Test Report issued under the responsibility of:

TEST REPORT

DIN VDE V 0124-100

Test requirements for generation units to be connected and operated parallel with the low voltage distribution networks

Report Number.	**220907STA099-EG-DE-001**
Total pages	**203**
Tested by (name + signature)	Allen Zhang / Test Engineer
Approved by (name + signature)	Lukes Lin / Project Supervisor
Date of issue	2022-12-29

Applicant's name	Dongguan kaideng Energy Technology Co., Ltd.
Address	4 th floor, Fuyuan business building, no. 1, Lane 13, xin'an maiyuan Road, Chang 'an town, Dongguan City, Guangdong, China
Manufacturer	Same as applicant
Address	Same as applicant

Testing laboratory name	Guangdong HuaChuang Technology Service Co., Ltd.
Address	Room 815, No.122, Houjie Road (West), Houjie Town, Dongguan City, Guangdong, 523960 P.R.C
Testing Location	As above
Address	As above

Test specification:

Standard	VDE AR-N 4105:2018-11 DIN VDE V 0124-100:2020-06
Test Report Form No.	VDE0124-100 VER.1.1

Issued by: Guangdong HuaChuang Technology Service Co., Ltd.
Address: Room 815, No.122, Houjie Road (West), Houjie Town, Dongguan City, Guangdong, 523960 P.R.C
Tel: +86 769 85598986 E-Mail: service@huachuang-ts.com Web: www.huachuang-ts.com

Product name .....:	Micro Solar Inverter
Trade Mark .....:	
Factory's name .....:	Dongguan kaideng Energy Technology Co., Ltd.
Factory address .....:	4 th floor, Fuyuan business building, no. 1, Lane 13, xin'an maiyuan Road, Chang 'an town, Dongguan City, Guangdong, China

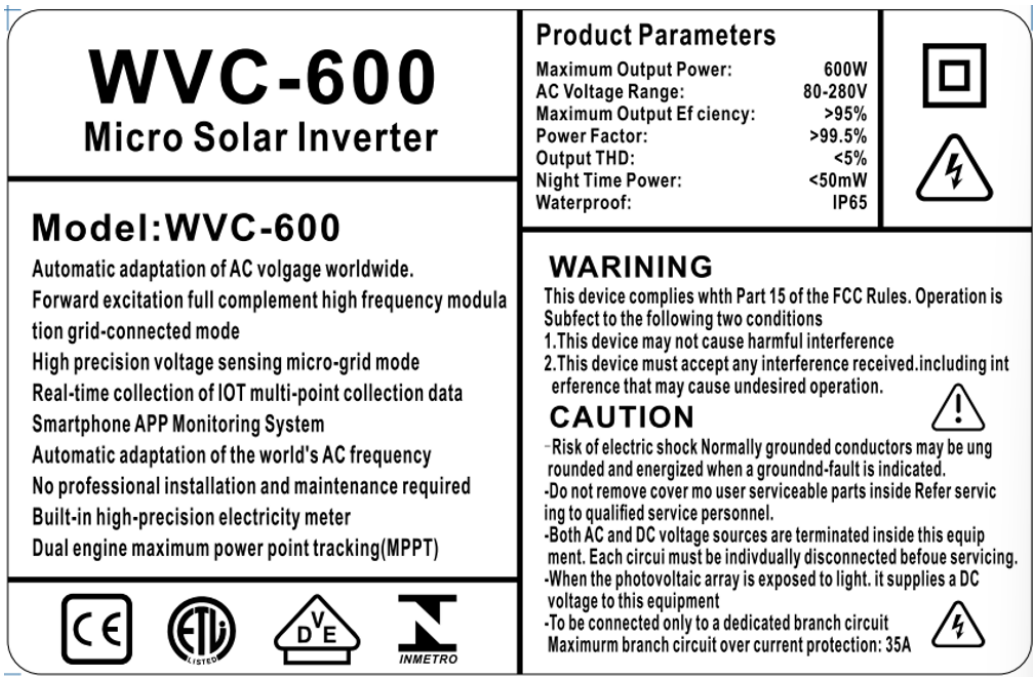
Model/Type reference .....:	**WVC-600**	**WVC-700**	**WVC-800**
Ratings:			
Max. DC Input voltage [V] .....:	60		
MPPT input voltage range [V] .....:	30-60		
Max. input DC current [A] .....:	14/14	16/16	18/18
Short-circuit current [A].....:	16/16	18/18	20/20
Nominal output AC voltage [V] .....:	230 V~, 50/60Hz		
Max. output AC current [A] .....:	2,6	3,05	3,50
Nominal active output power [W] .....:	600	700	800
Max. apparent output power [VA].....:	600	700	800
Note: All test were performed on 230Vac, 50Hz.			

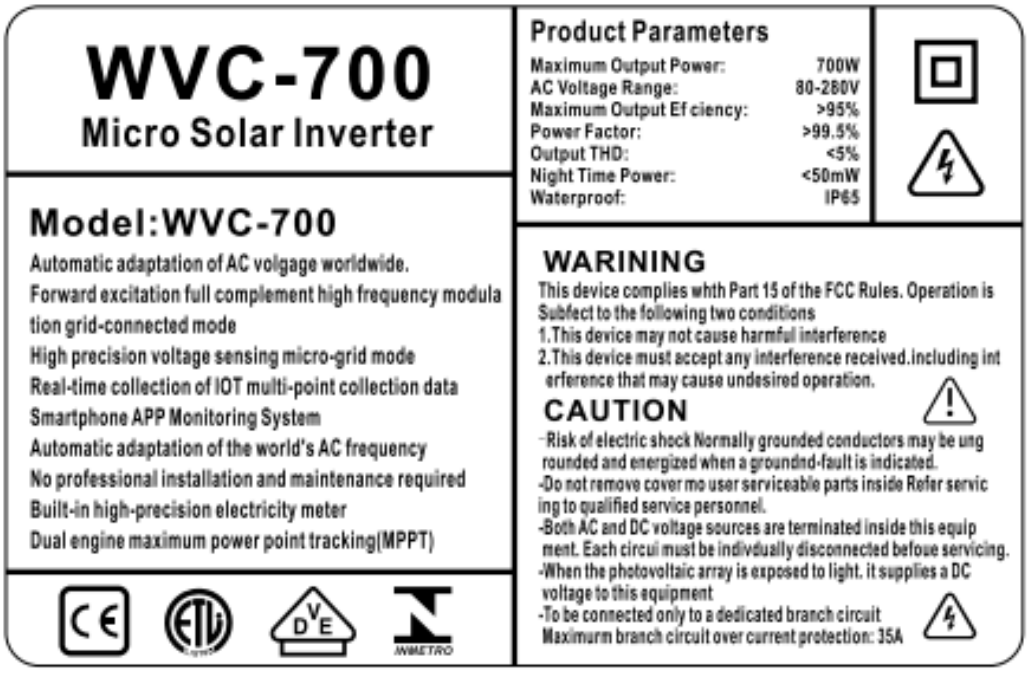
Contents

Revision history of test report

Issued Date	Description	Report Number
2022-12-29	Initial issue.	220907STA099-EG-DE-001

Copy of marking plate





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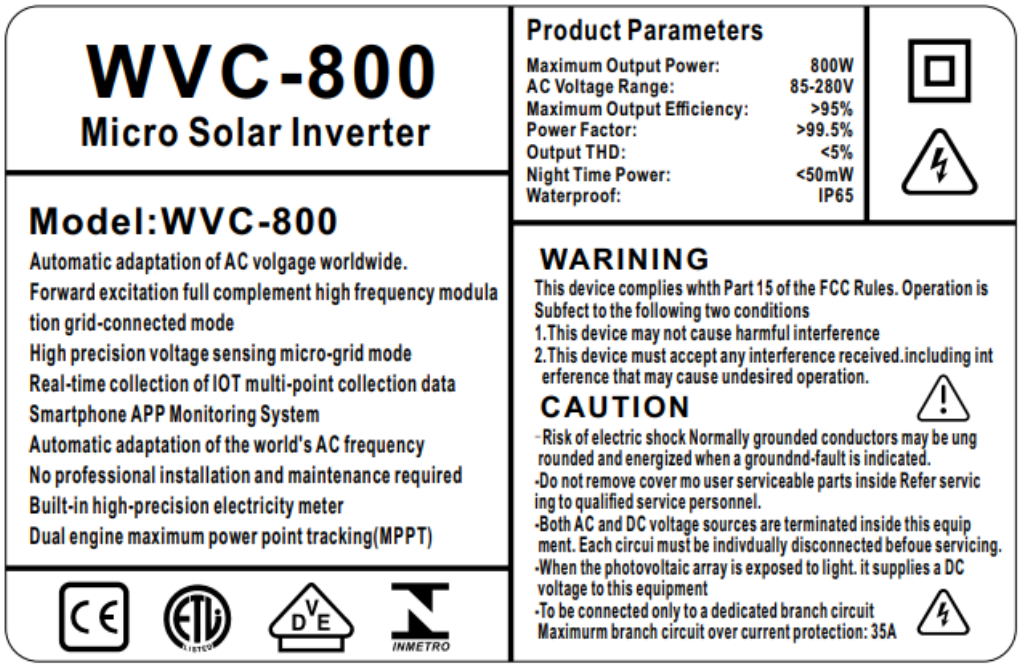


General remarks - documentation

Possible test case verdicts

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

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

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

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

Testing

Date of receipt of test items .....: 2022-09-07

Date(s) of performance of tests .....: 2022-09-07 to 2022-12-19

General remarks:

The test result presented in this report relate only to the object(s) tested. This report shall not be reproduced in part or in full without the written approval of the issuing testing laboratory.

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

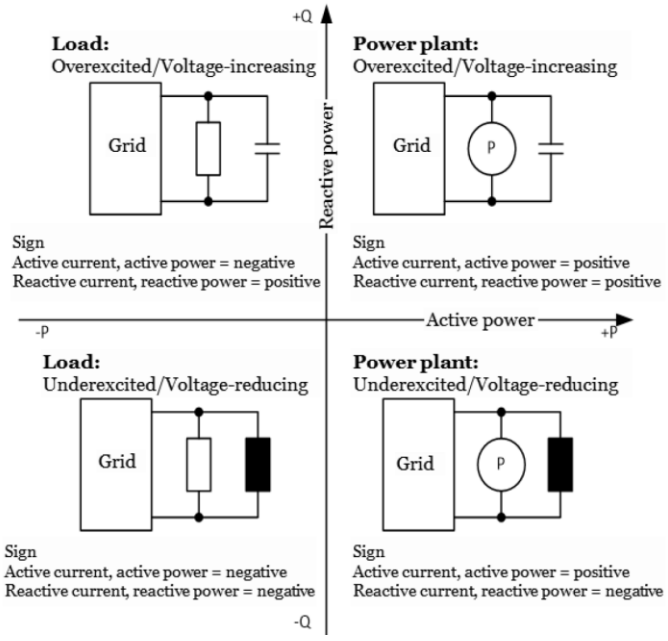
Throughout this report a ☒comma / ☐point is used as the decimal separator.

Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed.

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.



General remarks for testing

Test setup:

For the testing 2 test setups were used:

a) *Test setup 1:* used for tests except islanding prevention testing.

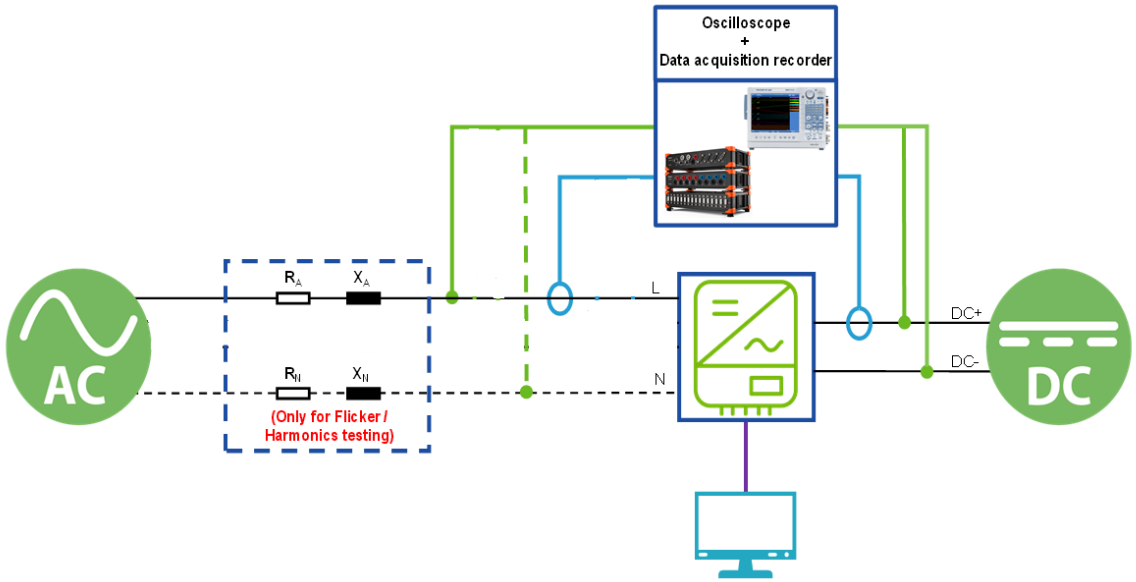


Figure 1 – Test setup 1

b) Test setup 2: Basic test configuration for islanding detection function

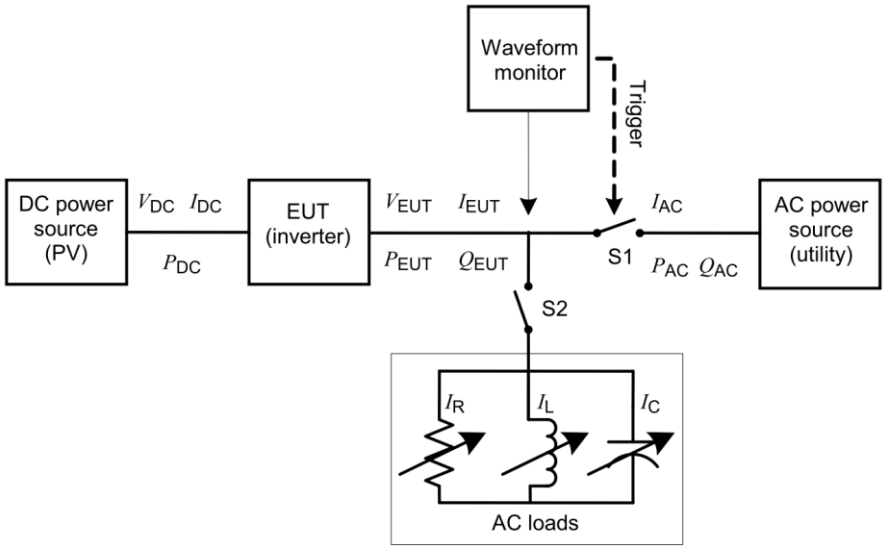


Figure 2 – Test circuit for islanding detection function in a power conditioner (inverter) from *IEC 62116:2014*

General product information

Equipment mobility ..... : Permanent connection

Operating condition ..... : Continuous

Class of equipment..... : Class I

Protection against ingress of water ..... : IP65 according to EN 60529

Mass of equipment [kg] ..... : Approximately 1,46kg

The system consists of an array of micro-inverters that convert direct current (DC) to alternating current (AC) and feed it into the public grid. The system is designed to install one micro-inverter for every two PV modules. Each micro-inverter works independently, ensuring that each PV module maximum power generation. This setup enables the user to directly control the efficiency of the individual PV module arrays, increasing the flexibility and availability of the system dependability. (see Figure 3)

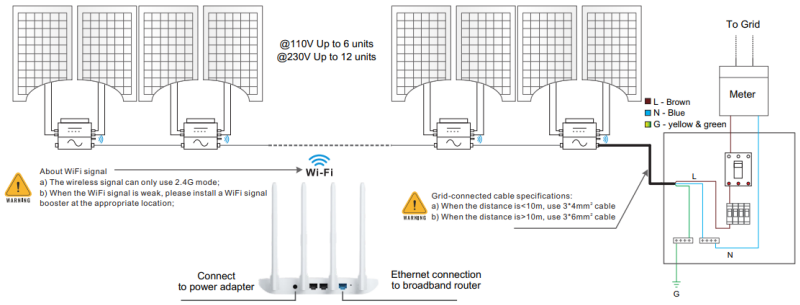


Figure 3 – Scheme of an installation

The product was tested on:

Hardware Version: A0

Software Version: WVC-700R3-22-60-Life-E2

General product information

Description of the power circuit (Figure 4):

The inverter converts DC voltage into alternating voltage. The unit does provide galvanic separation from input to output (transformer).

The output is switched off redundantly by the high-power switching bridge and relay. This assures that the opening of the output circuit will also operate in case of a single error.

The controller (U172) controls the relay by switching signals; measures the Bus voltage, grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground.

The unit provides relay in series in all output conductors. All the relay are tested before each start up.

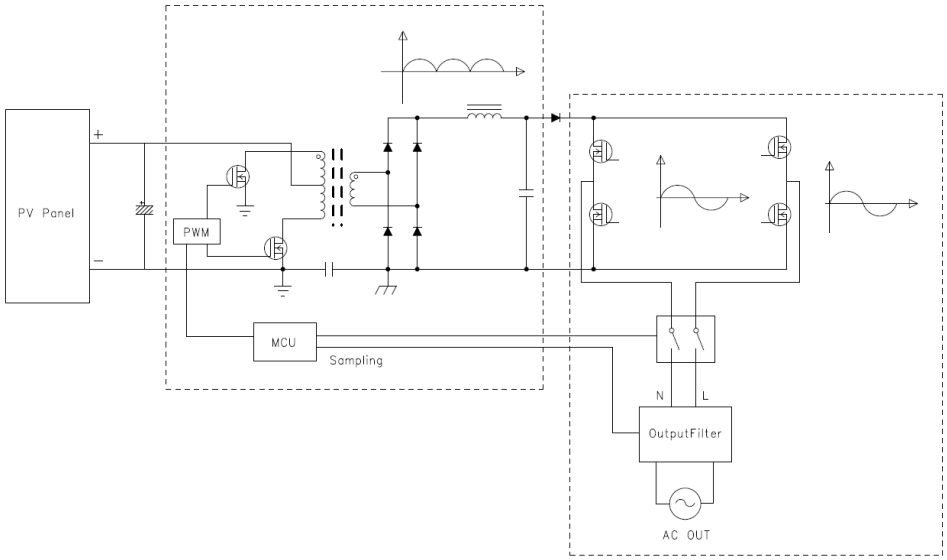


Figure 4 – Block diagram

Assessment

Clause/§	Requirement	Verdict
5.2	**Evidence of permissible network perturbations**	
5.2.1	General	**P**
5.2.2	Rapid voltage changes	**P**
5.2.3	Flicker	**P**
5.2.4	Harmonics and interharmonics	**P**
5.2.4.1 a)	Test Harmonics DIN EN 61000-3-2 (≤16 A per Phase)	**P**
5.2.4.1 a)	Test Harmonics DIN EN 61000-3-12 (≥16 A and ≤75 A per Phase)	**N/A**
5.2.4.1 b)	Test Harmonics and interharmonics DIN EN 61000-4-7 (≥75 A per Phase)	**P**
5.2.5	Commutation	**N/A**
5.2.6	Feed in of DC current	**P**
5.3	**Evidence of symmetry behaviour of inverters**	
5.3.1	General	**N/A**
5.3.2.1	Calculation of the asymmetry of three-phase inverters	**N/A**
5.3.2.2.1	Failure of single inverter modules	**N/A**
5.3.2.2.2	Power drop of single inverter modules	**N/A**
5.3.2.3.2	Symmetrical operation with a symmetry device	**N/A**
5.4	**Evidence of the behaviour of the generating unit on the network**	
5.4.1	General	**P**
5.4.2	Measurement of the active and reactive power range	**P**
5.4.3.3	Measurement of setting accuracy	**P**
5.4.3.4	Measurement of the power gradient	**P**
5.4.3.5	Measurement Priority Interfaces / Energy Management	**N/A**
5.4.4	Active power feed-in for PGUs at over-frequency	**P**
5.4.5	Active power feed-in of Storage systems for over-frequency	**P**
5.4.6	Active power feed-in for PGUs at underfrequency	**P**
5.4.7	Active power feed-in for storage systems at underfrequency	**N/A**
5.4.8	Static voltage stability / reactive power supply	**P**
5.4.8.2	Tests of the Reactive power / cos φ setting accuracy	**P**
	The regulating and control behaviour of the reactive power	**P**
5.4.8.3	Test of the displacement factor/active power characteristic curve cos φ (P)	**P**
	Test 1) for conducted PGUs - Accuracy (characteristic)	**P**
	Test 2) for conducted PGUs - dynamics	**N/A**
	Test 3) supply-dependent PGUs - Accuracy (characteristic curve)	**P**
	Test 4) supply-dependent PGUs - Dynamic	**P**
5.4.8.4.1	Test of the accuracy of the Q(U) regulation	**P**

Assessment

Clause/§	Requirement	Verdict
5.4.8.4.2	Test of the dynamics of the Q(U) regulation	**P**
5.5	**NS-protection**	
5.5.2	NS protection	**P**
5.5.2.1	Functional safety	**P**
5.5.3	Central NS-protection	**N/A**
5.5.4	Integrated NS-protection	**P**
5.5.6	Interface switch	**P**
5.5.6.2	Central interface switch	**N/A**
5.5.6.3	Integrated interface switch	**P**
5.5.7.2	Check of setting values	**P**
5.5.7.3	Wiring check	**N/A**
5.5.7.4	Voltage and frequency control	**P**
5.5.7.4.1	Voltage and frequency control – Single Phase	**P**
	Voltage and frequency control – Multi Phase (Phase to N)	**N/A**
	Voltage and frequency control – Multi Phase (Phase to Phase)	**N/A**
	Voltage and frequency control – Measuring the rise-in voltage protection as a running 10-minute mean value	**P**
	Voltage and frequency control – Frequency measurement	**P**
5.5.7.5	Reporting of NS protection	**P**
5.5.9	Constructional characteristics of NS protection	**P**
5.5.10.1	General	**P**
5.5.10.2	Passive Islanding Protection	**N/A**
5.5.10.3	Islanding protection according to table 6 – Load imbalance (real, reactive load) for test condition A (PGU output = 100%)	**P**
	Islanding protection according to table 7 – Load imbalance (real, reactive load) for test condition B (PGUT output = 66%)	**P**
	Islanding protection according to table 8 – Load imbalance (real, reactive load) for test condition C (PGU output = 33%)	**P**
5.6	**Connecting conditions and synchronization**	
5.6.1	General	**P**
5.6.2	Connecting conditions and synchronisation	**P**
5.7	**Evidence of $P_{AV,E}$ - Control**	
5.7.1	General	**N/A**
5.7.2.1	Test control dynamic	**N/A**
5.7.2.2	Test disconnection function	**N/A**
5.8	**Evidence dynamic grid support**	
5.8.1	General	**P**

Assessment

Clause/§	Requirement	Verdict
5.8.3	Testing of the dynamic grid support PGU Type 1	**N/A**
5.8.3	Testing of the dynamic grid support PGU Type 2	**P**
5.9	**Test of Ancillary Unit**	

Annex 1 – Test Results

5.2	Evidence of permissible network perturbations	
5.2.1	**General**	**P**

The electrical installations of the customer system shall be planned, constructed and operated so that reactions to the network operator's network and to the systems of other customers are permanently reduced to a permissible minimum. Should interfering reactions on the network operator's network occur nonetheless, the customer shall apply measures to his system that are to be coordinated with the network operator. The network operator is entitled to disconnect the power generation system concerned from the network until the deficiencies are corrected.

System perturbations are defined as:

- Rapid voltage changes
- Flicker
- Harmonics, interharmonics and higher frequencies (up to 9 kHz)

5.2.2 Rapid voltage changes	P

The purpose of the test is to determine k_i and k_{imax}.

The following three cases must be tested (where applicable).

- Switch-on for any capacity
- Unfavourable case when switching the generator step
- Switch-on for nominal capacity

Note: For PV-plants the inverter is the generator

- Switch-off for nominal capacity (no emergency shutdown, but operative shutdown)

If the manufacturer knows more critical cases (e.g., different cos φ parameters) then these additional have to be tested

Test conditions:

Frequency: 50 Hz ± 0,5%

THD of the voltage supply: ≤ 3 %

Voltage rises of the PGU at 100 P_{Emax} %: ≤ 3 %

WVC-800

Switch-on for any capacity (10% P_{Emax})

Phase	L1			L2			L3		
Single period effective values of the current [A]	0,094	0,082	0,063	--	--	--	--	--	--
Single period effective values of the voltage [V]	229,11	230,14	230,64	--	--	--	--	--	--
k_i value [1]	0,027	0,024	0,018	--	--	--	--	--	--
k_{imax} value [1]	0,027			--			--		

Unfavourable case when switching the generator step (not necessary for electronic inverter)

Phase	L1			L2			L3		
Single period effective values of the current [A]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Single period effective values of the voltage [V]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
k_i value [1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
k_{imax} value [1]	N/A			N/A			N/A		

Switch-on for nominal capacity

Phase	L1			L2			L3		
Single period effective values of the current [A]	0,069	0,077	0,081	--	--	--	--	--	--
Single period effective values of the voltage [V]	230,96	230,19	230,36	--	--	--	--	--	--
k_i value [1]	0,020	0,022	0,023	--	--	--	--	--	--
k_{imax} value [1]	0,023			--			--		

Switch-off for nominal capacity									
Phase	**L1**			**L2**			**L3**		
Single period effective values of the current [A]	2,110	2,106	2,096	--	--	--	--	--	--
Single period effective values of the voltage [V]	230,53	230,50	230,55	--	--	--	--	--	--
k_i value [1]	0,607	0,605	0,603	--	--	-	-	--	--
k_{imax} value [1]	0,607			--			--		

Grid Frequency [Hz]	50,00
Grid voltage [V]	230,0
Rated current I_r [A]	3,5
Highest k_{imax} value for all switching operations [1]	0,607

Note:

Limits:

k_{imax} = 1,2 for synchronous generators with fine synchronization, converter; (electronic inverter)

k_{imax} = 4 for asynchronous generators, which are switched on at 95% to 105% of their synchronous speed, if no further details are available regarding the type of current limitation. With regard to short-term compensation processes, the condition mentioned below for very short voltage changes must also be observed.

K_{imax} = 8 for asynchronous generators that are powered up by the network if I_a is unknown.

(I_a = starting current)

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.2.3 Flicker **These tests are designed to provide evidence that the requirements of VDE-AR-N 4100:2019-04 are met.**	**P**

Adherence to the thresholds for flicker must be verified as followed:

- For nominal currents ≤ 16 A per conductor to DIN EN 61000-3-3 (VDE 0838-3)
- For nominal currents > 16 A and ≤ 75 A per conductor to DIN EN 61000-3-11 (VDE 0838-11)

Test conditions:

Voltage: 86% U_n to 109% U_n

Frequency: 50 Hz ± 0,5%

THD of the voltage supply: ≤ 3 %

Voltage rises of the PGU at 100% P_{Emax}: ≤ 3 %

Assessment criterion:

Long-term flicker strength Plt to DIN EN 61000-3-3 (VDE 0838-3) must be ≤ 0,5.

Determination of the flicker coefficient:

$$c_{\psi k} = P_{st} \times (S_k / P_n)$$

where S_k is the short-circuit power of the network standby element (during the determination of the appropriate P_{st} values)

The value for the network standby element must be determined separately with measurements for rated currents > 75 A.

Note:

Grid impedance DIN EN 61000-3-3 (VDE 0838-3) [Ω]:	R_A = 0,24Ω jX_A = 0,15Ω / R_N = 0,16Ω jX_N = 0,10Ω (Rn and jXn only for single-phase units used!)
Grid impedance DIN EN 61000-3-11 (VDE 0838-11) [Ω]:	R_A = 0,24Ω jX_A = 0,15Ω / R_N = 0,16Ω jX_N = 0,10Ω (Rn and jXn only for line to neutral single-phase or three units used!) R_A = 0,15Ω jX_A= 0,15Ω / R_N = 0,01Ω jX_N= 0,01Ω (Rn and jXn only for line to line three-phase units used!)

Test result:

a) Flicker to DIN EN 61000-3-3 (VDE 0838-3) for generator units ≤ 75 A — **P**

EUT		Selection of limits	
☒ **1- phase**	☐ **3-phase**	☒ Equipment with rated current ≤16 A per phase	☐ Equipment with rated current ≤75 A per phase

	IEC EN 61000-3-3				*IEC EN 61000-3-11*
	d_{max}	d_c	T_{max}	P_{st}	P_{lt}
	0,70	0,68	0	0,152	0,150

Output voltage of the impedance network [V]	231,47

Reference impedance according the standard:

☒	Grid impedance DIN EN 61000-3-3 (VDE 0838-3) [Ω]:	R_A = 0,24Ω jX_A = 0,15Ω / R_N = 0,16Ω jX_N = 0,10Ω (Rn and jXn only for single-phase units used!)
☐	Grid impedance DIN EN 61000-3-11 (VDE 0838-3) [Ω]:	R_A = 0,24Ω jX_A = 0,15Ω / R_N = 0,16Ω jX_N = 0,10Ω (Rn and jXn only for line to neutral single-phase or three units used!)
☐	Grid impedance DIN EN 61000-3-11 (VDE 0838-3) [Ω]:	R_A = 0,15Ω jX_A= 0,15Ω / R_N = 0,01Ω jX_N= 0,01Ω (Rn and jXn only for line to line three-phase units used!)

Flicker for rated currents ≤75A to DIN EN 61000-3-3 (VDE 0838-3)				
Assessment criterion: Long-term flicker strength: P_{lt}≤0,5				
Grid impedance angle ψ_k	☒ 32° or ☐ 45			
Flicker coefficient c(ψ_k)	23,330			
Note: The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.				
b) Flicker to DIN EN 61000-3-3 (VDE 0838-3) for generator units ≤ 75 A	N/A			
Adherence to the thresholds for flicker must be verified as followed: - For PGUs (power generation units) and PSUs (power supply units) intended for PGSs (power generation systems) with nominal currents > 75 A, the measurements must be conducted as in 5.2.3.2.				
Test conditions: Voltage: 86% U_n to 109% U_n Frequency: 50 Hz ± 0,5% THD of the voltage supply: ≤ 3 % Voltage rises of the PGU at 100% P_{Emax}: ≤ 3 %				
Assessment criterion: Long-term flicker strength: P_{lt}≤0,5				
Test result:				
Flicker for rated currents >75A (at SCR = 20) (Calculation Flickermeter according to TG3)				
Rated Output voltage [V]	--			
Grid impedance angle ψ_k [°]	30	50	70	85
Flicker coefficient c(ψ_k) [1]	--	--	--	--
Short-term Flicker P_{st} [1]	--	--	--	--
Flicker step factor k($f\psi_k$) [1]	--	--	--	--
Voltage changes factor k($u\psi_k$) [1]	--	--	--	--

5.2.4	Harmonics and interharmonics	P

5.2.4.1 a)	Harmonics test	

EUT		Selection of limits		
☒	☐	☒	☐	☐
1-phase	*3-phase*	Equipment with input current ≤16 A per phase	Equipment with input current >16 A and ≤75 A per phase	Equipment with input current >75 A per phase
WVC-800		***IEC EN 61000-3-2***	***IEC EN 61000-3-12***	

Phase	**L1**	**L2**	**L3**
Power Level	**33%**	**33%**	**33%**
AC Power [W]	265	--	--
AC Voltage [V]	230,40	--	--
AC Current [A]	1,15	--	--
Frequency [Hg]	50,00	--	--

Harmonic	**Measured value I_h [A]**			**Measured value I_h [%I_1]**			**Limits [A]**
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	IEC EN 61000-3-2
1st	1,150	--	--	--	--	--	--
2nd	0,005	--	--	0,447	--	--	1,080
3rd	0,043	--	--	3,752	--	--	2,300
4th	0,003	--	--	0,282	--	--	0,430
5th	0,011	--	--	0,938	--	--	1,140
6th	0,002	--	--	0,181	--	--	0,300
7th	0,019	--	--	1,668	--	--	0,770
8th	0,002	--	--	0,153	--	--	0,263
9th	0,005	--	--	0,428	--	--	0,400
10th	0,001	--	--	0,123	--	--	0,184
11th	0,008	--	--	0,689	--	--	0,330
12th	0,001	--	--	0,092	--	--	0,153
13th	0,017	--	--	1,498	--	--	0,210
14th	0,001	--	--	0,084	--	--	0,131
15th	0,026	--	--	2,223	--	--	0,150
16th	0,001	--	--	0,077	--	--	0,115
17th	0,025	--	--	2,194	--	--	0,132
18th	0,001	--	--	0,071	--	--	0,102
19th	0,023	--	--	1,991	--	--	0,188
20th	0,001	--	--	0,079	--	--	0,092
21th	0,018	--	--	1,581	--	--	0,107
22th	0,001	--	--	0,076	--	--	0,084
23th	0,010	--	--	0,880	--	--	0,098
24th	0,001	--	--	0,074	--	--	0,077
25th	0,003	--	--	0,235	--	--	0,090
26th	0,001	--	--	0,076	--	--	0,071

27th	0,004	--	--	0,305	--	--	0,080
28th	0,001	--	--	0,075	--	--	0,066
29th	0,009	--	--	0,782	--	--	0,078
30th	0,001	--	--	0,078	--	--	0,061
31th	0,012	--	--	1,016	--	--	0,073
32th	0,001	--	--	0,077	--	--	0,057
33th	0,011	--	--	0,938	--	--	0,068
34th	0,001	--	--	0,074	--	--	0,054
35th	0,009	--	--	0,814	--	--	0,064
36th	0,001	--	--	0,083	--	--	0,051
37th	0,008	--	--	0,653	--	--	0,061
38th	0,001	--	--	0,072	--	--	0,048
39th	0,005	--	--	0,403	--	--	0,058
40th	0,001	--	--	0,071	--	--	0,046
THD [%]	--	--	--	0,447	--	--	--

Phase	**L1**	**L2**	**L3**
Power Level	**66%**	**66%**	**66%**
AC Power [W]	534	--	--
AC Voltage [V]	230,0	--	--
AC Current [A]	2,322	--	--
Frequency [Hz]	50,00	--	--

Harmonic	**Measured value I_h [A]**			**Measured value I_h [%I_1]**			**Limits [A]**
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	IEC EN 61000-3-2
1st	2,322	--	--	--	--	--	--
2nd	0,011	--	--	0,471	--	--	1,080
3rd	0,098	--	--	4,224	--	--	2,300
4th	0,006	--	--	0,271	--	--	0,430
5th	0,010	--	--	0,431	--	--	1,140
6th	0,004	--	--	0,153	--	--	0,300
7th	0,036	--	--	1,535	--	--	0,770
8th	0,003	--	--	0,141	--	--	0,263
9th	0,031	--	--	1,344	--	--	0,400
10th	0,003	--	--	0,109	--	--	0,184
11th	0,018	--	--	0,776	--	--	0,330
12th	0,002	--	--	0,067	--	--	0,153
13th	0,012	--	--	0,527	--	--	0,210
14th	0,002	--	--	0,066	--	--	0,131
15th	0,023	--	--	0,974	--	--	0,150
16th	0,001	--	--	0,059	--	--	0,115
17th	0,023	--	--	1,005	--	--	0,132
18th	0,001	--	--	0,052	--	--	0,102
19th	0,024	--	--	1,014	--	--	0,188

20th	0,001	--	--	0,060	--	--	0,092
21th	0,021	--	--	0,917	--	--	0,107
22th	0,001	--	--	0,052	--	--	0,084
23th	0,014	--	--	0,597	--	--	0,098
24th	0,001	--	--	0,050	--	--	0,077
25th	0,007	--	--	0,291	--	--	0,090
26th	0,001	--	--	0,052	--	--	0,071
27th	0,005	--	--	0,217	--	--	0,080
28th	0,001	--	--	0,049	--	--	0,066
29th	0,010	--	--	0,418	--	--	0,078
30th	0,001	--	--	0,053	--	--	0,061
31th	0,011	--	--	0,487	--	--	0,073
32th	0,001	--	--	0,055	--	--	0,057
33th	0,009	--	--	0,381	--	--	0,068
34th	0,001	--	--	0,053	--	--	0,054
35th	0,007	--	--	0,307	--	--	0,064
36th	0,001	--	--	0,055	--	--	0,051
37th	0,006	--	--	0,268	--	--	0,061
38th	0,001	--	--	0,053	--	--	0,048
39th	0,007	--	--	0,316	--	--	0,058
40th	0,001	--	--	0,050	--	--	0,046
THD [%]	--	--	--	3,376	--	--	--

Phase	**L1**	**L2**	**L3**
Power Level	**100%**	**100%**	**100%**
AC Power [W]	794	--	--
AC Voltage [V]	230,0	--	--
AC Current [A]	3,450	--	--
Frequency [Hz]	50,00	--	--

Harmonic	**Measured value I_h [A]**			**Measured value I_h [%I_1]**			**Limits [A]**
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	IEC EN 61000-3-2
1st	3,450	--	--	--	--	--	--
2nd	0,016	--	--	0,461	--	--	1,080
3rd	0,129	--	--	3,737	--	--	2,300
4th	0,007	--	--	0,212	--	--	0,430
5th	0,081	--	--	2,339	--	--	1,140
6th	0,005	--	--	0,138	--	--	0,300
7th	0,084	--	--	2,439	--	--	0,770
8th	0,005	--	--	0,145	--	--	0,263
9th	0,056	--	--	1,620	--	--	0,400
10th	0,003	--	--	0,076	--	--	0,184
11th	0,026	--	--	0,743	--	--	0,330
12th	0,002	--	--	0,061	--	--	0,153

13th	0,002	--	--	0,072	--	--	0,210
14th	0,002	--	--	0,058	--	--	0,131
15th	0,034	--	--	0,975	--	--	0,150
16th	0,001	--	--	0,039	--	--	0,115
17th	0,030	--	--	0,881	--	--	0,132
18th	0,002	--	--	0,047	--	--	0,102
19th	0,030	--	--	0,859	--	--	0,188
20th	0,001	--	--	0,043	--	--	0,092
21th	0,022	--	--	0,646	--	--	0,107
22th	0,001	--	--	0,039	--	--	0,084
23th	0,013	--	--	0,387	--	--	0,098
24th	0,002	--	--	0,044	--	--	0,077
25th	0,011	--	--	0,317	--	--	0,090
26th	0,001	--	--	0,037	--	--	0,071
27th	0,019	--	--	0,551	--	--	0,080
28th	0,001	--	--	0,036	--	--	0,066
29th	0,031	--	--	0,907	--	--	0,078
30th	0,001	--	--	0,042	--	--	0,061
31th	0,037	--	--	1,066	--	--	0,073
32th	0,001	--	--	0,037	--	--	0,057
33th	0,036	--	--	1,053	--	--	0,068
34th	0,001	--	--	0,037	--	--	0,054
35th	0,035	--	--	1,008	--	--	0,064
36th	0,001	--	--	0,040	--	--	0,051
37th	0,030	--	--	0,876	--	--	0,061
38th	0,001	--	--	0,035	--	--	0,048
39th	0,024	--	--	0,695	--	--	0,058
40th	0,001	--	--	0,035	--	--	0,046
THD [%]	--	--	--	2,043	--	--	--

PV-curve simulated according to	
Voltage of defined MPP [V]	42
Current of defined MPP [A]	20,7
FFU of PV curve [1]	--
Impedance [Ω]	
Line	R_A = 0,24 jX_A = 0,15
Neutral	R_N = 0,16 jX_N = 0,10

Note:
The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.2.4.1 b)	Test Harmonics DIN EN 61000-4-7 (≥75 A per Phase)	P

Harmonics

P/ P_{rE} [%]	5	10	20	30	40	50	60	70	80	90	100
Order	I_h [%]										
1	6,599	11,910	22,551	33,204	43,639	53,851	63,856	73,490	81,834	92,510	99,130
2	0,127	0,067	0,112	0,157	0,190	0,240	0,302	0,376	0,411	0,450	0,486
3	1,039	0,242	0,777	1,211	1,739	2,256	2,718	3,204	2,688	2,528	0,891
4	0,034	0,046	0,066	0,094	0,123	0,148	0,176	0,210	0,173	0,207	0,206
5	1,236	0,715	0,379	0,326	0,265	0,207	0,199	0,231	0,758	1,801	2,252
6	0,042	0,039	0,047	0,054	0,070	0,082	0,091	0,116	0,102	0,165	0,140
7	1,129	0,861	0,428	0,574	0,759	0,899	1,002	1,027	0,971	1,589	2,444
8	0,057	0,030	0,043	0,056	0,066	0,078	0,094	0,108	0,119	0,144	0,146
9	0,802	0,741	0,293	0,136	0,424	0,666	0,873	1,083	1,315	1,160	1,684
10	0,048	0,028	0,035	0,042	0,051	0,059	0,068	0,077	0,089	0,073	0,069
11	0,529	0,570	0,493	0,226	0,232	0,382	0,525	0,651	0,899	0,617	0,807
12	0,042	0,025	0,027	0,029	0,034	0,038	0,041	0,045	0,049	0,048	0,064
13	0,626	0,434	0,647	0,501	0,408	0,376	0,382	0,360	0,428	0,446	0,054
14	0,051	0,025	0,027	0,029	0,031	0,036	0,041	0,048	0,051	0,064	0,060
15	0,534	0,433	0,725	0,745	0,698	0,670	0,661	0,660	0,670	0,933	0,909
16	0,043	0,024	0,025	0,027	0,028	0,031	0,034	0,041	0,044	0,052	0,036
17	0,358	0,390	0,587	0,734	0,726	0,706	0,690	0,660	0,688	0,949	0,843
18	0,037	0,024	0,024	0,023	0,025	0,028	0,030	0,034	0,034	0,032	0,048
19	0,353	0,333	0,388	0,664	0,715	0,716	0,705	0,669	0,654	0,852	0,852
20	0,043	0,024	0,025	0,026	0,028	0,031	0,036	0,045	0,045	0,041	0,044
21	0,380	0,304	0,210	0,526	0,634	0,661	0,650	0,581	0,549	0,647	0,665
22	0,041	0,024	0,024	0,025	0,026	0,028	0,030	0,036	0,037	0,040	0,037
23	0,296	0,292	0,169	0,293	0,422	0,458	0,438	0,359	0,294	0,288	0,418
24	0,039	0,023	0,024	0,025	0,025	0,026	0,029	0,034	0,034	0,039	0,045
25	0,234	0,251	0,249	0,077	0,212	0,249	0,225	0,155	0,114	0,159	0,310
26	0,039	0,023	0,023	0,024	0,024	0,026	0,030	0,037	0,038	0,034	0,036
27	0,261	0,182	0,305	0,105	0,056	0,113	0,128	0,174	0,230	0,374	0,511
28	0,039	0,023	0,023	0,025	0,024	0,025	0,027	0,032	0,034	0,033	0,036
29	0,237	0,145	0,333	0,267	0,130	0,133	0,217	0,347	0,423	0,688	0,855
30	0,039	0,023	0,023	0,025	0,025	0,026	0,030	0,038	0,036	0,042	0,042
31	0,167	0,166	0,270	0,346	0,228	0,188	0,260	0,409	0,533	0,811	1,016
32	0,035	0,023	0,023	0,025	0,025	0,026	0,030	0,038	0,039	0,037	0,035
33	0,158	0,170	0,151	0,323	0,228	0,155	0,196	0,332	0,423	0,798	1,011
34	0,035	0,023	0,023	0,025	0,024	0,026	0,028	0,035	0,036	0,032	0,034
35	0,168	0,142	0,042	0,281	0,226	0,146	0,156	0,283	0,399	0,746	0,975
36	0,040	0,026	0,025	0,027	0,027	0,027	0,031	0,039	0,038	0,037	0,039
37	0,134	0,099	0,098	0,225	0,252	0,196	0,162	0,213	0,296	0,667	0,843
38	0,032	0,023	0,022	0,023	0,024	0,026	0,028	0,035	0,037	0,035	0,034
39	0,103	0,088	0,201	0,140	0,261	0,260	0,226	0,170	0,208	0,543	0,664
40	0,034	0,024	0,023	0,023	0,023	0,025	0,027	0,033	0,033	0,032	0,034
THC [%]	2,511	1,798	1,793	2,152	2,569	3,028	3,482	3,966	3,802	4,542	4,879
THDU40 [%]	0,104	0,067	0,066	0,068	0,070	0,071	0,079	0,083	0,086	0,088	0,049

5.2.4.1 b)	Test Harmonics DIN EN 61000-4-7 (≥75 A per Phase)										P
Interharmonics											
Test result:											
P/P_{rE} [%]	5	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]										
75	0,109	0,051	0,056	0,063	0,065	0,068	0,075	0,081	0,085	0,091	0,079
125	0,108	0,048	0,050	0,054	0,053	0,054	0,057	0,061	0,063	0,062	0,059
175	0,108	0,044	0,048	0,052	0,053	0,054	0,058	0,062	0,063	0,064	0,060
225	0,107	0,043	0,047	0,050	0,050	0,051	0,054	0,058	0,060	0,060	0,056
275	0,106	0,041	0,043	0,047	0,048	0,049	0,055	0,058	0,059	0,060	0,060
325	0,108	0,040	0,042	0,044	0,046	0,048	0,051	0,056	0,056	0,057	0,054
375	0,106	0,040	0,041	0,043	0,045	0,047	0,052	0,056	0,056	0,057	0,056
425	0,108	0,039	0,040	0,041	0,042	0,045	0,048	0,053	0,052	0,052	0,052
475	0,106	0,039	0,039	0,040	0,042	0,044	0,048	0,053	0,053	0,052	0,052
525	0,106	0,039	0,038	0,038	0,039	0,041	0,045	0,051	0,050	0,050	0,051
575	0,106	0,037	0,037	0,038	0,039	0,041	0,044	0,049	0,050	0,049	0,050
625	0,176	0,036	0,037	0,037	0,038	0,039	0,043	0,048	0,047	0,047	0,049
675	0,105	0,036	0,037	0,036	0,037	0,039	0,042	0,048	0,048	0,047	0,049
725	0,104	0,036	0,037	0,035	0,036	0,038	0,042	0,046	0,046	0,045	0,048
775	0,105	0,035	0,037	0,036	0,036	0,038	0,041	0,047	0,047	0,045	0,048
825	0,105	0,036	0,037	0,035	0,035	0,037	0,041	0,046	0,045	0,044	0,047
875	0,104	0,035	0,037	0,036	0,036	0,038	0,040	0,047	0,046	0,044	0,047
925	0,103	0,036	0,037	0,036	0,036	0,037	0,040	0,046	0,045	0,043	0,048
975	0,102	0,036	0,036	0,036	0,036	0,038	0,040	0,047	0,046	0,044	0,047
1025	0,102	0,036	0,037	0,036	0,036	0,037	0,040	0,047	0,046	0,044	0,047
1075	0,102	0,036	0,036	0,036	0,037	0,038	0,040	0,047	0,047	0,043	0,047
1125	0,099	0,036	0,036	0,037	0,036	0,037	0,039	0,046	0,047	0,044	0,047
1175	0,100	0,036	0,035	0,036	0,036	0,037	0,041	0,047	0,047	0,044	0,047
1225	0,100	0,035	0,036	0,037	0,037	0,037	0,040	0,047	0,048	0,045	0,047
1275	0,100	0,035	0,036	0,037	0,037	0,037	0,041	0,048	0,048	0,044	0,047
1325	0,099	0,035	0,036	0,037	0,036	0,037	0,041	0,048	0,049	0,045	0,048
1375	0,100	0,034	0,036	0,038	0,037	0,037	0,041	0,048	0,049	0,044	0,047
1425	0,098	0,035	0,037	0,038	0,036	0,037	0,040	0,049	0,050	0,045	0,047
1475	0,097	0,034	0,036	0,039	0,039	0,038	0,042	0,050	0,053	0,047	0,050
1525	0,098	0,035	0,036	0,037	0,037	0,037	0,042	0,051	0,051	0,045	0,048
1575	0,097	0,034	0,036	0,038	0,038	0,038	0,041	0,051	0,052	0,048	0,050
1625	0,095	0,035	0,036	0,038	0,037	0,037	0,042	0,051	0,051	0,045	0,048
1675	0,095	0,036	0,035	0,039	0,039	0,039	0,042	0,050	0,053	0,053	0,050
1725	0,100	0,036	0,036	0,038	0,037	0,037	0,041	0,049	0,050	0,044	0,048
1775	0,096	0,036	0,035	0,037	0,037	0,038	0,041	0,049	0,052	0,046	0,049
1825	0,092	0,036	0,036	0,037	0,037	0,037	0,041	0,050	0,050	0,045	0,048
1875	0,092	0,035	0,035	0,037	0,038	0,038	0,041	0,049	0,052	0,048	0,048
1925	0,093	0,035	0,037	0,036	0,037	0,038	0,040	0,048	0,049	0,044	0,048
1975	0,092	0,035	0,036	0,036	0,037	0,038	0,041	0,048	0,052	0,045	0,048

Higher Frequencies											
Test result:											
P/P_{rE} [%]	5	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]										
2,1	0,247	0,156	0,336	0,139	0,345	0,415	0,403	0,303	0,262	0,612	0,718
2,3	0,218	0,128	0,246	0,196	0,262	0,390	0,423	0,340	0,253	0,406	0,481
2,5	0,200	0,121	0,157	0,213	0,153	0,272	0,329	0,280	0,209	0,212	0,273
2,7	0,174	0,118	0,216	0,186	0,120	0,183	0,264	0,273	0,273	0,315	0,327
2,9	0,148	0,215	0,250	0,182	0,200	0,421	0,964	1,169	1,402	1,626	1,538
3,1	0,110	1,073	1,413	1,793	2,340	3,389	5,345	6,623	7,571	8,424	8,644
3,3	0,076	1,175	1,475	1,924	2,482	2,610	1,392	1,589	1,535	1,206	1,236
3,5	0,051	0,300	0,325	0,338	0,397	0,395	0,362	0,417	0,487	0,583	0,638
3,7	0,033	0,184	0,208	0,216	0,332	0,325	0,335	0,390	0,402	0,502	0,606
3,9	0,023	0,135	0,159	0,192	0,272	0,320	0,335	0,378	0,401	0,487	0,587
4,1	0,015	0,160	0,170	0,230	0,205	0,287	0,295	0,314	0,341	0,412	0,484
4,3	0,011	0,155	0,141	0,209	0,144	0,208	0,219	0,214	0,235	0,292	0,323
4,5	0,008	0,159	0,140	0,144	0,127	0,132	0,146	0,138	0,154	0,196	0,215
4,7	0,006	0,154	0,165	0,119	0,125	0,128	0,137	0,160	0,186	0,235	0,283
4,9	0,006	0,140	0,153	0,177	0,148	0,191	0,212	0,243	0,276	0,355	0,426
5,1	0,000	0,144	0,144	0,225	0,201	0,251	0,287	0,317	0,358	0,473	0,560
5,3	0,006	0,142	0,173	0,222	0,239	0,269	0,313	0,342	0,382	0,536	0,633
5,5	0,007	0,132	0,172	0,184	0,250	0,260	0,298	0,313	0,345	0,524	0,621
5,7	0,007	0,136	0,129	0,128	0,217	0,226	0,248	0,250	0,269	0,459	0,543
5,9	0,009	0,125	0,112	0,107	0,156	0,173	0,181	0,172	0,196	0,369	0,432
6,1	0,010	0,121	0,120	0,119	0,116	0,133	0,140	0,147	0,203	0,326	0,366
6,3	0,013	0,124	0,126	0,121	0,151	0,148	0,146	0,183	0,254	0,371	0,362
6,5	0,014	0,117	0,124	0,125	0,201	0,229	0,220	0,226	0,289	0,487	0,474
6,7	0,016	0,119	0,113	0,167	0,195	0,274	0,263	0,225	0,287	0,593	0,621
6,9	0,019	0,112	0,121	0,229	0,149	0,275	0,294	0,208	0,256	0,632	0,714
7,1	0,021	0,105	0,126	0,269	0,118	0,243	0,304	0,196	0,210	0,608	0,726
7,3	0,024	0,102	0,112	0,273	0,158	0,199	0,292	0,204	0,174	0,528	0,651
7,5	0,024	0,096	0,106	0,244	0,247	0,168	0,280	0,226	0,177	0,444	0,545
7,7	0,024	0,093	0,108	0,183	0,343	0,156	0,274	0,252	0,210	0,430	0,502
7,9	0,022	0,091	0,100	0,159	0,370	0,177	0,267	0,284	0,251	0,461	0,581
8,1	0,018	0,090	0,094	0,114	0,262	0,244	0,242	0,320	0,282	0,446	0,684
8,3	0,016	0,089	0,092	0,133	0,128	0,304	0,191	0,356	0,318	0,348	0,685
8,5	0,015	0,090	0,094	0,124	0,198	0,291	0,148	0,381	0,383	0,232	0,542
8,7	0,012	0,091	0,101	0,137	0,175	0,178	0,228	0,363	0,465	0,287	0,334
8,9	0,010	0,093	0,116	0,146	0,171	0,212	0,322	0,273	0,492	0,438	0,345

PV-curve simulated according to	
Voltage of defined MPP [V]	42
Current of defined MPP [A]	20,7
FFU of PV curve [1]	--
Impedance [Ω] Line	R_A = 0,24 jX_A= 0,15

Higher Frequencies	
Neutral	R_N = 0,16 jX_N= 0,10

Note:

The normalization current is 3,48A.

The currents of the harmonics measured according to DIN EN 61000-4-7 (VDE 0847-4-7): 2009-12, 5.6;

The currents of the interharmonics measured accordance with DIN EN 61000-4-7 (VDE 0817-4-7), Annex A;

The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with DIN EN 61000-4-7 (VDE 0847-4-7), Annex B.

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.2.5	Commutation	N/A

This test serves to determine the commutation currents, the project - specific identification and assessment of the

Commutation voltage dips according to VDE-AR-N 4100: 2020-06, 5.4.4.5 is required taking into account the short-circuit power at the point of connection.

- This check is only required for mains-controlled inverters.

5.2.6 Feed in of DC current	P

Test procedural:

The inverter must be used in the adjustment range Test1, Test2 and Test 3.

Each test point shall be held for min 5 minutes and I_{AC}, U_{AC}, $I_{dc\ in\ AC}$ of each phase has to be recorded.

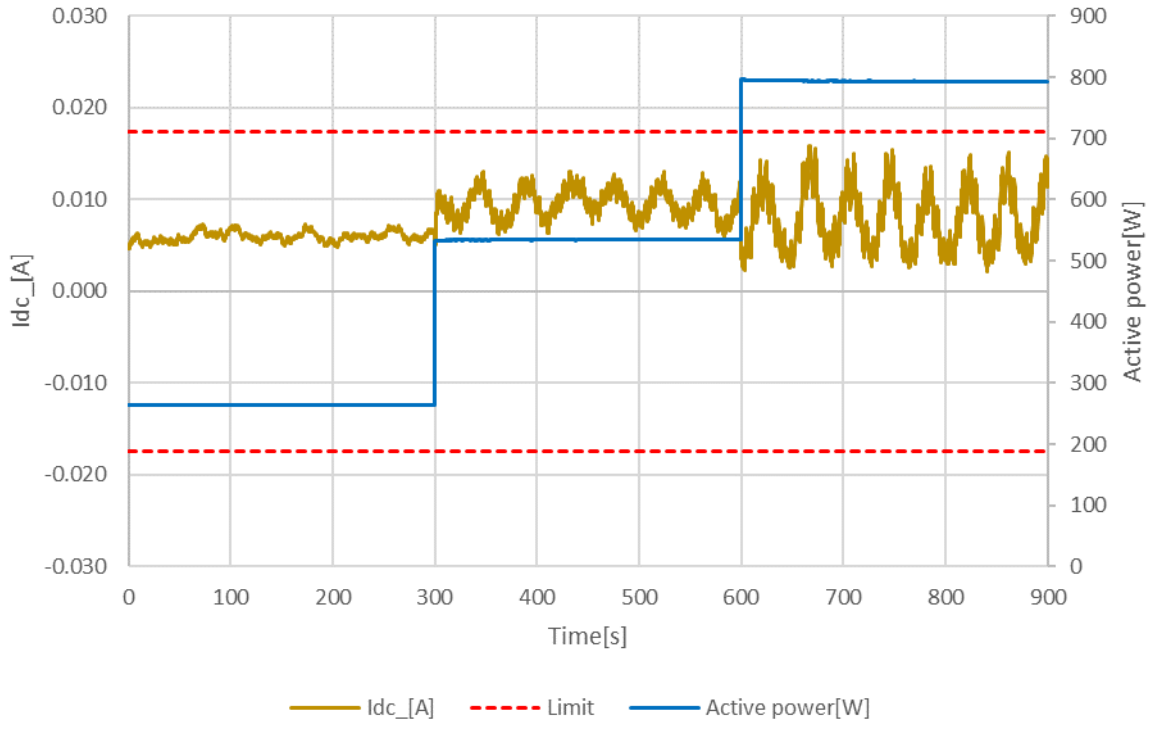
Measurement of $I_{dc\ in\ AC}$ must be done according to VDE AR-N 4100:2020-06 based on DIN EN 61000-4-7 (VDE-0847-4-7) over 10 fundamental periods.

Assessment criterion:

An inverter must not feed more than 0,5% of its rated current I_r or a maximum of 20 mA (the higher value is to be selected) as direct current.

Power Level [% of VA_r]	30% S_{Emax} to 40%S_{Emax}	60% S_{Emax} to 70%S_{Emax}	>95% S_{Emax}
AC Power [VA]	265	534	794
AC Voltage [V]	229,99	229,99	230,01
AC Current [A]	1,150	2,322	3,450
Max. DC Current in AC [mA]	7	13	16
Max. DC Current in AC [% of Ir]	0,21	0,38	0,46
Average. DC Current in AC [mA]	6	10	8
Average. DC Current in AC [% of Ir]	0,17	0,27	0,23

Graphs



Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.3	Evidence of symmetry behaviour of inverters	N/A

5.3.1	General	N/A
These tests serve to prove the requirements according to VDE-AR-N 4100: 2020-06, 5.5: These tests are not applicable for direct connected rotating machines! This test is necessary only for electronic inverters!		
Note: The tests of the “symmetry characteristics of three-phase inverter modules” were performed on the unit with the highest output power. Here is the maximum asymmetry given.		

5.3.2.1 Calculation of asymmetry	N/A
Test procedural: The maximum absolute difference between the apparent powers of the three phases is determined for each of the five measurements (1-min means) in the respective operating point. The maximum of these five values is again determined.	
Assessment criterion: The test is passed if the maximum value from the above measurements does not exceed 5 % S_{Emax} and ≤ 4600 VA.	
Note: The maximum inductive and capacitive values are specified by the manufacturer.	

5.4	Evidence of the behaviour of the generating unit on the network

5.4.1	General	P
	(These tests are designed to provide evidence that the requirements of VDE-AR-N 4105:2018-11, 5.7.2.2 are met and to determine the values for S_{Emax} and P_{Emax})	

Test Condition:

The measurements were performed in the testing laboratory at the grid-simulator.

Test voltage between 0,9 Un and 1,09 Un with ±2% Un until the test

Test frequency: 50Hz ± 0,5%

Note:

If an examination is required for any other requirements, these apply to this test.

5.4.2	**Measurement of the active power and reactive power range** (These tests are designed to provide evidence that the requirements of VDE-AR-N 4105:2018-11, 5.7.2.2 are met)	**P**

Test:

The setpoint signal must be reduced from 100% to 10% P_{rE}:

For adjustable PGUs in increments of 10% P_{rE} 1 minute must elapse after every change to the setpoint setting so that the PGU can settle at the new setpoint. Then the active power of the PGU must be measured as a 1-min mean value.

Assessment criterion:

a) for adjustable PGUs:

- no network disconnection
- the active power value does not exceed the setpoint by more than ±5% P_{rE}
- the setting time determined this way is ≤1min

Note:

The setting time is ≤ 1min. See “Graph of the setting accuracy”.

Setting values	cos φ = 1:	1,00
	cos φ over-excited:	0,95
	cos φ under-excited:	0,95

Test:

600s mean value	U [V]	$P_{Emax600\ c)}$ [W]	$S_{Emax600\ c)}$ [VA]	cos $\varphi_{Emax600}$ [-]
0,90 U_n at 100% P_{Emax}				
cos φ = 1	207,0	787	787	0,999
cos φ max. over-excited	207,0	776	816	0,950
0,95 U_n at 100% P_{Emax}				
cos φ max. under-excited	218,5	787	827	0,951
1,0 U_n at 100% P_{Emax}				
cos φ = 1	230,0	802	802	0,999
cos φ max. under-excited	230,0	794	836	0,950
cos φ max. over-excited	230,0	792	832	0,952
1,05 U_n at 100% P_{Emax}				
cos φ max. over-excited	241,5	799	841	0,950
1,09 U_n at 100% P_{Emax}				
cos φ = 1	250,7	814	814	0,999
cos φ max. under-excited	250,7	806	848	0,950

$S_{Emax600}$ and $P_{Emax\ 600}$	
$S_{Emax600}$= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$) [VA]	848
$P_{Emax\ 600}$= max ($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$) [W]	814

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.4.3 Measurement of setting accuracy	P

Test procedural:

The P setpoint was set by SW-Tool using RS485-interface.

(The active power can be set between 100%Pn and 10%Pn with a step size of 10%Pn)

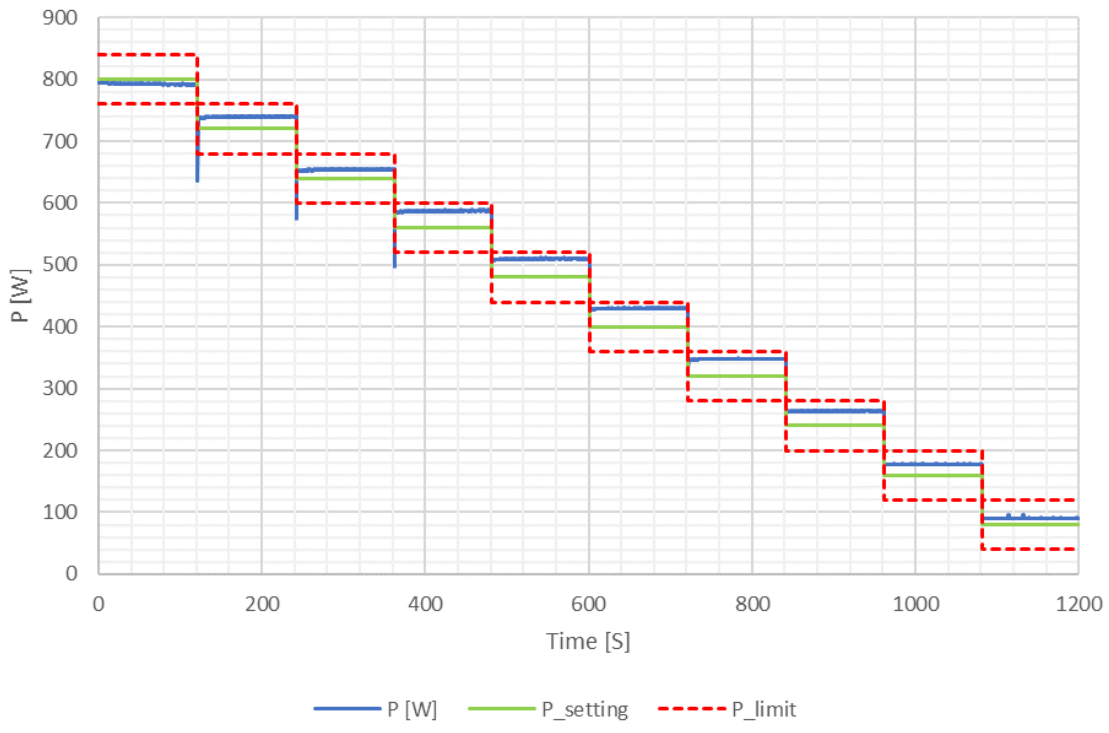
Assessment:

- no network disconnection occurs and
- the active power value does not deviate by more than 5% P_{rE} from the target value.

% of rated capability	Setpoint		Measured value		Deviation (P_{meas} - P_{set})		Limit ΔP_{E60} in %
	[W]	[%P_n]	[W]	[%Pn]	[W]	[%P_n]	
100	800	100	793	99,1	7	-0,9	≤ ±5% of P_{rE}
90	720	90	740	92,4	-20	2,4	
80	640	80	654	81,7	-14	1,7	
70	560	70	587	73,4	-27	3,4	
60	480	60	510	63,7	-30	3,7	
50	400	50	430	53,7	-30	3,7	
40	320	40	348	43,5	-28	3,5	
30	240	30	264	33,0	-24	3,0	
20	160	20	178	22,2	-18	2,2	
10	80	10	90	11,3	-10	1,3	

Overall maximum active power deviation to set point [%P_n]:	3,7

Graph of the setting accuracy:



5.4.3.4 Measurement of the power gradient	P

Test procedural:

The P setpoint was set by SW-Tool using RS485-interface.
The measurement of the power gradient takes place:

- Via a setpoint change from 100% to 5% of the rated effective power P_{rE} at time t0. If the technical performance is >5%, this should be specified.
- Via a setpoint change from 5% to 100% of the rated effective power P_{rE} at time t0. Is the technical Performance >5%, this should be specified?

Assessment:

- no network disconnection occurs and
- the power gradients determined in accordance with 5.4.3.4 shall not fall below 0,33 % P_{rE} and shall not exceed 0,66 % P_{rE}.
- The first gradient is to be formed 30 s after setting the setpoint jump.
- The formation of gradients is terminated 30 s before reaching the stationary final value.

