แบบตรวจสอบและรับรองรายงานผลการทดสอบ
อินเวอร์เตอร์ที่ใช้ในระบบผลิตไฟฟ้าประเภทเชื่อมต่อกับระบบโครงข่ายไฟฟ้าของการไฟฟ้านครหลวง

ส่วนที่ 1 การรับรองรายงานผลการทดสอบอินเวอร์เตอร์

1.1 รายละเอียดของอินเวอร์เตอร์	
ยี่ห้อ	HYXiPOWER
รุ่น	HYX-S125K-T2
Firmware Version	V01.02.00.0F
พิกัดทางไฟฟ้า	125 kW
1.2 รายละเอียดของรายงานผลการทดสอบ	
หมายเลขรายงานผลการทดสอบ	LS2A25061803EGTH01
ออกเมื่อวันที่	2025-07-23
ชื่อสถาบันหรือหน่วยงานที่ออกรายงานผลการทดสอบอินเวอร์เตอร์	LYNS-TCI TECHNOLOGY GUANGDONG CO., LTD.
ที่อยู่สถาบันหรือหน่วยงานที่ออกรายงานผลการทดสอบอินเวอร์เตอร์	Room 1201. Unit 2. Building 18. No. 7. Science and Technology Boulevard. Houjie Town. Dongguan City. Guangdong. 523960 P.R.C
1.3 การรับรองรายงานผลการทดสอบ	
ข้าพเจ้าขอรับรองว่าข้อมูลที่กรอกในเอกสารฉบับนี้มีความถูกต้องเป็นจริงและได้ตรวจสอบพบว่าผลการทดสอบอินเวอร์เตอร์ตามรายงานในข้อ 1.2 เป็นไปตามข้อกำหนดสำหรับอินเวอร์เตอร์ที่ใช้ในระบบผลิตไฟฟ้าประเภทเชื่อมต่อกับระบบโครงข่ายไฟฟ้าของการไฟฟ้านครหลวงทุกประการ	
ชื่อหน่วยตรวจสอบและรับรองผลการทดสอบอินเวอร์เตอร์	ศูนย์ทดสอบผลิตภัณฑ์ไฟฟ้าและอิเล็กทรอนิกส์
ที่อยู่หน่วยตรวจสอบและรับรองผลการทดสอบอินเวอร์เตอร์	141 อาคารกลุ่มนวัตกรรม ตึก D อุทยานวิทยาศาสตร์ประเทศไทย ถนนพหลโยธิน ตำบลคลองหนึ่ง อำเภอคลองหลวง จังหวัดปทุมธานี 12120
วันที่ออกเอกสาร	25 กรกฎาคม 2568

ตรวจสอบและรับรองข้อมูลโดย	อนุมัติโดย
ลงชื่อ	ลงชื่อ .....
(นายเอกชัย เต๊ะสนู)	(นายเรืองฤทธิ์ หนิแหนะ)
ตำแหน่ง..วิศวกร	ตำแหน่ง.ผู้จัดการฝ่ายปฏิบัติการ
	หมายเหตุ: ผู้อนุมัติต้องเป็นหัวหน้าสูงสุดของหน่วยตรวจสอบและรับรองผล การทดสอบ หรือผู้ที่ได้รับมอบหมายให้ปฏิบัติงานแทน

ส่วนที่ 2 รายละเอียดผลการทดสอบอินเวอร์เตอร์

2.1 การทดสอบกระแสฮาร์มอนิก (Harmonic Current)								
Order	33% of output current		66% of output current		100% of output current		Limit (% of output current)	Result confirmation
	measured in Amp*	% of output current*	measured in Amp*	% of output current*	measured in Amp*	% of output current*		
2nd	0.114	0.063	0.154	0.085	0.176	0.097	≤ 1%	☑Pass☐ Fail
3rd	0.385	0.212	0.520	0.287	0.839	0.463	≤ 4%	☑Pass ☐Fail
4th	0.069	0.038	0.092	0.051	0.109	0.060	≤ 1%	☑Pass ☐Fail
5th	1.725	0.952	2.082	1.149	2.704	1.493	≤ 4%	☑Pass ☐Fail
6th	0.048	0.026	0.049	0.027	0.040	0.022	≤ 1%	☑Pass ☐Fail
7th	1.427	0.788	2.080	1.148	1.500	0.828	≤ 4%	☑Pass☐Fail
8th	0.031	0.017	0.054	0.030	0.043	0.024	≤ 1%	☑Pass ☐Fail
9th	0.326	0.180	0.156	0.086	0.704	0.389	≤ 4%	☑Pass ☐Fail
10th	0.056	0.031	0.052	0.029	0.063	0.035	≤ 1%	☑Pass ☐Fail
11th	0.484	0.267	0.920	0.508	1.229	0.679	≤ 2%	☑Pass ☐Fail
12th	0.053	0.029	0.035	0.019	0.072	0.040	≤ 0.5%	☑Pass ☐Fail
13th	0.359	0.198	0.894	0.494	1.369	0.756	≤2%	☑Pass ☐Fail
14th	0.042	0.023	0.047	0.026	0.045	0.025	≤ 0.5%	☑Pass ☐Fail
15th	0.383	0.212	0.365	0.201	0.390	0.215	≤ 2%	☑Pass ☐Fail
16th	0.027	0.015	0.033	0.018	0.054	0.030	≤ 0.5%	☑Pass ☐Fail
17th	0.374	0.206	0.522	0.288	0.952	0.526	≤ 1.5%	☑Pass ☐Fail
18th	0.030	0.016	0.025	0.014	0.045	0.025	≤ 0.375%	☑Pass ☐Fail
19th	0.459	0.253	0.505	0.279	0.857	0.473	≤ 1.5%	☑Pass ☐Fail
20th	0.020	0.011	0.037	0.020	0.054	0.030	≤ 0.375%	☑Pass ☐Fail
21st	0.711	0.392	0.550	0.304	0.239	0.132	≤ 1.5%	☑Pass ☐Fail
22nd	0.030	0.017	0.050	0.028	0.072	0.040	≤ 0.375%	☑Pass ☐Fail
23rd	0.455	0.251	0.465	0.257	0.813	0.449	≤ 0.6%	☑Pass ☐Fail
24th	0.025	0.014	0.039	0.021	0.032	0.017	≤ 0.15%	☑Pass ☐Fail
25th	0.505	0.279	0.406	0.224	0.667	0.368	≤ 0.6%	☑Pass ☐Fail
26th	0.015	0.009	0.064	0.035	0.052	0.029	≤ 0.15%	☑Pass ☐Fail
27th	0.569	0.314	0.428	0.236	0.223	0.123	≤ 0.6%	☑Pass ☐Fail
28th	0.039	0.022	0.063	0.035	0.081	0.044	≤ 0.15%	☑Pass ☐Fail
29th	0.333	0.184	0.230	0.127	0.531	0.293	≤ 0.6%	☑Pass ☐Fail
30th	0.022	0.012	0.018	0.010	0.033	0.018	≤ 0.15%	☑Pass ☐Fail
31st	0.264	0.146	0.245	0.135	0.370	0.204	≤ 0.6%	☑Pass ☐Fail

Order	33% of output current		66% of output current		100% of output current		Limit (% of output current)	Result confirmation
	measured in Amp*	% of output current*	measured in Amp*	% of output current*	measured in Amp*	% of output current*		
32nd	0.023	0.013	0.036	0.020	0.042	0.023	≤ 0.15%	☑Pass ☐Fail
33rd	0.230	0.127	0.308	0.170	0.478	0.264	≤ 0.6%	☑Pass ☐Fail
34th	0.021	0.011	0.031	0.017	0.046	0.026	≤ 0.15%	☑Pass ☐Fail
35th	0.090	0.049	0.186	0.102	0.346	0.191	≤ 0.3%	☑Pass ☐Fail
36th	0.036	0.020	0.019	0.011	0.026	0.014	≤ 0.075%	☑Pass ☐Fail
37th	0.103	0.057	0.158	0.087	0.313	0.173	≤ 0.3%	☑Pass ☐Fail
38th	0.029	0.016	0.032	0.018	0.039	0.022	≤ 0.075%	☑Pass ☐Fail
39th	0.477	0.263	0.473	0.261	0.518	0.286	≤ 0.3%	☑Pass ☐Fail
40th	0.028	0.016	0.046	0.025	0.047	0.026	≤ 0.075%	☑Pass ☐Fail
TRDi	--	1.517	--	1.952	--	2.304	≤ 5%	☑Pass ☐Fail

อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.1 หน้า : 18 - 19

หมายเหตุ* กรณีอินเวอร์เตอร์ชนิด3 เฟส ให้ระบุค่าสูงสุดที่ได้จากแต่ละเฟส

2.2 การทดสอบแรงดันกระเพื่อม (Voltage Fluctuation)

	Pst	Plt
Limit	≤ 1.0	≤ 0.65
Test results	0.05	0.04
Result confirmation	☑Pass ☐Fail	☑Pass ☐Fail

อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.2 หน้า : 20-21

2.3 การทดสอบการจ่ายไฟฟ้ากระแสตรง (Direct Current)

Test level	33% of rated output current	66% of rated output current	100% of rated output current
Limit (% of rated output current)	≤ 0.5%	≤ 0.5%	≤ 0.5%
Test results* (% of rated output current)	0.206	0.313	0.353
Result confirmation	☑Pass ☐Fail	☑Pass ☐Fail	☑Pass ☐Fail

อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.3 หน้า: 22

หมายเหตุ * กรณีอินเวอร์เตอร์ชนิด 3 เฟส ให้ระบุค่าสูงสุดที่ได้จากแต่ละเฟส

2.4 การทดสอบช่วงความถี่ทำงาน (Operating Frequency Range)					
	Actual Trip Setting		Test Result	Limit	Result confirmation
	Frequency (Hz)	Trip Time (sec)	Trip Time* (sec)	Time Delay (sec)	
Under frequency	46.99	0.1	0.096	≤ 0.1	☑ Pass ☐ Fail
Over frequency	52.01	0.1	0.062	≤ 0.1	☑ Pass ☐ Fail
อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.5 หน้า: 30-31					
หมายเหตุ* ให้ระบุค่าสูงสุดที่ได้จากการทดสอบ					

2.5 การทดสอบช่วงแรงดันการทำงาน (Operating Voltage Range)						
☑ Grid-connected inverter which connected to the grid at low voltage (230/400V) (1)						
	Actual Setting			Result	Limit	Result confirmation
	☑ V_{L-N}setting(2) (V)	☐ V_{L-L}setting(2) (V)	Time Delay (sec)	Time Delay(3) (sec)	Time Delay (sec)	
Undervoltage level 2(4)	☑ 114 or ☐.....	☐ 198 or ☐.....	0.1	0.097	≤ 0.1	☑ Pass ☐ Fail
Undervoltage level 1	199	345	2.0	1.997	≤ 2	☑ Pass ☐ Fail
Overvoltage level 1	241	417	2.0	1.952	≤ 2	☑ Pass ☐ Fail
Overvoltage level 2(4)	☐ 311 or ☑..276..	☐ 539 or ☐.....	0.05	0.049	≤ 0.05	☑ Pass ☐ Fail
☐ Grid-connected inverter which connected to the grid at voltage ≥ 12kV(1)						
	Actual Setting			Result	Limit	Result confirmation
	V setting (%of rated output voltage)		Time Delay (sec)	Time Delay(3) (sec)	Time Delay (sec)	
Undervoltage level 2(4)	☐ 50% or ☐.....%		0.1		≤ 0.1	☐ Pass ☐ Fail
Undervoltage level 1	85%		2.0		≤ 2	☐ Pass ☐ Fail
Overvoltage level 1	110%		2.0		≤ 2	☐ Pass ☐ Fail
Overvoltage level 2(4)	☐135% or ☐.....%		0.05		≤ 0.05	☐ Pass ☐ Fail
อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.4 หน้า: 23-29						

Note(1) Select MEA's voltage level where grid-connected inverter connected to.
(2) Select between line-neutral or line-line voltage test based on the actual operation of inverter.
(3) Insert maximum value recorded during test.
(4) If inverter cannot be adjusted for overvoltage and/or undervoltage trip setting as per MEA's grid-connected Inverter regulation. it shall be adjusted the overvoltage or undervoltage trip setting to the maximum and/or minimum voltage that inverter can be set.

2.6 การทดสอบการป้องกันสภาวะไอส์แลนดิ่ง (Islanding Protection)									
Item	Test Condition C			Test Condition B			Test Condition A		
	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on Time (sec) (Limit ≤ 2 sec)	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on Time (sec) (Limit ≤ 2 sec)	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on Time (sec) (Limit ≤ 2 sec)
1	0	0	0.147	0	0	0.188	0	0	0.254
2	0	-5	0.124	0	-5	0.144	-10	-10	-
3	0	-4	0.145	0	-4	0.154	-10	-5	-
4	0	-3	0.140	0	-3	0.192	-10	0	-
5	0	-2	0.140	0	-2	0.205	-10	+5	-
6	0	-1	0.137	0	-1	0.194	-10	+10	-
7	0	1	0.149	0	1	0.203	-5	-10	-
8	0	2	0.146	0	2	0.168	-5	-5	0.150
9	0	3	0.130	0	3	0.186	-5	0	0.151
10	0	4	0.156	0	4	0.293	-5	+5	0.159
11	0	5	0.148	0	5	0.171	-5	+10	-
12							0	-10	-
13							0	-5	0.157
14							0	+5	0.238
15							0	+10	-
16							+5	-10	-
17							+5	-5	0.239
18							+5	0	0.153
19							+5	+5	0.151
20							+5	+10	-
21							+10	-10	-
22							+10	-5	-
23							+10	0	-
24							+10	+5	-
25							+10	+10	-
Result confirmation	☑ Pass ☐ Fail			☑ Pass ☐ Fail			☑ Pass ☐ Fail		
อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.6 หน้า : 32-36									

2.7 การทดสอบการเชื่อมต่อหลังไฟฟ้ากลับคืน (Power Recovery Response)					
	Actual Setting (sec)	Test Result (sec) (Limit ≥120)	Compliance with clause 5.10.2(c) of IEEE std1547.1-2005(1)	Compliance with clause 5.10.2(g) of IEEE std1547.1-2005(2)	Result confirmation
Under frequency	120	133	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Over frequency	120	141	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Under voltage level 2	120	152	☑Yes ☐No	☑Yes ☐No	☑Pas s☐Fail
Under voltage level 1	120	141	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Over voltage level 1	120	138	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Over voltage level 2	120	138	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.7 หน้า: 37-40					

Note (1) Adjust the voltage so that it is beyond the reconnect voltage by twice the manufacturer's stated tolerance. The simulated area EPS voltage source shall maintain the abnormal voltage for two times the reconnect time delay. Verify that the EUT does not reenergize the simulated area EPS.

(2) To verify that the timer resets for additional voltage excursions within the reconnect time. retest with an abnormal voltage step-change event that is introduced during the reconnect countdown period. While the unit is counting down to reconnect. step the voltage to a value 5% outside of the manufacturer's specified normal operating voltage for the trip time setting plus twice the manufacturer's stated timer accuracy. and then return to the normal operating voltage. The unit shall restart its reconnect timer and not reconnect until the grid voltage has been within the specified range for the specified reconnect time.

2.8 การตรวจสอบสถาบันหรือหน่วยงานที่ออกรายงานผลการทดสอบอินเวอร์เตอร์	
รายละเอียด	Result confirmation
☐ อินเวอร์เตอร์ผ่านการทดสอบจากสถาบันหรือหน่วยงานทดสอบที่เป็นกลางภายในประเทศ.ซึ่งได้รับการรับรองห้องปฏิบัติการทดสอบตามมาตรฐานมอก. 17025 (สำหรับอินเวอร์เตอร์) จากสำนักงานคณะกรรมการแห่งชาติว่าด้วยการรับรองระบบงาน.หรือได้รับการตรวจสอบและยอมรับจากการไฟฟ้านครหลวง.	☑ Pass ☐ Fail
☑ อินเวอร์เตอร์ผ่านการทดสอบจากสถาบันหรือหน่วยงานทดสอบที่เป็นกลางในต่างประเทศ.ซึ่งได้รับการรับรองห้องปฏิบัติการทดสอบตามมาตรฐาน ISO/IEC 17025 (สำหรับอินเวอร์เตอร์) จากหน่วยงานระดับชาติที่มีหน้าที่เทียบเคียงกันกับ.สำนักงานคณะกรรมการแห่งชาติว่าด้วยการรับรองระบบงาน.และอยู่ในทะเบียนขององค์กรความร่วมมือระหว่างประเทศว่าด้วยการรับรองห้องปฏิบัติการ (International Laboratory Accreditation Cooperation. ILAC)	

LYNS-TCi

TEST REPORT

MEA (2015)

Grid-connected inverter regulations of the Metropolitan Electricity Authority

Zhejiang Hyxi Technology Co., Ltd.

