



**BUREAU  
VERITAS**

# TEST REPORT

## OVE-directive R25

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

Report reference number..... : PVAT2101WDG0266-R2

Date of issue..... : 2023-05-10

Total number of pages..... : 151

Testing laboratory name..... : Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch

Address..... : No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China

Accreditation .....



Applicant's name..... : FSP TECHNOLOGY INC.

Address..... : No.22, Jianguo East Road, Taoyuan City, Taiwan 330.

### Test specification

Standard ..... : Tor Erzeuger Typ A:2022-04  
OVE-directive R25:2020-03

Test Report Form No..... : TOR Erzeuger Typ A VER.3

TRF Originator..... : Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch

Master TRF..... : Dated 2023-03-01

Test item description ..... : Hybrid solar inverter

Trademark .....



Model / Type..... : FSP Power manager 10KW

This report is governed by, and incorporates by reference, the Conditions of Testing as posted at the date of issuance of this report at <http://www.bureauveritas.com/home/about-us/our-business/cps/about-us/terms-conditions/> and is intended for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us. Measurement uncertainty is only provided upon request for accredited tests. Statements of conformity are based on simple acceptance criteria without taking measurement uncertainty into account, unless otherwise requested in writing. You have 60 days from date of issuance of this report to notify us of any material error or omission caused by our negligence or if you require measurement uncertainty; provided, however, that such notice shall be in writing and shall specifically address the issue you wish to raise. A failure to raise such issue within the prescribed time shall constitute your unqualified acceptance of the completeness of this report, the tests conducted and the correctness of the report contents.

| <b>Ratings..... :</b>                                         | <b>FSP Power manager 10KW</b> |
|---------------------------------------------------------------|-------------------------------|
| PV Array MPP DC voltage range [V].....:                       | 400-800                       |
| PV Array Input DC voltage range [V].....:                     | 300-900                       |
| Max. PV Array Input DC current [A] .....                      | 18,6 x 2 strings              |
| Battery Input DC voltage range [V] .....<br>[Discharge] ..... | 48                            |
| Max. Battery Input DC current [A] .....<br>[Discharge] .....  | 275                           |
| Output DC voltage range [V] .....<br>[Battery Charge] .....   | 48                            |
| Max. Output DC current [A] .....<br>[Battery Charge] .....    | 200                           |
| Output AC voltage [V] .....                                   | 3L/N/PE, 230/400, 50Hz        |
| Output AC current [A] .....                                   | 14,5                          |
| Initial short-circuit AC current $I_k$ [A] .....              | 17,0                          |
| Nominal Output power [kW].....:                               | 10,0                          |

**Testing Location..... : Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**  
**Address..... : No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China**

Tested by  
 (name and signature) ..... : Ryan He



Approved by  
 (name and signature) ..... : Ken Chan



**Manufacturer's name ..... : FSP TECHNOLOGY INC.**

**Manufacturer address..... : No.22, Jianguo East Road, Taoyuan City, Taiwan 330.**

**Factory's name ..... : VOLTRONIC POWER TECHNOLOGY CORP.**

**Factory address..... : 1-4F, Building 5, YuSheng Industrial Park, No.467, Section Xixiang, National Highway 107, Xixiang, Bao An District, Shenzhen, China.**

#### Document History

| Date                       | Internal reference | Modification / Change / Status                                                                                                                                                      | Revision |
|----------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 2021-02-20                 | Jack Shi           | This is a copy test report, the test results refer to the original test report PVAT200119N030-R1.                                                                                   | 0        |
| 2022-05-31                 | Ryan He            | Update report version;<br>Add table 5.4;<br>Remove model "FSP103PV-230TH-48";<br>Amend typos.                                                                                       | R1       |
| 2023-05-10                 | Ryan He            | Update report format;<br>Update clauses 5.3.2, 5.3.3, 5.3.4, 5.3.9, 5.3.10.1.2 and 5.6;<br>Add Annex Deviation Parameter of the Austria;<br>Modify the country setting name to TOR. | R2       |
| Supplementary information: |                    |                                                                                                                                                                                     |          |

### Test items particulars

Equipment mobility ..... : Permanent connection  
 Operating condition ..... : Continuous  
 Class of equipment..... : Class I  
 Protection against ingress of water . : IP20 according to EN 60529  
 Mass of equipment [kg] ..... : Approx. 45kg

### Test case verdicts

Test case does not apply  
 to the test object ..... : N/A  
 Test item does meet  
 the requirement ..... : P(ass)  
 Test item does not meet  
 the requirement ..... : F(ail)

### Testing

Date of receipt of test item..... : 2020-01-19, 2020-03-20  
 Date(s) of performance of test..... : 2020-01-19 to 2020-09-10, 2023-03-27 to 2023-04-11



### General remarks:

The test result presented in this report relate only to the object(s) tested.

The report shall state compliance of the tested objects with the requirements of Tor Erzeuger Typ A / OVE Directive R25.

All information in this test report limited to the type label, warning markings, trademark, block diagram, manual and datasheets are provided by the customer.

Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed. The measurement result is considered as "pass" according to the requirement if it is within the prescribed limit or exactly on the limit.

This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

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

"(see appended table)" refers to a table appended to the report.

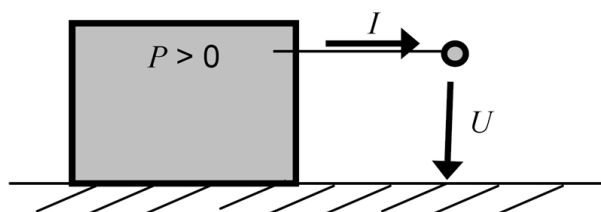
Throughout this report a comma is used as the decimal separator.

- "P<sub>rE</sub>" for the rated active power:  
 $P_{rE} = U_n \times I_r \times \cos \varphi$  (single-Phase);  $P_{rE} = \sqrt{3} U_n \times I_r \times \cos \varphi$  (three-Phase)
- "P<sub>ref</sub>" for the momentary power
- " $\Delta P_{E60}$ " in [%] =  $(P_{Setpoint} - P_{E60}) / P_{rE}$
- " $\Delta Q_{E60}$ " in [%] =  $(Q_{expected} - Q_{E60}) / P_{E_{max}}$
- "E<sub>0,2</sub>" for gliding average values over 200 milliseconds
- "E<sub>60</sub>" for gliding average values over 60 seconds
- "E<sub>600</sub>" for gliding average values over 10 minutes
- "(c)" for over-excited
- "(i)" for under-excited

### Active and reactive power:

The regarded system of the voltage and current vectors is the load view (Figure 2):

- If the inverter feeds to the grid the active power is measured with positive sign.



For the representation in quadrants, a power circle is chosen whose representation is compatible with mathematical representations of trigonometry and complex numbers (see Figure 2). Angles are counted positively counterclockwise as in mathematics. The phase angle is defined as the angle from the current pointer to the voltage pointer. The current pointer is always in the real axis; the position of the voltage pointer corresponds to the apparent power and the phase angle.

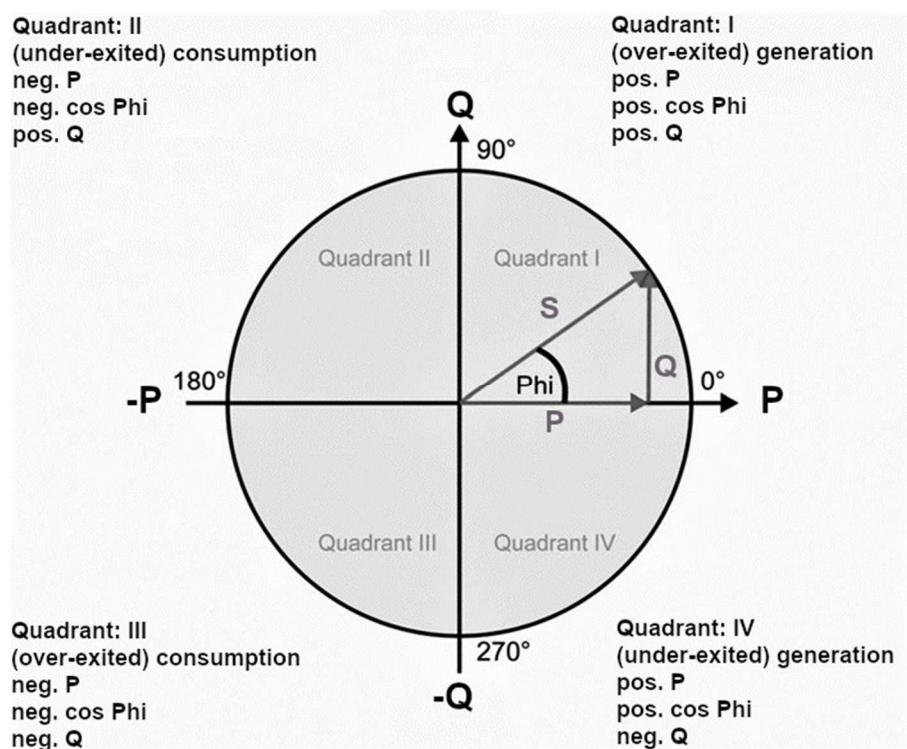


Figure 2

The different operating states can be represented in quadrants I to quadrant IV. The quadrants are named in a counter-clockwise direction.

### This Test Report consists of the following documents:

|                                                      |     |
|------------------------------------------------------|-----|
| Test Results.....                                    | 11  |
| Annex No. 1 Deviation Parameter of the Austria ..... | 142 |
| Annex No. 2 Pictures of the unit.....                | 146 |
| Annex No. 3 Test Equipment list .....                | 149 |

Copy of marking plate

 **FSP Technology Inc.**  
**Model No. : FSP Power manager 10KW**  
**PN: (PAR) PPF10L0101**  
**Serial No. :**   
 96161406100001

|                   |                                               |
|-------------------|-----------------------------------------------|
| PV<br>INPUT       | Nominal operating voltage 720Vdc              |
|                   | Vmax PV 900Vdc                                |
|                   | PV input voltage range 300-900Vdc             |
|                   | Isc PV 2*18.8A                                |
|                   | MPPT voltage range 400 ~ 800Vdc               |
| GRID/AC<br>OUTPUT | Nominal operating voltage 3/N/PE, 230/400 Vac |
|                   | Nominal output current 14.5A per phase        |
|                   | Nominal operating frequency 50Hz              |
|                   | Maximum power 10000W                          |
|                   | Power factor range 0.9 lead-0.9lag            |
| AC<br>INPUT       | Nominal operating voltage 3/N/PE, 230/400 Vac |
|                   | Maximum input current 40A per phase           |
|                   | Nominal operating frequency 50Hz              |
| BATTERY           | Battery voltage range 42~56Vdc                |
|                   | Maximum battery current 275A                  |

Ambient temperature:-10~+55°C  
 Enclosure:IP 20  
 Safety class I  
 VDE0128-1-1 VDE-AR-N 4105

5min

**WARNING:FIRE HAZARD.**  
 SUITABLE FOR MOUNTING ON CONCRETE OR OTHER  
 NON-COMBUSTIBLE SURFACE ONLY  
 CAUTION:THE DC AND AC BREAKER MUST HAVE BEEN  
 TURNED OFF BEFORE SERVICING.  
 MADE IN CHINA  
 No.22, Jianguo E Rd., Taoyuan City, Taiwan, R.O.C.

**Note:**

Example of marking plate

### General product information:

The Solar converter converts DC voltage into AC voltage.

The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and two relays. This assures that the opening of the output circuit will also operate in case of one error.

This unit is three phase inverter, that it is combine with UPS function and operation mode. The inverter is able to generate power from solar modules to feed the grid(utility) and charge extern battery, also feed in the power to grid from the extern batteries and PV array.

The Solar converter provides with PV array and external battery of input.

The input of Solar converter can be supplied from PV array and/or external battery only.

Rate of change of frequency (RoCoF) detection was used for LOM protection.

### Description of the electrical circuit:

The internal control is redundant built. It consists of Microcontroller Master DSP(U3) and Slave DSP(U4).

The Master DSP control the relays by switching signals; measures the PV voltage, PV current, Bus voltage, Battery voltage, grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Slave DSP is measures the grid voltage, AC current, grid frequency and residual current, also can switch off the relays independently, and communicate with Master DSP each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Master DSP. The Master DSP tests and calibrates before each start up all current sensors.

The unit provides two relays in series in all output conductors. When single fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up. Both CPU can switch of the relays.

### Block diagram of the utility interactive inverter:

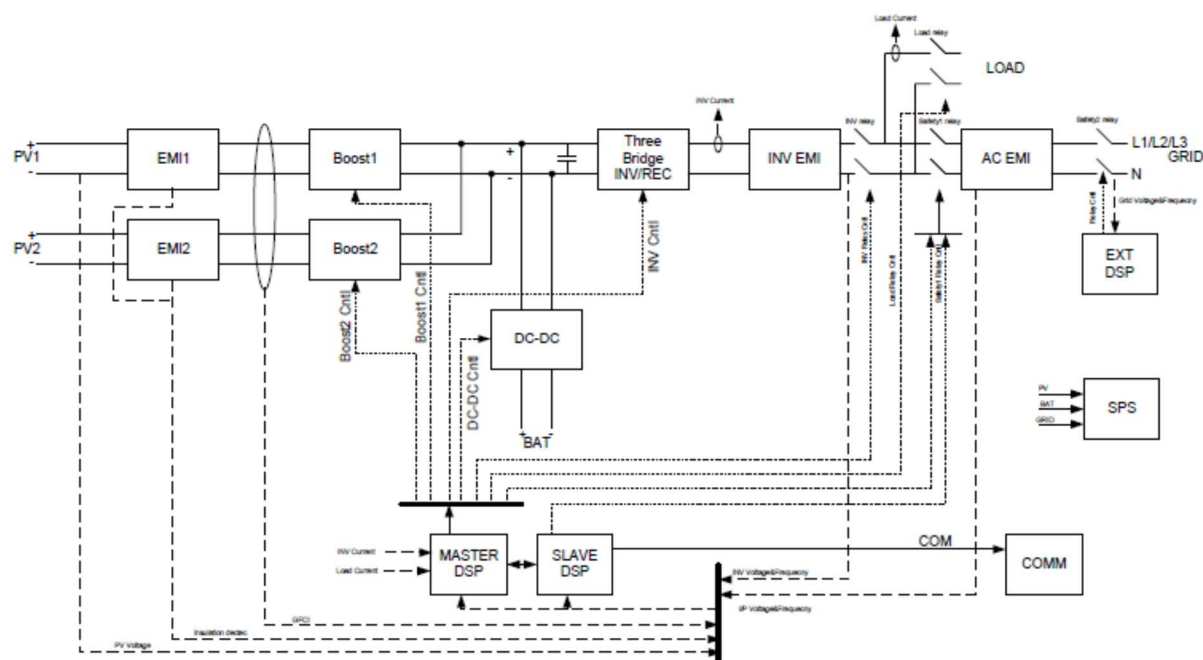


Figure 2 – Block diagram

### Description of the remote control in a typical installation:

The PV inverter may be assemble with modbus card for communication with PCs to internet and received the DNO signal and direction. One modbus card can be used in one PV inverter at the same time, up to 31 PV inverters can be monitored from one computer. The cables length between two ports should not be over 1500m.

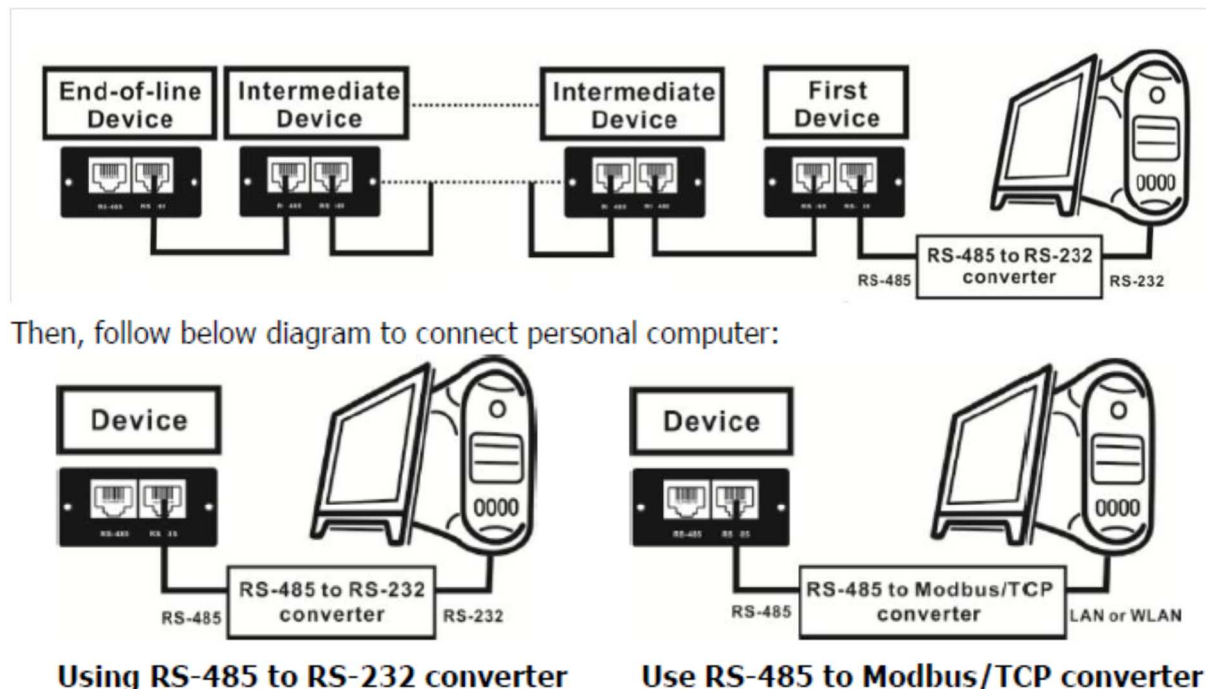


Figure 3 – Scheme of an installation

### Description of the connection to the ripple control receiver:

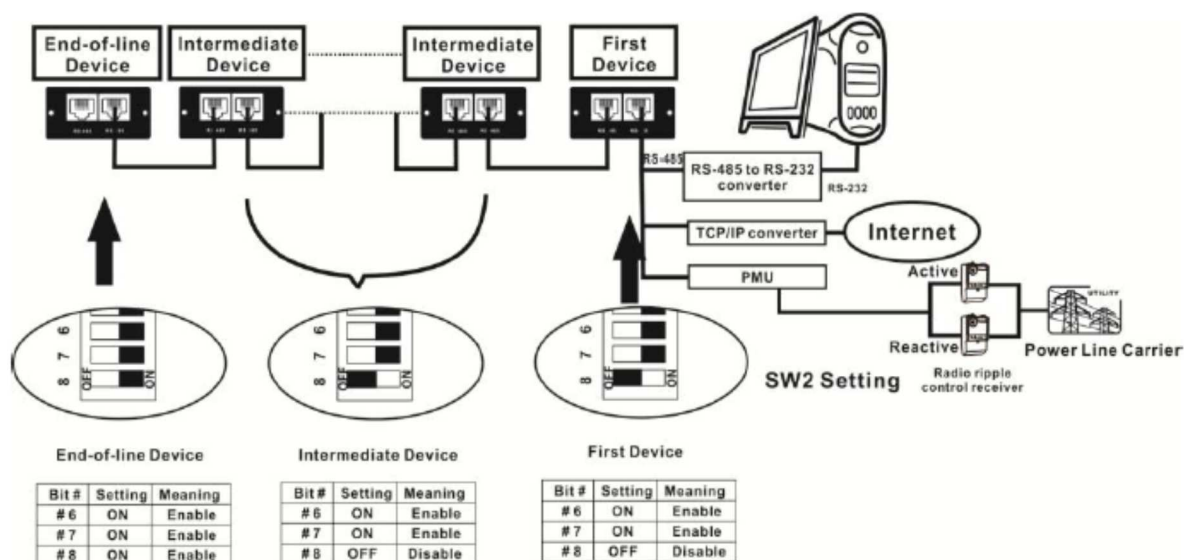


Figure 4 – Connection of the ripple control receiver in an installation

**Parameters set, country setup in inverter or parameter list in manual used for testing:**

Name of country setting in inverter: TOR.

**The product was tested on:**

Hardware: 00G

Software: 00G

# Test Results

| OVE directive R25 |                                                                 |         |
|-------------------|-----------------------------------------------------------------|---------|
| Clause            | Requirement – Test                                              | Verdict |
| 5.1               | Evidence of permissible network perturbations                   | P       |
| 5.2               | Evidence of symmetry behaviour of inverters                     | P       |
| 5.3               | Evidence of the behaviour of the generating unit on the network | P       |
| 5.4               | NS-protection                                                   | P       |
| 5.5               | Connecting conditions and synchronization                       | P       |
| 5.6               | Evidence dynamic grid support                                   | P       |
| 5.7               | Test of Ancillary Unit                                          | N/A     |



| OVE directive R25 |                                                      |          |
|-------------------|------------------------------------------------------|----------|
| Clause            | Requirement – Test                                   | Verdict  |
| <b>5.1</b>        | <b>Evidence of permissible network perturbations</b> |          |
| <b>5.1.1</b>      | General                                              | <b>P</b> |
| <b>5.1.2</b>      | Rapid voltage changes                                | <b>P</b> |
| <b>5.1.3</b>      | Flicker                                              | <b>P</b> |
| <b>5.1.4</b>      | Harmonics and interharmonics                         | <b>P</b> |

| 5.1.1 | General                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | P |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|       | <p>The electrical installations of the customer system shall be planned, constructed and operated so that reactions to the network operator's network and to the systems of other customers are permanently reduced to a permissible minimum. Should interfering reactions on the network operator's network occur nonetheless, the customer shall apply measures to his system that are to be coordinated with the network operator. The network operator is entitled to disconnect the power generation system concerned from the network until the deficiencies are corrected.</p> <p><u>System perturbations are defined as:</u></p> <ul style="list-style-type: none"> <li>- Rapid voltage changes</li> <li>- Flicker</li> <li>- Harmonics, interharmonics and higher frequencies (up to 9 kHz)</li> </ul> |   |

|                                                                                                                                                               |                       |        |        |        |        |        |        |        |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| 5.1.2                                                                                                                                                         | Rapid voltage changes |        |        |        |        |        |        | P      |        |
| These tests serve to demonstrate the requirements of TOR D2, Section 9.2.3                                                                                    |                       |        |        |        |        |        |        |        |        |
| The purpose of the test is to determine $k_i$ and $k_{imax}$ .                                                                                                |                       |        |        |        |        |        |        |        |        |
| The following cases must be tested (where applicable).                                                                                                        |                       |        |        |        |        |        |        |        |        |
| <div><div>- Switch-on for any capacity</div><div>- Unfavourable case when switching the generator step</div><div>- Switch-on for nominal capacity</div></div> |                       |        |        |        |        |        |        |        |        |
| Note: For PV-plants the inverter is the generator                                                                                                             |                       |        |        |        |        |        |        |        |        |
| <div><div>- Switch-off for nominal capacity (no emergency shutdown, but operative shutdown)</div></div>                                                       |                       |        |        |        |        |        |        |        |        |
| If the manufacturer knows more critical cases (e.g. different $\cos \varphi$ parameters) then these additional have to be tested                              |                       |        |        |        |        |        |        |        |        |
| Test conditions:                                                                                                                                              |                       |        |        |        |        |        |        |        |        |
| Frequency: 50Hz $\pm$ 0,5%                                                                                                                                    |                       |        |        |        |        |        |        |        |        |
| THD of the voltage supply: $\leq 3\%$                                                                                                                         |                       |        |        |        |        |        |        |        |        |
| Voltage rise of the PGU at 100% $P_{Emax}$ : $\leq 3\%$                                                                                                       |                       |        |        |        |        |        |        |        |        |
| Test:                                                                                                                                                         |                       |        |        |        |        |        |        |        |        |
| FSP POWER MANAGER 10KW                                                                                                                                        |                       |        |        |        |        |        |        |        |        |
| Switch-on for any capacity (10% $P_{Emax}$ )                                                                                                                  |                       |        |        |        |        |        |        |        |        |
| Phase                                                                                                                                                         | L1                    |        |        | L2     |        |        | L3     |        |        |
| Single period effective values of the current [A]                                                                                                             | 4,522                 | 4,364  | 2,569  | 2,253  | 4,303  | 4,510  | 3,320  | 1,691  | 2,936  |
| Single period effective values of the voltage [V]                                                                                                             | 234,05                | 232,81 | 231,47 | 229,32 | 230,79 | 230,59 | 229,03 | 229,38 | 230,41 |
| $k_i$ value [1]                                                                                                                                               | 0,312                 | 0,301  | 0,177  | 0,155  | 0,297  | 0,311  | 0,229  | 0,117  | 0,202  |
| $k_{imax}$ value [1]                                                                                                                                          | 0,312                 |        |        |        |        |        |        |        |        |
| Unfavourable case when switching the generator step (not necessary for electronic inverter)                                                                   |                       |        |        |        |        |        |        |        |        |
| Phase                                                                                                                                                         | L1                    |        |        | L2     |        |        | L3     |        |        |
| Single period effective values of the current [A]                                                                                                             | N/A                   | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    |
| Single period effective values of the voltage [V]                                                                                                             | N/A                   | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    |
| $k_i$ value [1]                                                                                                                                               | N/A                   | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    | N/A    |
| $k_{imax}$ value [1]                                                                                                                                          | N/A                   |        |        |        |        |        |        |        |        |
| Switch-on for nominal capacity                                                                                                                                |                       |        |        |        |        |        |        |        |        |
| Phase                                                                                                                                                         | L1                    |        |        | L2     |        |        | L3     |        |        |
| Single period effective values of the current [A]                                                                                                             | 4,094                 | 1,959  | 2,974  | 4,323  | 3,437  | 2,575  | 1,315  | 4,410  | 4,530  |
| Single period effective values of the voltage [V]                                                                                                             | 230,30                | 232,73 | 232,34 | 231,68 | 230,25 | 230,12 | 230,50 | 229,06 | 230,00 |
| $k_i$ value [1]                                                                                                                                               | 0,282                 | 0,135  | 0,205  | 0,298  | 0,237  | 0,178  | 0,091  | 0,304  | 0,312  |
| $k_{imax}$ value [1]                                                                                                                                          | 0,312                 |        |        |        |        |        |        |        |        |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |        |        |        |        |        |        |        |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| 5.1.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Rapid voltage changes |        |        |        |        |        |        | P      |        |
| These tests serve to demonstrate the requirements of TOR D2, Section 9.2.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |        |        |        |        |        |        |        |        |
| Switch-off for nominal capacity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |        |        |        |        |        |        |        |        |
| Phase                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | L1                    |        |        | L2     |        |        | L3     |        |        |
| Single period effective values of the current [A]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10,139                | 10.388 | 10.366 | 10,310 | 9,628  | 8,888  | 11,310 | 11,117 | 10,462 |
| Single period effective values of the voltage [V]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 235,01                | 233,81 | 235,93 | 230,71 | 231,92 | 230,51 | 232,71 | 232,39 | 230,83 |
| k <sub>i</sub> value [1]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0,699                 | 0,716  | 0,715  | 0,711  | 0,664  | 0,613  | 0,780  | 0,767  | 0,722  |
| k <sub>imax</sub> value [1]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0,780                 |        |        |        |        |        |        |        |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |        |        |        |        |        |        |        |        |
| Grid Frequency [Hz]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |        |        | 50,0   |        |        |        |        |        |
| Grid voltage [V]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |        |        | 230,0  |        |        |        |        |        |
| Rated current I <sub>r</sub> [A]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |        |        | 14,5   |        |        |        |        |        |
| Highest k <sub>imax</sub> value for all switching operations [1]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |        |        | 0,780  |        |        |        |        |        |
| <b>Note:</b><br>Limits:<br>k <sub>imax</sub> = 1,2 for synchronous generators with fine synchronization, converter; (electronic inverter)<br>k <sub>imax</sub> = 4 for asynchronous generators, which are switched on at 95% to 105% of their synchronous speed, if no further details are available regarding the type of current limitation. With regard to short-term compensation processes, the condition mentioned below for very short voltage changes must also be observed.<br>k <sub>imax</sub> = 8 for asynchronous generators that are powered up by the network if I <sub>a</sub> is unknown.<br>(I <sub>a</sub> = starting current)<br><br>The test results base on the test report “ PVDE190903N004”issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16. |                       |        |        |        |        |        |        |        |        |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                               |                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------|
| 5.1.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Flicker</b><br>These tests serve to demonstrate the requirements of TOR D2, Section 9.2.4. | P                                              |
| Adherence to the thresholds for flicker must be verified as followed: <ul style="list-style-type: none"><li>- For nominal currents ≤ 16 A per conductor to DIN EN 61000-3-3 (VDE 0838-3)</li><li>- For nominal currents &gt; 16 A and ≤ 75 A per conductor to DIN EN 61000-3-11 (VDE 0838-11)</li></ul>                                                                                                                                                                                                                 |                                                                                               |                                                |
| <b>Test conditions:</b><br>Voltage: 86% U <sub>n</sub> to 109% U <sub>n</sub><br>Frequency: 50Hz ± 0,5%<br>THD of the voltage supply: ≤3%<br>Voltage rise of the PGU at 100% P <sub>Emax</sub> : ≤3%                                                                                                                                                                                                                                                                                                                    |                                                                                               |                                                |
| <b>Test:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                               |                                                |
| <b>FSP POWER MANAGER 10KW</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                               |                                                |
| <b>Flicker to DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 (VDE 0838-11) for generator units ≤ 75 A</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                               |                                                |
| Grid impedance DIN EN 61000-3-3 (VDE 0838-3) [Ω]:                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                               | R <sub>A</sub> = 0,24Ω jX <sub>A</sub> = 0,15Ω |
| Output voltage of the impedance network [V]                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                               | 230                                            |
| Flicker to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Result:                                                                                       |                                                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | P <sub>It</sub>                                                                               | P <sub>st</sub> dc%                            |
| DIN EN 61000-3-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0,18                                                                                          | 0,18 0,09                                      |
| <b>Assessment criterion:</b><br>Long-term flicker strength P <sub>It</sub> to DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 must be ≤ 0,5.<br>Determination of the flicker coefficient:<br>$c_{\psi_k} = P_{st} \times (S_k / P_n)$<br>where S <sub>k</sub> is the short-circuit power of the network standby element (during the determination of the appropriate P <sub>st</sub> values)<br>The value for the network standby element must be determined separately with measurements for rated currents > 75 A. |                                                                                               |                                                |
| <b>Flicker for rated currents ≤75A to DIN EN 61000-3-3 (VDE 0838-3) / DIN EN 61000-3-11 (VDE 0838-11)</b>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                               |                                                |
| Grid impedance angle ψ <sub>k</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 32°                                                                                           |                                                |
| Flicker coefficient c(ψ <sub>k</sub> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3,60                                                                                          |                                                |
| <b>Assessment criterion:</b><br>Long-term flicker strength: P <sub>It</sub> ≤0,5                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                               |                                                |
| <b>Note:</b><br>The test results base on the test report “ PVDE190903N004”issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16.                                                                                                                                                                                                                                                                                                                                                             |                                                                                               |                                                |

| 5.1.4                  | Test Harmonics DIN EN 61000-3-2 (≤16 A per Phase) |                   |                       |                   |                       |                   | P                           |
|------------------------|---------------------------------------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------------|
| FSP POWER MANAGER 10KW |                                                   |                   |                       |                   |                       |                   |                             |
| Phase                  | L1                                                |                   | L2                    |                   | L3                    |                   |                             |
| Power Level            | 100%                                              |                   | 100%                  |                   | 100%                  |                   |                             |
| AC Power [W]           | 3399                                              |                   | 3331                  |                   | 3325                  |                   |                             |
| AC Voltage [V]         | 230,81                                            |                   | 230,75                |                   | 230,69                |                   |                             |
| AC Current [A]         | 14,726                                            |                   | 14,438                |                   | 14,412                |                   |                             |
| Frequency [Hz]         | 50,00                                             |                   | 50,00                 |                   | 50,00                 |                   |                             |
| THD40 [%]              | 3,103                                             |                   | 3,173                 |                   | 3,140                 |                   |                             |
| Harmonic               | Current Magnitude (A)                             | % of Funda-mental | Current Magnitude (A) | % of Funda-mental | Current Magnitude (A) | % of Funda-mental | Harmonic Current Limits (A) |
| 1st                    | 14,718                                            | 99,950            | 14,430                | 99,948            | 14,405                | 99,949            | --                          |
| 2nd                    | 0,301                                             | 2,043             | 0,246                 | 1,705             | 0,294                 | 2,038             | 1,080                       |
| 3rd                    | 0,168                                             | 1,138             | 0,260                 | 1,801             | 0,177                 | 1,226             | 2,300                       |
| 4th                    | 0,064                                             | 0,431             | 0,062                 | 0,432             | 0,064                 | 0,447             | 0,430                       |
| 5th                    | 0,205                                             | 1,395             | 0,171                 | 1,187             | 0,200                 | 1,389             | 1,140                       |
| 6th                    | 0,033                                             | 0,227             | 0,031                 | 0,213             | 0,035                 | 0,240             | 0,300                       |
| 7th                    | 0,064                                             | 0,437             | 0,095                 | 0,660             | 0,063                 | 0,434             | 0,770                       |
| 8th                    | 0,022                                             | 0,151             | 0,021                 | 0,144             | 0,023                 | 0,158             | 0,263                       |
| 9th                    | 0,037                                             | 0,251             | 0,040                 | 0,274             | 0,039                 | 0,271             | 0,400                       |
| 10th                   | 0,019                                             | 0,131             | 0,018                 | 0,125             | 0,020                 | 0,137             | 0,184                       |
| 11th                   | 0,028                                             | 0,192             | 0,044                 | 0,303             | 0,027                 | 0,188             | 0,330                       |
| 12th                   | 0,021                                             | 0,145             | 0,020                 | 0,140             | 0,023                 | 0,162             | 0,153                       |
| 13th                   | 0,026                                             | 0,176             | 0,039                 | 0,272             | 0,027                 | 0,185             | 0,210                       |
| 14th                   | 0,022                                             | 0,147             | 0,022                 | 0,149             | 0,023                 | 0,161             | 0,131                       |
| 15th                   | 0,034                                             | 0,233             | 0,023                 | 0,159             | 0,033                 | 0,230             | 0,150                       |
| 16th                   | 0,024                                             | 0,160             | 0,020                 | 0,136             | 0,023                 | 0,157             | 0,115                       |
| 17th                   | 0,037                                             | 0,254             | 0,052                 | 0,359             | 0,036                 | 0,248             | 0,132                       |
| 18th                   | 0,028                                             | 0,192             | 0,023                 | 0,157             | 0,029                 | 0,203             | 0,102                       |
| 19th                   | 0,037                                             | 0,248             | 0,028                 | 0,197             | 0,035                 | 0,245             | 0,188                       |
| 20th                   | 0,031                                             | 0,208             | 0,029                 | 0,202             | 0,032                 | 0,225             | 0,092                       |
| 21th                   | 0,044                                             | 0,302             | 0,046                 | 0,318             | 0,043                 | 0,297             | 0,107                       |
| 22th                   | 0,033                                             | 0,225             | 0,029                 | 0,200             | 0,031                 | 0,218             | 0,084                       |
| 23th                   | 0,047                                             | 0,317             | 0,048                 | 0,333             | 0,047                 | 0,328             | 0,098                       |
| 24th                   | 0,040                                             | 0,270             | 0,031                 | 0,217             | 0,040                 | 0,278             | 0,077                       |
| 25th                   | 0,050                                             | 0,337             | 0,050                 | 0,343             | 0,048                 | 0,330             | 0,090                       |
| 26th                   | 0,040                                             | 0,268             | 0,039                 | 0,267             | 0,045                 | 0,309             | 0,071                       |

| 5.1.4                                                                                                                                       | Test Harmonics DIN EN 61000-3-2 (≤16 A per Phase) |       |       |                                          |       |       | P     |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------|-------|------------------------------------------|-------|-------|-------|
| FSP POWER MANAGER 10KW                                                                                                                      |                                                   |       |       |                                          |       |       |       |
| 27th                                                                                                                                        | 0,056                                             | 0,380 | 0,056 | 0,389                                    | 0,053 | 0,367 | 0,080 |
| 28th                                                                                                                                        | 0,043                                             | 0,293 | 0,038 | 0,266                                    | 0,041 | 0,284 | 0,066 |
| 29th                                                                                                                                        | 0,056                                             | 0,380 | 0,054 | 0,374                                    | 0,056 | 0,386 | 0,078 |
| 30th                                                                                                                                        | 0,043                                             | 0,295 | 0,030 | 0,210                                    | 0,041 | 0,283 | 0,061 |
| 31th                                                                                                                                        | 0,055                                             | 0,376 | 0,064 | 0,443                                    | 0,056 | 0,391 | 0,073 |
| 32th                                                                                                                                        | 0,041                                             | 0,280 | 0,038 | 0,262                                    | 0,041 | 0,287 | 0,057 |
| 33th                                                                                                                                        | 0,048                                             | 0,327 | 0,042 | 0,289                                    | 0,044 | 0,306 | 0,068 |
| 34th                                                                                                                                        | 0,036                                             | 0,247 | 0,031 | 0,212                                    | 0,036 | 0,248 | 0,054 |
| 35th                                                                                                                                        | 0,043                                             | 0,295 | 0,048 | 0,334                                    | 0,042 | 0,288 | 0,064 |
| 36th                                                                                                                                        | 0,030                                             | 0,204 | 0,026 | 0,178                                    | 0,030 | 0,211 | 0,051 |
| 37th                                                                                                                                        | 0,041                                             | 0,275 | 0,039 | 0,268                                    | 0,041 | 0,287 | 0,061 |
| 38th                                                                                                                                        | 0,029                                             | 0,197 | 0,024 | 0,168                                    | 0,029 | 0,198 | 0,048 |
| 39th                                                                                                                                        | 0,031                                             | 0,208 | 0,034 | 0,238                                    | 0,031 | 0,212 | 0,058 |
| 40th                                                                                                                                        | 0,025                                             | 0,171 | 0,021 | 0,143                                    | 0,025 | 0,176 | 0,046 |
|                                                                                                                                             |                                                   |       |       |                                          |       |       |       |
| PV-curve simulated according to                                                                                                             |                                                   |       |       |                                          |       |       |       |
| Voltage of defined MPP [V]                                                                                                                  |                                                   |       |       | 700,0                                    |       |       |       |
| Current of defined MPP [A]                                                                                                                  |                                                   |       |       | 15,7                                     |       |       |       |
| FFU of PV curve [1]                                                                                                                         |                                                   |       |       | 0,68                                     |       |       |       |
| Impedance [Ω]                                                                                                                               |                                                   |       |       |                                          |       |       |       |
|                                                                                                                                             |                                                   |       |       | Line $R_A = 0,24 \text{ j}X_A = 0,15$    |       |       |       |
|                                                                                                                                             |                                                   |       |       | Neutral $R_N = 0,16 \text{ j}X_N = 0,10$ |       |       |       |
| <b>Note:</b>                                                                                                                                |                                                   |       |       |                                          |       |       |       |
| The test results base on the test report “ PVDE190903N004”issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16. |                                                   |       |       |                                          |       |       |       |

| 5.1.4                  | Test Harmonics DIN EN 61000-4-7 (≥75 A per Phase) |       |       |       |       |       |       |       |       |       | P     |
|------------------------|---------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| FSP POWER MANAGER 10KW |                                                   |       |       |       |       |       |       |       |       |       |       |
| Harmonics              |                                                   |       |       |       |       |       |       |       |       |       |       |
| P/ P <sub>FE</sub> [%] | 5                                                 | 10    | 20    | 30    | 40    | 50    | 60    | 70    | 80    | 90    | 100   |
| Order                  | I <sub>h</sub> [%]                                |       |       |       |       |       |       |       |       |       |       |
| 1                      | 5,55                                              | 10,66 | 20,97 | 30,08 | 40,40 | 50,73 | 61,23 | 71,55 | 81,74 | 92,44 | 99,58 |
| 2                      | 0,93                                              | 0,91  | 0,90  | 0,86  | 0,85  | 0,82  | 0,82  | 0,81  | 0,81  | 0,80  | 0,81  |
| 3                      | 1,75                                              | 1,82  | 1,72  | 1,54  | 1,42  | 1,34  | 1,29  | 1,30  | 1,30  | 1,30  | 1,32  |
| 4                      | 0,26                                              | 0,27  | 0,26  | 0,25  | 0,25  | 0,25  | 0,24  | 0,24  | 0,24  | 0,24  | 0,24  |
| 5                      | 0,78                                              | 0,97  | 1,36  | 1,42  | 1,37  | 1,26  | 1,18  | 1,12  | 1,06  | 1,03  | 1,14  |
| 6                      | 0,10                                              | 0,12  | 0,17  | 0,16  | 0,21  | 0,21  | 0,21  | 0,20  | 0,20  | 0,17  | 0,16  |
| 7                      | 0,74                                              | 0,60  | 0,69  | 0,89  | 0,94  | 0,87  | 0,77  | 0,70  | 0,66  | 0,77  | 0,78  |
| 8                      | 0,20                                              | 0,10  | 0,16  | 0,10  | 0,15  | 0,19  | 0,22  | 0,20  | 0,19  | 0,14  | 0,15  |
| 9                      | 0,50                                              | 0,73  | 0,30  | 0,55  | 0,69  | 0,70  | 0,67  | 0,67  | 0,70  | 0,77  | 0,76  |
| 10                     | 0,17                                              | 0,15  | 0,14  | 0,08  | 0,13  | 0,18  | 0,20  | 0,21  | 0,18  | 0,17  | 0,15  |
| 11                     | 0,23                                              | 0,65  | 0,31  | 0,40  | 0,49  | 0,58  | 0,61  | 0,63  | 0,65  | 0,65  | 0,71  |
| 12                     | 0,20                                              | 0,15  | 0,11  | 0,08  | 0,09  | 0,14  | 0,17  | 0,17  | 0,16  | 0,15  | 0,15  |
| 13                     | 0,24                                              | 0,38  | 0,36  | 0,23  | 0,26  | 0,41  | 0,45  | 0,48  | 0,52  | 0,54  | 0,60  |
| 14                     | 0,09                                              | 0,17  | 0,11  | 0,06  | 0,07  | 0,10  | 0,13  | 0,14  | 0,12  | 0,13  | 0,13  |
| 15                     | 0,35                                              | 0,35  | 0,52  | 0,29  | 0,18  | 0,19  | 0,29  | 0,37  | 0,44  | 0,49  | 0,54  |
| 16                     | 0,10                                              | 0,11  | 0,13  | 0,07  | 0,06  | 0,06  | 0,09  | 0,10  | 0,10  | 0,11  | 0,11  |
| 17                     | 0,30                                              | 0,45  | 0,57  | 0,37  | 0,22  | 0,10  | 0,20  | 0,28  | 0,34  | 0,41  | 0,45  |
| 18                     | 0,09                                              | 0,06  | 0,14  | 0,08  | 0,06  | 0,05  | 0,07  | 0,08  | 0,09  | 0,09  | 0,09  |
| 19                     | 0,40                                              | 0,35  | 0,50  | 0,42  | 0,21  | 0,11  | 0,17  | 0,25  | 0,29  | 0,34  | 0,38  |
| 20                     | 0,08                                              | 0,04  | 0,13  | 0,10  | 0,06  | 0,04  | 0,06  | 0,06  | 0,07  | 0,08  | 0,08  |
| 21                     | 0,43                                              | 0,38  | 0,54  | 0,56  | 0,31  | 0,19  | 0,11  | 0,16  | 0,21  | 0,28  | 0,33  |
| 22                     | 0,09                                              | 0,04  | 0,11  | 0,09  | 0,07  | 0,04  | 0,05  | 0,06  | 0,07  | 0,08  | 0,07  |
| 23                     | 0,39                                              | 0,37  | 0,48  | 0,52  | 0,28  | 0,16  | 0,11  | 0,16  | 0,21  | 0,26  | 0,29  |
| 24                     | 0,07                                              | 0,05  | 0,10  | 0,09  | 0,07  | 0,04  | 0,04  | 0,05  | 0,06  | 0,07  | 0,07  |
| 25                     | 0,43                                              | 0,40  | 0,49  | 0,54  | 0,34  | 0,21  | 0,13  | 0,12  | 0,16  | 0,21  | 0,25  |
| 26                     | 0,06                                              | 0,05  | 0,09  | 0,08  | 0,08  | 0,04  | 0,03  | 0,04  | 0,05  | 0,06  | 0,06  |
| 27                     | 0,41                                              | 0,42  | 0,44  | 0,52  | 0,38  | 0,23  | 0,15  | 0,13  | 0,14  | 0,19  | 0,21  |
| 28                     | 0,05                                              | 0,05  | 0,07  | 0,07  | 0,07  | 0,04  | 0,03  | 0,04  | 0,04  | 0,05  | 0,06  |
| 29                     | 0,34                                              | 0,35  | 0,33  | 0,40  | 0,31  | 0,18  | 0,13  | 0,11  | 0,11  | 0,13  | 0,15  |
| 30                     | 0,04                                              | 0,05  | 0,04  | 0,05  | 0,07  | 0,04  | 0,03  | 0,03  | 0,03  | 0,04  | 0,04  |
| 31                     | 0,29                                              | 0,29  | 0,27  | 0,33  | 0,28  | 0,17  | 0,12  | 0,10  | 0,09  | 0,10  | 0,11  |
| 32                     | 0,04                                              | 0,04  | 0,02  | 0,04  | 0,06  | 0,04  | 0,03  | 0,03  | 0,03  | 0,03  | 0,04  |
| 33                     | 0,25                                              | 0,25  | 0,23  | 0,27  | 0,24  | 0,16  | 0,12  | 0,11  | 0,10  | 0,09  | 0,10  |





|                       |                    |      |      |      |      |      |      |      |      |      |      |
|-----------------------|--------------------|------|------|------|------|------|------|------|------|------|------|
| 34                    | 0,04               | 0,03 | 0,02 | 0,03 | 0,05 | 0,04 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 |
| 35                    | 0,18               | 0,19 | 0,17 | 0,19 | 0,19 | 0,13 | 0,10 | 0,09 | 0,08 | 0,08 | 0,08 |
| 36                    | 0,03               | 0,02 | 0,03 | 0,02 | 0,04 | 0,03 | 0,02 | 0,03 | 0,02 | 0,03 | 0,03 |
| 37                    | 0,14               | 0,14 | 0,13 | 0,12 | 0,13 | 0,09 | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 |
| 38                    | 0,02               | 0,01 | 0,03 | 0,02 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 |
| 39                    | 0,12               | 0,12 | 0,11 | 0,09 | 0,11 | 0,08 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 |
| 40                    | 0,02               | 0,01 | 0,03 | 0,02 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 41                    | 0,09               | 0,09 | 0,10 | 0,08 | 0,10 | 0,09 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 |
| 42                    | 0,02               | 0,01 | 0,03 | 0,01 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 |
| 43                    | 0,08               | 0,08 | 0,08 | 0,06 | 0,09 | 0,08 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| 44                    | 0,02               | 0,01 | 0,03 | 0,01 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 |
| 45                    | 0,07               | 0,06 | 0,06 | 0,03 | 0,07 | 0,06 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 |
| 46                    | 0,01               | 0,01 | 0,02 | 0,01 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 |
| 47                    | 0,06               | 0,06 | 0,07 | 0,05 | 0,09 | 0,09 | 0,07 | 0,07 | 0,07 | 0,06 | 0,06 |
| 48                    | 0,01               | 0,01 | 0,02 | 0,01 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 |
| 49                    | 0,04               | 0,04 | 0,05 | 0,03 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,06 | 0,06 |
| 50                    | 0,01               | 0,01 | 0,01 | 0,01 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 |
| THC [%]               | 2,66               | 2,86 | 2,96 | 2,93 | 2,72 | 2,53 | 2,43 | 2,42 | 2,43 | 2,52 | 2,64 |
| THDU50 [%]            | 1,48               | 1,48 | 1,43 | 1,38 | 1,29 | 1,22 | 1,2  | 1,18 | 1,12 | 0,99 | 0,87 |
|                       |                    |      |      |      |      |      |      |      |      |      |      |
| P/P <sub>rE</sub> [%] | 5                  | 10   | 20   | 30   | 40   | 50   | 60   | 70   | 80   | 90   | 100  |
| f [Hz]                | I <sub>h</sub> [%] |      |      |      |      |      |      |      |      |      |      |
| 75                    | 0,30               | 0,32 | 0,40 | 0,47 | 0,59 | 0,68 | 0,79 | 0,91 | 1,02 | 1,16 | 1,29 |
| 125                   | 0,20               | 0,20 | 0,23 | 0,25 | 0,30 | 0,35 | 0,40 | 0,45 | 0,49 | 0,53 | 0,57 |
| 175                   | 0,17               | 0,16 | 0,16 | 0,16 | 0,20 | 0,22 | 0,24 | 0,26 | 0,28 | 0,30 | 0,34 |
| 225                   | 0,20               | 0,18 | 0,18 | 0,18 | 0,19 | 0,22 | 0,24 | 0,27 | 0,29 | 0,30 | 0,33 |
| 275                   | 0,17               | 0,19 | 0,20 | 0,19 | 0,20 | 0,20 | 0,20 | 0,21 | 0,21 | 0,22 | 0,25 |
| 325                   | 0,20               | 0,19 | 0,20 | 0,21 | 0,19 | 0,19 | 0,21 | 0,22 | 0,23 | 0,23 | 0,24 |
| 375                   | 0,16               | 0,15 | 0,17 | 0,19 | 0,19 | 0,17 | 0,16 | 0,15 | 0,15 | 0,16 | 0,16 |
| 425                   | 0,21               | 0,22 | 0,19 | 0,24 | 0,22 | 0,19 | 0,18 | 0,18 | 0,18 | 0,17 | 0,18 |
| 475                   | 0,09               | 0,14 | 0,11 | 0,14 | 0,19 | 0,20 | 0,18 | 0,18 | 0,19 | 0,19 | 0,18 |
| 525                   | 0,13               | 0,26 | 0,19 | 0,24 | 0,32 | 0,31 | 0,26 | 0,23 | 0,21 | 0,20 | 0,19 |
| 575                   | 0,11               | 0,10 | 0,12 | 0,11 | 0,18 | 0,19 | 0,16 | 0,15 | 0,15 | 0,14 | 0,14 |
| 625                   | 0,17               | 0,13 | 0,19 | 0,15 | 0,27 | 0,30 | 0,26 | 0,22 | 0,20 | 0,18 | 0,16 |
| 675                   | 0,11               | 0,08 | 0,13 | 0,10 | 0,16 | 0,19 | 0,17 | 0,15 | 0,13 | 0,12 | 0,12 |
| 725                   | 0,14               | 0,09 | 0,17 | 0,13 | 0,22 | 0,25 | 0,23 | 0,19 | 0,16 | 0,13 | 0,12 |
| 775                   | 0,05               | 0,07 | 0,08 | 0,08 | 0,10 | 0,13 | 0,12 | 0,10 | 0,09 | 0,09 | 0,10 |
| 825                   | 0,10               | 0,08 | 0,12 | 0,14 | 0,17 | 0,21 | 0,19 | 0,16 | 0,14 | 0,12 | 0,10 |

|                       |                    |      |      |      |      |      |      |      |      |      |      |
|-----------------------|--------------------|------|------|------|------|------|------|------|------|------|------|
| 875                   | 0,05               | 0,05 | 0,07 | 0,06 | 0,06 | 0,08 | 0,08 | 0,08 | 0,08 | 0,10 | 0,11 |
| 925                   | 0,08               | 0,09 | 0,07 | 0,13 | 0,16 | 0,19 | 0,19 | 0,18 | 0,17 | 0,15 | 0,14 |
| 975                   | 0,05               | 0,05 | 0,05 | 0,06 | 0,06 | 0,08 | 0,08 | 0,08 | 0,07 | 0,08 | 0,08 |
| 1025                  | 0,06               | 0,09 | 0,06 | 0,10 | 0,16 | 0,17 | 0,19 | 0,18 | 0,18 | 0,17 | 0,15 |
| 1075                  | 0,05               | 0,04 | 0,05 | 0,06 | 0,08 | 0,09 | 0,10 | 0,09 | 0,08 | 0,07 | 0,07 |
| 1125                  | 0,07               | 0,08 | 0,06 | 0,08 | 0,16 | 0,16 | 0,17 | 0,17 | 0,16 | 0,15 | 0,14 |
| 1175                  | 0,05               | 0,05 | 0,05 | 0,06 | 0,07 | 0,08 | 0,09 | 0,08 | 0,08 | 0,07 | 0,06 |
| 1225                  | 0,07               | 0,07 | 0,05 | 0,06 | 0,14 | 0,15 | 0,14 | 0,14 | 0,13 | 0,12 | 0,10 |
| 1275                  | 0,07               | 0,06 | 0,06 | 0,07 | 0,07 | 0,06 | 0,07 | 0,07 | 0,07 | 0,06 | 0,06 |
| 1325                  | 0,05               | 0,05 | 0,07 | 0,05 | 0,11 | 0,13 | 0,12 | 0,12 | 0,11 | 0,11 | 0,10 |
| 1375                  | 0,06               | 0,05 | 0,05 | 0,07 | 0,07 | 0,07 | 0,07 | 0,08 | 0,08 | 0,07 | 0,07 |
| 1425                  | 0,04               | 0,04 | 0,06 | 0,05 | 0,06 | 0,10 | 0,10 | 0,09 | 0,10 | 0,10 | 0,10 |
| 1475                  | 0,04               | 0,04 | 0,04 | 0,05 | 0,05 | 0,06 | 0,07 | 0,07 | 0,08 | 0,08 | 0,08 |
| 1525                  | 0,03               | 0,03 | 0,04 | 0,04 | 0,05 | 0,07 | 0,07 | 0,06 | 0,07 | 0,07 | 0,07 |
| 1575                  | 0,04               | 0,04 | 0,04 | 0,04 | 0,04 | 0,06 | 0,06 | 0,07 | 0,08 | 0,08 | 0,08 |
| 1625                  | 0,03               | 0,03 | 0,03 | 0,04 | 0,04 | 0,05 | 0,05 | 0,04 | 0,04 | 0,05 | 0,04 |
| 1675                  | 0,05               | 0,04 | 0,04 | 0,05 | 0,04 | 0,05 | 0,06 | 0,06 | 0,06 | 0,07 | 0,07 |
| 1725                  | 0,03               | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,04 | 0,04 | 0,04 | 0,04 | 0,05 |
| 1775                  | 0,04               | 0,04 | 0,04 | 0,04 | 0,03 | 0,04 | 0,05 | 0,06 | 0,07 | 0,08 | 0,08 |
| 1825                  | 0,03               | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 | 0,02 | 0,03 | 0,04 | 0,04 | 0,04 |
| 1875                  | 0,03               | 0,03 | 0,02 | 0,03 | 0,02 | 0,02 | 0,03 | 0,03 | 0,04 | 0,05 | 0,05 |
| 1925                  | 0,02               | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,03 | 0,04 | 0,05 |
| 1975                  | 0,02               | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 | 0,04 | 0,04 |
|                       |                    |      |      |      |      |      |      |      |      |      |      |
| P/P <sub>rE</sub> [%] | 5                  | 10   | 20   | 30   | 40   | 50   | 60   | 70   | 80   | 90   | 100  |
| f [kHz]               | I <sub>h</sub> [%] |      |      |      |      |      |      |      |      |      |      |
| 2,1                   | 0,13               | 0,13 | 0,13 | 0,11 | 0,15 | 0,13 | 0,10 | 0,10 | 0,11 | 0,11 | 0,13 |
| 2,3                   | 0,09               | 0,09 | 0,10 | 0,08 | 0,12 | 0,12 | 0,09 | 0,09 | 0,09 | 0,09 | 0,10 |
| 2,5                   | 0,06               | 0,07 | 0,07 | 0,06 | 0,10 | 0,10 | 0,09 | 0,08 | 0,09 | 0,09 | 0,09 |
| 2,7                   | 0,05               | 0,04 | 0,05 | 0,04 | 0,06 | 0,08 | 0,08 | 0,06 | 0,06 | 0,07 | 0,07 |
| 2,9                   | 0,03               | 0,03 | 0,03 | 0,03 | 0,04 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,05 |
| 3,1                   | 0,03               | 0,03 | 0,03 | 0,03 | 0,03 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 | 0,05 |
| 3,3                   | 0,03               | 0,03 | 0,03 | 0,02 | 0,03 | 0,04 | 0,05 | 0,06 | 0,05 | 0,05 | 0,05 |
| 3,5                   | 0,03               | 0,03 | 0,03 | 0,04 | 0,02 | 0,03 | 0,04 | 0,04 | 0,04 | 0,03 | 0,04 |
| 3,7                   | 0,04               | 0,03 | 0,03 | 0,03 | 0,02 | 0,03 | 0,04 | 0,05 | 0,04 | 0,04 | 0,04 |
| 3,9                   | 0,03               | 0,03 | 0,03 | 0,03 | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 |
| 4,1                   | 0,03               | 0,03 | 0,03 | 0,03 | 0,03 | 0,02 | 0,03 | 0,03 | 0,04 | 0,03 | 0,03 |
| 4,3                   | 0,03               | 0,03 | 0,03 | 0,03 | 0,03 | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,03 |

|     |      |      |      |      |      |      |      |      |      |      |      |
|-----|------|------|------|------|------|------|------|------|------|------|------|
| 4,5 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,03 |
| 4,7 | 0,03 | 0,03 | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 |
| 4,9 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 |
| 5,1 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 5,3 | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 |
| 5,5 | 0,02 | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 5,7 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 5,9 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 6,1 | 0,02 | 0,03 | 0,03 | 0,03 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 6,3 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 6,5 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 |
| 6,7 | 0,02 | 0,02 | 0,02 | 0,02 | 0,01 | 0,02 | 0,01 | 0,02 | 0,01 | 0,01 | 0,03 |
| 6,9 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,03 |
| 7,1 | 0,02 | 0,02 | 0,01 | 0,01 | 0,01 | 0,02 | 0,01 | 0,01 | 0,02 | 0,02 | 0,03 |
| 7,3 | 0,06 | 0,06 | 0,06 | 0,06 | 0,07 | 0,07 | 0,07 | 0,08 | 0,08 | 0,08 | 0,09 |
| 7,5 | 0,04 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,06 | 0,07 | 0,08 | 0,09 | 0,10 |
| 7,7 | 0,04 | 0,04 | 0,04 | 0,05 | 0,05 | 0,05 | 0,06 | 0,06 | 0,07 | 0,08 | 0,09 |
| 7,9 | 0,05 | 0,06 | 0,05 | 0,05 | 0,05 | 0,06 | 0,06 | 0,06 | 0,07 | 0,07 | 0,07 |
| 8,1 | 0,01 | 0,01 | 0,01 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,02 | 0,06 |
| 8,3 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,02 | 0,07 |
| 8,5 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,02 | 0,02 | 0,06 |
| 8,7 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,04 | 0,07 |
| 8,9 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,07 | 0,09 |

PV-curve simulated according to

Voltage of defined MPP [V] 700

Current of defined MPP [A] 15,7

FFU of PV curve [1] 0,68

Impedance [ $\Omega$ ]

Line  $R_A = 0,15 \text{ j}X_A = 0,15$   
Neutral  $R_N = 0,01 \text{ j}X_N = 0,01$ 

#### Note:

The normalization current is 14,5 A.

The harmonics, interharmonics and higher frequencies are maximum values of all three phases.

