CERTIFICATE

Applicant: **Victron Energy B.V.**
De Paal 35
1351 JG Almere
Netherlands

Product: **Battery Inverter with integrated automatic disconnection device between a generator and the public low-voltage grid**

Model: **Quattro-II 48/5000/70-50-50 230V**

Rating:

Mains voltage:	230V 50/60Hz
Mains current:	19A
Output power (feed in on-grid):	4,5kVA / 4,4kW
Output power (off-grid):	5,0kVA / 4,0kW
Pass through current:	50A

Intended use:

Battery Inverter with an automatic disconnection device with single phase mains surveillance in accordance with Engineering Recommendation G99-1 for photovoltaic systems with a single phase parallel coupling via an inverter to the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter.

Applied standards and guidelines:

SOP-9-1_15 GCC Certification Program, 09/21
Based on:
Engineering Recommendation G99 Issue 1 – Amendment 8; 01 September 2021
Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

The safety concept of an aforementioned representative product corresponds at the time of issue of this certificate to the valid safety specifications for the specified use in accordance with regulations. The units are only compliant with type A inverter connected power generating Module requirements

Report No: 22PP102-14_0

Certificate No: 23-509-00

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Kiwa Primara GmbH
Gewerbestraße 28
87600 Kaufbeuren
Germany
Tel. +49 8341 99726-0
primara@kiwa.com
www.kiwa.de

DAkkS
Deutsche
Akkreditierungsstelle
D-ZE-12089-01-00

Tanja Rottach
- Digitally signed | see http://ca.kiwa-deutschland.de for more details -

