TEST REPORT
IEC 61727 2nd ed.
Photovoltaic (PV) systems – Characteristics of the Utility interface

Report Reference No. .....:	190226174GZU-004
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Approved by (name + signature) .....:	Jason Fu
	Technical Team Leader
Date of issue.....:	03 Jun 2019
Number of pages	24 pages

Testing Laboratory .....:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address.....:	Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Testing location / procedure .....:	CBTL ☐ SMT ☐ TMP ☐ TL ☒
Testing location / address.....:	Same as above
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 2nd ed. 2004-12
Test procedure.....:	Type test
Non-standard test method……..:	N/A

Test Report Form No. .....:	IEC61727_2ed_a
TRRF Originator .....:	Intertek
Master TRRF .....:	Dated 2010-08

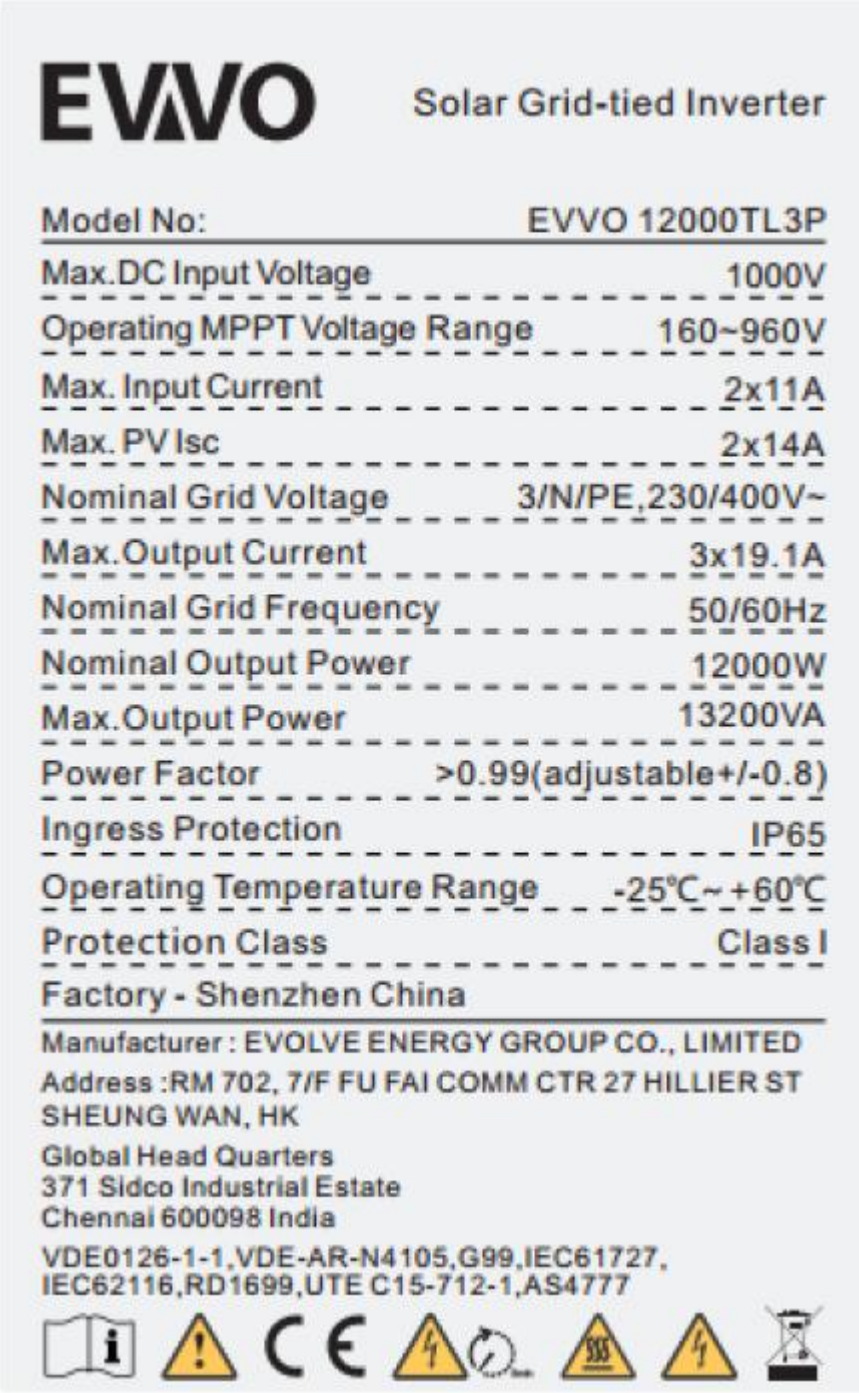
Test item description.....:	Solar inverter
Trade Mark .....:	EVVO
Manufacturer.....:	Same as applicant
Model/Type reference:	EVVO 3000TL3P, EVVO 4000TL3P, EVVO 4800TL3P, EVVO 5000TL3P, EVVO 6000TL3P, EVVO 8000TL3P, EVVO 10000TL3P, EVVO 12000TL3P

Ratings.....

