Product Service

# TEST REPORT
## Standard VDE-AR-N 4105:2018
## TUV SUD Test Report for Technical requirements for the connection of generator to and parallel operation with low-voltage distribution networks

| | |
|---|---|
| Report No.: | 64.290.23.30722.01 |
| Date of issue: | 2023-06-13 |
| Project handler: | Jinjing Peng |
| Testing laboratory: | TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch |
| Address: | TÜV SÜD Testing Center, D1 building, No. 63 Chuangqi Road, Shilou Town, Panyu District, Guangzhou 511447, P.R. China |
| Testing location: | as above |
| Client: | EAST Group Co., Ltd. |
| Client number: | 076644 |
| Address: | No.6 Northern Industry Road, Songshan Lake Sci. & Tech. Industry Park, 523808 DongGuan City, Guangdong Province PEOPLE'S REPUBLIC OF CHINA |
| Contact person: | Haijian Pan |
| Standard: | This TUV SUD test report form is based on the following requirements: VDE-AR-N 4105:2018+ DIN VDE V 0124-100:2020 |
| TRF number and revision: | TRF VDE-AR-N 4105:2018 rev.0/2018-11 |
| TRF originated by: | TUV SUD Product Service, Mr. Billy Qiu |
| Copyright blank test report: | This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TUV SUD Product Service.<br><br>TUV SUD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context. |
| General disclaimer: | This test report may only be quoted in full. Any use for advertising purposes must be granted in writing. This report is the result of a single examination of the object in question and is not generally applicable evaluation of the quality of other products in regular production. |
| Scheme: | ☐ TUV Mark ☐ EU-Directive ☒ Type verification of conformity<br>☐ GS Mark ☐ NRTL Mark ☐ without certification |
| Non-standard test method: | ☒ No ☐ Yes, see details under Summary of testing |
| National deviations: | N/A |
| Number of pages *(Report)*: | 151 |
| Number of pages *(Attachments)*: | N/A |
| Compiled by: | Jinjing Peng<br>*(Printed Name and Signature)* |
| Approved by: | Lucas Lu<br>*(Printed Name and Signature)* |



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| | |
|---|---|
| Type of test object: | Hybrid Inverter |
| Trademark: |  |
| Model and/or type reference: | EAHI-3000-SL, EAHI-3600-SL, EAHI-5000-SL, EAHI-6000-SL |
| Rating(s): | See page of 6 |
| Manufacturer: | EAST Group Co., Ltd. |
| Manufacturer number: | 076644 |
| Address: | No.6 Northern Industry Road, Songshan Lake Sci. & Tech. Industry Park, 523808 DongGuan City, Guangdong Province PEOPLE'S REPUBLIC OF CHINA |
| **Name and address of factory (ies)** *(only if certification is provided)*: | |
| Factory name: EAST Group Co., Ltd.<br>Address: No.6 Northern Industry Road, Songshan Lake Sci. & Tech. Industry Park, 523808 DongGuan City, Guangdong Province PEOPLE'S REPUBLIC OF CHINA | |
| Sub-contractors/ tests (clause): | N/A |
| Name: | N/A |
| Order description: | ☒ Complete test according to TRF |
| | ☐ Partial test according to manufacturer's specifications |
| | ☐ Preliminary test |
| | ☐ Spot check |
| | ☐ Others: |
| Date of order: | 2023-04-07 |
| Date of receipt of test item: | 2023-04-25 |
| Date(s) of performance of test: | 2023-04-25 to 2023-05-17 |



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| | |
|---|---|
| **Test item particulars** ..... : | |
| Equipment mobility ..... : | ☐ movable ☐ hand-held ☐ stationary<br>☒ fixed ☐ transportable ☐ for building-in |
| Connection to the mains ..... : | ☐ pluggable equipment ☐ direct plug-in<br>☒ permanent connection ☐ for building-in |
| Enviromental category ..... : | ☒ outdoor ☐ indoor unconditional ☐ indoor conditional |
| Over voltage category Mains..... : | ☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV |
| Over voltage category PV..... : | ☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV |
| Mains supply tolerance (%) ..... : | +/- 10% |
| Tested for power systems ..... : | TN system |
| IT testing, phase-phase voltage (V) .....: | N/A |
| Class of equipment.....: | ☒ Class I ☐ Class II ☐ Class III<br>☐ Not classified |
| Mass of equipment (kg) .....: | 21.4kg (EAHI-3000-SL, EAHI-3600-SL), 24.8(EAHI-5000-SL, EAHI-6000-SL) |
| Pollution degree.....: | PD 3 (External), PD 2 (Internal) |
| IP protection class .....: | IP 66 |
| **Possible test case verdicts:** | |
| test case does not apply to the test object: | N/A (not applicable / not included in the order) |
| test object does meet the requirement: | P (Pass) |
| test object does not meet the requirement: | F (Fail) |
| **Possible suffixes to the verdicts:** | |
| suffix for detailed information for the client: | C (Comment) |
| suffix for important information for factory inspection: | M (Manufacturing) |



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**Purpose of the product** (Description of intended use):

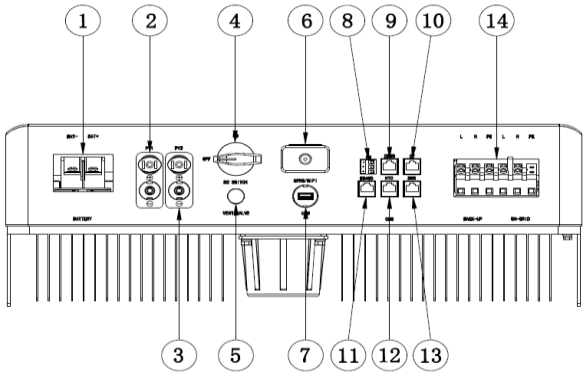
1. The unit is non-isolated (transformerless) hybrid inverter for connection with public low voltage grid, for outdoor use.

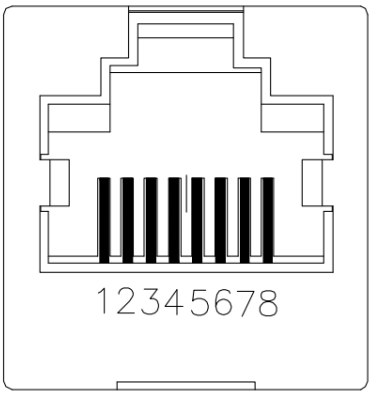
2. The unit may be connected single-phase, a storage unit and a balancing device must be used to ensure that the requirements of maximum permissible unbalance ≤ 4.6kVA according to 5.5.2 of VDE-AR-N 4100 are met and a registration with the grid operators in the finally installation.

3. If certain functions are not permitted by local regulation, the function shall be disabled by hardware or software setting (if applicable) by the manufacturer before putting into the market. For example, it's not permissible to draw electricity from the grid and then feed it back in order to claim statutory reimbursement in some nations.

4. Low voltage electrical installations shall comply with national and local regulation. Only qualified electricians are allowed to install and maintain the converter.

5. The scheme of remote control as below: data-logger receives the command from central computer and transfers it to the signal to PGU's RS-485 port, after receiving the signal, the inverter will decrease output active power to zero in 5 seconds. The RS-485 port and the connection schematic are as below:




| S/N | Mark | Purpose |
|---|---|---|
| 1 | Battery terminal | Connect the battery |
| 2 | Positive PV terminal | Connect the PV positive electrode |
| 3 | Negative PV terminal | Connect the PV negative electrode |
| 4 | PV input switch | Connect/ disconnect the PV switch |
| 5 | Vent valve | Discharge the growing air from housing |
| 6 | GPRS/WIFI | The inverter uploads the data/ connects with the upper computer by GPRS/WIFI |
| 7 | USB | USB upgrade interface |
| 8 | Dry contact input | Connect the user's dry contact circuit |
| 9 | Safety communication | Reserved according to Australia safety regulation |
| 10 | CT or kilo-watt-hour meter signal input | CT or kilo-watt-hour meter signal input provided externally on the inverter |
| 11 | RS485 | RS485 communication with the upper computer |
| 12 | NTC temperature sampling | Reserved |
| 13 | BMS communication | Battery communication input |
| 14 | AC wiring terminal | Load and grid input |

| Pin | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Definition | RS3_485- | RS3_485- | RS3_485- | RS3_485- | RS3_485+ | RS3_485+ | RS3_485+ | RS3_485+ |

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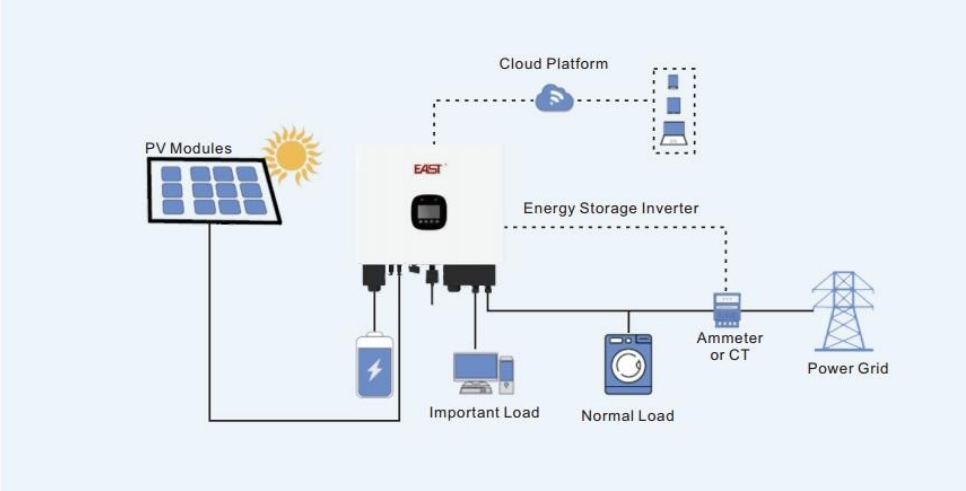
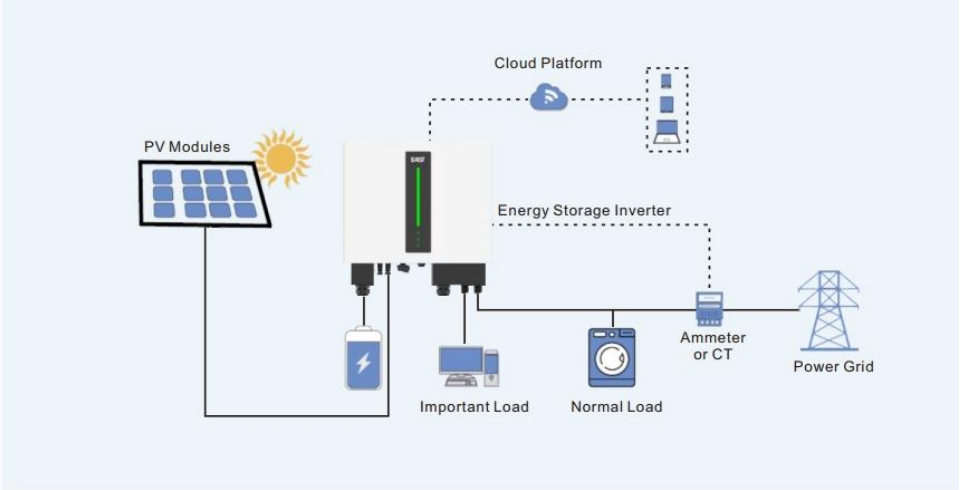
6. $P_{AV.E}$ monitoring function is implemented by the Smart electricity Meter, which measures the voltage and current and sends the data to the PGU. After receiving the power data from the grid connection point and comparing it with $P_{AV.E}$, if it is greater than $P_{AV.E}$, the PGU reduces the active power until finally the active power is equal to the set value of $P_{AV.E}$. $P_{AV.E}$ is 60% of the rated power.




**LCD Model**




**LED Model**

7. Software version: V1002, DSP: V1002, MCU: V1005, Firmware version: V1.0.

**Model differences:**

Model EAHI-6000-SL is the basic model, other models have same electric circuits topology design, same enclosure structure design, same main control circuits and firmware. The output power and current are limited by software. All models have LCD and LED appearance. Other differences are as follows:

| Component | Model | |
|---|---|---|
| | EAHI-3000-SL, EAHI-3600-SL | EAHI-5000-SL, EAHI-6000-SL |
| MPPT Tracker number | 1 | 2 |
| Inverter inductor | Single magnetic ring NPF22060 2.0*68Ts, 597.8uH±10% | Triple magnetic ring NPS22060*3P 1.7*2P 38Ts, 597.8uH±10% |
| DC switch | PEDS150R-HM25-2 | PEDS150R-HM25-4 |
| INV IGBT tube | JT050N065WED (650V, 50A, -55°C-175°C) | JT075N065WED (650V, 75A,-40°C-175°C)<br>CRG75T65AK5SD (650V, 75A, -55°C-150°C) |

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**Characteristic data** *(not shown on the marking plate)*:

| Model | EAHI-3000-SL | EAHI-3600-SL | EAHI-5000-SL | EAHI-6000-SL |
|---|---|---|---|---|
| PV input rating | | | | |
| Rated input voltage | 360 V d.c. | | | |
| Maximum input voltage | 550 V d.c. | | | |
| MPPT voltage range | 100 V d.c. – 540 V d.c. | | | |
| Full-load voltage range | 250 V d.c. – 450 V d.c. | | | |
| Maximum input current | 15 A d.c. | | 15 A d.c.*2 | |
| Maximum short circuit current | 20 A d.c. | | 20 A d.c.*2 | |
| Maximum input power | 4680 W | 4680 W | 6500 W | 7800 W |
| Battery input / output rating | | | | |
| Battery type | Lead-acid / Li-ion battery | | | |
| Rated voltage | 48.0 V d.c. / 51.2 V d.c. | | | |
| Battery voltage range | 42.0 V d.c. – 58.0 V d.c. | | | |
| Maximum charging current | 66 A d.c. | 75 A d.c. | 100 A d.c. | 100 A d.c. |
| Maximum charging power | 3000 W | 3600 W | 5000 W | 5000 W |
| Maximum discharging current | 66 A d.c. | 75 A d.c. | 100 A d.c. | 120 A d.c. |
| Maximum discharging power | 3000 W | 3600 W | 5000 W | 6000 W |
| Grid input rating | | | | |
| Rated input voltage | 230 V a.c. | | | |
| Rated output current | 13.05 A a.c. | 15.7 A a.c. | 21.8 A a.c. | 26.09 A a.c. |
| Maximum continuous input current | 13.05 A a.c. | 15.7 A a.c. | 21.8 A a.c. | 26.09 A a.c. |
| Maximum input power from grid to battery | 3000 W | 3600 W | 5000 W | 6000 W |
| Maximum input power from grid | 3000 W | 3600 W | 5000 W | 6000 W |
| Rated input frequency | 50 Hz | | | |
| Grid output rating | | | | |
| Rated output voltage | 230 V a.c. | | | |
| Rated output current | 13.05 A a.c. | 15.7 A a.c. | 21.8 A a.c. | 26.09 A a.c. |
| Maximum continuous output current | 13.05 A a.c. | 15.7 A a.c. | 21.8 A a.c. | 26.09 A a.c. |
| Rated output power | 3000 W | 3600 W | 5000 W | 6000 W |
| Maximum output active power | 3000 W | 3600 W | 5000 W | 6000 W |
| Maximum output apparent power | 3000 VA | 3600 VA | 5000 VA | 6000 VA |
| $P_{Emax}$ | 2999 W | 3622 W | 5020 W | 6025 W |
| $S_{Emax}$ | 3054 VA | 3601 VA | 5038 VA | 6043 VA |
| Rated output frequency | 50 Hz | | | |
| Power factor | 0.8 under-excited to 0.8 over-excited | | | |

**Attachments:**
N/A



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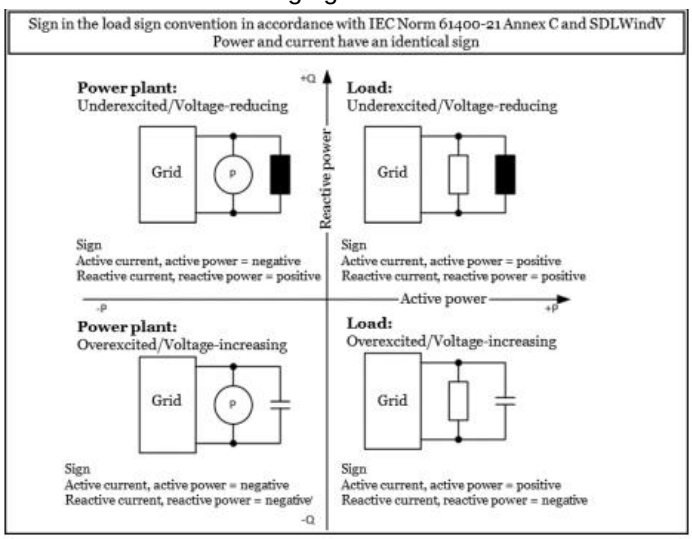
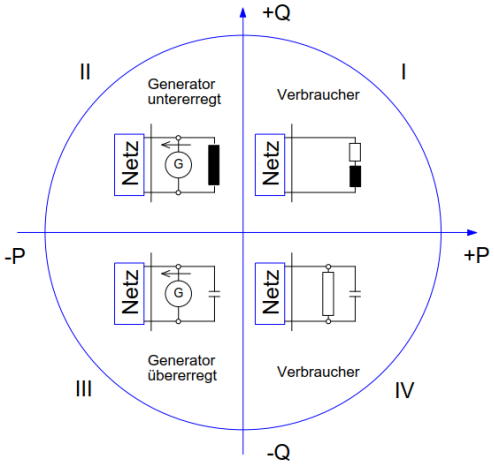
**Summary of testing:**

Full tests method is based on draft standard DIN VDE V 0124-100 (VDE V 0124-100):2020 as a reference, test voltage is on nominal voltage 230 Va.c., and nominal frequency 50Hz.
Load sign convention has been applied for all measurements and results given in this report. This is described in the following figure and table.




| | Capacitive(over-excited) | Inductive(under-excited) |
|---|---|---|
| Consumer (Charge mode) | IV. Quadrant<br>P > 0, the equipment draws active power from the mains (Charge mode)<br>Q < 0, the equipment supplies reactive power to the mains (capacitive behaviour) | I. Quadrant<br>P > 0, the equipment draws active power from the mains (Charge mode)<br>Q > 0, the equipment draws reactive power from the mains (inductive behaviour) |
| Generator (Discharge mode) | III. Quadrant<br>P < 0, the equipment supplies active power from the mains (Discharge mode)<br>Q < 0, the equipment supplies reactive power to the mains (capacitive behaviour) | II. Quadrant<br>P < 0, the equipment supplies active power from the mains (Discharge mode)<br>Q > 0, the equipment draws reactive power from the mains (inductive behaviour) |

| Clause | Test items | Test Model |
|---|---|---|
| 5.2.2 | Rapid voltage change | EAHI-3000-SL<br>EAHI-6000-SL |
| 5.2.3 | Flicker | EAHI-3000-SL<br>EAHI-6000-SL |
| 5.2.4 & 5.2.6 | Harmonics and inter-harmonics & Direct currents feed-in | EAHI-3000-SL<br>EAHI-6000-SL |
| 5.4.2 & 5.4.8.2 | Measurement of the active and reactive power range &Tests of Reactive power / displacement factor adjustment accuracy | EAHI-3000-SL<br>EAHI-3600-SL<br>EAHI-5000-SL<br>EAHI-6000-SL |
| 5.4.3 | Active power reduction by setpoint specification | EAHI-6000-SL |
| 5.4.4 | Active power feed-in from EZE at overfrequency | EAHI-6000-SL |



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| | | |
|---|---|---|
| 5.4.6 | Active power supply for EZE at underfrequency | EAHI-6000-SL |
| 5.4.8.3 | Test the displacement factor / active power characteristic curve cos $\varphi(P)$ | EAHI-6000-SL |
| 5.5.2 & 5.5.6.3 | NA protection safety fault test | EAHI-6000-SL |
| 5.5.4 & 5.5.7.4 | Integrated NA Protection and Protective devices and settings | EAHI-6000-SL |
| 5.5.7.2 | Voltage monitoring (integrated protection and interface switch)-setting check | EAHI-6000-SL |
| 5.5.7.3 | Wiring testing | EAHI-6000-SL |
| 5.5.7.5 | Reading the fault messages | EAHI-6000-SL |
| 5.5.9 | Structural features of NS-Protection | EAHI-6000-SL |
| 5.5.10 | Islanding detection | EAHI-6000-SL |
| 5.6 | Connection conditions and synchronisation | EAHI-6000-SL |
| 5.7 | Test of $P_{AV,E}$- monitoring | EAHI-6000-SL |
| 5.8 | Test of dynamic network support | EAHI-6000-SL |

☐ deviation(s) found

☒ no deviations found

**Additional information on Non-standard test method(s)**

Sub clause: N/A

Page: N/A

Rational: N/A

**If additional information is necessary, please provide**

N/A



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**Copy of marking plate:**

## Hybrid Inverter
**MODEL : EAHI-3000-SL**

**PV input**

| | |
|---|---|
| Max. input power | 4680 W |
| Rated input voltage | 360 Vd.c. |
| Max. input voltage | 550 Vd.c. |
| MPPT voltage range | 100 Vd.c. ~ 540 Vd.c. |
| PV max input current | 15 Ad.c. |
| Max. short circuit current | 20 Ad.c. |

**Battery**

| | |
|---|---|
| Rated voltage | 48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion) |
| Max.charge current | 66 Ad.c. |
| Max.discharge current | 66 Ad.c. |

**AC grid**

| | |
|---|---|
| Rated output voltage | 230 Va.c. |
| Rated grid frequency | 50 Hz |
| Rated input/output current | 13.05 Aa.c. |
| Rated input/output power | 3000W |
| Max. apparent power | 3000VA |
| Power factor range | 0.8 leading ~ 0.8 lagging |
| Input voltage range | 207 Va.c. ~ 253 Va.c. |

**Load output**

| | |
|---|---|
| Rated output power | 3000VA/3000W |
| Rated output voltage | 230 Va.c. |
| Rated output current | 13.05 Aa.c. |
| Rated output frequency | 50 Hz |

**General data**

| | |
|---|---|
| Dimensions(W×H×D) | 548x440x197 mm |
| Weight | 21.4 kg |
| Protection rating | IP66 |
| Operating temperature | -25 ~ 60°C |
| Protection class: | I |

HI03C2211300001

5 min

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## Hybrid Inverter
**MODEL : EAHI-3600-SL**

**PV input**

| | |
|---|---|
| Max. input power | 4680 W |
| Rated input voltage | 360 Vd.c. |
| Max. input voltage | 550 Vd.c. |
| MPPT voltage range | 100 Vd.c. ~ 540 Vd.c. |
| PV max input current | 15 Ad.c. |
| Max. short circuit current | 20 Ad.c. |

**Battery**

| | |
|---|---|
| Rated voltage | 48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion) |
| Max.charge current | 75 Ad.c. |
| Max.discharge current | 75 Ad.c. |

**AC grid**

| | |
|---|---|
| Rated output voltage | 230 Va.c. |
| Rated grid frequency | 50 Hz |
| Rated input/output current | 15.7 Aa.c. |
| Rated input/output power | 3600W |
| Max. apparent power | 3600VA |
| Power factor range | 0.8 leading ~ 0.8 lagging |
| Input voltage range | 207 Va.c. ~ 253 Va.c. |

**Load output**

| | |
|---|---|
| Rated output power | 3600VA/3600W |
| Rated output voltage | 230 Va.c. |
| Rated output current | 15.7 Aa.c. |
| Rated output frequency | 50 Hz |

**General data**

| | |
|---|---|
| Dimensions(W×H×D) | 548x440x197 mm |
| Weight | 21.4 kg |
| Protection rating | IP66 |
| Operating temperature | -25 ~ 60°C |
| Protection class: | I |

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5 min

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## Hybrid Inverter
**MODEL : EAHI-5000-SL**

**PV input**

| | |
|---|---|
| Max. input power | 6500 W |
| Rated input voltage | 360 Vd.c. |
| Max. input voltage | 550 Vd.c. |
| MPPT voltage range | 100 Vd.c. ~ 540 Vd.c. |
| PV max input current | 15 Ad.c.+15 Ad. c. |
| Max. short circuit current | 20 Ad.c.+20 Ad. c. |

**Battery**

| | |
|---|---|
| Rated voltage | 48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion) |
| Max.charge current | 100 Ad.c. |
| Max.discharge current | 100 Ad.c. |

**AC grid**

| | |
|---|---|
| Rated output voltage | 230 Va.c. |
| Rated grid frequency | 50 Hz |
| Rated input/output current | 21.8 Aa.c. |
| Rated input/output power | 5000W |
| Max. apparent power | 5000VA |
| Power factor range | 0.8 leading ~ 0.8 lagging |
| Input voltage range | 207 Va.c. ~ 253 Va.c. |

**Load output**

| | |
|---|---|
| Rated output power | 5000VA/5000W |
| Rated output voltage | 230 Va.c. |
| Rated output current | 21.8 Aa.c. |
| Rated output frequency | 50 Hz |

**General data**

| | |
|---|---|
| Dimensions(W×H×D) | 548x440x197 mm |
| Weight | 24.8 kg |
| Protection rating | IP66 |
| Operating temperature | -25 ~ 60°C |
| Protection class: | I |

HI05C2211300001

5 min

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## Hybrid Inverter
**MODEL : EAHI-6000-SL**

**PV input**

| | |
|---|---|
| Max. input power | 7800 W |
| Rated input voltage | 360 Vd.c. |
| Max. input voltage | 550 Vd.c. |
| MPPT voltage range | 100 Vd.c. ~ 540 Vd.c. |
| PV max input current | 15 Ad. c. +15 Ad. c. |
| Max. short circuit current | 20 Ad. c. +20 Ad. c. |

**Battery**

| | |
|---|---|
| Rated voltage | 48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion) |
| Max.charge current | 100 Ad.c. |
| Max.discharge current | 120 Ad.c. |

**AC grid**

| | |
|---|---|
| Rated output voltage | 230 Va.c. |
| Rated grid frequency | 50 Hz |
| Rated input/output current | 26.09 Aa.c. |
| Rated input/output power | 6000W |
| Max. apparent power | 6000VA |
| Power factor range | 0.8 leading ~ 0.8 lagging |
| Input voltage range | 207 Va.c. ~ 253 Va.c. |

**Load output**

| | |
|---|---|
| Rated output power | 6000VA/6000W |
| Rated output voltage | 230 Va.c. |
| Rated output current | 26.09 Aa.c. |
| Rated output frequency | 50 Hz |

**General data**

| | |
|---|---|
| Dimensions(W×H×D) | 548x440x197 mm |
| Weight | 24.8 kg |
| Protection rating | IP66 |
| Operating temperature | -25 ~ 60°C |
| Protection class: | I |

HI06C2211300001

5 min

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Remark: For application of this standard, the nominal voltage is 230 V a.c., nominal frequency is 50 Hz, and the power factor range: 0.8 under-excited … 0.8 over-excited.



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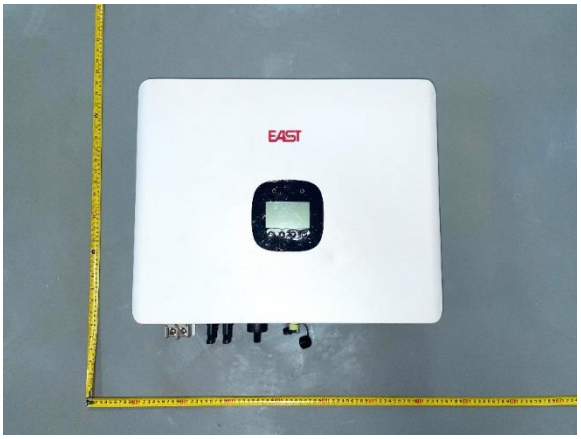
**Pictures of the product:**

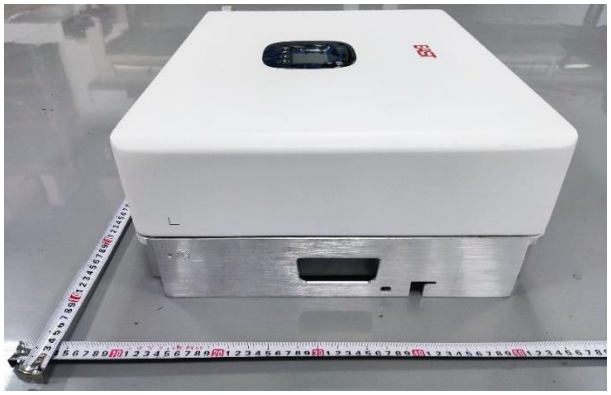
Inverter front view (LED)

Inverter front view (LCD)



Inverter right view

-



Overall view

Inverter terminal view
(EAHI-3000-SL, EAHI-3600-SL)

Inverter terminal view
(EAHI-5000-SL, EAHI-6000-SL)



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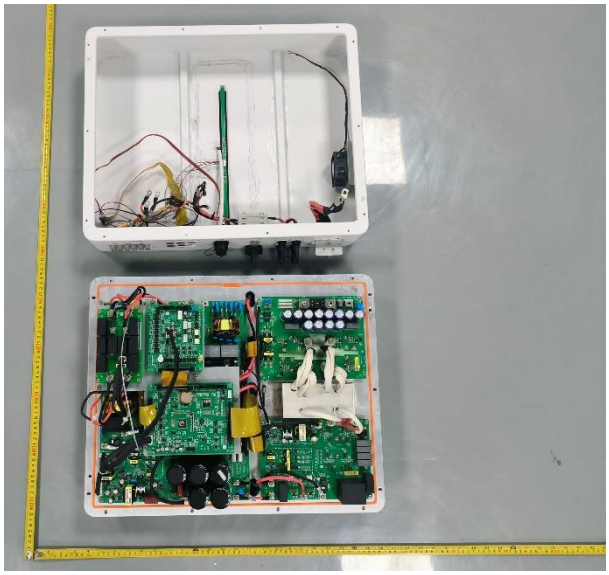
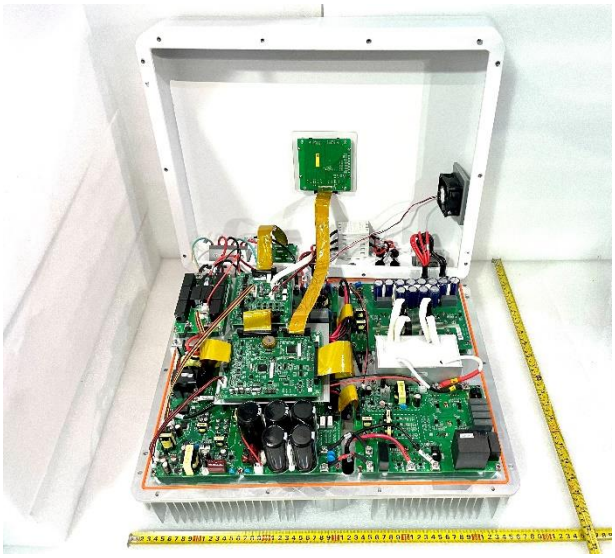
Inverter terminal view (With Terminal Cover)
(EAHI-3000-SL, EAHI-3600-SL)

Inverter terminal view(With Terminal Cover)
(EAHI-5000-SL, EAHI-6000-SL)

Internal view after opening the LED cover



Internal view after opening the LCD cover



**General remarks:**

*"(see remark #)" refers to a remark appended to the report.*
*"(see appended table)" refers to a table appended to the report.*
*Throughout this report a point is used as the decimal separator.*
*The test results presented in this report relate only to the object tested.*
*This report shall not be reproduced except in full without the written approval of the testing laboratory.*

**Abbreviations used in the report:**

Active power (P),
Reactive power (Q),
Apparent power (S),
Maximum apparent power of a power generation system ($S_{Amax}$),
Maximum apparent power of a power generation unit ($S_{Emax}$),
Maximum active power of a power generation system ($P_{Amax}$),
Maximum active power of a power generation unit ($P_{EMax}$),
Networks short-circuit power ($S_{kV}$),



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Point of common coupling (PCC),
Displacement factor (cos φ),
Power factor (λ),
Network impedance angle ($\psi_k$),
Short-term flicker strength ($P_{st}$),
Long-term flicker strength ($P_{lt}$),
Automatic reclosing (AR; geman: Automatische Widereinschaltung, AWE),
Power generation system (PGS; german: Erzeugungsanlage, EZA),
Power generation unit (PGU; german: Erzeugungseinheit, EZE),
Network and system protection (NS protection; german Netz- und Anlagenshutz, NA-Shutz),
Maximum switching current factor ($K_{imax}$),
Agreed active power of a connection for feed-in ($P_{AV, E}$)



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| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| VDE-AR-N 4105:2018 | | | |
| **5** | Grid connection | | P |
| 5.1 | Principles for determining the grid connection point | Determined in final installation | N/A |
| 5.2 | Rating of grid operation equipment | To be considered in final PGS | N/A |
| 5.3 | Permissible voltage change | | N/A |
| | For undisturbed operation of the network, the amount of the voltage change caused by all power generation systems with a network connection point in a low-voltage network shall at none of the PCCs in this network may a value of 3 % as compared with the voltage without power generation systems | Verified on system level with grid impedance | N/A |
| 5.4 | Grid reaction | See appendix table | P |
| | The permissible limits for network repercussions are also described for generation plants and storage in VDE-AR-N 4100, 5.4. For the connection assessment of generation plants and storage, the connector provides the network operator with the completed preprints E.2 to E.5 | Evaluated according to DIN VDE V 0124-100:2020, see below table | P |
| 5.5 | Connection criteria | | P |
| 5.5.1 | General | | P |
| 5.5.2 | $P_{AV, E}$ monitoring (feed-in limitation) | | P |
| | The measurement of the feed-in limit described in this subsection must be carried out at the central meter panel according to VDE-AR-N 4100, 7.2 | | P |
| | If exceeding the $P_{AV, E}$, the power of generation system and/or energy storage must be reduced within blue curve with specified time response according to Fig-1 | | P |



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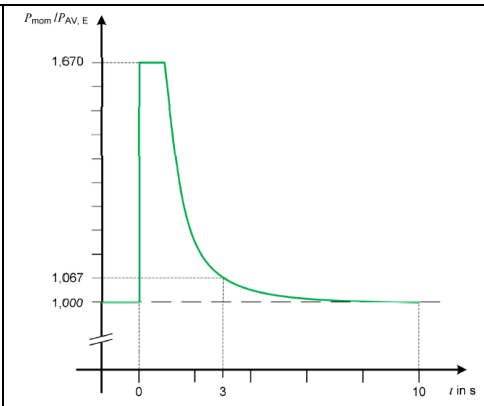
| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| |  <br>Figure 1 – Active power limit curve for power generation systems | | |
| 5.5.3 | Generation system ready for socket connection | | P |
| 5.6 | Three-phase converter system | | P |
| | In the case of three phase generation systems with grid feed-in via converters, the power must be fed three-phase symmetrically into the three outer conductors. The converter circuit is preferably to be built up as a rotary power unit. The positive sequence value must be used as a reference for the currents, even if the terminal voltages are not symmetrical. | | P |
| 5.7 | Behaviour of the power generation system at the grid | | P |
| 5.7.1 | General | | P |
| | If the grid frequency is between 47.5Hz and 51.5Hz, disconnection from grid is not permitted. The active power output shall follow Cl. 5.7.4.3. | Declaration by manufacturer | P |
| | The frequency/time requirement of operation of generation system are:<br>47.5Hz to 49.0Hz: >30 min;<br>49.0Hz to 51.0Hz: permanent;<br>51.0Hz to 51.5Hz: >30 min. | Declaration by manufacturer | P |
| | Generation unit must remain connection during rapid frequency change (RoCoF):<br>+/- 2.0Hz/s for average time window of 0.5s;<br>+/- 1.5Hz/s for average time window of 1s or<br>+/-1.25Hz/s for average time window of 2s | Declaration by manufacturer | P |
| 5.7.2 | Static voltage supporting/Reactive power control | | P |



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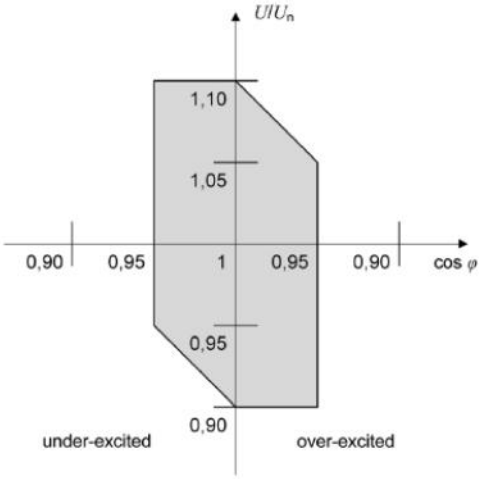
| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| 5.7.2.1 | General range condition | | P |
| | For static voltage supporting, the generation system should control reactive power to support slow (quasi-station) voltage change in distribution grid within agree limit | | P |
| | The reactive power controlling process is described in Cl. 5.7.2.4 with 3 methods | | P |
| | For energy storage system, during energy consumption from grid, the requirement should follow VDE-AR-N 4100 | | P |
| 5.7.2.2 | Reactive power control during $S_{Emax}$ | See appendix table | P |
| | For type 2 system with only converter, the output displacement factor should cover the area described in Fig-2 or Fig-3<br>  <br><br>**Figure 2 – Requirements for power generation units regarding the reactive power supply at the generator terminals ($\sum S_{Emax} \leq 4{,}6$ kVA)** | Evaluated according to DIN VDE V 0124-100:2020, cl 5.4.2, see below table, 0.8 under-excited to 0.8 over-excited | P |
| 5.7.2.3 | Reactive power control under $P_{Emax}$ | | P |
| | In addition, when active power is less than PEmax, the reactive power control should fulfil below requirement: | Evaluated according to DIN VDE V 0124-100:2020 Cl.5.4.2. See appended table | P |
| | The minimum reactive power control area should cover the red triangle P/Q diagram in Fig-5 or Fig-6. In the free operation area, a reduction of active power to facilitate reactive power is permitted | See appendix table | P |
| | The maximal deviation between setting value and actual value of the controlled reactive power should be 4.0% of $S_{Emax}$. In | | P |



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| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| | range of $0<P_{mom}/S_{Emax}<0.2$(or 0.1), the reactive power should be less than 10% of $S_{Emax}$. | | |
| 5.7.2.4 | Behaviour/process of reactive power control | | P |
| | The static voltage supporting with reactive power control should not influence dynamic grid supporting. The generation system should control the reactive power within range described in Fig-5 or Fig-6 using one of below process of controlling reactive power. The selection of process is informed during plan of grid connection | | P |
| | a) Reactive power-Voltage Q(U) | | N/A |
| | The reference voltage UQ0 is 400V/1.732 and calculation method could be arithmetic average of RMS value of three L-N voltage or positive sequence voltage. The voltage measurement tolerance should be less than 1% of rated voltage | | N/A |
| | The Q(U) control is only applicable to 3 phase generation unit and the requirement is performed on generation unit terminals | | N/A |
| | b) Displacement factor-Active power cos phi (P) | Evaluated according to DIN VDE V 0124-100:2020, cl 5.4.8.3, see below table | P |
| | The displacement power factor is dependent on the actual active power output according to Fig-8 and Fig-9 | | P |



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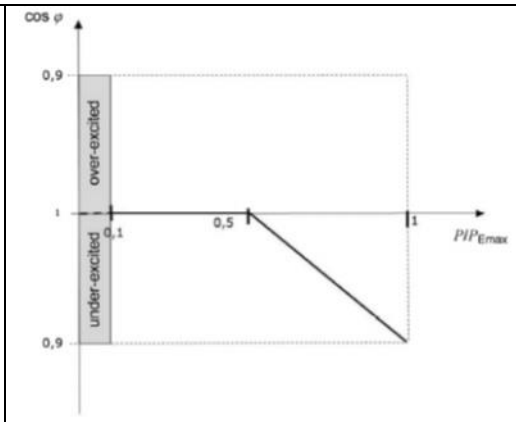
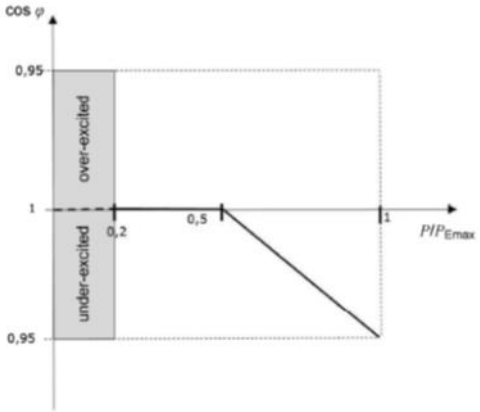
| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| |  <br>**Figure 9 – Standard characteristic curve for type 2 (inverters only)** $\sum S_{Emax} > 4{,}6$ kVA<br>  <br>**Figure 8 – Characteristic curve for type 2** $\sum S_{Emax} \leq 4{,}6$ kVA **and type 1, stirling generator, fuel cell** $\sum S_{Emax} > 4{,}6$ kVA | | |
| | c) Fixed displacement factor cos phi | Evaluated according to DIN VDE V 0124-100:2020, cl 5.4.8.2, see below table | P |
| | The displacement power factor is set as fixed value with minimal setting step value 0.01 and the maximal deviation between setting value and actual value of the controlled reactive power should be 4.0% of $S_{Emax}$. | | P |
| 5.7.2.5 | Requirement for the reactive power process of Type 2 system and Type 1 system | | P |
| | The control process of reactive power (process a, b and c) during setting value adjustment should follow PT-1 process of Fig-10. The PT-1 process 3 Tau should be | | P |



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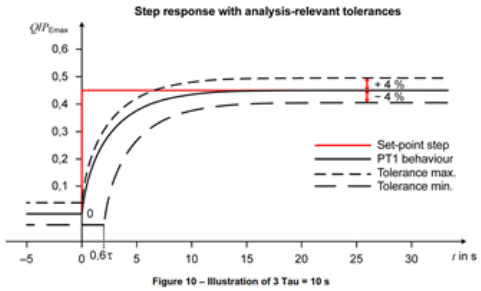
| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| | settable between 6s and 60s for Type 2 system with default setting as 10s.<br>  <br><br>Figure 10 – Illustration of 3 Tau = 10 s | | |
| 5.7.2.6 | Particular requirement during extension of generation system | Determined in final installation | N/A |
| 5.7.3 | Dynamic grid supporting | Evaluated according to DIN VDE V 0124-100:2020, cl 5.8, see below table | P |
| 5.7.3.1 | General | | P |
| | A grid fault start if the voltage at generation unit terminals is under 0.85 Un or over 1.15Un. | | P |
| | The grid fault ends when one of below two things happen in earlier:<br>The voltage of generation unit recover to range -15% Un to +10% Un or<br>5s after the start of the fault | | P |
| | Generation unit in mode “Energy supply” and Energy storage in mode “Energy supply” and “Energy consumption” should have dynamic grid support function | | P |
| | During grid fault, the generation unit and energy storage should fulfil below requirements in both balanced and unbalanced grid fault: | | P |
| | - No disconnection from the grid | | P |
| | - Overvoltage up to 1.2Un for period of 5s | | P |
| | - Type 2 unit and energy storage should not feed-in active or reactive current into grid during fault. | | P |
| | - Generation unit and energy storage should endure multiple grid faults followed | | P |
| | The FRT-Limit-Curve according to Fig-11 and Fig-12 is applicable to 1-, 2- and 3-phases fault | | P |



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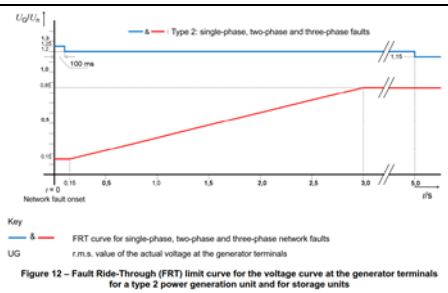
| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| |  <br>**Figure 12 – Fault Ride-Through (FRT) limit curve for the voltage curve at the generator terminals for a type 2 power generation unit and for storage units** | | |
| 5.7.3.2 | Dynamic grid supporting for Type 1 unit | | N/A |
| 5.7.3.3 | Dynamic grid supporting for Type 2 unit and energy storage | See appendix table | P |
| | The output current at all terminals should be limited less than 20% of rated current in 60ms and 10% of rated current in 100ms | | P |
| | Behaviour after end of fault:<br>Active current should recover back to normal value before fault within 1s after end of fault | | P |
| 5.7.4 | Active power output | Evaluated according to DIN VDE V 0124-100:2020, cl 5.4.3, see below table | P |
| 5.7.4.1 | During active power remote control required by grid security management, the change should fulfil power gradient requirement. The adjustment of power gradient direct on generation unit or energy storage is sufficient to fulfil the requirement:<br>Not faster than 0.66% $P_{Amax}$/s;<br>Not slower than 0.33% $P_{Amax}$/s. For generation system not slower than 4% $P_{Amax}$/minute | RS 485 communication port<br>Provided, Expected signal type: Differential signal | |
| | The generation system and energy storage shoul have a logic interface to receive active power order within 5s after sending by grid operator. | | P |
| 5.7.4.2 | Grid security management | | P |
| 5.7.4.2.1 | Generation system and energy storage | | P |
| | For PV system less than 30kWp, the certified technical control limited to 70% of installed module power of grid connection point or<br>PV system is equipped with remote active power control for limitation | RS 485 communication port Provided | P |



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| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| | For PV system large than 30kWp and less than 100kWp, it should be equipped with remote active power control for limitation | | N/A |
| | For PV system large than 100kWp, it should be equipped with remote active power control for limitation and report feed-in power in real time. | | N/A |
| | For Energy storage used in EEG or KWK-G system, if the PAmax>100kW, it should be equipped with remote active power control for limitation and report feed-in power in real time. | | N/A |
| 5.7.4.2.2 | Implementation of network security management | System solution | N/A |
| | The generation system and energy storage should control its active power without grid disconnection to 100%/60%/30%/0% of $P_{Amax}$. | | N/A |
| 5.7.4.3 | Active power adjustment during over and under frequency | For over frequency evaluated according to DIN VDE V 0124-100:2020, cl 5.4.4. For underfrequency evaluated according to DIN VDE V 0124-100:2020, cl 5.4.6. See appendix table for PGU test | P |
| | If the network frequency falls out of tolerance band of +/-200mHz from rated frequency of 50.0Hz, all generation unit and energy storage connected to the grid shall support grid stability by frequency regulation. | | P |
| | The accuracy of frequency measurement must be <10mHz. | | P |
| | For DC-coupling energy storage, type-2 unit is regarded. | | P |
| | During frequency change, the active power output should fulfil Fig-13, Fig-14 and/or Fig-15 | | P |



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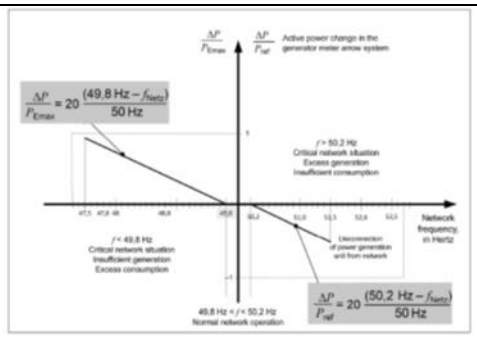
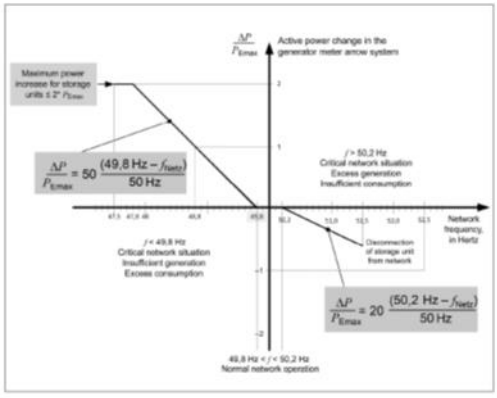
|---|---|---|---|
| |  <br>Key<br>$P_{Emax}$ highest active power of a power generation unit (10 min mean value)<br>$P_{ref}$ equals $P_{Emax}$ for type 1 power generation units or $P_{max}$ for type 2 power generation units at the moment when 50,2 Hz is exceeded.<br>$\Delta P$ power change<br>$f$ network frequency<br>**Figure 14 – Active power adjustment for type 1 and type 2 power generation units at over-frequency and under-frequency with a static value of 5 % and frequency limit values of 49,8 Hz and 50,2 Hz for starting the adjustment**<br>  <br>Key<br>$P_{Emax}$ highest active power of a power generation unit (10 min mean value)<br>$\Delta P$ power change<br>$f$ network frequency<br>**Figure 15 – Active power adjustment for storage units at an over-frequency with a static value of 5 % and an under-frequency with a static value of 2 % and frequency limit values of 49,8 Hz and 50,2 Hz for starting the adjustment** | | |
| 5.7.4.4 | Active power reduction depend on voltage is not required in this technical requirement | | N/A |
| 5.7.5 | Short circuit contribution | | P |
| **6** | Construction of the power generation system/network and system protection (NS-protection) | | P |
| 6.1 | General requirements | The PGU include integrated interface switch is type-tested according to DIN VDE V 0124-100:2020 Cl. 5.5.4 and 5.5.7.4. in the report. | P |
| 6.2 | Central NS protection | To be considered for PGS with point of connection to grid larger than 30kVA. | N/A |
| 6.3 | Integrated NS protection | | P |
| 6.4 | Interface switch | | P |
| 6.4.1 | The disconnection switch is used for NS protection can can be used as switch | Integrated power relay in the PGU. Each live conductor is | P |



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| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| | device in single generation unit (integrated interface switch) | constructed with two relays comply with A.6 requirement. | |
| | The interface switch must be designed and rated for the conditional short-circuit current and taking into account the protective devices required by 6.5. The switching ability of the interface switch is to be measured according to the higher value from the rated current of the upstream fuse and maximum initial short-circuit current contribution of the generation plant. The function control of the interface switch is to be realized according to a) or b) or (c): | | P |
| | a) Using a interface switch, that switch-on with control voltage and can automatic switch-off without voltage supply. The switch on-off state can be monitored | | N/A |
| | b) Minimum once daily check of on-off switch with the NS protection and monitoring of normal functions of interface switch | | N/A |
| | c) Using integrated interface switch and integrated NS protection for PV and ESS inverter according to DIN EN 62109 | | P |
| | If a defect is detected, the generation system should not feed-in grid and not reconnect to grid | | P |
| | The interface switch should switch all line conductors. In TT system, all pole disconnection should be realized. In this condition, the interface switch as grid disconnection device during islanding operation, it should comply with VDE-AR-E 2510-2 | | P |
| 6.4.2 | Central interface switch | Should be installed in system above 30kVA | N/A |
| 6.4.3 | Integrated interface switch | | P |
| 6.5 | Protective devices for the interface switch | | P |
| 6.5.1 | General | | P |
| | The specification given in 6.5.2 do not refer to the short-circuit protection, overload protection, electric shock protection and all-phase separator. The protection function may have to be extended by the connection owner if applicable | | P |



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| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| | The protection function shall be implemented as follows:<br>Voltage drop protection U<<br>Rise-in-voltage protection U><br>Rise-in-voltage protection U>><br>Frequency decrease protection f<<br>Frequency increase protection f><br>Islanding detection. | See appendix table | P |
| | Voltage protection devices should utilize the half-wave r.m.s value of 50Hz. | | P |
| | The rise-in voltage protection U> shall be designed as 10 minute mean value as required in DIN EN 50160 (power quality). The formation of a new 10 minute mean value shall be at least every 3s. | | P |
| | For PGS up to 30kVA, the voltage protection shall be measured between line and neutral | The voltage protection function in the PGU integrated NS protection is designed between line and neutral. | P |
| | For PGS more than 30kVA, the voltage protection shall be measured between line and neutral. The line to line voltage shall be determined or measured. | For use in PGS more than 30 kVA, central NS protection is needed. | N/A |
| | Frequency protection may be designed as single-phase equipment | | P |
| | The setting value of protection function and the last five dated failure report shall be readable at the NS protection. Interruption of supply shall not lead to loss of any failure report. Read-out shall be possible for central protection without any additional aid. For integrated NS protection read-out may use a data interface. | | P |
| 6.5.2 | The protection function setting should follow Table 2 | See appendix table | P |
| | The rise-in-voltage protection U> can be 1.1 to 1.15 Un, if used for up to 30kVA with only integrated NS protection, 1.1Un setting shall not be changed. | | P |
| | The tolerance of the setting value and trip value of voltage shall be maximum +/-1% and frequency +/-0.1% | | P |
| 6.5.3 | Islanding detection | Evaluated according to DIN VDE V 0124-100:2020 Cl.5.5.10. See appended table | P |



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| Clause | Requirement + Test | Result – Remark | Verdict |
|---|---|---|---|
| | The testing method is according to DIN EN 62116. Detection of an isolated network and disconnection of PGS shall be within 2s. | | P |
| 6.6 | Other requirements for generation system | | N/A |
| 6.6.1 | Ability to provide primary control power is not required in the technical requirement. If this function is included, reference to VDE-AR-N 4120, 10.5.3 | | N/A |
| 6.6.2 | Ability to provide secondary control and minute reserve is not required in the technical requirement. If this function is included, reference to VDE-AR-N 4120, 10.5.4 | | N/A |
| **7** | Metering for billing purpose | | N/A |
| **8** | Operation of the system | | P |
| 8.1 | General | | P |
| 8.2 | Particular characteristics of the management of the network operator's network | | N/A |
| 8.3 | Connection conditions and synchronisation | Evaluated according to DIN VDE V 0124-100:2020 Cl.5.6. See appended table | P |
| 8.4 | Particular requirement of plan, installation and in operation of generation system and energy storage with $P_{Amax} \geq 135kW$ | | N/A |
| **9** | Verification of electric features | | P |
| **Annex A** | Explanation (informative) | | N/A |
| **Annex B** | Measurement concepts (informative) | | N/A |
| **Annex C** | Examples of meter panel configurations (informative) | | N/A |
| **Annex D** | Example of connection assessment of generation plants – connection of a 20 kW photovoltaic plant (informative) | | N/A |
| **Annex E** | Form (Normative) | | P |



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**Following appendix table is based on the requirements of DIN VDE V 0124-100 (VDE V 0124-100):2020:**

| 5.2.2 | Rapid voltage change | P |
|---|---|---|

The possible switching
Case A: Switch on at any power level of primary energy
Case B: Worst case of switching of generator level
Case C: Switch on at the nominal power
Case D: Switch off at the nominal power (not emergency, but normal operational switch off)

| Test Model | EAHI-3000-SL | | |
|---|---|---|---|
| Nominal current of PGU $I_n$ (A) | 13.05 | The $k_{imax}$ value: | 0.99 |
| Test frequency (Hz) | 50.00 | -- | -- |

| Switching action | | Ia (A) | | | U(V) | | | ki |
|---|---|---|---|---|---|---|---|---|
| A | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 5.02 | -- | -- | 230.25 | -- | -- | 0.38 |
| | #2 | 2.55 | -- | -- | 230.16 | -- | -- | 0.20 |
| | #3 | 4.81 | -- | -- | 230.19 | -- | -- | 0.37 |
| B | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 6.49 | -- | -- | 230.89 | -- | -- | 0.50 |
| | #2 | 6.46 | -- | -- | 230.84 | -- | -- | 0.50 |
| | #3 | 6.64 | -- | -- | 230.84 | -- | -- | 0.51 |
| C | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 2.82 | -- | -- | 230.17 | -- | -- | 0.22 |
| | #2 | 2.69 | -- | -- | 230.18 | -- | -- | 0.21 |
| | #3 | 2.49 | -- | -- | 230.15 | -- | -- | 0.19 |
| D | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 12.98 | -- | -- | 231.70 | -- | -- | 0.99 |
| | #2 | 12.98 | -- | -- | 231.69 | -- | -- | 0.99 |
| | #3 | 12.94 | -- | -- | 231.70 | -- | -- | 0.99 |

| Test Model | EAHI-6000-SL | | |
|---|---|---|---|
| Nominal current of PGU $I_n$ (A) | 26.09 | The $k_{imax}$ value: | 0.99 |
| Test frequency (Hz) | 50.00 | -- | -- |

| Switching action | | Ia (A) | | | U(V) | | | ki |
|---|---|---|---|---|---|---|---|---|
| A | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 2.59 | -- | -- | 230.16 | -- | -- | 0.10 |



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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | #2 | 3.41 | -- | -- | 230.18 | -- | -- | 0.13 |
| | #3 | 5.09 | -- | -- | 230.17 | -- | -- | 0.20 |
| B | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 13.01 | -- | -- | 230.80 | -- | -- | 0.50 |
| | #2 | 13.00 | -- | -- | 230.78 | -- | -- | 0.50 |
| | #3 | 13.00 | -- | -- | 230.73 | -- | -- | 0.50 |
| C | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 2.68 | -- | -- | 230.16 | -- | -- | 0.10 |
| | #2 | 5.54 | -- | -- | 230.15 | -- | -- | 0.21 |
| | #3 | 5.53 | -- | -- | 230.13 | -- | -- | 0.21 |
| D | -- | L1 | L2 | L3 | L1-N | L2-N | L3-N | -- |
| | #1 | 25.85 | -- | -- | 231.21 | -- | -- | 0.99 |
| | #2 | 25.87 | -- | -- | 230.55 | -- | -- | 0.99 |
| | #3 | 25.77 | -- | -- | 230.35 | -- | -- | 0.99 |
| Supplementary information:<br>Choose the applicable case for the tested EZE.<br>Each case shall be measured for three times. | | | | | | | | |



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| 5.2.3 | Flicker | | | | | P |
|---|---|---|---|---|---|---|
| Test model | | EAHI-3000-SL | | | | |
| Simulated network voltage (V) | L1 (P-N) | 230.00 | | Network impedance | L1 | 0.24Ω +j0.15Ω |
| | -- | -- | | | N | 0.16Ω +j0.10Ω |
| EZE operating current (A) | L1 | 13.05 | | EZE operating power (VA) | 2998 | |
| Simulated network frequency (Hz) | 50.00 | | | Short circuit power Sk (VA) | 186913 | |
| Plt | L1 | 0.023 | | EZE nominal apparent power Sn(VA) | 3000 | |

| Test items | $d_{(t)\ -\ 500ms}$ [%] | $d_c$ [%] | $d_{max}$ [%] |
|---|---|---|---|
| Limit value | 3.30 | 3.30 | 4.00 |
| L1 | 0 | 0 | 0 |

| Pst | #1 | #2 | #3 | #4 | #5 | #6 |
|---|---|---|---|---|---|---|
| L1 | 0.036 | 0.024 | 0.015 | 0.017 | 0.019 | 0.019 |
| Pst | #7 | #8 | #9 | #10 | #11 | #12 |
| L1 | 0.020 | 0.021 | 0.022 | 0.023 | 0.023 | 0.025 |

Remark:Test according to DIN EN 61000-3-3.

| Test model | EAHI-6000-SL | | | | | |
|---|---|---|---|---|---|---|
| Simulated network voltage (V) | L1 (P-N) | 230.00 | | Network impedance | L1 | 0.15Ω +j0.15Ω |
| | -- | -- | | | N | 0.10Ω +j0.10Ω |
| EZE operating current (A) | L1 | 26.09 | | EZE operating power (VA) | 5998 | |
| Simulated network frequency (Hz) | 50.00 | | | Short circuit power Sk (VA) | 249373 | |
| Plt | L1 | 0.039 | | EZE nominal apparent power Sn(VA) | 6000 | |

| Test items | $d_{(t)\ -\ 500ms}$ [%] | $d_c$ [%] | $d_{max}$ [%] |
|---|---|---|---|
| Limit value | 3.30 | 3.30 | 4.00 |
| L1 | 0 | 0 | 0 |

| Pst | #1 | #2 | #3 | #4 | #5 | #6 |
|---|---|---|---|---|---|---|
| L1 | 0.036 | 0.037 | 0.042 | 0.042 | 0.042 | 0.041 |
| Pst | #7 | #8 | #9 | #10 | #11 | #12 |
| L1 | 0.042 | 0.040 | 0.040 | 0.037 | 0.037 | 0.036 |

Remark:Test according to DIN EN 61000-3-11.



