แบบตรวจสอบและรับรองรายงานผลการทดสอบ
อินเวอร์เตอร์ที่ใช้ในระบบผลิตไฟฟ้าประเภทเชื่อมต่อกับระบบโครงข่ายไฟฟ้าของการไฟฟ้านครหลวง

ส่วนที่ 1 การรับรองรายงานผลการทดสอบอินเวอร์เตอร์

1.1 รายละเอียดของอินเวอร์เตอร์	
ยี่ห้อ	Felicitysolar
รุ่น	IVGM20KLP3G1
Firmware Version	100
พิกัดทางไฟฟ้า	20 kW
1.2 รายละเอียดของรายงานผลการทดสอบ	
หมายเลขรายงานผลการทดสอบ	LS2A26040703EGTH08
ออกเมื่อวันที่	2026-06-16
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. China
1.3 การรับรองรายงานผลการทดสอบ	
ข้าพเจ้าขอรับรองว่าข้อมูลที่กรอกในเอกสารฉบับนี้มีความถูกต้องเป็นจริงและได้ตรวจสอบพบว่าผลการทดสอบอินเวอร์เตอร์ตามรายงานในข้อ 1.2 เป็นไปตามข้อกำหนดสำหรับอินเวอร์เตอร์ที่ใช้ในระบบผลิตไฟฟ้าประเภทเชื่อมต่อกับระบบโครงข่ายไฟฟ้าของการไฟฟ้านครหลวงทุกประการ	
ชื่อหน่วยตรวจสอบและรับรองผลการทดสอบอินเวอร์เตอร์	ศูนย์ทดสอบผลิตภัณฑ์ไฟฟ้าและอิเล็กทรอนิกส์
ที่อยู่หน่วยตรวจสอบและรับรองผลการทดสอบอินเวอร์เตอร์	141 อาคารกลุ่มนวัตกรรม ตึก D อุทยานวิทยาศาสตร์ประเทศไทย ถนนพหลโยธิน ตำบลคลองหนึ่ง อำเภอคลองหลวง จังหวัดปทุมธานี 12120
วันที่ออกเอกสาร	18 มิถุนายน 2569

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	0.041	0.143	0.049	0.170	0.056	0.192	≤ 1%	☑Pass☐ Fail
3rd	0.272	0.938	0.234	0.809	0.278	0.957	≤ 4%	☑Pass ☐Fail
4th	0.012	0.041	0.010	0.033	0.018	0.060	≤ 1%	☑Pass ☐Fail
5th	0.054	0.187	0.066	0.227	0.073	0.250	≤ 4%	☑Pass ☐Fail
6th	0.011	0.038	0.011	0.038	0.011	0.040	≤ 1%	☑Pass ☐Fail
7th	0.044	0.150	0.038	0.131	0.047	0.162	≤ 4%	☑Pass☐Fail
8th	0.016	0.055	0.010	0.036	0.008	0.026	≤ 1%	☑Pass ☐Fail
9th	0.106	0.364	0.081	0.280	0.118	0.408	≤ 4%	☑Pass ☐Fail
10th	0.010	0.033	0.009	0.030	0.010	0.035	≤ 1%	☑Pass ☐Fail
11th	0.122	0.422	0.114	0.394	0.169	0.584	≤ 2%	☑Pass ☐Fail
12th	0.009	0.032	0.011	0.036	0.010	0.034	≤ 0.5%	☑Pass ☐Fail
13th	0.117	0.403	0.098	0.339	0.150	0.516	≤2%	☑Pass ☐Fail
14th	0.009	0.031	0.006	0.022	0.012	0.042	≤ 0.5%	☑Pass ☐Fail
15th	0.091	0.316	0.100	0.344	0.115	0.396	≤ 2%	☑Pass ☐Fail
16th	0.008	0.028	0.009	0.031	0.010	0.036	≤ 0.5%	☑Pass ☐Fail
17th	0.061	0.209	0.084	0.290	0.095	0.327	≤ 1.5%	☑Pass ☐Fail
18th	0.007	0.025	0.009	0.029	0.010	0.034	≤ 0.375%	☑Pass ☐Fail
19th	0.050	0.173	0.059	0.204	0.068	0.233	≤ 1.5%	☑Pass ☐Fail
20th	0.009	0.031	0.006	0.021	0.007	0.024	≤ 0.375%	☑Pass ☐Fail
21st	0.072	0.249	0.035	0.120	0.044	0.153	≤ 1.5%	☑Pass ☐Fail
22nd	0.005	0.017	0.006	0.019	0.005	0.019	≤ 0.375%	☑Pass ☐Fail
23rd	0.065	0.224	0.033	0.113	0.034	0.119	≤ 0.6%	☑Pass ☐Fail
24th	0.011	0.038	0.006	0.020	0.004	0.013	≤ 0.15%	☑Pass ☐Fail
25th	0.050	0.171	0.033	0.114	0.018	0.063	≤ 0.6%	☑Pass ☐Fail
26th	0.007	0.024	0.005	0.017	0.004	0.012	≤ 0.15%	☑Pass ☐Fail
27th	0.038	0.131	0.033	0.114	0.028	0.098	≤ 0.6%	☑Pass ☐Fail
28th	0.003	0.012	0.004	0.015	0.005	0.017	≤ 0.15%	☑Pass ☐Fail
29th	0.054	0.186	0.032	0.110	0.016	0.055	≤ 0.6%	☑Pass ☐Fail
30th	0.009	0.030	0.009	0.030	0.004	0.015	≤ 0.15%	☑Pass ☐Fail
31st	0.063	0.216	0.038	0.130	0.015	0.053	≤ 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	0.006	0.021	0.006	0.019	0.004	0.012	≤ 0.15%	☑Pass ☐Fail
33rd	0.061	0.212	0.045	0.155	0.006	0.021	≤ 0.6%	☑Pass ☐Fail
34th	0.004	0.014	0.004	0.015	0.003	0.010	≤ 0.15%	☑Pass ☐Fail
35th	0.058	0.201	0.045	0.155	0.005	0.019	≤ 0.3%	☑Pass ☐Fail
36th	0.003	0.011	0.004	0.015	0.003	0.009	≤ 0.075%	☑Pass ☐Fail
37th	0.047	0.163	0.047	0.162	0.006	0.020	≤ 0.3%	☑Pass ☐Fail
38th	0.003	0.010	0.004	0.014	0.002	0.008	≤ 0.075%	☑Pass ☐Fail
39th	0.042	0.144	0.046	0.160	0.007	0.025	≤ 0.3%	☑Pass ☐Fail
40th	0.004	0.012	0.004	0.013	0.002	0.008	≤ 0.075%	☑Pass ☐Fail
TRDi	--	1.382	--	1.184	--	1.415	≤ 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	0.06	0.03
Result confirmation	☑Pass ☐Fail	☑Pass ☐Fail

อ้างอิงจากรายงานผลการทดสอบตามข้อ 6.2 หน้า : 20

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)	0.277	0.302	0.276
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	0.090	≤ 0.1	☑ Pass ☐ Fail
Over frequency	52.01	0.1	0.085	≤ 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	0.091	≤ 0.1	☑ Pass ☐ Fail
Undervoltage level 1	199	345	2.0	1.999	≤ 2	☑ Pass ☐ Fail
Overvoltage level 1	241	417	2.0	1.998	≤ 2	☑ Pass ☐ Fail
Overvoltage level 2(4)	☐311 or ☑.264....	☐ 539 or ☐.....	0.05	0.047	≤ 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	0.283	0	0	0.263	0	0	0.252
2	0	-5	0.094	0	-5	0.081	-10	-10	--
3	0	-4	0.134	0	-4	0.091	-10	-5	--
4	0	-3	0.122	0	-3	0.097	-10	0	--
5	0	-2	0.251	0	-2	0.106	-10	+5	--
6	0	-1	0.238	0	-1	0.119	-10	+10	--
7	0	1	0.156	0	1	0.212	-5	-10	--
8	0	2	0.135	0	2	0.127	-5	-5	0.134
9	0	3	0.115	0	3	0.113	-5	0	0.234
10	0	4	0.119	0	4	0.146	-5	+5	0.096
11	0	5	0.098	0	5	0.099	-5	+10	--
12							0	-10	--
13							0	-5	0.082
14							0	+5	0.079
15							0	+10	--
16							+5	-10	--
17							+5	-5	0.123
18							+5	0	0.245
19							+5	+5	0.133
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	131	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Over frequency	120	132	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Under voltage level 2	120	139	☑Yes ☐No	☑Yes ☐No	☑Pas s☐Fail
Under voltage level 1	120	147	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Over voltage level 1	120	138	☑Yes ☐No	☑Yes ☐No	☑Pass ☐Fail
Over voltage level 2	120	135	☑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)	



TEST REPORT

MEA (2015)

Grid-connected inverter regulations of the Metropolitan Electricity Authority

Guangzhou Felicity Solar Technology Co., Ltd.

For the unit(s) **IVGM20KLP3G1**

Test report no. **LS2A26040703EGTH08**

Date **2026-06-16**

ACCREDITED
Certificate # 5200.02

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Test report number.....:	**LS2A26040703EGTH08**
Date of issue.....:	2026-06-16
Total number of pages.....:	44
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 .....:	**Guangzhou Felicity Solar Technology Co., Ltd.**
Address.....:	(Airport Baiyun)No.2, 4, 6, 8, 10 and 12 Donghua Huaye Road, Renhe Town, Baiyun District, Guangzhou, Guangdong, P. R. 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: Hybrid Inverter
Trademark .....:	Felicitysolar® Make life full of hope (Felicitysolar)
Model / Type reference.....:	IVGM20KLP3G1
Technical data .....:	See section 3.1 on p.6
Dates of testing.....:	2026-04-07 to 2026-05-25

Tested / Report prepared by

Biscuit Ren (Test engineer)

Approved by

LYNS-TCi TECHNOLOGY LYNS-TCi

Lukes Lin (Project manager)

Contents

1 General information of test report....4
1.1 Important Note....4
1.2 Revision history....4
2 General remarks for documentation....5
3 General product information....7
3.1 Technical data of the unit(s)....7
3.2 Copy of marking plate....8
3.3 Description of the power circuit....9
4 General remarks for testing....10
4.1 Scope of measurements....10
4.2 Reference values....12
4.3 Measurement setup....12
4.4 Measurement equipment....14
5 Assessment overview....15
6 Measurement results....18
6.1 3.1.1 Harmonics....18
6.2 3.1.2 Voltage Fluctuation test....20
6.3 3.1.3 DC Injection....22
6.4 3.2.1 Operating Voltage Range....23
6.5 3.2.2 Operating Frequency Range....30
6.6 3.2.3 Islanding Protection....32
6.7 3.2.4 Response to Utility Recovery....37
Annex 1 - Photo of the unit....41

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
LS2A26040703EGTH08	2026-06-16	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

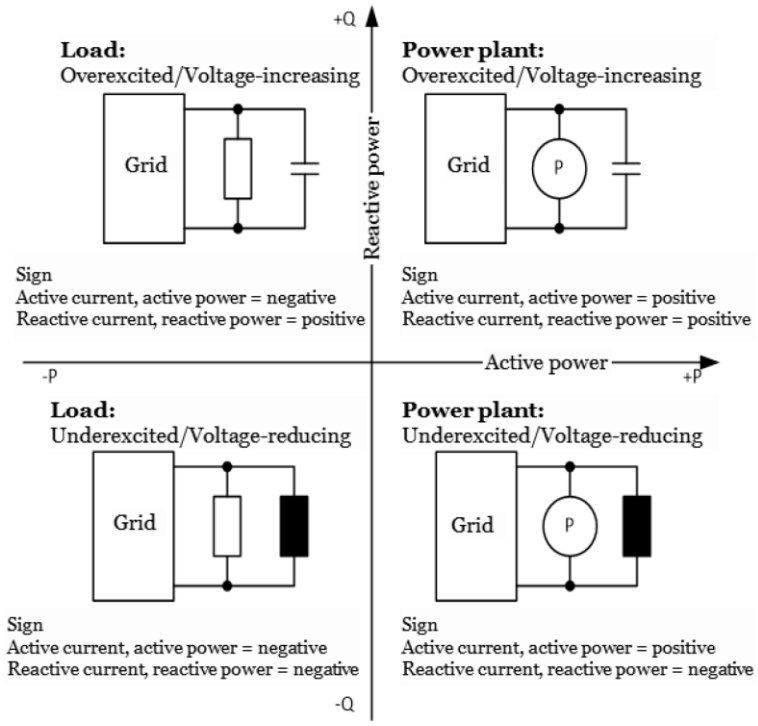
Abbreviations

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 ..... : Guangzhou Felicity Solar Technology Co., Ltd.