MODEL	EVVO 3000TL3P	EVVO 4000TL3P	EVVO 4800TL3P	EVVO 5000TL3P	EVVO 6000TL3P
Max PV voltage	1000Vdc				
MPPT Voltage range	160-960Vdc				
Max. input current	11/11A				
PV Isc	14/14A				
Max power(VA)	3300	4400	5000	5500	6600
Max output current	3×4.8 A	3×6.4 A	3×8.0A	3×8.0 A	3×9.6 A
Output voltage	3W/N/PE 230Vac/400Vac				
Nominal Frequency	50 Hz				
Power Factor	0.8 Leading to 0.8 Lagging				
Ambient Temperature	-25℃ - +60℃				
Protection Degree	IP65				
Protection Class	Class I				

MODEL	EVVO 8000TL3P	EVVO 10000TL3P	EVVO 12000TL3P
Max PV voltage	1000Vdc		
MPPT Voltage range	160-960Vdc		
Max. input current	11/11A		
PV Isc	14/14A		
Max power(VA)	8800	11000	13200
Max output current	3×12.8 A	3×15.9 A	3×19.1 A
Output voltage	3W/N/PE 230Vac/400Vac		
Nominal Frequency	50 Hz		
Power Factor	0.8 Leading to 0.8 Lagging		
Ambient Temperature	-25℃ - +60℃		
Protection Degree	IP65		
Protection Class	Class I		
Software Version	V 1.00		

Copy of marking plate:



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. The other model labels are identical with label above, except the model name and rating.

Summary of testing:
4.4 DC injection
4.6 Harmonic and waveform distortion
4.7 Power factor
5.2.1 Over/under voltage
5.2.2 Over/under frequency

Test item particulars	:	
Classification of installation and use	:	Fixed, IP 65
Supply Connection	:	Permanent connection
	:	
	:	
Possible test case verdicts:		
- 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)
Testing	:	
Date of receipt of test item	:	27 Feb., 2019
Date (s) of performance of tests	:	27 Feb 2019– 25 May, 2019

General remarks:

This report is not valid as a CB Test Report

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"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

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

This report is based on original report No. 170707054GZU-001, dated 11 Jul 2017 and Revision 1:25 Sep 2018 to apply for co-certificate.

Only applicant and model name are changed.

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 terminal. The structure of the unit complied with the IP 65 requirement.

The inverters intended to operate at ambient temperature -25℃ - +60℃, which will be specified in the user manual, however, the inverters will output full power when operated at 45℃, if operated at high than 45℃ temperature, the output power would be derated

Model difference:

All models have identical mechanical and electrical construction except some parameter of the software architecture in order to control the max output power. The detailed difference as following:

Model	EVVO 8000TL3P, EVVO 10000TL3P, EVVO 12000TL3P		EVVO 3000TL3P, EVVO 4000TL3P, EVVO 4800TL3P , EVVO 5000TL3P, EVVO 6000TL3P	
Componets	Specification	Numbers	Specification	Numbers
Inverter Chock	NPS226060*2+NPF226060*1 2.0Φ*2P*42Ts L=0.73mH	3	NPS226060*2 2.2Φ*1P*67Ts L=1.24mH	3
Bus capacitor	75μF/600V	4	75μF/600V	2

Other than special notice, the model EVVO 12000TL3P is as the representative test models in this report

IEC 61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
4	**Utility compatibility**		P
4.1	Rated Utility voltage (V) ..... :		P
	Nature of supply..... :		P
	Rated frequency (Hz)..... :	50Hz	P
	Rated power (W)..... :	See markings	P
	Rated current (A) ..... :	See markings	P
4.1	**Voltage, current and frequency**		P
4.1	Utility-interconnected Voltage range (V)..... :		P
4.3	**Flicker**		P
	The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC61000-3-3 for systems rated less than 16A		P
	The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC61000-3-5 for systems rated more than 16A		P
4.4	**DC injection**		P
	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 appended table)	P
4.5	**Normal frequency operating range**		P
	The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in §5.2.2	(see appended table)	P
4.6	**Harmonics and wave form distortion**		P
	The PV system output should have low current-distortion level to ensure that no adverse effects are caused to other equipment connected to the utility system	(see appended table)	P
	THD shall be less than 5% at rated output. Each individual shall be limited to the percentage listed in table 1		P
	Even harmonics in these ranges shall be less than 25% of the lower odd harmonic limits listed		P
4.7	**Power factor**		P

