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Evaluation Report
No. TRPVP05149/24E/05

Commission test for Hybrid Inverter

Applicant:	**Huizhou Foryou Optoelectronics Technology Co., LTD** Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China
File No.:	PVP05149/24E-05

Designed: by: Barry Yuan Digitally signed by Yuan Yong Date: 2024.08.05 15:52:26 +08'00'

Reviewed: by: Owen Gu Digitally signed by Owen Gu Date: 2024.08.05 16:30:38 +08'00'

TÜVNORD

Evaluation Report

File No.: PVP05149/24E-05 Report No.: TRPVP05149/24E/05

Applicant .... :	**Huizhou Foryou Optoelectronics Technology Co., LTD** Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China
Manufacturer .... :	**Huizhou Foryou Optoelectronics Technology Co., LTD** Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China
Factory...................................... :	**Huizhou Foryou Optoelectronics Technology Co., LTD** Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China
Order No. .... :	QT-PVP05149/24E
Date of Application [YYYY-MM-DD]... :	2024-06-05
Product(s) .... :	Hybrid Inverter
Model type(s)............................. :	EAG05K3L, EAG06K3L, EAG07K3L, EAG08K3L, EAG10K3L, EAG12K3L
Type of examination .... :	Commission testing only
Certification program: .... :	BOS-P-01 Rev. 00
Certification fundamental(s)....... :	DIN VDE V 0124-100:2020-06 VDE-AR-N 4105:2018
Testing Period [YYYY-MM-DD] start/end.................................... :	2024-06-30/2024-08-01
Testing Laboratory..................... :	**Dongguan BALUN Testing Technology Co., Ltd.** Room 104, 204, 205, Building 1, No. 6, Industrial South Road, Songshan Lake District, Dongguan, Guangdong, China
Annex(es) .... :	Annex 1: Test report no. BL-DG2480010-203 (248 pages)

Test results listed in this test report refer exclusively to the mentioned test sample.

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The submitted test samples as described in the reports hereunder are in compliance with the requirements / are tested according to the requirements:

VDE-AR-N 4105:2018 “Generators connected to the low-voltage distribution network –Technical requirements for the connection to and parallel operation with low-voltage distribution networks”
DIN VDE V 0124-100:2020-06 “Test requirements for generation units to be connected and operated parallel with the low voltage distribution networks”.

ilac-MRA CNAS 中国认可 国际互认 检测 TESTING CNAS L14701

TEST REPORT

Application number:	PVP05149/24E-05
Applicant:	Huizhou Foryou Optoelectronics Technology Co., LTD
Address:	Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China
Equipment Type:	Hybrid Inverter
Model Name:	EAG05K3L, EAG06K3L, EAG07K3L, EAG08K3L, EAG10K3L, EAG12K3L
Brand Name:	ADAYO
Ratings:	See copy of marking label and model list.
Test Standard:	**VDE-AR-N 4105:2018** **DIN VDE V 0124-100:2020-06**
Sample Arrival Date:	Jun. 30, 2024
Test Date:	Jun. 30, 2024 to Aug. 01, 2024
Date of Issue:	Aug. 02, 2024

ISSUED BY:

Dongguan BALUN Testing Technology Co., Ltd.

Tested by: Leo Sun

Leo Sun

Checked by: Tao Zheng

Tao Zheng

Approved by: Simon Qi

Simon Qi

CERTIFICATION • CONSULTING • SOLUTIONS • SERVICE BALUN Dongguan

Revision History

Version	Issue Date	Revisions Content
Rev. 01	Aug. 02, 2024	Initial Issue

List of Attachments:

None.

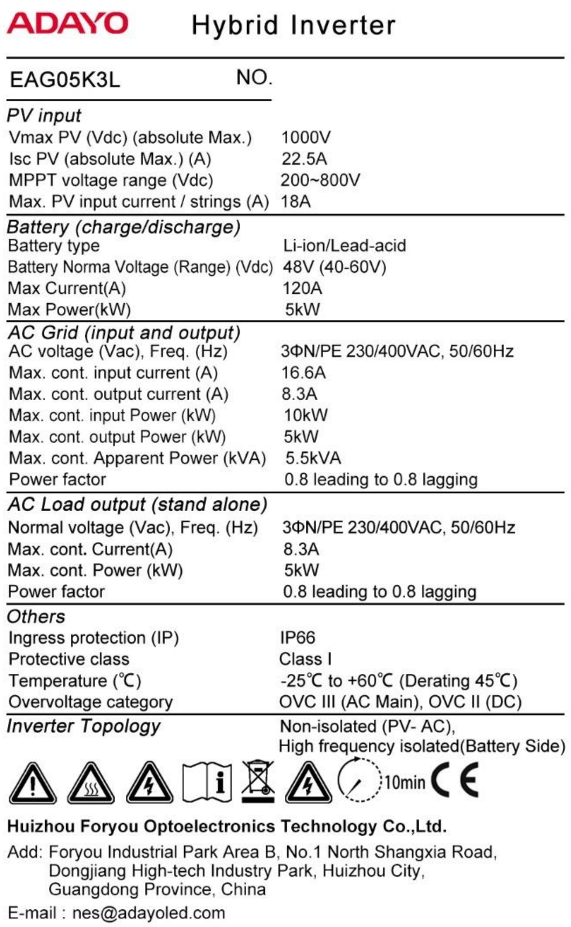
Summary of testing:

All the tests results confirmed to the requirements of the standard.

Tests performed (name of test and test clause):	**Testing location:**
5.2 Evidence of permissible network perturbations 5.3 Evidence of symmetry behaviour of inverters 5.4 Evidence of the behaviour of the generating unit on the network 5.5 NS-protection 5.6 Connecting conditions and synchronization 5.8 Evidence dynamic grid support	Dongguan BALUN Testing Technology Co., Ltd. Room 104, 204, 205, Building 1, No. 6, Industrial South Road, Songshan Lake District, Dongguan, Guangdong, China

☒ **The product fulfils the requirements of VDE-AR-N 4105:2018 & DIN VDE V 0124-100:2020-06**

Copy of marking plate:



ADAYO Hybrid Inverter

EAG05K3L NO.

PV input	
Vmax PV (Vdc) (absolute Max.)	1000V
Isc PV (absolute Max.) (A)	22.5A
MPPT voltage range (Vdc)	200~800V
Max. PV input current / strings (A)	18A
Battery (charge/discharge)	
Battery type	Li-ion/Lead-acid
Battery Norma Voltage (Range) (Vdc)	48V (40-60V)
Max Current(A)	120A
Max Power(kW)	5kW
AC Grid (input and output)	
AC voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. input current (A)	16.6A
Max. cont. output current (A)	8.3A
Max. cont. input Power (kW)	10kW
Max. cont. output Power (kW)	5kW
Max. cont. Apparent Power (kVA)	5.5kVA
Power factor	0.8 leading to 0.8 lagging
AC Load output (stand alone)	
Normal voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. Current(A)	8.3A
Max. cont. Power (kW)	5kW
Power factor	0.8 leading to 0.8 lagging
Others	
Ingress protection (IP)	IP66
Protective class	Class I
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)
Overvoltage category	OVC III (AC Main), OVC II (DC)
Inverter Topology	Non-isolated (PV- AC), High frequency isolated(Battery Side)

10min CE

Huizhou Foryou Optoelectronics Technology Co.,Ltd.

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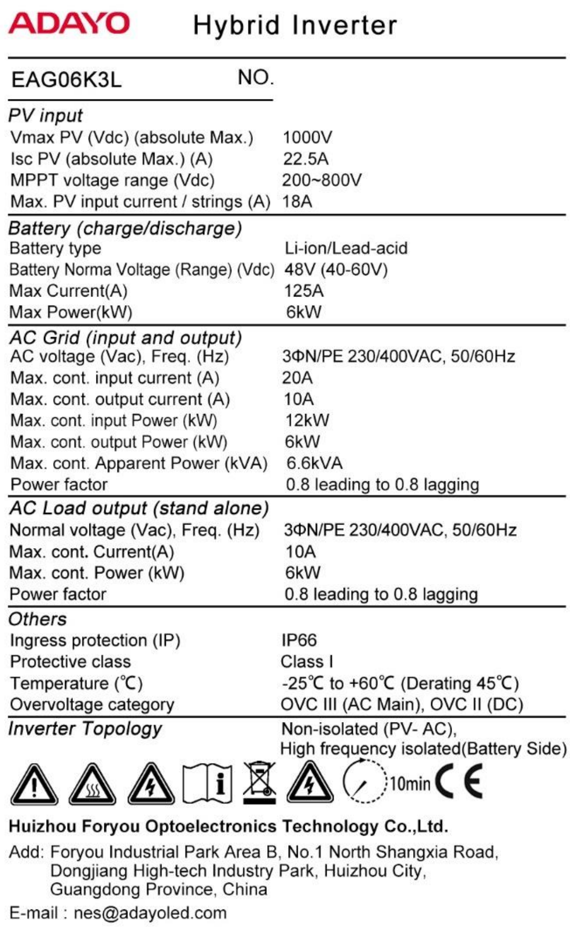

ADAYO Hybrid Inverter

EAG06K3L NO.

PV input	
Vmax PV (Vdc) (absolute Max.)	1000V
Isc PV (absolute Max.) (A)	22.5A
MPPT voltage range (Vdc)	200~800V
Max. PV input current / strings (A)	18A
Battery (charge/discharge)	
Battery type	Li-ion/Lead-acid
Battery Norma Voltage (Range) (Vdc)	48V (40-60V)
Max Current(A)	125A
Max Power(kW)	6kW
AC Grid (input and output)	
AC voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. input current (A)	20A
Max. cont. output current (A)	10A
Max. cont. input Power (kW)	12kW
Max. cont. output Power (kW)	6kW
Max. cont. Apparent Power (kVA)	6.6kVA
Power factor	0.8 leading to 0.8 lagging
AC Load output (stand alone)	
Normal voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. Current(A)	10A
Max. cont. Power (kW)	6kW
Power factor	0.8 leading to 0.8 lagging
Others	
Ingress protection (IP)	IP66
Protective class	Class I
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)
Overvoltage category	OVC III (AC Main), OVC II (DC)
Inverter Topology	Non-isolated (PV- AC), High frequency isolated(Battery Side)

10min CE

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ADAYO Hybrid Inverter

EAG07K3L NO.

PV input	
Vmax PV (Vdc) (absolute Max.)	1000V
Isc PV (absolute Max.) (A)	22.5A
MPPT voltage range (Vdc)	200~800V
Max. PV input current / strings (A)	18A
Battery (charge/discharge)	
Battery type	Li-ion/Lead-acid
Battery Norma Voltage (Range) (Vdc)	48V (40-60V)
Max Current(A)	150A
Max Power(kW)	7kW
AC Grid (input and output)	
AC voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. input current (A)	23.2A
Max. cont. output current (A)	11.6A
Max. cont. input Power (kW)	14kW
Max. cont. output Power (kW)	7kW
Max. cont. Apparent Power (kVA)	7.7kVA
Power factor	0.8 leading to 0.8 lagging
AC Load output (stand alone)	
Normal voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. Current(A)	11.6A
Max. cont. Power (kW)	7kW
Power factor	0.8 leading to 0.8 lagging
Others	
Ingress protection (IP)	IP66
Protective class	Class I
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)
Overvoltage category	OVC III (AC Main), OVC II (DC)
Inverter Topology	Non-isolated (PV- AC), High frequency isolated(Battery Side)

10min

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ADAYO Hybrid Inverter

EAG08K3L NO.

PV input	
Vmax PV (Vdc) (absolute Max.)	1000V
Isc PV (absolute Max.) (A)	22.5A/22.5A
MPPT voltage range (Vdc)	200~800V
Max. PV input current / strings (A)	18A/18A
Battery (charge/discharge)	
Battery type	Li-ion/Lead-acid
Battery Norma Voltage (Range) (Vdc)	48V (40-60V)
Max Current(A)	190A
Max Power(kW)	8kW
AC Grid (input and output)	
AC voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. input current (A)	26.6A
Max. cont. output current (A)	13.3A
Max. cont. input Power (kW)	16kW
Max. cont. output Power (kW)	8kW
Max. cont. Apparent Power (kVA)	8.8kVA
Power factor	0.8 leading to 0.8 lagging
AC Load output (stand alone)	
Normal voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. Current(A)	13.3A
Max. cont. Power (kW)	8kW
Power factor	0.8 leading to 0.8 lagging
Others	
Ingress protection (IP)	IP66
Protective class	Class I
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)
Overvoltage category	OVC III (AC Main), OVC II (DC)
Inverter Topology	Non-isolated (PV- AC), High frequency isolated(Battery Side)

10min

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ADAYO Hybrid Inverter

EAG10K3L NO.

PV input	
Vmax PV (Vdc) (absolute Max.)	1000V
Isc PV (absolute Max.) (A)	45A/22.5A
MPPT voltage range (Vdc)	200~800V
Max. PV input current / strings (A)	36A/18A
Battery (charge/discharge)	
Battery type	Li-ion/Lead-acid
Battery Norma Voltage (Range) (Vdc)	48V (40-60V)
Max Current(A)	210A
Max Power(kW)	10kW
AC Grid (input and output)	
AC voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. input current (A)	33.4A
Max. cont. output current (A)	16.7A
Max. cont. input Power (kW)	20kW
Max. cont. output Power (kW)	10kW
Max. cont. Apparent Power (kVA)	11kVA
Power factor	0.8 leading to 0.8 lagging
AC Load output (stand alone)	
Normal voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. Current(A)	16.7A
Max. cont. Power (kW)	10kW
Power factor	0.8 leading to 0.8 lagging
Others	
Ingress protection (IP)	IP66
Protective class	Class I
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)
Overvoltage category	OVC III (AC Main), OVC II (DC)
Inverter Topology	Non-isolated (PV- AC), High frequency isolated(Battery Side)

10min

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ADAYO Hybrid Inverter

EAG12K3L NO.

PV input	
Vmax PV (Vdc) (absolute Max.)	1000V
Isc PV (absolute Max.) (A)	45A/22.5A
MPPT voltage range (Vdc)	200~800V
Max. PV input current / strings (A)	36A/18A
Battery (charge/discharge)	
Battery type	Li-ion/Lead-acid
Battery Norma Voltage (Range) (Vdc)	48V (40-60V)
Max Current(A)	250A
Max Power(kW)	12kW
AC Grid (input and output)	
AC voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. input current (A)	40A
Max. cont. output current (A)	20A
Max. cont. input Power (kW)	24kW
Max. cont. output Power (kW)	12kW
Max. cont. Apparent Power (kVA)	13.2kVA
Power factor	0.8 leading to 0.8 lagging
AC Load output (stand alone)	
Normal voltage (Vac), Freq. (Hz)	3ΦN/PE 230/400VAC, 50/60Hz
Max. cont. Current(A)	20A
Max. cont. Power (kW)	12kW
Power factor	0.8 leading to 0.8 lagging
Others	
Ingress protection (IP)	IP66
Protective class	Class I
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)
Overvoltage category	OVC III (AC Main), OVC II (DC)
Inverter Topology	Non-isolated (PV- AC), High frequency isolated(Battery Side)

10min

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Test item particulars... :	
Equipment mobility .... :	Permanent connection
Operating condition.. :	Continuous
Class of equipment... :	Class I
Mass of equipment (kg) .... :	38kg
Possible test case verdicts:	
- test case does not apply to the test object...........:	N/A
- test object does meet the requirement..................:	P (Pass)
- test object was not evaluated for the requirement:	N/E
- test object does not meet the requirement...........:	F (Fail)

General remarks:	
"(See Enclosure #)" 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.**	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided .... :	☐ **Yes** ☒ **Not applicable**
When differences exist; they shall be identified in the General product information section.	
Name and address of Manufacturer (ies)............... :	**Huizhou Foryou Optoelectronics Technology Co., LTD** Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China
Name and address of factory (ies) .... :	**Huizhou Foryou Optoelectronics Technology Co., LTD** Building 6, B Area, No.1 North Shangxia Road, Dongjiang High-Tech Industry Park, Huizhou City, Guangdong Province, China

General product information:

The PCE under test (EUT) is hybrid inverter. During inverter, which convert the variable DC power generated from the Photovoltaic combiner box (with MPPT function) or Batteries to the stable utility AC power which can be fed into the electrical grid or off-grid load. AC circuit is protected by a mechanical disconnection device (relay). During fault condition defined in this standard, after the CPU receives the abnormal signal from the relevant protective detection circuit, the contact or will operate to disconnect the PV inverter active lines from grid automatically.

Differences of the models:

EAG05K3L, EAG06K3L, EAG07K3L, EAG08K3L, EAG10K3L, EAG12K3L use the same software program, main control circuit, drive circuit and power topology of hardware design except the power de-rating by software.

The product has two different views just because the control screen is different.

Front view for all model		

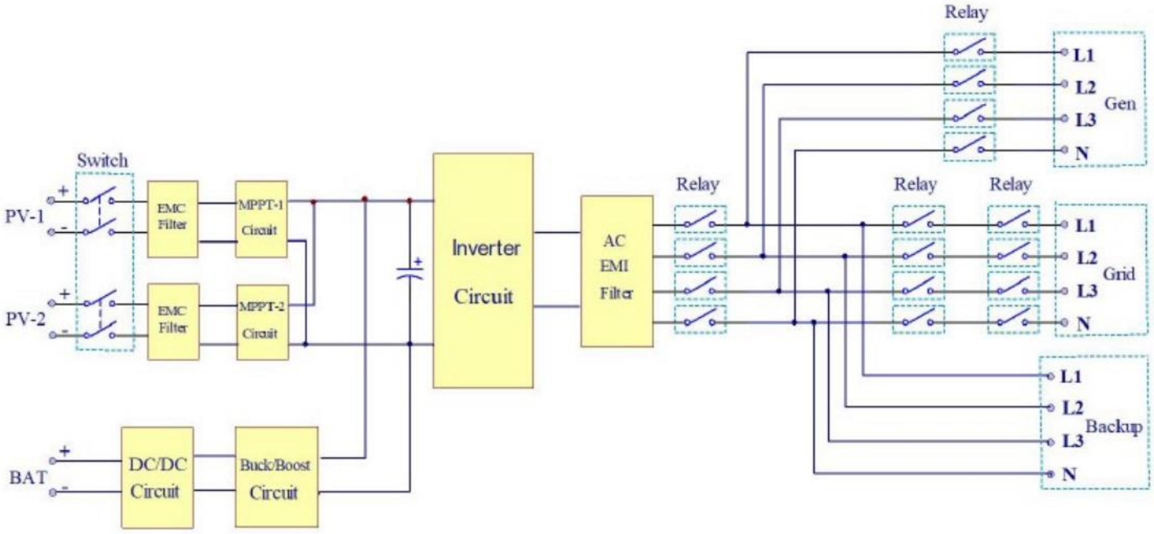
Hardware version: V1.0

Software version:

CPU1: V1.0

CPU2: V1.0

Block diagram:



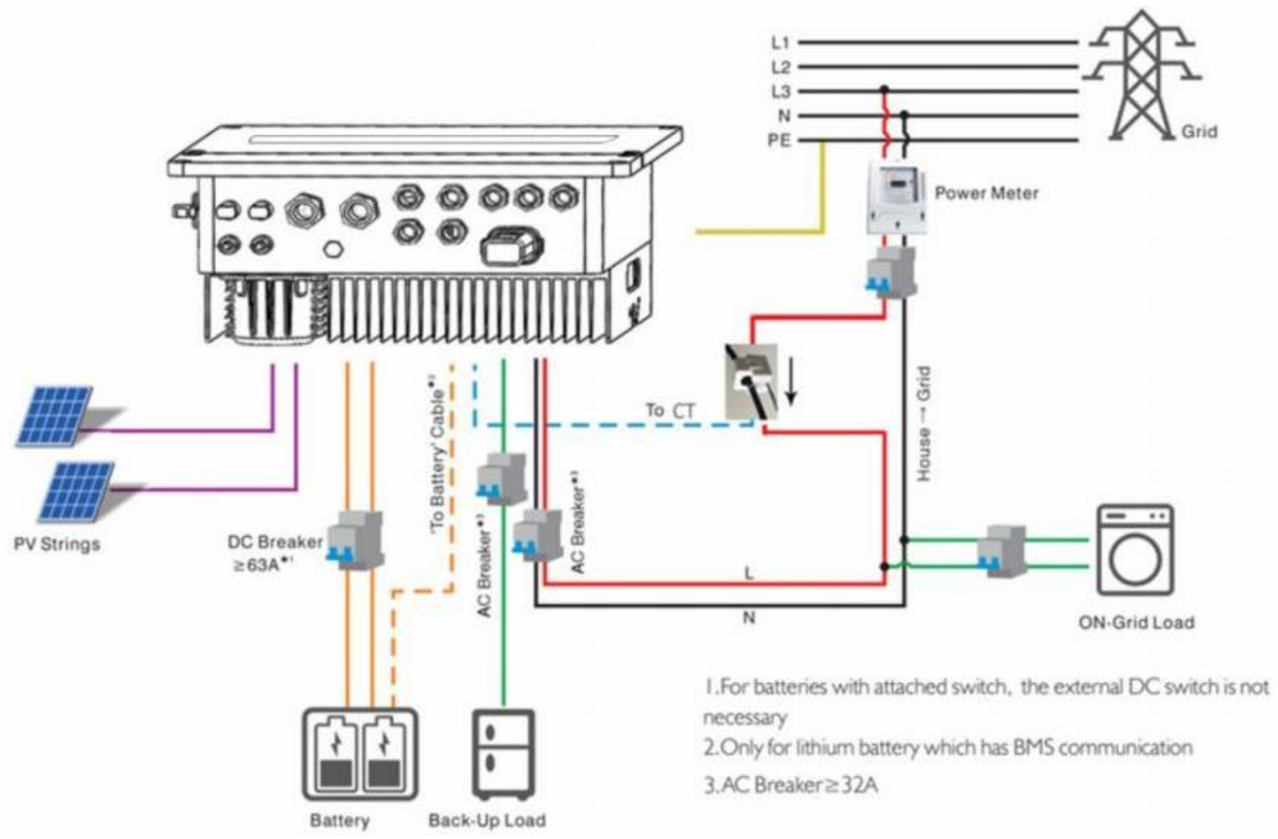
Model list:

Hybrid Inverter			
Model or Type designation	EAG05K3L	EAG06K3L	EAG07K3L
PV input parameters:			
V_{MAX} PV [Vd.c.]	1000		
MPP Voltage Range [Vd.c.]	200-800		
Max. PV Input Current [Ad.c.]	18		
DC Short-circuit current [Ad.c.]	22.5		
Battery parameters:			
Battery type	Li-ion/Lead-acid		
Battery Normal Voltage[Vd.c.]	48		
Max. Charge Current [Ad.c.]	120	125	150
Max. Discharge Current [Ad.c.]	120	125	150
AC output (Grid Side) parameters:			
Rated Output Voltage [Va.c.]	230/400 3W+N+PE		
Rated Output Frequency [Hz]	50/60		
Max. Output Power [kW]	5.0	6.0	7.0
Max. Apparent Power [kVA]	5.5	6.6	7.7
Max. Output Current [Aa.c.]	8.3	10.0	11.6
Power Factor cosφ [λ]	0.8(leading)-0.8(lagging)		
AC Load output (stand alone) parameters:			
Rated Output Voltage [Va.c.]	230/400 3W+N+PE		
Rated Output Frequency [Hz]	50/60		
Max. Output Power [kW]	5.0	6.0	7.0
Max. Output Current [Aa.c.]	8.3	10.0	11.6
Others:			
Protective Class	Class I		
Inverter Topology	Non-isolated		
Operation Temperature range[°C]	-25~60(Derating 45℃)		
Dimension[D*W*H mm]	475*683*256mm		

Weight[kg]	38kg		
Ingress protection	IP66		
Overvoltage-Category	DC (PV, Battery) II, AC(Main) III		
Hybrid Inverter			
Model or Type designation	EAG08K3L	EAG10K3L	EAG12K3L
PV input parameters:			
V_{MAX} PV [Vd.c.]	1000		
MPP Voltage Range [Vd.c.]	200-800		
Max. PV Input Current [Ad.c.]	18/18	36/18	36/18
DC Short-circuit current [Ad.c.]	22.5/22.5	45/22.5	45/22.5
Battery parameters:			
Battery type	Li-ion/Lead-acid		
Battery Normal Voltage[Vd.c.]	48		
Max. Charge Current [Ad.c.]	190	210	250
Max. Discharge Current [Ad.c.]	190	210	250
AC output (Grid Side) parameters:			
Rated Output Voltage [Va.c.]	230/400 3W+N+PE		
Rated Output Frequency [Hz]	50/60		
Max. Output Power [kW]	8.0	10.0	12.0
Max. Apparent Power [kVA]	8.8	11.0	13.2
Max. Output Current [Aa.c.]	13.3	16.7	20.0
Power Factor cosφ [λ]	0.8(leading)-0.8(lagging)		
AC Load output (stand alone) parameters:			
Rated Output Voltage [Va.c.]	230/400 3W+N+PE		
Rated Output Frequency [Hz]	50/60		
Max. Output Power [kW]	8.0	10.0	12.0
Max. Output Current [Aa.c.]	13.3	16.7	20.0
Others:			
Protective Class	Class I		
Inverter Topology	Non-isolated		

Operation Temperature Range[°C]	-25~60(Derating 45℃)
Dimension [D*W*H mm]	475*683*256mm
Weight [kg]	38kg
Ingress protection	IP66
Overvoltage-Category	DC (PV, Battery) II, AC(Main) III

Description of the remote control in a typical installation:



General remarks:

The test results presented in this report relate only to the object(s) tested.
This document may be published or passed on in full only.

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

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

- "P_N" for the nominal active power:

  $P_n = U_n \times I_n \times \cos\varphi_n$ (single-Phase); $P_n = \sqrt{3}\, U_n \times I_n \times \cos\varphi_n$ (single-phase)
- "_E0.2" for gliding average values over 200 milliseconds
- "_E60" for gliding average values over 60 seconds.
- "_E600" for gliding average values over 10 minutes.
- "(c)" for over-excited
- "(i)" for under-excited

Acronyms:

PGU: power generating unit

PGS: power generating system

The uncertainty of measurement was not given in test report, please see below information of measurement uncertainty:

- \- Voltage

  Type A uncertainty: u(Xi)=0.012 Combine standard uncertainty: Uc(%)=0.29

  Expansion uncertainty: U(%)=0.58 (factor k=2)
- \- Current

  Type A uncertainty: u(Xi)=0.011 Combine standard uncertainty: Uc(%)=0.49

  Expansion uncertainty: U(%)=0.98 (factor k=2)
- \- Power

  Type A uncertainty: u(Xi)=0.017 Combine standard uncertainty: Uc(%)=0.29

  Expansion uncertainty: U(%)=0.59 (factor k=2)
- \- Harmonics

  Error in Measurement: 0.04%
- \- Flicker

  Error in Measurement: 0.04%
- \- Current transducer

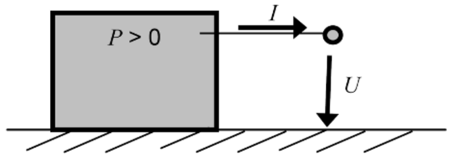
  Error in Measurement:

  DC current Urel=0.7% (factor k=2) AC current Urel=0.7% (factor k=2)

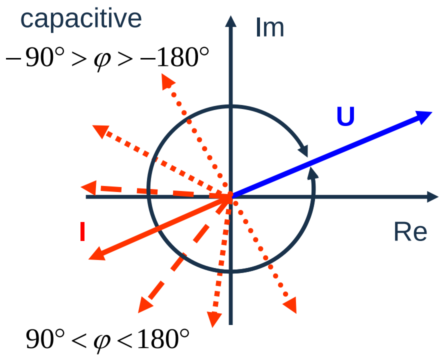
  Combine standard uncertainty: Uc(%)=0.49

The regarded system of the voltage and current vectors is the load view (Figure):

- If the inverter feeds to the grid the active power is measured with negative sign. For the sake of reading the document the measured active infeed power has a positive sign.



- If the inverter consumes inductive reactive power the reactive power is marked “inductive” or has a positive sign.
- If the inverter consumes capacitive reactive power the reactive power is marked “capacitive” or has a negative sign.



DIN VDE V 0124-100		
Clause	**Test**	**Result**
5.2	Evidence of permissible network perturbations	P
5.3	Evidence of symmetry behaviour of inverters	P
5.4	Evidence of the behaviour of the generating unit on the network	P
5.5	NS-protection	P
5.6	Connecting conditions and synchronization	P
5.7	Evidence of $P_{AV,E}$-Control	P
5.8	Evidence dynamic grid support	P
5.9	Test of Ancillary Unit	N/A

5.2 Evidence of permissible network perturbations		
Clause	**Test**	**Result**
5.2.1	General	P
5.2.2	Rapid voltage changes	P
5.2.3	Flicker	P
5.2.4	Harmonics and interharmonics, higher-frequency harmonic	P
5.2.4.1 a)	Test Harmonics DIN EN 61000-3-2 (≤16 A per Phase)	N/A
5.2.4.1 a)	Test Harmonics DIN EN 61000-3-12 (≥16 A and ≤75 A per Phase)	P
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

5.2.1 **General** These tests are designed to provide evidence that the requirements of VDE-AR-N 4105, 5.4 are met.	**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 These tests are designed to provide evidence that the requirements of VDE-AR-N 4105, 5.4.2 are met.	P

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

The following three cases must be tested to VDE-AR-N 4105.

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

Test conditions:

Frequency: 50 Hz ± 0.5%

THD of the voltage supply: ≤ 2.5 %

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

Model: EAG12K3L

Switch-on for any capacity (10% P_n)			
	L1	L2	L3
Single period effective values of the current [A]	1.01	0.83	0.81
Single period effective values of the voltage [V]	229.8	230.5	230.1
ki value	0.59	0.49	0.48
kimax value	0.59		
Switch-on for nominal capacity			
	L1	L2	L3
Single period effective values of the current [A]	0.82	0.79	0.91
Single period effective values of the voltage [V]	230.6	230.3	230.9
ki value	0.05	0.05	0.05
kimax value	0.05		
Switch-off for nominal capacity			
	L1	L2	L3
Single period effective values of the current [A]	12.70	12.14	11.62
Single period effective values of the voltage [V]	230.3	230.8	230.2
ki value	0.73	0.70	0.67
kimax value	0.73		
Highest k_{imax} value for all switching operations			
0.73			

5.2.3 Flicker These tests are designed to provide evidence that the requirements of VDE-AR-N 4100:2019-09 are met.
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) - For PGUs and PSUs intended for PGSs 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: ≤ 2.5 % Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %

Model: EAG12K3L			
Flicker to DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 (VDE 0838-11) for generator units ≤ 75 A			
Test Conditions: 100%Pn			
Flicker to:	Result:		
	P_{lt}	P_{st}	*dc%*
DIN EN 61000-3-11	0.84	0.118	0.013
Limit	0.5	0.75	3.3
Assessment criterion: Long-term flicker strength: P_{lt}≤0.5			

Flicker to DIN EN 61400-21 (VDE 0127-21) (or FGW TR3)	
Grid impedance angle ψ_k	32.00°
Flicker coefficient $c(\psi_k)$	0.271
Short-term flicker P_{st}	0.013
The table entries are worst case values.	
Assessment criterion: Determination of the flicker coefficient: $c(\psi_k)$ = Pst * (Sk / Pn) R_A=0.15 Ω jX_A=0.15 Ω R_N=0.10 Ω jX_N=0.10 Ω	

5.2.4 **Harmonics and interharmonics** 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 harmonic currents must be verified as followed:

- For nominal currents ≤ 16 A per conductor to DIN EN 61000-3-2 (VDE 0838-2)
- For nominal currents > 16 A and ≤ 75 A per conductor to DIN EN 61000-3-12 (VDE 0838-12)
- For PGUs intended for PGSs with nominal currents > 75 A, the measurements must be conducted as in table 1 of cl.5.4.2.2.2 .

Test conditions:

Voltage: 86% U_n to 109% U_n

Frequency: 50 Hz ± 0.5%

THD of the voltage supply: ≤ 2.5 %

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

Samplerate:≥20 kHz

5.2.4.1 a)	Test Harmonics DIN EN 61000-3-12 (> 16 A and ≤ 75 A per Phase)						P
Model: EAG12K3L							
Power Level	**33%**		**66%**		**100%**		**Limits of DIN EN 61000-3-12 [%]**
Harmonic	**Current Magnitude (A)**	**% of Funda-mental**	**Current Magnitude (A)**	**% of Funda-mental**	**Current Magnitude (A)**	**% of Funda-mental**	
2nd	0.025	0.142	0.051	0.292	0.075	0.429	-
3rd	0.037	0.211	0.075	0.433	0.113	0.652	8.0
4th	0.012	0.068	0.025	0.142	0.034	0.198	-
5th	0.010	0.058	0.020	0.114	0.029	0.169	4.0
6th	0.015	0.085	0.030	0.175	0.043	0.247	10.7
7th	0.018	0.101	0.036	0.210	0.055	0.317	2.67
8th	0.015	0.083	0.033	0.188	0.043	0.245	7.2
9th	0.013	0.073	0.025	0.145	0.036	0.205	2.0
10th	0.008	0.047	0.018	0.105	0.024	0.138	-
11th	0.015	0.089	0.032	0.185	0.048	0.276	1.6
12th	0.009	0.052	0.019	0.110	0.028	0.160	3.1
13th	0.029	0.164	0.056	0.323	0.082	0.470	1.33
14th	0.010	0.055	0.020	0.115	0.029	0.170	2.0
15th	0.015	0.087	0.029	0.168	0.043	0.248	-
16th	0.012	0.067	0.028	0.160	0.030	0.175	-
17th	0.062	0.356	0.125	0.720	0.184	1.059	-
18th	0.007	0.038	0.014	0.082	0.022	0.124	-
19th	0.046	0.262	0.092	0.529	0.133	0.764	-
20th	0.009	0.053	0.020	0.115	0.028	0.160	-
21th	0.005	0.030	0.009	0.054	0.011	0.065	-
22th	0.002	0.013	0.005	0.031	0.008	0.043	-
23th	0.001	0.009	0.003	0.018	0.005	0.026	-
24th	0.001	0.007	0.002	0.013	0.005	0.027	-
25th	0.002	0.010	0.004	0.023	0.004	0.024	-

26th	0.002	0.013	0.004	0.021	0.005	0.029	-
27th	0.003	0.015	0.006	0.037	0.006	0.036	-
28th	0.004	0.021	0.008	0.045	0.011	0.061	-
29th	0.001	0.009	0.003	0.020	0.003	0.019	-
30th	0.007	0.041	0.015	0.087	0.022	0.129	-
31th	0.002	0.012	0.005	0.031	0.005	0.029	-
32th	0.001	0.005	0.002	0.009	0.002	0.013	-
33th	0.003	0.018	0.007	0.041	0.008	0.046	-
34th	0.006	0.032	0.011	0.066	0.016	0.092	-
35th	0.002	0.013	0.005	0.028	0.005	0.031	-
36th	0.009	0.051	0.018	0.106	0.027	0.157	-
37th	0.003	0.016	0.007	0.039	0.008	0.045	-
38th	0.001	0.004	0.001	0.007	0.002	0.013	-
39th	0.002	0.014	0.006	0.032	0.006	0.036	-
40th	0.002	0.012	0.002	0.012	0.002	0.012	-
THC [A]	0.105	-	0.215	-	0.312	-	-
THD [%]	-	0.605	-	1.234	-	1.795	13
PWHD [%]	-	2.011	-	4.092	-	5.921	22

Note: The normalization current is 17.4Aa.c..

The stated harmonics are maximum values of all 3 phases.

5.2.4.1 b) Tests	P

The currents of the interharmonics to 2 kHz must be measured in accordance with DIN EN 61000-4-7 (VDE 0817-4-7), Annex A. The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with DIN EN 61000-4-7 (VDE 0847-4-7), Annex B.

Model: EAG12K3L

Harmonics

P/P$_n$ [%]	0/5	10	20	30	40	50	60	70	80	90	100
Order	I [%	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2	0.021	0.043	0.083	0.121	0.173	0.220	0.254	0.300	0.344	0.391	0.432
3	0.032	0.066	0.131	0.193	0.259	0.333	0.388	0.447	0.506	0.586	0.656
4	0.010	0.020	0.038	0.057	0.083	0.098	0.116	0.141	0.166	0.180	0.191
5	0.008	0.017	0.033	0.051	0.067	0.084	0.101	0.121	0.133	0.151	0.168
6	0.013	0.025	0.048	0.073	0.103	0.124	0.150	0.178	0.205	0.225	0.243
7	0.016	0.032	0.063	0.092	0.125	0.160	0.185	0.212	0.243	0.284	0.315
8	0.014	0.027	0.046	0.064	0.109	0.119	0.130	0.169	0.217	0.236	0.224
9	0.011	0.021	0.040	0.062	0.085	0.102	0.124	0.152	0.171	0.187	0.201
10	0.008	0.015	0.027	0.038	0.062	0.068	0.076	0.096	0.123	0.133	0.131
11	0.014	0.028	0.055	0.080	0.110	0.139	0.160	0.188	0.215	0.250	0.274
12	0.008	0.016	0.031	0.044	0.064	0.079	0.089	0.107	0.127	0.145	0.153
13	0.025	0.048	0.094	0.143	0.191	0.237	0.289	0.347	0.383	0.425	0.469
14	0.008	0.017	0.032	0.049	0.067	0.087	0.101	0.114	0.132	0.152	0.171
15	0.013	0.025	0.050	0.077	0.101	0.125	0.154	0.187	0.203	0.225	0.247
16	0.012	0.022	0.031	0.039	0.094	0.084	0.081	0.130	0.190	0.190	0.148
17	0.054	0.108	0.210	0.319	0.426	0.533	0.637	0.754	0.841	0.959	1.055
18	0.006	0.011	0.023	0.033	0.049	0.065	0.073	0.082	0.097	0.111	0.126
19	0.040	0.079	0.152	0.229	0.315	0.389	0.465	0.556	0.622	0.703	0.764
20	0.008	0.017	0.030	0.043	0.069	0.081	0.086	0.108	0.134	0.152	0.155
21	0.004	0.008	0.013	0.021	0.032	0.032	0.044	0.063	0.067	0.066	0.063
22	0.002	0.005	0.009	0.014	0.019	0.022	0.026	0.028	0.037	0.040	0.045
23	0.007	0.013	0.025	0.038	0.054	0.066	0.078	0.093	0.105	0.121	0.128
24	0.002	0.003	0.005	0.007	0.011	0.014	0.016	0.017	0.022	0.023	0.029
25	0.001	0.002	0.006	0.008	0.008	0.013	0.016	0.017	0.016	0.021	0.026
26	0.002	0.003	0.005	0.009	0.013	0.013	0.018	0.019	0.027	0.025	0.027
27	0.002	0.003	0.006	0.010	0.013	0.015	0.020	0.028	0.027	0.027	0.030
28	0.003	0.005	0.007	0.008	0.022	0.017	0.015	0.027	0.045	0.043	0.028
29	0.003	0.007	0.013	0.019	0.026	0.031	0.036	0.045	0.054	0.057	0.060
30	0.002	0.002	0.004	0.006	0.012	0.009	0.012	0.017	0.025	0.020	0.018
31	0.006	0.013	0.026	0.037	0.051	0.065	0.072	0.084	0.100	0.116	0.127
32	0.002	0.004	0.005	0.007	0.018	0.014	0.015	0.022	0.036	0.034	0.023
33	0.001	0.001	0.003	0.004	0.005	0.007	0.008	0.011	0.011	0.011	0.013
34	0.003	0.006	0.008	0.011	0.025	0.023	0.023	0.035	0.049	0.049	0.040

35	0.005	0.010	0.019	0.028	0.039	0.046	0.054	0.067	0.078	0.086	0.091
36	0.002	0.004	0.006	0.009	0.016	0.015	0.020	0.026	0.034	0.032	0.029
37	0.008	0.016	0.031	0.046	0.063	0.079	0.092	0.107	0.124	0.142	0.155
38	0.003	0.005	0.008	0.011	0.023	0.022	0.023	0.032	0.045	0.047	0.040
39	0.001	0.001	0.003	0.003	0.004	0.006	0.007	0.008	0.008	0.011	0.013
40	0.002	0.004	0.006	0.008	0.019	0.017	0.018	0.027	0.039	0.039	0.030
Interharmonics at continuous operation											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
75	0.009	0.018	0.036	0.054	0.072	0.100	0.113	0.129	0.146	0.168	0.196
125	0.004	0.008	0.018	0.027	0.036	0.046	0.052	0.062	0.068	0.078	0.093
175	0.004	0.008	0.017	0.026	0.032	0.040	0.050	0.059	0.068	0.073	0.079
225	0.004	0.008	0.017	0.027	0.033	0.040	0.051	0.060	0.069	0.076	0.078
275	0.003	0.006	0.013	0.021	0.027	0.033	0.038	0.046	0.055	0.061	0.065
325	0.003	0.008	0.016	0.022	0.026	0.034	0.045	0.055	0.058	0.060	0.067
375	0.003	0.007	0.015	0.024	0.029	0.036	0.043	0.053	0.064	0.068	0.070
425	0.004	0.009	0.017	0.023	0.030	0.039	0.051	0.058	0.061	0.068	0.076
475	0.003	0.007	0.014	0.019	0.024	0.032	0.039	0.047	0.050	0.056	0.063
525	0.002	0.005	0.011	0.017	0.020	0.026	0.032	0.038	0.043	0.046	0.050
575	0.003	0.005	0.010	0.016	0.024	0.030	0.031	0.035	0.042	0.052	0.060
625	0.004	0.008	0.015	0.020	0.030	0.038	0.047	0.051	0.053	0.064	0.076
675	0.004	0.008	0.016	0.023	0.029	0.040	0.045	0.055	0.059	0.065	0.079
725	0.005	0.010	0.020	0.030	0.039	0.053	0.062	0.071	0.078	0.087	0.105
775	0.006	0.012	0.025	0.036	0.044	0.056	0.071	0.088	0.096	0.101	0.109
825	0.005	0.011	0.023	0.035	0.042	0.051	0.063	0.078	0.091	0.098	0.100
875	0.006	0.010	0.021	0.035	0.046	0.059	0.063	0.073	0.091	0.104	0.117
925	0.005	0.010	0.020	0.027	0.036	0.049	0.059	0.070	0.070	0.078	0.096
975	0.004	0.008	0.017	0.027	0.036	0.045	0.051	0.059	0.070	0.082	0.088
1025	0.004	0.008	0.017	0.023	0.028	0.038	0.048	0.058	0.061	0.065	0.075
1075	0.003	0.007	0.013	0.019	0.025	0.033	0.040	0.046	0.051	0.056	0.064
1125	0.003	0.006	0.012	0.018	0.023	0.027	0.033	0.041	0.048	0.053	0.053
1175	0.003	0.005	0.011	0.016	0.021	0.027	0.031	0.037	0.041	0.046	0.052
1225	0.002	0.005	0.011	0.015	0.019	0.025	0.031	0.037	0.039	0.043	0.048
1275	0.002	0.004	0.009	0.013	0.017	0.022	0.026	0.031	0.035	0.039	0.044
1325	0.002	0.004	0.009	0.013	0.016	0.021	0.026	0.031	0.035	0.037	0.041
1375	0.002	0.004	0.008	0.012	0.015	0.020	0.025	0.029	0.031	0.035	0.040
1425	0.002	0.004	0.008	0.012	0.015	0.019	0.023	0.027	0.032	0.036	0.036
1475	0.002	0.003	0.007	0.010	0.013	0.017	0.019	0.025	0.026	0.029	0.033
1525	0.002	0.004	0.008	0.012	0.014	0.017	0.022	0.027	0.031	0.032	0.034
1575	0.002	0.003	0.006	0.010	0.012	0.016	0.018	0.022	0.025	0.028	0.031
1625	0.001	0.003	0.007	0.010	0.012	0.015	0.019	0.023	0.025	0.027	0.029
1675	0.002	0.003	0.006	0.009	0.012	0.015	0.019	0.022	0.023	0.026	0.030

1725	0.001	0.003	0.006	0.010	0.012	0.015	0.018	0.022	0.026	0.029	0.029
1775	0.001	0.003	0.006	0.008	0.010	0.013	0.016	0.020	0.022	0.024	0.026
1825	0.002	0.003	0.007	0.010	0.012	0.015	0.021	0.025	0.028	0.028	0.030
1875	0.001	0.003	0.006	0.009	0.011	0.014	0.016	0.020	0.023	0.025	0.027
1925	0.001	0.003	0.006	0.008	0.010	0.013	0.016	0.019	0.021	0.022	0.025
1975	0.001	0.003	0.005	0.008	0.010	0.013	0.016	0.018	0.020	0.022	0.026
Higher Frequencies components											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
2.1	0.010	0.020	0.039	0.057	0.079	0.104	0.119	0.135	0.150	0.173	0.205
2.3	0.005	0.011	0.021	0.030	0.041	0.054	0.063	0.072	0.078	0.089	0.107
2.5	0.007	0.014	0.027	0.040	0.054	0.072	0.084	0.094	0.104	0.120	0.142
2.7	0.006	0.012	0.024	0.034	0.046	0.060	0.072	0.082	0.090	0.102	0.119
2.9	0.003	0.006	0.013	0.018	0.023	0.030	0.037	0.044	0.048	0.053	0.058
3.1	0.004	0.008	0.015	0.021	0.028	0.037	0.045	0.052	0.056	0.062	0.073
3.3	0.003	0.007	0.015	0.023	0.027	0.035	0.044	0.053	0.059	0.065	0.068
3.5	0.002	0.005	0.009	0.013	0.018	0.023	0.028	0.031	0.035	0.039	0.045
3.7	0.003	0.005	0.011	0.016	0.021	0.027	0.032	0.036	0.041	0.046	0.054
3.9	0.002	0.005	0.009	0.014	0.018	0.023	0.027	0.032	0.037	0.041	0.046
4.1	0.002	0.005	0.010	0.015	0.019	0.025	0.030	0.034	0.038	0.043	0.050
4.3	0.002	0.004	0.008	0.011	0.016	0.020	0.024	0.027	0.030	0.035	0.040
4.5	0.002	0.003	0.007	0.011	0.014	0.017	0.020	0.024	0.028	0.031	0.034
4.7	0.002	0.003	0.007	0.010	0.014	0.017	0.020	0.024	0.027	0.030	0.034
4.9	0.002	0.004	0.008	0.012	0.015	0.019	0.023	0.027	0.030	0.034	0.038
5.1	0.002	0.004	0.008	0.013	0.017	0.021	0.025	0.029	0.034	0.038	0.041
5.3	0.002	0.003	0.007	0.011	0.014	0.018	0.021	0.024	0.028	0.032	0.035
5.5	0.002	0.004	0.009	0.013	0.017	0.022	0.025	0.030	0.034	0.038	0.043
5.7	0.002	0.004	0.009	0.013	0.017	0.021	0.026	0.030	0.034	0.038	0.042
5.9	0.002	0.004	0.007	0.011	0.014	0.019	0.022	0.025	0.029	0.032	0.037
6.1	0.002	0.004	0.008	0.012	0.016	0.021	0.024	0.028	0.032	0.036	0.041
6.3	0.002	0.004	0.008	0.012	0.016	0.020	0.024	0.028	0.031	0.035	0.039
6.5	0.002	0.004	0.007	0.011	0.014	0.019	0.022	0.025	0.028	0.032	0.037
6.7	0.002	0.004	0.008	0.011	0.015	0.020	0.023	0.026	0.030	0.034	0.039
6.9	0.002	0.004	0.008	0.013	0.017	0.021	0.024	0.027	0.033	0.038	0.042
7.1	0.005	0.011	0.021	0.032	0.042	0.053	0.063	0.072	0.083	0.093	0.104
7.3	0.004	0.007	0.014	0.021	0.028	0.036	0.041	0.047	0.054	0.063	0.071
7.5	0.002	0.005	0.009	0.014	0.020	0.025	0.027	0.030	0.036	0.044	0.050
7.7	0.002	0.004	0.008	0.013	0.018	0.023	0.025	0.029	0.035	0.041	0.045
7.9	0.012	0.022	0.044	0.071	0.098	0.118	0.130	0.153	0.185	0.217	0.235
8.1	0.003	0.005	0.010	0.018	0.027	0.033	0.031	0.035	0.047	0.060	0.063
8.3	0.002	0.006	0.011	0.016	0.018	0.023	0.032	0.039	0.042	0.041	0.046
8.5	0.002	0.005	0.011	0.017	0.019	0.022	0.029	0.039	0.045	0.046	0.043

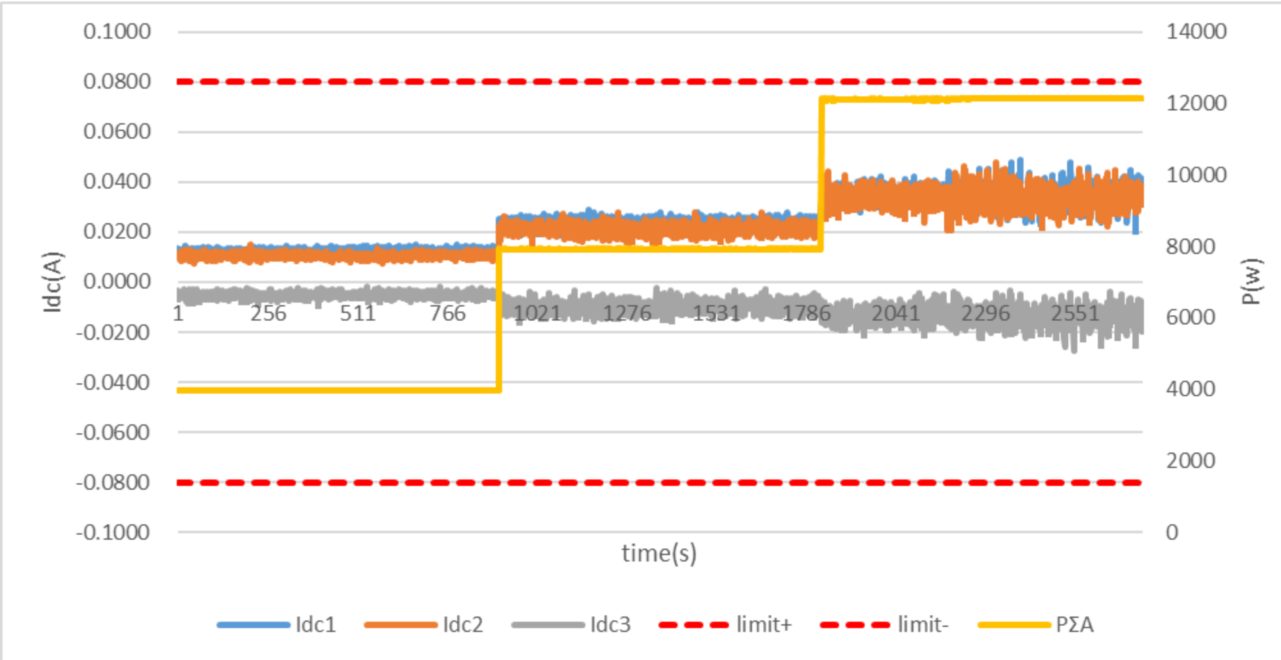
8.7	0.002	0.005	0.012	0.017	0.018	0.023	0.032	0.040	0.044	0.043	0.045
8.9	0.002	0.005	0.010	0.015	0.018	0.022	0.028	0.034	0.039	0.042	0.044

Note: The normalization current is 17.4a.c..
The stated harmonics are maximum values of all 3 phases.

Remark:
The currents of the interharmonics to 2 kHz must be measured in accordance with DIN EN 61000-4-7 (VDE 0817-4-7), Annex A. The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with DIN EN 61000-4-7 (VDE 0847-4-7), Annex B.
ih
R_A=0.15 Ω j_{xA}=0.15 Ω
R_N=0.16 Ω j_{xN}=0.10 Ω
Samplerate:20 kHz

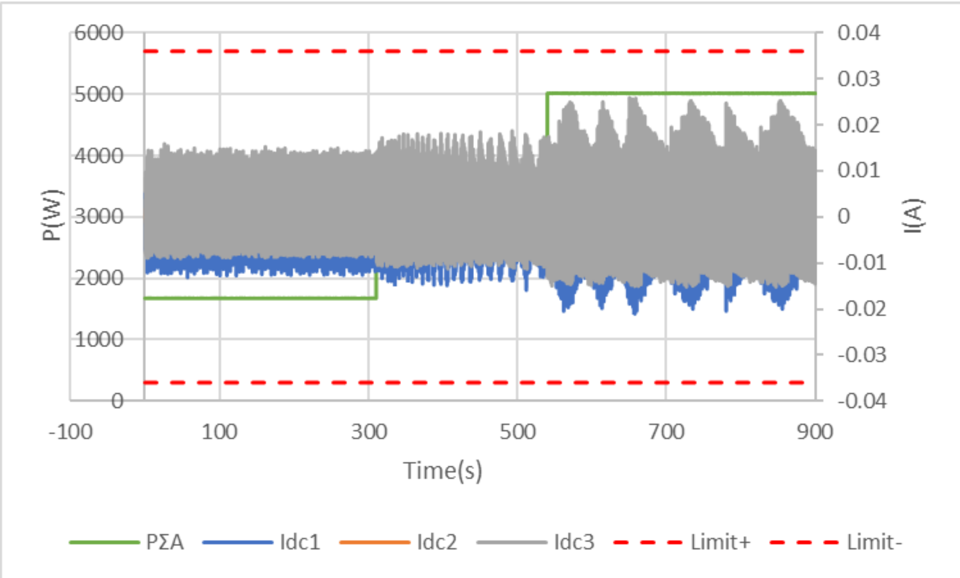
5.2.6 Feed in of DC current			P
Model: EAG12K3L			
Protection limit	Tested at three power levels limit 0.5% of I_{AC};nom		
Output power limit	30%-40%	60%-70%	>95%
Output power(W)	3965	7928	12130
Max. test value [mA]	13/11/-5	23/21/-9	35/34/-13
Max. test value [mA] / I_{rated} [%]	0.07/0.06/-0.03	0.13/0.12/-0.05	0.2/0.19/0.07

Diagram of permanent dc-injection



5.2.6 Feed in of DC current			P
Model: EAG05K3L			
Protection limit	Tested at three power levels limit 0.5% of I_{AC};nom		
Output power limit	30%-40%	60%-70%	>95%
Output power(W)	1675.7	3310.0	5015.1
Max. test value [mA]	12.6/6.0/14.4	14.6/7.1/16.5	20.8/9.3/25.3
Max. test value [mA] / I_{rated} [%]	0.17/0.08/0.20	0.20/0.10/0.23	0.29/0.13/0.35

Diagram of permanent dc-injection



Note:

The average rms value of the mains currents and mains voltages for each phase during the measurement period and the averaged values of the individual DC current components for each phase as percentages of I_{rated} must be written down in the protocol.

5.3 Evidence of symmetry behavior of inverters		
Clause	**Test**	**Result**
5.3.1	General	P
5.3.2.1	Calculation of the asymmetry of three-phase inverters	P
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

5.3.1 General These tests are designed to provide evidence that the requirements of VDE-AR-N 4100: 2019-04, 5.5 are met.		**P**
These tests serve to prove the requirements according to VDE-AR-N 4100: 2019-04, 5.5: These tests are not valid for direct connected rotating machines.		
5.3.2 Test in the test laboratory		**P**
Test Condition:	The measurements were performed in the testing laboratory. at the grid-simulator: U_N = between 86 % Un and 109% Un until the test Frequency: 50 Hz ± 0.5%	
Note: If an examination is required for any other requirements, these apply to this test.		

5.3.2.1	Calculation of asymmetry					P
Setting values	cos φ = 1			1.00		
	cos φ over-excited			+0.90		
	cos φ under-excited			-0.90		
Test: EAG12K3L						
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]	4069	4091	4067	-22	24	-2
	4069	4092	4067	-23	25	-2
	4068	4090	4066	-22	24	-2
	4055	4051	4076	4	-25	21
	4055	4051	4075	4	-24	20
cos $φ_{E60}$	0.9954					
max. asymmetry [VA]	-25					
b) maximum under-excited (i) at 100 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	4065	4025	4091	40	-66	26
	4066	4025	4061	41	-36	-5
	4063	4026	4023	37	3	-40
	4064	4026	4000	38	26	-64
	4067	4027	4000	40	27	-67
cos $φ_{E60}$	-0.9040					
max. asymmetry [VA]	-67					
c) maximum over-excited (c) at 100 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	4056	4031	4047	25	-16	-9
	4014	3963	4047	51	-84	33
	4063	4046	4025	17	21	-38
	4012	3994	4022	18	-28	10
	4010	3993	4021	17	-28	11
cos $φ_{E60}$	0.9030					
max. asymmetry [VA]	-84					
d) cos φ = 1 at 50 % P_{rE} ± 5 % P_{Emax}						

S_{E60} [VA]	2050	2008	2009	42	-1	-41
	2049	2008	2009	41	-1	-40
	2050	2009	2009	41	0	-41
	2050	2010	2010	40	0	-40
	2049	2008	2010	41	-2	-39
cos φ_{E60}	0.9920					
max. asymmetry [VA]	42					
e) maximum under-excited (i) at 50 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	2034	1968	2006	66	-38	-28
	2033	1969	2006	64	-37	-23
	2034	1969	2006	65	-37	-28
	2034	1969	2006	65	-37	-28
	2034	1969	2007	65	-38	-27
cos φ_{E60}	0.9040					
max. asymmetry [VA]	66					
f) maximum over-excited (c) at 50 % P_{rE} ± 5 % P_{Emax}						
S_{E60} [VA]	2037	1977	2023	60	-46	-14
	2037	1976	2023	61	-47	-14
	2038	1977	2023	61	-46	-15
	2037	1977	2023	60	-46	-14
	2039	1977	2023	62	-46	-16
cos φ_{E60}:	0.9060					
max. asymmetry [VA]	62					
Limit:	≤5% S_{Emax} and ≤4600VA					

Test:

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.

5.4Evidence of the behaviour of the generating unit on the network		
Clause	**Requirement – Test**	**Verdict**
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 overfrequency	N/A
5.4.5	Active power feed-in of Storage systems for overfrequency	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	P
	Test 3) supply-dependent PGUs - Accuracy (characteristic curve)	P
	Test 4) supply-dependent PGUs - Dynamic	P
5.4.8.4.1	Test of the accuracy of the Q(U) regulation	P
5.4.8.4.2	Test of the dynamics of the Q(U) regulation	P

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 SEmax and PEmax)		**P**
Test Condition:	The measurements were performed in the testing laboratory. at the grid-simulator: U_N = between 86 % Un and 109% Un until the test Frequency: 50 Hz ± 0.5%	
Designation for under-excited and over-excited: - "(c)" stands for over-excited. - "(i)" stands for under-excited.		
Note: If an examination is required for any other requirements, these apply to this test. The RoCoF requirements of the VDE-AR-N 4105:2018-11, 5.7.1 are not part of the Unit certification.		

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 VDE-AR-N 4105:2018-11, 5.7.2.2 are met)					**P**
Setting values	cos φ = 1:	1			
	cos φ max. over-excited:	+0.90			
	cos φ max. under-excited:	-0.90			
Model: EAG05K3L					
600 s mean value	0.90 ± 0.2 U_n	0.95 ± 0.2 U_n	1.0 ± 0.2 U_n	1.05 ± 0.2 U_n	1.09 ± 0.2 U_n
a) cos φ 1 at 100% P_{Emax}					
U [V]:	207.2	218.6	230.7	241.7	250.2
$P_{Emax60\ d)}$ [W]	5014.4	5045.9	5025.5	5108.0	5005.2
$S_{Emax60\ d)}$ [VA]	5039.6	5072.6	5033.1	5135.0	5031.7
Q measure [Var]	497.1	512.1	253.0	517.9	507.8
cos $φ_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.995
b) maximum under-excited (i) at 100% PEmax					
U [V]:	206.9	218.3	230.2	241.3	250.5
$P_{Emax60\ d)}$ [W]	5007.1	5051.4	5000.5	5026.0	5038.2
$S_{Emax60\ d)}$ [VA]	5542.2	5592.4	5530.7	5564.6	5578.8
Q measure [Var]	-2372.6	-2395.9	-2361.3	-2384.4	-2391.9
cos $φ_{Emax60\text{-}over\text{-}excited}$	0.903	0.903	0.904	0.903	0.903
c) maximum over-excited (c) at 100% PEmax					
U [V]:	207.4	218.9	230.1	241.6	250.8
$P_{Emax60\ d)}$ [W]	5009.4	5045.3	4992.9	4954.5	4916.5
$S_{Emax60\ d)}$ [VA]	5544.0	5582.9	5495.2	5454.2	5437.1
Q measure [Var]	2371.8	2386.6	2291.6	2275.8	2315.7
cos $φ_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.909	0.908	0.904
d) cos φ 1 at 50% PEmax					
U [V]:	207.2	218.7	230.7	242.8	250.3
$P_{Emax60\ d)}$ [W]	2507.1	2504.3	2502.1	2505.2	2504.0
$S_{Emax60\ d)}$ [VA]	2519.8	2517.0	2514.8	2509.2	2516.7
Q measure [Var]	248.5	249.0	248.7	107.8	248.7
cos $φ_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.995	0.998	0.995
e) maximum under-excited (i) at 50% PEmax					
U [V]:	206.8	218.8	230.2	241.5	250.6
$P_{Emax60\ d)}$ [W]	2503.2	2518.1	2529.9	2515.6	2520.4
$S_{Emax60\ d)}$ [VA]	2770.6	2770.9	2797.9	2781.7	2789.4
Q measure [Var]	-1186.0	-1155.0	-1194.0	-1184.3	-1193.4
cos $φ_{Emax60\text{-}over\text{-}excited}$	0.903	0.909	0.904	0.904	0.904
f) maximum over-excited (c) at 50% PEmax					
U [V]:	207.4	219.0	231.3	241.5	250.6
$P_{Emax60\ e)}$[W]	2505.0	2504.8	2526.4	5072.8	2519.2
$S_{Emax60\ e)}$ [VA]	2772.4	2772.4	2806.6	5613.1	2788.1
Q measure [Var]	1186.0	1186.4	1221.5	2398.9	1192.7
cos $φ_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.900	0.904	0.904
$S_{Emax600}$ and $P_{Emax\ 600}$					
$S_{Emax600}$[VA]= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$)	5592.4				
$P_{Emax\ 600}$[W]= max($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$)	5108.0				

Model: EAG06K3L					
600 s mean value	0.90 ± 0.2 U_n	0.95 ± 0.2 U_n	1.0 ± 0.2 U_n	1.05 ± 0.2 U_n	1.09 ± 0.2 U_n
a) cos φ 1 at 100% P_{Emax}					
U [V]:	207.6	218.7	230.7	241.6	250.8
$P_{Emax60\ d)}$ [W]	6048.9	6020.2	6141.8	6024.8	6020.1
$S_{Emax60\ d)}$ [VA]	6079.8	6050.8	6151.0	6056.7	6050.6
Q measure [Var]	603.1	598.9	305.7	612.2	598.5
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.995
b) maximum under-excited (i) at 100% P_{Emax}					
U [V]:	206.8	218.3	230.2	241.4	250.8
$P_{Emax60\ d)}$ [W]	6034.8	6007.2	6028.6	6015.6	5923.0
$S_{Emax60\ d)}$ [VA]	6679.9	6648.8	6667.8	6660.2	6523.1
Q measure [Var]	-2859.9	-2845.7	-2846.6	-2854.8	-2731.7
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.903	0.904	0.904	0.903	0.908
c) maximum over-excited (c) at 100% P_{Emax}					
U [V]:	207.4	219.0	231.3	241.9	250.8
$P_{Emax60\ d)}$ [W]	6059.9	6023.1	6036.2	6048.0	5974.7
$S_{Emax60\ d)}$ [VA]	6706.7	6666.3	6705.8	6693.5	6578.6
Q measure [Var]	2869.3	2852.6	2918.7	2863.9	2753.1
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.9	0.904	0.908
d) cos φ 1 at 50% P_{Emax}					
U [V]:	207.6	218.7	230.7	241.3	250.3
$P_{Emax60\ d)}$ [W]	3038.6	3010.3	3071.8	3017.5	3028.9
$S_{Emax60\ d)}$ [VA]	3054.4	3025.6	3076.5	3032.9	3044.3
Q measure [Var]	306.1	299.4	150.2	300.6	301.0
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.995
e) maximum under-excited (i) at 50% P_{Emax}					
U [V]:	207.3	218.3	230.1	241.4	250.6
$P_{Emax60\ d)}$ [W]	3023.6	3032.2	3050.9	3052.9	3045.3
$S_{Emax60\ d)}$ [VA]	3346.7	3356.4	3383.6	3380.3	3370.4
Q measure [Var]	-1432.6	-1437.0	-1462.5	-1449.3	-1442.2
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.903	0.903	0.902	0.903	0.904
f) maximum over-excited (c) at 50% P_{Emax}					
U [V]:	207.4	219.0	231.8	241.6	250.6
$P_{Emax60\ e)}$[W]	3029.8	3011.6	3007.9	3087.1	3098.8
$S_{Emax60\ e)}$ [VA]	3353.2	3333.2	3327.4	3417.0	3429.5
Q measure [Var]	1434.6	1426.2	1421.9	1462.7	1467.1
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.904	0.903	0.904
$S_{Emax600}$ and $P_{Emax\ 600}$					
$S_{Emax600}$[VA]= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$)	6706.7				
$P_{Emax\ 600}$[W]= max($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$)	6141.8				

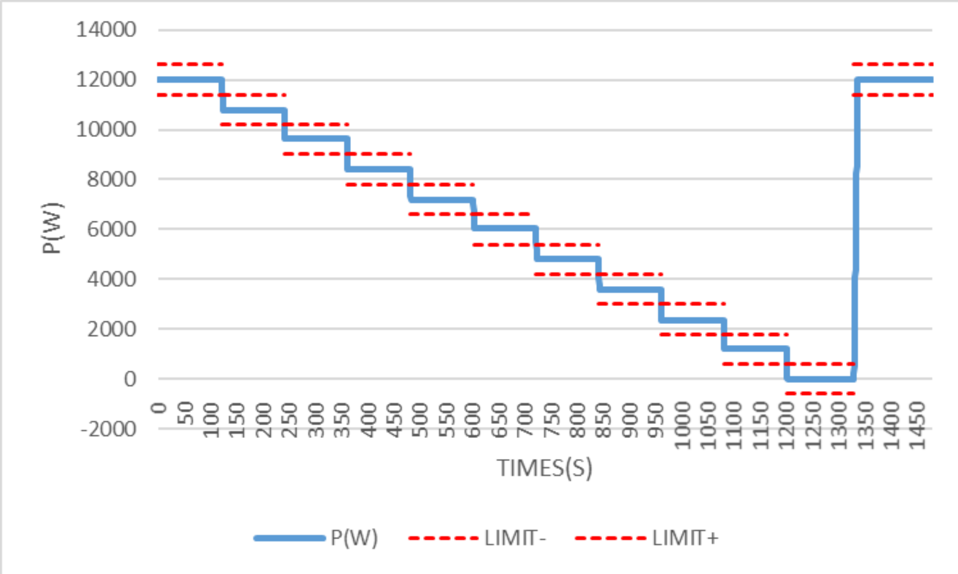
Model: EAG07K3L					
600 s mean value	0.90 ± 0.2 U_n	0.95 ± 0.2 U_n	1.0 ± 0.2 U_n	1.05 ± 0.2 U_n	1.09 ± 0.2 U_n
a) cos φ 1 at 100% P_{Emax}					
U [V]:	207.6	218.7	230.7	241.3	250.8
$P_{Emax60\ d)}$ [W]	7029.1	7056.0	7130.9	7065.4	7168.2
$S_{Emax60\ d)}$ [VA]	7064.4	7091.8	7141.7	7101.3	7204.5
Q measure [Var]	695.8	701.5	352.6	703.8	712.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.995
b) maximum under-excited (i) at 100% P_{Emax}					
U [V]:	207.3	218.3	230.1	241.0	250.9
$P_{Emax60\ d)}$ [W]	7046.8	7005.4	7032.4	7027.1	6929.3
$S_{Emax60\ d)}$ [VA]	7801.0	7750.3	7799.2	7777.3	7660.1
Q measure [Var]	-3341.9	-3313.2	-3371.2	-3328.1	-3257.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.903	0.904	0.902	0.904	0.905
c) maximum over-excited (c) at 100% P_{Emax}					
U [V]:	207.9	219.0	230.2	241.6	250.6
$P_{Emax60\ d)}$ [W]	7017.9	7029.9	6912.4	7056.2	7050.7
$S_{Emax60\ d)}$ [VA]	7767.2	7780.6	7631.3	7810.3	7803.2
Q measure [Var]	3323.6	3329.4	3231.0	3343.2	3338.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.906	0.903	0.904
d) cos φ 1 at 50% P_{Emax}					
U [V]:	207.6	218.7	230.7	241.3	250.8
$P_{Emax60\ d)}$ [W]	3507.6	3502.3	3508.9	3510.0	3515.0
$S_{Emax60\ d)}$ [VA]	3525.3	3520.0	3514.2	3527.9	3532.8
Q measure [Var]	347.7	348.1	171.4	349.2	349.7
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.995
e) maximum under-excited (i) at 50% P_{Emax}					
U [V]:	207.3	218.4	230.2	241.0	250.6
$P_{Emax60\ d)}$ [W]	3505.7	3507.9	3483.7	3504.6	3523.3
$S_{Emax60\ d)}$ [VA]	3880.5	3882.3	3852.5	3878.8	3899.7
Q measure [Var]	-1661.7	-1661.1	-1643.6	-1660.0	-1669.2
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.903	0.904	0.904	0.904	0.903
f) maximum over-excited (c) at 50% P_{Emax}					
U [V]:	207.8	219.0	230.8	242.0	250.6
$P_{Emax60\ e)}$[W]	3501.4	3505.7	3580.4	3535.3	3509.1
$S_{Emax60\ e)}$ [VA]	3875.2	3880.0	3977.8	3910.6	3883.9
Q measure [Var]	1658.3	1660.3	1731.8	1666.4	1662.0
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.9	0.904	0.904
$S_{Emax600}$ and $P_{Emax\ 600}$					
$S_{Emax600}$[VA]= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$)	7810.3				
$P_{Emax\ 600}$[W]= max($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$)	7168.2				

Model: EAG08K3L					
600 s mean value	0.90 ± 0.2 U_n	0.95 ± 0.2 U_n	1.0 ± 0.2 U_n	1.05 ± 0.2 U_n	1.09 ± 0.2 U_n
a) cos φ 1 at 100% P_{Emax}					
U [V]:	207.6	218.7	230.6	241.3	250.8
$P_{Emax60\ d)}$ [W]	8041.9	8050.2	8066.0	8046.4	8133.5
$S_{Emax60\ d)}$ [VA]	8082.5	8091.0	8078.1	8087.2	8174.8
Q measure [Var]	797.9	800.2	399.8	800.3	809.3
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.999	0.995	0.995
b) maximum under-excited (i) at 100% P_{Emax}					
U [V]:	207.3	218.4	230.2	241.0	250.9
$P_{Emax60\ d)}$ [W]	8063.0	8059.1	7921.8	8031.2	7915.7
$S_{Emax60\ d)}$ [VA]	8924.2	8919.1	8744.2	8888.3	8746.6
Q measure [Var]	-3819.5	-3816.1	-3696.3	-3803.0	-3714.0
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.906	0.904	0.905
c) maximum over-excited (c) at 100% P_{Emax}					
U [V]:	207.9	219.0	231.1	241.6	250.6
$P_{Emax60\ d)}$ [W]	8020.8	8025.6	8077.2	8010.8	8086.0
$S_{Emax60\ d)}$ [VA]	8877.3	8881.8	8957.1	8866.1	8950.4
Q measure [Var]	3798.9	3799.0	3868.6	3793.7	3831.7
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.902	0.904	0.903
d) cos φ 1 at 50% P_{Emax}					
U [V]:	207.6	218.7	230.6	241.3	251.0
$P_{Emax60\ d)}$ [W]	4021.2	4026.0	4099.5	4023.0	4070.5
$S_{Emax60\ d)}$ [VA]	4041.5	4046.4	4105.7	4043.5	4091.1
Q measure [Var]	398.7	400.0	206.7	400.4	404.7
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.995
e) maximum under-excited (i) at 50% P_{Emax}					
U [V]:	207.3	218.4	230.0	241.0	250.5
$P_{Emax60\ d)}$ [W]	4031.7	4021.6	4187.9	4015.1	4012.4
$S_{Emax60\ d)}$ [VA]	4462.5	4450.8	4631.9	4443.5	4443.8
Q measure [Var]	-1910.3	-1904.4	-1977.6	-1901.1	-1907.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.903	0.904	0.904	0.904	0.903
f) maximum over-excited (c) at 50% P_{Emax}					
U [V]:	207.9	219.0	231.9	241.7	251.3
$P_{Emax60\ e)}$[W]	4010.2	4020.2	4053.0	4005.7	4163.8
$S_{Emax60\ e)}$ [VA]	4438.5	4449.4	4484.7	4433.4	4608.7
Q measure [Var]	1899.4	1903.7	1918.2	1897.0	1972.8
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.904	0.904	0.903
$S_{Emax600}$ and $P_{Emax\ 600}$					
$S_{Emax600}$[VA]= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$)	8957.1				
$P_{Emax\ 600}$[W]= max($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$)	8133.5				

Model: EAG10K3L					
600 s mean value	0.90 ± 0.2 U_n	0.95 ± 0.2 U_n	1.0 ± 0.2 U_n	1.05 ± 0.2 U_n	1.09 ± 0.2 U_n
a) cos φ 1 at 100% P_{Emax}					
U [V]:	207.6	218.7	230.7	241.3	250.5
$P_{Emax60\ d)}$ [W]	10052.8	10016.8	10184.5	10059.3	10010.6
$S_{Emax60\ d)}$ [VA]	10103.5	10067.6	10199.9	10110.3	10024.0
Q measure [Var]	996.9	995.6	513.8	999.8	463.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.999
b) maximum under-excited (i) at 100% P_{Emax}					
U [V]:	207.3	218.4	230.2	241.0	250.9
$P_{Emax60\ d)}$ [W]	10079.8	10026.4	9880.8	10038.0	9858.7
$S_{Emax60\ d)}$ [VA]	11155.8	11096.4	10886.3	11107.8	10867.6
Q measure [Var]	-4773.7	-4747.6	-4564.5	-4749.6	-4567.0
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.908	0.904	0.907
c) maximum over-excited (c) at 100% P_{Emax}					
U [V]:	207.9	219.0	230.3	241.6	250.6
$P_{Emax60\ d)}$ [W]	10042.3	10018.2	10079.6	10079.0	10060.1
$S_{Emax60\ d)}$ [VA]	11114.2	11087.9	11177.5	11155.0	11137.1
Q measure [Var]	4755.1	4744.4	4827.1	4772.6	4774.1
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.902	0.904	0.903
d) cos φ 1 at 50% P_{Emax}					
U [V]:	207.6	218.6	230.7	241.3	250.7
$P_{Emax60\ d)}$ [W]	5027.2	5043.9	5183.8	5064.0	5085.5
$S_{Emax60\ d)}$ [VA]	5052.5	5070.6	5191.6	5089.7	5118.4
Q measure [Var]	498.2	512.1	261.9	503.7	-146.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.999	0.995	0.994
e) maximum under-excited (i) at 50% P_{Emax}					
U [V]:	207.3	218.3	230.1	241.0	250.2
$P_{Emax60\ d)}$ [W]	5040.7	5011.8	5063.2	5019.6	5089.4
$S_{Emax60\ d)}$ [VA]	5578.9	5547.8	5621.8	5555.1	5629.1
Q measure [Var]	-2387.4	-2375.5	-2441.5	-2376.4	-2395.0
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.903	0.901	0.904	0.904
f) maximum over-excited (c) at 50% P_{Emax}					
U [V]:	207.9	219.0	230.9	241.6	250.6
$P_{Emax60\ e)}$[W]	5021.1	5009.4	5090.1	5039.5	5029.8
$S_{Emax60\ e)}$ [VA]	5557.1	5544.2	5644.8	5577.5	5568.2
Q measure [Var]	2377.6	2372.2	2438.2	2386.5	2386.8
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.902	0.904	0.903
$S_{Emax600}$ and $P_{Emax\ 600}$					
$S_{Emax600}$[VA]= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$)	11177.5				
$P_{Emax\ 600}$[W]= max($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$)	10184.5				

Model: EAG12K3L					
600 s mean value	0.90 ± 0.2 U_n	0.95 ± 0.2 U_n	1.0 ± 0.2 U_n	1.05 ± 0.2 U_n	1.09 ± 0.2 U_n
a) cos φ 1 at 100% P_{Emax}					
U [V]:	207.6	218.7	230.7	241.3	250.3
$P_{Emax60\ d)}$ [W]	12048.4	12045.5	12141.6	12068.6	12067.9
$S_{Emax60\ d)}$ [VA]	12109.0	12106.2	12159.8	12129.8	12086.1
Q measure [Var]	1192.9	1194.2	607.5	1200.0	605.8
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.999	0.995	0.999
b) maximum under-excited (i) at 100% P_{Emax}					
U [V]:	207.3	218.4	230.2	241.0	249.7
$P_{Emax60\ d)}$ [W]	12049.9	12018.2	12030.6	12012.5	12022.8
$S_{Emax60\ d)}$ [VA]	13336.3	13303.7	13304.6	13293.6	13294.9
Q measure [Var]	-5706.7	-5697.4	-5677.2	-5686.1	-5671.0
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.903	0.904	0.904	0.904
c) maximum over-excited (c) at 100% P_{Emax}					
U [V]:	207.9	219.0	231.2	241.7	250.9
$P_{Emax60\ d)}$ [W]	12032.3	12036.3	12021.6	12027.3	12049.4
$S_{Emax60\ d)}$ [VA]	13316.7	13321.4	13376.6	13310.8	13386.3
Q measure [Var]	5697.6	5700.2	5866.3	5694.1	5826.7
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.8987	0.904	0.900
d) cos φ 1 at 50% P_{Emax}					
U [V]:	207.7	218.7	230.7	241.2	250.7
$P_{Emax60\ d)}$ [W]	6024.1	6059.2	6027.2	6031.9	6100.1
$S_{Emax60\ d)}$ [VA]	6054.4	6089.7	6036.3	6063.9	6140.3
Q measure [Var]	596.5	599.8	301.7	612.4	-177.6
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.995	0.995	0.998	0.995	0.993
e) maximum under-excited (i) at 50% P_{Emax}					
U [V]:	207.3	218.3	230.1	240.9	250.2
$P_{Emax60\ d)}$ [W]	6025.0	6065.1	6095.2	6006.0	6027.5
$S_{Emax60\ d)}$ [VA]	6668.3	6714.9	6767.8	6647.4	6667.9
Q measure [Var]	-2853.7	-2877.8	-2939.6	-2844.8	-2839.3
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.903	0.901	0.904	0.904
f) maximum over-excited (c) at 50% P_{Emax}					
U [V]:	207.9	219.0	230.3	241.7	250.3
$P_{Emax60\ e)}$[W]	6015.4	6049.9	6074.3	6013.2	6034.6
$S_{Emax60\ e)}$ [VA]	6657.5	6695.9	6735.8	6654.8	6043.6
Q measure [Var]	2848.4	2865.1	2908.6	2846.8	300.4
cos $\varphi_{Emax60\text{-}over\text{-}excited}$	0.904	0.904	0.902	0.904	0.998
$S_{Emax600}$ and $P_{Emax\ 600}$					
$S_{Emax600}$[VA]= max($S_{Emax600\ a)}$, $S_{Emax600\ b)}$, $S_{Emax600\ c)}$)	13386.3				
$P_{Emax\ 600}$[W]= max($P_{Emax600\ a)}$, $P_{Emax600\ b)}$, $P_{Emax600\ c)}$)	12141.6				

5.4.3.3 Measurement of setting accuracy												P
Graph of the setting accuracy:												



Test:

1-min mean value / P_n/P [%]	100	90	80	70	60	50	40	30	20	10	0*	100
$P_{Setpoint}$[W]:	12000	10800	9600	8400	7200	6000	4800	3600	2400	1200	0	12000
P_{E60} [W]:	12007	10754	9645	8401	7163	6056	4815	3579	2334	1225	-8	12019
ΔP_{E60}/ P_{Emax} [%]:	0.06	-0.38	0.37	0.01	-0.31	0.47	0.13	-0.18	-0.55	0.21	-0.07	0.15
Limit ΔP_{E60}/ P_{Emax}	± 5 % of P_{Emax}											

Test:

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

a) For adjustable PGUs in increments of 10% P_{Emax}, 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,

b) For all other PGUs, in line with their adjustable steps, 5 minutes must elapse after the setpoint setting is changed 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:

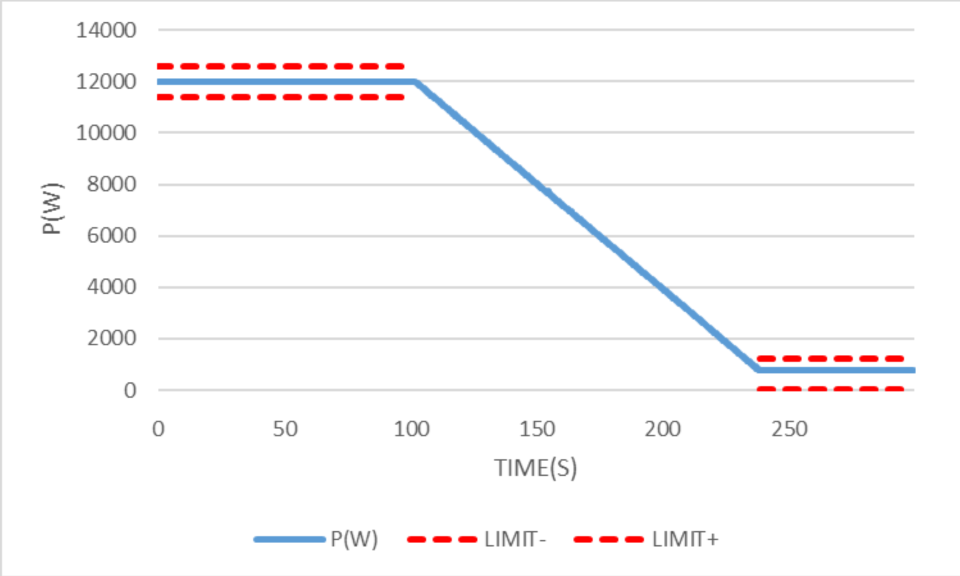
- no network disconnection
- the active power value does not exceed the setpoint by more than ± 5% PrE
- the setting time determined this way is ≤1min

Note:

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

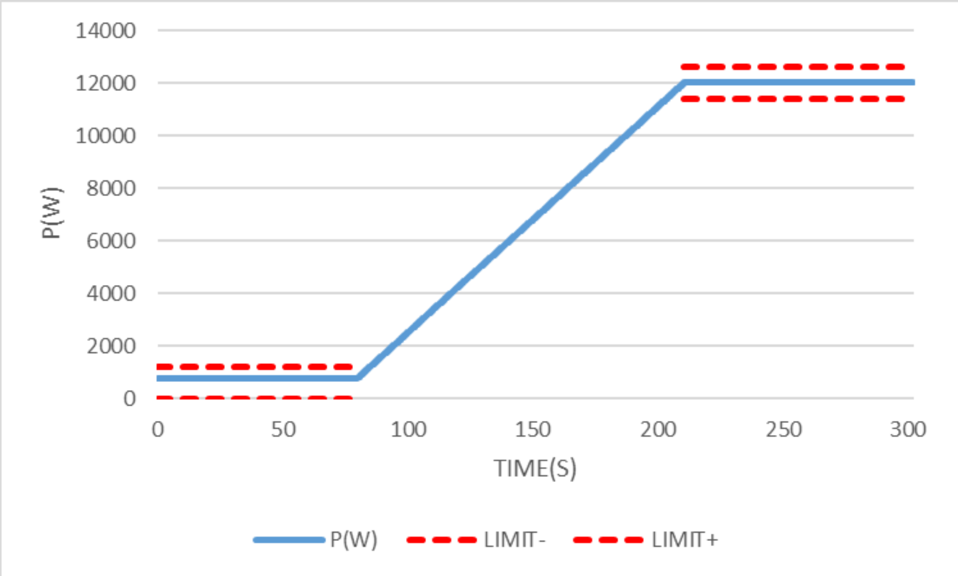
*, the minimum stable output active power is -2W.