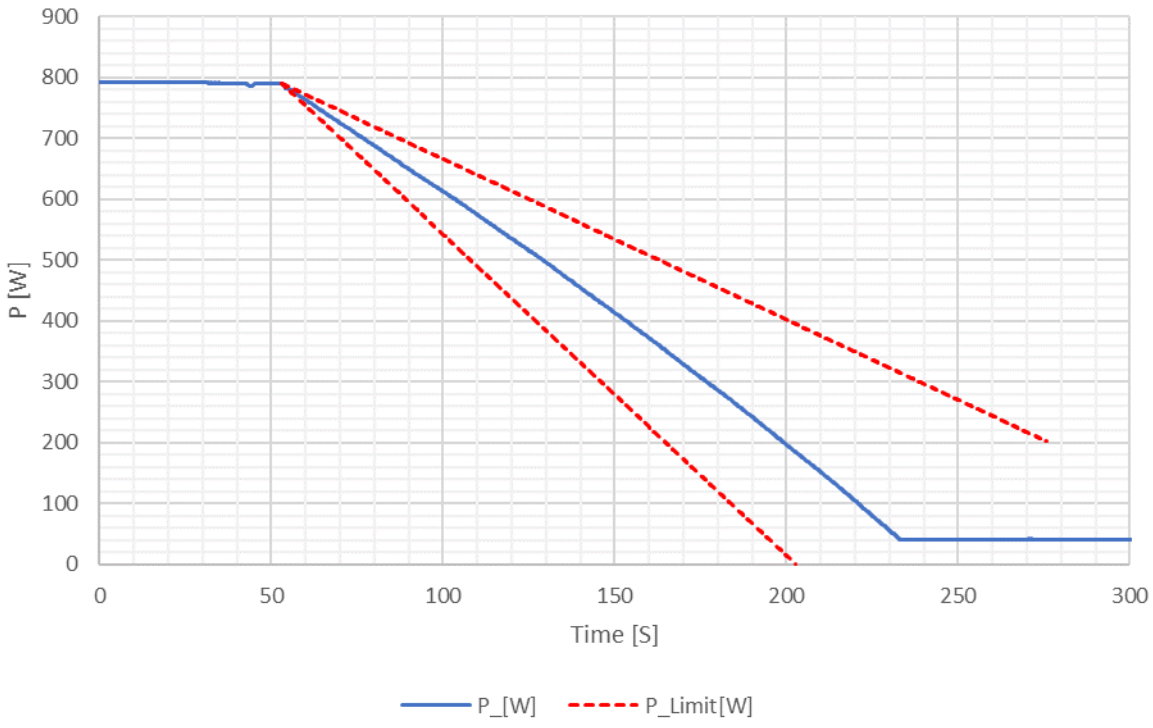
Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Verification the setting Power gradient change from 100%P_{rE} to 5%P_{rE}

$P_{\_setting}$ point step	Setting value	Measured value
$P_{before\ power\ change}$ = 100% P_{rE} ± 5% P_{rE}	100,0% P_{rE}	98,94% P_{rE}
Power gradient (during power change):	0,5 %P_{rE} / s	0,52%P_{rE} /s
$P_{after\ power\ change}$ = 5% P_{rE} ± 5% P_{rE}	5,0% P_{rE}	5,10% P_{rE}

Graph of the gradient 100% to <5% P_{rE}

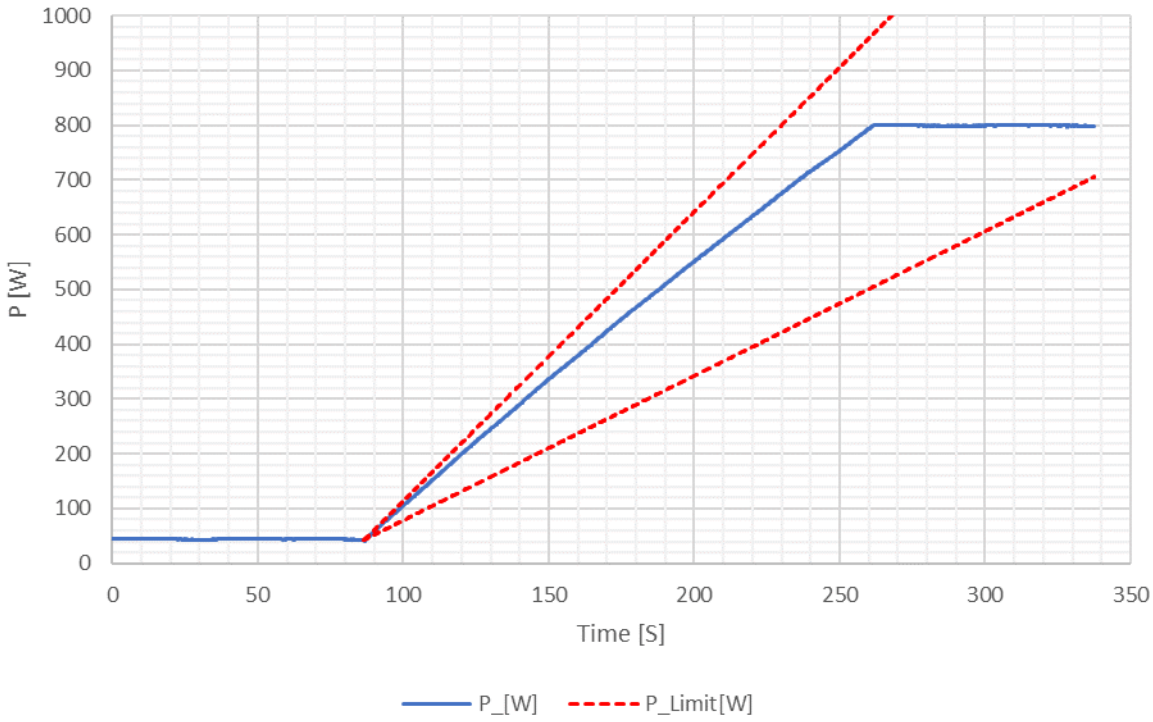


Verification the setting Power gradient change from 5% to 100%

$P_{\_setting}$ point step	Setting value	Measured value

$P_{before\ power\ change}$ = 5% P_{rE} ± 5% P_{rE}	5,0% P_{rE}	5,51% P_{rE}
Power gradient (during power change):	0,5 %P_{rE} / s	0,54%P_{rE} /s
$P_{after\ power\ change}$ = 100% P_{rE} ± 5% P_{rE}	100,0 % P_{rE}	99,92% P_{rE}
Limit of power gradient [%P_{rE} / s]:	0,33 to 0,66	
Inverter remains in operation?	☒ yes	
	☐ no	

Graph of the gradient <5% to 100% P_{rE}



5.4.3.5 Measurement priority interfaces / energy management system	N/A
Test 1 (Measurement priority interfaces) Note: The unit provides only one interface for active power reduction. Test omitted.	
Test 2 (logical interface): Test steps a) the PGU is operated with no less than 90% P_{rE}; b) the change of state of the logic signal.	
Assessment: Test 1: a) The lowest setpoint is always given priority b) the setpoint at the interface programmed for the NSM is never exceeded Test 2: **c)** during the examination of the logical interface (input port), the active power feed of the EZE was completely terminated within a maximum of 5 s after the state change of the logical signal.	
Note: The inverter has no related logic interface, but it can limit the inverter power output through APP/PC software.	

5.4.4	**Active power feed-in for PGU´s at overfrequency** (These tests are designed to provide evidence that the requirements of VDE-AR-N 4105:2018-11 5.7.4.3. and VDE-AR-N 4105:2018-11 8.3.1. are met)	**P**

Test cycle for adjustable PGUs:

Test 1:

1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [%P_{Emax}]:	Frequency [Hz]	$P_{setpoint}$ [W]	P_{E60} [W]	P_{E60} [%P_{Emax}]	ΔP_{E60} [%P_{Emax}]	**Limit** $\lvert\Delta P_{E60}\rvert$ [%P_{Emax}]	Available DC-power [%]:
Measurement: 100% P_{Emax}; start frequency 50,20Hz; droop s setting = 5% (40% P_{ref}/Hz)									
a)	50,00	100	50,00	800	792	99,02	-0,98	≤10	100
b)	50,25	98	50,25	784	752	93,99	-4,01		
c)	50,70	80	50,70	640	637	79,60	-0,40		
d)	51,40	52	51,40	416	450	56,21	4,21		
e)	50,70	80	50,70	640	638	79,78	-0,22		
f)	50,25	98	50,25	784	754	94,20	-3,80		
g)	50,00	100	50,00	800	792	99,04	-0,96		
h)	51,65	0	51,65	0	0	-0,04	-0,04		
i)	50,15	0	50,15	0	0	-0,04	-0,04		
j)	50,00	100	50,00	800	794	99,15	-0,85		

Frequency Step	**Response time [s]**	**Settling time [s]**
b) → c)	0,2	0,2
c) → d)	0,4	0,4
d) → e)	0,4	0,4
e) → f)	0,4	0,4

Initial time delay T_V setting value [s]:	Initial time delay T_V measured value (Determined during frequency step a) → b)) [s]:
2	0,2

Test 2:

1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [%P_{Emax}]:	Frequency [Hz]	$P_{setpoint}$ [W]	P_{E60} [W]	P_{E60} [%P_{Emax}]	ΔP_{E60} [%P_{Emax}]	**Limit** $\lvert\Delta P_{E60}\rvert$ [%P_{Emax}]	Available DC-power [%]:
Measurement: 60% P_{Emax}; start frequency 50,50Hz; droop s setting = 12% (16,67% P_{ref}/Hz)									
a)	50,00	60	50,00	480	485	60,65	0,65	≤10	60
b)	50,40	60	50,40	480	488	60,98	0,98		
c)	50,70	58	50,70	472	478	59,70	1,70		100
d)	51,40	51	51,40	408	421	52,66	1,66		
e)	50,70	58	50,70	464	468	58,47	0,47		
f)	50,40	60 – 100	50,40	480	488	61,01	1,01		
g)	50,00	100	50,00	800	792	99,01	-0,99		

Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,2	0,2
c) → d)	0,4	0,4
d) → e)	0,4	0,4
e) → f)	0,4	0,4

Initial time delay T_V setting value [s]:	Initial time delay T_V measured value (Determined during frequency step a) → b)) [s]:
2,0	0,2

DC setting values:	
PV-curve simulated according to	
Voltage of defined MPP [V]	42
Current of defined MPP [A]	20,7
FFU of PV curve [1]	--

Note:

* Results recorded at 1 minute after the transient process of power change completed.

According to VDE-AR-N 4105, DC-coupled storage systems are classified as Type 2 units. Therefore, the test specifications of section 5.4.4 Active power feed-in of PGU for over frequency are to be used for these.

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Assessment criterion:

The test is regarded as passed:

The active power reduces between measuring points in clause 5.4.5.1 a) to g) and j), the expected active power output, after settling, adjusts with a deviation ≤ ±10% P_{Emax}. Deviations arising from the fact that the maximum discharge capacity is less than P_{Emax} are permissible. In the measuring points h) and i) no active power may be delivered.

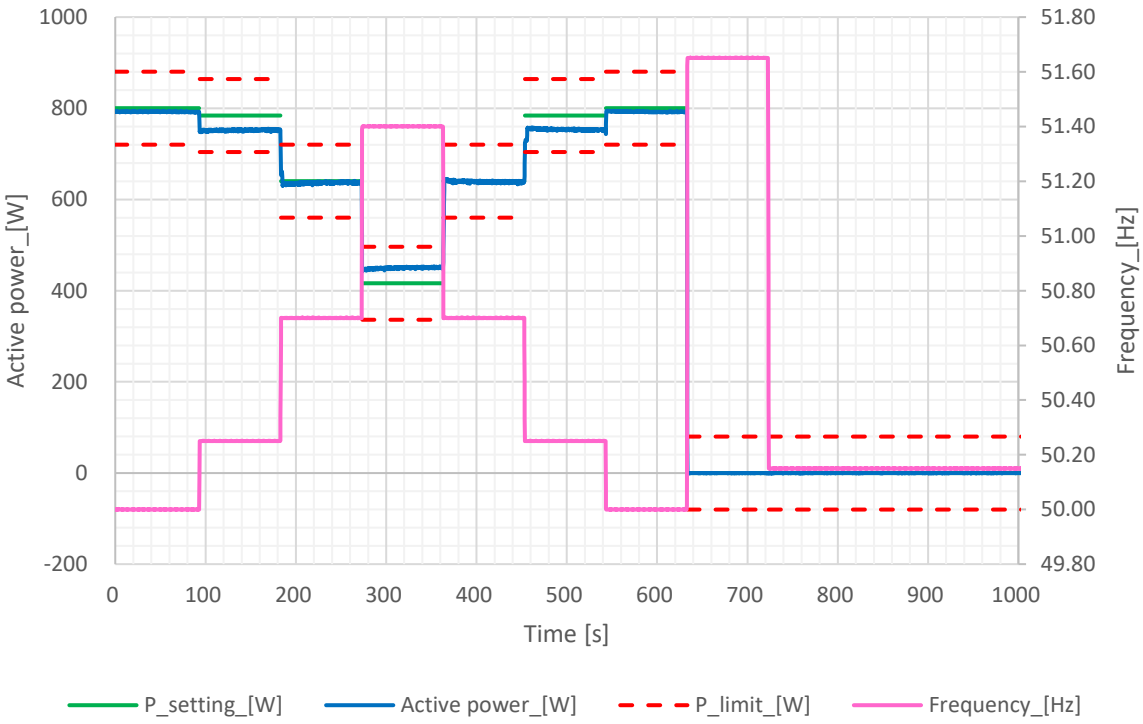
The initial time delay TV of the frequency-dependent adaptation of the active power output ≤ 2 s.

The response time of the adaptation of the active power output is a maximum of 1s

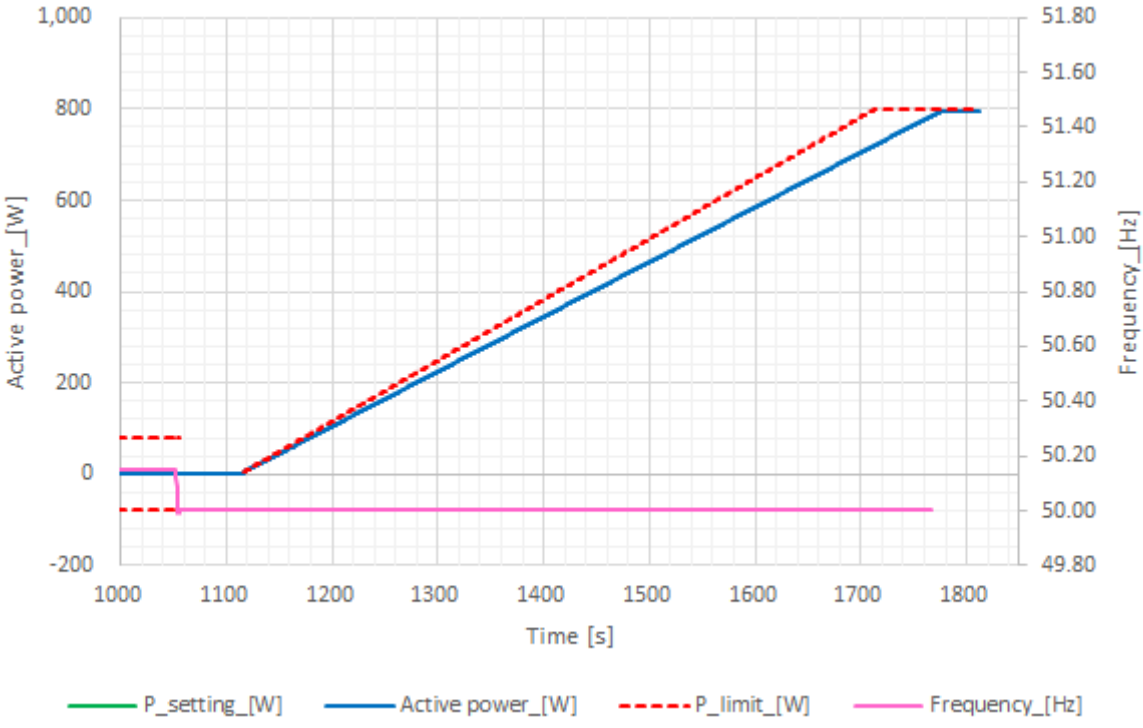
the settling time of the adaptation of the active power output is a maximum time of 30 s (for type 1 units and for type 2 units with rotating machines) or respectively a maximum time of 20 s

The connection time at point j) is at least 60 s and the power is then increased with a gradient of ≤ 10% P_{Emax}/min.

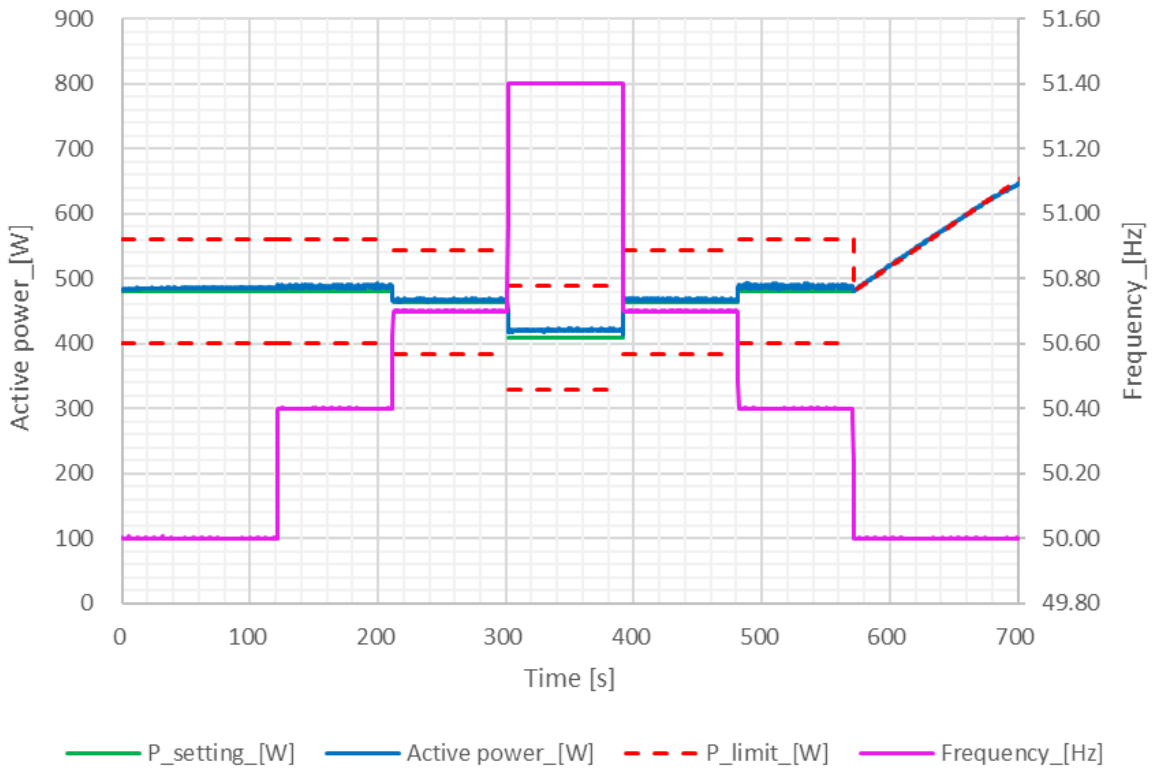
Graph Test 1@ 100% P_{Emax}



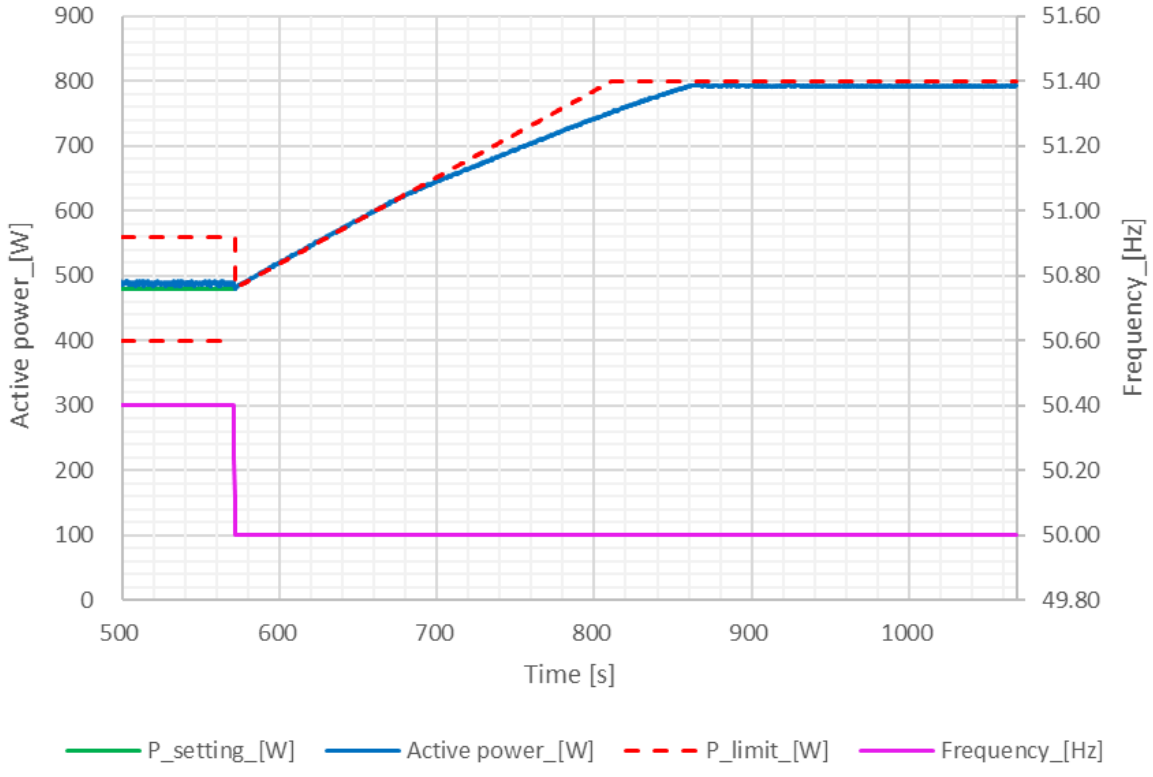
Gradient Test 1



Graph Test2 @ 60% P_{Emax}



Gradient Test 2



5.4.6 Active power feed-in for PGUs at underfrequency	P

Test cycle for adjustable PGUs:

Test 1:

1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [% of P_{Emax}]:	Frequency [Hz]:	$P_{setpoint}$ [W]:	P_{E60} [W]:	P_{E60} [% of P_{Emax}]:	ΔP_{E60} [%]	**Limit** ΔP_{E60} in %	Available DC-power [%]:
Measurement: -100% P_{Emax}; start frequency 49,80Hz; droop s setting = 2% (100% P_{ref}/Hz)									
a)	50,00	10	50,00	80	100	12,49	2,49	≤10	100%
b)	49,75	12	49,75	96	106	13,23	1,23		
c)	48,80	50	48,80	400	432	53,99	3,99		
d)	47,60	98	47,60	784	773	96,62	-1,38		
e)	48,80	50	48,80	400	430	53,70	3,70		
f)	49,85	12	49,85	96	106	13,21	1,21		
g)	50,00	10	50,00	80	100	12,47	2,47		
h)	47,35	0	47,35	0	0	-0,04	-0,04		
i)	47,60	0	47,60	0	-1	-0,06	-0,06		
j)	50,00	10	50,00	80	100	12,50	2,50		

Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,2	0,2
c) → d)	0,4	0,4
d) → e)	0,4	0,4
e) → f)	0,4	0,4

Initial time delay T_V setting value [s]:	Initial time delay T_V measured value (Determined during frequency step a) → b)) [s]:
2	0,2

5.4.6 Active power feed-in for PGUs at underfrequency	P

Test 2:

1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [% of P_{Emax}]:	Frequency [Hz]:	$P_{setpoint}$ [W]:	P_{E60} [W]:	P_{E60} [% of P_{Emax}]:	ΔP_{E60} [%]	**Limit** ΔP_{E60} in %	Available DC-power [%]:
Measurement: 10% P_{Emax}; start frequency 49,80Hz; droop s setting = 2% (100% P_{ref}/Hz)									
a)	50,00	60	50,00	480	486	60,74	0,74	≤ ±10% of PEmax	100
b)	49,75	62	49,75	496	535	66,88	4,88		
c)	49,20	84	49,20	672	688	85,97	1,97		
d)	48,80	100	48,80	800	785	98,14	-1,86		
e)	49,20	84	49,20	672	690	86,26	2,26		
f)	49,85	60	49,85	480	483	60,36	0,36		
g)	50,00	60	50,00	480	486	60,75	0,75		

Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,4	0,4
c) → d)	0,4	0,4
d) → e)	0,4	0,4
e) → f)	0,4	0,4

Initial time delay T_V setting value [s]:	Initial time delay T_V measured value (Determined during frequency step a) → b)) [s]:
2	0,4

DC setting values:

PV-curve simulated according to	
Voltage of defined MPP [V]	42
Current of defined MPP [A]	20,7
FFU of PV curve [1]	--

5.4.6 Active power feed-in for PGUs at underfrequency	P

Assessment criterion:

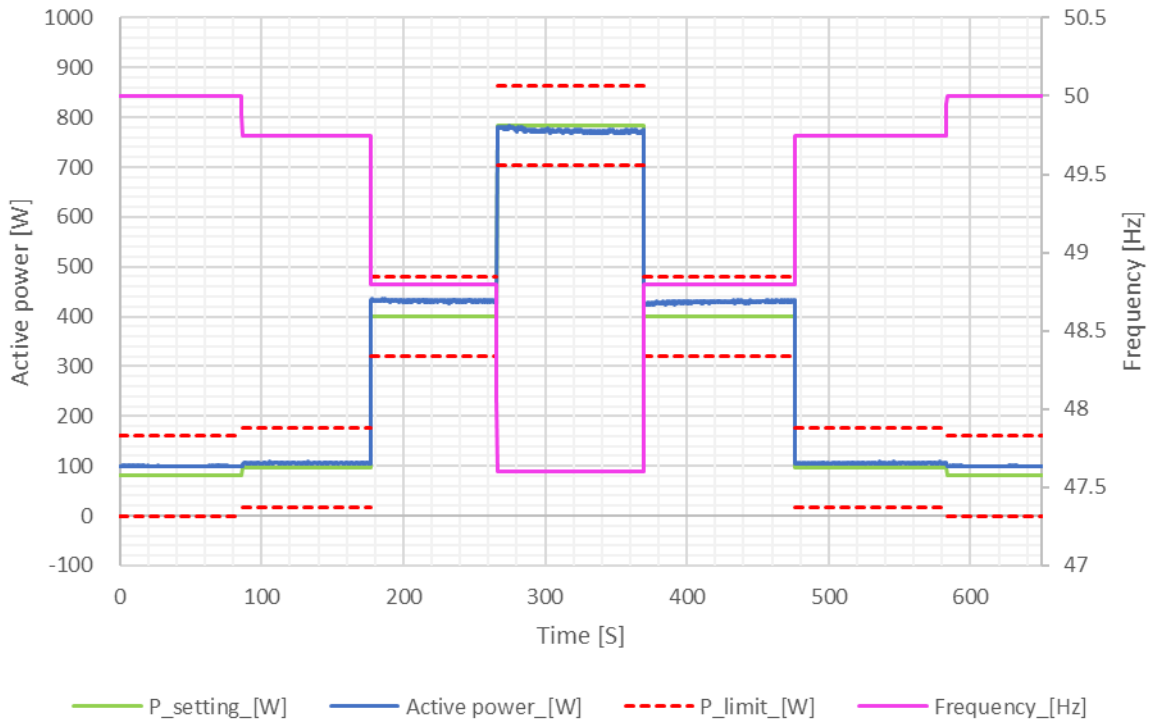
The test is regarded as passed if the Storage system:

- The active power reduces between measuring points 5.4.7.1 a) and j), the expected active power output, after settling, adjusts with a deviation ≤ ±10% P_{Emax}. Deviations arising from the fact that the maximum discharge capacity is less than P_{Emax} are permissible. In the measuring points h) and i) no active power may be delivered.
- The initial time delay T_V of the frequency-dependent adaptation of the active power output ≤2s.
- The response time of the adaptation of the active power output /-consumption is a maximum of 1s and.
- the settling time of the adaptation of the active power output /-consumption is a maximum time of 20s.
- The connection time at point j) is at least 60s and the power is then increased with a gradient of ≤ ±10% P_{Emax}/min.

Note:

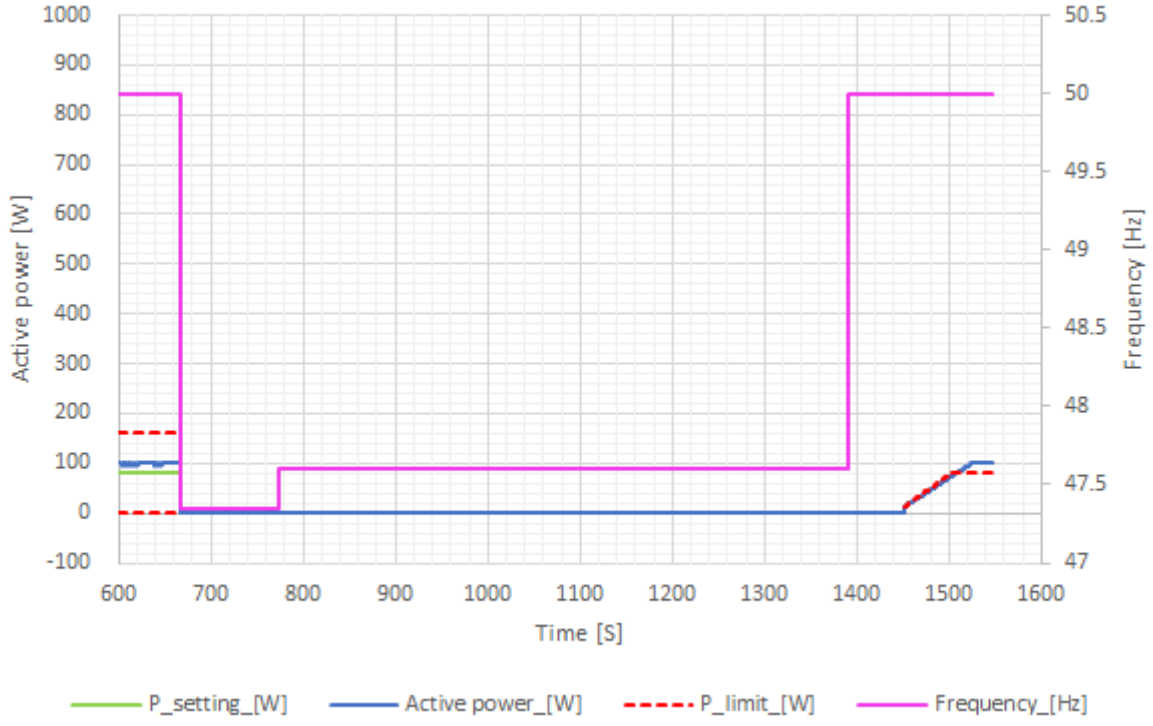
The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Graph Test 1@ 100% P_{Emax}

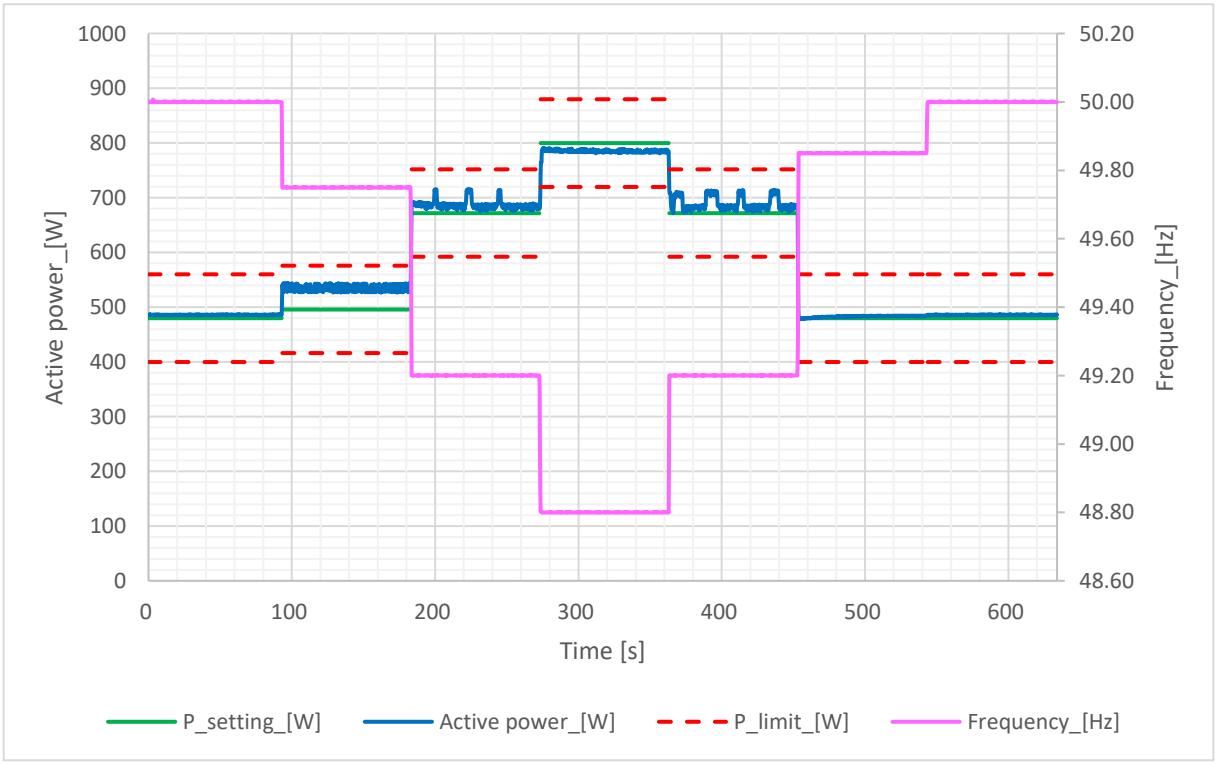


5.4.6 Active power feed-in for PGUs at underfrequency	P

Gradient Test 1



Graph Test2 @ 60% P_{Emax}



5.4.8 Static voltage stability / reactive power supply

The test serves as verification of the reactive power mode according to VD-AR-N 4105: 2018-11, 5.7.2 of the PGU in normal operation.

5.4.8.2 Tests of the Reactive power / cos φ setting accuracy — **P**

Setting values			
	cos φ under-excited	0,95	0,98
	cos φ over-excited	0,95	0,98

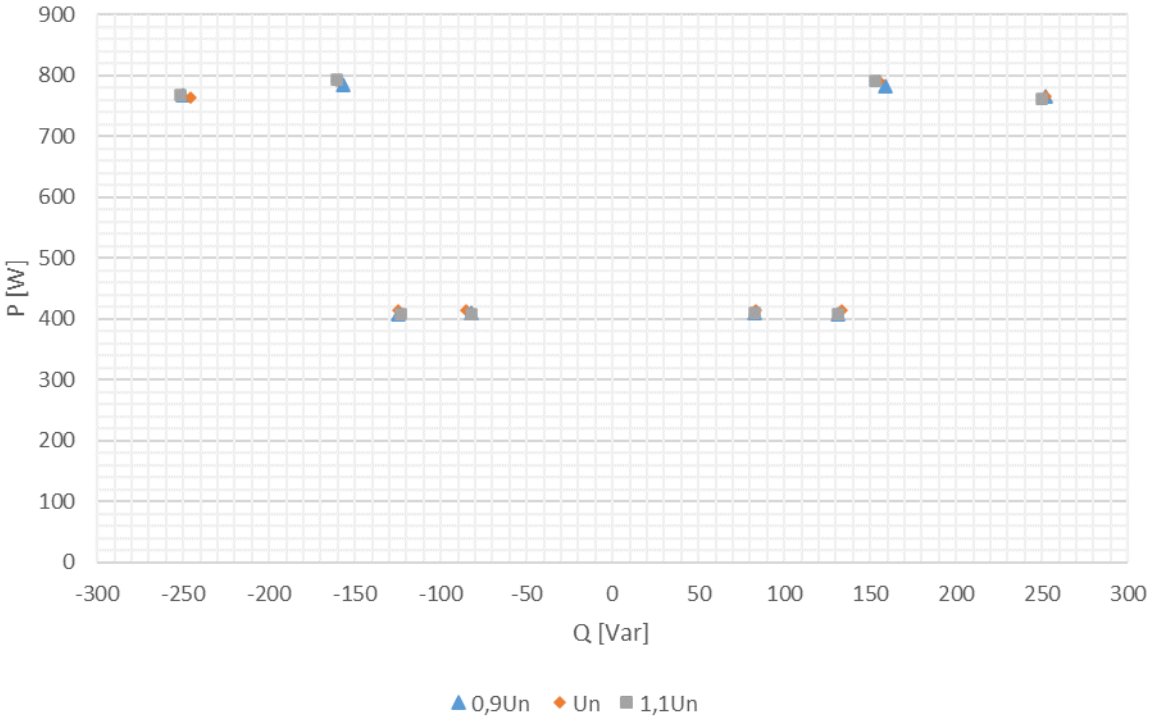
Test:

60 s mean value	0,9 U_n		U_n		1,1 U_n	
Active power	40 – 60% P_{Emax}	S_{Emax}	40 – 60% P_{Emax}	S_{Emax}	40 – 60% P_{Emax}	S_{Emax}
cos φ 0,95 over-excited						
U [V]	207,0	207,0	230,0	230,0	253,0	253
P_{E60} [W]	409	766	414	765	408	761
Q_{E60} [Var]	132	252	133	252	131	250
S_{E60} [VA]	430	806	435	806	429	801
cos $\varphi_{E60\ over\text{-}excited}$	0,952	0,950	0,952	0,950	0,952	0,950
$Q_{expected}$ [Var]	131	250	131	250	131	250
ΔQ_{E60} [%]	0,00	0,28	0,22	0,27	-0,03	-0,02
cos φ 0,95 under-excited						
U [V]	207,0	207,0	230,0	230,0	253,0	253,0
P_{E60} [W]	409	768	414	764	408	768
Q_{E60} [Var]	-125	-250	-125	-246	-123	-252
S_{E60} [VA]	428	807	432	802	426	808
cos $\varphi_{E60\ under\text{-}excited}$	0,957	0,951	0,958	0,952	0,957	0,950
$Q_{expected}$ [Var]	-131	-250	-131	-250	-131	-250
ΔQ_{E60} [%]	0,84	-0,01	0,87	0,50	1,01	-0,24
cos φ 0,98 over-excited						
U [V]	207,0	207,0	230,0	230,0	253,0	253,0
P_{E60} [W]	411	784	415	791	410	792
Q_{E60} [Var]	83	159	84	155	82	153
S_{E60} [VA]	419	800	423	806	418	807
cos $\varphi_{E60\ over\text{-}excited}$	0,980	0,980	0,980	0,981	0,980	0,982
$Q_{expected}$ [Var]	81	159	81	159	81	159
ΔQ_{E60} [%]	0,23	-0,02	0,29	-0,49	0,15	-0,76

cos φ 0,98 under-excited						
U [V]	207,0	207,0	230,0	230,0	253,0	253,0
P_{E60} [W]	411	784	415	792	409	793
Q_{E60} [Var]	-82	-157	-85	-160	-82	-160
S_{E60} [VA]	419	800	423	808	417	809
cos $\varphi_{E60\ under\text{-}excited}$	0,981	0,981	0,980	0,980	0,980	0,980
$Q_{expected}$ [Var]	-81	-159	-81	-159	-81	-159
ΔQ_{E60} [%]	-0,12	0,28	-0,45	-0,16	-0,15	-0,13

Limit		
cos φ_{E60}	cos φ = 0,94 to 0,96 (c) and cos φ = 0,94 to 0,96 (i) cos φ = 0,97 to 0,99 (c) and cos φ = 0,97 to 0,99 (i)	P
cos φ settling steps	≤ 0,01	P
ΔQ_{E60} in %	≤ ±4% P_{Emax}	P

Graph: Q/P diagram



Test:

applies for PGUs Type 2 - only inverter ΣS_{Emax} ≤ 4,6 kVA

a) and b) For cos φ 0,95 over-excited and φ 0,95 under-excited, the active power will be measured at value between 40% P_{Emax} and 60% and S_{Emax} and a second time,

for cos φ 0,98 over-excited and φ 0,98 under-excited, the active power will be measured at a value between 40% P_{Emax} and 60% and S_{Emax}

applies for PGUs Type 2 - only inverter ΣS_{Emax} ≥ 4,6 kVA

c) and d) For cos φ 0,90 over-excited and φ 0,90 under-excited, the active power will be measured at value between 40% P_{Emax} and 60% and S_{Emax} and a second time,

for cos φ 0,95 over-excited and φ 0,95 under-excited, the active power will be measured at a value between 40% P_{Emax} and 60% and S_{Emax}

applies PGUs Type 1 as well as for type 2 plants with Stirling generators and fuel cells $\Sigma S_{Emax} \leq 4{,}6$ kVA

e) without specification of the cos φ the active power will be measured at value between 40% P_{Emax} and 60% and S_{Emax}.

applies for PGUs Type 1 as well as for type 2 plants with Stirling generators and fuel cells $\Sigma S_{Emax} > 4{,}6$ kVA

f) and g) For cos φ 0,95 over-excited and cos φ 0,95 under-excited, the active power will be measured at value between 40% P_{Emax} and 60% and S_{Emax} and a second time,

for cos φ 0,98 over-excited and φ 0,98 under-excited, the active power will be measured at a value between 40% P_{Emax} and 60% and S_{Emax}

applies for PGUs Type 2 Asynchronous generators:

h) without specification of the cos φ the active power will be measured at value $S_{Emax.}$ The test is performed only at U_n.

Assessment criterion:

applies for PGUs Type 2 - only inverter $\Sigma S_{Emax} \leq 4{,}6$ kVA

The Q setpoint is calculated by using the required cos φ setpoint one time at 0.95 and one time at 0,98 and the measured apparent power of the fundamental. The test is passed if all the Q 60 s mean values of the fundamental component for a) are in the range of Q set point ± 4% P_{Emax} overexcited and for b) in the range of Q set point ± 4% P_{Emax} under-excited. In addition, a setting of the cos φ must be possible within a step size of at least 0.01.

applies for PGUs Type 2 - only inverter $\Sigma S_{Emax} \geq 4{,}6$ kVA

The Q setpoint is calculated by using the required cos φ setpoint one time at 0.90 and one time at 0,95 and the measured apparent power of the fundamental. The test is passed if all the Q 60 s mean values of the fundamental component for a) are in the range of Q set point ± 4% P_{Emax} overexcited and for c) in the range of Q set point ± 4% P_{Emax} under-excited. In addition, a setting of the cos φ must be possible within a step size of at least 0.01.

applies for PGUs Type 1 as well as for type 2 plants with Stirling generators and fuel cells $\Sigma S_{Emax} \leq 4{,}6$ kVA

The Q setpoint is calculated by using the required cos φ setpoint one time at 0.95 and one time at 0,98 and the measured apparent power of the fundamental. The test is passed if all the Q 60 s mean values of the fundamental from e) are in the range Q maximal overexcited till Q minimal under-excited.

applies for PGUs Type 1 as well as for type 2 plants with Stirling generators and fuel cells $\Sigma S_{Emax} \geq 4.6$ kVA

The Q setpoint is calculated by using the required cos φ setpoint one time at 0.95 and one time at 0,98 and the measured apparent power of the fundamental. The test is passed if all the Q 60 s mean values of the fundamental component for a) are in the range of Q set point ± 4% P_{Emax} overexcited and for f) in the range of Q set point ± 4% P_{Emax} under-excited. In addition, a setting of the cos φ must be possible within a step size of at least 0.01.

applies for PGUs Type 1 Asynchronous generators:

The test is passed if the cos φ Q 60 s mean values of h) is in the range cos φ = 0,95 under excited ±0,02.

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

	The regulating and control behavior of the reactive power	P

The regulating or control behaviour of the reactive power is based on the PT-1 behaviour shown in Figure 10. Each reactive power value, which results from the control behaviour specified by the network operator, can be set between 6s and 60s (for Type 1 between 10s and 60s). The signal runtime includes the detection of the mains voltage or the active and reactive power.

Step response with the tolerances relevant for the evaluation

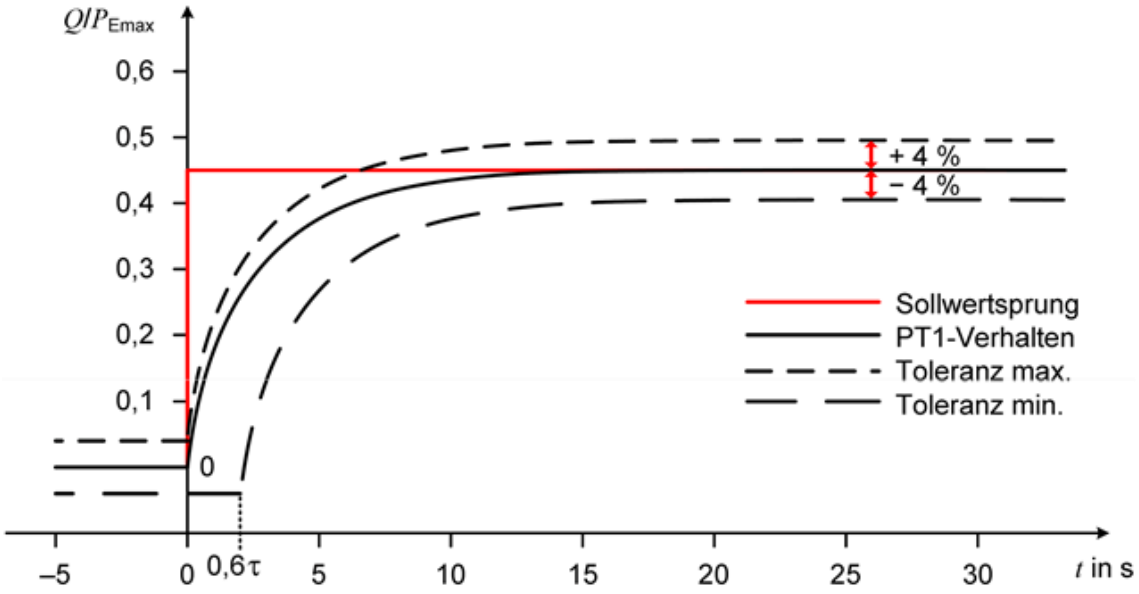


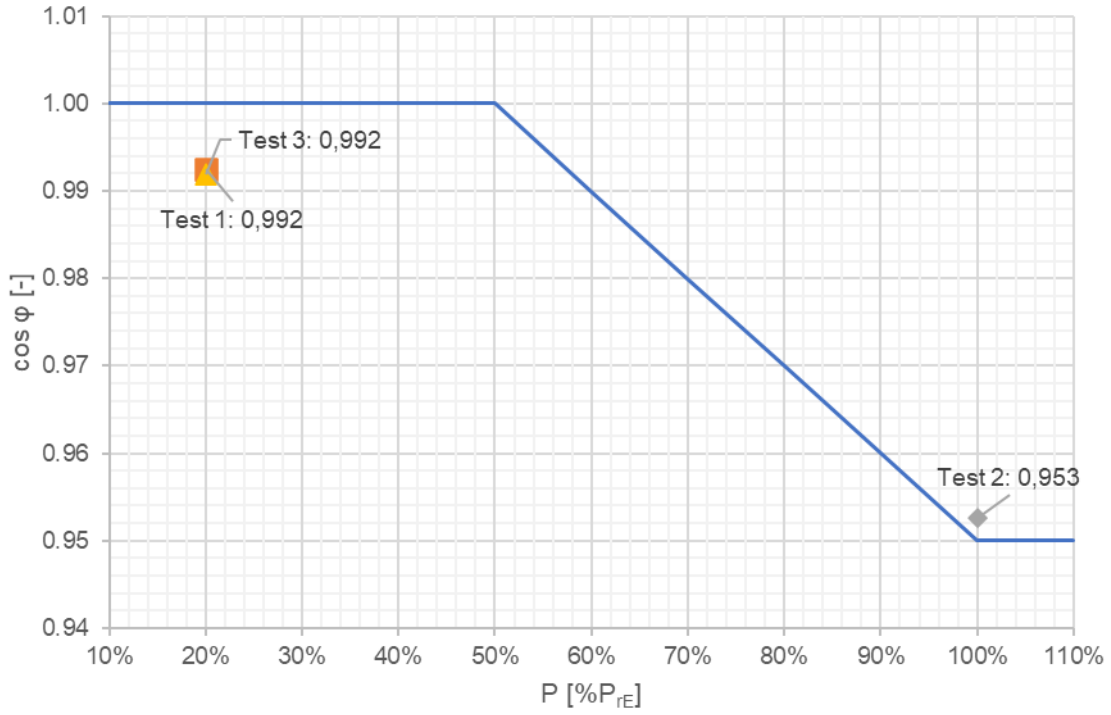
Figure 10 - Illustration at 3 tau = 10 s

Comment:

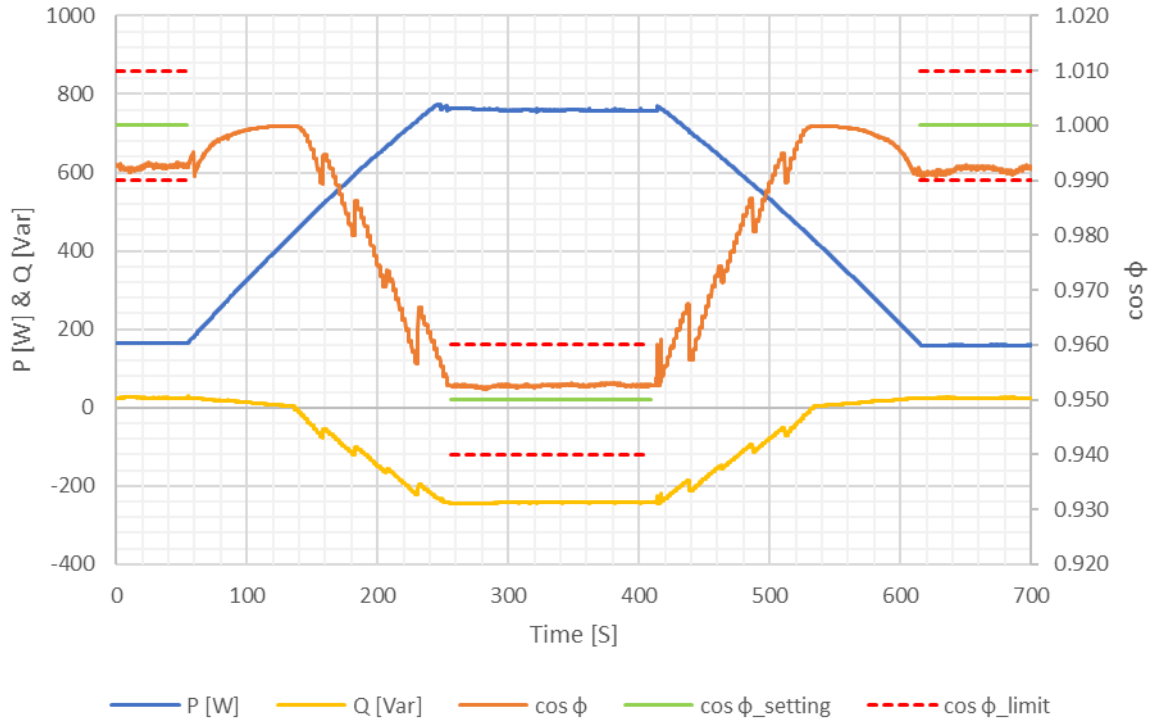
The regulation and control behaviour according to PT-1 is implemented and checked for all reactive power control modes.

5.4.8.3 Test of the displacement factor/active power characteristic curve cos φ (P) The test serves as verification of the standard cos φ (P) curve according to VDE-AR-N 4105:2018-11, 5.7.2.4.			**P**
Test 1) for conducted PGUs - Accuracy (characteristic)			
Measurement: 20-100-20% P_{Emax}			
P_{Emax}/P [%]	20	100	20
U [V]	230,41	230,42	230,41
P_{E30} [W]	165	759	160
P_{E30} of P_{Emax} [%]	20,61	94,88	19,95
Q_{E30} [VAr]	25	-242	25
$Q_{expected}$	0	-249	0
ΔQ_{E30} [%]	3,16	0,94	3,16
cos φ_{E30}	0,992	0,953	0,992
cos $\varphi_{setpoint}$ of P_{E30}	1,00	0,95	1,00
P gradient [% of P_{rE}/s]	0,51	0,51	
Limit			
ΔQ_{E30} in %	≤ ±4,0% relative to P_{Emax}		P
Note: The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.			

Graph of Test 1)



Graph of Test 1)



Assessment criterion:

Test 5.4.8.3 (1) and (3) are passed if, for all calculated reactive power values, the maximum deviation between the reactive power setpoint (calculated from the characteristic curve to be verified) and the reactive power actual value at the generator terminals is a maximum of ±4,0% based on P_{Emax}.

Test 3) supply-dependent PGUs - Accuracy (characteristic curve)

Measurement: 20-100% P_{Emax}

P_{Emax}/P [%]	U [V]	P_{E30} [W]	P_{E30} of P_{Emax} [%]	Q_{E30} [VAr]	$Q_{expected}$	ΔQ_{E30} [%]	cos φ_{E30}	cos $\varphi_{setpoint}$ of P_{E30}	P_{DC}[W]
20	230,37	167	20,90	19	0	2,43	0,993	1,00	184
30	230,38	247	30,89	20	0	2,46	0,997	1,00	272
40	230,37	325	40,67	14	0	1,81	0,999	1,00	358
50	230,39	401	50,18	8	0	1,04	0,999	1,00	442
60	230,38	484	60,46	-52	-68	2,07	0,994	0,99	532
70	230,38	566	70,69	-100	-114	1,66	0,985	0,98	622
80	230,39	643	80,32	-156	-160	0,54	0,972	0,97	707
90	230,39	721	90,11	-197	-210	1,67	0,965	0,96	793
100	230,40	779	97,35	-251	-250	-0,20	0,952	0,95	857

Measurement: 100-20% P_{Emax}

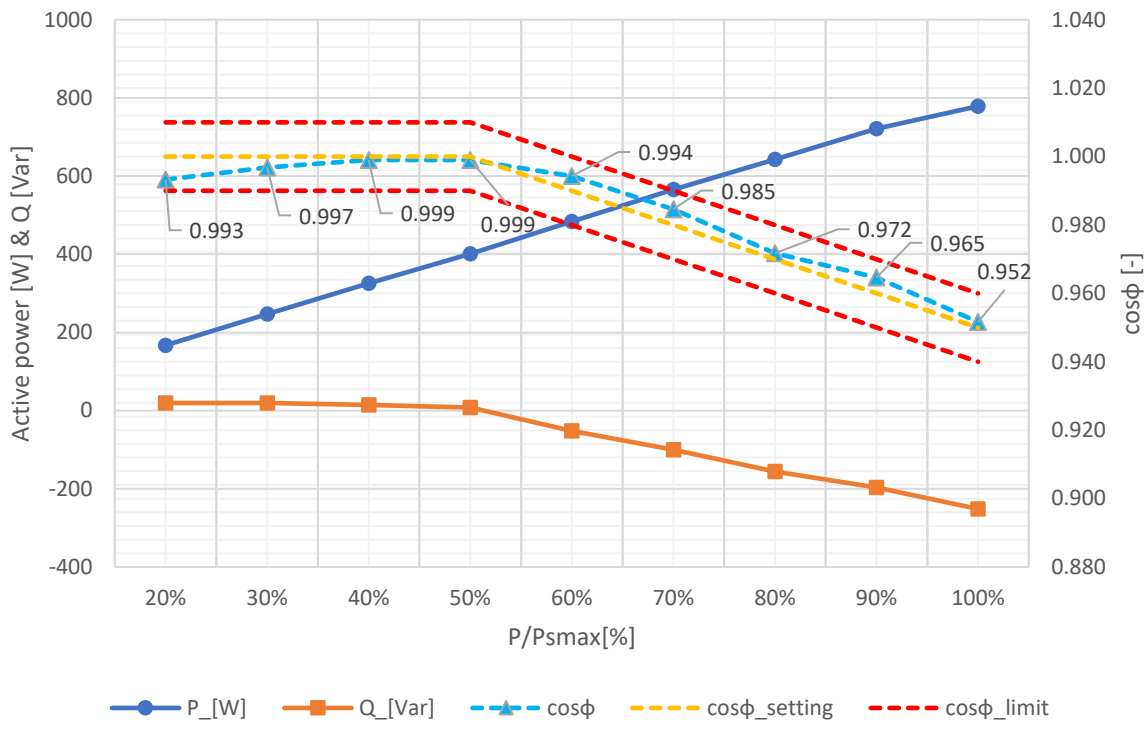
P_{Emax}/P [%]	U [V]	P_{E30} [W]	P_{E30} of P_{Emax} [%]	Q_{E30} [VAr]	$Q_{expected}$	ΔQ_{E30} [%]	cos φ_{E30}	cos $\varphi_{setpoint}$ of P_{E30}	P_{DC}[W]
100	230,40	777	97,19	-251	-250	-0,10	0,952	0,95	855
90	230,40	718	89,74	-191	-210	2,35	0,966	0,96	790
80	230,41	639	79,90	-159	-160	0,20	0,971	0,97	703
70	230,38	567	70,88	-107	-114	0,87	0,983	0,98	624
60	230,40	478	59,70	-50	-68	2,27	0,994	0,99	525
50	230,39	406	50,76	8	0	0,94	0,999	1,00	447
40	230,38	323	40,38	14	0	1,78	0,999	1,00	355
30	230,39	246	30,78	19	0	2,44	0,997	1,00	271
20	230,37	167	20,82	10	0	1,30	0,998	1,00	183

Limit

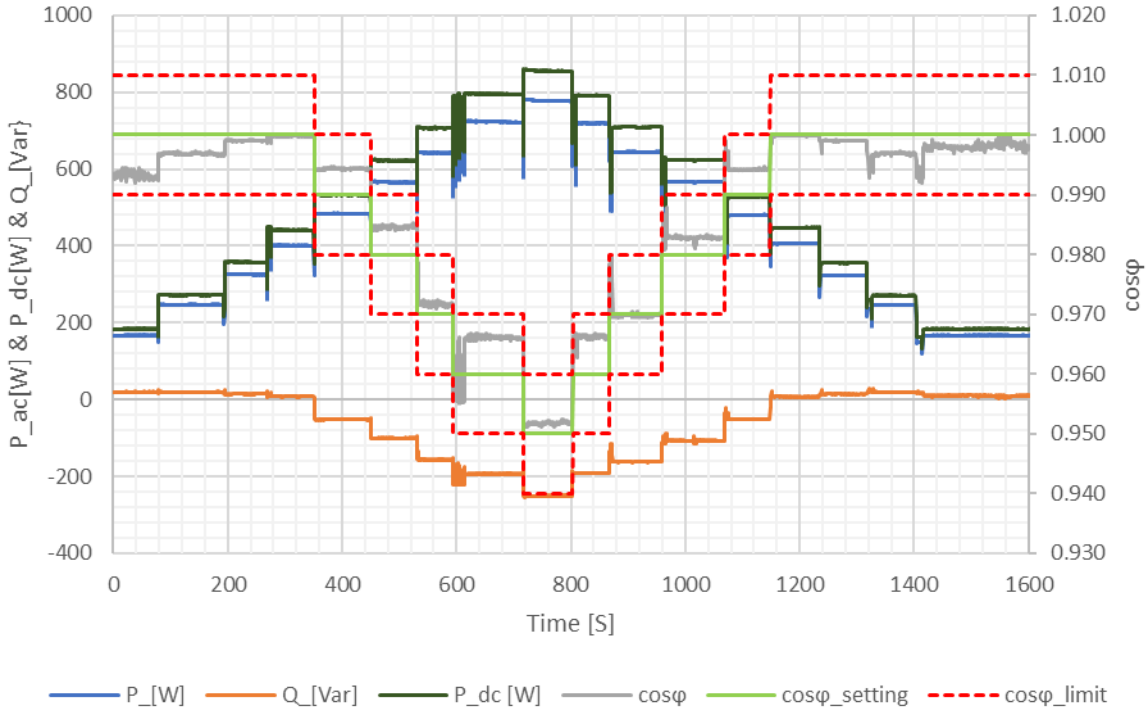
ΔQ_{E30} in %	≤ ±4,0% relative to P_{Emax}	P

Test 4): supply-dependent PGUs - Dynamic				
P_{Emax}/P_n [%]	100	40	100	75
U [V]	230,31	230,30	230,30	230,30
P_{E30} [W]	770	337	773	601
P_{E30} of P_{Emax} [%]	96,31	42,14	96,62	75,19
Q_{E30} [VAr]	-241	7	-244	-122
$Q_{expected}$	-249	0	-249	-137
ΔQ_{E30} [%]	1,00	0,87	0,62	1,87
cos φ_{E30}	0,95	1,00	0,95	0,98
cos $\varphi_{setpoint}$ of P_{E30}	0,95	1,000	0,95	0,975
T [s]	--	9,6	9,4	9,2
Limit				
ΔQ_{E30} in %	≤ ±4,0% relative to P_{Emax}			P
DC setting values:				
PV-curve simulated according to				
Voltage of defined MPP [V]			42	
Current of defined MPP [A]			20,7	
FFU of PV curve [1]			--	

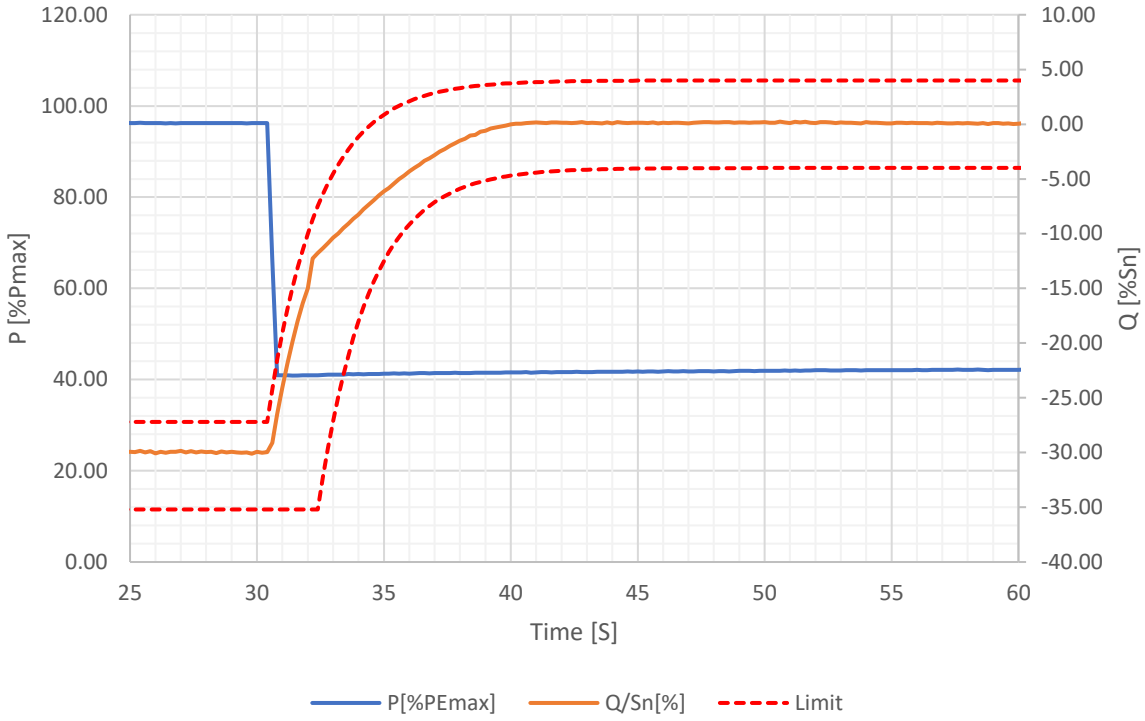
Graph of Test 3)



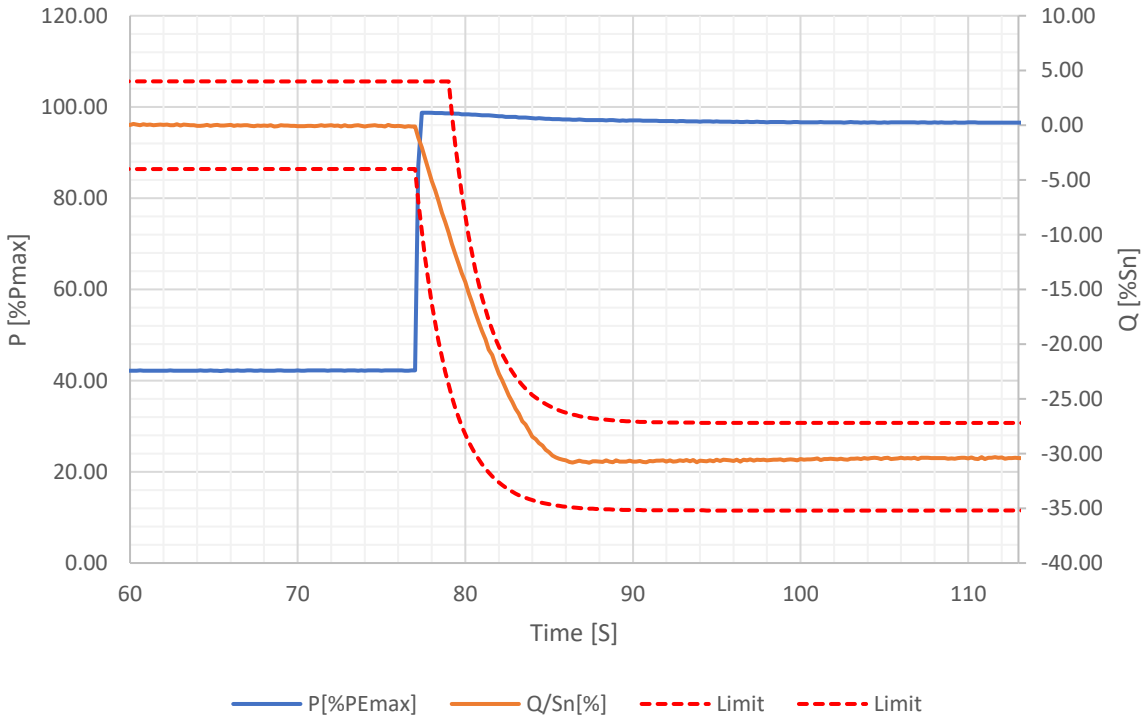
Graph of Test 3): 20% to 100% to 20%



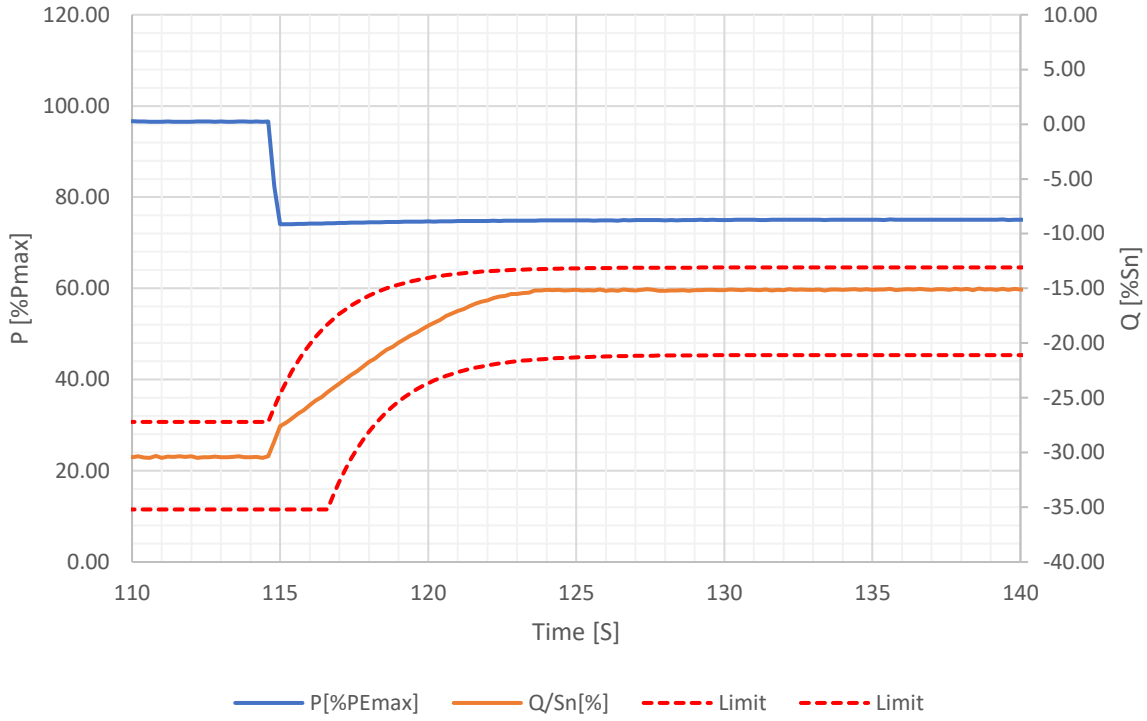
Graph of Test 4): 100% to 40%



Graph of Test 4): 40% to 100%



Graph of Test 4): 100% to 75%



Assessment criterion:

Test 5.4.8.3 (2) is considered to have been passed if the PGU meets the requirements for the performance gradient in VDE AR-N 4105: 2018-11, 5.7.4.2.