For the unit(s) **HYX-S125K-T2**

Test report no. **LS2A25061803EGTH01**

Date **2025-07-23**

ilac-MRA ACCREDITED Certificate # 5200.02

Lyns-tci Technology Guangdong Co., Ltd.
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Test report number.....:	**LS2A25061803EGTH01**
Date of issue.....:.....	2025-07-23
Total number of pages.....:.....	43
Testing laboratory .....:	**LYNS-TCI TECHNOLOGY GUANGDONG CO., LTD.**
Address.....:	Room 1201, Unit 2, Building 18, No. 7, Science and Technology Boulevard, Houjie Town, Dongguan City, Guangdong, 523960 P.R. China
Testing location.....:	**Same as above**
Address.....:	Same as above
Applicant's name .....:	**Zhejiang Hyxi Technology Co., Ltd.**
Address.....:	Room 216, Block A, Building 1, No. 57 Jiang'er Road, Changhe Street, Binjiang District, Hangzhou, Zhejiang,China
Test specification	
Standard .....:	**MEA (2015)** Grid-connected inverter regulations of the Metropolitan Electricity Authority
Test report form number.....:	MEA_v2.0
Test report form(s) originator.....:	LYNS-TCI TECHNOLOGY GUANGDONG CO., LTD.
Master TRF .....:	Dated 2025-05-28
Test item description.....:	Device Category: **Inverter** Device Type: **Three Phase String Inverter**
Trademark .....:	HYXiPOWER
Model / Type reference.....:	HYX-S125K-T2
Technical data .....:	See section 3.1 on p.6
Dates of testing.....:	2025-06-18 to 2025-07-07

Tested / Report prepared by

Biscuit Ren (Project engineer)

Approved by

Lukes Lin (Project manager)

Contents

1 General information of test report

1.1 Important Note

General disclaimer

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

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Information on derived or extended models of the range as provided by the applicant (if any) is included in this report for information purposes only. LYNS shall not be liable for any incorrect results due to unclear, incorrect, incomplete, misleading or false information provided by client.

1.2 Revision history

Report version	Date	Editor	Modification / Change	Status
LS2A25061803EGTH01	2025-07-23	Biscuit Ren	Initial report was written	Active

2 General remarks for documentation

The test results presented in this report relate only to the object(**s**) tested.

Throughout this report a ☒ comma ',' / ☐ point '.' is used as decimal separator and a ☒ point '.' / ☐ comma ',' as thousands separator.

The following **suffixes/indices** are used for variables in tables and figures:

n	Nominal value
max	Maximum value
Lx	index of phase x
LxLy	phase-to-phase voltages of phase x and phase y

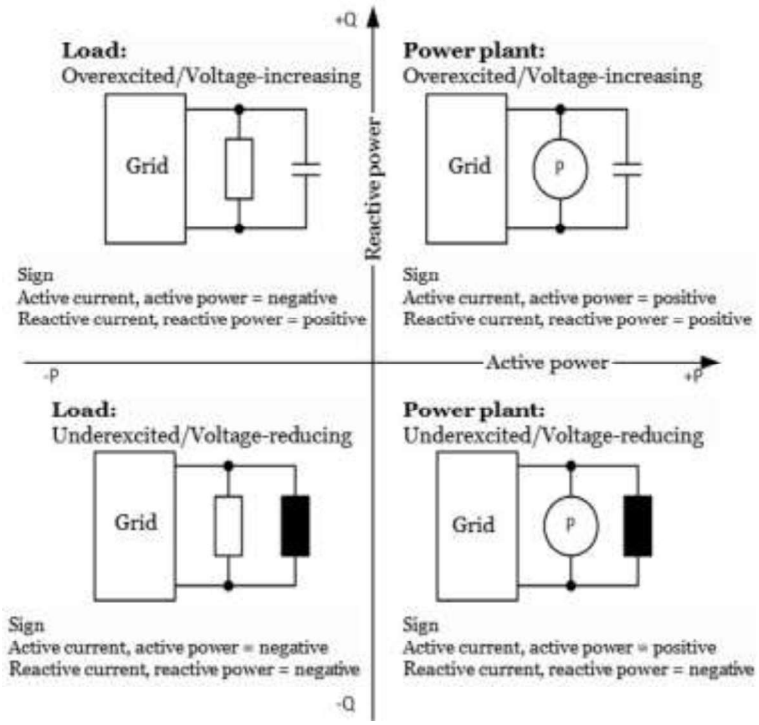
Abbreviations

AC	:	Alternating Current
DC	:	Direct Current
EUT	:	Equipment Under Test
LV	:	Low Voltage
MP	:	Measurement Point
MPP	:	Maximum Power Point
MV	:	Medium Voltage
PGU	:	Power Generating Unit
PWHD	:	Partial Weighted Harmonic Distortion
THD	:	Total Harmonic Distortion
PWHD	:	Partial Weighted Harmonic Distortion

Direction definition of P and Q

in this test report, the regarded system of the voltage and current vectors is the active sign convention system:

- If the inverter feeds to the grid the active power is measured with positive sign.
- If the inverter injects reactive power / current with leading power factor the reactive power / current is marked “leading” or “inductive” (under-excited) or has a negative sign.
- If the inverter injects reactive power / current with lagging power factor the reactive power / current is marked “lagging” or “capacitive” (over-excited) or has a positive sign.



3 General product information

Factory's name ..... : DBG (Jiaxing) Technology Electronics Co, Ltd.

Factory address ..... : Building A, No. 148, Tianshu Road, Jiaxing Economic and Technology Development Zone, Jiaxing City, Zhejiang,P. R. China

3.1 Technical data of the unit(s)

Unit / Type ..... :	**HYX-S125K-T2**
Hardware version (tested) ..... :	V1.0
Software version (tested) ..... :	V01.02.00.0F
DC input (PV)	
Max. DC input voltage [V]..... :	1100
Operating MPPT voltage range [V]..... :	140 ~ 1000
Max.Input DC current (per MPPT) [A] ... :	40
AC connection	
Nominal output AC voltage [V] ..... :	3L/N/PE 220/230(phase-neutral) 380/400(phase-phase)
Output AC current [A] ..... :	max. 180,4
AC output frequency [Hz] ..... :	50/60
Nominal active output power P_n [kW] .... :	125,0
Max. apparent power [kVA] ..... :	125,0
Note: All test items are carried out at 230V, 50Hz.	

Equipment mobility ..... : Permanent connection

Operating condition..... : Continuous

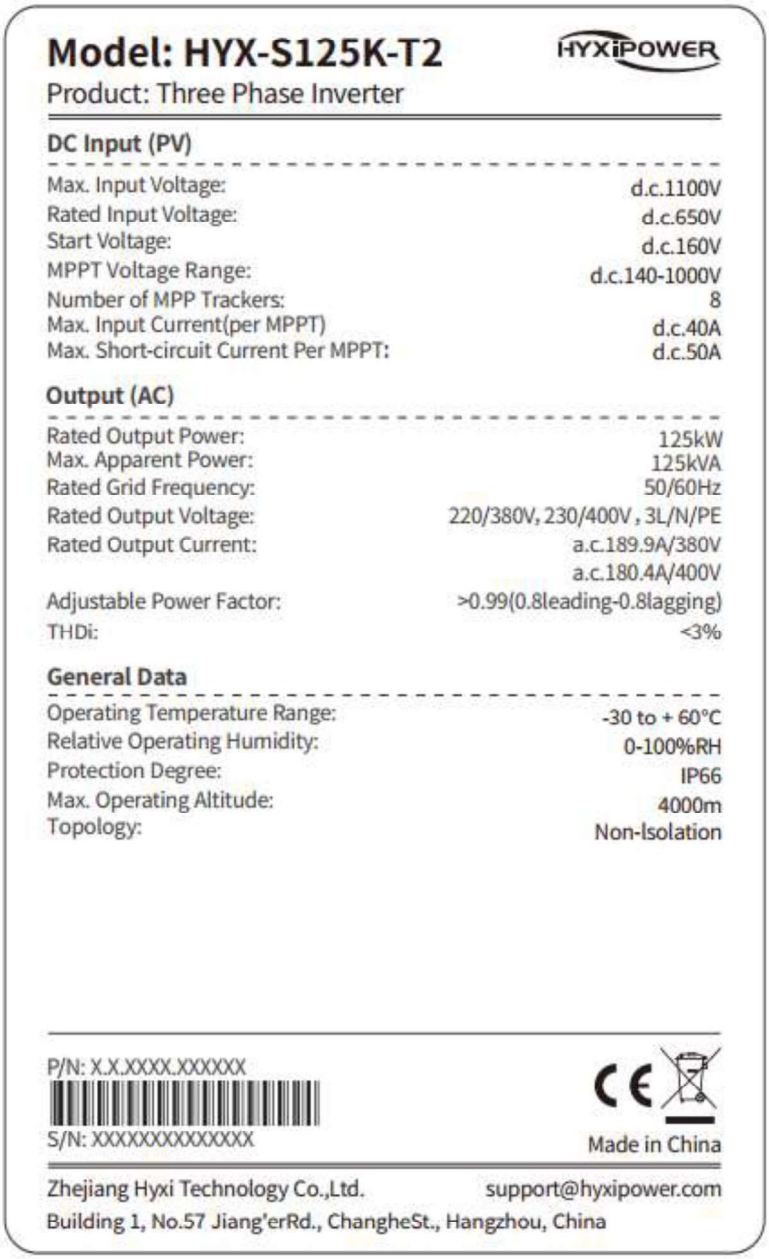
Class of equipment..... : Class I

Protection against ingress of water ..... : IP66

Mass of equipment [kg] ..... : 93

Type of internal transformer ..... : No internal transformer (transformerless)

3.2 Copy of marking plate



Note:

The marking plates shown above may be only a draft. The use of certification marks on products must be approved by the respective NCBs to which these marks belong.

The marking plate is attached to the side surface or the back of the enclosure and is visible after installation.

3.3 Description of the power circuit

The unit's input and output are protected by varistors to ground. The unit is providing EMI filtering at the input and output of the batteries to the mains. The unit does not offer galvanic separation from input to output (transformerless).

The output is redundantly switched off by the high-power switching bridge and two relays in series. When a single fault is applied to one relay, another redundant relay provides basic isolation maintained between the battery and the mains. All relays are tested before each start.

The internal control is redundant. It consists of a master controller (U5) and a slave controller (U8).

The main controller (U5) controls the relays with switching signals; measures DC voltage, DC current, bus voltage, AC voltage, AC frequency, AC current injected into DC, and insulation resistance of the matrix to ground. It also tests the current sensors and RCMU circuits before each startup.

The slave controller (U8) measures the mains voltage, mains frequency and residual current, can also switch off the relays independently, and communicates with the master controller (U5).

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Master controller (U5). The master controller (U5) tests and calibrates all the current sensors before each start-up.

The unit provides two relays in series on all output conductors.

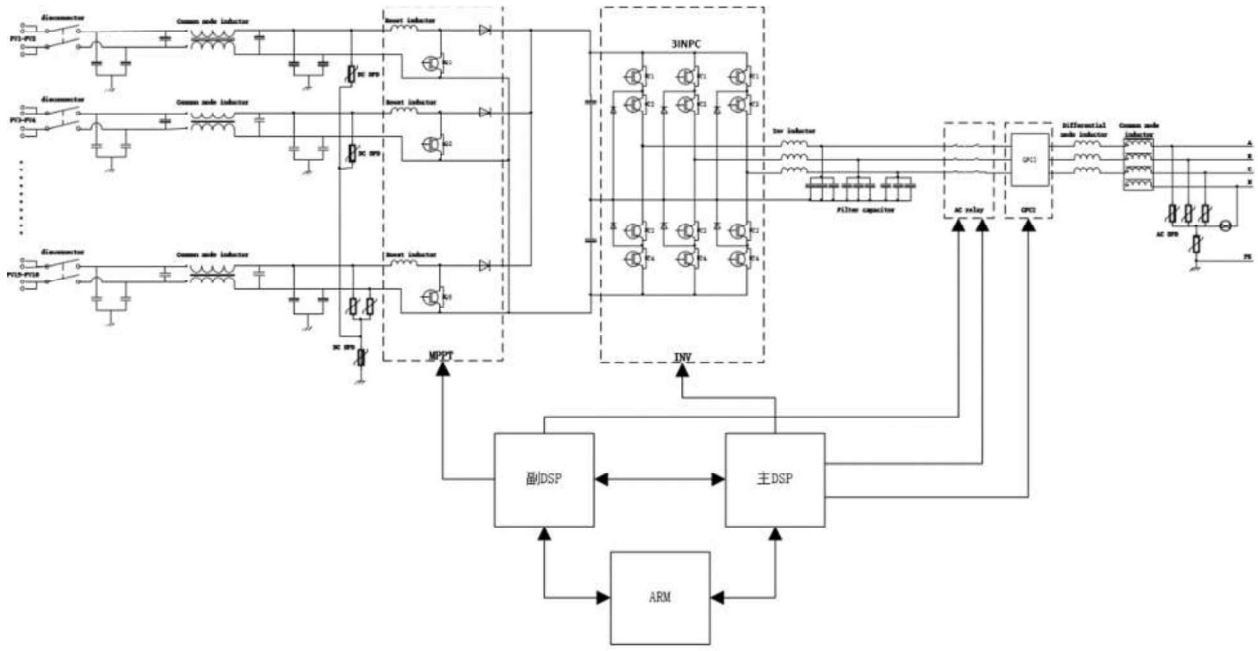


Figure 1 – Block diagram of the power circuit

4 General remarks for testing

4.1 Scope of measurements

Date of receipt of test items ..... : 2025-06-18

Date(s) of performance of tests ..... : 2025-06-18 to 2025-07-07

During the test period stated above following environmental data were recorded:

- Temperature: 25.4°C
- Rel. humidity: 48.9%RH
- Air pressure: 998.0 hPa

Provincial Electricity Authority's Regulation on the Power Network System Interconnection Code B.E.2559 (2016)				
Clause & Requirements	**Section in this report**	**Standard Reference**		**Tests completed**
		Test procedure	**Assessment criteria**	
3.1.1 Harmonic	6.1	IEEE Std 1547.1-2005	MEA	☒
3.1.2 Voltage Fluctuation	6.2	IEC 61000-3-5 IEC 61400-21	IEC 61000-3-5	☒
3.1.3 Direction Current Injection	6.3	IEEE Std 1547.1-2005	MEA	☒
3.2.1 Operating Voltage Range	6.4	MEA	MEA	☒
3.2.2 Operating Frequency Range	6.5	MEA	MEA	☒
3.2.3 Islanding Protection	6.6	IEC 62116:2014	MEA	☒
3.2.4 Response to Utility Recovery	6.7	IEEE Std 1547.1-2005	MEA	☒

Note:

The products were tested on:

- **HYX-S125K-T2**
  - Serial No.: 20302252000077
  - Hardware Version: V1.0
  - Software Version: V01.02.00.0F

- **Interface protection settings**
  (according to Grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA:2015)

☒ Table 1 Grid-connected inverter which connected to the grid at low voltage (230/400V)

Parameter	Max. clearance time *	Trip setting **	
		Line to neutral	Line to Line
Over voltage (level 2)	0.05s	311 V***	540 V***
Over voltage (level 1)	2.0s	241 V	417 V
Under voltage (level 1)	2.0s	199 V	345 V
Under voltage (level 2)	0.1s	114 V	198 V
Over frequency	0.1s	51 Hz	
Under frequency	0.1s	47 Hz	
Reconnection time	≥ 120s		
Permanent DC-injection	0.5% of rated current of the converter		
Loss of main IEC 62116:2014	Inverter shall detect and disconnect within 0.3s		

* Trip time refers to the time between the abnormal condition occurring and the inverter ceasing to energize the utility line. The power conversion system control circuits shall remain connected to the utility to allow sensing of utility electrical conditions for use by the “reconnect” feature.

** The phase - to- neutral voltages are monitored by the PGU integrated protection relay.

*** If inverter cannot be adjusted for overvoltage trip setting and/or undervoltage trip setting up to the specified value, it shall be adjusted the overvoltage trip setting and/or undervoltage trip setting to the maximum voltage and/or minimum voltage that inverter can be set.

☐ Table 2 Grid-connected inverter which connected to the grid at voltage ≥ 12kV

Parameter	Max. clearance time *	Trip setting **
Over voltage (level 2)	0.05s	230V + 35% V (310.5 V)***
Over voltage (level 1)	2.0s	230 V + 10% V 253.0 V
Under voltage (level 1)	2.0s	230 V – 15% V 195.5 V
Under voltage (level 2)	0.1s	230 V - 50% V 115.0 V
Over frequency	0.1s	51 Hz
Under frequency	0.1s	47 Hz
Reconnection time	≥ 120s	
Permanent DC-injection	0.5% of rated current of the converter	
Loss of main IEC 62116:2014	Inverter shall detect and disconnect within 0.3s	

* Trip time refers to the time between the abnormal condition occurring and the inverter ceasing to energize the utility line. The power conversion system control circuits shall remain connected to the utility to allow sensing of utility electrical conditions for use by the “reconnect” feature.

** The phase - to- phase voltages are monitored by the PGU integrated protection relay.

*** If inverter cannot be adjusted for overvoltage trip setting and/or undervoltage trip setting up to the specified value, it shall be adjusted the overvoltage trip setting and/or undervoltage trip setting to the maximum voltage and/or minimum voltage that inverter can be set.

- Measurement done at output terminals of the EUT, see Figure 3 and Figure 4.

