

EXTRACT FROM REPORT N. 2220 / 0183 – E2 – TG3

REFERENCE STANDARD

FGW TG3: DETERMINATION OF THE ELECTRICAL CHARACTERISTICS OF POWER GENERATING UNITS AND SYSTEMS, STORAGE SYSTEMS AS WELL FOR THEIR COMPONENTS IN MV, HV AND EHV GRIDS.

(REV. 25 DATED ON 01/09/2018 + SUPPLEMENT 1 DATED ON 22/01/2019)

Reference Test Report Number.....: **2220 / 0183 – E2 – TG3 (Extract from test results) [*]**

[] This extract from test results cancels and supersedes the document no. 2220 / 0183 – E1 – TG3 (Extract from test results). See Test Report Historical revision table on page 2.*

Product Type: **3 Phase Grid Connected PV Inverter**

Tested Model.....: **SUNNY TRIPOWER STP 50-40**

Variant Models: **SUNNY TRIPOWER STP 50-41**

APPLICANT

Name.....: **SMA SOLAR TECHNOLOGY AG**

Address: **Sonnenallee 1, 34266 Niestetal (Germany)**

TESTING LABORATORY

Name.....: **SGS Tecnos, S.A. (Electrical Testing Laboratory)**

Address: **C/ Trespaderne, 29 - Edificio Barajas 1
28042 Madrid (Spain)**

Conducted (tested) by.....: **Miguel Rodriguez
(Project Engineer)**



Reviewed and Approved by: **Omar Kalim
(Technical Reviewer)**

Date of issue: **07/06/2021**

Number of pages.....: **30**

Important Note:

- This document is issued by the Company under its General Conditions of service accessible at http://www.sgs.com/terms_and_conditions.htm. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.
- This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.
- Unless otherwise stated the results shown in this test report refer only to the sample(s) tested as received. **Information of derived or extension models of the range as provided by the applicant, (if any), is included in this report only for informative purposes.** The Company SGS shall not be liable for any incorrect results arising from unclear, erroneous, incomplete, misleading or false information provided by Client.

Document Historical Revision:

Test Report Version	Date	Resume
Extract from report n. 2220 / 0183 – TG3	15/01/2021	First issuance
Extract from report n. 2220 / 0183 – E1 – TG3	16/03/2021	The model SUNNY TRIPOWER STP 50-41 has been added as new variant model into the scope of this document. Further editorial changes have been added.
Extract from report n. 2220 / 0183 – E2 – TG3	07/06/2021	This report is updated to add compliance with the standard VDE-AR-N 4120: 2018-11. No new tests have been performed because existing deviations between standards VDE-AR-N 4120: 2018-11 and VDE-AR-N 4110: 2018-11 were already considered for the testing performed for the first issuance of this report. Further editorial changes have been added.

INDEX

1	SCOPE	4
2	GENERAL INFORMATION	5
2.1	TESTING PERIOD AND CLIMATIC CONDITIONS	5
2.2	EQUIPMENT UNDER TESTING	5
2.2.1	Reference Values	8
3	TEST RESULTS	9
3.1	NENNDATEN / RATED DATA:	9
3.2	POWER QUALITY	10
3.2.1	Wirkleistungsspitzen / Power Peaks	10
3.2.2	Schalthandlungen / Switching Operation	11
3.2.3	Unsymmetrie / Unbalances	13
3.2.4	Flicker	14
3.2.5	Oberschwingungsmessungen / Harmonics	15
3.2.6	Zwischenharmonische / Interharmonics	16
3.2.7	Höhere Frequenzen / Higher Frequencies components	17
3.3	GRID CONTROL CAPABILITY	18
3.3.1	Wirkleistungs einspeisung in Abhängigkeit der Netzfrequenz / Active power vs frequency	18
3.3.2	Blindleistungsbereitstellung / Provision of reactive power	19
3.4	PROTECTION SYSTEM	27
3.4.1	Trennung der EZE vom Netz / Cut-off from grid	27
3.4.2	Zuschaltbedingungen / Cut-in conditions	29
3.4.3	Zuschaltbedingungen nach Auslösung des Entkopplungsschutzes / Cut-in conditions after tripping of protection	29
3.5	RESPONSE DURING GRID FAULTS	30

1 Scope

SGS Tecnos, S.A. (Electrical Testing Laboratory) has been contracted by SMA SOLAR TECHNOLOGY AG, in order to perform testing according to FGW-TG3: Technical Guidelines for Power Generating Units and Systems. TG3 (Revision 25 Dated 01/09/2018 + Supplement 1 Dated 22/01/2019): Determination of Electrical Characteristics of Power Generating Units and Systems, Storage Systems as well for their Components in MV, HV and EHV grids.

