Test Report issued under the responsibility of:

LYNS-TCi

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.	**LS2A25082503EGDE01**
Total pages	231
Tested by (name + signature)	Biscuit Ren / Test engineer
Approved by (name + signature)	Lukes Lin / Project Manager
Date of issue	2025-11-26

Applicant's name	Marstek energy Co., Ltd.
Address	1-4F, BLDG#9, 1/F, BLDG#5, West Industrial Park, South of the Intersection of Ma'anshan Tunnel and Zhangshe Avenue, Xiangxi High-tech Zone, Hunan Province, China
Manufacturer	Hamedata Technology Co.,Limited
Address	1-3F & 6-8F,BLDG#A, Changfang Industrial Park, No.2 Guihua 5th Road, Pingshan District, Shenzhen, Guangdong, China

Testing laboratory name	Lyns-tci Technology Guangdong Co., Ltd.
Address	Room 1201, Unit 2, Building 18, No. 7, Science and Technology Boulevard, Houjie Town, Dongguan City, Guangdong, 523960 P.R.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: Lyns-tci Technology Guangdong Co., Ltd.
Address: Room 1201, Unit 2, Building 18, No. 7, Science and Technology Boulevard, Houjie Town, Dongguan City, Guangdong, 523960 P.R.C
Tel: +86 769 85598986 E-Mail: service-hc@lyns-tci.com Web: www.lyns-tci.com

Product name ..... :	MARSTEK VENUS-E (Energy Storage System)
Trade Mark ..... :	MARSTEK
Factory's name ..... :	Hamedata Technology Co.,Limited
Factory address ..... :	1-3F & 6-8F,BLDG#A, Changfang Industrial Park, No.2 Guihua 5th Road, Pingshan District, Shenzhen, Guangdong, China

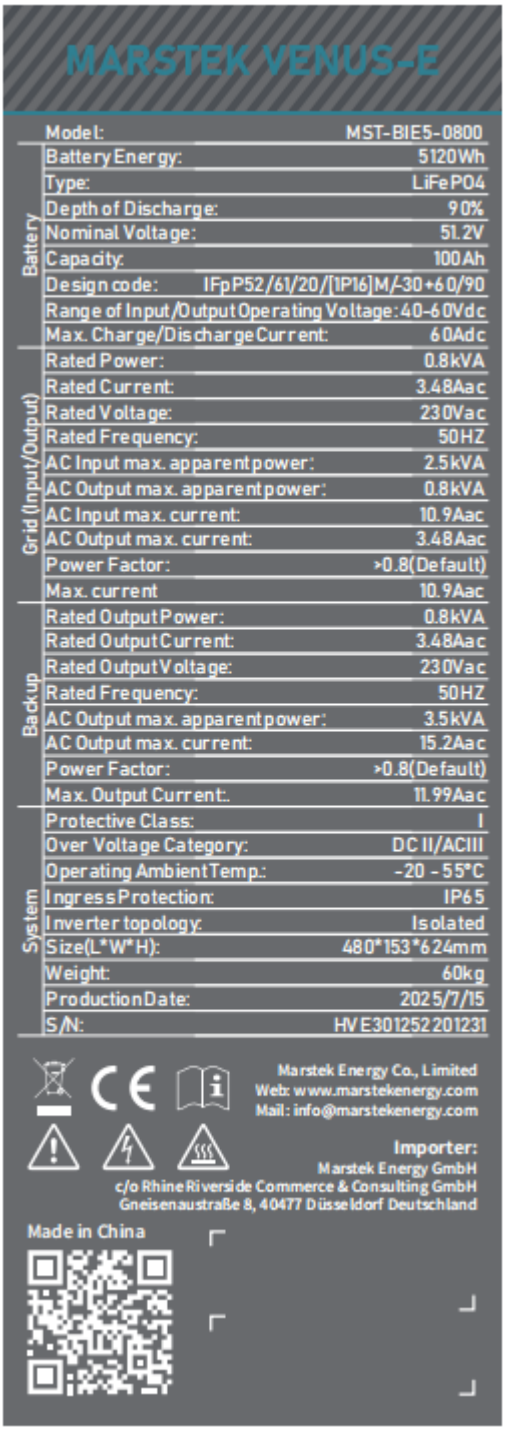
Model/Type reference ..... :	**MST-BIE5-2500**	**MST-BIE5-0800**
Ratings:		
Battery Model ..... :	GSP50160119F	
Battery Type ..... :	LiFePO4	
Battery voltage range [V]..... :	40-60	
Battery Rated Voltage [V]..... :	51,2	
Battery Energy[V] ..... :	5,12kWh	
Maximum charge/discharge current [A] ..... :	60/60	
Firmware version of the BMS	106	
Rated Input AC voltage [V]..... :	230Vac, L+N+PE, 50Hz	
Rated Input AC Power [kVA] ..... :	2,5	
Rated Input AC Current [A] ..... :	10,9	
Max. apparent power [kVA] ..... :	2,5	
Max. current [A] ..... :	10,9	
Rated output AC voltage [V]..... :	230Vac, L+N+PE ,50Hz	
AC Output Rated Current [A] ..... :	10,9	3,48
Max AC Output Current [A] ..... :	10,9	3,48
Rated active power P_{rE} [kW]..... :	2,5	0,8
Maximum active power P_{Emax} [kW]... :	2,5	0,8
Rated apparent power S_{rE} [kVA] ..... :	2,5	0,8
Maximum apparent power S_{Emax} [kVA] ..... :	2,5	0,8
Software version..... :	113	

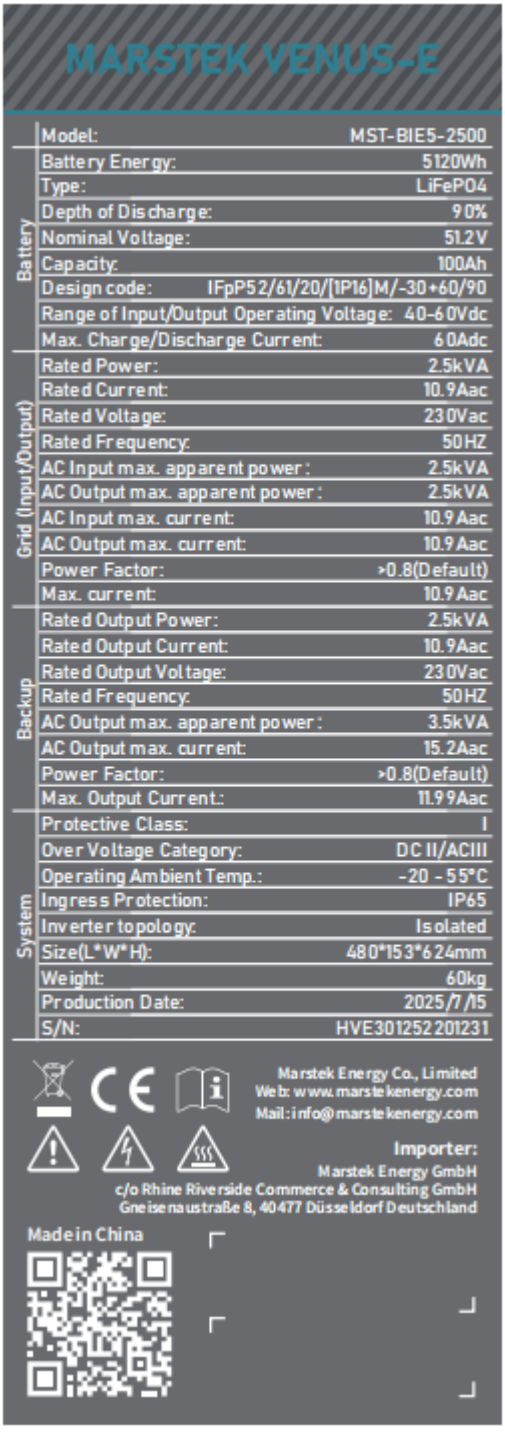
Contents

Revision history of test report

Issued Date	Description	Report Number
2025-11-26	Initial issue.	LS2A25082503EGDE01

Copy of marking plate





Note:

The marking plates shown above may be only a draft. The use of certification marks on products must be approved by the respective NCBs to which these marks belong. The marking plate is attached to the side surface or the back of the enclosure and is visible after installation.

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 .....: 2025-09-03

Date(s) of performance of tests .....: 2025-09-03 to 2025-11-23

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.

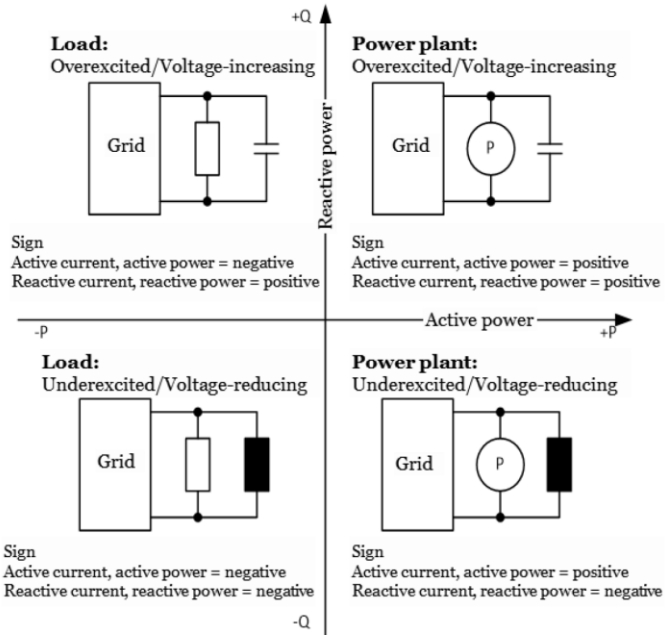
Throughout this report a ☒comma / ☐point is used as the decimal separator.

Conformity statements are decided in accordance with ILAC-G8:09/2019 Binary Statement for Simple Acceptance Rule, 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.

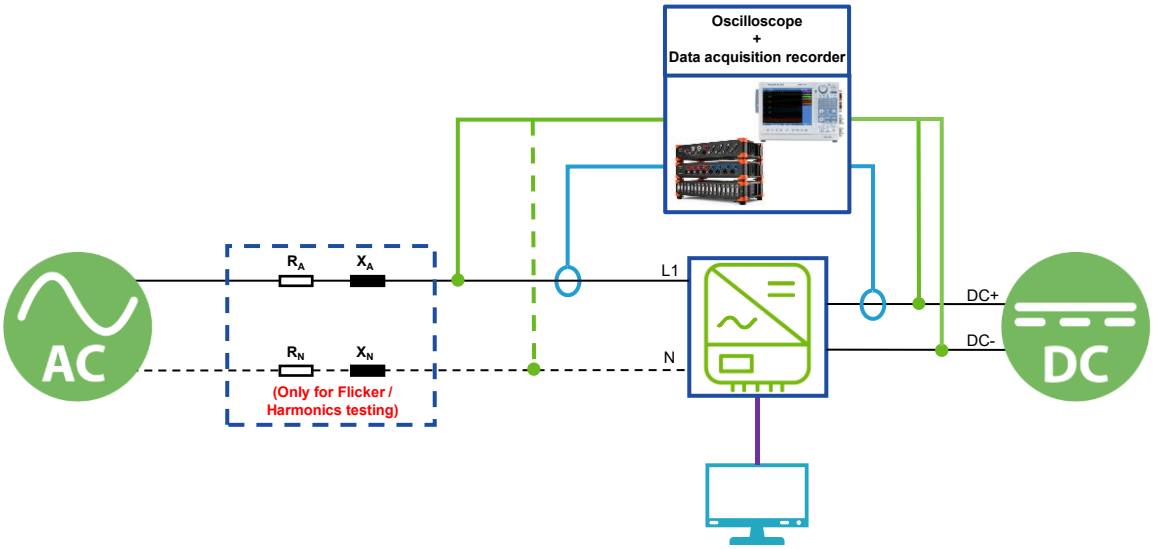


Figure 1 – Test setup 1

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

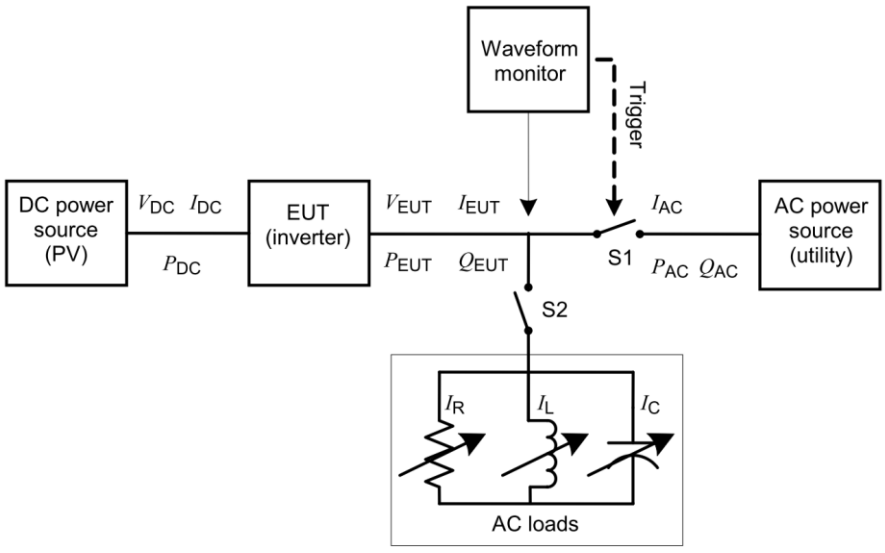


Figure 2 – Test circuit for islanding detection function in a power conditioner (inverter) from IEC 62116:2014

General product information

Equipment mobility	:	Permanent connection
Operating condition	:	Continuous
Class of equipment	:	Class I
Protection against ingress of water	:	IP65
Mass of equipment [kg]	:	Approximately 60kg

General product information

The **MST-BIE5-0800** and **MST-BIE5-2500** is a single-phase storage inverter. The inverter is designed to convert the direct current power generated from the battery into grid-compatible AC current and to feed the AC current into the utility grid. (See Figure 3)

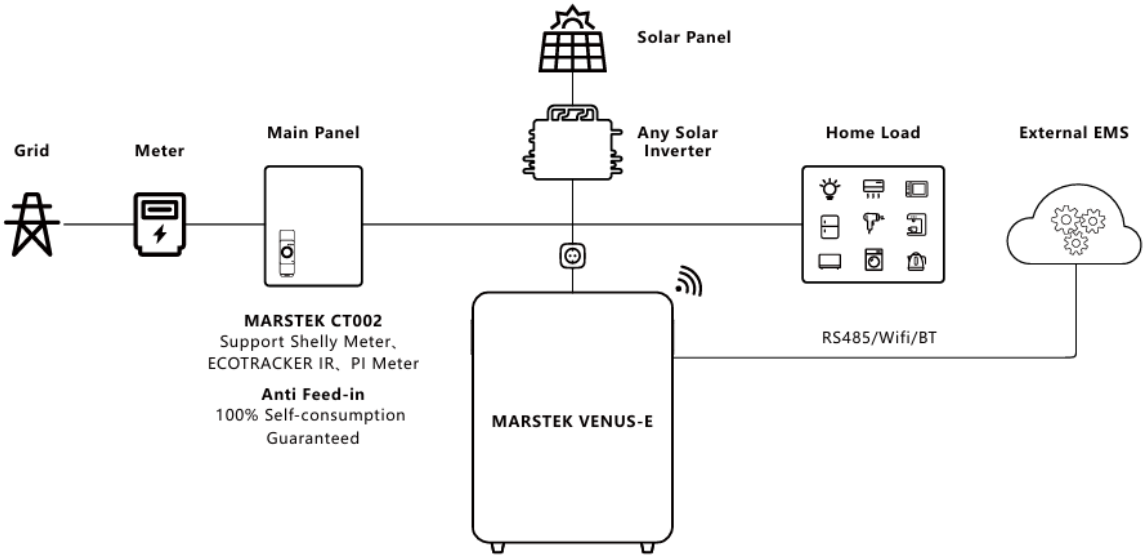


Figure 3 – Scheme of an installation

The product was tested on the EUT **MST-BIE5-2500**.

Hardware Version: V34

Software Version: 113

Model Difference:

The units in the series are identical hardware platform. The implemented control and firmware are identical in all units. There is no difference regarding AC behavior between the PGU-types apart from the power rating deviation and current limitation of each unit.

The units in the product series:

- sharing the same control electronics.
- with the same firmware.
- with the same construction solutions including the power part.
- with the same number of phases.
- with the same power electronics, filters and transducers designed for different sizes of current ratings.

General product information

Description of the power circuit (Figure 4):

This inverter converts the DC power of the battery into AC power, with single-phase output and both input and output have varistor grounding protection. It adopts an isolation transformer topology.
The control system adopts a redundant master-slave DSP architecture: U28 is the main DSP responsible for relay control, bus voltage, grid voltage and frequency, AC current (including DC injection) measurement, and calibration of current sensors before startup; U9 is a DSP that independently monitors the voltage and frequency of the power grid. It can disconnect relays separately and communicate with the main DSP for mutual inspection, improving protection reliability.
The output part achieves dual protection through isolation transformers and relays: even if a single relay fails, the isolation transformer can still maintain insulation and disconnect. When the system detects an abnormality in the relay, it will sound an alarm and display an error code. All relays undergo self inspection before starting up.

The current signal is collected by sensors, and both AC and DC components are sent to the main DSP for analysis. The battery voltage and temperature are monitored by BMS and interact with the control board through CAN to manage charging and discharging.

Working mode:

Grid connected mode: Close relay K1, which can charge the battery or feed power to the grid, with a rated power of 2500 W/800W;

Off grid mode: Close relay K2 and supply power to the load through the Backup interface, with a rated power of 2500 W.

In the event of a malfunction, the master-slave DSP collaboratively triggers protection, and if necessary, a relay or isolation transformer is used for secondary disconnection to ensure basic insulation between the battery and the grid.

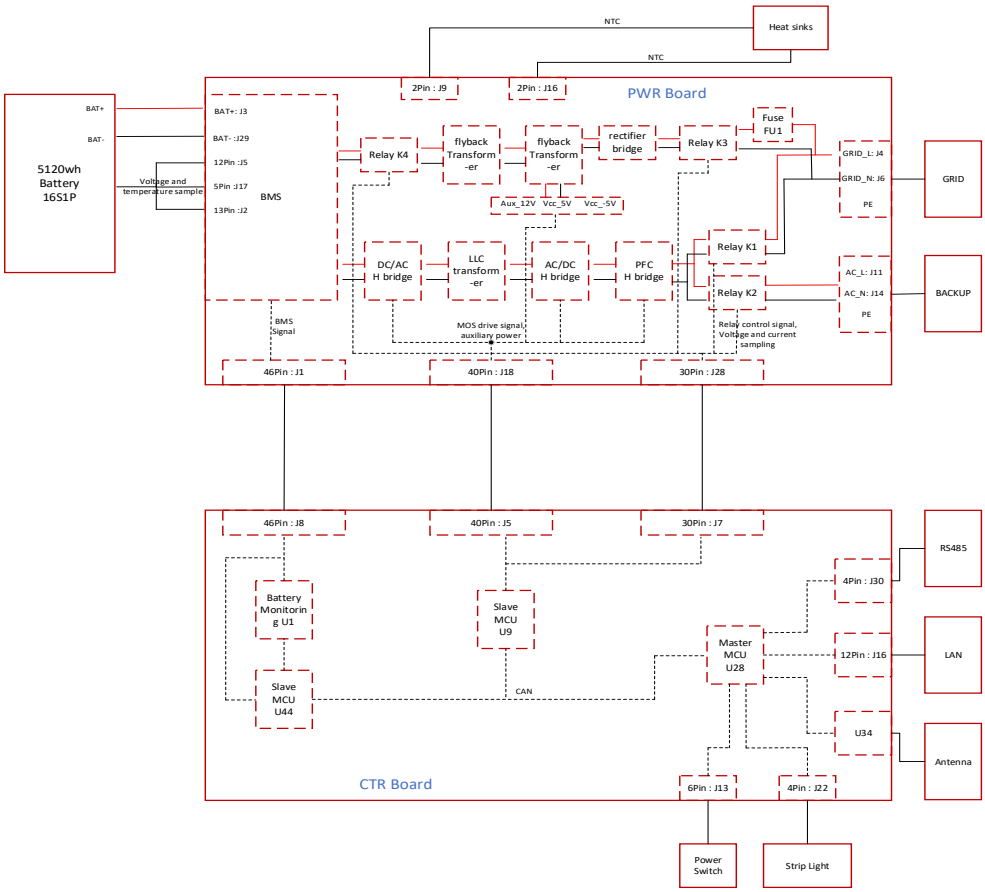


Figure 4 – Block diagram

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	**P**
5.4.4	Active power feed-in for PGUs at over-frequency	**N/A**
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	**N/A**
5.4.7	Active power feed-in for storage systems at underfrequency	**P**
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	**N/A**

Assessment

Clause/§	Requirement	Verdict
5.4.8.4.2	Test of the dynamics of the Q(U) regulation	**N/A**
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 %

Assessment criterion:

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)

MST-BIE5-2500

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

Phase	L1			L2			L3		
Single period effective values of the current [A]	0,840	0,997	1,031	--	--	--	--	--	--
Single period effective values of the voltage [V]	229,9	229,8	229,8	--	--	--	--	--	--
k_i value [1]	0,019	0,023	0,024	--	--	--	--	--	--
k_{imax} value [1]	0,024			--			--		

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]	1,938	1,061	1,070	--	--	--	--	--	--
Single period effective	229,5	229,8	229,9	--	--	--	--	--	--

values of the voltage [V]									
k_i value [1]	0,045	0,024	0,025	--	--	--	--	--	--
k_{imax} value [1]	0,045			--			--		
Switch-off for nominal capacity									
Phase	**L1**			**L2**			**L3**		
Single period effective values of the current [A]	1,270	0,391	1,461	--	--	--	--	--	--
Single period effective values of the voltage [V]	229,8	229,2	229,7	--	--	--	--	--	--
k_i value [1]	0,029	0,009	0,034	--	--	--	--	--	--
k_{imax} value [1]	0,034								

Grid Frequency [Hz]	50,0
Grid voltage [V]	230,0
Rated current I_r [A]	10,870
Highest k_{imax} value for all switching operations [1]	0,045

Note:

The test results of the **MST-BIE5-2500** 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!)

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Test result:

a) Flicker to DIN EN 61000-3-11 (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				
MST-BIE5-2500		*IEC EN 61000-3-3*			*IEC EN 61000-3-11*				
		Starting			Stopping			Running	
		d_{max}	d_c	T_{max}	d_{max}	d_c	T_{max}	P_{st}	P_{lt}
Phase L1		1,438	0,002	0,000	0,564	0,002	0,000	0,020	0,019
Phase L2		--	--		--	--		--	--
Phase L3		--	--		--	--		--	--
Output voltage of the impedance network [V]					230,0				
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 61000-3-11 (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)	0,400	
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 rise 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(fψ_k) [1]	--	--	--	--
Voltage change factor k(uψ_k) [1]	--	--	--	--

5.2.4	Harmonics and interharmonics	P

5.2.4.1 a)	Harmonics test	P

EUT		Selection of limits		
☒	☐	☒	☐	☐
1-phase	*3-phase*	Class A 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
MST-BIE5-2500		***IEC EN 61000-3-2***	***IEC EN 61000-3-12***	

Phase	**L1**	**L2**	**L3**
Power Level	**30%**	**30%**	**30%**
AC Power [W]	751	--	--
AC Voltage [V]	229,8	--	--
AC Current [A]	3,272	--	--
Frequency [Hz]	50,00	--	--

Harmonic	**Measured value I_h [A]**			**Measured value I_h [%I_1]**			**Limits [A]** IEC EN 61000-3-2
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	
1st	3,268	--	--		--	--	--
2nd	0,007	--	--	0,228	--	--	1,080
3rd	0,039	--	--	1,196	--	--	2,300
4th	0,003	--	--	0,089	--	--	0,430
5th	0,041	--	--	1,269	--	--	1,140
6th	0,004	--	--	0,120	--	--	0,300
7th	0,022	--	--	0,661	--	--	0,770
8th	0,005	--	--	0,147	--	--	0,263
9th	0,020	--	--	0,601	--	--	0,400
10th	0,004	--	--	0,109	--	--	0,184
11th	0,019	--	--	0,585	--	--	0,330
12th	0,003	--	--	0,100	--	--	0,153
13th	0,009	--	--	0,264	--	--	0,210
14th	0,004	--	--	0,108	--	--	0,131
15th	0,018	--	--	0,551	--	--	0,150
16th	0,005	--	--	0,138	--	--	0,115
17th	0,019	--	--	0,574	--	--	0,132
18th	0,004	--	--	0,117	--	--	0,102
19th	0,017	--	--	0,512	--	--	0,188
20th	0,004	--	--	0,127	--	--	0,092
21th	0,010	--	--	0,295	--	--	0,107
22th	0,004	--	--	0,113	--	--	0,084
23th	0,009	--	--	0,285	--	--	0,098
24th	0,004	--	--	0,111	--	--	0,077
25th	0,004	--	--	0,138	--	--	0,090
26th	0,003	--	--	0,103	--	--	0,071

27th	0,006	--	--	0,174	--	--	0,080
28th	0,003	--	--	0,087	--	--	0,066
29th	0,009	--	--	0,283	--	--	0,078
30th	0,003	--	--	0,085	--	--	0,061
31th	0,012	--	--	0,381	--	--	0,073
32th	0,003	--	--	0,087	--	--	0,057
33th	0,010	--	--	0,303	--	--	0,068
34th	0,003	--	--	0,079	--	--	0,054
35th	0,003	--	--	0,087	--	--	0,064
36th	0,002	--	--	0,072	--	--	0,051
37th	0,004	--	--	0,115	--	--	0,061
38th	0,003	--	--	0,077	--	--	0,048
39th	0,004	--	--	0,115	--	--	0,058
40th	0,002	--	--	0,075	--	--	0,046
THD [%]	--	--	--	2,444	--	--	--

Phase	**L1**	**L2**	**L3**
Power Level	**60%**	**60%**	**60%**
AC Power [W]	1500	--	--
AC Voltage [V]	229,7	--	--
AC Current [A]	6,532	--	--
Frequency [Hz]	50,00	--	--

Harmonic	**Measured value I_h [A]**			**Measured value I_h [%I_1]**			**Limits [A]** IEC EN 61000-3-2
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	
1st	6,530	--	--		--	--	--
2nd	0,011	--	--	0,172	--	--	1,080
3rd	0,048	--	--	0,730	--	--	2,300
4th	0,003	--	--	0,051	--	--	0,430
5th	0,034	--	--	0,527	--	--	1,140
6th	0,004	--	--	0,060	--	--	0,300
7th	0,017	--	--	0,258	--	--	0,770
8th	0,004	--	--	0,064	--	--	0,263
9th	0,015	--	--	0,235	--	--	0,400
10th	0,005	--	--	0,073	--	--	0,184
11th	0,021	--	--	0,318	--	--	0,330
12th	0,004	--	--	0,064	--	--	0,153
13th	0,019	--	--	0,290	--	--	0,210
14th	0,004	--	--	0,054	--	--	0,131
15th	0,022	--	--	0,344	--	--	0,150
16th	0,004	--	--	0,067	--	--	0,115
17th	0,025	--	--	0,377	--	--	0,132
18th	0,004	--	--	0,058	--	--	0,102

19th	0,014	--	--	0,217	--	--	0,188
20th	0,004	--	--	0,055	--	--	0,092
21th	0,010	--	--	0,150	--	--	0,107
22th	0,004	--	--	0,061	--	--	0,084
23th	0,013	--	--	0,202	--	--	0,098
24th	0,004	--	--	0,060	--	--	0,077
25th	0,010	--	--	0,151	--	--	0,090
26th	0,004	--	--	0,056	--	--	0,071
27th	0,005	--	--	0,069	--	--	0,080
28th	0,004	--	--	0,067	--	--	0,066
29th	0,006	--	--	0,097	--	--	0,078
30th	0,004	--	--	0,059	--	--	0,061
31th	0,014	--	--	0,210	--	--	0,073
32th	0,004	--	--	0,059	--	--	0,057
33th	0,008	--	--	0,127	--	--	0,068
34th	0,004	--	--	0,057	--	--	0,054
35th	0,005	--	--	0,080	--	--	0,064
36th	0,004	--	--	0,055	--	--	0,051
37th	0,006	--	--	0,084	--	--	0,061
38th	0,004	--	--	0,054	--	--	0,048
39th	0,004	--	--	0,060	--	--	0,058
40th	0,004	--	--	0,055	--	--	0,046
THD [%]	--	--	--	1,304	--	--	--

Phase	**L1**	**L2**	**L3**
Power Level	**100%**	**100%**	**100%**
AC Power [W]	2489	--	--
AC Voltage [V]	229,7	--	--
AC Current [A]	10,838	--	--
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	10,836	--	--		--	--	--
2nd	0,011	--	--	0,102	--	--	1,080
3rd	0,088	--	--	0,815	--	--	2,300
4th	0,004	--	--	0,041	--	--	0,430
5th	0,045	--	--	0,417	--	--	1,140
6th	0,005	--	--	0,042	--	--	0,300
7th	0,028	--	--	0,259	--	--	0,770
8th	0,005	--	--	0,045	--	--	0,263
9th	0,026	--	--	0,241	--	--	0,400
10th	0,004	--	--	0,041	--	--	0,184

11th	0,029	--	--	0,266	--	--	0,330
12th	0,004	--	--	0,034	--	--	0,153
13th	0,030	--	--	0,278	--	--	0,210
14th	0,004	--	--	0,038	--	--	0,131
15th	0,035	--	--	0,323	--	--	0,150
16th	0,005	--	--	0,050	--	--	0,115
17th	0,038	--	--	0,349	--	--	0,132
18th	0,005	--	--	0,042	--	--	0,102
19th	0,029	--	--	0,268	--	--	0,188
20th	0,005	--	--	0,044	--	--	0,092
21th	0,015	--	--	0,141	--	--	0,107
22th	0,005	--	--	0,043	--	--	0,084
23th	0,010	--	--	0,090	--	--	0,098
24th	0,005	--	--	0,050	--	--	0,077
25th	0,013	--	--	0,117	--	--	0,090
26th	0,006	--	--	0,054	--	--	0,071
27th	0,008	--	--	0,069	--	--	0,080
28th	0,007	--	--	0,061	--	--	0,066
29th	0,005	--	--	0,050	--	--	0,078
30th	0,006	--	--	0,060	--	--	0,061
31th	0,011	--	--	0,104	--	--	0,073
32th	0,006	--	--	0,055	--	--	0,057
33th	0,012	--	--	0,107	--	--	0,068
34th	0,006	--	--	0,058	--	--	0,054
35th	0,006	--	--	0,058	--	--	0,064
36th	0,008	--	--	0,070	--	--	0,051
37th	0,007	--	--	0,064	--	--	0,061
38th	0,007	--	--	0,068	--	--	0,048
39th	0,010	--	--	0,091	--	--	0,058
40th	0,007	--	--	0,066	--	--	0,046
THD [%]	--	--	--	1,248	--	--	--

DC Battery (Source) input current	55
DC Battery (Source) input voltage	51,2
$P_{DC\text{-}Sum}$ [W]	2816
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 **MST-BIE5-2500** 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

L1 phase

P/ P_{rE} [%]	5	10	20	30	40	50	60	70	80	90	100
Order	I_h [%]										
1	5,014	9,9176	20,0284	30,0656	40,1304	50,0848	60,076	69,9384	79,994	90,0772	99,6912
2	0,037	0,055	0,064	0,064	0,083	0,101	0,101	0,110	0,110	0,101	0,101
3	0,745	0,653	0,451	0,359	0,359	0,377	0,442	0,524	0,616	0,718	0,810
4	0,046	0,046	0,037	0,028	0,028	0,028	0,028	0,028	0,037	0,046	0,037
5	0,506	0,570	0,469	0,377	0,331	0,322	0,313	0,331	0,350	0,377	0,414
6	0,028	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,046
7	0,248	0,313	0,285	0,202	0,147	0,129	0,156	0,184	0,212	0,239	0,258
8	0,028	0,037	0,028	0,046	0,046	0,046	0,037	0,037	0,046	0,046	0,046
9	0,166	0,175	0,212	0,184	0,156	0,138	0,138	0,156	0,184	0,221	0,239
10	0,028	0,028	0,028	0,037	0,037	0,046	0,046	0,037	0,037	0,037	0,037
11	0,037	0,074	0,147	0,175	0,175	0,175	0,193	0,212	0,230	0,248	0,267
12	0,028	0,037	0,028	0,028	0,037	0,037	0,037	0,037	0,037	0,037	0,037
13	0,092	0,064	0,028	0,083	0,120	0,147	0,175	0,202	0,230	0,248	0,276
14	0,028	0,028	0,037	0,037	0,028	0,028	0,037	0,037	0,037	0,028	0,037
15	0,184	0,202	0,184	0,166	0,166	0,184	0,202	0,230	0,267	0,294	0,322
16	0,037	0,037	0,046	0,046	0,037	0,037	0,037	0,046	0,046	0,046	0,046
17	0,147	0,175	0,193	0,175	0,166	0,193	0,230	0,258	0,294	0,322	0,350
18	0,028	0,028	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,046
19	0,092	0,120	0,156	0,156	0,138	0,129	0,129	0,156	0,184	0,221	0,267
20	0,028	0,028	0,028	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,046
21	0,037	0,037	0,064	0,092	0,092	0,092	0,092	0,092	0,101	0,120	0,138
22	0,018	0,028	0,028	0,037	0,037	0,037	0,037	0,037	0,037	0,037	0,046
23	0,064	0,055	0,055	0,083	0,110	0,120	0,120	0,101	0,092	0,083	0,092
24	0,018	0,018	0,028	0,037	0,028	0,037	0,037	0,037	0,037	0,037	0,046
25	0,037	0,046	0,028	0,037	0,064	0,074	0,092	0,110	0,120	0,120	0,120
26	0,018	0,018	0,028	0,028	0,037	0,037	0,037	0,037	0,037	0,037	0,055
27	0,028	0,028	0,046	0,055	0,046	0,037	0,046	0,046	0,046	0,055	0,074
28	0,018	0,028	0,028	0,028	0,028	0,037	0,037	0,074	0,101	0,055	0,064
29	0,083	0,083	0,083	0,083	0,110	0,074	0,055	0,046	0,037	0,037	0,046
30	0,018	0,018	0,028	0,028	0,028	0,028	0,037	0,046	0,046	0,046	0,055
31	0,055	0,064	0,092	0,110	0,120	0,110	0,129	0,129	0,129	0,110	0,101
32	0,018	0,018	0,028	0,028	0,028	0,037	0,037	0,037	0,046	0,046	0,055
33	0,074	0,074	0,074	0,092	0,101	0,092	0,074	0,074	0,083	0,092	0,110
34	0,018	0,018	0,018	0,028	0,028	0,037	0,037	0,037	0,037	0,046	0,055
35	0,037	0,037	0,028	0,028	0,028	0,037	0,046	0,046	0,046	0,055	0,055
36	0,028	0,028	0,018	0,018	0,028	0,028	0,037	0,037	0,046	0,055	0,074
37	0,028	0,028	0,028	0,037	0,028	0,037	0,055	0,046	0,055	0,064	0,064
38	0,018	0,028	0,028	0,028	0,028	0,028	0,037	0,037	0,046	0,064	0,064
39	0,055	0,055	0,037	0,037	0,037	0,037	0,037	0,046	0,074	0,083	0,092
40	0,018	0,018	0,028	0,018	0,028	0,028	0,037	0,037	0,055	0,055	0,064
THC [%]	1,008	1,012	0,850	0,736	0,705	0,718	0,785	0,883	1,001	1,117	1,242

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	0,037	0,031	0,027	0,040	0,052	0,056	0,056	0,052	0,050	0,039	0,044
125	0,043	0,033	0,031	0,043	0,054	0,060	0,056	0,048	0,045	0,038	0,044
175	0,036	0,031	0,036	0,048	0,054	0,057	0,050	0,040	0,039	0,039	0,051
225	0,047	0,046	0,041	0,050	0,057	0,058	0,050	0,044	0,041	0,043	0,051
275	0,043	0,045	0,047	0,050	0,056	0,049	0,045	0,040	0,037	0,042	0,053
325	0,041	0,045	0,049	0,059	0,066	0,052	0,049	0,044	0,041	0,046	0,056
375	0,035	0,040	0,055	0,068	0,069	0,055	0,048	0,038	0,037	0,047	0,060
425	0,036	0,033	0,049	0,060	0,063	0,058	0,046	0,042	0,040	0,050	0,061
475	0,042	0,043	0,057	0,064	0,061	0,054	0,044	0,044	0,045	0,056	0,067
525	0,031	0,039	0,053	0,062	0,063	0,053	0,048	0,044	0,044	0,054	0,069
575	0,053	0,059	0,068	0,069	0,064	0,051	0,045	0,045	0,047	0,056	0,066
625	0,047	0,053	0,067	0,070	0,063	0,054	0,049	0,046	0,049	0,057	0,072
675	0,055	0,060	0,066	0,065	0,052	0,044	0,049	0,054	0,053	0,057	0,064
725	0,051	0,066	0,076	0,076	0,066	0,054	0,058	0,060	0,059	0,062	0,072
775	0,081	0,086	0,079	0,065	0,052	0,049	0,057	0,058	0,055	0,055	0,061
825	0,084	0,084	0,079	0,065	0,054	0,056	0,062	0,062	0,059	0,062	0,067
875	0,041	0,041	0,041	0,047	0,064	0,076	0,081	0,073	0,066	0,060	0,061
925	0,056	0,057	0,050	0,044	0,053	0,064	0,070	0,068	0,064	0,058	0,063
975	0,036	0,034	0,042	0,060	0,078	0,079	0,070	0,057	0,052	0,046	0,059
1025	0,039	0,037	0,043	0,062	0,083	0,088	0,083	0,067	0,058	0,049	0,057
1075	0,062	0,072	0,081	0,087	0,085	0,071	0,056	0,049	0,053	0,062	0,070
1125	0,042	0,056	0,073	0,082	0,082	0,073	0,057	0,051	0,055	0,066	0,076
1175	0,090	0,093	0,089	0,078	0,061	0,053	0,064	0,077	0,083	0,085	0,081
1225	0,087	0,101	0,100	0,092	0,076	0,056	0,052	0,068	0,076	0,081	0,081
1275	0,067	0,051	0,042	0,052	0,073	0,093	0,105	0,103	0,094	0,090	0,087
1325	0,092	0,077	0,049	0,047	0,067	0,091	0,108	0,113	0,106	0,093	0,086
1375	0,108	0,126	0,151	0,158	0,146	0,157	0,145	0,114	0,076	0,123	0,140
1425	0,054	0,077	0,110	0,122	0,125	0,117	0,102	0,081	0,068	0,070	0,089
1475	0,069	0,066	0,055	0,043	0,047	0,067	0,092	0,109	0,125	0,133	0,135
1525	0,080	0,097	0,091	0,073	0,057	0,052	0,062	0,084	0,104	0,119	0,125
1575	0,031	0,029	0,035	0,054	0,072	0,082	0,088	0,090	0,084	0,077	0,068
1625	0,046	0,042	0,036	0,060	0,086	0,100	0,109	0,110	0,103	0,092	0,068
1675	0,042	0,048	0,070	0,076	0,075	0,065	0,056	0,055	0,070	0,097	0,108
1725	0,033	0,037	0,053	0,064	0,067	0,060	0,057	0,059	0,068	0,100	0,106
1775	0,103	0,099	0,095	0,078	0,052	0,046	0,055	0,066	0,077	0,100	0,094
1825	0,091	0,102	0,105	0,095	0,074	0,056	0,064	0,067	0,080	0,108	0,104
1875	0,039	0,051	0,073	0,097	0,118	0,125	0,119	0,110	0,105	0,101	0,092
1925	0,044	0,037	0,043	0,076	0,113	0,129	0,129	0,120	0,117	0,101	0,093
1975	0,094	0,081	0,078	0,074	0,059	0,044	0,056	0,081	0,125	0,127	0,136

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

Higher Frequencies

Test result:

P/P_{rE} [%]	5	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]										
2,1	0,168	0,174	0,194	0,203	0,204	0,195	0,197	0,225	0,268	0,248	0,253
2,3	0,096	0,101	0,109	0,122	0,139	0,174	0,210	0,232	0,247	0,291	0,277
2,5	0,203	0,203	0,229	0,246	0,245	0,231	0,221	0,216	0,238	0,237	0,231
2,7	0,258	0,236	0,210	0,217	0,244	0,271	0,293	0,313	0,316	0,314	0,328
2,9	0,419	0,407	0,393	0,382	0,365	0,334	0,301	0,262	0,228	0,221	0,244
3,1	0,190	0,223	0,265	0,290	0,321	0,333	0,343	0,352	0,353	0,351	0,354
3,3	0,088	0,094	0,126	0,148	0,162	0,167	0,180	0,200	0,214	0,237	0,276
3,5	0,099	0,099	0,106	0,106	0,109	0,114	0,128	0,143	0,162	0,187	0,228
3,7	0,090	0,097	0,106	0,116	0,127	0,131	0,128	0,123	0,120	0,120	0,136
3,9	0,075	0,074	0,074	0,075	0,083	0,090	0,102	0,114	0,126	0,141	0,147
4,1	0,052	0,053	0,055	0,062	0,066	0,071	0,075	0,084	0,090	0,105	0,106
4,3	0,051	0,055	0,059	0,064	0,070	0,076	0,083	0,087	0,094	0,105	0,104
4,5	0,055	0,054	0,057	0,061	0,067	0,073	0,084	0,099	0,123	0,136	0,157
4,7	0,088	0,097	0,110	0,132	0,155	0,180	0,207	0,239	0,279	0,315	0,359
4,9	0,047	0,049	0,050	0,055	0,059	0,062	0,067	0,078	0,079	0,083	0,092
5,1	0,050	0,050	0,053	0,057	0,057	0,055	0,059	0,062	0,065	0,071	0,079
5,3	0,046	0,046	0,044	0,046	0,049	0,054	0,057	0,061	0,065	0,069	0,075
5,5	0,048	0,044	0,041	0,041	0,042	0,042	0,046	0,052	0,057	0,061	0,067
5,7	0,041	0,045	0,045	0,045	0,043	0,044	0,045	0,047	0,046	0,051	0,056
5,9	0,042	0,042	0,046	0,049	0,049	0,047	0,048	0,053	0,059	0,065	0,081
6,1	0,045	0,048	0,051	0,053	0,058	0,064	0,071	0,086	0,100	0,117	0,146
6,3	0,027	0,030	0,035	0,037	0,036	0,034	0,035	0,036	0,036	0,038	0,040
6,5	0,026	0,027	0,028	0,031	0,032	0,032	0,033	0,034	0,033	0,035	0,036
6,7	0,024	0,025	0,028	0,030	0,030	0,030	0,030	0,031	0,031	0,032	0,033
6,9	0,022	0,022	0,024	0,027	0,029	0,028	0,029	0,029	0,029	0,029	0,030
7,1	0,021	0,022	0,023	0,025	0,025	0,026	0,027	0,027	0,027	0,028	0,029
7,3	0,022	0,023	0,023	0,025	0,026	0,027	0,027	0,027	0,029	0,030	0,030
7,5	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,031	0,031	0,033	0,034
7,7	0,025	0,025	0,026	0,030	0,034	0,027	0,027	0,027	0,027	0,028	0,029
7,9	0,028	0,029	0,030	0,027	0,023	0,030	0,030	0,027	0,025	0,032	0,035
8,1	0,021	0,022	0,023	0,024	0,024	0,023	0,023	0,026	0,030	0,026	0,026
8,3	0,018	0,019	0,019	0,022	0,023	0,022	0,022	0,021	0,020	0,021	0,022
8,5	0,016	0,017	0,018	0,019	0,020	0,021	0,022	0,021	0,020	0,020	0,020
8,7	0,016	0,016	0,018	0,018	0,018	0,018	0,019	0,020	0,020	0,020	0,021
8,9	0,019	0,020	0,020	0,021	0,021	0,020	0,019	0,019	0,019	0,021	0,022

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

DC Battery (Source) input current	55
DC Battery (Source) input voltage	51,2
$P_{DC\text{-}Sum}$ [W]	2816
Impedance [Ω] Line Neutral	 $R_A = 0,24\ jX_A = 0,15$ $R_N = 0,16\ jX_N = 0,10$

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.

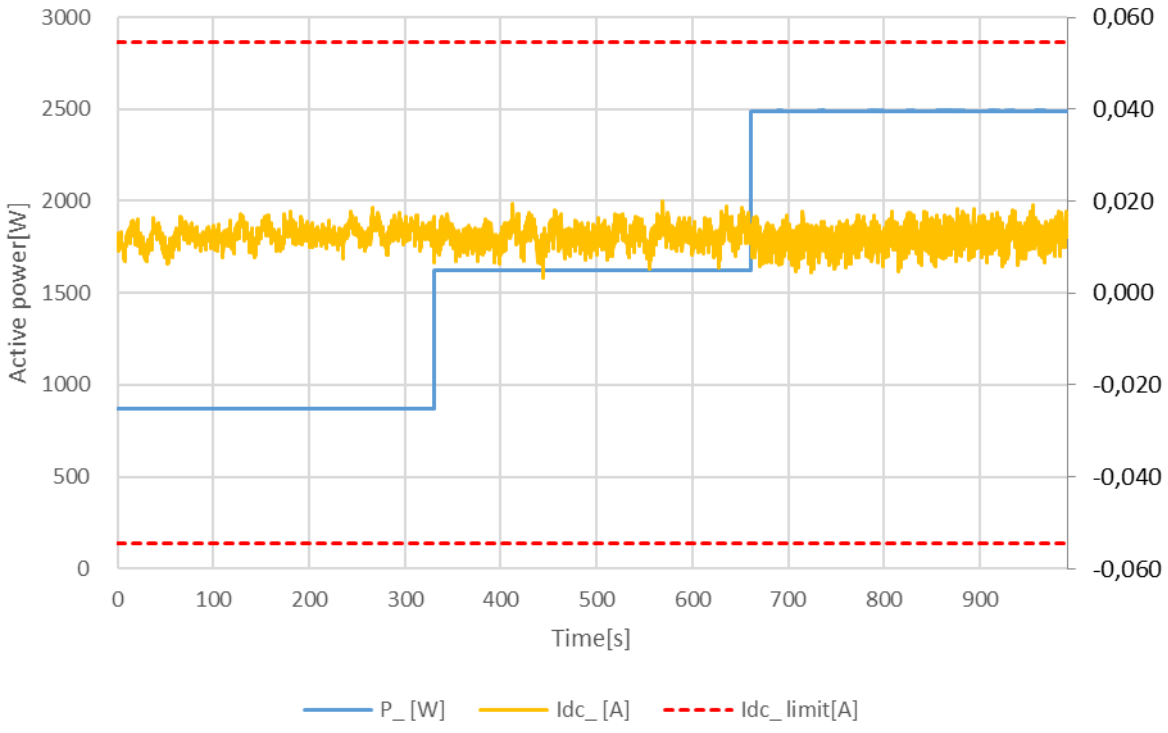
Assessment criterion:

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.

MST-BIE5-2500

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]	872	1622	2490
AC Voltage [V]	229,8	229,7	229,7
AC Current [A]	3,796	7,058	10,840
Max. DC Current in AC [mA]	19	20	19
Max. DC Current in AC [% of Ir]	0,174	0,183	0,174
Average. DC Current in AC [mA]	13	12	12
Average. DC Current in AC [% of Ir]	0,119	0,110	0,110

Graphs for MST-BIE5-2500



Note:

The test results of the **MST-BIE5-2500** 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.

Setting values	cos φ = 1	--
	cos φ over-excited	--
	cos φ under-excited	--

Test:

1-min mean value	L1	L2	L3	|L1 – L2|	|L2 – L3|	|L3 – L1|
a) cos φ = 1 at 100 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
cos φ_{E60}	--					
max. asymmetry [VA]	--					
b) maximum under-excited (i) at 100 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
cos φ_{E60}	--					
max. asymmetry [VA]	--					

c) maximum over-excited (c) at 100 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
cos φ_{E60}	--					
max. asymmetry [VA]	--					
d) cos φ = 1 at 50 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
cos φ_{E60}	--					
max. asymmetry [VA]	--					
e) maximum under-excited (i) at 50 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
cos φ_{E60}	--					
max. asymmetry [VA]	--					
f) maximum over-excited (c) at 50 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
	--	--	--	--	--	--
cos φ_{E60}:	--					
max. asymmetry [VA]	--					
Limit:	≤5% S_{Emax} and ≤4600VA					

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

5.4.1 General (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})	P
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”.

The maximum inductive and capacitive values are specified by the manufacturer.

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

MST-BIE5-2500				
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	206,72	2427	2428	0,999
cos φ max. over-excited	206,73	2343	2467	0,950
0,95 U_n at 100% P_{Emax}				
cos φ max. under-excited	218,22	2399	2527	0,950
1,0 U_n at 100% P_{Emax}				
cos φ = 1	229,70	2489	2490	0,999
cos φ max. under-excited	229,71	2369	2495	0,949
cos φ max. over-excited	229,71	2368	2493	0,950
1,05 U_n at 100% P_{Emax}				
cos φ max. over-excited	241,19	2367	2492	0,950
1,09 U_n at 100% P_{Emax}				
cos φ = 1	251,38	2485	2486	0,999
cos φ max. under-excited	251,38	2369	2496	0,949

$S_{Emax600}$ and $P_{Emax\ 600}$	
$S_{Emax600}$= max ($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$) [VA]	2527
$P_{Emax\ 600}$= max ($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$) [W]	2489

Note:

The test results of the **MST-BIE5-2500** 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 RS485 port.

(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.

Note:

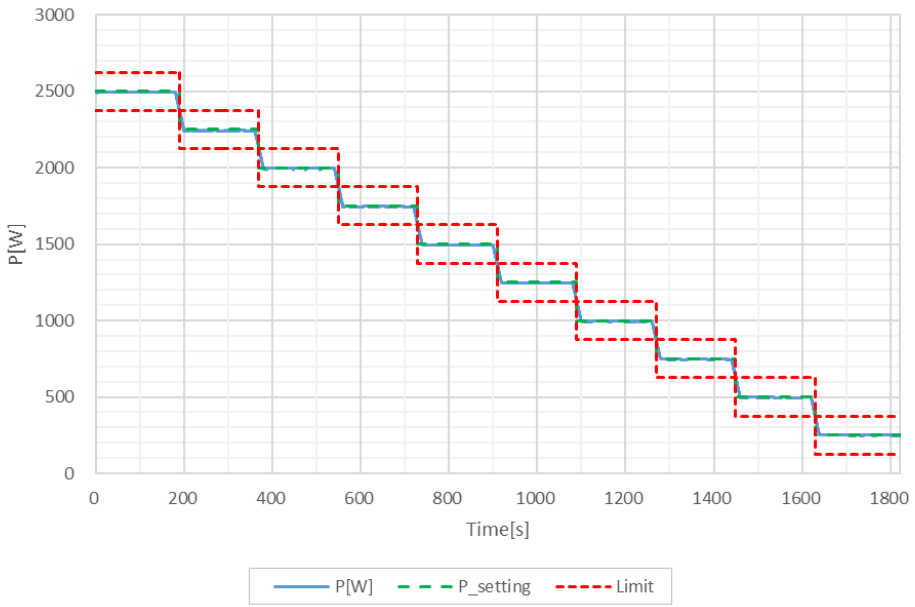
The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

MST-BIE5-2500

% of rated capability	Setpoint		Measured value		Deviation (P_{meas} - P_{set})		Limit ΔP_{E60} in %
	[W]	[%P_n]	[W]	[%Pn]	[W]	[%P_n]	
100	2500	100,0	2494	99,74	-6	-0,26	≤ ±5% of P_{rE}
90	2250	90,0	2243	89,71	-7	-0,29	
80	2000	80,0	1996	79,84	-4	-0,16	
70	1750	70,0	1746	69,83	-4	-0,17	
60	1500	60,0	1495	59,82	-5	-0,18	
50	1250	50,0	1246	49,82	-4	-0,18	
40	1000	40,0	995	39,79	-5	-0,21	
30	750	30,0	746	29,83	-4	-0,17	
20	500	20,0	497	19,87	-3	-0,13	
10	250	10,0	249	9,97	-1	-0,03	

Overall maximum active power deviation to set point [%P_n]:	0,29

Graph of the setting accuracy: MST-BIE5-2500



5.4.3.4 Measurement of the power gradient	P

Test procedural:

The P setpoint was set by RS485 port.
The measurement of the power gradient takes place:

- Via a setpoint change from 100% to 5% of the rated effective power PrE 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 PrE 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.

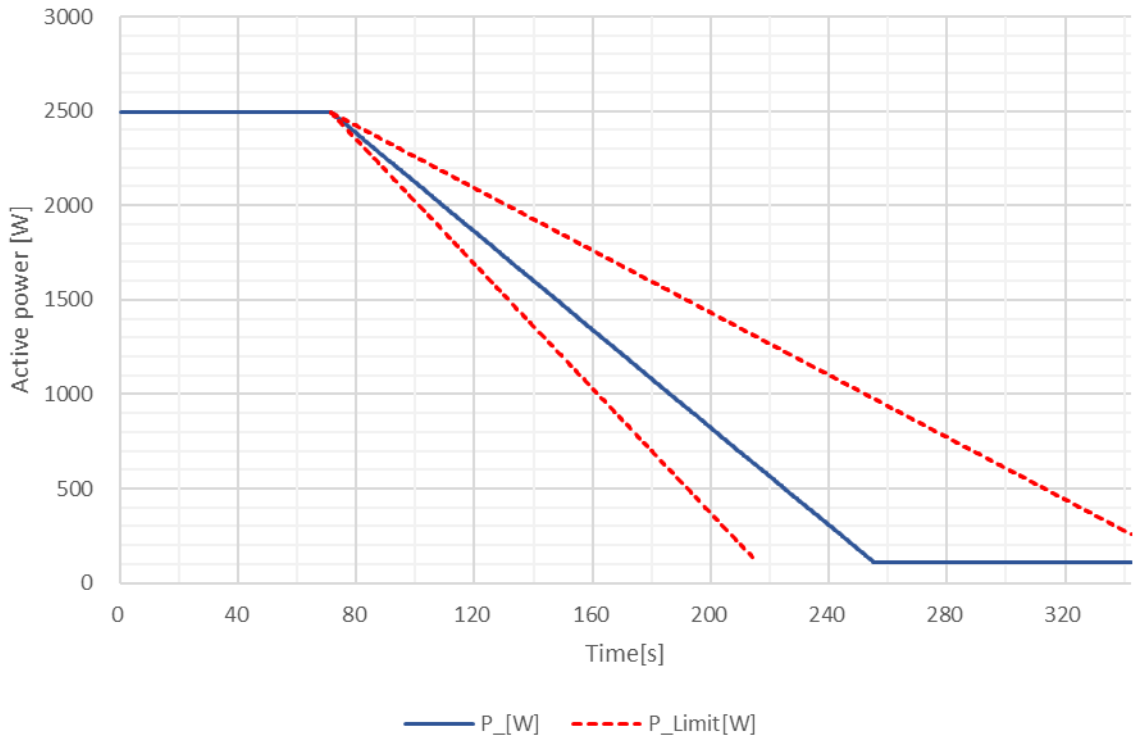
Note:

The test results of the **MST-BIE5-2500** 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} at MST-BIE5-2500

$P_{\_setting}$ point step	Setting value	Measured value
$P_{before\ power\ change}$ = 100% P_{rE} ± 5% P_{rE}	100,0% P_{rE}	99,72% P_{rE}
Power gradient (during power change):	0,5 %P_{rE} / s	0,50%P_{rE} / s
$P_{after\ power\ change}$ = 5% P_{rE} ± 5% P_{rE}	5,0% P_{rE}	4,44 % P_{rE}

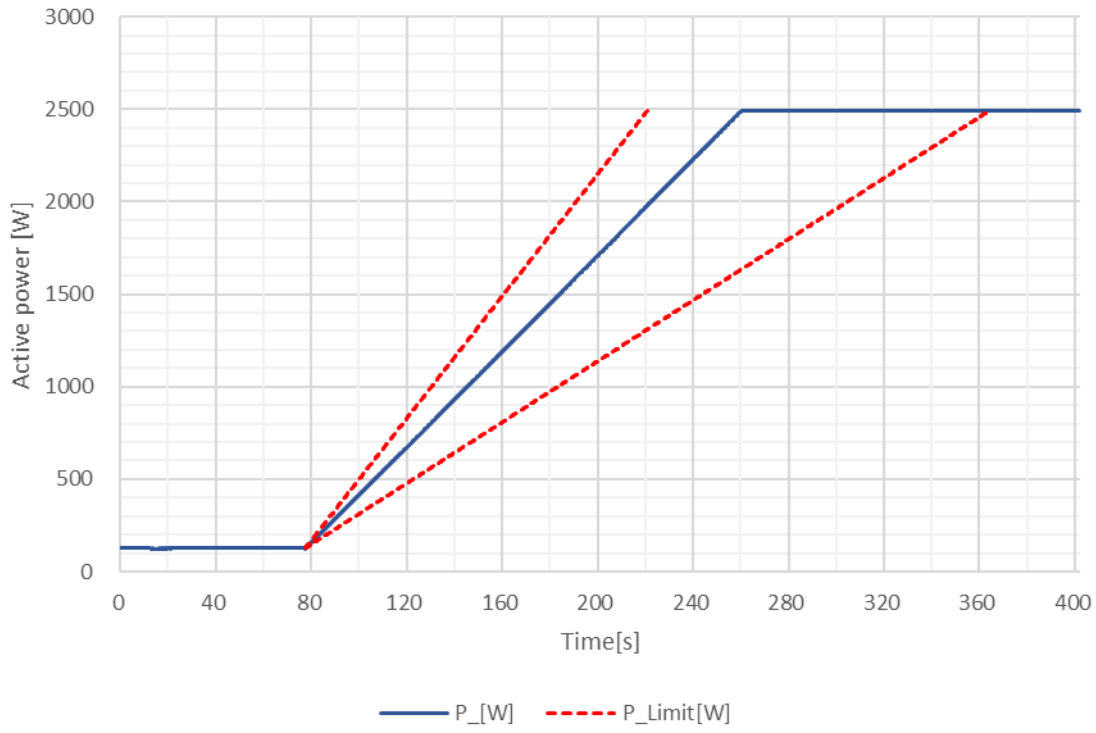
Graph of the gradient 100% to 5% P_{rE}



5.4.3.4 Measurement of the power gradient		P

Verification the setting Power gradient change from 5% to 100% at MST-BIE5-2500		
$P_{\_setting}$ point step	Setting value	Measured value
$P_{before\ power\ change}$ = 5% P_{rE} ± 5% P_{rE}	5,0% P_{rE}	5,03% P_{rE}
Power gradient (during power change):	0,5 %P_{rE} / s	0,50%P_{rE} / s
$P_{after\ power\ change}$ = 100% P_{rE} ± 5% P_{rE}	100,0 % P_{rE}	99,72 % 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% PrE



5.4.3.5 Measurement priority interfaces / energy management system	P

Test procedural:

Test 1 (Measurement priority interfaces)

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:

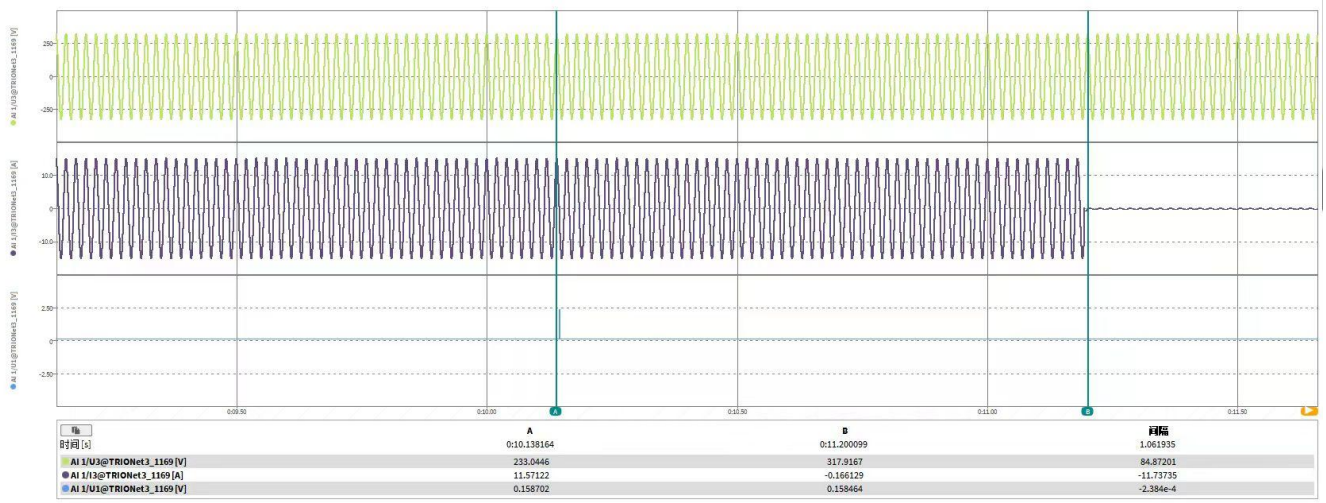
The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Test results:

Test1: The unit provides two communication interfaces for active power reduction.

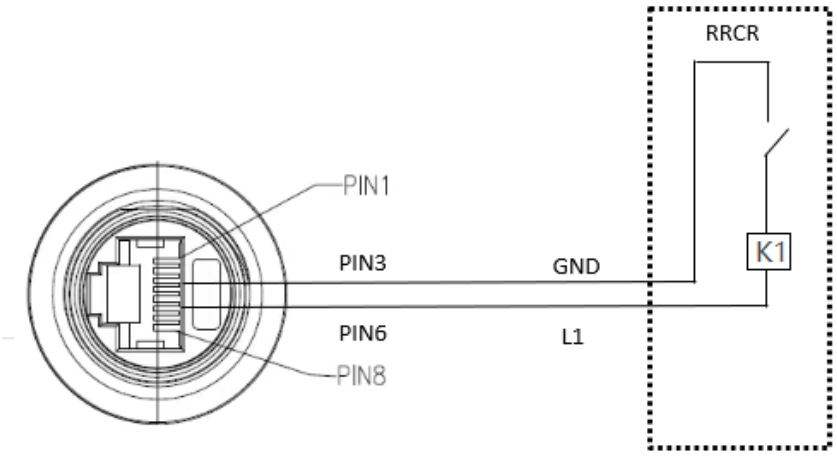
Interface NSM with Test condition		$P/P_{rE(Setpoint)}$	$P/P_{rE(Measured)}$
Test 1 (Interface low priority Interface WiFi)	Interface WiFi	70%	69,96%
	Interface RS485	90%	
Test 2 (Interface low priority Interface RS485)	Interface WiFi	90%	70,02%
	Interface RS485	70%	

Test 2: Use logical interface to test the result of stopping active power output.



High level description of logic interface:

The PGU equipped with a logic interface for ceasing active power output within 5 s following an instruction being received. The following is a possible configuration (if another configuration is required, this can be agreed with the manufacturer):



where RRCR = Radio Ripple Control Receiver.

The signal from the Power Generating Module that is being switched can be either DC (Voltage value 5 V)

Function description of the terminal:

Pin	Pin name	Description	Connected to(RRCR)
3	GND	Ground	K1-Relay 1 output
6	L1	Relay contact 1 input	K1-Relay 1 output

Relay status: close is 1, open is 0

L1	Pn	Power drop rate	Cos(φ)
1	0%	＜5s	1
0	100%	--	1

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)	N/A

Test cycle for adjustable PGUs:

Test 1: MST-BIE5-2500

Test point: No.	Test point: [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 50,20Hz; droop s setting = 5% (40% P_{ref}/Hz)									
a)	50,00	100	--	--	--	--	--	≤ ±10% of P_{Emax}	--
b)	50,25	98	--	--	--	--	--		
c)	50,70	80	--	--	--	--	--		
d)	51,40	52	--	--	--	--	--		
e)	50,70	80	--	--	--	--	--		
f)	50,25	98	--	--	--	--	--		
g)	50,00	100	--	--	--	--	--		
h)	51,65	0	--	--	--	--	--		
i)	50,15	0	--	--	--	--	--		
j)	50,00	100	--	--	--	--	--		

Frequency Step	Response time [s]	Settling time [s]
b) → c)	--	--
c) → d)	--	--
d) → e)	--	--
e) → f)	--	--

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

Test 2: MST-BIE5-2500

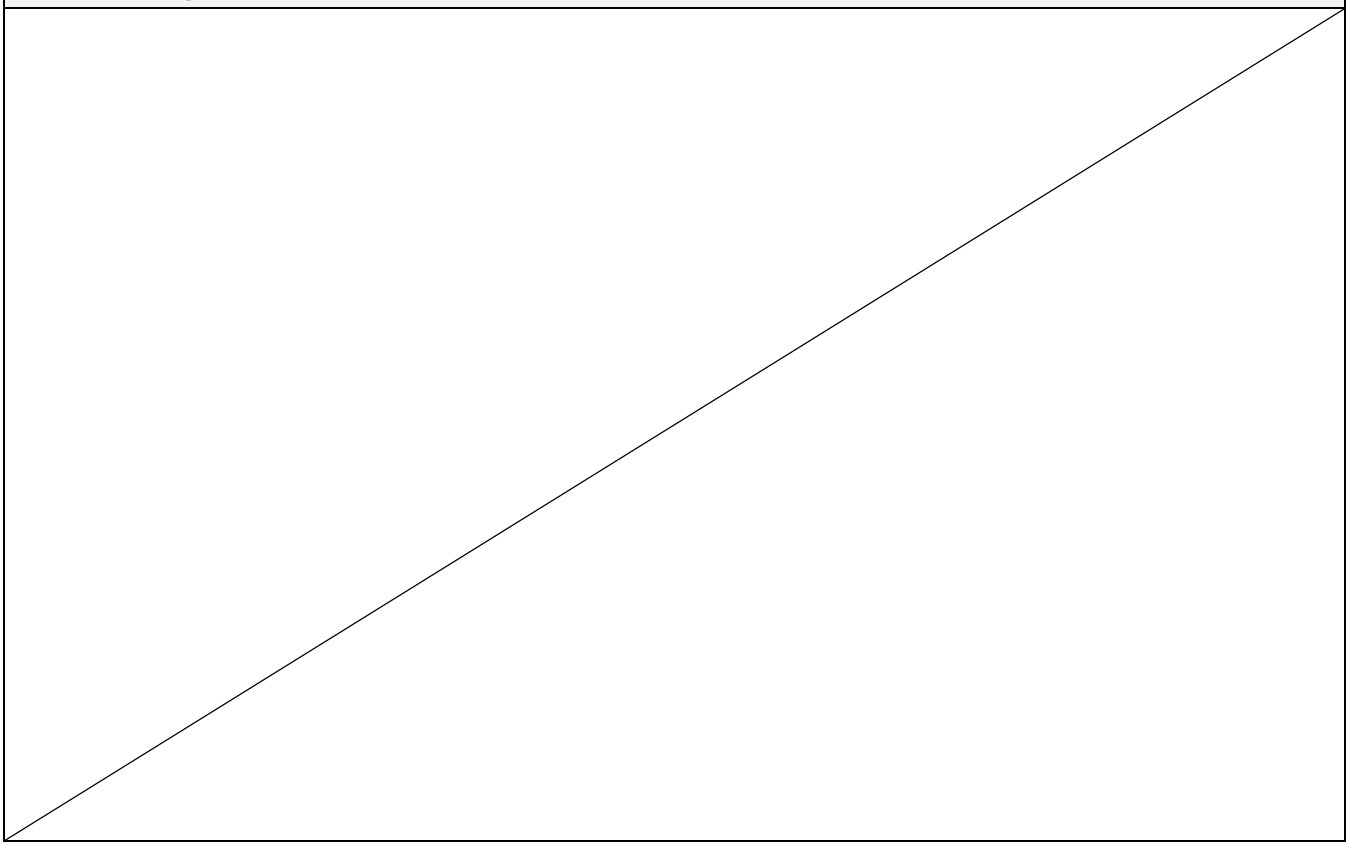
1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [% of P_{Emax}]:	Frequency [Hz]:	$P_{setpoint}$ [W]:	P_{E60} [W]:	P_{E60}[% of P_{Emax}]:	ΔP_{E60} [%]	**Limit** ΔP_{E60} in %	Available DC-power [%]:
Measurement: 60% P_{Emax}; start frequency 50,50Hz; droop s setting = 12% (16,67% P_{ref}/Hz)									
a)	50,00	60	--	--	--	--	--	≤ ±10% of P_{Emax}	--
b)	50,40	60	--	--	--	--	--		
c)	50,70	58	--	--	--	--	--		
d)	51,40	51	--	--	--	--	--		
e)	50,70	58	--	--	--	--	--		
f)	50,40	60 – 100	--	--	--	--	--		
g)	50,00	100	--	--	--	--	--		

Frequency Step	Response time [s]	Settling time [s]
b) → c)	--	--
c) → d)	--	--
d) → e)	--	--
e) → f)	--	--

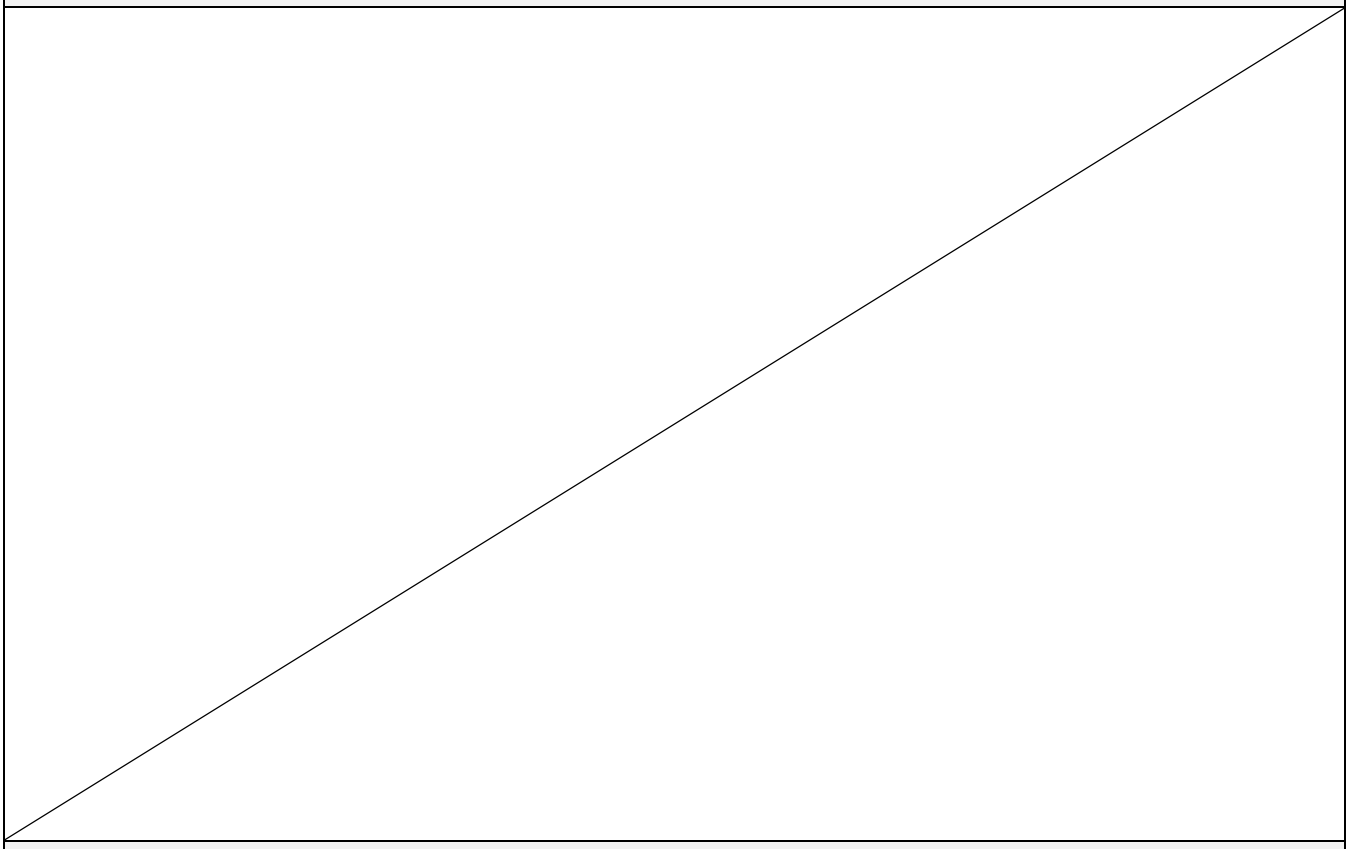
Initial time delay T_V setting value [s]:	Initial time delay T_V measured value (Determined during frequency step a) → b)) [s]:
0	--

DC setting values:	
PV-curve simulated according to	
Voltage of defined MPP [V]	--
Current of defined MPP [A]	--
FFU of PV curve [1]	--
P_{DC} [W]	--

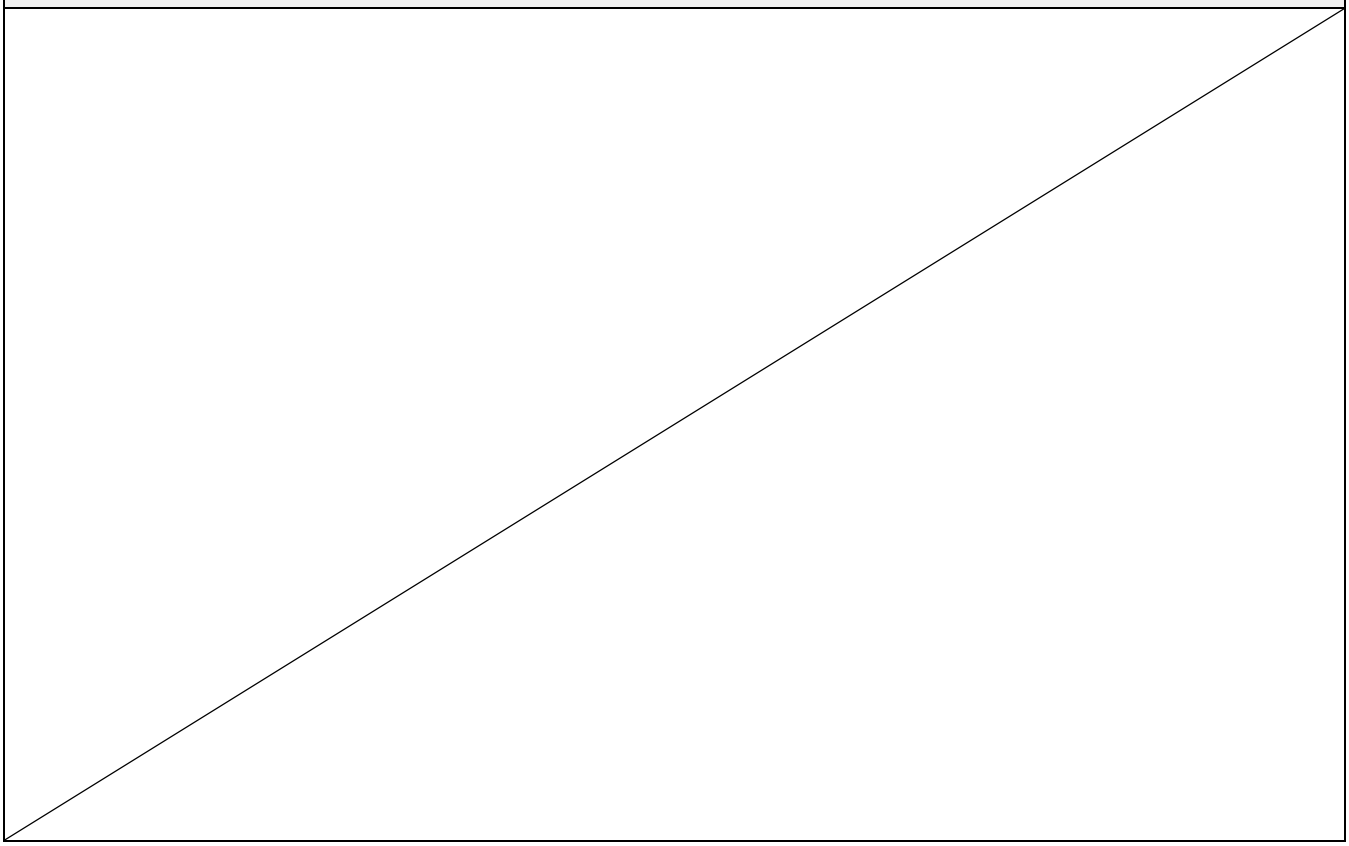
Graph Test 1@ 100% P_{Emax}



Gradient Test 1



Graph Test2 @ 60% P_{Emax}



Assessment criterion:

The test is regarded as passed:

a) for controllable PGU if:

- The active power reduces between measuring points 5.4.4.1 a) to g) and j), the expected active power output, after settling, adjusts with a deviation ≤ ±10% P_{Emax}.

b) for conditionally adjustable PGU, if:

- they behave as described in a) inside their control range and
- outside the control range, the power supplied when leaving the control range remains constant until it is switched off
- the connection time in j) and where appropriate in g) corresponds to the manufacturer's information on the random number generator;

NOTE: The Uniform distribution of the disconnection frequency in maximum increments of 0,1 Hz between the end of the control range (at least 50,2 Hz) and 51,5 Hz shall be proofed by a manufacturer's declaration.

c) for non-adjustable PGU, if

- a disconnection takes place between 50,2 Hz and 51,5 Hz;
- the connection time in j) and where appropriate in g) corresponds to the manufacturer's information on the random number generator;

NOTE The Uniform distribution of the disconnection frequency in maximum increments of 0,1 Hz between 50,2 In the measurement points h) and i) shall no active power be given.