Test 5.4.8.3 (4) is passed if the step response of the reactive power in test steps c) and e) shows PT1 behaviour according to VDE-AR-N 4105: 2018-11, 5.7.2.5 and for test step d) optionally the power gradient lies between the limits defined in VDE AR-N 4105: 2018-11, 5.7.4.1 or the step response of the reactive power also has PT1 behaviour according to VDE-AR-N 4105: 2018-11, 5.7.2.5.

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.4.8.4	Test the reactive power-voltage characteristic Q(U)	
	The validation of the Q (U) regulation according to VDE-AR-N 4105: 2018-05, 5.7.2.4 is divided into two partial tests, so that on the one hand the accuracy and on the other hand the dynamics of the Q (U) control is checked. For all inverter-coupled systems, only the inverter must be tested.	
5.4.8.4.1	Test of the reactive power-voltage characteristic Q(U)	P

Voltage steps	[Vac] L1	[Vac] L2	[Vac] L3	P_{start} [W]	$Q_{measured}$ [VAr]	$Q_{setting}$ [VAr]	ΔQ [%Pemax]
100	230,26	--	--	802	-18	0	-2,25
99	228,00	--	--	800	-18	0	-2,26
98	225,71	--	--	799	-18	0	-2,29
97	223,42	--	--	764	9	0	1,12
96	221,14	--	--	762	68	62	0,73
95	218,83	--	--	758	130	125	0,69
94	216,55	--	--	751	201	187	1,76
93	214,26	--	--	748	260	250	1,32
92	211,95	--	--	746	260	250	1,30
91	209,67	--	--	745	258	250	1,11
90	207,36	--	--	743	258	250	0,99
91	209,68	--	--	745	258	250	1,05
92	211,98	--	--	746	259	250	1,19
93	214,00	--	--	747	260	250	1,25
94	216,43	--	--	749	211	187	2,98
95	218,73	--	--	757	135	125	1,24
96	221,04	--	--	761	73	62	1,34
97	223,33	--	--	763	12	0	1,52
98	225,63	--	--	799	-20	0	-2,45
99	227,94	--	--	800	-20	0	-2,47
100	230,23	--	--	801	-20	0	-2,45
101	232,53	--	--	803	-19	0	-2,43
102	234,83	--	--	804	-20	0	-2,44
103	237,13	--	--	776	-24	0	-3,01
104	239,43	--	--	772	-63	-62	-0,13
105	241,73	--	--	772	-103	-125	2,70
106	244,03	--	--	772	-174	-187	1,64
107	246,33	--	--	769	-233	-250	2,02
108	248,63	--	--	770	-248	-250	0,19
109	250,92	--	--	770	-249	-250	0,13

110	253,23	--	--	771	-250	-250	-0,03
109	250,91	--	--	770	-249	-250	0,13
108	248,63	--	--	769	-248	-250	0,15
107	246,33	--	--	769	-237	-250	1,57
106	244,04	--	--	772	-177	-187	1,28
105	241,73	--	--	772	-107	-125	2,26
104	239,44	--	--	772	-68	-62	-0,65
103	237,15	--	--	772	-27	0	-3,39
102	234,85	--	--	805	-20	0	-2,52
101	232,56	--	--	803	-20	0	-2,53
100	230,25	--	--	802	-20	0	-2,49

Assessment criterion:

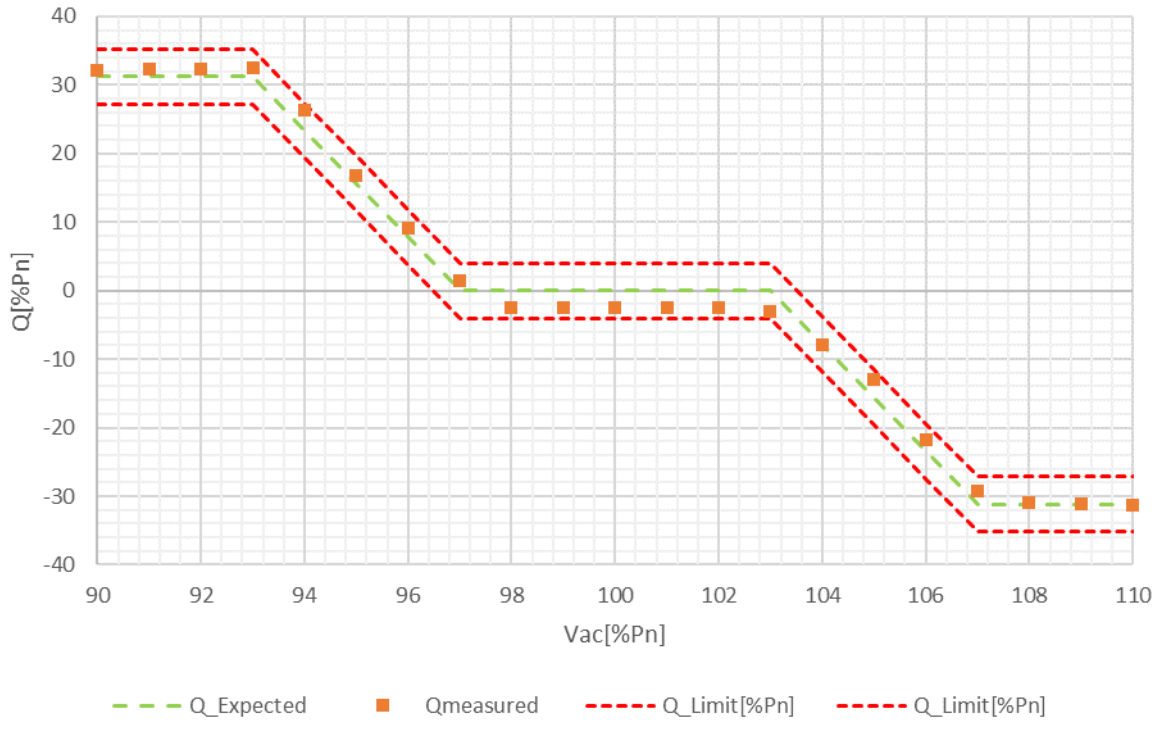
To pass the Q (U) accuracy test, the measured stationary value pairs U_{PGU} and Q_{PGU}, taking account to the correct sign in the consumer metering system, must be within VDE-AR-N 4105: 2018-11, in 5.7.2.4, Figure 7 Q (U) shown characteristic. The stationary value pairs U_{PGU} and Q_{PGU} are determined by averaging over 30 seconds at the end of the respective measuring section analogously to Chapter 5.4.3.2. The permissible deviations are with the maximum measuring error of the voltage of 1% U_n stated in VDE-AR-N 4105: 2018-11 and a setting accuracy of 4% P_{EMax}.

$$Q_{EZE,tol} = \pm(0.01 \cdot U_{N,Y} \cdot k_{QU} + 0.04 \cdot P_{EMax}) = \pm 0{,}25 \cdot P_{EMax} \cdot (\sin(\arccos(\varphi_{min})) + 0.16).$$

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Graph of Q(U) curve



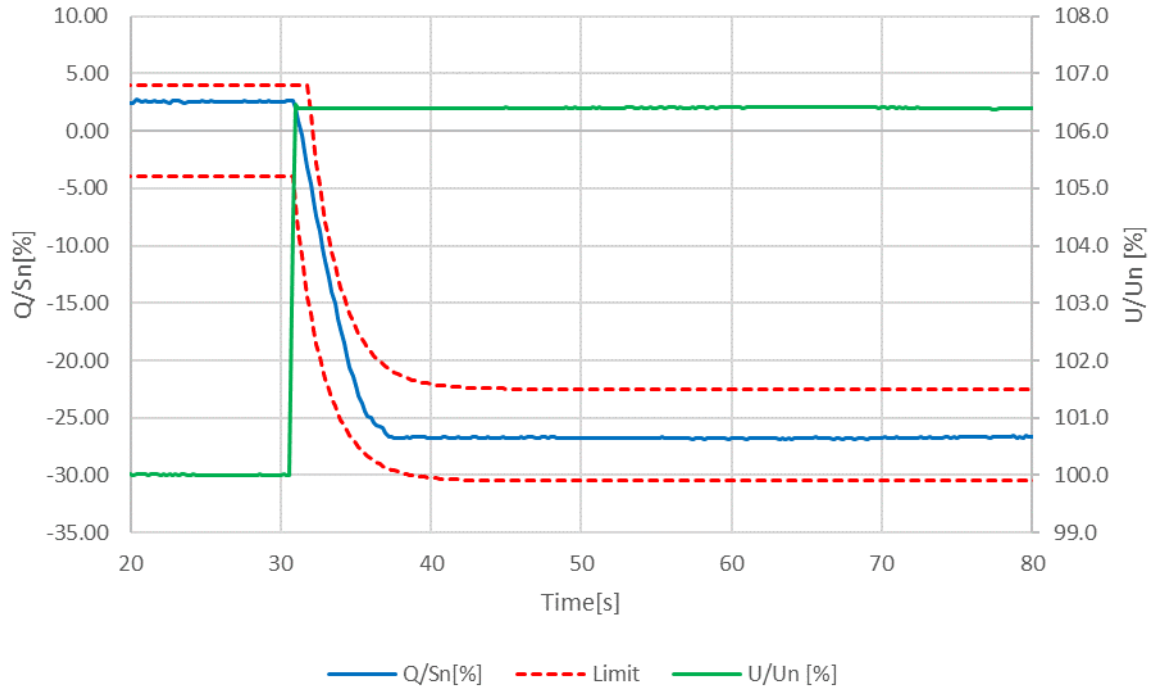
5.4.8.4.2 Test of the dynamics of the Q(U) regulation	P

Setting values	Qmax [var]	k↓QU	X_{Netz}	$\Delta U_{ind,Y}$ [V]	$\Delta U_{kap,Y}$ [V]	Tau
	249	--	--	215,28	244,72	3Tau = 10s

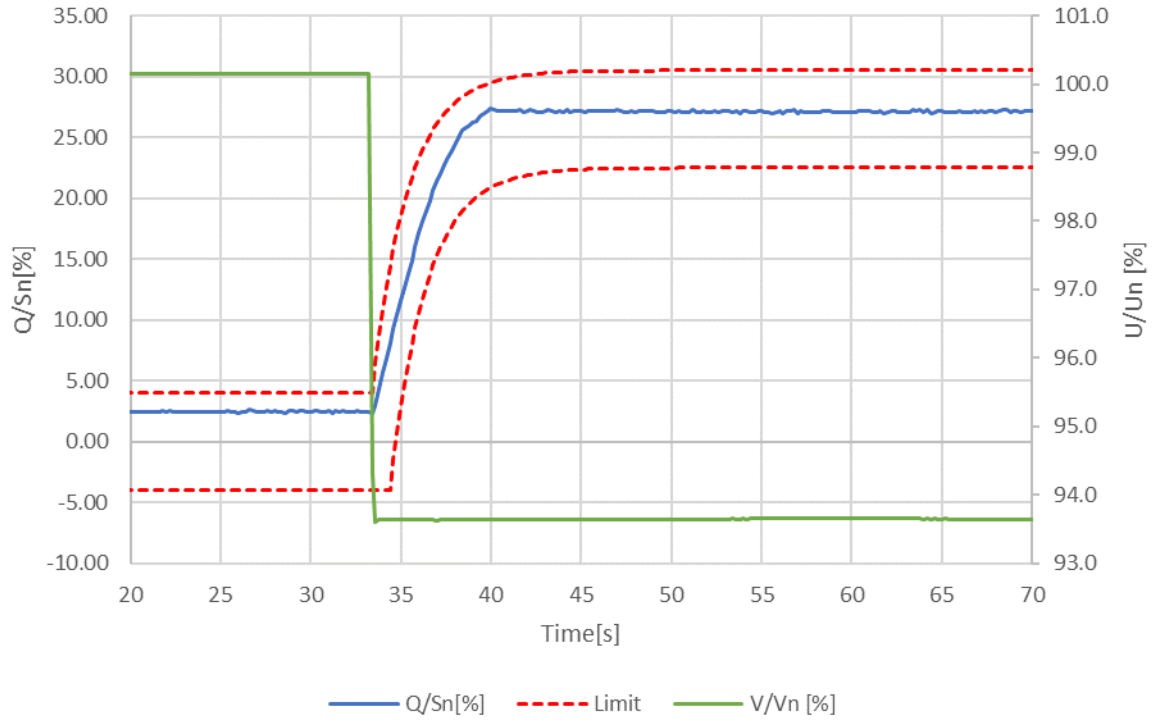
Voltage steps	U_{start} [V] L1	U_{start} [V] L2	U_{start} [V] L3	U_{end} [V] L1	U_{end} [V] L2	U_{end} [V] L3	Q_{start} [VAr]	Q_{end} [VAr]	Settling time[s]
Test1:100→106,4	230,03	--	--	244,74	--	--	20	-214	6,4
Test2:100→106,4	230,02	--	--	244,81	--	--	17	-221	6,6
Test3:100→106,4	230,02	--	--	244,73	--	--	19	-210	6,2
Test1:100→93,6	230,36	--	--	215,39	--	--	20	217	6,6
Test2:100→93,6	230,07	--	--	215,43	--	--	19	213	6,2
Test3:100→93,6	230,05	--	--	215,38	--	--	18	219	6,4

PV-curve simulated according to	
Voltage of defined MPP [V]	42
Current of defined MPP [A]	20,7
FFU of PV curve [1]	--
P_{DC} [W]	870

Graph of Q(U) dynamics: Test1:100→106,4



Graph of Q(U) dynamics: Test1:100→93,6



Assessment criterion:

For passing the test on the dynamics of the Q (U) control, the measured, time profiles of the reactive power have to be determined in the “positive sequence” Q_{PGU} during the entire measuring period in the PT1-like tolerances according to VDE-AR-N 4105: 2018-11, 5.7.2.5. For this purpose, the tolerance bands are entered into the diagram of the respective measurement according to the formulas below. It should be distinguished according to the expected PGU behavior (inductive, capacitive). An exemplary representation of the tolerance bands for the capacitive case is shown in Figure 6. Physically caused compensation processes (for example with type 1 PGU) are to be excluded from the evaluation, if they decay in a time range smaller than one third of the Q (U) - set time.

The variable T corresponds to the set - up time of the generating plant and three times the parameterized PT1 time constant Tau (T = 3Tau). The measurement of the time starts at the time of the excitation in 5. 4.8.3.2a) or the manipulation in 5.4.8.3.2 b).

Since the increase or decrease of the voltage according to the formula given in 5.4.8.3.2 represents only an approximation to the real behavior of the closed control loop, the steady-state final value Qset is determined from the measurement. For this purpose, a 10 - second mean value is formed at the end of the one - minute measurement period via the three - phase reactive power in the positive sequence system. Likewise, the starting value of the reactive power (positive sequence) Qstart (= offset) before the respective voltage change is determined over a 10-second averaging.

The response time of the overall system to be evaluated is measured starting from the excitation according to 5.4.8.3.2 a) or the manipulation according to 5.4.8.3.2 b) until reaching 95% of the steady end value in the positive sequence Qsoll and is with the factor 5/3 to multiply. This factor takes into account the effect of the feedback on the control dynamics of the Q (U) control and is strongly related to the formula of the net replacement reactance.

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.5	Testing of NS protection	
5.5.2	**NS protection**	**P**

The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary, with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1).

5.5.2.1	Functional safety	P

Test procedural:

- It should be checked that a single error does not result in the loss of the security function.
- Typical errors must be checked, where applicable:
  - a) Error of an AD converter or measuring card for voltage measurement;
  - b) malfunction or freezing of a microprocessor or PLC;
  - c) merging or clamping the contacts of the switching output;
  - d) Overvoltage of the supply voltage;
  - e) Breakage of the line in connecting lines between the measuring input and the control output to the dome switch;
  - f) Failure of the supply voltage (auxiliary voltage).

Assessment criterion:

- The NS protection must send a shutdown command to the coupling switch.
- If the error is detected, the device is switched off within 10 s after error detection.

If the auxiliary voltage fails with the central NS protection or if the control fails with the integrated NS protection, the switch-off command must be given immediately

Note:

The errors in the control circuit simulate that the safety is even ensured during a single fault.

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
Relay fault Z1 (pin5-4)	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
Relay fault Z1 (pin7-3)	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
Relay fault Z3 (pin3-8)	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
Relay fault Z3 (pin4-6)	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
Voltage monitoring R9	Open	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Voltage monitoring R10	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Voltage monitoring U6(pin7-6)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display

								Red.
Voltage monitoring C46	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Voltage monitoring C1	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Voltage monitoring C36	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Voltage monitoring C4	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Q6 (pinC-B)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q5, Q6 damaged LED light indicate display Red.
Q6 (pinC-E)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q5, Q6 damaged LED light indicate display Red.
Q5 (pinC-B)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q5, Q6 damaged LED light indicate display Red.
Q5 (pinC-E)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q5, Q6 damaged LED light indicate display Red.
Q9 (pinC-B)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q7, Q9 damaged LED light indicate display Red.
Q9 (pinC-E)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q7, Q9 damaged LED light indicate display Red.

Q7 (pinC-B)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q7, Q9 damaged LED light indicate display Red.
Q7 (pinC-E)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. U4, Q7, Q9 damaged LED light indicate display Red.
PV ISO defected R76	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
PV ISO defected R78	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
PV ISO defected U12 pin4 - 1	short before start-up	230Vac 0,01A	48Vdc, 0,02A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter cannot star-up. LED light indicate display Red.
PV voltage monitoring C45	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
PV voltage monitoring C40	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
PV voltage monitoring R85	Open	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
PV voltage monitoring R76	Open	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
PV voltage monitoring R73	Open	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Communication between U2 pin 46	Open	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Communication between U2 pin 47	Open	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
U2 pin24 to GND (+3.3VD to GND)	Short	230Vac 3,2A	48Vdc, 16,3A	5min	F1	230Vac, 0,01A	48Vdc, 0,02A	The inverter disconnection immediately from grid. LED light indicate display Red.
Note: The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.								

5.5.3 Central NS-protection	**N/A**
5.5.3.1 Test	**N/A**
- The auxiliary voltage of the NS protection is switched off	**N/A**
- The test facility on the NS protection is actuated	**N/A**
Assessment criterion: The test is considered to have been passed if a signal for the immediate shutdown is generated.	

5.5.4 Integrated NS protection	P
The integrated NS protection is tested in 5.5.7 and in connection with the examination of the entire NS protection chain and switch.	
Note: For test results see 5.5.2.1 Functional safety.	

5.5.6 Interface switch	
5.5.6.1 General	**P**
These tests serve to demonstrate the requirements of VDE-AR-N 4105: 2018-11, 6.4	
5.5.6.2 Documentation for the design of the central interface switch	**N/A**
Some details of the central NS protection and the PGU are necessary for the design of a central interface switch. The manufacturer's documentation must therefore contain the following information.	
- maximum operating time of the central interface switch (manufacturer NS protection)	**N/A**
- Operating time of the protective device (manufacturer NA protection)	**N/A**
- maximum initial short-circuit alternating current (manufacturer PGU)	**N/A**
- maximum AC circuit breaker / grid fuse for the PGU (manufacturer PGU)	**N/A**
- circuit diagram / connection diagram (NS protection / coupling switch) contains the required control and feedback signals (manufacturer NS protection)	**N/A**
Assessment criterion: The test is considered as pass when the documentation of the manufacturer included the necessary information.	
Note: Information checked in the manual and datasheet for the external NS protection and coupling switch used in the PGU.	

5.5.6.3 Integrated interface switch	**P**
5.5.6.3.1 Test (functional chain integrated NS-protection and integrated interface switch)	**P**
Following monitoring options of an interface switch are valid (a) or (b) or (c):	
(a) Use of a interface switch in which a control voltage must be constantly applied when switched on and which switches off automatically when this voltage is not present. The operational switch-on and switch-off processes is monitored	
The disconnection of the control voltage leads to the instantaneous disconnection of the interface switch.	P
A simulated defect during the closing and opening of the interface switch leads to an instantaneous shutdown of the PGU. A restart is not possible.	P
A simulated defect of the interface switch after the NS protection as operated leads to an instantaneous shutdown of the PGU. A restart is not possible.	P
The switch-off time of the whole reaction chain is within 0,2s.	P
(b) The interface switch is switched on and off at least once a day by the NS protection and the proper functioning of the coupling switch is monitored.	
A simulated defect of the interface switch during the daily test leads to an instantaneous shutdown of the PGU. A restart is not possible.	N/A
A simulated defect of the interface switch after the NS protection has operated leads to an instantaneous shutdown of the PGU. A restart is not possible.	N/A
A function for daily switching on and off is available and explained by a manufacturer's declaration.	N/A
(c) Use of the integrated coupling switch and the integrated NA protection for PV and battery converters according to DIN EN 62109 (VDE 0126-14-1).	
The integrated interface switch and NS protection is complied with DIN EN 62109 (VDE 0126-14-1).	N/A
Note: See test results 5.5.2.1 functional safety.	
The inverter has a galvanic separating break device. The interface switch is short-circuit proof for the maximum short-circuit current of the power generation unit.	
Max. initial short-circuit current of the PGU (power generation unit)	= 10A, 230 Vac
Max. switching current relay	= 16 A, 250 Vac
Response time of interface switch for integrated NS protection	≤ 15 ms

Datasheet of the relay (Interface switch):

c UL us
File No.:E134517

VDE
File No.:116934

CQC
File No.:CQC17002168381

Features

- Low height: 15.7 mm
- 16A switching capability
- 5kV dielectric strength (between coil and contacts)
- Creepage distance: 10mm
- Meeting VDE 0700, 0631 reinforce insulation
- Product in accordance to IEC 60335-1 available
- Sockets available
- Plastic sealed and flux proofed types available
- UL insulation system: Class F available

RoHS compliant

CONTACT DATA

Contact arrangement	1A, 1B, 1C	2A, 2B, 2C
Contact resistance[1]	100mΩ max.(at 1A 6VDC)	
Contact material	See ordering info.	
Contact rating (Res. load)	12A/16A 250VAC	8A 250VAC
Max. switching voltage	440VAC / 300VDC	
Max. switching current	12A / 16A	8A
Max. switching power	3000VA / 4000VA	2000VA
Mechanical endurance	1×10^7 OPS	
Electrical endurance	1H3B type: 1×10^5 OPS (16A 250VAC, Resistive load, Room temp., 1s on 9s off) 2H4B type: 5×10^4 OPS (8A 250VAC, Resistive load, Room temp., 1s on 9s off)	

Notes: 1) The data shown above are initial values.

CHARACTERISTICS

Insulation resistance		1000MΩ (at 500VDC)
Dielectric strength	Between coil & contacts	5000VAC 1min
	Between open contacts	1000VAC 1min
	Between contact sets	2500VAC 1min
Surge voltage (between coil & contacts)		10kV (1.2 / 50μs)
Operate time (at nomi. volt.)		15ms max.
Release time (at nomi. volt.)		8ms max.
Temperature rise (at nomi. volt.)		55K max.
Shock resistance *	Functional	98m/s²
	Destructive	980m/s²
Vibration resistance *		10Hz to 150Hz 10g/5g
Humidity		5% to 85% RH
Ambient temperature		-40°C to 85°C
Termination		PCB
Unit weight		Approx. 13.5g
Construction		Plastic sealed, Flux proofed

Notes: 1) The data shown above are initial values.
2) * Index is not in relay length direction.
3) UL insulation system: Class F, Class B.

COIL

Coil power	Approx. 400mW

COIL DATA at 23°C

Nominal Voltage VDC	Pick-up Voltage VDC max.[1]	Drop-out Voltage VDC min.[1]	Max. Voltage VDC [2]	Coil Resistance Ω
5	3.50	0.5	7.5	62 x (1±10%)
6	4.20	0.6	9.0	90 x (1±10%)
9	6.30	0.9	13.5	202 x (1±10%)
12	8.40	1.2	18	360 x (1±10%)
18	12.60	1.8	27	810 x (1±10%)
24	16.80	2.4	36	1440 x (1±10%)
48[3]	33.60	4.8	72	5760 x (1±15%)
60[3]	42.00	6.0	90	7500 x (1±15%)
110[3]	77.00	11.0	165	25200 x (1±15%)

Notes: 1) The data shown above are initial values.
2) Maximum voltage refers to the maximum voltage which relay coil could endure in a short period of time.
3) For products with rated voltage ⩾ 48V, measures should be taken to prevent coil overvoltage in order to protect coil in test and application (eg. Connect diodes in parallel).

HONGFA RELAY
ISO9001, IATF16949 , ISO14001, OHSAS18001, IECQ QC 080000 CERTIFIED 2022 Rev. 1.00

5.5.7.2 Check of setting values	P
5.5.7.2.1 Test	P

Test procedural:

- Before the further tests begin, the factory setting values of the test object must be checked.
- The test object must be reset to factory settings.
- The test object must be put into operation according to the user manual. If an operator input is required, the setting for VDE-ARN 4105:2018 must be selected.

Assessment criterion:

- The exam is passed if the following points are met:
- The factory setting values correspond
  a) With integrated NA protection of VDE-AR-N 4105: 2018-11, 6.5.2 Table 2 (see also Table 36).
  b) With central NA protection, either the factory settings of VDE-AR-N 4105: 2018-11, 6.5.2, Table 2 (see also Table 36) or these values can be set.
- In the event of an operator input, the test object only goes into operation after settings have been selected.
- The setting values that can be changed according to 4105: 2018-11, 6.5.1 and 6.5.2 can be set within the specified limits and are protected against unauthorized access.
- The setting values that cannot be changed according to VDE-AR-N 4105: 2018-11, 6.5.1 and 6.5.2 cannot be changed or are protected from unauthorized access by an additional separate protection system

Setting values:

PGU type	Description	Parameter name	Set value in p.u.	Set value L-N	Set value L-L *2)
	nominal voltage	U_n	1	230,0V	400V
	Nominal frequency	f_n	1	50Hz	50Hz
a) name set of parameters (Parameter setup name in manual or software)					
☐ Stirling generators, fuel cells, coupled directly or via a converter Synchronous and asynchronous generators with $P_n \leq 50$ kW	Excitation threshold U>>	N/A	N/A	N/A	N/A
	Delay time U>>	N/A	N/A	N/A	N/A
	Excitation threshold U>	N/A	N/A	N/A	N/A
	Delay time U> * 1)	N/A	N/A	N/A	N/A
	Excitation threshold U<	N/A	N/A	N/A	N/A
	Delay time U<	N/A	N/A	N/A	N/A
	Excitation threshold U<<	N/A	N/A	N/A	N/A
	Delay time U<<	N/A	N/A	N/A	N/A
	Excitation threshold f>	N/A	N/A	N/A	N/A
	Delay time f>	N/A	N/A	N/A	N/A
	Excitation threshold f<	N/A	N/A	N/A	N/A
	Delay time f<	N/A	N/A	N/A	N/A
b) name set of parameters (Parameter setup name in manual or software)					
☐ directly coupled synchronous and asynchronous generators with $P_n > 50$ kW	Excitation threshold U>>	N/A	N/A	N/A	N/A
	Delay time U>>	N/A	N/A	N/A	N/A
	Excitation threshold U>	N/A	N/A	N/A	N/A
	Delay time U> * 1)	N/A	N/A	N/A	N/A
	Excitation threshold U<	N/A	N/A	N/A	N/A
	Delay time U<	N/A	N/A	N/A	N/A

	Excitation threshold U<<	N/A	N/A	N/A	N/A
	Delay time U<<	N/A	N/A	N/A	N/A
	Excitation threshold f>	N/A	N/A	N/A	N/A
	Delay time f>	N/A	N/A	N/A	N/A
	Excitation threshold f<	N/A	N/A	N/A	N/A
	Delay time f<	N/A	N/A	N/A	N/A
c) name set of parameters (Parameter setup name in manual or software)					
☒ Inverter	Excitation threshold U>>	N/A	--	287,5V	--
	Delay time U>>	N/A	--	100ms	--
	Excitation threshold U>	N/A	--	253,0V	--
	Delay time U> * 1)	N/A	--	100ms *1)	--
	Excitation threshold U<	N/A	--	184,0V	--
	Delay time U<	N/A	--	3000ms	--
	Excitation threshold U<<	N/A	--	103,5V	--
	Delay time U<<	N/A	--	300ms	--
	Excitation threshold f>	N/A	--	51,5Hz	--
	Delay time f>	N/A	--	100ms	--
	Excitation threshold f<	N/A	--	47,5Hz	--
	Delay time f<	N/A	--	100ms	--
*1) 10-min mean value *2) testing of external NS-protection					

Factory settings correspond to the values according the Inverter of Table 36 of VDE 0124	P
There are no factory settings. The information on the setting values in the instruction manual correspond to those in Inverter of Table 36 of VDE 0124.	N/A
External NS protection: settings and delay times are password protected settable	N/A
External NS protection: It is possible to read the setting values without a tool	N/A
Integrated NS protection: the setting values are visible via a data interface or display	P
The limit values for U> can be set between 110% and 115% and, in the case of directly coupled synchronous and asynchronous generators with P_{rE} >50kW, the time delay for U< and U<< can be set. All other limit values are protected against unauthorized access.	P

5.5.7.3 Wiring check	**N/A**
5.5.7.3.1 Test	**N/A**

Test procedural:

- The wiring of the test object must be checked by applying the test voltages.
- For single-phase EZE, the wiring test is adapted, only the feed-in phase is to be evaluated.
- It must be checked that the test object correctly evaluates line to line voltages and line to neutral conductor voltages. This test step is not applicable for single-phase EZE.

Assessment criterion:

This check is not evaluated. If a phase rotation is detected, it shall be corrected and the test repeated.

5.5.7.4 Voltage and frequency control	P
5.5.7.4.1 Voltage and frequency control – Single Phase	**P**

Test procedural:

- For a single-phase EZE, only the feed-in phase needs to be checked.
- Before each test step, the EZE must be operated symmetrically with rated voltage and rated frequency for at least 10 s in feed-in mode.
- The P setpoint was set by SW-Tool using RS485-interface.

Assessment criterion:

- The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of Un.
- The disconnection time includes disconnect time + operate time of the integrated relay. Therefore, limit is given with +0,100s according to Table 2 set values of the NS-protection according to VDE AR-N 4105:2018.

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Integrated NS protection single phase ≤30kVA

Setting values of the NS protection:	Setting	Value [V]	Time [s]	Setting	Value [V]	Time [s]
				U>>	287,5	0,1
	U<	184,0	3,0	U<<	103,5	0,3

Operating time of the monitoring device:

L1 to N:	**Under voltage 1 (4.2):**			**Over voltage 1 (1.2):**		
Ramp [start V to stop V]	>188,6 → <179,4			<282,9 → >292,1		
Step size [V]	<1,15			<1,15		
Step length [s]	>3,200			>0,400		
Limit [V]	184,0 ±1% U_n			287,5 ±1% U_n		
Measurement [V]	183,2	183,4	183,2	286,4	286,5	286,6

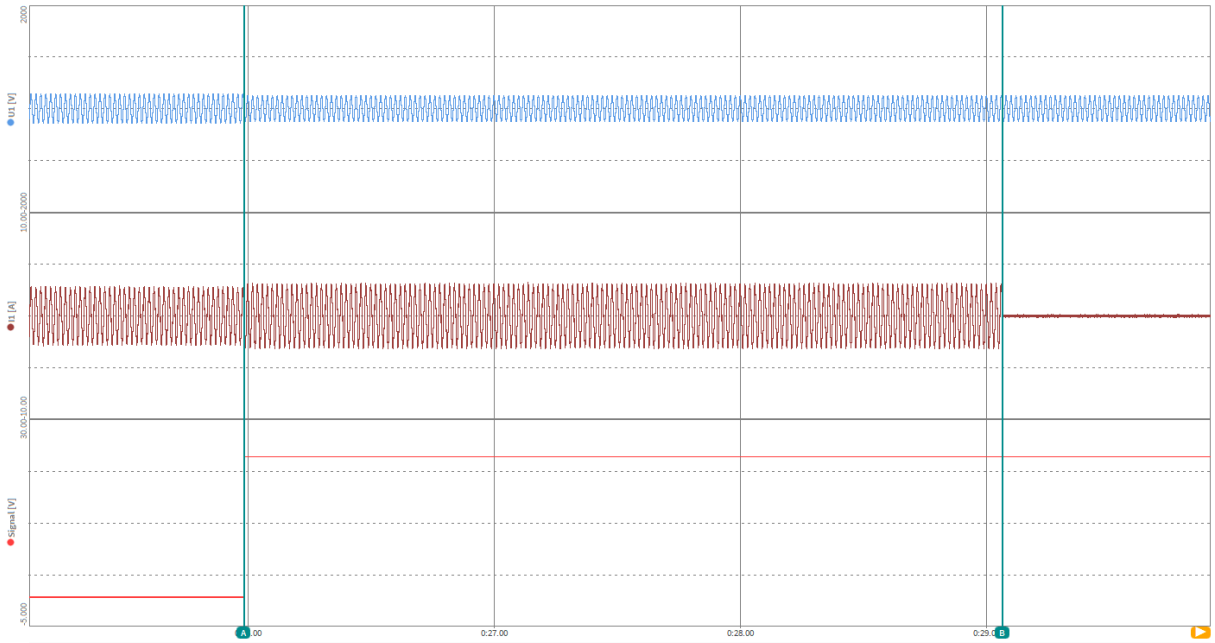
L1 to N:	**Under voltage 1 (5.2):**			**Over voltage 1 (2.2):**		
Jump [start V to stop V]	>200,1 → <179,4			<282,9 → >292,1		
Step size [V]	>9,2			>9,2		
Step length [s]	>3,200			>0,400		
Limit [s]	3,000 ≤t ≤3,100			0,100 ≤t ≤0,200		
Measurement [s]	3,082	3,033	3,024	0,177	0,162	0,188

L1 to N:	**Under voltage 2 (6.2):**		
Ramp [start V to stop V]:	>108,1 → <98,9		
Step size [V]	<1,15		
Step length [s]	>0,500		
Limit [V]:	103,5 ±1% U_n		
Measurement [V:]	104,1	104,6	104,7

L1 to N:	**Under voltage 2 (7.2):**
Jump [start V to stop V]:	>108,1 → <98,9
Step size [V]	>9,2

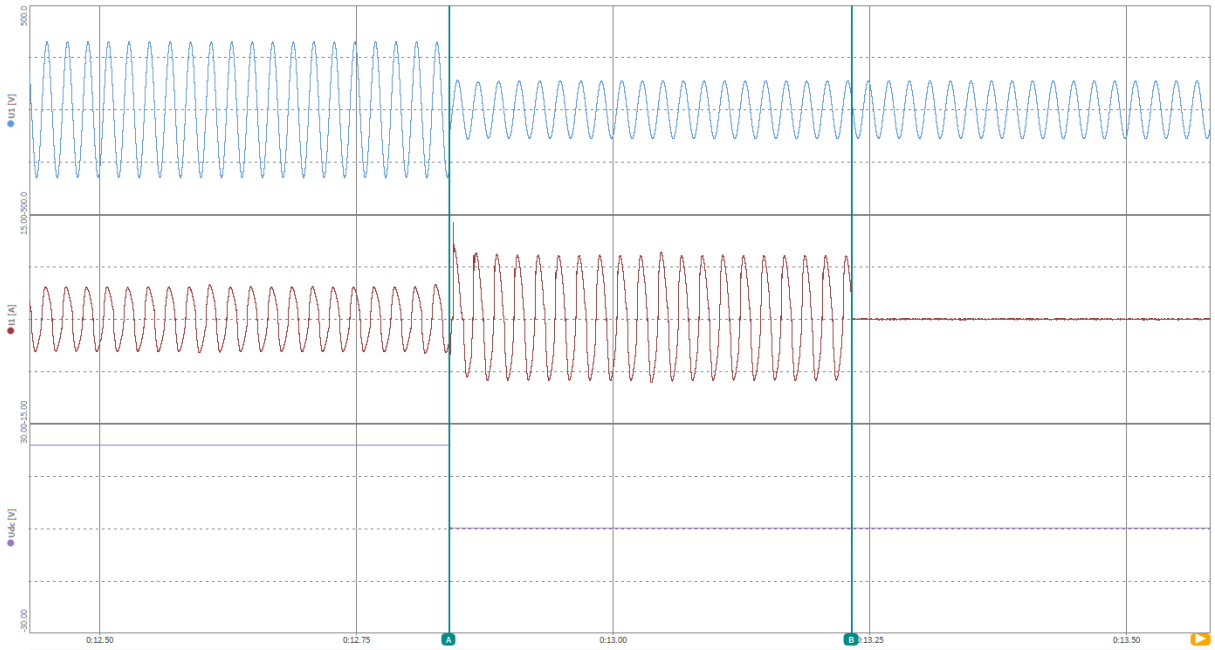
Step length [s]	>0,500			
Limit [s]:	0,300 ≤t ≤0,400			
Measurement [s]:	0,385	0,389	0,392	

Under voltage 1 (5.2):



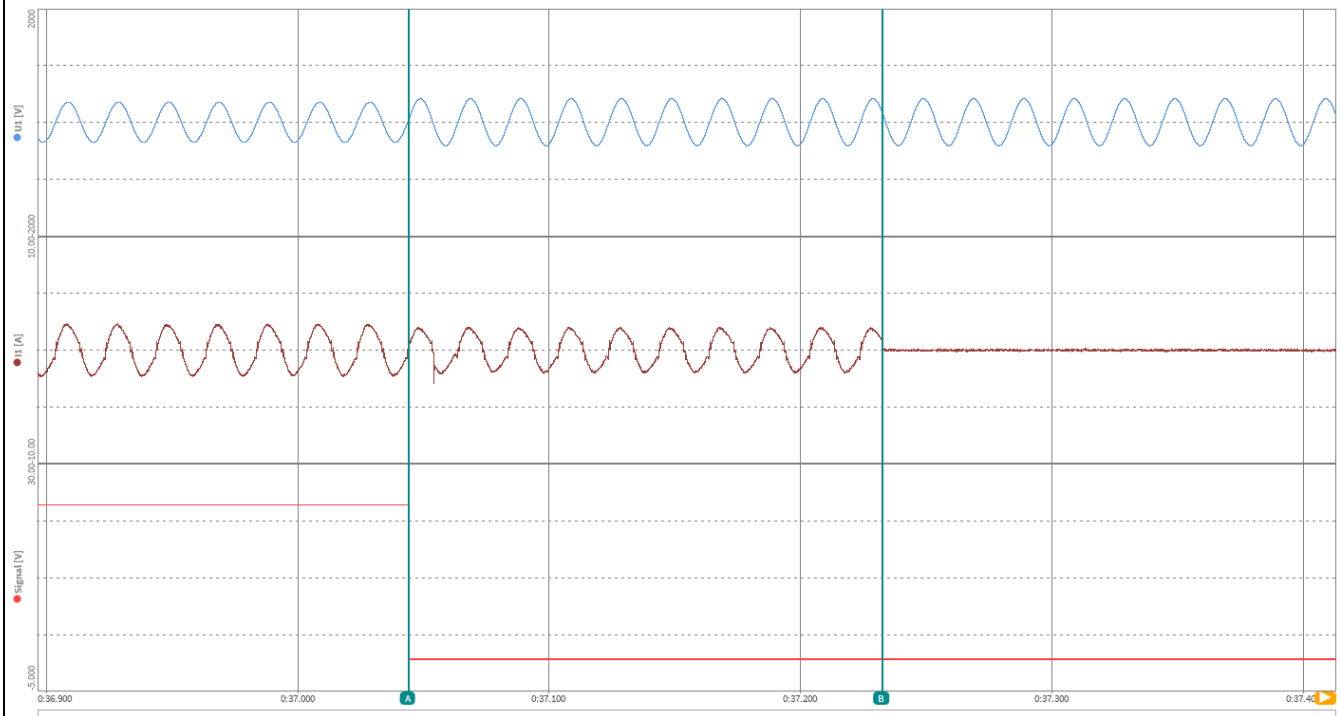
	A	B	Delta
Time [s]	0:25.98509	0:29.06663	3.08155
U1 [V]	60.74381	-58.08759	-118.8314
I1 [A]	0.749230	-0.089407	-0.838637
Signal [V]	21.18564	23.77463	2.588988

Under voltage 2 (7.2):



	A	B	Delta
Time [s]	0:12.8404073	0:13.2325624	0.3921551
U1 [V]	-275.8658	45.36128	321.2271
I1 [A]	-3.452897	-0.130534	3.322363
Udc [V]	24.01209	0.157118	-23.85497

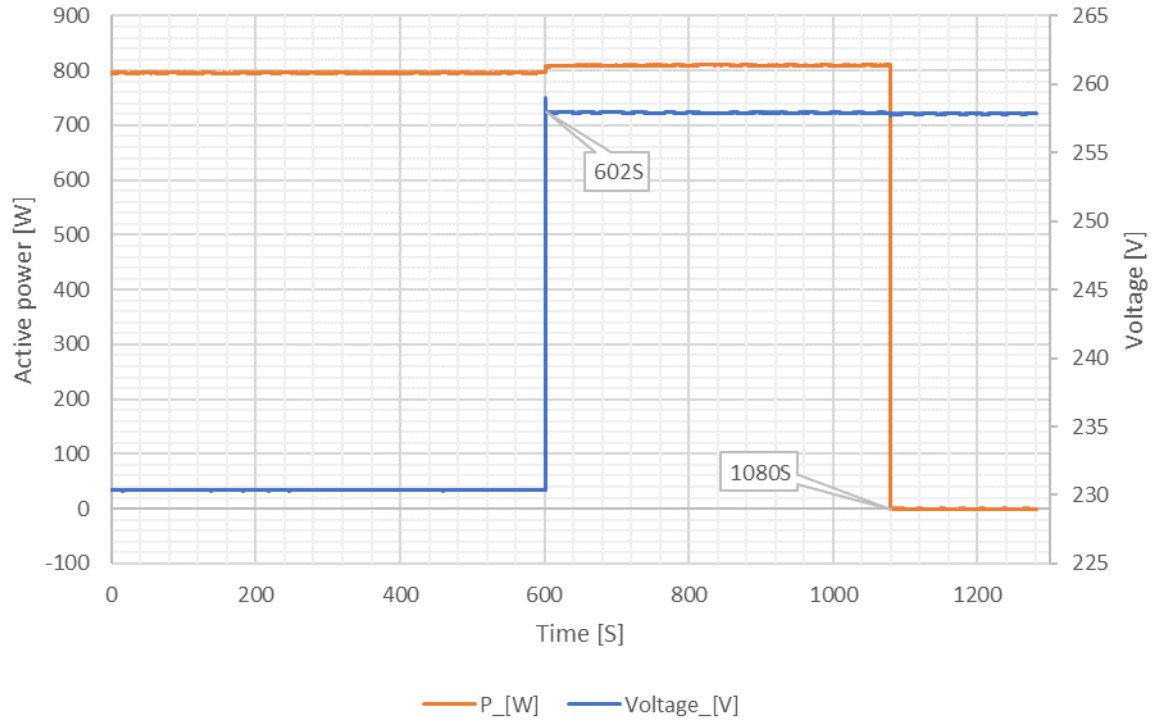
Over voltage 1 (2.2):



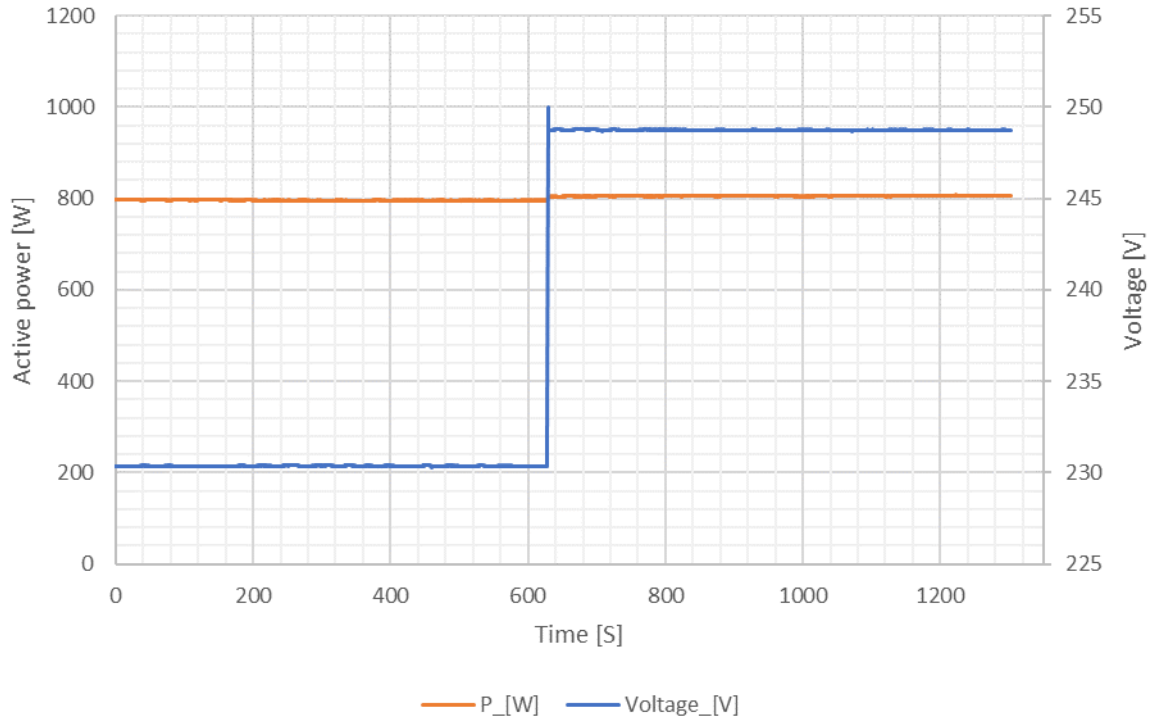
	A	B	Delta
Time [s]	0:37.0440950	0:37.2324648	0.1883699
U1 [V]	27.20738	172.7891	145.5817
I1 [A]	-0.025034	0.704527	0.729561
Signal [V]	7.323266	-0.164986	-7.488251

5.5.7.4 Voltage and frequency control			**P**
5.5.7.4.1 Measuring the rise-in voltage protection as a running 10-minute mean value			**P**
Setting values of the NS protection:	Setting U> [V]	253,0	
	Setting $T_{disconnection\ U>}$ [s]	600	
Operating time of the monitoring device:			
L1-N:	**Over voltage 10-minute mean value (3.1):**		
Ramp [start V to stop V]	230,0 → 257,6		
Step size [V]	27,6		
Step length [s]	>600,2		
Limit for disconnection [s]	450 to 550		
Measurement [s]	478		
L1-N:	**Over voltage 10-minute mean value (3.2):**		
Ramp [start V to stop V]	230,0 → >248,4		
Step size [V]	18,4		
Step length [s]	>600,2		
Limit for reconnection [s]	no disconnection (also after 600s)		
Measurement [s]	No disconnection		
L1-N:	**Over voltage 10-minute mean value (3.3):**		
Ramp [start V to stop V]	243,8 → >262,2		
Step size [V]	18,4		
Step length [s]	>600,2		
Limit for disconnection[s]	225s to 375		
Measurement [s]	336		
Note: The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.			

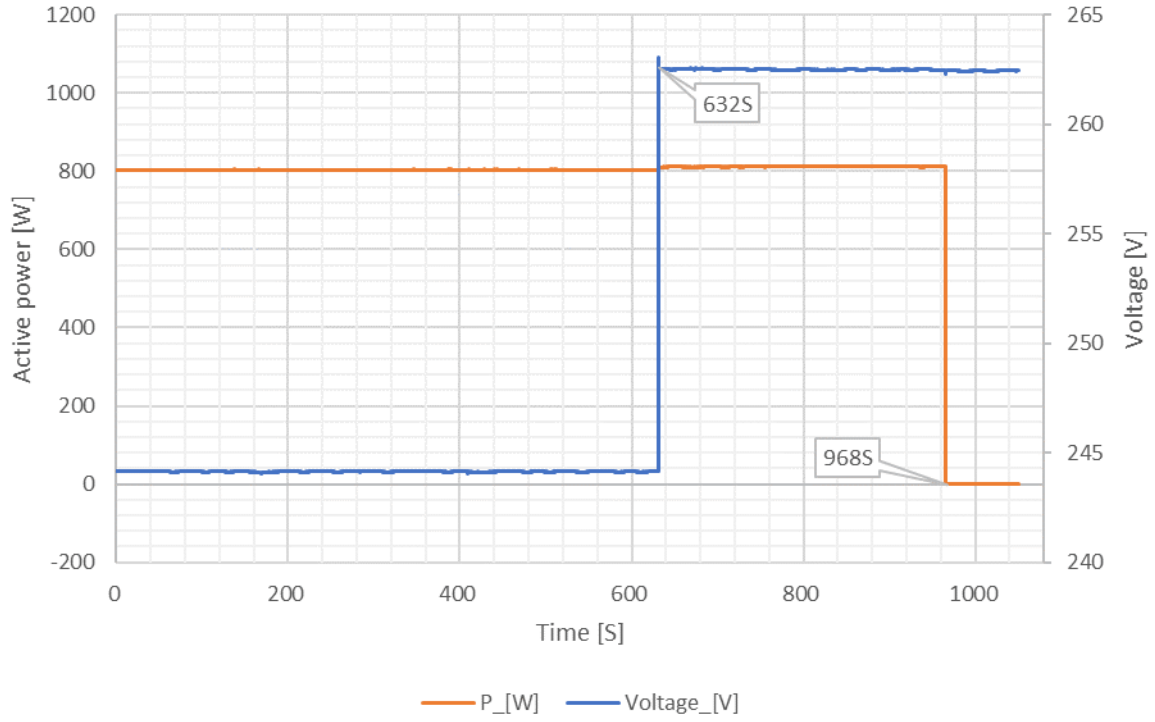
Over voltage 10-minute mean value (3.1):



Over voltage 10-minute mean value (3.2):



Over voltage 10-minute mean value (3.3):



5.5.7.4 Voltage and frequency control	P
5.5.7.4.1 Voltage and frequency control – Frequency measurement	P

Test procedural:

- For a single-phase EZE, only the feed-in phase needs to be checked.
- Before each test step, the EZE must be operated symmetrically with rated voltage and rated frequency for at least 10 s in feed-in mode.
- The P setpoint was set by SW-Tool using RS485-interface.

Assessment criterion:

- The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of f_n.
- The disconnection time includes disconnect time + operate time of the integrated relay. Therefore, limit is given with +0,100s according to Table 2 set values of the NS-protection according to VDE AR-N 4105:2018.

Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

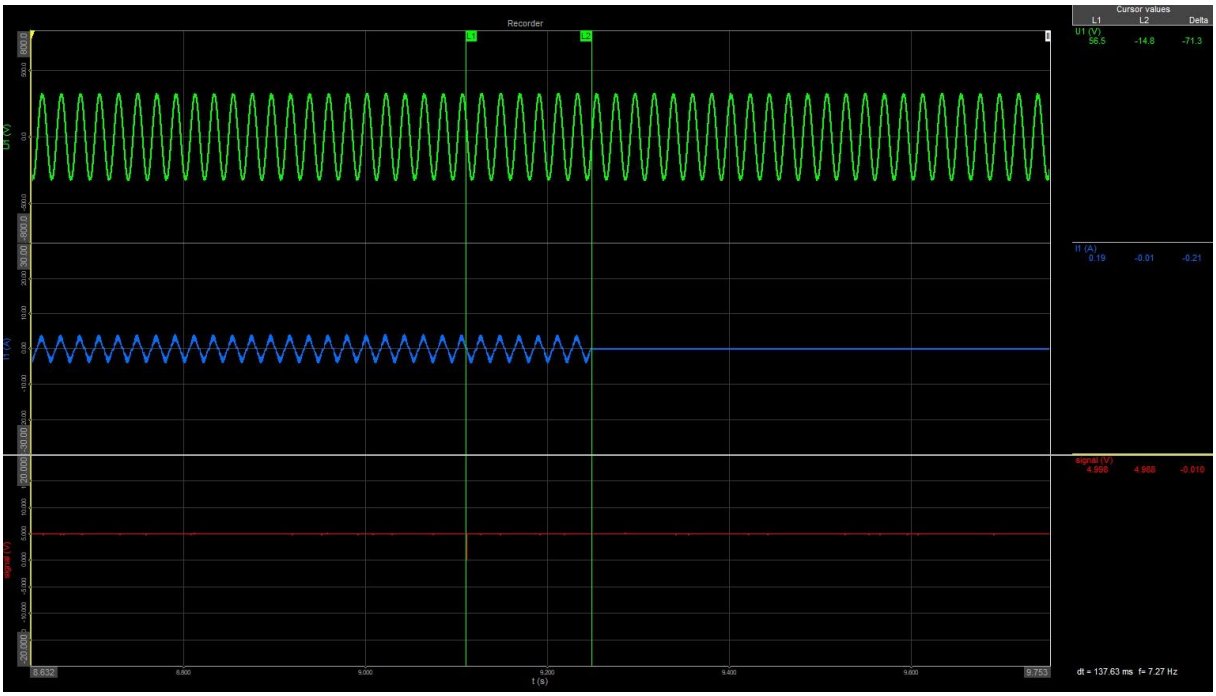
Setting values of the NS protection:	Setting	Value [Hz]	Time [s]
	f<	47,5	0,1
	f>	51,5	0,1

Operating time of the monitoring device:

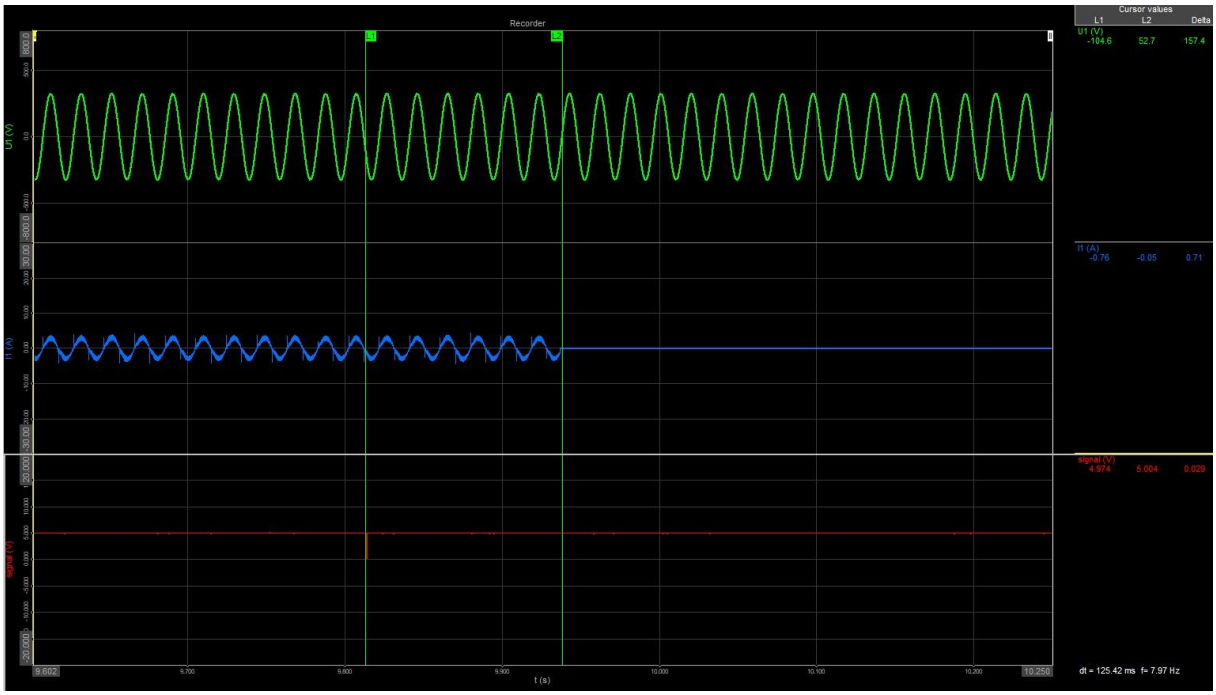
	Under frequency (10.1):			**Over frequency (8.1):**		
Ramp [start Hz to stop Hz]	47,60 → 47,40			51,40 → 51,60		
Step size [Hz]	<0,025			<0,025		
Step length [s]	>0,4			>0,4		
Limit [Hz]	47,50 ±1% f_n			51,50 ±1% f_n		
Measurement [Hz]	47,51	47,50	47,50	51,50	51,51	51,50

	Under frequency (11.1):			**Over frequency (9.1):**		
Jump [start Hz to stop Hz]	47,60 → 47,40			51,40 → 51,60		
Step size [Hz]	>0,2			>0,2		
Step length [s]	>0,4			>0,4		
Limit [s]	0,100 ≤t ≤0,200			0,100 ≤t ≤0,200		
Disconnection time [s]	0,104	0,137	0,138	0,125	0,108	0,124

Under frequency (11.1):



Over frequency (9.1):



5.5.7.5 Reporting NS protection	P

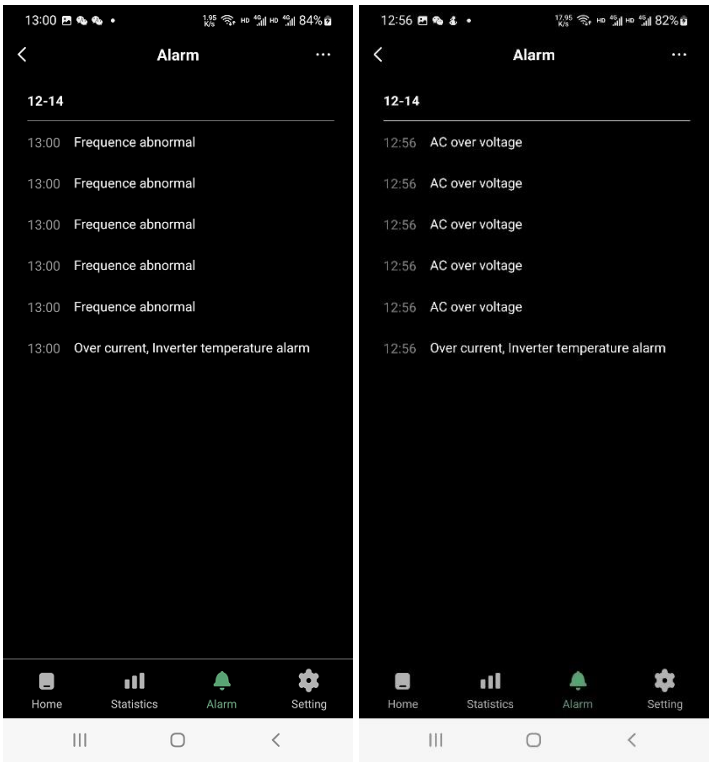
Test procedural:

- At least the last 5 error messages can be read at the EZE or the external NA protection.
- The supply voltage must then be interrupted for 3 s.
- The error messages must then be read out again.

Assessment criterion:

At least the last 5 error messages including time stamps that were recorded before the voltage interruption and at least 5 error messages including time stamps that were recorded after the voltage interruption must be documented

Picture of 5 last dated failure:



5.5.9 Constructional characteristics of NS protection	**P**
5.5.9.1 General	**P**
These tests serve to demonstrate the requirements of VDE-AR-N 4105: 2018-11, 6.5.2.	
5.5.9.2 Test	**P**
Type of NS protection: ☒Internal / ☐external	
NS-protection is sealed or a password protection is used (or both)	P
adjustability of U> and the time delays for U< and U<< is given	P
All other protective functions are either permanently protected or protected from unauthorized access by additional, separate protection (example password)	P

5.5.10 Islanding detection	P
For power generation systems, islanding detection must be carried out using one of the following processes: a) active method, e.g., by means of frequency – shift process (oscillating circuit) b) passive method by means of the three-phase voltage monitoring (possible only for power generation systems without inverters or for single-phase power generation units with inverters). (see 5.4.5.3 3-phase voltage control) With the passive process, it is important to provide evidence that the power generation unit can be set not equal to 120°.	
5.5.10.1 General	**P**
These tests serve as proof of the requirements of VDE-AR-N 4105: 2018-11, 6.5.3. The maximum switch-off time is 9 s.	

5.5.10.2 Passive Islanding detection	N/A
The passive procedure is implemented by the voltage increase and voltage decrease protection of the NS protection.	
Note: A passive procedure is possible with the help of three-phase voltage monitoring (only for generating units without converter or for single-phase generating units with converter) The three-phase voltage monitoring is also permissible with the structural integration of several single-phase generating units that feed into different external conductors, as long as the currents of these generating units are regulated independently of each other so that any phase positions can be set.	

5.5.10.3 Islanding protection according to table 6 - Load imbalance (real, reactive load) for test condition A (PGU output = 100%)	**P**

Test conditions	Frequency: 50 ±1% f_n U_n = 230 ±1%U_n Distortion factor of chokes ≤2%
Disconnection limit	2s (IEC 62116)

No	P_{PGU} 1) [% of PGU rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{PGU} [W]	voltage [V]	Q_f [1]	Run on Time [s]	Re-marks5)
1	100	100	0	0	0,047	803	44	0,997	257	BL
2	100	100	-5	-5	0,809	803	44	1,023	233	IB
3	100	100	-5	0	0,830	803	44	1,050	235	IB
4	100	100	-5	+5	0,809	803	44	1,076	224	IB
5	100	100	0	-5	0,067	803	44	0,972	203	IB
6	100	100	0	+5	0,067	803	44	1,022	223	IB
7	100	100	+5	-5	0,848	803	44	0,926	215	IB
8	100	100	+5	0	0,830	803	44	0,950	214	IB
9	100	100	+5	+5	0,848	803	44	0,973	203	IB

Parameter at 0%	L= 210,33mH	R= 65,88 Ω	C= 48,17µF

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

1) PPGU: PGU output power

2) PAC: Real power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.

3) QAC: Reactive power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.

4) Fundamental of IAC when RLC is adjusted

5) BL: Balance condition, IB: Imbalance condition.

Condition A:

PGU output power PPGU = Maximum 6)

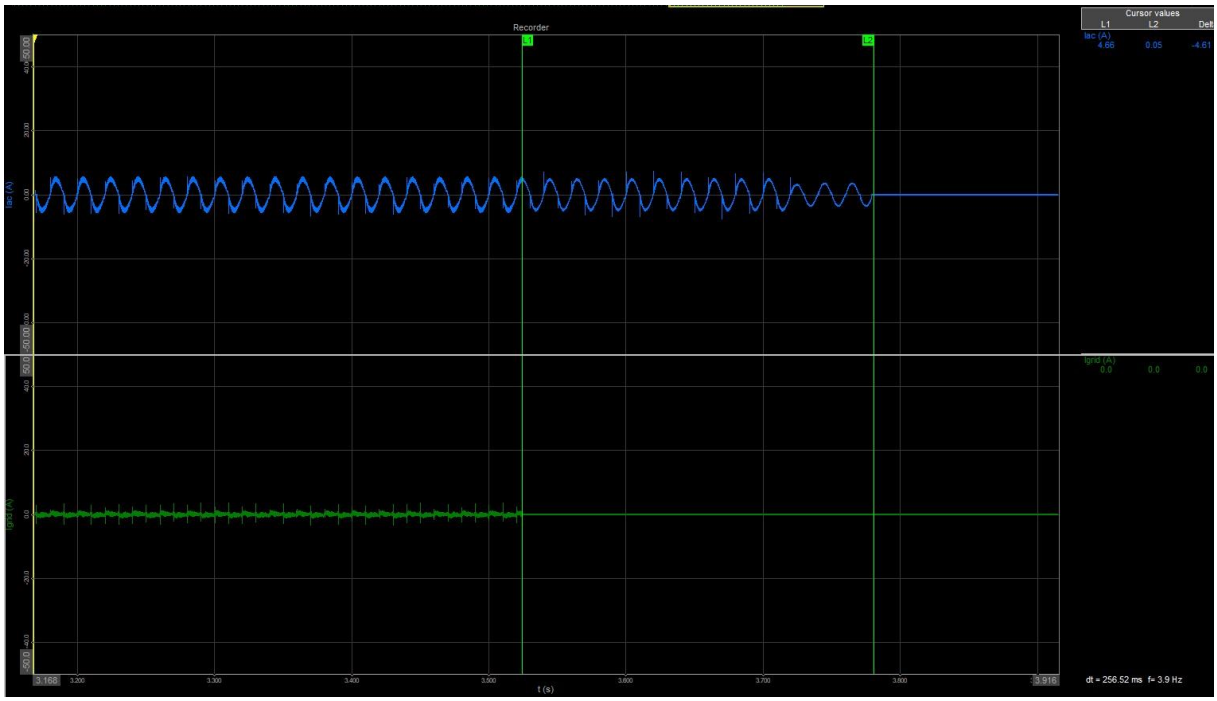
PGU input voltage 6) ≥ 75% of rated input voltage range

6) Maximum PGU output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.