4.2 Reference values

Reference values for the p.u. or percentage calculations:

	HYX-S125K-T2
Rated power P_n [kW]	125,0
Rated voltage (Phase-to-neutral), U_n [V]	230
Rated current, I_n [A]	181,16

4.3 Measurement setup

Tests documented in this test report were performed using the following test configuration:

- ☐ Measurements in the field on real grid
- ☐ Test bench tests on real grid
- ☒ Test bench tests on an AC grid simulator

The PGU is connected on the DC-side to a PV-simulator and on the AC-side to an AC-grid simulator. The AC-grid simulator is operated with nominal conditions of Un = 220V (phase-to- neutral) and fn = 50 Hz unless stated otherwise by the applied test requirement.

Available primary power is modified by adapting the short circuit current (I) value of the I-V curve. Following example shows a PV-curve (I = 207,692A, Uoc = 764,35 V) simulated according to EN50530:

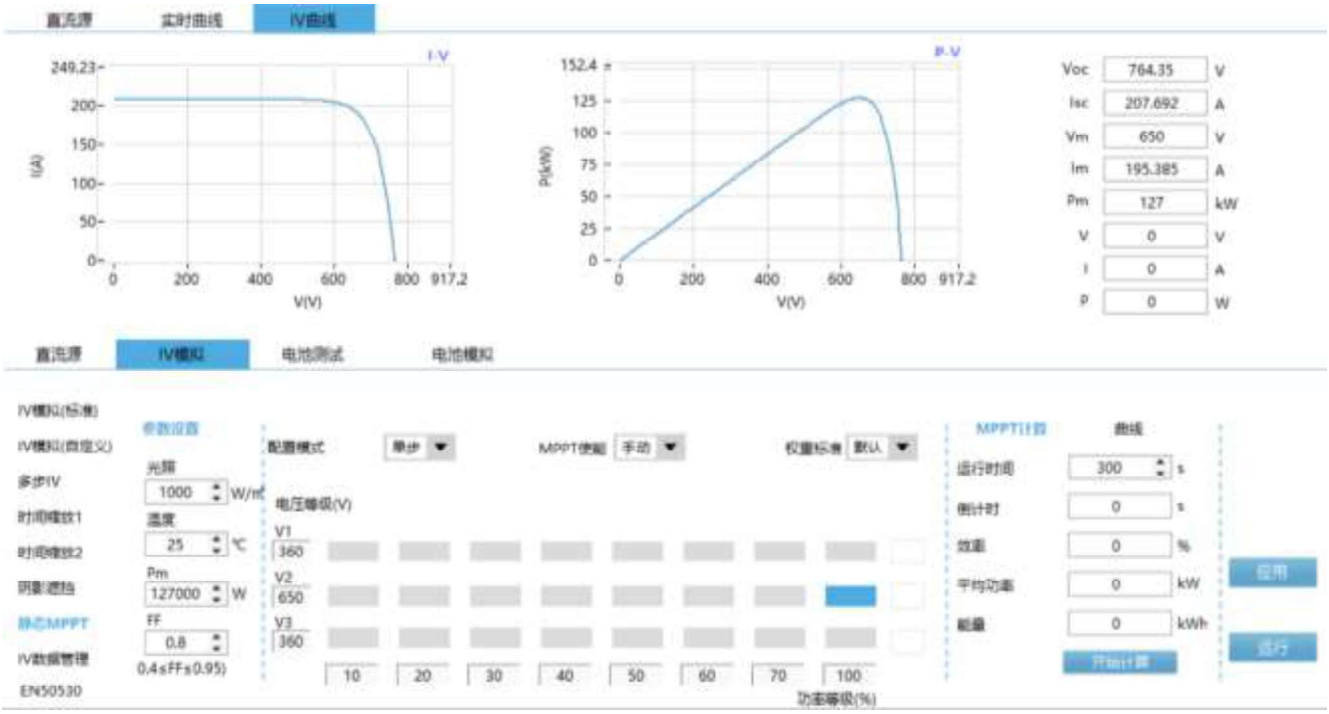


Figure 2 – DC characteristics for testing

The measurement setups are shown in Figure 3 and Figure 4.The specific test and measurement devices are stated in section 4.4.

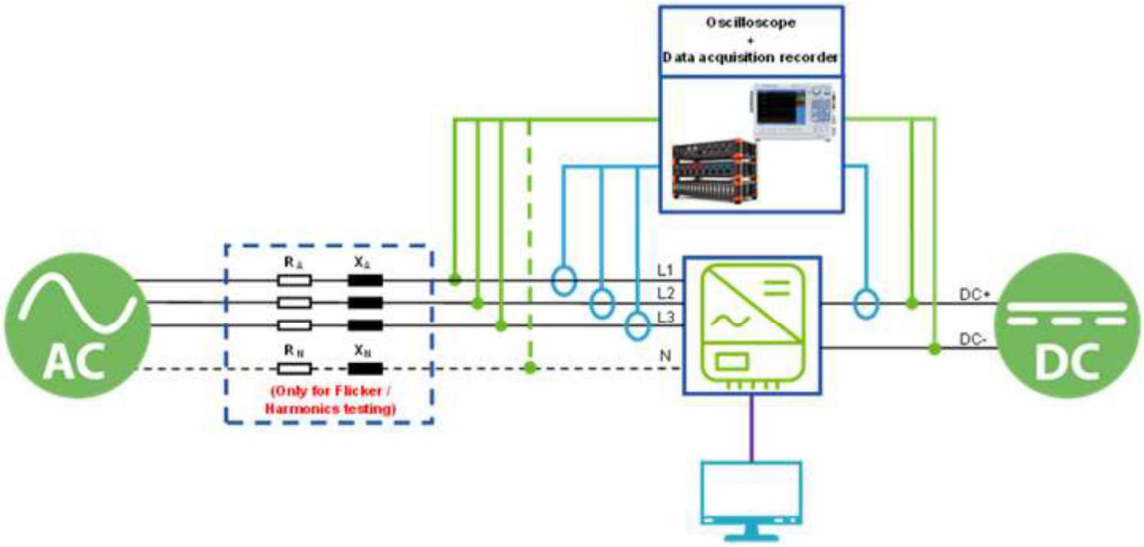


Figure 3 – Measurement setup used for Three-phase tests except Loss of Mains and Short Circuit test

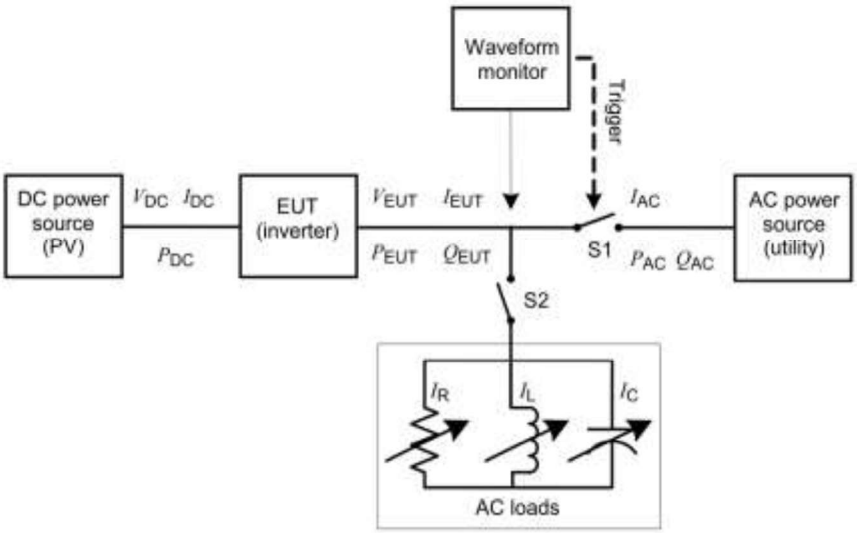


Figure 4–Test circuit for Loss of Mains according to *IEC 62116:2014*

4.4 Measurement equipment

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
DC source	HC-ENG-043	KEWELL	S7000-21K-2000-0040	6018888221003326	Monitored by Power Analyzer
	HC-ENG-044	KEWELL	S7000-21K-2000-0040	6018888221003320	
	HC-ENG-049	KEWELL	S7000-21K-2000-0040	6018888221201709	
	HC-ENG-050	KEWELL	S7000-21K-2000-0040	6018888221201708	
	HC-ENG-051	KEWELL	S7000-21K-2000-0040	6018888220400688	
	HC-ENG-052	KEWELL	S7000-21K-2000-0040	6018888220400696	
	HC-ENG-053	KEWELL	S7000-21K-2000-0040	6018888220501273	
AC source	HC-ENG-030	Kewell	KAC-45-345-33	6018888220300485	
	HC-ENG-038	Kewell	KAC-45-345-33	6018888220903208	
	HC-ENG-039	Kewell	KAC-45-345-33	6018888220903207	
	HC-ENG-040	Kewell	KAC-45-345-33	6018888220903255	
Load	HC-ENG-058	HuaChuang	IMAX3312-200KW	20230325002	
Data acquisition instrument	HC-ENG-047	DEWETRON	TRION-1820-POWER	A1222045/ C5220854	2026-03-20
Current sensor		SIGNALTEC	CT 400	1222140764	
		SIGNALTEC	CT 400	1222140765	
		SIGNALTEC	CT 400	1222140766	
		SIGNALTEC	CT 400	1222140767	

Note:

All measurement equipment was used within the calibration period. Copy of calibration certificates are available at the laboratory for reference.

5 Assessment overview

Possible test case verdicts:

Test item does meet the requirement.....: P (Pass)

Test item does not meet the requirement....: F (Fail)

Test case does not apply to the test object...: N/A

Test case is not rated .....: N/R

Reference to declaration documents.....: R/D

<table>
<tr><th colspan="4">Grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA:2015)</th></tr>
<tr><th>Clause/§</th><th>Technical requirements (MEA:2015)</th><th>Remark</th><th>Verdict</th></tr>
<tr><td>3.1</td><td>Power Quality Control</td><td></td><td>P</td></tr>
<tr><td>3.1.1</td><td>Harmonics
When the inverter is supplying power to balanced linear loads, it shall not generate harmonic currents into the power networks exceeding the following limits (expressed as percentage relative to rated current of inverter).
<table>
<tr><th>Odd Order</th><th>Current limit (%)</th><th></th><th>Even Order</th><th>Current limit (%)</th></tr>
<tr><td>3 - 9</td><td>4.0</td><td></td><td>2 - 10</td><td>1.0</td></tr>
<tr><td>11 - 15</td><td>2.0</td><td></td><td>12 - 16</td><td>0.5</td></tr>
<tr><td>17 - 21</td><td>1.5</td><td></td><td>18 - 22</td><td>0.375</td></tr>
<tr><td>23 - 33</td><td>0.6</td><td></td><td>24 - 34</td><td>0.15</td></tr>
<tr><td>≥ 35</td><td>0.3</td><td></td><td>≥ 36</td><td>0.075</td></tr>
<tr><td colspan="5">Total harmonic current distortion (THDi) 5.0 %</td></tr>
</table></td><td>Total harmonic distortion and individual harmonics of current are within the in MEA (2015) given limits.

Test results see 6.1</td><td>P</td></tr>
<tr><td>3.1.2</td><td>Voltage Fluctuation
Inverters shall not cause voltage fluctuation beyond the limits defined by the IEC 61000-3-3 (2008) for inverters with rated current ≤ 16 A or IEC 61000-3-5 (2009) for inverters with rated currents greater than 75 A or IEC 61000-3-11 (2000) for inverters with rated currents ≤ 75 A.</td><td>Requirements according to IEC 61000-3-5 given limits.

Test results see 6.2</td><td>P</td></tr>
<tr><td>3.1.3</td><td>Direct Current Injection
Inverters shall not generate a direct current injection into the power network more than 0.5% of the rated current of the inverter.</td><td>The overall max. DC Injection of the unit is lower than the required limit (0.5%I_n).

Test results see 6.3</td><td>P</td></tr>
<tr><td>3.2</td><td>Response to Electrical System</td><td></td><td>P</td></tr>
<tr><td>3.2.1</td><td>Operating Voltage Range</td><td></td><td>P</td></tr>
<tr><td></td><td>1. Grid-connected inverter which connected to the grid at</td><td></td><td>P</td></tr>
</table>

Grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA:2015)			
Clause/§	**Technical requirements (MEA:2015)**	**Remark**	**Verdict**
	low voltage (230/400V) Inverter shall disconnect from the power network in case that line-to-line voltage or line-to-neutral voltage in the power network is out of 346 - 416 V and 200 - 240 V range respectively, for the following periods: Voltage Range (Volt) / Line to Line / Line to Neutral / Max. Disconnecting Time (Second) V < 199 / V < 115 / 0.1 199 ≤ V < 346 / 115 ≤ V < 200 / 2.0 346 ≤ V ≤ 416 / 200 ≤ V ≤ 240 / continuously operate (without disconnection) 416 < V < 539 / 240 < V < 311 / 2.0 V ≥ 539 / V ≥ 311 / 0.05	If the voltages exceed the protection thresholds as stated in the table above, the unit disconnects from the grid within the required disconnection delay. Please note that, deviating from requirement of MEA (2015) the voltages are monitored by the PGU integrated protection relay. This needs to be taken into account for project planning. Requirements according to According to Grid-connected inverter which connected to the grid at low voltage (230/400V) are met. Test results see 6.4	P
	2. Grid-connected inverter which connected to the grid at voltage ≥ 12kV Inverter shall disconnect from the power network within the following periods in case that voltage in the power network is out of range specified in below table; Voltage Range (% Nominal Voltage of Inverter) / Max. Disconnecting Time (Second) V < 50% / 0.1 50% ≤ V < 85% / 2.0 85% ≤ V ≤ 110% / continuously operate (without disconnection) 110% < V < 135% / 2.0 V ≥ 135% / 0.05	If the voltages exceed the protection thresholds as stated in the table above, the unit disconnects from the grid within the required disconnection delay. Please note that, deviating from requirement of MEA (2015) the voltages are monitored by the PGU integrated protection relay. This needs to be taken into account for project planning.	N/A
3.2.2	**Operating Frequency Range** The inverter should disconnect from the power network within 0.1 second if the frequency of the power network is not in the range of 47 - 52 Hz.	If the frequency outside the range between 47.00 Hz – 52.00 Hz, the unit disconnects from the grid within 0,1s. Test results see 6.5	P

Grid-connected inverter regulations of the Metropolitan Electricity Authority (MEA:2015)			
Clause/§	**Technical requirements (MEA:2015)**	**Remark**	**Verdict**
3.2.3	**Islanding Protection** Islanding Protection In case of islanding occur, the inverter shall detect and disconnect itself from the power network within 2 seconds. Since MEA had installed automatic source transfer system to reduce the outage time for customer. When this system operate, customer will see the 0.3 second interruption event and this event also force inverter to the islanding condition in 0.3 second period. After 0.3 second period, power system will re-energize power back to the inverter. If inverter cannot disconnect within this period, it may face out of synchronization problem which voltage from inverter is out of phase with voltage from supplied source. This event may cause a transient voltage and damage the inverter. Hence, if inverter do not disconnect from the power network within 0.3 second when islanding condition occur and cause the damage to itself or other equipment from out of synchronization problem. This must be full responsibility of inverter owner.	The unit is able to detect island situation and disconnects from the grid within 0.3 s. Test results see 6.6	P
3.2.4	**Response to Utility Recovery** After automatic disconnection of the inverter due to power outage or voltage / frequency being out of the specified range and when the power network returns to normal condition, the inverter shall delay the reconnection to the power networks for at least 2 minutes.	The unit can wait for the required reconnection delay 120 s before reconnecting to the power grid. Test results see 6.7	P

6 Measurement results

6.1 3.1.1 Harmonics

Test procedure and test conditions:

Tests were conducted according to according to IEEE Std 1547.1-2005, chapter 5.11.1.

Assessment criteria:

The Inverter output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the power grid. Each individual harmonic shall not exceed the in table given limits as below.

Odd Order	Current limit (%)		Even Order	Current limit (%)
3 - 9	4.0		2 - 10	1.0
11 - 15	2.0		12 - 16	0.5
17 - 21	1.5		18 - 22	0.375
23 - 33	0.6		24 - 34	0.15
≥ 35	0.3		≥ 36	0.075
Total harmonic current distortion (THDi) 5.0 %				

Test results:

Total harmonic distortion and individual harmonics of current are within the given limits.