The following standards are covered with testing of FGW-TG3 (Revision 25 Dated 01/09/2018) (*):

- VDE-AR-N 4110: 2018-11. Technical requirements for the connection and operation of customer installations to the medium voltage network (TAR medium voltage).
- VDE-AR-N 4120: 2018-11. Technical requirements for the connection and operation of customer installations to the high voltage network (TAR high voltage).

This document is an extract from the test report 2220 / 0183 – E2- TG3 compliant with the Annex B of FGW TG3 (Rev. 25 dated on 01/09/2018 + supplement 1 dated on 22/01/2019).

FGW-TG3+SP1

2 General Information

2.1 Testing Period and Climatic conditions

The necessary testing has been performed between the 10th of June and the 29th of October 2020.
All the tests and checks have been performed at $25 \pm 10^{\circ}\text{C}$, $90 \text{ kPa} \pm 10 \text{ kPa}$ and $50\% \text{ RH} \pm 20\% \text{ RH}$.

SITE TEST

Name.....: **SMA SOLAR TECHNOLOGY AG**
Address: Sonnenallee 1, 34266 Niestetal (Germany)

2.2 Equipment under Testing

Apparatus type: Grid-Connected PV Inverter
Installation: 3 Phase ~ / Fixed installation
Manufacturer: SMA SOLAR TECHNOLOGY AG
Trademark: Sunny Tripower
Model / Type reference: STP 50-40
Serial Number: 3000733176
Software Version: 03.10.03.R (main processor)
Rated Characteristics: Input: $1000 \text{ V}_{\text{dc,max}}$ ($500\text{-}800 \text{ V}_{\text{dc,MPPT}}$); 20 A_{dc} Max/MPPT;
2strings per MPPT; total 6 MPPT.
Output: 3~+N 230/400Vac; 50/60 Hz; $72.5 \text{ A}_{\text{ac}}$ Max.; 50 kW;
50 kVA.

Date of manufacturing: 2017

Test item particulars
Input: DC PV
Output.....: 3 Phase ~+N+PE
Class of protection against electric shock...: Class I
Degree of protection against moisture: IP 65
Type of connection to the main supply: Three-phase – Fixed installation
Cooling group.....: Forced ventilation (Fan)
Modular: No
Internal Transformer.....: No

FGW-TG3+SP1

Copy of marking plate:



Note:

1. Label is attached on the side surface of enclosure and visible after installation.

FGW-TG3+SP1

Equipment under testing:

- **STP 50-40**

The variant models is:

- **STP 50-41**

All tests have been performed on the model STP 50-40. The test results obtained on the model STP 50-40 are essentially valid for the derived model STP 50-41.

Per declaration of the manufacturer the model STP 50-40 is identical to the model STP 50-40 regarding the connection and operation of the inverter in accordance with grid connection requirements of the tested standards. The main reason for the development of the STP 50-41 is the inclusion of the AFCI (Arc-Fault Circuit Interrup-tion) function.

The main hardware differences between both inverter models STP 50-41 and STP 50-40 are listed below:

- New PCB board PL-ARTX with the AFCI function
- Minor modification of the communication board PL-BFS for the signals of the PL-ARTX and PL-ACRLY
- Minor modification of the PL-ACRLY and PL-DCEMV boards

The variants models have been included in this test report as they have the same following features as the tested model:

- Same connection system and hardware topology.
- Same control algorithm.
- Same Firmware Version.
- Output power within $1/\sqrt{10}$ and 2 times the rated output power or the EUT or Modular inverters.

The results obtained apply only to the particular sample tested that is the subject of the present test report. The most unfavourable result values of the verifications and tests performed are contained herein. Throughout this report a point (~~comma~~) is used as the decimal separator.