7) Based on PGU 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 × PGU maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the PGU should not be operated outside of its allowable input voltage range.

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Disconnection at P_{AC} 0% & Q_{AC} 0%



5.5.10.3 Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (PGU output = 50 % – 66 %)	**P**

Test conditions	Frequency: 50 ±1% f_n U_n = 230 ±1%U_n Distortion factor of chokes ≤2%
Disconnection limit	2s (IEC 62116)

No	P_{PGU} [1)] [% of PGU rating]	Reactive load [% of Q_L in 6.1.[d)1]]	P_{AC} [2)] [% of nominal]	Q_{AC} [3)] [% of nominal]	I_{AC} [4)] [A]	P_{PGU} [W]	Voltage [V]	Q_f [1]	Run on Time [s]	Re-marks[5)]
12	66	66	0	-5	0,017	526	39	0,975	209	BL
13	66	66	0	-4	0,015	526	39	0,980	240	IB
14	66	66	0	-3	0,013	526	39	0,985	242	IB
15	66	66	0	-2	0,012	526	39	0,990	205	IB
16	66	66	0	-1	0,010	526	39	0,995	294	IB
2	66	66	0	0	0,007	526	39	1,000	239	IB
17	66	66	0	1	0,008	526	39	1,005	260	IB
18	66	66	0	2	0,008	526	39	1,010	301	IB
19	66	66	0	3	0,007	526	39	1,015	309	IB
20	66	66	0	4	0,007	526	39	1,020	237	IB
21	66	66	0	5	0,007	526	39	1,025	215	IB

Parameter at 0%	L= 319,55 mH	R= 100,18 Ω	C= 31,71 µF

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

1) P_{PGU}: PGU output power

2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.

3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.

4) Fundamental of I_{AC} when RLC is adjusted

5) BL: Balance condition, IB: Imbalance condition.

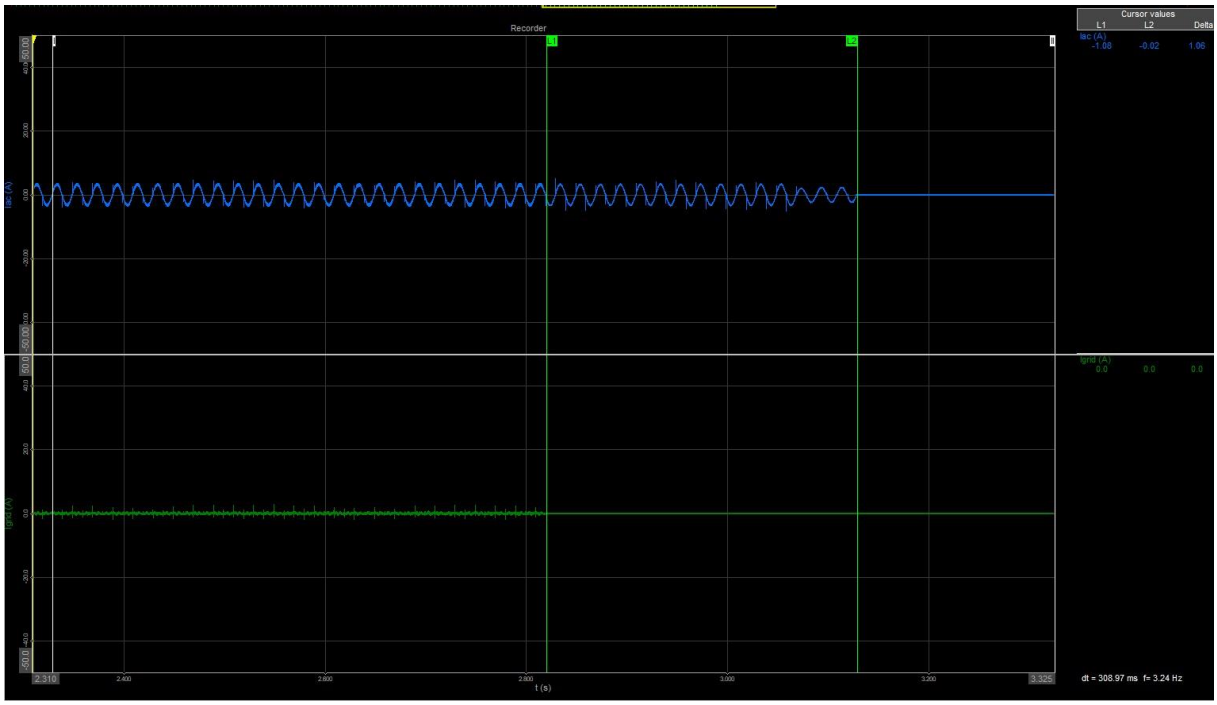
Condition B:

PGU output power P_{PGU} = 50 % – 66 % of maximum

PGU input voltage 6) = 50 % of rated input voltage range, ±10 %

6) Based on PGU rated input operating range. For example, If range is between X volts and Y volts, 50 % of range =X + 0,5 × (Y – X). Y shall not exceed 0,8 × PGU maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the PGU should not be operated outside of its allowable input voltage range.

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Disconnection time at P_{AC} 0% and Q_{AC} 3%


5.5.10.3 Islanding protection according Table 8 – Load imbalance (reactive load) for test condition B (PGU output = 25 % – 33 %)										**P**
Test conditions			Frequency: 50 ±1% f_n U_n = 230 ±1%U_n Distortion factor of chokes ≤2%							
Disconnection limit			2s (IEC 62116)							
No	P_{PGU} [1)] [% of PGU rating]	Reactive load [% of Q_L in 6.1.[d)] 1]	P_{AC} [2)] [% of nominal]	Q_{AC} [3)] [% of nominal]	I_{AC} [4)] [A]	P_{PGU} [W]	Voltage [V]	Q_f [1]	Run on Time [ms]	Re-marks[5)]
22	33	33	0	-5	0,023	256	34	0,975	221	BL
23	33	33	0	-4	0,022	256	34	0,980	234	IB
24	33	33	0	-3	0,021	256	34	0,985	240	IB
25	33	33	0	-2	0,020	256	34	0,990	235	IB
26	33	33	0	-1	0,020	256	34	0,995	207	IB
3	33	33	0	0	0,017	256	34	1,000	220	IB
27	33	33	0	1	0,018	256	34	1,005	211	IB
28	33	33	0	2	0,018	256	34	1,010	236	IB
29	33	33	0	3	0,017	256	34	1,015	224	IB
30	33	33	0	4	0,017	256	34	1,020	248	IB
31	33	33	0	5	0,017	256	34	1,025	223	IB

Parameter at 0%	L= 639,10 mH	R= 200,40 Ω	C= 15,85 µF

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

[1)] P_{PGU}: PGU output power

[2)] P_{AC}: Real power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.

[3)] Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.

[4)] Fundamental of I_{AC} when RLC is adjusted

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

Condition B:

PGU output power P_{PGU} = 25 % – 33 % [6)] of maximum

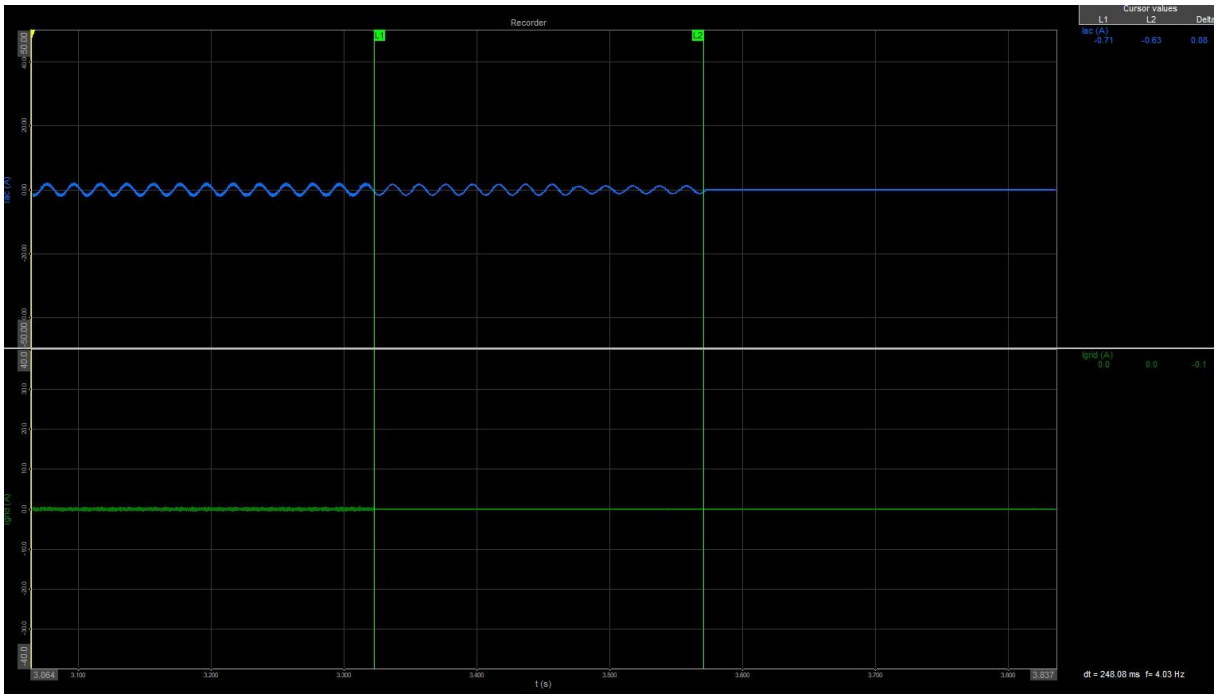
PGU input voltage [7)] < 20 % of rated input voltage range

[6)] Or minimum allowable PGU output level if greater than 33 %.

[7)] Based on PGU rated input operating range. For example, if range is between X volts and Y volts, 20 % of range =X + 0,2 × (Y – X). Y shall not exceed 0,8 × PGU maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the PGU should not be operated outside of its allowable input voltage range.

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Disconnection time at P_{AC} 0% and Q_{AC} +2%



5.6.2. Connecting conditions and synchronisation				P
Test:				
	f_{ist}	**Reset time:**	**Limit:**	
Connecting conditions for frequencies:				
a)	<47,45Hz	No reconnection	No resetting allowed	
	Switch to:			
b)	≥47,55Hz	76 s	≥60s	
c)	>50,15Hz	No reconnection	No resetting allowed	
	Switch to:			
d)	≤50,05Hz	68 s	≥60s	
Connecting conditions for voltages:				
e)	84%	No reconnection	No resetting allowed	
	Switch to:			
f)	≥86%	80 s	≥60s	
g)	111%	No reconnection	No resetting allowed	
	Switch to:			
h)	≤109%	74 s	≥60s	

Test:

see points a) to h) for the test process.

The measurement was carried out with a programmable AC source.

e.g., connecting conditions for frequencies: Point a) and b). The AC source was programmed in such a way that the first step of 230V/50Hz to 200V/47,0Hz resulted in a faulty disconnection. Thereafter the voltage and frequency for 100s is set to 215V/47,45Hz. Switching on again is not permitted. After a lapse of 100s the voltage is set to 230V/47,55Hz. Setting again after 60s is permitted.

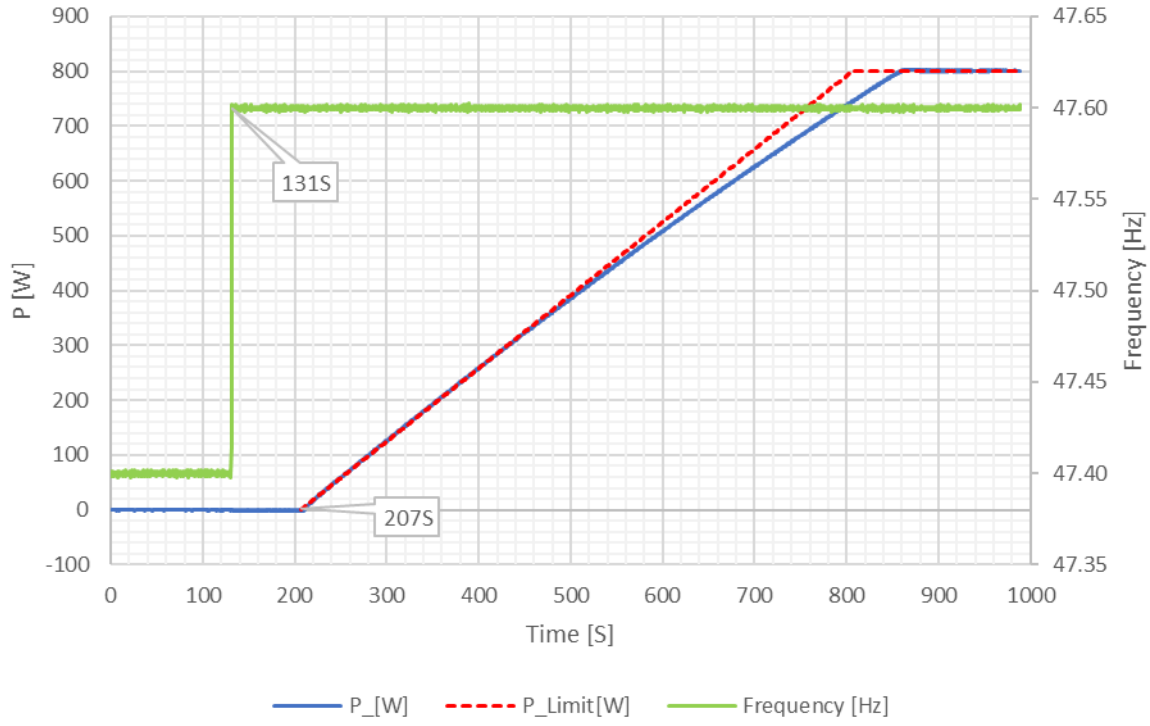
Assessment criterion:

After actuating the NS protection, it should be checked that the system can only be switched within the tolerance ranges ((80% $U_n \leq U \leq 110\%$ U_n) and (47,50Hz ≤f ≤50,10Hz)) at the earliest after 60s after voltage and frequency has remained within the tolerance ranges.

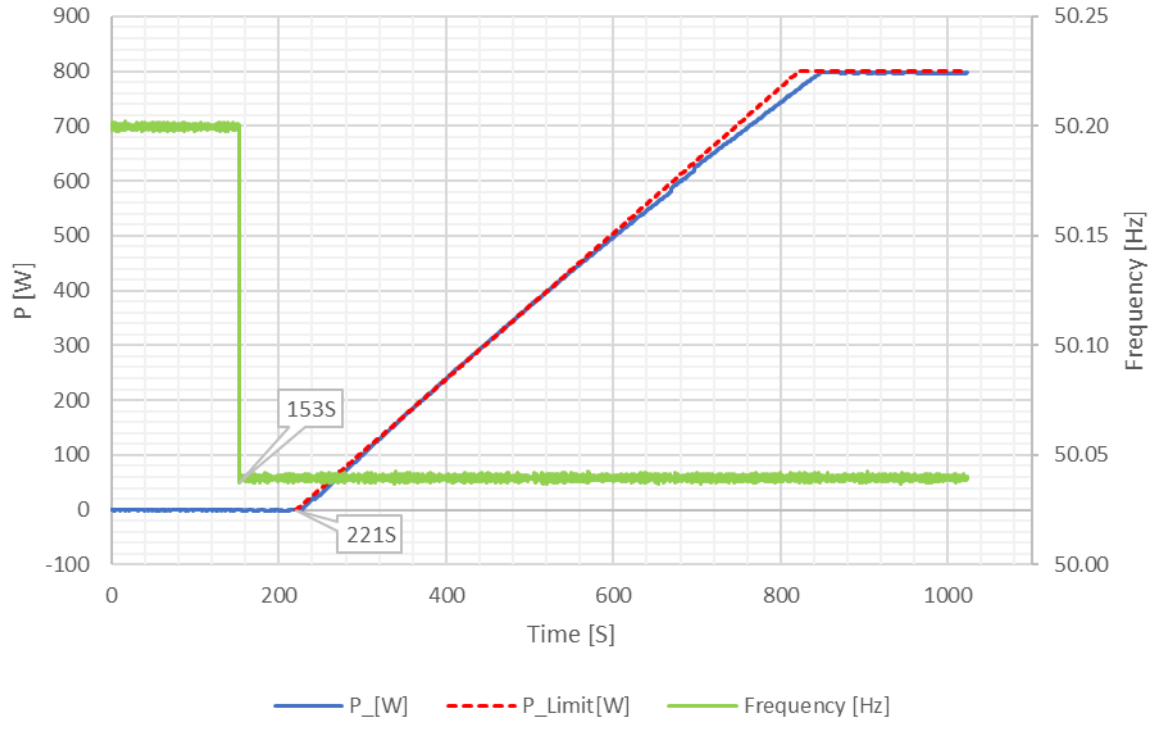
Note:

The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

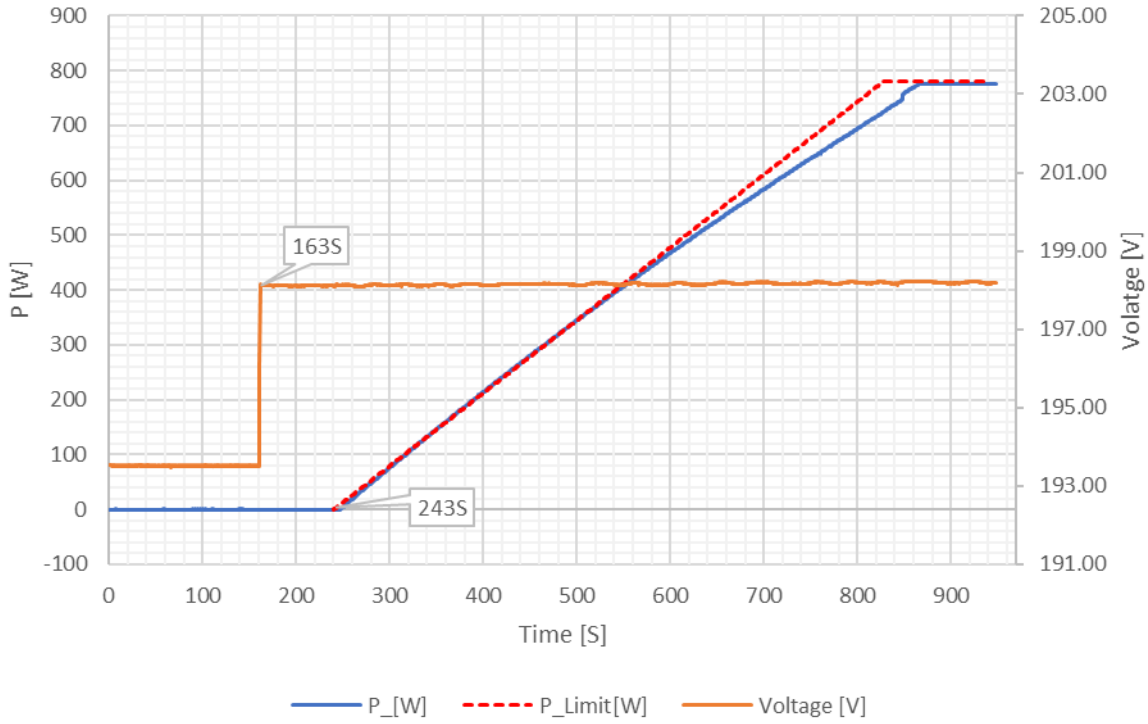
Connecting conditions for frequencies: 47,55Hz



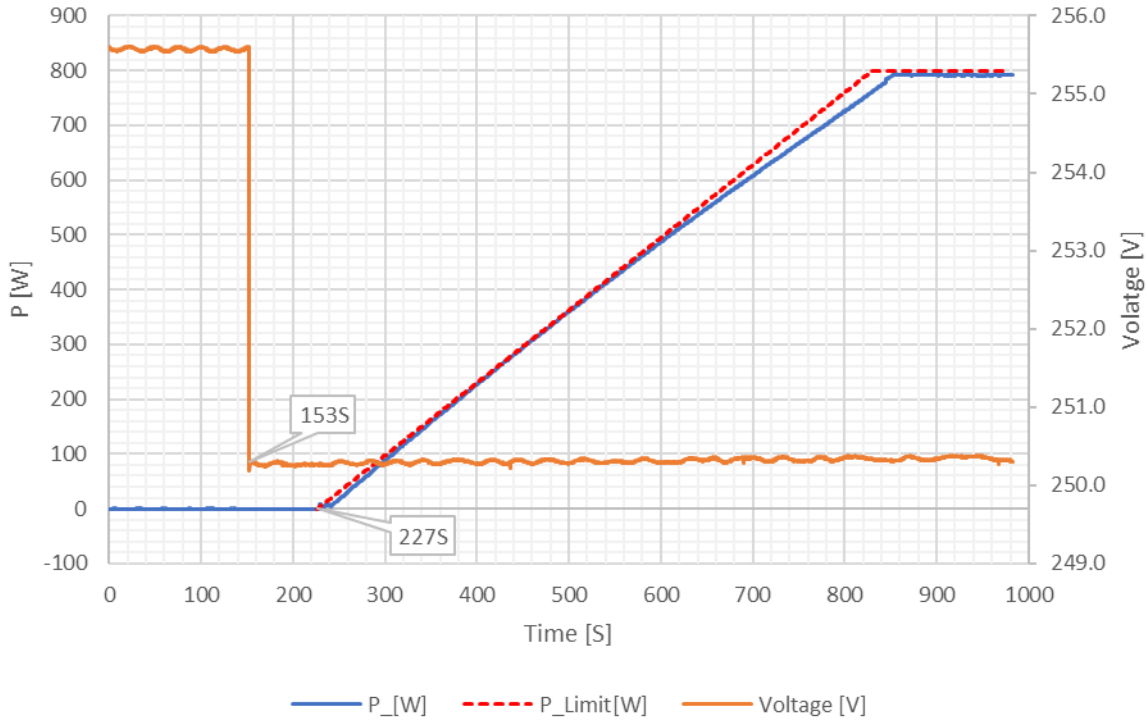
Connecting conditions for frequencies: 50,05Hz



Connecting conditions for voltages: 86%Un



Connecting conditions for voltages: 109%Un



5.7 Evidence of $P_{AV,E}$ -Control

5.7.1 General — N/A

The test serves to prove the requirements of VDE-AR-N 4105: 2018 - 11, 5.5.2. The $P_{AV,E}$-monitoring may, but does not have to be integrated into the PGU. If the $P_{AV,E}$-monitoring is not as a unit built, but distributed over several devices, the entire impact chain is analogous to the examination of NA protection including the communicative Check coupling.

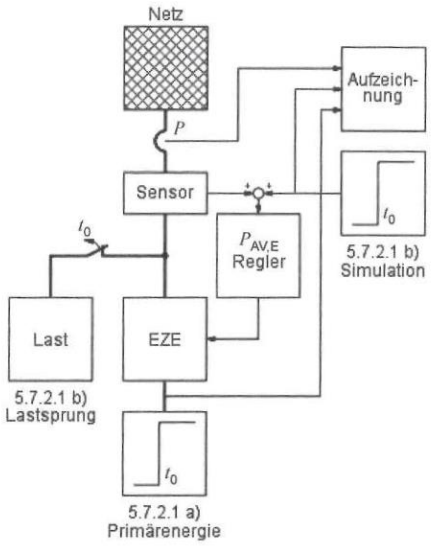


Bild 8 – Skizze des Prüfaufbaus zur Prüfung der Regeldynamik

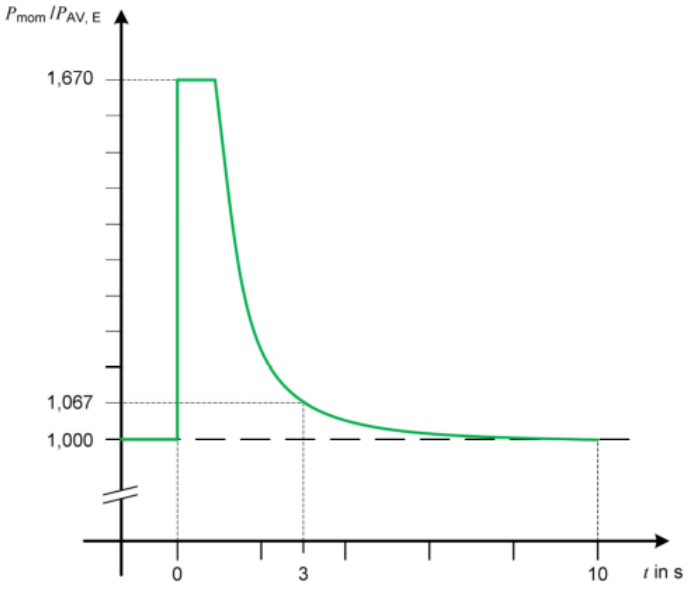


Bild 1 – Wirkleistungs-Grenzkurve für Erzeugungsanlagen

The PGU with any necessary additional components is installed according to the manufacturer's instructions and parameterized so that the feed limitation $P_{AV,E}$ is activated at ≥ 60% P_{rE}. The power jump can be simulated either by a jump in the primary energy supply or by the fall of a load become:

a) Primary energy supply jump: The primary energy supply is adjusted so that the PGU supplies the power $P_{AV,E}$ = 60% P_{rE} with a tolerance of -2%. At the time t0, the primary energy supply is to be suddenly increased so that the PGU can provide the rated output.

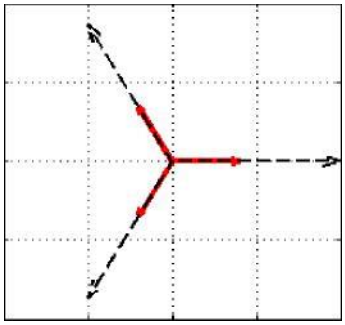
b) Loss of load: The PGU is operated at nominal power. Via a load which is to be connected symmetrically to all feeding phases parallel to the PGU, the power at the grid connection point is set to $P_{AV,E}$ with a tolerance of -2%. At time t0, the load is switched off. The elimination of the load can also be simulated by an appropriate offset on the power measurement signal.

The closed loop must not be disconnected. Here, the sum of the effective active values of all 3 phases at the grid connection point must be recorded for at least 15s from the power jump.

5.8 Evidence dynamic grid support		
5.8.1	General	**P**
5.8.3	Testing of the dynamic grid support PGU Type 1	**N/A**
5.8.3	Testing of the dynamic grid support PGU Type 2	**P**

5.8.1 General	P

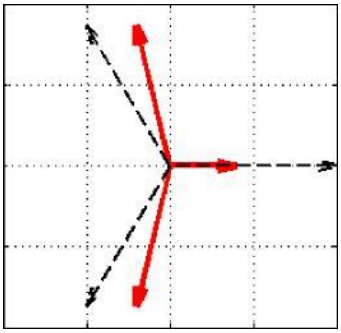
FRT test for three-phase symmetrical (Test ref no. 1.x)



Typ-A

LVRT test for two-phase asymmetrical fault (Test ref no. 1.3.x to 4.3.x)

Test No.	V/V_{nom}	Phase-to-earth voltages			Phase angles		
		$u_1/u_{1,nom}$	$u_2/u_{2,nom}$	$u_3/u_{3,nom}$	φ_{u1}(U)	φ_{u2}(V)	φ_{u3}(W)
1.3, 1.4	0,15 ± 0,05	0,62 ± 0,05	0,15 ± 0,05	0,62 ± 0,05	-143°	120°	23°
2.3, 2.4, 3.3, 3.4	0,50 ± 0,05	0,76 ± 0,05	0,50 ± 0,05	0,76 ± 0,05	-131°	120°	11°
4.3, 4.4	0,50 ± 0,05	0,93 ± 0,05	0,85 ± 0,05	0,93 ± 0,05	-123°	120°	3°
Normal condition	1	1	1	1	-120°	120°	0°



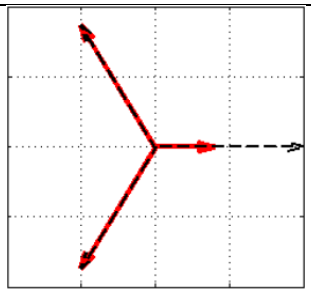
Typ-D

FRT test for two-phase asymmetrical fault (Test ref no. 5.3.x to 7.3.x)

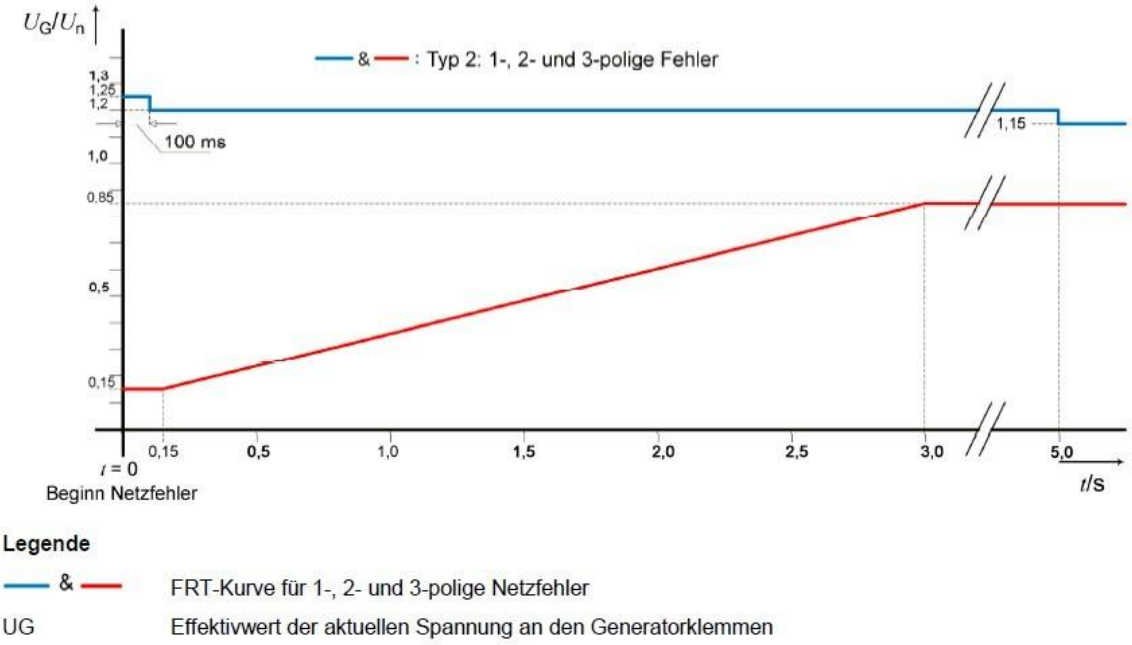
Test No.	V/V_{nom}	Phase-to-earth voltages			Phase angles		
		$u_1/u_{1,nom}$	$u_2/u_{2,nom}$	$u_3/u_{3,nom}$	φ_{u1}(U)	φ_{u2}(V)	φ_{u3}(W)
5.3, 5.4	1,25 ± 0,05	1,08 ± 0,05	1,25 ± 0,05	1,06 ± 0,05	-115°	-120°	6°
6.3,6.4	1,20 ± 0,05	1,06 ± 0,05	1,20 ± 0,05	1,05 ± 0,05	-116°	-120°	5°
7.3,7,4	1,15 ± 0,05	1,04 ± 0,05	1,15 ± 0,05	1,04 ± 0,05	-117°	-120°	4°
Normal condition	1	1	1	1	-120°	120°	0°

FRT test for two-phase asymmetrical fault (Test ref no. x.3.x)

5.8.1 General	P



Typ-B



Legende

& FRT-Kurve für 1-, 2- und 3-polige Netzfehler

UG Effektivwert der aktuellen Spannung an den Generatorklemmen

Bild 12 – Fault-Ride-Through-Grenzkurve für den Spannungsverlauf an den Generatorklemmen für eine Erzeugungseinheit vom Typ 2 und für Speicher

Figure 12 - Fault ride-through limit curve for the voltage curve at the generator terminals for a **type 2** generation unit and for storage

5.8.3	Testing of the dynamic grid support	P
	For PGUs Type 2 and storage systems	P
	1-phase systems	

Test	Voltage dip to [p.u.]	Dip type	duration [s]	P set point [p.u.]	Q set point [p.u.]	Comment	Recovery response time [s]		Test ref. No.*
							P	Q	
1	0,15 to 0,25	A	for 0,15 ≥0,150 / for 0,25 ≥0,500	1	0 to ± 0,1	Symmetric	0,380	0	1.1
				0,2 to 0,6			0,077	0	1.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,379	0	1.3
				0,2 to 0,6			0,087	0	1.4
		D2[2)]		1			0,381	0	1.5
2	0,50 to 0,60	A	for 0,50 ≥1,500 / for 0,60 ≥2,000	1	Max. over excited	Symmetric	0,367	9,804	2.1
				0,2 to 0,6			0,068	9,765	2.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,373	9,998	2.3
				0,2 to 0,6			0,061	9,989	2.4
3	0,50 to 0,60	A	for 0,50 ≥1,500 / for 0,60 ≥2,000	1	Max. under excited	Symmetric	0,370	9,205	3.1
				0,2 to 0,6			0,068	9,824	3.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,389	9,670	3.3
				0,2 to 0,6			0,062	9,895	3.4
4	0,85 to 0,90	A	≥60,000	1	0 to ± 0,1	Symmetric	0,002	0	4.1
				0,2 to 0,6			0,050	0	4.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,054	0	4.3
				0,2 to 0,6			0,054	0	4.4
5	1,20 to 1,25	A	≥0,100	1	0 to ± 0,1	Symmetric	0,362	0	5.1
				0,2 to 0,6			0,061	0	5.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,261	0	5.3
				0,2 to 0,6			0,165	0	5.4
		D2[2)]		1			0,369	0	5.5
6	1,15 to 1,20	A	≥5,000	1	0 to ± 0,1	Symmetric	0,362	0	6.1
				0,2 to 0,6			0.061	0	6.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,261	0	6.3
				0,2 to 0,6			0,122	0	6.4
7	1,10 to 1,15	A	≥60,000	1	0 to ± 0,1	Symmetric	0,362	0	7.1
				0,2 to 0,6			0,061	0	7.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,260	0	7.3
				0,2 to 0,6			0,488	0	7.4

5.8.3	Testing of the dynamic grid support	P

Note:

At lease the recording must begin at least 10s before the error occurs. After a faulty declaration (Voltage in the range 0,85 U_n ≤U ≤ 1,1U_n), the recording must continue for at least another 60s.

Behaviour during the network error:

No disconnection of the PGU during the voltage drops the grid. If the PGU disconnects from the grid, the time of disconnection must be documented.

- Type 2 units and storage systems are not allowed to inject either active or reactive current during a line voltage at the PGUs terminals below 0,8 Un and above 1,15 Un. This requirement is met if, in the event of an under-/ under voltage dip, the injected current of the generating unit and / or the storage systems does not exceed 20% of the rated current Ir and no more than 10% Ir after 0,06s after the occurrence of this under-/ under voltage dip in any phase.

Behaviour after the end of the error:

- Not disconnection of the PGU within 60s after the end of the fault.
- Type 2 units and storage systems: Reaction time of active power up to 1s, Reaction time of reactive power according to PT1 behaviour with $3\tau = 10s$ in accordance with VDE-AR-N 4105: 2018-11, 5.7.2.5

Table above shows test sequences for single-phase unit.

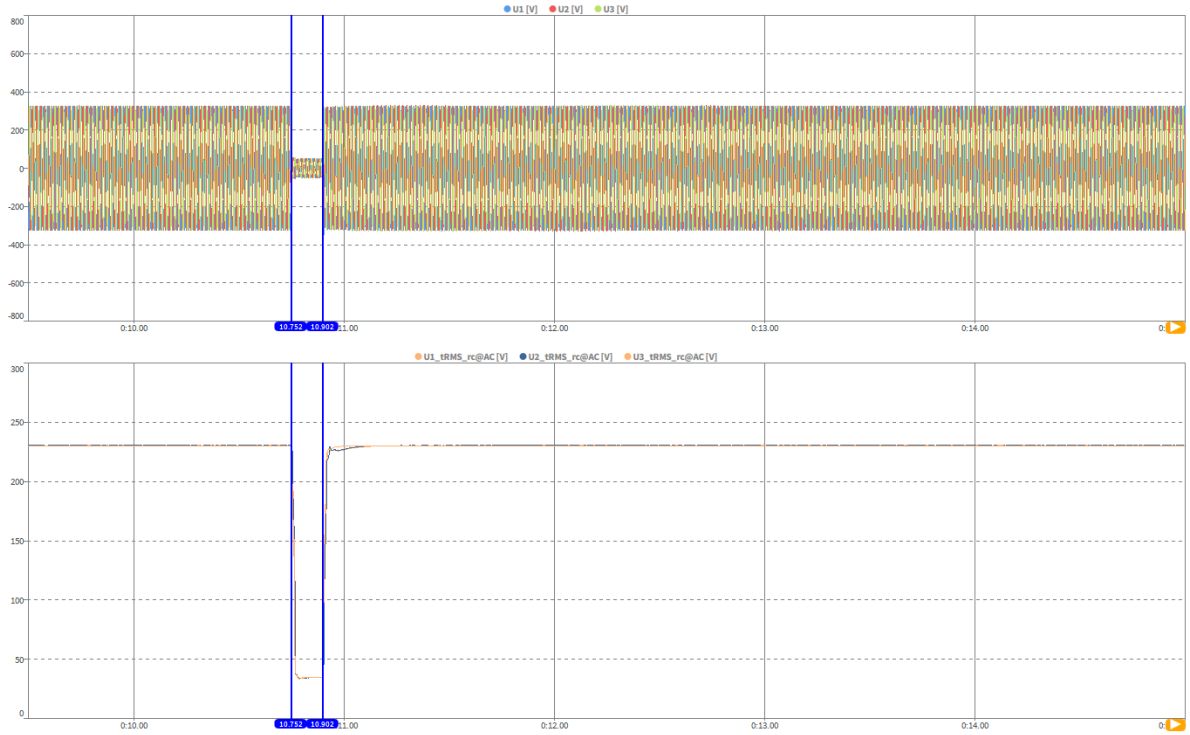
- [1)] One-phase EZE are connected to the phase W and N for error pattern D1
- [2)] One-phase EZE are connected to the phase V and N for error pattern D2

The test has been performed twice and only show one times tested result in the test report.

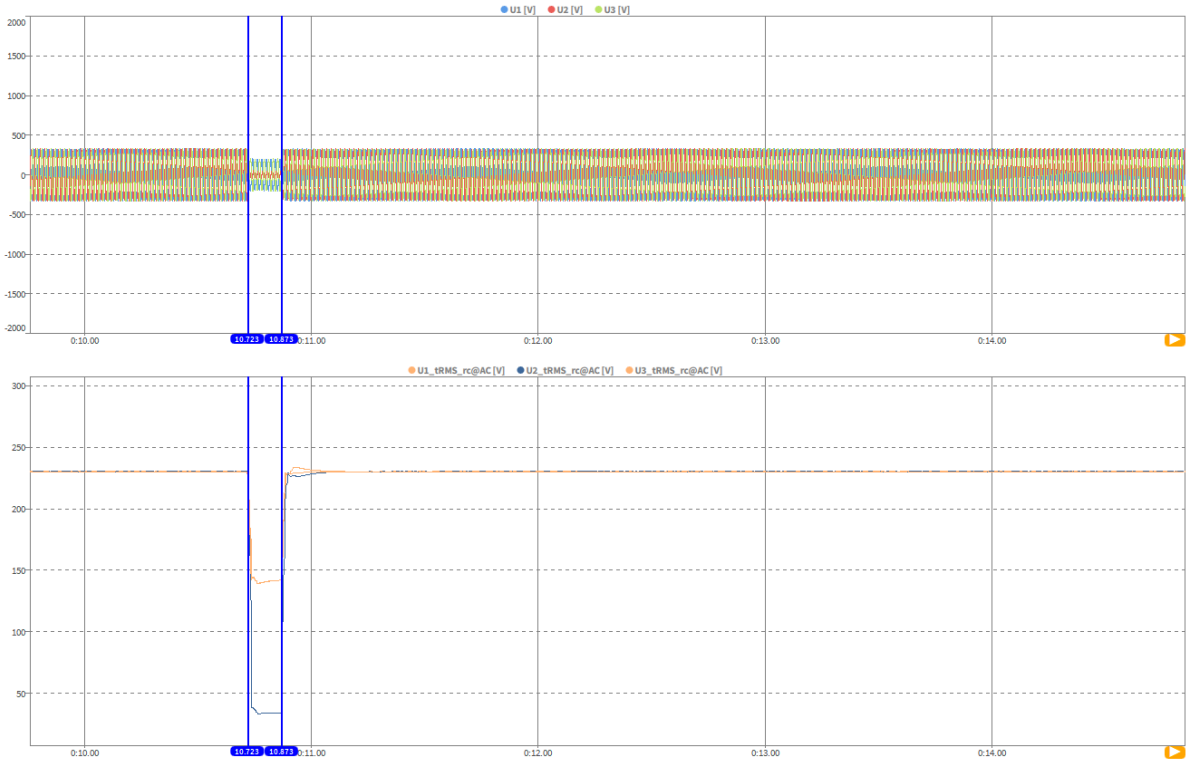
The test results of the **WVC-800** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.8.3	For PGUs Type 2 and storage systems – no load	P