Current Harmonics

Rated current I_n [A]: 181,159

P [%P_n]	33		66		100		Limit [5]	Verdict
Order	[A]	[%I_n]	[A]	[%I_n]	[A]	[%I_n]	[%In]	
1	61,387		119,735		179,841		--	--
2	0,114	0,063	0,154	0,085	0,176	0,097	1	Pass
3	0,385	0,212	0,520	0,287	0,839	0,463	4	Pass
4	0,069	0,038	0,092	0,051	0,109	0,060	1	Pass
5	1,725	0,952	2,082	1,149	2,704	1,493	4	Pass
6	0,048	0,026	0,049	0,027	0,040	0,022	1	Pass
7	1,427	0,788	2,080	1,148	1,500	0,828	4	Pass
8	0,031	0,017	0,054	0,030	0,043	0,024	1	Pass
9	0,326	0,180	0,156	0,086	0,704	0,389	4	Pass
10	0,056	0,031	0,052	0,029	0,063	0,035	1	Pass
11	0,484	0,267	0,920	0,508	1,229	0,679	2	Pass
12	0,053	0,029	0,035	0,019	0,072	0,040	0,5	Pass
13	0,359	0,198	0,894	0,494	1,369	0,756	2	Pass
14	0,042	0,023	0,047	0,026	0,045	0,025	0,5	Pass
15	0,383	0,212	0,365	0,201	0,390	0,215	2	Pass
16	0,027	0,015	0,033	0,018	0,054	0,030	0,5	Pass
17	0,374	0,206	0,522	0,288	0,952	0,526	1,5	Pass
18	0,030	0,016	0,025	0,014	0,045	0,025	0,375	Pass
19	0,459	0,253	0,505	0,279	0,857	0,473	1,5	Pass
20	0,020	0,011	0,037	0,020	0,054	0,030	0,375	Pass
21	0,711	0,392	0,550	0,304	0,239	0,132	1,5	Pass
22	0,030	0,017	0,050	0,028	0,072	0,040	0,375	Pass
23	0,455	0,251	0,465	0,257	0,813	0,449	0,6	Pass
24	0,025	0,014	0,039	0,021	0,032	0,017	0,15	Pass
25	0,505	0,279	0,406	0,224	0,667	0,368	0,6	Pass
26	0,015	0,009	0,064	0,035	0,052	0,029	0,15	Pass
27	0,569	0,314	0,428	0,236	0,223	0,123	0,6	Pass
28	0,039	0,022	0,063	0,035	0,081	0,044	0,15	Pass

29	0,333	0,184	0,230	0,127	0,531	0,293	0,6	Pass
30	0,022	0,012	0,018	0,010	0,033	0,018	0,15	Pass
31	0,264	0,146	0,245	0,135	0,370	0,204	0,6	Pass
32	0,023	0,013	0,036	0,020	0,042	0,023	0,15	Pass
33	0,230	0,127	0,308	0,170	0,478	0,264	0,6	Pass
34	0,021	0,011	0,031	0,017	0,046	0,026	0,15	Pass
35	0,090	0,049	0,186	0,102	0,346	0,191	0,3	Pass
36	0,036	0,020	0,019	0,011	0,026	0,014	0,075	Pass
37	0,103	0,057	0,158	0,087	0,313	0,173	0,3	Pass
38	0,029	0,016	0,032	0,018	0,039	0,022	0,075	Pass
39	0,477	0,263	0,473	0,261	0,518	0,286	0,3	Pass
40	0,028	0,016	0,046	0,025	0,047	0,026	0,075	Pass
41	0,192	0,106	0,216	0,119	0,292	0,161	0,3	Pass
42	0,016	0,009	0,055	0,030	0,030	0,017	0,075	Pass
43	0,170	0,094	0,243	0,134	0,269	0,149	0,3	Pass
44	0,024	0,013	0,040	0,022	0,037	0,021	0,075	Pass
45	0,286	0,158	0,283	0,156	0,341	0,188	0,3	Pass
46	0,028	0,016	0,055	0,030	0,057	0,031	0,075	Pass
47	0,097	0,053	0,199	0,110	0,146	0,080	0,3	Pass
48	0,022	0,012	0,028	0,016	0,050	0,028	0,075	Pass
49	0,120	0,067	0,172	0,095	0,215	0,118	0,3	Pass
50	0,036	0,020	0,043	0,024	0,074	0,041	0,075	Pass
THD [%I_1] [6)]	--	1,517	--	1,952	--	2,304	<5%	Pass

[6)] Total current harmonic distortion is calculated according to formula (MEA (2015).

$$THDi = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \cdots}}{I_1} \times 100\%$$

6.2 3.1.2 Voltage Fluctuation test

☐ **The EUT with output rated current ≤ 75A per phase**

Output parameters of grid		Voltage [V]:	--	Frequency [Hz]:	--
Phase of EUT		**Selection of limits**			
☐	☐	☐		☐	
1-phase	*3-phase*	Equipment with rated current ≤16 A per phase *IEC EN 61000-3-3*		Equipment with rated current ≤75 A per phase *IEC EN 61000-3-11*	

Results:
Requirements according to IEC 61000-3-3 are met.

	Phase No.	Starting			Stopping			Running	
		d_{max}	d_c	T_{max}	d_{max}	d_c	T_{max}	P_{st}	P_{lt}
Measured Values at test impedance	L1	--	--	--	--	--	--	--	--
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	--	--	--	--	--	--	--	--
Limits according to 61000-3-3 & 61000-3-11		4%	3,3%	500 ms	4%	3,3%	500 ms	1.0	0,3
Z_{test}				R = -- Ω			X = -- Ω		
Z_{ref}		☐ *1-phase*		R = 0,40 Ω			X = 0,25 Ω		
		☐ *3-phase*		R = 0,24 Ω			X = 0,15 Ω		
Z_{max}*				R = -- Ω			X = -- Ω		

Note:4
* The specified R and X of Z_{max} are calculated, for example, based on an impedance angle of 32°. Resistance and reactance for other impedance angles can be calculated using the provided Z_{max}.

☒ **The EUT with output rated current more than 75A per phase**

Test procedure and test conditions:

Tests were conducted according to test procedure described in IEC 61400-21, which is appropriately adapted for the power conversion system, whereby the wind speed is replaced by the respective primary power of the power producer:

Tests were done on the following output power level of the power producer:

<5%Pn, 10%Pn, 20%Pn, … (in 10% step), 90%Pn, 95%Pn, 100%Pn, only continuous operation (running) was considered, measurement at every power level was record for 10 min.

Note:

The stated flicker are maximum values over all 3 phases.

Test results:

According to IEC 61000-3-5 are met.

No.	% of rated power	d_c [%]	D_{max} [%]	d(t) [ms]	P_{st}	P_{lt}
Limit		**3.3**	**4.0**	**500 3.3%**	**1.0**	**0.65**
1	3	0,54	0,60	0	0,05	
2	10	0,54	0,60	0	0,04	
3	20	0,02	0,13	0	0,04	
4	30	0,55	0,21	0	0,05	
5	40	0,54	0,61	0	0,05	
6	50	0,01	0,61	0	0,05	
7	60	0,02	0,11	0	0,04	
8	70	0,54	0,11	0	0,04	
9	80	0,01	0,60	0	0,04	
10	90	0,02	0,11	0	0,04	
11	95	0,55	0,13	0	0,05	
12	100	0,01	0,61	0	0,04	0,04
Results		Pass	Pass	Pass	Pass	Pass

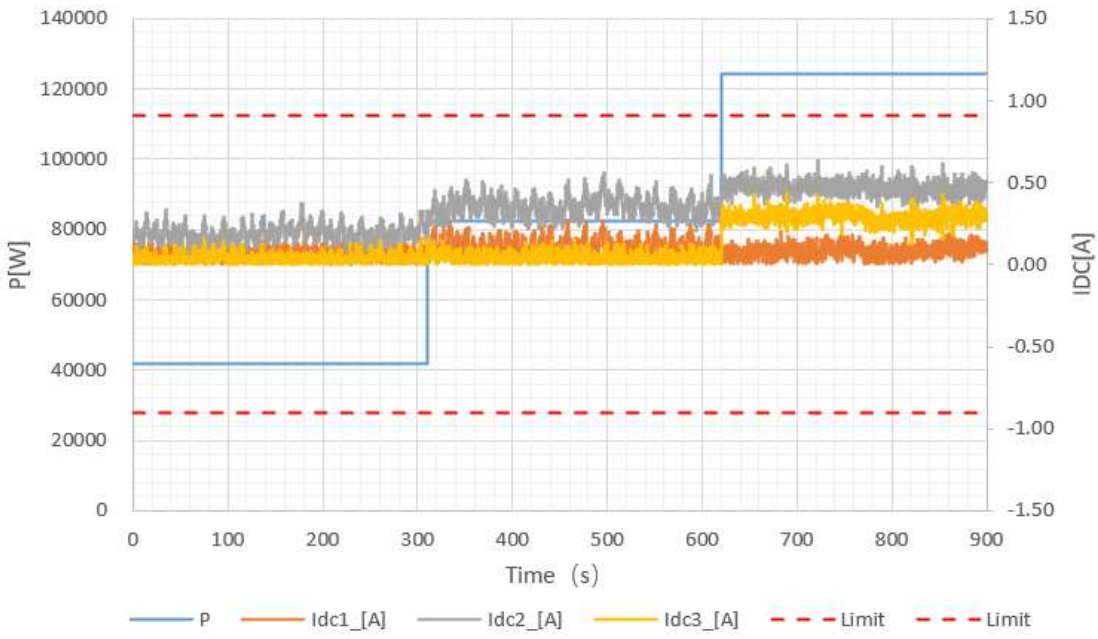
6.3 3.1.3 DC Injection

Test procedure and test conditions: Tests were conducted according to IEEE Std 1547.1-2020 section 5.6, testing was also done at additional output power level of 33%P_n and 66%P_n.
Assessment criteria: The inverter shall not inject DC current greater than 0,5%I_n at PCC under any operating condition.
Test results: The overall max. DC Injection of the unit is lower than the required limit.

MEA Limit:	**0,5%I_n:0,906 A**					
Output power:	Max. test value phase L1 [A]:	Mean test value phase L1 [A]	Max. test value phase L2 [A]:	Mean test value phase L2 [A]	Max. test value phase L3 [A]:	Mean test value phase L3 [A]
33%P_n	0,188	0,069	0,374	0,186	0,159	0,039
66%P_n	0,271	0,103	0,567	0,348	0,161	0,042
100%P_n	0,251	0,085	0,640	0,460	0,436	0,274

Output power:	**MEA Limit [%I_n]**	**Overall max. DC Injection [%I_n]**	**verdict**
33%P_n	0,5	0,206	Pass
66%P_n		0,313	Pass
100%P_n		0,353	Pass

Diagram of permanent DC-injection



6.4 3.2.1 Operating Voltage Range

Test procedure and test conditions:

Tests were conducted according to MEA (2015) section 3.7.

(Note: the trip setting, and delay of the voltage protection is adjustable, If necessary, the protection parameters can be set according to requirement of the grid operator.)

In addition, test procedure according to IEEE Std 1547.1-2020, chapter 5.4.2, 5.4.3 and Annex A in compliance with IEC 61727:2004 was considered.

During the tests, the unit was operated at nominal frequency (50 Hz) and output power of 50%P_n *.

(Note:

* This is considered sufficient to identify the disconnection of the unit.)

Assessment criteria:

The converter system must disconnect from the grid if the line to neutral voltage is out of the specified level as detailed in the following table:

☒ Grid-connected inverter which connected to the grid at low voltage (230/400V)

Voltage Range (Volt)		Max. Disconnecting Time (Second)
Line to Line	Line to Neutral	
V < 199	V < 115	0.1
199 ≤ V < 346	115 ≤ V < 200	2.0
346 ≤ V ≤ 416	200 ≤ V ≤ 240	continuously operate (without disconnection)
416 < V < 539	240 < V < 311	2.0
V ≥ 539	V ≥ 311	0.05

☐ Grid-connected inverter which connected to the grid at voltage ≥ 12kV

Voltage Range (% Nominal Voltage of Inverter)	Max. Disconnecting Time (Second)
V < 50%	0.1
50% ≤ V < 85%	2.0
85% ≤ V ≤ 110%	continuously operate (without disconnection)
110% < V < 135%	2.0
V ≥ 135%	0.05

Test results:

If the line to neutral voltages exceeds the protection thresholds as stated in the table above, the unit disconnects from the grid within the required disconnection delay.

Please note that, deviating from requirement of MEA (2015) the line to neutral voltages is monitored by the PGU integrated protection relay. This needs to be taken into account for project planning.

Note:

The grid monitoring unit is integrated in the PGU and senses at the grid terminals (low-voltage level) of the PGU.

The line to neutral voltages is monitored by the PGU integrated protection relay. The following tables show results of line to neutral voltages.

(1) Select MEA's voltage level where grid-connected inverter connected to.

(2) Select between line-neutral or line-line voltage test based on the actual operation of inverter.

(3) Insert maximum value recorded during test.

(4) If inverter cannot be adjusted for overvoltage and/or undervoltage trip setting as per MEA's grid-connected Inverter regulation, it shall be adjusted the overvoltage or undervoltage trip setting to the maximum and/or minimum voltage that inverter can be set.

☒ Grid-connected inverter which connected to the grid at low voltage (230/400V) (1)										
		First level undervoltage					First level overvoltage			
Trip setting [V]		199 (= 90%$V_{n,\ L\text{-}N}$)					241 (= 110%$V_{n,\ L\text{-}N}$)			
Measured trip value [V]		All	L1	L2	L3		All	L1	L2	L3
		198,4	198,3	198,9	198,3		241,2	241,8	241,4	242,1
		198,6	198,5	198,9	198,3		241,2	241,9	241,5	242,2
		198,6	198,5	198,9	198,3		241,2	241,9	241,5	242,1
		198,4	198,5	198,9	198,3		241,1	242,0	241,6	242,3
		198,4	198,2	198,9	198,3		241,1	241,5	241,4	242,2
Trip time limit [s]		≤ 2,0					≤ 2,0			
Measured trip time [s]	230 V → 204 V on hold 4 s→ 198 V	All	L1	L2	L3	230 V → 236 V on hold 4 s → 242 V	All	L1	L2	L3
		1,997	1,930	1,931	1,952		1,900	1,911	1,920	1,931
		1,704	1,950	1,928	1,922		1,900	1,916	1,914	1,929
		1,696	1,931	1,934	1,941		1,904	1,910	1,950	1,933
		1,705	1,926	1,928	1,937		1,909	1,921	1,907	1,932
		1,703	1,935	1,949	1,940		1,934	1,910	1,909	1,952

		Second level undervoltage					Second level overvoltage			
Trip setting [V]		114 (= 50%$V_{n,\ L\text{-}N}$) (4)					276 (= 120%$V_{n,\ L\text{-}N}$) (4)			
Measured trip value [V]		All	L1	L2	L3		All	L1	L2	L3
		111,9	112,1	112,6	112,5		277,6	277,2	277,6	277,2
		112,4	112,3	112,7	111,8		277,1	277,4	277,7	277,2
		112,5	112,2	112,6	112,5		277,1	277,3	277,7	277,6
		112,0	111,9	112,8	112,8		277,1	277,6	277,4	277,1
		112,7	112,3	112,3	112,4		277,8	277,2	277,8	277,5
Trip time limit [s]		≤ 0,1					≤ 0,05			
Measured trip time [s]	230 V → 204 V on hold 0.2 s→ 113 V	All	L1	L2	L3	230 V → 236 V on hold 0.1 s → 312 V	All	L1	L2	L3
		0,060	0,091	0,093	0,075		0,035	0,031	0,045	0,044
		0,059	0,091	0,092	0,094		0,035	0,034	0,046	0,037
		0,059	0,091	0,093	0,095		0,036	0,034	0,048	0,037
		0,057	0,091	0,094	0,096		0,035	0,036	0,049	0,038
		0,058	0,091	0,094	0,097		0,035	0,036	0,031	0,040

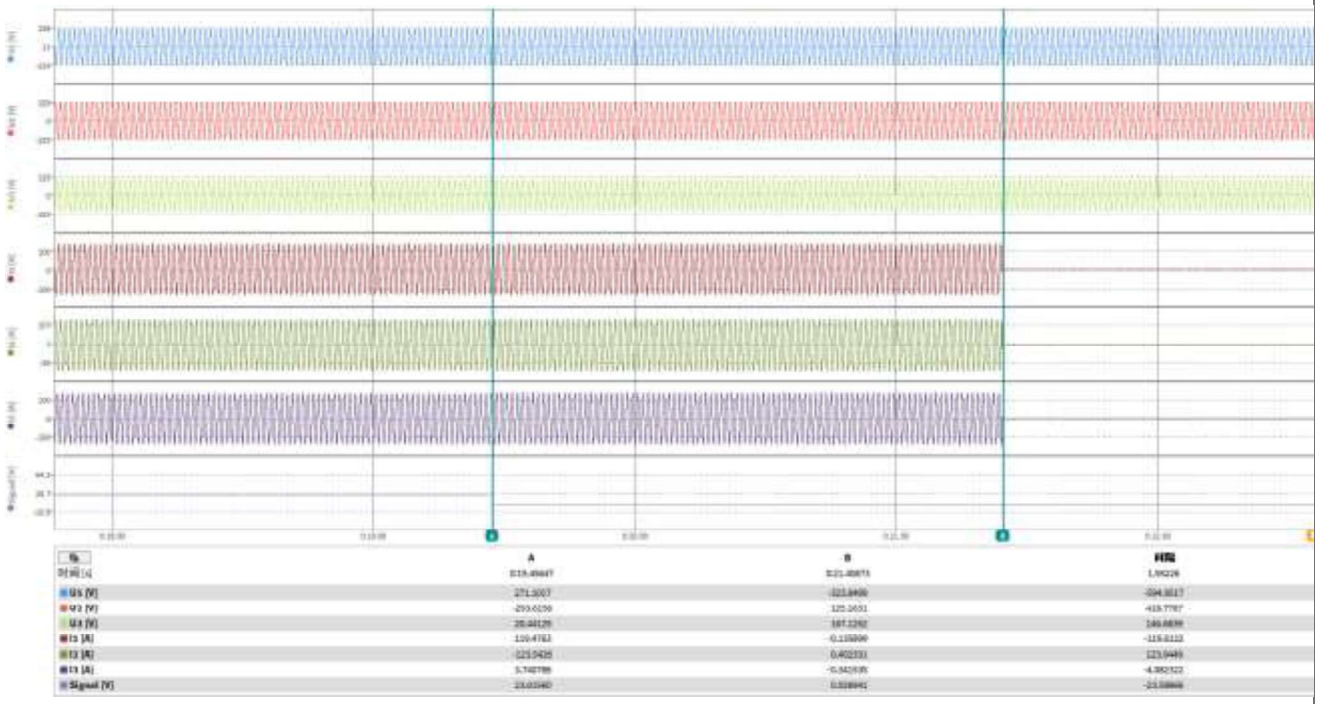
Overall maximum value in all conditions						
	☒ $V_{L\text{-}N}$ setting(2) [V]	☐ $V_{L\text{-}L}$ setting(2) [V]	Measured trip value [V]	Measured Time Delay [sec](3)	Limit Time Delay [sec]	Result confirmation
Undervoltage level 2(4)	☒114 or ☐....	☐198 or ☐....	112,8	0,097	≤ 0,1	Pass
Undervoltage level 1	199	345	198,9	1,997	≤ 2,0	Pass
Overvoltage level 1	241	417	242,3	1,952	≤ 2,0	Pass
Overvoltage level 2(4)	☐311 or ☒276	☐539 or ☐....	277,8	0,049	≤ 0,05	Pass