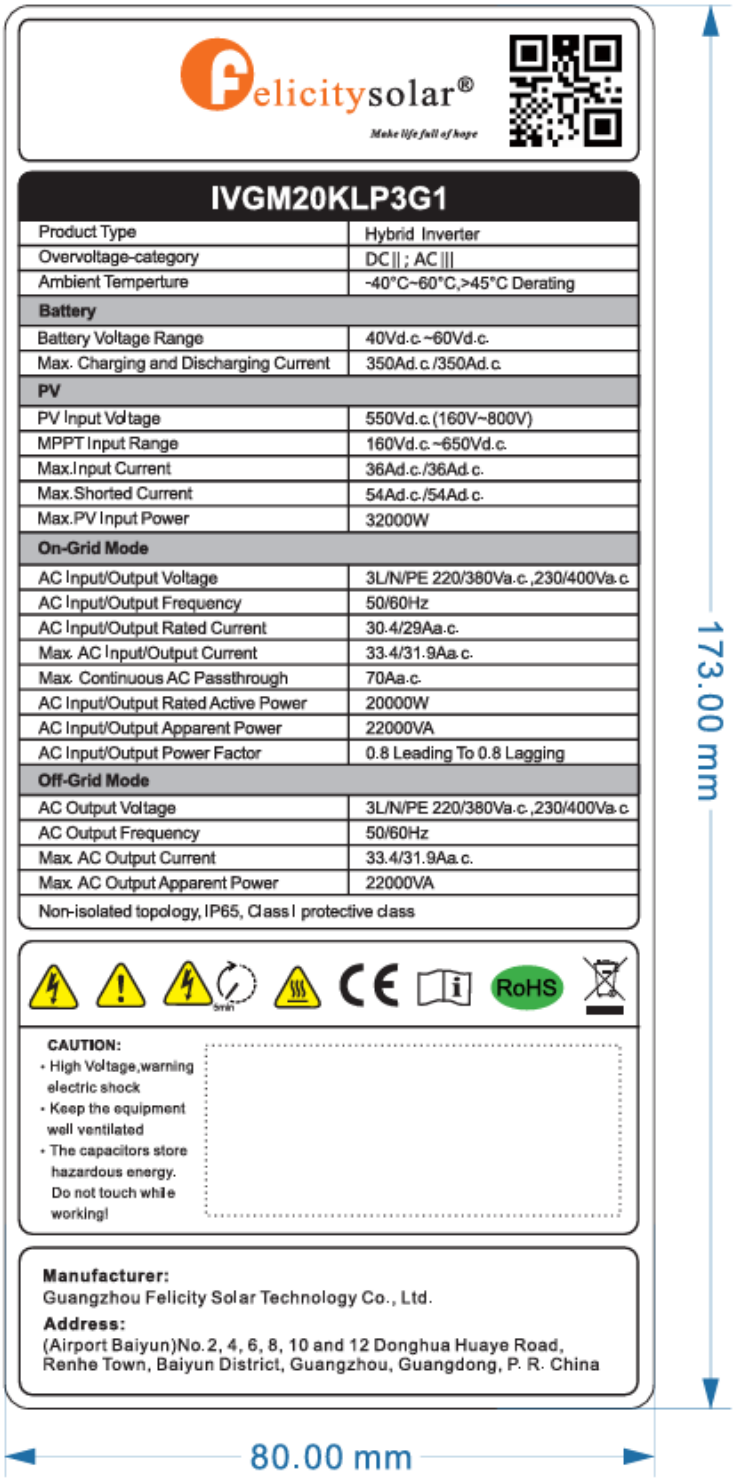
Factory address ..... : (Airport Baiyun)No.2, 4, 6, 8, 10 and 12 Donghua Huaye Road, Renhe Town, Baiyun District, Guangzhou, Guangdong, P. R. China

3.1 Technical data of the unit(s)

Unit / Type ..... :	**IVGM20KLP3G1**
Hardware version (tested) ..... :	1.0
Software version (tested) ..... :	100
PV input	
Max. PV input voltage [V] ..... :	800
Operating MPPT voltage range [V]..... :	160-650
PV input current [A] ..... :	36/36
Battery	
Battery Voltage Range [V] ..... :	40 ~ 60
Max. Charge / Discharge Current [A] .... :	350/350
AC output	
Nominal output AC voltage [V] ..... :	3L/N/PE, 220/230
Max. output AC current [A] ..... :	33.4/31.9
AC output frequency [Hz] ..... :	50/60
Nominal active power P_n [kW] ..... :	20.0
Max. apparent power [kVA] ..... :	22.0
Note: All test items are carried out at 230V, 50Hz.	

Mass of equipment [kg] .....:	60.2
Communication.....:	CAN, RS485, WiFi/4G
Operating Ambient Temperature.....:	-40°C to +60°C
IP Rating.....:	IP65
Protective Class.....:	Class I
Topology.....:	Non-isolated

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 PV and battery input and output are protected by varistors to ground. The unit is providing EMI filtering at the PV and battery DC input and AC output side towards 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 PV and battery inputs and the mains. All relays are tested before each start.

The internal control is redundant. It consists of a main DSP (U26) and a slave DSP (U29).

The main DSP (U26) controls the relays with switching signals; measures PV input voltage, PV input current, battery input voltage, battery input current, 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 DSP (U29) measures the mains voltage, mains frequency and residual current, can also switch off the relays independently, and communicates with the main DSP (U26). The current is measured by a current sensor. The AC current signal and the injected DC current signal together with PV and battery input signals are sent to the main DSP (U26). The main DSP (U26) tests and calibrates all the current sensors before each start-up.

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

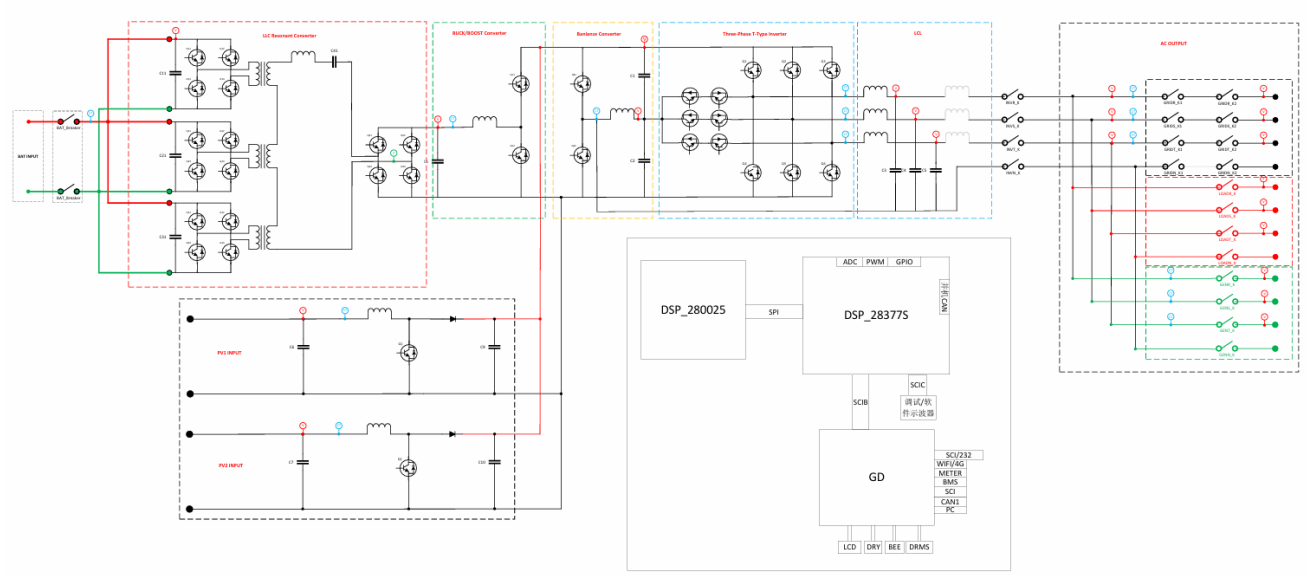


Figure 1 – Block diagram of the power circuit

4 General remarks for testing

4.1 Scope of measurements

Date of receipt of test items ..... : 2026-04-07

Date(s) of performance of tests ..... : 2026-04-07 to 2026-05-25

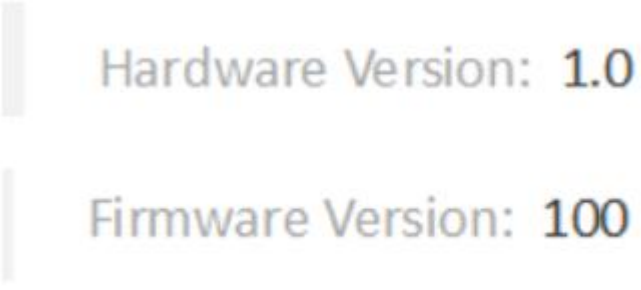
During the test period stated above following environmental data were recorded:

- Temperature: 26.4°C
- Rel. humidity: 48.9%RH
- Air pressure: 998.1 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 61000-3-11	MEA IEC 61000-3-11	☒
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:**IVGM20KLP3G1**
Serial No.: 120420004826110202
Hardware Version: 1.0
Software Version: 100



- **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 2s	

* 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.

- 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:

	IVGM20KLP3G1
Nominal active output power P_n [kW]	20.0
Rated voltage (phase-to-neutral), U_n [V]	230
Rated current, I_n [A]	28.986

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 = 230V (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 (Isc= 38.654A, U_{oc} =646.76 V)simulated according to EN50530:

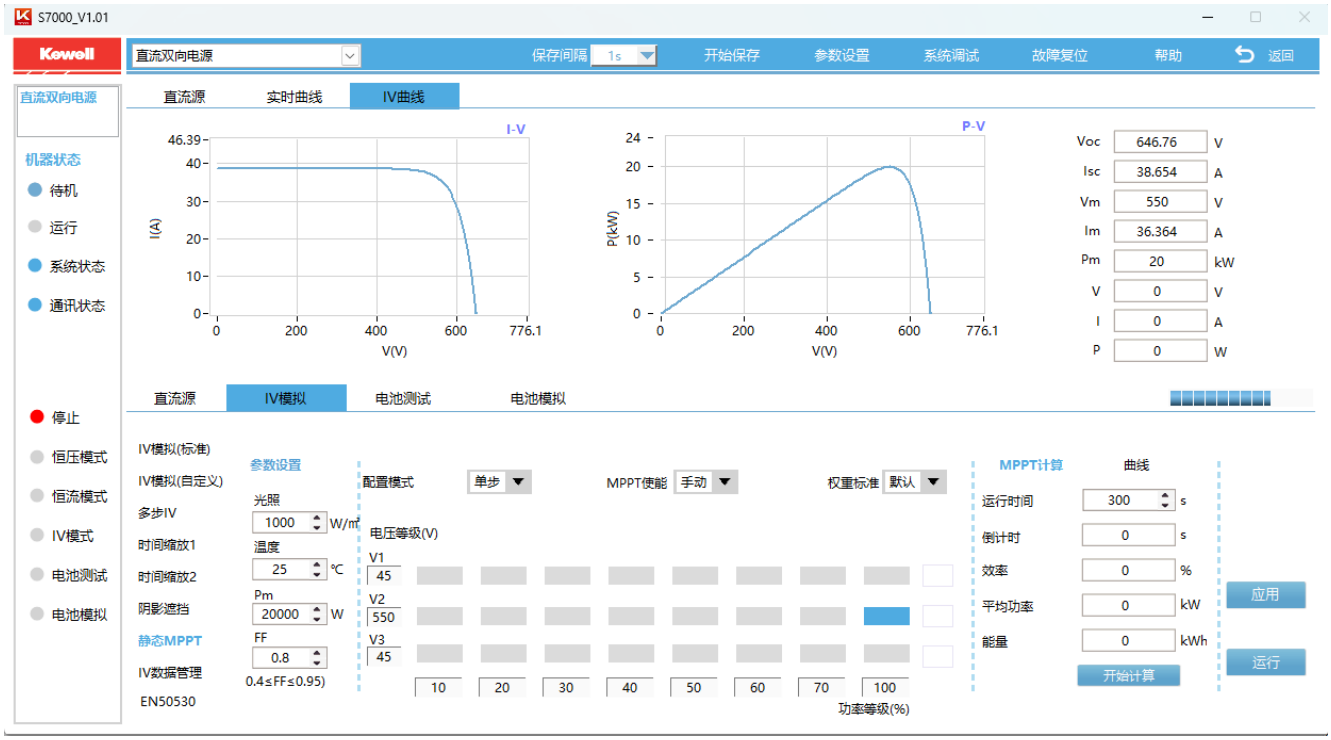


Figure 2 – DC characteristics for testing

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

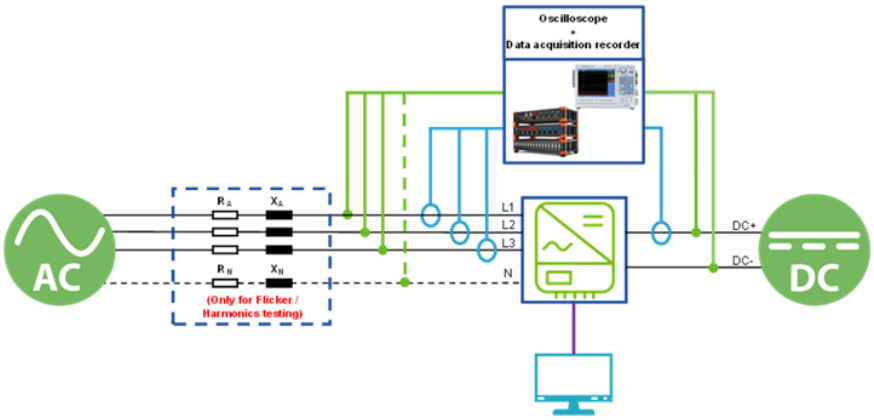


Figure 3 – Measurement setup used for single-phase tests except Loss of Mains and Short Circuit test

