CO., LIMITED**
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**
2019-07-23	Dora Zhang	This is a copy test report.	--
Supplementary information:			

Test items particulars

Equipment mobility ..... :	Permanent connection
Operating condition ..... :	Continuous
Class of equipment ..... :	Class I
Mass of equipment [kg] ..... :	EVVO 50000TL3P, EVVO 60000TL3P: 68kg; EVVO 70000TL3P-HV: 70kg

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 ..... :	2017-12-21
Date(s) of performance of test ..... :	2017-12-21 to 2018-01-31

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.

The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

Throughout this report a comma 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.

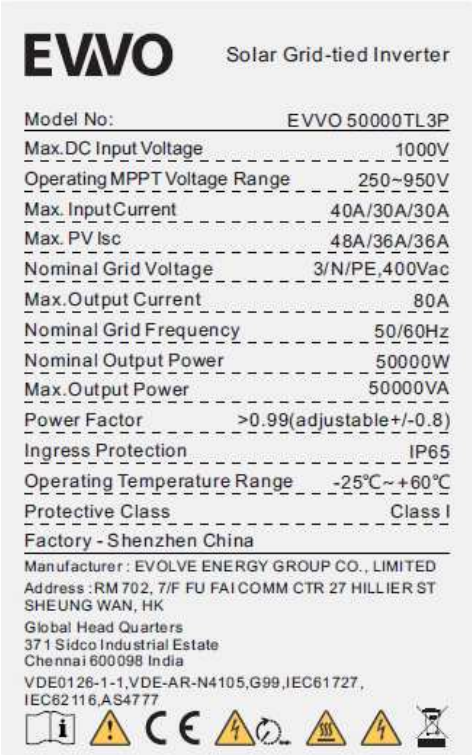
Tolerances on trip values tabel 2 EN50438:

- 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:

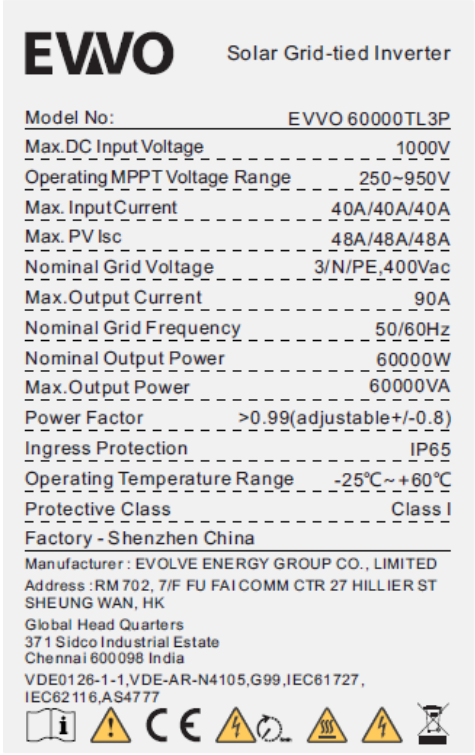


EVVO Solar Grid-tied Inverter

Model No:	EVVO 50000TL3P
Max.DC Input Voltage	1000V
Operating MPPT Voltage Range	250~950V
Max. Input Current	40A/30A/30A
Max. PV Isc	48A/36A/36A
Nominal Grid Voltage	3/N/PE,400Vac
Max.Output Current	80A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	50000W
Max.Output Power	50000VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

Factory - Shenzhen China

Manufacturer : EVOLVE ENERGY GROUP CO., LIMITED
Address :RM 702, 7/F FU FAI COMM CTR 27 HILLIER ST SHEUNG WAN, HK
Global Head Quarters
371 Sidco Industrial Estate
Chennai 600098 India
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,AS4777



EVVO Solar Grid-tied Inverter

Model No:	EVVO 60000TL3P
Max.DC Input Voltage	1000V
Operating MPPT Voltage Range	250~950V
Max. Input Current	40A/40A/40A
Max. PV Isc	48A/48A/48A
Nominal Grid Voltage	3/N/PE,400Vac
Max.Output Current	90A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	60000W
Max.Output Power	60000VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

Factory - Shenzhen China

Manufacturer : EVOLVE ENERGY GROUP CO., LIMITED
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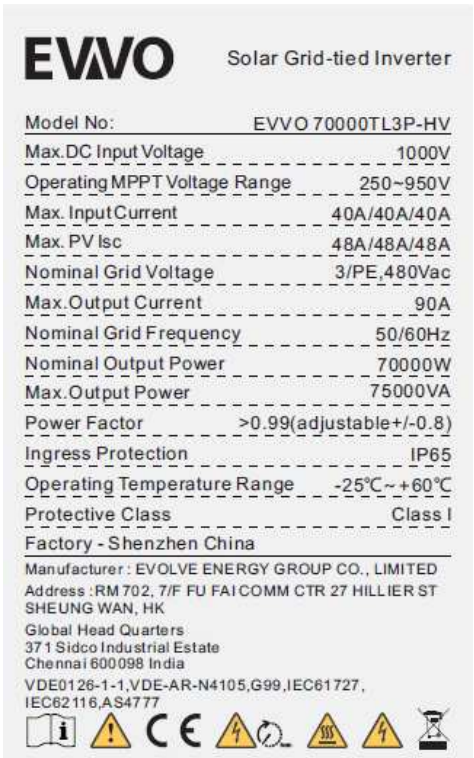

EVVO Solar Grid-tied Inverter

Model No:	EVVO 70000TL3P-HV
Max.DC Input Voltage	1000V
Operating MPPT Voltage Range	250~950V
Max. Input Current	40A/40A/40A
Max. PV Isc	48A/48A/48A
Nominal Grid Voltage	3/PE,480Vac
Max.Output Current	90A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	70000W
Max.Output Power	75000VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

Factory - Shenzhen China

Manufacturer : EVOLVE ENERGY GROUP CO., LIMITED
Address :RM 702, 7/F FU FAI COMM CTR 27 HILLIER ST SHEUNG WAN, HK
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Chennai 600098 India
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,AS4777

General product information:

The Solar Grid-tied 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 two relays for each phases in series. This assures that the opening of the output circuit will also operate in case of one error. Block diagram as following:

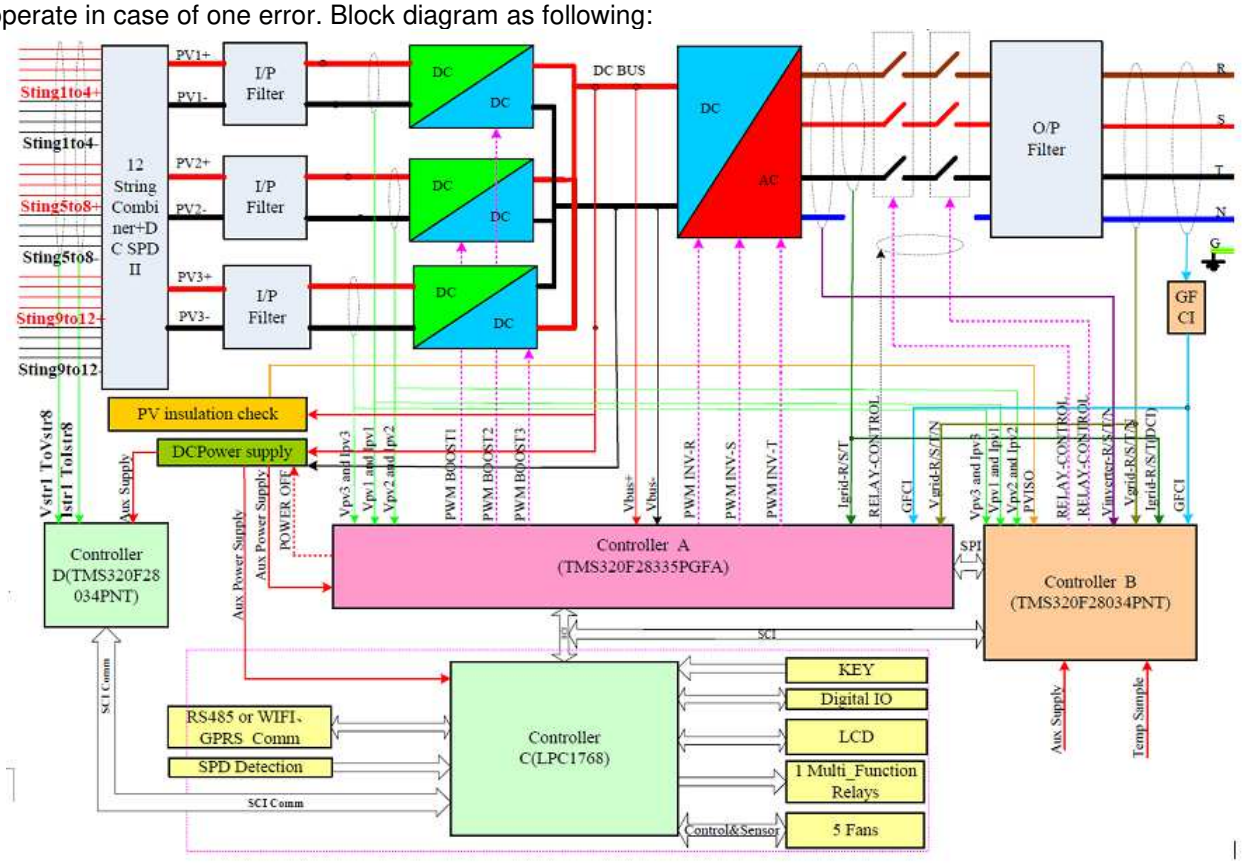


Figure 1 Block diagram

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

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

The slave DSP (UC73) is using for sample the grid voltage, frequency, DC voltage, current and residual current, also can open the relays independently and communicate with master DSP (UC20) each other.

The grid voltage is measured before the relays. The voltage between polarity is calculated. The voltage signals are sent to both DSP. In addition this signal is used for the frequency measurement.

The unit provides two relays in series in each phase. The relays are tested before each start up. Each DSP switch off each relays.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the main DSP (UC20). The main DSP (UC20) tests and calibrates before each start up all current sensors.

The RCMU is located at the AC output. The RCMU is tested before each start up by the main DSP (UC20). While unit working, if a high level residual current occurs, the RCMU will give signal to DSP assuring that unit grid-off from AC mains.

The model EVVO 70000TL3P-HV is identical to EVVO 50000TL3P and EVVO 60000TL3P except the numbers of the input PV terminals, Sic diodes, Sis MOS, BOOST inductors and INV inductors, the output ac voltage and output power derated by software.

The product was tested on:

Hardware version: V1.00

Software version: V2.00

Default interface protection settings according IEC 61727:2004:		
Parameter	**Max. clearance time***	**Trip setting**
Over voltage (level 2)	0,05s	230V +35% (310,5V)**
Over voltage (level 1)	2,0s	230V +10% (253V)
Under voltage (level 1)	2,0s	230V -15% (195,5V)
Under voltage (level 2)	0,1s	230V -50% (115V)
Over frequency	0,2s	50Hz +2% (51,0Hz)
Under frequency	0,2s	50Hz -2% (49,0Hz)
Reconnection time	20s to 300s	
Permanent DC-injection	1% of rated inverter output current	
* 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.		

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 (1) and 4.6 (2)	**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 No. PV190627N026-1.	**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 No. PV190627N026-1.	**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
Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-11			
	Starting	**Stopping**	**Running**	
Limit	3,3%	3,3%	P_{st}=1,0	P_{lt}=0,65
Test value	*	*	*	*
inverter >16A EVVO 60000TL3P				
Limit	dc% = 3,3		P_{st}=1,0	P_{lt}=0,65
Test value	See below			

L1 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30<OFF>	4.00<OFF>	500<OFF> 3.30(%)	1.00<OFF>	0.65 N:12
No. 1	0.00	0.38	0	0.30	
2	0.00	0.38	0	0.30	
3	0.00	0.38	0	0.30	
4	0.00	0.38	0	0.30	
5	0.00	0.38	0	0.30	
6	0.00	0.38	0	0.30	
7	0.00	0.38	0	0.30	
8	0.00	0.39	0	0.30	
9	0.00	0.39	0	0.30	
10	0.00	0.39	0	0.30	
11	0.00	0.39	0	0.30	
12	0.00	0.39	0	0.31	
Result					0.30 Pass

L2 Phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30<OFF>	4.00<OFF>	500<OFF> 3.30(%)	1.00<OFF>	0.65 N:12
No. 1	0.00	0.31	0	0.27	
2	0.00	0.31	0	0.27	
3	0.00	0.31	0	0.27	
4	0.00	0.41	0	0.26	
5	0.00	0.41	0	0.26	
6	0.00	0.41	0	0.26	
7	0.00	0.41	0	0.27	
8	0.00	0.41	0	0.27	
9	0.00	0.41	0	0.27	
10	0.00	0.41	0	0.27	
11	0.00	0.41	0	0.27	
12	0.00	0.41	0	0.26	
Result					0.27 Pass

L3 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30<OFF>	4.00<OFF>	500<OFF> 3.30(%)	1.00<OFF>	0.65 N:12
No. 1	0.00	0.62	0	0.26	
2	0.00	0.62	0	0.26	
3	0.00	0.62	0	0.26	
4	0.00	0.62	0	0.26	
5	0.00	0.62	0	0.27	
6	0.00	0.62	0	0.26	
7	0.00	0.62	0	0.28	
8	0.00	0.62	0	0.27	
9	0.00	0.62	0	0.29	
10	0.00	0.64	0	0.30	
11	0.00	0.64	0	0.31	
12	0.00	0.64	0	0.28	
Result					0.28 Pass

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 60000TL3P is valid for the EVVO 50000TL3P since it is similar in hardware and just power derated by software.

The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

inverter >16A EVVO 70000TL3P-HV			
Limit	dc% = 3,3	P_{st}=1,0	P_{lt}=0,65
Test value	See below		

L1 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30<OFF>	4.00<OFF>	500<OFF> 3.30(%)	1.00<OFF>	0.65 N:12
No. 1	0.00	0.31	0	0.39	
2	0.00	0.38	0	0.39	
3	0.00	0.38	0	0.40	
4	0.00	0.38	0	0.40	
5	0.00	0.42	0	0.40	
6	0.00	0.42	0	0.40	
7	0.00	0.42	0	0.40	
8	0.00	0.42	0	0.41	
9	0.00	0.42	0	0.41	
10	0.00	0.42	0	0.40	
11	0.00	0.42	0	0.40	
12	0.00	0.44	0	0.40	
Result					0.40 Pass

L2 Phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30<OFF>	4.00<OFF>	500<OFF> 3.30(%)	1.00<OFF>	0.65 N:12
No. 1	0.00	0.31	0	0.29	
2	0.00	0.41	0	0.30	
3	0.00	0.41	0	0.30	
4	0.00	0.41	0	0.32	
5	0.00	0.41	0	0.30	
6	0.00	0.41	0	0.30	
7	0.00	0.41	0	0.31	
8	0.00	0.41	0	0.31	
9	0.00	0.41	0	0.30	
10	0.00	0.41	0	0.30	
11	0.00	0.41	0	0.30	
12	0.00	0.41	0	0.30	
Result					0.30 Pass

L3 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30<OFF>	4.00<OFF>	500<OFF> 3.30(%)	1.00<OFF>	0.65 N:12
No. 1	0.00	0.48	0	0.37	
2	0.00	0.57	0	0.37	
3	0.00	0.57	0	0.38	
4	0.00	0.57	0	0.38	
5	0.00	0.57	0	0.38	
6	0.00	0.57	0	0.38	
7	0.00	0.57	0	0.39	
8	0.00	0.57	0	0.40	
9	0.00	0.57	0	0.39	
10	0.00	0.57	0	0.39	
11	0.00	0.57	0	0.38	
12	0.00	0.57	0	0.37	
Result					0.38 Pass

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 test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