IEC 61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
	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 appended table)	P
	Specially designed systems that provide reactive power compensation may operate outside of the limit with utility approval		P
5	**Personnel safety and equipment protection**		P
	The PV system should operate safe and proper		P
	The protection function may be provided as and internal or external device in the system		P
	IEC60364-5-55 or national codes may be applicable		P
5.1	**Loss of Utility**		P
	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 limits	Considered in IEC 62116	P
	A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to a fault condition or the distribution line switched out during maintenance.		P
	If inverters (single or multiple) have DC-SELV input and have accumulated power below 1kW then no mechanical disconnect (relay) is required		N/A
5.2	**Over / under voltage and frequency**		P
	Abnormal conditions can arise on the utility system that require a response from the connected photovoltaic system. This response is to ensure the safety of the utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system		P
5.2.1	**Over / Under voltage**		P
	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	(see appended table)	P
	All discussions regarding system voltage refer to the local nominal voltage		P
5.2.2	**Over / Under frequency**		P

IEC 61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
	When the utility frequency deviates outside the specific conditions the photovoltaic system shall cease to energize the utility line. When the utility frequency is outside the range of ±1Hz, the system shall cease to energize the utility line within 0.2 s.	(see appended table)	P
5.3	**Islanding protection**		P
	The PV system must cease to energize the utility line within 2 s of loss utility	Considered in IEC 62116	P
5.4	**Response to Utility recovery**		P
	Following an out-of-range utility condition that 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		P
5.5	**Earthing**		N/A
	The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712		N/A
5.6	**Short circuit protection**		N/A
	The photovoltaic system shall have short-circuit protection in accordance with IEC60364-7-712	This short-circuit protection will be considered at point of connection to the AC mains	N/A
5.7	**Isolation switching**		N/A
	A method of isolation and switching shall be provided in accordance with IEC 60364-7-712	Should consider in the end use.	N/A

Appendix 1: Test tables

4.4	DC injection
Rated output load (W)	12000
Rated output current (Arms)	17.4A/phase
Measured DC current (A)	R: 9.2744mA Y: 9.2780mA B: 3.8022mA
DC injection current (%)	R: 0.0486% Y: 0.0486% B: 0.0199%
Limit: DC injection current is not greater than 1 % of the rated inverter output current.	

4.3	TABLE: Voltage Fluctuations and Flicker			P
Model	EVVO 10000TL3P (R phase)			
	dc (%)	Dmax (%)	Running	
Limit	3.3	4.0	Pst = 1.0	Plt =0.65
Test value	1.99	3.30	0.17	0.15
Model	EVVO 10000TL3P (Y phase)			
	dc (%)	Dmax (%)	Running	
Limit	3.3	4.0	Pst = 1.0	Plt =0.65
Test value	2.45	3.60	0.20	0.17
Model	EVVO 10000TL3P (B phase)			
	dc (%)	Dmax (%)	Running	
Limit	3.3	4.0	Pst = 1.0	Plt =0.65
Test value	1.97	3.50	0.21	0.19
Model	EVVO 12000TL3P (R phase)			
	dc (%)	Dmax (%)	Running	
Limit	3.3	4.0	Pst = 1.0	Plt =0.65
Test value	0	3.94	0.36	0.25
Model	EVVO 12000TL3P (Y phase)			
	dc (%)	Dmax (%)	Running	
Limit	3.3	4.0	Pst = 1.0	Plt =0.65
Test value	0	3.60	0.33	0.23
Model	EVVO 12000TL3P (B phase)			

Appendix 1: Test tables

	dc (%)	Dmax (%)	Running	
Limit	3.3	4.0	Pst = 1.0	Plt =0.65
Test value	0	3.23	0.31	0.22

4.6	Harmonics and wave form distortion (for EVVO 4000TL3P)	P
Watts	4.020kW	
Vrms	230V	
Arms	R: 5.82A Y: 5.83A B: 5.79A	
PF	0.9999	
Frequency	50.0Hz	

Harmonics	Harmonic current % of Fundamental			Harmonic Current Limits (%)
	Phase R	Phase Y	Phase B	
1st	--	--	--	
2nd	0.0789	0.0841	0.1052	1.0%
3rd	0.3205	0.0910	0.2538	4.0%
4th	0.0602	0.0983	0.0677	1.0%
5th	0.1729	0.4024	0.5451	4.0%
6th	0.0834	0.0237	0.0963	1.0%
7th	0.2066	0.2225	0.4200	4.0%
8th	0.0984	0.0263	0.1161	1.0%
9th	0.2451	0.0583	0.2853	4.0%
10th	0.0815	0.0168	0.0932	0.5%
11th	0.1144	0.2193	0.3374	2.0%
12th	0.0854	0.0235	0.0752	0.5%
13th	0.0270	0.3510	0.3612	2.0%
14th	0.0764	0.0263	0.1041	0.5%
15th	0.3260	0.1157	0.4001	2.0%
16th	0.0997	0.0224	0.0816	0.5%
17th	0.2413	0.2324	0.4528	1.5%