5.4.3.4 Measurement of the power gradient	P
Graph of the adjustment time:	



Test:1		
1-min mean value	100% of P_{Emax}	5%of P_{Emax}
$P_{Setpoint}$[W]:	12000	600
P_{E60} [W]:	11994	754
$\Delta P_{E60}/ P_{Emax\ t}$ [%]:	-0.05	1.29
Limit $\Delta P_{E60}/ P_{Emax}$:	± 5%of P_{Emax}	
Measurements $\Delta P/\Delta t$ [%P_{rE}/s]	0.39	
Limit $\Delta P/\Delta t$ [%P_{rE}/s]	0.33-0.66	

Gragh of the adjustment time



Test:2

1-min mean value	5% of P_{Emax}	100% of P_{Emax}
$P_{Setpoint}$[W]:	600	12000
P_{E60} [W]:	757	12034
$\Delta P_{E60}/P_{Setpoint}$ [%]:	1.31	0.28
Limit $\Delta P_{E60}/P_{Setpoint}$:	± 5%of P_{Emax}	
Measurements $\Delta P/\Delta t$ [%P_{rE}/s]	0.43	
Limit $\Delta P/\Delta t$ [%P_{rE}/s]	0.33-0.66	

Test:

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 criterion:

for adjustable PGUs:

- no network disconnection
- the active power value does not exceed the setpoint by more than 5% P_{rE}
- the power gradient determined according 5.4.3.4 not be less than 0.33% P_{rE}/s and not more than 0.66% P_{rE}/s. The first gradient is to be created 30 s after the setpoint jump has been set.

The formation of gradients is ended 30 s before the static end value is reached.

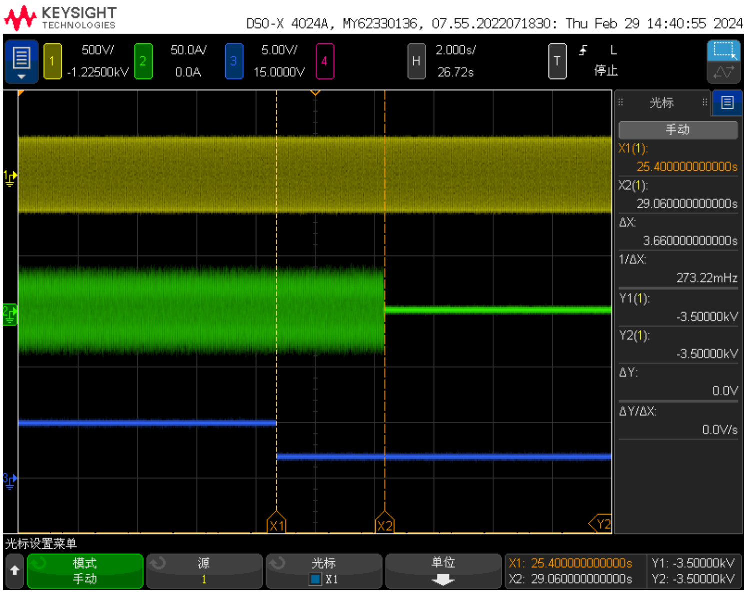
NOTE These times were determined by the maximum or minimum prescribed gradients and with a performance delta of ±10% P_{rE} around the target value.

5.4.3.5	Measurement priority interfaces / energy management system	P

a) The lowest setpoint is always given priority

		$P/P_{rE\ Setpoint}$	$P/P_{rE\ Measured}$
Test 1	Interface NSM (Digital inputs)	-	-
	Interface low Priority Modbus etc. (Software)	-	
Test 2	Interface NSM (Digital inputs)	-	-
	Interface low Priority Modbus etc. (Software)	-	

b) The setpoint at the interface programmed for the NSM is never exceeded



Note:

When receiving power commands from CAN Communication Interface and RS485 Communication Interface, the lowest power set point is always given priority.

Assessment criterion:

for measurements 5.4.3.5 either

a) the lowest setpoint is always given priority

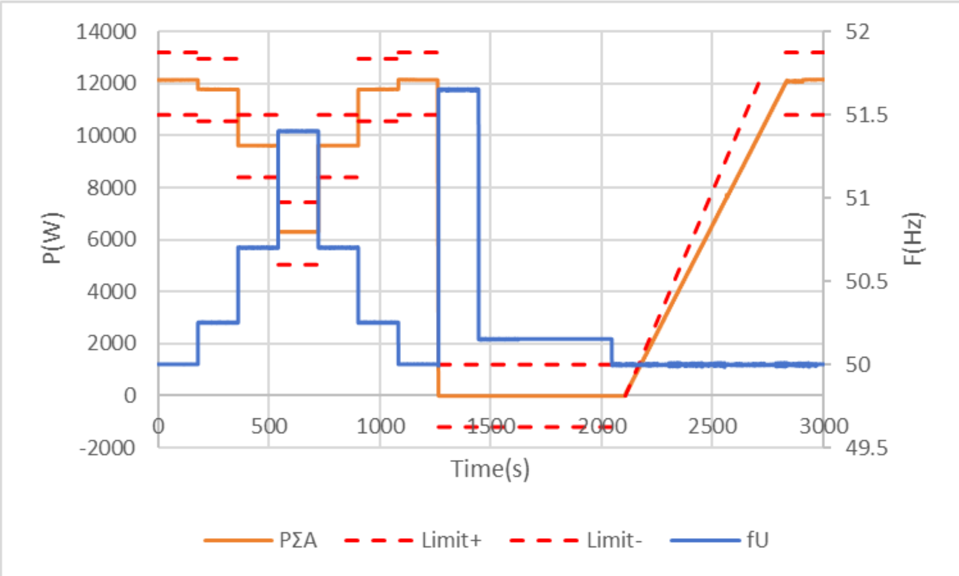
or

b) the setpoint at the interface programmed for the NSM is never exceeded

- When the logical interface (input port) was tested, the active power feed-in of the PGU was completely terminated within a maximum of 5s after the change in status of the logical signal.

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

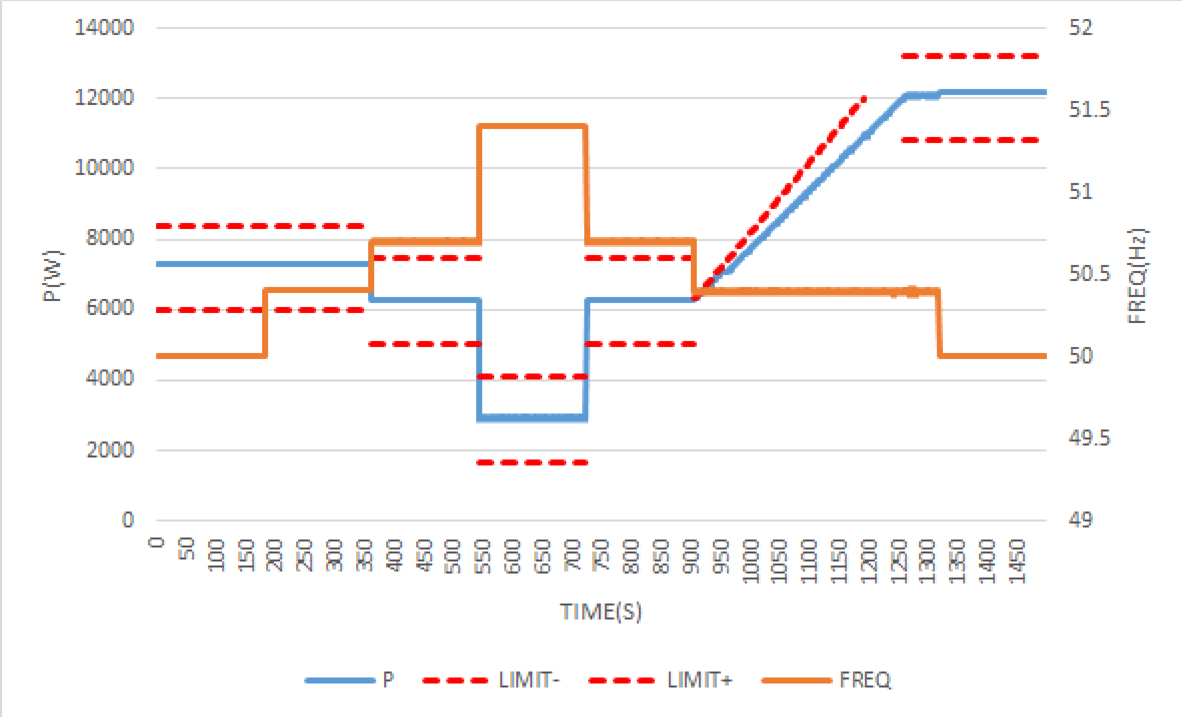
1, Measurement a) to g): Active power output 100% P_{Emax}



1-min mean value	a) 50.00 Hz	b) 50.25 Hz	c) 50.70 Hz	d) 51.40 Hz	e) 50.70 Hz	f) 50.25 Hz	g) 50.00 Hz	h) 51.65 Hz	i) 50.15 Hz	j) 50.00 Hz
Frequency [Hz]:	50	50.25	50.7	51.4	50.7	50.25	50	51.65	50.15	50
Expected active power output [% P_{Emax}]:	100	98	80	52	80	98	100	0	0	100
$P_{setpoint}$ [W]:	12000	11760	9600	6240	9600	11760	12000	0	0	12000
P_{E60} [W]:	12143	11780	9619	6304	9624	11784	12148	3	4	12094
$\Delta P_{E60}/P_{Emax}$ [%]:	1.19	0.17	0.16	0.53	0.20	0.20	1.23	0.03	0.03	0.78
The response times <2s	--	0.8	0.2	0.2	0.2	0.2	--	--	--	--
The steady times <20s	--	1.8	1.6	1.8	1.8	1.6	--	--	--	--

j) Reconnection time: 62s; Maximal Rising Gradient [%Pn/min]: 7.8%, Limitation [%Pn/min]: 10%.

2, Measurement a) to g): Active power output 60% P_{Emax}



1-min mean value	a) 50.00Hz	b) 50.40Hz	c) 50.70Hz	d) 51.40Hz	e) 50.70Hz	f) 50.40 Hz	g) 50.00Hz
Frequency [Hz]:	50	50.4	50.7	51.4	50.7	50.4	50
Expected active power output [% PEmax] (for Typ 2 PGU):	60	60	58	51	58	60-100*	100
$P_{setpoint}$ [W]:	7200	7200	6240	2880	6240	12000	12000
P_{E60} [W]:	7290.5	7310.5	6279.3	2940.5	6281.5	12091.6	12175.6
$\Delta P_{E60}/P_{Emax}$ [%]:	0.75	0.92	0.33	0.50	0.35	0.76	1.46
The response times <2s	--	--	0.2	0.2	0.2	--	--
The steady times <20s	--	--	0.2	0.2	0.2	--	--
g) Maximal Rising Gradient [%Pn/min]: 6.5%, Limitation [%Pn/min]: 10%.							
Limit ΔP_{E60}/ P_{Emax}:	±10% of P_{Emax}						

Note: The maximal measured delay time is 0.95s.

Assessment criterion:

The test is regarded as passed:

a) for controllable PGU if:

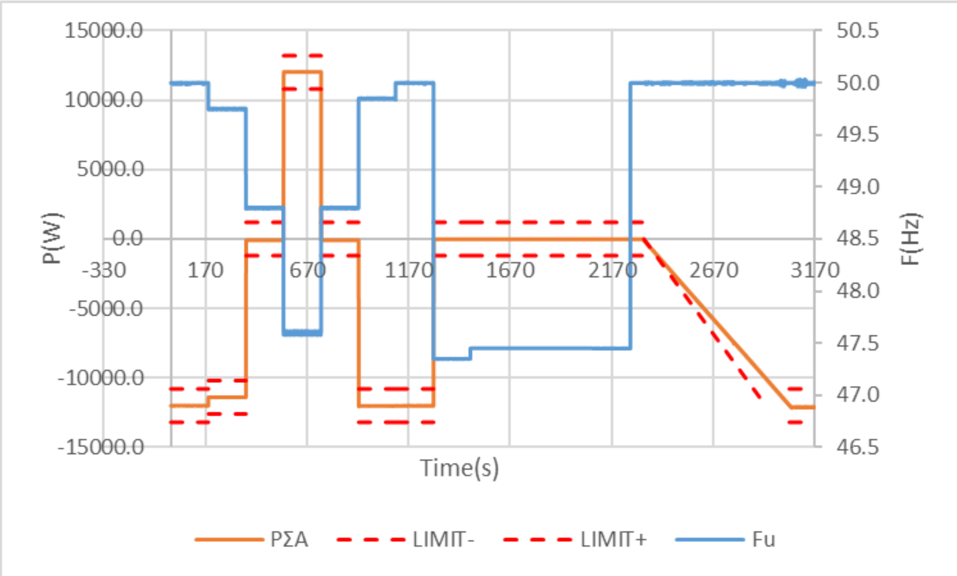
- The active power reduces between measuring points 5.4.4.1 a) to g) and j). the expected active power output. after settling. adjusts with a deviation ≤ ±10% P_{Emax}.

In the measurement points h) and i) shall no active power be given.

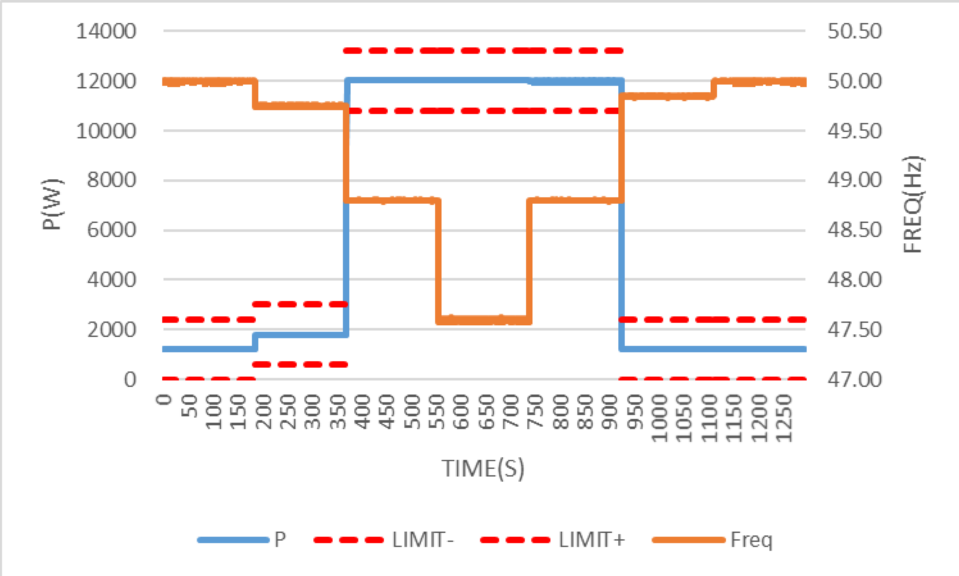
- The initial time delay TV of the frequency-dependent adaptation of the active power output ≤ 2 s.

- The response time of the adaptation of the active power output is a maximum of 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% PEmax/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 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 Hz and 51.5 Hz shall be proofed by a manufacturer's declaration. **d) for linear generators with SEmax ≤ 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).

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**
1, Measurement a) to g): Active power output -100% P_{Emax}	



1-min mean value	a) 50.00 Hz	b) 49.75 Hz	c) 48.80 Hz	d) 47.60 Hz	e) 48.80 Hz	f) 49.85 Hz	g) 50.00 Hz	h) 47.35 Hz	i) 47.45 Hz	j) 50.00 Hz
Frequency [Hz]:	50	49.75	48.8	47.6	48.8	49.85	50	47.35	47.45	50
Expected active power output [% P_{Emax}]:	-100	-95	0	100	0	-100	-100	0	0	-100
Psetpoint [W]:	-12000	-11400	0	12000	0	-12000	-12000	0	0	-12000
P_{E60} [W]:	-12011	-11398	-88	12042	-88	-12029	-12014	-23	-21	-12113
$\Delta P_{E60}/P_{Emax}$ [%]:	-0.09%	0.01%	-0.74%	0.35%	-0.74%	-0.24%	-0.12%	-0.19%	-0.18%	-0.94%
The response times <2s	--	0.2	0.4	0.2	0.2	0.4	--	--	--	--
The settling times <20s	--	0.4	1.2	1.2	1.0	1.4	--	--	--	--
j) Reconnection time: 61s; Maximal Rising Gradient [Pn%/min]: 8.3%, Limitation [Pn%/min]: 10%.										

2, Measurement a) to g): Active power output 10% Pemax							
							
1-min mean value	a) 50.00 Hz	b) 49.75 Hz	c) 48.80 Hz	d) 47.60 Hz	e) 48.80 Hz	f) 49.85 Hz	g) 50.00 Hz
Frequency [Hz]:	50	49.75	48.8	47.6	48.8	49.85	50
Expected active power output [% P_{Emax}]:	10	15	100	100	100	10	10
Psetpoint [W]:	1200	1800	12000	12000	12000	1200	1200
P_{E60} [W]:	1206.301	1799.727	12024.942	12032.602	12005.999	1200.129	1204.407
$\Delta P_{E60}/P_{Emax}$ [%]:	0.05%	0.00%	0.21%	0.27%	0.05%	0.00%	0.04%
The response times <2s	--	0.2	0.2	0.2	0.2	0.2	--
The settling times <20s	--	0.6	1.0	0.2	0.2	0.8	--
Limit $\Delta P_{E60}/ P_{Emax}$:	±10% of P_{Emax}						
Note: The maximal measured delay time is 0.91s.							

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).

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 (1):			1		
	cos φ over-excited:			+0.90		
	cos φ under-excited:			-0.90		
Test1:						
600 s mean value	$0.9U_n$		U_n		$1.1U_n$	
Active power	S_{Emax}	40 – 60 $\%P_{Emax}$	S_{Emax}	40 – 60 $\%P_{Emax}$	S_{Emax}	40 – 60 $\%P_{Emax}$
cos φ 0.90under-excited						
U [V]:	207.1	207.3	230.3	230.6	253.4	253.4
P_{E60} [W]:	12028.9	6041.7	12052.3	6047.8	12031.5	6023.8
Q_{E60} [Var]:	-5627.4	-2870.3	-5734.5	-2879.5	-5752.9	-2872.1
cos $\varphi_{E60\text{-under-excited}}$:	0.9057	0.9031	0.9029	0.9028	0.902	0.9025
cos φ 0.90 over-excited						
U [V]:	207.4	207.4	230.5	230.5	253.4	253.4
P_{E60} [W]:	12048.8	6050.7	12028.7	6016.8	12040.7	6052.4
Q_{E60} [Var]:	5628.4	2828.3	5753.3	2875.7	5731.4	2882.8
cos $\varphi_{E60\text{-over-excited}}$:	0.9059	0.9058	0.902	0.9021	0.9024	0.9023
Limit cos φ_{E60}:	cos φ= 0.89 to 0.91 (c) and cos φ= 0.89 to 0.91 (i)					
Setting values	cos φ (1):			1		
	cos φ over-excited:			+0.95		
	cos φ under-excited:			-0.95		
Test2:						
600 s mean value	$0.9U_n$		U_n		$1.1\ U_n$	
Active power	S_{Emax}	40 – 60 $\%P_{Emax}$	S_{Emax}	40 – 60 $\%P_{Emax}$	S_{Emax}	40 – 60 $\%P_{Emax}$
cos φ 0.95under-excited						
U [V]:	207.3	207.3	230.7	230.7	253.4	253.4
P_{E60} [W]:	12032.4	6033.3	12041.2	6018.2	12040.4	6020.4
Q_{E60} [Var]:	-3900.1	-1957.4	-3872.6	-1889.5	-3895.4	-1956.5
cos $\varphi_{E60\text{-under-excited}}$:	0.9512	0.9511	0.9519	0.954	0.9513	0.9509
cos φ 0.95 over-excited						
U [V]:	207.5	207.5	230.5	230.5	253.4	253.4
P_{E60} [W]:	12087.4	6086.0	12031.3	6045.4	12038.1	6039.9
Q_{E60} [Var]:	3774.6	1901.4	3888.6	1950.8	3975.2	1949.4

cos $\varphi_{E60\text{-over-excited}}$:	0.9545	0.9544	0.9514	0.9516	0.949	0.9511
Limit cos φ_{E60}:	cos φ= 0.94 to 0.96 I and cos φ= 0.94 to 0.96 (i)					

Test:

applies for PGUs Type 2 – only inverter ΣSEmax ≥ 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% Pemax and 60% and Semax 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% Pemax and 60% and S_{Emax}

applies for PGUs Type 2 – only inverter $\Sigma S_{Emax} \geq$ 4.6 Kva

230) 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% Pemax 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 Semax 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% Pemax 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 Un.

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% Pemax overexcited and for c) in the range of Q set point ± 4% Pemax 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 ΣSEmax ≥ 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% Pemax overexcited and for f) in the range of Q set point ± 4% Pemax 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.

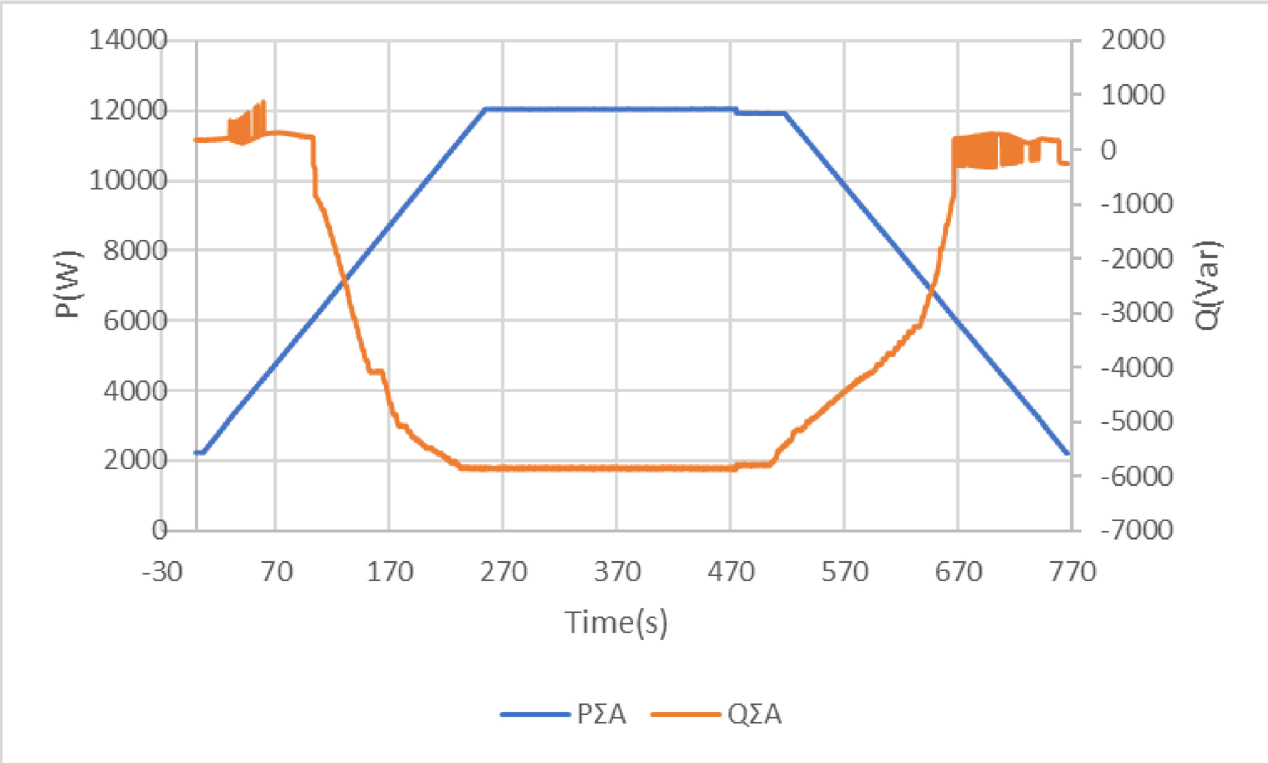
5.4.8.3 Test of the displacement factor/active power characteristic curve cos φ (P)			P
Test 1):			
P_{Emax}/P [%]	20%	100%	20%
30 s mean value	20% to 100% to 20% P_{Emax}		
U [V]:	229.95	230.08	230.00
P_{E30} [W]:	2211.80	12044.90	2192.50
P_{E30} of P_{Emax} [%]:	18.43	100.37	18.27
Q_{E30} [Var]:	235.47	-5854.15	175.53
cos φ_{E30}:	0.9905	0.8986	0.9901
cos $\varphi_{setpoint}$ of P_{E30}:	1.0000	0.9000	1.0000
Limit cos φ $_{E30}$:	cos $\varphi_{setpoint}$ ± 0.01		
Test 2):			
P_{Emax}/P [%]	20%	100%	20%
30 s mean value	20% to 100% to 20% P_{Emax}		
U [V]:	230.02	230.04	230.04
P_{E30} [W]:	2462.18	12025.70	2461.99
P_{E30} of P_{Emax} [%]:	20.52	100.21	20.52
Q_{E30} [Var]:	83.17	-4431.68	85.71
cos φ_{E30}:	0.9972	0.9018	0.9972
cos $\varphi_{setpoint}$ of P_{E30}:	1.0000	0.9000	1.0000
Limit cos φ $_{E30}$:	cos $\varphi_{setpoint}$ ± 0.01		

Test 3):									
P_{Emax}/P [%]	20	30	40	50	60	70	80	90	100
30 s mean value	20% to 100% P_{Emax}								
U [V]:	230.9	230.5	230.5	230.3	230.3	230.4	230.3	230.3	230.3
P_{DC} [W]	2721.3	3931.8	5146.7	6294.5	7657.6	8625.7	10079.8	11247.5	12366.2
P_{E30} [W]:	2409.2	3606.1	4809.4	6088.9	7207.3	8410.3	9622.4	10815.9	12061.6
P_{E30} of P_{Emax} [%]:	20.0	30.0	40.0	50.7	60.0	70.1	80.1	90.1	100.0
Q_{E30} [Var]:	-99.4	-152.7	-176	-225.4	-1411.1	-2372.8	-3400.3	-4567.8	-5719.5
cos φ_{E30}:	0.995	0.995	0.996	0.996	0.981	0.962	0.943	0.921	0.903
cos $\varphi_{setpoint}$ of P_{E30}:	1	1	1	1	0.98	0.96	0.94	0.92	0.90
Limit cos φ $_{E30}$:	cos $\varphi_{setpoint}$ ± 0.01								
Test 3):									
P_{Emax}/P [%]	100	90	80	70	60	50	40	30	20
30 s mean value	100% to 20% P_{Emax}								
U [V]:	230.3	230.3	230.3	230.3	230.3	230.2	230.2	230.3	230.3
P_{DC} [W]	12376.9	11194.4	9846.5	8644.8	7415.9	6160.1	4953.3	3804.3	2706.6
P_{E30} [W]:	12068.8	10814.5	9608.5	8406.0	7215.8	6041.3	4810.1	3610.9	2410.6

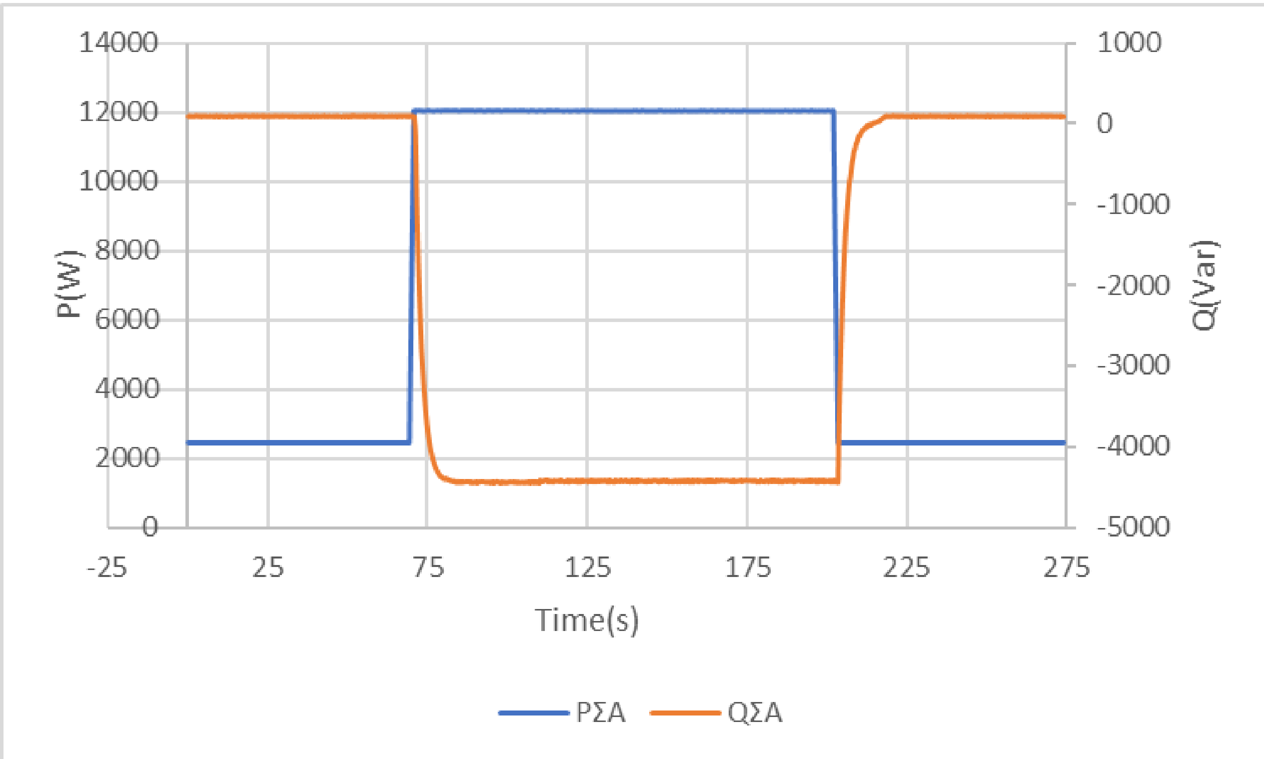
P_{E30} of P_{Emax} [%]:	100.0	90.1	80.1	70.1	60.0	50.3	40.1	30.1	20.1
Q_{E30} [Var]:	-5753.3	-4508.9	-3426.7	-2391.8	-1443.9	-370.7	-314.3	-154.7	-104.1
cos φ_{E30}:	0.902	0.923	0.942	0.962	0.980	0.995	0.994	0.995	0.995
cos $\varphi_{setpoint}$ of P_{E30}:	0.90	0.92	0.94	0.96	0.98	1	1	1	1
Limit cos φ_{E30}:	cos $\varphi_{setpoint}$ ± 0.01								

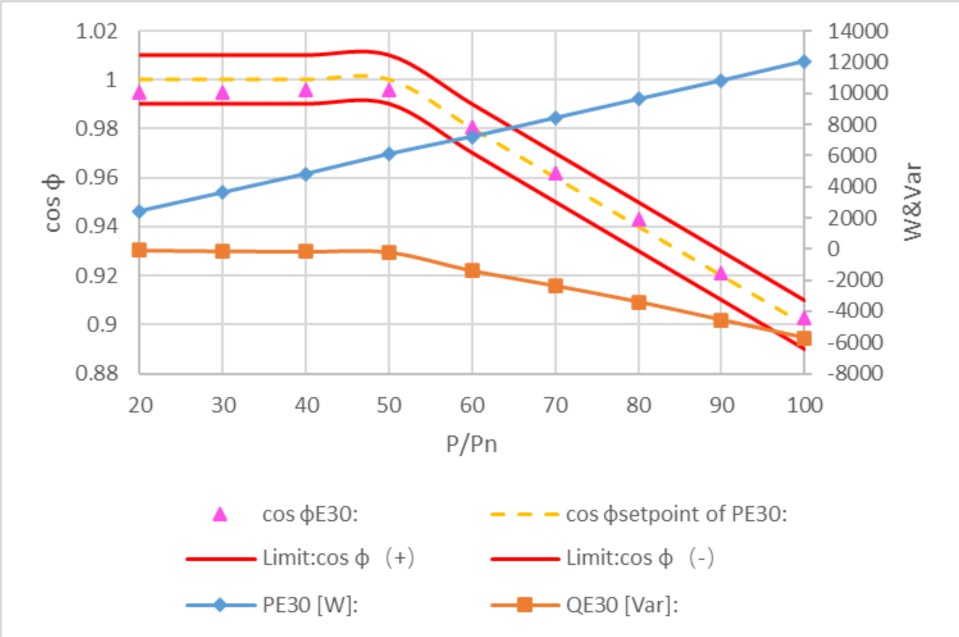
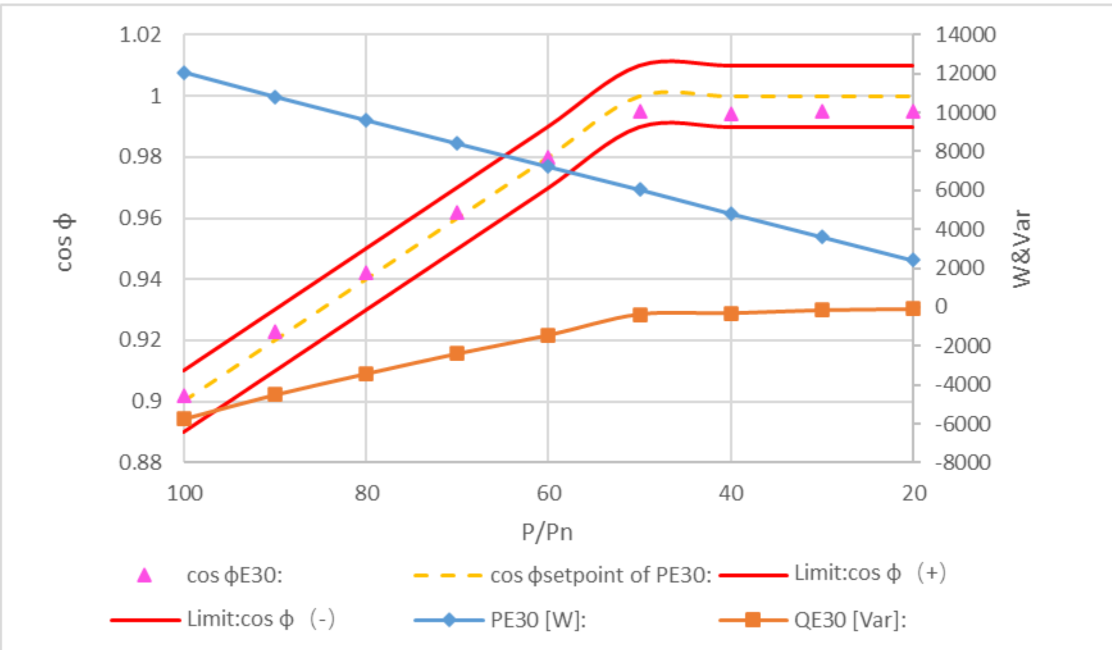
Test 4):				
P_{Emax}/P_n [%]	100	40	100	75
30 s mean value	100% to 40% to 100% to 75%			
U [V]:	230.1	230.7	230.3	230.3
P_{DC} [W]	13333	4824	13337	9473
P_{E30} [W]:	12052	4817	12078	9015
P_{E30} of P_{Emax} [%]:	100.4	40.1	100.6	75.1
Q_{E30} [Var]:	-4600	-129	-4592	-2907
cos φ_{E30}:	0.9038	0.9985	0.9039	0.9516
cos $\varphi_{setpoint}$ of P_{E30}:	0.90	1	0.90	0.95
T_0[s]:	--	12.8	13.6	8.8

Test 1: 20% to 100% to 20% PEmax

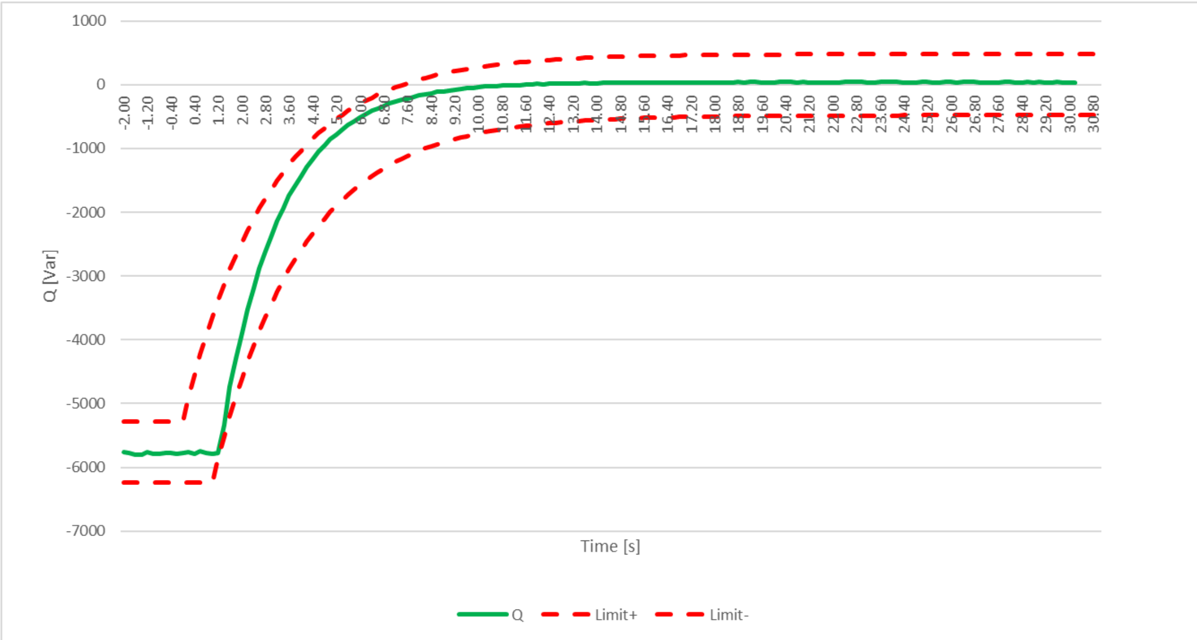


Test 2: 20% to 100% to 20% PEmax

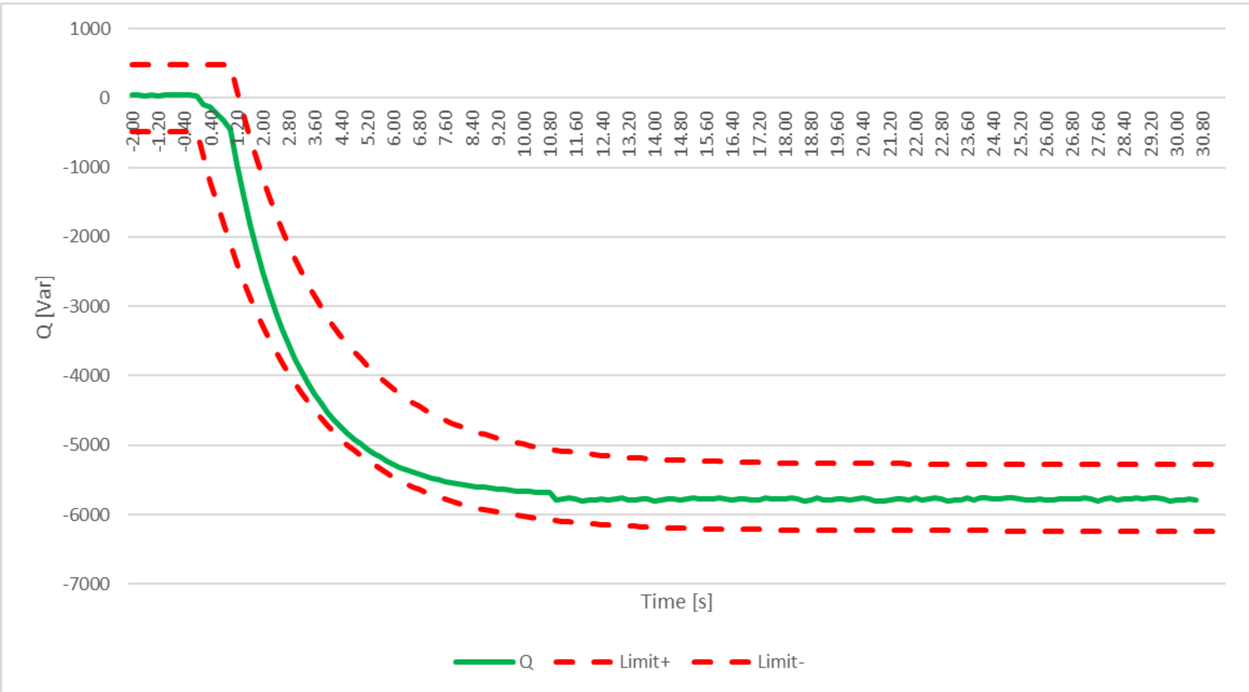


Graph of cos φ(P): 20% to 100% P_{Emax}

Graph of cos φ(P): 100% to 20% P_{Emax}


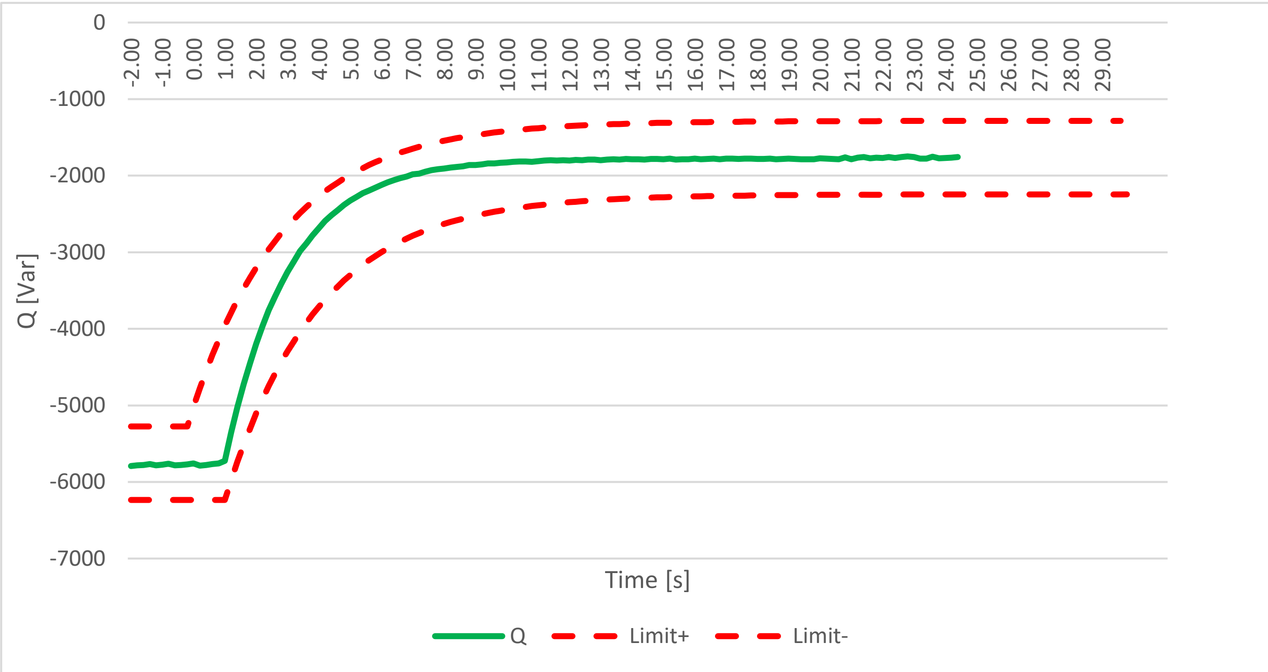
Step (100% to 40%)



Step (40% to 100%)



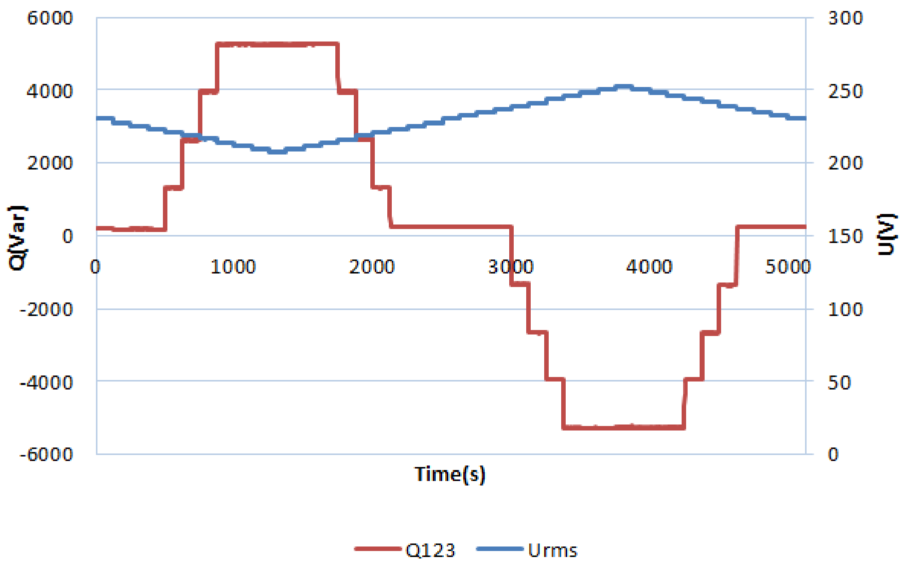
Step (100% to 75%)



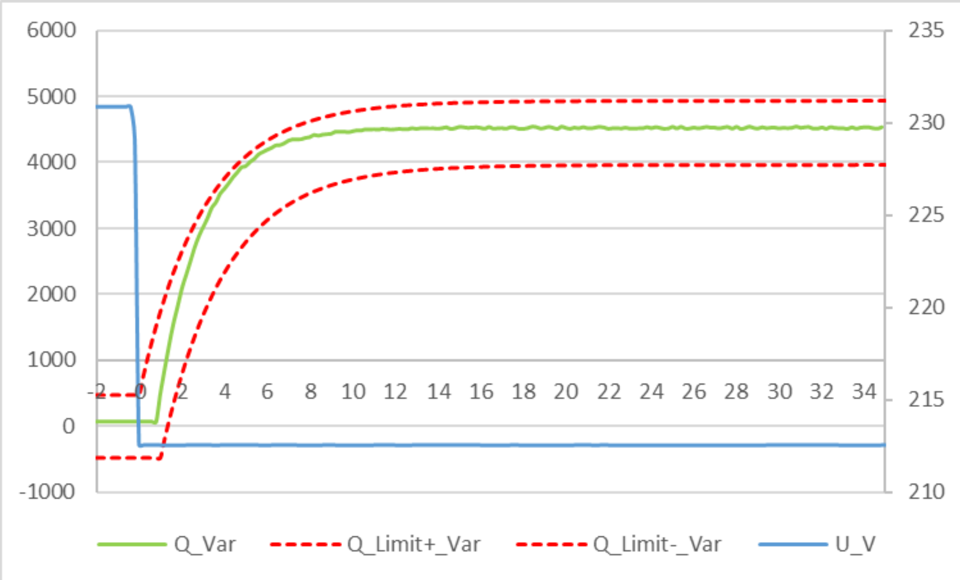
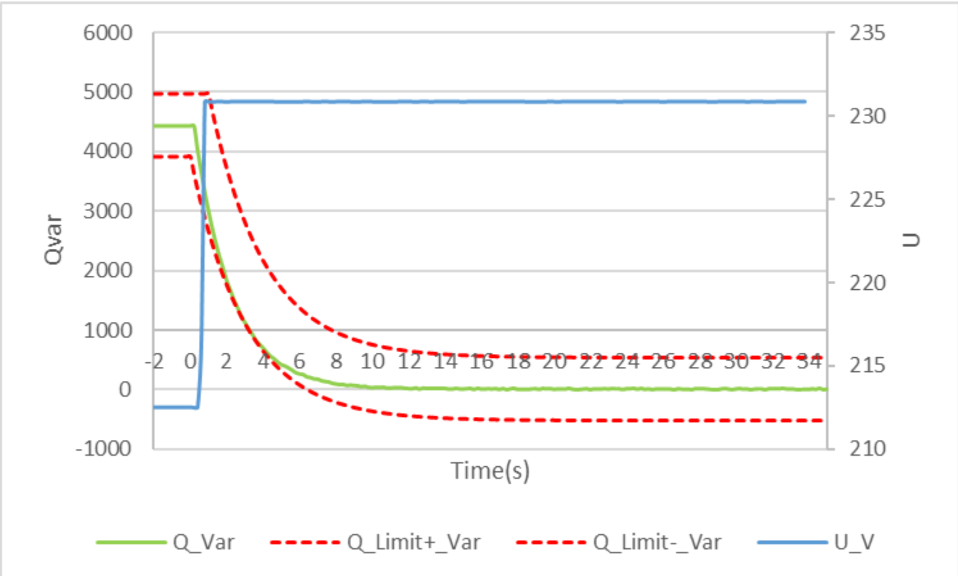
5.4.8.4.1 Test of the accuracy of the Q (U) regulation					P
Q（U） curve settings:	U/Un	0.93	0.97	1.03	1.07
	Q/S_{Emax}	+0.436	0	0	-0.436
	3Tau [s]	10			
Test:					
Vac Set point	Measured U [V]	Measured Q [Var]	Expected Q [Var]	Tolerance $\Delta Q/P_{Emax}$ [%]	Limit $\Delta Q/P_{Emax}$[%]
1.00Un	230.1	195.1	0	1.63	≤±4
0.99Un	228.0	176.8	0	1.47	≤±4
0.98Un	225.4	183.7	0	1.53	≤±4
0.97Un	223.1	176.4	0	1.47	≤±4
0.96Un	220.9	1443.6	1439	0.04	≤±4
0.95Un	218.6	2860.5	2878	-0.15	≤±4
0.94Un	216.2	4322.4	4317	0.04	≤±4
0.93Un	213.9	5740.4	5755	-0.12	≤±4
0.92Un	211.6	5742.9	5755	-0.10	≤±4
0.91Un	209.3	5724.1	5755	-0.26	≤±4
0.90Un	207.0	5736.5	5755	-0.15	≤±4
0.91Un	209.3	5735.4	5755	-0.16	≤±4
0.92Un	211.6	5744.7	5755	-0.09	≤±4
0.93Un	213.9	5753.3	5755	-0.01	≤±4
0.94Un	216.2	4317.6	4317	0.00	≤±4
0.95Un	218.5	2901.3	2878	0.19	≤±4
0.96Un	220.8	1449.0	1439	0.08	≤±4
0.97Un	223.1	244.8	0	2.04	≤±4
0.98Un	225.5	243.2	0	2.03	≤±4
0.99Un	227.8	243.7	0	2.03	≤±4
1.00Un	230.1	244.2	0	2.04	≤±4
1.01Un	232.3	244.6	0	2.04	≤±4
1.02Un	234.7	243.2	0	2.03	≤±4
1.03Un	236.9	245.6	0	2.05	≤±4
1.04Un	239.3	-1449.9	-1439	-0.09	≤±4
1.05Un	241.5	-2889.3	-2878	-0.09	≤±4
1.06Un	243.8	-4299.6	-4317	0.14	≤±4
1.07Un	246.1	-5755.4	-5755	0.00	≤±4
1.08Un	248.4	-5759.2	-5755	-0.04	≤±4
1.09Un	250.7	-5766.6	-5755	-0.10	≤±4
1.10Un	253.0	-5733.5	-5755	0.18	≤±4
1.09Un	250.7	-5745.9	-5755	0.08	≤±4

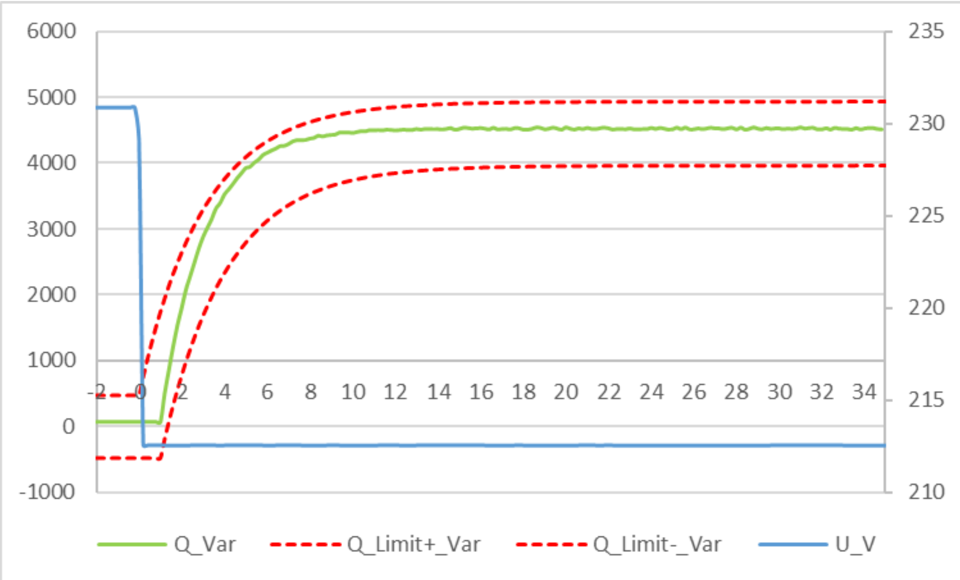
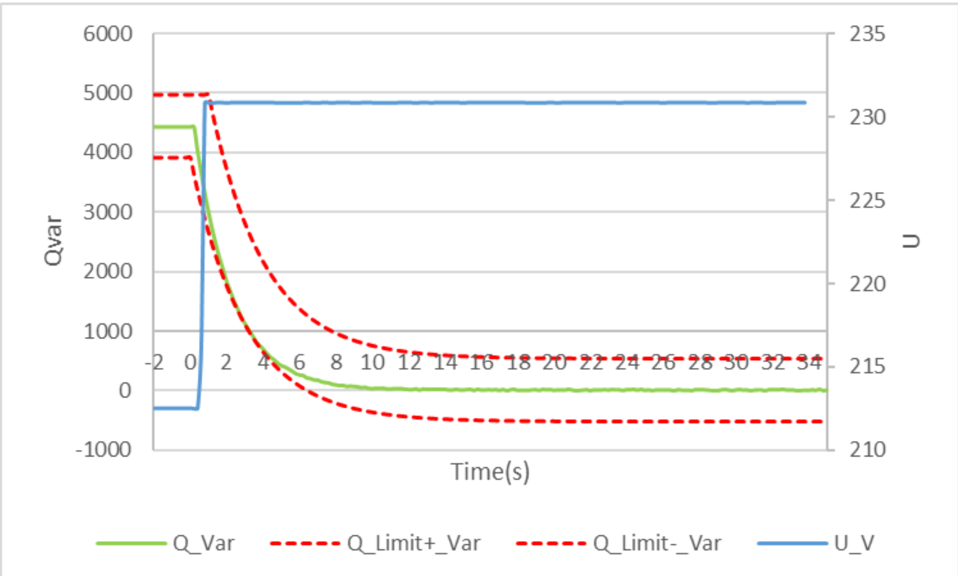
1.08Un	248.4	-5739.1	-5755	0.13	≤±4
1.07Un	246.2	-5730.2	-5755	0.21	≤±4
1.06Un	243.8	-4301.4	-4317	0.13	≤±4
1.05Un	241.6	-2898.5	-2878	-0.17	≤±4
1.04Un	239.2	-1479.1	-1439	-0.33	≤±4
1.03Un	237.0	240.1	0	2.00	≤±4
1.02Un	234.7	242.0	0	2.02	≤±4
1.01Un	232.4	244.7	0	2.04	≤±4
1.00Un	230.1	244.2	0	2.04	≤±4
Note: Xnet=0.141Ohm					

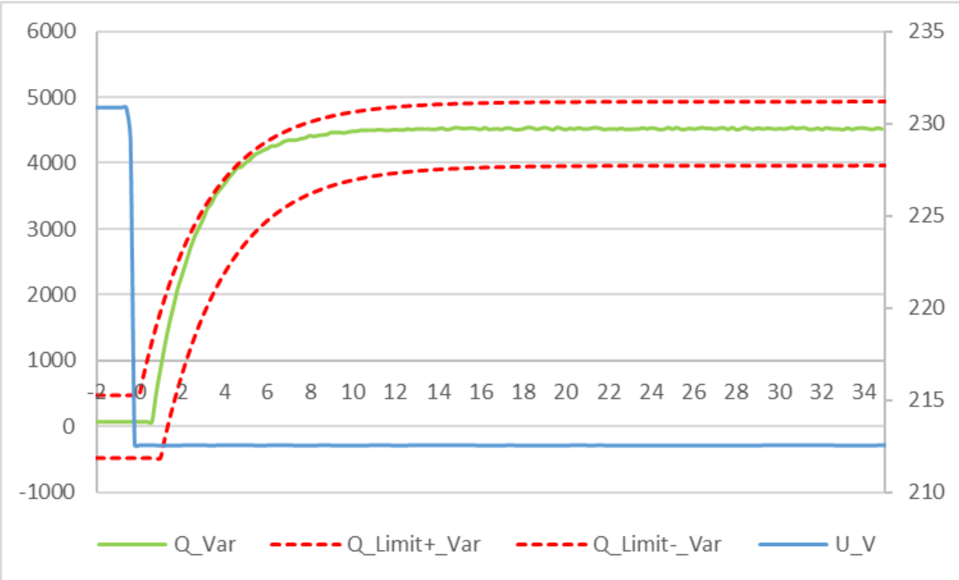
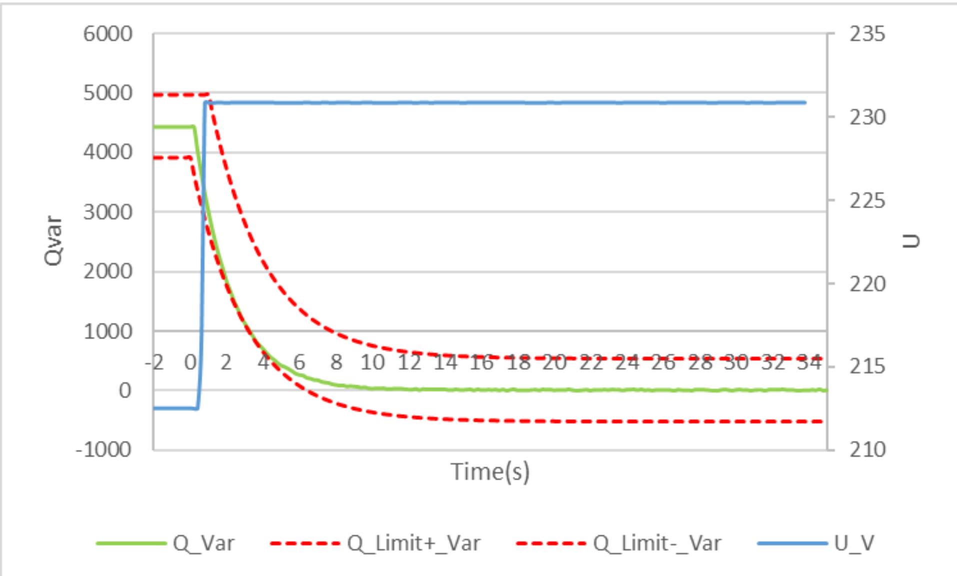
Diagram

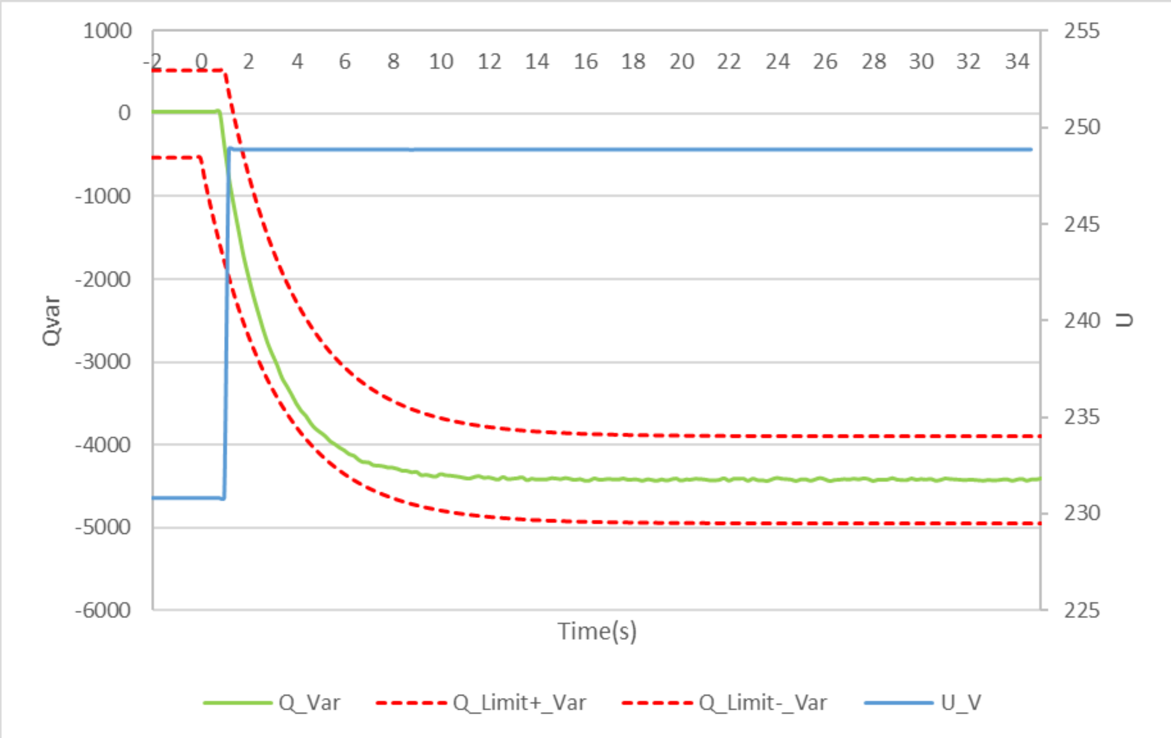
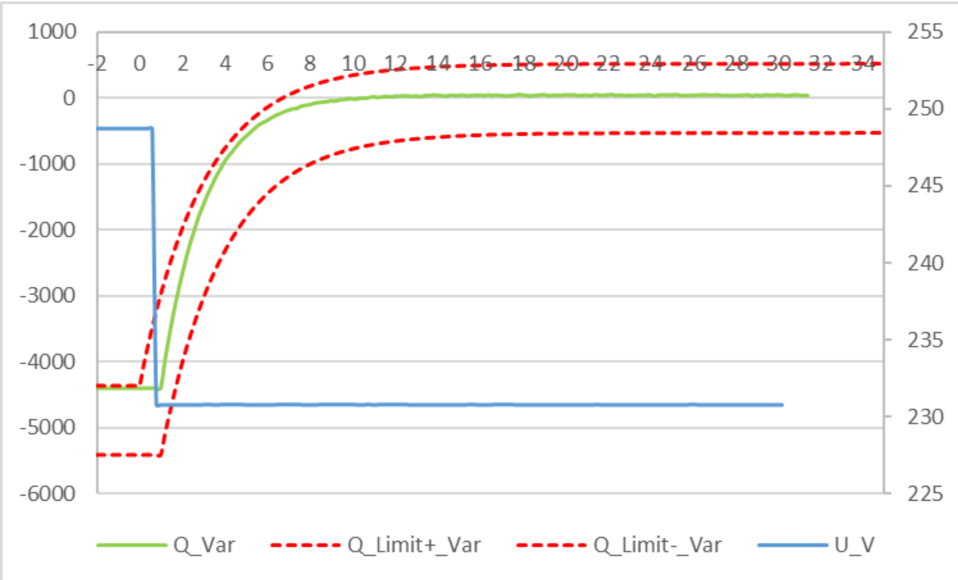


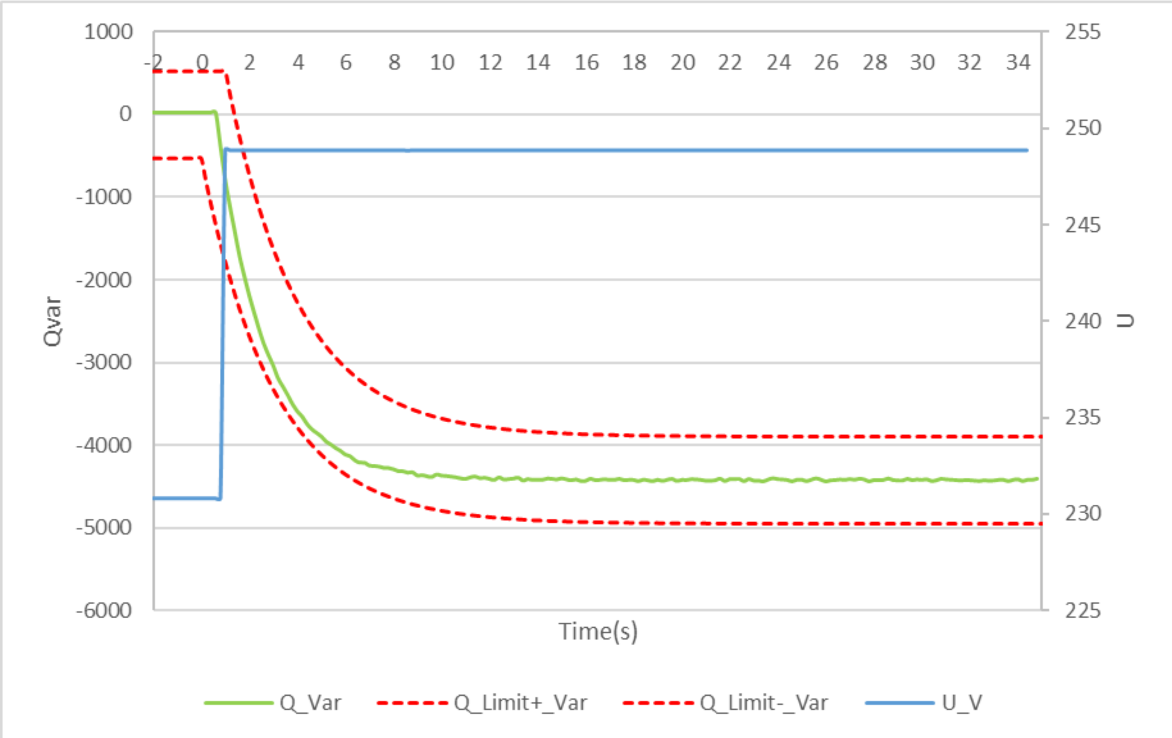
5.4.8.4.2 Test of the accuracy of the Q (U) regulation							**P**
Valtage jump U_{EZE}/U_n [p.u.]		Measured Q [Var]	Expected Q [Var]	Tolerance $\Delta Q/P_{Emax}$ [%]	Measured T=3 τ^{***} [s]	Limit $\Delta Q/P_{Emax}$[%]	
1a	Un -> Un+$\Delta U_{ind,Y}$	4535	4892	-2.98	11.4	≤±4	
1b	Un+$\Delta U_{ind,Y}$-> Un	7	0	0.06	11.0	≤±4	
2a	Un -> Un+$\Delta U_{ind,Y}$	4529	4892	-3.03	10.2	≤±4	
2b	Un+$\Delta U_{ind,Y}$-> Un	5	0	0.04	11.8	≤±4	
3a	Un -> Un+$\Delta U_{ind,Y}$	4529	4892	-3.03	10.8	≤±4	
3b	Un+$\Delta U_{ind,Y}$-> Un	5	0	0.04	13.2	≤±4	
4a	Un -> Un+$\Delta U_{cap,Y}$	-4424	-4892	3.90	10.2	≤±4	
4b	Un+$\Delta U_{cap,Y}$-> Un	39	0	0.33	12.6	≤±4	
5a	Un -> Un+$\Delta U_{cap,Y}$	-4415	-4892	3.98	11.8	≤±4	
5b	Un+$\Delta U_{cap,Y}$-> Un	39	0	0.33	12.4	≤±4	
6a	Un -> Un+$\Delta U_{cap,Y}$	-4419	-4892	3.94	10.4	≤±4	
6b	Un+$\Delta U_{cap,Y}$-> Un	40	0	0.33	12.6	≤±4	
Note: KRR=4.92 KQU=3.16 Xnet=0.141Ohm							

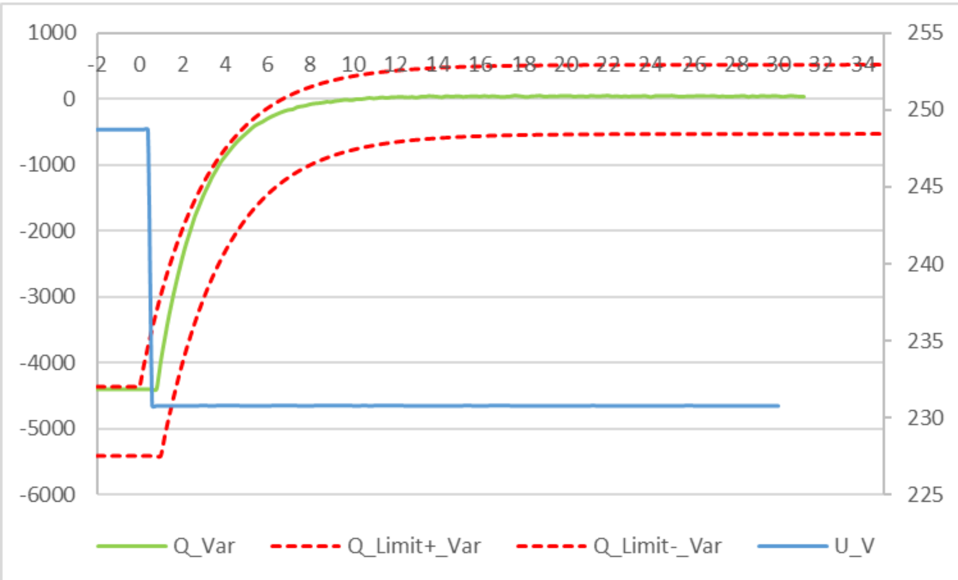
1a: Un -> Un+$\Delta U_{ind,Y}$

1b: Un+$\Delta U_{ind,Y}$-> Un


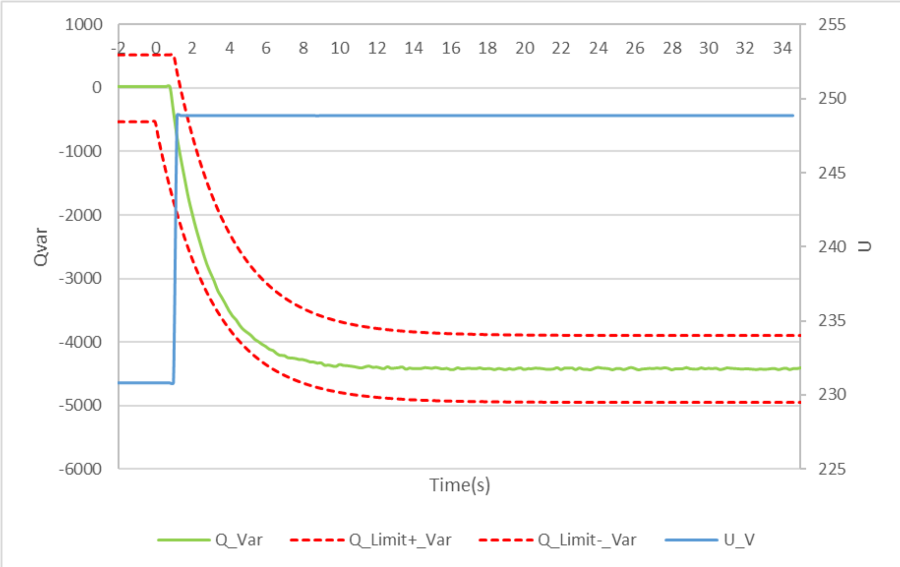
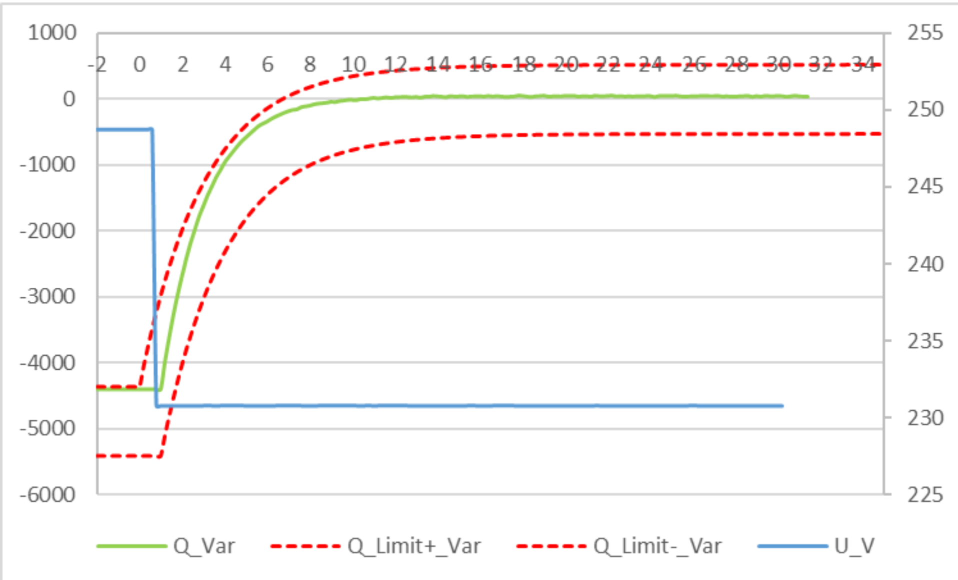
2a: Un -> Un+ΔU$_{ind,Y}$

2b: Un+ΔU$_{ind,Y}$-> Un


3a: Un -> Un+ΔU$_{ind,Y}$

3b: Un+ΔU$_{ind,Y}$-> Un


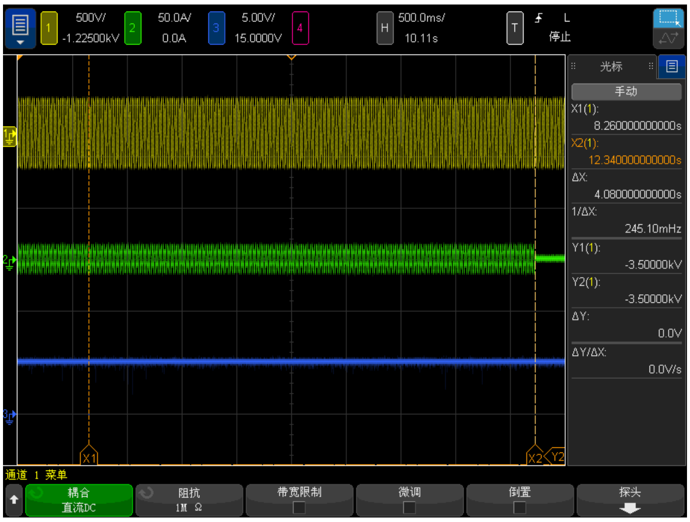
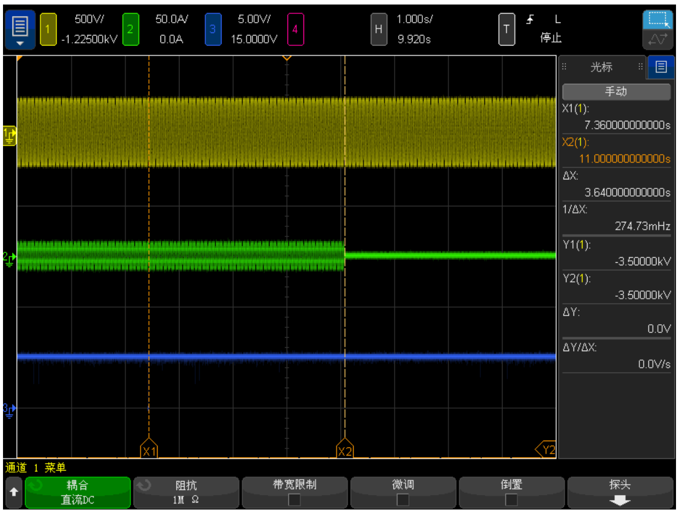
4a: Un -> Un+$\Delta U_{cap,Y}$

4b: Un+$\Delta U_{cap,Y}$-> Un


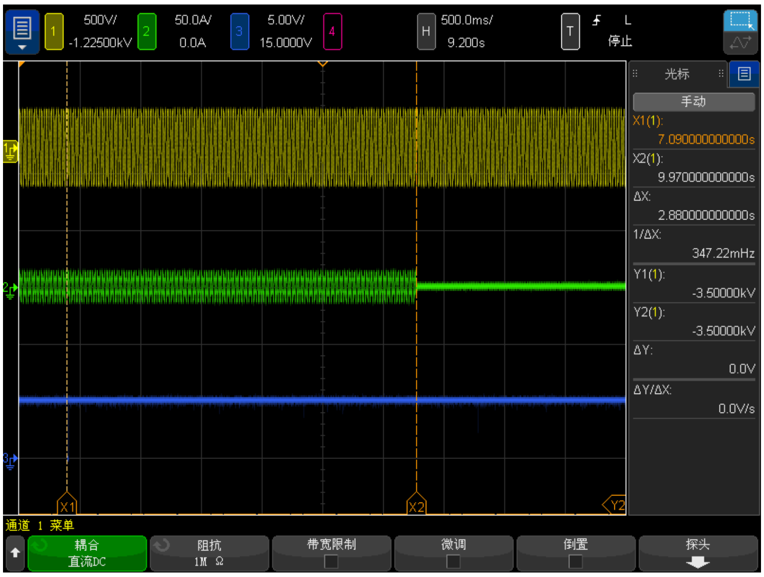
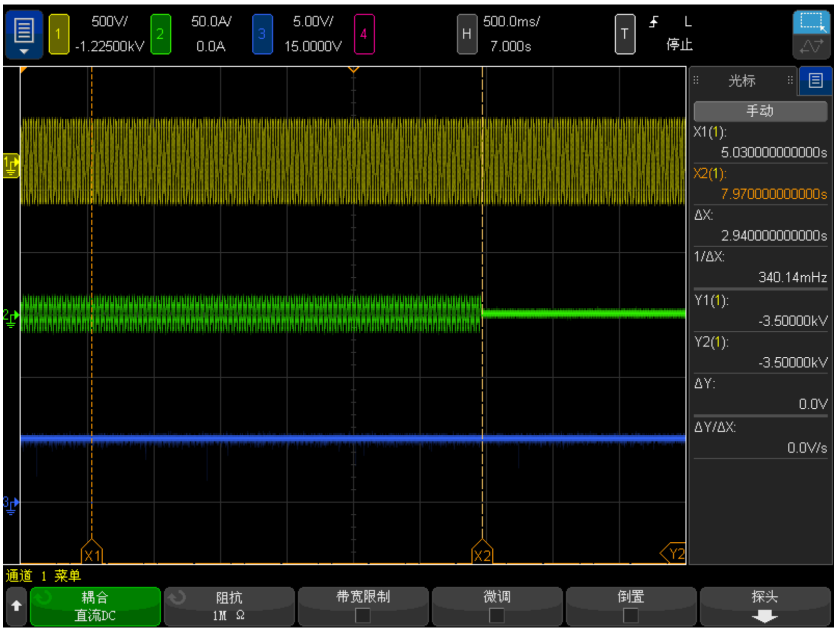
5a: Un -> Un+$\Delta U_{cap,Y}$


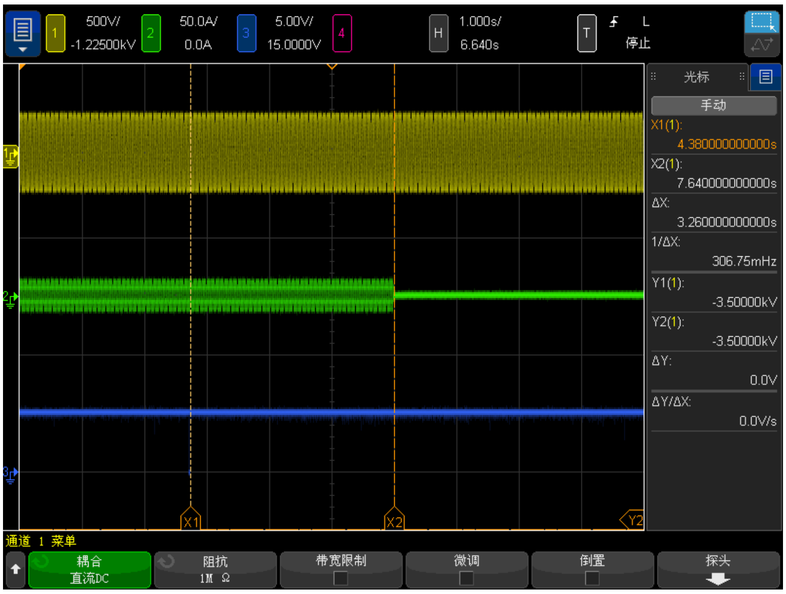
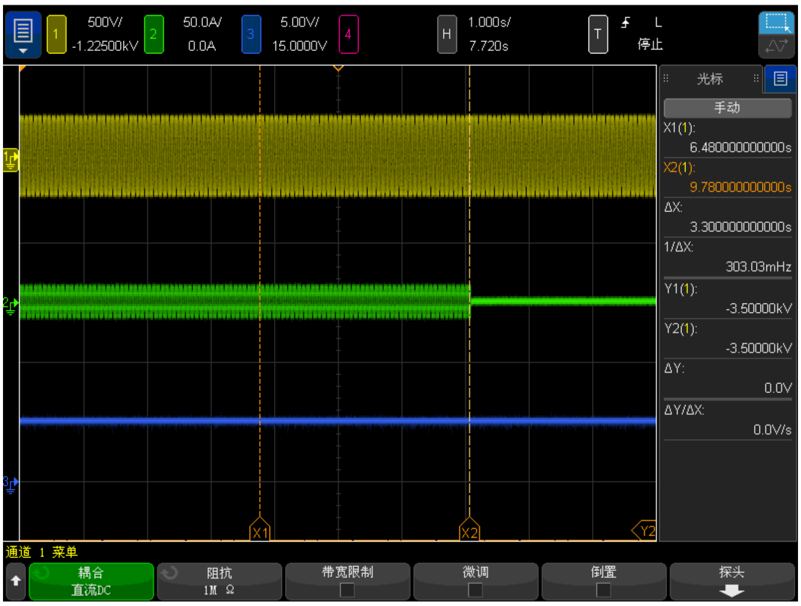
5b: Un+$\Delta U_{cap,Y}$-> Un


6a: Un -> Un+$\Delta U_{cap,Y}$

6b: Un+$\Delta U_{cap,Y}$-> Un


5.5 Testing of NS protection		
Clause	**Test**	**Result**
5.5.1	NS protection	**P**
5.5.2.1	Functional safety	**P**
5.5.3	Central NS-protection	**P**
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 – Single Phase	**N/A**
	Voltage and frequency control – Multi Phase (Phase to N)	**P**
	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 table 6 – Load imbalance (real, reactive load) for test condition A (PGU output = 100%)	**P**
	Islanding protection according table 6 – Load imbalance (real, reactive load) for test condition A (PGUT output = 66%)	**P**
	Islanding protection according table 6 – Load imbalance (real, reactive load) for test condition A (PGU output = 33%)	**p**

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).							
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
a.	Error of an AD converter or measuring card for voltage measurement		650 Vdc 230Vac	10s	--	--	The unit disconnect within 10s, no damage, no fire, no hazard
							
b.	malfunction or freezing of a microprocessor or PLC		650 Vdc 230Vac	10s	--	--	The unit disconnect within 10s, no damage, no fire, no hazard
							
c.	Merging or jamming of the contacts of the switching output		650 Vdc 230Vac	10s	--	--	The unit disconnect within 10s, no damage, no fire, no hazard

						
d.	overvoltage of the supply voltage	650 Vdc 230Vac	10s	--	--	The unit disconnect within 10s, no damage, no fire, no hazard
						

e.	Cable break in connecting cables between the measuring input and the control output to the coupling Switch	650 Vdc 230Vac	10s	--	--	The unit disconnect within 10s, no damage, no fire, no hazard
	 					
f.	Failure of the supply voltage (auxiliary voltage)	800 Vdc 230Vac	10s	--	--	The unit disconnect within 10s, no damage, no fire, no hazard
	 					

5.5.2.1 Functional safety							P
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
1.	PV1+to PV1-	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
2.	PV1+to PV1-	Polarity revers	500V	10min	/	/	The power supply voltage is 1V,and the inverter is not turned on,no damage,no hazard,no fire
3.	PV input	Overload 120%	500V	2h	/	/	Unit normal operation,no damage,nc hazard,no fire.
4.	AC output	Short circuit	500V	10min	/	/	Unit shut down no damage,no hazard, no fire.
5.	AC output	18N reverse	500V	10min	/	/	The machine doesn't start properly,no damage,no hazard,no fire.
6.	Bus Capacitor EC2	Short circuit	500V	10min	/	/	Unit shut down,the screen goes black, no damage,no hazard,no fire
7.	KF9	Short circuit before start up	500V	10min	/	/	Unit can't start up,error message:" Relay fault",no damage,no hazard no fire.
8.	KF9	open circuit before start up	500V	10min	/	/	Unit can't start up,error message:" Relay fault",no damage,no hazard no fire.
9.	KF10	Short circuit before start up	500V	10min	/	/	Unit can't start up,error message:" Relay fault",no damage,no hazard, no fire.
10.	KF10	open circuit before start Up	500V	10min	/	/	Unit can't start up,error message:" Relay fault",no damage,no hazard no fire.
11.	KF14	open circuit	500V	10min	/	/	Unit can't start up,error message:" Relay fault",no damage,no hazard,no fire.
12.	KF15	Short circuit before	500V	10min	/	/	Unit can't start up,error message:" Relay fault",no damage,no hazard,no

5.5.2.1 Functional safety							P
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
		start up					fire.
13.	KF15	open circuit before start up	500V	10min	/	/	Unit can't start up,error message:” Relay fault”,no damage,no hazard,no fire.
14.	transformer T1 Pin 10 to Pin 11	Short circuit	500V	10min	/	/	Unit can't start up,error message:” Relay fault”,no damage,no hazard,no fire.
15.	transformer T1 Pin 14 to Pin 16	Short circuit	500V	10min	/	/	The unit cannot be started until it is powered on,no damage,no hazard no fire
16.	GFCI monitoring TX1000 Pin2 to Pin3	Short circuit	500V	10min	/	/	The unit cannot be started until it is powered on,no display,no damage, no hazard,no fire
17.	IGBT Q1-1 Pin G to C	Short circuit	500V	10min	/	/	Grid trip,error message:”Gournd I Failure”,no damage,no hazard,no fire.
18.	IGBT Q1-1 Pin G to E	Short circui	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
19.	IGBT Q2-1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
20.	IGBT Q2-1 Pin G to E	Short circui	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
21.	IGBT Q3-1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
22.	IGBT Q3-1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
23.	IGBT QH-H-1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
24.	IGBT QH-H-1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire

5.5.2.1 Functional safety							P
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
25.	IGBT Q-BL-UP Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,no damage,nc hazard,no fire
26.	IGBT Q-BL-UP Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,screen goes black IGBT damaged,no hazard,no fire.
27.	IGBT QH-BUCK-1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
28.	IGBT QH-BUCK-1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
29.	IGBT QH-BOOST-1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
30.	IGBT QH-BOOST-1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
31.	MOSFET PV1-Q1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
32.	MOSFET PV1-Q1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
33.	MOSFET PV2-Q1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
34.	MOSFET PV2-Q1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
35.	MOSFET QL-H1 Pin G to C	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.
36.	MOSFET QL-H1 Pin G to E	Short circuit	500V	10min	/	/	Unit shut down,screen goes black, IGBT damaged,no hazard,no fire.

