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

Report Number.....:	191012003GZU-001
Date of issue.....:	11 Nov., 2019
Total number of pages	20 Pages
Name of Testing Laboratory preparing the Report .....:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Applicant's name .....:	Hitachi Hi-Rel Power Electronics Pvt. Ltd.
Address.....:	SM 3 & 4, Sanand – II GIDC, Industrial Estate, Boll Village, Sanand – 382 110, Gujarat, India.
Test specification:	
Standard.....:	IEC 61727:2004
Test procedure .....:	Type approval
Non-standard test method .....:	N/A
Test Report Form No. .....:	IEC61727B
Test Report Form(s) Originator ....:	TÜV SÜD Product Service GmbH
Master TRF.....:	Dated 2017-11-03

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Test item description.....	Solar Grid Tied Inverter
Trade Mark	HITACHI
Manufacturer	Same as applicant
Model/Type reference	Hiverter Si-3.3K, Hiverter Si-4.4K, Hiverter Si-5K, Hiverter Si-5.5K, Hiverter Si-6.6K, Hiverter Si-8.8K, Hiverter Si-11K, Hiverter Si-12K

Ratings .....

MODEL	Hiverter Si-3.3K	Hiverter Si-4.4K	Hiverter Si-5K	Hiverter Si-5.5K	Hiverter Si-6.6K
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	Hiverter Si-8.8K	Hiverter Si-11K	Hiverter Si-12K
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		

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	**CB Testing Laboratory:**	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch	
Testing location/ address.....		Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China	
☐	**Associated CB Testing Laboratory:**	N/A	
Testing location/ address.....		N/A	
Tested by (name, function, signature).....		Tommy Zhong Technical Manager	Tommy
Approved by (name, function, signature).		Jason Fu Technical Team Leader	Jason Fu
☐	**Testing procedure: TMP/CTF Stage 1:**	N/A	
Testing location/ address.....		N/A	
Tested by (name, function, signature).....		N/A	
Approved by (name, function, signature).		N/A	
☐	**Testing procedure: WMT/CTF Stage 2:**	N/A	
Testing location/ address.....		N/A	
Tested by (name + signature).....		N/A	
Witnessed by (name, function, signature).....		N/A	
Approved by (name, function, signature).		N/A	
☐	**Testing procedure: SMT/CTF Stage 3 or 4:**	N/A	
Testing location/ address.....		N/A	
Tested by (name, function, signature).....		N/A	
Witnessed by (name, function, signature).....		N/A	
Approved by (name, function, signature).		N/A	
Supervised by (name, function, signature).....		N/A	

List of Attachments (including a total number of pages in each attachment): **N/A**	
Summary of testing:	
Tests performed (name of test and test clause): All applicable tests	**Testing location:** Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Summary of compliance with National Differences: **List of countries addressed** N/A ☒ **The product fulfils the requirements of IEC 61727:2004**	

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

HITACHI

Solar Grid Tied Inverter

Model No.	Hiverter Si-12K
Max. DC Input Voltage	1000V
Operating MPPT Voltage Range	160~960V
Max. Input Current	2x11A
Max. PV Isc	2x14A
Nominal Grid Voltage	3/N/PE,230/400V~
Max. Output Current	3x19.1A
Nominal Grid Frequency	50Hz/60Hz
Nominal Output Power	12000W
Max. Output Power	13200VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C ~+60°C
Protective Class	Class I

Hitachi Hi-Rel Power Electronics Pvt. Ltd.

Survey No. 3 & 4, Sanand GIDC - II, Industrial Estate, Nr. Bol Village, Chharodi, Sanand – 382110, Gujarat, India, www.hitachi-hirel.com

Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation
3. The other model labels are identical with label above, except the model name and rating.

Test item particulars.....:	
Classification of installation and use.....:	Fixed and outdoor use
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 .....:	12 Oct., 2019
Date (s) of performance of tests.....:	04 Nov., 2019

General remarks:

"(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 ☐ comma / ☒ point is used as the decimal separator.