Tanja Rottach
Certification Engineer

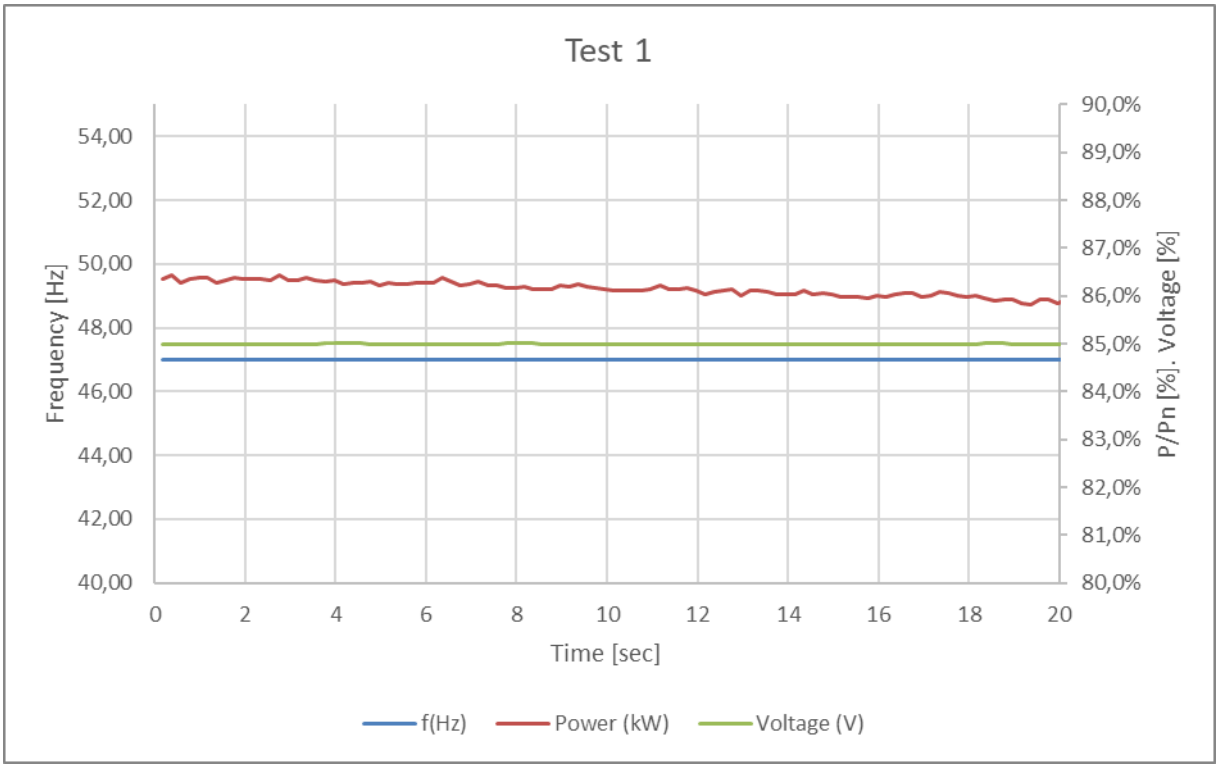
GRID CODE
COMPLIANCE
G99 ISSUE 1

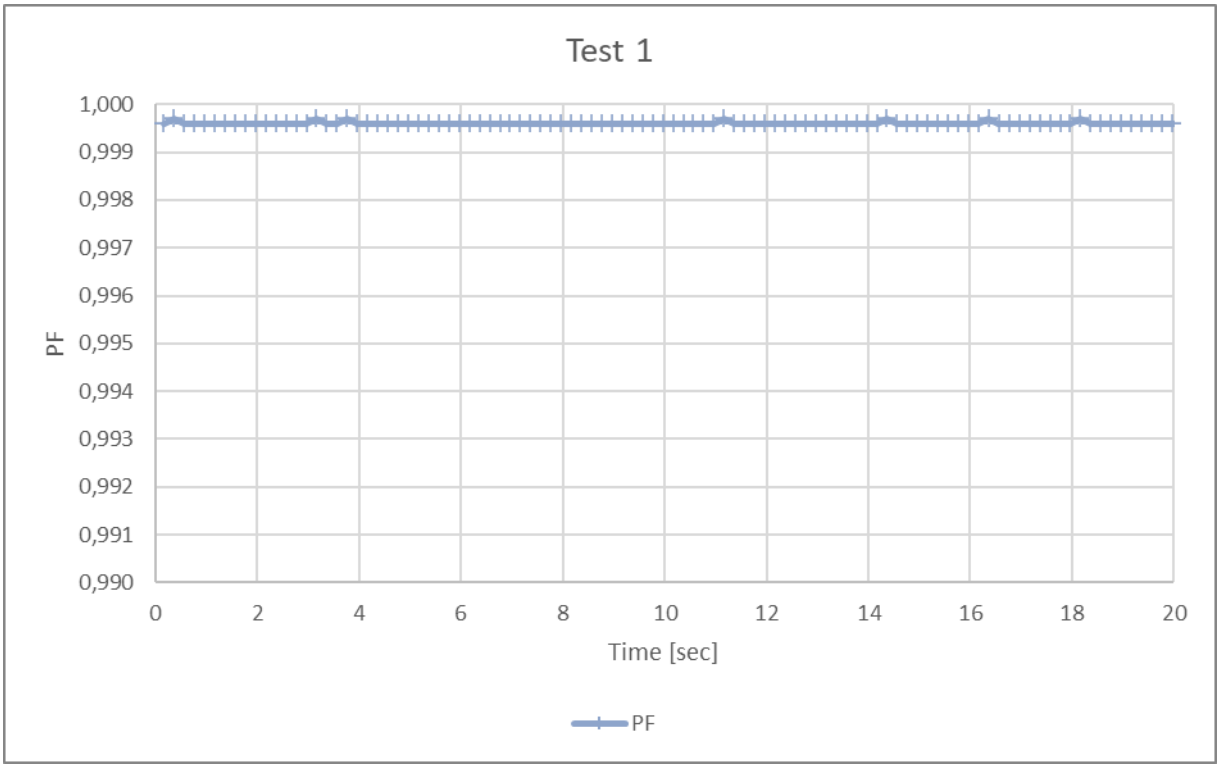
Operating Range:					
	U [V]	f [Hz]	Cos ϕ	P [kW]	No disconnection occurs (Y/N)
Test 1	85%Un 195,5V	47,00Hz	1,00	Registered Capacity	-
Measured 20s avg	195,5	47,00	1,000	2,1*	Y
Test 2	85%Un 195,5V	47,50Hz	1,00	Registered Capacity	-
Measured 90min avg	195,7	47,50	1,000	2,1*	Y
Test 3	110%Un 253V	51,50Hz	1,00	Registered Capacity	-
Measured 90min avg	253,0	51,50	0,998	2,4	Y
Test 4	110%Un 253V	52,00Hz	1,00	Registered Capacity	-
Measured 15min avg	253,0	52,00	0,998	2,4	Y
Test 5	100%Un 230V	50,00Hz	1,00	Registered Capacity	-
Measured 90min avg	230,1	50,00	1,000	2,4	Y

Test 6	Start frequency	Change	End frequency	Confirm no trip
Positive frequency drift	49,5Hz	+1,0Hz/sec	50,0Hz	No trip
Negative frequency drift	50,5Hz	-1,0Hz/sec	50,0Hz	No trip

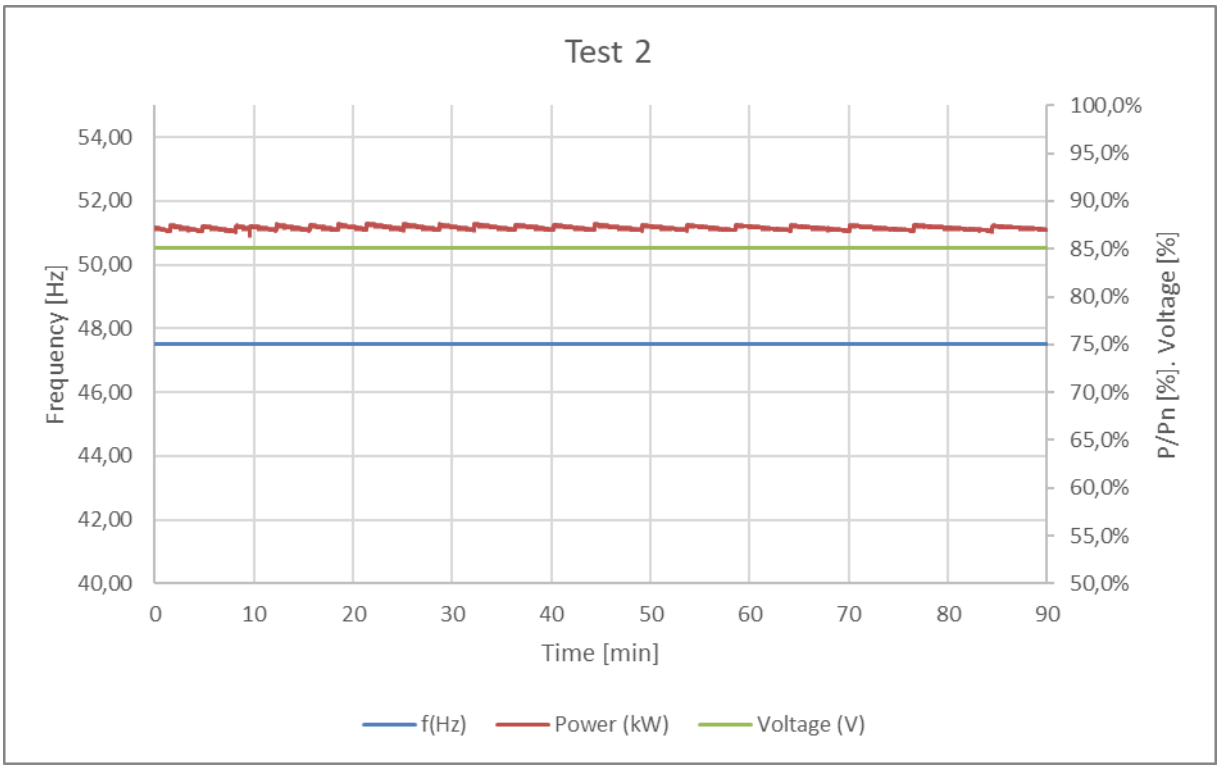
*The test is performed at registered capacity without limitation of the supplied primary source. The output power is limited because of the low voltage of the grid which trigger the maximum current of the inverter.