5.5.2.1 Functional safety							P
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
37.	RCMU B6 pin1-pin2	Open circuit before start up	500V	10min	/	/	Unit can't start up,no damage,no hazard,no fire
38.	RCMU B6 pin1-pin2	Short circuit before start up	500V	10min	/	/	Unit can't start up,error message:” isolation failure",no damage,no hazard,no fire.
39.	DC Voltage detect R560	Open circui	500V	10min	/	/	Unit can't start up,error message:” isolation failure”,no damage,nc hazard,no fire
40.	DC Voltage detect R560	Short circuit	500V	10min	/	/	Unit stops the connection to the grid immediately,no damage,no hazard,no fire
41.	DC current B1	Open circuit	500V	10min	/	/	Unit stops the connection to the grid immediately,no damage,no hazard,no fire
42.	DC current B1	Short circuit	500V	10min	/	/	Unit shut down,no damage,no hazard,no fire
43.	Bus voltage resistance monitoring R240	Open circuit	500V	10min	/	/	Unit shut down,no damage,nc hazard,no fire
44.	Bus voltage resistance monitoring, R240	Short circui	500V	10min	/	/	Unit shut down,error message:”DC BUS HIGH”,damage,no hazard,no fire.,no damage,no hazard,no fire.
45.	Grid voltage resistance monitoring R183	Open circuit	500V	10min	/	/	Unit shut down,error message:"DC BUS LOW”,damage,no hazard,no fire.,no damage,no hazard,no fire
46.	Grid voltage resistance monitoring R183	Short circuit	500V	10min	/	/	Unit shut down,display "VAC Failure" no damage,no hazard,no fire
47.	Frequency resistance monitoring	Open circuit	500V	10min	/	/	Unit shut down,display "VAC Failure" no damage,no hazard,no fire

5.5.2.1 Functional safety							P
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
	R453						
48.	Frequency resistance monitoring R453	Short circuit	500V	10min	/	/	Unit shut down,display"VAC Failure" no damage,no hazard,no fire
49.	Main CPU1, loss control	C34 Pin 1-Pin2 Open circuit	500V	10min	/	/	Unit shut down,display "VAC Failure" no damage,no hazard,no fire
50.	Slave CPU1, loss control	C34 Pin 1-Pin2 Open circuit	500V	10min	/	/	Unit shut down,display"CPU Failure" no damage,no hazard,no fire

Note:

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

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.

5.5.3 Central NS-protection	
5.5.3.1 Test "functional safety"	**P**
The following tests must be carried out one after the other	
	Shutdown signal
The auxiliary voltage of the NS protection is switched off	P
The test facility on the NS protection is actuated	P
The test is passed if a signal for the instantaneous shutdown is generated	
5.5.3.2 Evaluation criterion	
The test is passed if a signal for the instantaneous shutdown is generated	

5.5.4 Integrated NS protection	P
The integrated NA 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	P
The interface switch consists of two electrical break devices connected in series and is therefore designed with redundancy, See 5.5.2.1 Functional safety for the test for single-fault tolerance and fault finding with subsequent disconnection for the entire functional chain, An all-pole galvanic break device is provided,	
Note: For synchronous machines, the break device for synchronisation is designed three pole instead of four pole.	

5.5.6.3 **Integrated interface switch**	**P**
The galvanically separated inverter has a galvanic separating break device The inverter that is not galvanically separated has two independent galvanically separating breaking devices See 5.4.5.2 Functional safety for the test for single-fault tolerance of the interface switch The interface switch is short-circuit proof for the maximum short-circuit current of the power generation unit, Model: AZSR143 Max. switching current relay =50A, 277 Vac Operate time ≤20ms	

Datasheet of the relay:

AZSR143

50 AMP MINIATURE POWER RELAY

FEATURES

- 50 Amp switching capability
- Contact gap: 1.8 mm
- Dielectric strength 4.5 kV_{RMS}
- 10kV Surge
- UL class F insulation
- UL / CUR E365652
- TÜV B0887930015
- CQC 19002227975

CONTACTS

Arrangement	SPST-N.O. (1 Form A)
Ratings (max.) switched power switched current continuous current switched voltage	(resistive load) 13850 VA 50 A 50 A 277 VAC
Rated Loads **UL/CUR/TÜV/CQC**	43 A at 277 VAC, resistive, 85°C, 30k cycles 33 A at 277 VAC, resistive, 105°C, 30k cycles 50 A at 277 VAC, resistive, 85°C, 6k cycles 20 A at 277 VAC on, carry 50A, 20A 277VAC off, resistive, 85°C, 50k cycles
Contact material	$AgSnO_2$ (silver tin oxide)
Contact gap	1.8 mm
Contact resistance initial typical	(load contact) ≤ 100 mΩ < 3 mΩ

COIL

Nominal coil DC voltages	5, 9, 12, 18, 24, 48
Dropout voltage	> 5% of nominal coil voltage
Holding voltage	> 35% of nominal coil voltage
Coil power nominal holding power at pickup voltage max continuous	(at 23 °C) 1.6 W 196 mW 900 mW 2.3 W
Temperature Rise	70 K (126°F) at nom. coil voltage, 43A, 85°C
Max. temperature	Class F insulation - 155°C (311°F)

GENERAL DATA

Life Expectancy mechanical electrical	(minimum operations) 1×10^5 see UL/CUR/TÜV/CQC ratings
Operate Time	20 ms (max.) at nominal coil voltage
Release Time	10 ms (max.) at nominal coil voltage, without coil suppression
Dielectric Strength coil to load contacts open load contacts	(at sea level for 1 min.) 4500 V_{RMS} 2500 V_{RMS}
Surge Voltage	10kV @1.2/50µs (coil to contacts)
Insulation Resistance	1000 MΩ (min.) at 23°C, 500 VDC, 50% RH
Temperature Range operating storage	(at nominal coil voltage) -40°C (-40°F) to 85°C (185°F) -40°C (-40°F) to 105°C (221°F)
Vibration resistance	0.062" (1.5 mm) DA at 10–55 Hz
Shock	20 g
Enclosure protection category material group flammability	P.B.T. polyester RT II, flux proof IIIa UL94 V-0
Terminals	Tinned copper alloy, P. C.
Soldering max. temperature max. time	 270 °C 5 s
Dimensions length width height	 30.4 mm (1.20") 15.9 mm (0.63") 25.15 mm (0.99")
Weight	25 grams (approx.)
Compliance	UL 508, IEC 61810-1, RoHS, REACH
Packing unit in pcs	50 per plastic tray / 500 per carton box

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Datasheet of the relay:

AZSR143

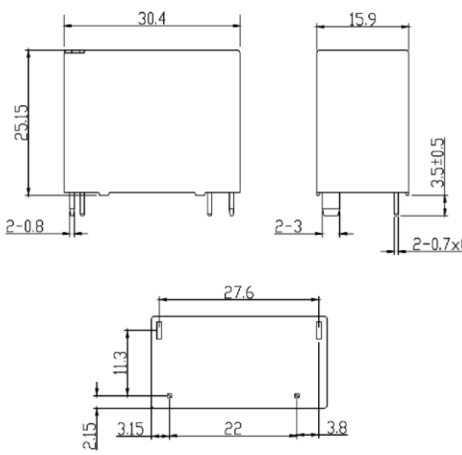
COIL VOLTAGE SPECIFICATIONS

Nominal Coil VDC	Must Operate VDC	Min. Holding VDC	Max. Cont. VDC	Resistance Ohm ± 10%
5	3.75	1.75	6.0	15.5
9	6.75	3.15	10.8	50.5
12	9.0	4.2	14.4	90.0
18	13.5	6.3	21.6	202.5
24	18.0	8.4	28.8	360.0
48	36.0	16.8	57.6	1440

Note: All values at 23°C (73°F), upright position, terminals downward.

MECHANICAL DATA

Dimensions in mm. Tolerance: ±0.3mm



ORDERING DATA

AZSR143-1AE-□□D

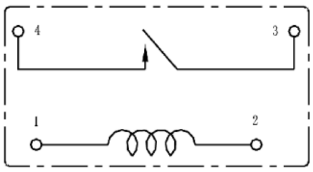
Nominal coil voltage
see coil voltage specifications table

Example ordering data

AZSR143-1AE-24D With 24 VDC coil

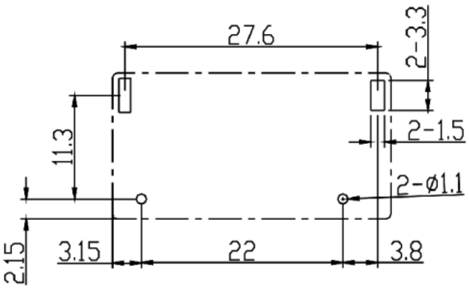
WIRING DIAGRAMS

Viewed towards terminals



PC BOARD LAYOUT

Viewed towards terminals. Dimensions in mm.



NOTES

1. All values at 23°C (73°F).
2. Relay may pull in with less than "Must Operate" value.
3. Provide sufficient PCB cross section as heat spreader on terminals.
4. Specifications subject to change without notice.

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Datasheet of the relay:

AZSR143

DISCLAIMER

This product specification is to be used in conjunction with the application notes which can be downloaded from the regional ZETTLER relay websites. The specification provides an overview of the most significant part features. Any individual applications and operating conditions are not taken into consideration. It is recommended to test the product under application conditions. Responsibility for the application remains with the customer. Proper operation and service life cannot be guaranteed if the part is operated outside the specified limits.

ZETTLER GROUP

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5.5.7.2	Check of setting values				P
5.5.7.2.1	Test				P
Setting values:					
PGU type	Description	Parameter name	Set value in p.u.	Set value L-N	Set value L-L *2)
	Nominal voltage	Un	1	230.0V	--
	Nominal frequency	Fn	1	50Hz	--
a) Name of country setting in inverter "Germany"					
Inverter	Excitation threshold U>>	AU>>	1.25	287.5V	500V
	Delay time U>>	tU>>	-	0.100s	0.100s
	Excitation threshold U>	AU>	1.10	253.0V	440V
	Delay time U> * 1)	tU>	-	0.100s *1)	0.100s *1)
	Excitation threshold U<	AU<	0.8	184.0V	320V
	Delay time U<	tU<	-	3s	3s
	Excitation threshold U<<	AU<<	0.45	103.5V	180V
	Delay time U<<	tU<<	-	0.300s	0.300s
	Excitation threshold f>	Af>	1.03	51.5Hz	51.5Hz
	Delay time f>	tf>	-	0.100s	0.100s
	Excitation threshold f<	Af<	0.95	47.5Hz	47.5Hz
	Delay time f<	tf<	-	0.100s	0.100s

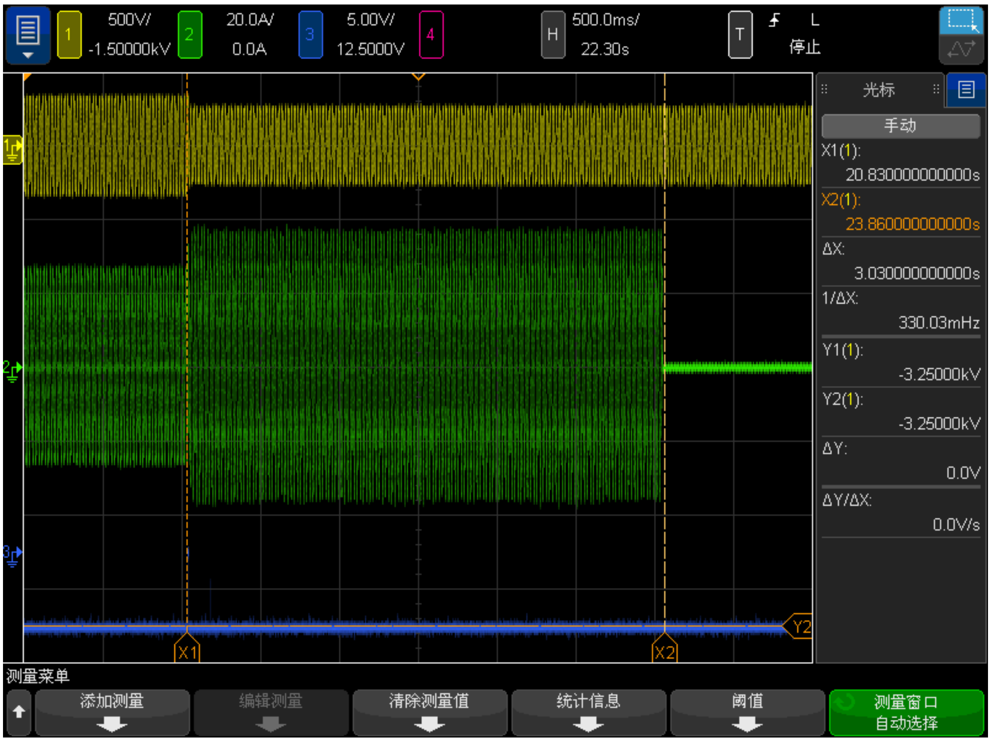
*1) 10-min mean value
*2) testing of external NS-protection

Factory settings correspond to the values in Table 36	Yes
There are no factory settings. The information on the setting values in the instructions manual correspond to those in Table 36.	No
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	Yes
The limit values for U> can be set between 110% and 115% and, in the case of directly coupled synchronous and asynchronous generators with PrE >50kW, the time delay for U< and U<< can be set. All other limit values are protected against unauthorized access.	Yes

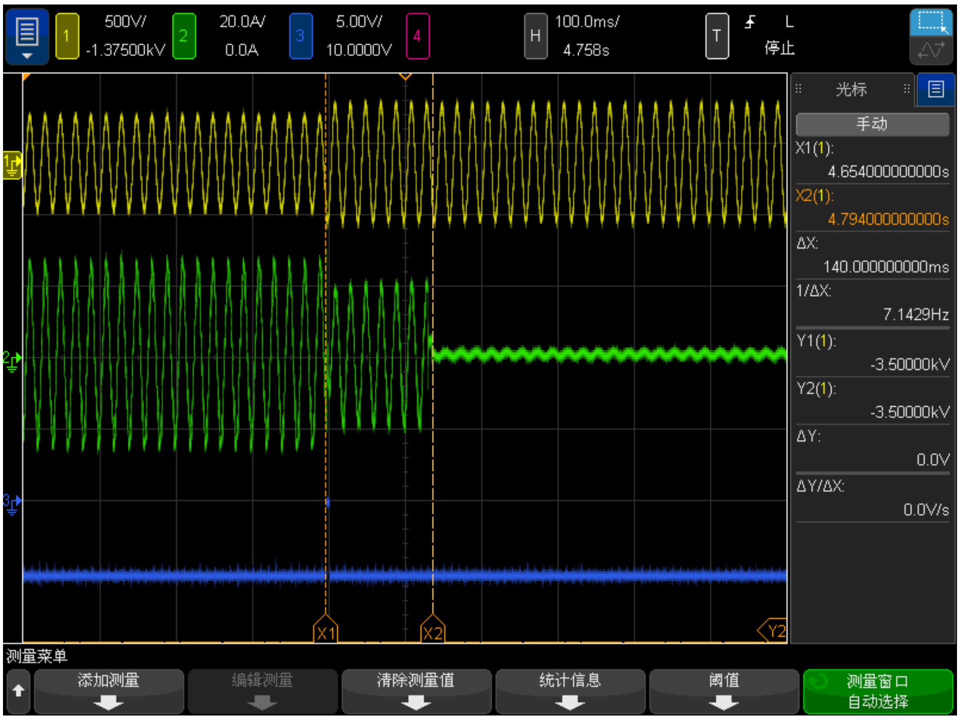
Assessment criterion:
The exam is passed if the following points are met:
The factory setting values correspond
With integrated NA protection of VDE-AR-N 4105: 2018-11, 6.5.2 Table 2 (see also Table 36).
With central NA protection, either the factory settings of VDE-AR-N 4105: 2018-11, 6.5.2, Table 2 (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

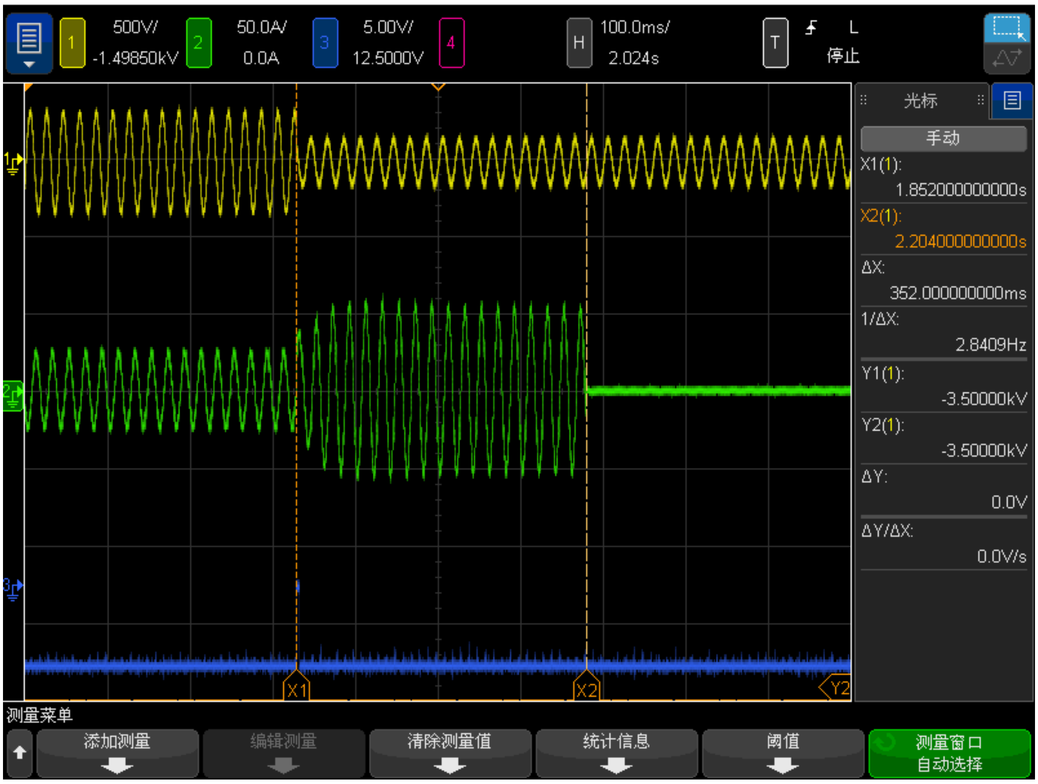
5.5.7.4 Voltage control						P
Integrated NS protection single phase (phase to neutral)						
Setting values of the NS protection:	Setting U< [V]:		287.5			
	Setting U> [V]:		184			
	Setting U<< [V]:		103.5			
	Setting $T_{disconnection}$ [ms]		/			
Operating time of the monitoring device:						
L1 to N:	**Under voltage 1:**			**Over voltage 1:**		
Step [V to V]:	188.6 V to 179.4 V			282.9 V to 292.1 V		
Limit [V]:	184.0 V			287.5 V		
Measurement [V:]	184.04	183.80	183.73	287.53	287.20	287.21
Limit [ms]:	3000 - 3100 ms			100-200ms		
Disconnection time [ms]:	3030	3020	3030	140.0	138.0	140.0
L-N	**Under voltage 2:**					
Step [V to V]:	108.1V to 98.9 V					
Limit [V]:	103.5V					
Measurement [V:]	103.49	103.41	103.48			
Limit [ms]:	300-400ms					
Disconnection time [ms]:	348.0	352.0	350.0			
Note: The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of U_n ,						

Under voltage 1:



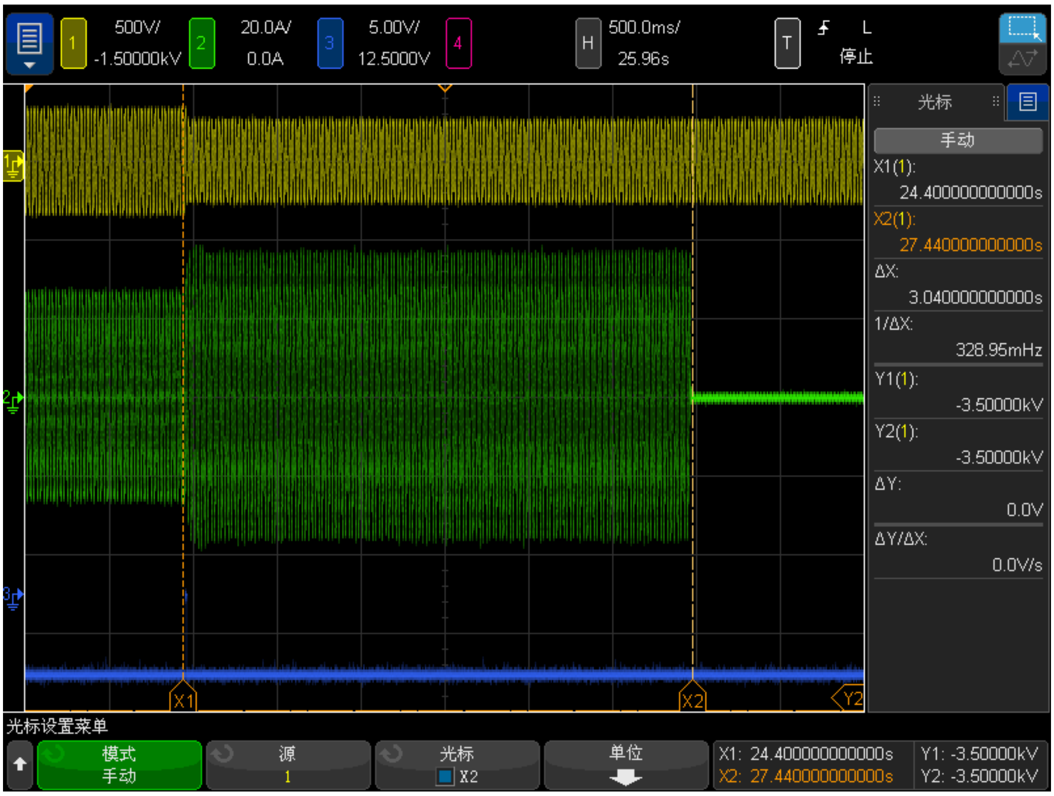
Over voltage 1:



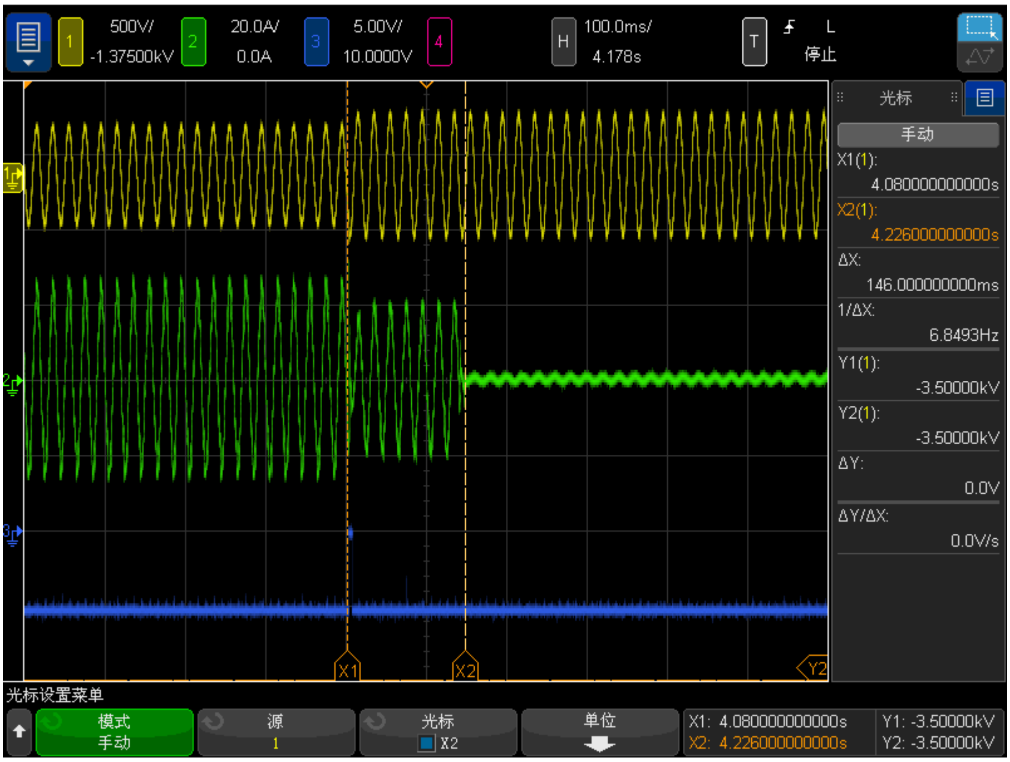
Under voltage 2:


5.5.7.4 Voltage control							P
Integrated NS protection single phase (phase to neutral)							
Setting values of the NS protection:	Setting U< [V]:		287.5				
	Setting U> [V]:		184				
	Setting U<< [V]:		103.5				
	Setting $T_{disconnection}$ [ms]		/				
Operating time of the monitoring device:							
L2 to N:	**Under voltage 1:**			**Over voltage 1:**			
Step [V to V]:	188.6 V to 179.4 V			282.9 V to 292.1 V			
Limit [V]:	184.0 V			287.5 V			
Measurement [V:]	185.57	183.85	183.82	287.12	286.86	287.05	
Limit [ms]:	3000 - 3100 ms			100-200ms			
Disconnection time [ms]:	3040	3020	3040	142.0	140.0	146.0	
L-N	**Under voltage 2:**						
Step [V to V]:	108.1V to 98.9 V						
Limit [V]:	103.5V						
Measurement [V:]	103.43	103.44	103.45				
Limit [ms]:	300-400ms						
Disconnection time [ms]:	354.0	358.0	350.0				
Note: The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of U_n ,							

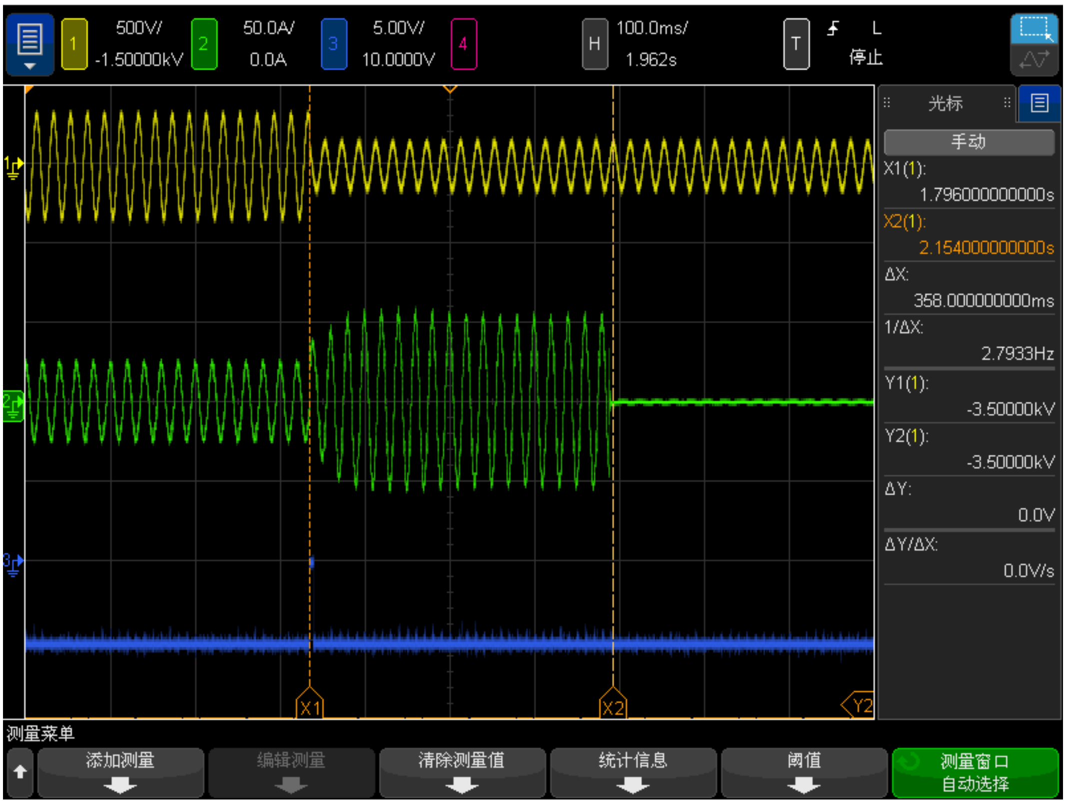
Under voltage 1:



Over voltage 1:

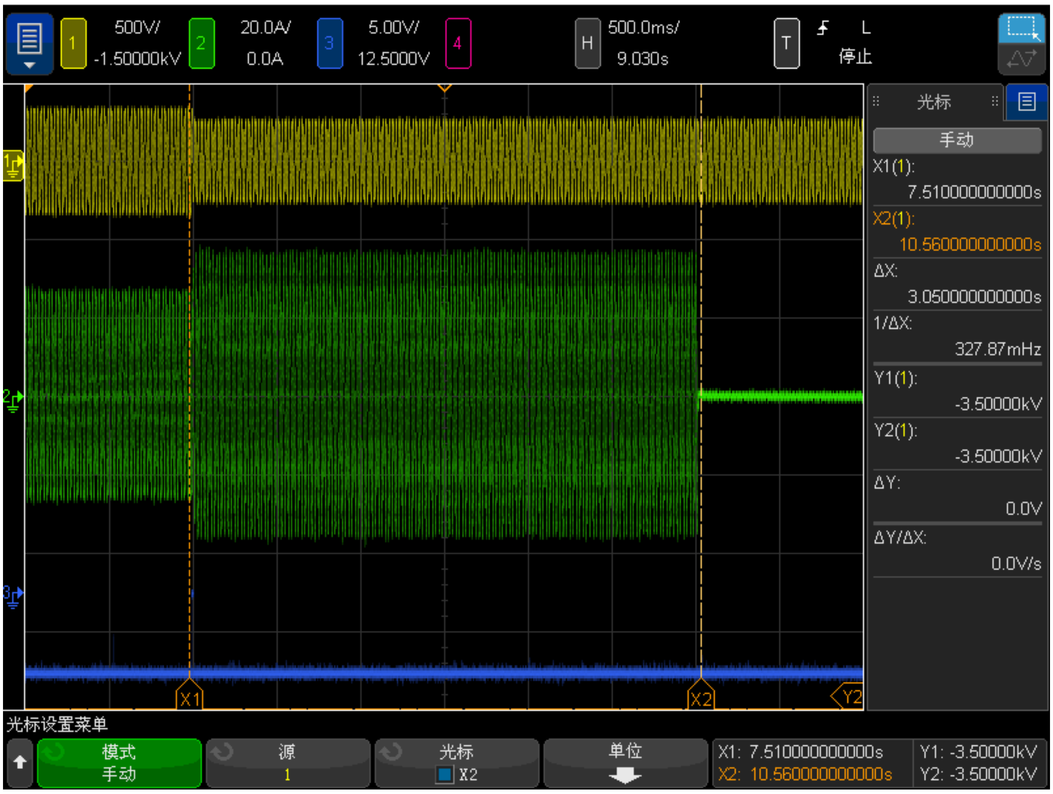


Under voltage 2:

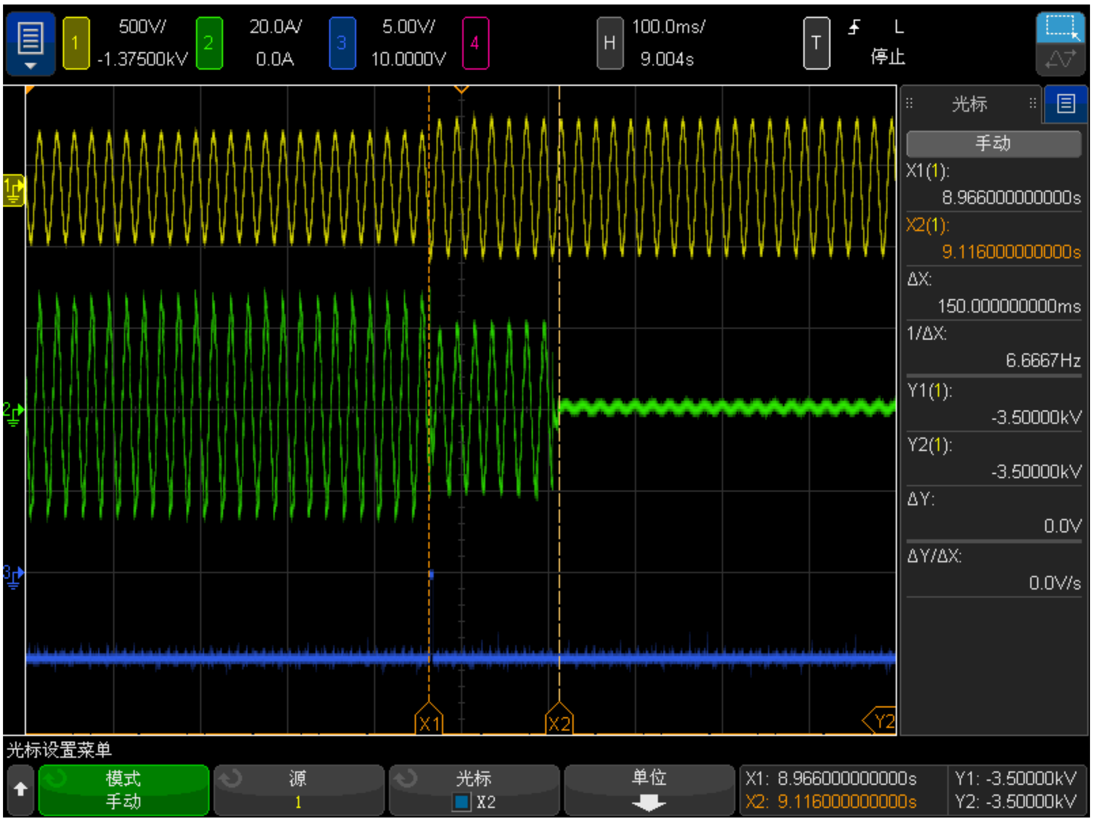


5.5.7.4 Voltage control						P
Integrated NS protection single phase (phase to neutral)						
Setting values of the NS protection:	Setting U< [V]:	287.5				
	Setting U> [V]:	184				
	Setting U<< [V]:	103.5				
	Setting $T_{disconnection}$ [ms]	/				
Operating time of the monitoring device:						
L3 to N:	**Under voltage 1:**			**Over voltage 1:**		
Step [V to V]:	188.6 V to 179.4 V			282.9 V to 292.1 V		
Limit [V]:	184.0 V			287.5 V		
Measurement [V:]	183.58	184.25	183.27	287.36	287.36	287.36
Limit [ms]:	3000 - 3100 ms			100-200ms		
Disconnection time [ms]:	3020	3050	3030	146.0	150.0	148.0
L-N	**Under voltage 2:**					
Step [V to V]:	108.1V to 98.9 V					
Limit [V]:	103.5V					
Measurement [V:]	103.41	103.50	103.44			
Limit [ms]:	300-400ms					
Disconnection time [ms]:	348.0	356.0	350.0			
Note: The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1% of U_n ,						

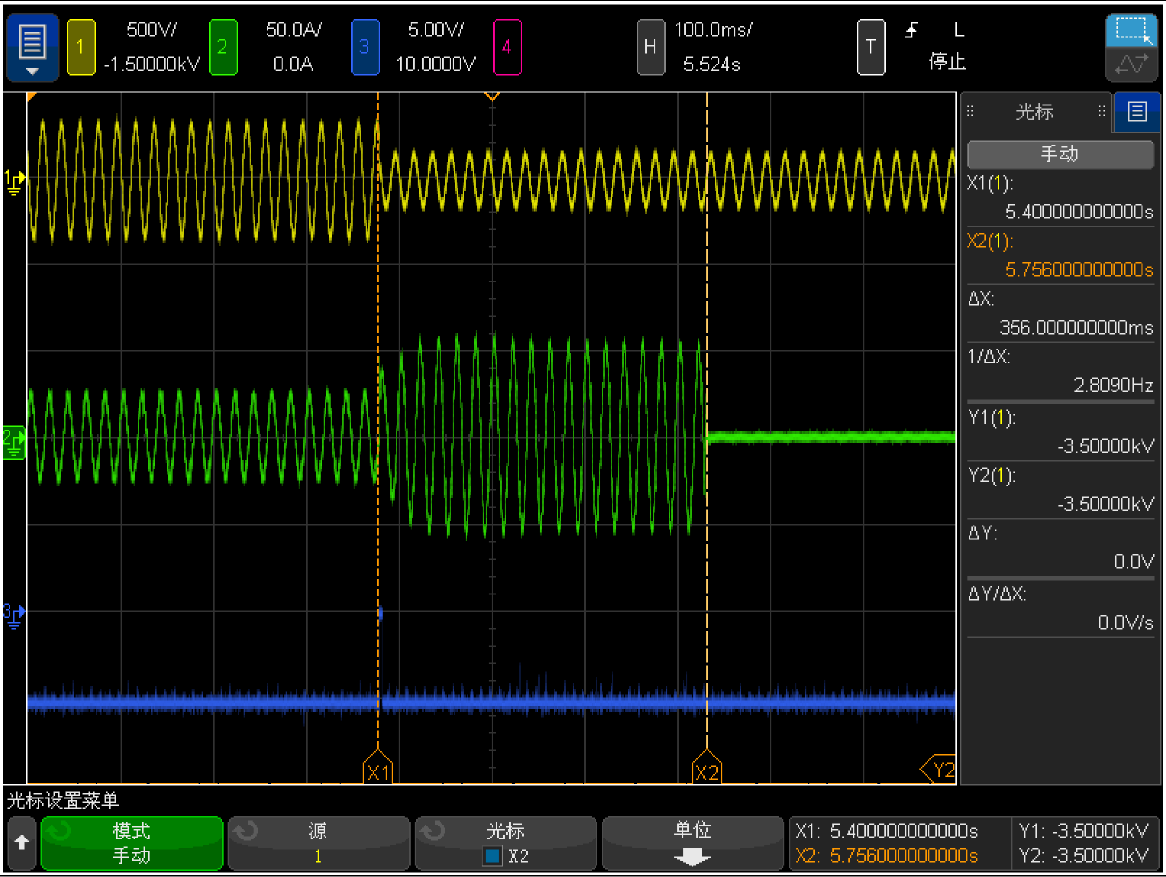
Under voltage 1:



Over voltage 1:



Under voltage 2:



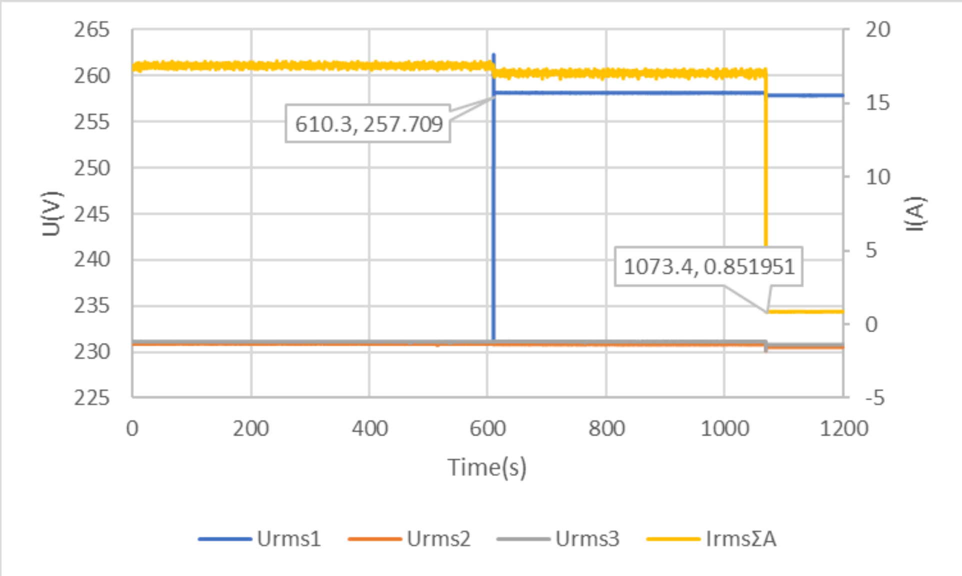
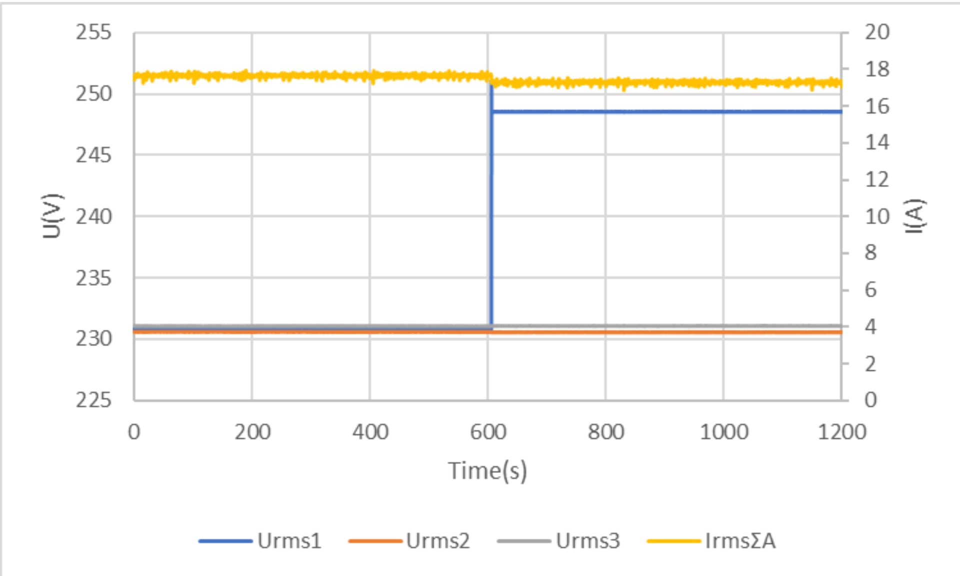
5.5.7.4 Measuring the rise-in voltage protection as a running 10-minute mean value			P
Test:			
		Disconnection time [s]:	Limit [s]:
a)	The voltage is set to 100% U_n and held for 600 s, Thereafter the voltage is set to 112% U_n, Disconnection must take place within 600 s,		
	Phase 1:	463.1	600
	Phase 2:	453.8	
	Phase 3:	459.9	
b)	The voltage is set to U_n for 600 s and then to 108% U_n for 600 s, No disconnection should take place,		
	Phase 1:	No disconnection	Disconnection should not take place,
	Phase 2:	No disconnection	
	Phase 3:	No disconnection	
c)	The voltage is set to 106 % U_n and held for 600 s, Thereafter the voltage is set to 114 % U_n, Disconnection must take place within 300 s or about 50 % of the disconnection time measured in point a),*		
	Phase 1:	330.2	The disconnection time should be about 50 % of the value measured in a), *
	Phase 2:	326.2	
	Phase 3:	327.6	

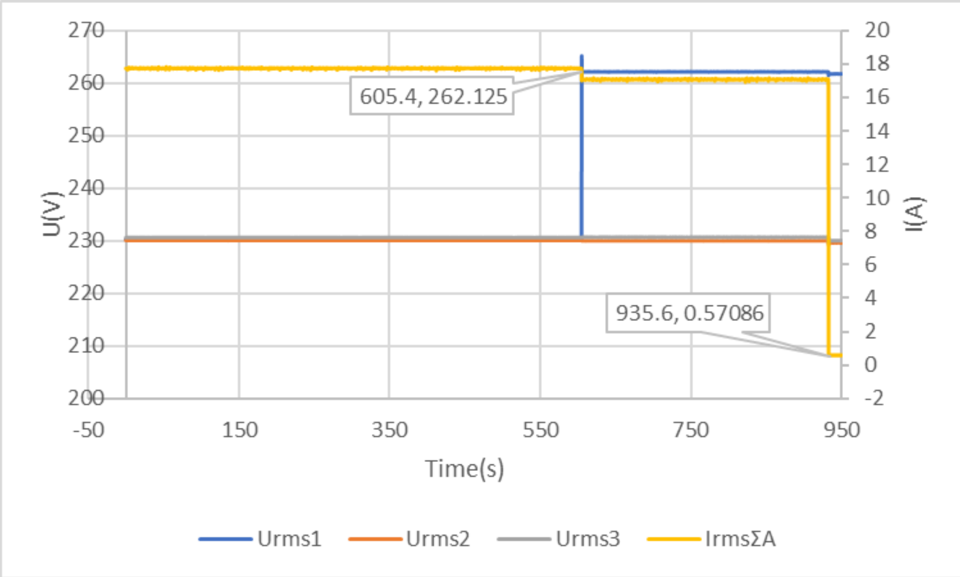
Test:
a) This test serves as proof of the measurement accuracy and the maximum set time,
b) This test serves as proof of the measurement accuracy,
c) This test serves as proof of the correct formation of the 10 minute running mean value,

Assessment criterion:
The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1 % of Un.

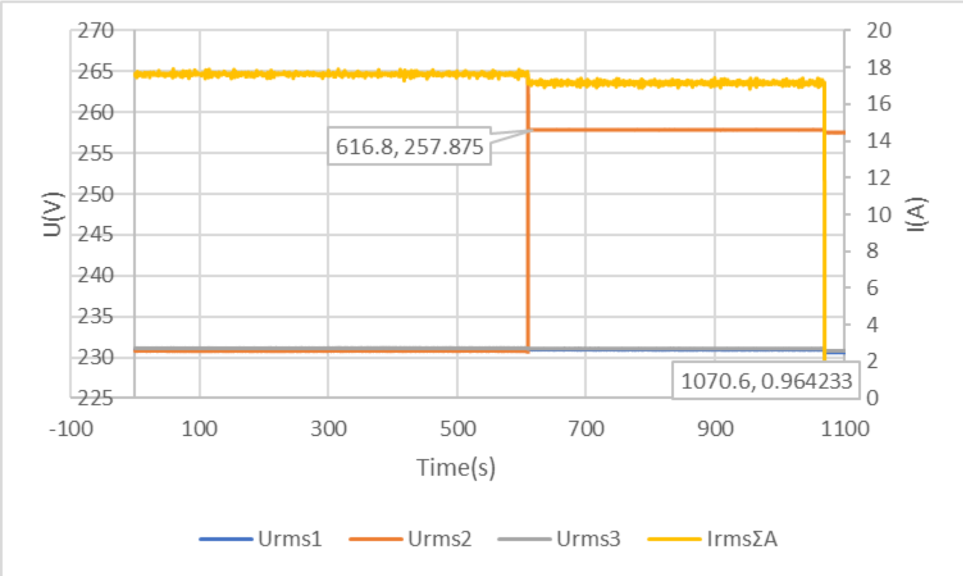
Limit values:
Rise-in voltage protection U>1.1U_n after a max. 600 s. the switch off after 200 ms.

Note:
If only one integrated NS protection is used for the power generation systems ≤30kVA. the value of the rise-in voltage protection U> of 1.1 U_n may not be changed.
*If the setting value is set to 600 s. then the disconnection time can be in the range between 225 s and 375 s.

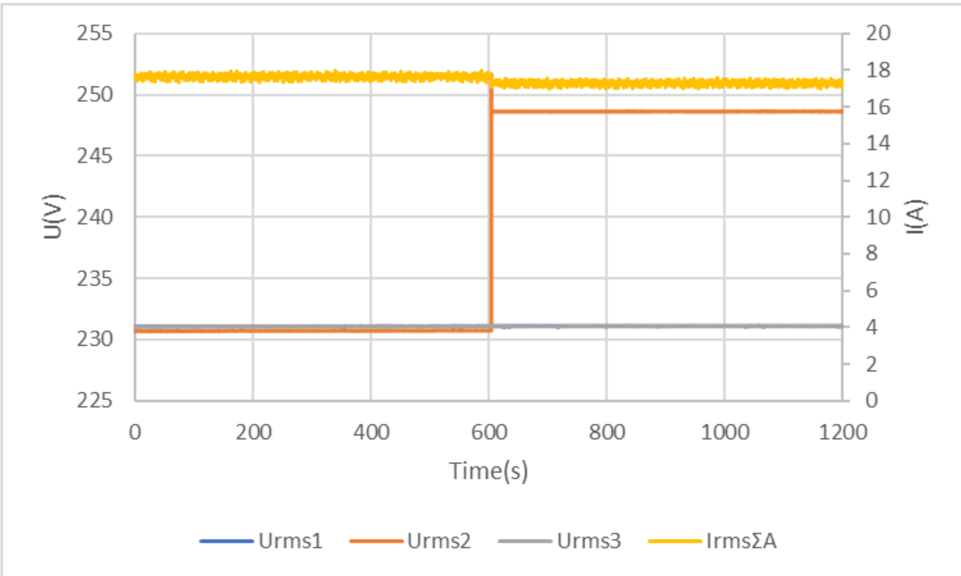
Phase 1
Voltage: a) 112%Un

Voltage: b) 108%Un


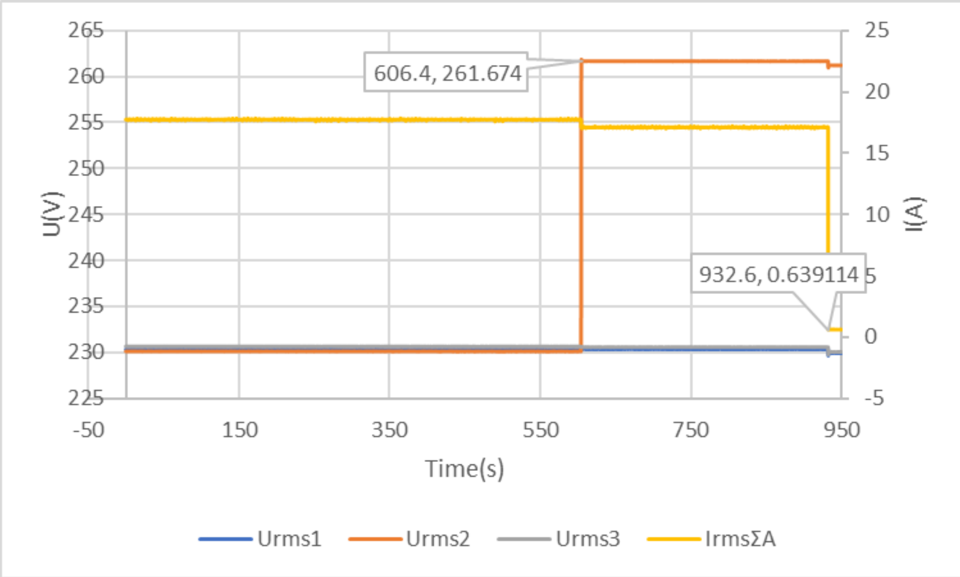
Voltage: c) 114%Un


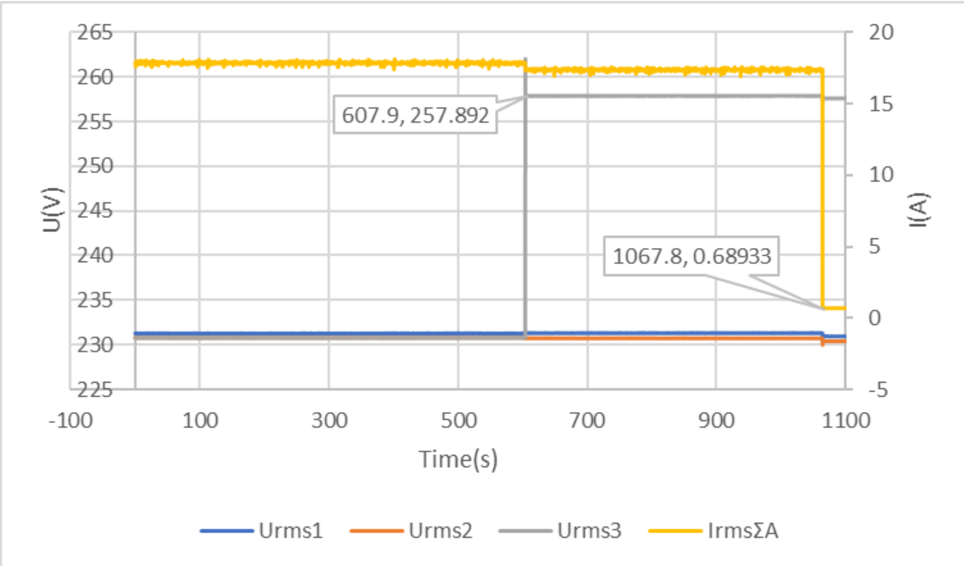
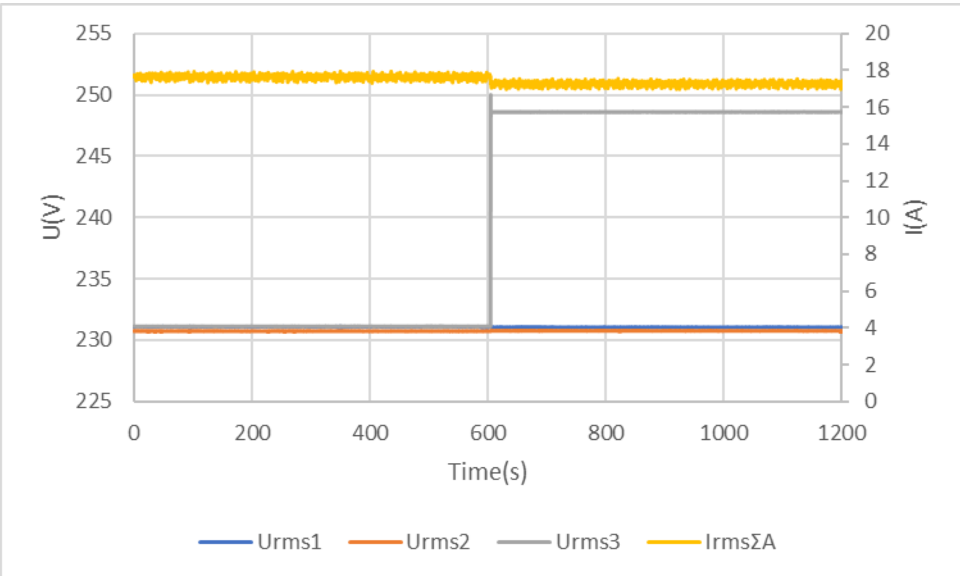
Phase 2
Voltage: a) 112%Un

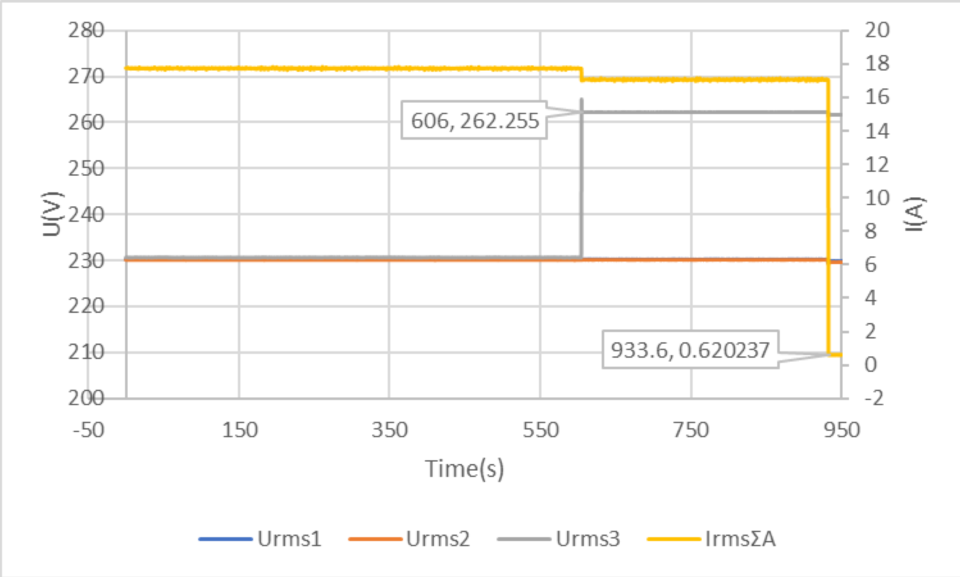


Voltage: b) 108%Un



Voltage: c) 114%Un


Phase 3
Voltage: a) 112%Un

Voltage: b) 108%Un


Voltage: c) 114%Un


5.5.7.4 Frequency measurement						**P**
Setting values of the NS protection:	Setting f< [Hz]:		47.5			
	Setting f>[Hz]:		51.5			
	Setting $T_{disconnection}$ [ms]		200			
Operating time of the monitoring device						
	Under frequency			**Over frequency**		
Ramp [Hz to Hz]:	47.60 Hz -> 47.40 Hz			51.40 Hz -> 51.60 Hz		
Limit [Hz]:	47.5±0.05Hz			51.5±0.05Hz		
Measurement [Hz]:	47.53	47.55	47.53	51.55	51.52	51.52
Limit [ms]:	100-200ms			100-200ms		
Disconnection time [ms]:	138.0	139.0	135.0	134.0	132.0	134.0

Test:

Testing of the frequency over protection f> and of the under frequency protection f <,

a) The frequency must be set to fn 50.0 Hz and kept. A jump to 51.3 Hz must be performed and held for 60 sec. Afterwards. a jump to 51.7 Hz must be performed and held.
b) The frequency must be set to fn 50.0 Hz and kept. A jump to 47.7 Hz must be performed and held for 60 sec. Afterwards. a jump to 47.3 Hz must be performed and held.

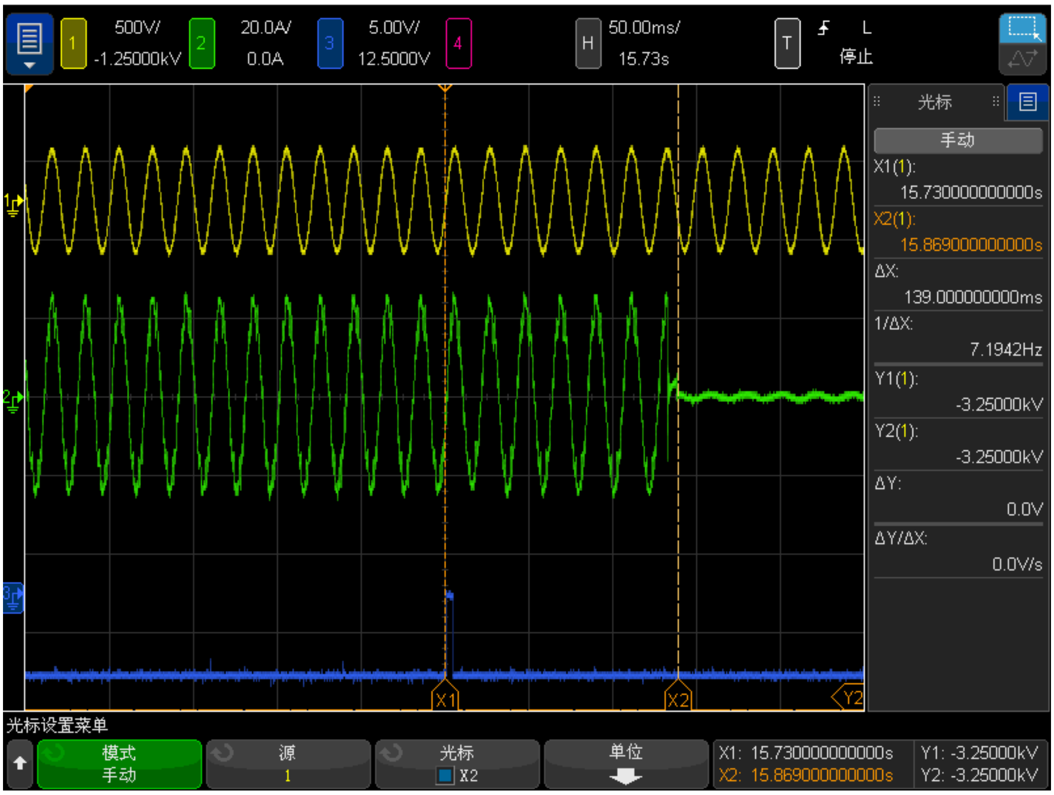
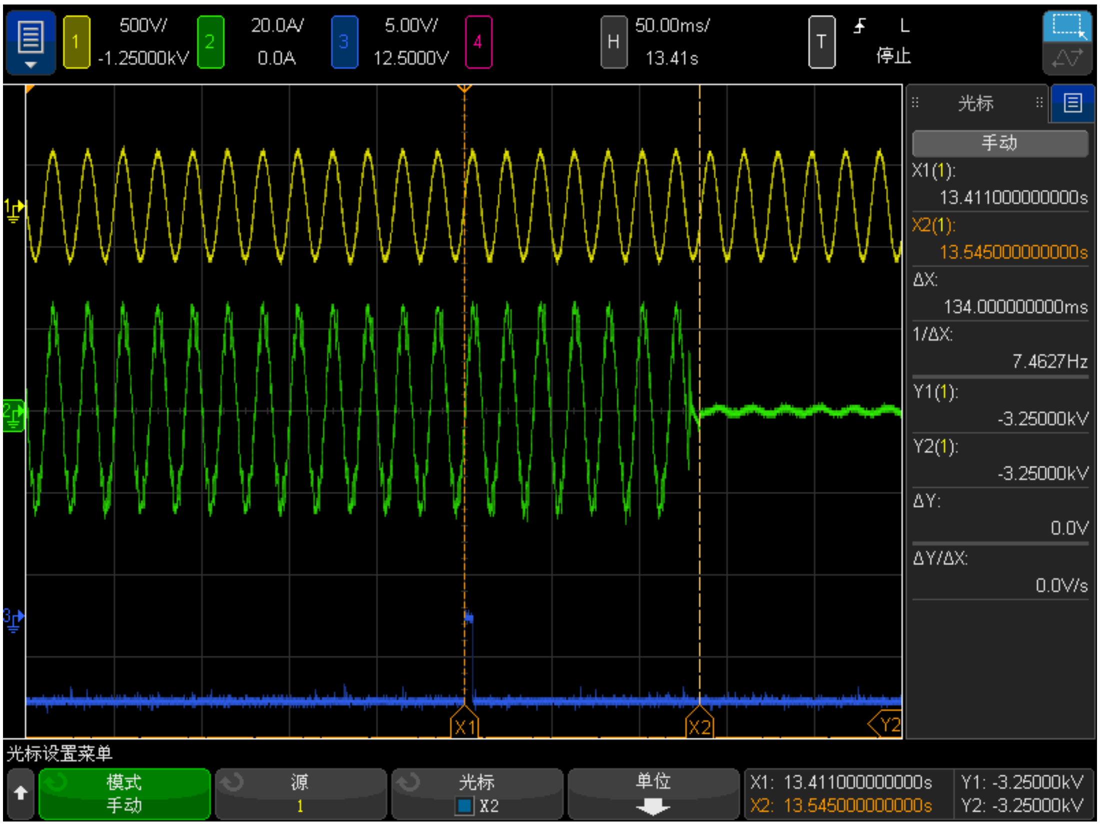
Assessment criteria:

The Test is passed if

a) after the jump to 51.3 Hz no shutdown has taken place and after the jump to 51.7 Hz. a shutdown within 200ms is done.
b) after the jump to 47.7 Hz no shutdown has taken place and after the jump to 47.3 Hz. a shutdown within 200ms is done

Note:

The setting value and the trip value of the frequency may not vary by more than ±0.1 % f_n .

Under frequency

Over frequency


5.5.7.5 Reporting NS protection	**P**
The last 5 dated failure reports on the NS protection can be read, An interruption in the supply voltage of ≤ 3s does not result in any loss of failure reports, Central NS protection: It is possible to read the setting values and the failure reports of the NS protection independently of the operational state and without any additional aids, Integrated NS protection: It is possible to read out the values of the NS protection via the data interface, if the values are not directly readable, 9:45:13 Start communication 9:45:13 Communication successful 9:45:14 Fault: bus voltage undervoltage; (AC voltage instantaneous undervoltage) no mains; A phase undervoltage; B phase undervoltage; C phase undervoltage; 9:45:14 Status: AC RMS Undervoltage (2812);	

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		
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

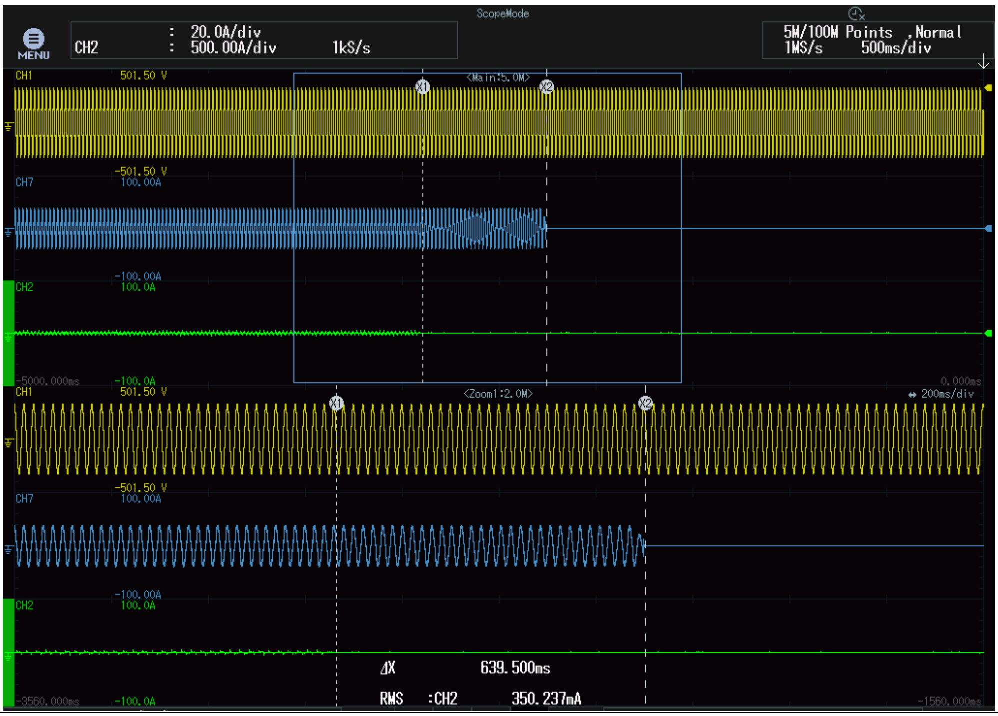
5.5.10 Islanding detection
(these tests are designed to provide evidence that the requirements of VDE-AR-N 4105, 6.5.3 are met)
For power generation systems, islanding detection must be carried out using one of the following processes: a) active method, e,g, by means of frequency – shift process (oscillating circuit) b) passive method with the help of the single-phase voltage control (only possible for power generation systems without converters or for single-phase generation units with converters), (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°,

5.5.10.2 Passive method	**N/A**
Single-phase voltage control is permitted for islanding detection, as the currents of the power generation unit are controlled independently, so that arbitrary phase relationships can develop,	
Test: The test is performed according to the voltage disconnection testing clause 5.5.7.2), The test is passed, if the current follows without phase displacement of the voltage on the displaced phase, For test results, see clause 5.5.7.2) above,	

5.5.10.3 Islanding protection according table 6 - Load imbalance (real. reactive load) for test condition A (EUT output = 100%)												P
Test conditions			Frequency: 50±0.1Hz UN=230±3Vac Distortion factor of chokes < 2% Quality =1									
Disconnection limit			2s (IEC 62116)									
No	PEUT 1) [% of EUT rating]	Reactive load [% of QL in 6.1.d) 1]	PAC 2) [% of nominal]	QAC 3) [% of nominal]	IAC 4) [A]			PEUT [kW]	VDC [V]	Qf [1]	Run on Time [ms]	Remarks 5)
					L1	L2	L3					
1	100	100	0	0	0.4	0.4	0.4	12	650	0.97	639.5	BL
2	100	100	-10	-10	0.4	0.4	0.4	12	650	0.95	330.0	IB
3	100	100	-10	-5	0.4	0.4	0.4	12	650	0.93	320.0	IB
4	100	100	-10	0	0.4	0.4	0.4	12	650	0.91	265.0	IB
5	100	100	-10	+5	0.4	0.4	0.4	12	650	0.88	305.0	IB
6	100	100	-10	+10	0.4	0.4	0.4	12	650	0.86	300.0	IB
7	100	100	-5	-10	0.4	0.4	0.4	12	650	0.99	335.0	IB
8	100	100	-5	-5	0.4	0.4	0.4	12	650	0.97	325.0	IB
9	100	100	-5	0	0.4	0.4	0.4	12	650	0.94	245.0	IB
10	100	100	-5	+5	0.4	0.4	0.4	12	650	0.92	290.0	IB
11	100	100	-5	+10	0.4	0.4	0.4	12	650	0.90	285.0	IB
12	100	100	0	-10	0.4	0.4	0.4	12	650	1.03	304.5	IB
13	100	100	0	-5	0.4	0.4	0.4	12	650	1.00	274.5	IB
14	100	100	0	+5	0.4	0.4	0.4	12	650	0.95	234.5	IB
15	100	100	0	+10	0.4	0.4	0.4	12	650	0.93	554.5	IB
16	100	100	+5	-10	0.4	0.4	0.4	12	650	1.09	325.0	IB
17	100	100	+5	-5	0.4	0.4	0.4	12	650	1.07	345.0	IB
18	100	100	+5	0	0.4	0.4	0.4	12	650	1.04	285.0	IB
19	100	100	+5	+5	0.4	0.4	0.4	12	650	1.01	280.0	IB
20	100	100	+5	+10	0.4	0.4	0.4	12	650	0.99	250.0	IB
21	100	100	+10	-10	0.4	0.4	0.4	12	650	1.16	290.0	IB
22	100	100	+10	-5	0.4	0.4	0.4	12	650	1.13	245.0	IB
23	100	100	+10	0	0.4	0.4	0.4	12	650	1.10	260.0	IB
24	100	100	+10	+5	0.4	0.4	0.4	12	650	1.07	245.0	IB

25	100	100	+10	+10	0.4	0.4	0.4	12	650	1.05	395.0	IB
Parameter at 0% per phase			L= 5.62 mH			R= 3.53Ω				C= 1806 uF		

Note:
RLC is adjusted to min. ±1% of the inverter rated output power
1) PEUT: EUT output power
2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) QAC: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) Fundamental of IAC when RLC is adjusted
5) BL: Balance condition. IB: Imbalance condition.
Condition A:
EUT output power PEUT = Maximum 6)
EUT input voltage 6) = >75% of rated input voltage range
6) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
7) Based on EUT rated input operating range. For example. If range is between X volts and Y volts. 90 % of range =X + 0.75 × (Y – X). Y shall not exceed 0.8 × EUT maximum system voltage (i.e.. maximum allowable array open circuit voltage). In any case. the EUT should not be operated outside of its allowable input voltage range.

Scope pictures of the disconnection time
Disconnection at No. 1

Note: Blue: EUT output current signal Green: Grid side current signal

5.5.10.3 Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)													P
Test conditions			Frequency: 50±0.1Hz UN=230±3Vac Distortion factor of chokes < 2% Quality =1										
Disconnection limit			2s (IEC 62116)										
No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]			P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks5)	
					L1	L2	L3						
1	66	66	0	-5	0.1	0.1	0.1	7.9	650	1.01	220.0	IB	
2	66	66	0	-4	0.1	0.1	0.1	7.9	650	1.00	260.0	IB	
3	66	66	0	-3	0.1	0.1	0.1	7.9	650	1.00	265.0	IB	
4	66	66	0	-2	0.1	0.1	0.1	7.9	650	0.99	275.0	IB	
5	66	66	0	-1	0.1	0.1	0.1	7.9	650	0.99	295.0	IB	
6	66	66	0	0	0.1	0.1	0.1	7.9	650	0.98	320.0	BL	
7	66	66	0	1	0.1	0.1	0.1	7.9	650	0.98	310.0	IB	
8	66	66	0	2	0.1	0.1	0.1	7.9	650	0.97	280.0	IB	
9	66	66	0	3	0.1	0.1	0.1	7.9	650	0.97	265.0	IB	
10	66	66	0	4	0.1	0.1	0.1	7.9	650	0.96	255.0	IB	
11	66	66	0	5	0.1	0.1	0.1	7.9	650	0.96	250.0	IB	
Parameter at 0% per phase			L= 8.51 mH			R= 5.34Ω			C= 1192 uF				

Note:

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

1) PEUT: EUT output power

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

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

4) Fundamental of IAC when RLC is adjusted

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

Condition B:

EUT output power PEUT = 50 % – 66 % of maximum

EUT input voltage 6) = 50 % of rated input voltage range. ±10 %

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

range.
Scope pictures of the disconnection time
Disconnection at No. 6

Note: Blue: EUT output current signal Green: Grid side current signal

5.5.10.3 Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (EUT output = 25 % – 33 %)	P

Test conditions	Frequency: 50±0.1Hz U_N=230±3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	2s (IEC 62116)

No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6.1.d) 1]	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]			P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks 5)
					L1	L2	L3					
1	33	33	0	-5	0.1	0.1	0.1	4	650	0.99	215.0	IB
2	33	33	0	-4	0.1	0.1	0.1	4	650	0.98	230.0	IB
3	33	33	0	-3	0.1	0.1	0.1	4	650	0.98	240.0	IB
4	33	33	0	-2	0.1	0.1	0.1	4	650	0.98	275.0	IB
5	33	33	0	-1	0.1	0.1	0.1	4	650	0.97	285.0	IB
6	33	33	0	0	0.1	0.1	0.1	4	650	0.97	305.0	BL
7	33	33	0	1	0.1	0.1	0.1	4	650	0.96	295.0	IB
8	33	33	0	2	0.1	0.1	0.1	4	650	0.95	255.0	IB
9	33	33	0	3	0.1	0.1	0.1	4	650	0.95	245.0	IB
10	33	33	0	4	0.1	0.1	0.1	4	650	0.94	225.0	IB
11	33	33	0	5	0.1	0.1	0.1	4	650	0.94	215.0	IB

Parameter at 0% per phase	L= 17.02 mH	R= 10.69 Ω	C= 596 uF

Note:

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

1) P_{EUT}: EUT output power

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

3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT 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:

EUT output power PEUT = 25 % – 33 % 6) of maximum

EUT input voltage 7) = <20 % of rated input voltage range

6) Or minimum allowable EUT output level if greater than 33 %.