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| 5.2.4&5.2.6 | Harmonics and inter-harmonics& Feed-in of direct currents | P |
|---|---|---|

For current ≤16 A

| Test Model | EAHI-3000-SL |
|---|---|

Phase L1-N

| Harmon. Nr. | P/$P_n$ | | | | | | | | | | | Limit (A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| | A | A | A | A | A | A | A | A | A | A | A | |
| 0 | 0.358 % | 0.403 % | 0.377 % | 0.439 % | 0.461 % | 0.475 % | 0.475 % | 0.496 % | 0.395 % | 0.462 % | 0.485 % | 0.5% $I_R$ |
| 1 | 0.491 | 1.181 | 2.478 | 3.777 | 5.074 | 6.374 | 7.668 | 8.962 | 10.250 | 11.547 | 12.834 | - |
| 2 | 0.005 | 0.006 | 0.007 | 0.007 | 0.010 | 0.011 | 0.010 | 0.013 | 0.012 | 0.017 | 0.020 | 1.08 |
| 3 | 0.050 | 0.078 | 0.064 | 0.052 | 0.039 | 0.034 | 0.033 | 0.034 | 0.035 | 0.040 | 0.048 | 2.30 |
| 4 | 0.008 | 0.008 | 0.006 | 0.005 | 0.005 | 0.005 | 0.004 | 0.004 | 0.005 | 0.008 | 0.007 | 0.43 |
| 5 | 0.045 | 0.029 | 0.040 | 0.040 | 0.037 | 0.033 | 0.030 | 0.027 | 0.026 | 0.025 | 0.023 | 1.14 |
| 6 | 0.006 | 0.005 | 0.006 | 0.005 | 0.004 | 0.004 | 0.003 | 0.004 | 0.005 | 0.006 | 0.006 | 0.30 |
| 7 | 0.030 | 0.030 | 0.027 | 0.039 | 0.044 | 0.042 | 0.039 | 0.036 | 0.034 | 0.030 | 0.028 | 0.77 |
| 8 | 0.005 | 0.005 | 0.006 | 0.007 | 0.003 | 0.003 | 0.003 | 0.003 | 0.004 | 0.004 | 0.008 | 0.23 |
| 9 | 0.018 | 0.007 | 0.027 | 0.034 | 0.043 | 0.043 | 0.042 | 0.041 | 0.040 | 0.039 | 0.039 | 0.40 |
| 10 | 0.007 | 0.005 | 0.008 | 0.006 | 0.006 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.18 |
| 11 | 0.009 | 0.013 | 0.018 | 0.028 | 0.041 | 0.044 | 0.047 | 0.047 | 0.046 | 0.045 | 0.044 | 0.33 |
| 12 | 0.005 | 0.004 | 0.004 | 0.006 | 0.006 | 0.007 | 0.005 | 0.007 | 0.007 | 0.007 | 0.007 | 0.15 |
| 13 | 0.008 | 0.014 | 0.005 | 0.023 | 0.033 | 0.040 | 0.042 | 0.044 | 0.044 | 0.043 | 0.044 | 0.21 |
| 14 | 0.011 | 0.007 | 0.015 | 0.012 | 0.009 | 0.009 | 0.009 | 0.011 | 0.006 | 0.007 | 0.007 | 0.13 |
| 15 | 0.009 | 0.006 | 0.007 | 0.017 | 0.025 | 0.034 | 0.039 | 0.042 | 0.044 | 0.045 | 0.044 | 0.15 |
| 16 | 0.005 | 0.005 | 0.006 | 0.005 | 0.006 | 0.006 | 0.008 | 0.005 | 0.007 | 0.006 | 0.006 | 0.12 |
| 17 | 0.008 | 0.009 | 0.011 | 0.010 | 0.020 | 0.030 | 0.037 | 0.040 | 0.042 | 0.043 | 0.044 | 0.13 |
| 18 | 0.004 | 0.005 | 0.008 | 0.009 | 0.007 | 0.006 | 0.004 | 0.003 | 0.004 | 0.003 | 0.003 | 0.10 |
| 19 | 0.008 | 0.007 | 0.011 | 0.008 | 0.016 | 0.022 | 0.028 | 0.032 | 0.036 | 0.039 | 0.042 | 0.12 |
| 20 | 0.004 | 0.004 | 0.008 | 0.012 | 0.010 | 0.008 | 0.008 | 0.008 | 0.005 | 0.006 | 0.007 | 0.09 |
| 21 | 0.009 | 0.005 | 0.012 | 0.012 | 0.012 | 0.015 | 0.022 | 0.028 | 0.032 | 0.036 | 0.039 | 0.11 |
| 22 | 0.005 | 0.003 | 0.008 | 0.006 | 0.006 | 0.006 | 0.006 | 0.005 | 0.007 | 0.006 | 0.005 | 0.08 |
| 23 | 0.004 | 0.006 | 0.011 | 0.011 | 0.010 | 0.015 | 0.022 | 0.029 | 0.033 | 0.035 | 0.038 | 0.10 |
| 24 | 0.005 | 0.004 | 0.010 | 0.004 | 0.005 | 0.007 | 0.006 | 0.005 | 0.007 | 0.005 | 0.005 | 0.08 |
| 25 | 0.007 | 0.005 | 0.006 | 0.015 | 0.013 | 0.013 | 0.017 | 0.021 | 0.025 | 0.029 | 0.032 | 0.09 |
| 26 | 0.005 | 0.006 | 0.003 | 0.012 | 0.011 | 0.009 | 0.007 | 0.006 | 0.004 | 0.004 | 0.004 | 0.07 |



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| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 0.005 | 0.004 | 0.005 | 0.015 | 0.015 | 0.013 | 0.012 | 0.014 | 0.019 | 0.025 | 0.030 | 0.08 |
| 28 | 0.005 | 0.003 | 0.004 | 0.013 | 0.013 | 0.011 | 0.008 | 0.008 | 0.005 | 0.005 | 0.006 | 0.07 |
| 29 | 0.004 | 0.004 | 0.004 | 0.014 | 0.017 | 0.014 | 0.011 | 0.014 | 0.018 | 0.024 | 0.029 | 0.08 |
| 30 | 0.004 | 0.005 | 0.009 | 0.006 | 0.004 | 0.006 | 0.008 | 0.008 | 0.010 | 0.008 | 0.007 | 0.06 |
| 31 | 0.004 | 0.003 | 0.003 | 0.011 | 0.015 | 0.014 | 0.014 | 0.017 | 0.019 | 0.023 | 0.025 | 0.07 |
| 32 | 0.009 | 0.006 | 0.010 | 0.009 | 0.004 | 0.008 | 0.010 | 0.010 | 0.013 | 0.012 | 0.010 | 0.06 |
| 33 | 0.004 | 0.004 | 0.004 | 0.008 | 0.012 | 0.014 | 0.016 | 0.017 | 0.018 | 0.022 | 0.024 | 0.07 |
| 34 | 0.008 | 0.006 | 0.007 | 0.011 | 0.005 | 0.007 | 0.010 | 0.011 | 0.014 | 0.013 | 0.012 | 0.05 |
| 35 | 0.004 | 0.004 | 0.005 | 0.006 | 0.014 | 0.016 | 0.017 | 0.015 | 0.014 | 0.016 | 0.019 | 0.06 |
| 36 | 0.005 | 0.004 | 0.004 | 0.009 | 0.004 | 0.005 | 0.007 | 0.008 | 0.011 | 0.010 | 0.011 | 0.05 |
| 37 | 0.004 | 0.003 | 0.004 | 0.005 | 0.013 | 0.016 | 0.017 | 0.016 | 0.015 | 0.016 | 0.020 | 0.06 |
| 38 | 0.003 | 0.003 | 0.003 | 0.009 | 0.005 | 0.004 | 0.005 | 0.006 | 0.009 | 0.008 | 0.008 | 0.05 |
| 39 | 0.005 | 0.003 | 0.005 | 0.004 | 0.011 | 0.016 | 0.018 | 0.017 | 0.015 | 0.015 | 0.017 | 0.06 |
| 40 | 0.004 | 0.003 | 0.007 | 0.007 | 0.008 | 0.007 | 0.005 | 0.004 | 0.007 | 0.006 | 0.006 | 0.05 |
| THD | 0.648 % | 0.734 % | 0.741 % | 0.815 % | 0.890 % | 0.943 % | 0.992 % | 1.037 % | 1.075 % | 1.125 % | 1.185 % | 5% |

Remark: Iref=13.05A, the test accroding to DIN EN 61000-3-2.

For current 16A < I ≤ 75A

| Harmon. Nr. | P/PEmax | | | | | | | | | | | Limit (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | |
| | Ih/Iref(%) | | | | | | | | | | | |
| 0 | 0.265 | 0.247 | 0.333 | 0.293 | 0.284 | 0.241 | 0.297 | 0.319 | 0.391 | 0.378 | 0.402 | 0.5% $I_R$ |
| 1 | 0.356 | 2.484 | 5.095 | 7.694 | 10.294 | 12.887 | 15.477 | 18.084 | 20.658 | 23.256 | 25.850 | - |
| 2 | 0.005 | 0.008 | 0.009 | 0.010 | 0.010 | 0.011 | 0.012 | 0.013 | 0.013 | 0.013 | 0.014 | 8.0 |
| 3 | 0.084 | 0.093 | 0.074 | 0.070 | 0.100 | 0.111 | 0.140 | 0.184 | 0.235 | 0.293 | 0.485 | 21.6 |
| 4 | 0.009 | 0.005 | 0.006 | 0.006 | 0.007 | 0.011 | 0.009 | 0.009 | 0.010 | 0.010 | 0.011 | 4.0 |
| 5 | 0.076 | 0.054 | 0.069 | 0.059 | 0.074 | 0.074 | 0.066 | 0.060 | 0.057 | 0.068 | 0.100 | 10.7 |
| 6 | 0.006 | 0.007 | 0.006 | 0.006 | 0.006 | 0.008 | 0.006 | 0.006 | 0.006 | 0.005 | 0.005 | 2.67 |
| 7 | 0.044 | 0.044 | 0.070 | 0.067 | 0.073 | 0.063 | 0.058 | 0.058 | 0.053 | 0.061 | 0.083 | 7.2 |
| 8 | 0.006 | 0.008 | 0.006 | 0.006 | 0.006 | 0.007 | 0.006 | 0.006 | 0.005 | 0.007 | 0.006 | 2.0 |
| 9 | 0.025 | 0.055 | 0.058 | 0.068 | 0.079 | 0.078 | 0.076 | 0.077 | 0.082 | 0.081 | 0.058 | 3.8 |
| 10 | 0.004 | 0.009 | 0.006 | 0.005 | 0.006 | 0.006 | 0.006 | 0.007 | 0.006 | 0.006 | 0.007 | 1.6 |
| 11 | 0.017 | 0.036 | 0.048 | 0.066 | 0.079 | 0.080 | 0.077 | 0.070 | 0.067 | 0.063 | 0.067 | 3.1 |
| 12 | 0.007 | 0.009 | 0.009 | 0.008 | 0.008 | 0.008 | 0.008 | 0.009 | 0.010 | 0.008 | 0.008 | 1.33 |



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| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 0.014 | 0.009 | 0.036 | 0.053 | 0.068 | 0.072 | 0.075 | 0.080 | 0.078 | 0.076 | 0.067 | 2.0 |
| 14 | 0.004 | 0.014 | 0.007 | 0.005 | 0.006 | 0.004 | 0.004 | 0.006 | 0.006 | 0.005 | 0.005 | - |
| 15 | 0.012 | 0.007 | 0.029 | 0.044 | 0.061 | 0.065 | 0.068 | 0.068 | 0.069 | 0.074 | 0.060 | - |
| 16 | 0.005 | 0.006 | 0.010 | 0.010 | 0.008 | 0.008 | 0.008 | 0.007 | 0.007 | 0.008 | 0.007 | - |
| 17 | 0.010 | 0.005 | 0.024 | 0.036 | 0.049 | 0.059 | 0.063 | 0.063 | 0.069 | 0.064 | 0.072 | - |
| 18 | 0.003 | 0.011 | 0.008 | 0.006 | 0.006 | 0.006 | 0.006 | 0.009 | 0.007 | 0.006 | 0.006 | - |
| 19 | 0.011 | 0.013 | 0.016 | 0.025 | 0.039 | 0.050 | 0.053 | 0.060 | 0.057 | 0.055 | 0.062 | - |
| 20 | 0.004 | 0.015 | 0.009 | 0.006 | 0.007 | 0.008 | 0.004 | 0.005 | 0.004 | 0.004 | 0.004 | - |
| 21 | 0.009 | 0.019 | 0.009 | 0.018 | 0.031 | 0.041 | 0.049 | 0.054 | 0.052 | 0.059 | 0.052 | - |
| 22 | 0.002 | 0.010 | 0.009 | 0.009 | 0.009 | 0.008 | 0.010 | 0.009 | 0.009 | 0.007 | 0.009 | - |
| 23 | 0.007 | 0.011 | 0.009 | 0.018 | 0.024 | 0.036 | 0.047 | 0.047 | 0.052 | 0.054 | 0.053 | - |
| 24 | 0.002 | 0.006 | 0.010 | 0.011 | 0.009 | 0.007 | 0.010 | 0.009 | 0.010 | 0.008 | 0.009 | - |
| 25 | 0.007 | 0.011 | 0.013 | 0.015 | 0.015 | 0.028 | 0.036 | 0.042 | 0.048 | 0.049 | 0.051 | - |
| 26 | 0.004 | 0.011 | 0.010 | 0.007 | 0.004 | 0.004 | 0.005 | 0.006 | 0.006 | 0.007 | 0.007 | - |
| 27 | 0.005 | 0.011 | 0.014 | 0.010 | 0.011 | 0.022 | 0.030 | 0.038 | 0.040 | 0.043 | 0.045 | - |
| 28 | 0.004 | 0.010 | 0.011 | 0.006 | 0.004 | 0.003 | 0.005 | 0.006 | 0.006 | 0.008 | 0.010 | - |
| 29 | 0.005 | 0.008 | 0.015 | 0.011 | 0.011 | 0.017 | 0.027 | 0.034 | 0.037 | 0.042 | 0.044 | - |
| 30 | 0.001 | 0.008 | 0.007 | 0.010 | 0.008 | 0.008 | 0.007 | 0.006 | 0.007 | 0.006 | 0.009 | - |
| 31 | 0.006 | 0.004 | 0.014 | 0.014 | 0.012 | 0.013 | 0.021 | 0.028 | 0.034 | 0.037 | 0.040 | - |
| 32 | 0.003 | 0.009 | 0.006 | 0.011 | 0.011 | 0.011 | 0.010 | 0.011 | 0.010 | 0.010 | 0.011 | - |
| 33 | 0.007 | 0.004 | 0.013 | 0.015 | 0.015 | 0.012 | 0.018 | 0.025 | 0.030 | 0.034 | 0.037 | - |
| 34 | 0.003 | 0.009 | 0.006 | 0.012 | 0.011 | 0.011 | 0.011 | 0.010 | 0.009 | 0.008 | 0.009 | - |
| 35 | 0.006 | 0.004 | 0.013 | 0.014 | 0.013 | 0.008 | 0.014 | 0.021 | 0.027 | 0.031 | 0.035 | - |
| 36 | 0.002 | 0.007 | 0.006 | 0.009 | 0.009 | 0.010 | 0.009 | 0.008 | 0.008 | 0.008 | 0.008 | - |
| 37 | 0.005 | 0.005 | 0.011 | 0.014 | 0.015 | 0.011 | 0.013 | 0.018 | 0.024 | 0.029 | 0.033 | - |
| 38 | 0.002 | 0.005 | 0.006 | 0.008 | 0.008 | 0.007 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | - |
| 39 | 0.005 | 0.005 | 0.009 | 0.014 | 0.016 | 0.012 | 0.010 | 0.016 | 0.021 | 0.026 | 0.031 | - |
| 40 | 0.001 | 0.003 | 0.009 | 0.007 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.007 | - |
| $THC/I_{ref}$ | 0.497 | 0.551 | 0.626 | 0.686 | 0.855 | 0.907 | 0.986 | 1.106 | 1.254 | 1.444 | 2.088 | 23 |
| $PWHC/I_{ref}$ | 0.545 | 0.904 | 1.195 | 1.506 | 1.841 | 2.179 | 2.528 | 2.809 | 3.041 | 3.210 | 3.325 | 23 |
| Remark: Iref=26.09A, the test accroding to DIN EN 61000-3-12. | | | | | | | | | | | | |



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| 5.4.2 & 5.4.8.2 | Measurement of reactive and active power range& Checking reactive power / displacement factor setting accuracy | P |
|---|---|---|
| 5.4.2 | Measurement of reactive and active power range | |

| Test Model | $S_{Emax600}$ (VA) | $P_{Emax600}$(W) |
|---|---|---|
| EAHI-3000-SL | 3054.40 | -2998.51 |
| EAHI-3600-SL | 3601.08 | -3621.87 |
| EAHI-5000-SL | 5037.60 | -5019.99 |
| EAHI-6000-SL | 6042.80 | -6024.70 |

| Test Model | **EAHI-3000-SL** | | | | | |
|---|---|---|---|---|---|---|
| Test voltage | Cosφ setting | $P_{600}$ [W] | $Q_{600}$ [Var] | $S_{600}$ [VA] | Cosφ $_{600}$ | U [V] |
| 0.90 Un* | 1.00 | -2716.71 | 23.73 | 2716.82 | 0.999 | 207.37 |
| 1.00 Un | 1.00 | -2998.51 | 9.10 | 2998.53 | 0.999 | 230.36 |
| 1.09 Un | 1.00 | -2993.53 | -20.36 | 2993.60 | 0.999 | 251.01 |
| 0.95 Un* | 0.80 un | -2373.73 | 1797.61 | 2977.59 | 0.797 un | 218.77 |
| 1.00 Un* | 0.80 un | -2405.25 | 1796.72 | 3002.24 | 0.801 un | 250.91 |
| 1.09 Un* | 0.80 un | -2410.37 | 1819.42 | 3019.96 | 0.798 un | 230.25 |
| 0.90 Un* | 0.80 ov | -2219.50 | -1638.02 | 2758.49 | 0.805 ov | 207.13 |
| 1.00 Un* | 0.80 ov | -2426.55 | -1808.57 | 3026.40 | 0.802 ov | 230.65 |
| 1.05 Un* | 0.80 ov | -2445.19 | -1830.42 | 3054.40 | 0.801 ov | 241.29 |
| Test Model | **EAHI-3600-SL** | | | | | |
| Test voltage | Cosφ setting | $P_{600}$ [W] | $Q_{600}$ [Var] | $S_{600}$ [VA] | Cosφ $_{600}$ | U [V] |
| 0.90 Un* | 1.00 | -3225.97 | 55.41 | 3226.45 | 0.999 | 207.44 |
| 1.00 Un | 1.00 | -3621.87 | 47.73 | 3622.19 | 0.999 | 230.44 |
| 1.09 Un | 1.00 | -3601.02 | 20.63 | 3601.08 | 0.999 | 251.08 |
| 0.95 Un* | 0.80 un | -2722.93 | 2045.38 | 3405.57 | 0.800 un | 218.60 |
| 1.00 Un* | 0.80 un | -2854.98 | 2133.11 | 3563.85 | 0.801 un | 230.13 |
| 1.09 Un* | 0.80 un | -2838.93 | 2114.78 | 3540.04 | 0.802 un | 250.87 |
| 0.90 Un* | 0.80 ov | -2557.36 | -1901.45 | 3186.79 | 0.803 ov | 207.08 |
| 1.00 Un* | 0.80 ov | -2875.74 | -2151.16 | 3591.29 | 0.801 ov | 230.53 |
| 1.05 Un* | 0.80 ov | -2868.93 | -2154.37 | 3587.77 | 0.800 ov | 241.55 |
| Test Model | **EAHI-5000-SL** | | | | | |
| Test voltage | Cosφ setting | $P_{600}$ [W] | $Q_{600}$ [Var] | $S_{600}$ [VA] | Cosφ $_{600}$ | U [V] |
| 0.90 Un* | 1.00 | -4502.50 | 132.18 | 4504.48 | 0.999 | 207.64 |



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| | | | | | | |
|---|---|---|---|---|---|---|
| 1.00 Un | 1.00 | -5019.99 | 129.01 | 5021.66 | 0.999 | 230.62 |
| 1.09 Un | 1.00 | -4992.39 | 105.02 | 4993.50 | 0.999 | 251.25 |
| 0.95 Un* | 0.80 un | -3822.74 | 2851.24 | 4768.95 | 0.802 un | 218.72 |
| 1.00 Un* | 0.80 un | -4038.90 | 3010.76 | 5037.60 | 0.802 un | 230.26 |
| 1.09 Un* | 0.80 un | -3987.60 | -3987.60 | 4947.58 | 0.806 un | 250.82 |
| 0.90 Un* | 0.80 ov | -3625.53 | -2661.07 | 4497.31 | 0.806 ov | 207.15 |
| 1.00 Un* | 0.80 ov | -3946.23 | -2954.76 | 4930.04 | 0.800 ov | 230.54 |
| 1.05 Un* | 0.80 ov | -4001.29 | -2915.97 | 4951.08 | 0.808 ov | 241.58 |
| Test Model | **EAHI-6000-SL** | | | | | |
| Test voltage | Cosφ setting | $P_{600}$ [W] | $Q_{600}$ [Var] | $S_{600}$ [VA] | Cosφ $_{600}$ | U [V] |
| 0.90 Un* | 1.00 | -5383.70 | 190.92 | 5387.09 | 0.999 | 207.77 |
| 1.00 Un | 1.00 | -6024.70 | 198.75 | 6027.99 | 0.999 | 230.75 |
| 1.09 Un | 1.00 | -5992.79 | 163.98 | 5995.05 | 0.999 | 251.38 |
| 0.95 Un* | 0.80 un | -4573.30 | 3418.79 | 5709.92 | 0.801 un | 219.05 |
| 1.00 Un* | 0.80 un | -4834.29 | 3590.46 | 6021.77 | 0.803 un | 230.21 |
| 1.09 Un* | 0.80 un | -4831.29 | 3541.74 | 5990.43 | 0.807 un | 250.86 |
| 0.90 Un* | 0.80 ov | -4370.50 | -3232.92 | 5436.27 | 0.804 ov | 207.64 |
| 1.00 Un* | 0.80 ov | -4849.68 | -3605.00 | 6042.80 | 0.803 ov | 230.34 |
| 1.05 Un* | 0.80 ov | -4840.54 | -3604.35 | 6035.08 | 0.802 ov | 241.57 |

Remark: " * " This case limited by the maximum apparent power, active power cannot reach the rated power.

**5.4.8.2 Checking reactive power / displacement factor setting accuracy**

**Case a) Tested at Nominal voltage 0.90 Un, test 1min**

| $P/S_{Emax}$ (%) | 50 | 100 |
|---|---|---|
| Cosφ setting | 0.800 un | 0.800 un |
| Cosφ $_{60}$ | 0.800 un | 0.803 un |
| $P_{60}$ (W) | -2428.96 | -4350.12 |
| $Q_{60}$ (Var) | 1819.91 | 3230.40 |
| $S_{60}$ (VA) | 3035.11 | 5418.40 |
| U $_{60}$ [V] | 206.96 | 207.54 |
| Percentage of Q deviation ($\%P_{Emax}$) | -0.03% | -0.54% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.800 ov | 0.800 ov |
| Cosφ $_{60}$ | 0.802 ov | 0.801 ov |



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| | | |
|---|---|---|
| $P_{60}$ (W) | -2444.06 | -4419.24 |
| $Q_{60}$ (Var) | -1821.44 | -3302.94 |
| $S_{60}$ (VA) | 3048.13 | 5517.16 |
| $U_{60}$ [V] | 206.97 | 208.10 |
| Percentage of Q deviation (%$P_{Emax}$) | 0.19% | 0.19% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.900 un | 0.900 un |
| Cosφ $_{60}$ | 0.903 un | 0.900 un |
| $P_{60}$ (W) | -2708.59 | -4836.63 |
| $Q_{60}$ (Var) | 1291.17 | 2341.21 |
| $S_{60}$ (VA) | 3000.60 | 5373.49 |
| $U_{60}$ [V] | 207.19 | 207.63 |
| Percentage of Q deviation (%$P_{Emax}$) | -0.31% | -0.02% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.900 ov | 0.900 ov |
| Cosφ $_{60}$ | -0.901 ov | -0.903 ov |
| $P_{60}$ (W) | -2741.62 | -4910.84 |
| $Q_{60}$ (Var) | -1323.29 | -2337.30 |
| $S_{60}$ (VA) | 3044.27 | 5438.70 |
| $U_{60}$ [V] | 207.10 | 207.70 |
| Percentage of Q deviation (%$P_{Emax}$) | 0.07% | 0.62% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| **Case b): Tested at Nominal voltage 1.0Un, test 1min** | | |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.800 un | 0.800 un |
| Cosφ $_{60}$ | 0.801 un | 0.801 un |
| $P_{60}$ (W) | -2395.60 | -4833.77 |
| $Q_{60}$ (Var) | 1788.21 | 3608.67 |
| $S_{60}$ (VA) | 2989.42 | 6032.24 |
| $U_{60}$ [V] | 231.65 | 231.62 |
| Percentage of Q deviation (%$P_{Emax}$) | -0.14% | -0.28% |



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| | | |
|---|---|---|
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.800 ov | 0.800 ov |
| Cosφ 60 | 0.800 ov | 0.803 ov |
| $P_{60}$ (W) | -2431.01 | -4851.81 |
| $Q_{60}$ (Var) | -1824.70 | -3607.17 |
| $S_{60}$ (VA) | 3039.63 | 6045.80 |
| U 60 [V] | 230.54 | 231.80 |
| Percentage of Q deviation ($\%P_{Emax}$) | -0.02% | 0.53% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.900 un | 0.900 un |
| Cosφ 60 | 0.903 un | 0.902 un |
| $P_{60}$ (W) | -2768.22 | -5459.36 |
| $Q_{60}$ (Var) | 1319.17 | 2614.34 |
| $S_{60}$ (VA) | 3066.48 | 6053.05 |
| U 60 [V] | 230.66 | 232.00 |
| Percentage of Q deviation ($\%P_{Emax}$) | -0.33% | -0.45% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.900 ov | 0.900 ov |
| Cosφ 60 | 0.900 ov | 0.904 ov |
| $P_{60}$ (W) | -2729.92 | -5451.03 |
| $Q_{60}$ (Var) | -1325.58 | -2577.22 |
| $S_{60}$ (VA) | 3034.74 | 6029.58 |
| U 60 [V] | 230.60 | 232.11 |
| Percentage of Q deviation ($\%P_{Emax}$) | -0.05% | 0.95% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| **Case c): Tested at Nominal voltage 1.1Un, test 1min** | | |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.800 un | 0.800 un |
| Cosφ 60 | 0.801 un | 0.809 un |
| $P_{60}$ (W) | -2443.48 | -4842.59 |
| $Q_{60}$ (Var) | 1824.85 | 3523.69 |



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| | | |
|---|---|---|
| $S_{60}$ (VA) | 3049.70 | 5988.91 |
| $U_{60}$ [V] | 253.41 | 253.06 |
| Percentage of Q deviation ($\%P_{Emax}$) | -0.13% | -1.80% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.800 ov | 0.800 ov |
| Cosφ $_{60}$ | 0.802 ov | 0.801 ov |
| $P_{60}$ (W) | -2415.63 | -4824.86 |
| $Q_{60}$ (Var) | -1796.83 | -3600.90 |
| $S_{60}$ (VA) | 3010.63 | 6020.45 |
| $U_{60}$ [V] | 253.02 | 253.17 |
| Percentage of Q deviation ($\%P_{Emax}$) | 0.25% | 0.30% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.900 un | 0.900 un |
| Cosφ $_{60}$ | 0.901 un | 0.901 un |
| $P_{60}$ (W) | -2690.09 | -5405.17 |
| $Q_{60}$ (Var) | 1298.19 | 2596.51 |
| $S_{60}$ (VA) | 2986.96 | 5996.48 |
| $U_{60}$ [V] | 253.25 | 253.20 |
| Percentage of Q deviation ($\%P_{Emax}$) | -0.07% | -0.32% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |
| $P/S_{Emax}$ (%) | 50 | 100 |
| Cosφ setting | 0.900 ov | 0.900 ov |
| Cosφ $_{60}$ | 0.902 ov | 0.905 ov |
| $P_{60}$ (W) | -2717.30 | -5432.07 |
| $Q_{60}$ (Var) | -1299.74 | -2556.04 |
| $S_{60}$ (VA) | 3012.15 | 6003.39 |
| $U_{60}$ [V] | 253.24 | 253.14 |
| Percentage of Q deviation ($\%P_{Emax}$) | 0.25% | 1.13% |
| Tolerance within 4% $P_{Emax}$ | Yes | Yes |



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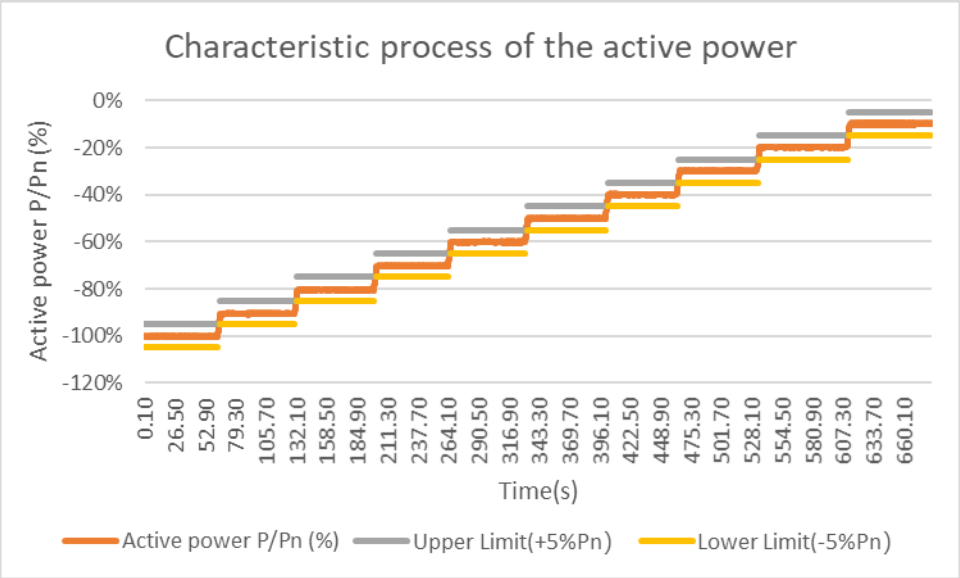
| 5.4.3 | Reduction of active power by setpoint specification | | | | | | | | P | |
|---|---|---|---|---|---|---|---|---|---|---|
| P/Pn (%) | 100 | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 |
| Setting value(W) | 6000 | 5400 | 4800 | 4200 | 3600 | 3000 | 2400 | 1800 | 1200 | 600 |
| Measured value(W) | 6011 | 5428 | 4844 | 4213 | 3605 | 2997 | 2405 | 1794 | 1178 | 570 |
| Devation(W) | 11 | 28 | 44 | 13 | 5 | 3 | 5 | 6 | 22 | 30 |




| | |
|---|---|
| Maximum active power gradient (0.66% Pn inst (or P controllable) per second) | |
| Sample test from 100% $P_n$ to 5% $P_n$, settling time [s], (see the graphic below): | 202.0s |
| Sample test from 5% $P_n$ to 100% $P_n$, settling time [s], (see the graphic below): | 204.0s |
| Sample test from 100% $P_n$ to 5% $P_n$ Gradient [%Pn/s], (see the graphic below): | 0.47%Pn/s |
| Sample test from 5% $P_n$ to 100% $P_n$ Gradient [%Pn/s], (see the graphic below): | 0.47%Pn/s |
| Minimum active power gradient(0.33% Pn inst (or P controllable) per second) | |
| Sample test from 100% $P_n$ to 5% $P_n$, settling time [s], (see the graphic below): | 281.0s |
| Sample test from 5% $P_n$ to 100% $P_n$, settling time [s], (see the graphic below): | 280.0s |
| Sample test from 100% $P_n$ to 5% $P_n$ Gradient [%Pn/s], (see the graphic below): | 0.34%Pn/s |
| Sample test from 5% $P_n$ to 100% $P_n$ Gradient [%Pn/s], (see the graphic below): | 0.34%Pn/s |
| During the active power regulation, the PGU disconnect from the grid or not? | No |



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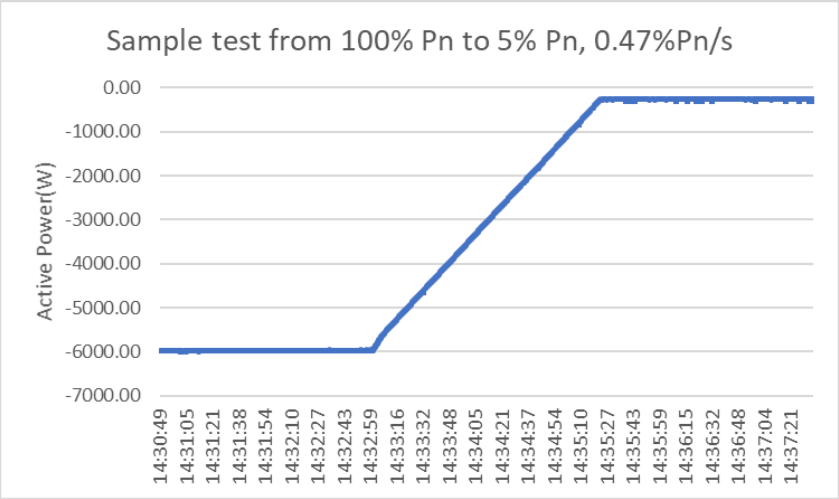
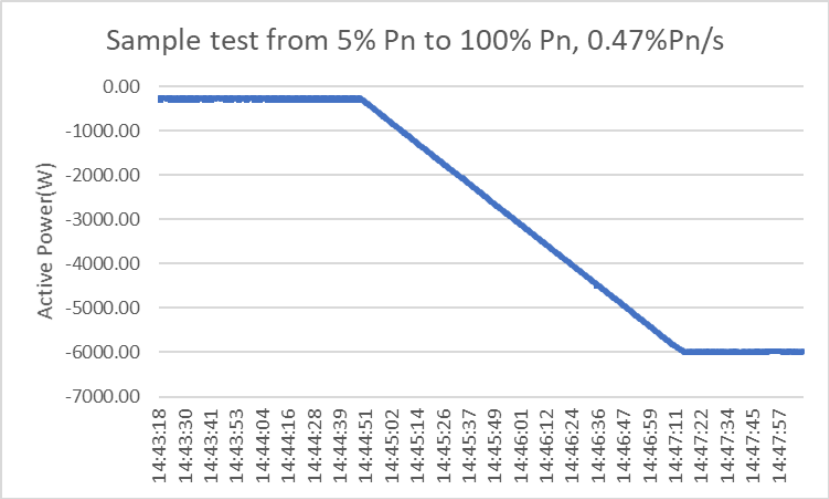
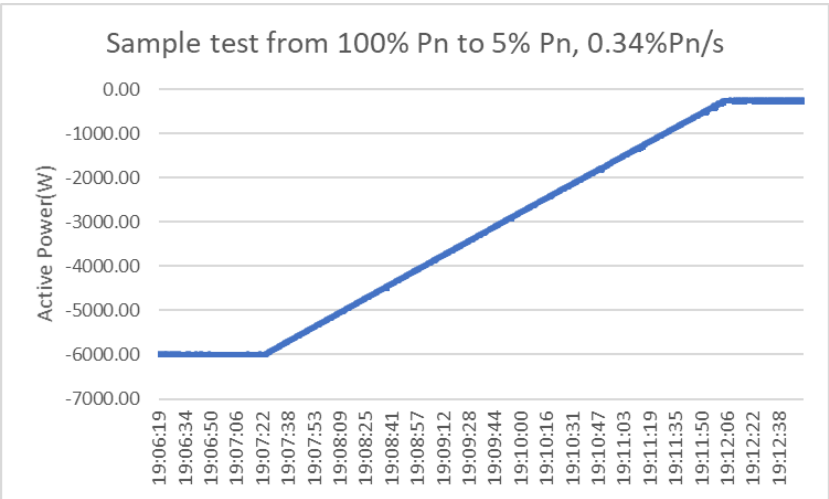
Graphic of change setpoint from 100% Pn to 5% Pn curve with 0.47%Pn/s power gradient




Graphic of change setpoint from 5% Pn to 100% Pn curve with 0.47%Pn/s power gradient




Graphic of change setpoint from 100% Pn to 5% Pn curve with 0.34%Pn/s power gradient



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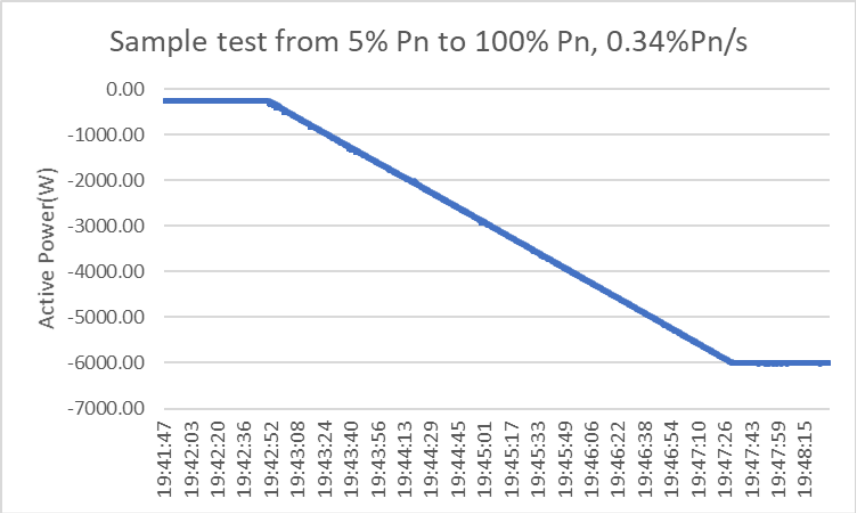
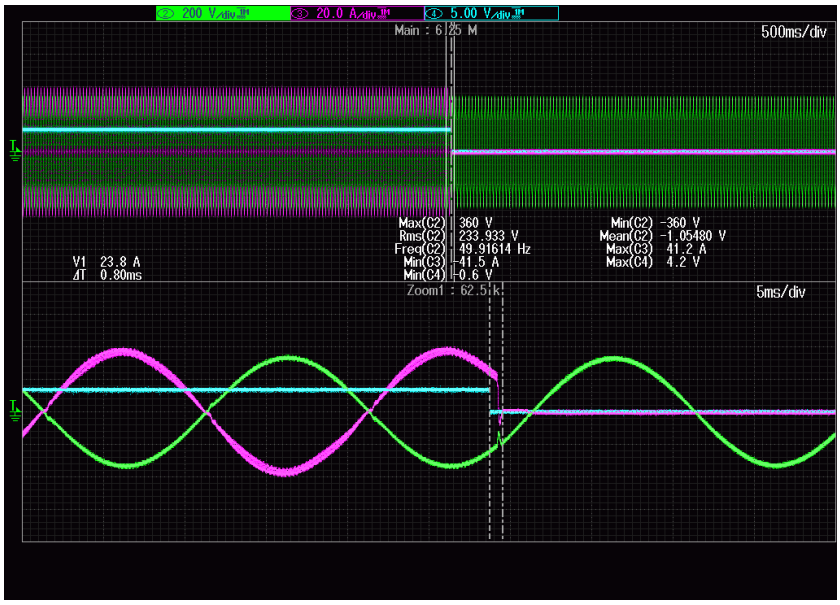
Graphic of change setpoint from 5% Pn to 100% Pn curve with 0.34%Pn/s power gradient




| logical interface (input port) | |
|---|---|
| Interface type | RS485 |
| Expected signal type (e.g. AC, DC); | Differential signal |
| Confirm that an input port is provided and can be used to shut down the module within 5s | Yes |

Supplementary information:




Green [V]: grid voltage signal.

Purple [A]: inverter current signal.

Blue [V]: command trigger signal.



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| 5.4.4 | **Active power feed-in from EZE at overfrequency** | P |
|---|---|---|

Test 1: generation unit, over-frequency regulation, with active power reduction frequency start point=50.2Hz, gradient s=5% (40 % $P_{ref}$/Hz)

TYPE 2 inverter DC input power is set to 100% of maximum active output power till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 40% of $P_M$ per hertz) for more than 10% $P_{Emax}$.

$P_M$ = -5990 W , 10% $P_{Emax}$= -600 W .

| Test sequence | Freq (Hz) | Measured active output power $P_{measure}$ (W) | The calculated active output power as per feature curve $P_{shall}$ (W) | Deviation of $P_{measure}$ and $P_{shall}$ (W) | Deviation within 10% $P_{Emax}$ (Yes/No) |
|---|---|---|---|---|---|
| a) | 50.00 | -5990 | -- | -- | -- |
| b) | 50.25 | -5879 | -5870 | -9 | Yes |
| c) | 50.70 | -4794 | -4792 | -2 | Yes |
| d) | 51.40 | -3104 | -3115 | 11 | Yes |
| e) | 50.70 | -4796 | -4792 | -4 | Yes |
| f) | 50.25 | -5884 | -5870 | -14 | Yes |
| g) | 50.00 | -5998 | -- | -- | -- |
| h) | 51.65 | Protection | Protection | -- | -- |
| i) | 50.15 | No reconnection | Maintain 134.4 s | -- | -- |
| j) | 50.00 | See below table | 100% PM (waiting for 70.0s, then power rise up with gradient of <10 $P_{Emax}$/min) | -- | -- |

| Test sequence | Frequency (Hz) | Time after step bac from 50.00 Hz t (min) | Measured active output power $P_{10}$ (W) | Arised active power ΔP during next 0.5 minute (W) | Gradient of arising active power ΔP/t (W/1 min.) | Gradient of arising active power ΔP/ $P_n$/t (%/1 min.) | Limit within 10% of $P_{Emax}$/min (Yes/No) |
|---|---|---|---|---|---|---|---|
| j) | 50.00 | 0.0 min | 0 | -- | -- | -- | -- |
| j) | 50.00 | 0.0 min | The time that the active power start increases after the frequency change to 50.00Hz (s) | | | | 70.0s |
| j) | 50.00 | 0.5 min | -73 | -73 | -146 | 2.43% | Yes |
| j) | 50.00 | 1.0 min | -340 | -267 | -534 | 8.90% | Yes |
| j) | 50.00 | 1.5 min | -634 | -294 | -588 | 9.80% | Yes |
| j) | 50.00 | 2.0 min | -915 | -281 | -562 | 9.37% | Yes |
| j) | 50.00 | 2.5 min | -1191 | -276 | -552 | 9.20% | Yes |
| j) | 50.00 | 3.0 min | -1471 | -280 | -560 | 9.33% | Yes |
| j) | 50.00 | 3.5 min | -1746 | -275 | -550 | 9.17% | Yes |



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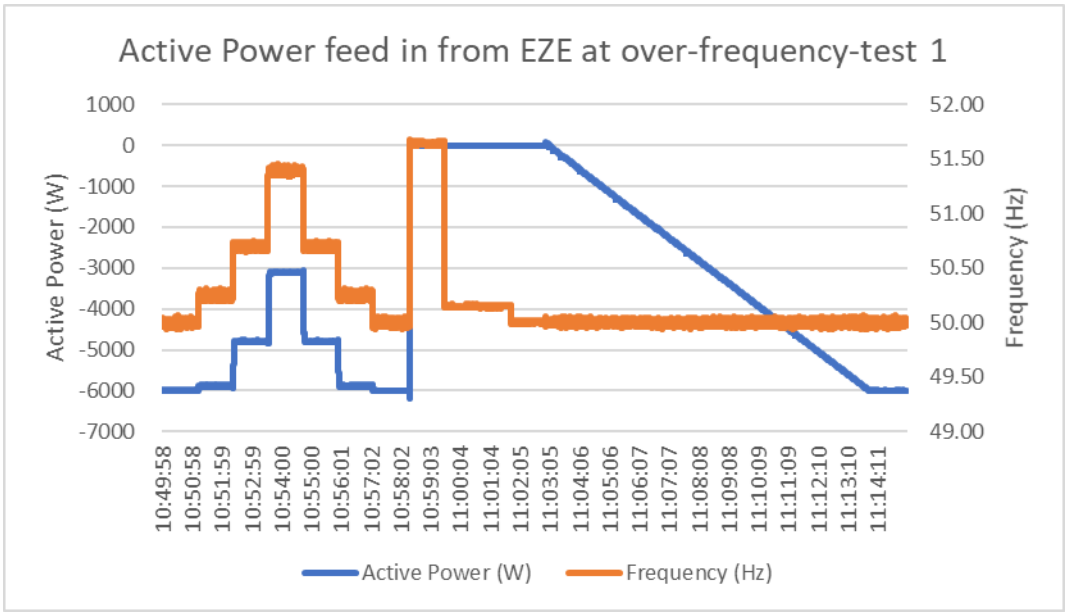
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| j) | 50.00 | 4.0 min | -2019 | -273 | -546 | 9.10% | Yes |
| j) | 50.00 | 4.5 min | -2294 | -275 | -550 | 9.17% | Yes |
| j) | 50.00 | 5.0 min | -2570 | -276 | -552 | 9.20% | Yes |
| j) | 50.00 | 5.5 min | -2845 | -275 | -550 | 9.17% | Yes |
| j) | 50.00 | 6.0 min | -3122 | -277 | -554 | 9.23% | Yes |
| j) | 50.00 | 6.5 min | -3398 | -276 | -552 | 9.20% | Yes |
| j) | 50.00 | 7.0 min | -3672 | -274 | -548 | 9.13% | Yes |
| j) | 50.00 | 7.5 min | -3949 | -277 | -554 | 9.23% | Yes |
| j) | 50.00 | 8.0 min | -4225 | -276 | -552 | 9.20% | Yes |
| j) | 50.00 | 8.5 min | -4500 | -275 | -550 | 9.17% | Yes |
| j) | 50.00 | 9.0 min | -4775 | -275 | -550 | 9.17% | Yes |
| j) | 50.00 | 9.5 min | -5051 | -276 | -552 | 9.20% | Yes |
| j) | 50.00 | 10.0 min | -5329 | -278 | -556 | 9.27% | Yes |
| j) | 50.00 | 10.5 min | -5606 | -277 | -554 | 9.23% | Yes |
| j) | 50.00 | 11.0 min | -5883 | -277 | -554 | 9.23% | Yes |
| j) | 50.00 | 11.5 min | -5997 | -114 | -228 | 3.80% | Yes |
| j) | 50.00 | 12.0 min | -5996 | 1 | 2 | 0.03% | Yes |

Graphic of the active power change:




| Max. and Mean active power gradient after returning from an overfrequency | |
|---|---|
| Max. active power gradient | 9.80 $P_{Emax}$/min |

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| | |
|---|---|
| Mean active power gradient | 8.69 $P_{Emax}$/min |
| Defined active power gradient | 10.00% $P_{Emax}$/min |

Test 2: generation unit, over-frequency regulation, with active power reduction frequency start point=50.5Hz, gradient s=12% (16.67 % $P_{ref}$/Hz)

inverter DC input power is set to 60% of maximum active output power till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 16.7% of $P_M$ per hertz) for more than 10% $P_{Emax}$., once the frequency rise above 50.5Hz, the DC input power shall immediately be set to a point to support 100% active output power.