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

The test results base on the test report "PVDE190903N004" issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16.

| OVE directive R25 |                                                       |            |
|-------------------|-------------------------------------------------------|------------|
| Clause            | Requirement – Test                                    | Verdict    |
| <b>5.2</b>        | <b>Evidence of symmetry behaviour of inverters</b>    |            |
| <b>5.2.1</b>      | General                                               | <b>P</b>   |
| <b>5.2.2</b>      | Calculation of the asymmetry of three-phase inverters | <b>P</b>   |
| <b>5.2.2 a)</b>   | Failure of single inverter modules                    | <b>N/A</b> |
| <b>5.2.2 b)</b>   | Power drop of single inverter modules                 | <b>N/A</b> |

| 5.2.1                                                                                                                                                                                                                           | General | P |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---|
| <p>These tests serve to prove the requirements according to TOR Erzeuger, 6.1.1.</p> <p>These tests are not applicable for direct connected rotating machines!</p> <p>This test is necessary only for electronic inverters!</p> |         |   |
| <p><b>Note:</b></p> <p>The tests of the “symmetry characteristics of three-phase inverter modules” were performed on the unit with the highest output power. Here is the maximum asymmetry given.</p>                           |         |   |

| 5.2.2                                                                                    | Calculation of asymmetry |       |       |         |         | P       |
|------------------------------------------------------------------------------------------|--------------------------|-------|-------|---------|---------|---------|
| Setting values                                                                           | cos φ = 1                |       |       | 1,00    |         |         |
|                                                                                          | cos φ over-excited       |       |       | 0,90    |         |         |
|                                                                                          | cos φ under-excited      |       |       | 0,90    |         |         |
| Test:                                                                                    |                          |       |       |         |         |         |
| FSP POWER MANAGER 10KW                                                                   |                          |       |       |         |         |         |
| 1-min mean value                                                                         | L1                       | L2    | L3    | L1 – L2 | L2 – L3 | L3 – L1 |
| a) cos φ = 1 at 100 % P <sub>rE</sub> ± 5 % P <sub>E<sub>max</sub></sub>                 |                          |       |       |         |         |         |
| S <sub>E60</sub> [kVA]                                                                   | 3,333                    | 3,030 | 3,030 | 0,030   | 0,000   | -0,030  |
|                                                                                          | 3,334                    | 3,304 | 3,304 | 0,029   | 0,001   | -0,030  |
|                                                                                          | 3,333                    | 3,303 | 3,303 | 0,030   | 0,000   | -0,030  |
|                                                                                          | 3,333                    | 3,304 | 3,303 | 0,029   | 0,001   | -0,030  |
|                                                                                          | 3,332                    | 3,303 | 3,303 | 0,029   | 0,000   | -0,030  |
| COS φ <sub>E60</sub>                                                                     | 0,999                    |       |       |         |         |         |
| max. asymmetry [kVA]                                                                     | 0,030                    |       |       |         |         |         |
| b) maximum under-excited (i) at 100 % P <sub>rE</sub> ± 5 % P <sub>E<sub>max</sub></sub> |                          |       |       |         |         |         |
| S <sub>E60</sub> [kVA]                                                                   | 3,365                    | 3,320 | 3,313 | 0,045   | 0,007   | -0,052  |
|                                                                                          | 3,365                    | 3,320 | 3,313 | 0,045   | 0,008   | -0,052  |
|                                                                                          | 3,367                    | 3,322 | 3,315 | 0,045   | 0,008   | -0,052  |
|                                                                                          | 3,364                    | 3,319 | 3,312 | 0,045   | 0,008   | -0,052  |
|                                                                                          | 3,369                    | 3,325 | 3,317 | 0,044   | 0,007   | -0,051  |
| COS φ <sub>E60</sub>                                                                     | -0,893                   |       |       |         |         |         |
| max. asymmetry [kVA]                                                                     | -0,052                   |       |       |         |         |         |
| c) maximum over-excited (c) at 100 % P <sub>rE</sub> ± 5 % P <sub>E<sub>max</sub></sub>  |                          |       |       |         |         |         |
| S <sub>E60</sub> [kVA]                                                                   | 3,308                    | 3,296 | 3,307 | 0,012   | -0,011  | -0,001  |
|                                                                                          | 3,304                    | 3,292 | 3,303 | 0,012   | -0,011  | -0,001  |
|                                                                                          | 3,304                    | 3,292 | 3,303 | 0,012   | -0,011  | -0,001  |
|                                                                                          | 3,306                    | 3,294 | 3,305 | 0,012   | -0,011  | -0,001  |
|                                                                                          | 3,304                    | 3,292 | 3,303 | 0,012   | -0,011  | -0,001  |
| COS φ <sub>E60</sub>                                                                     | 0,900                    |       |       |         |         |         |
| max. asymmetry [kVA]                                                                     | 0,012                    |       |       |         |         |         |
| d) cos φ = 1 at 50 % P <sub>rE</sub> ± 5 % P <sub>E<sub>max</sub></sub>                  |                          |       |       |         |         |         |
| S <sub>E60</sub> [kVA]                                                                   | 1,695                    | 1,686 | 1,685 | 0,010   | 0,001   | -0,011  |
|                                                                                          | 1,695                    | 1,685 | 1,684 | 0,010   | 0,001   | -0,011  |
|                                                                                          | 1,696                    | 1,686 | 1,685 | 0,010   | 0,001   | -0,011  |
|                                                                                          | 1,695                    | 1,685 | 1,685 | 0,010   | 0,001   | -0,011  |
|                                                                                          | 1,695                    | 1,686 | 1,685 | 0,010   | 0,001   | -0,011  |
| COS φ <sub>E60</sub>                                                                     | 0,998                    |       |       |         |         |         |

| 5.2.2                                                                                                                                                                                                                                  |                                              | Calculation of asymmetry |       |         |         |         | P |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--------------------------|-------|---------|---------|---------|---|
| Setting values                                                                                                                                                                                                                         | cos φ = 1                                    |                          |       | 1,00    |         |         |   |
|                                                                                                                                                                                                                                        | cos φ over-excited                           |                          |       | 0,90    |         |         |   |
|                                                                                                                                                                                                                                        | cos φ under-excited                          |                          |       | 0,90    |         |         |   |
| Test:                                                                                                                                                                                                                                  |                                              |                          |       |         |         |         |   |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                 |                                              |                          |       |         |         |         |   |
| 1-min mean value                                                                                                                                                                                                                       | L1                                           | L2                       | L3    | L1 – L2 | L2 – L3 | L3 – L1 |   |
| max. asymmetry [kVA]                                                                                                                                                                                                                   | -0,011                                       |                          |       |         |         |         |   |
| e) maximum under-excited (i) at 50 % P <sub>rE</sub> ± 5 % P <sub>E<sub>max</sub></sub>                                                                                                                                                |                                              |                          |       |         |         |         |   |
| S <sub>E60</sub> [kVA]                                                                                                                                                                                                                 | 1,891                                        | 1,876                    | 1,860 | 0,014   | 0,016   | -0,031  |   |
|                                                                                                                                                                                                                                        | 1,891                                        | 1,877                    | 1,861 | 0,014   | 0,016   | -0,030  |   |
|                                                                                                                                                                                                                                        | 1,892                                        | 1,878                    | 1,862 | 0,014   | 0,016   | -0,030  |   |
|                                                                                                                                                                                                                                        | 1,892                                        | 1,878                    | 1,861 | 0,014   | 0,016   | -0,030  |   |
|                                                                                                                                                                                                                                        | 1,892                                        | 1,878                    | 1,861 | 0,014   | 0,016   | -0,031  |   |
| COS φ <sub>E60</sub>                                                                                                                                                                                                                   | -0,898                                       |                          |       |         |         |         |   |
| max. asymmetry [kVA]                                                                                                                                                                                                                   | -0,031                                       |                          |       |         |         |         |   |
| f) maximum over-excited (c) at 50 % P <sub>rE</sub> ± 5 % P <sub>E<sub>max</sub></sub>                                                                                                                                                 |                                              |                          |       |         |         |         |   |
| S <sub>E60</sub> [kVA]                                                                                                                                                                                                                 | 1,859                                        | 1,857                    | 1,869 | 0,002   | -0,011  | 0,010   |   |
|                                                                                                                                                                                                                                        | 1,859                                        | 1,858                    | 1,870 | 0,002   | -0,012  | 0,011   |   |
|                                                                                                                                                                                                                                        | 1,858                                        | 1,857                    | 1,869 | 0,002   | -0,012  | 0,011   |   |
|                                                                                                                                                                                                                                        | 1,860                                        | 1,858                    | 1,870 | 0,002   | -0,012  | 0,011   |   |
|                                                                                                                                                                                                                                        | 1,860                                        | 1,859                    | 1,871 | 0,002   | -0,012  | 0,011   |   |
| COS φ <sub>E60</sub> :                                                                                                                                                                                                                 | 0,901                                        |                          |       |         |         |         |   |
| max. asymmetry [kVA]                                                                                                                                                                                                                   | -0,012                                       |                          |       |         |         |         |   |
| Limit:                                                                                                                                                                                                                                 | ≤5% S <sub>E<sub>max</sub></sub> and 3,68kVA |                          |       |         |         |         |   |
| Test:                                                                                                                                                                                                                                  |                                              |                          |       |         |         |         |   |
| The maximum absolute difference between the apparent powers of the three phases is determined for each of the five measurements (1-min means) in the respective operating point. The maximum of these five values is again determined. |                                              |                          |       |         |         |         |   |
| Assessment criterion:                                                                                                                                                                                                                  |                                              |                          |       |         |         |         |   |
| The test is passed if the maximum value from the above measurements does not exceed ≤5% S <sub>E<sub>max</sub></sub> and 3,68kVA                                                                                                       |                                              |                          |       |         |         |         |   |
| Note:                                                                                                                                                                                                                                  |                                              |                          |       |         |         |         |   |
| The maximum inductive and capacitive values are specified by the manufacturer.                                                                                                                                                         |                                              |                          |       |         |         |         |   |
| The test results base on the test report “ PVDE190903N004”issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16.                                                                                            |                                              |                          |       |         |         |         |   |

| OVE directive R25 |                                                                                     |          |
|-------------------|-------------------------------------------------------------------------------------|----------|
| Clause            | Requirement – Test                                                                  | Verdict  |
| <b>5.3</b>        | <b>Evidence of the behaviour of the generating unit on the network</b>              |          |
| <b>5.3.1</b>      | General                                                                             | <b>P</b> |
| <b>5.3.2</b>      | Measurement of the active and reactive power range                                  | <b>P</b> |
| <b>5.3.3</b>      | End of active power feed-in after OFF command via remote (ripple control) interface | <b>P</b> |
| <b>5.3.4</b>      | Active power feed-in for PGUs at overfrequency                                      | <b>P</b> |
| <b>5.3.5</b>      | Active power feed-in for PGUs at underfrequency                                     | <b>P</b> |
| <b>5.3.6</b>      | Voltage-controlled active power limitation P(V)                                     | <b>P</b> |
| <b>5.3.6.1</b>    | Voltage-controlled active power limitation P(V) - <u>quasi-stationary behavior</u>  | <b>P</b> |
| <b>5.3.6.2</b>    | Voltage-controlled active power limitation P(V) - <u>dynamic behavior</u>           | <b>P</b> |
| <b>5.3.7</b>      | Reactive power setpoint control “fix cos $\varphi$ ”                                | <b>P</b> |
| <b>5.3.8</b>      | Test of the displacement factor/active power characteristic curve cos $\varphi$ (P) | <b>P</b> |
| <b>5.3.9</b>      | Reactive power setpoint control “fix Q”                                             | <b>P</b> |
| <b>5.3.10</b>     | Voltage-controlled control functions “Q= f(V)”                                      | <b>P</b> |
| <b>5.3.10.1.1</b> | Voltage-controlled control functions “Q= f(V)” - <u>quasi-stationary behavior</u>   | <b>P</b> |
| <b>5.3.10.1.2</b> | Voltage-controlled control functions “Q= f(V)” - <u>dynamic behavior</u>            | <b>P</b> |
| <b>5.3.11</b>     | Protection of set values                                                            | <b>P</b> |



|                                                                                                     |                                                                                                                                                                                                                         |          |
|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 5.3.1                                                                                               | <b>General</b><br>(these tests are designed to provide evidence that the requirements of Tor Erzeuger section 5 are met and to determine the values for S <sub>E<sub>max</sub></sub> and P <sub>E<sub>max</sub></sub> ) | <b>P</b> |
| <b>Test Condition:</b>                                                                              | The measurements were performed in the testing laboratory at the grid-simulator.<br>Test voltage between 0,86 Un and 1,09 Un with ±2% Un until the test<br>Test frequency: 50Hz ±0,5%                                   |          |
| <b>Note:</b><br>If an examination is required for any other requirements, these apply to this test. |                                                                                                                                                                                                                         |          |

| 5.3.2                                                               | Measurement of the active power and reactive power range<br>(these tests are designed to provide evidence that the requirements of TOR Erzeuger, section 5.3.3 are met) |                |                     | P |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------------------|---|
| Setting values                                                      | cos φ = 1 [1]:                                                                                                                                                          | 1              |                     |   |
|                                                                     | Q = 43,6% over-excited:                                                                                                                                                 | 4360 Var       |                     |   |
|                                                                     | Q = 43,6% under-excited:                                                                                                                                                | -4360 Var      |                     |   |
| Test:                                                               |                                                                                                                                                                         |                |                     |   |
| FSP POWER MANAGER 10KW                                              |                                                                                                                                                                         |                |                     |   |
| 60 s mean value                                                     | 0,86 U <sub>n</sub>                                                                                                                                                     | U <sub>n</sub> | 1,09 U <sub>n</sub> |   |
| a) cos φ 1 at 100% P <sub>E<sub>max</sub></sub>                     |                                                                                                                                                                         |                |                     |   |
| U [V]                                                               | 198,09                                                                                                                                                                  | 230,36         | 250,99              |   |
| P <sub>E<sub>max</sub>60 a)</sub> [kW]                              | 8,566                                                                                                                                                                   | 10,049         | 10,082              |   |
| S <sub>E<sub>max</sub>60 a)</sub> [kVA]                             | 8,574                                                                                                                                                                   | 10,059         | 10,092              |   |
| Q <sub>E<sub>max</sub>60 a)</sub> [kVar]                            | 0,117                                                                                                                                                                   | 0,203          | -0,012              |   |
| cos φ <sub>E<sub>max</sub>60</sub>                                  | 0,999                                                                                                                                                                   | 0,999          | 0,999               |   |
| b) maximum under-excited (i) at 100% P <sub>E<sub>max</sub></sub>   |                                                                                                                                                                         |                |                     |   |
| U [V]                                                               | 198,02                                                                                                                                                                  | 230,23         | 250,90              |   |
| P <sub>E<sub>max</sub>60 b)</sub> [kW]                              | 7,464                                                                                                                                                                   | 9,026          | 8,991               |   |
| S <sub>E<sub>max</sub>60 b)</sub> [kVA]                             | 8,631                                                                                                                                                                   | 10,036         | 10,007              |   |
| Q <sub>E<sub>max</sub>60 b)</sub> [kVar]                            | -4,316                                                                                                                                                                  | -4,366         | -4,368              |   |
| cos φ <sub>E<sub>max</sub>60-under-excited</sub>                    | 0,865                                                                                                                                                                   | 0,899          | 0,898               |   |
| c) maximum over-excited (c) at 100% P <sub>E<sub>max</sub></sub>    |                                                                                                                                                                         |                |                     |   |
| U [V]                                                               | 198,18                                                                                                                                                                  | 230,23         | 251,07              |   |
| P <sub>E<sub>max</sub>60 c)</sub> [kW]                              | 7,371                                                                                                                                                                   | 8,824          | 9,064               |   |
| S <sub>E<sub>max</sub>60 c)</sub> [kVA]                             | 8,528                                                                                                                                                                   | 9,851          | 10,072              |   |
| Q <sub>E<sub>max</sub>60 c)</sub> [kVar]                            | 4,279                                                                                                                                                                   | 4,370          | 4,382               |   |
| cos φ <sub>E<sub>max</sub>60-over-excited</sub>                     | 0,864                                                                                                                                                                   | 0,896          | 0,900               |   |
| d) maximum under-excited (i) at 20-30% P <sub>E<sub>max</sub></sub> |                                                                                                                                                                         |                |                     |   |
| U [V]                                                               | 197,87                                                                                                                                                                  | 230,07         | 250,78              |   |
| P <sub>E<sub>max</sub>60 d)</sub> [kW]                              | 2,972                                                                                                                                                                   | 2,947          | 2,950               |   |
| S <sub>E<sub>max</sub>60 d)</sub> [kVA]                             | 5,280                                                                                                                                                                   | 5,262          | 5,263               |   |
| Q <sub>E<sub>max</sub>60 d)</sub> [kVar]                            | -4,355                                                                                                                                                                  | -4,348         | -4,344              |   |
| cos φ <sub>E<sub>max</sub>60-under-excited</sub>                    | 0,563                                                                                                                                                                   | 0,560          | 0,561               |   |
| e) maximum over-excited (c) at 20-30% P <sub>E<sub>max</sub></sub>  |                                                                                                                                                                         |                |                     |   |
| U [V]                                                               | 197,93                                                                                                                                                                  | 230,25         | 250,95              |   |
| P <sub>E<sub>max</sub>60 e)</sub> [kW]                              | 3,000                                                                                                                                                                   | 3,013          | 3,029               |   |
| S <sub>E<sub>max</sub>60 e)</sub> [kVA]                             | 5,238                                                                                                                                                                   | 5,251          | 5,266               |   |
| Q <sub>E<sub>max</sub>60 e)</sub> [kVar]                            | 4,287                                                                                                                                                                   | 4,292          | 4,298               |   |
| cos φ <sub>E<sub>max</sub>60-over-excited</sub>                     | 0,573                                                                                                                                                                   | 0,574          | 0,575               |   |

| 5.3.2                                                                                                                                                                                                                                                                                 |        | Measurement of the active power and reactive power range<br>(these tests are designed to provide evidence that the requirements of TOR Erzeuger, section 5.3.3 are met) |           | P |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---|
| Setting values                                                                                                                                                                                                                                                                        |        | cos φ = 1 [1]:                                                                                                                                                          | 1         |   |
|                                                                                                                                                                                                                                                                                       |        | Q = 43,6% over-excited:                                                                                                                                                 | 4360 Var  |   |
|                                                                                                                                                                                                                                                                                       |        | Q = 43,6% under-excited:                                                                                                                                                | -4360 Var |   |
| Test:                                                                                                                                                                                                                                                                                 |        |                                                                                                                                                                         |           |   |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                                |        |                                                                                                                                                                         |           |   |
| f) maximum under-excited (i) at 10-20% P <sub>E<sub>max</sub></sub>                                                                                                                                                                                                                   |        |                                                                                                                                                                         |           |   |
| U [V]                                                                                                                                                                                                                                                                                 | 197,90 | 230,04                                                                                                                                                                  | 250,73    |   |
| P <sub>E<sub>max</sub>60 f)</sub> [kW]                                                                                                                                                                                                                                                | 1,870  | 1,866                                                                                                                                                                   | 1,878     |   |
| S <sub>E<sub>max</sub>60 f)</sub> [kVA]                                                                                                                                                                                                                                               | 4,730  | 4,725                                                                                                                                                                   | 4,727     |   |
| Q <sub>E<sub>max</sub>60 f)</sub> [kVar]                                                                                                                                                                                                                                              | -4,336 | -4,329                                                                                                                                                                  | -4,324    |   |
| COS φ <sub>E<sub>max</sub>60-under-excited</sub>                                                                                                                                                                                                                                      | 0,395  | 0,395                                                                                                                                                                   | 0,397     |   |
| g) maximum over-excited (c) at 10-20% P <sub>E<sub>max</sub></sub>                                                                                                                                                                                                                    |        |                                                                                                                                                                         |           |   |
| U [V]                                                                                                                                                                                                                                                                                 | 198,04 | 230,25                                                                                                                                                                  | 250,90    |   |
| P <sub>E<sub>max</sub>60 i)</sub> [kW]                                                                                                                                                                                                                                                | 1,854  | 1,875                                                                                                                                                                   | 1,883     |   |
| S <sub>E<sub>max</sub>60 i)</sub> [kVA]                                                                                                                                                                                                                                               | 4,697  | 4,716                                                                                                                                                                   | 4,727     |   |
| Q <sub>E<sub>max</sub>60 i)</sub> [kVar]                                                                                                                                                                                                                                              | 4,307  | 4,318                                                                                                                                                                   | 4,325     |   |
| COS φ <sub>E<sub>max</sub>60-over-excited</sub>                                                                                                                                                                                                                                       | 0,395  | 0,398                                                                                                                                                                   | 0,398     |   |
| h) maximum under-excited (i) at 0-10% P <sub>E<sub>max</sub></sub>                                                                                                                                                                                                                    |        |                                                                                                                                                                         |           |   |
| U [V]                                                                                                                                                                                                                                                                                 | 197,81 | 230,02                                                                                                                                                                  | 250,72    |   |
| P <sub>E<sub>max</sub>60 i)</sub> [kW]                                                                                                                                                                                                                                                | 0,959  | 0,976                                                                                                                                                                   | 0,979     |   |
| S <sub>E<sub>max</sub>60 i)</sub> [kVA]                                                                                                                                                                                                                                               | 4,464  | 4,462                                                                                                                                                                   | 4,461     |   |
| Q <sub>E<sub>max</sub>60 i)</sub> [kVar]                                                                                                                                                                                                                                              | -4,351 | -4,343                                                                                                                                                                  | -4,338    |   |
| COS φ <sub>E<sub>max</sub>60-under-excited</sub>                                                                                                                                                                                                                                      | 0,215  | 0,219                                                                                                                                                                   | 0,219     |   |
| i) maximum over-excited (c) at 0-10% P <sub>E<sub>max</sub></sub>                                                                                                                                                                                                                     |        |                                                                                                                                                                         |           |   |
| U [V]                                                                                                                                                                                                                                                                                 | 197,99 | 230,21                                                                                                                                                                  | 250,89    |   |
| P <sub>E<sub>max</sub>60 i)</sub> [kW]                                                                                                                                                                                                                                                | 0,990  | 0,998                                                                                                                                                                   | 1,002     |   |
| S <sub>E<sub>max</sub>60 i)</sub> [kVA]                                                                                                                                                                                                                                               | 4,456  | 4,468                                                                                                                                                                   | 4,480     |   |
| Q <sub>E<sub>max</sub>60 i)</sub> [kVar]                                                                                                                                                                                                                                              | 4,337  | 4,345                                                                                                                                                                   | 4,356     |   |
| COS φ <sub>E<sub>max</sub>60-over-excited</sub>                                                                                                                                                                                                                                       | 0,222  | 0,223                                                                                                                                                                   | 0,224     |   |
| S <sub>E<sub>max</sub>60</sub> and P <sub>E<sub>max</sub>60</sub>                                                                                                                                                                                                                     |        |                                                                                                                                                                         |           |   |
| S <sub>E<sub>max</sub>60</sub> = max(S <sub>E<sub>max</sub>60 a)</sub> , S <sub>E<sub>max</sub>60 b)</sub> , S <sub>E<sub>max</sub>60 c)</sub> ) [kVA]                                                                                                                                |        | 10,092                                                                                                                                                                  |           |   |
| P <sub>E<sub>max</sub>60</sub> = max(P <sub>E<sub>max</sub>60 a)</sub> , P <sub>E<sub>max</sub>60 b)</sub> , P <sub>E<sub>max</sub>60 c)</sub> ) [kW]                                                                                                                                 |        | 10,082                                                                                                                                                                  |           |   |
| Test:                                                                                                                                                                                                                                                                                 |        |                                                                                                                                                                         |           |   |
| * For test d - I, the test voltage at which the highest active power was achieved is taken!                                                                                                                                                                                           |        |                                                                                                                                                                         |           |   |
| The PGU is operated in all possible of the following operating points, whereby each operating point must be kept for at least 1 minutes after the settling process has subsided. During the partial measurements a) to c) below, the primary energy source must not limit the output. |        |                                                                                                                                                                         |           |   |

| 5.3.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Measurement of the active power and reactive power range<br>(these tests are designed to provide evidence that the requirements of TOR Erzeuger, section 5.3.3 are met) | P         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Setting values                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | cos $\varphi$ = 1 [1]:                                                                                                                                                  | 1         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Q = 43,6% over-excited:                                                                                                                                                 | 4360 Var  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Q = 43,6% under-excited:                                                                                                                                                | -4360 Var |
| <b>Test:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |           |
| <b>FSP POWER MANAGER 10KW</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                         |           |
| <p>Measurement points a-c has to be performed at <math>U_n</math>, <math>0,86U_n</math> and <math>1,09 U_n</math></p> <p>a) With <math>0,86 U_n</math>, <math>U_n</math> and <math>1,09 U_n</math>, the maximum possible active power must be set under the specification of a cos (<math>\varphi</math>) 1.</p> <p>b) With <math>0,86 U_n</math>, <math>U_n</math> and <math>1,09 U_n</math>, the maximum possible active power with maximum <u>under-excited</u> operation must be set (Q = 43,6%/S<sub>n</sub>.)</p> <p>c) At <math>0,86 U_n</math>, <math>U_n</math> and <math>1,09 U_n</math>, the maximum possible active power with maximum <u>overexcited</u> operation must be set(Q = 43,6%/S<sub>n</sub>.)</p> <p>d) With <math>0,86 U_n^*</math>, <math>U_n^*</math> and <math>1,09 U_n^*</math>, the 20-30% active power which was determined values from a) with maximum <u>under-excited</u> operation must be set (Q =43,6%/S<sub>n</sub>.)</p> <p>e) At <math>0,86 U_n^*</math>, <math>U_n^*</math> and <math>1,09 U_n^*</math>, the 20-30% possible active power which was determined values from a) with maximum <u>overexcited</u> operation must be set(Q =43,6%/S<sub>n</sub>.)</p> <p>f) With <math>0,86 U_n^*</math>, <math>U_n^*</math> and <math>1,09 U_n^*</math>, the 10-20% active power which was determined values from a) with maximum <u>under-excited</u> operation must be set (Q =43,6%/S<sub>n</sub>.)</p> <p>g) At <math>0,86 U_n^*</math>, <math>U_n^*</math> and <math>1,09 U_n^*</math>, the 10-20% possible active power which was determined values from a) with maximum <u>overexcited</u> operation must be set(Q =43,6%/S<sub>n</sub>.)</p> <p>h) With <math>0,86 U_n^*</math>, <math>U_n^*</math> and <math>1,09 U_n^*</math>, the 0-10% active power which was determined values from a) with maximum <u>under-excited</u> operation must be set (Q =43,6%/S<sub>n</sub>.)</p> <p>i) At <math>0,86 U_n^*</math>, <math>U_n^*</math> and <math>1,09 U_n^*</math>, the 0-10% possible active power which was determined values from a) with maximum <u>overexcited</u> operation must be set(Q =43,6%/S<sub>n</sub>.)</p> |                                                                                                                                                                         |           |
| <p><b>Assessment criterion:</b></p> <p>S<sub>E<sub>max</sub>60</sub> and P<sub>E<sub>max</sub> 60</sub> are determined by the highest value measured.</p> $S_{E_{max}60} = \max(S_{E_{max}60a), S_{E_{max}60b), S_{E_{max}60c)})$ $P_{E_{max}60} = \max(P_{E_{max}60a), P_{E_{max}60b), P_{E_{max}60c)})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                         |           |
| <p><b>Note:</b></p> <p>Q = 31,2 (<math>\varphi</math> 0,95)      (i) and (c):      PGU <math>\leq</math> 3,68 kVA</p> <p>Cos phi = (<math>\varphi</math>) 0,90      (i) and (c):      PGU <math>\leq</math> 3,68 kVA (only Inverter)</p> <p>Q = 43,6 (<math>\varphi</math> 0,90)      (i) and (c):      PGU <math>&gt;</math> 3,68 kVA (only Inverter)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                         |           |

|         |                                                                                                                                                                                |   |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 5.3.3.1 | <b>End of active power feed-in after OFF command via remote (ripple control) interface</b><br>These tests serve to demonstrate the requirements of Tor Erzeuger, Section 5.4.1 | P |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

**Test:**
**FSP POWER MANAGER 10KW**

|                                   |    |    |
|-----------------------------------|----|----|
| 1-min mean value / $P_{rE}/P$ [%] | 30 | <5 |
|-----------------------------------|----|----|

|                     |       |       |
|---------------------|-------|-------|
| $P_{Setpoint}$ [kW] | 3,000 | 0,500 |
|---------------------|-------|-------|

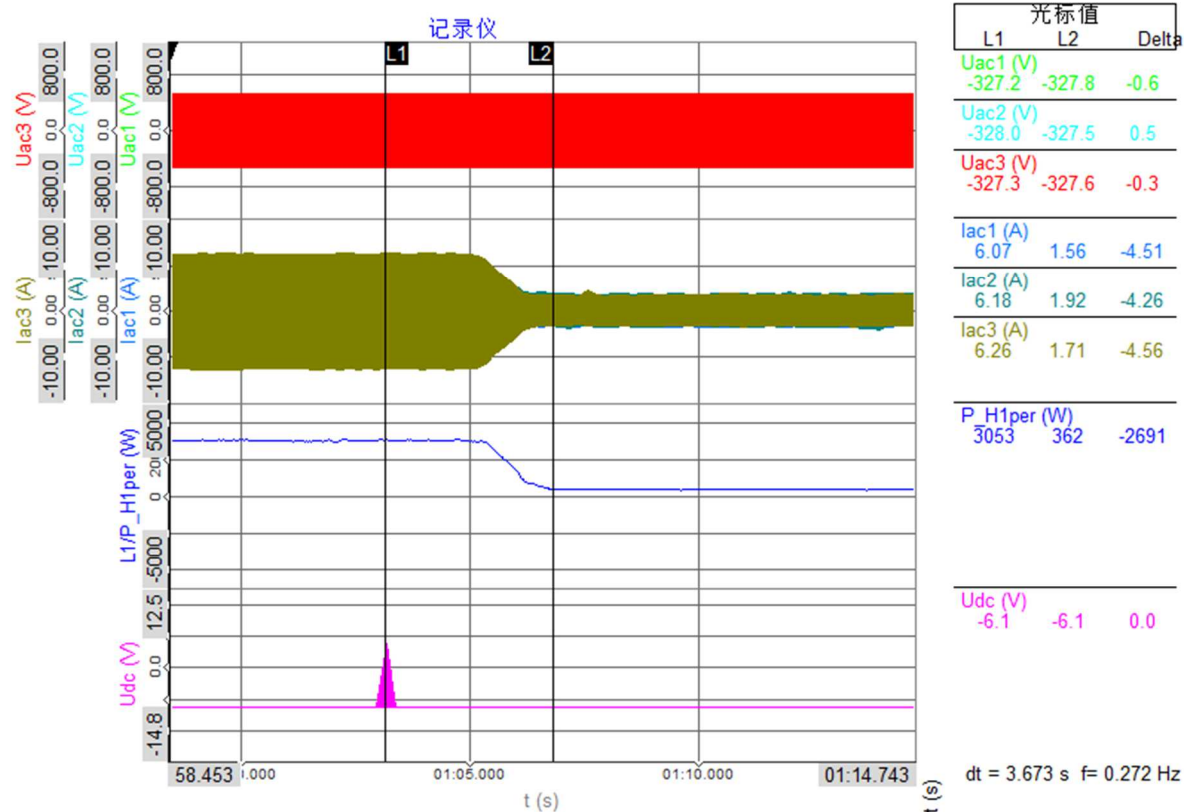
|                |       |       |
|----------------|-------|-------|
| $P_{E60}$ [kW] | 3,053 | 0,362 |
|----------------|-------|-------|

|           |       |  |
|-----------|-------|--|
| $T_0$ [s] | 3,7 s |  |
|-----------|-------|--|

**Limit**

|           |   |   |
|-----------|---|---|
| $T_0$ [s] | 5 | P |
|-----------|---|---|

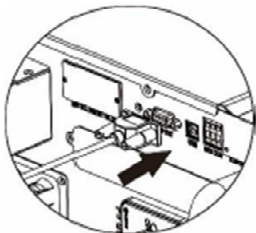
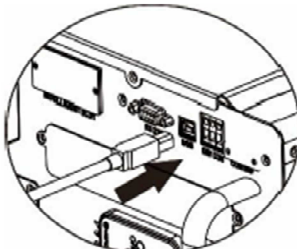
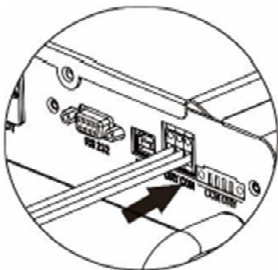
Graph of active power



Picture of used interface + Manual description.

## 9. Communication

The inverter is equipped with several communication ports and it is also equipped with a slot for alternative communication interfaces in order to communicate with a PC with corresponding software. This intelligent slot is suitable to install with SNMP card and Modbus card. Follow below procedure to connect communication wiring and install the software.

|                                                                                                                    |                                                                                     |
|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| For RS232 port, you should use a DB9 cable as follows:                                                             | For USB port, you should use a USB cable as follows:                                |
|                                   |   |
| For Dry contact port, please remove insulation sleeve 8 mm for three conductors and insert three cables into ports | For SNMP or MODBUS card, you should use RJ45 cables as follows:                     |
|                                  |  |

Please install monitoring software in your computer. Detailed information is listed in the next chapter. After software is installed, you may initial the monitoring software and extract data through communication port.

### Test:

Interface used: RS-232 communication port.

The setpoint signal is reduced from 30% to <5%  $P_{rE}$ .

For this test, the PGU is operated with an effective power of at least 20%  $P_{rE}$ .

The command to terminate the active power feed is then given via the provided interface (input port) and the time until the actual termination of the active power feed is measured.

### Assessment criterion:

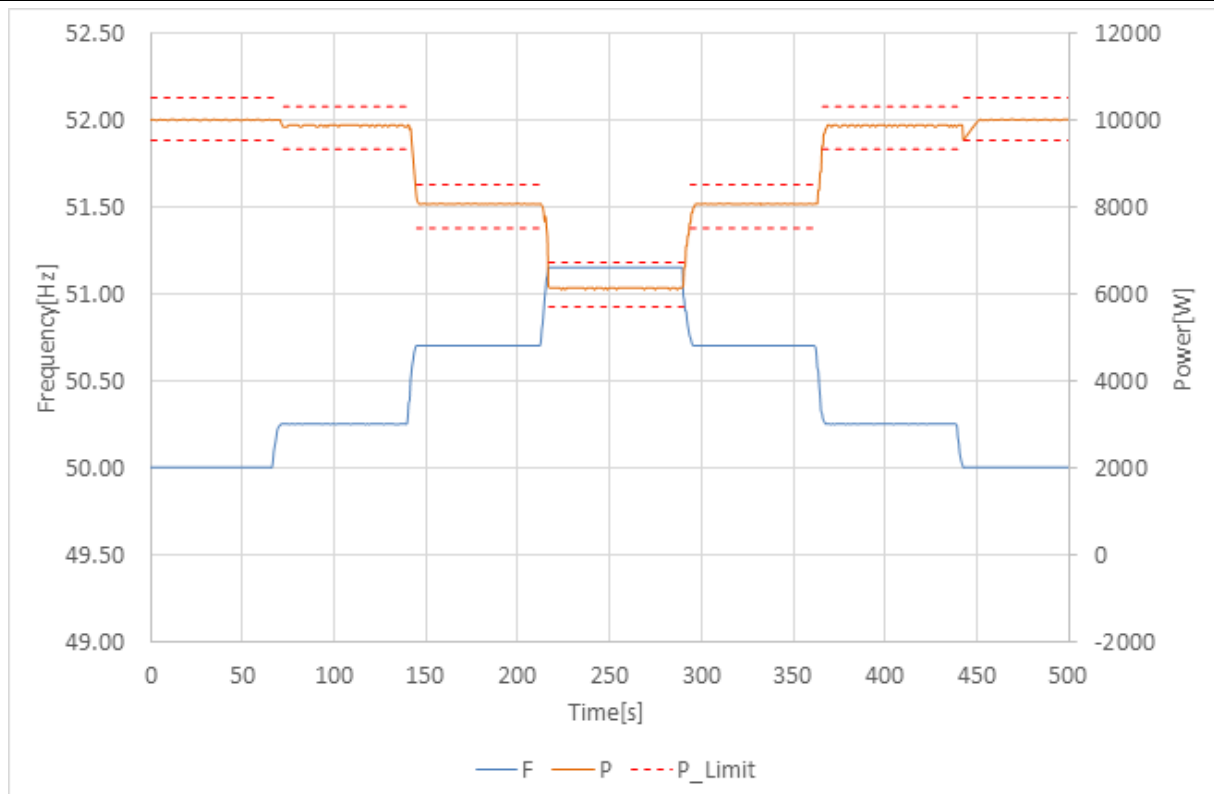
The test is passed if the PGU ends the active power feed within 5s. The criterion is an active power feed-in <5%  $P_{rE}$ .

A separation of the PGU from the network is permitted, but not mandatory

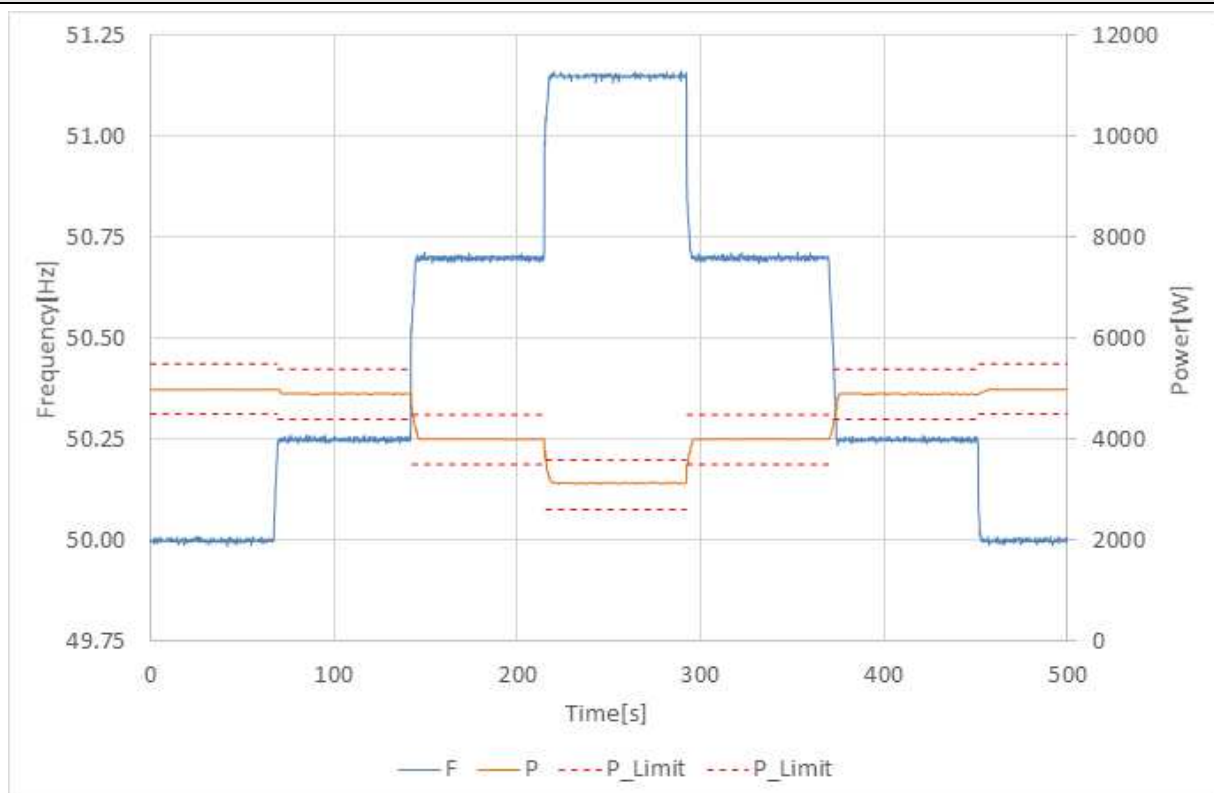
### Note:

|                                                                                                                                                |                                                                                                                                                       |       |       |       |       |       |        |
|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|-------|--------|
| 5.3.4                                                                                                                                          | Active power feed-in for PGUs at overfrequency<br>(these tests are designed to provide evidence of the requirements of TOR Erzeuger, 5.1.3 and 5.5.2) |       |       |       |       |       | P      |
| Test cycle for adjustable PGUs:                                                                                                                |                                                                                                                                                       |       |       |       |       |       |        |
| FSP POWER MANAGER 10KW                                                                                                                         |                                                                                                                                                       |       |       |       |       |       |        |
| Test 1:                                                                                                                                        |                                                                                                                                                       |       |       |       |       |       |        |
| 1-min mean value                                                                                                                               | 50,00                                                                                                                                                 | 50,25 | 50,70 | 51,15 | 50,70 | 50,25 | 50,00  |
| Expected active power output [% P <sub>E<sub>max</sub></sub> ]:                                                                                | 100                                                                                                                                                   | 98    | 80    | 62    | 80    | 98    | 100    |
| Measurement: 100% P <sub>E<sub>max</sub></sub> ; start frequency 50,20Hz; droop s setting = 5% (40% P <sub>ref</sub> /Hz)                      |                                                                                                                                                       |       |       |       |       |       |        |
| Frequency [Hz]                                                                                                                                 | 50,00                                                                                                                                                 | 50,25 | 50,70 | 51,15 | 50,70 | 50,25 | 50,00  |
| P <sub>setpoint</sub> [kW]                                                                                                                     | 10,000                                                                                                                                                | 9,800 | 8,000 | 6,200 | 8,000 | 9,800 | 10,000 |
| P <sub>E60</sub> [kW]                                                                                                                          | 9,993                                                                                                                                                 | 9,863 | 8,064 | 6,156 | 8,060 | 9,863 | 9,934  |
| ΔP <sub>E60</sub> [%]                                                                                                                          | -0,07                                                                                                                                                 | 0,63  | 0,64  | -0,44 | 0,60  | 0,63  | -0,66  |
| Available DC-power [%]                                                                                                                         | 100                                                                                                                                                   |       |       |       |       |       |        |
| Test 2:                                                                                                                                        |                                                                                                                                                       |       |       |       |       |       |        |
| Measurement: Active power output 40% and 60% after freezing > 80% P <sub>E<sub>max</sub></sub> droop s setting = 5% (40% P <sub>ref</sub> /Hz) |                                                                                                                                                       |       |       |       |       |       |        |
| Frequency [Hz]                                                                                                                                 | 50,00                                                                                                                                                 | 50,25 | 50,70 | 51,15 | 50,70 | 50,25 | 50,00  |
| P <sub>setpoint</sub> [kW]                                                                                                                     | 5,000                                                                                                                                                 | 4,900 | 4,000 | 3,100 | 4,000 | 4,900 | 10,000 |
| P <sub>E60</sub> [kW]                                                                                                                          | 4,968                                                                                                                                                 | 4,962 | 4,050 | 3,147 | 4,049 | 4,960 | 9,944  |
| ΔP <sub>E60</sub> [%]                                                                                                                          | -0,32                                                                                                                                                 | 0,62  | 0,50  | 0,47  | 0,49  | 0,60  | -0,56  |
| Available DC-power [%]                                                                                                                         | 40 – 60                                                                                                                                               |       | 100   |       |       |       |        |
| Active Power Gradient                                                                                                                          | 9,55%P <sub>E<sub>max</sub></sub> /min                                                                                                                |       |       |       |       |       |        |
| Limit                                                                                                                                          |                                                                                                                                                       |       |       |       |       |       |        |
| ΔP <sub>E60</sub> in %                                                                                                                         | ≤ +5% of P <sub>E<sub>max</sub></sub>                                                                                                                 |       |       |       |       |       | P      |
| DC setting values:                                                                                                                             |                                                                                                                                                       |       |       |       |       |       |        |
| PV-curve simulated according to                                                                                                                |                                                                                                                                                       |       |       |       |       |       |        |
| Voltage of defined MPP [V]                                                                                                                     |                                                                                                                                                       |       |       | 700   |       |       |        |
| Current of defined MPP [A]                                                                                                                     |                                                                                                                                                       |       |       | 15,7  |       |       |        |
| FFU of PV curve [1]                                                                                                                            |                                                                                                                                                       |       |       | 0,68  |       |       |        |
| P <sub>DC</sub> [kW]                                                                                                                           |                                                                                                                                                       |       |       | 11,0  |       |       |        |

**Graph Test 1@ 100%  $P_{Emax}$**

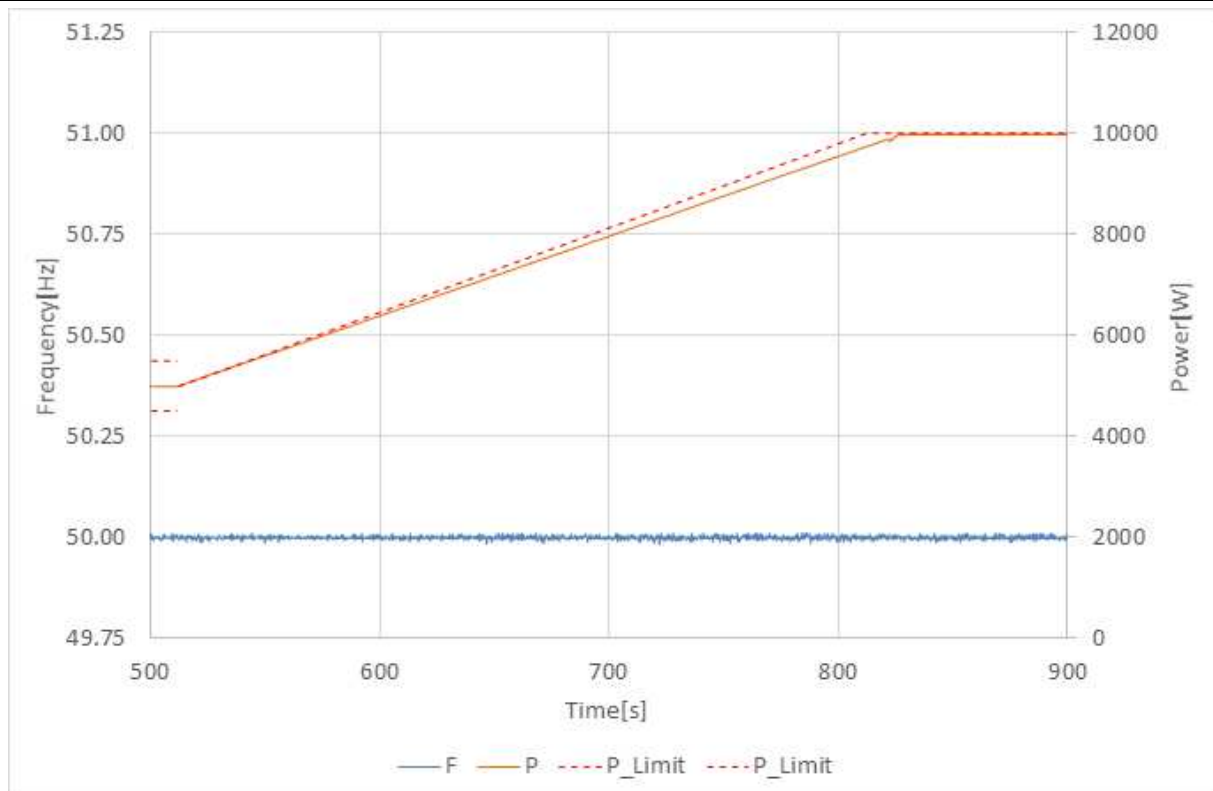


**Graph Test2 @ 40-60%  $P_{Emax}$**





## Gradient Test 2



### Assessment criterion:

For  $f = 50,2$  Hz, the value of the  $P_{ref}$  active power currently being generated is "frozen".

#### a) For adjustable PGUs when:

- 1) the active power reduces between measuring points b) and f) given above with a gradient of 40%  $P_{ref}$  per Hz for a decreasing frequency (or rises for a frequency decreasing again).
- 2) the maximum active power gradient occurring in point g) is lower than 10% of maximum active power  $P_{Emax}$  every minute, and
- 3) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from  $P_{Emax}$  by more than  $\pm 5\%$ .

#### b) For conditionally adjustable PGUs

- 1) when they behave as in a) within their adjustment range, and
- 2) when, outside the adjustable range, the power fed in on leaving the adjustment range remains constant until shutdown. Shutdown must be no later than at 51,5Hz.

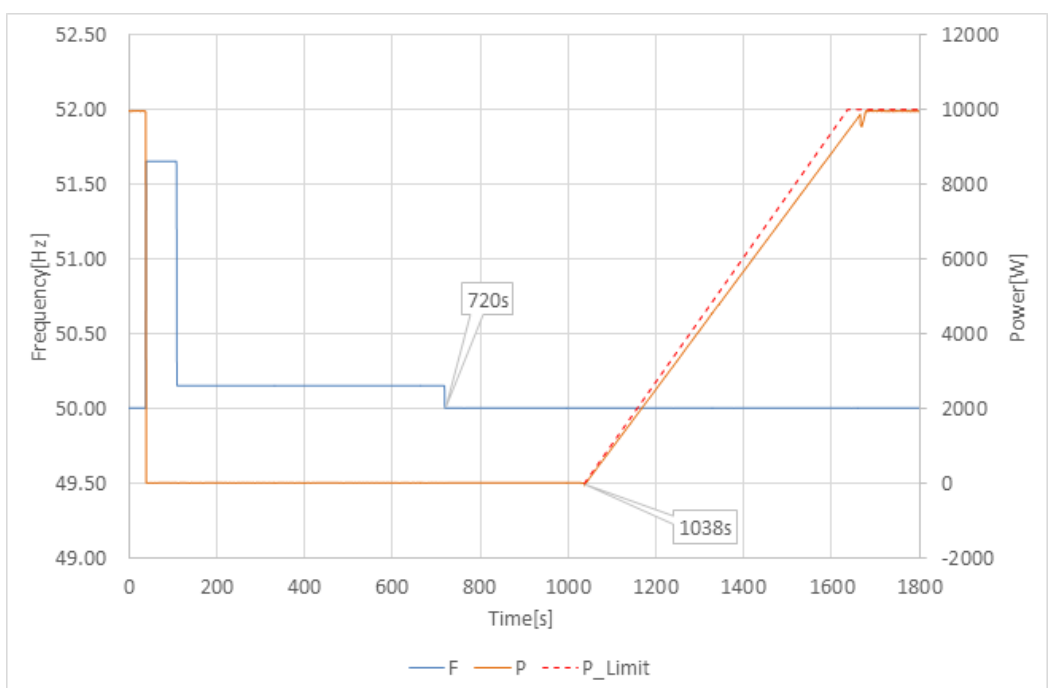
#### c) for non-regulated PGU, if

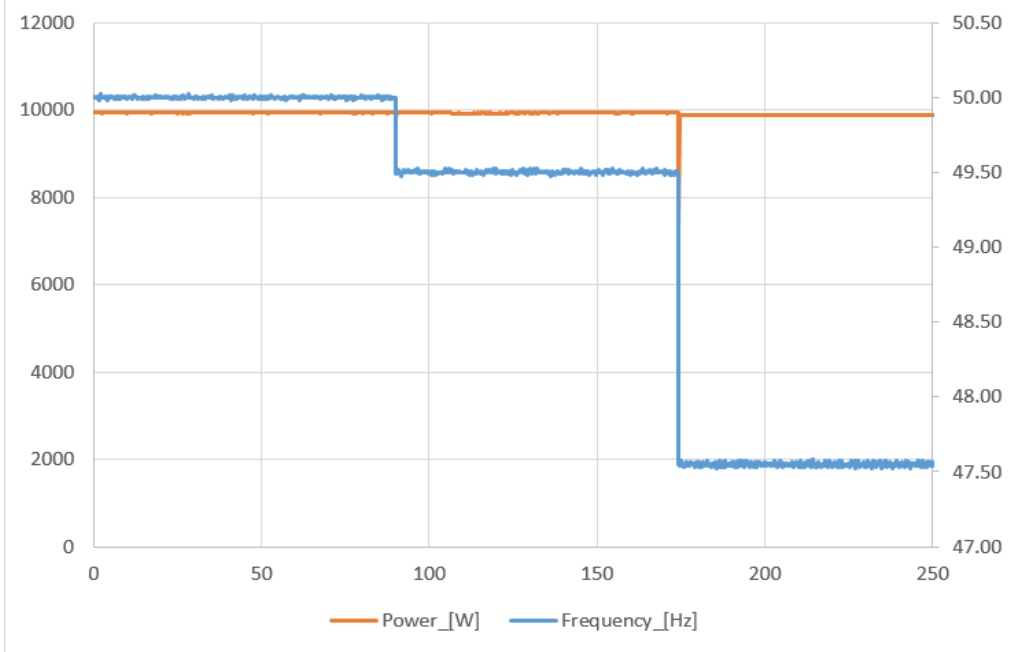
- a switch-off between 50,2Hz and 51,5Hz takes place within 1s;
- The connection time in point j) corresponds to the manufacturer's information on the random generator

Note:

The even distribution of the switch-off frequency in a maximum of 0,1 Hz steps between the end of the controllable range (at least 50,2Hz) and 51,5Hz must be proven by a manufacturer's declaration.

**Note:**

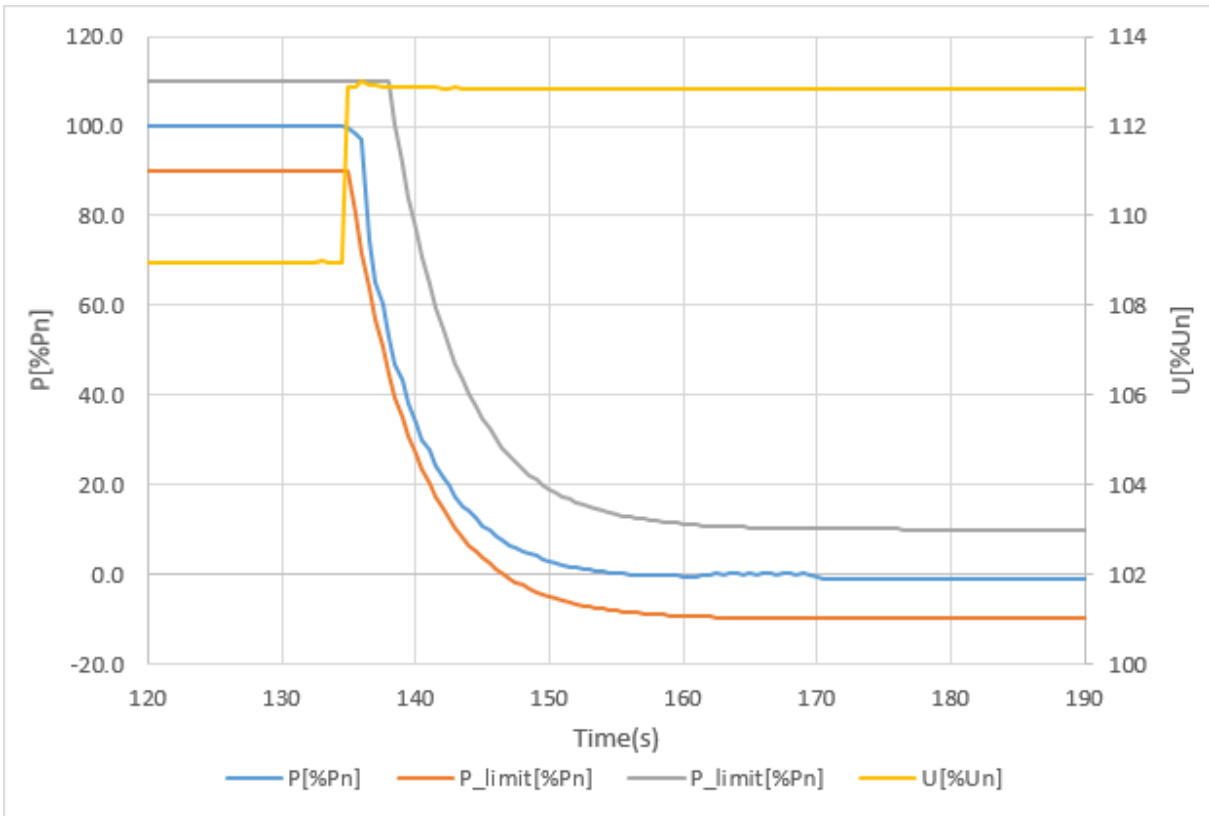
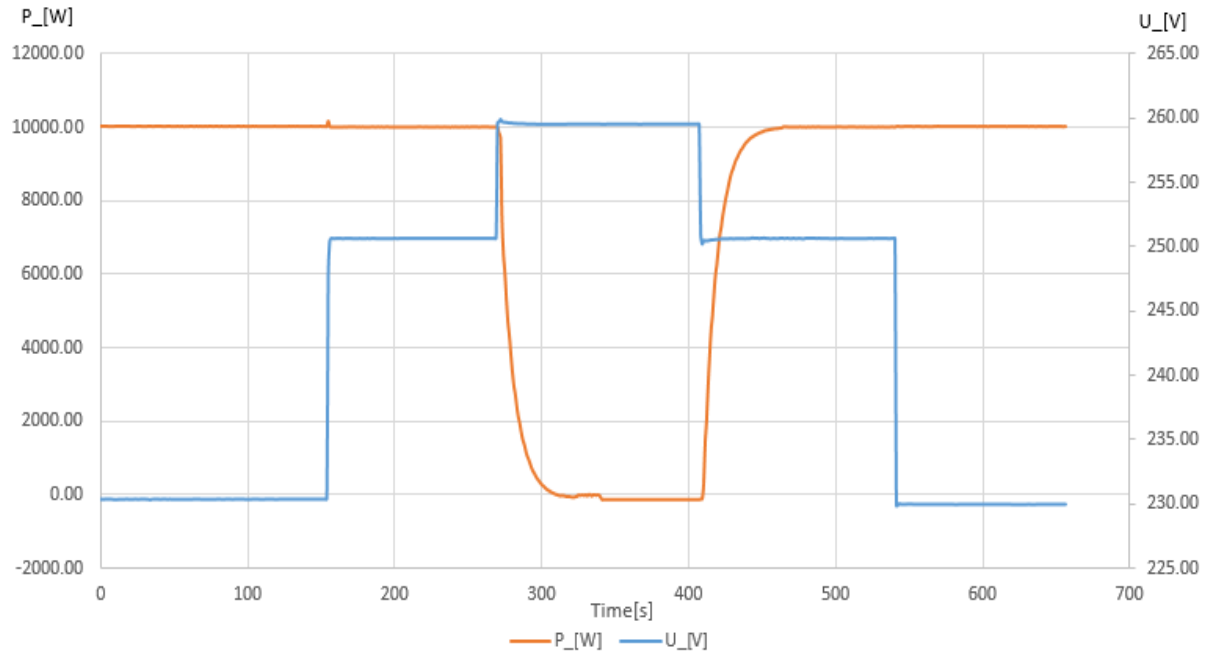
|                                                                                                                                                                                   |                                                                                   |                     |                     |                     |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------|---------------------|---------------------|---|
| 5.3.4.1.2                                                                                                                                                                         | Test cycle for all PGUs (adjustable, conditionally adjustable and non-adjustable) |                     |                     |                     | P |
| Test:                                                                                                                                                                             |                                                                                   |                     |                     |                     |   |
| FSP POWER MANAGER 10KW                                                                                                                                                            |                                                                                   |                     |                     |                     |   |
| 1-min mean value                                                                                                                                                                  | g) 50,00Hz ± 0,01Hz                                                               | h) 51,65Hz ± 0,05Hz | i) 50,15Hz ± 0,01Hz | j) 50,00Hz ± 0,01Hz |   |
| 1) g) 50,00Hz ± 0,01Hz to h) 51,65Hz ± 0,05Hz                                                                                                                                     |                                                                                   |                     |                     |                     |   |
| Disconnection time [s]:                                                                                                                                                           | 0,166                                                                             | Limit [s]:          | 0,2                 |                     |   |
| Max. Gradient [%]:                                                                                                                                                                | 9,36                                                                              | Limit [%]:          | 10,0                |                     |   |
| Test:                                                                                                                                                                             |                                                                                   |                     |                     |                     |   |
| Following tests a) to g), frequency h) 51,65Hz ± 0,05Hz must be set for at least 0,2s. Afterwards, frequency i) 50,15Hz ± 0,01Hz is enabled and kept for at least 7 minutes.      |                                                                                   |                     |                     |                     |   |
| Afterwards, frequency j) 50,00Hz ± 0,01Hz is enabled and kept until transient oscillation of the active power at the earliest.                                                    |                                                                                   |                     |                     |                     |   |
| Assessment criterion:                                                                                                                                                             |                                                                                   |                     |                     |                     |   |
| The PGU must have disconnected from the network no later than 0,2s after frequency h) is reached.                                                                                 |                                                                                   |                     |                     |                     |   |
| Thereafter, also whilst frequency i) is being held, there may be no resynchronisation or active power feed-in, i.e. not on the characteristic curve as tested before in a) to g). |                                                                                   |                     |                     |                     |   |
| a) For adjustable PGUs when:                                                                                                                                                      |                                                                                   |                     |                     |                     |   |
| ab) the maximum active power gradient occurring in point j) is lower than 10% of maximum active power P <sub>E<sub>max</sub></sub> every minute, and                              |                                                                                   |                     |                     |                     |   |
| ac) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from P <sub>E<sub>max</sub></sub> by more than ±5%.                        |                                                                                   |                     |                     |                     |   |
| b) For conditionally adjustable PGUs                                                                                                                                              |                                                                                   |                     |                     |                     |   |
| ba) when they behave as in a) within their adjustment range, and                                                                                                                  |                                                                                   |                     |                     |                     |   |
| bb) when, outside the adjustable range, the power fed in on leaving the adjustment range remains constant until shutdown. Shutdown must be no later than at 51,5 Hz.              |                                                                                   |                     |                     |                     |   |
| Graph:                                                                                                                                                                            |                                                                                   |                     |                     |                     |   |
|                                                                                               |                                                                                   |                     |                     |                     |   |
| Note:                                                                                                                                                                             |                                                                                   |                     |                     |                     |   |