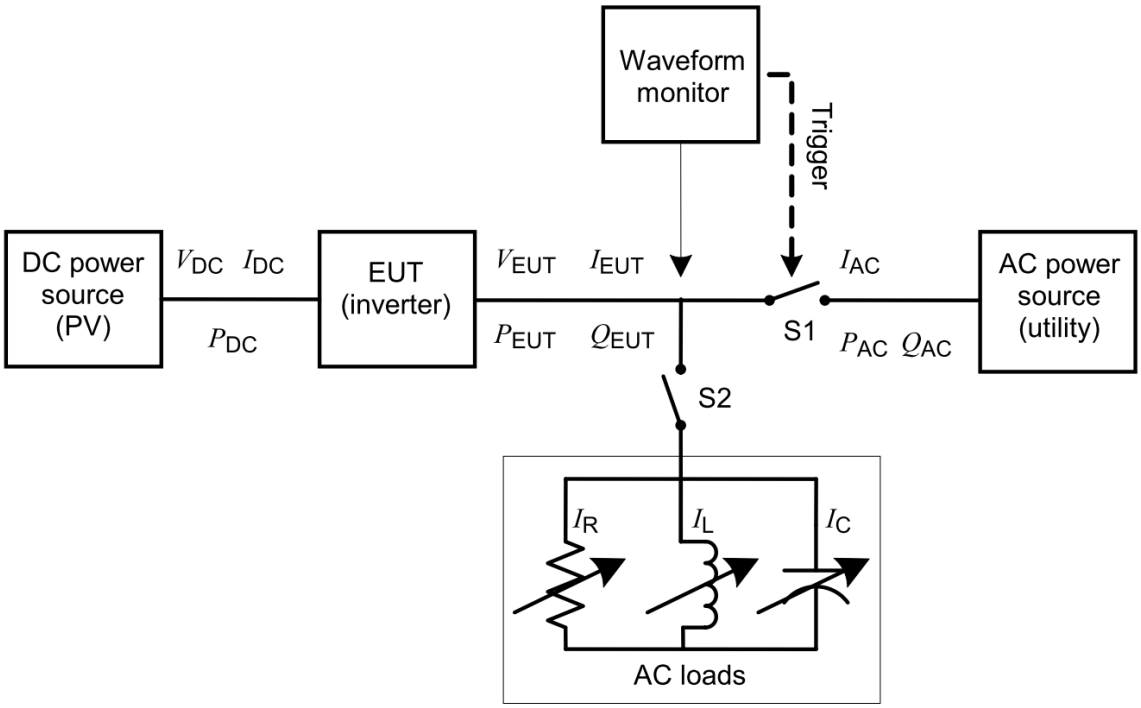


Figure 4– Test circuit for Loss of Mains according to *IEC 62116:2014*

4.4 Measurement equipment

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
DC power supply [1]	HC-ENG-043	KEWELL	S7000-21K-2000-0040	6018888221003326	Monitoring by power analyzer
AC Simulator[1]	HC-ENG-048	KEWELL	KAC-S-150-33	6040012007024114	
RLC Load	HC-ENG-059	LYNS-Tci	IMAX5345-45KVA	20230415013	
Power analyser	HC-ENG-046	DEWETRON	TRION-1820-POWER	A1222035/ C5220875	2026-03-20
Current sensor		SIGNALTEC	CT 400	1221300591	
Current sensor		SIGNALTEC	CT 400	1221300592	
Current sensor		SIGNALTEC	CT 400	1221300593	
Current sensor		SIGNALTEC	CT 400	1221300594	

Note:

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

[1] The AC simulator and DC sources do not need to be calibrated, since the AC voltage and current is measured and determined using the calibrated oscilloscope and power analyser.

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 61000-3-11 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>
</table>

<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>3.2.1</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 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:
<table>
<tr><th colspan="2">Voltage Range (Volt)</th><th rowspan="2">Max. Disconnecting Time (Second)</th></tr>
<tr><th>Line to Line</th><th>Line to Neutral</th></tr>
<tr><td>V < 199</td><td>V < 115</td><td>0.1</td></tr>
<tr><td>199 ≤ V < 346</td><td>115 ≤ V < 200</td><td>2.0</td></tr>
<tr><td>346 ≤ V ≤ 416</td><td>200 ≤ V ≤ 240</td><td>continuously operate (without disconnection)</td></tr>
<tr><td>416 < V < 539</td><td>240 < V < 311</td><td>2.0</td></tr>
<tr><td>V ≥ 539</td><td>V ≥ 311</td><td>0.05</td></tr>
</table></td><td>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</td><td>P</td></tr>
<tr><td></td><td>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;
<table>
<tr><th>Voltage Range (% Nominal Voltage of Inverter)</th><th>Max. Disconnecting Time (Second)</th></tr>
<tr><td>V < 50%</td><td>0.1</td></tr>
<tr><td>50% ≤ V < 85%</td><td>2.0</td></tr>
<tr><td>85% ≤ V ≤ 110%</td><td>continuously operate (without disconnection)</td></tr>
<tr><td>110% < V < 135%</td><td>2.0</td></tr>
<tr><td>V ≥ 135%</td><td>0.05</td></tr>
</table></td><td>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.</td><td>N/A</td></tr>
<tr><td>3.2.2</td><td>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.</td><td>If the frequency outside the range between 47.00 Hz – 52.00 Hz, the unit disconnects from the grid within 0.1 s.

Test results see 6.5</td><td>P</td></tr>
</table>

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]: 28,985

P [%P_n]	33		66		100		Limit [5]	Verdict
Order	[A]	[%I_n]	[A]	[%I_n]	[A]	[%I_n]	[%In]	
1	9,692		19,278		29,543		--	--
2	0,041	0,143	0,049	0,170	0,056	0,192	1	Pass
3	0,272	0,938	0,234	0,809	0,278	0,957	4	Pass
4	0,012	0,041	0,010	0,033	0,018	0,060	1	Pass
5	0,054	0,187	0,066	0,227	0,073	0,250	4	Pass
6	0,011	0,038	0,011	0,038	0,011	0,040	1	Pass
7	0,044	0,150	0,038	0,131	0,047	0,162	4	Pass
8	0,016	0,055	0,010	0,036	0,008	0,026	1	Pass
9	0,106	0,364	0,081	0,280	0,118	0,408	4	Pass
10	0,010	0,033	0,009	0,030	0,010	0,035	1	Pass
11	0,122	0,422	0,114	0,394	0,169	0,584	2	Pass
12	0,009	0,032	0,011	0,036	0,010	0,034	0,5	Pass
13	0,117	0,403	0,098	0,339	0,150	0,516	2	Pass
14	0,009	0,031	0,006	0,022	0,012	0,042	0,5	Pass
15	0,091	0,316	0,100	0,344	0,115	0,396	2	Pass
16	0,008	0,028	0,009	0,031	0,010	0,036	0,5	Pass
17	0,061	0,209	0,084	0,290	0,095	0,327	1,5	Pass
18	0,007	0,025	0,009	0,029	0,010	0,034	0,375	Pass
19	0,050	0,173	0,059	0,204	0,068	0,233	1,5	Pass
20	0,009	0,031	0,006	0,021	0,007	0,024	0,375	Pass
21	0,072	0,249	0,035	0,120	0,044	0,153	1,5	Pass
22	0,005	0,017	0,006	0,019	0,005	0,019	0,375	Pass
23	0,065	0,224	0,033	0,113	0,034	0,119	0,6	Pass
24	0,011	0,038	0,006	0,020	0,004	0,013	0,15	Pass
25	0,050	0,171	0,033	0,114	0,018	0,063	0,6	Pass
26	0,007	0,024	0,005	0,017	0,004	0,012	0,15	Pass
27	0,038	0,131	0,033	0,114	0,028	0,098	0,6	Pass
28	0,003	0,012	0,004	0,015	0,005	0,017	0,15	Pass

29	0,054	0,186	0,032	0,110	0,016	0,055	0,6	Pass
30	0,009	0,030	0,009	0,030	0,004	0,015	0,15	Pass
31	0,063	0,216	0,038	0,130	0,015	0,053	0,6	Pass
32	0,006	0,021	0,006	0,019	0,004	0,012	0,15	Pass
33	0,061	0,212	0,045	0,155	0,006	0,021	0,6	Pass
34	0,004	0,014	0,004	0,015	0,003	0,010	0,15	Pass
35	0,058	0,201	0,045	0,155	0,005	0,019	0,3	Pass
36	0,003	0,011	0,004	0,015	0,003	0,009	0,075	Pass
37	0,047	0,163	0,047	0,162	0,006	0,020	0,3	Pass
38	0,003	0,010	0,004	0,014	0,002	0,008	0,075	Pass
39	0,042	0,144	0,046	0,160	0,007	0,025	0,3	Pass
40	0,004	0,012	0,004	0,013	0,002	0,008	0,075	Pass
41	0,048	0,165	0,044	0,151	0,006	0,022	0,3	Pass
42	0,004	0,012	0,005	0,016	0,004	0,015	0,075	Pass
43	0,050	0,174	0,042	0,143	0,009	0,030	0,3	Pass
44	0,003	0,009	0,003	0,012	0,002	0,007	0,075	Pass
45	0,053	0,182	0,047	0,161	0,015	0,051	0,3	Pass
46	0,004	0,015	0,003	0,011	0,002	0,007	0,075	Pass
47	0,047	0,164	0,043	0,150	0,015	0,051	0,3	Pass
48	0,003	0,011	0,003	0,011	0,004	0,013	0,075	Pass
49	0,039	0,135	0,041	0,142	0,010	0,035	0,3	Pass
50	0,003	0,011	0,005	0,016	0,003	0,009	0,075	Pass
THD [$\%I_1$] [6)]	--	1,382	--	1,184	--	1,415	<5%	Pass

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

6.2 3.1.2 Voltage Fluctuation test

☒ The EUT with output rated current ≤ 75A per phase

Output parameters of grid		Voltage [V]:	230,0	Frequency [Hz]:	50,0
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 61000-3-11* 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	0,27	0,12	0,00	0,41	0,20	0,00	0,06	0,03
	L2	0,32	0,14	0,00	0,26	0,11	0,00	0,02	0,01
	L3	0,33	0,21	0,00	0,30	0,11	0,00	0,02	0,02
Limits according to 61000-3-11		4%	3,3%	500 ms	4%	3,3%	500 ms	1,0	0,3
Z_{test}				R = 0,24 Ω			X = 0,15 Ω		
Z_{ref}		☐ *1-phase*		R = 0,40 Ω			X = 0,25 Ω		
		☒ *3-phase*		R = 0,24 Ω			X = 0,15 Ω		

Note:

* 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	--	--	--	--	
2	10	--	--	--	--	
3	20	--	--	--	--	
4	30	--	--	--	--	
5	40	--	--	--	--	
6	50	--	--	--	--	
7	60	--	--	--	--	
8	70	--	--	--	--	
9	80	--	--	--	--	
10	90	--	--	--	--	
11	95	--	--	--	--	
12	100	--	--	--	--	
Results		--	--	--	--	--

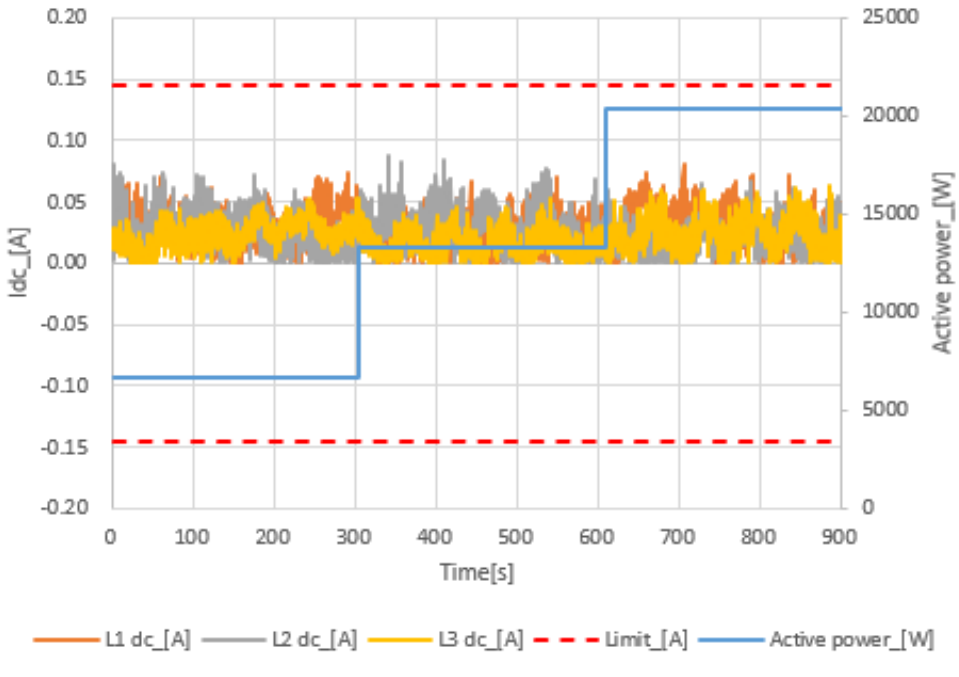
6.3 3.1.3 DC Injection

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:0,145A**					
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	0,073	0,027	0,080	0,027	0,054	0,024
66%P_n	0,071	0,023	0,088	0,029	0,053	0,016
100%P_n	0,080	0,030	0,067	0,021	0,063	0,024

Output power:	MEA Limit [%I_n]	Overall max. DC Injection [%I_n]	verdict
33%P_n	0,5	0,277	Pass
66%P_n		0,302	Pass
100%P_n		0,276	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					241			
Measured trip value [V]		All	L1	L2	L3		All	L1	L2	L3
		198,7	198,1	198,7	198,9		241,9	241,8	241,7	241,9
		198,6	198,1	198,7	198,9		241,9	241,8	241,7	241,9
		198,6	198,8	198,7	198,9		241,9	241,8	241,7	241,9
		198,6	198,8	198,7	198,9		241,9	241,8	241,7	241,9
		198,6	198,1	198,7	198,9		241,9	241,8	241,7	241,9
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
		1,993	1,994	1,980	1,993		1,984	1,998	1,985	1,980
		1,994	1,984	1,978	1,992		1,996	1,986	1,986	1,984
		1,977	1,982	1,999	1,997		1,983	1,988	1,988	1,997
		1,978	1,997	1,985	1,981		1,985	1,985	1,988	1,993
		1,994	1,988	1,983	1,999		1,988	1,998	1,988	1,988