7) Based on EUT rated input operating range. For example. If range is between X volts and Y volts. 10 % of range =X + 0.2 × (Y – X). Y shall not exceed 0.8 × EUT maximum system voltage (i.e.. maximum allowable

array open circuit voltage). In any case. the EUT should not be operated outside of its allowable input voltage range.
Scope pictures of the disconnection time
Disconnection at No. 6

Note: Blue: EUT output current signal Green: Grid side current signal

5.6 Testing of connecting conditions and synchronisation		
Clause	**Test**	**Result**
5.6	Connecting conditions and synchronisation	**P**

5.6.2 Connecting conditions and synchronization			P
Model: EAG12K3L			
Setting values of the NS protection:	Setting $T_{reconnection\ 60s}$ [s]:	60	
	Setting f< [Hz]:	47.5	
	Setting f> [Hz]:	50.1	
	Setting V< [V]:	195.5	
	Setting V>> [V]:	253.0	

Test:			
	f_{ist}	**Reset time:**	**Limit:**
Connecting conditions for frequencies:			
a)	< 47.45Hz	No reconnection	No resetting allowed
	Switch to:		
b)	≥ 47.55Hz	64.8	≥ 60 s
c)	> 50.15Hz	No reconnection	No resetting allowed
	Switch to:		
d)	≤ 50.05Hz	61.0	≥ 60 s
Connecting conditions for voltages:			
e)	< 84%	No reconnection	No resetting allowed
	Switch to:		
f)	≥ 86%	62.4	≥ 60 s
g)	> 111 %	No reconnection	No resetting allowed
	Switch to:		
h)	≤ 109%	64.4	≥ 60 s

Test:

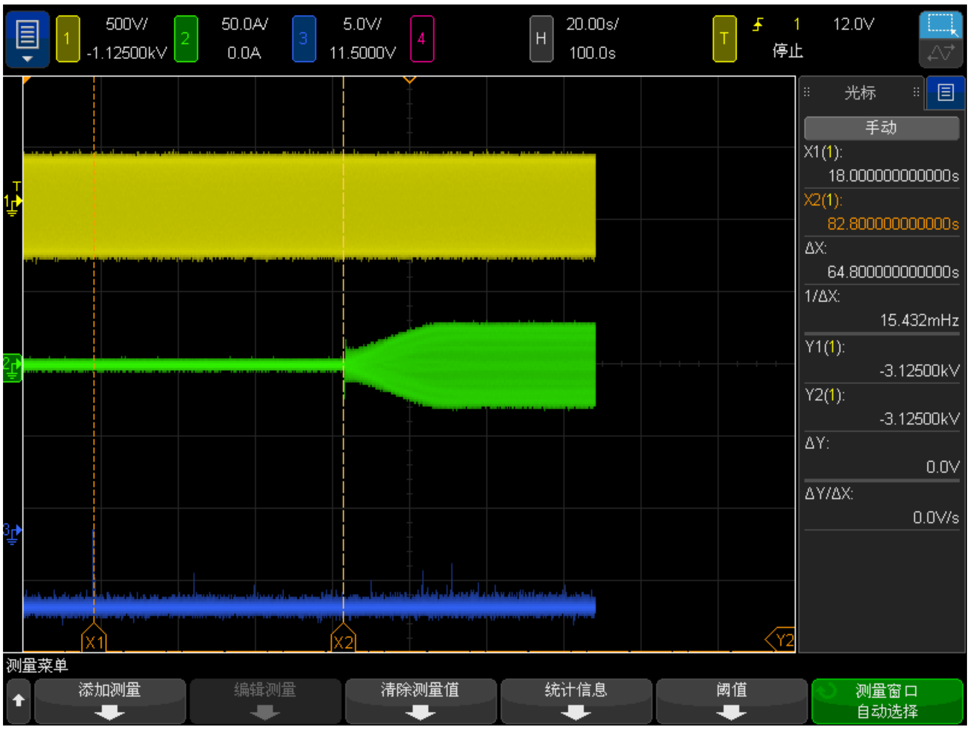
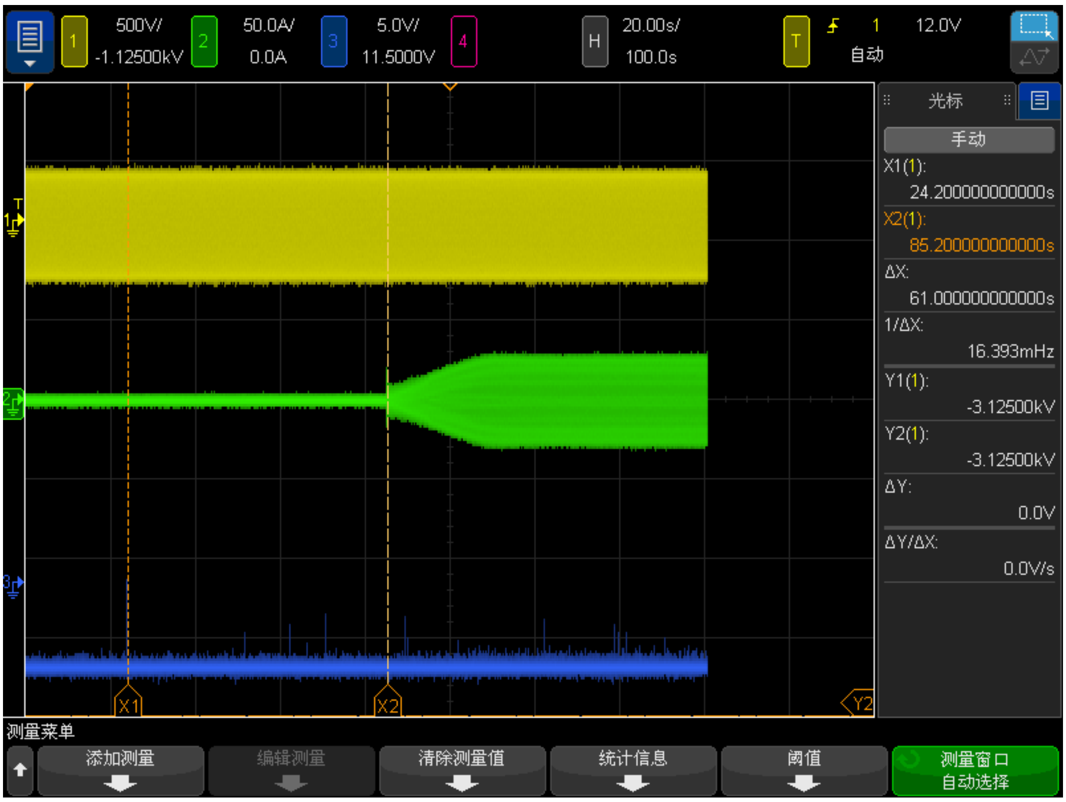
see points a) to h) for the test process.

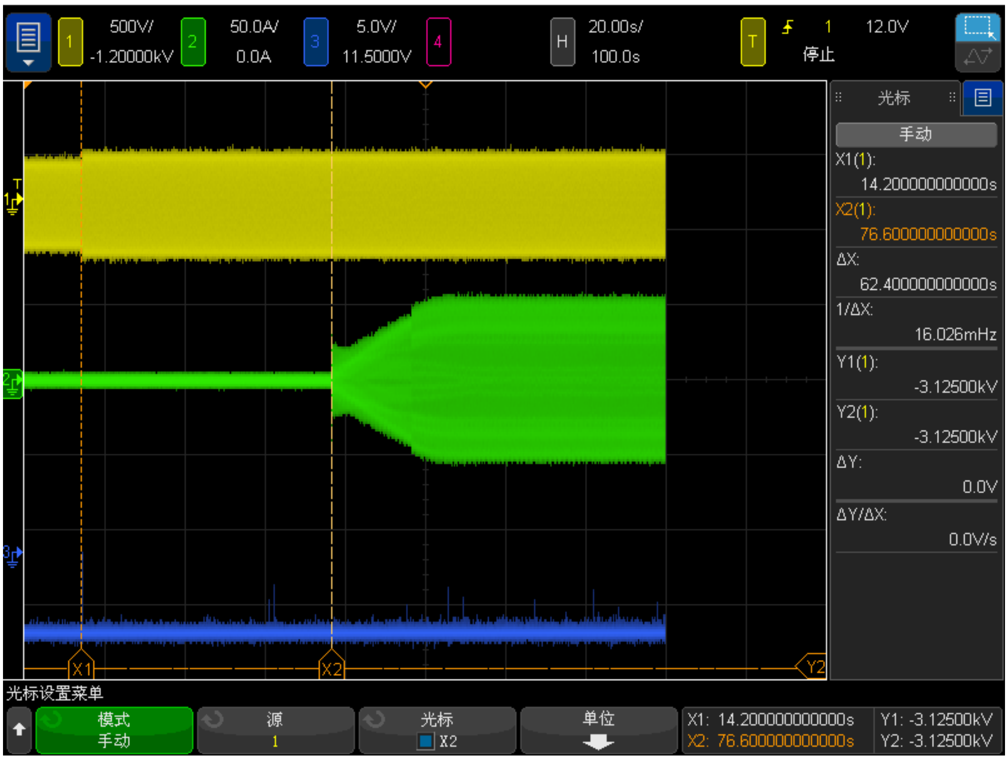
The measurement was carried out with a programmable AC source.

e.g. connecting conditions for frequencies: Point a) and b). The AC source was programmed in such a way that the first step of 230 V / 50 Hz to 200 V / 47.0 Hz resulted in a faulty disconnection. Thereafter the voltage and frequency for 100 s is set to 215 V / 47.45 Hz. Switching on again is not permitted. After a lapse of 100 s the voltage is set to 230 V / 47.55 Hz. Setting again after 60 s is permitted.

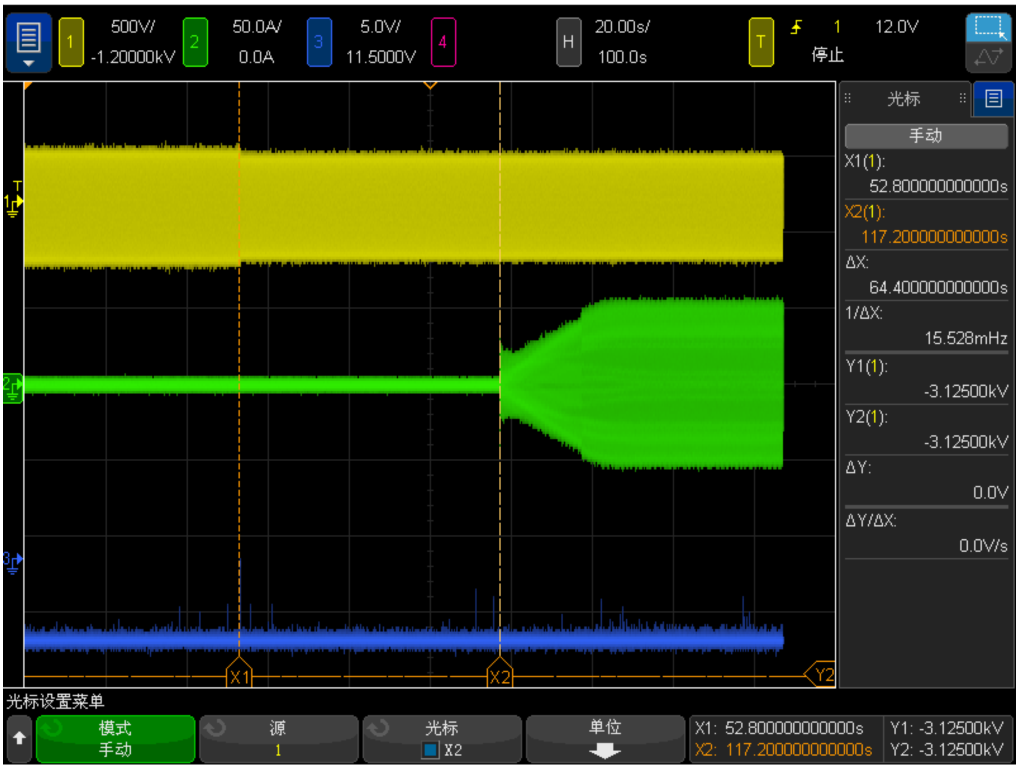
Assessment criterion:

After actuating the NS protection it should be checked that the system can only be switched within the tolerance ranges (($80\% \; U_n \leq U \leq 110\% \; U_n$) and ($47.5 \text{ Hz} \leq f \leq 50.05\text{Hz}$)) at the earliest after 60 s after voltage and frequency has remained within the tolerance ranges.

a) < 47.45 Hz to b) ≥ 47.55 Hz:

c) > 50.15 Hz to d) ≤ 50.05 Hz:

e) < 84 % Un to f) ≥ 86 % Un:



g) > 111 % Un to h) ≤ 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 PAV, 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.

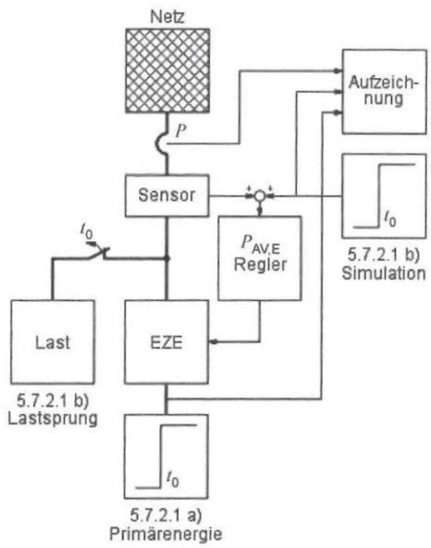


Bild 8 – Skizze des Prüfaufbaus zur Prüfung der Regeldynamik

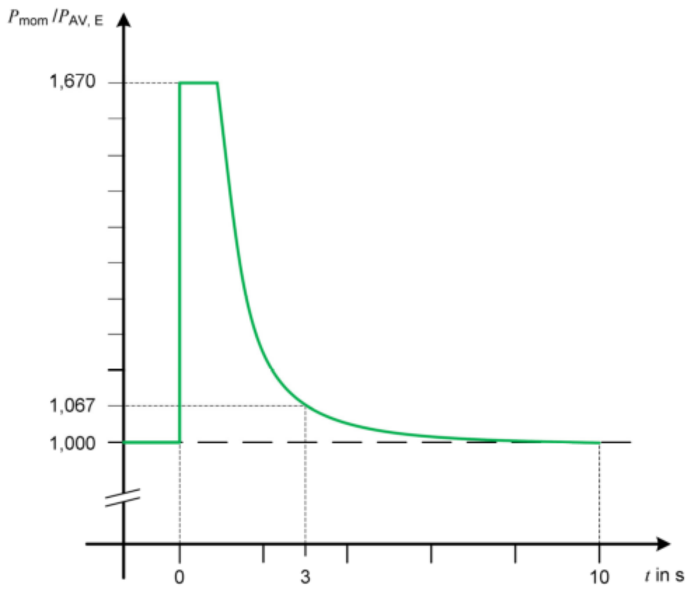


Bild 1 – Wirkleistungs-Grenzkurve für Erzeugungsanlagen

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) 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.

b) 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.

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

P_{SUM} inverter[W]	**P_{SUM} load[W]**	**Settling time[s]**
-	-	-

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

P_{SUM} before energy jump [W]	**P_{SUM} after energy jump [W]**	**P_{DC} before energy jump [W]**	**Available P_{DC} after energy jump [W]**	**Settling time [s]**
-	-	-	-	-

5.7.2.2	**Test disconnection function**	**N/A**

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:

According to the manufacturer's declaration, $P_{AV,E}$ monitoring function is not integrated in the EZE. The function can be implemented according to the specifications of the VDE-AR-N 4105 Chapter 5.5.2 in a stand-alone equipment. So the evaluation in not application in this declaration.

5.8 Evidence dynamic grid support		
Clause	**Test**	**Result**
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

For PGUs Type 2 and storage systems	P
General:	

At lease the recording must begin at least 10 s before the error occurs. After a faulty declaration (Voltage in the range 0.85 $U_n \leq U \leq 1.1\ U_n$). the recording must continue for at least another 60 s.

Behavior during the network error:

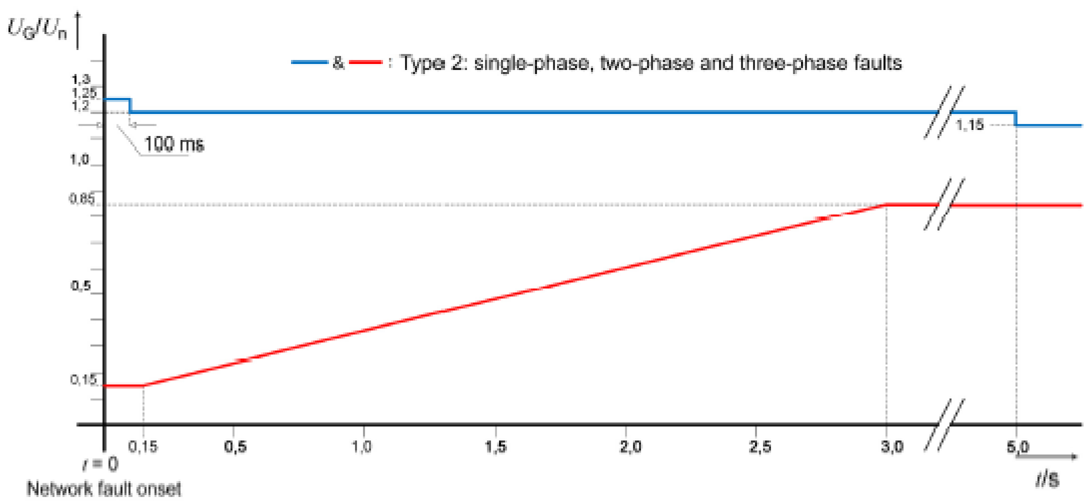
No disconnection of the PGU during the voltage drops the grid. If the PGU disconnects from the grid. the time of disconnection must be documented.

- Type 1 units have to support the line voltage during a line fault principle by supplying a suitable active and reactive current. It is not permitted that the increase in the voltage due to the reactive current supply cause the overvoltage limit curve (cf. VDE-AR-N 4105:2018-11) to be exceeded during a network fault and / or after a network fault.
- Asynchronous generators must remain connected to the grid during the tests shown and principle. may supply an active and reactive current.
- Type 2 units and storage systems are not allowed to inject neither 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 a 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 60 ms after the occurrence of this under-/ under voltage dip in any phase.

Behavior after the end of the error:

- Not disconnection of the PGU within 60 s after the end of the fault.
- Type 1 units and asynchronous machines: Reaction time of active power maximum 6 s. Reaction time of reactive power as fast as possible.

Type 2 units and storage systems: Reaction time of active power up to 1 s. Reaction time of reactive power according to PT1 behavior with 3 tau = 10 s in accordance with VDE-AR-N 4105: 2018-11.



Key

&	FRT curve for single-phase, two-phase and three-phase network faults
UG	r.m.s. value of the actual voltage at the generator terminals

Test	Voltage dip to (U_n / p.u.)	Dip type	duration (ms) (2)*	P set point (P_{rE} / p.u.)	Q set point (Q / p.u.)	Comment	Test ref. No.	Result
1	0.15 to 0.25	A	for 0.15 ≥ 150 / for 0.25 ≥ 250	1	0 to ± 0.1	Symetric	1.1	P
				0.2 to 0.6			1.2	P
		D1		1		Asymetric (ph-2-ph + Dy5-Trafo)	1.3	P
				0.2 to 0.6			1.4	P
		D2		1			1.5	P
2	0.50 to 0.60	A	for 0.50 ≥ 1500 / for 0.60 ≥ 2000	1	Max. over exceeded	Symetric	2.1	P
				0.2 to 0.6			2.2	P
		D1		1		Asymetric (ph-2-ph + Dy5-Trafo)	2.3	P
				0.2 to 0.6			2.4	P
3	0.50 to 0.60	A	for 0.50 ≥ 1500 / for 0.60 ≥ 2000	1	Max. under exceeded	Symetric	3.1	P
				0.2 to 0.6			3.2	P
		D1		1		Asymetric (ph-2-ph + Dy5-Trafo)	3.3	P
				0.2 to 0.6			3.4	P
4	0.85 to 0.90	A	≥ 60000	1	0 to ± 0.1	Symetric	4.1	P
				0.2 to 0.6			4.2	P
		D1		1		Asymetric (ph-2-ph + Dy5-Trafo)	4.3	P
				0.2 to 0.6			4.4	P
5	1.20 to 1.25	A	≥ 100	1	0 to ± 0.1	Symetric	5.1	P
				0.2 to 0.6			5.2	P
		D1		1		Asymetric (ph-2-ph + Dy5-Trafo)	5.3	P
				0.2 to 0.6			5.4	P
		D2		1			5.5	P
6	1.15 to 1.20	A	≥ 5000	1	0 to ± 0.1	Symetric	6.1	P
				0.2 to 0.6			6.2	P
		D1		1		Asymetric	6.3	P

				0.2 to 0.6		(ph-2-ph + Dy5-Trafo)	6.4	P
7	1.10 to 1.15	A	≥ 60000	1	0 to ± 0.1	Symetric	7.1	P
				0.2 to 0.6			7.2	P
		D1		1		Asymetric (ph-2-ph + Dy5-Trafo)	7.3	P
				0.2 to 0.6			7.4	P

Test conditions:

Voltage simulator fall and rise time: < 20ms

Used sample rate: 10 kHz

Note:

At lease The recording must begin at least 10 s before the error occurs. After a faulty declaration (Voltage in the range 0.85 $U_n \leq U \leq 1.1 U_n$). the recording must continue for at least another 60 s.

Behavior 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 1 units have to support the line voltage during a line fault principle by supplying a suitable active and reactive current. It is not permitted that the increase in the voltage due to the reactive current supply cause the overvoltage limit curve (cf. VDE-AR-N 4105:2018-11) to be exceeded during a network fault and / or after a network fault.
- Asynchronous generators must remain connected to the grid during the tests shown and principle. may supply an active and reactive current.
- Type 2 units and storage systems are not allowed to inject neither 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 a 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 60 ms after the occurrence of this under-/ under voltage dip in any phase.

Behavior after the end of the error:

- Not disconnection of the PGU within 60 s after the end of the fault.
- Type 1 units and asynchronous machines: Reaction time of active power maximum 6 s. Reaction time of reactive power as fast as possible.

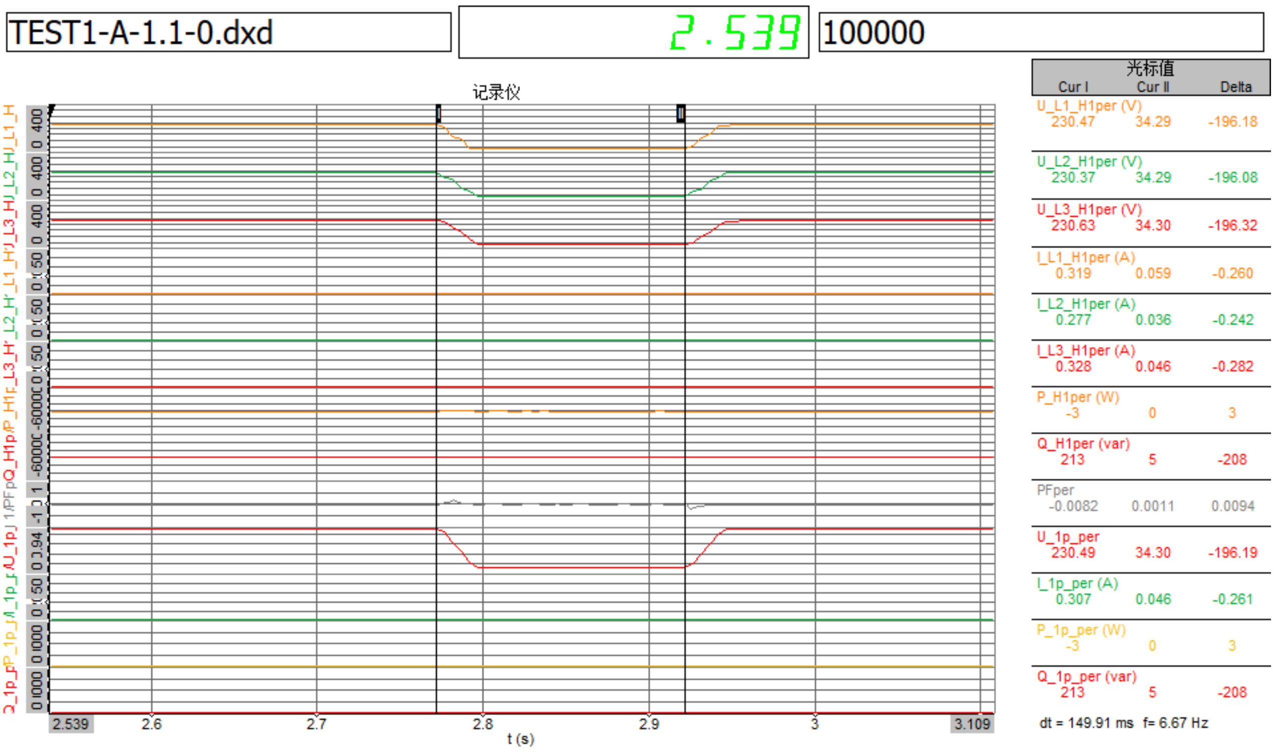
Type 2 units and storage systems: Reaction time of active power up to 1 s. Reaction time of reactive power according to PT1 behavior with 3 tau = 10 s in accordance with VDE-AR-N 4105: 2018-11. 5.7.2.5

*The unit was single phase type.

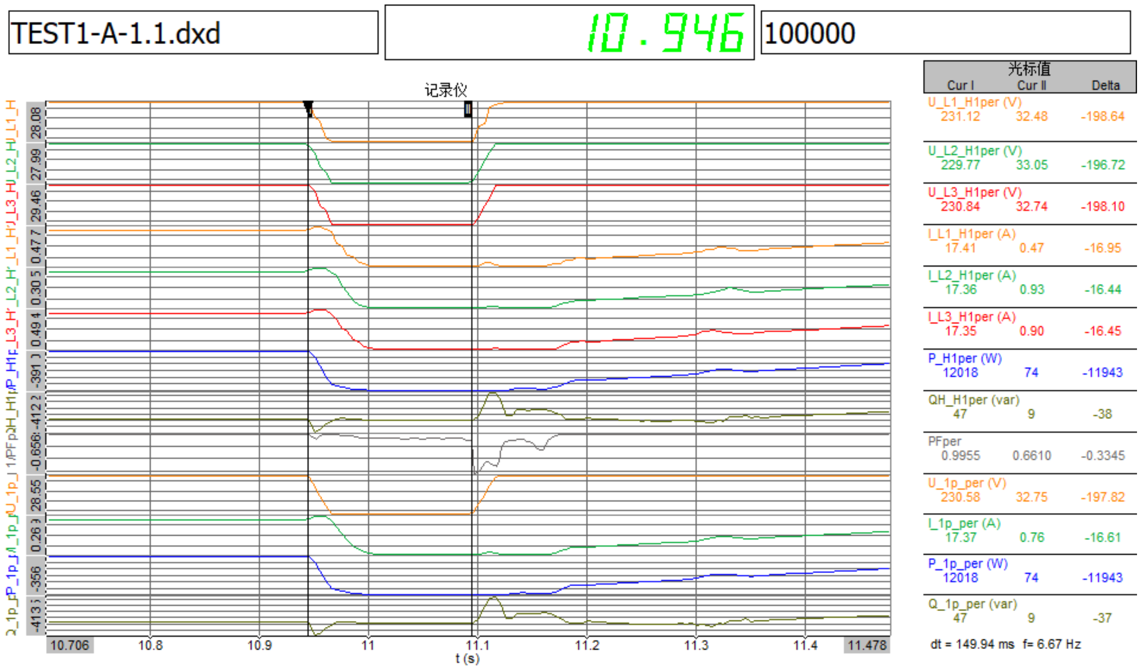
Test 1.1 – symmetrical fault (V/Vnom = 0.15 to 0.25)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	1.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	10.19.19	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	0.15	[p.u.]
	5	Setpoint fault duration	-	-	150	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10946	[ms]
	7	Time point of fault clearance (t2)	Total	-	11096	[ms]
	8	Fault duration in no load test	Total	-	150	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.86	[p.u.]
	10		Positive sequence		0.86	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9959	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.13	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.05	[p.u.]
	20		Phase 2	t_1 +60 ms	0.05	[p.u.]
	21		Phase 3	t_1 +60 ms	0.06	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.04	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.05	[p.u.]

Test 1.1 – symmetrical fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	30	Active power rising time	Positive sequence	-	0.59	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

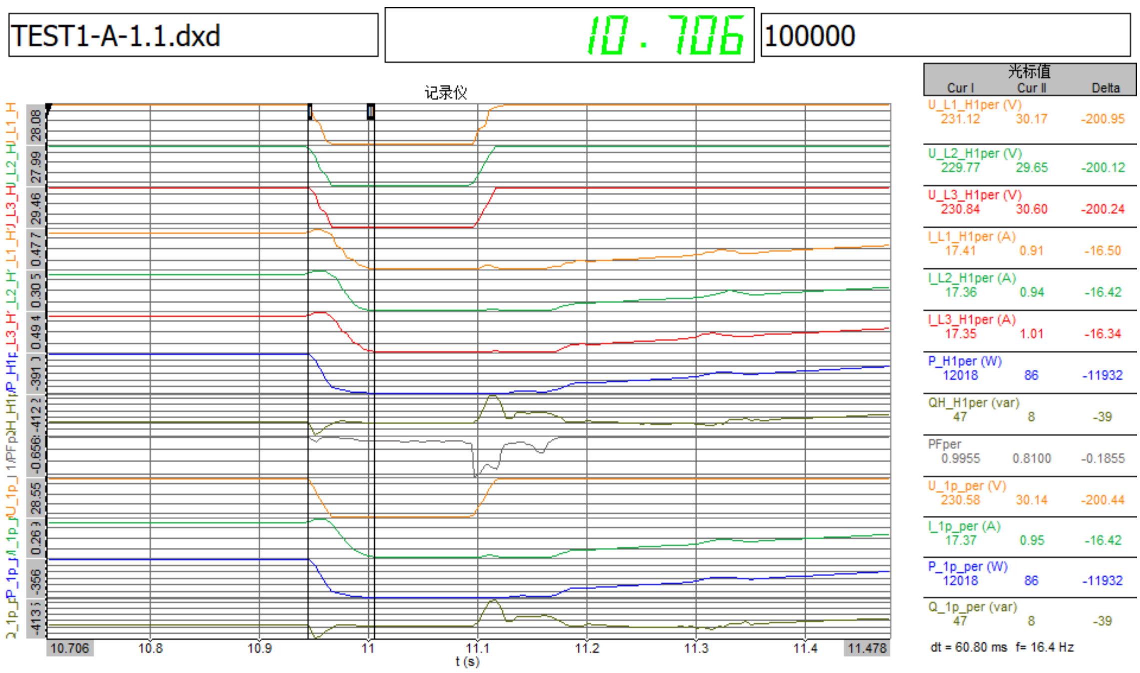
Test 1.1 – symmetrical fault - Voltage depth in no load test



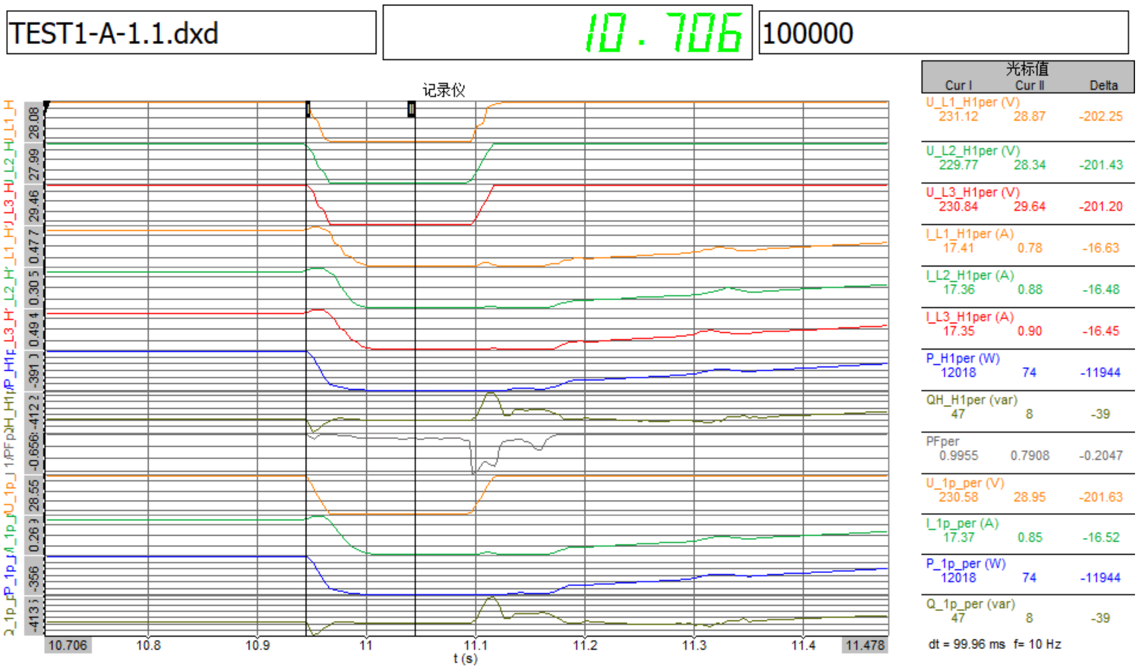
Test 1.1 – symmetrical fault - Fault duration



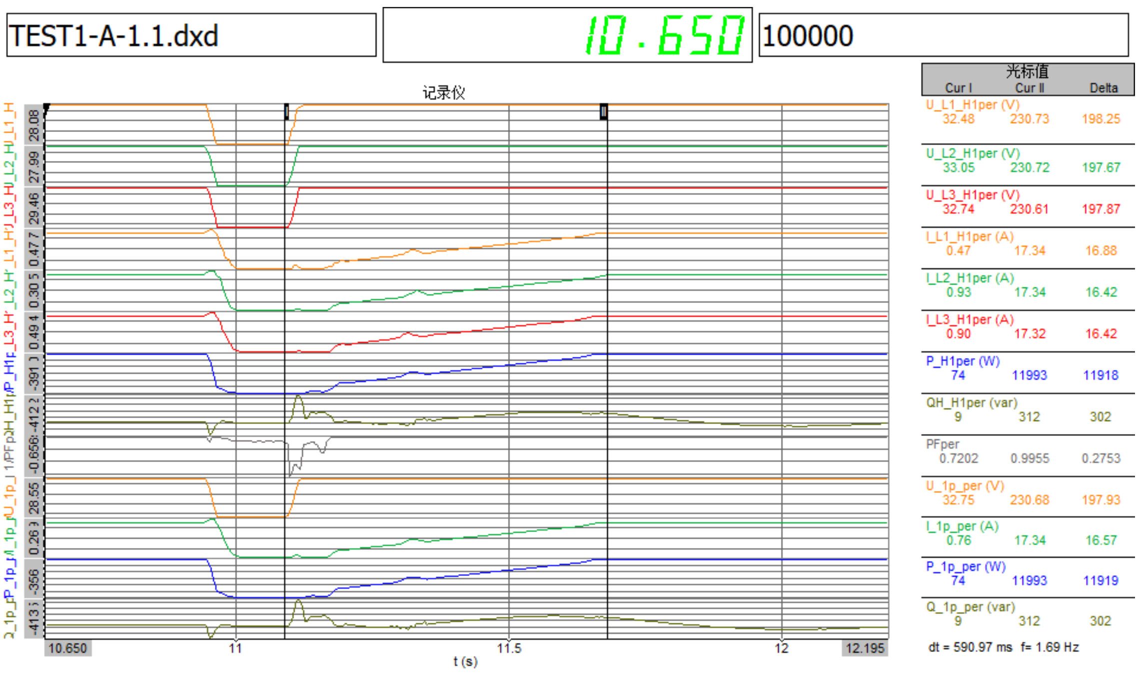
Test 1.1 – symmetrical fault - t1 +60 ms



Test 1.1 – symmetrical fault - t1 +100 ms



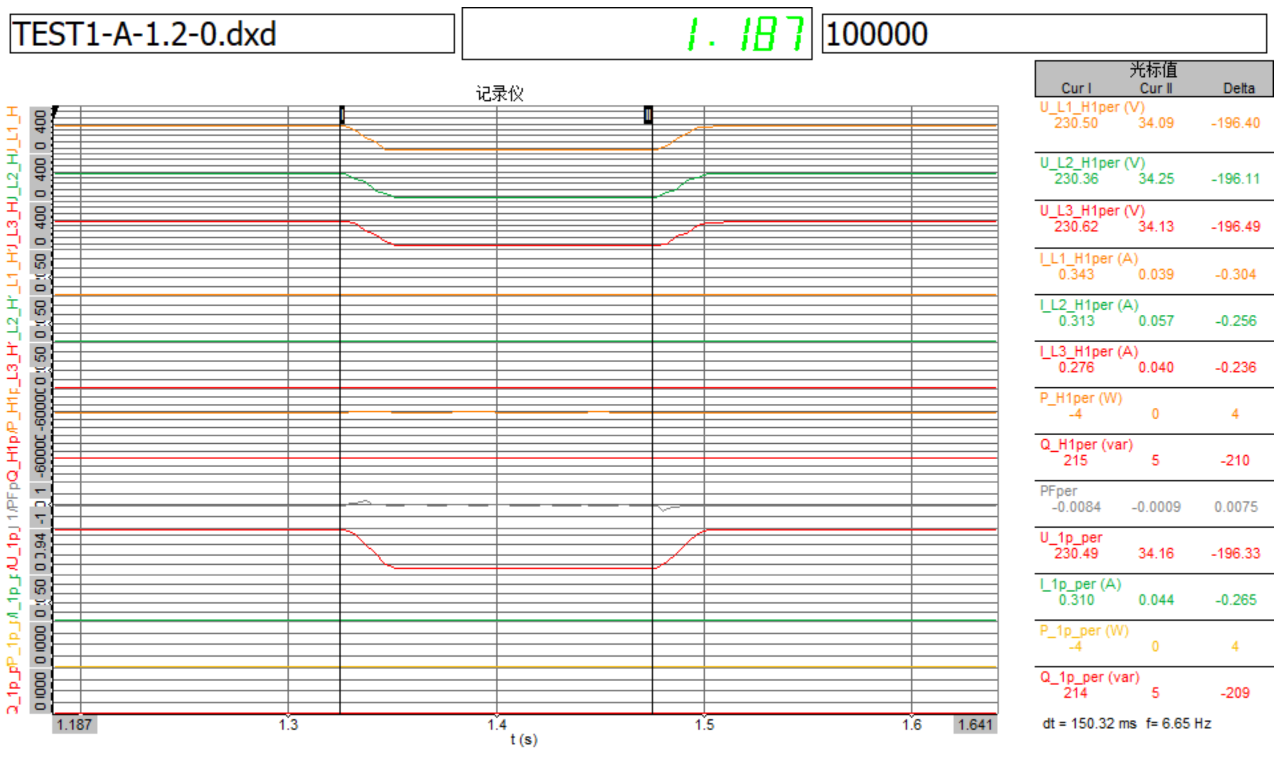
Test 1.1 – symmetrical fault - Recover time - Active power



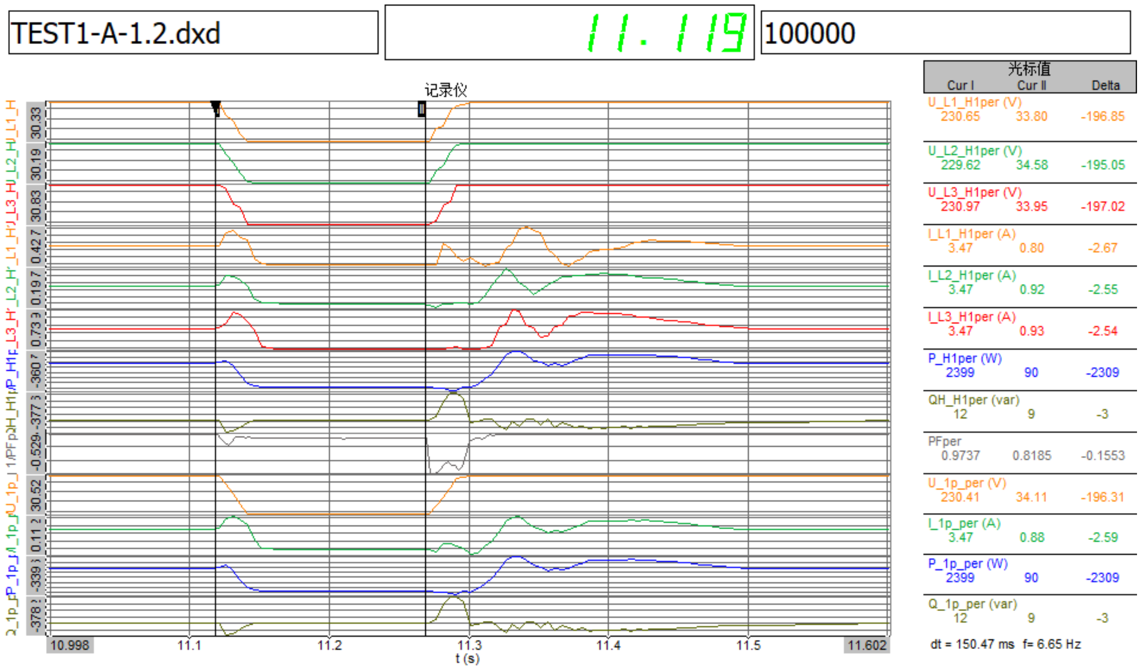
Test 1.2 – symmetrical fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	1.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	10.26.08	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	0.15	[p.u.]
	5	Setpoint fault duration	-	-	150	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11119	[ms]
	7	Time point of fault clearance (t2)	Total	-	11270	[ms]
	8	Fault duration in no load test	Total	-	151	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.86	[p.u.]
	10		Positive sequence		0.86	[p.u.]
Before break-in $<t_1$	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9703	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 ms to t_2-20 ms	0.14	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.05	[p.u.]
	20		Phase 2	t_1 +60 ms	0.05	[p.u.]
	21		Phase 3	t_1 +60 ms	0.05	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.04	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.05	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.20	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.20	[p.u.]
After break-in $>t_2$	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.23	[s]

Test 1.2 – symmetrical fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

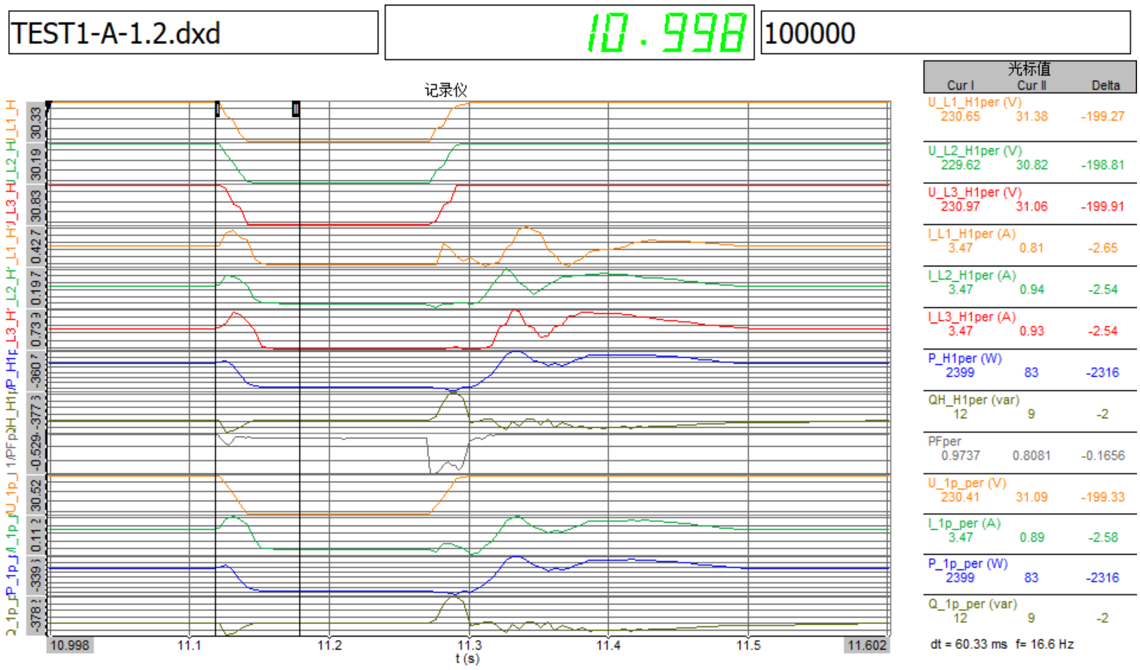
Test 1.2 – symmetrical fault - Voltage depth in no load test



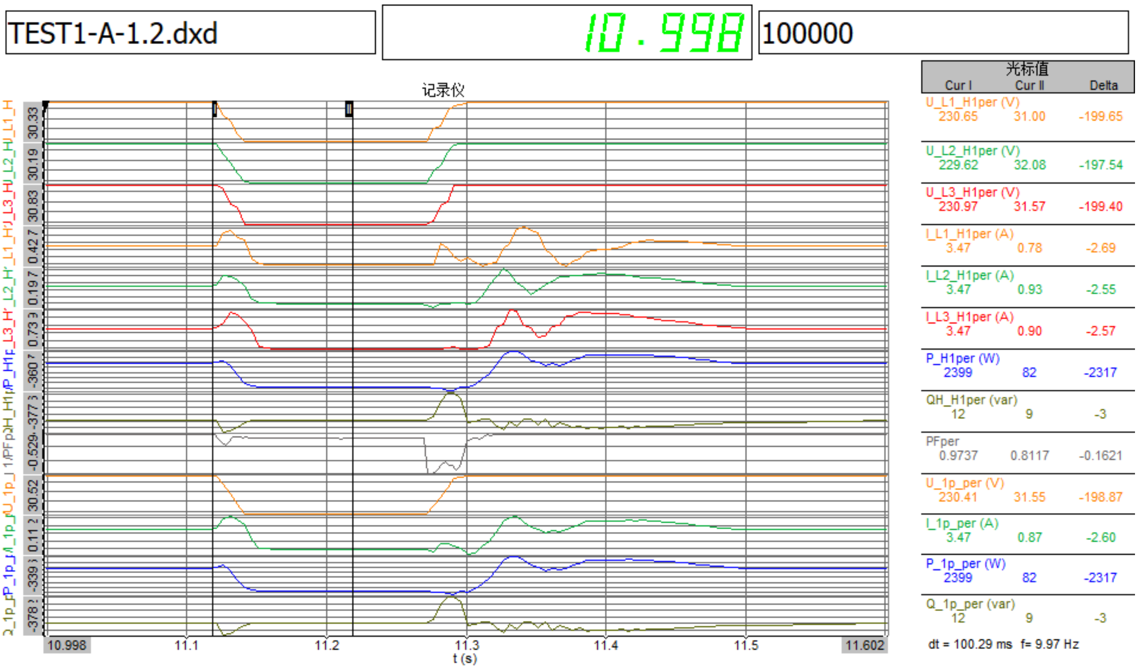
Test 1.2 – symmetrical fault - Fault duration



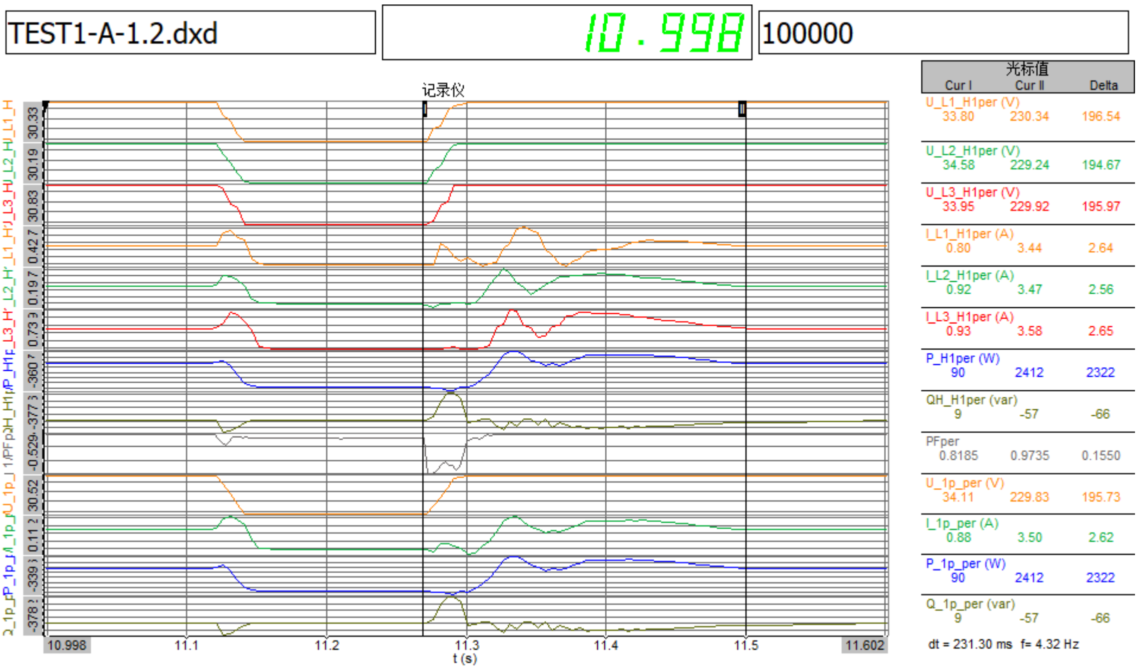
Test 1.2 – symmetrical fault - t1 +60 ms



Test 1.2 – symmetrical fault - t1 +100 ms



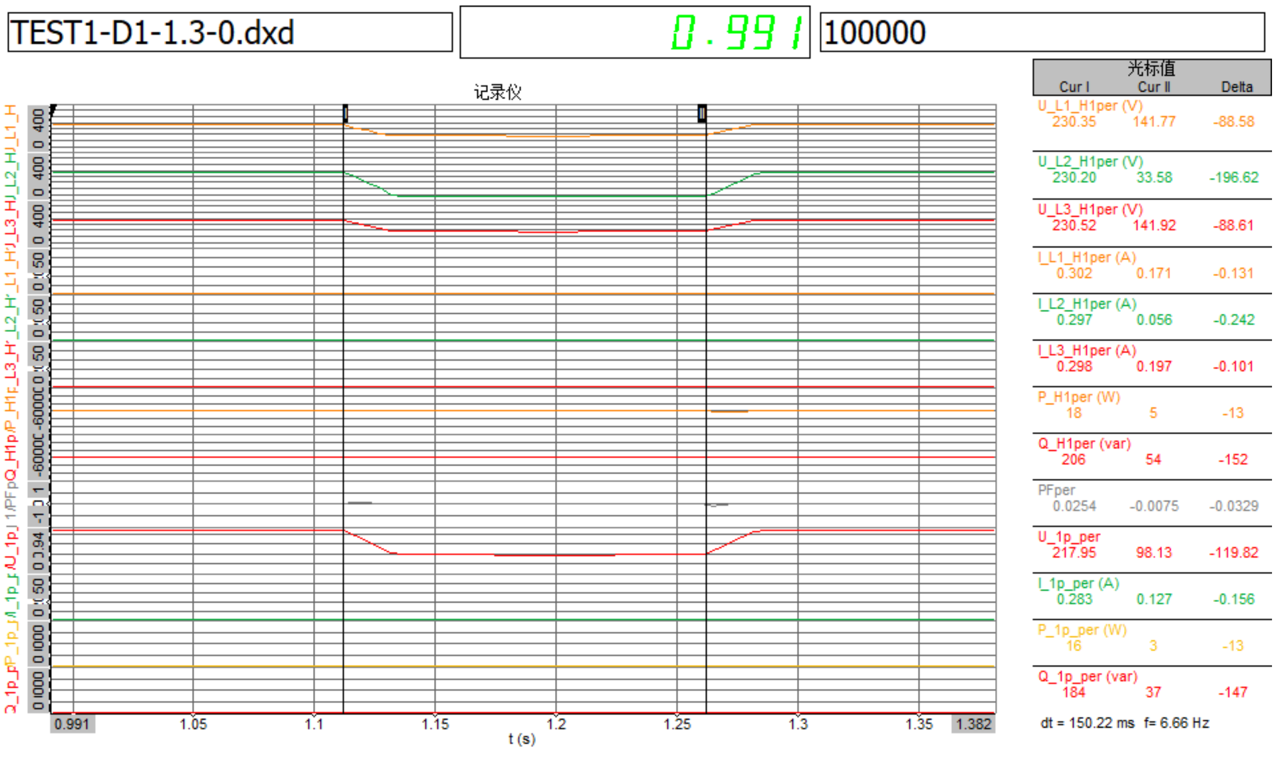
Test 1.2 – symmetrical fault - Recover time - Active power



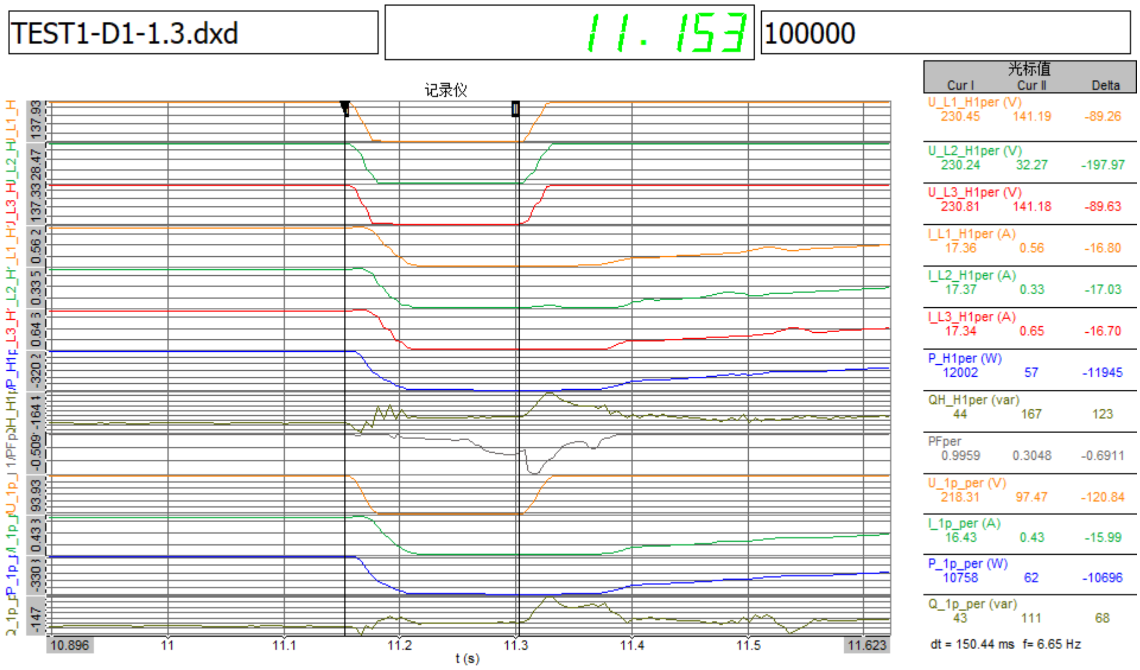
Test 1.3 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	1.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	10.31.45	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase - phase	-	0.15	[p.u.]
	5	Setpoint fault duration	-	-	150	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11153	[ms]
	7	Time point of fault clearance (t2)	Total	-	11304	[ms]
	8	Fault duration in no load test	Total	-	151	[ms]
	9	Voltage depth in no load test	Total	t1+100 ms to t2 and t1-10 s to t1	0.38	[p.u.]
	10		Positive sequence		0.52	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t1-10 s to t1	1.00	[p.u.]
	12	Current	Positive sequence	t1-500 ms to t1-100 ms	0.94	[p.u.]
	13	Active power	Total	t1-10 s to t1	1.00	[p.u.]
	14		Positive sequence	t1-10 s to t1	0.90	[p.u.]
	15	Reactive power	Positive sequence	t1-10 s to t1	0.00	[p.u.]
	16		Total	t1-10 s to t1	0.00	[p.u.]
	17	cos φ	-	t1-10 s to t1	0.9957	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t1+100 to to t2-20 ms	0.13	[p.u.]
	19	Phase current	Phase 1	t1 +60 ms	0.10	[p.u.]
	20		Phase 2	t1 +60 ms	0.06	[p.u.]
	21		Phase 3	t1 +60 ms	0.08	[p.u.]
	22	Phase current	Phase 1	t1 +100 ms	0.05	[p.u.]
	23		Phase 2	t1 +100 ms	0.05	[p.u.]
	24		Phase 3	t1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	1.00	[p.u.]
	26		Positive sequence	t1 +100 ms to t2-20 ms	0.90	[p.u.]
After break-in >t2	27	Voltage	Line-neutral voltage	t2 +3 s to t2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t2 +3 s to t2 +10 s	0.02	[p.u.]
	29		Total	t2 +3 s to t2 +10 s	0.02	[p.u.]
	30	Active power rising time	Positive sequence	-	0.63	[s]

Test 1.3 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.15 to 0.25)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

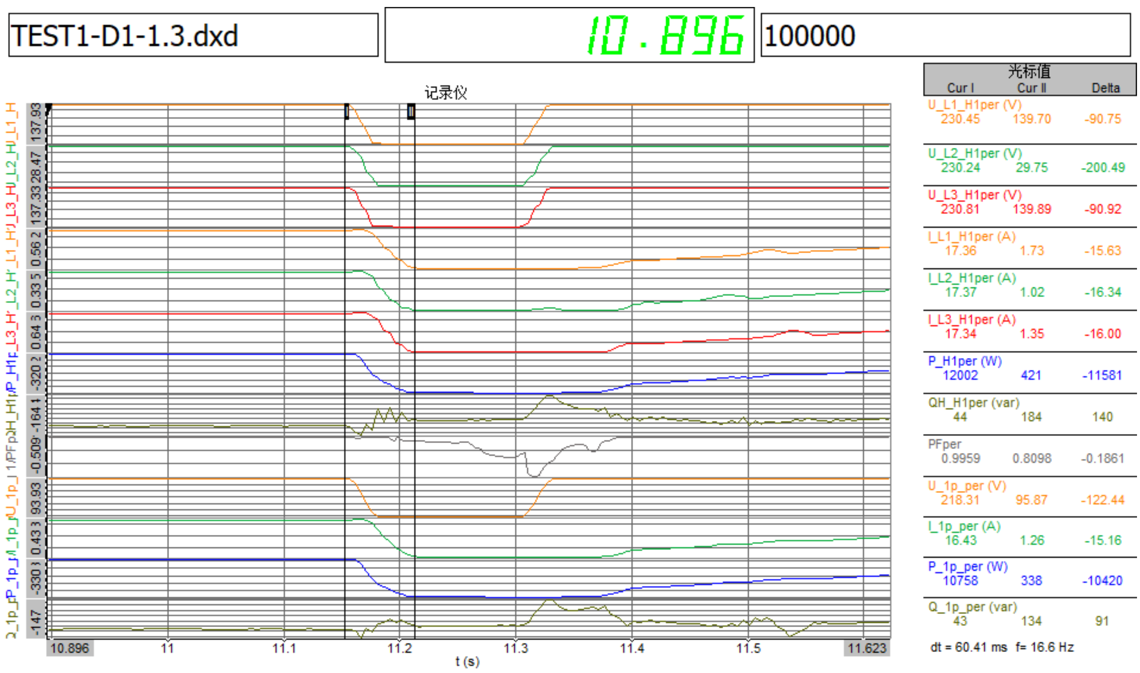
Test 1.3 – symmetrical fault - Voltage depth in no load test



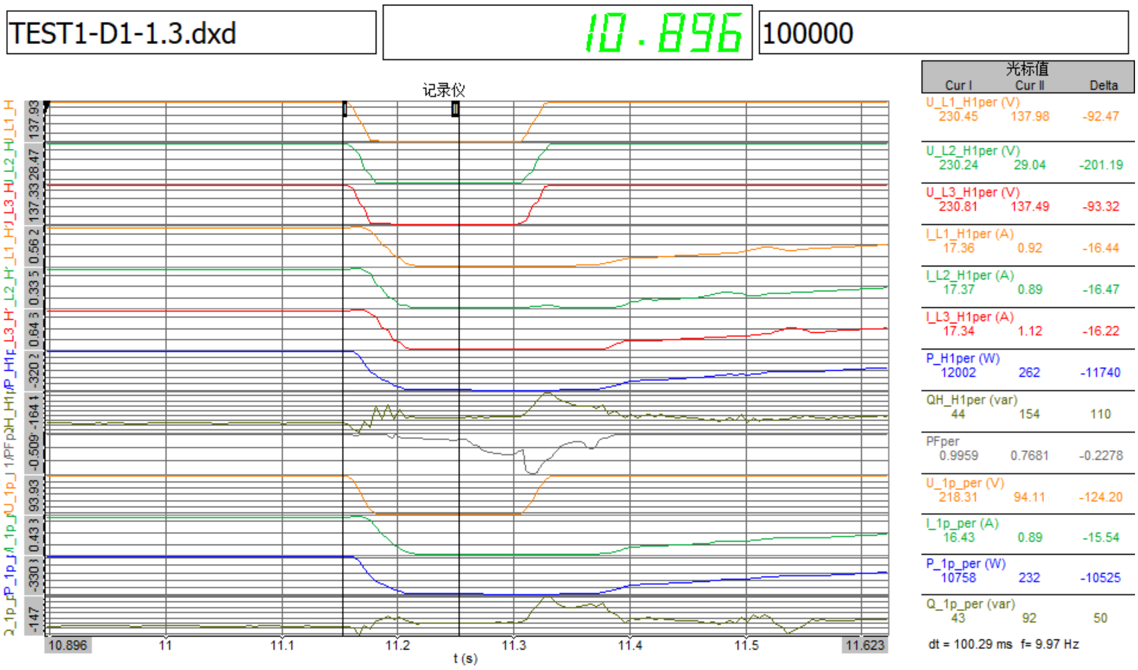
Test 1.3 – Asymmetrical fault - Fault duration



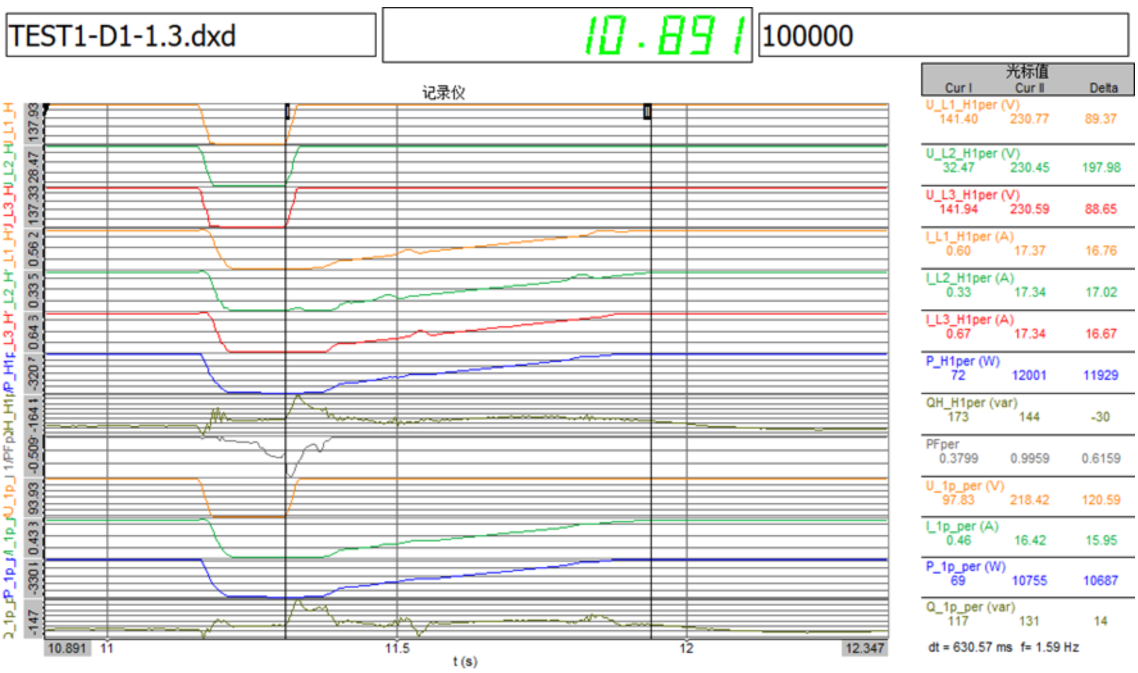
Test 1.3 – Asymmetrical fault - t_1 +60 ms



Test 1.3 – Asymmetrical fault - t1 +100 ms



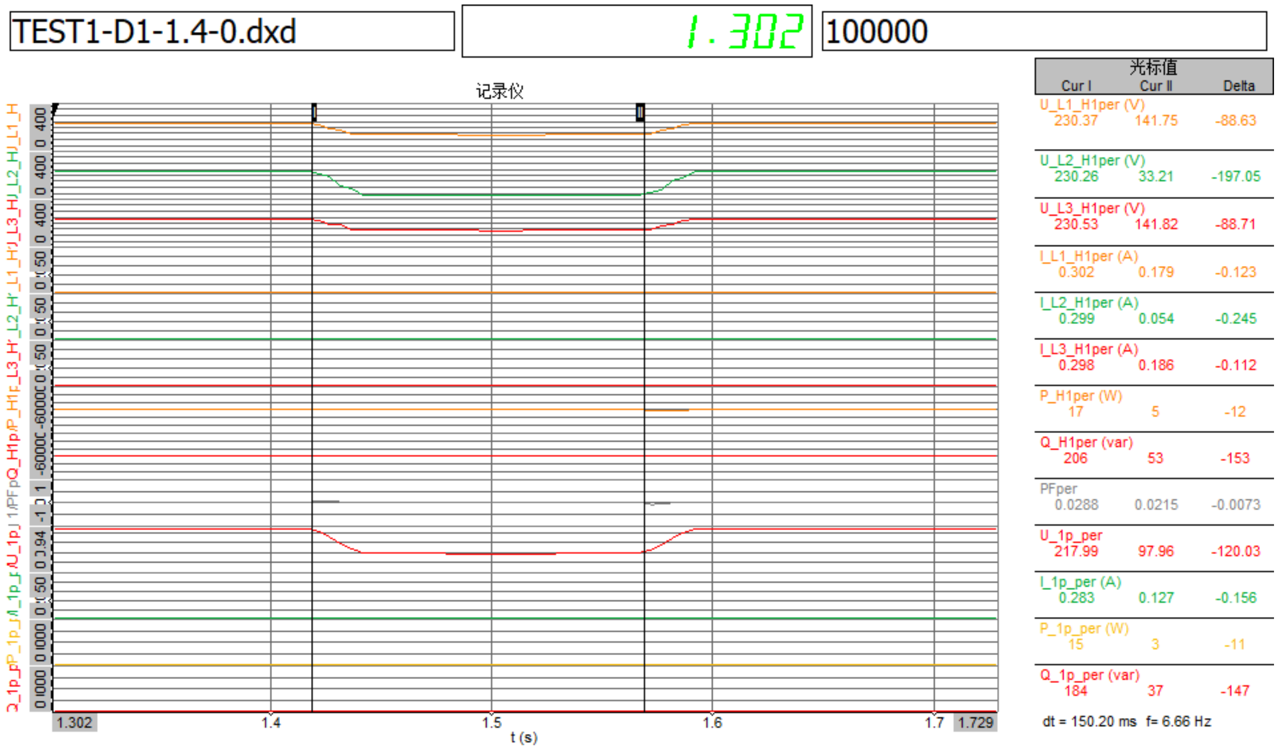
Test 1.3 – Asymmetrical fault - Recover time - Active power



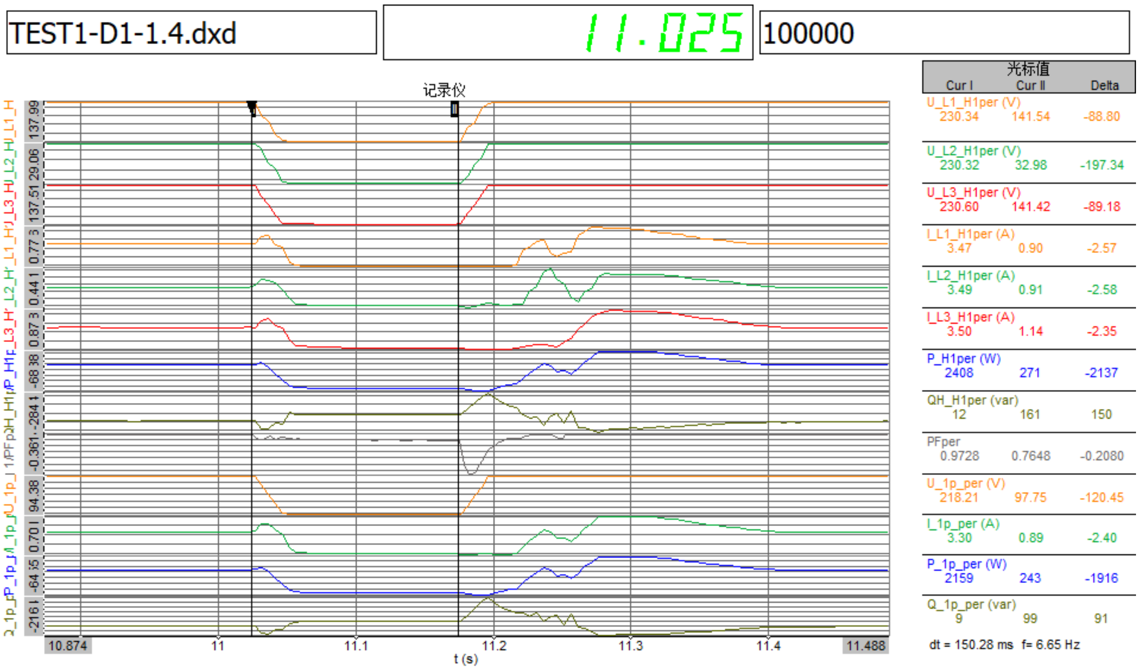
Test 1.4 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	1.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	10.39.54	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	0.15	[p.u.]
	5	Setpoint fault duration	-	-	150	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11025	[ms]
	7	Time point of fault clearance (t2)	Total	-	11175	[ms]
	8	Fault duration in no load test	Total	-	150	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.38	[p.u.]
	10		Positive sequence		0.55	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.19	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.18	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9723	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.13	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.05	[p.u.]
	20		Phase 2	t_1 +60 ms	0.06	[p.u.]
	21		Phase 3	t_1 +60 ms	0.07	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.05	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.02	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.02	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.18	[p.u.]
	30	Active power rising time	Positive sequence	-	0.23	[s]

Test 1.4 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

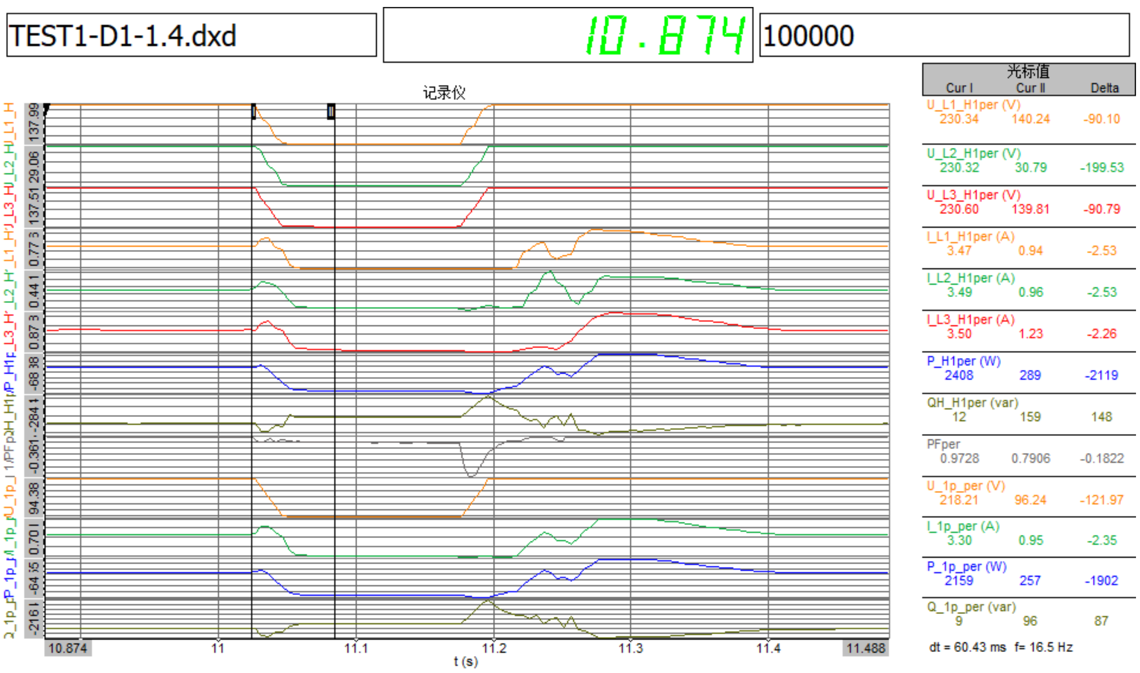
Test 1.4 – symmetrical fault - Voltage depth in no load test



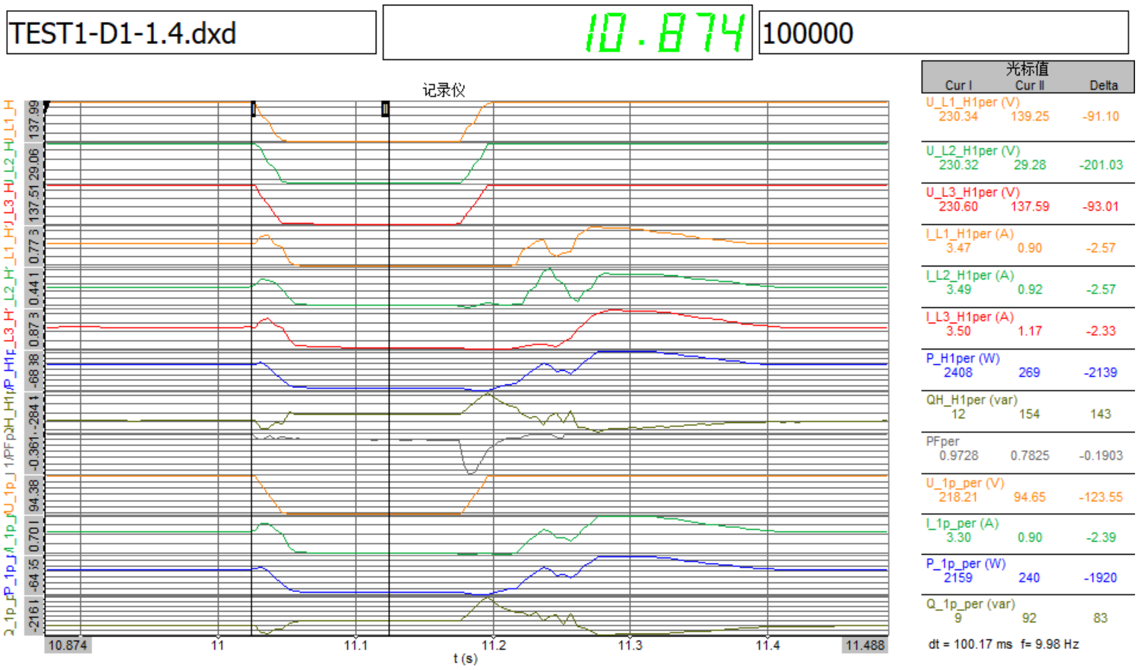
Test 1.4 – Asymmetrical fault - Fault duration



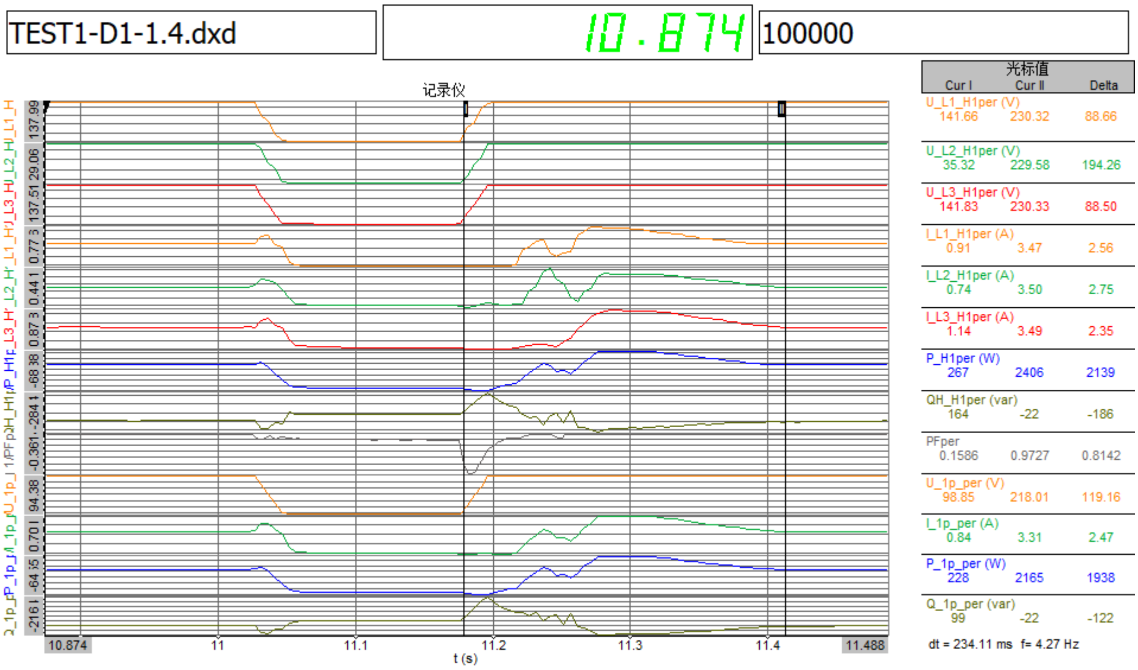
Test 1.4 – Asymmetrical fault - t_1 +60 ms



Test 1.4 – Asymmetrical fault - t1 +100 ms



Test 1.4 – Asymmetrical fault - Recover time - Active power

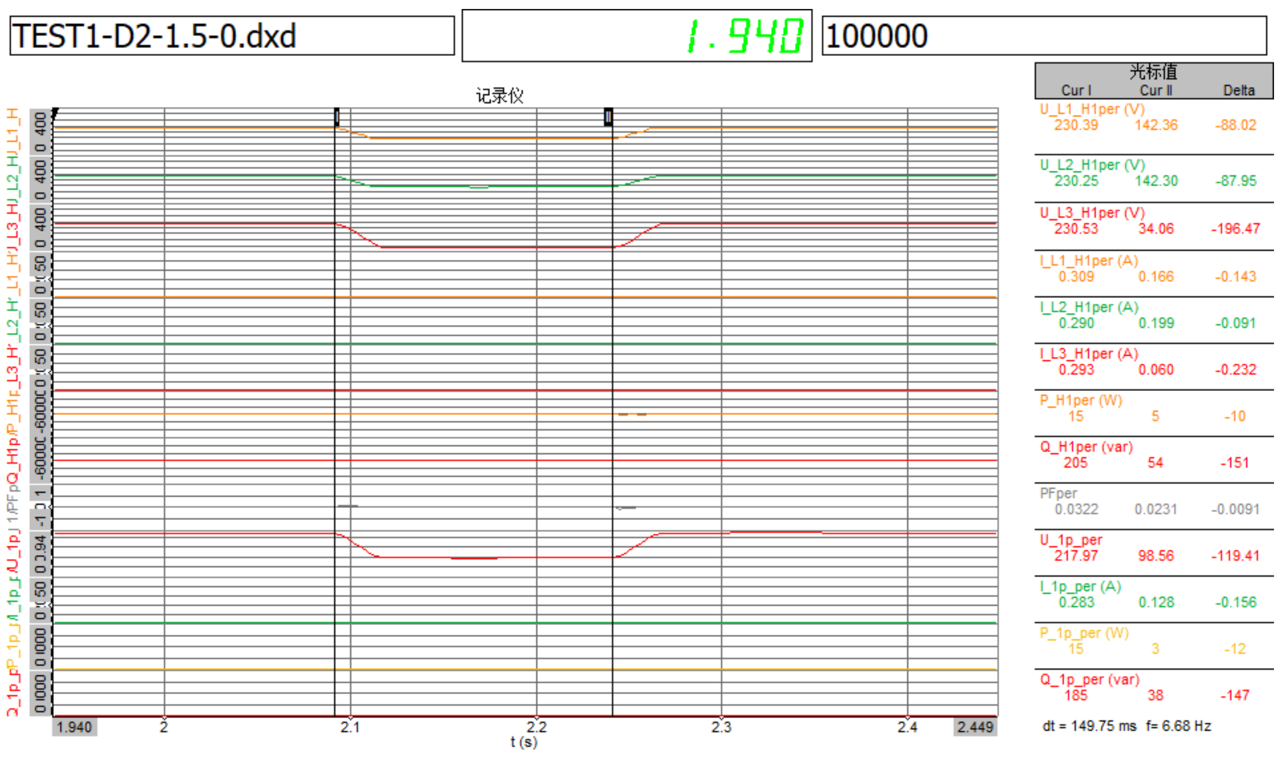


Test 1.5 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.15 to 0.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	1.5	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	10.47.22	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D2	-
	4	Setpoint break-in depth	Phase – phase	-	0.15	[p.u.]
	5	Setpoint fault duration	-	-	150	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11133	[ms]
	7	Time point of fault clearance (t2)	Total	-	11283	[ms]
	8	Fault duration in no load test	Total	-	150	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.38	[p.u.]
	10		Positive sequence		0.55	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	0.95	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.94	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.90	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9958	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.13	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.06	[p.u.]
	20		Phase 2	t_1 +60 ms	0.08	[p.u.]
	21		Phase 3	t_1 +60 ms	0.05	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.05	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.05	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	1.00	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.90	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	0.95	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.90	[p.u.]
	30	Active power rising time	Positive sequence	-	0.61	[s]