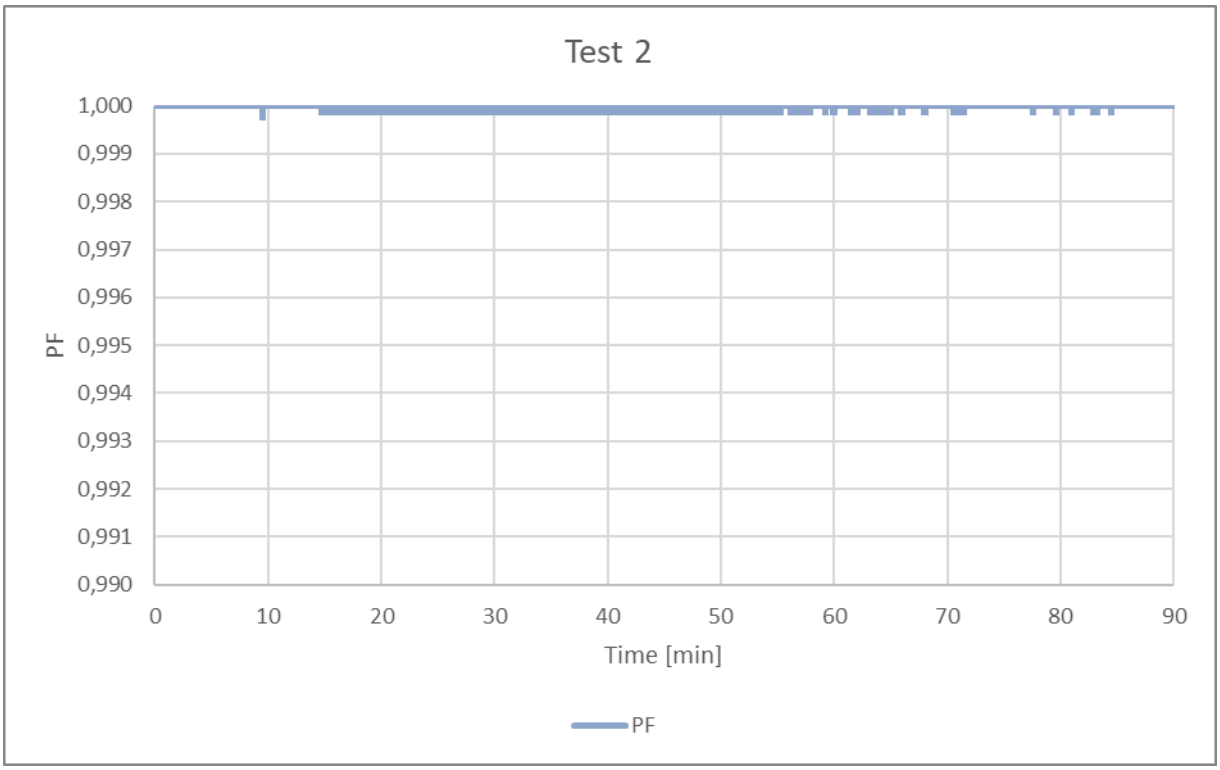
Test 1 - Frequency, Voltage, active power over time diagram



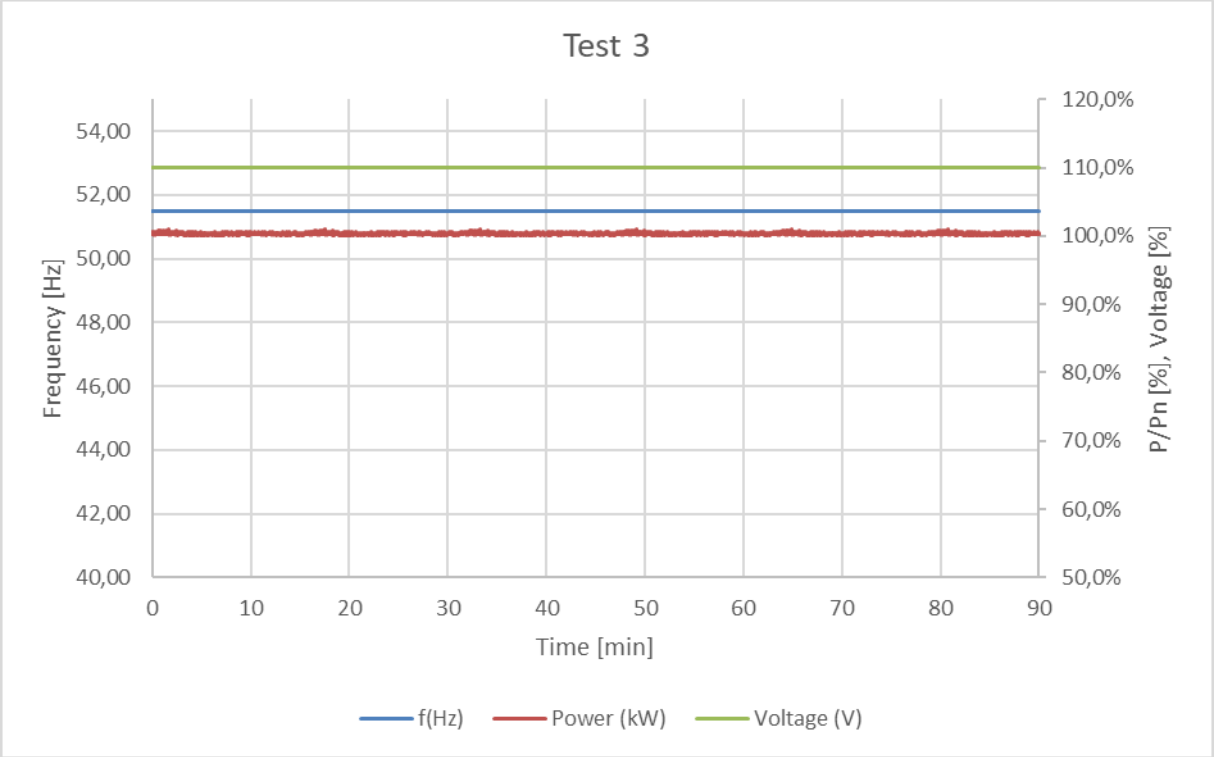


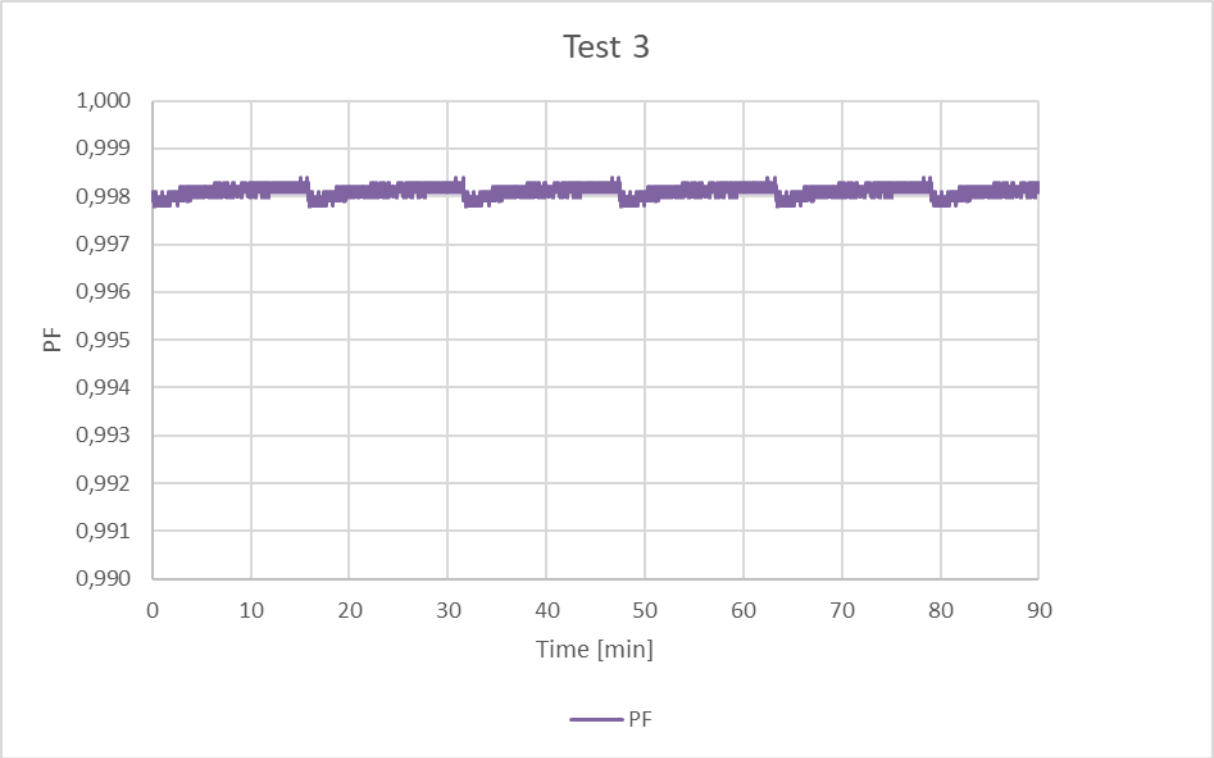
Test 2 - Frequency, Voltage, active power over time diagram