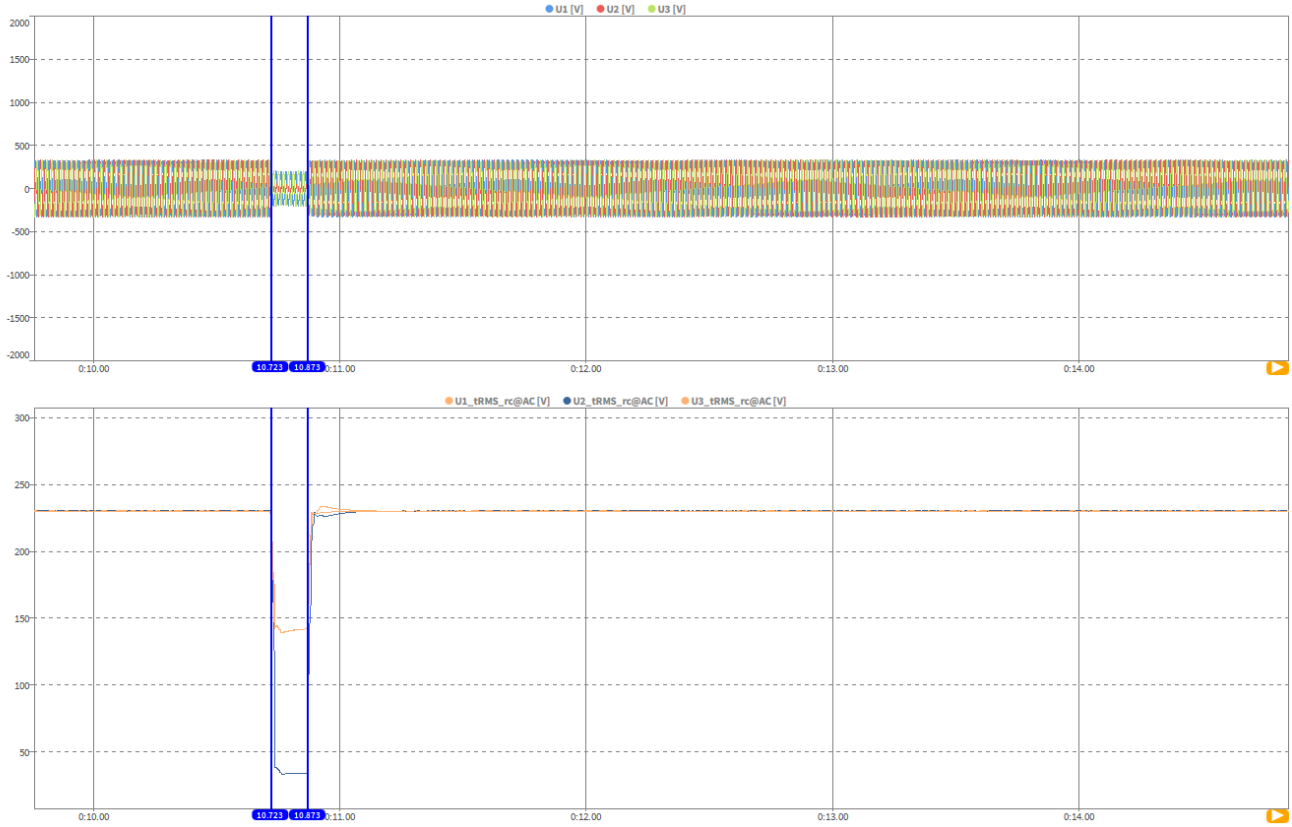
1.1



1.3

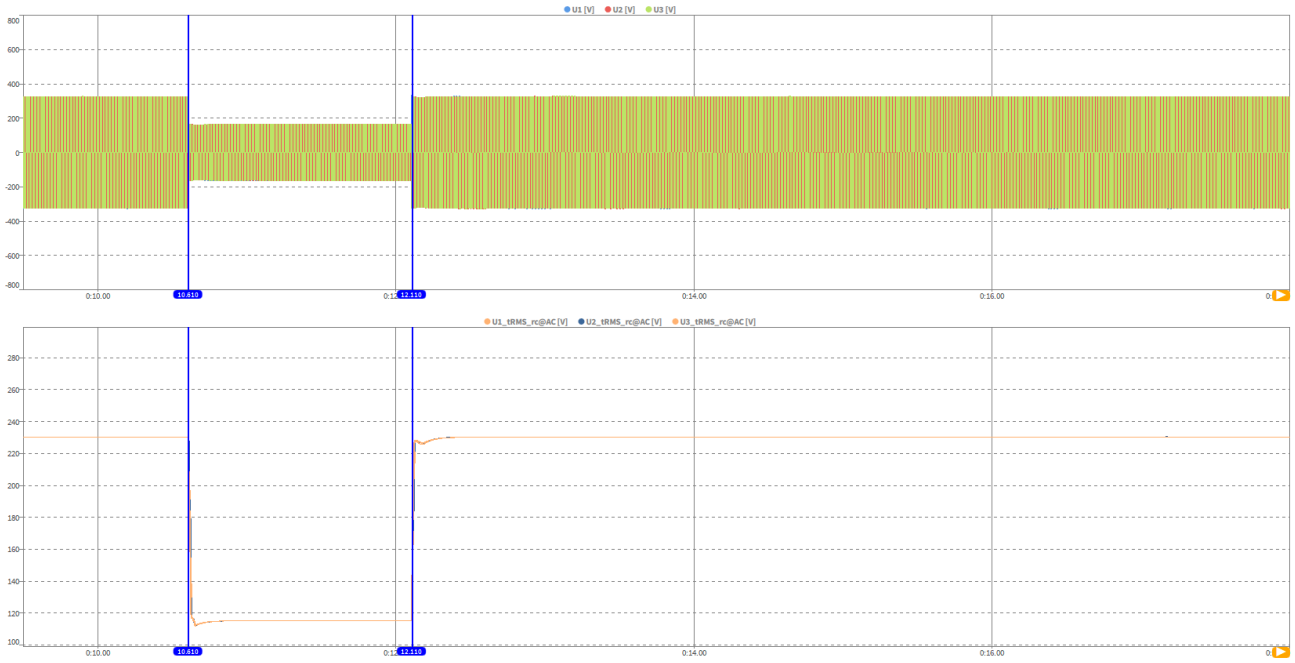


5.8.3	For PGUs Type 2 and storage systems – no load	P
	1.5	

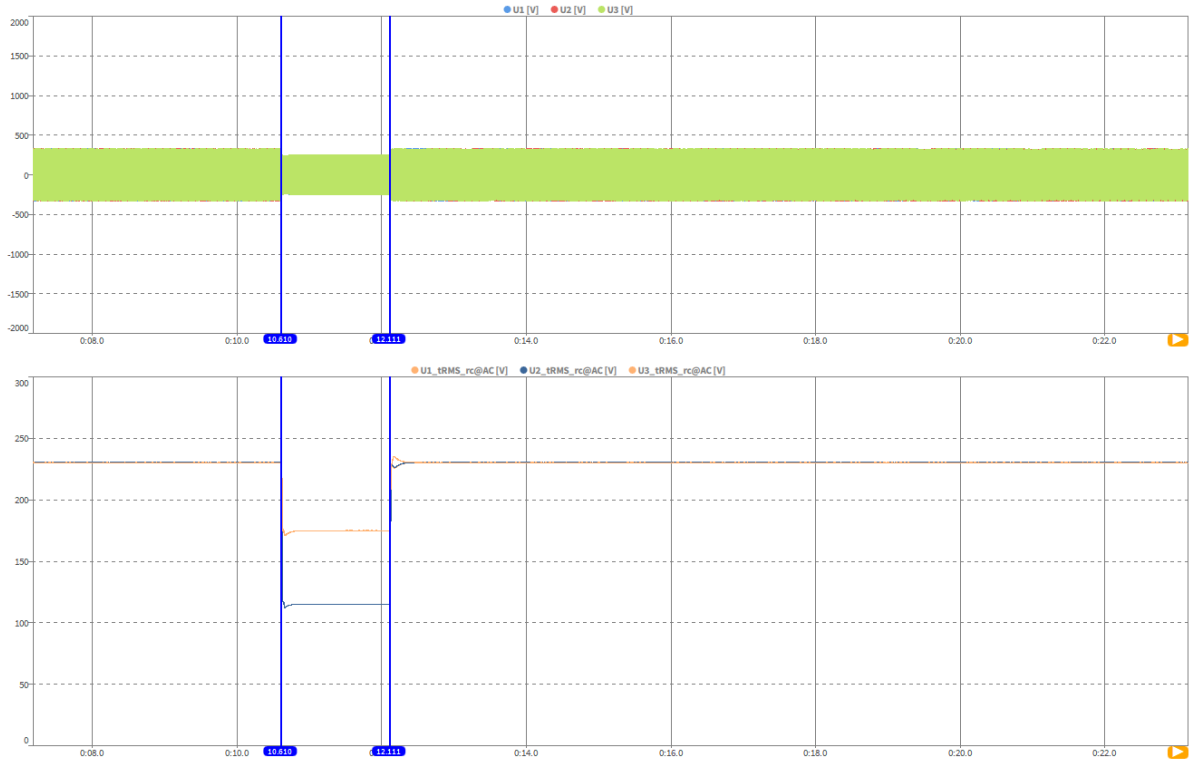


5.8.3	For PGUs Type 2 and storage systems – no load	P

2.1

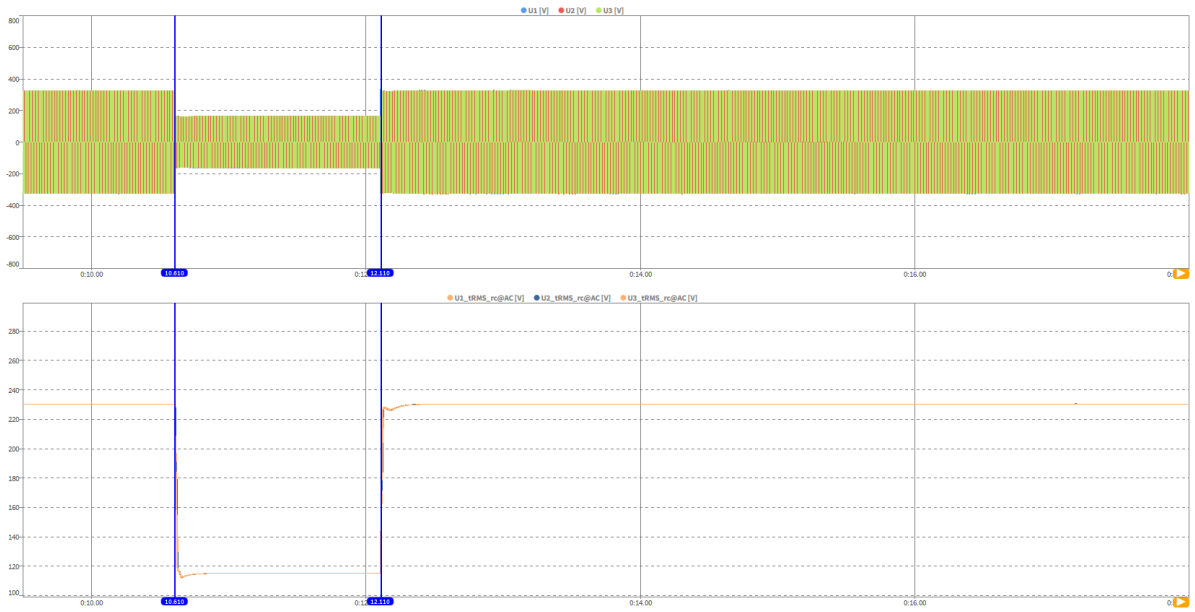


2.3

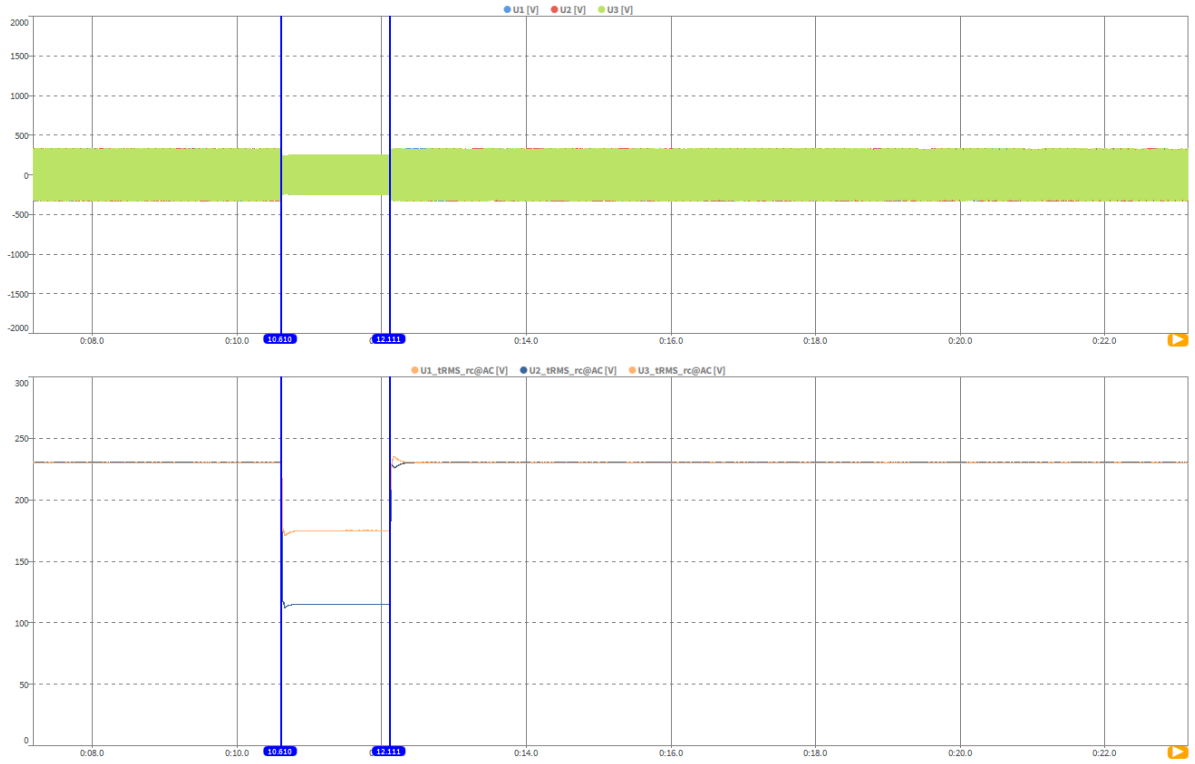


5.8.3	For PGUs Type 2 and storage systems – no load	P

3.1

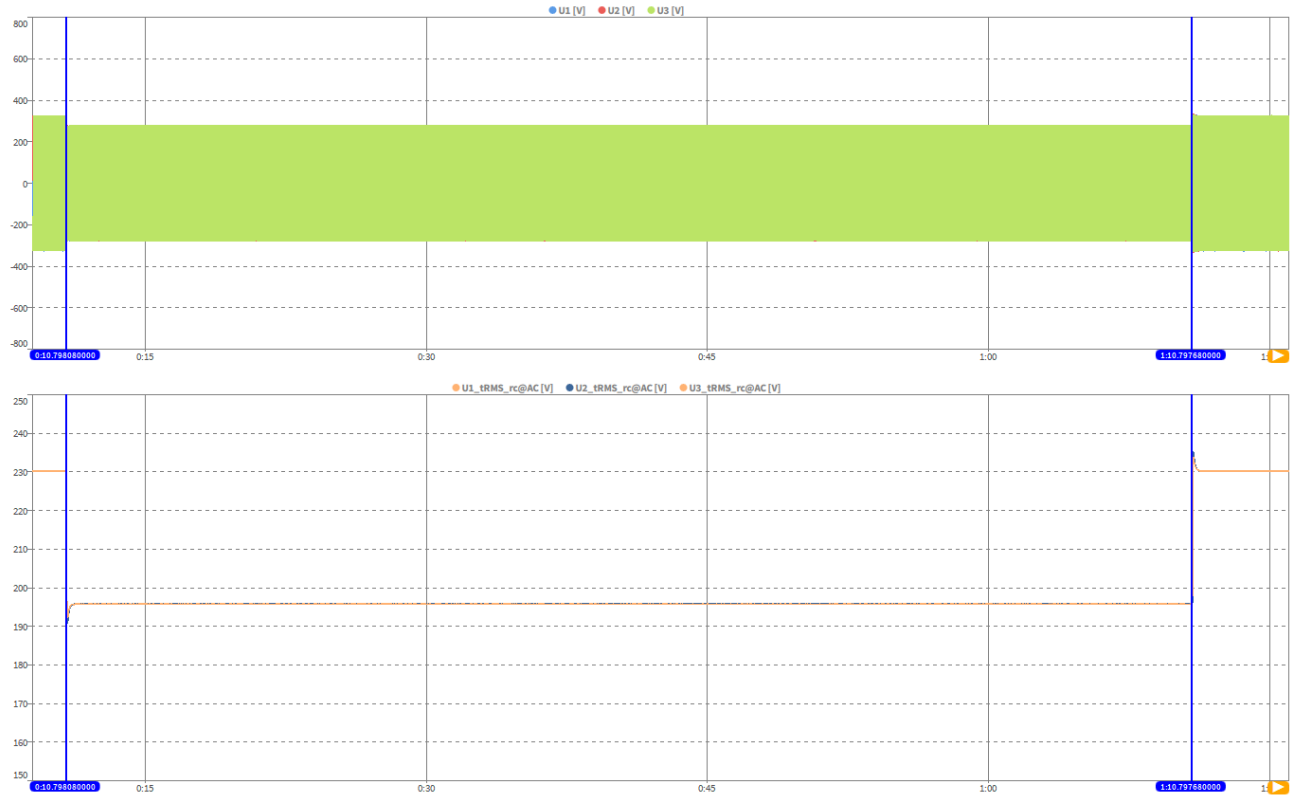


3.3

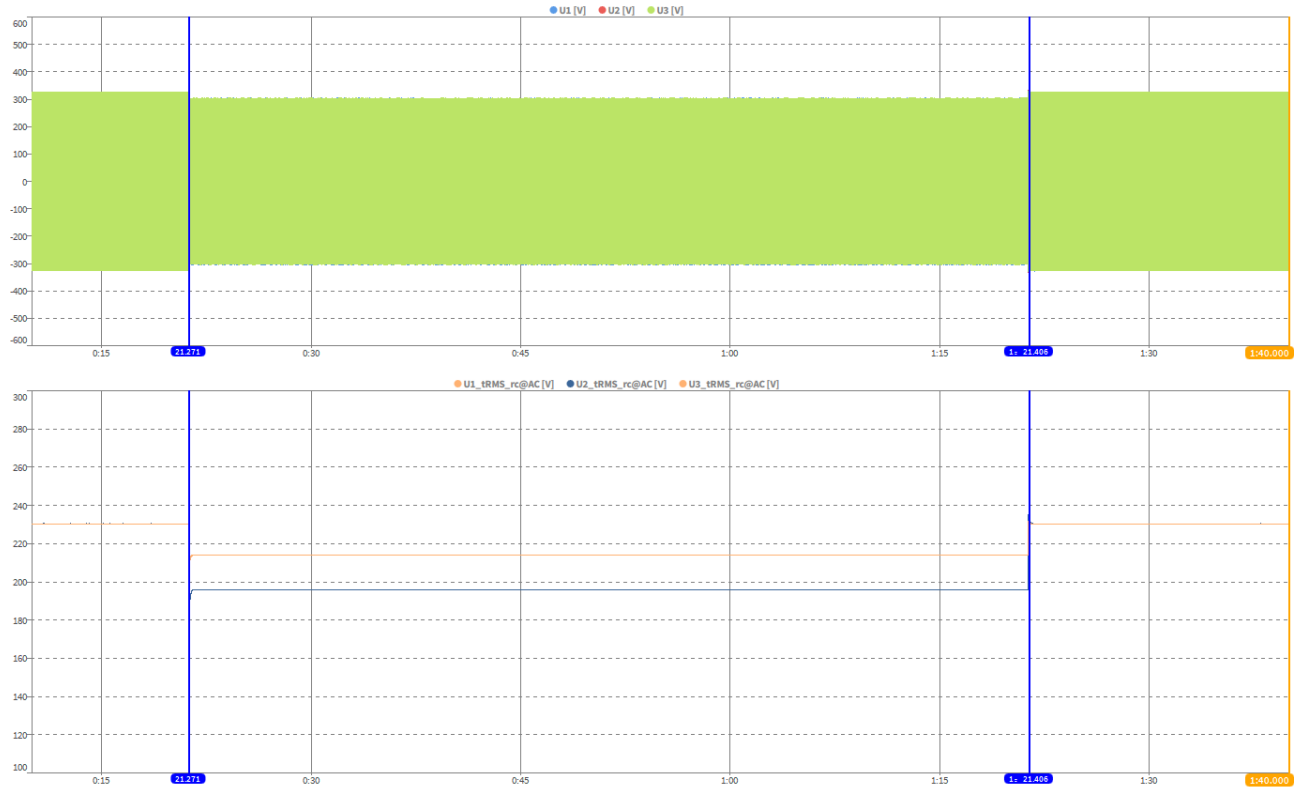


5.8.3	For PGUs Type 2 and storage systems – no load	P

4.1

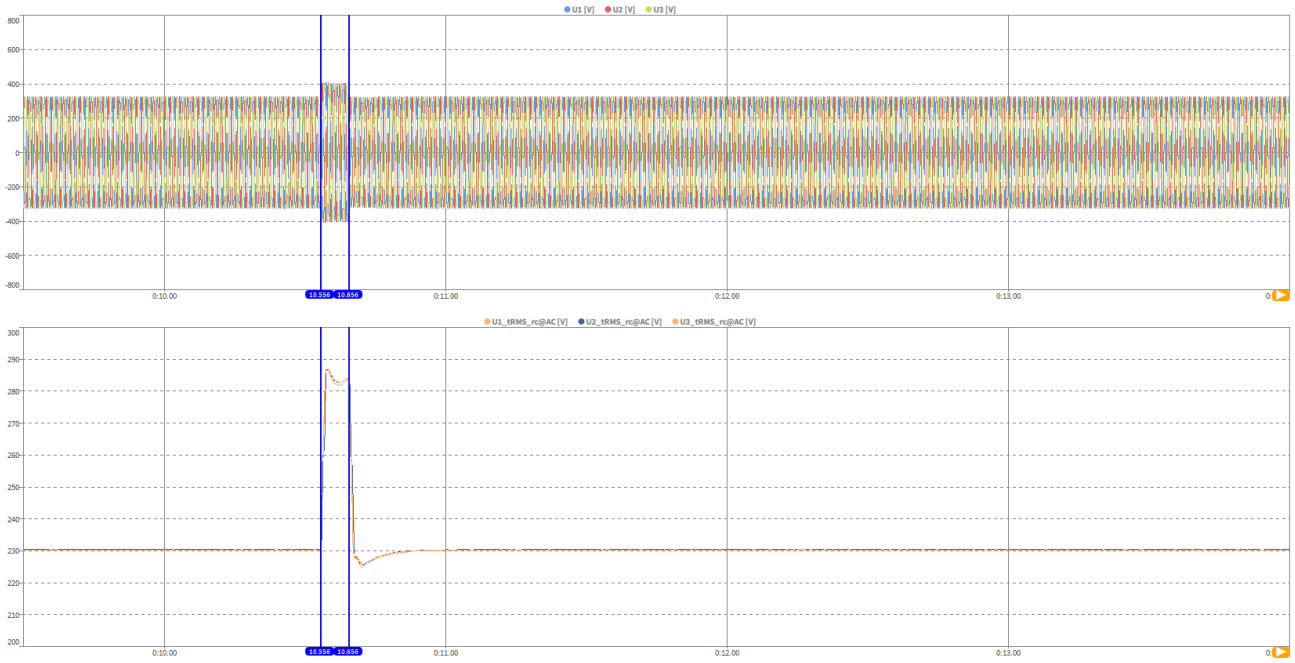


4.3

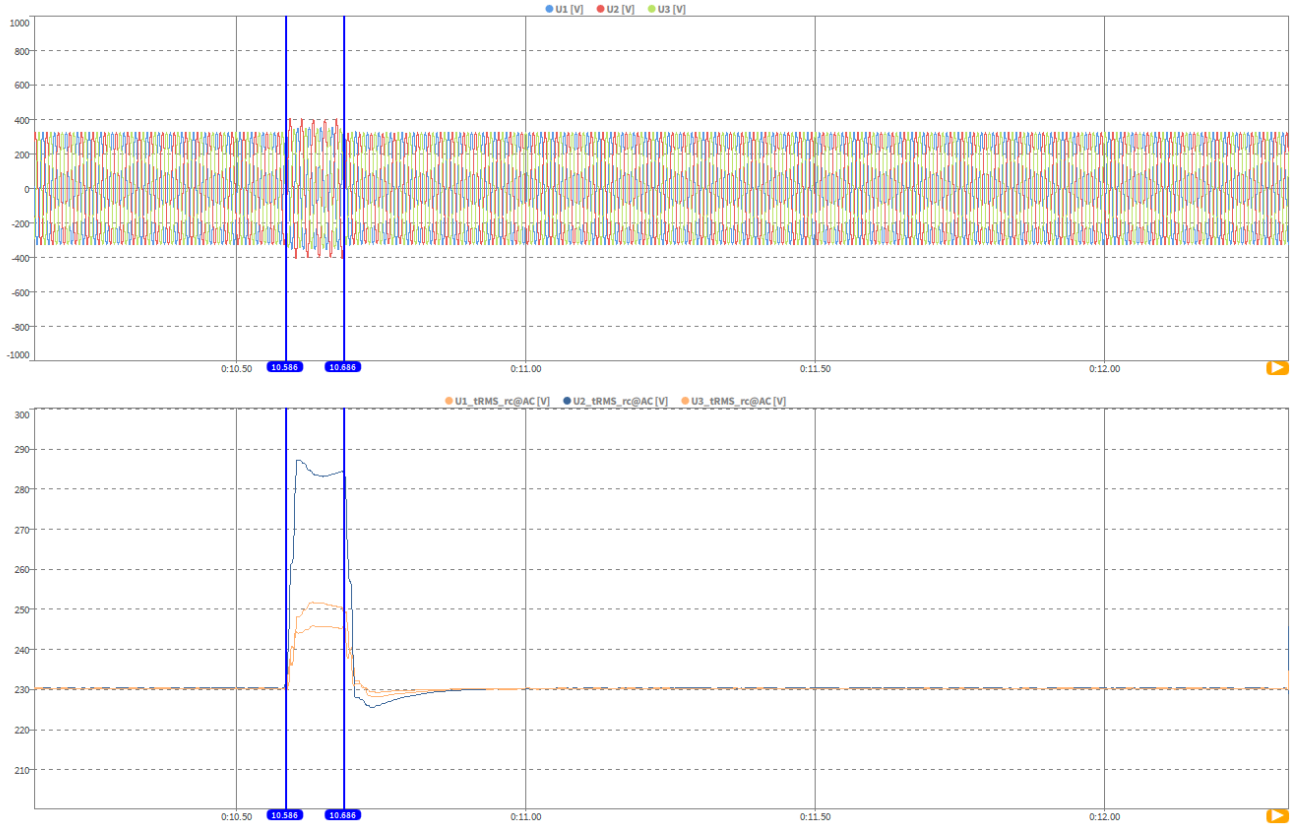


5.8.3	For PGUs Type 2 and storage systems – no load	P

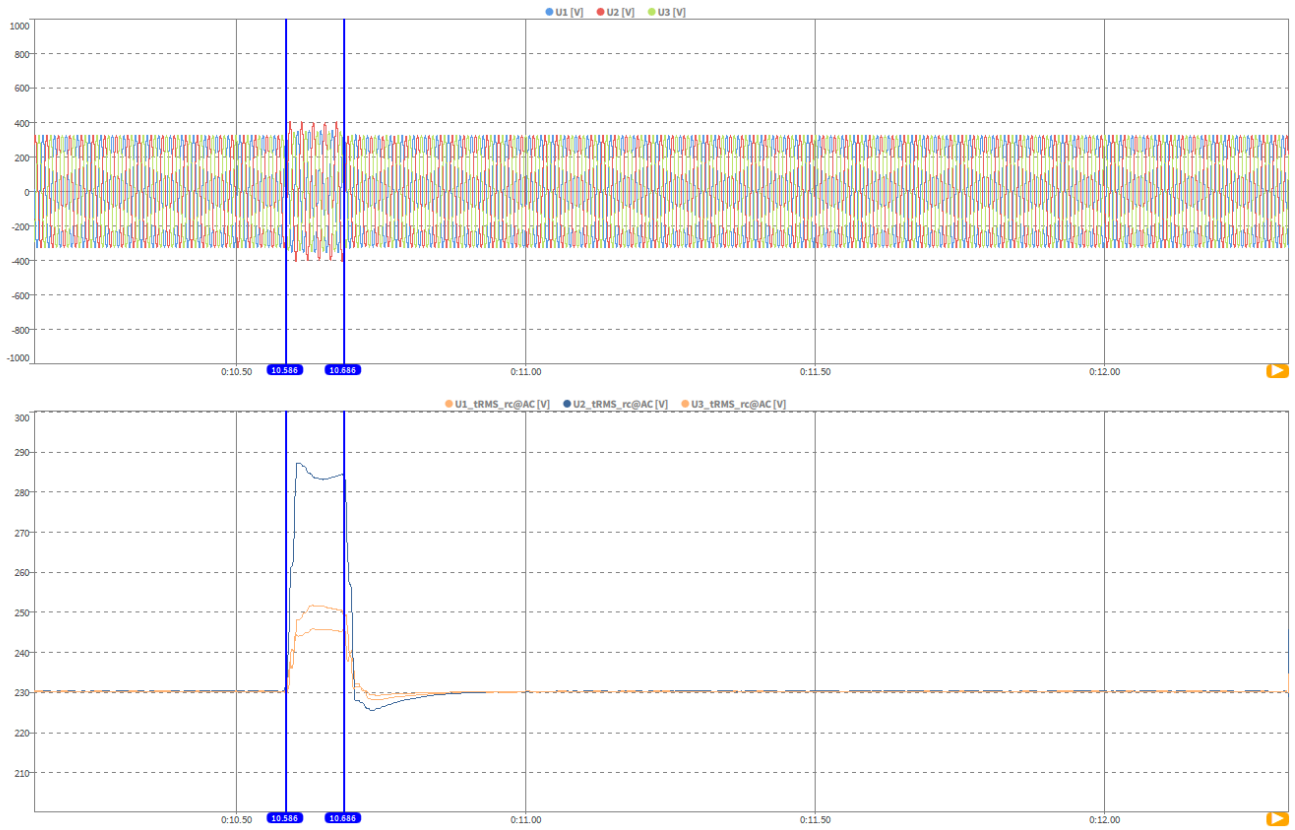
5.1



5.3

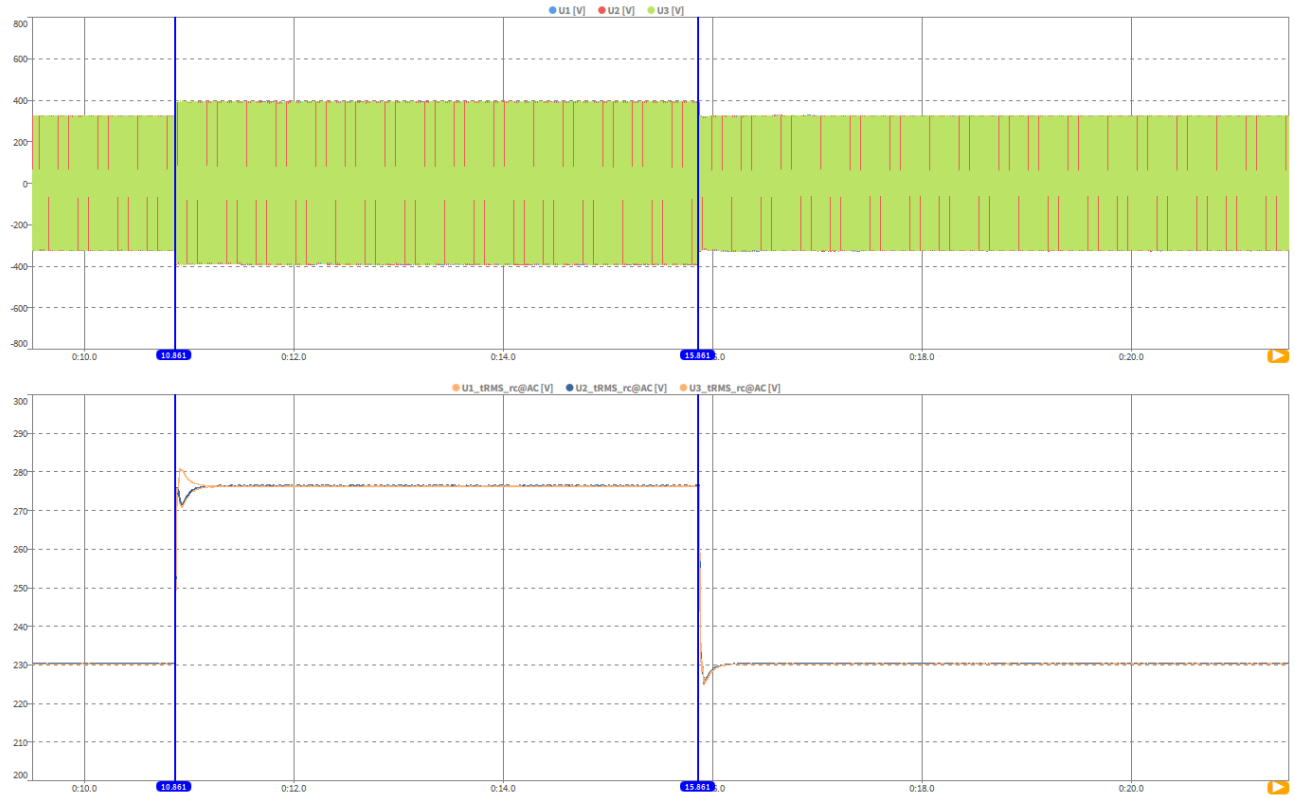


5.8.3	For PGUs Type 2 and storage systems – no load	P
	5.5	

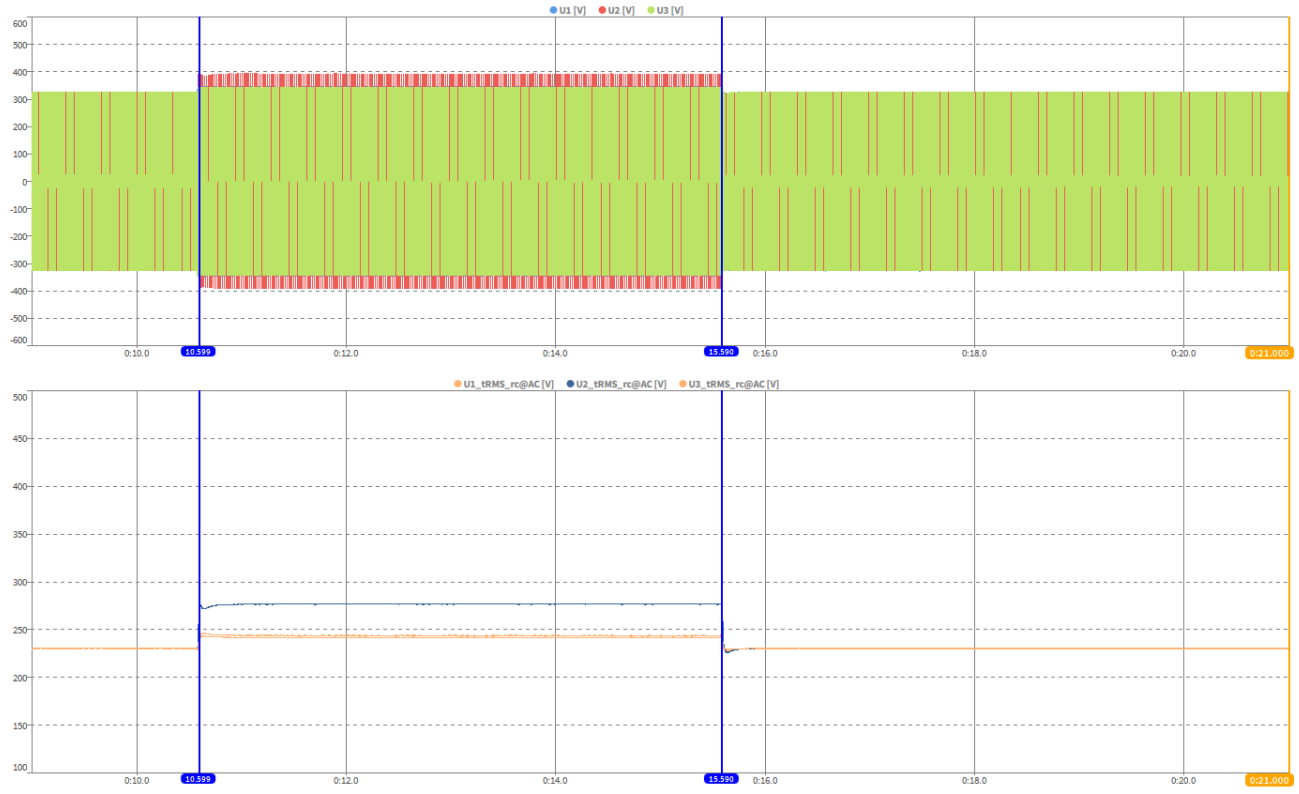


5.8.3	For PGUs Type 2 and storage systems – no load	P

6.1

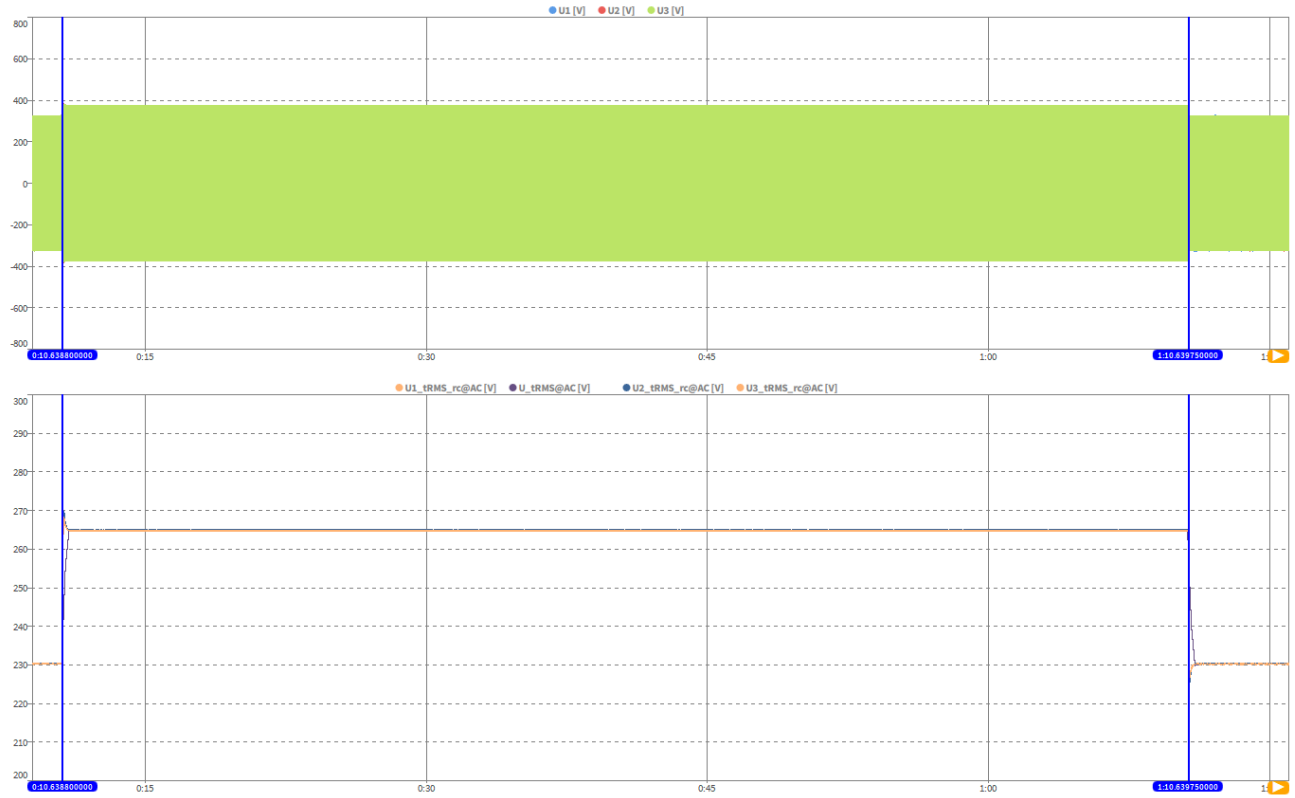


6.3

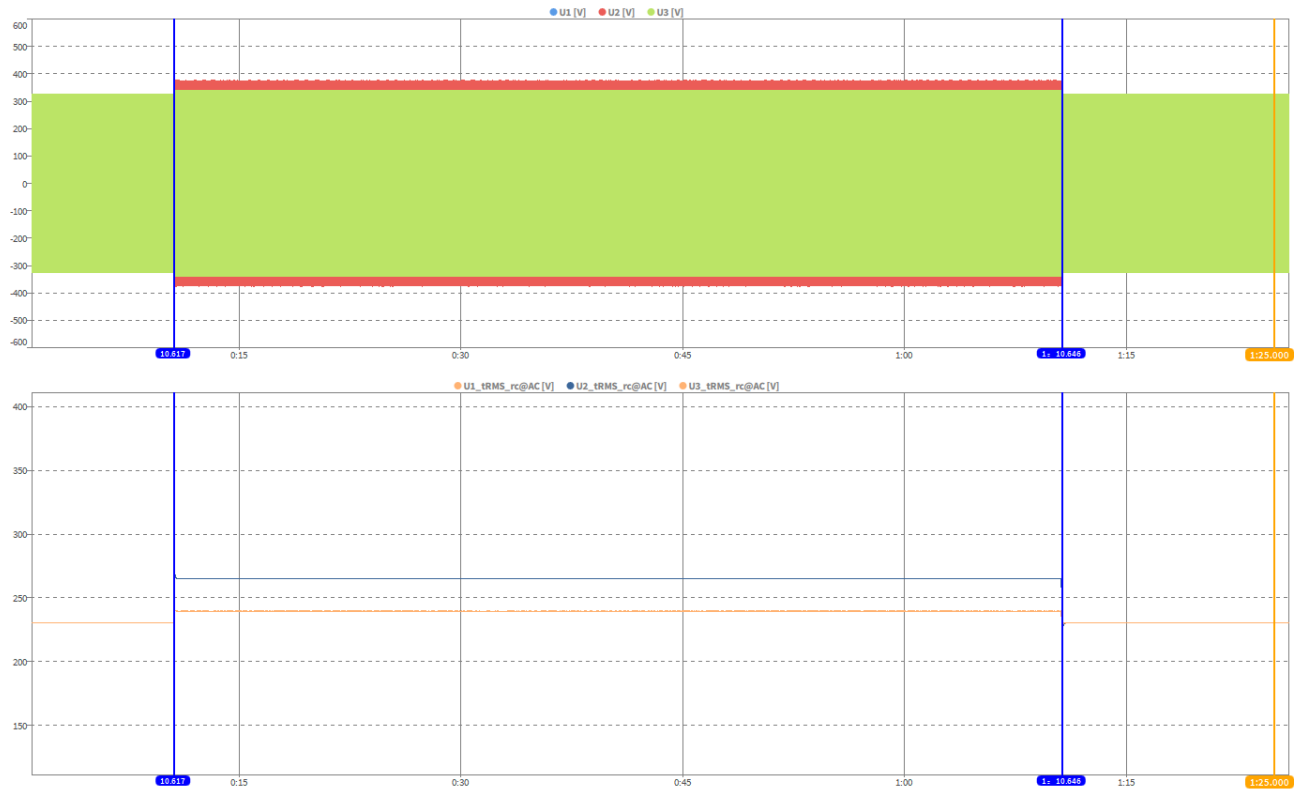


5.8.3	For PGUs Type 2 and storage systems – no load	P

7.1



7.3

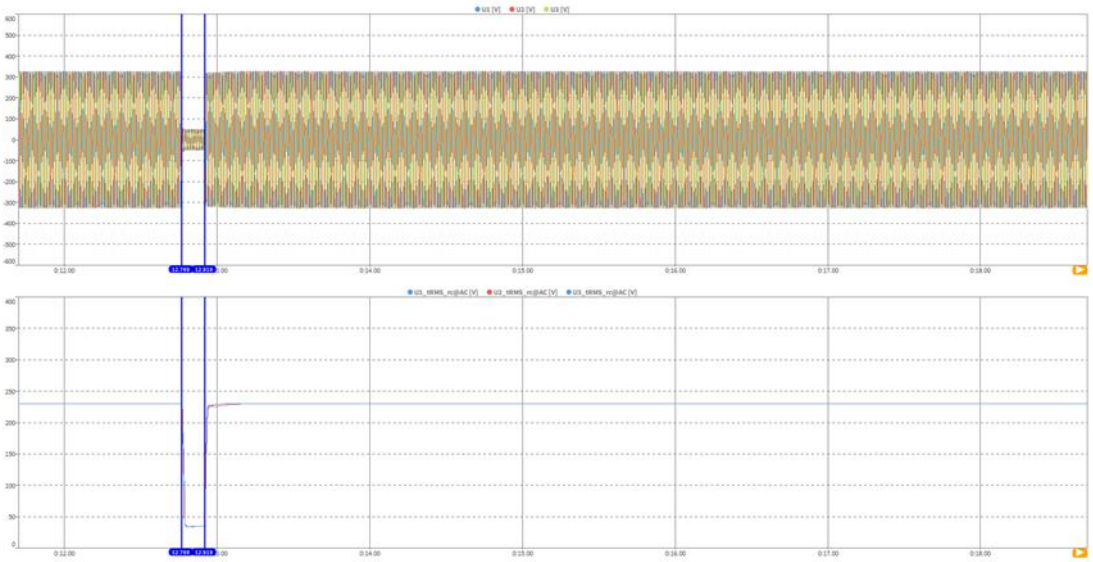


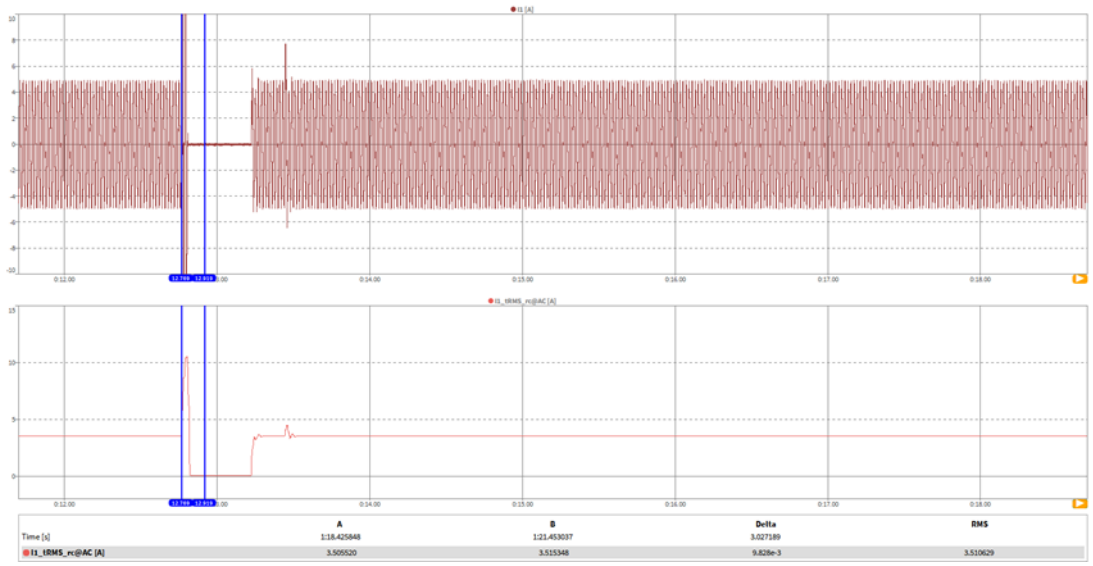
5.8.3	For PGUs Type 2 and storage systems	P

1.1

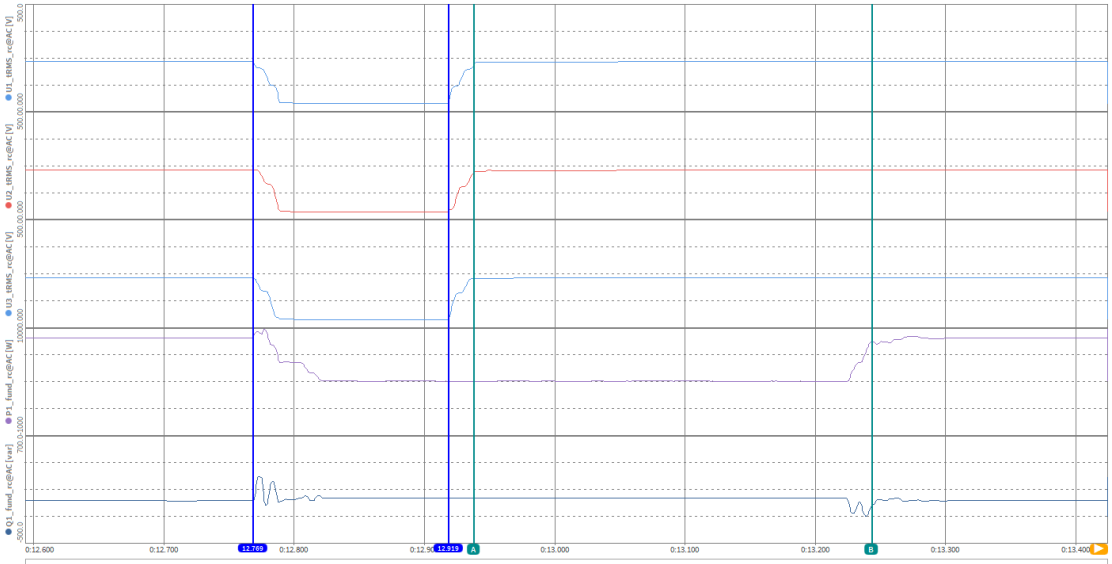
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.1
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	16:50:22
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
		Point of fault entry	Total	--	ms	10752
	7	Point of fault clearance	Total	--	ms	10902
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,150
	10		Phase 2			0,149
	11		Phase 3			0,150
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,009
	17	Active power	Total	t1-10s to t1	p.u.	1,004
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,041
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,993
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,150
	23		Phase 2			0,150
	24		Phase 3			0,150
	25	Line current	Phase 1	t1+60ms	p.u.	0,012
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,012
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,002
	34		Phase 2			1,000
	35		Phase 3			1,001
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,004
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,305
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,041
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



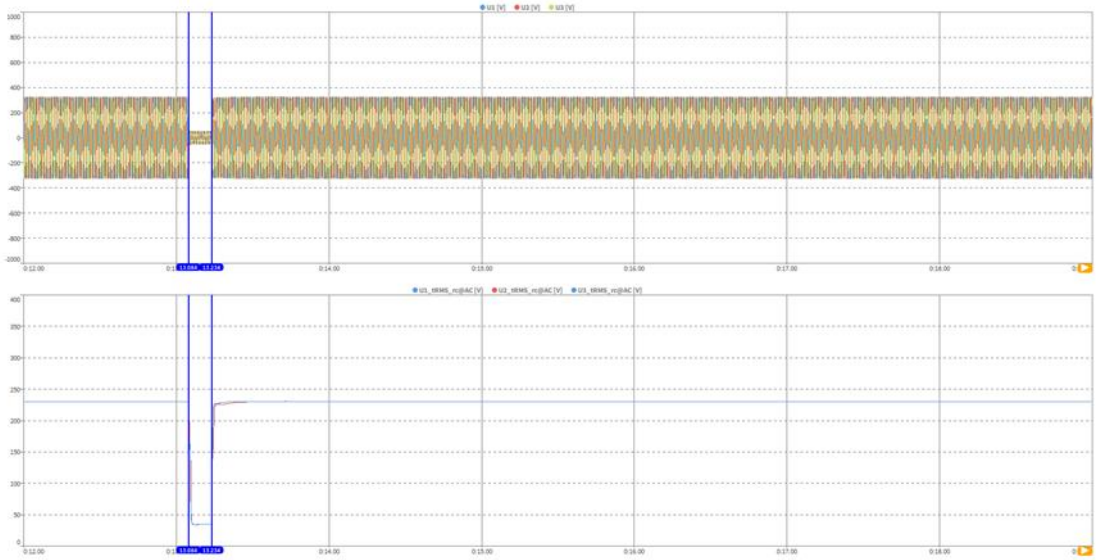
	A	B	Delta	RMS
Time [s]	0:12.9382	0:13.2433	0.3051	
U1_tRMS_rc@AC [V]	199.2547	230.5706	31.31592	228.1537
U2_tRMS_rc@AC [V]	202.7428	229.9084	27.16554	227.9862
U3_tRMS_rc@AC [V]	224.3104	230.2686	5.958160	229.4871
P1_fund_rc@AC [W]	-0.999144	727.2840	728.2831	103.3506
Q1_fund_rc@AC [var]	-0.302213	-106.1359	-105.8337	33.50817

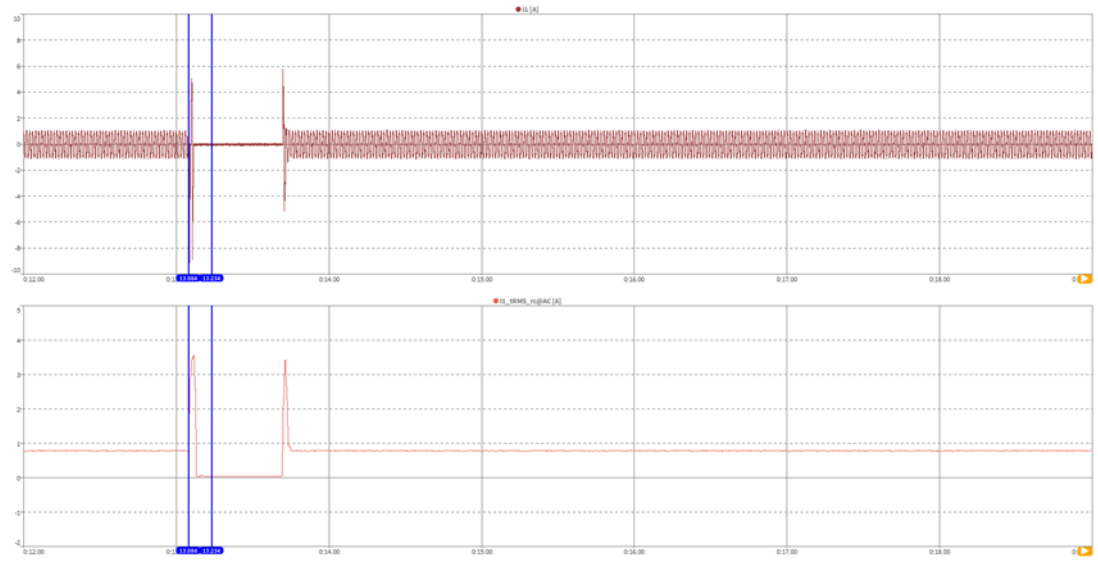
5.8.3	For PGUs Type 2 and storage systems	P

1.2

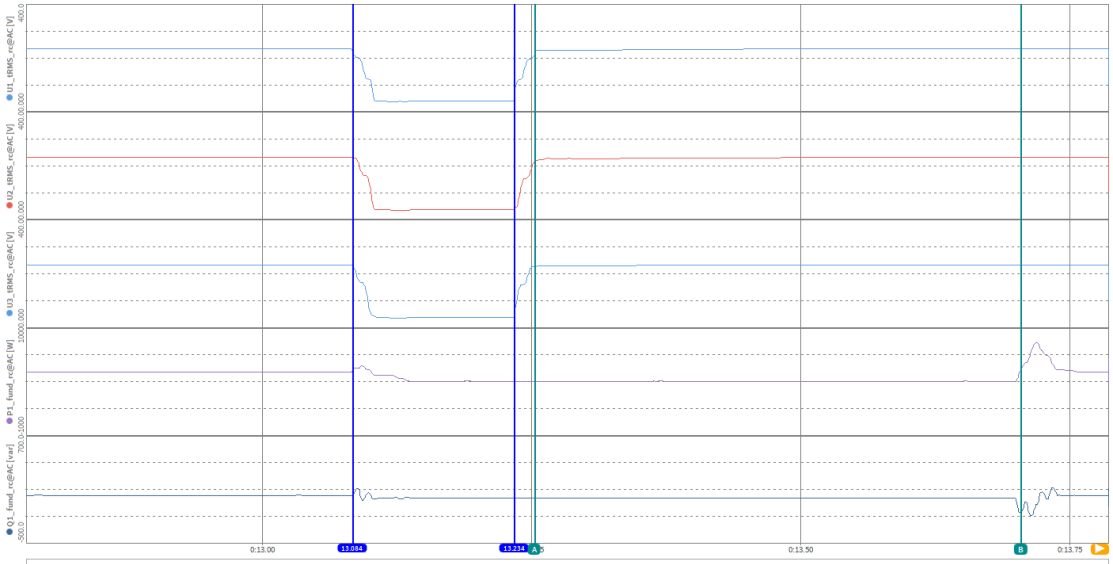
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.2
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	16:57:58
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
		Point of fault entry	Total	--	ms	10752
	7	Point of fault clearance	Total	--	ms	10902
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,150
	10		Phase 2			0,149
	11		Phase 3			0,150
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,224
	17	Active power	Total	t1-10s to t1	p.u.	0,220
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,049
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,976
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,150
	23		Phase 2			0,150
	24		Phase 3			0,150
	25	Line current	Phase 1	t1+60ms	p.u.	0,014
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,014
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,000
	35		Phase 3			1,001
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,220
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,452
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,039
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



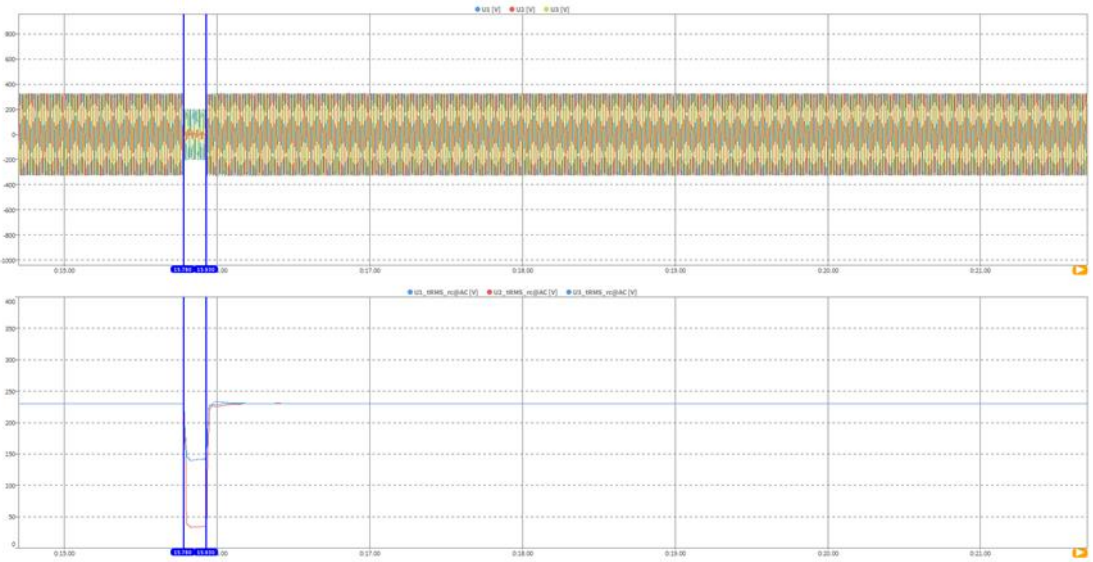
	A	B	Delta	RMS
Time [s]	0:13.2531	0:13.7048	0.4516	
U1_tRMS_rc@AC [V]	200.1980	230.4141	30.21608	228.8367
U2_tRMS_rc@AC [V]	203.8275	229.9776	26.15004	228.6398
U3_tRMS_rc@AC [V]	224.5347	230.2247	5.689987	229.7755
P1_fund_rc@AC [W]	-0.269031	191.1866	191.4556	11.66841
Q1_fund_rc@AC [var]	0.348094	-165.2573	-165.6054	11.77960

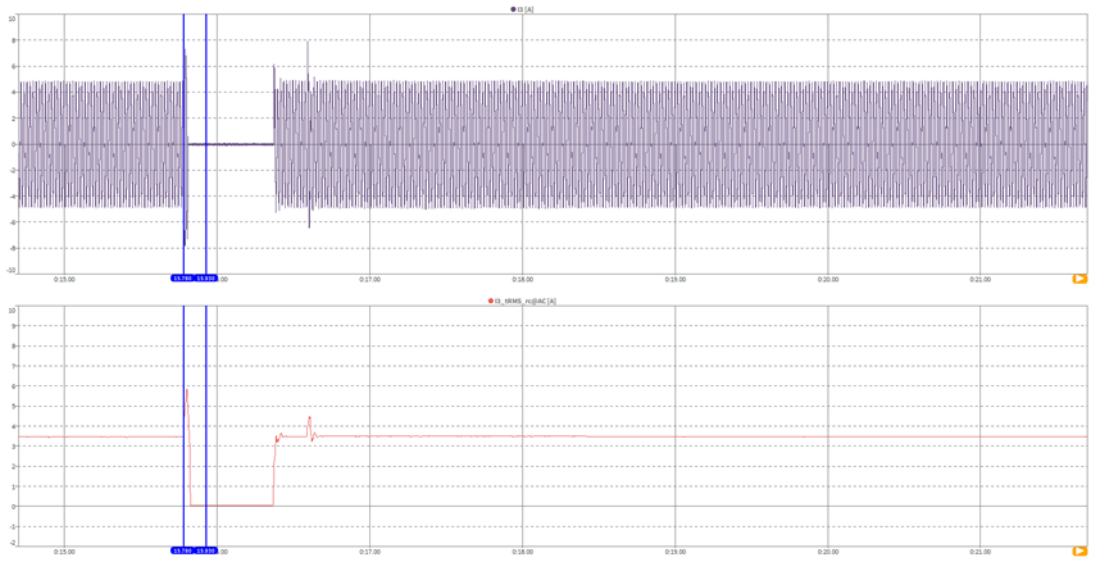
5.8.3	For PGUs Type 2 and storage systems	P

1.3

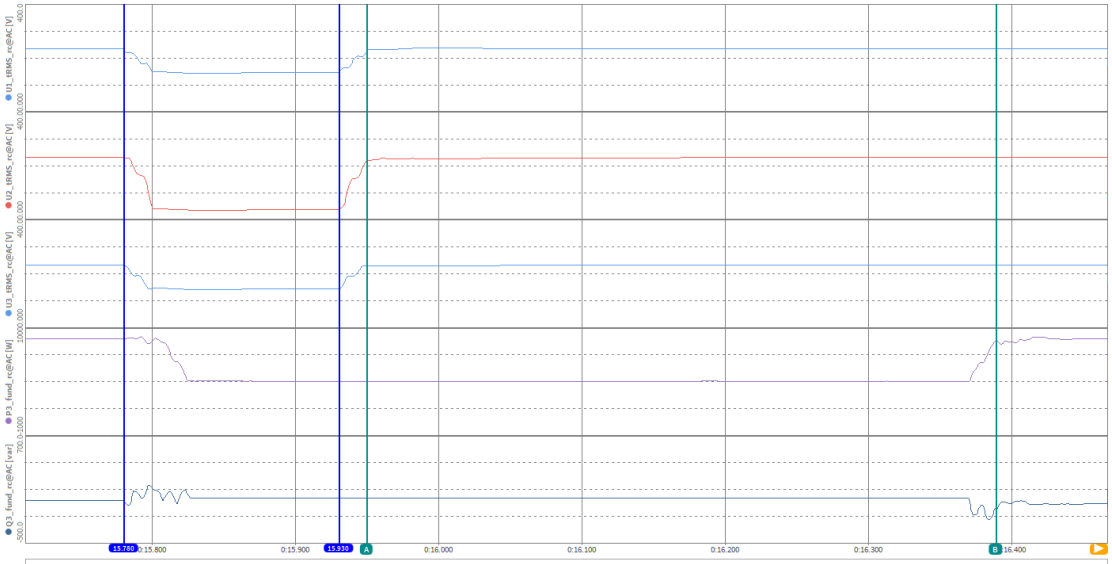
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.3
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	18:18:34
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
		Point of fault entry	Total	--	ms	10723
	7	Point of fault clearance	Total	--	ms	10873
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,617
	10		Phase 2			0,150
	11		Phase 3			0,616
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,995
	17	Active power	Total	t1-10s to t1	p.u.	0,989
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,039
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,993
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,617
	23		Phase 2			0,149
	24		Phase 3			0,615
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,011
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,011
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,000
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,991
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,439
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,040
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



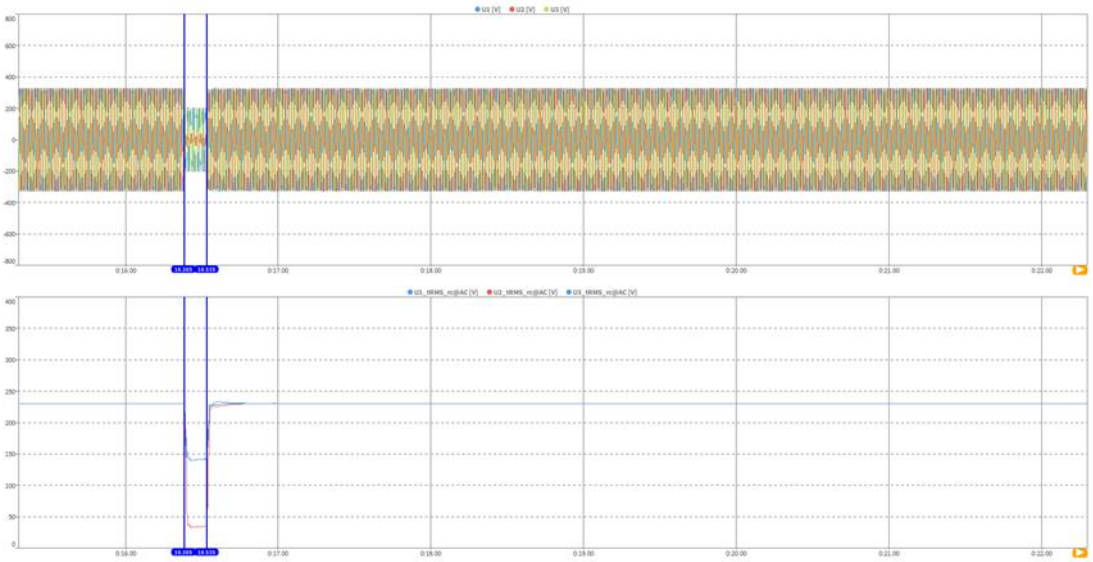
	A	B	Delta	RMS
Time [s]	0:15.950085	0:16.388897	0.438813	
U1_tRMS_rc@AC [V]	211.1418	230.3307	19.18896	230.8505
U2_tRMS_rc@AC [V]	207.8117	230.0288	22.21707	228.6528
U3_tRMS_rc@AC [V]	228.8898	230.7087	1.818985	229.9370
P3_fund_rc@AC [W]	-1.336256	733.9003	735.2365	87.59733
Q3_fund_rc@AC [var]	0.334037	-135.2020	-135.5360	33.61888

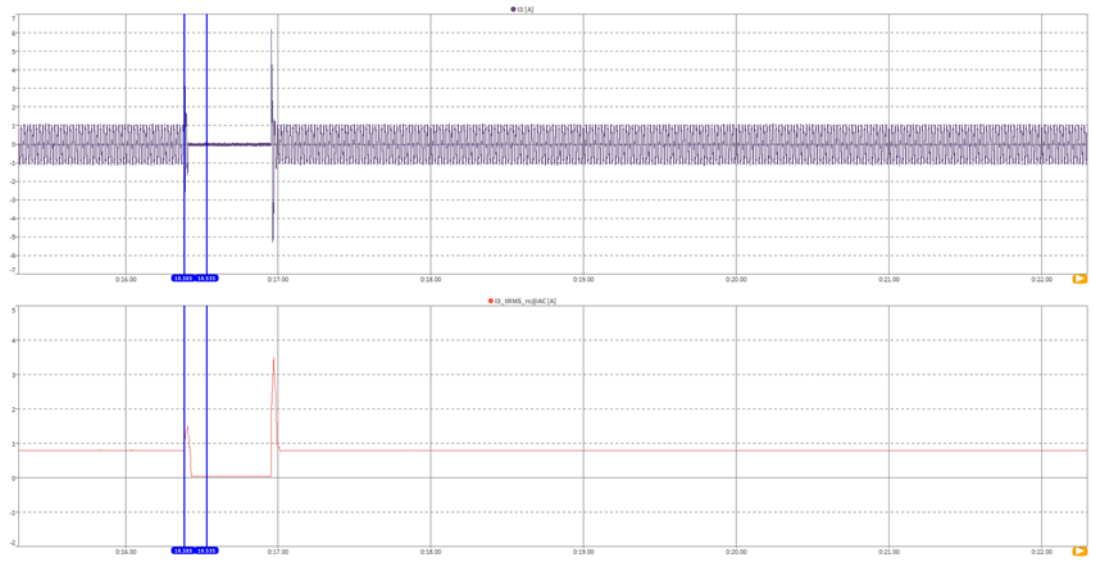
5.8.3	For PGUs Type 2 and storage systems	P

1.4

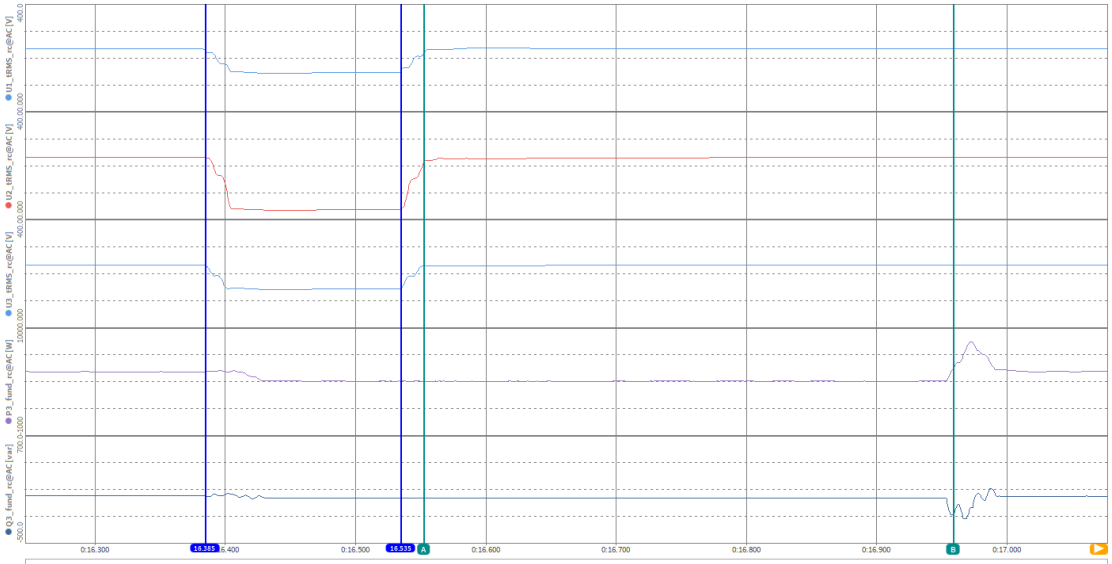
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.4
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	18:21:42
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
		Point of fault entry	Total	--	ms	10723
	7	Point of fault clearance	Total	--	ms	10873
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,615
	10		Phase 2			0,149
	11		Phase 3			0,615
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,227
	17	Active power	Total	t1-10s to t1	p.u.	0,222
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,050
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,976
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,617
	23		Phase 2			0,149
	24		Phase 3			0,616
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,012
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,010
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,000
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,221
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,406
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,038
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



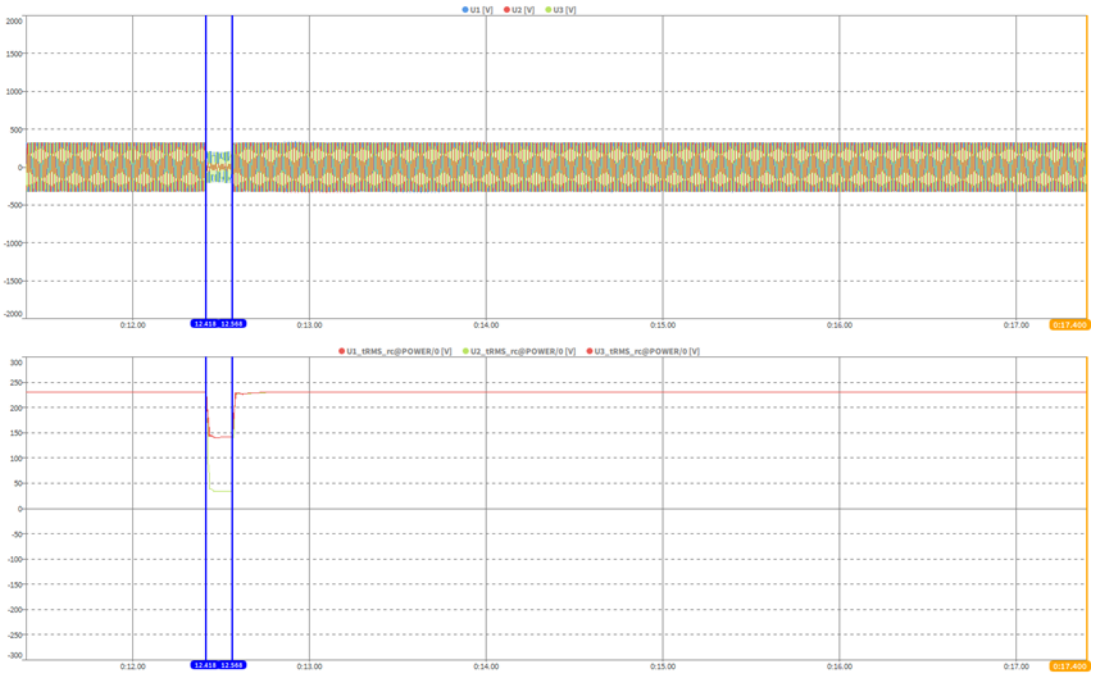
	A	B	Delta	RMS
Time [s]	0:16.552770	0:16.958788	0.406019	
U1_tRMS_rc@AC [V]	206.2031	230.3422	24.13916	230.8529
U2_tRMS_rc@AC [V]	197.2924	230.0392	32.74677	228.4642
U3_tRMS_rc@AC [V]	228.4255	230.4855	2.060013	229.8960
P3_fund_rc@AC [W]	-0.297054	206.7345	207.0315	13.82901
Q3_fund_rc@AC [var]	-0.261678	-187.7548	-187.4931	14.90996

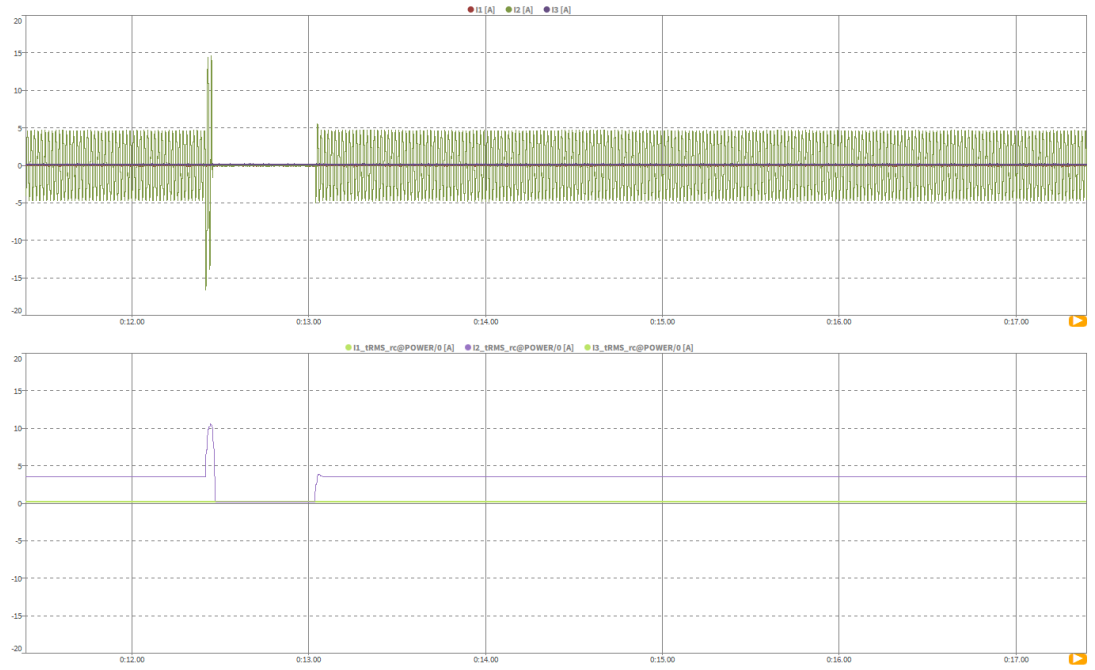
5.8.3	For PGUs Type 2 and storage systems	P

1.5

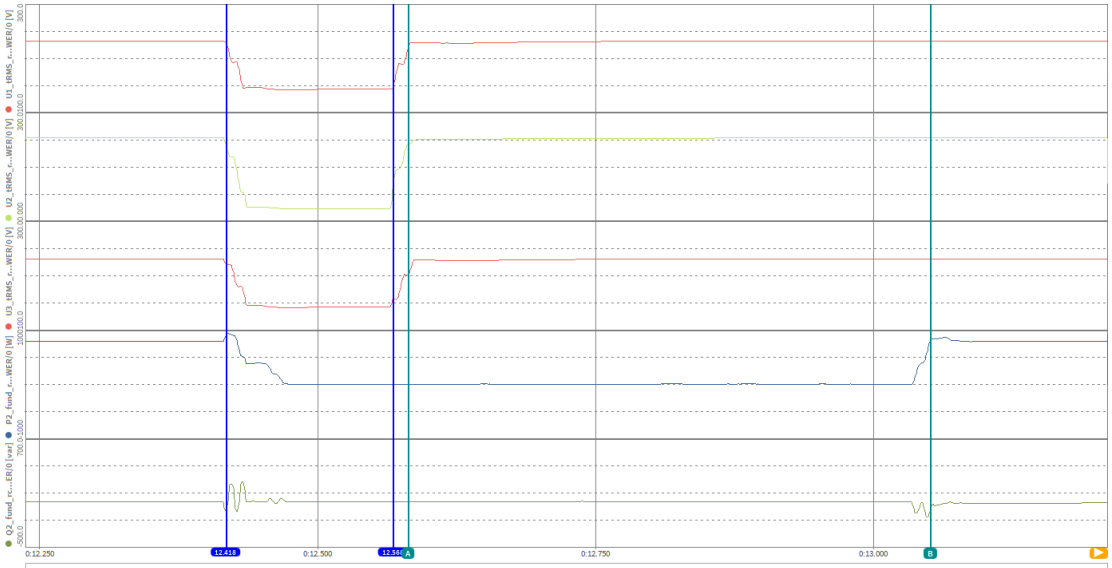
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.5
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	20:39:57
	3	Fault type (phase)	--	--	--	D2
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
		Point of fault entry	Total	--	ms	10723
	7	Point of fault clearance	Total	--	ms	10873
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,615
	10		Phase 2			0,149
	11		Phase 3			0,615
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,003
	17	Active power	Total	t1-10s to t1	p.u.	0,986
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,007
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,992
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,615
	23		Phase 2			0,149
	24		Phase 3			0,616
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			0,015
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			0,013
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,984
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,469
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,002
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



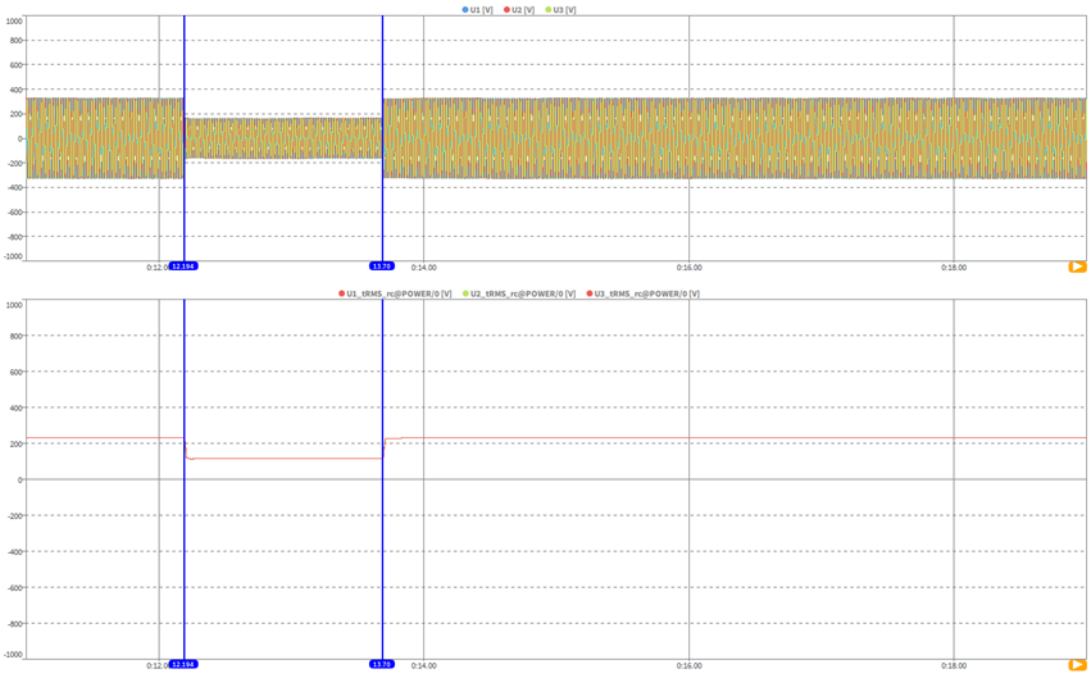
	A	B	Delta	RMS
Time [s]	0:12.58200	0:13.05106	0.46906	
U1_tRMS_rc@POWER/0 [V]	210.4090	230.3866	19.97755	229.3015
U2_tRMS_rc@POWER/0 [V]	209.7872	230.4750	20.68782	229.0485
U3_tRMS_rc@POWER/0 [V]	200.3168	230.4998	30.18295	229.4548
P2_fund_rc@POWER/0 [W]	-2.197510	769.3231	771.5206	79.36136
Q2_fund_rc@POWER/0 [var]	0.612690	-129.7978	-130.4105	19.26540

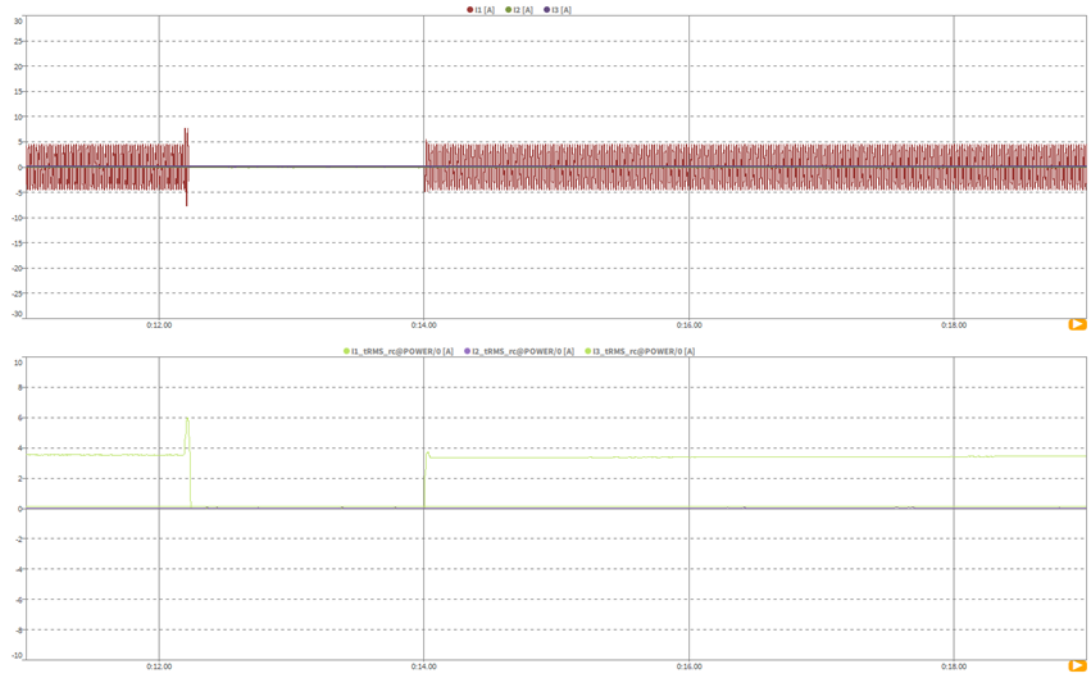
5.8.3	For PGUs Type 2 and storage systems	P

2.1

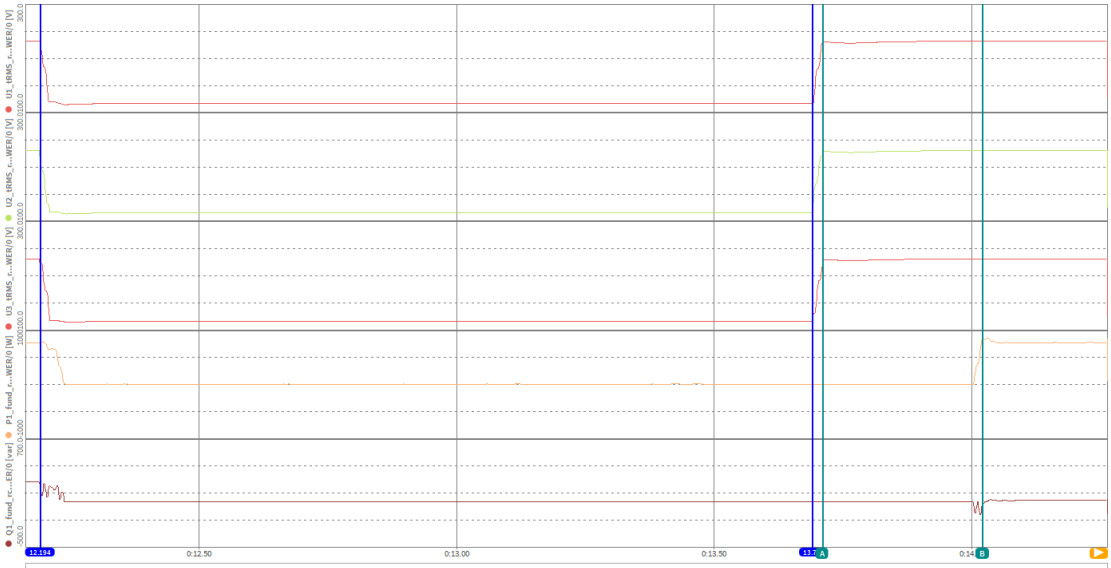
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.1
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	20:28:21
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12110
	8	Fault duration in empty load test	Total	--	ms	1500
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,500
	10		Phase 2			0,501
	11		Phase 3			0,501
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,016
	17	Active power	Total	t1-10s to t1	p.u.	0,947
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,278
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,959
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,501
	23		Phase 2			0,500
	24		Phase 3			0,501
	25	Line current	Phase 1	t1+60ms	p.u.	0,014
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,014
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,000
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,951
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,311
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,227
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,553
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

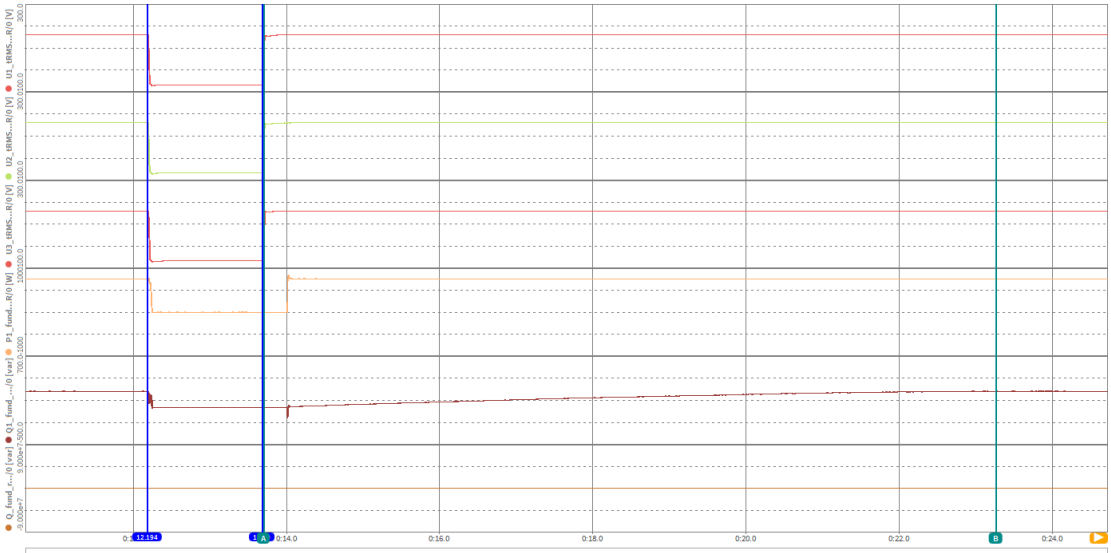




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:13.70975	0:14.02082	0.31106	
U1_tRMS_rc@POWER/0 [V]	217.6321	230.5588	12.92673	228.8222
U2_tRMS_rc@POWER/0 [V]	218.7587	230.0698	11.31105	228.7166
U3_tRMS_rc@POWER/0 [V]	198.1494	230.4428	32.29338	229.0197
P1_fund_rc@POWER/0 [W]	-1.081199	782.0694	783.1506	100.6725
Q1_fund_rc@POWER/0 [var]	0.775205	-87.60325	-88.37845	21.22545