		Second level undervoltage					Second level overvoltage			
Trip setting [V]		114					264			
Measured trip value [V]		All	L1	L2	L3		All	L1	L2	L3
		113,6	113,2	113,0	113,2		264,1	264,9	264,8	264,1
		113,6	113,2	113,0	113,2		264,1	264,9	264,8	264,1
		113,6	113,2	113,0	113,2		264,1	264,9	264,8	264,1
		113,6	113,2	113,0	113,2		264,1	264,9	264,8	264,1
		113,6	113,2	113,0	113,2		264,1	264,9	264,8	264,1
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
		0,066	0,087	0,088	0,087		0,044	0,045	0,046	0,046
		0,087	0,068	0,089	0,087		0,046	0,026	0,046	0,047
		0,088	0,089	0,069	0,089		0,027	0,047	0,027	0,047
		0,069	0,090	0,091	0,070		0,047	0,028	0,048	0,047
		0,090	0,070	0,090	0,090		0,028	0,049	0,028	0,048

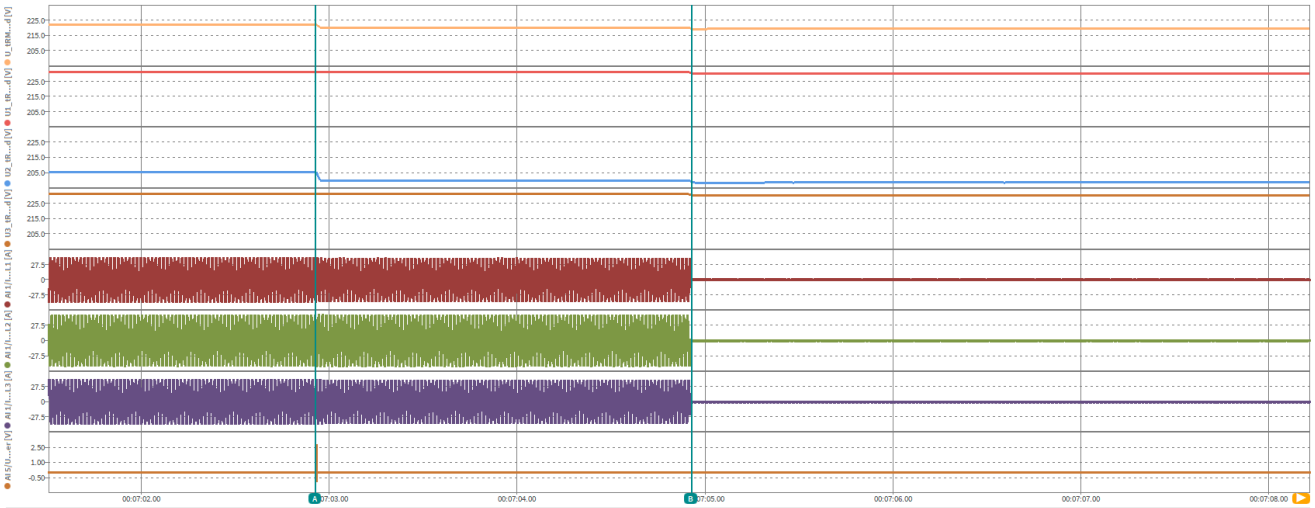
Overall maximum value in all conditions						
	☒ V_{L-N} setting[2] [V]	☐ V_{L-L} setting[2] [V]	Measured trip value [V]	Measured Time Delay [sec][3]	Limit Time Delay [sec]	Result confirmation
Undervoltage level 2[4]	☒114 or ☐....	☐198 or ☐....	113,9	0,091	≤ 0,1	Pass
Undervoltage level 1	199	345	198,9	1,999	≤ 2,0	Pass
Overvoltage level 1	241	417	241,9	1,998	≤ 2,0	Pass
Overvoltage level 2[4]	☒264 or ☐298	☐539 or ☐....	264,9	0,047	≤ 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
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--
		--	--	--	--		--	--	--	--

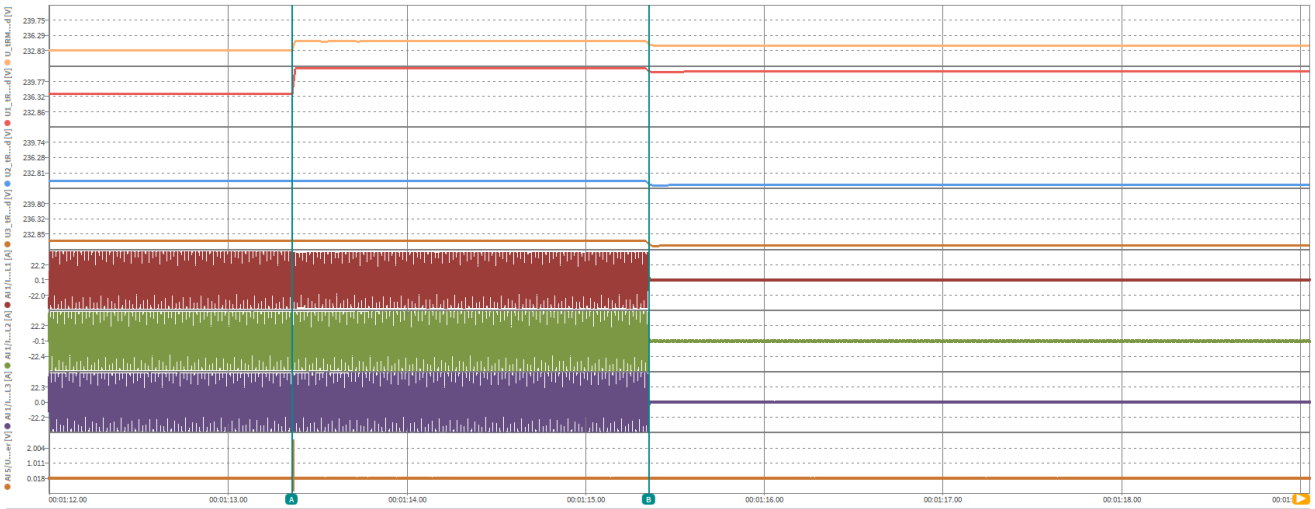
Overall maximum result in all conditions					
	V setting [% of rated output voltage]	Measured trip value [V]	Measured Time Delay [sec][3]	Limit Time Delay [sec]	Result confirmation
Undervoltage level 2[4]	☐50% Vn or ☐.....% Vn	--	--	≤ 0,1	--
Undervoltage level 1	85% Vn	--	--	≤ 2,0	--
Overvoltage level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

Under Voltage First Level single phase



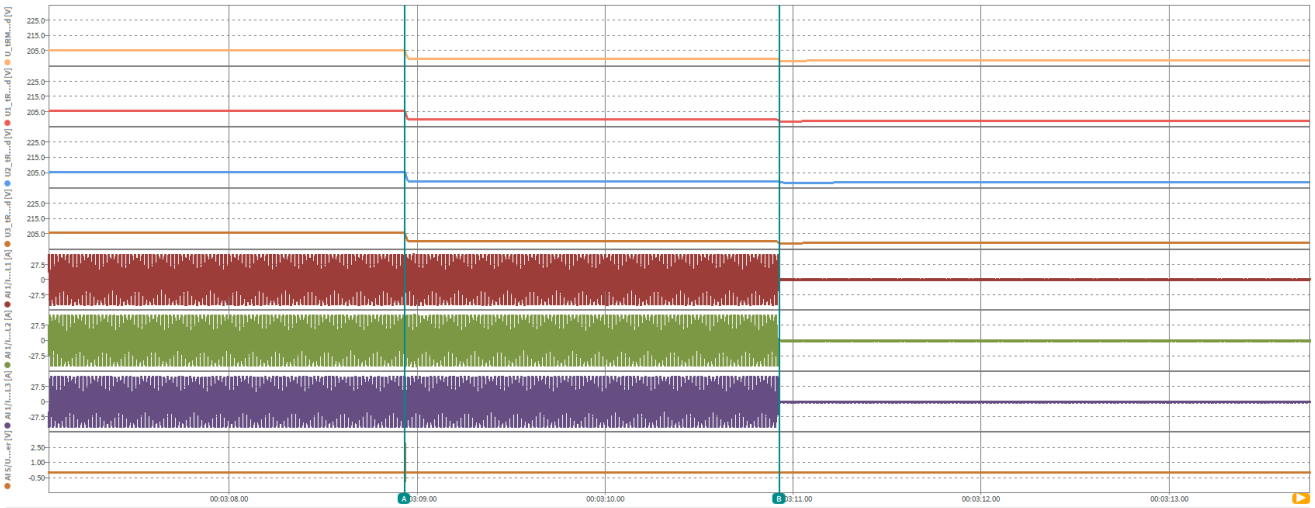
	A	B	间隔
时间 [s]	7:02.928100	7:04.927300	1.999200
U_tRMS@Grid [V]	222.1848	220.1768	-2.007996
U1_tRMS@Grid [V]	230.7175	230.6784	-0.039063
U2_tRMS@Grid [V]	204.9789	199.0230	-5.955902
U3_tRMS@Grid [V]	230.8580	230.8290	-0.029022
AI 1/I1_Grid_L1 [A]	-8.074284	0.380039	8.454323
AI 1/I2_Grid_L2 [A]	42.89341	-0.549793	-43.44321
AI 1/I3_Grid_L3 [A]	-30.58720	-0.795364	29.79183
AI 5/U4_Trigger [V]	0.026464	0.024080	-2.384e-3

Over voltage First Level single phase



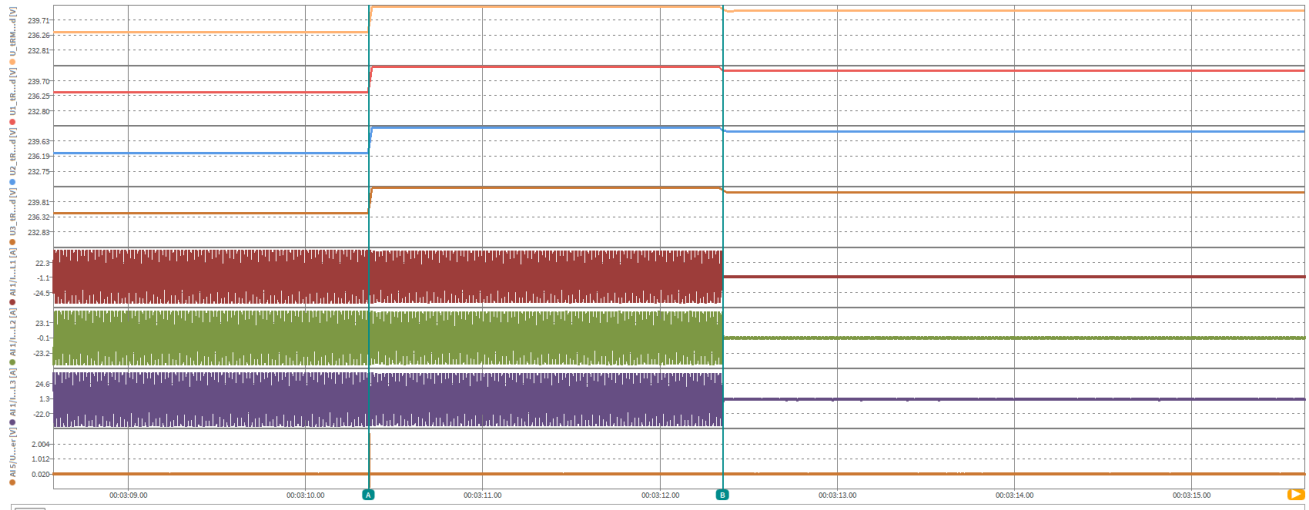
	A	B	间隔
时间 [s]	1:13.357700	1:15.355800	1.998100
U_tRMS@Grid [V]	232.8619	234.8676	2.005768
U1_tRMS@Grid [V]	236.7837	242.7571	5.973465
U2_tRMS@Grid [V]	230.7968	230.8224	0.025574
U3_tRMS@Grid [V]	231.0051	231.0233	0.018280
AI 1/I1_Grid_L1 [A]	-40.01271	2.142083	42.15479
AI 1/I2_Grid_L2 [A]	25.90889	0.998441	-24.91045
AI 1/I3_Grid_L3 [A]	15.09118	-2.838372	-17.92956
AI 5/U4_Trigger [V]	0.021458	0.023127	1.669e-3