18th	0.0786	0.0190	0.0888	0.5%
19th	0.2148	0.1954	0.0409	1.5%
20th	0.0718	0.0095	0.0740	0.5%
21st	0.3849	0.0746	0.3325	1.5%
22nd	0.0644	0.0288	0.0934	0.5%
23rd	0.3301	0.1876	0.2818	0.6%
24th	0.0419	0.0123	0.0550	0.5%
25th	0.2376	0.1276	0.2450	0.6%
26th	0.0558	0.0086	0.0561	0.5%
27th	0.2685	0.0172	0.2794	0.6%
28th	0.0547	0.0121	0.0619	0.5%
29th	0.1251	0.0658	0.0646	0.6%
30th	0.0381	0.0212	0.0521	0.5%
31st	0.0595	0.0575	0.1058	0.6%
32nd	0.0316	0.0052	0.0414	0.5%
33rd	0.1848	0.0160	0.2050	0.6%
Total THD	1.1296	0.8049	1.3806	5%

Model: EVVO 12000TL3P	
Watts	11.993kW
Vrms	230V
Arms	R: 17.37A Y: 17.35A B: 17.31A
PF	0.9999
Frequency	50.0Hz

Harmonics	Harmonic current % of Fundamental			Harmonic Current Limits (%)
	Phase R	Phase Y	Phase B	
1st	--	--	--	
2nd	0.1008	0.1323	0.0600	1.0%
3rd	0.0240	0.2725	0.2535	4.0%
4th	0.0548	0.0890	0.0376	1.0%
5th	0.2397	0.2469	0.1081	4.0%

Appendix 1: Test tables

6th	0.0216	0.0267	0.0357	1.0%
7th	0.6924	0.8889	0.7232	4.0%
8th	0.0645	0.0654	0.0759	1.0%
9th	0.1205	0.2624	0.1495	4.0%
10th	0.0216	0.0595	0.0483	0.5%
11th	0.1453	0.3188	0.1773	2.0%
12th	0.0307	0.0743	0.0440	0.5%
13th	0.0414	0.0751	0.1052	2.0%
14th	0.0278	0.0811	0.0567	0.5%
15th	0.0305	0.1040	0.1228	2.0%
16th	0.0269	0.0874	0.0772	0.5%
17th	0.3377	0.3071	0.2347	1.5%
18th	0.0265	0.0458	0.0291	0.5%
19th	0.2593	0.2939	0.2991	1.5%
20th	0.0105	0.0252	0.0181	0.5%
21st	0.0362	0.0474	0.0270	1.5%
22nd	0.0164	0.0302	0.0270	0.5%
23rd	0.1467	0.1781	0.1795	0.6%
24th	0.0125	0.0068	0.0051	0.5%
25th	0.1779	0.1845	0.2189	0.6%
26th	0.0114	0.0030	0.0090	0.5%
27th	0.0185	0.0388	0.0192	0.6%
28th	0.0108	0.0059	0.0089	0.5%
29th	0.1747	0.1330	0.1867	0.6%
30th	0.0057	0.0026	0.0069	0.5%
31st	0.1739	0.1500	0.1583	0.6%
32nd	0.0117	0.0137	0.0060	0.5%
33rd	0.0082	0.0289	0.0354	0.6%
Total THD	1.0550	1.2266	1.0656	5%
Note:				

Appendix 1: Test tables

4.7	TABLE: Power Factor								P
Model	EVVO 4000TL3P								
Output Power (%)	50	60	70	80	90	100			
Output Power Test Value (W)	660.07	796.61	928.11	1064.44	1196.83	1332.96			
	668.05	805.09	939.03	1075.29	1209.25	1344.96			
	663.47	799.31	933.47	1067.18	1200.63	1335.69			
Vrms (V)	230.34	230.35	230.31	230.41	230.38	230.43			
	230.33	230.34	230.40	230.43	230.48	230.45			
	23O.32	230.35	230.38	230.41	230.44	230.46			
Arms (A)	2.88	3.47	4.04	4.63	5.25	5.79			
	2.91	3.51	4.09	4.67	5.22	5.84			
	2.89	3.48	4.06	4.64	5.22	5.80			
Output Power test value (VA)	663.38	799.47	930.38	1066.44	1198.37	1333.61			
	671.19	807.76	941.19	1077.02	1210.66	1346.12			
	666.27	801.72	935.33	1068.77	1201.85	1336.77			
Power factor Limit agging	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90			
Power factor	0.9950	0.9964	0.9976	0.9981	0.9987	0.9990			
	0.9953	0.9967	0.9977	0.9984	0.9988	0.9991			
	0.9958	0.9970	0.9980	0.9985	0.9989	0.9992			
Model	EVVO 12000TL3P								
Output Power (%)	50	60	70	80	90	100			
Output Power Test Value (W)	1993.84	2395.17	2789.39	3189.41	3583.18	3999.89			
	2008.73	2409.45	2807.65	3205.89	3605.93	4018.25			
	1989.36	2391.03	2790.92	3188.47	3585.05	3997.21			
Vrms (V)	230.18	230.05	230.15	230.22	230.24	230.27			
	230.13	230.01	230.11	230.21	230.27	230.26			
	230.19	230.07	230.15	230.24	230.31	230.25			
Arms (A)	8.66	10.41	12.12	13.85	15.56	17.37			
	8.73	10.48	12.20	13.93	15.66	17.45			
	8.64	10.39	12.20	13.85	15.57	17.36			
Output Power test value (VA)	1993.85	2395.17	2789.39	3189.43	3583.18	3999.89			
	2008.77	2409.47	2807.66	3205.95	3605.93	4018.28			
	1989.43	2391.08	2790.95	3188.56	3585.09	3997.26			