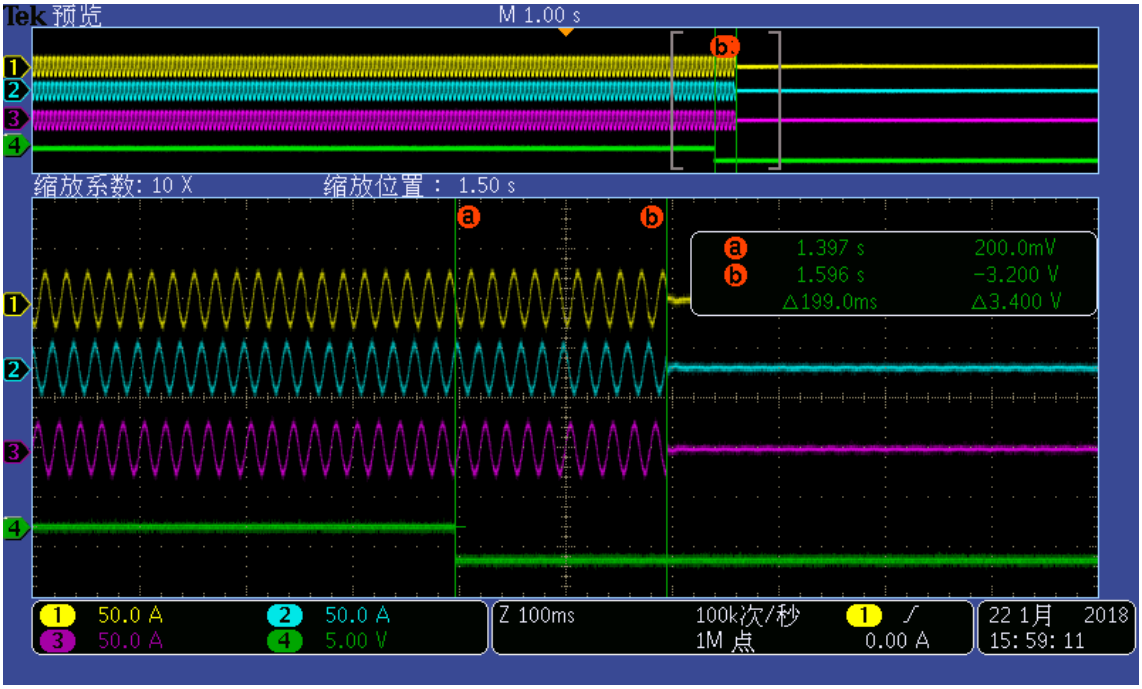
4.4 Monitoring of DC-Injection				P
EVVO 60000TL3P				
Test conditions:	U_N = 230Vac; Uinput =700Vdc; Rated Power: 60kW			
DC Injection [A]	**Limits**	**Trip Time L1 [ms]**	**Trip Time L2 [ms]**	**Trip Time L3 [ms]**
-1,0 A	I_{DC}:> 1A than disconnection within 0,2 sec	199	180	180
+1,0 A	I_{DC}:> 1A than disconnection within 0,2 sec	180	199	178

Note:
A dc-current of 1A is injected, disconnection time of max. 0,2s

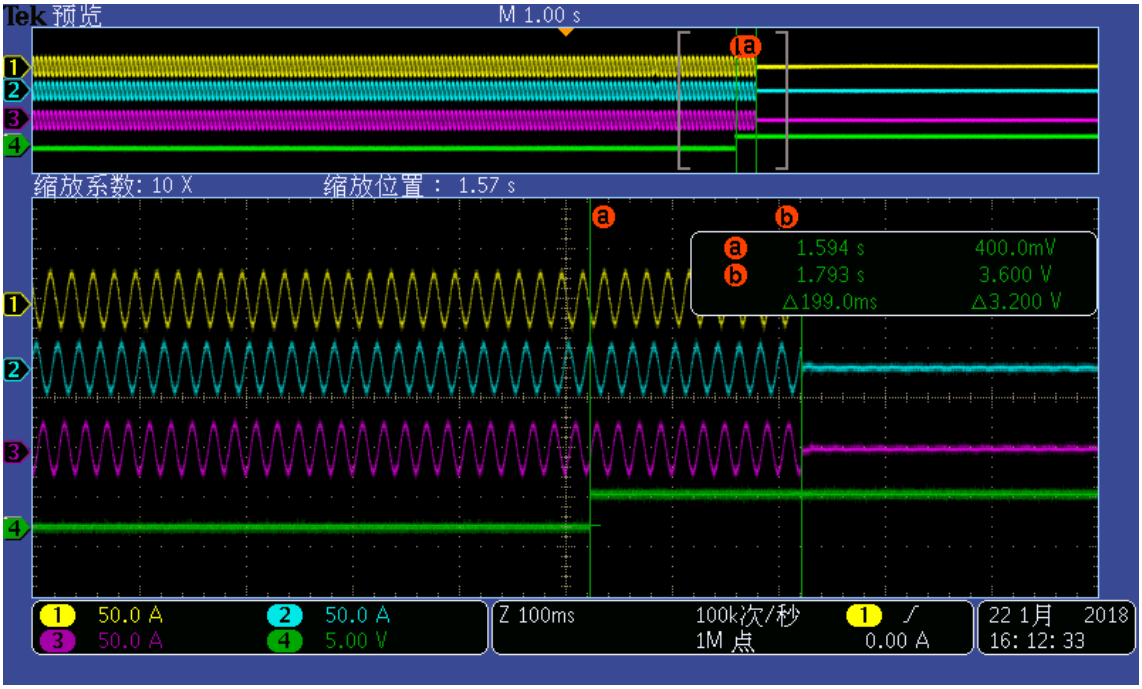
The tests had been performed on the EVVO 60000TL3P is valid for the EVVO 50000TL3P since it is similar in hardware and just power derated by software.

The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

Negative DC-Injection:

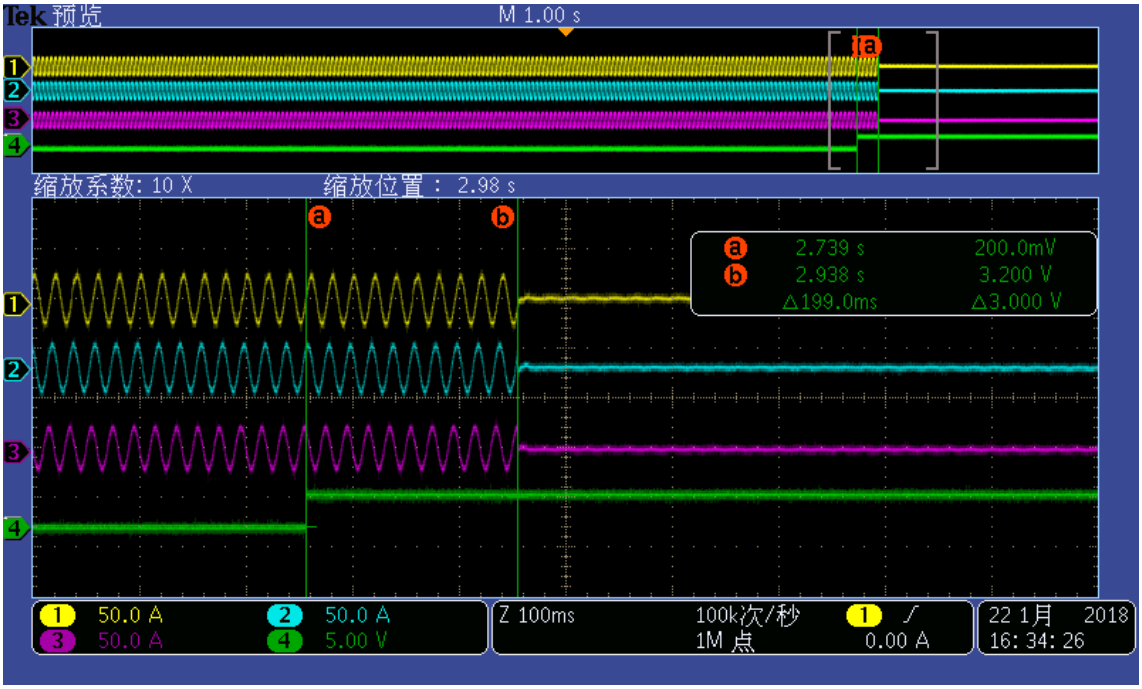


Positive DC-Injection:

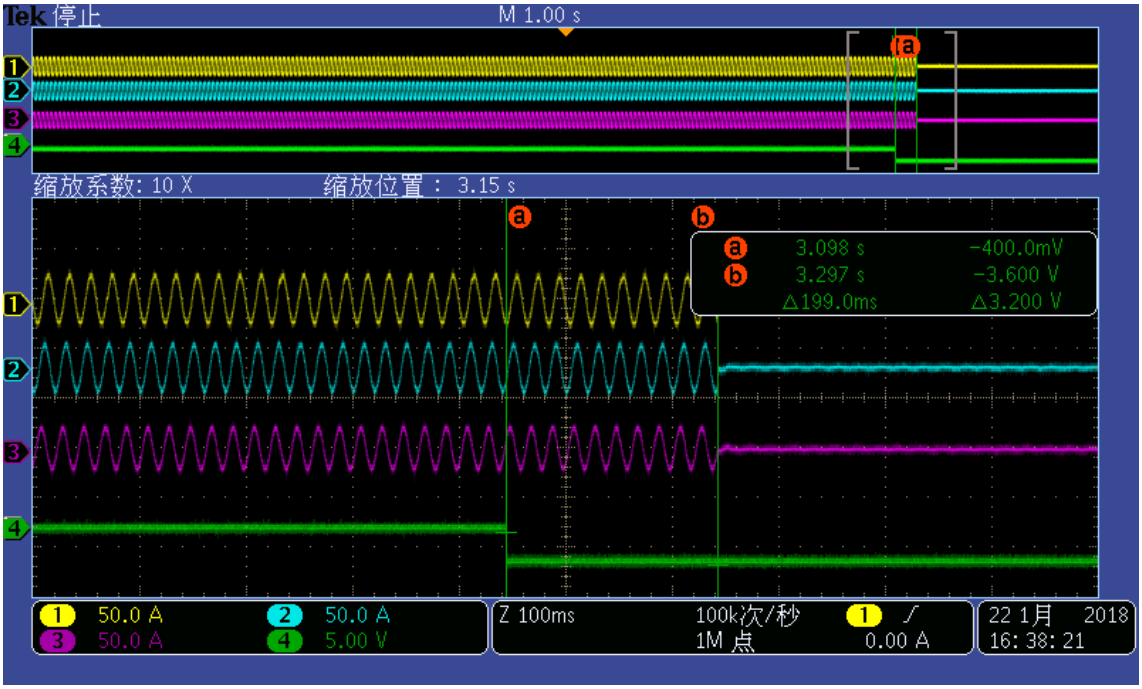


EVVO 70000TL3P-HV				
Test conditions:	U_N = 480Vac; Uinput =720Vdc; Rated Power: 70kW			
DC Injection [A]	**Limits**	**Trip Time L1 [ms]**	**Trip Time L2 [ms]**	**Trip Time L3 [ms]**
-1,0 A	I_{DC}:> 1A than disconnection within 0,2 sec	180	180	199
+1,0 A	I_{DC}:> 1A than disconnection within 0,2 sec	197	199	179
Note: A dc-current of 1A is injected, disconnection time of max. 0,2s The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.				

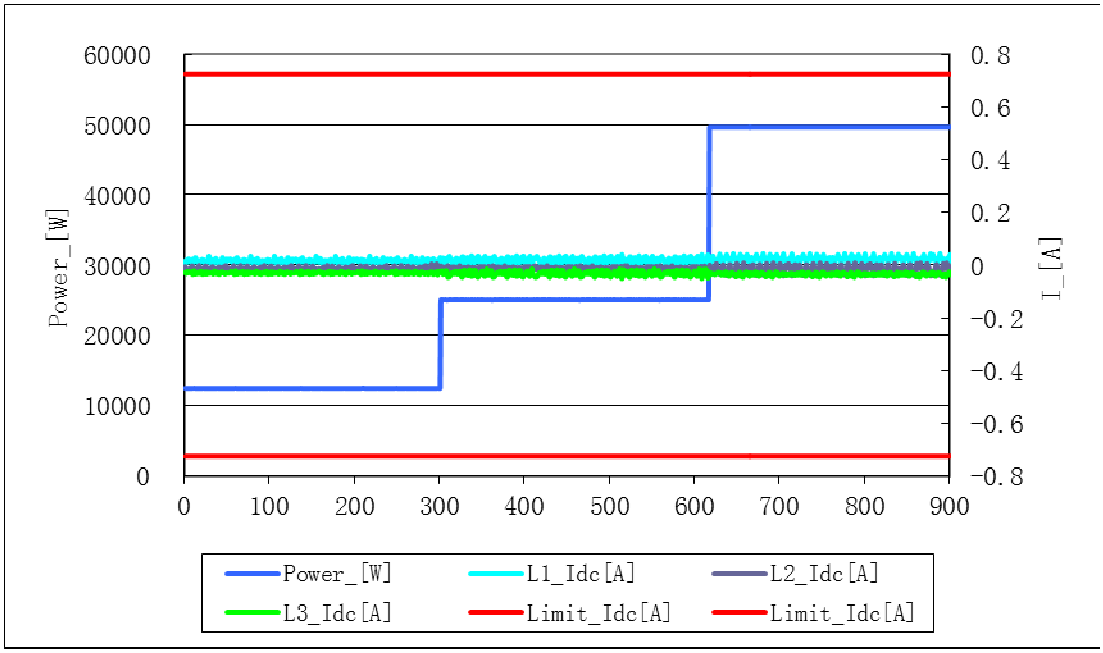
Negative DC-Injection:



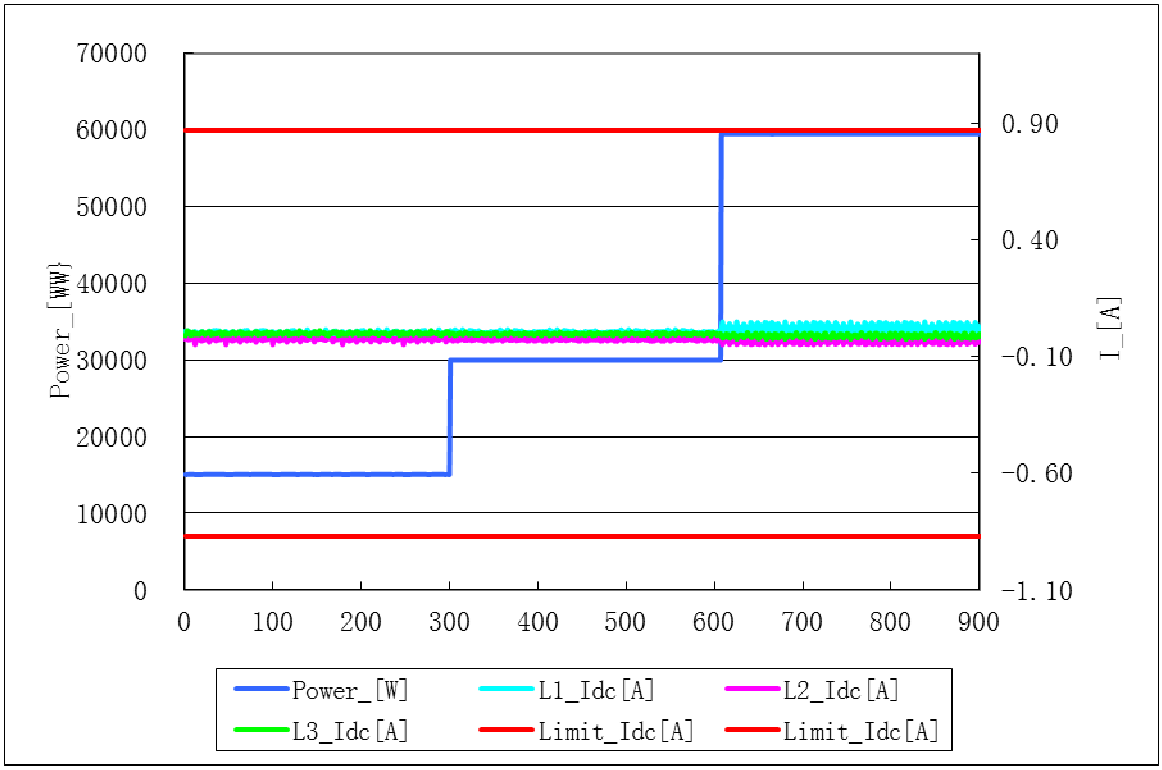
Positive DC-Injection:



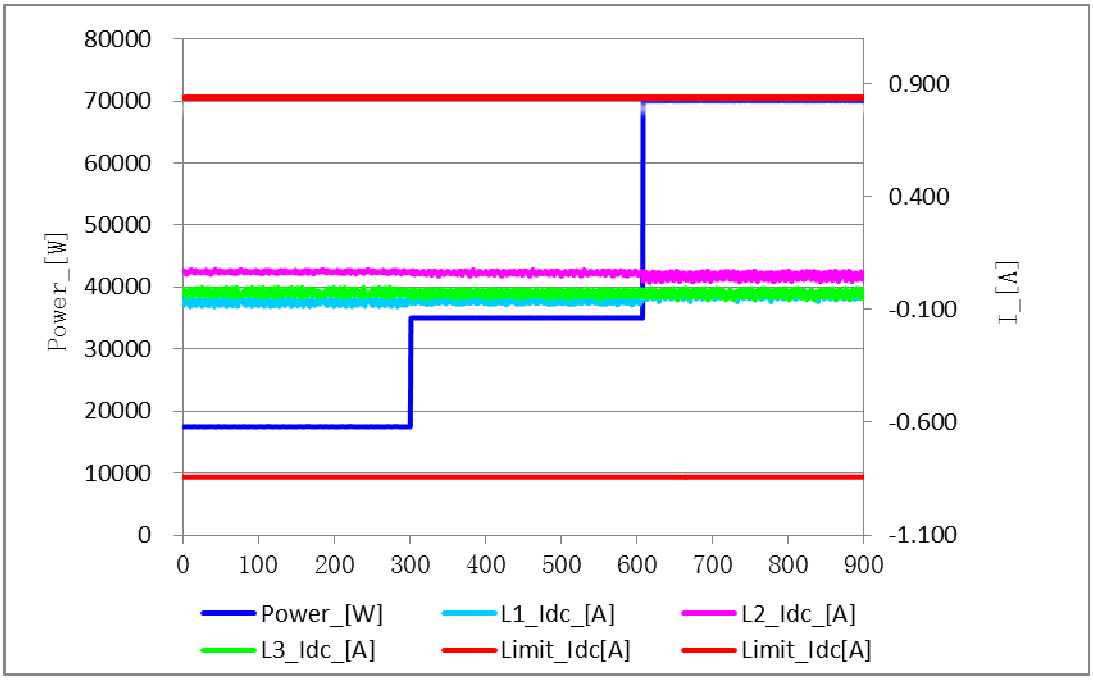
4.4 Monitoring of Permanent DC-Injection			P
EVVO 50000TL3P			
IEC61727 Limit:	**1% of Inom (724mA)**		
Output power:	25%	50%	100%
Test Value Phase L1:	35 mA	41 mA	45 mA
Test Value Phase L2:	26 mA	28 mA	40 mA
Test Value Phase L3:	37 mA	51 mA	46 mA



EVVO 60000TL3P			
IEC61727 Limit:	**1% of Inom (870mA)**		
Output power:	25%	50%	100%
Test Value Phase L1:	21 mA	17 mA	49 mA
Test Value Phase L2:	49 mA	34 mA	50 mA
Test Value Phase L3:	12 mA	12 mA	26 mA



EVVO 70000TL3P-HV			
IEC61727 Limit:	**1% of Inom (842mA)**		
Output power:	25%	50%	100%
Test Value Phase L1:	87 mA	79 mA	65 mA
Test Value Phase L2:	78 mA	77 mA	51 mA
Test Value Phase L3:	46 mA	51 mA	53 mA



Note:
The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

4.6 Harmonic Current Limit Test — P

EVVO 50000TL3P

Watts	16545/16638/16517
VA	16546/16639/16520
Vrms	230,03/229,80,230,20
Arms	71,931/72,406/71,764
PF	0,999
Frequency	50,00
THD50 (%)	0,35/0,43/0,53

Harmonics	Current Magnitude [A]			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	L2	L3	L1	L2	L3		
1st	71,931	72,405	71,763	99,264	99,919	99,032	Three Phase	
2nd	0,076	0,095	0,111	0,105	0,131	0,154	Three Phase	1
3rd	0,059	0,159	0,114	0,081	0,220	0,157	Three Phase	4
4th	0,045	0,036	0,058	0,062	0,049	0,081	Three Phase	1
5th	0,141	0,155	0,266	0,195	0,213	0,367	Three Phase	4
6th	0,024	0,038	0,030	0,033	0,053	0,041	Three Phase	1
7th	0,094	0,094	0,084	0,130	0,130	0,115	Three Phase	4
8th	0,021	0,023	0,021	0,030	0,032	0,029	Three Phase	1
9th	0,061	0,035	0,046	0,085	0,049	0,063	Three Phase	4
10th	0,020	0,022	0,017	0,028	0,031	0,023	Three Phase	0,5
11th	0,027	0,050	0,066	0,037	0,069	0,092	Three Phase	2
12th	0,011	0,014	0,012	0,016	0,020	0,017	Three Phase	0,5
13th	0,016	0,048	0,034	0,022	0,067	0,047	Three Phase	2
14th	0,010	0,011	0,012	0,014	0,015	0,016	Three Phase	0,5
15th	0,043	0,016	0,038	0,059	0,021	0,053	Three Phase	2
16th	0,011	0,013	0,009	0,015	0,017	0,013	Three Phase	0,5
17th	0,036	0,057	0,067	0,050	0,079	0,092	Three Phase	1,5
18th	0,009	0,008	0,008	0,012	0,011	0,010	Three Phase	0,5
19th	0,037	0,068	0,060	0,051	0,094	0,082	Three Phase	1,5
20th	0,009	0,011	0,008	0,013	0,016	0,012	Three Phase	0,5
21th	0,027	0,009	0,023	0,037	0,012	0,032	Three Phase	1,5
22th	0,045	0,052	0,020	0,062	0,072	0,028	Three Phase	0,5
23th	0,051	0,051	0,064	0,071	0,070	0,089	Three Phase	0,6
24th	0,008	0,008	0,007	0,011	0,012	0,010	Three Phase	0,5
25th	0,042	0,058	0,054	0,058	0,080	0,075	Three Phase	0,6
26th	0,007	0,007	0,006	0,010	0,010	0,009	Three Phase	0,5
27th	0,014	0,007	0,016	0,020	0,009	0,022	Three Phase	0,6
28th	0,007	0,007	0,007	0,010	0,010	0,010	Three Phase	0,5
29th	0,050	0,048	0,058	0,070	0,066	0,080	Three Phase	0,6
30th	0,007	0,006	0,007	0,009	0,009	0,009	Three Phase	0,5
31th	0,051	0,057	0,055	0,070	0,078	0,076	Three Phase	0,6
32th	0,007	0,006	0,005	0,009	0,009	0,007	Three Phase	0,5
33th	0,011	0,007	0,007	0,015	0,010	0,009	Three Phase	0,6

EVVO 60000TL3P								
Watts				19835/19965/19806				
VA				19837/19966/19809				
Vrms				230,09/229,88/230,31				
Arms				86,213/86,855/86,010				
PF				0,999				
Frequency				50,00Hz				
THD50 (%)				0,31/0,39/0,43				
Harmonics	**Current Magnitude [A]**			**% of Fundamental**			**Phase**	**Harmonic Current Limits [%]**
	L1	**L2**	**L3**	**L1**	**L2**	**L3**		
1st	86,213	86,854	86,009	99,145	99,882	98,910	Three Phase	
2nd	0,095	0,099	0,076	0,110	0,113	0,087	Three Phase	1
3rd	0,095	0,167	0,075	0,109	0,192	0,087	Three Phase	4
4th	0,033	0,045	0,055	0,038	0,051	0,063	Three Phase	1
5th	0,123	0,181	0,267	0,141	0,208	0,307	Three Phase	4
6th	0,027	0,047	0,045	0,031	0,054	0,051	Three Phase	1
7th	0,084	0,086	0,080	0,097	0,099	0,092	Three Phase	4
8th	0,025	0,028	0,018	0,028	0,032	0,021	Three Phase	1
9th	0,059	0,045	0,045	0,068	0,052	0,052	Three Phase	4
10th	0,019	0,018	0,023	0,022	0,021	0,026	Three Phase	0,5
11th	0,033	0,038	0,066	0,038	0,044	0,076	Three Phase	2
12th	0,014	0,018	0,012	0,016	0,020	0,014	Three Phase	0,5
13th	0,018	0,046	0,032	0,020	0,053	0,037	Three Phase	2
14th	0,014	0,010	0,014	0,016	0,011	0,016	Three Phase	0,5
15th	0,041	0,017	0,033	0,047	0,020	0,038	Three Phase	2
16th	0,012	0,012	0,011	0,014	0,014	0,013	Three Phase	0,5
17th	0,040	0,053	0,069	0,046	0,061	0,079	Three Phase	1,5
18th	0,010	0,008	0,009	0,011	0,010	0,010	Three Phase	0,5
19th	0,039	0,069	0,061	0,045	0,079	0,070	Three Phase	1,5
20th	0,009	0,010	0,009	0,010	0,012	0,011	Three Phase	0,5
21th	0,027	0,011	0,025	0,032	0,012	0,029	Three Phase	1,5
22th	0,022	0,026	0,014	0,026	0,030	0,016	Three Phase	0,5
23th	0,062	0,059	0,073	0,072	0,067	0,084	Three Phase	0,6
24th	0,008	0,008	0,007	0,009	0,009	0,008	Three Phase	0,5
25th	0,047	0,066	0,061	0,054	0,076	0,070	Three Phase	0,6
26th	0,007	0,008	0,006	0,008	0,009	0,007	Three Phase	0,5
27th	0,014	0,007	0,017	0,016	0,008	0,019	Three Phase	0,6
28th	0,007	0,007	0,007	0,008	0,008	0,008	Three Phase	0,5
29th	0,059	0,054	0,063	0,067	0,063	0,072	Three Phase	0,6
30th	0,007	0,007	0,007	0,008	0,008	0,008	Three Phase	0,5
31th	0,057	0,065	0,062	0,066	0,074	0,071	Three Phase	0,6
32th	0,006	0,007	0,006	0,007	0,008	0,007	Three Phase	0,5
33th	0,011	0,007	0,007	0,013	0,008	0,008	Three Phase	0,6

EVVO 70000TL3P-HV								
Watts				23352/23331/23382				
VA				23351/23333/23385				
Vrms				279,28/279,01/280,14				
Arms				83,613/83,613/83,629				
PF				0,999				
Frequency				50,00				
THD50 (%)				0,53/0,60/0,41				
Harmonics	**Current Magnitude [A]**			**% of Fundamental**			**Phase**	**Harmonic Current Limits [%]**
	L1	**L2**	**L3**	**L1**	**L2**	**L3**		
1st	83,612	83,627	83,474	100,335	100,352	100,169	Three Phase	
2nd	0,077	0,043	0,048	0,092	0,051	0,057	Three Phase	1
3rd	0,186	0,053	0,142	0,223	0,064	0,170	Three Phase	4
4th	0,047	0,031	0,042	0,056	0,037	0,051	Three Phase	1
5th	0,299	0,421	0,157	0,359	0,506	0,189	Three Phase	4
6th	0,042	0,036	0,029	0,050	0,043	0,035	Three Phase	1
7th	0,109	0,175	0,157	0,130	0,210	0,189	Three Phase	4
8th	0,089	0,072	0,038	0,106	0,086	0,046	Three Phase	1
9th	0,157	0,058	0,104	0,189	0,070	0,125	Three Phase	4
10th	0,042	0,015	0,038	0,050	0,018	0,046	Three Phase	0,5
11th	0,020	0,041	0,032	0,024	0,050	0,039	Three Phase	2
12th	0,022	0,020	0,019	0,027	0,024	0,023	Three Phase	0,5
13th	0,022	0,035	0,030	0,026	0,042	0,036	Three Phase	2
14th	0,013	0,014	0,011	0,016	0,017	0,013	Three Phase	0,5
15th	0,047	0,022	0,044	0,056	0,027	0,053	Three Phase	2
16th	0,025	0,021	0,020	0,030	0,025	0,024	Three Phase	0,5
17th	0,041	0,069	0,032	0,050	0,083	0,038	Three Phase	1,5
18th	0,011	0,010	0,010	0,013	0,012	0,012	Three Phase	0,5
19th	0,054	0,041	0,055	0,065	0,049	0,066	Three Phase	1,5
20th	0,012	0,011	0,010	0,014	0,013	0,012	Three Phase	0,5
21th	0,011	0,015	0,022	0,014	0,018	0,027	Three Phase	1,5
22th	0,009	0,009	0,010	0,011	0,011	0,012	Three Phase	0,5
23th	0,051	0,079	0,055	0,061	0,095	0,067	Three Phase	0,6
24th	0,008	0,008	0,008	0,010	0,009	0,009	Three Phase	0,5
25th	0,049	0,044	0,054	0,059	0,053	0,065	Three Phase	0,6
26th	0,007	0,006	0,007	0,008	0,008	0,008	Three Phase	0,5
27th	0,007	0,011	0,012	0,009	0,013	0,015	Three Phase	0,6
28th	0,006	0,006	0,007	0,008	0,008	0,008	Three Phase	0,5
29th	0,048	0,063	0,052	0,057	0,075	0,063	Three Phase	0,6
30th	0,008	0,006	0,007	0,009	0,008	0,009	Three Phase	0,5
31th	0,058	0,053	0,065	0,069	0,064	0,079	Three Phase	0,6
32th	0,006	0,006	0,007	0,008	0,008	0,008	Three Phase	0,5
33th	0,011	0,007	0,014	0,013	0,009	0,016	Three Phase	0,6
Note: The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.								

4.7 Power factor					P
Test conditions:	**EVVO 50000TL3P**				
Output power [kW] / **Test AC voltage [V]**	**~10% 5kW**	**~25% 12,5kW**	**~50% 25kW**	**~75% 37,5kW**	**~100% 50kW**
230V	0,966i	0,995i	0,999i	0,999i	0,999i
Test conditions:	**EVVO 60000TL3P**				
Output power [kW] / **Test AC voltage [V]**	**~10% 6kW**	**~25% 15kW**	**~50% 30kW**	**~75% 45kW**	**~100% 60kW**
230V	0,977i	0,996i	0,999i	0,999i	0,999i
Test conditions:	**EVVO 70000TL3P-HV**				
Output power [kW] / **Test AC voltage [V]**	**~10% 7kW**	**~25% 17,5kW**	**~50% 35,kW**	**~75% 52,5kW**	**~100% 70kW**
480V	0,996i	0,999i	0,999i	0,999i	0,999i

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 test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

5.2.1 Voltage monitoring									P
IEC 61727: First Level									
EVVO 60000TL3P									
Test conditions:	Output power: 6,0kW Frequency: 50Hz								
L1 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 2,0s**			**253,0V**	**<= 2,0s**			
Trip value	**195,1V**				**253,7V**				
Disconnection time	230V to 191V	1952	1924	1956	230V to 258V	1948	1932	1928	
L2 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 2,0s**			**253,0V**	**<= 2,0s**			
Trip value	**195,2V**				**252,8V**				
Disconnection time	230V to 191V	388	365	377	230V to 258V	1924	1932	1920	
L3 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 2,0s**			**253,0V**	**<= 2,0s**			
Trip value	**195,2V**				**253,8V**				
Disconnection time	230V to 191V	1952	403	1928	230V to 258V	1940	1936	1948	
Reconnection time*	20s<t<300s	43 s			20s<t<300s	43 s			
Reconnection time for India*	at least 90s	112s			at least 90s	112s			

IEC 61727: Second Level									
Test conditions:	Output power: 6,0kW Frequency: 50Hz								
L1 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**115,0V**	**<= 100ms**			**310,0V**	**<= 50ms**			
Trip value	**114,9V**				**310,2V**				
Disconnection time	230V to 110V	52	57	52	230V to 315V	24	17	21	
L2 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**115,0V**	**<= 100ms**			**310,0V**	**<= 50ms**			
Trip value	**114,7V**				**310,1V**				
Disconnection time	230V to 110V	62	53	73	230V to 315V	22	19	28	
L3 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**115,0V**	**<= 100ms**			**310,0V**	**<= 50ms**			
Trip value	**114,8V**				**310,0V**				
Disconnection time	230V to 110V	49	45	66	230V to 315V	24	26	17	
Reconnection time*	20s<t<300s	37s			20s<t<300s	37s			
Reconnection time for India*	at least 90s	100s			at least 90s	100s			