This report is based on the report 170707054GZU-001, dated 11 Jul., 2017 Revision 1: 25 Sep., 2018 and changes the applicant, trade mark, product name and model name to apply for a new certificate. The model Hiverter Si-3.3K, Hiverter Si-4.4K, Hiverter Si-5K, Hiverter Si-5.5K, Hiverter Si-6.6K, Hiverter Si-8.8K, Hiverter Si-11K, Hiverter Si-12K in this report are same as the model SOFAR 3.3KTL-X, SOFAR 4.4KTL-X, SOFAR 5KTL-X, SOFAR 5.5KTL-X, SOFAR 6.6KTL-X, SOFAR 8.8KTL-X, SOFAR 11KTL-X, SOFAR 12KTL-X respectively in the report 170707054GZU-001, dated 11 Jul., 2017 Revision 1: 25 Sep., 2018, except the product name, model name and the trade Mark.

This report shall be used together with report No. 191012003GZU-002.

Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	☐ **Yes** ☒ **Not applicable**

When differences exist; they shall be identified in the General product information section.

Name and address of factory (ies) ..... :	Dongguan SOFAR SOLAR Co., Ltd. 1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City.

General product information:

Product covered by this report is grid-connected PV inverter for indoor or outdoor installation. The connections to the DC input and AC output are go through the terminals. 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	Hiverter Si-8.8K, Hiverter Si-11K, Hiverter Si-12K		Hiverter Si-3.3K, Hiverter Si-4.4K, Hiverter Si-5K, Hiverter Si-5.5K, Hiverter Si-6.6K	
Components	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 Hiverter Si-12K 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

IEC 61727:2004			
Clause	Requirement – Test	Result – Remark	Verdict
	All discussions regarding system voltage refer to the local nominal voltage		P
5.2.2	**Over / Under frequency**		P
	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

4.4	DC injection
Rated output load (W)	12000
Rated output current (Arms)	17.4A/phase
Measured DC current (A)	R: 9.2744mA S: 9.2780mA T: 3.8022mA
DC injection current (%)	R: 0.0486% S: 0.0486% T: 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	Hiverter Si-11K (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	Hiverter Si-11K (S 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	Hiverter Si-11K (T 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	Hiverter Si-12K (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	Hiverter Si-12K (S 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	Hiverter Si-12K (T phase)			
	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 Hiverter Si-4.4K)	P
Watts	4.020kW	
Vrms	230V	
Arms	R: 5.82A S: 5.83A T: 5.79A	
PF	0.9999	
Frequency	50.0Hz	

Harmonics	Harmonic current % of Fundamental			Harmonic Current Limits (%)
	Phase R	Phase S	Phase T	
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: Hiverter Si-12K	
Watts	11.993kW
Vrms	230V
Arms	R: 17.37A S: 17.35A T: 17.31A
PF	0.9999
Frequency	50.0Hz

Harmonics	Harmonic current % of Fundamental			Harmonic Current Limits (%)
	Phase R	Phase S	Phase T	
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%

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:				