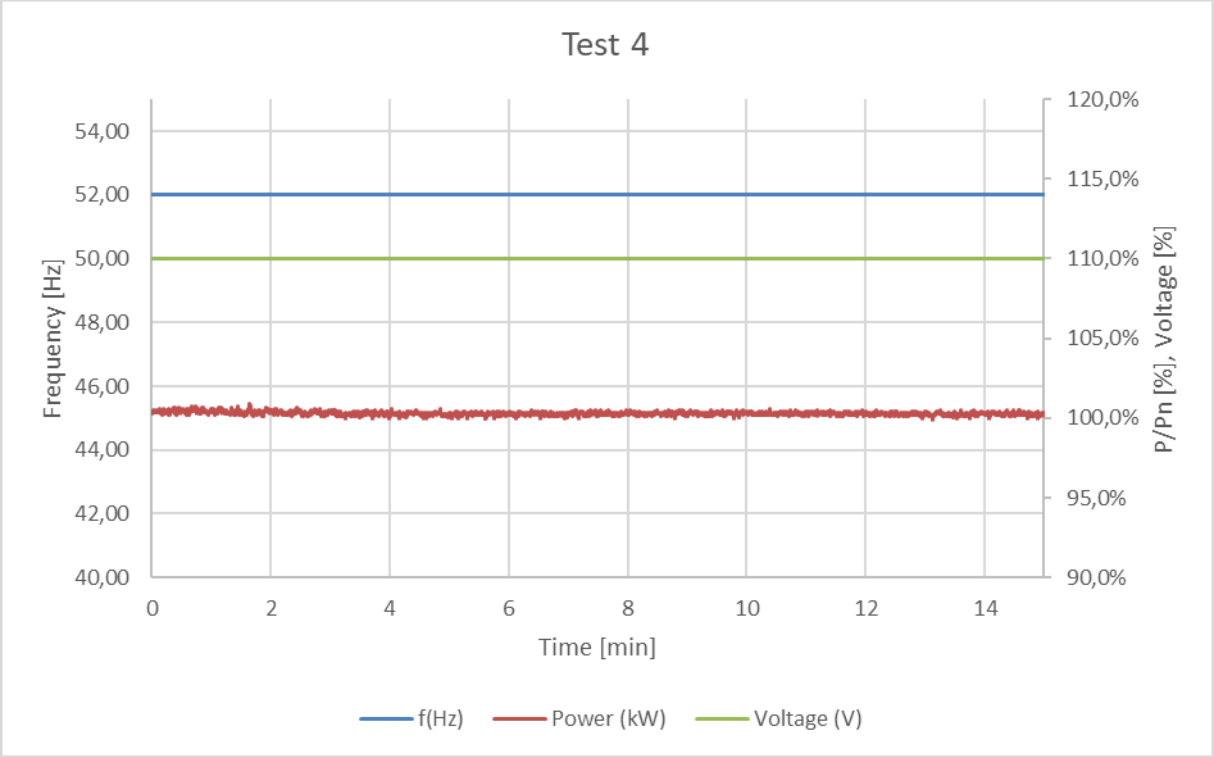


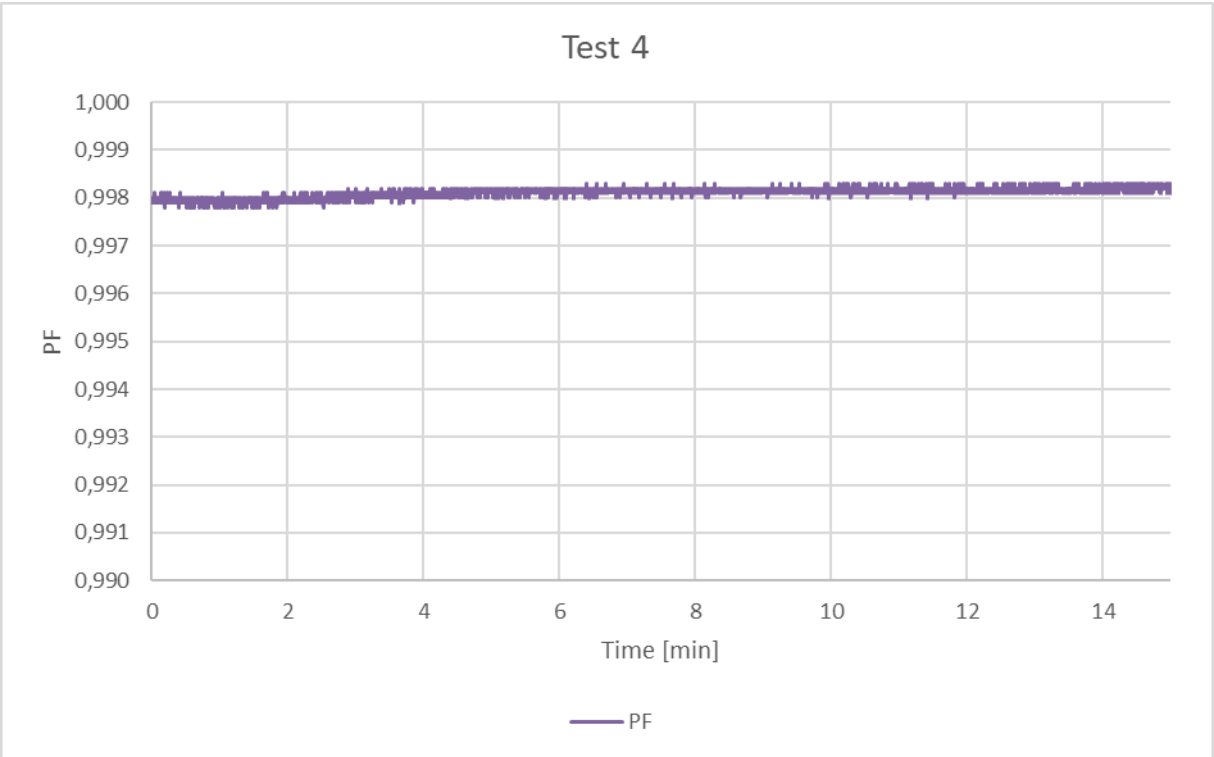
Test 3 - Frequency, Voltage, active power over time diagram