- The initial time delay T_V 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 8 s (type 1 units and type 2 units with rotating machines) or 2 s (all other type 2 units)
- 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 (for all other generation units type 2) and
- 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.
- In the case of generating units with combustion engines or gas turbines, if the criteria for response time and settling time are not met, the test shall be passed, even if the adaptation of active power output occurs with a power gradient of at least 66% P_{Emax} per min (corresponding to 1,11% P_{Emax} per s).

Hz and 51,5 Hz shall be proofed by a manufacturer's declaration.

d) for linear generators with S_{Emax} ≤ 4,6 kVA,

- if they disconnect from the mains at a frequency ≥ 50,2 Hz and their maximum upper frequency limit (as specified by the manufacturer), but at the latest when they exceed 51,5 Hz.
- the connection time in j) and where appropriate in g) corresponds to the manufacturer's information on the random number generator;

Subsequently no more resynchronisation/active power feed-in is permitted, also while the frequency 5.4.4.1 i) is maintained (i.e., no running on the characteristic curve as previously tested in a) at g).

Note:

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.4.5	Active power feed-in of Storage systems for 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: MST-BIE5-2500

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** $\lvert\Delta P_{E60}\rvert$ [%P_{Emax}]	SOC [%] *
Measurement: 100% P_{Emax}; start frequency 50,20Hz; droop s setting = 5% (40% P_{Emax}/Hz)									
a)	50,00	100	50,00	2500	2488	99,52	-0,48	≤ 10	85
b)	50,25	98	50,25	2450	2439	97,55	-0,45		83
c)	50,70	80	50,70	2000	1993	79,72	-0,28		82
d)	51,40	52	51,40	1300	1297	51,88	-0,12		82
e)	50,70	80	50,70	2000	1989	79,58	-0,42		81
f)	50,25	98	50,25	2450	2437	97,48	-0,52		81
g)	50,00	100	50,00	2500	2488	99,52	-0,48		80
h)	51,65	0	51,65	0	-22	-0,88	-0,88		79
i)	50,15	0	50,15	0	-23	-0,94	-0,94		79
j)	50,00	100	50,00	2500	2488	99,52	-0,48		74

Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,3	0,5
c) → d)	0,3	0,4
d) → e)	0,4	0,4
e) → f)	0,3	0,4

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

Test 2: MST-BIE5-2500

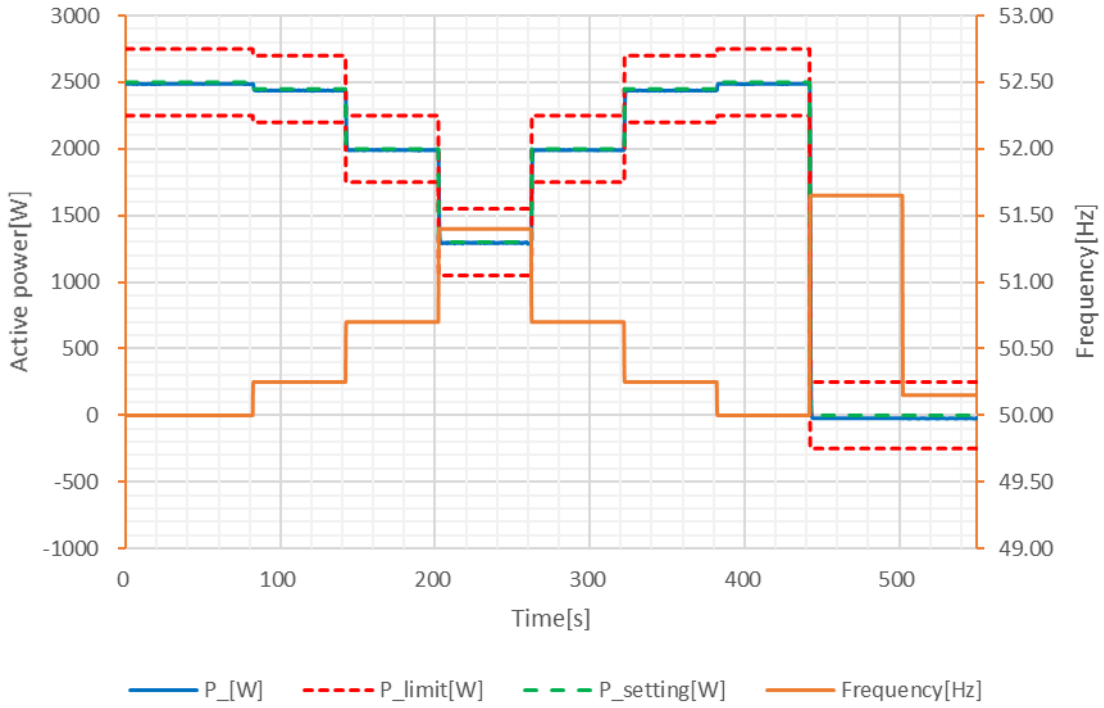
1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [% of P_{Emax}]:	Frequency [Hz]:	$P_{setpoint}$ [W]:	P_{E60} [W]:	P_{E60} [% of P_{Emax}]:	ΔP_{E60} [%]	**Limit** $\lvert\Delta P_{E60}\rvert$ [%P_{Emax}]	SOC [%] *
Measurement: 60% P_{Emax}; start frequency 50,50Hz; droop s setting = 5% (40% P_{Emax}/Hz)									
a)	50,00	60	50,00	1500	1494	59,76	-0,24	≤ 10	95
b)	50,40	60	50,40	1500	1495	59,78	-0,22		94
c)	50,70	52	50,70	1300	1294	51,78	-0,22		93
d)	51,40	24	51,40	600	595	23,78	-0,22		93
e)	50,70	52	50,70	1300	1291	51,64	-0,36		93
f)	50,40	60 - 100	50,40	--	2488	99,53	-0,47		92
g)	50,00	100	50,00	2500	2488	99,52	-0,48		89

Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,2	0,4
c) → d)	0,3	0,4
d) → e)	0,2	0,4
e) → f)	0,2	0,4

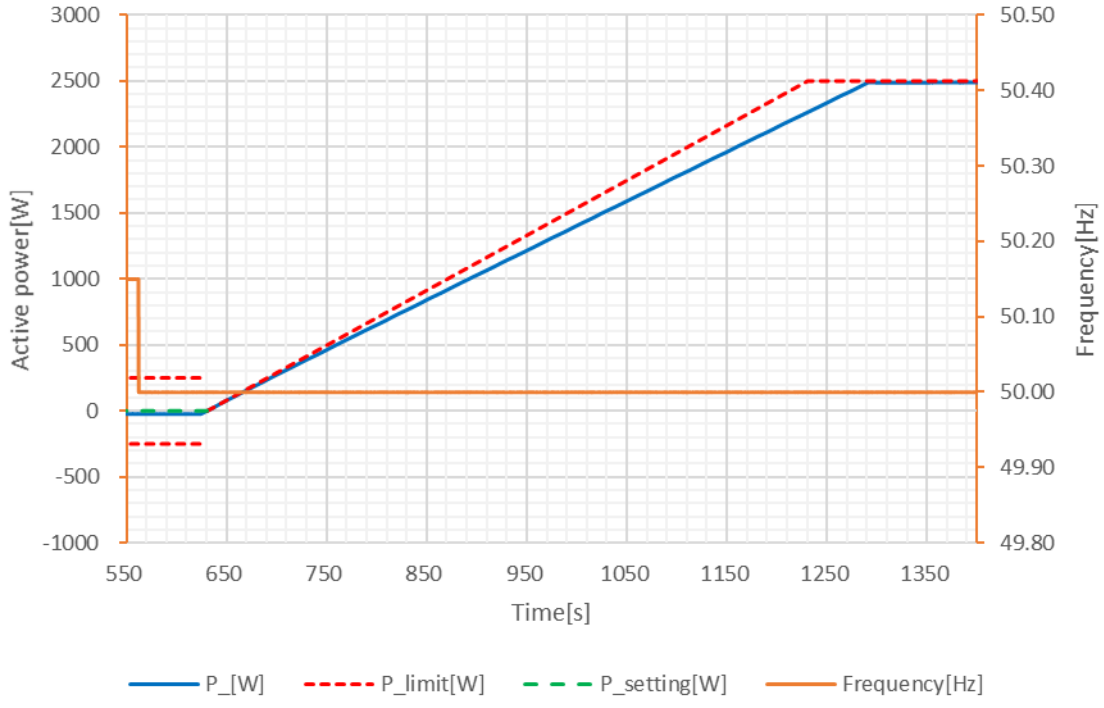
Initial time delay T_V setting value [s]:	Initial time delay T_V measured value (Determined during frequency step a) → b)) [s]:
0	0,2

DC setting values:	
DC Battery (Source) input current	55
DC Battery (Source) input voltage	51,2
$P_{DC\text{-}Sum}$ [W]	2816

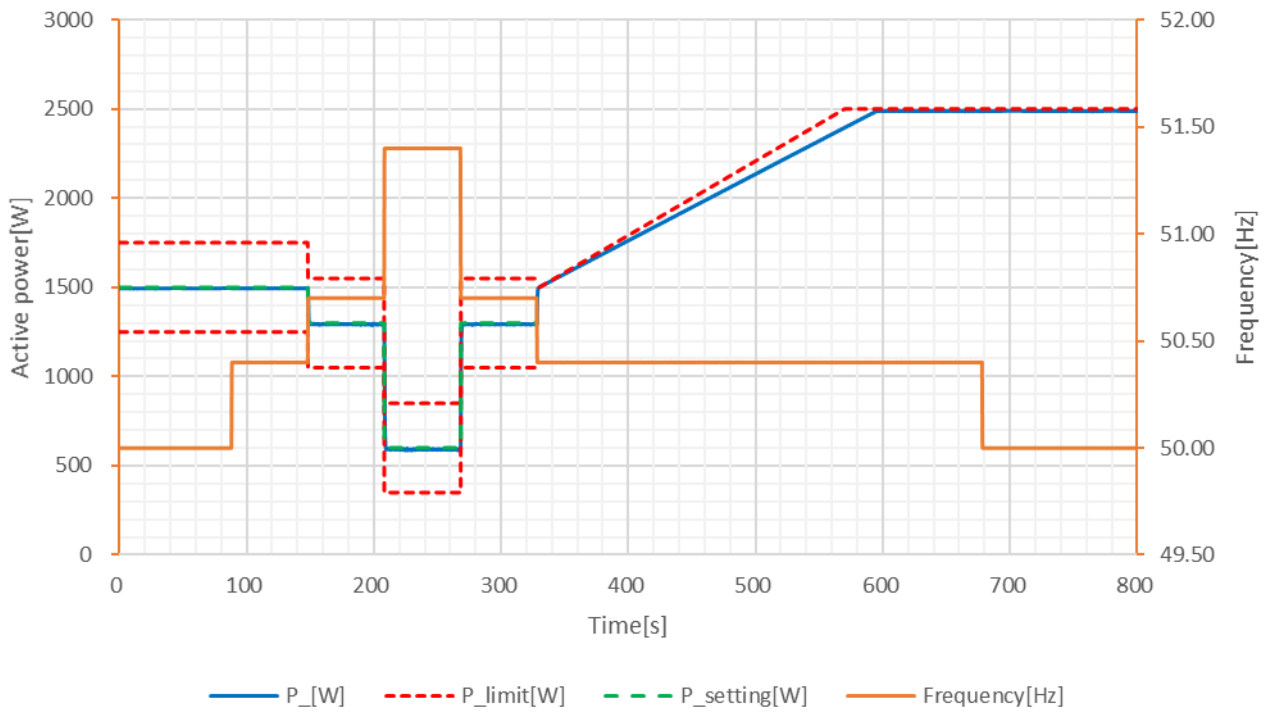
Graph Test 1@ 100% P_{Emax}



Gradient Test 1



Graph Test2 @ 60% P_{Ema}



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 T_V 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.

Note:

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

The default LFSM-O curve setting of the **MST-BIE5-0800** to **MST-BIE5-2500** series complies with the requirements for storage units according to VDE-AR-N 4105.

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.4.6	**Active power feed-in for PGUs at underfrequency** (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) (Not for DC-coupled Storage systems)	**N/A**

Test cycle for adjustable PGUs:

Test 1:MST-BIE5-2500

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 = 5% (40% P_{ref}/Hz)									
a)	50,00	10	--	--	--	--	--	≤ ±10% of P_{Emax}	--
b)	49,75	12	--	--	--	--	--		
c)	48,80	50	--	--	--	--	--		
d)	47,60	98	--	--	--	--	--		
e)	48,80	50	--	--	--	--	--		
f)	49,75	12	--	--	--	--	--		
g)	50,00	10	--	--	--	--	--		
h)	47,35	0	--	--	--	--	--		
i)	47,40	0	--	--	--	--	--		
j)	50,00	10	--	--	--	--	--		

Frequency Step	Response time [s]	Settling time [s]
b) → c)	--	--
c) → d)	--	--
d) → e)	--	--
e) → f)	--	--

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

Test 2: MST-BIE5-2500

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: 60% P_{Emax}; start frequency 49,80Hz; droop s setting = 5% (40% P_{ref}/Hz)									
a)	50,00	60	--	--	--	--	--	≤ ±10% of P_{Emax}	--
b)	49,75	62	--	--	--	--	--		
c)	49,20	84	--	--	--	--	--		
d)	48,80	100	--	--	--	--	--		
e)	49,20	84	--	--	--	--	--		
f)	49,85	60	--	--	--	--	--		
g)	50,00	60	--	--	--	--	--		

5.4.6 **Active power feed-in for PGUs at underfrequency** (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) (Not for DC-coupled Storage systems)	**N/A**

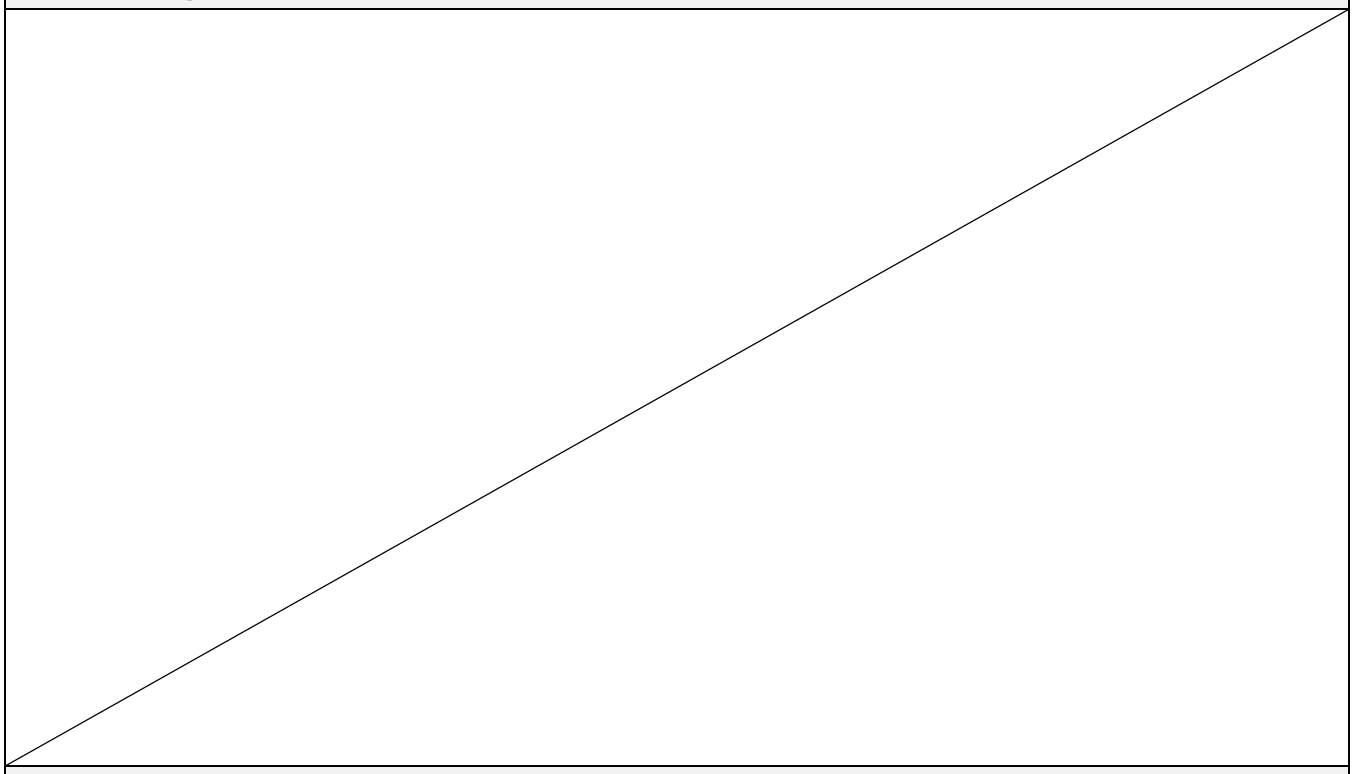
Frequency Step	Response time [s]	Settling time [s]
b) → c)	--	--
c) → d)	--	--
d) → e)	--	--
e) → f)	--	--

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

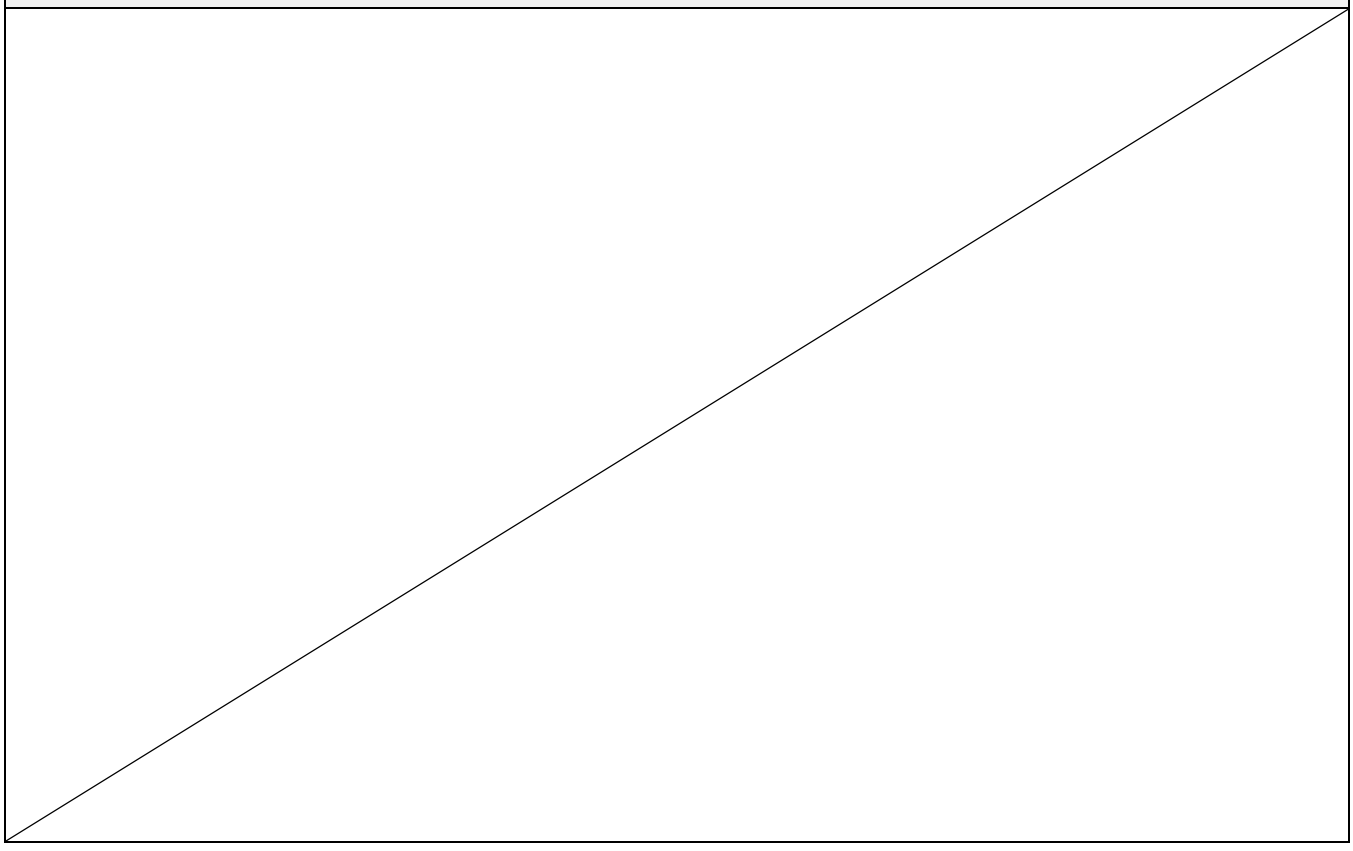
DC setting values:	
PV-curve simulated according to	
Voltage of defined MPP [V]	--
Current of defined MPP [A]	--
FFU of PV curve [1]	--
P_{DC} [W]	--

5.4.6	**Active power feed-in for PGUs at underfrequency** (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) (Not for DC-coupled Storage systems)	**N/A**

Graph Test 1@ 10% P_{Emax}

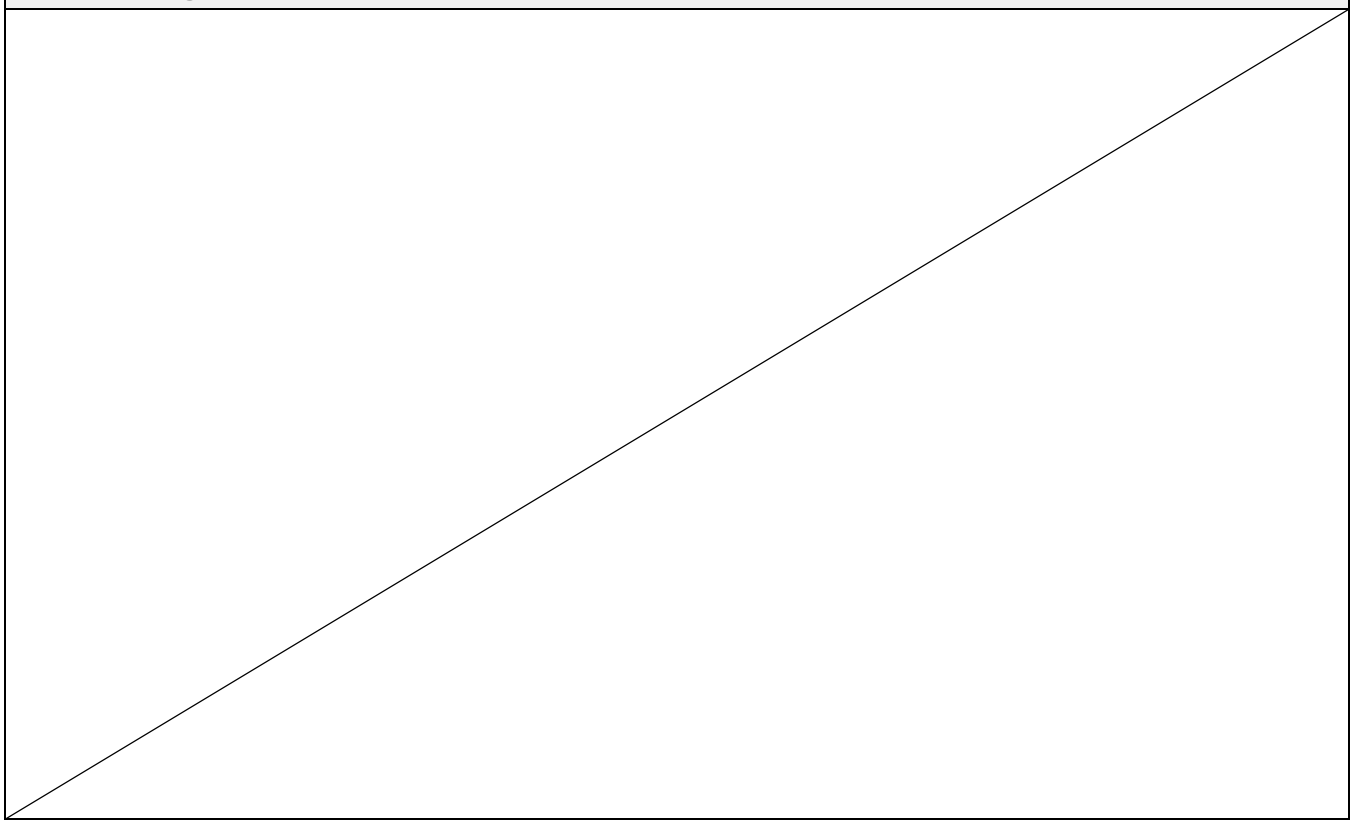


Gradient Test 1



5.4.6	**Active power feed-in for PGUs at underfrequency** (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) (Not for DC-coupled Storage systems)	**N/A**

Graph Test2 @ 60% P_{Emax}



5.4.6	**Active power feed-in for PGUs at underfrequency** (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) (Not for DC-coupled Storage systems)	**N/A**

Assessment criterion:

The test is regarded as passed:

a) for controllable PGU if:

- The active power reduces between measuring points 5.4.4.1 a) to g) and j), the expected active power output, after settling, adjusts with a deviation ≤ ±10% P_{Emax}. Deviations according to VDE-AR-N 4105: 2018-11, 5.7.4.3, Figure 13 and due to the technical restrictions described 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 ≤ 2 s.
- The response time of the adaptation of the active power output is a maximum of 8 s (type 1 units and type 2 units with rotating machines) or 2 s (all other type 2 units)
- 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 (for all other generation units type 2) and
- 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.
- In the case of generating units with combustion engines or gas turbines, if the criteria for response time and settling time are not met, the test shall be passed, even if the adaptation of active power output occurs with a power gradient of at least 66% P_{Emax} per min (corresponding to 1,11% P_{Emax} per s).

b) for conditionally adjustable PGU, if:

- they behave as descripted in a) inside their control range and
- no disconnection takes place between 49,8 Hz and 47,5 Hz;
- the connection time in j) corresponds to the manufacturer's information on the random number generator;

NOTE: The Uniform distribution of the disconnection frequency in maximum increments of 0,1 Hz between the end of the control range (at least 50,2 Hz) and 51,5 Hz shall be proofed by a manufacturer's declaration.

c) for non-adjustable PGU, if

- no disconnection takes place between 49,8 Hz and 47,5 Hz;
- the connection time in j) corresponds to the manufacturer's information on the random number generator;

NOTE The Uniform distribution of the disconnection frequency in maximum increments of 0,1 Hz between 50,2 Hz and 51.5 Hz shall be proofed by a manufacturer's declaration.

d) for linear generators with S_{Emax} ≤ 4,6 kVA,

- if they disconnect from the mains at a frequency ≤ 49,8 Hz and their maximum upper frequency limit (as specified by the manufacturer), but at the latest when they exceed 47,5 Hz.

The connection time in j) corresponds to the manufacturer's information on the random number generator;

Subsequently no more resynchronization/active power feed-in is permitted, also while the frequency 5.4.4.1 i) is maintained (i.e no running on the characteristic curve as previously tested in a) at g).

Note:

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.4.7	Active power feed-in for Storage systems at underfrequency (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: MST-BIE5-2500

1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [% of P_n]:	Frequency [Hz]:	$P_{setpoint}$ [W]:	P_{E60} [W]:	P_{E60} [% of P_n]:	ΔP_{E60} [%]	**Limit** $\lvert\Delta P_{E60}\rvert$ [%P_n]	SOC [%] *	Available active power in charging or discharging mode [%Pn]
Measurement: -100% P_{Emax}; start frequency 49,80Hz; droop s setting = 2% (100% P_{Emax}/Hz)										
a)	50,00	-100	50,00	-2500	-2541	-101,64	-1,64	≤ 10	70	-110
b)	49,75	-95	49,75	-2375	-2415	-96,60	-1,60		71	-110
c)	48,80	0	48,80	0	-33	-1,32	-1,32		72	+110
d)	47,60	100	47,60	2500	2487	99,48	-0,52		72	+110
e)	48,80	0	48,80	0	-15	-0,60	-0,60		71	+110
f)	49,85	-100	49,85	-2500	-2532	-101,28	-1,28		71	-110
g)	50,00	-100	50,00	-2500	-2542	-101,68	-1,68		73	-110
h)	47,35	0	47,35	0	-24	-0,96	-0,96		73	+110
i)	47,40	0	47,40	0	-24	-0,96	-0,96		73	+110
j)	50,00	-100	50,00	-2500	-2541	-101,64	-1,64		78	-110

Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,4	1,0
c) → d)	0,4	1,6
d) → e)	0,6	1,0
e) → f)	0,4	1,0

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

Test 2: MST-BIE5-2500

1-min mean value: No.	1-min mean value: [Hz]	Expected active power output [% of P_n]:	Frequency [Hz]:	$P_{setpoint}$ [W]:	P_{E60} [W]:	P_{E60} [% of P_n]:	ΔP_{E60} [%]	**Limit** $\lvert\Delta P_{E60}\rvert$ [%P_n]	SOC [%] *	Available active power in charging or discharging mode [%Pn]
Measurement: 10% P_{Emax}; start frequency 49,80Hz; droop s setting = 2% (100% P_{Emax}/Hz)										
a)	50,00	10	50,00	250	250	10,00	0,00	≤ 10	77	+110
b)	49,75	15	49,75	375	374	14,96	-0,04		76	+110
c)	48,80	100	48,80	2500	2488	99,52	-0,48		76	+110
d)	47,60	100	47,60	2500	2495	99,80	-0,20		75	+110

5.4.7	Active power feed-in for Storage systems at underfrequency (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
e)	48,80	100	48,80	2500	2496	99,84	-0,16		74	+110
f)	49,85	10	49,85	250	259	10,36	0,36		73	+110
g)	50,00	10	50,00	250	249	9,96	-0,04		73	+110

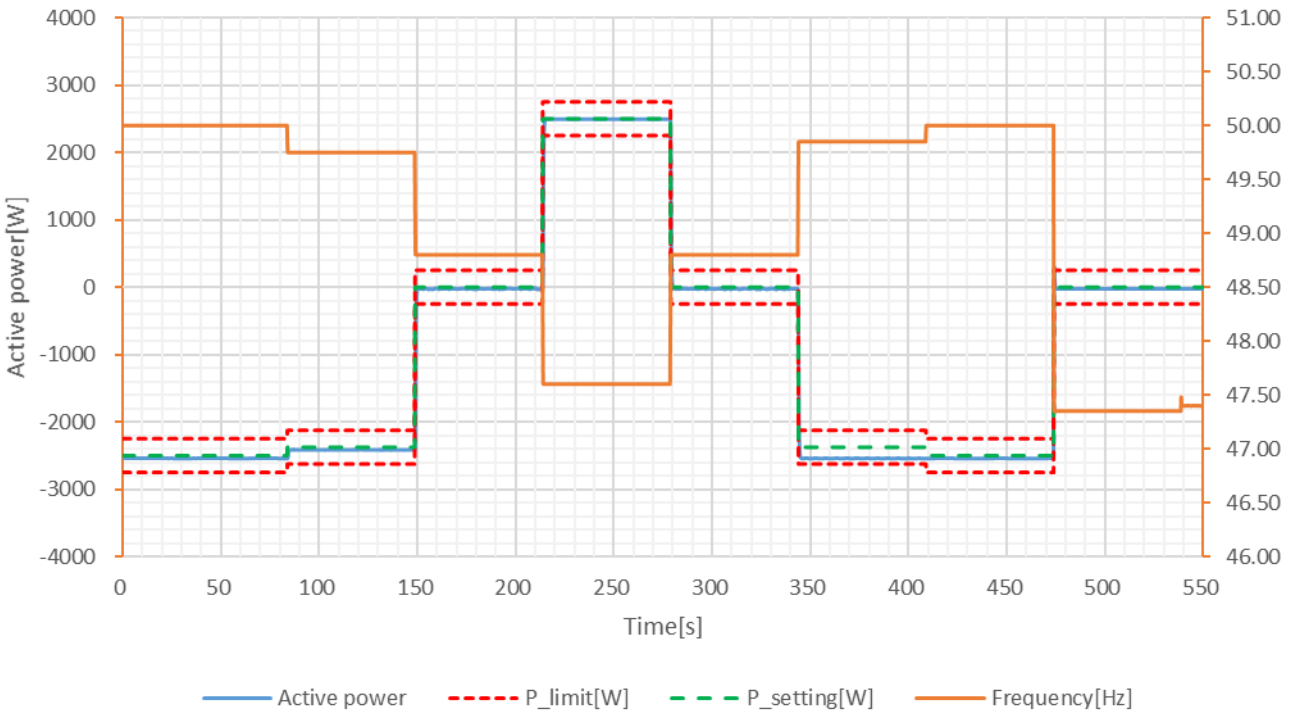
Frequency Step	Response time [s]	Settling time [s]
b) → c)	0,4	1,0
c) → d)	0,2	0,4
d) → e)	0,2	0,4
e) → f)	0,6	1,0

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

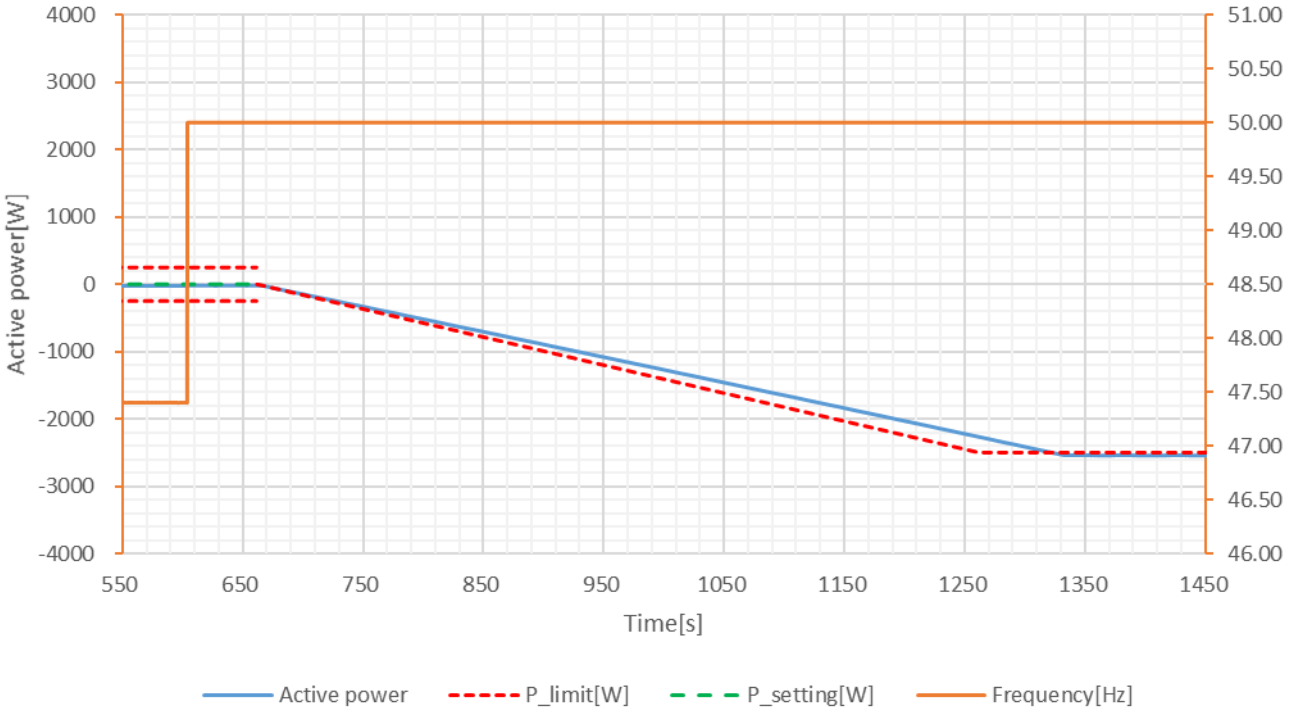
DC setting values:	
DC Battery (Source) input current	55
DC Battery (Source) input voltage	51,2
$P_{DC\text{-}Sum}$ [W]	2816

5.4.7	Active power feed-in for Storage systems at underfrequency (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

Graph Test 1@ -100% P_{Emax}

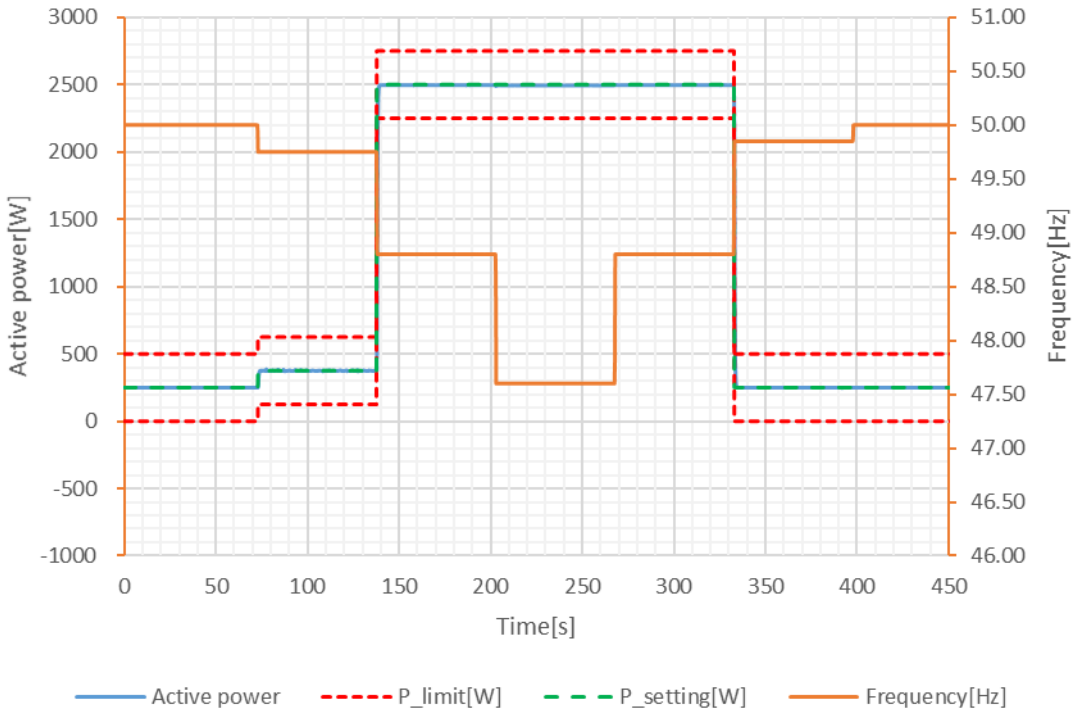


Gradient Test 1



5.4.7	Active power feed-in for Storage systems at underfrequency (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

Graph Test2 @ 10% P_{Emax}



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:

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

The default LFSM-U curve setting of the **MST-BIE5-0800** to **MST-BIE5-2500** series complies with the requirements for storage units according to VDE-AR-N 4105.

The test results of the **MST-BIE5-2500** 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 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**

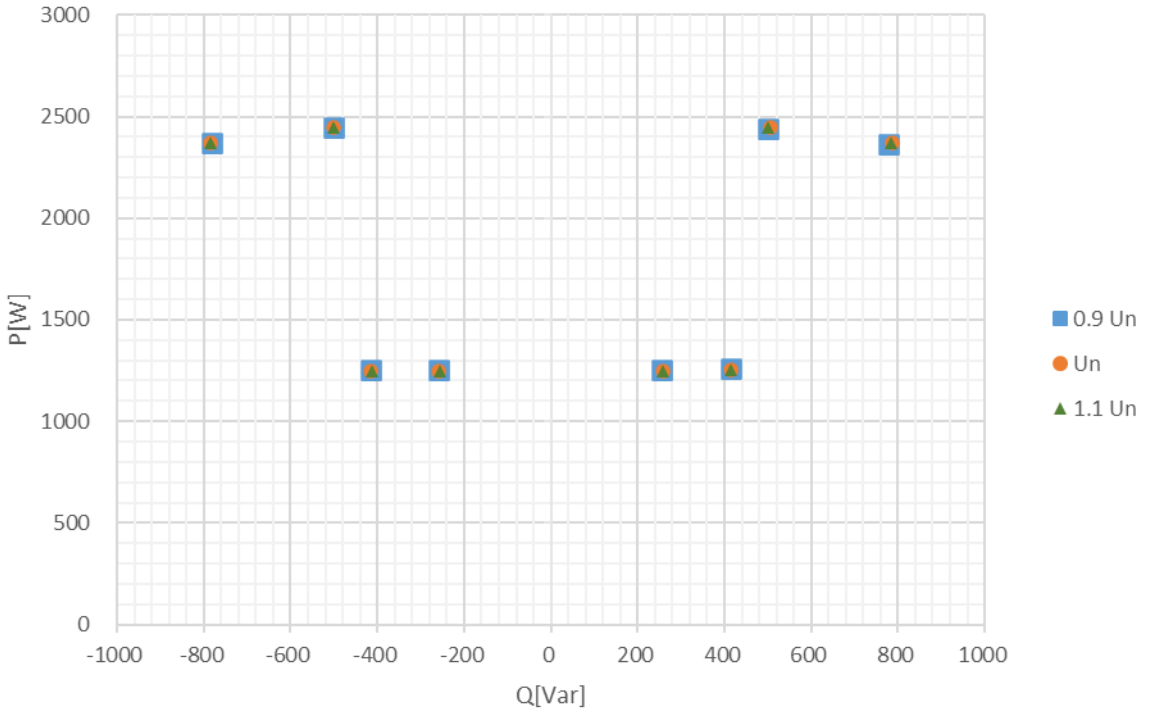
Setting values			
	cos φ under-excited	0,95	0,98
	cos φ over-excited	0,95	0,98

Test: MST-BIE5-2500

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]	206,64	206,52	229,66	229,54	252,66	252,58
P_{E60} [W]	1257	2363	1251	2368	1251	2370
Q_{E60} [Var]	414	779	413	788	414	784
S_{E60} [VA]	1324	2488	1317	2496	1317	2497
cos $\varphi_{E60\ over\text{-}excited}$	0,950	0,950	0,949	0,949	0,949	0,949
$Q_{expected}$ [Var]	413	777	411	779	411	780
ΔQ_{E60} [%]	0,01	0,06	0,09	0,36	0,09	0,19
cos φ 0,95 under-excited						
U [V]	206,62	206,51	229,64	229,53	252,66	252,56
P_{E60} [W]	1255	2374	1246	2372	1247	2373
Q_{E60} [Var]	-415	-781	-414	-784	-412	-784
S_{E60} [VA]	1322	2499	1313	2498	1314	2499
cos $\varphi_{E60\ under\text{-}excited}$	0,950	0,950	0,949	0,950	0,950	0,950
$Q_{expected}$ [Var]	-413	-780	-410	-780	-410	-780
ΔQ_{E60} [%]	0,08	0,04	0,16	0,14	0,06	0,15
cos φ 0,98 over-excited						
U [V]	206,64	206,52	229,66	229,55	252,67	252,59
P_{E60} [W]	1256	2443	1247	2445	1250	2448
Q_{E60} [Var]	256	500	258	508	258	502
S_{E60} [VA]	1282	2494	1273	2497	1276	2499
cos $\varphi_{E60\ over\text{-}excited}$	0,980	0,980	0,979	0,979	0,979	0,980
$Q_{expected}$ [Var]	255	496	253	497	254	497
ΔQ_{E60} [%]	0,05	0,14	0,20	0,44	0,15	0,18

cos φ 0,98 under-excited						
U [V]	206,64	206,52	229,65	229,54	252,66	252,57
P_{E60} [W]	1255	2444	1245	2445	1248	2447
Q_{E60} [Var]	-258	-500	-258	-502	-254	-501
S_{E60} [VA]	1281	2495	1271	2496	1274	2498
cos $\varphi_{E60\ under\text{-}excited}$	0,979	0,980	0,979	0,980	0,980	0,980
$Q_{expected}$ [Var]	-255	-496	-253	-497	-253	-497
ΔQ_{E60} [%]	0,14	0,14	0,20	0,19	0,04	0,14

Graph: Q/P diagram



Test:

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

cos φ Minimum step size: 0,01.

The test results of the **MST-BIE5-2500** 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

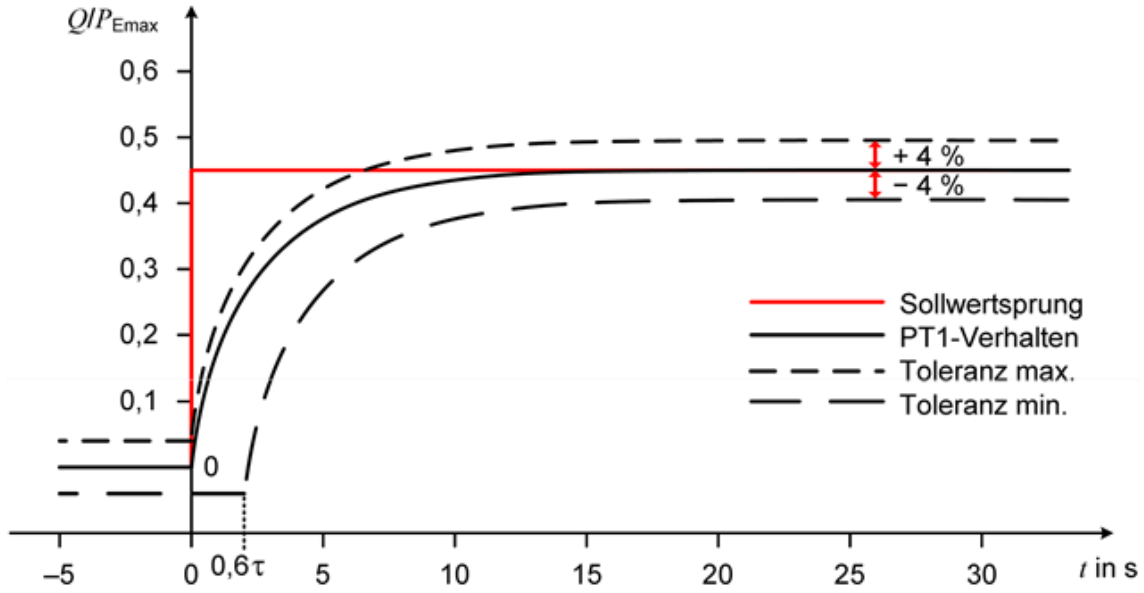


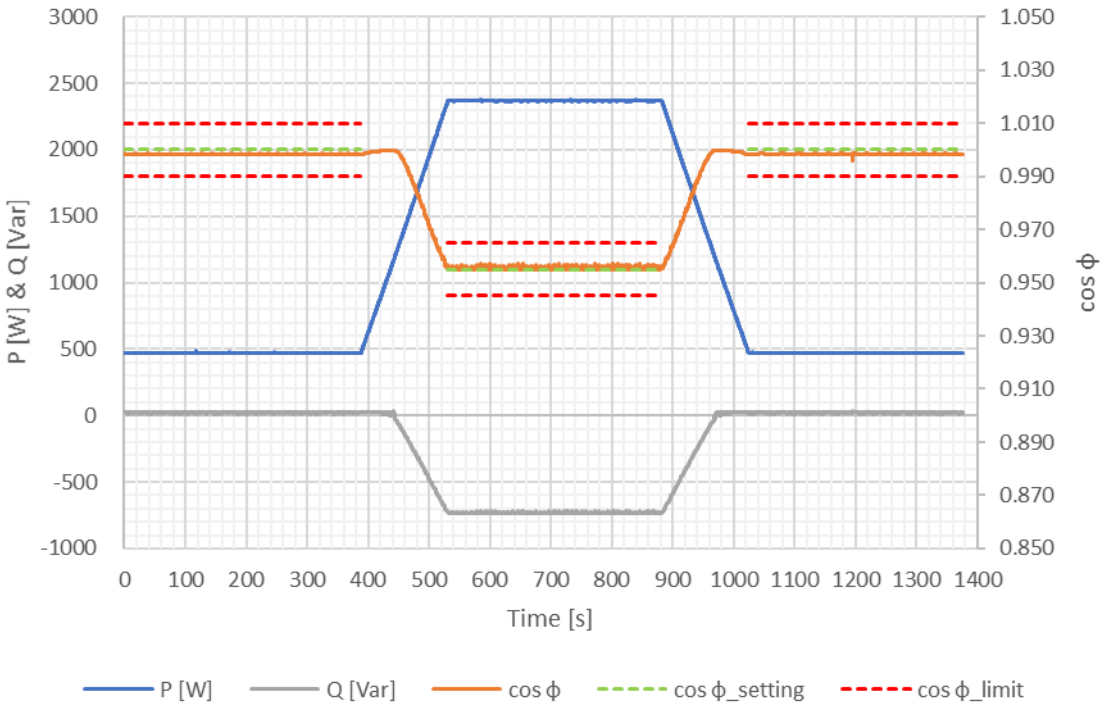
Figure 10 - Illustration at 3 tau = 10 s

Comment:

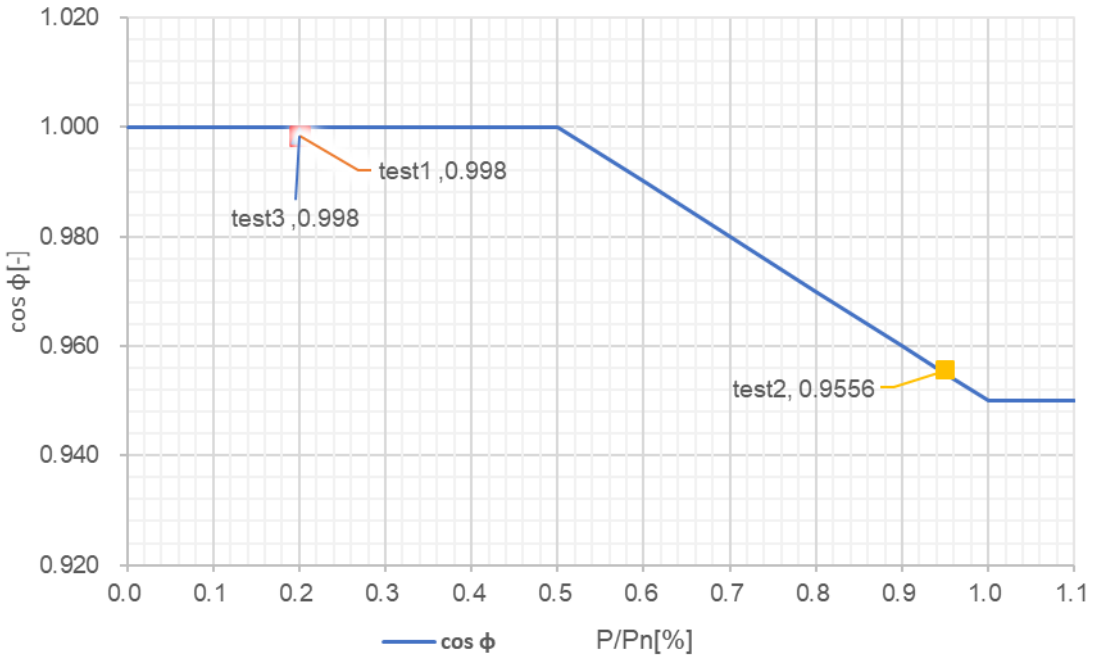
The regulation and control behaviour according to PT-1 is implemented and checked for all reactive power control modes.

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

MST-BIE5-2500			
Test 1) for conducted PGUs (Battery) - Accuracy (characteristic)			
Measurement: 20-100-20% P_n			
P_E/P [%]	20	100	20
U [V]	229,90	229,81	229,86
P_{E30} [W]	484	2367	524
P_{E30} of P_E [%]	19,37	94,69	20,98
Q_{E30} [VAr]	25	-730	29
$Q_{expected}$	0	-733	0
ΔQ_{E30} [%]	1,01	0,09	1,15
cos φ_{E30}	0,998	0,956	0,998
cos $\varphi_{setpoint}$ of P_{E30}	1,000	0,955	1,000
Limit			
ΔQ_{E30} in %	≤ ±4,0% relative to P_{Emax}		P
DC setting values:			
DC Battery (Source) input current	55		
DC Battery (Source) input voltage	51,2		
$P_{DC\text{-}Sum}$ [W]	2816		
Graph of Test 1)			



Graph of Test 1)



Assessment criterion:

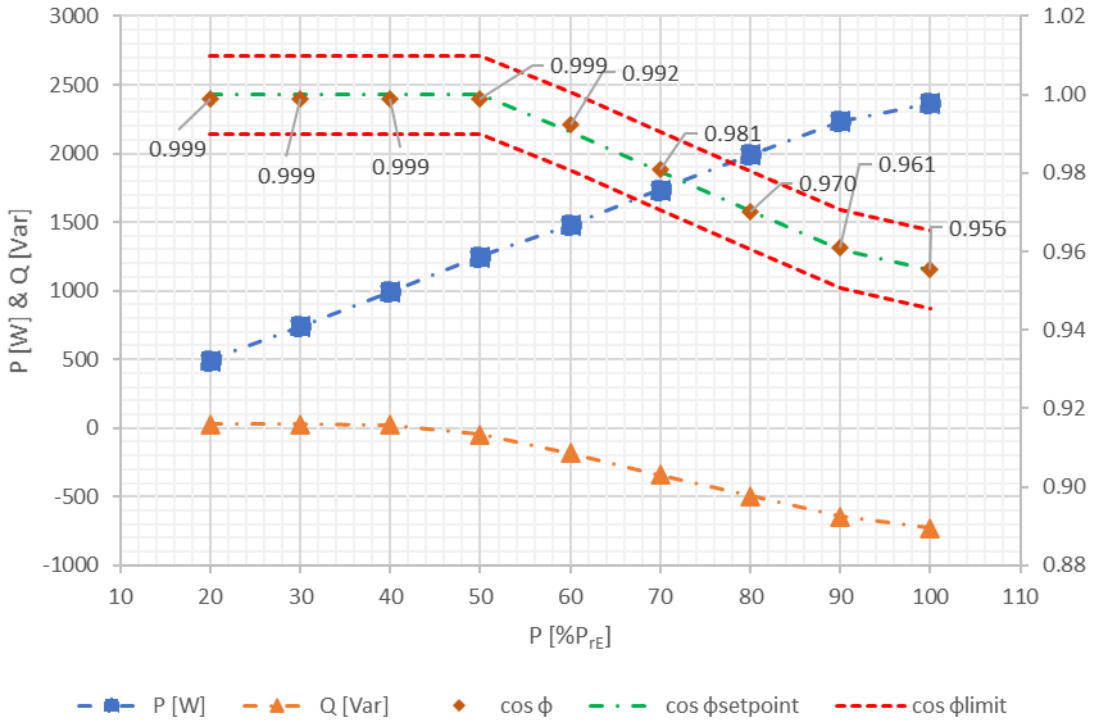
Test 5.4.8.3 (1) and (3) are passed if, for all calculated reactive power values, the maximum deviation between the reactive power setpoint (calculated from the characteristic curve to be verified) and the reactive power actual value at the generator terminals is a maximum of ±4,0% based on P_{Emax}.

Test 3) supply-dependent PGUs - Accuracy (characteristic curve)									
MST-BIE5-2500									
Measurement: 20-100% P_n									
P_{Emax}/P [%]	U [V]	P_{E30} [W]	P_{E30} of P_n [%]	Q_{E30} [VAr]	$Q_{expected}$	ΔQ_{E30} [%]	cos φ_{E30}	cos $\varphi_{setpoint}$ of P_{E30}	P_{DC}[W]
20	229,88	494	19,77	27	0	1,07	0,999	1,000	527
30	229,88	742	29,68	28	0	1,11	0,999	1,000	794
40	229,87	996	39,84	22	0	0,86	0,999	1,000	1061
50	229,86	1249	49,97	-45	0	-1,81	0,999	1,000	1312
60	229,83	1482	59,27	-183	-204	0,85	0,992	0,991	1560
70	229,82	1736	69,42	-343	-347	0,16	0,981	0,981	1813
80	229,80	1991	79,64	-496	-496	-0,01	0,970	0,970	2092
90	229,79	2236	89,42	-643	-647	0,16	0,961	0,961	2341
100	229,80	2367	94,66	-730	-732	0,07	0,956	0,955	2481
Measurement: 100-20% P_n									
P_{Emax}/P [%]	U [V]	P_{E30} [W]	P_{E30} of P_n [%]	Q_{E30} [VAr]	$Q_{expected}$	ΔQ_{E30} [%]	cos φ_{E30}	cos $\varphi_{setpoint}$ of P_{E30}	P_{DC}[W]
100	229,81	2366	94,64	-731	-732	0,05	0,955	0,955	2481
90	229,82	2235	89,38	-644	-647	0,10	0,961	0,961	2342
80	229,83	1990	79,59	-499	-496	-0,13	0,970	0,970	2093
70	229,85	1734	69,37	-346	-347	0,06	0,981	0,981	1814
60	229,85	1481	59,23	-186	-203	0,68	0,992	0,991	1560
50	229,87	1249	49,95	-47	0	-1,86	0,999	1,000	1313
40	229,87	996	39,84	21	0	0,84	0,999	1,000	1039
30	229,88	742	29,68	27	0	1,10	0,999	1,000	795
20	229,88	494	19,78	27	0	1,06	0,999	1,000	527
Limit									
ΔQ_{E30} in %	≤ ±4,0% relative to P_{Emax}							P	

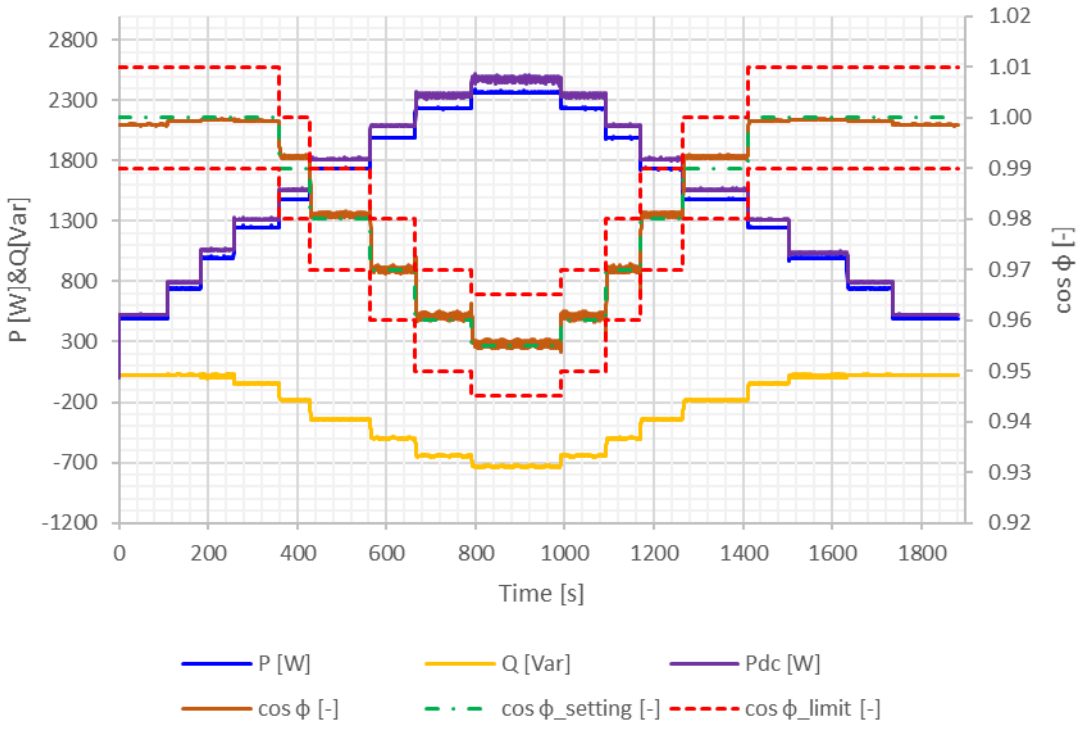
Test 4): supply-dependent PGUs - Dynamic				
MST-BIE5-2500				
P_{Emax}/P_n [%]	100	40	100	75
U [V]	229,81	229,87	229,81	229,83
P_{E30} [W]	2367	983	2367	1850
P_{E30} of P_n [%]	94,68	39,32	94,68	74,00
Q_{E30} [Var]	-731	22	-730	-414
$Q_{expected}$	-732	0	-732	-413
ΔQ_{E30} [%]	0,06	0,88	0,09	-0,05

cos φ $_{E30}$	0,956	1,000	0,956	0,976
cos $\varphi_{setpoint}$ of P_{E30}	0,955	1,000	0,955	0,976
T [s]	--	9,6	9,2	9,8
Limit				
ΔQ_{E30} in %	≤ ±4,0% relative to P_{Emax}			P
DC setting values:				
DC Battery (Source) input current	55			
DC Battery (Source) input voltage	51,2			
$P_{DC\text{-}Sum}$ [W]	2816			

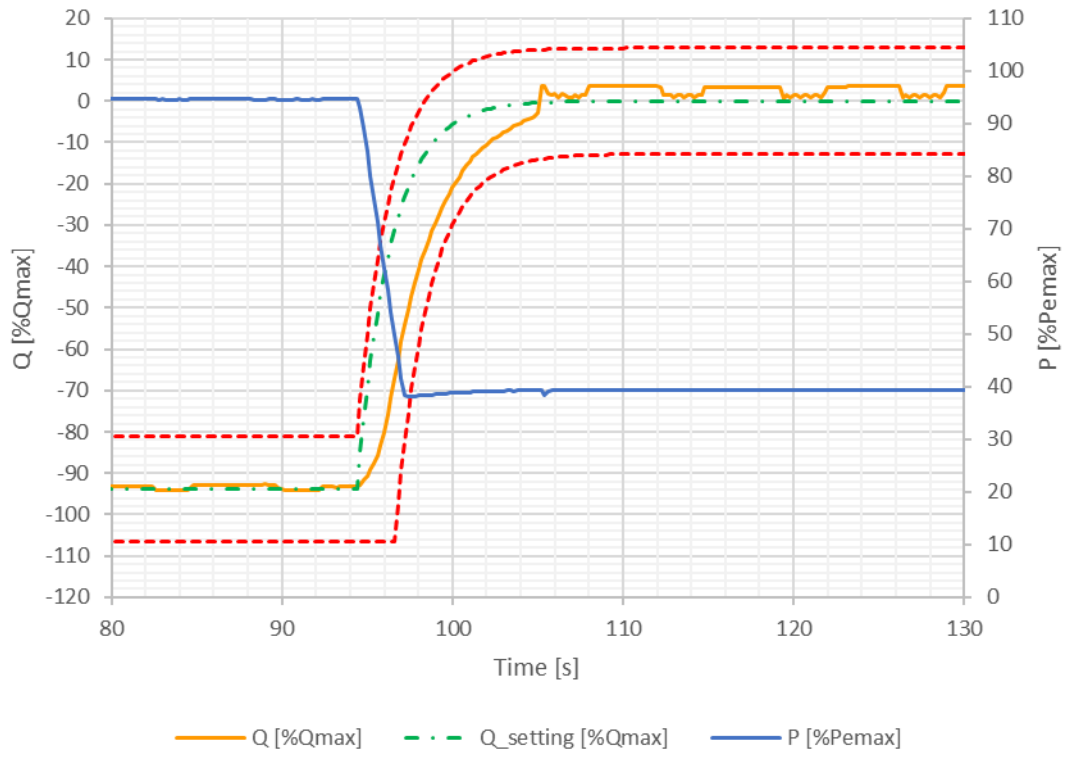
Graph of Test 3)



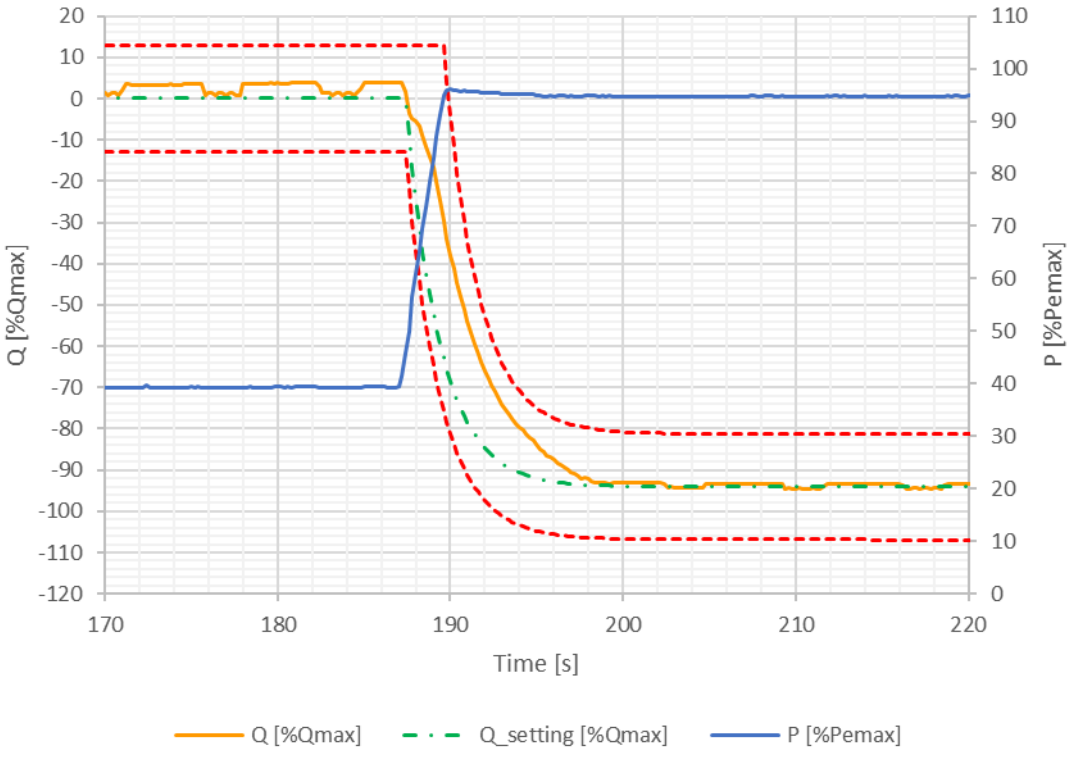
Graph of Test 3): 20% to 100% to 20%



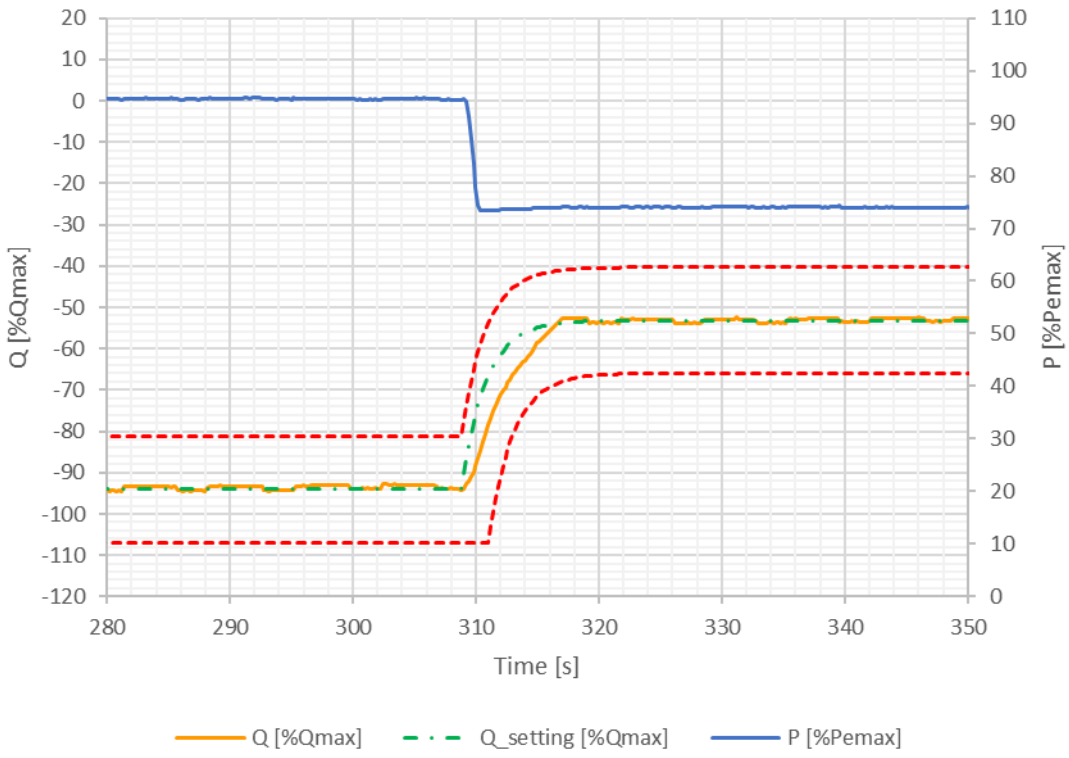
Graph of Test 4): 100% to 40%



Graph of Test 4): 40% to 100%



Graph of Test d): 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 **MST-BIE5-2500** 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)	N/A

Voltage steps	[Vac] L1	[Vac] L2	[Vac] L3	P_{start} [W]	$Q_{measured}$ [VAr]	$Q_{setting}$ [VAr]	ΔQ [%Pn]
100	--	--	--	--	--	--	--
99	--	--	--	--	--	--	--
98	--	--	--	--	--	--	--
97	--	--	--	--	--	--	--
96	--	--	--	--	--	--	--
95	--	--	--	--	--	--	--
94	--	--	--	--	--	--	--
93	--	--	--	--	--	--	--
92	--	--	--	--	--	--	--
91	--	--	--	--	--	--	--
90	--	--	--	--	--	--	--
91	--	--	--	--	--	--	--
92	--	--	--	--	--	--	--
93	--	--	--	--	--	--	--
94	--	--	--	--	--	--	--
95	--	--	--	--	--	--	--
96	--	--	--	--	--	--	--
97	--	--	--	--	--	--	--
98	--	--	--	--	--	--	--
99	--	--	--	--	--	--	--
100	--	--	--	--	--	--	--
101	--	--	--	--	--	--	--
102	--	--	--	--	--	--	--
103	--	--	--	--	--	--	--
104	--	--	--	--	--	--	--
105	--	--	--	--	--	--	--
106	--	--	--	--	--	--	--
107	--	--	--	--	--	--	--
108	--	--	--	--	--	--	--
109	--	--	--	--	--	--	--

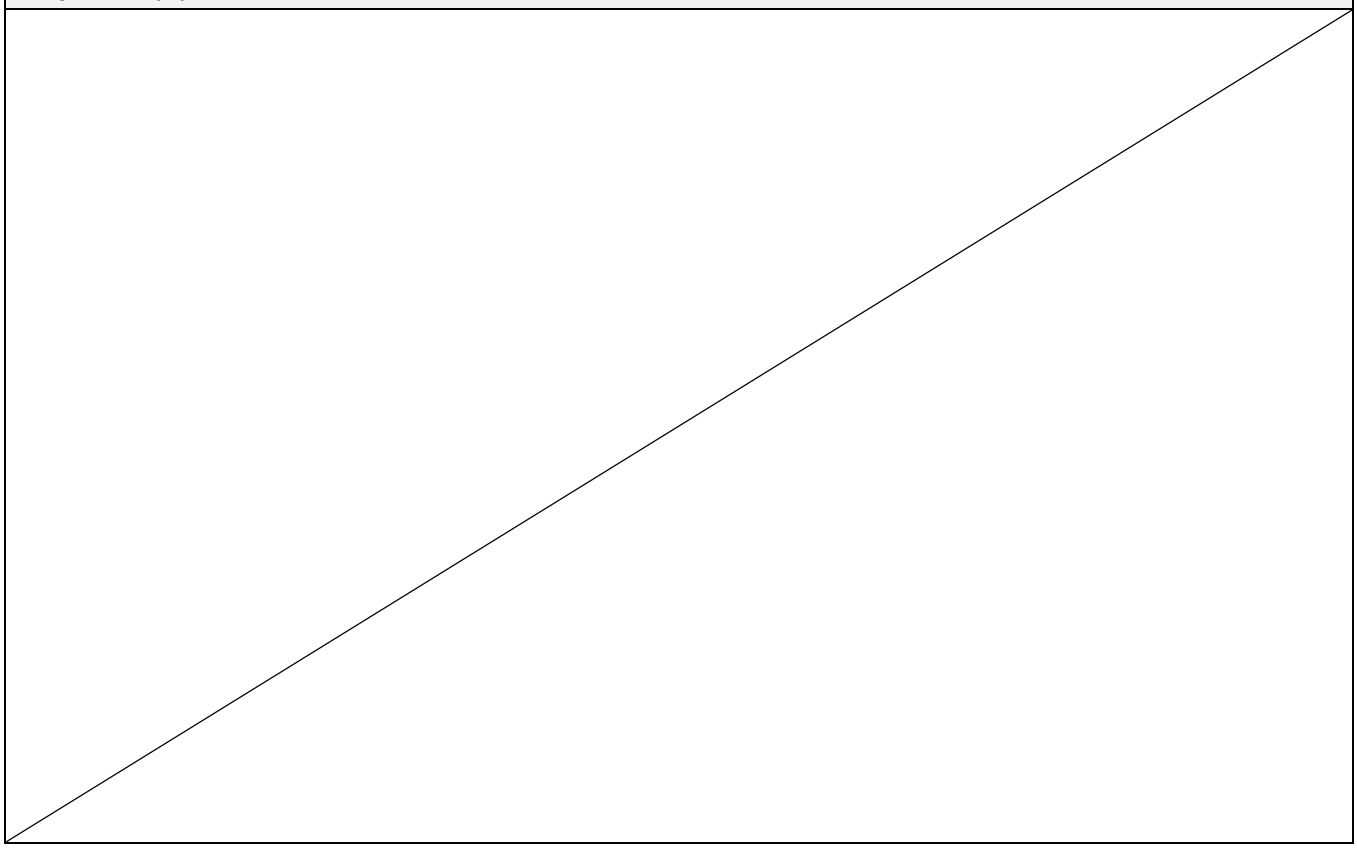
110	--	--	--	--	--	--	--
109	--	--	--	--	--	--	--
108	--	--	--	--	--	--	--
107	--	--	--	--	--	--	--
106	--	--	--	--	--	--	--
105	--	--	--	--	--	--	--
104	--	--	--	--	--	--	--
103	--	--	--	--	--	--	--
102	--	--	--	--	--	--	--
101	--	--	--	--	--	--	--
100	--	--	--	--	--	--	--

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}.

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

Graph of Q(U) curve



5.4.8.4.2 Test of the dynamics of the Q(U) regulation	N/A

Setting values	Qmax [var]	kQU	X_{Netz}	$\Delta U_{ind,Y}$ [V]	$\Delta U_{kap,Y}$ [V]	Tau
	--	--	--	--	--	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	--	--	--	--	--	--	--	--	--
Test2:100→106,4	--	--	--	--	--	--	--	--	--
Test3:100→106,4	--	--	--	--	--	--	--	--	--
Test1:100→93,6	--	--	--	--	--	--	--	--	--
Test2:100→93,6	--	--	--	--	--	--	--	--	--
Test3:100→93,6	--	--	--	--	--	--	--	--	--

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

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.

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	
HAME-PWR-BI2500W V34								
Relay Fault K3B Pin6 and Pin7	short before start-up	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter cannot start-up. Error message: Relay Sticking. R234/R236, D83 damage. No hazard.
Relay Fault K3B Pin2 and Pin3	short before start-up	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter cannot start-up. Error message: Relay Sticking. R234/R236, D83 damage. No hazard.
Relay Fault K1B Pin5 and Pin4	short before start-up	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter cannot start-up. Error message: Relay Sticking No damage. No hazard.
Relay Fault K1B Pin2 and Pin3	short before start-up	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter cannot start-up. Error message: Relay Sticking No damage. No hazard.
BUS voltage detection circuit R31	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.
BUS voltage	Short	Vac	Vdc	10min	FU1	Vac	Vdc	The inverter immediately

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
HAME-PWR-BI2500W V34								
detection circuit R35		230V	51,2V			230V	51,2V	disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.
BUS voltage detection circuit R37	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.
BUS voltage detection circuit R39	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.
GRID voltage detection circuit R106	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
GRID voltage detection circuit R118	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
GRID voltage detection circuit R123	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
GRID voltage detection circuit R123	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
GRID voltage detection circuit R199	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
HAME-PWR-BI2500W V34								
GRID voltage detection circuit R199	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
GRID voltage detection circuit R450	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
GRID voltage detection circuit R450	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
BAT voltage detection circuit R30	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal battery voltage sampling No damage. No hazards.
BAT voltage detection circuit R416	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal battery voltage sampling No damage. No hazards.
HAME-CTR-BI2500W V35								
Communication fault U45 pin3 to pin2 (VCC5V to VCC3V	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication fault Y1 Pin1 and Pin2	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication fault Y2 Pin1 and Pin2	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
HAME-PWR-BI2500W V34								
Communication fault Y2 Pin1 and Pin3	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication of main CPU U28A Pin93	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication of slave CPU U9B Pin82	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication of main CPU U28A CC_GND and CC_MCU_3.3V	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication of main CPU and slave CPU R399	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication fault Y3 Pin1 and Pin2	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication fault Y4 Pin1 and Pin3	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
Communication fault Y4 Pin1 and Pin2	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: Communication exception No damage. No hazards.
GRID voltage detection circuit R247	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
HAME-PWR-BI2500W V34								
								No damage. No hazards.
GRID voltage detection circuit U21A Pin3 and Pin1	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
GRID voltage detection circuit R237	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
GRID voltage detection circuit D58	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal grid voltage sampling No damage. No hazards.
Inverter voltage detection circuit D65	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
Inverter voltage detection circuit R271	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
Inverter voltage detection circuit U21D Pin12 and Pin14	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
Inverter voltage detection circuit R262	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter voltage sampling No damage. No hazards.
DCI detection circuit R250	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter DC

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
HAME-PWR-BI2500W V34								
								Component Sampling No damage. No hazards.
DCI detection circuit U21C Pin10 and Pin8	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter DC Component Sampling No damage. No hazards.
DCI detection circuit R261	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Inverter DC Component Sampling No damage. No hazards.
GRID current detection circuit R278	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the buzzer will sound an alarm, the warn light is on, Abnormal Output Current Sampling No damage. No hazards.
GRID current detection circuit U22A Pin3 and Pin1	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the buzzer will sound an alarm, the warn light is on, Abnormal Output Current Sampling No damage. No hazards.
GRID current detection circuit R280	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the buzzer will sound an alarm, the warn light is on, Abnormal Output Current Sampling No damage. No hazards.
BUS voltage detection circuit R40	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.
BUS voltage detection circuit U22D Pin13 and Pin14	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.