☐ Grid-connected inverter which connected to the grid at voltage ≥ 12kV [1]										
		First level undervoltage					First level overvoltage			
Trip setting [V]		195.5 (= 85%$V_{n, L-N}$)					253 (= 110%$V_{n, L-N}$)			
Measured trip value [V]		All	L1	L2	L3		All	L1	L2	L3
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
Trip time limit [s]		≤ 2,0					≤ 2,0			
Measured trip time [s]	230 V → 204 V on hold 4 s→ 194 V	All	L1	L2	L3	230 V → 236 V on hold 4 s → 254 V	All	L1	L2	L3
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--

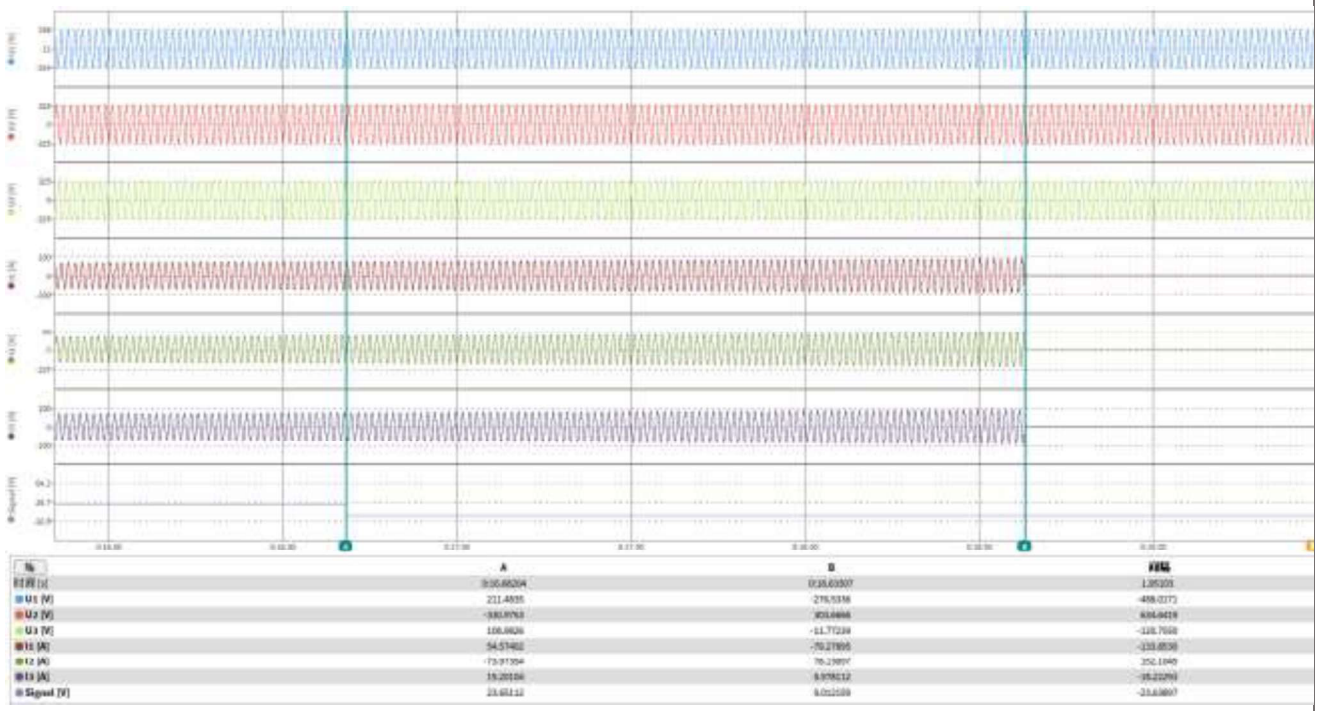
		Second level undervoltage					Second level overvoltage			
Trip setting [V]		114 (= 50%$V_{n, L-N}$) [4]					311 (= 135%$V_{n, L-N}$) [4]			
Measured trip value [V]		All	L1	L2	L3		All	L1	L2	L3
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
Trip time limit [s]		≤ 0,1					≤ 0,05			
Measured trip time [s]	230 V → 204 V on hold 0.1 s→ 113 V	All	L1	L2	L3	230 V → 236 V on hold 0.1s → 312 V	All	L1	L2	L3
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--

Overall maximum result in all conditions					
	V setting [% of rated output voltage]	Measured trip value [V]	Measured Time Delay [sec][3]	Limit Time Delay [sec]	Result confirmation
Undervoltage level 2[4]	☐50% Vn or ☐.....% Vn	--	--	≤ 0,1	--
Undervoltage level 1	85% Vn	--	--	≤ 2,0	--
Overvoltage level 1	110%Vn	--	--	≤ 2,0	--
Overvoltage level 2[4]	☐135% Vn or ☐.....% Vn	--	--	≤ 0,05	--