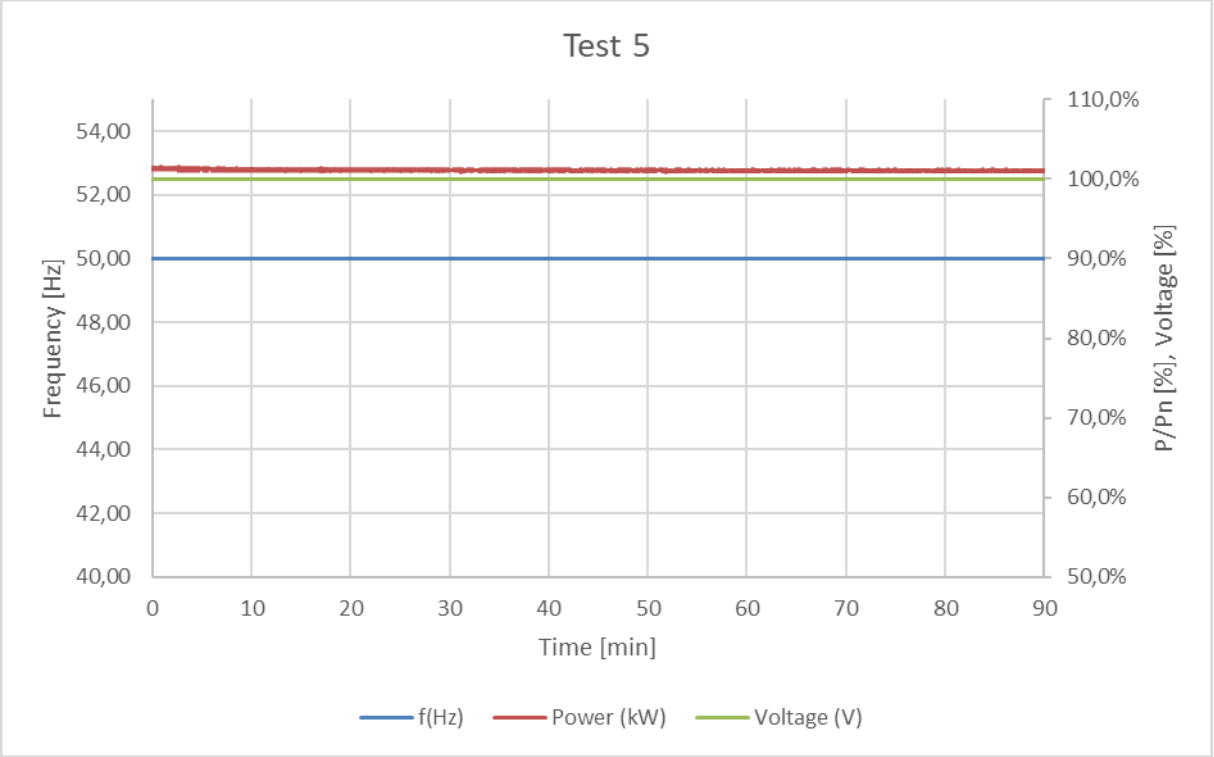


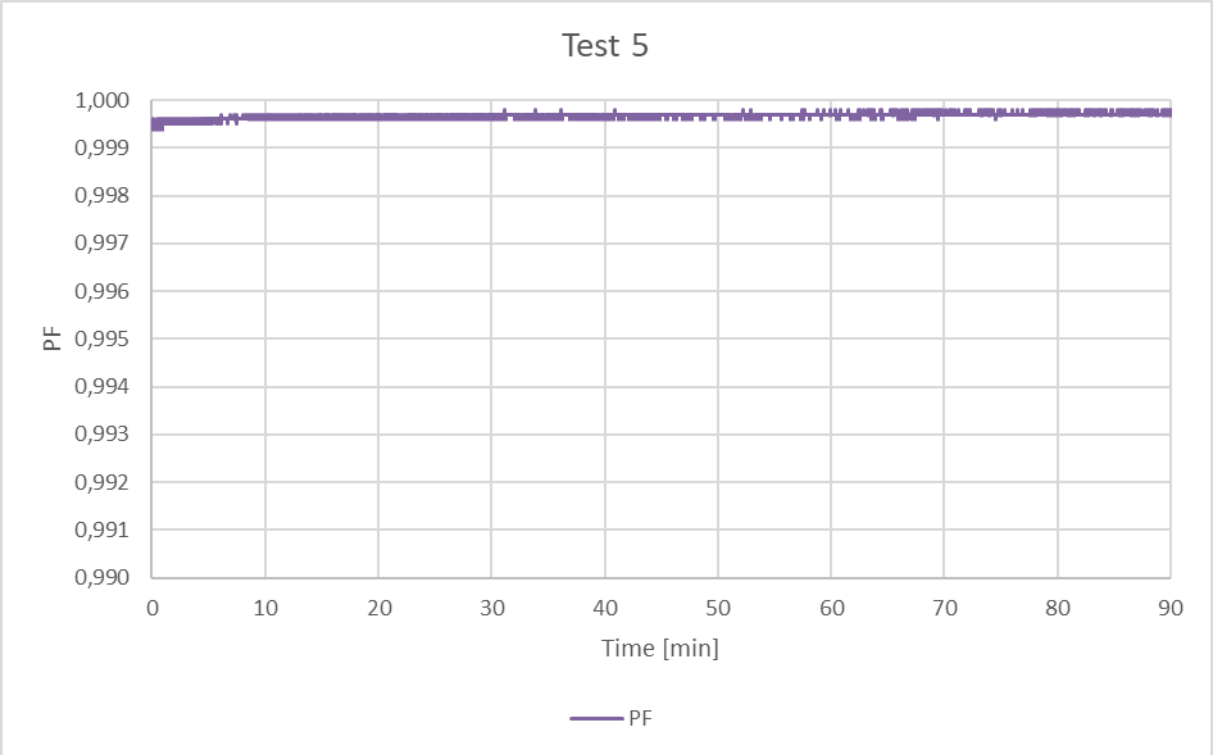
Test 4 - Frequency, Voltage, active power over time diagram