Component No.	Fault	Test condition:		Test time: [min]	Fuse no.[A]	Fault condition:		Result:
		AC	DC			AC	DC	
HAME-PWR-BI2500W V34								
BUS voltage detection circuit R41	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal Bus Voltage Sampling: No damage. No hazards.
BAT current detection circuit R48	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal battery current sampling No damage. No hazards.
BAT current detection circuit U3B Pin6 and Pin7	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal battery current sampling No damage. No hazards.
BAT current detection circuit R49	Open	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal battery current sampling No damage. No hazards.
BAT current detection circuit C131	Short	Vac 230V	Vdc 51,2V	10min	FU1	Vac 230V	Vdc 51,2V	The inverter immediately disconnection from grid. Error message: the warn light is on, Abnormal battery current sampling No damage. No hazards.
Note: The errors in the control circuit simulate that the safety is even ensured during a single fault. The test results of the **MST-BIE5-2500** 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.	
Relay model: **HF140FF-G**	
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)	= 10,9 A, 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):

Test Relay model: **HF140FF-G**

HF140FF-G MINIATURE INTERMEDIATE POWER RELAY

c UL us
File No.:E134517

File No.:R50149131

File No.:CQC10002046173

Features

- 16A switching capability
- 5kV dielectric strength (between coil and contacts)
- 2.0mm contact gap available
- Plastic sealed and flux proofed types available
- Sockets available
- UL insulation system:Class F

RoHS compliant

CONTACT DATA

Contact arrangement	2A, 2C
Contact resistance	100mΩ max.(at 1A 6VDC)
Contact material	$AgSnO_2$
Contact rating (Res. load)	16A 250VAC
Max. switching voltage	250VAC
Max. switching current	16A
Max. switching power	4000VA
Mechanical endurance	W type: 1 x 10^5OPS
Electrical endurance	W type(1.5mm)-2ZWTF: NO 3 x 10^4OPS, NC 1 x 10^4OPS (Resistive load,1s on 9s off) W type(2.0mm)-2ZWTF(456): NO 3 x 10^4OPS, NC 6 x 10^3OPS (Resistive load,1s on 9s off)

Notes: 1) The data shown above are initial values.
2) For plastic sealed type, the venting-hole should be excised in electrical endurance test.
3) Large gap (W type) products: the ambient temperature of the relay is -40°C ~ 75°C; (When used at 75°C ~ 85°C, step-down maintenance is required: applying rated voltage for 200ms firstly to ensure stable connection, then reduce to and maintain 45- 65% of rated voltage.)

SAFETY APPROVAL RATINGS

UL	16A 250VAC Resistive at 85°C 1/3HP 125VAC NO/NC,40°C 3/4HP 250/240VAC,NO,40°C TV-5, 125VAC,40°C
TÜV	16A 250VAC Resistive at 85°C
CQC	16A 250VAC Resistive at 85°C

Notes: 1) All values unspecified are at room temperature.
2) Only typical loads are listed above. Other load specifications can be available upon request.

CHARACTERISTICS

Insulation resistance		1000MΩ (at 500VDC)
Dielectric strength	Between coil & contacts	5000VAC 1min
	Between contacts sets	3000VAC 1min
	Between open contacts	W type:2500VAC 1min
Surge voltage (between coil & contacts)		10kV (1.2/50 μs)
Operate time (at nomi. volt.)		20ms max.
Release time (at nomi. volt.)		15ms max.
Humidity		5% to 85% RH
Ambient temperature		-40°C to 85°C
Shock resistance	Functional	98m/s²
	Destructive	980m/s²
Vibration resistance		10Hz to 55Hz 1.5mmDA
Termination		PCB
Unit weight		Approx. 19g
Construction		Plastic sealed, Flux proofed

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

COIL

Coil power	W type(1.5mm): Approx. 800mW W type(2.0mm): Approx. 1.4W

HONGFA RELAY
ISO9001, IATF16949 , ISO14001, ISO45001, IECQ QC 080000, ISO/IEC 27001 CERTIFIED 2024 Rev. 1.00

260

COIL DATA

at 23°C

W Type (1.5mm)

Nominal Voltage VDC	Pick-up Voltage VDC max.	Drop-out Voltage VDC min.	Max. Allowable Voltage VDC	Coil Resistance Ω
3	≤2.40	≥0.15	3.3	11.3 x (1±10%)
5	≤4.00	≥0.25	5.5	31 x (1±10%)
6	≤4.80	≥0.30	6.6	45 x (1±10%)
9	≤7.20	≥0.45	9.9	101 x (1±10%)
12	≤9.60	≥0.60	13.2	180 x (1±10%)
15	≤12.0	≥0.75	16.5	280 x (1±10%)
18	≤14.4	≥0.90	19.8	405 x (1±10%)
24	≤19.2	≥1.20	26.4	720 x (1±10%)
36	≤28.8	≥1.80	39.6	1620x (1±10%)
48	≤38.4	≥2.40	52.8	2880 x (1±10%)
60	≤48.0	≥3.00	66.0	4500 x (1±10%)
110	≤88.0	≥5.50	121.0	15100 x (1±10%)

W Type (2.0mm)

Nominal Voltage VDC	Pick-up Voltage VDC max.	Drop-out Voltage VDC min.	Max. Allowable Voltage VDC	Coil Resistance Ω
3	≤2.40	≥0.15	3.3	6x (1±10%)
5	≤4.00	≥0.25	5.5	18 x (1±10%)
6	≤4.80	≥0.30	6.6	26 x (1±10%)
9	≤7.20	≥0.45	9.9	58 x (1±10%)
12	≤9.60	≥0.60	13.2	102 x (1±10%)
15	≤12.0	≥0.75	16.5	160 x (1±10%)
18	≤14.4	≥0.90	19.8	230 x (1±10%)
24	≤19.2	≥1.20	26.4	410 x (1±10%)
36	≤28.8	≥1.80	39.6	925x (1±10%)
48	≤38.4	≥2.40	52.8	1650 x (1±10%)
60	≤48.0	≥3.00	66.0	2570 x (1±10%)
110	≤88.0	≥5.50	121.0	8068 x (1±10%)

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) In order to meet the stated product performance, please apply rated voltage to coil.
4) For the CO version whose contact gap is 1.5 mm/2.0mm, the operation voltage ≤85% of rated voltage,the coil resistance tolerance is (1±15%).

ORDERING INFORMATION

HF140FF-G/ 024 -2Z S W T G F (XXX)

Type	
Coil voltage	3,5,6,9,12,15,18,24,36,48,60,110VDC
Contact arrangement	**2H:** 2 Form A **2Z:** 2 Form C
Construction	**S:** Plastic sealed **Nil:** Flux proofed
Contact Gap	**W:** Large contact gap
Contact material	**T:** $AgSnO_2$
Contact plating	**G:** Gold plated **Nil:** No gold plated
Insulation standard	**F:** Class F **Nil:** Class F
Special code	**XXX:** Customer special requirement **Nil:** Standard

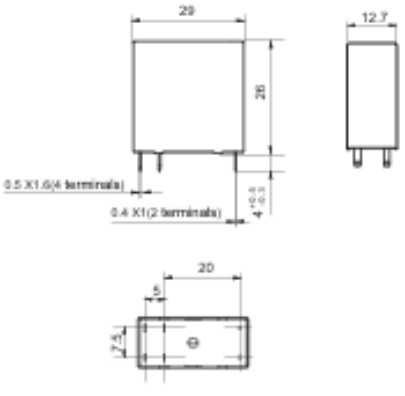
Notes: 1) We recommend flux proofed types for a clean environment (free from contaminations like H_2S, SO_2, NO_2, dust, etc.).
We suggest to choose plastic sealed types and validate it in real application for an unclean environment (with contaminations like H_2S,
2) Contact is recommended for suitable condition and specifications if water cleaning or surface process is involved in assembling relays on PCB.SO_2, NO_2, dust, etc).
3) There are two specifications to W type: 1.5mm contact gap and 2.0mm contact gap.The default W type is 1.5mm. So please add the special code "(456)" when releasing order,if 2.0mm contact gap is required.
4) The customer special requirement express as special code after evaluating by Hongfa. e.g.(456) means contact gap can reach 2.0mm.

OUTLINE DIMENSIONS, WIRING DIAGRAM AND PC BOARD LAYOUT

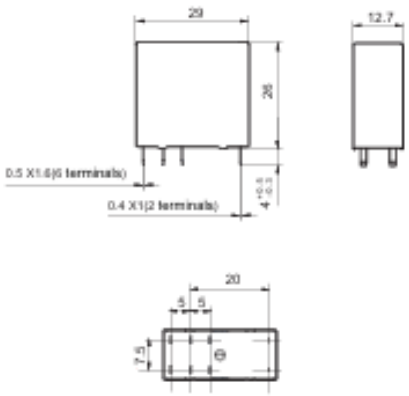
Unit: mm

Outline Dimensions

2 Form A

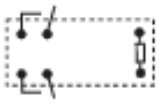


2 Form C

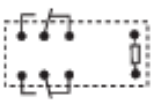


Wiring Diagram (Bottom view)

2 Form A

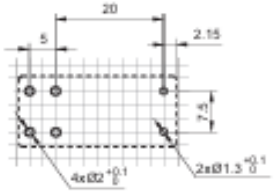


2 Form C

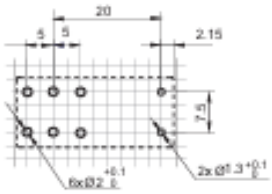


PCB Layout (Bottom view)

2 Form A



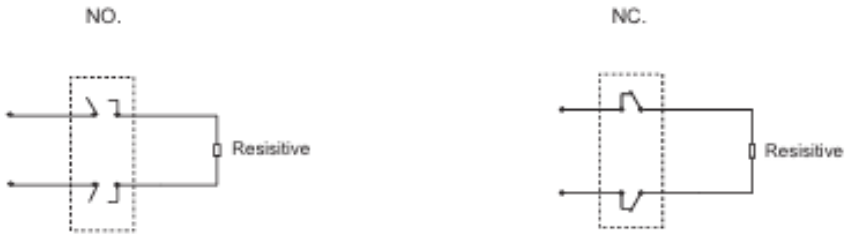
2 Form C



Remark: 1) In case of no tolerance shown in outline dimension: outline dimension ≤1mm, tolerance should be ±0.2mm; outline dimension >1mm and ≤5mm, tolerance should be ±0.3mm; outline dimension >5mm, tolerance should be ±0.4mm.
2) The tolerance without indicating for PCB layout is always ±0.1mm.
3) The width of the gridding is 2.5mm.

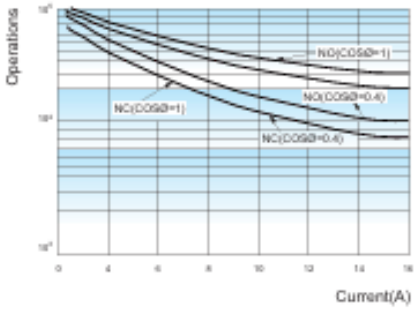
262

ELECTRICAL DURABILITY WIRING DIAGRAM



CHARACTERISTIC CURVES

ENDURANCE CURVE



250VAC resistive load/switching current

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)					
☐ Synchronous and asynchronous generators coupled directly or via a converter Stirling generators, fuel cells, 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>>	Over Volt 2 [V]	--	287,5	--
	Delay time U>>	OV2 Delay Time [ms]	--	100	--
	Excitation threshold U>	Over Volt 1 [V]	--	253,0	--
	Delay time U> * 1)	OV1 Delay Time [ms] *1)	--	100 *1)	--
	Excitation threshold U<	Under Volt 1 [V]	--	184,0	--
	Delay time U<	UV1 Delay Time [ms]	--	3000	--
	Excitation threshold U<<	Under Volt 2 [V]	--	103,5	--
	Delay time U<<	UV2 Delay Time [ms]	--	300	--
	Excitation threshold f>	Under Freg 1 [Hz]	--	51,5	--
	Delay time f>	UF1 Delay Time [ms]	--	100	--
	Excitation threshold f<	Over Freg 1 [Hz]	--	47,5	--
	Delay time f<	OF1 Delay Time [ms]	--	100	--
*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.

Note:

Wiring Test Voltage Monitoring and Frequency Monitoring

Setting values:

Phase	Voltage [Vac]	Phase angle [°]	Frequency [Hz]
U L1-E	219,4	0	50,00
U L2-E	230,9	-120	50,00
U L3-E	242,5	120	50,00

Measured values:

Phase	Voltage [Vac]	Phase angle [°]	Frequency [Hz]
U L1-E	--	--	--
U L2-E	--	--	--
U L3-E	--	--	--

Checking Voltage Reference Voltage Monitoring and Frequency Monitoring

Setting values:

Phase	Voltage [Vac]	Phase angle [°]	Frequency [Hz]
U L1-E	0	0	50,00
U L2-E	230,9	150	50,00
U L3-E	230,9	-150	50,00

Measured values:

Phase	Voltage [Vac]	Phase angle [°]	Frequency [Hz]
U L1-E	--	--	--
U L2-E	--	--	--
U L3-E	--	--	--

5.5.7.4	Voltage and frequency control	P
5.5.7.4.1	Voltage and frequency control – Multi 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 RS485 port.

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 **MST-BIE5-2500** 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 multi-phase ≤30kVA

	Setting	Value [V]	Time [ms]	Setting	Value [V]	Time [ms]
Setting values of the NS protection:	U>>	287,5	100			
	U<	184,0	3000	U<<	103,5	300

Operating time of the monitoring device:

MST-BIE5-2500

L to N:	**Under voltage AU< (4.4):**			**Over voltage AU>> (1.4):**		
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	183,2	183,4	288,2	288,3	288,6

L to N:	**Under voltage tU< (5.4):**			**Over voltage tU>> (2.4):**		
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]	3,035	3,039	3,036	0,120	0,142	0,141

L to N:	**Under voltage AU<< (6.4):**		
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]	103,3	103,2	103,4

L to N:	**Under voltage tU<< (7.4):**
Jump [start V to stop V]	>108,1 → <98,9
Step size [V]	>9,2
Step length [s]	>0,500

5.5.7.4	Voltage and frequency control	P
5.5.7.4.1	Voltage and frequency control – Multi 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 RS485 port.

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 **MST-BIE5-2500** 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 multi-phase ≤30kVA

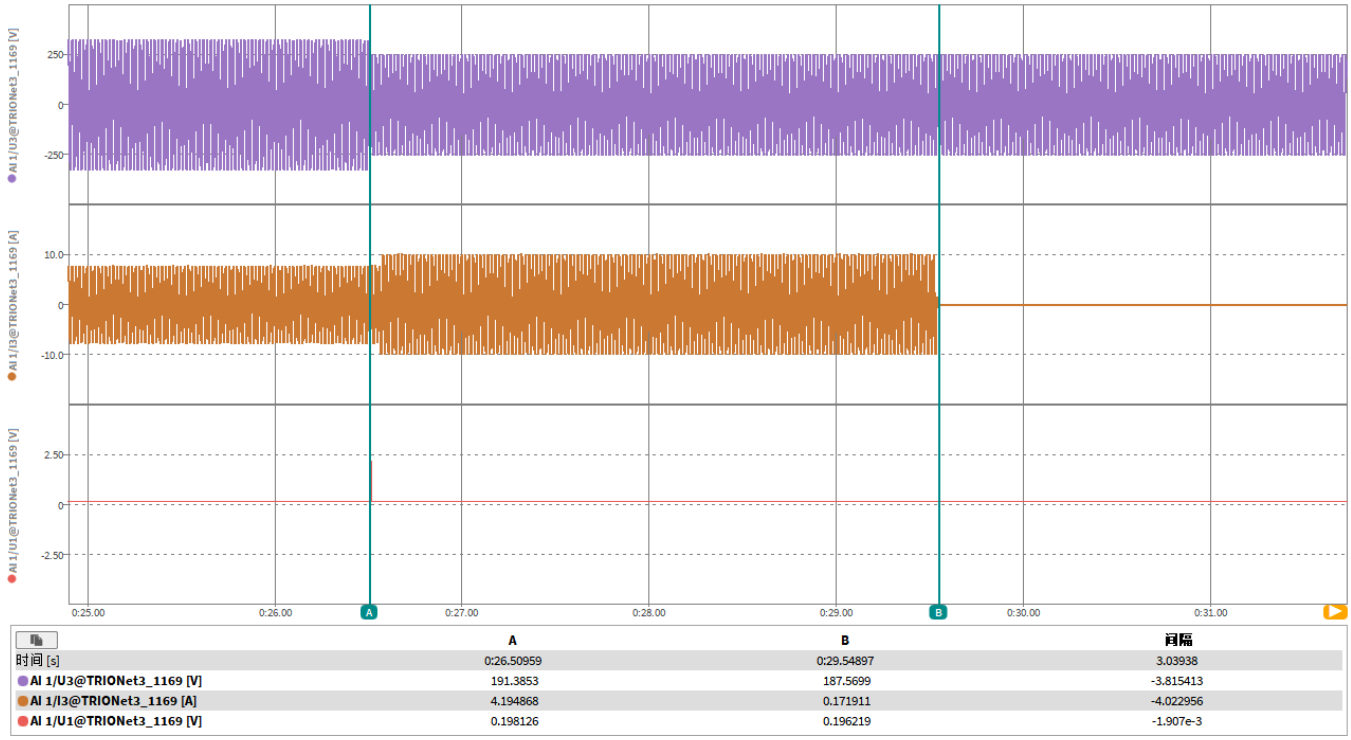
	Setting	Value [V]	Time [ms]	Setting	Value [V]	Time [ms]
Setting values of the NS protection:	U>>	287,5	100			
	U<	184,0	3000	U<<	103,5	300

Operating time of the monitoring device:

MST-BIE5-2500

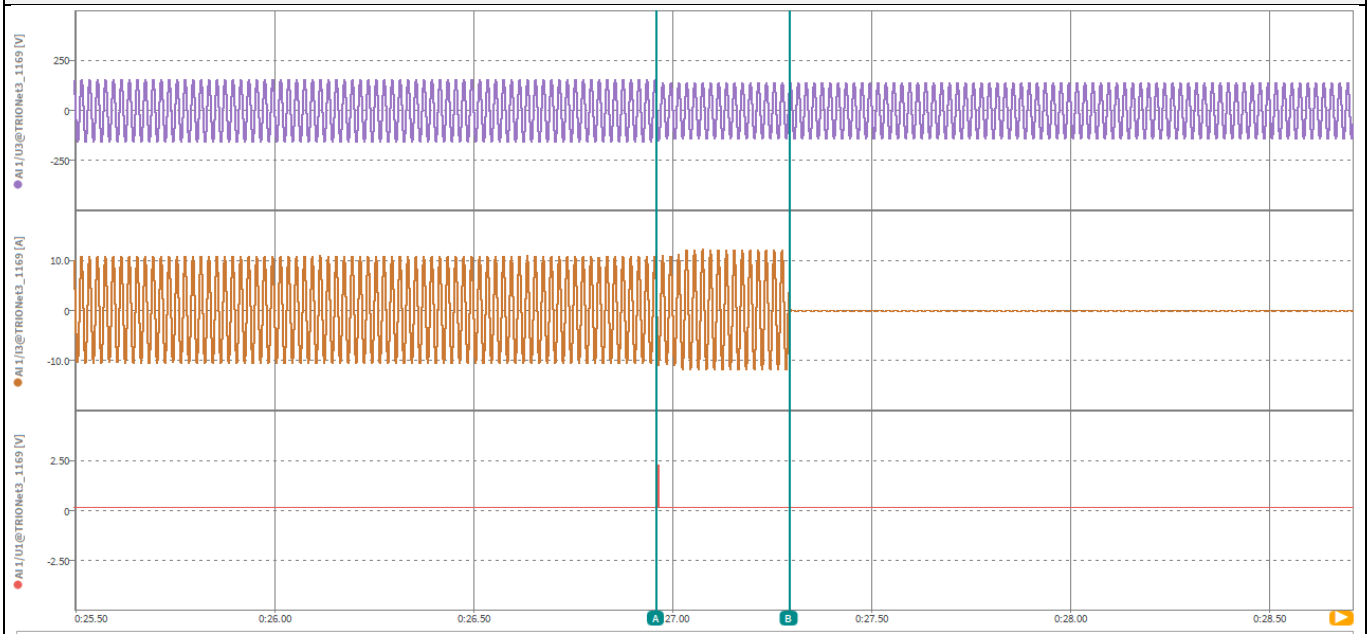
Limit [s]	0,300 ≤t ≤0,400			
Measurement [s]	0,302	0,335	0,323	

Under voltage AU<: L to N:



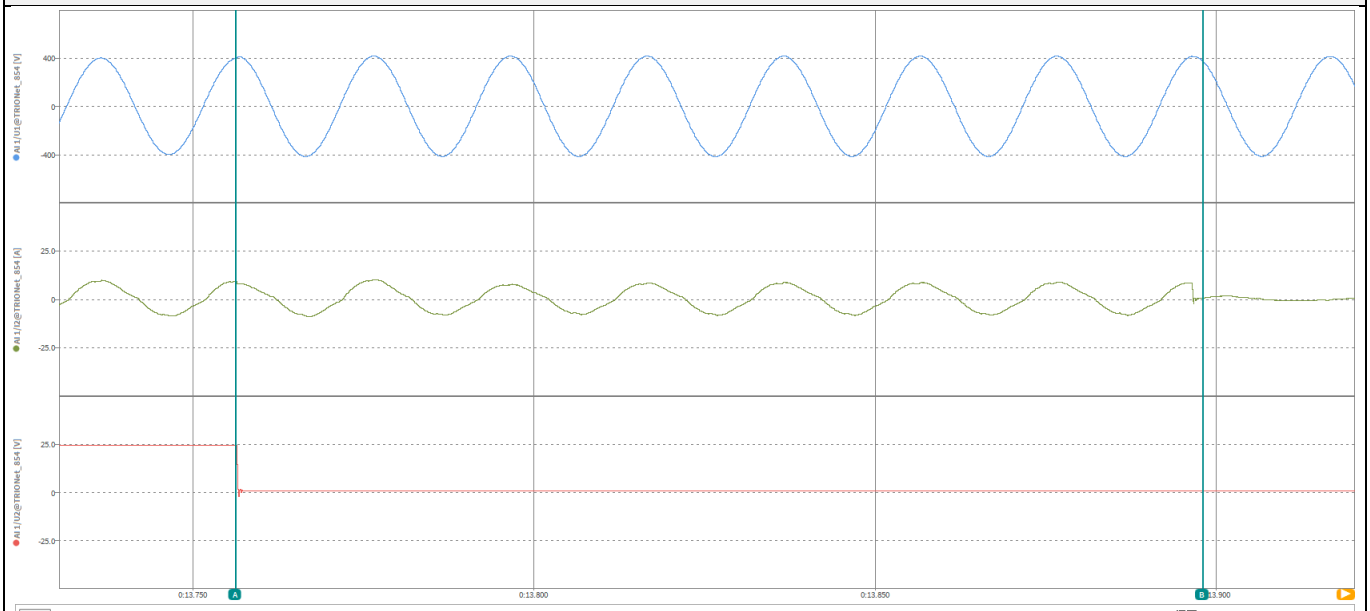
	A	B	间隔
时间 [s]	0:26.50959	0:29.54897	3.03938
AI 1/U3@TRIONet3_1169 [V]	191.3853	187.5699	-3.815413
AI 1/I3@TRIONet3_1169 [A]	4.194868	0.171911	-4.022956
AI 1/U1@TRIONet3_1169 [V]	0.198126	0.196219	-1.907e-3

Under voltage AU<<: L to N:



	A	B	间隔
时间 [s]	0:26.95915	0:27.29391	0.33477
AI 1/U3@TRIONet3_1169 [V]	129.0798	61.99932	-67.08050
AI 1/I3@TRIONet3_1169 [A]	7.874859	-0.278700	-8.153558
AI 1/U1@TRIONet3_1169 [V]	0.197887	0.195026	-2.861e-3

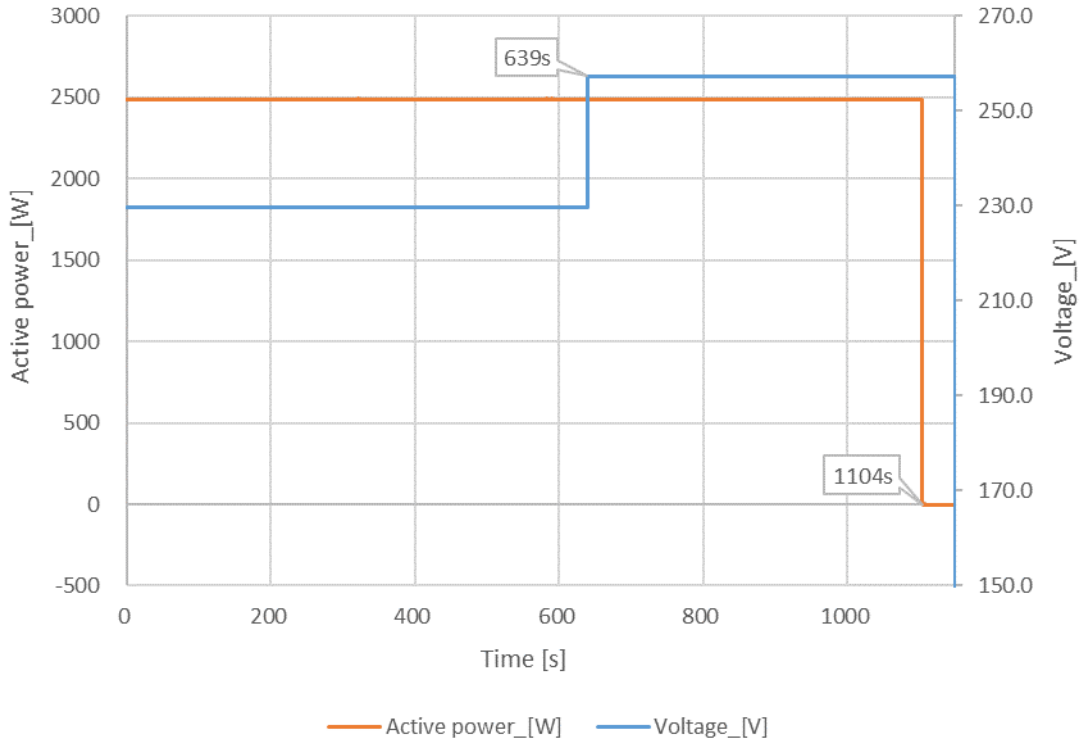
Over voltage AU>>: L to N:



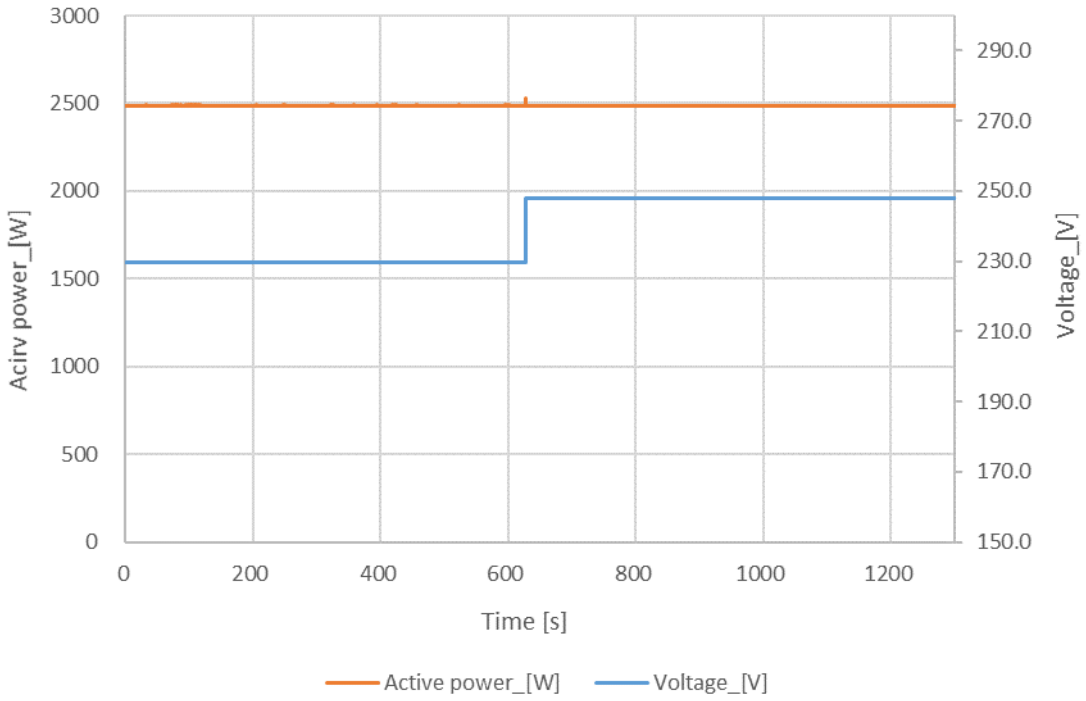
	A	B	间隔
时间 [s]	0:13.7563071	0:13.8979293	0.1416222
AI 1/U1@TRIONet_854 [V]	401.7217	377.9483	-23.77343
AI 1/I2@TRIONet_854 [A]	9.364486	0.597239	-8.767248
AI 1/U2@TRIONet_854 [V]	24.60456	0.665665	-23.93890

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
Note: The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.		
Operating time of the monitoring device:		
L-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]	465s	
L-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	
L-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]	248s	

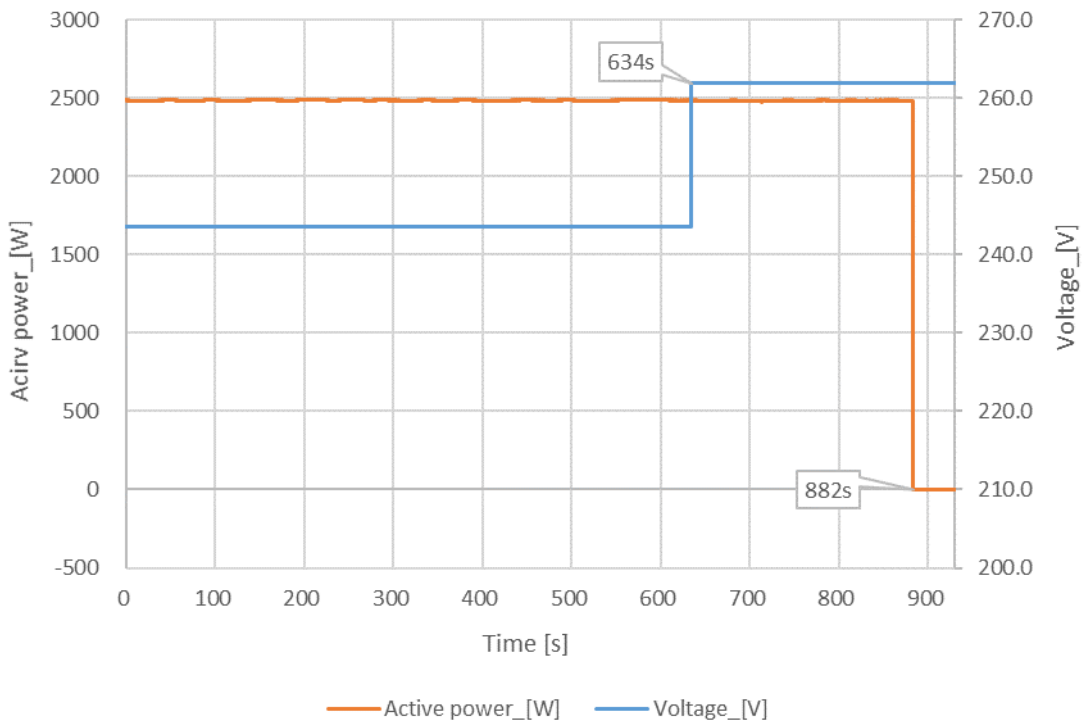
Over voltage 10-minute mean value (3.1):



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 RS485 port.

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:

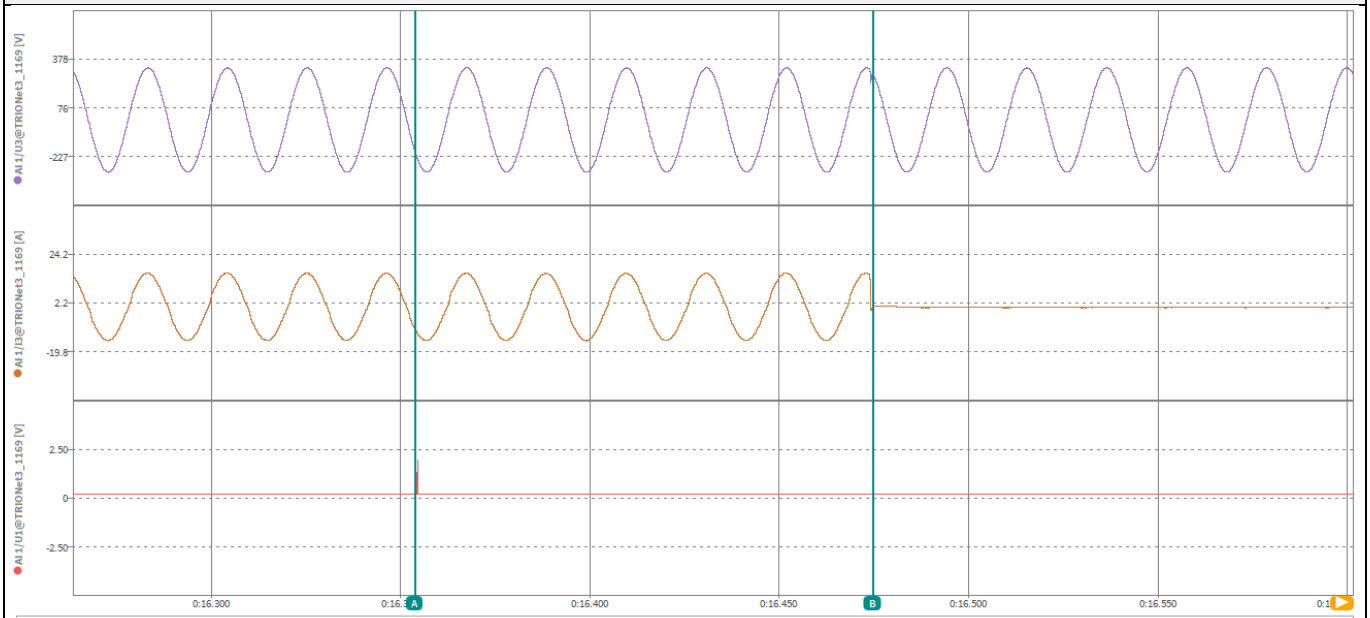
The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

Setting values of the NS protection:	Setting	Value [Hz]	Time [ms]
	f<	47,5	100
	f>	51,5	100

Operating time of the monitoring device:

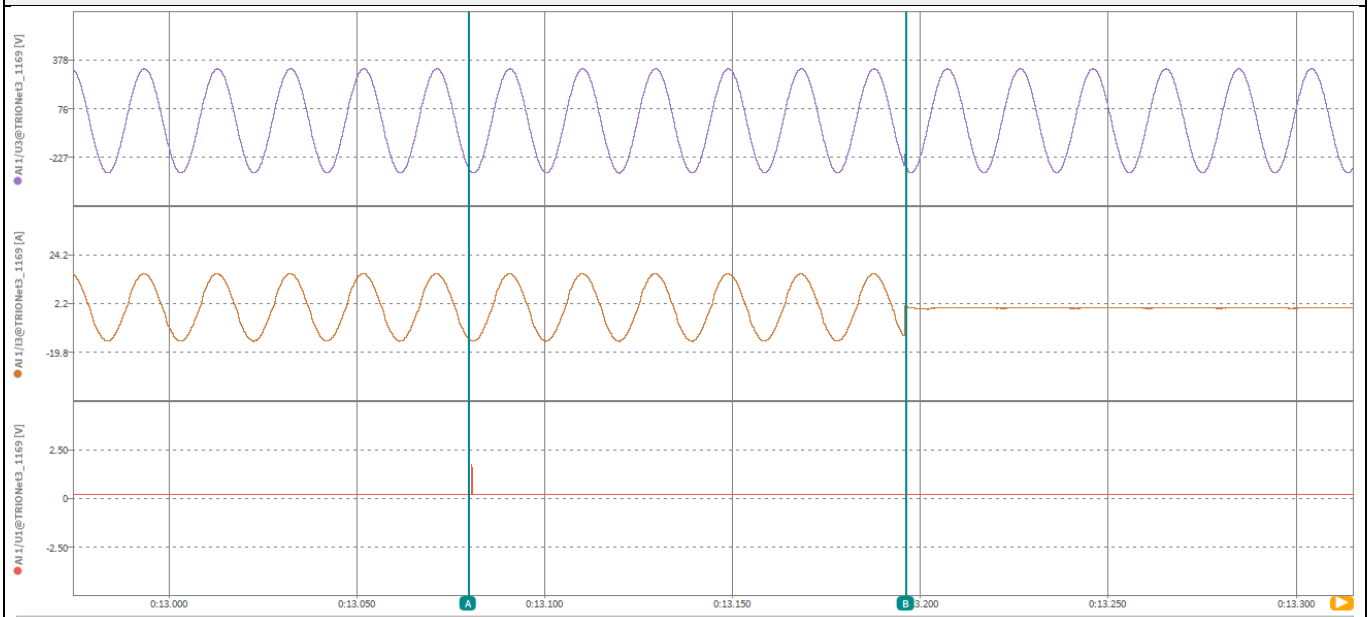
	Under frequency Af< (10.1):			**Over frequency Af> (8.1):**		
Ramp [start Hz to stop Hz]	47,60 → 47,40			51,40 → 51,60		
Step size [Hz]	<0,025			<0,025		
Step length [s]	>0,4			>0,4		
Limit [Hz]	47,50 ±0,1% f_n			51,50 ±0,1% f_n		
Measurement [Hz]	47,47	47,48	47,47	51,50	51,50	51,50
	Under frequency Tf< (11.1):			**Over frequency Tf> (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]	0,117	0,121	0,117	0,111	0,116	0,112

Under frequency Af< (11.1):



	A	B	间隔
时间 [s]	0:16.353958	0:16.474777	0.120819
AI 1/U3@TRIONet3_1169 [V]	-181.9596	279.0964	461.0560
AI 1/I3@TRIONet3_1169 [A]	-9.263743	-0.230062	9.033681
AI 1/U1@TRIONet3_1169 [V]	0.193119	0.193357	2.384e-4

Over frequency Af> (9.1):



	A	B	间隔
时间 [s]	0:13.079722	0:13.196197	0.116476
AI 1/U3@TRIONet3_1169 [V]	-291.3251	-250.1526	41.17251
AI 1/I3@TRIONet3_1169 [A]	-13.87178	1.385343	15.25712
AI 1/U1@TRIONet3_1169 [V]	0.191689	0.192404	7.153e-4

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.

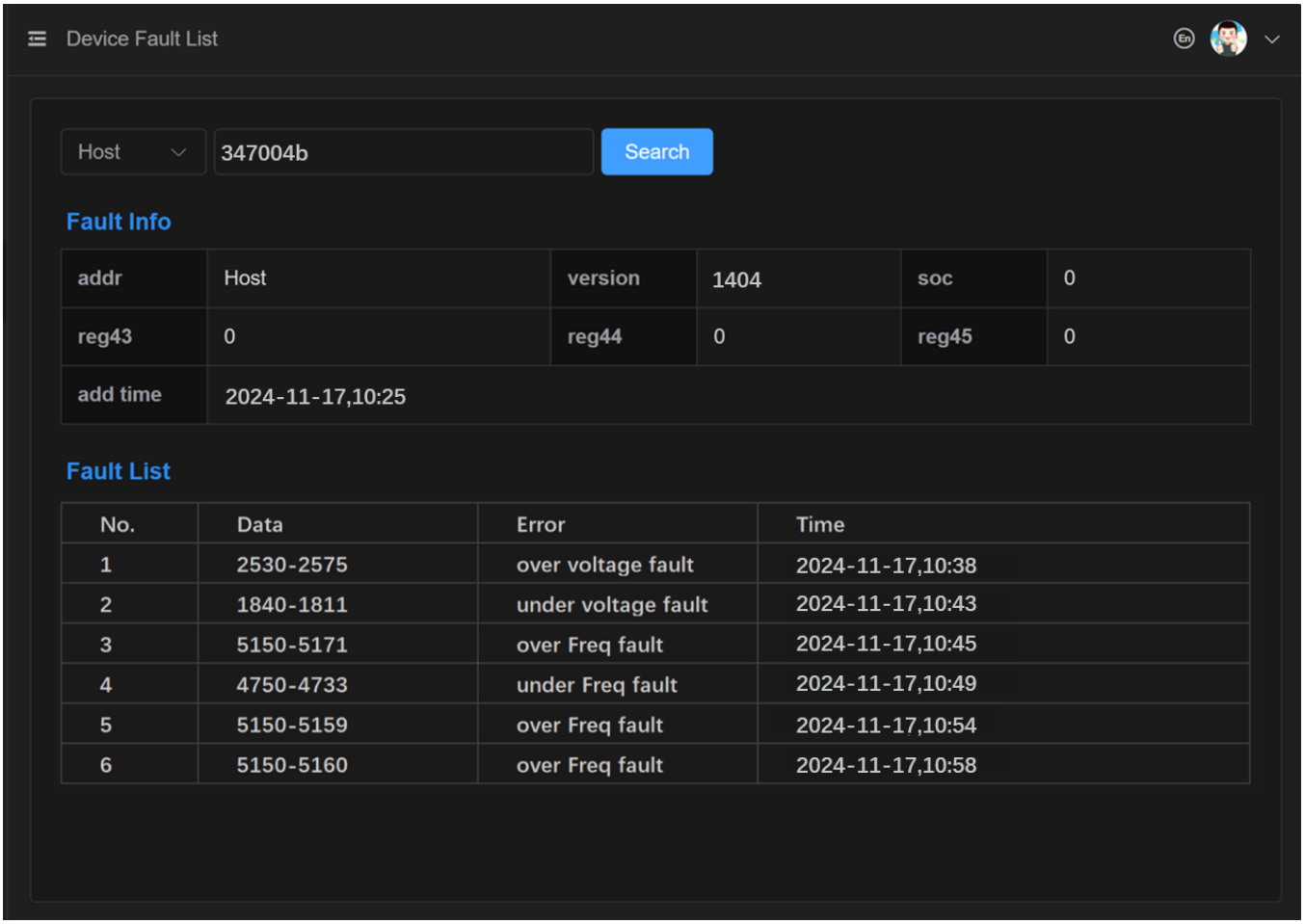
Assessment criterion:

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.

Note:

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

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]	P_{PGU} [W]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Re-marks[5]
1	100	100	0	0	2500	51,2	1,01	**784**	Test A at BL
8	100	100	-5	-5	2500	51,2	1,02	324	Test A at IB
9	100	100	-5	0	2500	51,2	1,05	562	Test A at IB
10	100	100	-5	+5	2500	51,2	1,08	194	Test A at IB
13	100	100	0	-5	2500	51,2	0,99	182	Test A at IB
14	100	100	0	+5	2500	51,2	1,03	303	Test A at IB
17	100	100	+5	-5	2500	51,2	0,95	295	Test A at IB
18	100	100	+5	0	2500	51,2	0,96	280	Test A at IB
19	100	100	+5	+5	2500	51,2	0,98	217	Test A at IB

Parameter at 0%	L= 67,39 mH	R= 21,16 Ω	C= 150,51 µF
I_{AC} [4][A]	0,078		

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 A:

PGU output power P_{PGU} = Maximum [6]

PGU input voltage [6] ≥ 75% of rated input voltage range

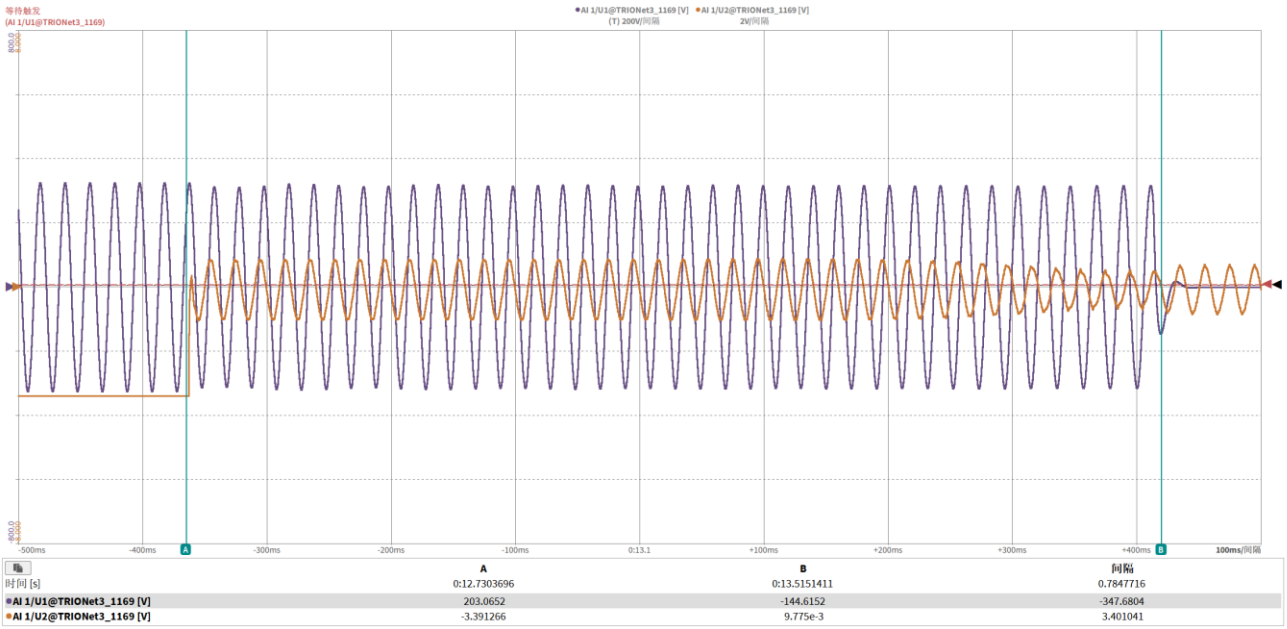
[6] Maximum PGU output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.

[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 energy storage system is tested according to the battery's rated input voltage of 51.2V.)

The test results of the **MST-BIE5-2500** 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%



	A	B	间隔
时间 [s]	0:12.7303696	0:13.5151411	0.7847716
AI 1/U1@TRIONet3_1169 [V]	203.0652	-144.6152	-347.6804
AI 1/U2@TRIONet3_1169 [V]	-3.391266	9.775e-3	3.401041

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]	P_{PGU} [W]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Re-marks[5]
26	66	66	0	-5	1600	51,2	0,96	107	Test B at IB
27	66	66	0	-4	1600	51,2	0,97	116	Test B at IB
28	66	66	0	-3	1600	51,2	0,98	126	Test B at IB
29	66	66	0	-2	1600	51,2	0,98	130	Test B at IB
30	66	66	0	-1	1600	51,2	0,99	157	Test B at IB
31	66	66	0	0	1600	51,2	1,00	548	Test B at BL
32	66	66	0	1	1600	51,2	1,01	169	Test B at IB
33	66	66	0	2	1600	51,2	1,02	156	Test B at IB
34	66	66	0	3	1600	51,2	1,03	139	Test B at IB
35	66	66	0	4	1600	51,2	1,03	138	Test B at IB
36	66	66	0	5	1600	51,2	1,04	127	Test B at IB

Parameter at 0%	L= 105,29mH	R= 33,06 Ω	C= 96,32 µF
I_{AC} [4][A]	0,020		

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

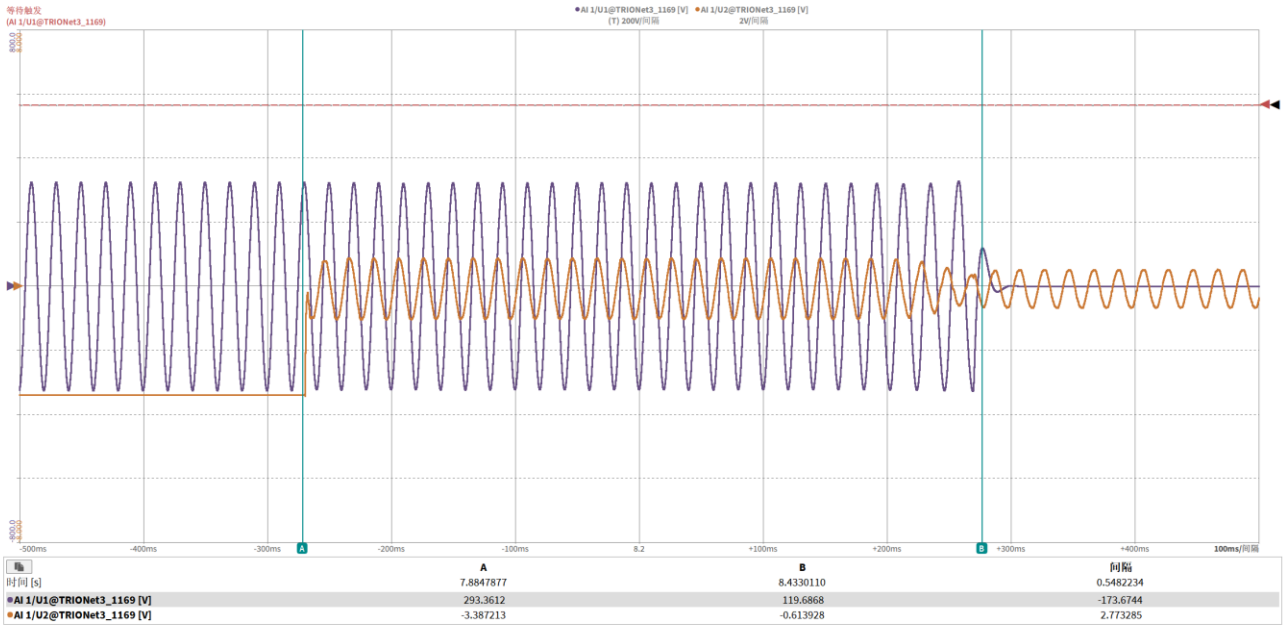
PGU input voltage [6] = 50 % of rated input voltage range, ±10 %

[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 energy storage system is tested according to the battery's rated input voltage of 51.2V.)

The test results of the **MST-BIE5-2500** 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} 0%



	A	B	间隔
时间 [s]	7.8847877	8.4330110	0.5482234
AI 1/U1@TRIONet3_1169 [V]	293.3612	119.6868	-173.6744
AI 1/U2@TRIONet3_1169 [V]	-3.387213	-0.613928	2.773285

5.5.10.3 Islanding protection according Table 8 – Load imbalance (reactive load) for test condition C (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]	P_{PGU} [W]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Re-marks[5]
22	33	33	0	-5	800	51,2	0,96	79	Test C at IB
23	33	33	0	-4	800	51,2	0,96	89	Test C at IB
24	33	33	0	-3	800	51,2	0,97	100	Test C at IB
25	33	33	0	-2	800	51,2	0,98	113	Test C at IB
26	33	33	0	-1	800	51,2	0,99	134	Test C at IB
3	33	33	0	0	800	51,2	1,00	224	Test C at BL
27	33	33	0	1	800	51,2	1,01	141	Test C at IB
28	33	33	0	2	800	51,2	1,02	125	Test C at IB
29	33	33	0	3	800	51,2	1,02	125	Test C at IB
30	33	33	0	4	800	51,2	1,03	117	Test C at IB
31	33	33	0	5	800	51,2	1,00	98	Test C at IB

Parameter at 0%	L= 210,59 mH	R= 66,13 Ω	C= 48,16 µF
I_{AC} [4][A]	0,096		

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 C:

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

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

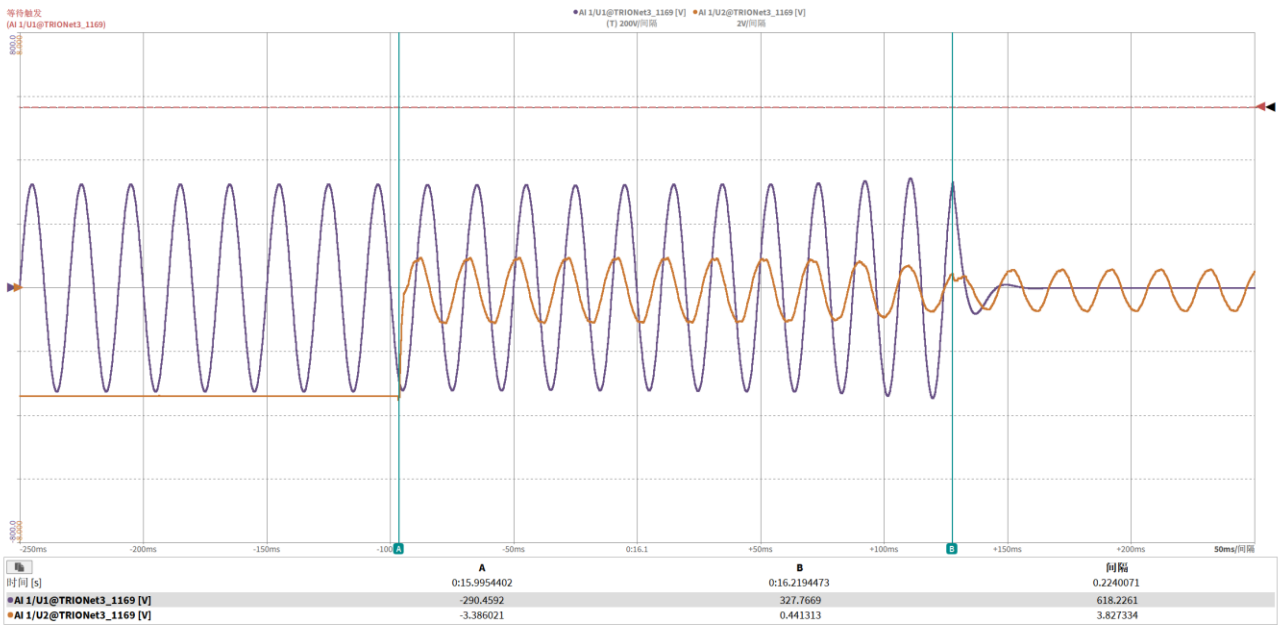
[6] Or minimum allowable PGU output level if greater than 33 %.

[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 energy storage system is tested according to the battery's rated input voltage of 51.2V.)

The test results of the **MST-BIE5-2500** 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} 0%



	A	B	间隔
时间 [s]	0:15.9954402	0:16.2194473	0.2240071
AI 1/U1@TRIONet3_1169 [V]	-290.4592	327.7669	618.2261
AI 1/U2@TRIONet3_1169 [V]	-3.386021	0.441313	3.827334

5.6.2. Connecting conditions and synchronisation				P
Test: MST-BIE5-2500				
	f_{ist}	**Reset time:**	**Limit:**	
Connecting conditions for frequencies:				
a)	<47,45Hz	No reconnection	No resetting allowed	
	Switch to:			
b)	≥47,55Hz	61s	≥60s	
c)	>50,15Hz	No reconnection	No resetting allowed	
	Switch to:			
d)	≤50,05Hz	61s	≥60s	
Connecting conditions for voltages:				
e)	84%	No reconnection	No resetting allowed	
	Switch to:			
f)	≥86%	61s	≥60s	
g)	111%	No reconnection	No resetting allowed	
	Switch to:			
h)	≤109%	64s	≥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 230V/47,0Hz resulted in a faulty disconnection. Thereafter the voltage and frequency for 100s is set to 230V/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.

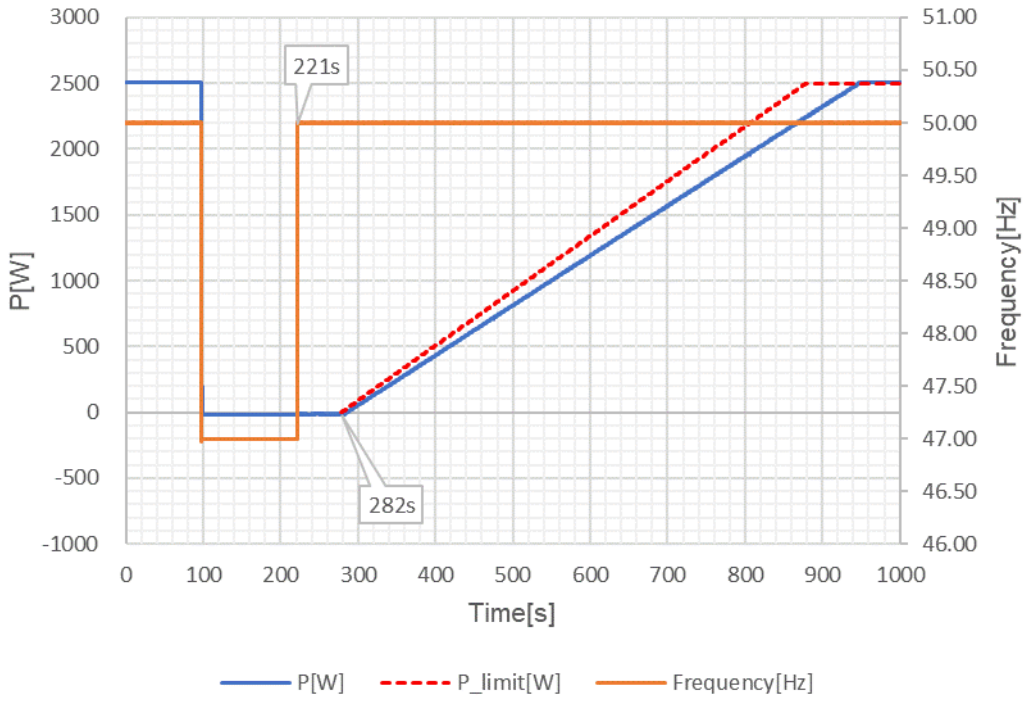
Assessment criterion:

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

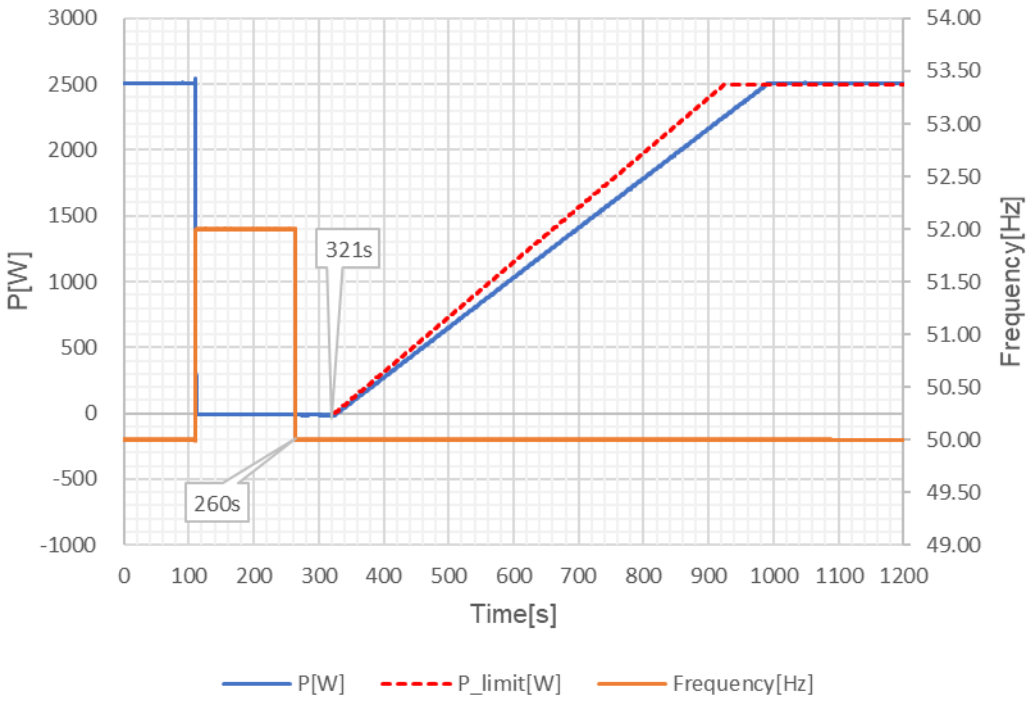
Note:

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

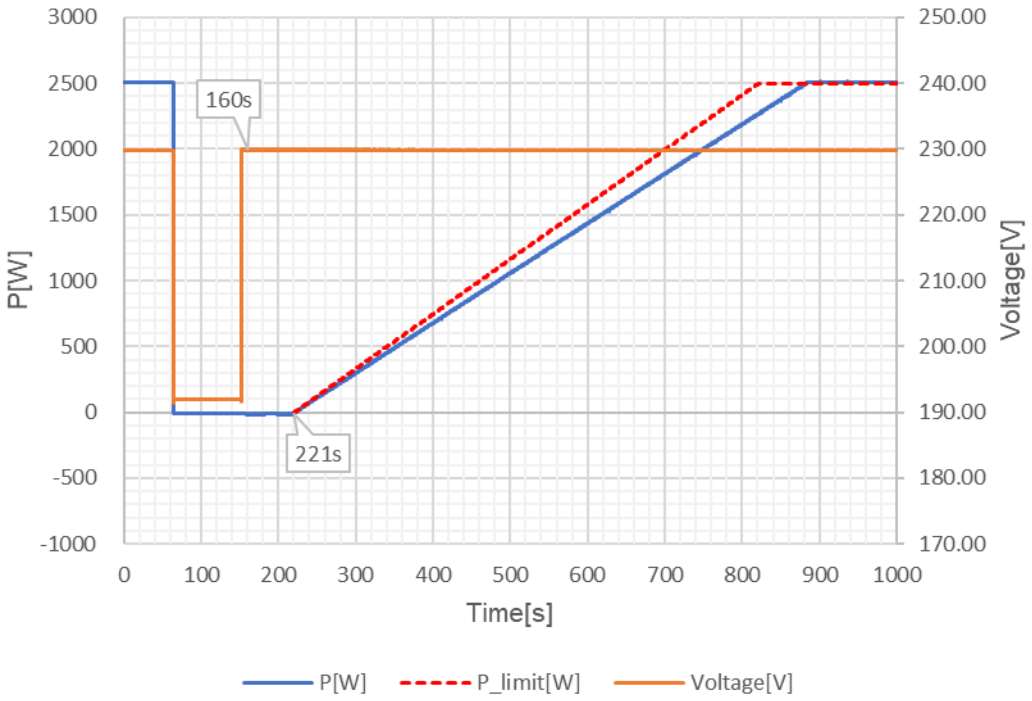
Connecting conditions for frequencies: 47,55Hz



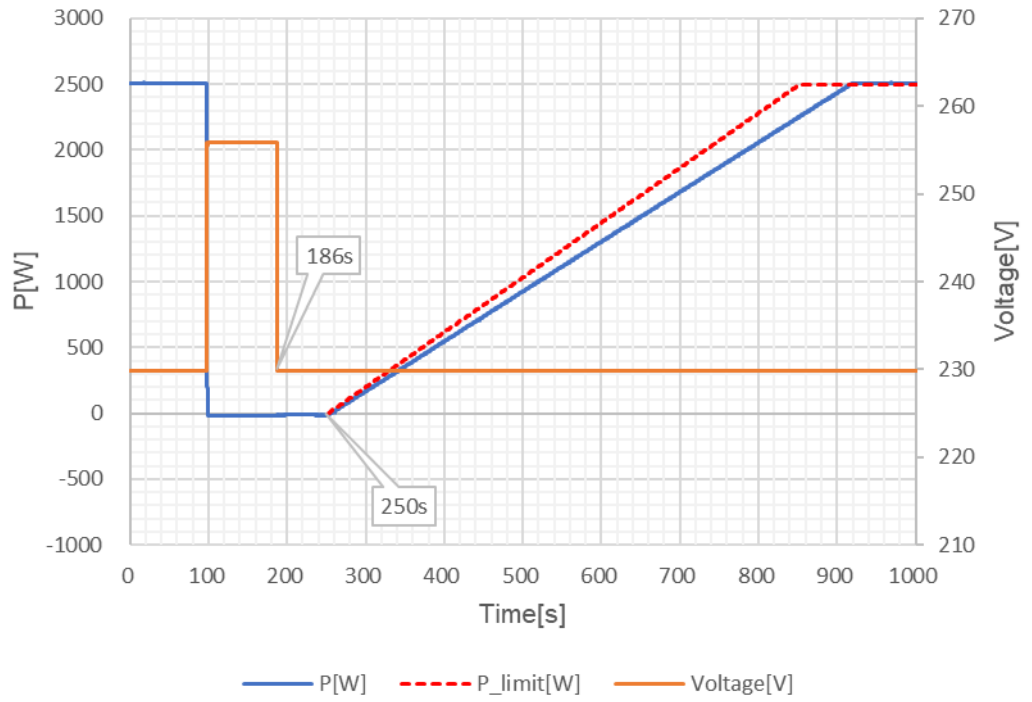
Connecting conditions for frequencies: 50,05Hz



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.

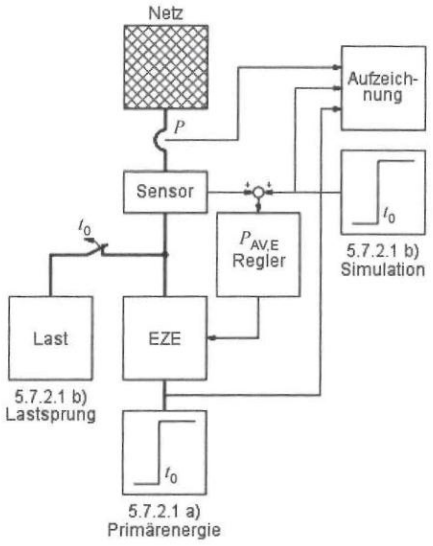


Bild 8 – Skizze des Prüfaufbaus zur Prüfung der Regeldynamik

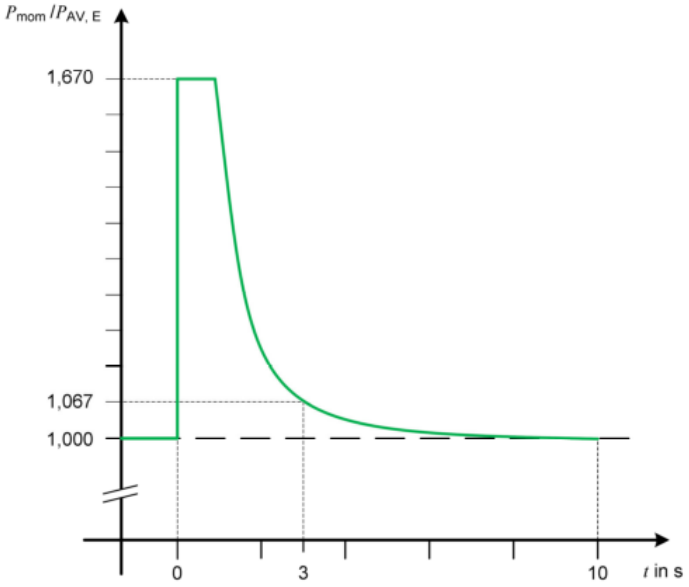


Bild 1 – Wirkleistungs-Grenzkurve für Erzeugungsanlagen

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.

5.7.2.1 Test of control the dynamic

Parameter setting for testing

The $P_{AV,E}$ -control power was setting to 60%PrE through the parameter settling limitation feed power of maximum total system power of smart power meter.

For step descripted of testing

Test a): Primary energy supply jump

a) The primary energy supply is set so that the EZE feeds the power $P_{AV,E}$ = 60% P_{rE} with a tolerance of −2%.
b) At time t0, the primary energy supply has to be increased by leaps and bounds so that the EZE can provide the nominal output.
c) Waiting for the output power were stabilizing (keep at lease 60s) then sudden added the primary supply to nominal power of EZE.

Test b): Loss of load setting:

d) Adjust load with 40%PrE at least with a tolerance of +2% to make the active power at the meter position to be $P_{AV,E}$ =60%PrE with a tolerance of −2%.
e) e) Waiting for the output power were stabilizing (keep at lease 60s) then sudden disconnected the load.

Assessment criterion:

The test in accordance with 5.7.2.1 is considered passed if the active power measured at the grid connection point does not exceed the limit curve in VDE-AR-N 4105:2018-11, 5.5.2, Figure 1.

Note:

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

5.7.2.1 Test a): Primary energy supply jump **N/A**

The primary energy supply is set so that the EZE feeds the power PAV, E = 60% PrE with a tolerance of −2%.		Setting the primary supply allows the EZE to reach nominal power		response time [s]
P_{DC} [W]	P_{SUM} [W]	P_{DC} [W]	P_{SUM} [W]	
--	--	--	--	--

5.7.2.1 Test b): Loss of load **N/A**

P_{load} [W]	P_{SUM} before disconnect the load [W]	P_{SUM} after disconnect the load [W]	response time [s]
--	--	--	--

Note:

P_{DC}: setting value of the primary supply power

P_{SUM}: active power at the meter position

P_{load}: setting value of the load power

Datasheet of the meter:
Diagram: Test a): Primary energy supply jump

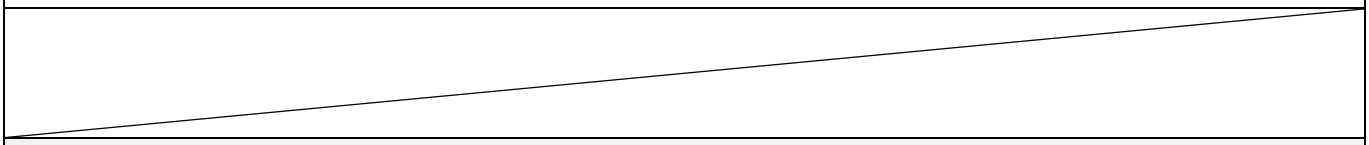
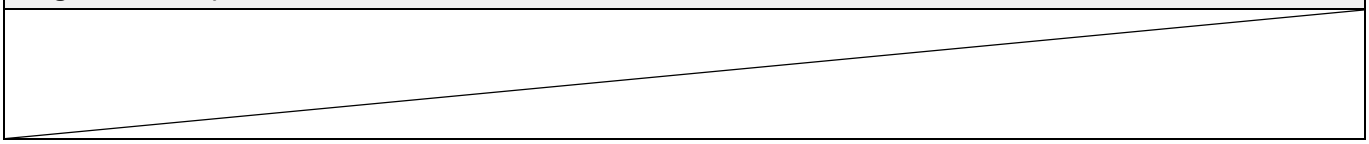
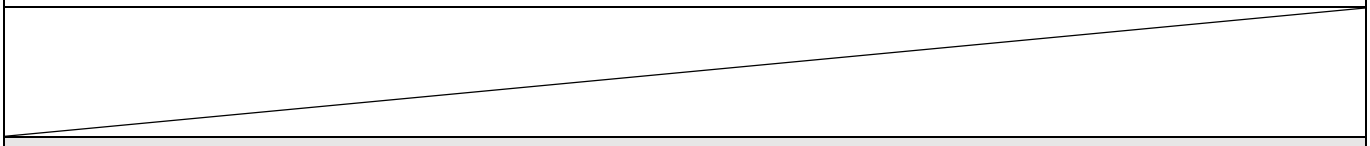



Diagram: Test b): Loss of load


5.7.2.2 Test disconnection function			N/A
Test:	**P_{SUM} before energy jump [W]**	**Required energy jump [W]**	**Disconnection time [s]**
a)	--	--	--
b)	--	--	--
c)	--	--	--
d)	--	--	--
Diagram:			
			

Assessment criterion:

The test according to 5.7.2.2 shall be deemed to have been passed if, in the case of a), there were no shutdowns and, in the case of b), c) and d), a shutdown after the time t defined in Table 16.

Table 16

Test	Rated Power	Limit Disconnect time t
a)	$0,98*P_{AV,E}$	No disconnection
b)	$1,02*P_{AV,E} – 1,067*P_{AV,E}$	t < 10s + 0,2s
c)	$1,067*P_{AV,E} – 1,670*P_{AV,E}$	t < 3s + 0,2s
d)	$1,690*P_{AV,E}$	t < 0,2s

Note:

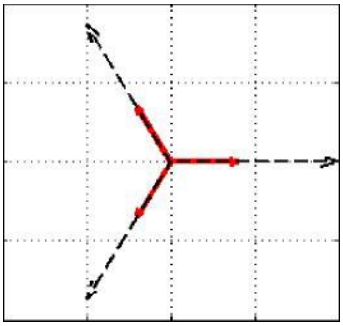
The EUT evaluated and tested the examination of regular dynamics used the P calculation check with a real EZE according to requirement of VDE-AR-N 4105, 5.5.2.

The nominal output power of EZE declared by manufacture.