$P_M$ = -3579 W , 10% $P_{Emax}$= -600 W .

| Test sequence | Freq (Hz) | Measured active output power $P_{measure}$ (W) | The calculated active output power as per feature curve $P_{shall}$ (W) | Deviation of $P_{measure}$ and $P_{shall}$ (W) | Deviation within 10% $P_{Emax}$ (Yes/No) |
|---|---|---|---|---|---|
| a) | 50.00 | -3579 | -- | -- | -- |
| b) | 50.40 | -3580 | -- | -- | -- |
| c) | 50.70 | -3462 | -3460 | -2 | Yes |
| d) | 51.40 | -3038 | -3042 | 4 | Yes |
| e) | 50.70 | -3462 | -3460 | -2 | Yes |
| f) | 50.40 | See below table | Go back to 60% first and then from 60% rise to 100% (power rise up with gradient of <10 $P_{Emax}$/min) | -- | -- |
| g) | 50.00 | -5998 | -- | -- | -- |

| Test sequence | Frequency (Hz) | Time after step bac from 50.00 Hz t (min) | Measured active output power $P_{10}$ (W) | Arised active power ΔP during next 0.5 minute (W) | Gradient of arising active power ΔP/t (W/1 min.) | Gradient of arising active power ΔP/ $P_n$/t (%/1 min.) | Limit within 10% of $P_{Emax}$/min (Yes/No) |
|---|---|---|---|---|---|---|---|
| f) | 50.40 | 0.0 min | -3582 | -- | -- | -- | -- |
| f) | 50.40 | 0.5 min | -3742 | -160 | -320 | 5.33% | Yes |
| f) | 50.40 | 1.0 min | -4018 | -276 | -552 | 9.20% | Yes |
| f) | 50.40 | 1.5 min | -4293 | -275 | -550 | 9.17% | Yes |
| f) | 50.40 | 2.0 min | -4477 | -184 | -368 | 6.13% | Yes |
| f) | 50.40 | 2.5 min | -4706 | -229 | -458 | 7.63% | Yes |
| f) | 50.40 | 3.0 min | -4982 | -276 | -552 | 9.20% | Yes |
| f) | 50.40 | 3.5 min | -5260 | -278 | -556 | 9.27% | Yes |
| f) | 50.40 | 4.0 min | -5536 | -276 | -552 | 9.20% | Yes |



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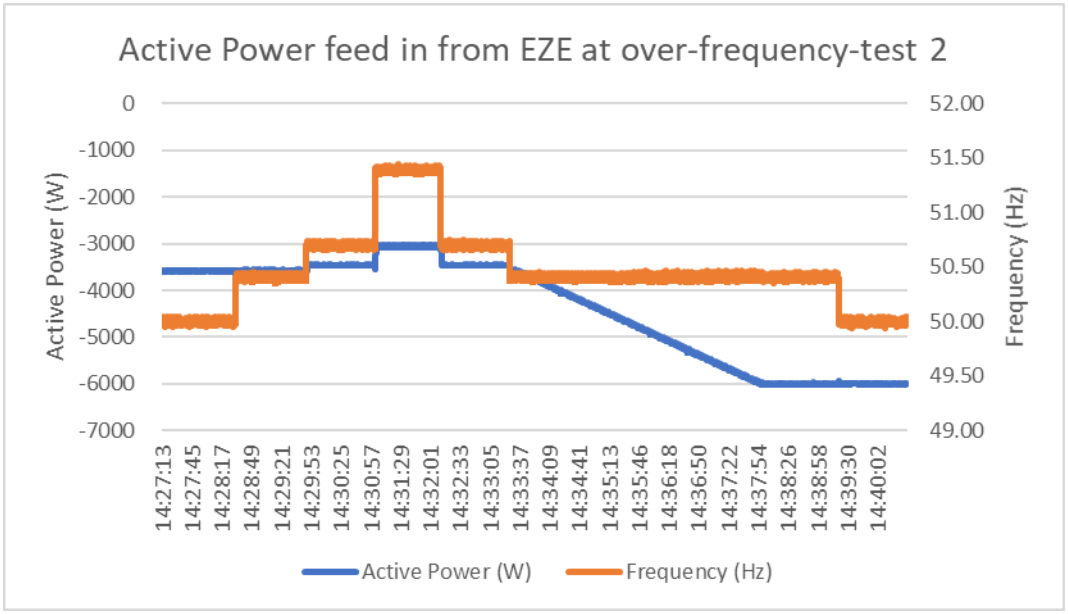
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| f) | 50.40 | 4.5 min | -5813 | -277 | -554 | 9.23% | Yes |
| f) | 50.40 | 5.0 min | -5998 | -185 | -370 | 6.17% | Yes |
| f) | 50.40 | 5.5 min | -5998 | -- | -- | -- | -- |




Active power reaction time

With active power reduction frequency start point=50.2Hz, gradient s=5%, P=100%$P_{Emax}$

| Test Point | Frequency (Hz) | Measured active output power $P_{10}$ (W) | Settling time (s) Limit: <2s | Rise time (s) Limit: <30s |
|---|---|---|---|---|
| 1 | 50.00 | -6006 | -- | -- |
| 2 | 50.20 | -5996 | -- | -- |
| 3 | 51.40 | -3209 | 0.45 | 0.94 |

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| 5.4.6 | TABLE: Active power supply for EZE at underfrequency | P |
|---|---|---|

Inverter DC input power is set to 10% of maximum active output power first. After the TYPE 2 inverter step into frequency range under 49.8Hz, the TYPE 2 inverter available input power is set to 100% of maximum active output. The output active power should regulate the active power with gradient of 40% $P_{Emax}$/Hz till technical maximum power.

10%$P_{Emax}$= -600 W

| Test sequence | Freq (Hz) | Measured active output power $P_{measure}$ (W) | The calculated active output power as per feature curve $P_{shall}$ (W) | Deviation of $P_{measure}$ and $P_{shall}$ (W) | Deviation within 10% $P_{Emax}$ (Yes/No) |
|---|---|---|---|---|---|
| 1 | 50.00 | -556 | -- | -- | -- |
| 2 | 49.75 | -684 | -676 | -8 | Yes |
| 4 | 48.80 | -2979 | -2956 | -23 | Yes |
| 6 | 47.60 | -5874 | -5836 | -38 | Yes |
| 7 | 48.80 | -2980 | -2956 | -24 | Yes |
| 8 | 49.75 | -691 | -676 | -15 | Yes |
| 9 | 50.00 | -555 | -- | -- | -- |
| 10 | 47.35 | Protection | Protection | -- | -- |
| 11 | 47.45 | No reconnection | Maintain 137.5 s | -- | -- |
| 12 | 50.00 | See below table | 10% $P_{Emax}$ (waiting for 75.1s, then power rise up with gradient of <10 $P_{Emax}$/min) | -- | -- |

| Test sequence | Frequency (Hz) | Time after step bac from 50.00 Hz t (min) | Measured active output power $P_{10}$ (W) | Arised active power ΔP during next 0,5 minute (W) | Gradient of arising active power ΔP/t (W/1 min.) | Gradient of arising active power ΔP/ $P_n$/t (%/1 min.) | Limit within 10% of $P_{Emax}$/min (Yes/No) |
|---|---|---|---|---|---|---|---|
| 12 | 50.00 | 0.0 min | 0 | -- | -- | -- | -- |
| 12 | 50.00 | 0.0 min | The time that the active power start increases after the frequency change to 50.00Hz (s) | | | | 75.1s |
| 12 | 50.00 | 0.5 min | -33 | 33 | 66 | 1.10% | Yes |
| 12 | 50.00 | 1.0 min | -215 | 182 | 364 | 6.07% | Yes |
| 12 | 50.00 | 1.5 min | -496 | 281 | 562 | 9.37% | Yes |
| 12 | 50.00 | 2.0 min | -554 | 58 | 116 | 1.93% | Yes |
| 12 | 50.00 | 2.5 min | -554 | 0 | -- | -- | -- |
| 12 | 50.00 | 3.0 min | -553 | 1 | -- | -- | -- |



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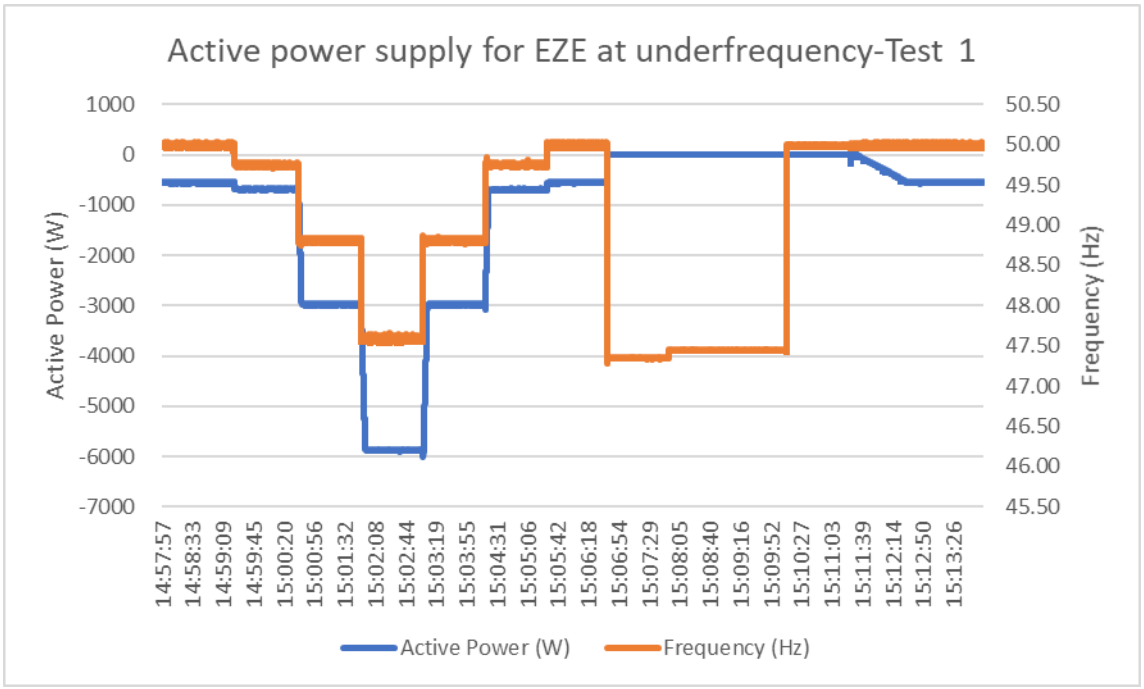


| | |
|---|---|
| Max. active power gradient | 9.37%$P_{Emax}$/min |
| Mean active power gradient | 4.62%$P_{Emax}$/min |
| Defined active power gradient | 10.00%$P_{Emax}$/min |

TYPE 2 inverter DC input power is set to 60% of maximum active output power or minimum opera table active power first. After the TYPE 2 inverter step into frequency range under 49.8Hz, the TYPE 2 inverter available input power is set to 100% of maximum active output. The output active power should regulate the active power with gradient of 40% $P_{Emax}$/Hz till technical maximum power.

10%$P_{Emax}$= -600 W

| Test sequence | Freq (Hz) | Measured active output power $P_{measure}$ (W) | The calculated active output power as per feature curve $P_{shall}$ (W) | Deviation of $P_{measure}$ and $P_{shall}$ (W) | Deviation within 10% $P_{Emax}$ (Yes/No) |
|---|---|---|---|---|---|
| 1 | 50.00 | -3574 | -- | -- | -- |
| 2 | 49.75 | -3701 | -3694 | -7 | Yes |
| 3 | 49.20 | -5027 | -5014 | -13 | Yes |
| 4 | 48.80 | -5987 | -5974 | -13 | Yes |
| 5 | 49.20 | -5030 | -5014 | -16 | Yes |
| 6 | 49.85 | -3577 | -- | -- | -- |
| 7 | 50.00 | -3578 | -- | -- | -- |



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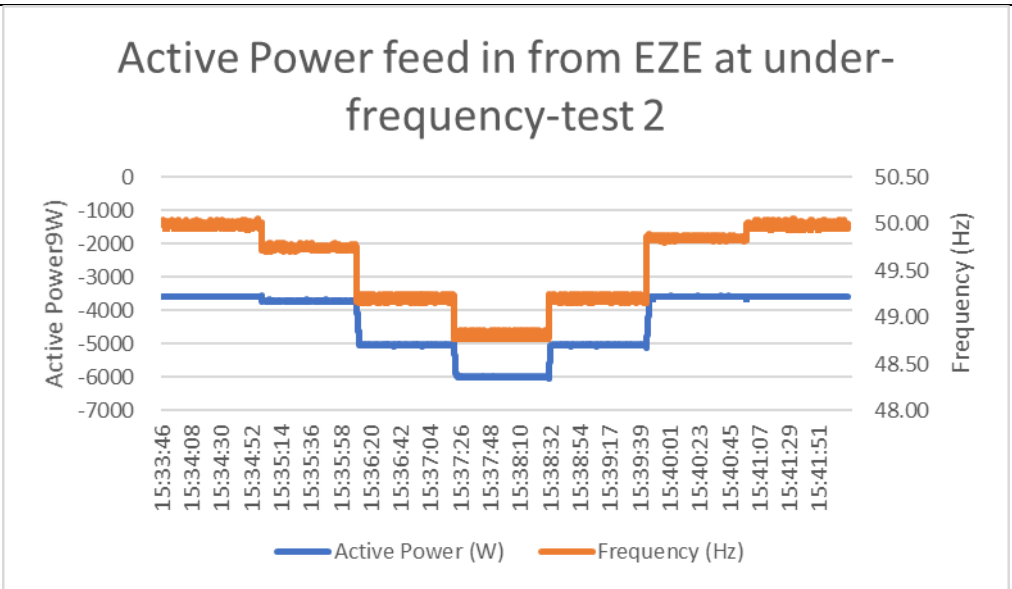


Active power reaction time

With active power reduction frequency start point=49.8Hz, gradient s=5%, P=10%$P_{Emax}$

| Test Point | Frequency (Hz) | Measured active output power $P_{10}$ (W) | Settling time (s) Limit: <2s | Rise time (s) Limit: <30s |
|---|---|---|---|---|
| 1 | 50.00 | -581 | -- | -- |
| 2 | 49.80 | -588 | -- | -- |
| 3 | 47.60 | -5964 | 0.30 | 1.33 |



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| 5.4.8.3 | TABLE: Testing of the displacement factor/active power characteristic cos φ (P) | P |
|---|---|---|

**1)Test steps for guided EZE accuracy (characteristic)**

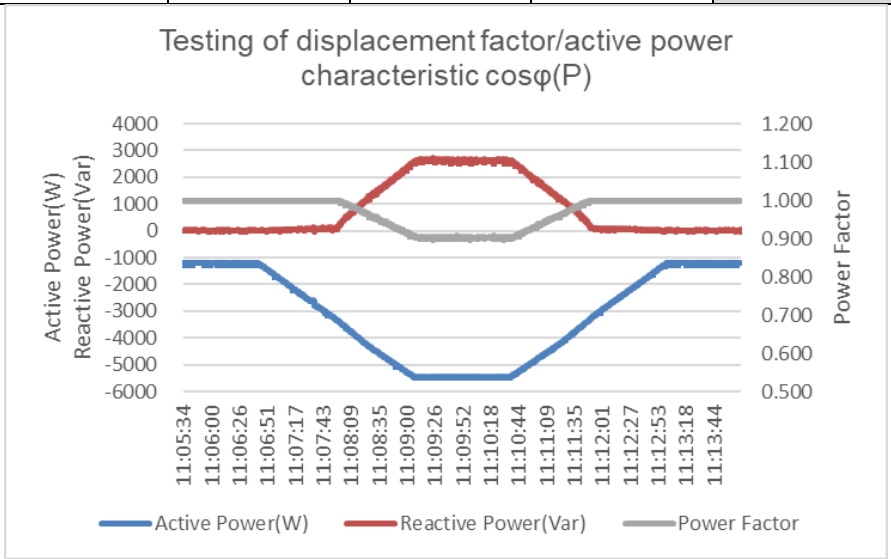
| Maximal active power $P_{Emax}$ with the tested displacement factor (W) | -5400 |
|---|---|

Trip #1

During the test, the active power gradient setting at 0.5% Pn/s

Response of the reactive power set 3-Tau=10s

| Percentage of output active power $P/P_{Emax}$ (%) | Measured active power P (W) | Measured apparent power S (VA) | Measured displacement factor cosφ | Measured reactive power Q(Var) | Displacement factor as to feature curve | Deviation of displacement reactive power |
|---|---|---|---|---|---|---|
| 20% | -1207 | 1207 | 1.000 | 7 | 1.000 | 7 |
| 100% | -5468 | 6065 | 0.902 un | 2624 | 0.900 un | 8 |
| 20% | -1208 | 1208 | 1.000 | 6 | 1.000 | 6 |




Trip #2

The active power gradient setting at 100% Pn/s

Response of the reactive power set 3-Tau=10s

| Percentage of output active power $P/P_{Emax}$ (%) | Measured active power P (W) | Measured apparent power S (VA) | Measured displacement factor cosφ | Measured reactive power Q(Var) | Displacement factor as to feature curve | Deviation of displacement reactive power |
|---|---|---|---|---|---|---|
| 20% | -1187 | 1187 | 1.000 | 2 | 1.000 | 2 |
| 100% | -5512 | 6046 | 0.904 un | 2483 | 0.900 un | -133 |
| 20% | -1188 | 1188 | 1.000 un | 2 | 1.000 | 2 |



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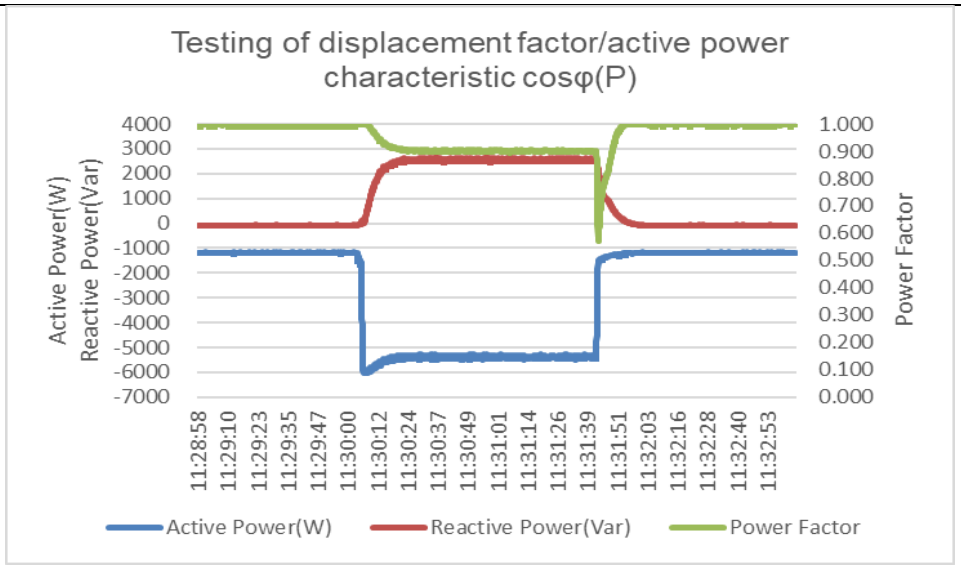


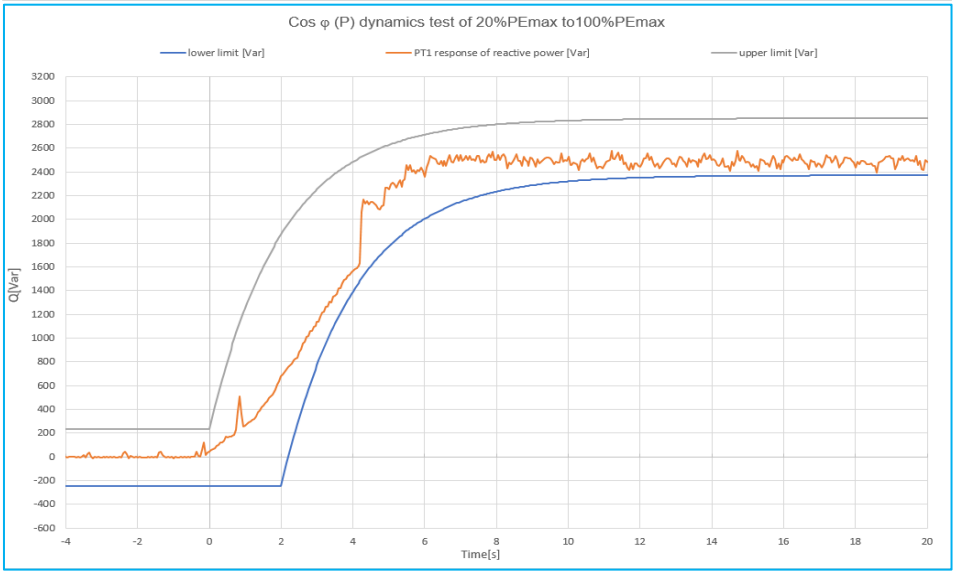


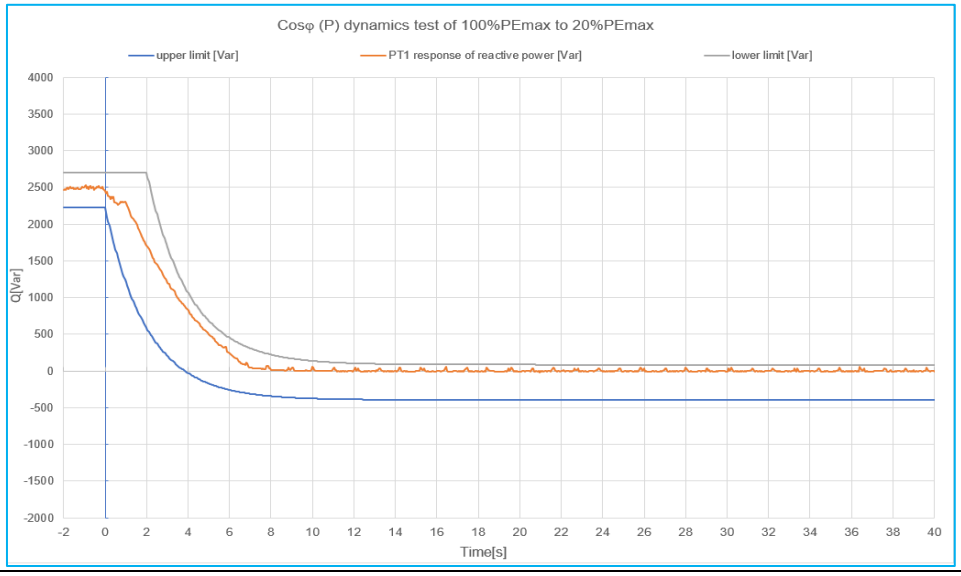




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| 5.5.2 & 5.5.6.3 | NA protection safety fault test | | | | | P |
|---|---|---|---|---|---|---|
| Ambient temperature (°C) ……..: | | | | | | 26°C |
| Relative humidity……: | | | | | | 55% |
| No. | component | Fault | Input (Vdc) | Output (Vac, W) | Test duration | Observation |
| INV PCB | | | | | | |
| 1. | R478 (Resistance of PV voltage sampling circuit） | O-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the PV voltage sampling value was incorrect, no fault was detected. No hazard. No damage. |
| 2. | C and E of Q10 (Switch device of PV2 boost circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady red, “PV2 over current” fault was detected. No output voltage. Q10 was damaged, No hazards. |
| 3. | R57 (Drive resistance of Q10 of PV2 drive circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, PV2 circuit was not operated. The unit operated normally. No hazard. No damage. |
| 4. | C and E of Q19 (Switch device of INV circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady red, “INV overcurrent, Grid fast check abnormal, INV inductor current limited, leakage current exceeded” faults were detected. No output voltage. Q18 and Q20 were damaged, no hazards. |
| 5. | R25 (Drive resistance of Q19) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady yellow, “Inverter self-test failed” fault was detected. No output voltage. No hazard. No damage. |
| 6. | R468 (Resistance of bus capacitor voltage sampling circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady red, “Bus capacitor” faults were detected. No output voltage. No hazard. No damage. |
| 7. | R213 (Resistance of grid voltage sampling circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage. |
| 8. | R155 (Resistance of load voltage sampling circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage. |
| 9. | R102 of HCT3 (PV1 current sampling circuit) | O-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. The inverter could not detect the PV1 current. No fault was detected. No hazard. No damage. |
| 10. | R73 of HCT2 (Load current sampling circuit) | O-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady red. “Output over current” fault |



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| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | was detected. No output voltage. No hazard. No damage. |
| 11. | R93 of HCT4 (Grid current sampling circuit) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage. |
| Boost board | | | | | | |
| 12. | R65 (Drive resistance of Q21 of TX3 primary winding) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage. |
| 13. | R31 (Drive resistance of U1 of drive IC of Q1) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage. |
| 14. | R18 (Drive resistance of U11 of drive IC of Q6) | S-C | 420 | 230,6000 | 3min | The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage. |

AC Filter board

| No. | Component | Fault | Supply voltage (V) | Test time | Fuse # | Fuse current (A) | Observation |
|---|---|---|---|---|---|---|---|
| 1. | K3 L phase | S-C | 420Vd.c. | 3min | / | / | The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally. |
| 2. | K4 N phase | S-C | 420Vd.c. | 3min | / | / | The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally. |
| 3. | K5 L phase | S-C | 420Vd.c. | 3min | / | / | The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally. |
| 4. | K6 N phase | S-C | 420Vd.c. | 3min | / | / | The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally. |

Supplementary information:

S-C: Short circuit

O-C: Open circuit

During the test: Fire do not propagate beyond the PCE;

Equipment do not 60mit molten metal;

Enclosures do not deform to cause non-compliance with the standard.



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| 5.5.4 & 5.5.7.4 | Integrated NA Protection and Protective devices and settings | | | | | P |
|---|---|---|---|---|---|---|
| Test step | Size | Apply to | Jump height ΔU, Δf | Step length Δt | Measured value | Limit |
| 1.1 | U>> | L1-N | < 1.15 V | >400 ms | 288.69 V | 287.5±2.3 V |
| 1.2 | U>> | L1-N | < 1.15 V | >400 ms | 288.66 V | 287.5±2.3 V |
| 1.3 | U>> | L1-N | < 1.15 V | >400 ms | 288.66 V | 287.5±2.3 V |
| 2.1 | U>> | L1-N | >9.2 V | >400 ms | 146.00 ms | 100-200ms |
| 2.2 | U>> | L1-N | >9.2 V | >400 ms | 134.00 ms | 100-200ms |
| 2.3 | U>> | L1-N | >9.2 V | >400 ms | 133.00 ms | 100-200ms |
| 3.1 | U> | L1-N | 27.6 V | > 600.2 s | 452.00 s | 450-550 s |
| 3.2 | U> | L1-N | 18.4 V | > 600.2 s | No disconnection | No disconnection |
| 3.3 | U> | L1-N | < 1.15 V | > 600.2 s | 250.00 s | 225-375s |
| 4.1 | U< | L1-N | < 1.15 V | >3.2 s | 183.62 V | 184±2.3 V |
| 4.2 | U< | L1-N | < 1.15 V | >3.2 s | 183.65 V | 184±2.3 V |
| 4.3 | U< | L1-N | < 1.15 V | >3.2 s | 183.24 V | 184±2.3 V |
| 5.1 | U< | L1-N | > 9.2 V | >3.2 s | 3.06 s | 3.0-3.1s |
| 5.2 | U< | L1-N | > 9.2 V | >3.2 s | 3.04 s | 3.0-3.1s |
| 5.3 | U< | L1-N | > 9.2 V | >3.2 s | 3.05 s | 3.0-3.1s |
| 6.1 | U<< | L1-N | <1.15 V | >500 ms | 101.20 V | 103±2.3 V |
| 6.2 | U<< | L1-N | <1.15 V | >500 ms | 101.30 V | 103±2.3 V |
| 6.3 | U<< | L1-N | < 1.15 V | >500 ms | 101.60 V | 103±2.3 V |
| 7.1 | U<< | L1-N | > 9.2 V | >500 ms | 330.00 ms | 300-400ms |
| 7.2 | U<< | L1-N | > 9.2 V | >500 ms | 335.00 ms | 300-400ms |
| 7.3 | U<< | L1-N | > 9.2 V | >500 ms | 340.00 ms | 300-400ms |
| 8.1 | f> | f | < 25 mHz | > 400 ms | 51.49 Hz | 51.5±0.05Hz |
| 9.1 | f> | f | > 0.2 Hz | > 400 ms | 122.00 ms | 100-200ms |
| 10.1 | f< | f | < 25 mHz | > 400 ms | 47.49 Hz | 47.5±0.05Hz |
| 11.1 | f< | f | > 0.2 Hz | > 400 ms | 110.00 ms | 100-200ms |



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| 5.5.7.2 | **Voltage monitoring (integrated protection and interface switch)-setting check** | P |
|---|---|---|
| AC Relay information | Manufacture: Xiamen Hongfa Electroacoustic Co., Ltd.<br>Model: HF161F-40W<br>Rated/Max current:43A<br>Release time:10ms | |

| Description | Parameter name | Setting value in pu | Setting value L-N | Check match (yes or not) |
|---|---|---|---|---|
| Excitation threshold U>> | AU>> | 1.25 | 287.5 V | YES |
| Delay time U>> | tU>> | – | 100 ms | YES |
| Excitation threshold U> | AU> | 1.10 | 253 V | YES |
| Delay time U>[a] | tU> | – | 100 ms [a] | - |
| Excitation threshold U< | AU< | 0.8 | 184 V | YES |
| Delay time U<. | tU< | – | 3 s | YES |
| Excitation threshold U<< | AU<< | 0.45 | 103.5 V | YES |
| Delay time U<< | tU<< | – | 300 ms | YES |
| Excitation threshold f> | Af> | 1.03 | 51.5 Hz | YES |
| Delay time f> | Tf> | – | 100 ms | YES |
| Excitation threshold f< | Af< | 0.95 | 47.5 Hz | YES |
| Delay time f< | Tf< | – | 100 ms | YES |

Remark: “a”: Moving 10 min mean protection.

The NS prectection setting is shown by the computer：

| | Name | Echo | Unit | Range | | Name | Echo | Unit | Range |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Excitation threshold U> | 253.0 | V | 230~280 | | Delay time U> | 100 | ms | 20~4000 |
| 2 | Excitation threshold U>> | 287.5 | V | 230~300 | | Delay time U>> | 100 | ms | 20~4000 |
| 3 | Excitation threshold U< | 184.0 | V | 160~200 | | Delay time U< | 3000 | ms | 20~4000 |
| 4 | Excitation threshold U<< | 103.5 | V | 30~200 | | Delay time U<< | 300 | ms | 20~4000 |
| 5 | Excitation threshold f> | 51.50 | Hz | 50~65 | | Delay time f> | 100 | ms | 20~4000 |
| 6 | Excitation threshold f< | 47.50 | Hz | 45~59.8 | | Delay time f< | 100 | ms | 20~4000 |



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| 5.5.7.3 | Wiring test | | | P |
|---|---|---|---|---|
| **Table 37 –Wiring Test** | Voltage Value (V) | | | Frequency Frequency (Hz) |
| | Phase L1-N | Phase L2-N | Phase L3-N | |
| Setting | 230.0 V (0°) | 230.0 V (-120°) | 230.0 V (120°) | 50 Hz |
| Read at NA protection | 231.0 V | - | - | 49.99 Hz |

| | Name | Echo | Unit | | Name | Echo | Unit |
|---|---|---|---|---|---|---|---|
| 1 | MCU SW Ver. | 1120 | | | DSP SW Ver. | 69 | |
| 2 | MCU HW Ver. | 0 | | | DSP HW Ver. | 0 | |
| 3 | System Current Mode | Battery First | | | System Running Status | STAND BY | |
| 4 | DCDC TEMP. | 31.0 | ℃ | | BUS VOLT. | 304.6 | V |
| 5 | Daily E-Generated | 0.00 | kWh | | Total E-Generated | 42.63 | kWh |
| 6 | Rated Power | 6 | KW | | BATT Capacity | 0.000 | kWh |
| 7 | PV1 VOLT. | 26.3 | V | | PV1 CURR. | 0.2 | A |
| 8 | PV1 Power | 5 | W | | PV2 VOLT. | 26.2 | V |
| 9 | PV2 CURR. | 0.1 | A | | PV2 POWER | 3 | W |
| 10 | BATT Status | NULL | | | BATT VOLT. | 58.1 | V |
| 11 | BATT CURR. | 0.0 | A | | BATT POWER | 0 | W |
| 12 | BATT SOC | 0 | % | | BMS Flag | N/A | |
| 13 | Grid Status | N/A | | | Grid FREQ. | 49.99 | Hz |
| 14 | Grid VOLT. | 231.0 | V | | Grid Apparent Power | 25 | VA |
| 15 | Grid Active Power | 0 | W | | Grid Reactive Power | 25 | VAR |
| 16 | CT CURR. | 0.0 | A | | CT Power | -12 | W |
| 17 | CT direction | CT Buying | | | INV TEMP. | 31.0 | ℃ |
| 18 | INV Status | N/A | | | INV Output FREQ. | 0.00 | Hz |
| 19 | INV Output VOLT. | 1.4 | V | | INV Output CURR. | 0.1 | A |
| 20 | INV Apparent Power | 0 | VA | | INV Active Power | 0 | W |

| | | | | |
|---|---|---|---|---|
| Setting | 219.4 V (0°) | 230.9 V (-120°) | 242.5 V (120°) | 50 Hz |
| Read at NA protection | 220.9 V | - | - | 49.99 Hz |

Number of arguments in a single line: 2

| | Name | Echo | Unit | | Name | Echo | Unit |
|---|---|---|---|---|---|---|---|
| 1 | MCU SW Ver. | 1120 | | | DSP SW Ver. | 69 | |
| 2 | MCU HW Ver. | 0 | | | DSP HW Ver. | 0 | |
| 3 | System Current Mode | Battery First | | | System Running Status | STAND BY | |
| 4 | DCDC TEMP. | 31.0 | ℃ | | BUS VOLT. | 300.2 | V |
| 5 | Daily E-Generated | 0.00 | kWh | | Total E-Generated | 42.63 | kWh |
| 6 | Rated Power | 6 | KW | | BATT Capacity | 0.000 | kWh |
| 7 | PV1 VOLT. | 26.9 | V | | PV1 CURR. | 0.2 | A |
| 8 | PV1 Power | 6 | W | | PV2 VOLT. | 26.8 | V |
| 9 | PV2 CURR. | 0.1 | A | | PV2 POWER | 3 | W |
| 10 | BATT Status | NULL | | | BATT VOLT. | 58.2 | V |
| 11 | BATT CURR. | 0.0 | A | | BATT POWER | 4 | W |
| 12 | BATT SOC | 0 | % | | BMS Flag | N/A | |
| 13 | Grid Status | N/A | | | Grid FREQ. | 49.99 | Hz |
| 14 | Grid VOLT. | 220.9 | V | | Grid Apparent Power | 17 | VA |
| 15 | Grid Active Power | 1 | W | | Grid Reactive Power | 17 | VAR |
| 16 | CT CURR. | 0.1 | A | | CT Power | -12 | W |
| 17 | CT direction | CT Buying | | | INV TEMP. | 31.0 | ℃ |
| 18 | INV Status | N/A | | | INV Output FREQ. | 0.00 | Hz |
| 19 | INV Output VOLT. | 1.1 | V | | INV Output CURR. | 0.0 | A |
| 20 | INV Apparent Power | 0 | VA | | INV Active Power | 0 | W |



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| 5.5.7.5 | Reading the fault messages | P |
|---|---|---|
| Test sequence | | Test result |
| The last five date failure report readable | | P |
| Interruptions of supply with duration of 3s or longer shall not lead to loss of any of the failure report | | P |
| Read our shall be possible at the central NA protection irrespective of the operational state of the power generation system and without any additional aids | | P |
| For a integrated NA protection, a read out may be carried out using data interface. | | P |



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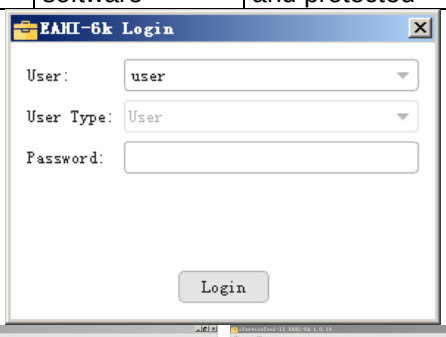
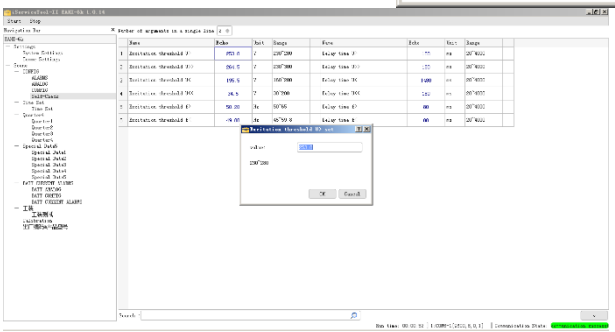
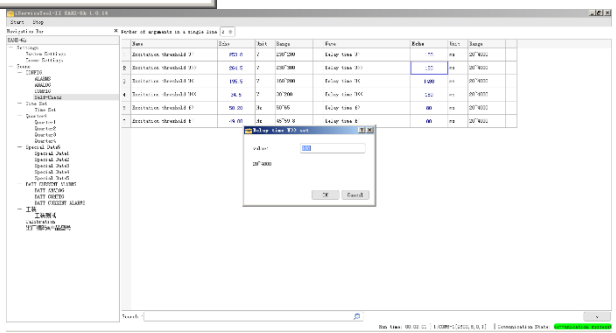
| 5.5.9 | TABLE: Structural features of NA protection | | P |
|---|---|---|---|
| Type and form of protection against unauthorized access | ☐ NS protection sealable | ☒ NS protection password protected | ☐ other appropriate measure |
| If NS protection password protected | Testing based on the manufacturer's instructions | | ☒ Pass ☐ Fail |

| NS protection functions setting value | Trip value | | Trip time | |
|---|---|---|---|---|
| Rise-in-voltage protection *U* >> | ☐ fixed in software | ☒ adjustable and protected | ☐ fixed in software | ☒ adjustable and protected |
| Rise-in-voltage protection *U* >> | ☐ fixed in software | ☒ adjustable and protected | ☐ fixed in software | ☒ adjustable and protected |
| Voltage drop protection *U* < | ☐ fixed in software | ☒ adjustable and protected | ☐ fixed in software | ☒ adjustable and protected |
| Voltage drop protection *U* << | ☐ fixed in software | ☒ adjustable and protected | ☐ fixed in software | ☒ adjustable and protected |
| Frequency decrease protection *f* < | ☐ fixed in software | ☒ adjustable and protected | ☐ fixed in software | ☒ adjustable and protected |
| Frequency increase protection *f* > | ☐ fixed in software | ☒ adjustable and protected | ☐ fixed in software | ☒ adjustable and protected |







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| 5.5.10 | Islanding detection | | | | | | | | P |
|---|---|---|---|---|---|---|---|---|---|
| No. | $P_{EUT}$ (% of EUT rating) | Reactive load (% of normial) | $P_{AC}$ | $Q_{AC}$ | Run-on time(ms) | $P_{EUT}$ (W) | Actual $Q_f$ | $V_{DC}$ （V） | Which load is selected to be adjusted (C or L) |
| Test condition A | | | | | | | | | |
| 1 | 100 | 100 | 0 | 0 | 687 | 5930 | 1.01 | 57.6 | - |
| 2 | 100 | 100 | -5 | -5 | 666 | 5749 | 1.03 | 57.6 | C |
| 3 | 100 | 100 | -5 | 0 | 758 | 5823 | 1.06 | 57.6 | C |
| 4 | 100 | 100 | -5 | +5 | 567 | 5805 | 1.09 | 57.6 | C |
| 5 | 100 | 100 | 0 | -5 | 860 | 5827 | 0.97 | 57.6 | C |
| 6 | 100 | 100 | 0 | +5 | 747 | 5812 | 1.04 | 57.6 | C |
| 7 | 100 | 100 | +5 | -5 | 720 | 5804 | 0.93 | 57.6 | C |
| 8 | 100 | 100 | +5 | 0 | 549 | 5839 | 0.96 | 57.6 | C |
| 9 | 100 | 100 | +5 | +5 | 799 | 5853 | 0.99 | 57.6 | C |
| 10 | 100 | 100 | -10 | +10 | 290 | 5847 | 1.16 | 57.6 | C |
| 11 | 100 | 100 | -5 | +10 | 295 | 5841 | 1.10 | 57.6 | C |
| 12 | 100 | 100 | 0 | +10 | 280 | 5842 | 1.05 | 57.6 | C |
| 13 | 100 | 100 | +10 | +10 | 266 | 5808 | 0.96 | 57.6 | C |
| 14 | 100 | 100 | +10 | +5 | 716 | 5827 | 0.94 | 57.6 | C |
| 15 | 100 | 100 | +10 | 0 | 409 | 5801 | 0.91 | 57.6 | C |
| 16 | 100 | 100 | +10 | -5 | 628 | 5785 | 0.89 | 57.6 | C |
| 17 | 100 | 100 | +10 | -10 | 813 | 5859 | 0.88 | 57.6 | C |
| 18 | 100 | 100 | +5 | -10 | 332 | 5820 | 0.91 | 57.6 | C |
| 19 | 100 | 100 | 0 | -10 | 809 | 5824 | 0.96 | 57.6 | C |
| 20 | 100 | 100 | -5 | -10 | 515 | 5836 | 1.00 | 57.6 | C |
| 21 | 100 | 100 | -10 | -10 | 666 | 5831 | 1.05 | 57.6 | C |
| 22 | 100 | 100 | -10 | -5 | 372 | 5813 | 1.08 | 57.6 | C |
| 23 | 100 | 100 | -10 | 0 | 808 | 5867 | 1.11 | 57.6 | C |
| 24 | 100 | 100 | -10 | +5 | 555 | 5820 | 1.14 | 57.6 | C |
| Test condition B | | | | | | | | | |
| 1 | 66 | 66 | 0 | 0 | 685 | 3809 | 1.00 | 51.0 | - |
| 2 | 66 | 66 | 0 | -5 | 526 | 3782 | 0.98 | 51.0 | C |
| 3 | 66 | 66 | 0 | -4 | 760 | 3810 | 0.99 | 51.0 | C |
| 4 | 66 | 66 | 0 | -3 | 621 | 3780 | 0.98 | 51.0 | C |
| 5 | 66 | 66 | 0 | -2 | 756 | 3781 | 0.99 | 51.0 | C |



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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 66 | 66 | 0 | -1 | 656 | 3807 | 0.99 | 51.0 | C |
| 7 | 66 | 66 | 0 | 1 | 843 | 3807 | 1.00 | 51.0 | C |
| 8 | 66 | 66 | 0 | 2 | 458 | 3802 | 1.01 | 51.0 | C |
| 9 | 66 | 66 | 0 | 3 | 397 | 3805 | 1.01 | 51.0 | C |
| 10 | 66 | 66 | 0 | 4 | 503 | 3805 | 1.02 | 51.0 | C |
| 11 | 66 | 66 | 0 | 5 | 293 | 3799 | 1.02 | 51.0 | C |
| Test condition C | | | | | | | | | |
| 1 | 33 | 33 | 0 | 0 | 264 | 1873 | 1.00 | 40.8 | - |
| 2 | 33 | 33 | 0 | -5 | 277 | 1863 | 0.98 | 40.8 | C |
| 3 | 33 | 33 | 0 | -4 | 335 | 1862 | 0.99 | 40.8 | C |
| 4 | 33 | 33 | 0 | -3 | 354 | 1865 | 0.99 | 40.8 | C |
| 5 | 33 | 33 | 0 | -2 | 262 | 1871 | 0.99 | 40.8 | C |
| 6 | 33 | 33 | 0 | -1 | 358 | 1871 | 1.00 | 40.8 | C |
| 7 | 33 | 33 | 0 | 1 | 301 | 1870 | 1.01 | 40.8 | C |
| 8 | 33 | 33 | 0 | 2 | 349 | 1868 | 1.01 | 40.8 | C |
| 9 | 33 | 33 | 0 | 3 | 280 | 1870 | 1.02 | 40.8 | C |
| 10 | 33 | 33 | 0 | 4 | 524 | 1868 | 1.02 | 40.8 | C |
| 11 | 33 | 33 | 0 | 5 | 346 | 1868 | 1.03 | 40.8 | C |

Remark:

1. The input source used in the test is the battery;

2. For test condition A:

If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.

3.For test condition B and C:

If run-on times are still increasing at the 95 % or 105 % points, additional 1 % increments are taken until run-on times begin decreasing.



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| 5.6 | Connection conditions and synchronization | P |
|---|---|---|
| Test procedure | a) f=47.45Hz, no reconnection allowed | Yes |
| | b) f=47.55Hz, reconnection allowed | Yes |
| | c) f=50.15Hz, no reconnection allowed | Yes |
| | d) f=50.05Hz, reconnection allowed | Yes |
| | e) U=84% Un, no reconnection allowed | Yes |
| | f) U=86% Un, reconnection allowed | Yes |
| | g) U=111% Un, no reconnection allowed | Yes |
| | h) U=109% Un, reconnection allowed | Yes |



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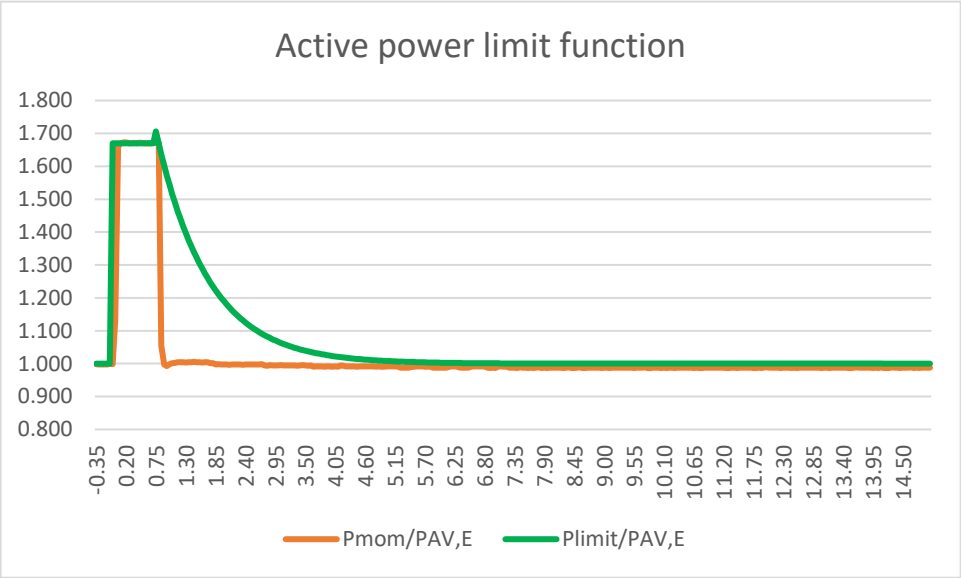
| 5.7 | Proof of $P_{AV,E}$ monitoring | | P |
|---|---|---|---|
| **5.7.2.1** | **Checking the control dynamics** | | |
| Pn (W) | 6000 | $P_{AV,E}$ setting value (W) | 3600 |
| Test a) | Maximum EZE output power before switch load | | Maximum EZE output power after switch load for 10 s |
| Measured power value | -3566.82 | | -3562.62 |
| Pm/ $P_{AV,E}$ | 99.08% | | 98.96% |
| Tolerance (-2%) | -0.92% | | -1.04% |
| Power cure (time for 1.067 $P_{AV,E}$) |  | | |





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| 5.8 | Proof of dynamic grid support | | | | | | P |
|---|---|---|---|---|---|---|---|
| Test number definition | Test | Voltage during fault | Phase fault type | Fault duration (ms) | Load | Cosφ setting | Test Number |
| | 1 | 0.15-0.25 | 1 phase | At 0.15pu> 150<br>At 0.25pu> 200 | Full load | 1 | 1.1 |
| | | | | | Partial load | | 1.2 |
| | | | 1 phase D1 | | Full load | | 1.3 |
| | | | | | Partial load | | 1.4 |
| | | | 1 phase D2 | | Full load | | 1.5 |
| | | | | | | | |
| | 2 | 0.50-0.60 | 1 phase | at 0.50pu ≥1500<br>at 0.60pu ≥2000 | Full load | maximum over-excited | 2.1 |
| | | | | | Partial load | maximum over-excited | 2.2 |
| | | | 1 phase D1 | | Full load | maximum over-excited | 2.3 |
| | | | | | Partial load | maximum over-excited | 2.4 |
| | | | | | | | |
| | 3 | 0.50-0.60 | 1 phase | at 0.50pu ≥1500<br>at 0.60pu ≥2000 | Full load | maximum under-excited | 3.1 |
| | | | | | Partial load | maximum under-excited | 3.2 |
| | | | 1 phase D1 | | Full load | maximum under-excited | 3.3 |
| | | | | | Partial load | maximum under-excited | 3.4 |
| | | | | | | | |
| | 4 | 0.85-0.90 | 1 phase | ≥ 60000 | Full load | 1 | 4.1 |
| | | | | | Partial load | | 4.2 |
| | | | 1 phase D1 | | Full load | | 4.3 |
| | | | | | Partial load | | 4.4 |
| | | | | | | | |
| | 5 | 1.20 to 1.25 | 1 phase | ≥ 100 | Full load | 1 | 5.1 |
| | | | | | Partial | | 5.2 |



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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | load | | |
| | | | 1 phase D1 | | Full load | | 5.3 |
| | | | | | Partial load | | 5.4 |
| | | | 1 phase D2 | | Full load | | 5.5 |
| | | | | | | | |
| | 6 | 1.15 to 1.20 | 1 phase | ≥ 5000 | Full load | 1 | 6.1 |
| | | | | | Partial load | | 6.2 |
| | | | 1 phase D1 | | Full load | | 6.3 |
| | | | | | Partial load | | 6.4 |
| | | | | | | | |
| | 7 | 1.10-1.15 | 1 phase | ≥ 60000 | Full load | 1 | 7.1 |
| | | | | | Partial load | | 7.2 |
| | | | 1 phase D1 | | Full load | | 7.3 |
| | | | | | Partial load | | 7.4 |



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 1.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/14 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 20:41:14 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 23112 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23324 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 212 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.847 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.011 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.987 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.997 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.032 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.999 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.149 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.103 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.013 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.016 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.001 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.010 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -1.000 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.995 |
| | 23 | Active power recover time | Total | - | ms | 361 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.032 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.030 |



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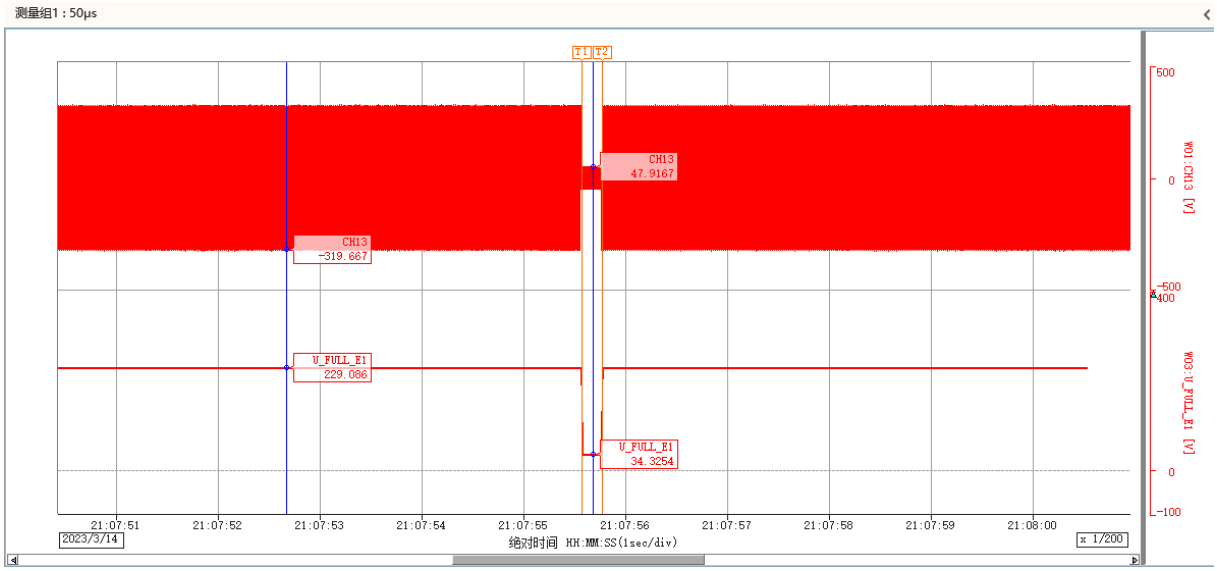
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 12 |