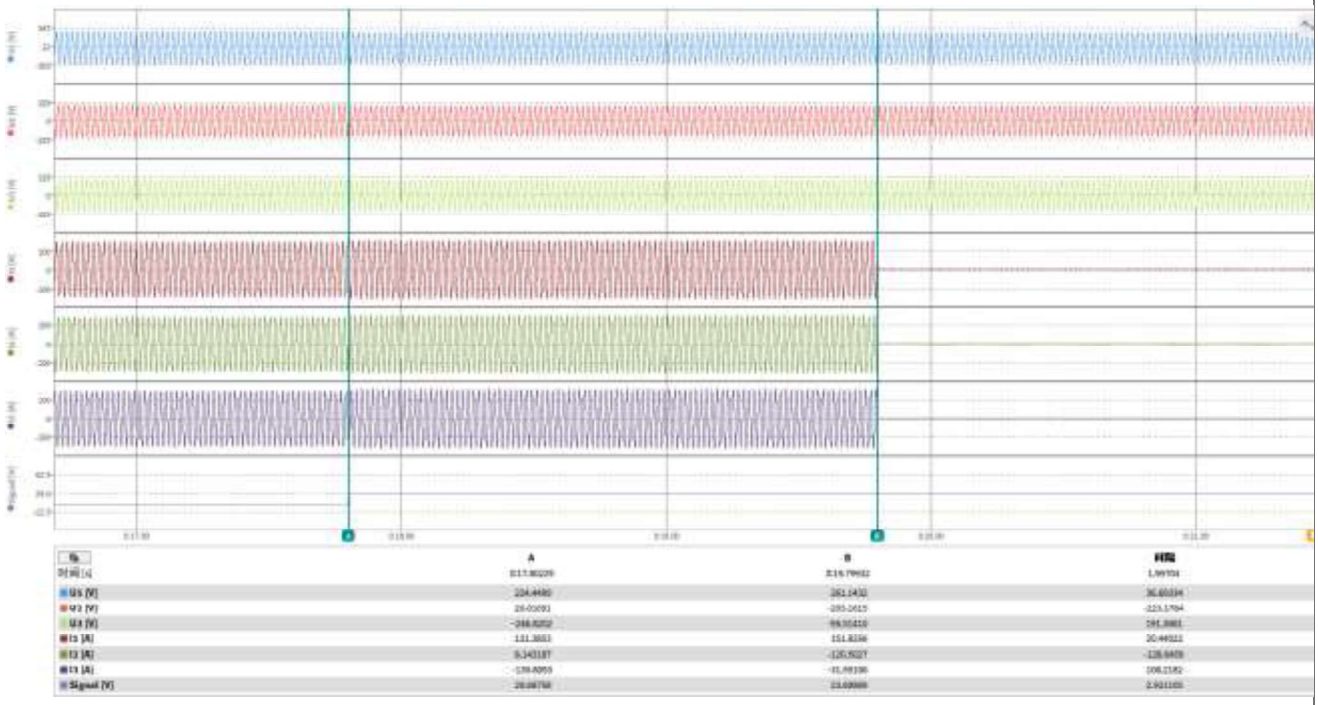
Under Voltage First Level single phase



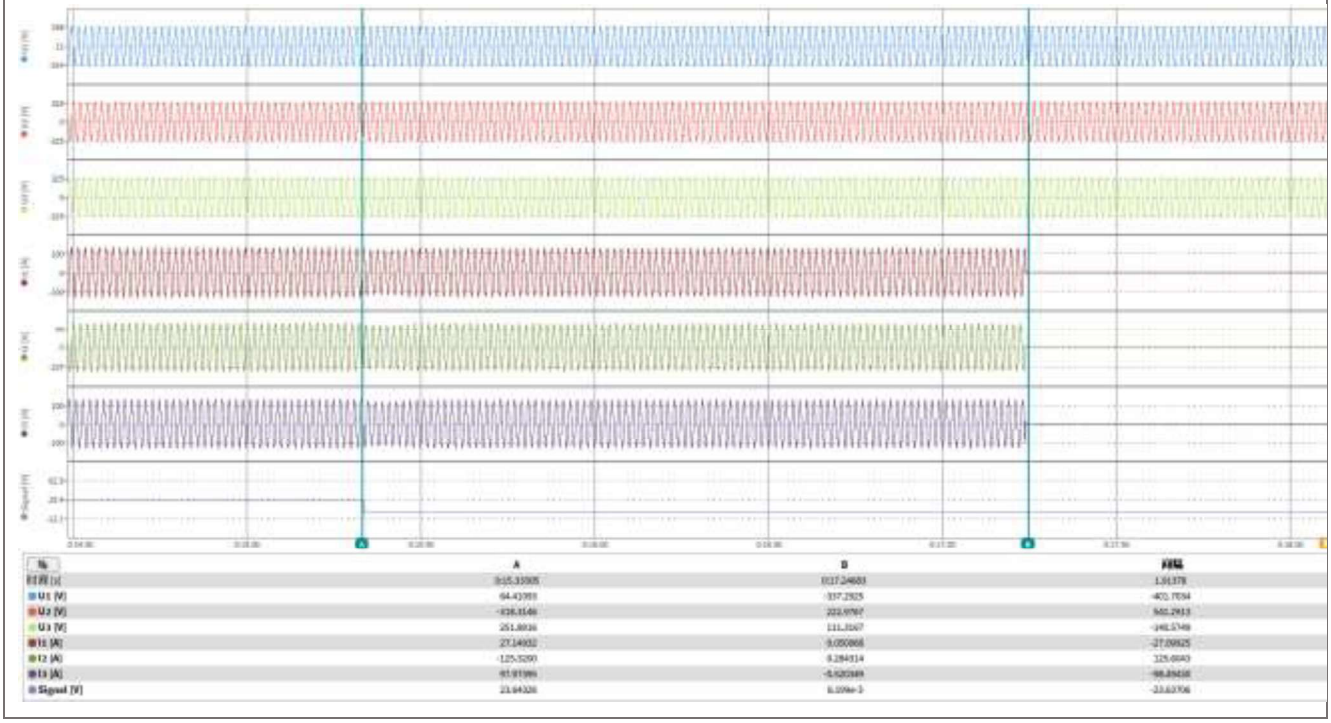
Over voltage First Level single phase



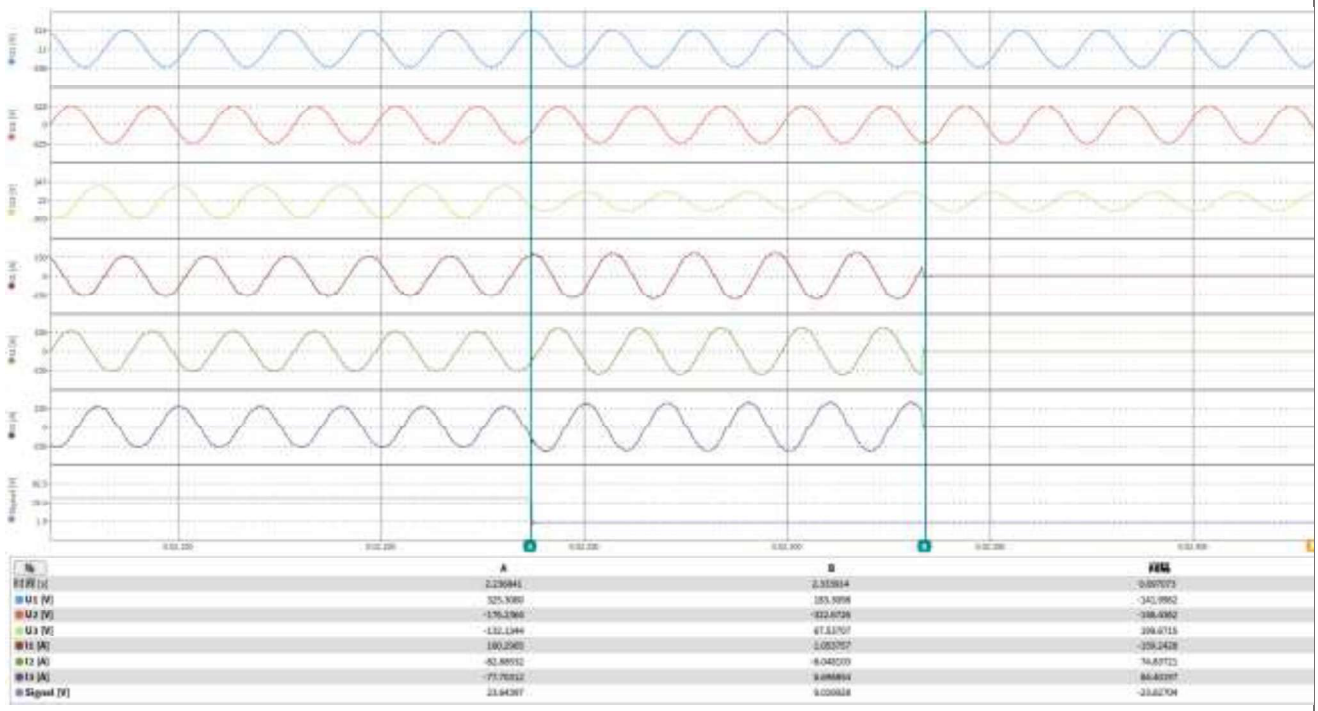
Under Voltage First Level all phases



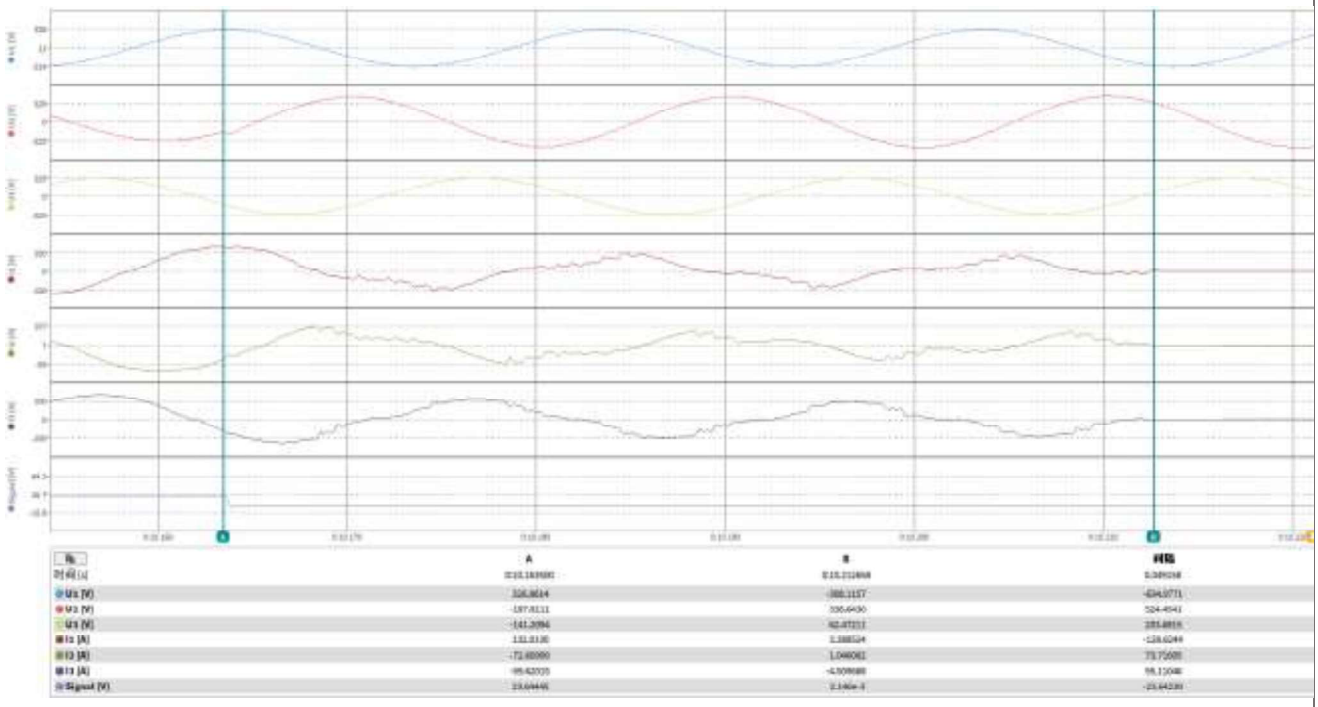
Over voltage First Level all phases



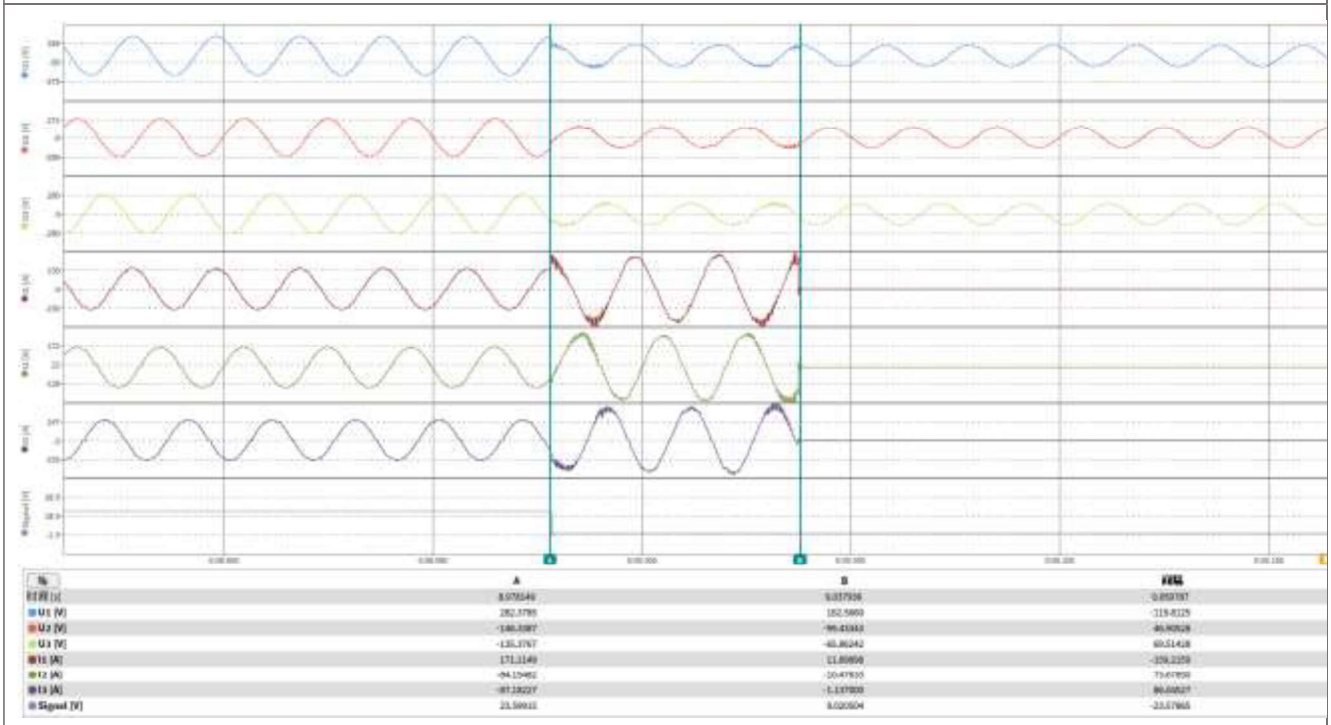
Under Voltage Second Level single phase



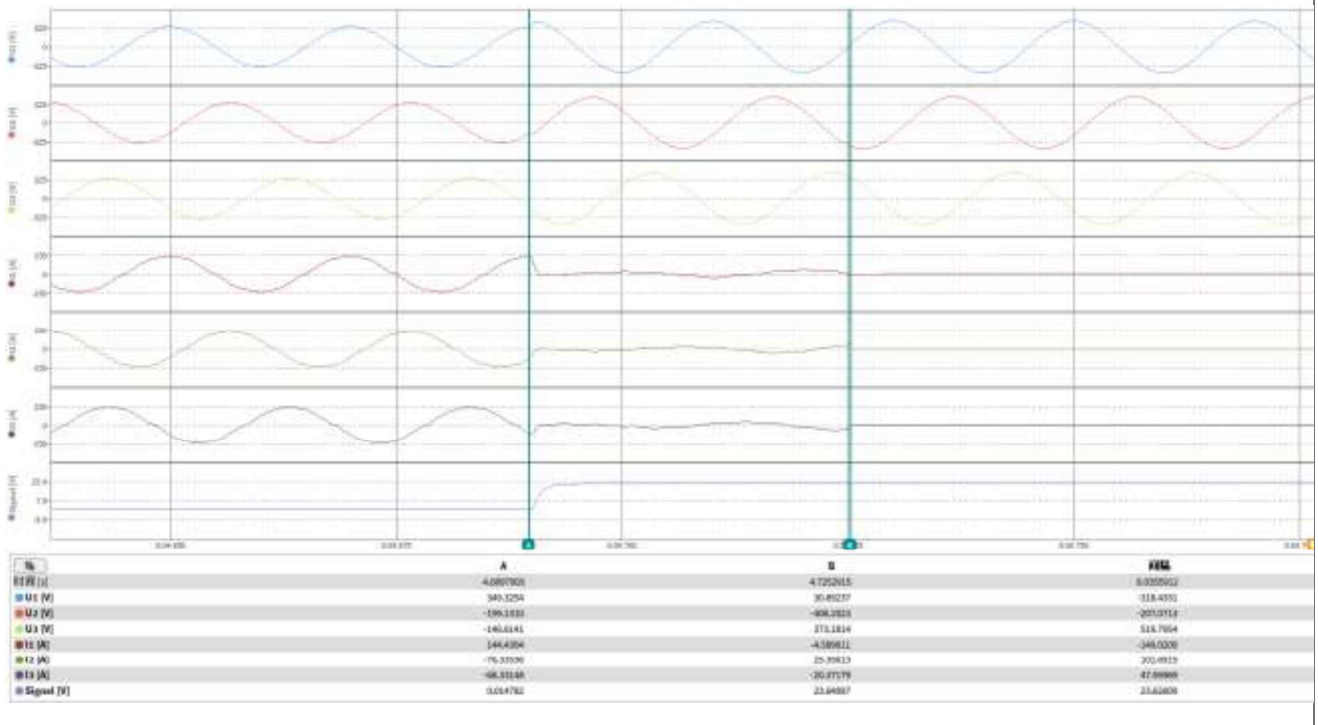
Over voltage Second Level single phase



Under Voltage Second Level all phase



Over voltage Second Level all phase



6.5 3.2.2 Operating Frequency Range

Test procedure and test conditions:

Tests were conducted according to MEA (2015) section 3.2.2, the overfrequency trip value was set to 52,00 Hz and the underfrequency trip value was set to 47,00 Hz.

(Note: the trip setting, and delay of the frequency protection is adjustable, if necessary, the protection parameters can be set according to requirement of the grid operator.)

In addition, test procedure according to IEEE Std 1547.1-2020, chapter 5.5.1, 5.5.2 and Annex A in compliance with IEC 61727:2004 was considered.

During the tests, the unit was operated at nominal AC voltage (230 V) and output power of 50%P_n [3].

(Note:

[3] This is considered sufficient to identify the disconnection of the unit.)

Assessment criteria:

In case that the frequency at the interconnection point is not between 47.00 Hz – 52.00 Hz, the converter system must disconnect from the grid within 0,1s.

Test results:

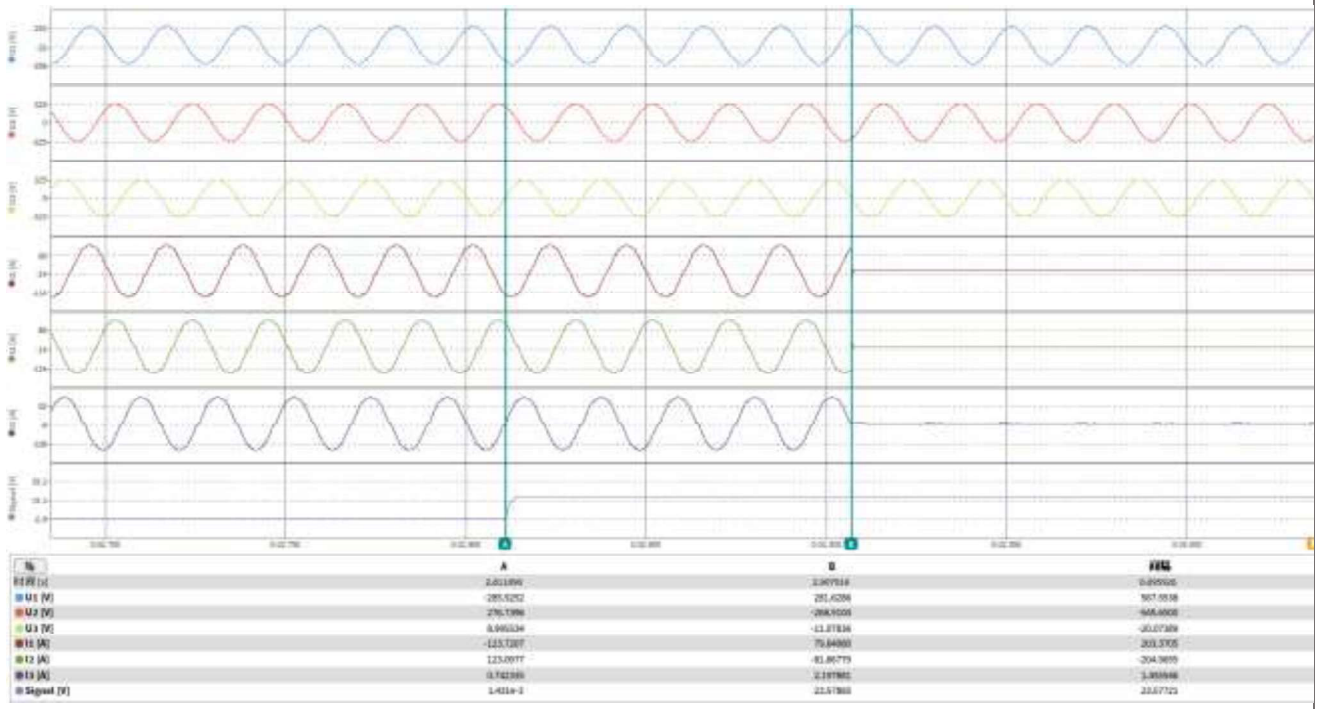
If the frequency outside the range between 47.00 Hz – 52.00 Hz, the unit disconnects from the grid within 0,1s.

		Underfrequency		**Overfrequency**
Trip setting [Hz]		**46,99**		**52,01**
Measured trip value [V]		46,95		52,02
		46,98		52,02
		46,96		52,02
		46,99		52,02
		46,98		52,02
Trip time limit [s]		**≤ 0,1**		**≤ 0,1**
Measured trip time [s]	50,0Hz → 47,2Hz on hold 0,2 s→ 46,9	0,095	50,0Hz → 51,8Hz on hold 0,2 s→ 52,1Hz	0,061
		0,096		0,062
		0,095		0,062
		0,095		0,062
		0,096		0,061

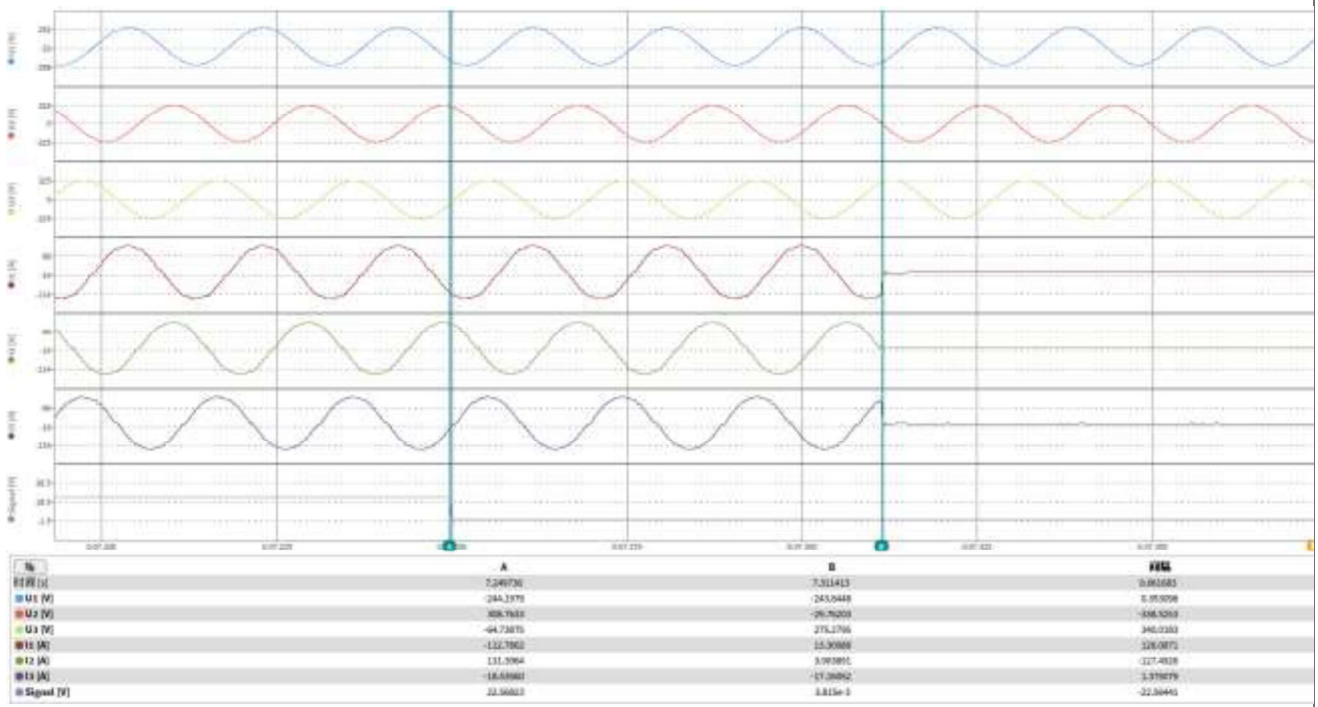
Overall maximum value in all conditions

	Actual Trip Setting		Test Result		Limit Time Delay [sec]	Result confirmation
	Frequency (Hz)	Trip Time (sec)	Measured trip value [Hz]	Measured Time Delay [sec]		
Underfrequency	46,99	0,1	46,99	0,096	≤ 0,1	Pass
Overfrequency	52,01	0,1	52,02	0,062	≤ 0,1	Pass

Underfrequency



Overfrequency



6.6 3.2.3 Islanding Protection

Test procedure and test conditions:

Tests were conducted according to table 9 of IEC 62116:2014.

All test condition setting according the table 6 and table 7 specified requirements of IEC 62116:2014.

Table 6 – Load imbalance (real, reactive load) for test condition A (EUT output = 100 %)

% change in active load, reactive load from nominal output power				
–10, +10	–5, +10	0, +10	+5, +10	+10, +10
–10, +5	–5, +5	0, +5	+5, +5	+10, +5
–10, 0	–5, 0		+5, 0	+10, 0
–10, –5	–5, –5	0, –5	+5, –5	+10, –5
–10, –10	–5, –10	0, –10	+5, –10	+10, –10

The numbers in each cell, e.g. *+M, +N*, are used to represent the % change for active and reactive power. The first number *M* represents the active power % and the second number *N* represents the reactive power %. Actual load values shall be within ±1 % of those specified.