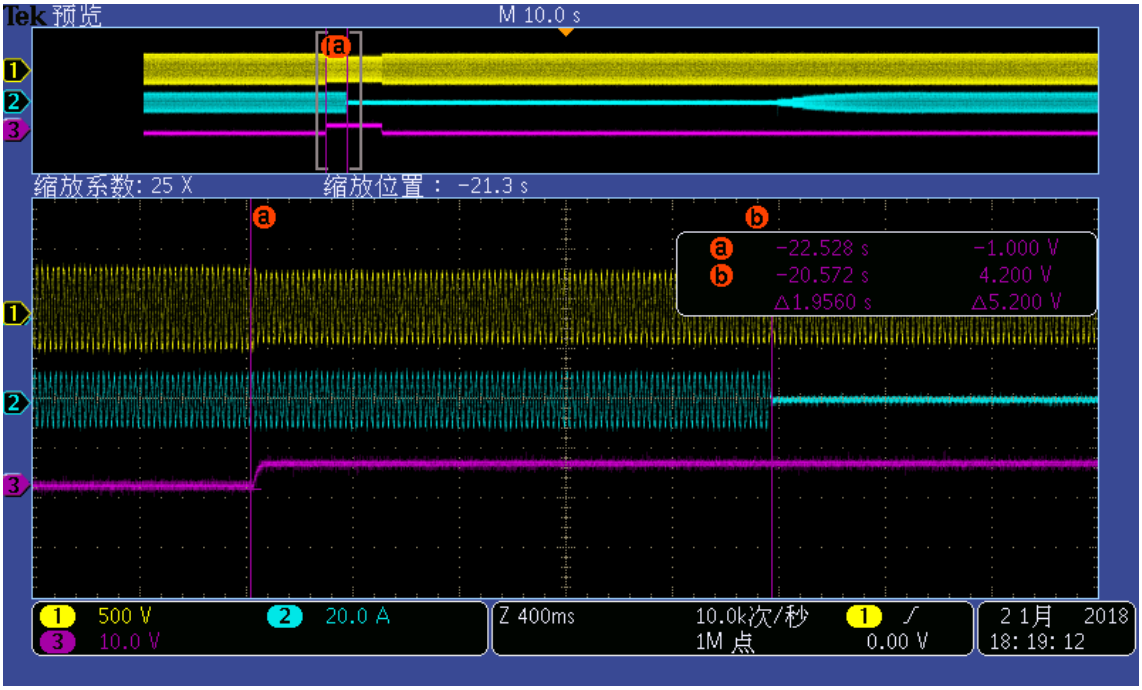
Note:

* The reconnection time value can be adjustable.
  For India deviation: the default setting is 300s.
  For IEC 61727: the default setting is 30s.

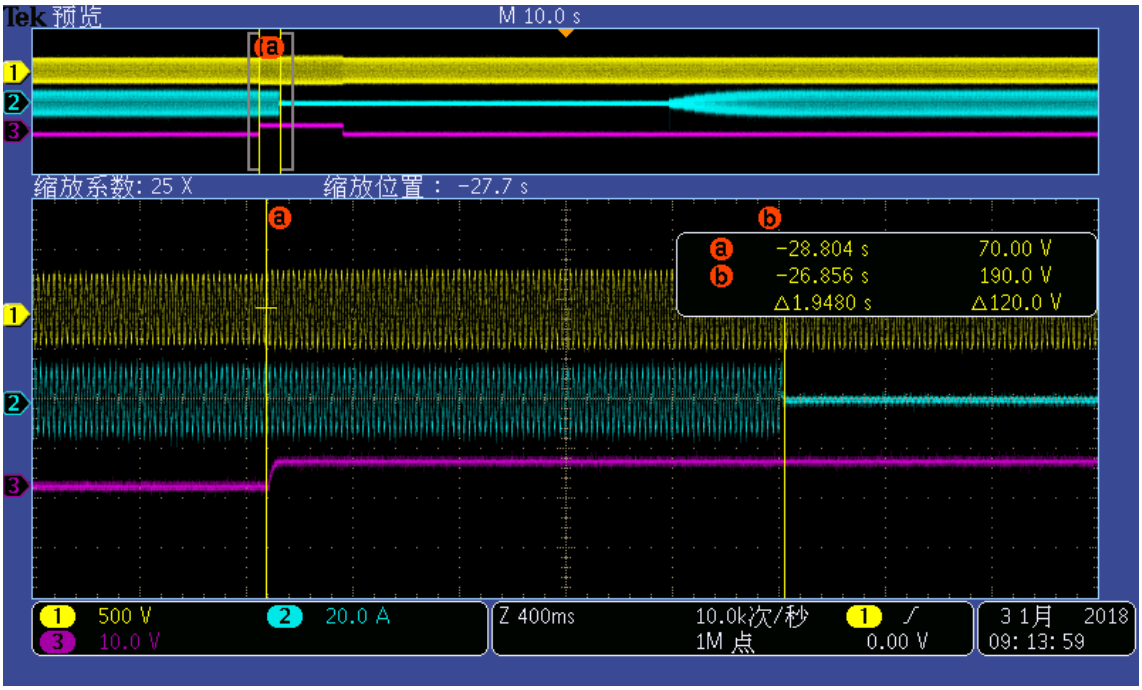
  The tests had been performed on the EVVO 60000TL3P is valid for the EVVO 50000TL3P since it is similar in hardware and just power derated by software.