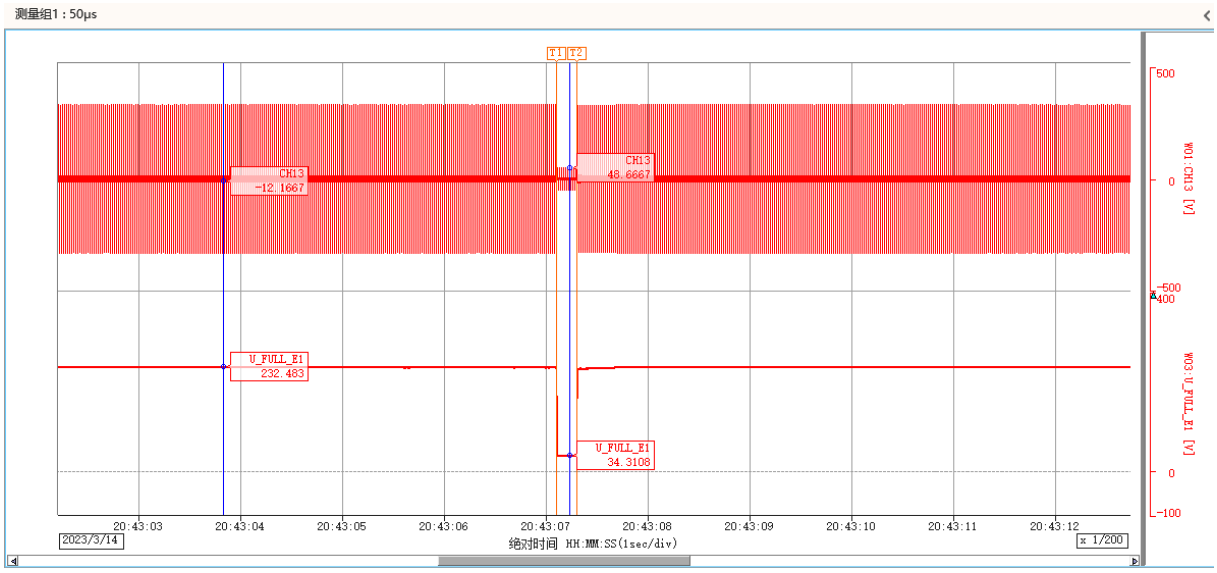
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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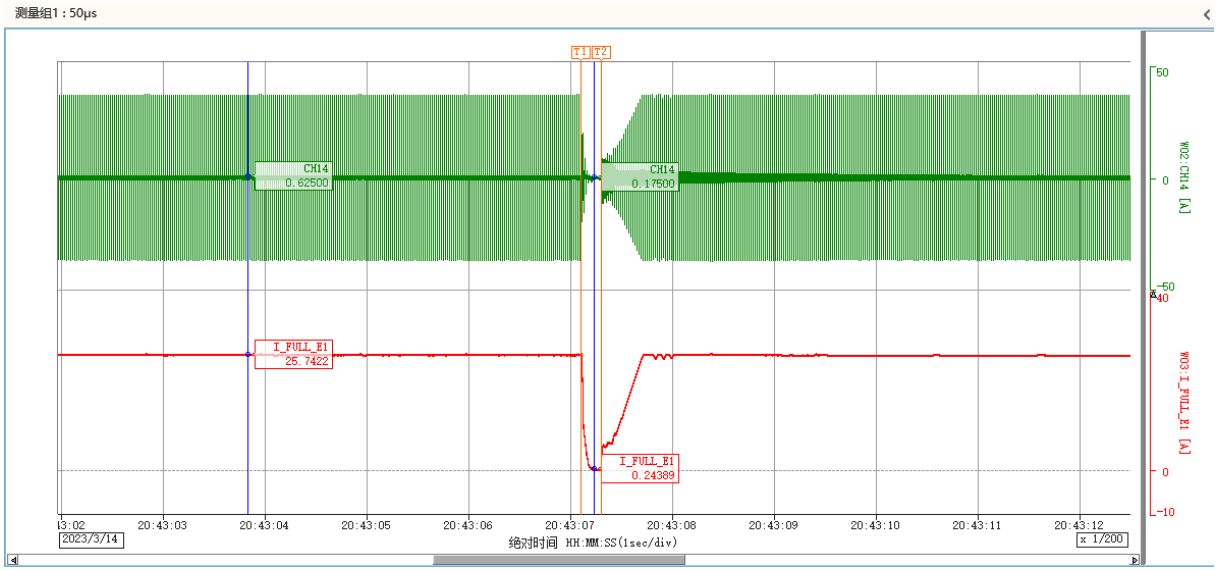
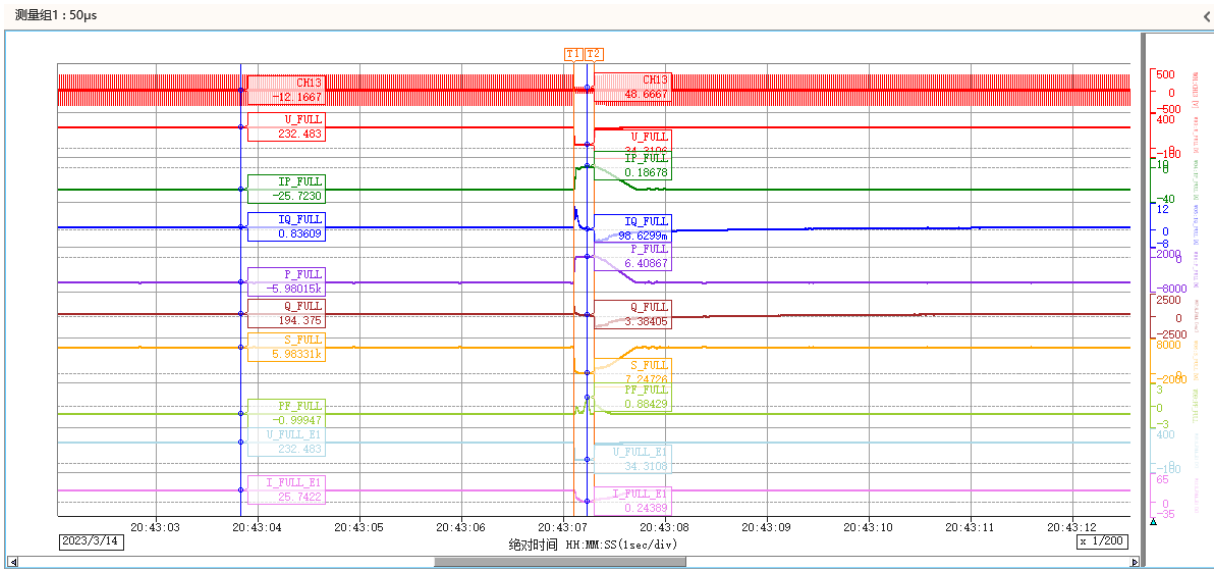
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 1.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/14 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 17:25:42 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 22527 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 22736 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 209 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.847 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.999 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.200 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.199 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.149 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.066 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.015 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.015 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.000 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.999 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.196 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.198 |
| | 23 | Active power recover time | Total | - | ms | 113 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.003 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.001 |



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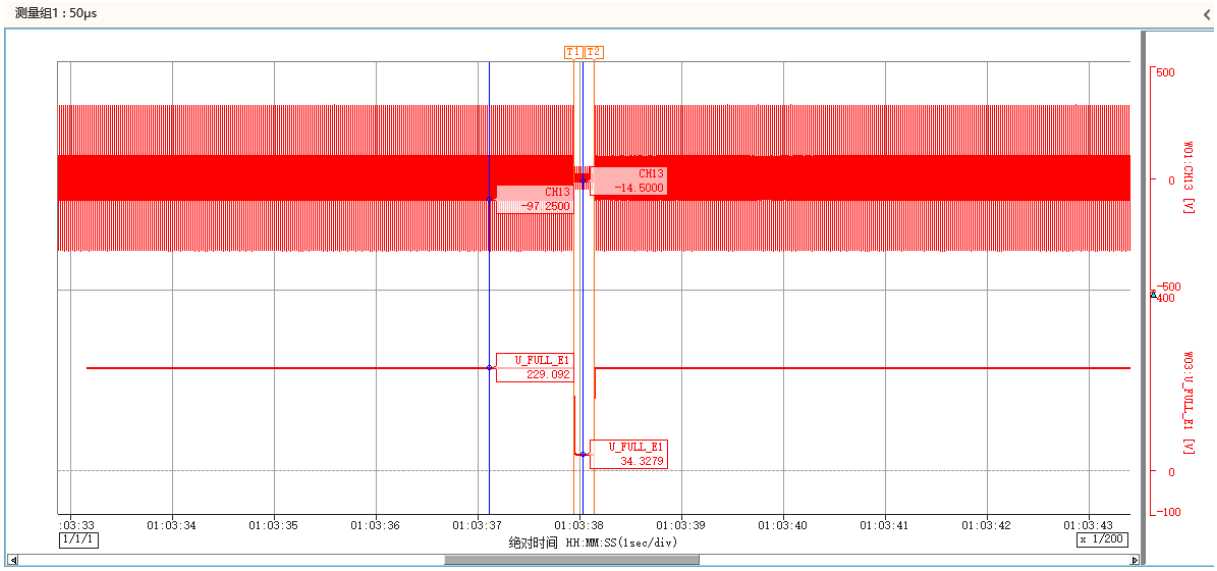
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 12 |

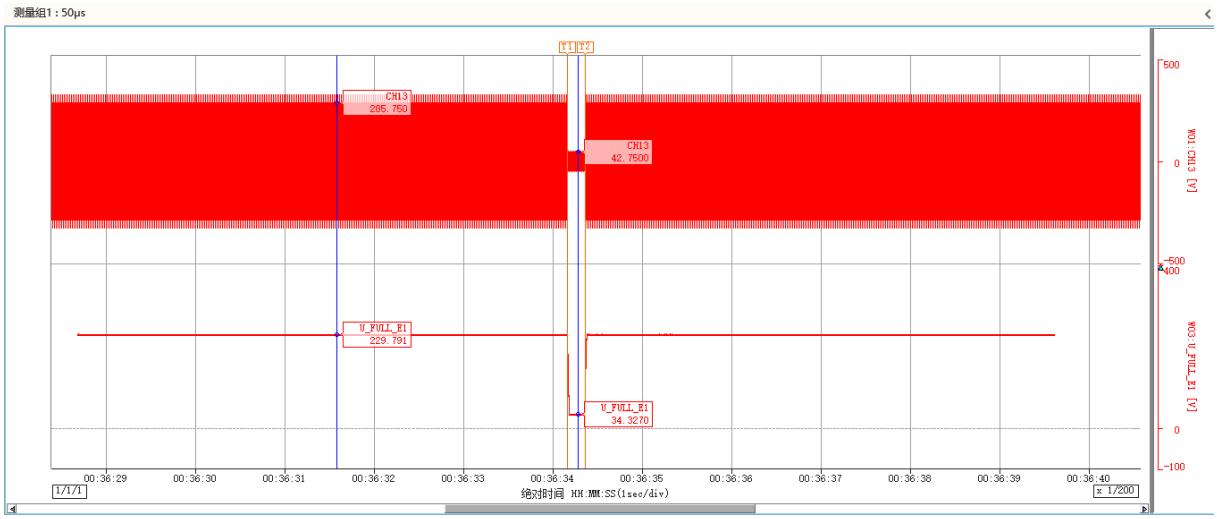
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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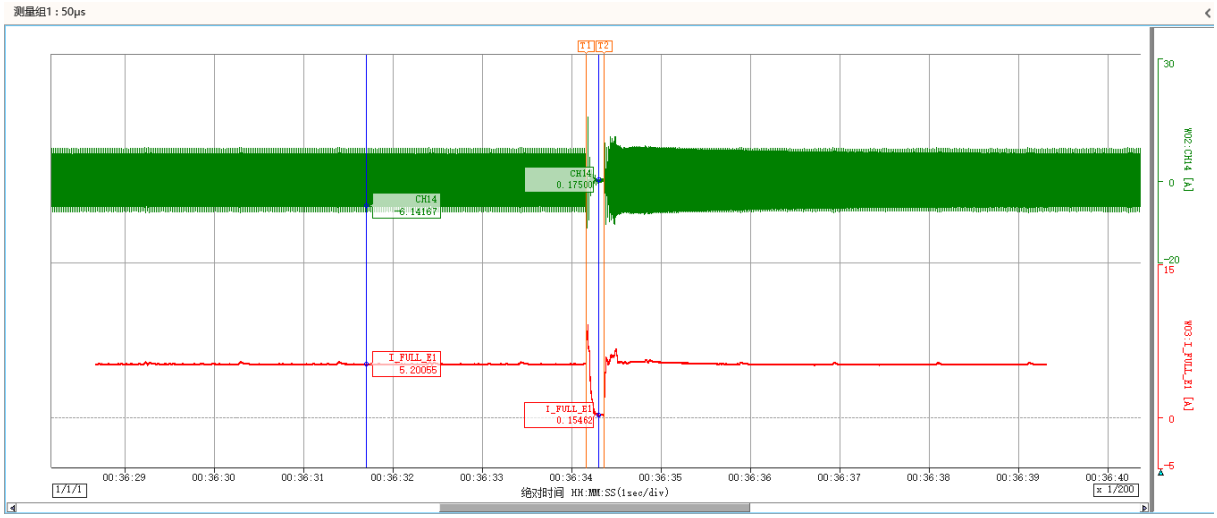
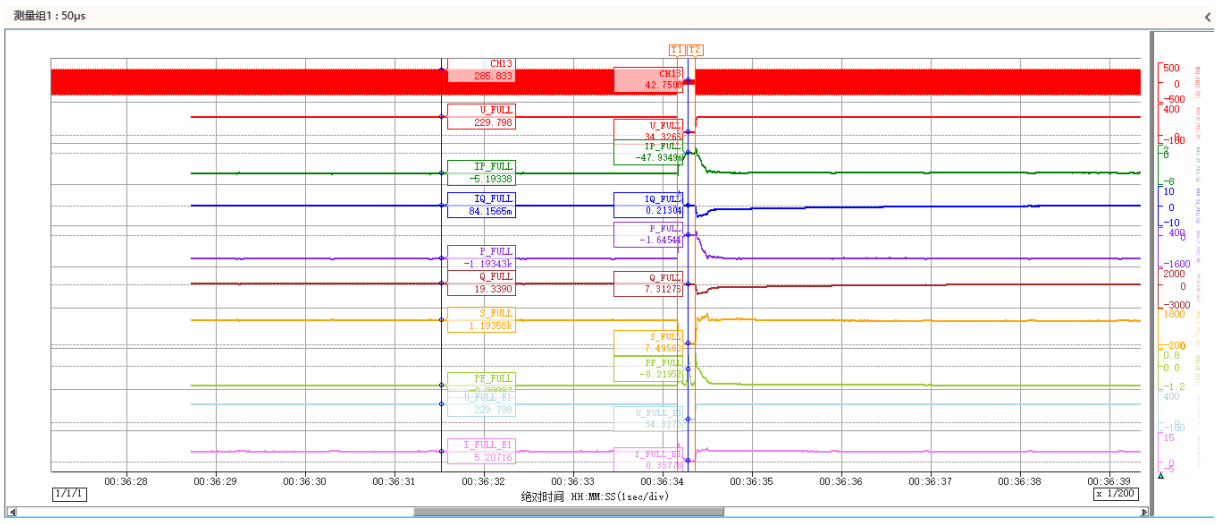
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 1.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 9:11:53 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21714 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 21921 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 207 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.132 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.996 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.997 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.031 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.872 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 1.008 |
| | 17 | | L1 | t1+100ms | [p.u.] | 1.017 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 1.025 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.865 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.997 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.998 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.034 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.033 |



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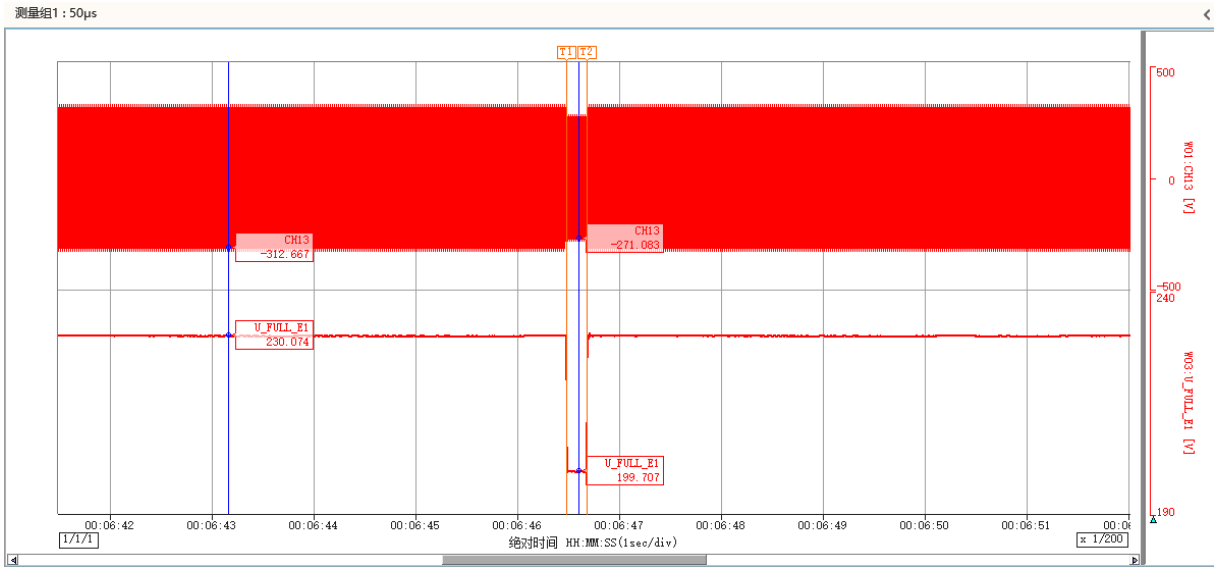
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

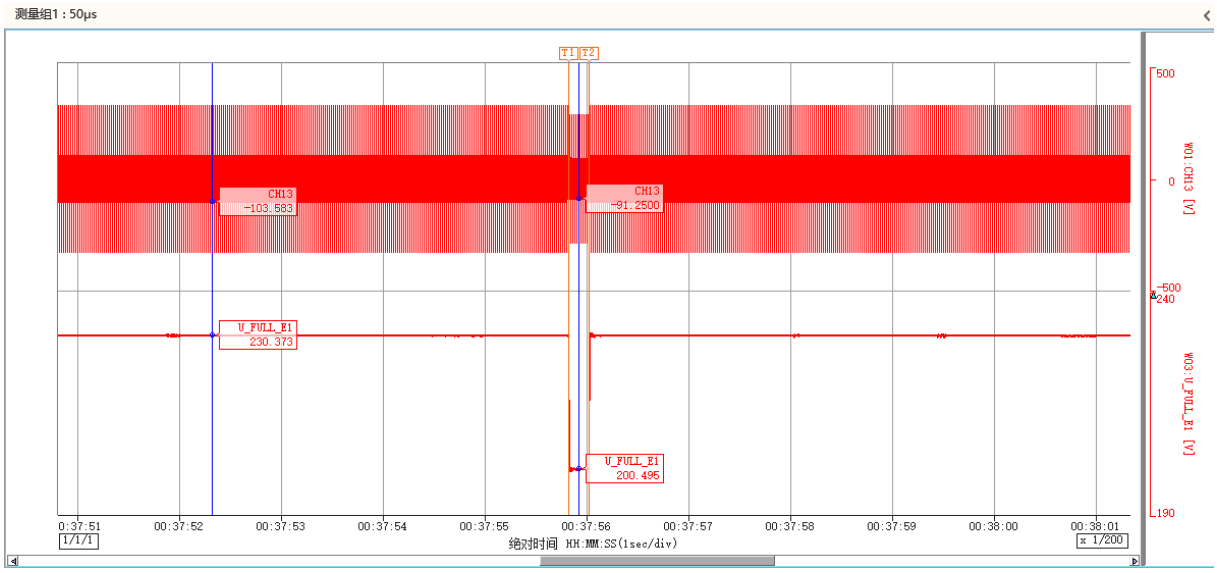
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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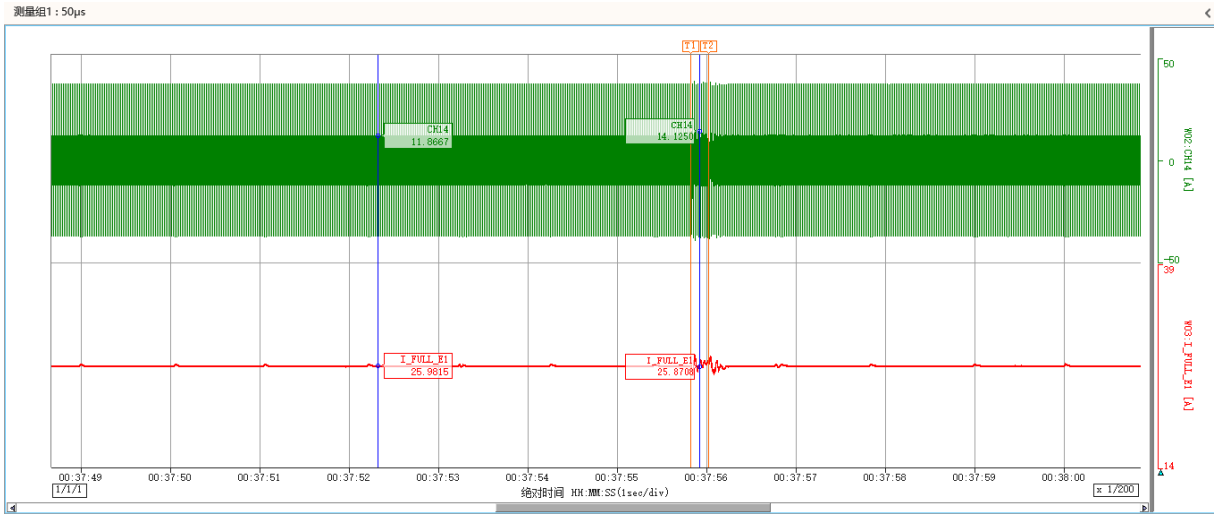
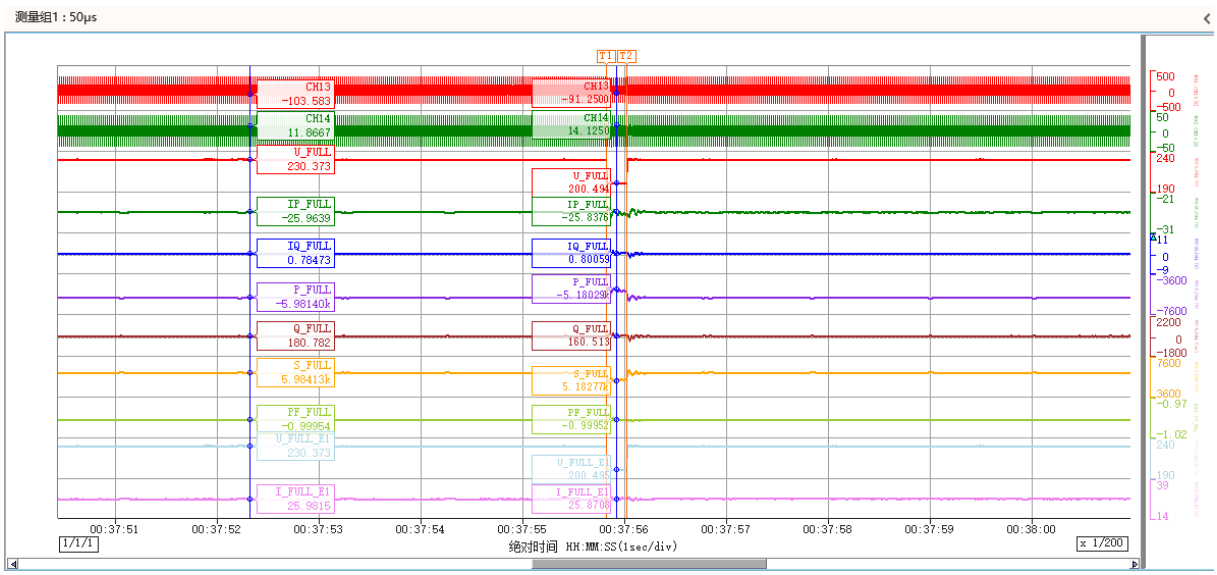
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 1.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 10:28:35 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 19797 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 20004 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 207 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.130 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.999 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.206 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.205 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.869 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.217 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.217 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.229 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.170 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.999 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.205 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.205 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.003 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.003 |



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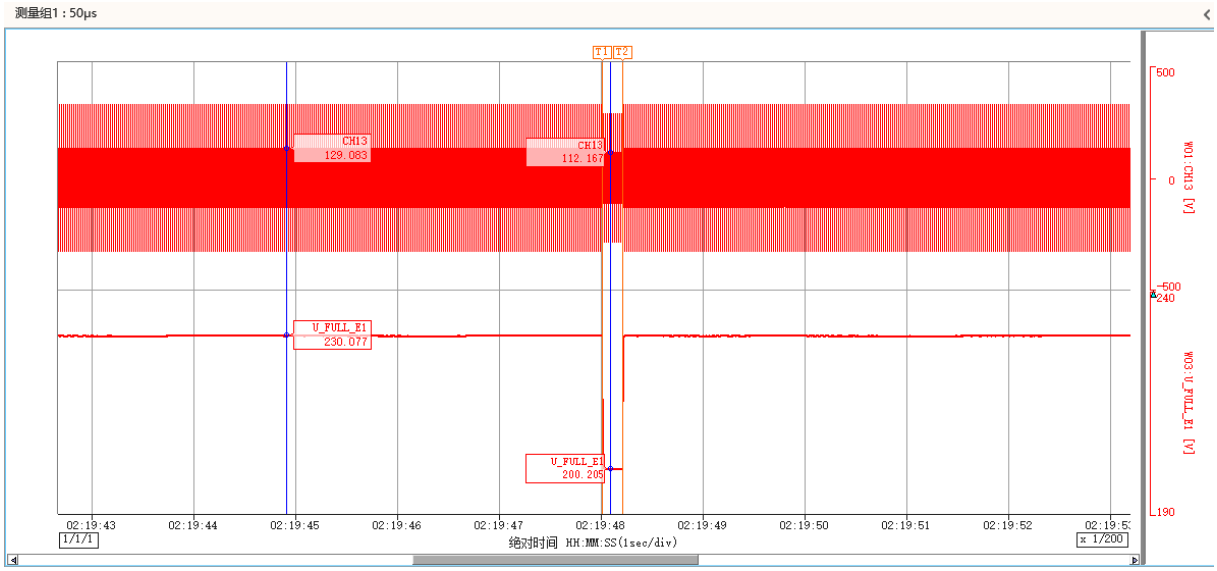
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

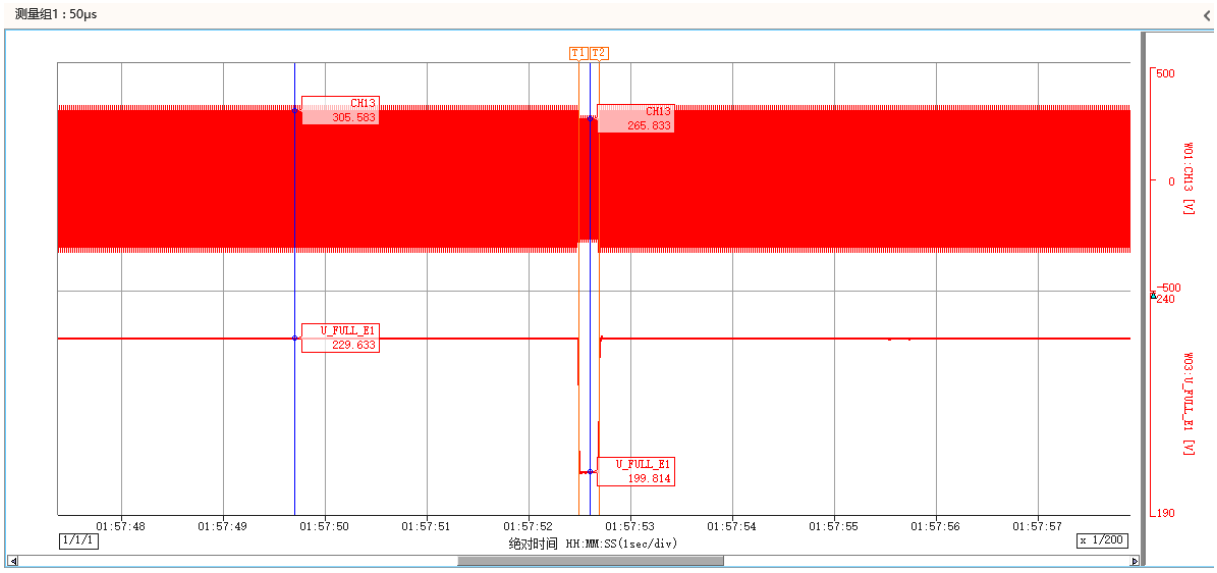
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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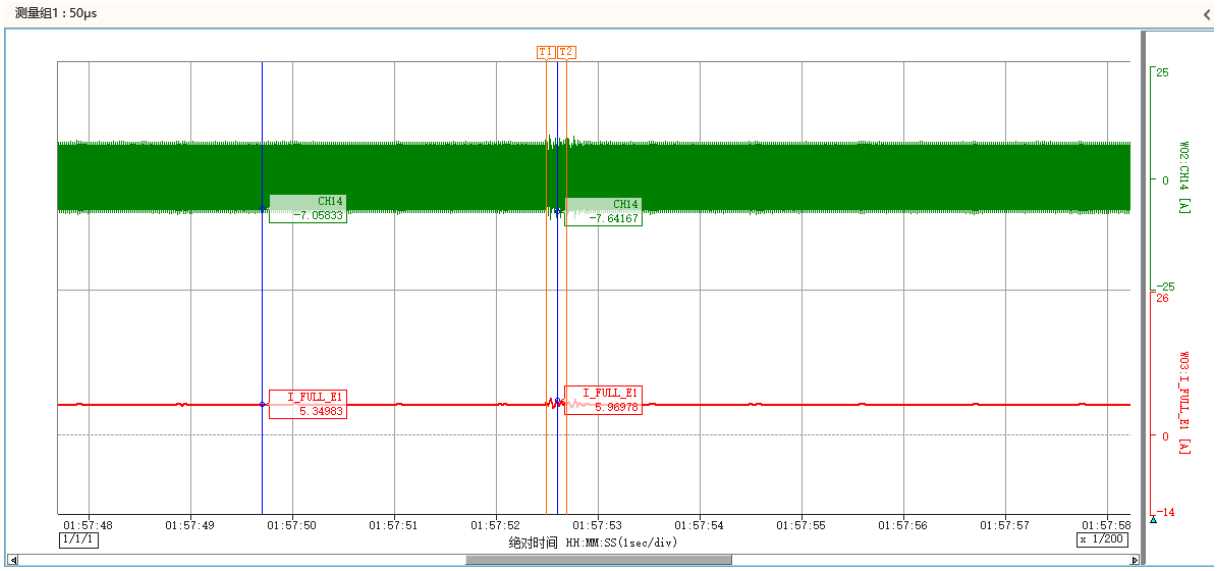
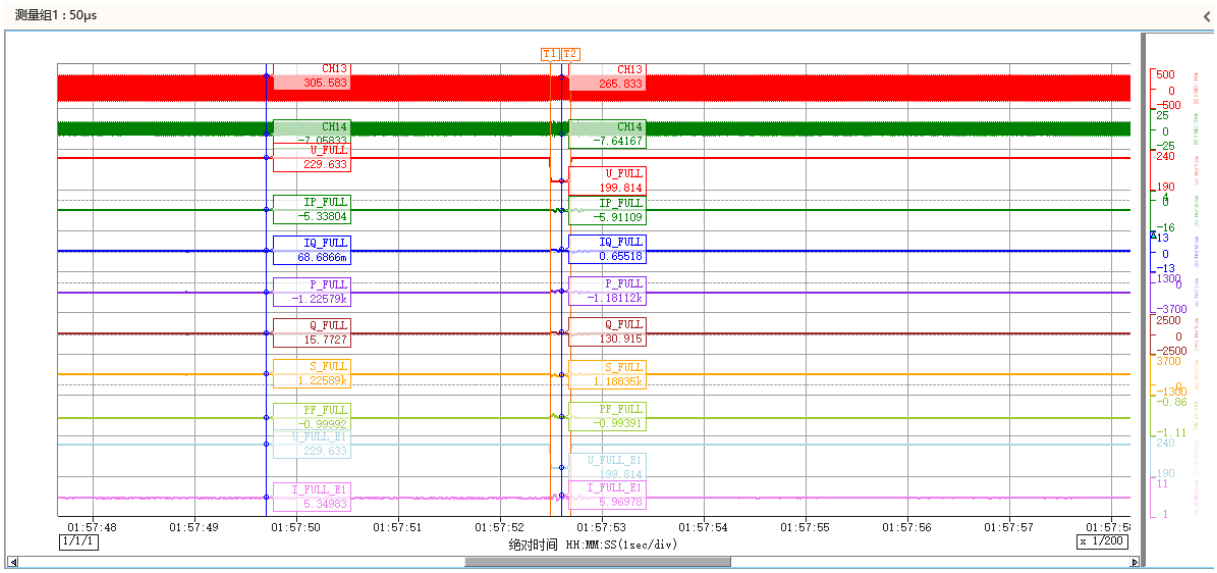
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 1.5 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 11:06:48 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 20026 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 20232 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 206 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.130 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.997 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.997 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.034 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.999 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.875 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 1.004 |
| | 17 | | L1 | t1+100ms | [p.u.] | 1.019 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 1.023 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.869 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.999 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.998 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.031 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.031 |



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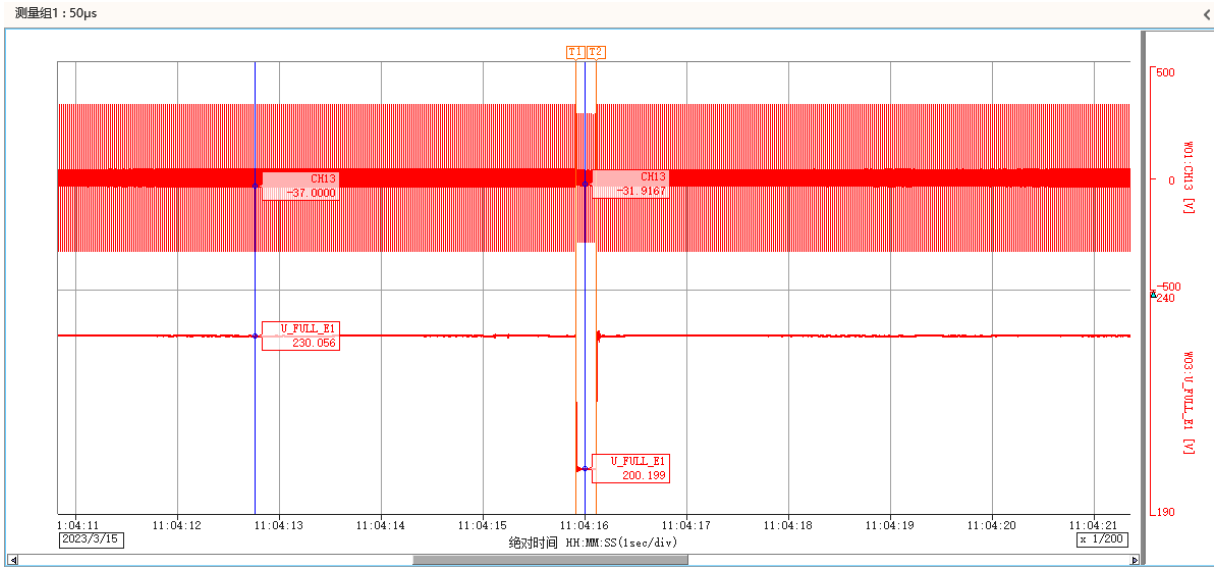
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

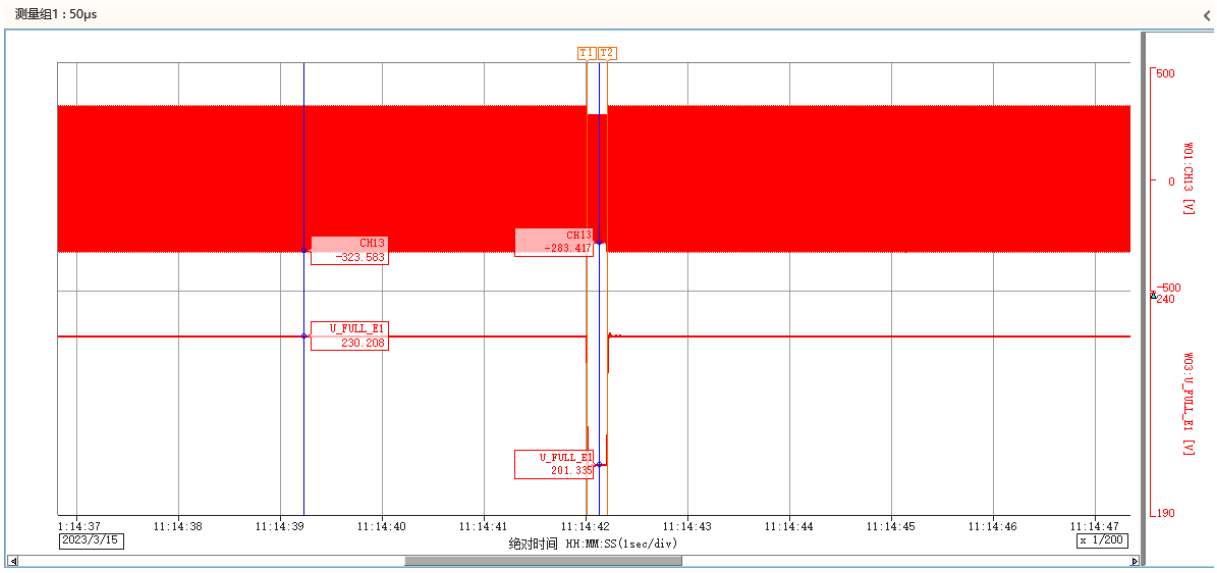
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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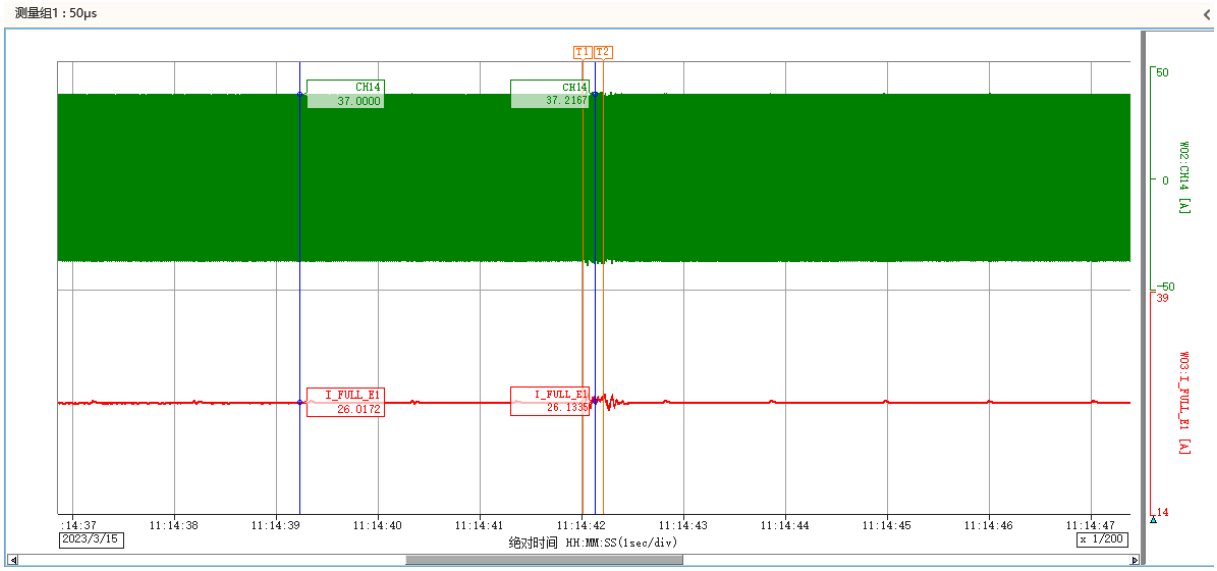
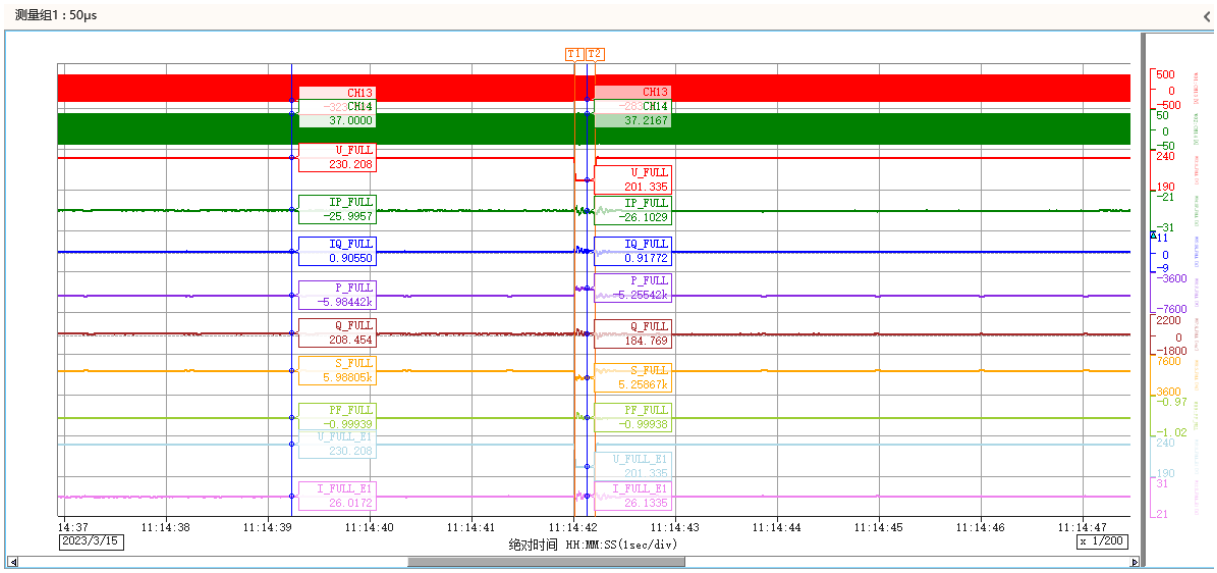
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 2.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 14:31:55 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21773 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23346 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1573 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.500 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.008 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.798 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.804 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.599 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.802 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.498 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.046 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.074 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.017 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.008 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.008 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.920 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.840 |
| | 23 | Active power recover time | Total | - | ms | 368 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.599 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.540 |



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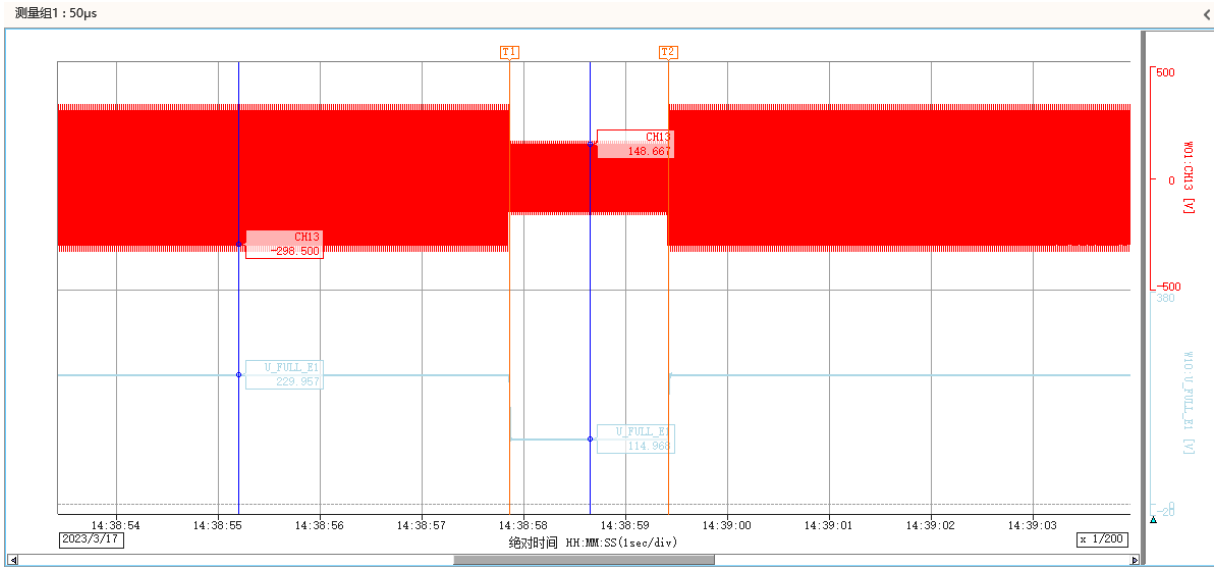
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 8650 |

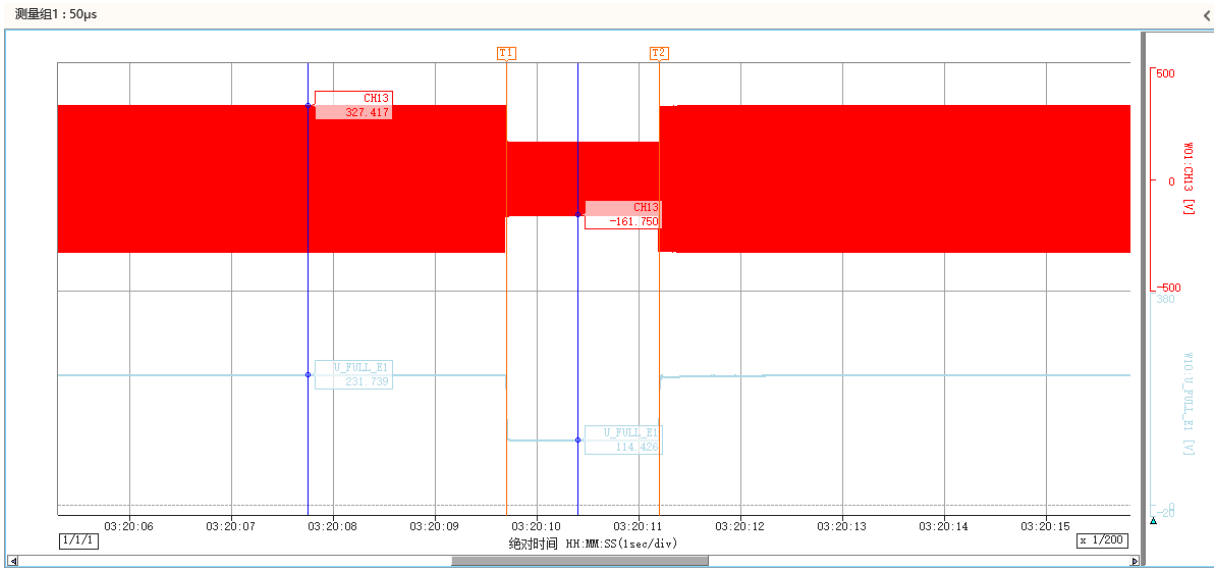
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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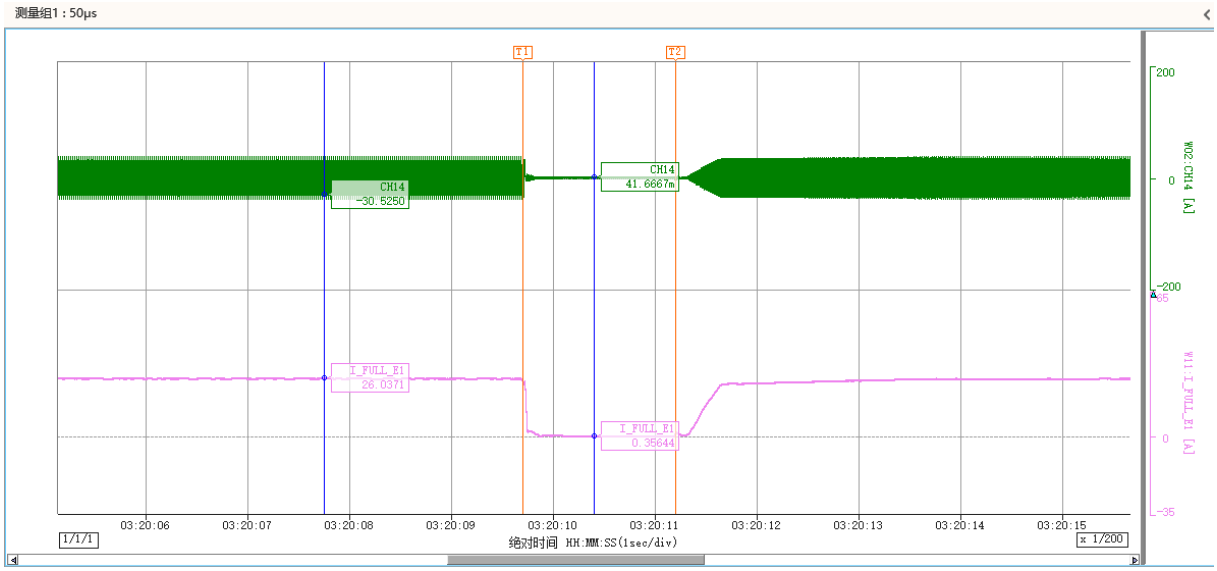
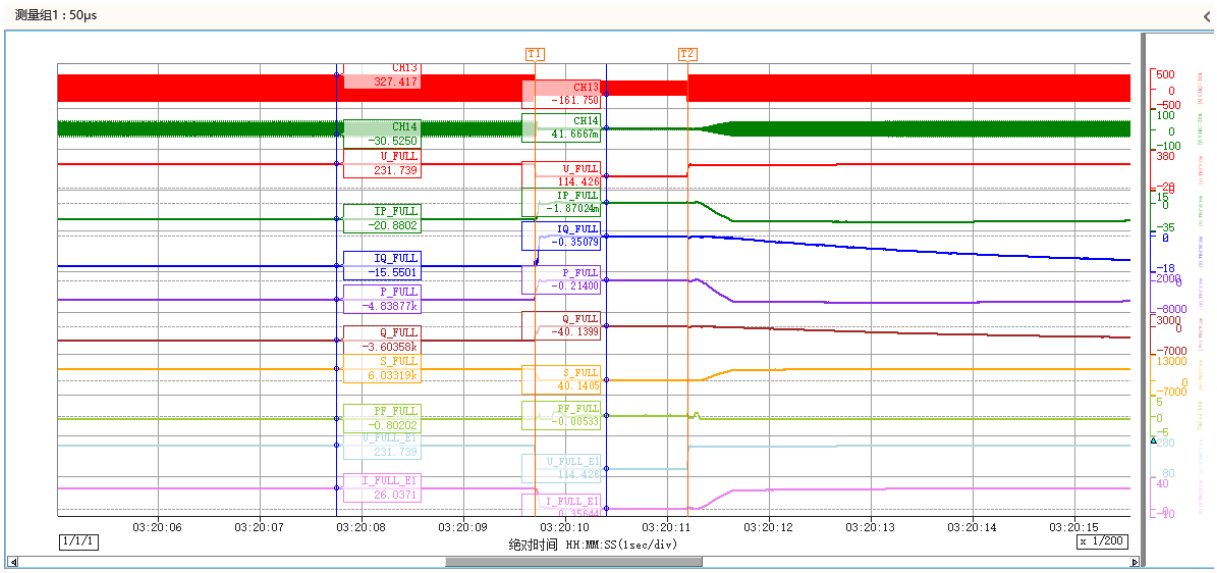
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 2.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 15:17:37 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21775 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23344 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1569 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.500 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.998 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.204 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.204 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.150 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.806 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.497 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.026 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.035 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.012 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.006 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.998 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.207 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.207 |
| | 23 | Active power recover time | Total | - | ms | 192 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.150 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.137 |



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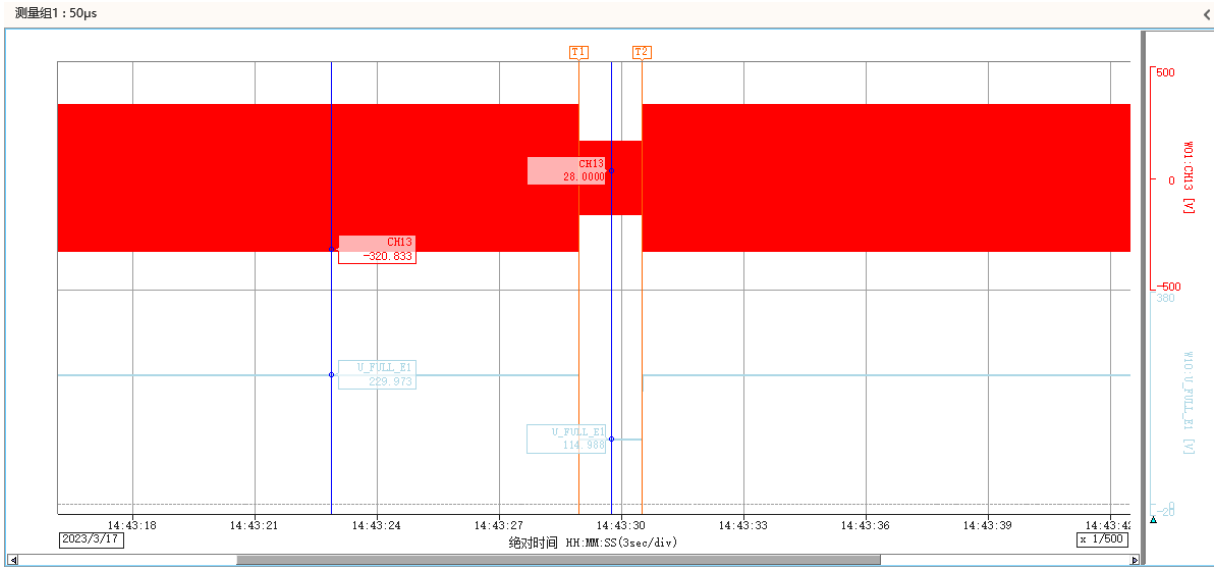
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 8515 |