Appendix 1: Test tables

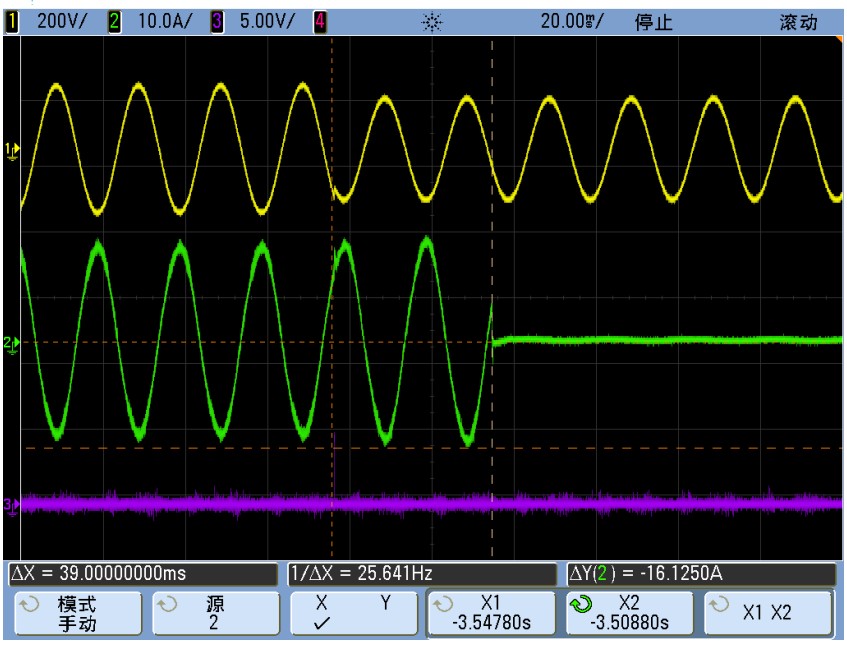
Power factor Limit agging	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90			
Power factor	0.9999 0.9999 0.9999	0.9999 0.9999 0.9999	0.9999 0.9999 0.9999	0.9999 0.9999 0.9999	0.9999 0.9999 0.9999	0.9999 0.9999 0.9999			