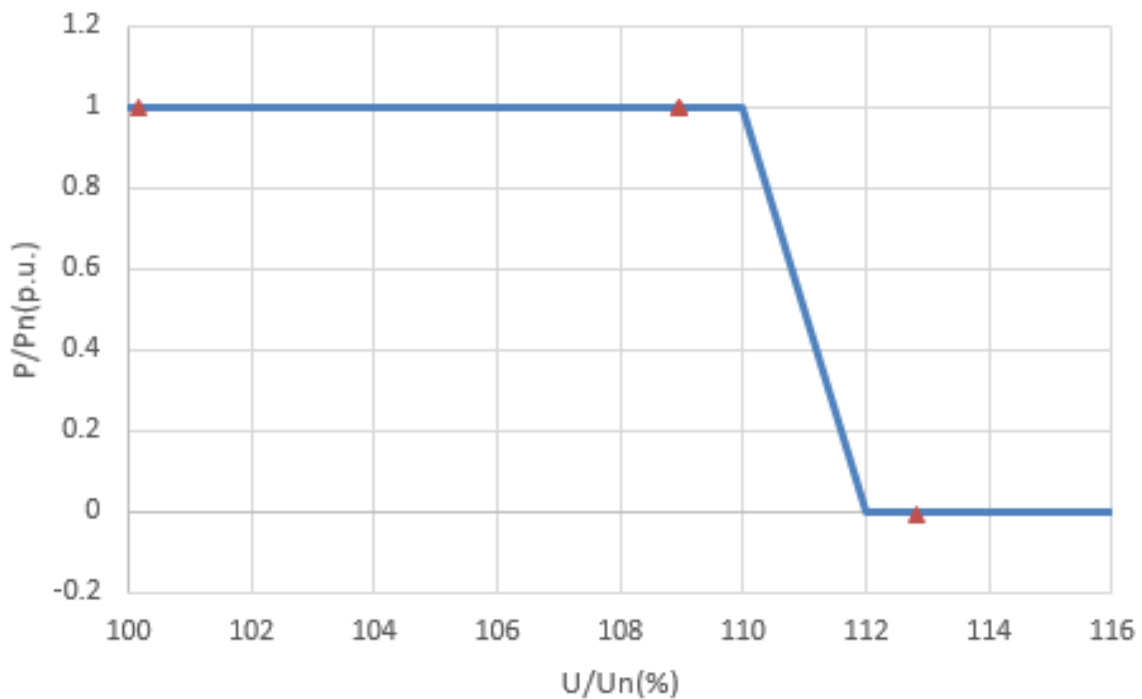
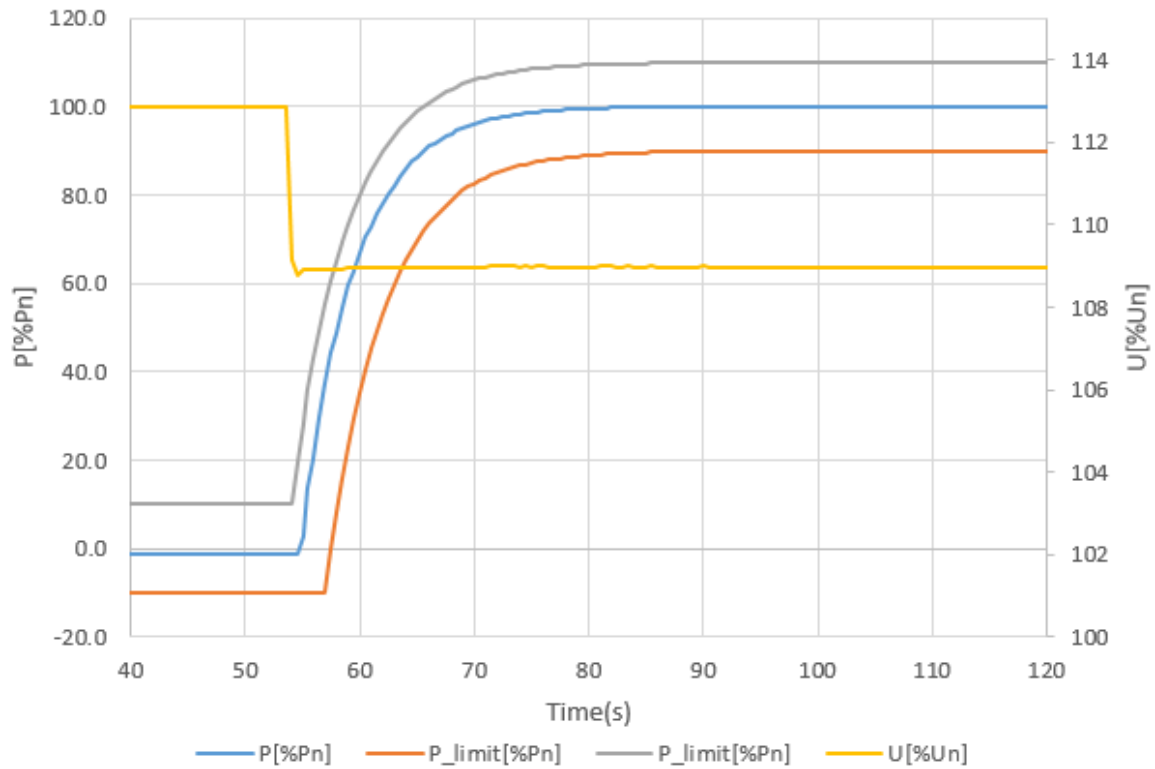
|                                                                                                                                                                                                                                                                        |                                                                                                                                             |                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 5.3.5                                                                                                                                                                                                                                                                  | <b>Active power feed-in for underfrequency</b><br>(these tests are designed to provide evidence of the requirements of TOR Erzeuger, 5.1.5) | P                                        |
| Test:                                                                                                                                                                                                                                                                  |                                                                                                                                             |                                          |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                 |                                                                                                                                             |                                          |
| Graph of frequency a) to c):                                                                                                                                                                                                                                           |                                                                                                                                             |                                          |
|                                                                                                                                                                                     |                                                                                                                                             |                                          |
| For non-synchronous EZE:                                                                                                                                                                                                                                               |                                                                                                                                             |                                          |
| 1-min mean value                                                                                                                                                                                                                                                       | a) 50 ± 0,01 [Hz]                                                                                                                           | b) -0,50[ Hz]      c)- 2,4 to - 2,5 [Hz] |
| Frequency [Hz]:                                                                                                                                                                                                                                                        | 50,00                                                                                                                                       | 49,50      47,55                         |
| P <sub>E60</sub> [kW]:                                                                                                                                                                                                                                                 | 9,933                                                                                                                                       | 9,930      9,883                         |
| ΔP <sub>b</sub> /P <sub>c</sub> [%]:                                                                                                                                                                                                                                   | <0,15%                                                                                                                                      |                                          |
| Test:                                                                                                                                                                                                                                                                  |                                                                                                                                             |                                          |
| Operating point b) and c) must be kept for at least 1 minute.                                                                                                                                                                                                          |                                                                                                                                             |                                          |
| The test must be carried out at 100% P <sub>Emax</sub> .                                                                                                                                                                                                               |                                                                                                                                             |                                          |
| With a programmable AC source, the PGU is operated at 100% P <sub>Emax</sub> and 50Hz ±0,01Hz, thereafter the frequency is reduced to -0,5Hz and after 1 minute reduce to -2,4Hz to -2,5Hz. A 1-min mean value is recorded both before and after the frequency change. |                                                                                                                                             |                                          |
| Assessment criterion:                                                                                                                                                                                                                                                  |                                                                                                                                             |                                          |
| For synchronous PGU:                                                                                                                                                                                                                                                   |                                                                                                                                             |                                          |
| - The test is passed if the PGU does not reduce the power when the grid frequency changes from operating point a) to b) and the power drops by a maximum of 10% P <sub>rE</sub> per Hz from operating point b) to c).                                                  |                                                                                                                                             |                                          |
| For non-synchronous PGU:                                                                                                                                                                                                                                               |                                                                                                                                             |                                          |
| - The test is passed if the PGU changes from operating point a) to b) when the network frequency changes does not reduce the power and from operating point b) to c) the power drops by a maximum of 2% P <sub>rE</sub> per Hz.                                        |                                                                                                                                             |                                          |
| Note:                                                                                                                                                                                                                                                                  |                                                                                                                                             |                                          |

|                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                |                                       |                                        |                       |                                        |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|----------------------------------------|-----------------------|----------------------------------------|----------|
| 5.3.6                                                                                                                                                                                                                                                                                          | <b>Voltage-controlled active power limitation P(V)</b><br>The test serves as verification of the active power reduction mode at over voltage according to TOR Erzeuger, 5.3.6. |                                       |                                        |                       |                                        | <b>P</b> |
| 5.3.6.1.1                                                                                                                                                                                                                                                                                      | <b>Voltage-controlled active power limitation P(V) - <u>quasi-stationary behavior</u></b>                                                                                      |                                       |                                        |                       |                                        | <b>P</b> |
| Test:                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                |                                       |                                        |                       |                                        |          |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                                         |                                                                                                                                                                                |                                       |                                        |                       |                                        |          |
| <b>Vac<sub>setpoint</sub><br/>[%Un]</b>                                                                                                                                                                                                                                                        | <b>Vac<sub>expected</sub><br/>[V]</b>                                                                                                                                          | <b>Vac<sub>measured</sub><br/>[V]</b> | <b>P<sub>,tol_under</sub><br/>[kW]</b> | <b>Power<br/>[kW]</b> | <b>P<sub>,tol_upper</sub><br/>[kW]</b> |          |
| 100                                                                                                                                                                                                                                                                                            | 230,0                                                                                                                                                                          | 230,66                                | 9,0                                    | 9,938                 | 11,0                                   |          |
| 109                                                                                                                                                                                                                                                                                            | 250,7                                                                                                                                                                          | 251,23                                | 9,0                                    | 9,947                 | 11,0                                   |          |
| 110                                                                                                                                                                                                                                                                                            | 253,0                                                                                                                                                                          | 253,52                                | 9,0                                    | 9,142                 | 11,0                                   |          |
| 111                                                                                                                                                                                                                                                                                            | 255,3                                                                                                                                                                          | 255,66                                | 4,0                                    | 4,731                 | 6,0                                    |          |
| 112                                                                                                                                                                                                                                                                                            | 257,6                                                                                                                                                                          | 257,80                                | -1,0                                   | 0,356                 | 1,0                                    |          |
| 113                                                                                                                                                                                                                                                                                            | 259,9                                                                                                                                                                          | 260,07                                | -1,0                                   | -0,090                | 1,0                                    |          |
| 112                                                                                                                                                                                                                                                                                            | 257,6                                                                                                                                                                          | 257,80                                | -1,0                                   | 0,136                 | 1,0                                    |          |
| 111                                                                                                                                                                                                                                                                                            | 255,3                                                                                                                                                                          | 255,24                                | 4,0                                    | 5,011                 | 6,0                                    |          |
| 110                                                                                                                                                                                                                                                                                            | 253,0                                                                                                                                                                          | 253,16                                | 9,0                                    | 9,226                 | 11,0                                   |          |
| 109                                                                                                                                                                                                                                                                                            | 250,7                                                                                                                                                                          | 250,80                                | 9,0                                    | 9,883                 | 11,0                                   |          |
| 100                                                                                                                                                                                                                                                                                            | 230,0                                                                                                                                                                          | 230,54                                | 9,0                                    | 9,945                 | 11,0                                   |          |
| Setting values :<br>Time constant Tau= 5s<br>Active delay = 0s (not active)<br>Activation threshold = 110% Un                                                                                                                                                                                  |                                                                                                                                                                                |                                       |                                        |                       |                                        |          |
| Assessment criterion:<br>The quasi-steady-state behavior test has been passed, if<br>- the active power values measured according to 5.3.6.2.1 (30s mean values) in stationary operation are within the tolerance band of ±10% P <sub>FE</sub> and ±1% Un of the specified P(V) characteristic |                                                                                                                                                                                |                                       |                                        |                       |                                        |          |
| Note:<br>The test was performed with no delay. The delay is adjustable in the range from 0s to 3s.                                                                                                                                                                                             |                                                                                                                                                                                |                                       |                                        |                       |                                        |          |

|                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------|---------------------------------|---|
| 5.3.6                                                                                                                                                                                                                                                                                                                                                            | Voltage-controlled active power limitation P(V)The test serves as verification of the active power reduction mode at over voltage according to TOR Erzeuger, 5.3.6. |                                                                                                                                                           |                                 |               |                                 | P |
| 5.3.6.1.2                                                                                                                                                                                                                                                                                                                                                        | Voltage-controlled active power limitation P(V) - <u>dynamic behavior</u>                                                                                           |                                                                                                                                                           |                                 |               |                                 | P |
| Test:                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| Vac <sub>setpoint</sub><br>[%Un]                                                                                                                                                                                                                                                                                                                                 | Vac <sub>expected</sub><br>[V]                                                                                                                                      | Vac <sub>measured</sub><br>[V]                                                                                                                            | P <sub>,tol_under</sub><br>[kW] | Power<br>[kW] | P <sub>,tol_upper</sub><br>[kW] |   |
| 100                                                                                                                                                                                                                                                                                                                                                              | 230,0                                                                                                                                                               | 230,38                                                                                                                                                    | 9,0                             | 10,008        | 11,0                            |   |
| 109                                                                                                                                                                                                                                                                                                                                                              | 250,7                                                                                                                                                               | 250,64                                                                                                                                                    | 9,0                             | 9,991         | 11,0                            |   |
| 113                                                                                                                                                                                                                                                                                                                                                              | 259,9                                                                                                                                                               | 259,52                                                                                                                                                    | -1,0                            | -0,093        | 1,0                             |   |
| 109                                                                                                                                                                                                                                                                                                                                                              | 250,7                                                                                                                                                               | 250,64                                                                                                                                                    | 9,0                             | 9,988         | 11,0                            |   |
| 100                                                                                                                                                                                                                                                                                                                                                              | 230,0                                                                                                                                                               | 229,98                                                                                                                                                    | 9,0                             | 10,005        | 11,0                            |   |
|                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| Set value Tau                                                                                                                                                                                                                                                                                                                                                    | 5 s                                                                                                                                                                 |                                                                                                                                                           |                                 |               |                                 |   |
| Assessment criterion:                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| The dynamic behavior test is passed if                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| - The determined time course of the active power during the measurement according to 5.3.6.2.2 within the entire measurement period is within the tolerance bands that result from the behavior of an equivalent PT1 element (1st order filter). Permissible tolerances for the active power values are ±10% P <sub>rE</sub> as well as for the time +3 seconds. |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| The tolerance bands are calculated according to Table 2.                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| - There are no discontinuities in the characteristic curve, power fluctuations or a shutdown of the PGU;                                                                                                                                                                                                                                                         |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| - A reduction of the active power down to a power of <10% P <sub>rE</sub> or to that of the manufacturer specified minimum performance is possible                                                                                                                                                                                                               |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |
| increase in active power<br>P <sub>2</sub> > P <sub>1</sub>                                                                                                                                                                                                                                                                                                      | Upper Tolerance band:                                                                                                                                               | for all t: P <sub>2</sub> – (P <sub>2</sub> – P <sub>1</sub> ) e <sup>( –t / Tau )</sup> + 0,10 PrE                                                       |                                 |               |                                 |   |
|                                                                                                                                                                                                                                                                                                                                                                  | Lower Tolerance band:                                                                                                                                               | for t < 3 Second: P <sub>1</sub> – 0,10 PrE<br>für t ≥ 3 Second: P <sub>2</sub> – (P <sub>2</sub> – P <sub>1</sub> ) e( [–t+3 Seconds] / Tau ) – 0,10 PrE |                                 |               |                                 |   |
| drop in active power<br>P <sub>2</sub> < P <sub>1</sub>                                                                                                                                                                                                                                                                                                          | Upper Tolerance band:                                                                                                                                               | for t < 3 Second: P <sub>1</sub> + 0,10 PrE<br>for t ≥ 3 Second: P <sub>2</sub> – (P <sub>2</sub> – P <sub>1</sub> ) e( [–t+3 Seconds] / Tau ) + 0,10 PrE |                                 |               |                                 |   |
|                                                                                                                                                                                                                                                                                                                                                                  | Lower Tolerance band:                                                                                                                                               | for all t: P <sub>2</sub> – (P <sub>2</sub> – P <sub>1</sub> ) e <sup>( –t / Tau )</sup> – 0,10 PrE                                                       |                                 |               |                                 |   |
| Note:                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                     |                                                                                                                                                           |                                 |               |                                 |   |

### Graph of Voltage-controlled active power limitation P(V)

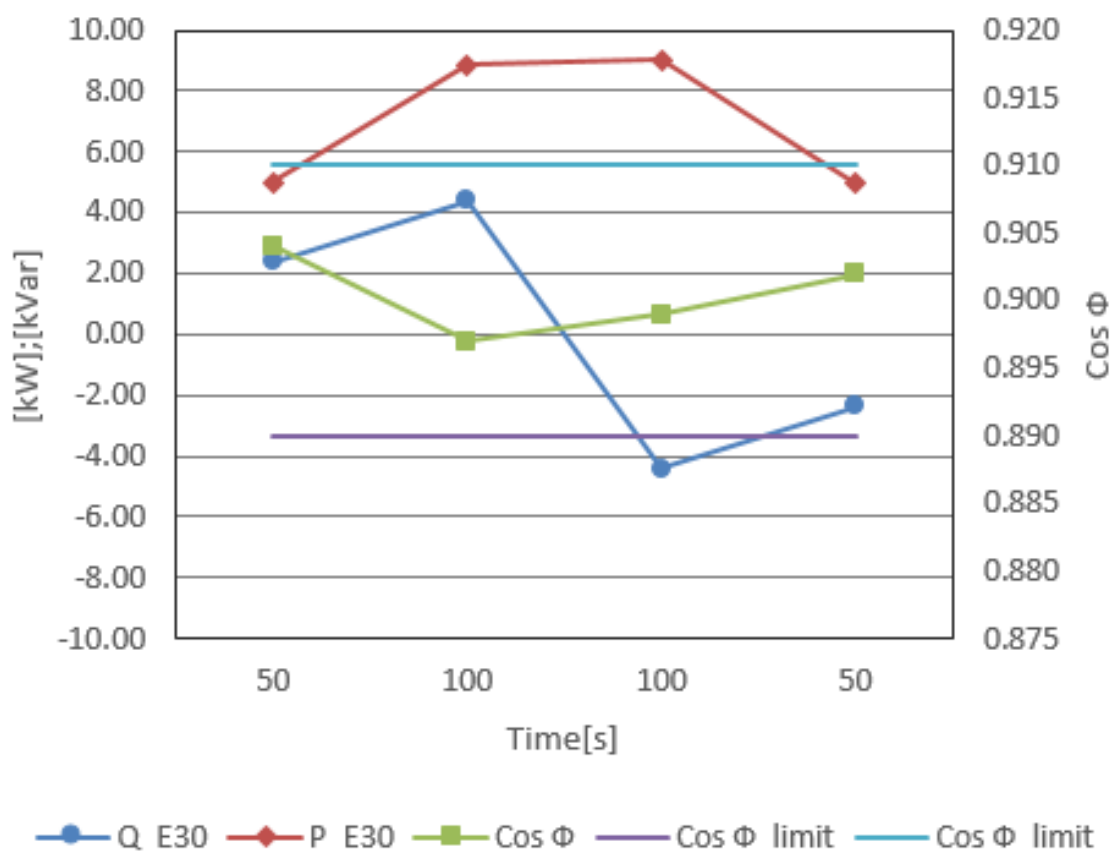




|                                   |                                                                                                                                             |                              |                                       |                              |                                       |                              |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------------|------------------------------|---------------------------------------|------------------------------|
| 5.3.7                             | Reactive power setpoint control “fix cos φ”<br>The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4. |                              |                                       |                              |                                       | P                            |
| 5.3.7.1                           |                                                                                                                                             |                              |                                       |                              |                                       |                              |
| Setting values                    | cos φ under-excited:                                                                                                                        |                              |                                       | 0,90                         |                                       |                              |
|                                   | cos φ over-excited:                                                                                                                         |                              |                                       | 0,90                         |                                       |                              |
| Test:                             |                                                                                                                                             |                              |                                       |                              |                                       |                              |
| FSP POWER MANAGER 10KW            |                                                                                                                                             |                              |                                       |                              |                                       |                              |
| 30 s mean value                   | 0,91U <sub>n</sub>                                                                                                                          |                              | U <sub>n</sub>                        |                              | 1,09 U <sub>n</sub>                   |                              |
| Active power                      | 40 – 60% P <sub>E<sub>max</sub></sub>                                                                                                       | S <sub>E<sub>max</sub></sub> | 40 – 60% P <sub>E<sub>max</sub></sub> | S <sub>E<sub>max</sub></sub> | 40 – 60% P <sub>E<sub>max</sub></sub> | S <sub>E<sub>max</sub></sub> |
| a) cos φ 0,9 over-excited         |                                                                                                                                             |                              |                                       |                              |                                       |                              |
| U [V]                             | 209,65                                                                                                                                      | 209,41                       | 230,42                                | 230,61                       | 251,04                                | 251,22                       |
| P <sub>E30</sub> [W]              | 4,979                                                                                                                                       | 8,286                        | 4,994                                 | 8,876                        | 4,997                                 | 8,863                        |
| Q <sub>E30</sub> [VAr]            | 2,400                                                                                                                                       | 3,987                        | 2,366                                 | 4,379                        | 2,332                                 | 4,322                        |
| cos φ <sub>E30-over-excited</sub> | 0,901                                                                                                                                       | 0,901                        | 0,904                                 | 0,897                        | 0,906                                 | 0,899                        |
| cos φ <sub>setpoint</sub>         | 0,900                                                                                                                                       | 0,900                        | 0,900                                 | 0,900                        | 0,900                                 | 0,900                        |
| Δcos φ                            | 0,001                                                                                                                                       | 0,001                        | 0,004                                 | -0,003                       | 0,006                                 | -0,001                       |
| b) cos φ 0,9 under-excited        |                                                                                                                                             |                              |                                       |                              |                                       |                              |
| U [V]                             | 209,64                                                                                                                                      | 209,81                       | 230,33                                | 230,55                       | 251,03                                | 251,20                       |
| P <sub>E30</sub> [W]              | 4,959                                                                                                                                       | 8,302                        | 4,972                                 | 9,039                        | 4,974                                 | 9,000                        |
| Q <sub>E30</sub> [VAr]            | -2,347                                                                                                                                      | -3,962                       | -2,377                                | -4,394                       | -2,411                                | -4,439                       |
| cos φ <sub>E30-over-excited</sub> | 0,904                                                                                                                                       | 0,902                        | 0,902                                 | 0,899                        | 0,900                                 | 0,897                        |
| cos φ <sub>setpoint</sub>         | 0,900                                                                                                                                       | 0,900                        | 0,900                                 | 0,900                        | 0,900                                 | 0,900                        |
| Δcos φ                            | 0,004                                                                                                                                       | 0,002                        | 0,002                                 | -0,001                       | 0,000                                 | -0,003                       |
| Limit                             |                                                                                                                                             |                              |                                       |                              |                                       |                              |
| cos φ <sub>E30</sub>              | cos φ= 0,89 to 0,91 (c) and cos φ= 0,89 to 0,91 (i)                                                                                         |                              |                                       |                              |                                       |                              |



### Graph P/Q/U/cos φ



### Test:

**\*\*applies for Units  $\Sigma S_{E_{max}} \leq 3,68$  kVA**

For cos φ 0,95 over-excited and cos φ 0,95 under-excited, the active power will be measured at value between 40%  $P_{E_{max}}$  and 60% and  $S_{E_{max}}$

**\*applies for Units  $\Sigma S_{E_{max}} \geq 3,68$  kVA**

For cos φ 0,90 over-excited and cos φ 0,90 under-excited, the active power will be measured at value between 40%  $P_{E_{max}}$  and 60% and  $S_{E_{max}}$

### Assessment criterion:

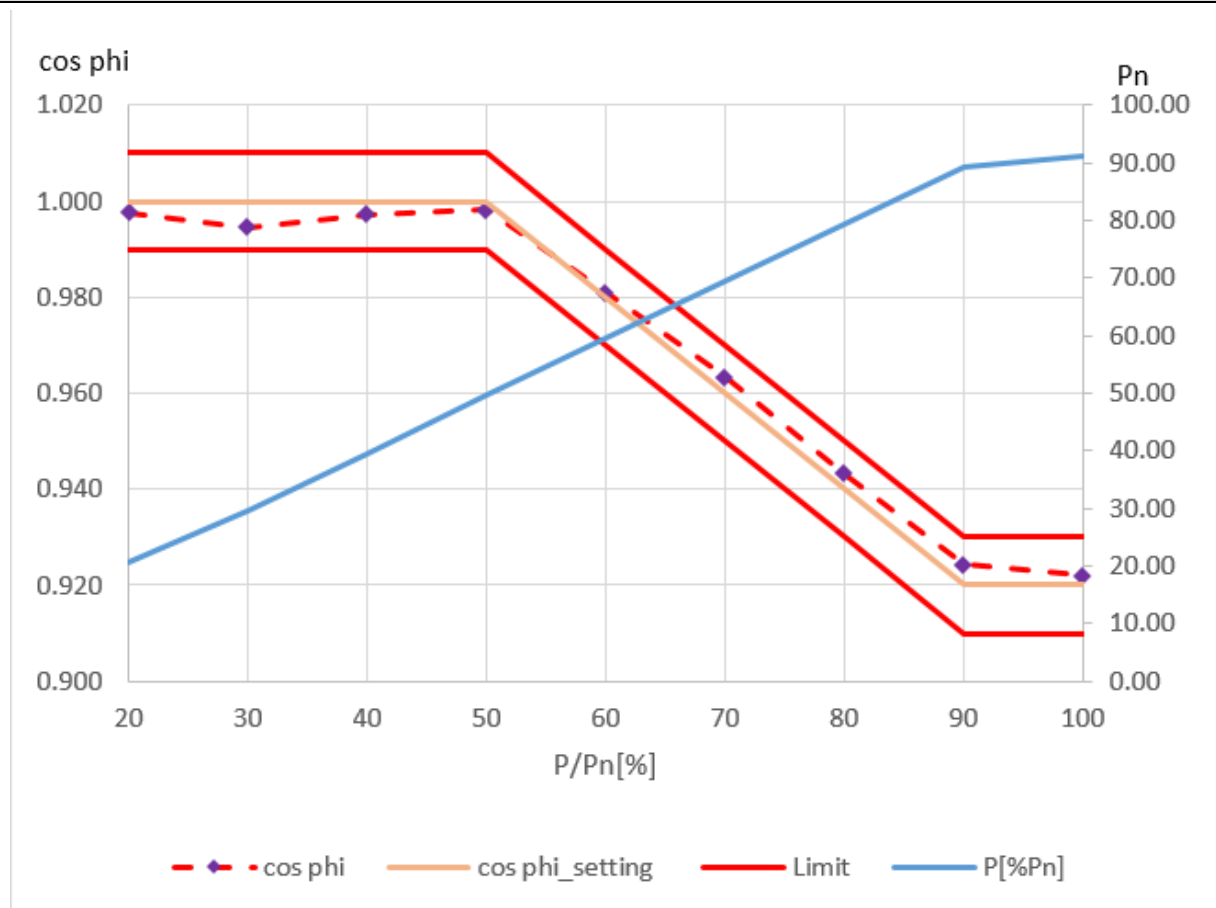
The test is passed if all cos φ values (30s mean) do not deviate from the specification by more than  $\pm 0,01$ .

For PGU with generators directly connected to the grid, which cannot regulate reactive power due to the principle, such as asynchronous generators, and therefore use non-controllable fixed capacities, the tolerance band increases from 0,01 to 0,02. This device type is only evaluated at  $U_n$ .

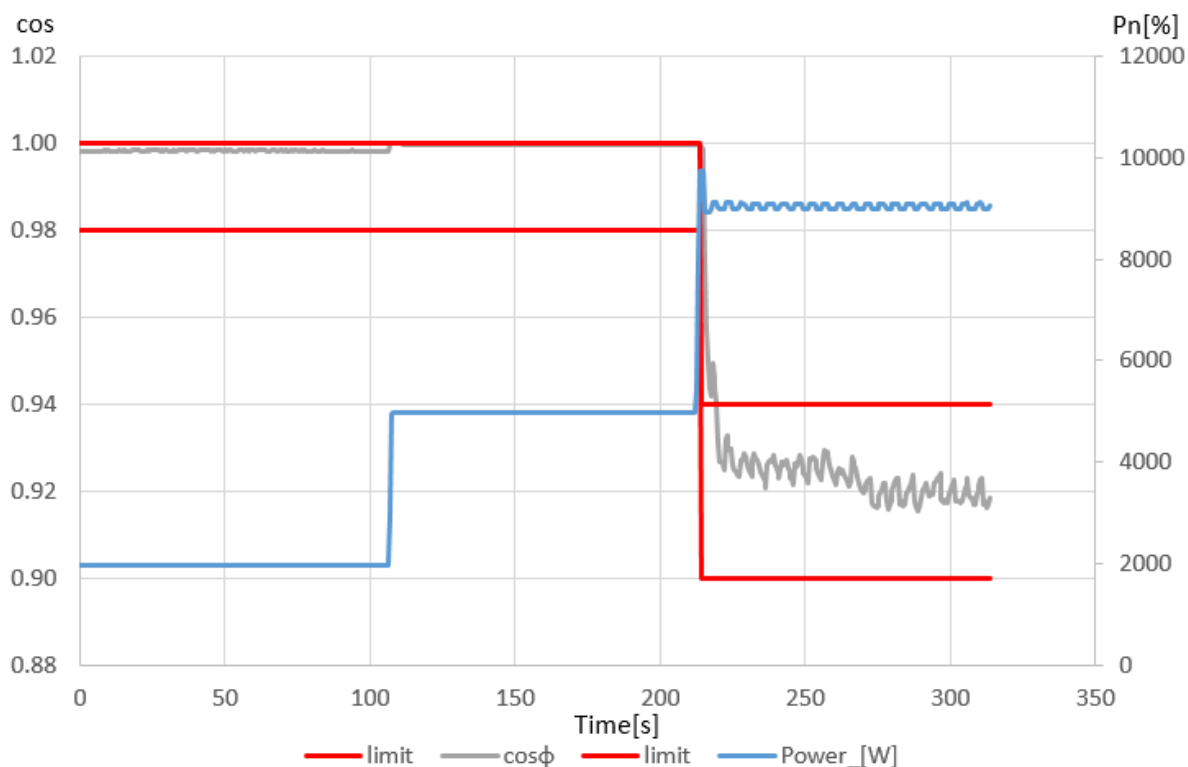
### Note:

|                                                       |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| 5.3.8                                                 | Test of the displacement factor/active power characteristic curve $\cos \varphi$ (P)<br>The test serves as verification of the standard $\cos \varphi$ (P) curve according to TOR Erzeuger, 5.3.4.1. |        |        |        |        |        |        |        | P      |
| Test:                                                 |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| FSP POWER MANAGER 10KW                                |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| Test a):                                              |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| P <sub>E<sub>max</sub></sub> /P [%]                   | 20                                                                                                                                                                                                   | 30     | 40     | 50     | 60     | 70     | 80     | 90     | 100    |
| 30 s mean value                                       | 20% to 100% P <sub>E<sub>max</sub></sub>                                                                                                                                                             |        |        |        |        |        |        |        |        |
| U [V]                                                 | 230,11                                                                                                                                                                                               | 230,28 | 230,31 | 230,35 | 230,35 | 230,38 | 230,40 | 230,44 | 230,44 |
| P <sub>E30</sub> [kW]                                 | 2,051                                                                                                                                                                                                | 2,956  | 3,958  | 4,960  | 5,957  | 6,943  | 7,938  | 8,935  | 9,132  |
| P <sub>E30</sub> of P <sub>E<sub>max</sub></sub> [%]  | 20,51                                                                                                                                                                                                | 29,56  | 39,58  | 49,60  | 59,57  | 69,43  | 79,38  | 89,35  | 91,32  |
| Q <sub>E30</sub> [kVAr]                               | -0,142                                                                                                                                                                                               | 0,307  | 0,291  | 0,298  | -1,098 | -1,921 | -2,786 | -3,686 | -3,831 |
| cos $\varphi$ <sub>E30</sub>                          | 0,998                                                                                                                                                                                                | 0,995  | 0,997  | 0,998  | 0,981  | 0,963  | 0,943  | 0,924  | 0,922  |
| cos $\varphi$ <sub>setpoint</sub> of P <sub>E30</sub> | 1,000                                                                                                                                                                                                | 1,000  | 1,000  | 1,000  | 0,981  | 0,961  | 0,941  | 0,921  | 0,917  |
| Limit                                                 |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| cos $\varphi$ <sub>E30</sub>                          | cos $\varphi$ <sub>setpoint</sub> ±0,01                                                                                                                                                              |        |        |        |        |        |        |        |        |
| Test a):                                              |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| P <sub>E<sub>max</sub></sub> /P [%]                   | 100                                                                                                                                                                                                  | 90     | 80     | 70     | 60     | 50     | 40     | 30     | 20     |
| 30 s mean value                                       | 100% to 20% P <sub>E<sub>max</sub></sub>                                                                                                                                                             |        |        |        |        |        |        |        |        |
| U [V]                                                 | 230,00                                                                                                                                                                                               | 230,00 | 230,00 | 230,00 | 230,00 | 230,00 | 230,00 | 230,00 | 230,10 |
| P <sub>E30</sub> [kW]                                 | 9,132                                                                                                                                                                                                | 8,934  | 7,938  | 6,941  | 5,978  | 4,980  | 3,971  | 2,968  | 2,050  |
| P <sub>E30</sub> of P <sub>E<sub>max</sub></sub> [%]  | 91,32                                                                                                                                                                                                | 89,34  | 79,38  | 69,41  | 59,78  | 49,80  | 39,71  | 29,68  | 20,50  |
| Q <sub>E30</sub> [kVAr]:                              | -3,831                                                                                                                                                                                               | -3,749 | -2,833 | -1,998 | -1,233 | 0,316  | 0,300  | 0,311  | -0,144 |
| cos $\varphi$ <sub>E30</sub>                          | 0,922                                                                                                                                                                                                | 0,922  | 0,942  | 0,961  | 0,979  | 0,998  | 0,997  | 0,995  | 0,998  |
| cos $\varphi$ <sub>setpoint</sub> of P <sub>E30</sub> | 0,917                                                                                                                                                                                                | 0,921  | 0,941  | 0,961  | 0,980  | 1,000  | 1,000  | 1,000  | 1,000  |
| Limit                                                 |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| cos $\varphi$ <sub>E30</sub>                          | cos $\varphi$ <sub>setpoint</sub> ±0,01                                                                                                                                                              |        |        |        |        |        |        |        |        |
| Test b):                                              |                                                                                                                                                                                                      |        |        |        |        |        |        |        |        |
| P <sub>E<sub>max</sub></sub> /P <sub>rE</sub> [%]     | 20                                                                                                                                                                                                   |        |        | 50     |        |        | 90     |        |        |
| 30 s mean value                                       | 20% to 50% to 100% P <sub>E<sub>max</sub></sub>                                                                                                                                                      |        |        |        |        |        |        |        |        |
| U [V]                                                 | 230,29                                                                                                                                                                                               |        |        | 230,44 |        |        | 230,58 |        |        |
| P <sub>E30</sub> [kW]                                 | 1,976                                                                                                                                                                                                |        |        | 4,967  |        |        | 9,048  |        |        |
| P <sub>E30</sub> of P <sub>E<sub>max</sub></sub> [%]  | 19,76                                                                                                                                                                                                |        |        | 49,67  |        |        | 90,48  |        |        |
| Q <sub>E30</sub> [kVAr]                               | -0,114                                                                                                                                                                                               |        |        | 0,122  |        |        | -3,798 |        |        |
| cos $\varphi$ <sub>E30</sub>                          | 0,998                                                                                                                                                                                                |        |        | 0,999  |        |        | 0,922  |        |        |
| cos $\varphi$ <sub>setpoint</sub> of P <sub>E30</sub> | 1,000                                                                                                                                                                                                |        |        | 1,000  |        |        | 0,919  |        |        |
| T <sub>0</sub> [s]                                    | 8,5                                                                                                                                                                                                  |        |        |        |        |        |        |        |        |

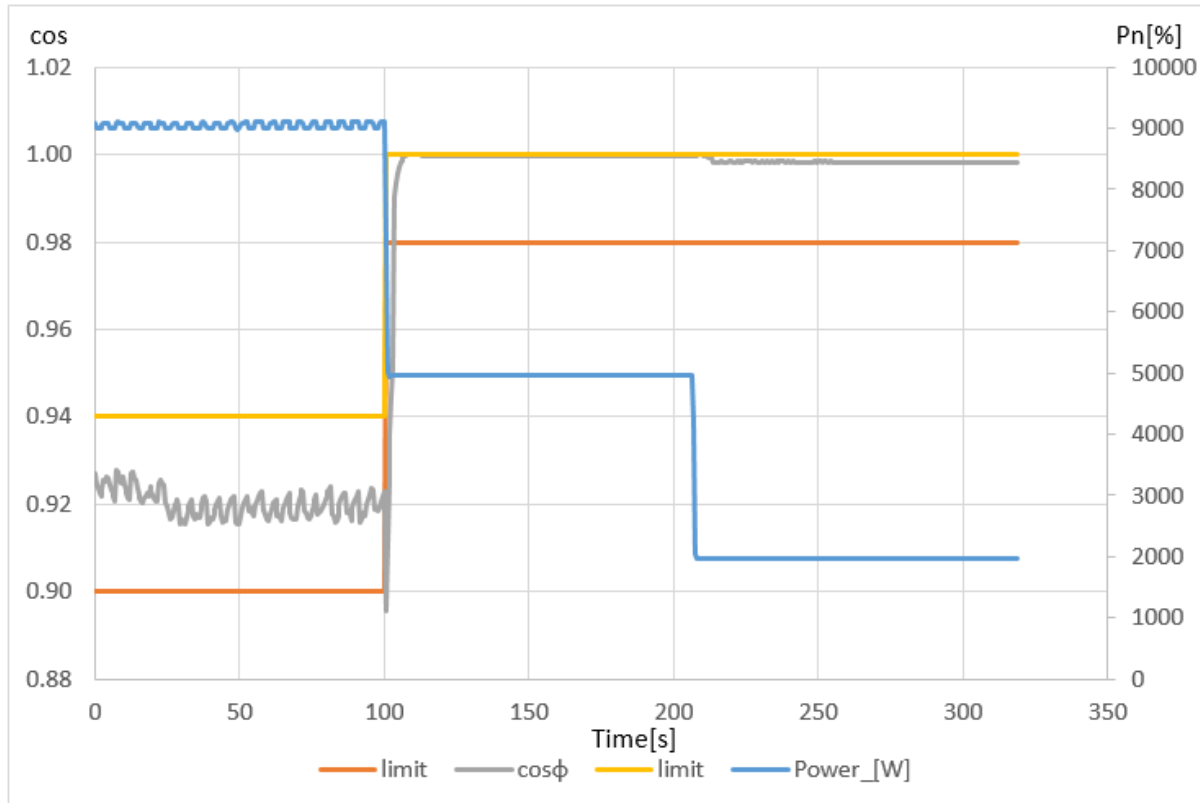
| 30 s mean value                               | 100% to 50% to 20% P <sub>E<sub>max</sub></sub> |        |        |
|-----------------------------------------------|-------------------------------------------------|--------|--------|
| U [V]                                         | 230,59                                          | 230,45 | 230,29 |
| P <sub>E30</sub> [kW]                         | 9,048                                           | 4,967  | 1,975  |
| P <sub>E30</sub> [%]                          | 90,48                                           | 49,67  | 19,75  |
| Q <sub>E30</sub> [kVAr]                       | -3,851                                          | 0,119  | -0,115 |
| cos ϕ <sub>E30</sub>                          | 0,920                                           | 0,999  | 0,998  |
| cos ϕ <sub>setpoint</sub> of P <sub>E30</sub> | 0,919                                           | 1,000  | 1,000  |
| T <sub>0</sub> [s]                            | 10,0                                            |        |        |
| Limit:                                        |                                                 |        |        |
| T <sub>0</sub> [s]                            | 10 s                                            |        |        |
| cos ϕ <sub>E30</sub>                          | cos ϕ <sub>setpoint</sub> ±0,02                 |        |        |

Graph of  $\cos \varphi(P)$ : Test a)


Graph of setting ( $T_0$ ) time: Test b) 20% to 50% to 100%



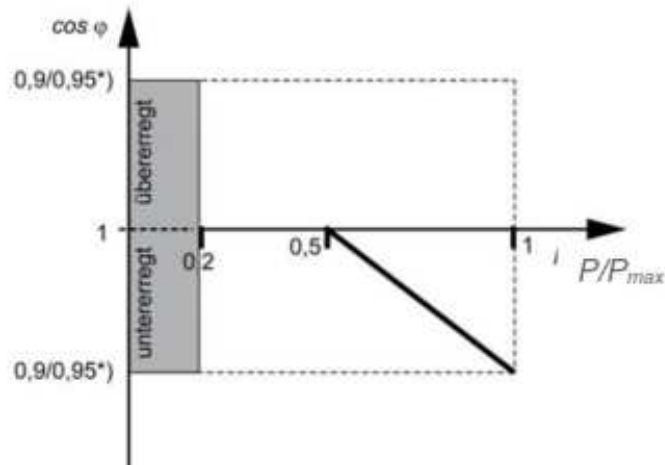
Graph of setting ( $T_0$ ) time: Test b) 100% to 50% to 20%



### Test:

- Test 1: Using the standard characteristic curve increases the active power from 20%  $P_{E_{max}}$  in increments of 10%  $P_{E_{max}}$  to  $P_{E_{max}}$ . The test is carried out in reverse.
- Test 2: Using the standard characteristic curve increases the active power from 20%  $P_{E_{max}}$  to 50%  $P_{E_{max}}$  and to  $P_{E_{max}}$ . The test is carried out in reverse. After the PGU has settled, the end value reached is determined as a 30s mean value.

### Characteristic Curve $\cos \varphi$ (P)



\*) Depending on  $S_{Amax}$

### Assessment criterion:

Test 1:  $\cos \varphi$  accuracy  $\cos \varphi (\pm 0,02)$

Test 2:  $\cos \varphi$  accuracy  $\cos \varphi (\pm 0,01)$

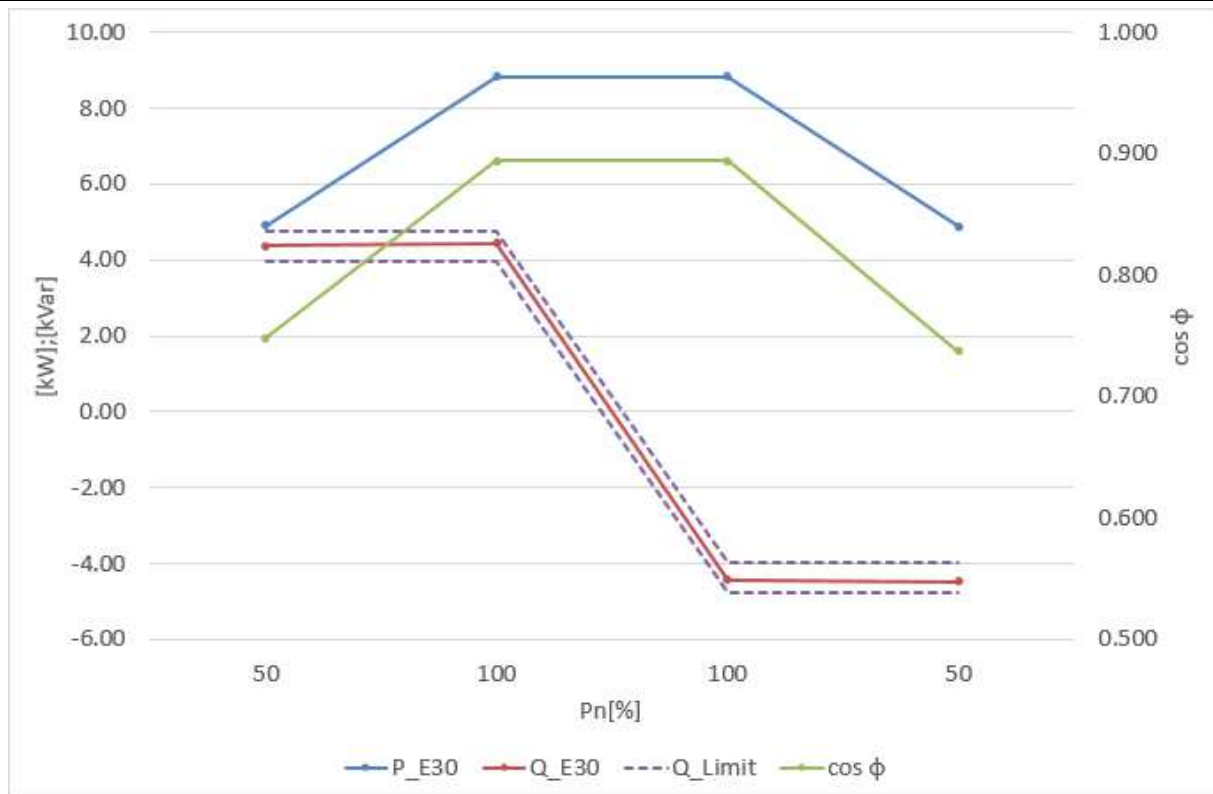
The active power steps must be approached with an accuracy of  $\pm 5\% P_{rE}$ .

For the test to be passed, the  $\cos \varphi$  setpoint from the active power must be measured at the terminals of the PGU within a settling time of 10s.

### Note:

|                                   |                                                                                                                                         |                              |                                       |                              |                                       |                              |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------------|------------------------------|---------------------------------------|------------------------------|
| 5.3.9                             | Reactive power setpoint control “fix Q”<br>The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4. |                              |                                       |                              |                                       | P                            |
| 5.3.9.1                           |                                                                                                                                         |                              |                                       |                              |                                       |                              |
| Setting values                    | Q over-excited:                                                                                                                         |                              |                                       | 4360 Var                     |                                       |                              |
|                                   | Q under-excited:                                                                                                                        |                              |                                       | -4360 Var                    |                                       |                              |
| Test:                             |                                                                                                                                         |                              |                                       |                              |                                       |                              |
| FSP POWER MANAGER 10KW            |                                                                                                                                         |                              |                                       |                              |                                       |                              |
| 30 s mean value                   | 0,91U <sub>n</sub>                                                                                                                      |                              | U <sub>n</sub>                        |                              | 1,09 U <sub>n</sub>                   |                              |
| Active power                      | 40 – 60% P <sub>E<sub>max</sub></sub>                                                                                                   | S <sub>E<sub>max</sub></sub> | 40 – 60% P <sub>E<sub>max</sub></sub> | S <sub>E<sub>max</sub></sub> | 40 – 60% P <sub>E<sub>max</sub></sub> | S <sub>E<sub>max</sub></sub> |
| a) over-excited                   |                                                                                                                                         |                              |                                       |                              |                                       |                              |
| U [V]                             | 209,66                                                                                                                                  | 209,93                       | 230,35                                | 230,62                       | 251,07                                | 251,21                       |
| P <sub>E30</sub> [kW]             | 4,901                                                                                                                                   | 8,795                        | 4,920                                 | 8,832                        | 4,929                                 | 8,848                        |
| Q <sub>E30</sub> [kVAr]           | 4,406                                                                                                                                   | 4,483                        | 4,365                                 | 4,435                        | 4,075                                 | 4,393                        |
| Q <sub>setpoint</sub> [kVAr]      | 4,360                                                                                                                                   | 4,360                        | 4,360                                 | 4,360                        | 4,360                                 | 4,360                        |
| ΔQ [VAr]                          | 0,046                                                                                                                                   | 0,123                        | 0,005                                 | 0,075                        | -0,295                                | 0,033                        |
| cos φ <sub>E30-over-excited</sub> | 0,744                                                                                                                                   | 0,891                        | 0,748                                 | 0,894                        | 0,768                                 | 0,896                        |
| b) under-excited                  |                                                                                                                                         |                              |                                       |                              |                                       |                              |
| U [V]                             | 209,67                                                                                                                                  | 209,85                       | 230,35                                | 230,56                       | 251,03                                | 251,21                       |
| P <sub>E30</sub> [kW]             | 4,862                                                                                                                                   | 8,806                        | 4,879                                 | 8,842                        | 4,885                                 | 8,858                        |
| Q <sub>E30</sub> [kVAr]           | -4,438                                                                                                                                  | -4,392                       | -4,468                                | -4,428                       | -4,500                                | -4,465                       |
| Q <sub>setpoint</sub> [kVAr]      | -4,360                                                                                                                                  | -4,360                       | -4,360                                | -4,360                       | -4,360                                | -4,360                       |
| ΔQ [VAr]                          | -0,078                                                                                                                                  | -0,032                       | -0,102                                | -0,068                       | -0,140                                | -0,105                       |
| cos φ <sub>E30-over-excited</sub> | 0,739                                                                                                                                   | 0,895                        | 0,737                                 | 0,894                        | 0,735                                 | 0,893                        |
| Limit                             |                                                                                                                                         |                              |                                       |                              |                                       |                              |
| Q <sub>E30</sub>                  | ≤ ±4% S <sub>n</sub> (electronic inverter)                                                                                              |                              |                                       |                              |                                       |                              |

### Graph P, Q, U



### Test:

\*\*applies for inverter  $\Sigma S_{E_{max}} \leq 3,68$  kVA

For Q = 31,2 over-excited and Q = 31,2 under-excited, the active power will be measured at value between 40%  $P_{E_{max}}$  and 60% and  $S_{E_{max}}$

\*applies for inverter  $\Sigma S_{E_{max}} \geq 3,68$  kVA

For Q = 43,6 over-excited and Q=43,6 under-excited, the active power will be measured at value between 40%  $P_{E_{max}}$  and 60% and  $S_{E_{max}}$

\*\*Q = 31,2 ( $\phi$  0,95) (i) and (c): PGU  $\leq 3,68$  kVA

\*Q = 43,6 ( $\phi$  0,90) (i) and (c): PGU  $> 3,68$  kVA

### Assessment criterion:

The test is passed if all Q values (30 s mean) are not more than  $\pm 4\%$   $S_n$  from the specification differ.

In the case of PGU with generators directly connected to the grid, which cannot regulate reactive power due to the principle, such as asynchronous generators, and therefore use non-controllable fixed capacities, the tolerance band extends from  $\pm 4\%$   $P_{rE}$  to  $\pm 10\%$   $P_{rE}$ . This device type is only used at  $U_n$  rated.

### Note:

|                                                |                       |                                                                                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
|------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-------------------------------|-------------------------|-------------------------------|-------------------------------------------|-------------------------------------|-------------------------------------------|--|
| 5.3.10                                         |                       | Voltage-controlled control functions “Q= f(V)”<br>The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.2 |                       |                       |                               |                         |                               |                                           |                                     | P                                         |  |
| 5.3.10.1.1                                     |                       | Test Voltage-controlled control functions “Q= f(V)” - quasi-stationary behavior                                                                 |                       |                       |                               |                         |                               |                                           |                                     | P                                         |  |
| Test: 5.3.10.1.1 a) to n) 100% P <sub>rE</sub> |                       |                                                                                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
| FSP POWER MANAGER 10KW                         |                       |                                                                                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
| Voltage steps                                  | U <sub>step</sub> [%] | U <sub>meas</sub> [V]                                                                                                                           | U <sub>meas</sub> [%] | P <sub>30s</sub> [kW] | Q <sub>tol_under</sub> [kVAr] | Q <sub>30s</sub> [kVAr] | Q <sub>tol_upper</sub> [kVAr] | Q <sub>tol_under</sub> [%S <sub>n</sub> ] | Q <sub>30s</sub> [%S <sub>n</sub> ] | Q <sub>tol_upper</sub> [%S <sub>n</sub> ] |  |
| 1                                              | 100                   | 230,00                                                                                                                                          | 100,00                | 10,000                | -0,400                        | 0,309                   | 0,400                         | -4,00                                     | 3,09                                | 4,00                                      |  |
| 2                                              | 101                   | 232,00                                                                                                                                          | 100,87                | 10,000                | -0,400                        | 0,311                   | 0,400                         | -4,00                                     | 3,11                                | 4,00                                      |  |
| 3                                              | 102                   | 235,00                                                                                                                                          | 102,17                | 10,000                | -0,400                        | 0,314                   | 0,400                         | -4,00                                     | 3,14                                | 4,00                                      |  |
| 4                                              | 103                   | 237,00                                                                                                                                          | 103,04                | 10,000                | -0,400                        | 0,316                   | 0,400                         | -4,00                                     | 3,16                                | 4,00                                      |  |
| 5                                              | 104                   | 239,00                                                                                                                                          | 103,91                | 10,000                | -0,400                        | 0,318                   | 0,400                         | -4,00                                     | 3,18                                | 4,00                                      |  |
| 6                                              | 105                   | 241,00                                                                                                                                          | 104,78                | 10,000                | -0,400                        | 0,362                   | 0,400                         | -4,00                                     | 3,62                                | 4,00                                      |  |
| 7                                              | 106                   | 244,00                                                                                                                                          | 106,09                | 9,855                 | -1,853                        | -1,640                  | -1,053                        | -18,53                                    | -16,40                              | -10,53                                    |  |
| 8                                              | 107                   | 246,00                                                                                                                                          | 106,96                | 9,489                 | -3,307                        | -3,096                  | -2,507                        | -33,07                                    | -30,96                              | -25,07                                    |  |
| 9                                              | 108                   | 248,00                                                                                                                                          | 107,83                | 8,958                 | -4,760                        | -4,405                  | -3,960                        | -47,60                                    | -44,05                              | -39,60                                    |  |
| 10                                             | 109                   | 251,00                                                                                                                                          | 109,13                | 8,955                 | -4,760                        | -4,403                  | -3,960                        | -47,60                                    | -44,03                              | -39,60                                    |  |
| 11                                             | 110                   | 253,05                                                                                                                                          | 110,02                | 8,949                 | -4,760                        | -4,402                  | -3,960                        | -47,60                                    | -44,02                              | -39,60                                    |  |
| 12                                             | 111                   | 255,17                                                                                                                                          | 110,95                | 4,862                 | -4,760                        | -4,468                  | -3,960                        | -47,60                                    | -44,68                              | -39,60                                    |  |
| 13                                             | 112                   | 257,67                                                                                                                                          | 112,03                | -0,093                | -0,400                        | -0,324                  | 0,400                         | -4,00                                     | -3,24                               | 4,00                                      |  |
| 14                                             | 113                   | 259,97                                                                                                                                          | 113,03                | -0,122                | -0,400                        | -0,323                  | 0,400                         | -4,00                                     | -3,23                               | 4,00                                      |  |
| 15                                             | 112                   | 257,66                                                                                                                                          | 112,03                | -0,113                | -0,400                        | -0,327                  | 0,400                         | -4,00                                     | -3,27                               | 4,00                                      |  |
| 16                                             | 111                   | 255,22                                                                                                                                          | 110,96                | 4,858                 | -4,760                        | -4,469                  | -3,960                        | -47,60                                    | -44,69                              | -39,60                                    |  |
| 17                                             | 110                   | 253,04                                                                                                                                          | 110,02                | 8,950                 | -4,760                        | -4,403                  | -3,960                        | -47,60                                    | -44,03                              | -39,60                                    |  |
| 18                                             | 109                   | 251,00                                                                                                                                          | 109,13                | 8,954                 | -4,760                        | -4,404                  | -3,960                        | -47,60                                    | -44,04                              | -39,60                                    |  |
| 19                                             | 108                   | 248,00                                                                                                                                          | 107,83                | 8,957                 | -4,760                        | -4,404                  | -3,960                        | -47,60                                    | -44,04                              | -39,60                                    |  |
| 20                                             | 107                   | 246,00                                                                                                                                          | 106,96                | 9,474                 | -3,307                        | -3,137                  | -2,507                        | -33,07                                    | -31,37                              | -25,07                                    |  |
| 21                                             | 106                   | 244,00                                                                                                                                          | 106,09                | 9,839                 | -1,853                        | -1,725                  | -1,053                        | -18,53                                    | -17,25                              | -10,53                                    |  |
| 22                                             | 105                   | 241,00                                                                                                                                          | 104,78                | 10,000                | -0,400                        | 0,375                   | 0,400                         | -4,00                                     | 3,75                                | 4,00                                      |  |
| 23                                             | 104                   | 239,00                                                                                                                                          | 103,91                | 10,000                | -0,400                        | 0,317                   | 0,400                         | -4,00                                     | 3,17                                | 4,00                                      |  |
| 24                                             | 103                   | 237,00                                                                                                                                          | 103,04                | 10,000                | -0,400                        | 0,316                   | 0,400                         | -4,00                                     | 3,16                                | 4,00                                      |  |
| 25                                             | 102                   | 235,00                                                                                                                                          | 102,17                | 10,000                | -0,400                        | 0,314                   | 0,400                         | -4,00                                     | 3,14                                | 4,00                                      |  |
| 26                                             | 101                   | 232,00                                                                                                                                          | 100,87                | 10,000                | -0,400                        | 0,312                   | 0,400                         | -4,00                                     | 3,12                                | 4,00                                      |  |
| 27                                             | 100                   | 230,00                                                                                                                                          | 100,00                | 10,009                | -0,400                        | 0,310                   | 0,400                         | -4,00                                     | 3,10                                | 4,00                                      |  |
| 28                                             | 99                    | 228,00                                                                                                                                          | 99,13                 | 10,009                | -0,400                        | 0,309                   | 0,400                         | -4,00                                     | 3,09                                | 4,00                                      |  |
| 29                                             | 98                    | 225,00                                                                                                                                          | 97,83                 | 10,011                | -0,400                        | 0,307                   | 0,400                         | -4,00                                     | 3,07                                | 4,00                                      |  |
| 30                                             | 97                    | 223,00                                                                                                                                          | 96,96                 | 10,017                | -0,400                        | 0,304                   | 0,400                         | -4,00                                     | 3,04                                | 4,00                                      |  |



|                                                |                       |                                                                                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
|------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-------------------------------|-------------------------|-------------------------------|-------------------------------------------|-------------------------------------|-------------------------------------------|--|
| 5.3.10                                         |                       | Voltage-controlled control functions “Q= f(V)”<br>The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.2 |                       |                       |                               |                         |                               |                                           |                                     | P                                         |  |
| 5.3.10.1.1                                     |                       | Test Voltage-controlled control functions “Q= f(V)” - quasi-stationary behavior                                                                 |                       |                       |                               |                         |                               |                                           |                                     | P                                         |  |
| Test: 5.3.10.1.1 a) to n) 100% P <sub>rE</sub> |                       |                                                                                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
| FSP POWER MANAGER 10KW                         |                       |                                                                                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
| Voltage steps                                  | U <sub>step</sub> [%] | U <sub>meas</sub> [V]                                                                                                                           | U <sub>meas</sub> [%] | P <sub>30s</sub> [kW] | Q <sub>tol_under</sub> [kVAr] | Q <sub>30s</sub> [kVAr] | Q <sub>tol_upper</sub> [kVAr] | Q <sub>tol_under</sub> [%S <sub>n</sub> ] | Q <sub>30s</sub> [%S <sub>n</sub> ] | Q <sub>tol_upper</sub> [%S <sub>n</sub> ] |  |
| 31                                             | 96                    | 221,00                                                                                                                                          | 96,09                 | 10,020                | -0,400                        | 0,321                   | 0,400                         | -4,00                                     | 3,21                                | 4,00                                      |  |
| 32                                             | 95                    | 219,00                                                                                                                                          | 95,22                 | 9,959                 | 0,690                         | 1,260                   | 1,490                         | 6,90                                      | 12,60                               | 14,90                                     |  |
| 33                                             | 94                    | 216,00                                                                                                                                          | 93,91                 | 9,797                 | 1,780                         | 2,283                   | 2,580                         | 17,80                                     | 22,83                               | 25,80                                     |  |
| 34                                             | 93                    | 214,00                                                                                                                                          | 93,04                 | 9,486                 | 2,870                         | 3,409                   | 3,670                         | 28,70                                     | 34,09                               | 36,70                                     |  |
| 35                                             | 92                    | 212,00                                                                                                                                          | 92,17                 | 9,133                 | 3,960                         | 4,297                   | 4,760                         | 39,60                                     | 42,97                               | 47,60                                     |  |
| 36                                             | 91                    | 209,00                                                                                                                                          | 90,87                 | 9,140                 | 3,960                         | 4,298                   | 4,760                         | 39,60                                     | 42,98                               | 47,60                                     |  |
| 37                                             | 90                    | 207,00                                                                                                                                          | 90,00                 | 9,142                 | 3,960                         | 4,296                   | 4,760                         | 39,60                                     | 42,96                               | 47,60                                     |  |
| 38                                             | 89                    | 205,00                                                                                                                                          | 89,13                 | 9,147                 | 3,960                         | 4,296                   | 4,760                         | 39,60                                     | 42,96                               | 47,60                                     |  |
| 39                                             | 88                    | 202,00                                                                                                                                          | 87,83                 | 9,158                 | 3,960                         | 4,295                   | 4,760                         | 39,60                                     | 42,95                               | 47,60                                     |  |
| 40                                             | 87                    | 200,00                                                                                                                                          | 86,96                 | 9,159                 | 3,960                         | 4,299                   | 4,760                         | 39,60                                     | 42,99                               | 47,60                                     |  |
| 41                                             | 86                    | 198,00                                                                                                                                          | 86,09                 | 9,165                 | 3,960                         | 4,299                   | 4,760                         | 39,60                                     | 42,99                               | 47,60                                     |  |
| 42                                             | 85                    | 195,00                                                                                                                                          | 84,78                 | 9,167                 | 3,960                         | 4,298                   | 4,760                         | 39,60                                     | 42,98                               | 47,60                                     |  |
| 43                                             | 86                    | 198,00                                                                                                                                          | 86,09                 | 9,165                 | 3,960                         | 4,299                   | 4,760                         | 39,60                                     | 42,99                               | 47,60                                     |  |
| 44                                             | 87                    | 200,00                                                                                                                                          | 86,96                 | 9,160                 | 3,960                         | 4,299                   | 4,760                         | 39,60                                     | 42,99                               | 47,60                                     |  |
| 45                                             | 88                    | 202,00                                                                                                                                          | 87,83                 | 9,157                 | 3,960                         | 4,299                   | 4,760                         | 39,60                                     | 42,99                               | 47,60                                     |  |
| 46                                             | 89                    | 205,00                                                                                                                                          | 89,13                 | 9,144                 | 3,960                         | 4,301                   | 4,760                         | 39,60                                     | 43,01                               | 47,60                                     |  |
| 47                                             | 90                    | 207,00                                                                                                                                          | 90,00                 | 9,142                 | 3,960                         | 4,300                   | 4,760                         | 39,60                                     | 43,00                               | 47,60                                     |  |
| 48                                             | 91                    | 209,00                                                                                                                                          | 90,87                 | 9,138                 | 3,960                         | 4,303                   | 4,760                         | 39,60                                     | 43,03                               | 47,60                                     |  |
| 49                                             | 92                    | 212,00                                                                                                                                          | 92,17                 | 9,129                 | 3,960                         | 4,296                   | 4,760                         | 39,60                                     | 42,96                               | 47,60                                     |  |
| 50                                             | 93                    | 214,00                                                                                                                                          | 93,04                 | 9,490                 | 2,870                         | 3,388                   | 3,670                         | 28,70                                     | 33,88                               | 36,70                                     |  |
| 51                                             | 94                    | 216,00                                                                                                                                          | 93,91                 | 9,785                 | 1,780                         | 2,325                   | 2,580                         | 17,80                                     | 23,25                               | 25,80                                     |  |
| 52                                             | 95                    | 218,00                                                                                                                                          | 94,78                 | 9,957                 | 0,690                         | 1,258                   | 1,490                         | 6,90                                      | 12,58                               | 14,90                                     |  |
| 53                                             | 96                    | 221,00                                                                                                                                          | 96,09                 | 10,019                | -0,400                        | 0,324                   | 0,400                         | -4,00                                     | 3,24                                | 4,00                                      |  |
| 54                                             | 97                    | 223,00                                                                                                                                          | 96,96                 | 10,016                | -0,400                        | 0,305                   | 0,400                         | -4,00                                     | 3,05                                | 4,00                                      |  |
| 55                                             | 98                    | 225,00                                                                                                                                          | 97,83                 | 10,011                | -0,400                        | 0,308                   | 0,400                         | -4,00                                     | 3,08                                | 4,00                                      |  |
| 56                                             | 99                    | 228,00                                                                                                                                          | 99,13                 | 10,008                | -0,400                        | 0,309                   | 0,400                         | -4,00                                     | 3,09                                | 4,00                                      |  |
| 57                                             | 100                   | 230,00                                                                                                                                          | 100,00                | 10,007                | -0,400                        | 0,311                   | 0,400                         | -4,00                                     | 3,11                                | 4,00                                      |  |

|                                               |                        |                                                                                 |                        |                       |                               |                         |                               |                                           |                                     |                                           |  |
|-----------------------------------------------|------------------------|---------------------------------------------------------------------------------|------------------------|-----------------------|-------------------------------|-------------------------|-------------------------------|-------------------------------------------|-------------------------------------|-------------------------------------------|--|
| 5.3.10.1.1                                    |                        | Test Voltage-controlled control functions “Q= f(V)” - quasi-stationary behavior |                        |                       |                               |                         |                               |                                           |                                     | P                                         |  |
| Test: 5.3.10.1.1 a) to n) 20% P <sub>rE</sub> |                        |                                                                                 |                        |                       |                               |                         |                               |                                           |                                     |                                           |  |
| FSP POWER MANAGER 10KW                        |                        |                                                                                 |                        |                       |                               |                         |                               |                                           |                                     |                                           |  |
| Voltage steps                                 | U <sub>_step</sub> [%] | U <sub>_meas</sub> [V]                                                          | U <sub>_meas</sub> [%] | P <sub>30s</sub> [kW] | Q <sub>tol_under</sub> [kVAr] | Q <sub>30s</sub> [kVAr] | Q <sub>tol_upper</sub> [kVAr] | Q <sub>tol_under</sub> [%S <sub>n</sub> ] | Q <sub>30s</sub> [%S <sub>n</sub> ] | Q <sub>tol_upper</sub> [%S <sub>n</sub> ] |  |
| 1                                             | 100                    | 229,97                                                                          | 99,99                  | 1,958                 | -0,400                        | 0,283                   | 0,400                         | -4,00                                     | 2,83                                | 4,00                                      |  |
| 2                                             | 101                    | 232,32                                                                          | 101,01                 | 1,948                 | -0,400                        | 0,284                   | 0,400                         | -4,00                                     | 2,84                                | 4,00                                      |  |
| 3                                             | 102                    | 234,64                                                                          | 102,02                 | 1,942                 | -0,400                        | 0,286                   | 0,400                         | -4,00                                     | 2,86                                | 4,00                                      |  |
| 4                                             | 103                    | 236,91                                                                          | 103,00                 | 1,937                 | -0,400                        | 0,287                   | 0,400                         | -4,00                                     | 2,87                                | 4,00                                      |  |
| 5                                             | 104                    | 239,23                                                                          | 104,01                 | 1,931                 | -0,400                        | 0,288                   | 0,400                         | -4,00                                     | 2,88                                | 4,00                                      |  |
| 6                                             | 105                    | 241,51                                                                          | 105,00                 | 1,926                 | -0,400                        | 0,297                   | 0,400                         | -4,00                                     | 2,97                                | 4,00                                      |  |
| 7                                             | 106                    | 243,78                                                                          | 105,99                 | 1,905                 | -1,853                        | -1,598                  | -1,053                        | -18,53                                    | -15,98                              | -10,53                                    |  |
| 8                                             | 107                    | 246,07                                                                          | 106,99                 | 1,878                 | -3,307                        | -3,040                  | -2,507                        | -33,07                                    | -30,40                              | -25,07                                    |  |
| 9                                             | 108                    | 248,37                                                                          | 107,99                 | 1,842                 | -4,760                        | -4,486                  | -3,960                        | -47,60                                    | -44,86                              | -39,60                                    |  |
| 10                                            | 109                    | 250,70                                                                          | 109,00                 | 1,838                 | -4,760                        | -4,485                  | -3,960                        | -47,60                                    | -44,85                              | -39,60                                    |  |
| 11                                            | 110                    | 253,12                                                                          | 110,05                 | 1,833                 | -4,760                        | -4,485                  | -3,960                        | -47,60                                    | -44,85                              | -39,60                                    |  |
| 12                                            | 111                    | 255,44                                                                          | 111,06                 | 1,828                 | -4,760                        | -4,483                  | -3,960                        | -47,60                                    | -44,83                              | -39,60                                    |  |
| 13                                            | 112                    | 257,69                                                                          | 112,04                 | -0,092                | -0,400                        | -0,323                  | 0,400                         | -4,00                                     | -3,23                               | 4,00                                      |  |
| 14                                            | 113                    | 259,98                                                                          | 113,03                 | -0,122                | -0,400                        | -0,322                  | 0,400                         | -4,00                                     | -3,22                               | 4,00                                      |  |
| 15                                            | 112                    | 257,69                                                                          | 112,04                 | -0,118                | -0,400                        | -0,323                  | 0,400                         | -4,00                                     | -3,23                               | 4,00                                      |  |
| 16                                            | 111                    | 255,40                                                                          | 111,04                 | 1,829                 | -4,760                        | -4,484                  | -3,960                        | -47,60                                    | -44,84                              | -39,60                                    |  |
| 17                                            | 110                    | 253,13                                                                          | 110,06                 | 1,833                 | -4,760                        | -4,484                  | -3,960                        | -47,60                                    | -44,84                              | -39,60                                    |  |
| 18                                            | 109                    | 250,71                                                                          | 109,01                 | 1,838                 | -4,760                        | -4,485                  | -3,960                        | -47,60                                    | -44,85                              | -39,60                                    |  |
| 19                                            | 108                    | 248,41                                                                          | 108,00                 | 1,843                 | -4,760                        | -4,487                  | -3,960                        | -47,60                                    | -44,87                              | -39,60                                    |  |
| 20                                            | 107                    | 246,11                                                                          | 107,00                 | 1,879                 | -3,307                        | -3,044                  | -2,507                        | -33,07                                    | -30,44                              | -25,07                                    |  |
| 21                                            | 106                    | 243,80                                                                          | 106,00                 | 1,905                 | -1,853                        | -1,606                  | -1,053                        | -18,53                                    | -16,06                              | -10,53                                    |  |
| 22                                            | 105                    | 241,51                                                                          | 105,00                 | 1,926                 | -0,400                        | 0,298                   | 0,400                         | -4,00                                     | 2,98                                | 4,00                                      |  |
| 23                                            | 104                    | 239,22                                                                          | 104,01                 | 1,932                 | -0,400                        | 0,290                   | 0,400                         | -4,00                                     | 2,90                                | 4,00                                      |  |
| 24                                            | 103                    | 236,92                                                                          | 103,01                 | 1,937                 | -0,400                        | 0,289                   | 0,400                         | -4,00                                     | 2,89                                | 4,00                                      |  |
| 25                                            | 102                    | 234,62                                                                          | 102,01                 | 1,942                 | -0,400                        | 0,288                   | 0,400                         | -4,00                                     | 2,88                                | 4,00                                      |  |
| 26                                            | 101                    | 232,32                                                                          | 101,01                 | 1,948                 | -0,400                        | 0,287                   | 0,400                         | -4,00                                     | 2,87                                | 4,00                                      |  |
| 27                                            | 100                    | 230,02                                                                          | 100,01                 | 1,954                 | -0,400                        | 0,285                   | 0,400                         | -4,00                                     | 2,85                                | 4,00                                      |  |
| 28                                            | 99                     | 227,72                                                                          | 99,01                  | 1,960                 | -0,400                        | 0,284                   | 0,400                         | -4,00                                     | 2,84                                | 4,00                                      |  |
| 29                                            | 98                     | 225,41                                                                          | 98,01                  | 1,966                 | -0,400                        | 0,282                   | 0,400                         | -4,00                                     | 2,82                                | 4,00                                      |  |
| 30                                            | 97                     | 223,12                                                                          | 97,01                  | 1,973                 | -0,400                        | 0,280                   | 0,400                         | -4,00                                     | 2,80                                | 4,00                                      |  |
| 31                                            | 96                     | 220,82                                                                          | 96,01                  | 1,983                 | -0,400                        | 0,279                   | 0,400                         | -4,00                                     | 2,79                                | 4,00                                      |  |
| 32                                            | 95                     | 218,52                                                                          | 95,01                  | 1,983                 | 0,690                         | 1,285                   | 1,490                         | 6,90                                      | 12,85                               | 14,90                                     |  |