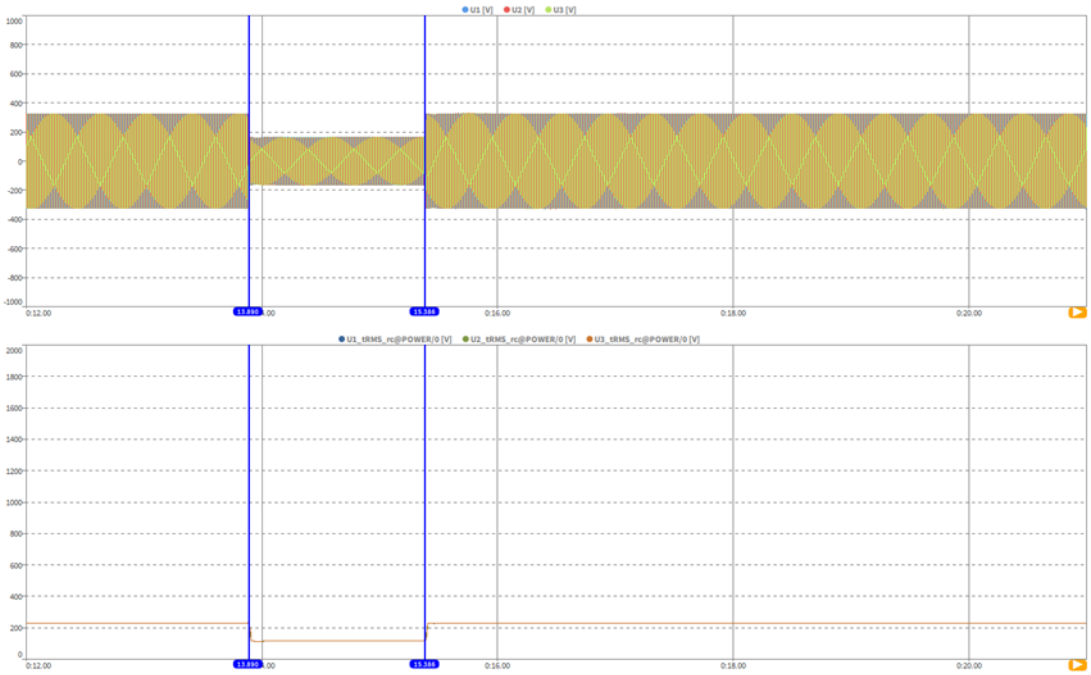
	A	B	Delta	RMS
Time [s]	0:13.70975	0:23.26319	9.55344	
U1_tRMS_rc@POWER/0 [V]	217.6321	230.3229	12.69078	230.2856
U2_tRMS_rc@POWER/0 [V]	218.7587	230.1012	11.34251	230.0573
U3_tRMS_rc@POWER/0 [V]	198.1494	230.3968	32.24744	230.3702
P1_fund_rc@POWER/0 [W]	-1.081199	755.8768	756.9580	750.9219
Q1_fund_rc@POWER/0 [var]	0.775205	225.7523	224.9771	150.9337
Q_fund_rc@POWER/0 [var]	0.787788	225.6956	224.9078	151.5453

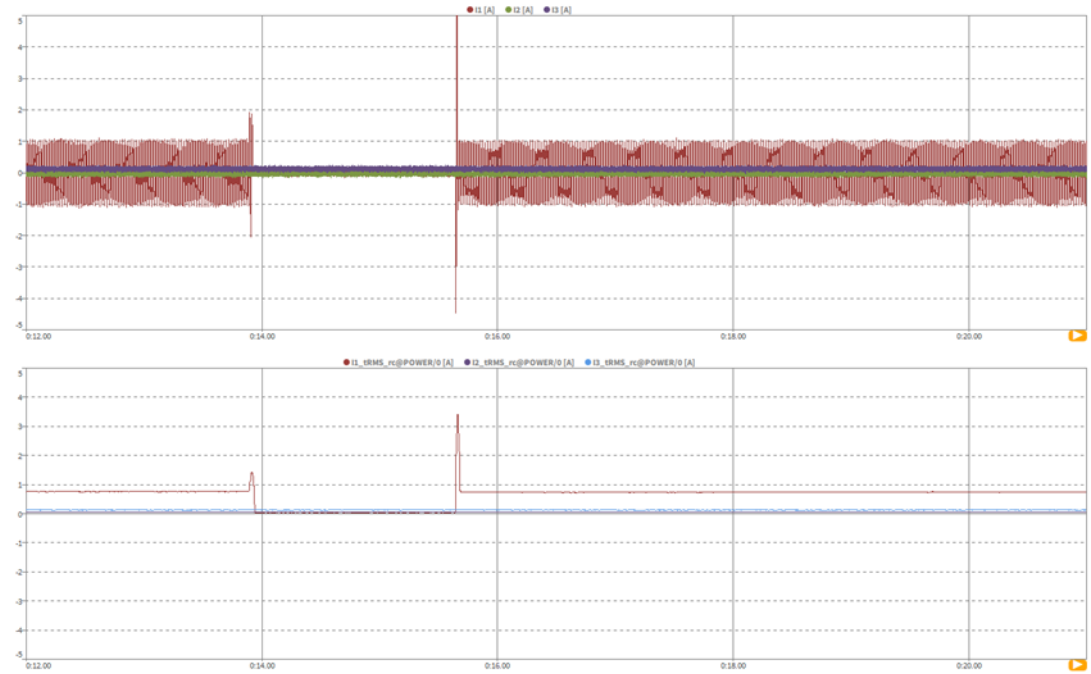
5.8.3	For PGUs Type 2 and storage systems	P

2.2

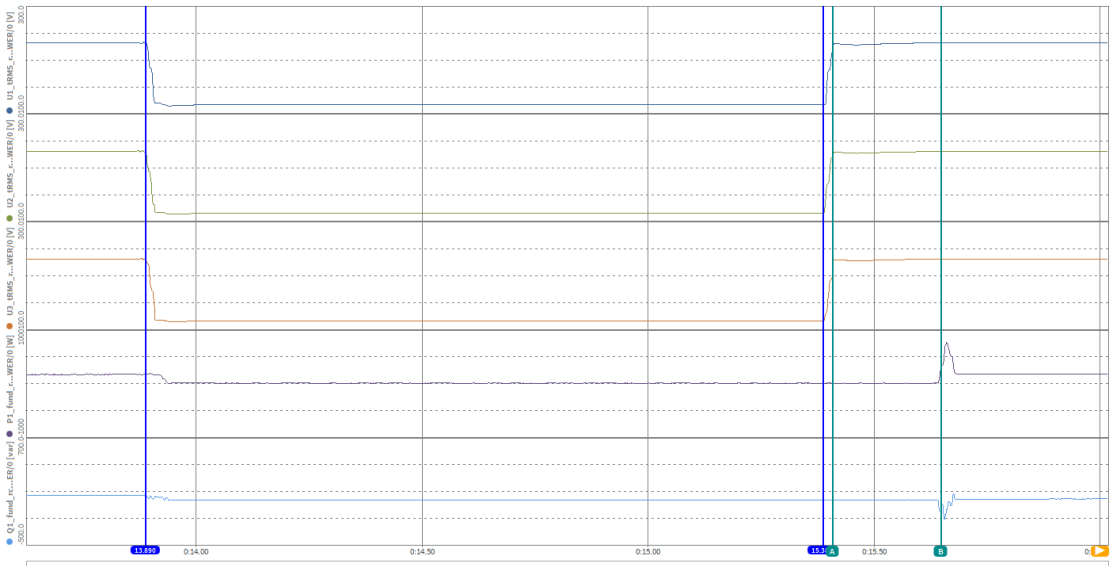
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.2
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	16:18:01
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12110
	8	Fault duration in empty load test	Total	--	ms	1500
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,500
	10		Phase 2			0,501
	11		Phase 3			0,501
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,201
	17	Active power	Total	t1-10s to t1	p.u.	0,203
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,064
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,956
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,501
	23		Phase 2			0,501
	24		Phase 3			0,501
	25	Line current	Phase 1	t1+60ms	p.u.	0,064
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,020
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,204
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,239
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,052
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,712
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

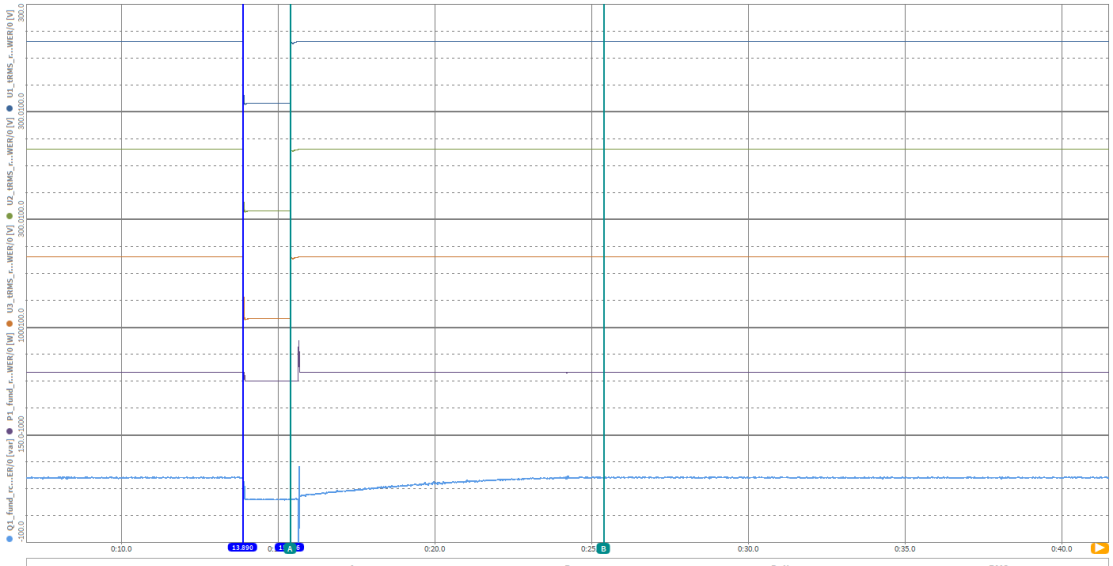




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:15.4087	0:15.6477	0.2390	
U1_tRMS_rc@POWER/0 [V]	212.5949	230.1770	17.58215	228.3826
U2_tRMS_rc@POWER/0 [V]	218.7696	229.9687	11.19914	228.3895
U3_tRMS_rc@POWER/0 [V]	195.0860	230.2371	35.15111	228.5881
P1_fund_rc@POWER/0 [W]	-0.102216	183.3732	183.4754	14.65479
Q1_fund_rc@POWER/0 [var]	-0.402117	-129.6300	-129.2279	12.42001



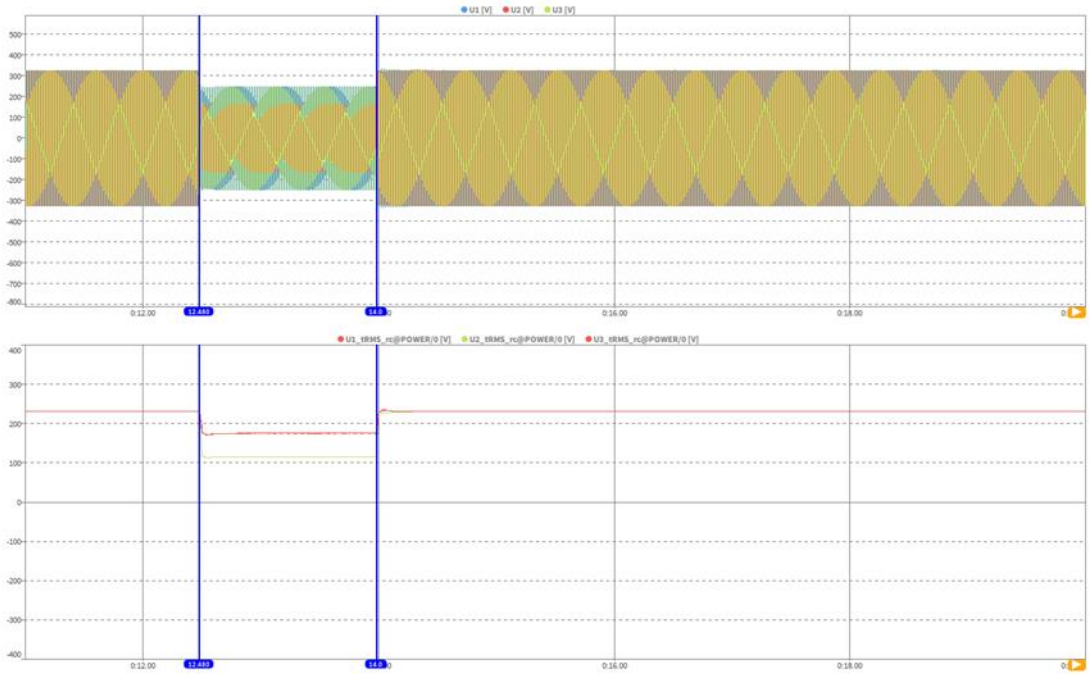
	A	B	Delta	RMS
Time [s]	0:15.4064	0:25.3917	9.9853	
U1_tRMS_rc@POWER/0 [V]	194.1867	230.2949	36.10822	230.2698
U2_tRMS_rc@POWER/0 [V]	213.0975	230.1306	17.03302	230.1341
U3_tRMS_rc@POWER/0 [V]	190.6240	230.5155	39.89148	230.4389
P1_fund_rc@POWER/0 [W]	0.415071	161.8713	161.4562	163.8027
Q1_fund_rc@POWER/0 [var]	-0.263877	51.31908	51.58295	38.99987

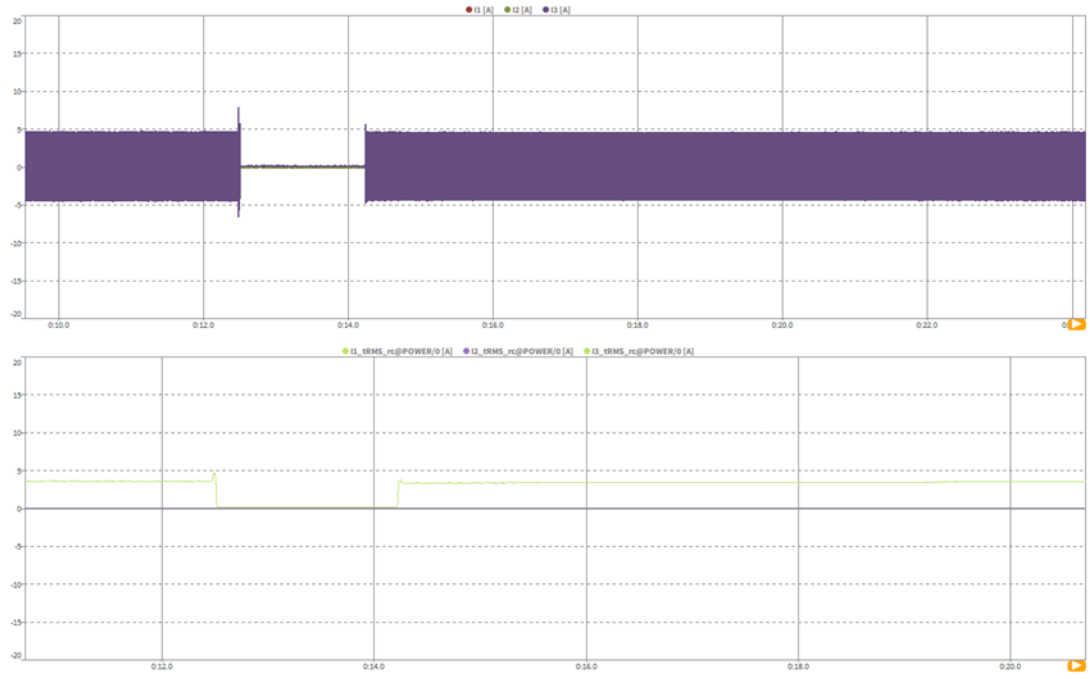
5.8.3	For PGUs Type 2 and storage systems	P

2.3

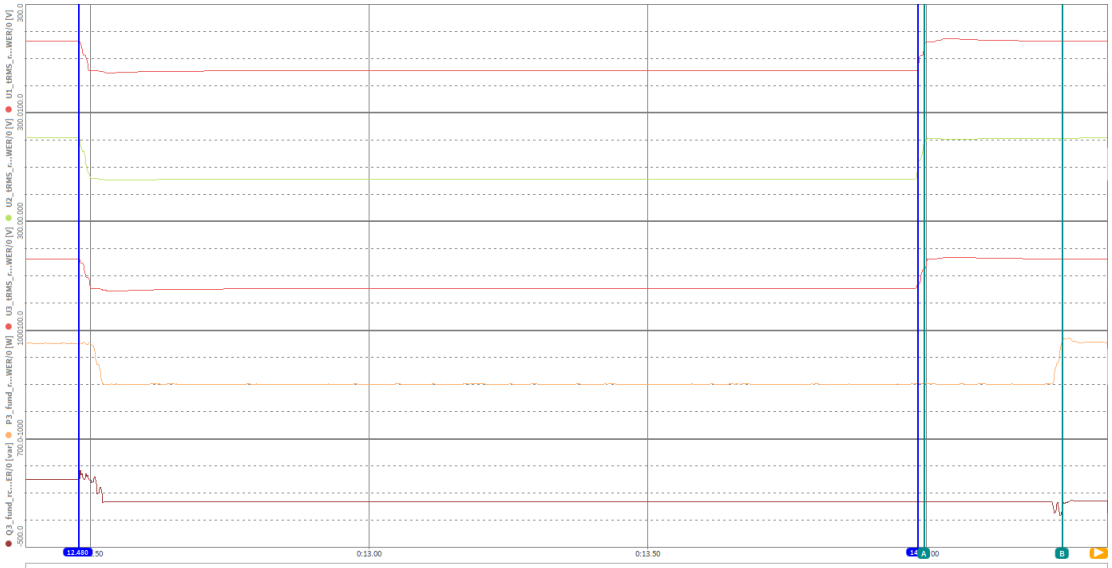
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.3
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:49:37
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12111
	8	Fault duration in empty load test	Total	--	ms	1501
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,760
	10		Phase 2			0,501
	11		Phase 3			0,760
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,001
	17	Active power	Total	t1-10s to t1	p.u.	0,945
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,312
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,950
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,761
	23		Phase 2			0,500
	24		Phase 3			0,761
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,034
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,034
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,951
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,248
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,254
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,598
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

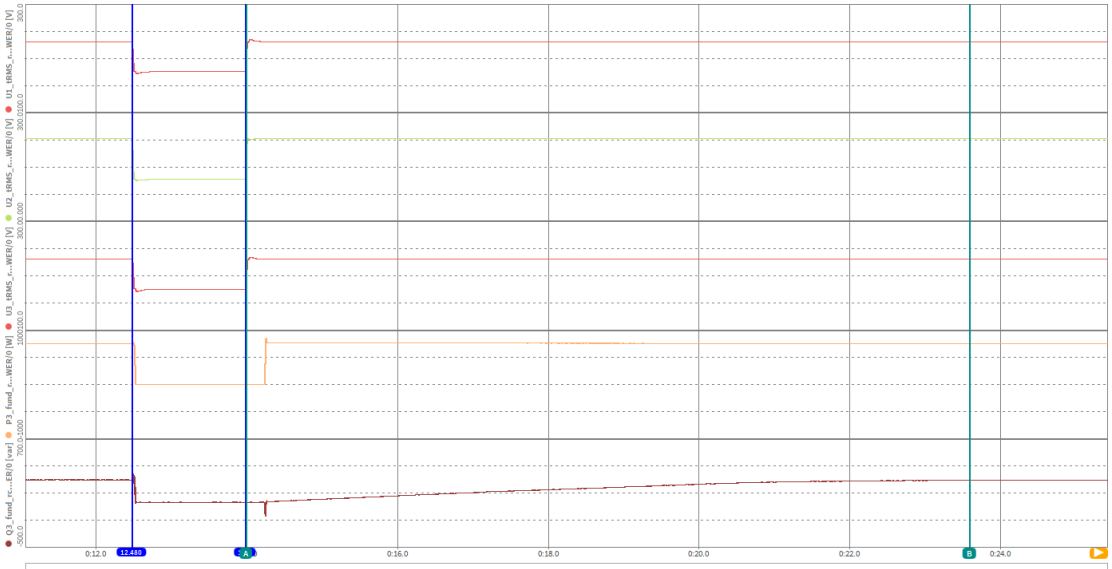




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:13.9956	0:14.2435	0.2479	
U1_tRMS_rc@POWER/0 [V]	207.7198	230.5955	22.87572	231.5920
U2_tRMS_rc@POWER/0 [V]	202.4597	229.9586	27.49899	228.1529
U3_tRMS_rc@POWER/0 [V]	211.5445	230.9346	19.39009	231.2366
P3_fund_rc@POWER/0 [W]	0.529101	775.6749	775.1458	110.9365
Q3_fund_rc@POWER/0 [var]	-0.459714	-109.2094	-108.7497	25.15662



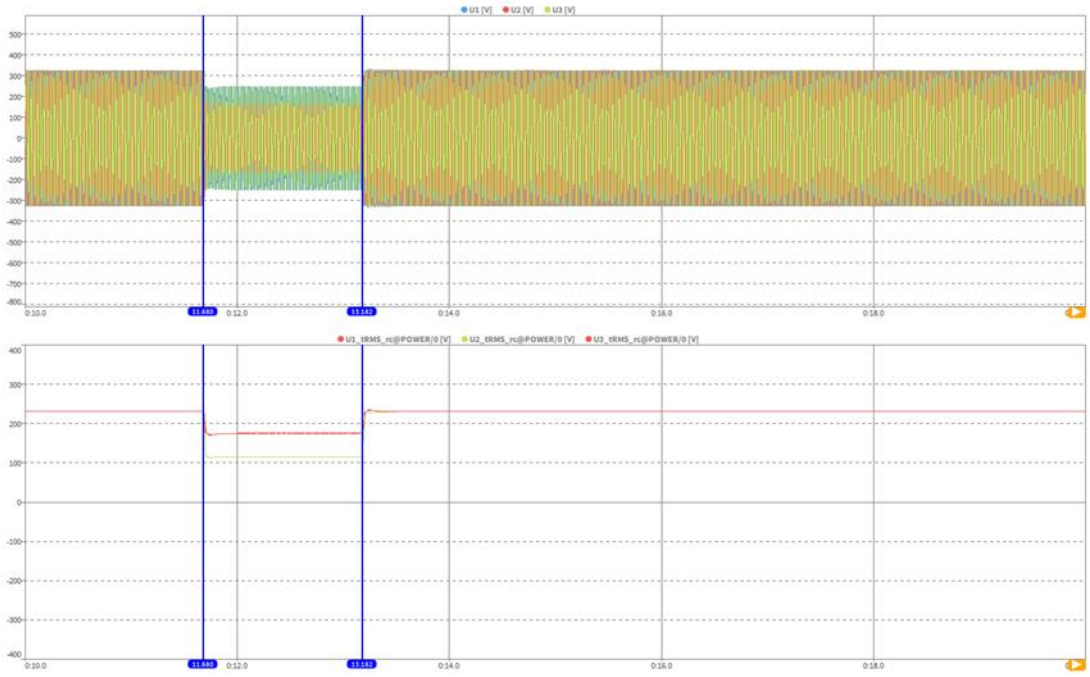
	A	B	Delta	RMS
Time [s]	0:13.9956	0:23.5931	9.5975	
U1_tRMS_rc@POWER/0 [V]	207.7198	230.3710	22.65123	230.3369
U2_tRMS_rc@POWER/0 [V]	202.4597	230.1829	27.72321	230.1029
U3_tRMS_rc@POWER/0 [V]	211.5445	230.4967	18.95227	230.5211
P3_fund_rc@POWER/0 [W]	0.529101	756.2050	755.6759	753.8298
Q3_fund_rc@POWER/0 [var]	-0.459714	243.5547	244.0144	169.3792

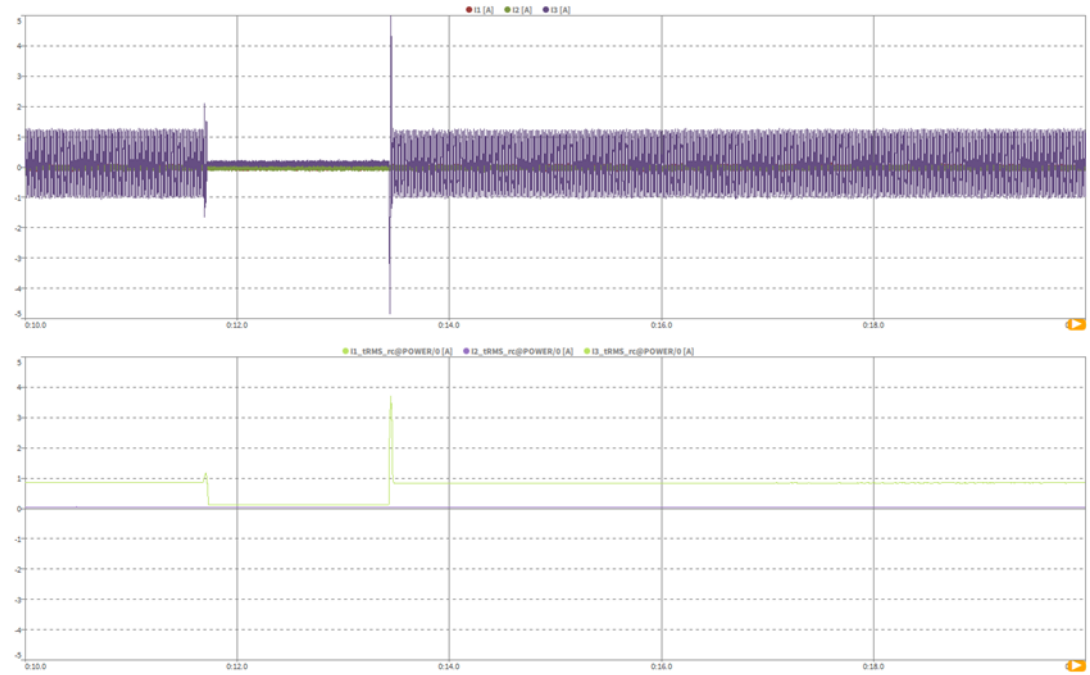
5.8.3	For PGUs Type 2 and storage systems	P

2.4

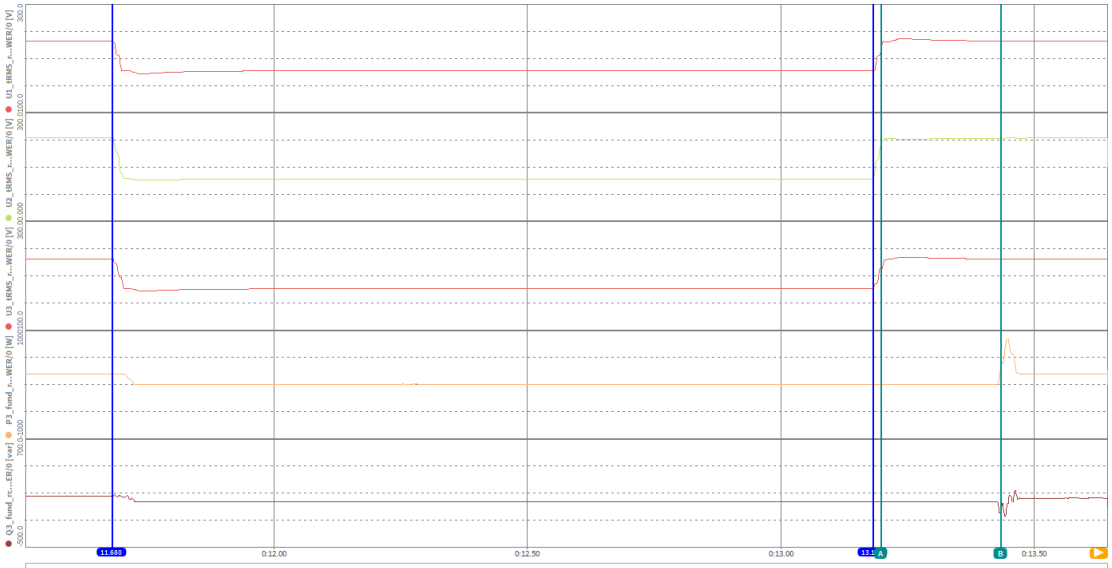
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.4
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:52:36
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12111
	8	Fault duration in empty load test	Total	--	ms	1501
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,760
	10		Phase 2			0,501
	11		Phase 3			0,760
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,200
	17	Active power	Total	t1-10s to t1	p.u.	0,226
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,234
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,952
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,761
	23		Phase 2			0,500
	24		Phase 3			0,761
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,034
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,035
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,226
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,236
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,066
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,628
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

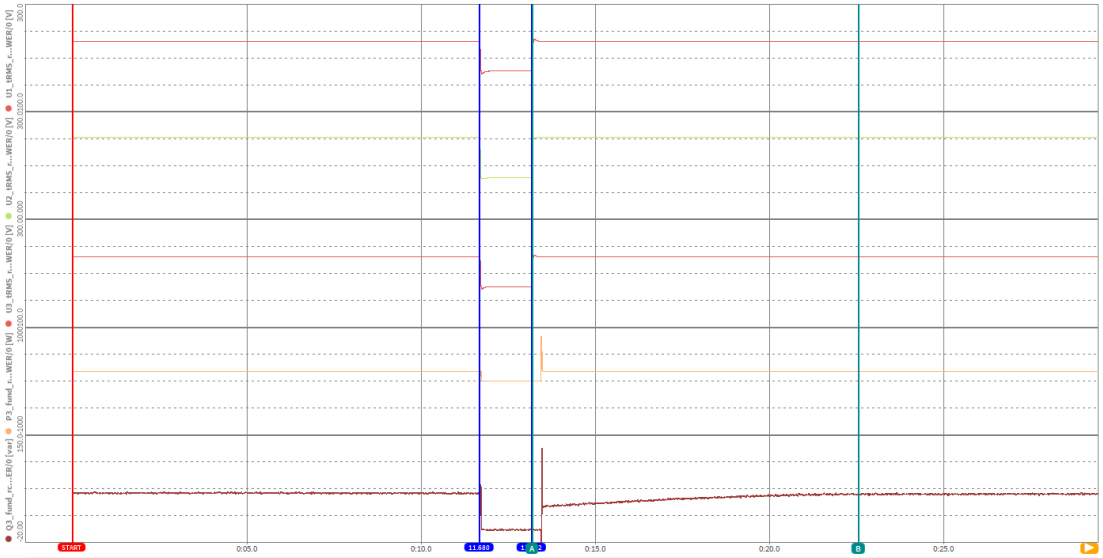




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:13.1977	0:13.4341	0.2364	
U1_tRMS_rc@POWER/0 [V]	205.4871	230.5917	25.10457	231.5633
U2_tRMS_rc@POWER/0 [V]	196.1295	229.8652	33.73564	228.0030
U3_tRMS_rc@POWER/0 [V]	210.5983	230.8275	20.22917	231.1513
P3_fund_rc@POWER/0 [W]	-1.098602	241.0119	242.1105	20.18963
Q3_fund_rc@POWER/0 [var]	-0.127307	-130.8136	-130.6863	13.95857



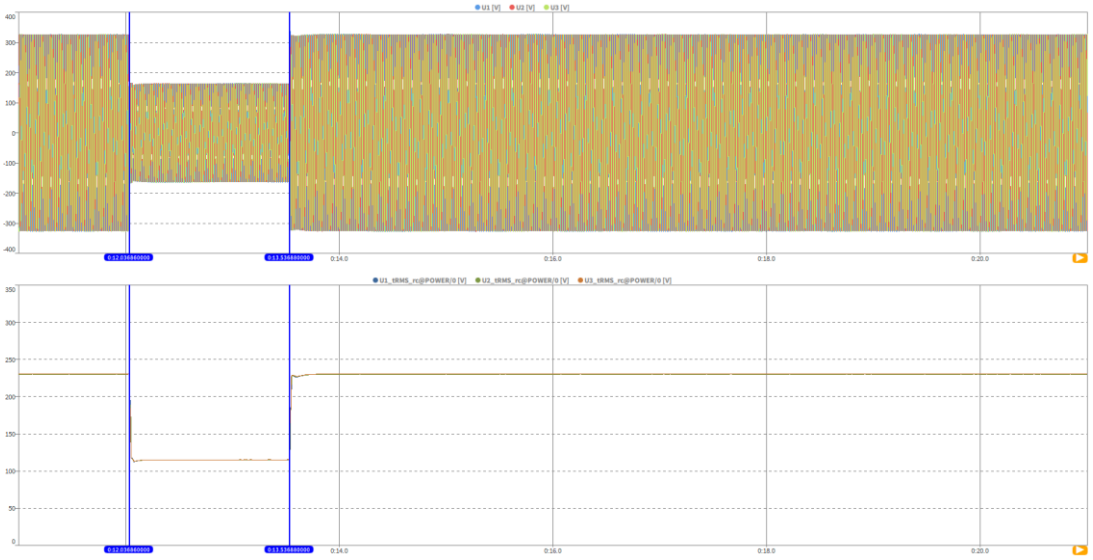
	A	B	Delta	RMS
Time [s]	0:13.20001	0:22.55636	9.35635	
U1_tRMS_rc@POWER/0 [V]	213.9617	230.2900	16.32834	230.3385
U2_tRMS_rc@POWER/0 [V]	212.7560	230.1208	17.36478	230.1042
U3_tRMS_rc@POWER/0 [V]	211.8096	230.4836	18.67398	230.5124
P3_fund_rc@POWER/0 [W]	-1.155716	181.3989	182.5546	181.7994
Q3_fund_rc@POWER/0 [var]	0.301090	55.91536	55.61427	49.07781

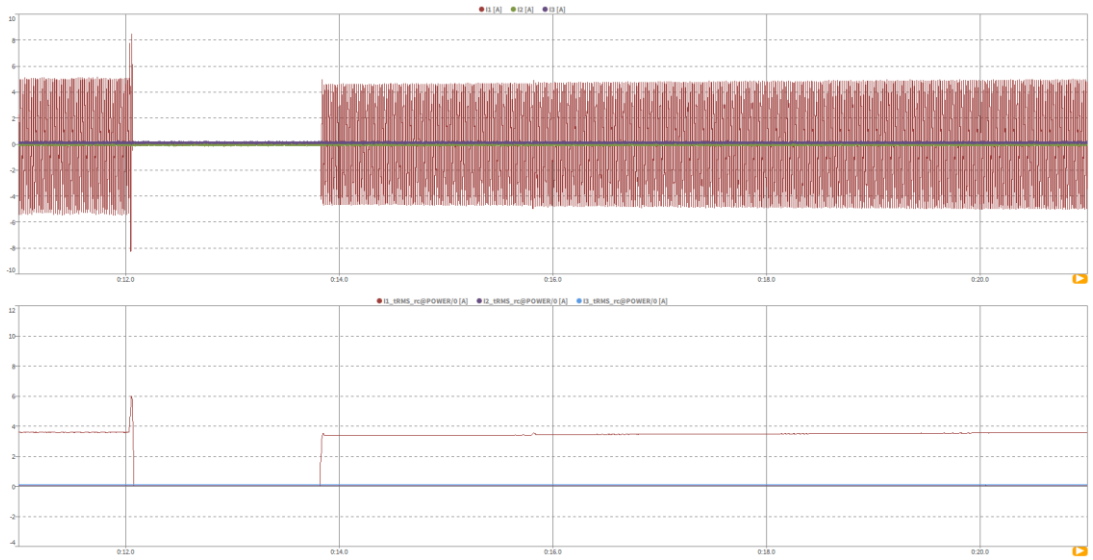
5.8.3	For PGUs Type 2 and storage systems	P

3.1

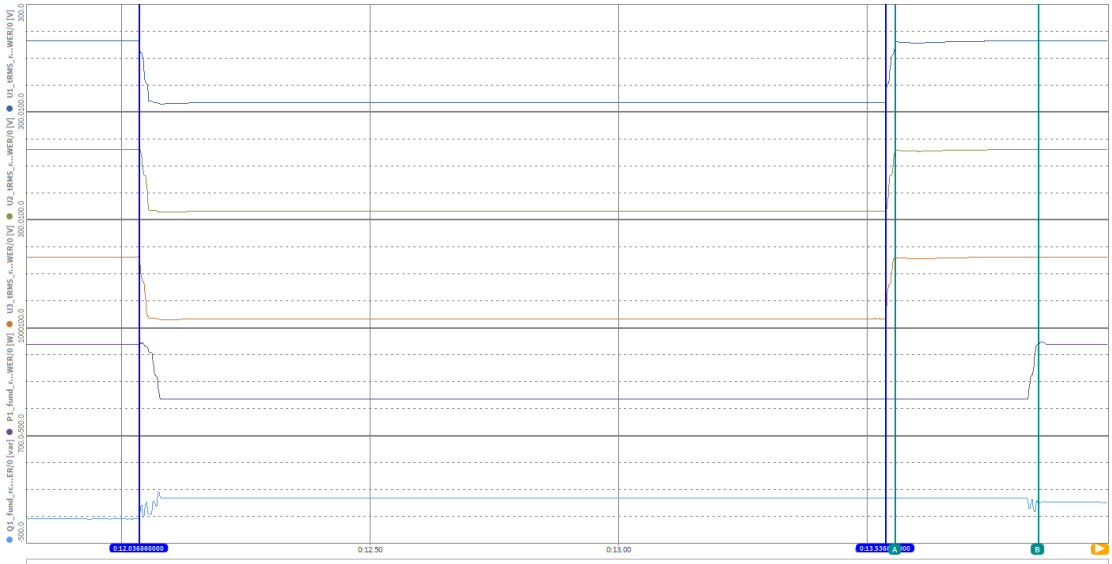
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.1
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	14:20:05
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12110
	8	Fault duration in empty load test	Total	--	ms	1500
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,500
	10		Phase 2			0,501
	11		Phase 3			0,501
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,030
	17	Active power	Total	t1-10s to t1	p.u.	0,958
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,296
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,954
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,501
	23		Phase 2			0,500
	24		Phase 3			0,501
	25	Line current	Phase 1	t1+60ms	p.u.	0,012
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,012
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,962
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,287
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,251
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,712
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

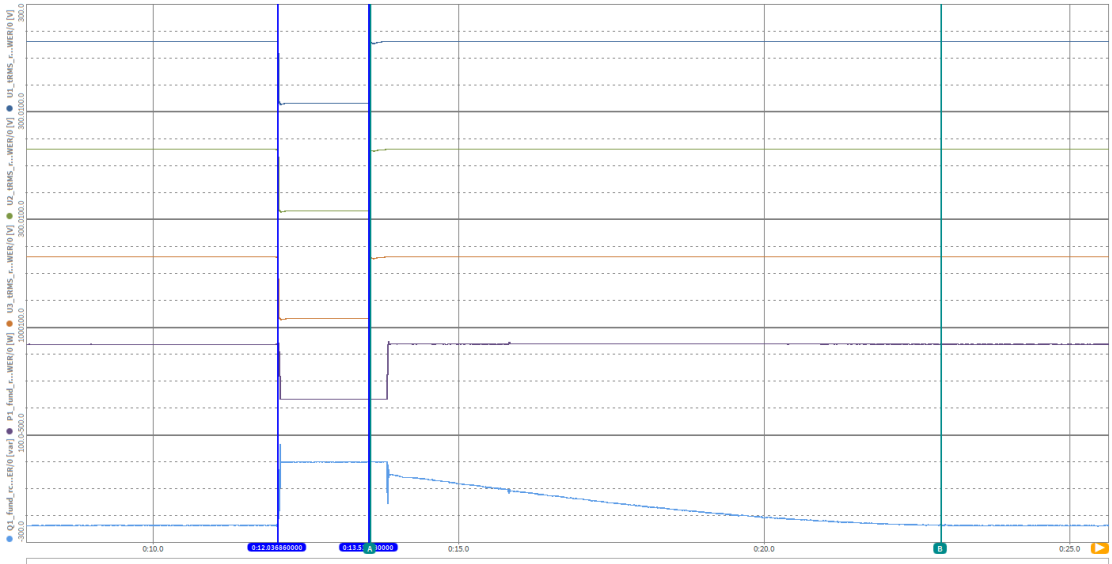




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:13.55597	0:13.84298	0.28701	
U1_tRMS_rc@POWER/0 [V]	209.5049	230.4730	20.96811	228.6352
U2_tRMS_rc@POWER/0 [V]	215.2334	230.0119	14.77847	228.7098
U3_tRMS_rc@POWER/0 [V]	227.0951	230.4509	3.355835	229.2248
P1_fund_rc@POWER/0 [W]	0.127019	759.7748	759.6478	115.7746
Q1_fund_rc@POWER/0 [var]	-4.870e-3	-25.93646	-25.93159	23.61437



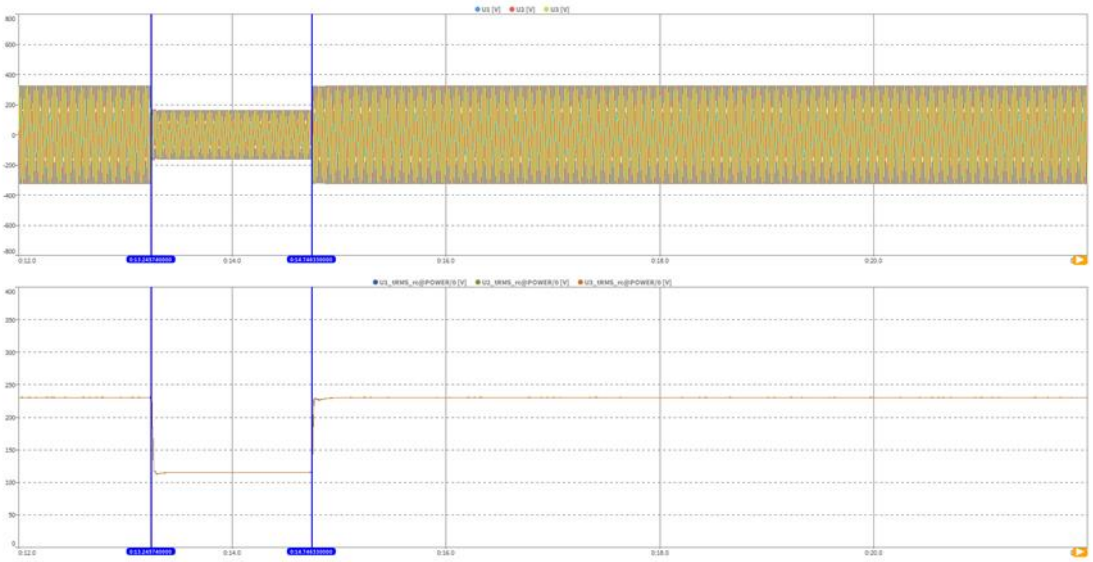
	A	B	Delta	RMS
Time [s]	0:13.5527	0:22.8881	9.3354	
U1_tRMS_rc@POWER/0 [V]	204.3343	230.3310	25.99667	230.2596
U2_tRMS_rc@POWER/0 [V]	189.0588	230.2184	41.15965	230.1086
U3_tRMS_rc@POWER/0 [V]	215.0984	230.4792	15.38087	230.4214
P1_fund_rc@POWER/0 [W]	0.197644	768.6541	768.4565	758.2369
Q1_fund_rc@POWER/0 [var]	-4.789e-3	-236.8848	-236.8800	169.6596

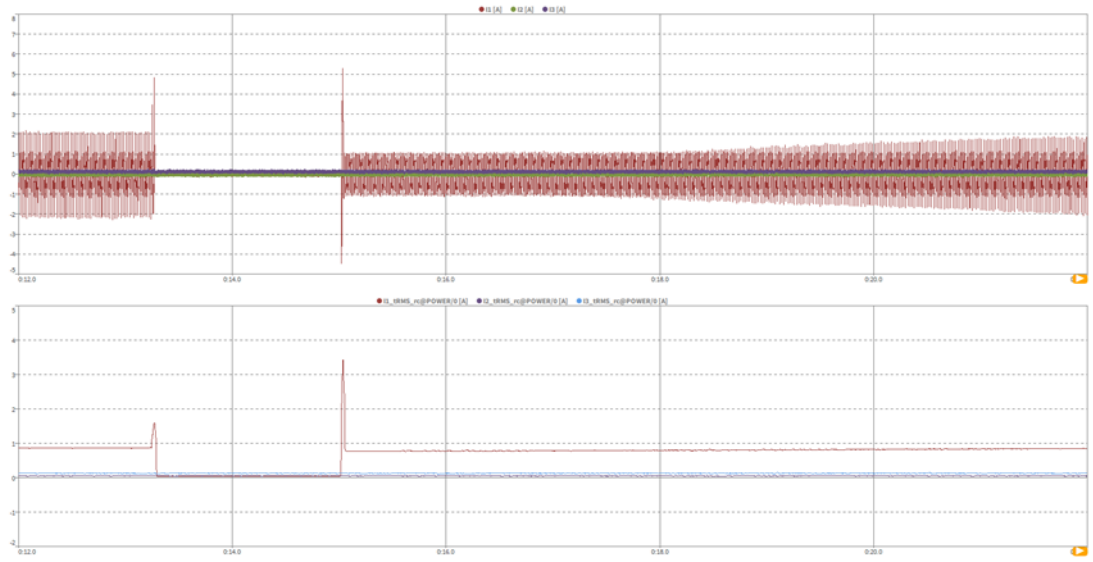
5.8.3	For PGUs Type 2 and storage systems	P

3.2

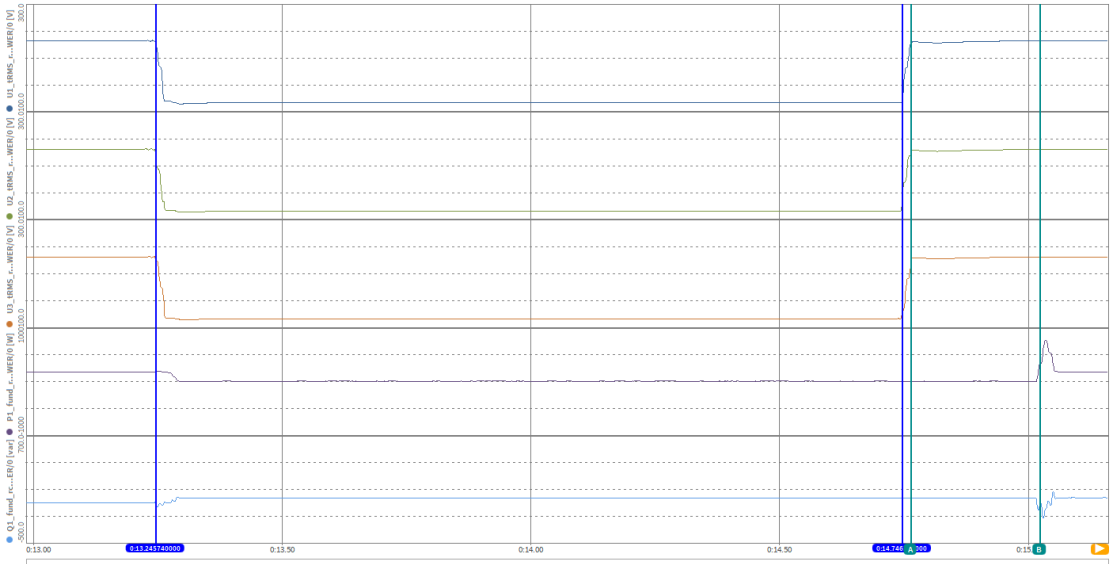
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.2
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	16:13:57
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12110
	8	Fault duration in empty load test	Total	--	ms	1500
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,500
	10		Phase 2			0,501
	11		Phase 3			0,501
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,248
	17	Active power	Total	t1-10s to t1	p.u.	0,217
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,067
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,954
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,501
	23		Phase 2			0,501
	24		Phase 3			0,501
	25	Line current	Phase 1	t1+60ms	p.u.	0,013
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,012
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,217
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,260
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,055
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,261
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

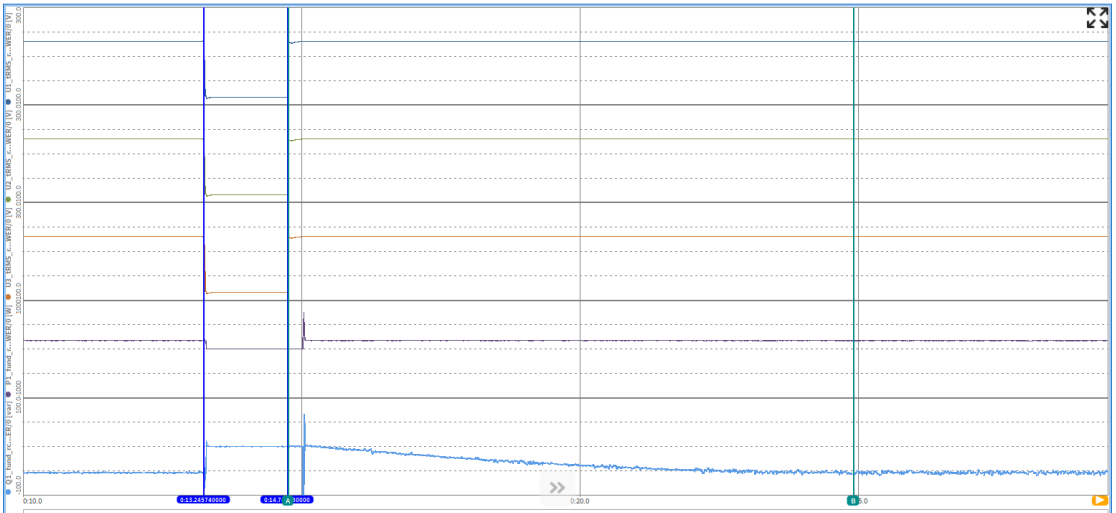




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:14.7631	0:15.0227	0.2596	
U1_tRMS_rc@POWER/0 [V]	218.9527	230.2728	11.32008	228.5563
U2_tRMS_rc@POWER/0 [V]	218.2255	230.0150	11.78951	228.5187
U3_tRMS_rc@POWER/0 [V]	199.4013	230.3258	30.92447	228.8322
P1_fund_rc@POWER/0 [W]	-0.214730	235.1962	235.4109	19.64861
Q1_fund_rc@POWER/0 [var]	0.532994	-131.8412	-132.3742	14.50817



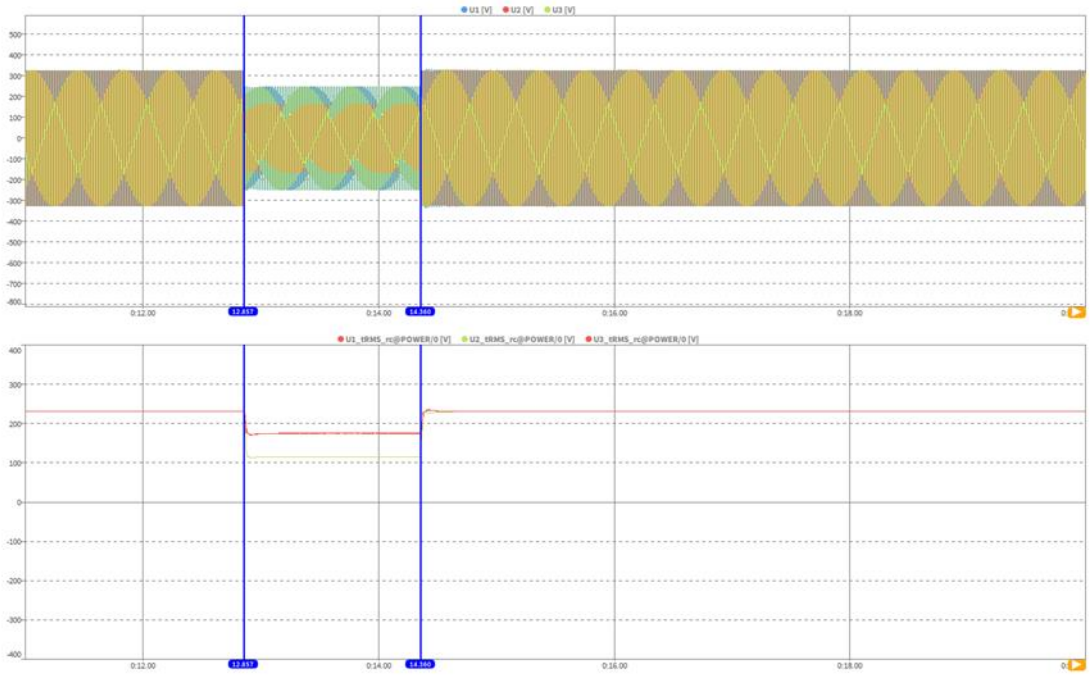
	A	B	Delta	RMS
Time [s]	0:14.7612	0:24.9104	0:10.1492	
U1_tRMS_rc@POWER/0 [V]	201.7444	230.2927	28.54839	230.2704
U2_tRMS_rc@POWER/0 [V]	215.9733	230.1781	14.20474	230.1331
U3_tRMS_rc@POWER/0 [V]	190.5385	230.4288	39.89032	230.4374
P1_fund_rc@POWER/0 [W]	0.127191	172.4495	172.3223	173.5492
Q1_fund_rc@POWER/0 [var]	0.448298	-55.34021	-55.78851	38.28717

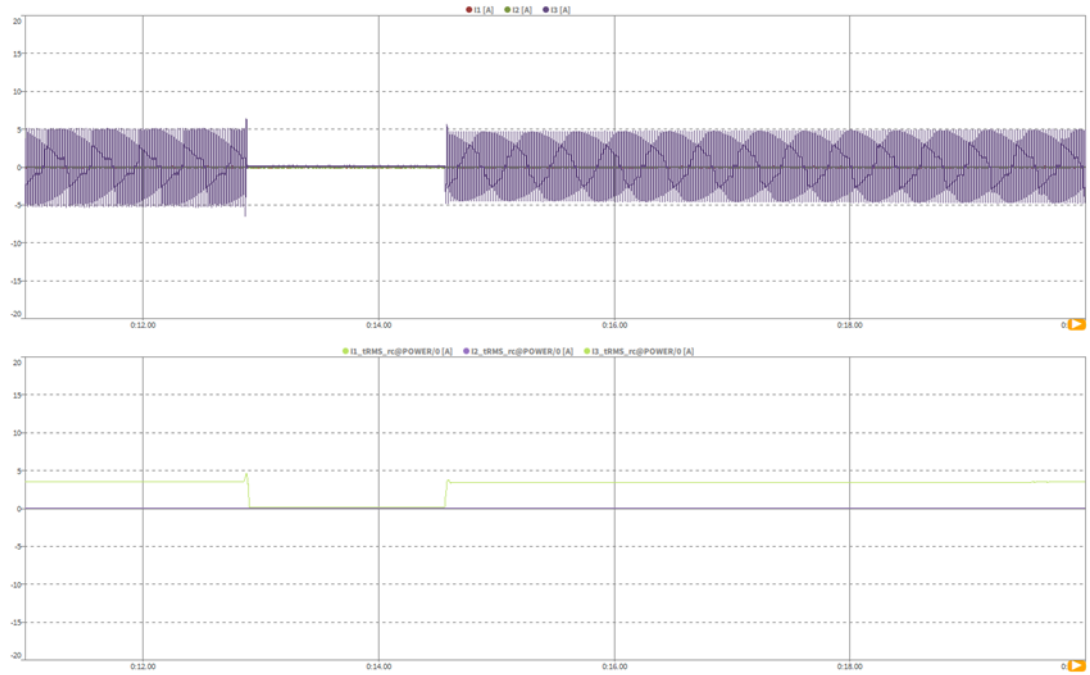
5.8.3	For PGUs Type 2 and storage systems	P

3.3

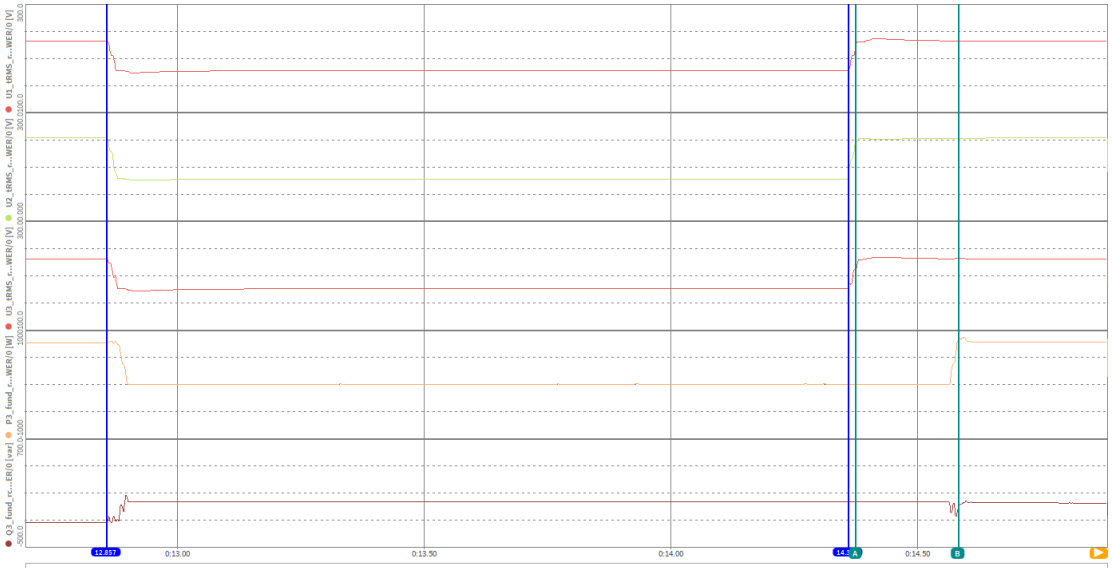
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.3
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:58:47
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12111
	8	Fault duration in empty load test	Total	--	ms	1501
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,760
	10		Phase 2			0,501
	11		Phase 3			0,760
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,005
	17	Active power	Total	t1-10s to t1	p.u.	0,957
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,290
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,957
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,761
	23		Phase 2			0,500
	24		Phase 3			0,760
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,033
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,034
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,960
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,208
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,239
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,653
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

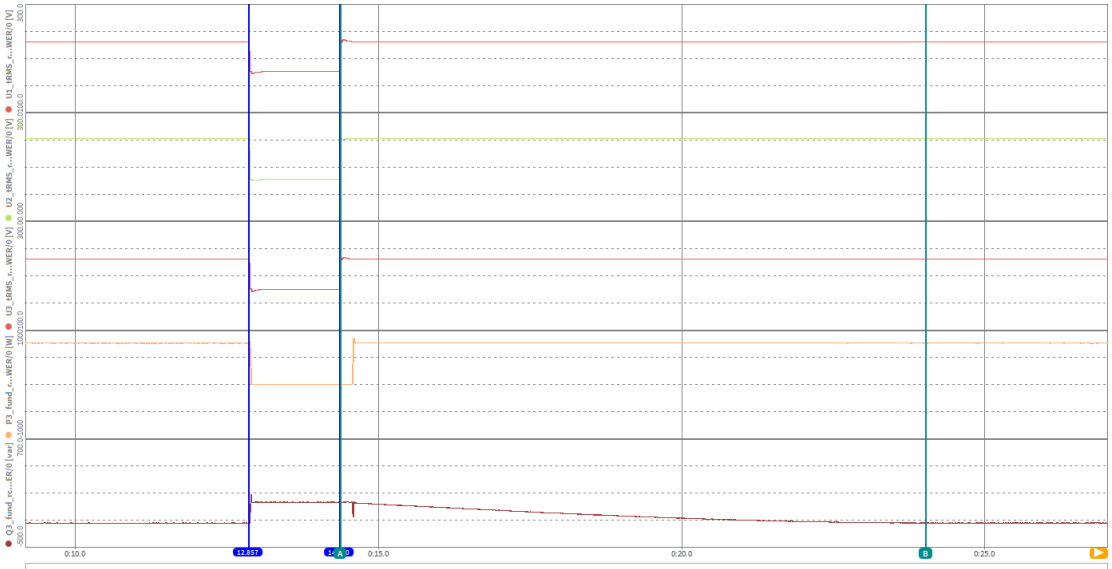




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:14.3743	0:14.5818	0.2075	
U1_tRMS_rc@POWER/0 [V]	207.6523	230.8440	23.19173	231.7857
U2_tRMS_rc@POWER/0 [V]	202.0102	229.7671	27.75691	227.8477
U3_tRMS_rc@POWER/0 [V]	211.3915	231.1283	19.73679	231.3014
P3_fund_rc@POWER/0 [W]	-2.381490	773.1984	775.5799	120.2089
Q3_fund_rc@POWER/0 [var]	0.510399	-119.8386	-120.3490	28.74798



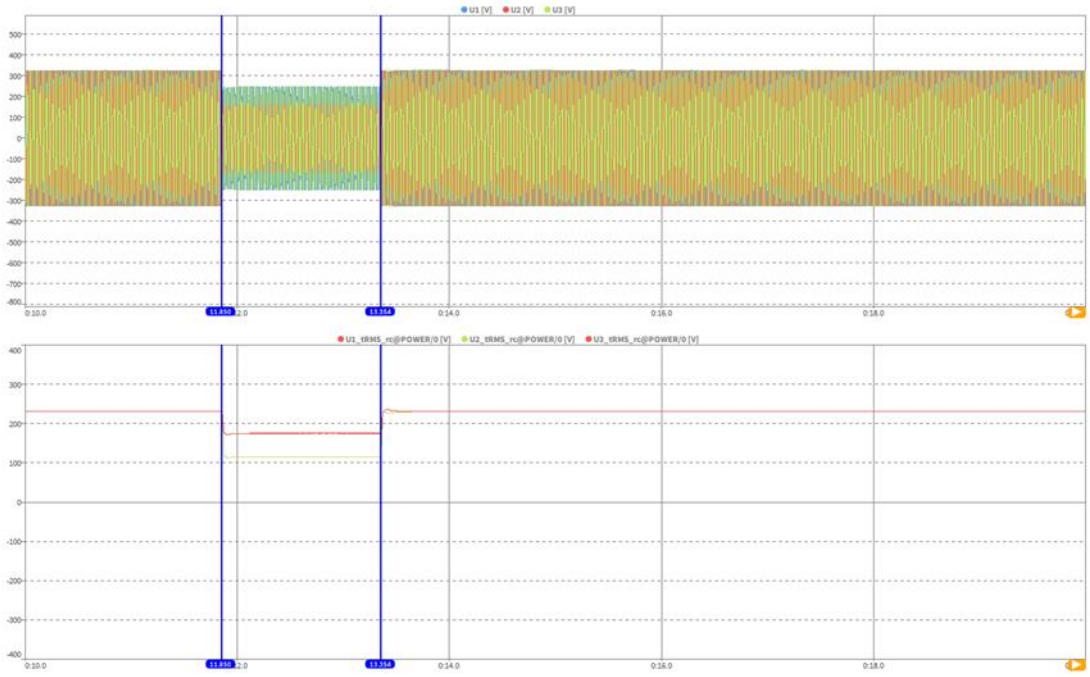
	A	B	Delta	RMS
Time [s]	0:14.37428	0:24.02776	9.65348	
U1_tRMS_rc@POWER/0 [V]	207.6523	230.3036	22.65138	230.3540
U2_tRMS_rc@POWER/0 [V]	202.0102	230.2186	28.20845	230.1054
U3_tRMS_rc@POWER/0 [V]	211.3915	230.5120	19.12047	230.5114
P3_fund_rc@POWER/0 [W]	-2.381490	765.9323	768.3138	761.6832
Q3_fund_rc@POWER/0 [var]	0.510399	-231.9270	-232.4374	160.3977

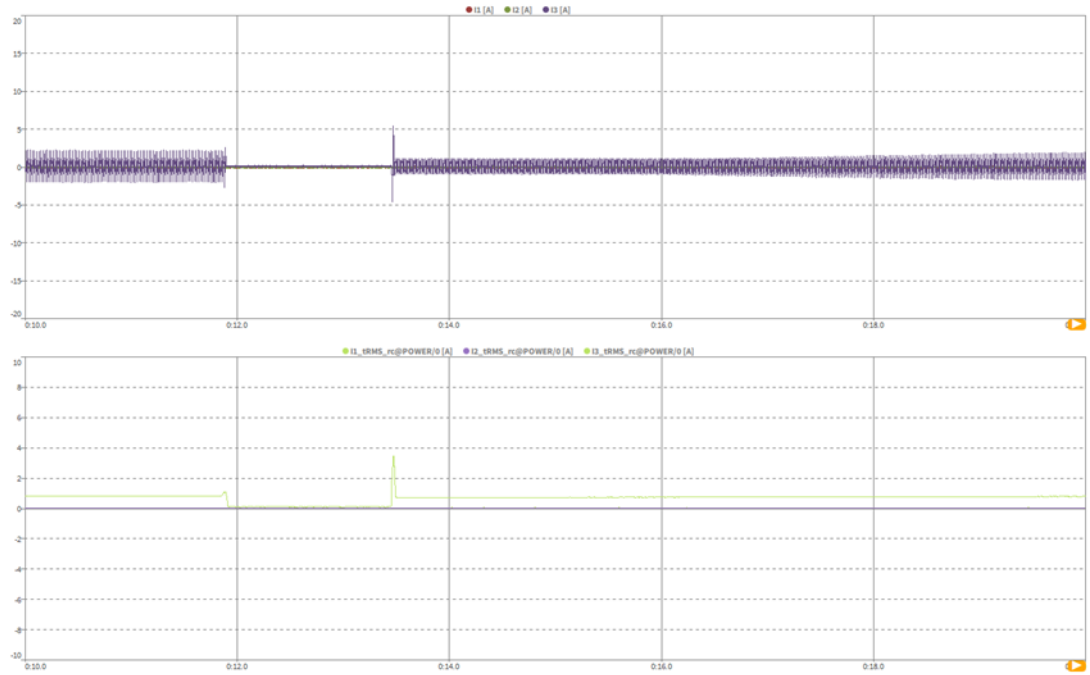
5.8.3	For PGUs Type 2 and storage systems	P

3.4

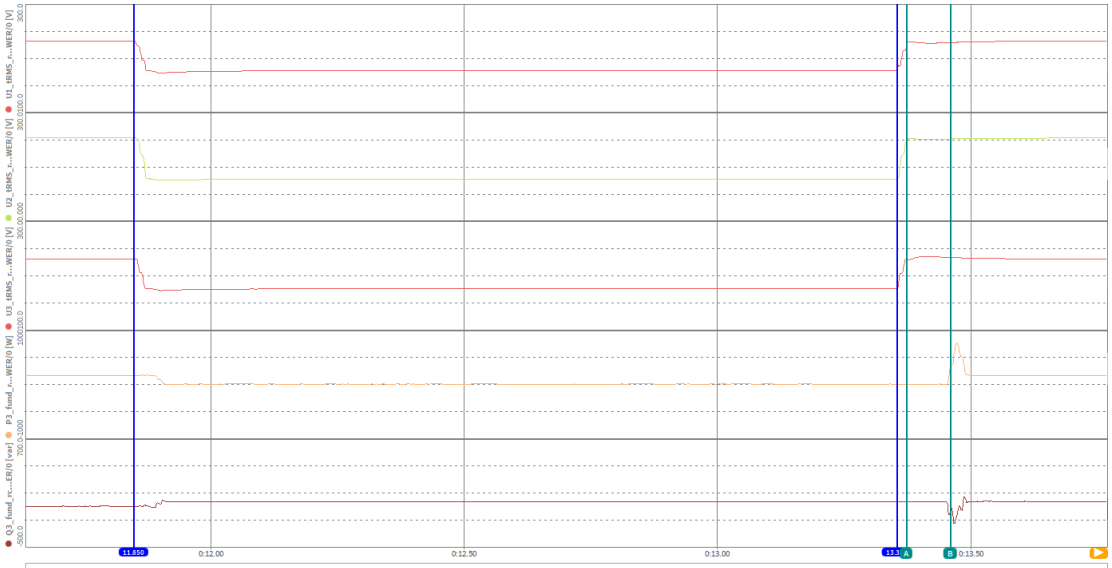
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.4
	1	Date	--	--	yyyy.mm.dd	2022.12.13
	2	Time (start of test)	--	--	hh:mm:ss.f	21:53:52
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
		Point of fault entry	Total	--	ms	10610
	7	Point of fault clearance	Total	--	ms	12111
	8	Fault duration in empty load test	Total	--	ms	1501
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,760
	10		Phase 2			0,501
	11		Phase 3			0,760
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,201
	17	Active power	Total	t1-10s to t1	p.u.	0,202
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,064
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,954
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,761
	23		Phase 2			0,500
	24		Phase 3			0,761
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,089
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,031
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,201
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,087
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,053
	40		Pos.			--
	41	Reactive power rising time	total	--	s	9,501
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P