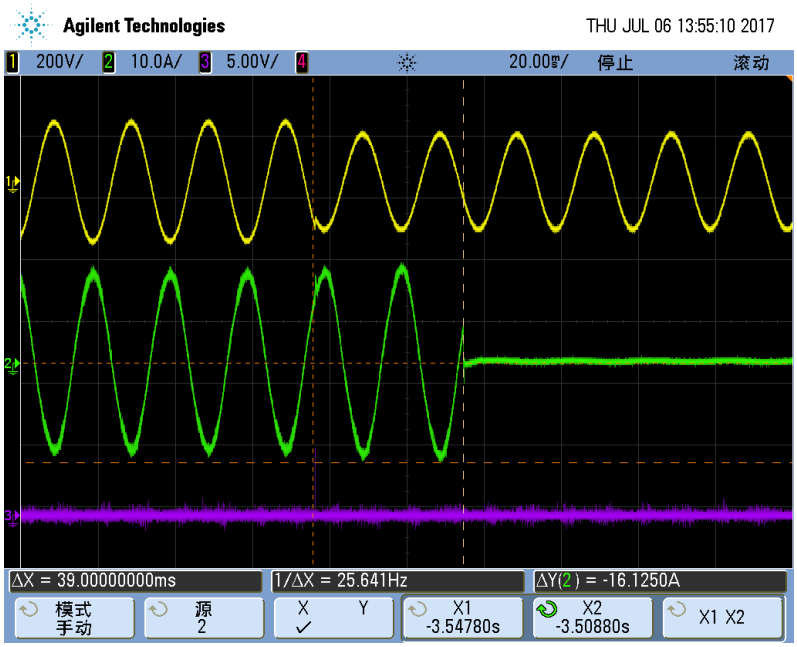
4.7	TABLE: Power Factor								P
Model	Hiverter Si-4.4K								
Output Power (%)	50	60	70	80	90	100			
Output Power Test Value (W)	660.07 668.05 663.47	796.61 805.09 799.31	928.11 939.03 933.47	1064.44 1075.29 1067.18	1196.83 1209.25 1200.63	1332.96 1344.96 1335.69			
Vrms (V)	230.34 230.33 23O.32	230.35 230.34 230.35	230.31 230.40 230.38	230.41 230.43 230.41	230.38 230.48 230.44	230.43 230.45 230.46			
Arms (A)	2.88 2.91 2.89	3.47 3.51 3.48	4.04 4.09 4.06	4.63 4.67 4.64	5.25 5.22 5.22	5.79 5.84 5.80			
Output Power test value (VA)	663.38 671.19 666.27	799.47 807.76 801.72	930.38 941.19 935.33	1066.44 1077.02 1068.77	1198.37 1210.66 1201.85	1333.61 1346.12 1336.77			
Power factor Limit lagging	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90			
Power factor	0.9950 0.9953 0.9958	0.9964 0.9967 0.9970	0.9976 0.9977 0.9980	0.9981 0.9984 0.9985	0.9987 0.9988 0.9989	0.9990 0.9991 0.9992			
Model	Hiverter Si-12K								
Output Power (%)	50	60	70	80	90	100			
Output Power Test Value (W)	1993.84 2008.73 1989.36	2395.17 2409.45 2391.03	2789.39 2807.65 2790.92	3189.41 3205.89 3188.47	3583.18 3605.93 3585.05	3999.89 4018.25 3997.21			
Vrms (V)	230.18 230.13 230.19	230.05 230.01 230.07	230.15 230.11 230.15	230.22 230.21 230.24	230.24 230.27 230.31	230.27 230.26 230.25			
Arms (A)	8.66 8.73 8.64	10.41 10.48 10.39	12.12 12.20 12.20	13.85 13.93 13.85	15.56 15.66 15.57	17.37 17.45 17.36			
Output Power test value (VA)	1993.85 2008.77 1989.43	2395.17 2409.47 2391.08	2789.39 2807.66 2790.95	3189.43 3205.95 3188.56	3583.18 3605.93 3585.09	3999.89 4018.28 3997.26			
Power factor Limit lagging	> 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			