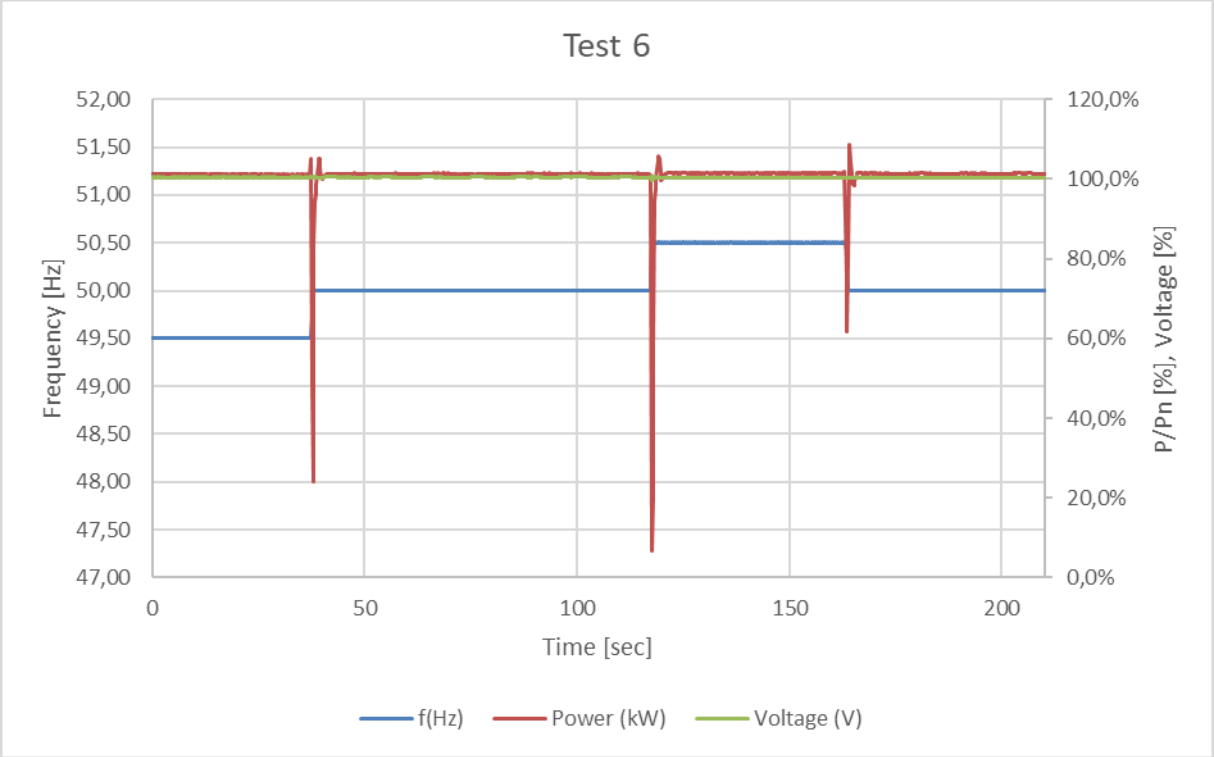


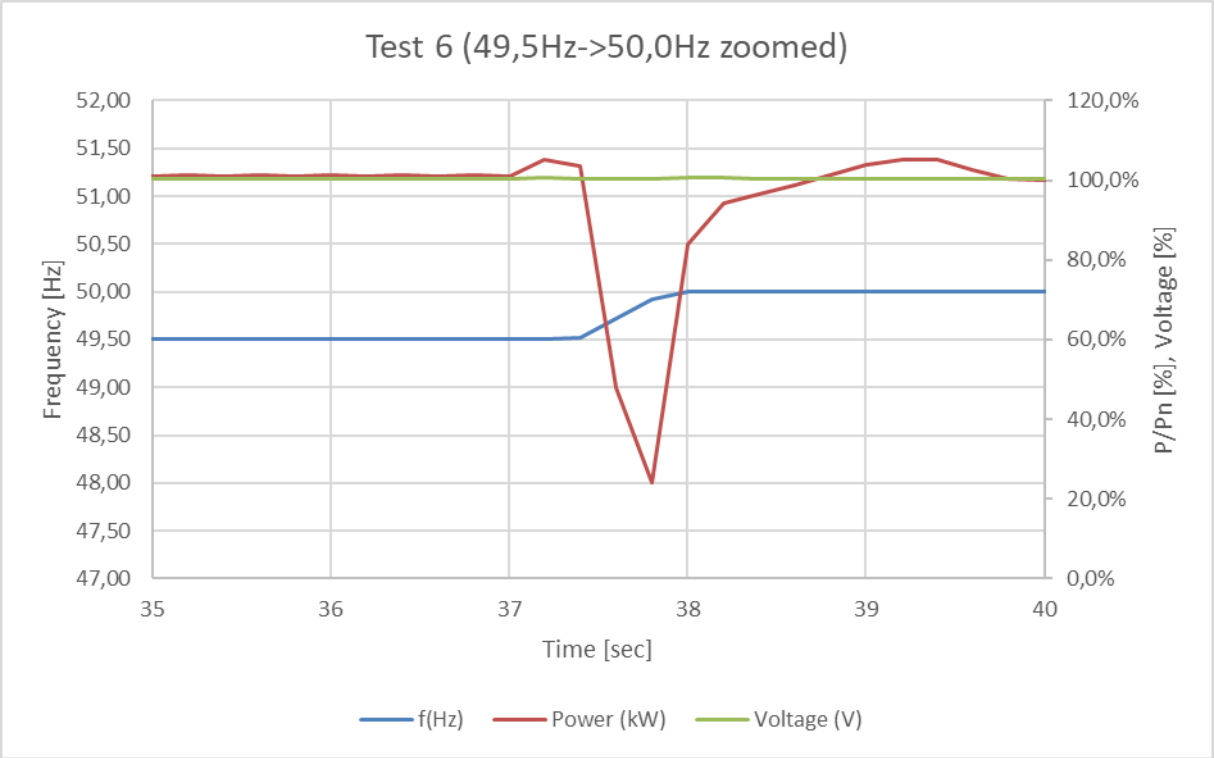
Test 5 - Frequency, Voltage, active power over time diagram