| 5.3.10.1.1                                    |                       | Test Voltage-controlled control functions “Q= f(V)” - quasi-stationary behavior |                       |                       |                               |                         |                               |                                           |                                     | P                                         |  |
|-----------------------------------------------|-----------------------|---------------------------------------------------------------------------------|-----------------------|-----------------------|-------------------------------|-------------------------|-------------------------------|-------------------------------------------|-------------------------------------|-------------------------------------------|--|
| Test: 5.3.10.1.1 a) to n) 20% P <sub>RE</sub> |                       |                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
| FSP POWER MANAGER 10KW                        |                       |                                                                                 |                       |                       |                               |                         |                               |                                           |                                     |                                           |  |
| Voltage steps                                 | U <sub>step</sub> [%] | U <sub>meas</sub> [V]                                                           | U <sub>meas</sub> [%] | P <sub>30s</sub> [kW] | Q <sub>tol_under</sub> [kVAr] | Q <sub>30s</sub> [kVAr] | Q <sub>tol_upper</sub> [kVAr] | Q <sub>tol_under</sub> [%S <sub>n</sub> ] | Q <sub>30s</sub> [%S <sub>n</sub> ] | Q <sub>tol_upper</sub> [%S <sub>n</sub> ] |  |
| 33                                            | 94                    | 216,22                                                                          | 94,01                 | 1,971                 | 1,780                         | 2,323                   | 2,580                         | 17,80                                     | 23,23                               | 25,80                                     |  |
| 34                                            | 93                    | 213,92                                                                          | 93,01                 | 1,990                 | 2,870                         | 3,372                   | 3,670                         | 28,70                                     | 33,72                               | 36,70                                     |  |
| 35                                            | 92                    | 211,61                                                                          | 92,00                 | 2,009                 | 3,960                         | 4,211                   | 4,760                         | 39,60                                     | 42,11                               | 47,60                                     |  |
| 36                                            | 91                    | 209,26                                                                          | 90,98                 | 2,018                 | 3,960                         | 4,210                   | 4,760                         | 39,60                                     | 42,10                               | 47,60                                     |  |
| 37                                            | 90                    | 206,99                                                                          | 90,00                 | 2,024                 | 3,960                         | 4,210                   | 4,760                         | 39,60                                     | 42,10                               | 47,60                                     |  |
| 38                                            | 89                    | 204,68                                                                          | 88,99                 | 2,030                 | 3,960                         | 4,207                   | 4,760                         | 39,60                                     | 42,07                               | 47,60                                     |  |
| 39                                            | 88                    | 202,39                                                                          | 88,00                 | 2,036                 | 3,960                         | 4,208                   | 4,760                         | 39,60                                     | 42,08                               | 47,60                                     |  |
| 40                                            | 87                    | 200,07                                                                          | 86,99                 | 2,043                 | 3,960                         | 4,207                   | 4,760                         | 39,60                                     | 42,07                               | 47,60                                     |  |
| 41                                            | 86                    | 197,76                                                                          | 85,98                 | 2,049                 | 3,960                         | 4,205                   | 4,760                         | 39,60                                     | 42,05                               | 47,60                                     |  |
| 42                                            | 85                    | 195,47                                                                          | 84,99                 | 2,056                 | 3,960                         | 4,205                   | 4,760                         | 39,60                                     | 42,05                               | 47,60                                     |  |
| 43                                            | 86                    | 197,77                                                                          | 85,99                 | 2,049                 | 3,960                         | 4,204                   | 4,760                         | 39,60                                     | 42,04                               | 47,60                                     |  |
| 44                                            | 87                    | 200,07                                                                          | 86,99                 | 2,043                 | 3,960                         | 4,207                   | 4,760                         | 39,60                                     | 42,07                               | 47,60                                     |  |
| 45                                            | 88                    | 202,37                                                                          | 87,99                 | 2,036                 | 3,960                         | 4,209                   | 4,760                         | 39,60                                     | 42,09                               | 47,60                                     |  |
| 46                                            | 89                    | 204,67                                                                          | 88,98                 | 2,031                 | 3,960                         | 4,207                   | 4,760                         | 39,60                                     | 42,07                               | 47,60                                     |  |
| 47                                            | 90                    | 206,97                                                                          | 89,99                 | 2,025                 | 3,960                         | 4,212                   | 4,760                         | 39,60                                     | 42,12                               | 47,60                                     |  |
| 48                                            | 91                    | 209,29                                                                          | 90,99                 | 2,018                 | 3,960                         | 4,211                   | 4,760                         | 39,60                                     | 42,11                               | 47,60                                     |  |
| 49                                            | 92                    | 211,59                                                                          | 92,00                 | 2,009                 | 3,960                         | 4,212                   | 4,760                         | 39,60                                     | 42,12                               | 47,60                                     |  |
| 50                                            | 93                    | 213,88                                                                          | 92,99                 | 1,992                 | 2,870                         | 3,413                   | 3,670                         | 28,70                                     | 34,13                               | 36,70                                     |  |
| 51                                            | 94                    | 216,18                                                                          | 93,99                 | 1,972                 | 1,780                         | 2,348                   | 2,580                         | 17,80                                     | 23,48                               | 25,80                                     |  |
| 52                                            | 95                    | 218,47                                                                          | 94,99                 | 1,984                 | 0,690                         | 1,285                   | 1,490                         | 6,90                                      | 12,85                               | 14,90                                     |  |
| 53                                            | 96                    | 220,77                                                                          | 95,99                 | 1,983                 | -0,400                        | 0,306                   | 0,400                         | -4,00                                     | 3,06                                | 4,00                                      |  |
| 54                                            | 97                    | 223,09                                                                          | 97,00                 | 1,973                 | -0,400                        | 0,281                   | 0,400                         | -4,00                                     | 2,81                                | 4,00                                      |  |
| 55                                            | 98                    | 225,41                                                                          | 98,00                 | 1,966                 | -0,400                        | 0,282                   | 0,400                         | -4,00                                     | 2,82                                | 4,00                                      |  |
| 56                                            | 99                    | 227,73                                                                          | 99,01                 | 1,961                 | -0,400                        | 0,284                   | 0,400                         | -4,00                                     | 2,84                                | 4,00                                      |  |
| 57                                            | 100                   | 230,02                                                                          | 100,01                | 1,954                 | -0,400                        | 0,286                   | 0,400                         | -4,00                                     | 2,86                                | 4,00                                      |  |

|                                                     |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
|-----------------------------------------------------|-----------------------|---------------------------------------------------------------------------------|-----------------------|-----------------------|------------------------------------|-------------------------|-------------------------------|-------------------------------------------|-------------------------------------|-------------------------------------------|--|
| 5.3.10.1.1                                          |                       | Test Voltage-controlled control functions “Q= f(V)” - quasi-stationary behavior |                       |                       |                                    |                         |                               |                                           |                                     | P                                         |  |
| Test: 5.3.10.1.1 o) to z) Test@91%U <sub>n</sub>    |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
| FSP POWER MANAGER 10KW                              |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
| Voltage steps                                       | U <sub>step</sub> [%] | U <sub>meas</sub> [V]                                                           | U <sub>meas</sub> [%] | P <sub>30s</sub> [kW] | Q <sub>tol_under</sub> [kVAr]      | Q <sub>30s</sub> [kVAr] | Q <sub>tol_upper</sub> [kVAr] | Q <sub>tol_under</sub> [%S <sub>n</sub> ] | Q <sub>30s</sub> [%S <sub>n</sub> ] | Q <sub>tol_upper</sub> [%S <sub>n</sub> ] |  |
| 1                                                   | 91                    | 209,26                                                                          | 90,98                 | 0,018                 | -0,400                             | -0,301                  | 0,400                         | -4,00                                     | -3,01                               | 4,00                                      |  |
| 2                                                   | 91                    | 209,26                                                                          | 90,98                 | 0,608                 | 0,757                              | 1,107                   | 1,557                         | 7,57                                      | 11,07                               | 15,57                                     |  |
| 3                                                   | 91                    | 209,26                                                                          | 90,98                 | 1,091                 | 1,781                              | 2,115                   | 2,581                         | 17,81                                     | 21,15                               | 25,81                                     |  |
| 4                                                   | 91                    | 209,26                                                                          | 90,98                 | 1,548                 | 2,757                              | 3,076                   | 3,557                         | 27,57                                     | 30,76                               | 35,57                                     |  |
| 5                                                   | 91                    | 209,26                                                                          | 90,98                 | 2,112                 | 3,960                              | 4,209                   | 4,760                         | 39,60                                     | 42,09                               | 47,60                                     |  |
| 6                                                   | 91                    | 209,26                                                                          | 90,98                 | 1,549                 | 2,758                              | 3,078                   | 3,558                         | 27,58                                     | 30,78                               | 35,58                                     |  |
| 7                                                   | 91                    | 209,26                                                                          | 90,98                 | 1,091                 | 1,784                              | 2,119                   | 2,584                         | 17,84                                     | 21,19                               | 25,84                                     |  |
| 8                                                   | 91                    | 209,26                                                                          | 90,98                 | 0,608                 | 0,759                              | 1,108                   | 1,559                         | 7,59                                      | 11,08                               | 15,59                                     |  |
| 9                                                   | 91                    | 209,26                                                                          | 90,98                 | 0,019                 | -0,400                             | -0,302                  | 0,400                         | -4,00                                     | -3,02                               | 4,00                                      |  |
| Test: 5.3.10.1.1 o) to z) Test@109%U <sub>n</sub>   |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
| FSP POWER MANAGER 10KW                              |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
| Voltage steps                                       | U <sub>step</sub> [%] | U <sub>meas</sub> [V]                                                           | U <sub>meas</sub> [%] | P <sub>30s</sub> [kW] | Q <sub>tol_under</sub> [kVAr]      | Q <sub>30s</sub> [kVAr] | Q <sub>tol_upper</sub> [kVAr] | Q <sub>tol_under</sub> [%S <sub>n</sub> ] | Q <sub>30s</sub> [%S <sub>n</sub> ] | Q <sub>tol_upper</sub> [%S <sub>n</sub> ] |  |
| 1                                                   | 109                   | 250,93                                                                          | 109,10                | -0,001                | -0,701                             | 0,128                   | 0,099                         | -4,00                                     | 1,28                                | 4,00                                      |  |
| 2                                                   | 109                   | 250,92                                                                          | 109,10                | 0,398                 | -1,597                             | -1,243                  | -0,797                        | -15,97                                    | -12,43                              | -7,97                                     |  |
| 3                                                   | 109                   | 250,93                                                                          | 109,10                | 0,881                 | -2,596                             | -2,227                  | -1,796                        | -25,96                                    | -22,27                              | -17,96                                    |  |
| 4                                                   | 109                   | 250,93                                                                          | 109,10                | 1,364                 | -3,610                             | -3,225                  | -2,810                        | -36,10                                    | -32,25                              | -28,10                                    |  |
| 5                                                   | 109                   | 250,93                                                                          | 109,10                | 1,941                 | -4,760                             | -4,414                  | -3,960                        | -47,60                                    | -44,14                              | -39,60                                    |  |
| 6                                                   | 109                   | 250,93                                                                          | 109,10                | 1,364                 | -3,613                             | -3,228                  | -2,813                        | -36,13                                    | -32,28                              | -28,13                                    |  |
| 7                                                   | 109                   | 250,93                                                                          | 109,10                | 0,881                 | -2,599                             | -2,231                  | -1,799                        | -25,99                                    | -22,31                              | -17,99                                    |  |
| 8                                                   | 109                   | 250,92                                                                          | 109,10                | 0,397                 | -1,598                             | -1,244                  | -0,798                        | -15,98                                    | -12,44                              | -7,98                                     |  |
| 9                                                   | 109                   | 250,92                                                                          | 109,10                | -0,102                | -0,720                             | -0,334                  | 0,080                         | -4,00                                     | -3,34                               | 4,00                                      |  |
| Setting values for the Q(U) characteristic test:    |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
| Required voltage points according table 3           |                       | Voltage (U/U <sub>n</sub> )                                                     |                       |                       | Reactive power (Q/S <sub>n</sub> ) |                         |                               | Time constant Tau                         |                                     |                                           |  |
| a                                                   |                       | 0,92                                                                            |                       |                       | 43,6% (over exited)                |                         |                               | 3s                                        |                                     |                                           |  |
| b                                                   |                       | 0,96                                                                            |                       |                       | 0,0                                |                         |                               |                                           |                                     |                                           |  |
| c                                                   |                       | 1,05                                                                            |                       |                       | 0,0                                |                         |                               |                                           |                                     |                                           |  |
| d                                                   |                       | 1,08                                                                            |                       |                       | 43,6% (under exited)               |                         |                               |                                           |                                     |                                           |  |
| Assessment criterion:                               |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |
| The examination of inpatient behaviour is passed if |                       |                                                                                 |                       |                       |                                    |                         |                               |                                           |                                     |                                           |  |

- The 30s mean values of the reactive power values measured in stationary operation measured according to 5.3.10.1.1 are within the tolerance band of  $\pm 4\%$   $S_n$  and  $\pm 1\%$   $U_n$  of the set Q (U) characteristic.

- in the power range  $P_{min}$  up to  $20\% P_{rE}$  the time course of the reactive power is constant and when  $P = 0$  the reactive power goes towards 0. Compliance with the tolerance band of  $\pm 4\%$   $S_n$  is in this Active power range not required.

**Note:**

**5.3.10.1.2 Test Voltage-controlled control functions “Q= f(V)” - dynamic behavior**

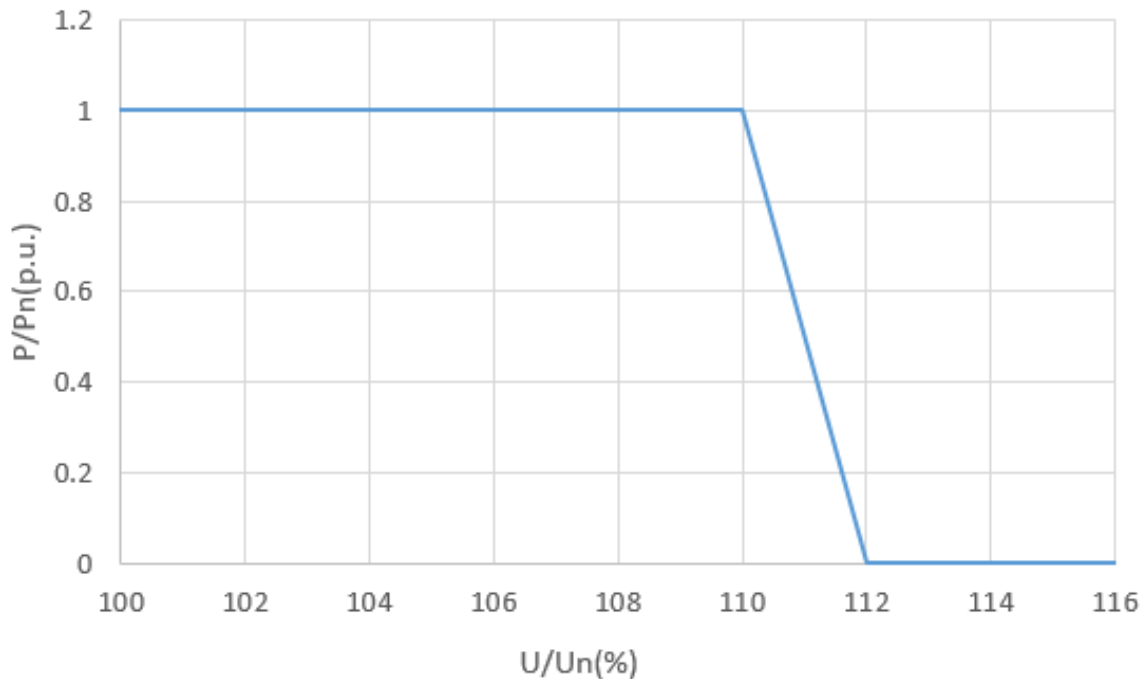
P

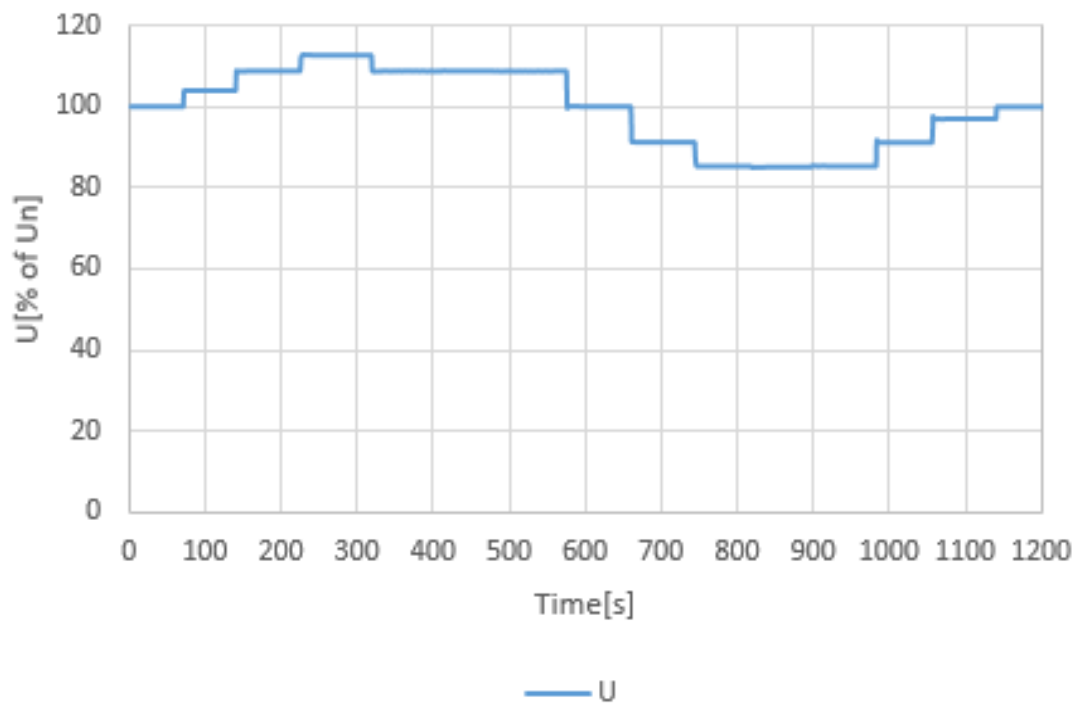
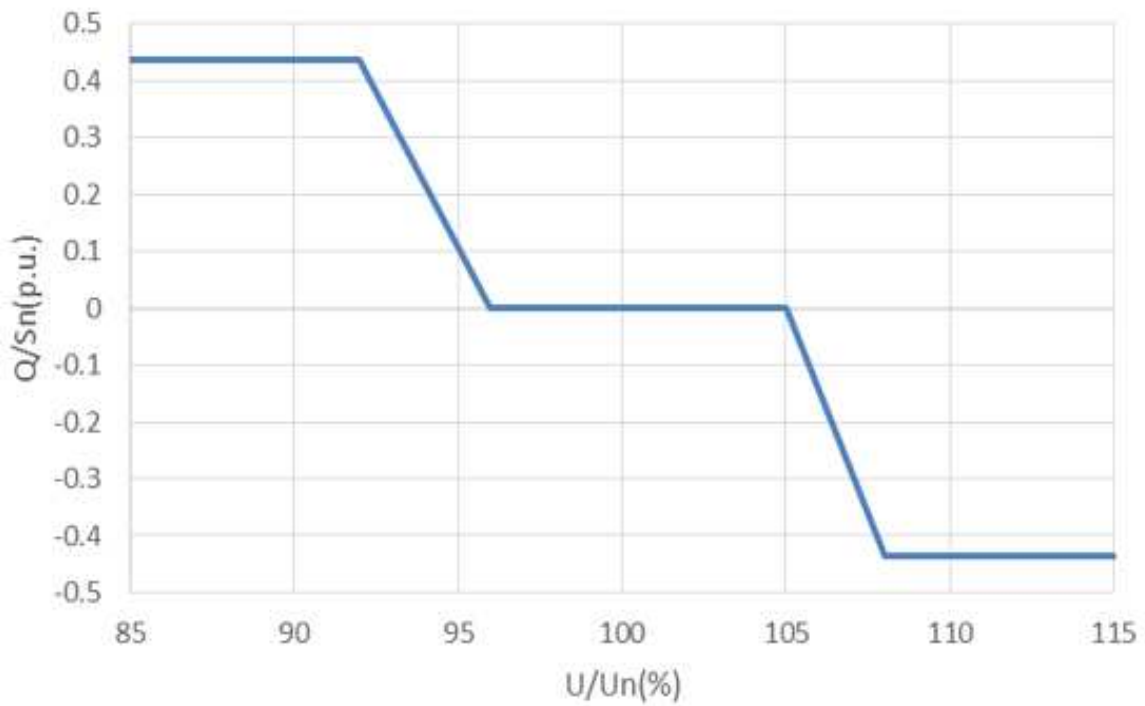
**FSP POWER MANAGER 10KW**

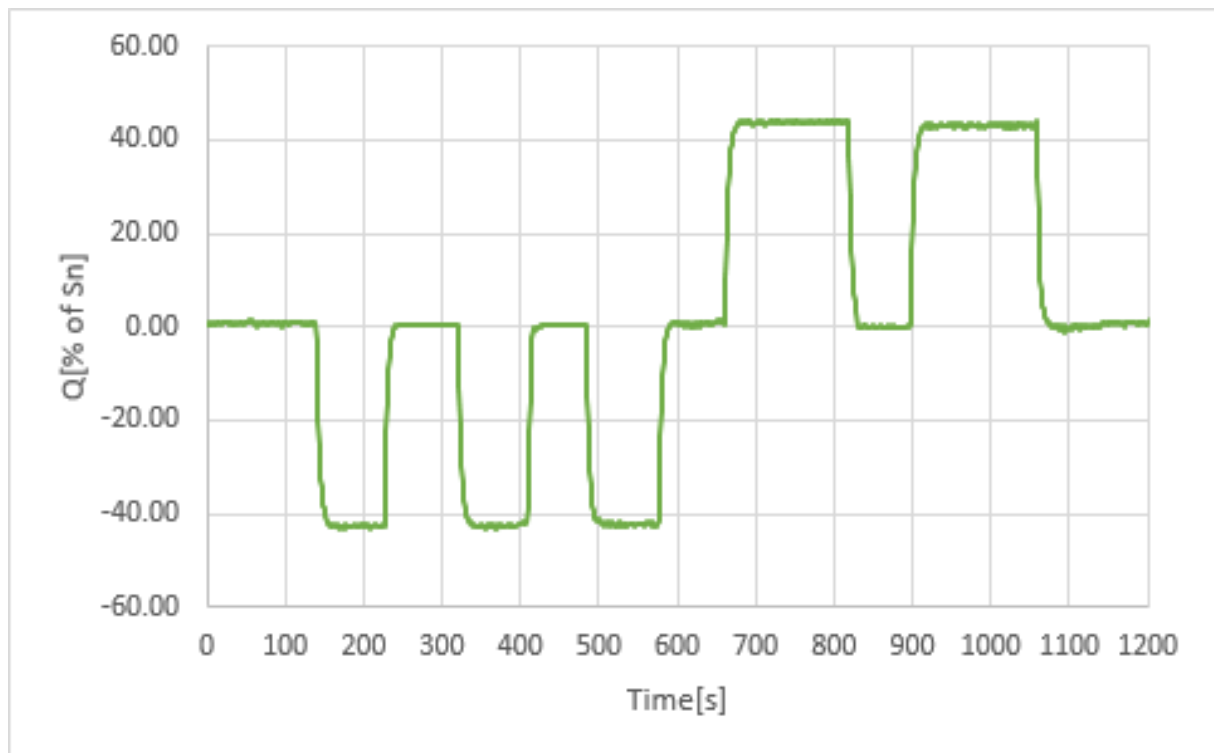
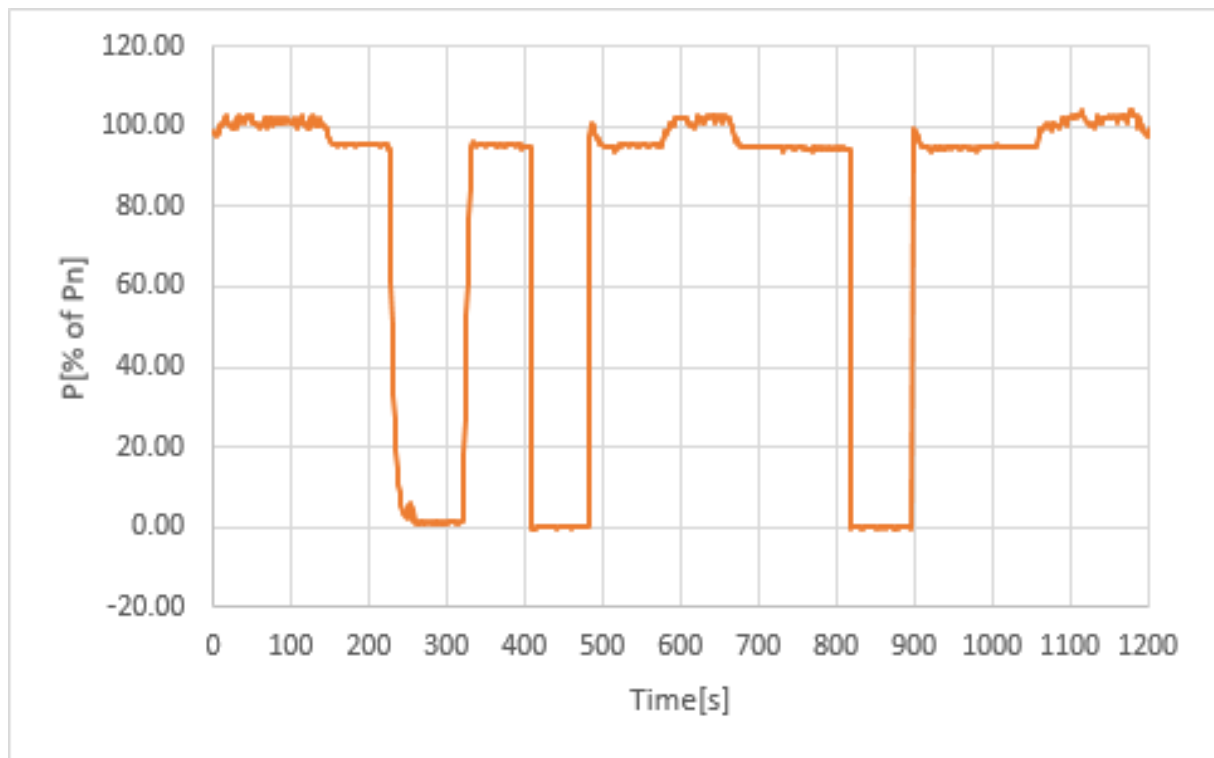
| U <sub>step</sub><br>[%] | U <sub>meas</sub><br>[V] | U <sub>meas</sub><br>[%] | P <sub>tol_under</sub><br>[kW] | P <sub>30s</sub><br>[kW] | P <sub>tol_upper</sub><br>[kW] | P <sub>30s</sub><br>[%] | Q <sub>tol_under</sub><br>[kVAr] | Q <sub>30s</sub><br>[kVAr] | Q <sub>tol_upper</sub><br>[kVAr] | Q <sub>set</sub><br>[%S <sub>n</sub> ] | Q <sub>30s</sub><br>[%S <sub>n</sub> ] |
|--------------------------|--------------------------|--------------------------|--------------------------------|--------------------------|--------------------------------|-------------------------|----------------------------------|----------------------------|----------------------------------|----------------------------------------|----------------------------------------|
| 100                      | 230,28                   | 100,12                   | 9,0                            | 9,770                    | 11,0                           | 97,70                   | -0,40                            | 0,08                       | 0,40                             | 0                                      | 0,76                                   |
| 104                      | 239,46                   | 104,11                   | 9,0                            | 10,200                   | 11,0                           | 102,00                  | -0,40                            | 0,07                       | 0,40                             | 0                                      | 0,70                                   |
| 109                      | 250,76                   | 109,03                   | 8,0                            | 9,520                    | 11,0                           | 95,20                   | -4,76                            | -4,31                      | -3,96                            | -43,6                                  | -43,10                                 |
| 113                      | 259,87                   | 112,99                   | 0,0                            | 0,196                    | 1,0                            | 1,96                    | -0,40                            | 0,02                       | 0,40                             | 0                                      | 0,23                                   |
| 109                      | 250,67                   | 108,99                   | 8,0                            | 9,530                    | 11,0                           | 95,30                   | -4,76                            | -4,26                      | -3,96                            | -43,6                                  | -42,60                                 |
| 109                      | 250,76                   | 109,03                   | 0,0                            | 0,005                    | 1,0                            | 0,05                    | -0,40                            | 0,03                       | 0,40                             | 0                                      | 0,31                                   |
| 109                      | 250,69                   | 109,00                   | 8,0                            | 9,530                    | 11,0                           | 95,30                   | -4,76                            | -4,28                      | -3,96                            | -43,6                                  | -42,80                                 |
| 100                      | 230,23                   | 100,10                   | 9,0                            | 10,100                   | 11,0                           | 101,00                  | -0,40                            | 0,06                       | 0,40                             | 0                                      | 0,56                                   |
| 91                       | 209,64                   | 91,15                    | 8,0                            | 9,490                    | 11,0                           | 94,90                   | 3,96                             | 4,38                       | 4,76                             | 43,6                                   | 43,80                                  |
| 85                       | 195,78                   | 85,12                    | 8,0                            | 9,450                    | 11,0                           | 94,50                   | 3,96                             | 4,38                       | 4,76                             | 43,6                                   | 43,80                                  |
| 85                       | 195,34                   | 84,93                    | 0,0                            | -0,018                   | 1,0                            | -0,18                   | -0,40                            | 0,01                       | 0,40                             | 0                                      | 0,10                                   |
| 85                       | 195,79                   | 85,13                    | 8,0                            | 9,470                    | 11,0                           | 94,70                   | 3,96                             | 4,30                       | 4,76                             | 43,6                                   | 43,00                                  |
| 91                       | 209,54                   | 91,10                    | 8,0                            | 9,510                    | 11,0                           | 95,10                   | 3,96                             | 4,31                       | 4,76                             | 43,6                                   | 43,10                                  |
| 97                       | 223,19                   | 97,04                    | 9,0                            | 10,200                   | 11,0                           | 102,00                  | -0,40                            | 0,00                       | 0,40                             | 0                                      | 0,03                                   |
| 100                      | 230,12                   | 100,05                   | 9,0                            | 9,930                    | 11,0                           | 99,30                   | -0,40                            | 0,10                       | 0,40                             | 0                                      | 1,01                                   |

Note:

Graph

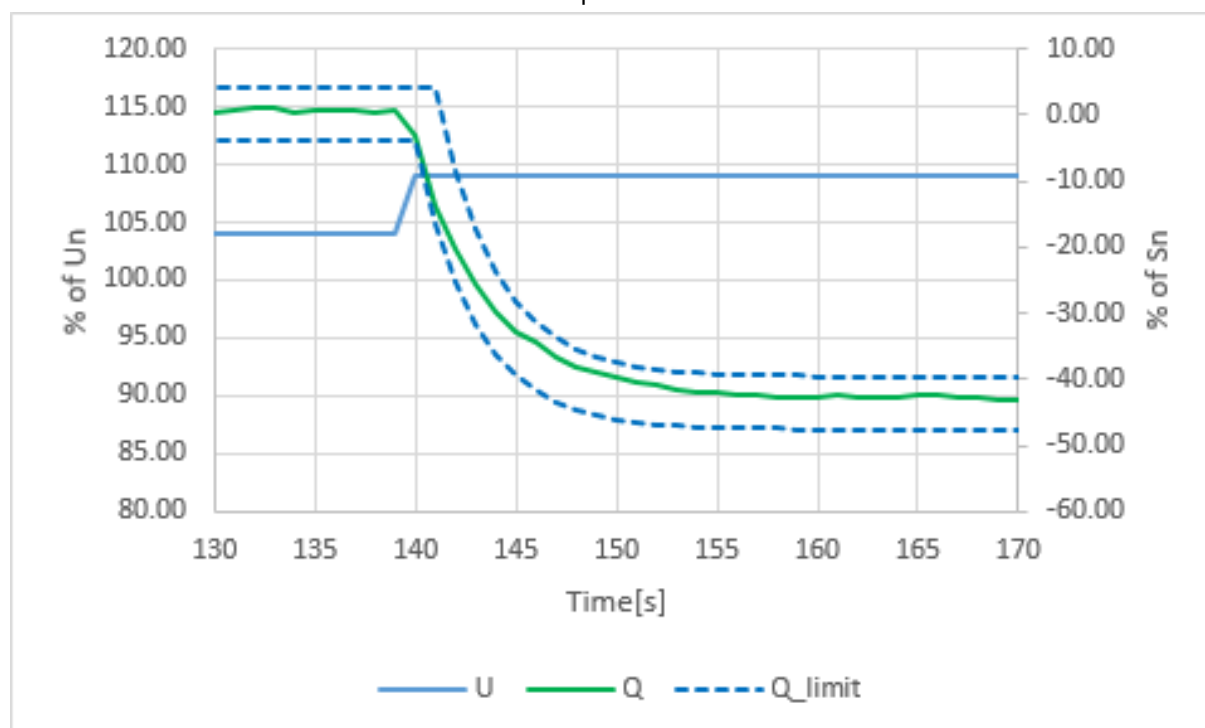




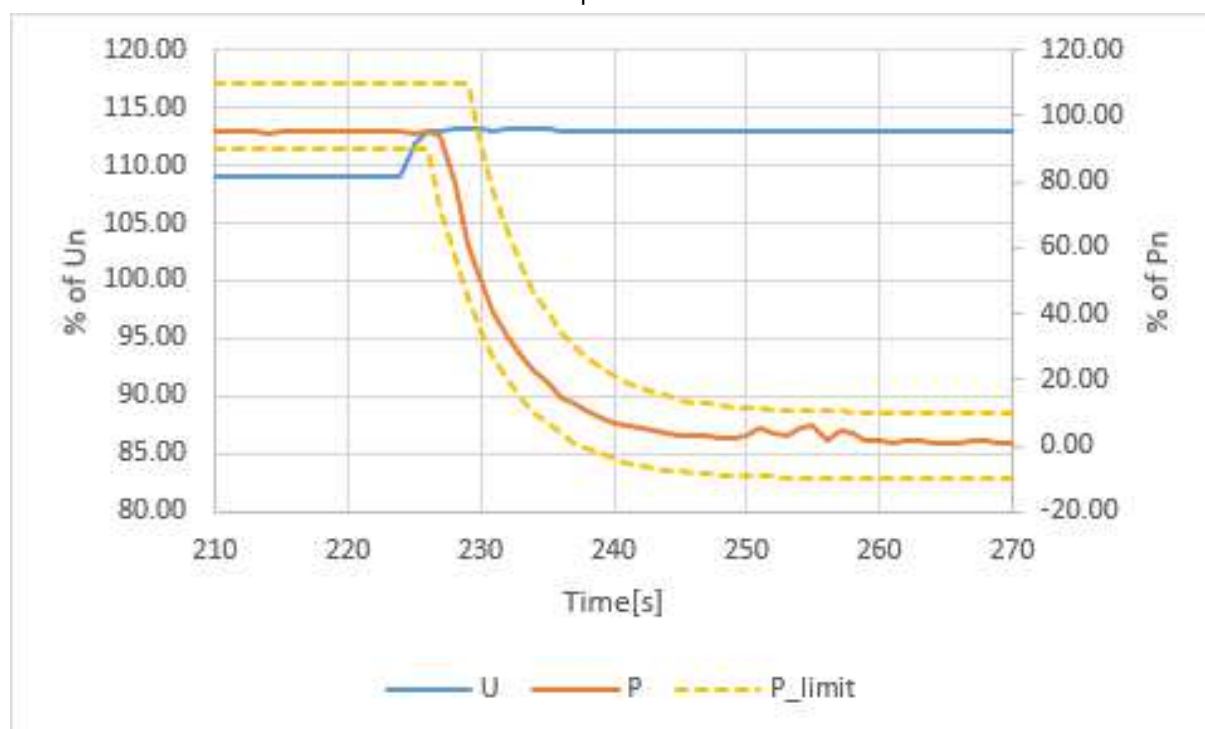




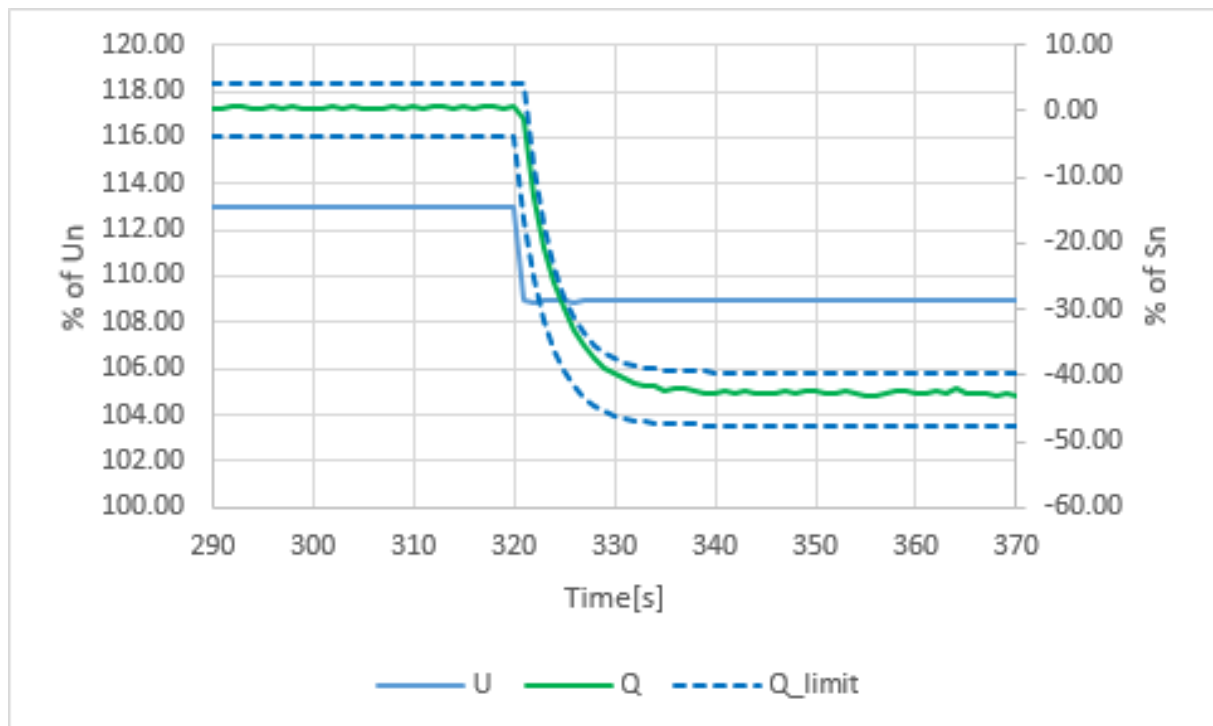
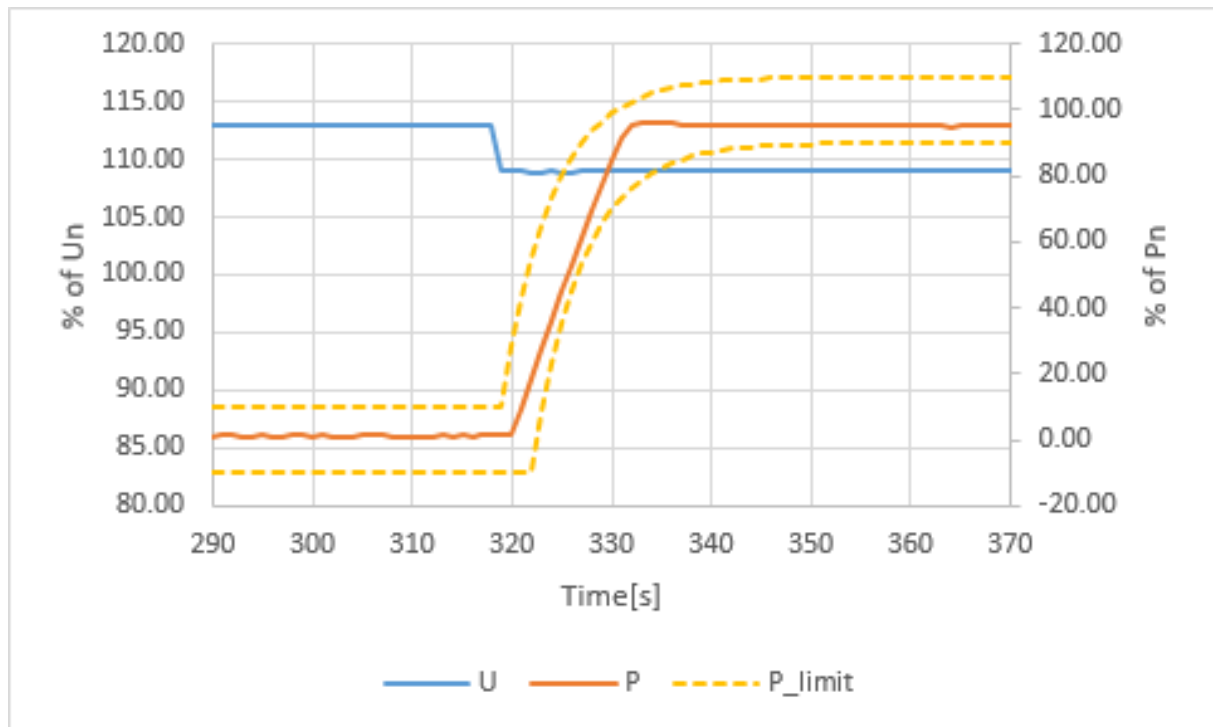
Test steps form 2 to 3



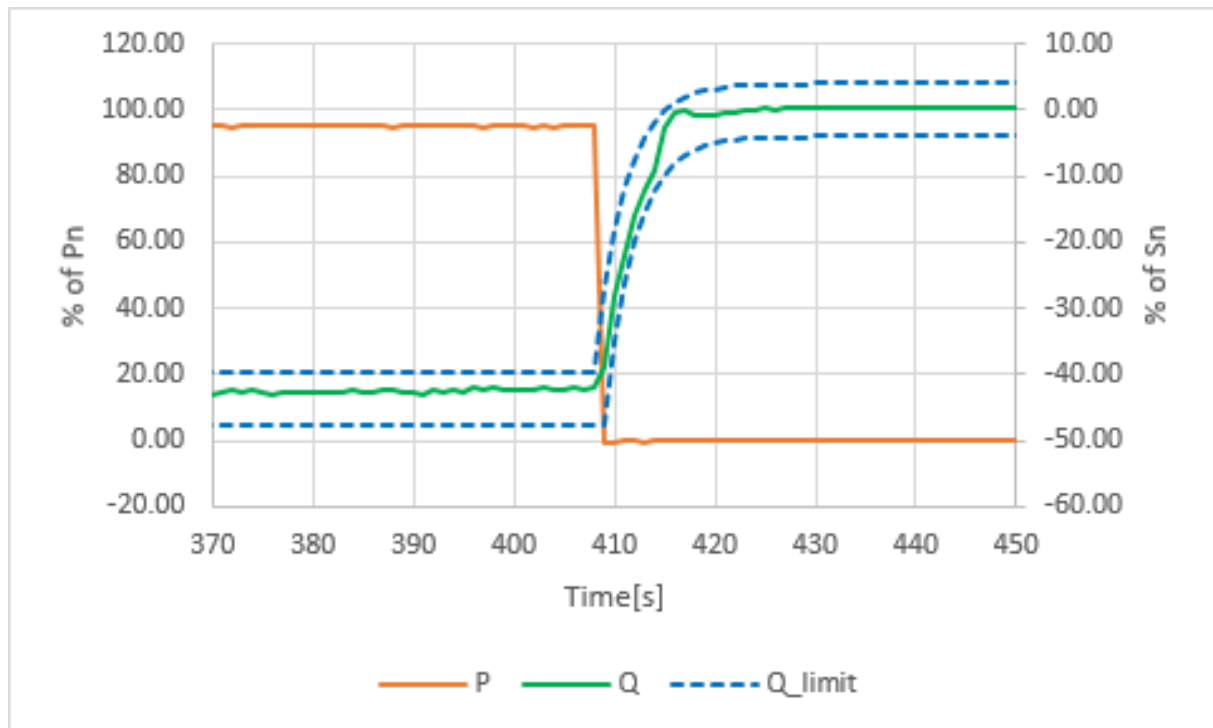
Test steps form 3 to 4



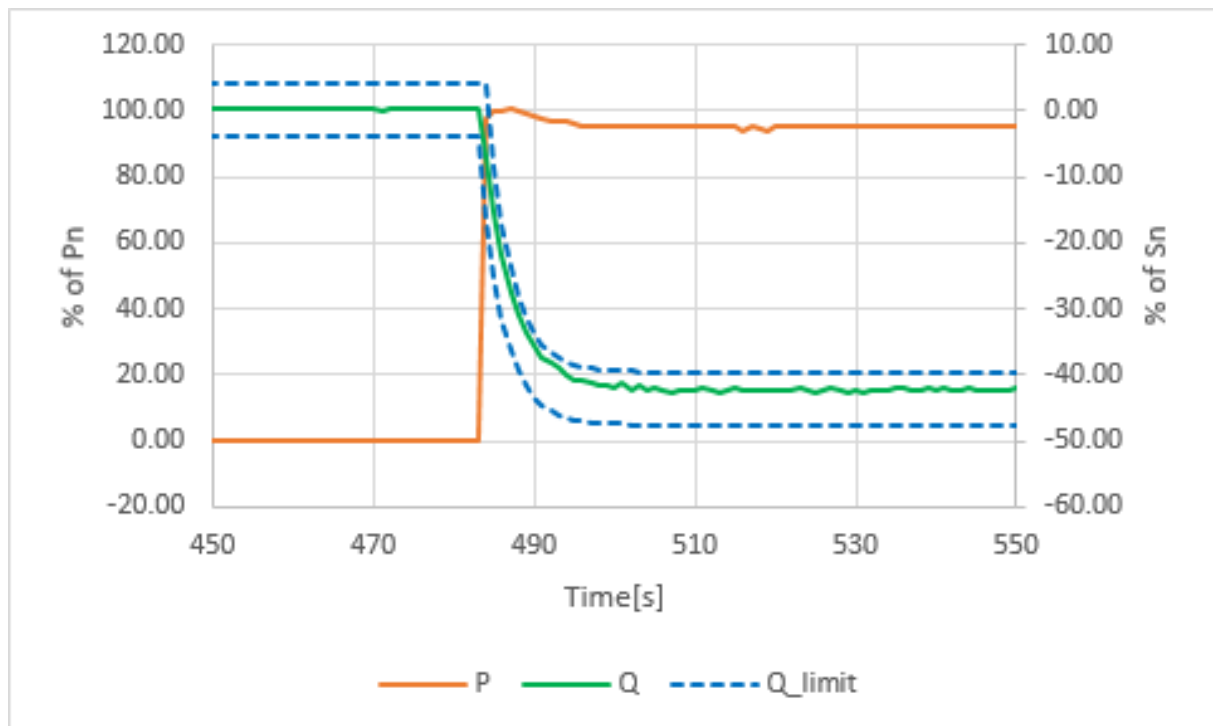
Test steps form 4 to 5



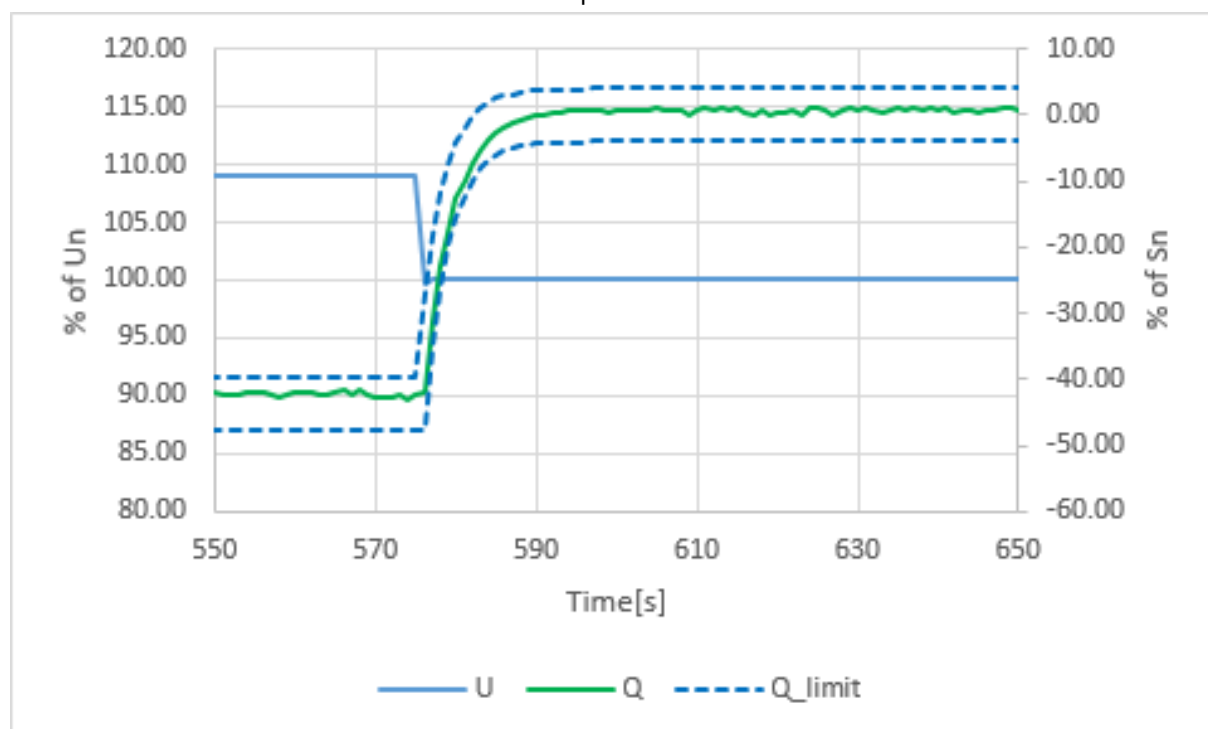
Test steps form 5 to 6



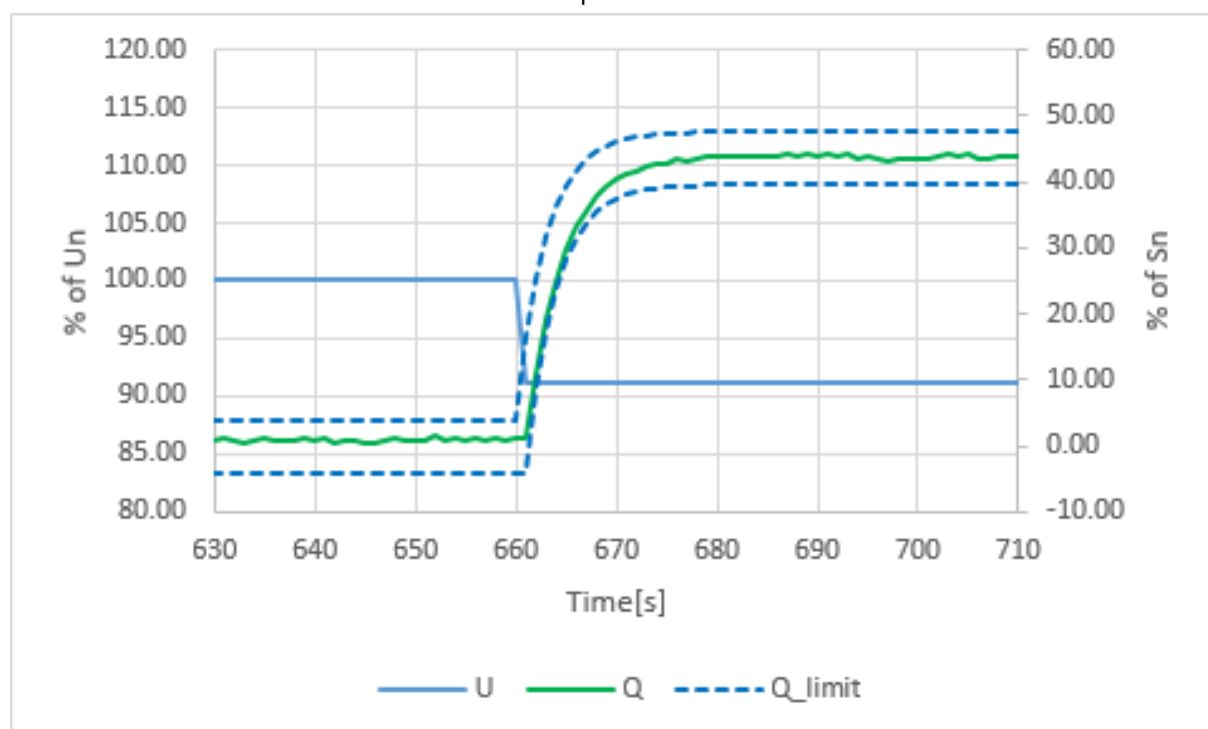
Test steps form 6 to 7



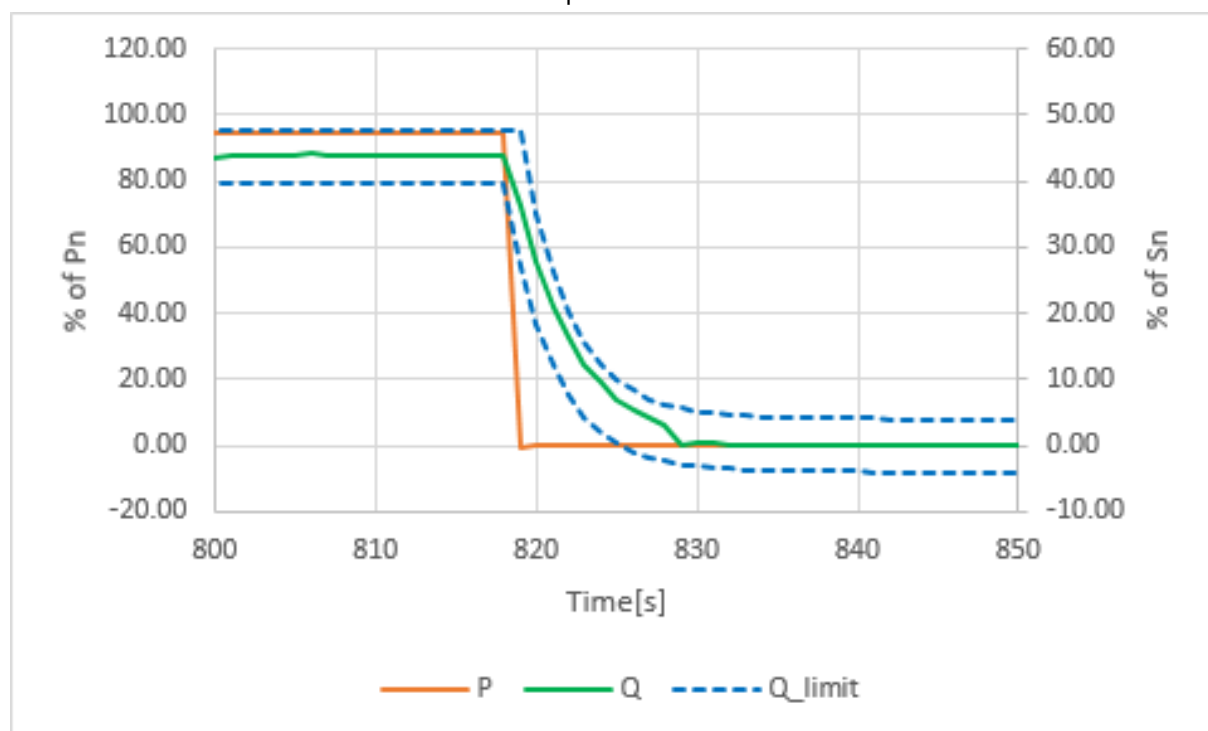
Test steps form 7 to 8



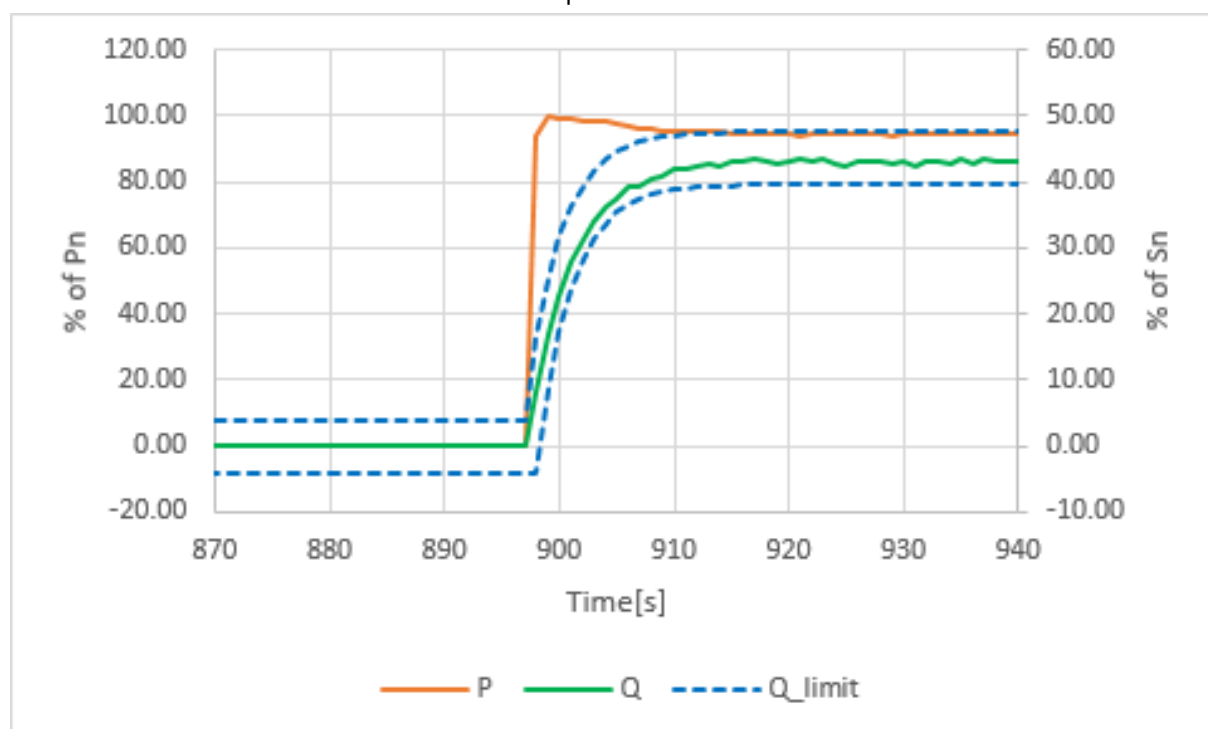
Test steps form 8 to 9



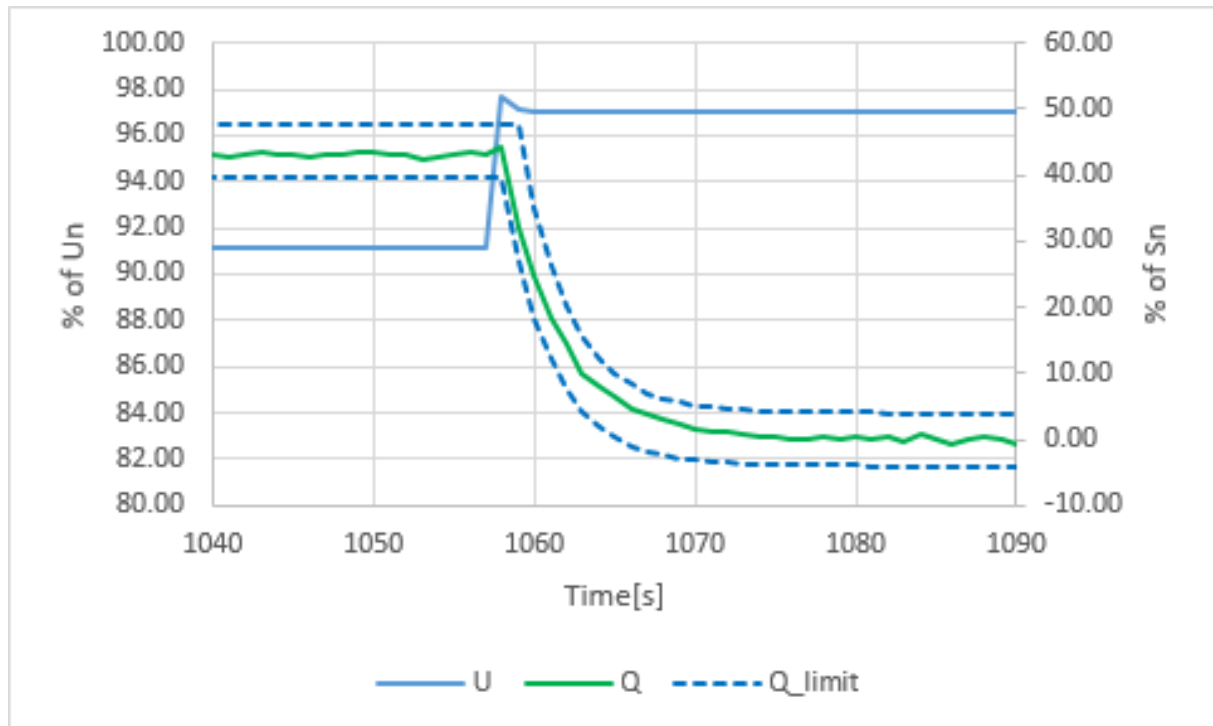
Test steps form 10 to 11



Test steps form 11 to 12



Test steps form 13 to 14



**5.3.11 Protection of set values**

The test serves as evidence of the requirements according to TOR Erzeuger, 6.2.3

All parameters are password protected.