Table 7 – Load imbalance (reactive load) for test condition B (EUT output = 50 % to 66 %) and test condition C (EUT output = 25 % to 33 %)

% change in active load, reactive load from nominal output power
0, –5
0, –4
0, –3
0, –2
0, –1
0, 1
0, 2
0, 3
0, 4
0, 5

In Table 7 the numbers in each box, e.g. *+M, +N*, are used to represent the % change for active and reactive power. The first number *M* represents the active power % and the second number *N* represents the reactive power %. Actual load values shall be within ±1 % of those specified.

Condition A:

EUT output power PEUT = Maximum [1)]

EUT input voltage[2)] >75% of rated input voltage range

[1)] Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.

[2)] Based on EUT rated input operating range. For example, if range is between X volts and Y volts, 75 % of range =X + 0.75 × (Y – X). Y shall not exceed 0.8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

Test Condition B:

EUT output power PEUT = 50 % – 66 %[3)] of maximum

EUT input voltage[2)] = 50 % of rated input voltage range, ±10 %

Test Condition C:

EUT output power PEUT = 25 % – 33 % [4)] of maximum

EUT input voltage[2)] < 20 % of rated input voltage range

[5)] Or minimum allowable EUT output level if greater than 33 %.

Frequency:	U_N	RLC consumes inverter real power	Distortion factor of chokes	Quality
50+/-0.2Hz	230 +/-3Vac	within +/- 3%	< 3%	1

Note:

RLC is adjusted to min. ±1% of the inverter rated output power

[a)] P_{EUT}: EUT output power

[b)] P_{AC}: Real power flow at S1 in Figure 4. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

[c)] Q_{AC}: Reactive power flow at S1 in Figure 4. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

[d)] BL: Balance condition, IB: Imbalance condition.

[e)] Teset table A according Table 9 – List of tested condition and run on time, the No. 1 P_{ac} 0% and Q_{ac} 0% balance condition of test condition A disconnection time does maximum disconnection time in all condition.

[f)] Teset table B according Table 9 – List of tested condition and run on time, the No. 1 P_{ac} 0% and Q_{ac} 0% balance condition of test condition A disconnection time does not maximum disconnection time in all condition.

Assessment criteria:

To prevent islanding while there is no power supply at the power network system, a connection requester's generator must be capable to disconnect from the power network system within 0.3 second.

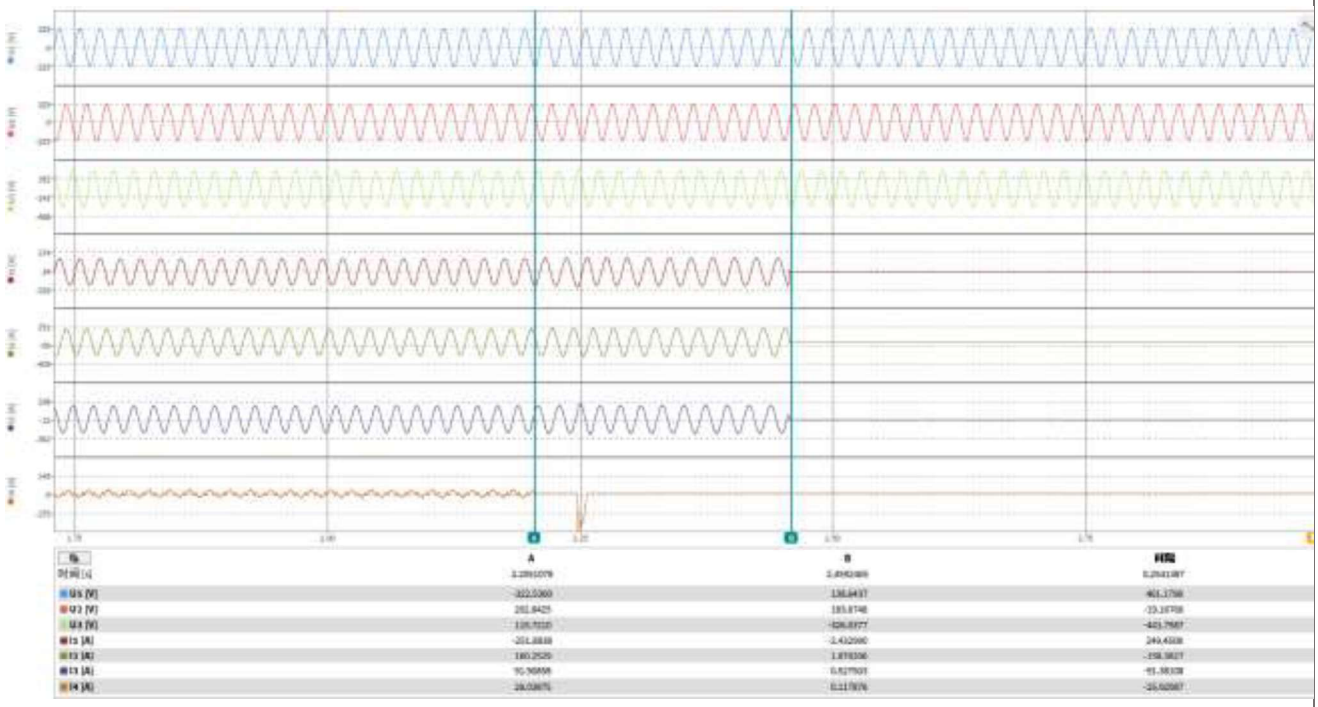
Test results:
The unit is able to detect island situation and disconnects from the grid within 0.3 s.

Table 9 – List of tested condition and run on time [e)]

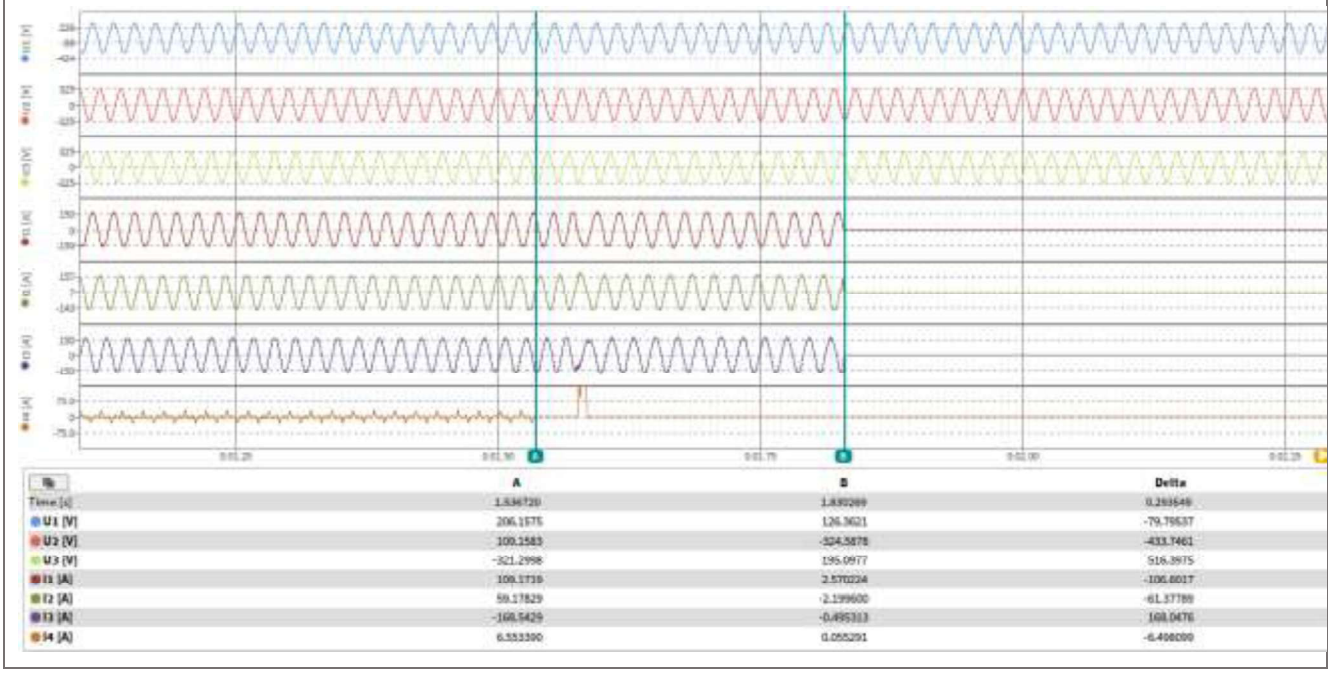
No.	P_{EUT} [a)] (% of EUT rating)	Reactive load (% of Q_L in 6.1[d) 1)]	P_{AC} [b)] (% of nominal)	Q_{AC} [c)] (% of nominal)	Run on Time (ms)	P_{EUT} (kW per phase)	Actual Q_f	V_{DC}[2)]	Remarks[d)]
1	100[1)]	100	0	0	254	125,00	1,003	760	Test A at BL
2	66[3)]	66	0	0	188	82,50	0,999	640	Test B at BL
3	33[4), 5)]	33	0	0	147	41,25	0,989	496	Test B at BL
4	100[1)]	100	-5	-5	150	125,00	1,029	760	Test A at IB
5	100[1)]	100	-5	0	151	125,00	1,056	760	Test A at IB
6	100[1)]	100	-5	+5	159	125,00	1,082	760	Test A at IB
7	100[1)]	100	0	-5	157	125,00	0,977	760	Test A at IB
8	100[1)]	100	0	+5	238	125,00	1,028	760	Test A at IB
9	100[1)]	100	+5	-5	239	125,00	0,931	760	Test A at IB
10	100[1)]	100	+5	0	153	125,00	0,955	760	Test A at IB
11	100[1)]	100	+5	+5	151	125,00	0,979	760	Test A at IB
12	66[3)]	66	0	-5	144	82,50	0,974	640	Test B at IB
13	66[3)]	66	0	-4	154	82,50	0,979	640	Test B at IB
14	66[3)]	66	0	-3	192	82,50	0,984	640	Test B at IB
15	66[3)]	66	0	-2	205	82,50	0,989	640	Test B at IB
16	66[3)]	66	0	-1	194	82,50	0,994	640	Test B at IB
17	66[3)]	66	0	1	203	82,50	1,004	640	Test B at IB
18	66[3)]	66	0	2	168	82,50	1,009	640	Test B at IB
19	66[3)]	66	0	3	186	82,50	1,014	640	Test B at IB
20	66[3)]	66	0	4	293	82,50	1,019	640	Test B at IB
21	66[3)]	66	0	5	171	82,50	1,024	640	Test B at IB
22	33[4)]	33	0	-5	124	41,25	0,964	496	Test B at IB
23	33[4), 5)]	33	0	-4	145	41,25	0,969	496	Test B at IB
24	33[4), 5)]	33	0	-3	140	41,25	0,974	496	Test B at IB
25	33[4), 5)]	33	0	-2	140	41,25	0,979	496	Test B at IB
26	33[4), 5)]	33	0	-1	137	41,25	0,984	496	Test B at IB
27	33[4), 5)]	33	0	1	149	41,25	0,994	496	Test B at IB
28	33[4), 5)]	33	0	2	146	41,25	0,999	496	Test B at IB
29	33[4), 5)]	33	0	3	130	41,25	1,004	496	Test B at IB
30	33[4), 5)]	33	0	4	156	41,25	1,009	496	Test B at IB
31	33[4), 5)]	33	0	5	148	41,25	1,014	496	Test B at IB

EUT output = 100%			
Parameter at 0% per phase	L= 4,02 mH	R=1,27 Ω	C= 2519,11 µF
Iac(A):	1545mA		
EUT output = 50 % – 66 %			
Parameter at 0% per phase	L= 60, mH	R=1,91Ω	C= 1665,10 µF
Iac(A):	1235mA		
EUT output = 25 % – 33 %			
Parameter at 0% per phase	L= 12.25 mH	R=3,47Ω	C= 827,19 µF
Iac(A):	1633mA		

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load No. 1



Disconnection at P_{AC} 0% and Q_{AC} 4% reactive load No. 20



Disconnection at P_{AC} 0% and Q_{AC} 4% reactive load No. 30

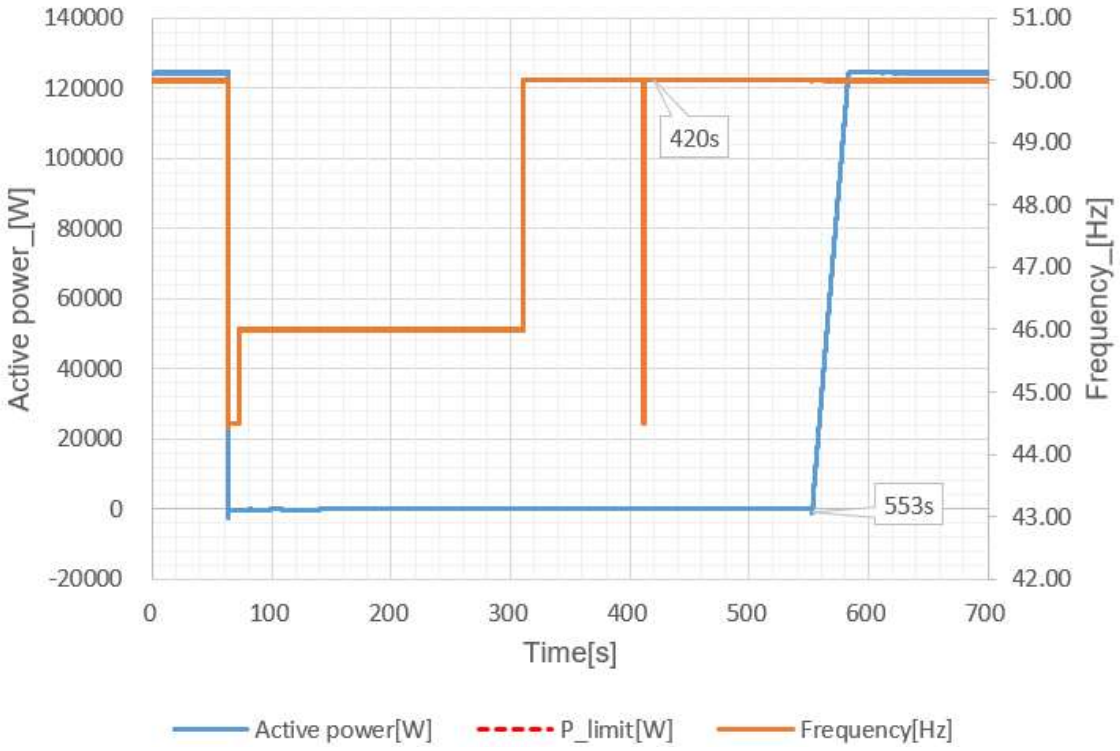
	A	B	Delta
Time [s]	3.038813	3.194854	0.156041
U1 [V]	274.2355	250.1533	-24.08219
U2 [V]	13.86738	-306.0968	-319.9642
U3 [V]	-287.6227	53.62130	341.2440
I1 [A]	75.92865	-17.30495	-93.23359
I2 [A]	-0.350663	-36.88772	-36.53705
I3 [A]	-75.63293	54.43456	130.0675
I4 [A]	-1.434229	0.099995	1.534224

6.7 3.2.4 Response to Utility Recovery

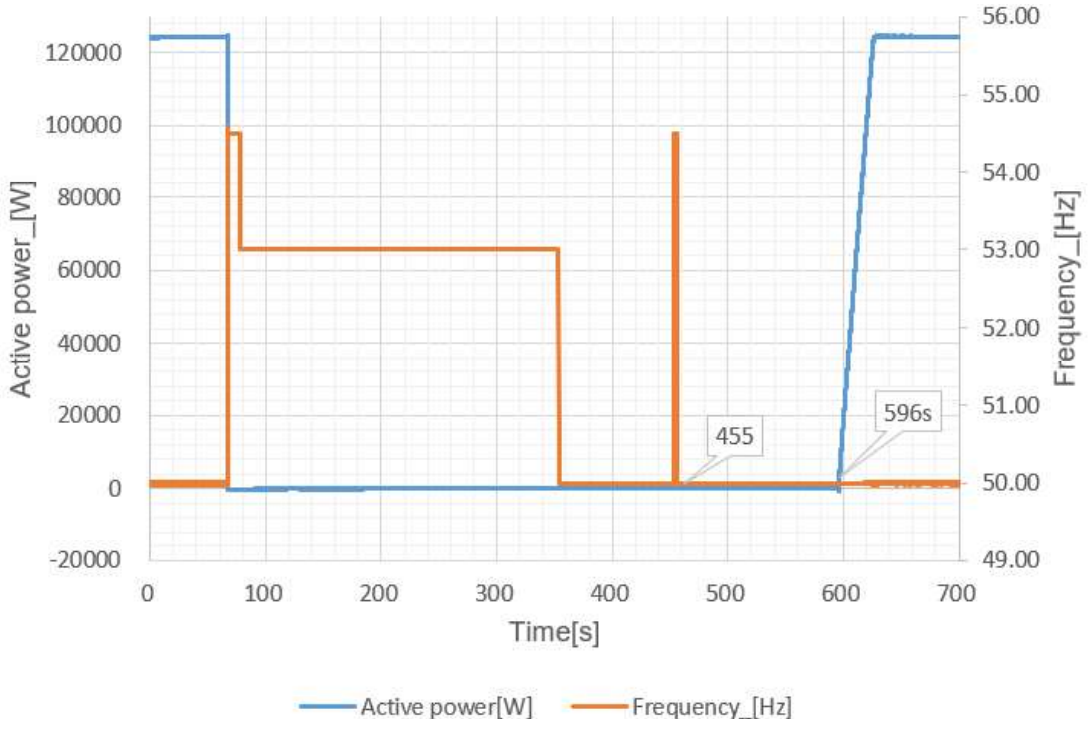
Test procedure and test conditions: Tests were conducted according to IEEE Std 1547.1-2005, chapter 5.10
Assessment criteria: After the disconnection, if the power grid resumes to normal state, the power producer must be able to wait about 120 seconds before reconnecting to the power grid.
Test results: The unit can wait for the required reconnection delay time before reconnecting to the power grid.