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

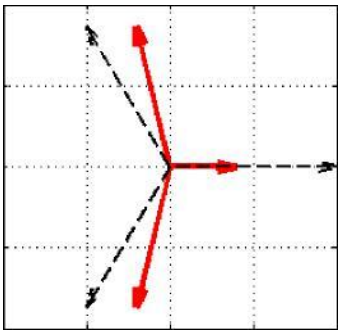
FRT test for three-phase symmetrical (Test ref no. x.1.x)



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}	φ_{u2}	φ_{u3}
1.3, 1.4, 1.5	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°



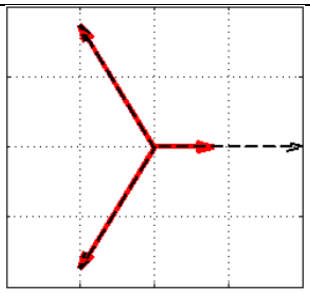
Typ-D

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

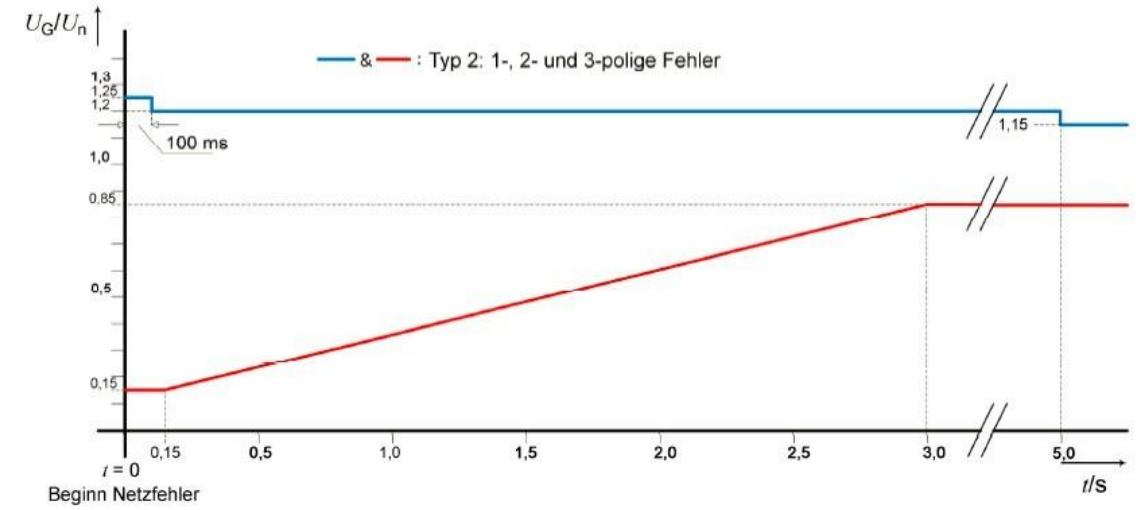
Test No.	V/V_{nom}	Phase-to-earth voltages			Phase angles		
		$u_1/u_{1,nom}$	$u_2/u_{2,nom}$	$u_3/u_{3,nom}$	φ_{u1}	φ_{u2}	φ_{u3}
5.3, 5.4	1,25 ± 0,05	1,08 ± 0,05	1,25 ± 0,05	1,06 ± 0,05	-115°	-120°	6°
6.3,6.4	1,20 ± 0,05	1,06 ± 0,05	1,20 ± 0,05	1,05 ± 0,05	-116°	-120°	5°
7.3,7,4	1,15 ± 0,05	1,04 ±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

MST-BIE5-2500

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	0,391	--	1.1
				0,2 to 0,6			0,629	--	1.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,714	--	1.3
				0,2 to 0,6			0,641	--	1.4
		D2[2)]		1			0,707	--	1.5
2	0,50 to 0,60	A	for 0,50 ≥1,5 / for 0,60 ≥2,000	1	Max. over excited**	Symmetric	0,782	9,960	2.1
				0,2 to 0,6			0,837	9,985	2.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,861	9,935	2.3
				0,2 to 0,6			0,729	9,925	2.4
3	0,50 to 0,60	A	for 0,50 ≥1,500 / for 0,60 ≥2,000	1	Max. under excited**	Symmetric	0,850	9,952	3.1
				0,2 to 0,6			0,929	9,869	3.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,820	9,913	3.3
				0,2 to 0,6			0,940	9,904	3.4
4	0,85 to 0,90	A	≥60,000	1	0 to ± 0,1	Symmetric	0,067	--	4.1
				0,2 to 0,6			0,060	--	4.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,049	--	4.3
				0,2 to 0,6			0,049	--	4.4
5	1,20 to 1,25	A	≥0,100	1	0 to ± 0,1	Symmetric	0,771	--	5.1
				0,2 to 0,6			0,881	--	5.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,069	--	5.3
				0,2 to 0,6			0,119	--	5.4
		D2[2)]		1			0,785	--	5.5
6	1,15 to 1,20	A	≥5,000	1	0 to ± 0,1	Symmetric	0,889	--	6.1
				0,2 to 0,6			0,733	--	6.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,063	--	6.3
				0,2 to 0,6			0,060	--	6.4
7	1,10 to 1,15	A	≥60,000	1	0 to ± 0,1	Symmetric	0,064	--	7.1
				0,2 to 0,6			0,064	--	7.2
		D1[1)]		1		Asymmetric (ph-ph + Dy5-transformer)	0,049	--	7.3
				0,2 to 0,6			0,048	--	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 3τ = 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

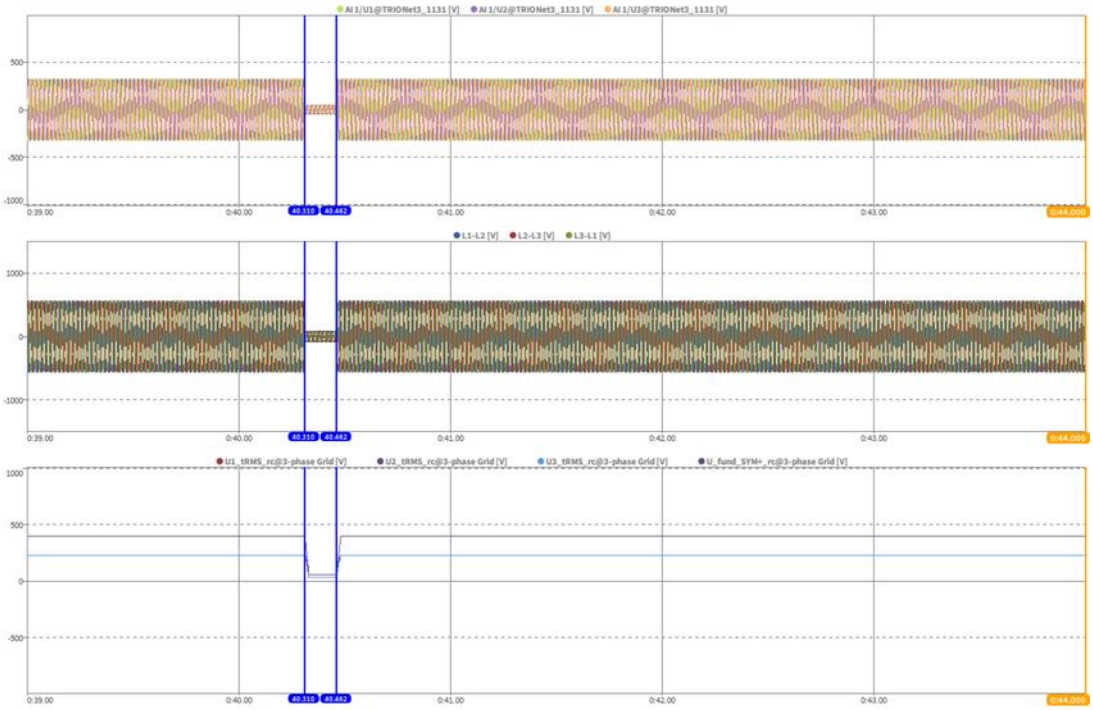
“*” The test has been performed twice and only show one times tested result in the test report.

The test results of the **MST-BIE5-2500** can be applied to other units in the product series directly, since it is identical in hardware and just power derated by software.

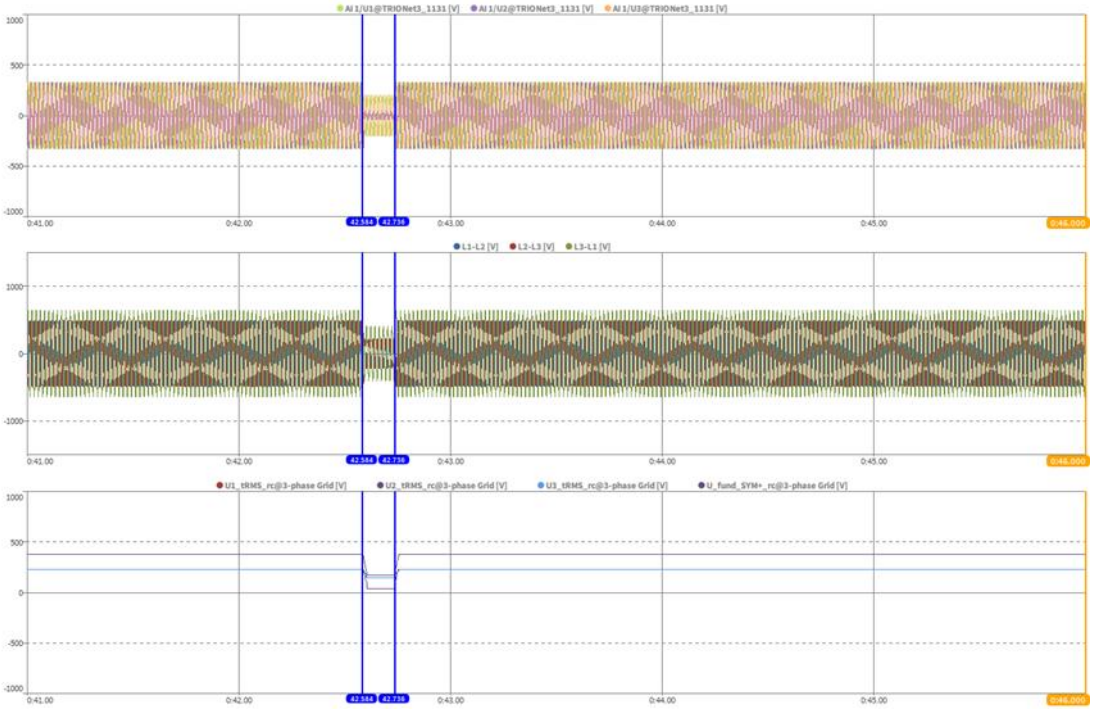
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

1.1



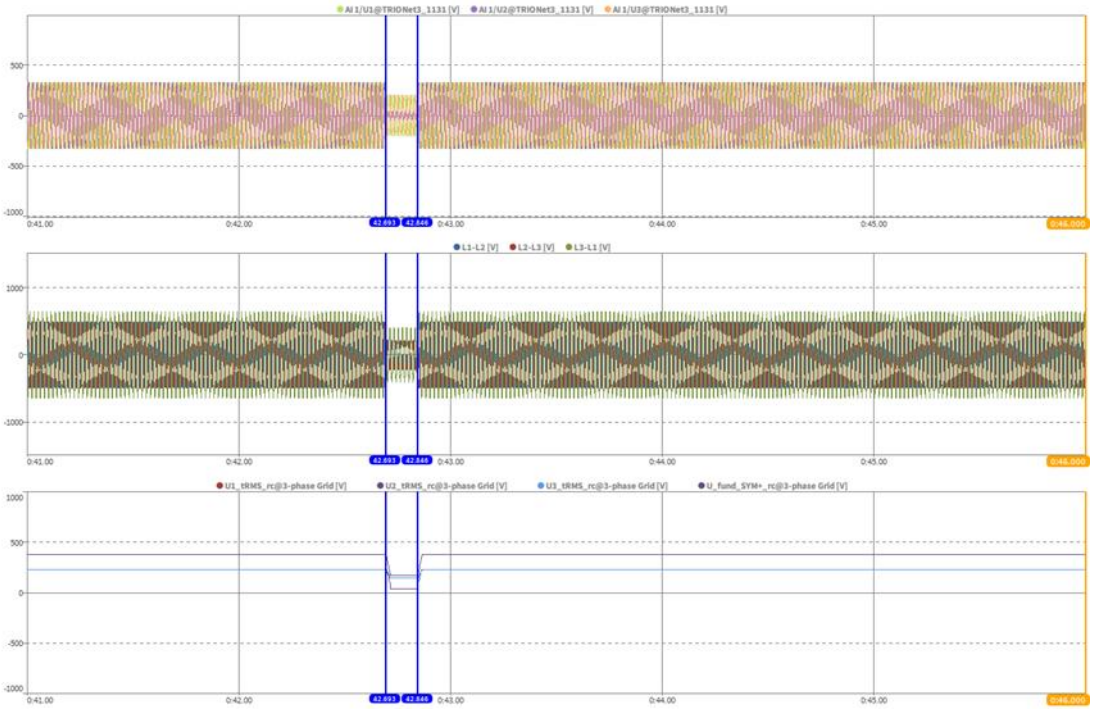
1.3



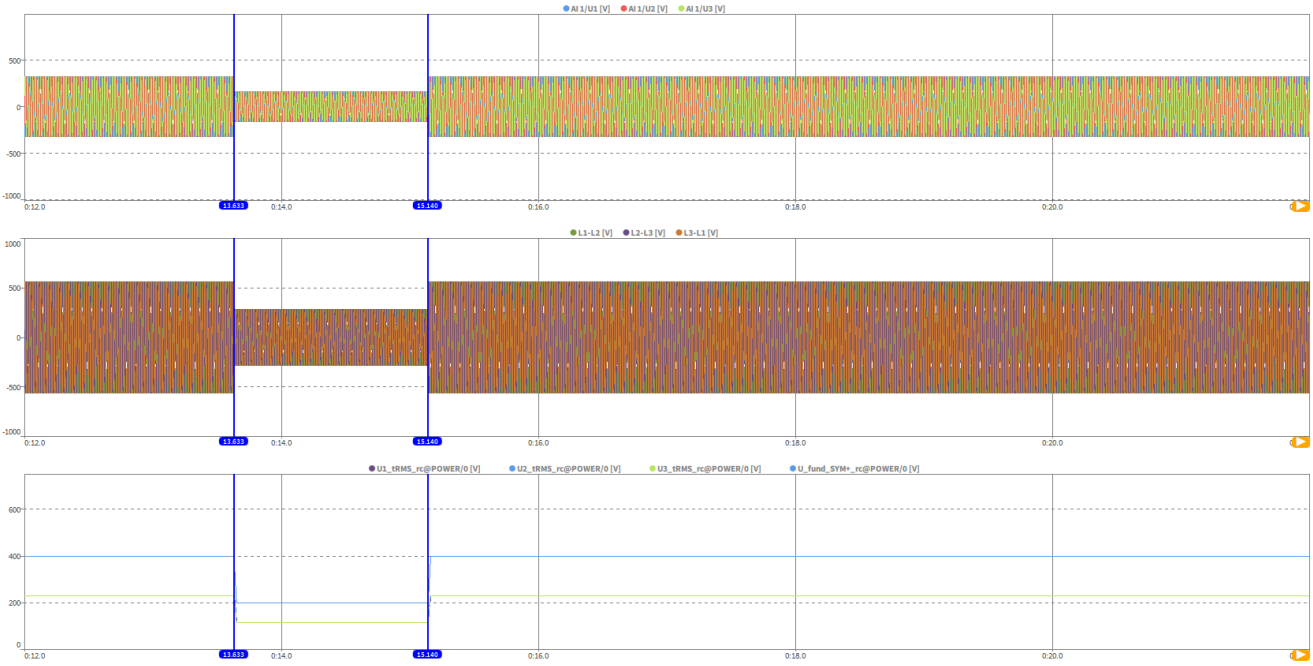
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

1.5



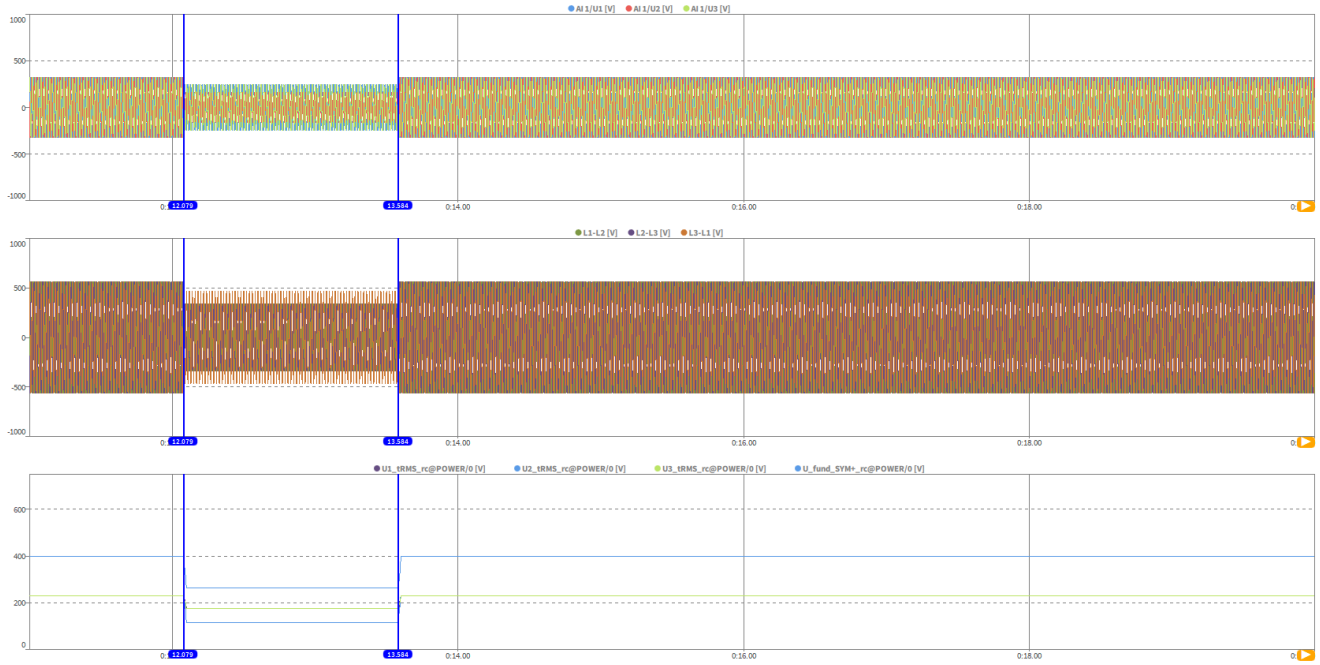
2.1



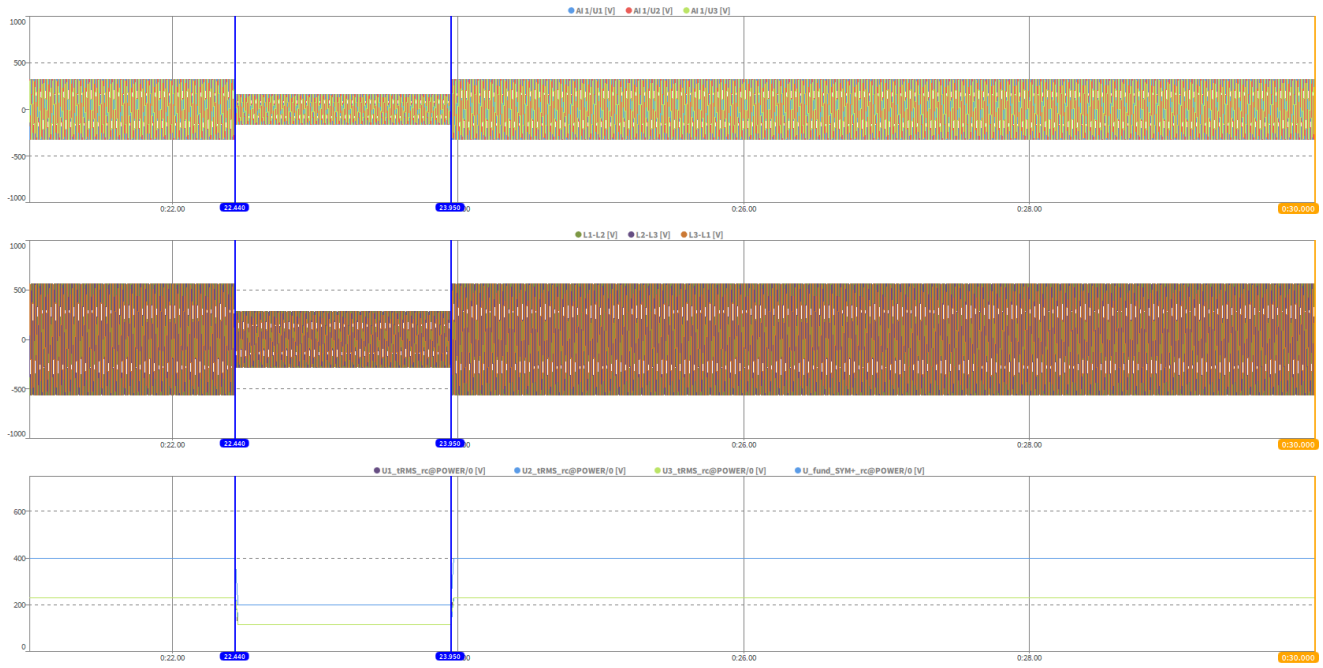
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

2.3



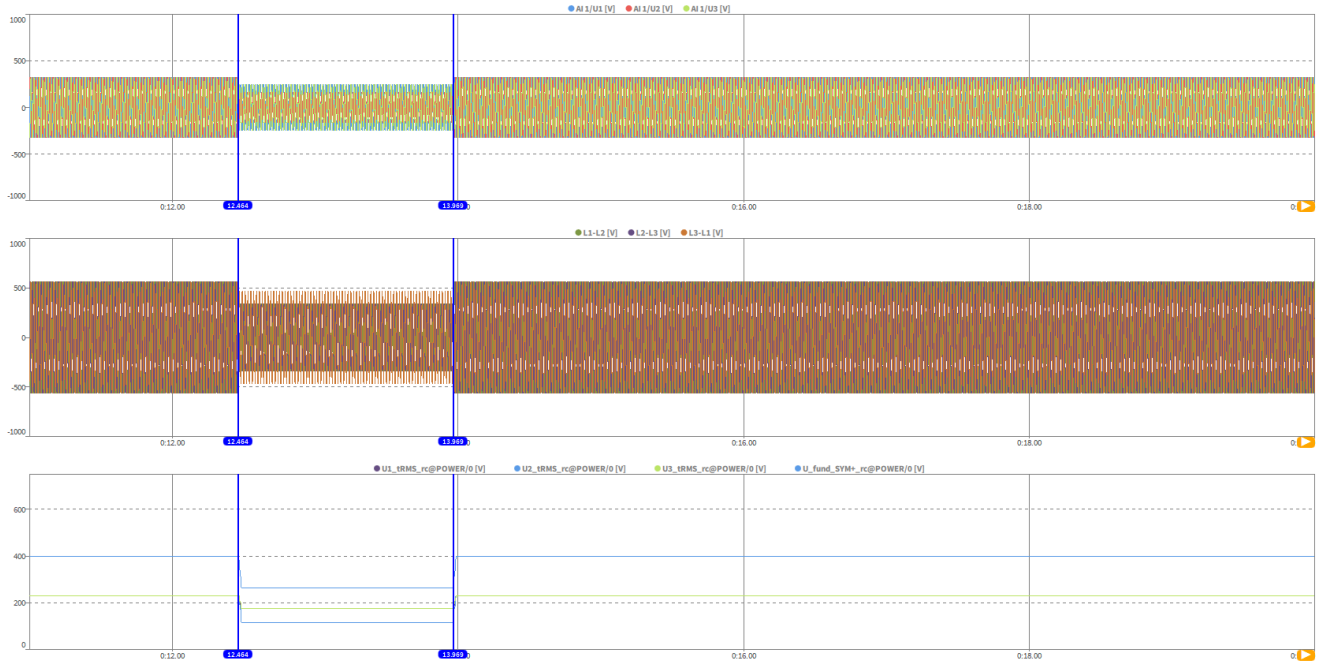
3.1



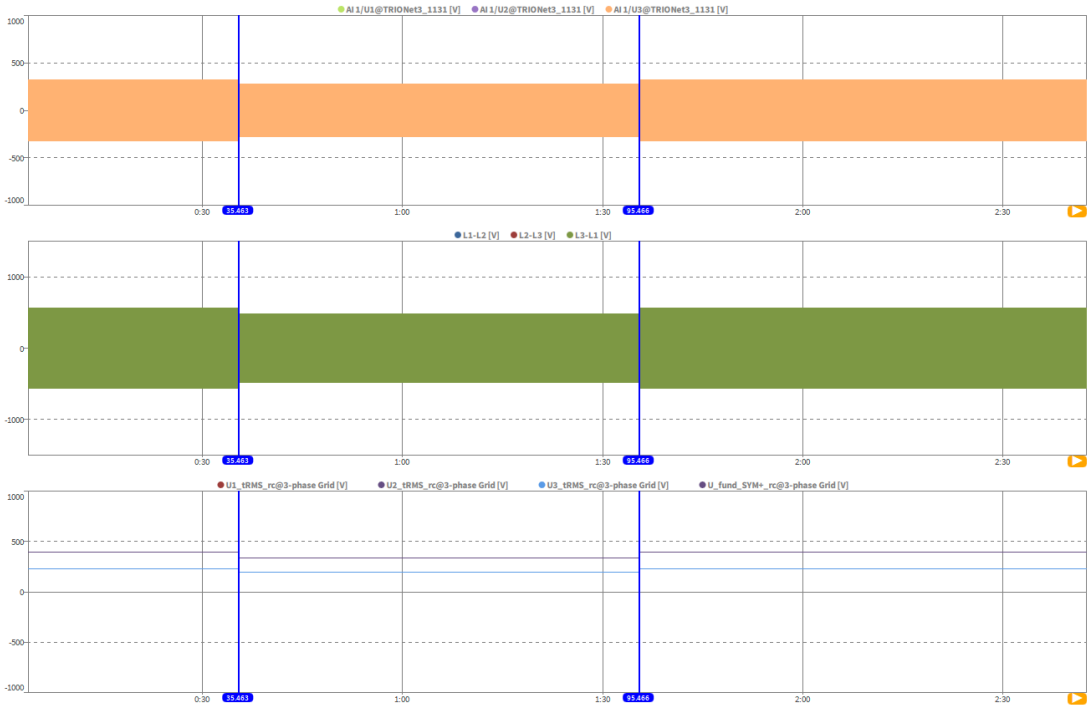
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

3.3



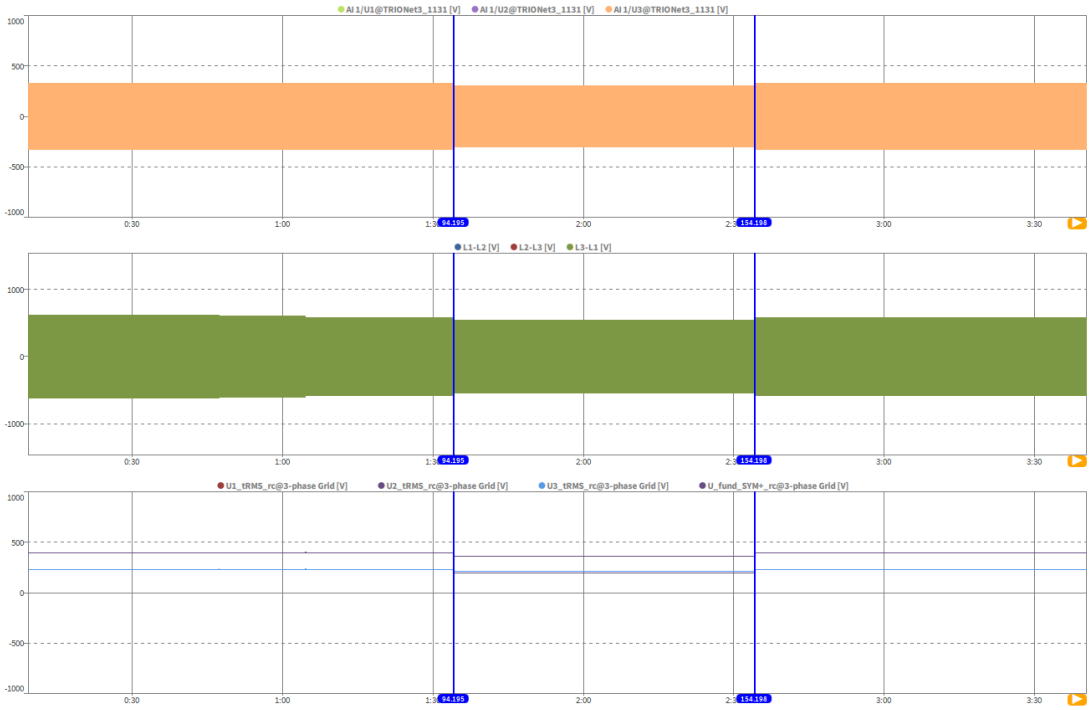
4.1



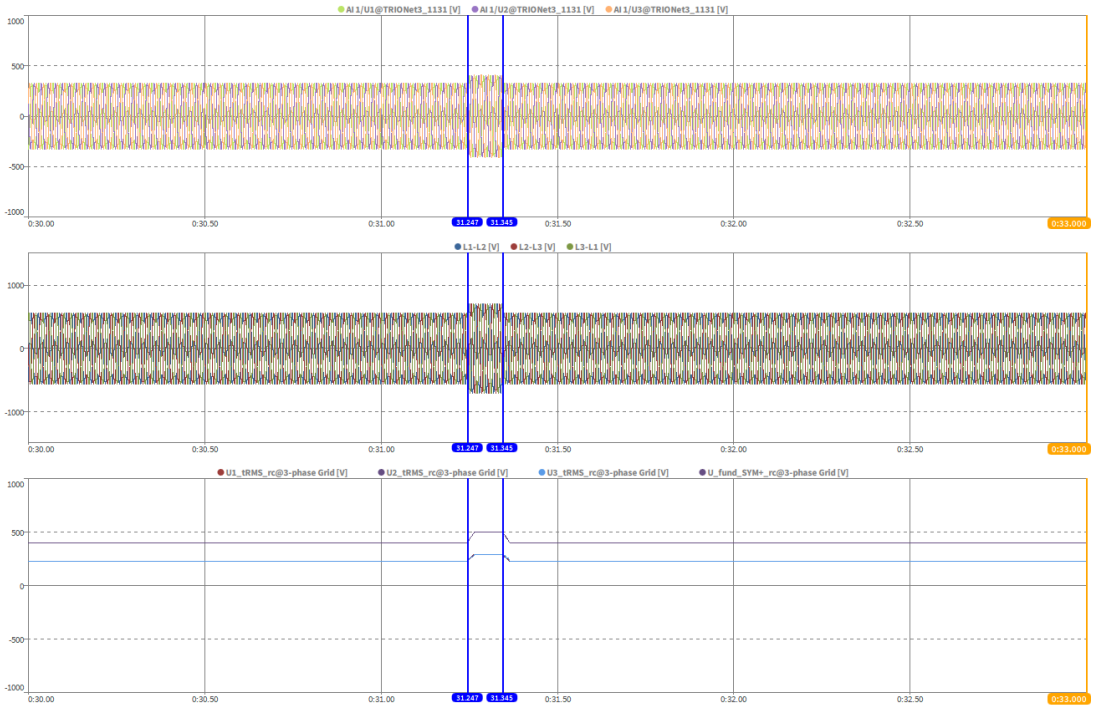
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

4.3



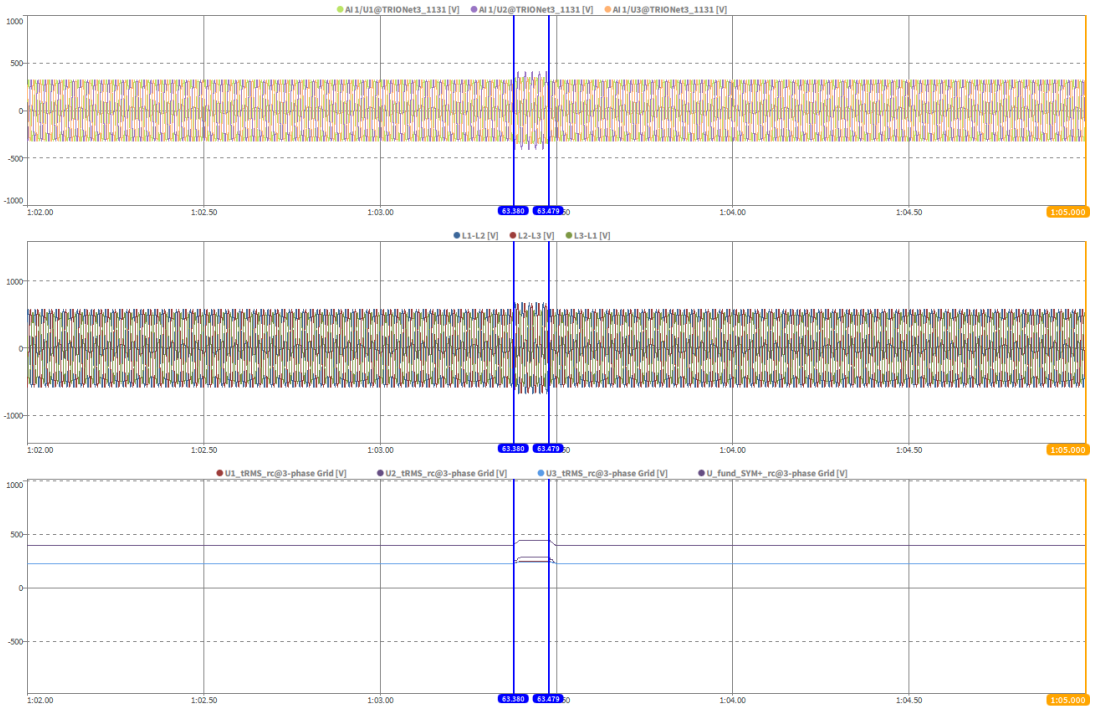
5.1



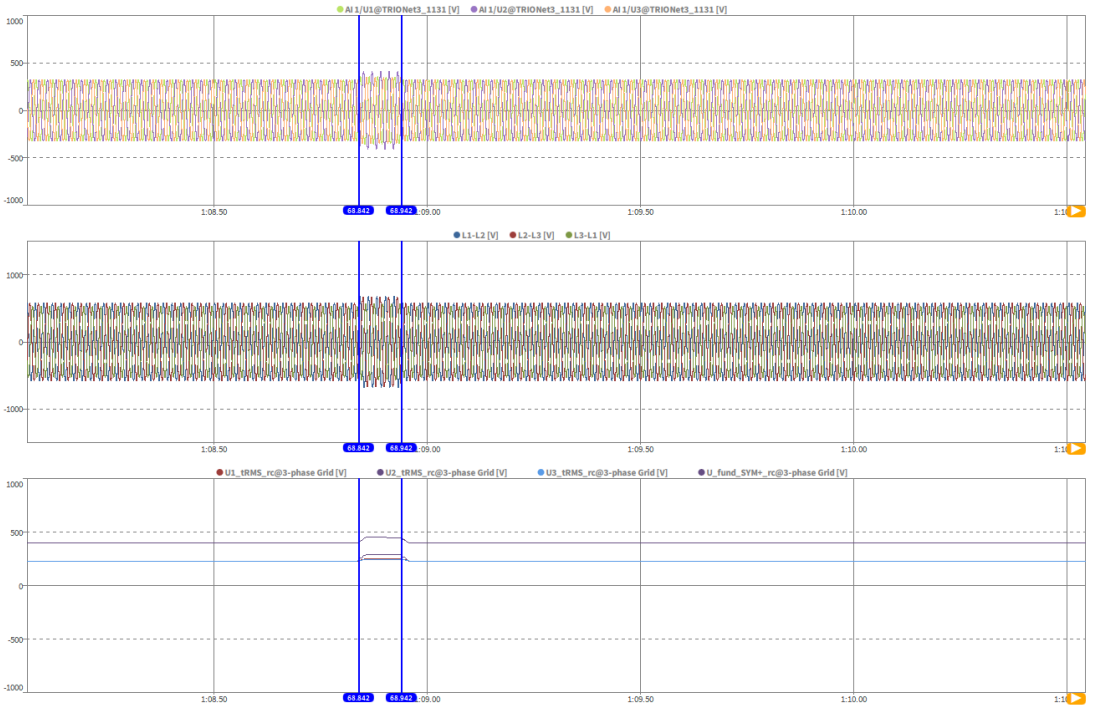
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

5.3



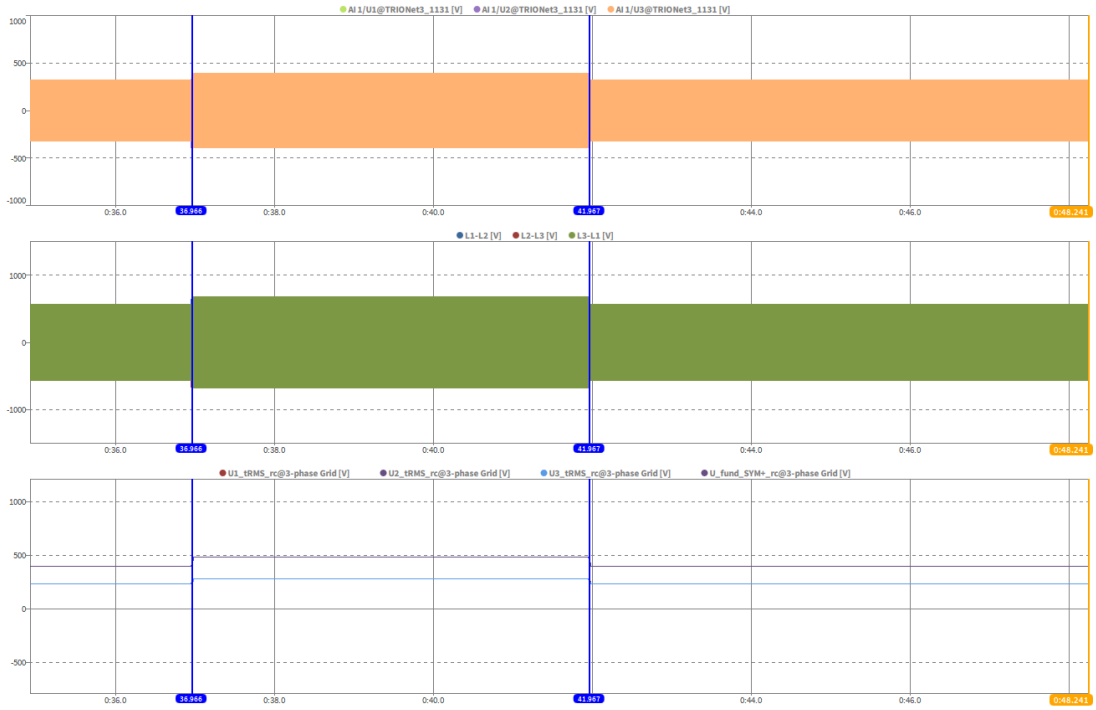
5.5



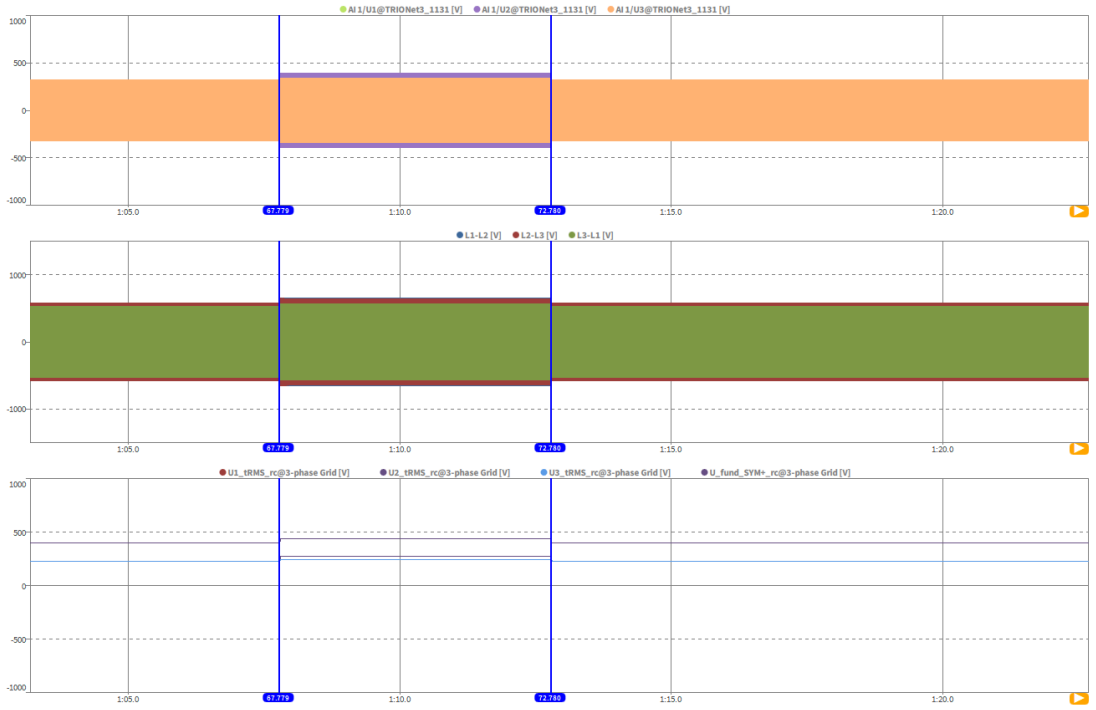
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

6.1



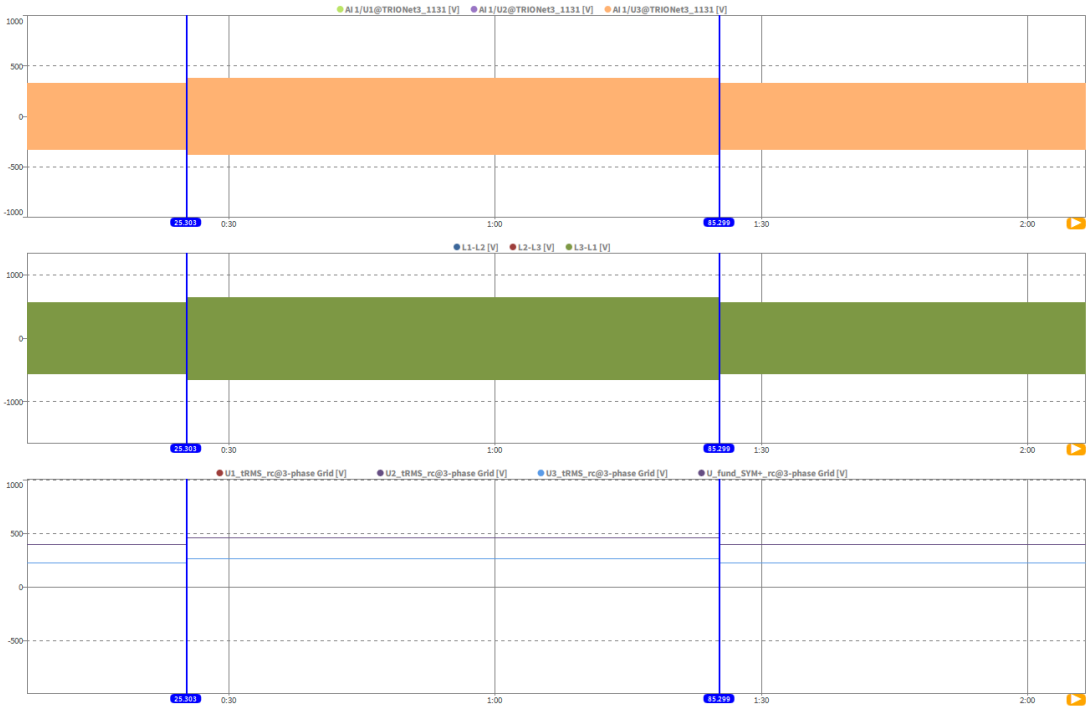
6.3



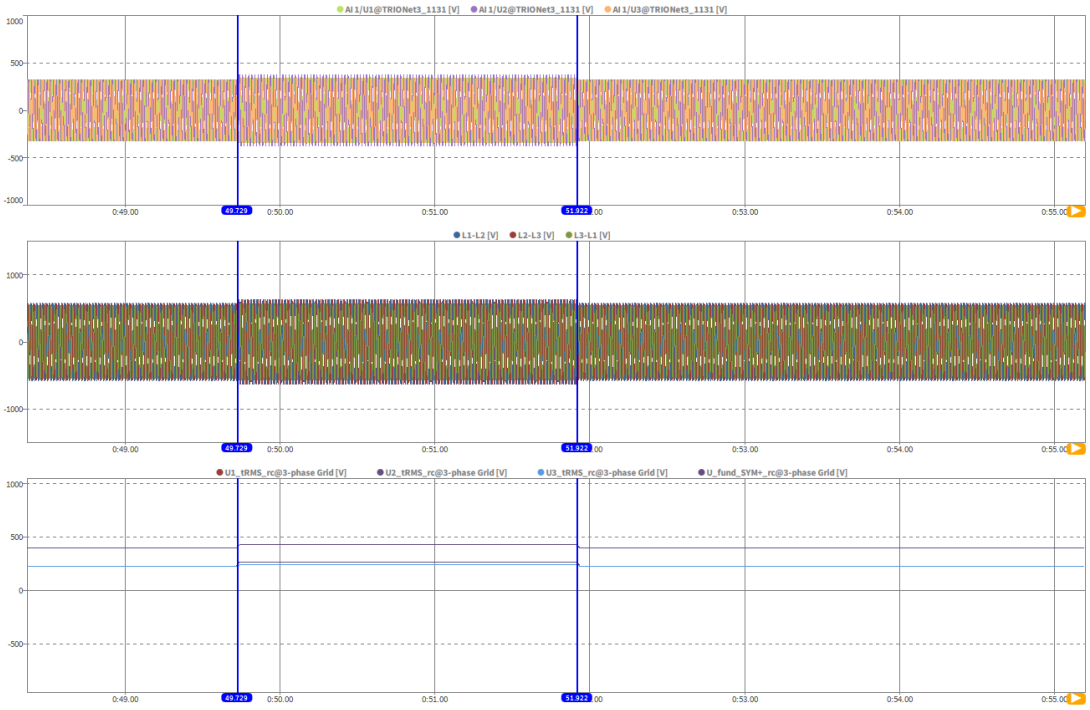
5.8.3	For PGUs Type 2 and storage systems – no load	P

MST-BIE5-2500

7.1



7.3



5.8.3	For PGUs Type 2 and storage systems	P

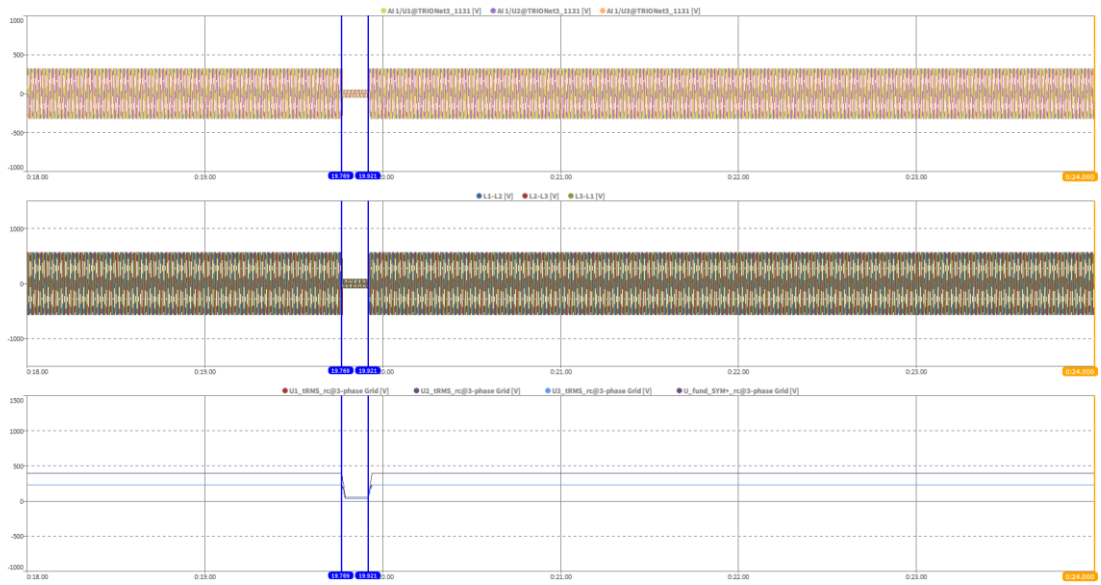
MST-BIE5-2500

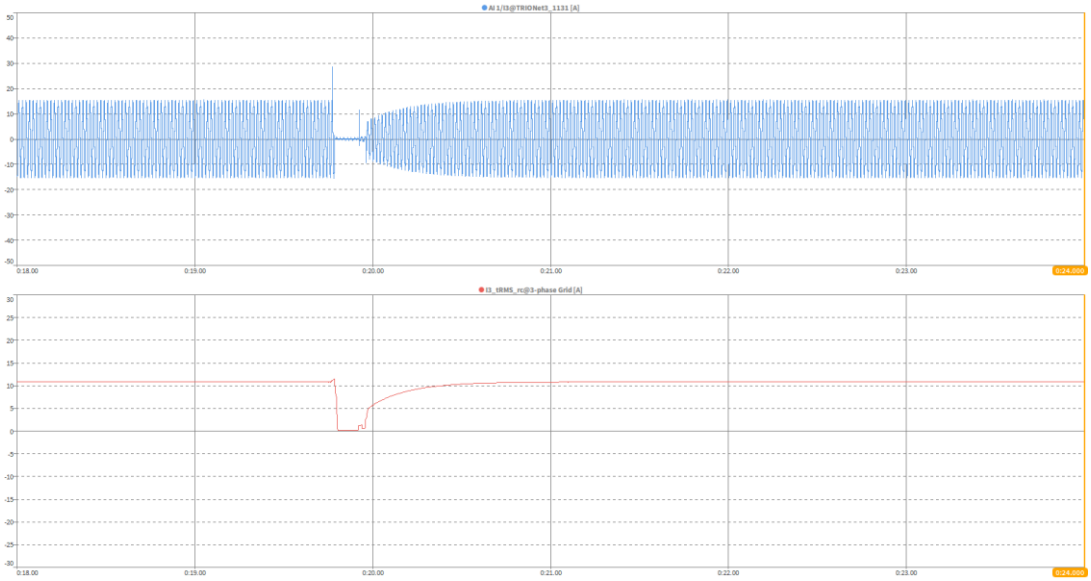
1.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1,1
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	18:12:07
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
	6	Point of fault entry	Total	--	ms	19769
	7	Point of fault clearance	Total	--	ms	19921
	8	Fault duration in empty load test	Total	--	ms	152
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,149
	10		Total (Phase 2)			0,149
	11		Total (Phase 3)			0,150
	12		Positive sequence			0,149
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,995
	17	Active power	Total	t1-10s to t1	p.u.	0,994
	18		Pos.			0,994
	19	Reactive power	Total	t1-10s to t1	p.u.	0,015
	20		Pos.			0,002
	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.	0,149
	23		Phase 2			0,149
	24		Phase 3			0,150
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,014
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,013
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			0,000
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,994
	37		Pos.			0,994
	38	Active power rising time	Total	--	s	0,391
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,016
	40		Pos.			0,002
	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

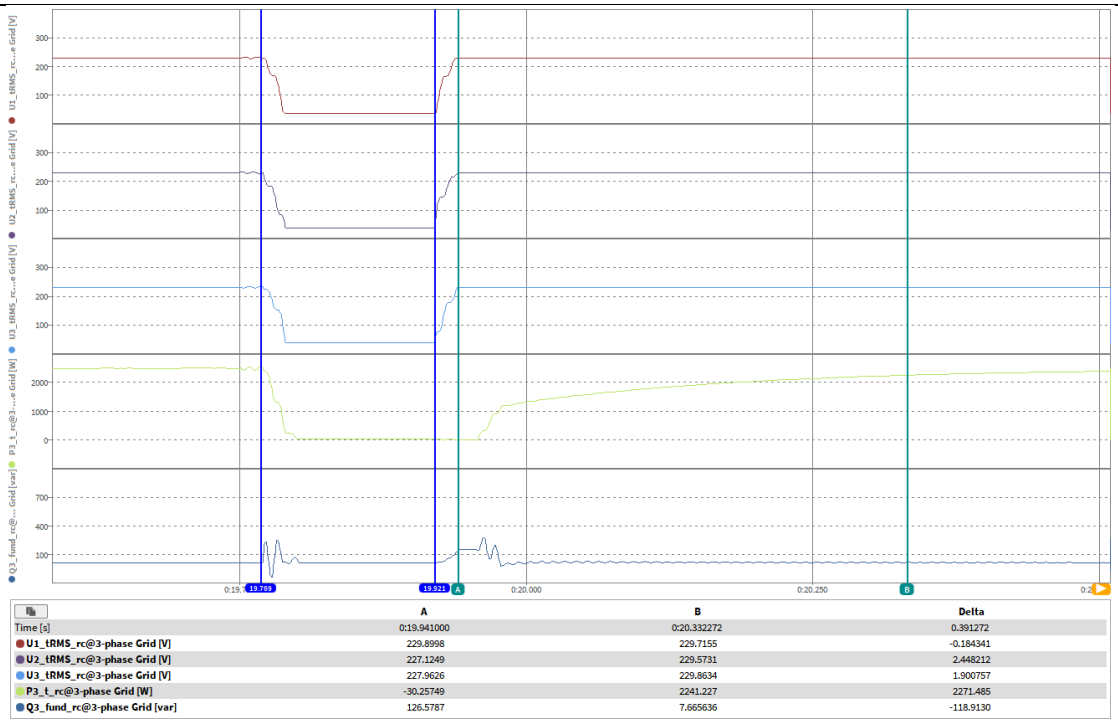
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:19.941000	0:20.332272	0.391272
U1_tRMS_rc@3-phase Grid [V]	229.8998	229.7155	-0.184341
U2_tRMS_rc@3-phase Grid [V]	227.1249	229.5731	2.448212
U3_tRMS_rc@3-phase Grid [V]	227.9626	229.8634	1.900757
P3_t_rc@3-phase Grid [W]	-30.25749	2241.227	2271.485
Q3_fund_rc@3-phase Grid [var]	126.5787	7.665636	-118.9130

5.8.3	For PGUs Type 2 and storage systems	P

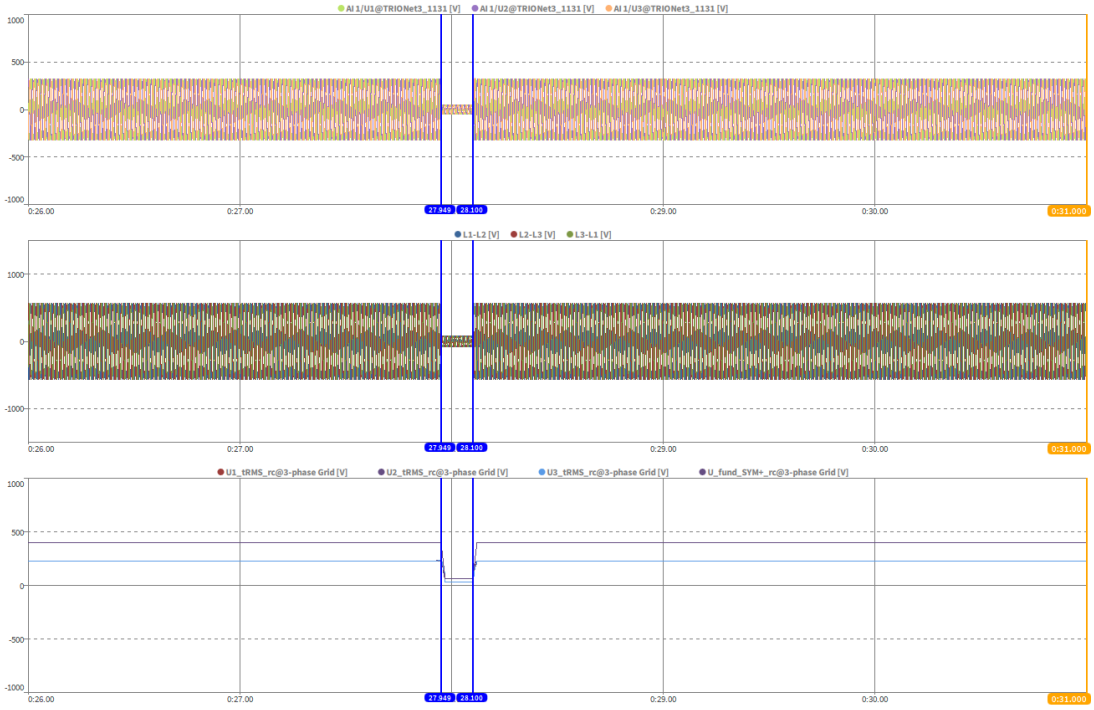
MST-BIE5-2500

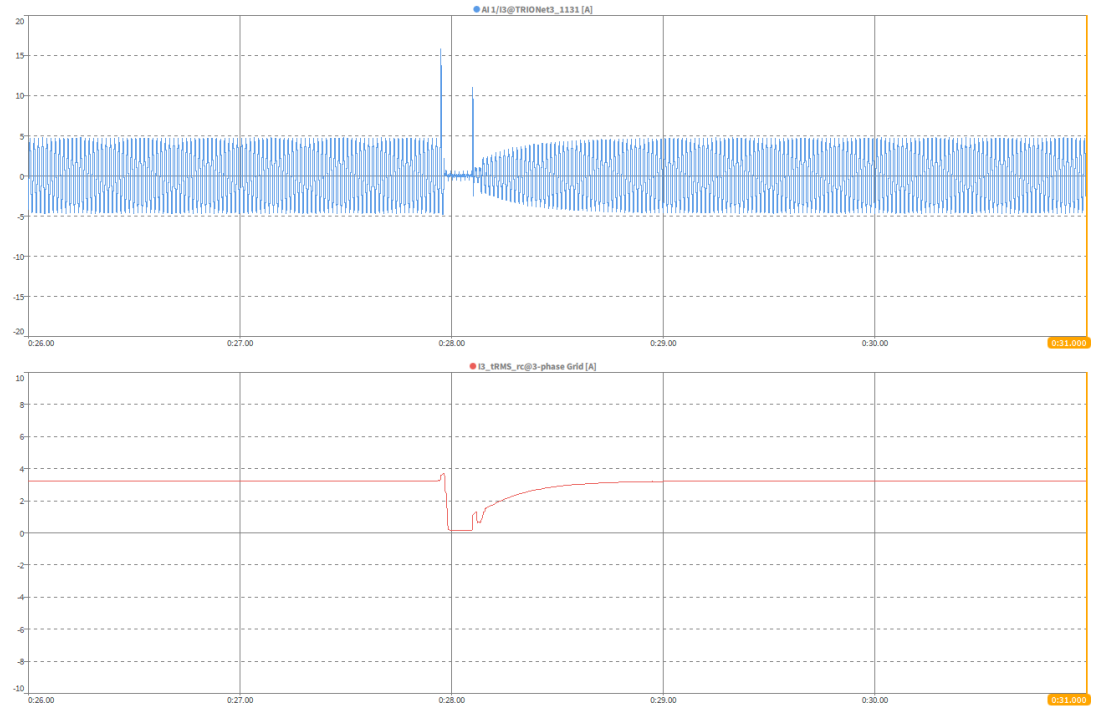
1.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1,2
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	18:21:41
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
	6	Point of fault entry	Total	--	ms	27949
	7	Point of fault clearance	Total	--	ms	28100
	8	Fault duration in empty load test	Total	--	ms	151
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,149
	10		Total (Phase 2)			0,149
	11		Total (Phase 3)			0,150
	12		Positive sequence			0,149
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			1,000
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,298
	17	Active power	Total	t1-10s to t1	p.u.	0,298
	18		Pos.			0,298
	19	Reactive power	Total	t1-10s to t1	p.u.	0,010
	20		Pos.			0,003
	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.	0,149
	23		Phase 2			0,149
	24		Phase 3			0,150
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,013
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,013
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			0,000
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			1,000
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,298
	37		Pos.			0,298
	38	Active power rising time	Total	--	s	0,629
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,010
	40		Pos.			0,003
	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

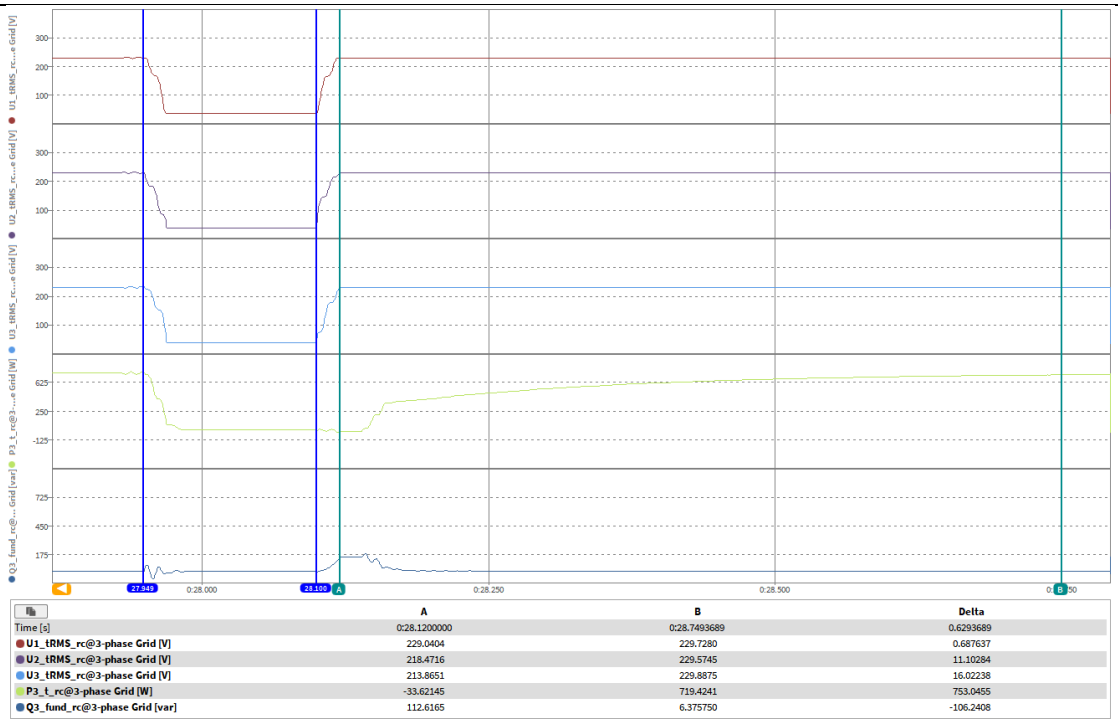
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:28.1200000	0:28.7493689	0.6293689
U1_tRMS_rc@3-phase Grid [V]	229.0404	229.7280	0.687637
U2_tRMS_rc@3-phase Grid [V]	218.4716	229.5745	11.10284
U3_tRMS_rc@3-phase Grid [V]	213.8651	229.8875	16.02238
P3_t_rc@3-phase Grid [W]	-33.62145	719.4241	753.0455
Q3_fund_rc@3-phase Grid [var]	112.6165	6.375750	-106.2408

5.8.3	For PGUs Type 2 and storage systems	P

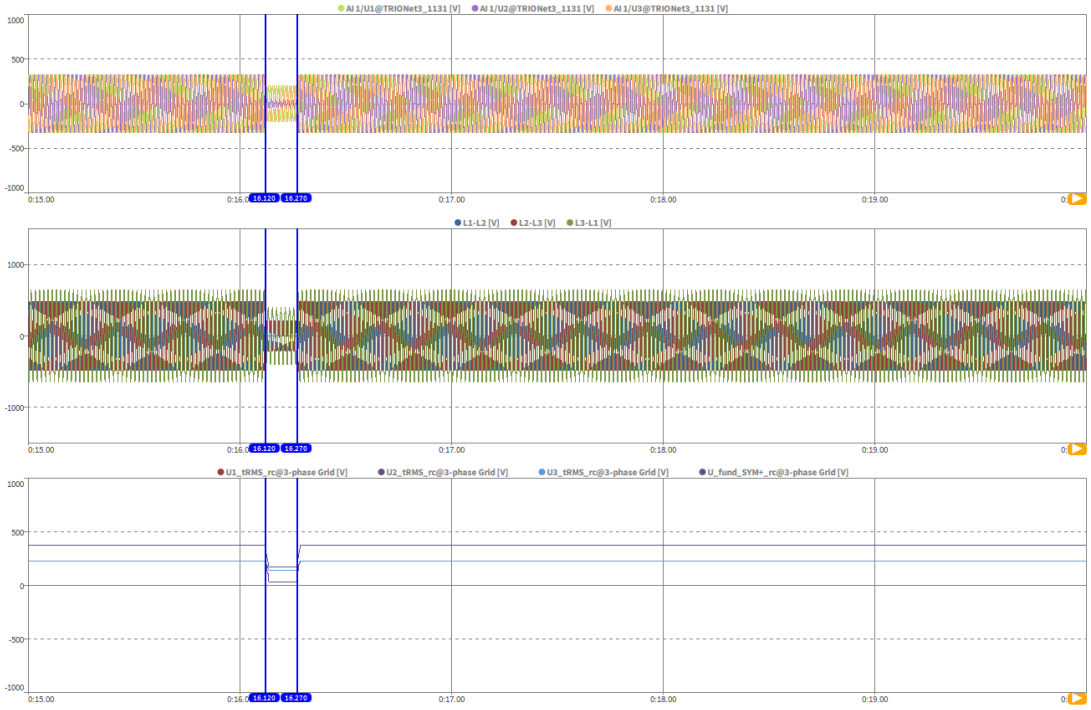
MST-BIE5-2500

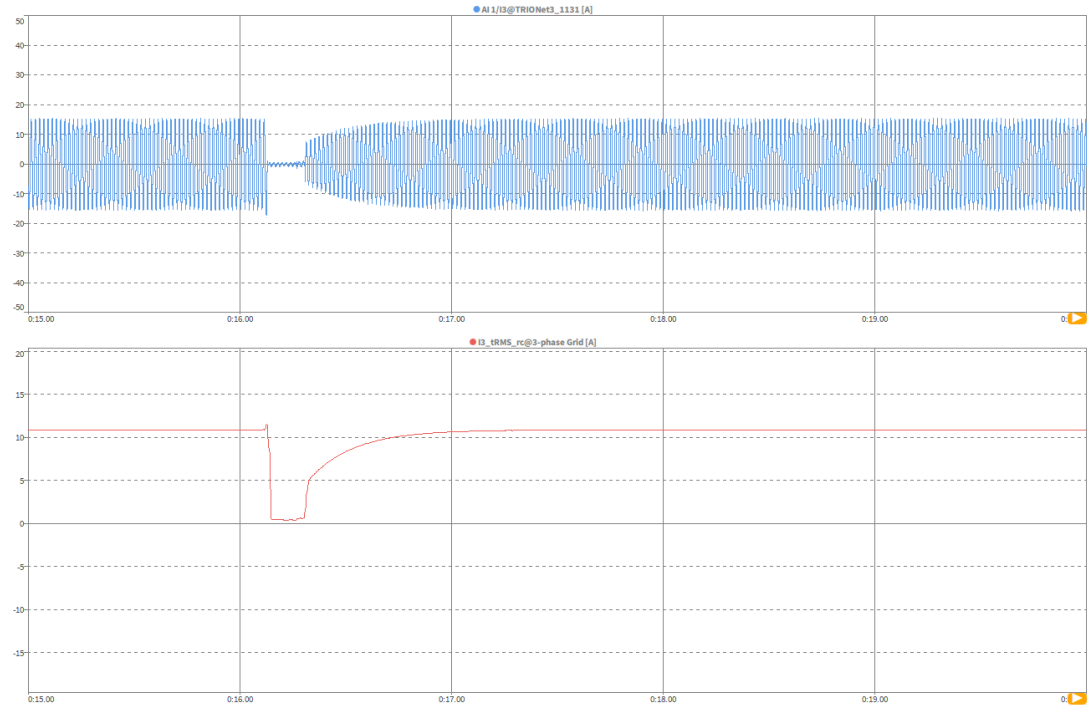
1.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1,3
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	10:51:53
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
	6	Point of fault entry	Total	--	ms	16120
	7	Point of fault clearance	Total	--	ms	16270
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,619
	10		Total (Phase 2)			0,149
	11		Total (Phase 3)			0,619
	12		Positive sequence			0,427
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,001
	17	Active power	Total	t1-10s to t1	p.u.	1,000
	18		Pos.			1,000
	19	Reactive power	Total	t1-10s to t1	p.u.	0,041
	20		Pos.			0,008
	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.	0,619
	23		Phase 2			0,149
	24		Phase 3			0,619
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,041
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,040
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			0,002
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,000
	37		Pos.			1,000
	38	Active power rising time	Total	--	s	0,714
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,042
	40		Pos.			0,009
	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

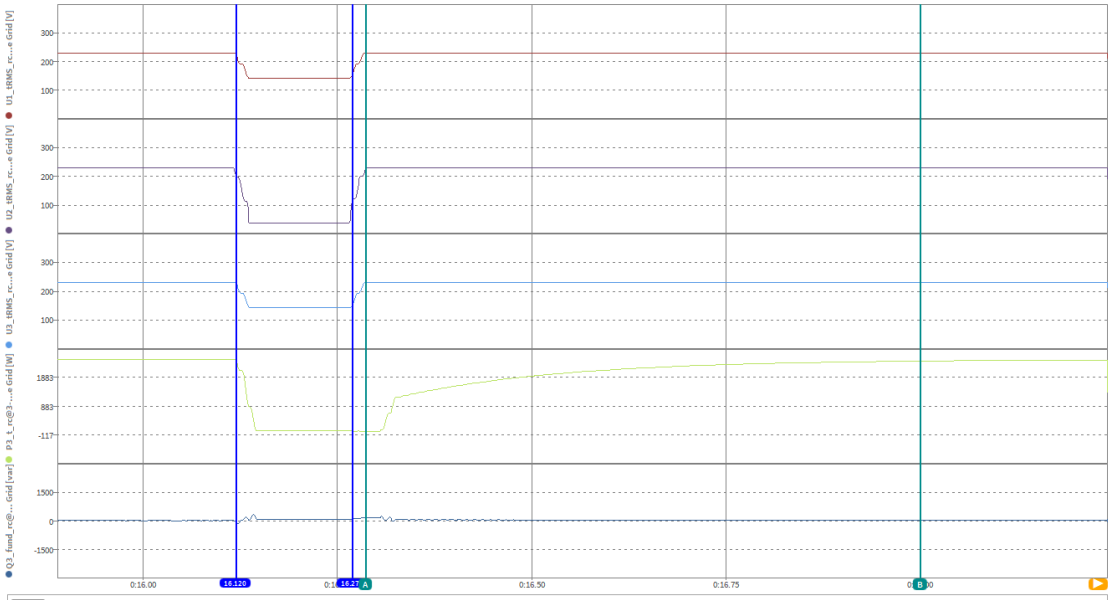
MST-BIE5-2500



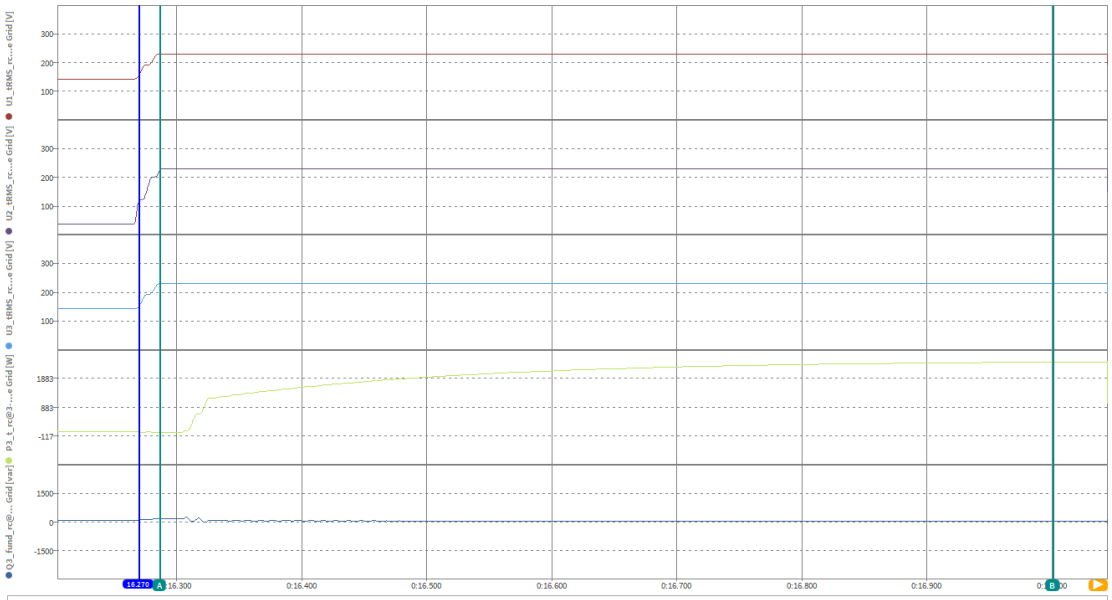


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:16.287108	0:17.000657	0.713549
U1_tRMS_rc@3-phase Grid [V]	228.9409	229.7388	0.797928
U2_tRMS_rc@3-phase Grid [V]	209.7707	229.6341	19.86337
U3_tRMS_rc@3-phase Grid [V]	227.0959	229.7126	2.616623
P3_t_rc@3-phase Grid [W]	-28.28472	2444.146	2472.431
Q3_fund_rc@3-phase Grid [var]	132.2605	-11.54439	-143.8049



	A	B	Delta
Time [s]	0:16.287108	0:17.000657	0.713549
U1_tRMS_rc@3-phase Grid [V]	228.9409	229.7388	0.797928
U2_tRMS_rc@3-phase Grid [V]	209.7707	229.6341	19.86337
U3_tRMS_rc@3-phase Grid [V]	227.0959	229.7126	2.616623
P3_t_rc@3-phase Grid [W]	-28.28472	2444.146	2472.431
Q3_fund_rc@3-phase Grid [var]	132.2605	-11.54439	-143.8049

5.8.3	For PGUs Type 2 and storage systems	P

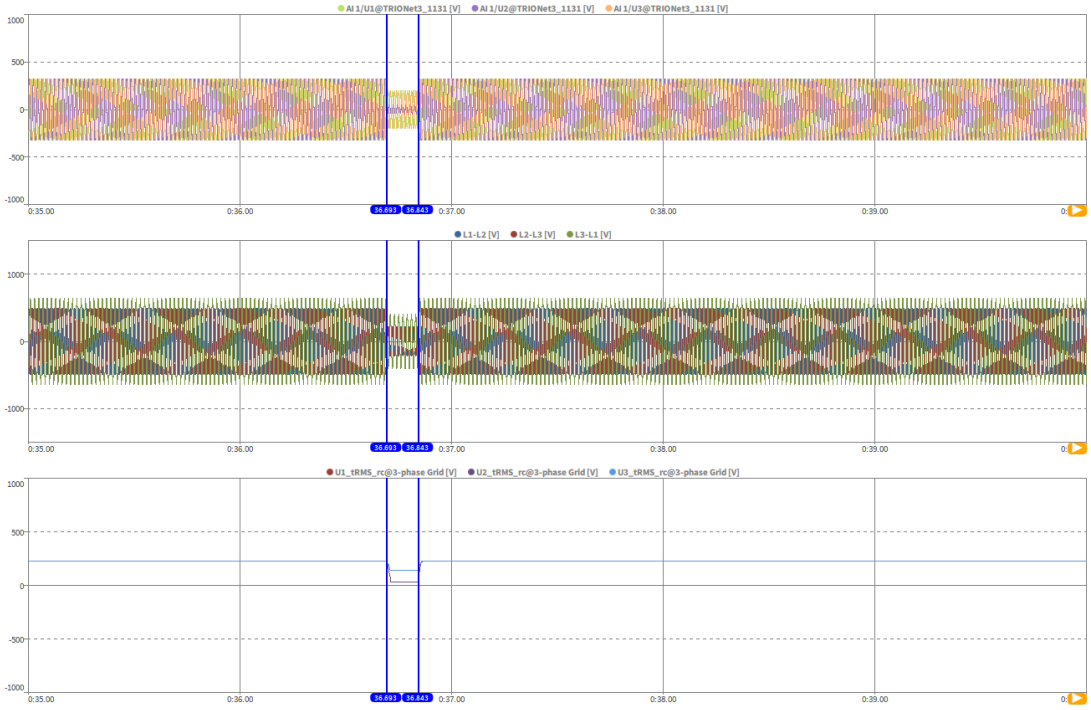
MST-BIE5-2500

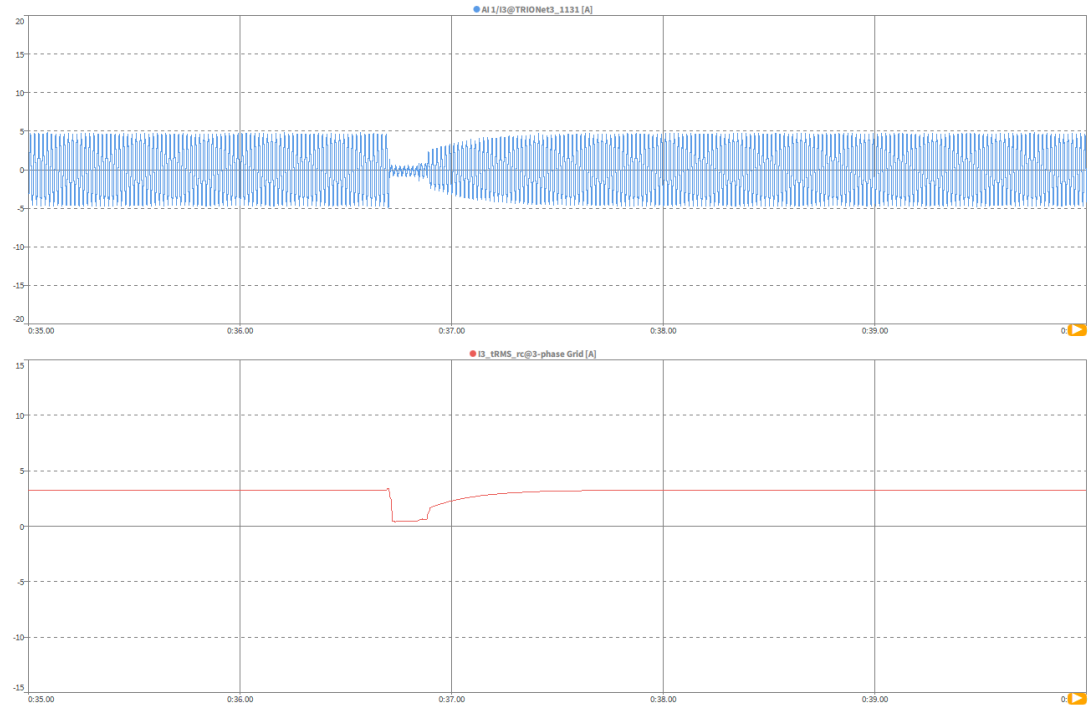
1.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1,4
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	10:56:23
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
	6	Point of fault entry	Total	--	ms	36693
	7	Point of fault clearance	Total	--	ms	36843
	8	Fault duration in empty load test	Total	--	ms	150
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,619
	10		Total (Phase 2)			0,149
	11		Total (Phase 3)			0,620
	12		Positive sequence			0,356
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,299
	18		Pos.			0,299
	19	Reactive power	Total	t1-10s to t1	p.u.	0,013
	20		Pos.			0,002
	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.	0,619
	23		Phase 2			0,149
	24		Phase 3			0,620
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,039
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,040
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			0,002
	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,641
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,013
	40		Pos.			0,002
	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