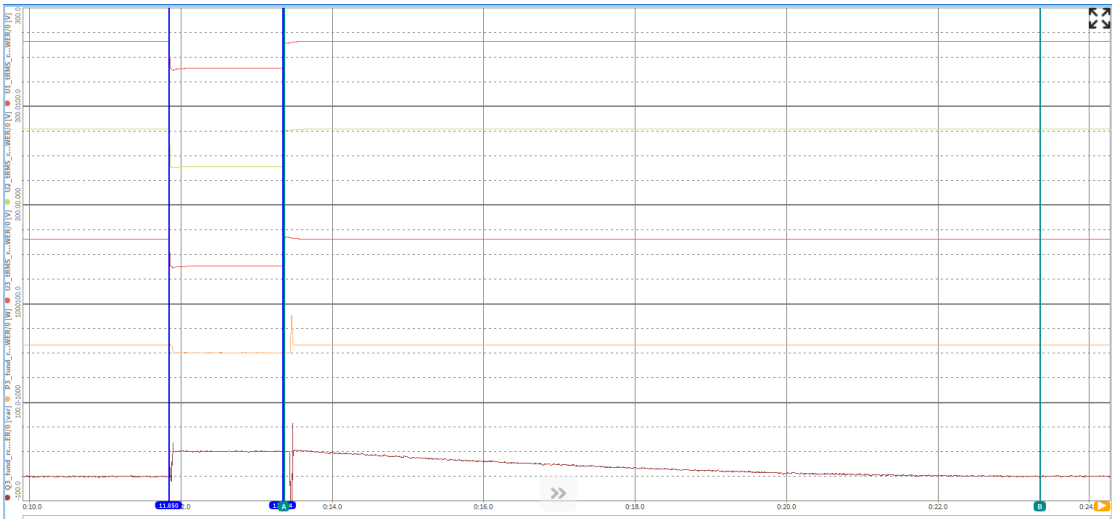




5.8.3	For PGUs Type 2 and storage systems	P



	A	B	Delta	RMS
Time [s]	0:13.3731	0:13.4601	0.0870	
U1_tRMS_rc@POWER/0 [V]	213.7573	227.7458	13.98849	227.0247
U2_tRMS_rc@POWER/0 [V]	207.8571	227.7154	19.85834	226.9998
U3_tRMS_rc@POWER/0 [V]	228.7281	233.4254	4.697311	233.4344
P3_fund_rc@POWER/0 [W]	-0.804408	233.4423	234.2467	32.96491
Q3_fund_rc@POWER/0 [var]	-0.638079	-142.5035	-141.8654	25.83706



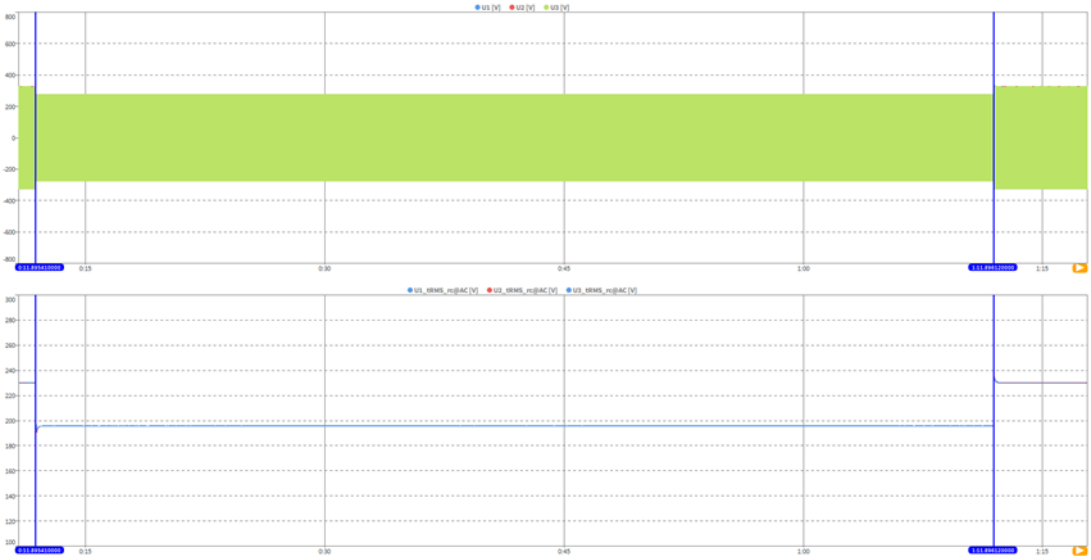
	A	B	Delta	RMS
Time [s]	0:13.3685	0:23.3500	9.9815	
U1_tRMS_rc@POWER/0 [V]	212.7117	230.3622	17.65053	230.2695
U2_tRMS_rc@POWER/0 [V]	182.7323	230.2323	47.50006	230.1274
U3_tRMS_rc@POWER/0 [V]	210.2666	230.4572	20.19061	230.5045
P3_fund_rc@POWER/0 [W]	-0.998105	159.4978	160.4959	162.5893
Q3_fund_rc@POWER/0 [var]	-0.358219	-52.32802	-51.96980	36.79528

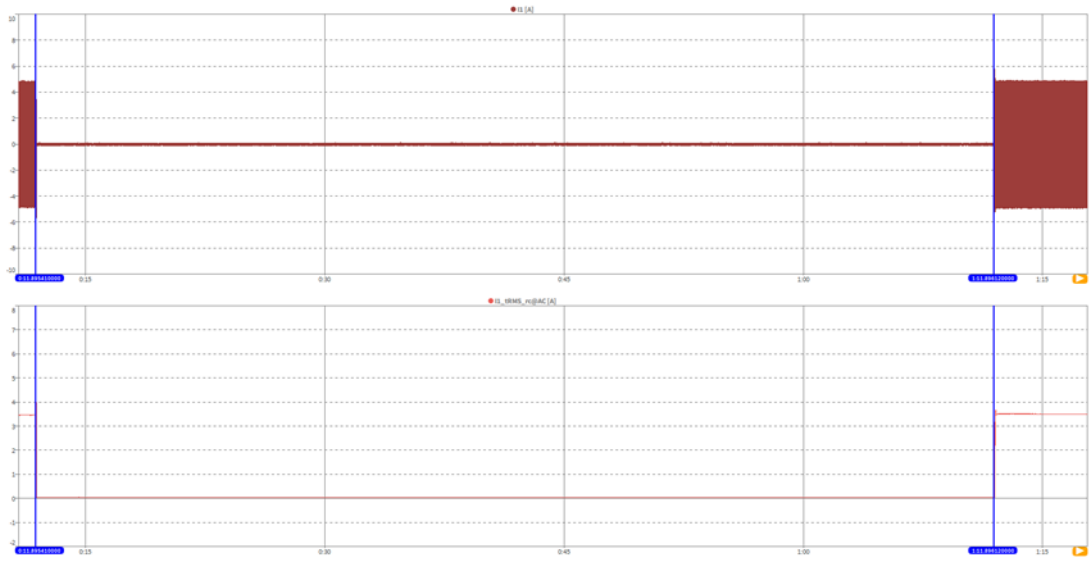
5.8.3	For PGUs Type 2 and storage systems	P

4.1

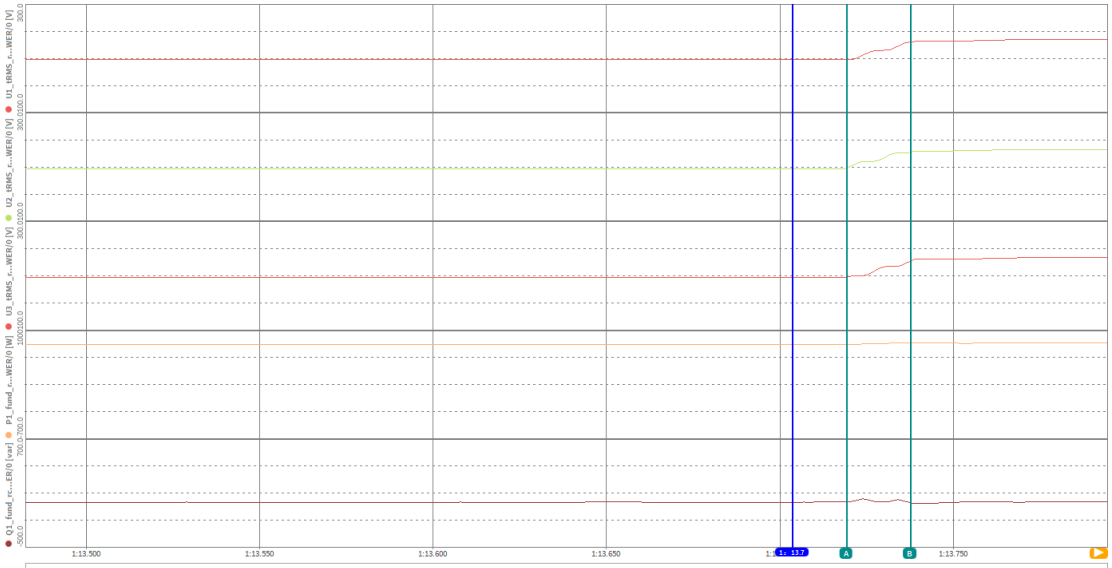
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4.1
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	20:35:38
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	10798
	7	Point of fault clearance	Total	--	ms	70798
	8	Fault duration in empty load test	Total	--	ms	60000
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,851
	10		Phase 2			0,851
	11		Phase 3			0,851
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,007
	17	Active power	Total	t1-10s to t1	p.u.	1,001
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,006
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,999
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,851
	23		Phase 2			0,851
	24		Phase 3			0,852
	25	Line current	Phase 1	t1+60ms	p.u.	0,097
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,095
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,971
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,995
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,018
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,005
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



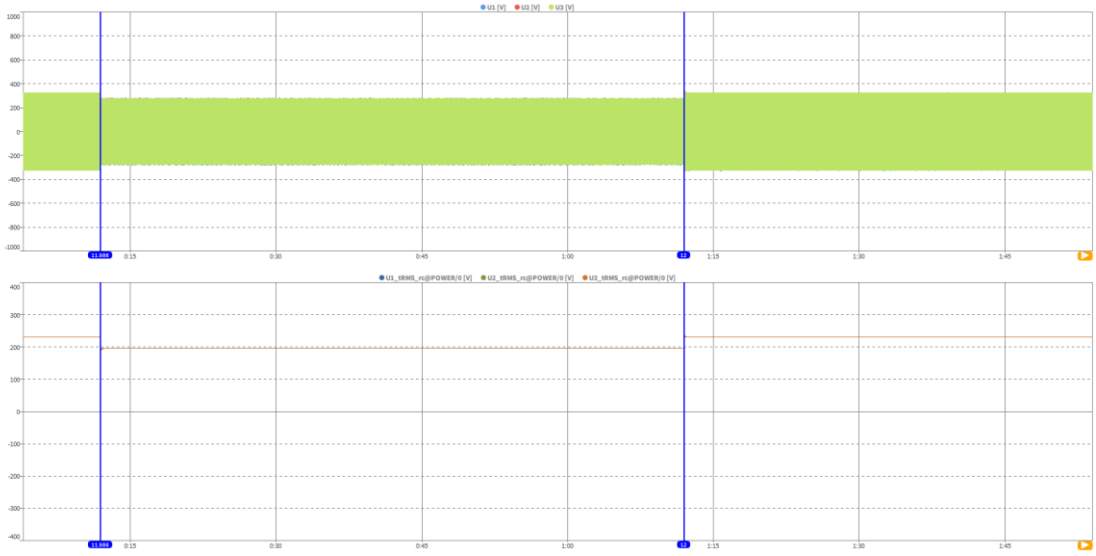
	A	B	Delta	RMS
Time [s]	1:13.7192	1:13.7376	0.0184	
U1_tRMS_rc@POWER/0 [V]	195.7710	228.9747	33.20370	211.6913
U2_tRMS_rc@POWER/0 [V]	195.7458	226.3560	30.61021	213.7716
U3_tRMS_rc@POWER/0 [V]	195.9223	224.0307	28.10844	209.3091
P1_fund_rc@POWER/0 [W]	775.3611	798.5125	23.15131	788.0014
Q1_fund_rc@POWER/0 [var]	-6.156134	-5.670640	0.485494	15.73893

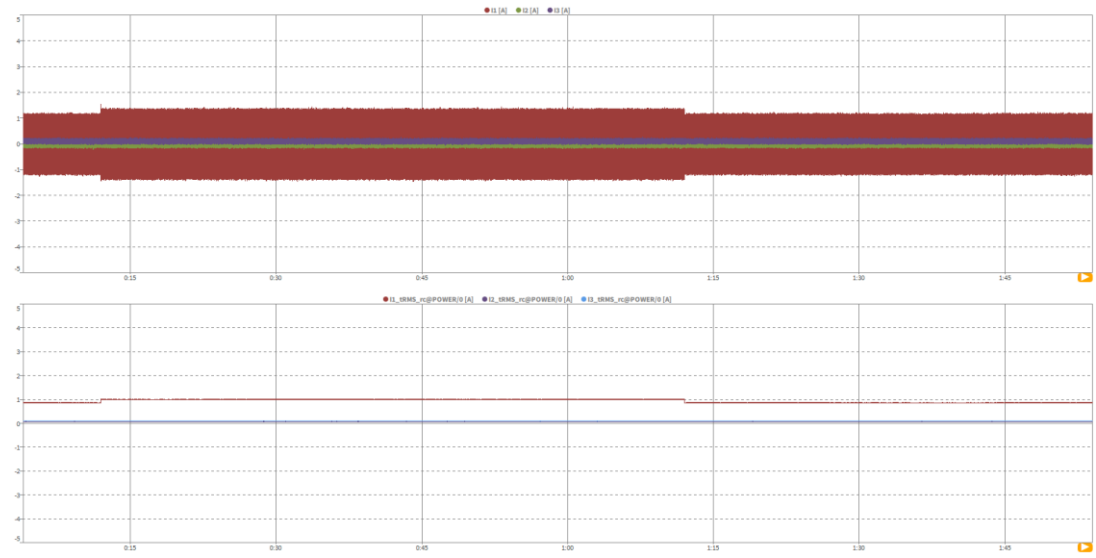
5.8.3	For PGUs Type 2 and storage systems	P

4.2

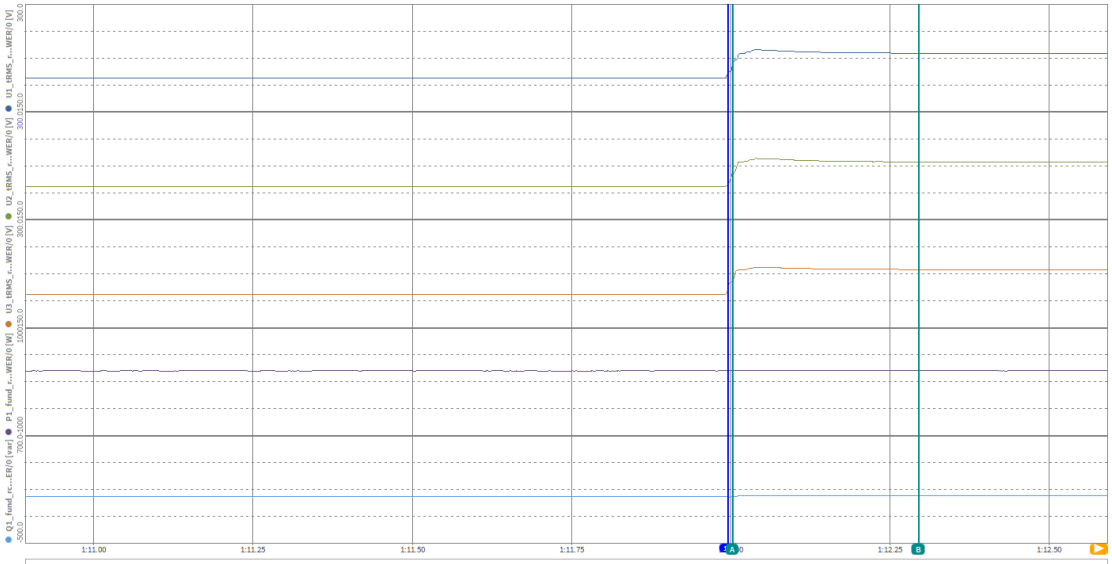
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4.2
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	12:03:19
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	10798
	7	Point of fault clearance	Total	--	ms	70798
	8	Fault duration in empty load test	Total	--	ms	60000
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,851
	10		Phase 2			0,851
	11		Phase 3			0,851
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,248
	17	Active power	Total	t1-10s to t1	p.u.	0,243
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,031
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,992
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,851
	23		Phase 2			0,851
	24		Phase 3			0,851
	25	Line current	Phase 1	t1+60ms	p.u.	0,096
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,095
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,241
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,242
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,292
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,031
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



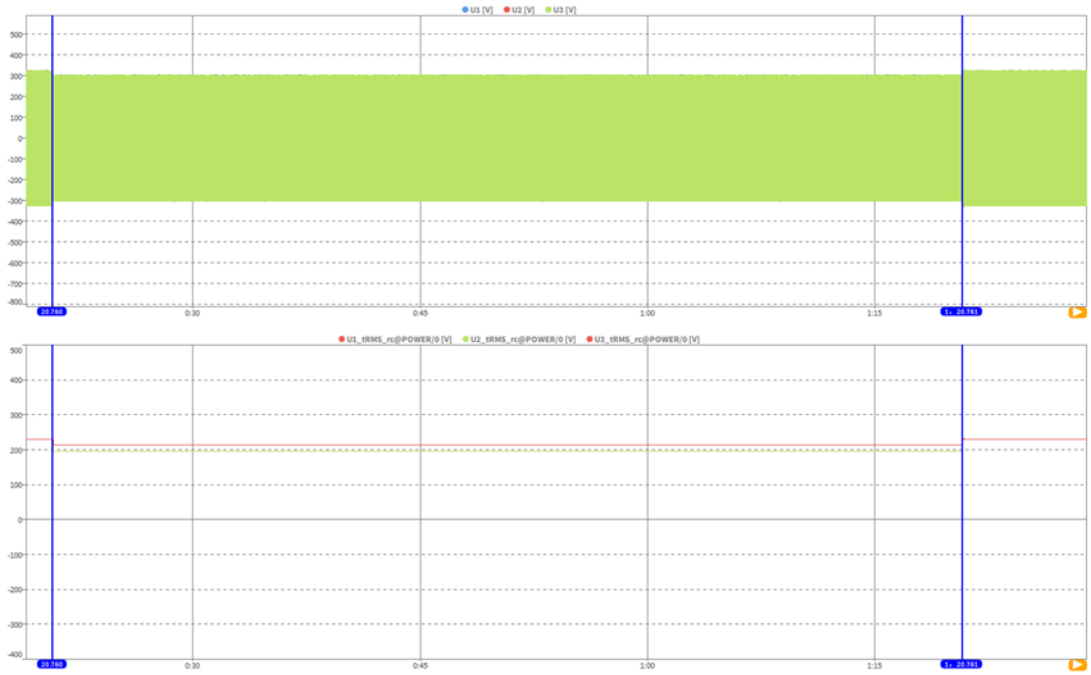
	A	B	Delta	RMS
Time [s]	1:12.0030	1:12.2951	0.2921	
U1_tRMS_rc@POWER/0 [V]	206.5864	230.4527	23.86635	231.3142
U2_tRMS_rc@POWER/0 [V]	209.2924	230.2625	20.97008	231.1406
U3_tRMS_rc@POWER/0 [V]	212.7885	230.4714	17.68283	231.0359
P1_fund_rc@POWER/0 [W]	194.6964	194.7379	0.041473	194.0199
Q1_fund_rc@POWER/0 [var]	16.75858	24.85983	8.101244	24.65359

5.8.3	For PGUs Type 2 and storage systems	P

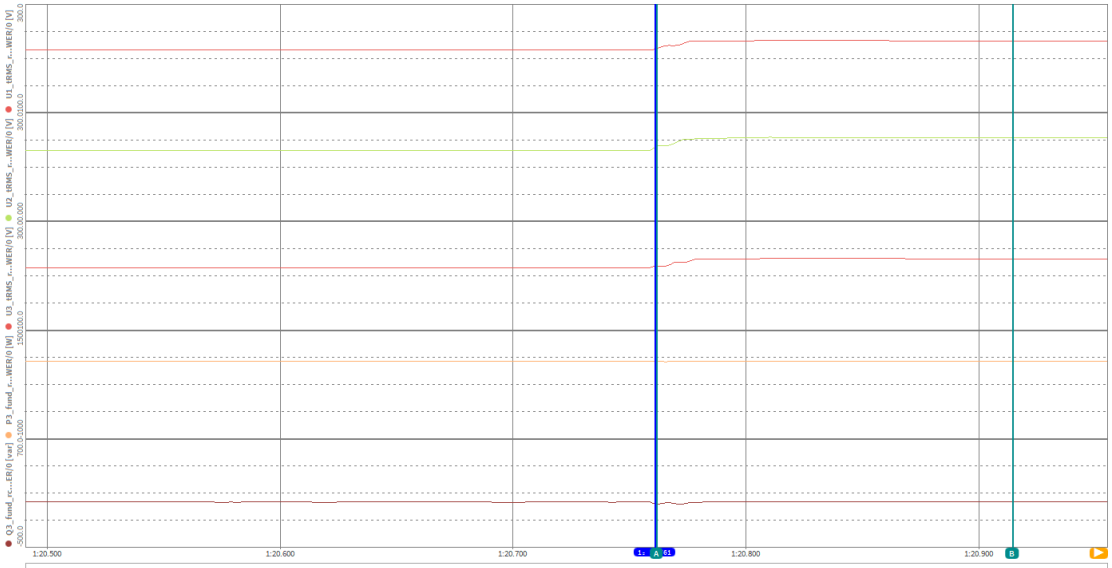
4.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4.3
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:36:20
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	21271
	7	Point of fault clearance	Total	--	ms	81406
	8	Fault duration in empty load test	Total	--	ms	60005
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,931
	10		Phase 2			0,852
	11		Phase 3			0,931
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,001
	17	Active power	Total	t1-10s to t1	p.u.	0,986
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,015
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,991
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,931
	23		Phase 2			0,851
	24		Phase 3			0,932
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			1,059
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			1,057
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,971
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,979
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,153
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,005
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P



5.8.3	For PGUs Type 2 and storage systems	P



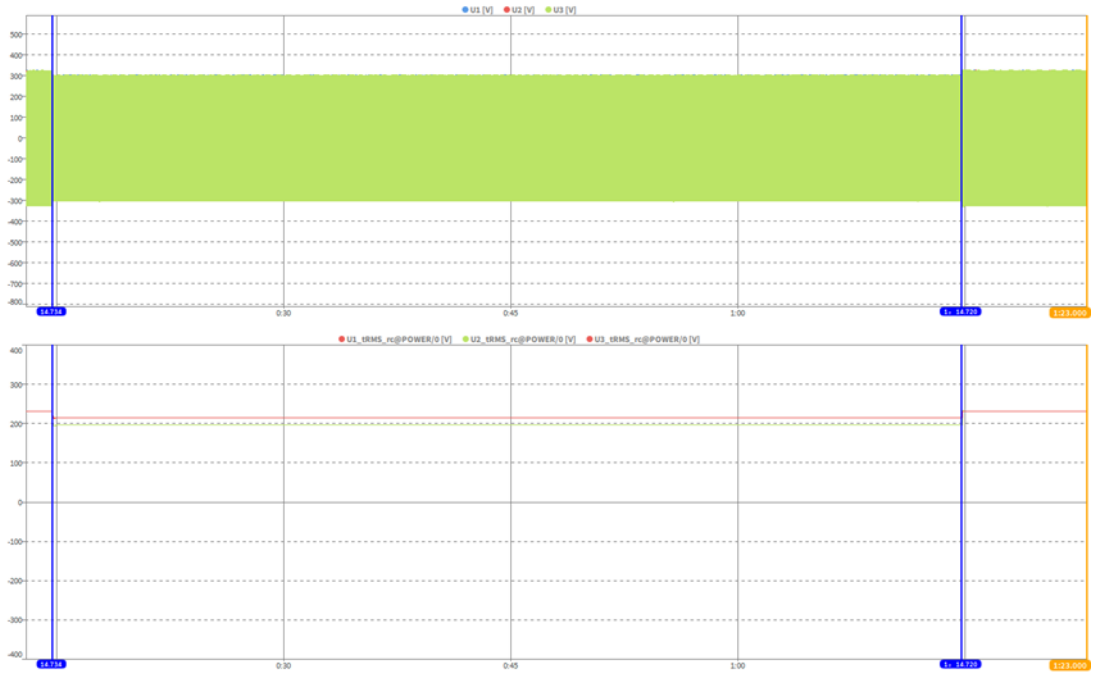
	A	B	Delta	RMS
Time [s]	1:20.7618	1:20.9144	0.1526	
U1_tRMS_rc@POWER/0 [V]	215.1295	230.6510	15.52155	230.1443
U2_tRMS_rc@POWER/0 [V]	202.0912	230.7384	28.64719	229.5245
U3_tRMS_rc@POWER/0 [V]	216.7108	230.7733	14.06255	229.9951
P3_fund_rc@POWER/0 [W]	776.6915	783.7256	7.034058	782.1474
Q3_fund_rc@POWER/0 [var]	-22.73142	-4.441588	18.28983	8.600975

5.8.3	For PGUs Type 2 and storage systems	P

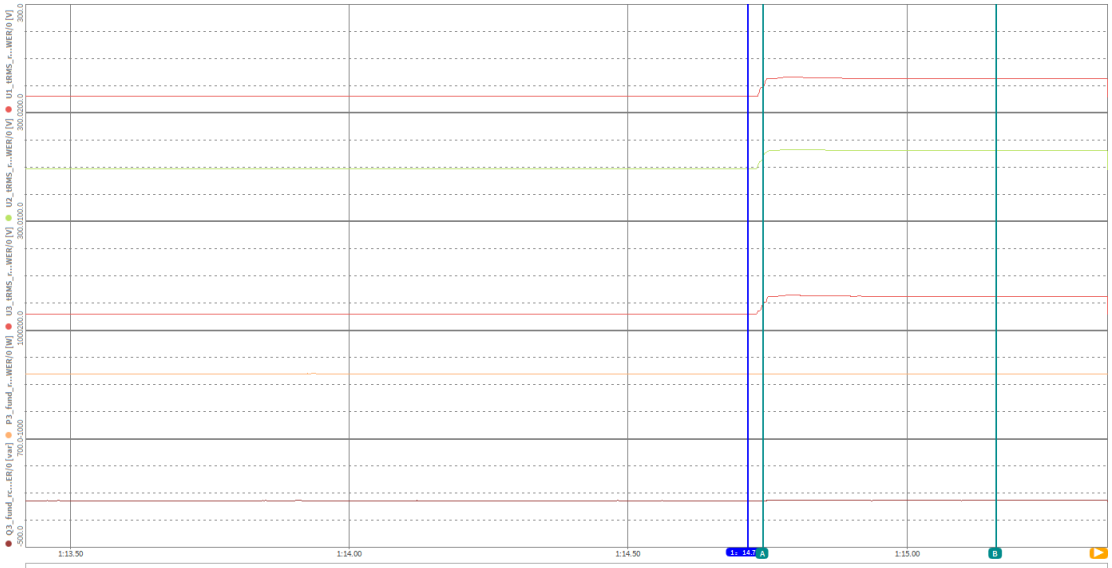
4.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4.4
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	16:36:22
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	21271
	7	Point of fault clearance	Total	--	ms	81406
	8	Fault duration in empty load test	Total	--	ms	60005
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	0,931
	10		Phase 2			0,852
	11		Phase 3			0,931
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,242
	17	Active power	Total	t1-10s to t1	p.u.	0,236
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,055
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,997
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,932
	23		Phase 2			0,851
	24		Phase 3			0,932
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,261
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,262
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,236
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,002
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,237
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,418
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,056
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P



5.8.3	For PGUs Type 2 and storage systems	P



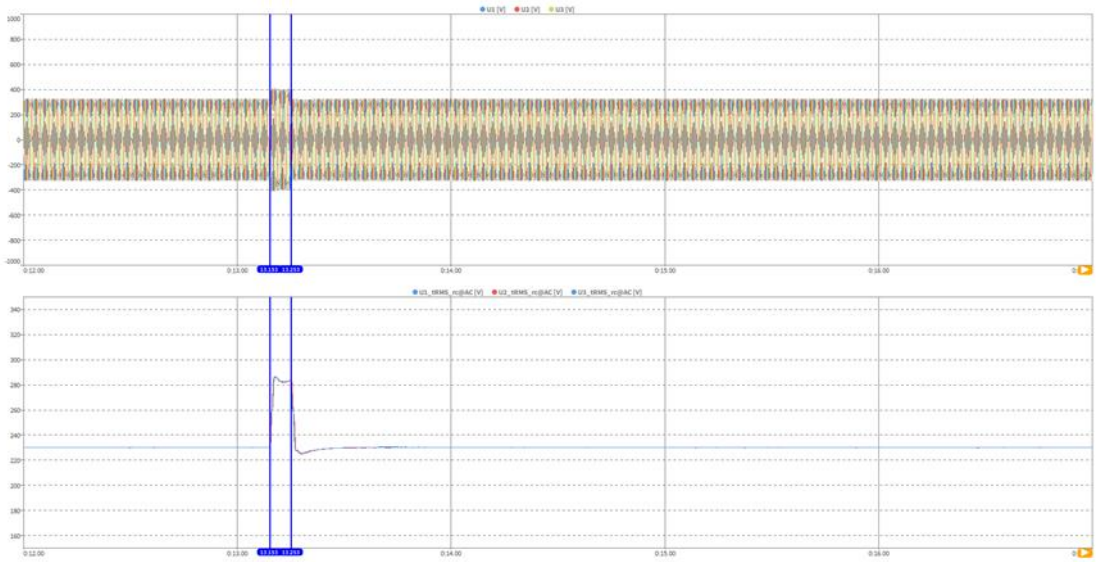
	A	B	Delta	RMS
Time [s]	1:14.74114	1:15.15919	0.41804	
U1_tRMS_rc@POWER/0 [V]	222.4303	230.4283	7.997971	230.5155
U2_tRMS_rc@POWER/0 [V]	209.5874	230.2152	20.62776	230.3309
U3_tRMS_rc@POWER/0 [V]	218.5403	230.5154	11.97516	230.5384
P3_fund_rc@POWER/0 [W]	187.2986	189.6507	2.352142	189.8266
Q3_fund_rc@POWER/0 [var]	9.614891	11.83161	2.216723	12.84271

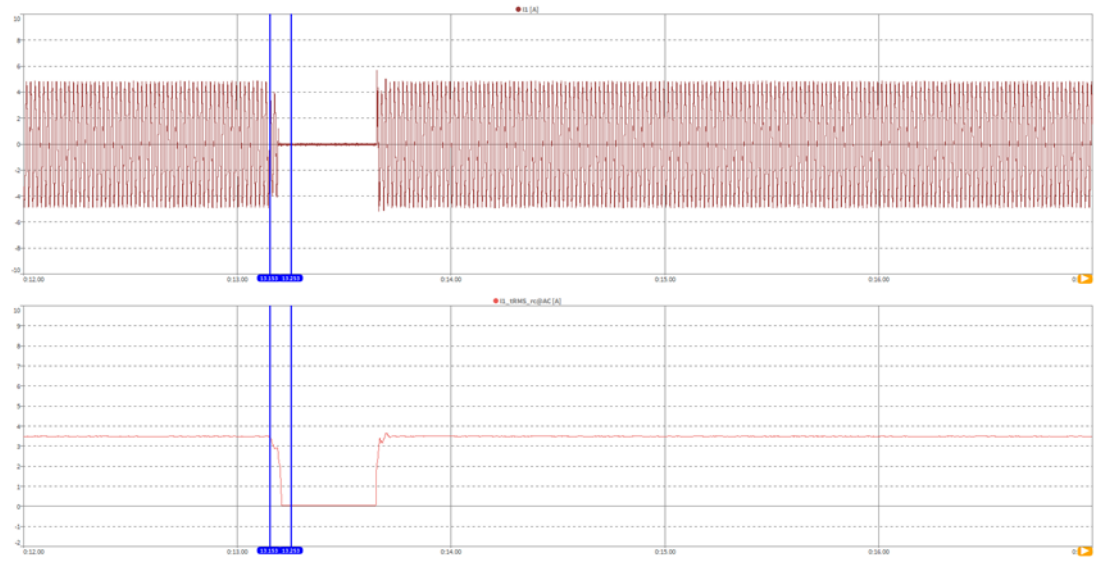
5.8.3	For PGUs Type 2 and storage systems	P

5.1

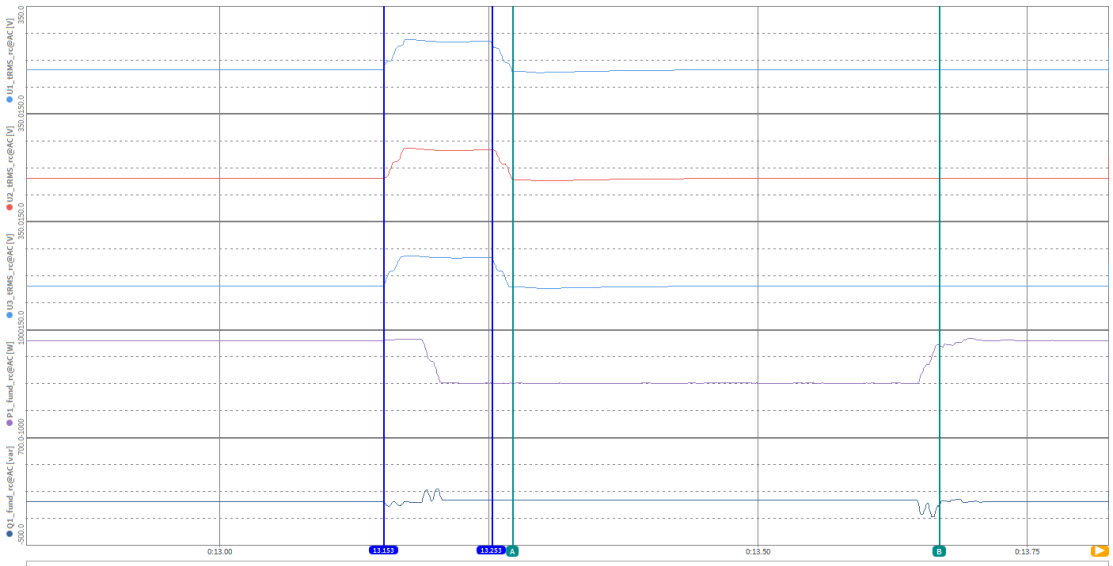
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5.1
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	17:50:17
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
		Point of fault entry	Total	--	ms	10556
	7	Point of fault clearance	Total	--	ms	10656
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,232
	10		Phase 2			1,235
	11		Phase 3			1,235
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,003
	17	Active power	Total	t1-10s to t1	p.u.	0,992
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,024
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,993
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,232
	23		Phase 2			1,233
	24		Phase 3			1,234
	25	Line current	Phase 1	t1+60ms	p.u.	0,012
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,011
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,002
	34		Phase 2			1,000
	35		Phase 3			1,001
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,996
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,396
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,026
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



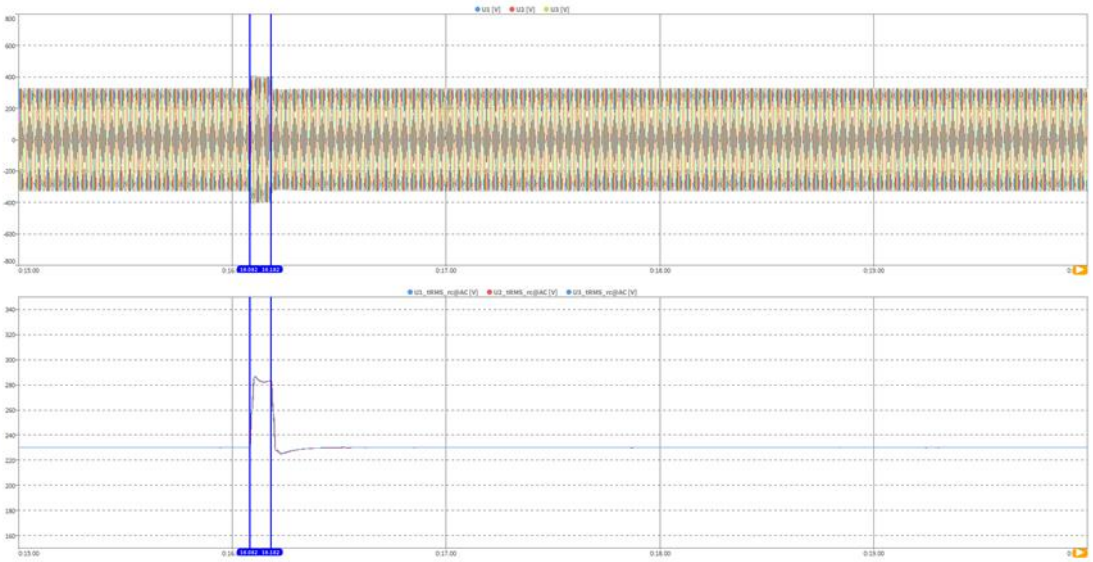
	A	B	Delta	RMS
Time [s]	0:13.272568	0:13.668670	0.396102	
U1_tRMS_rc@AC [V]	233.2552	230.6207	-2.634506	228.9898
U2_tRMS_rc@AC [V]	230.0883	230.0211	-0.067184	228.8393
U3_tRMS_rc@AC [V]	228.7266	230.2672	1.540634	229.1095
P1_fund_rc@AC [W]	5.004e-3	724.9424	724.9374	99.34421
Q1_fund_rc@AC [var]	-0.727789	-56.42537	-55.69758	27.81305

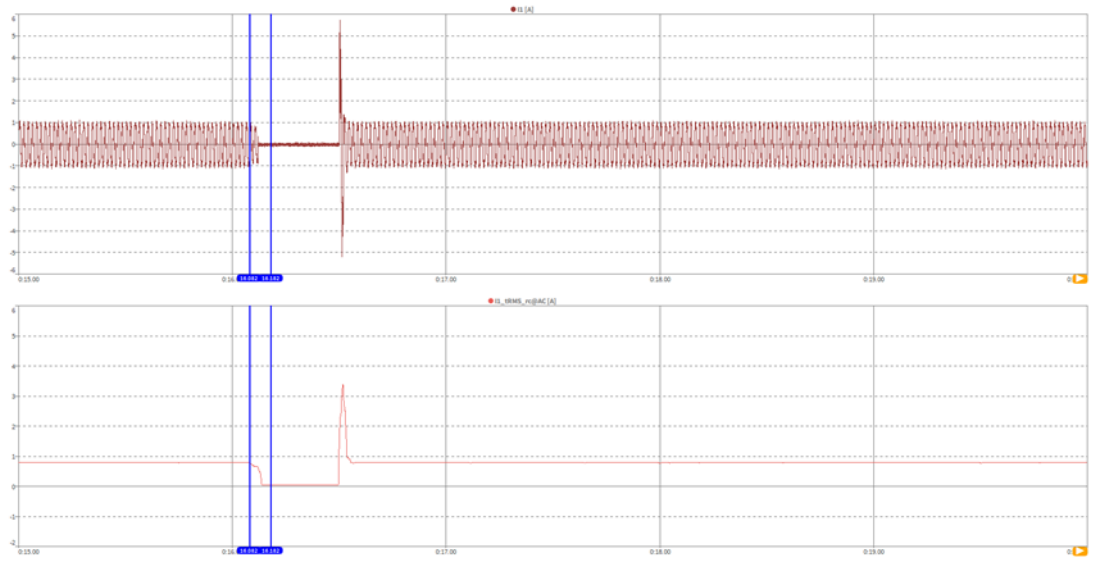
5.8.3	For PGUs Type 2 and storage systems	P

5.2

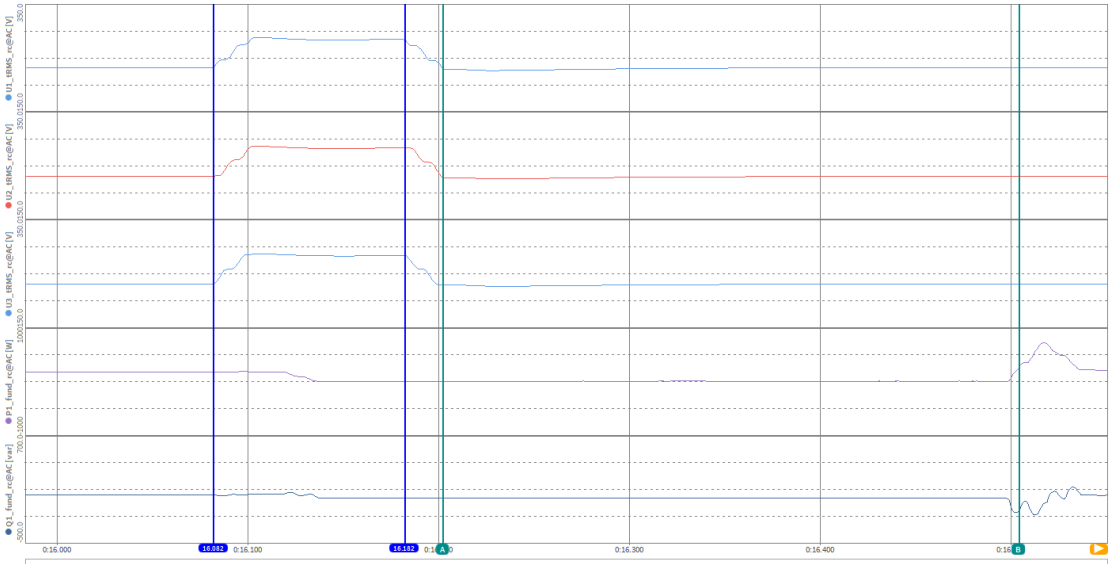
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5.2
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	17:42:42
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
		Point of fault entry	Total	--	ms	10556
	7	Point of fault clearance	Total	--	ms	10656
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,232
	10		Phase 2			1,235
	11		Phase 3			1,235
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,226
	17	Active power	Total	t1-10s to t1	p.u.	0,219
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,041
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,983
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,232
	23		Phase 2			1,232
	24		Phase 3			1,234
	25	Line current	Phase 1	t1+60ms	p.u.	0,012
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,011
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,000
	35		Phase 3			1,001
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,218
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,302
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,042
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



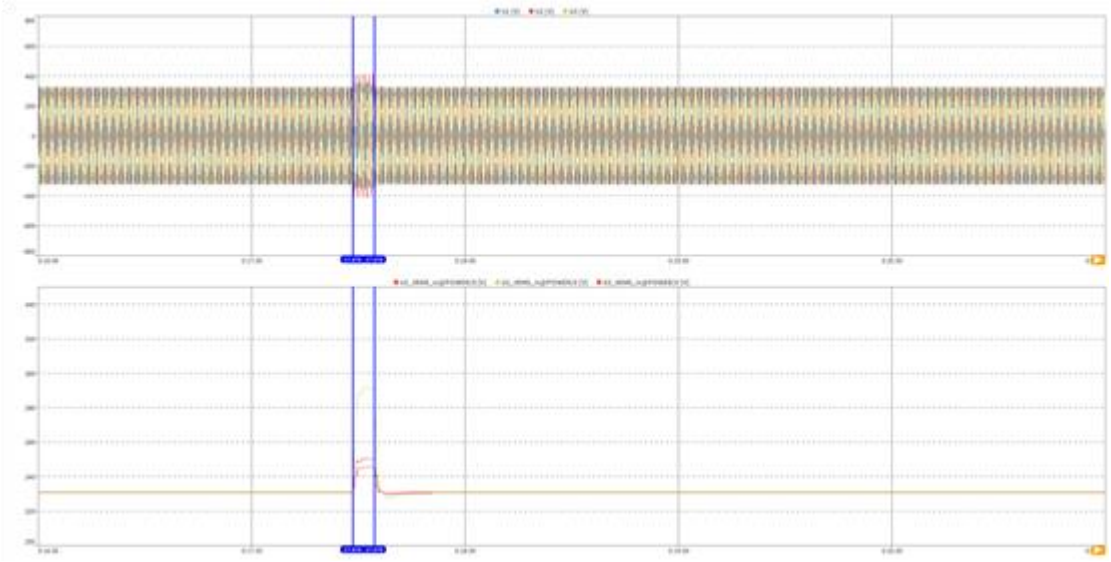
	A	B	Delta	RMS
Time [s]	0:16.202350	0:16.503996	0.301646	
U1_tRMS_rc@AC [V]	231.8022	230.2921	-1.510162	228.6076
U2_tRMS_rc@AC [V]	229.1527	229.8949	0.742157	228.4772
U3_tRMS_rc@AC [V]	228.5783	230.0665	1.488190	228.7612
P1_fund_rc@AC [W]	-0.917143	207.0689	207.9861	17.39387
Q1_fund_rc@AC [var]	-1.539722	-161.5517	-160.0120	16.11355

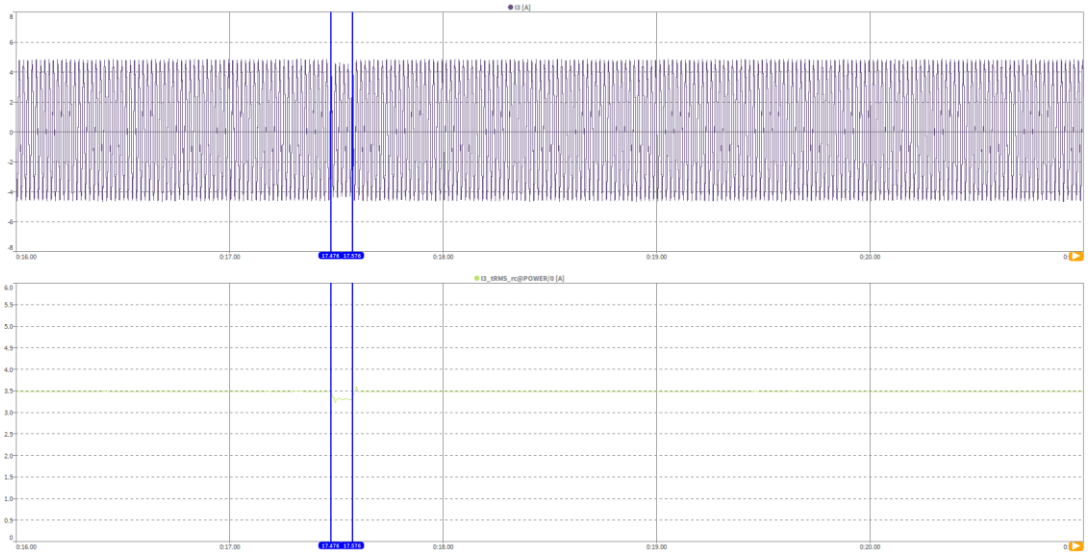
5.8.3	For PGUs Type 2 and storage systems	P

5.3

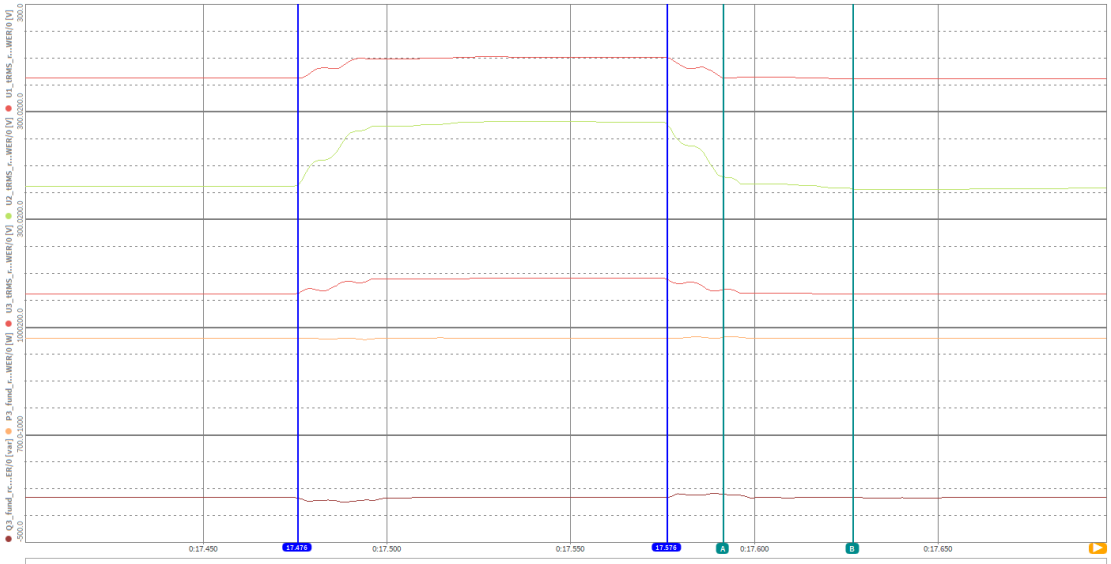
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5.3
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:29:29
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
		Point of fault entry	Total	--	ms	10586
	7	Point of fault clearance	Total	--	ms	10686
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,087
	10		Phase 2			1,235
	11		Phase 3			1,067
	12		Total			1,002
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,998
	17	Active power	Total	t1-10s to t1	p.u.	0,991
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,006
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,999
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,086
	23		Phase 2			1,262
	24		Phase 3			1,065
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,950
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,946
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,998
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,990
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,035
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,006
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



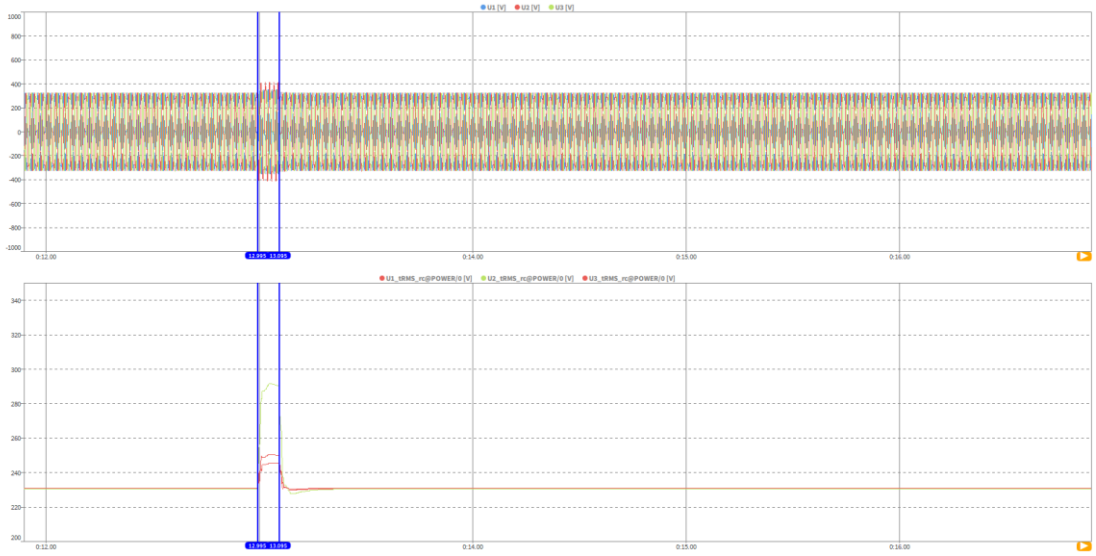
	A	B	Delta	RMS
Time [s]	0:17.591433	0:17.626756	0.035323	
U1_tRMS_rc@POWER/0 [V]	231.3241	229.4855	-1.838593	230.6468
U2_tRMS_rc@POWER/0 [V]	238.9801	228.1977	-10.78235	232.0905
U3_tRMS_rc@POWER/0 [V]	233.9913	230.2682	-3.723099	231.2944
P3_fund_rc@POWER/0 [W]	805.9444	792.5226	-13.42175	797.7056
Q3_fund_rc@POWER/0 [var]	35.60593	-5.944390	-41.55032	13.36565

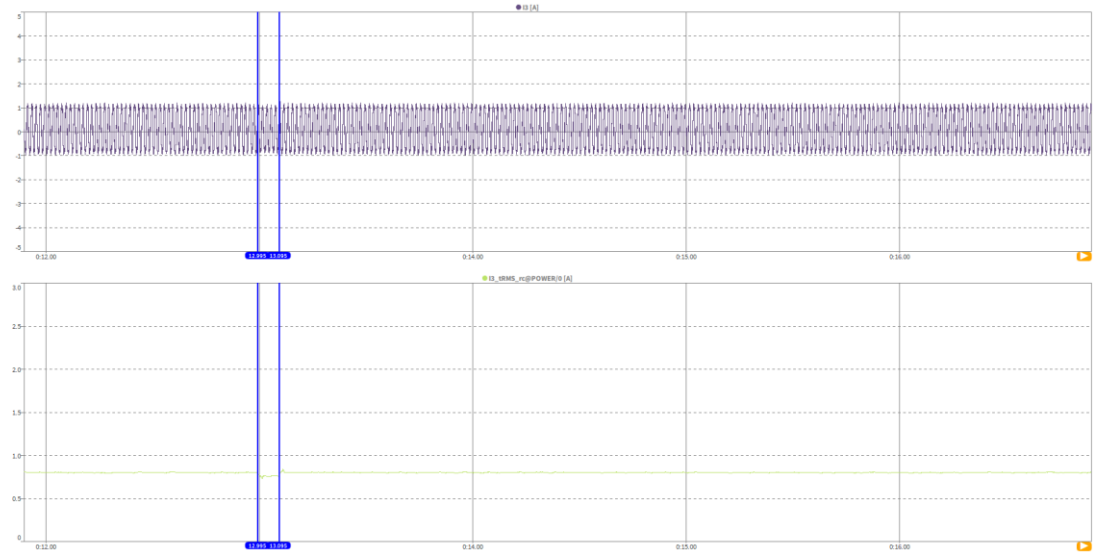
5.8.3	For PGUs Type 2 and storage systems	P

5.4

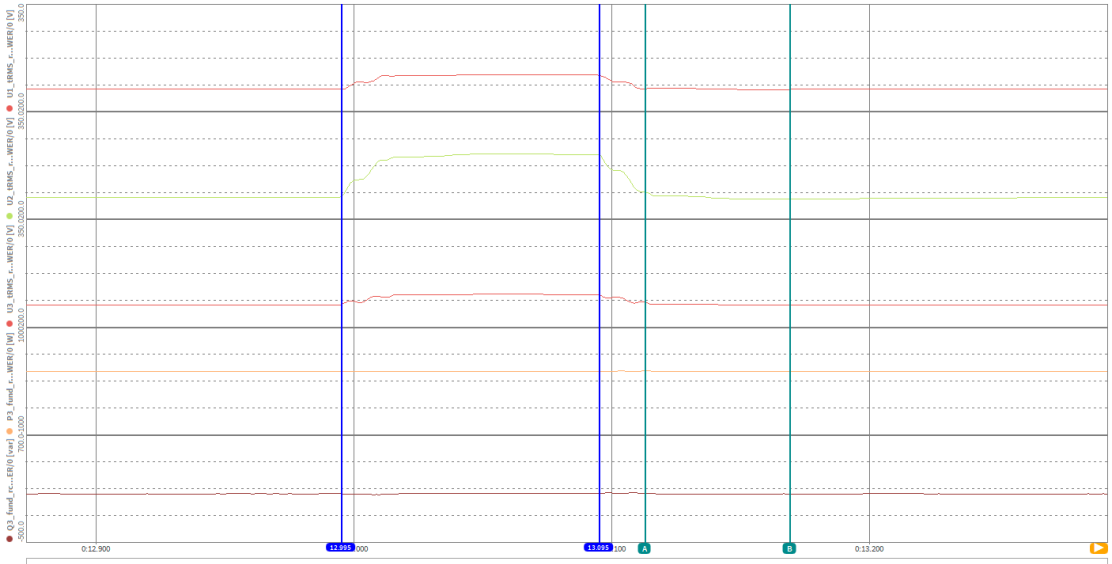
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5.4
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:31:57
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
		Point of fault entry	Total	--	ms	10586
	7	Point of fault clearance	Total	--	ms	10686
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,087
	10		Phase 2			1,235
	11		Phase 3			1,067
	12		Total			1,002
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,228
	17	Active power	Total	t1-10s to t1	p.u.	0,217
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,073
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,978
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,086
	23		Phase 2			1,263
	24		Phase 3			1,065
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,216
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,216
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,218
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,217
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,056
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,073
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



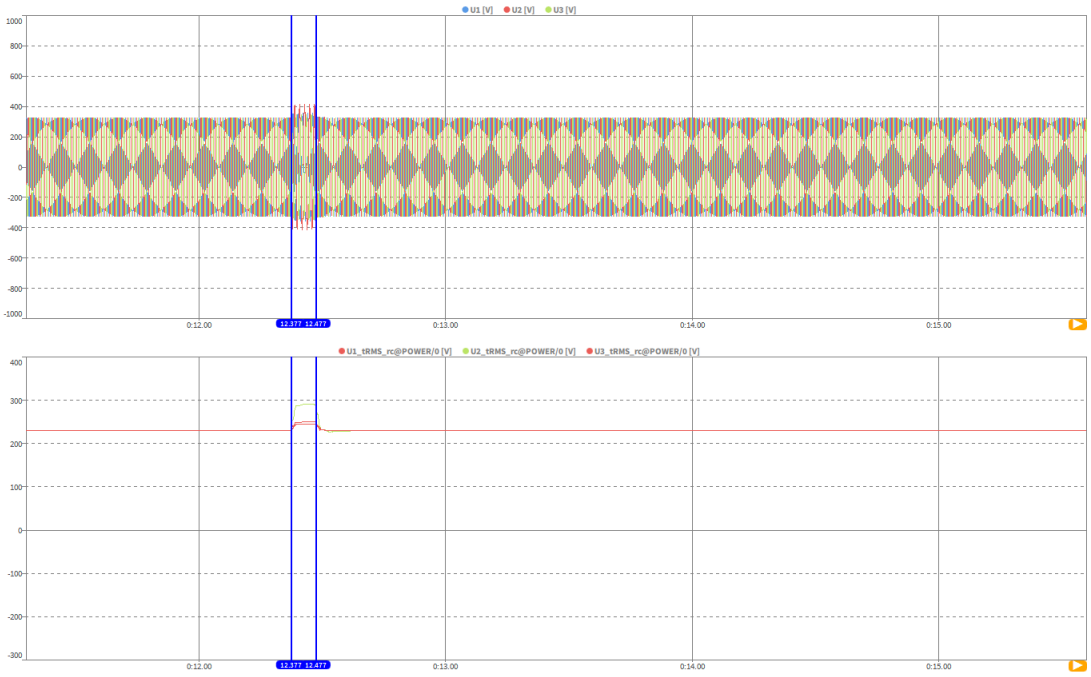
	A	B	Delta	RMS
Time [s]	0:13.112839	0:13.169102	0.056263	
U1_tRMS_rc@POWER/0 [V]	230.2695	229.4445	-0.824951	230.2076
U2_tRMS_rc@POWER/0 [V]	237.9821	227.6005	-10.38164	230.1171
U3_tRMS_rc@POWER/0 [V]	234.5164	230.1418	-4.374557	230.7213
P3_fund_rc@POWER/0 [W]	178.4884	172.8619	-5.626495	174.2037
Q3_fund_rc@POWER/0 [var]	44.88541	37.51720	-7.368202	37.59016

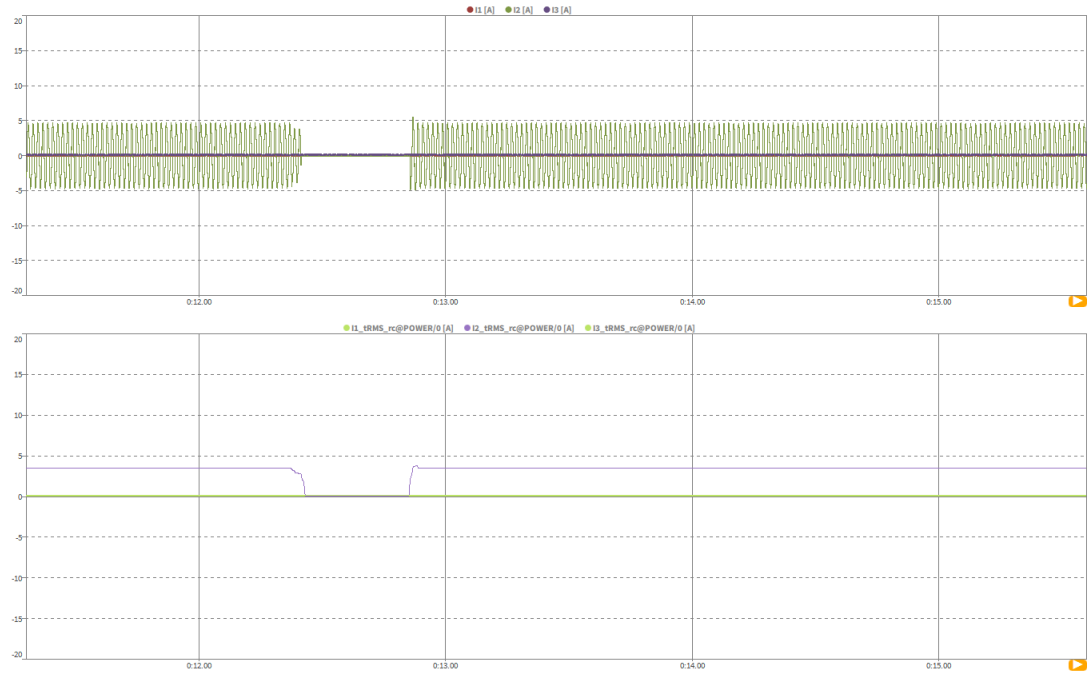
5.8.3	For PGUs Type 2 and storage systems	P

5.5

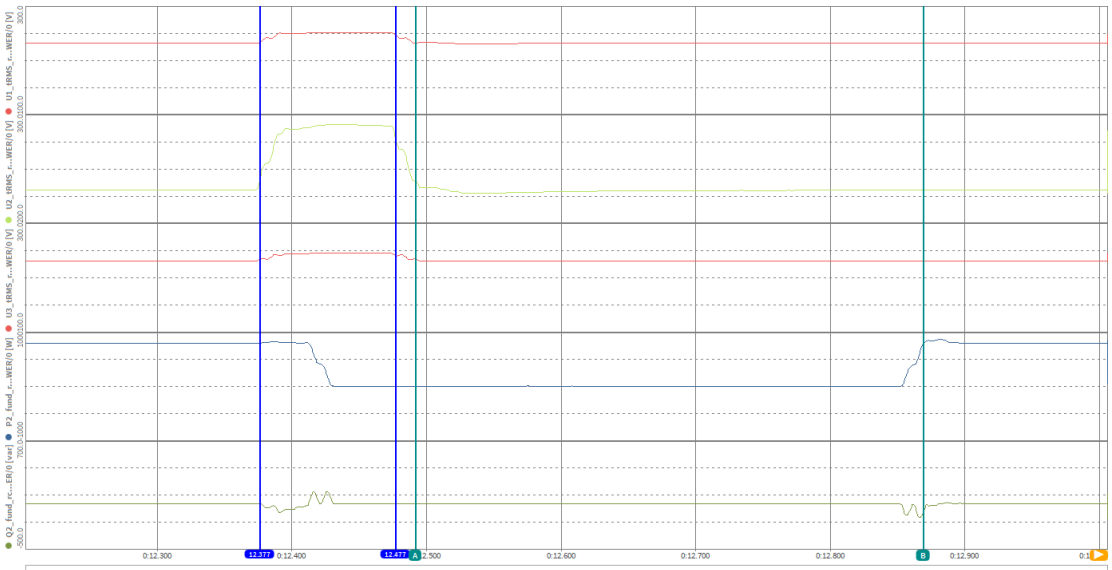
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5.5
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	20:48:04
	3	Fault type (phase)	--	--	--	D2
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
		Point of fault entry	Total	--	ms	10586
	7	Point of fault clearance	Total	--	ms	10686
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,087
	10		Phase 2			1,235
	11		Phase 3			1,067
	12		Total			1,002
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,001
	17	Active power	Total	t1-10s to t1	p.u.	0,986
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,003
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,992
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,087
	23		Phase 2			1,263
	24		Phase 3			1,065
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			0,015
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			0,014
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,001
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,985
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,377
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,004
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