The behaviour of the system on the mains concerning settings by software updates is not changed.

| OVE directive R25 |                                                                                                                        |            |
|-------------------|------------------------------------------------------------------------------------------------------------------------|------------|
| Clause            | Test                                                                                                                   | Result     |
| <b>5.4</b>        | <b>NS protection</b>                                                                                                   |            |
| 5.4               | Functional safety (VDE AR-N 4105 / VDE 0124-100)                                                                       | <b>P</b>   |
| 5.4               | Central NS-protection (VDE AR-N 4105 / VDE 0124-100)                                                                   | <b>N/A</b> |
| 5.4               | Integrated NS protection (VDE AR-N 4105 / VDE 0124-100)                                                                | <b>P</b>   |
| 5.4               | Interface switch (VDE AR-N 4105 / VDE 0124-100)                                                                        | <b>N/A</b> |
| 5.4               | Integrated interface switch (VDE AR-N 4105 / VDE 0124-100)                                                             | <b>P</b>   |
| 5.4               | Check of setting values (TOR Erzeuger Typ A)                                                                           | <b>P</b>   |
| 5.4.1.1.1         | Voltage control Single Phase                                                                                           | <b>P</b>   |
| 5.4.1.1.1         | Voltage control Multi Phase (Phase to N)                                                                               | <b>P</b>   |
| 5.4.1.1.1         | Voltage control Multi Phase (Phase to Phase)                                                                           | <b>P</b>   |
| 5.4.1.1.2         | Measuring the rise-in voltage protection as a running 10-minute mean value                                             | <b>P</b>   |
| 5.4.2.1           | Frequency measurement                                                                                                  | <b>P</b>   |
| 5.4               | Reporting NS protection (VDE AR-N 4105 / VDE 0124-100)                                                                 | <b>P</b>   |
| 5.4               | Constructional characteristics of NS protection (VDE AR-N 4105 / VDE 0124-100)                                         | <b>P</b>   |
| 5.4.3             | Islanding protection according table 6 – Load imbalance (real, reactive load) for test condition A (EUT output = 100%) | <b>P</b>   |
|                   | Islanding protection according table 6 – Load imbalance (real, reactive load) for test condition A (EUT output = 66%)  | <b>P</b>   |
|                   | Islanding protection according table 6 – Load imbalance (real, reactive load) for test condition A (EUT output = 33%)  | <b>P</b>   |
| <b>5.5</b>        | <b>Connecting conditions and synchronization</b>                                                                       |            |
| 5.5.1             | Test                                                                                                                   | <b>P</b>   |
| <b>5.6</b>        | <b>Evidence dynamic grid support</b>                                                                                   |            |
| 5.6.1             | General                                                                                                                | <b>P</b>   |
| 5.6.3             | Test                                                                                                                   | <b>P</b>   |
| <b>5.7</b>        | <b>Test of Ancillary Unit</b>                                                                                          |            |
| 5.7.1             | General                                                                                                                | <b>N/A</b> |
| 5.7.2             | Test                                                                                                                   | <b>N/A</b> |



| 5.4                                                                                                                                                                                                                                                                            | NS protection                                    |                 |                 |                  |             |                  |                 | P                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------|-----------------|------------------|-------------|------------------|-----------------|----------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                                                  |                 |                 |                  |             |                  |                 |                                                                            |
| 5.4                                                                                                                                                                                                                                                                            | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                 |                  |             |                  |                 | P                                                                          |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                                                  |                 |                 |                  |             |                  |                 |                                                                            |
| Component No.                                                                                                                                                                                                                                                                  | Fault                                            | Test condition: |                 | Test time: [min] | Fuse no.[A] | Fault condition: |                 | Result:                                                                    |
|                                                                                                                                                                                                                                                                                |                                                  | AC              | DC              |                  |             | AC               | DC              |                                                                            |
| Mis-wiring with phase                                                                                                                                                                                                                                                          | Revesed before start up                          | 230V<br>0,01A   | 800V<br>0,05A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter can not start up.<br>No damage.<br>No hazard.                     |
| PV + to PV -                                                                                                                                                                                                                                                                   | Revesed before start up                          | 230V<br>0,01A   | 800V<br>0,05A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter can not start up.<br>No damage.<br>No hazard.                     |
| Battery + to Battery -                                                                                                                                                                                                                                                         | Revesed                                          | 230V<br>0,01A   | 48V<br>0,05A    | 2min             | --          | 230V<br>0,01A    | 48V<br>0,05A    | DC breaker turned off immediatery.<br>No damage. No hazard.                |
| Battery + to Battery -                                                                                                                                                                                                                                                         | Short                                            | 230V<br>0,01A   | 48V<br>0,05A    | 2min             | --          | 230V<br>0,01A    | 48V<br>0,05A    | DC breaker turned off immediatery.<br>No damage. No hazard.                |
| Battery                                                                                                                                                                                                                                                                        | Over charge                                      | 230V<br>44,7A   | 48V<br>200A     | 7hours           | --          | 230V<br>44,7A    | 48V<br>200A     | After 7 hours testing, no high temperature.<br>No damage. No hazard.       |
| Battery                                                                                                                                                                                                                                                                        | Over discharge                                   | 230V<br>43A     | 48V<br>218A     | 7hours           | --          | 230V<br>43A      | 48V<br>218A     | Ater testing, no high temperature.<br>No damage. No hazard.                |
| Output                                                                                                                                                                                                                                                                         | Overload                                         | 230V<br>47,3A   | 47,4V<br>251,4A | 3,4 hours        | --          | 230V<br>47,3A    | 47,4V<br>251,4A | Inverter normal working, no high temperature.<br>No damage. No hazard.     |
| 71-000292-00G<br>PV SPS<br>Q8 (PinD&PinS)                                                                                                                                                                                                                                      | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>D69&Q7 damage.<br>No hazard. |
| 71-000292-00G<br>PV SPS<br>Q8 (PinD&PinG)                                                                                                                                                                                                                                      | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>Q7&Q8 damage.<br>No hazard.  |
| 71-000292-00G<br>PV SPS<br>C94                                                                                                                                                                                                                                                 | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>No damage.<br>No hazard.     |
| 71-000292-00G<br>PV SPS<br>U21(Pin3&Pin4)                                                                                                                                                                                                                                      | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>No damage.<br>No hazard.     |

| 5.4                                                                                                                                                                                                                                                                            | NS protection                                    |                 |                 |                  |             |                  |               | P                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------|-----------------|------------------|-------------|------------------|---------------|------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                                                  |                 |                 |                  |             |                  |               |                                                                                          |
| 5.4                                                                                                                                                                                                                                                                            | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                 |                  |             |                  |               | P                                                                                        |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                                                  |                 |                 |                  |             |                  |               |                                                                                          |
| Component No.                                                                                                                                                                                                                                                                  | Fault                                            | Test condition: |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                  |
|                                                                                                                                                                                                                                                                                |                                                  | AC              | DC              |                  |             | AC               | DC            |                                                                                          |
| 71-000292-00G<br>PV SPS<br>U21(Pin1)                                                                                                                                                                                                                                           | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>CE1, C11 damage.<br>No hazard.             |
| 71-000292-00G<br>GRID SPS<br>Rec1(Pin2&Pin3)                                                                                                                                                                                                                                   | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>REC1, REC2 damage.<br>No hazard.           |
| 71-000292-00G<br>GRID SPS<br>C74                                                                                                                                                                                                                                               | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>REC1, REC2 damage.<br>No hazard.           |
| 71-000292-00G<br>GRID SPS<br>Q18 (PinD&PinS)                                                                                                                                                                                                                                   | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>REC1, REC2, Q14 damage.<br>No hazard.      |
| 71-000292-00G<br>GRID SPS<br>Q18 (PinD&PinG)                                                                                                                                                                                                                                   | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>REC1, REC2, Q14, Q18 damage.<br>No hazard. |
| 71-000292-00G<br>GRID SPS<br>U22(Pin1)                                                                                                                                                                                                                                         | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>CE3, C24 damage.<br>No hazard.             |
| 71-000292-00G<br>BAT SPS<br>CE6                                                                                                                                                                                                                                                | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>F2 damage.<br>No hazard.                   |
| 71-000292-00G<br>BAT SPS<br>Q12(Pin2&Pin3)                                                                                                                                                                                                                                     | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>R212, R213, U7 damage.<br>No hazard.       |
| 71-000292-00G<br>BAT SPS<br>C25                                                                                                                                                                                                                                                | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Inverter disconnect from grid immediately.<br>No damage.                                 |

| 5.4                                                                                                                                                                                                                                                                            | NS protection                                    |                 |                 |                  |             |                  |                 | P                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------|-----------------|------------------|-------------|------------------|-----------------|-----------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                                                  |                 |                 |                  |             |                  |                 |                                                                                         |
| 5.4                                                                                                                                                                                                                                                                            | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                 |                  |             |                  |                 | P                                                                                       |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                                                  |                 |                 |                  |             |                  |                 |                                                                                         |
| Component No.                                                                                                                                                                                                                                                                  | Fault                                            | Test condition: |                 | Test time: [min] | Fuse no.[A] | Fault condition: |                 | Result:                                                                                 |
|                                                                                                                                                                                                                                                                                |                                                  | AC              | DC              |                  |             | AC               | DC              |                                                                                         |
|                                                                                                                                                                                                                                                                                |                                                  |                 |                 |                  |             |                  |                 | No hazard.                                                                              |
| 71-000292-00G<br>BAT SPS<br>Q6 (PinD&PinS)                                                                                                                                                                                                                                     | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>F2 damage.<br>No hazard.                  |
| 71-000292-00G<br>BAT SPS<br>Q6 (PinD&PinG)                                                                                                                                                                                                                                     | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>Q6, F2 damage.<br>No hazard.              |
| 71-000292-00G<br>BUS SOFT STAR<br>D67                                                                                                                                                                                                                                          | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>IGBT18, IGBT21, D24 damage.<br>No hazard. |
| 71-000292-00G<br>BUS SOFT STAR<br>C110                                                                                                                                                                                                                                         | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>IGBT1, IGBT4 damage.<br>No hazard.        |
| 71-000292-00G<br>BUS SOFT STAR<br>Q10(PinD&PinS)                                                                                                                                                                                                                               | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>F2 damage.<br>No hazard.                  |
| 71-000292-00G<br>BUS SOFT STAR<br>Q10(PinD&PinG)                                                                                                                                                                                                                               | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>F2, Q10, R245 damage.<br>No hazard.       |
| 71-000292-00G<br>BUS SOFT STAR<br>U17(Pin3&Pin4)                                                                                                                                                                                                                               | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>No damage. No hazard.                     |
| 71-000292-00G<br>DC fan (near SPS board)                                                                                                                                                                                                                                       | Blocked                                          | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>No damage. No hazard.                     |
| 71-000292-00G<br>DC fan (near ventilation)                                                                                                                                                                                                                                     | Blocked                                          | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A   | Inverter disconnect from grid immediately.<br>No damage. No hazard.                     |
| Ventilation                                                                                                                                                                                                                                                                    | Blanket wrapped                                  | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>38,695A  | 800V<br>11,589A | The PCE power dropped to 8.9KW.                                                         |

| 5.4                                                                                                                                                                                                                                                                            |                       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|-----------------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                       |                                                  |                 |                  |             |                  |               |                                                                                                                       |
| 5.4                                                                                                                                                                                                                                                                            |                       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                                     |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                       |                                                  |                 |                  |             |                  |               |                                                                                                                       |
| Component No.                                                                                                                                                                                                                                                                  | Fault                 | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                               |
|                                                                                                                                                                                                                                                                                |                       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                                       |
|                                                                                                                                                                                                                                                                                |                       |                                                  |                 |                  |             |                  |               | No damage. No hazard.                                                                                                 |
| 71-000293-00G<br>Output current sensor defect<br>CT3(Pin8)                                                                                                                                                                                                                     | Open                  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Error message:"05 ERROR" (Inverter current exceed the upper limit);<br>Inverter was disconnect from grid immediately. |
| 71-000293-00G<br>Output current sensor defect<br>CT2(Pin9)                                                                                                                                                                                                                     | Open                  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,05A | Error message:"05 ERROR" (Inverter current exceed the upper limit);<br>Inverter was disconnect from grid immediately. |
| 71-000293-00G<br>Relay defect<br>RY7(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                                       |
| 71-000293-00G<br>Relay defect<br>RY5(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                                       |
| 71-000293-00G<br>Relay defect<br>RY2(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                                       |
| 71-000293-00G<br>Relay defect<br>RY1(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                                       |
| 71-000293-00G<br>Relay defect<br>RY9(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                                       |
| 71-000293-00G<br>Relay defect<br>RY8(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',                                                                      |

| 5.4                                                                                                                                                                                                                                                                            |                       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| 5.4                                                                                                                                                                                                                                                                            |                       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                             |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| Component No.                                                                                                                                                                                                                                                                  | Fault                 | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                       |
|                                                                                                                                                                                                                                                                                |                       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                               |
|                                                                                                                                                                                                                                                                                |                       |                                                  |                 |                  |             |                  |               | Inverter does not start up.                                                                                   |
| 71-000293-00G<br>Relay defect<br>RY6(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                               |
| 71-000293-00G<br>Relay defect<br>RY4(Pin3&Pin4)                                                                                                                                                                                                                                | Short before start up | 230V<br>0,01A                                    | 800V<br>0,02A   | 10min            | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"07 ERROR" (relay work abnormal)',<br>Inverter does not start up.                               |
| 71-000293-00G<br>Grid voltage monitoring<br>R93                                                                                                                                                                                                                                | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R89                                                                                                                                                                                                                                | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R13                                                                                                                                                                                                                                | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R17                                                                                                                                                                                                                                | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R8                                                                                                                                                                                                                                 | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |

| 5.4                                                                                                                                                                                                                                                                            |       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| 5.4                                                                                                                                                                                                                                                                            |       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                             |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| Component No.                                                                                                                                                                                                                                                                  | Fault | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                       |
|                                                                                                                                                                                                                                                                                |       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                               |
| 71-000293-00G<br>Grid voltage monitoring<br>R4                                                                                                                                                                                                                                 | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R92                                                                                                                                                                                                                                | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R88                                                                                                                                                                                                                                | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R18                                                                                                                                                                                                                                | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R16                                                                                                                                                                                                                                | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R7                                                                                                                                                                                                                                 | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000293-00G<br>Grid voltage monitoring<br>R3                                                                                                                                                                                                                                 | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |



| 5.4                                                                                                                                                                                                                                                                            | NS protection                                    |                 |                 |                  |             |                  |               | P                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------|-----------------|------------------|-------------|------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                                                  |                 |                 |                  |             |                  |               |                                                                                                               |
| 5.4                                                                                                                                                                                                                                                                            | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                 |                  |             |                  |               | P                                                                                                             |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                                                  |                 |                 |                  |             |                  |               |                                                                                                               |
| Component No.                                                                                                                                                                                                                                                                  | Fault                                            | Test condition: |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                       |
|                                                                                                                                                                                                                                                                                |                                                  | AC              | DC              |                  |             | AC               | DC            |                                                                                                               |
| 71-000297-00G<br>Isolation monitoring defect<br>R56                                                                                                                                                                                                                            | Open before start up                             | 230V<br>0,01A   | 800V<br>0,02A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (insulation resistance);<br>Inverter does not start up.                              |
| 71-000297-00G<br>Isolation monitoring<br>R68                                                                                                                                                                                                                                   | Open before start up                             | 230V<br>0,01A   | 800V<br>0,02A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (insulation resistance);<br>Inverter does not start up.                              |
| 71-000297-00G<br>Isolation monitoring defect<br>R82                                                                                                                                                                                                                            | Open before start up                             | 230V<br>0,01A   | 800V<br>0,02A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (insulation resistance);<br>Inverter does not start up.                              |
| 71-000297-00G<br>Isolation monitoring defect<br>R89                                                                                                                                                                                                                            | Open before start up                             | 230V<br>0,01A   | 800V<br>0,02A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (insulation resistance);<br>Inverter does not start up.                              |
| 71-000297-00G<br>Isolation monitoring defect<br>R158                                                                                                                                                                                                                           | Open before start up                             | 230V<br>0,01A   | 800V<br>0,02A   | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (insulation resistance);<br>Inverter does not start up.                              |
| 71-000368-00G<br>Grid voltage monitoring defect<br>R1                                                                                                                                                                                                                          | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect<br>R 5                                                                                                                                                                                                                         | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect                                                                                                                                                                                                                                | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';                                                        |

| 5.4                                                                                                                                                                                                                                                                            |       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| 5.4                                                                                                                                                                                                                                                                            |       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                             |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| Component No.                                                                                                                                                                                                                                                                  | Fault | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                       |
|                                                                                                                                                                                                                                                                                |       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                               |
| R9                                                                                                                                                                                                                                                                             |       |                                                  |                 |                  |             |                  |               | PV inverter was disconnected from grid immediately.                                                           |
| 71-000368-00G<br>Grid voltage monitoring defect R13                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R17                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R21                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>RELAY Board R25                                                                                                                                                                                                                                               | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R29                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R33                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect                                                                                                                                                                                                                                | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';                                                        |



| 5.4                                                                                                                                                                                                                                                                            |       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| 5.4                                                                                                                                                                                                                                                                            |       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                             |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| Component No.                                                                                                                                                                                                                                                                  | Fault | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                       |
|                                                                                                                                                                                                                                                                                |       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                               |
| R37                                                                                                                                                                                                                                                                            |       |                                                  |                 |                  |             |                  |               | PV inverter was disconnected from grid immediately.                                                           |
| 71-000368-00G<br>Grid voltage monitoring defect R41                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R45                                                                                                                                                                                                                            | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R2                                                                                                                                                                                                                             | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R6                                                                                                                                                                                                                             | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R10                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R14                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect                                                                                                                                                                                                                                | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';                                                        |

| 5.4                                                                                                                                                                                                                                                                            |       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| 5.4                                                                                                                                                                                                                                                                            |       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                             |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |       |                                                  |                 |                  |             |                  |               |                                                                                                               |
| Component No.                                                                                                                                                                                                                                                                  | Fault | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                       |
|                                                                                                                                                                                                                                                                                |       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                               |
| R18                                                                                                                                                                                                                                                                            |       |                                                  |                 |                  |             |                  |               | PV inverter was disconnected from grid immediately.                                                           |
| 71-000368-00G<br>Grid voltage monitoring defect R22                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R26                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R30                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R34                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R38                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect R42                                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';<br>PV inverter was disconnected from grid immediately. |
| 71-000368-00G<br>Grid voltage monitoring defect                                                                                                                                                                                                                                | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR" (Line voltage is different)';                                                        |

| 5.4                                                                                                                                                                                                                                                                            | NS protection                                    |                 |                 |                  |             |                  |               | P                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------|-----------------|------------------|-------------|------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                                                  |                 |                 |                  |             |                  |               |                                                                                                                                          |
| 5.4                                                                                                                                                                                                                                                                            | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                 |                  |             |                  |               | P                                                                                                                                        |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                                                  |                 |                 |                  |             |                  |               |                                                                                                                                          |
| Component No.                                                                                                                                                                                                                                                                  | Fault                                            | Test condition: |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                                                  |
|                                                                                                                                                                                                                                                                                |                                                  | AC              | DC              |                  |             | AC               | DC            |                                                                                                                                          |
| R46                                                                                                                                                                                                                                                                            |                                                  |                 |                 |                  |             |                  |               | PV inverter was disconnected from grid immediately.                                                                                      |
| 71-000368-00G<br>DSP lost of control<br>C73                                                                                                                                                                                                                                    | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Inverter was shut down immediately.                                                                                                      |
| 71-500375-00G<br>DSP lost of control<br>XL1                                                                                                                                                                                                                                    | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Shutdown immediately,<br>No breakdown                                                                                                    |
| 71-500375-00G<br>DSP lost of control<br>C12                                                                                                                                                                                                                                    | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Shutdown immediately,<br>No breakdown                                                                                                    |
| 71-500375-00G<br>DSP lost of control<br>C72                                                                                                                                                                                                                                    | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Shutdown immediately,<br>No breakdown                                                                                                    |
| 71-500375-00G<br>DSP lost of control<br>XL3                                                                                                                                                                                                                                    | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Shutdown immediately,<br>No breakdown                                                                                                    |
| 71-500375-00G<br>DSPs communication defect<br>R528                                                                                                                                                                                                                             | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "17 ERROR" (Communication loss between master CPU and slave CPU)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>DSPs communication defect<br>R527                                                                                                                                                                                                                             | Open                                             | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "17 ERROR" (Communication loss between master CPU and slave CPU)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Inverter voltage monitoring defect<br>U10(Pin5&Pin6)                                                                                                                                                                                                          | Short                                            | 230V<br>43A     | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately.                               |

| 5.4                                                                                                                                                                                                                                                                            |       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |       |                                                  |                 |                  |             |                  |               |                                                                                                            |
| 5.4                                                                                                                                                                                                                                                                            |       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                          |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |       |                                                  |                 |                  |             |                  |               |                                                                                                            |
| Component No.                                                                                                                                                                                                                                                                  | Fault | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                    |
|                                                                                                                                                                                                                                                                                |       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                            |
| 71-500375-00G<br>Inverter voltage monitoring defect R75                                                                                                                                                                                                                        | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Inverter voltage monitoring defect U10(Pin9&Pin10)                                                                                                                                                                                                            | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Inverter voltage monitoring defect R84                                                                                                                                                                                                                        | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid frequency monitoring defect R93                                                                                                                                                                                                                          | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "04 warning" ( Line frequency LOW)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid frequency monitoring defect U4(Pin8&Pin9)                                                                                                                                                                                                                | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "04 warning" ( Line frequency LOW)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid voltage monitoring defect U11(Pin2&Pin3)                                                                                                                                                                                                                 | Short | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid voltage monitoring defect R101                                                                                                                                                                                                                           | Open  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |

| 5.4                                                                                                                                                                                                                                                                            |                       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|------------------------------------------------------------------------------------------------------------|
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                       |                                                  |                 |                  |             |                  |               |                                                                                                            |
| 5.4                                                                                                                                                                                                                                                                            |                       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                          |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                       |                                                  |                 |                  |             |                  |               |                                                                                                            |
| Component No.                                                                                                                                                                                                                                                                  | Fault                 | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                    |
|                                                                                                                                                                                                                                                                                |                       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                            |
| 71-500375-00G<br>Grid voltage monitoring defect U11(Pin5&Pin6)                                                                                                                                                                                                                 | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid voltage monitoring defect R106                                                                                                                                                                                                                           | Open                  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"36 ERROR(Line voltage is different),<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid frequency monitoring defect U81(Pin5&Pin6)                                                                                                                                                                                                               | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "04 warning" ( Line frequency LOW)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid frequency monitoring defect R119                                                                                                                                                                                                                         | Open                  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "04 warning" ( Line frequency LOW)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid frequency monitoring defect U81(Pin2&Pin3)                                                                                                                                                                                                               | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "04 warning" ( Line frequency LOW)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Grid frequency monitoring defect R126                                                                                                                                                                                                                         | Open                  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "04 warning" ( Line frequency LOW)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Isolation detection defect U14(Pin9&Pin10)                                                                                                                                                                                                                    | Short before start-up | 230V<br>0A                                       | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (Solar insulation resistance too low)',                                           |

|                                                                                                                                                                                                                                                                                |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------|-----------------|------------------|-------------|------------------|---------------|-------------------------------------------------------------------------------------------------------------------------|
| 5.4                                                                                                                                                                                                                                                                            |                       | NS protection                                    |                 |                  |             |                  |               | P                                                                                                                       |
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
| 5.4                                                                                                                                                                                                                                                                            |                       | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |                  |             |                  |               | P                                                                                                                       |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
| Component No.                                                                                                                                                                                                                                                                  | Fault                 | Test condition:                                  |                 | Test time: [min] | Fuse no.[A] | Fault condition: |               | Result:                                                                                                                 |
|                                                                                                                                                                                                                                                                                |                       | AC                                               | DC              |                  |             | AC               | DC            |                                                                                                                         |
|                                                                                                                                                                                                                                                                                |                       |                                                  |                 |                  |             |                  |               | PV inverter was disconnected from grid immediately.                                                                     |
| 71-500375-00G<br>Isolation detection defect<br>R182                                                                                                                                                                                                                            | Open before start-up  | 230V<br>0A                                       | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (Solar insulation resistance too low)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Isolation detection defect<br>U14(Pin12&Pin13)                                                                                                                                                                                                                | Short before start-up | 230V<br>0A                                       | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (Solar insulation resistance too low)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Isolation detection defect R187                                                                                                                                                                                                                               | Open before start-up  | 230V<br>0A                                       | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message:"13 ERROR" (Solar insulation resistance too low)',<br>PV inverter was disconnected from grid immediately. |
| 71-500375-00G<br>Residual current monitoring defect<br>R25                                                                                                                                                                                                                     | Open                  | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "16 ERROR" (GFCI Over),<br>No hazard,<br>PV inverter was disconnected from grid immediately.             |
| 71-500375-00G<br>Residual current monitoring defect<br>C52                                                                                                                                                                                                                     | Short                 | 230V<br>43A                                      | 800V<br>2x6,25A | 2min             | --          | 230V<br>0,01A    | 800V<br>0,02A | Error message: "16 ERROR" (GFCI Over),<br>No hazard,<br>PV inverter was disconnected from grid immediately.             |
| Note:                                                                                                                                                                                                                                                                          |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
| The errors in the control circuit simulate that the safety is even ensured during a single fault.                                                                                                                                                                              |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
| Assessment criterion:                                                                                                                                                                                                                                                          |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
| The NS protection must send a shutdown command to the coupling switch.                                                                                                                                                                                                         |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |
| If the error is detected, the device is switched off within 10 s after error detection.                                                                                                                                                                                        |                       |                                                  |                 |                  |             |                  |               |                                                                                                                         |

|                                                                                                                                                                                                                                                                                |                                                  |                 |    |                  |             |                  |    |         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------|----|------------------|-------------|------------------|----|---------|
| 5.4                                                                                                                                                                                                                                                                            | NS protection                                    |                 |    |                  |             |                  | P  |         |
| The test serves as verification of the reactive power mode according to TOR Erzeuger, 5.3.4.<br>The test for error detection with subsequent shutdown is carried out by means of error simulation, if necessary with additional error tests (see VDE-AR-N 4105: 2018-11, 6.1). |                                                  |                 |    |                  |             |                  |    |         |
| 5.4                                                                                                                                                                                                                                                                            | Functional safety (VDE AR-N 4105 / VDE 0124-100) |                 |    |                  |             |                  | P  |         |
| FSP POWER MANAGER 10KW                                                                                                                                                                                                                                                         |                                                  |                 |    |                  |             |                  |    |         |
| Component No.                                                                                                                                                                                                                                                                  | Fault                                            | Test condition: |    | Test time: [min] | Fuse no.[A] | Fault condition: |    | Result: |
|                                                                                                                                                                                                                                                                                |                                                  | AC              | DC |                  |             | AC               | DC |         |
| If the auxiliary voltage fails with the central NS protection or if the control fails with the integrated NS protection, the switch-off command must be given immediately.                                                                                                     |                                                  |                 |    |                  |             |                  |    |         |

|                                                                                                                         |                                                         |   |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|---|
| 5.4                                                                                                                     | Integrated NS protection (VDE AR-N 4105 / VDE 0124-100) | P |
| The integrated NS protection is tested in connection with the examination of the entire NS protection chain and switch. |                                                         |   |
| <b>Note:</b><br>For test results see Functional safety.                                                                 |                                                         |   |



|                                                                                                                                                                                                                                                     |                                                                                  |                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------|
| 5.4                                                                                                                                                                                                                                                 | Integrated interface switch (VDE AR-N 4105 / VDE 0124-100)                       | P                 |
|                                                                                                                                                                                                                                                     | Test (functional chain integrated NS-protection and integrated interface switch) | P                 |
| Following monitoring options of an interface switch are valid (a) or (b) or (c):                                                                                                                                                                    |                                                                                  |                   |
| <b>(a) Use of an interface switch in which a control voltage must be constantly applied when switched on and which switches off automatically when this voltage is not present. The operational switch-on and switch-off processes is monitored</b> |                                                                                  |                   |
| The disconnection of the control voltage leads to the instantaneous disconnection of the interface switch.                                                                                                                                          |                                                                                  | N/A               |
| A simulated defect during the closing and opening of the interface switch leads to an instantaneous shutdown of the PGU. A restart is not possible.                                                                                                 |                                                                                  | N/A               |
| A simulated defect of the interface switch after the NS protection as operated leads to an instantaneous shutdown of the PGU. A restart is not possible.                                                                                            |                                                                                  | N/A               |
| The switch-off time of the whole reaction chain is within 0,2s.                                                                                                                                                                                     |                                                                                  | N/A               |
| <b>(b) The interface switch is switched on and off at least once a day by the NS protection and the proper functioning of the coupling switch is monitored.</b>                                                                                     |                                                                                  |                   |
| A simulated defect of the interface switch during the daily test leads to an instantaneous shutdown of the PGU. A restart is not possible.                                                                                                          |                                                                                  | N/A               |
| A simulated defect of the interface switch after the NS protection has operated leads to an instantaneous shutdown of the PGU. A restart is not possible.                                                                                           |                                                                                  | N/A               |
| A function for daily switching on and off is available and explained by a manufacturer's declaration.                                                                                                                                               |                                                                                  | N/A               |
| <b>(c) Use of the integrated coupling switch and the integrated NA protection for PV and battery converters according to DIN EN 62109 (VDE 0126-14-1).</b>                                                                                          |                                                                                  |                   |
| The integrated interface switch and NS protection is comply with DIN EN 62109 (VDE 0126-14-1).<br>See IEC 62109-2 test report "LD140506N039-R3" issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16.                   |                                                                                  | P                 |
| <b>Note:</b><br>See test results 5.5.2.1 functional safety.                                                                                                                                                                                         |                                                                                  |                   |
|                                                                                                                                                                                                                                                     |                                                                                  |                   |
| The inverter has a galvanic separating break device.<br>The interface switch is short-circuit proof for the maximum short-circuit current of the power generation unit.                                                                             |                                                                                  |                   |
| Max. initial short-circuit current of the PGU (power generation unit)                                                                                                                                                                               |                                                                                  | = 14,5 A, 230 Vac |
| Max. switching current relay                                                                                                                                                                                                                        |                                                                                  | = 40 A, 277 Vac   |

**Datasheet of the relay (interface protection relay / Interface switch):**

REVISION:A/1

DATE SUBMITTED:2015/01/20

**HATF901ASDC12-1-2-4421**

**40 Amp**



File No.:E75887



File No.:R 50194653





**FEATURES**

- The minimum air gap between the two contacts is 2.0mm
- 4000VAC high dielectric strength between contacts and coil

**CONTACT RATINGS**

|                           |                              |
|---------------------------|------------------------------|
| Contact Arrangement       | 1A                           |
| Contact Resistance        | 50mΩ (1A 24VDC)              |
| Contact Material          | AgSnO                        |
| Contact Rating(Resistive) | 40A/277VAC, 30A/28VDC        |
| Max. Switching Voltage    | 277VAC/28VDC                 |
| Max. Switching Current    | 40A                          |
| Max. Switching Power      | 11080VA/840W                 |
| Mechanical Life           | 1×10 <sup>7</sup> operations |
| Electrical Life           | 5×10 <sup>4</sup> operations |

**ORDERING INFORMATION**

| Model             | HAT | F | 901 | A | S | DC12 | -1 | -2 | -4421 |
|-------------------|-----|---|-----|---|---|------|----|----|-------|
| F:Class F         |     |   |     |   |   |      |    |    |       |
| 901:PCB Pins Only |     |   |     |   |   |      |    |    |       |
| A:SPST-NO         |     |   |     |   |   |      |    |    |       |
| S:Sealed          |     |   |     |   |   |      |    |    |       |
| Coil Voltage      |     |   |     |   |   |      |    |    |       |
| Without Pin 6     |     |   |     |   |   |      |    |    |       |
| Contact Gap:2=2mm |     |   |     |   |   |      |    |    |       |
| Customer Code     |     |   |     |   |   |      |    |    |       |

**CHARACTERISTICS**

|                              |                         |                       |
|------------------------------|-------------------------|-----------------------|
| Insulation Resistance        |                         | 1000MΩ (at 500VDC)    |
| Dielectric Strength          | Between coil & contacts | 4000VAC 1min          |
|                              | Between open contacts   | 1500VAC 1min          |
| Operate time (at nom. volt.) |                         | ≤15ms                 |
| Release time (at nom. volt.) |                         | ≤10ms                 |
| Humidity                     |                         | 98% RH, 40°C          |
| Ambient temperature          |                         | -40°C~+105°C          |
| Shock Resistance             | Functional              | 98m/s²                |
|                              | Destructive             | 980m/s²               |
| Vibration resistance         |                         | 10Hz to 55Hz 1.5mm DA |
| Unit weight                  |                         | Approx. 36g           |
| Construction                 |                         | Sealed                |

Notes:1) The data shown above are initial values.  
2) Please find coil temperature curve in the characteristic curved below.

**COIL DATA**

at 25°C

| Nominal Voltage VDC | Pick-up Voltage (Max.) VDC | Drop-out Voltage (Min.) VDC | Max. Allowable Voltage VDC | Coil Resistance Ω±10% |
|---------------------|----------------------------|-----------------------------|----------------------------|-----------------------|
| 12                  | 9.00                       | 1.20                        | 15.6                       | 155                   |

**COIL**

|            |               |
|------------|---------------|
| Coil Power | Approx. 900mW |
|------------|---------------|

**SAFETY APPROVAL RATINGS**

|        |    |                                                                                                             |
|--------|----|-------------------------------------------------------------------------------------------------------------|
| UL&CUL | NO | 1HP/120VAC, 2HP/277VAC, 2HP/240VAC<br>20A/277VAC Ballast, 30A/120VAC Ballast<br>40A/277VAC Resistive Load * |
| TüV    |    | 40/240VAC(NO), 40/240VAC(NC) 6×10 <sup>3</sup> operations*<br>20A/240VAC/14VDC, 15A/240VAC/14VDC            |

\*Note: If you need this rating, please contact our company.  
For the additional ratings, please contact our company.

This datasheet is for customers' reference. All the specifications are subject to change without notice.

**HASCO**  
RELAYS & ELECTRONICS INT'L. CORP.  
\* SINCE 1976 \*

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**RELAYS**

REVISION:A/1 DATE SUBMITTED:2015/01/20

## HATF901ASDC12-1-2-4421

40 Amp

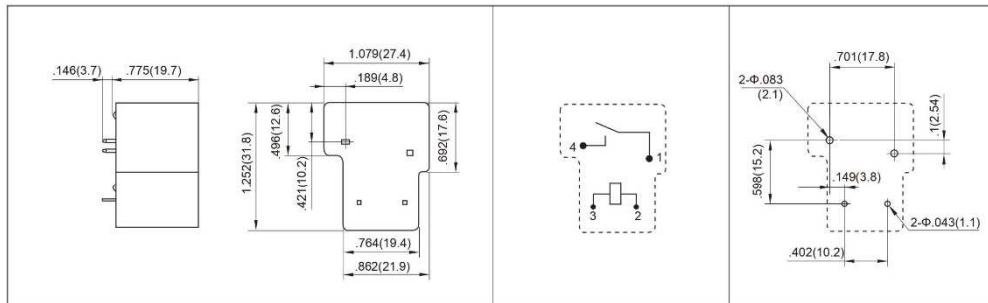
OUTLINE DIMENSIONS, WIRING DIAGRAM AND PC BOARD LAYOUT.

Unit: inch(mm)

Outline Dimensions

Wiring Diagram  
(Bottom view)

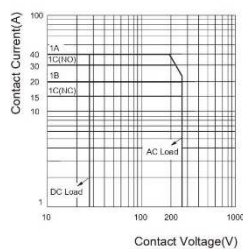
PCB Layout  
(Bottom view)



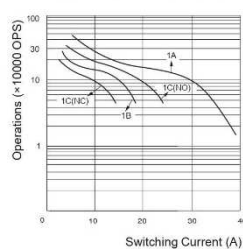
Remark: 1) In case of no tolerance shown in outline dimension: outline dimension  $\leq 1\text{mm}$ , tolerance should be  $\pm 0.2\text{mm}$ ; outline dimension  $> 1\text{mm}$  and  $\leq 5\text{mm}$ , tolerance should be  $\pm 0.3\text{mm}$ ; outline dimension  $> 5\text{mm}$ , tolerance should be  $\pm 0.4\text{mm}$ .  
2) The tolerance without indicating for PCB layout is always  $\pm 0.1\text{mm}$ .

## CHARACTERISTIC CURVES

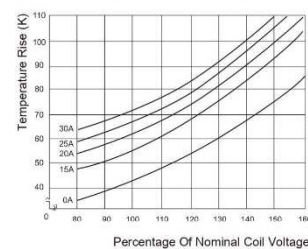
MAXIMUM SWITCHING POWER



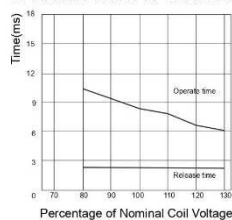
ENDURANCE CURVE



COIL TEMPERATURE RISE



OPERATE TIME / RELEASE TIME



This datasheet is for customers' reference. All the specifications are subject to change without notice.

**HASCO**  
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|                                                                                                                                                                  |                                        |                |                   |               |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------|-------------------|---------------|---------------|
| 5.4                                                                                                                                                              | Check of setting values (TOR Erzeuger) |                |                   |               | P             |
|                                                                                                                                                                  | Test                                   |                |                   |               | P             |
| FSP POWER MANAGER 10KW                                                                                                                                           |                                        |                |                   |               |               |
| Setting values check TOR                                                                                                                                         |                                        |                |                   |               |               |
| PGU type                                                                                                                                                         | Description                            | Parameter name | Set value in p.u. | Set value L-N | Set value L-L |
|                                                                                                                                                                  | nominal voltage                        | $U_n$          | 1                 | 230,0 V       | 400 V         |
|                                                                                                                                                                  | Nominal frequency                      | $f_n$          | 1                 | 50 Hz         | 50 Hz         |
| Name of country setting in inverter "TOR"                                                                                                                        |                                        |                |                   |               |               |
| Inverter with limited dynamic grid support according to Tor Erzeuger Typ A 5.2.2.1                                                                               | Excitation threshold $U_{>>}$          | $AU_{>>}$      | 1,15              | 264,5V        | 458,1V        |
|                                                                                                                                                                  | Delay time $U_{>>}$                    | $tU_{>>}$      | -                 | 0,1s          | 0,1s          |
|                                                                                                                                                                  | Excitation threshold $U_{>}$           | $AU_{>}$       | 1,11              | 255,3V        | 442,2V        |
|                                                                                                                                                                  | Delay time $U_{>} * 1)$                | $tU_{>}$       | -                 | 0,1s *1)      | 0,1s *1)      |
|                                                                                                                                                                  | Excitation threshold $U_{<}$           | $AU_{<}$       | 0,8               | 184,0 V       | 318,7V        |
|                                                                                                                                                                  | Delay time $U_{<}$                     | $tU_{<}$       | -                 | 1,5s          | 1,5s          |
|                                                                                                                                                                  | Excitation threshold $U_{<<}$          | $AU_{<<}$      | 0,25              | 57,5V         | 99,6V         |
|                                                                                                                                                                  | Delay time $U_{<<}$                    | $tU_{<<}$      | -                 | 0,5s          | 0,5s          |
|                                                                                                                                                                  | Excitation threshold $f_{>}$           | $Af_{>}$       | 1,03              | 51,5Hz        | 51,5Hz        |
|                                                                                                                                                                  | Delay time $f_{>}$                     | $tf_{>}$       | -                 | 0,1s          | 0,1s          |
|                                                                                                                                                                  | Excitation threshold $f_{<}$           | $Af_{<}$       | 0,95              | 47,5Hz        | 47,5Hz        |
|                                                                                                                                                                  | Delay time $f_{<}$                     | $tf_{<}$       | -                 | 0,1s          | 0,1s          |
| *1) 10-min mean value                                                                                                                                            |                                        |                |                   |               |               |
| Factory settings correspond to the values stated.                                                                                                                |                                        |                |                   |               | Yes           |
| There are no factory settings. The information on the setting values in the instructions manual correspond to those stated.                                      |                                        |                |                   |               | No            |
| External NS protection: settings and delay times are password protected settable                                                                                 |                                        |                |                   |               | N/A           |
| External NS protection: It is possible to read the setting values without a tool                                                                                 |                                        |                |                   |               | N/A           |
| Integrated NS protection: the setting values are visible via a data interface or display                                                                         |                                        |                |                   |               | Yes           |
| Assessment criterion:                                                                                                                                            |                                        |                |                   |               |               |
| The exam is passed if the following points are met:                                                                                                              |                                        |                |                   |               |               |
| The setting values that can be changed according to Tor Erzeuger Typ A and can be set within the specified limits and are protected against unauthorized access. |                                        |                |                   |               |               |

|                                                                |                                                                 |           |           |                 |           |           |  |
|----------------------------------------------------------------|-----------------------------------------------------------------|-----------|-----------|-----------------|-----------|-----------|--|
| 5.4.1.1.1                                                      | Voltage control (Inverters with automatic disconnection device) |           |           |                 |           | P         |  |
| Integrated NS protection multi phase ≤30kVA (phase to neutral) |                                                                 |           |           |                 |           |           |  |
| Setting values of the NS protection:                           | Setting                                                         | Value [V] | Time [ms] | Setting         | Value [V] | Time [ms] |  |
|                                                                |                                                                 |           |           | U>>             | 264,5     | 100       |  |
|                                                                | U<                                                              | 184,0     | 1500      | U<<             | 57,5      | 500       |  |
| Operating time of the monitoring device:                       |                                                                 |           |           |                 |           |           |  |
| L1 to N:                                                       |                                                                 |           |           |                 |           |           |  |
|                                                                | Under voltage 1:                                                |           |           |                 |           |           |  |
| Step [V to V]                                                  | 230,0 to 177,1                                                  |           |           |                 |           |           |  |
| Limit [V]                                                      | 184,0                                                           |           |           |                 |           |           |  |
| Measurement [V]                                                | 184,2                                                           | 184,5     | 184,4     |                 |           |           |  |
| Deviation trip setting and value [V]                           | 0,2                                                             | 0,5       | 0,4       |                 |           |           |  |
| Limit [ms]                                                     | 1500 ± 100                                                      |           |           |                 |           |           |  |
| Disconnection time [ms]                                        | 1582                                                            | 1596      | 1596      |                 |           |           |  |
| Deviation trip setting and time [ms]                           | 82                                                              | 96        | 96        |                 |           |           |  |
|                                                                |                                                                 |           |           |                 |           |           |  |
|                                                                | Under voltage 2:                                                |           |           | Over voltage 2: |           |           |  |
| Step [V to V]                                                  | 230,0 to 50,6                                                   |           |           | 230,0 to 271,4  |           |           |  |
| Limit [V]                                                      | 57,5                                                            |           |           | 264,5           |           |           |  |
| Measurement [V]                                                | 56,9                                                            | 56,8      | 57,0      | 264,4           | 264,3     | 264,4     |  |
| Deviation trip setting and value [V]                           | -0,6                                                            | -0,7      | -0,5      | -0,1            | -0,2      | -0,1      |  |
| Limit [ms]                                                     | 500 ± 100                                                       |           |           | 100 ± 100       |           |           |  |
| Disconnection time [ms]                                        | 536                                                             | 539       | 542       | 197             | 193       | 197       |  |
| Deviation trip setting and time [ms]                           | 36                                                              | 39        | 42        | 97              | 93        | 97        |  |
| L2 to N:                                                       |                                                                 |           |           |                 |           |           |  |
|                                                                | Under voltage 1:                                                |           |           |                 |           |           |  |
| Step [V to V]                                                  | 230,0 to 177,1                                                  |           |           |                 |           |           |  |
| Limit [V]                                                      | 184,0                                                           |           |           |                 |           |           |  |
| Measurement [V]                                                | 185,2                                                           | 185,0     | 185,2     |                 |           |           |  |
| Deviation trip setting and value [V]                           | 1,2                                                             | 1,0       | 1,2       |                 |           |           |  |
| Limit [ms]                                                     | 1500 ± 100                                                      |           |           |                 |           |           |  |
| Disconnection time [ms]                                        | 1598                                                            | 1598      | 1596      |                 |           |           |  |
| Deviation trip setting and time [ms]                           | 98                                                              | 98        | 96        |                 |           |           |  |
|                                                                |                                                                 |           |           |                 |           |           |  |
|                                                                | Under voltage 2:                                                |           |           | Over voltage 2: |           |           |  |
| Step [V to V]                                                  | 230,0 to 50,6                                                   |           |           | 230,0 to 271,4  |           |           |  |
| Limit [V]                                                      | 57,5                                                            |           |           | 264,5           |           |           |  |
| Measurement [V]                                                | 57,9                                                            | 57,8      | 57,9      | 264,8           | 264,5     | 264,6     |  |
| Deviation trip setting and value [V]                           | 0,4                                                             | 0,3       | 0,4       | 0,3             | 0,0       | 0,1       |  |

|                                                                                                                    |                                                                 |           |           |                 |           |           |
|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-----------|-----------|-----------------|-----------|-----------|
| 5.4.1.1.1                                                                                                          | Voltage control (Inverters with automatic disconnection device) |           |           |                 |           | P         |
| Integrated NS protection multi phase ≤30kVA (phase to neutral)                                                     |                                                                 |           |           |                 |           |           |
| Setting values of the NS protection:                                                                               | Setting                                                         | Value [V] | Time [ms] | Setting         | Value [V] | Time [ms] |
|                                                                                                                    |                                                                 |           |           | U>>             | 264,5     | 100       |
|                                                                                                                    | U<                                                              | 184,0     | 1500      | U<<             | 57,5      | 500       |
| Operating time of the monitoring device:                                                                           |                                                                 |           |           |                 |           |           |
| Limit [ms]                                                                                                         | 500 ± 100                                                       |           |           | 100 ± 100       |           |           |
| Disconnection time [ms]                                                                                            | 553                                                             | 554       | 555       | 199             | 199       | 197       |
| Deviation trip setting and time [ms]                                                                               | 53                                                              | 54        | 55        | 99              | 99        | 97        |
| L3 to N:                                                                                                           |                                                                 |           |           |                 |           |           |
|                                                                                                                    | Under voltage 1:                                                |           |           |                 |           |           |
| Step [V to V]                                                                                                      | 230,0 to 177,1                                                  |           |           |                 |           |           |
| Limit [V]                                                                                                          | 184,0                                                           |           |           |                 |           |           |
| Measurement [V]                                                                                                    | 185,1                                                           | 185,3     | 185,3     |                 |           |           |
| Deviation trip setting and value [V]                                                                               | 1,1                                                             | 1,3       | 1,3       |                 |           |           |
| Limit [ms]                                                                                                         | 1500 ± 100                                                      |           |           |                 |           |           |
| Disconnection time [ms]                                                                                            | 1596                                                            | 1588      | 1588      |                 |           |           |
| Deviation trip setting and time [ms]                                                                               | 96                                                              | 88        | 88        |                 |           |           |
|                                                                                                                    |                                                                 |           |           |                 |           |           |
|                                                                                                                    | Under voltage 2:                                                |           |           | Over voltage 2: |           |           |
| Step [V to V]                                                                                                      | 230,0 to 50,6                                                   |           |           | 230,0 to 271,4  |           |           |
| Limit [V]                                                                                                          | 57,5                                                            |           |           | 264,5           |           |           |
| Measurement [V]                                                                                                    | 56,8                                                            | 56,8      | 56,9      | 264,6           | 264,4     | 264,5     |
| Deviation trip setting and value [V]                                                                               | -0,7                                                            | -0,7      | -0,6      | 0,1             | -0,1      | 0,0       |
| Limit [ms]                                                                                                         | 500 ± 100                                                       |           |           | 100 ± 100       |           |           |
| Disconnection time [ms]                                                                                            | 555                                                             | 556       | 556       | 187             | 199       | 199       |
| Deviation trip setting and time [ms]                                                                               | 55                                                              | 56        | 56        | 87              | 99        | 99        |
| Note:                                                                                                              |                                                                 |           |           |                 |           |           |
| The permitted tolerance between setting value and trip value of the voltage may not exceed ±1% of U <sub>n</sub> . |                                                                 |           |           |                 |           |           |

| 5.4.1.1.2 Measuring the rise-in voltage protection as a running 10-minute mean value |                                               | P     |
|--------------------------------------------------------------------------------------|-----------------------------------------------|-------|
| Setting values of the NS protection:                                                 | Setting U> [V]                                | 255,3 |
|                                                                                      | Setting T <sub>disconnection U&gt;</sub> [s]  | 600   |
|                                                                                      | Setting T <sub>disconnection</sub> [ms]       | 100   |
| <b>Operating time of the monitoring device:</b>                                      |                                               |       |
| <b>FSP POWER MANAGER 10KW</b>                                                        |                                               |       |
| L1-N:                                                                                | <b>Over voltage 10-minute mean value (a):</b> |       |
| Ramp [start V to stop V]                                                             | 230,0 → 259,9                                 |       |
| Step size [V]                                                                        | 29,9                                          |       |
| Step length [s]                                                                      | >600,2                                        |       |
| Limit for disconnection [s]                                                          | 600                                           |       |
| Measurement [s]                                                                      | 529,5                                         |       |
| Deviation trip setting and time [s]                                                  | -70,5                                         |       |
| L1-N:                                                                                | <b>Over voltage 10-minute mean value (b):</b> |       |
| Ramp [start V to stop V]                                                             | 230,0 → >250,7                                |       |
| Step size [V]                                                                        | 20,7                                          |       |
| Step length [s]                                                                      | >600,2                                        |       |
| Limit for reconnection [s]                                                           | no disconnection (also after 600s)            |       |
| Measurement [s]                                                                      | N/A, no disconnection                         |       |
| Deviation trip setting and time [s]                                                  | N/A, no disconnection                         |       |
| L1-N:                                                                                | <b>Over voltage 10-minute mean value (c):</b> |       |
| Ramp [start V to stop V]                                                             | 246,1 → >264,5                                |       |
| Step size [V]                                                                        | 18,4                                          |       |
| Step length [s]                                                                      | >600,2                                        |       |
| Limit for disconnection[s]                                                           | 225 – 375                                     |       |
| Measurement [s]                                                                      | 279,0                                         |       |
| Deviation trip setting and time [s]                                                  | -21,0                                         |       |
| L2-N:                                                                                | <b>Over voltage 10-minute mean value (a):</b> |       |
| Ramp [start V to stop V]                                                             | 230,0 → 259,9                                 |       |
| Step size [V]                                                                        | 29,9                                          |       |
| Step length [s]                                                                      | >600,2                                        |       |
| Limit for disconnection [s]                                                          | 600                                           |       |
| Measurement [s]                                                                      | 520,5                                         |       |
| Deviation trip setting and time [s]                                                  | -79,5                                         |       |



| 5.4.1.1.2                           | Measuring the rise-in voltage protection as a running 10-minute mean value | P |
|-------------------------------------|----------------------------------------------------------------------------|---|
|                                     |                                                                            |   |
| L2-N:                               | Over voltage 10-minute mean value (b):                                     |   |
| Ramp [start V to stop V]            | 230,0 → >250,7                                                             |   |
| Step size [V]                       | 20,7                                                                       |   |
| Step length [s]                     | >600,2                                                                     |   |
| Limit for reconnection [s]          | no disconnection (also after 600s)                                         |   |
| Measurement [s]                     | N/A, no disconnection                                                      |   |
| Deviation trip setting and time [s] | N/A, no disconnection                                                      |   |
|                                     |                                                                            |   |
| L2-N:                               | Over voltage 10-minute mean value (c):                                     |   |
| Ramp [start V to stop V]            | 246,1 → >264,5                                                             |   |
| Step size [V]                       | 18,4                                                                       |   |
| Step length [s]                     | >600,2                                                                     |   |
| Limit for disconnection[s]          | 225 – 375                                                                  |   |
| Measurement [s]                     | 276,0                                                                      |   |
| Deviation trip setting and time [s] | -24,0                                                                      |   |
|                                     |                                                                            |   |
| L3-N:                               | Over voltage 10-minute mean value (a):                                     |   |
| Ramp [start V to stop V]            | 230,0 → 259,9                                                              |   |
| Step size [V]                       | 29,9                                                                       |   |
| Step length [s]                     | >600,2                                                                     |   |
| Limit for disconnection [s]         | 600                                                                        |   |
| Measurement [s]                     | 528,0                                                                      |   |
| Deviation trip setting and time [s] | -72,0                                                                      |   |
|                                     |                                                                            |   |
| L3-N:                               | Over voltage 10-minute mean value (b):                                     |   |
| Ramp [start V to stop V]            | 230,0 → >250,7                                                             |   |
| Step size [V]                       | 20,7                                                                       |   |
| Step length [s]                     | >600,2                                                                     |   |
| Limit for reconnection [s]          | no disconnection (also after 600s)                                         |   |
| Measurement [s]                     | N/A, no disconnection                                                      |   |
| Deviation trip setting and time [s] | N/A, no disconnection                                                      |   |
|                                     |                                                                            |   |
| L3-N:                               | Over voltage 10-minute mean value (c):                                     |   |
| Ramp [start V to stop V]            | 246,1 → >264,5                                                             |   |
| Step size [V]                       | 18,4                                                                       |   |



| 5.4.1.1.2                                                                                                                                                                                                           | Measuring the rise-in voltage protection as a running 10-minute mean value | P |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---|
| Step length [s]                                                                                                                                                                                                     | >600,2                                                                     |   |
| Limit for disconnection[s]                                                                                                                                                                                          | 225 – 375                                                                  |   |
| Measurement [s]                                                                                                                                                                                                     | 290,0                                                                      |   |
| Deviation trip setting and time [s]                                                                                                                                                                                 | -10,0                                                                      |   |
| <b>Note:</b><br>*If the setting value is set to 600s, then the disconnection time can be in the range between 225s and 375s.<br>→default threshold: 111% Un. If the threshold is not adjustable than set to 110%Un. |                                                                            |   |

| 5.4.2.1                                                                                                                                                                                      | Frequency measurement                   |       |       |                 |       |       | P |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------|-------|-----------------|-------|-------|---|
| Setting values of the NS protection:                                                                                                                                                         | Setting f< [Hz]                         |       |       | 47,50           |       |       |   |
|                                                                                                                                                                                              | Setting f>[Hz]                          |       |       | 51,50           |       |       |   |
|                                                                                                                                                                                              | Setting T <sub>disconnection</sub> [ms] |       |       | 100             |       |       |   |
| Operating time of the monitoring device                                                                                                                                                      |                                         |       |       |                 |       |       |   |
|                                                                                                                                                                                              | Under frequency:                        |       |       | Over frequency: |       |       |   |
| Ramp [Hz to Hz]                                                                                                                                                                              | 48,00 -> 47,00                          |       |       | 51,00 -> 52,00  |       |       |   |
| Limit [Hz]                                                                                                                                                                                   | 47,50                                   |       |       | 51,50           |       |       |   |
| Measurement [Hz]                                                                                                                                                                             | 47,51                                   | 47,50 | 47,50 | 51,51           | 51,50 | 51,50 |   |
| Deviations setting and trip value [Hz]                                                                                                                                                       | 0,01                                    | 0,00  | 0,00  | 0,01            | 0,00  | 0,00  |   |
| Limit [ms]                                                                                                                                                                                   | 100 ± 100                               |       |       | 100 ± 100       |       |       |   |
| Disconnection time [ms]                                                                                                                                                                      | 110                                     | 112   | 122   | 85              | 88    | 85    |   |
| Deviation trip setting and time [ms]                                                                                                                                                         | 10                                      | 12    | 22    | -15             | -12   | -15   |   |
| <b>Test:</b>                                                                                                                                                                                 |                                         |       |       |                 |       |       |   |
| Testing of the frequency over protection f> and of the under frequency protection f<.                                                                                                        |                                         |       |       |                 |       |       |   |
| To determine the switch-off time, a ramp must be run at 1Hz/s                                                                                                                                |                                         |       |       |                 |       |       |   |
| <b>Note:</b>                                                                                                                                                                                 |                                         |       |       |                 |       |       |   |
| The setting value and the trip value of the frequency may not vary by more than ±0,1% f <sub>n</sub> .                                                                                       |                                         |       |       |                 |       |       |   |
| A total tripping time of the individual protective functions including the intrinsic time of the switching device in the decoupling point of maximum 0,2 s must be achievable be achievable. |                                         |       |       |                 |       |       |   |

|            |                                                               |          |
|------------|---------------------------------------------------------------|----------|
| <b>5.4</b> | <b>Reporting NS protection (VDE AR-N 4105 / VDE 0124-100)</b> | <b>P</b> |
|------------|---------------------------------------------------------------|----------|

The last 5 dated failure reports on the NS protection can be read. An interruption in the supply voltage of  $\leq 3s$  does not result in any loss of failure reports.

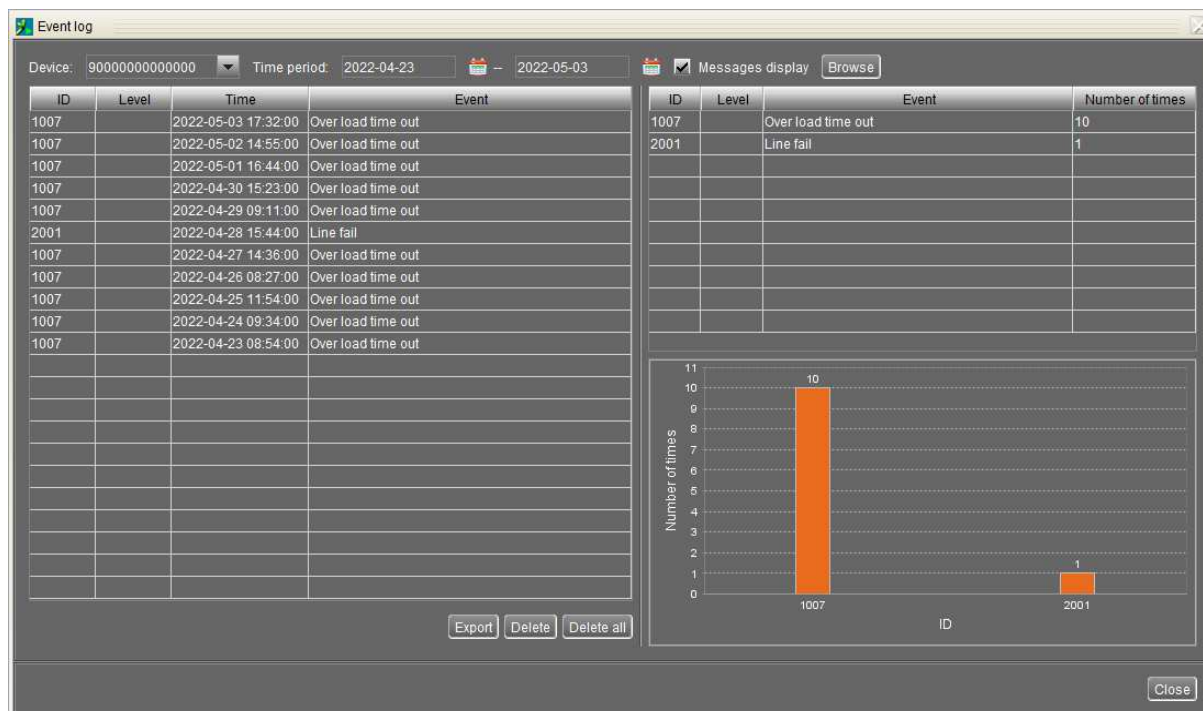
Central NS protection:

It is possible to read the setting values and the failure reports of the NS protection independently of the operational state and without any additional aids.

Integrated NS protection:

It is possible to read out the values of the NS protection via the data interface, if the values are not directly readable.