FGW-TG3+SP1

2.2.1 Reference Values

Reference Values	
Rated power, P_n in kW	50
Rated apparent power, S_n in kVA	50
Rated wind speed (only WT), v_n in m/s	Not applicable
Rated current (determined), I_n in A	72.5
Rated output voltage, (phase to phase) U_n in Vac	400
Note: In this report p.u. values are calculated as follows: -For Active & Reactive Power p.u values are reference to P_n -For Currents p.u values, the reference is always I_n -For Voltages p.u values, the reference is always U_n	

3 TEST RESULTS

3.1 Nenndaten / Rated data:

Nennscheinleistung S_n	50 kVA	Nennstrom I_n	72.5 A
Nennfrequenz f_n rated frequency f_n	50 Hz	Nennspannung U_n rated Voltage U_n	230 / 400 V

3.2 Power quality

3.2.1 Wirkleistungsspitzen / Power Peaks

Test results are offered in the following table:

Wirkleistungsspitzen in kW / Power peaks in kW		Wirkleistungsspitzen in p.u. / Power peaks in p.u.		Anzahl 10-Minuten Datensätze in / Number of 10-minute data set
$p_{600} = P_{600}/P_n$	50298	$p_{60} = P_{60}/P_n$	1.01	2
$p_{600} = P_{600}/P_n$	50295	$p_{60} = P_{60}/P_n$	1.01	2

Note: the MPP of the PV-generator is 56100W corresponding to 625 Vdc. The DC Power has been varied between 40800 W and 61200 W in the test performed.

3.2.2 Schalthandlungen / Switching Operation

- Test 1: Switching at $P_{\text{available}} < 10\% P_n$. Power gradient 25 % P_n /min.

Schalthandlungen / Case of switching operation	Einschalten bei $P_{\text{verfügbar}} < 10\% P_n$ (Einschaltwindgeschw.) / Start-up at $P_{\text{available}} < 10\% P_n$ (cut-in wind speed)			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{10}	20			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{120}	240			
Netzimpedanzwinkel / Grid impedance angle	30°	50°	70°	85°
Flickerformfaktor / Flicker step factor, $k_f (\Psi_k)$	0.041	0.045	0.049	0.053
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.118	0.100	0.078	0.068

- Test 2: Switching at $P_{\text{available}} < 10\% P_n$. Power gradient Maximum.

Schalthandlungen / Case of switching operation	Einschalten bei $P_{\text{verfügbar}} < 10\% P_n$ (Einschaltwindgeschw.) / Start-up at $P_{\text{available}} < 10\% P_n$ (cut-in wind speed)			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{10}	20			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{120}	240			
Netzimpedanzwinkel / Grid impedance angle	30°	50°	70°	85°
Flickerformfaktor / Flicker step factor, $k_f (\Psi_k)$	0.051	0.049	0.048	0.048
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.120	0.100	0.082	0.079

- Test 3: Switching at $P_{\text{available}} = P_n$. Power gradient 25 % P_n /min.

Schalthandlungen / Case of switching operation	Einschalten bei $P_{\text{verfügbar}} = P_n$ (Nennwindgeschwindigkeit) Start-up at $P_{\text{available}} = P_n$ (rated wind speed)			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{10}	20			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{120}	240			
Netzimpedanzwinkel / Grid impedance angle	30°	50°	70°	85°
Flickerformfaktor / Flicker step factor, $k_f (\Psi_k)$	0.041	0.045	0.049	0.053
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.199	0.161	0.115	0.093

FGW-TG3+SP1

- Test 4: Switching at $P_{\text{available}} = P_n$. Power gradient Maximum.

Schalthandlungen / Case of switching operation	Einschalten bei $P_{\text{verfügbar}} - P_n$ (Nennwindgeschwindigkeit) Start-up at $P_{\text{available}} P_n$ (rated wind speed)			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{10}	20			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{120}	240			
Netzimpedanzwinkel / Grid impedance angle	30°	50°	70°	85°
Flickerformfaktor / Flicker step factor, $k_f (\Psi_k)$	0.076	0.082	0.065	0.052
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.967	0.634	0.495	0.359

- Test 5: Service shutdown at rated power (no emergency stop).