  The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

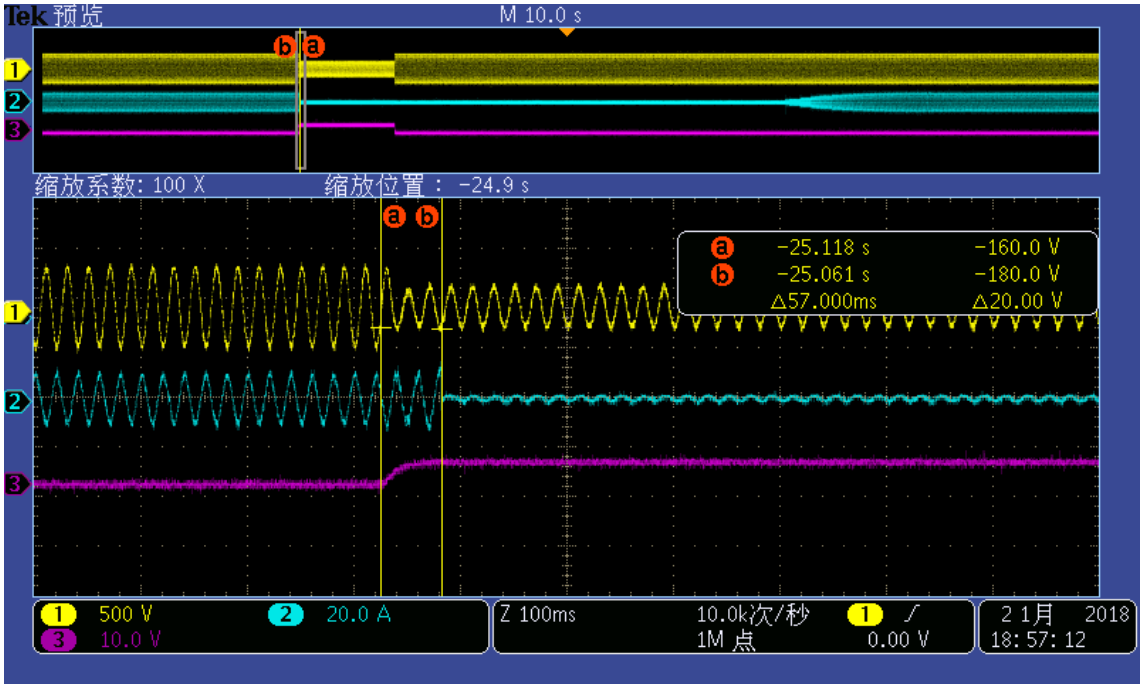
Under Voltage First Level, L1 phase



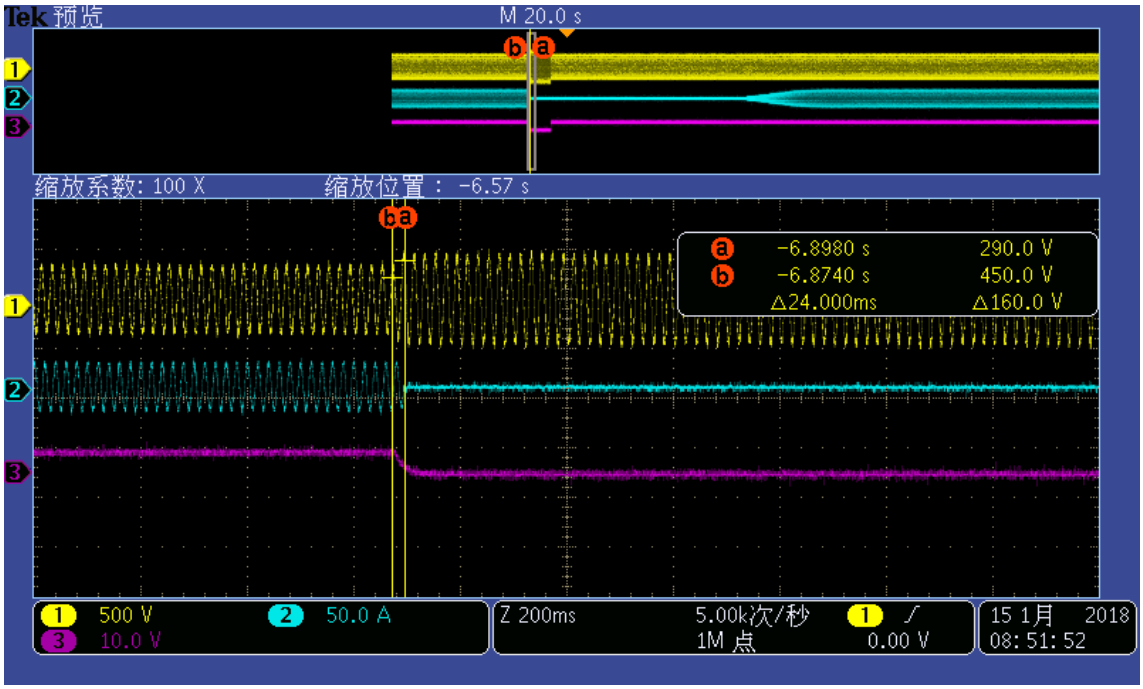
Over voltage First Level, L1 phase



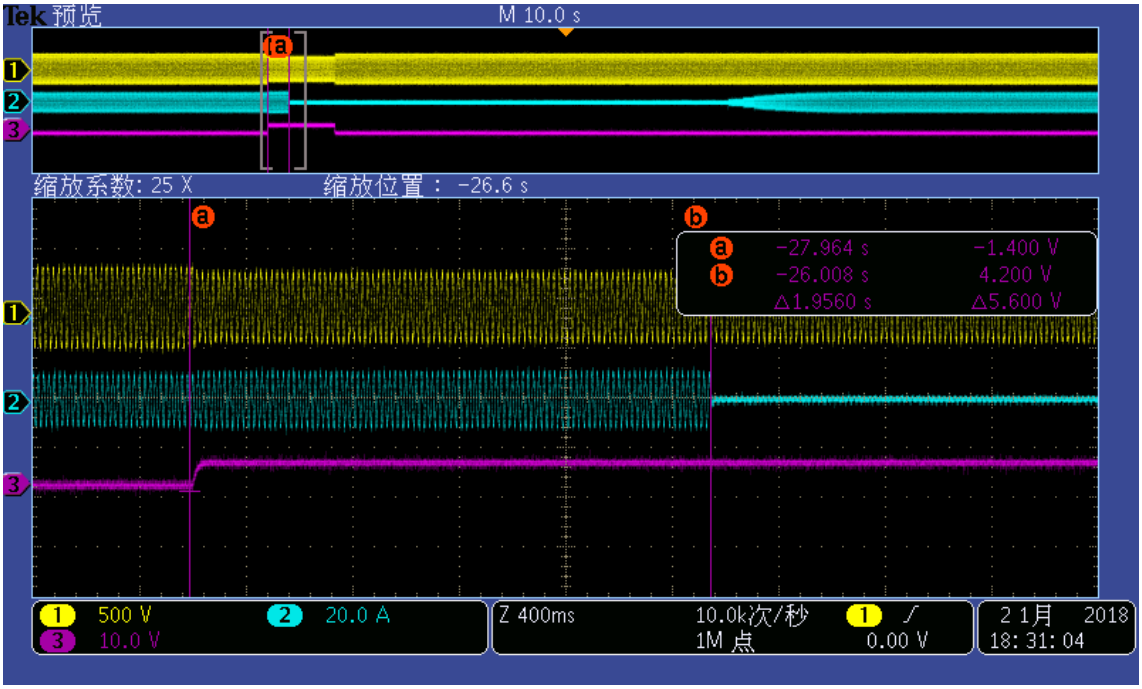
Under Voltage Second Level, L1 phase



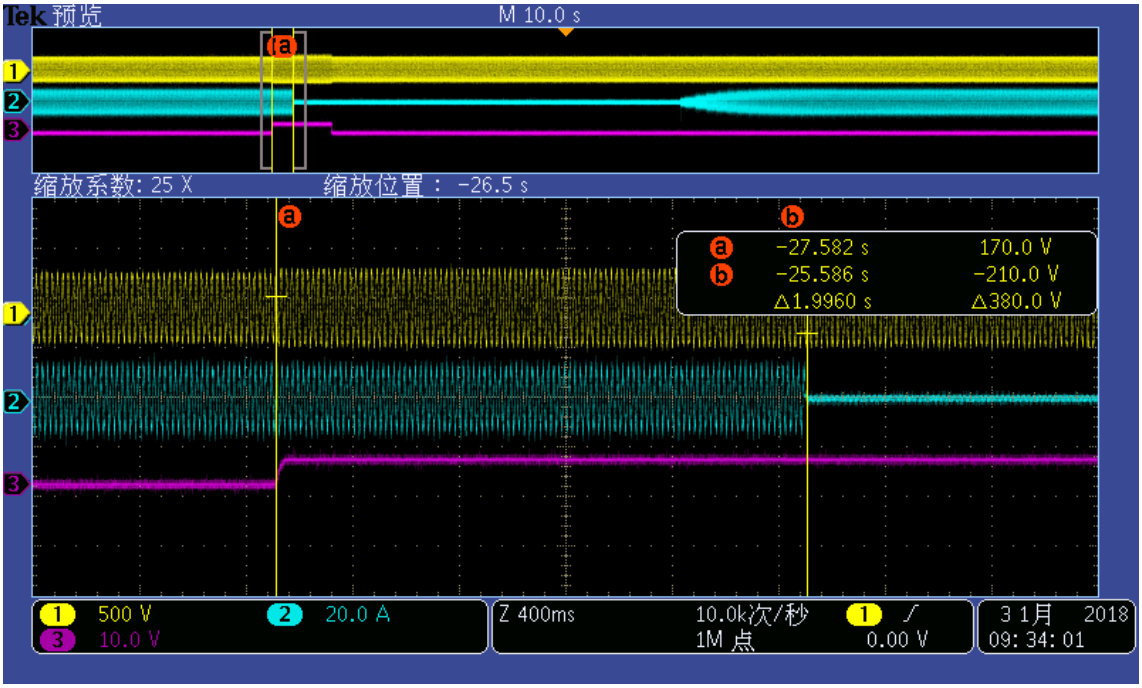
Over voltage Second Level, L1 phase



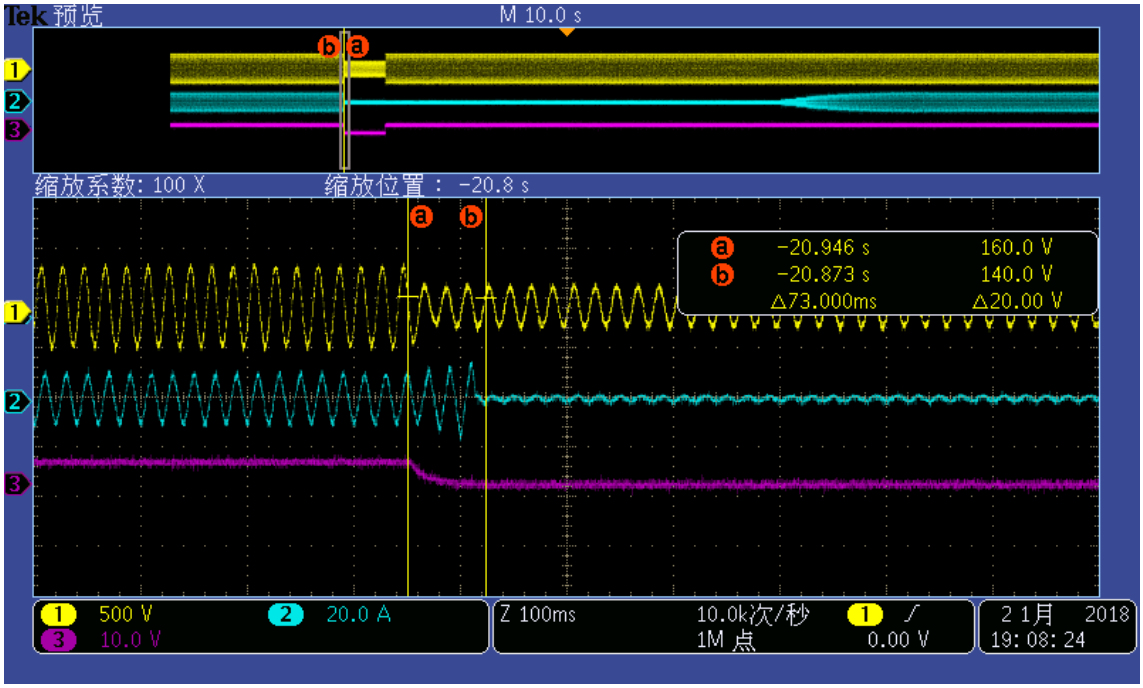
Under Voltage First Level, L2 phase



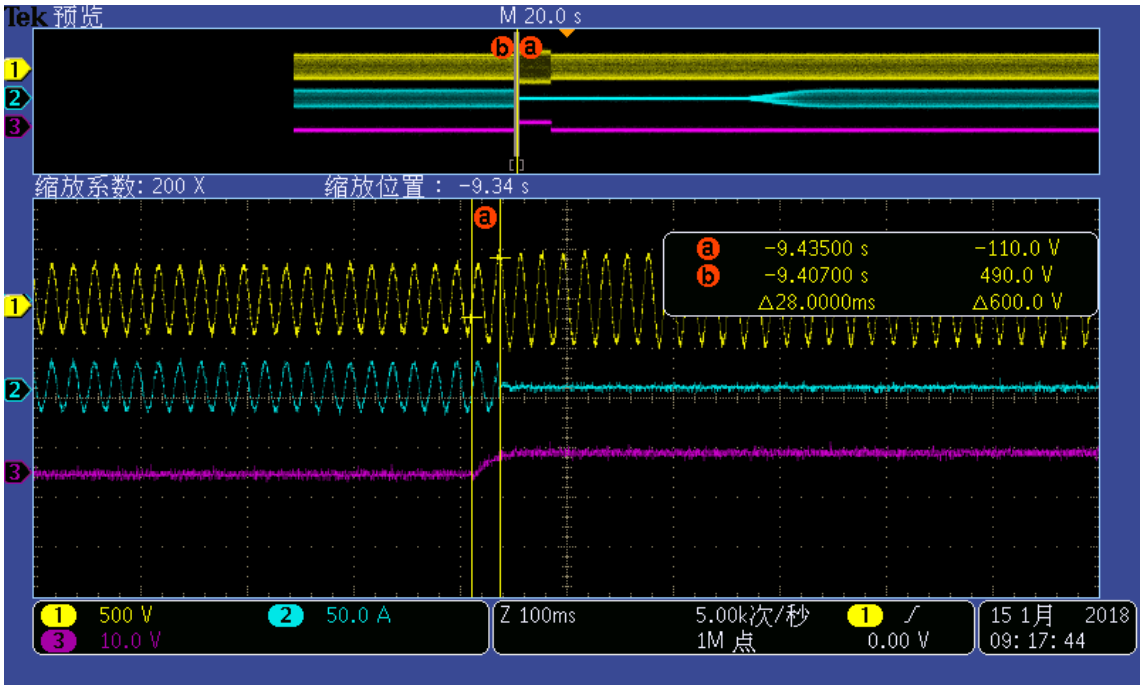
Over voltage First Level, L2 phase



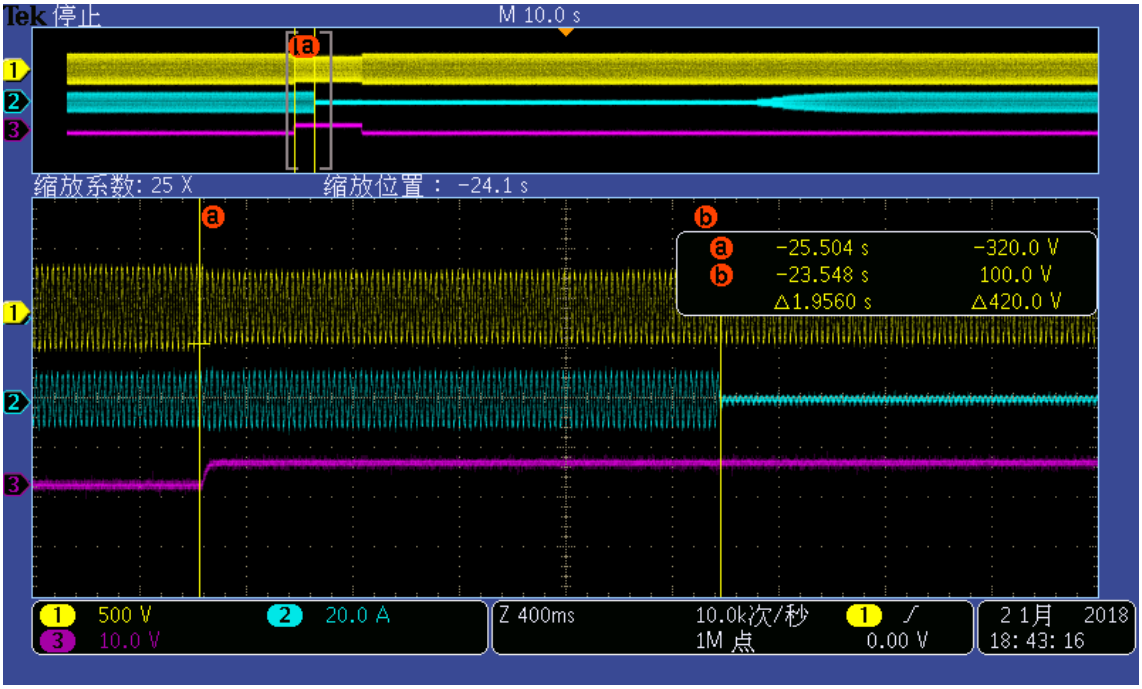
Under Voltage Second Level, L2 phase



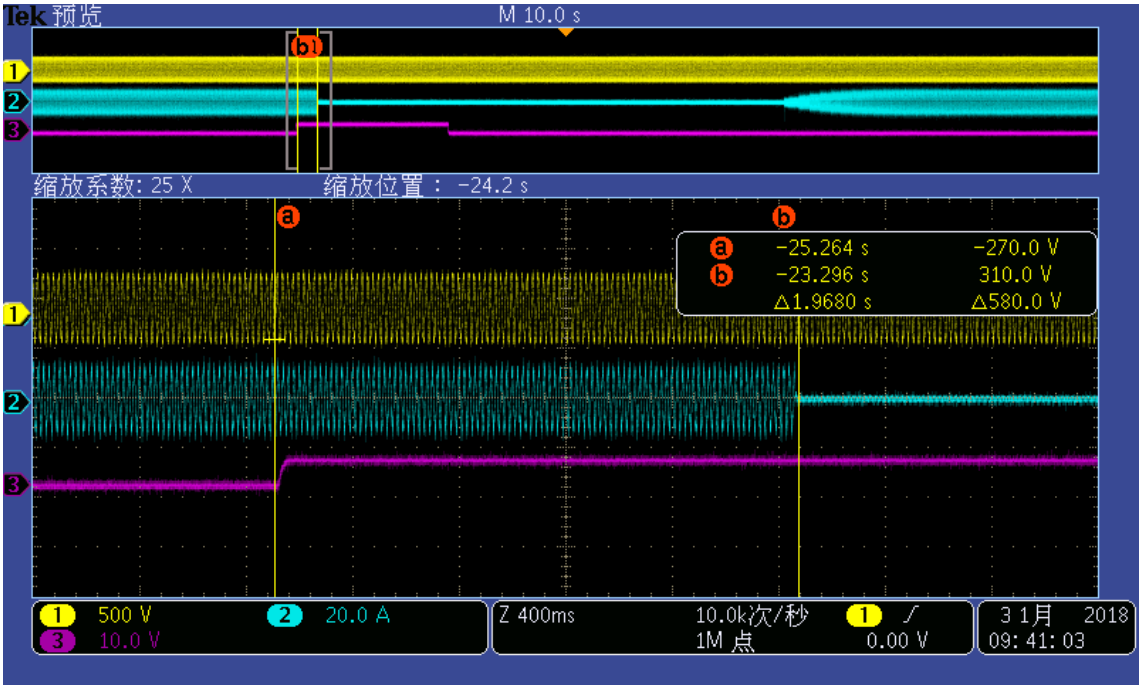
Over voltage Second Level, L2 phase



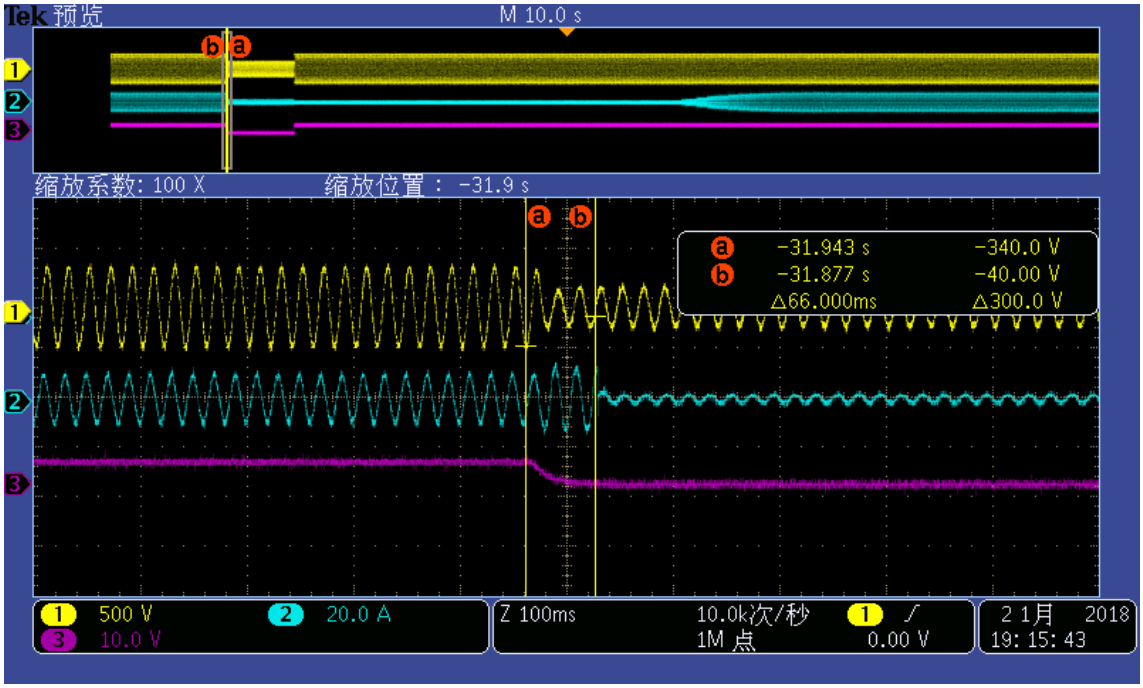
Under Voltage First Level, L3 phase



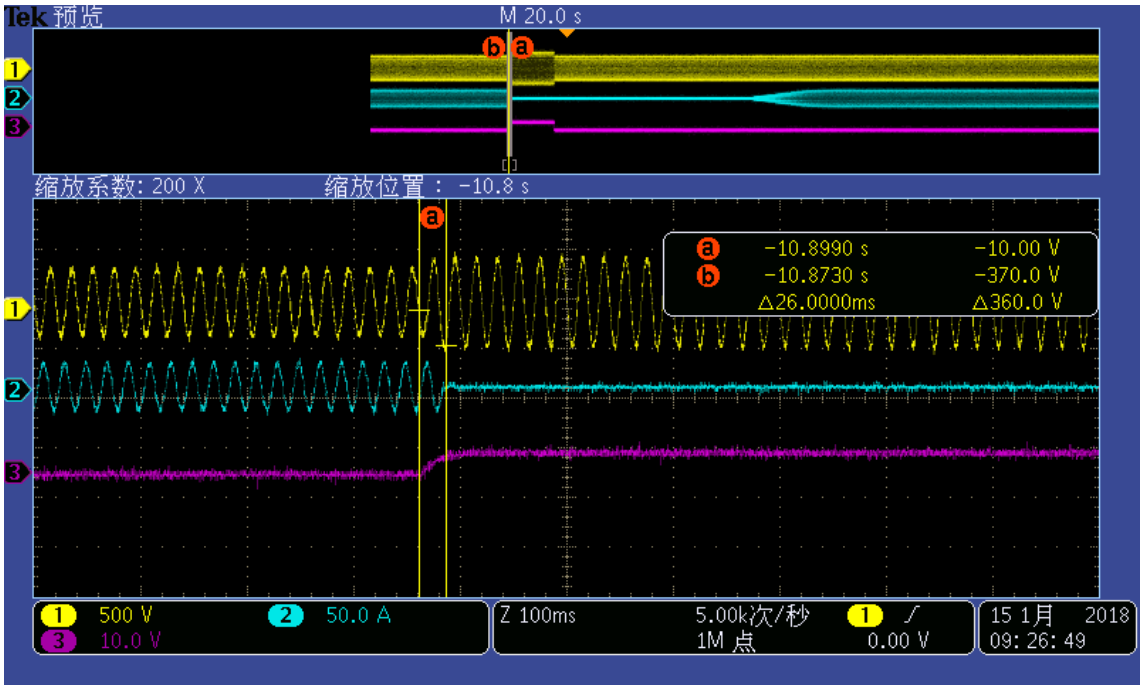
Over voltage First Level, L3 phase



Under Voltage Second Level, L3 phase



Over voltage Second Level, L3 phase



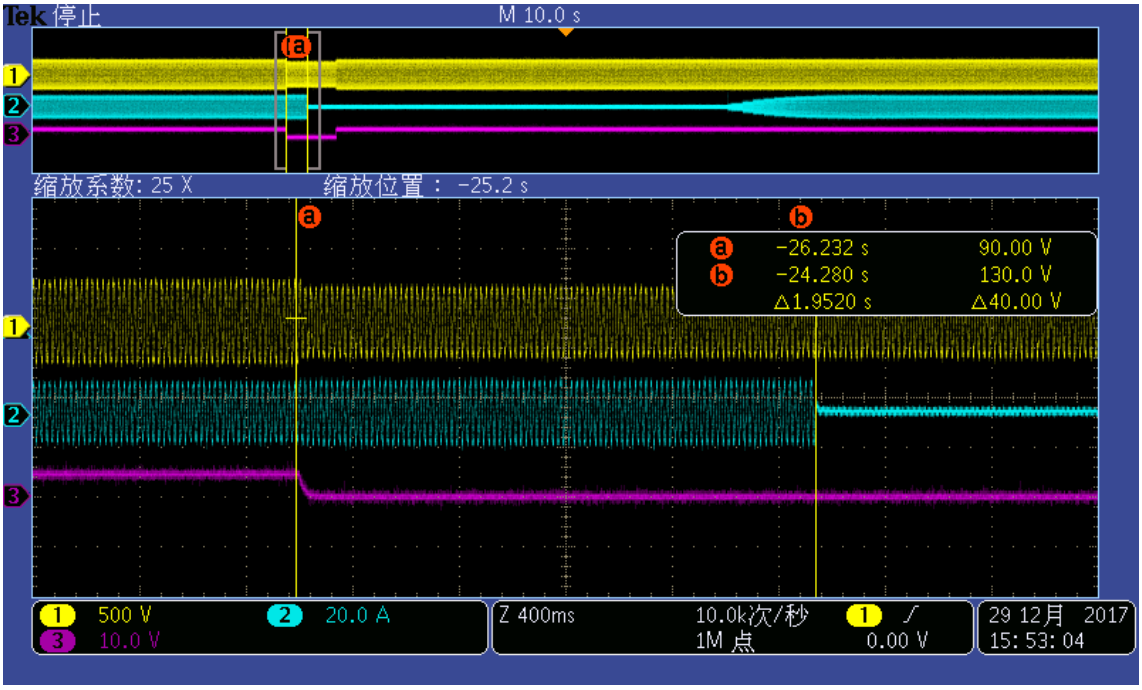
IEC 61727: First Level								
EVVO 70000TL3P-HV								
Test conditions:	Output power: 6,0kW Frequency: 50Hz							
L1 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**235,5V**	**<= 2,0s**			**304,7V**	**<= 2,0s**		
Trip value	**233,2V**				**305,0V**			
Disconnection time	277V to 230V	1936	1952	1936	277V to 307V	1936	1936	1932
L2 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**235,5V**	**<= 2,0s**			**304,7V**	**<= 2,0s**		
Trip value	**233,3V**				**304,8V**			
Disconnection time	277V to 230V	1946	1920	1952	277V to 307V	1952	1928	1936
L3 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**235,5V**	**<= 2,0s**			**304,7V**	**<= 2,0s**		
Trip value	**233,5V**				**304,2V**			
Disconnection time	277V to 230V	1928	1948	1953	277V to 307V	1956	1932	1936
Reconnection time*	20s<t<300s	37s			20s<t<300s	37s		
Reconnection time for India*	at least 90s	100s			at least 90s	100s		