Appendix 1: Test tables

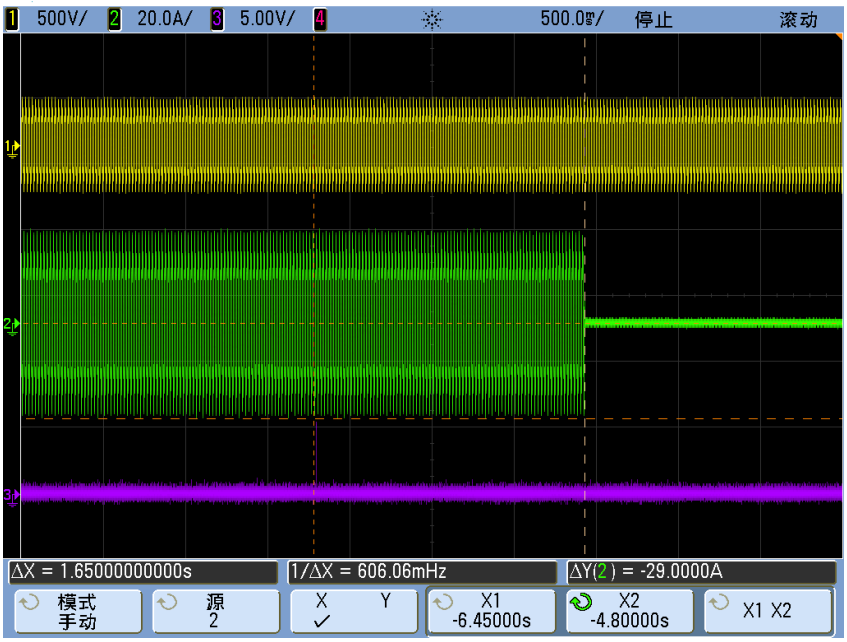
4. Test for Over/under voltage

Model: EVVO 12000TL3P					
deviation	Voltage(s)	Measured Tripp Voltage	Maximum trip time	Measured trip time	Remark
V < 0.5 x Vnominal	All phase:115V	114.26V	0,1s	38.6ms	P
	Phase R:115V	114.21V	0,1s	38.4ms	P
	Phase Y:115V	114.26V	0,1s	39.0ms	P
	Phase B:115V	114.51V	0,1s	38.5ms	P
50% ≤ V < 85%	All phase:195.5V	194.72V	2s	1.65s	P
	Phase R:195.5V	194.61V	2s	1.63s	P
	Phase Y:195.5V	194.83V	2s	1.65s	P
	Phase B:195.5V	194.72V	2s	1.65s	P
85% ≤ V < 110%	<253V	250.29	Continuous operation	--	P
110% ≤ V < 135%	All phase:254V	255.17V	2s	1.635s	P
	Phase R:254V	255.19V	2s	1.650s	P
	Phase Y:254V	255.34V	2s	1.640s	P
	Phase B:254V	254.97V	2s	1.642s	P
135% ≤ V	All phase:310.5V	311.7V	0,05s	40.0ms	P
	Phase R: 310.5V	311.9V	0,05s	43.8ms	P
	Phase Y:315.5V	311.8V	0,05s	32.0ms	P
	Phase B:315.5V	311.7V	0,05s	35.6ms	P