Under Voltage First Level all phase



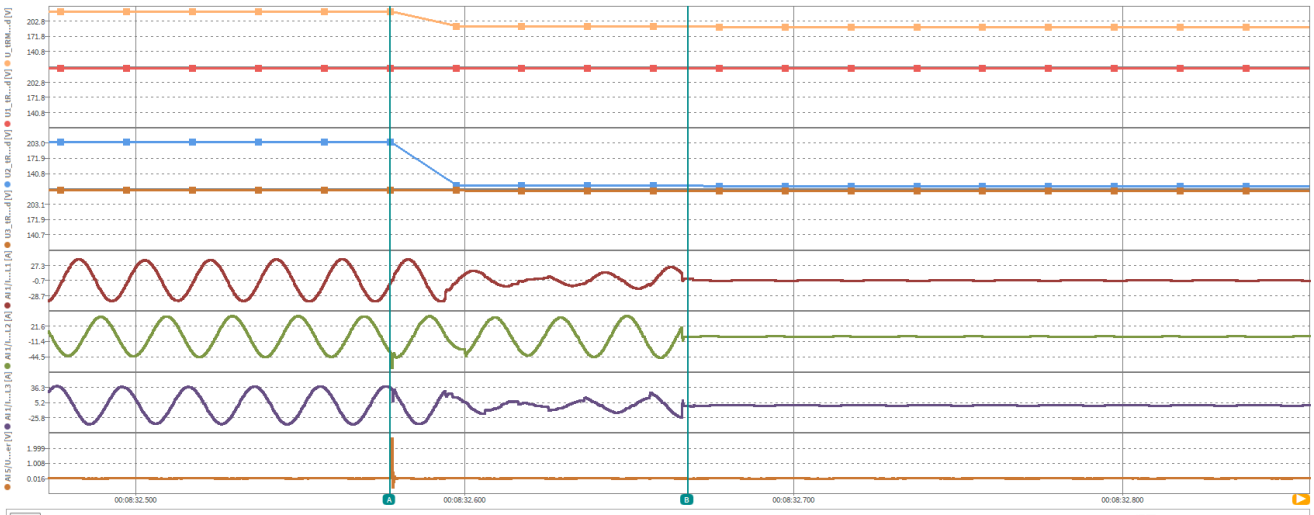
时间 [s]	A	B	间隔
U_tRMS@Grid [V]	3:08.934700	3:10.928200	1.993500
U1_tRMS@Grid [V]	204.9551	198.9528	-6.002274
U2_tRMS@Grid [V]	204.9274	198.9167	-6.010666
U3_tRMS@Grid [V]	204.8695	198.8621	-6.007401
AI 1/I1_Grid_L1 [A]	205.0683	199.0796	-5.988754
AI 1/I2_Grid_L2 [A]	-45.46309	0.236511	45.69960
AI 1/I3_Grid_L3 [A]	17.38024	-0.661850	-18.04209
AI 5/U4_Trigger [V]	25.95425	-0.560284	-26.51453
	0.025988	0.023127	-2.861e-3

Over Voltage First Level all phase



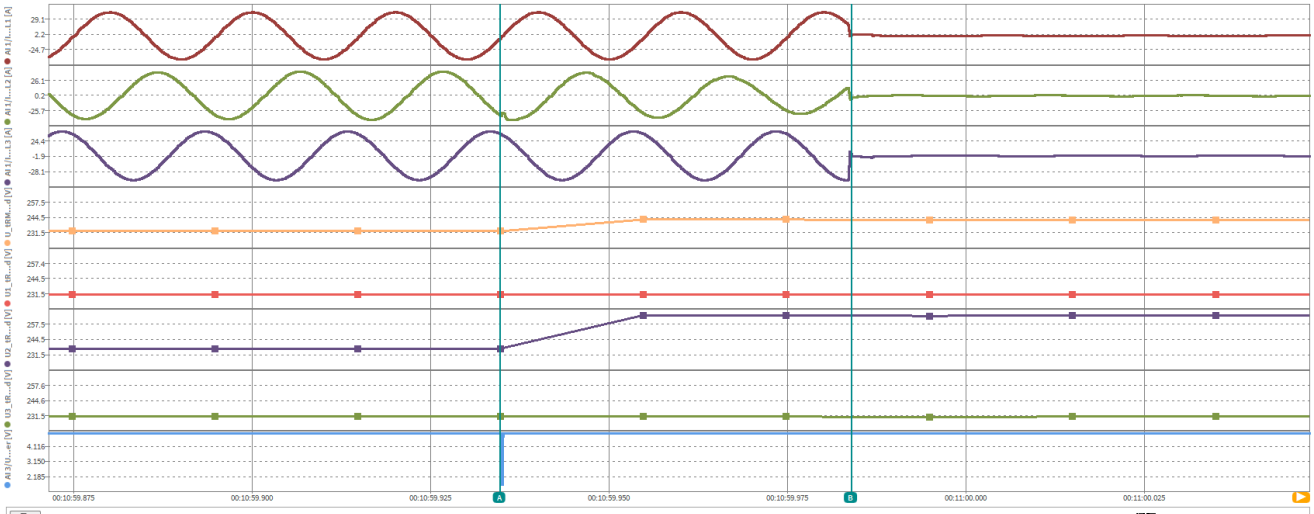
时间 [s]	A	B	间隔
U_tRMS@Grid [V]	3:10.360800	3:12.356600	1.995800
U1_tRMS@Grid [V]	236.8398	242.8159	5.976105
U2_tRMS@Grid [V]	236.8114	242.7889	5.977448
U3_tRMS@Grid [V]	236.7514	242.7306	5.979279
AI 1/I1_Grid_L1 [A]	236.9565	242.9281	5.971634
AI 1/I2_Grid_L2 [A]	-18.52976	0.751625	19.28139
AI 1/I3_Grid_L3 [A]	-21.34329	2.300683	23.64397
AI 5/U4_Trigger [V]	40.45272	-2.904175	-43.35690
	0.021458	0.021696	2.384e-4

Under Voltage Second Level single phase



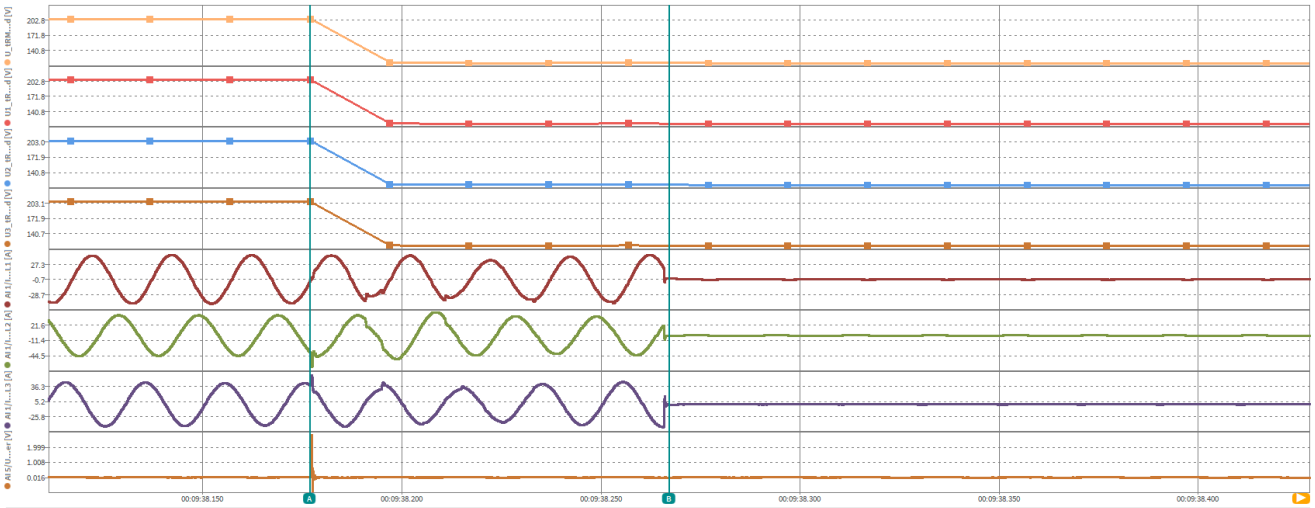
	A	B	间隔
时间 [s]	8:32.5772000	8:32.6677000	0.0905000
U_tRMS@Grid [V]	222.1846	191.4397	-30.74493
U1_tRMS@Grid [V]	230.7189	229.9390	-0.779861
U2_tRMS@Grid [V]	204.9890	114.4919	-90.49710
U3_tRMS@Grid [V]	230.8461	229.8883	-0.957825
AI 1/I1_Grid_L1 [A]	-8.563042	2.628327	11.19137
AI 1/I2_Grid_L2 [A]	-33.37240	-1.086712	32.28569
AI 1/I3_Grid_L3 [A]	36.92007	-1.813889	-38.73396
AI 5/U4_Trigger [V]	0.027180	0.020027	-7.153e-3

Over voltage Second Level single phase



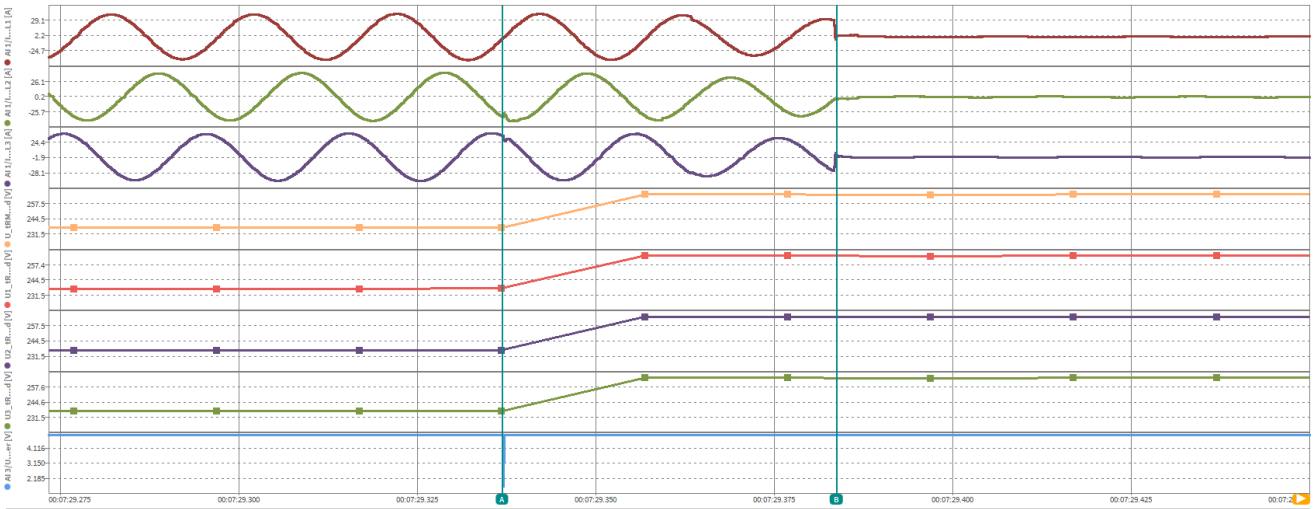
	A	B	间隔
时间 [s]	00:10:59.9347000	00:10:59.9839000	0.0492000
AI 1/I1_Grid_L1 [A]	-5.518437	0.615120	6.133557
AI 1/I2_Grid_L2 [A]	-33.55980	-5.103112	28.45669
AI 1/I3_Grid_L3 [A]	38.34343	2.617359	-35.72607
U_tRMS@Grid [V]	232.2260	241.8725	9.646515
U1_tRMS@Grid [V]	230.2351	230.2621	0.026978
U2_tRMS@Grid [V]	236.1837	265.0397	28.85594
U3_tRMS@Grid [V]	230.2591	230.3158	0.056610
AI 3/U3_Trigger [V]	4.972458	4.975558	3.099e-3

Under Voltage Second Level all phase



	A	B	间隔
时间 [s]	9:38.1770000	9:38.2672000	0.0902000
U_tRMS@Grid [V]	204.9405	113.8817	-91.05879
U1_tRMS@Grid [V]	204.9608	113.9949	-90.96584
U2_tRMS@Grid [V]	204.8533	113.8478	-91.00556
U3_tRMS@Grid [V]	205.0073	113.8023	-91.20499
AI 1/I1_Grid_L1 [A]	-4.624844	1.093388	5.718232
AI 1/I2_Grid_L2 [A]	-36.55386	-0.993729	35.56013
AI 1/I3_Grid_L3 [A]	39.57272	-1.230240	-40.80296
AI 5/U4_Trigger [V]	0.029325	0.020742	-8.583e-3

Over voltage Second Level all phase



	A	B	间隔
时间 [s]	7:29.3370000	7:29.3838000	0.0468000
AI 1/I1_Grid_L1 [A]	-2.705097	0.595570	3.300667
AI 1/I2_Grid_L2 [A]	-35.30312	-3.638745	31.66437
AI 1/I3_Grid_L3 [A]	36.35025	2.649784	-33.70047
U_tRMS@Grid [V]	236.2288	265.1377	28.90891
U1_tRMS@Grid [V]	236.3873	265.0319	28.64453
U2_tRMS@Grid [V]	236.1164	265.1772	29.06076
U3_tRMS@Grid [V]	236.1828	265.2042	29.02144
AI 3/U3_Trigger [V]	4.783392	4.972220	0.188828

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 0.1 s.