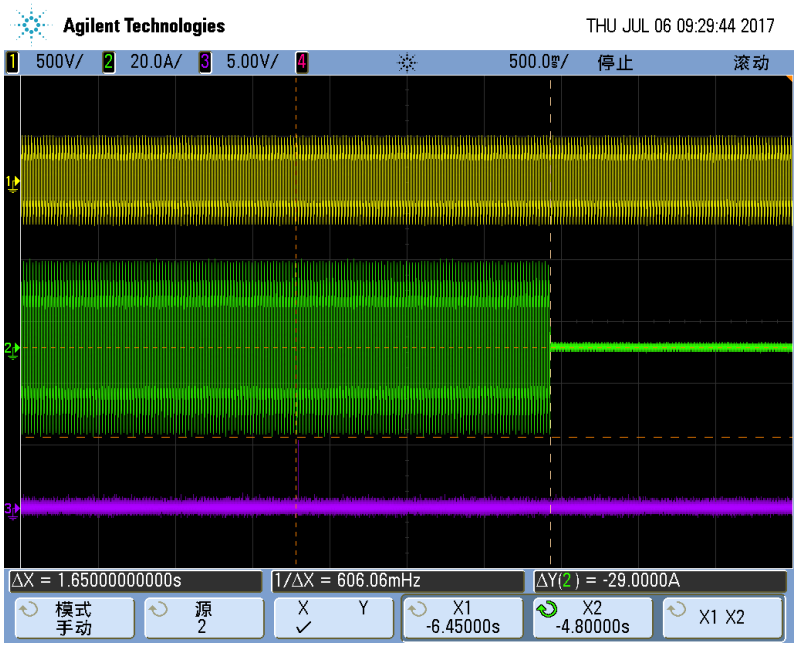
4. Test for Over/under voltage

Model: Hiverter Si-12K					
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 A:115V	114.21V	0,1s	38.4ms	P
	Phase B:115V	114.26V	0,1s	39.0ms	P
	Phase C:115V	114.51V	0,1s	38.5ms	P
50% ≤ V < 85%	All phase:195.5V	194.72V	2s	1.65s	P
	Phase A:195.5V	194.61V	2s	1.63s	P
	Phase B:195.5V	194.83V	2s	1.65s	P
	Phase C: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 A:254V	255.19V	2s	1.650s	P
	Phase B:254V	255.34V	2s	1.640s	P
	Phase C:254V	254.97V	2s	1.642s	P
135% ≤ V	All phase:310.5V	311.7V	0,05s	40.0ms	P
	Phase A: 310.5V	311.9V	0,05s	43.8ms	P
	Phase B:315.5V	311.8V	0,05s	32.0ms	P
	Phase C:315.5V	311.7V	0,05s	35.6ms	P