Appendix 1: Test tables

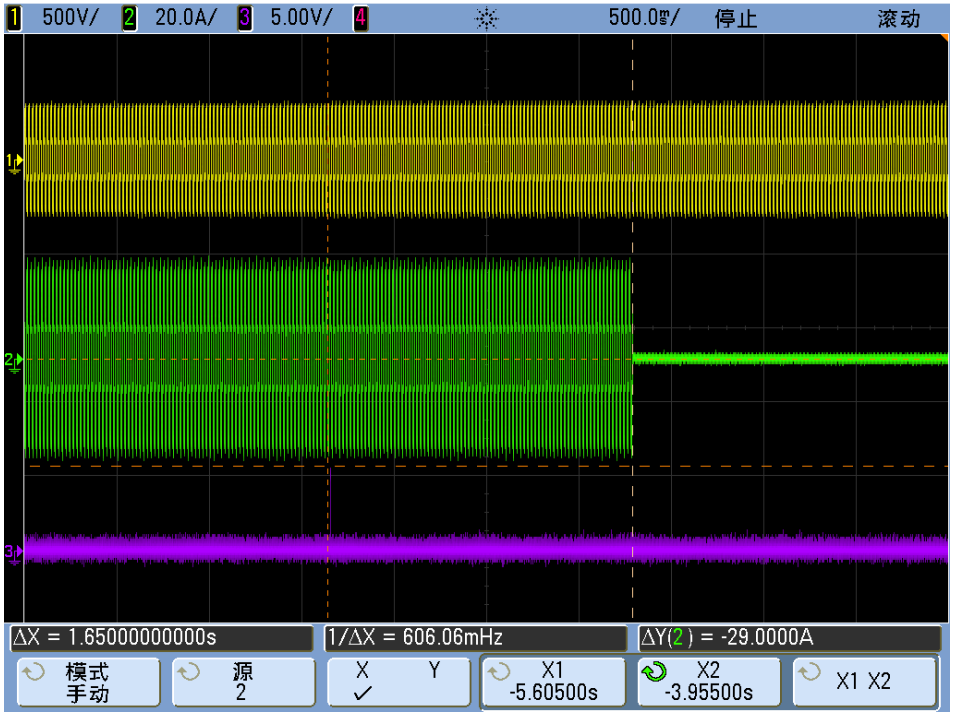


V < 0.5 x Vnominal

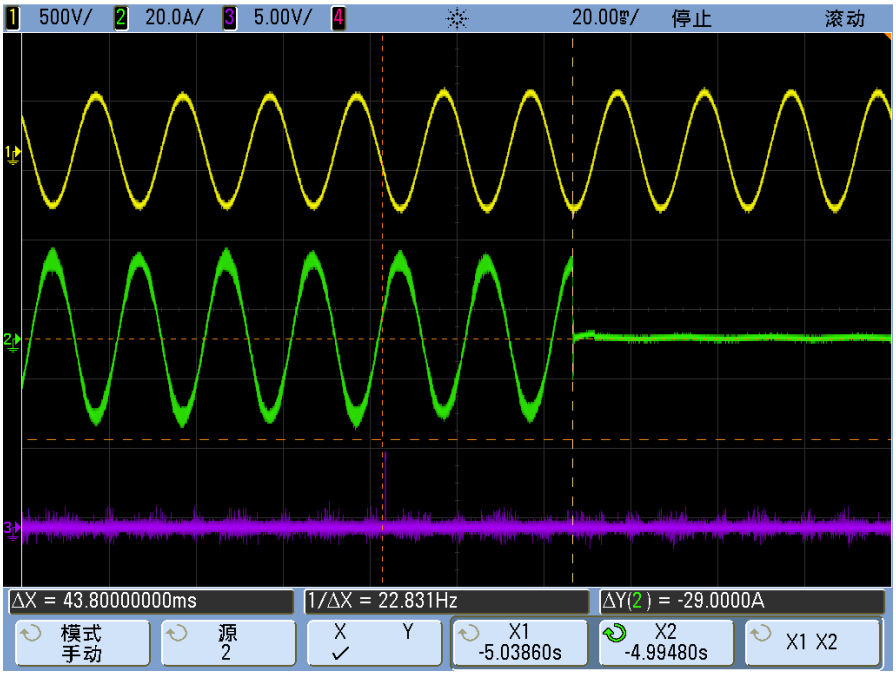


50% ≤ V < 85%

Appendix 1: Test tables



110% ≤ V < 135%

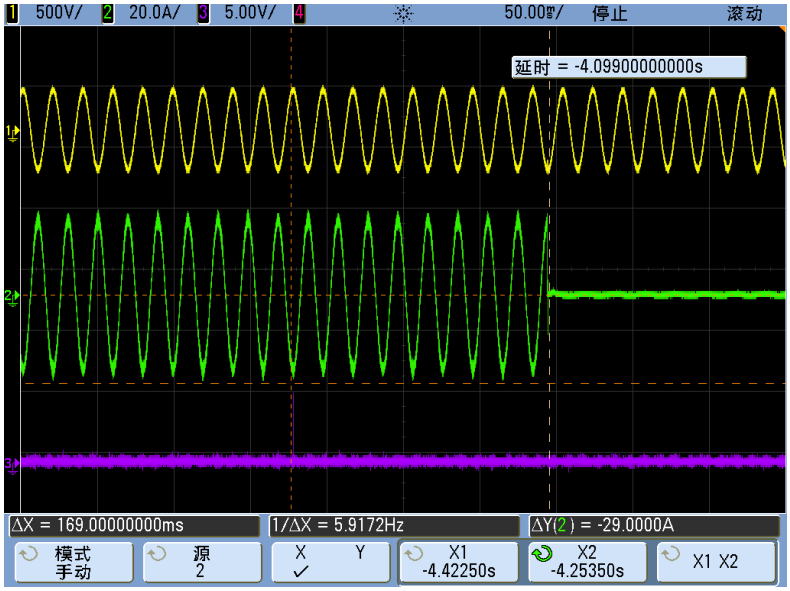


135% ≤ V

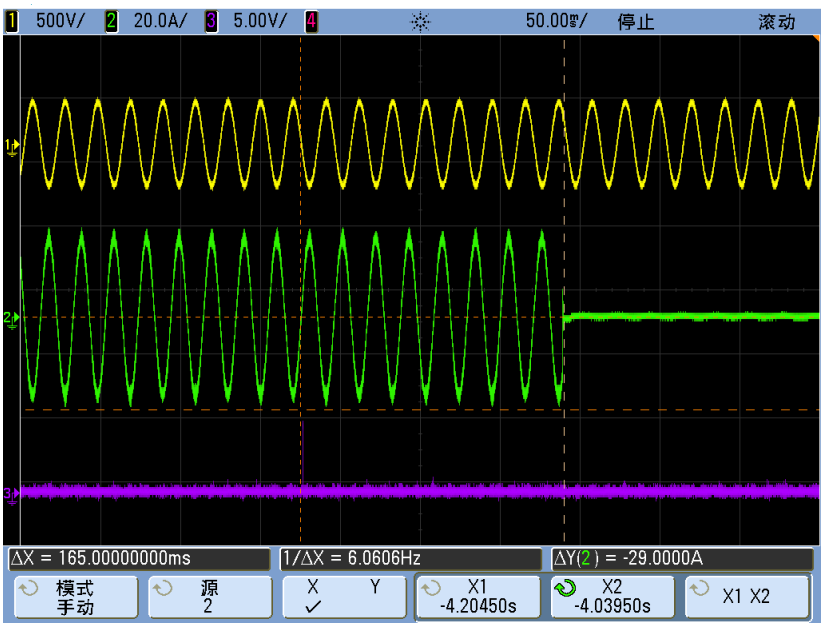
Appendix 1: Test tables

5. Test for Over/under frequency

Model: EVVO 12000TL3P				
deviation	Frequency(s)	Maximum trip time	Measured trip time	Remark
Over frequency	51.1Hz	200ms	169.0ms	P
Under Frequency	48.9Hz	200ms	165.0ms	P