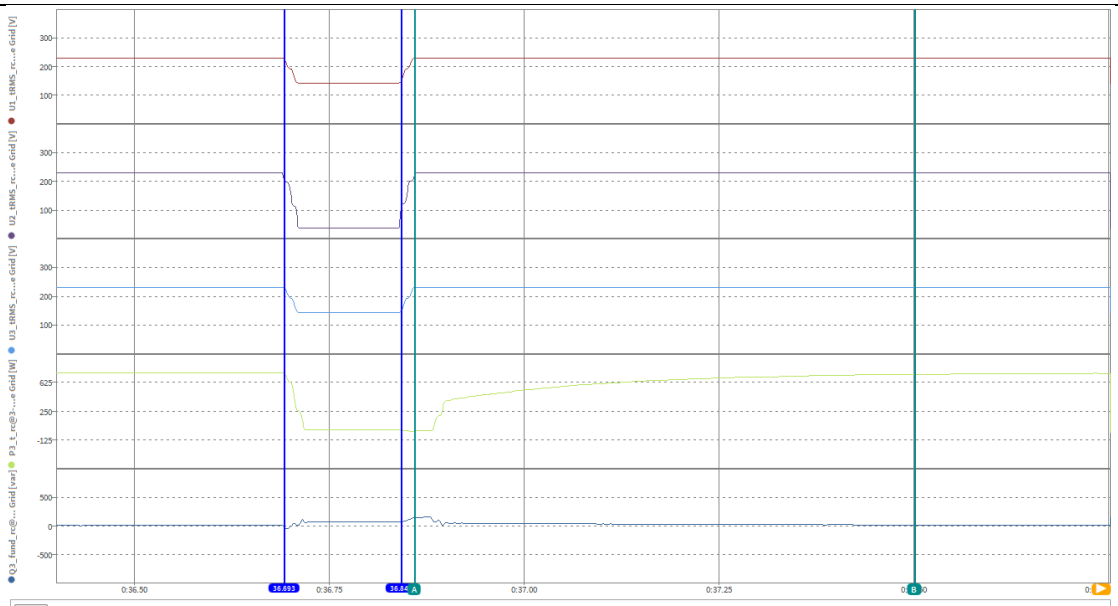
MST-BIE5-2500



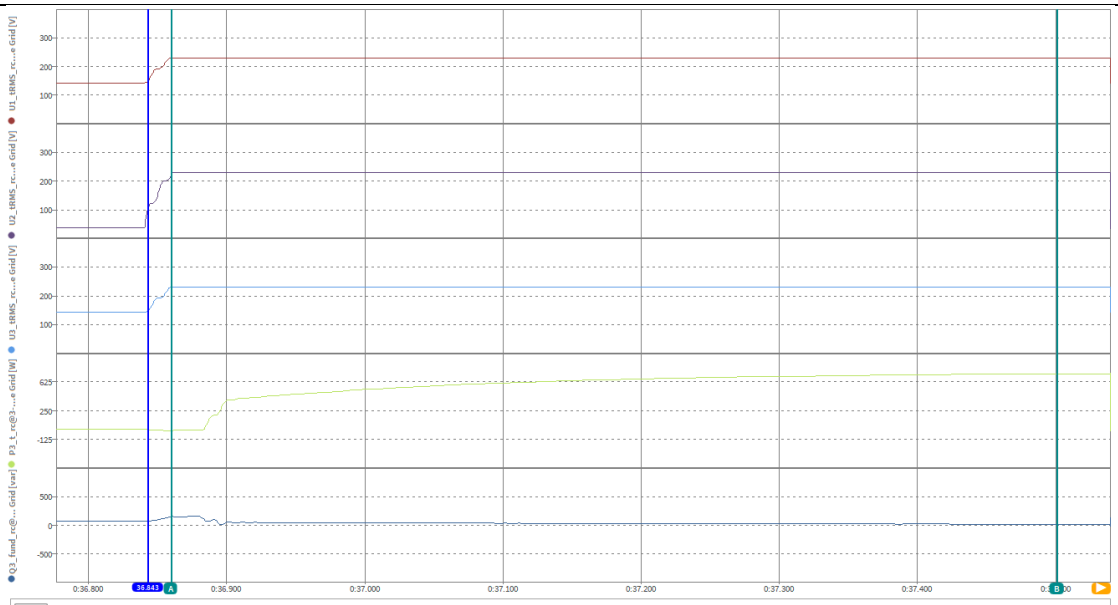


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:36.859993	0:37.500949	0.640956
U1_tRMS_rc@3-phase Grid [V]	227.9136	229.7419	1.828293
U2_tRMS_rc@3-phase Grid [V]	206.3637	229.6328	23.26915
U3_tRMS_rc@3-phase Grid [V]	225.3934	229.8165	4.423141
P3_t_rc@3-phase Grid [W]	-28.31633	726.6601	754.9764
Q3_fund_rc@3-phase Grid [var]	129.7089	5.915645	-123.7932



	A	B	Delta
Time [s]	0:36.859993	0:37.500949	0.640956
U1_tRMS_rc@3-phase Grid [V]	227.9136	229.7419	1.828293
U2_tRMS_rc@3-phase Grid [V]	206.3637	229.6328	23.26915
U3_tRMS_rc@3-phase Grid [V]	225.3934	229.8165	4.423141
P3_t_rc@3-phase Grid [W]	-28.31633	726.6601	754.9764
Q3_fund_rc@3-phase Grid [var]	129.7089	5.915645	-123.7932

5.8.3	For PGUs Type 2 and storage systems	P

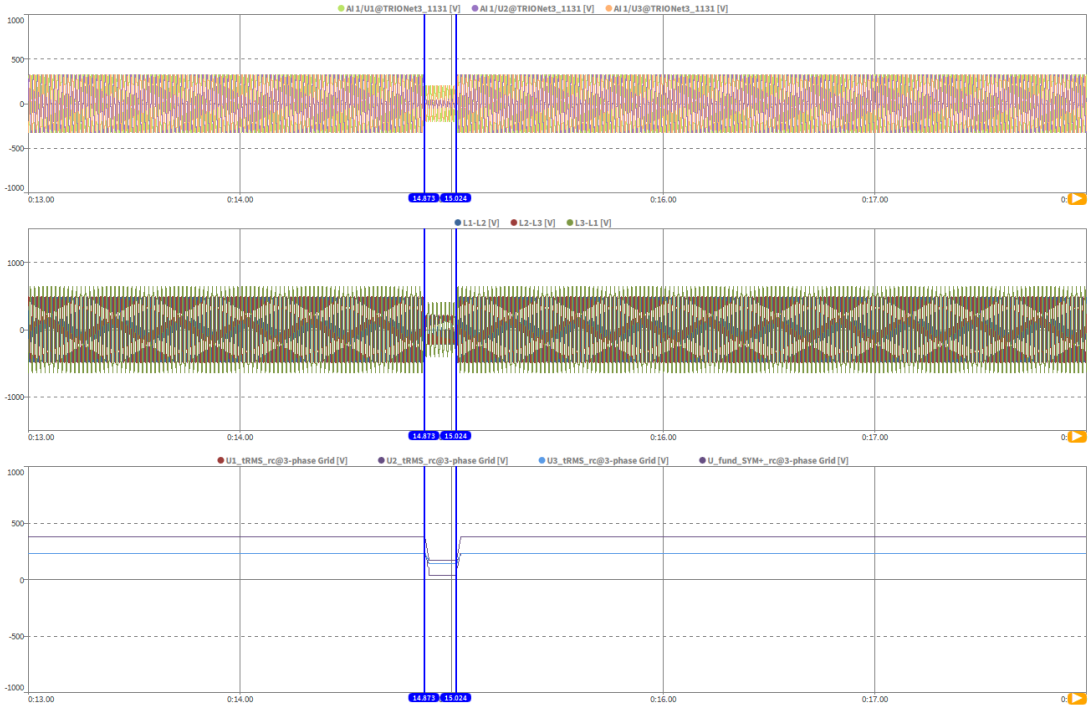
MST-BIE5-2500

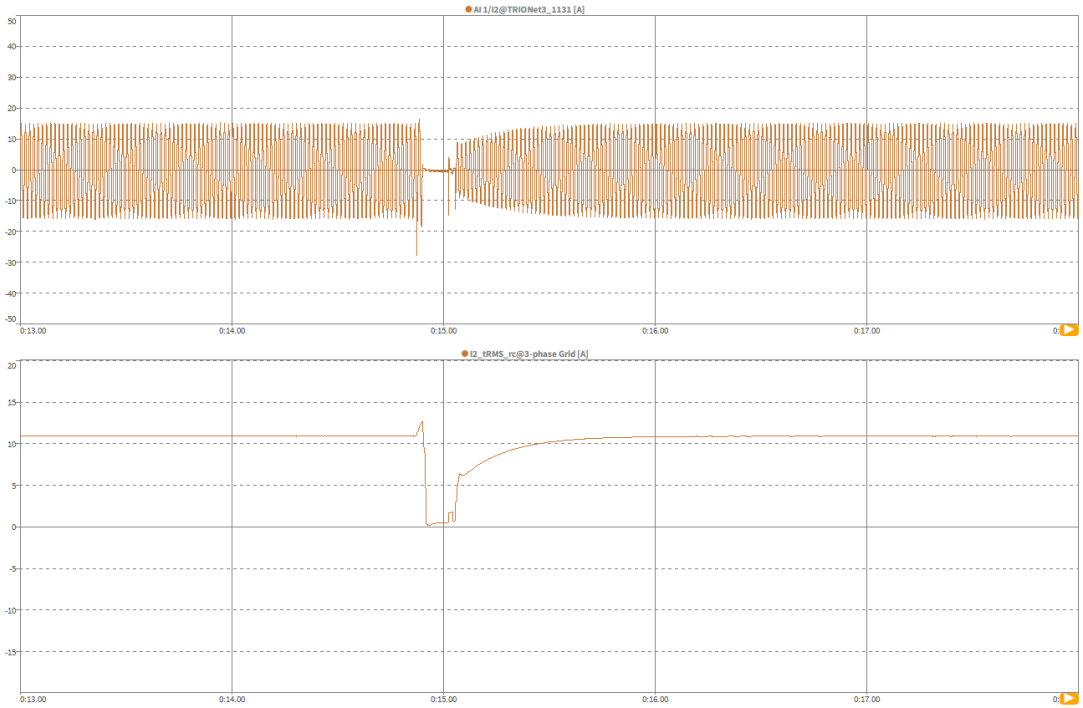
1.5

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1,5
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:56:47
	3	Fault type (phase)	--	--	--	D2
	4	Setting voltage depth	Line to line	--	p.u.	0,15
	5	Setting dip duration		--	--	150
	6	Point of fault entry	Total	--	ms	14873
	7	Point of fault clearance	Total	--	ms	15024
	8	Fault duration in empty load test	Total	--	ms	151
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,619
	10		Total (Phase 2)			0,147
	11		Total (Phase 3)			0,620
	12		Positive sequence			0,427
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,997
	15		Phase 3			1,000
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,003
	17	Active power	Total	t1-10s to t1	p.u.	1,000
	18		Pos.			1,000
	19	Reactive power	Total	t1-10s to t1	p.u.	0,058
	20		Pos.			0,009
	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.	0,619
	23		Phase 2			0,147
	24		Phase 3			0,620
	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			0,043
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,000
	32		Pos.			0,000
	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,997
	35		Phase 3			1,000
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,000
	37		Pos.			1,000
	38	Active power rising time	Total	--	s	0,707
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,058
	40		Pos.			0,009
	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

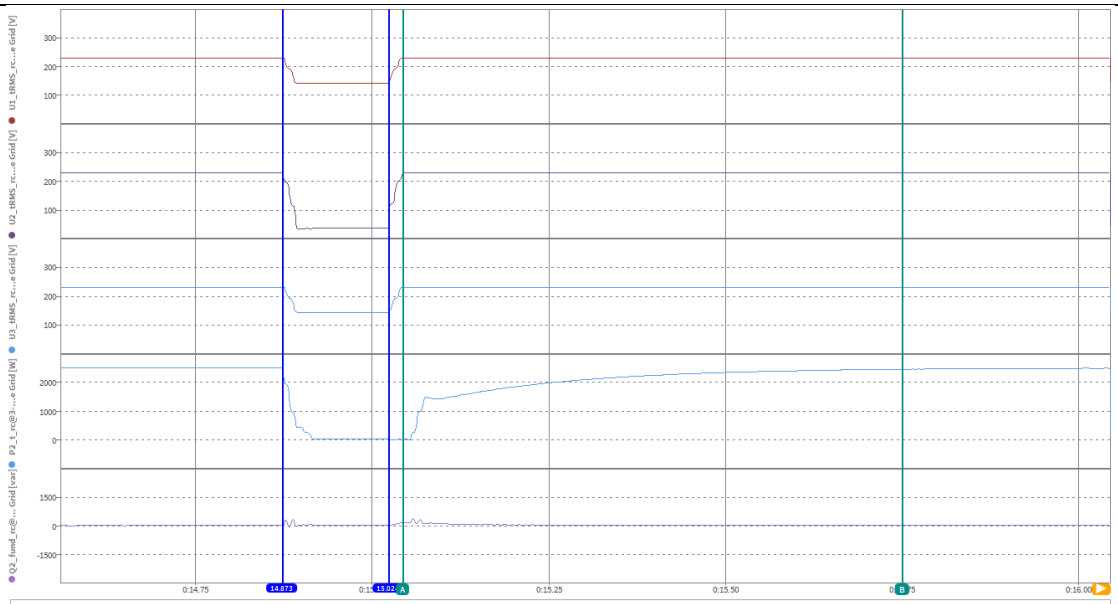
MST-BIE5-2500



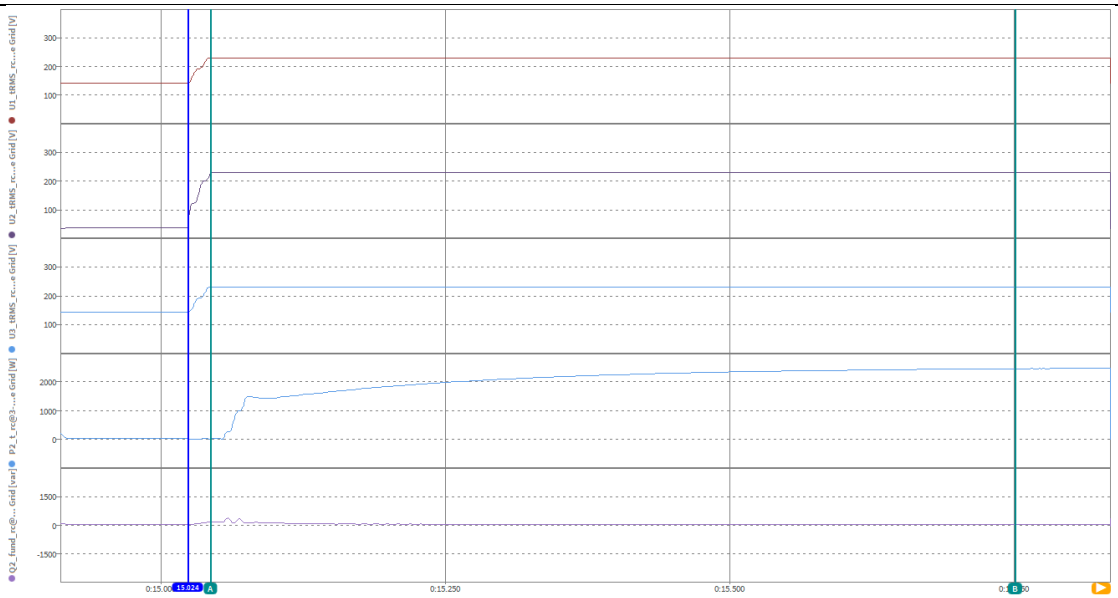


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:15.044000	0:15.750949	0.706949
U1_tRMS_rc@3-phase Grid [V]	229.6010	229.7263	0.125305
U2_tRMS_rc@3-phase Grid [V]	214.4276	229.3946	14.96700
U3_tRMS_rc@3-phase Grid [V]	228.5240	229.9105	1.386459
P2_t_rc@3-phase Grid [W]	-18.57657	2448.947	2467.523
Q2_fund_rc@3-phase Grid [var]	126.2352	-4.193688	-130.4289



	A	B	Delta
Time [s]	0:15.044000	0:15.750949	0.706949
U1_tRMS_rc@3-phase Grid [V]	229.6010	229.7263	0.125305
U2_tRMS_rc@3-phase Grid [V]	214.4276	229.3946	14.96700
U3_tRMS_rc@3-phase Grid [V]	228.5240	229.9105	1.386459
P2_t_rc@3-phase Grid [W]	-18.57657	2448.947	2467.523
Q2_fund_rc@3-phase Grid [var]	126.2352	-4.193688	-130.4289

5.8.3	For PGUs Type 2 and storage systems	P

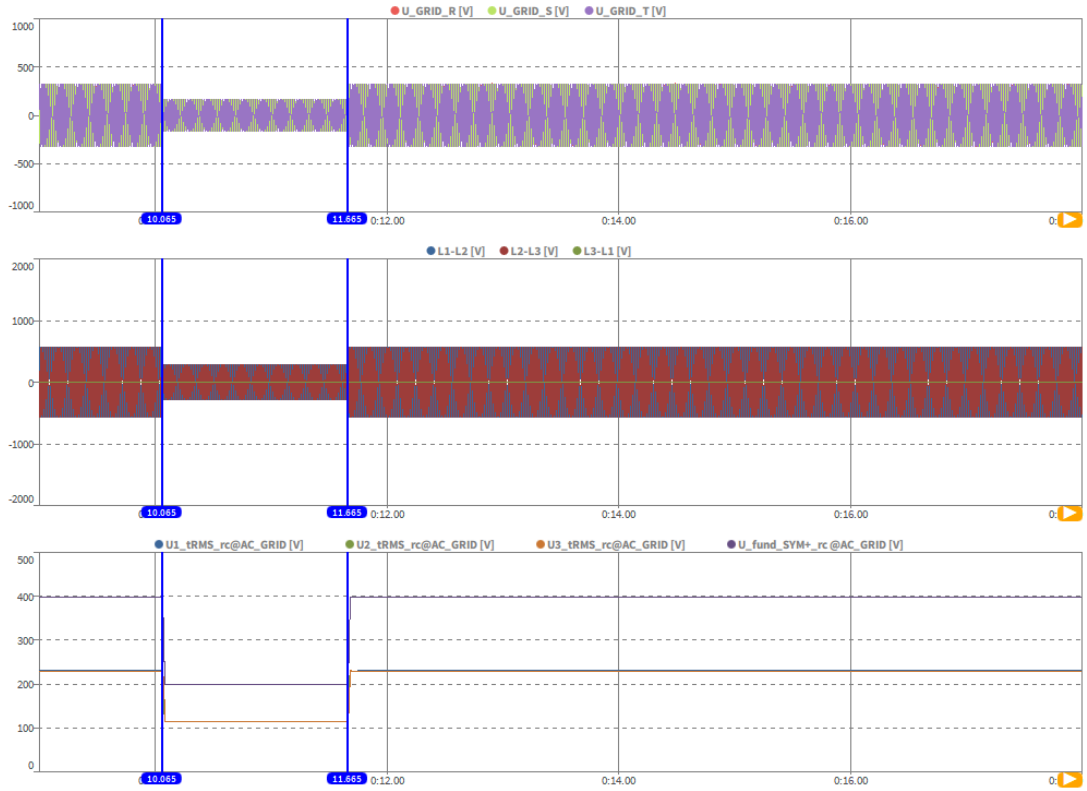
MST-BIE5-2500

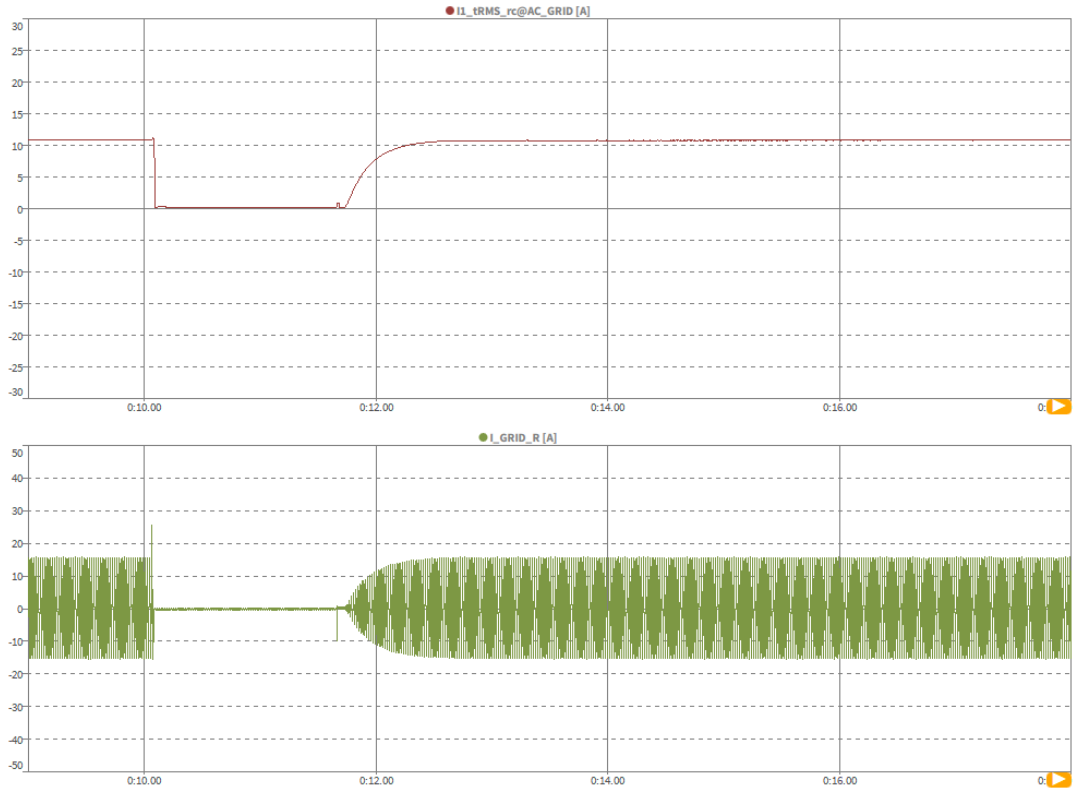
2.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2,1
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	15:21:36
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	10065
	7	Point of fault clearance	Total	--	ms	11665
	8	Fault duration in empty load test	Total	--	ms	1600
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,496
	10		Total (Phase 2)			0,496
	11		Total (Phase 3)			0,496
	12		Positive sequence			0,496
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			1,000
	15		Phase 3			1,003
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,993
	17	Active power	Total	t1-10s to t1	p.u.	0,946
	18		Pos.			0,944
	19	Reactive power	Total	t1-10s to t1	p.u.	0,316
	20		Pos.			0,315
	21	Cosφ	Total	t1-10s to t1	--	0,949
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,496
	23		Phase 2			0,496
	24		Phase 3			0,496
	25	Line current	Phase 1	t1+60ms	p.u.	0,008
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,009
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,004
	32		Pos.			0,004
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			1,000
	35		Phase 3			1,003
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,960
	37		Pos.			0,955
	38	Active power rising time	Total	--	s	0,782
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,262
	40		Pos.			0,261
	41	Reactive power rising time	total	--	s	9,960
	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

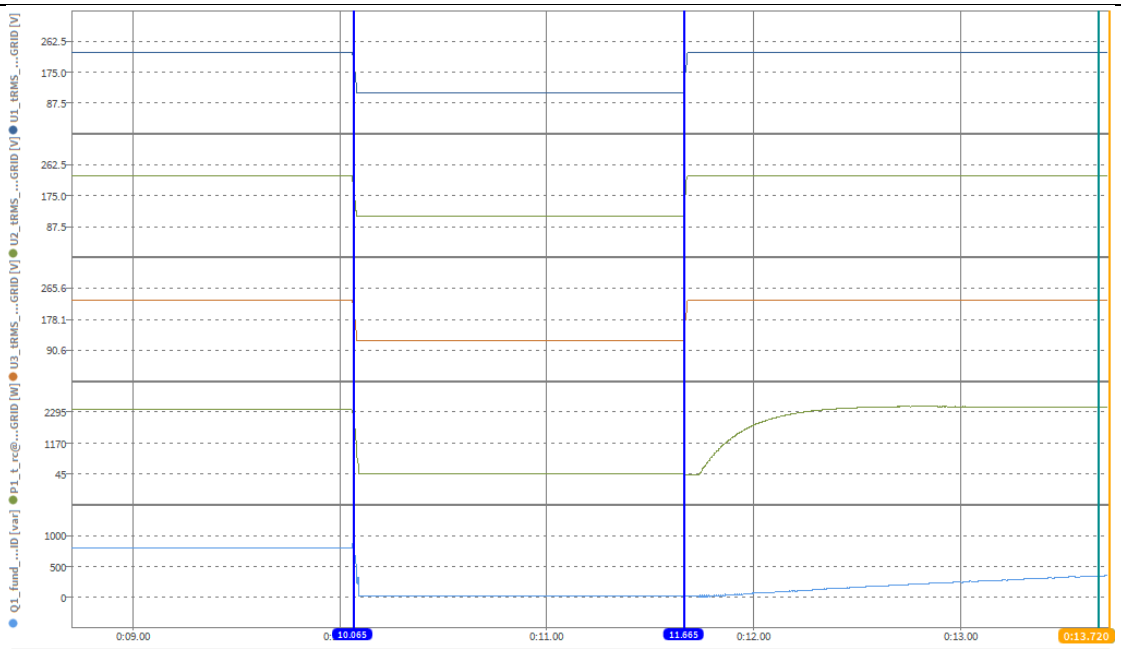
MST-BIE5-2500



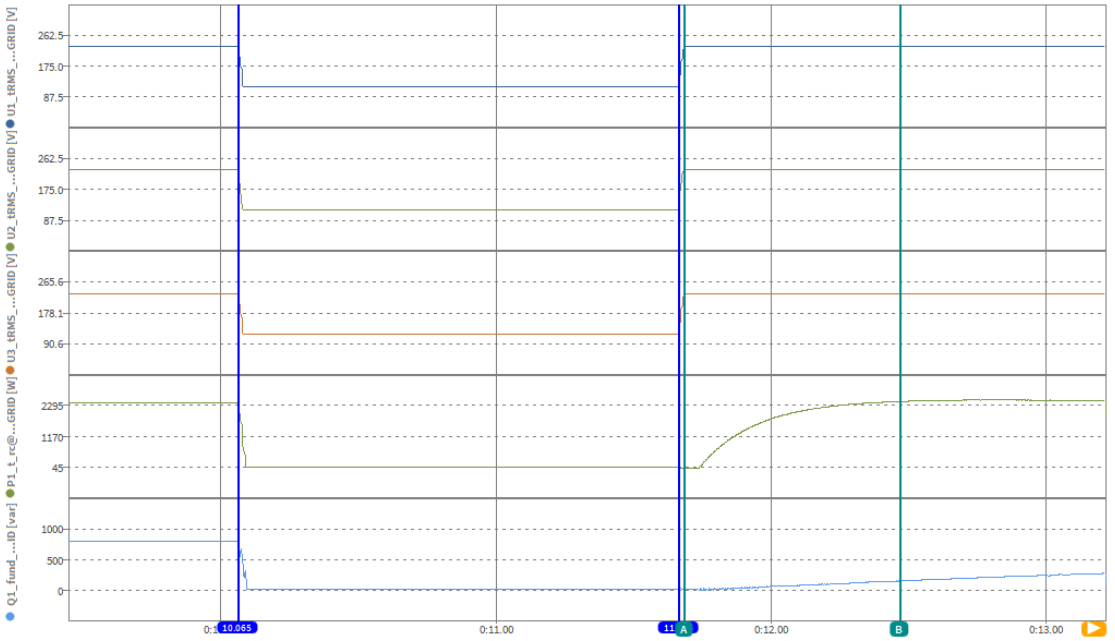


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



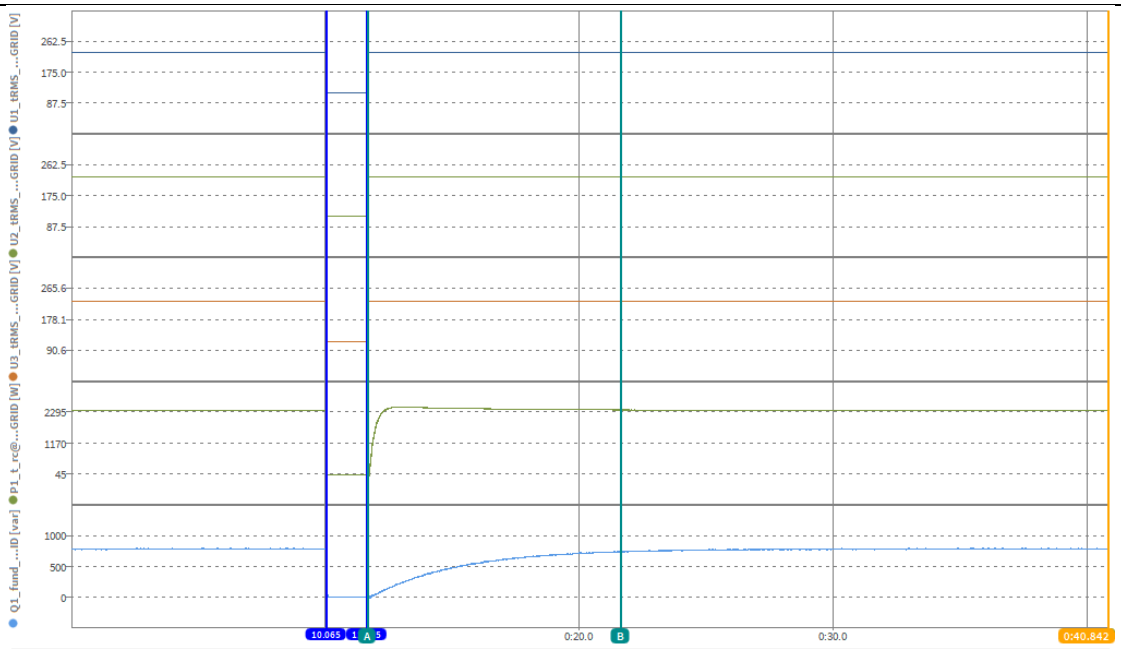
	A	B	间隔
时间 [s]	0:13.6698067	0:13.7199797	0.0501730
U1_tRMS_rc@AC_GRID [V]	231.0500	231.0478	-2.213e-3
U2_tRMS_rc@AC_GRID [V]	229.9369	229.9392	2.350e-3
U3_tRMS_rc@AC_GRID [V]	229.9037	229.9024	-1.282e-3
P1_t_rc@AC_GRID [W]	2464.577	2463.240	-1.336914
Q1_fund_rc@AC_GRID [var]	331.0134	334.5475	3.534088



	A	B	间隔
时间 [s]	0:11.6865772	0:12.4681291	0.7815519
U1_tRMS_rc@AC_GRID [V]	229.4693	231.0419	1.572617
U2_tRMS_rc@AC_GRID [V]	229.1388	229.9383	0.799469
U3_tRMS_rc@AC_GRID [V]	229.5254	229.9171	0.391632
P1_t_rc@AC_GRID [W]	-52.07288	2423.907	2475.980
Q1_fund_rc@AC_GRID [var]	-0.910495	134.3082	135.2187

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	0:11.6844994	0:21.6448505	9.9603511
U1_tRMS_rc@AC_GRID [V]	213.0259	230.9907	17.96477
U2_tRMS_rc@AC_GRID [V]	220.7151	229.9381	9.222961
U3_tRMS_rc@AC_GRID [V]	213.0838	229.8834	16.79962
P1_t_rc@AC_GRID [W]	-52.86155	2379.310	2432.171
Q1_fund_rc@AC_GRID [var]	-3.213472	738.9641	742.1776

5.8.3	For PGUs Type 2 and storage systems	P

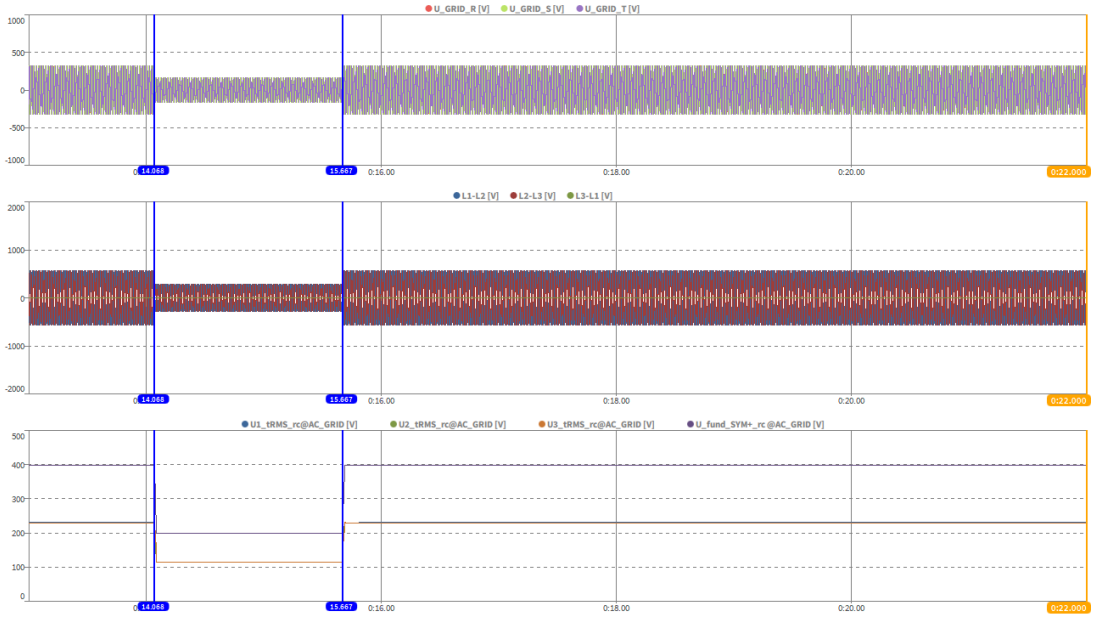
MST-BIE5-2500

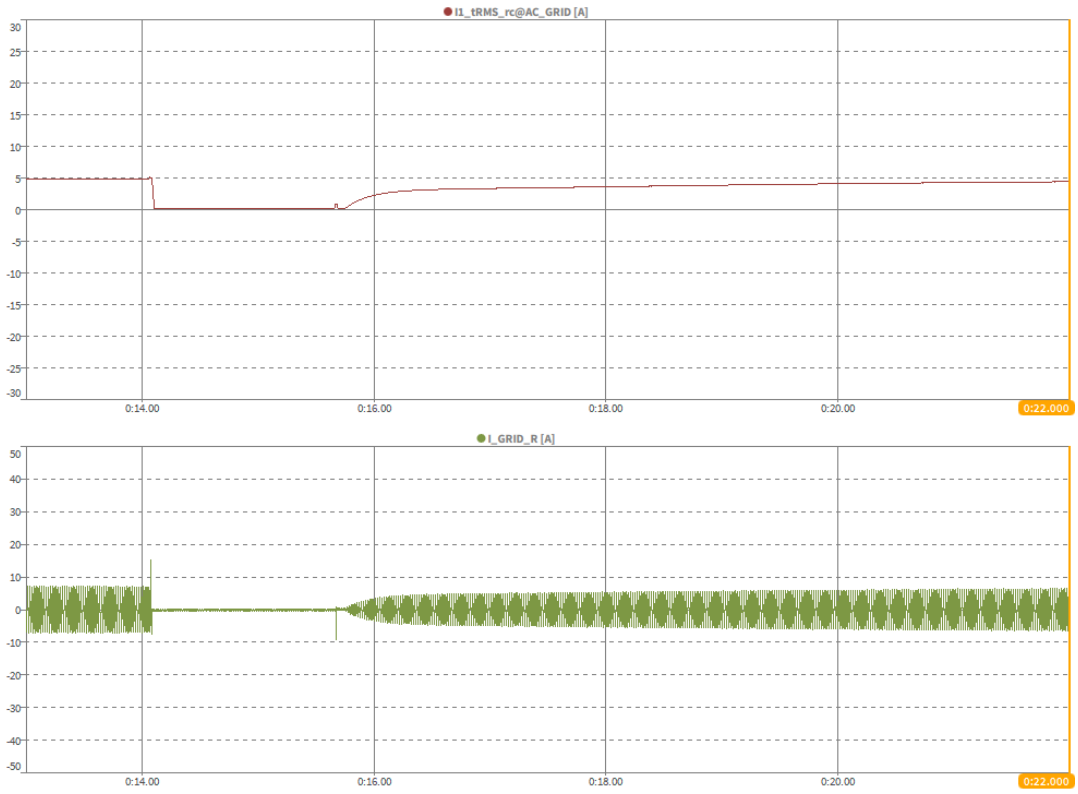
2.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2,2
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	15:29:35
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	14068
	7	Point of fault clearance	Total	--	ms	15667
	8	Fault duration in empty load test	Total	--	ms	1599
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,500
	10		Total (Phase 2)			0,500
	11		Total (Phase 3)			0,500
	12		Positive sequence			0,500
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,003
	14		Phase 2			1,000
	15		Phase 3			0,998
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,296
	17	Active power	Total	t1-10s to t1	p.u.	0,294
	18		Pos.			0,294
	19	Reactive power	Total	t1-10s to t1	p.u.	0,316
	20		Pos.			0,316
	21	Cosφ	Total	t1-10s to t1	--	0,680
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,500
	23		Phase 2			0,500
	24		Phase 3			0,500
	25	Line current	Phase 1	t1+60ms	p.u.	0,008
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,027
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,004
	32		Pos.			0,004
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,004
	34		Phase 2			1,002
	35		Phase 3			1,000
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,293
	37		Pos.			0,293
	38	Active power rising time	Total	--	s	0,837
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,282
	40		Pos.			0,282
	41	Reactive power rising time	total	--	s	9,985
	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

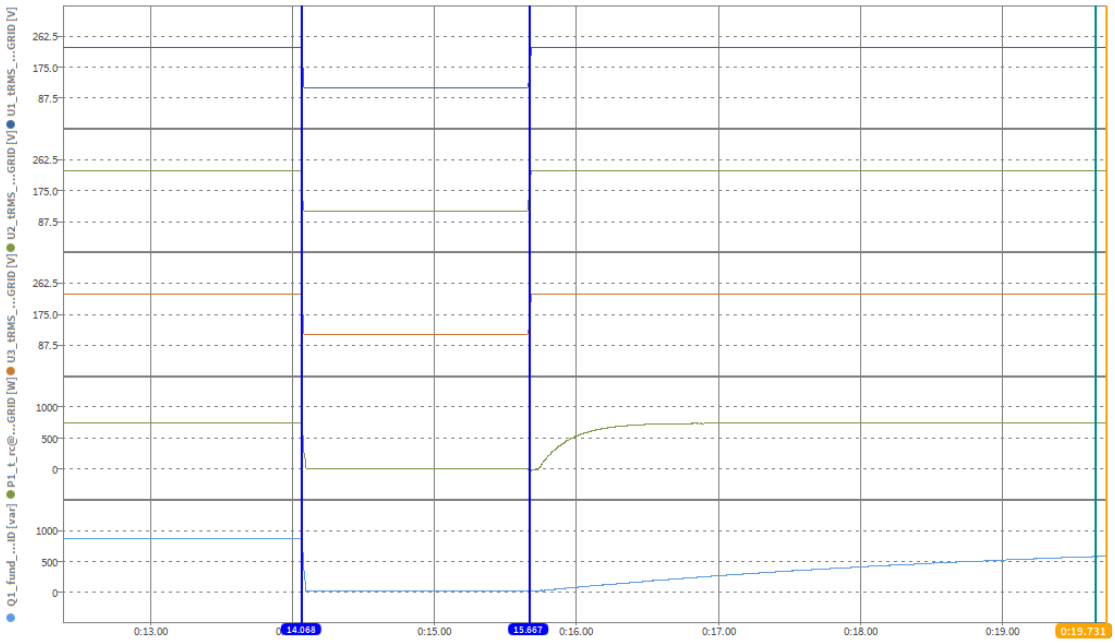
MST-BIE5-2500



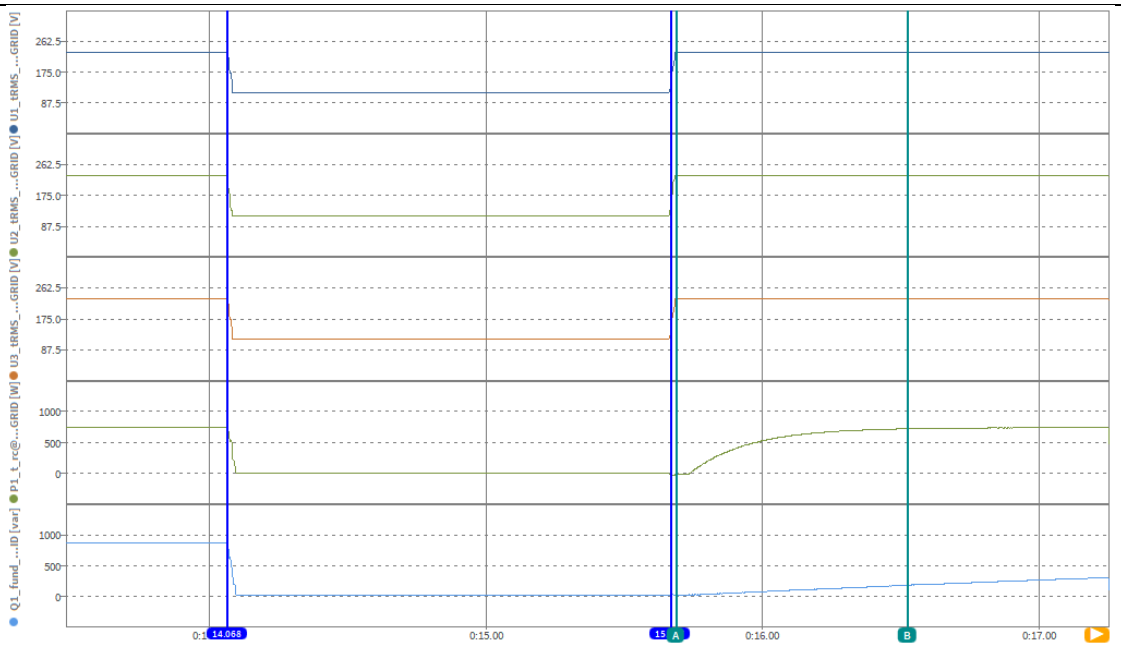


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



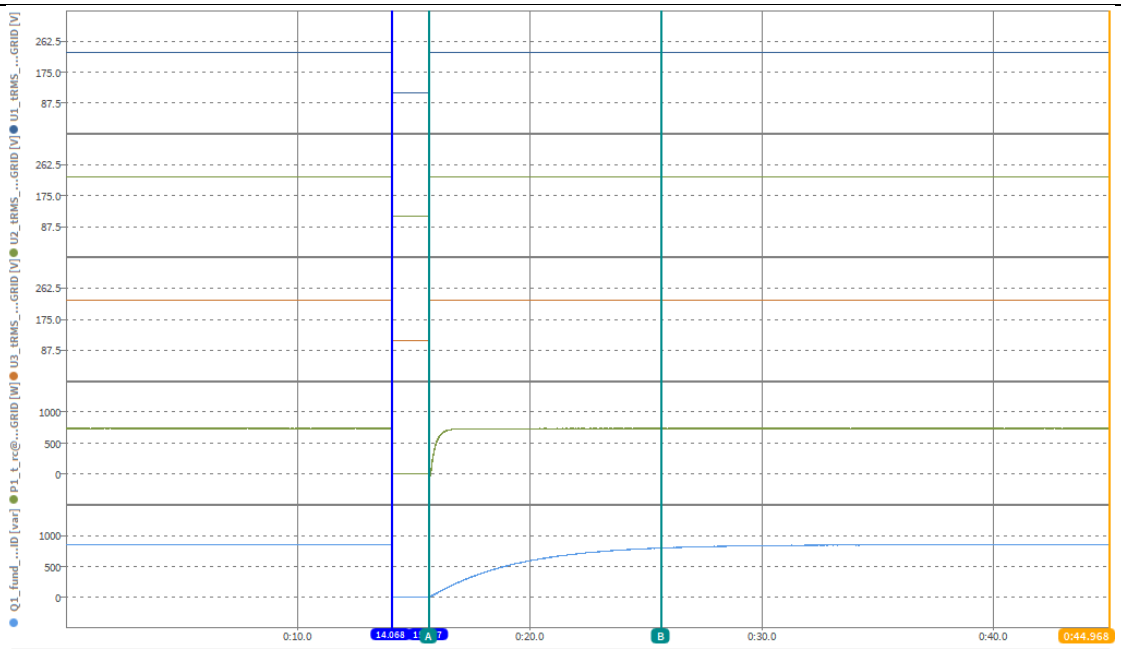
	A	B	间隔
时间 [s]	0:19.65746	0:19.73092	0.07346
U1_tRMS_rc@AC_GRID [V]	230.2661	230.2605	-5.585e-3
U2_tRMS_rc@AC_GRID [V]	229.9430	229.9431	6.104e-5
U3_tRMS_rc@AC_GRID [V]	229.9484	229.9430	-5.447e-3
P1_t_rc@AC_GRID [W]	730.3315	730.8500	0.518555
Q1_fund_rc@AC_GRID [var]	564.2968	569.0309	4.734131



	A	B	间隔
时间 [s]	0:15.688482	0:16.525249	0.836767
U1_tRMS_rc@AC_GRID [V]	224.6107	230.2640	5.653336
U2_tRMS_rc@AC_GRID [V]	225.0931	229.9430	4.849884
U3_tRMS_rc@AC_GRID [V]	224.6685	229.9602	5.291763
P1_t_rc@AC_GRID [W]	-54.15802	707.8103	761.9683
Q1_fund_rc@AC_GRID [var]	-2.313698	164.4992	166.8129

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	0:15.688482	0:25.673156	9.984674
U1_tRMS_rc@AC_GRID [V]	224.6107	230.2549	5.644257
U2_tRMS_rc@AC_GRID [V]	225.0931	229.9442	4.851074
U3_tRMS_rc@AC_GRID [V]	224.6685	229.9341	5.265686
P1_t_rc@AC_GRID [W]	-54.15802	733.9570	788.1150
Q1_fund_rc@AC_GRID [var]	-2.313698	799.8414	802.1551

5.8.3	For PGUs Type 2 and storage systems	P

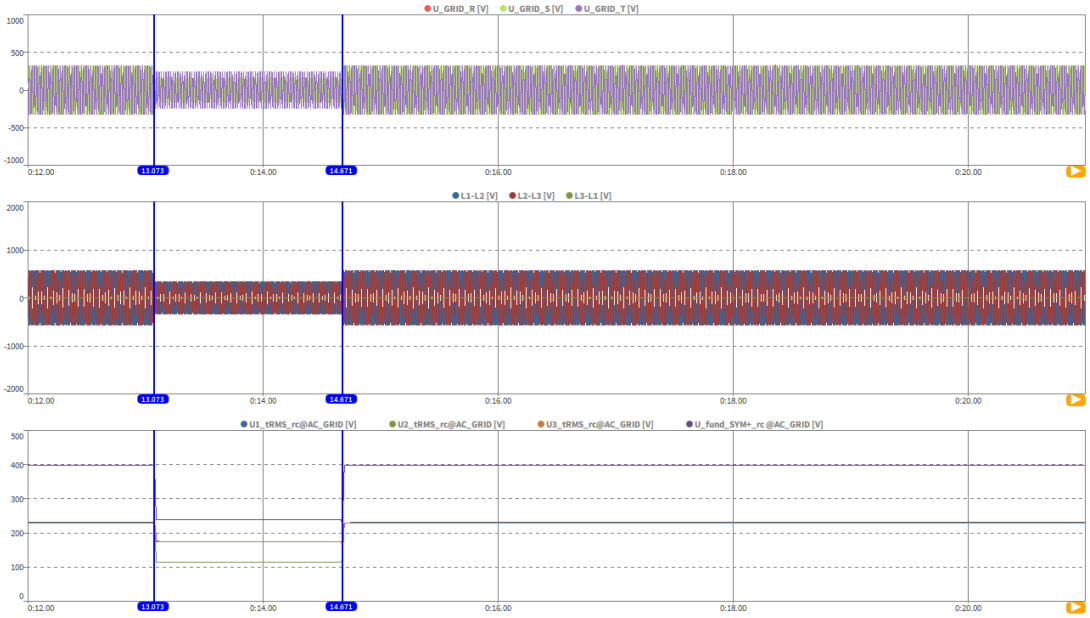
MST-BIE5-2500

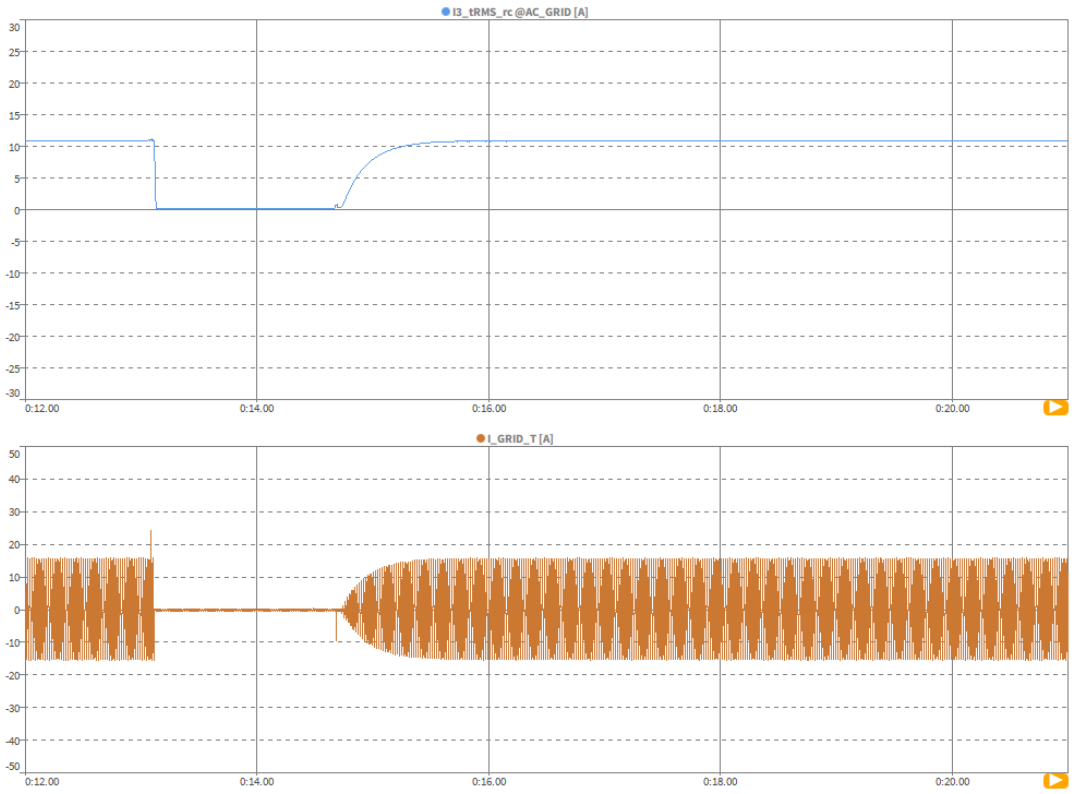
2.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2,3
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	15:59:35
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	13073
	7	Point of fault clearance	Total	--	ms	14671
	8	Fault duration in empty load test	Total	--	ms	1598
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,757
	10		Total (Phase 2)			0,496
	11		Total (Phase 3)			0,757
	12		Positive sequence			0,667
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,004
	14		Phase 2			1,000
	15		Phase 3			1,000
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,992
	17	Active power	Total	t1-10s to t1	p.u.	0,944
	18		Pos.			0,944
	19	Reactive power	Total	t1-10s to t1	p.u.	0,329
	20		Pos.			0,327
	21	Cosφ	Total	t1-10s to t1	--	0,944
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,757
	23		Phase 2			0,496
	24		Phase 3			0,757
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,017
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,015
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,009
	32		Pos.			0,008
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,004
	34		Phase 2			1,000
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,960
	37		Pos.			0,958
	38	Active power rising time	Total	--	s	0,861
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,276
	40		Pos.			0,274
	41	Reactive power rising time	total	--	s	9,935
	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

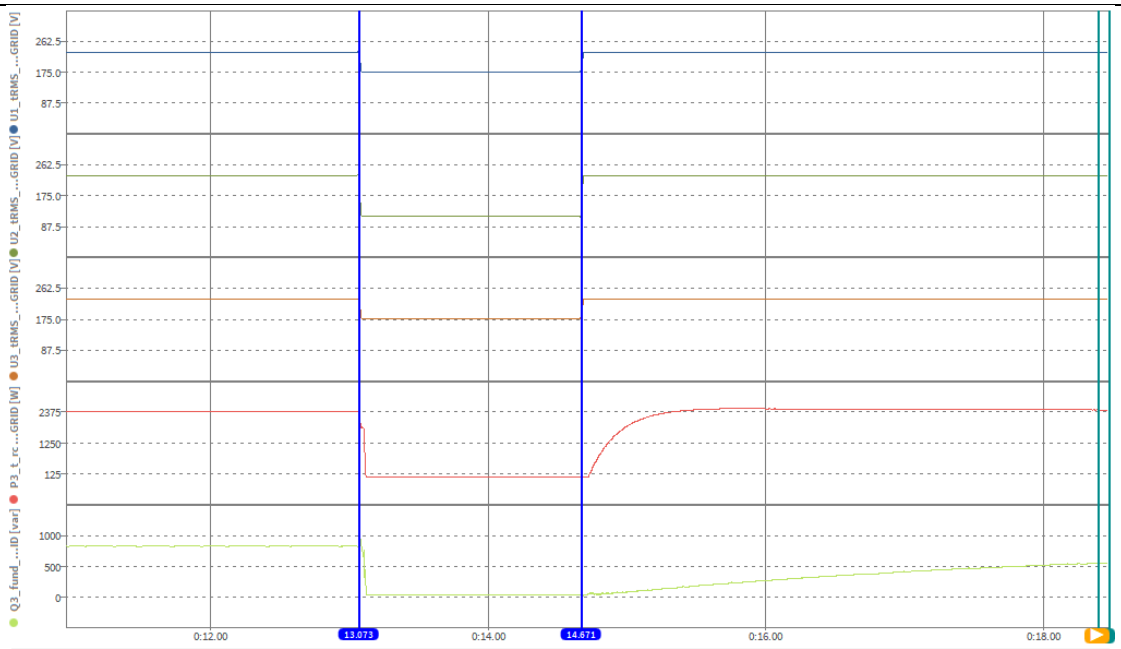
MST-BIE5-2500



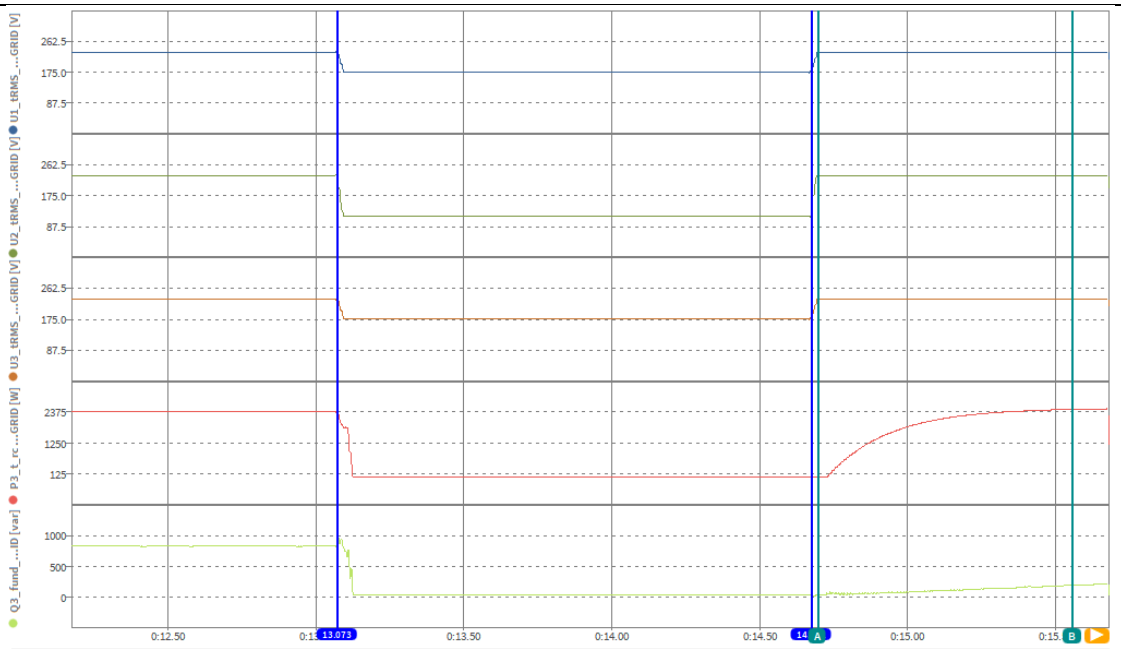


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



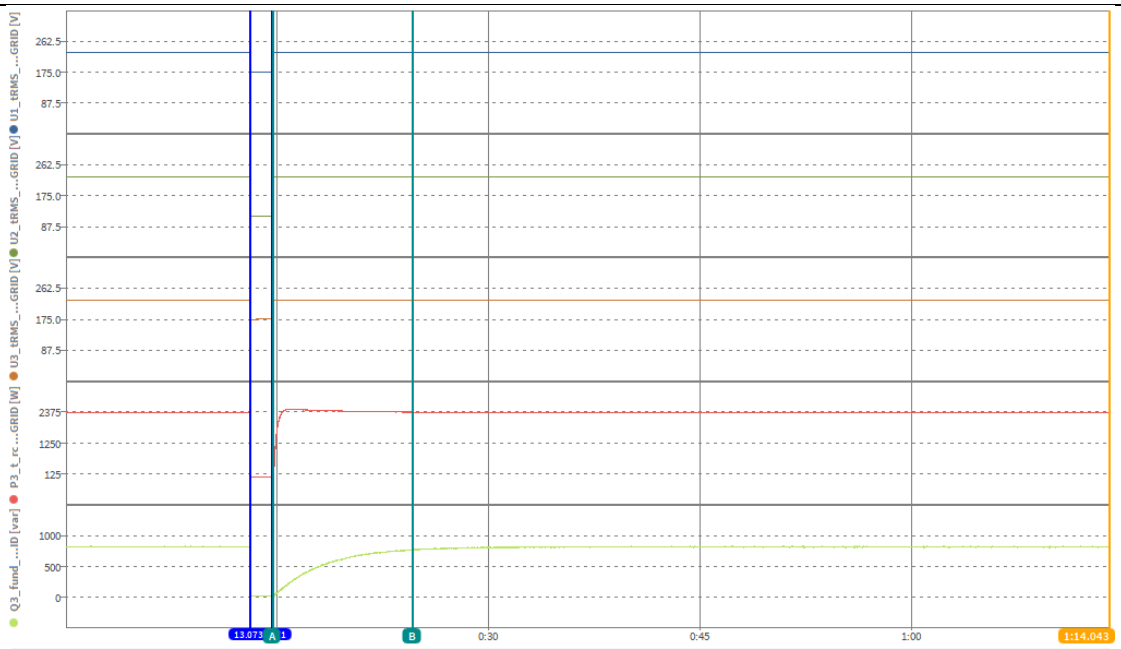
	A	B	间隔
时间 [s]	0:18.399016	0:18.474147	0.075131
U1_tRMS_rc@AC_GRID [V]	231.0308	231.0237	-7.111e-3
U2_tRMS_rc@AC_GRID [V]	229.9380	229.9358	-2.243e-3
U3_tRMS_rc@AC_GRID [V]	229.9019	229.8954	-6.516e-3
P3_t_rc @AC_GRID [W]	2435.313	2434.813	-0.499268
Q3_fund_rc @AC_GRID [var]	537.3184	539.1995	1.881104



	A	B	间隔
时间 [s]	0:14.695412	0:15.556765	0.861353
U1_tRMS_rc@AC_GRID [V]	218.0851	231.0537	12.96867
U2_tRMS_rc@AC_GRID [V]	225.7066	229.9361	4.229462
U3_tRMS_rc@AC_GRID [V]	218.1397	229.9183	11.77864
P3_t_rc @AC_GRID [W]	-45.01731	2454.724	2499.741
Q3_fund_rc @AC_GRID [var]	15.50266	174.7204	159.2178

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	0:14.695412	0:24.630491	9.935079
U1_tRMS_rc@AC_GRID [V]	218.0851	230.9978	12.91278
U2_tRMS_rc@AC_GRID [V]	225.7066	229.9340	4.227371
U3_tRMS_rc@AC_GRID [V]	218.1397	229.8965	11.75682
P3_t_rc @AC_GRID [W]	-45.01731	2376.669	2421.687
Q3_fund_rc @AC_GRID [var]	15.50266	771.3785	755.8759

5.8.3	For PGUs Type 2 and storage systems	P

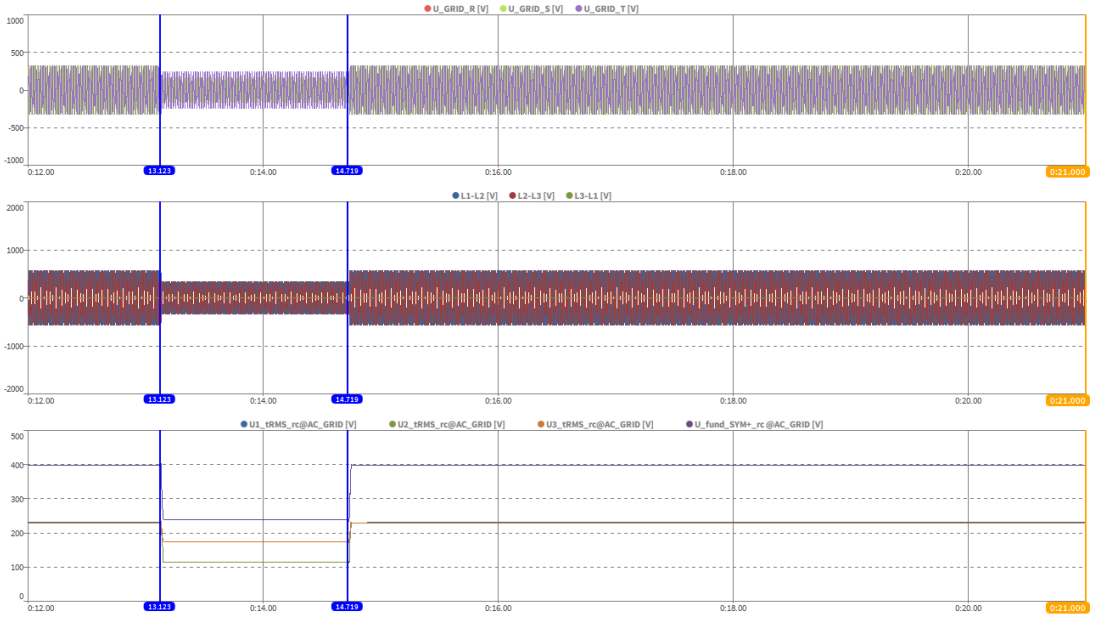
MST-BIE5-2500

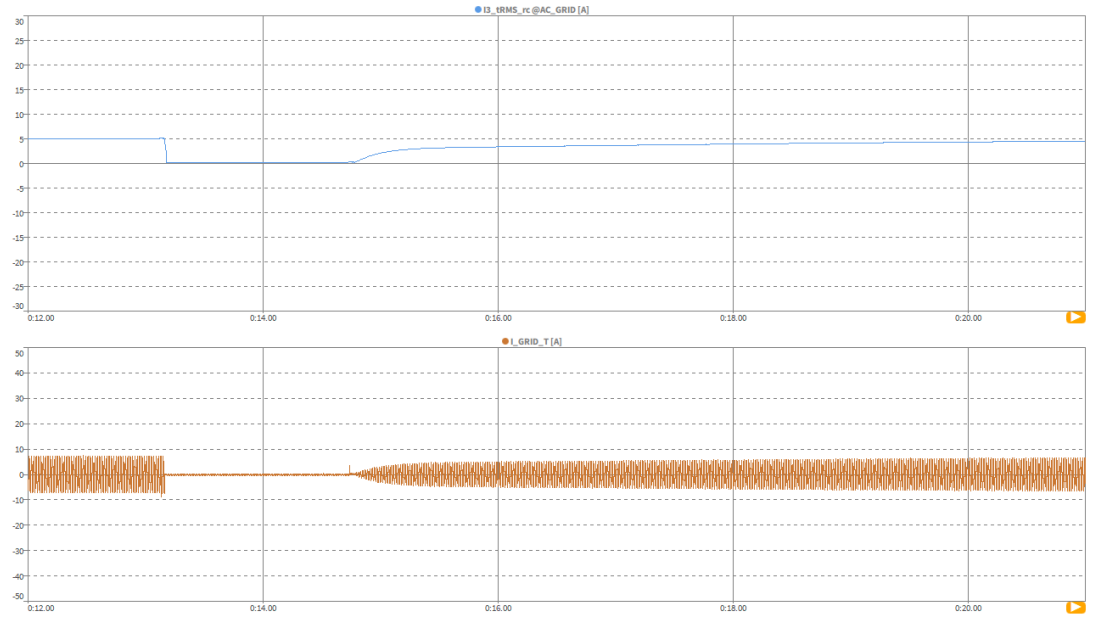
2.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2,4
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	16:51:30
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	13123
	7	Point of fault clearance	Total	--	ms	14719
	8	Fault duration in empty load test	Total	--	ms	1596
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,760
	10		Total (Phase 2)			0,500
	11		Total (Phase 3)			0,760
	12		Positive sequence			0,668
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,998
	14		Phase 2			1,002
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,296
	17	Active power	Total	t1-10s to t1	p.u.	0,294
	18		Pos.			0,294
	19	Reactive power	Total	t1-10s to t1	p.u.	0,316
	20		Pos.			0,316
	21	Cosφ	Total	t1-10s to t1	--	0,681
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,760
	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			0,028
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,015
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,009
	32		Pos.			0,009
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,004
	34		Phase 2			1,001
	35		Phase 3			1,000
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,294
	37		Pos.			0,294
	38	Active power rising time	Total	--	s	0,729
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,294
	40		Pos.			0,294
	41	Reactive power rising time	total	--	s	9,925
	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

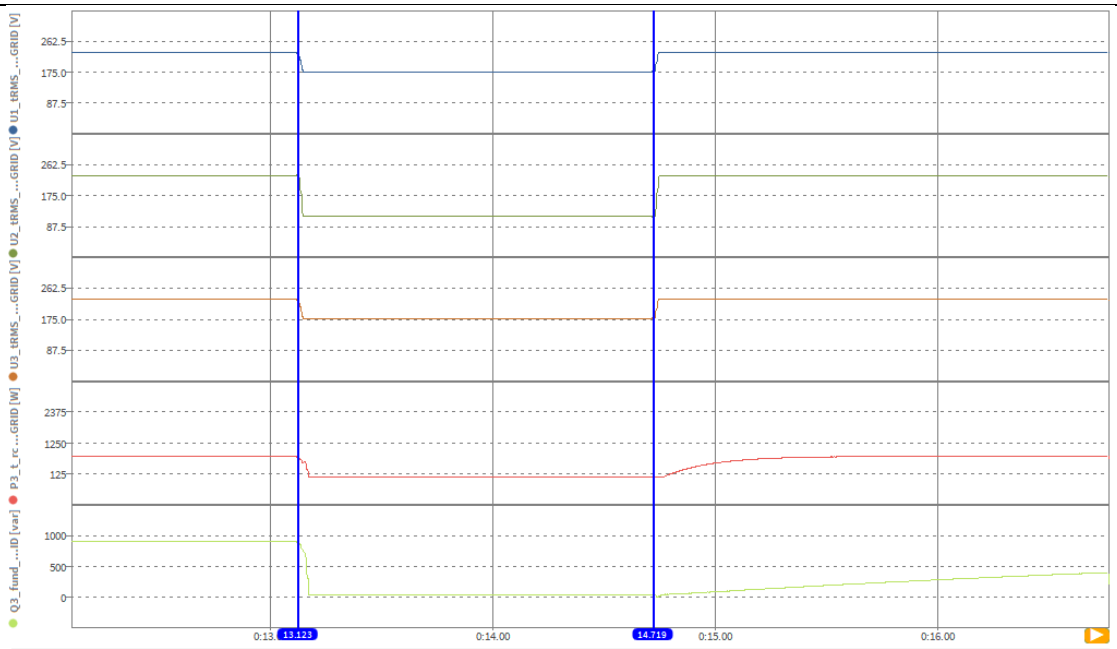
MST-BIE5-2500



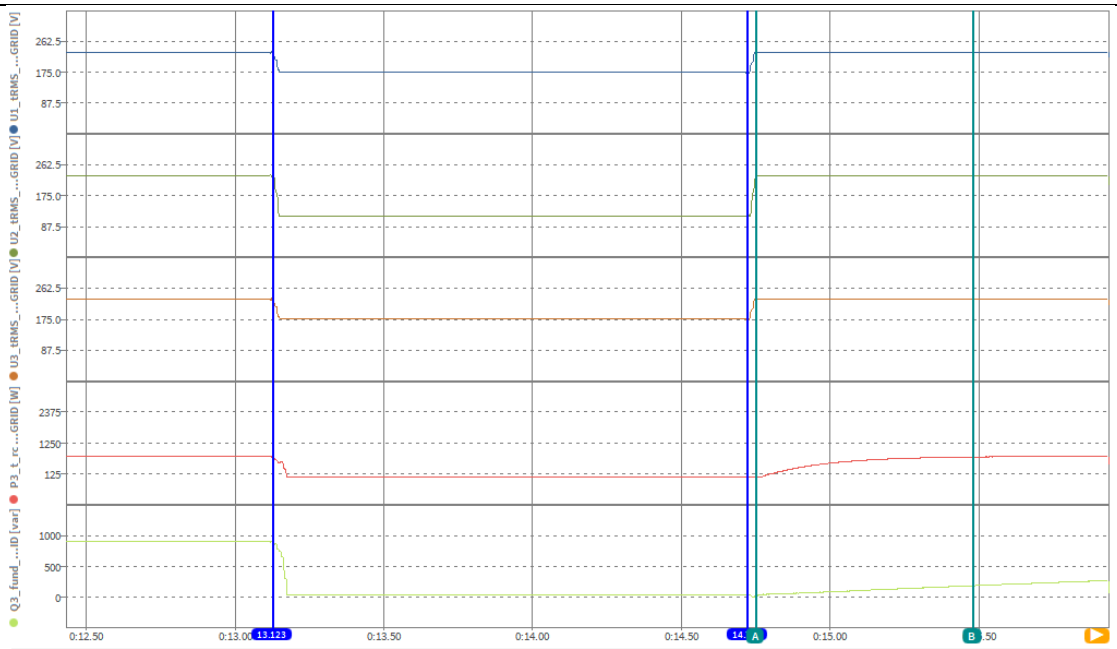


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



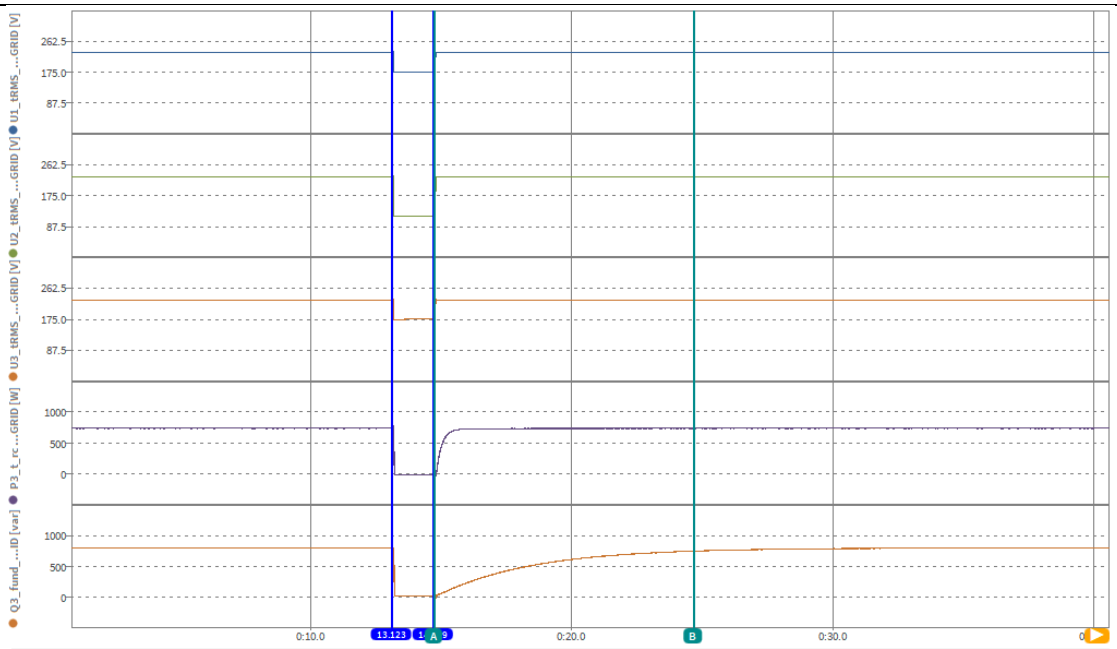
	A	B	间隔
时间 [s]	0:20.54021	0:20.65021	0.11000
U1_tRMS_rc@AC_GRID [V]	230.2543	230.2510	-3.311e-3
U2_tRMS_rc@AC_GRID [V]	229.9407	229.9363	-4.425e-3
U3_tRMS_rc@AC_GRID [V]	229.9348	229.9327	-2.121e-3
P3_t_rc @AC_GRID [W]	734.2391	734.5797	0.340515
Q3_fund_rc @AC_GRID [var]	711.7619	715.9708	4.208923



	A	B	间隔
时间 [s]	0:14.75017	0:15.47945	0.72929
U1_tRMS_rc@AC_GRID [V]	229.8498	230.2508	0.401062
U2_tRMS_rc@AC_GRID [V]	203.7025	229.9359	26.23338
U3_tRMS_rc@AC_GRID [V]	229.9066	229.9502	0.043610
P3_t_rc @AC_GRID [W]	-44.35035	702.1157	746.4660
Q3_fund_rc @AC_GRID [var]	-10.95896	167.4067	178.3657

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	0:14.75065	0:24.67564	9.92499
U1_tRMS_rc@AC_GRID [V]	231.7862	230.2517	-1.534515
U2_tRMS_rc@AC_GRID [V]	213.2728	229.9352	16.66243
U3_tRMS_rc@AC_GRID [V]	231.8409	229.9318	-1.909180
P3_t_rc @AC_GRID [W]	-43.49359	734.6260	778.1196
Q3_fund_rc @AC_GRID [var]	-6.972074	750.9955	757.9675

5.8.3	For PGUs Type 2 and storage systems	P

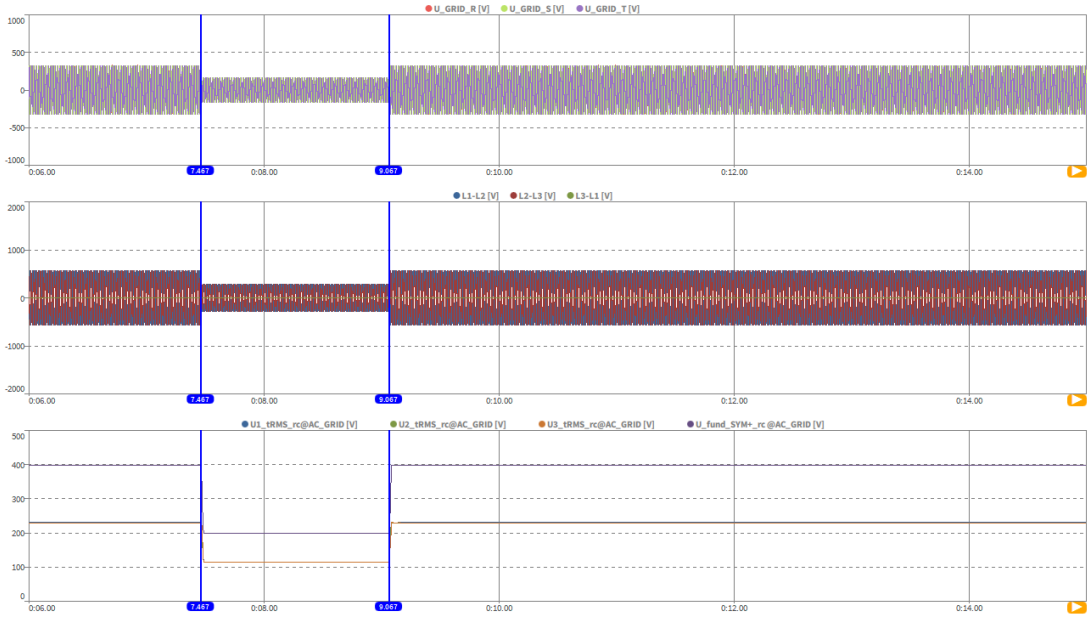
MST-BIE5-2500

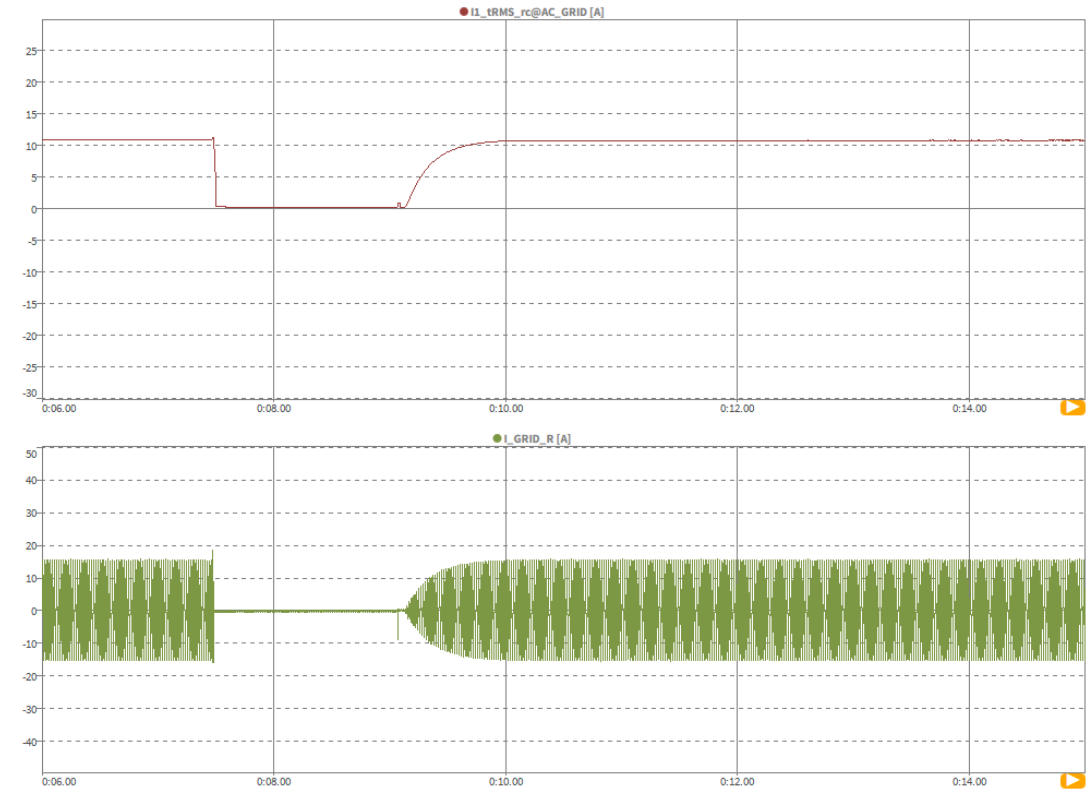
3.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3,1
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	16:11:30
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	7467
	7	Point of fault clearance	Total	--	ms	9067
	8	Fault duration in empty load test	Total	--	ms	1600
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,496
	10		Total (Phase 2)			0,496
	11		Total (Phase 3)			0,496
	12		Positive sequence			0,496
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,004
	14		Phase 2			1,000
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,993
	17	Active power	Total	t1-10s to t1	p.u.	0,946
	18		Pos.			0,946
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,312
	20		Pos.			-0,312
	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.	0,496
	23		Phase 2			0,496
	24		Phase 3			0,496
	25	Line current	Phase 1	t1+60ms	p.u.	0,008
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,009
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,004
	32		Pos.			0,004
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,004
	34		Phase 2			1,000
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,961
	37		Pos.			0,961
	38	Active power rising time	Total	--	s	0,850
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,258
	40		Pos.			-0,256
	41	Reactive power rising time	total	--	s	9,952
	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