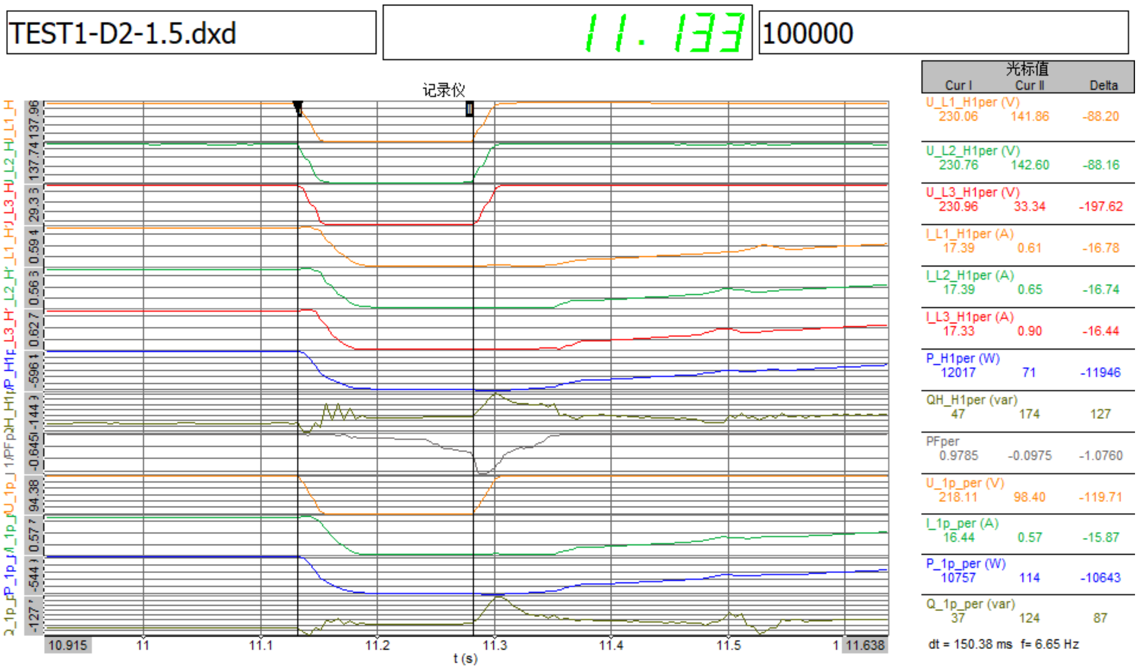
Test 1.5 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.15 to 0.25)

	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

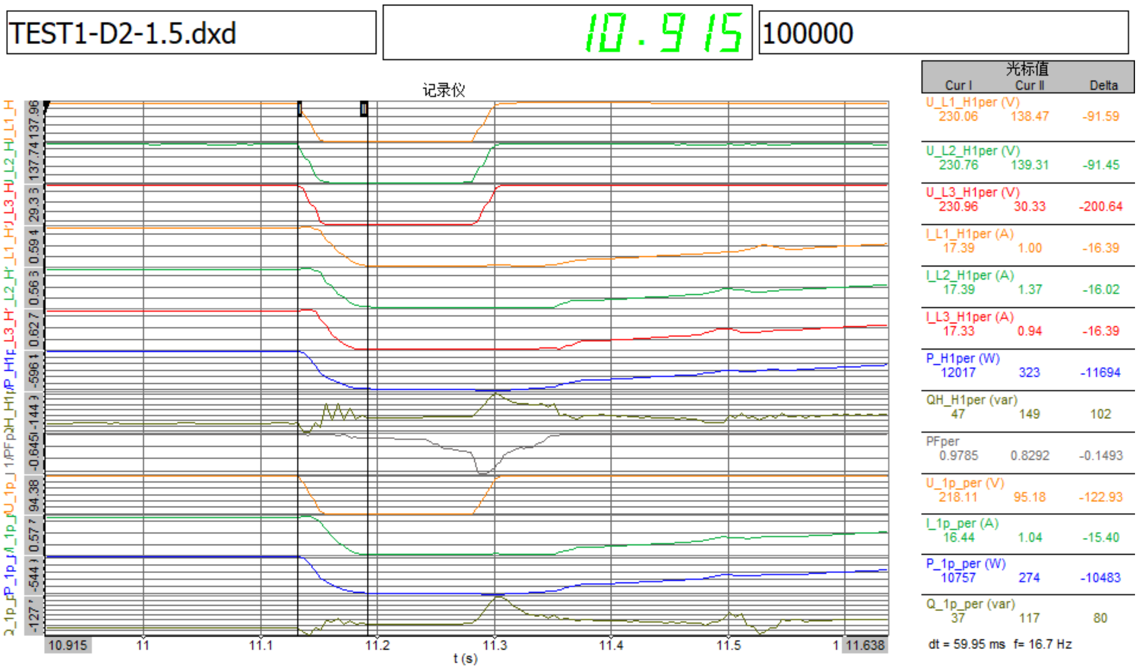
Test 1.5 – symmetrical fault - Voltage depth in no load test



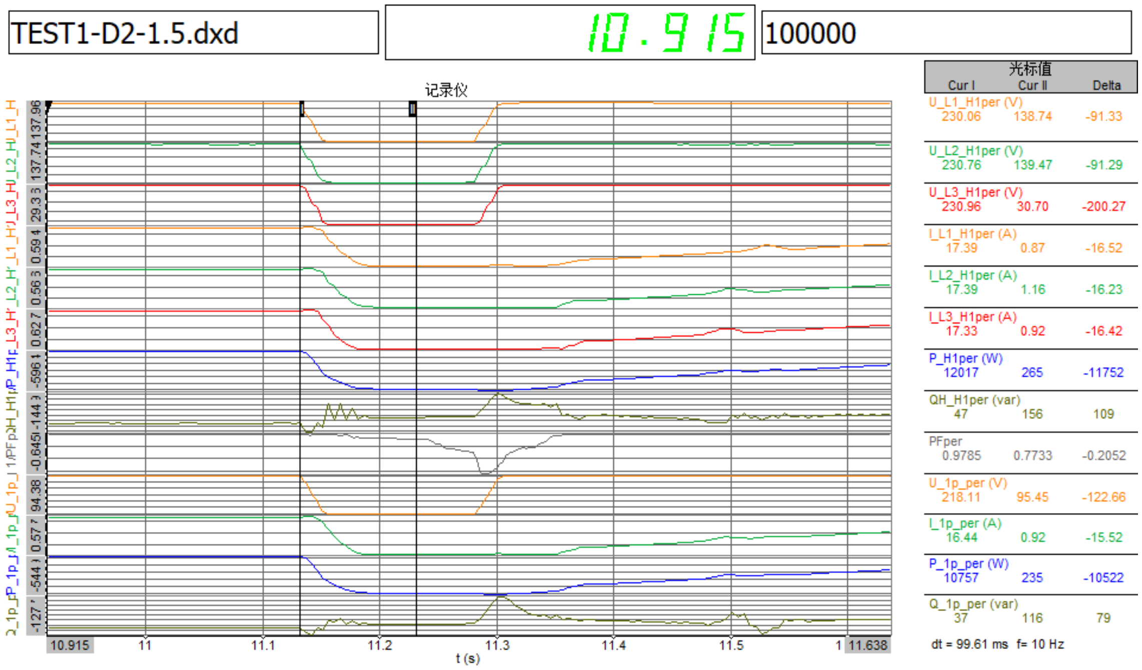
Test 1.5 – Asymmetrical fault - Fault duration



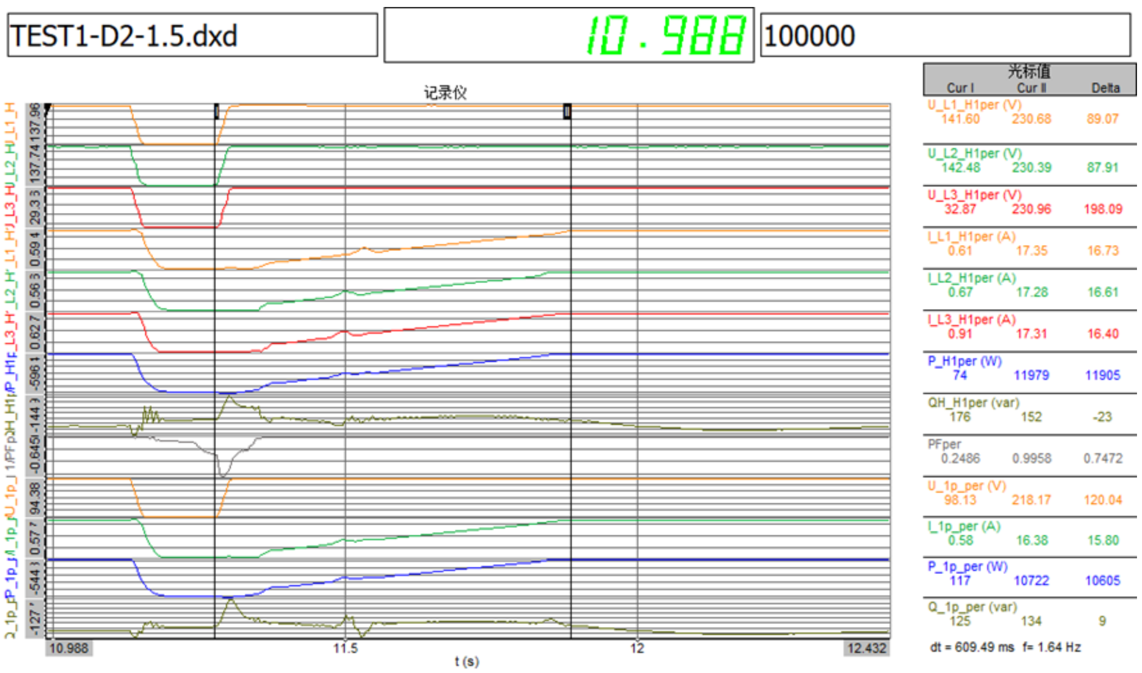
Test 1.5 – Asymmetrical fault - t_1 +60 ms



Test 1.5 – Asymmetrical fault - t_1 +100 ms



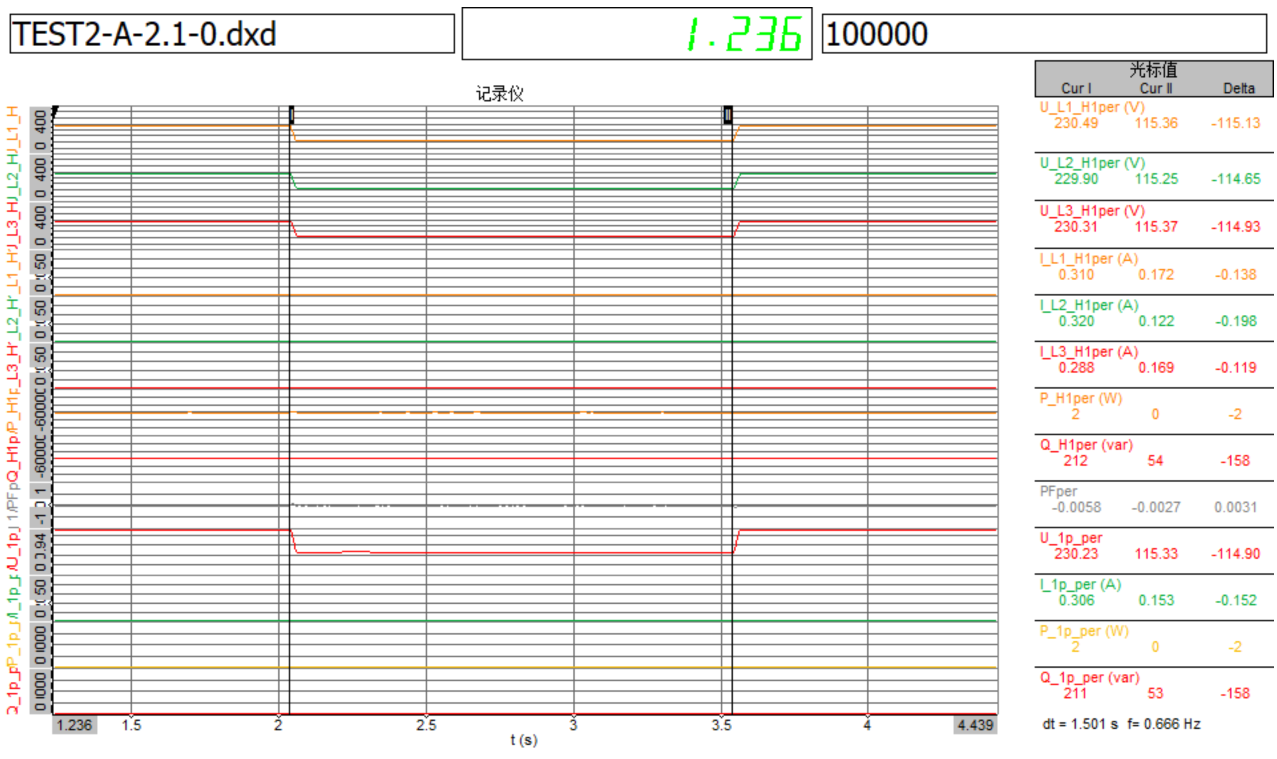
Test 1.5 – Asymmetrical fault - Recover time - Active power



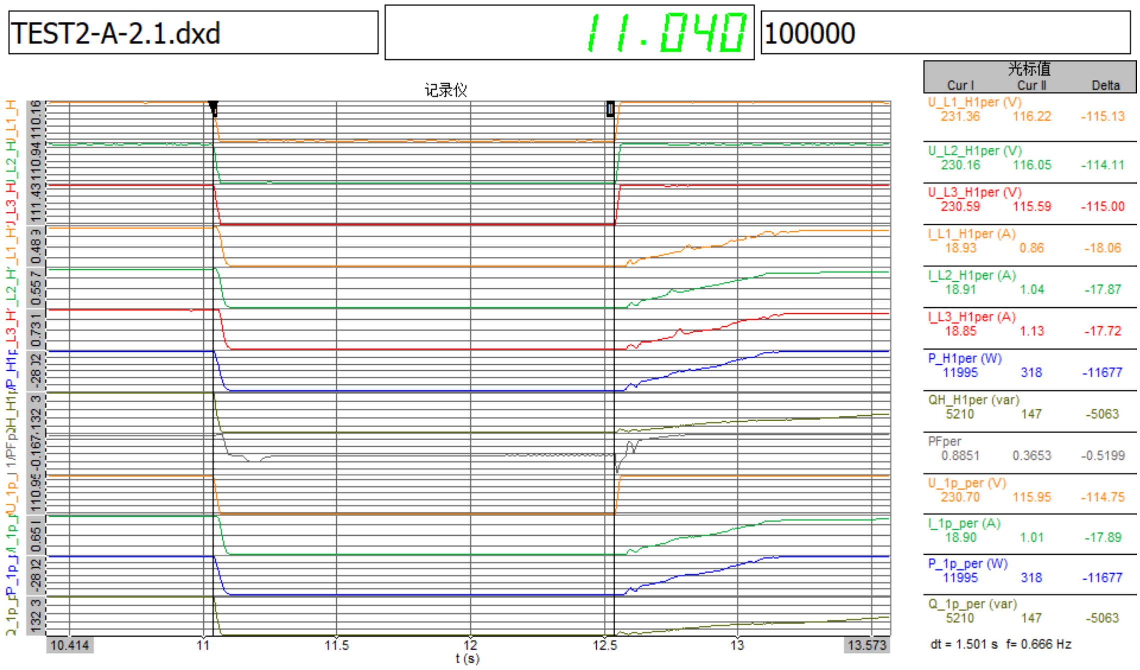
Test 2.1 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	2.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	10.54.58	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11040	[ms]
	7	Time point of fault clearance (t2)	Total	-	12542	[ms]
	8	Fault duration in no load test	Total	-	1502	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.50	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.09	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.44	[p.u.]
	16		Total	t_1-10 s to t_1	0.44	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.8932	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.49	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.06	[p.u.]
	20		Phase 2	t_1 +60 ms	0.07	[p.u.]
	21		Phase 3	t_1 +60 ms	0.10	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.05	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	1.00	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	1.00	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	30	Active power rising time	Positive sequence	-	0.64	[s]

Test 2.1 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.43	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.43	[p.u.]
	33	Reactive power rising time	Positive sequence	-	5.21	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

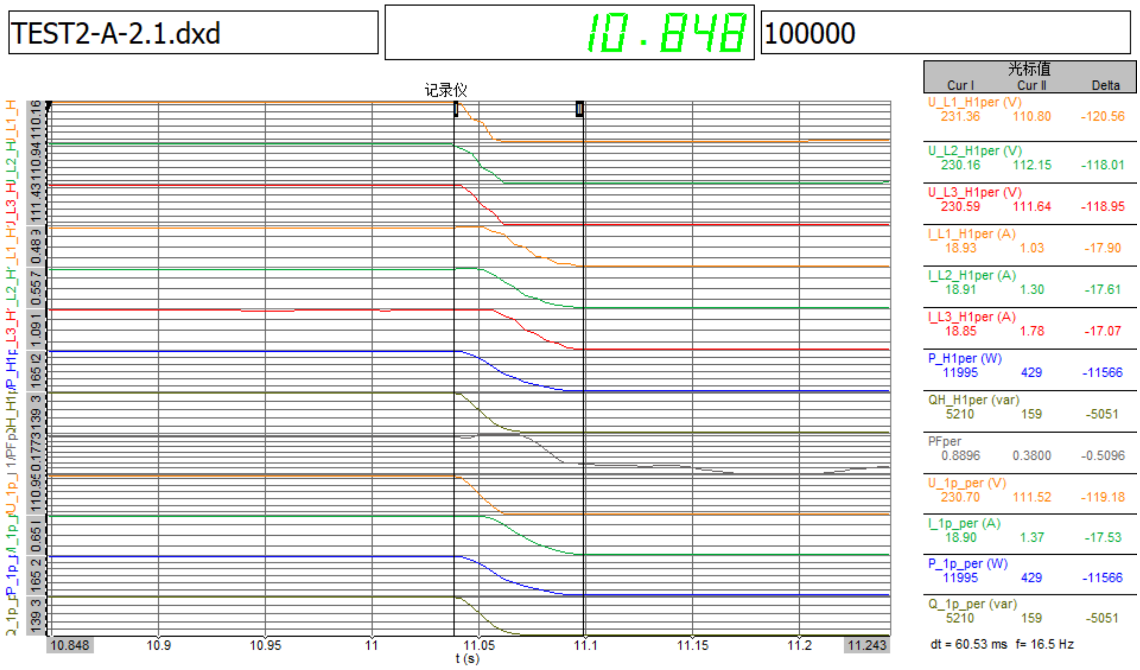
Test 2.1 – symmetrical fault - Voltage depth in no load test



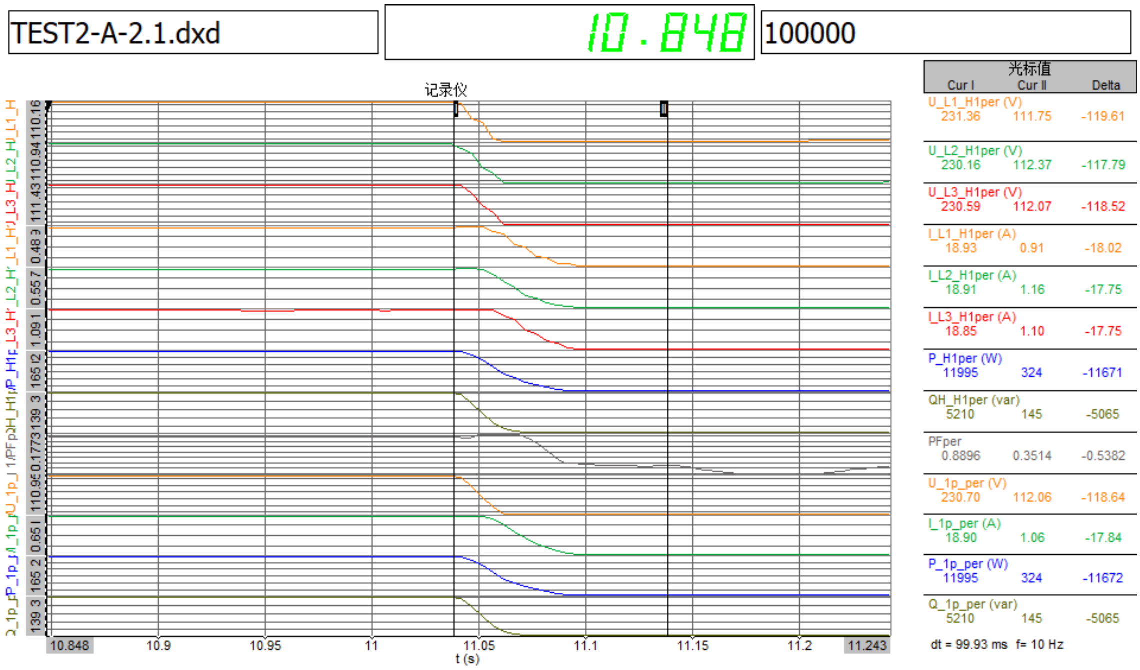
Test 2.1 – symmetrical fault - Fault duration



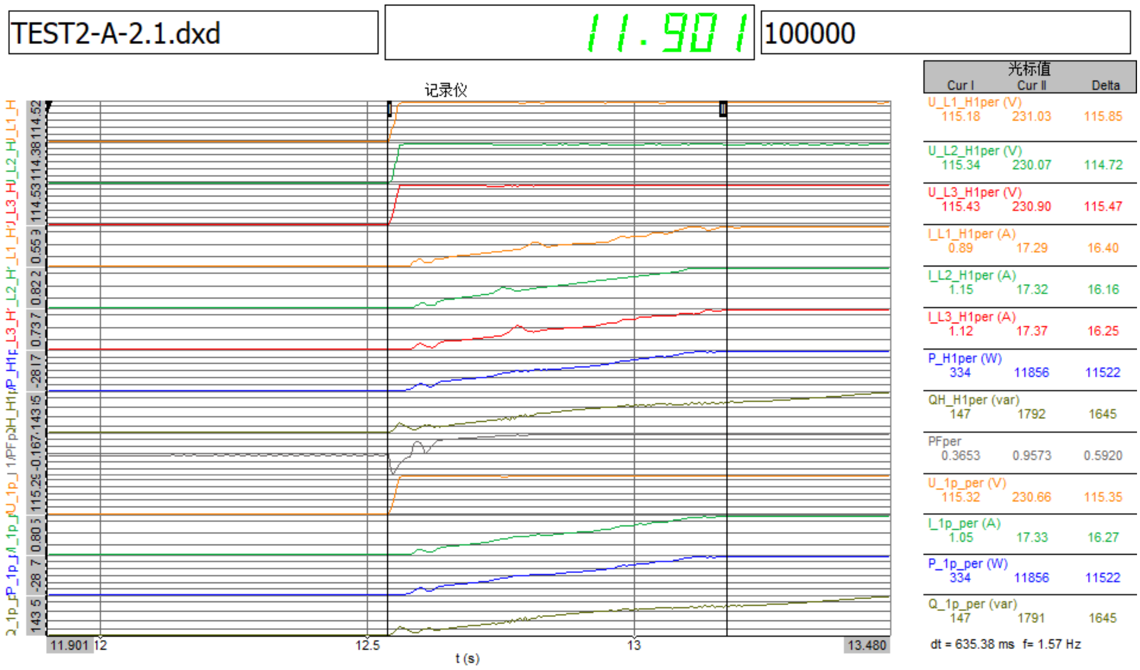
Test 2.1 – symmetrical fault - t_1 +60 ms



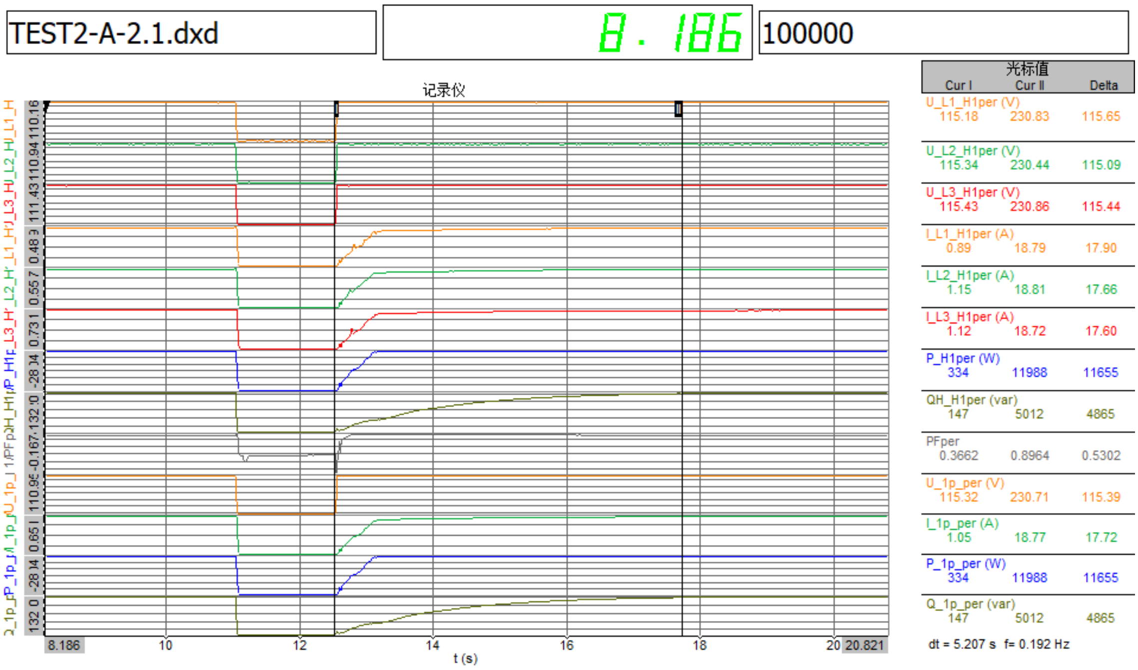
Test 2.1 – symmetrical fault - t_1 +100 ms



Test 2.1 – symmetrical fault - Recover time - Active power



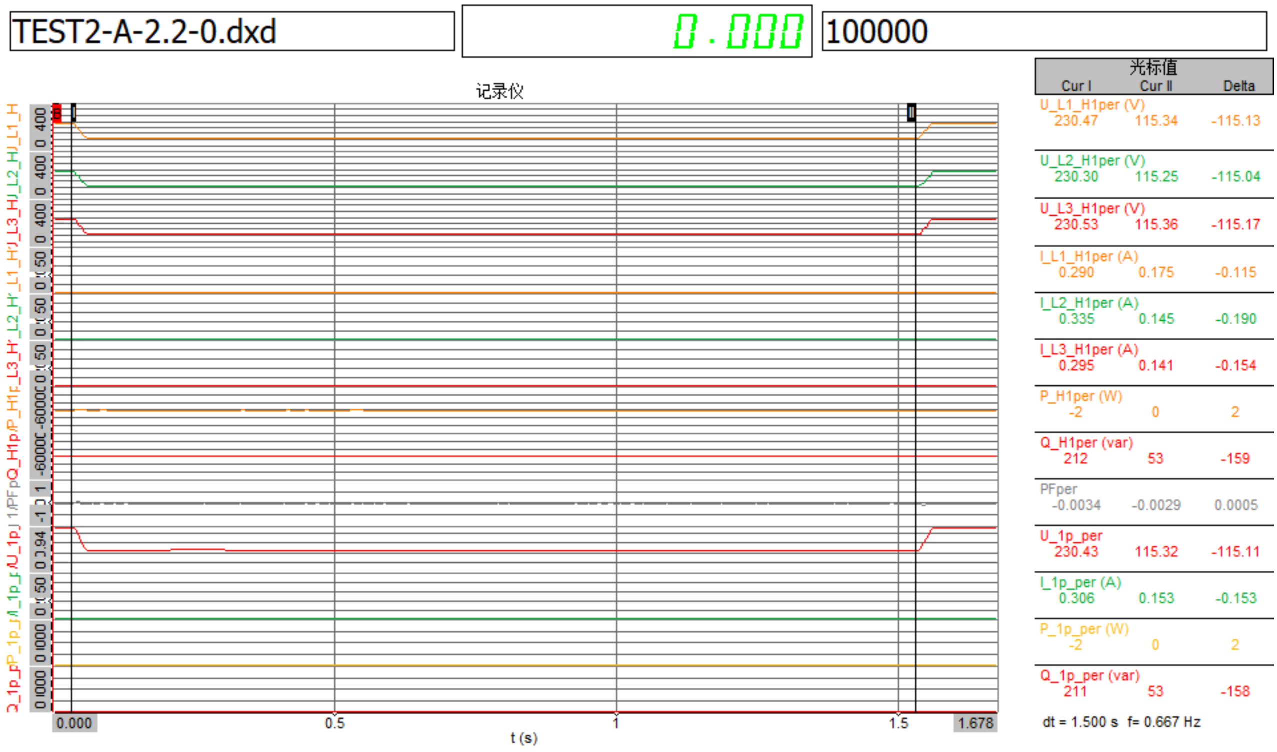
Test 2.1 – symmetrical fault - Recover time - Reactive power



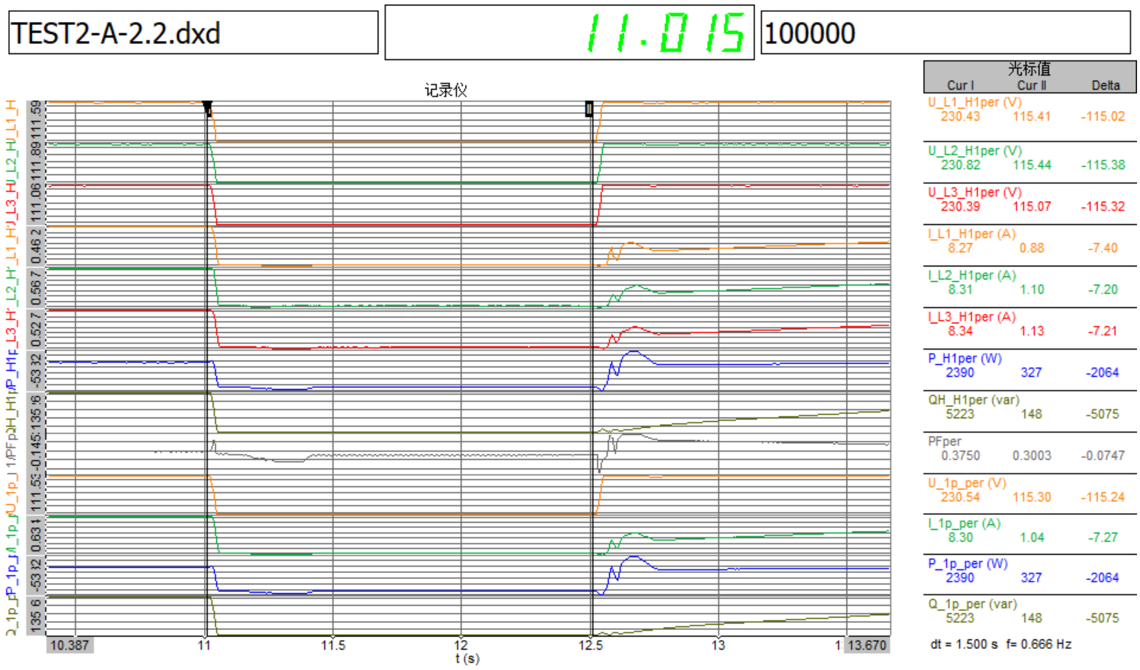
Test: Test 2.2 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	2.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	11.04.30	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase – phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11015	[ms]
	7	Time point of fault clearance (t2)	Total	-	12515	[ms]
	8	Fault duration in no load test	Total	-	1500	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.50	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.48	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.44	[p.u.]
	16		Total	t_1-10 s to t_1	0.44	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.3898	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.49	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.05	[p.u.]
	20		Phase 2	t_1 +60 ms	0.07	[p.u.]
	21		Phase 3	t_1 +60 ms	0.07	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.05	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	0.49	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.03	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.03	[p.u.]
	30	Active power rising time	Positive sequence	-	0.22	[s]

Test: Test 2.2 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	33	Reactive power rising time	Positive sequence	-	7.24	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

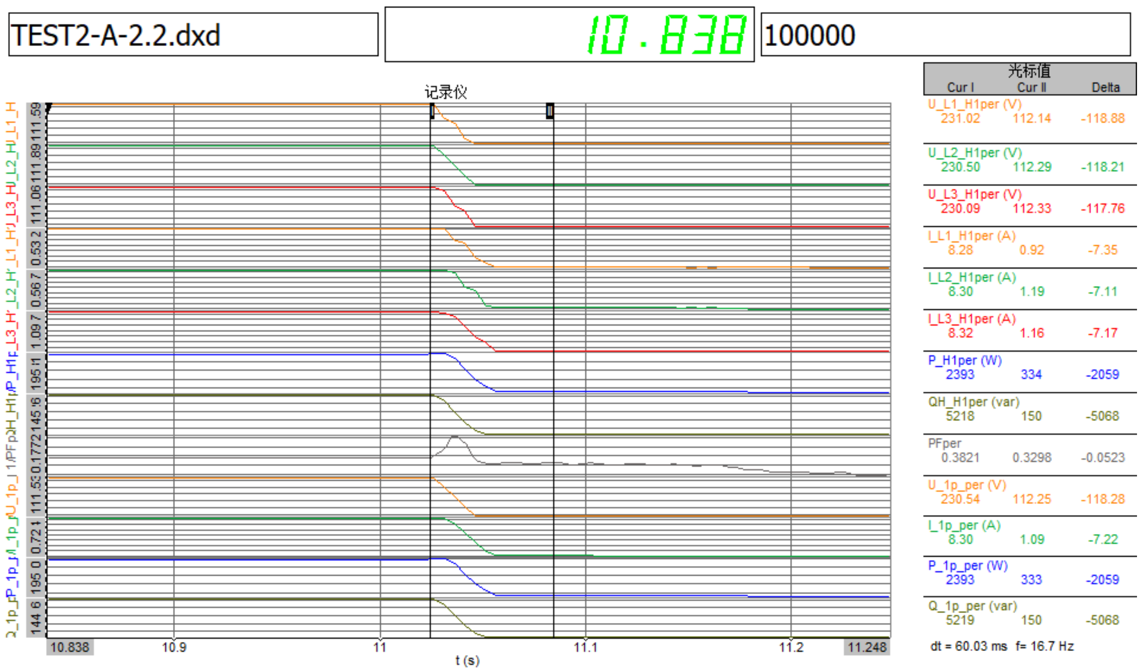
Test 2.2 – symmetrical fault - Voltage depth in no load test



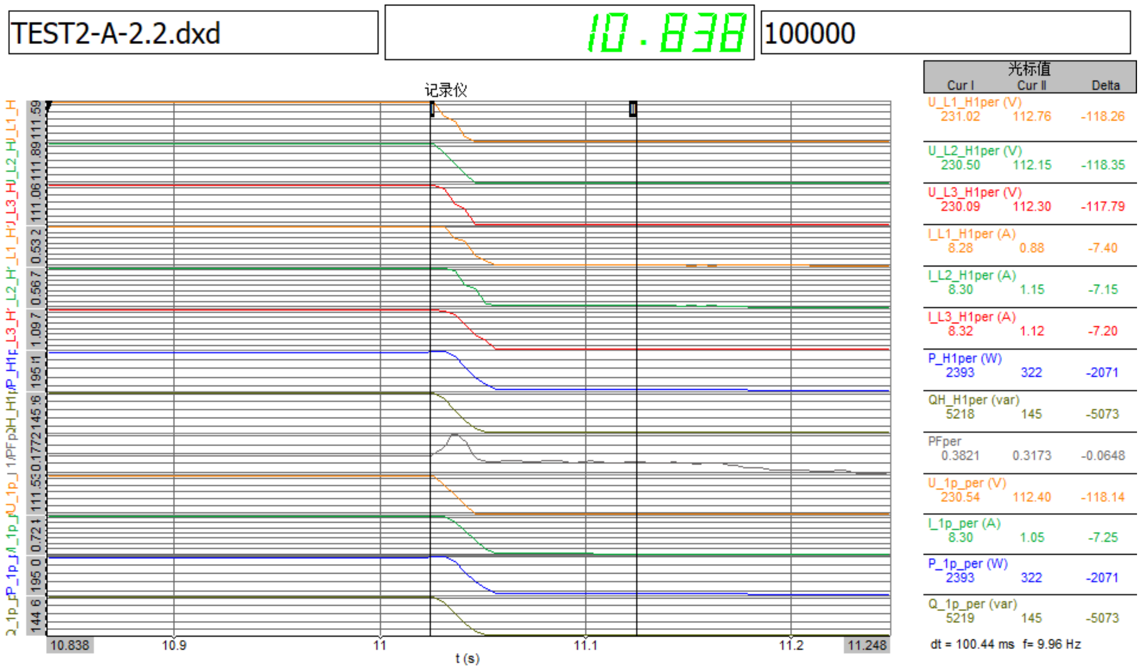
Test 2.2 – symmetrical fault - Fault duration



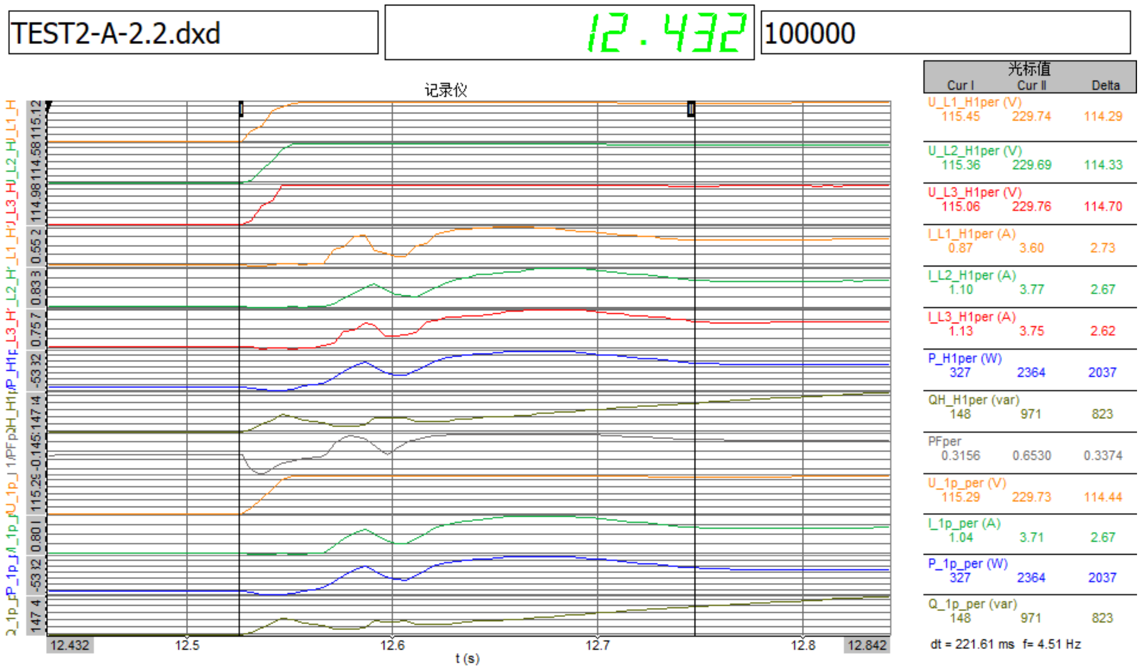
Test 2.2 – symmetrical fault - t_1 +60 ms



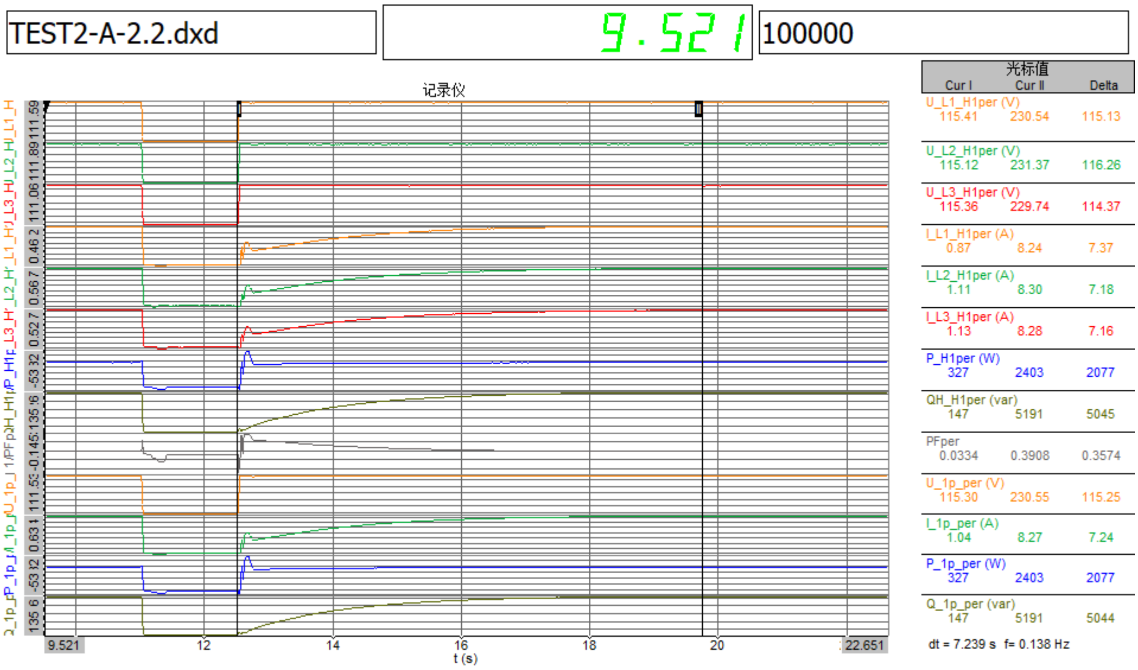
Test 2.2 – symmetrical fault - t_1 +100 ms



Test 2.2 – symmetrical fault - Recover time - Active power

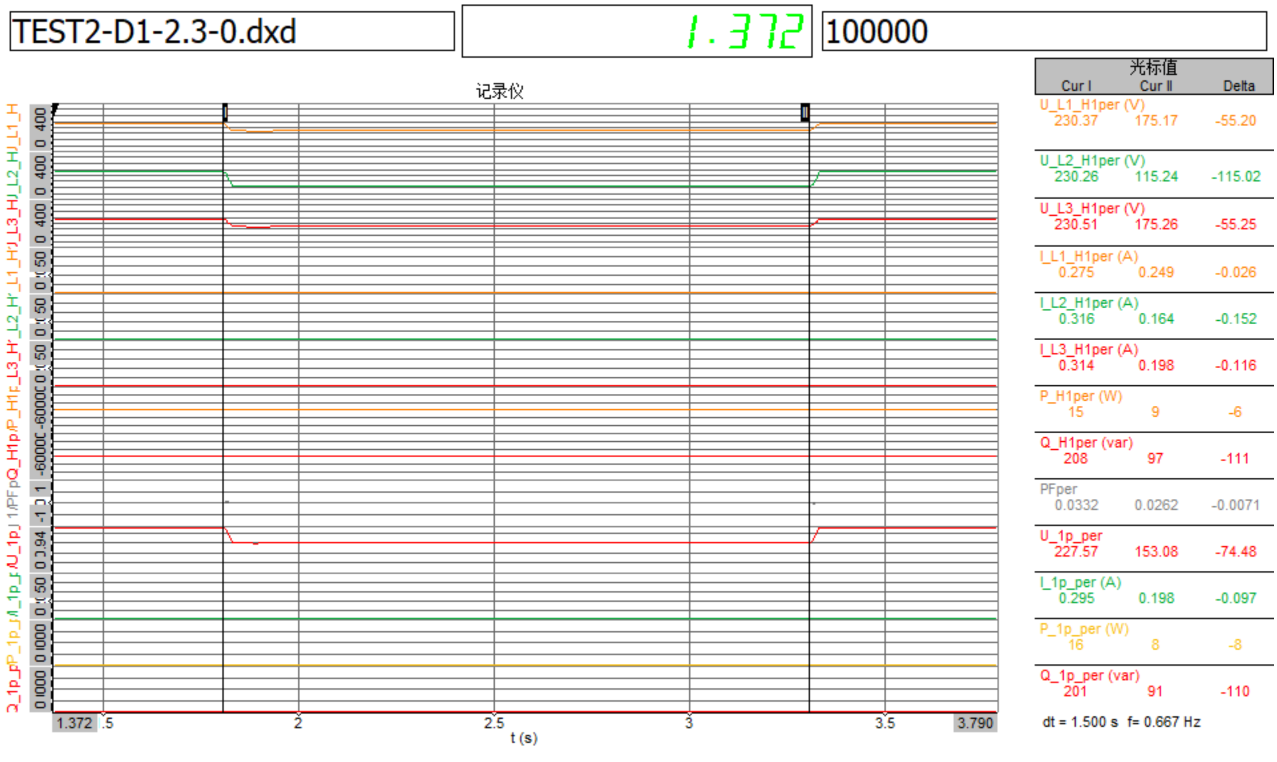


Test 2.2 – symmetrical fault - Recover time - Reactive power

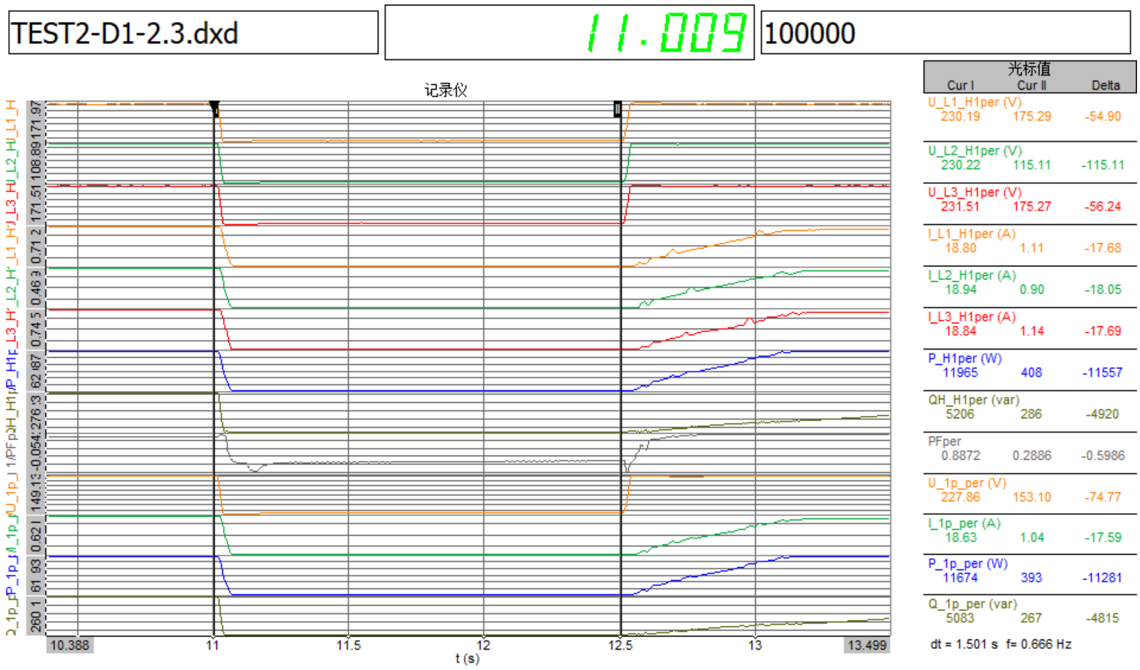


Test 2.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	2.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	11.35.39	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase - phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11009	[ms]
	7	Time point of fault clearance (t2)	Total	-	12510	[ms]
	8	Fault duration in no load test	Total	-	1501	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.33	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	13.23	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.97	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.44	[p.u.]
	16		Total	t_1-10 s to t_1	0.43	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.8880	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.48	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.08	[p.u.]
	20		Phase 2	t_1 +60 ms	0.06	[p.u.]
	21		Phase 3	t_1 +60 ms	0.07	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.06	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	0.99	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.97	[p.u.]
	30	Active power rising time	Positive sequence	-	0.71	[s]

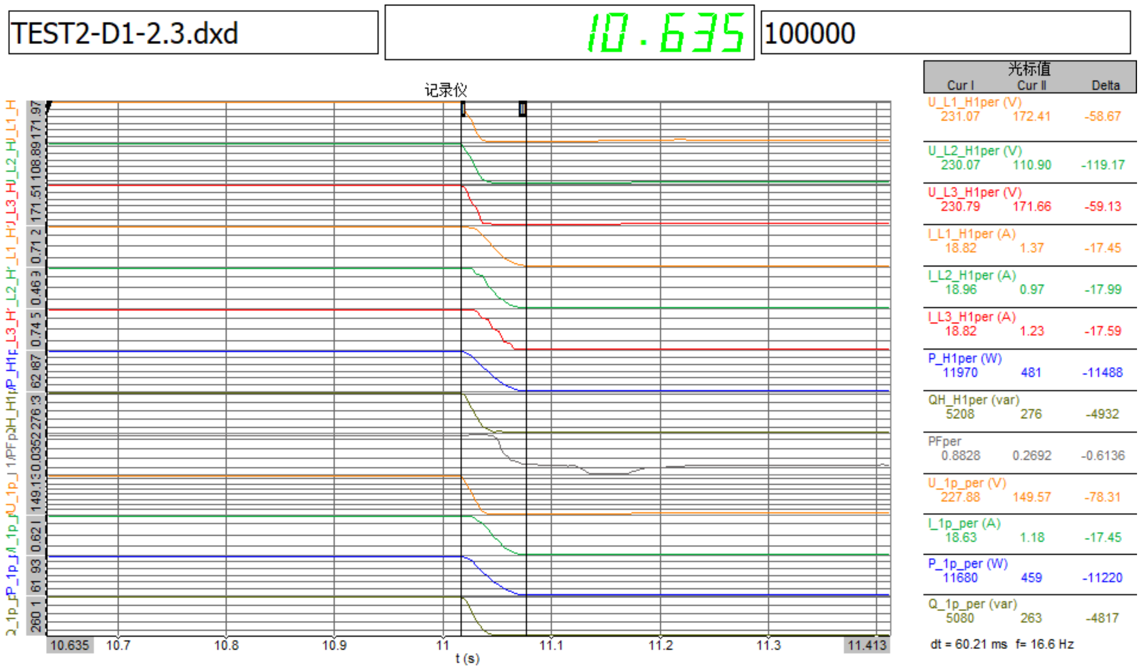
Test 2.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.44	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.42	[p.u.]
	33	Reactive power rising time	Positive sequence	-	8.35	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-
Test 2.3 – symmetrical fault - Voltage depth in no load test						



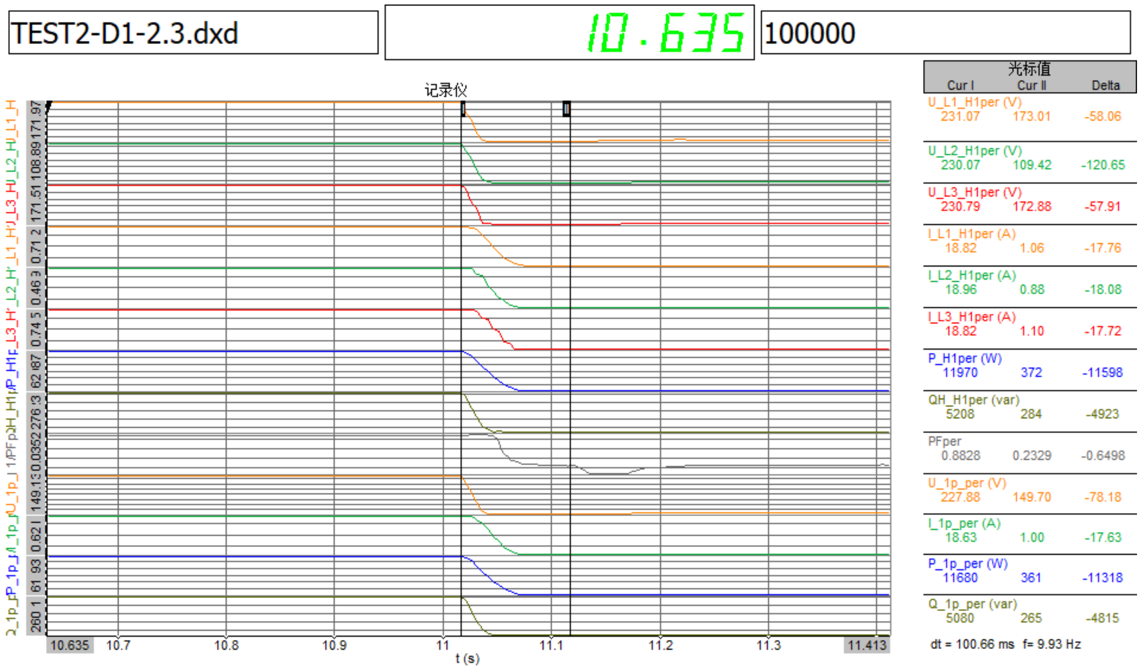
Test 2.3 – Asymmetrical fault - Fault duration



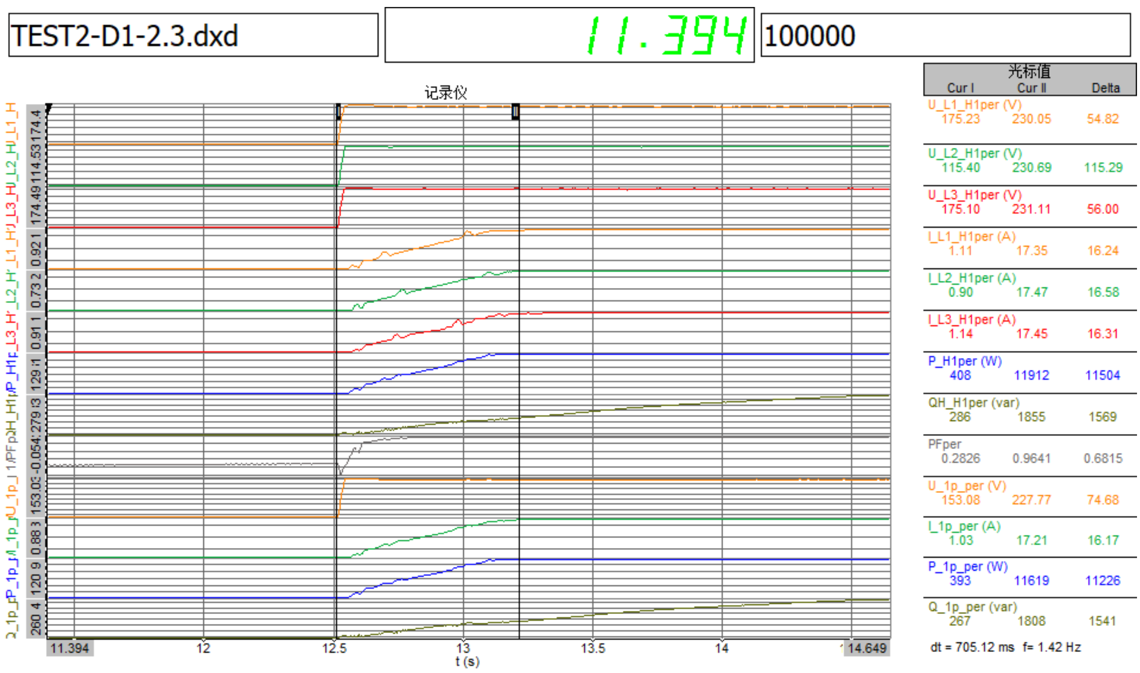
Test 2.3 – Asymmetrical fault - t_1 +60 ms



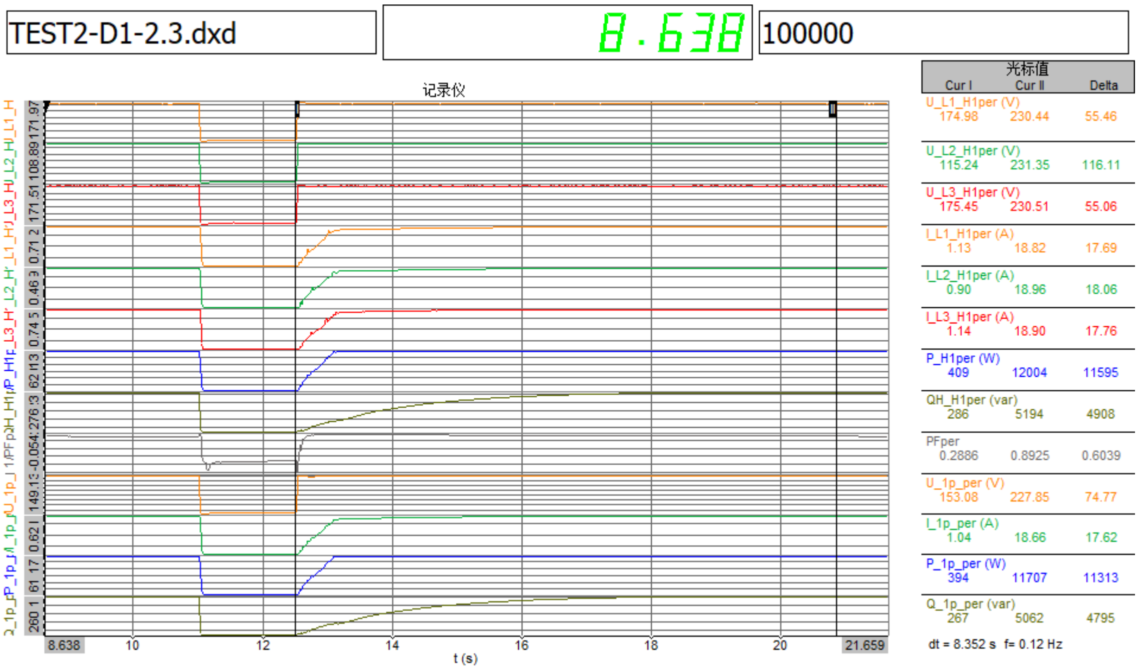
Test 2.3 – Asymmetrical fault - t_1 +100 ms



Test 2.3 – Asymmetrical fault - Recover time - Active power



Test 2.3 – Asymmetrical fault - Recover time - Reactive power

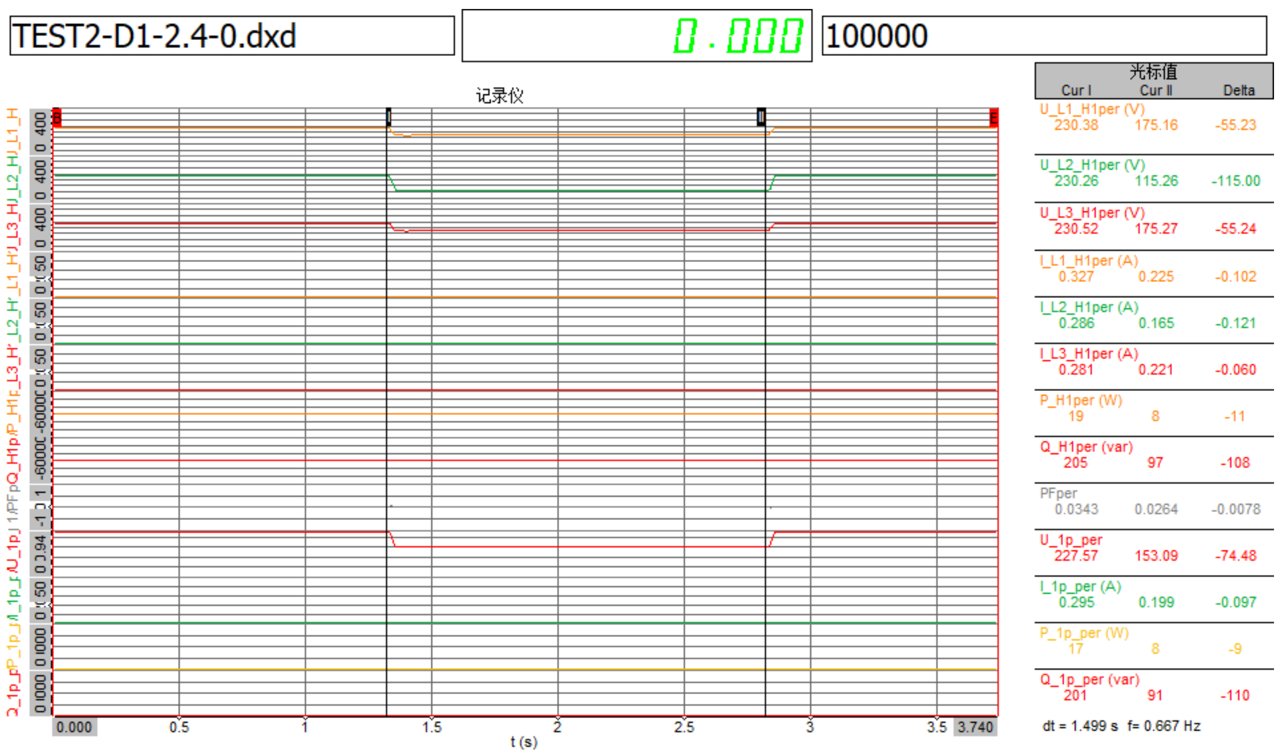


Test: Test 2.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)

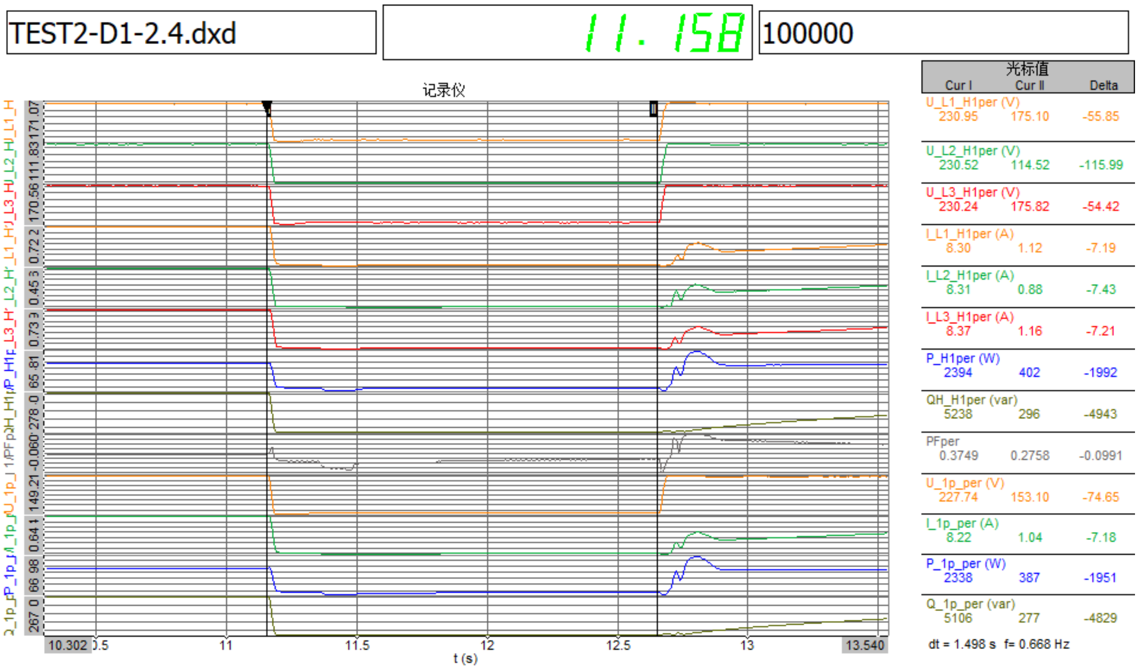
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	2.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	13.07.47	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11158	[ms]
	7	Time point of fault clearance (t2)	Total	-	12656	[ms]
	8	Fault duration in no load test	Total	-	1498	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.33	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.48	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.44	[p.u.]
	16		Total	t_1-10 s to t_1	0.42	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.3870	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.53	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.06	[p.u.]
	20		Phase 2	t_1 +60 ms	0.05	[p.u.]
	21		Phase 3	t_1 +60 ms	0.07	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.06	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.22	[s]

Test: Test 2.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.43	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.42	[p.u.]
	33	Reactive power rising time	Positive sequence	-	6.16	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

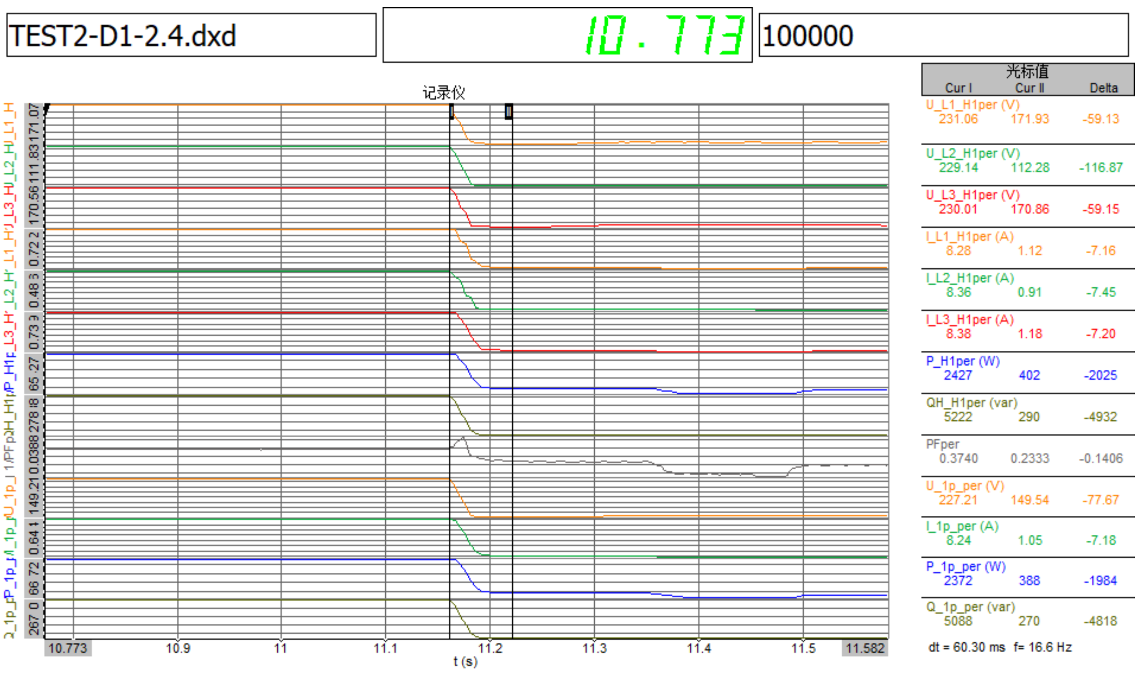
Test 2.4 – symmetrical fault - Voltage depth in no load test



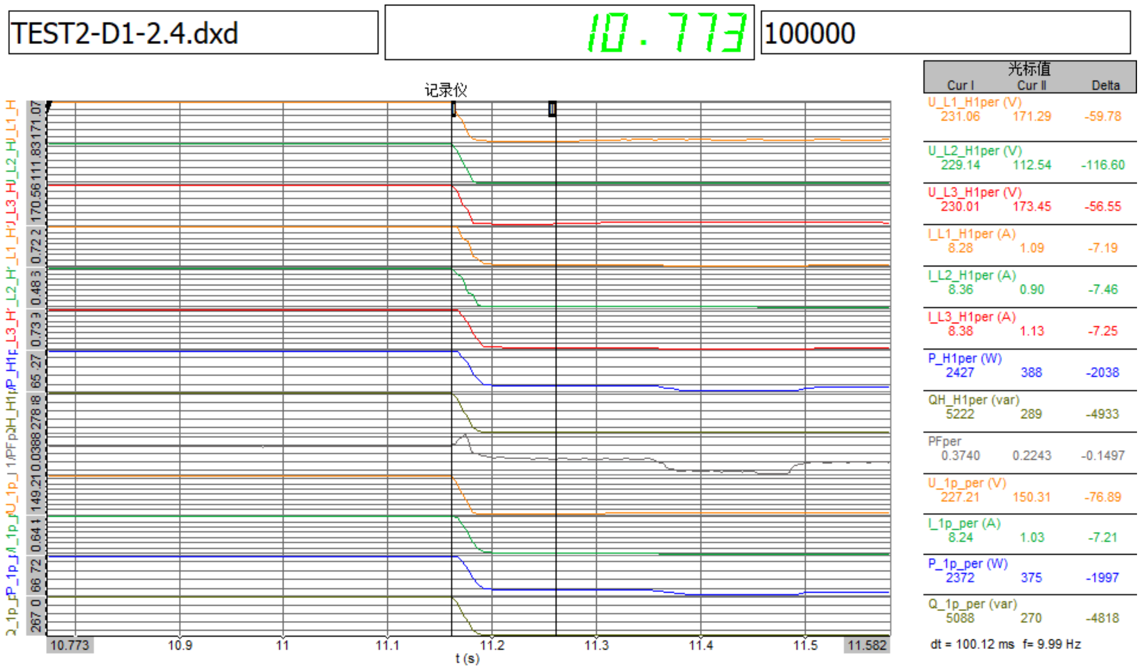
Test 2.4 – Asymmetrical fault - Fault duration



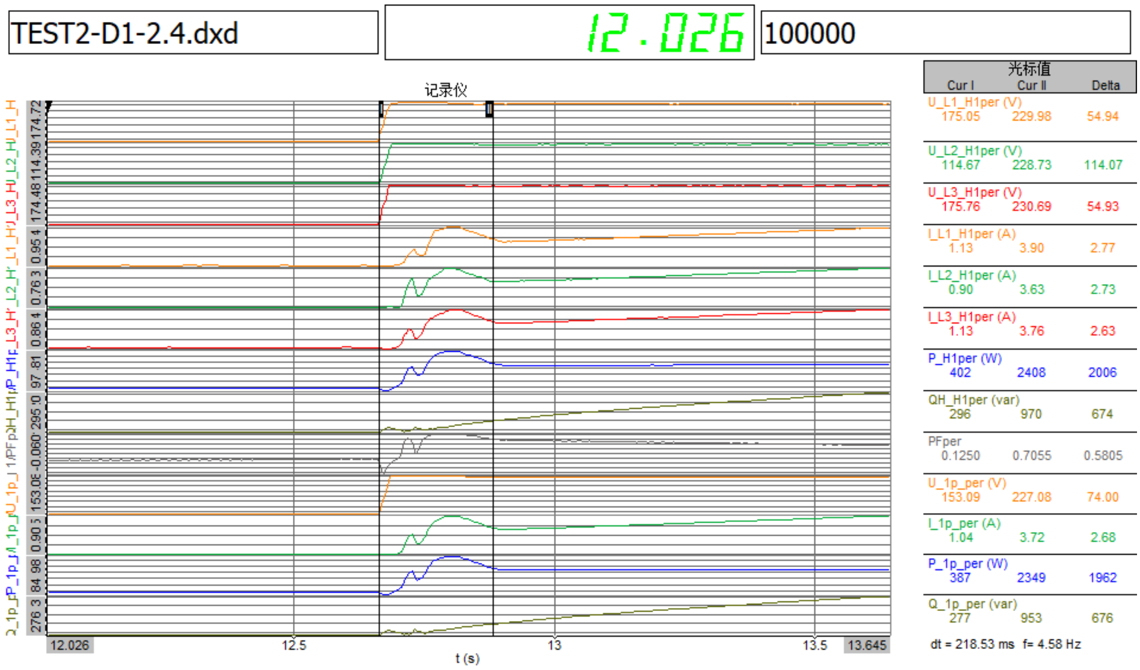
Test 2.4 – Asymmetrical fault - t_1 +60 ms



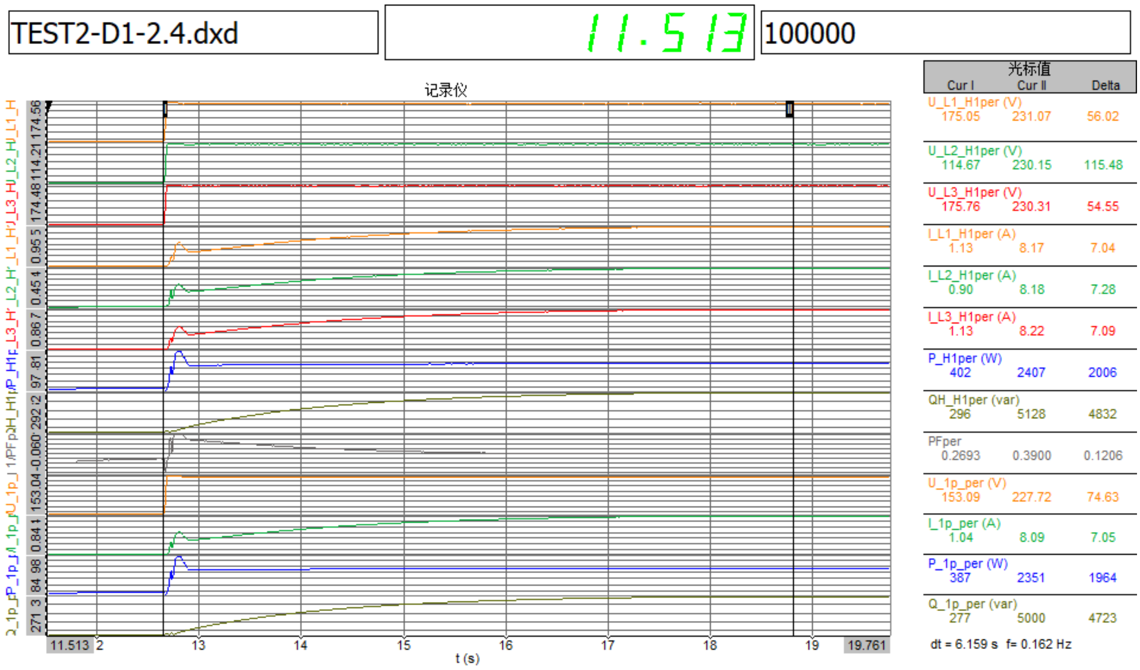
Test 2.4 – Asymmetrical fault - t_1 +100 ms



Test 2.4 – Asymmetrical fault - Recover time - Active power



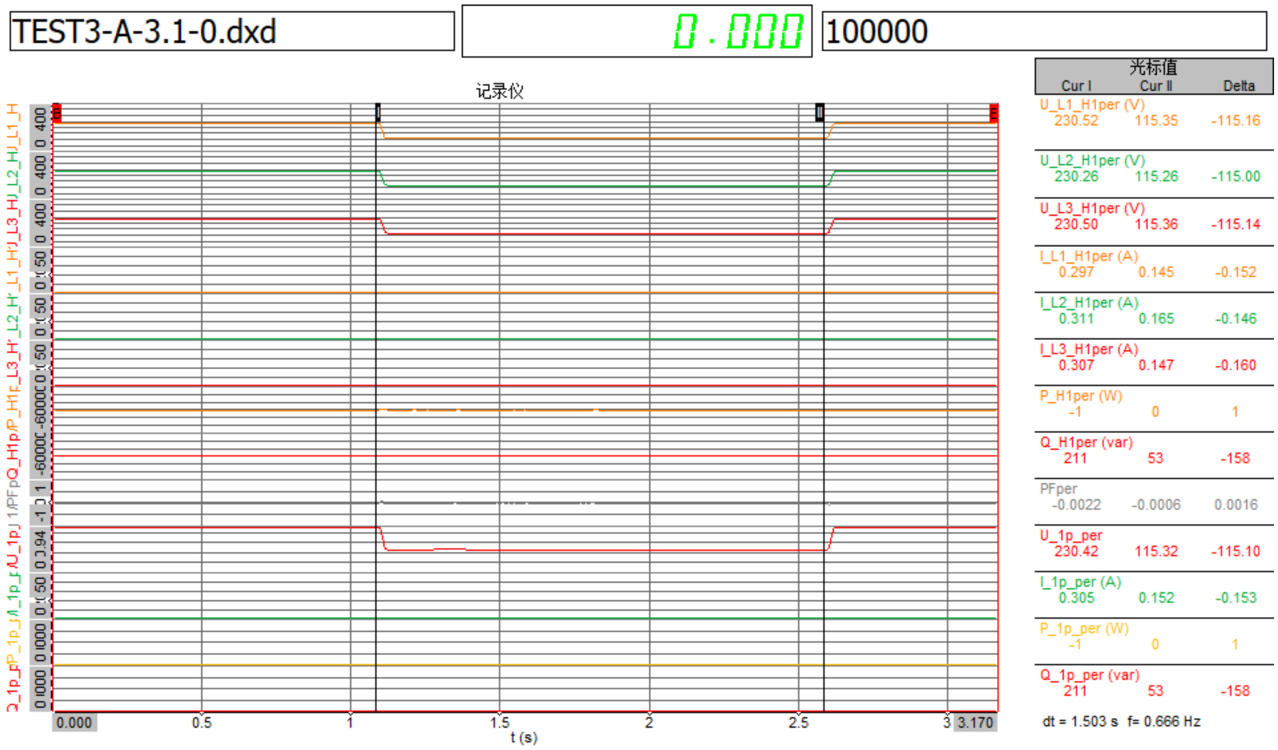
Test 2.4 – Asymmetrical fault - Recover time - Reactive power



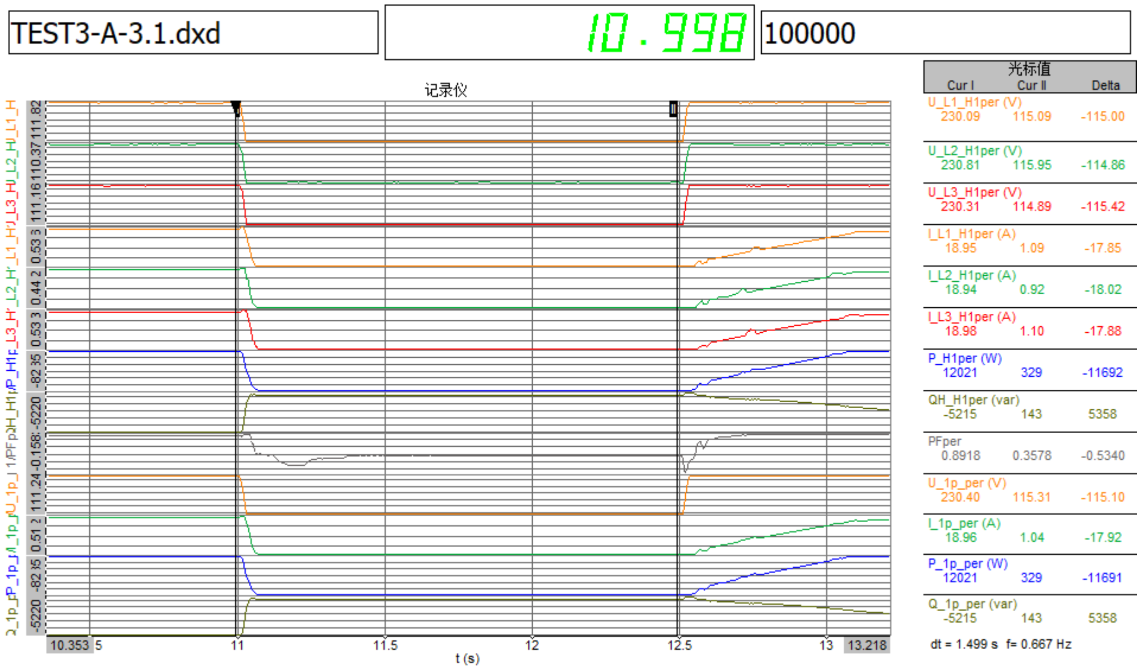
Test 3.1 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	3.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	14.08.13	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10998	[ms]
	7	Time point of fault clearance (t2)	Total	-	12496	[ms]
	8	Fault duration in no load test	Total	-	1498	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.50	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.09	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	-0.43	[p.u.]
	16		Total	t_1-10 s to t_1	-0.43	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.8877	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.53	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.07	[p.u.]
	20		Phase 2	t_1 +60 ms	0.06	[p.u.]
	21		Phase 3	t_1 +60 ms	0.12	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.06	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]