IEC 61727: Second Level								
Test conditions:	Output power: 6,0kW Frequency: 50Hz							
L1 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**138,5V**	**<= 100ms**			**374,0V**	**<= 50ms**		
Trip value	**137,8V**				**375,4V**			
Disconnection time	277V to 130V	44	46	50	277V to 378V	21	18	24
L2 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**138,5V**	**<= 100ms**			**374,0V**	**<= 50ms**		
Trip value	**137,4V**				**375,1V**			
Disconnection time	277V to 130V	59	66	63	277V to 378V	31	37	36
L3 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time [ms]			Voltage	Time [ms]		
Limit	**138,5V**	**<= 100ms**			**374,0V**	**<= 50ms**		
Trip value	**137,1V**				**375,6**			
Disconnection time	277V to 130V	62	47	61	277V to 378V	30	33	41
Reconnection time*	20s<t<300s	37s			20s<t<300s	37s		
Reconnection time for India*	at least 90s	100s			at least 90s	100s		

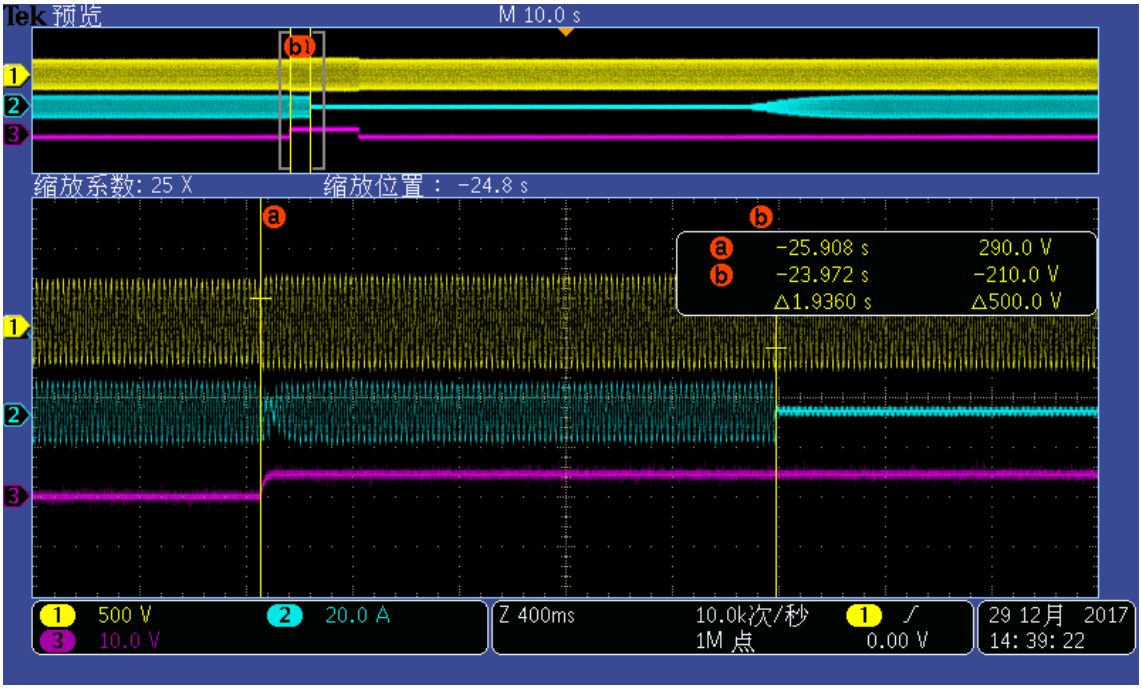
Note:
* The reconnection time value can be adjustable.
For India deviation: the default setting is 300s.
For IEC 61727: the default setting is 30s.