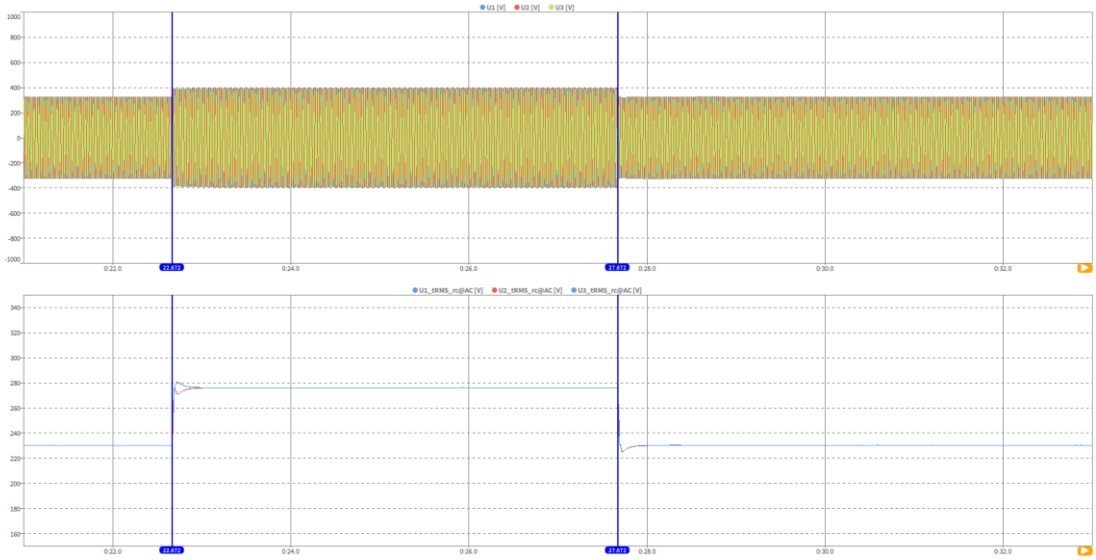
	A	B	Delta	RMS
Time [s]	0:12.492119	0:12.869067	0.376948	
U1_tRMS_rc@POWER/0 [V]	230.4569	230.3226	-0.134384	230.1575
U2_tRMS_rc@POWER/0 [V]	238.2496	230.4083	-7.841370	229.6202
U3_tRMS_rc@POWER/0 [V]	234.5828	230.4774	-4.105362	230.4418
P2_fund_rc@POWER/0 [W]	-1.678250	749.1542	750.8325	85.58760
Q2_fund_rc@POWER/0 [var]	0.168312	-127.1326	-127.3009	20.17249

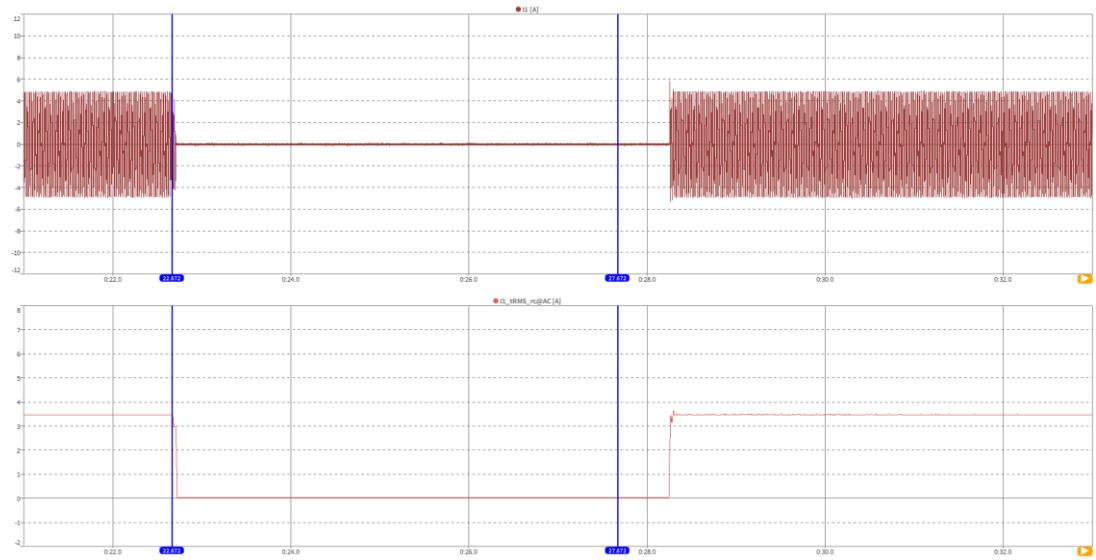
5.8.3	For PGUs Type 2 and storage systems	P

6.1

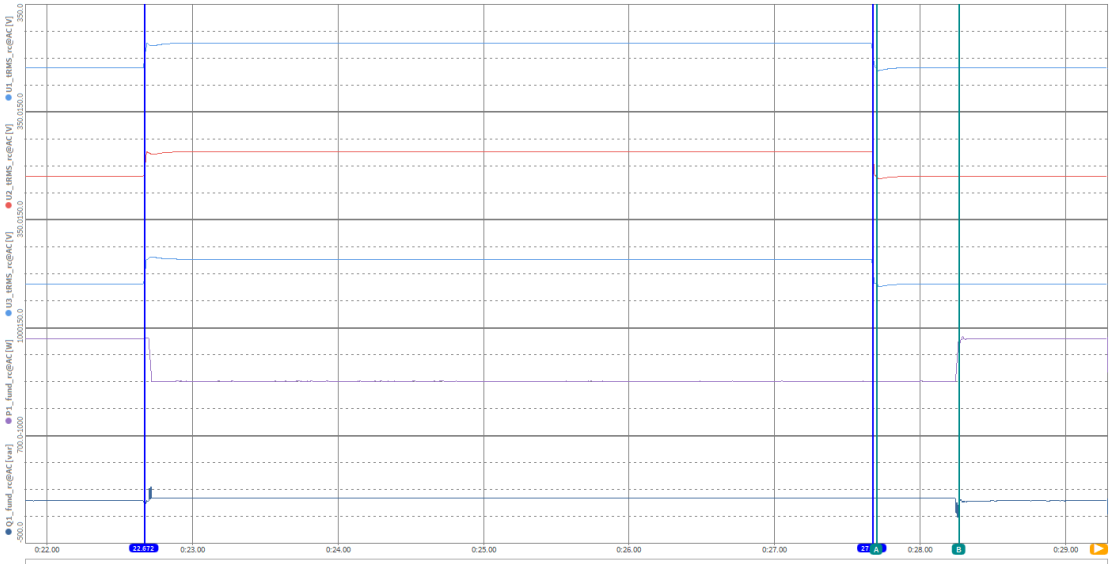
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6.1
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	17:56:22
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
		Point of fault entry	Total	--	ms	10861
	7	Point of fault clearance	Total	--	ms	15861
	8	Fault duration in empty load test	Total	--	ms	5000
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,201
	10		Phase 2			1,202
	11		Phase 3			1,201
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,995
	17	Active power	Total	t1-10s to t1	p.u.	0,991
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,039
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,993
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,201
	23		Phase 2			1,200
	24		Phase 3			1,201
	25	Line current	Phase 1	t1+60ms	p.u.	0,013
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,012
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,002
	34		Phase 2			1,000
	35		Phase 3			1,001
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,993
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,567
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,038
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



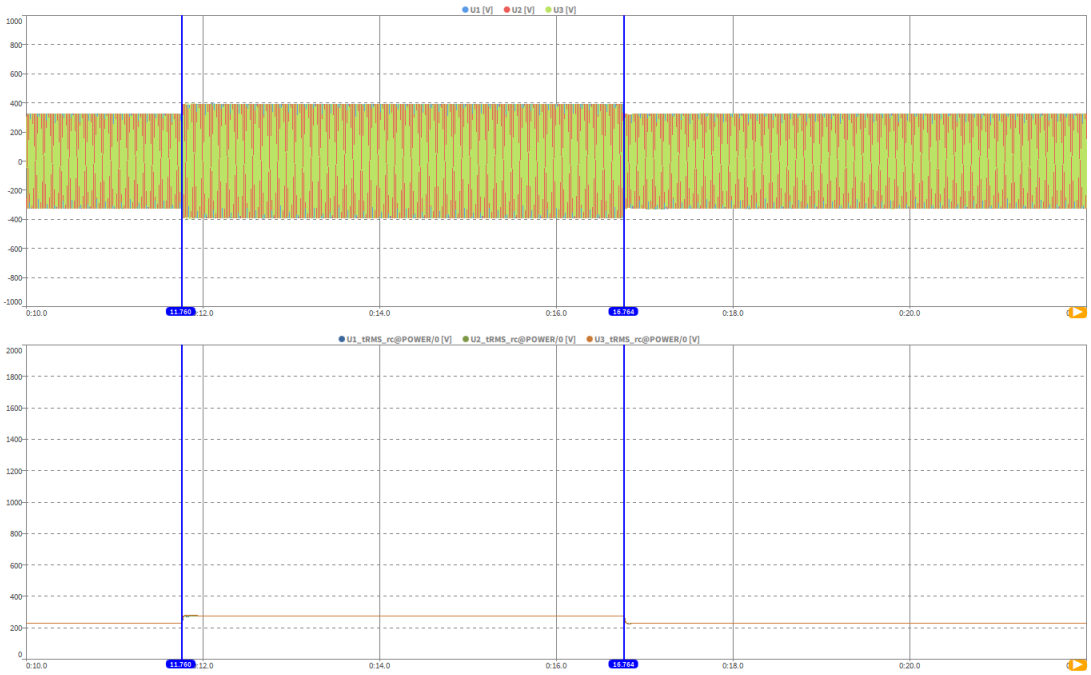
	A	B	Delta	RMS
Time [s]	0:27.70091	0:28.26779	0.56688	
U1_tRMS_rc@AC [V]	230.2437	230.6841	0.440445	229.4893
U2_tRMS_rc@AC [V]	229.7706	230.0721	0.301559	229.3046
U3_tRMS_rc@AC [V]	230.9060	230.3034	-0.602646	229.4718
P1_fund_rc@AC [W]	-2.008750	730.4620	732.4707	87.17085
Q1_fund_rc@AC [var]	-0.685307	-85.28084	-84.59553	26.21769

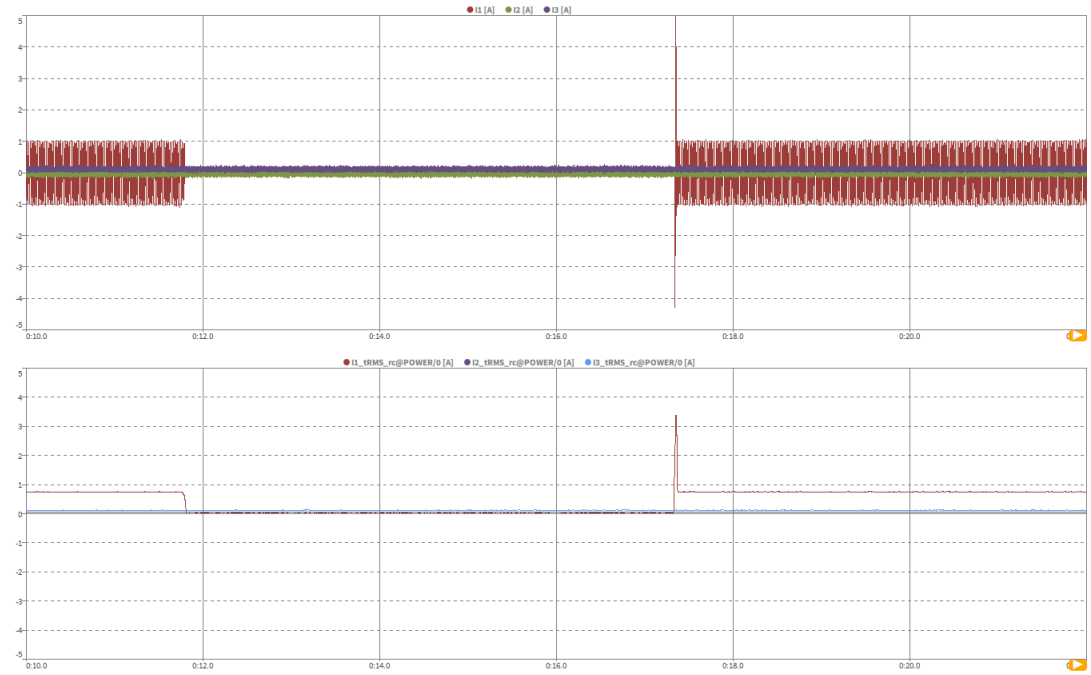
5.8.3	For PGUs Type 2 and storage systems	P

6.2

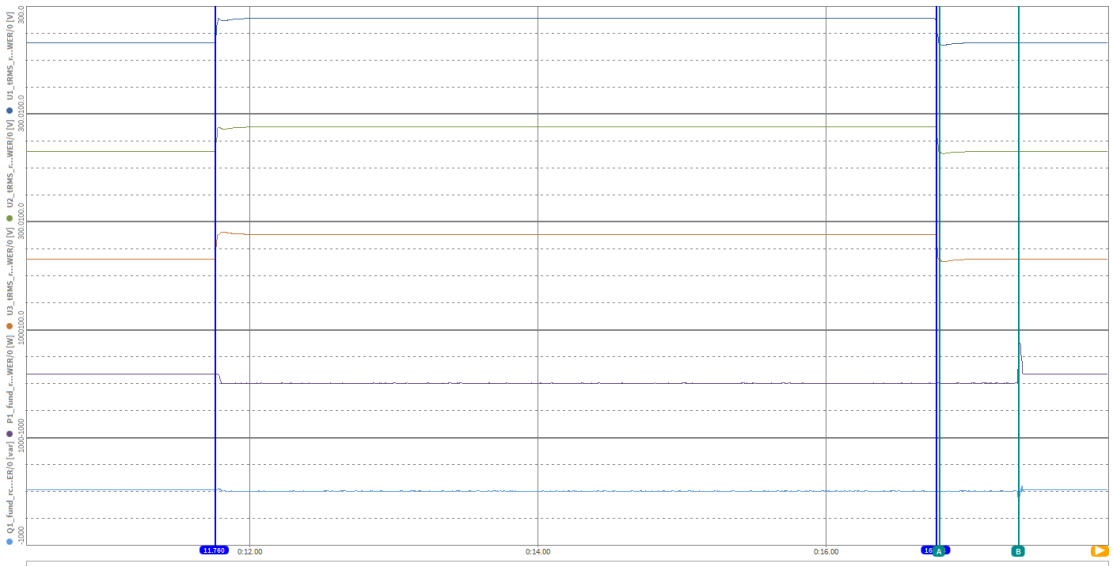
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6.2
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	13:32:30
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
		Point of fault entry	Total	--	ms	10861
	7	Point of fault clearance	Total	--	ms	15861
	8	Fault duration in empty load test	Total	--	ms	5000
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,201
	10		Phase 2			1,202
	11		Phase 3			1,201
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,000
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,216
	17	Active power	Total	t1-10s to t1	p.u.	0,208
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,032
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,988
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,201
	23		Phase 2			1,200
	24		Phase 3			1,202
	25	Line current	Phase 1	t1+60ms	p.u.	0,060
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,021
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,000
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,209
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,551
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,033
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



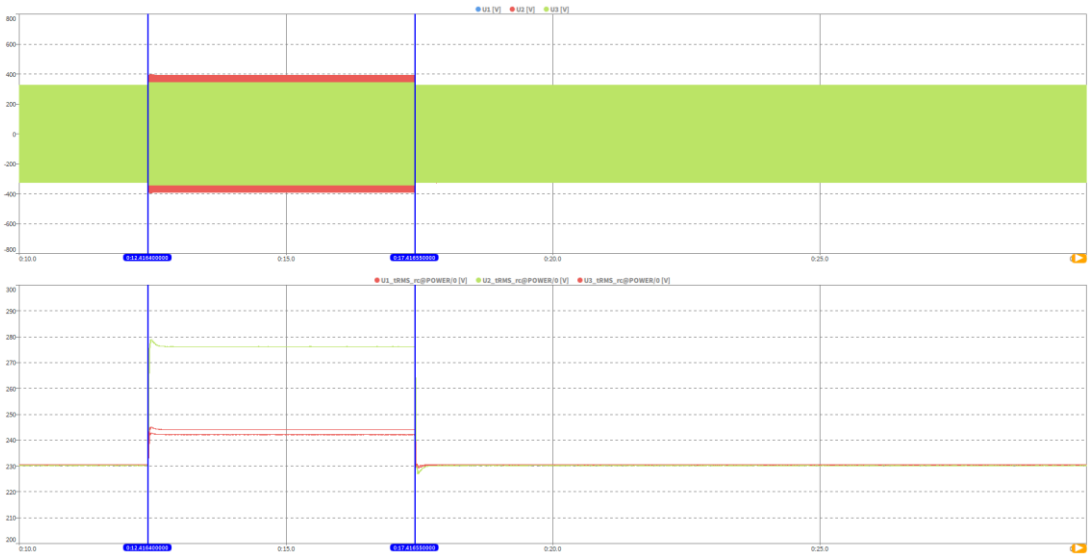
	A	B	Delta	RMS
Time [s]	0:16.78570	0:17.33676	0.55106	
U1_tRMS_rc@POWER/0 [V]	233.0558	230.3858	-2.669998	229.5349
U2_tRMS_rc@POWER/0 [V]	231.5520	230.0925	-1.459503	229.4539
U3_tRMS_rc@POWER/0 [V]	231.3020	230.3916	-0.910385	229.5617
P1_fund_rc@POWER/0 [W]	0.243148	220.4808	220.2376	12.39331
Q1_fund_rc@POWER/0 [var]	-0.494989	-113.1169	-112.6219	8.370819

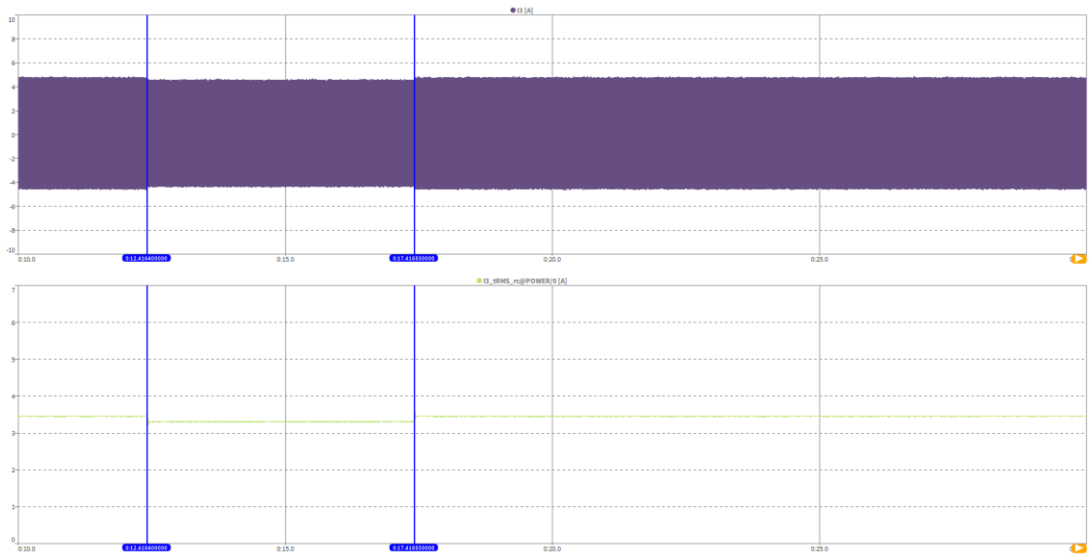
5.8.3	For PGUs Type 2 and storage systems	P

6.3

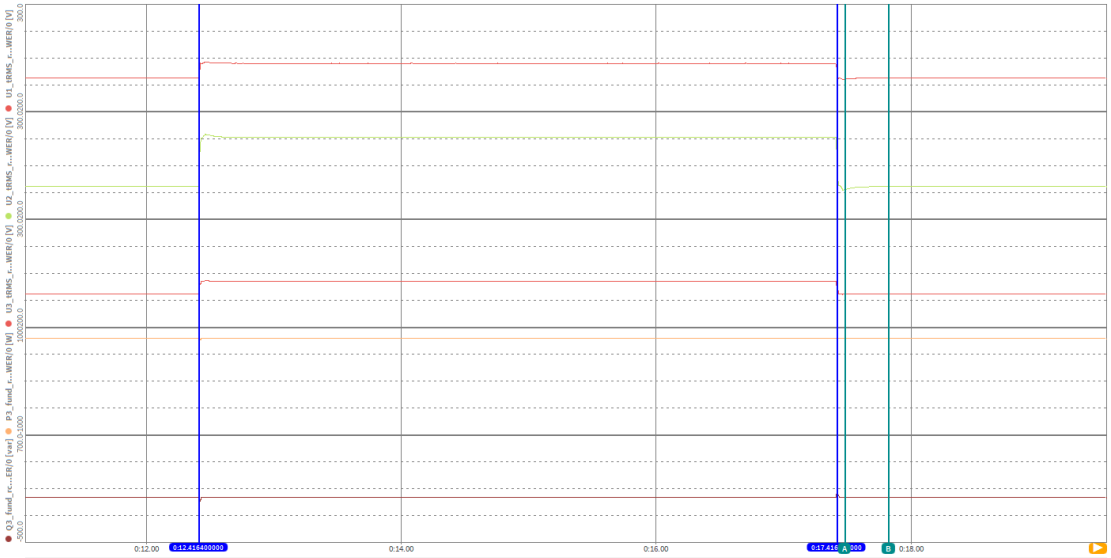
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6.3
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:26:55
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
		Point of fault entry	Total	--	ms	10599
	7	Point of fault clearance	Total	--	ms	15590
	8	Fault duration in empty load test	Total	--	ms	4991
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,061
	10		Phase 2			1,202
	11		Phase 3			1,052
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,992
	17	Active power	Total	t1-10s to t1	p.u.	0,986
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,002
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,999
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,061
	23		Phase 2			1,201
	24		Phase 3			1,053
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,948
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,950
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,991
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,985
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,346
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,002
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



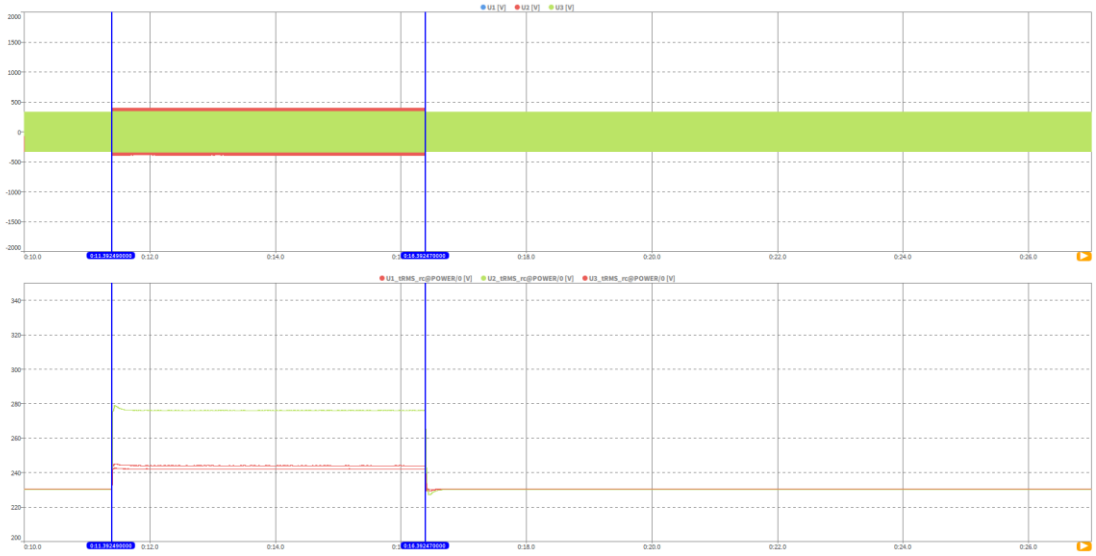
	A	B	Delta	RMS
Time [s]	0:17.47917	0:17.82512	0.34595	
U1_tRMS_rc@POWER/0 [V]	229.1814	230.2523	1.070847	230.0647
U2_tRMS_rc@POWER/0 [V]	227.0847	230.1270	3.042328	229.4891
U3_tRMS_rc@POWER/0 [V]	230.0251	230.4647	0.439575	230.3859
P3_fund_rc@POWER/0 [W]	788.1638	786.9506	-1.213135	788.2014
Q3_fund_rc@POWER/0 [var]	-0.576857	-1.319176	-0.742319	1.486777

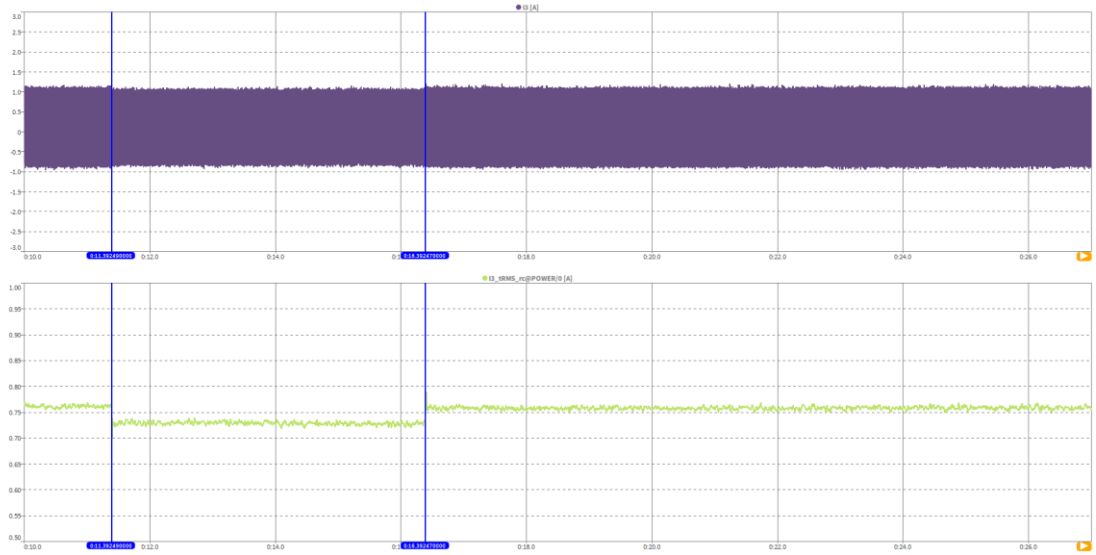
5.8.3	For PGUs Type 2 and storage systems	P

6.4

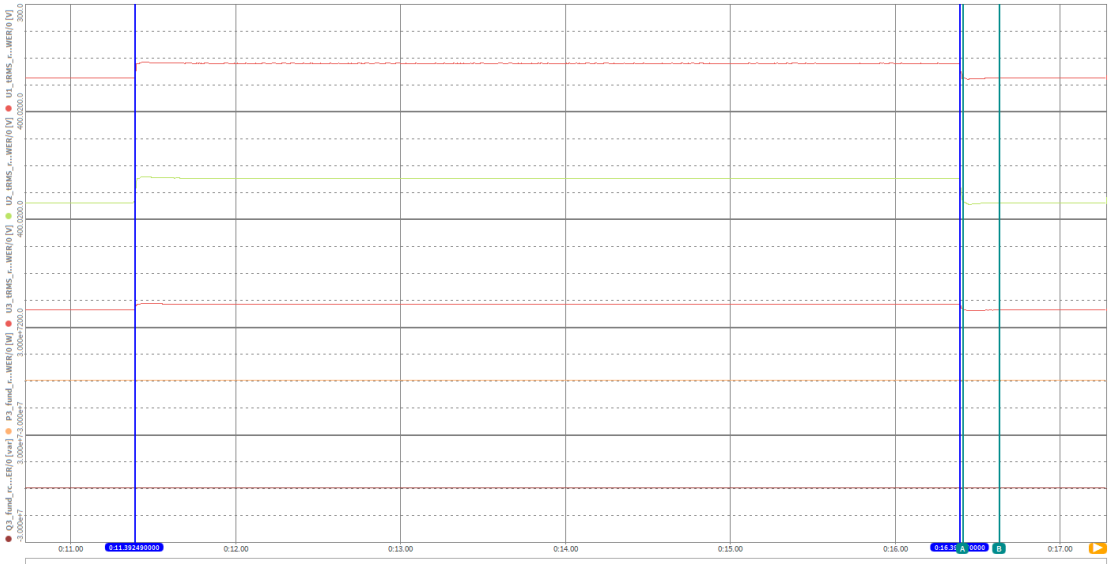
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6.4
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:24:00
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
		Point of fault entry	Total	--	ms	10599
	7	Point of fault clearance	Total	--	ms	15590
	8	Fault duration in empty load test	Total	--	ms	4991
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,061
	10		Phase 2			1,202
	11		Phase 3			1,052
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,219
	17	Active power	Total	t1-10s to t1	p.u.	0,207
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,048
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,991
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,061
	23		Phase 2			1,201
	24		Phase 3			1,053
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,948
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,950
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,045
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,206
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,222
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,046
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



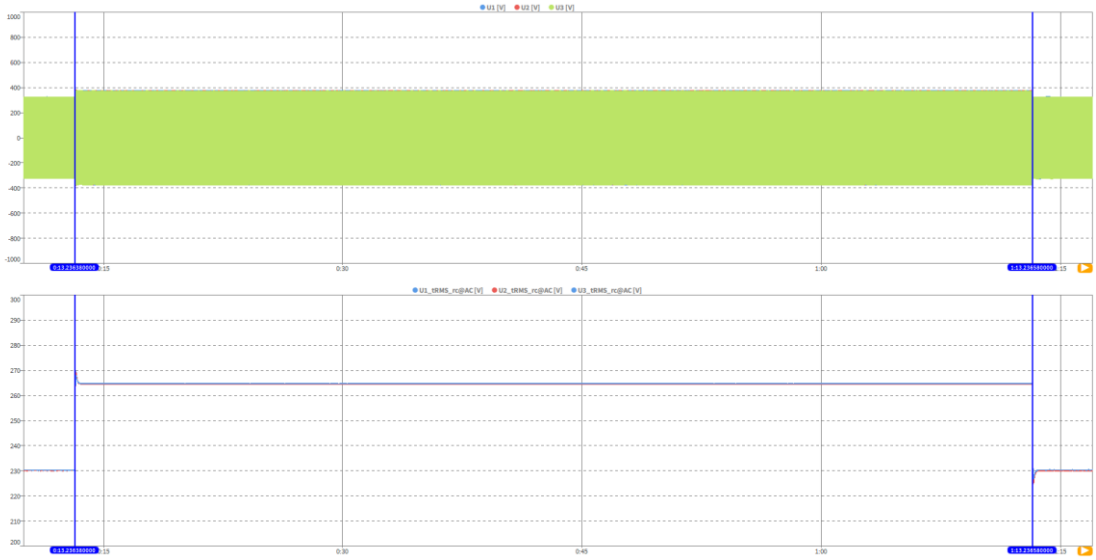
	A	B	Delta	RMS
Time [s]	0:16.40910	0:16.63136	0.22226	
U1_tRMS_rc@POWER/0 [V]	229.4881	230.2043	0.716202	229.8986
U2_tRMS_rc@POWER/0 [V]	235.0291	229.8926	-5.136551	229.0503
U3_tRMS_rc@POWER/0 [V]	233.6485	230.3920	-3.256485	230.3265
P3_fund_rc@POWER/0 [W]	167.5596	163.5857	-3.973816	164.7294
Q3_fund_rc@POWER/0 [var]	44.83888	38.46753	-6.371353	38.33944

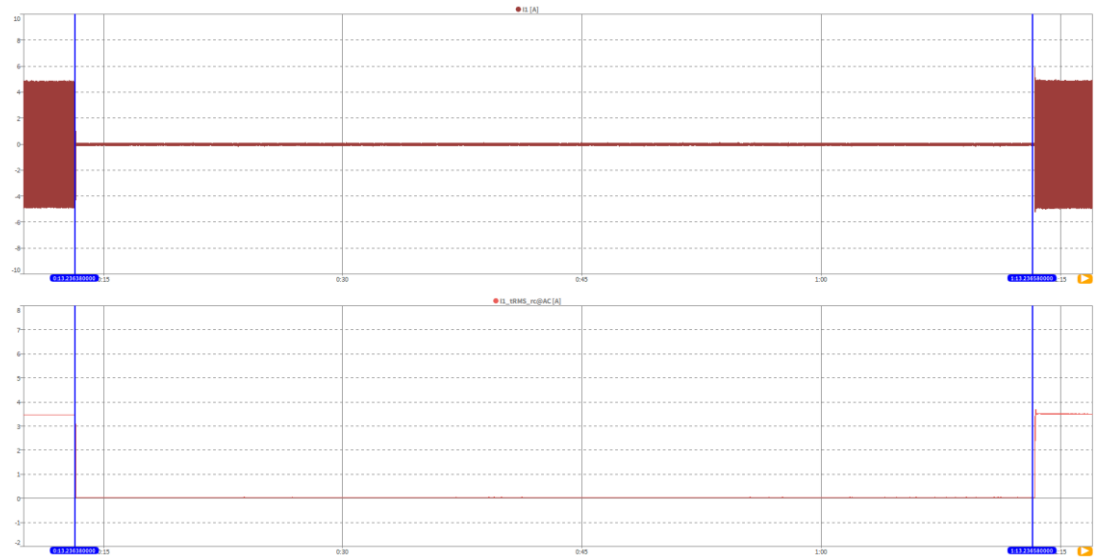
5.8.3	For PGUs Type 2 and storage systems	P

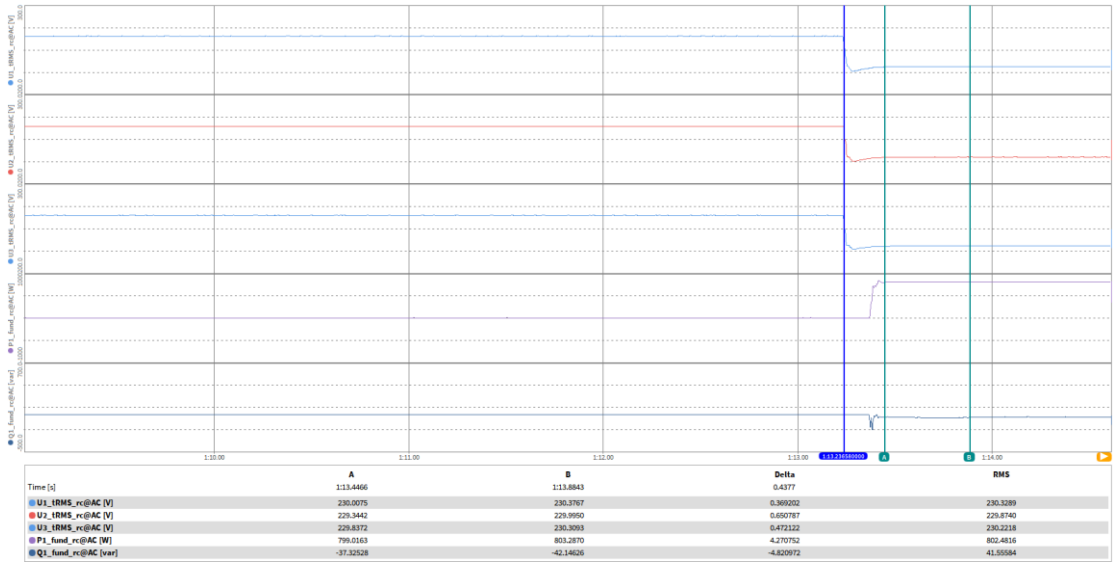
7.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7.1
	1	Date	--	--	yyyy.mm.dd	2022.12.4
	2	Time (start of test)	--	--	hh:mm:ss.f	18:06:47
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	10639
	7	Point of fault clearance	Total	--	ms	70639
	8	Fault duration in empty load test	Total	--	ms	60000
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,151
	10		Phase 2			1,151
	11		Phase 3			1,152
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,002
	14		Phase 2			1,000
	15		Phase 3			1,001
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,998
	17	Active power	Total	t1-10s to t1	p.u.	0,993
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,040
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,993
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,151
	23		Phase 2			1,150
	24		Phase 3			1,151
	25	Line current	Phase 1	t1+60ms	p.u.	0,012
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,010
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,002
	34		Phase 2			1,000
	35		Phase 3			1,001
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,999
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,438
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,043
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P







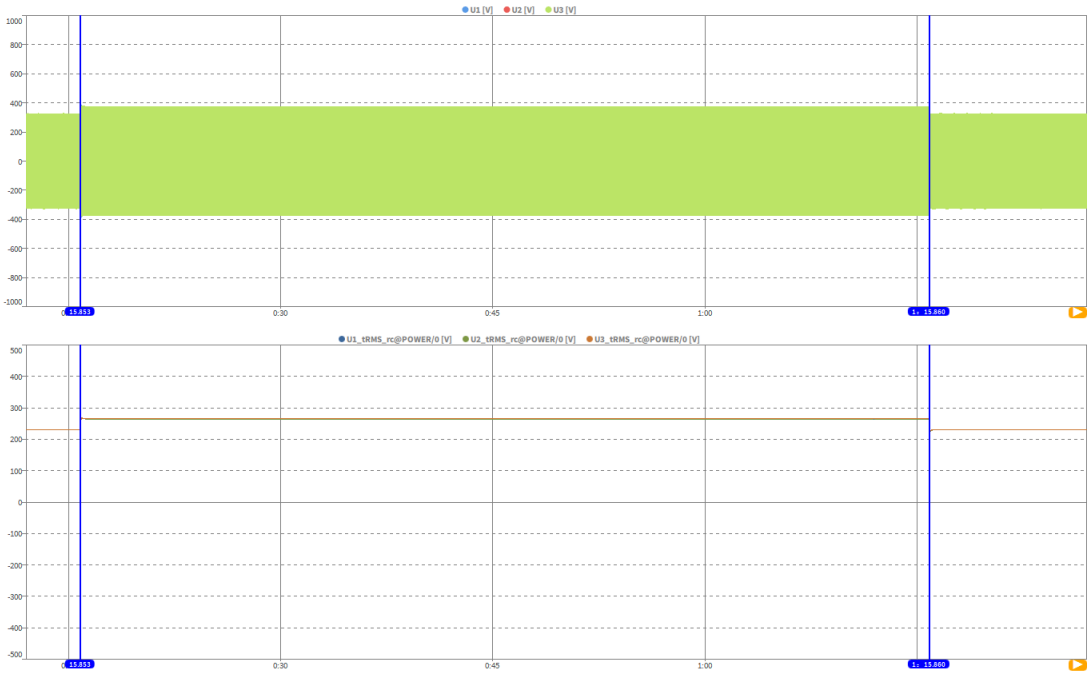
	A	B	Delta	RMS
Time [s]	1:13.4466	1:13.8843	0.4377	
U1_tRMS_rc@AC [V]	230.0075	230.3767	0.369202	230.3289
U2_tRMS_rc@AC [V]	229.3442	229.9950	0.650787	229.8740
U3_tRMS_rc@AC [V]	229.8372	230.3093	0.472122	230.2218
P1_fund_rc@AC [W]	799.0163	803.2870	4.270752	802.4816
Q1_fund_rc@AC [var]	-37.32528	-42.14626	-4.820972	41.55584

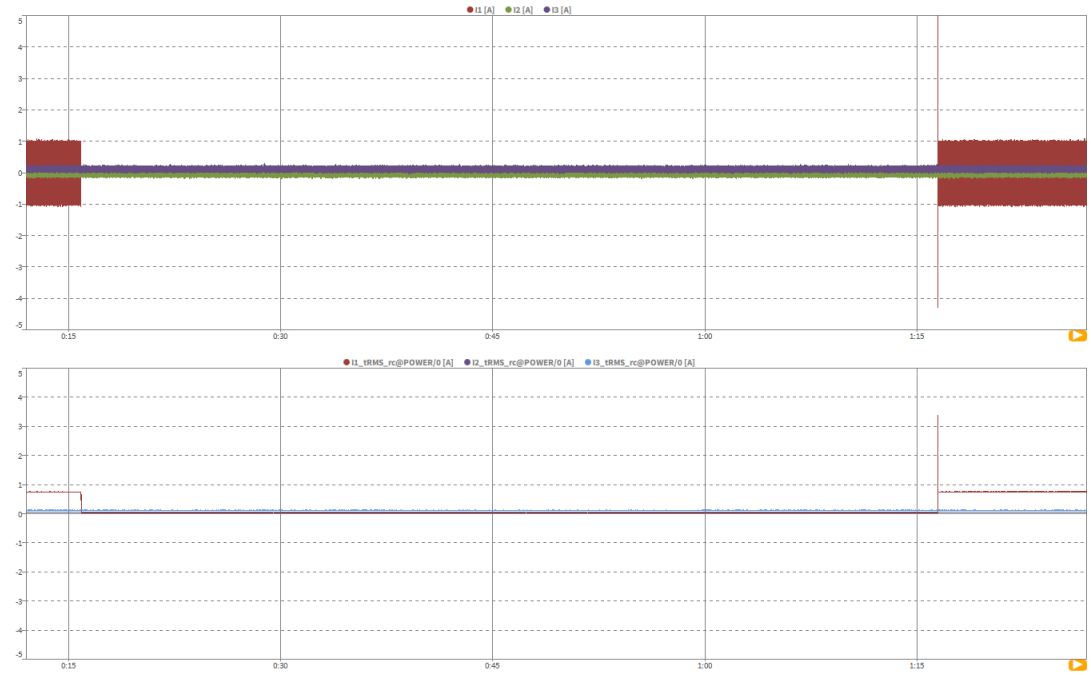
5.8.3	For PGUs Type 2 and storage systems	P

7.2

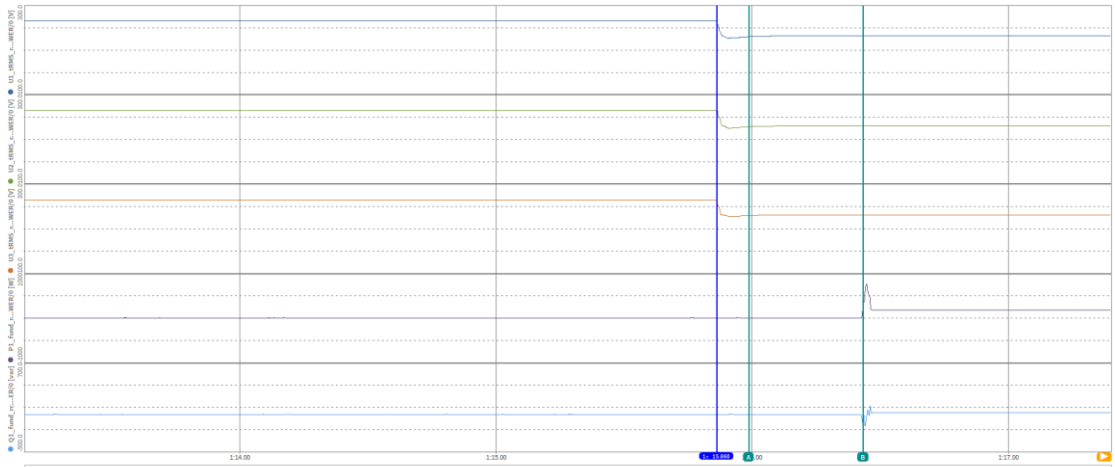
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7.2
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	13:38:53
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	10639
	7	Point of fault clearance	Total	--	ms	70639
	8	Fault duration in empty load test	Total	--	ms	60000
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,151
	10		Phase 2			1,151
	11		Phase 3			1,152
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,003
	14		Phase 2			1,000
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,215
	17	Active power	Total	t1-10s to t1	p.u.	0,209
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,032
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,988
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,151
	23		Phase 2			1,150
	24		Phase 3			1,152
	25	Line current	Phase 1	t1+60ms	p.u.	0,061
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,020
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,210
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,421
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,033
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



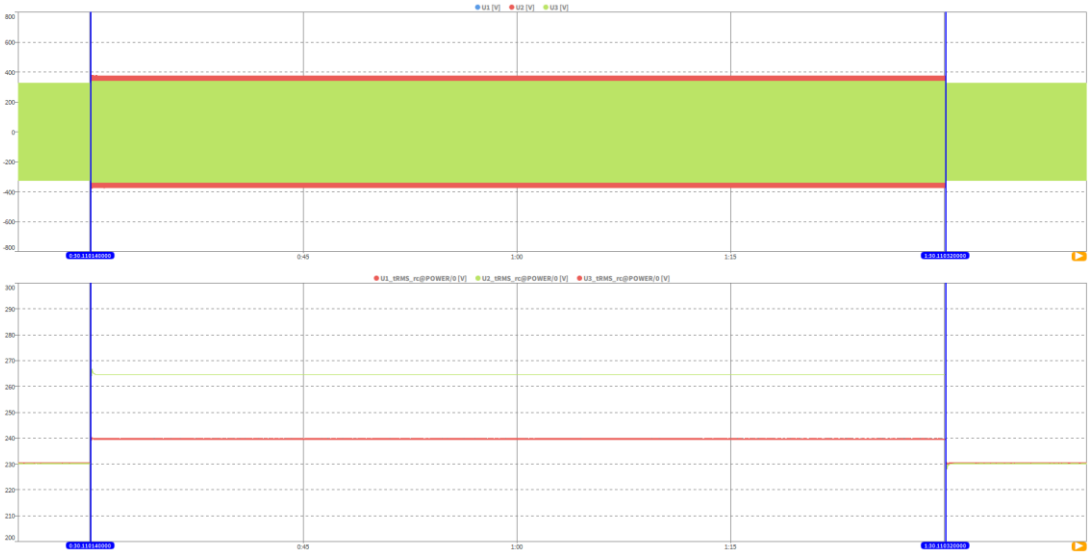
Time [s]	A 1:15.9868	B 1:16.4332	Delta 0.4464	RMS
U1_tRMS_rc@POWER/0 [V]	228.1999	230.3492	2.149323	229.8921
U2_tRMS_rc@POWER/0 [V]	227.9028	230.0986	2.195786	229.7745
U3_tRMS_rc@POWER/0 [V]	228.8943	230.4745	1.580276	230.1975
P1_fund_rc@POWER/0 [W]	-1.931806	212.8703	214.8021	13.16266
Q1_fund_rc@POWER/0 [var]	0.945788	-113.2688	-114.2146	9.013929

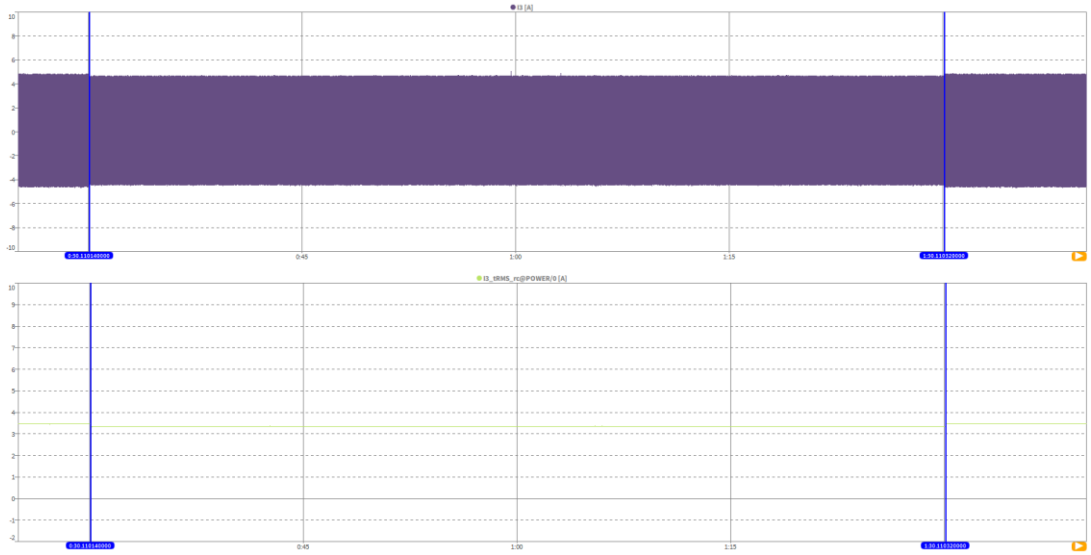
5.8.3	For PGUs Type 2 and storage systems	P

7.3

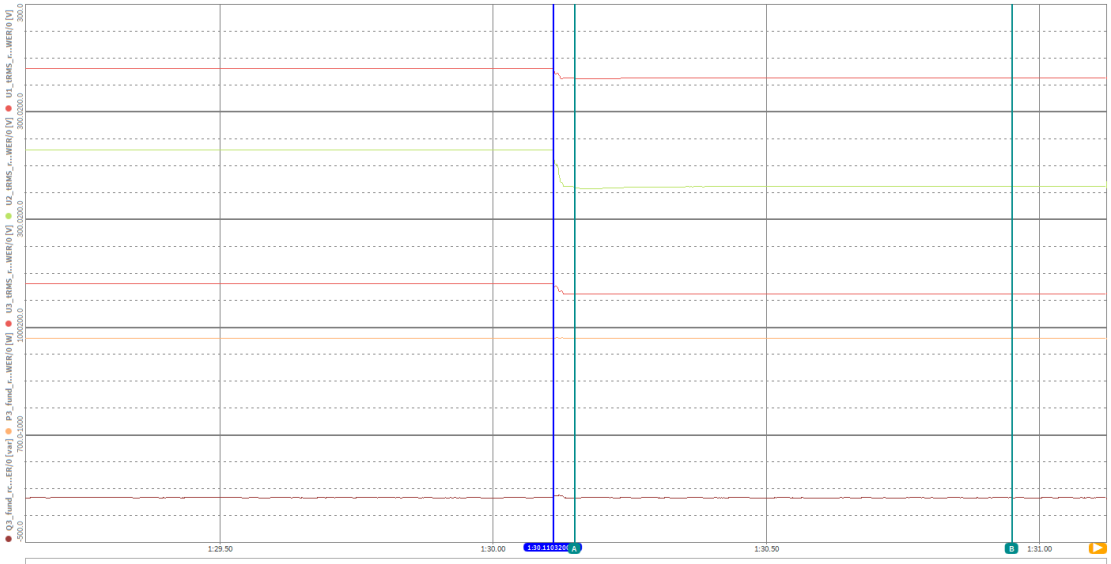
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7.3
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:12:45
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	10617
	7	Point of fault clearance	Total	--	ms	70645
	8	Fault duration in empty load test	Total	--	ms	60028
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,041
	10		Phase 2			1,152
	11		Phase 3			1,042
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,995
	17	Active power	Total	t1-10s to t1	p.u.	0,989
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,009
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	1,000
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,041
	23		Phase 2			1,151
	24		Phase 3			1,040
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,961
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,961
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,994
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,989
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,800
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,008
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P



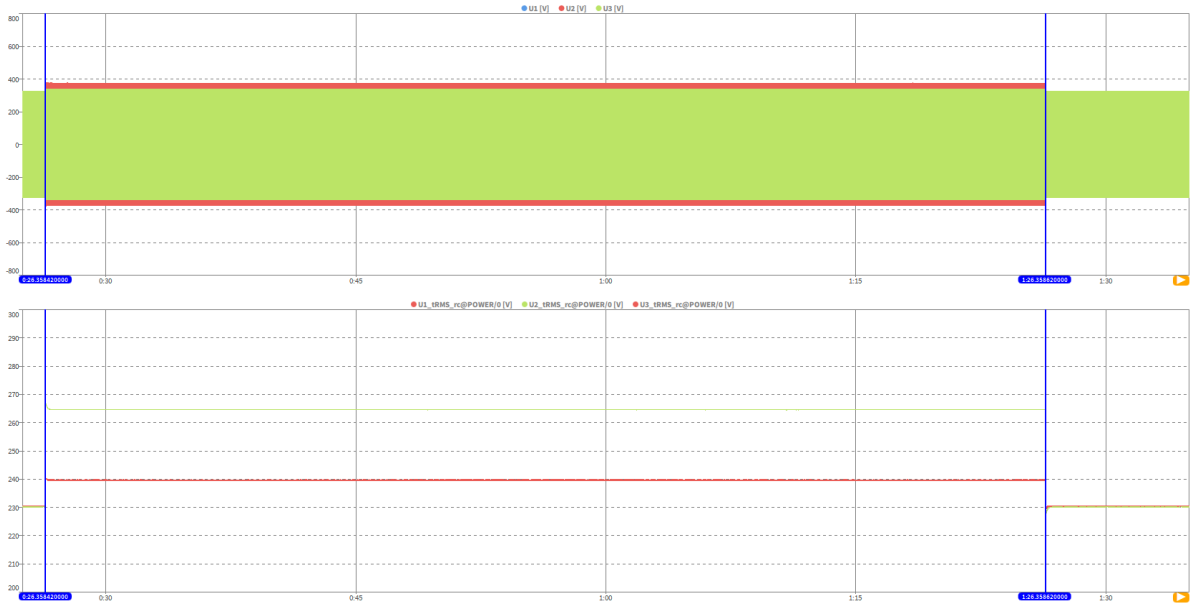
	A	B	Delta	RMS
Time [s]	1:30.1494	1:30.9491	0.7997	
U1_tRMS_rc@POWER/0 [V]	230.0166	230.3199	0.303329	230.2226
U2_tRMS_rc@POWER/0 [V]	229.8671	230.1681	0.300995	229.8743
U3_tRMS_rc@POWER/0 [V]	230.4323	230.4747	0.042404	230.4401
P3_fund_rc@POWER/0 [W]	791.1254	792.1769	1.051575	791.5714
Q3_fund_rc@POWER/0 [var]	-9.070612	-6.476529	2.594083	6.688894

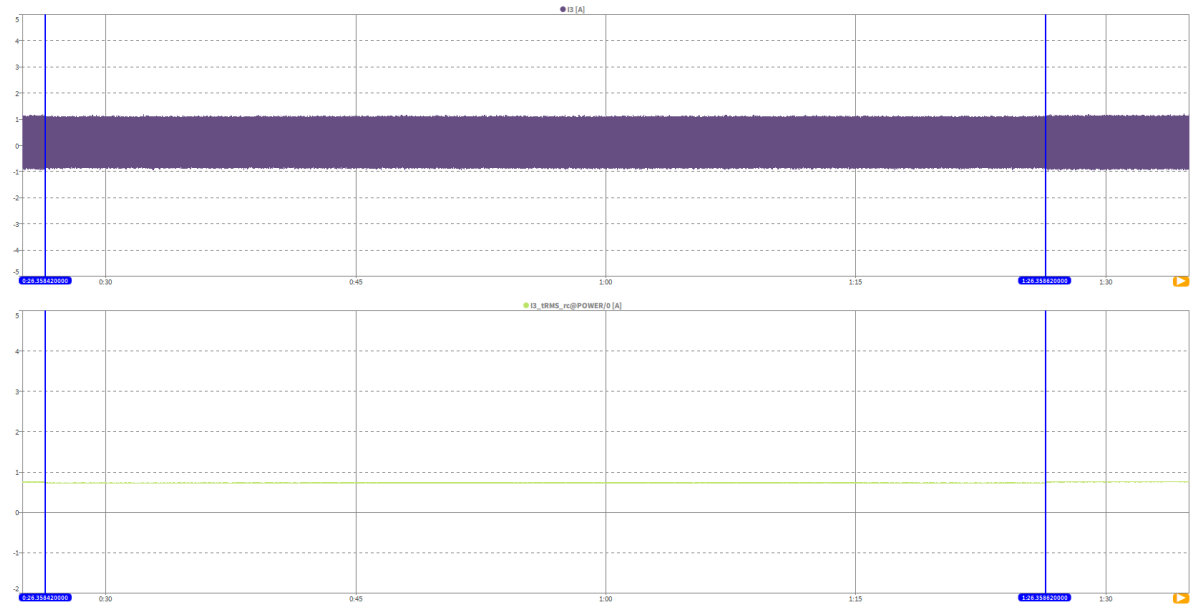
5.8.3	For PGUs Type 2 and storage systems	P

7.4

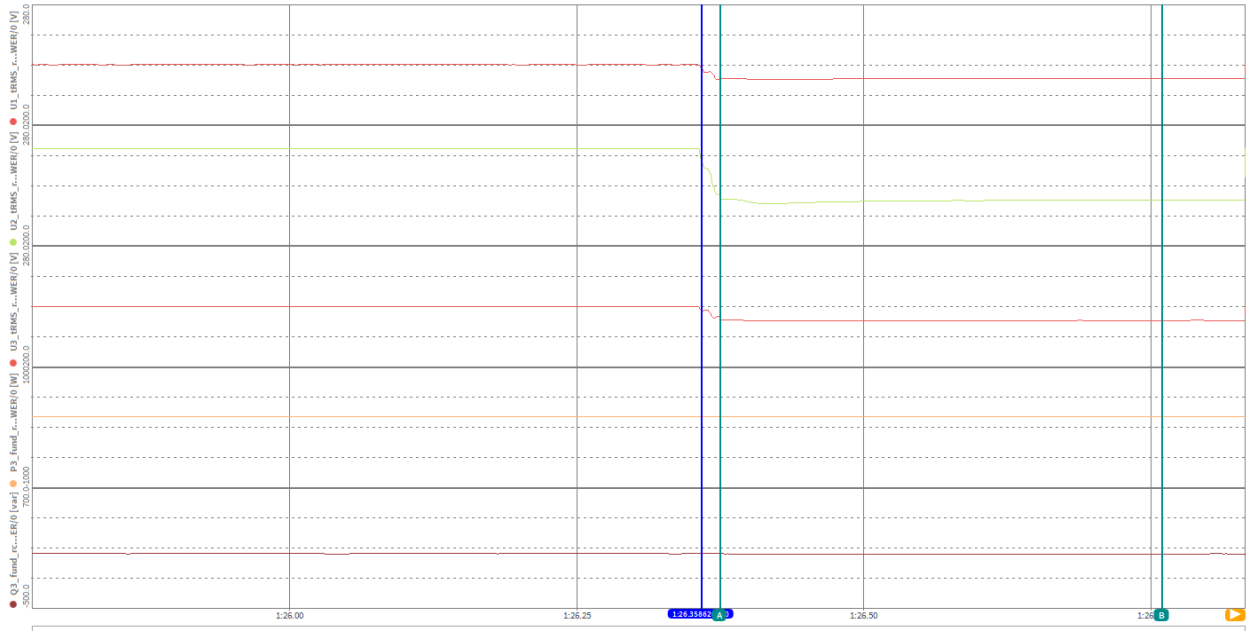
Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7.4
	1	Date	--	--	yyyy.mm.dd	2022.12.12
	2	Time (start of test)	--	--	hh:mm:ss.f	19:20:17
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
		Point of fault entry	Total	--	ms	10617
	7	Point of fault clearance	Total	--	ms	70645
	8	Fault duration in empty load test	Total	--	ms	60028
	9	Voltage depth/height in empty load test	Phase 1	t1+100ms to t2 and t1-10s to t1	p.u.	1,041
	10		Phase 2			1,152
	11		Phase 3			1,042
	12		Total			1,001
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,001
	14		Phase 2			1,001
	15		Phase 3			1,002
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,217
	17	Active power	Total	t1-10s to t1	p.u.	0,206
	18		Pos.			--
	19	Reactive power	Total	t1-10s to t1	p.u.	0,047
	20		Pos.			--
	21	Cosφ	Total	t1-10s to t1	--	0,976
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	1,041
	23		Phase 2			1,151
	24		Phase 3			1,043
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,210
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,210
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,206
	32		Pos.			--
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,001
	34		Phase 2			1,001
	35		Phase 3			1,002
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,206
	37		Pos.			--
	38	Active power rising time	Total	--	s	0,385
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,047
	40		Pos.			--
	41	Reactive power rising time	total	--	s	--
	42	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	Yes

5.8.3	For PGUs Type 2 and storage systems	P





5.8.3	For PGUs Type 2 and storage systems	P

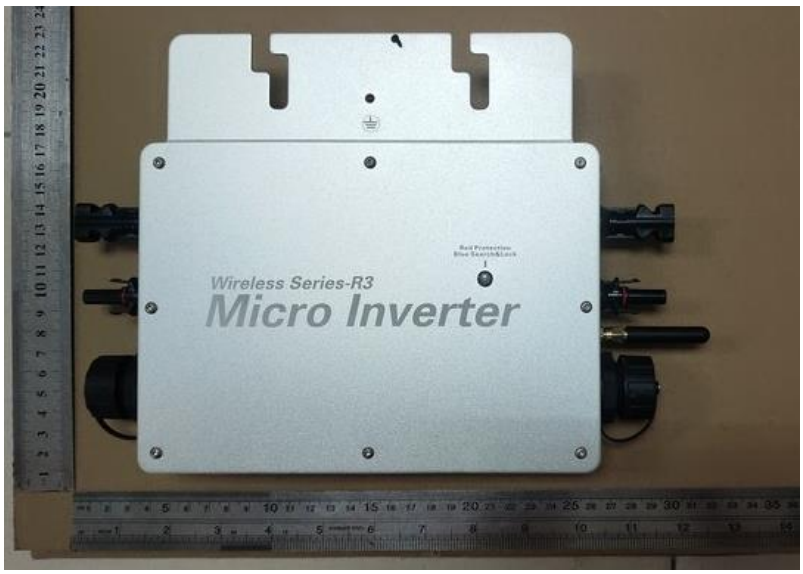


	A	B	Delta	RMS
Time [s]	1:26.3748	1:26.7596	0.3848	
U1_tRMS_rc@POWER/0 [V]	229.6046	230.2711	0.666595	230.1188
U2_tRMS_rc@POWER/0 [V]	233.7156	230.0913	-3.624283	229.6523
U3_tRMS_rc@POWER/0 [V]	233.0523	230.4447	-2.607590	230.4192
P3_fund_rc@POWER/0 [W]	166.4579	164.5475	-1.910385	164.3962
Q3_fund_rc@POWER/0 [var]	41.29215	37.39046	-3.901688	36.94846

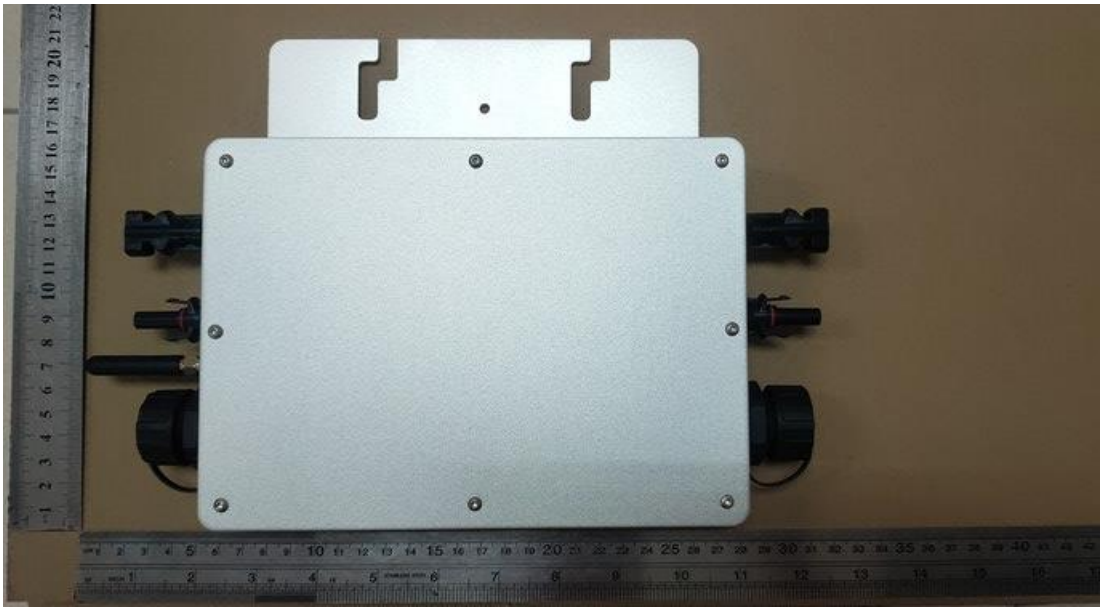
Annex 2 – Pictures of the unit

Photos of EUT

General view -1



General view -2



Photos of EUT

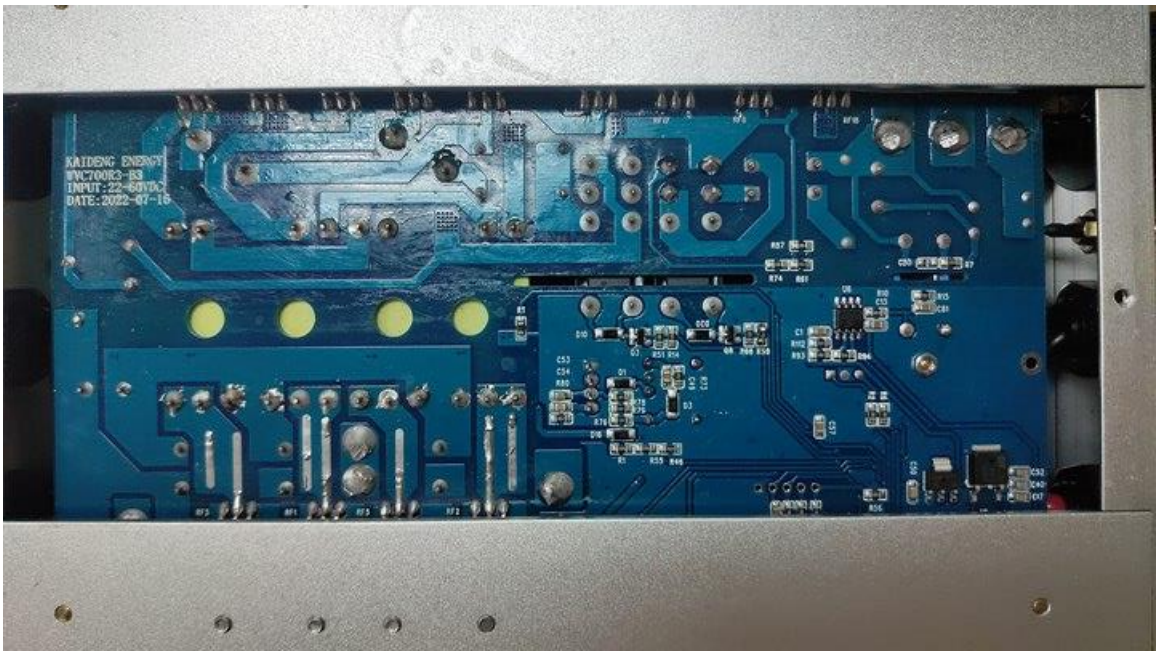
General view -3

General view -4

Photos of EUT

Internal view -1

Internal view -2



Annex 3 – Test equipment list

Date(s) of performance of tests: 2022-09-07 to 2022-12-19

Equipment	Internal No.	Manufacturer	Type	Serial No.	Due date Calibration
DC source	HC-ENG-011	Chroma	62150H-1000S	62150EF00314	Monitored by Power Analyzer
	HC-ENG-010	Chroma	62150H-1000S	62150EF01653	
AC source	HC-ENG-012	Chroma	61830	//	
Load	HC-ENG-005	Qunling	ACLT-3803H	93H006289	
Data acquisition instrument	HC-ENG-003	DEWESOFT	SIRIUSi-HS-4xHV-4xLV	DB20123915	2023-09-05
	HC-ENG-029	DEWETRON	TRION-1820-POWER	A1228623	2023-06-23
Current sensor	HC-ENG-019	LEM	IT 400-S	82021060080	2023-09-05
	HC-ENG-020	LEM	IT 400-S	82021060081	2023-09-05
	HC-ENG-021	LEM	IT 400-S	82021060082	2023-09-05
	HC-ENG-022	LEM	IT 400-S	82021060084	2023-09-05

---End of test report--