Test 3.1 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	30	Active power rising time	Positive sequence	-	0.58	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	-0.43	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	-0.43	[p.u.]
	33	Reactive power rising time	Positive sequence	-	6.43	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

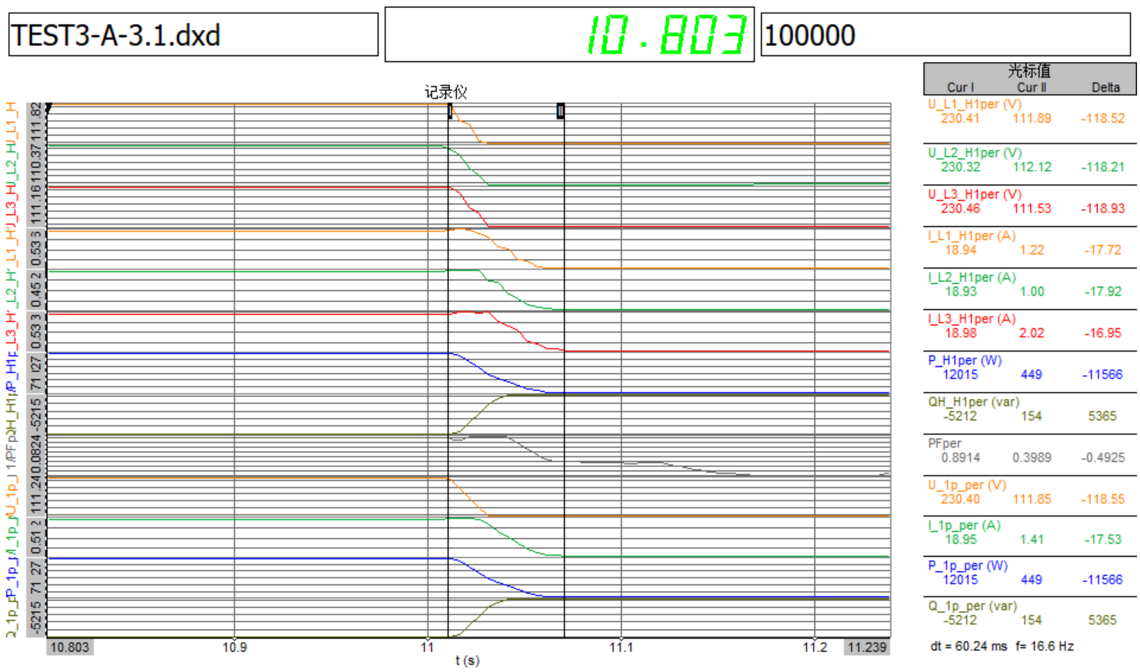
Test 3.1 – symmetrical fault - Voltage depth in no load test



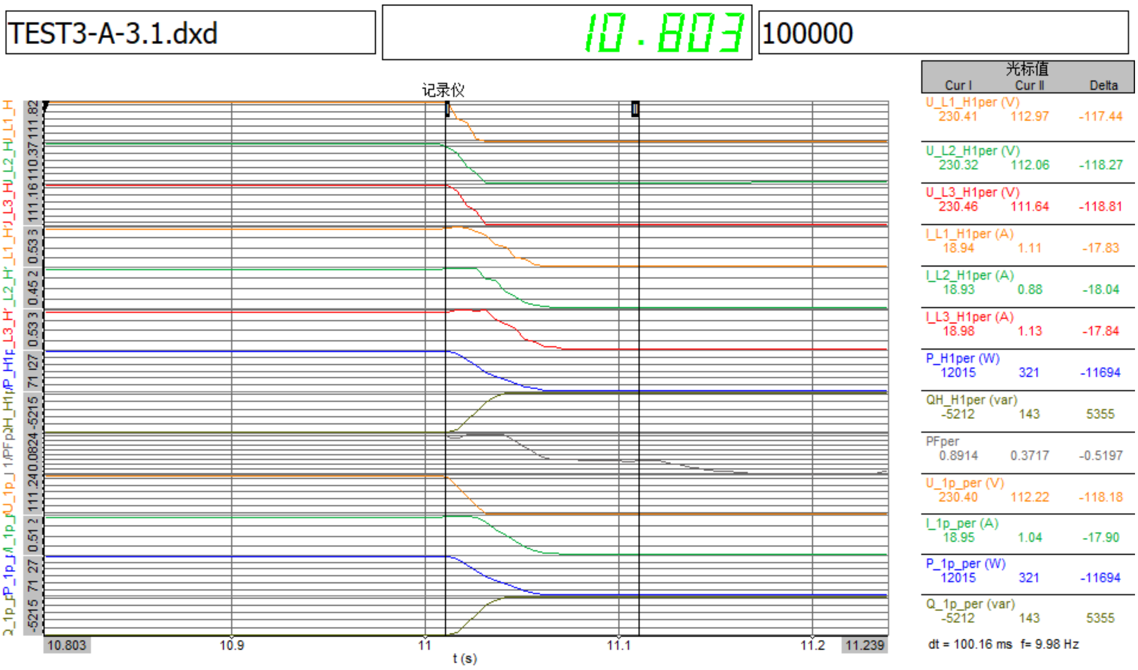
Test 3.1 – symmetrical fault - Fault duration



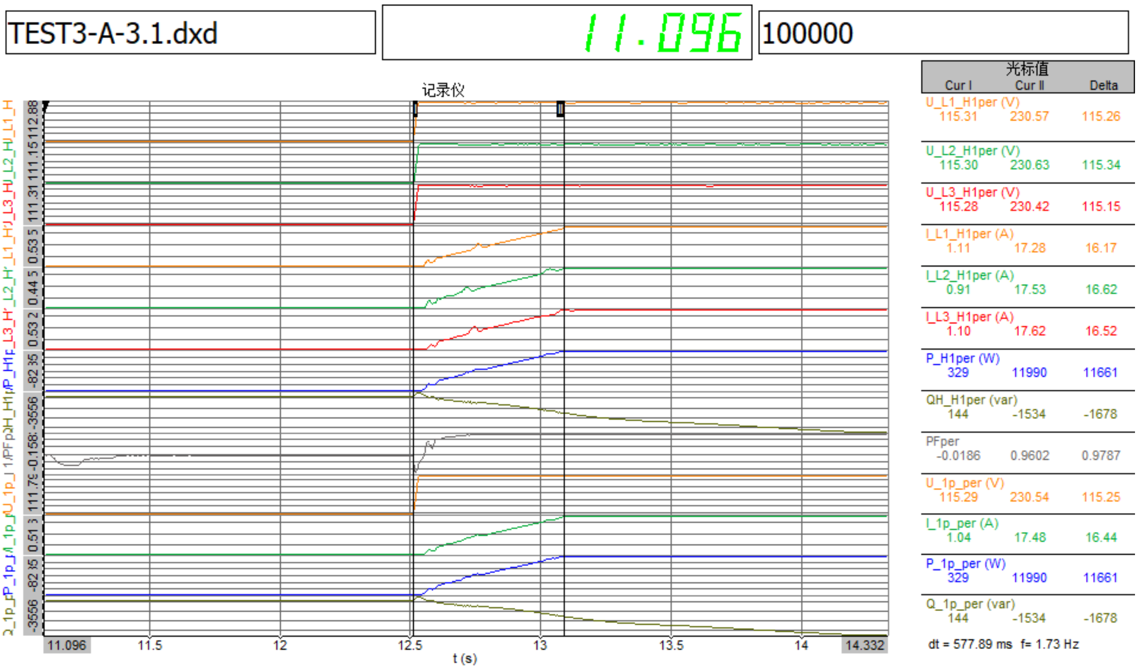
Test 3.1 – symmetrical fault - t_1 +60 ms



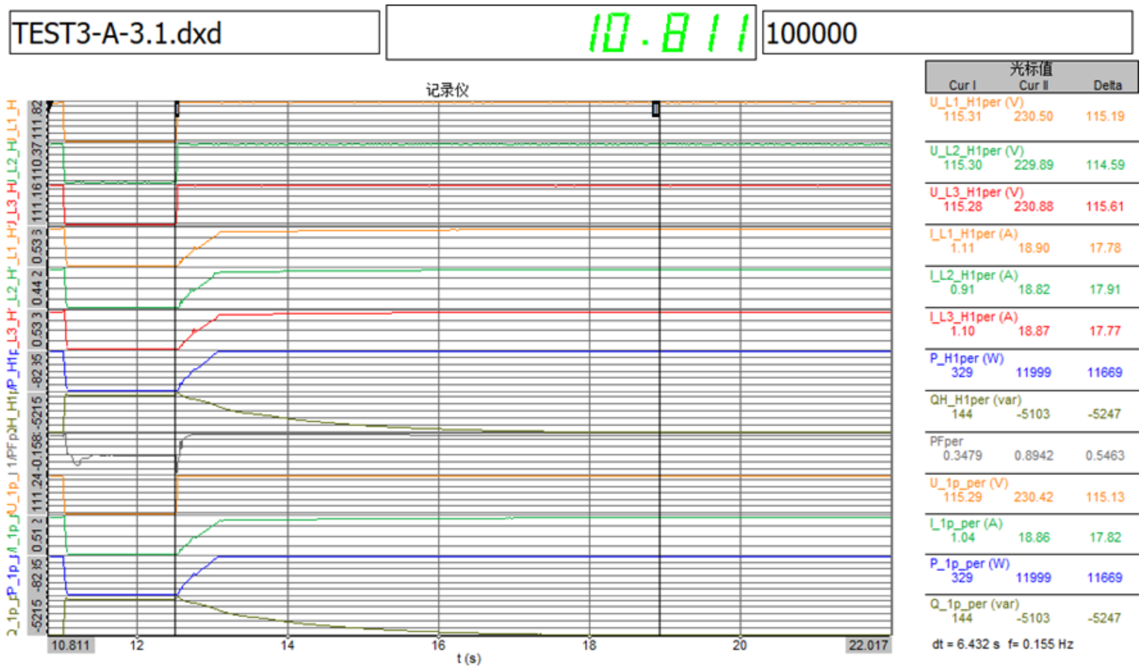
Test 3.1 – symmetrical fault - t_1 +100 ms



Test 3.1 – symmetrical fault - Recover time - Active power



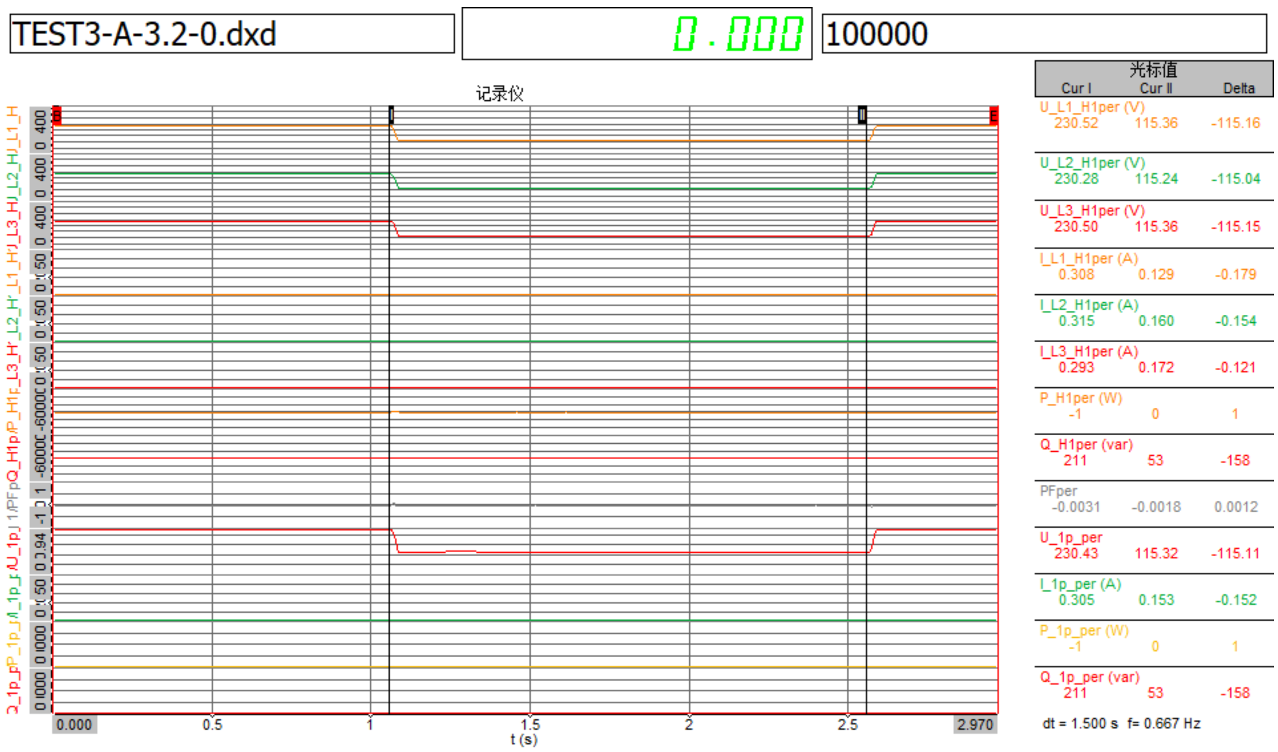
Test 3.1 – symmetrical fault - Recover time - Reactive power



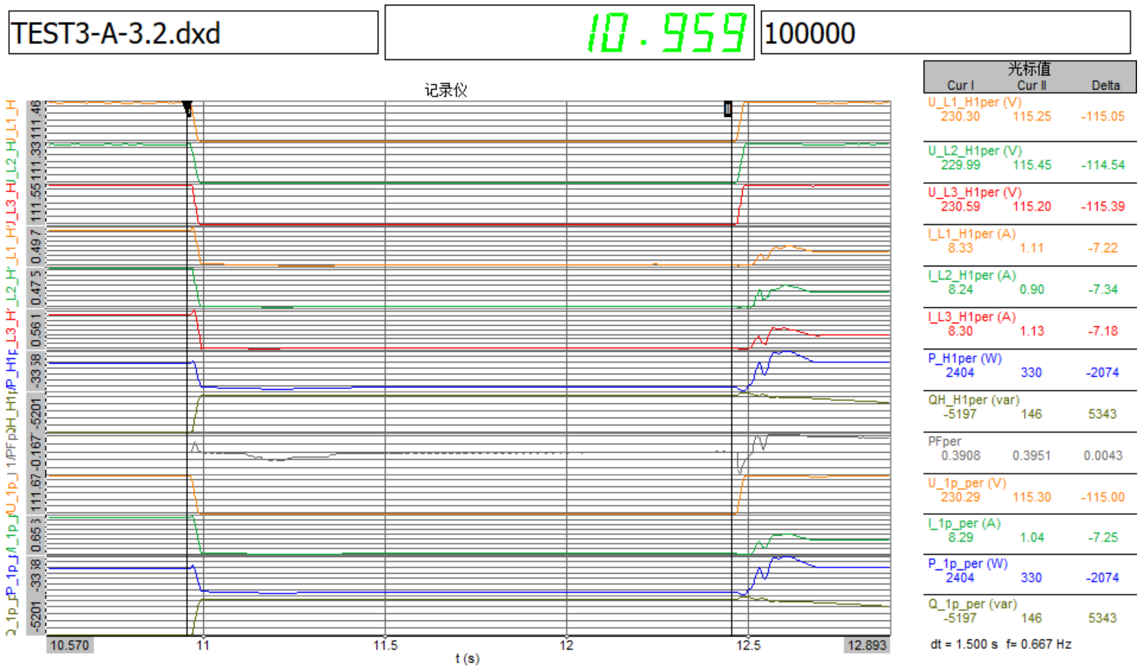
Test 3.2 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	3.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	14.17.47	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase – phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10959	[ms]
	7	Time point of fault clearance (t2)	Total	-	12458	[ms]
	8	Fault duration in no load test	Total	-	1499	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.50	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.48	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	-0.43	[p.u.]
	16		Total	t_1-10 s to t_1	-0.43	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.3814	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.49	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.07	[p.u.]
	20		Phase 2	t_1 +60 ms	0.05	[p.u.]
	21		Phase 3	t_1 +60 ms	0.06	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.06	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.22	[s]

Test 3.2 – symmetrical fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	-0.43	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	-0.43	[p.u.]
	33	Reactive power rising time	Positive sequence	-	7.07	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

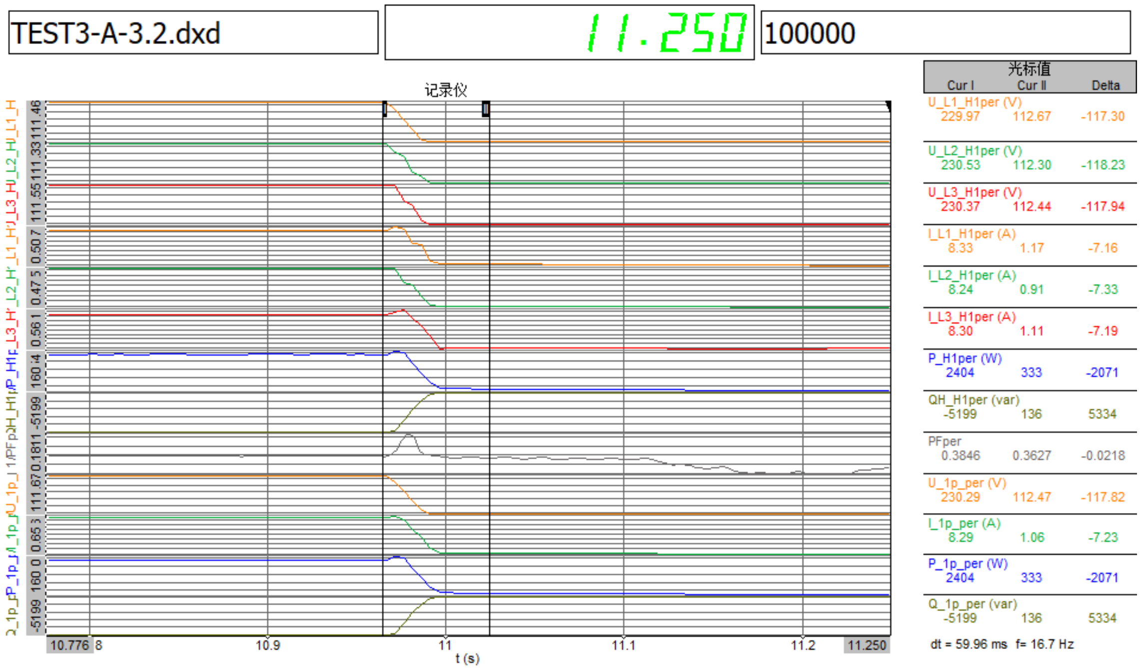
Test 3.2 – symmetrical fault - Voltage depth in no load test



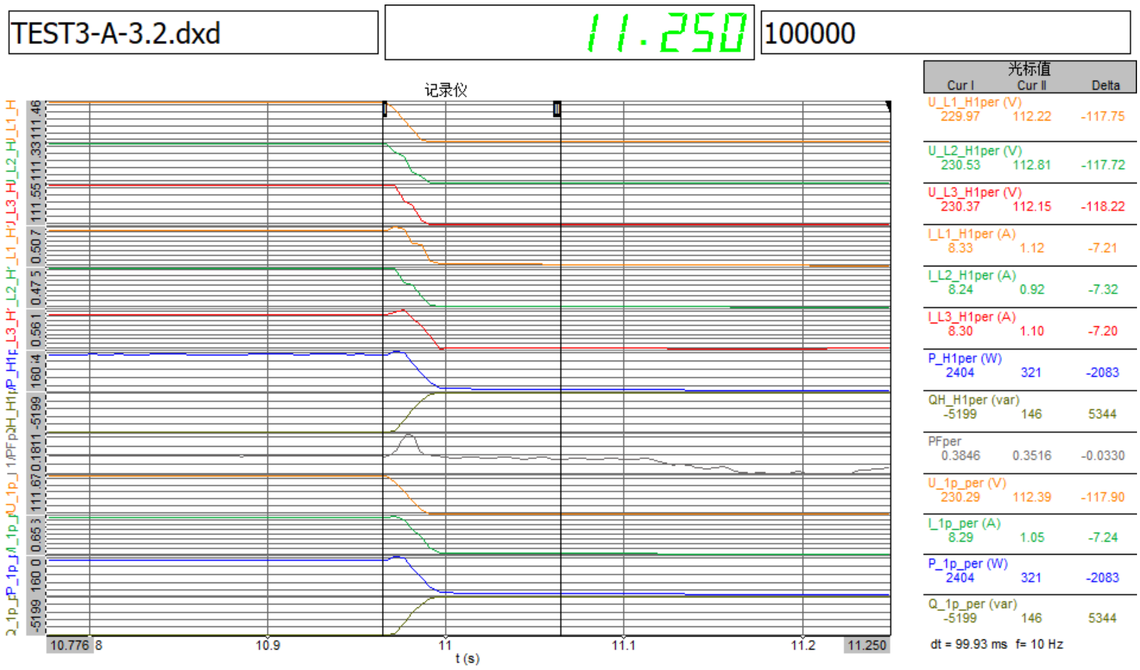
Test 3.2 – symmetrical fault - Fault duration



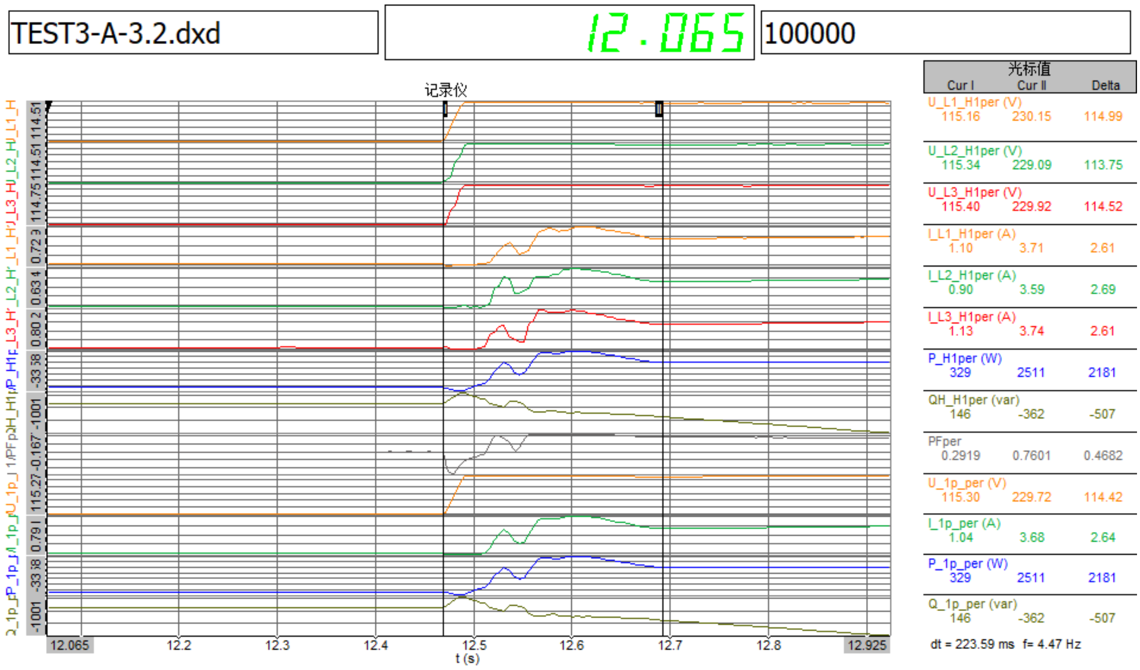
Test 3.2 – symmetrical fault - t_1 +60 ms



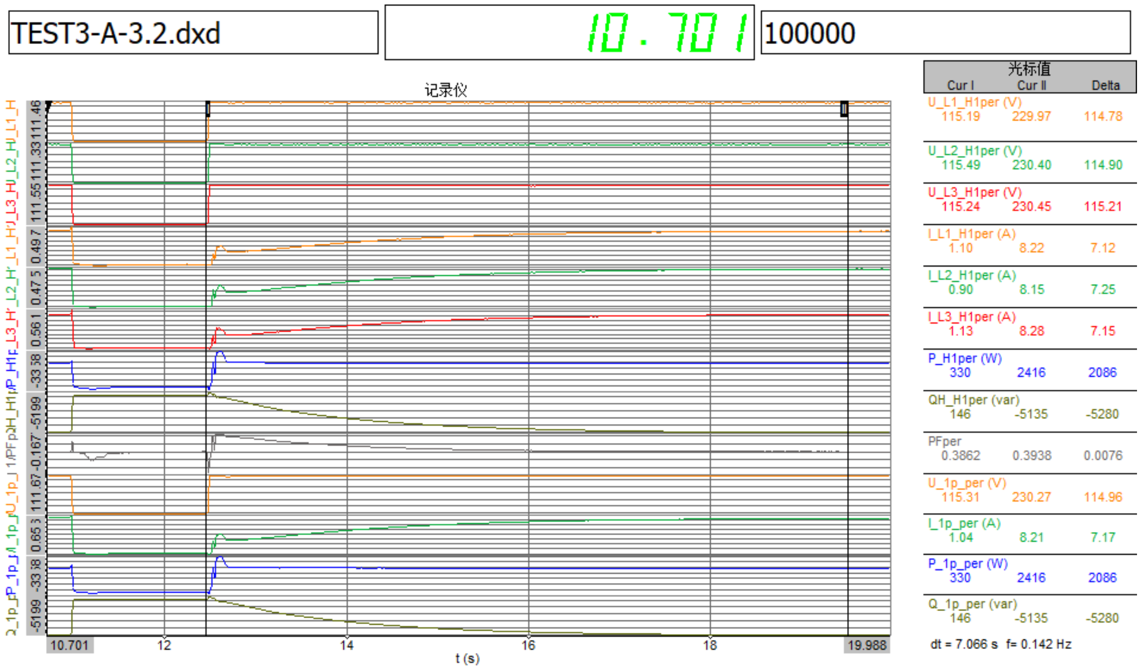
Test 3.2 – symmetrical fault - t_1 +100 ms



Test 3.2 – symmetrical fault - Recover time - Active power



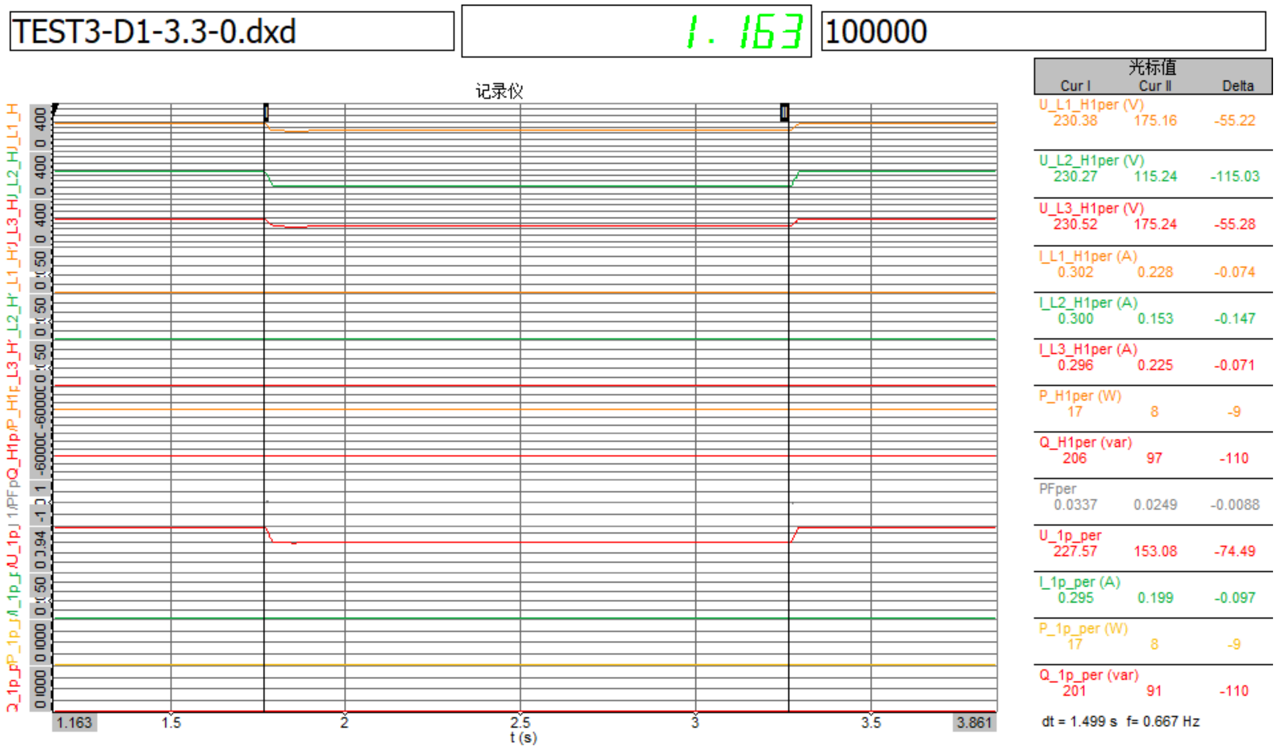
Test 3.2 – symmetrical fault - Recover time - Reactive power



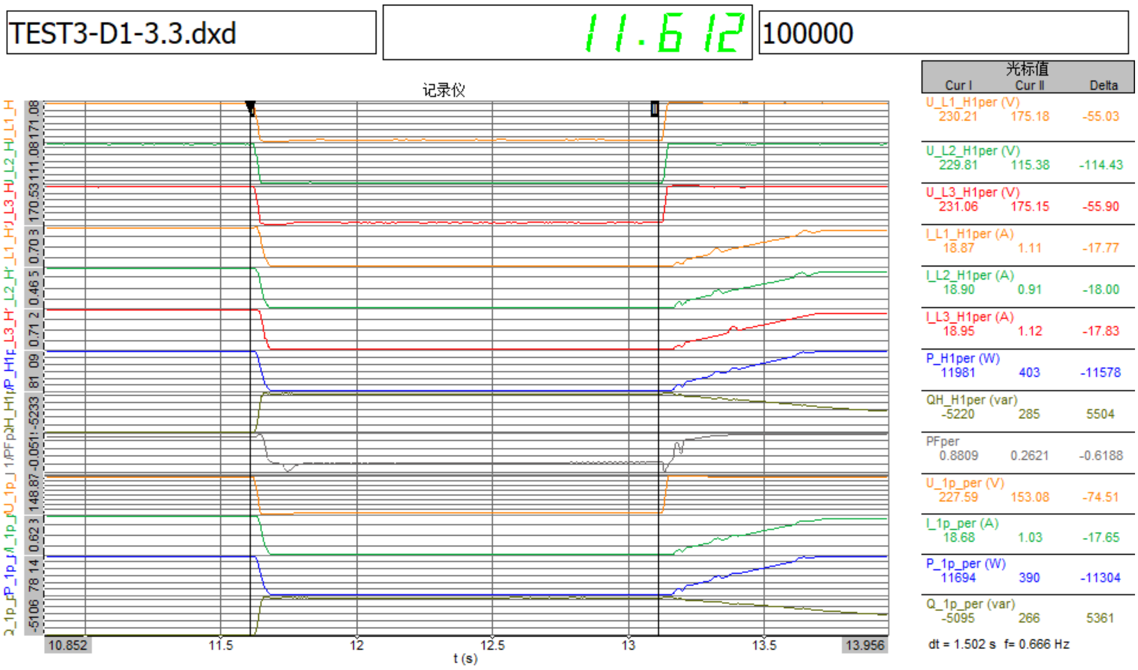
Test 3.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	3.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	14.26.05	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	0.5	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11621	[ms]
	7	Time point of fault clearance (t2)	Total	-	13114	[ms]
	8	Fault duration in no load test	Total	-	1493	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50 0.33	[p.u.]
	10		Positive sequence		0.50	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.08	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.97	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	-0.43	[p.u.]
	16		Total	t_1-10 s to t_1	-0.42	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.8792	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.49	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.08	[p.u.]
	20		Phase 2	t_1 +60 ms	0.06	[p.u.]
	21		Phase 3	t_1 +60 ms	0.08	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.06	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.06	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.98	[p.u.]

Test 3.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
	30	Active power rising time	Positive sequence	-	0.52	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	-0.43	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	-0.42	[p.u.]
	33	Reactive power rising time	Positive sequence	-	7.39	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

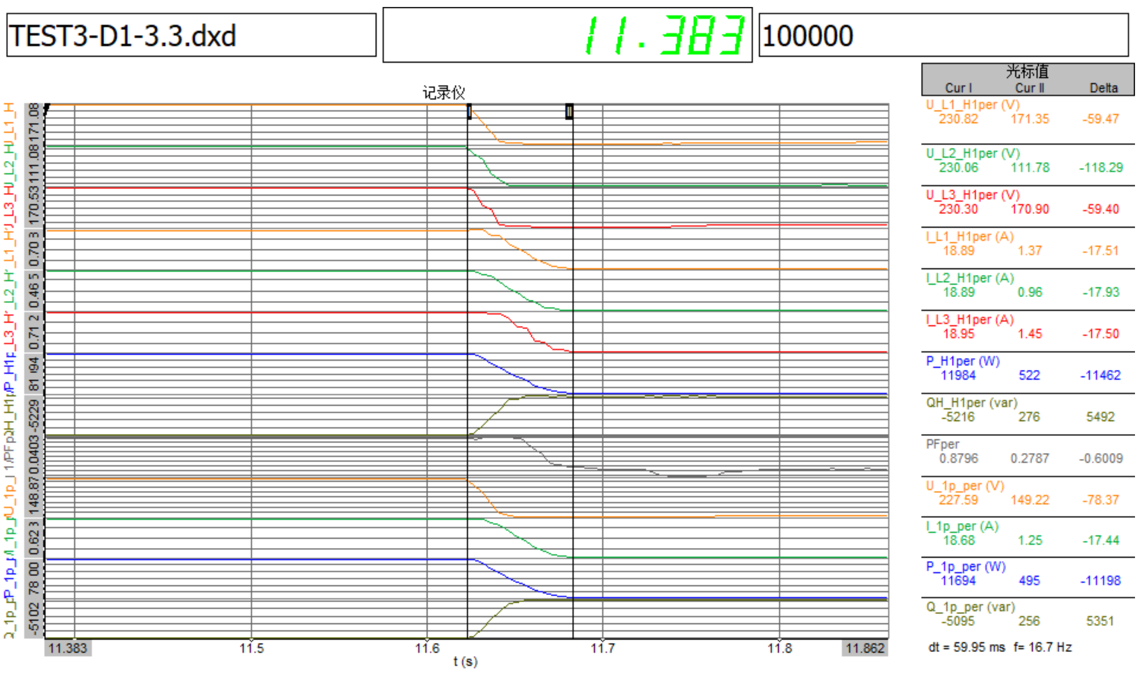
Test 3.3 – symmetrical fault - Voltage depth in no load test



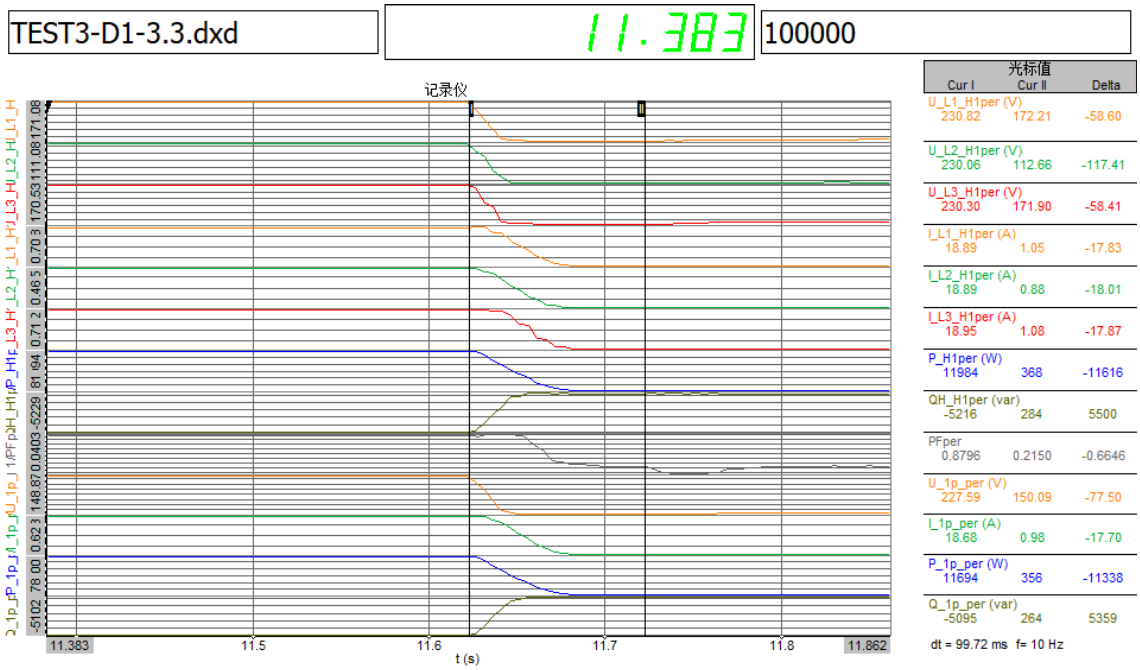
Test 3.3 – Asymmetrical fault - Fault duration



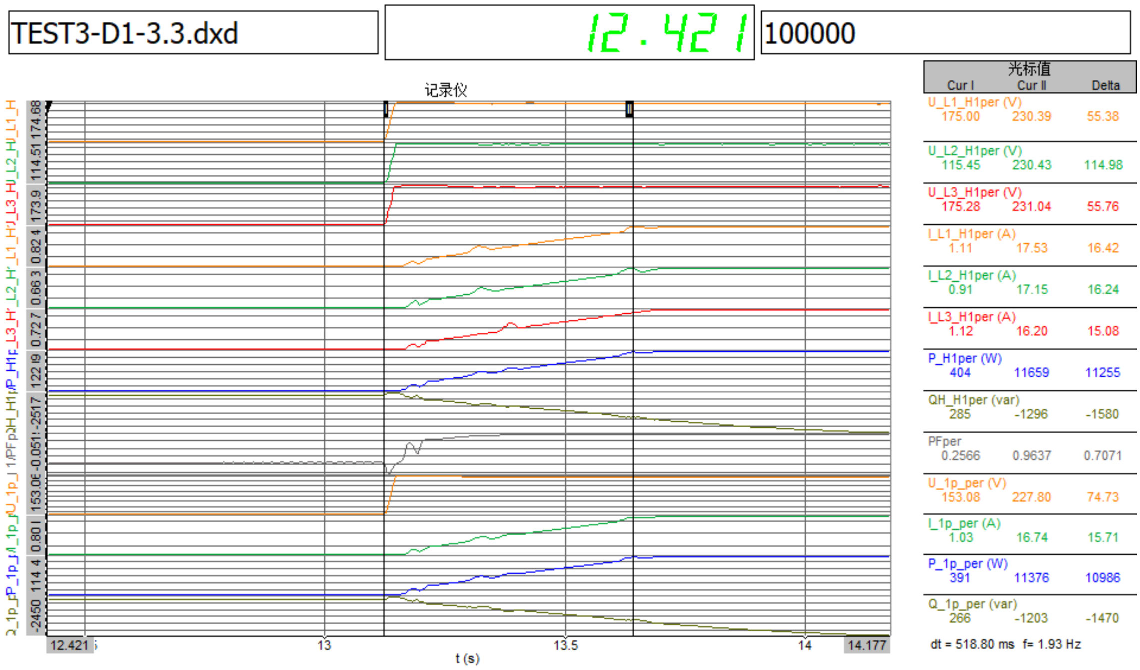
Test 3.3 – Asymmetrical fault - t_1 +60 ms



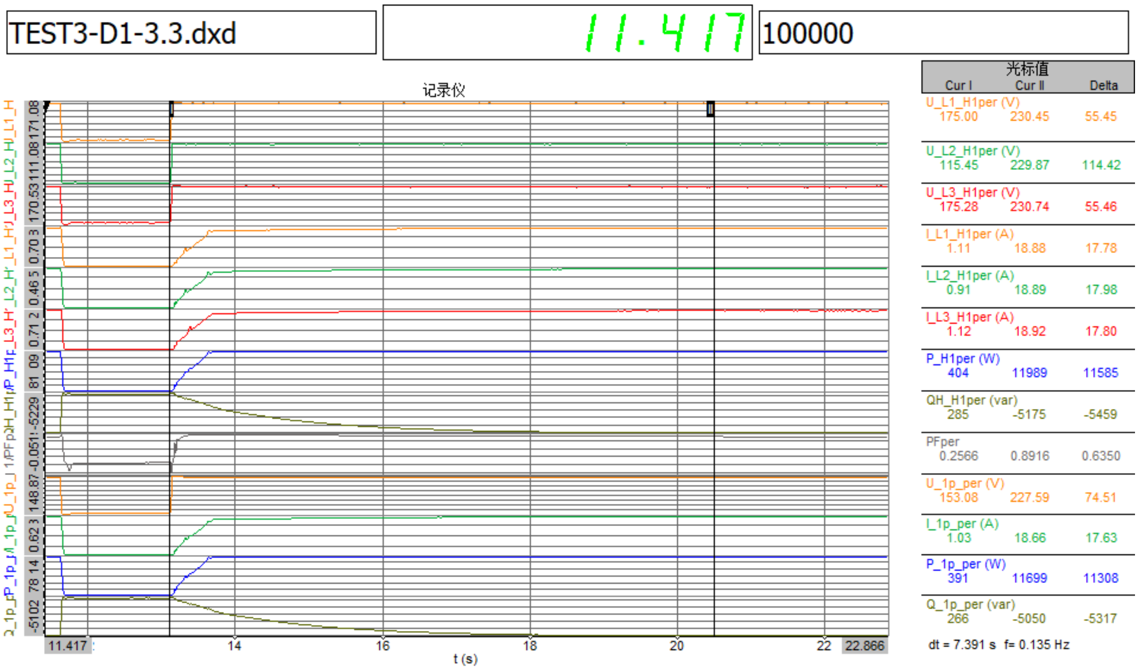
Test 3.3 – Asymmetrical fault - t_1 +100 ms



Test 3.3 – Asymmetrical fault - Recover time - Active power



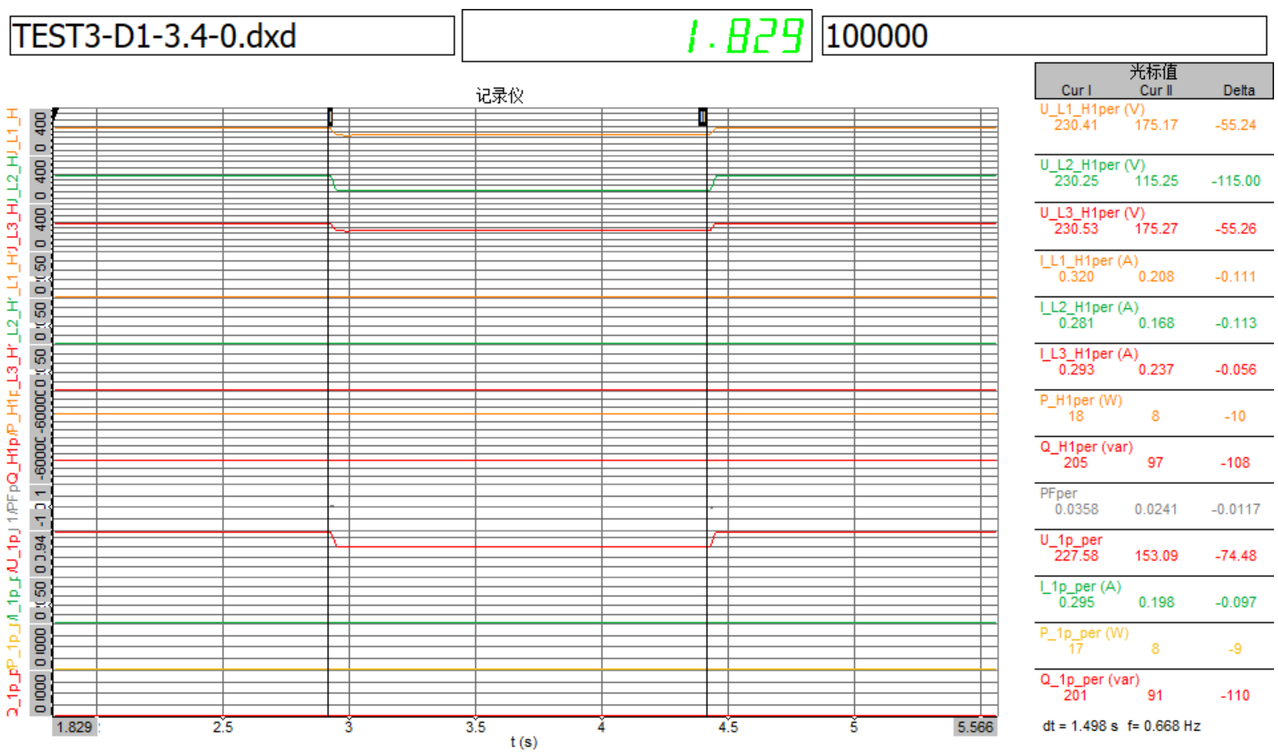
Test 3.3 – Asymmetrical fault - Recover time - Reactive power



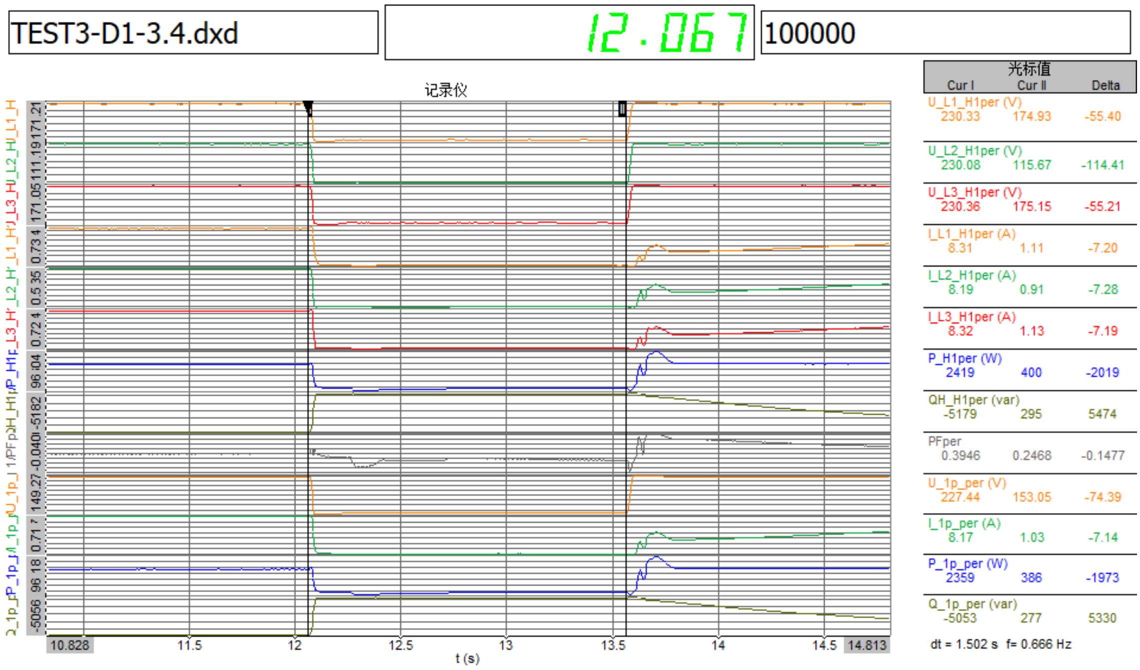
Test 3.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	3.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.02.05	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	0.50	[p.u.]
	5	Setpoint fault duration	-	-	1500	[ms]
	6	Time point of fault occurrence (t1)	Total	-	12067	[ms]
	7	Time point of fault clearance (t2)	Total	-	13569	[ms]
	8	Fault duration in no load test	Total	-	1502	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.50	[p.u.]
	10		Positive sequence		0.32	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.47	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	-0.43	[p.u.]
	16		Total	t_1-10 s to t_1	-0.42	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.3963	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.49	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.07	[p.u.]
	20		Phase 2	t_1 +60 ms	0.05	[p.u.]
	21		Phase 3	t_1 +60 ms	0.07	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.06	[p.u.]
	23		Phase 2	t_1 +100 ms	0.05	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.23	[s]

Test 3.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.50 to 0.60)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	-0.43	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	-0.42	[p.u.]
	33	Reactive power rising time	Positive sequence	-	8.17	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

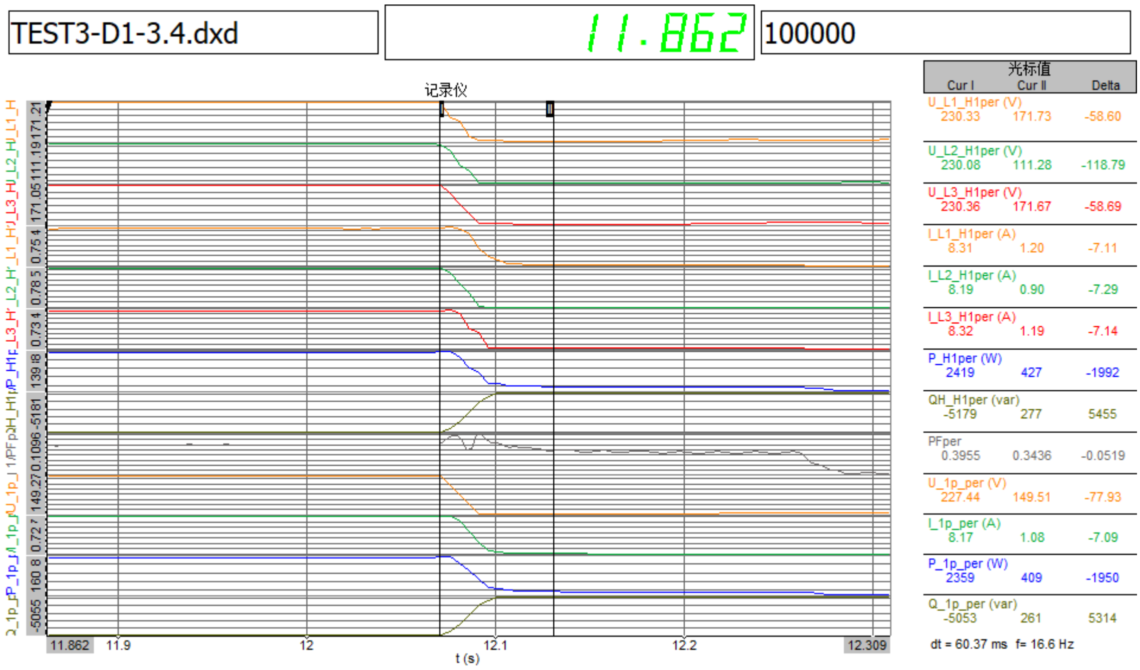
Test 3.4 – symmetrical fault - Voltage depth in no load test



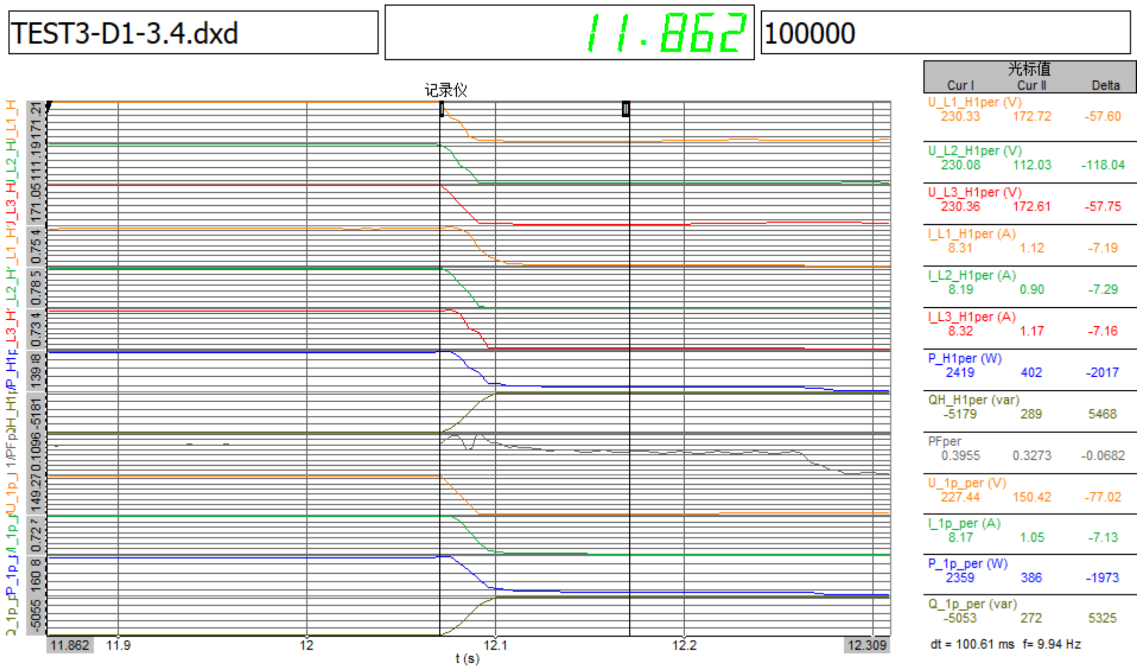
Test 3.4 – Asymmetrical fault - Fault duration



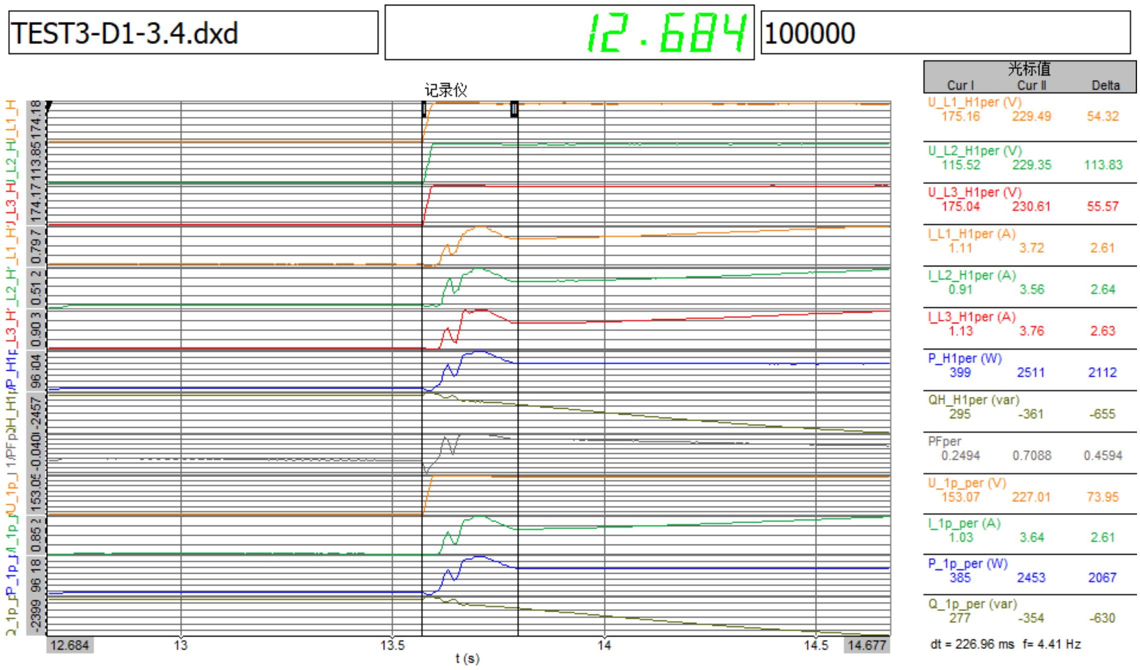
Test 3.4 – Asymmetrical fault - t_1 +60 ms



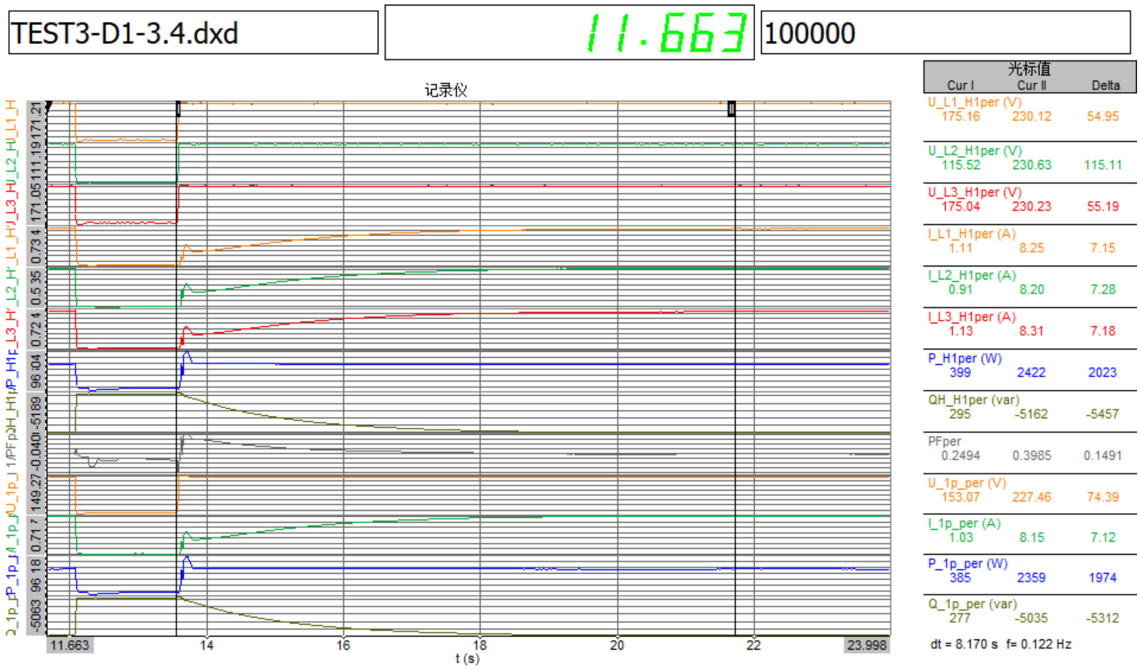
Test 3.4 – Asymmetrical fault - t_1 +100 ms



Test 3.4 – Asymmetrical fault - Recover time - Active power



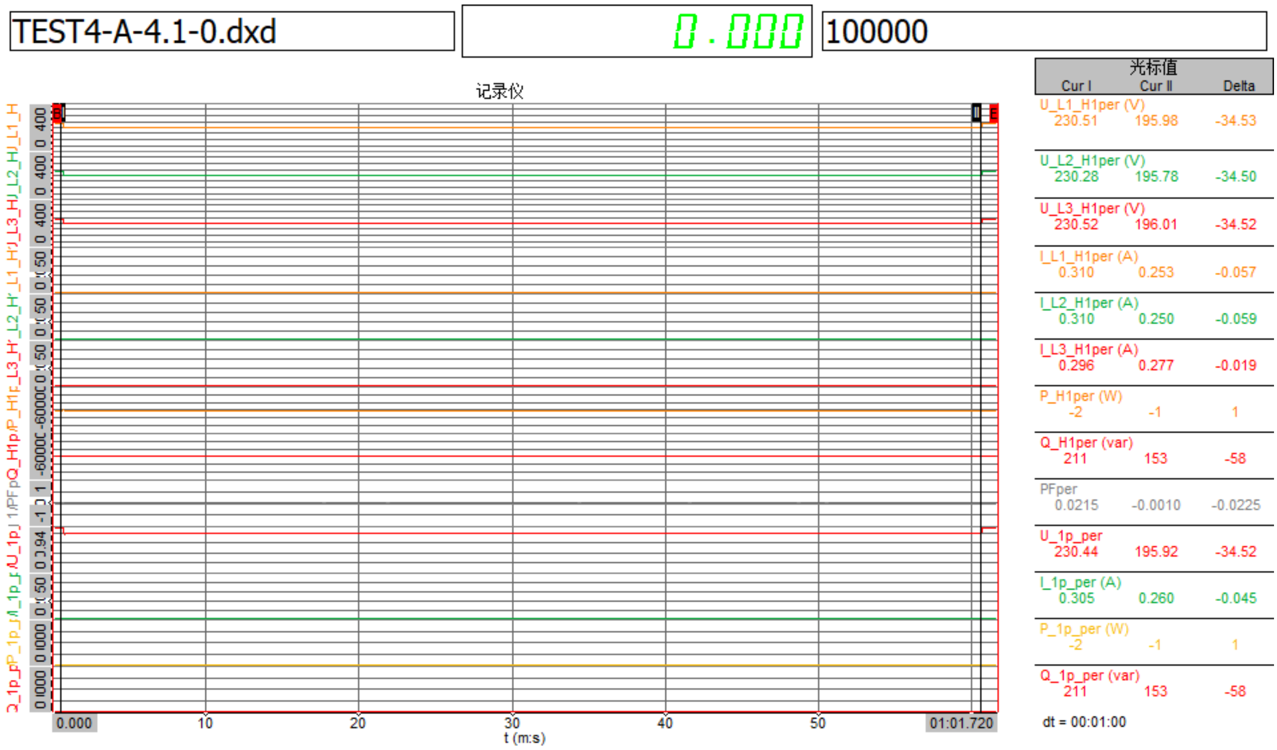
Test 3.4 – Asymmetrical fault - Recover time - Reactive power



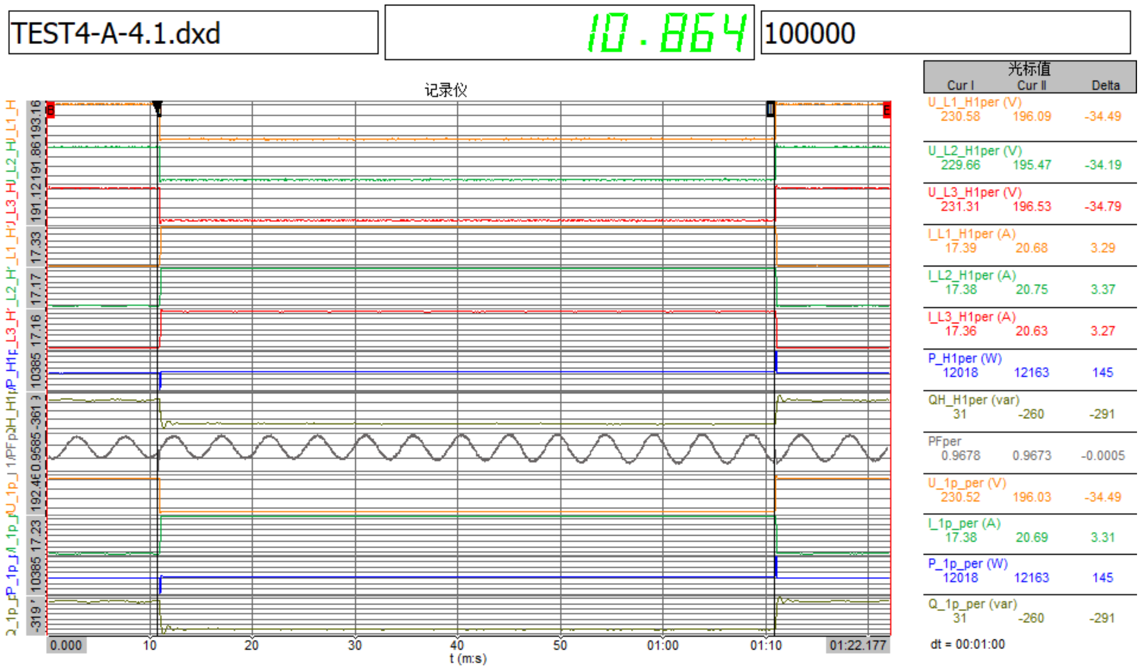
Test 4.1 – symmetrical fault (V/Vnom = 0.85 to 0.90)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	4.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.13.11	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	3 phase	-
	4	Setpoint break-in depth	Phase - phase	-	0.85	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10864	[ms]
	7	Time point of fault clearance (t2)	Total	-	70960	[ms]
	8	Fault duration in no load test	Total	-	60096	[ms]
	9	Voltage depth in no load test	Total	t1+100 ms to t2 and t1-10 s to t1	0.15	[p.u.]
	10		Positive sequence		0.15	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t1-10 s to t1	1.00	[p.u.]
	12	Current	Positive sequence	t1-500 ms to t1-100 ms	1.00	[p.u.]
	13	Active power	Total	t1-10 s to t1	1.00	[p.u.]
	14		Positive sequence	t1-10 s to t1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t1-10 s to t1	0.00	[p.u.]
	16		Total	t1-10 s to t1	0.00	[p.u.]
	17	cos φ	-	t1-10 s to t1	0.9660	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t1+100 to to t2-20 ms	0.84	[p.u.]
	19	Phase current	Phase 1	t1 +60 ms	1.07	[p.u.]
	20		Phase 2	t1 +60 ms	1.06	[p.u.]
	21		Phase 3	t1 +60 ms	1.07	[p.u.]
	22	Phase current	Phase 1	t1 +100 ms	1.13	[p.u.]
	23		Phase 2	t1 +100 ms	1.13	[p.u.]
	24		Phase 3	t1 +100 ms	1.13	[p.u.]
	25	Active power	Total	t1 +100 ms to t2-20 ms	0.95	[p.u.]
	26		Positive sequence	t1 +100 ms to t2-20 ms	0.95	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t2 +3 s to t2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t2 +3 s to t2 +10 s	1.00	[p.u.]
	29		Total	t2 +3 s to t2 +10 s	1.00	[p.u.]
	30	Active power rising time	Positive sequence	-	-	[s]

Test 4.1 – symmetrical fault (V/Vnom = 0.85 to 0.90)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t2 +3 s to t2 +10 s	0.00	[p.u.]
	32		Total	t2 +3 s to t2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t2 to t2 +60 s	Yes	-

Test 4.1 – symmetrical fault - Voltage depth in no load test



Test 4.1 – symmetrical fault - Fault duration

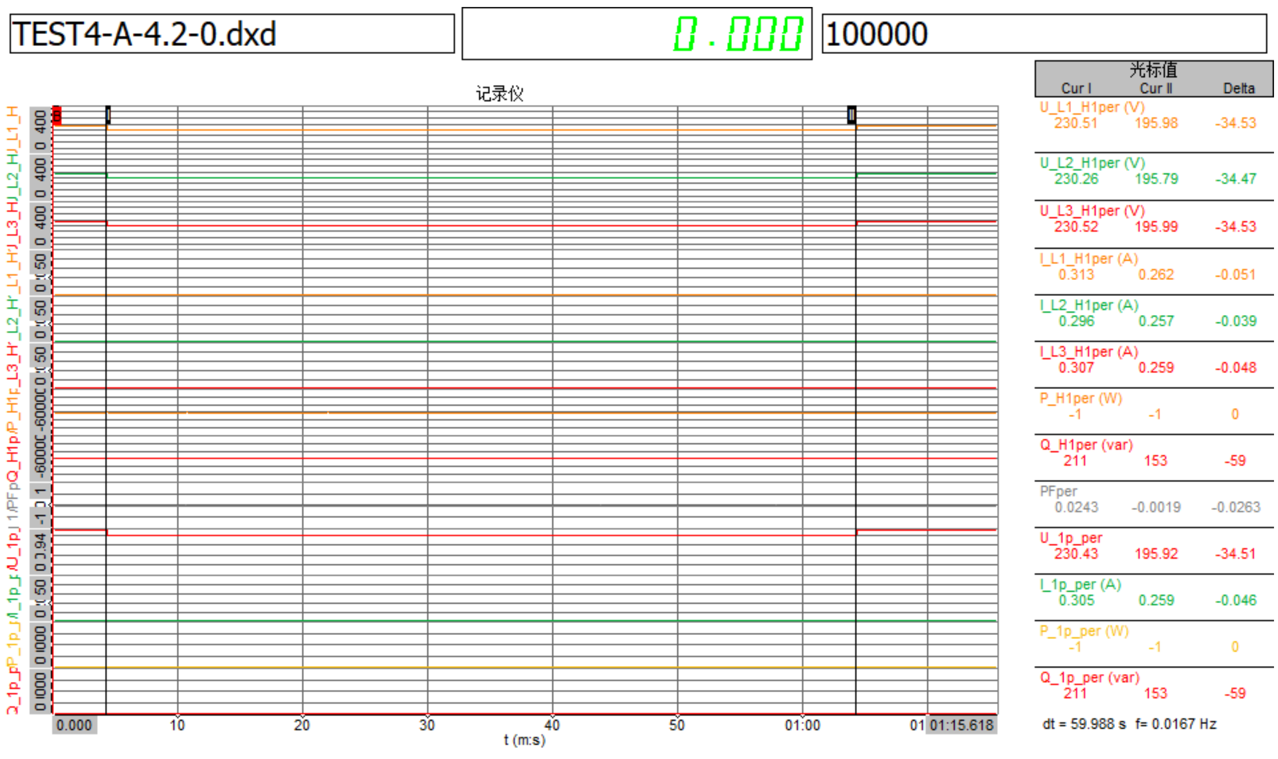


Test 4.2 – symmetrical fault (V/Vnom = 0.85 to 0.90)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	4.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.26.04	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	0.85	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11420	[ms]
	7	Time point of fault clearance (t2)	Total	-	71424	[ms]
	8	Fault duration in no load test	Total	-	60004	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.15	[p.u.]
	10		Positive sequence		0.15	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.7304	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.84	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.24	[p.u.]
	20		Phase 2	t_1 +60 ms	0.24	[p.u.]
	21		Phase 3	t_1 +60 ms	0.24	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.06	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.04	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.04	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	-	[s]

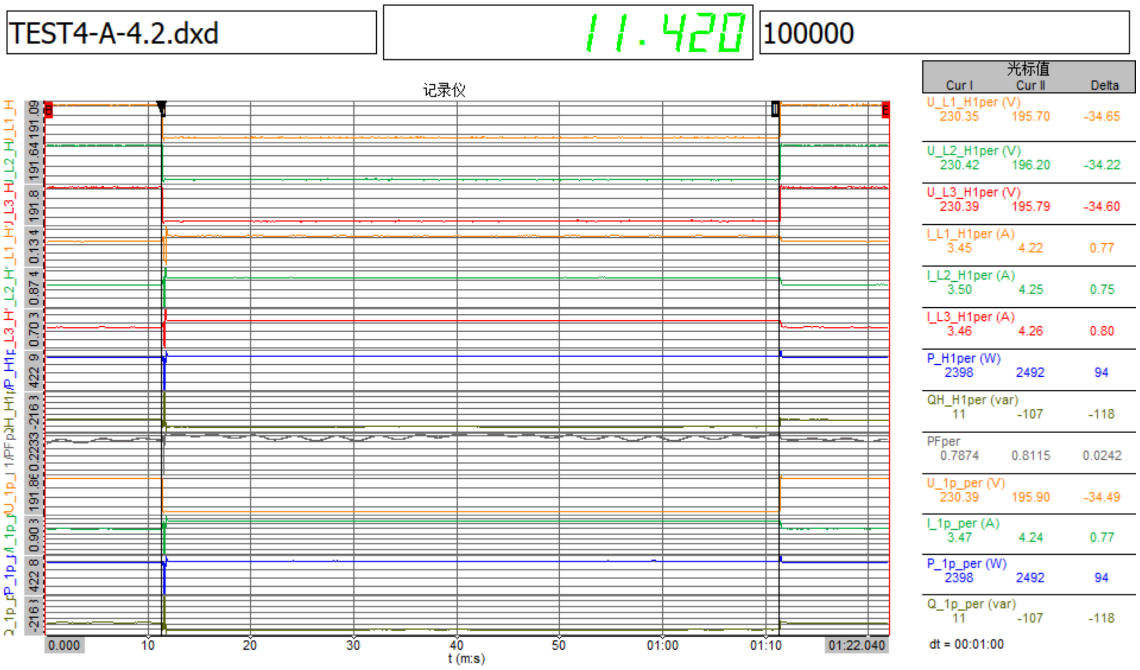
Test 4.2 – symmetrical fault (V/Vnom = 0.85 to 0.90)

	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

Test 4.2 – symmetrical fault - Voltage depth in no load test



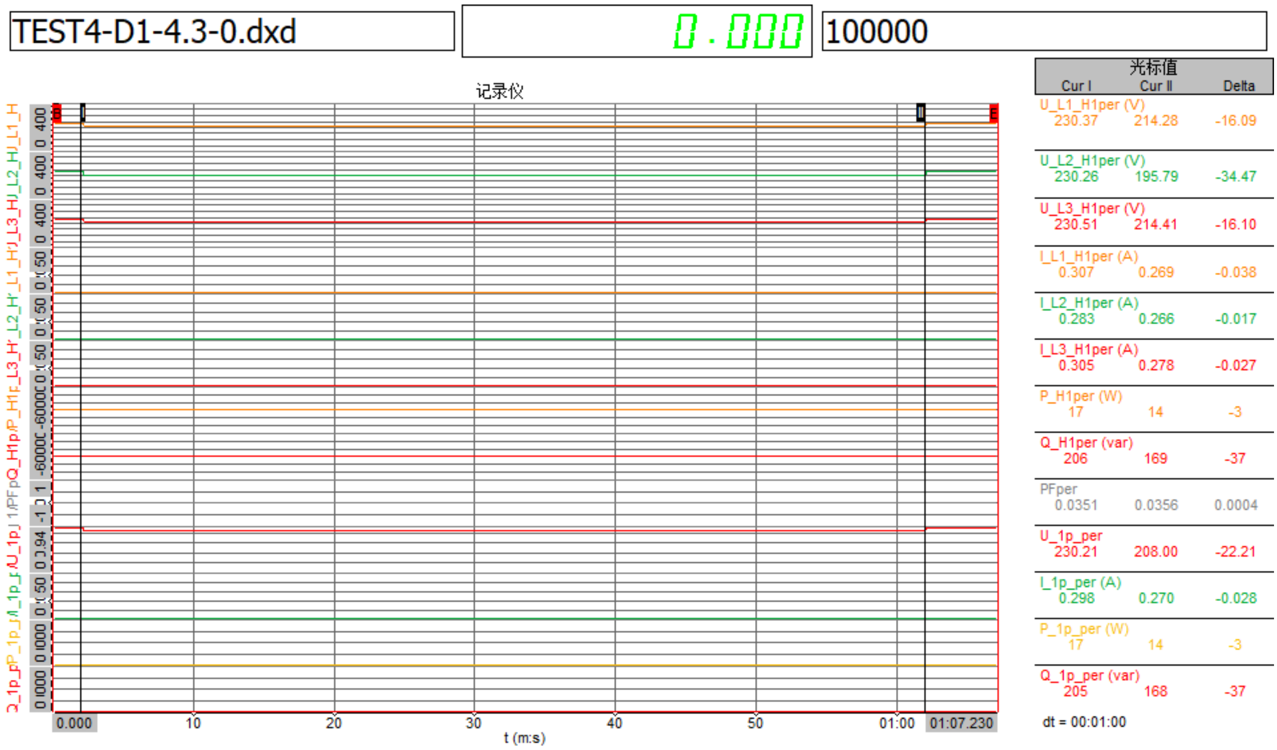
Test 4.2 – symmetrical fault - Fault duration



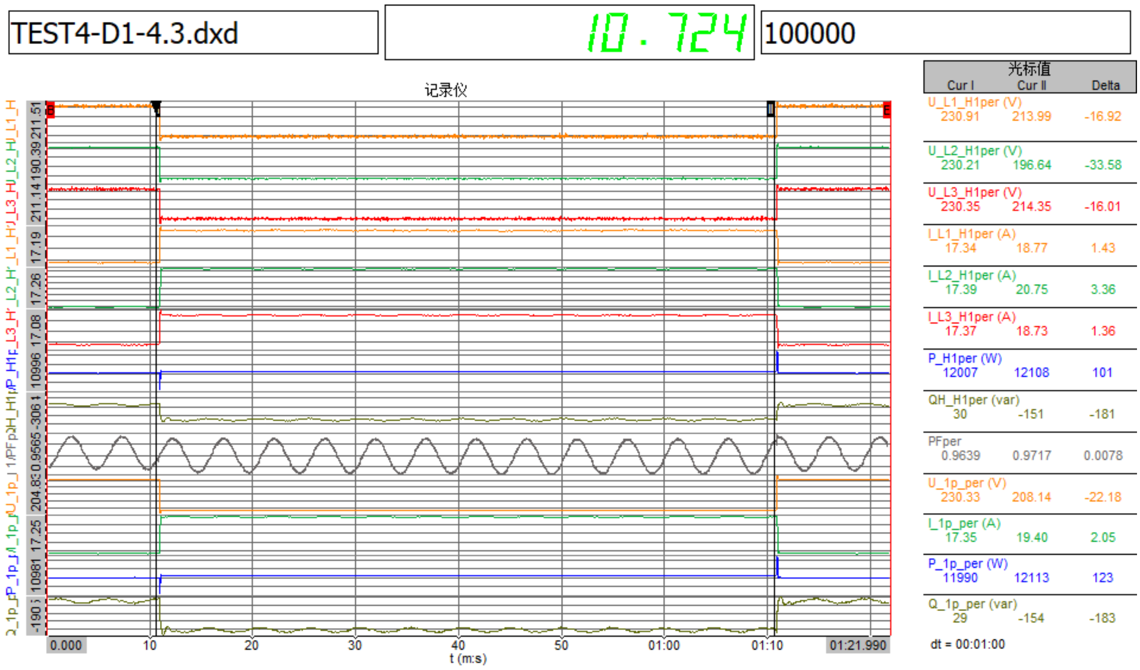
Test 4.3 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.85 to 0.90)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	4.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.34.16	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	0.85	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10724	[ms]
	7	Time point of fault clearance (t2)	Total	-	70798	[ms]
	8	Fault duration in no load test	Total	-	60074	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.15	[p.u.]
	10		Positive sequence		0.10	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9648	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.83	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	1.06	[p.u.]
	20		Phase 2	t_1 +60 ms	1.07	[p.u.]
	21		Phase 3	t_1 +60 ms	1.06	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	1.09	[p.u.]
	23		Phase 2	t_1 +100 ms	1.13	[p.u.]
	24		Phase 3	t_1 +100 ms	1.09	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.99	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.99	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]

Test 4.3 –Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.85 to 0.90)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
	30	Active power rising time	Positive sequence	-	-	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

Test 4.3 – symmetrical fault - Voltage depth in no load test



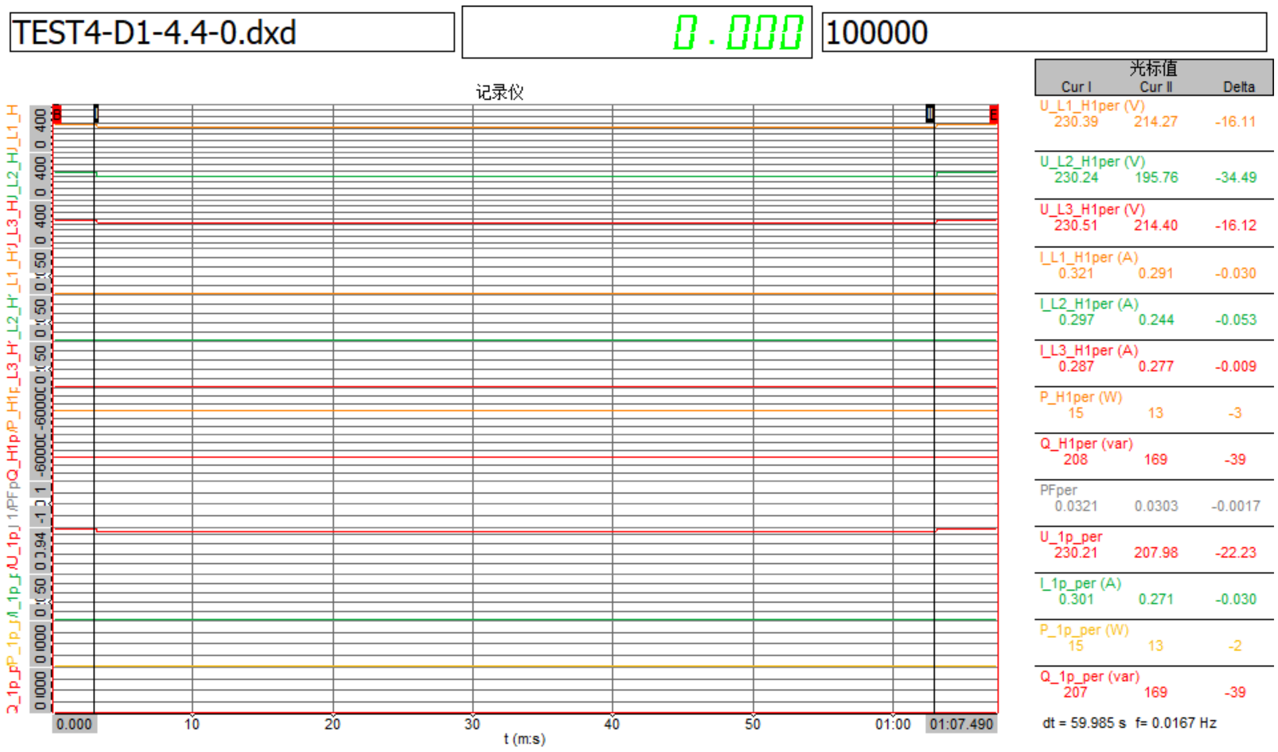
Test 4.3 – Asymmetrical fault - Fault duration