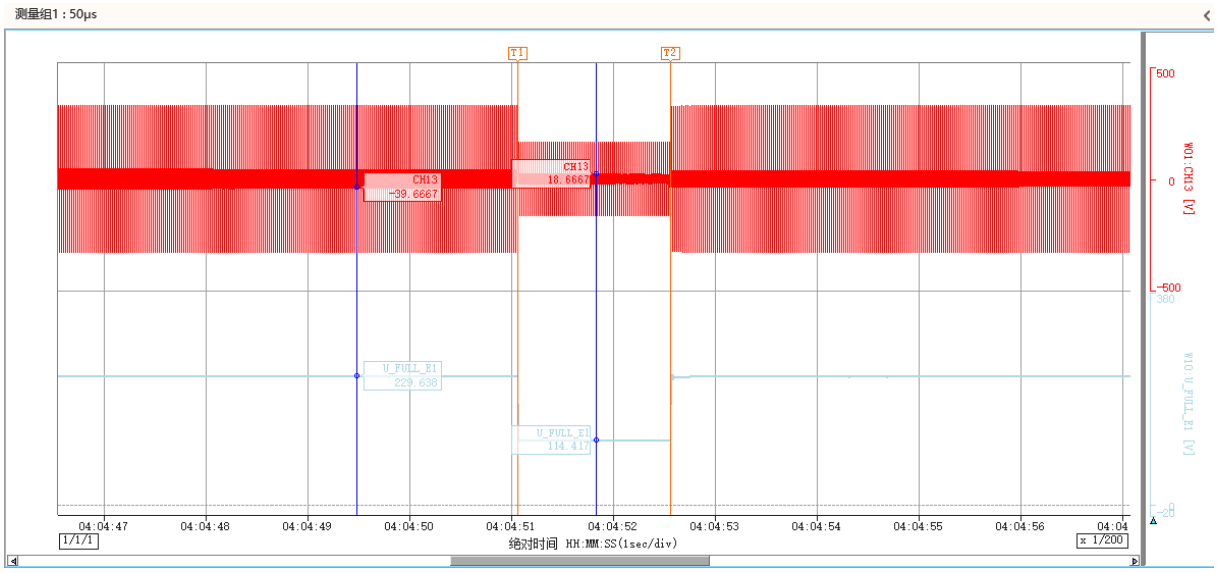
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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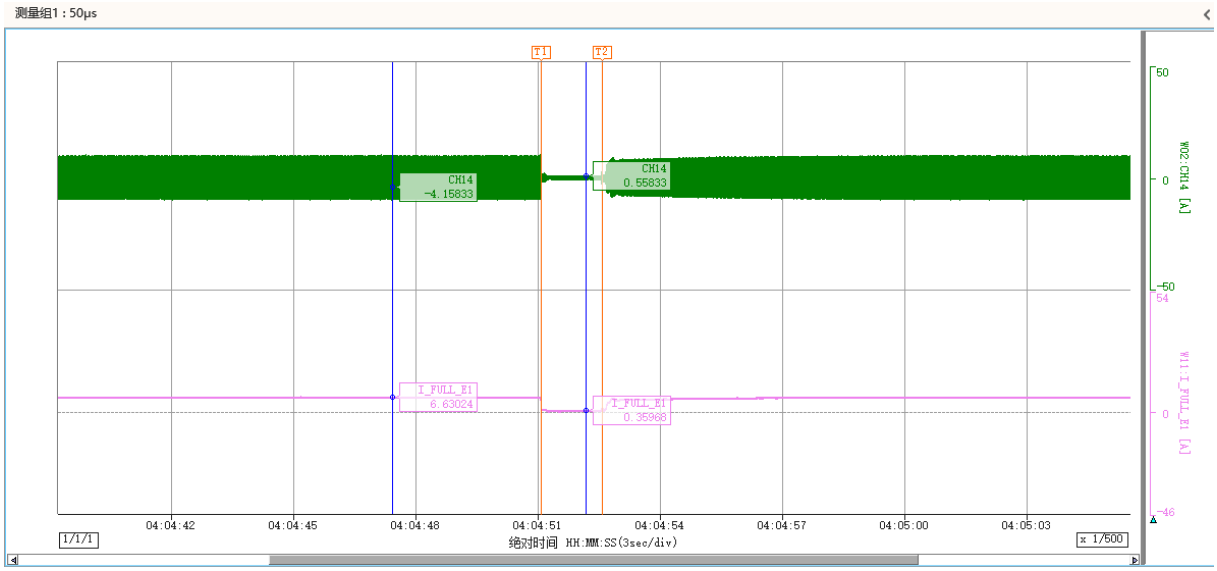
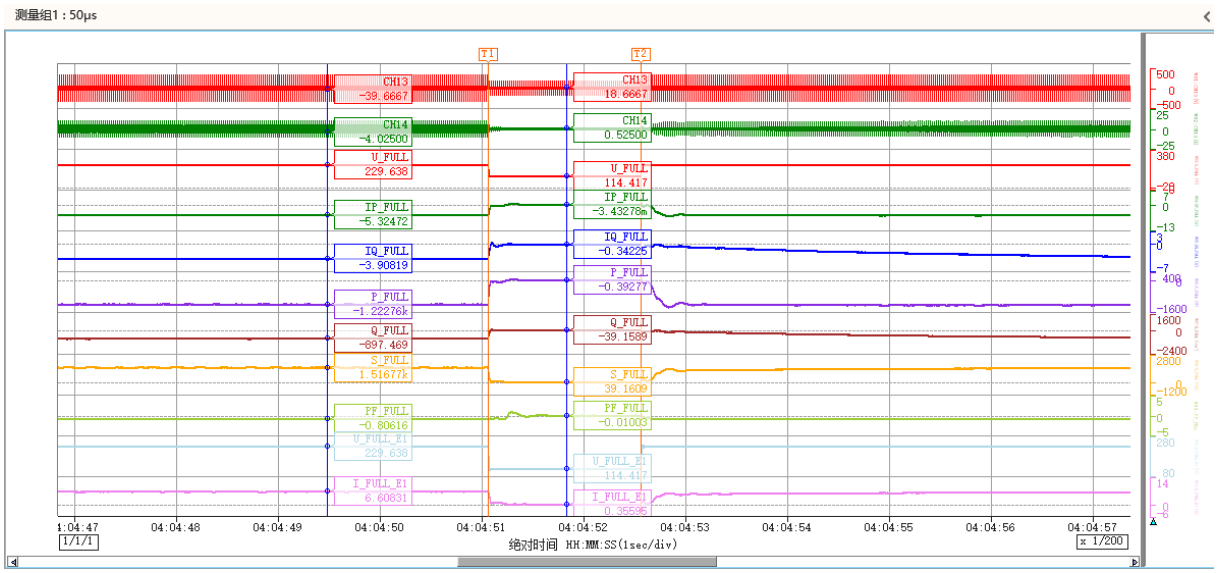
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 2.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 20:25:59 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21961 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23521 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1560 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.099 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.008 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.810 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.816 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.599 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.806 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.906 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.826 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.841 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.807 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.732 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.008 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.816 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.816 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.596 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.599 |



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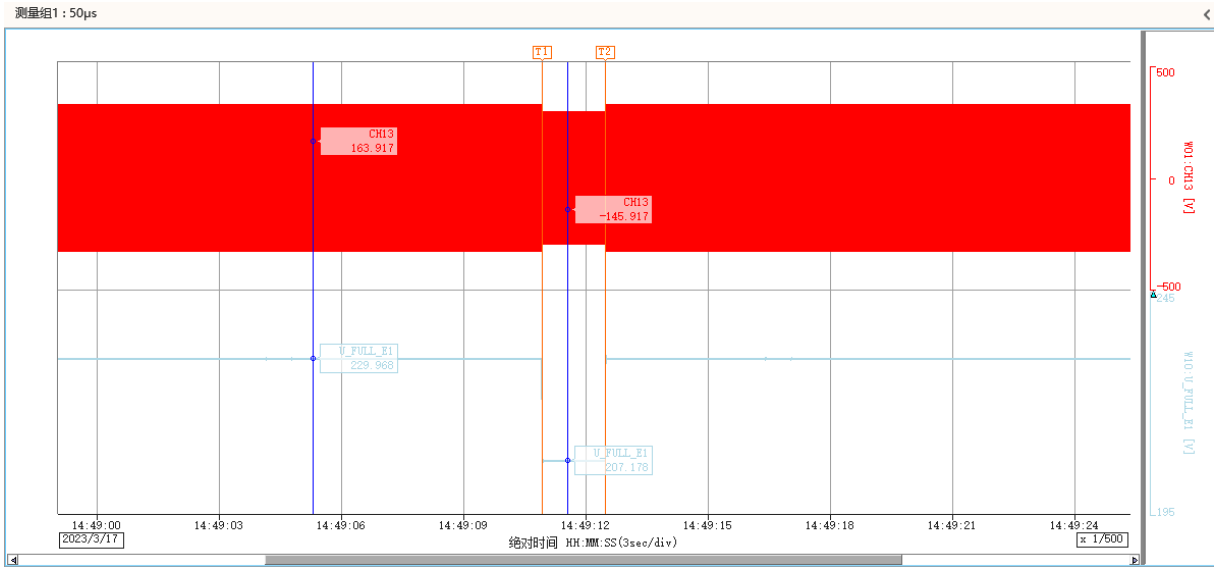
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

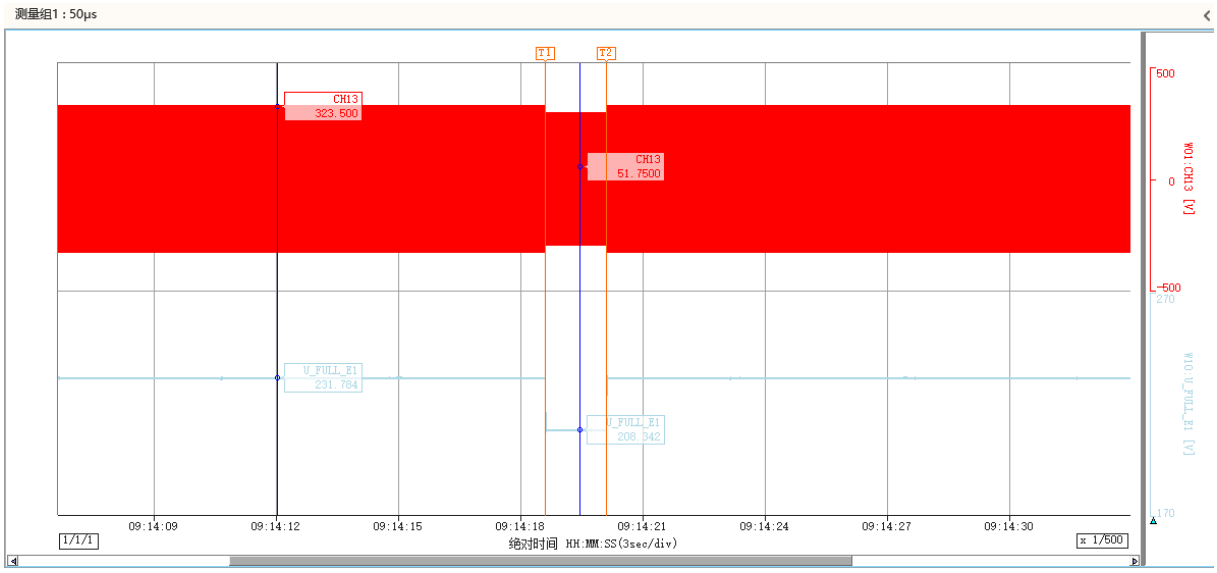
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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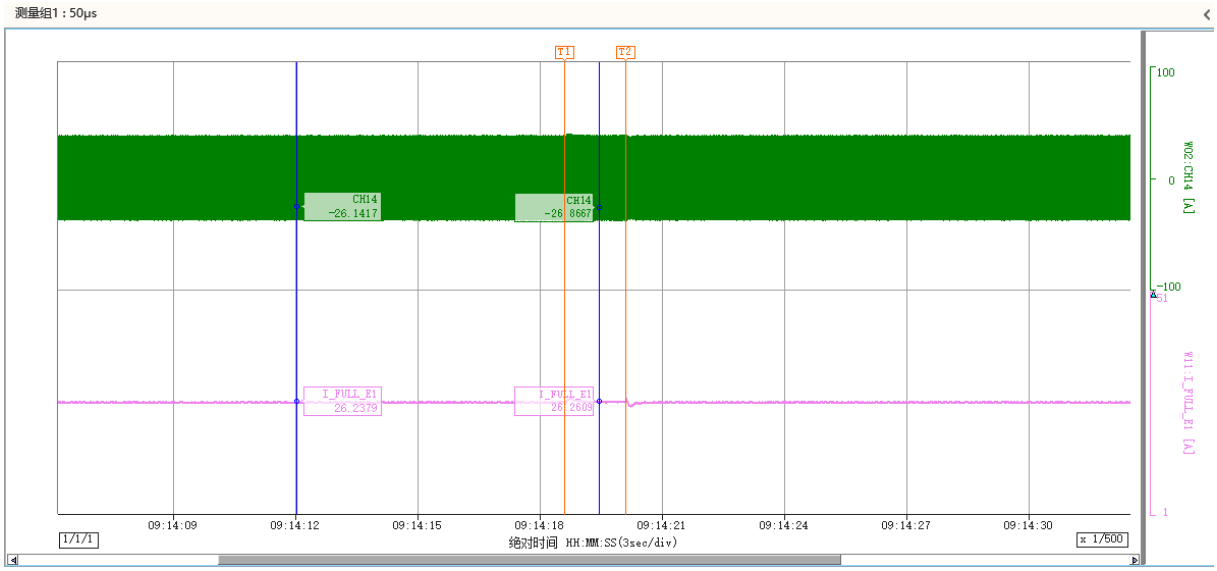
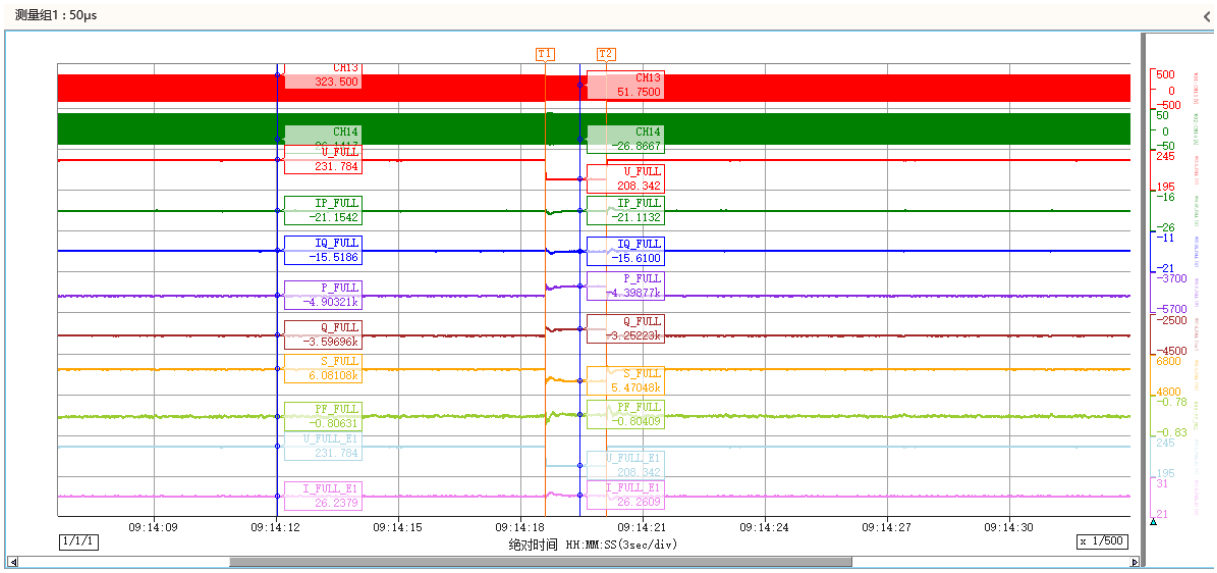
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 2.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 17:29:46 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21961 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23521 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1560 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.099 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.998 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.209 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.208 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.152 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.807 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.899 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.212 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.220 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.212 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.191 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.998 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.214 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.209 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.153 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.152 |



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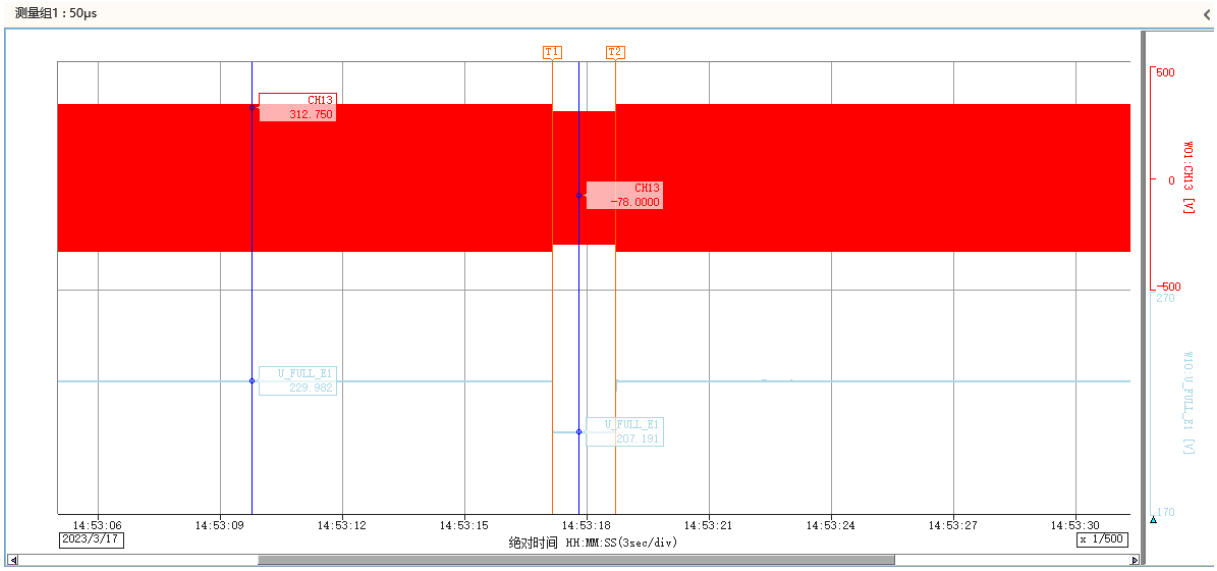
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

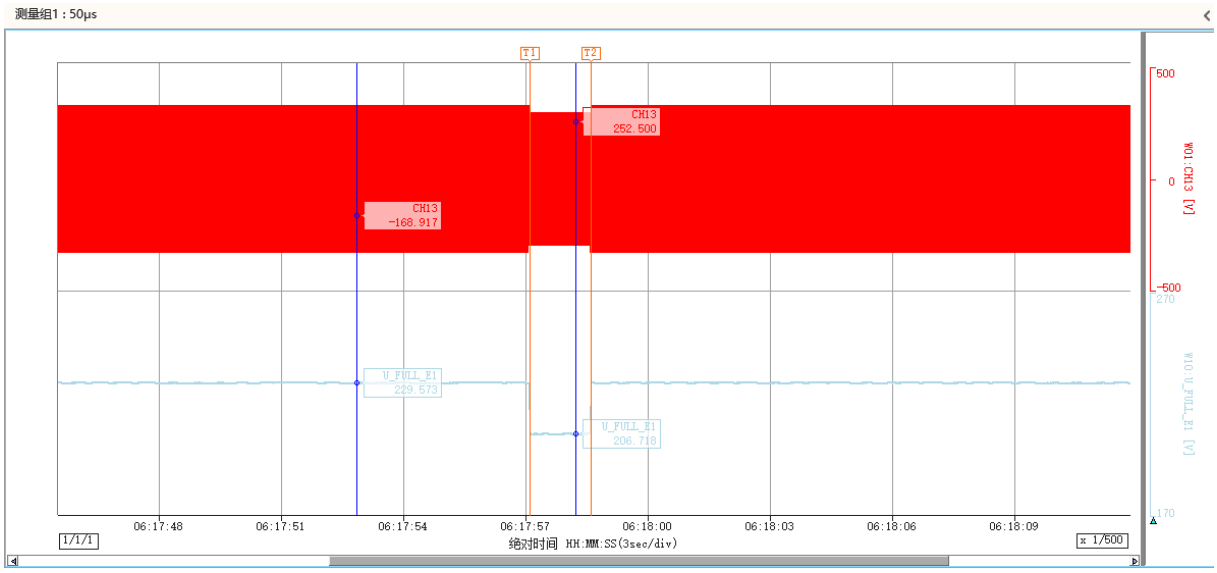
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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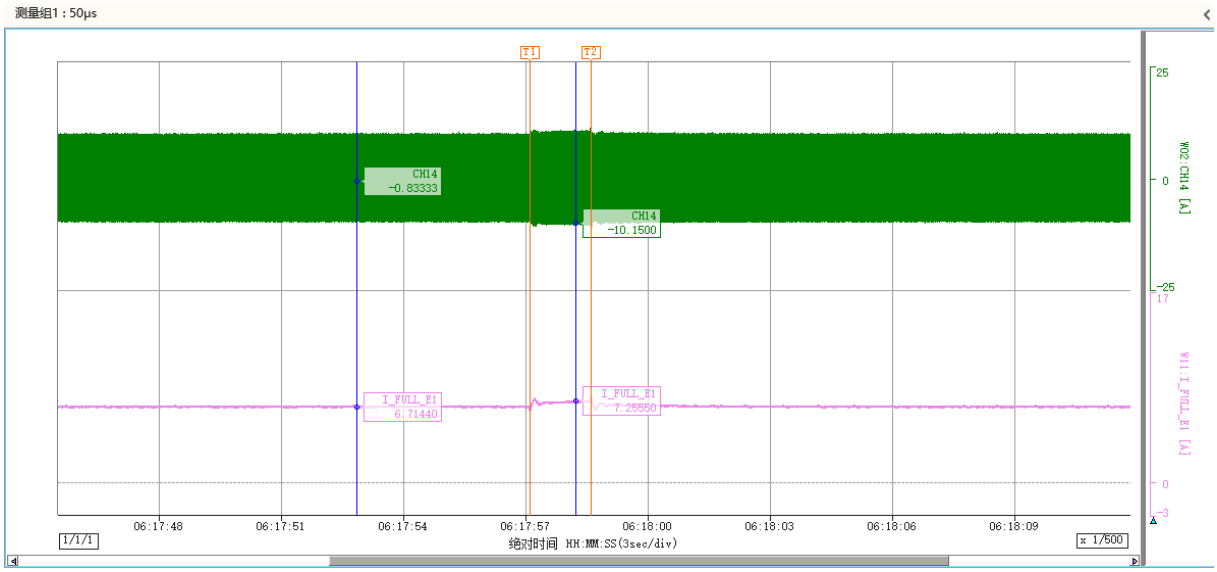
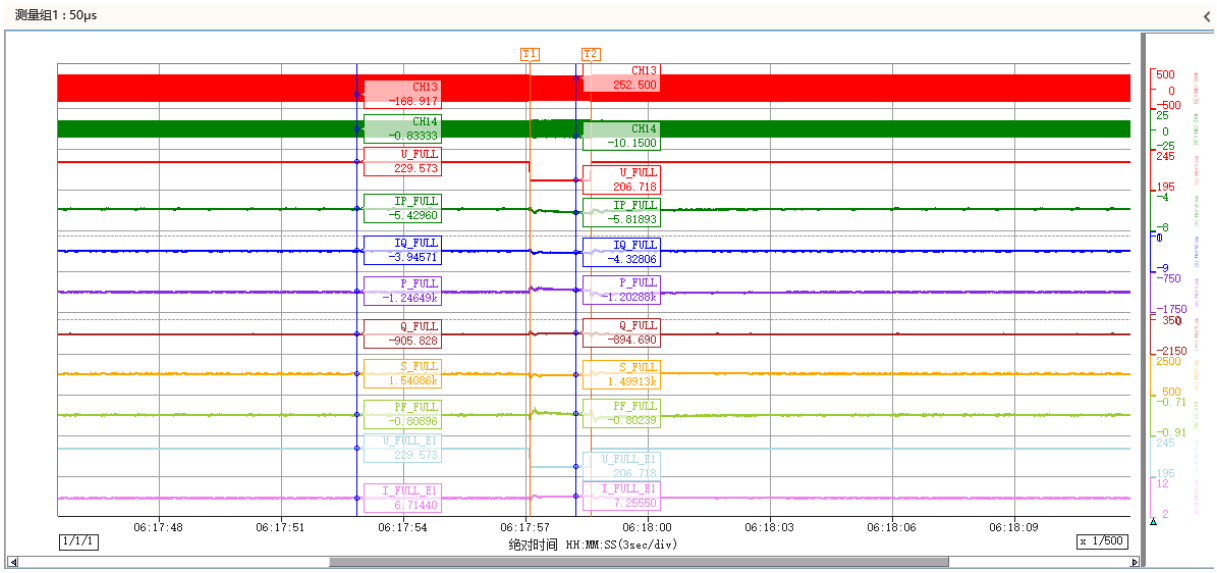
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 3.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 16:27:55 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21902 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23475 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1573 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.500 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.998 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.800 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.798 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.596 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.801 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.497 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.021 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.028 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.006 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.003 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.999 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.975 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.837 |
| | 23 | Active power recover time | Total | - | ms | 298 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.596 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.539 |



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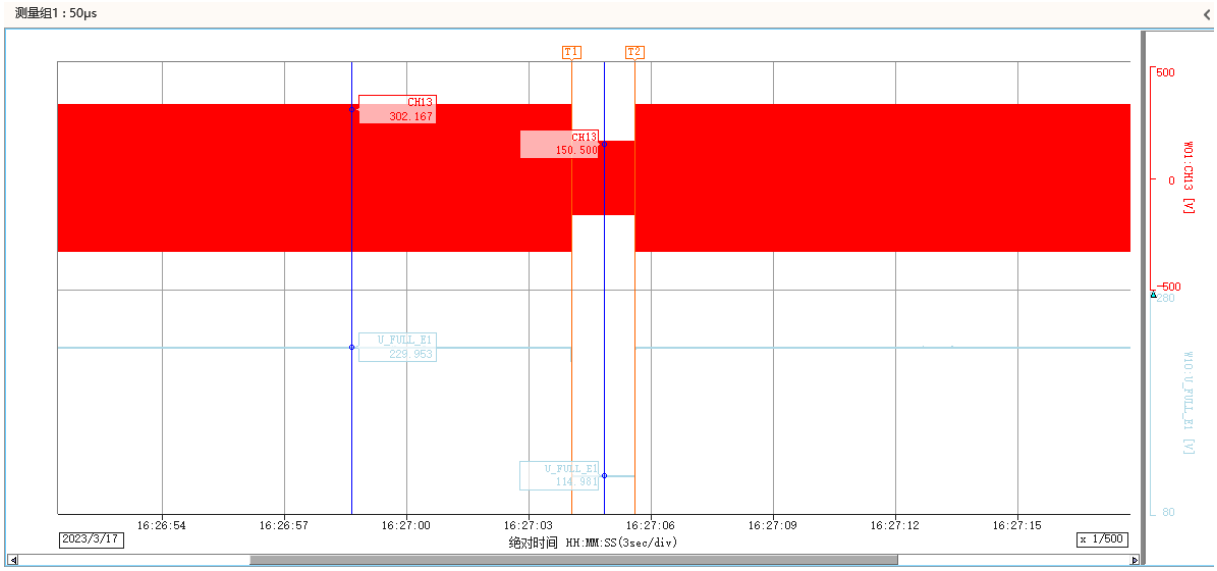
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 8514 |

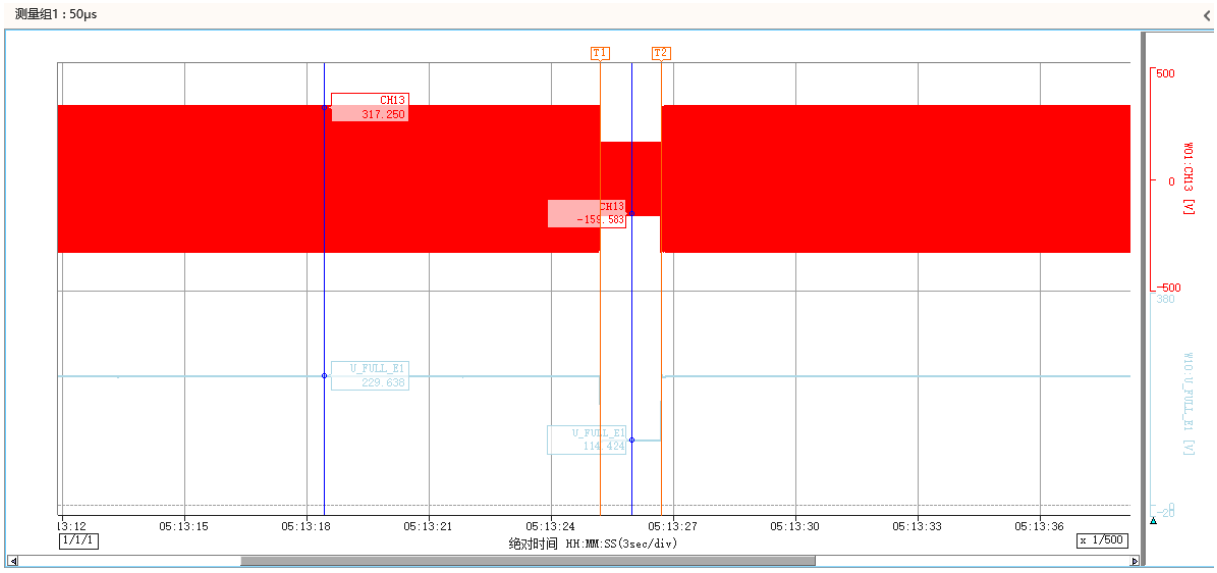
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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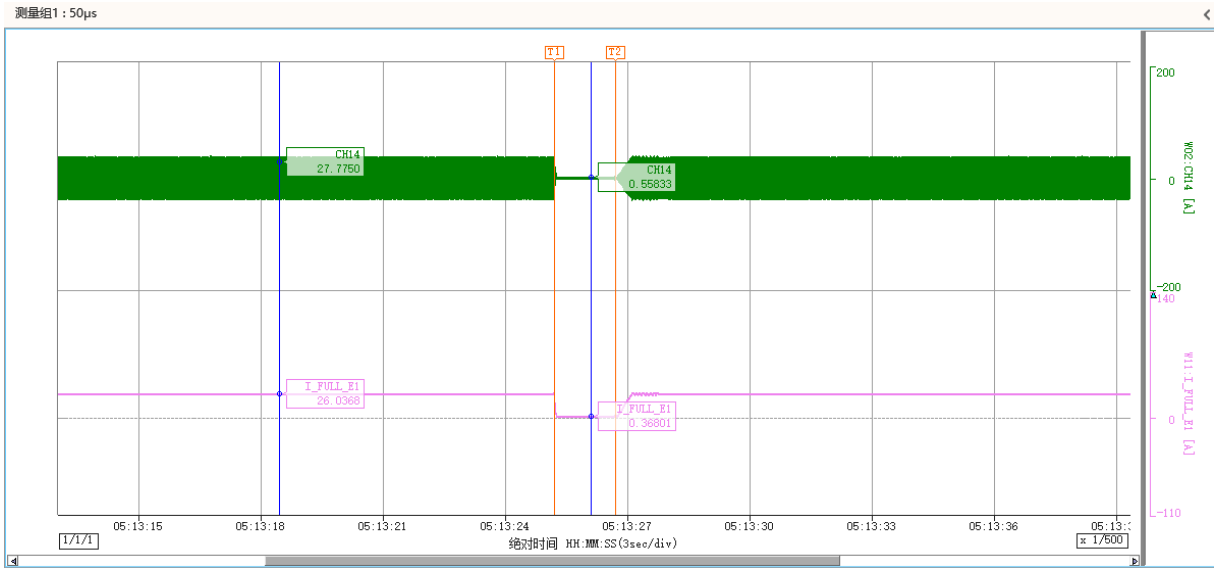
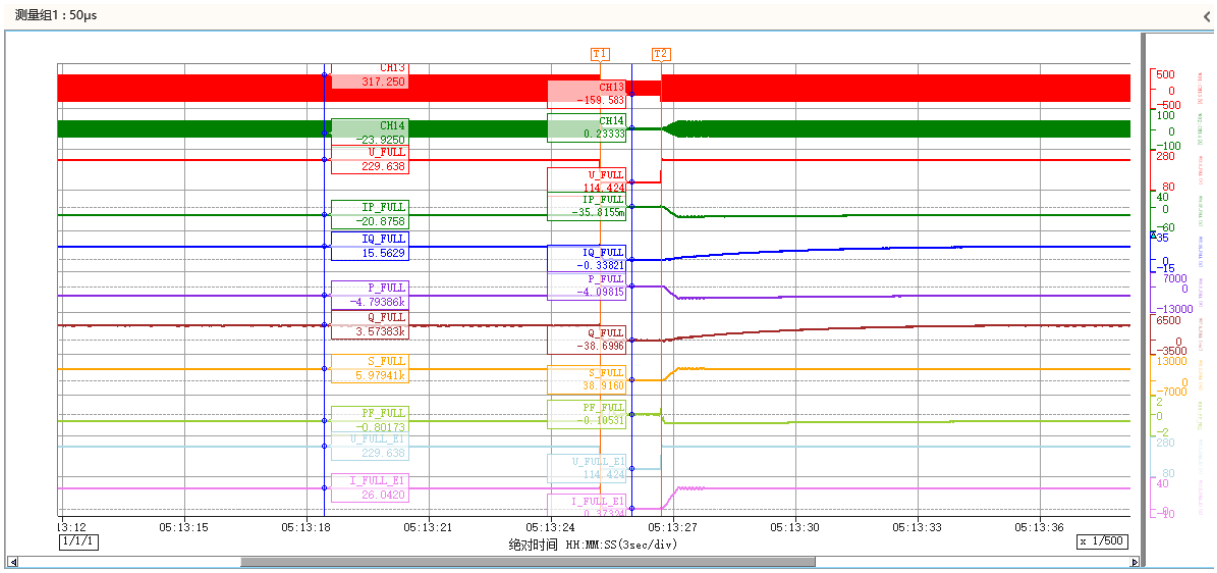
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 3.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 15:58:09 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21902 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23475 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1573 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.500 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.996 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.208 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.207 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.150 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.809 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.497 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.001 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.028 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.010 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.005 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.996 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.204 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.203 |
| | 23 | Active power recover time | Total | - | ms | 180 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.152 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.131 |



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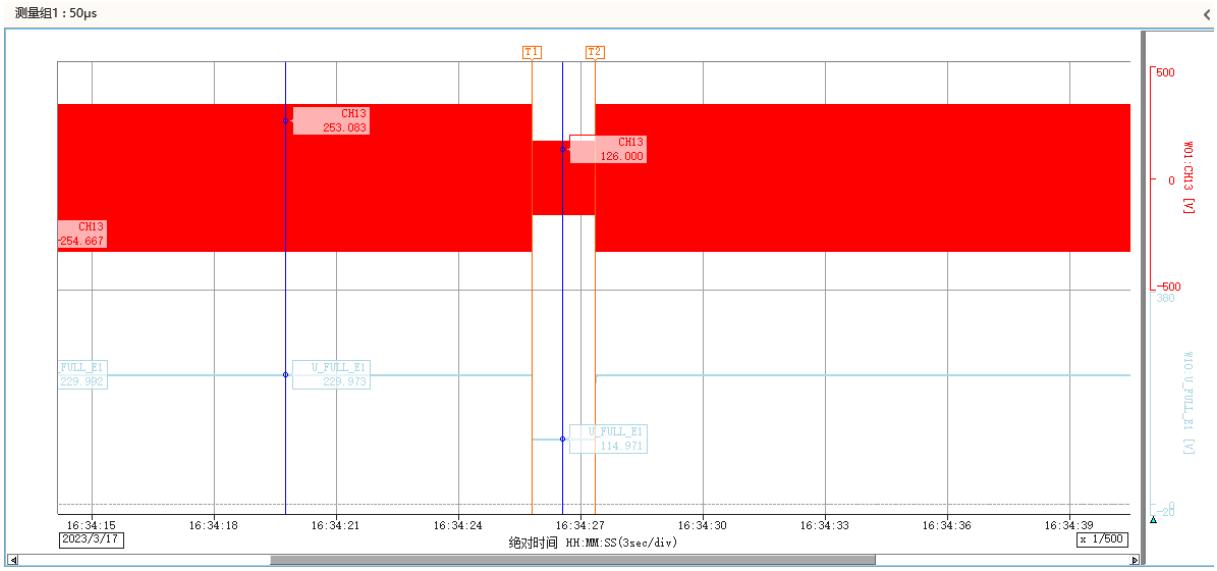
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 8664 |

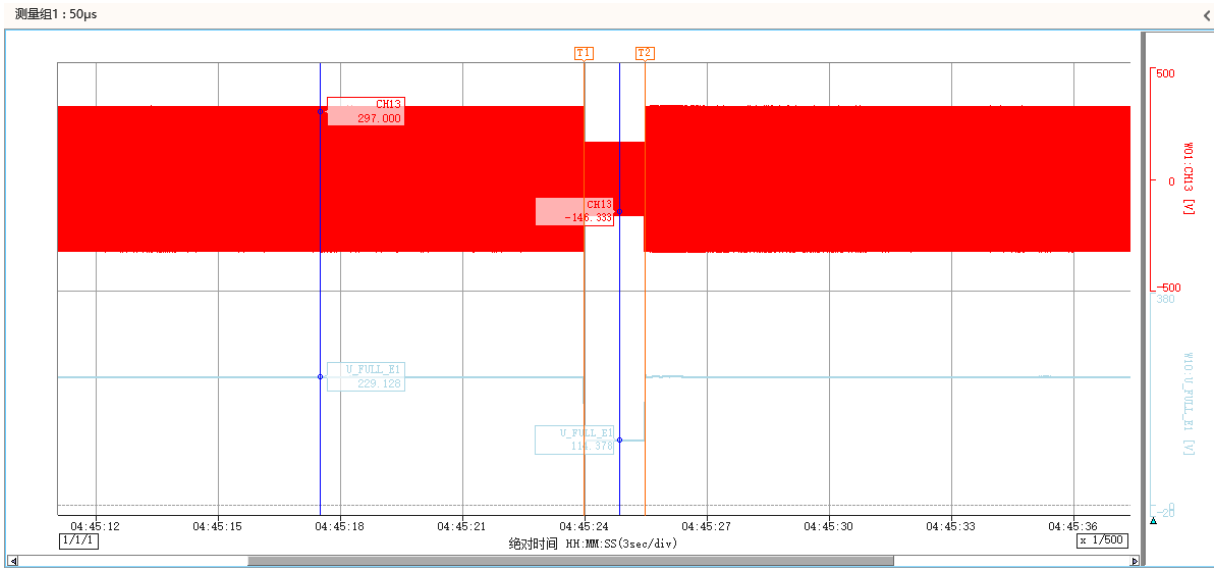
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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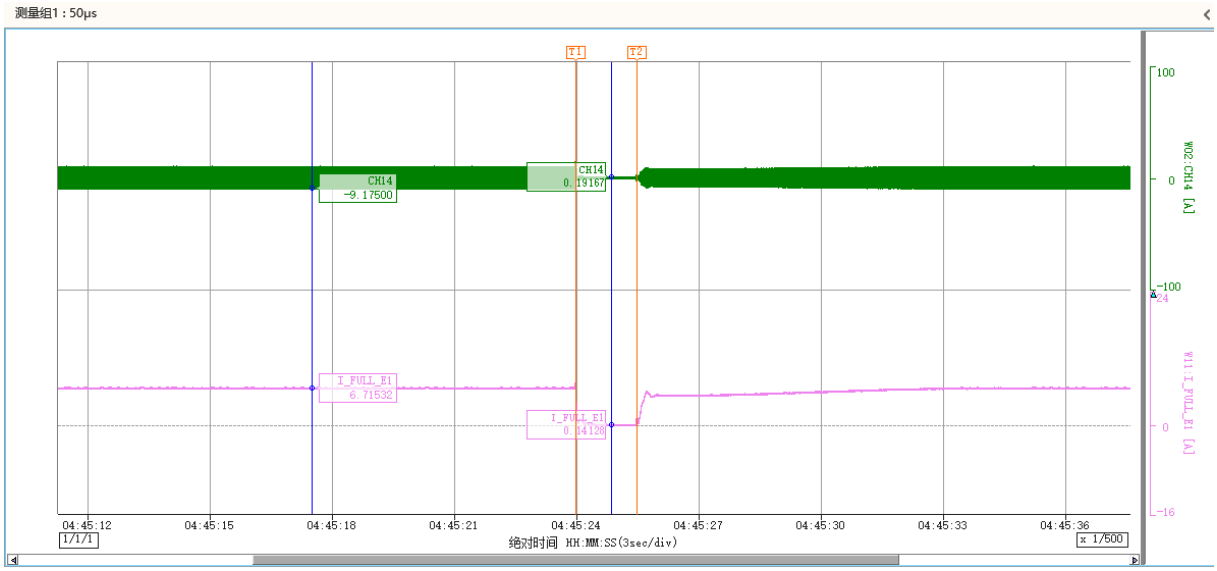
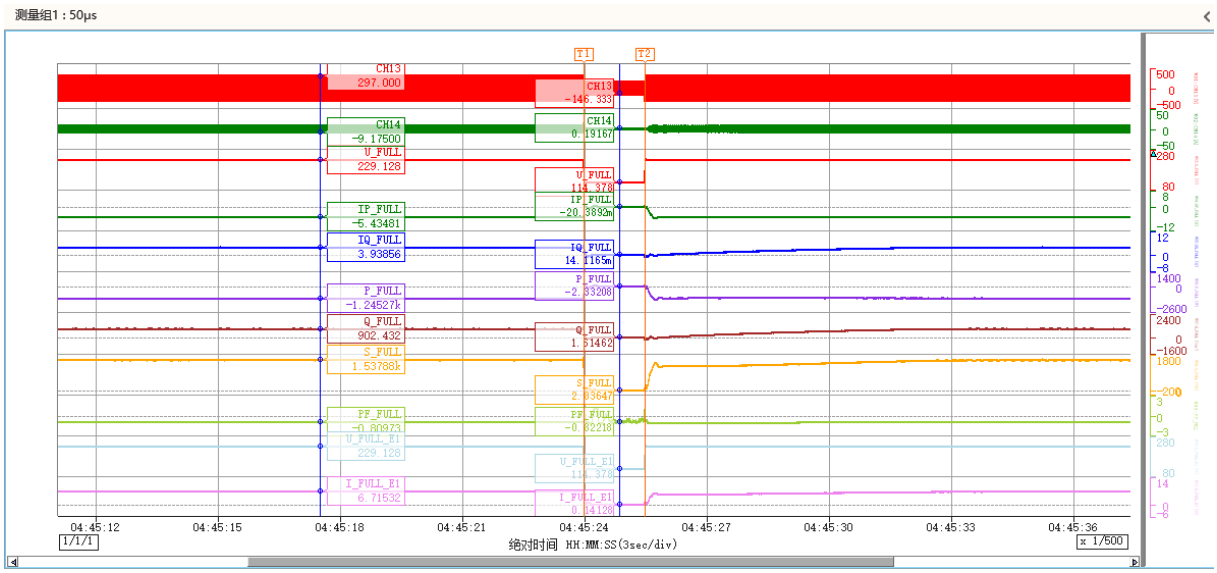
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 3.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 9:08:36 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 22143 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23704 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1561 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.099 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.805 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.806 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.601 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.802 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.902 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.816 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.824 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.792 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.716 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.805 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.806 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.600 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.600 |



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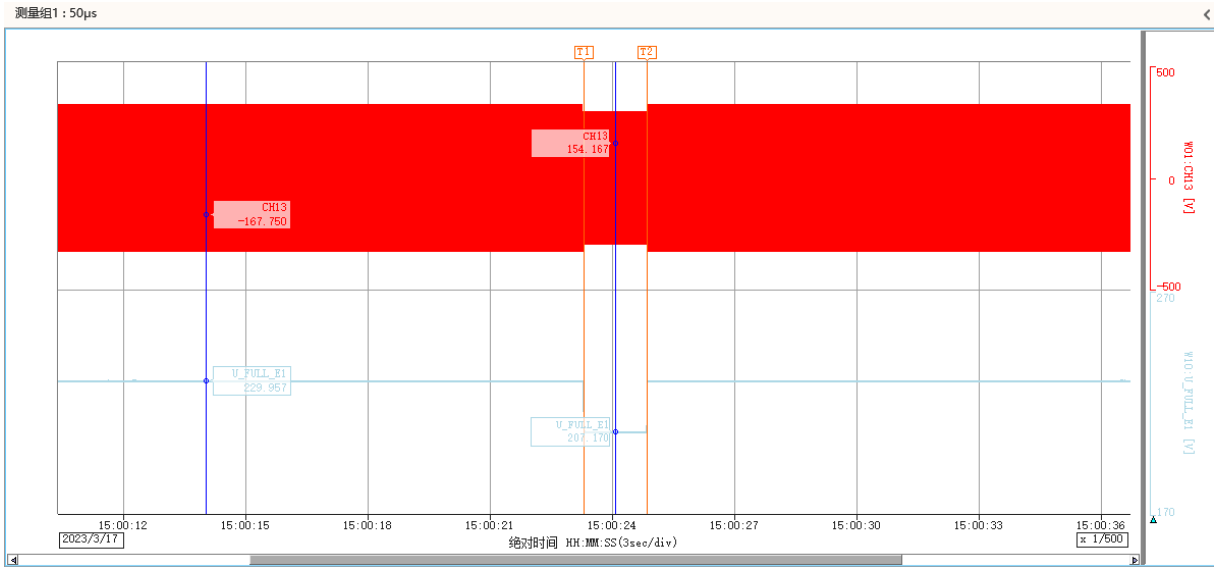
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

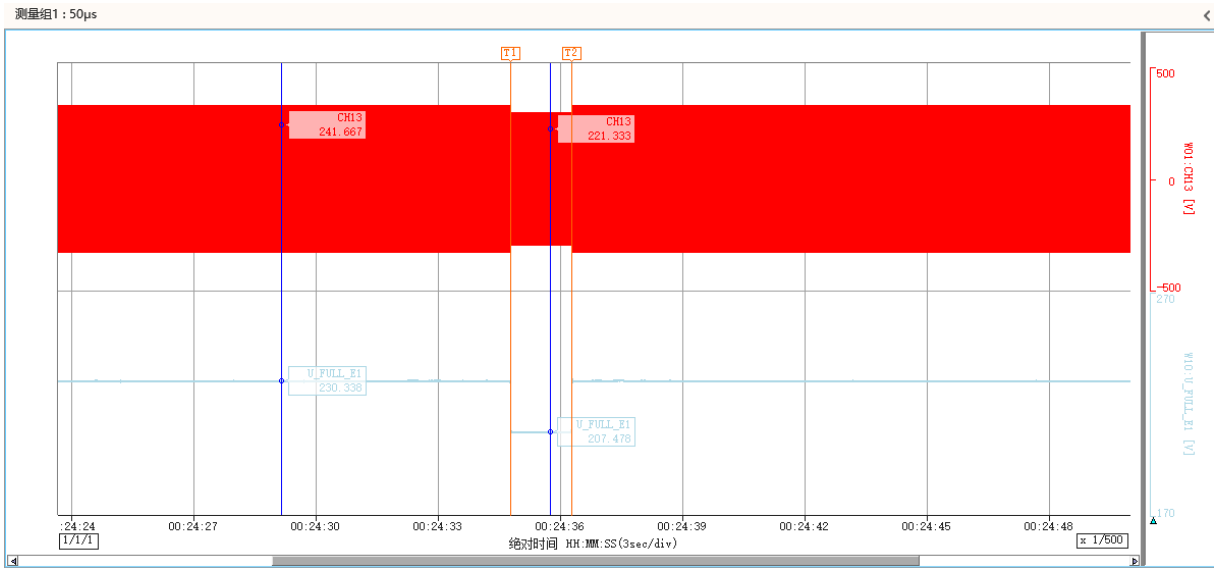
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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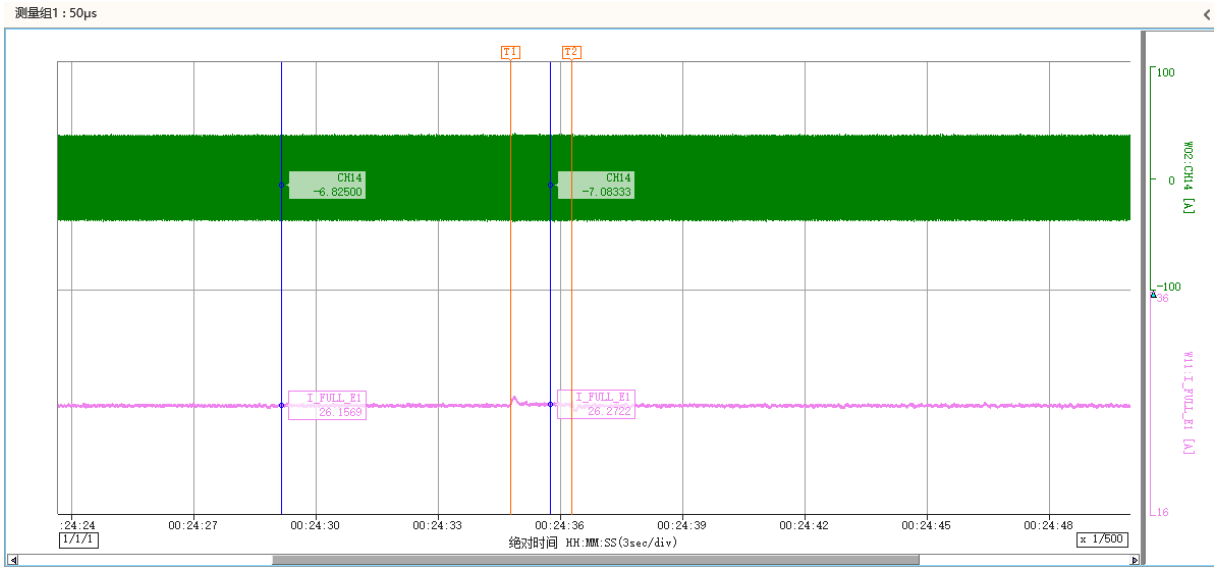
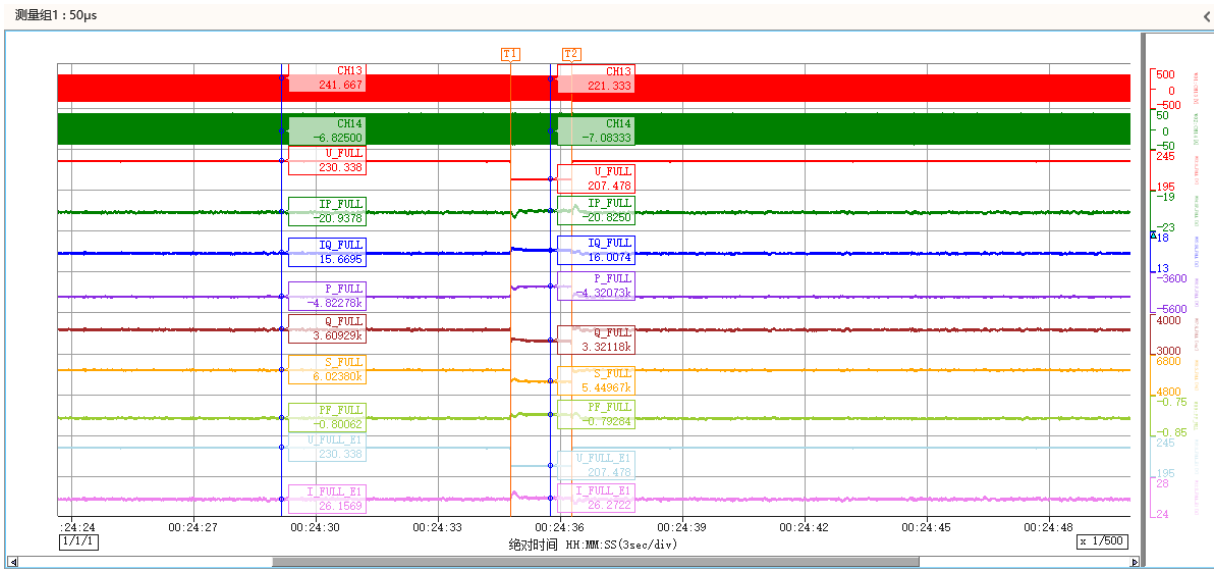
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms
Active and reactive power as moving average over 20 ms
Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 3.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/4/28 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 17:02:58 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 22143 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 23704 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 1561 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.099 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.996 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.213 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.212 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.153 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.810 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.896 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.218 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.226 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.211 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.189 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.996 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.219 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.212 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.154 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.153 |



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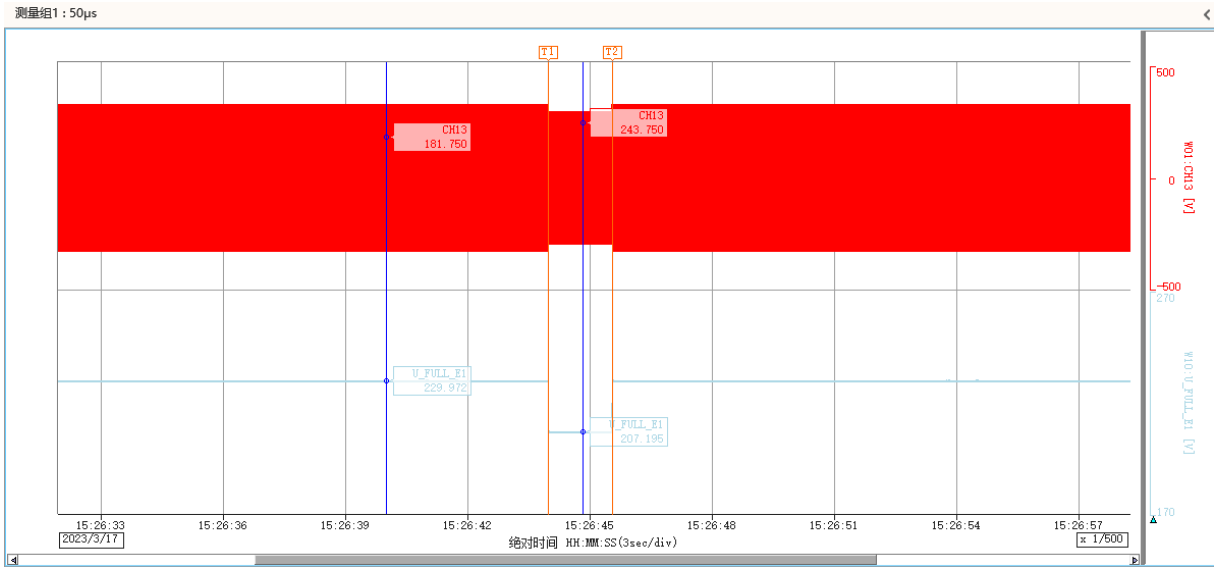
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