The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

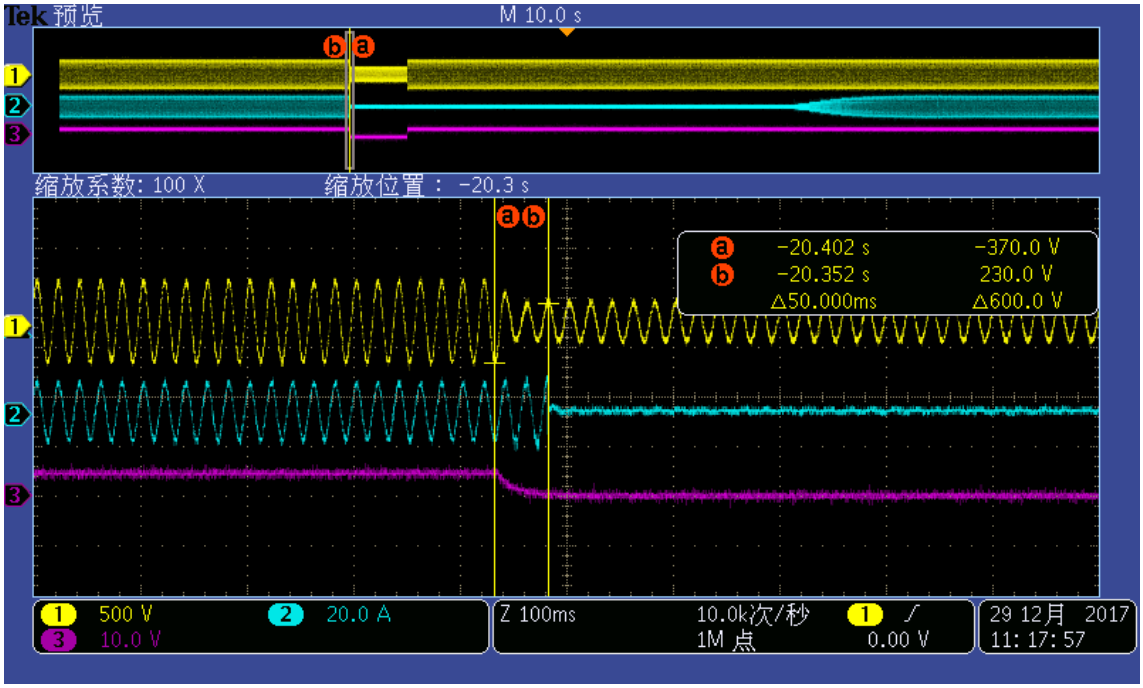
Under Voltage First Level, L1 phase



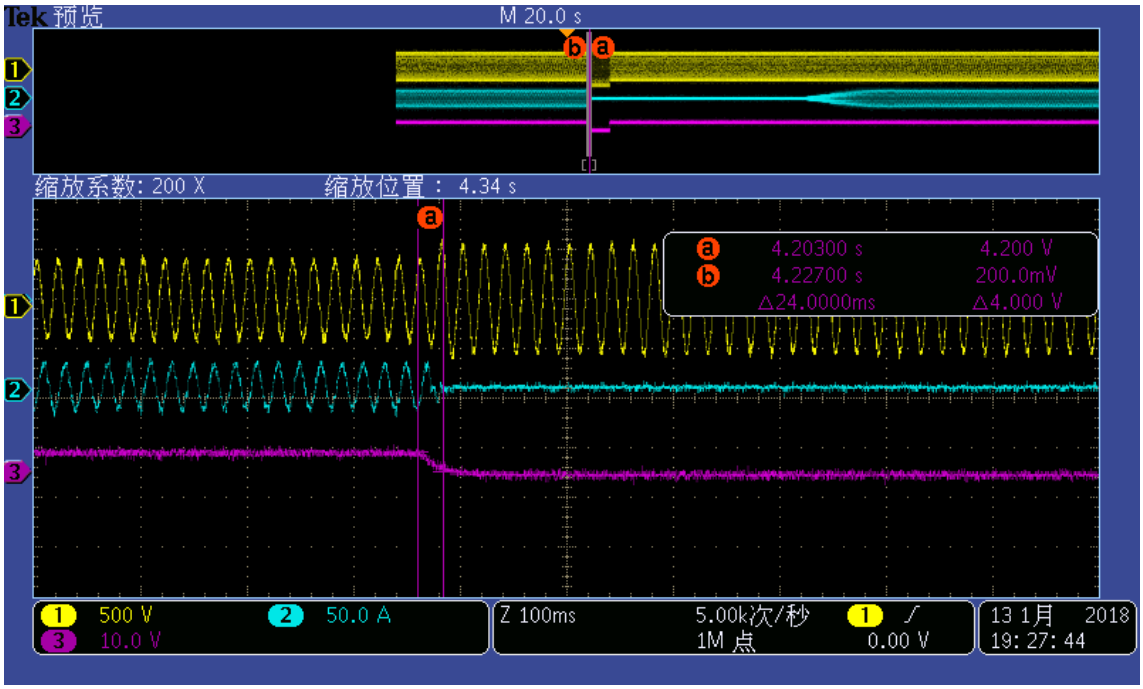
Over voltage First Level, L1 phase



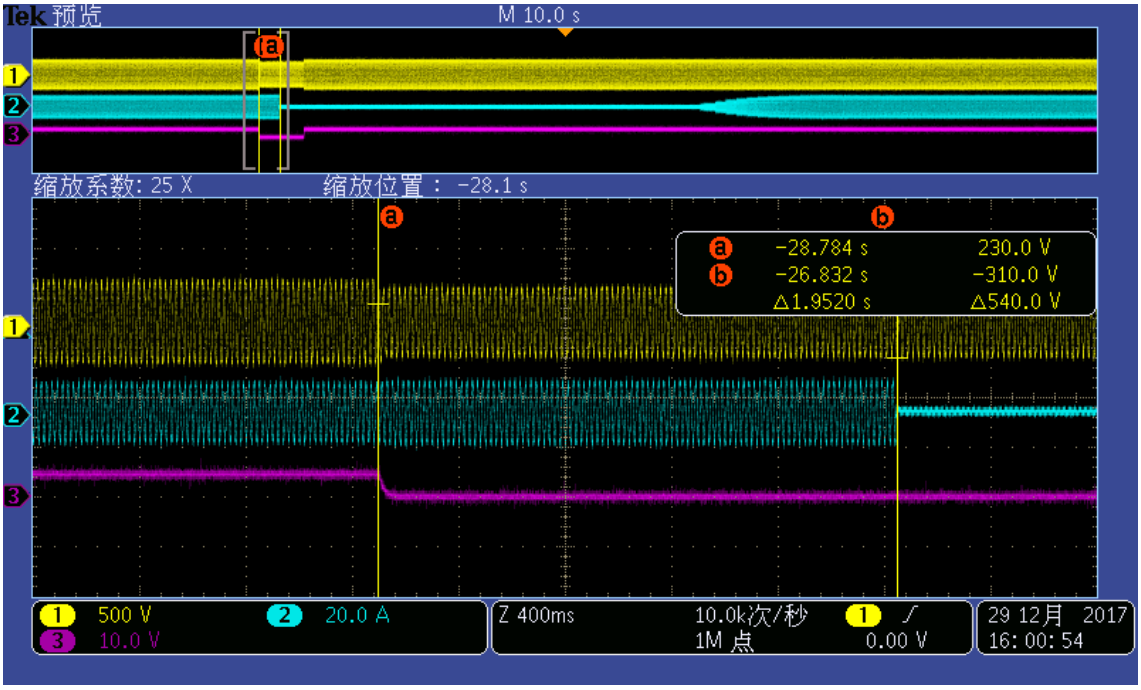
Under Voltage Second Level, L1 phase



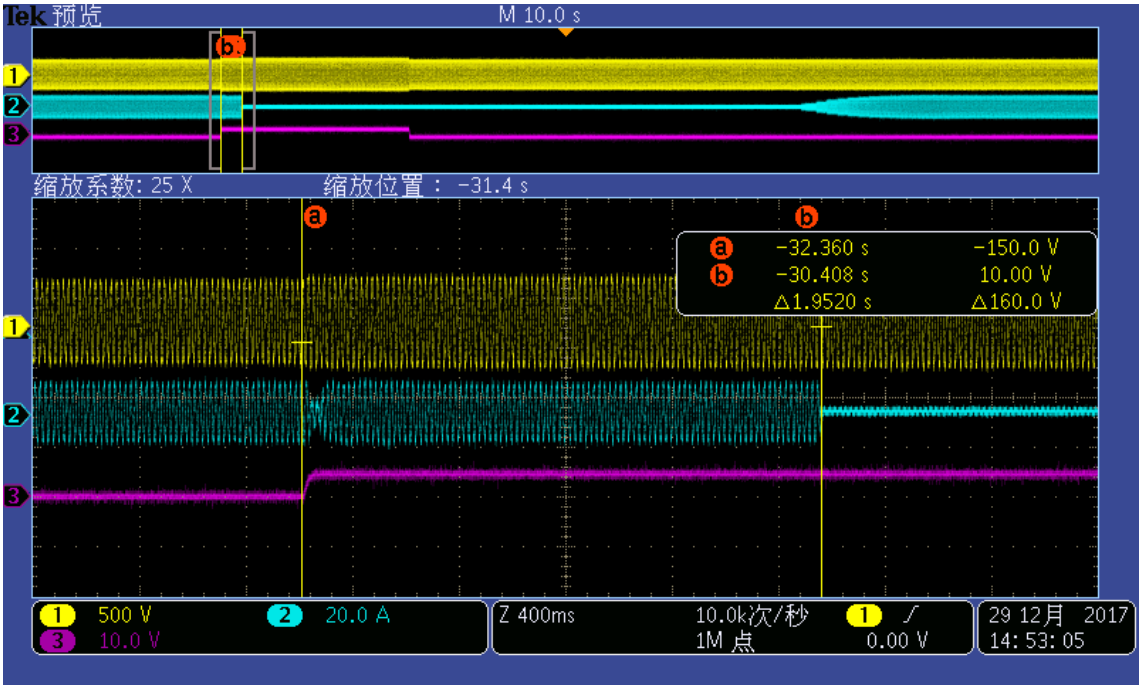
Over voltage Second Level, L1 phase



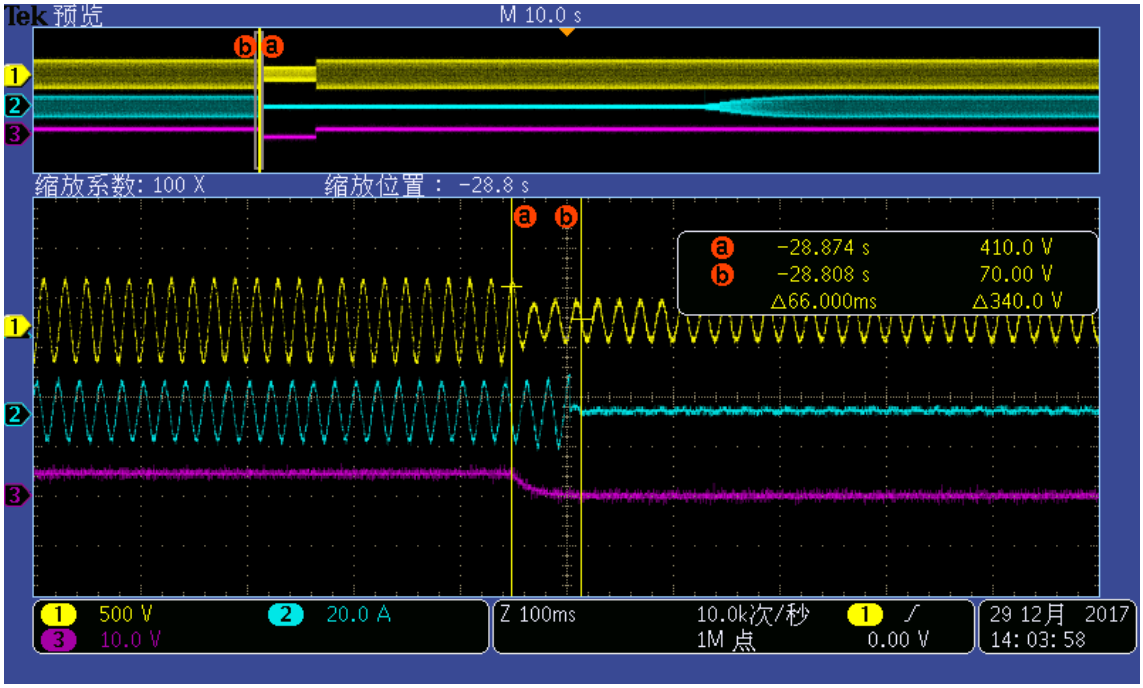
Under Voltage First Level, L2 phase



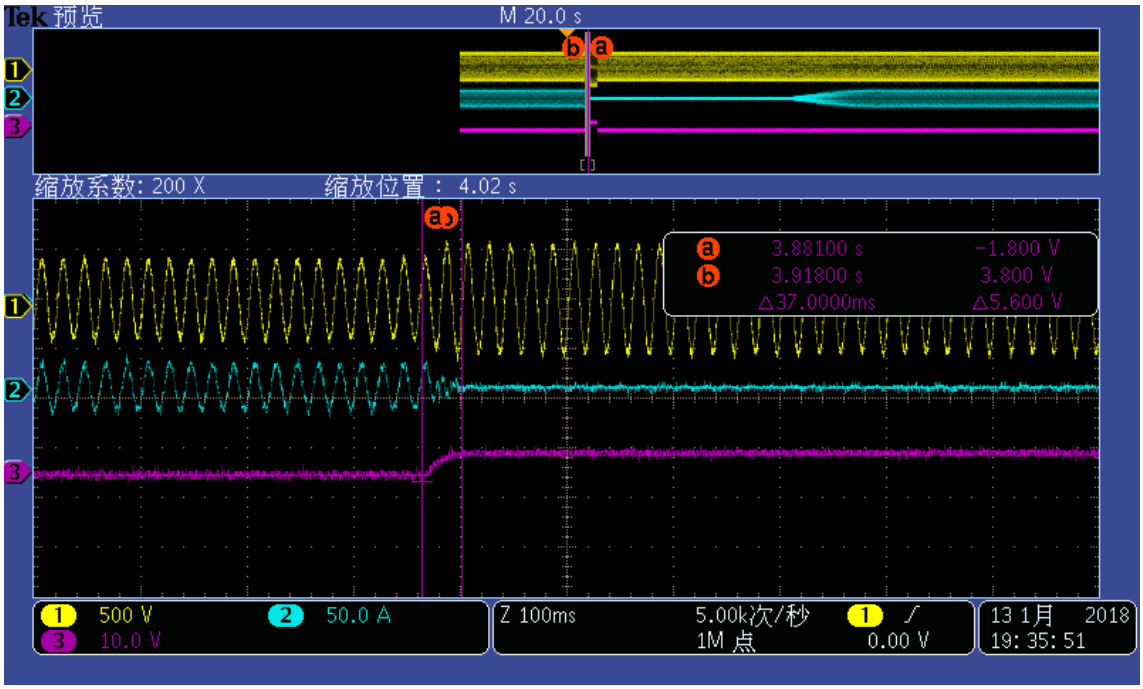
Over voltage First Level, L2 phase



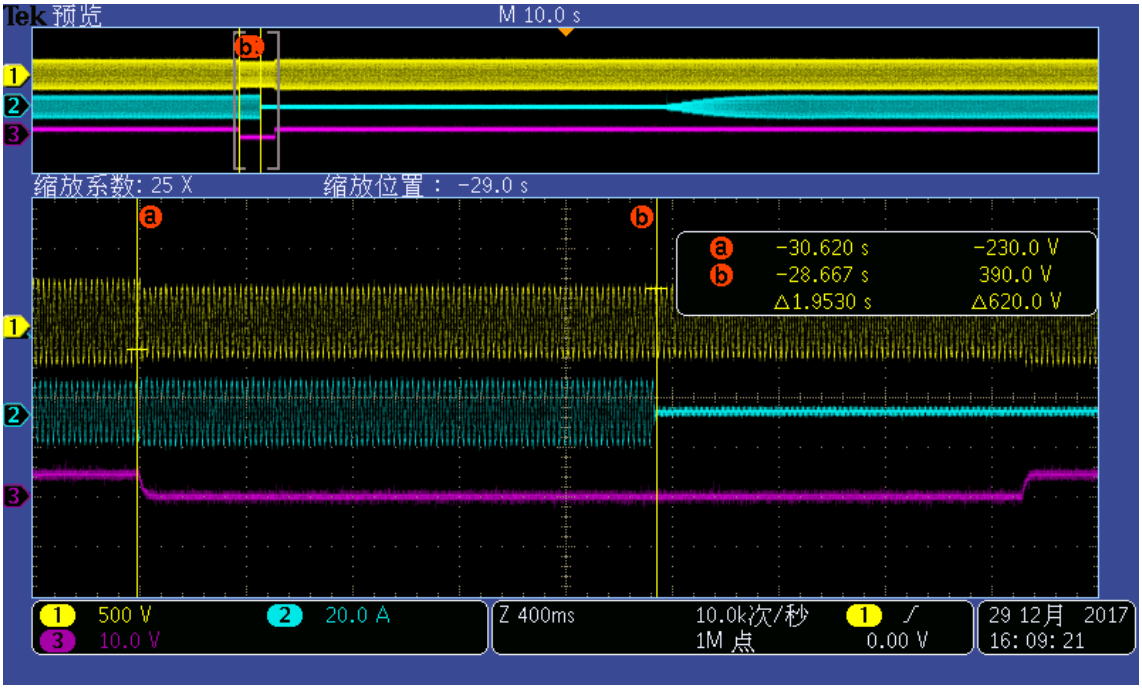
Under Voltage Second Level, L2 phase



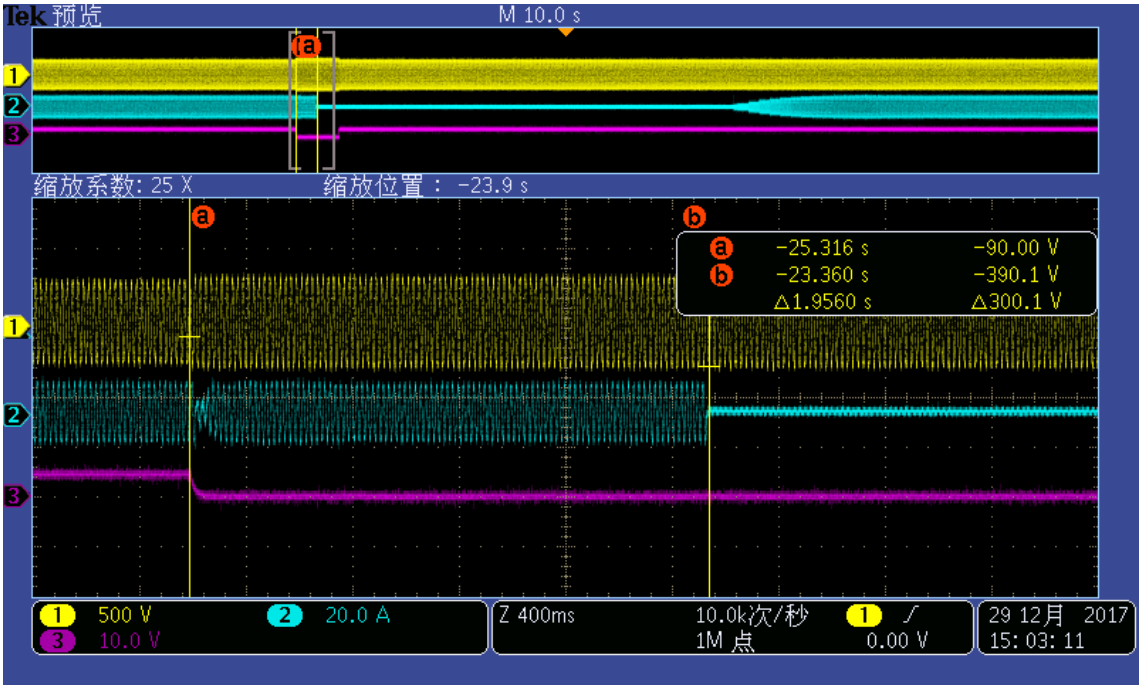
Over voltage Second Level, L2 phase



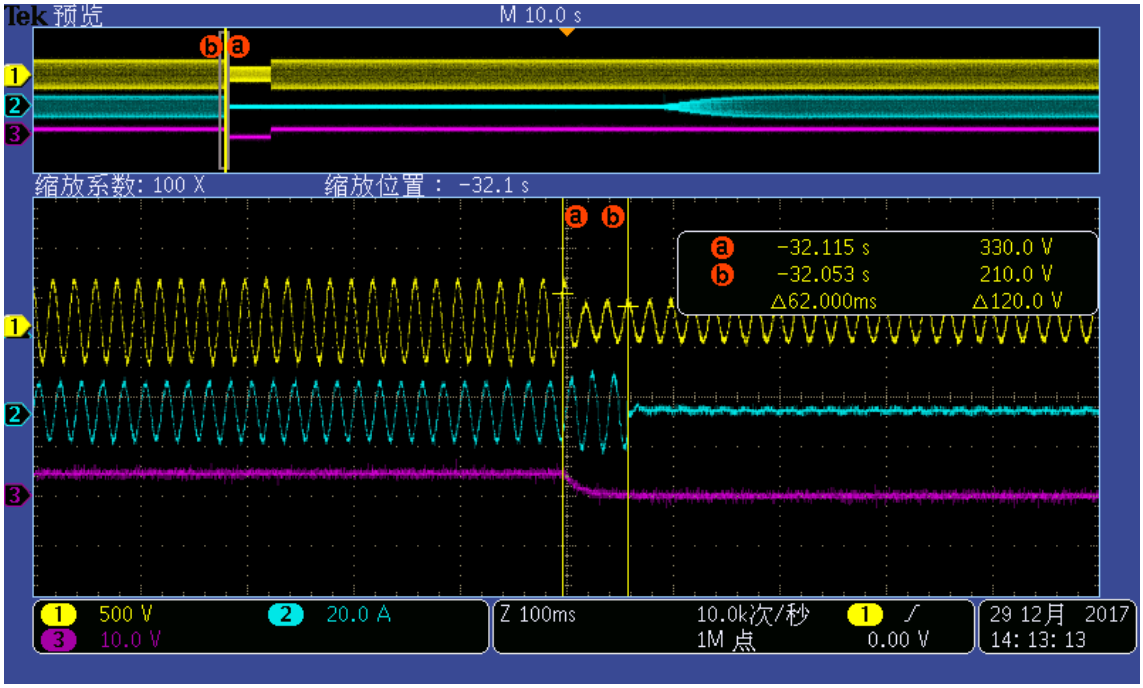
Under Voltage First Level, L3 phase



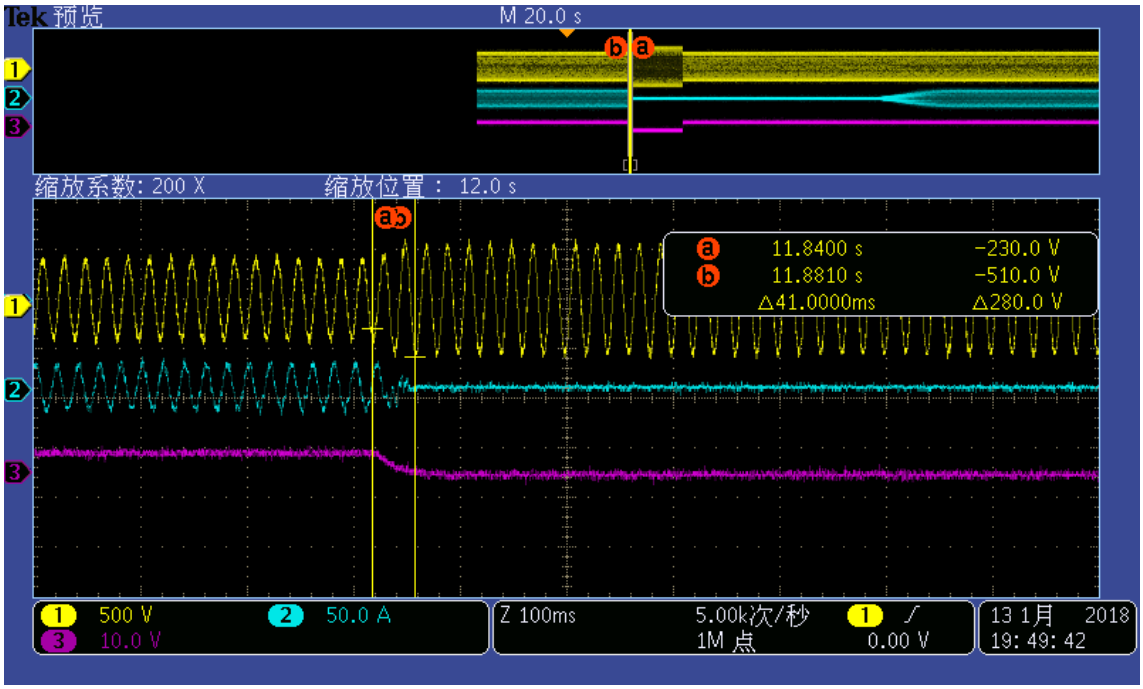
Over voltage First Level, L3 phase



Under Voltage Second Level, L3 phase



Over voltage Second Level, L3 phase



5.2.2 Frequency monitoring — P

IEC 61727

EVVO 60000TL3P

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		49,00Hz	49,00Hz	49,00Hz		51,00Hz	51,00Hz	51,00Hz
Disconnection time	49,01Hz to 48,99Hz	172	169	199	50,99Hz to 51,01Hz	34	35	157
Reconnection time*	20s<t<300s	37s			20s<t<300s	37s		
Reconnection time for India*	at least 90s	100s			at least 90s	100s		

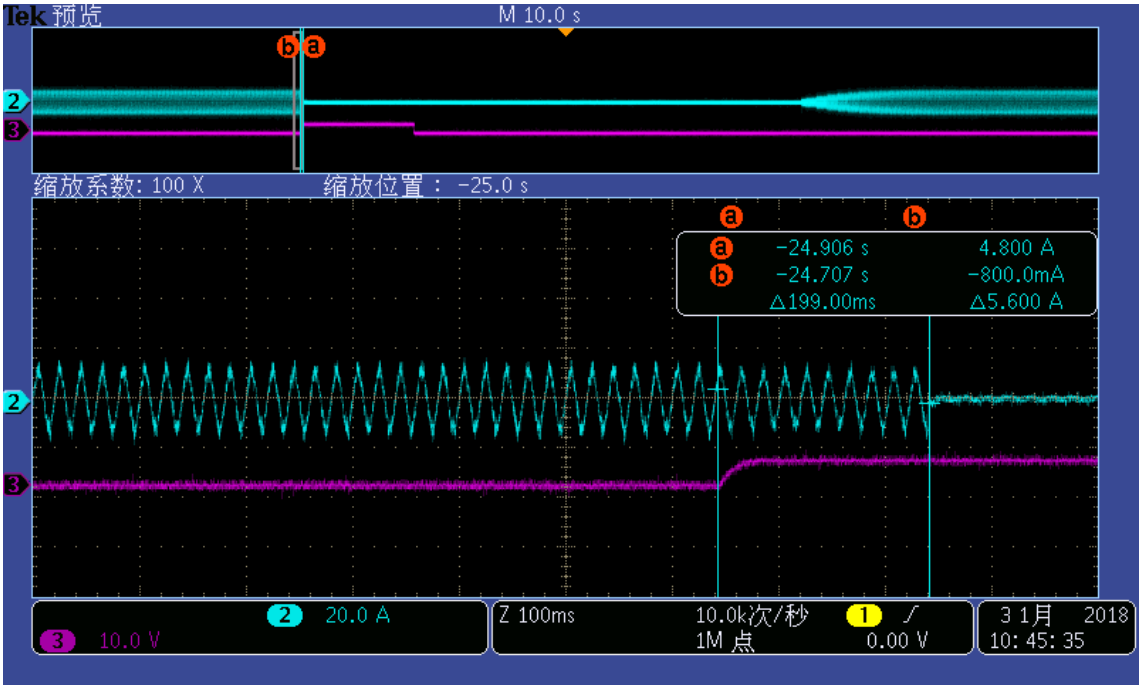
Note:

* The reconnection time value can be adjustable.
For India deviation: the default setting is 300s.
For IEC 61727: the default setting is 30s.