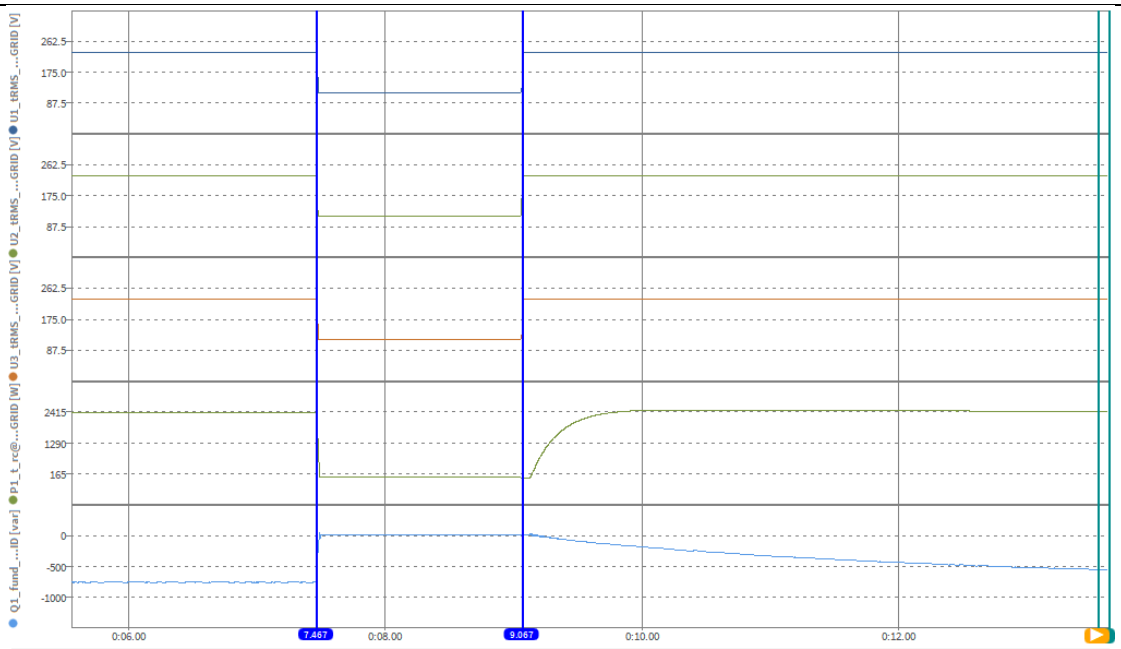
MST-BIE5-2500



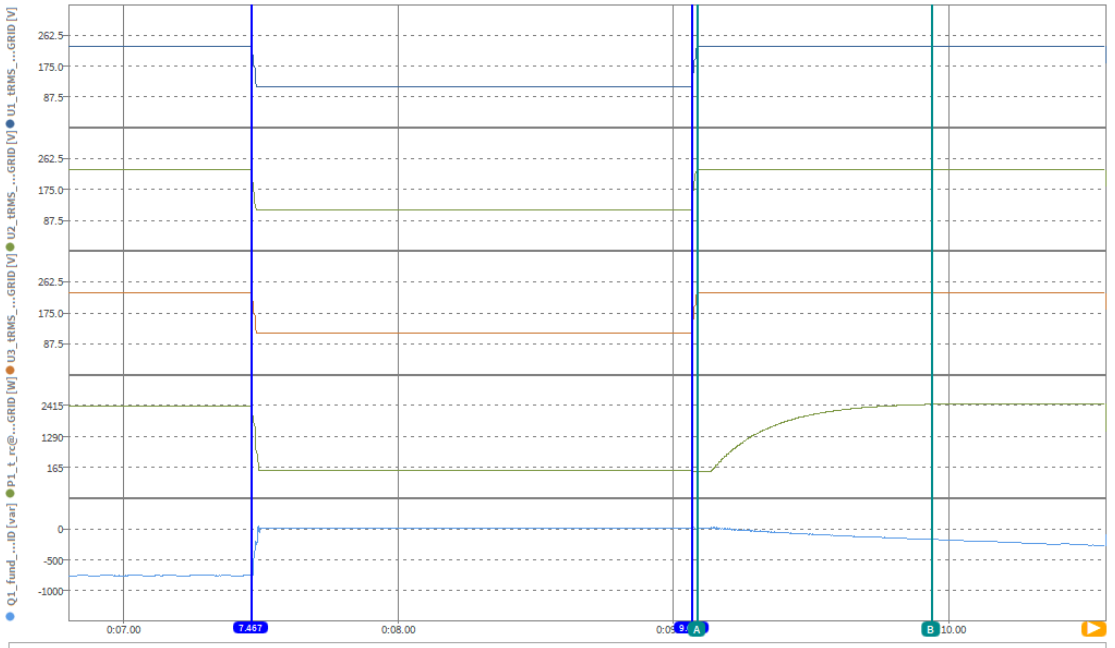


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



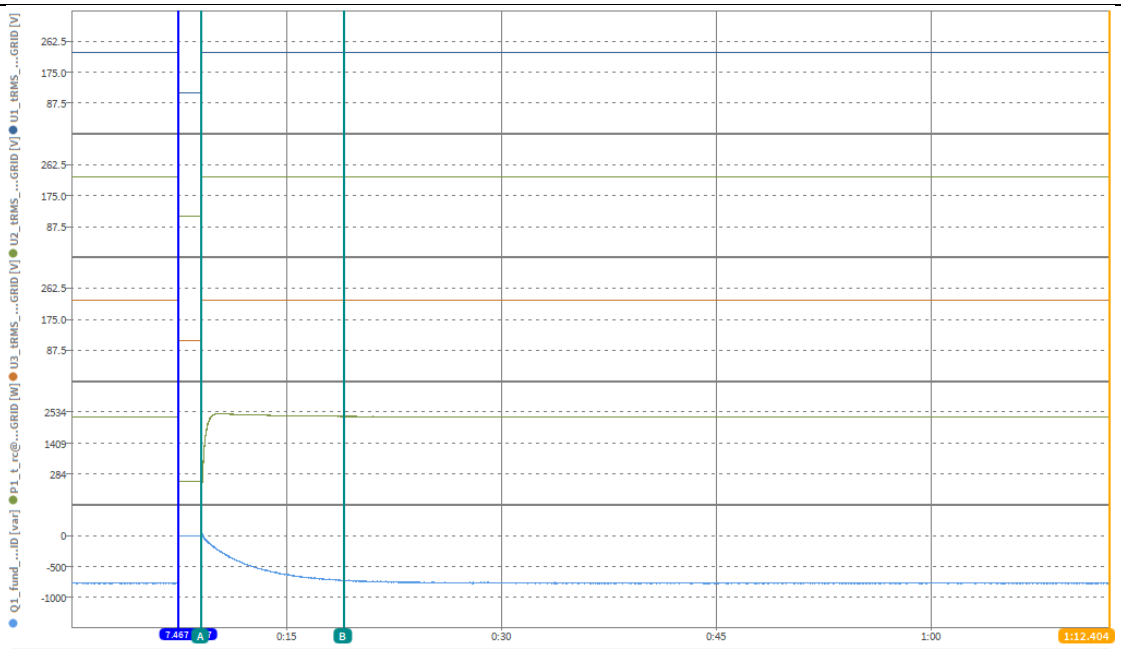
	A	B	间隔
时间 [s]	0:13.557346	0:13.638150	0.080804
U1_tRMS_rc@AC_GRID [V]	230.9986	231.0059	7.263e-3
U2_tRMS_rc@AC_GRID [V]	229.9342	229.9369	2.716e-3
U3_tRMS_rc@AC_GRID [V]	229.8778	229.8838	5.951e-3
P1_t_rc@AC_GRID [W]	2420.298	2421.593	1.294922
Q1_fund_rc@AC_GRID [var]	-565.3704	-564.1703	1.200012



	A	B	间隔
时间 [s]	9.087427	9.937438	0.850011
U1_tRMS_rc@AC_GRID [V]	217.7807	231.0138	13.23305
U2_tRMS_rc@AC_GRID [V]	221.9017	229.9353	8.033554
U3_tRMS_rc@AC_GRID [V]	217.8390	229.8802	12.04115
P1_t_rc@AC_GRID [W]	-54.16672	2442.922	2497.089
Q1_fund_rc@AC_GRID [var]	-11.86715	-182.0865	-170.2193

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	9.087427	0:19.039380	9.951953
U1_tRMS_rc@AC_GRID [V]	217.7807	230.9819	13.20114
U2_tRMS_rc@AC_GRID [V]	221.9017	229.9356	8.033890
U3_tRMS_rc@AC_GRID [V]	217.8390	229.8826	12.04353
P1_t_rc@AC_GRID [W]	-54.16672	2376.561	2430.728
Q1_fund_rc@AC_GRID [var]	-11.86715	-736.1383	-724.2712

5.8.3	For PGUs Type 2 and storage systems	P

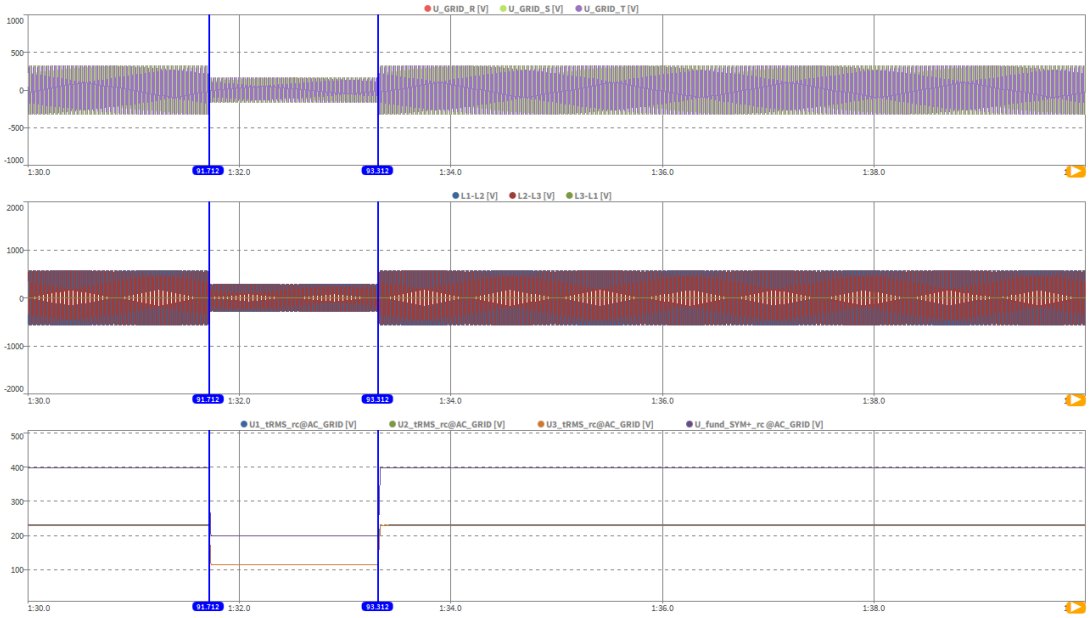
MST-BIE5-2500

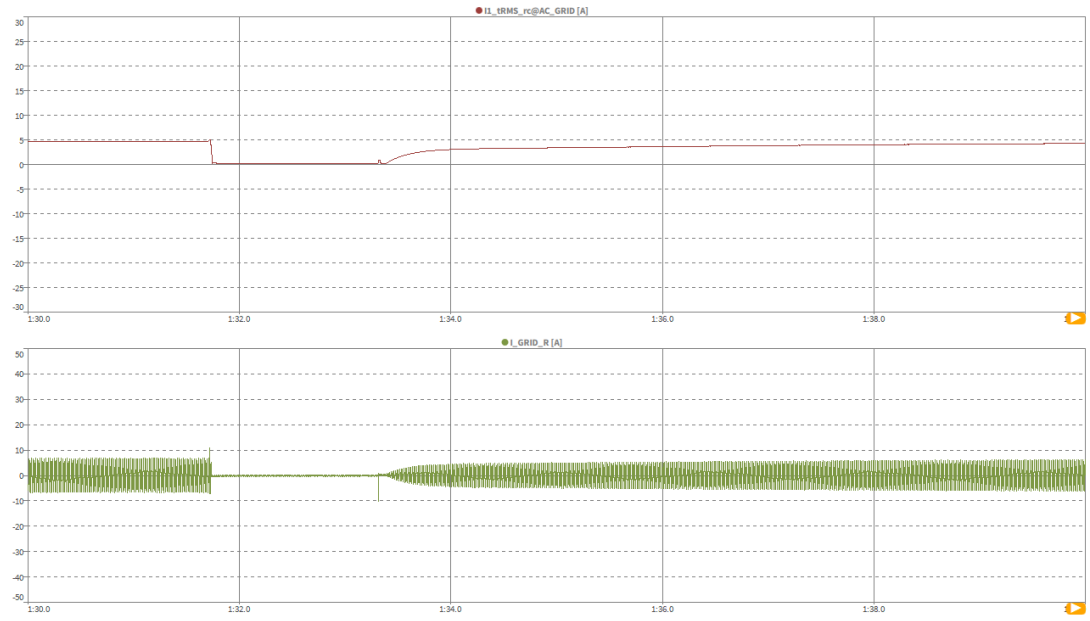
3.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3,2
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	17:11:35
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	91712
	7	Point of fault clearance	Total	--	ms	93312
	8	Fault duration in empty load test	Total	--	ms	1600
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,500
	10		Total (Phase 2)			0,500
	11		Total (Phase 3)			0,500
	12		Positive sequence			0,500
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,998
	14		Phase 2			0,999
	15		Phase 3			1,000
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,286
	17	Active power	Total	t1-10s to t1	p.u.	0,286
	18		Pos.			0,286
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,319
	20		Pos.			-0,318
	21	Cosφ	Total	t1-10s to t1	--	0,666
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,500
	23		Phase 2			0,500
	24		Phase 3			0,500
	25	Line current	Phase 1	t1+60ms	p.u.	0,020
	26		Phase 2			--
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	0,009
	29		Phase 2			--
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,002
	32		Pos.			0,002
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,002
	34		Phase 2			0,996
	35		Phase 3			1,000
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,286
	37		Pos.			0,286
	38	Active power rising time	Total	--	s	0,929
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,264
	40		Pos.			-0,263
	41	Reactive power rising time	total	--	s	9,869
	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

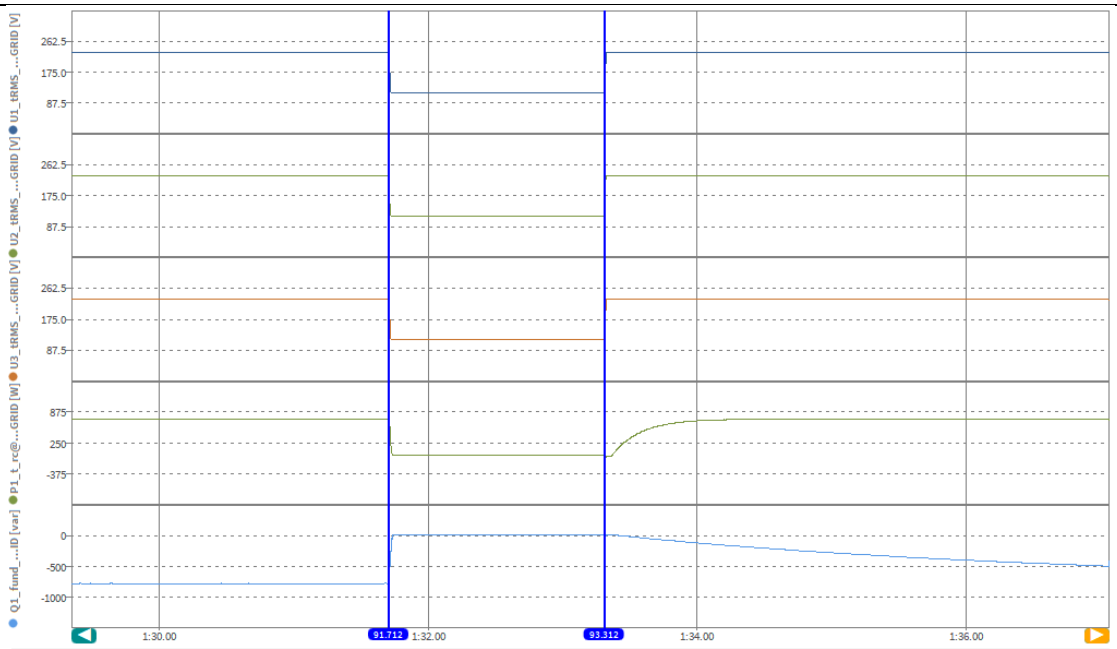
MST-BIE5-2500



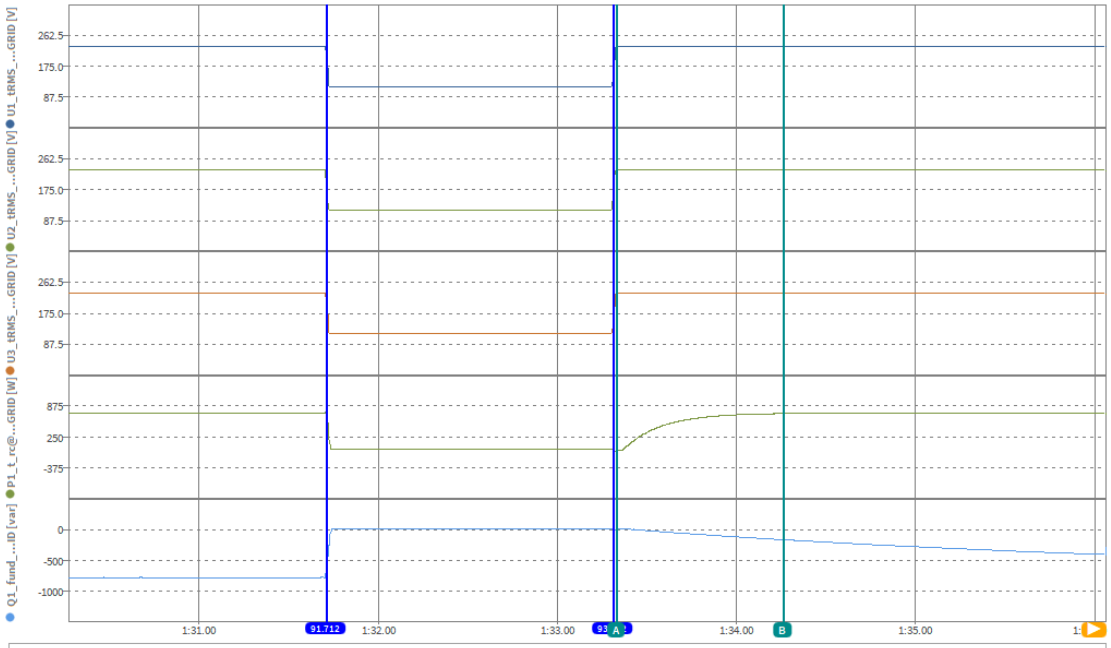


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



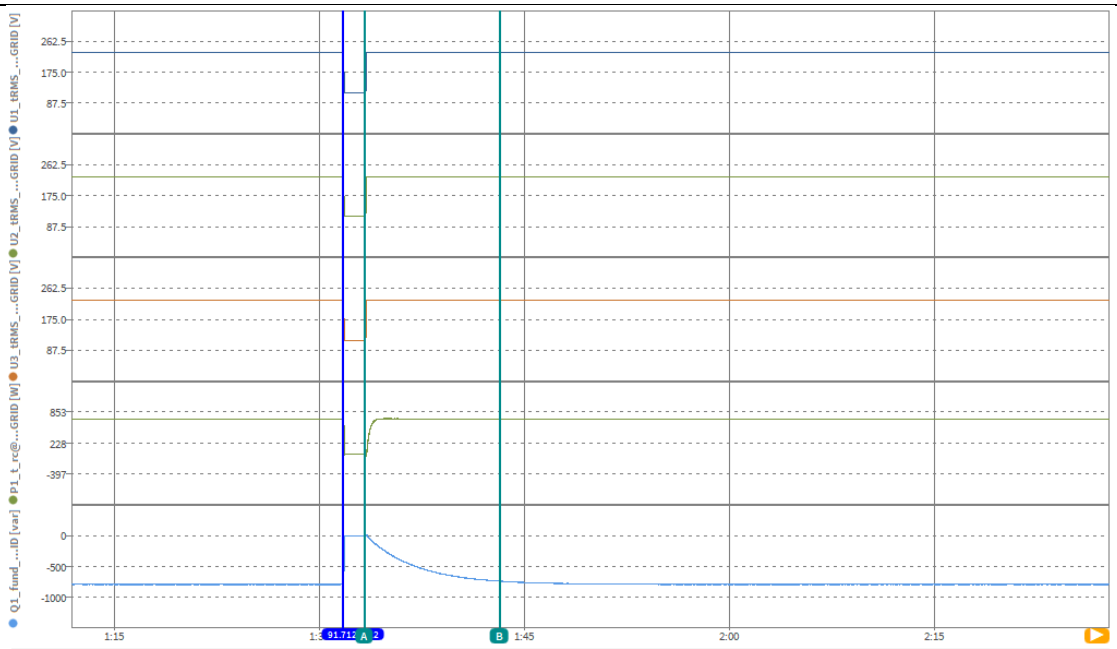
	A	B	间隔
时间 [s]	0:29.576120	1:58.304480	1:28.728360
U1_tRMS_rc@AC_GRID [V]	230.2251	230.2279	2.792e-3
U2_tRMS_rc@AC_GRID [V]	229.9360	229.9385	2.502e-3
U3_tRMS_rc@AC_GRID [V]	229.9229	229.9242	1.328e-3
P1_t_rc@AC_GRID [W]	711.9580	715.2303	3.272339
Q1_fund_rc@AC_GRID [var]	-799.1918	-795.8561	3.335693



	A	B	间隔
时间 [s]	1:33.33291	1:34.26164	0.92873
U1_tRMS_rc@AC_GRID [V]	227.9499	230.2119	2.261932
U2_tRMS_rc@AC_GRID [V]	227.6574	229.9379	2.280548
U3_tRMS_rc@AC_GRID [V]	228.0073	229.9058	1.898514
P1_t_rc@AC_GRID [W]	-54.85211	710.4506	765.3027
Q1_fund_rc@AC_GRID [var]	-10.87020	-176.4735	-165.6033

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	1:33.33291	1:43.20225	9.86934
U1_tRMS_rc@AC_GRID [V]	227.9499	230.2246	2.274704
U2_tRMS_rc@AC_GRID [V]	227.6574	229.9387	2.281281
U3_tRMS_rc@AC_GRID [V]	228.0073	229.9204	1.913071
P1_t_rc@AC_GRID [W]	-54.85211	715.5643	770.4164
Q1_fund_rc@AC_GRID [var]	-10.87020	-745.2780	-734.4078

5.8.3	For PGUs Type 2 and storage systems	P

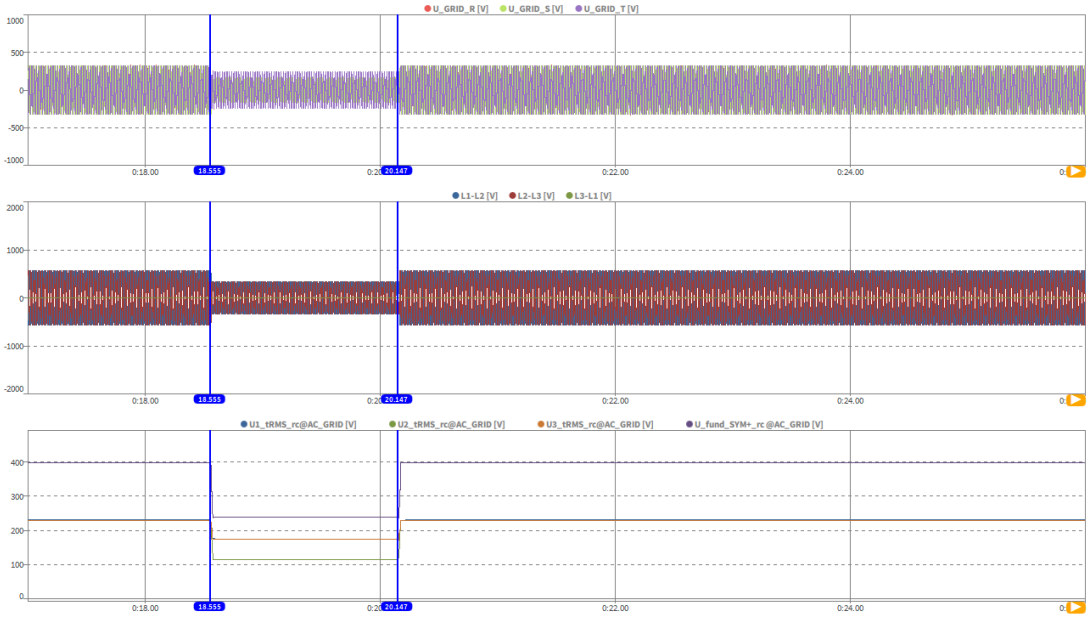
MST-BIE5-2500

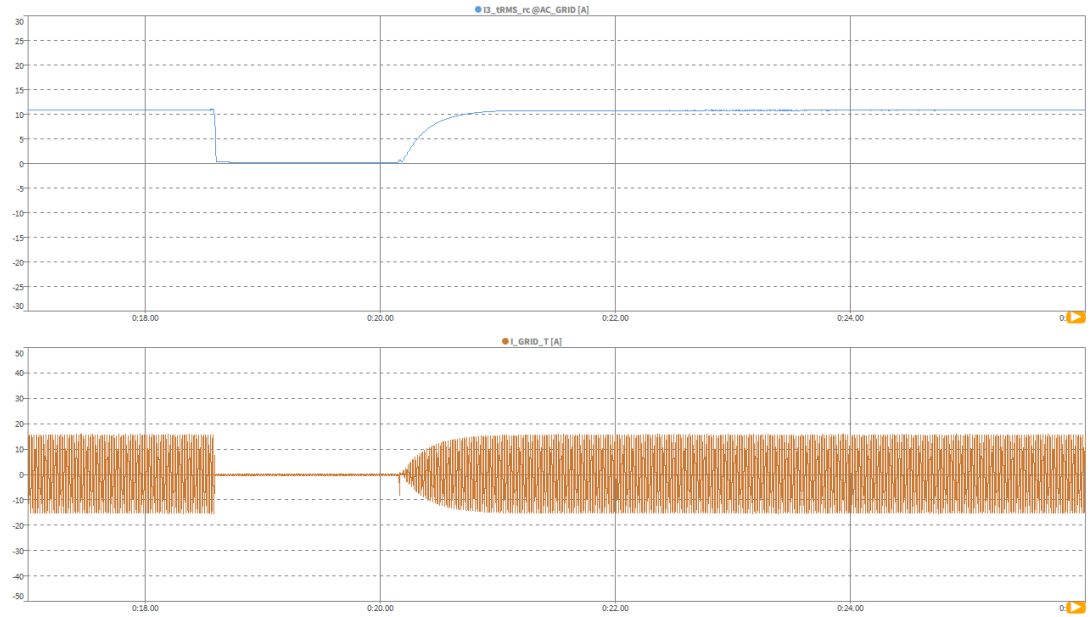
3.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3,3
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	18:11:31
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1600
	6	Point of fault entry	Total	--	ms	18555
	7	Point of fault clearance	Total	--	ms	20147
	8	Fault duration in empty load test	Total	--	ms	1592
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,757
	10		Total (Phase 2)			0,500
	11		Total (Phase 3)			0,757
	12		Positive sequence			0,669
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	1,004
	14		Phase 2			1,000
	15		Phase 3			1,000
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,993
	17	Active power	Total	t1-10s to t1	p.u.	0,949
	18		Pos.			0,949
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,314
	20		Pos.			-0,312
	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.	0,757
	23		Phase 2			0,500
	24		Phase 3			0,757
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,038
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,014
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,004
	32		Pos.			0,004
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,004
	34		Phase 2			1,000
	35		Phase 3			1,000
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,961
	37		Pos.			0,960
	38	Active power rising time	Total	--	s	0,820
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,264
	40		Pos.			-0,262
	41	Reactive power rising time	total	--	s	9,913
	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

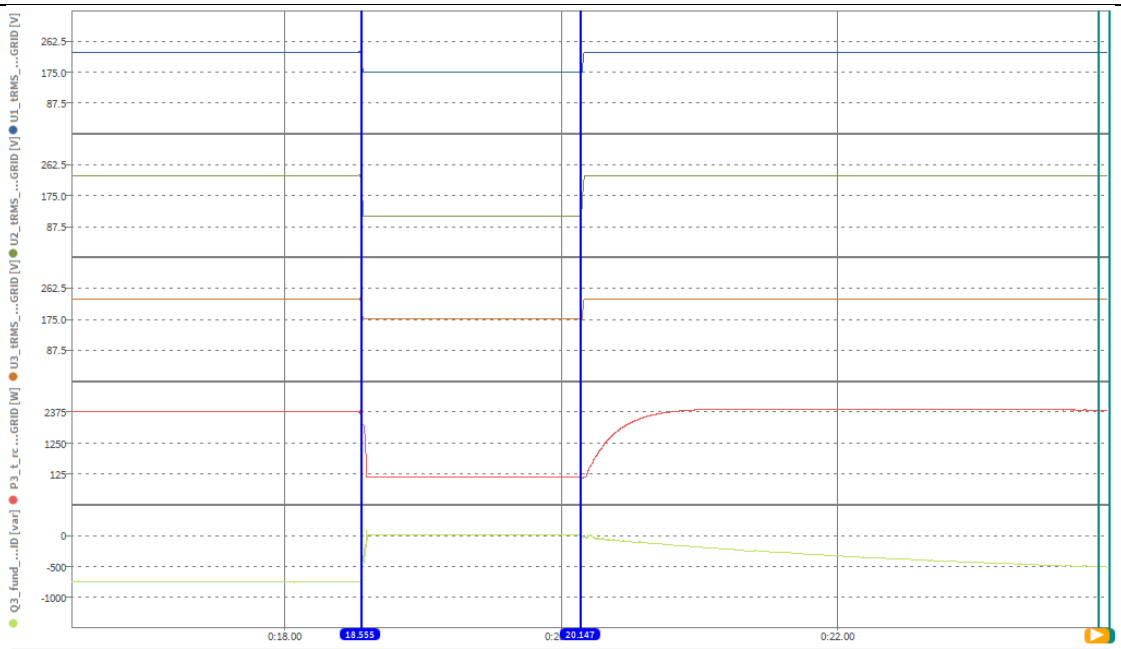
MST-BIE5-2500



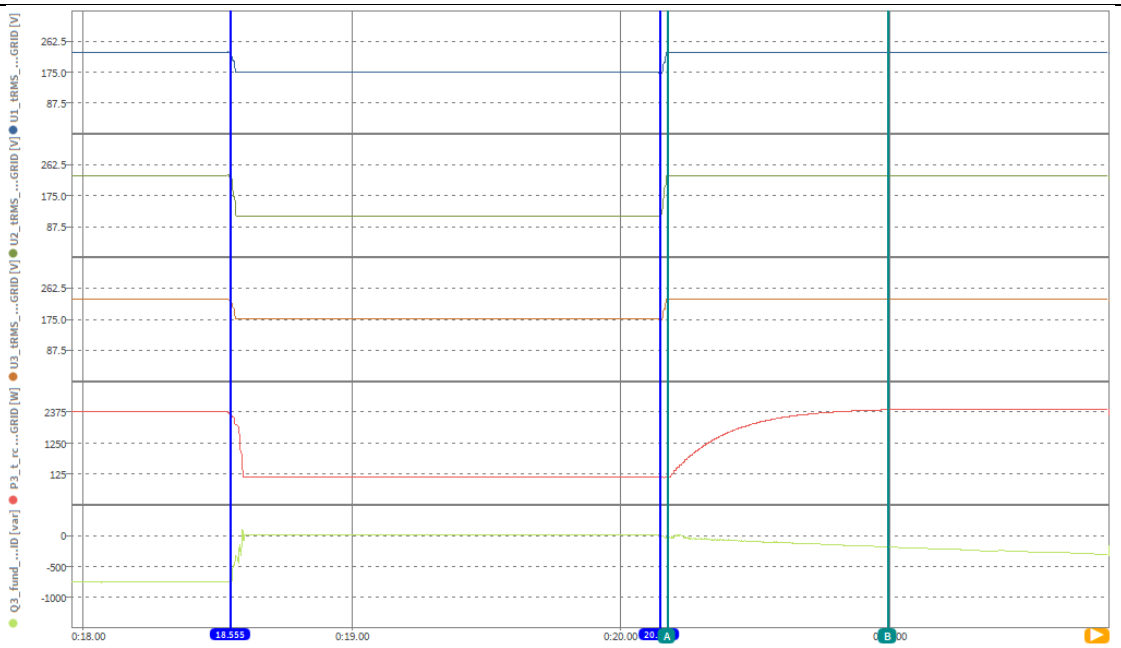


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



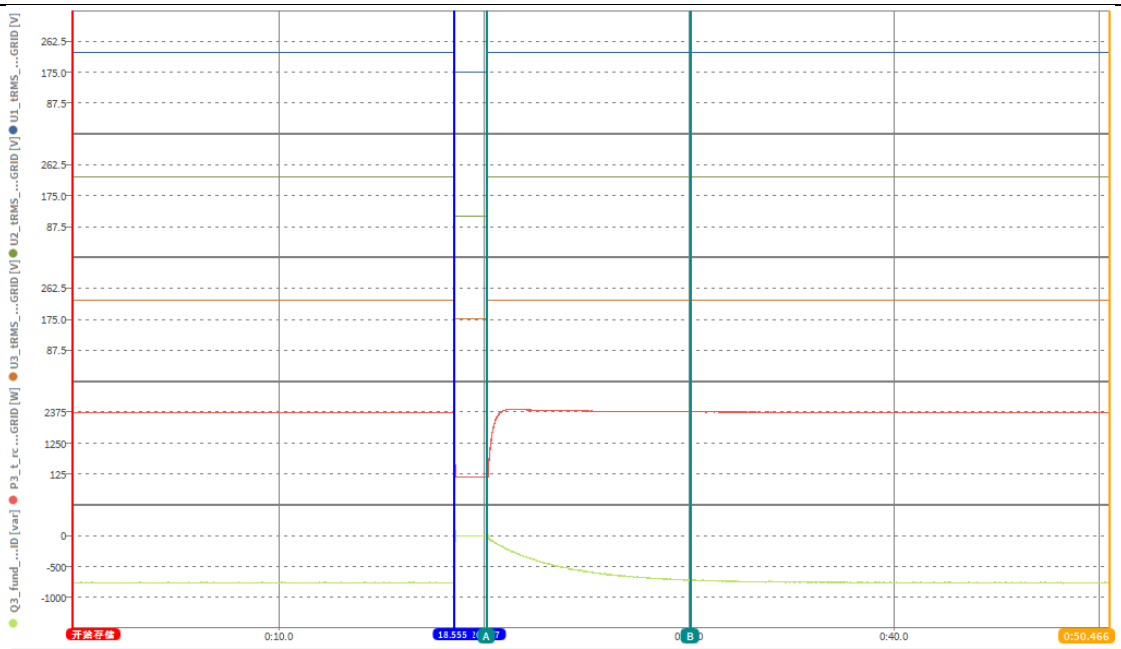
	A	B	间隔
时间 [s]	0:23.89467	0:23.96980	0.07513
U1_tRMS_rc@AC_GRID [V]	231.0130	231.0156	2.533e-3
U2_tRMS_rc@AC_GRID [V]	229.9367	229.9357	-1.038e-3
U3_tRMS_rc@AC_GRID [V]	229.8891	229.8920	2.869e-3
P3_t_rc @AC_GRID [W]	2433.300	2432.449	-0.850586
Q3_fund_rc @AC_GRID [var]	-522.2265	-529.2099	-6.983398



	A	B	间隔
时间 [s]	0:20.173469	0:20.993284	0.819815
U1_tRMS_rc@AC_GRID [V]	224.2512	231.0172	6.765976
U2_tRMS_rc@AC_GRID [V]	209.4239	229.9347	20.51079
U3_tRMS_rc@AC_GRID [V]	224.3083	229.8874	5.579071
P3_t_rc @AC_GRID [W]	-45.17659	2443.039	2488.216
Q3_fund_rc @AC_GRID [var]	-45.07338	-197.3337	-152.2603

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	0:20.173469	0:30.086030	9.912562
U1_tRMS_rc@AC_GRID [V]	224.2512	230.9941	6.742935
U2_tRMS_rc@AC_GRID [V]	209.4239	229.9357	20.51180
U3_tRMS_rc@AC_GRID [V]	224.3083	229.8956	5.587250
P3_t_rc @AC_GRID [W]	-45.17659	2383.795	2428.972
Q3_fund_rc @AC_GRID [var]	-45.07338	-723.9359	-678.8625

5.8.3	For PGUs Type 2 and storage systems	P

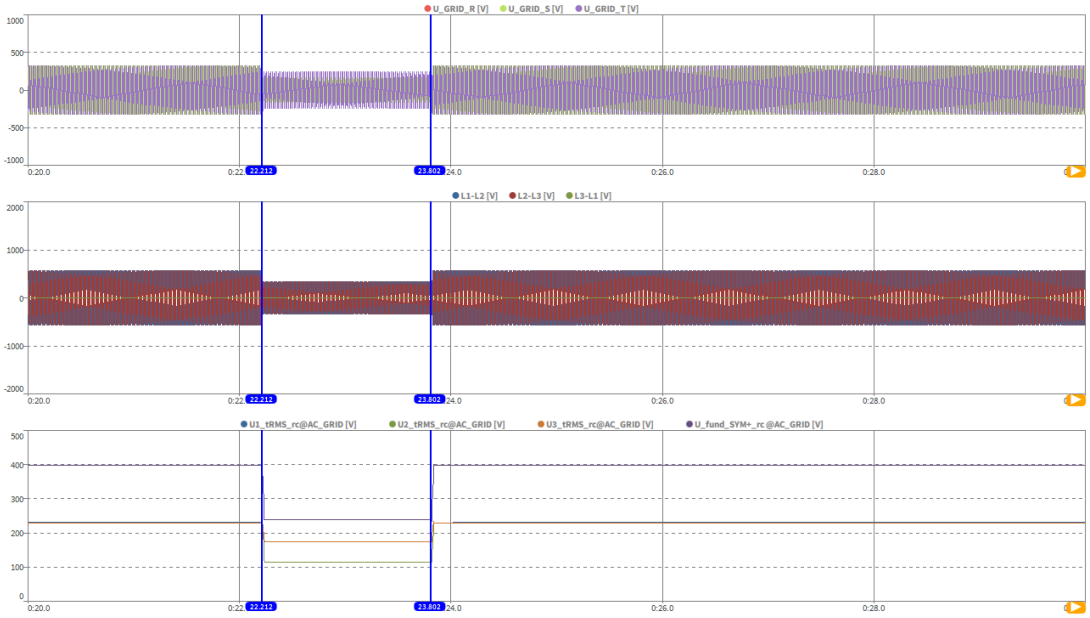
MST-BIE5-2500

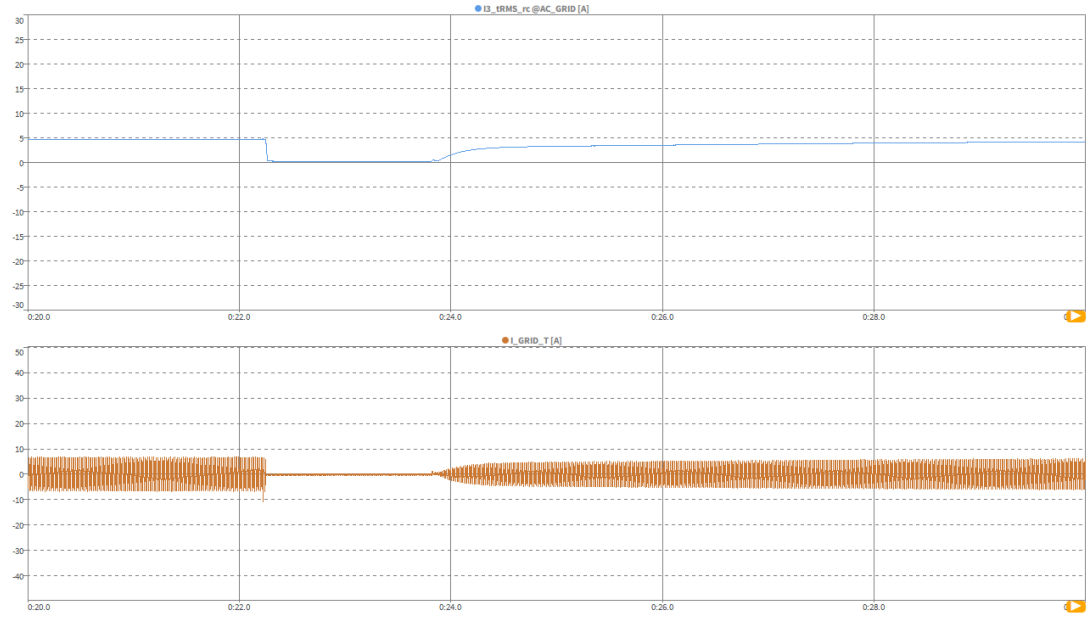
3.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3,4
	1	Date	--	--	yyyy.mm.dd	2025/11/22
	2	Time (start of test)	--	--	hh:mm:ss.f	18:31:32
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,5
	5	Setting dip duration		--	--	1500
	6	Point of fault entry	Total	--	ms	22212
	7	Point of fault clearance	Total	--	ms	23802
	8	Fault duration in empty load test	Total	--	ms	1590
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,760
	10		Total (Phase 2)			0,500
	11		Total (Phase 3)			0,759
	12		Positive sequence			0,669
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			1,000
	15		Phase 3			1,003
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,286
	17	Active power	Total	t1-10s to t1	p.u.	0,285
	18		Pos.			0,285
	19	Reactive power	Total	t1-10s to t1	p.u.	-0,315
	20		Pos.			-0,314
	21	Cosφ	Total	t1-10s to t1	--	0,670
During dip t1 to t2	22	Voltage	Phase 1	t1+100ms to t2-20ms	p.u.	0,760
	23		Phase 2			0,500
	24		Phase 3			0,759
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,044
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,014
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,010
	32		Pos.			0,010
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	1,000
	34		Phase 2			1,000
	35		Phase 3			1,003
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,286
	37		Pos.			0,286
	38	Active power rising time	Total	--	s	0,940
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	-0,269
	40		Pos.			-0,268
	41	Reactive power rising time	total	--	s	9,904
	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

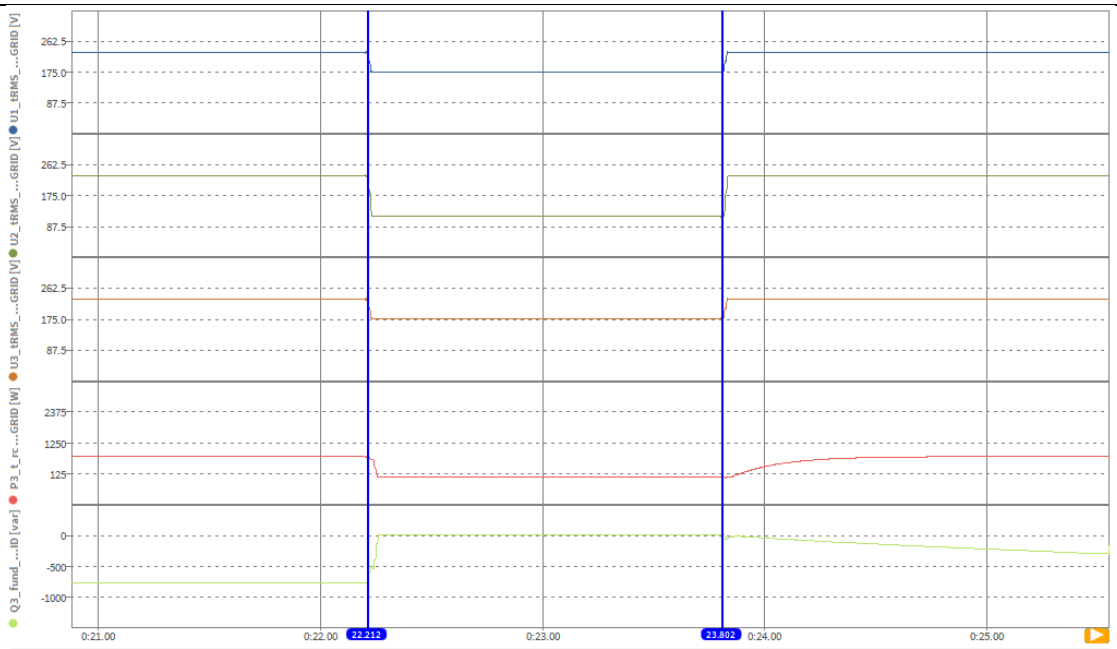
MST-BIE5-2500



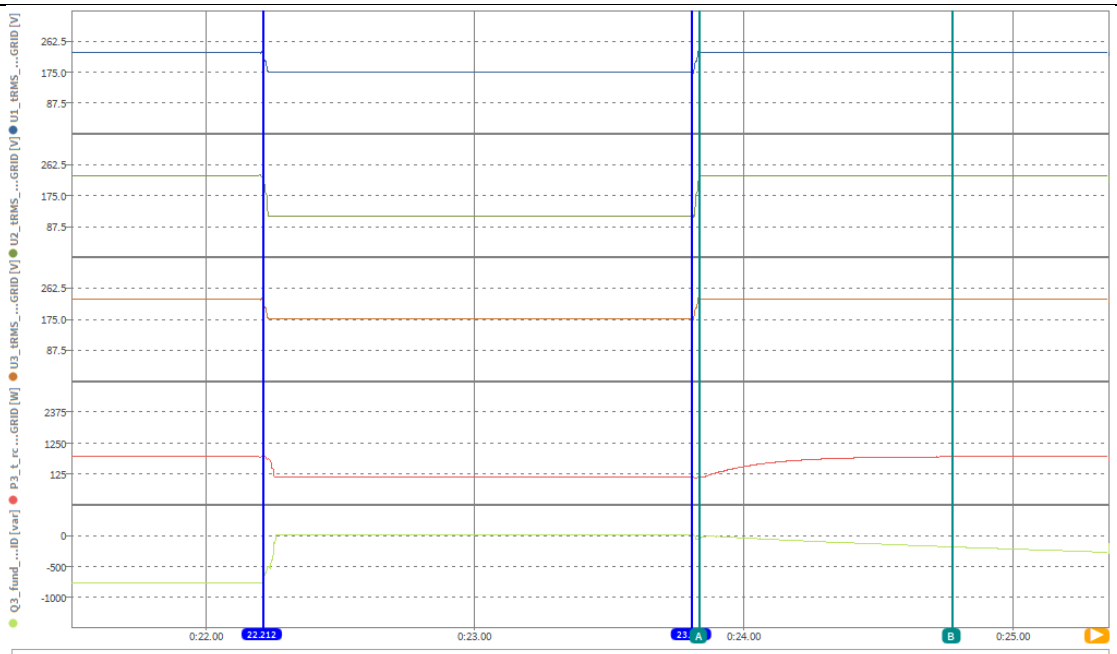


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



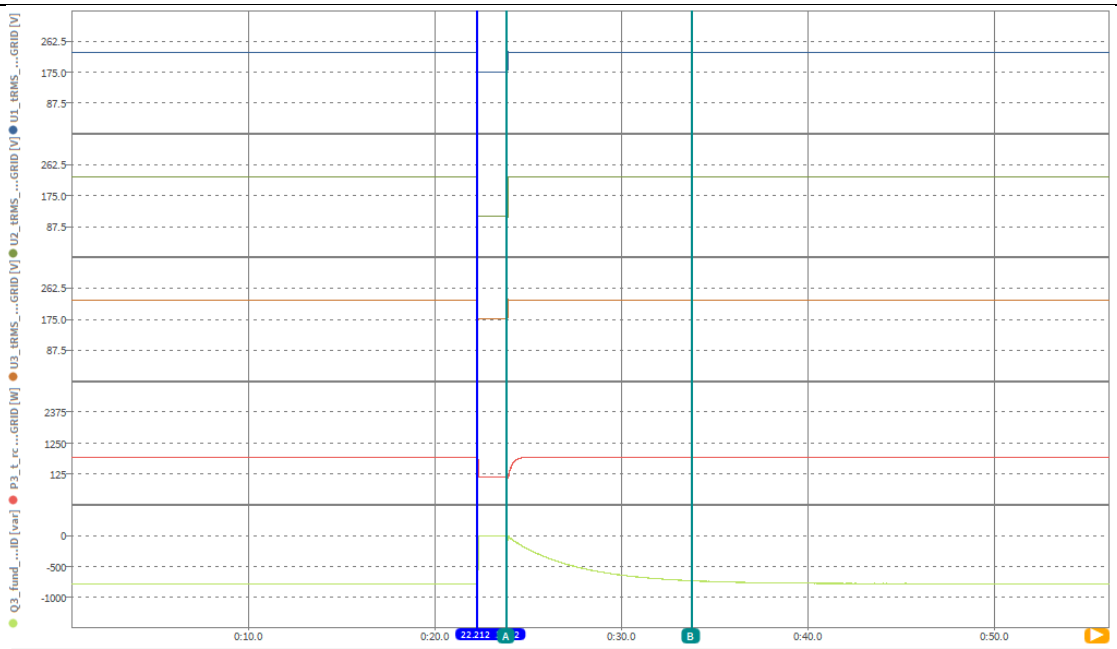
	A	B	间隔
时间 [s]	0:30.045021	0:30.166021	0.121000
U1_tRMS_rc@AC_GRID [V]	230.2251	230.2287	3.571e-3
U2_tRMS_rc@AC_GRID [V]	229.9352	229.9383	3.052e-3
U3_tRMS_rc@AC_GRID [V]	229.9209	229.9236	2.670e-3
P3_t_rc @AC_GRID [W]	715.8159	714.6330	-1.182861
Q3_fund_rc @AC_GRID [var]	-648.7213	-653.8997	-5.178406



	A	B	间隔
时间 [s]	0:23.83501	0:24.77490	0.93990
U1_tRMS_rc@AC_GRID [V]	228.3910	230.2124	1.821442
U2_tRMS_rc@AC_GRID [V]	197.4587	229.9370	32.47830
U3_tRMS_rc@AC_GRID [V]	228.4507	229.9070	1.456299
P3_t_rc @AC_GRID [W]	-49.48650	710.5007	759.9872
Q3_fund_rc @AC_GRID [var]	-72.37278	-196.4512	-124.0785

5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	间隔
时间 [s]	0:23.83501	0:33.73883	9.90382
U1_tRMS_rc@AC_GRID [V]	228.3910	230.2274	1.836411
U2_tRMS_rc@AC_GRID [V]	197.4587	229.9318	32.47305
U3_tRMS_rc@AC_GRID [V]	228.4507	229.9240	1.473267
P3_t_rc @AC_GRID [W]	-49.48650	714.9790	764.4655
Q3_fund_rc @AC_GRID [var]	-72.37278	-736.5353	-664.1626

5.8.3	For PGUs Type 2 and storage systems	P

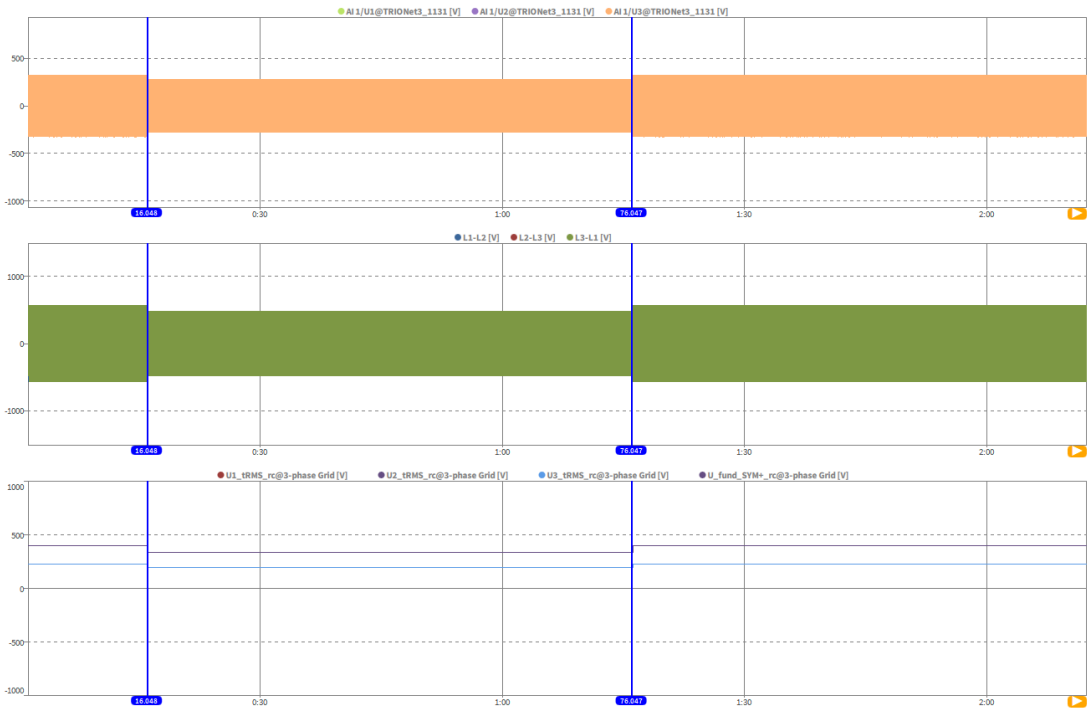
MST-BIE5-2500

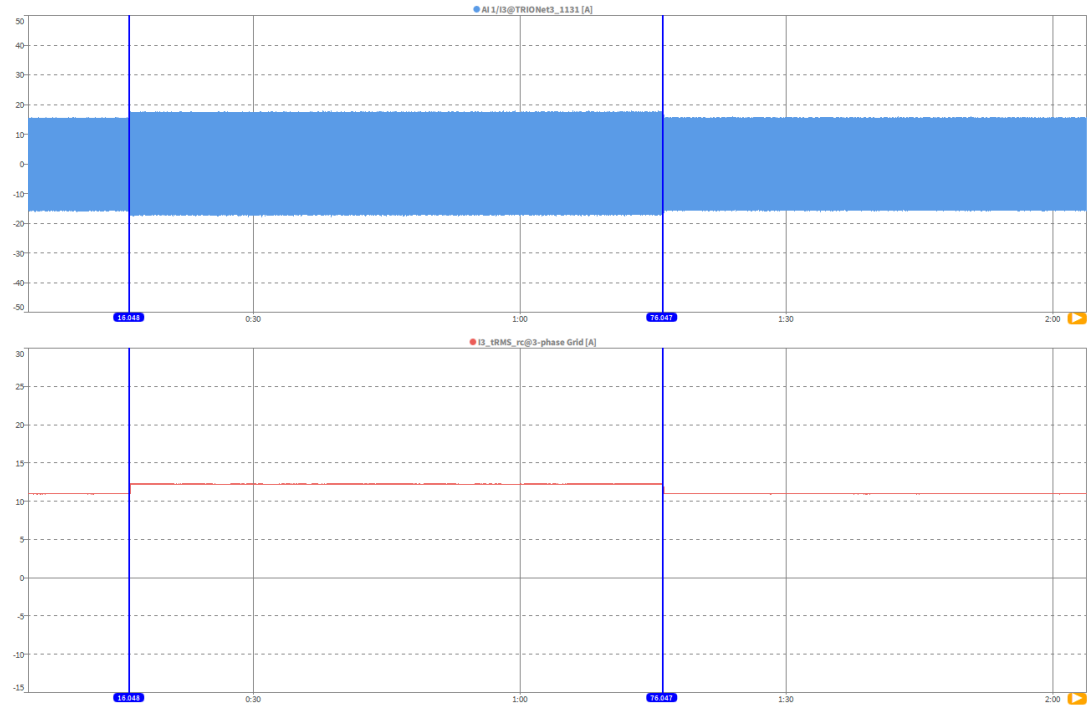
4.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4,1
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	19:42:32
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	16048
	7	Point of fault clearance	Total	--	ms	76050
	8	Fault duration in empty load test	Total	--	ms	60002
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,849
	10		Total (Phase 2)			0,848
	11		Total (Phase 3)			0,848
	12		Positive sequence			0,848
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,008
	17	Active power	Total	t1-10s to t1	p.u.	1,006
	18		Pos.			1,006
	19	Reactive power	Total	t1-10s to t1	p.u.	0,037
	20		Pos.			0,007
	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.	0,849
	23		Phase 2			0,848
	24		Phase 3			0,848
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			1,127
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			1,127
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,955
	32		Pos.			0,955
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,007
	37		Pos.			1,007
	38	Active power rising time	Total	--	s	0,067
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,033
	40		Pos.			0,007
	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

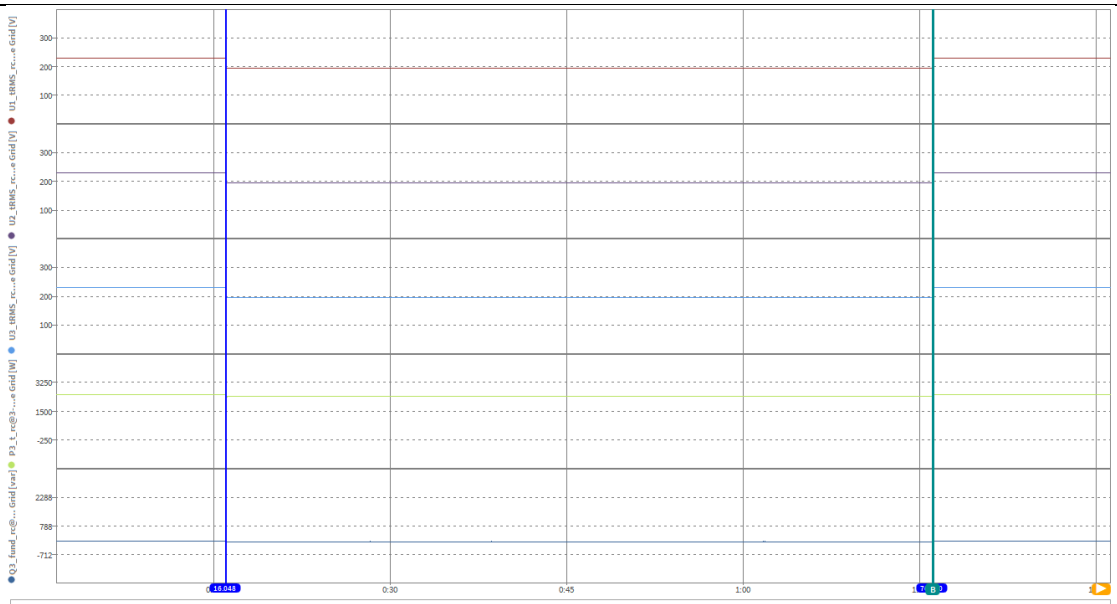
MST-BIE5-2500



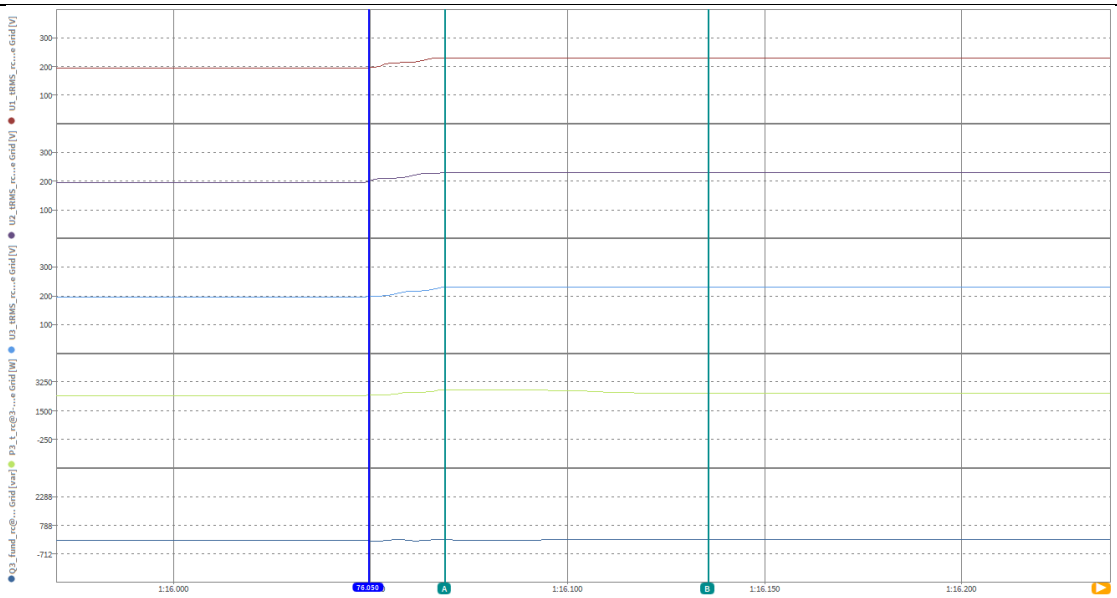


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:16.0689121	1:16.1356234	0.0667113
U1_tRMS_rc@3-phase Grid [V]	229.9093	229.8182	-0.091141
U2_tRMS_rc@3-phase Grid [V]	229.2271	229.5981	0.371017
U3_tRMS_rc@3-phase Grid [V]	229.2826	229.6107	0.328110
P3_t_rc@3-phase Grid [W]	2747.750	2517.604	-230.1460
Q3_fund_rc@3-phase Grid [var]	-21.53511	-16.94463	4.590483



	A	B	Delta
Time [s]	1:16.0689121	1:16.1356234	0.0667113
U1_tRMS_rc@3-phase Grid [V]	229.9093	229.8182	-0.091141
U2_tRMS_rc@3-phase Grid [V]	229.2271	229.5981	0.371017
U3_tRMS_rc@3-phase Grid [V]	229.2826	229.6107	0.328110
P3_t_rc@3-phase Grid [W]	2747.750	2517.604	-230.1460
Q3_fund_rc@3-phase Grid [var]	-21.53511	-16.94463	4.590483

5.8.3	For PGUs Type 2 and storage systems	P

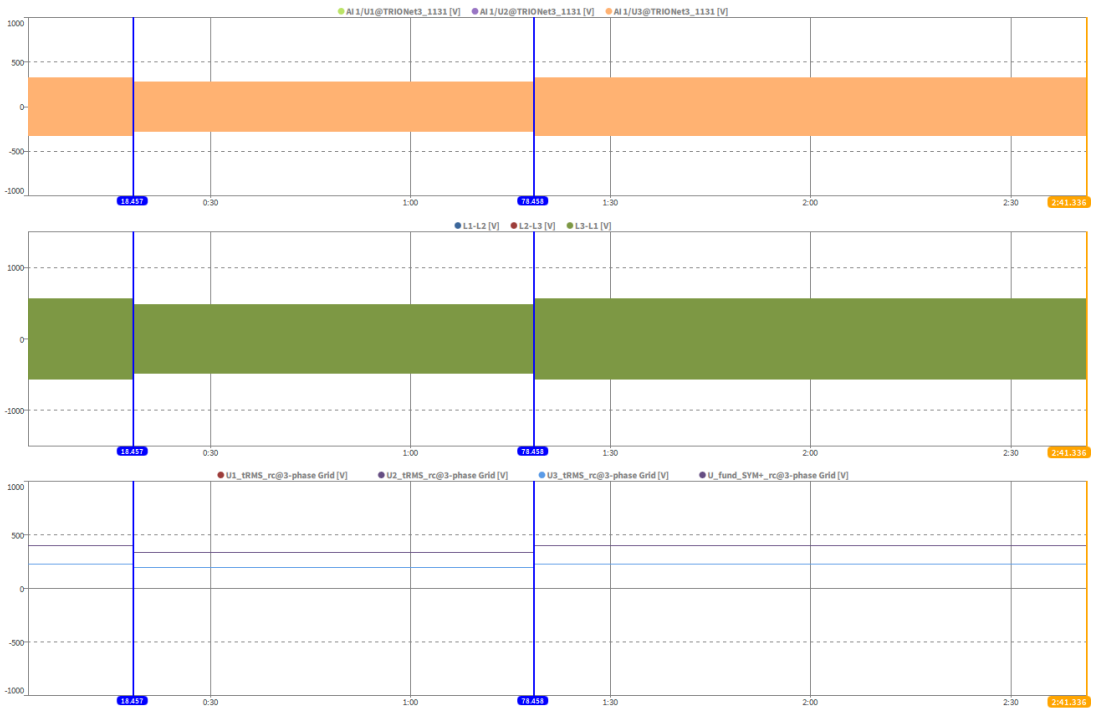
MST-BIE5-2500

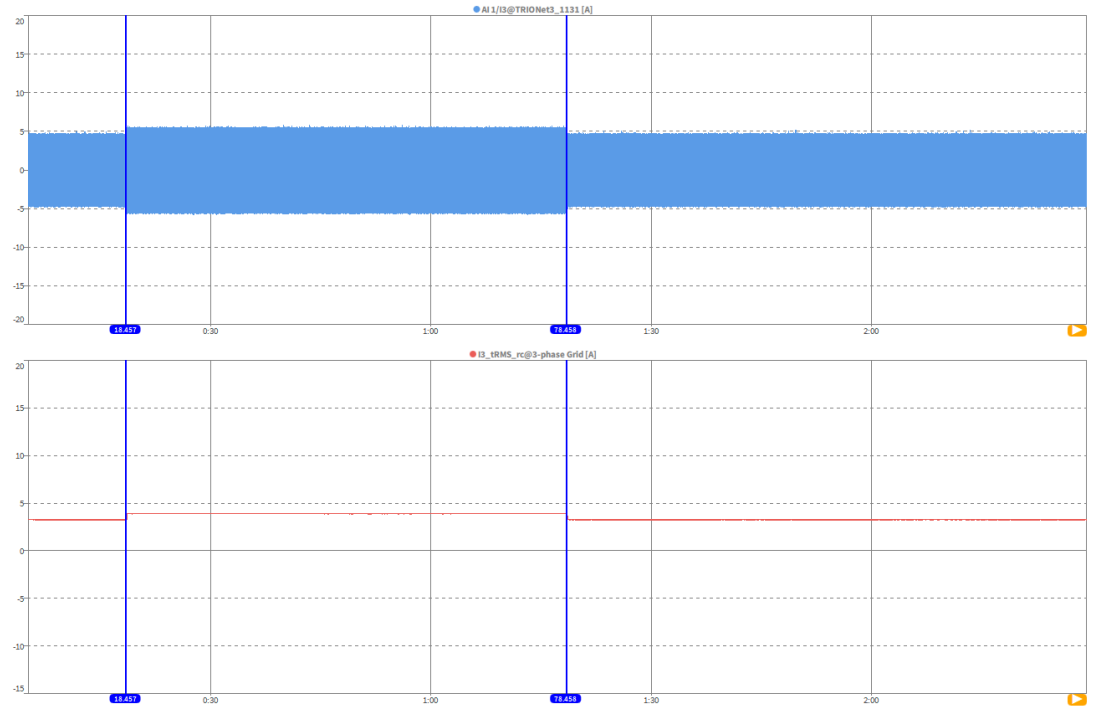
4.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4,2
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	19:46:20
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	18457
	7	Point of fault clearance	Total	--	ms	78458
	8	Fault duration in empty load test	Total	--	ms	60001
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,849
	10		Total (Phase 2)			0,848
	11		Total (Phase 3)			0,849
	12		Positive sequence			0,849
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,299
	18		Pos.			0,299
	19	Reactive power	Total	t1-10s to t1	p.u.	0,014
	20		Pos.			0,001
	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.	0,849
	23		Phase 2			0,848
	24		Phase 3			0,849
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,341
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,357
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,302
	32		Pos.			0,301
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,060
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,014
	40		Pos.			0,002
	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

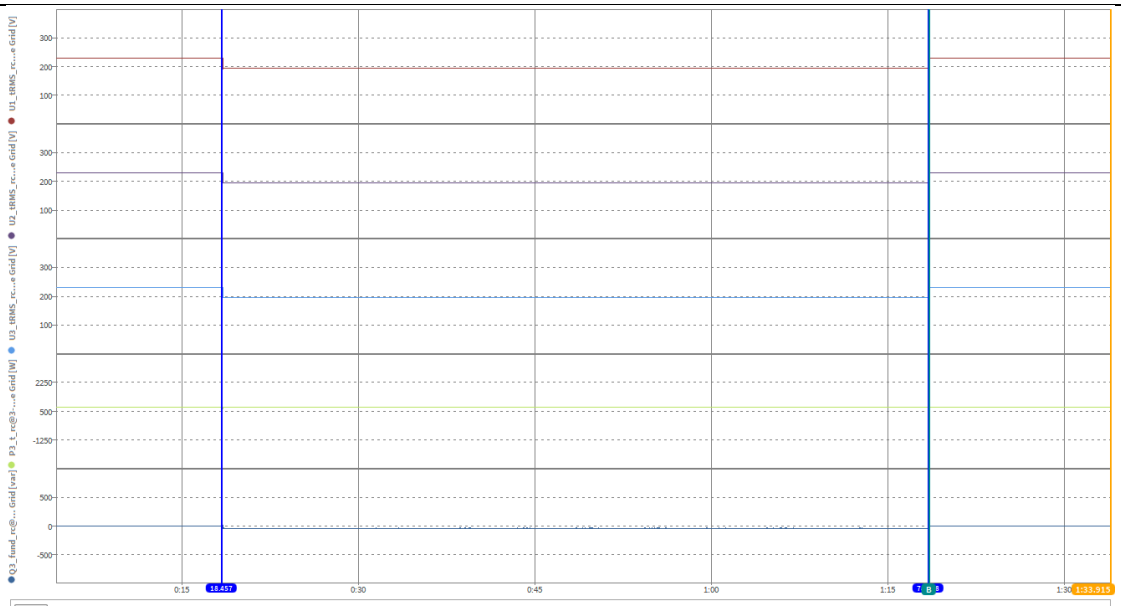
MST-BIE5-2500



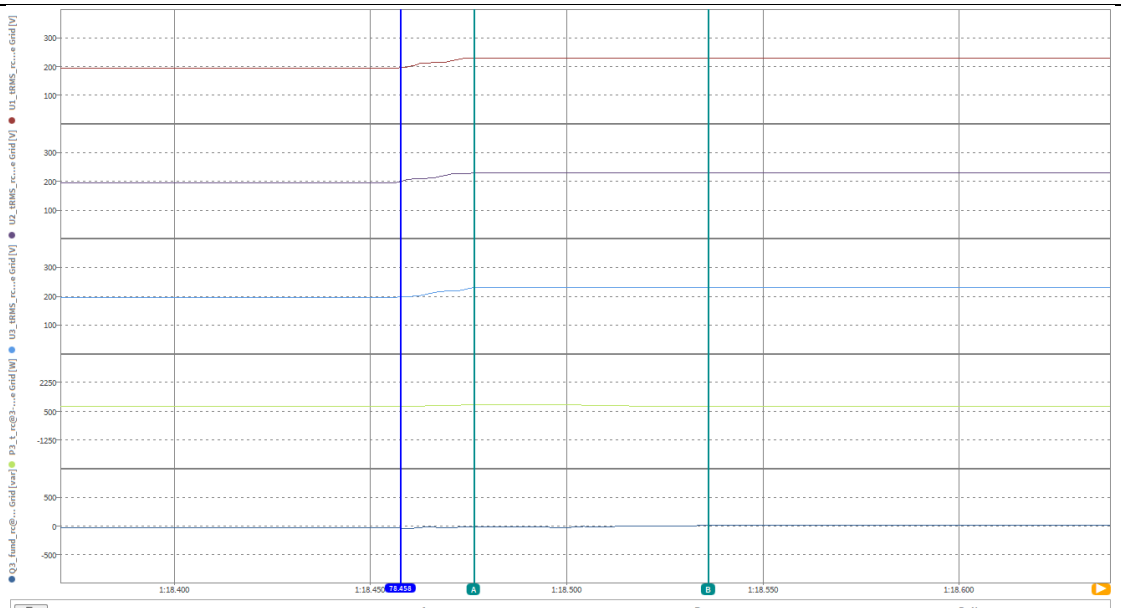


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:18.476406	1:18.536159	0.059753
U1_tRMS_rc@3-phase Grid [V]	229.7823	229.8386	0.056320
U2_tRMS_rc@3-phase Grid [V]	227.2717	229.6053	2.333557
U3_tRMS_rc@3-phase Grid [V]	226.6021	229.8056	3.203568
P3_t_rc@3-phase Grid [W]	861.3171	746.1934	-115.1238
Q3_fund_rc@3-phase Grid [var]	-23.49619	-5.461514	18.03467



	A	B	Delta
Time [s]	1:18.476406	1:18.536159	0.059753
U1_tRMS_rc@3-phase Grid [V]	229.7823	229.8386	0.056320
U2_tRMS_rc@3-phase Grid [V]	227.2717	229.6053	2.333557
U3_tRMS_rc@3-phase Grid [V]	226.6021	229.8056	3.203568
P3_t_rc@3-phase Grid [W]	861.3171	746.1934	-115.1238
Q3_fund_rc@3-phase Grid [var]	-23.49619	-5.461514	18.03467