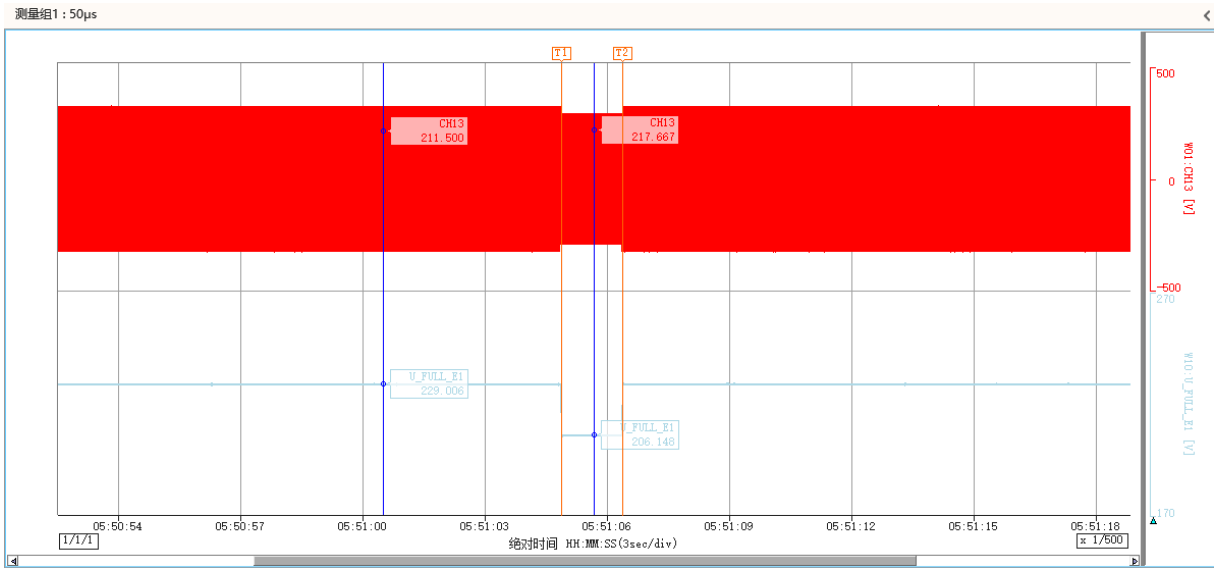
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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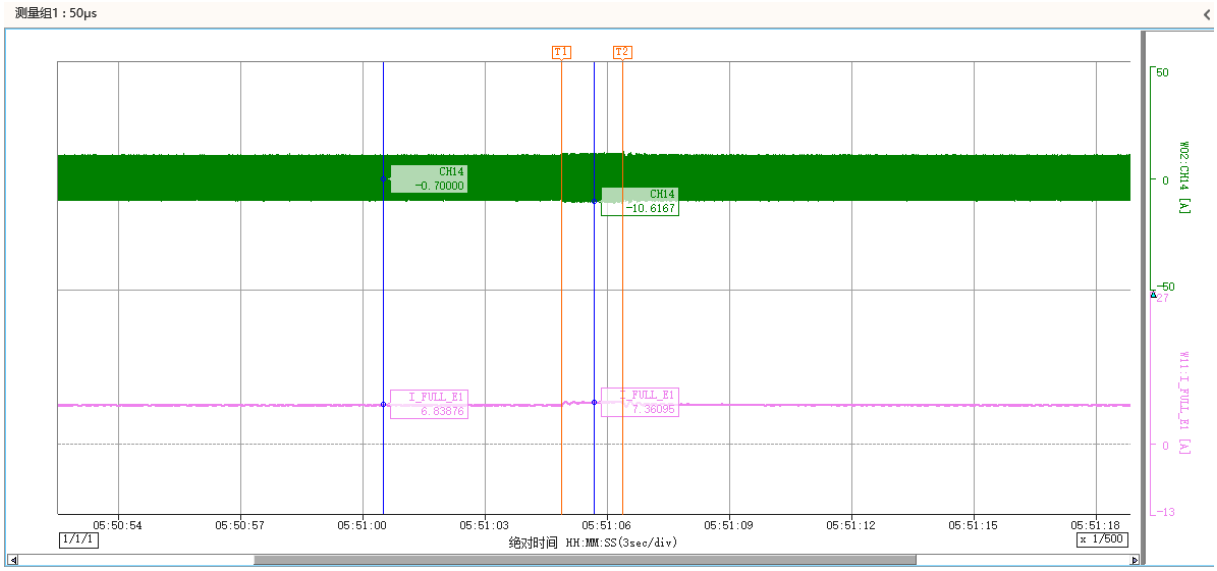
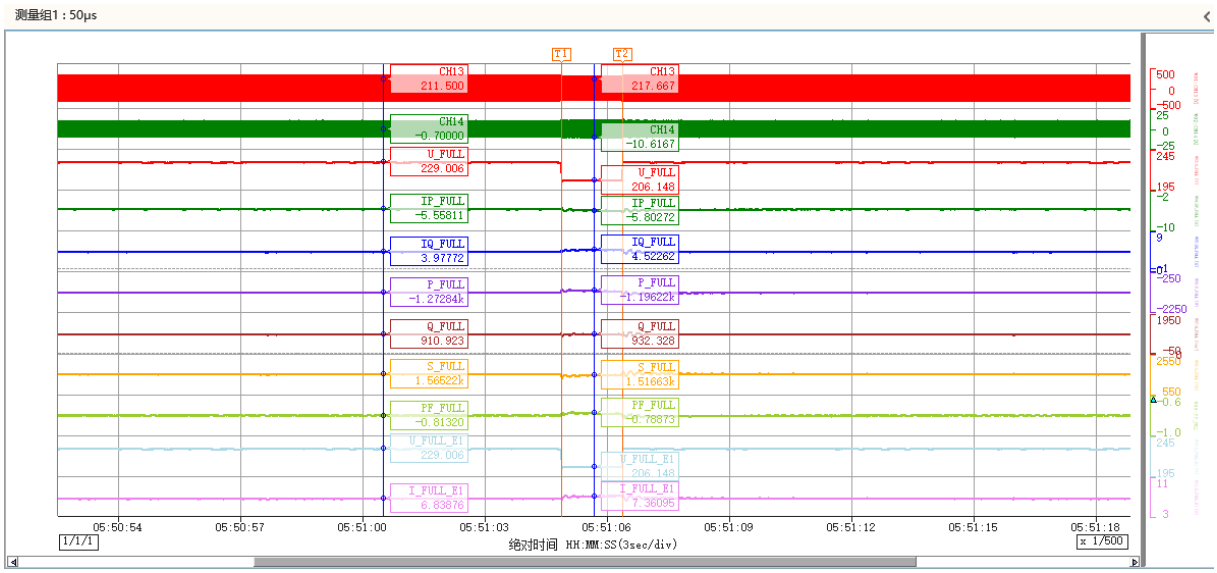
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 4.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 10:11:21 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21716 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82724 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61008 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.149 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.009 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -1.001 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -1.010 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.860 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -1.003 |
| | 17 | | L1 | t1+100ms | [p.u.] | -1.027 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -1.005 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.864 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.009 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -1.009 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -1.010 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.004 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.004 |



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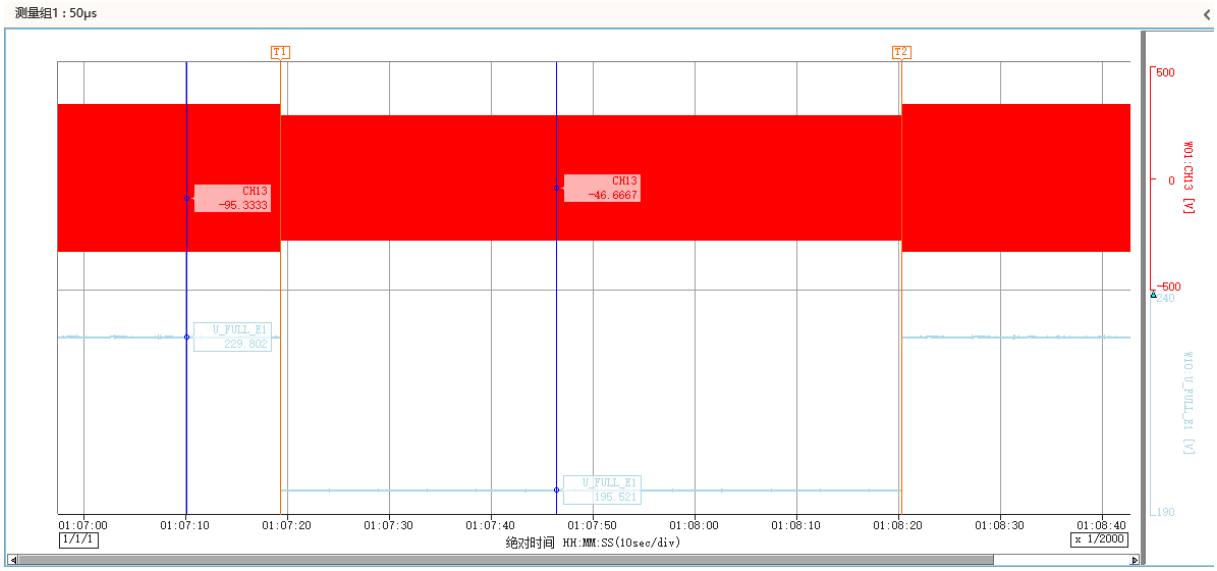
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 5 |

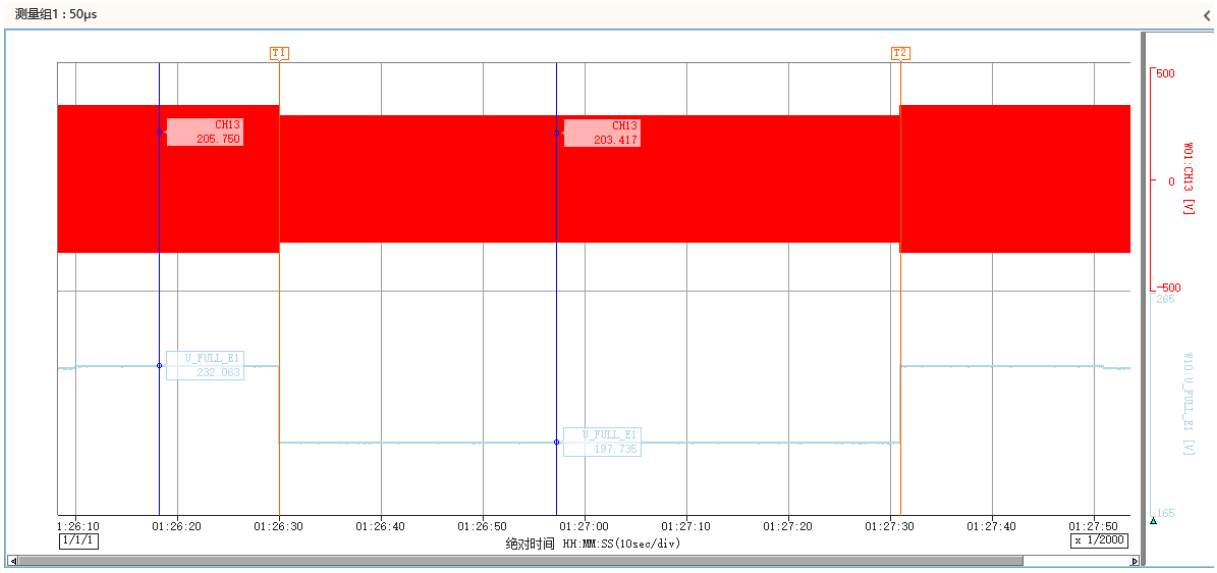
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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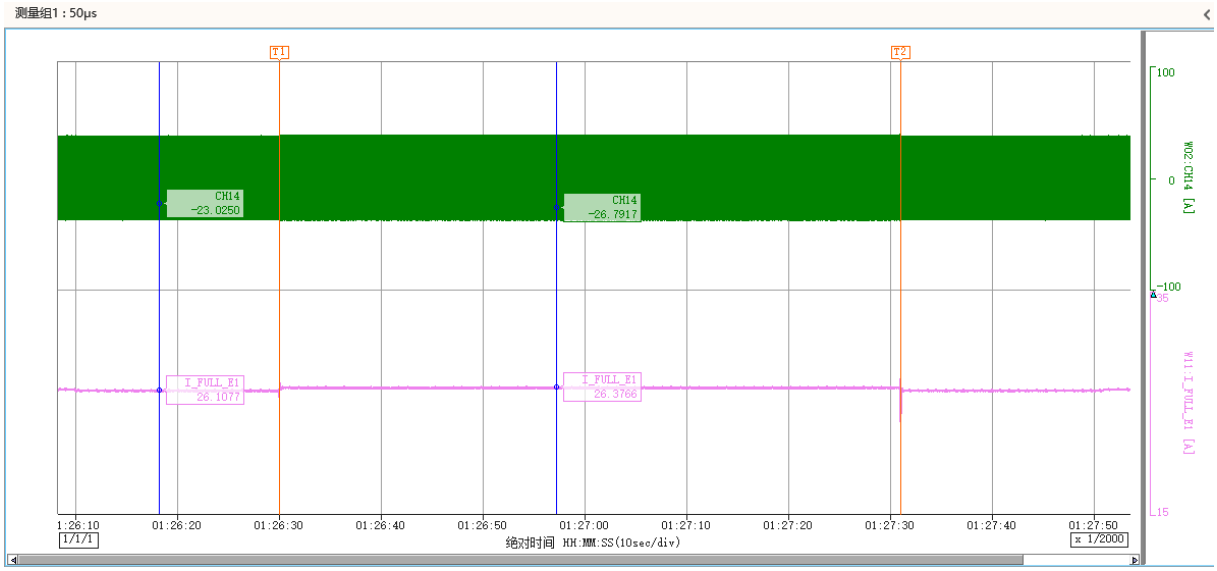
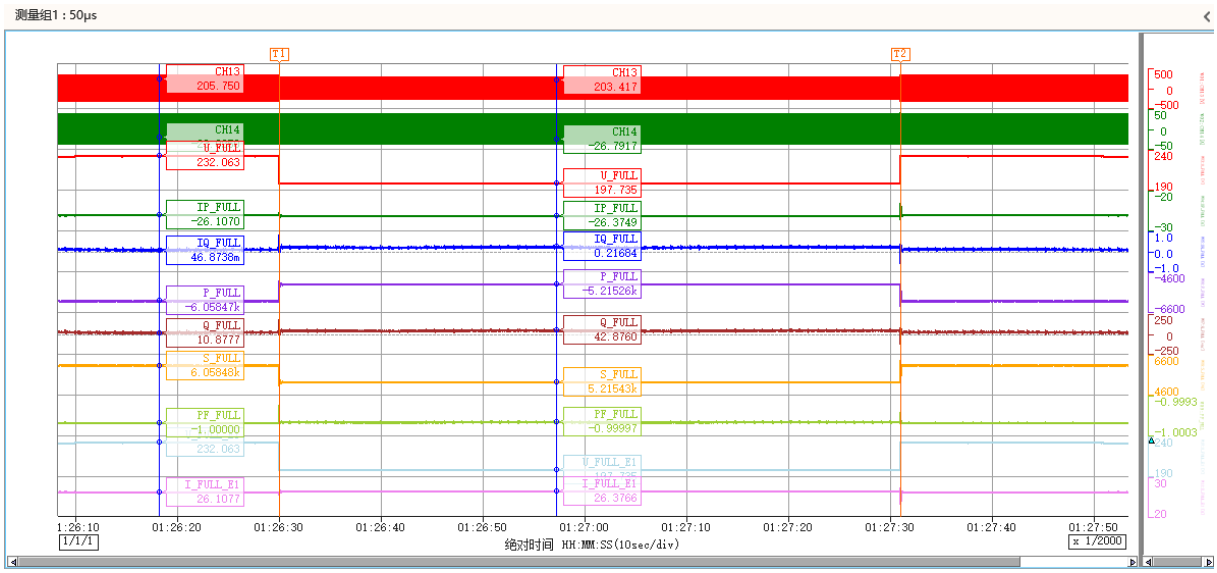
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 4.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 10:30:58 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21716 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82724 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61008 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.149 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.205 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.205 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.020 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.995 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.853 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.210 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.219 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.205 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.175 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.228 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.208 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.020 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.020 |



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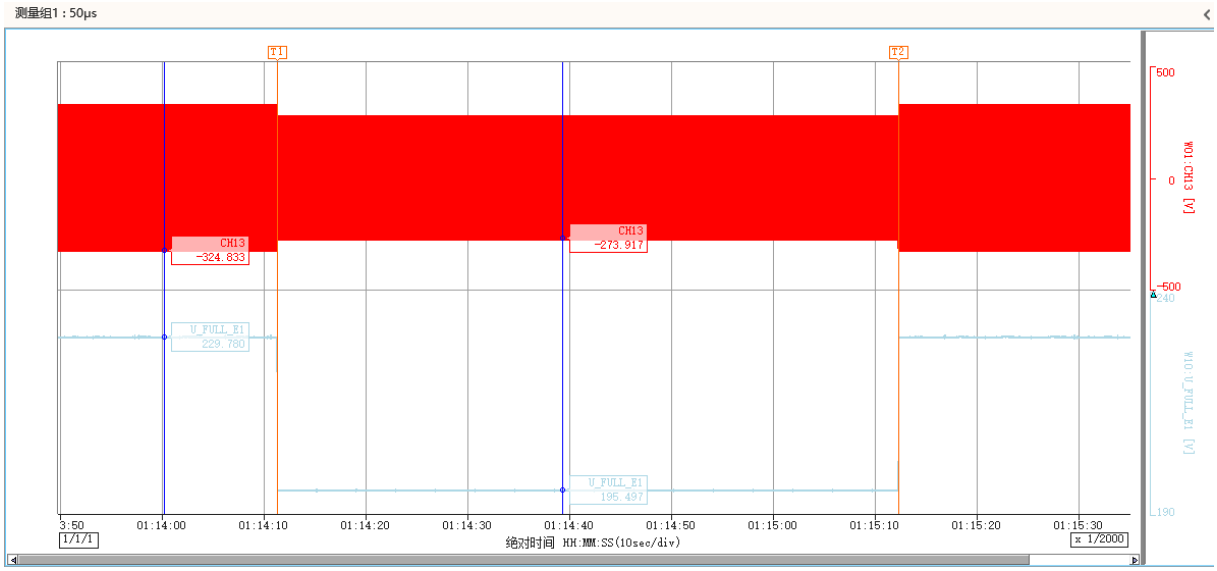
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 7 |

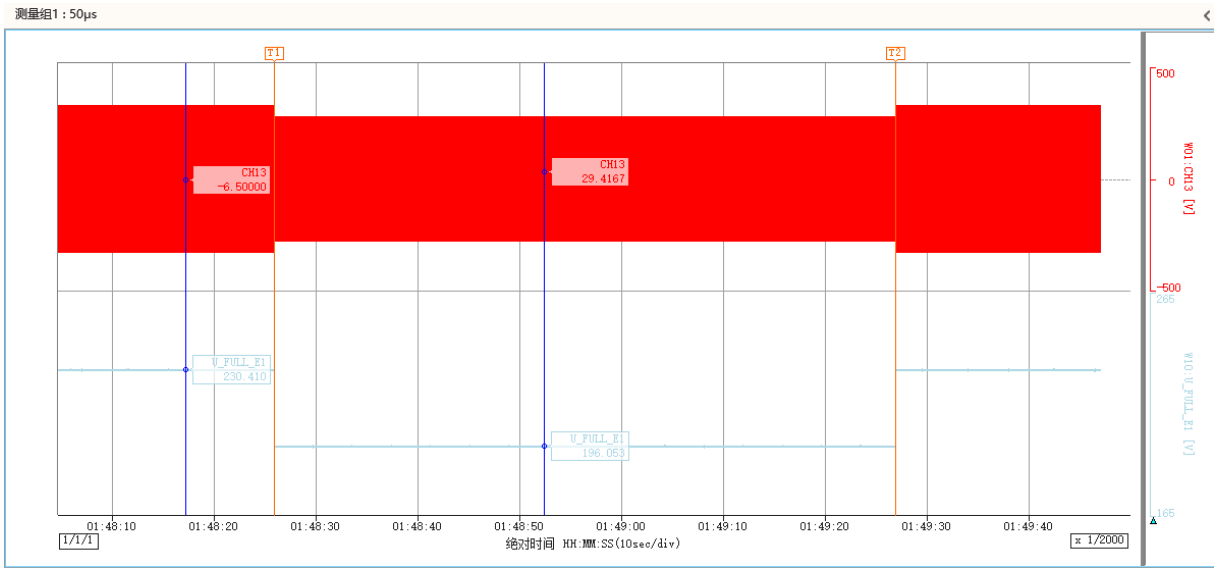
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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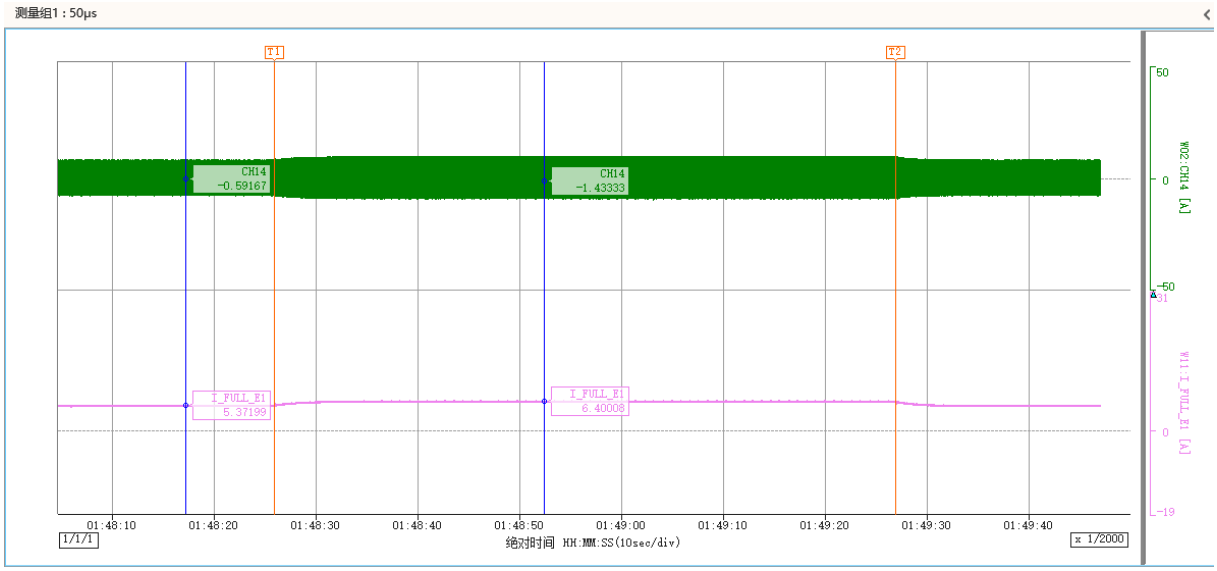
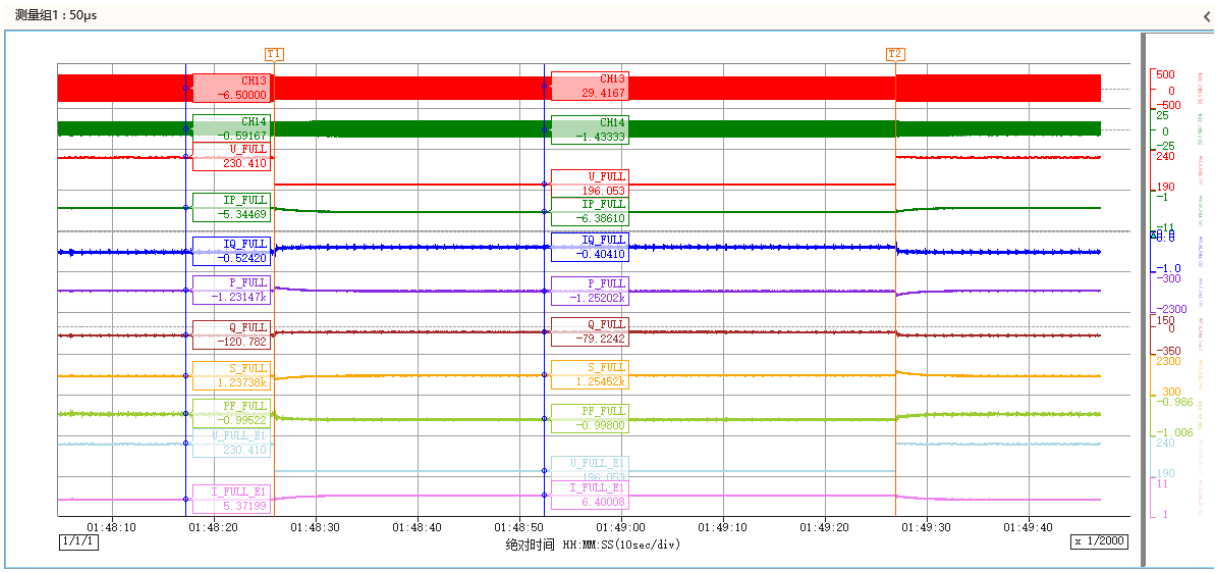
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 4.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 11:03:10 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21295 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82305 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61010 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.035 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.009 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -1.001 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -1.010 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.974 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -1.006 |
| | 17 | | L1 | t1+100ms | [p.u.] | -1.010 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -1.003 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.976 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.009 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -1.010 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -1.010 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.002 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.004 |



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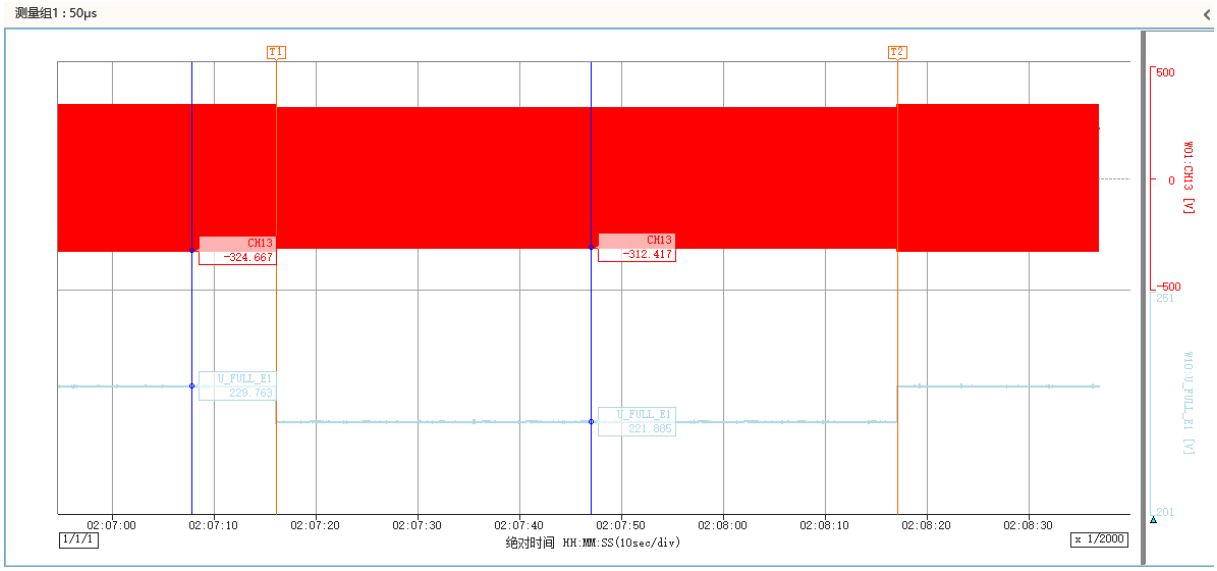
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 6 |

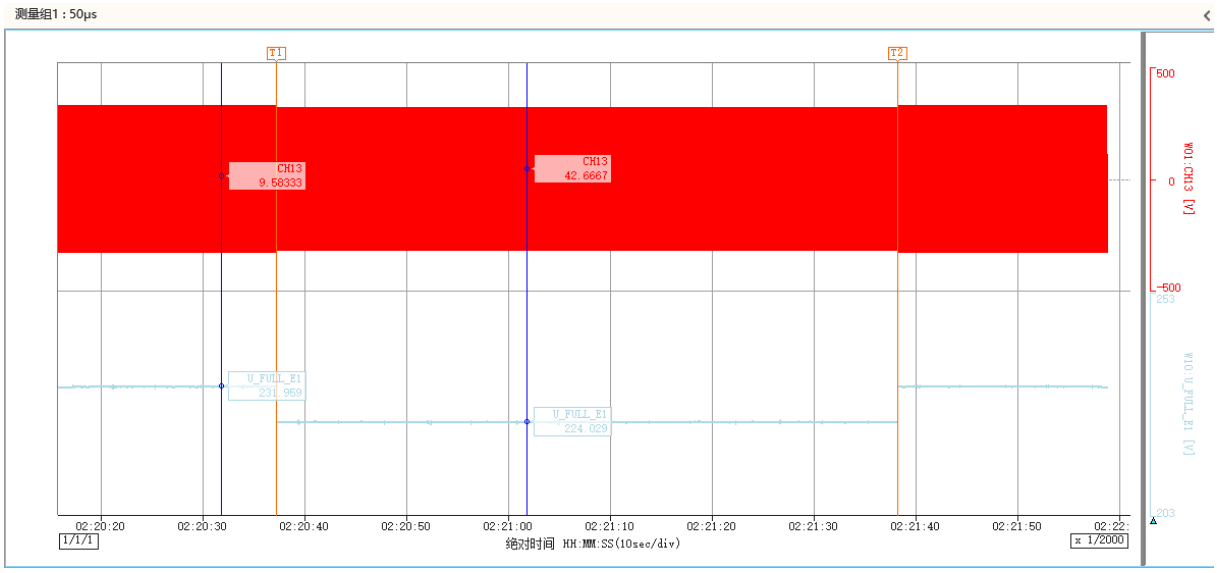
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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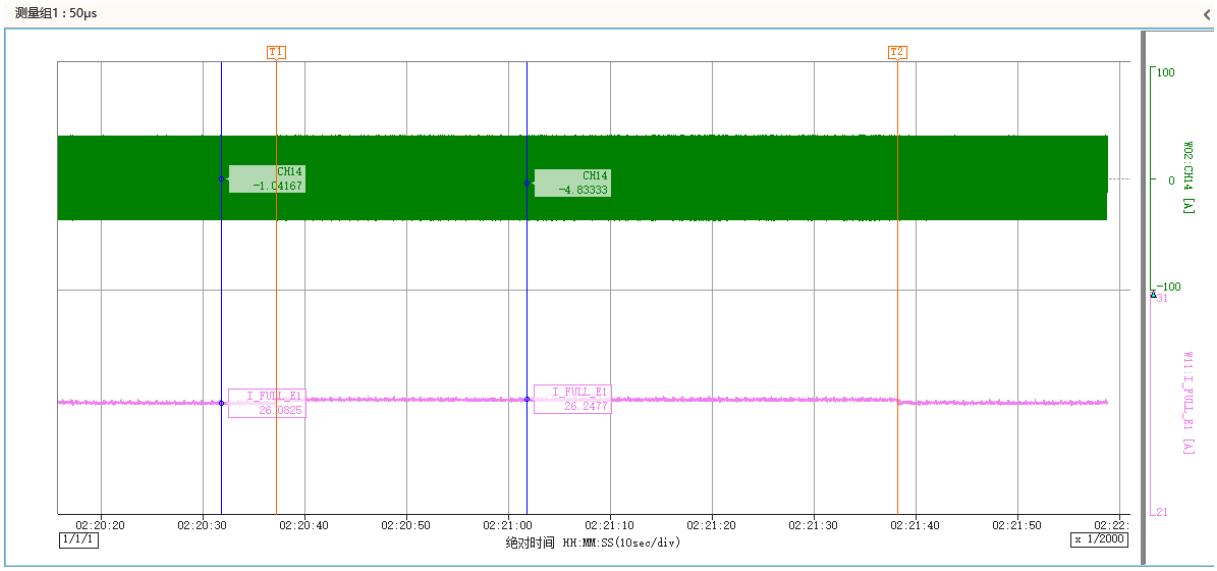
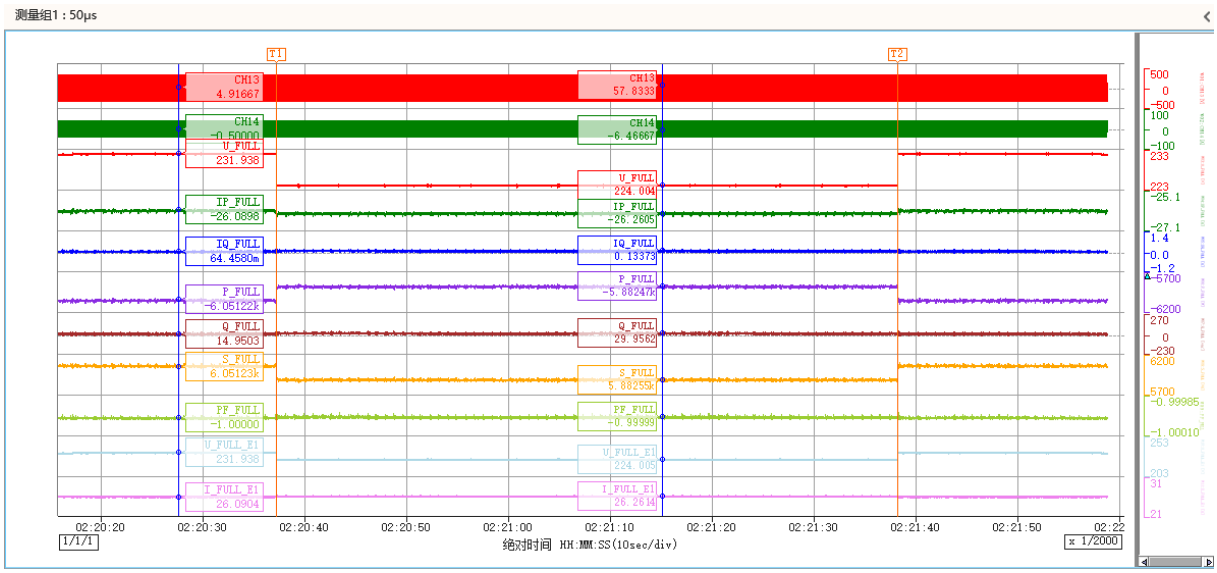
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms
Active and reactive power as moving average over 20 ms
Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 4.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 11:18:43 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21295 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82305 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61010 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.035 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.205 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.206 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.020 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.995 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 0.967 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.207 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.209 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.205 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.198 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.210 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.206 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.020 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.020 |



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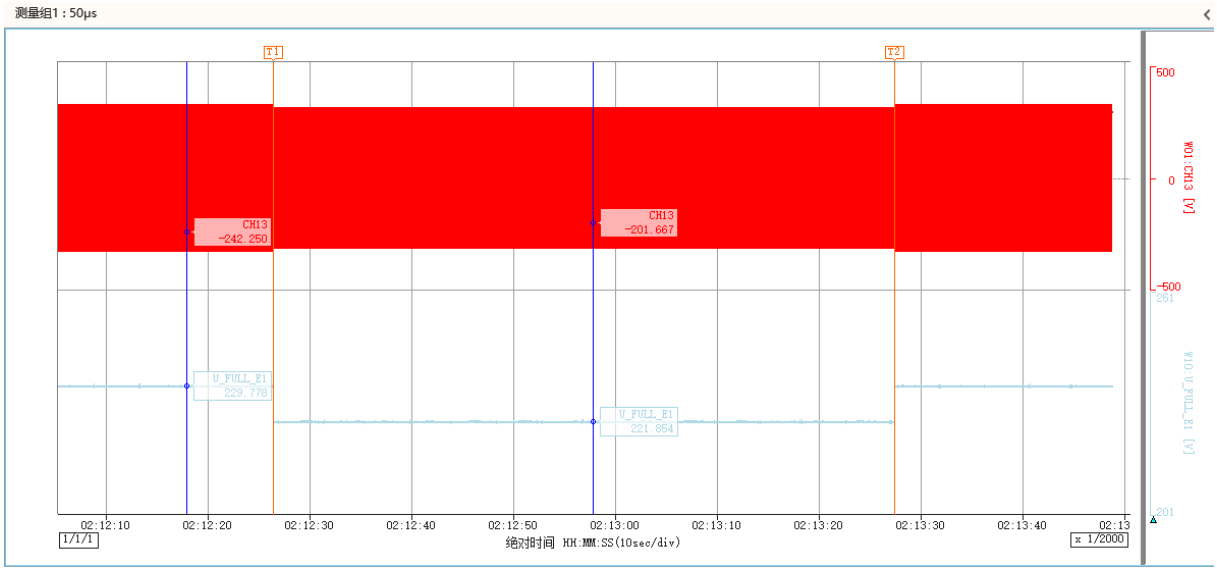
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 7 |

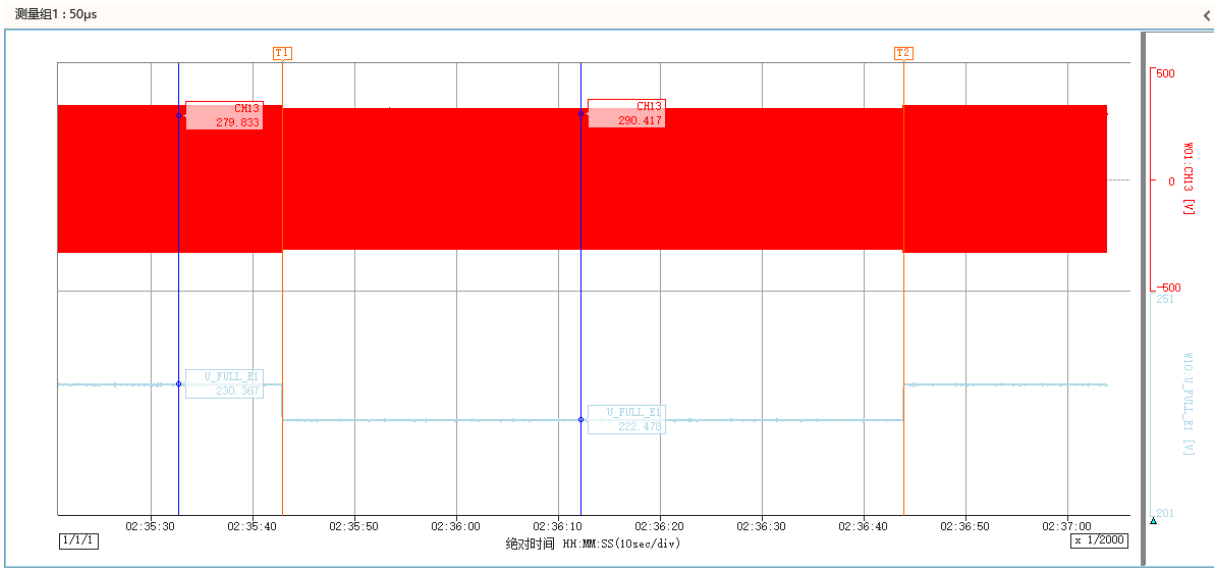
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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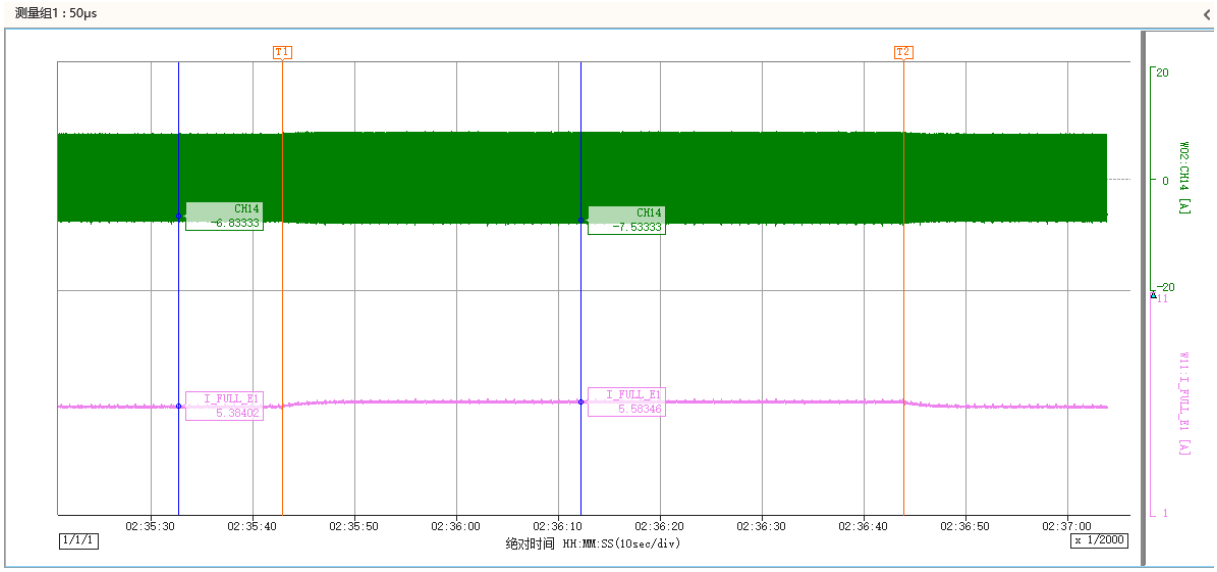
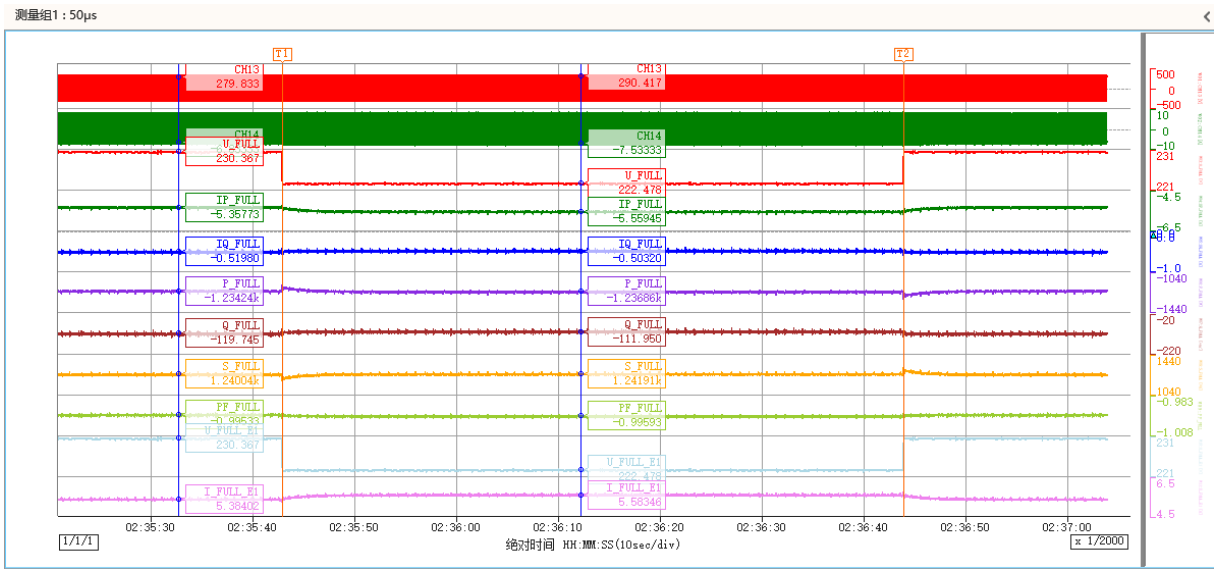
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 5.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 15:39:40 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 20324 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 20485 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 161 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.249 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.998 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.998 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.031 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.250 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.059 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.079 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.094 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.000 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.998 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.998 |
| | 23 | Active power recover time | Total | - | ms | 358 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.033 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.030 |



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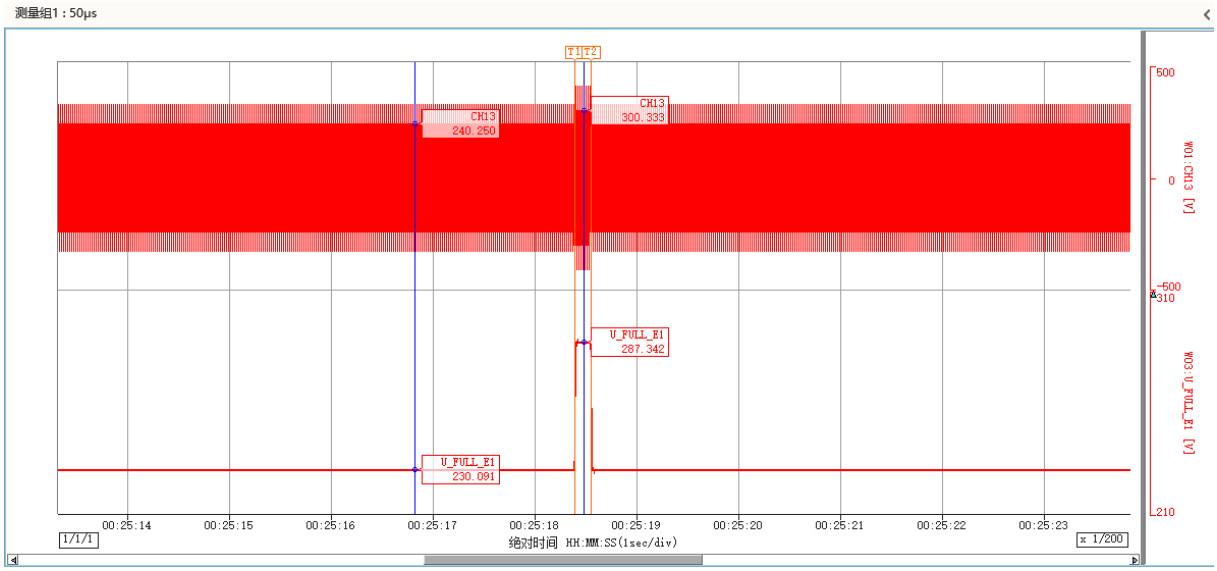
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 23 |

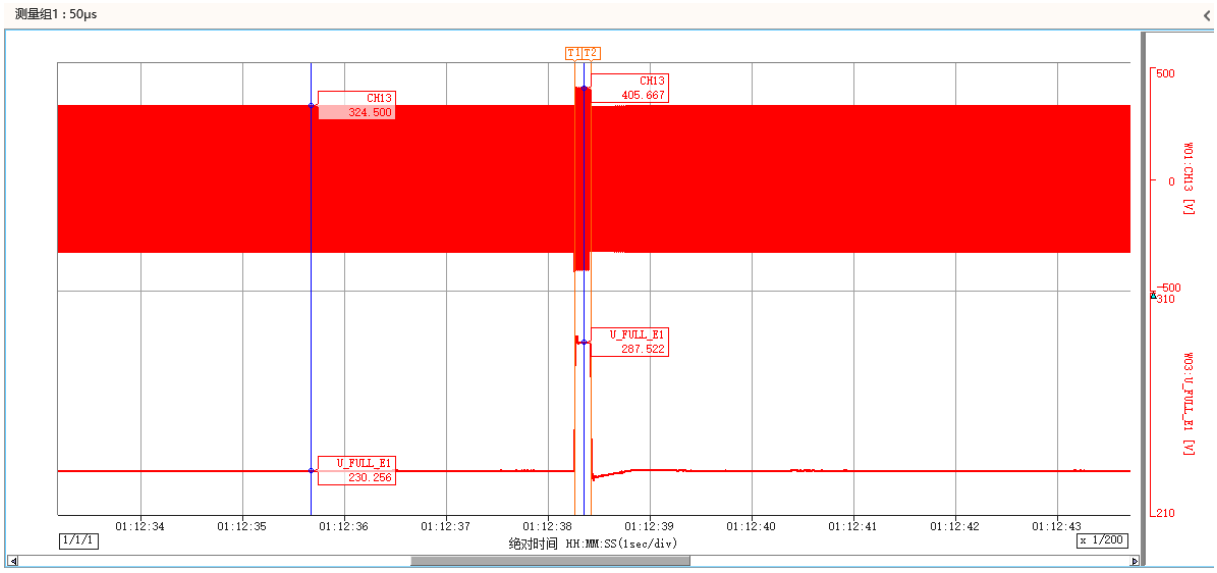
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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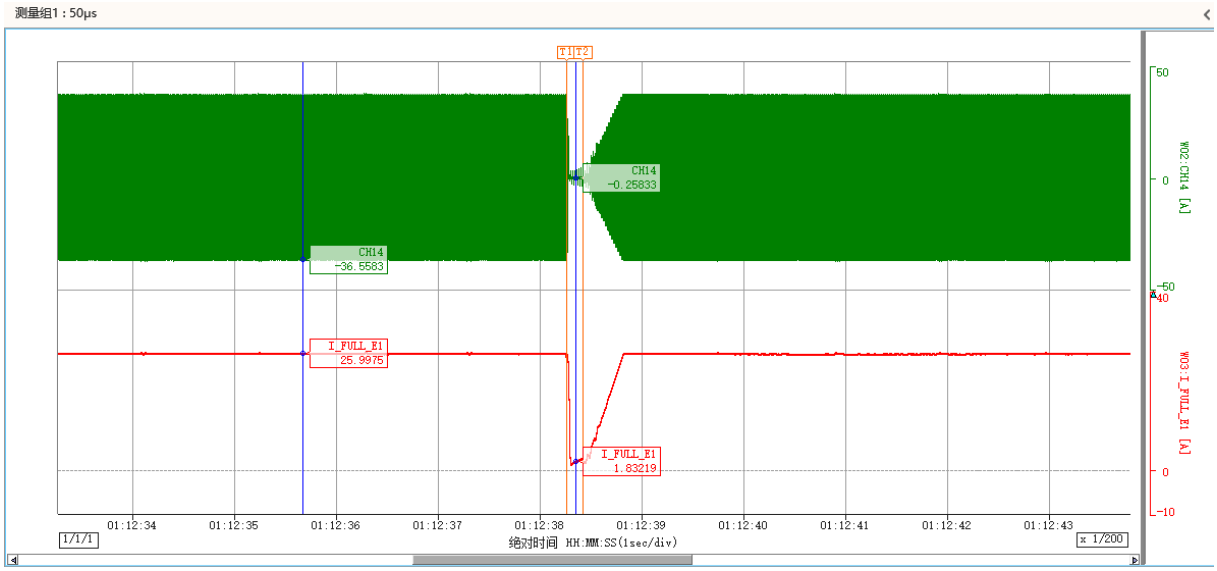
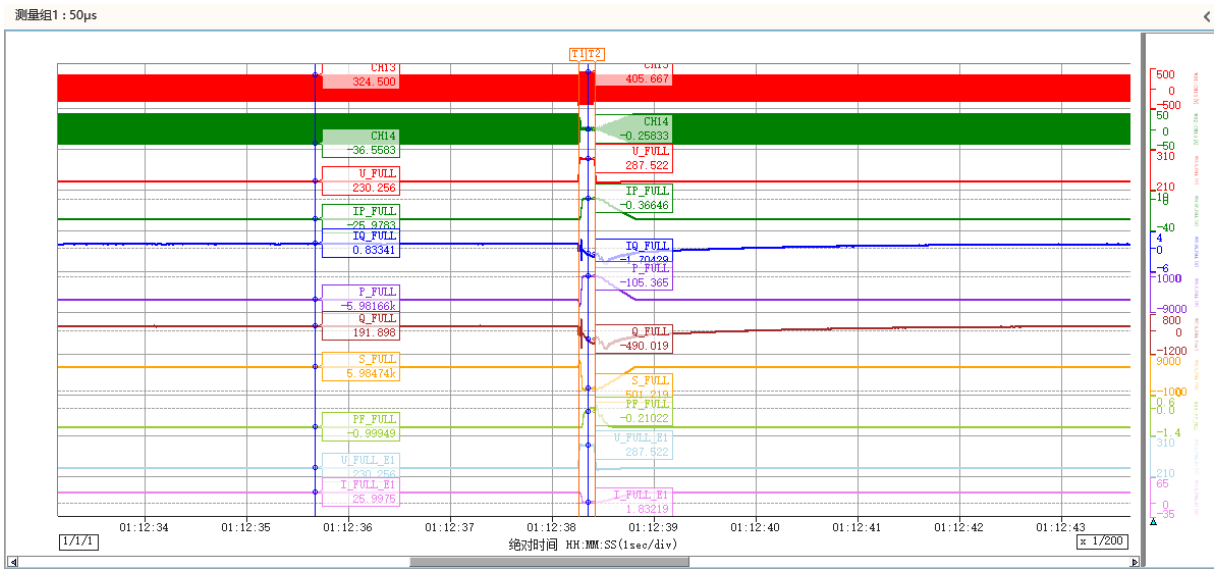
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 5.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 16:02:01 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 19994 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 20155 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 161 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.249 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.999 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.206 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.206 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.250 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.076 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.090 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.094 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.003 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.999 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.202 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.204 |
| | 23 | Active power recover time | Total | - | ms | 92 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.002 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.002 |



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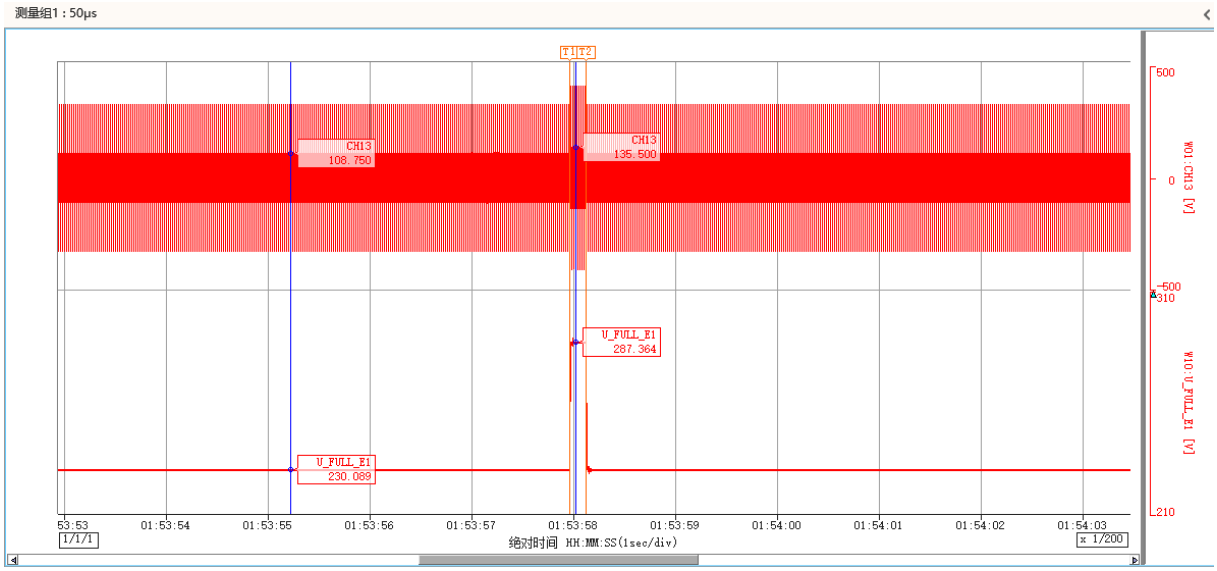
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 13 |