**Picture of 5 last dated failure:**

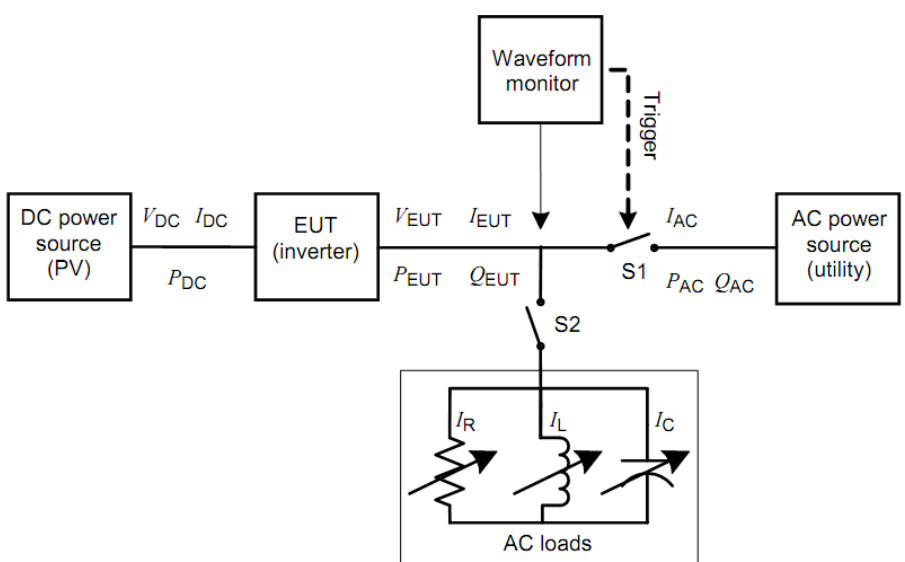


**Assessment criterion:**

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

**Note:**

|                                                                                                                                                             |                                                                                       |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|----------|
| <b>5.4</b>                                                                                                                                                  | <b>Constructional characteristics of NS protection (VDE AR-N 4105 / VDE 0124-100)</b> | <b>P</b> |
|                                                                                                                                                             | <b>General</b>                                                                        | <b>P</b> |
| These tests serve to demonstrate the requirements of VDE-AR-N 4105: 2018-11, 6.5.2.                                                                         |                                                                                       |          |
|                                                                                                                                                             | <b>Test</b>                                                                           | <b>P</b> |
| Type of NS protection: Internal                                                                                                                             |                                                                                       |          |
| NS-protection is sealed or a password protection is used (or both)                                                                                          |                                                                                       | Yes      |
| adjustability of U <sub>&gt;</sub> and the time delays for U <sub>&lt;</sub> and U <sub>&lt;&lt;</sub> is given                                             |                                                                                       | Yes      |
| All other protective functions are either permanently protected or protected from unauthorized access by additional, separate protection (example password) |                                                                                       | Yes      |

| 5.4.3      Islanding protection                                                                                                    |           | P               |
|------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|
| Test circuit and parameters                                                                                                        |           |                 |
| Parameter                                                                                                                          | Symbol    | Units           |
| <b>EUT DC Input</b>                                                                                                                |           |                 |
| DC voltage                                                                                                                         | $V_{DC}$  | V               |
| DC Current                                                                                                                         | $I_{DC}$  | A               |
| DC Power                                                                                                                           | $P_{DC}$  | W               |
| <b>EUT AC output</b>                                                                                                               |           |                 |
| AC voltage                                                                                                                         | $V_{EUT}$ | V               |
| AC current                                                                                                                         | $I_{EUT}$ | A               |
| Real power                                                                                                                         | $P_{EUT}$ | W               |
| Reactive power                                                                                                                     | $Q_{EUT}$ | VA <sub>r</sub> |
| <b>Test Load</b>                                                                                                                   |           |                 |
| Resistive load current                                                                                                             | $I_R$     | A               |
| Inductive load current                                                                                                             | $I_L$     | A               |
| Capacitive load current                                                                                                            | $I_C$     | A               |
| <b>AC (utility) power source</b>                                                                                                   |           |                 |
| Utility real power                                                                                                                 | $P_{AC}$  | W               |
| Utility reactive power                                                                                                             | $Q_{AC}$  | VA <sub>r</sub> |
| Utility current                                                                                                                    | $I_{AC}$  | A               |
| Block diagram test circuit IEC 62116:2008                                                                                          |           |                 |
|  <p style="text-align: right;">IEC 1567/08</p> |           |                 |
| <b>Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)</b>                                  |           |                 |

| 5.4.3                     |                                                     | Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (PGU output = 100%) |                                                                                                               |                                                 |                                      |                                    |                        |                       |                    | P                     |  |
|---------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------|------------------------------------|------------------------|-----------------------|--------------------|-----------------------|--|
| Test conditions           |                                                     |                                                                                                                        | Frequency: 50 ±1% f <sub>n</sub><br>U <sub>n</sub> = 230 ±1%U <sub>n</sub><br>Distortion factor of chokes ≤2% |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| Disconnection limit       |                                                     |                                                                                                                        | 2s (IEC 62116)                                                                                                |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| FSP POWER MANAGER 10KW    |                                                     |                                                                                                                        |                                                                                                               |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| No                        | P <sub>PGU</sub> <sup>1)</sup><br>[% of PGU rating] | Reactive load<br>[% of Q <sub>L</sub> in 6.1.d) <sup>1)</sup>                                                          | P <sub>AC</sub> <sup>2)</sup><br>[% of nominal]                                                               | Q <sub>AC</sub> <sup>3)</sup><br>[% of nominal] | I <sub>AC</sub> <sup>4)</sup><br>[A] | P <sub>PGU</sub><br>[kW per phase] | V <sub>DC</sub><br>[V] | Q <sub>f</sub><br>[1] | Run on Time<br>[s] | Remarks <sup>5)</sup> |  |
| 1                         | 100                                                 | 100                                                                                                                    | 0                                                                                                             | 0                                               | 0,208                                | 3,333                              | 615                    | 1,006                 | 0,174              | BL                    |  |
| 32                        | 100                                                 | 100                                                                                                                    | -10                                                                                                           | -10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 33                        | 100                                                 | 100                                                                                                                    | -10                                                                                                           | -5                                              | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 34                        | 100                                                 | 100                                                                                                                    | -10                                                                                                           | 0                                               | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 35                        | 100                                                 | 100                                                                                                                    | -10                                                                                                           | +5                                              | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 36                        | 100                                                 | 100                                                                                                                    | -10                                                                                                           | +10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 37                        | 100                                                 | 100                                                                                                                    | -5                                                                                                            | -10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 4                         | 100                                                 | 100                                                                                                                    | -5                                                                                                            | -5                                              | 1,319                                | 3,333                              | 615                    | 1,032                 | 0,160              | IB                    |  |
| 5                         | 100                                                 | 100                                                                                                                    | -5                                                                                                            | 0                                               | 1,399                                | 3,333                              | 615                    | 1,059                 | 0,123              | IB                    |  |
| 6                         | 100                                                 | 100                                                                                                                    | -5                                                                                                            | +5                                              | 1,385                                | 3,333                              | 615                    | 1,085                 | 0,154              | IB                    |  |
| 38                        | 100                                                 | 100                                                                                                                    | -5                                                                                                            | +10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 39                        | 100                                                 | 100                                                                                                                    | 0                                                                                                             | -10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 7                         | 100                                                 | 100                                                                                                                    | 0                                                                                                             | -5                                              | 0,677                                | 3,333                              | 615                    | 0,981                 | 0,159              | IB                    |  |
| 8                         | 100                                                 | 100                                                                                                                    | 0                                                                                                             | +5                                              | 0,686                                | 3,333                              | 615                    | 1,031                 | 0,130              | IB                    |  |
| 40                        | 100                                                 | 100                                                                                                                    | 0                                                                                                             | +10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 41                        | 100                                                 | 100                                                                                                                    | +5                                                                                                            | -10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 9                         | 100                                                 | 100                                                                                                                    | +5                                                                                                            | -5                                              | 0,438                                | 3,333                              | 615                    | 0,934                 | 0,168              | IB                    |  |
| 10                        | 100                                                 | 100                                                                                                                    | +5                                                                                                            | 0                                               | 0,417                                | 3,333                              | 615                    | 0,958                 | 0,123              | IB                    |  |
| 11                        | 100                                                 | 100                                                                                                                    | +5                                                                                                            | +5                                              | 0,430                                | 3,333                              | 615                    | 0,982                 | 0,155              | IB                    |  |
| 42                        | 100                                                 | 100                                                                                                                    | +5                                                                                                            | +10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 43                        | 100                                                 | 100                                                                                                                    | +10                                                                                                           | -10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 44                        | 100                                                 | 100                                                                                                                    | +10                                                                                                           | -5                                              | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 45                        | 100                                                 | 100                                                                                                                    | +10                                                                                                           | 0                                               | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 46                        | 100                                                 | 100                                                                                                                    | +10                                                                                                           | +5                                              | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
| 47                        | 100                                                 | 100                                                                                                                    | +10                                                                                                           | +10                                             | --                                   | --                                 | --                     | --                    | --                 | IB                    |  |
|                           |                                                     |                                                                                                                        |                                                                                                               |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| Parameter at 0% per phase |                                                     |                                                                                                                        | L= 51,98 mH                                                                                                   |                                                 | R= 16,43 Ω                           |                                    |                        | C= 194,92 μF          |                    |                       |  |

| 5.4.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Islanding protection according table 6 - Load imbalance (real, reactive load) for test condition A (PGU output = 100%) | P |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---|
| <p><b>Note:</b></p> <p>RLC is adjusted to min. +/-1% of the inverter rated output power</p> <p>1) <math>P_{PGU}</math>: PGU output power</p> <p>2) <math>P_{AC}</math>: Real power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.</p> <p>3) <math>Q_{AC}</math>: Reactive power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.</p> <p>4) Fundamental of <math>I_{AC}</math> when RLC is adjusted</p> <p>5) BL: Balance condition, IB: Imbalance condition.</p> <p>Condition A:</p> <p>PGU output power <math>P_{PGU} = \text{Maximum}</math> <sup>6)</sup></p> <p>PGU input voltage <sup>6)</sup> <math>\geq 75\%</math> of rated input voltage range</p> <p><sup>6)</sup> Maximum PGU output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.</p> <p><sup>7)</sup> Based on PGU rated input operating range. For example, If range is between X volts and Y volts, 75 % of range <math>= X + 0,75 \times (Y - X)</math>. Y shall not exceed <math>0,8 \times</math> PGU maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the PGU should not be operated outside of its allowable input voltage range.</p> <p>The test results base on the test report "PVDE190903N004" issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16.</p> |                                                                                                                        |   |

| 5.4.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                     |                                                               | Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (PGU output = 50 % – 66 %) |                                                 |                                      |                                    |                        |                       |                    | P                     |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------|------------------------------------|------------------------|-----------------------|--------------------|-----------------------|--|
| Test conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                     |                                                               | Frequency: 50 ±1% f <sub>n</sub><br>U <sub>n</sub> = 230 ±1%U <sub>n</sub><br>Distortion factor of chokes ≤2%           |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| Disconnection limit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                     |                                                               | 2s (IEC 62116)                                                                                                          |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | P <sub>PGU</sub> <sup>1)</sup><br>[% of PGU rating] | Reactive load<br>[% of Q <sub>L</sub> in 6.1.d) <sup>1)</sup> | P <sub>AC</sub> <sup>2)</sup><br>[% of nominal]                                                                         | Q <sub>AC</sub> <sup>3)</sup><br>[% of nominal] | I <sub>AC</sub> <sup>4)</sup><br>[A] | P <sub>PGU</sub><br>[kW per phase] | V <sub>DC</sub><br>[V] | Q <sub>f</sub><br>[1] | Run on Time<br>[s] | Remarks <sup>5)</sup> |  |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | -5                                              | 0,470                                | 2,200                              | 510                    | 0,966                 | 0,194              | BL                    |  |
| 13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | -4                                              | 0,463                                | 2,200                              | 510                    | 0,971                 | 0,197              | IB                    |  |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | -3                                              | 0,456                                | 2,200                              | 510                    | 0,976                 | 0,179              | IB                    |  |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | -2                                              | 0,450                                | 2,200                              | 510                    | 0,981                 | 0,205              | IB                    |  |
| 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | -1                                              | 0,446                                | 2,200                              | 510                    | 0,986                 | 0,112              | IB                    |  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 66                                                  | 66                                                            | 0                                                                                                                       | 0                                               | 0,305                                | 2,200                              | 510                    | 0,991                 | 0,214              | IB                    |  |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | 1                                               | 0,439                                | 2,200                              | 510                    | 0,996                 | 0,193              | IB                    |  |
| 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | 2                                               | 0,437                                | 2,200                              | 510                    | 1,001                 | 0,217              | IB                    |  |
| 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | 3                                               | 0,436                                | 2,200                              | 510                    | 1,006                 | 0,152              | IB                    |  |
| 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | 4                                               | 0,435                                | 2,200                              | 510                    | 1,010                 | 0,182              | IB                    |  |
| 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 66                                                  | 66                                                            | 0                                                                                                                       | 5                                               | 0,436                                | 2,200                              | 510                    | 1,015                 | 0,149              | IB                    |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                     |                                                               |                                                                                                                         |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| Parameter at 0% per phase                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                     |                                                               | L= 76,20 mH                                                                                                             |                                                 | R= 23,72 Ω                           |                                    | C= 132,98 μF           |                       |                    |                       |  |
| <b>Note:</b><br>RLC is adjusted to min. +/-1% of the inverter rated output power<br><sup>1)</sup> P <sub>PGU</sub> : PGU output power<br><sup>2)</sup> P <sub>AC</sub> : Real power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.<br><sup>3)</sup> Q <sub>AC</sub> : Reactive power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.<br><sup>4)</sup> Fundamental of I <sub>AC</sub> when RLC is adjusted<br><sup>5)</sup> BL: Balance condition, IB: Imbalance condition.<br>Condition B:<br>PGU output power P <sub>PGU</sub> = 50 % – 66 % of maximum<br>PGU input voltage <sup>6)</sup> = 50 % of rated input voltage range, ±10 %<br><sup>6)</sup> Based on PGU rated input operating range. For example, If range is between X volts and Y volts, 50 % of range =X + 0,5 × (Y – X). Y shall not exceed 0,8 × PGU maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the PGU should not be operated outside of its allowable input voltage range.<br>The test results base on the test report “ PVDE190903N004”issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16. |                                                     |                                                               |                                                                                                                         |                                                 |                                      |                                    |                        |                       |                    |                       |  |



| 5.4.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                     |                                                    | Islanding protection according Table 7 – Load imbalance (reactive load) for test condition B (PGU output = 25 % – 33 %) |                                                 |                                      |                                    |                        |                       |                    | P                     |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------|------------------------------------|------------------------|-----------------------|--------------------|-----------------------|--|
| Test conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                     |                                                    | Frequency: 50 ±1% f <sub>n</sub><br>U <sub>n</sub> = 230 ±1%U <sub>n</sub><br>Distortion factor of chokes ≤2%           |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| Disconnection limit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                     |                                                    | 2s (IEC 62116)                                                                                                          |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | P <sub>PGU</sub> <sup>1)</sup><br>[% of PGU rating] | Reactive load<br>[% of Q <sub>L</sub> in 6.1.d) 1] | P <sub>AC</sub> <sup>2)</sup><br>[% of nominal]                                                                         | Q <sub>AC</sub> <sup>3)</sup><br>[% of nominal] | I <sub>AC</sub> <sup>4)</sup><br>[A] | P <sub>PGU</sub><br>[kW per phase] | V <sub>DC</sub><br>[V] | Q <sub>f</sub><br>[1] | Run on Time<br>[s] | Remarks <sup>5)</sup> |  |
| 22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | -5                                              | 0,229                                | 1,100                              | 384                    | 0,994                 | 0,169              | BL                    |  |
| 23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | -4                                              | 0,226                                | 1,100                              | 384                    | 0,999                 | 0,184              | IB                    |  |
| 24                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | -3                                              | 0,224                                | 1,100                              | 384                    | 1,004                 | 0,167              | IB                    |  |
| 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | -2                                              | 0,222                                | 1,100                              | 384                    | 1,010                 | 0,167              | IB                    |  |
| 26                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | -1                                              | 0,220                                | 1,100                              | 384                    | 1,015                 | 0,124              | IB                    |  |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 33                                                  | 33                                                 | 0                                                                                                                       | 0                                               | 0,218                                | 1,100                              | 384                    | 1,020                 | 0,180              | IB                    |  |
| 27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | 1                                               | 0,218                                | 1,100                              | 384                    | 1,025                 | 0,271              | IB                    |  |
| 28                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | 2                                               | 0,218                                | 1,100                              | 384                    | 1,030                 | 0,179              | IB                    |  |
| 29                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | 3                                               | 0,218                                | 1,100                              | 384                    | 1,035                 | 0,190              | IB                    |  |
| 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | 4                                               | 0,219                                | 1,100                              | 384                    | 1,040                 | 0,146              | IB                    |  |
| 31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 33                                                  | 33                                                 | 0                                                                                                                       | 5                                               | 0,220                                | 1,100                              | 384                    | 1,045                 | 0,137              | IB                    |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                     |                                                    |                                                                                                                         |                                                 |                                      |                                    |                        |                       |                    |                       |  |
| Parameter at 0% per phase                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                     |                                                    | L= 163,45 mH                                                                                                            |                                                 | R= 52,38 Ω                           |                                    | C= 61,99 μF            |                       |                    |                       |  |
| <b>Note:</b><br>RLC is adjusted to min. +/-1% of the inverter rated output power<br><sup>1)</sup> P <sub>PGU</sub> : PGU output power<br><sup>2)</sup> P <sub>AC</sub> : Real power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.<br><sup>3)</sup> Q <sub>AC</sub> : Reactive power flow at S1 in Figure 1. Positive means power from PGU to utility. Nominal is the 0 % test condition value.<br><sup>4)</sup> Fundamental of I <sub>AC</sub> when RLC is adjusted<br><sup>5)</sup> BL: Balance condition, IB: Imbalance condition.<br>Condition B:<br>PGU output power P <sub>PGU</sub> = 25 % – 33 % <sup>6)</sup> of maximum<br>PGU input voltage <sup>7)</sup> < 20 % of rated input voltage range<br><sup>6)</sup> Or minimum allowable PGU output level if greater than 33 %.<br><sup>7)</sup> Based on PGU rated input operating range. For example, If range is between X volts and Y volts, 20 % of range =X + 0,2 × (Y – X). Y shall not exceed 0,8 × PGU maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the PGU should not be operated outside of its allowable input voltage range.<br>The test results base on the test report “ PVDE190903N004”issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2020-01-16. |                                                     |                                                    |                                                                                                                         |                                                 |                                      |                                    |                        |                       |                    |                       |  |

|                                             |                                                                                                                                                                                                                                                                                                                                                             |                    |                      |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------|
| 5.5                                         | <b>Connecting conditions and synchronisation</b><br>The connection and synchronization are carried out or monitored by at least one suitable device. This device can be implemented in the control of the PGU or in the automatic activation point (integrated or external) and is according to the TOR generator, section 5.5.2. set and check as follows: |                    | <b>P</b>             |
| Connecting conditions for frequencies:      |                                                                                                                                                                                                                                                                                                                                                             |                    |                      |
|                                             | <b>f<sub>ist</sub></b>                                                                                                                                                                                                                                                                                                                                      | <b>Reset time:</b> | <b>Limit:</b>        |
| a)                                          | <47,45Hz                                                                                                                                                                                                                                                                                                                                                    | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| b)                                          | ≥47,55Hz                                                                                                                                                                                                                                                                                                                                                    | 316,0 s            | ≥300s                |
| c)                                          | >50,15Hz                                                                                                                                                                                                                                                                                                                                                    | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| d)                                          | ≤50,05Hz                                                                                                                                                                                                                                                                                                                                                    | 319,5 s            | ≥300s                |
| Connecting conditions for voltages: Phase 1 |                                                                                                                                                                                                                                                                                                                                                             |                    |                      |
|                                             | <b>U<sub>n</sub></b>                                                                                                                                                                                                                                                                                                                                        | <b>Reset time:</b> | <b>Limit:</b>        |
| e)                                          | <84%                                                                                                                                                                                                                                                                                                                                                        | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| f)                                          | ≥86%                                                                                                                                                                                                                                                                                                                                                        | 317,0 s            | ≥300s                |
| g)                                          | >110%                                                                                                                                                                                                                                                                                                                                                       | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| h)                                          | ≤108%                                                                                                                                                                                                                                                                                                                                                       | 314,5 s            | ≥300s                |
| Connecting conditions for voltages: Phase 2 |                                                                                                                                                                                                                                                                                                                                                             |                    |                      |
|                                             | <b>U<sub>n</sub></b>                                                                                                                                                                                                                                                                                                                                        | <b>Reset time:</b> | <b>Limit:</b>        |
| e)                                          | <84%                                                                                                                                                                                                                                                                                                                                                        | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| f)                                          | ≥86%                                                                                                                                                                                                                                                                                                                                                        | 319,0 s            | ≥300s                |
| g)                                          | >110%                                                                                                                                                                                                                                                                                                                                                       | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| h)                                          | ≤108%                                                                                                                                                                                                                                                                                                                                                       | 312,5 s            | ≥300s                |
| Connecting conditions for voltages: Phase 3 |                                                                                                                                                                                                                                                                                                                                                             |                    |                      |
|                                             | <b>U<sub>n</sub></b>                                                                                                                                                                                                                                                                                                                                        | <b>Reset time:</b> | <b>Limit:</b>        |
| e)                                          | <84%                                                                                                                                                                                                                                                                                                                                                        | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| f)                                          | ≥86%                                                                                                                                                                                                                                                                                                                                                        | 321,0 s            | ≥300s                |
| g)                                          | >110%                                                                                                                                                                                                                                                                                                                                                       | No reconnection    | No resetting allowed |
|                                             | Switch to:                                                                                                                                                                                                                                                                                                                                                  |                    |                      |
| h)                                          | ≤108%                                                                                                                                                                                                                                                                                                                                                       | 310,0 s            | ≥300s                |

**Note:**

The test is passed if the PGU or the automatic disconnection point can only be switched on within the tolerance bands according to the TOR Erzeuger, Section 5.5.2 and after the voltage and frequency have remained within the tolerance bands after 300s at the earliest.

$\geq 300s \triangleq$  restart and if no error was produced

$\geq 300s \triangleq$  if an error was produced.

|                                                                                                                                                                                                                                                                                                                                                                                                     |                                            |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------|
| <b>5.6</b>                                                                                                                                                                                                                                                                                                                                                                                          | <b>Testing of the dynamic grid support</b> | <b>P</b> |
| <b>5.6.1</b>                                                                                                                                                                                                                                                                                                                                                                                        | <b>General</b>                             |          |
| <p>These tests serve to demonstrate the requirements of the requirements regarding robustness and dynamic network support according to TOR producers, Section 5.2.</p> <p>The aim of these tests is to determine whether the test specimen is able to drive through voltage dips undamaged and to behave accordingly. The device under test can be a generation unit (PGU) or a storage system.</p> |                                            |          |

|                                                                         |                                                  |                                     |                                                |                       |                                       |                      |        |        |  |
|-------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------|------------------------------------------------|-----------------------|---------------------------------------|----------------------|--------|--------|--|
| 5.6.3                                                                   |                                                  | Testing of the dynamic grid support |                                                |                       |                                       |                      |        | P      |  |
| For PGUs asynchronous generator/inverter(1-phase and 3-phase Inverters) |                                                  |                                     |                                                |                       |                                       |                      |        |        |  |
| Load definition                                                         |                                                  |                                     |                                                |                       |                                       |                      |        |        |  |
|                                                                         |                                                  |                                     | requirement                                    |                       |                                       | Used for testing     |        |        |  |
| Full load                                                               |                                                  |                                     | P <sub>rE</sub> ±2% P <sub>rE</sub>            |                       |                                       | 100% P <sub>rE</sub> |        |        |  |
| Partial load                                                            |                                                  |                                     | 0,2·P <sub>rE</sub> ~ 0,6·P <sub>rE</sub>      |                       |                                       | 0,3 P <sub>rE</sub>  |        |        |  |
| Test:                                                                   |                                                  |                                     |                                                |                       |                                       |                      |        |        |  |
| FSP POWER MANAGER 10KW                                                  |                                                  |                                     |                                                |                       |                                       |                      |        |        |  |
| Test                                                                    | Voltage<br>Fault depth<br>[p.u. U <sub>n</sub> ] | Fault<br>type                       | Fault duration<br>[s]                          | Load / P-<br>setpoint | Q-<br>setpoint<br>[%P <sub>rE</sub> ] | Test No.             | Test 1 | Test 2 |  |
| 1                                                                       | 0,15 ... 0,25<br>typical: 0,15                   | 3-phase<br>(type A)                 | ≥0,150 (at<br>U=0,15)<br>≥0,250 (at<br>U=0,25) | full load             | (0 -<br>±10%)<br>0                    | 1.1                  | ☒      | ☐      |  |
|                                                                         |                                                  | partial<br>load                     |                                                | 1.2                   |                                       | ☒                    | ☐      |        |  |
|                                                                         |                                                  | 2-phase<br>(type D1)                |                                                | full load             |                                       | 1.3                  | ☒      | ☐      |  |
|                                                                         |                                                  | 2-phase<br>(type D2)                |                                                | full load             |                                       | 1.3.a                | ☒      | ☐      |  |
|                                                                         |                                                  | 2-phase<br>(type D1)                |                                                | partial<br>load       |                                       | 1.4                  | ☒      | ☐      |  |
| 2                                                                       | 0,50 ... 0,60<br>typical: 0,50                   | 3-phase<br>(type A)                 | ≥0,840 (at<br>U=0,50)<br>≥1,020 (at<br>U=0,60) | full load             | (0 -<br>±10%)<br>0                    | 2.1                  | ☒      | ☐      |  |
|                                                                         |                                                  | partial<br>load                     |                                                | 2.2                   |                                       | ☒                    | ☐      |        |  |
|                                                                         |                                                  | 2-phase<br>(type D1)                |                                                | full load             |                                       | 2.3                  | ☒      | ☐      |  |
|                                                                         |                                                  | partial<br>load                     |                                                | 2.4                   |                                       | ☒                    | ☐      |        |  |
| 3                                                                       | 0,85 ... 0,90<br>typical: 0,85                   | 3-phase<br>(type A)                 | ≥60,000                                        | full load             | (0 -<br>±10%)<br>0                    | 3.1                  | ☒      | ☐      |  |
|                                                                         |                                                  | partial<br>load                     |                                                | 3.2                   |                                       | ☒                    | ☐      |        |  |
|                                                                         |                                                  | 2-phase<br>(type D1)                |                                                | full load             |                                       | 3.3                  | ☒      | ☐      |  |
|                                                                         |                                                  | partial<br>load                     |                                                | 3.4                   |                                       | ☒                    | ☐      |        |  |

| 5.6.3        |                                | Testing of the dynamic grid support |                                                |         |   |       | P |  |
|--------------|--------------------------------|-------------------------------------|------------------------------------------------|---------|---|-------|---|--|
| No load test |                                |                                     |                                                |         |   |       |   |  |
| 0            | 0,15 ... 0,25<br>typical: 0,15 | 3-phase<br>(type A)                 | ≥0,150 (at<br>U=0,15)<br>≥0,250 (at<br>U=0,25) | No load | 0 | 0.1.1 | ☒ |  |
|              |                                | 2-phase<br>(type D1)                |                                                |         |   | 0.1.2 | ☒ |  |
|              |                                | 2-phase<br>(type D2)                |                                                |         |   | 0.1.3 | ☒ |  |
|              | 0,50 ... 0,60<br>typical: 0,50 | 3-phase<br>(type A)                 | ≥0,840 (at<br>U=0,50)<br>≥1,020 (at<br>U=0,60) |         |   | 0.2.1 | ☒ |  |
|              |                                | 2-phase<br>(type D1)                |                                                |         |   | 0.2.2 | ☒ |  |
|              | 0,85 ... 0,90<br>typical: 0,85 | 3-phase<br>(type A)                 | ≥60,000                                        |         |   | 0.3.1 | ☒ |  |
|              |                                | 2-phase<br>(type D1)                |                                                |         |   | 0.3.2 | ☒ |  |

**Note:**

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

Behavior during the network fault

- No separation of the EZE from the grid during the break-in. If the EZE disconnects from the network, the time of the disconnection must be documented.

- Non-synchronous units and memories must not feed in either an active or a reactive current during a network fault and a voltage at the terminals of the EZE below  $0,8 U_n$ . This

The requirement is met if, in the event of a voltage dip or the current fed in by the generating unit and / or the memory 0,06s after the occurrence of this voltage dip / increase

in no phase conductor does not exceed 20% of the rated current  $I_r$  and after 0,1s no more than 10%  $I_r$ .

Behavior after the end of the error

- No separation of the EZE within 60s after the end of the fault;
- Synchronous units: Start-up time of the active power maximum 6s;
- Non-synchronous units and memory: Rise time of the active power maximum 1s.

The disconnect device (N/A protection) was disabled during the tests.

The PGU is set to "LVRT Zero Current Mode" during FRT testing, the below are the setting screenshots for English version and Germany version.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|-------------------------------------------------------------------------------------------|
| 5.6.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Testing of the dynamic grid support | P                                                                                         |
| <b>Test setup</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                     |                                                                                           |
| Grid simulator (grid conditions varied)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                     | <input checked="" type="checkbox"/>                                                       |
| Test bench                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                     | <input type="checkbox"/>                                                                  |
| Identifier of test setup                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                     | See Annex 3 – Test equipment list                                                         |
| Schematic of test setup: <div style="display: flex; align-items: center; justify-content: center; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">Low impedance<br/>programmable<br/>AC Source</div> <div style="margin: 0 10px;">—</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">Line impedance<br/>stabilisation<br/>network (<math>X_G</math>, <math>R_G</math>)</div> <div style="margin: 0 10px;">—</div> <div style="text-align: center;">●<br/>MP</div> <div style="margin: 0 10px;">—</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">PGU</div> <div style="margin: 0 10px;">—</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">PV simulator</div> </div> |                                     | Note on test setup:<br>Instead of an LVRT test bench a low-voltage AC simulator was used. |
| Note:<br>Evaluation of data measured at MP.<br>Used sample rate: 10 kHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                     |                                                                                           |
| <b>Grid parameters at MP1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                     |                                                                                           |
| Nominal voltage PCC // $U_G$ [V]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                     | 230 V (P-N) / 400 V (P-P)                                                                 |
| Nominal apparent power of test setup // $S_n$ [kVA]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                     | 10                                                                                        |
| Short-circuit power of the test setup // $S_{sc}$ [kVA]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                     | $\geq 3 \times S_{n,PGU}$                                                                 |
| Grid reactance $X_G$ [ $\Omega$ ]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                     | 5,56                                                                                      |
| Grid impedance $R_G$ [ $\Omega$ ]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                     | 1,81                                                                                      |

### 5.6.3

### Testing of the dynamic grid support

P

Parameters setting

|                                                             |                                                                       |      |       |                                                               |                                                                       |    |       |
|-------------------------------------------------------------|-----------------------------------------------------------------------|------|-------|---------------------------------------------------------------|-----------------------------------------------------------------------|----|-------|
| Min. PV input voltage:                                      | 300                                                                   | V    | Apply | Battery re-discharging voltage when Grid is available:        | 54                                                                    | V  | Apply |
| Max. PV input voltage:                                      | 900                                                                   | V    | Apply | Battery cut-off discharging voltage when grid is unavailable: | 42                                                                    | V  | Apply |
| Min. MPP voltage:                                           | 400                                                                   | V    | Apply | Battery re-discharging voltage when Grid is unavailable:      | 48                                                                    | V  | Apply |
| Max. MPP voltage:                                           | 800                                                                   | V    | Apply | Battery temperature compensation:                             | 0                                                                     | mV | Apply |
| Max. charging current:                                      | 200                                                                   | A    | Apply | Max. battery discharge current in hybrid mode:                | 275                                                                   | A  | Apply |
| Max. AC charging current:                                   | 60                                                                    | A    | Apply | Feeding grid power calibration R:                             | 0                                                                     | W  | Apply |
| Bulk charging voltage(C.V. voltage):                        | 56                                                                    | V    | Apply | Feeding grid power calibration S:                             | 0                                                                     | W  | Apply |
| Floating charging voltage:                                  | 54                                                                    | V    | Apply | Feeding grid power calibration T:                             | 0                                                                     | W  | Apply |
| Battery cut-off discharging voltage when grid is available: | 48                                                                    | V    | Apply | Zero Current Undervoltage Point:                              | 184                                                                   | V  | Apply |
| Start LCD screen-saver after:                               | 60                                                                    | Sec. | Apply | Zero current overvoltage point:                               | 264.5                                                                 | V  | Apply |
| Generator port:                                             | disable                                                               |      | Apply |                                                               |                                                                       |    |       |
| External CT Relay:                                          | disable                                                               |      | Apply |                                                               |                                                                       |    |       |
| Mute buzzer alarm:                                          | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply | Zero current ride through mode:                               | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |    | Apply |
| Mute the buzzer in the Standby mode:                        | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply | Parallel for output:                                          | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |    | Apply |
| Mute alarm in battery mode:                                 | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply | Output Neutral line grounding in battery mode:                | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |    | Apply |
| Activate Li-Fe battery while commissioning:                 | <input type="radio"/> Yes <input checked="" type="radio"/> No         |      | Apply | BMS battery connect:                                          | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |    | Apply |
| Generator as AC source:                                     | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply |                                                               |                                                                       |    |       |

Parameters setting

|                                                             |                                                                       |      |       |                                                               |                                                                       |    |       |
|-------------------------------------------------------------|-----------------------------------------------------------------------|------|-------|---------------------------------------------------------------|-----------------------------------------------------------------------|----|-------|
| Min. PV input voltage:                                      | 300                                                                   | V    | Apply | Battery re-discharging voltage when Grid is available:        | 54                                                                    | V  | Apply |
| Max. PV input voltage:                                      | 900                                                                   | V    | Apply | Battery cut-off discharging voltage when grid is unavailable: | 42                                                                    | V  | Apply |
| Min. MPP voltage:                                           | 400                                                                   | V    | Apply | Battery re-discharging voltage when Grid is unavailable:      | 48                                                                    | V  | Apply |
| Max. MPP voltage:                                           | 800                                                                   | V    | Apply | Battery temperature compensation:                             | 0                                                                     | mV | Apply |
| Max. charging current:                                      | 200                                                                   | A    | Apply | Max. battery discharge current in hybrid mode:                | 275                                                                   | A  | Apply |
| Max. AC charging current:                                   | 60                                                                    | A    | Apply | Feeding grid power calibration R:                             | 0                                                                     | W  | Apply |
| Bulk charging voltage(C.V. voltage):                        | 56                                                                    | V    | Apply | Feeding grid power calibration S:                             | 0                                                                     | W  | Apply |
| Floating charging voltage:                                  | 54                                                                    | V    | Apply | Feeding grid power calibration T:                             | 0                                                                     | W  | Apply |
| Battery cut-off discharging voltage when grid is available: | 48                                                                    | V    | Apply | Nullstrom-Unterspannungspunkt:                                | 184                                                                   | V  | Apply |
| Start LCD screen-saver after:                               | 60                                                                    | Sec. | Apply | Nullstrom-Überspannungspunkt:                                 | 264.5                                                                 | V  | Apply |
| Generator port:                                             | disable                                                               |      | Apply |                                                               |                                                                       |    |       |
| External CT Relay:                                          | disable                                                               |      | Apply |                                                               |                                                                       |    |       |
| Mute buzzer alarm:                                          | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply | Stromloser Ride-Through-Modus:                                | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |    | Apply |
| Mute the buzzer in the Standby mode:                        | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply | Parallel for output:                                          | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |    | Apply |
| Mute alarm in battery mode:                                 | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply | Output Neutral line grounding in battery mode:                | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |    | Apply |
| Activate Li-Fe battery while commissioning:                 | <input type="radio"/> Yes <input checked="" type="radio"/> No         |      | Apply | BMS battery connect:                                          | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |    | Apply |
| Generator as AC source:                                     | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      | Apply |                                                               |                                                                       |    |       |

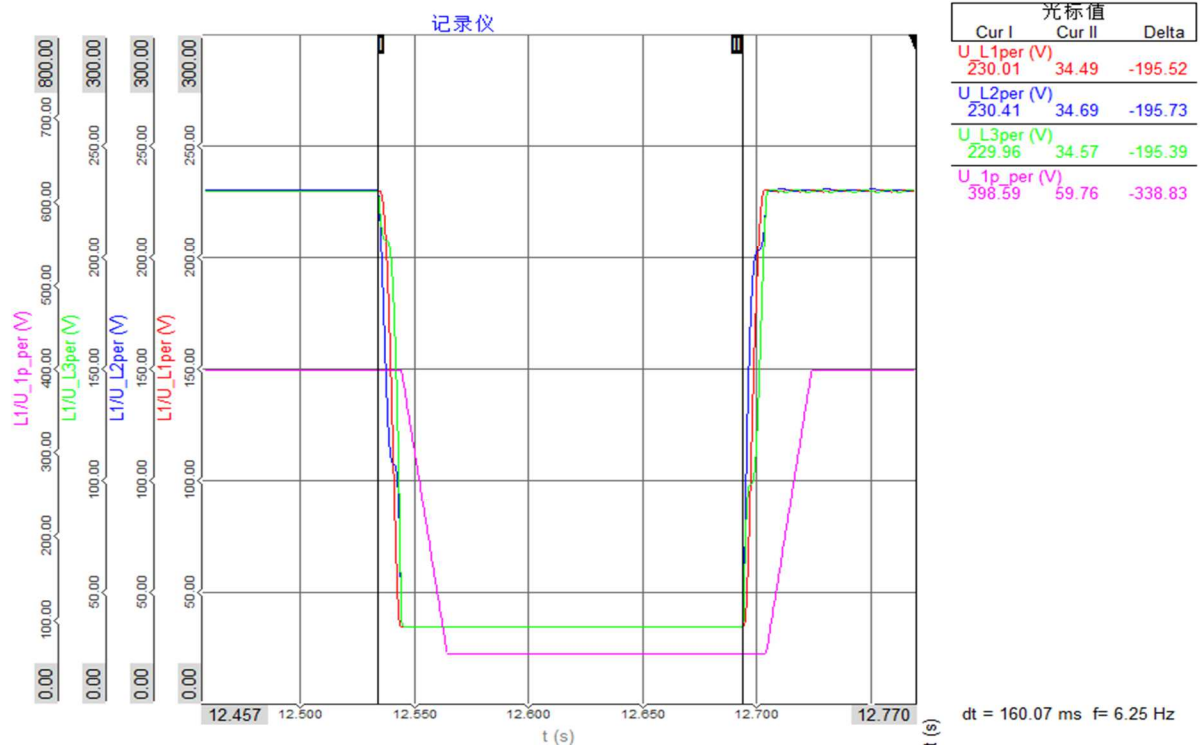
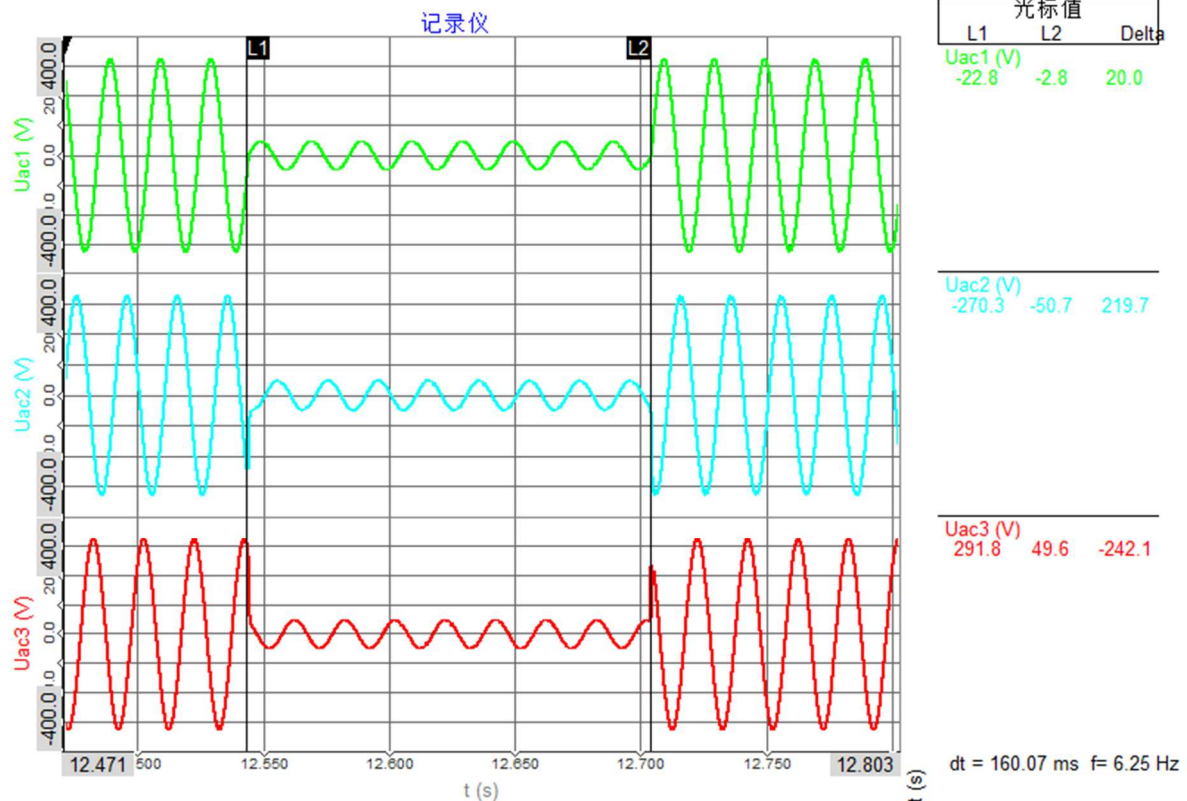


5.6.3

Testing of the dynamic grid support

P

No load test 0.1.1

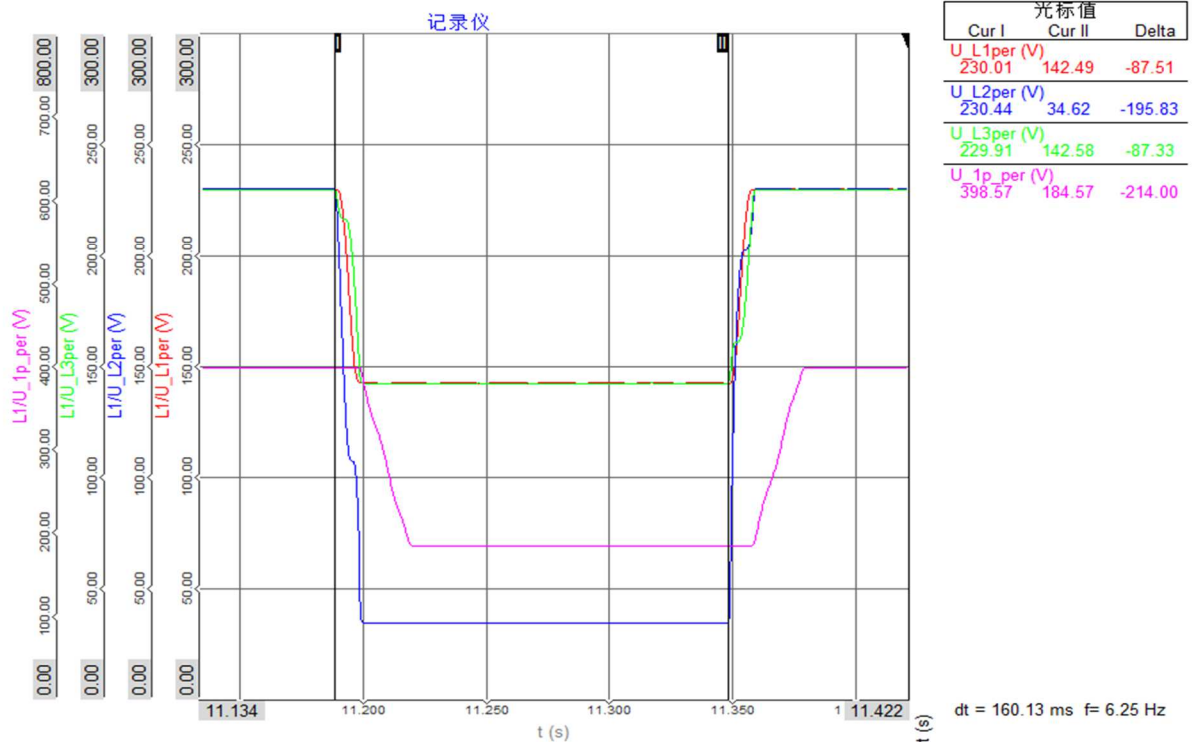
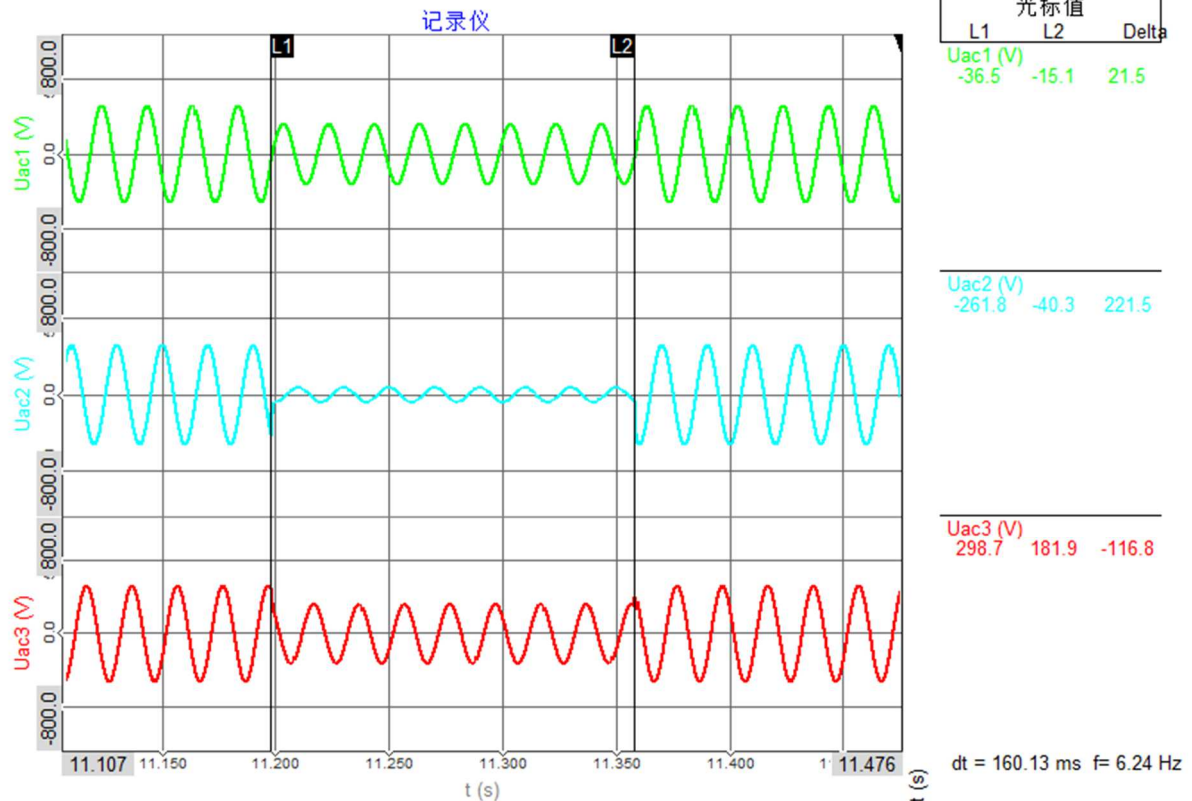


5.6.3

Testing of the dynamic grid support

P

No load test 0.1.2

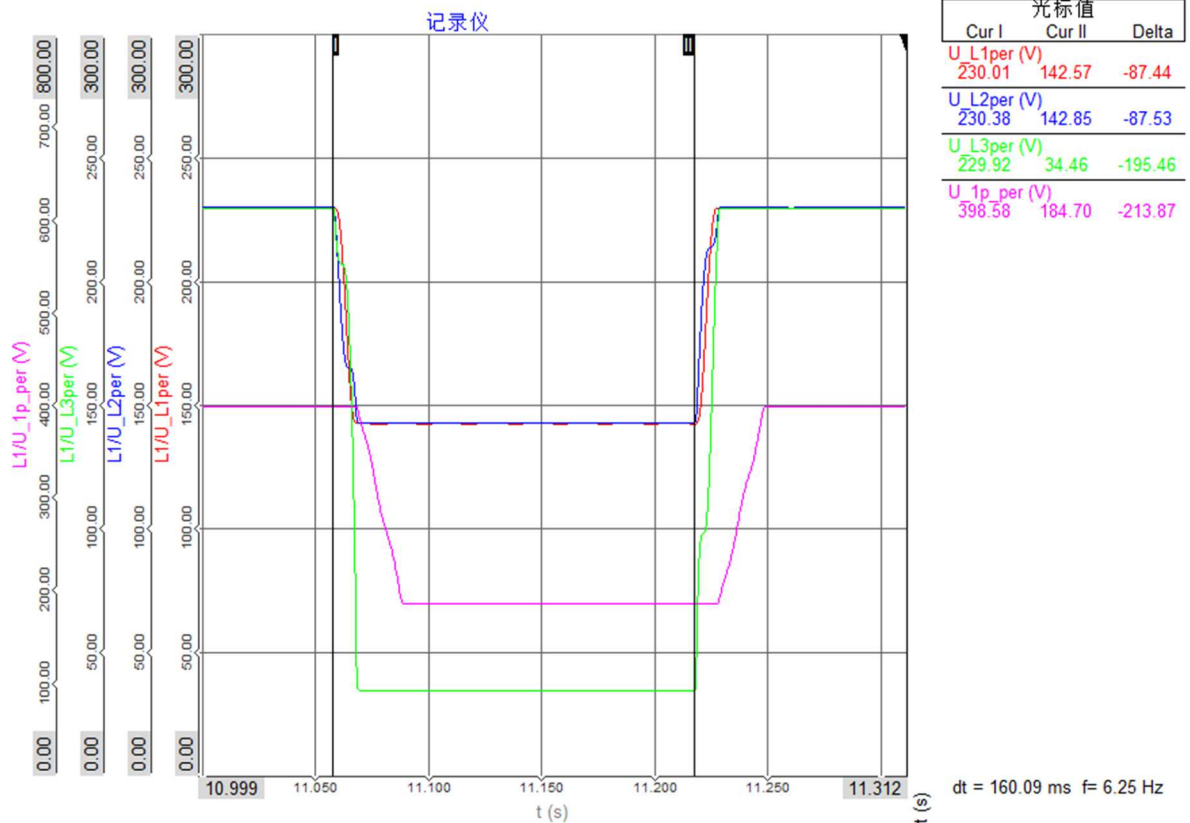
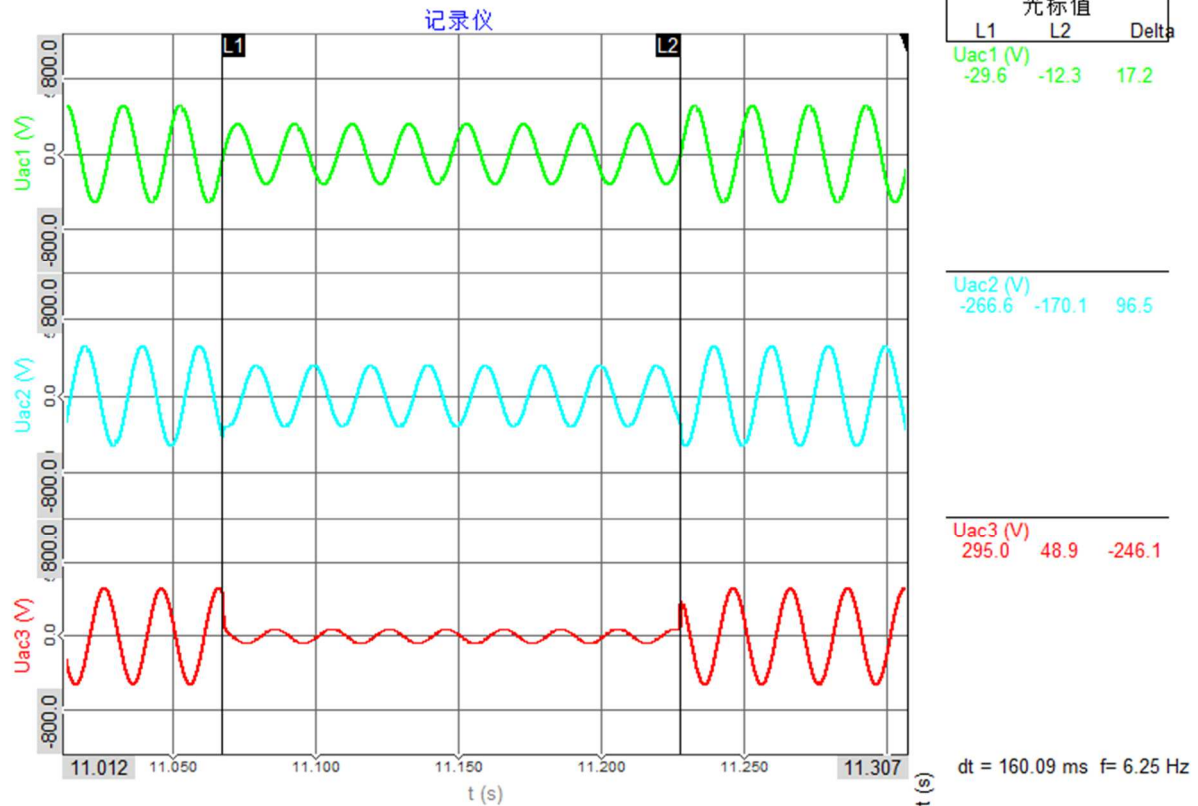


5.6.3

Testing of the dynamic grid support

P

No load test 0.1.3

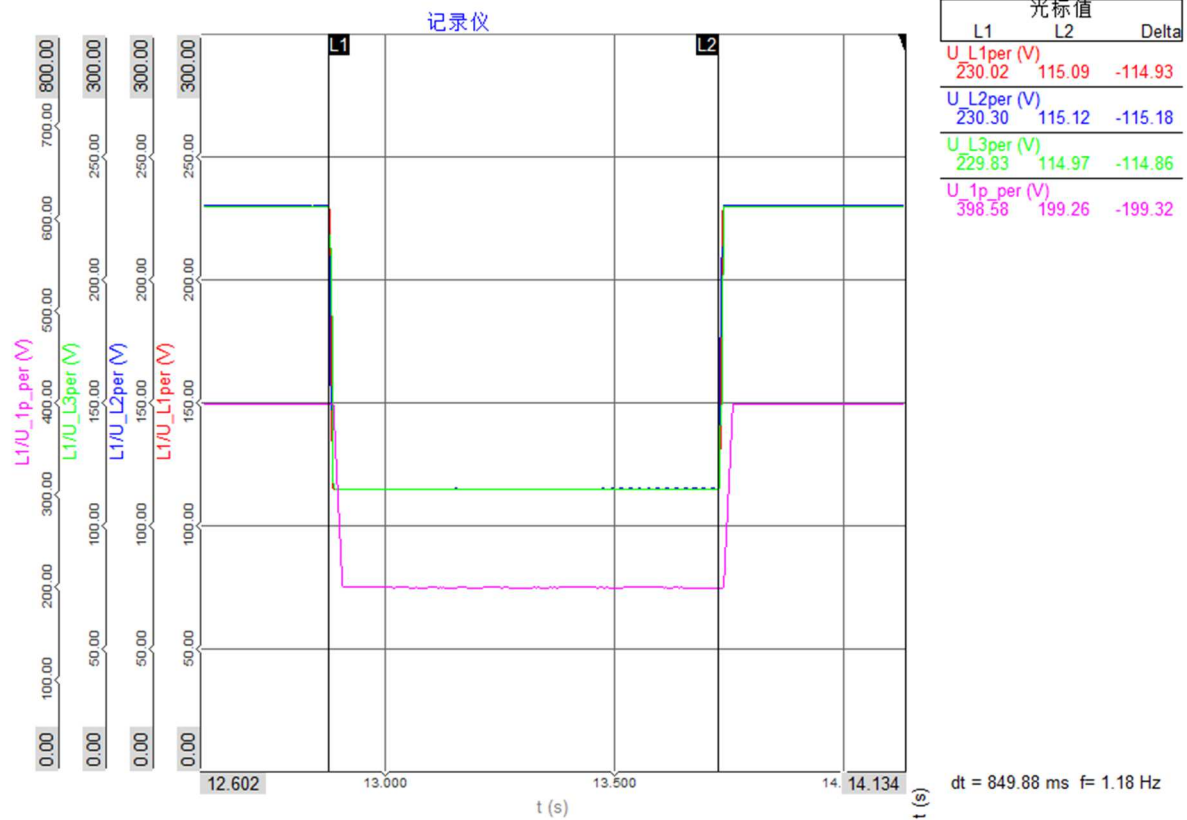
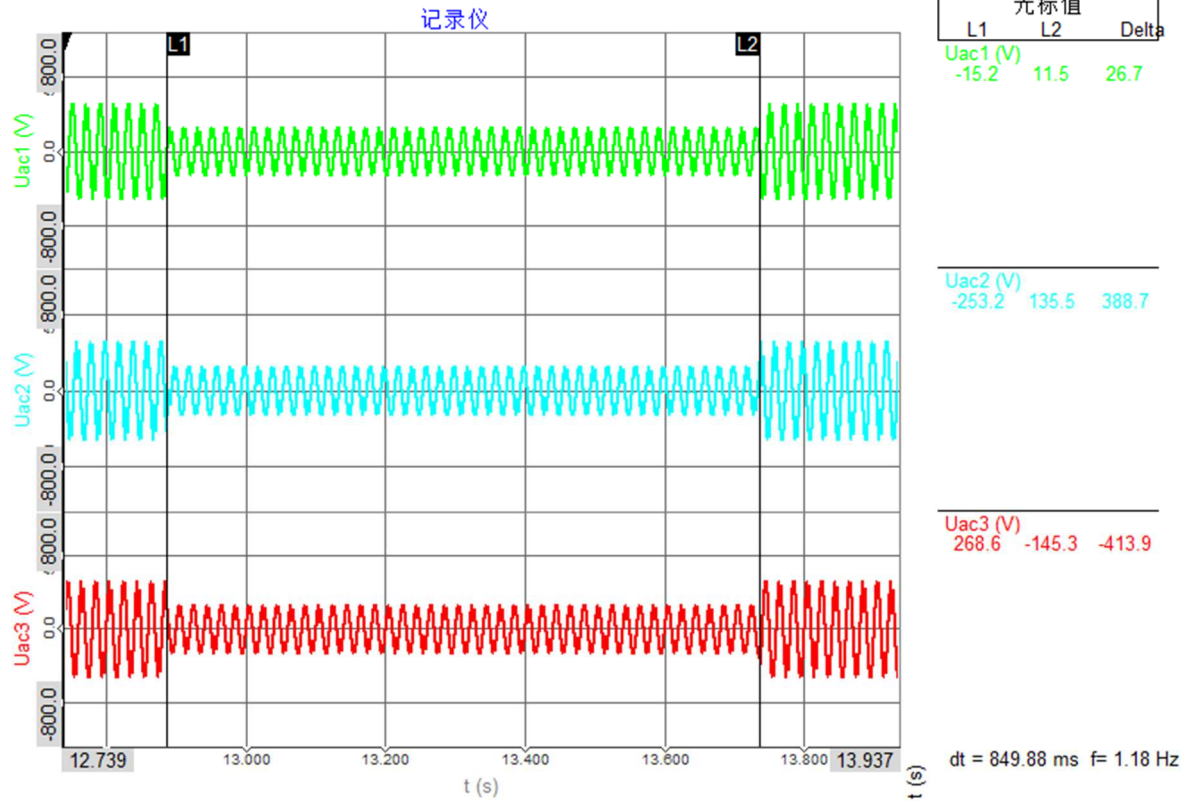


5.6.3

Testing of the dynamic grid support

P

No load test 0.2.1

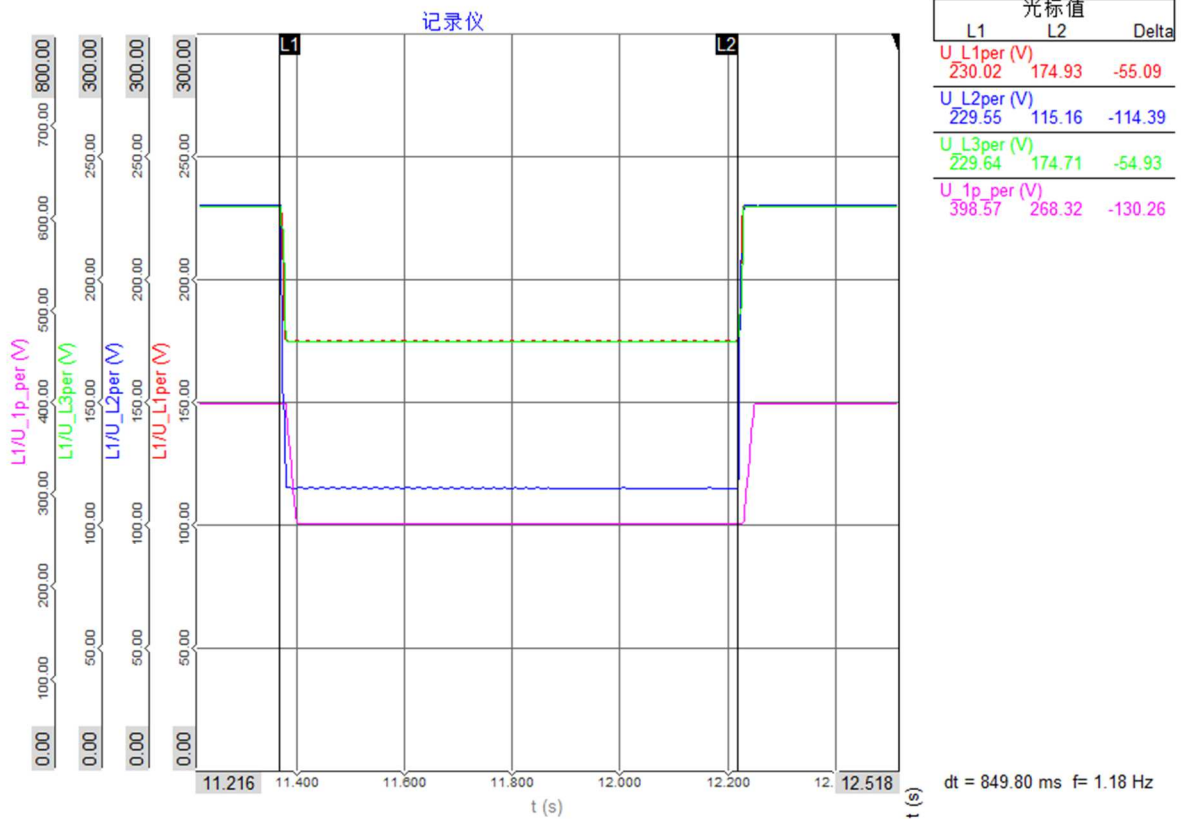
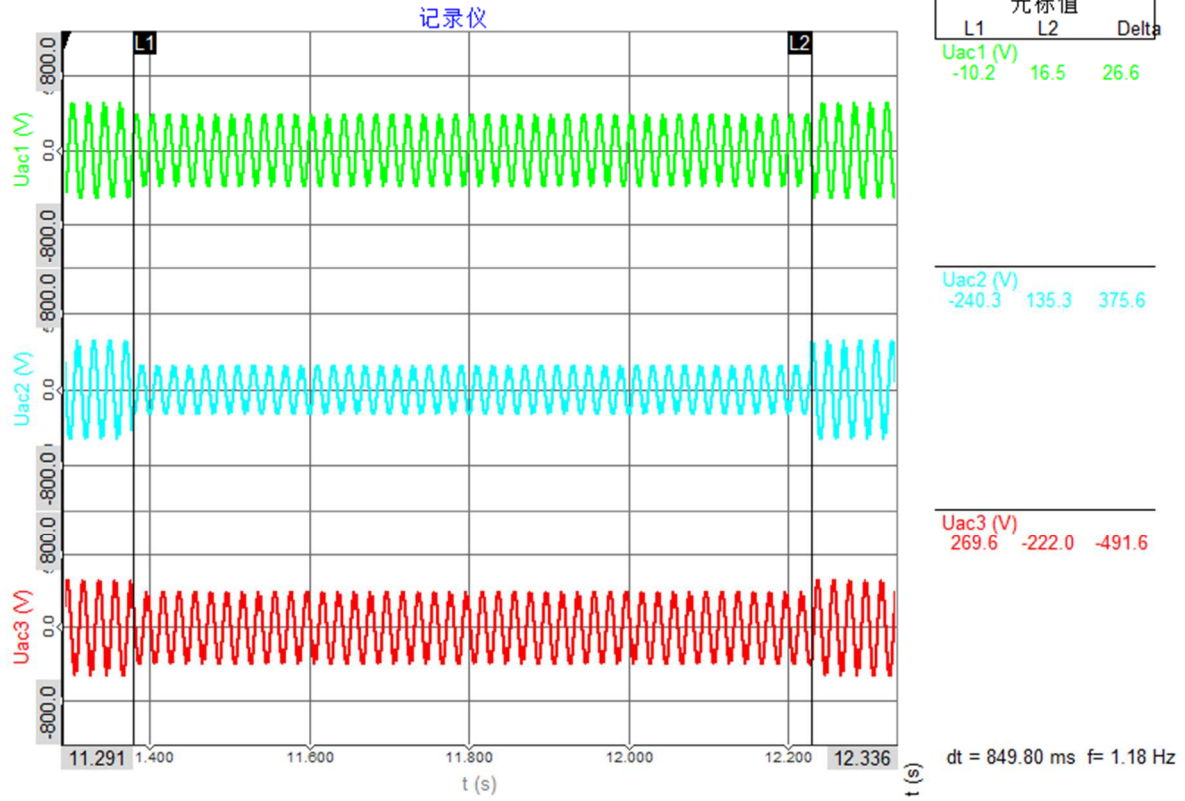


5.6.3

Testing of the dynamic grid support

P

No load test 0.2.2



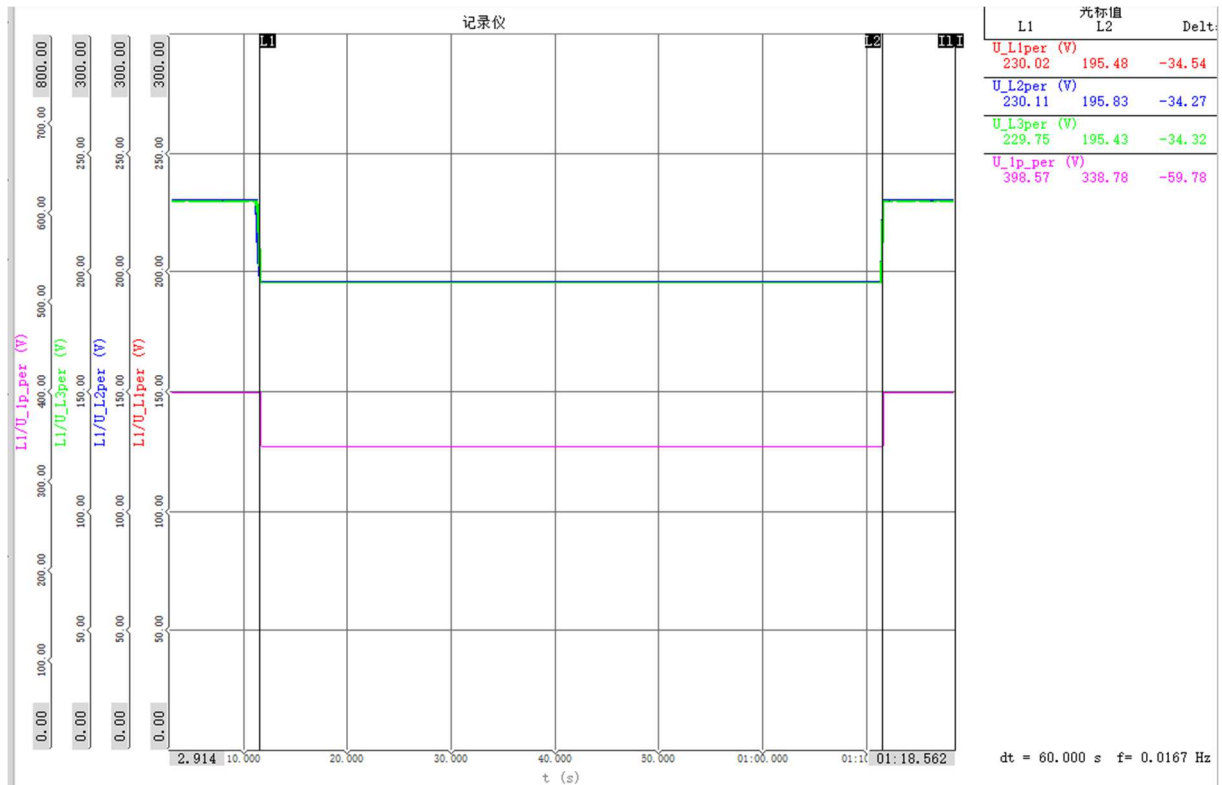
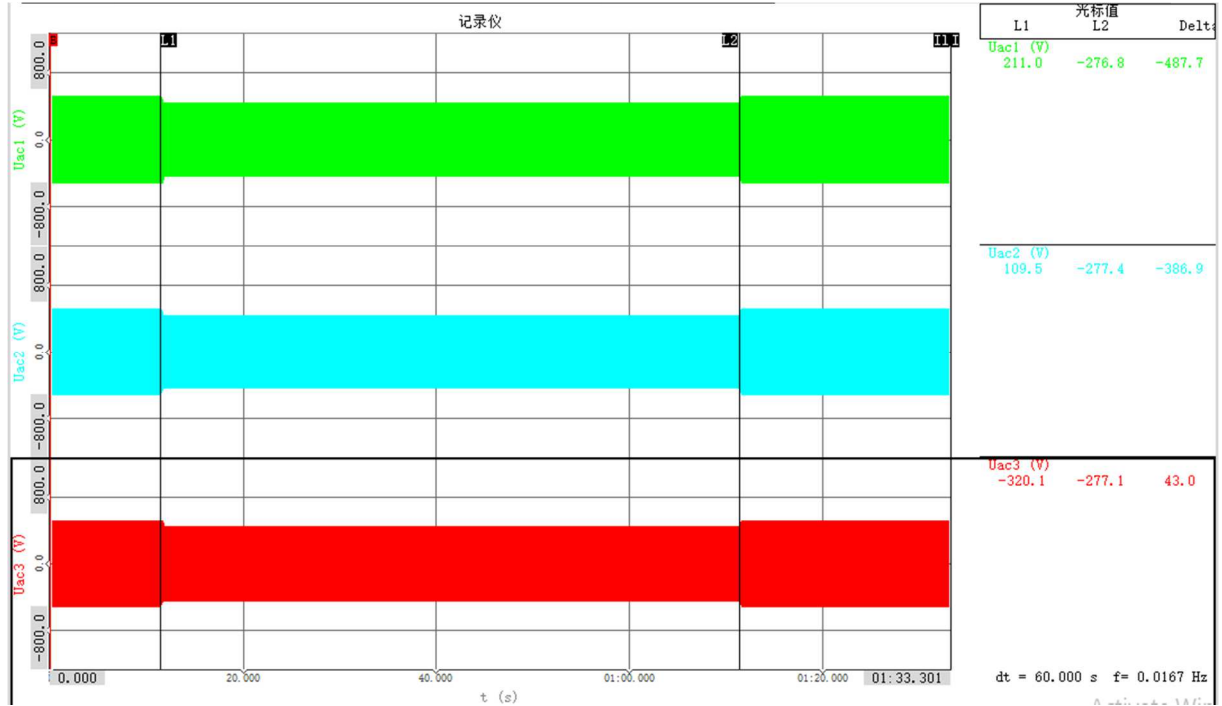