5.8.3	For PGUs Type 2 and storage systems	P

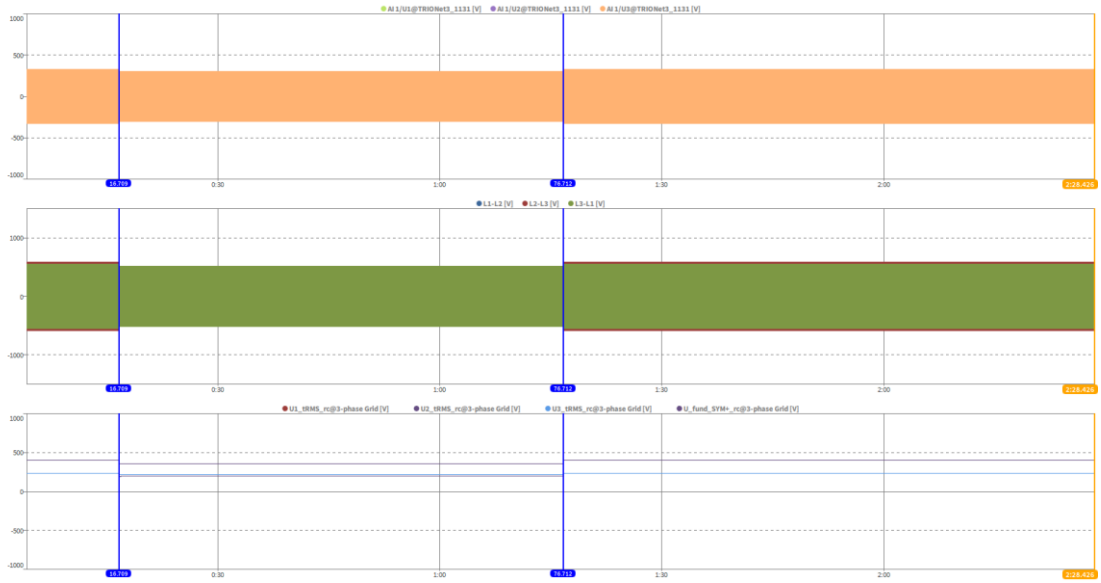
MST-BIE5-2500

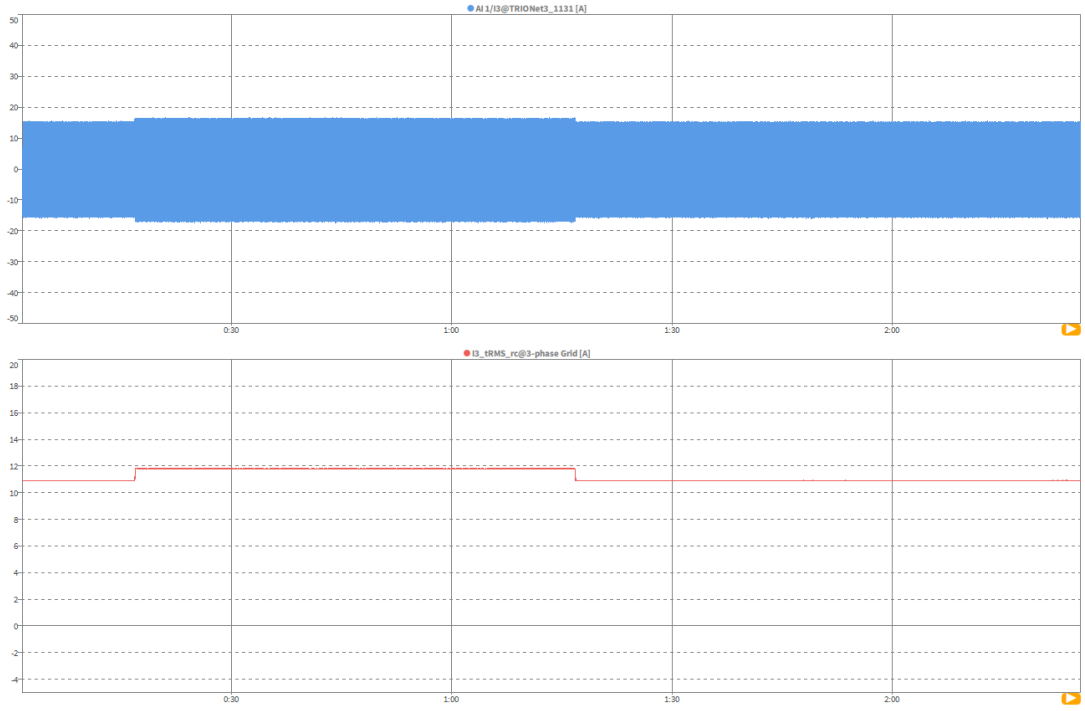
4.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4,3
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	13:56:50
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	16709
	7	Point of fault clearance	Total	--	ms	76712
	8	Fault duration in empty load test	Total	--	ms	60003
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,929
	10		Total (Phase 2)			0,848
	11		Total (Phase 3)			0,928
	12		Positive sequence			0,897
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,002
	17	Active power	Total	t1-10s to t1	p.u.	1,000
	18		Pos.			1,000
	19	Reactive power	Total	t1-10s to t1	p.u.	0,040
	20		Pos.			0,008
	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.	0,929
	23		Phase 2			0,848
	24		Phase 3			0,928
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			1,054
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			1,089
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	1,006
	32		Pos.			1,006
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,000
	37		Pos.			1,000
	38	Active power rising time	Total	--	s	0,049
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,043
	40		Pos.			0,009
	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

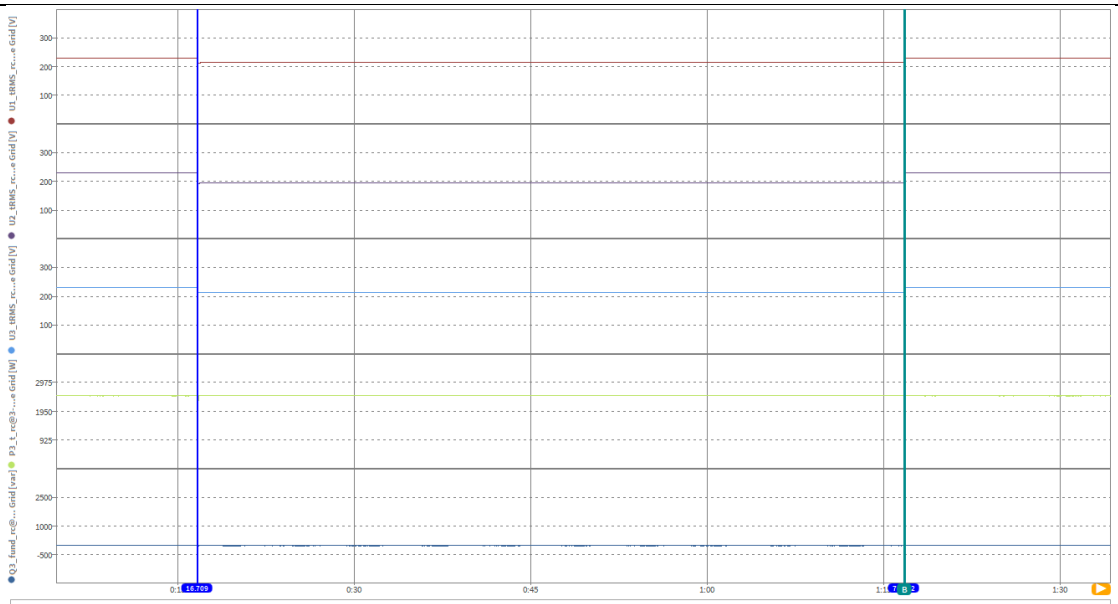
MST-BIE5-2500



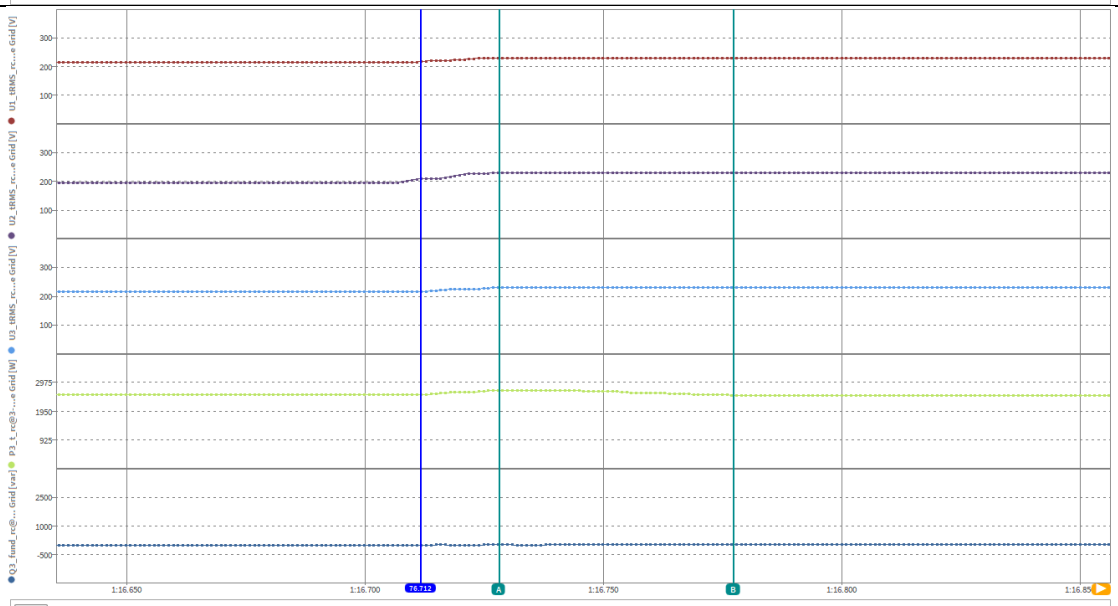


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:16.7281	1:16.7773	0.0492
U1_tRMS_rc@3-phase Grid [V]	229.8837	229.8639	-0.019806
U2_tRMS_rc@3-phase Grid [V]	228.4521	229.5954	1.143326
U3_tRMS_rc@3-phase Grid [V]	228.9901	229.6121	0.621994
P3_t_rc@3-phase Grid [W]	2675.542	2507.594	-167.9480
Q3_fund_rc@3-phase Grid [var]	-32.04564	-7.992244	24.05340



	A	B	Delta
Time [s]	1:16.7281	1:16.7773	0.0492
U1_tRMS_rc@3-phase Grid [V]	229.8837	229.8639	-0.019806
U2_tRMS_rc@3-phase Grid [V]	228.4521	229.5954	1.143326
U3_tRMS_rc@3-phase Grid [V]	228.9901	229.6121	0.621994
P3_t_rc@3-phase Grid [W]	2675.542	2507.594	-167.9480
Q3_fund_rc@3-phase Grid [var]	-32.04564	-7.992244	24.05340

5.8.3	For PGUs Type 2 and storage systems	P

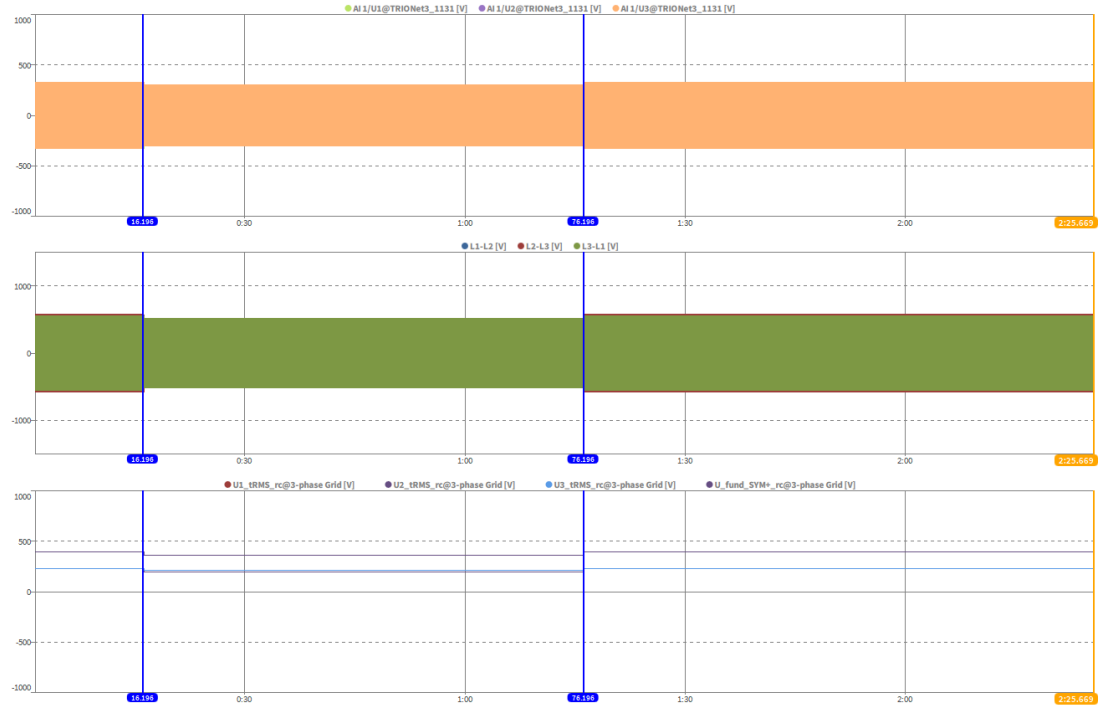
MST-BIE5-2500

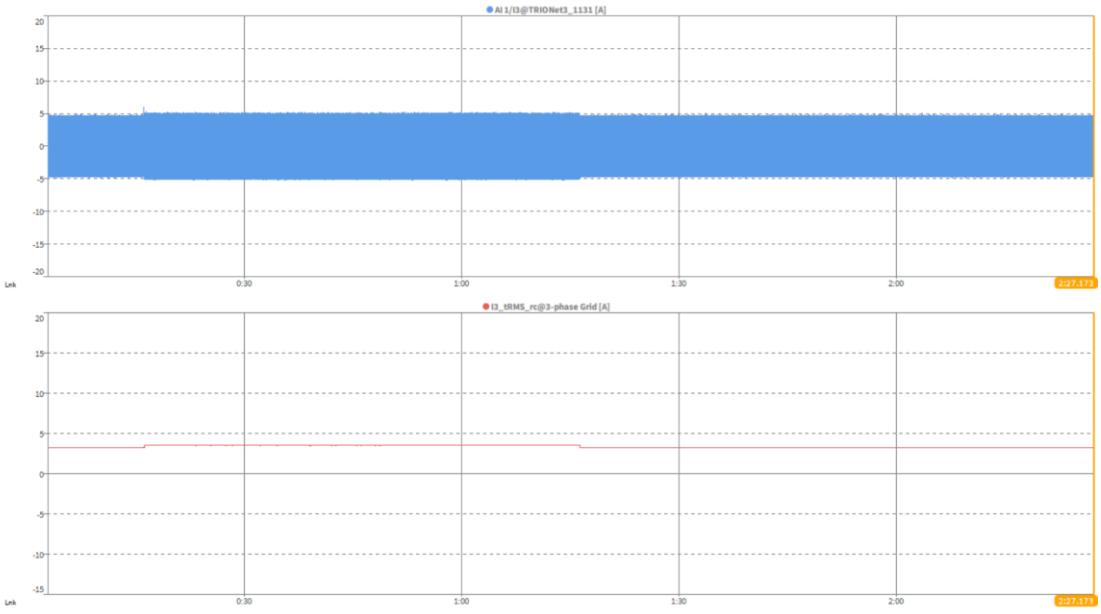
4.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	4,4
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:00:48
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	0,85
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	16196
	7	Point of fault clearance	Total	--	ms	76196
	8	Fault duration in empty load test	Total	--	ms	60000
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	0,929
	10		Total (Phase 2)			0,848
	11		Total (Phase 3)			0,929
	12		Positive sequence			0,897
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,299
	18		Pos.			0,299
	19	Reactive power	Total	t1-10s to t1	p.u.	0,013
	20		Pos.			0,001
	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.	0,929
	23		Phase 2			0,848
	24		Phase 3			0,929
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,317
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,324
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,299
	32		Pos.			0,299
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,069
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,013
	40		Pos.			0,001
	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

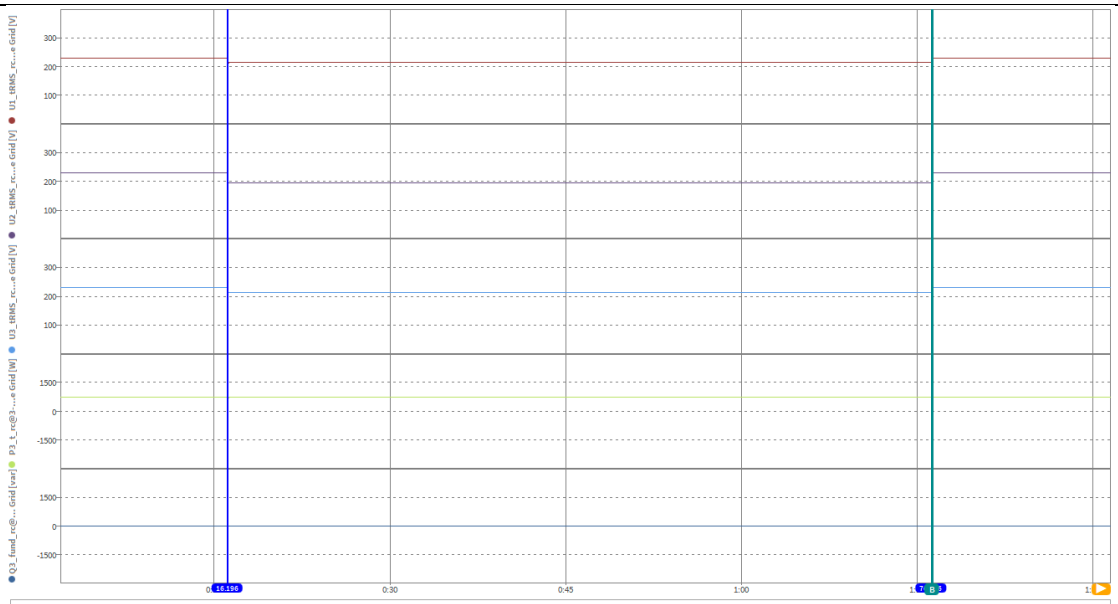
MST-BIE5-2500



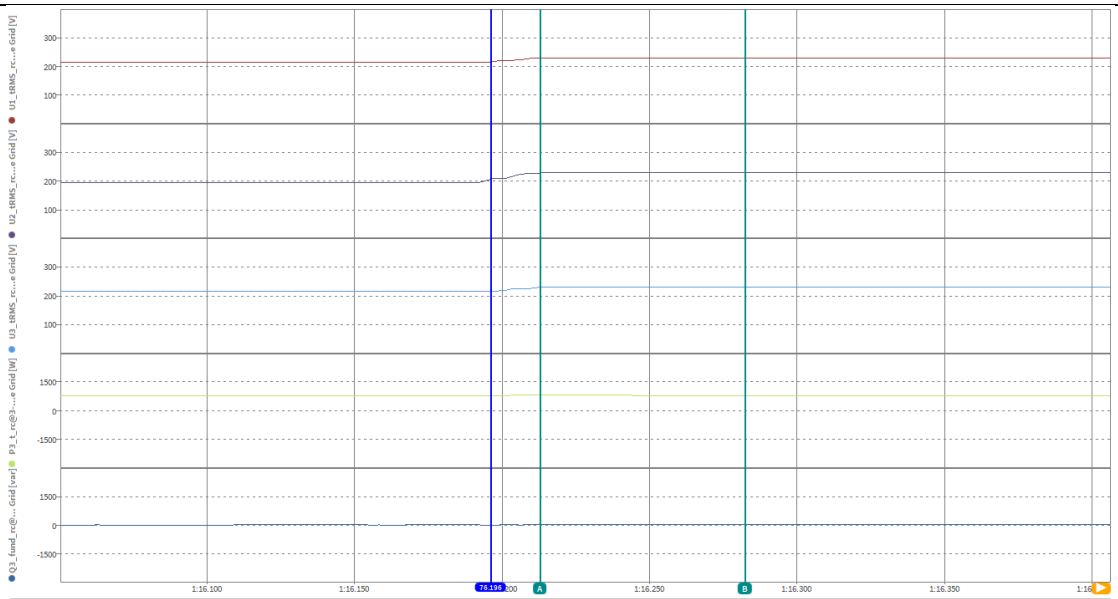


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:16.21541	1:16.28248	0.06707
U1_tRMS_rc@3-phase Grid [V]	229.8989	229.8516	-0.047348
U2_tRMS_rc@3-phase Grid [V]	229.6348	229.5931	-0.041702
U3_tRMS_rc@3-phase Grid [V]	229.8291	229.8136	-0.015564
P3_t_rc@3-phase Grid [W]	801.8322	745.6853	-56.14685
Q3_fund_rc@3-phase Grid [var]	-13.61544	-2.938405	10.67704



	A	B	Delta
Time [s]	1:16.21302	1:16.28248	0.06946
U1_tRMS_rc@3-phase Grid [V]	229.8765	229.8516	-0.024918
U2_tRMS_rc@3-phase Grid [V]	227.7259	229.5931	1.867233
U3_tRMS_rc@3-phase Grid [V]	228.6740	229.8136	1.139572
P3_t_rc@3-phase Grid [W]	796.9229	745.6853	-51.23761
Q3_fund_rc@3-phase Grid [var]	-12.07227	-2.938405	9.133867

5.8.3	For PGUs Type 2 and storage systems	P

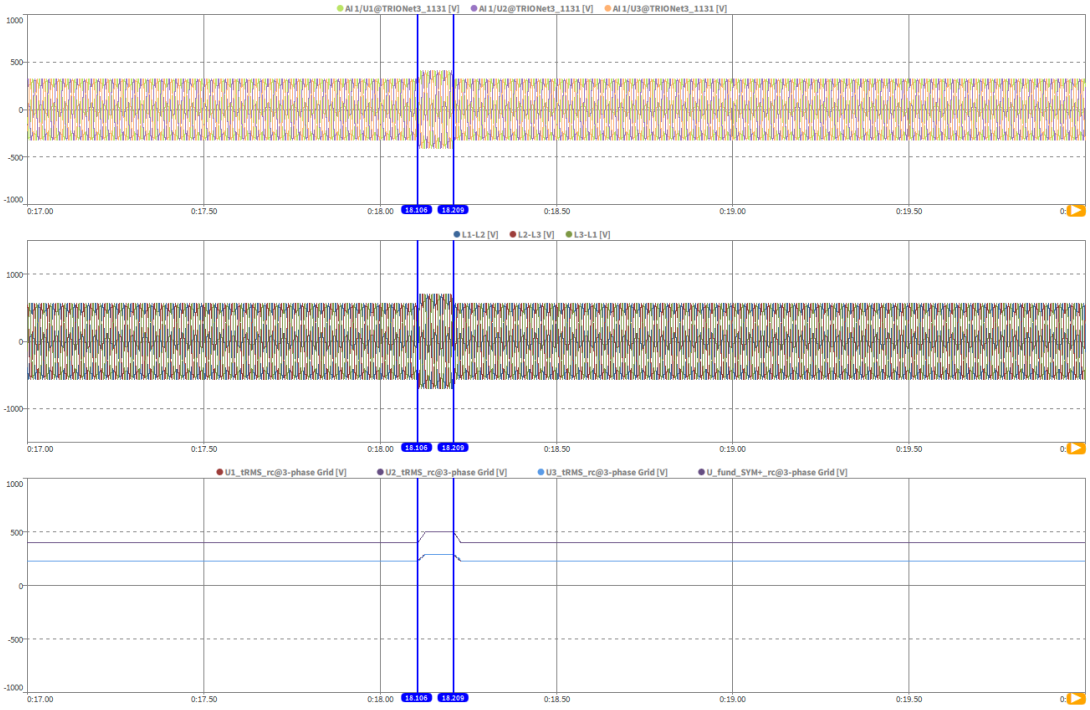
MST-BIE5-2500

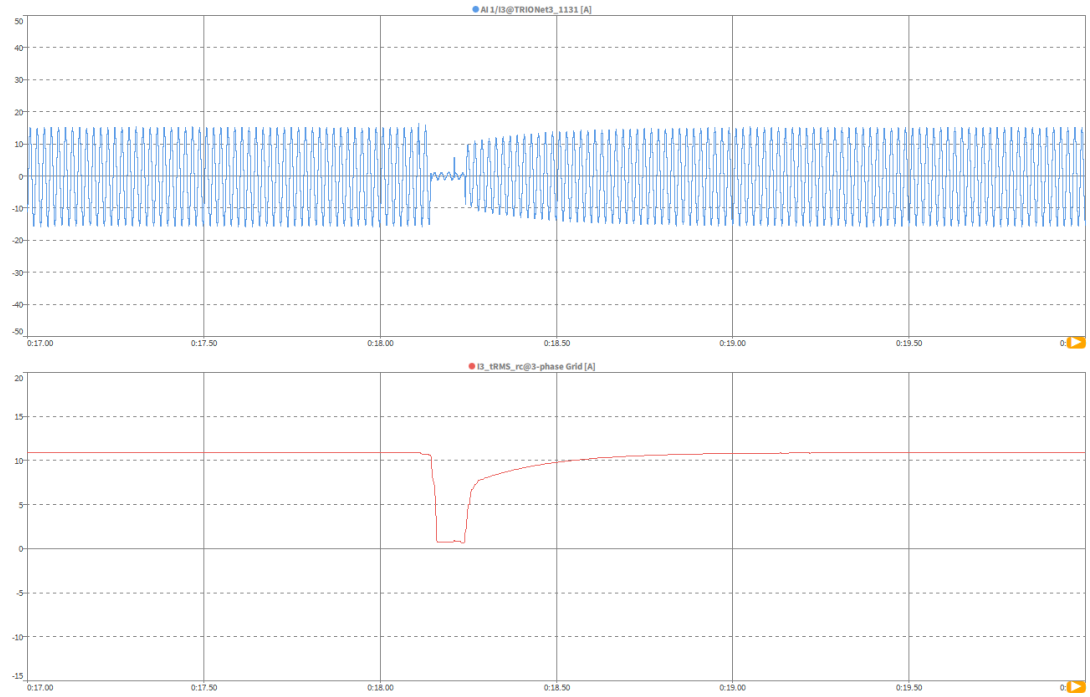
5.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5,1
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	9:48:24
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
	6	Point of fault entry	Total	--	ms	18106
	7	Point of fault clearance	Total	--	ms	18209
	8	Fault duration in empty load test	Total	--	ms	103
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,246
	10		Total (Phase 2)			1,249
	11		Total (Phase 3)			1,251
	12		Positive sequence			1,243
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,002
	17	Active power	Total	t1-10s to t1	p.u.	1,000
	18		Pos.			1,000
	19	Reactive power	Total	t1-10s to t1	p.u.	0,044
	20		Pos.			0,008
	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.	1,246
	23		Phase 2			1,249
	24		Phase 3			1,251
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,071
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,072
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,011
	32		Pos.			0,011
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,000
	37		Pos.			1,000
	38	Active power rising time	Total	--	s	0,771
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,045
	40		Pos.			0,008
	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

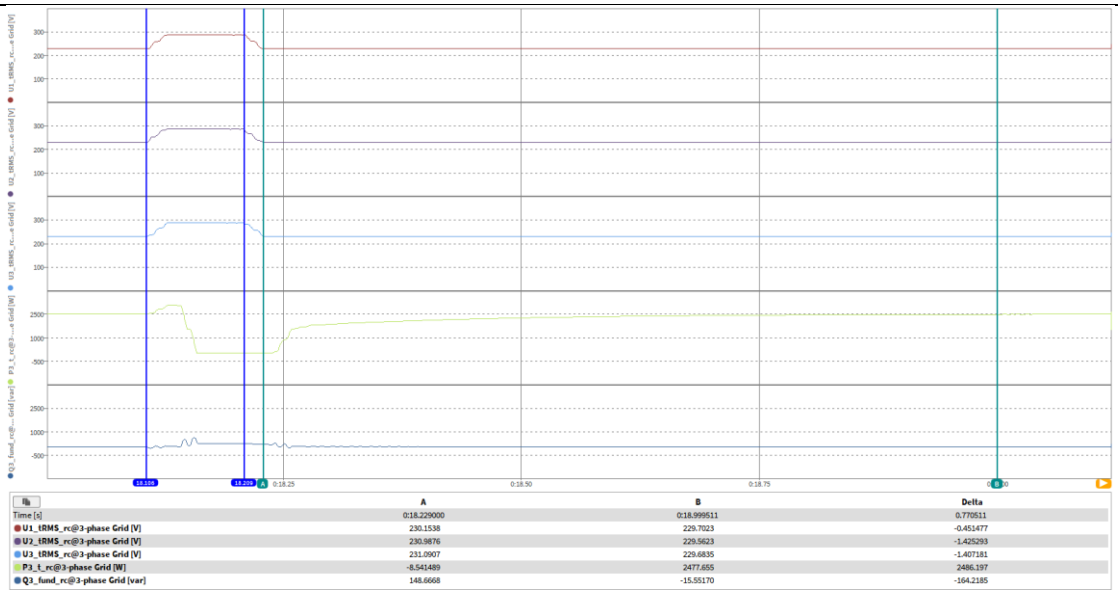
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:18.229000	0:18.999511	0.770511
U1_tRMS_rc@3-phase Grid [V]	230.1538	229.7023	-0.451477
U2_tRMS_rc@3-phase Grid [V]	230.9876	229.5623	-1.425293
U3_tRMS_rc@3-phase Grid [V]	231.0907	229.6835	-1.407181
P3_t_rc@3-phase Grid [W]	-8.541489	2477.655	2486.197
Q3_fund_rc@3-phase Grid [var]	148.6668	-15.55170	-164.2185

5.8.3	For PGUs Type 2 and storage systems	P

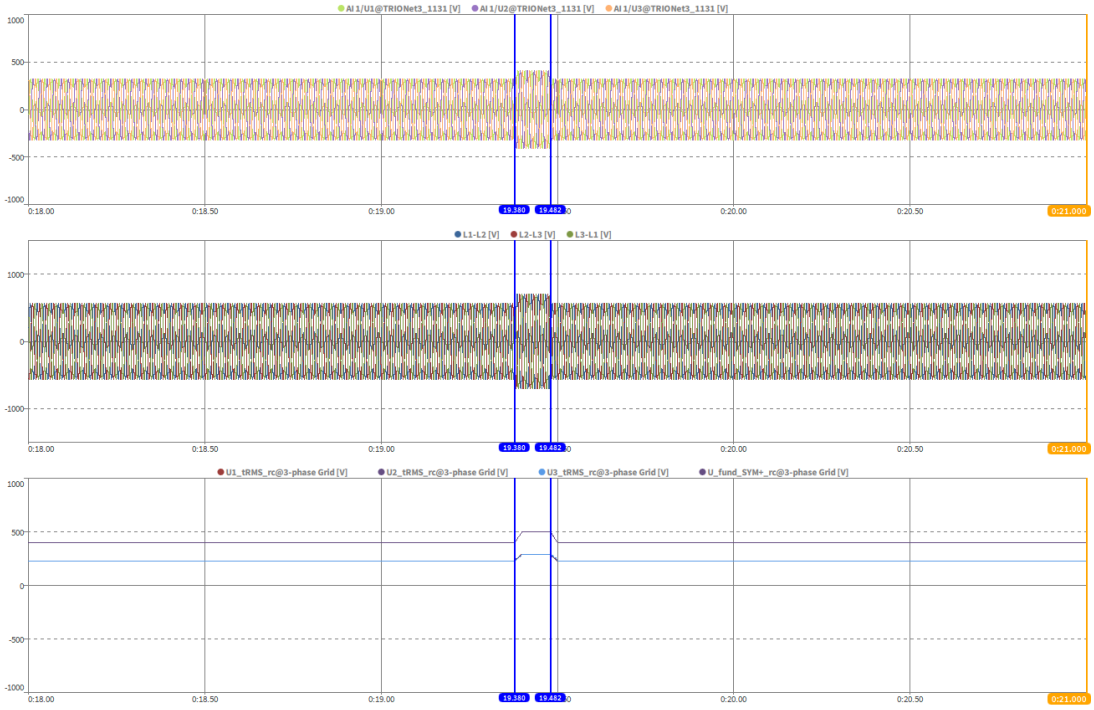
MST-BIE5-2500

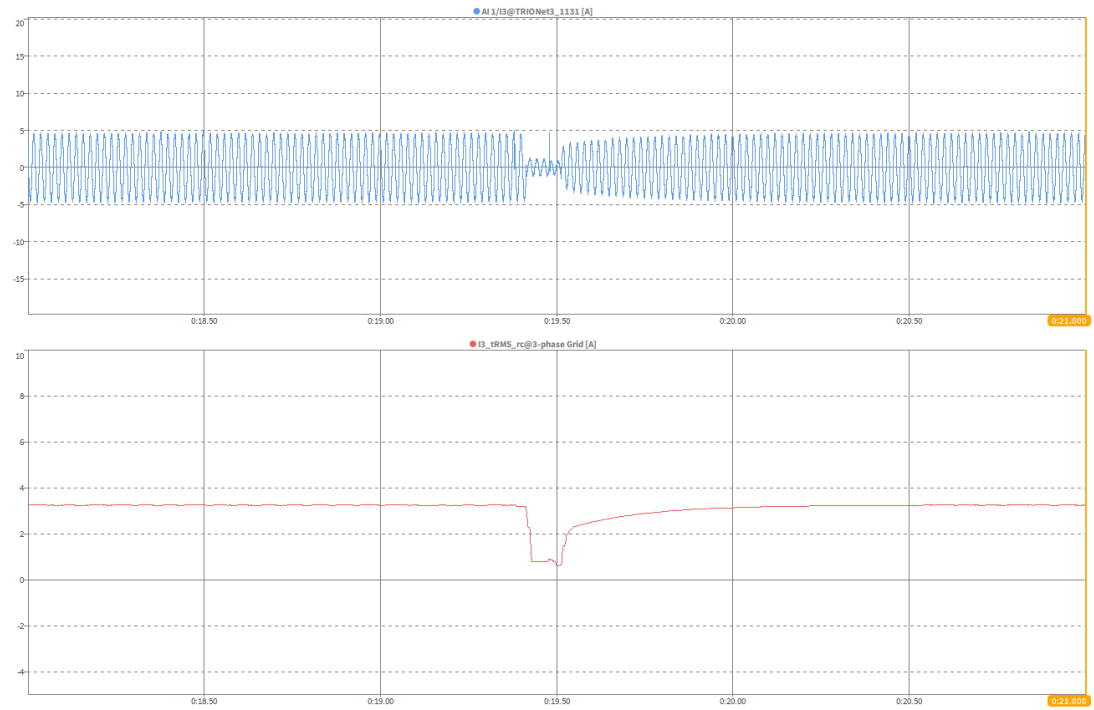
5.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5,2
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	9:50:33
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
	6	Point of fault entry	Total	--	ms	19380
	7	Point of fault clearance	Total	--	ms	19482
	8	Fault duration in empty load test	Total	--	ms	102
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,250
	10		Total (Phase 2)			1,226
	11		Total (Phase 3)			1,238
	12		Positive sequence			1,238
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,298
	17	Active power	Total	t1-10s to t1	p.u.	0,298
	18		Pos.			0,298
	19	Reactive power	Total	t1-10s to t1	p.u.	0,014
	20		Pos.			0,001
	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.	1,250
	23		Phase 2			1,226
	24		Phase 3			1,238
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,073
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,072
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,011
	32		Pos.			0,011
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,811
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,014
	40		Pos.			0,001
	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

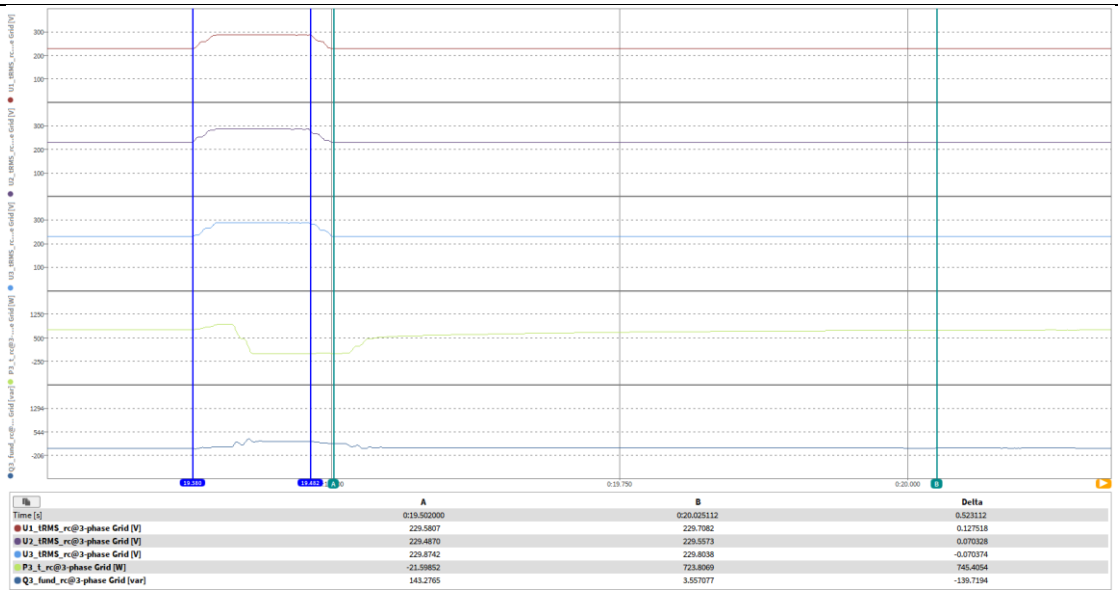
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:19.502000	0:20.025112	0.523112
U1_tRMS_rc@3-phase Grid [V]	229.5807	229.7082	0.127518
U2_tRMS_rc@3-phase Grid [V]	229.4870	229.5573	0.070328
U3_tRMS_rc@3-phase Grid [V]	229.8742	229.8038	-0.070374
P3_t_rc@3-phase Grid [W]	-21.59652	723.8069	745.4054
Q3_fund_rc@3-phase Grid [var]	143.2765	3.557077	-139.7194

5.8.3	For PGUs Type 2 and storage systems	P

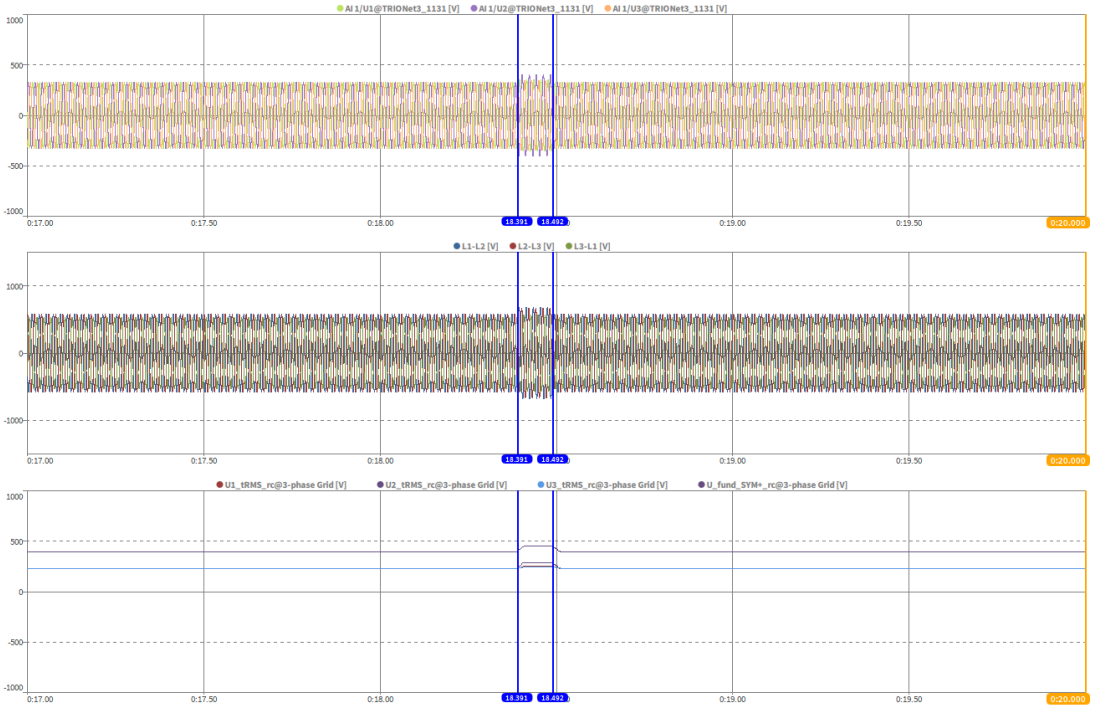
MST-BIE5-2500

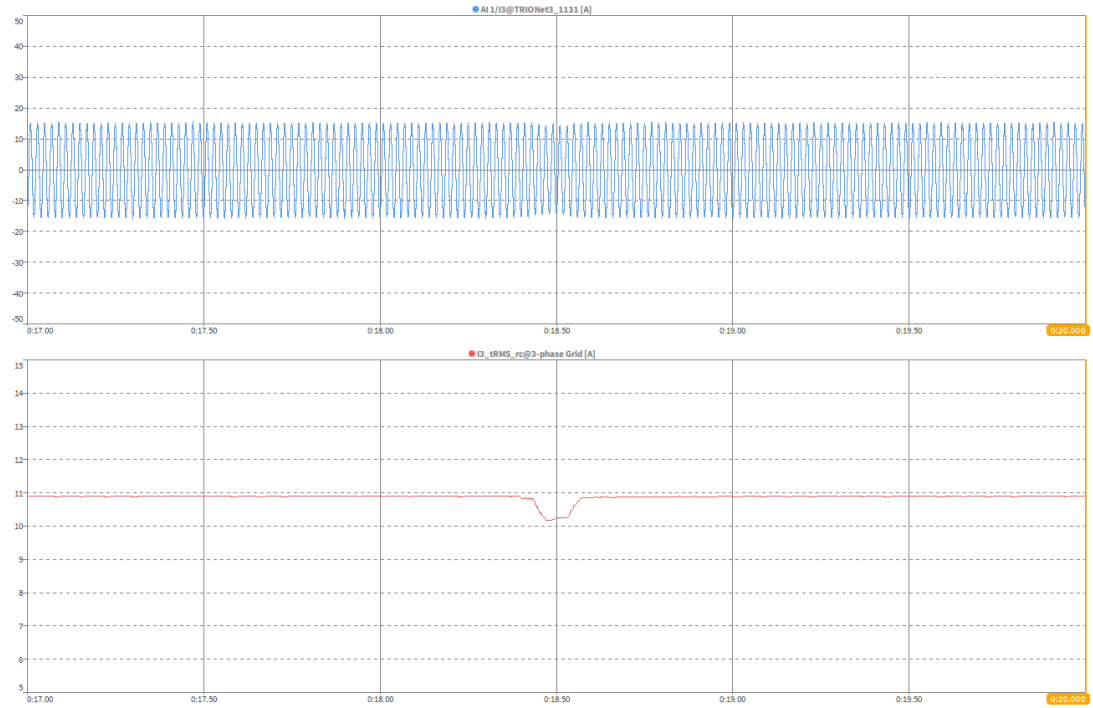
5.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5,3
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:07:29
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
	6	Point of fault entry	Total	--	ms	18391
	7	Point of fault clearance	Total	--	ms	18492
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,085
	10		Total (Phase 2)			1,238
	11		Total (Phase 3)			1,060
	12		Positive sequence			1,124
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,002
	17	Active power	Total	t1-10s to t1	p.u.	1,000
	18		Pos.			1,000
	19	Reactive power	Total	t1-10s to t1	p.u.	0,043
	20		Pos.			0,009
	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.	1,085
	23		Phase 2			1,238
	24		Phase 3			1,060
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,960
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,938
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,993
	32		Pos.			0,993
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,001
	37		Pos.			1,001
	38	Active power rising time	Total	--	s	0,069
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,044
	40		Pos.			0,008
	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

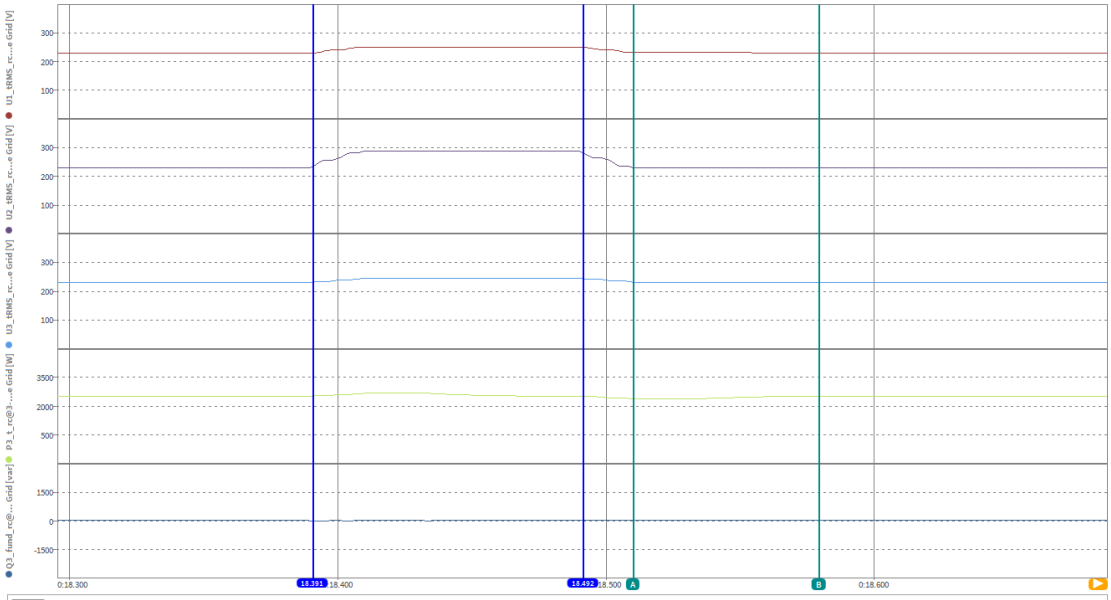
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:18.510234	0:18.579507	0.069272
U1_tRMS_rc@3-phase Grid [V]	231.1346	230.6439	-0.490707
U2_tRMS_rc@3-phase Grid [V]	232.8972	229.5660	-3.331177
U3_tRMS_rc@3-phase Grid [V]	231.7181	230.3365	-1.381683
P3_t_rc@3-phase Grid [W]	2371.742	2499.416	127.6746
Q3_fund_rc@3-phase Grid [var]	-16.17004	-20.57445	-4.404409

5.8.3	For PGUs Type 2 and storage systems	P

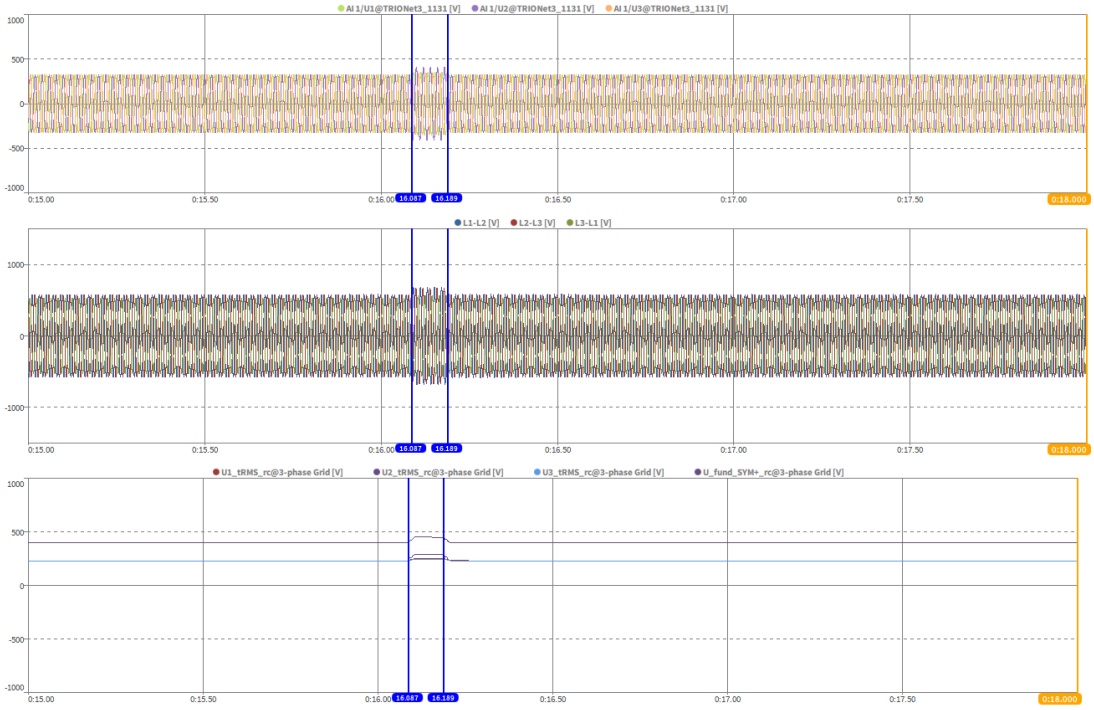
MST-BIE5-2500

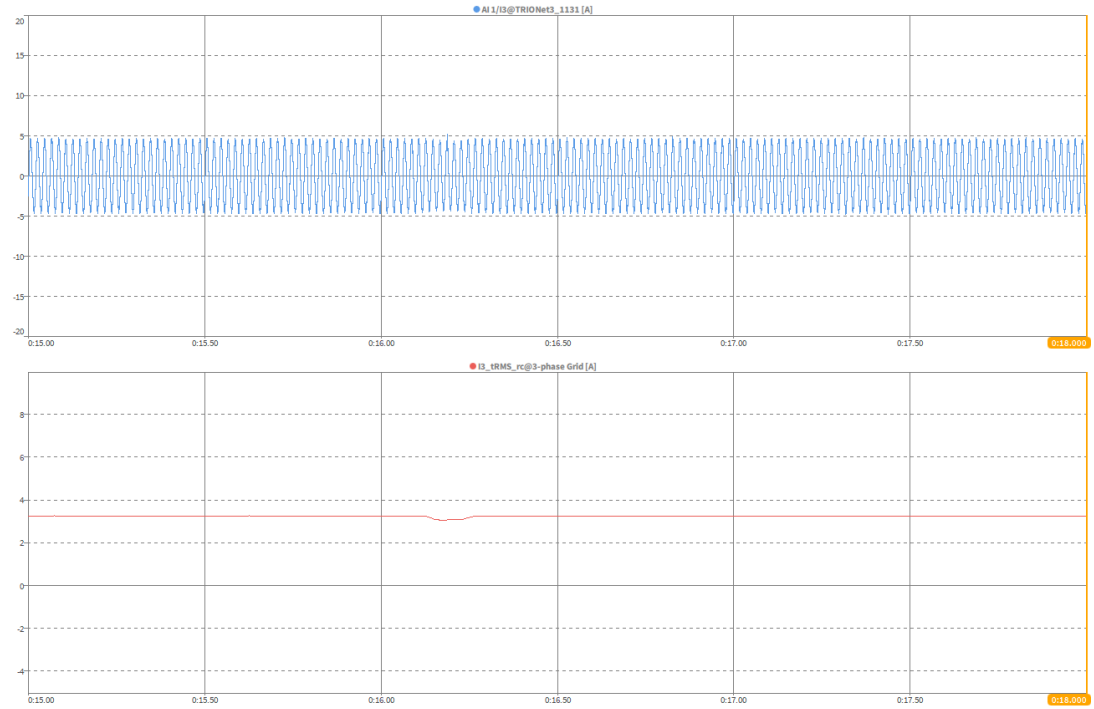
5.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5,4
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:04:58
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
	6	Point of fault entry	Total	--	ms	16087
	7	Point of fault clearance	Total	--	ms	16189
	8	Fault duration in empty load test	Total	--	ms	102
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,084
	10		Total (Phase 2)			1,248
	11		Total (Phase 3)			1,060
	12		Positive sequence			1,120
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,299
	18		Pos.			0,299
	19	Reactive power	Total	t1-10s to t1	p.u.	0,013
	20		Pos.			0,001
	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.	1,084
	23		Phase 2			1,248
	24		Phase 3			1,060
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,287
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,281
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,299
	32		Pos.			0,298
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,298
	37		Pos.			0,298
	38	Active power rising time	Total	--	s	0,119
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,013
	40		Pos.			0,001
	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

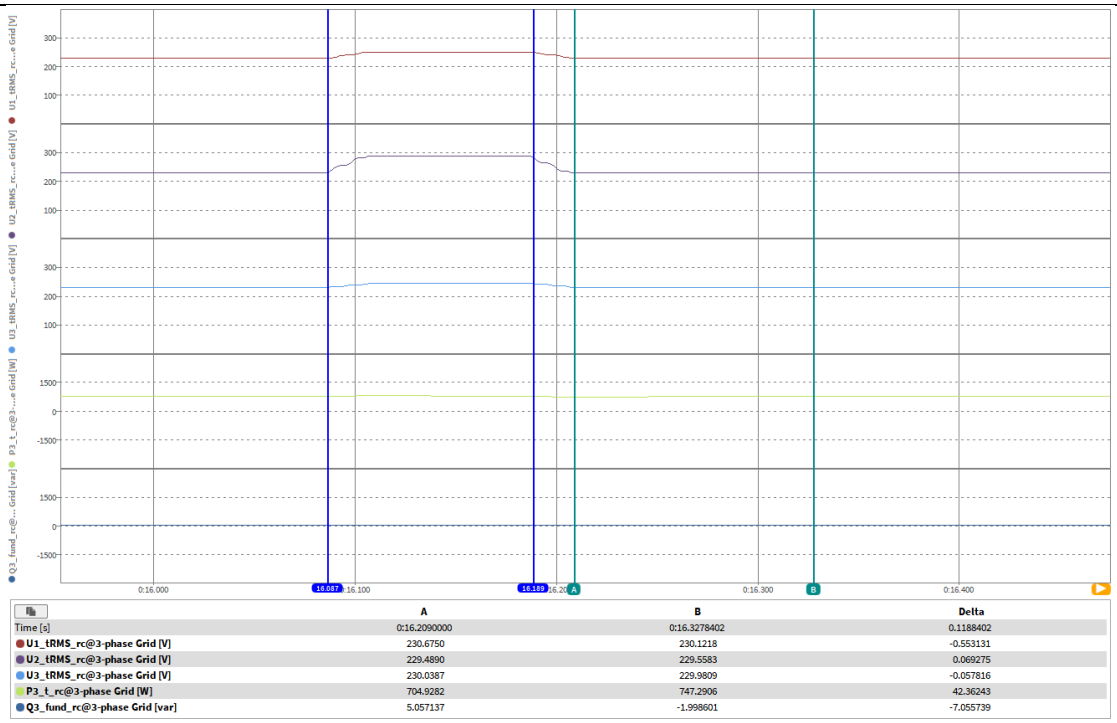
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:16.2090000	0:16.3278402	0.1188402
U1_tRMS_rc@3-phase Grid [V]	230.6750	230.1218	-0.553131
U2_tRMS_rc@3-phase Grid [V]	229.4890	229.5583	0.069275
U3_tRMS_rc@3-phase Grid [V]	230.0387	229.9809	-0.057816
P3_t_rc@3-phase Grid [W]	704.9282	747.2906	42.36243
Q3_fund_rc@3-phase Grid [var]	5.057137	-1.998601	-7.055739

5.8.3	For PGUs Type 2 and storage systems	P

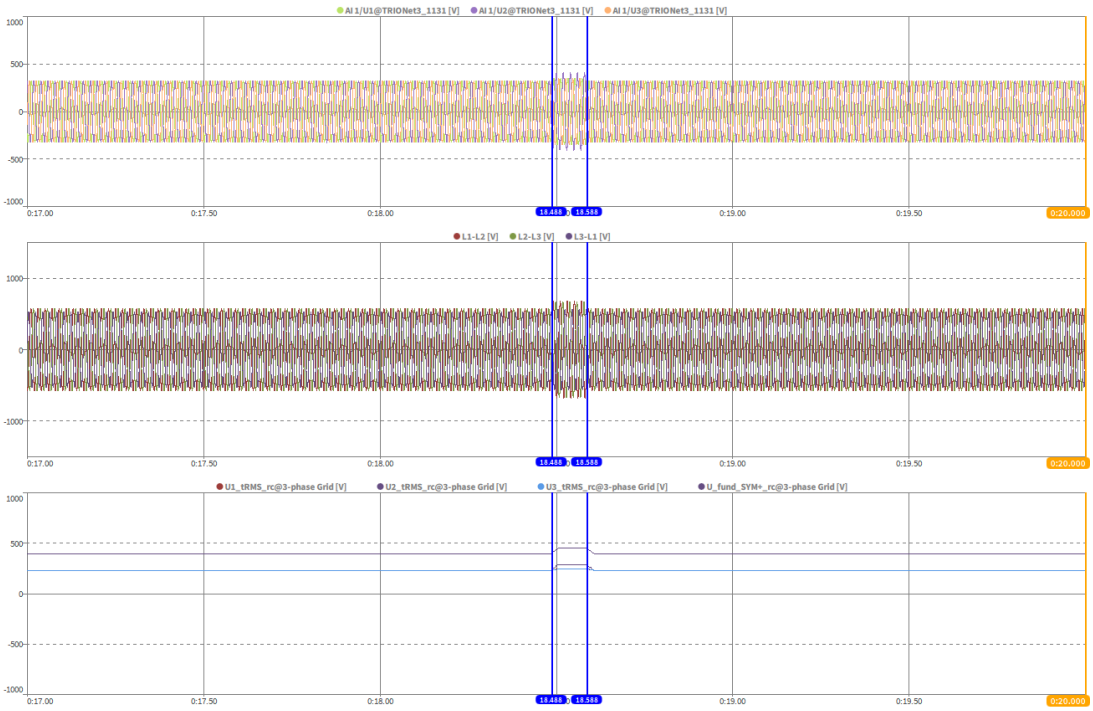
MST-BIE5-2500

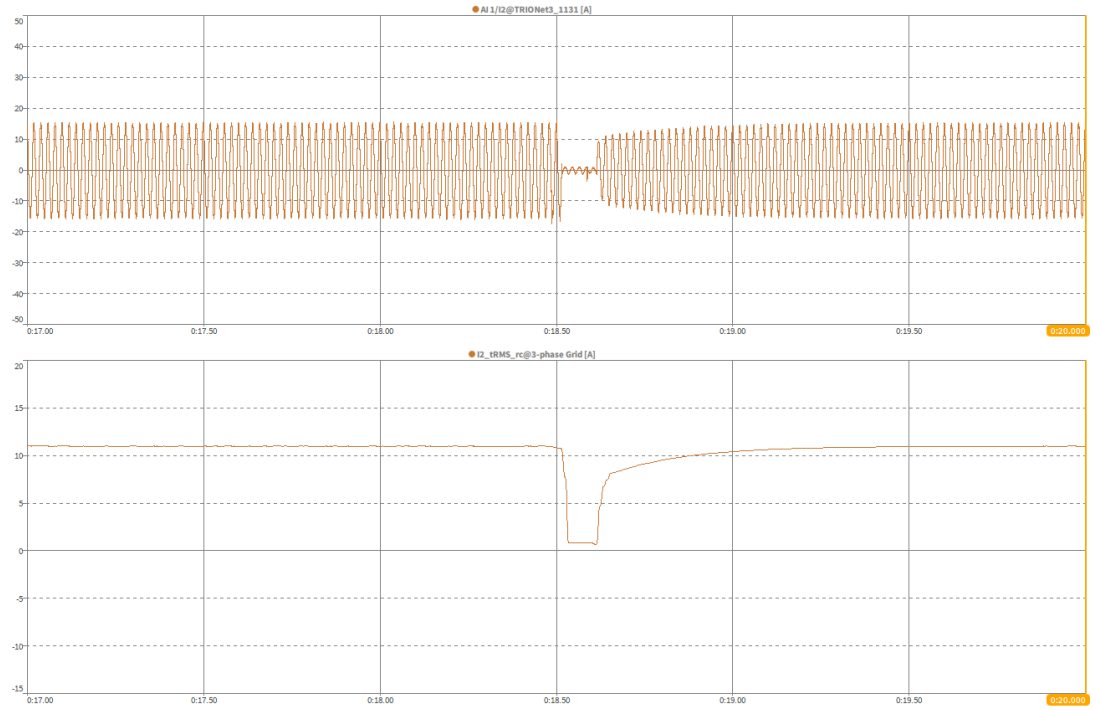
5.5

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	5,5
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	15:03:33
	3	Fault type (phase)	--	--	--	D2
	4	Setting voltage depth	Line to line	--	p.u.	1,25
	5	Setting dip duration		--	--	100
	6	Point of fault entry	Total	--	ms	18488
	7	Point of fault clearance	Total	--	ms	18588
	8	Fault duration in empty load test	Total	--	ms	100
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,080
	10		Total (Phase 2)			1,247
	11		Total (Phase 3)			1,060
	12		Positive sequence			1,121
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,997
	15		Phase 3			0,997
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,009
	17	Active power	Total	t1-10s to t1	p.u.	1,007
	18		Pos.			1,007
	19	Reactive power	Total	t1-10s to t1	p.u.	0,043
	20		Pos.			0,007
	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.	1,080
	23		Phase 2			1,247
	24		Phase 3			1,060
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			0,073
	27		Phase 3			--
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			0,073
	30		Phase 3			--
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,012
	32		Pos.			0,012
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,997
	35		Phase 3			0,997
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,007
	37		Pos.			1,007
	38	Active power rising time	Total	--	s	0,785
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,043
	40		Pos.			0,008
	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

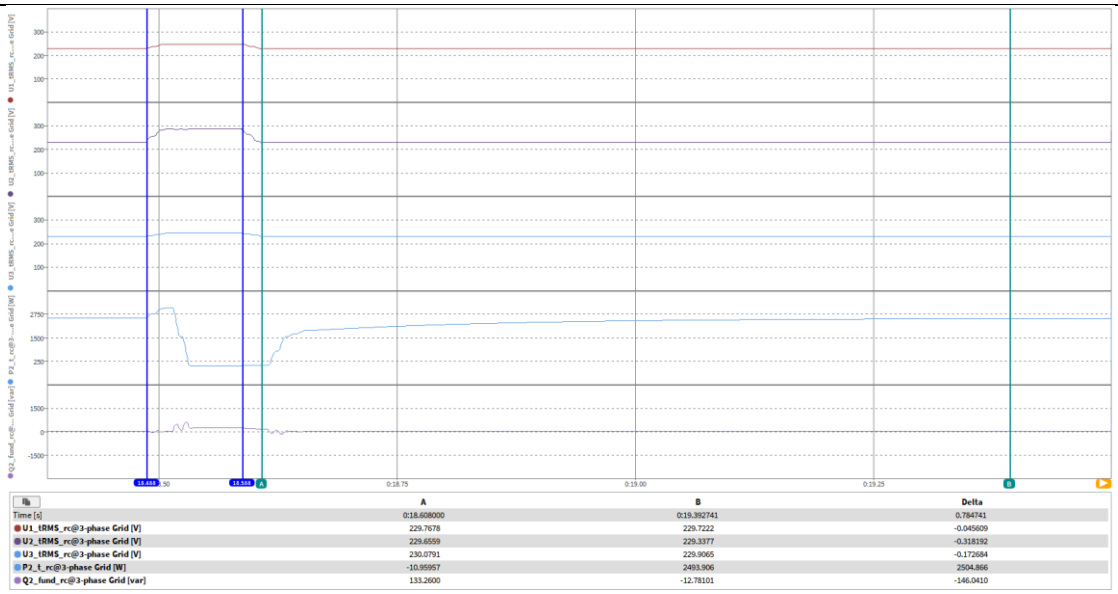
MST-BIE5-2500





5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:18.608000	0:19.392741	0.784741
U1_tRMS_rc@3-phase Grid [V]	229.7678	229.7222	-0.045609
U2_tRMS_rc@3-phase Grid [V]	229.6559	229.3377	-0.318192
U3_tRMS_rc@3-phase Grid [V]	230.0791	229.9065	-0.172684
P2_t_rc@3-phase Grid [W]	-10.95957	2493.906	2504.866
Q2_fund_rc@3-phase Grid [var]	133.2600	-12.78101	-146.0410

5.8.3	For PGUs Type 2 and storage systems	P

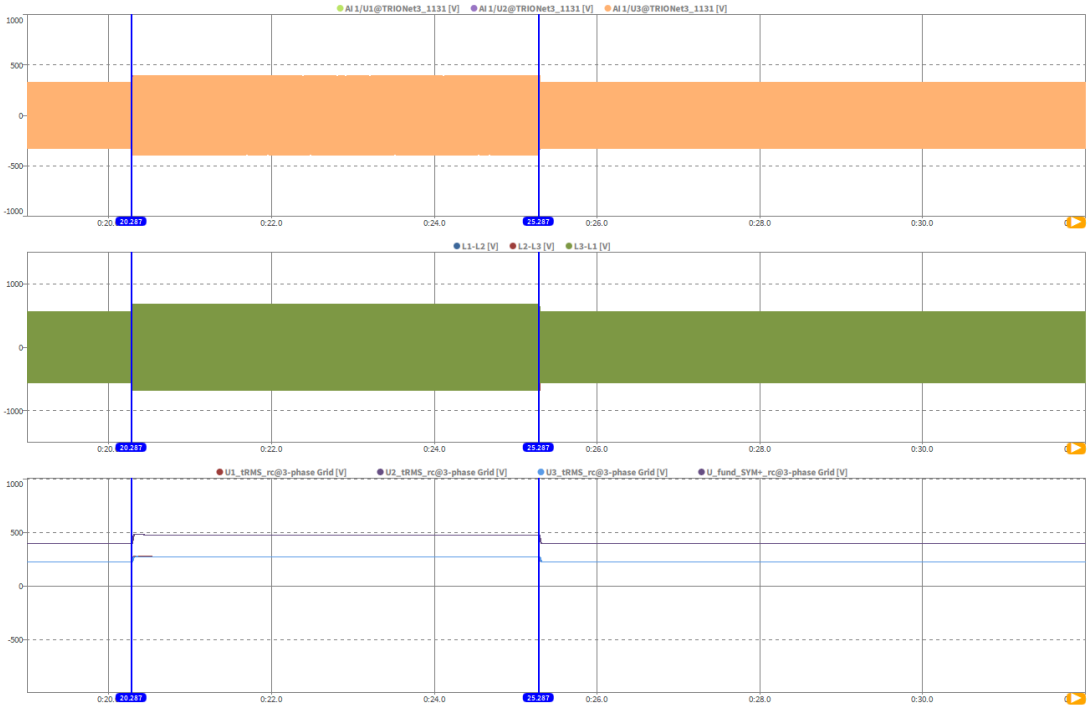
MST-BIE5-2500

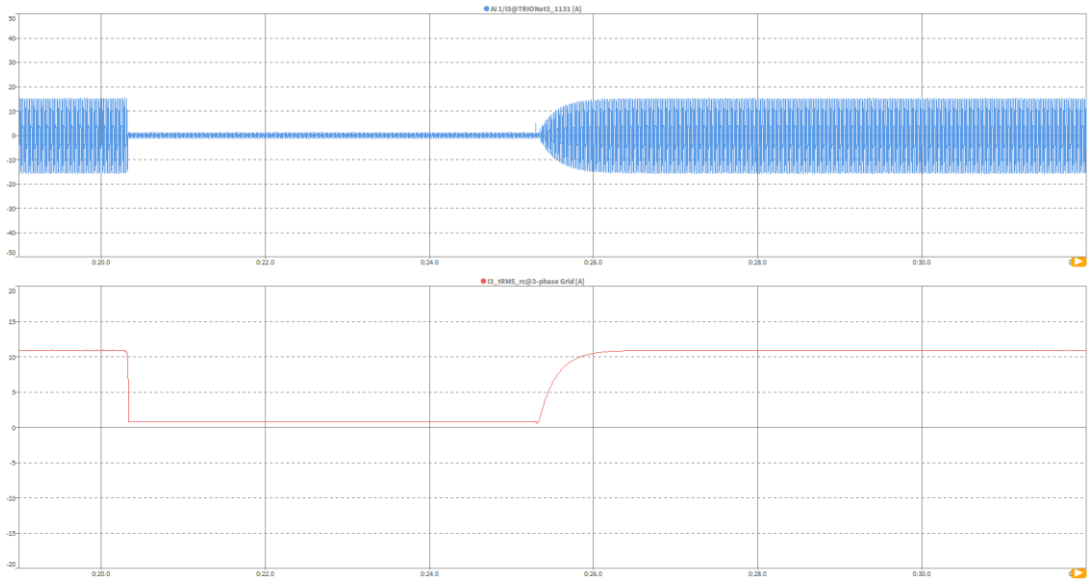
6.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6,1
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	9:55:35
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
	6	Point of fault entry	Total	--	ms	20287
	7	Point of fault clearance	Total	--	ms	25287
	8	Fault duration in empty load test	Total	--	ms	5000
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,199
	10		Total (Phase 2)			1,198
	11		Total (Phase 3)			1,200
	12		Positive sequence			1,198
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,002
	17	Active power	Total	t1-10s to t1	p.u.	1,000
	18		Pos.			1,000
	19	Reactive power	Total	t1-10s to t1	p.u.	0,045
	20		Pos.			0,008
	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.	1,199
	23		Phase 2			1,198
	24		Phase 3			1,200
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,068
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,069
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,010
	32		Pos.			0,010
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,000
	37		Pos.			1,000
	38	Active power rising time	Total	--	s	0,889
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,045
	40		Pos.			0,009
	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

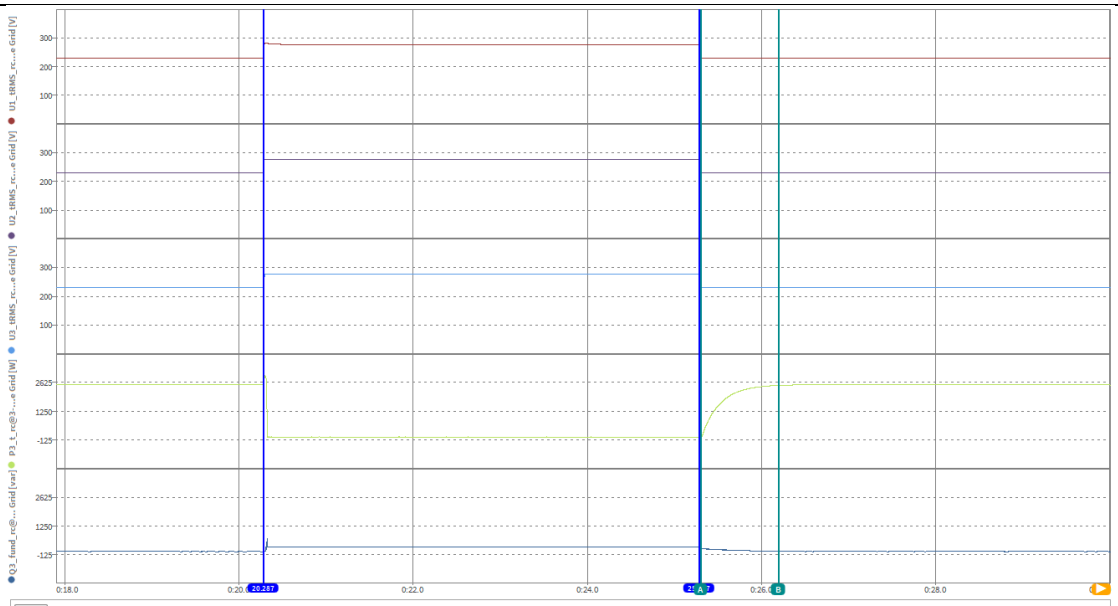
MST-BIE5-2500



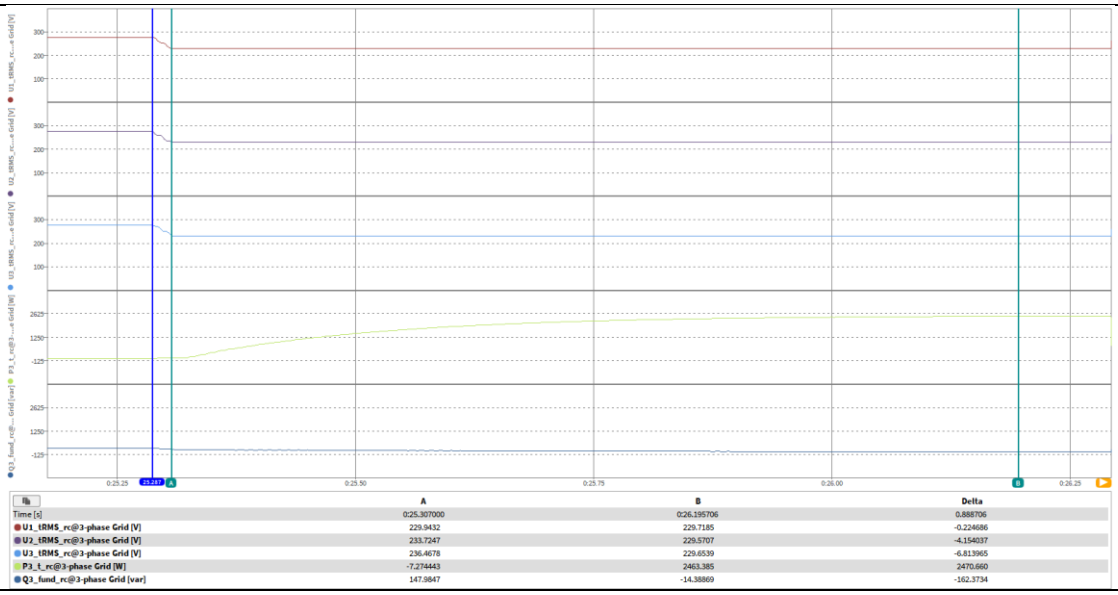


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:25.3070	0:26.1957	0.8887
U1_tRMS_rc@3-phase Grid [V]	229.9432	229.7185	-0.224686
U2_tRMS_rc@3-phase Grid [V]	233.7247	229.5707	-4.154037
U3_tRMS_rc@3-phase Grid [V]	236.4678	229.6539	-6.813965
P3_t_rc@3-phase Grid [W]	-7.274443	2463.385	2470.660
Q3_fund_rc@3-phase Grid [var]	147.9847	-14.38869	-162.3734



	A	B	Delta
Time [s]	0:25.307000	0:26.195706	0.888706
U1_tRMS_rc@3-phase Grid [V]	229.9432	229.7185	-0.224686
U2_tRMS_rc@3-phase Grid [V]	233.7247	229.5707	-4.154037
U3_tRMS_rc@3-phase Grid [V]	236.4678	229.6539	-6.813965
P3_t_rc@3-phase Grid [W]	-7.274443	2463.385	2470.660
Q3_fund_rc@3-phase Grid [var]	147.9847	-14.38869	-162.3734

5.8.3	For PGUs Type 2 and storage systems	P

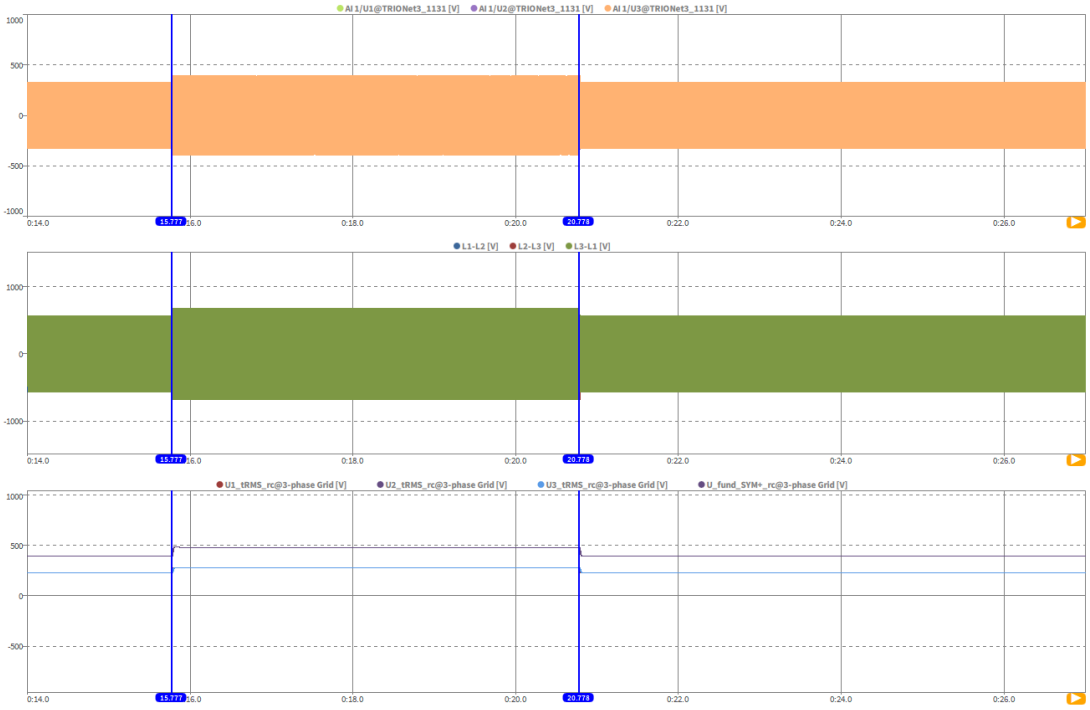
MST-BIE5-2500

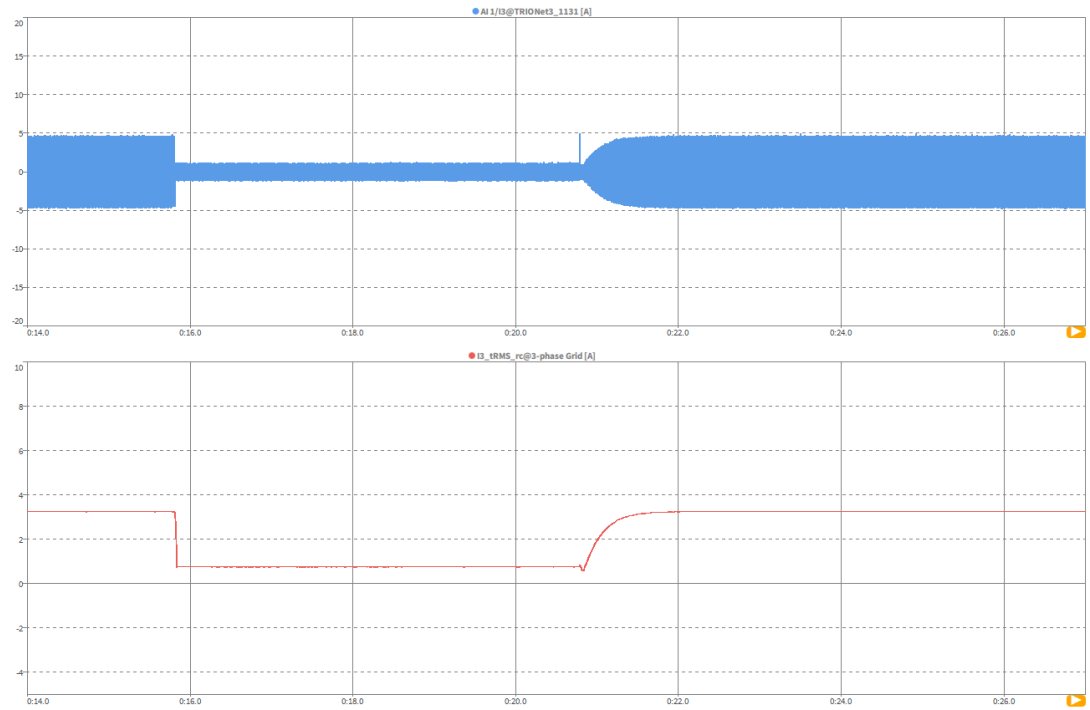
6.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6,2
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	9:53:06
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
	6	Point of fault entry	Total	--	ms	15777
	7	Point of fault clearance	Total	--	ms	20778
	8	Fault duration in empty load test	Total	--	ms	5001
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,199
	10		Total (Phase 2)			1,198
	11		Total (Phase 3)			1,200
	12		Positive sequence			1,198
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,298
	17	Active power	Total	t1-10s to t1	p.u.	0,298
	18		Pos.			0,298
	19	Reactive power	Total	t1-10s to t1	p.u.	0,014
	20		Pos.			0,002
	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.	1,199
	23		Phase 2			1,198
	24		Phase 3			1,200
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,071
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,069
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,011
	32		Pos.			0,011
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,733
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,014
	40		Pos.			0,001
	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