Test results:

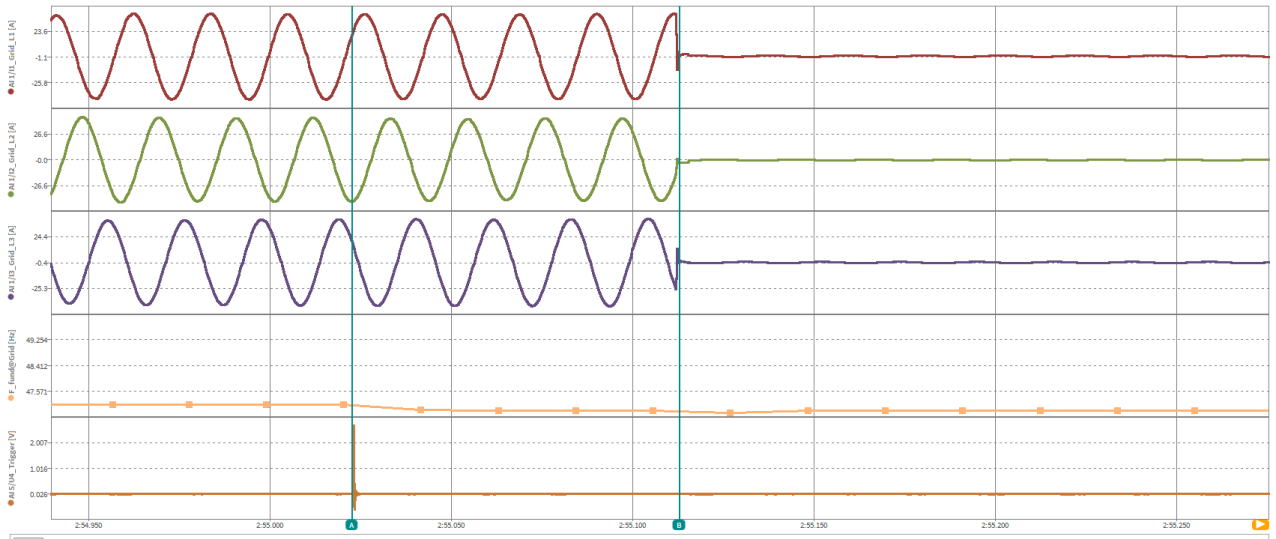
If the frequency outside the range between 47.00 Hz – 52.00 Hz, the unit disconnects from the grid within 0,1 s.

		Underfrequency		Over frequency
Trip setting [Hz]		**46,99**		**52,01**
Measured trip value [Hz]		46,98		52,06
		46,98		52,06
		46,98		52,06
		46,98		52,06
		46,98		52,06
Trip time limit [s]		**≤ 0,1**		**≤ 0,1**
Measured trip time [s]	50,0Hz → 47,2Hz on hold 0,2 s→ 46,9	0,069	50,0Hz → 51,8Hz on hold 0,2 s→ 52,1Hz	0,064
		0,070		0,064
		0,069		0,085
		0,070		0,085
		0,090		0,084

Overall maximum value in all conditions

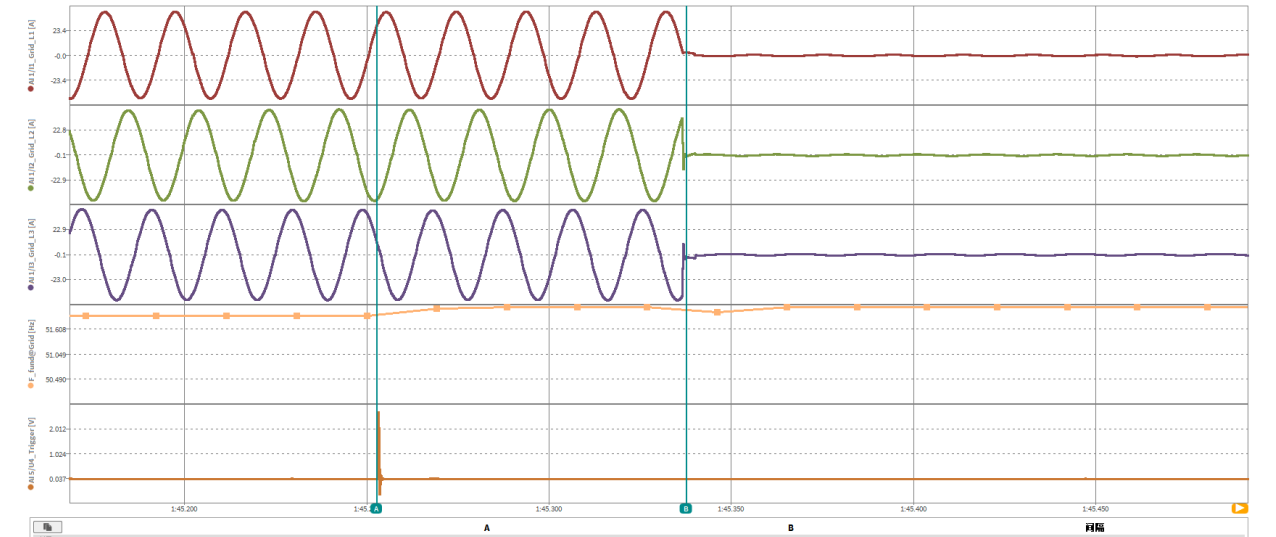
	Actual Trip Setting		Test Result		Limit Time Delay [sec]	Result confirmation
	Frequency (Hz)	Trip Time (sec)	Measured trip value [Hz]	Measured Time Delay [sec]		
Underfrequency	46,99	0,1	46,98	0,090	≤ 0,1	Pass
Over frequency	52,01	0,1	52,01	0,085	≤ 0,1	Pass

Underfrequency



	A	B	间隔
时间 [s]	2:55.0228000	2:55.1130000	0.0902000
AI 1/I1_Grid_L1 [A]	21.74248	1.096379	-20.64610
AI 1/I2_Grid_L2 [A]	-43.14333	-2.728995	40.41434
AI 1/I3_Grid_L3 [A]	19.18531	2.023937	-17.16137
F_fund@Grid [Hz]	47.10100	46.89150	-0.209503
AI 5/U4_Trigger [V]	0.025034	0.024796	-2.384e-4

Over frequency



	A	B	间隔
时间 [s]	1:45.2528000	1:45.3377000	0.0849000
AI 1/I1_Grid_L1 [A]	28.34667	2.943646	-25.40302
AI 1/I2_Grid_L2 [A]	-40.97658	-0.926074	40.05051
AI 1/I3_Grid_L3 [A]	11.43003	-2.272366	-13.70239
F_fund@Grid [Hz]	51.89917	52.10255	0.203381
AI 5/U4_Trigger [V]	0.027895	0.022888	-5.007e-3

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.

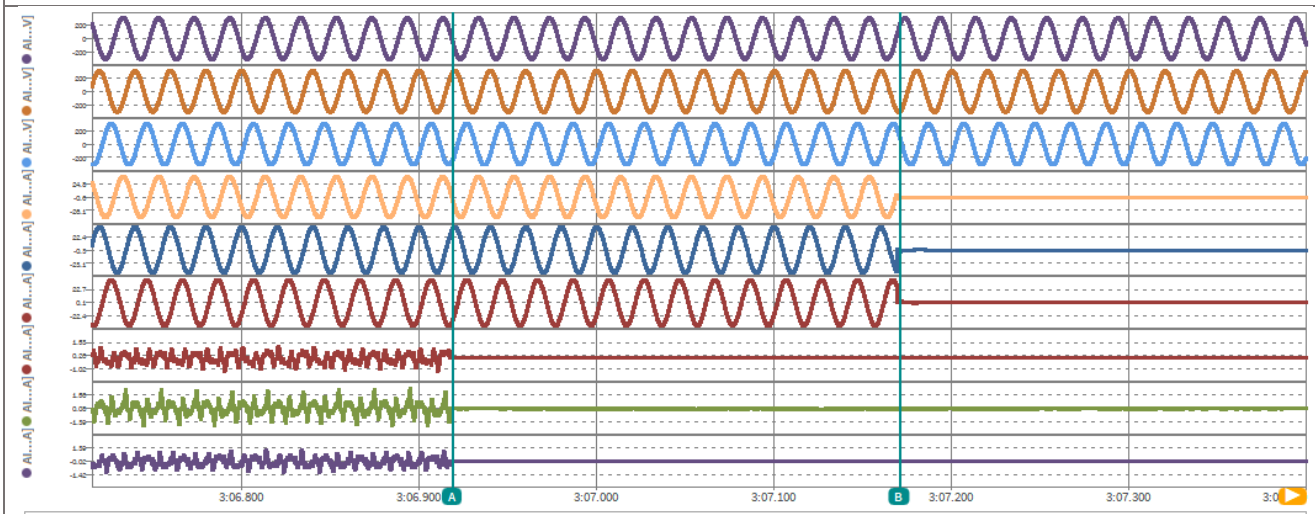
Test results:
The unit is able to detect island situation and disconnects from the grid within 0,3 s.

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 (s)	P_{EUT} (kW)	Actual Q_f	V_{DC} [2)]	Remarks[d)]
1	100[1)]	100	0	0	0,252	20,00	1,034	580	Test A at BL
8	100[1)]	100	-5	-5	0,134	20,00	1,061	580	Test A at IB
9	100[1)]	100	-5	0	0,234	20,00	1,088	580	Test A at IB
10	100[1)]	100	-5	+5	0,096	20,00	1,115	580	Test A at IB
13	100[1)]	100	0	-5	0,082	20,00	1,008	580	Test A at IB
14	100[1)]	100	0	+5	0,079	20,00	1,059	580	Test A at IB
17	100[1)]	100	+5	-5	0,123	20,00	0,960	580	Test A at IB
18	100[1)]	100	+5	0	0,245	20,00	0,985	580	Test A at IB
19	100[1)]	100	+5	+5	0,133	20,00	1,009	580	Test A at IB
1	66[3)]	66	0	0	0,263	13,20	1,037	446	Test B at BL
2	66[3)]	66	0	-5	0,081	13,20	1,011	446	Test B at IB
3	66[3)]	66	0	-4	0,091	13,20	1,016	446	Test B at IB
4	66[3)]	66	0	-3	0,097	13,20	1,022	446	Test B at IB
5	66[3)]	66	0	-2	0,106	13,20	1,027	446	Test B at IB
6	66[3)]	66	0	-1	0,119	13,20	1,032	446	Test B at IB
7	66[3)]	66	0	1	0,212	13,20	1,043	446	Test B at IB
8	66[3)]	66	0	2	0,127	13,20	1,048	446	Test B at IB
9	66[3)]	66	0	3	0,113	13,20	1,053	446	Test B at IB
10	66[3)]	66	0	4	0,146	13,20	1,058	446	Test B at IB
11	66[3)]	66	0	5	0,099	13,20	1,063	446	Test B at IB
1	33[4), 5)]	33	0	0	0,283	6,60	1,043	332	Test C at BL
2	33[4), 5)]	33	0	-5	0,094	6,60	1,017	332	Test C at BL
3	33[4), 5)]	33	0	-4	0,134	6,60	1,022	332	Test C at BL
4	33[4), 5)]	33	0	-3	0,122	6,60	1,028	332	Test C at BL
5	33[4), 5)]	33	0	-2	0,251	6,60	1,033	332	Test C at BL
6	33[4), 5)]	33	0	-1	0,238	6,60	1,038	332	Test C at BL
7	33[4), 5)]	33	0	1	0,156	6,60	1,049	332	Test C at BL
8	33[4), 5)]	33	0	2	0,135	6,60	1,054	332	Test C at BL
9	33[4), 5)]	33	0	3	0,115	6,60	1,059	332	Test C at BL
10	33[4), 5)]	33	0	4	0,119	6,60	1,064	332	Test C at BL
11	33[4), 5)]	33	0	5	0,098	6,60	1,069	332	Test C at BL

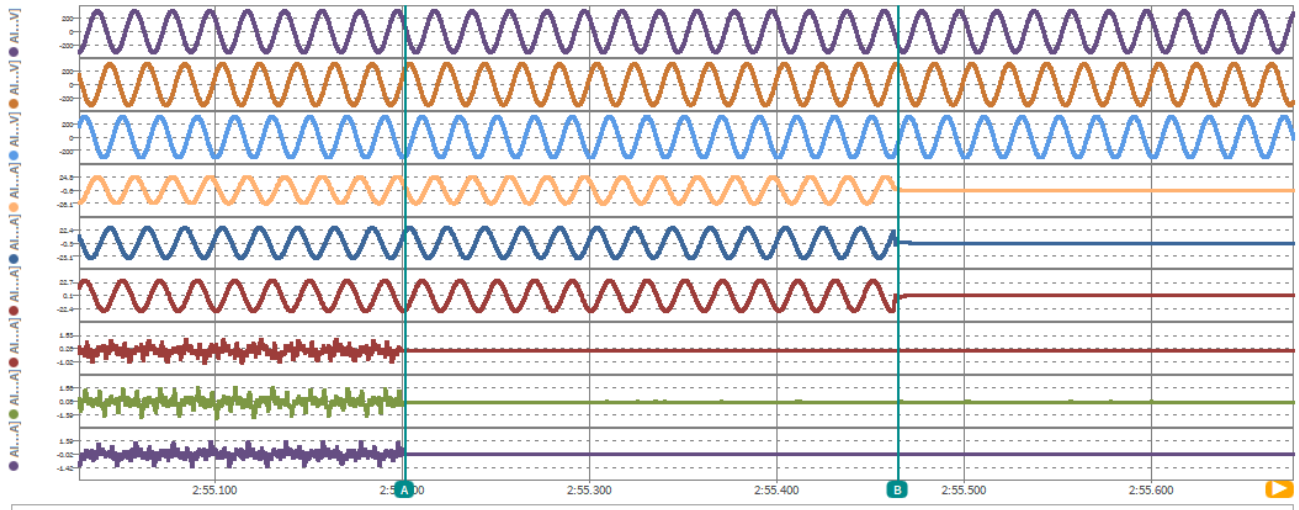
EUT output = 100%			
Parameter at 0% per phase	L= 19,62 mH	R=7,65 Ω	C= 385,71 µF
Iac(A):	0,189		
EUT output = 50 % – 66 %			
Parameter at 0% per phase	L= 30,05mH	R=11,75 Ω	C= 234,15 µF
Iac(A):	0,199		
EUT output = 25 % – 33 %			
Parameter at 0% per phase	L=59,75 mH	R=23,49Ω	C= 117,75 µF
Iac(A):	0,101		