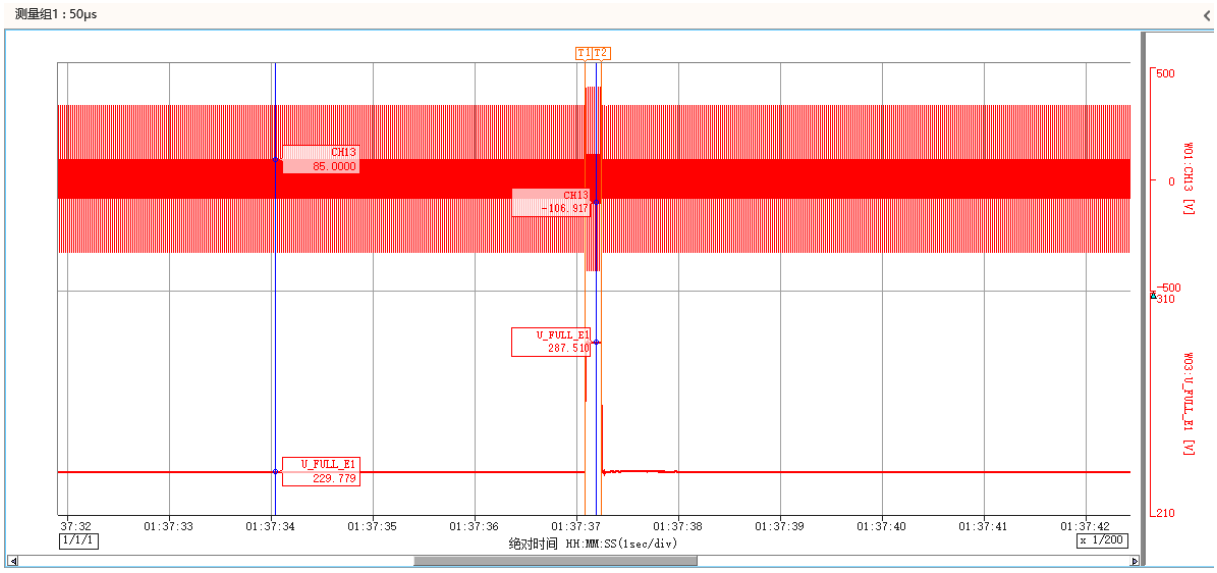
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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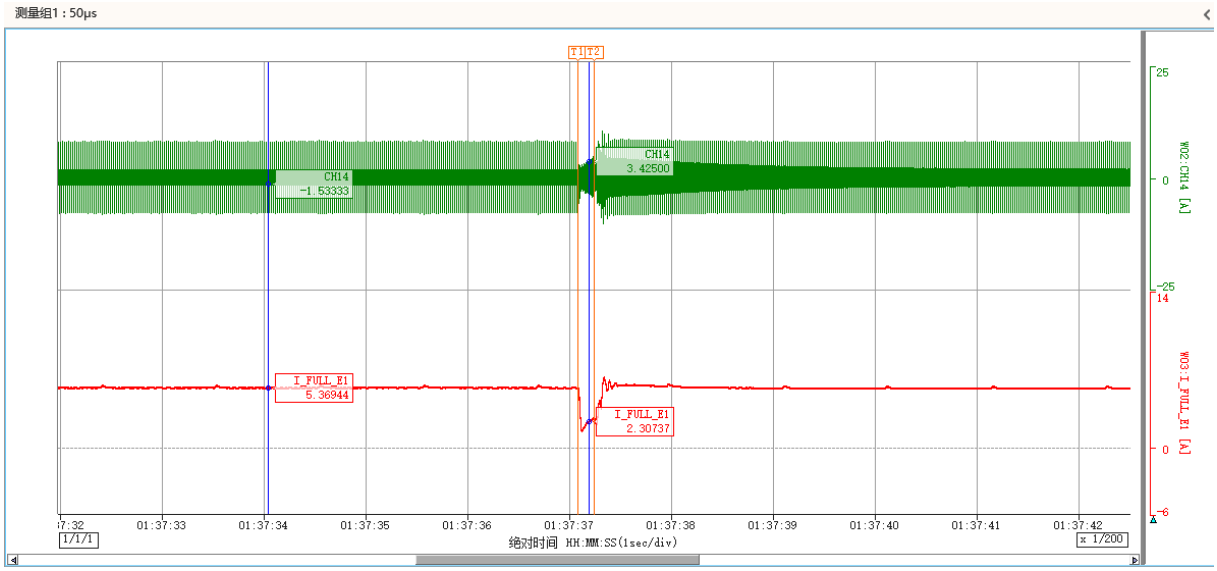
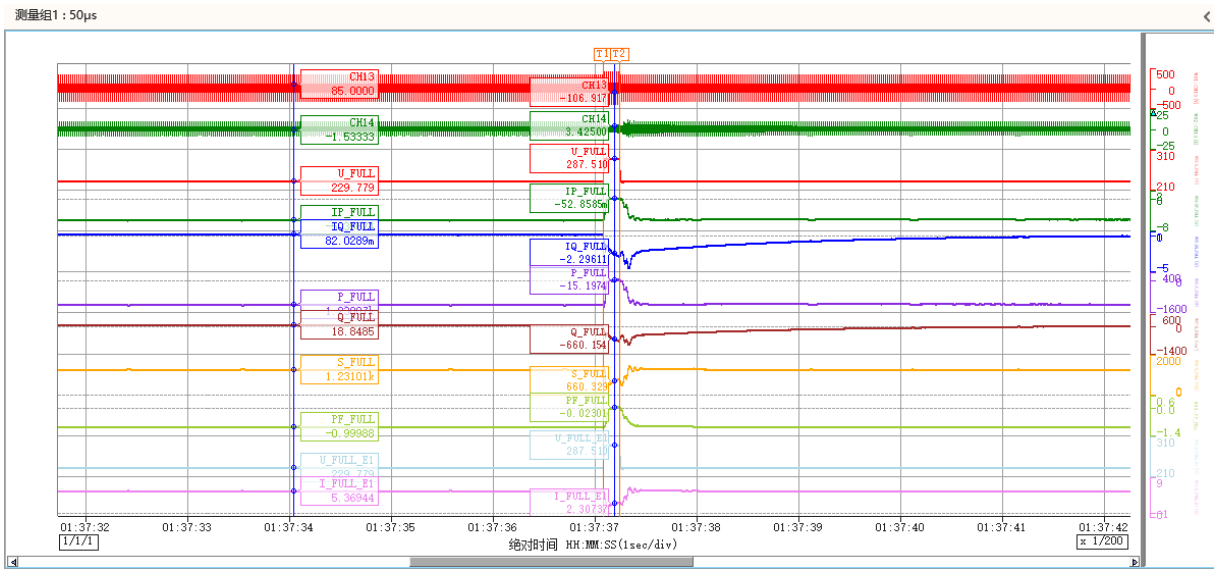
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 5.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 16:31:09 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 19793 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 19953 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 160 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.063 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.998 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.998 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.034 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.999 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.076 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.920 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.909 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.932 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.977 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.997 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.997 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.034 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.032 |



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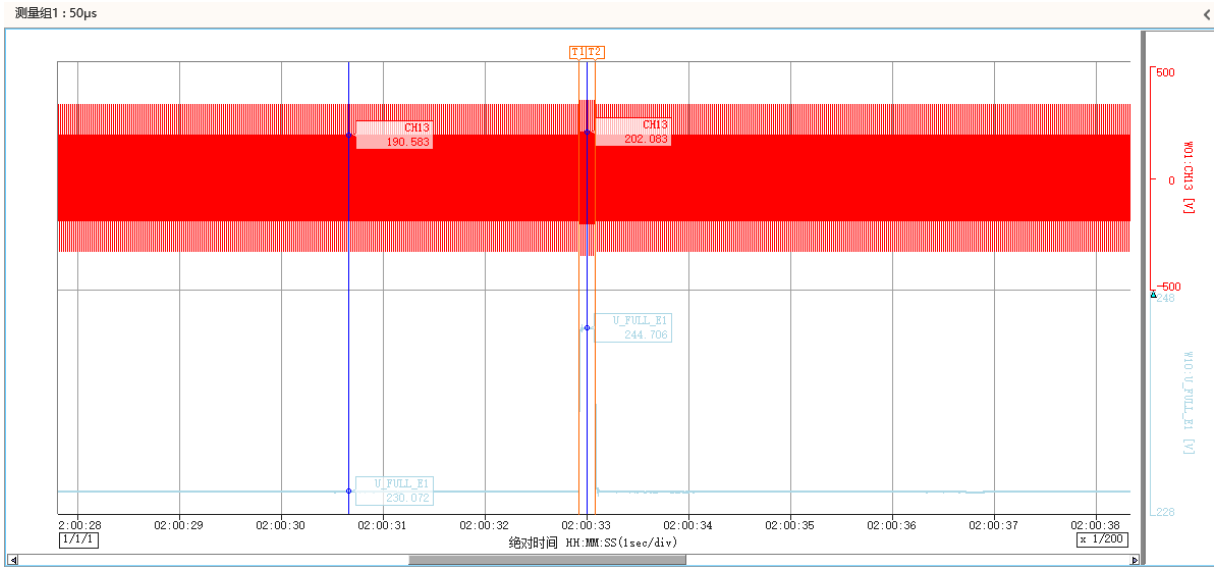
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

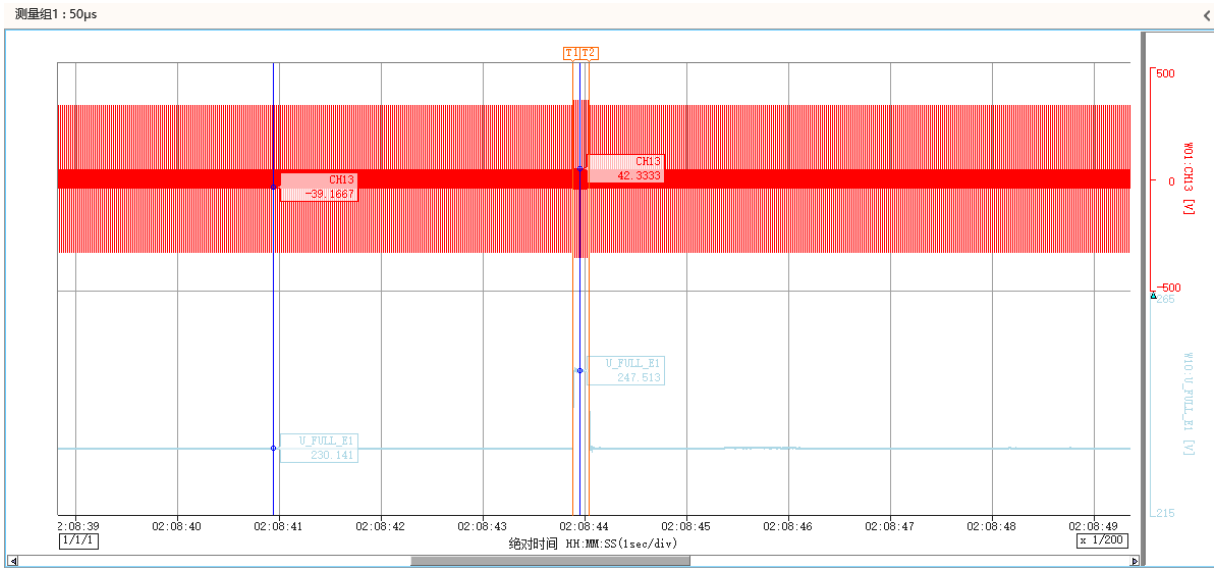
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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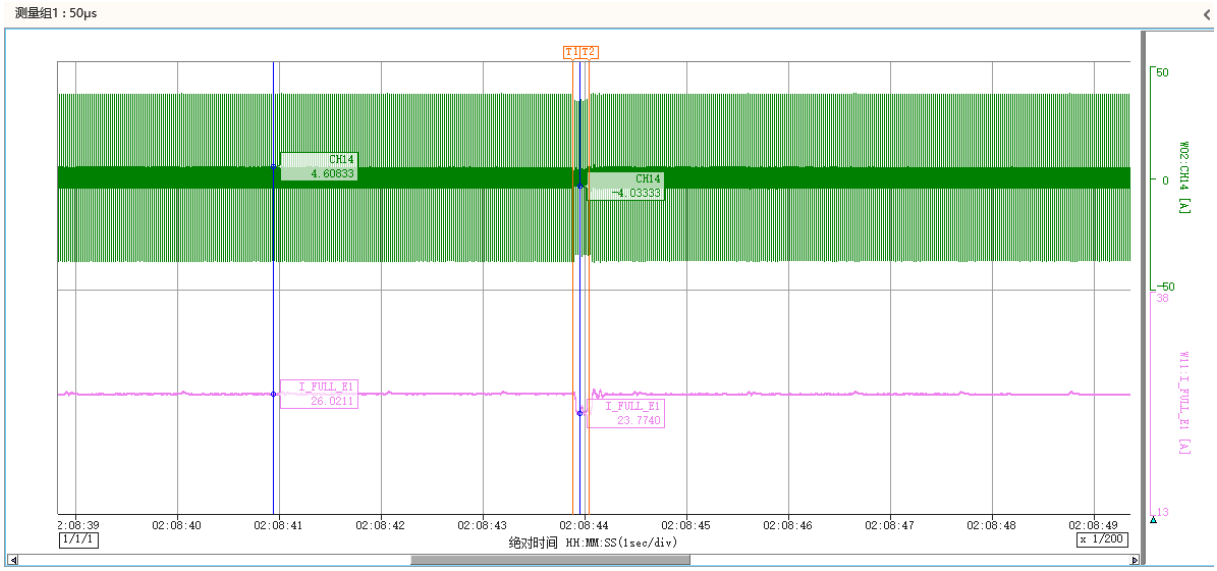
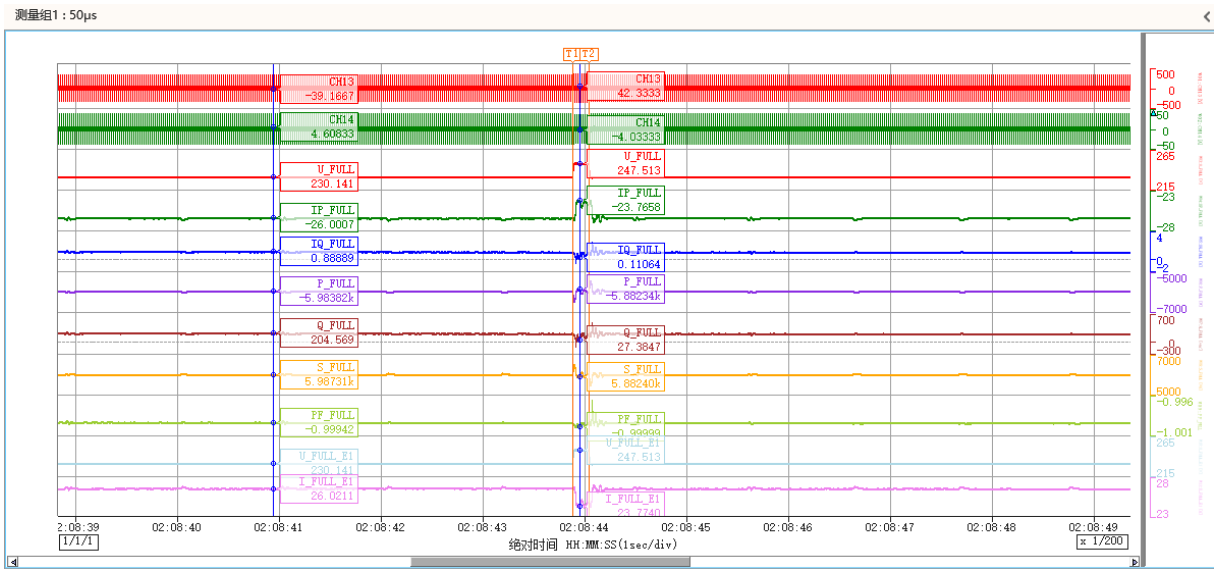
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 5.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 17:15:50 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21887 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 22047 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 160 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.063 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 0.999 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.206 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.206 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.066 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.190 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.184 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.194 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.195 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 0.999 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.205 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.205 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.003 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.003 |



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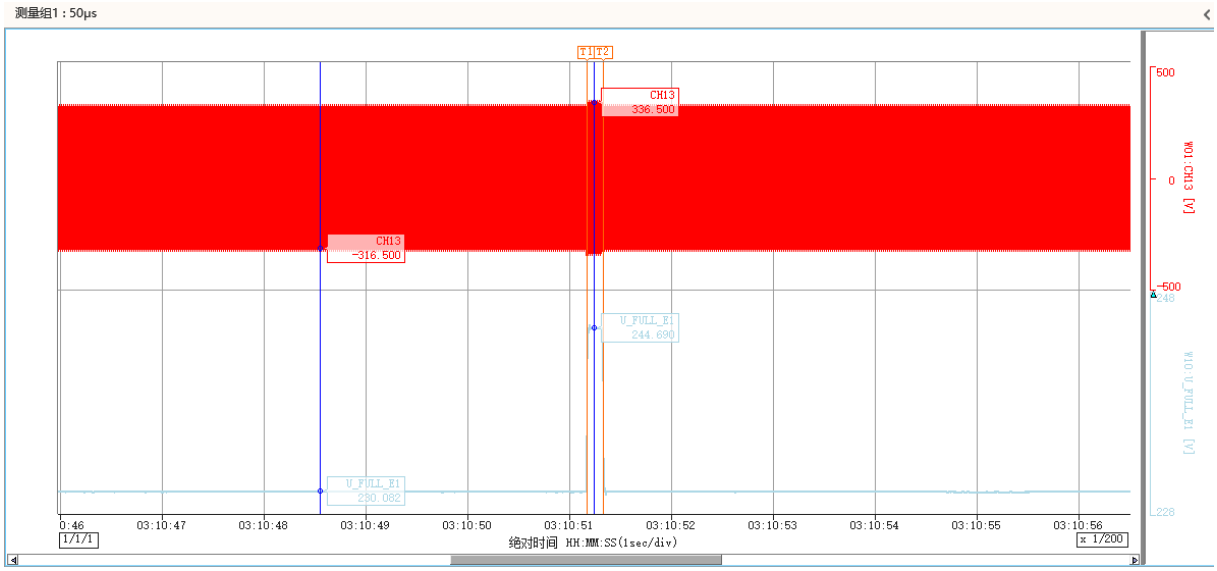
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

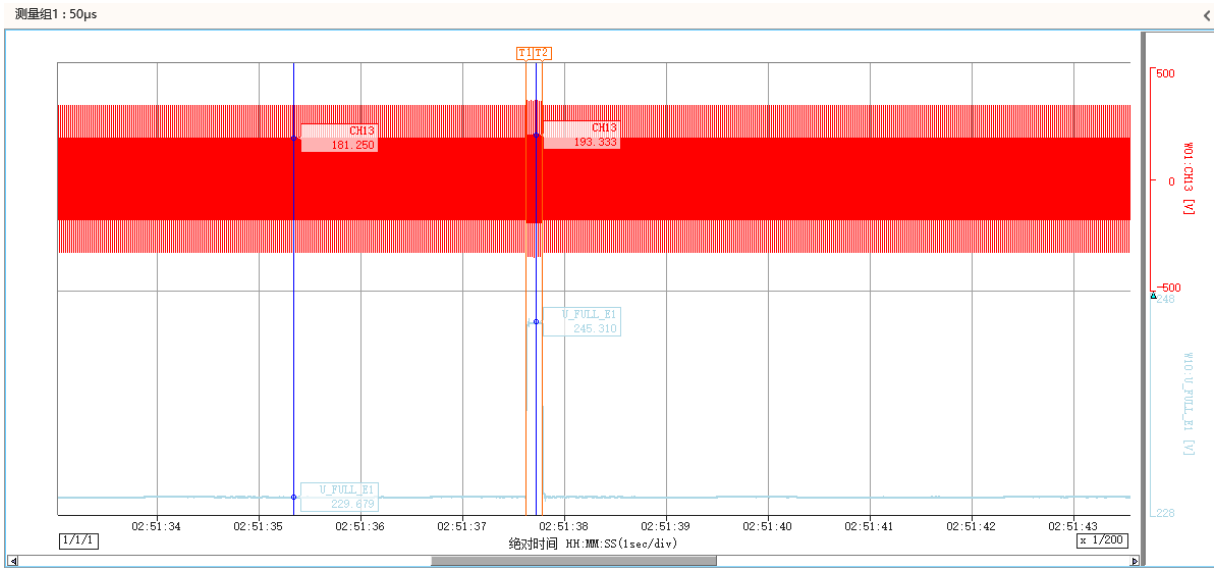
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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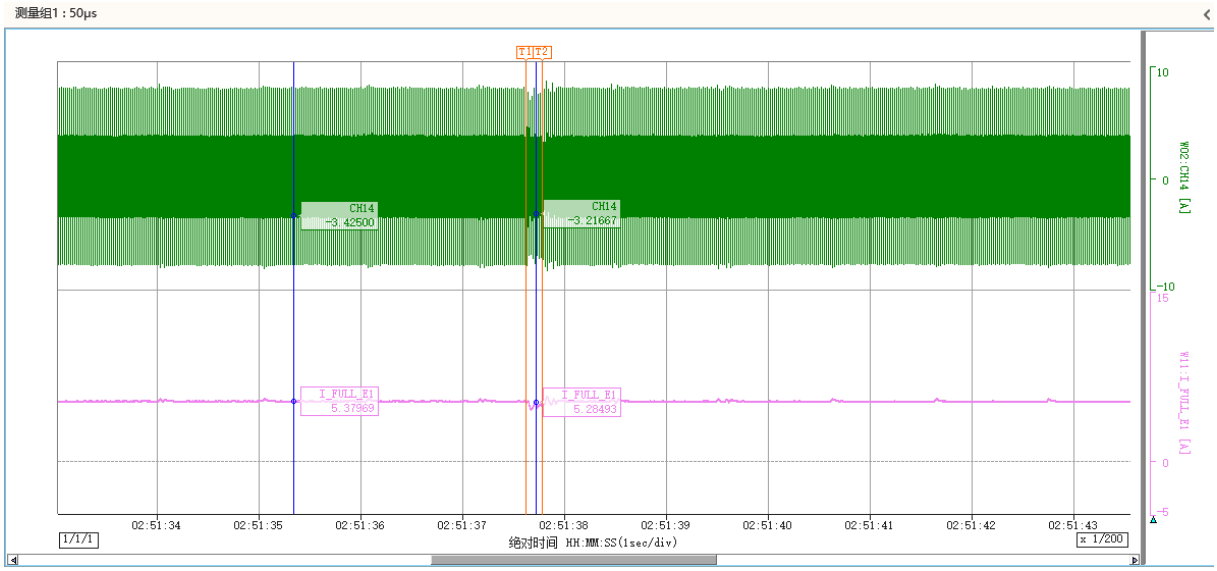
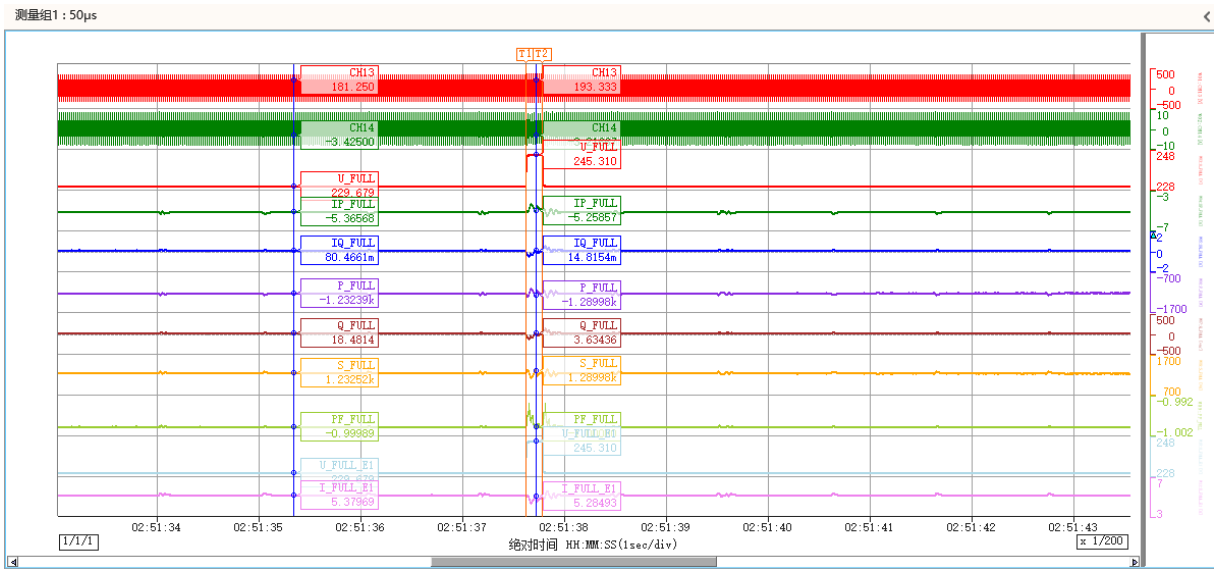
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 5.5 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/10 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 17:47:55 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 20013 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 20174 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 161 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.064 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.998 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.998 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.034 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.999 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.076 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.920 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.908 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.933 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.978 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.997 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.997 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.030 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.032 |



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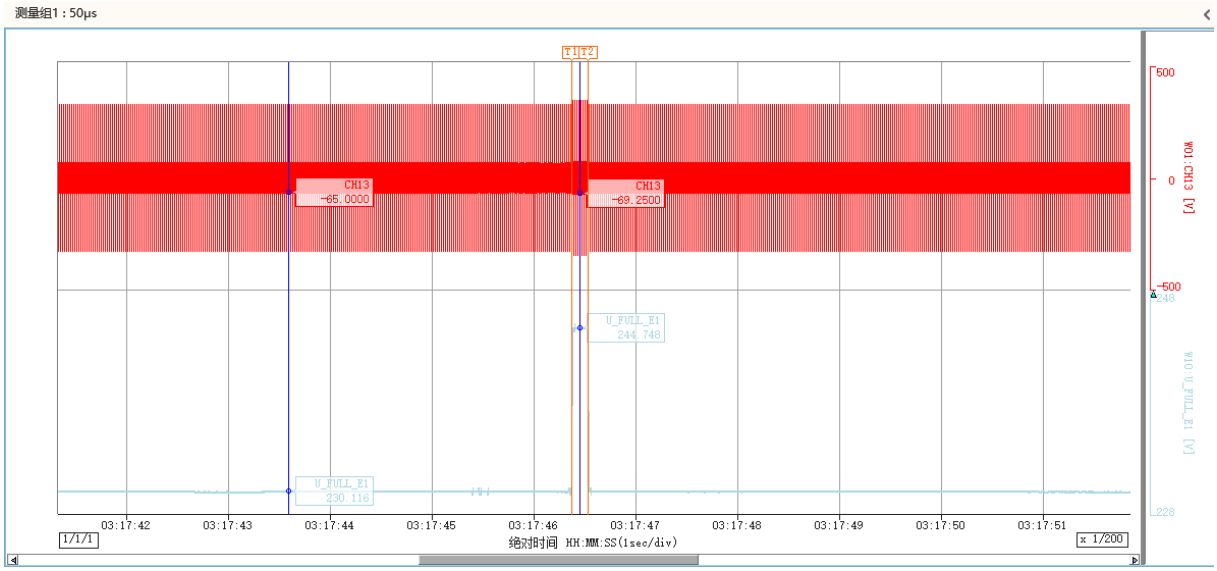
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

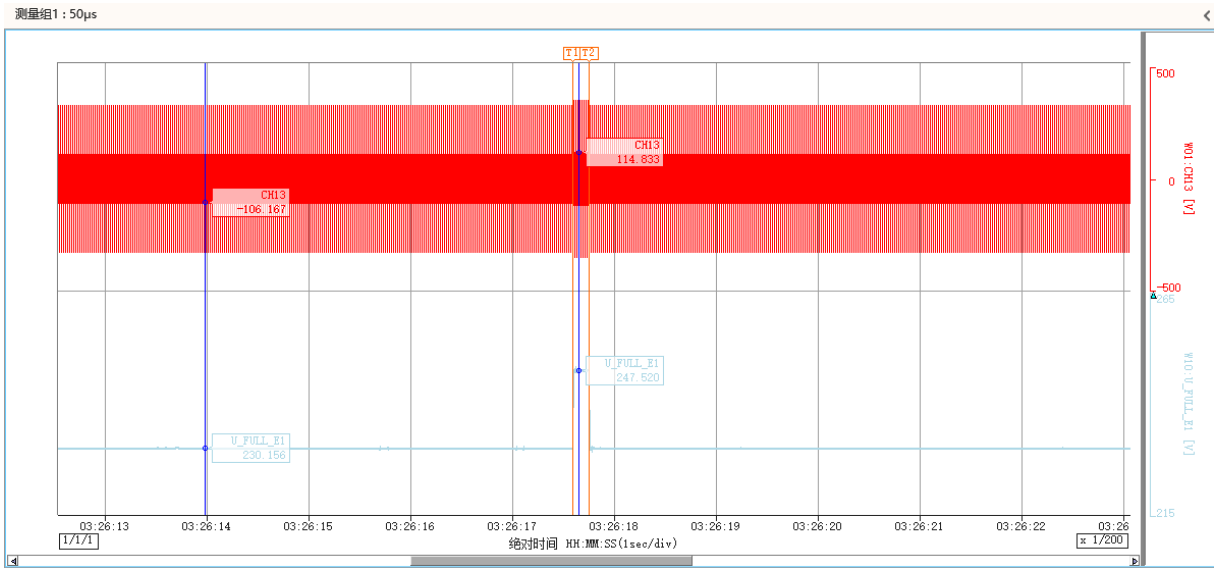
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages



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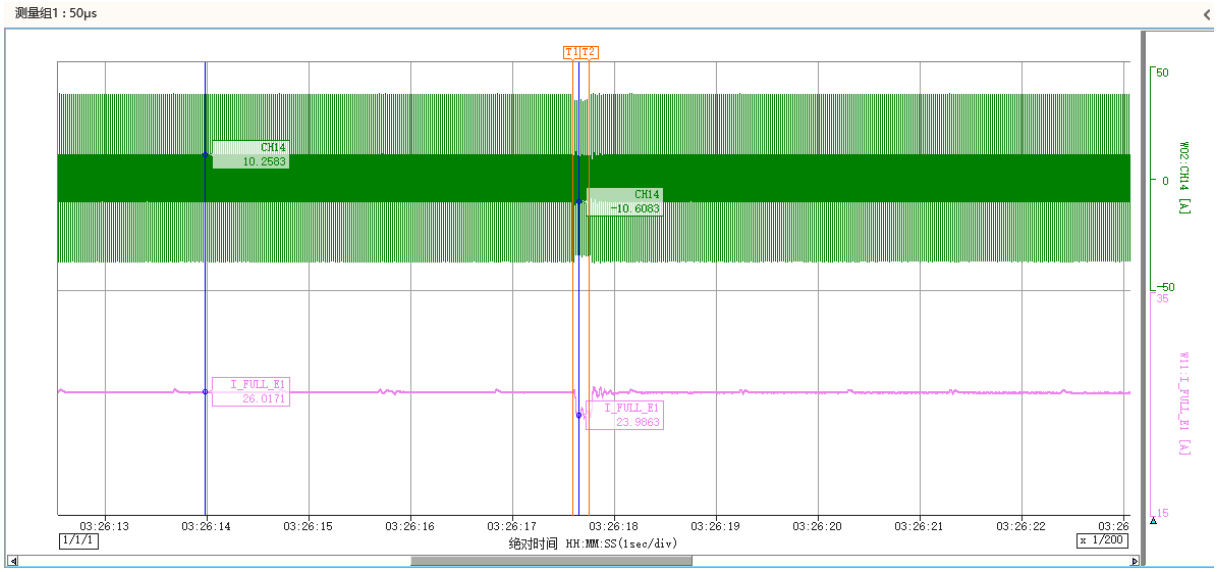
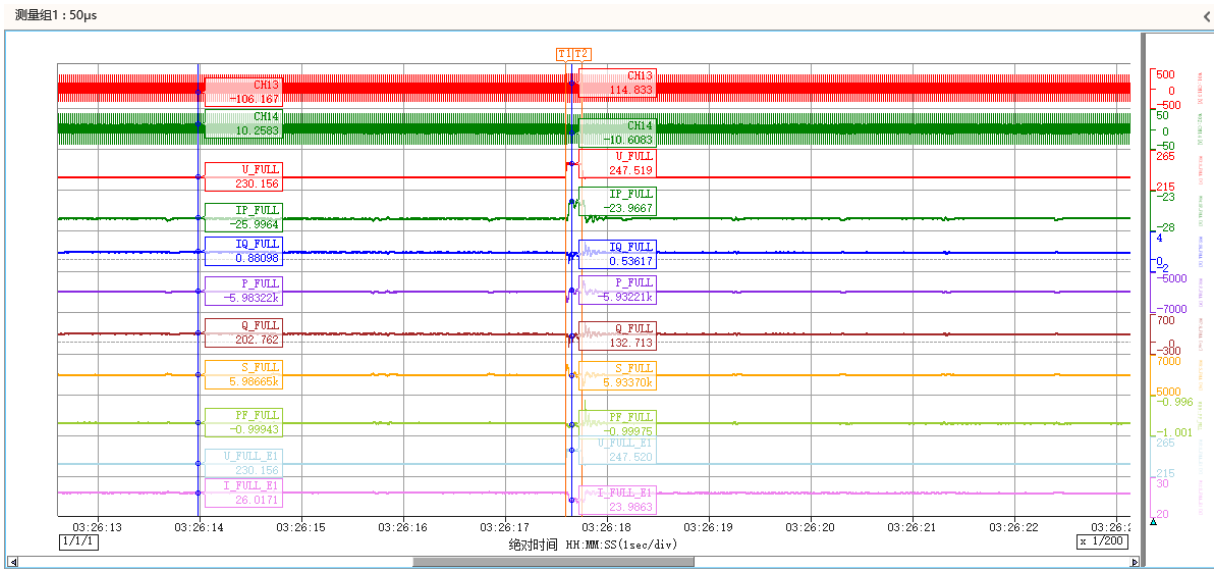
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 6.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/12 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 9:22:37 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21127 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 26227 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 5100 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.199 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.997 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.998 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.033 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.999 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.199 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.057 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.068 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.081 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.022 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.999 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.998 |
| | 23 | Active power recover time | Total | - | ms | 351 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.032 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.031 |



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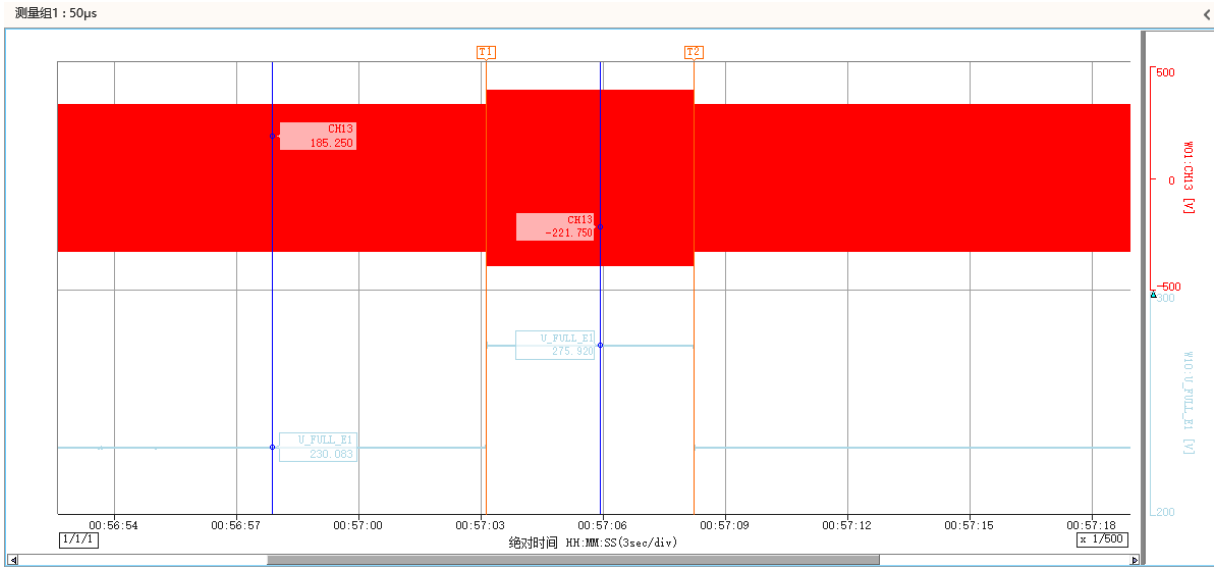
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 6 |

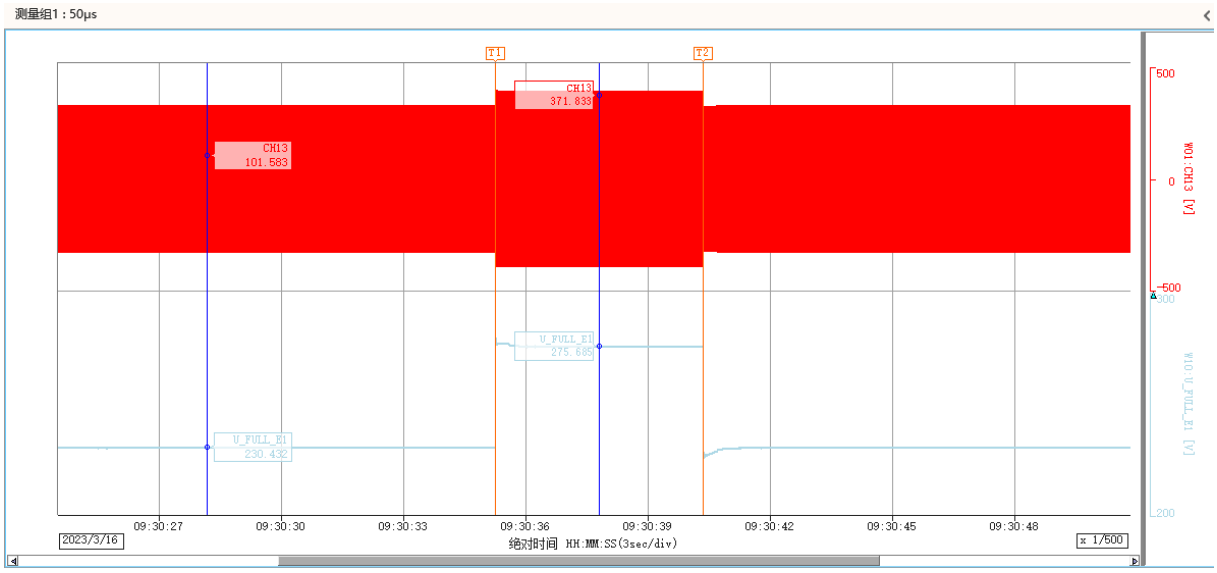
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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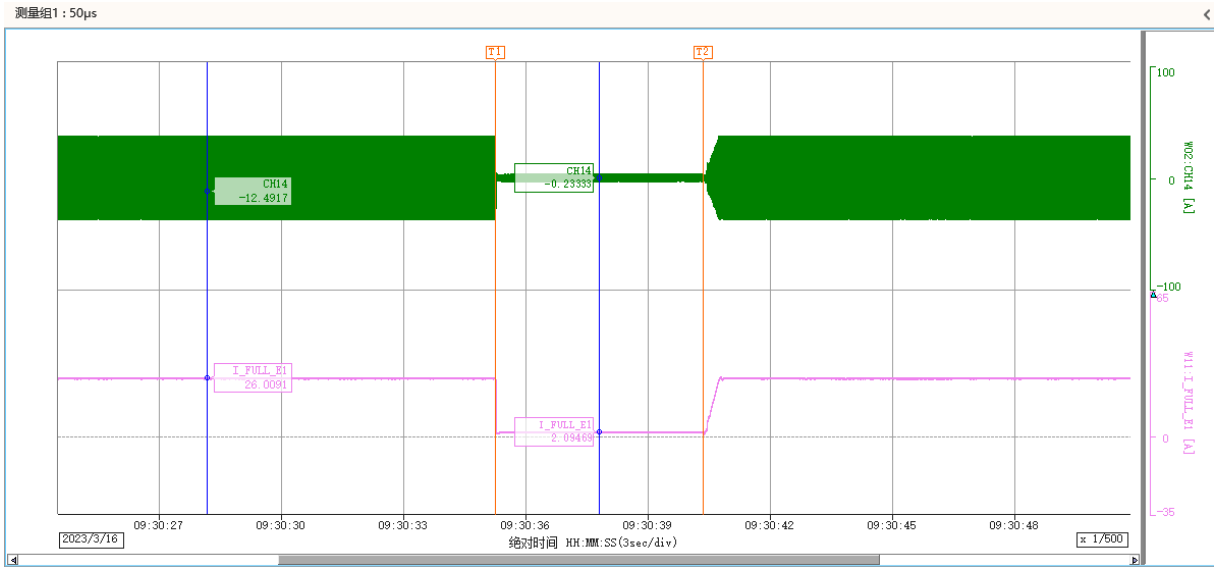
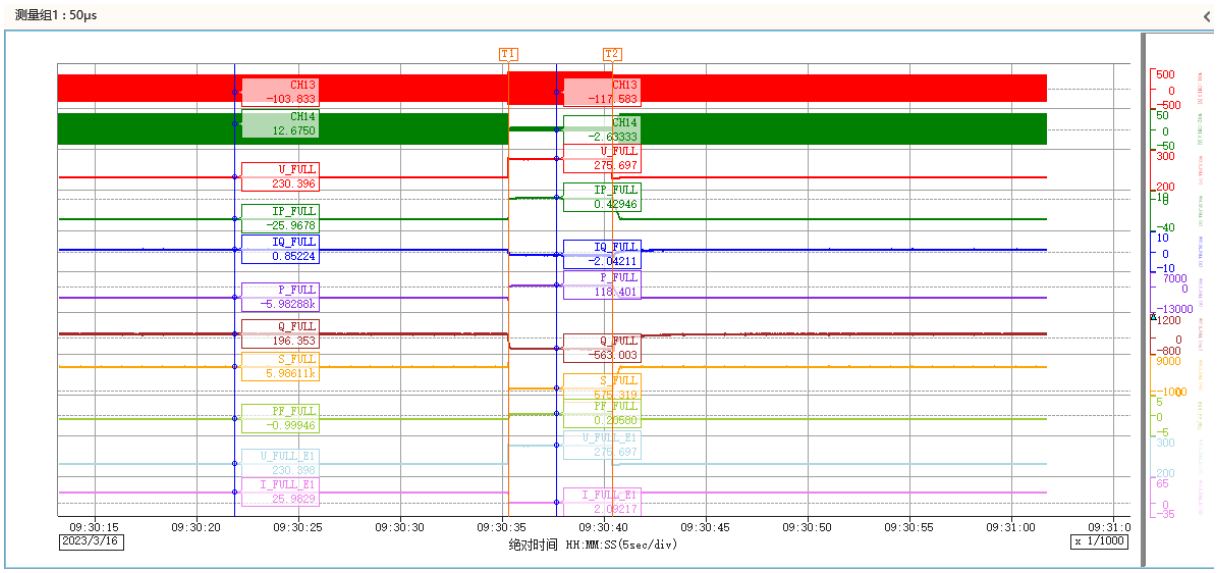
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 6.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/12 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 10:42:14 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 22181 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 27282 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 5101 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.200 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.000 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.206 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.206 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.200 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.058 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.069 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.081 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.021 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.000 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.203 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.205 |
| | 23 | Active power recover time | Total | - | ms | 107 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.003 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.001 |



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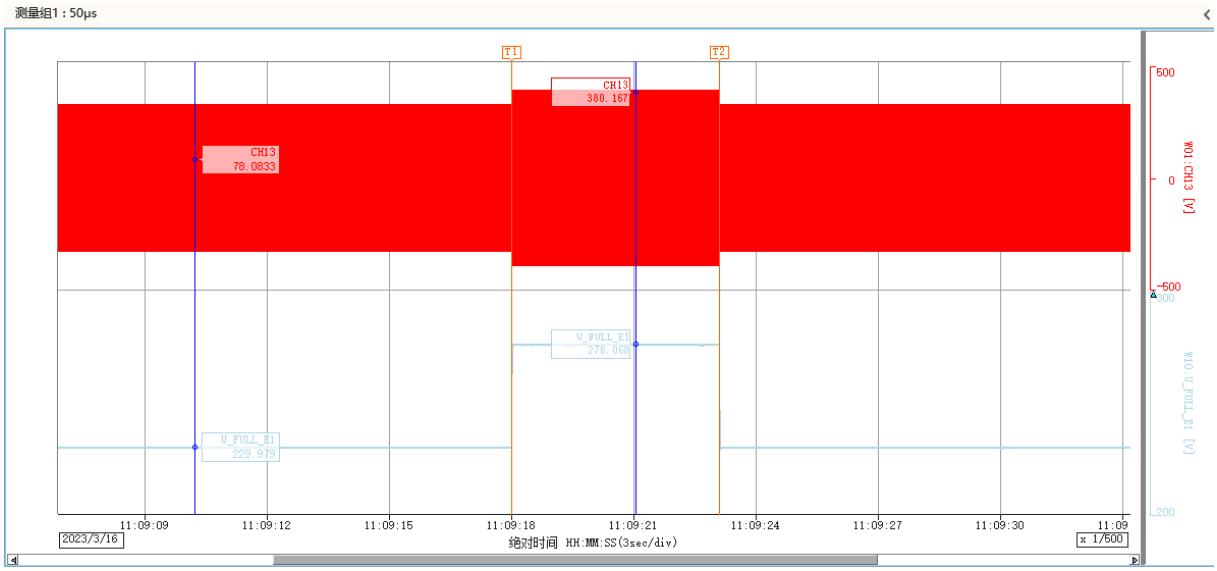
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

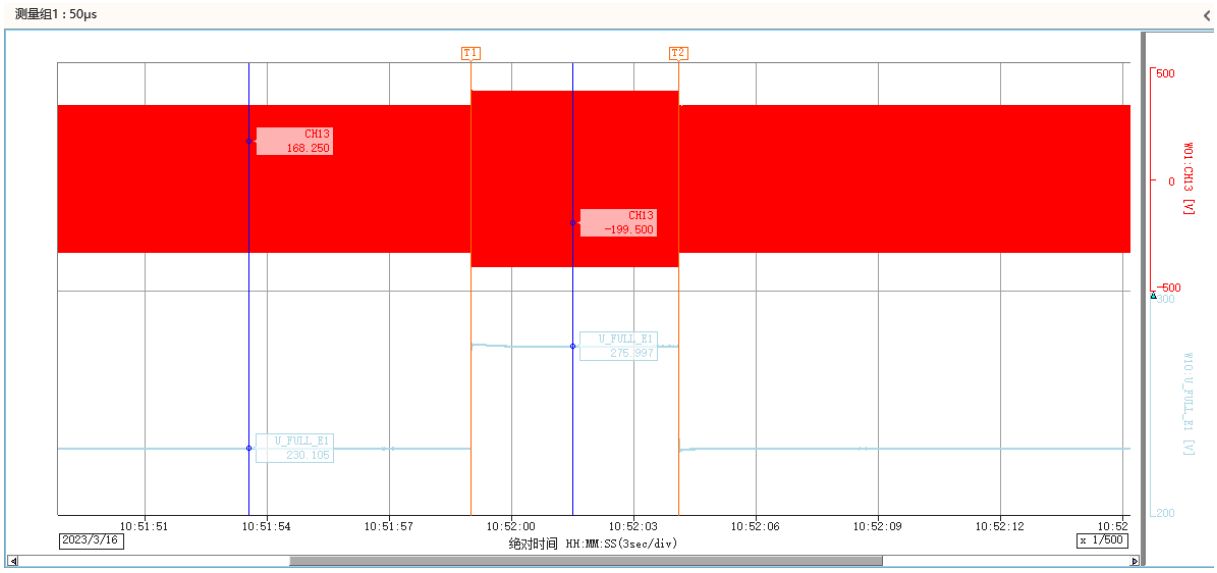
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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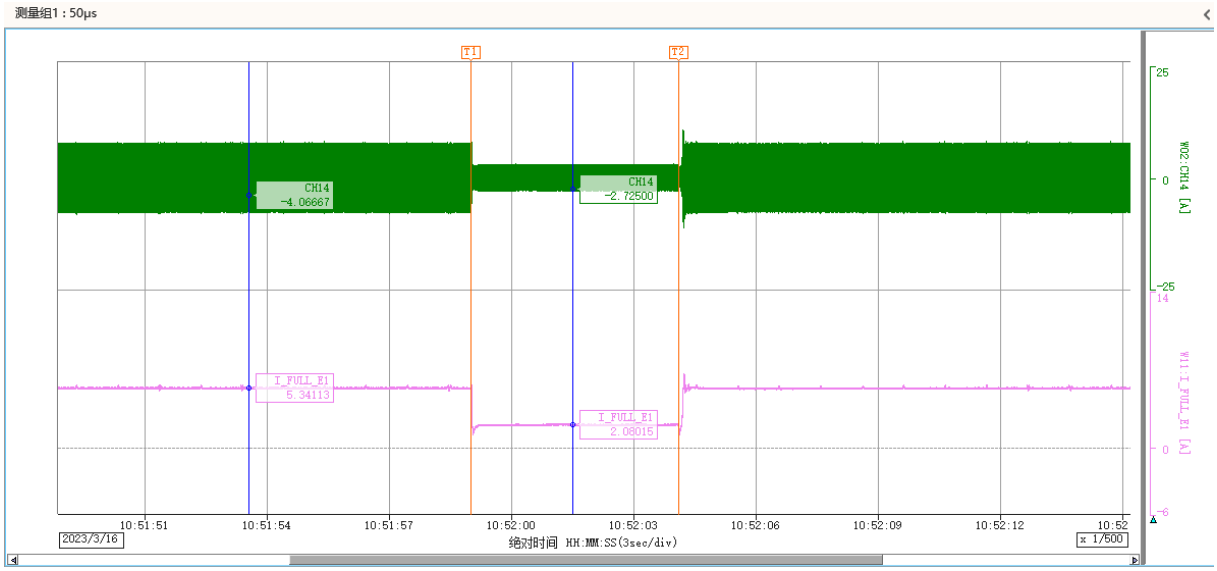
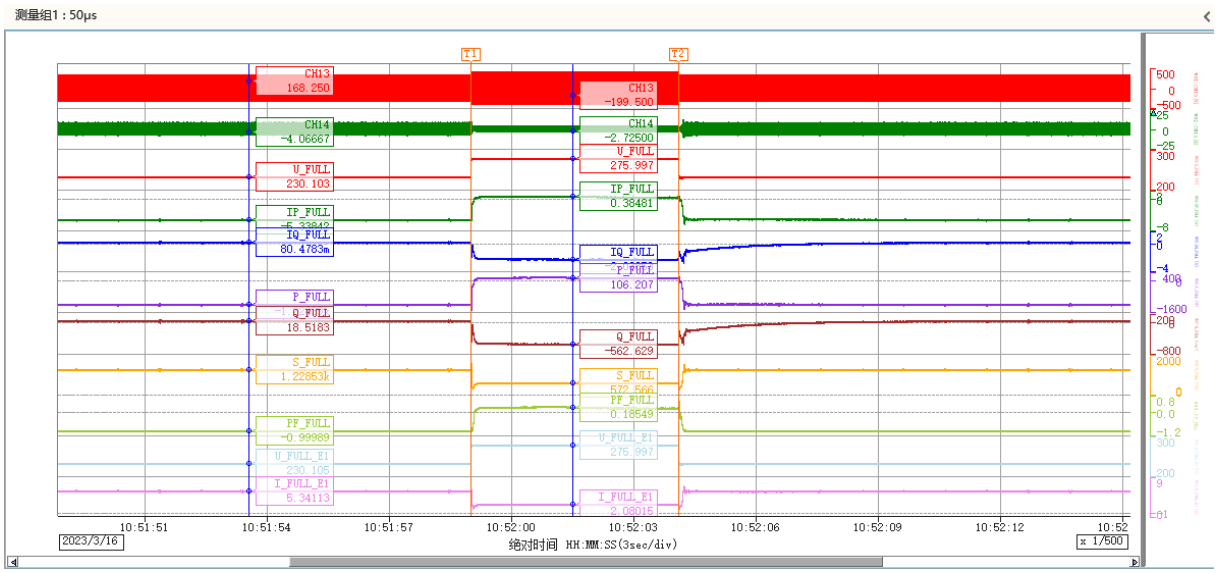
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 6.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/12 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 9:37:47 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21718 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 26826 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 5108 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.054 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.997 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.999 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.033 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.999 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.054 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.937 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.942 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.957 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.985 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.998 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.999 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.033 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.033 |



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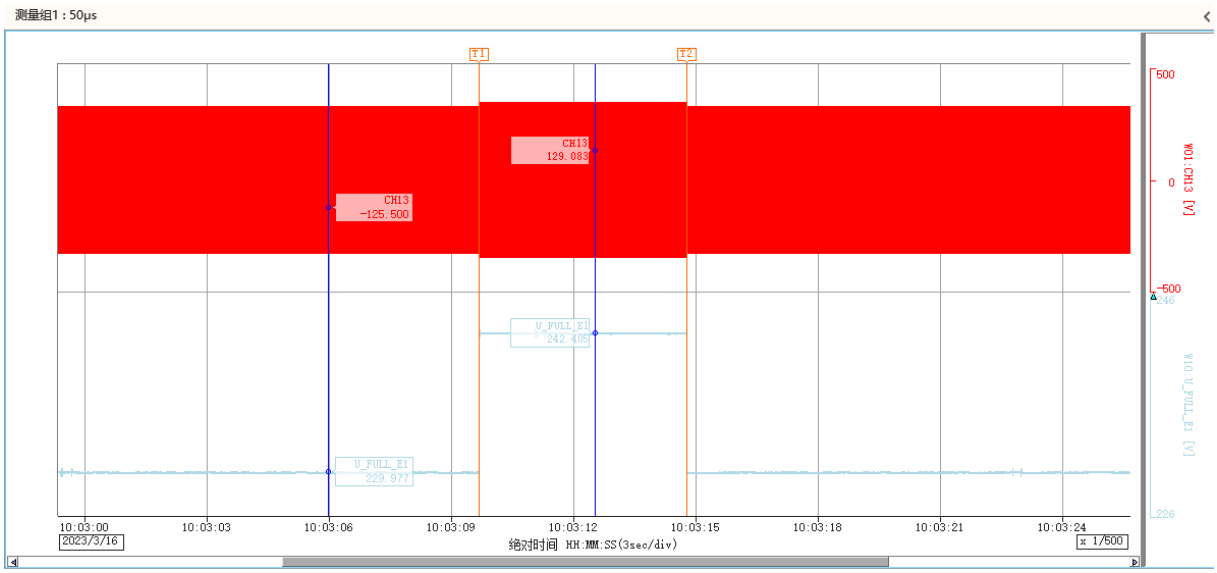
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 4 |