5.6.3

Testing of the dynamic grid support

P

No load test 0.3.1

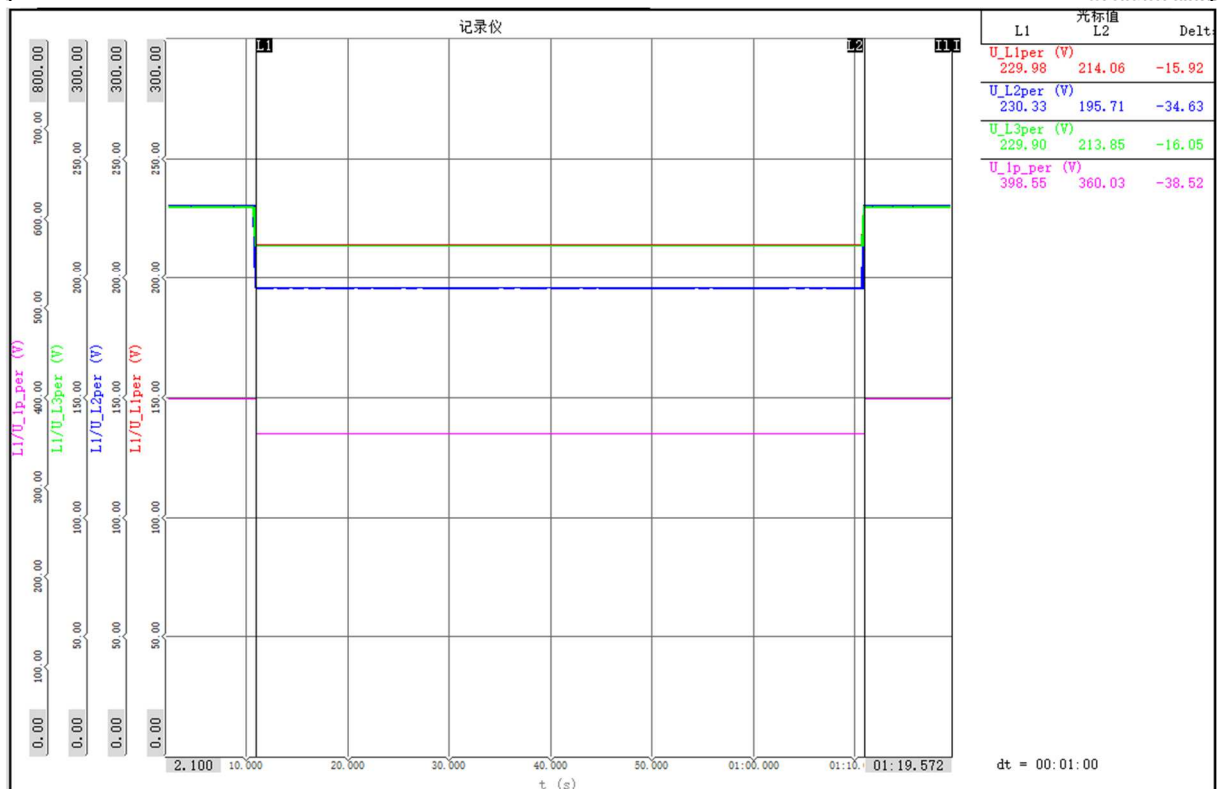
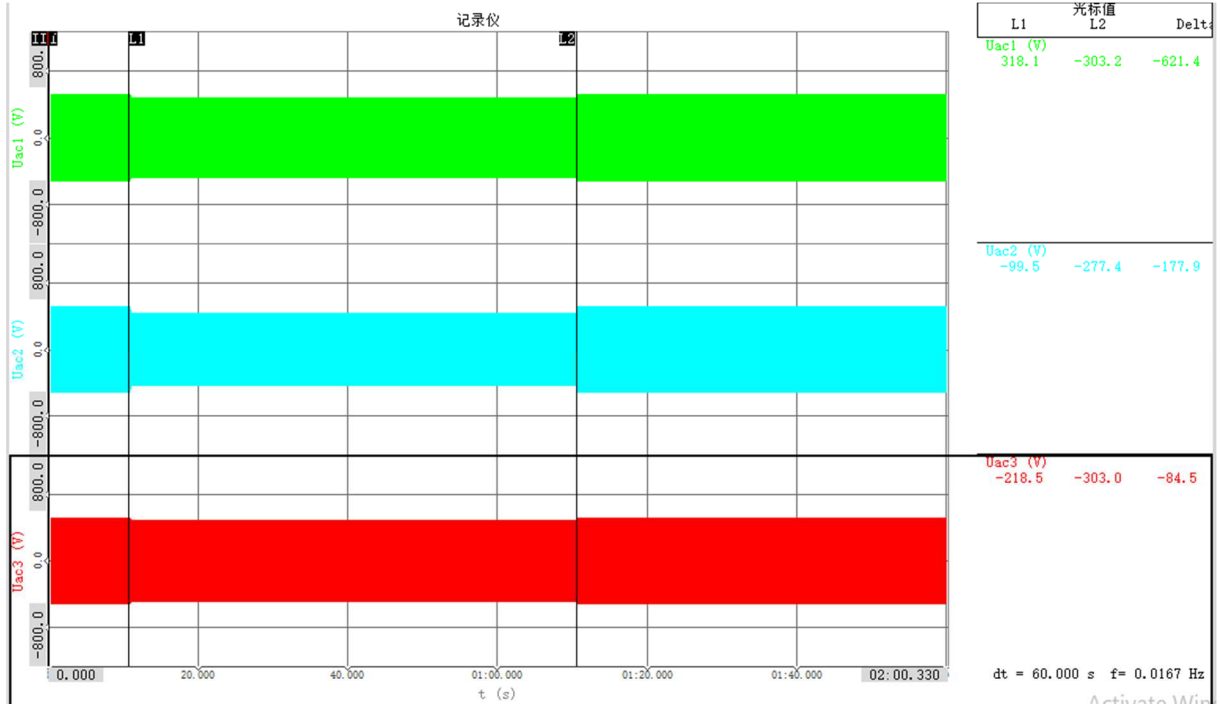


5.6.3

Testing of the dynamic grid support

P

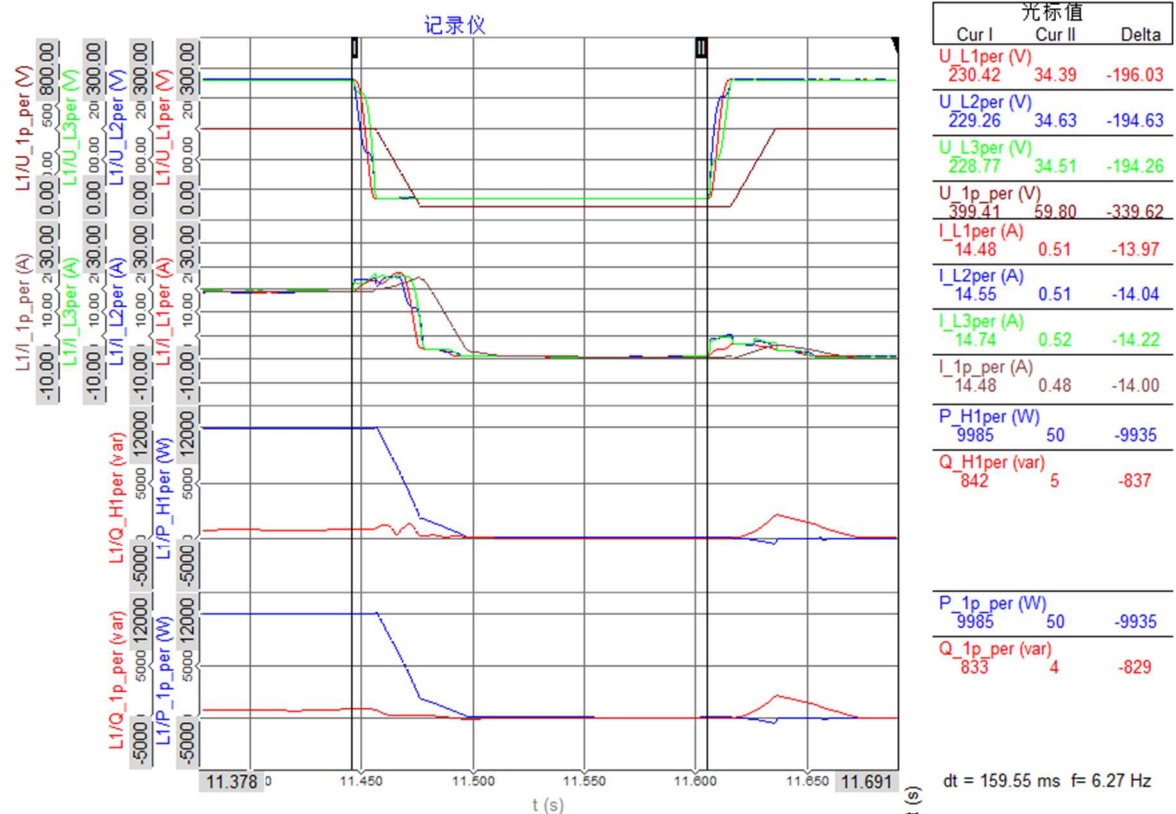
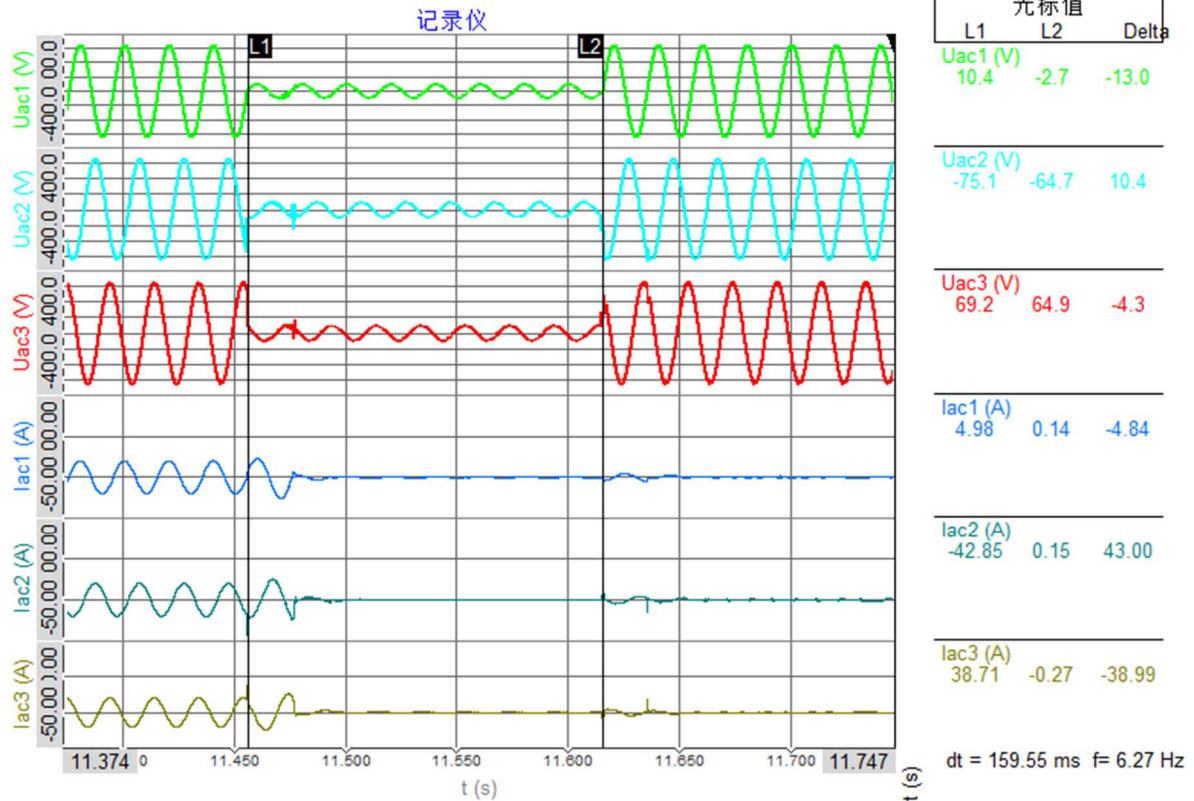
No load test 0.3.2



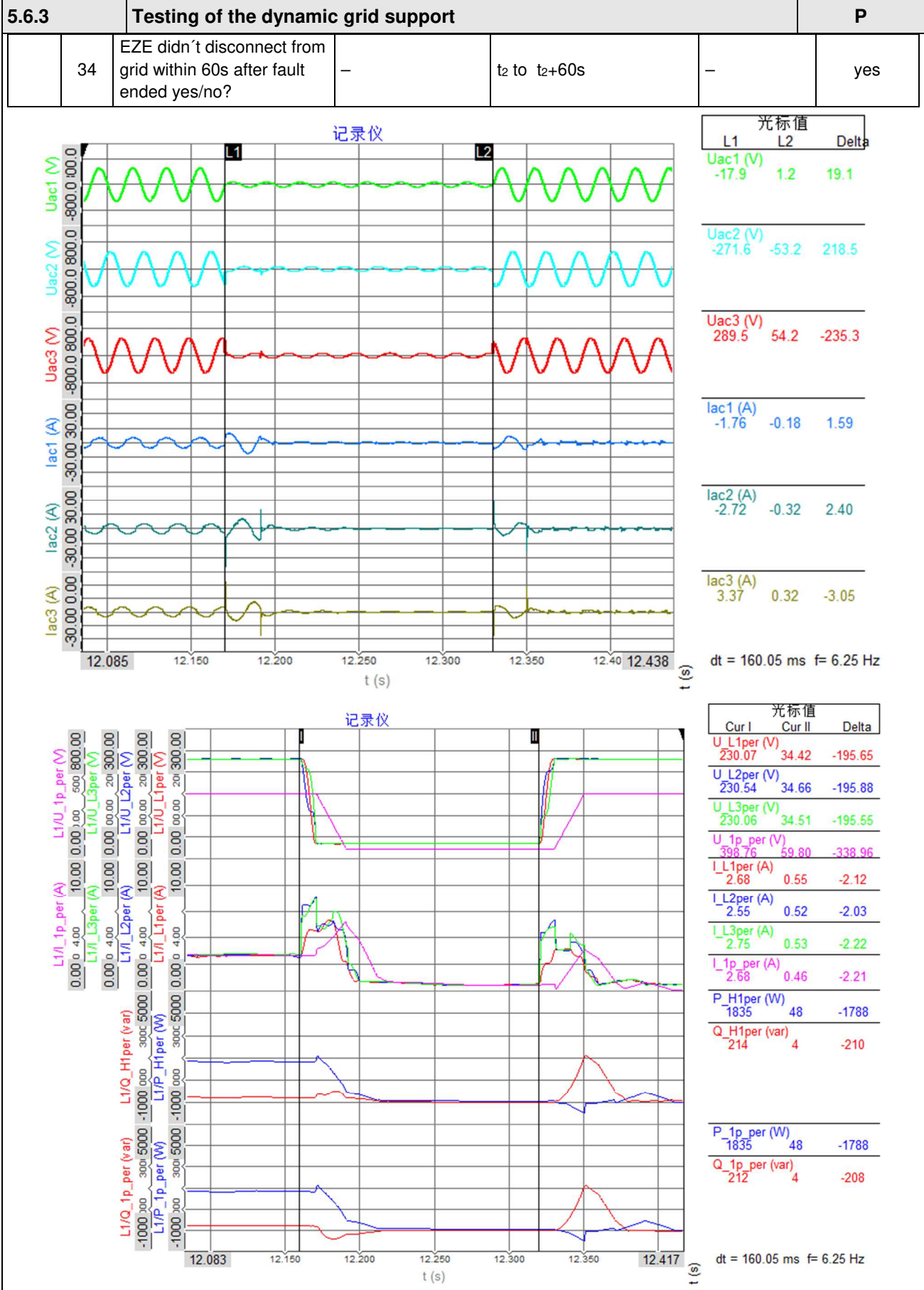
| 5.6.3               |     | Testing of the dynamic grid support        |                   |                                                               |              | P          |
|---------------------|-----|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------|------------|
| Load tests 1.1      |     |                                            |                   |                                                               |              |            |
|                     | No. | Parameter                                  | Phase reference   | Reference time                                                | Value (unit) | Value      |
| General information | 0   | Test no.                                   | –                 | –                                                             | –            | 1.1        |
|                     | 1   | Date                                       | –                 | –                                                             | [dd.mm.yyyy] | 27.03.2023 |
|                     | 2   | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f] | 14:10:40   |
|                     | 3   | Type of fault (number of affected phases)  | –                 | –                                                             | –            | A(3)       |
|                     | 4   | Drop depth setpoint                        | Phase             | –                                                             | [p.u]        | 0,15       |
|                     | 5   | Drop duration setpoint                     | Total             | –                                                             | [ms]         | 150        |
|                     | 6   | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]         | 11445      |
|                     | 7   | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]         | 11605      |
|                     | 8   | Fault duration determined from test        | Total             | –                                                             | [ms]         | 160        |
|                     | 9   | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]       | 0,150      |
|                     | 10  |                                            | Positive sequence |                                                               |              | 0,149      |
| Before $t_1$        | 11  | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]       | 1,002      |
|                     | 12  | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]       | 1,001      |
|                     | 13  | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 1,000      |
|                     | 14  |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,999      |
|                     | 15  | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,077      |
|                     | 16  |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,084      |
|                     | 17  | cos φ                                      | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,996      |
| $t_1$ till $t_2$    | 18  | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,150      |
|                     | 19  | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,046      |
|                     | 20  |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,043      |
|                     | 21  |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,045      |
|                     | 22  | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,033      |
|                     | 23  |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,031      |
|                     | 24  |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,032      |
|                     | 25  | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,004      |
|                     | 26  |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,004      |
| After $t_2$         | 27  | Voltage                                    | Phase to Neutral  | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 1,002      |
|                     | 28  | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,993      |
|                     | 29  |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,993      |
|                     | 30  | Response time active power                 | Positive sequence | -                                                             | [s]          | 0,703      |
|                     | 31  | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,075      |
|                     | 32  |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,077      |
|                     | 33  | Response time reactive power               | Positive sequence | –                                                             | [s]          | N/A        |



| 5.6.3 |    | Testing of the dynamic grid support                                  |   |                    |   | P   |  |
|-------|----|----------------------------------------------------------------------|---|--------------------|---|-----|--|
|       | 34 | EZE didn't disconnect from grid within 60s after fault ended yes/no? | — | $t_2$ to $t_2+60s$ | — | yes |  |



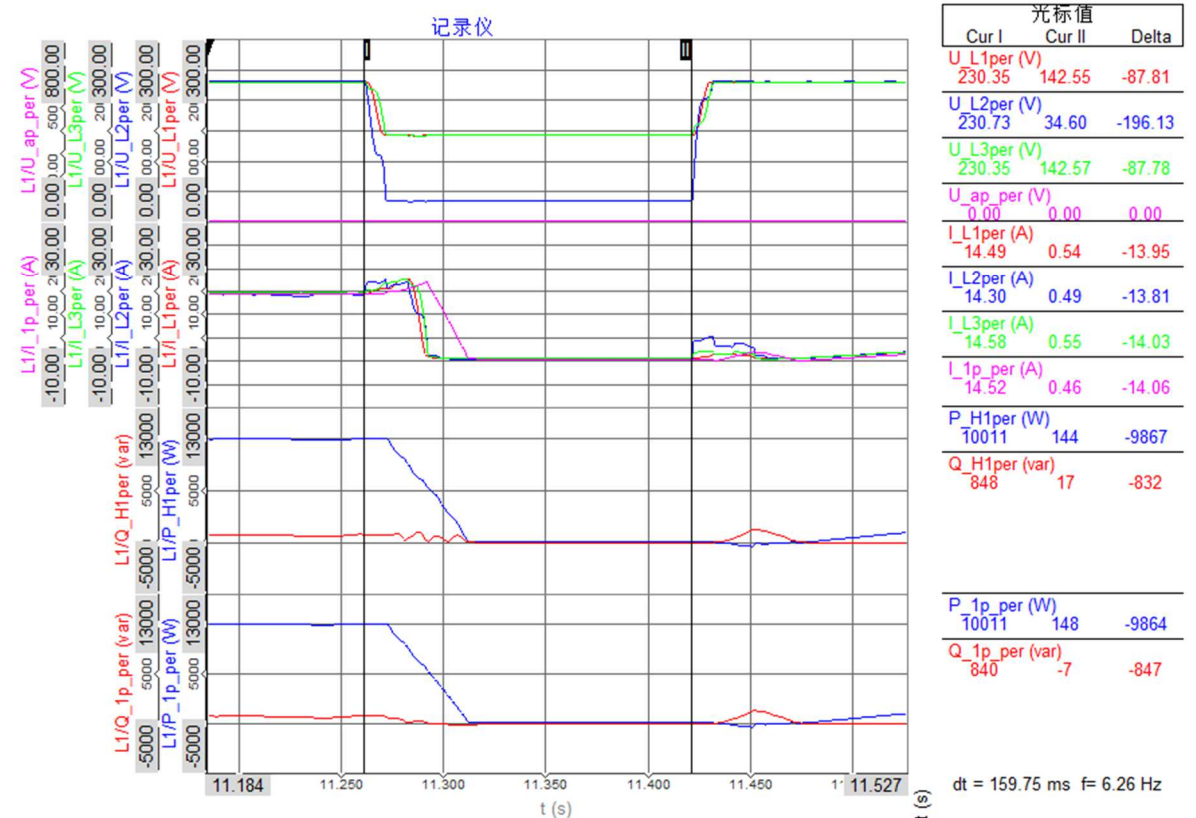
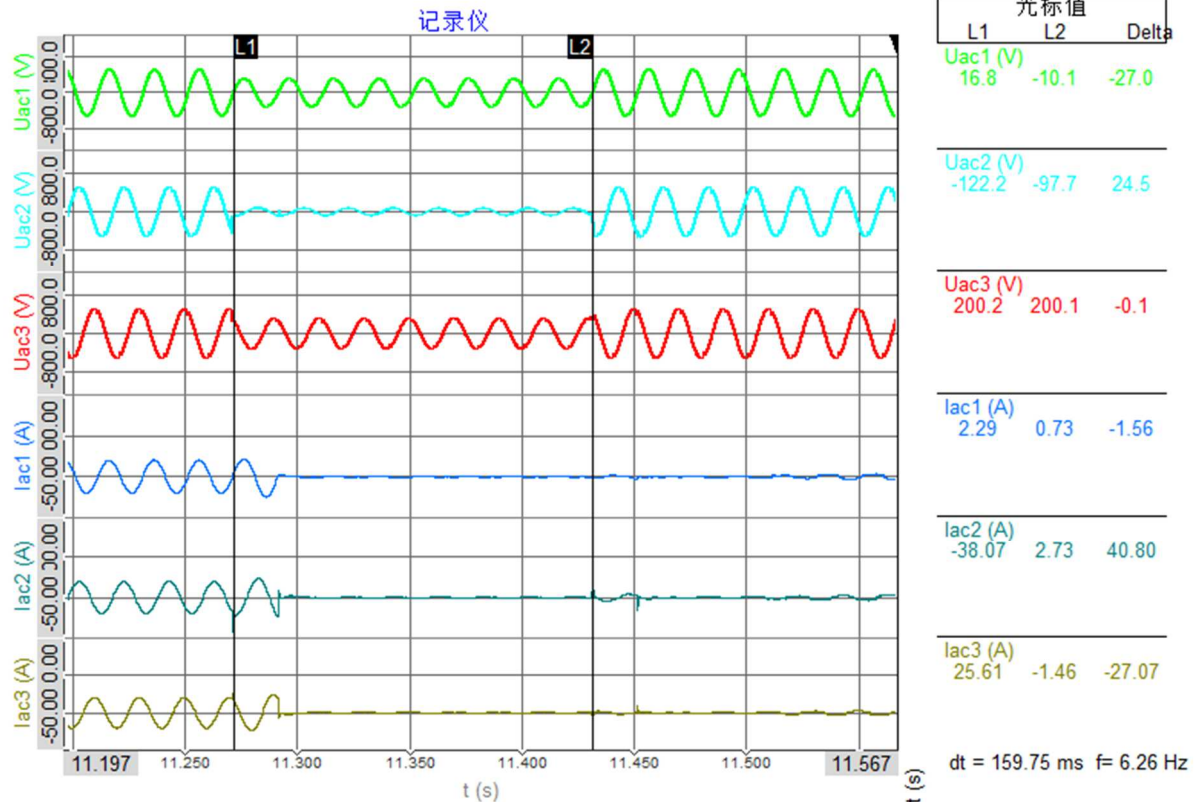
| 5.6.3                              |     | Testing of the dynamic grid support        |                   |                                                                                    |              | P          |
|------------------------------------|-----|--------------------------------------------|-------------------|------------------------------------------------------------------------------------|--------------|------------|
| Load tests 1.2                     |     |                                            |                   |                                                                                    |              |            |
|                                    | No. | Parameter                                  | Phase reference   | Reference time                                                                     | Value (unit) | Value      |
| General information                | 0   | Test no.                                   | –                 | –                                                                                  | –            | 1.2        |
|                                    | 1   | Date                                       | –                 | –                                                                                  | [dd.mm.yyyy] | 27.03.2023 |
|                                    | 2   | Time ( Start of test)                      | –                 | –                                                                                  | [hh:mm:ss.f] | 11:25:50   |
|                                    | 3   | Type of fault (number of affected phases)  | –                 | –                                                                                  | –            | A(3)       |
|                                    | 4   | Drop depth setpoint                        | Phase             | –                                                                                  | [p.u]        | 0,15       |
|                                    | 5   | Drop duration setpoint                     | Total             | –                                                                                  | [ms]         | 150        |
|                                    | 6   | Fault occurrence (r1)                      | Total             | –                                                                                  | [ms]         | 12160      |
|                                    | 7   | Fault clearance (r2)                       | Total             | –                                                                                  | [ms]         | 12320      |
|                                    | 8   | Fault duration determined from test        | Total             | –                                                                                  | [ms]         | 160        |
|                                    | 9   | Measeured value of voltage drop / increase | Total             | t <sub>1</sub> +100ms to t <sub>2</sub> and t <sub>1</sub> -10 s to t <sub>1</sub> | [p.u.]       | 0,150      |
|                                    | 10  |                                            | Positive sequence |                                                                                    |              | 0,149      |
| Before t <sub>1</sub>              | 11  | Voltage                                    | Phase to Neutral  | t <sub>1</sub> -10s to t <sub>1</sub>                                              | [p.u.]       | 1,000      |
|                                    | 12  | Current                                    | Positive sequence | t <sub>1</sub> -500 ms to t <sub>1</sub> -100 ms                                   | [p.u.]       | 0,188      |
|                                    | 13  | Active power                               | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,188      |
|                                    | 14  |                                            | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,174      |
|                                    | 15  | Reactive power                             | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,021      |
|                                    | 16  |                                            | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,021      |
|                                    | 17  | cos φ                                      | -                 | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,981      |
| t <sub>1</sub> till t <sub>2</sub> | 18  | Voltage                                    | Phase to Neutral  | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,150      |
|                                    | 19  | Phase current                              | Phase 1           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,046      |
|                                    | 20  |                                            | Phase 2           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,046      |
|                                    | 21  |                                            | Phase 3           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,046      |
|                                    | 22  | Phase current                              | Phase 1           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,034      |
|                                    | 23  |                                            | Phase 2           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,032      |
|                                    | 24  |                                            | Phase 3           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,031      |
|                                    | 25  | Active power                               | Total             | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,005      |
|                                    | 26  |                                            | Positive sequence | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,005      |
| After t <sub>2</sub>               | 27  | Voltage                                    | Phase to Neutral  | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 1,001      |
|                                    | 28  | Active power                               | Positive sequence | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]       | 0,216      |
|                                    | 29  |                                            | Total             | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]       | 0,216      |
|                                    | 30  | Response time active power                 | Positive sequence | -                                                                                  | [s]          | 0,223      |
|                                    | 31  | Reactive power                             | Positive sequence | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 0,024      |
|                                    | 32  |                                            | Total             | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 0,025      |
|                                    | 33  | Response time reactive power               | Positive sequence | –                                                                                  | [s]          | N/A        |



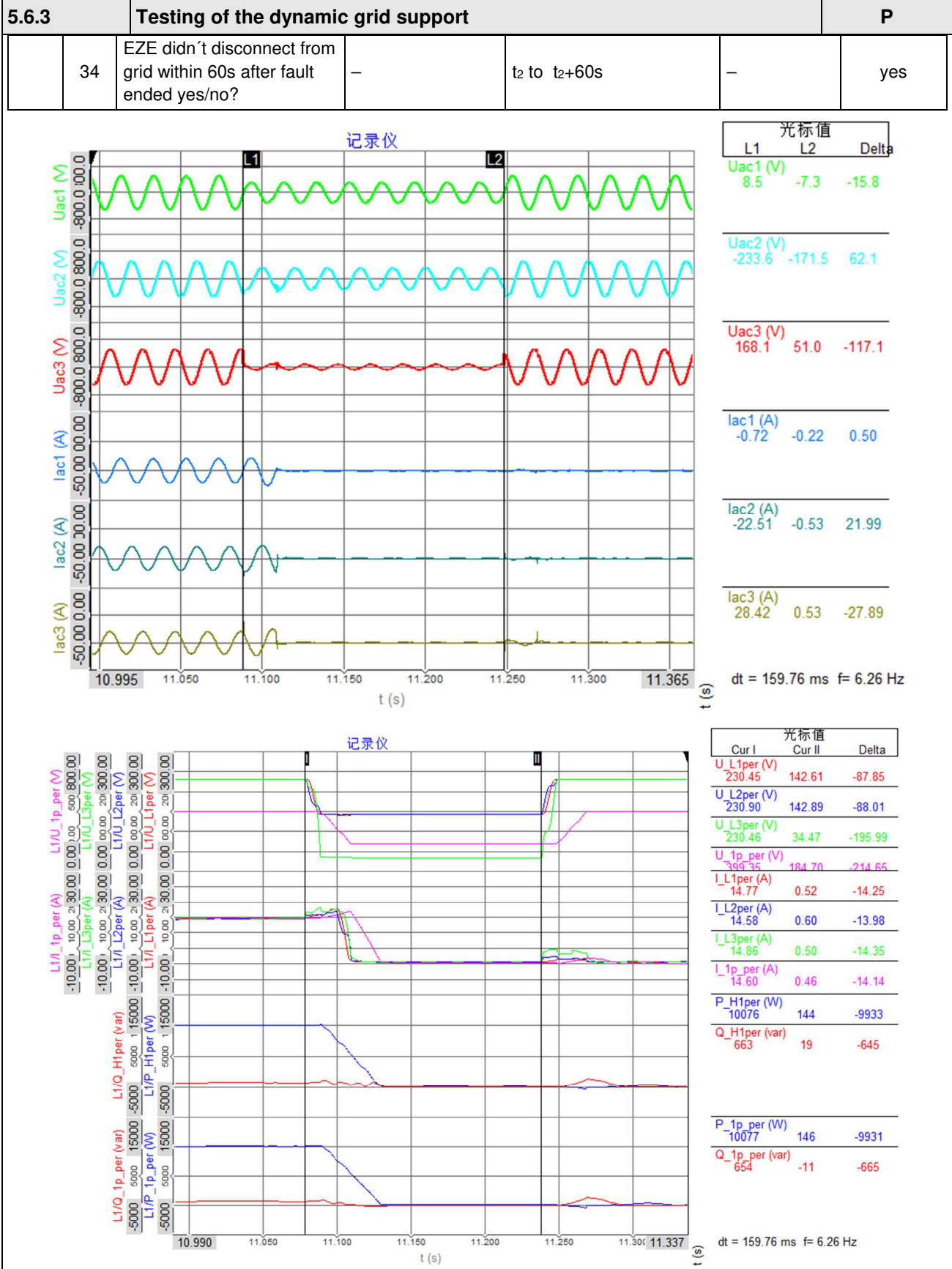
| 5.6.3               |     | Testing of the dynamic grid support        |                   |                                                                |              | P          |
|---------------------|-----|--------------------------------------------|-------------------|----------------------------------------------------------------|--------------|------------|
| Load tests 1.3      |     |                                            |                   |                                                                |              |            |
|                     | No. | Parameter                                  | Phase reference   | Reference time                                                 | Value (unit) | Value      |
| General information | 0   | Test no.                                   | –                 | –                                                              | –            | 1.3        |
|                     | 1   | Date                                       | –                 | –                                                              | [dd.mm.yyyy] | 27.03.2023 |
|                     | 2   | Time ( Start of test)                      | –                 | –                                                              | [hh:mm:ss.f] | 14:19:35   |
|                     | 3   | Type of fault (number of affected phases)  | –                 | –                                                              | –            | D1(2)      |
|                     | 4   | Drop depth setpoint                        | Phase             | –                                                              | [p.u]        | 0,15       |
|                     | 5   | Drop duration setpoint                     | Total             | –                                                              | [ms]         | 150        |
|                     | 6   | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                              | [ms]         | 11260      |
|                     | 7   | Fault clearance ( <i>r</i> 2)              | Total             | –                                                              | [ms]         | 11420      |
|                     | 8   | Fault duration determined from test        | Total             | –                                                              | [ms]         | 160        |
|                     | 9   | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10 \text{ s to } t_1$ | [p.u.]       | 0,151      |
|                     | 10  |                                            | Positive sequence |                                                                |              | 0,461      |
| Before $t_1$        | 11  | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                       | [p.u.]       | 1,002      |
|                     | 12  | Current                                    | Positive sequence | $t_1-500 \text{ ms to } t_1-100 \text{ ms}$                    | [p.u.]       | 0,994      |
|                     | 13  | Active power                               | Total             | $t_1-10 \text{ s to } t_1$                                     | [p.u.]       | 1,001      |
|                     | 14  |                                            | Positive sequence | $t_1-10 \text{ s to } t_1$                                     | [p.u.]       | 1,001      |
|                     | 15  | Reactive power                             | Positive sequence | $t_1-10 \text{ s to } t_1$                                     | [p.u.]       | 0,084      |
|                     | 16  |                                            | Total             | $t_1-10 \text{ s to } t_1$                                     | [p.u.]       | 0,085      |
|                     | 17  | cos $\varphi$                              | -                 | $t_1-10 \text{ s to } t_1$                                     | [p.u.]       | 0,996      |
| $t_1$ till $t_2$    | 18  | Voltage                                    | Phase to Neutral  | $t_1+100 \text{ ms to } t_2-20 \text{ ms}$                     | [p.u.]       | 0,150      |
|                     | 19  | Phase current                              | Phase 1           | $t_1+60 \text{ ms}$                                            | [p.u.]       | 0,041      |
|                     | 20  |                                            | Phase 2           | $t_1+60 \text{ ms}$                                            | [p.u.]       | 0,035      |
|                     | 21  |                                            | Phase 3           | $t_1+60 \text{ ms}$                                            | [p.u.]       | 0,039      |
|                     | 22  | Phase current                              | Phase 1           | $t_1 +100 \text{ ms}$                                          | [p.u.]       | 0,039      |
|                     | 23  |                                            | Phase 2           | $t_1 +100 \text{ ms}$                                          | [p.u.]       | 0,035      |
|                     | 24  |                                            | Phase 3           | $t_1 +100 \text{ ms}$                                          | [p.u.]       | 0,038      |
|                     | 25  | Active power                               | Total             | $t_1+100 \text{ ms to } t_2-20 \text{ ms}$                     | [p.u.]       | 0,014      |
|                     | 26  |                                            | Positive sequence | $t_1+100 \text{ ms to } t_2-20 \text{ ms}$                     | [p.u.]       | 0,014      |
| After $t_2$         | 27  | Voltage                                    | Phase to Neutral  | $t_2+3 \text{ s to } t_2+10 \text{ s}$                         | [p.u.]       | 1,001      |
|                     | 28  | Active power                               | Positive sequence | $t_2+3 \text{ s to } r_2+10 \text{ s}$                         | [p.u.]       | 0,995      |
|                     | 29  |                                            | Total             | $t_2+3 \text{ s to } r_2+10 \text{ s}$                         | [p.u.]       | 0,995      |
|                     | 30  | Response time active power                 | Positive sequence | -                                                              | [s]          | 0,625      |
|                     | 31  | Reactive power                             | Positive sequence | $t_2+3 \text{ s to } t_2+10 \text{ s}$                         | [p.u.]       | 0,065      |
|                     | 32  |                                            | Total             | $t_2+3 \text{ s to } t_2+10 \text{ s}$                         | [p.u.]       | 0,067      |
|                     | 33  | Response time reactive power               | Positive sequence | –                                                              | [s]          | N/A        |



| 5.6.3 |    | Testing of the dynamic grid support                                  |   |                                       |   | P   |
|-------|----|----------------------------------------------------------------------|---|---------------------------------------|---|-----|
|       | 34 | EZE didn't disconnect from grid within 60s after fault ended yes/no? | — | t <sub>2</sub> to t <sub>2</sub> +60s | — | yes |



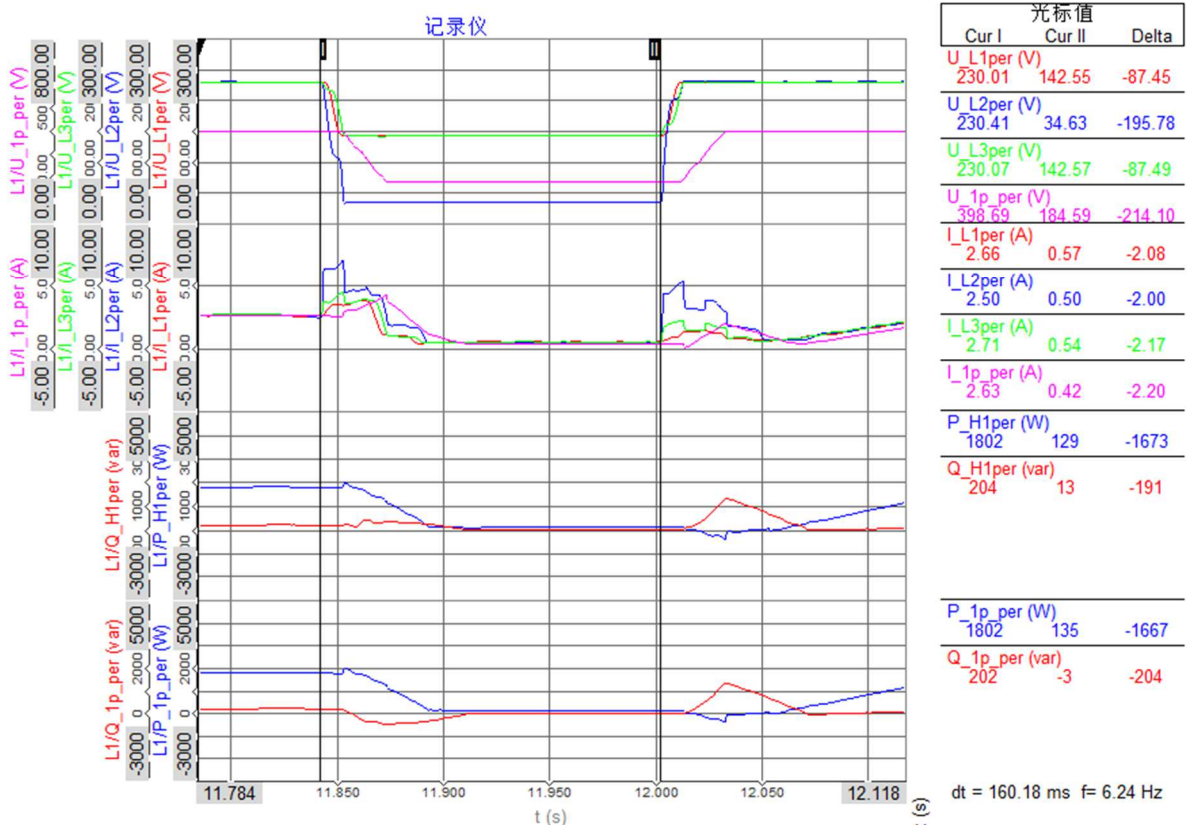
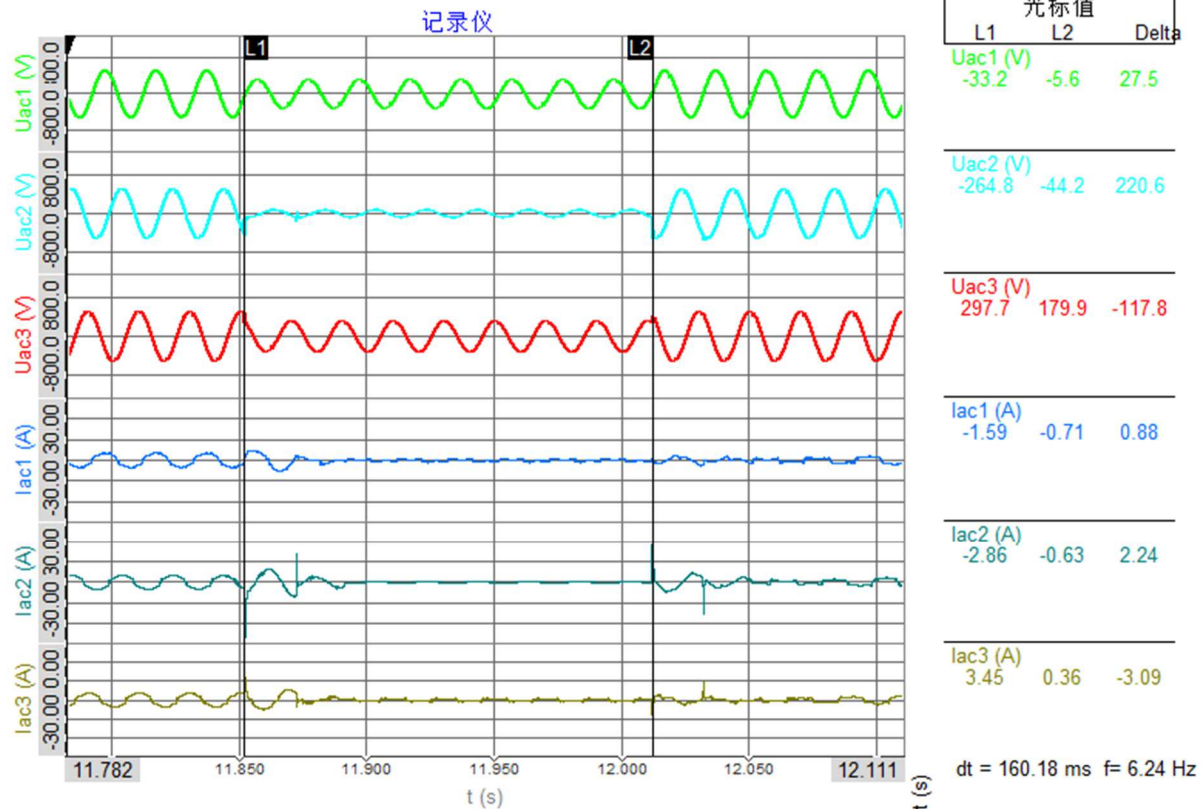
| 5.6.3               |             | Testing of the dynamic grid support        |                   |                                                               |                                      | P          |
|---------------------|-------------|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------------------------------|------------|
| Load tests 1.3.a    |             |                                            |                   |                                                               |                                      |            |
|                     | No.         | Parameter                                  | Phase reference   | Reference time                                                | Value (unit)                         | Value      |
| General information | 0           | Test no.                                   | –                 | –                                                             | –                                    | 1.3.a      |
|                     | 1           | Date                                       | –                 | –                                                             | [dd.mm.yyyy]                         | 29.03.2023 |
|                     | 2           | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f]                         | 14:04:17   |
|                     | 3           | Type of fault (number of affected phases)  | –                 | –                                                             | –                                    | D2(2)      |
|                     | 4           | Drop depth setpoint                        | Phase             | –                                                             | [p.u]                                | 0,15       |
|                     | 5           | Drop duration setpoint                     | Total             | –                                                             | [ms]                                 | 150        |
|                     | 6           | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]                                 | 11075      |
|                     | 7           | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]                                 | 11235      |
|                     | 8           | Fault duration determined from test        | Total             | –                                                             | [ms]                                 | 160        |
|                     | 9           | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]                               | 0,150      |
|                     | 10          |                                            | Positive sequence |                                                               |                                      | 0,462      |
| Before $t_1$        | 11          | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]                               | 1,002      |
|                     | 12          | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]                               | 1,009      |
|                     | 13          | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 1,006      |
|                     | 14          |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 1,006      |
|                     | 15          | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,065      |
|                     | 16          |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,066      |
|                     | 17          | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,996      |
| $t_1$ till $t_2$    | 18          | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,150      |
|                     | 19          | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,041      |
|                     | 20          |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,039      |
|                     | 21          |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,036      |
|                     | 22          | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,039      |
|                     | 23          |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,038      |
|                     | 24          |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,035      |
|                     | 25          | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,015      |
|                     | 26          |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,015      |
|                     | After $t_2$ | 27                                         | Voltage           | Phase to Neutral                                              | $t_2+3\text{ s to } t_2+10\text{ s}$ | [p.u.]     |
| 28                  |             | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 1,000      |
| 29                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 1,000      |
| 30                  |             | Response time active power                 | Positive sequence | -                                                             | [s]                                  | 0,661      |
| 31                  |             | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,073      |
| 32                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,076      |
| 33                  |             | Response time reactive power               | Positive sequence | –                                                             | [s]                                  | N/A        |



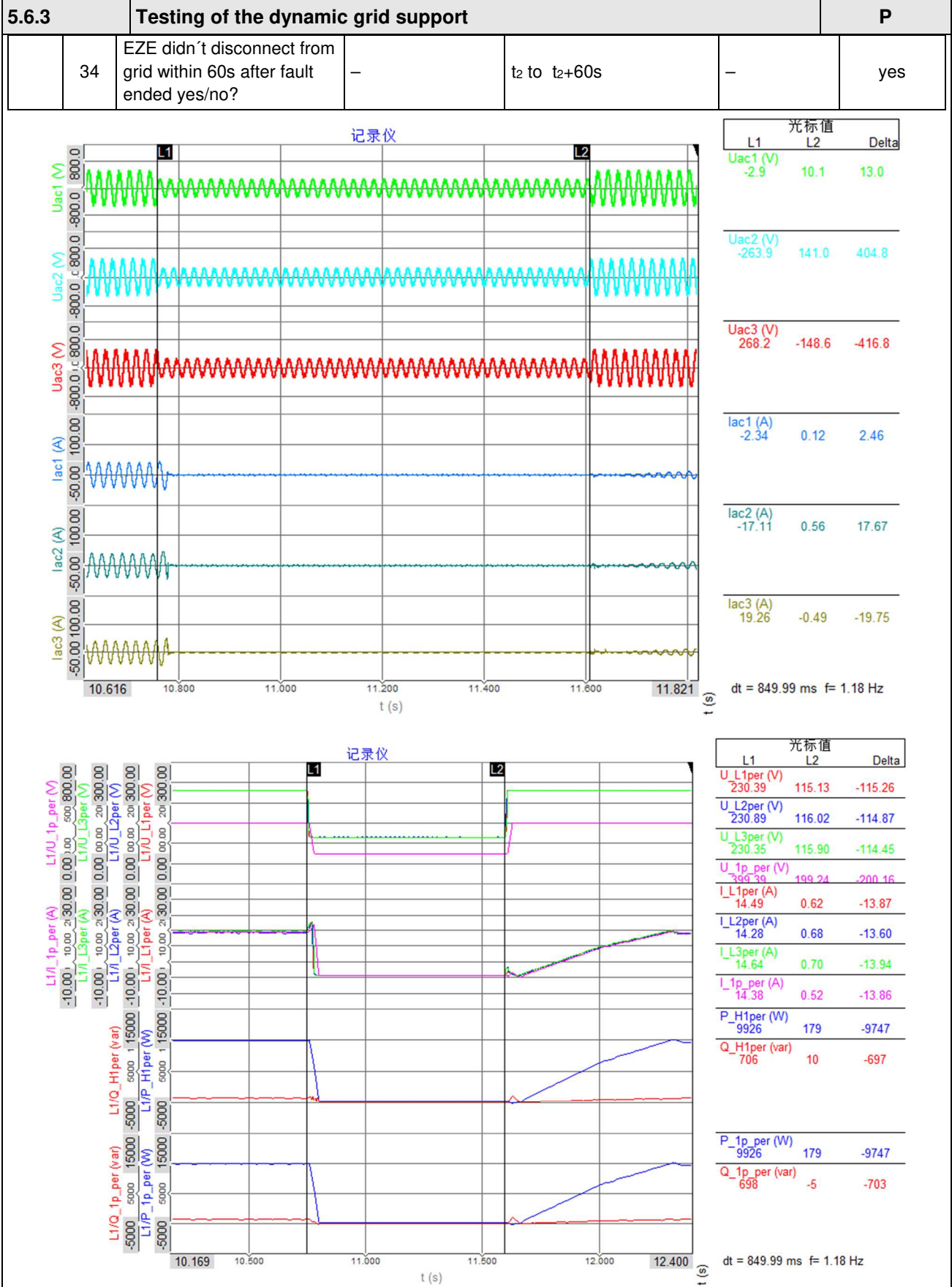
| 5.6.3               |             | Testing of the dynamic grid support        |                   |                                                               |                                      | P          |
|---------------------|-------------|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------------------------------|------------|
| Load tests 1.4      |             |                                            |                   |                                                               |                                      |            |
|                     | No.         | Parameter                                  | Phase reference   | Reference time                                                | Value (unit)                         | Value      |
| General information | 0           | Test no.                                   | –                 | –                                                             | –                                    | 1.4        |
|                     | 1           | Date                                       | –                 | –                                                             | [dd.mm.yyyy]                         | 27.03.2023 |
|                     | 2           | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f]                         | 11:33:39   |
|                     | 3           | Type of fault (number of affected phases)  | –                 | –                                                             | –                                    | D1(2)      |
|                     | 4           | Drop depth setpoint                        | Phase             | –                                                             | [p.u]                                | 0,15       |
|                     | 5           | Drop duration setpoint                     | Total             | –                                                             | [ms]                                 | 150        |
|                     | 6           | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]                                 | 11840      |
|                     | 7           | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]                                 | 12000      |
|                     | 8           | Fault duration determined from test        | Total             | –                                                             | [ms]                                 | 160        |
|                     | 9           | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]                               | 0,151      |
|                     | 10          |                                            | Positive sequence |                                                               |                                      | 0,461      |
| Before $t_1$        | 11          | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]                               | 1,002      |
|                     | 12          | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]                               | 0,188      |
|                     | 13          | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,180      |
|                     | 14          |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,180      |
|                     | 15          | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,020      |
|                     | 16          |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,021      |
|                     | 17          | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,981      |
| $t_1$ till $t_2$    | 18          | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,151      |
|                     | 19          | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,039      |
|                     | 20          |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,033      |
|                     | 21          |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,035      |
|                     | 22          | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,041      |
|                     | 23          |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,034      |
|                     | 24          |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,039      |
|                     | 25          | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,013      |
|                     | 26          |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,013      |
|                     | After $t_2$ | 27                                         | Voltage           | Phase to Neutral                                              | $t_2+3\text{ s to } t_2+10\text{ s}$ | [p.u.]     |
| 28                  |             | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,231      |
| 29                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,231      |
| 30                  |             | Response time active power                 | Positive sequence | -                                                             | [s]                                  | 0,254      |
| 31                  |             | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,025      |
| 32                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,026      |
| 33                  |             | Response time reactive power               | Positive sequence | –                                                             | [s]                                  | N/A        |



| 5.6.3 |    | Testing of the dynamic grid support                                  |   |                                       |   | P   |
|-------|----|----------------------------------------------------------------------|---|---------------------------------------|---|-----|
|       | 34 | EZE didn't disconnect from grid within 60s after fault ended yes/no? | — | t <sub>2</sub> to t <sub>2</sub> +60s | — | yes |

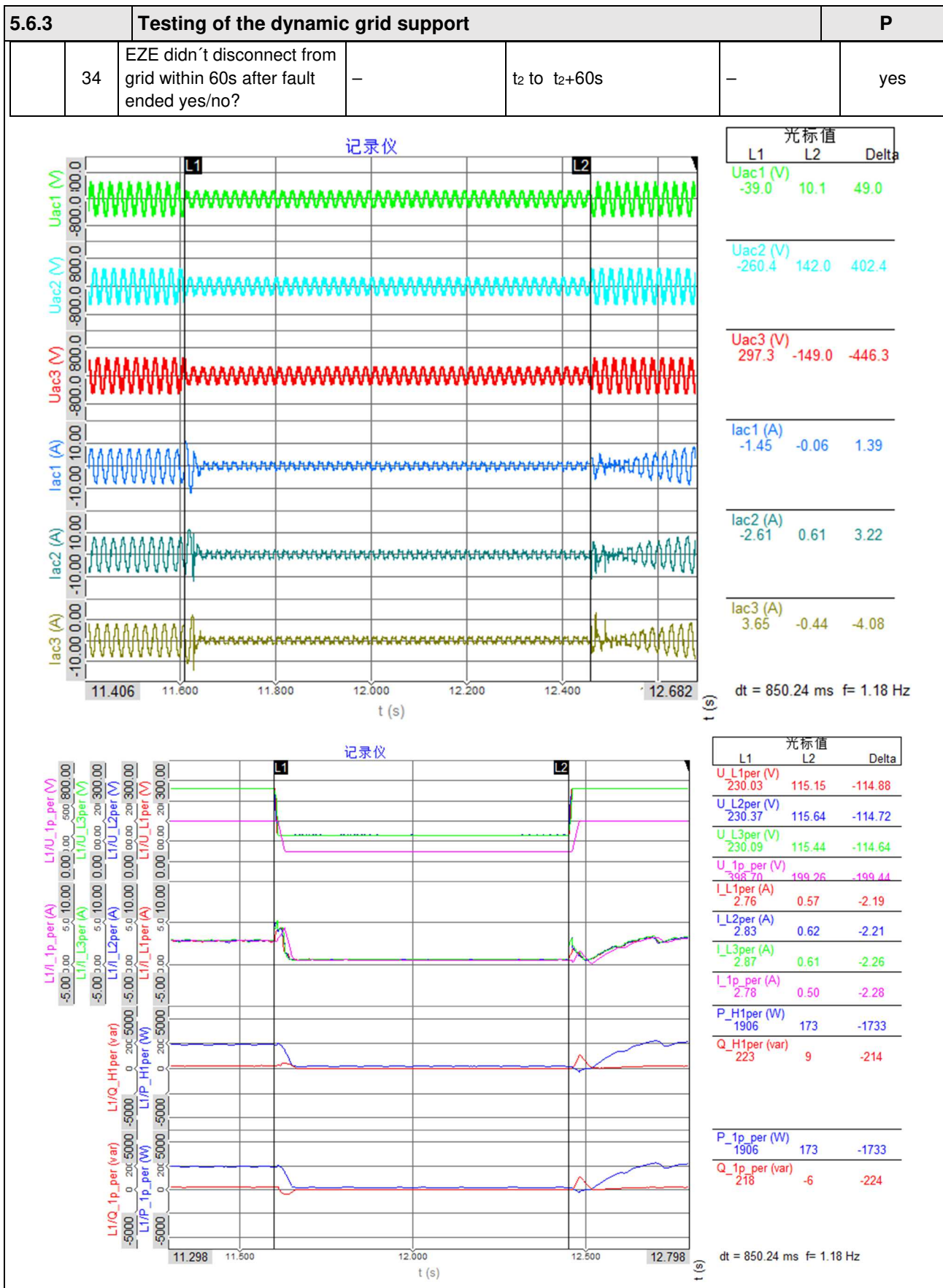


| 5.6.3               |     | Testing of the dynamic grid support        |                   |                                                               |              | P          |
|---------------------|-----|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------|------------|
| Load tests 2.1      |     |                                            |                   |                                                               |              |            |
|                     | No. | Parameter                                  | Phase reference   | Reference time                                                | Value (unit) | Value      |
| General information | 0   | Test no.                                   | –                 | –                                                             | –            | 2.1        |
|                     | 1   | Date                                       | –                 | –                                                             | [dd.mm.yyyy] | 29.03.2023 |
|                     | 2   | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f] | 15:12:29   |
|                     | 3   | Type of fault (number of affected phases)  | –                 | –                                                             | –            | A(3)       |
|                     | 4   | Drop depth setpoint                        | Phase             | –                                                             | [p.u]        | 0,5        |
|                     | 5   | Drop duration setpoint                     | Total             | –                                                             | [ms]         | 840        |
|                     | 6   | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]         | 10750      |
|                     | 7   | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]         | 11600      |
|                     | 8   | Fault duration determined from test        | Total             | –                                                             | [ms]         | 850        |
|                     | 9   | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]       | 0,500      |
|                     | 10  |                                            | Positive sequence |                                                               |              | 0,498      |
| Before $t_1$        | 11  | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]       | 1,004      |
|                     | 12  | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]       | 0,996      |
|                     | 13  | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,996      |
|                     | 14  |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,996      |
|                     | 15  | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,074      |
|                     | 16  |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,075      |
|                     | 17  | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,996      |
| $t_1$ till $t_2$    | 18  | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,501      |
|                     | 19  | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,041      |
|                     | 20  |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,041      |
|                     | 21  |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,040      |
|                     | 22  | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,041      |
|                     | 23  |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,043      |
|                     | 24  |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,039      |
|                     | 25  | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,018      |
|                     | 26  |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,018      |
| After $t_2$         | 27  | Voltage                                    | Phase to Neutral  | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 1,003      |
|                     | 28  | Active power                               | Positive sequence | $t_2+3\text{ s to } r_2+10\text{ s}$                          | [p.u.]       | 1,023      |
|                     | 29  |                                            | Total             | $t_2+3\text{ s to } r_2+10\text{ s}$                          | [p.u.]       | 1,023      |
|                     | 30  | Response time active power                 | Positive sequence | -                                                             | [s]          | 0,627      |
|                     | 31  | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,073      |
|                     | 32  |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,076      |
|                     | 33  | Response time reactive power               | Positive sequence | –                                                             | [s]          | N/A        |

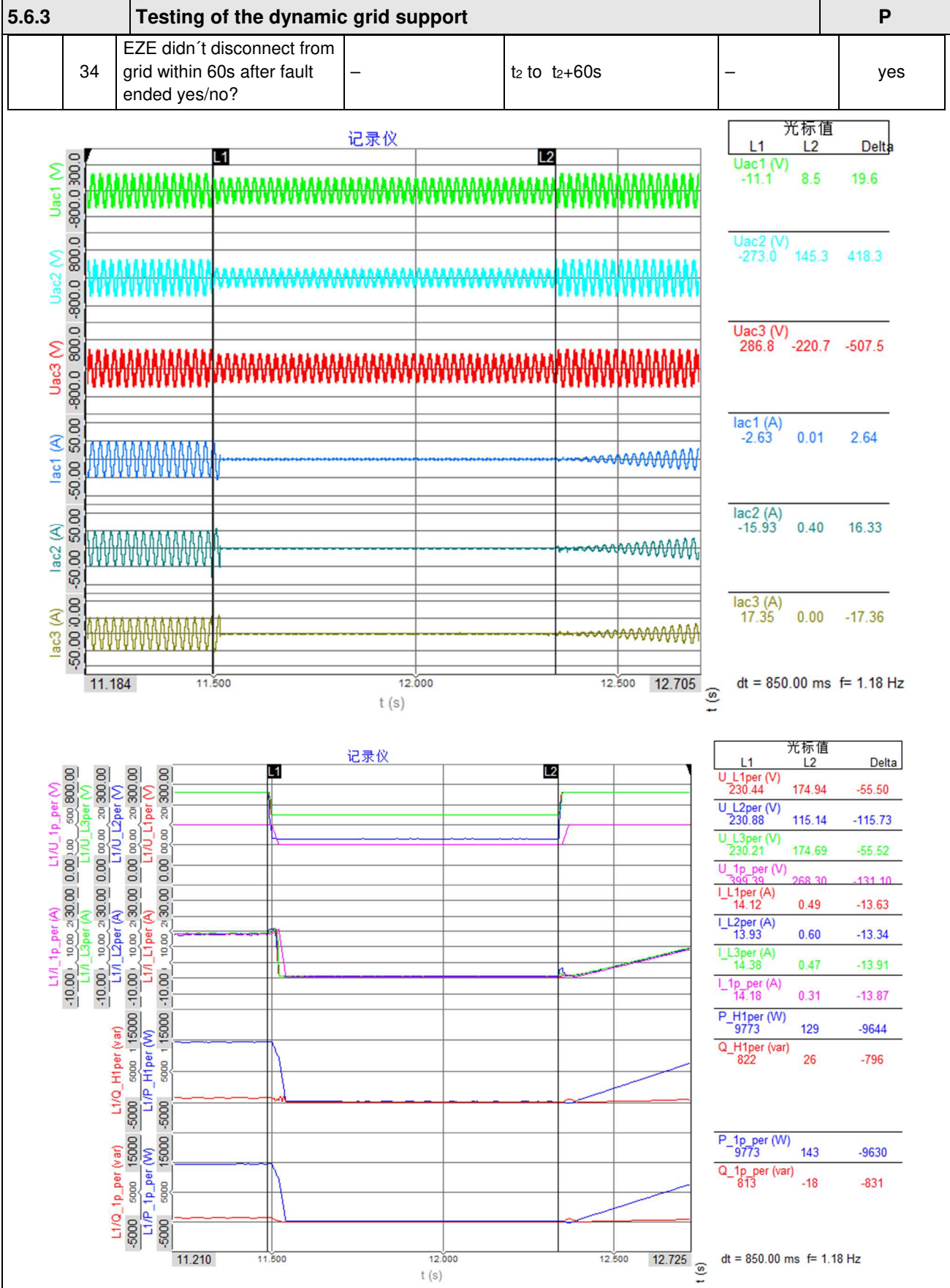


| 5.6.3                              |     | Testing of the dynamic grid support        |                   |                                                                                    |              | P          |
|------------------------------------|-----|--------------------------------------------|-------------------|------------------------------------------------------------------------------------|--------------|------------|
| Load tests 2.2                     |     |                                            |                   |                                                                                    |              |            |
|                                    | No. | Parameter                                  | Phase reference   | Reference time                                                                     | Value (unit) | Value      |
| General information                | 0   | Test no.                                   | –                 | –                                                                                  | –            | 2.2        |
|                                    | 1   | Date                                       | –                 | –                                                                                  | [dd.mm.yyyy] | 29.03.2023 |
|                                    | 2   | Time ( Start of test)                      | –                 | –                                                                                  | [hh:mm:ss.f] | 15:23:57   |
|                                    | 3   | Type of fault (number of affected phases)  | –                 | –                                                                                  | –            | A(3)       |
|                                    | 4   | Drop depth setpoint                        | Phase             | –                                                                                  | [p.u]        | 0,50       |
|                                    | 5   | Drop duration setpoint                     | Total             | –                                                                                  | [ms]         | 840        |
|                                    | 6   | Fault occurrence (r1)                      | Total             | –                                                                                  | [ms]         | 11600      |
|                                    | 7   | Fault clearance (r2)                       | Total             | –                                                                                  | [ms]         | 12450      |
|                                    | 8   | Fault duration determined from test        | Total             | –                                                                                  | [ms]         | 850        |
|                                    | 9   | Measeured value of voltage drop / increase | Total             | t <sub>1</sub> +100ms to t <sub>2</sub> and t <sub>1</sub> -10 s to t <sub>1</sub> | [p.u.]       | 0,500      |
|                                    | 10  |                                            | Positive sequence |                                                                                    |              | 0,498      |
| Before t <sub>1</sub>              | 11  | Voltage                                    | Phase to Neutral  | t <sub>1</sub> -10s to t <sub>1</sub>                                              | [p.u.]       | 1,002      |
|                                    | 12  | Current                                    | Positive sequence | t <sub>1</sub> -500 ms to t <sub>1</sub> -100 ms                                   | [p.u.]       | 0,197      |
|                                    | 13  | Active power                               | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,191      |
|                                    | 14  |                                            | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,191      |
|                                    | 15  | Reactive power                             | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,022      |
|                                    | 16  |                                            | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,022      |
|                                    | 17  | cos φ                                      | -                 | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,982      |
| t <sub>1</sub> till t <sub>2</sub> | 18  | Voltage                                    | Phase to Neutral  | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,501      |
|                                    | 19  | Phase current                              | Phase 1           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,040      |
|                                    | 20  |                                            | Phase 2           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,036      |
|                                    | 21  |                                            | Phase 3           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,035      |
|                                    | 22  | Phase current                              | Phase 1           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,046      |
|                                    | 23  |                                            | Phase 2           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,041      |
|                                    | 24  |                                            | Phase 3           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,038      |
|                                    | 25  | Active power                               | Total             | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,019      |
|                                    | 26  |                                            | Positive sequence | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,019      |
| After t <sub>2</sub>               | 27  | Voltage                                    | Phase to Neutral  | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 1,001      |
|                                    | 28  | Active power                               | Positive sequence | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]       | 0,203      |
|                                    | 29  |                                            | Total             | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]       | 0,203      |
|                                    | 30  | Response time active power                 | Positive sequence | -                                                                                  | [s]          | 0,231      |
|                                    | 31  | Reactive power                             | Positive sequence | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 0,023      |
|                                    | 32  |                                            | Total             | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 0,023      |
|                                    | 33  | Response time reactive power               | Positive sequence | –                                                                                  | [s]          | N/A        |





| 5.6.3                              |     | Testing of the dynamic grid support        |                   |                                                                                    |              | P          |
|------------------------------------|-----|--------------------------------------------|-------------------|------------------------------------------------------------------------------------|--------------|------------|
| Load tests 2.3                     |     |                                            |                   |                                                                                    |              |            |
|                                    | No. | Parameter                                  | Phase reference   | Reference time                                                                     | Value (unit) | Value      |
| General information                | 0   | Test no.                                   | –                 | –                                                                                  | –            | 2.3        |
|                                    | 1   | Date                                       | –                 | –                                                                                  | [dd.mm.yyyy] | 29.03.2023 |
|                                    | 2   | Time ( Start of test)                      | –                 | –                                                                                  | [hh:mm:ss.f] | 15:17:48   |
|                                    | 3   | Type of fault (number of affected phases)  | –                 | –                                                                                  | –            | D1(2)      |
|                                    | 4   | Drop depth setpoint                        | Phase             | –                                                                                  | [p.u]        | 0,50       |
|                                    | 5   | Drop duration setpoint                     | Total             | –                                                                                  | [ms]         | 840        |
|                                    | 6   | Fault occurrence (r1)                      | Total             | –                                                                                  | [ms]         | 11498      |
|                                    | 7   | Fault clearance (r2)                       | Total             | –                                                                                  | [ms]         | 12348      |
|                                    | 8   | Fault duration determined from test        | Total             | –                                                                                  | [ms]         | 850        |
|                                    | 9   | Measeured value of voltage drop / increase | Total             | t <sub>1</sub> +100ms to t <sub>2</sub> and t <sub>1</sub> -10 s to t <sub>1</sub> | [p.u.]       | 0,501      |
|                                    | 10  |                                            | Positive sequence |                                                                                    |              | 0,671      |
| Before t <sub>1</sub>              | 11  | Voltage                                    | Phase to Neutral  | t <sub>1</sub> -10s to t <sub>1</sub>                                              | [p.u.]       | 1,004      |
|                                    | 12  | Current                                    | Positive sequence | t <sub>1</sub> -500 ms to t <sub>1</sub> -100 ms                                   | [p.u.]       | 0,975      |
|                                    | 13  | Active power                               | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,977      |
|                                    | 14  |                                            | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,977      |
|                                    | 15  | Reactive power                             | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,081      |
|                                    | 16  |                                            | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,082      |
|                                    | 17  | cos φ                                      | -                 | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]       | 0,996      |
| t <sub>1</sub> till t <sub>2</sub> | 18  | Voltage                                    | Phase to Neutral  | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,501      |
|                                    | 19  | Phase current                              | Phase 1           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,039      |
|                                    | 20  |                                            | Phase 2           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,045      |
|                                    | 21  |                                            | Phase 3           | t <sub>1</sub> +60 ms                                                              | [p.u.]       | 0,036      |
|                                    | 22  | Phase current                              | Phase 1           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,036      |
|                                    | 23  |                                            | Phase 2           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,045      |
|                                    | 24  |                                            | Phase 3           | t <sub>1</sub> +100 ms                                                             | [p.u.]       | 0,035      |
|                                    | 25  | Active power                               | Total             | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,014      |
|                                    | 26  |                                            | Positive sequence | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]       | 0,016      |
| After t <sub>2</sub>               | 27  | Voltage                                    | Phase to Neutral  | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 1,003      |
|                                    | 28  | Active power                               | Positive sequence | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]       | 0,992      |
|                                    | 29  |                                            | Total             | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]       | 0,992      |
|                                    | 30  | Response time active power                 | Positive sequence | -                                                                                  | [s]          | 0,616      |
|                                    | 31  | Reactive power                             | Positive sequence | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 0,065      |
|                                    | 32  |                                            | Total             | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]       | 0,066      |
|                                    | 33  | Response time reactive power               | Positive sequence | –                                                                                  | [s]          | N/A        |