Reconnection conduction	Limit reconnection delay [s]	Max. measured reconnection delay [s]	Verdict
Reconnection after underfrequency protection	120	133	Pass
Reconnection after overfrequency protection		141	Pass
Reconnection after undervoltage second level protection		152	Pass
Reconnection after undervoltage first level protection		141	Pass
Reconnection after overvoltage first level protection		138	Pass
Reconnection after overvoltage second level protection		138	Pass

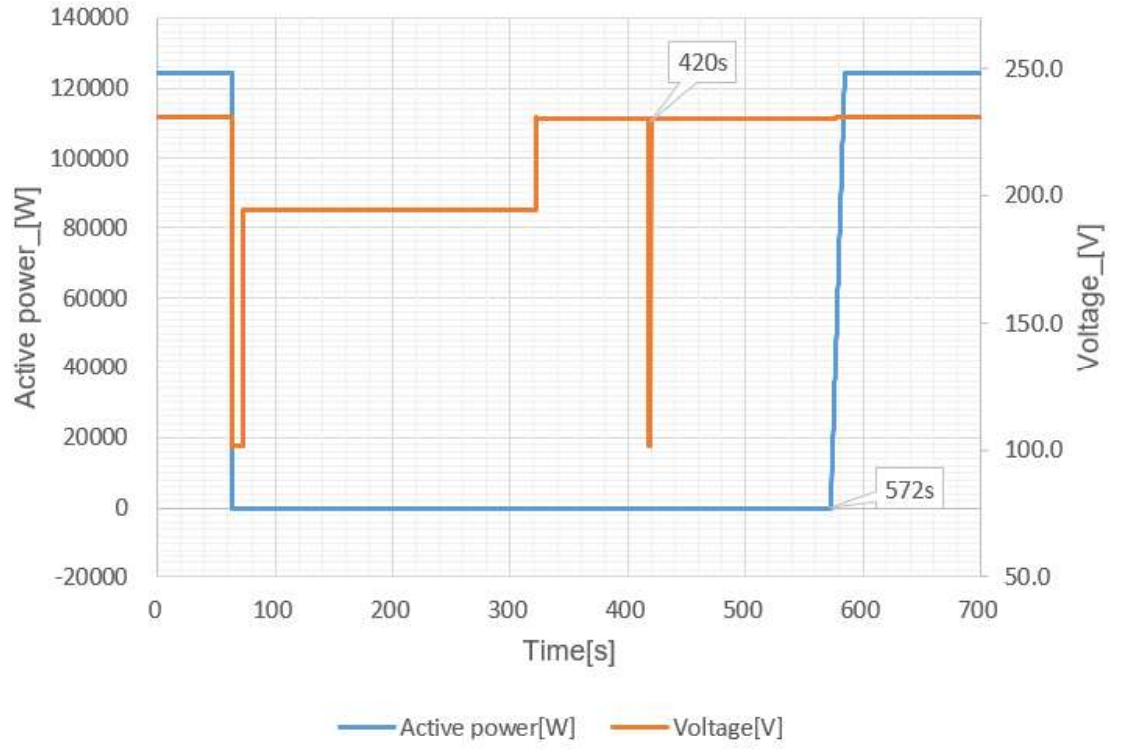
Reconnection after underfrequency protection



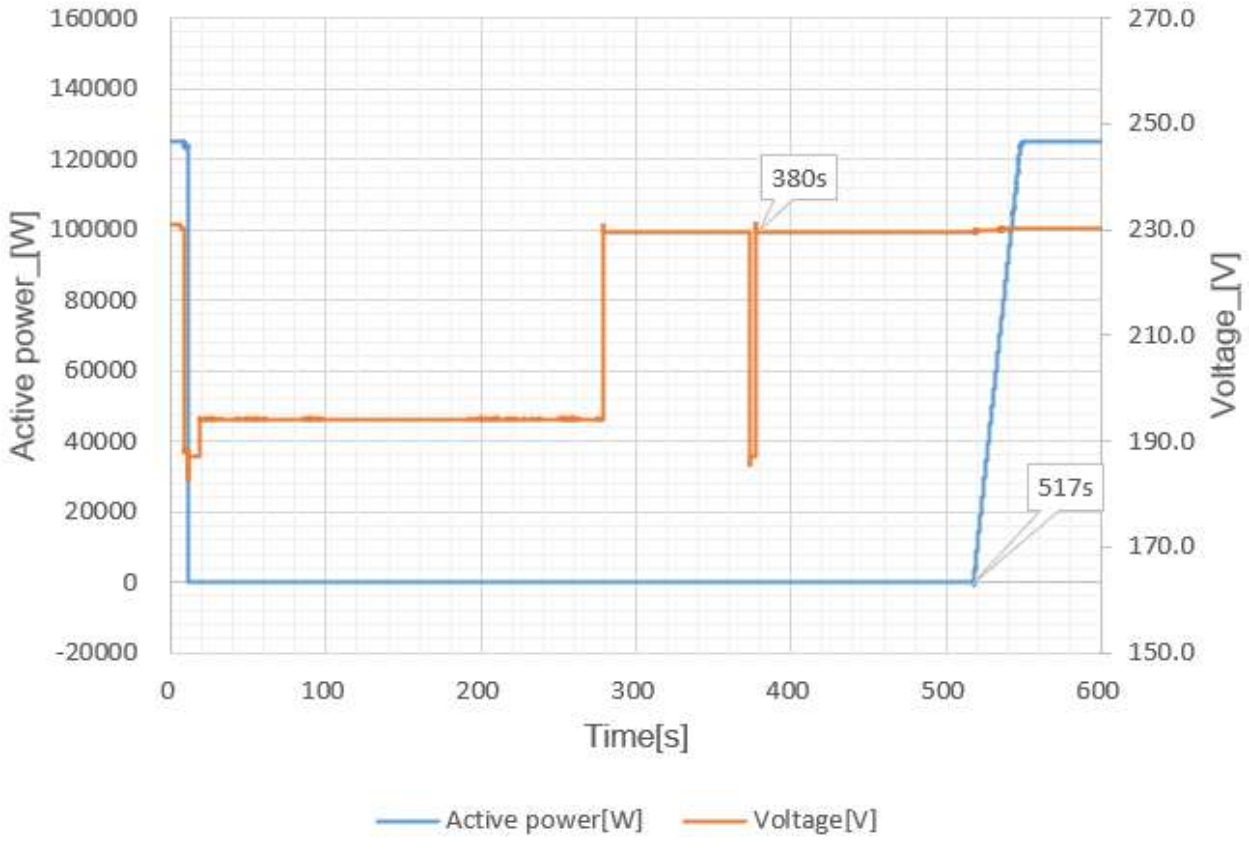
Reconnection after overfrequency protection



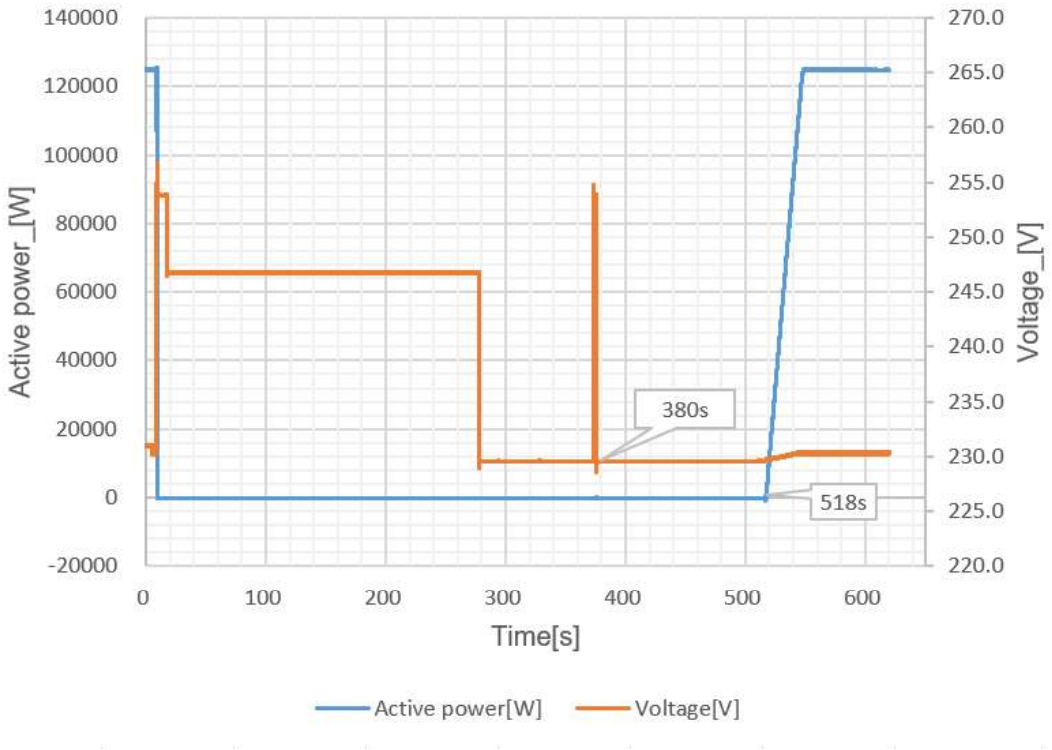
Reconnection after undervoltage second level protection



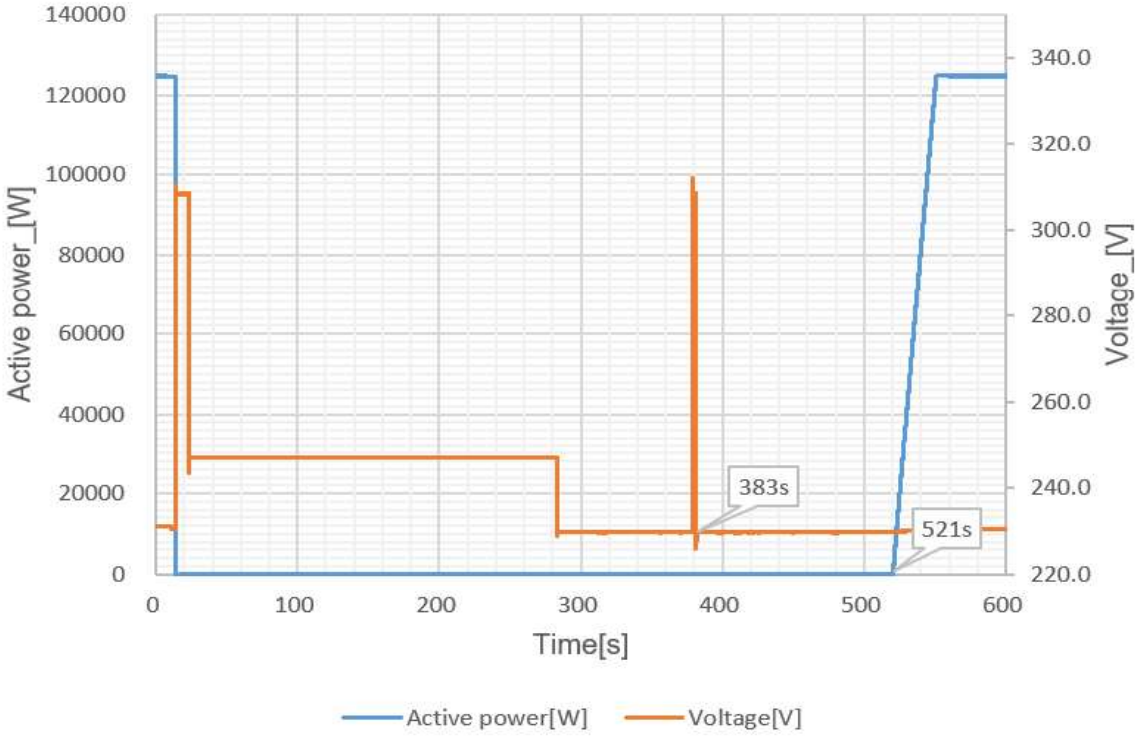
Reconnection after undervoltage first level protection



Reconnection after overervoltage first level protection



Reconnection after overvoltage second level protection

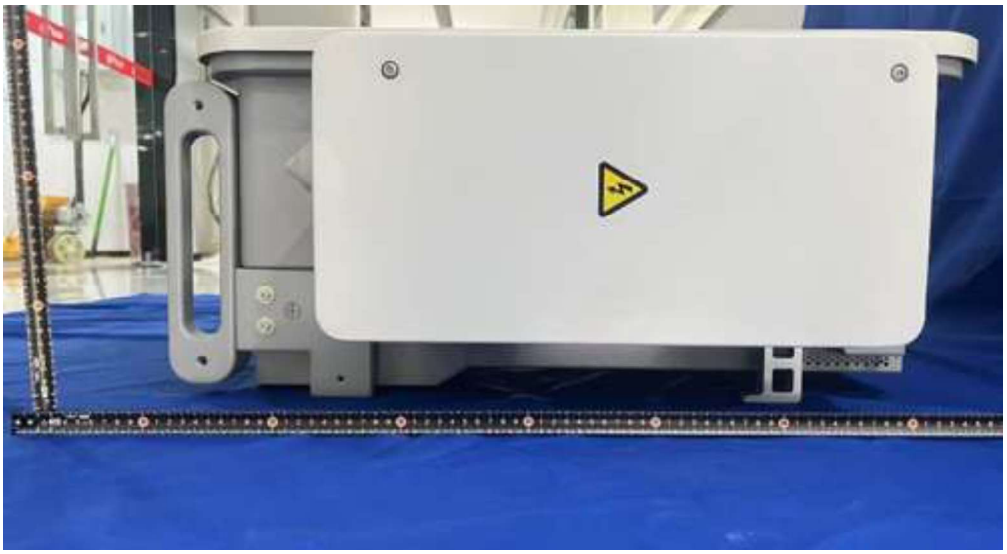


Annex 1 - Photo of the unit

Enclosure front view

Enclosure left view

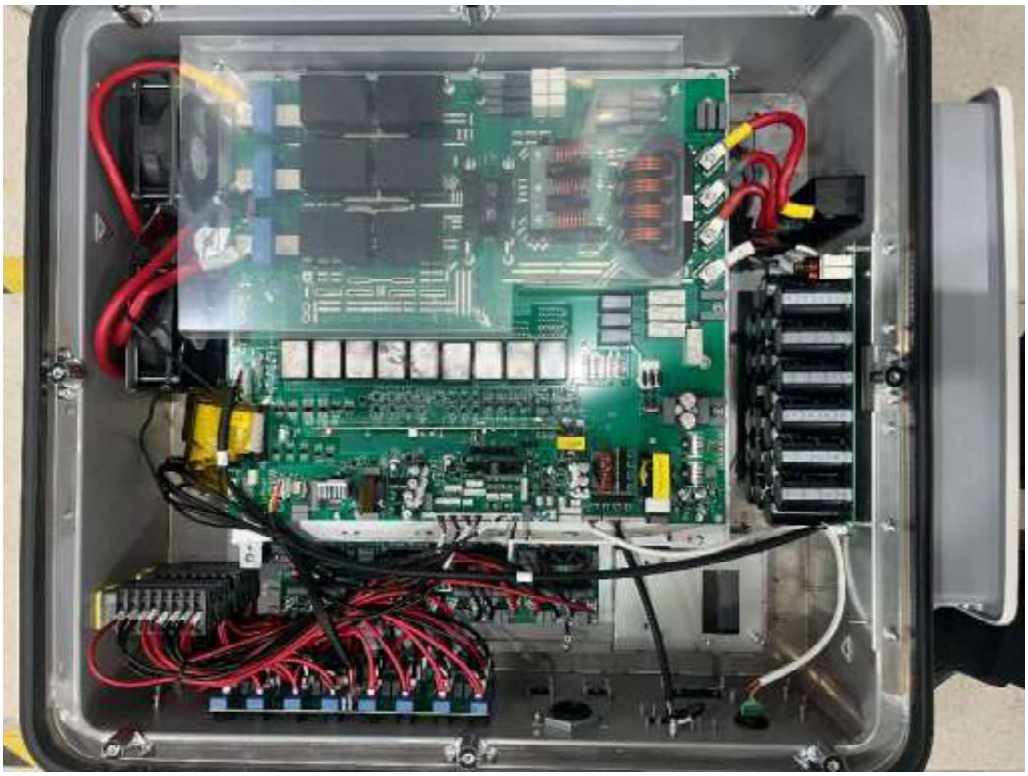
Enclosure right view



Enclosure rear view

Enclosure bottom view

Internal view



»»»» **End of Test Report** ««««