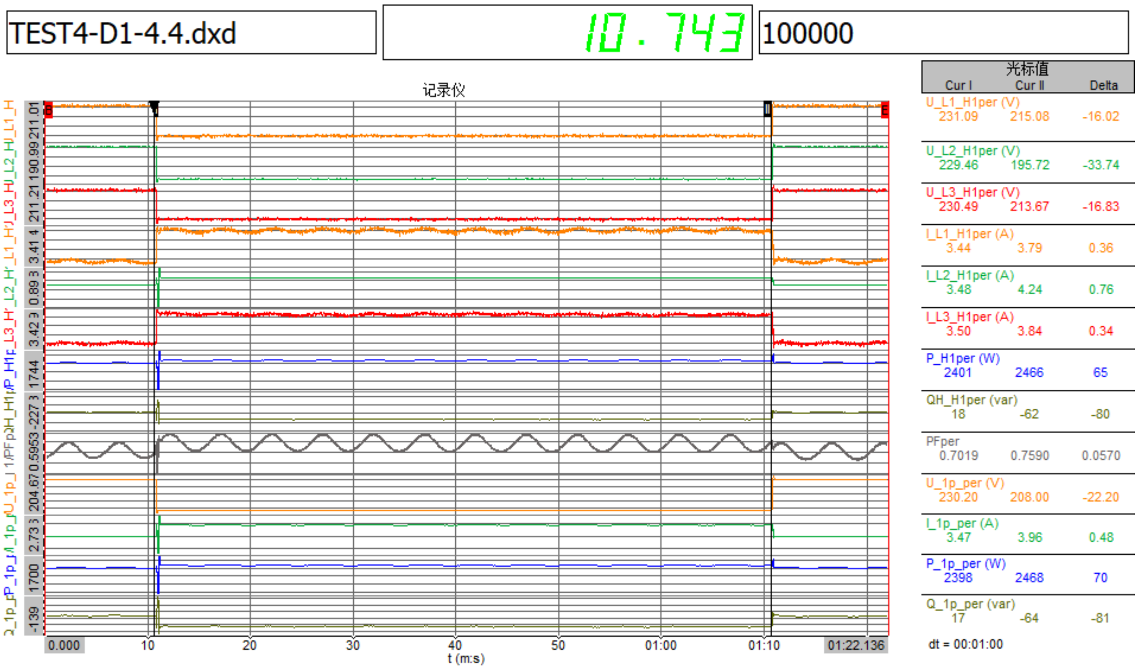
Test 4.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.85 to 0.90)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	4.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.39.33	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	0.85	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10743	[ms]
	7	Time point of fault clearance (t2)	Total	-	70809	[ms]
	8	Fault duration in no load test	Total	-	60066	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.15	[p.u.]
	10		Positive sequence		0.10	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.7066	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	0.83	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.22	[p.u.]
	20		Phase 2	t_1 +60 ms	0.24	[p.u.]
	21		Phase 3	t_1 +60 ms	0.22	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.22	[p.u.]
	23		Phase 2	t_1 +100 ms	0.06	[p.u.]
	24		Phase 3	t_1 +100 ms	0.22	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.15	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.14	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]

Test 4.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 0.85 to 0.90)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	30	Active power rising time	Positive sequence	-	-	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

Test 4.4 – symmetrical fault - Voltage depth in no load test



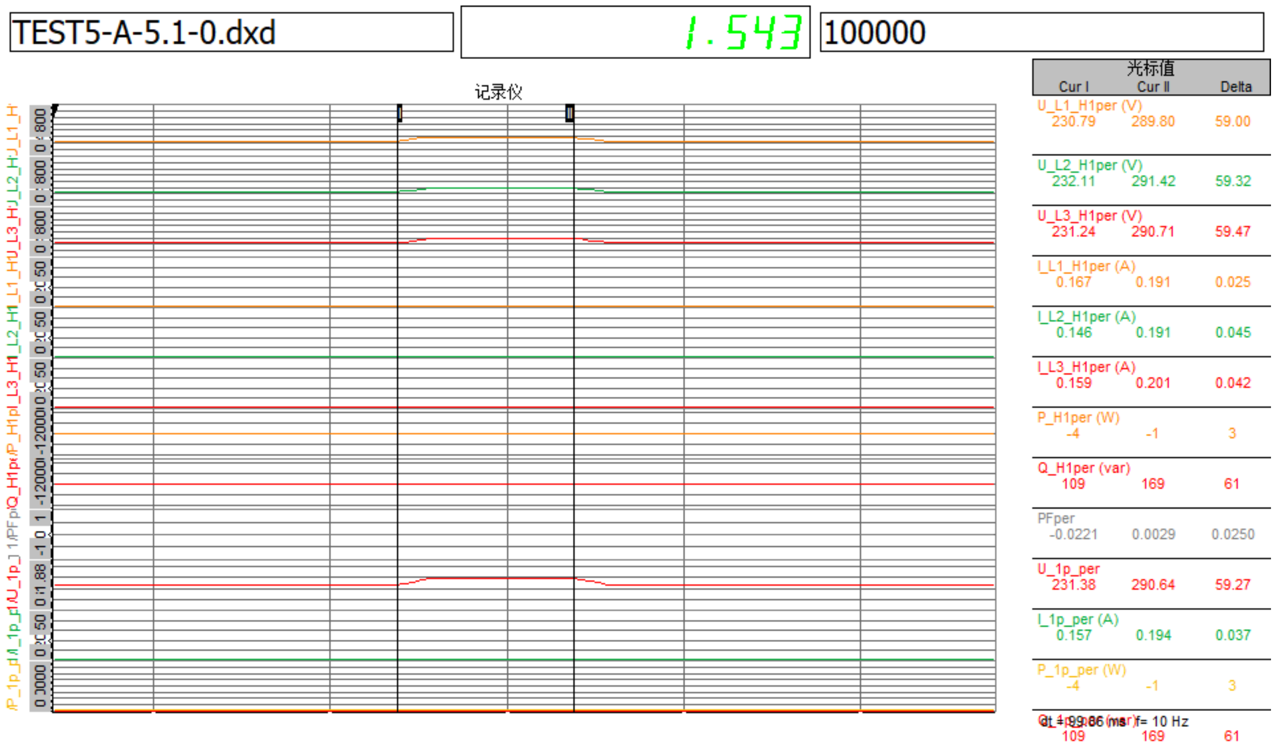
Test 4.4 – Asymmetrical fault - Fault duration



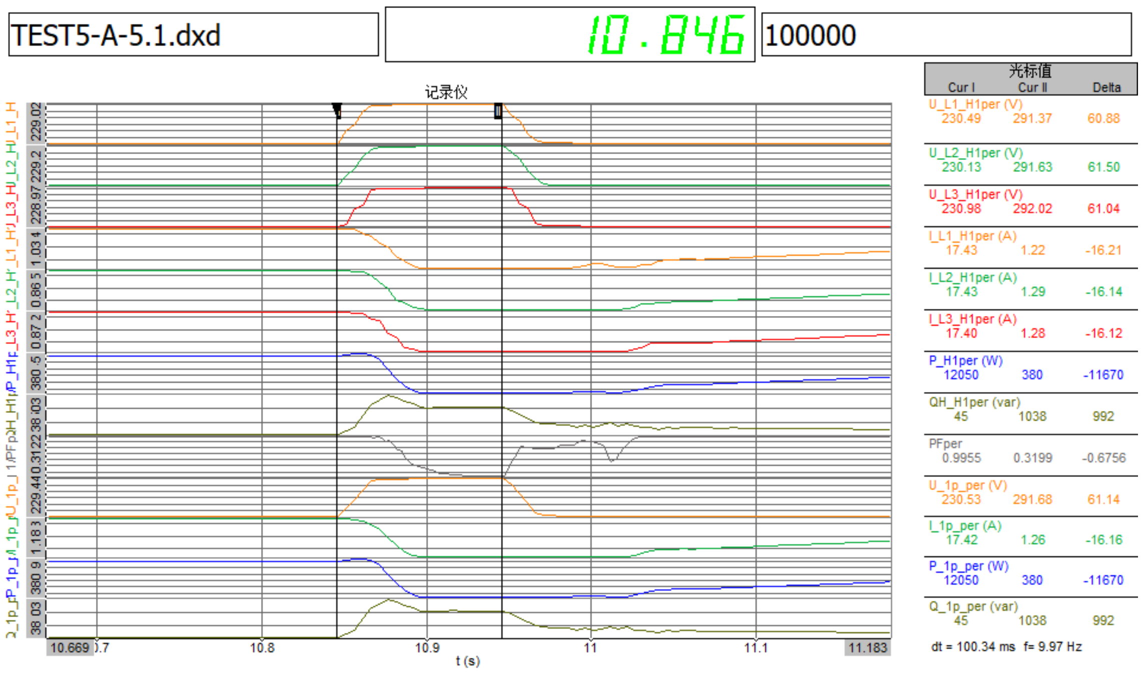
Test: Test 5.1 – symmetrical fault (V/Vnom = 1.20 to 1.25)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	5.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.54.43	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	1.25	[p.u.]
	5	Setpoint fault duration	-	-	100	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10846	[ms]
	7	Time point of fault clearance (t2)	Total	-	10946	[ms]
	8	Fault duration in no load test	Total	-	100	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.26	[p.u.]
	10		Positive sequence		0.27	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9955	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.27	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.07	[p.u.]
	20		Phase 2	t_1 +60 ms	0.08	[p.u.]
	21		Phase 3	t_1 +60 ms	0.09	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]

Test: Test 5.1 – symmetrical fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	30	Active power rising time	Positive sequence	-	0.61	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

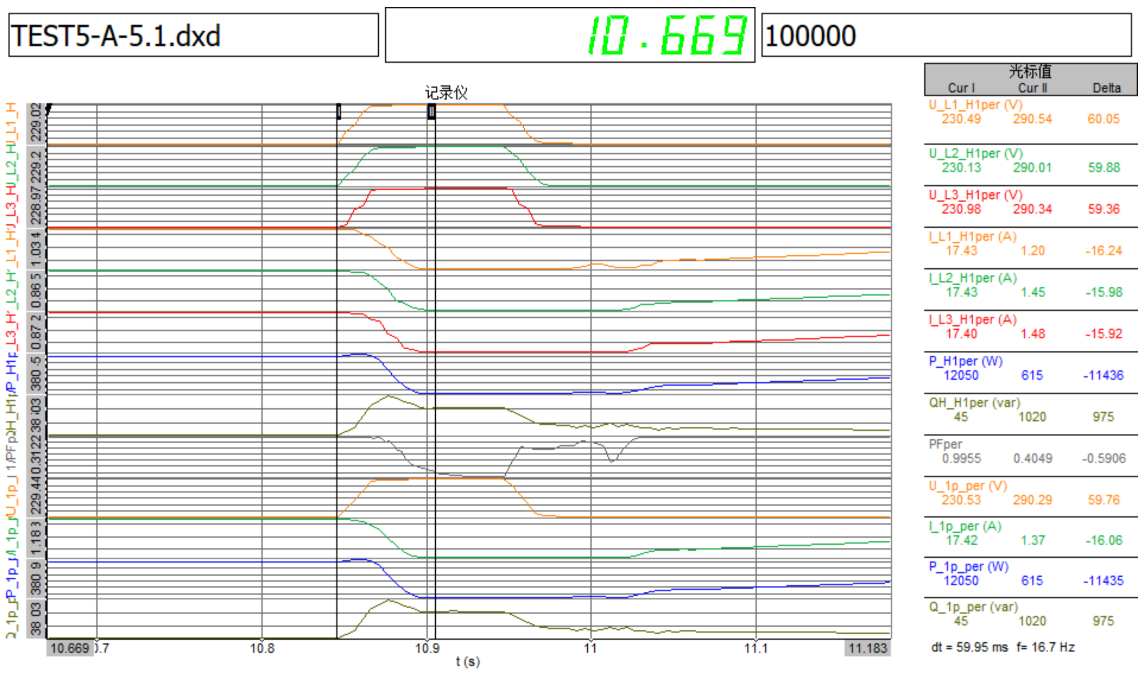
Test 5.1 – symmetrical fault - Voltage depth in no load test



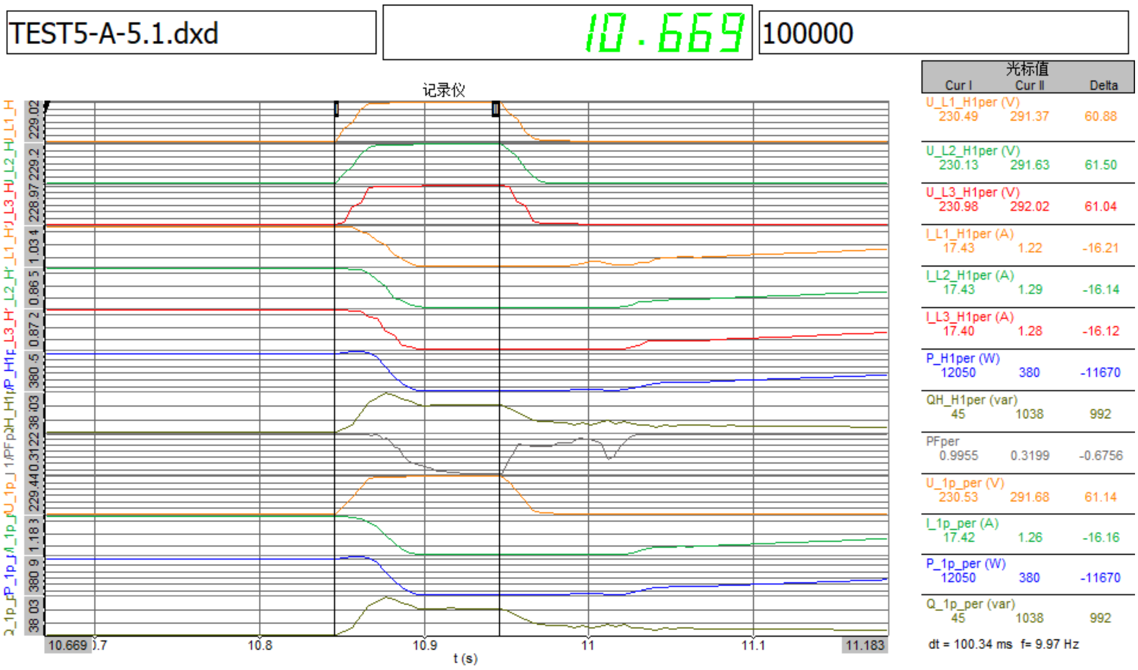
Test 5.1 – symmetrical fault - Fault duration



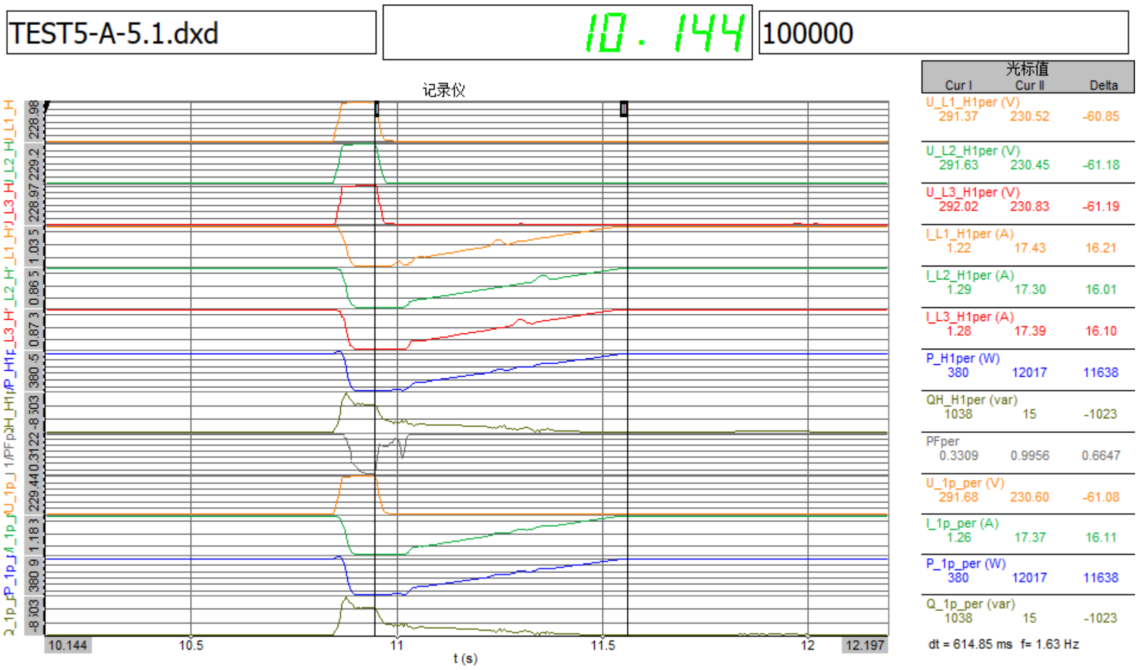
Test 5.1 – symmetrical fault - t_1 +60 ms



Test 5.1 – symmetrical fault - t_1 +100 ms



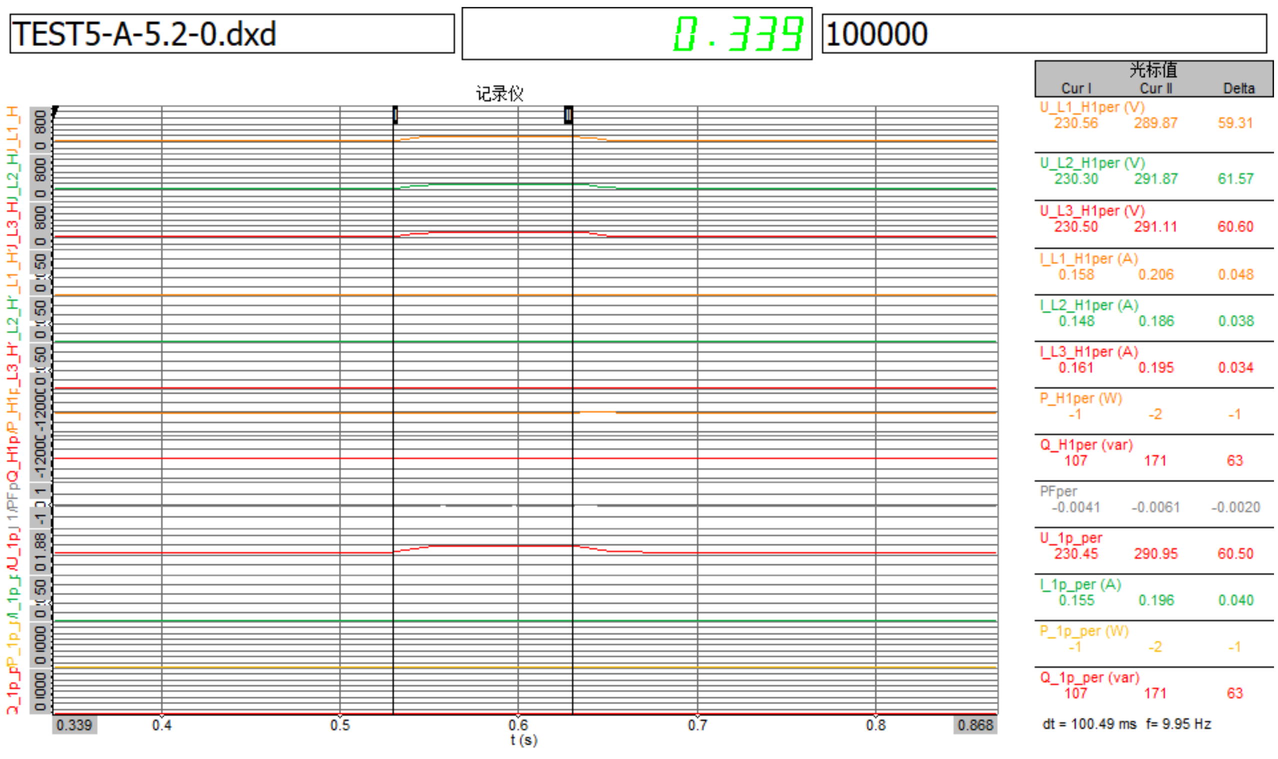
Test 5.1 – symmetrical fault - Recover time - Active power



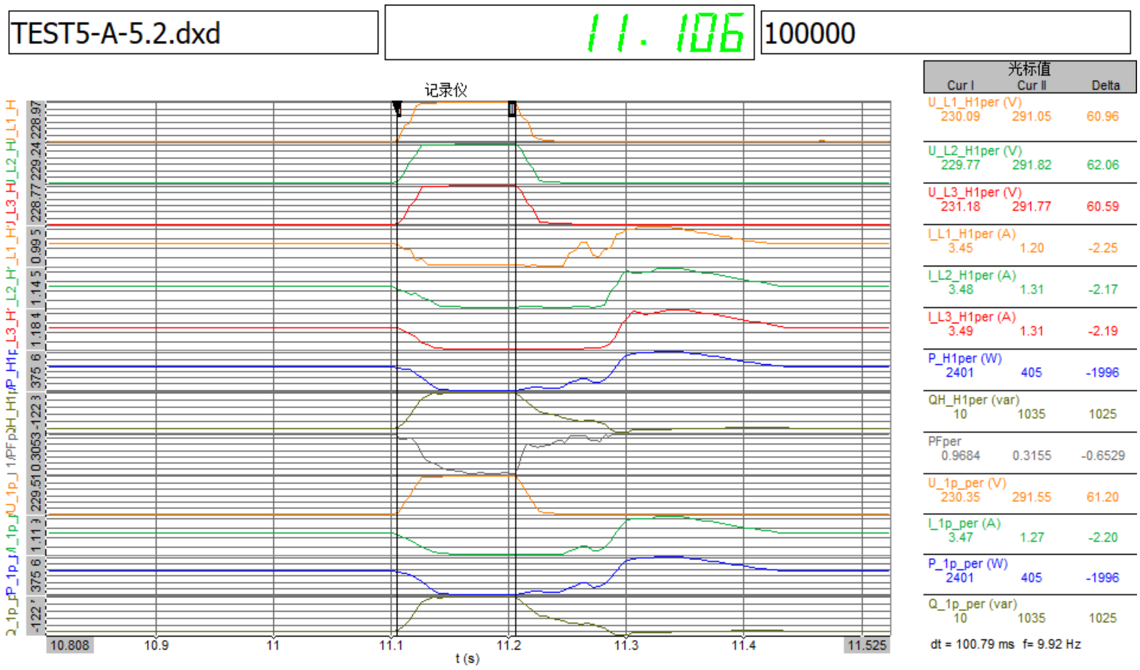
Test 5.2 – symmetrical fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	5.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	15.58.40	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase – phase	-	1.25	[p.u.]
	5	Setpoint fault duration	-	-	100	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11106	[ms]
	7	Time point of fault clearance (t2)	Total	-	11207	[ms]
	8	Fault duration in no load test	Total	-	101	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.26	[p.u.]
	10		Positive sequence		0.26	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9731	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.27	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.07	[p.u.]
	20		Phase 2	t_1 +60 ms	0.08	[p.u.]
	21		Phase 3	t_1 +60 ms	0.07	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.08	[p.u.]
	24		Phase 3	t_1 +100 ms	0.08	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.24	[s]

Test 5.2 – symmetrical fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

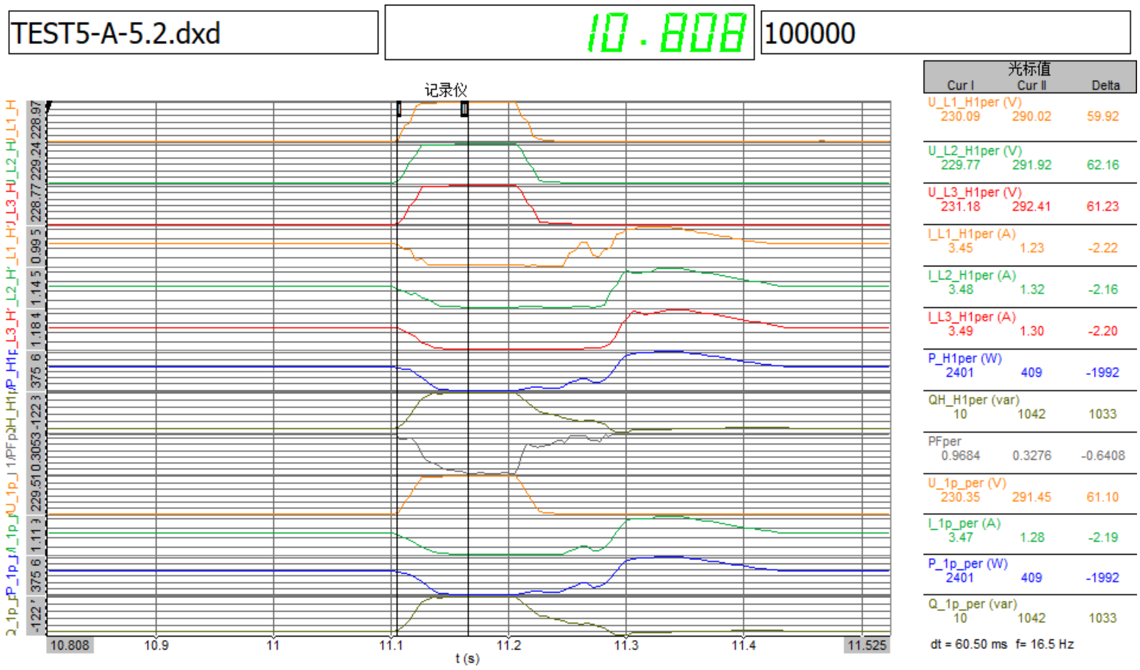
Test 5.2 – symmetrical fault - Voltage depth in no load test



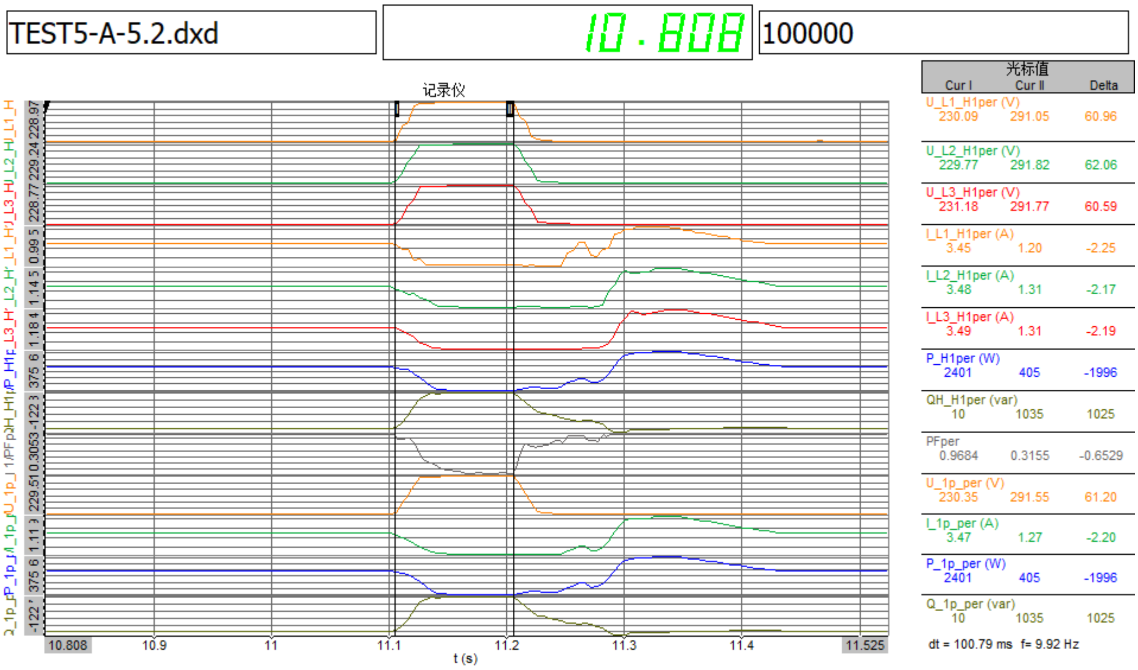
Test 5.2 – symmetrical fault - Fault duration



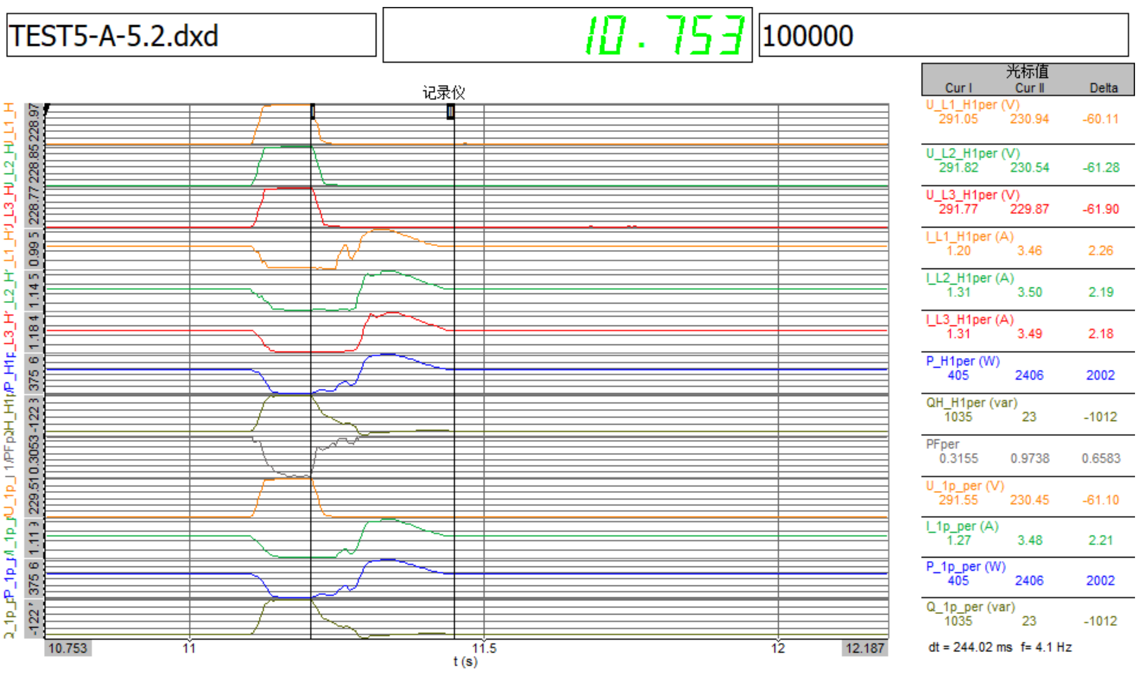
Test 5.2 – symmetrical fault - t_1 +60 ms



Test 5.2 – symmetrical fault - t_1 +100 ms



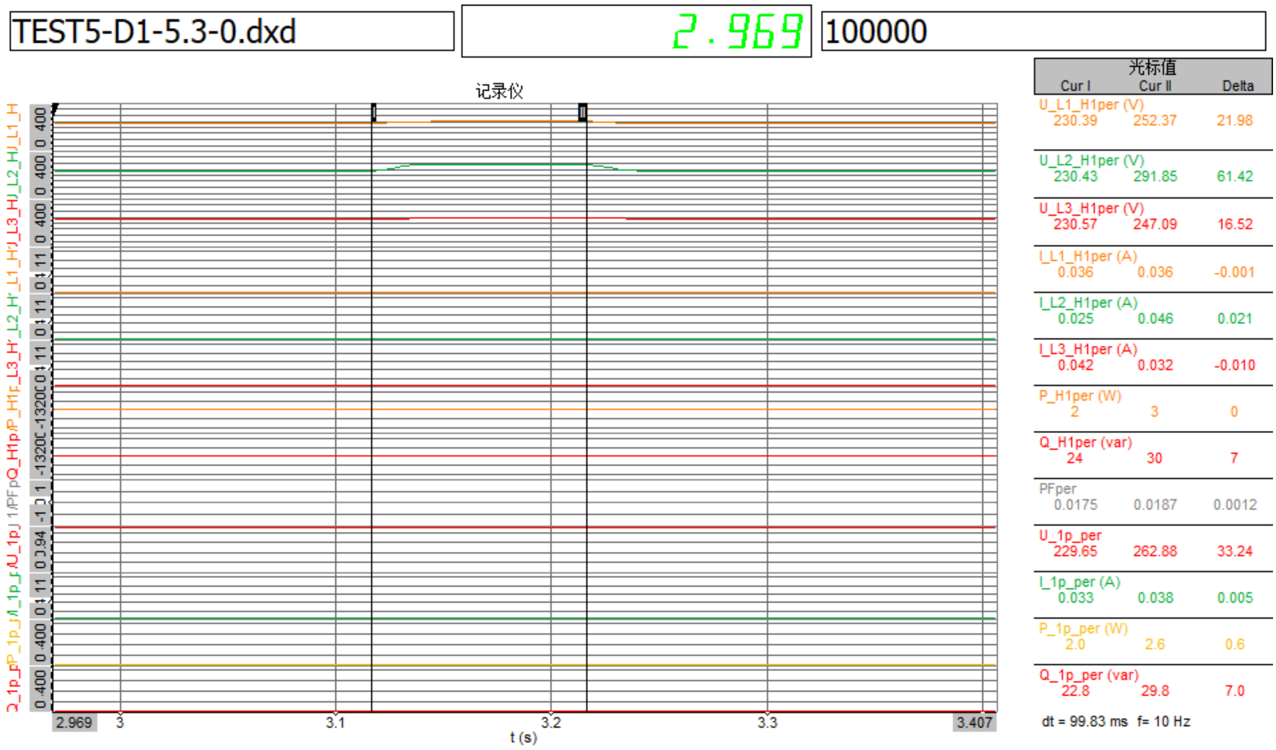
Test 5.2 – symmetrical fault - Recover time - Active power



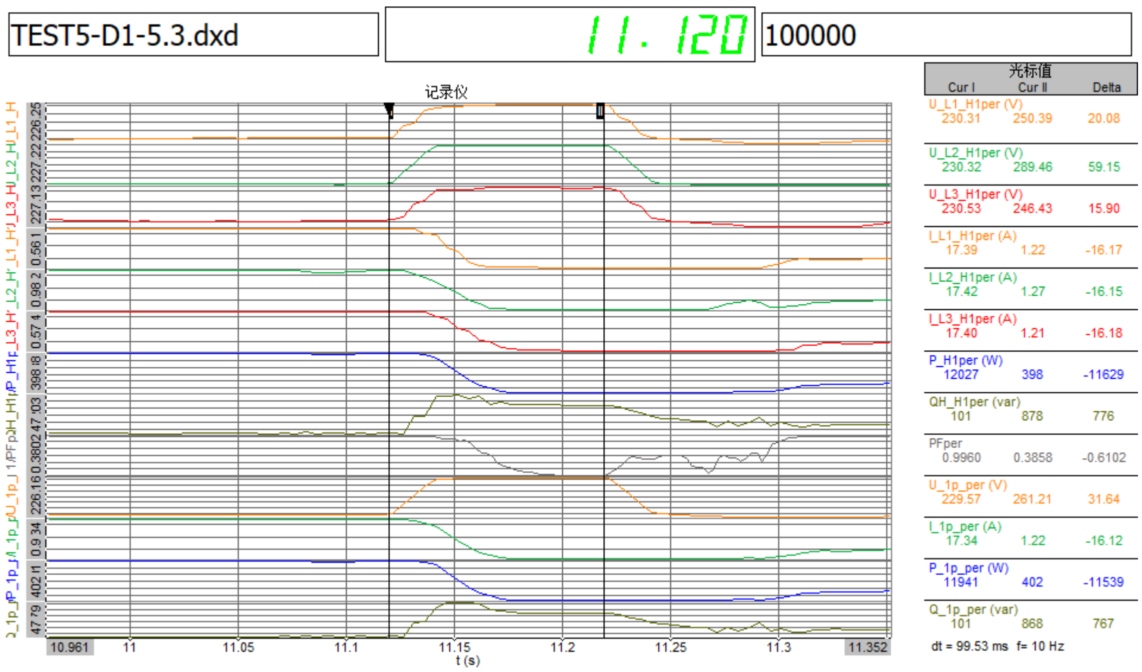
Test: Test 5.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	5.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	20.37.05	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	1.20	[p.u.]
	5	Setpoint fault duration	-	-	100	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11120	[ms]
	7	Time point of fault clearance (t2)	Total	-	11220	[ms]
	8	Fault duration in no load test	Total	-	100	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.26	[p.u.]
	10		Positive sequence		0.14	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.99	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.01	[p.u.]
	16		Total	t_1-10 s to t_1	0.01	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9961	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.26	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.08	[p.u.]
	20		Phase 2	t_1 +60 ms	0.07	[p.u.]
	21		Phase 3	t_1 +60 ms	0.12	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.99	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.99	[p.u.]
	30	Active power rising time	Positive sequence	-	0.65	[s]

Test: Test 5.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

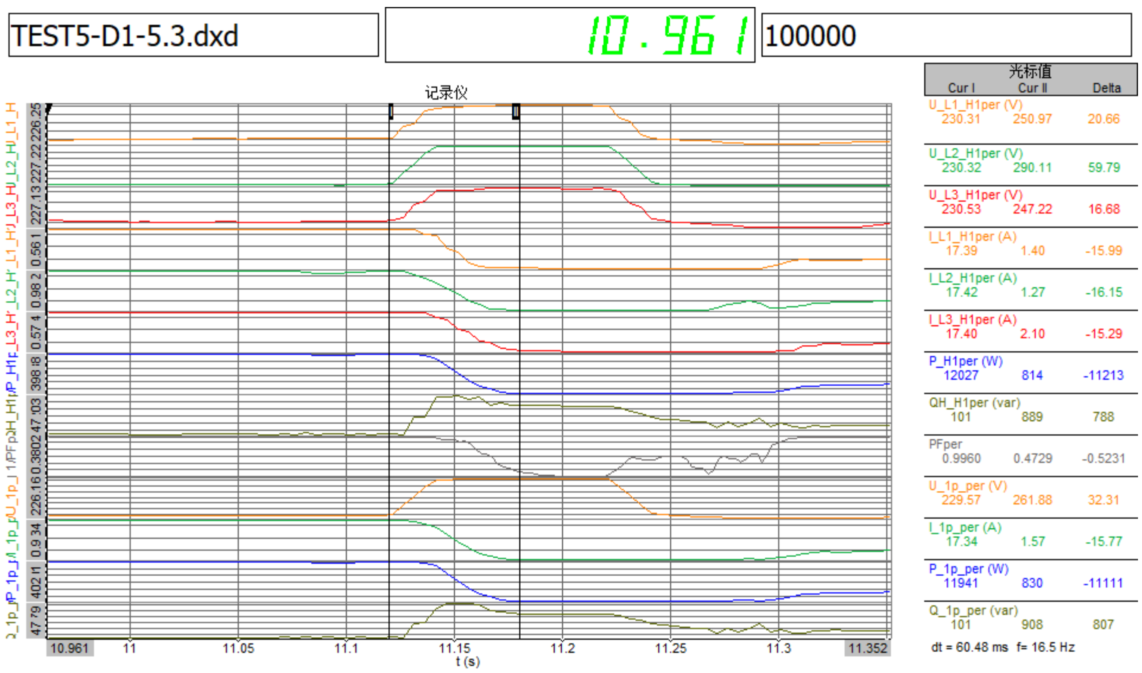
Test 5.3 – symmetrical fault - Voltage depth in no load test



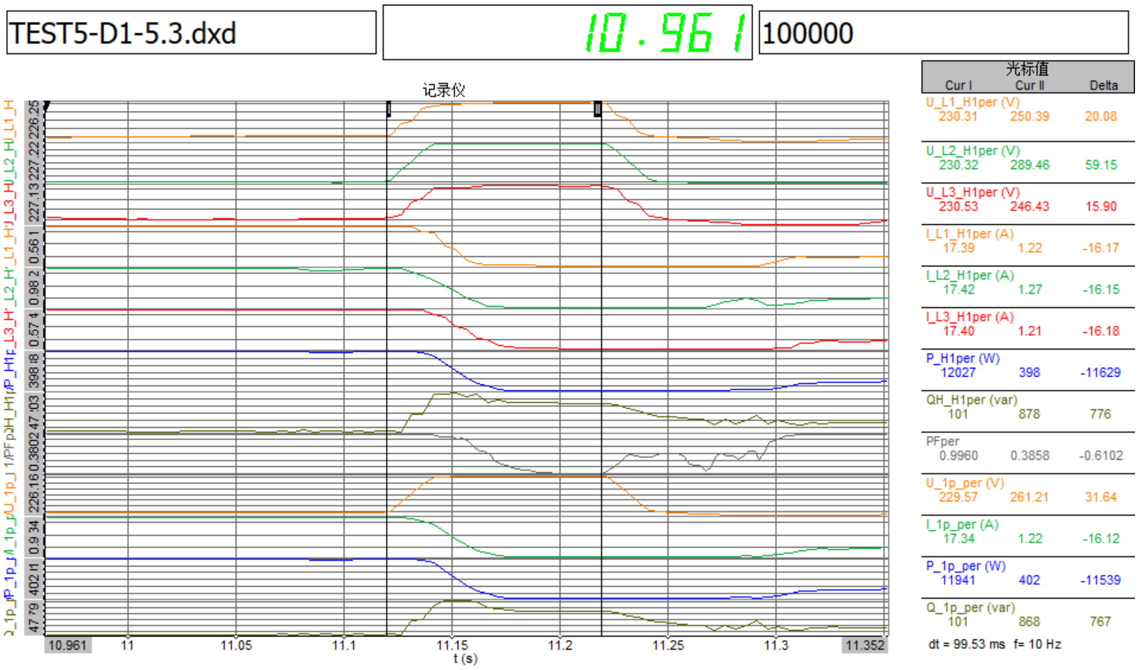
Test 5.3 – Asymmetrical fault - Fault duration



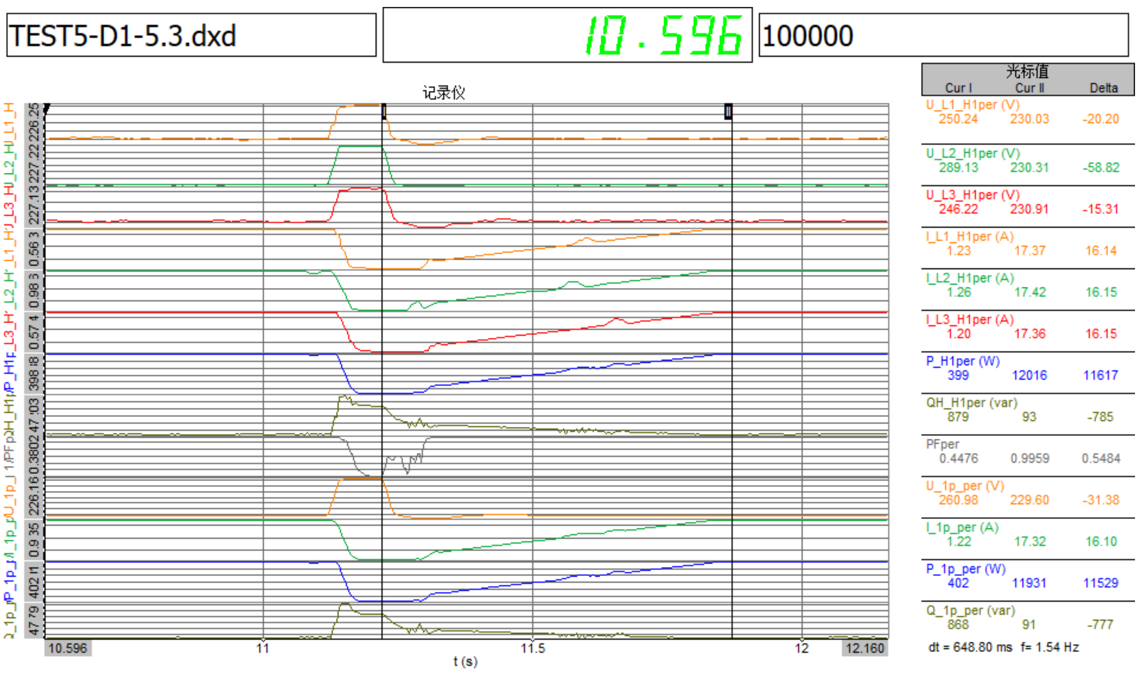
Test 5.3 – Asymmetrical fault - t_1 +60 ms



Test 5.3 – Asymmetrical fault - t_1 +100 ms



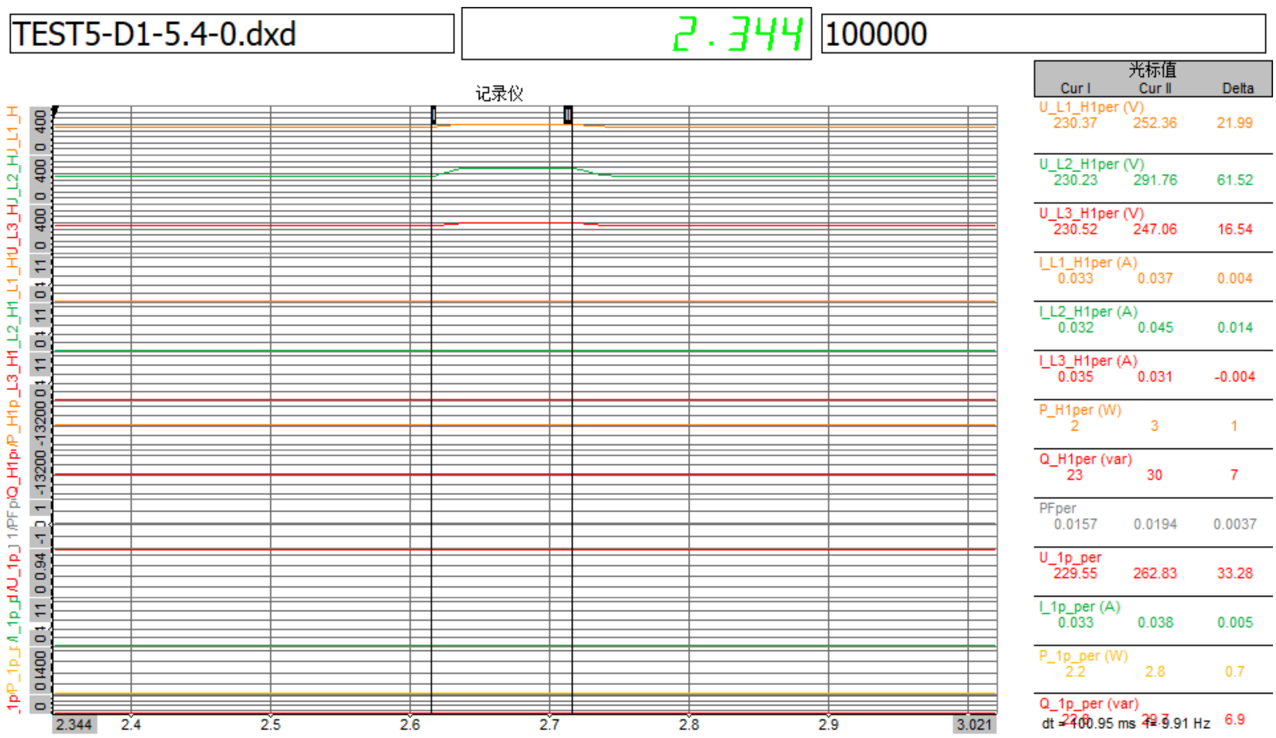
Test 5.3 – Asymmetrical fault - Recover time - Active power



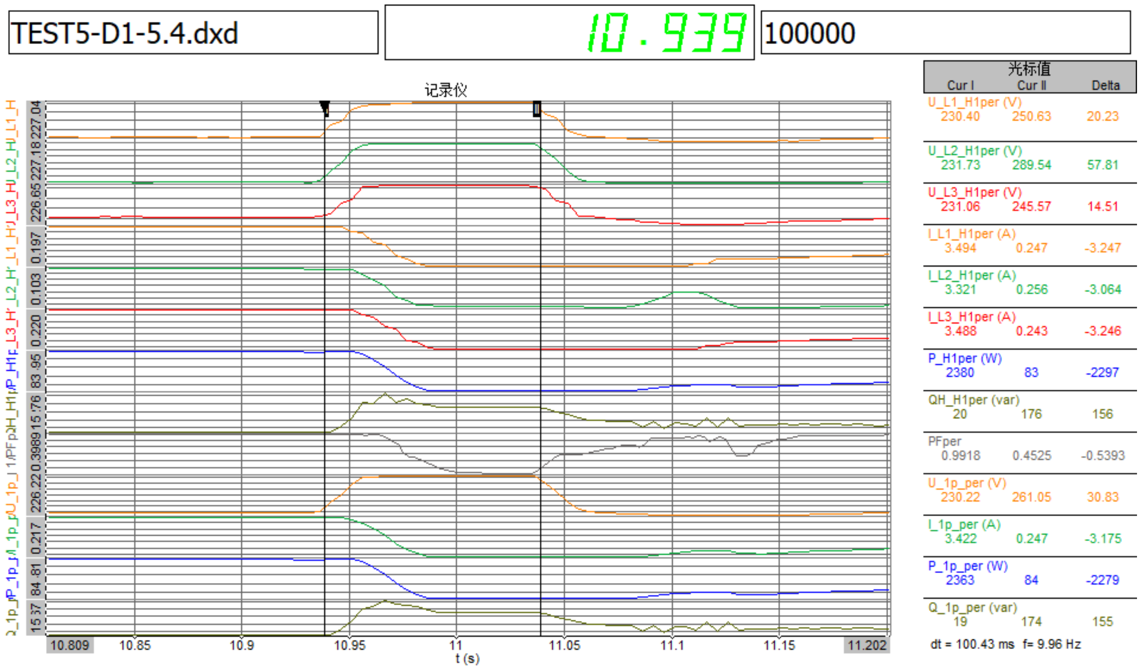
Test 5.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	5.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	20.55.16	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase - phase	-	1.25	[p.u.]
	5	Setpoint fault duration	-	-	100	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10939	[ms]
	7	Time point of fault clearance (t2)	Total	-	11039	[ms]
	8	Fault duration in no load test	Total	-	100	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.27	[p.u.]
	10		Positive sequence		0.15	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9958	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.26	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.02	[p.u.]
	20		Phase 2	t_1 +60 ms	0.02	[p.u.]
	21		Phase 3	t_1 +60 ms	0.02	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.01	[p.u.]
	23		Phase 2	t_1 +100 ms	0.01	[p.u.]
	24		Phase 3	t_1 +100 ms	0.01	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.71	[s]

Test 5.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

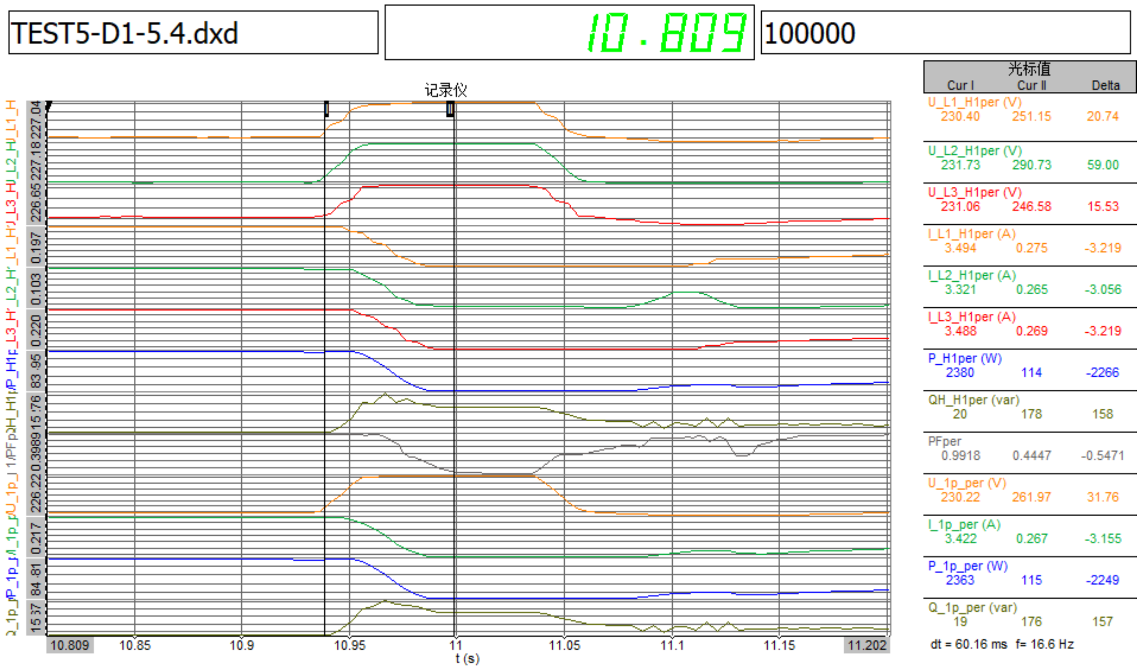
Test 5.4 – symmetrical fault - Voltage depth in no load test



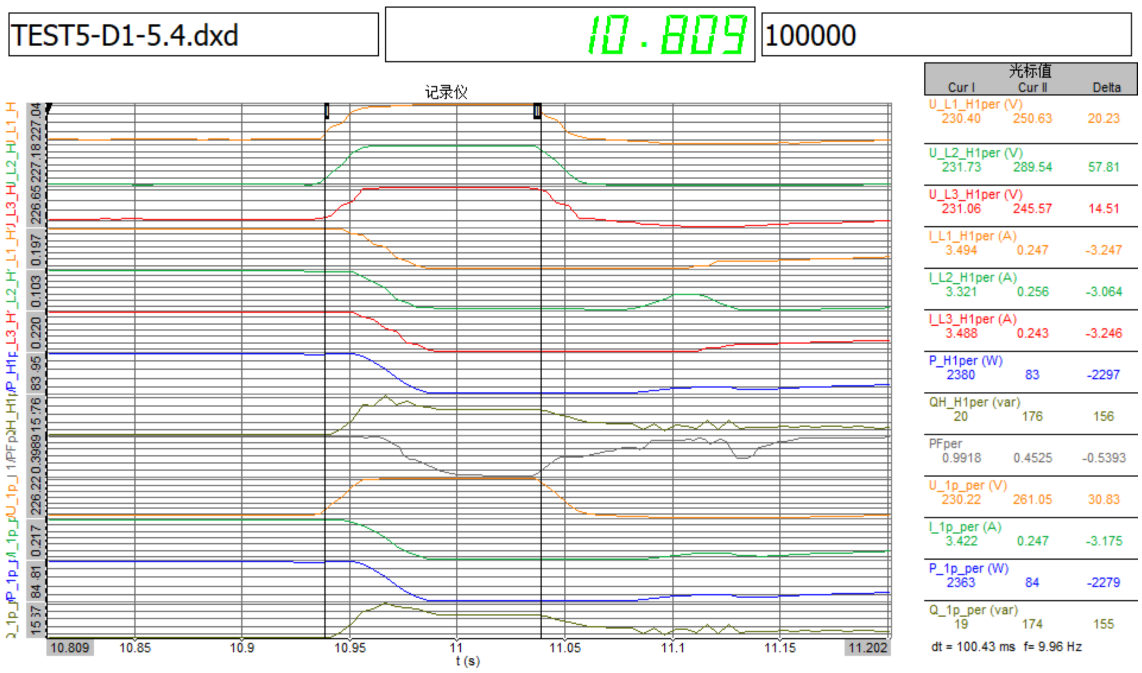
Test 5.4 – Asymmetrical fault - Fault duration



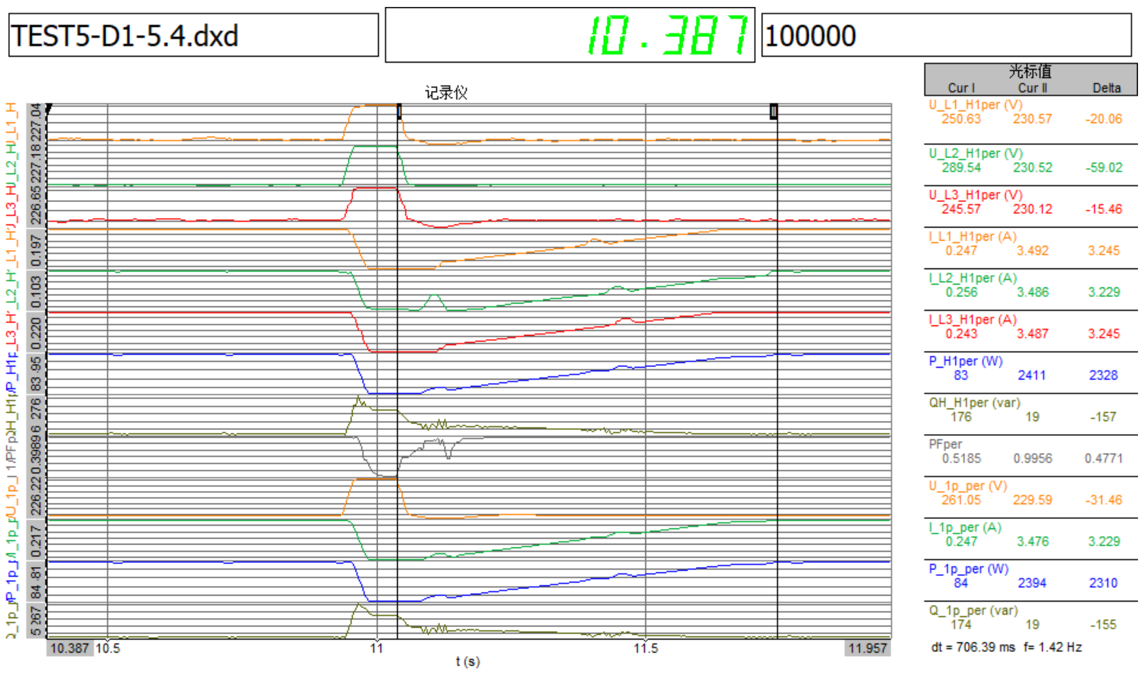
Test 5.4 – Asymmetrical fault - t_1 +60 ms



Test 5.4 – Asymmetrical fault - t_1 +100 ms



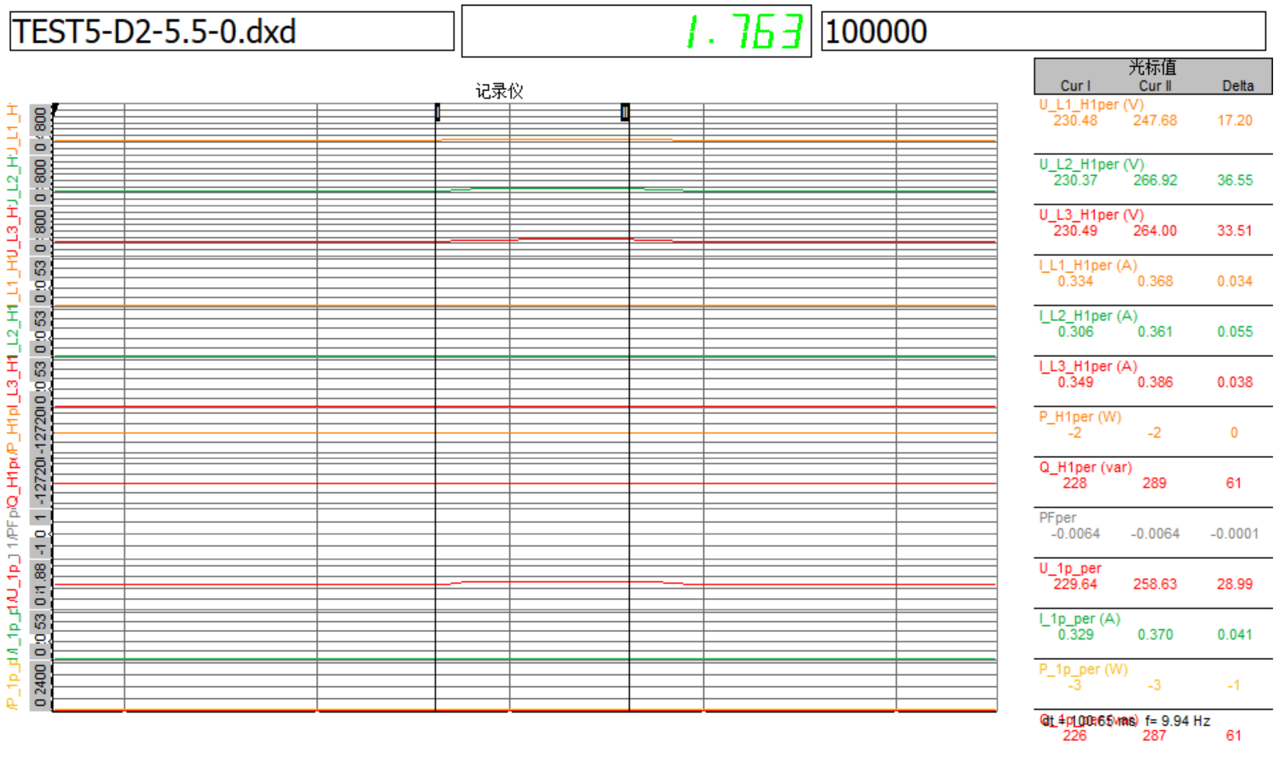
Test 5.4 – Asymmetrical fault - Recover time - Active power



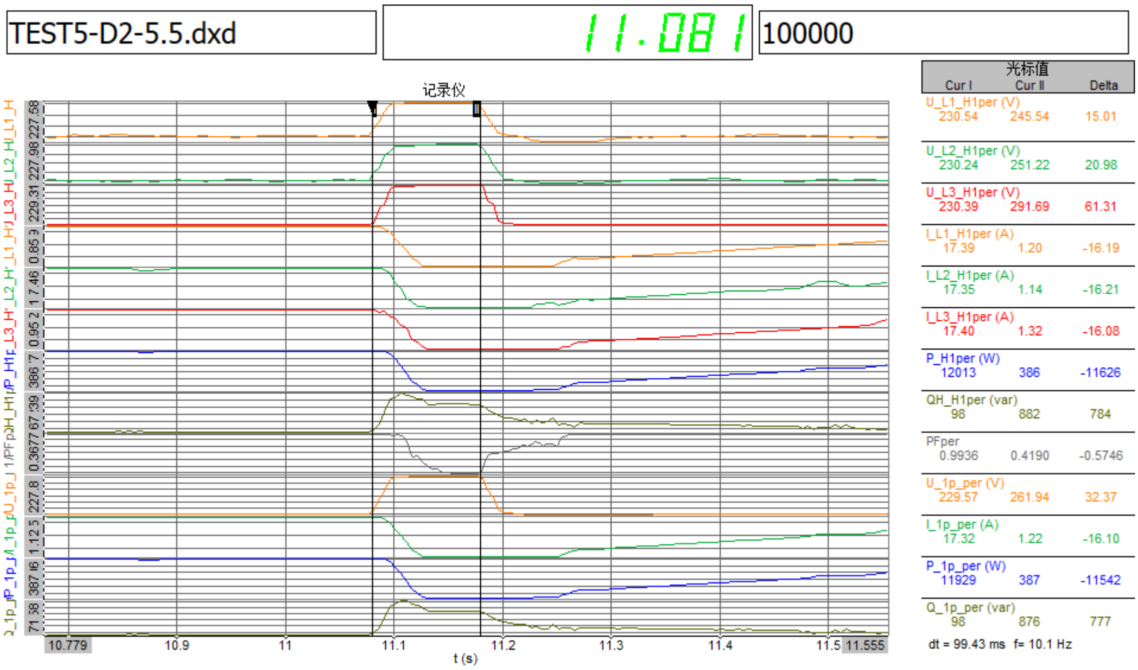
Test: Test 5.5 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	5.5	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	21.07.41	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D2	-
	4	Setpoint break-in depth	Phase – phase	-	1.20	[p.u.]
	5	Setpoint fault duration	-	-	100	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11081	[ms]
	7	Time point of fault clearance (t2)	Total	-	11180	[ms]
	8	Fault duration in no load test	Total	-	99	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.25	[p.u.]
	10		Positive sequence		0.14	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.99	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.01	[p.u.]
	16		Total	t_1-10 s to t_1	0.01	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9960	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.27	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.08	[p.u.]
	20		Phase 2	t_1 +60 ms	0.07	[p.u.]
	21		Phase 3	t_1 +60 ms	0.08	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.08	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.99	[p.u.]
	30	Active power rising time	Positive sequence	-	0.63	[s]

Test: Test 5.5 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.20 to 1.25)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

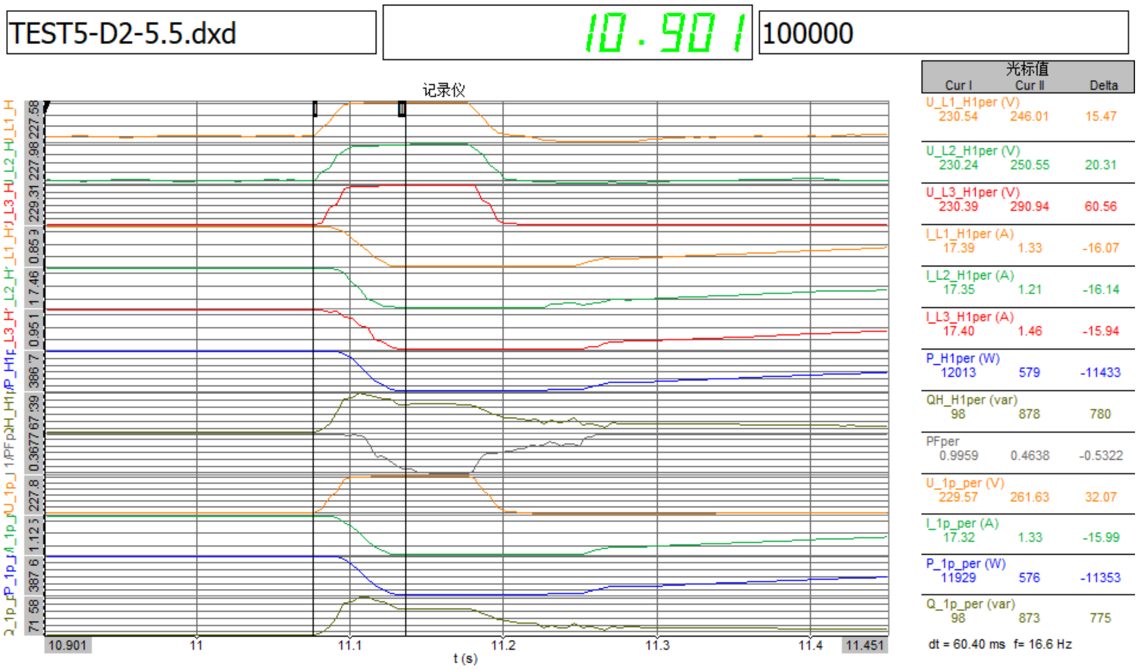
Test 5.5 – symmetrical fault - Voltage depth in no load test



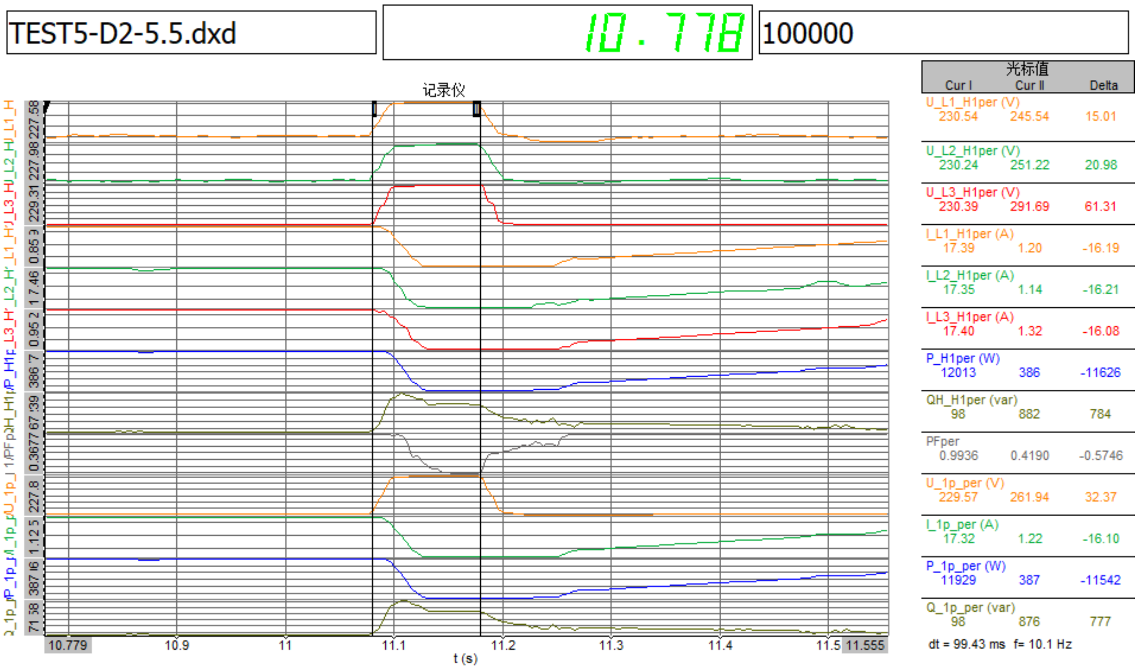
Test 5.5 – Asymmetrical fault - Fault duration



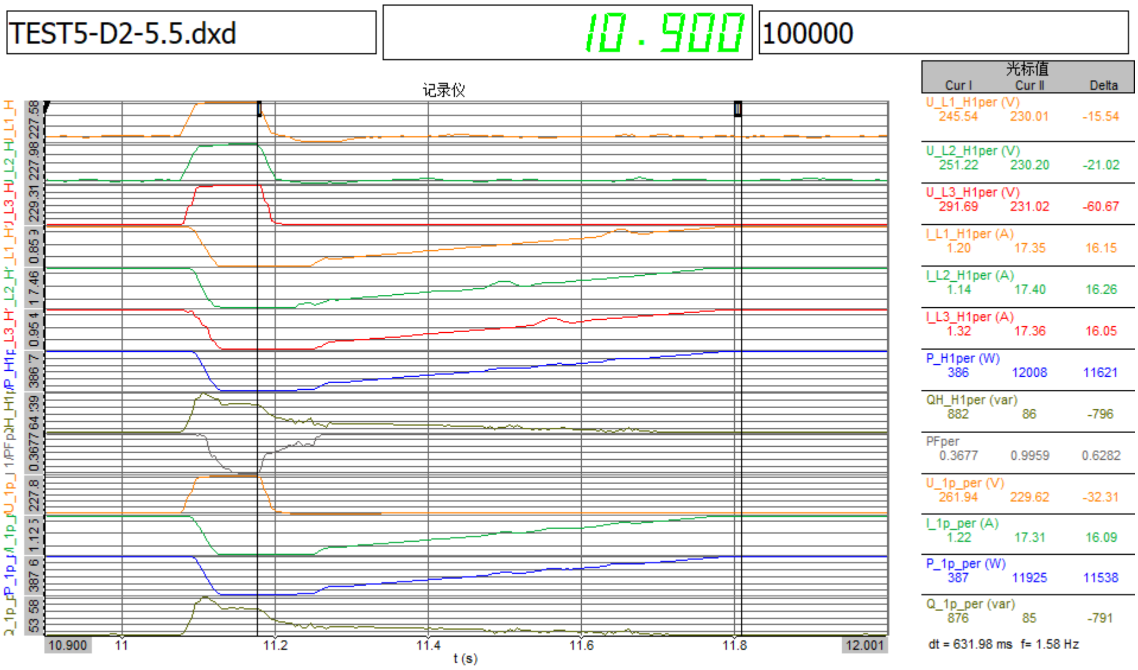
Test 5.5 – Asymmetrical fault - t_1 +60 ms



Test 5.5 – Asymmetrical fault - t_1 +100 ms



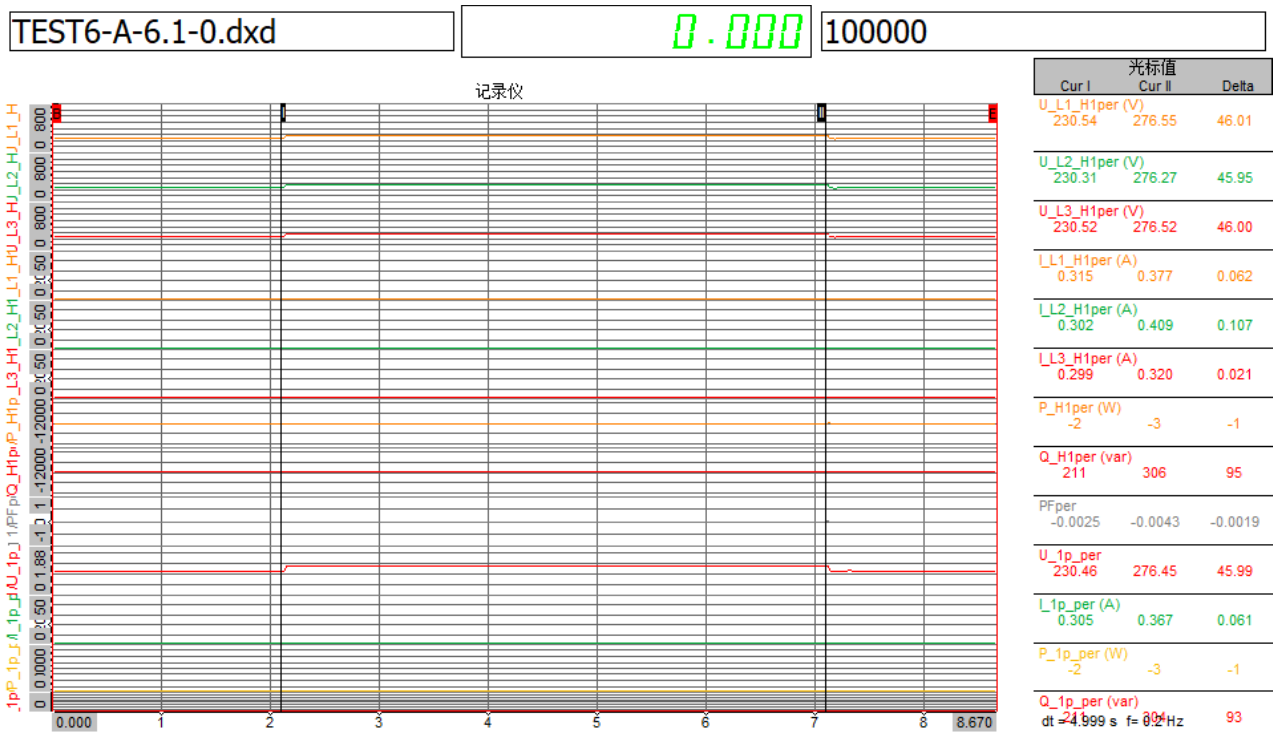
Test 5.5 – Asymmetrical fault - Recover time - Active power



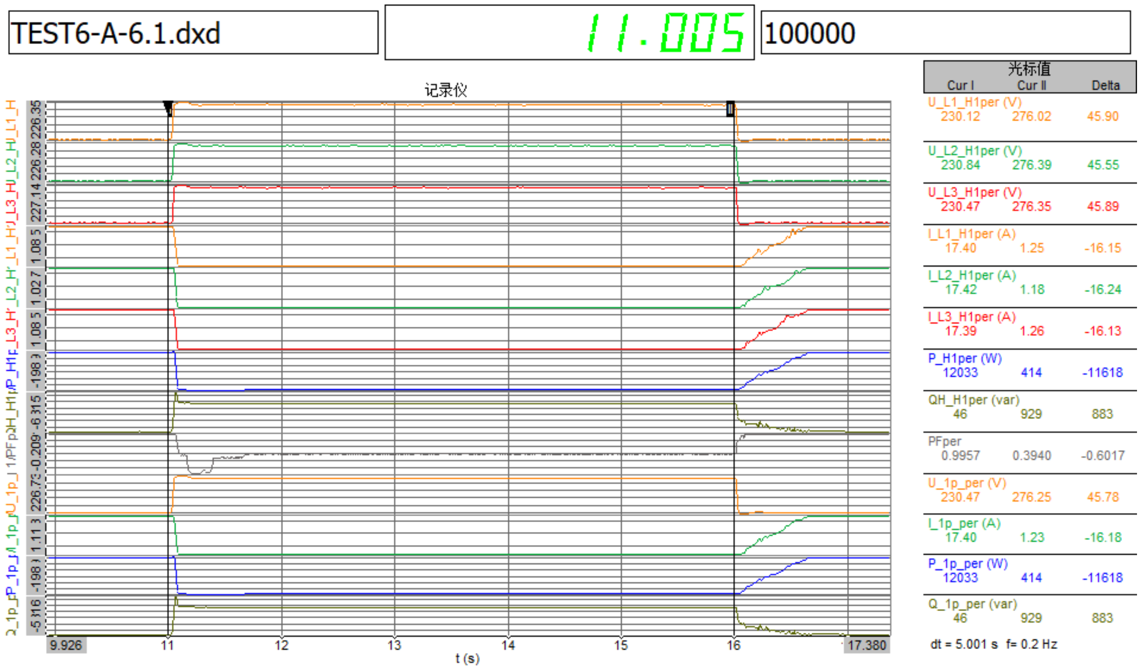
Test 6.1– symmetrical fault (V/Vnom = 1.15 to 1.20)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	6.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	17.56.30	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	1.20	[p.u.]
	5	Setpoint fault duration	-	-	5000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11005	[ms]
	7	Time point of fault clearance (t2)	Total	-	16006	[ms]
	8	Fault duration in no load test	Total	-	5001	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.21	[p.u.]
	10		Positive sequence		0.20	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9956	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.22	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.08	[p.u.]
	20		Phase 2	t_1 +60 ms	0.07	[p.u.]
	21		Phase 3	t_1 +60 ms	0.08	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	30	Active power rising time	Positive sequence	-	0.71	[s]

Test 6.1– symmetrical fault (V/Vnom = 1.15 to 1.20)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

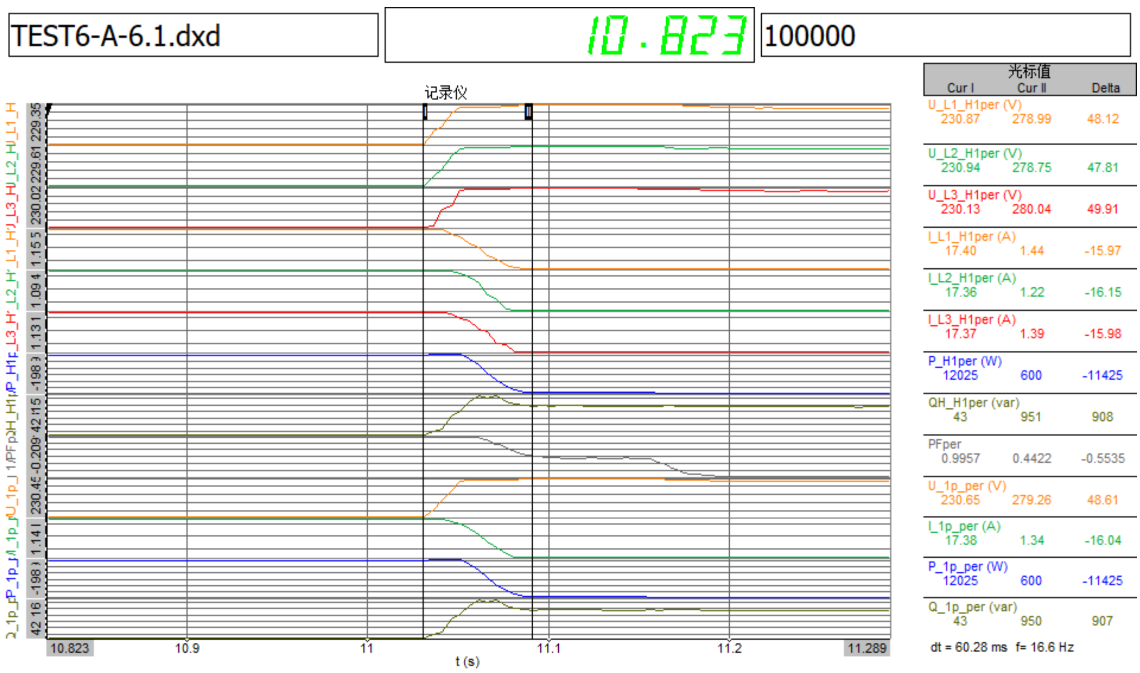
Test 6.1 – symmetrical fault - Voltage depth in no load test



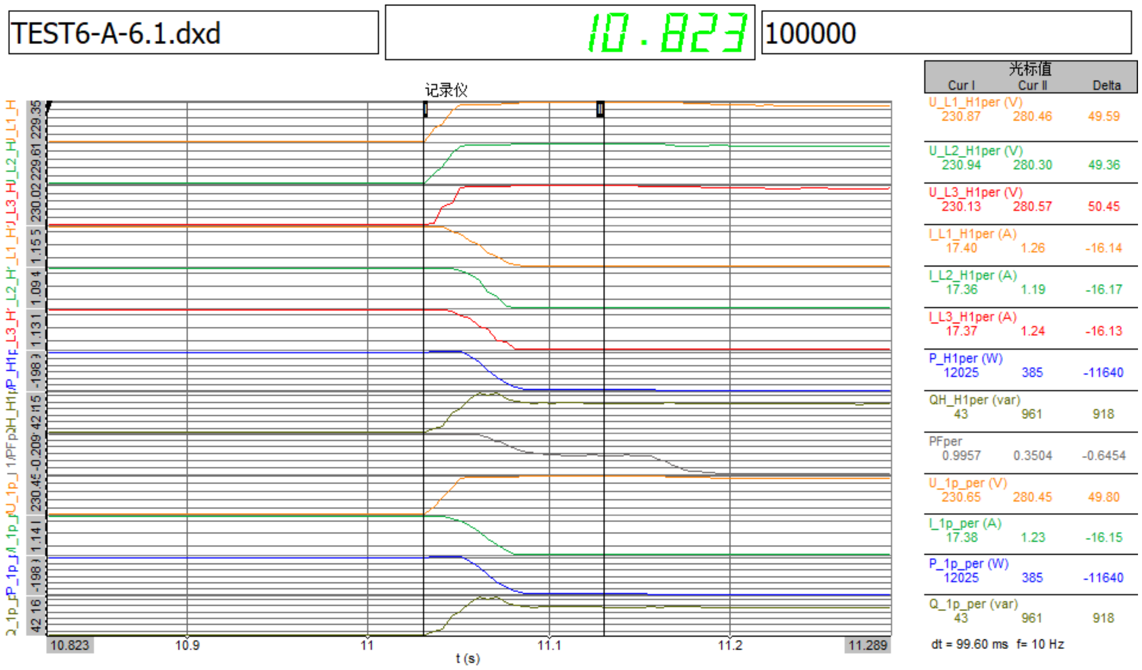
Test 6.1 – symmetrical fault - Fault duration