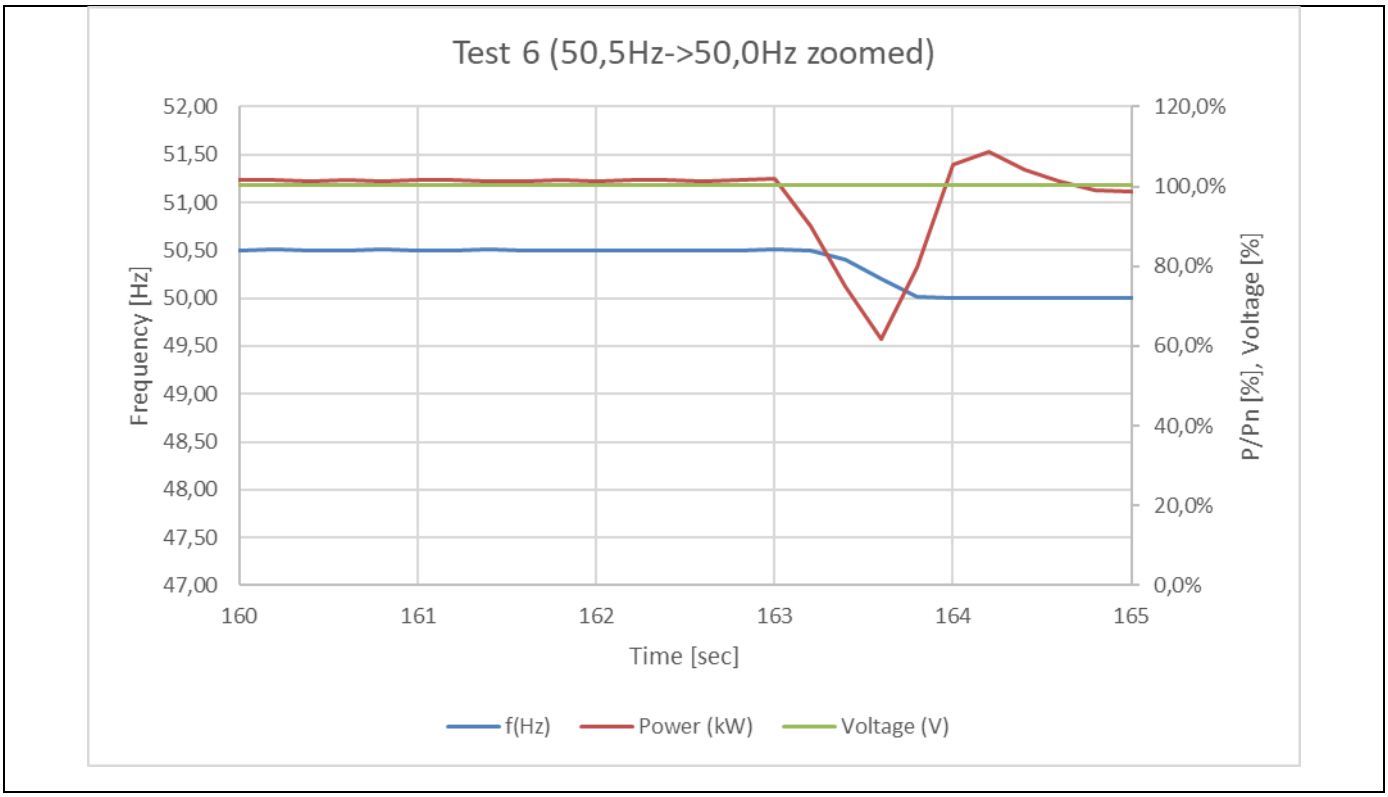




Test 6 - Frequency, Voltage, active power over time diagram






Test 6 (50,5Hz->50,0Hz zoomed)
52,00
51,50
51,00
50,50
50,00
49,50
49,00
48,50
48,00
47,50
47,00
Frequency [Hz]
120,0%
100,0%
80,0%
60,0%
40,0%
20,0%
0,0%
P/Pn [%], Voltage [%]
160
161
162
163
164
165
Time [sec]
f(Hz)
Power (kW)
Voltage (V)

Power Quality – Harmonics

Generating Unit tested to BS EN 61000-3-12

Generating Unit rating per phase (rpp)	4,4	kVA	Harmonics % =Measured Value (Amps) x 23/rating per phase (kVA)

Harmonic	At 45-55% of rated output						Limit in BS EN 61000-3-12	
	Measured Value (A)			Measured Value (%)			1 phase	3 phase
	L1	L2	L3	L1	L2	L3		
2	0,053	—	—	0,277	—	—	8%	8%
3	0,600	—	—	3,136	—	—	21,6%	Not stated
4	0,055	—	—	0,288	—	—	4%	4%
5	0,256	—	—	1,338	—	—	10,7%	10,7%
6	0,038	—	—	0,199	—	—	2,67%	2,67%
7	0,193	—	—	1,009	—	—	7,2%	7,2%
8	0,029	—	—	0,152	—	—	2%	2%
9	0,143	—	—	0,748	—	—	3,8%	Not stated
10	0,021	—	—	0,110	—	—	1,6%	1,6%
11	0,052	—	—	0,272	—	—	3,1%	3,1%
12	0,015	—	—	0,078	—	—	1,33%	1,33%
13	0,027	—	—	0,141	—	—	2%	2%
THD	—	—	—	3,694	—	—	23%	13%
PWHD	—	—	—	1,636	—	—	23%	22%

Harmonic	At 100% of Registered Capacity						Limit in BS EN 61000-3-12	
	Measured Value (A)			Measured Value (%)			1 phase	3 phase
	L1	L2	L3	L1	L2	L3		
2	0,048	—	—	0,251	—	—	8%	8%
3	0,304	—	—	1,589	—	—	21,6%	Not stated
4	0,040	—	—	0,209	—	—	4%	4%
5	0,285	—	—	1,490	—	—	10,7%	10,7%
6	0,032	—	—	0,167	—	—	2,67%	2,67%
7	0,130	—	—	0,680	—	—	7,2%	7,2%
8	0,023	—	—	0,120	—	—	2%	2%
9	0,090	—	—	0,470	—	—	3,8%	Not stated
10	0,017	—	—	0,089	—	—	1,6%	1,6%
11	0,069	—	—	0,361	—	—	3,1%	3,1%
12	0,011	—	—	0,058	—	—	1,33%	1,33%
13	0,053	—	—	0,277	—	—	2%	2%
THD	—	—	—	2,423	—	—	23%	13%
PWHD	—	—	—	1,275	—	—	23%	22%

Power Quality – Voltage Fluctuations and Flicker								
Test start date	2019-08-01			Test End date			2019-08-01	
Test Location	Kiwa Primara GmbH, Gewerbestraße 28, 87600 Kaufbeuren, Germany							
	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured Values	3,344	3,344	150,0ms	-3,469	-3,377	0,0ms	0,027	0,027
Normalised to standard impedance	3,344	3,344	150,0ms	-3,469	-3,377	0,0ms	0,027	0,027
Normalised to required maximum impedance	3,268	3,268	0,0ms	-3,390	-3,300	0,0ms	0,026	0,026
Limit set under BS EN 61000-3-11	4%	3,3%	500ms (>3,3%)*	4%	3,3%	500ms (>3,3%)*	1,0	0,65
*500ms is the maximum allowed time above 3,3%.								