Over frequency

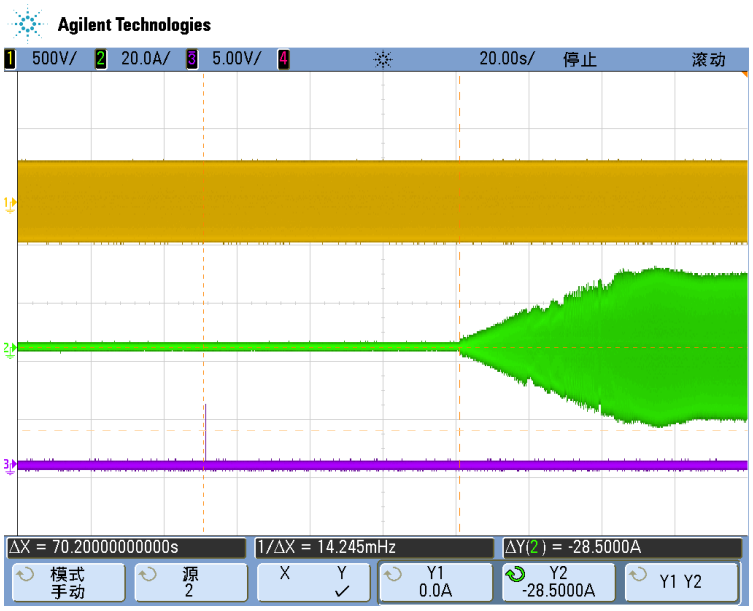


Under Frequency

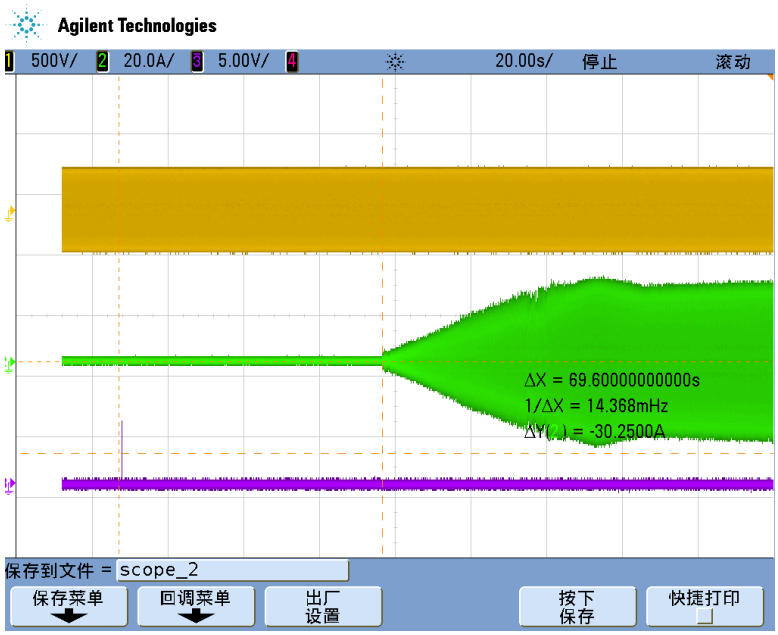
Appendix 1: Test tables

6. Test for Response to utility recovery

Model: EVVO 12000TL3P			
deviation	Setting recovery time	Measured recovery time	Remark
Over frequency	20-300s	70.2s	P
Under Frequency	20-300s	69.6s	P



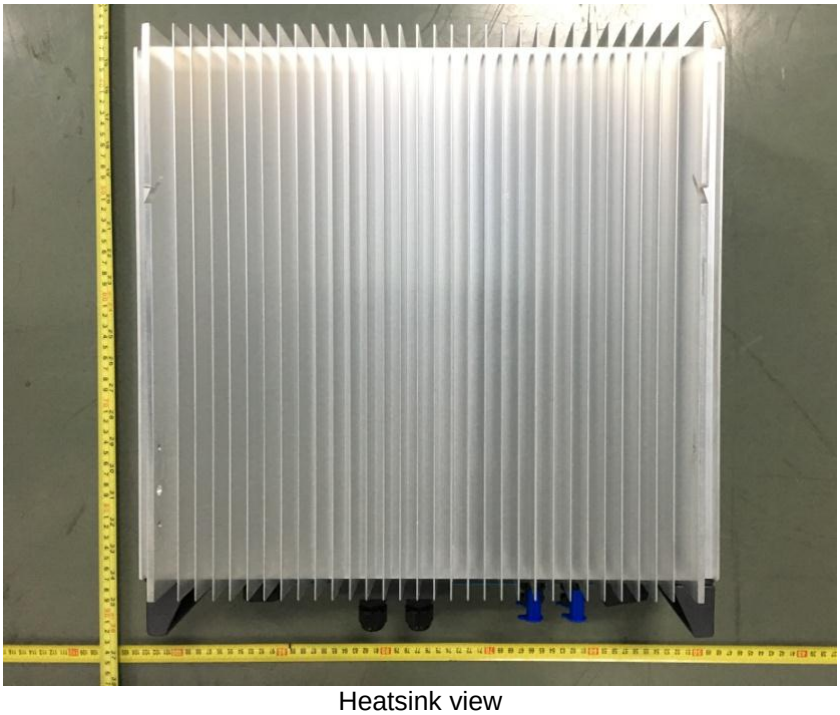
Recovery time of over frequency



Recovery time of under frequency

Appendix 2: Photos

Overview



Heatsink view

Appendix 2: Photos

Internal view for EVVO 12000TL3P、EVVO 10000TL3P、 EVVO 8000TL3P

Internal view for EVVO 3000TL3P, EVVO 4000TL3P, EVVO 4800TL3P , EVVO 5000TL3P, EVVO 6000TL3P

Appendix 2: Photos

Input/output terminal view