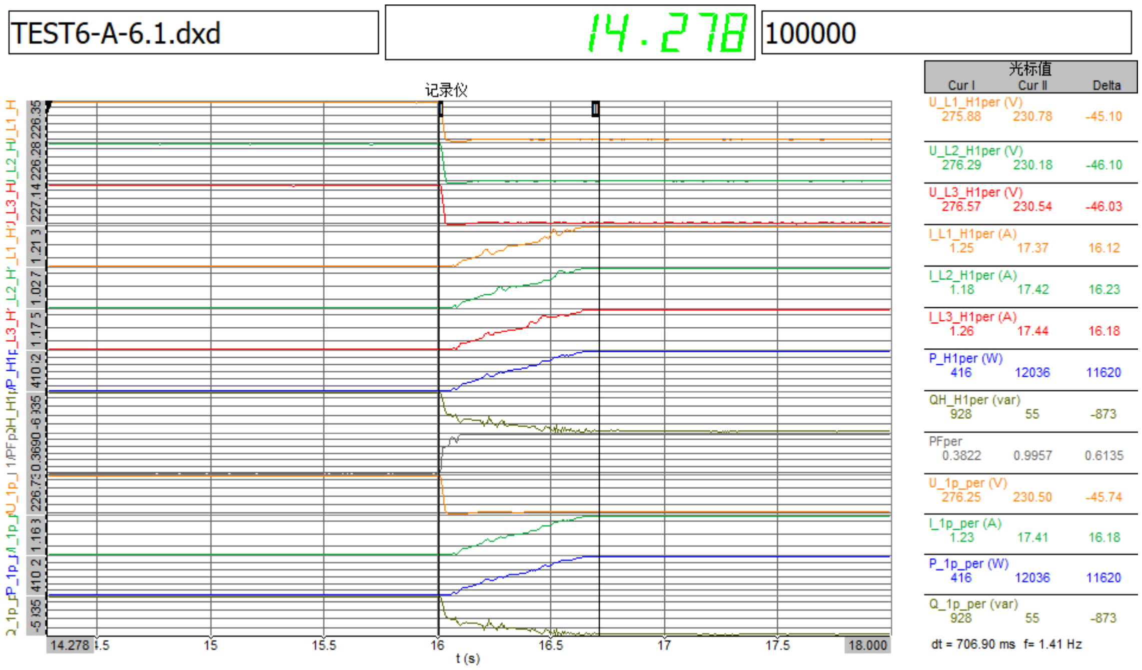
Test 6.1 – symmetrical fault - t_1 +60 ms



Test 6.1 – symmetrical fault - t_1 +100 ms



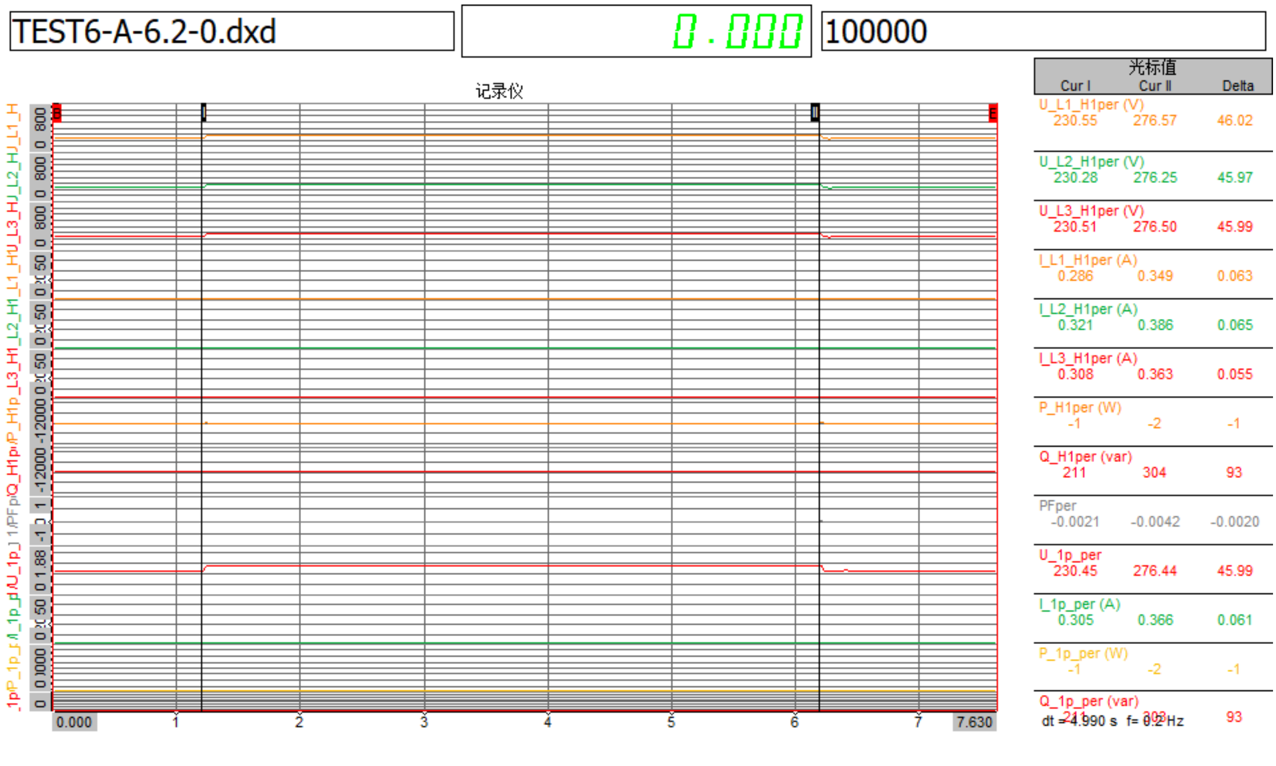
Test 6.1 – symmetrical fault - Recover time - Active power



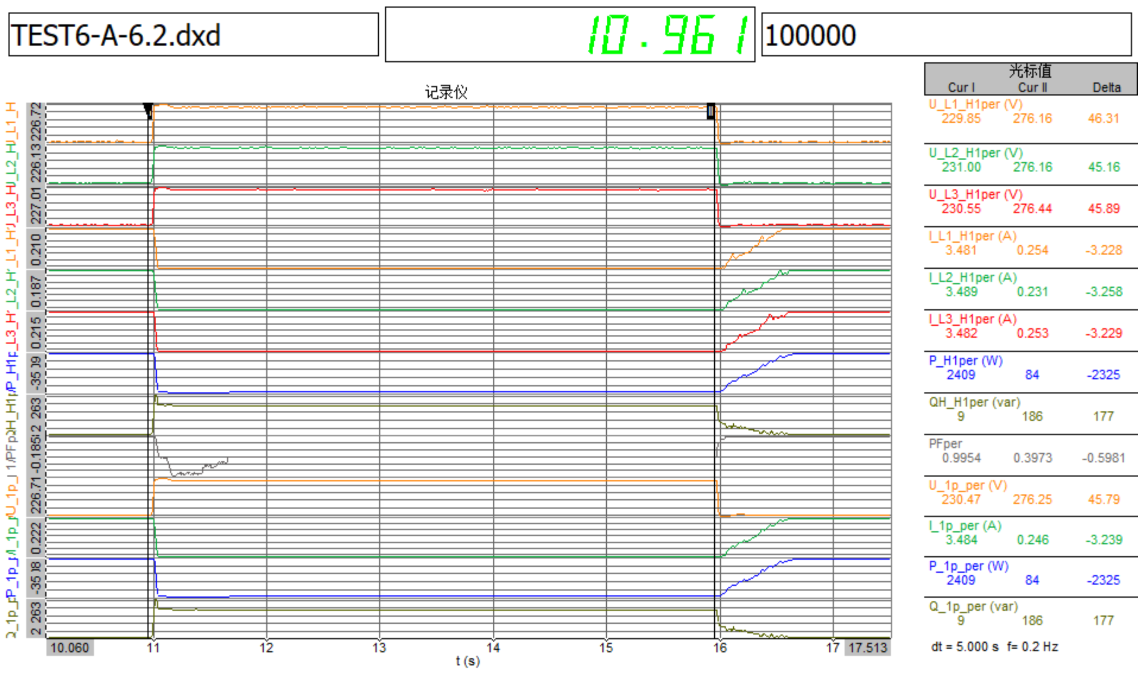
Test 6.2– symmetrical fault (V/Vnom = 1.15 to 1.20)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	6.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.08.56	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	1.15	[p.u.]
	5	Setpoint fault duration	-	-	5000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10961	[ms]
	7	Time point of fault clearance (t2)	Total	-	15961	[ms]
	8	Fault duration in no load test	Total	-	5000	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.20	[p.u.]
	10		Positive sequence		0.20	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9952	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.22	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.02	[p.u.]
	20		Phase 2	t_1 +60 ms	0.01	[p.u.]
	21		Phase 3	t_1 +60 ms	0.02	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.01	[p.u.]
	23		Phase 2	t_1 +100 ms	0.01	[p.u.]
	24		Phase 3	t_1 +100 ms	0.01	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	30	Active power rising time	Positive sequence	-	0.67	[s]

Test 6.2– symmetrical fault (V/Vnom = 1.15 to 1.20)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

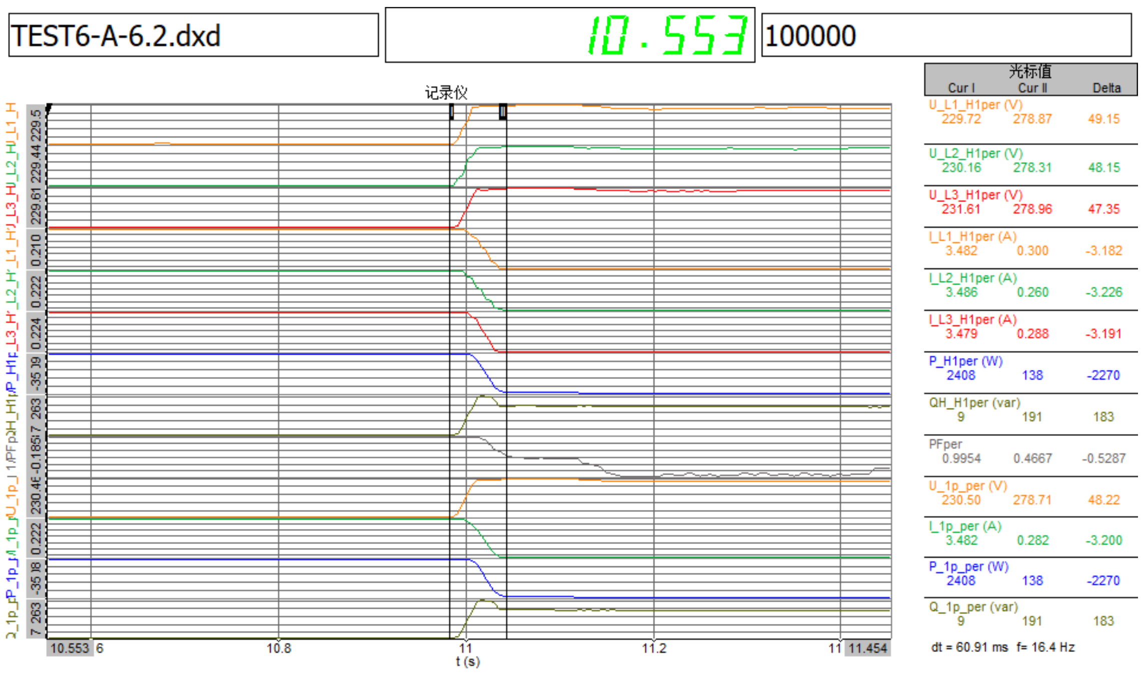
Test 6.2 – symmetrical fault - Voltage depth in no load test



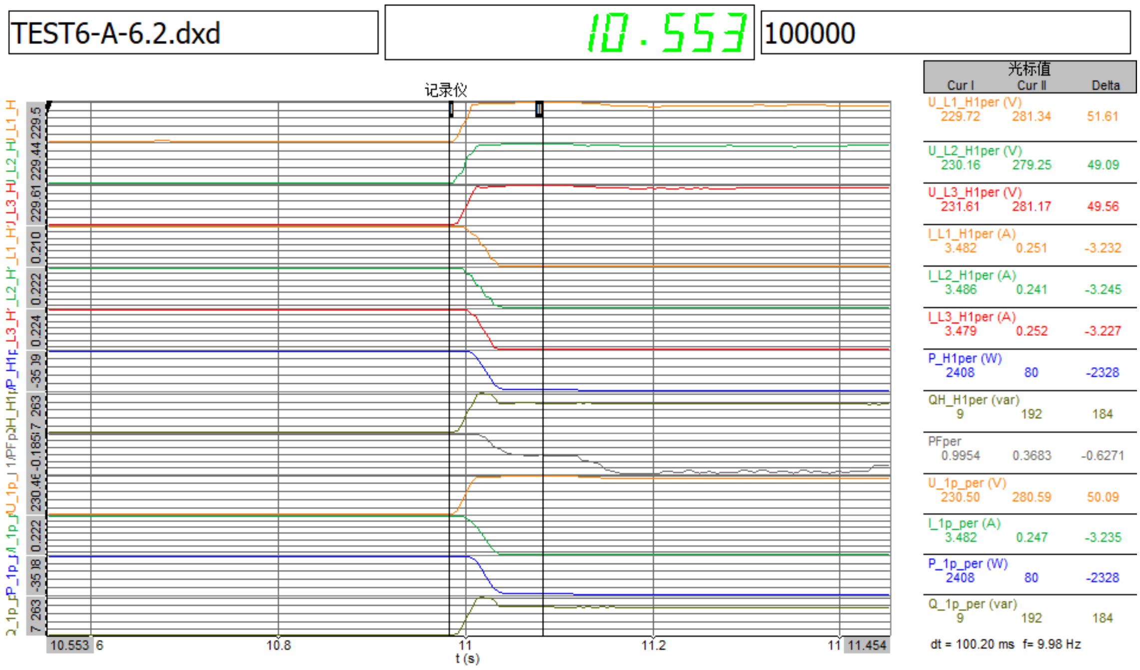
Test 6.2 – symmetrical fault - Fault duration



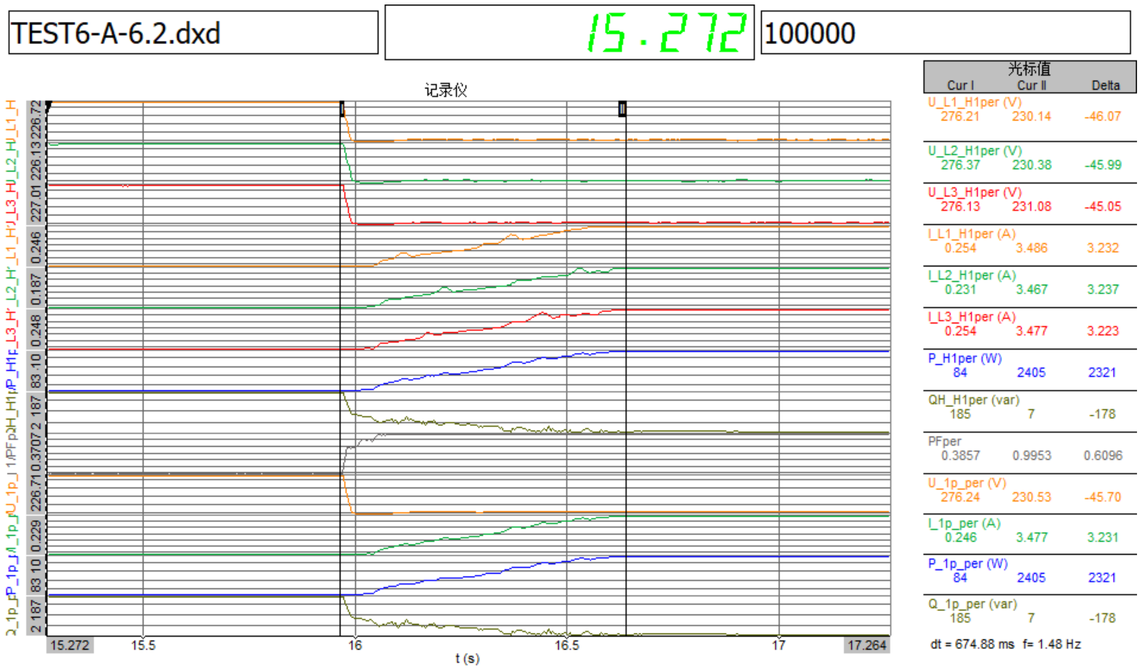
Test 6.2 – symmetrical fault - t_1 +60 ms



Test 6.2 – symmetrical fault - t_1 +100 ms



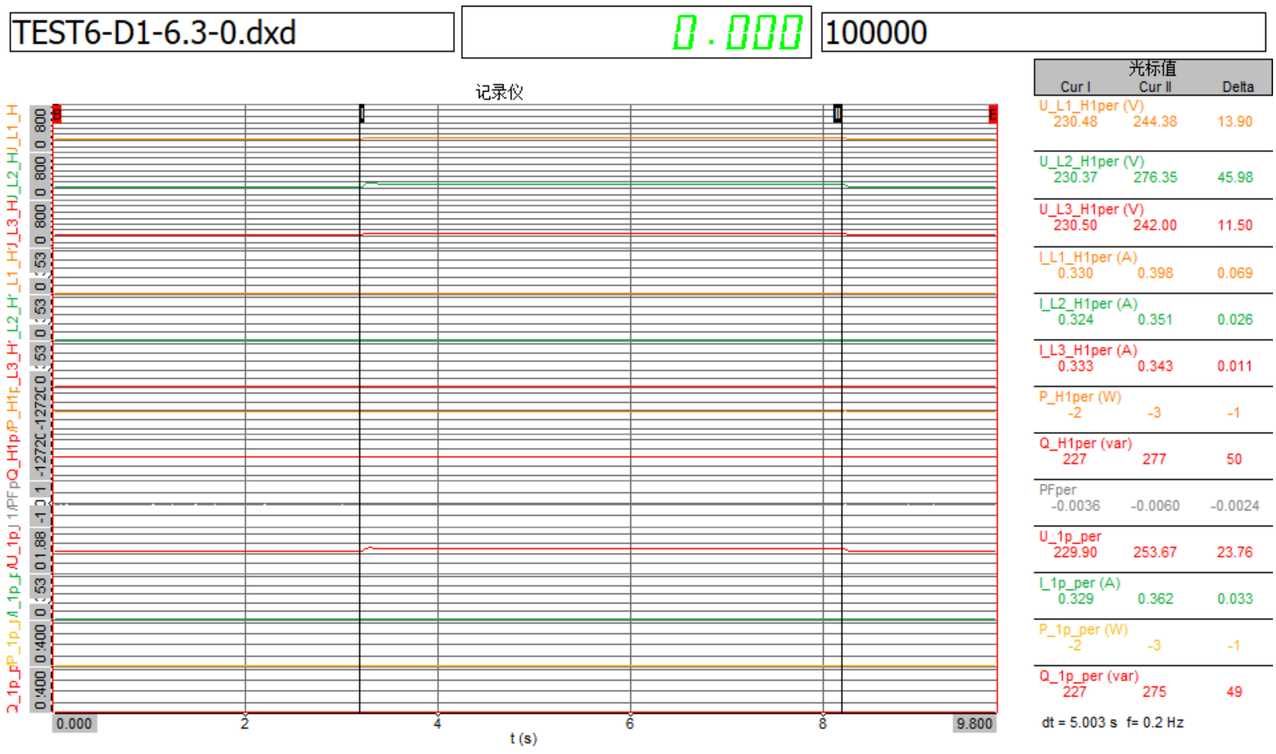
Test 6.2 – symmetrical fault - Recover time - Active power



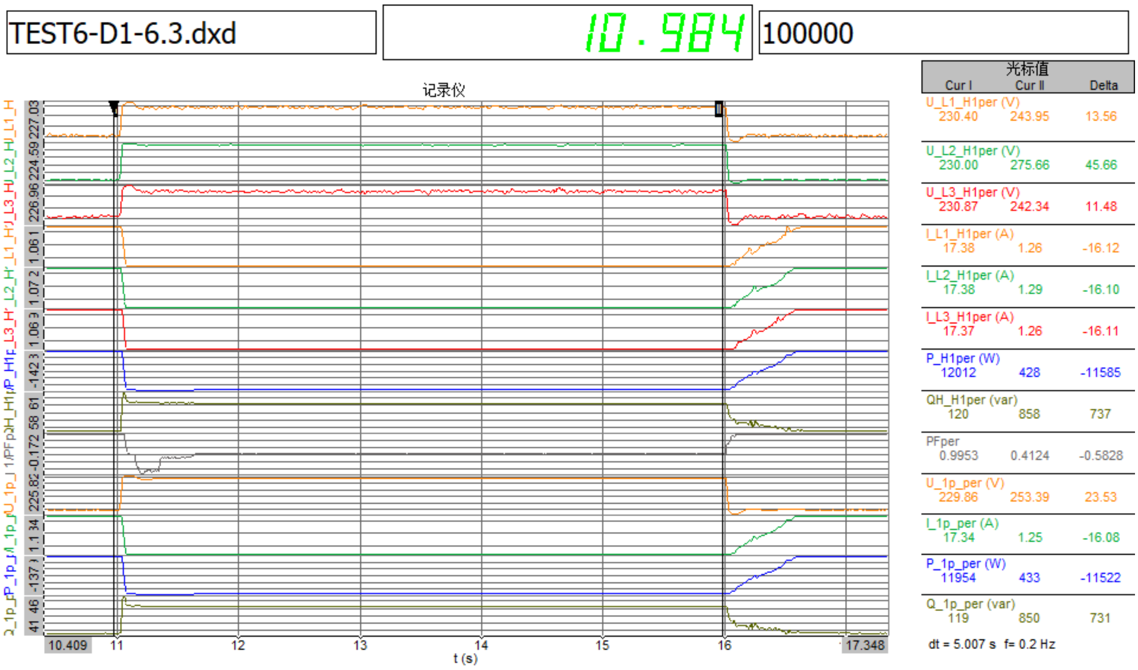
Test 6.3– Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.15 to 1.20)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	6.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.13.05	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	1.15	[p.u.]
	5	Setpoint fault duration	-	-	5000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10984	[ms]
	7	Time point of fault clearance (t2)	Total	-	15991	[ms]
	8	Fault duration in no load test	Total	-	5007	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.20	[p.u.]
	10		Positive sequence		0.10	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	1.00	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.01	[p.u.]
	16		Total	t_1-10 s to t_1	0.01	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9953	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.21	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.09	[p.u.]
	20		Phase 2	t_1 +60 ms	0.07	[p.u.]
	21		Phase 3	t_1 +60 ms	0.09	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.07	[p.u.]
	23		Phase 2	t_1 +100 ms	0.07	[p.u.]
	24		Phase 3	t_1 +100 ms	0.07	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.03	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.99	[p.u.]

Test 6.3– Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.15 to 1.20)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	30	Active power rising time	Positive sequence	-	0.65	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.01	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

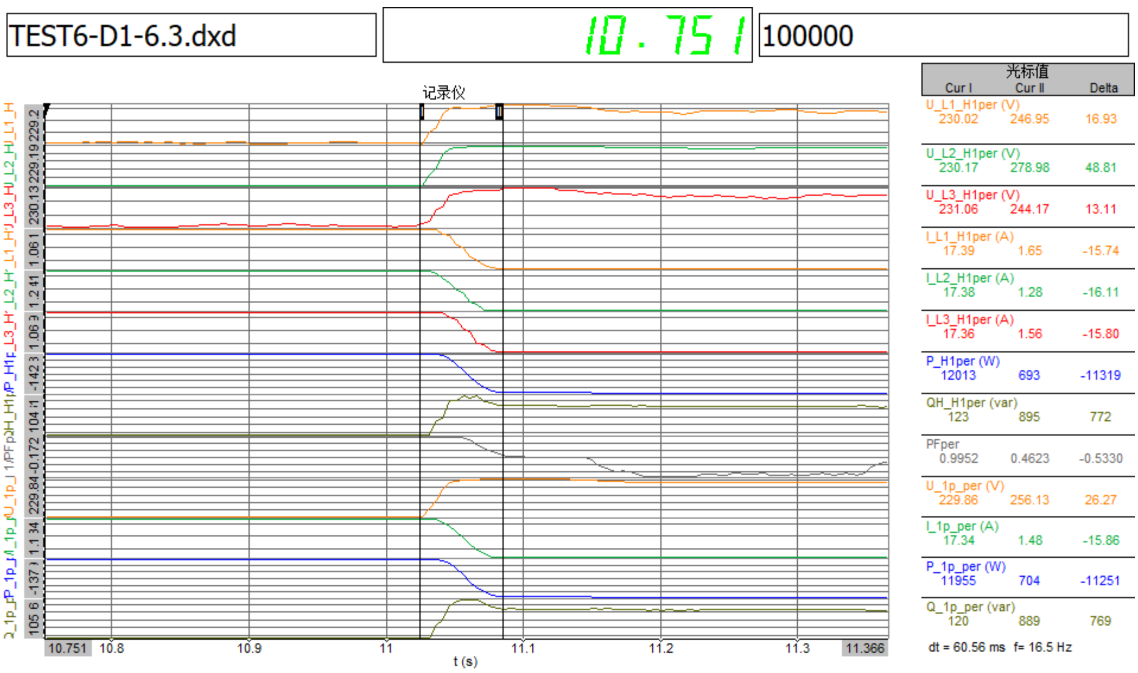
Test 6.3 – symmetrical fault - Voltage depth in no load test



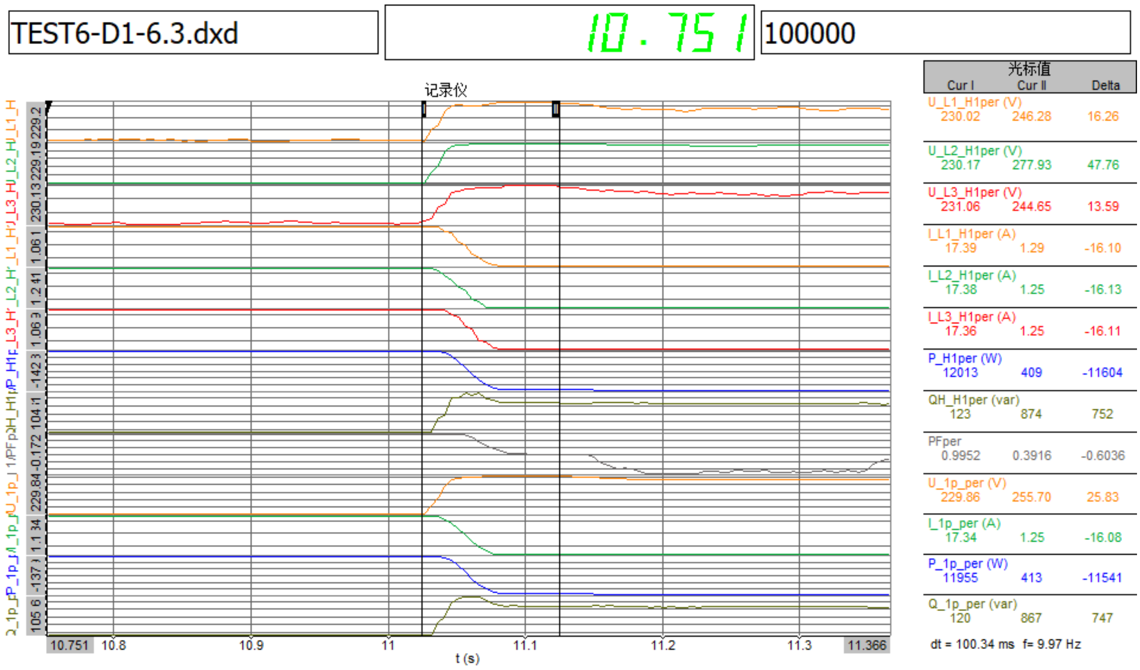
Test 6.3 – Asymmetrical fault - Fault duration



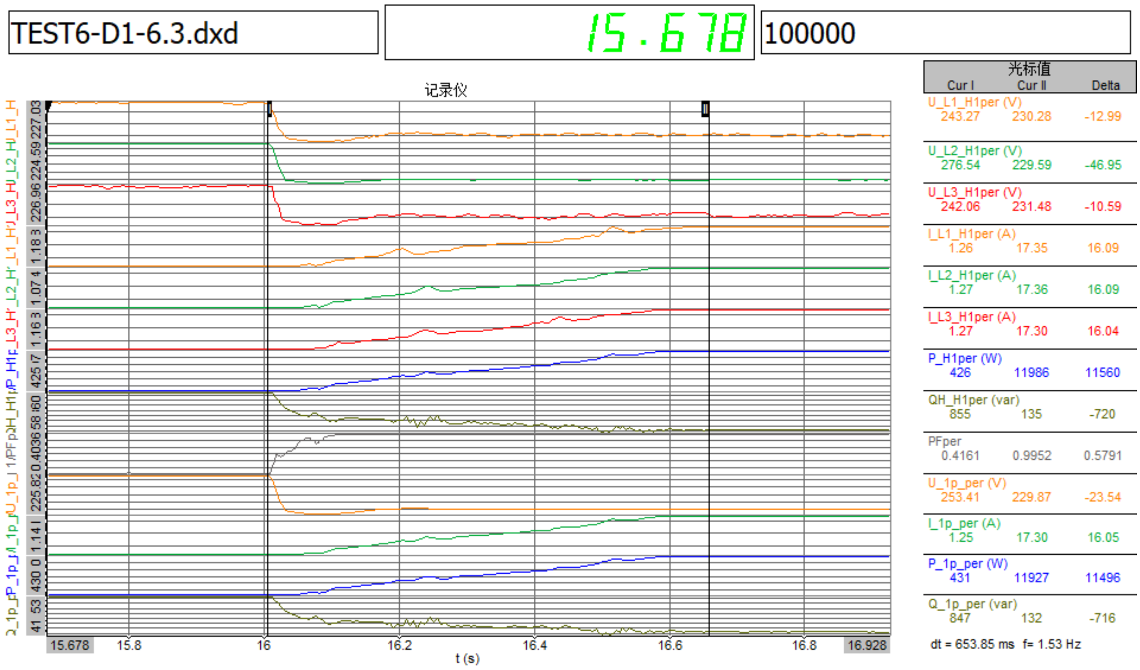
Test 6.3 – Asymmetrical fault - t_1 +60 ms



Test 6.3 – Asymmetrical fault - t_1 +100 ms



Test 6.3 – Asymmetrical fault - Recover time - Active power

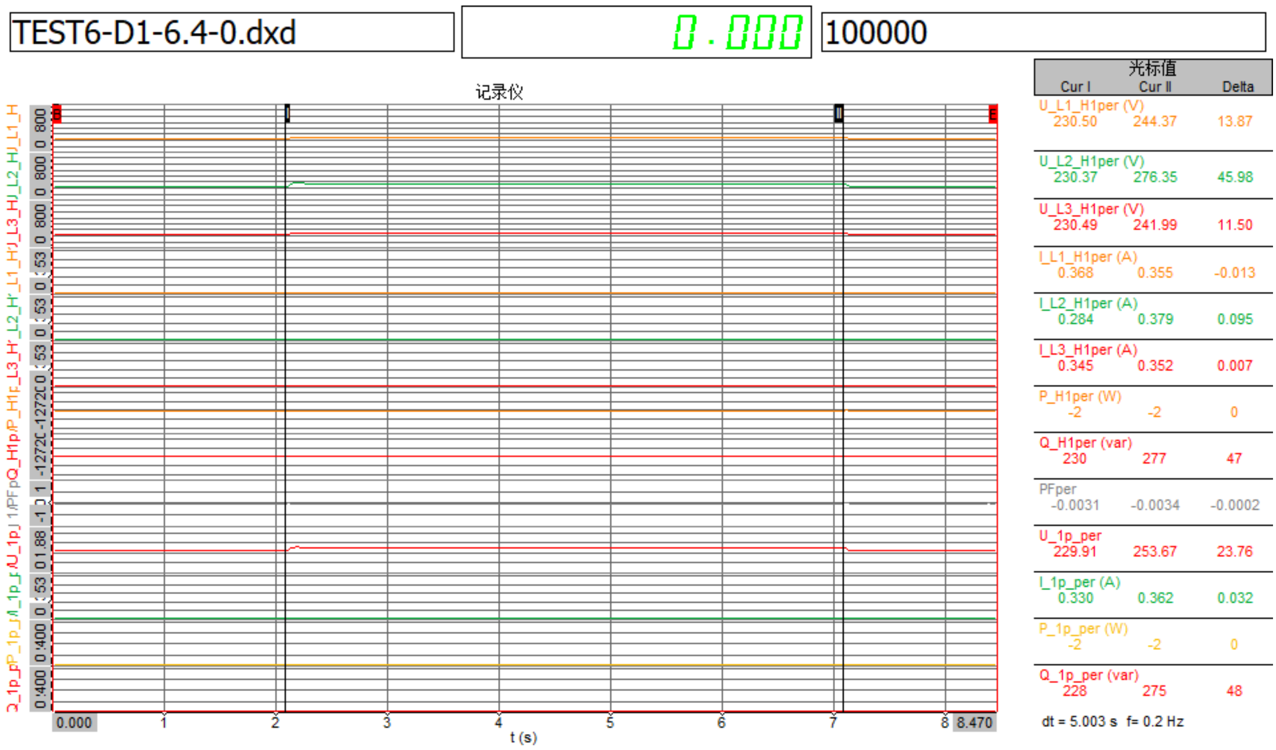


Test 6.4– Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.15 to 1.20)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	6.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.16.23	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase - phase	-	1.15	[p.u.]
	5	Setpoint fault duration	-	-	5000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10940	[ms]
	7	Time point of fault clearance (t2)	Total	-	15937	[ms]
	8	Fault duration in no load test	Total	-	4997	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.20	[p.u.]
	10		Positive sequence		0.10	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.01	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9952	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.21	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.02	[p.u.]
	20		Phase 2	t_1 +60 ms	0.01	[p.u.]
	21		Phase 3	t_1 +60 ms	0.02	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.01	[p.u.]
	23		Phase 2	t_1 +100 ms	0.01	[p.u.]
	24		Phase 3	t_1 +100 ms	0.01	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.01	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]

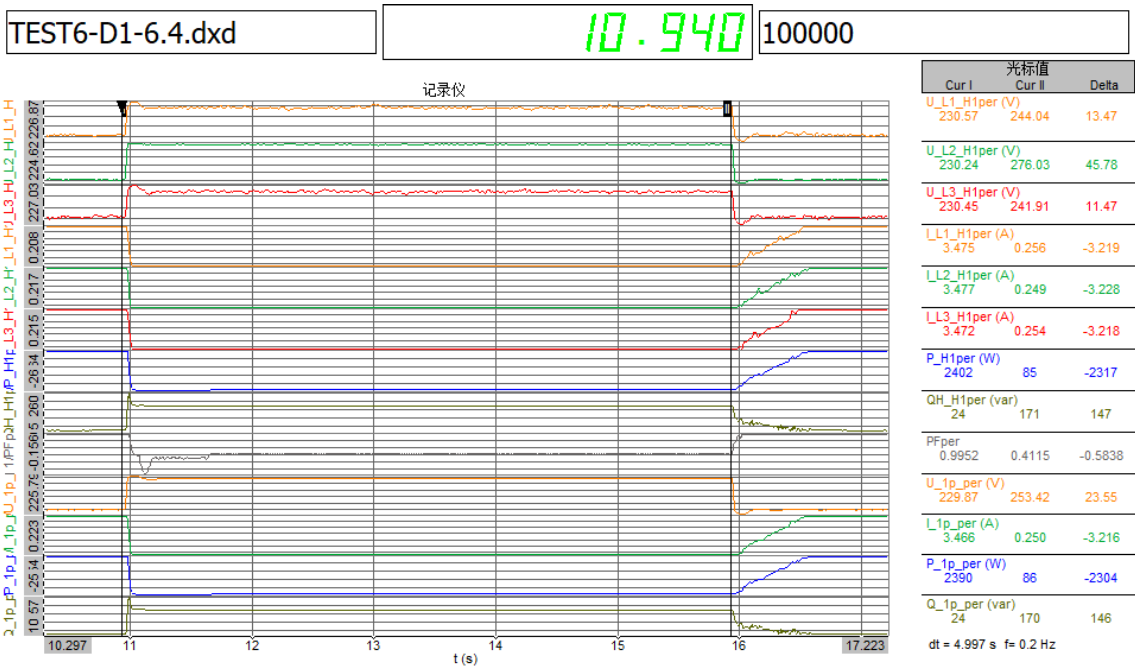
Test 6.4– Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.15 to 1.20)

	No.	Parameter	phase reference	reference time	Value	[Unit]
	30	Active power rising time	Positive sequence	-	0.66	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

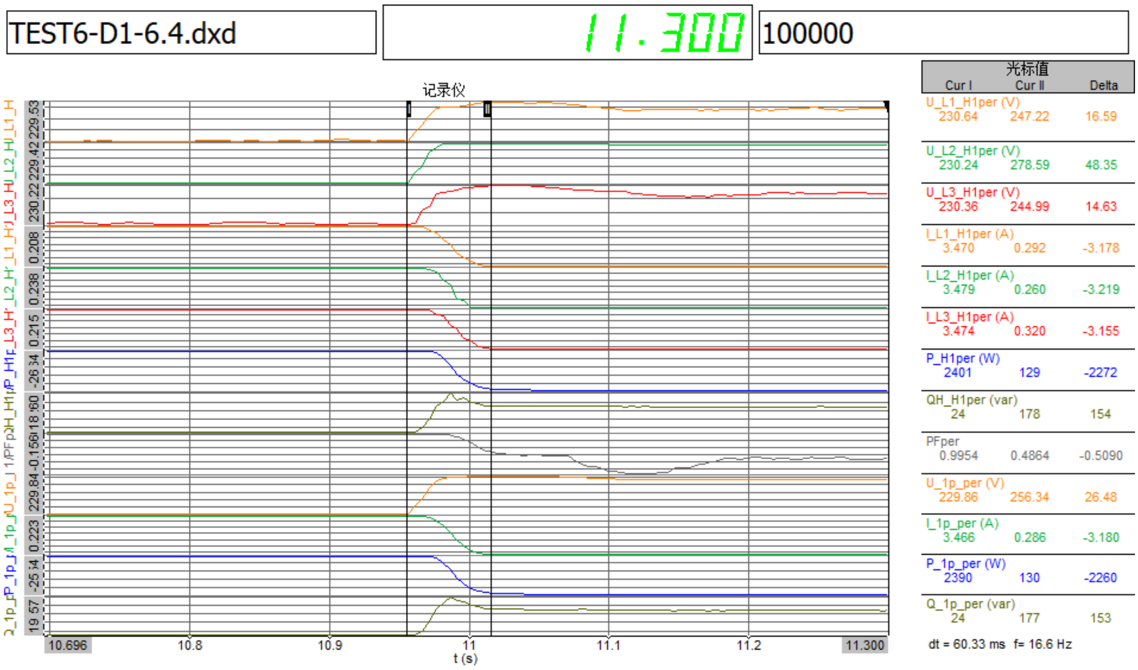
Test 6.4 – symmetrical fault - Voltage depth in no load test



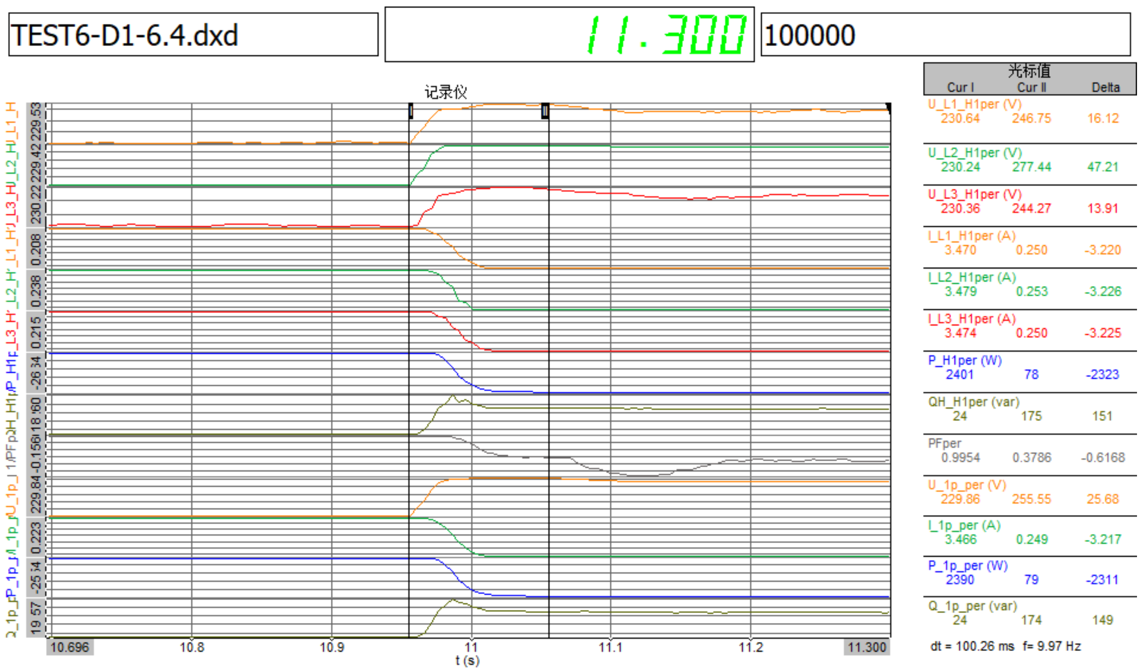
Test 6.4 – Asymmetrical fault - Fault duration



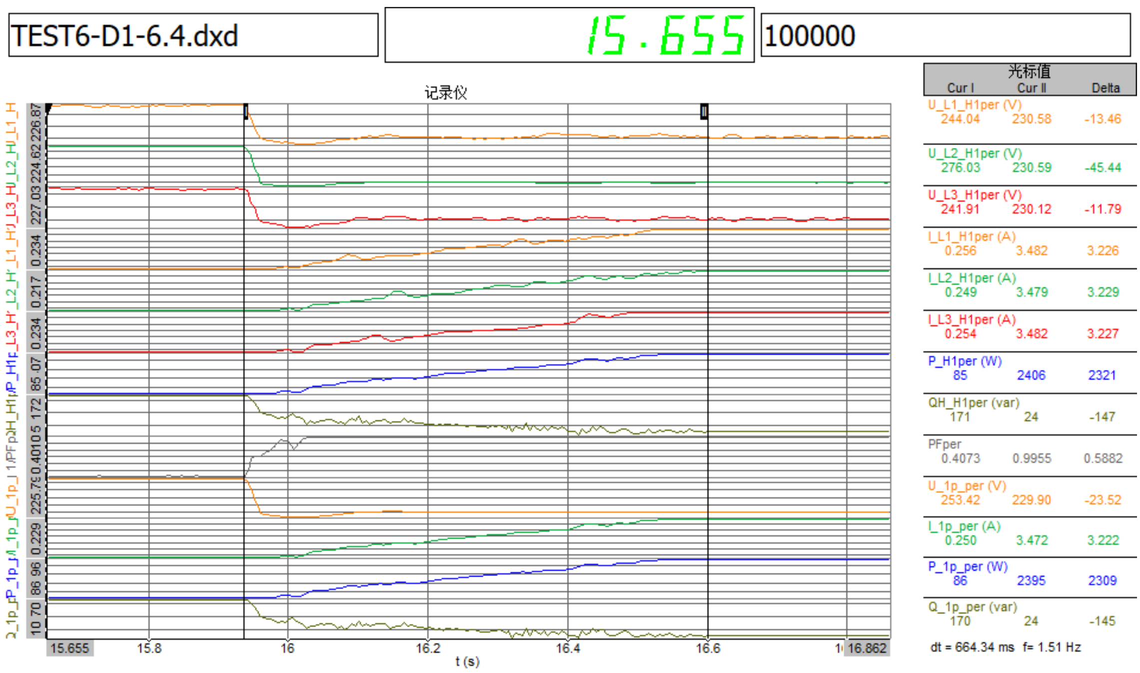
Test 6.4 – Asymmetrical fault - t_1 +60 ms



Test 6.4 – Asymmetrical fault - t_1 +100 ms



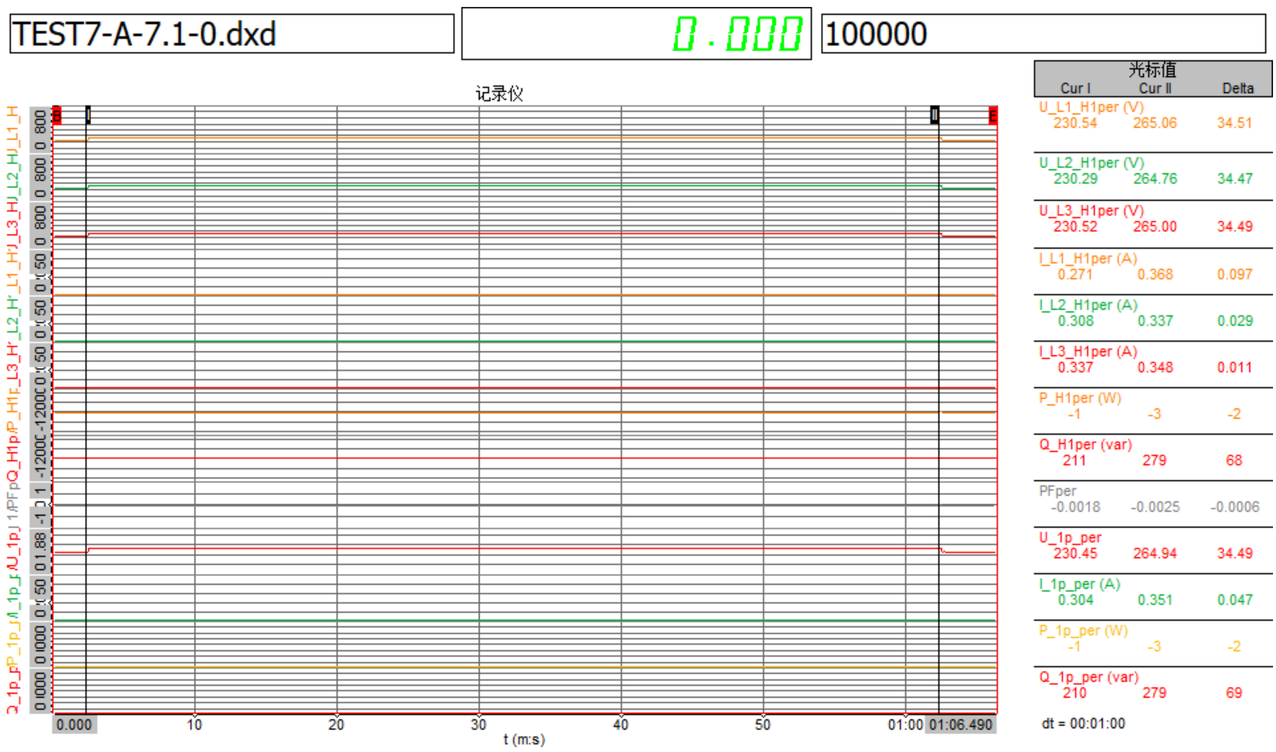
Test 6.4 – Asymmetrical fault - Recover time - Active power



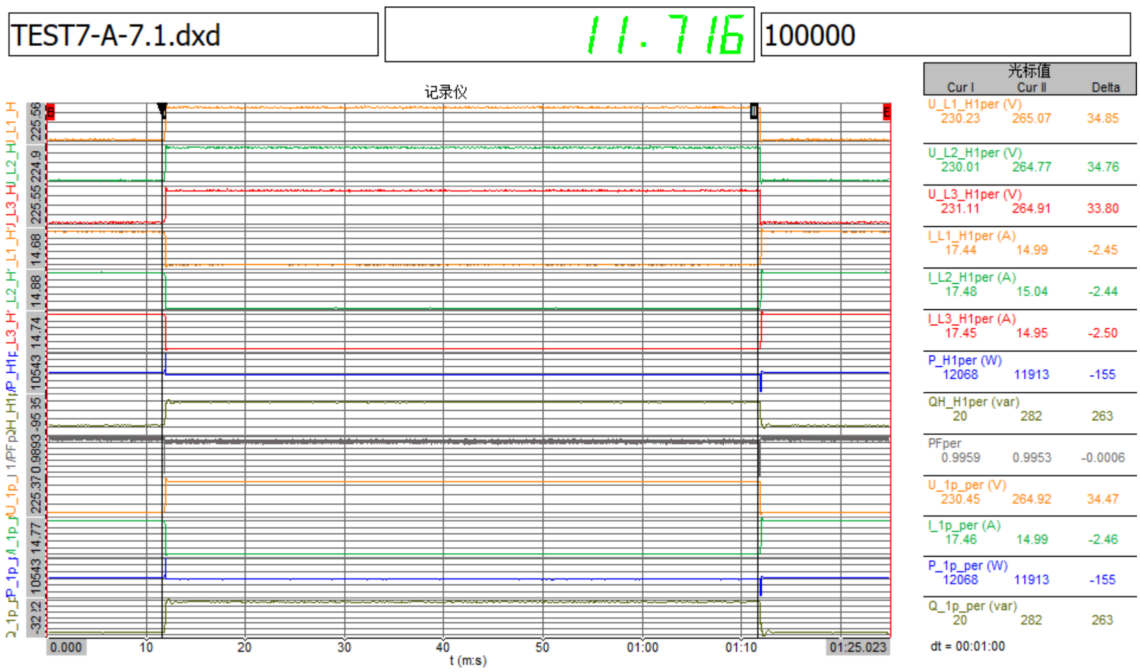
Test 7.1 – symmetrical fault (V/Vnom = 1.10 to 1.15)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	7.1	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.19.21	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase - phase	-	1.15	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11716	[ms]
	7	Time point of fault clearance (t2)	Total	-	71742	[ms]
	8	Fault duration in no load test	Total	-	60026	[ms]
	9	Voltage depth in no load test	Total	t1+100 ms to t2 and t1-10 s to t1	0.15	[p.u.]
	10		Positive sequence		0.07	[p.u.]
Before break-in <t1	11	Voltage	Line-neutral voltage	t1-10 s to t1	1.00	[p.u.]
	12	Current	Positive sequence	t1-500 ms to t1-100 ms	1.00	[p.u.]
	13	Active power	Total	t1-10 s to t1	1.01	[p.u.]
	14		Positive sequence	t1-10 s to t1	1.01	[p.u.]
	15	Reactive power	Positive sequence	t1-10 s to t1	0.00	[p.u.]
	16		Total	t1-10 s to t1	0.00	[p.u.]
	17	cos φ	-	t1-10 s to t1	0.9959	[p.u.]
Dduring the break-in t1 to t2	18	voltage	Line-neutral voltage	t1+100 to to t2-20 ms	1.17	[p.u.]
	19	Phase current	Phase 1	t1 +60 ms	0.93	[p.u.]
	20		Phase 2	t1 +60 ms	0.94	[p.u.]
	21		Phase 3	t1 +60 ms	0.94	[p.u.]
	22	Phase current	Phase 1	t1 +100 ms	0.87	[p.u.]
	23		Phase 2	t1 +100 ms	0.88	[p.u.]
	24		Phase 3	t1 +100 ms	0.88	[p.u.]
	25	Active power	Total	t1 +100 ms to t2-20 ms	1.02	[p.u.]
	26		Positive sequence	t1 +100 ms to t2-20 ms	1.02	[p.u.]
After break-in >t2	27	Voltage	Line-neutral voltage	t2 +3 s to t2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t2 +3 s to t2 +10 s	1.01	[p.u.]
	29		Total	t2 +3 s to t2 +10 s	1.01	[p.u.]
	30	Active power rising time	Positive sequence	-	0.23	[s]

Test 7.1 – symmetrical fault (V/Vnom = 1.10 to 1.15)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	31	Reactive power	Positive sequence	t2 +3 s to t2 +10 s	0.00	[p.u.]
	32		Total	t2 +3 s to t2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t2 to t2 +60 s	Yes	-

Test 7.1 – symmetrical fault - Voltage depth in no load test



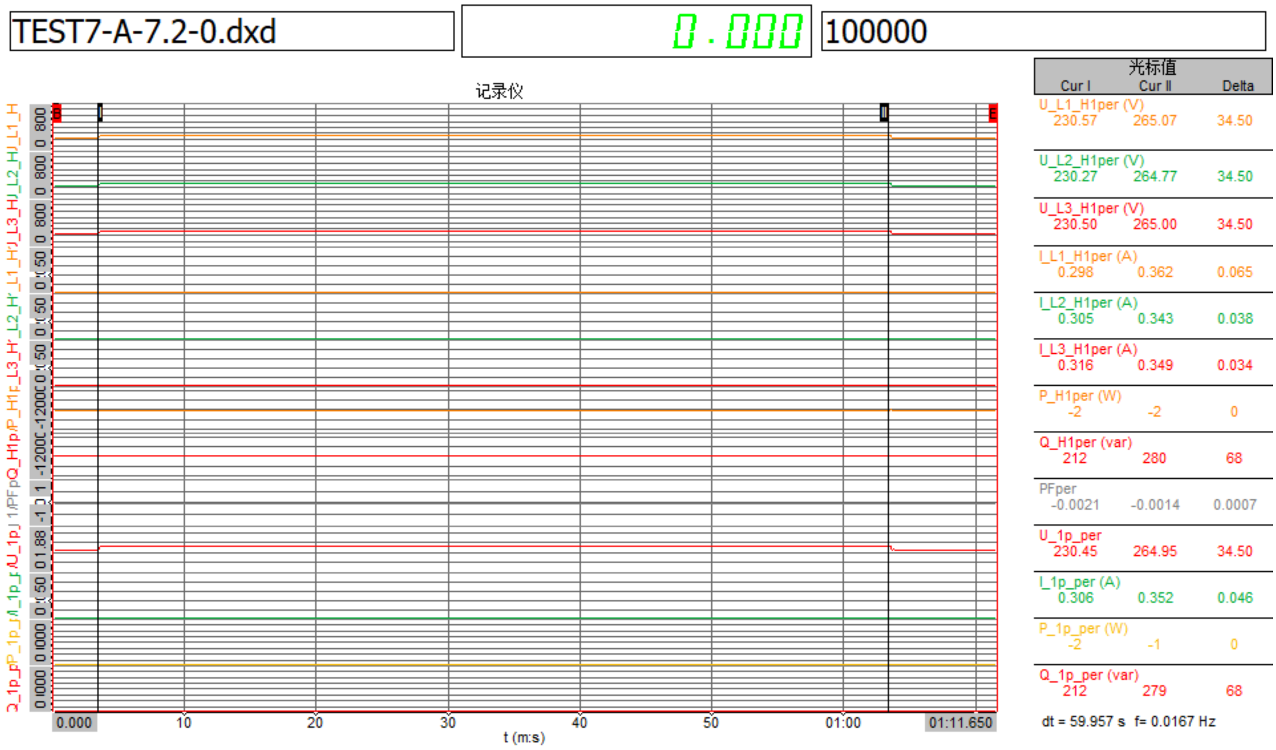
Test 7.1 – symmetrical fault - Fault duration



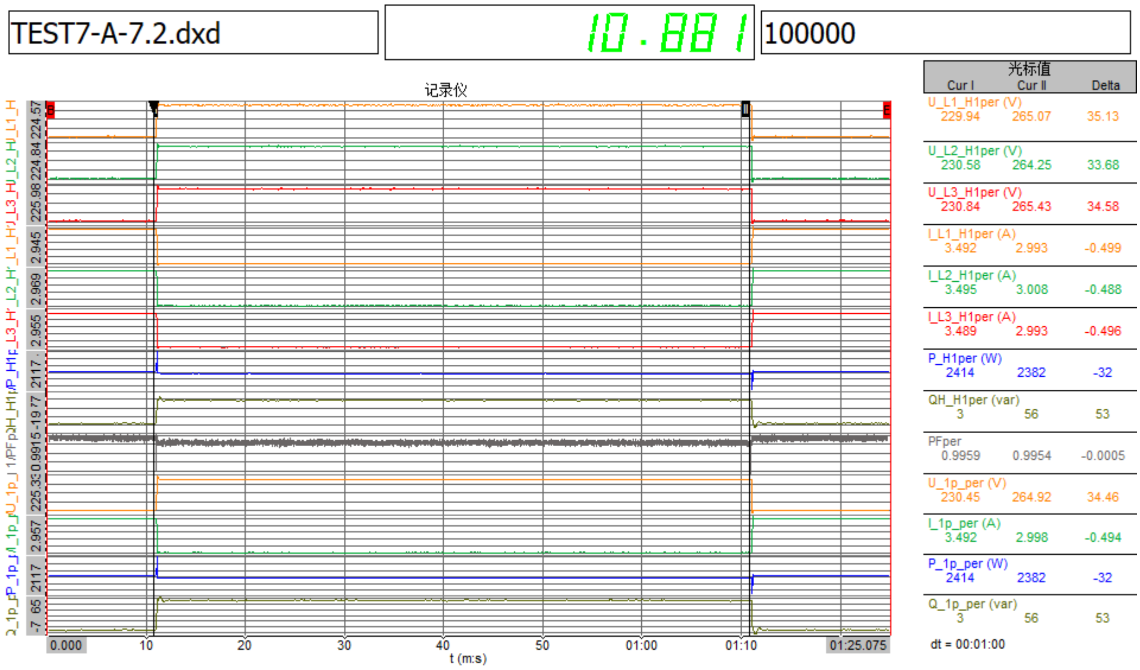
Test 7.2 – symmetrical fault (V/Vnom = 1.10 to 1.15)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	7.2	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.25.34	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	A	-
	4	Setpoint break-in depth	Phase – phase	-	1.15	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10881	[ms]
	7	Time point of fault clearance (t2)	Total	-	70953	[ms]
	8	Fault duration in no load test	Total	-	60072	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.15	[p.u.]
	10		Positive sequence		0.15	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.20	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	0.20	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9959	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.18	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.19	[p.u.]
	20		Phase 2	t_1 +60 ms	0.19	[p.u.]
	21		Phase 3	t_1 +60 ms	0.19	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.18	[p.u.]
	23		Phase 2	t_1 +100 ms	0.18	[p.u.]
	24		Phase 3	t_1 +100 ms	0.18	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	0.21	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	0.21	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	0.20	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	0.20	[p.u.]

Test 7.2 – symmetrical fault (V/Vnom = 1.10 to 1.15)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	30	Active power rising time	Positive sequence	-	0.21	[s]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

Test 7.2 – symmetrical fault - Voltage depth in no load test



Test 7.2 – symmetrical fault - Fault duration

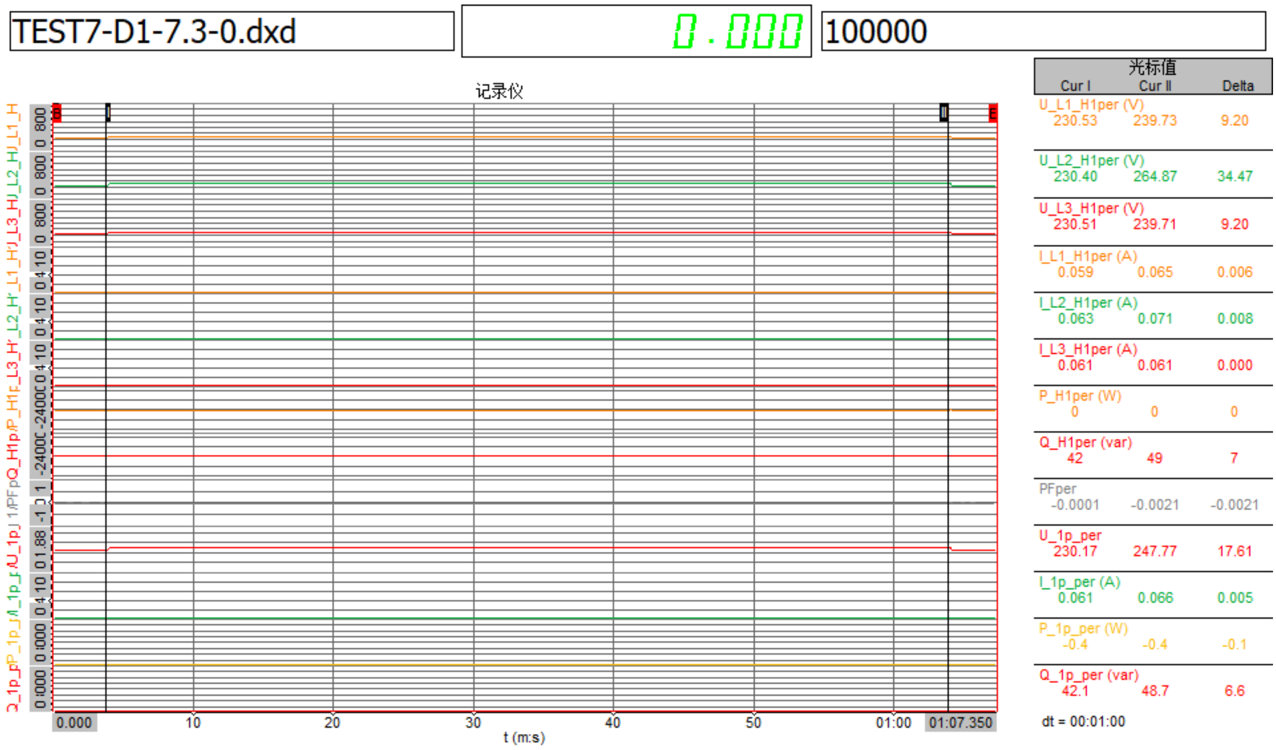


Test 7.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.10 to 1.15)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
General information	0	Test number	-	-	7.3	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.28.10	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	1.15	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	10650	[ms]
	7	Time point of fault clearance (t2)	Total	-	70738	[ms]
	8	Fault duration in no load test	Total	-	60088	[ms]
	9	Voltage depth in no load test	Total	t_1+100 ms to t_2 and t_1-10 s to t_1	0.15	[p.u.]
	10		Positive sequence		0.08	[p.u.]
Before break-in <t_1	11	Voltage	Line-neutral voltage	t_1-10 s to t_1	1.00	[p.u.]
	12	Current	Positive sequence	t_1-500 ms to t_1-100 ms	0.99	[p.u.]
	13	Active power	Total	t_1-10 s to t_1	1.00	[p.u.]
	14		Positive sequence	t_1-10 s to t_1	1.00	[p.u.]
	15	Reactive power	Positive sequence	t_1-10 s to t_1	0.00	[p.u.]
	16		Total	t_1-10 s to t_1	0.00	[p.u.]
	17	cos φ	-	t_1-10 s to t_1	0.9690	[p.u.]
Dduring the break-in t_1 to t_2	18	voltage	Line-neutral voltage	t_1+100 to to t_2-20 ms	1.17	[p.u.]
	19	Phase current	Phase 1	t_1 +60 ms	0.94	[p.u.]
	20		Phase 2	t_1 +60 ms	0.94	[p.u.]
	21		Phase 3	t_1 +60 ms	0.95	[p.u.]
	22	Phase current	Phase 1	t_1 +100 ms	0.94	[p.u.]
	23		Phase 2	t_1 +100 ms	0.88	[p.u.]
	24		Phase 3	t_1 +100 ms	0.94	[p.u.]
	25	Active power	Total	t_1 +100 ms to t_2-20 ms	1.01	[p.u.]
	26		Positive sequence	t_1 +100 ms to t_2-20 ms	1.00	[p.u.]
After break-in >t_2	27	Voltage	Line-neutral voltage	t_2 +3 s to t_2 +10 s	1.01	[p.u.]
	28	Active power	Positive sequence	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	29		Total	t_2 +3 s to t_2 +10 s	1.00	[p.u.]
	30	Active power rising time	Positive sequence	-	0.12	[s]

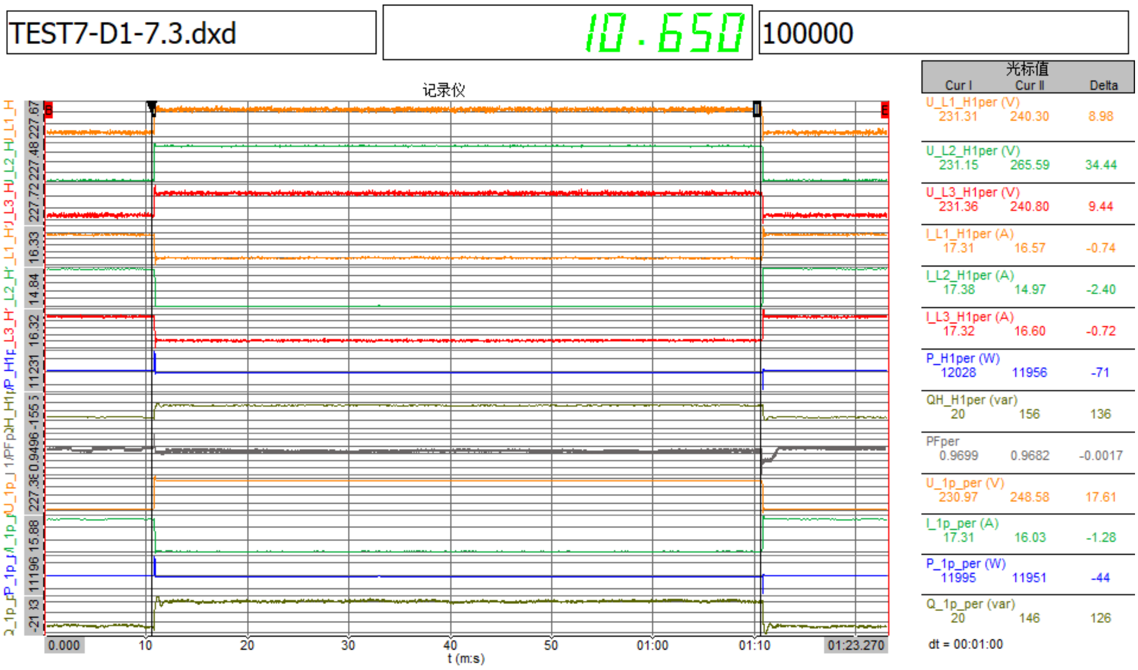
Test 7.3 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.10 to 1.15)

	No.	Parameter	phase reference	reference time	Value	[Unit]
	31	Reactive power	Positive sequence	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	32		Total	t_2 +3 s to t_2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	-	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t_2 to t_2 +60 s	Yes	-

Test 7.3 – symmetrical fault - Voltage depth in no load test



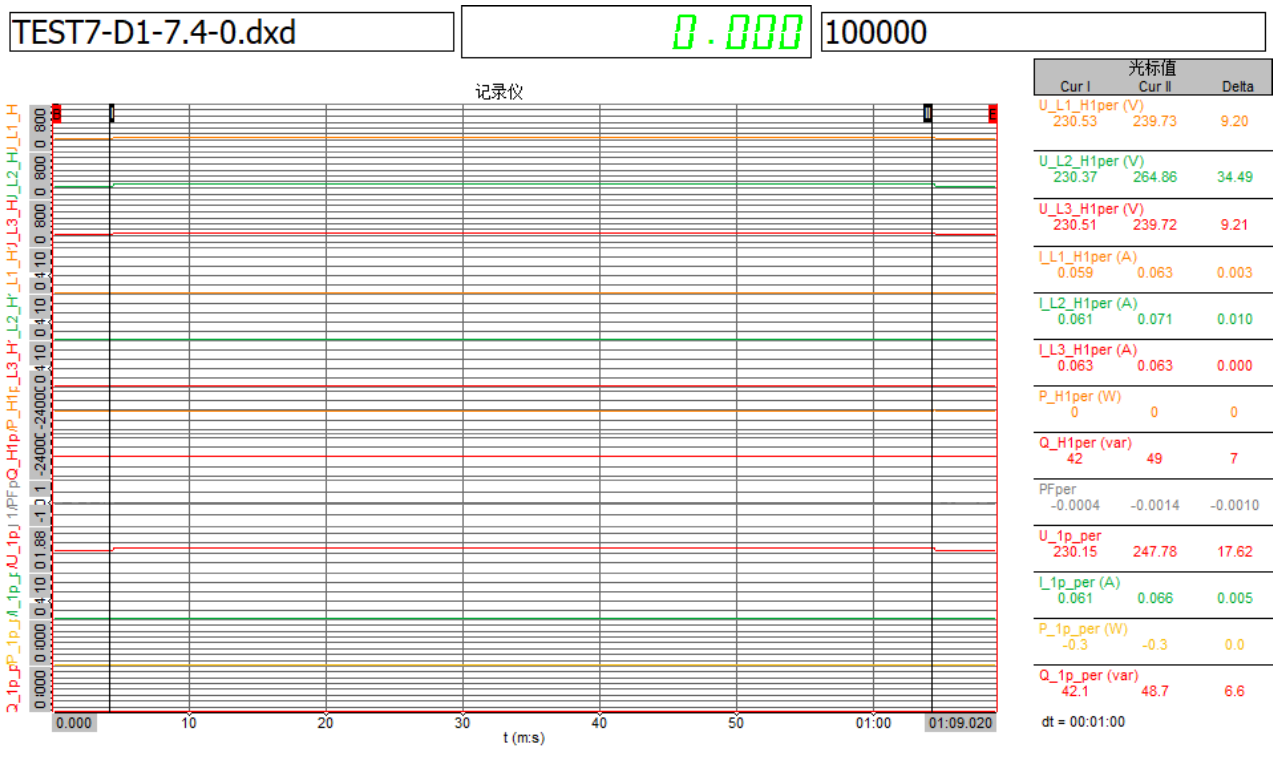
Test 7.3 – Asymmetrical fault - Fault duration



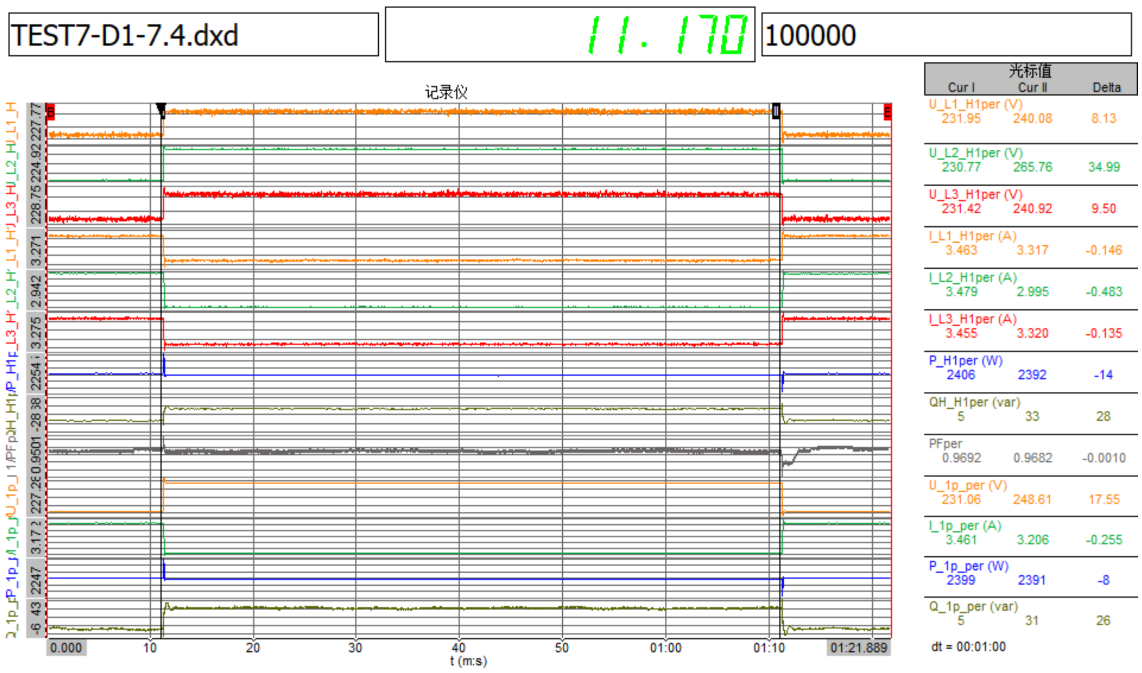
Test 7.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.10 to 1.15)						
	No.	Parameter	phase reference	reference time	Value	[Unit]
General information	0	Test number	-	-	7.4	-
	1	Date	-	-	21.3.2024	[dd.mm.yyyy]
	2	Time (start of the test)	-	-	18.43.19	[hh.mm.ss.f]
	3	Type of error (affected phases)	-	-	D1	-
	4	Setpoint break-in depth	Phase – phase	-	1.10	[p.u.]
	5	Setpoint fault duration	-	-	60000	[ms]
	6	Time point of fault occurrence (t1)	Total	-	11170	[ms]
	7	Time point of fault clearance (t2)	Total	-	71170	[ms]
	8	Fault duration in no load test	Total	-	60000	[ms]
	9	Voltage depth in no load test	Total	t1+100 ms to t2 and t1-10 s to t1	0.15	[p.u.]
	10		Positive sequence		0.08	[p.u.]
Before break-in <t1	11	Voltage	Line-neutral voltage	t1-10 s to t1	1.01	[p.u.]
	12	Current	Positive sequence	t1-500 ms to t1-100 ms	0.20	[p.u.]
	13	Active power	Total	t1-10 s to t1	0.20	[p.u.]
	14		Positive sequence	t1-10 s to t1	0.20	[p.u.]
	15	Reactive power	Positive sequence	t1-10 s to t1	0.00	[p.u.]
	16		Total	t1-10 s to t1	0.00	[p.u.]
	17	cos φ	-	t1-10 s to t1	0.9680	[p.u.]
Dduring the break-in t1 to t2	18	voltage	Line-neutral voltage	t1+100 to to t2-20 ms	1.18	[p.u.]
	19	Phase current	Phase 1	t1 +60 ms	0.19	[p.u.]
	20		Phase 2	t1 +60 ms	0.19	[p.u.]
	21		Phase 3	t1 +60 ms	0.19	[p.u.]
	22	Phase current	Phase 1	t1 +100 ms	0.19	[p.u.]
	23		Phase 2	t1 +100 ms	0.18	[p.u.]
	24		Phase 3	t1 +100 ms	0.19	[p.u.]
	25	Active power	Total	t1 +100 ms to t2-20 ms	0.20	[p.u.]
	26		Positive sequence	t1 +100 ms to t2-20 ms	0.20	[p.u.]
After break-	27	Voltage	Line-neutral voltage	t2 +3 s to t2 +10 s	1.01	[p.u.]
	28	Active power	Positive sequence	t2 +3 s to t2 +10 s	0.20	[p.u.]
	29		Total	t2 +3 s to t2 +10 s	0.20	[p.u.]

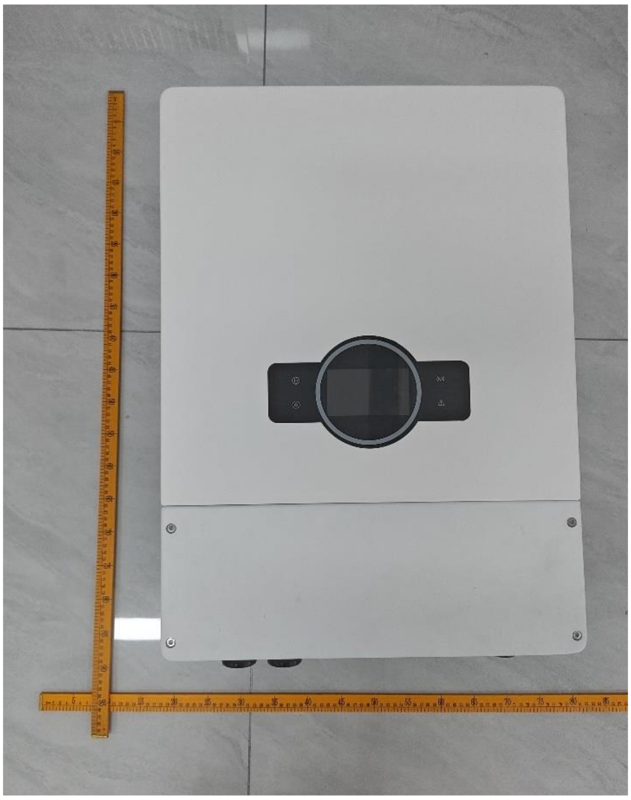
Test 7.4 – Asymetric (ph-2-ph + Dy5-Trafo) fault (V/Vnom = 1.10 to 1.15)						
	No.	**Parameter**	**phase reference**	**reference time**	**Value**	**[Unit]**
	30	Active power rising time	Positive sequence	-	0.18	[s]
	31	Reactive power	Positive sequence	t2 +3 s to t2 +10 s	0.00	[p.u.]
	32		Total	t2 +3 s to t2 +10 s	0.00	[p.u.]
	33	Reactive power rising time	Positive sequence	-	–	[s]
	34	Generator has not disconnected from the grid within 60 s after the end of the fault	-	t2 to t2 +60 s	Yes	-

Test 7.4 – symmetrical fault - Voltage depth in no load test



Test 7.4 – Asymmetrical fault - Fault duration



Pictures of the unit
 Front enclosure view for all models (No screen)
 Front enclosure view for all models (screen)

Pictures of the unit
 Back enclosure view for all models
 Left enclosure view for all models (No screen)

Pictures of the unit

Left enclosure view for all models(screen)

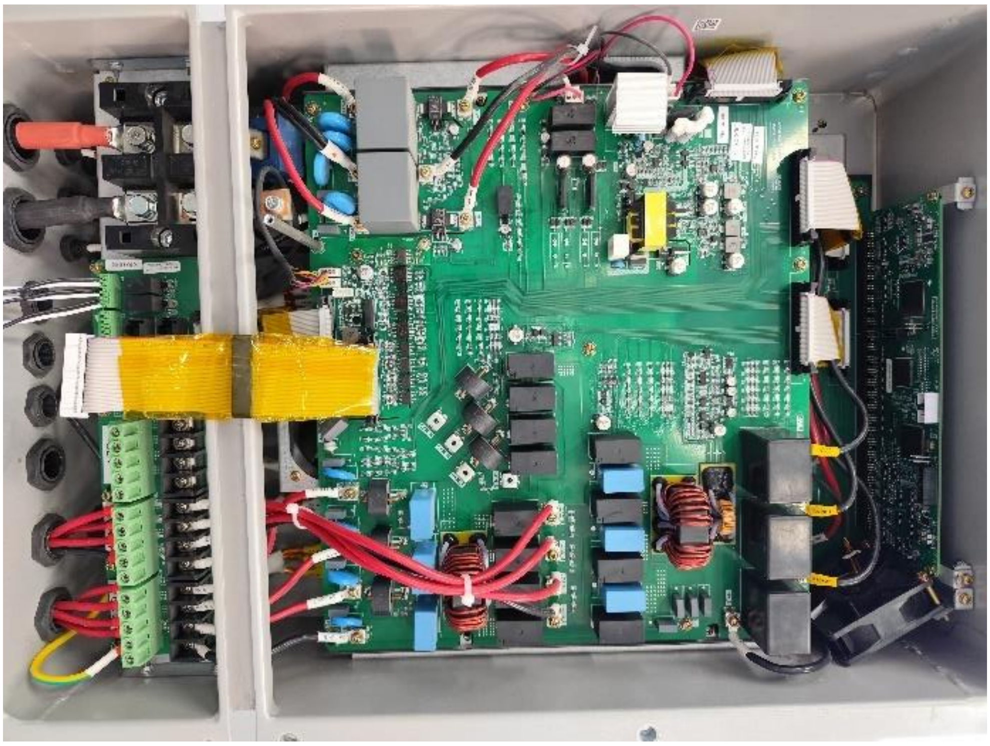
Right enclosure view for all models (No screen)

Pictures of the unit
 Right enclosure view for all models (screen)
 Top enclosure view for all models (No screen)

Pictures of the unit
 Top enclosure view for all models(screen)
 Bottom enclosure view for all models (No screen)

Pictures of the unit

Bottom enclosure view for all models(screen)



Internal view all models

Test Equipment list				
No	**Test Equipment**	**Equipment model**	**Equipment No.**	**Calibration due date**
1	AC supply	KACM-75-33	BZ-DGD-L193	2024/11/01
2	DC supply	Chroma 6215011-1000s	BZ-DGD-L009	2025/01/22
3	Programmable ac load	ACLT-3820	BZ-DGD-L063	2024/09/06
4	Power analyser	PA6000H	BZ-DGD-L059	2024/09/19
5	Power analyser	DEWE2-PA7	BZ-DGD-L119	2024/10/20
6	Current sensor	CT6863-05	BZ-DGD-L026-1	2025/01/22
7	Current sensor	CT6863-05	BZ-DGD-L026-2	2025/01/22
8	Current sensor	CT6863-05	BZ-DGD-L026-3	2025/01/22
9	Current sensor	CT6863-05	BZ-DGD-L026-4	2025/01/22

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