Appendix 1: Test tables

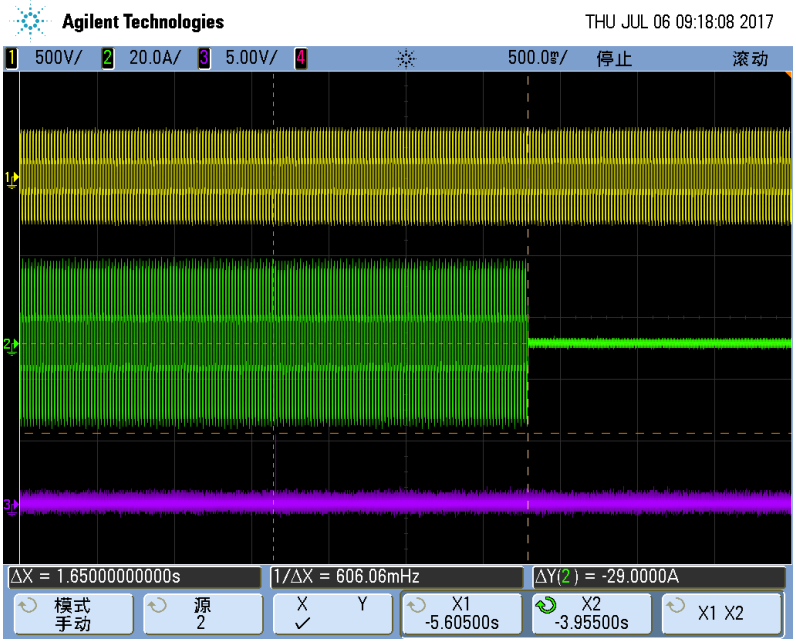


V < 0.5 x Vnominal

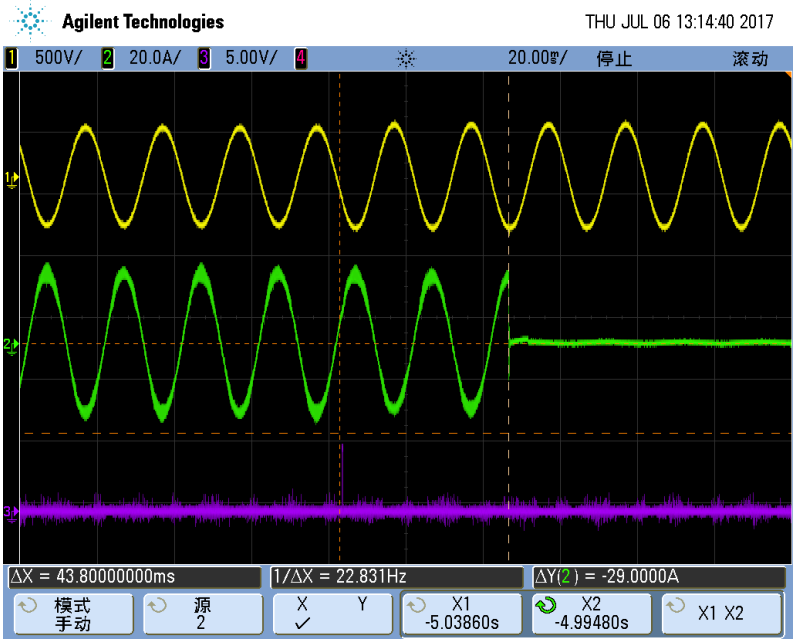


50% ≤ V < 85%

Appendix 1: Test tables



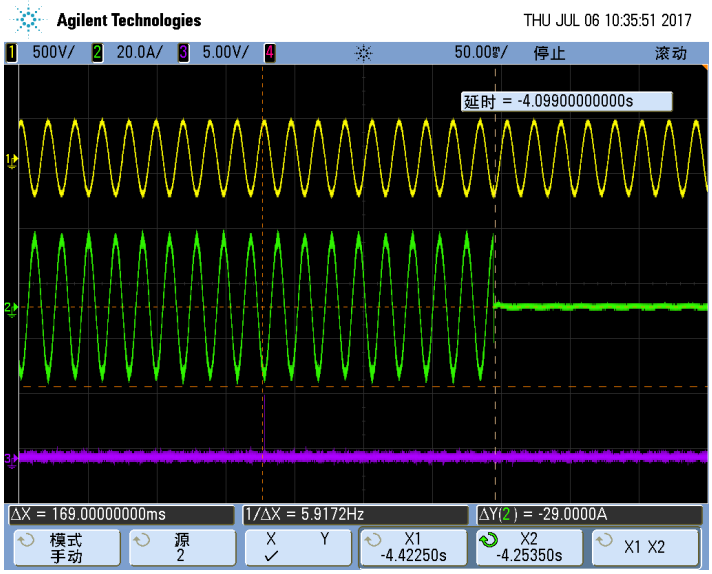
110% ≤ V < 135%



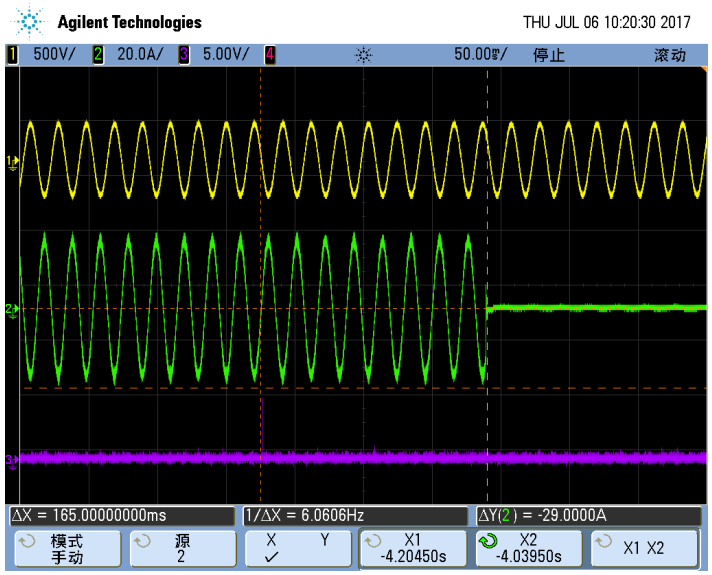
135% ≤ V

5. Test for Over/under frequency

Model: Hiverter Si-12K				