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



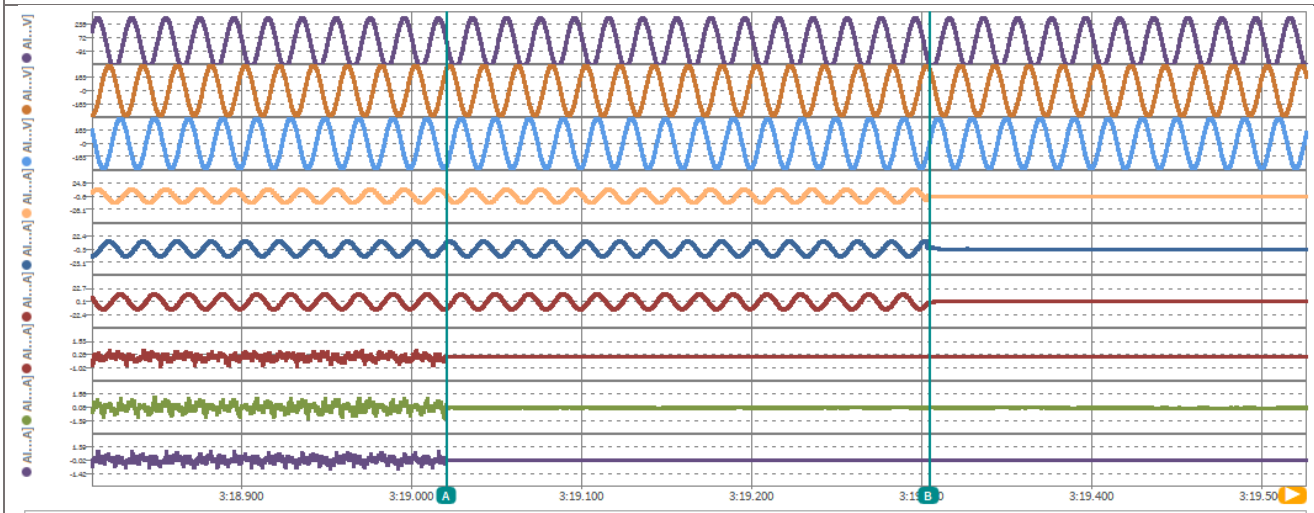
	A	B	间隔
时间 [s]	3:06.9191000	3:07.1708000	0.2517000
AI 3/U1_EUT_L1 [V]	-12.63690	177.8741	190.5110
AI 3/U2_EUT_L2 [V]	287.3824	-324.6920	-612.0744
AI 3/U3_EUT_L3 [V]	-275.1892	147.4178	422.6070
AI 3/I1_EUT_L1 [A]	-0.736237	0.095844	0.832081
AI 3/I2_EUT_L2 [A]	35.69031	-5.024433	-40.71474
AI 3/I3_EUT_L3 [A]	-34.34944	4.311085	38.66053
AI 1/I1_Grid_L1 [A]	0.040513	0.058156	0.017643
AI 1/I2_Grid_L2 [A]	0.052798	0.053275	4.768e-4
AI 1/I3_Grid_L3 [A]	0.021823	0.015624	-6.199e-3

Test B: Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load No. 6



	A	B	间隔
时间 [s]	2:55.2016000	2:55.4647000	0.2631000
AI 3/U1_EUT_L1 [V]	76.02764	-219.2874	-295.3150
AI 3/U2_EUT_L2 [V]	235.8101	316.5875	80.77741
AI 3/U3_EUT_L3 [V]	-311.3368	-98.78922	212.5476
AI 3/I1_EUT_L1 [A]	5.368233	0.731468	-4.636765
AI 3/I2_EUT_L2 [A]	19.20366	1.558781	-17.64488
AI 3/I3_EUT_L3 [A]	-25.76065	-3.024578	22.73607
AI 1/I1_Grid_L1 [A]	0.061017	0.069123	8.106e-3
AI 1/I2_Grid_L2 [A]	-2.038e-3	0.014651	0.016689
AI 1/I3_Grid_L3 [A]	0.034697	0.032790	-1.907e-3

Test C: Disconnection at P_{AC} 0% and Q_{AC} 0 % reactive load No. 6



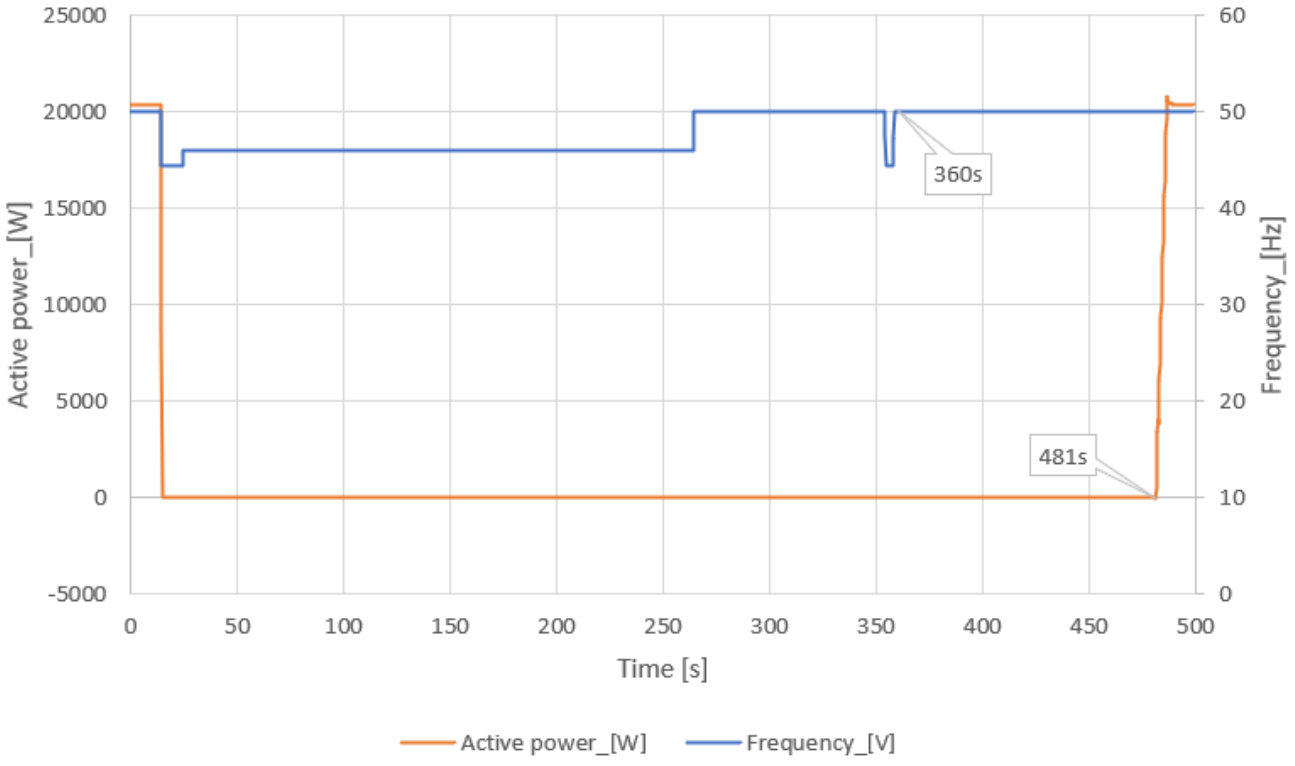
	A	B	间隔
时间 [s]	3:19.0214000	3:19.3045000	0.2831000
AI 3/U1_EUT_L1 [V]	-13.26180	-276.1898	-262.9280
AI 3/U2_EUT_L2 [V]	287.4360	286.4461	-0.989914
AI 3/U3_EUT_L3 [V]	-274.9129	-10.01906	264.8938
AI 3/I1_EUT_L1 [A]	0.010490	-0.824451	-0.834942
AI 3/I2_EUT_L2 [A]	11.88850	2.534390	-9.354115
AI 3/I3_EUT_L3 [A]	-11.18422	-2.134323	9.049893
AI 1/I1_Grid_L1 [A]	0.010949	0.048142	0.037193
AI 1/I2_Grid_L2 [A]	0.056136	0.049937	-6.199e-3
AI 1/I3_Grid_L3 [A]	9.425e-3	0.011809	2.384e-3

6.7 3.2.4 Response to Utility Recovery

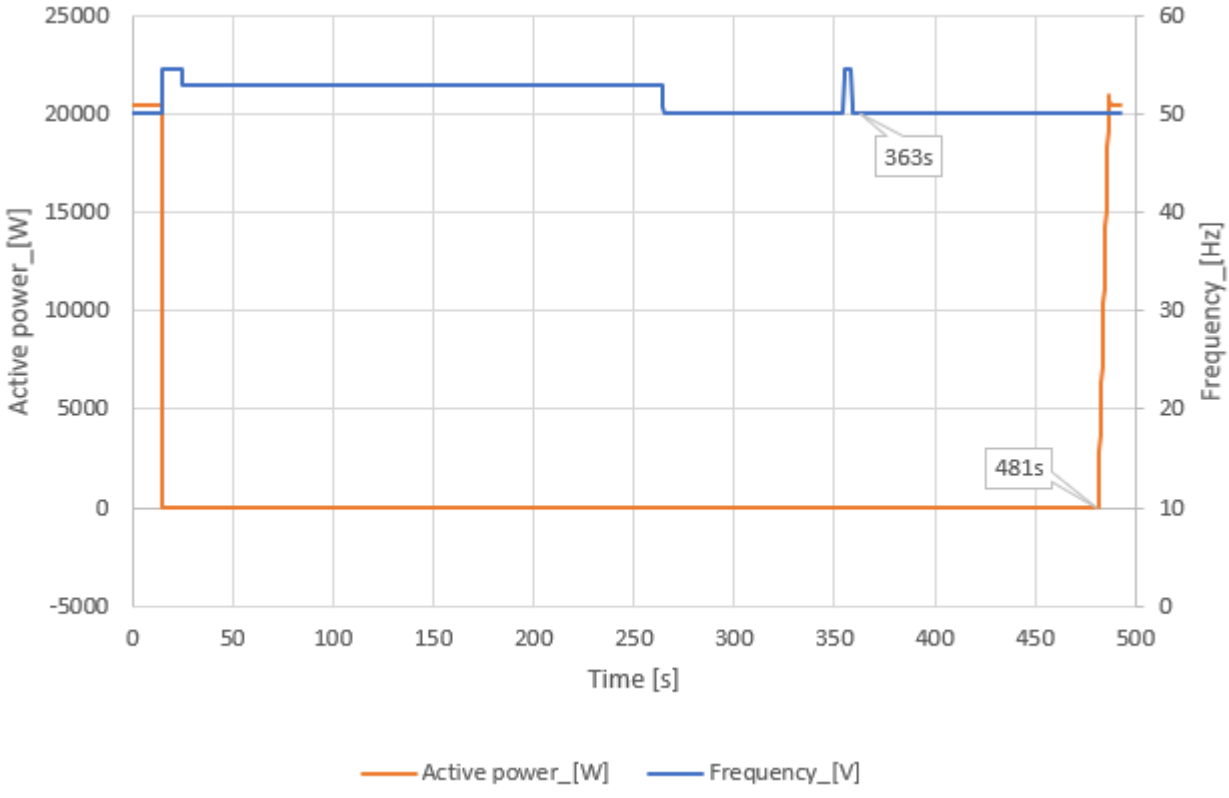
Test procedure and test conditions: Tests were conducted according to IEEE Std 1547.1-2005, chapter 5.10
Assessment criteria: After the disconnection, if the power grid resumes to normal state, the power producer must be able to wait about 120 seconds before reconnecting to the power grid.
Test results: 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	131	Pass
Reconnection after overfrequency protection		132	Pass
Reconnection after undervoltage protection – Level 2		139	Pass
Reconnection after undervoltage protection – Level 1		147	Pass
Reconnection after overvoltage protection – Level 1		138	Pass
Reconnection after overvoltage protection – Level 2		135	Pass

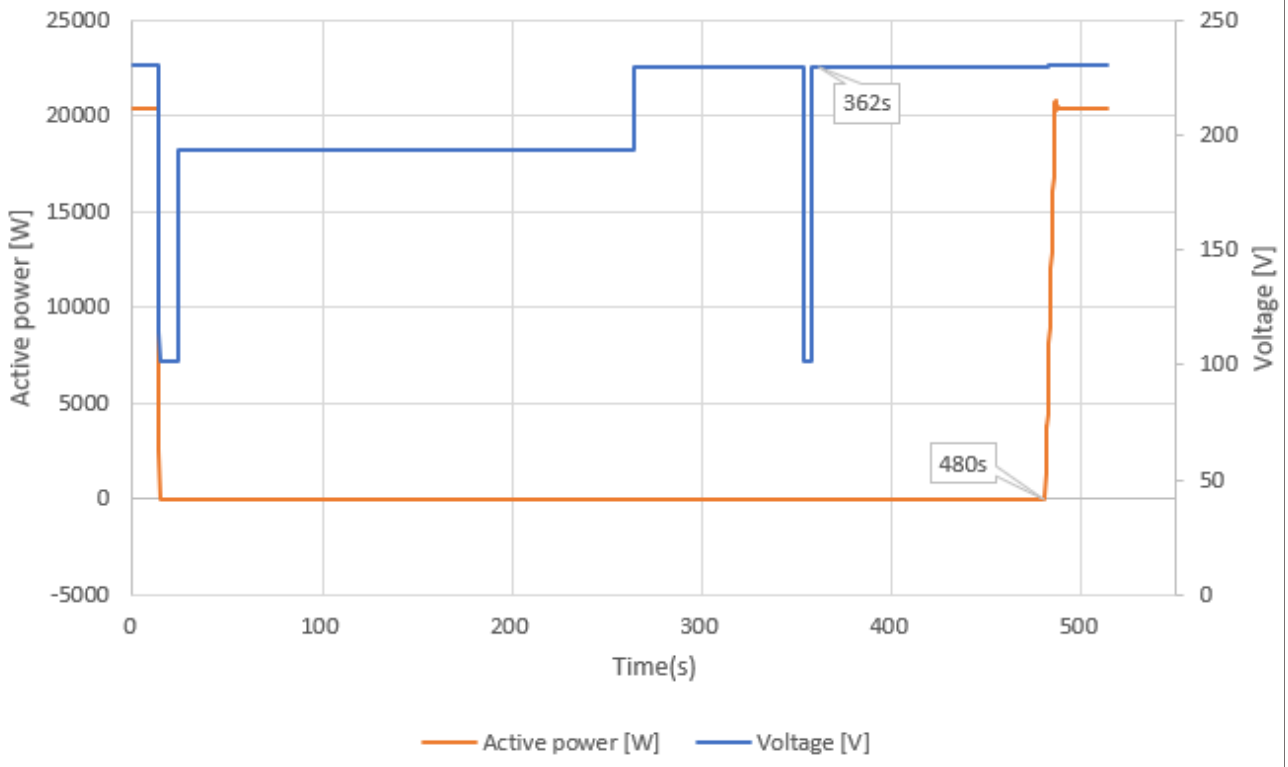
Reconnection after underfrequency protection