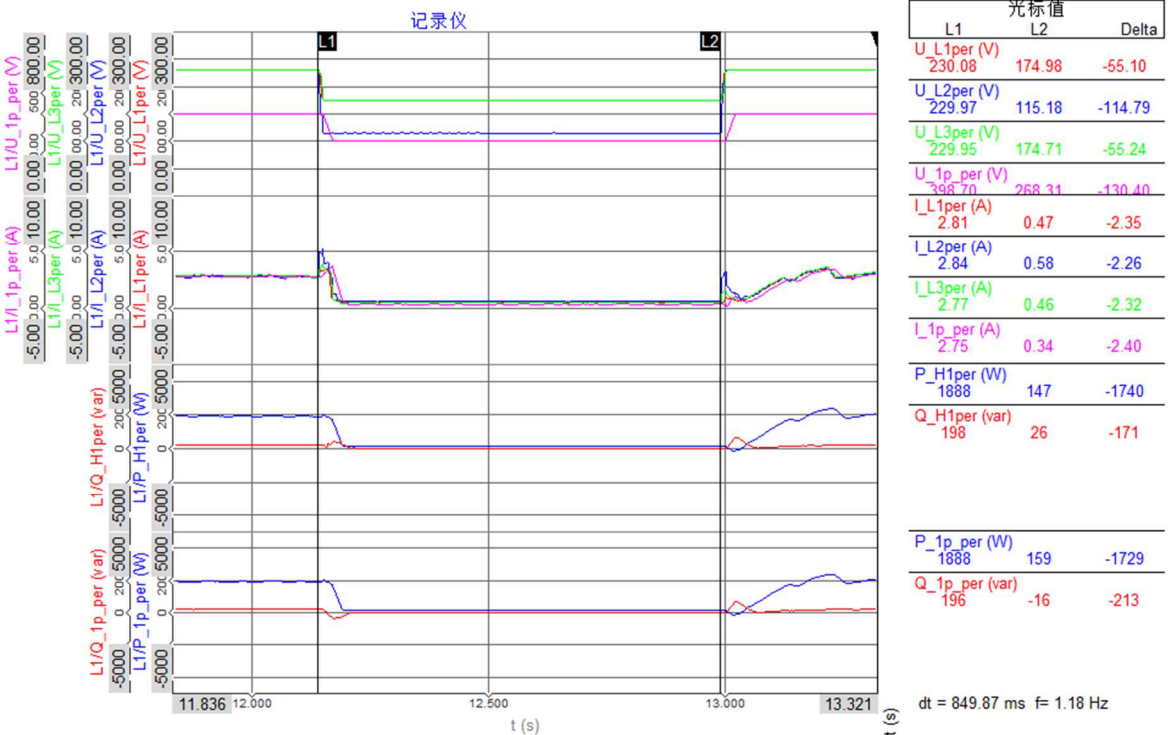
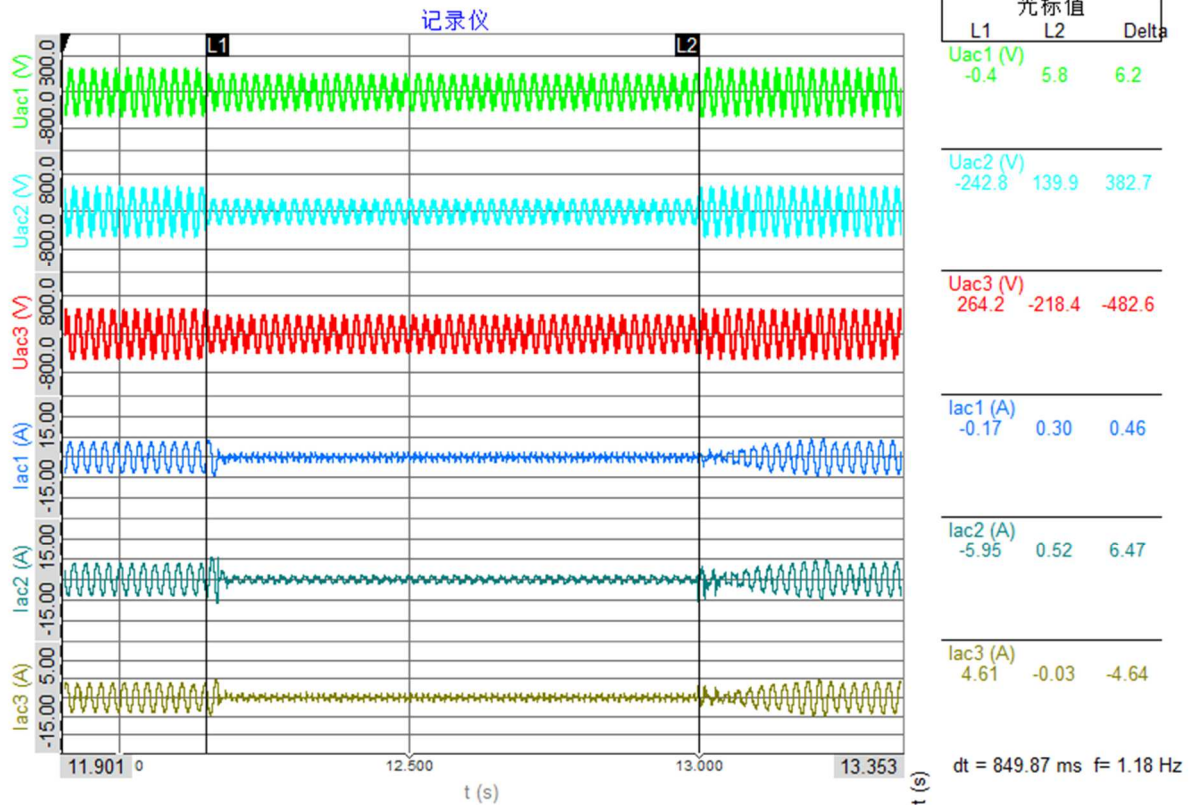


| 5.6.3                              |                      | Testing of the dynamic grid support        |                   |                                                                                    |                                             | P          |
|------------------------------------|----------------------|--------------------------------------------|-------------------|------------------------------------------------------------------------------------|---------------------------------------------|------------|
| Load tests 2.4                     |                      |                                            |                   |                                                                                    |                                             |            |
|                                    | No.                  | Parameter                                  | Phase reference   | Reference time                                                                     | Value (unit)                                | Value      |
| General information                | 0                    | Test no.                                   | –                 | –                                                                                  | –                                           | 2.4        |
|                                    | 1                    | Date                                       | –                 | –                                                                                  | [dd.mm.yyyy]                                | 29.03.2023 |
|                                    | 2                    | Time ( Start of test)                      | –                 | –                                                                                  | [hh:mm:ss.f]                                | 15:21:31   |
|                                    | 3                    | Type of fault (number of affected phases)  | –                 | –                                                                                  | –                                           | D1(2)      |
|                                    | 4                    | Drop depth setpoint                        | Phase             | –                                                                                  | [p.u]                                       | 0,5        |
|                                    | 5                    | Drop duration setpoint                     | Total             | –                                                                                  | [ms]                                        | 840        |
|                                    | 6                    | Fault occurrence (r1)                      | Total             | –                                                                                  | [ms]                                        | 12150      |
|                                    | 7                    | Fault clearance (r2)                       | Total             | –                                                                                  | [ms]                                        | 13000      |
|                                    | 8                    | Fault duration determined from test        | Total             | –                                                                                  | [ms]                                        | 850        |
|                                    | 9                    | Measeured value of voltage drop / increase | Total             | t <sub>1</sub> +100ms to t <sub>2</sub> and t <sub>1</sub> -10 s to t <sub>1</sub> | [p.u.]                                      | 0,501      |
|                                    | 10                   |                                            | Positive sequence |                                                                                    |                                             | 0,671      |
| Before t <sub>1</sub>              | 11                   | Voltage                                    | Phase to Neutral  | t <sub>1</sub> -10s to t <sub>1</sub>                                              | [p.u.]                                      | 1,002      |
|                                    | 12                   | Current                                    | Positive sequence | t <sub>1</sub> -500 ms to t <sub>1</sub> -100 ms                                   | [p.u.]                                      | 0,195      |
|                                    | 13                   | Active power                               | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]                                      | 0,189      |
|                                    | 14                   |                                            | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]                                      | 0,189      |
|                                    | 15                   | Reactive power                             | Positive sequence | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]                                      | 0,020      |
|                                    | 16                   |                                            | Total             | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]                                      | 0,020      |
|                                    | 17                   | cos φ                                      | -                 | t <sub>1</sub> -10 s to t <sub>1</sub>                                             | [p.u.]                                      | 0,982      |
| t <sub>1</sub> till t <sub>2</sub> | 18                   | Voltage                                    | Phase to Neutral  | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]                                      | 0,501      |
|                                    | 19                   | Phase current                              | Phase 1           | t <sub>1</sub> +60 ms                                                              | [p.u.]                                      | 0,034      |
|                                    | 20                   |                                            | Phase 2           | t <sub>1</sub> +60 ms                                                              | [p.u.]                                      | 0,041      |
|                                    | 21                   |                                            | Phase 3           | t <sub>1</sub> +60 ms                                                              | [p.u.]                                      | 0,030      |
|                                    | 22                   | Phase current                              | Phase 1           | t <sub>1</sub> +100 ms                                                             | [p.u.]                                      | 0,035      |
|                                    | 23                   |                                            | Phase 2           | t <sub>1</sub> +100 ms                                                             | [p.u.]                                      | 0,042      |
|                                    | 24                   |                                            | Phase 3           | t <sub>1</sub> +100 ms                                                             | [p.u.]                                      | 0,032      |
|                                    | 25                   | Active power                               | Total             | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]                                      | 0,014      |
|                                    | 26                   |                                            | Positive sequence | t <sub>1</sub> +100 ms to t <sub>2</sub> -20 ms                                    | [p.u.]                                      | 0,015      |
|                                    | After t <sub>2</sub> | 27                                         | Voltage           | Phase to Neutral                                                                   | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s | [p.u.]     |
| 28                                 |                      | Active power                               | Positive sequence | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]                                      | 0,204      |
| 29                                 |                      |                                            | Total             | t <sub>2</sub> +3 s to r2+10 s                                                     | [p.u.]                                      | 0,204      |
| 30                                 |                      | Response time active power                 | Positive sequence | -                                                                                  | [s]                                         | 0,187      |
| 31                                 |                      | Reactive power                             | Positive sequence | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]                                      | 0,022      |
| 32                                 |                      |                                            | Total             | t <sub>2</sub> +3 s to t <sub>2</sub> +10 s                                        | [p.u.]                                      | 0,023      |
| 33                                 |                      | Response time reactive power               | Positive sequence | –                                                                                  | [s]                                         | N/A        |

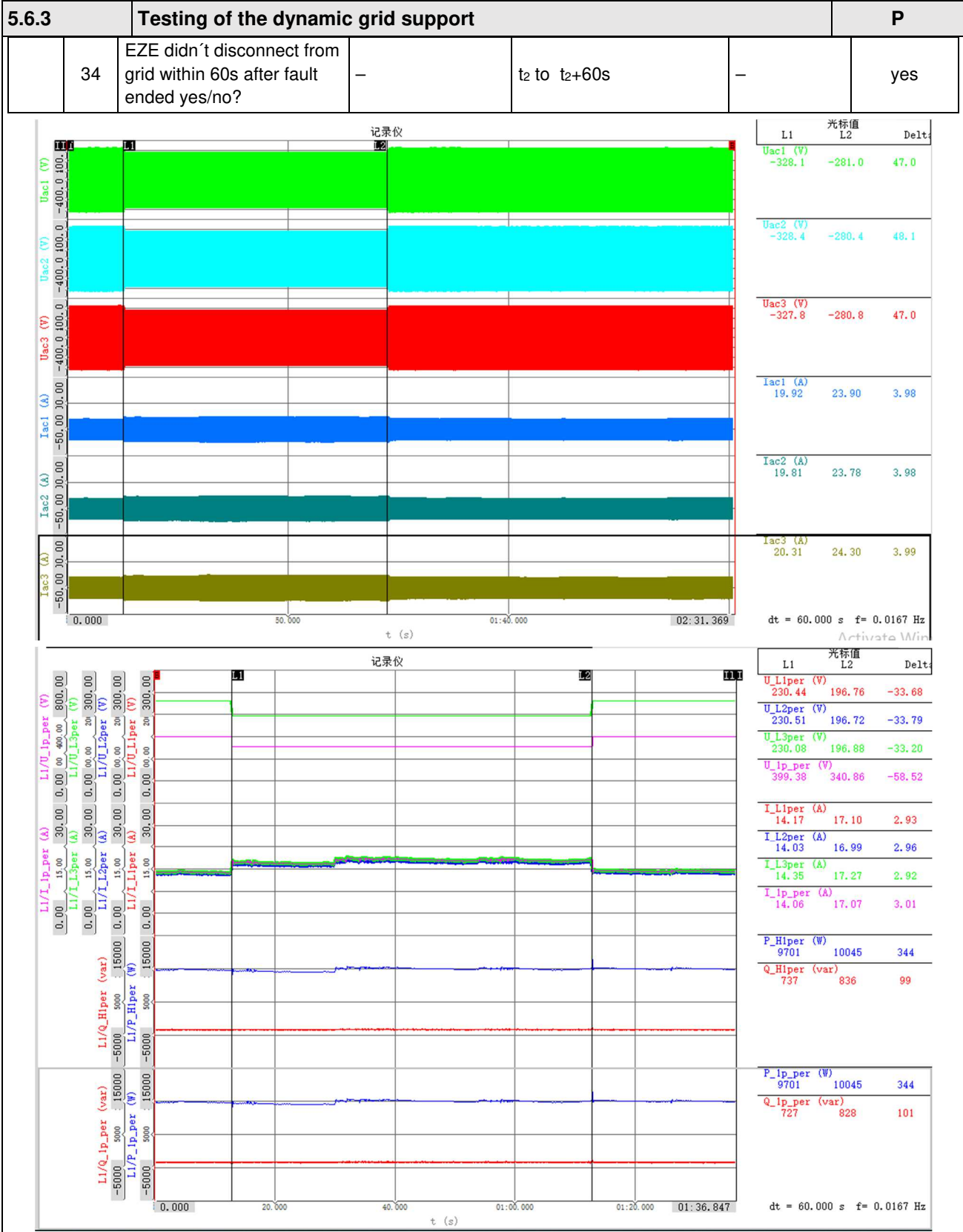


**5.6.3** **Testing of the dynamic grid support** **P**

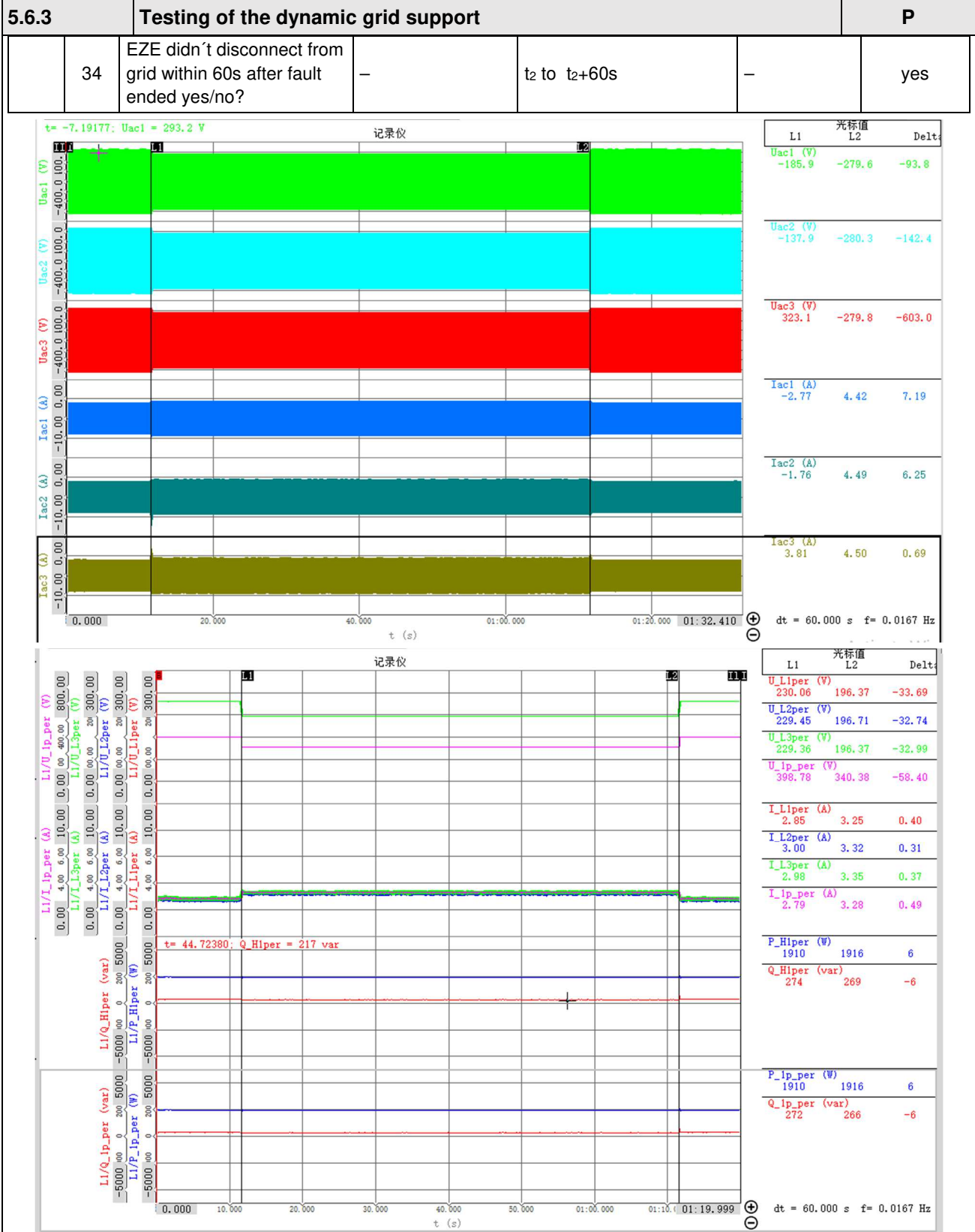
|    |                                                                      |   |                    |   |     |
|----|----------------------------------------------------------------------|---|--------------------|---|-----|
| 34 | EZE didn't disconnect from grid within 60s after fault ended yes/no? | — | $t_2$ to $t_2+60s$ | — | yes |
|----|----------------------------------------------------------------------|---|--------------------|---|-----|



| 5.6.3               |             | Testing of the dynamic grid support        |                   |                                                               |                                      | P          |
|---------------------|-------------|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------------------------------|------------|
| Load tests 3.1      |             |                                            |                   |                                                               |                                      |            |
|                     | No.         | Parameter                                  | Phase reference   | Reference time                                                | Value (unit)                         | Value      |
| General information | 0           | Test no.                                   | –                 | –                                                             | –                                    | 3.1        |
|                     | 1           | Date                                       | –                 | –                                                             | [dd.mm.yyyy]                         | 30.03.2023 |
|                     | 2           | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f]                         | 10:52:53   |
|                     | 3           | Type of fault (number of affected phases)  | –                 | –                                                             | –                                    | A(3)       |
|                     | 4           | Drop depth setpoint                        | Phase             | –                                                             | [p.u]                                | 0,85       |
|                     | 5           | Drop duration setpoint                     | Total             | –                                                             | [ms]                                 | 60000      |
|                     | 6           | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]                                 | 12000      |
|                     | 7           | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]                                 | 72000      |
|                     | 8           | Fault duration determined from test        | Total             | –                                                             | [ms]                                 | 60000      |
|                     | 9           | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]                               | 0,850      |
|                     | 10          |                                            | Positive sequence |                                                               |                                      | 0,847      |
| Before $t_1$        | 11          | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]                               | 1,002      |
|                     | 12          | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]                               | 0,972      |
|                     | 13          | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,974      |
|                     | 14          |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,974      |
|                     | 15          | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,076      |
|                     | 16          |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,075      |
|                     | 17          | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,996      |
| $t_1$ till $t_2$    | 18          | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,856      |
|                     | 19          | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 1,127      |
|                     | 20          |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 1,107      |
|                     | 21          |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 1,139      |
|                     | 22          | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 1,162      |
|                     | 23          |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 1,124      |
|                     | 24          |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 1,174      |
|                     | 25          | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,993      |
|                     | 26          |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,993      |
|                     | After $t_2$ | 27                                         | Voltage           | Phase to Neutral                                              | $t_2+3\text{ s to } t_2+10\text{ s}$ | [p.u.]     |
| 28                  |             | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,999      |
| 29                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,999      |
| 30                  |             | Response time active power                 | Positive sequence | -                                                             | [s]                                  | 0,308      |
| 31                  |             | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,085      |
| 32                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,086      |
| 33                  |             | Response time reactive power               | Positive sequence | –                                                             | [s]                                  | N/A        |

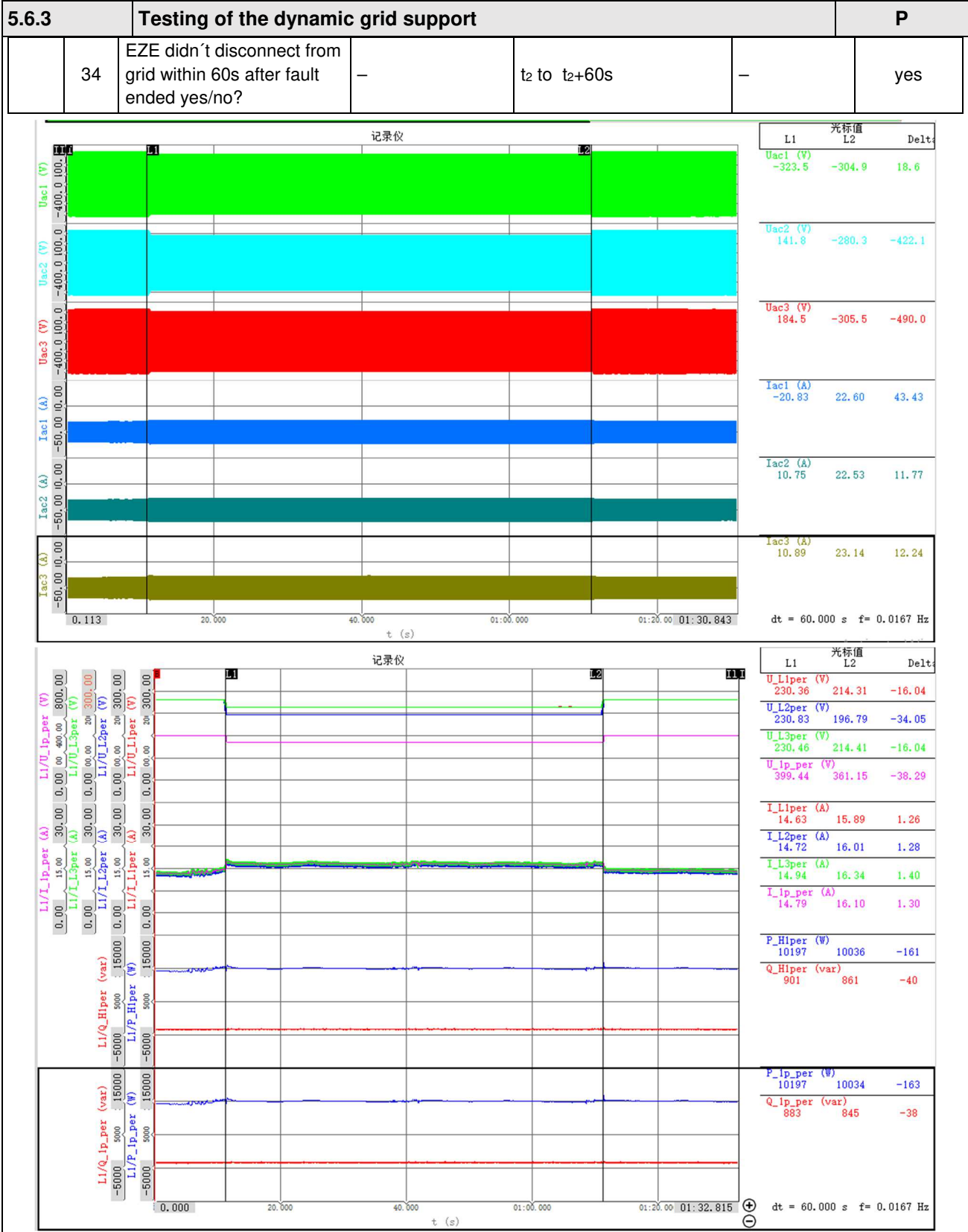


| 5.6.3               |             | Testing of the dynamic grid support        |                   |                                                               |                                      | P          |
|---------------------|-------------|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------------------------------|------------|
| Load tests 3.2      |             |                                            |                   |                                                               |                                      |            |
|                     | No.         | Parameter                                  | Phase reference   | Reference time                                                | Value (unit)                         | Value      |
| General information | 0           | Test no.                                   | –                 | –                                                             | –                                    | 3.2        |
|                     | 1           | Date                                       | –                 | –                                                             | [dd.mm.yyyy]                         | 30.03.2023 |
|                     | 2           | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f]                         | 9:32:20    |
|                     | 3           | Type of fault (number of affected phases)  | –                 | –                                                             | –                                    | A(3)       |
|                     | 4           | Drop depth setpoint                        | Phase             | –                                                             | [p.u]                                | 0,85       |
|                     | 5           | Drop duration setpoint                     | Total             | –                                                             | [ms]                                 | 60000      |
|                     | 6           | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]                                 | 11720      |
|                     | 7           | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]                                 | 71720      |
|                     | 8           | Fault duration determined from test        | Total             | –                                                             | [ms]                                 | 60000      |
|                     | 9           | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]                               | 0,850      |
|                     | 10          |                                            | Positive sequence |                                                               |                                      | 0,847      |
| Before $t_1$        | 11          | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]                               | 1,000      |
|                     | 12          | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]                               | 0,193      |
|                     | 13          | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,191      |
|                     | 14          |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,191      |
|                     | 15          | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,027      |
|                     | 16          |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,027      |
|                     | 17          | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]                               | 0,981      |
| $t_1$ till $t_2$    | 18          | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,854      |
|                     | 19          | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,226      |
|                     | 20          |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,227      |
|                     | 21          |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]                               | 0,232      |
|                     | 22          | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,230      |
|                     | 23          |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,230      |
|                     | 24          |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]                               | 0,233      |
|                     | 25          | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,192      |
|                     | 26          |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]                               | 0,192      |
|                     | After $t_2$ | 27                                         | Voltage           | Phase to Neutral                                              | $t_2+3\text{ s to } t_2+10\text{ s}$ | [p.u.]     |
| 28                  |             | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,193      |
| 29                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,193      |
| 30                  |             | Response time active power                 | Positive sequence | -                                                             | [s]                                  | 0,098      |
| 31                  |             | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,028      |
| 32                  |             |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]                               | 0,028      |
| 33                  |             | Response time reactive power               | Positive sequence | –                                                             | [s]                                  | N/A        |



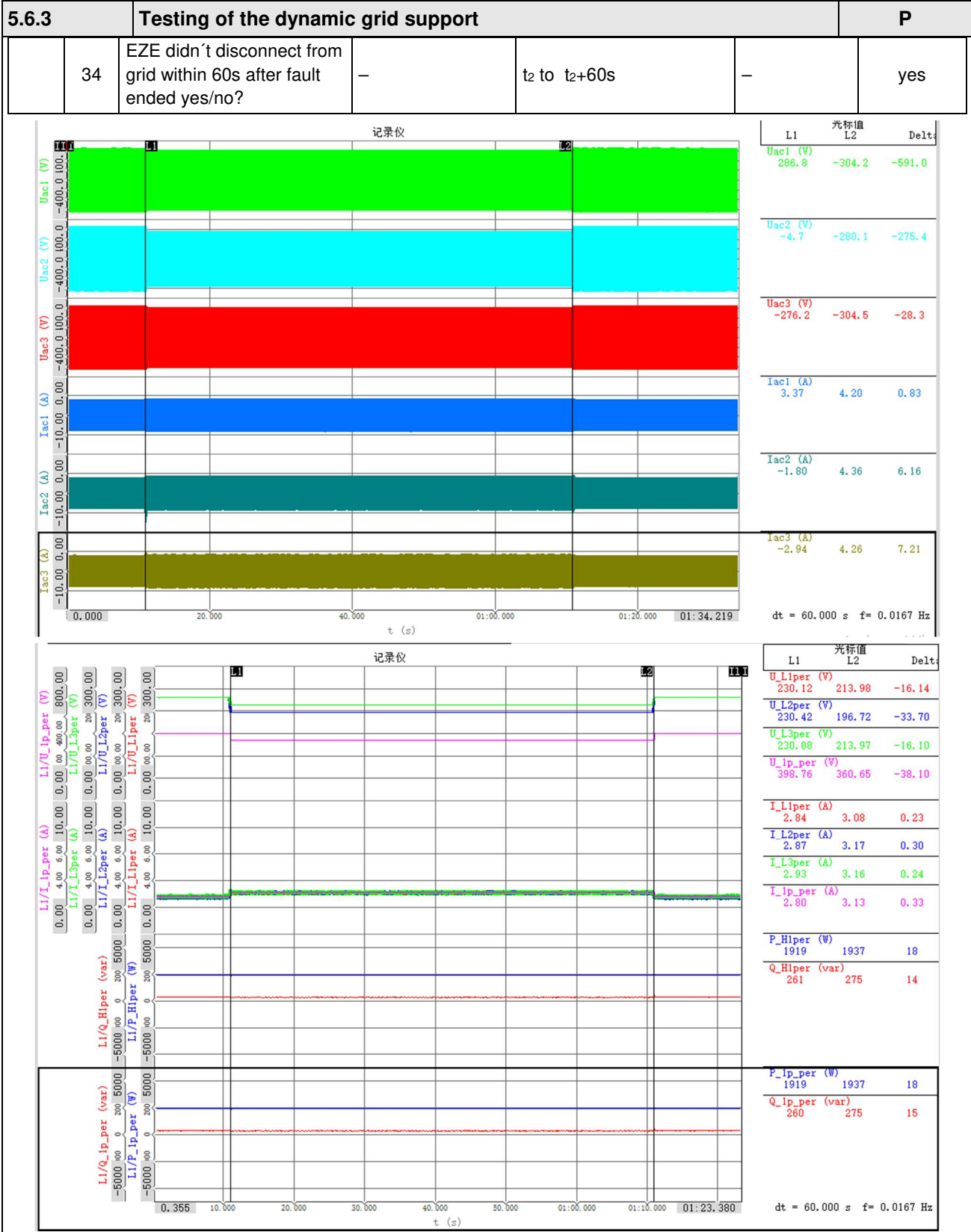
| 5.6.3               |     | Testing of the dynamic grid support        |                   |                                                               |              | P          |
|---------------------|-----|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------|------------|
| Load tests 3.3      |     |                                            |                   |                                                               |              |            |
|                     | No. | Parameter                                  | Phase reference   | Reference time                                                | Value (unit) | Value      |
| General information | 0   | Test no.                                   | –                 | –                                                             | –            | 3.3        |
|                     | 1   | Date                                       | –                 | –                                                             | [dd.mm.yyyy] | 20.03.2023 |
|                     | 2   | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f] | 10:49:20   |
|                     | 3   | Type of fault (number of affected phases)  | –                 | –                                                             | –            | D1(2)      |
|                     | 4   | Drop depth setpoint                        | Phase             | –                                                             | [p.u]        | 0,85       |
|                     | 5   | Drop duration setpoint                     | Total             | –                                                             | [ms]         | 60000      |
|                     | 6   | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]         | 11370      |
|                     | 7   | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]         | 71370      |
|                     | 8   | Fault duration determined from test        | Total             | –                                                             | [ms]         | 60000      |
|                     | 9   | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]       | 0,851      |
|                     | 10  |                                            | Positive sequence |                                                               |              | 0,900      |
| Before $t_1$        | 11  | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]       | 1,001      |
|                     | 12  | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]       | 1,025      |
|                     | 13  | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,988      |
|                     | 14  |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,988      |
|                     | 15  | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,086      |
|                     | 16  |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,087      |
|                     | 17  | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,996      |
| $t_1$ till $t_2$    | 18  | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,855      |
|                     | 19  | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]       | 1,132      |
|                     | 20  |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]       | 1,097      |
|                     | 21  |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]       | 1,136      |
|                     | 22  | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]       | 1,147      |
|                     | 23  |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]       | 1,147      |
|                     | 24  |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]       | 1,170      |
|                     | 25  | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 1,021      |
|                     | 26  |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 1,021      |
| After $t_2$         | 27  | Voltage                                    | Phase to Neutral  | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 1,002      |
|                     | 28  | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,999      |
|                     | 29  |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,999      |
|                     | 30  | Response time active power                 | Positive sequence | -                                                             | [s]          | 0,072      |
|                     | 31  | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,078      |
|                     | 32  |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,081      |
|                     | 33  | Response time reactive power               | Positive sequence | –                                                             | [s]          | N/A        |





| 5.6.3               |                   | Testing of the dynamic grid support        |                   |                                                               |              | P          |
|---------------------|-------------------|--------------------------------------------|-------------------|---------------------------------------------------------------|--------------|------------|
| Load tests 3.4      |                   |                                            |                   |                                                               |              |            |
|                     | No.               | Parameter                                  | Phase reference   | Reference time                                                | Value (unit) | Value      |
| General information | 0                 | Test no.                                   | –                 | –                                                             | –            | 3.4        |
|                     | 1                 | Date                                       | –                 | –                                                             | [dd.mm.yyyy] | 30.03.2023 |
|                     | 2                 | Time ( Start of test)                      | –                 | –                                                             | [hh:mm:ss.f] | 9:36:39    |
|                     | 3                 | Type of fault (number of affected phases)  | –                 | –                                                             | –            | D1(2)      |
|                     | 4                 | Drop depth setpoint                        | Phase             | –                                                             | [p.u]        | 0,85       |
|                     | 5                 | Drop duration setpoint                     | Total             | –                                                             | [ms]         | 60000      |
|                     | 6                 | Fault occurrence ( <i>r</i> 1)             | Total             | –                                                             | [ms]         | 10930      |
|                     | 7                 | Fault clearance ( <i>r</i> 2)              | Total             | –                                                             | [ms]         | 70930      |
|                     | 8                 | Fault duration determined from test        | Total             | –                                                             | [ms]         | 60000      |
|                     | 9                 | Measeured value of voltage drop / increase | Total             | $t_1+100\text{ms to } t_2\text{and } t_1-10\text{ s to } t_1$ | [p.u.]       | 0,851      |
| 10                  | Positive sequence |                                            | 0,900             |                                                               |              |            |
| Before $t_1$        | 11                | Voltage                                    | Phase to Neutral  | $t_1-10\text{s to } t_1$                                      | [p.u.]       | 1,000      |
|                     | 12                | Current                                    | Positive sequence | $t_1-500\text{ ms to } t_1-100\text{ ms}$                     | [p.u.]       | 0,193      |
|                     | 13                | Active power                               | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,189      |
|                     | 14                |                                            | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,189      |
|                     | 15                | Reactive power                             | Positive sequence | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,025      |
|                     | 16                |                                            | Total             | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,025      |
|                     | 17                | $\cos \varphi$                             | -                 | $t_1-10\text{ s to } t_1$                                     | [p.u.]       | 0,982      |
| $t_1$ till $t_2$    | 18                | Voltage                                    | Phase to Neutral  | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,855      |
|                     | 19                | Phase current                              | Phase 1           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,210      |
|                     | 20                |                                            | Phase 2           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,217      |
|                     | 21                |                                            | Phase 3           | $t_1+60\text{ ms}$                                            | [p.u.]       | 0,217      |
|                     | 22                | Phase current                              | Phase 1           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,210      |
|                     | 23                |                                            | Phase 2           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,222      |
|                     | 24                |                                            | Phase 3           | $t_1+100\text{ ms}$                                           | [p.u.]       | 0,220      |
|                     | 25                | Active power                               | Total             | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,192      |
|                     | 26                |                                            | Positive sequence | $t_1+100\text{ ms to } t_2-20\text{ ms}$                      | [p.u.]       | 0,192      |
| After $t_2$         | 27                | Voltage                                    | Phase to Neutral  | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 1,000      |
|                     | 28                | Active power                               | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,193      |
|                     | 29                |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,193      |
|                     | 30                | Response time active power                 | Positive sequence | -                                                             | [s]          | 0,098      |
|                     | 31                | Reactive power                             | Positive sequence | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,028      |
|                     | 32                |                                            | Total             | $t_2+3\text{ s to } t_2+10\text{ s}$                          | [p.u.]       | 0,029      |
|                     | 33                | Response time reactive power               | Positive sequence | –                                                             | [s]          | N/A        |

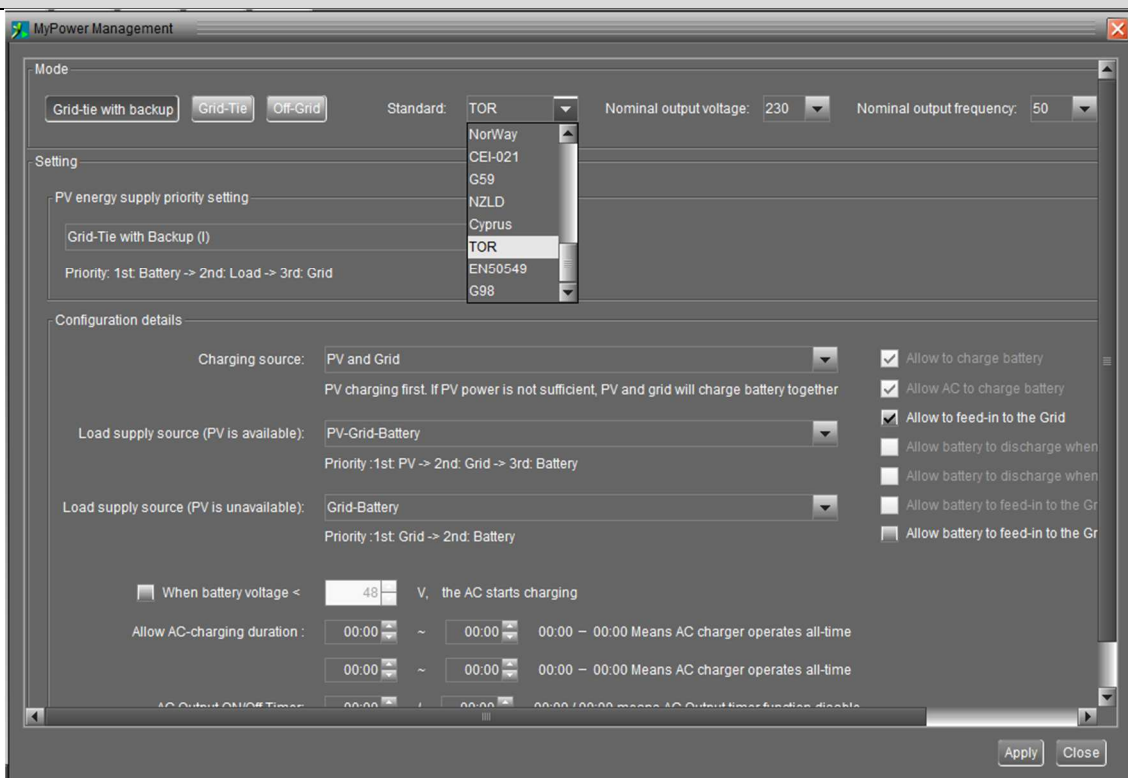




# **Annex No. 1**

## **Deviation Parameter of the Austria**

### Country selection



**MyPower Management**

**Mode**

Grid-tie with backup | Grid-Tie | Off-Grid

Standard: TOR

Nominal output voltage: 230

Nominal output frequency: 50

**Setting**

PV energy supply priority setting

Grid-Tie with Backup (I)

Priority: 1st: Battery -> 2nd: Load -> 3rd: Grid

**Configuration details**

Charging source: PV and Grid

PV charging first. If PV power is not sufficient, PV and grid will charge battery together

Load supply source (PV is available): PV-Grid-Battery

Priority: 1st: PV -> 2nd: Grid -> 3rd: Battery

Load supply source (PV is unavailable): Grid-Battery

Priority: 1st: Grid -> 2nd: Battery

When battery voltage < 48 V, the AC starts charging

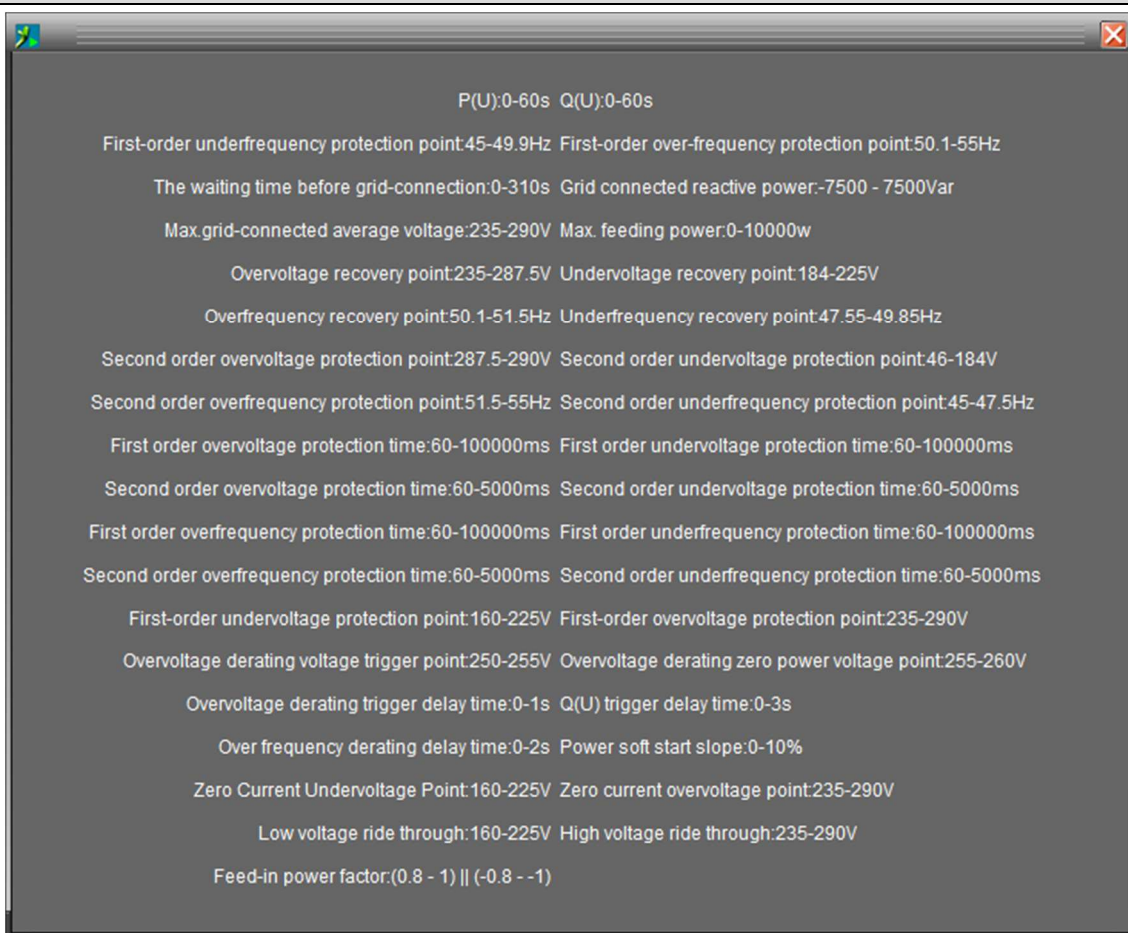
Allow AC-charging duration: 00:00 ~ 00:00 00:00 - 00:00 Means AC charger operates all-time

00:00 ~ 00:00 00:00 - 00:00 Means AC charger operates all-time

AC Output ON/OFF Time: 00:00 ~ 00:00 00:00 - 00:00 means AC Output time function disable

Apply Close

### Parameters setting range



P(U):0-60s Q(U):0-60s

First-order underfrequency protection point:45-49.9Hz First-order over-frequency protection point:50.1-55Hz

The waiting time before grid-connection:0-310s Grid connected reactive power:-7500 - 7500Var

Max.grid-connected average voltage:235-290V Max. feeding power:0-10000w

Overvoltage recovery point:235-287.5V Undervoltage recovery point:184-225V

Overfrequency recovery point:50.1-51.5Hz Underfrequency recovery point:47.55-49.85Hz

Second order overvoltage protection point:287.5-290V Second order undervoltage protection point:46-184V

Second order overfrequency protection point:51.5-55Hz Second order underfrequency protection point:45-47.5Hz

First order overvoltage protection time:60-100000ms First order undervoltage protection time:60-100000ms

Second order overvoltage protection time:60-5000ms Second order undervoltage protection time:60-5000ms

First order overfrequency protection time:60-100000ms First order underfrequency protection time:60-100000ms

Second order overfrequency protection time:60-5000ms Second order underfrequency protection time:60-5000ms

First-order undervoltage protection point:160-225V First-order overvoltage protection point:235-290V

Overvoltage derating voltage trigger point:250-255V Overvoltage derating zero power voltage point:255-260V

Overvoltage derating trigger delay time:0-1s Q(U) trigger delay time:0-3s

Over frequency derating delay time:0-2s Power soft start slope:0-10%

Zero Current Undervoltage Point:160-225V Zero current overvoltage point:235-290V

Low voltage ride through:160-225V High voltage ride through:235-290V

Feed-in power factor:(0.8 - 1) || (-0.8 - -1)

## Parameters setting

Parameters setting 2

|                                                                                           |                                                                                   |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| First-order undervoltage protection point: 184 V <input type="button" value="Apply"/>     | Grid connected reactive power: 0 Var <input type="button" value="Apply"/>         |
| First-order overvoltage protection point: 264.5 V <input type="button" value="Apply"/>    | Max. grid-connected average voltage: 255.3 V <input type="button" value="Apply"/> |
| First-order underfrequency protection point: 47.5 Hz <input type="button" value="Apply"/> | Max. feed-in grid power: 10,000 W <input type="button" value="Apply"/>            |
| First-order over-frequency protection point: 51.5 Hz <input type="button" value="Apply"/> | Feed-in power factor: 1 <input type="button" value="Apply"/>                      |
| The waiting time before grid-connection: 300 Sec. <input type="button" value="Apply"/>    |                                                                                   |

|                                                                                            |                                                                                             |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Overvoltage recovery point: 250.7 V <input type="button" value="Apply"/>                   | Second order overfrequency protection time: 100 ms <input type="button" value="Apply"/>     |
| Undervoltage recovery point: 195.5 V <input type="button" value="Apply"/>                  | Second order underfrequency protection time: 100 ms <input type="button" value="Apply"/>    |
| Overfrequency recovery point: 50.1 Hz <input type="button" value="Apply"/>                 | LongTimeOvervoltageProtection: 10 min <input type="button" value="Apply"/>                  |
| Underfrequency recovery point: 47.5 Hz <input type="button" value="Apply"/>                | Q(U): 5 s <input type="button" value="Apply"/>                                              |
| Second order overvoltage protection point: 264.5 V <input type="button" value="Apply"/>    | P(U): 5 s <input type="button" value="Apply"/>                                              |
| Second order undervoltage protection point: 57.5 V <input type="button" value="Apply"/>    | Low voltage ride through voltage: 195.5 V <input type="button" value="Apply"/>              |
| Second order overfrequency protection point: 51.5 Hz <input type="button" value="Apply"/>  | High voltage ride through voltage: 253 V <input type="button" value="Apply"/>               |
| Second order underfrequency protection point: 47.5 Hz <input type="button" value="Apply"/> | Low pressure crossing time: 1.5 s <input type="button" value="Apply"/>                      |
| First order overvoltage protection time: 100 ms <input type="button" value="Apply"/>       | High voltage crossing time: 1.5 s <input type="button" value="Apply"/>                      |
| First order undervoltage protection time: 1,500 ms <input type="button" value="Apply"/>    | Overvoltage derating voltage trigger point: 253 V <input type="button" value="Apply"/>      |
| Second order overvoltage protection time: 100 ms <input type="button" value="Apply"/>      | Overvoltage derating zero power voltage point: 257.6 V <input type="button" value="Apply"/> |
| Second order undervoltage protection time: 500 ms <input type="button" value="Apply"/>     | Overvoltage derating trigger delay time: 0 s <input type="button" value="Apply"/>           |
| First order overfrequency protection time: 100 ms <input type="button" value="Apply"/>     | Q(U) trigger delay time: 0 s <input type="button" value="Apply"/>                           |
| First order underfrequency protection time: 100 ms <input type="button" value="Apply"/>    | Power soft start slope: 9 % <input type="button" value="Apply"/>                            |

|                                                                                                                                        |                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Over voltage derating: <input type="radio"/> Enable <input checked="" type="radio"/> Disable <input type="button" value="Apply"/>      | High voltage ride through: <input type="radio"/> Enable <input checked="" type="radio"/> Disable <input type="button" value="Apply"/> |
| Under frequency drop power: <input type="radio"/> Enable <input checked="" type="radio"/> Disable <input type="button" value="Apply"/> | AC charging soft start: <input type="radio"/> Enable <input checked="" type="radio"/> Disable <input type="button" value="Apply"/>    |
| Low voltage ride through: <input checked="" type="radio"/> Enable <input type="radio"/> Disable <input type="button" value="Apply"/>   |                                                                                                                                       |

Over frequency derating: ☒ Enable ☐ Disable

|                                 |                          |
|---------------------------------|--------------------------|
| Drop rated power point: 50.2 Hz | Trigger delay time: 0 ms |
| Drop rated power slope: 40 %    |                          |

Reactive power automatic control enable: ☒ Enable ☐ Disable

|                                            |                                     |
|--------------------------------------------|-------------------------------------|
| Maximum reactive power response: 4.843 Var | Reduce rated power point 3: 241.5 V |
| Reduce rated power point 1: 211.6 V        | Reduce rated power point 4: 248.4 V |
| Reduce rated power point 2: 220.8 V        |                                     |

Auto-adjustable PF value with power

|                                                          |                                                                                                            |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Auto-adjustment starts when power rate reaches 50 %      | <input type="radio"/> Enable <input checked="" type="radio"/> Disable <input type="button" value="Apply"/> |
| Minimum PF value when power percentage reaches 100% -0.9 |                                                                                                            |

Parameters setting

|                                                             |         |      |       |                                                               |       |    |       |
|-------------------------------------------------------------|---------|------|-------|---------------------------------------------------------------|-------|----|-------|
| Min. PV input voltage:                                      | 300     | V    | Apply | Battery re-discharging voltage when Grid is available:        | 54    | V  | Apply |
| Max. PV input voltage:                                      | 900     | V    | Apply | Battery cut-off discharging voltage when grid is unavailable: | 42    | V  | Apply |
| Min. MPP voltage:                                           | 400     | V    | Apply | Battery re-discharging voltage when Grid is unavailable:      | 48    | V  | Apply |
| Max. MPP voltage:                                           | 800     | V    | Apply | Battery temperature compensation:                             | 0     | mV | Apply |
| Max. charging current:                                      | 200     | A    | Apply | Max. battery discharge current in hybrid mode:                | 275   | A  | Apply |
| Max. AC charging current:                                   | 60      | A    | Apply | Feeding grid power calibration R:                             | 0     | W  | Apply |
| Bulk charging voltage(C.V. voltage):                        | 56      | V    | Apply | Feeding grid power calibration S:                             | 0     | W  | Apply |
| Floating charging voltage:                                  | 54      | V    | Apply | Feeding grid power calibration T:                             | 0     | W  | Apply |
| Battery cut-off discharging voltage when grid is available: | 48      | V    | Apply | Zero Current Undervoltage Point:                              | 184   | V  | Apply |
| Start LCD screen-saver after:                               | 60      | Sec. | Apply | Zero current overvoltage point:                               | 264.5 | V  | Apply |
| Generator port:                                             | disable |      | Apply |                                                               |       |    |       |
| External CT Relay:                                          | disable |      | Apply |                                                               |       |    |       |

|                                             |                                                                       |       |                                                |                                                                       |       |
|---------------------------------------------|-----------------------------------------------------------------------|-------|------------------------------------------------|-----------------------------------------------------------------------|-------|
| Mute buzzer alarm:                          | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply | Zero current ride through mode:                | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply |
| Mute the buzzer in the Standby mode:        | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply | Parallel for output:                           | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply |
| Mute alarm in battery mode:                 | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply | Output Neutral line grounding in battery mode: | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply |
| Activate Li-Fe battery while commissioning: | <input type="radio"/> Yes <input checked="" type="radio"/> No         | Apply | BMS battery connect:                           | <input checked="" type="radio"/> Enable <input type="radio"/> Disable | Apply |
| Generator as AC source:                     | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply |                                                |                                                                       |       |

|                                             |                                                                       |       |                                                |                                                                       |       |
|---------------------------------------------|-----------------------------------------------------------------------|-------|------------------------------------------------|-----------------------------------------------------------------------|-------|
| Mute alarm in battery mode:                 | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply | Output Neutral line grounding in battery mode: | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply |
| Activate Li-Fe battery while commissioning: | <input type="radio"/> Yes <input checked="" type="radio"/> No         | Apply | BMS battery connect:                           | <input checked="" type="radio"/> Enable <input type="radio"/> Disable | Apply |
| Generator as AC source:                     | <input type="radio"/> Enable <input checked="" type="radio"/> Disable | Apply |                                                |                                                                       |       |

Battery equalization: ☐ Enable ☒ Disable

|                       |      |     |                       |     |        |
|-----------------------|------|-----|-----------------------|-----|--------|
| Equalization voltage: | 58.4 | V   | Equalization timeout: | 120 | Min    |
| Equalization time:    | 60   | Min | Equalization period:  | 30  | Day(s) |

Apply

Real-time activate battery equalization: ☐ Activate ☒ Cancel Apply

When float charging current is less than X (A) and continued T (Min), then charger off; when battery voltage is less than Y (V), then charger on again.

|    |   |   |    |    |      |    |    |   |       |
|----|---|---|----|----|------|----|----|---|-------|
| X: | 0 | A | T: | 60 | Min. | Y: | 53 | V | Apply |
|----|---|---|----|----|------|----|----|---|-------|

Any schedule change will affect the power generated and shall be conservatively made.

System time: 2023-05-09 18:57:10 Apply

Note:

1. The waiting time before grid-connection is apply to start-up and reconnection both. The default setting is 300s.
2. The Q(U) setting is the PT1 (Tau) parameter for Q(U) function.
3. The P(U) setting is the PT1 (Tau) parameter for P(U) function.
4. The Max grid-connected average voltage is the 10 min moving average overvoltage protection value.

## **Annex No. 2**

### **Pictures of the unit**



### Enclosure front



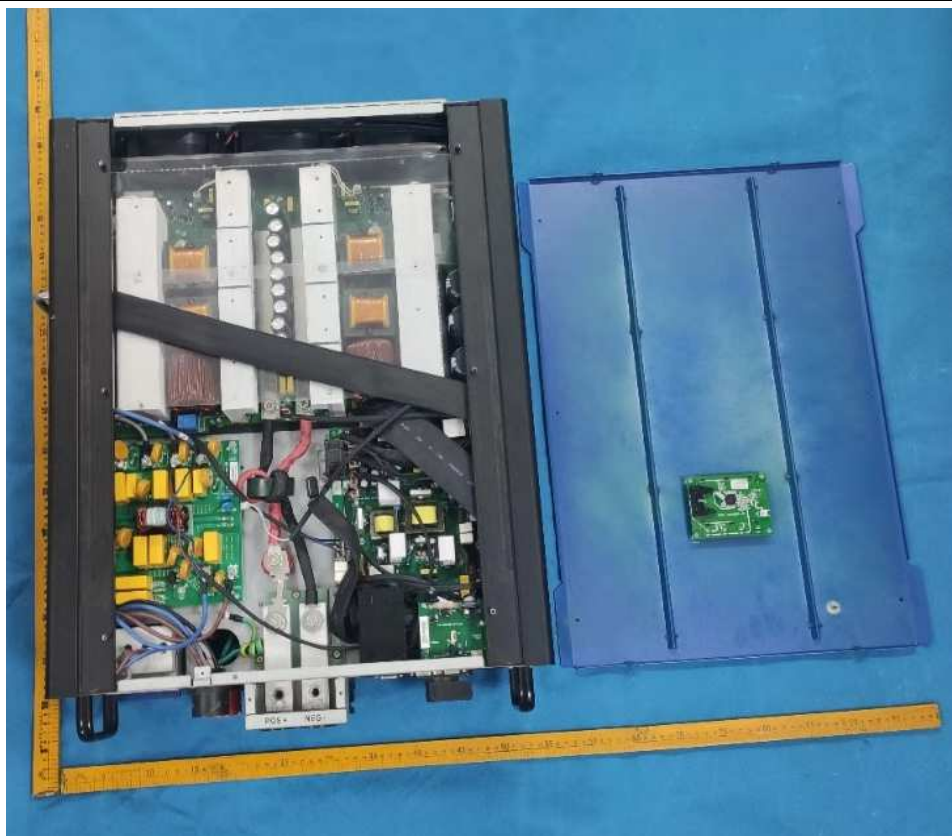
### Enclosure rear view



## Enclosure Bottom view



## Internal view:





## Annex No. 3

# Test Equipment list

**Testing Location:** Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch

**Date(s) of performance test:** 2020-01-19 to 2020-09-10

| Equipment                                   | Internal No. | Manufacturer | Type         | Serial No.    | Last Calibration            |
|---------------------------------------------|--------------|--------------|--------------|---------------|-----------------------------|
| Power Analyzer                              | A4080002DG   | YOKOGAWA     | WT3000       | 91M210852     | Sep. 12, 2019               |
| AC Source                                   | A7040019DG   | Chroma       | 61512        | 61512000439   | Monitored by Power Analyzer |
| AC Source                                   | A7040020DG   | Chroma       | 61512        | 61512000438   |                             |
| DC Simulation Power Supply                  | A7040016DG   | Chroma       | 62150H-1000S | 62150EF00490  |                             |
| DC Simulation Power Supply                  | A7040017DG   | Chroma       | 620028       | 620028EF00120 |                             |
| RLC Load                                    | A7150027DG   | Qunling      | ACLT-3803H   | 93VOO2869     |                             |
| Eight Channel Digital Phosphor Oscilloscope | A4089017DG   | YOKOGAWA     | DL850        | 91N726247     | Sep. 24, 2019               |
| Oscilloscope probel                         | A1490008DG   | YOKOGAWA     | 701901       | //            | Sep. 20, 2019               |
| Oscilloscope probel                         | A1490009DG   | YOKOGAWA     | 701901       | //            | Sep. 20, 2019               |
| Oscilloscope probel                         | A1490010DG   | YOKOGAWA     | 701901       | //            | Sep. 20, 2019               |
| Current transducer                          | A1060007DG   | YOKOGAWA     | CT200        | 1130700012    | Sep. 12, 2019               |
| Current transducer                          | A1060008DG   | YOKOGAWA     | CT200        | 1130700017    | Sep. 12, 2019               |
| Current transducer                          | A1060009DG   | YOKOGAWA     | CT200        | 1130700019    | Sep. 12, 2019               |

**Testing Location:** Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch

**Date(s) of performance test:** 2023-03-27 to 2023-04-11

| Equipment                  | Internal No. | Manufacturer | Type                 | Serial No.    | Next Calibration            |
|----------------------------|--------------|--------------|----------------------|---------------|-----------------------------|
| Power Analyzer             | A4080002DG   | YOKOGAWA     | WT3000               | 91M210852     | Aug. 28, 2023               |
| Power Analyzer             | A4080004DG   | DEWESoft     | SIRIUSi-HS-4xHV-4xLV | DB19104221    | Jul. 14, 2023               |
| AC Source                  | A7040043DG   | Chroma       | 61845                | 618453800209  | Monitored by Power Analyzer |
| DC Simulation Power Supply | A7040015DG   | Chroma       | 62150H-1000S         | 62150EF00488  |                             |
|                            | A7040016DG   | Chroma       | 62150H-1000S         | 62150EF00490  |                             |
|                            | A7040017DG   | Chroma       | 620028               | 620028EF00120 |                             |
|                            | A7040021DG   | Chroma       | 62150H-1000S         | 62150EF00609  |                             |
|                            | A7040022DG   | Chroma       | 62150H-1000S         | 62150EF00595  |                             |
| RLC Load                   | A7150027DG   | Qunling      | ACLT-3803H           | 93VOO2869     |                             |
| Current transducer         | A1060008DG   | YOKOGAWA     | CT200                | 1130700017    | Jul. 19,2023                |
|                            | A1060009DG   | YOKOGAWA     | CT200                | 1130700019    | Jul. 19,2023                |
|                            | A1060010DG   | YOKOGAWA     | CT200                | 1130700016    | Jul. 19,2023                |
|                            | A1060012DG   | YOKOGAWA     | CT200                | 1130700018    | Jul. 19,2023                |
| Temp. & Humi. Recorder     | A7440033DG   | HUATO        | S580-TH              | HT20103923    | Jan. 31, 2024               |

--End of Test Report--