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

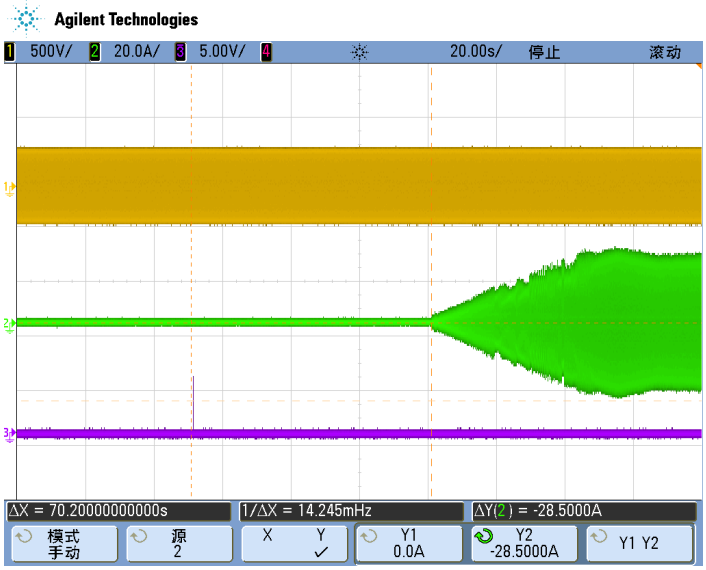


Under Frequency

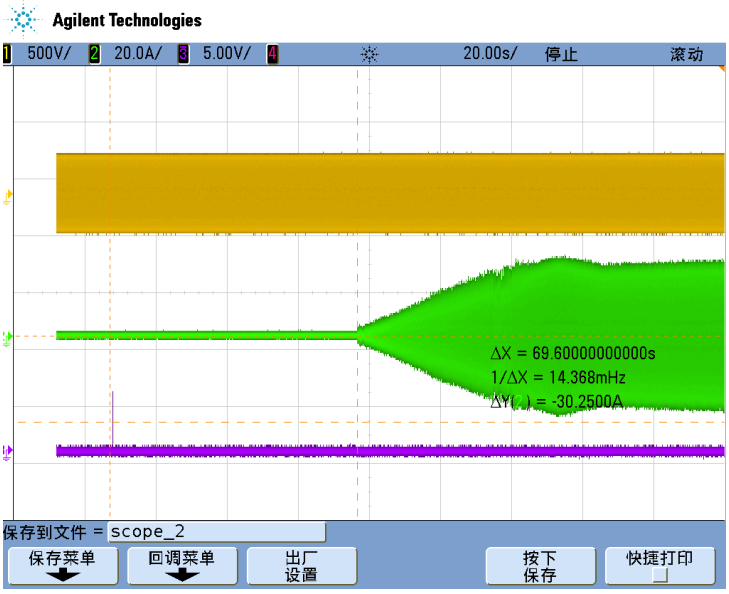
Appendix 1: Test tables

6. Test for Response to utility recovery

Model: Hiverter Si-12K			
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

--- End of test report---