Test Impedance	R	0,4	Ω	X	0,25	Ω
Standard Impedance	R	0,4	Ω	X	0,25	Ω
Maximum Impedance	R	0,39	Ω	X	0,24	Ω

Power Quality – DC injection			
Test power level	10%	55%	100%
Recorded DC value in Amps	-0,001	0,001	0,005
As % of rated AC current	-0,01%	0,00%	0,03%
Limit	0,25%	0,25%	0,25%

Power Factor			
Voltage	0,94 pu (216.2 V)	1,0 pu (230 V)	1,1 pu (253 V)
Measured Value	1,000	1,000	1,000
Power Factor Limit	>0,95		

Protection – Frequency Tests						
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency time	Confirm no trip
U/F stage 1	47,5 Hz	20 s	47,40Hz	20,06s	47,7Hz 30s	No trip
U/F stage 2	47,0 Hz	0,5 s	46,90Hz	0,60s	47,2 Hz 19,5s	No trip
					46,8 Hz 0,45 s	No trip
O/F	52,0 Hz	0,5 s	52,00Hz	0,56s	51,8 Hz 120 s	No trip
					52,2Hz 0,45s	No trip

Protection – Voltage Tests.						
Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage time	Confirm no trip
U/V	0,8 pu (184V)	2,5s	182,5V	2,54s	188 V 5 s	No trip
					180V 2,45 s	No trip
O/V stage 1	1,14 pu (262,2V)	1,0s	261,2V	1,07s	258,2 V 5,0 s	No trip
O/V stage 2	1,19 pu (273,7V)	0,5s	273,0	0,59s	269,7 V 0,95 s	No trip
					277,7 V 0,45 s	No trip

Protection – Loss of Mains Test according BS EN 62116 for Inverters.						
Test Power and imbal-ance	33% -5% Q	66% -5% Q	100% -5% P	33% +5% Q	66% +5% Q	100% +5% P
Trip time (s)	0.199	0.209	0.263	0.151	0.166	0.150

Protection – Frequency change, Vector Shift Stability test.			
	Start frequnecy	Change	Confirm no trip
Positive vector shift	49,5Hz	+50 dregrees	No Trip
Negative vector shift	50,5Hz	- 50 dregrees	No Trip

Protection – Frequency Change, RoCoF Stability Test			
Ramp range	Test frequency ramp	Test duration	Confirm no Trip
49,0 Hz to 51,0 Hz	+0,95 Hzs^{-1}	2,1 s	No trip
51,0 Hz to 49,0 Hz	-0,95 Hzs^{-1}	2,1 s	No trip

Protection – Limited Frequency Sensitive Mode – Over frequency Test				
Active Power response to rising frequency/time plots are attached				N
Test sequence at **registered capacity** >80%	Measured **Active Power** output [kW]	Frequency [Hz]	Primary power source (if applicable	**Active Power** Gradient
Step a) 50,00Hz ± 0,01Hz	2,40	50,00	—	—
Step b) 50,45Hz ± 0,05Hz	2,38	50,45		—
Step c) 50,70Hz ± 0,10Hz	2,26	50,70		—
Step d) 51,15Hz ± 0,05Hz	2,04	51,15		—
Step e) 51,70Hz ± 0,10Hz	2,26	50,70		—
Step f) 50,45Hz ± 0,05Hz	2,38	50,45		—
Step g) 50,00Hz ± 0,01Hz	2,40	50,00		9,5%
Test sequence at **registered capacity** 40% - 60%	Measured **Active Power** output [kW]	Frequency [Hz]	Primary power source (if applicable	**Active Power** Gradient
Step a) 50,00Hz ± 0,01Hz	1,22	50,00	—	—
Step b) 50,45Hz ± 0,05Hz	1,20	50,45		—
Step c) 50,70Hz ± 0,10Hz	1,07	50,70		—
Step d) 51,15Hz ± 0,05Hz	0,85	51,15		—
Step e) 50,70Hz ± 0,01Hz	1,07	50,70		—
Step f) 50,45 Hz ± 0,05Hz	1,20	50,45		—
Step g) 50,00 Hz ± 0,01Hz	1,22	50,00		9,9%

The test was performed using the MultiPlus-II 48/3000/35-32. The behavior of the generator is valid for the Quattro-II 48/5000/70-50-50 230V.

The Quattro-II is a stand-alone battery charger and battery inverter system equipped with two AC inputs and 2 AC outputs. The difference between Victron Quattro-II and Victron Multiplus-II is the additional AC output port. This port do not affect the rest of the already tested Grid Code functions in the Multiplus-II unit.

Protection – Reconnection Timer					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
>20s	Max. 27,3 Min. 25,2	At 1,16 pu (266,2V)	At 0,78pu (180,0V)	At 47,4 Hz	At 52,1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		No reconnection	No reconnection	No reconnection	No reconnection

Fault Level Contribution		
For Inverter Output		
Time after fault	Volts	Amps
20ms	85,1	19,27
100ms	0,0	0,0
250ms	0,0	0,0
500ms	0,0	0,0
Time to trip	0,03	In seconds
As SSEGs (small-scale embedded generators) for PV are inverter-connected the max. short circuit current is the max. AC current.		

Self-Monitoring Sold state switching	
It has been verified that in the event of the solid state switching device failing to disconnect the Power Park Module, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	NA*
*there are no solid state switching devices in the unit, mechanical relays are provided	

Wiring functional Tests	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	NA
Logic interface (input port)	
Confirm that an input port is provided and can be used to shut down the module.	YES
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	YES
**When the switch is closed the Micro-generator can operate normally. When the switch is opened the Micro-generator will reduce its Active Power to zero within 5 s. The signal from the Micro-generator that is being switched is DC (maximum value 5V).*	
Cyber security	
Confirm that the Power Generating Module has been designed to comply with cyber security requirements, as detailed in 9.1.7.	YES
Additional Comments	