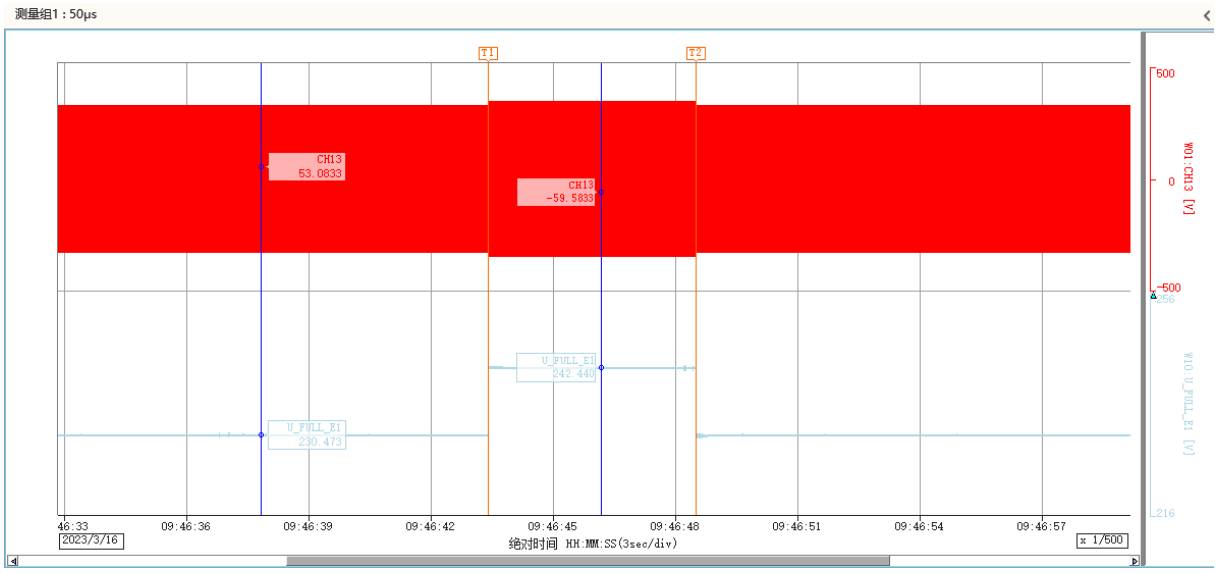
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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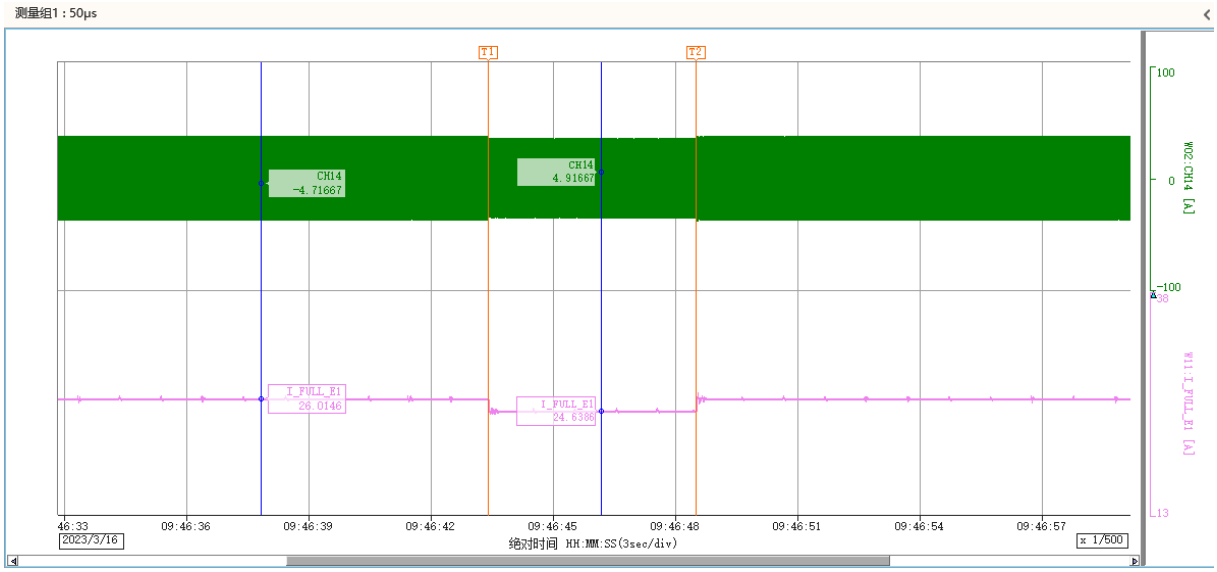
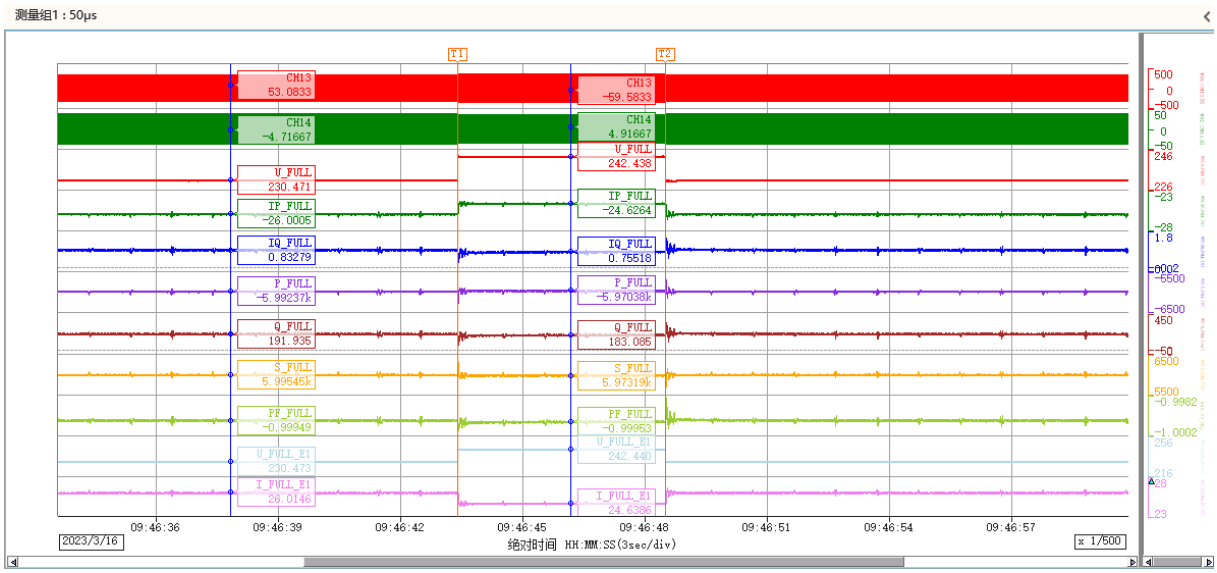
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms
Active and reactive power as moving average over 20 ms
Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 6.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/12 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 10:12:13 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21616 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 26725 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 5109 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.054 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.206 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.206 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.054 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.195 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.191 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.202 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.188 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.209 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.206 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.003 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.003 |



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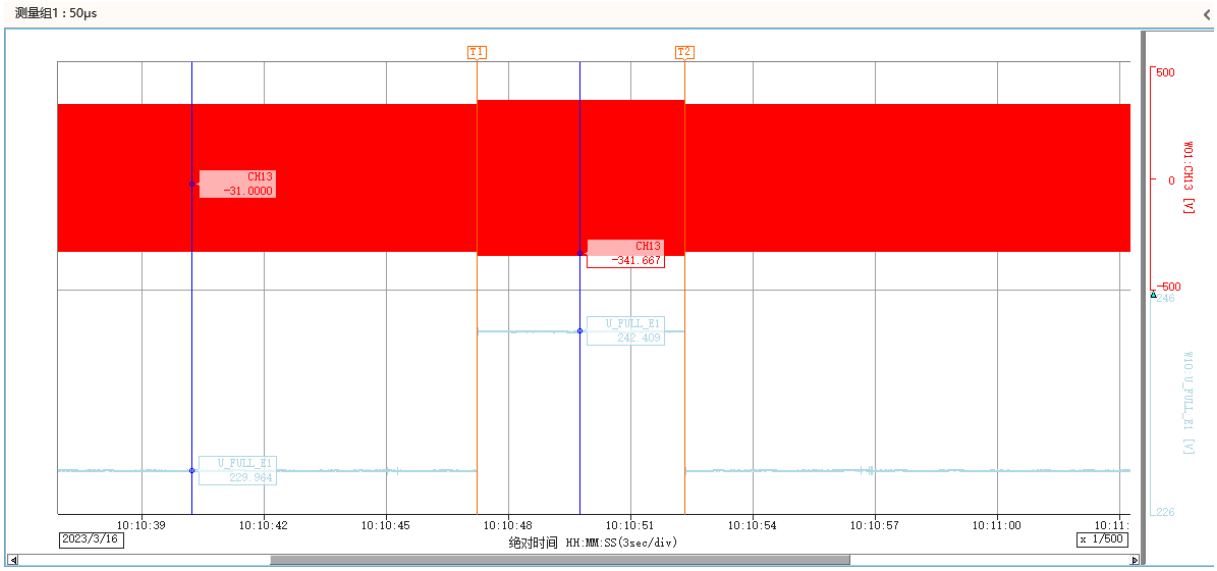
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

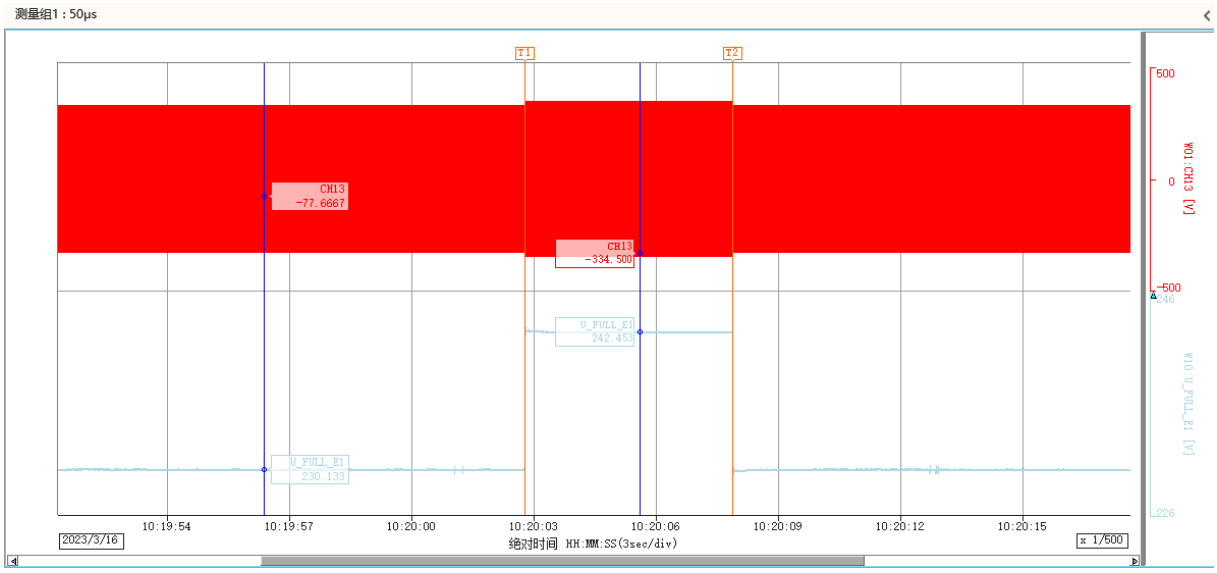
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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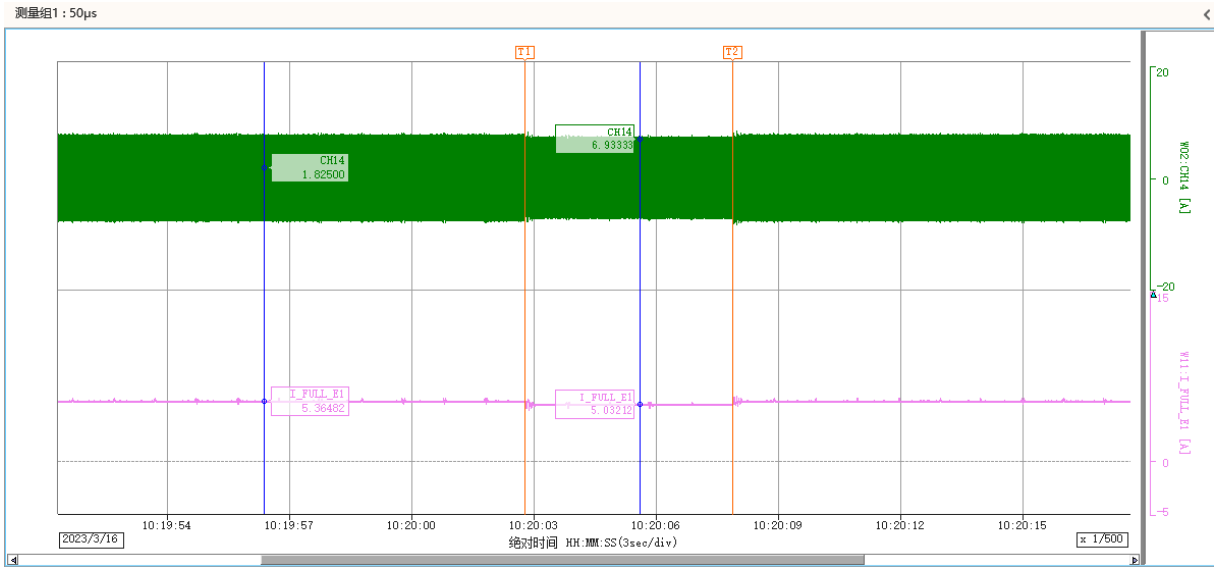
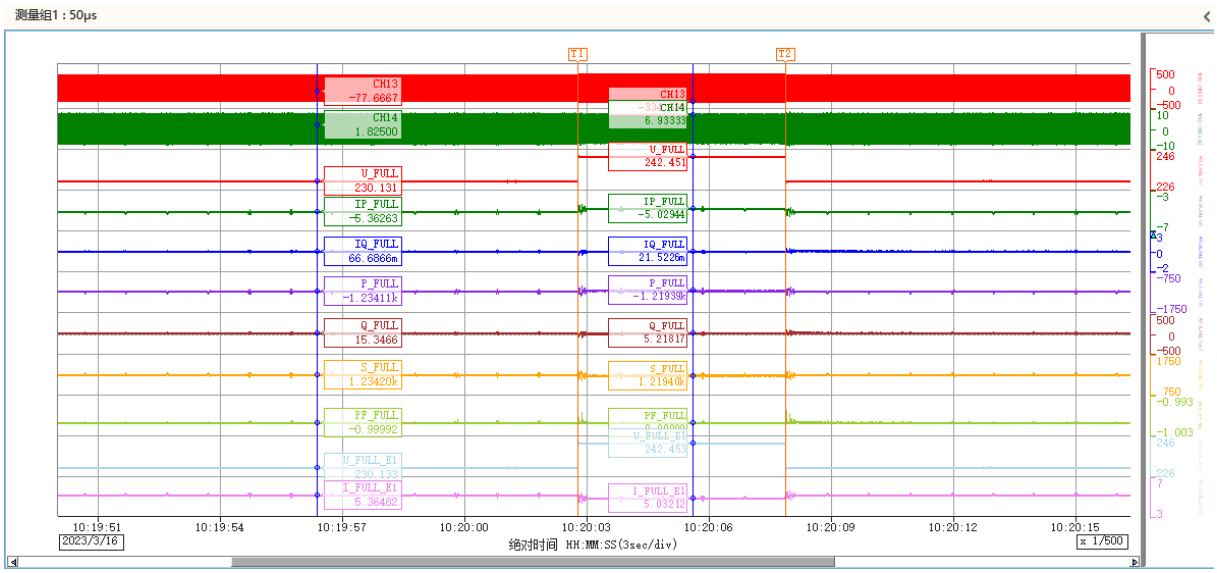
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 7.1 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 15:22:34 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21751 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82767 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61016 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.151 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.002 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 1.004 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -1.006 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.023 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.151 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.090 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.028 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.028 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.014 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.002 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -1.013 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -1.007 |
| | 23 | Active power recover time | Total | - | ms | 367 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.022 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.022 |



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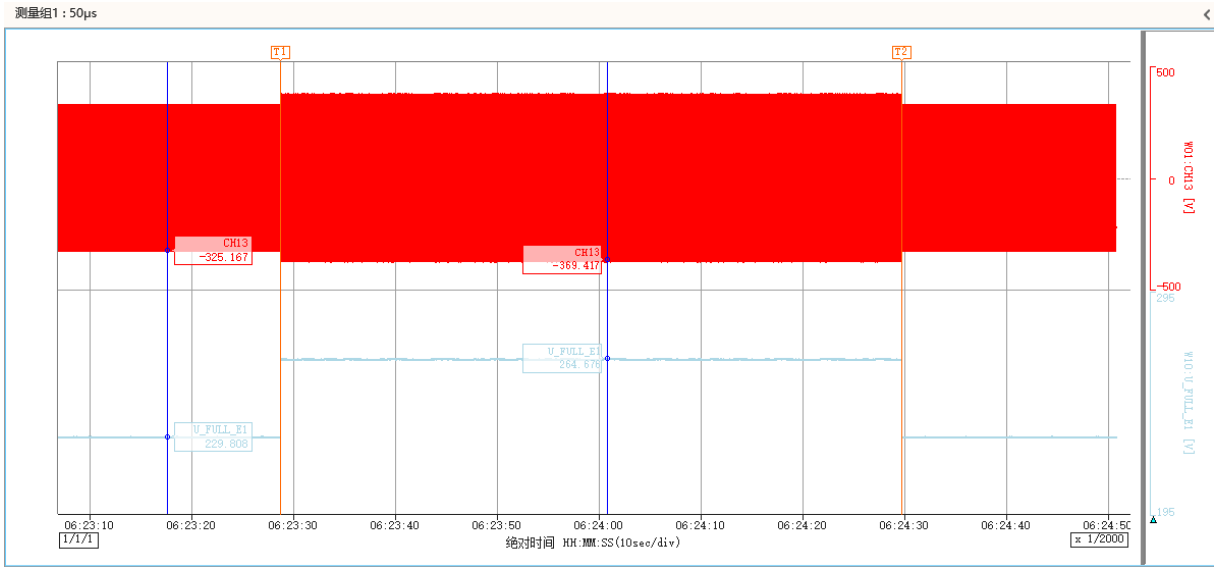
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 10 |

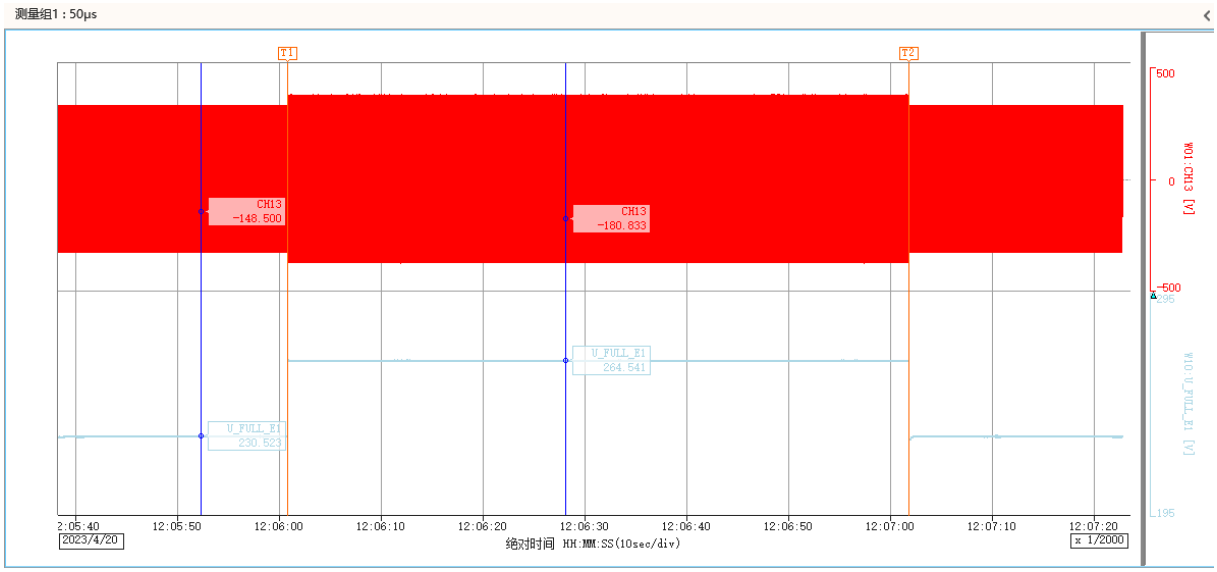
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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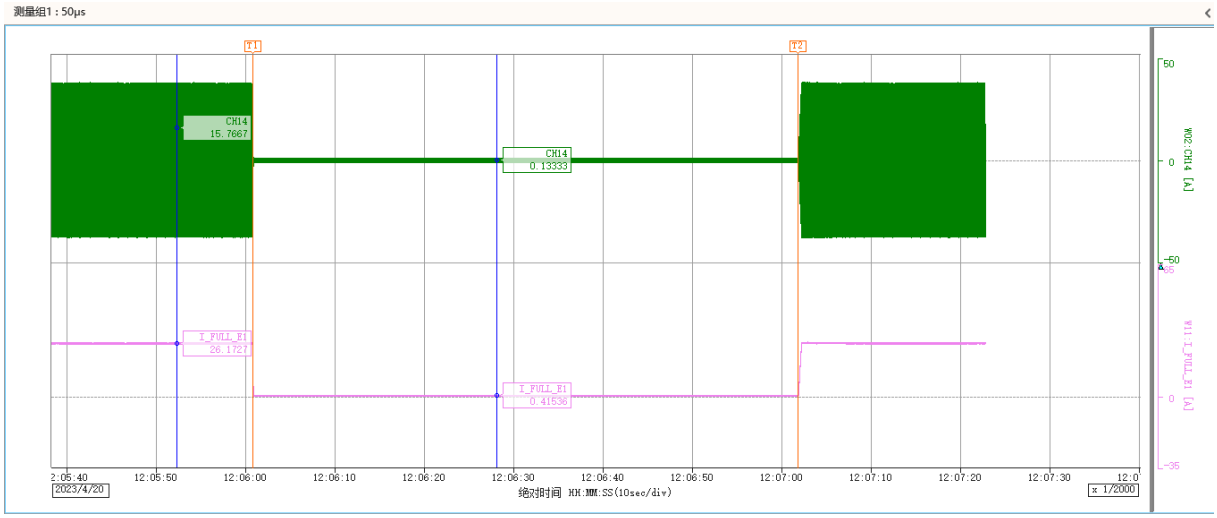
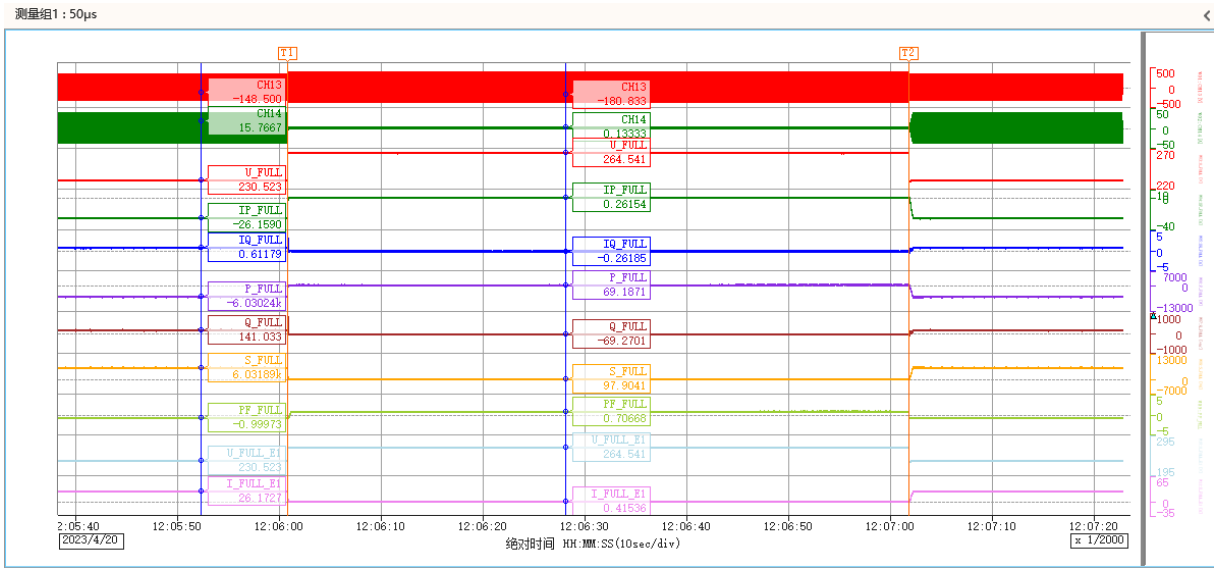
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms







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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 7.2 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/12 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 15:37:37 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21767 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82768 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61001 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.151 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | 0.197 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.197 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.000 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.151 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | 0.031 |
| | 17 | | L1 | t1+100ms | [p.u.] | 0.019 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | 0.019 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | 0.015 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.203 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.198 |
| | 23 | Active power recover time | Total | - | ms | 158 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.001 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.001 |



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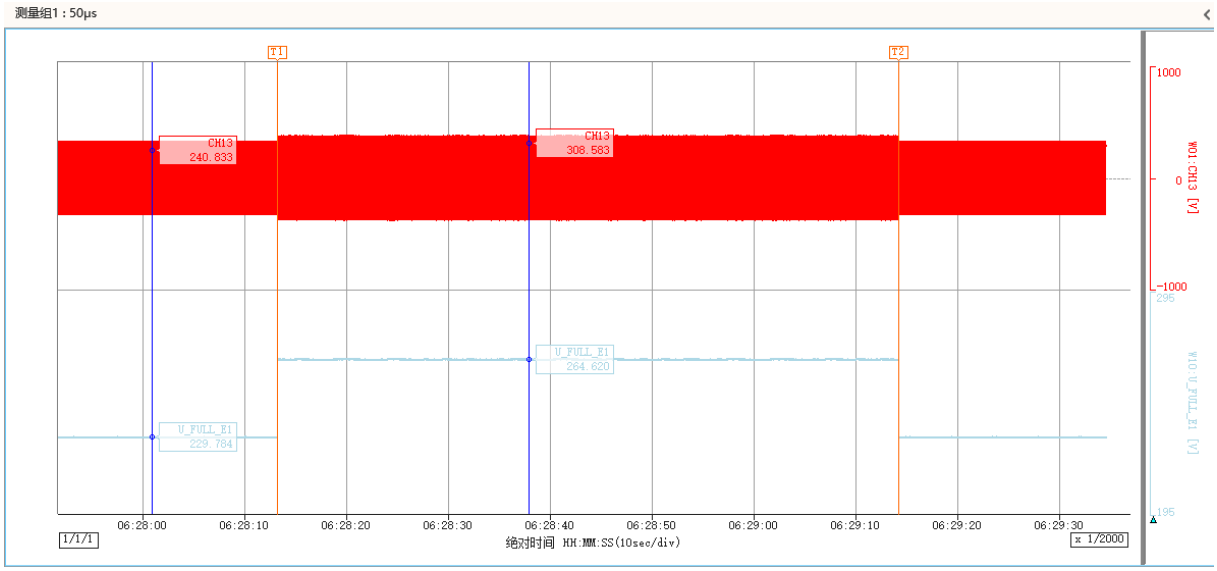
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 8 |

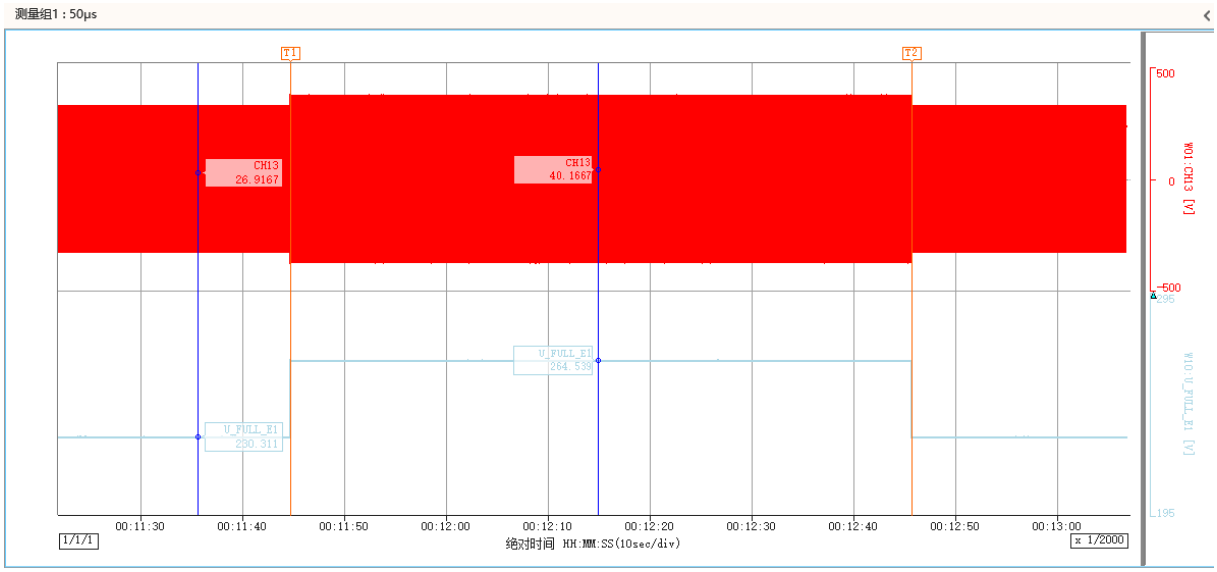
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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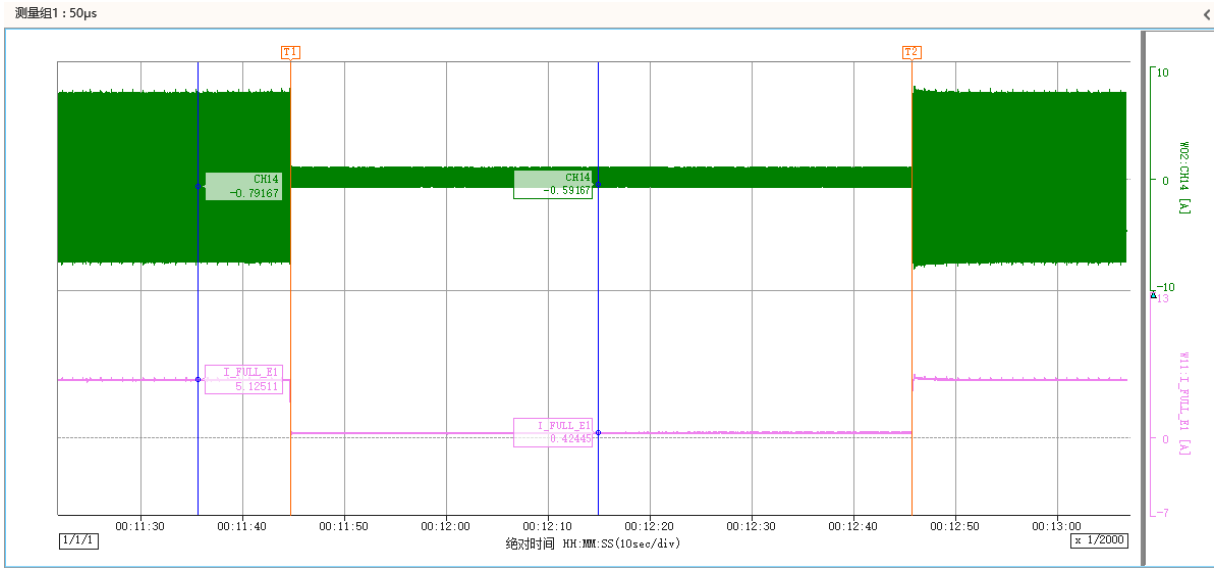
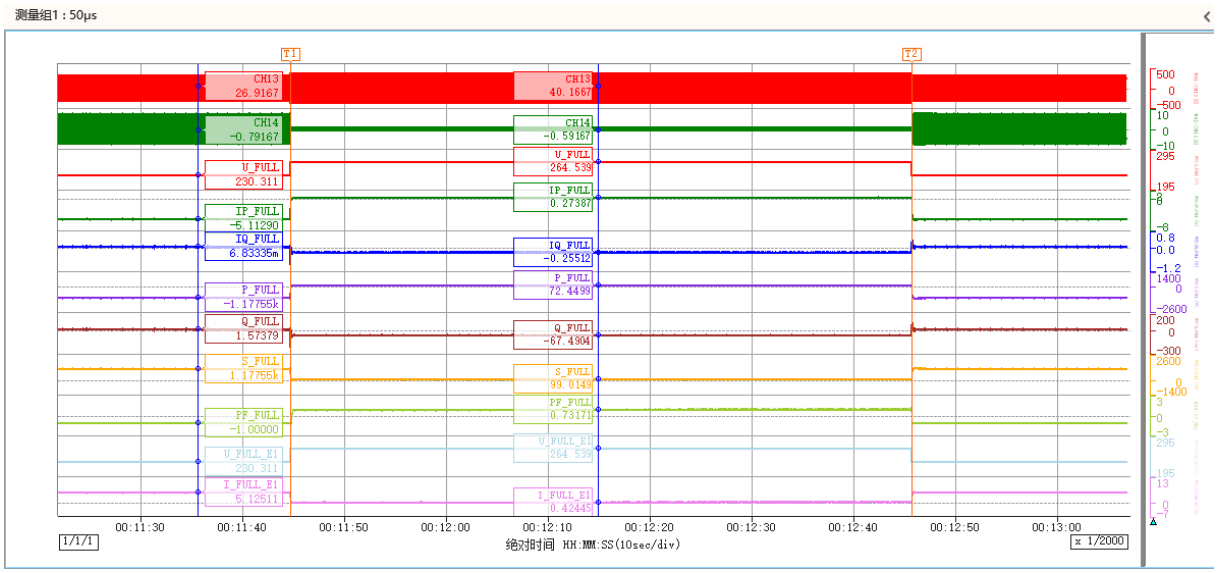
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms

Active and reactive power as moving average over 20 ms

Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 7.3 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 16:29:37 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21653 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82664 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61011 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.041 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.004 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -1.007 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -1.011 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | 0.003 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 1.000 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.045 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.964 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.962 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.960 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -1.004 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.009 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -1.011 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -1.012 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | 0.003 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | 0.003 |



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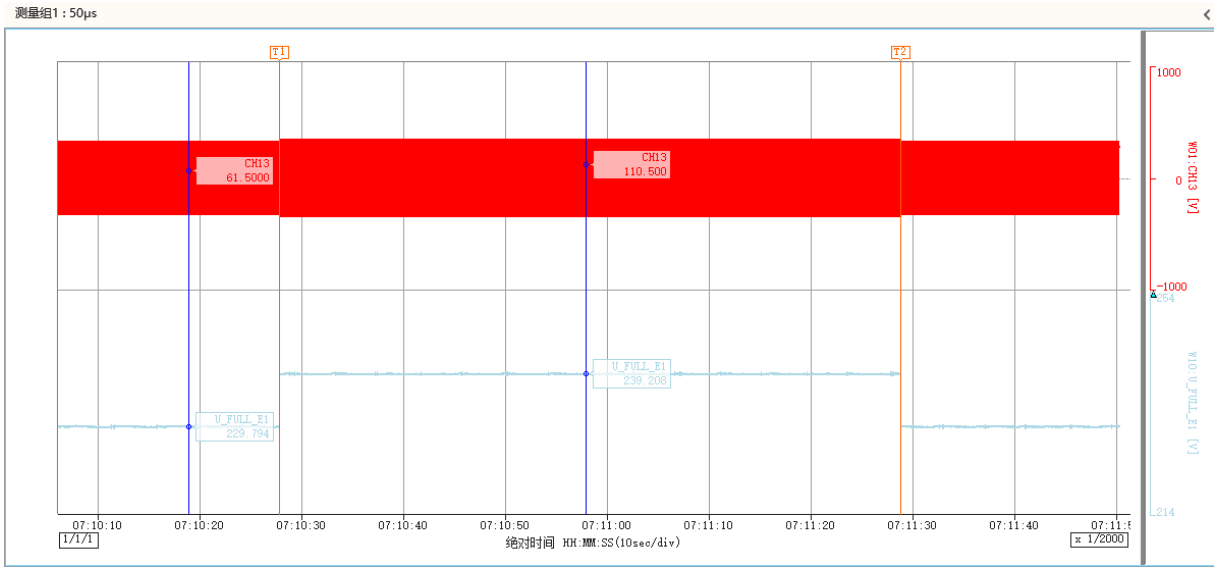
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

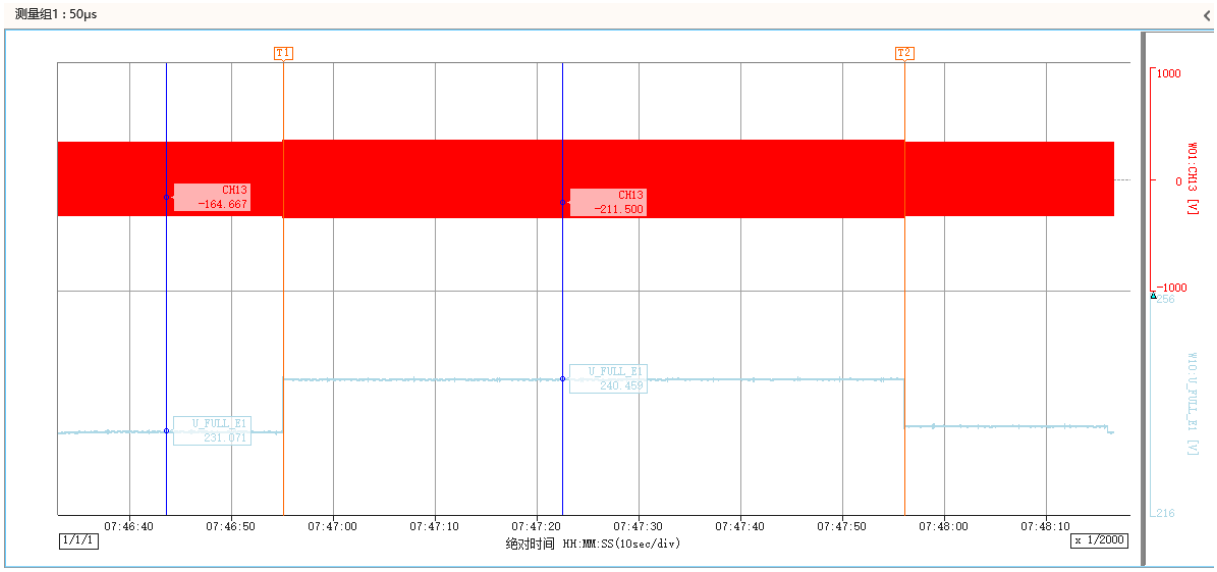
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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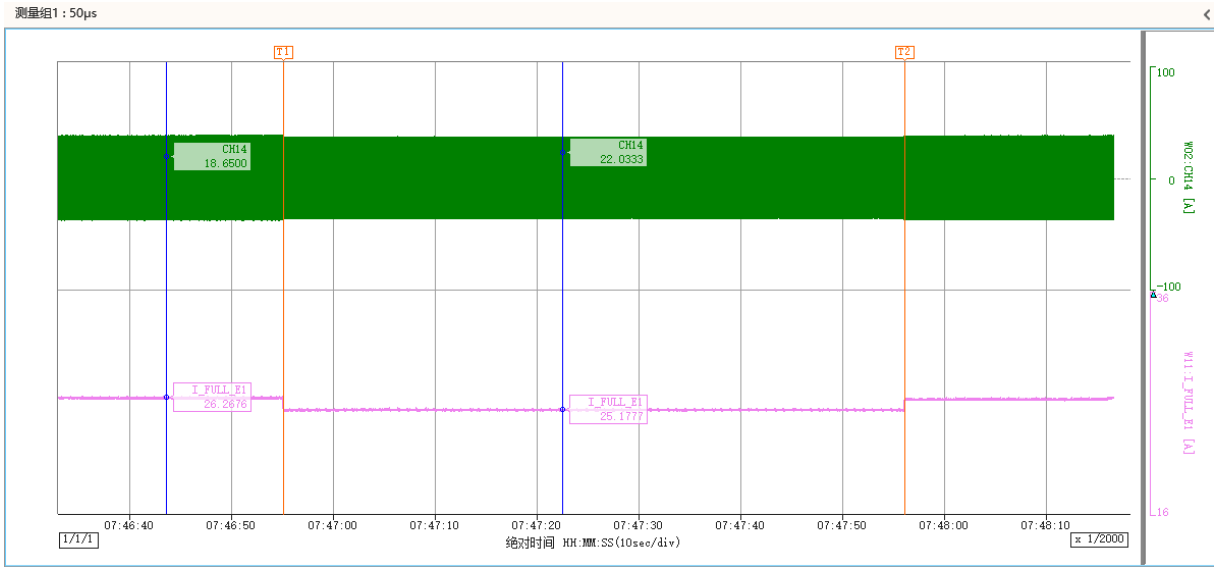
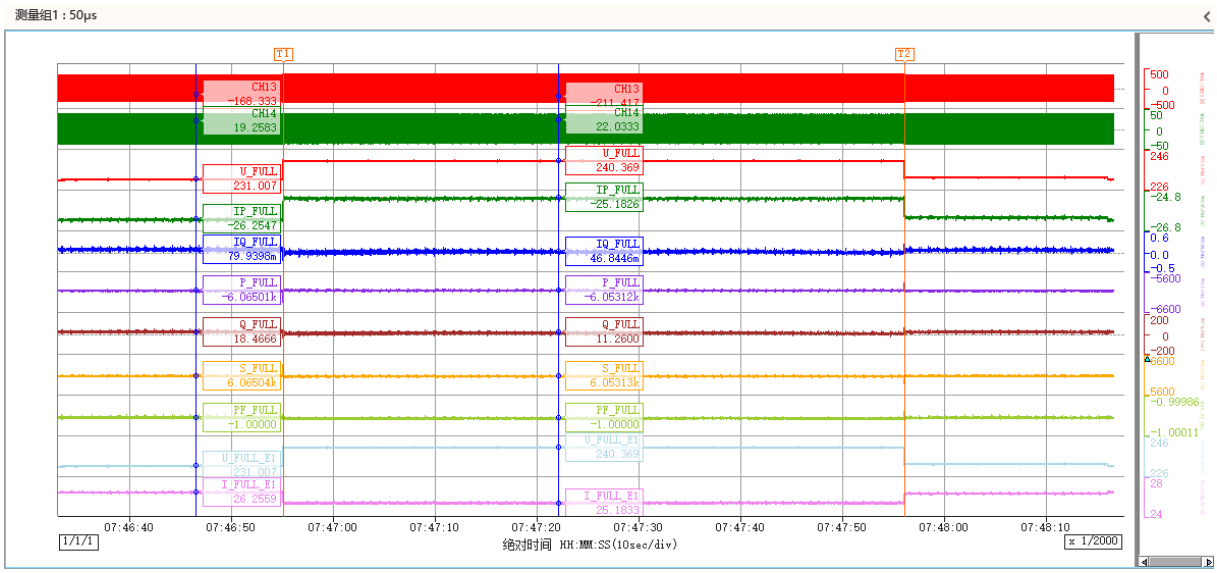
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms
Active and reactive power as moving average over 20 ms
Apparent power as moving average over 20 ms



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| | No | Parameter | Phase reference | Reference time | [Unit] | Value |
|---|---|---|---|---|---|---|
| General information | 0 | Test number | - | - | - | 7.4 |
| | 1 | Fault type (affected phases) | - | - | Phase | 1 |
| | 2 | Date | - | - | [dd.mm.yyyy] | 2023/5/15 |
| | 3 | Time (start of the test) | - | - | [hh:mm:ss.f] | 16:07:27 |
| | 4 | Time of fault occurrence ($t_1$) | - | - | [ms] | 21653 |
| | 5 | Time of fault clearance ($t_2$) | - | - | [ms] | 82664 |
| | 6 | Fault duration determined from no load test | - | - | [ms] | 61011 |
| | 7 | Voltage drop depth | L1-N | t1+100ms to t2 and t1-10s to t1 | [p.u.] | 0.041 |
| Before t1 | 10 | Voltage | L1-N | t1-10s to t1 | [p.u.] | 1.001 |
| | 11 | Active current | L1 | t1-10s to t1 | [p.u.] | -0.206 |
| | 12 | Active power | Total | t1-10s to t1 | [p.u.] | -0.206 |
| | 13 | Reactive power | Total | t1-10s to t1 | [p.u.] | -0.020 |
| | 14 | cos φ | Total | t1-10s to t1 | - | 0.995 |
| t1 to t2 | 15 | Voltage | L1-N | t1+100ms to t2-20ms | [p.u.] | 1.042 |
| | 16 | Momentary Current | L1 | t1+60ms | [p.u.] | -0.195 |
| | 17 | | L1 | t1+100ms | [p.u.] | -0.195 |
| | 18 | Max current after t1+100ms during fault | L1 | t1+100ms to t2-20ms | [p.u.] | -0.194 |
| | 19 | Active power | Total | t1+100ms to t2-20ms | [p.u.] | -0.202 |
| After t2 | 20 | Voltage | L1-N | t2+3s to t2+10s | [p.u.] | 1.001 |
| | 21 | Active power | Total | t2+1s | [p.u.] | -0.204 |
| | 22 | | Total | t2+3s to t2+10s | [p.u.] | -0.206 |
| | 23 | Active power recover time | Total | - | ms | 0 |
| | 24 | Reactive power | Total | t2+10s | [p.u.] | -0.020 |
| | 25 | | Total | t2+3s to t2+10s | [p.u.] | -0.020 |



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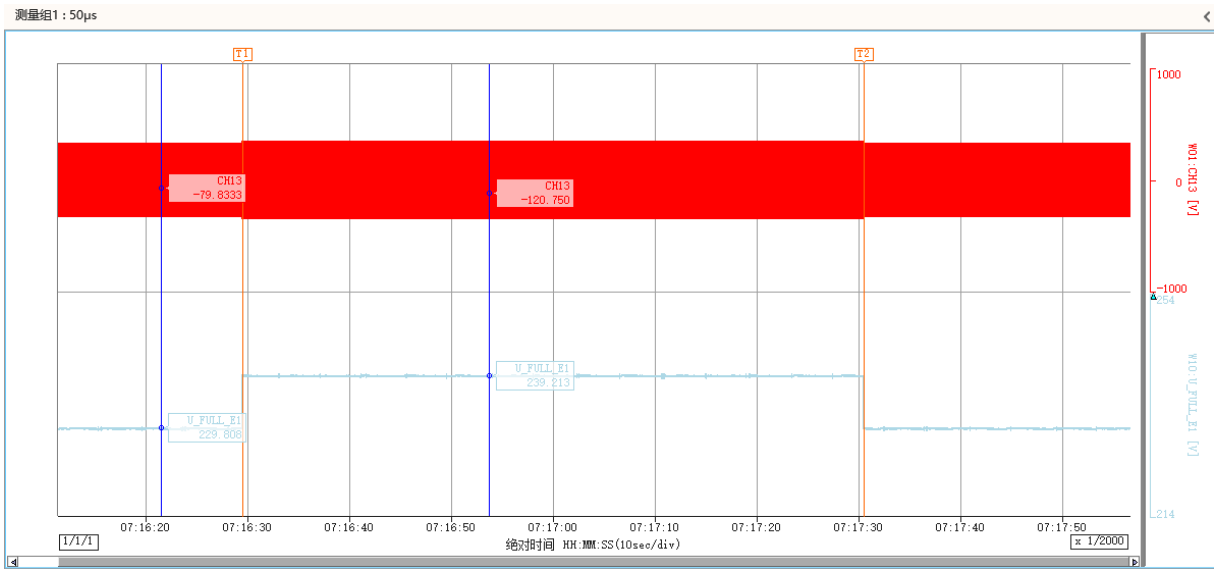
| | | | | | | |
|---|---|---|---|---|---|---|
| | 26 | Reactive power recover time | Total | - | ms | 0 |

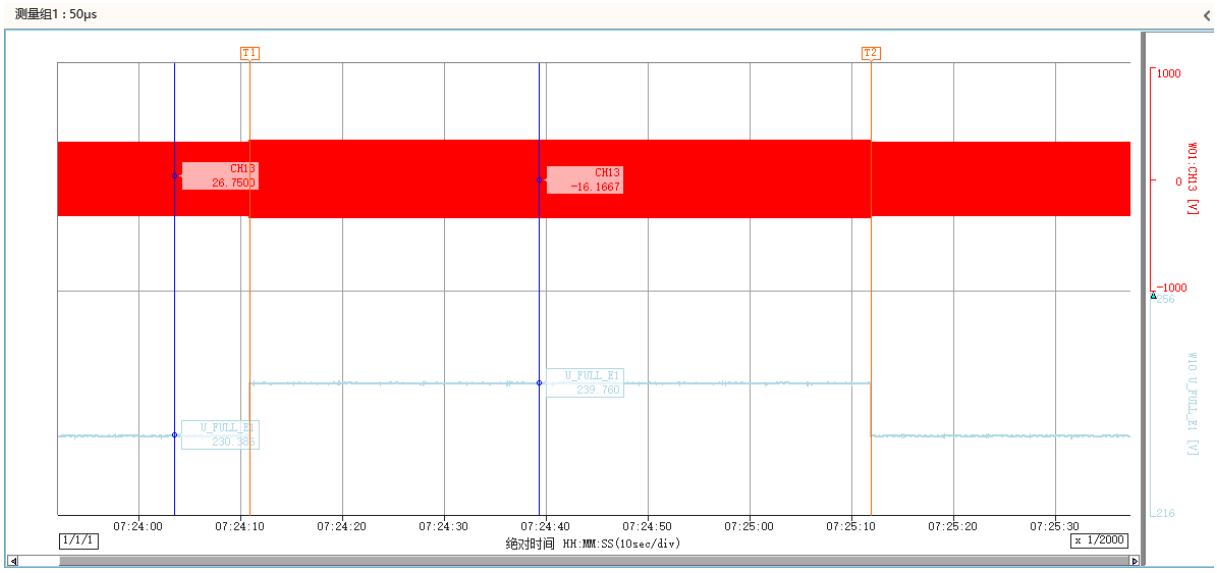
Graphic:

Phase-to-neutral voltages (no load)

RMS Phase-to-neutral voltages as moving averages over 20 ms (no load)




Phase-to-neutral voltages and RMS Phase-to-neutral voltages







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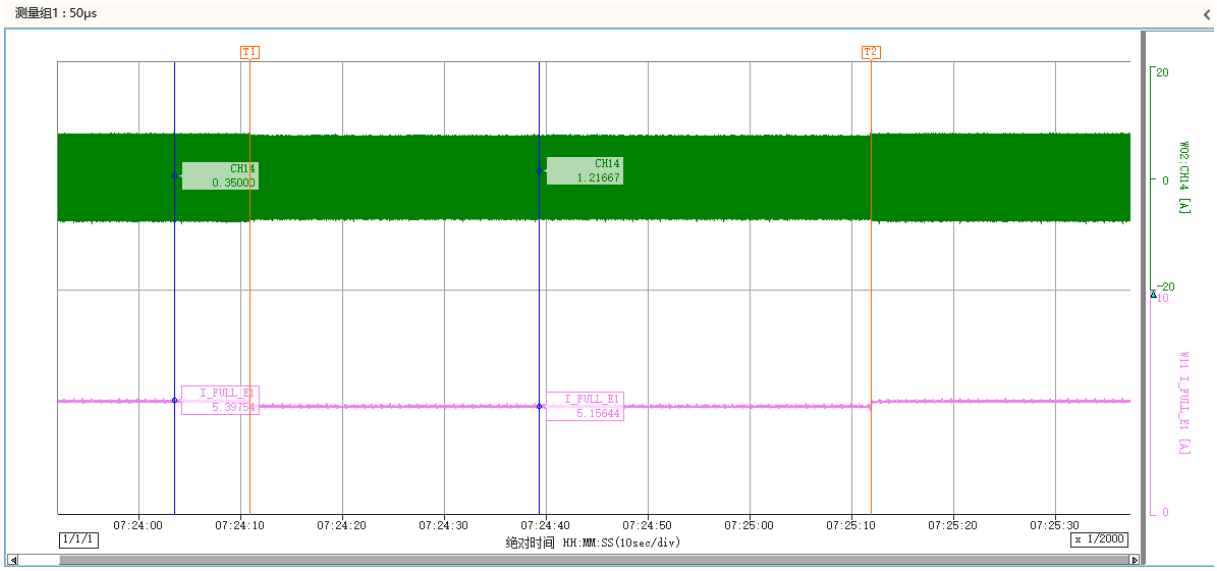
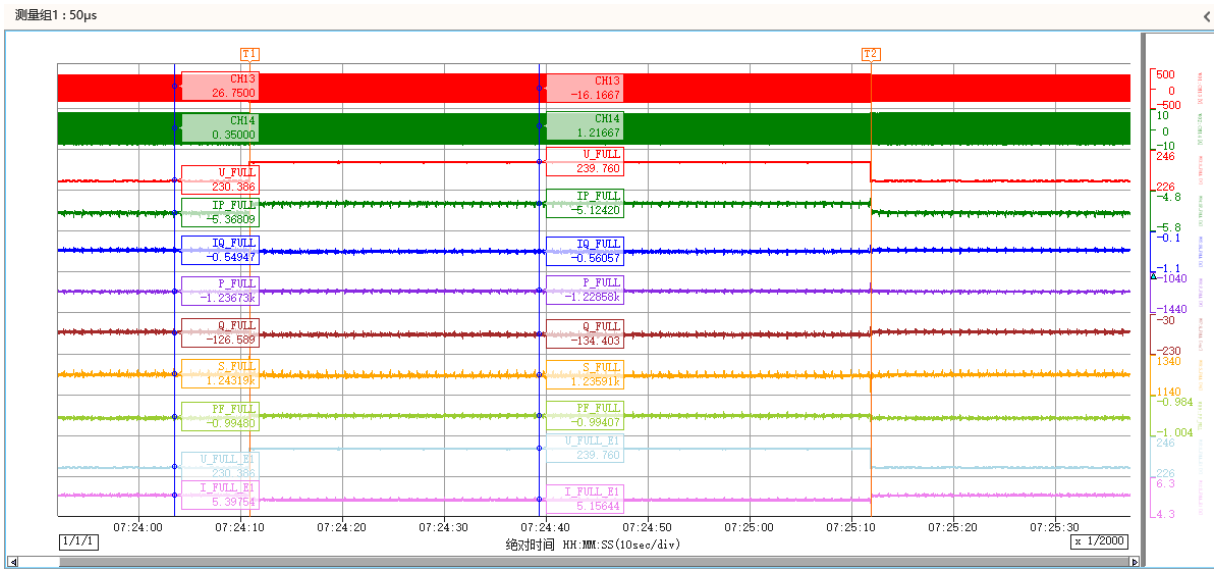
Phase currents and RMS phase currents as moving averages over 20 ms




RMS Phase-to-neutral voltages and current as moving averages over 20 ms
Active and reactive power as moving average over 20 ms
Apparent power as moving average over 20 ms




. ……End of test report……

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