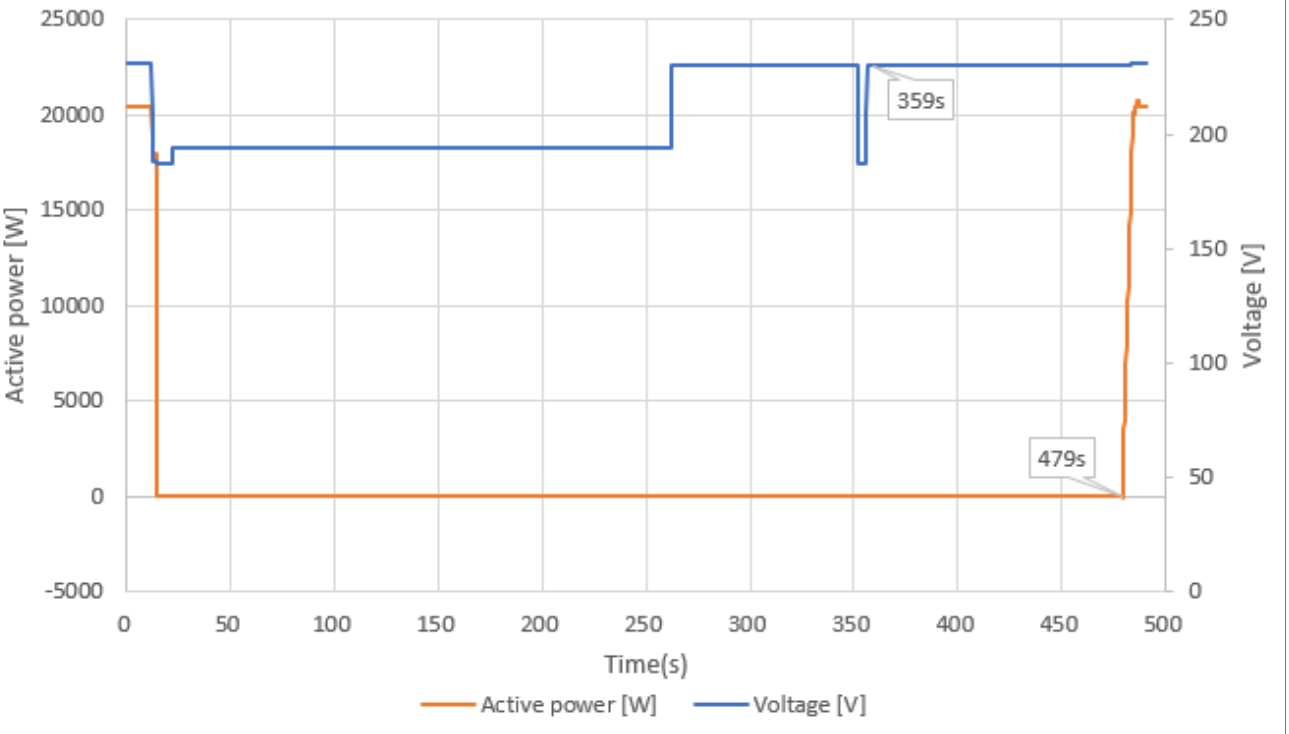
Reconnection after overfrequency protection



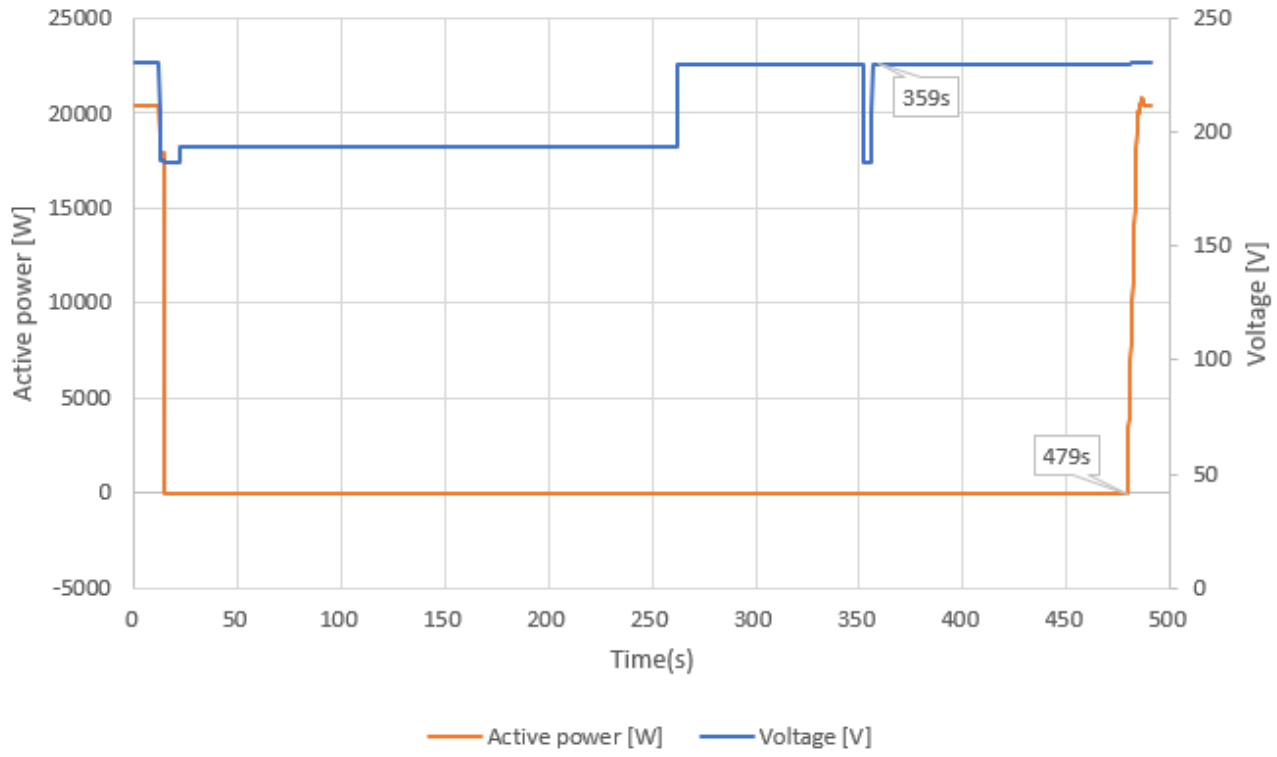
Reconnection after undervoltage protection – Level 2



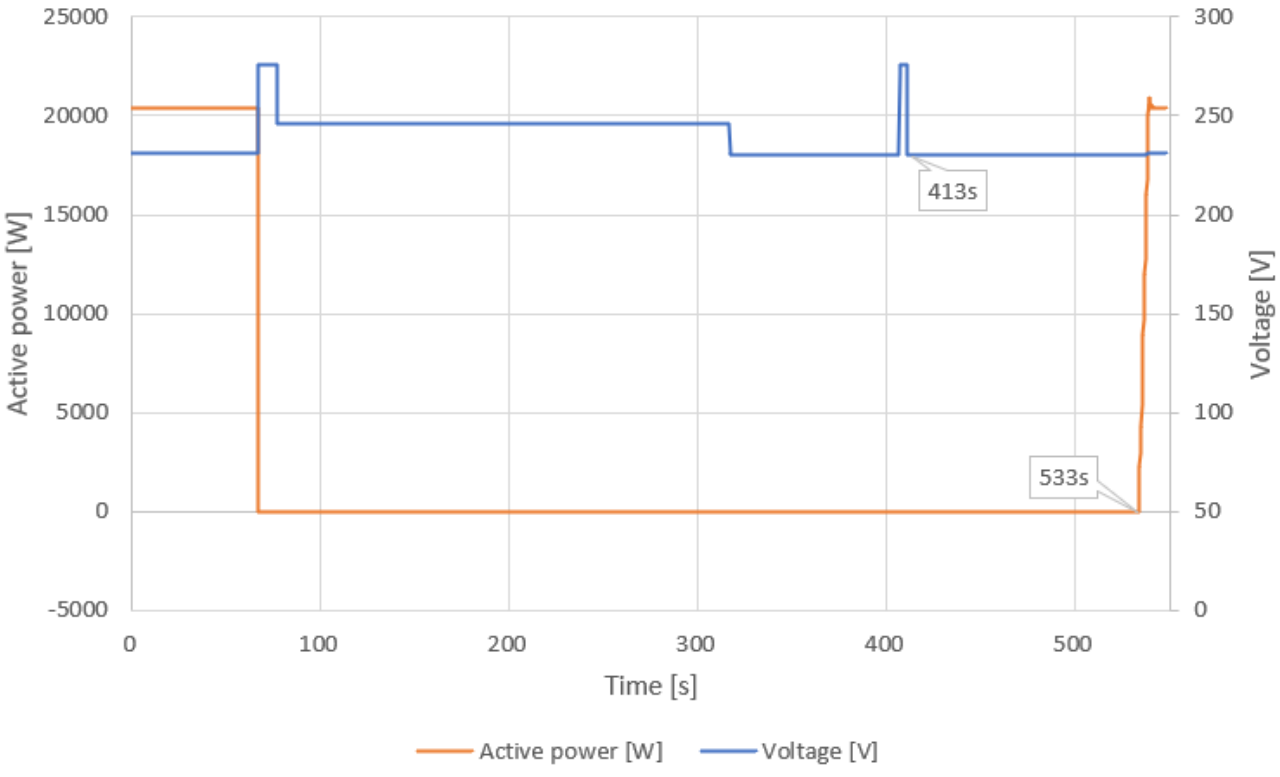
Reconnection after undervoltage protection – Level 1



Reconnection after overvoltage protection – Level 1



Reconnection after overvoltage protection – Level 2

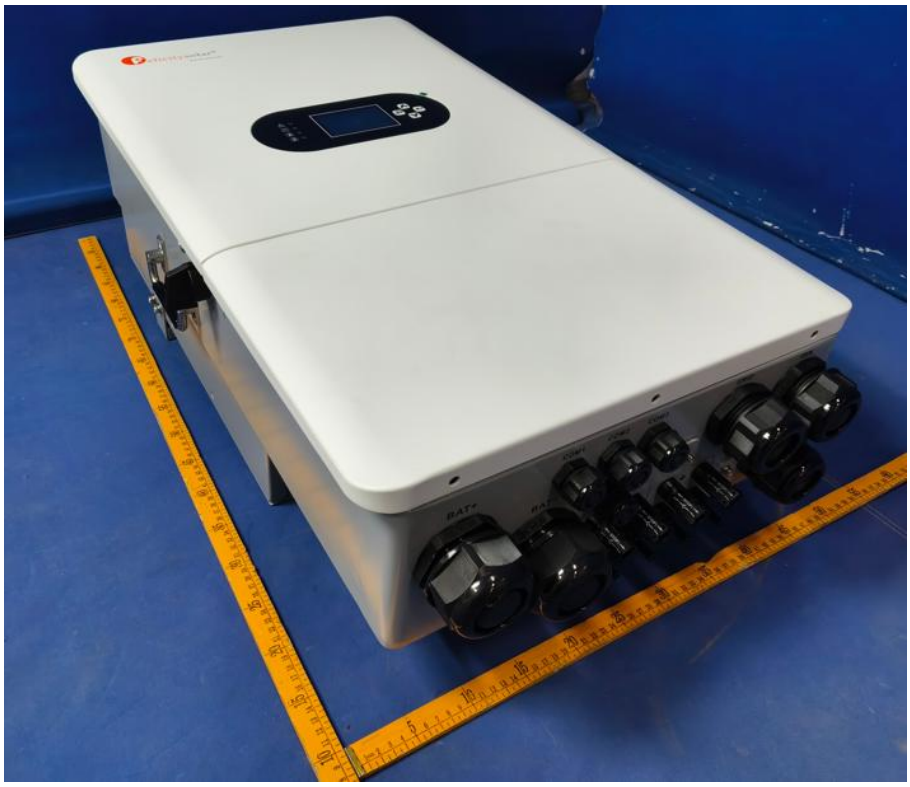


Annex 1 - Photo of the unit

Enclosure front view



Enclosure left view



Enclosure right view



Enclosure rear view



Enclosure bottom view



Enclosure top view



Enclosure Internal view



>>>> End of Test Report <<<<