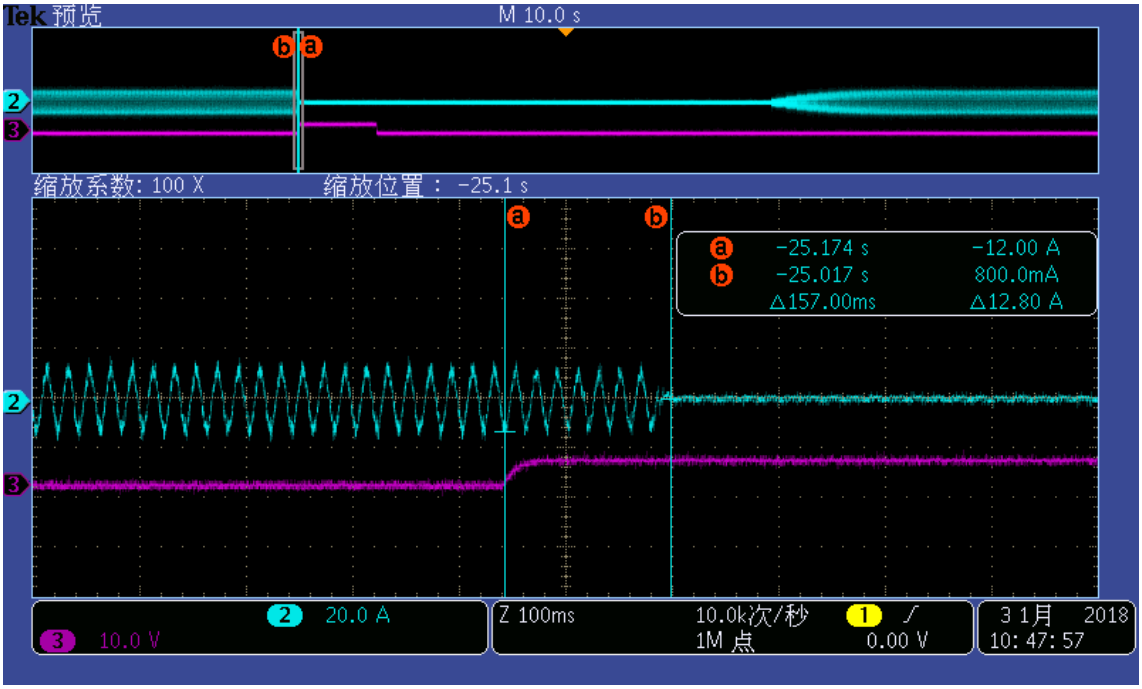
The tests had been performed on the EVVO 60000TL3P is valid for the EVVO 50000TL3P since it is similar in hardware and just power derated by software.

The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

Under Frequency:



Over Frequency:

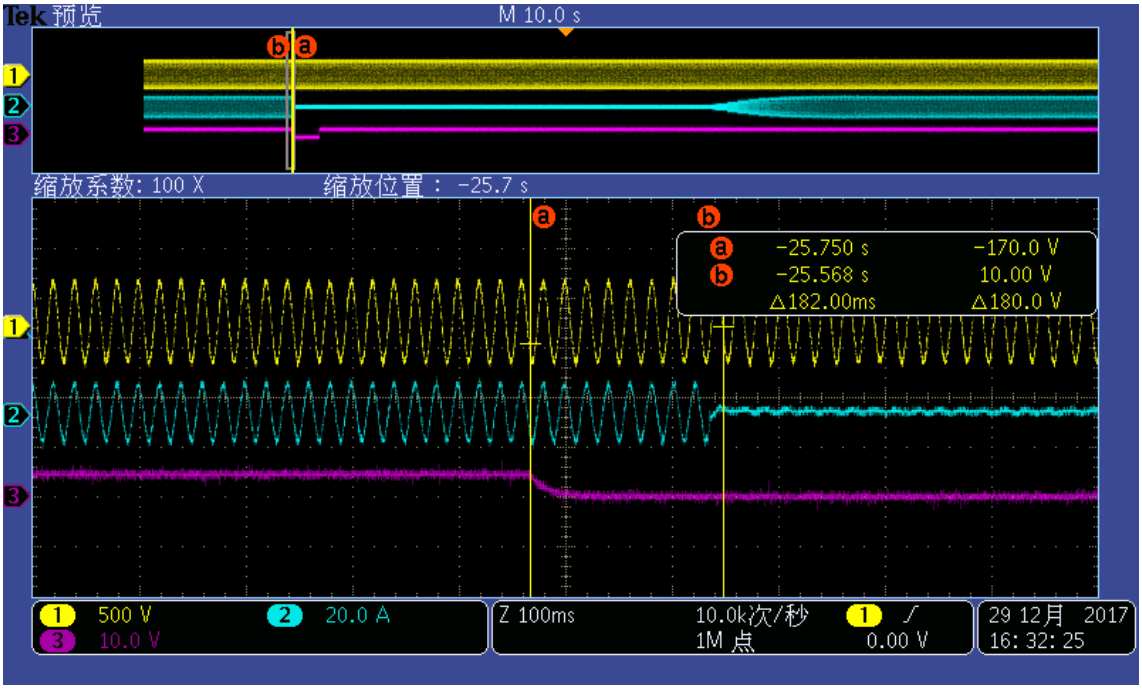


EVVO 70000TL3P-HV								
Test conditions:	Any output power level							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N
Limit	49,00Hz	200ms	200ms	200ms	51,00Hz	200ms	200ms	200ms
Trip value		49,00Hz	49,00Hz	49,00Hz		51,00Hz	51,00Hz	51,00Hz
Disconnection time	49,01Hz to 48,99Hz	168	182	173	50,99Hz to 51,01Hz	33	31	37
Reconnection time*	20s<t<300s	37s			20s<t<300s	146s		
Reconnection time for India*	at least 90s	100s			at least 90s	100s		

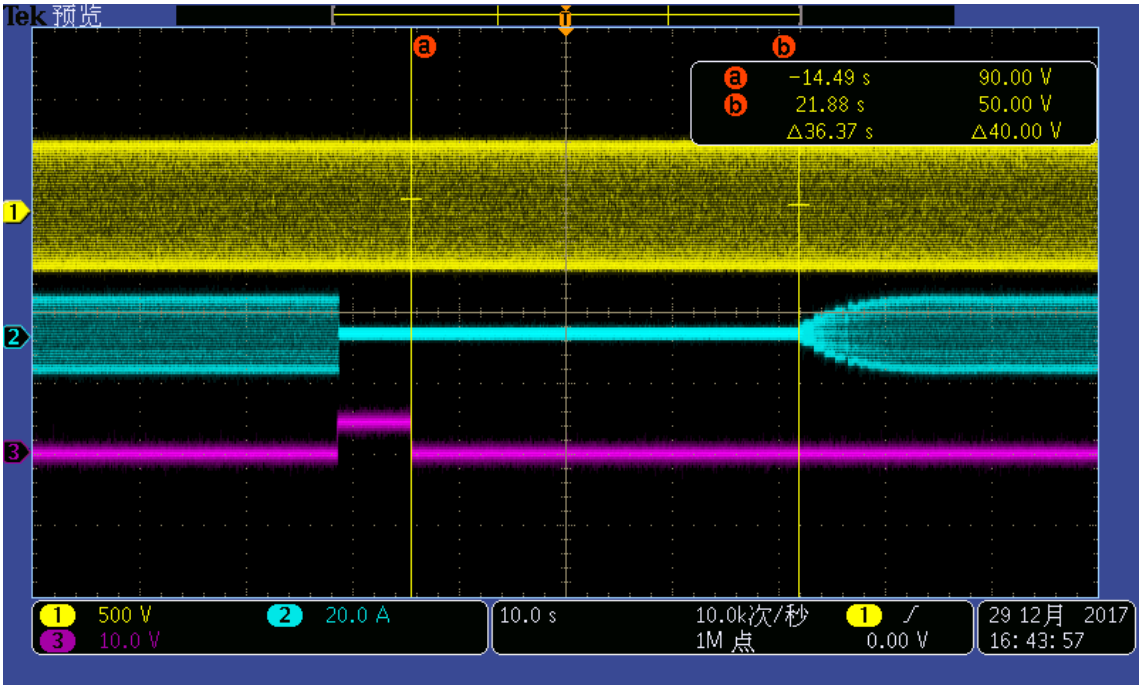
Note:
* The reconnection time value can be adjustable.
For India deviation: the default setting is 300s.
For IEC 61727: the default setting is 30s.

The test results refer to the original test report PV171221N009 issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on Jan. 31, 2018.

Under Frequency:



Over Frequency:

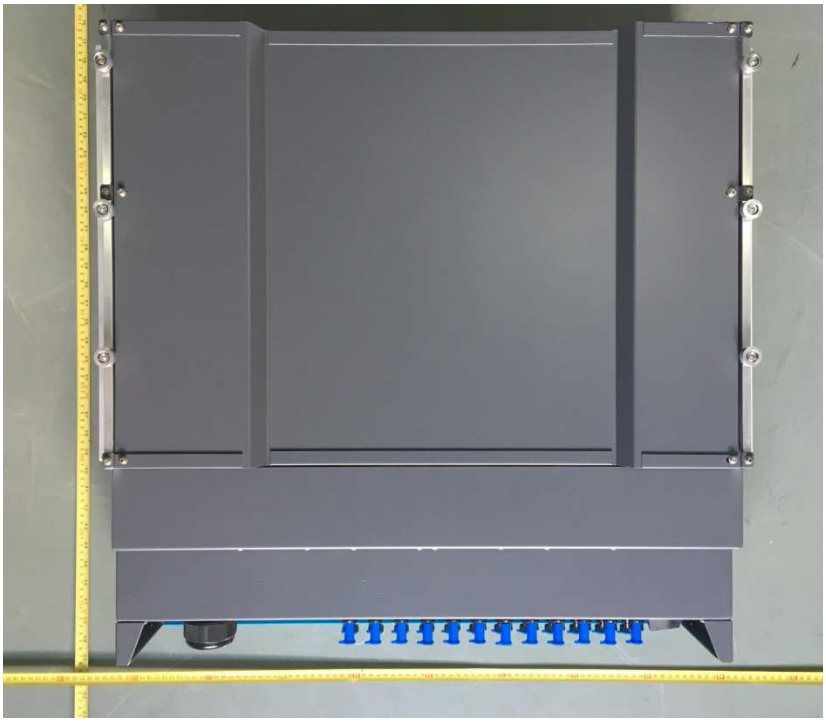


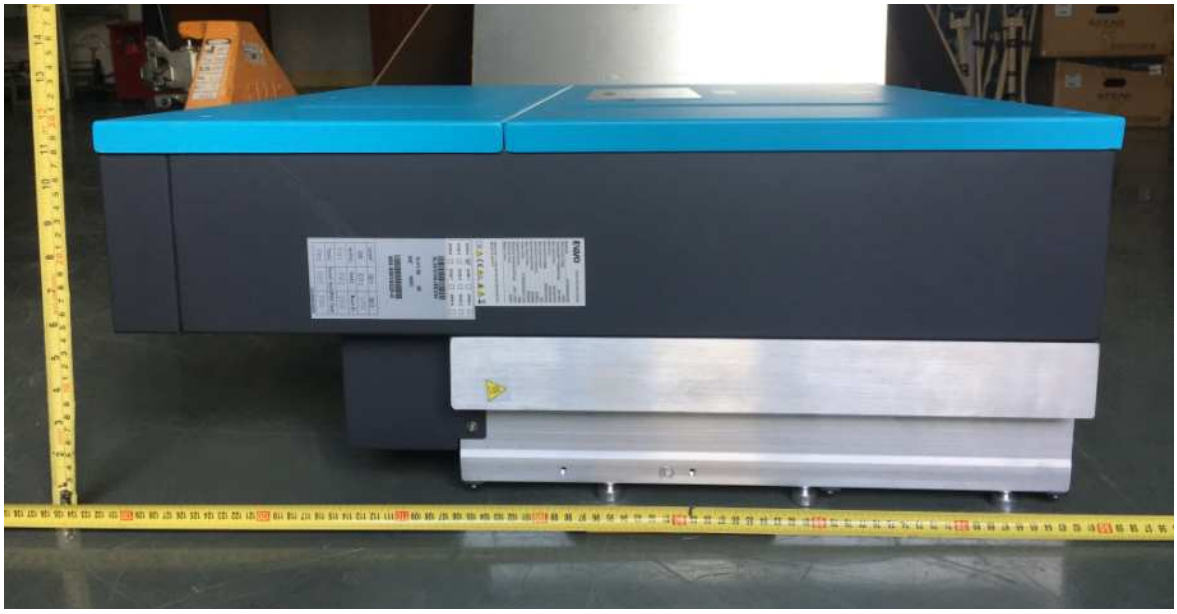
Annex 1

Pictures of the unit
The full pictures refer to PHOTO DOCUMENT
Project No.: 190627N026
Date: 20190723

Front view

Rear view



Side view


Terminal view


Annex 2
Test equipment list

Test location: Shenzhen Academy of Metrology & Quality Inspection
Performed dates of test: 2017-12-21 to 2018-01-31

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
Power Analyzer	SB8900	YOKOGAWA	WT3000	91LB39847	Apr. 12, 2017
AC Source	SB9540/03	ACPOWER	AFG-S-331507	C312020029	Monitored by Power Analyzer
DC Simulation Power Supply	SB9540/02	Chroma	62000H	--	
RLC Load	SB9605	Qunling	ACLT-3830H	--	
PV inverter test system	SB9540	Chroma	--	CH0240021207	
ScopeCorder	SB11177	YOKOGAWA	DL850-H-HC/HD1	91P215763	Mar. 13, 2017
	SB9146	TEKTRONIX	DP03034	--	Apr. 13, 2017
Current transducer	SB9618/07	YOKOGAWA	751552	1132540023	Mar. 10, 2017
	SB9618/08	YOKOGAWA	751552	1132320003	Mar. 10, 2017
	SB9618/09	YOKOGAWA	751552	1132320004	Mar. 10, 2017
	SB11205	YOKOGAWA	96001	--	Aug. 28, 2017
	SB11206	YOKOGAWA	96001	--	Aug. 28, 2017
	SB11207	YOKOGAWA	96001	--	Aug. 28, 2017