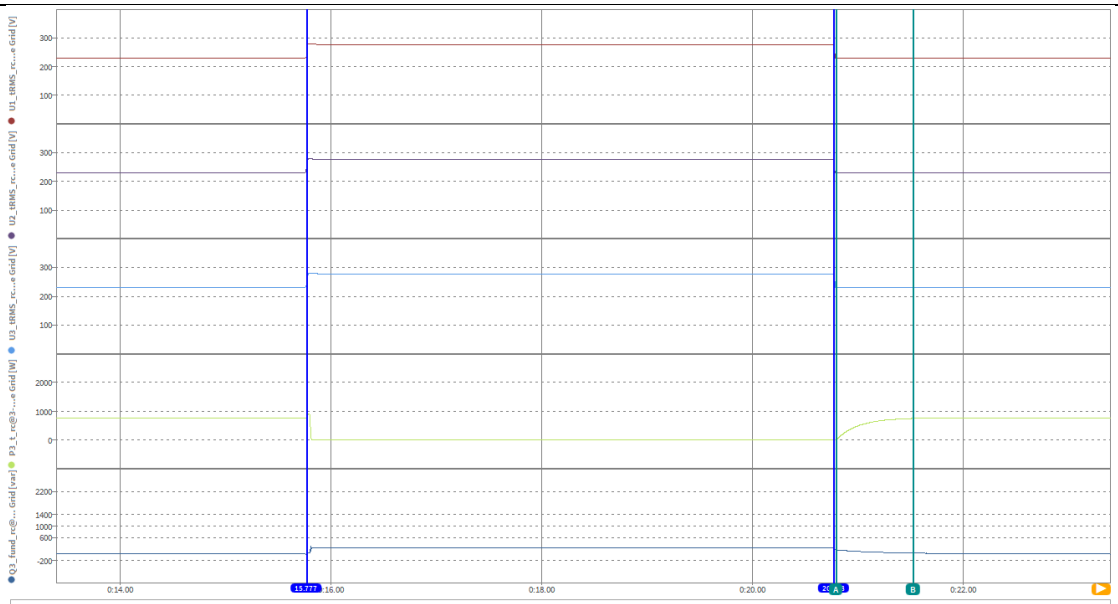
MST-BIE5-2500



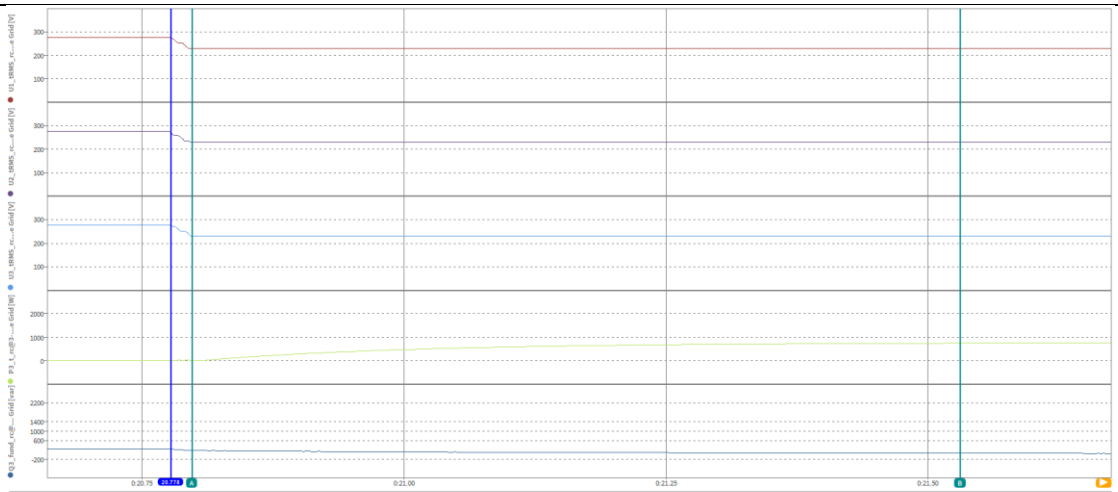


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:20.798000	0:21.530827	0.732827
U1_tRMS_rc@3-phase Grid [V]	229.3276	229.7154	0.387817
U2_tRMS_rc@3-phase Grid [V]	229.5425	229.5564	0.013901
U3_tRMS_rc@3-phase Grid [V]	229.7590	229.7899	0.030869
P3_t_rc@3-phase Grid [W]	-23.57647	724.4522	748.0287
Q3_fund_rc@3-phase Grid [var]	140.0207	21.08776	-118.9330



	A	B	Delta
Time [s]	0:20.798000	0:21.530827	0.732827
U1_tRMS_rc@3-phase Grid [V]	229.3276	229.7154	0.387817
U2_tRMS_rc@3-phase Grid [V]	229.5425	229.5564	0.013901
U3_tRMS_rc@3-phase Grid [V]	229.7590	229.7899	0.030869
P3_t_rc@3-phase Grid [W]	-23.57647	724.4522	748.0287
Q3_fund_rc@3-phase Grid [var]	140.0207	21.08776	-118.9330

5.8.3	For PGUs Type 2 and storage systems	P

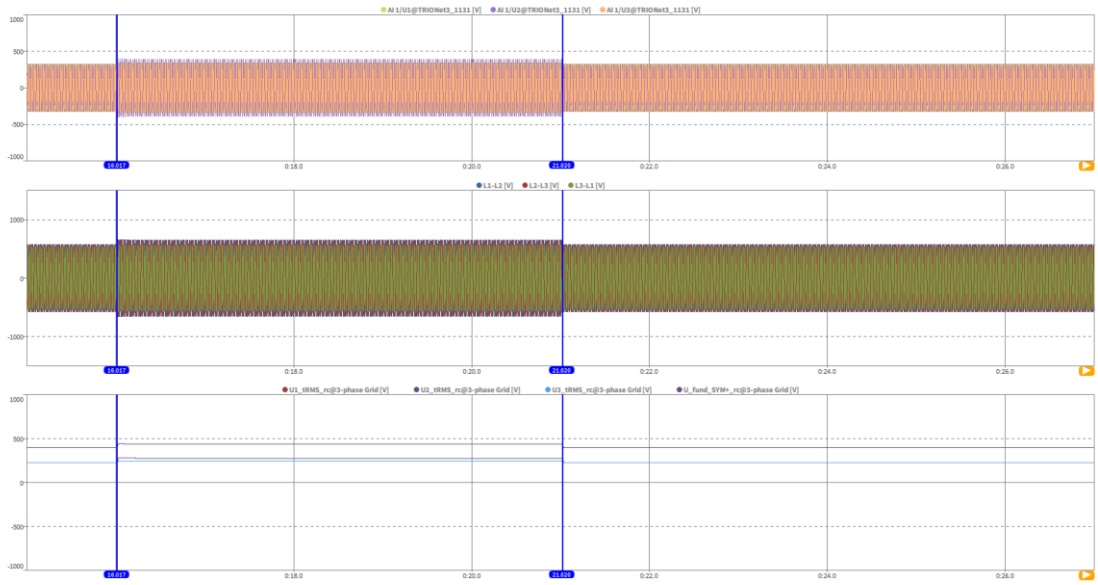
MST-BIE5-2500

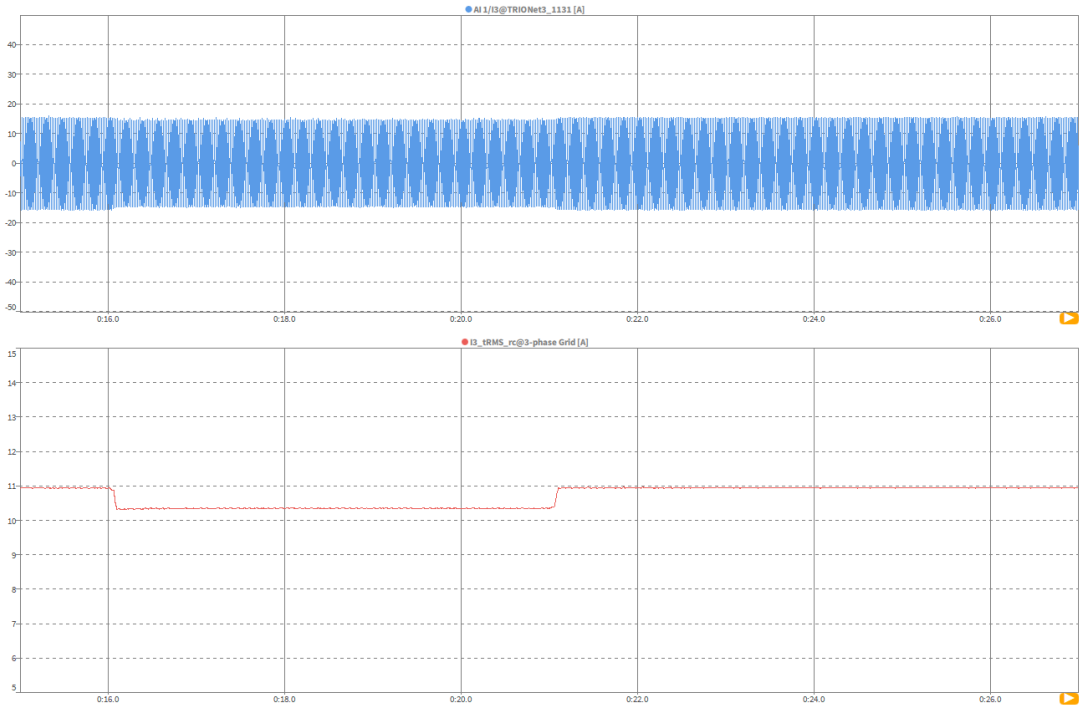
6.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6,3
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:13:35
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
	6	Point of fault entry	Total	--	ms	16017
	7	Point of fault clearance	Total	--	ms	21020
	8	Fault duration in empty load test	Total	--	ms	5003
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,059
	10		Total (Phase 2)			1,198
	11		Total (Phase 3)			1,049
	12		Positive sequence			1,095
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,005
	17	Active power	Total	t1-10s to t1	p.u.	1,004
	18		Pos.			1,004
	19	Reactive power	Total	t1-10s to t1	p.u.	0,041
	20		Pos.			0,007
	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.	1,059
	23		Phase 2			1,198
	24		Phase 3			1,049
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,976
	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.	0,998
	32		Pos.			0,998
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,005
	37		Pos.			1,005
	38	Active power rising time	Total	--	s	0,063
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,040
	40		Pos.			0,007
	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

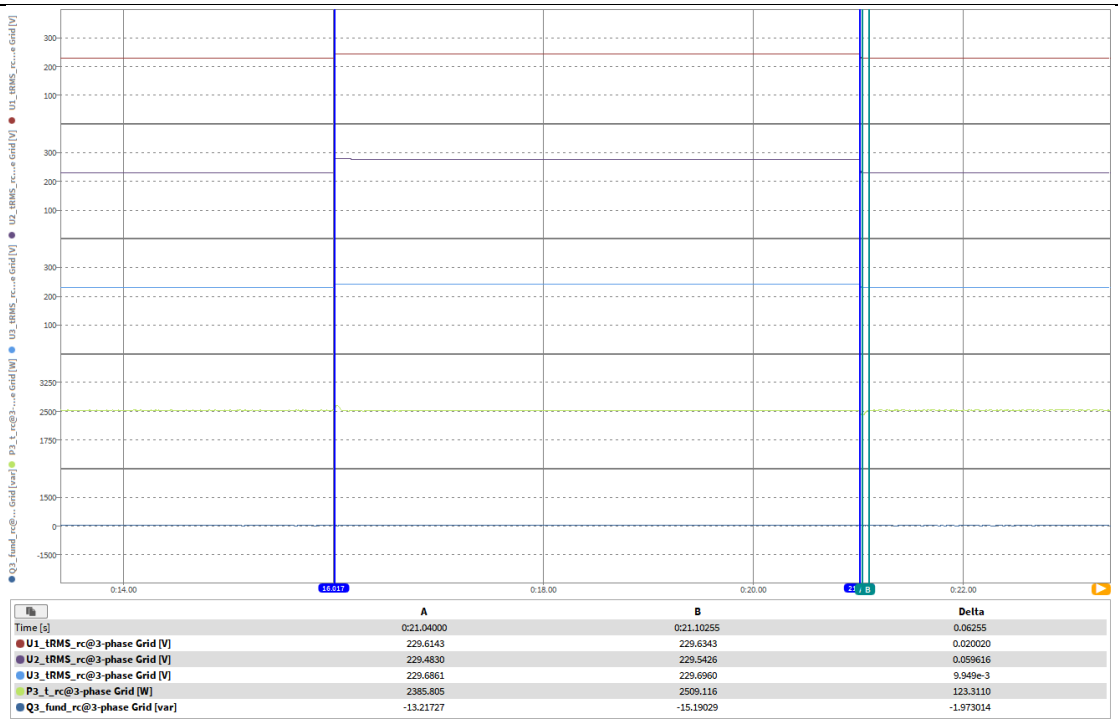
MST-BIE5-2500



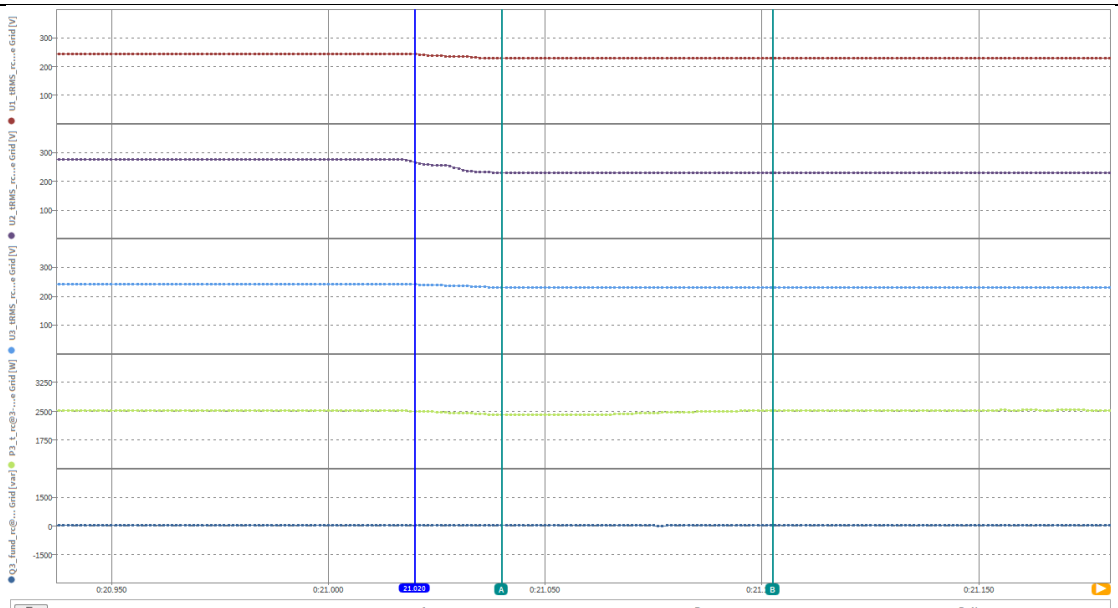


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:21.04000	0:21.10255	0.06255
U1_tRMS_rc@3-phase Grid [V]	229.6143	229.6343	0.020020
U2_tRMS_rc@3-phase Grid [V]	229.4830	229.5426	0.059616
U3_tRMS_rc@3-phase Grid [V]	229.6861	229.6960	9.949e-3
P3_t_rc@3-phase Grid [W]	2385.805	2509.116	123.3110
Q3_fund_rc@3-phase Grid [var]	-13.21727	-15.19029	-1.973014



	A	B	Delta
Time [s]	0:21.04000	0:21.10255	0.06255
U1_tRMS_rc@3-phase Grid [V]	229.6143	229.6343	0.020020
U2_tRMS_rc@3-phase Grid [V]	229.4830	229.5426	0.059616
U3_tRMS_rc@3-phase Grid [V]	229.6861	229.6960	9.949e-3
P3_t_rc@3-phase Grid [W]	2385.805	2509.116	123.3110
Q3_fund_rc@3-phase Grid [var]	-13.21727	-15.19029	-1.973014

5.8.3	For PGUs Type 2 and storage systems	P

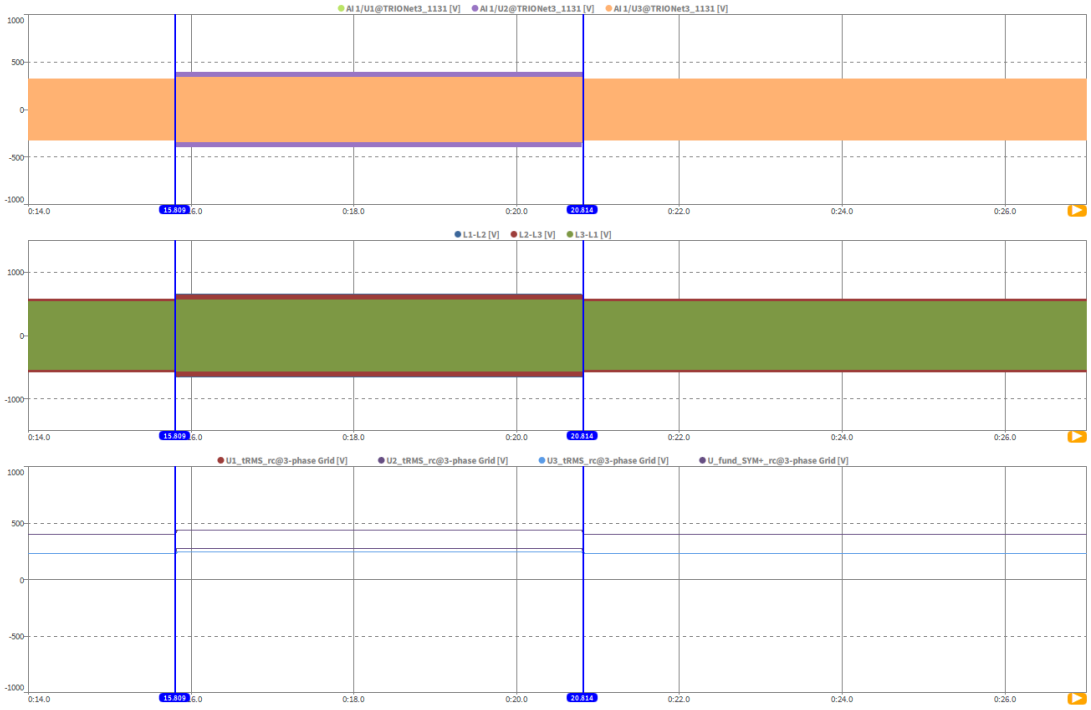
MST-BIE5-2500

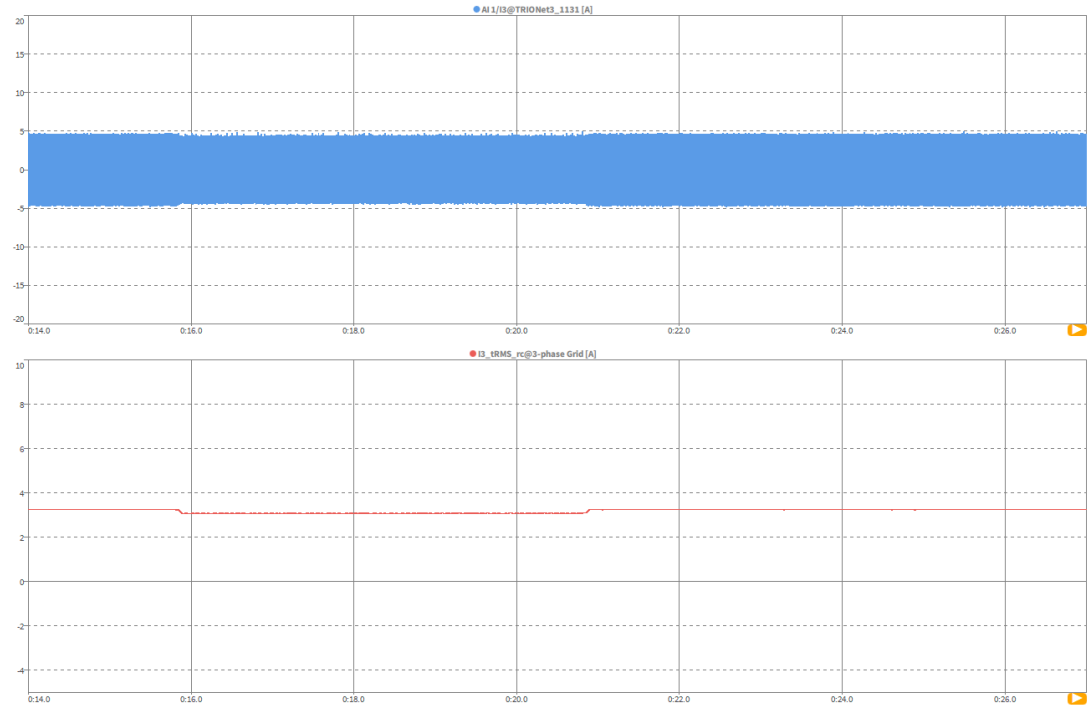
6.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	6,4
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:14:47
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,2
	5	Setting dip duration		--	--	5000
	6	Point of fault entry	Total	--	ms	15809
	7	Point of fault clearance	Total	--	ms	20814
	8	Fault duration in empty load test	Total	--	ms	5005
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,059
	10		Total (Phase 2)			1,198
	11		Total (Phase 3)			1,049
	12		Positive sequence			1,095
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,298
	18		Pos.			0,298
	19	Reactive power	Total	t1-10s to t1	p.u.	0,014
	20		Pos.			0,001
	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.	1,059
	23		Phase 2			1,198
	24		Phase 3			1,049
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,291
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,283
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,297
	32		Pos.			0,297
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,298
	37		Pos.			0,298
	38	Active power rising time	Total	--	s	0,060
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,014
	40		Pos.			0,001
	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

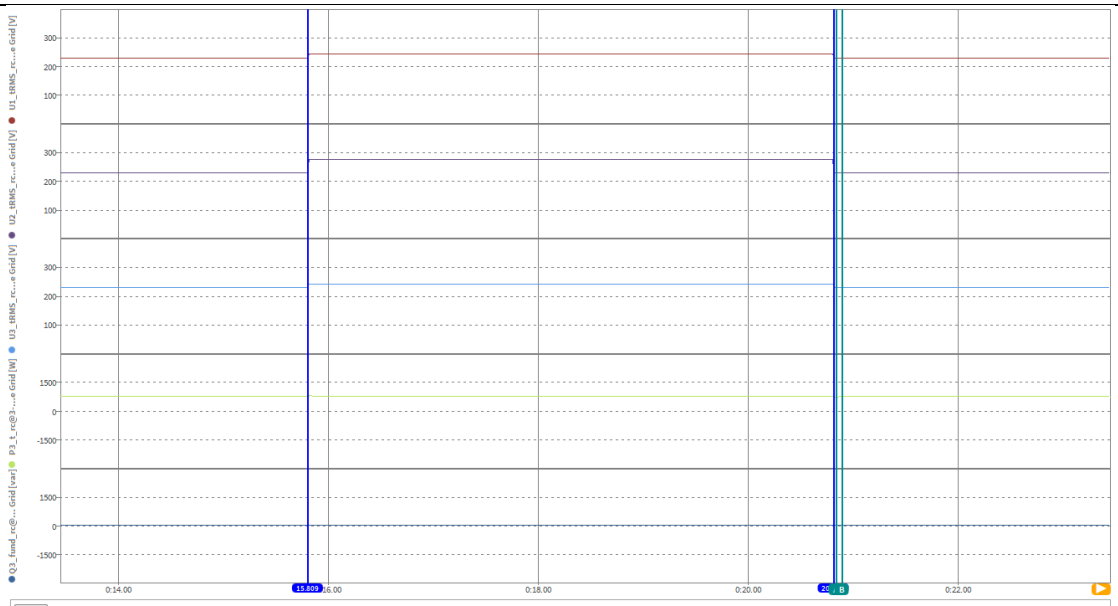
MST-BIE5-2500



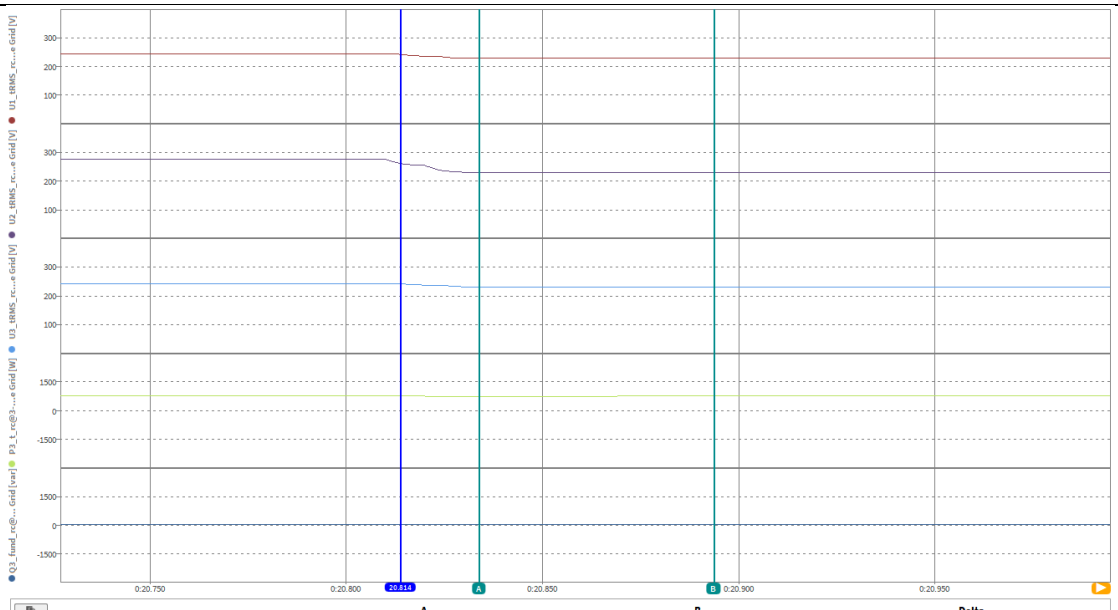


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	0:20.83400	0:20.89372	0.05972
U1_tRMS_rc@3-phase Grid [V]	229.5961	229.6298	0.033676
U2_tRMS_rc@3-phase Grid [V]	229.4970	229.5483	0.051270
U3_tRMS_rc@3-phase Grid [V]	229.8016	229.8065	4.898e-3
P3_t_rc@3-phase Grid [W]	709.5237	745.3251	35.80145
Q3_fund_rc@3-phase Grid [var]	2.644560	-2.485064	-5.129624



	A	B	Delta
Time [s]	0:20.83400	0:20.89372	0.05972
U1_tRMS_rc@3-phase Grid [V]	229.5961	229.6298	0.033676
U2_tRMS_rc@3-phase Grid [V]	229.4970	229.5483	0.051270
U3_tRMS_rc@3-phase Grid [V]	229.8016	229.8065	4.898e-3
P3_t_rc@3-phase Grid [W]	709.5237	745.3251	35.80145
Q3_fund_rc@3-phase Grid [var]	2.644560	-2.485064	-5.129624

5.8.3	For PGUs Type 2 and storage systems	P

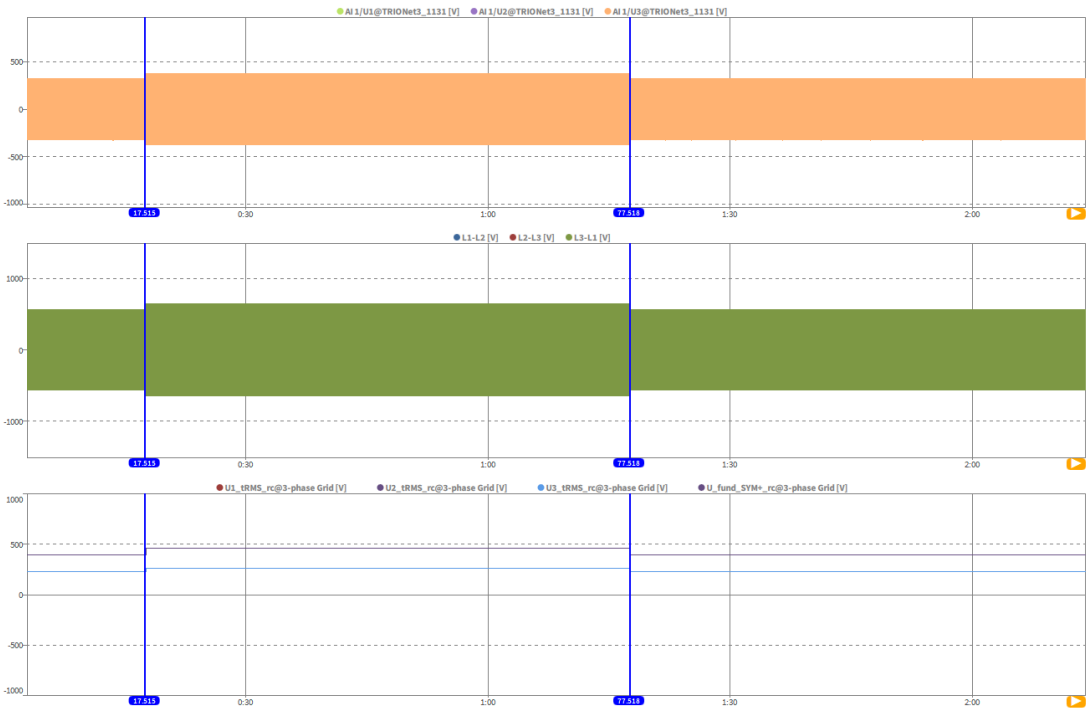
MST-BIE5-2500

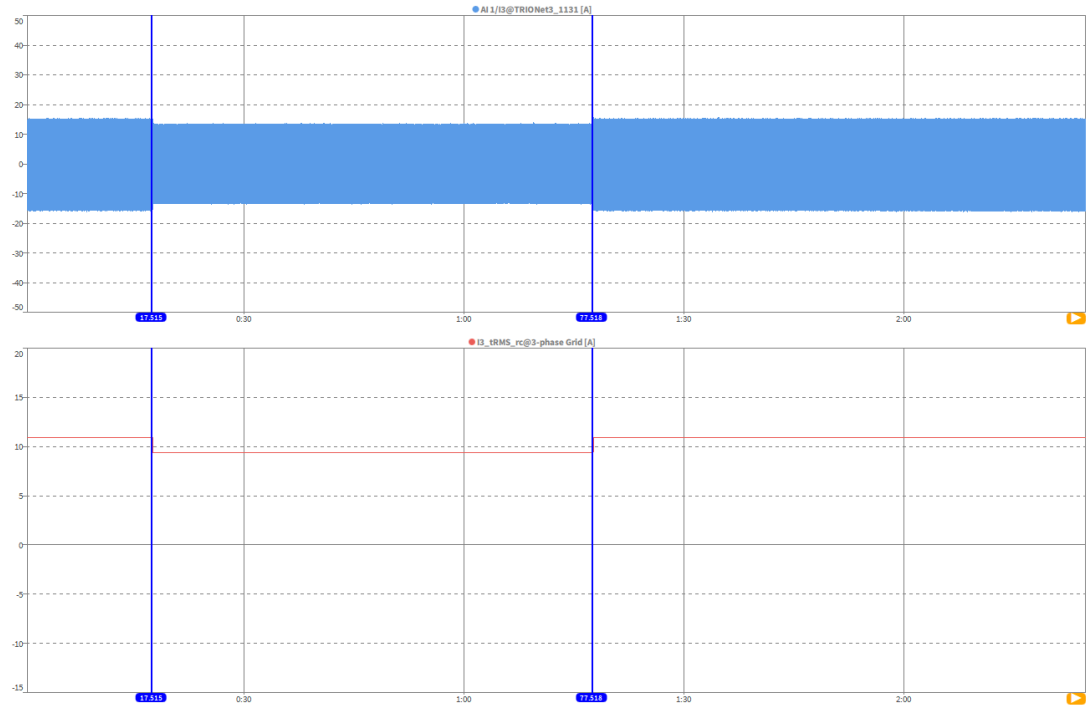
7.1

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7,1
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	9:58:40
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	17515
	7	Point of fault clearance	Total	--	ms	77518
	8	Fault duration in empty load test	Total	--	ms	60003
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,148
	10		Total (Phase 2)			1,147
	11		Total (Phase 3)			1,148
	12		Positive sequence			1,147
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,003
	17	Active power	Total	t1-10s to t1	p.u.	1,001
	18		Pos.			1,001
	19	Reactive power	Total	t1-10s to t1	p.u.	0,047
	20		Pos.			0,008
	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.	1,148
	23		Phase 2			1,147
	24		Phase 3			1,148
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,909
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,862
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,990
	32		Pos.			0,990
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,001
	37		Pos.			1,001
	38	Active power rising time	Total	--	s	0,064
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,046
	40		Pos.			0,008
	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

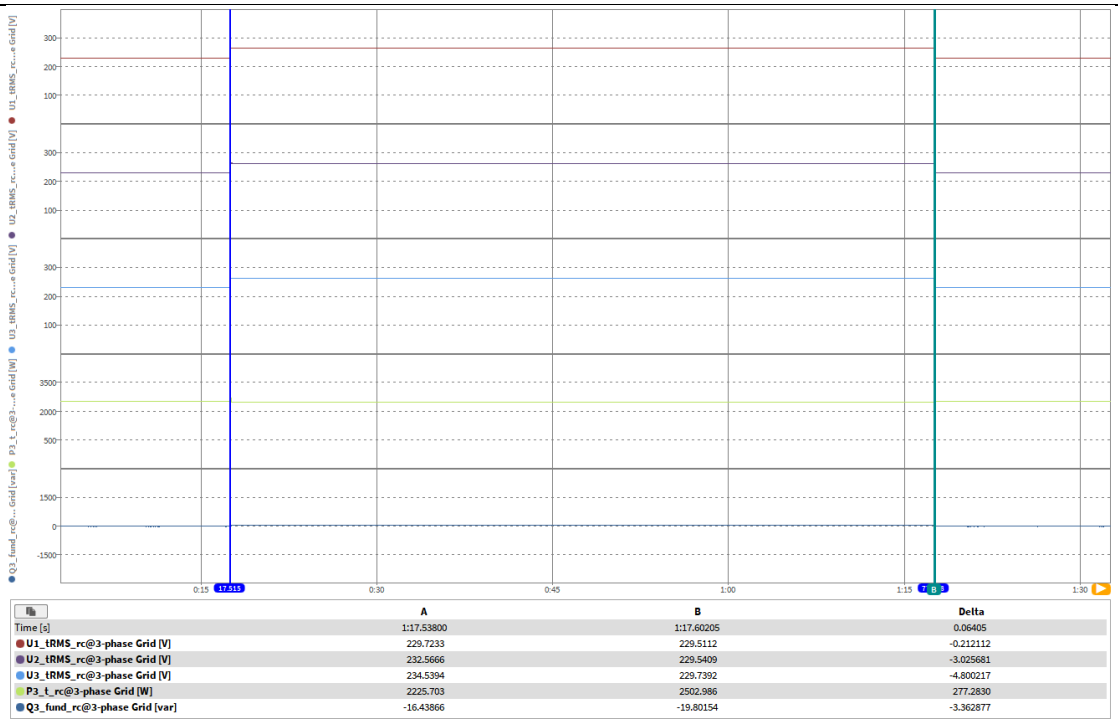
MST-BIE5-2500



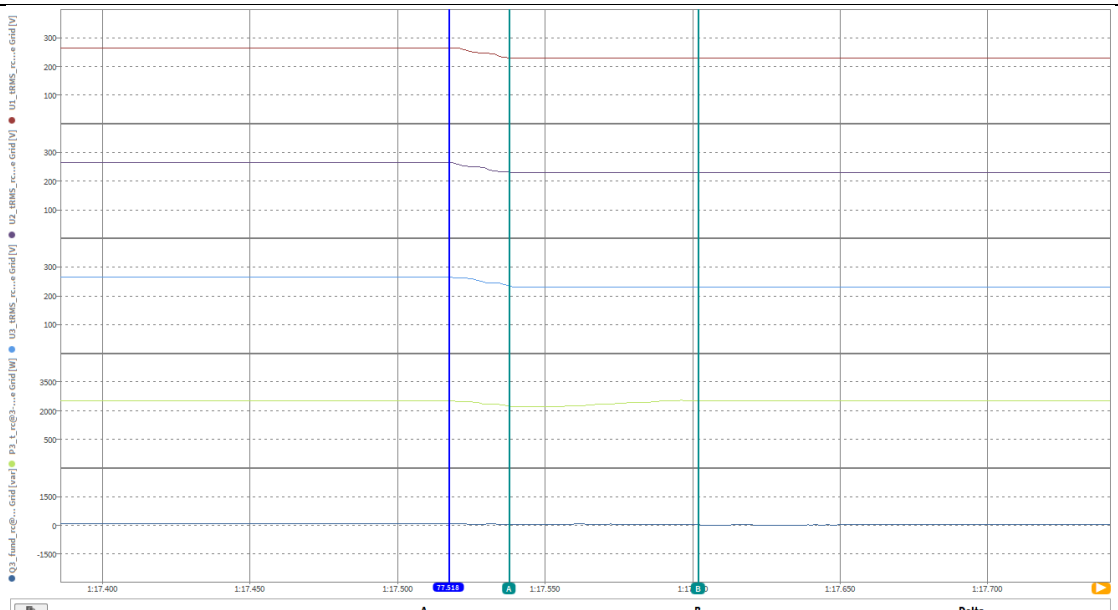


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:17.53800	1:17.60205	0.06405
U1_tRMS_rc@3-phase Grid [V]	229.7233	229.5112	-0.212112
U2_tRMS_rc@3-phase Grid [V]	232.5666	229.5409	-3.025681
U3_tRMS_rc@3-phase Grid [V]	234.5394	229.7392	-4.800217
P3_t_rc@3-phase Grid [W]	2225.703	2502.986	277.2830
Q3_fund_rc@3-phase Grid [var]	-16.43866	-19.80154	-3.362877



	A	B	Delta
Time [s]	1:17.53800	1:17.60205	0.06405
U1_tRMS_rc@3-phase Grid [V]	229.7233	229.5112	-0.212112
U2_tRMS_rc@3-phase Grid [V]	232.5666	229.5409	-3.025681
U3_tRMS_rc@3-phase Grid [V]	234.5394	229.7392	-4.800217
P3_t_rc@3-phase Grid [W]	2225.703	2502.986	277.2830
Q3_fund_rc@3-phase Grid [var]	-16.43866	-19.80154	-3.362877

5.8.3	For PGUs Type 2 and storage systems	P

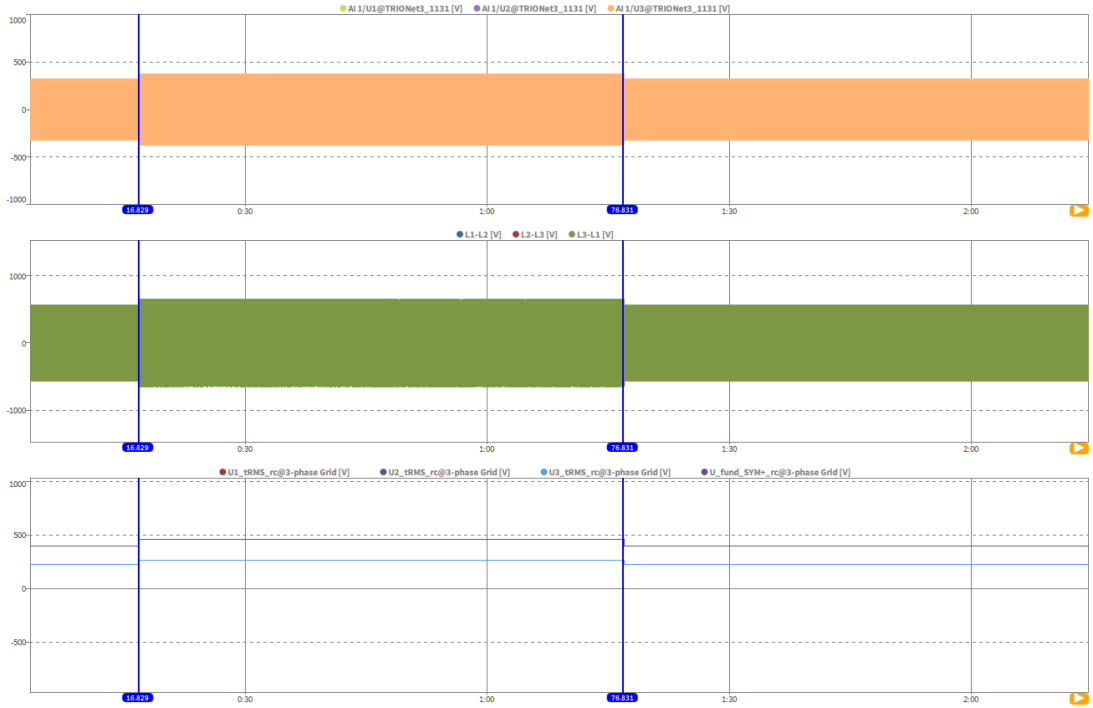
MST-BIE5-2500

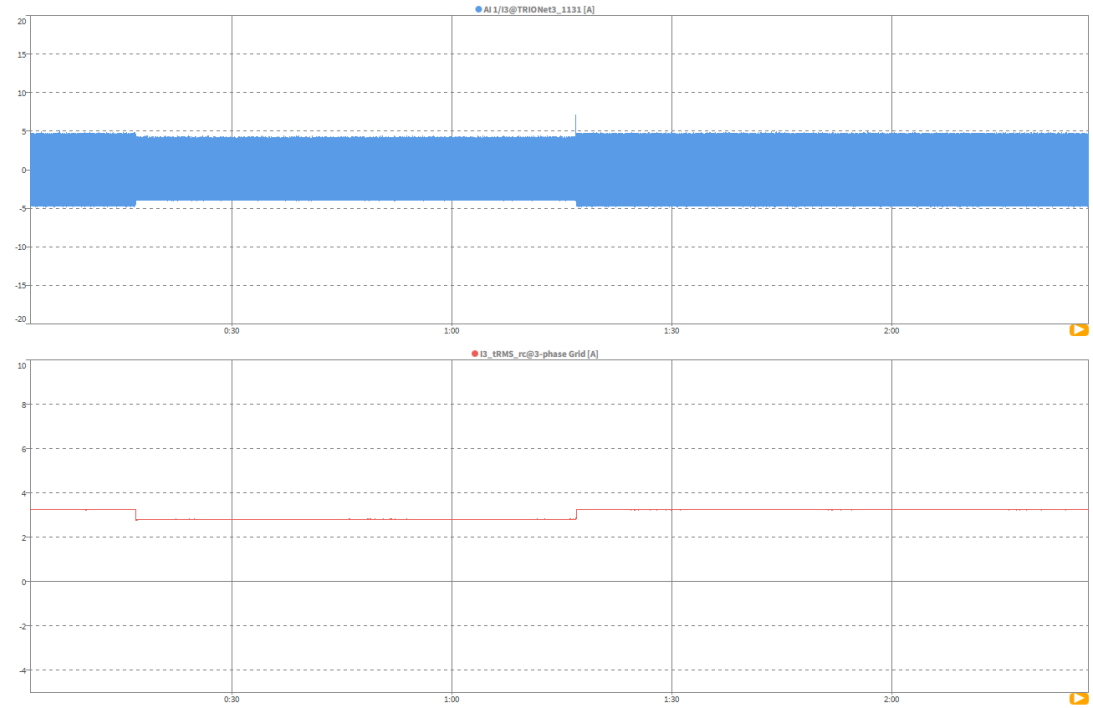
7.2

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7,2
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	10:02:12
	3	Fault type (phase)	--	--	--	A
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	16829
	7	Point of fault clearance	Total	--	ms	76831
	8	Fault duration in empty load test	Total	--	ms	60002
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,148
	10		Total (Phase 2)			1,147
	11		Total (Phase 3)			1,148
	12		Positive sequence			1,147
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,298
	18		Pos.			0,298
	19	Reactive power	Total	t1-10s to t1	p.u.	0,014
	20		Pos.			0,002
	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.	1,148
	23		Phase 2			1,147
	24		Phase 3			1,148
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,271
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,255
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,295
	32		Pos.			0,295
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,064
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,014
	40		Pos.			0,002
	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

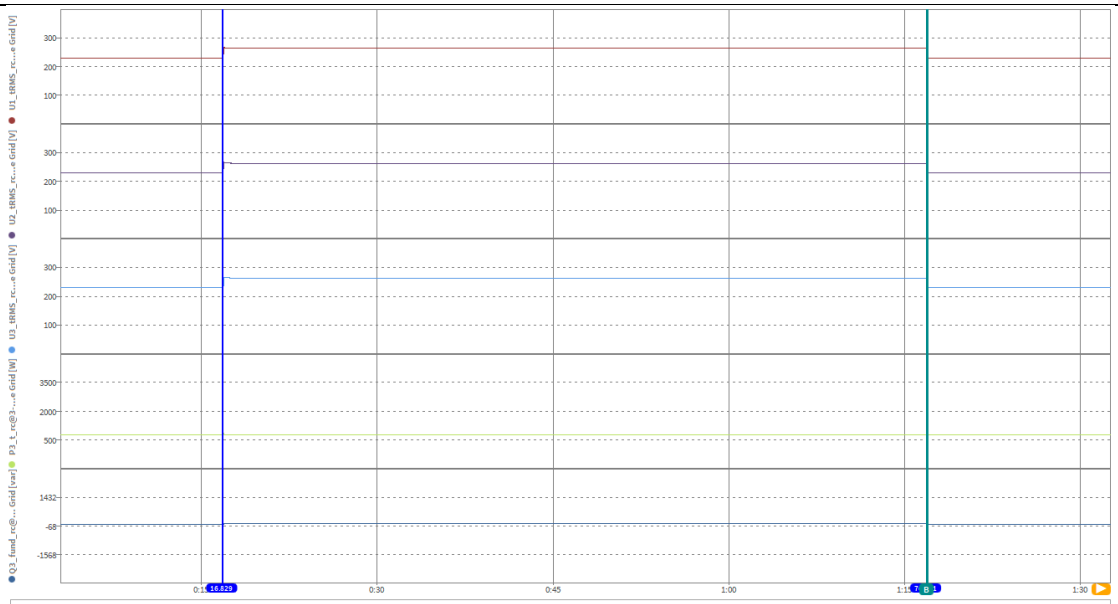
MST-BIE5-2500



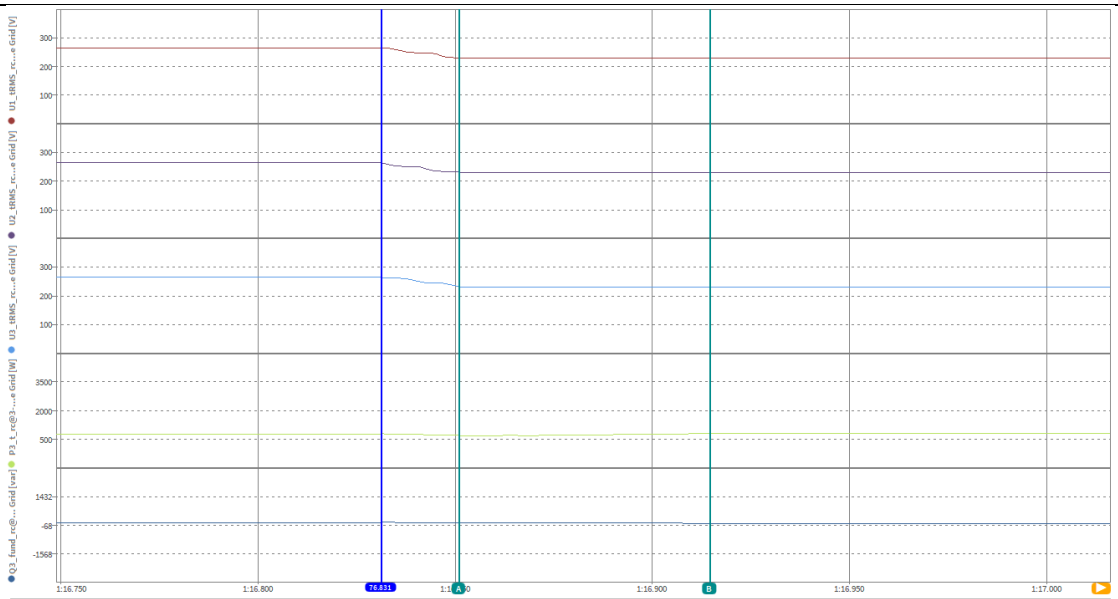


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:16.8510	1:16.9146	0.0636
U1_tRMS_rc@3-phase Grid [V]	229.4984	229.5705	0.072128
U2_tRMS_rc@3-phase Grid [V]	230.9088	229.5414	-1.367401
U3_tRMS_rc@3-phase Grid [V]	231.3493	229.7990	-1.550323
P3_t_rc@3-phase Grid [W]	659.5093	746.3839	86.87457
Q3_fund_rc@3-phase Grid [var]	14.14134	-2.633649	-16.77499



	A	B	Delta
Time [s]	1:16.8510	1:16.9146	0.0636
U1_tRMS_rc@3-phase Grid [V]	229.4984	229.5705	0.072128
U2_tRMS_rc@3-phase Grid [V]	230.9088	229.5414	-1.367401
U3_tRMS_rc@3-phase Grid [V]	231.3493	229.7990	-1.550323
P3_t_rc@3-phase Grid [W]	659.5093	746.3839	86.87457
Q3_fund_rc@3-phase Grid [var]	14.14134	-2.633649	-16.77499

5.8.3	For PGUs Type 2 and storage systems	P

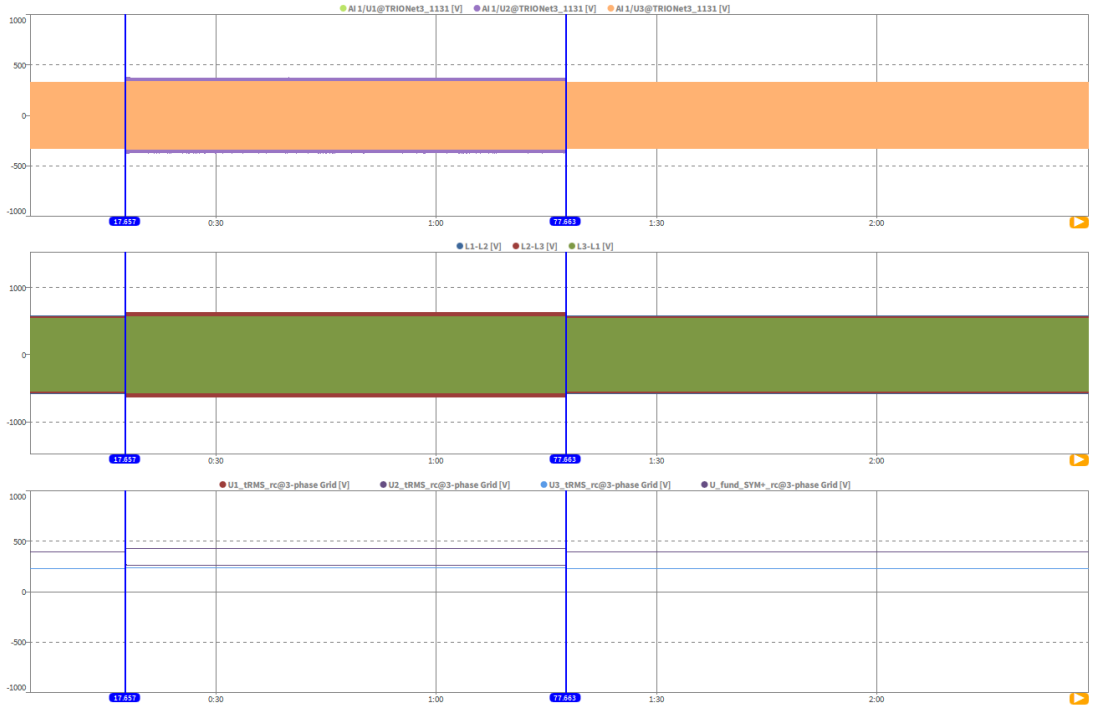
MST-BIE5-2500

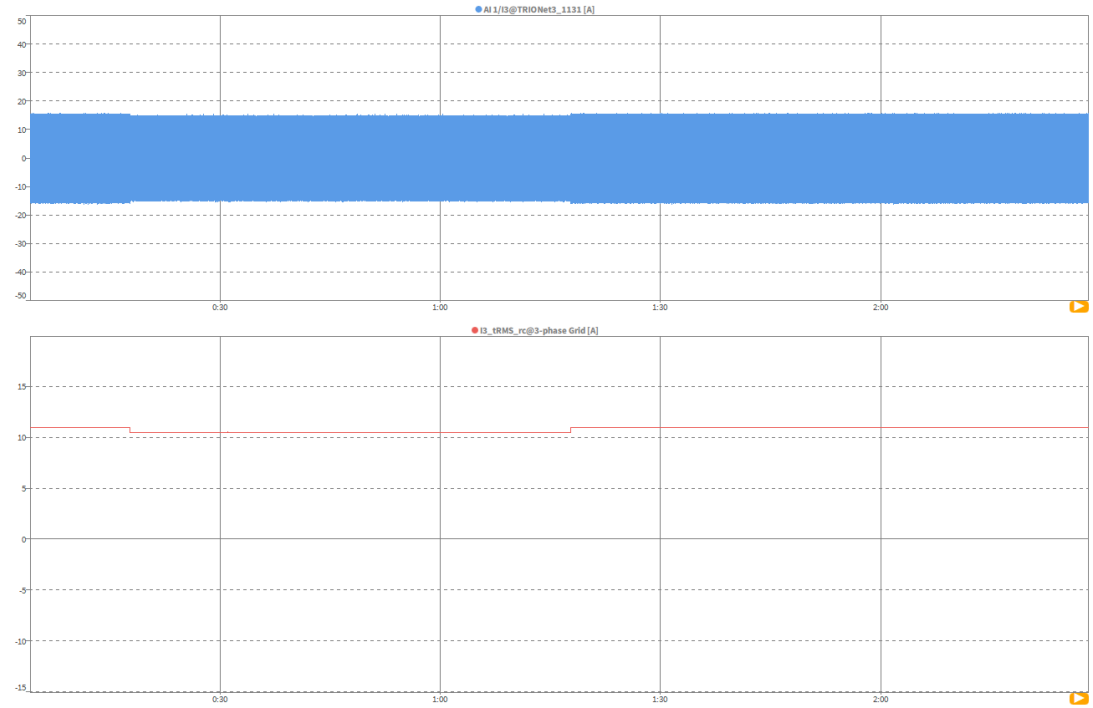
7.3

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7,3
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:22:17
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	17657
	7	Point of fault clearance	Total	--	ms	77663
	8	Fault duration in empty load test	Total	--	ms	60006
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,039
	10		Total (Phase 2)			1,148
	11		Total (Phase 3)			1,039
	12		Positive sequence			1,069
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	1,007
	17	Active power	Total	t1-10s to t1	p.u.	1,006
	18		Pos.			1,006
	19	Reactive power	Total	t1-10s to t1	p.u.	0,037
	20		Pos.			0,008
	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.	1,039
	23		Phase 2			1,148
	24		Phase 3			1,039
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,974
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,962
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	1,001
	32		Pos.			1,001
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	1,007
	37		Pos.			1,007
	38	Active power rising time	Total	--	s	0,049
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,036
	40		Pos.			0,007
	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

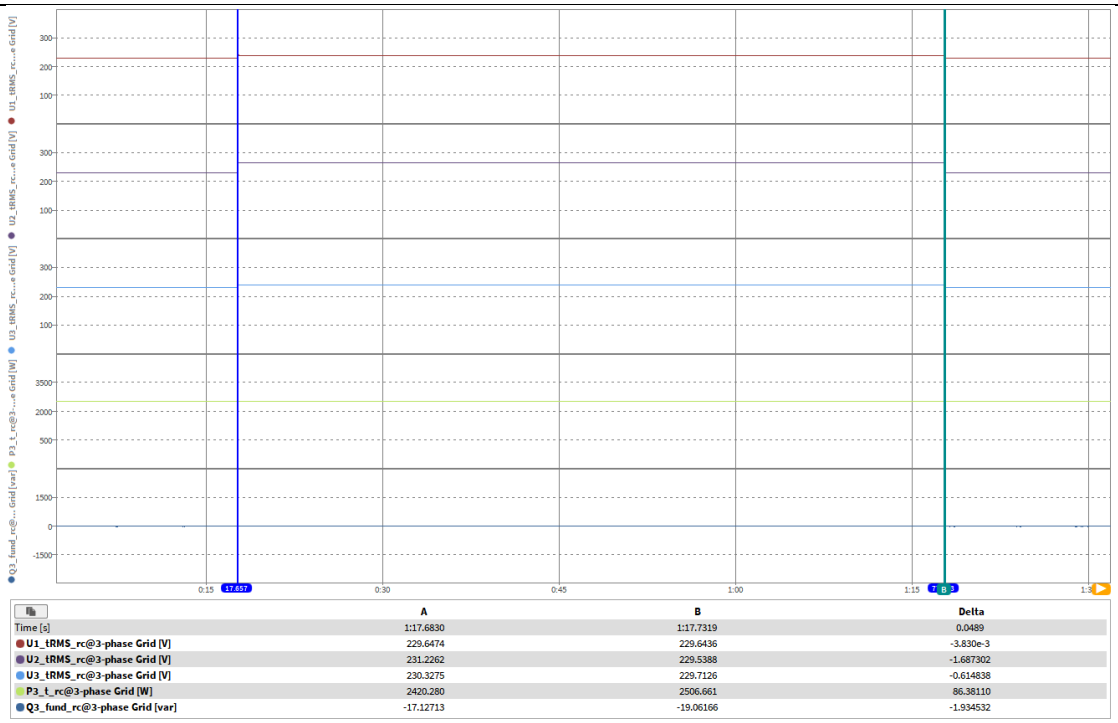
MST-BIE5-2500



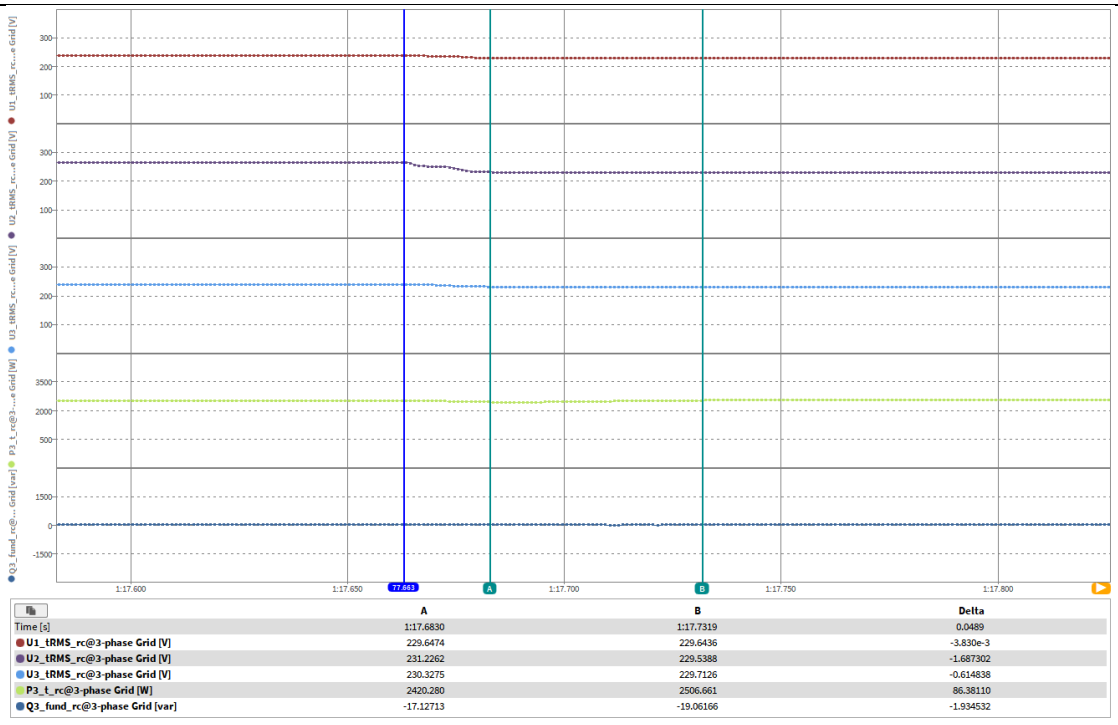


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:17.6830	1:17.7319	0.0489
U1_tRMS_rc@3-phase Grid [V]	229.6474	229.6436	-3.830e-3
U2_tRMS_rc@3-phase Grid [V]	231.2262	229.5388	-1.687302
U3_tRMS_rc@3-phase Grid [V]	230.3275	229.7126	-0.614838
P3_t_rc@3-phase Grid [W]	2420.280	2506.661	86.38110
Q3_fund_rc@3-phase Grid [var]	-17.12713	-19.06166	-1.934532



	A	B	Delta
Time [s]	1:17.6830	1:17.7319	0.0489
U1_tRMS_rc@3-phase Grid [V]	229.6474	229.6436	-3.830e-3
U2_tRMS_rc@3-phase Grid [V]	231.2262	229.5388	-1.687302
U3_tRMS_rc@3-phase Grid [V]	230.3275	229.7126	-0.614838
P3_t_rc@3-phase Grid [W]	2420.280	2506.661	86.38110
Q3_fund_rc@3-phase Grid [var]	-17.12713	-19.06166	-1.934532

5.8.3	For PGUs Type 2 and storage systems	P

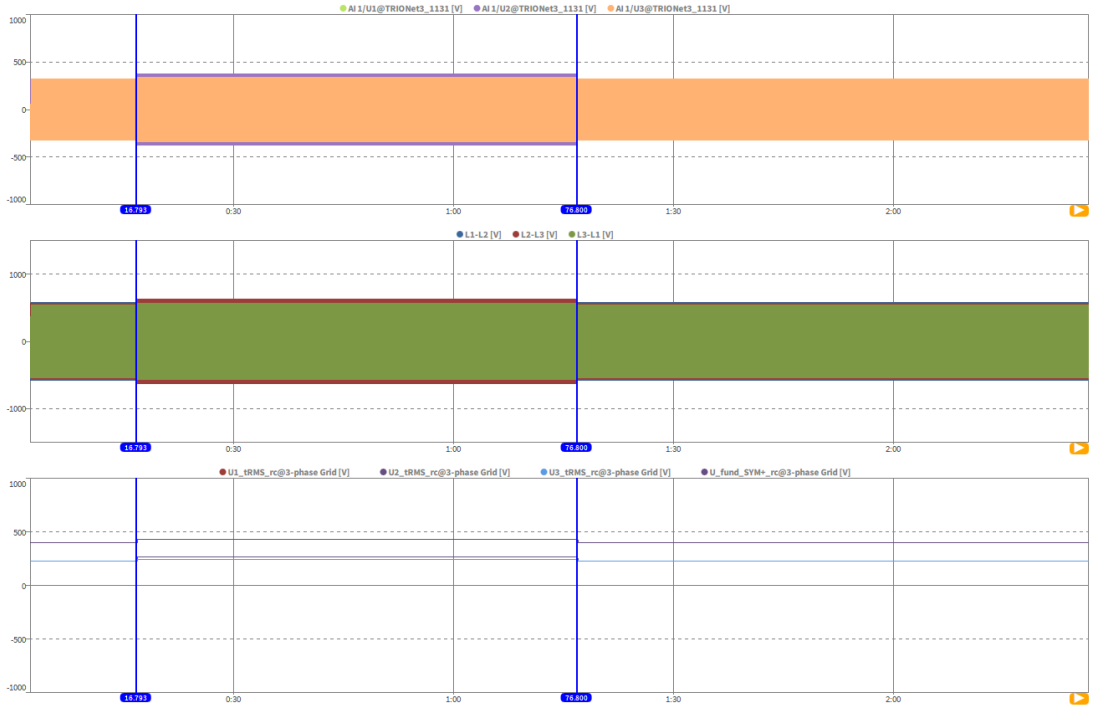
MST-BIE5-2500

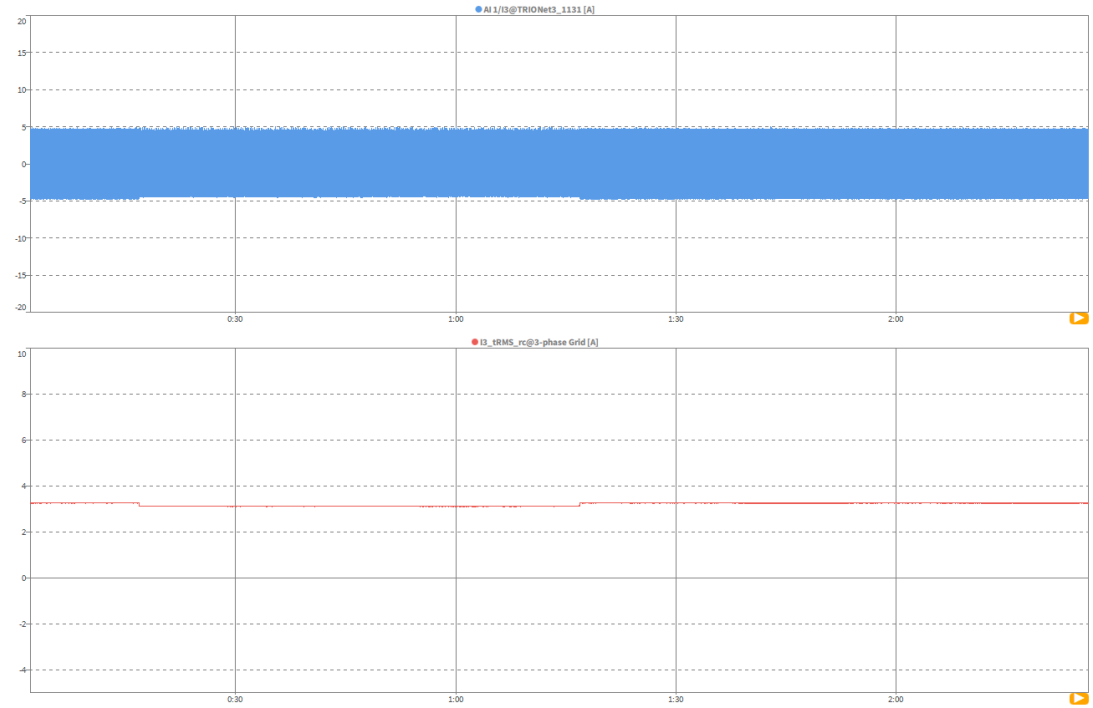
7.4

Condition						Measured value
Item	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	7,4
	1	Date	--	--	yyyy.mm.dd	2025/9/13
	2	Time (start of test)	--	--	hh:mm:ss.f	14:32:25
	3	Fault type (phase)	--	--	--	D1
	4	Setting voltage depth	Line to line	--	p.u.	1,15
	5	Setting dip duration		--	--	60000
	6	Point of fault entry	Total	--	ms	16793
	7	Point of fault clearance	Total	--	ms	76800
	8	Fault duration in empty load test	Total	--	ms	60007
	9	Voltage depth/height in empty load test	Total (Phase 1)	t1+100ms to t2 and t1-10s to t1	p.u.	1,038
	10		Total (Phase 2)			1,145
	11		Total (Phase 3)			1,039
	12		Positive sequence			1,070
Before dip <t1	13	Voltage	Phase 1	t1-10s to t1	p.u.	0,999
	14		Phase 2			0,998
	15		Phase 3			0,999
	16	Current	Pos.	t1-500ms to t1-100ms	p.u.	0,299
	17	Active power	Total	t1-10s to t1	p.u.	0,299
	18		Pos.			0,299
	19	Reactive power	Total	t1-10s to t1	p.u.	0,014
	20		Pos.			0,001
	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.	1,038
	23		Phase 2			1,145
	24		Phase 3			1,039
	25	Line current	Phase 1	t1+60ms	p.u.	--
	26		Phase 2			--
	27		Phase 3			0,291
	28	Line current	Phase 1	t1+100ms	p.u.	--
	29		Phase 2			--
	30		Phase 3			0,287
	31	Active power	Total	t1+100ms to t2-20ms	p.u.	0,298
	32		Pos.			0,298
After dip > t2	33	Voltage	Phase 1	t2+3s to t2+10s	p.u.	0,999
	34		Phase 2			0,998
	35		Phase 3			0,999
	36	Active power	Total	t2+3s to t2+10s	p.u.	0,299
	37		Pos.			0,299
	38	Active power rising time	Total	--	s	0,048
	39	Reactive power	Total	t2+3s to t2+10s	p.u.	0,014
	40		Pos.			0,001
	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

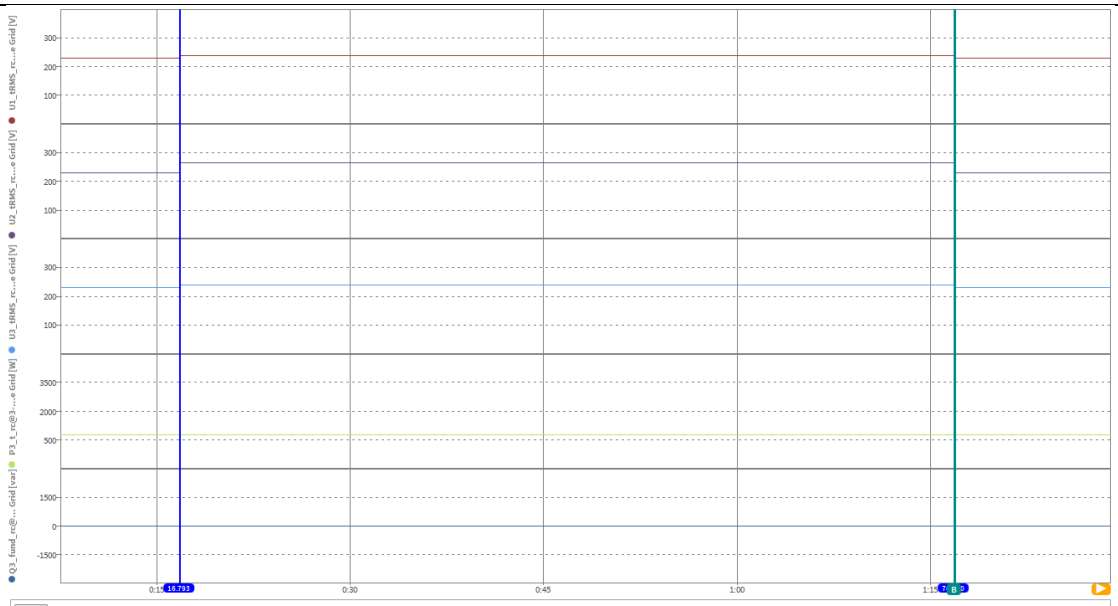
MST-BIE5-2500



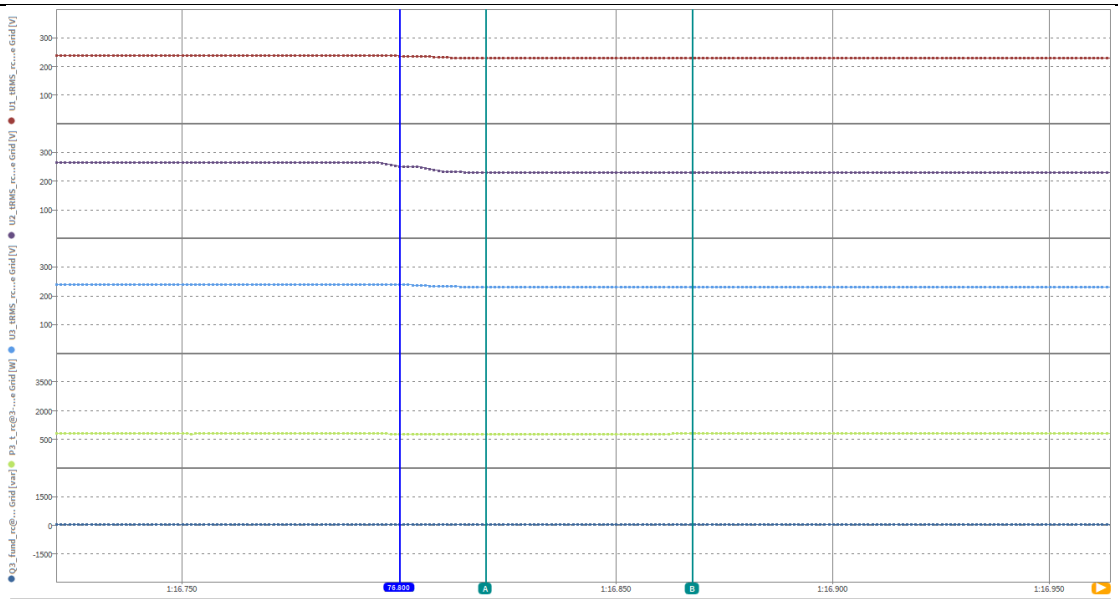


5.8.3	For PGUs Type 2 and storage systems	P

MST-BIE5-2500



	A	B	Delta
Time [s]	1:16.8200	1:16.8677	0.0477
U1_tRMS_rc@3-phase Grid [V]	229.6282	229.6462	0.017990
U2_tRMS_rc@3-phase Grid [V]	229.5104	229.5376	0.027191
U3_tRMS_rc@3-phase Grid [V]	229.7963	229.8123	0.016006
P3_t_rc@3-phase Grid [W]	720.0394	749.1108	29.07147
Q3_fund_rc@3-phase Grid [var]	1.063808	-2.979999	-4.043807



	A	B	Delta
Time [s]	1:16.8200	1:16.8677	0.0477
U1_tRMS_rc@3-phase Grid [V]	229.6282	229.6462	0.017990
U2_tRMS_rc@3-phase Grid [V]	229.5104	229.5376	0.027191
U3_tRMS_rc@3-phase Grid [V]	229.7963	229.8123	0.016006
P3_t_rc@3-phase Grid [W]	720.0394	749.1108	29.07147
Q3_fund_rc@3-phase Grid [var]	1.063808	-2.979999	-4.043807

Annex 2 – Pictures of the unit

Enclosure front view

Enclosure rear side view

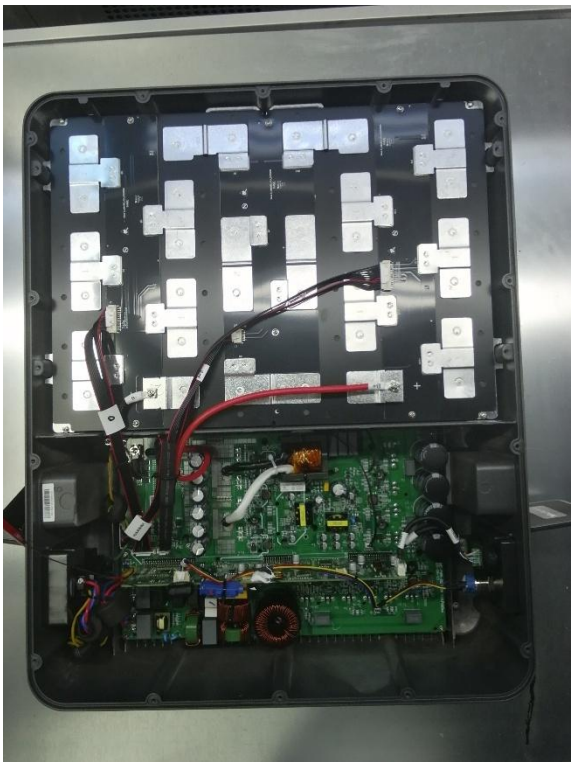
Enclosure side view-1

Enclosure side view-2

Enclosure TOP view

Enclosure bottom view

Enclosure internal view



Annex 3 – Test equipment list

Date(s) of performance of tests: 2025-09-03 to 2025-11-23

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
AC source	HC-ENG-030	KEWELL	KAC-45-345-33	6018888220300485	Monitored by Power Analyzer
DC source	HC-ENG-043	KEWELL	S7000-21K-2000-0040	6018888221003326	
RLC load	HC-ENG-005	Qunling Energy Resources	ACLT-3803H	93H006289	
RCD Load	HC-ENG-059	LYNS-Tci	IMAX5345-45KVA	20230415013	
Power analyser	HC-ENG-029	DEWETRON	TRION-1820-POWER	ACLT-3803H	2026-03-20
Current sensor	HC-ENG-029-001	SIGNALTEC	CT 400	1221300587	2026-03-20
	HC-ENG-029-002	SIGNALTEC	CT 400	1221300588	2026-03-20
	HC-ENG-029-003	SIGNALTEC	CT 400	1221300595	2026-03-20
	HC-ENG-029-004	SIGNALTEC	CT 400	1221300596	2026-03-20
Humidity & Temperature recorder	HC-ENG-002	Jiangsu Jingchuang Electric Co., Ltd.	GSP-8A	CMA215000031	2026-03-23

---End of test report--