Schalthandlungen / Case of switching operation	Seviceabschaltung bei Nennleistung / Cut off at rated power			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{10}	10			
Max Anz. Schalthandlungen / Max, number of switching operations, N_{120}	120			
Netzimpedanzwinkel / Grid impedance angle	30°	50°	70°	85°
Flickerformfaktor / Flicker step factor, $k_f (\Psi_k)$	0.981	0.819	0.571	0.460
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	1.075	0.905	0.715	0.637

FGW-TG3+SP1
3.2.3 Unsymmetrie / Unbalances
Table of results

P_{DC}/P_{max}	P_{AC} [W]	$U_{1,+}$ [V]	$U_{1,-}$ [V]	$I_{1,+}$ [A]	$I_{1,-}$ [A]	u_i [%]
10 %	4981.187	398.272	0.047	9.095	0.018	0.201
20 %	10002.888	398.259	0.055	18.209	0.031	0.168
30 %	15021.898	398.250	0.070	27.281	0.043	0.158
40 %	20018.701	398.237	0.091	36.484	0.058	0.159
50 %	25017.266	398.231	0.119	45.365	0.063	0.138
60 %	29877.247	398.225	0.137	54.299	0.081	0.149
70 %	34927.531	398.214	0.152	63.396	0.089	0.140
80 %	40201.057	398.202	0.173	72.994	0.112	0.153
90 %	44711.686	398.199	0.199	72.993	0.110	0.150
100 %	48910.222	398.181	0.216	72.998	0.101	0.138
110 %	50305.178	398.176	0.224	72.996	0.106	0.145
120 %	50306.152	398.175	0.221	72.992	0.100	0.137

According to VDE-AR-N 4110: 2018-11 and VDE-AR-N 4120: 2018-11, from the 10%P_n, the generating unit shall not exceed a maximum limit defined at 1.5%, for VDE-AR-N 4110: 2018-11 and a maximum limit defined at 2.5%, for VDE-AR-N 4120: 2018-11.

3.2.4 Flicker

[illegible]

FGW-TG3+SP1

3.2.5 Oberschwingungsmessungen / Harmonics

Pbin [%]	3	10	20	30	40	50	60	70	80	90	100	Max
Order	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n	I _h /I _n
1	2.99	10.00	19.92	29.94	39.89	49.19	58.92	68.73	78.40	88.07	97.57	97.57
2	0.06	0.08	0.23	0.21	0.17	0.24	0.16	0.20	0.20	0.18	0.13	0.24
3	0.03	0.03	0.03	0.04	0.04	0.03	0.05	0.06	0.04	0.07	0.06	0.07
4	0.08	0.11	0.10	0.05	0.09	0.14	0.09	0.03	0.13	0.03	0.11	0.14
5	0.37	0.18	0.38	0.26	0.40	0.42	0.45	0.49	0.45	0.53	0.50	0.53
6	0.06	0.05	0.06	0.06	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
7	0.26	0.20	0.04	0.09	0.25	0.29	0.32	0.37	0.38	0.43	0.45	0.45
8	0.14	0.09	0.03	0.10	0.10	0.02	0.10	0.11	0.03	0.11	0.09	0.14
9	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.05	0.02	0.06	0.04	0.06
10	0.14	0.09	0.05	0.07	0.11	0.06	0.11	0.05	0.06	0.05	0.11	0.14
11	0.22	0.30	0.16	0.06	0.09	0.14	0.15	0.18	0.17	0.20	0.18	0.30
12	0.08	0.06	0.10	0.04	0.09	0.10	0.09	0.04	0.09	0.04	0.09	0.10
13	0.19	0.16	0.07	0.10	0.07	0.11	0.13	0.15	0.12	0.16	0.15	0.19
14	0.07	0.06	0.10	0.05	0.06	0.09	0.07	0.05	0.09	0.04	0.07	0.10
15	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.04	0.03	0.04
16	0.04	0.04	0.07	0.03	0.05	0.07	0.05	0.03	0.07	0.04	0.06	0.07
17	0.12	0.11	0.10	0.07	0.03	0.07	0.08	0.11	0.09	0.12	0.11	0.12
18	0.04	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.04
19	0.10	0.08	0.09	0.05	0.03	0.05	0.07	0.08	0.06	0.09	0.08	0.10
20	0.03	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.03
21	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02
22	0.03	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.03
23	0.05	0.03	0.06	0.04	0.04	0.04	0.05	0.06	0.06	0.07	0.07	0.07
24	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.02
25	0.03	0.04	0.05	0.04	0.03	0.03	0.04	0.05	0.05	0.06	0.05	0.06
26	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02
27	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02
28	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
29	0.02	0.01	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04
30	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
31	0.01	0.02	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.03	0.04
32	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.01
33	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
34	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01
35	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03
36	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
37	0.00	0.00	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.03
38	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
41	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
THDi	0.60	0.50	0.53	0.41	0.55	0.61	0.66	0.73	0.68	0.80	0.77	0.80

3.2.6 Zwischenharmonische / Interharmonics

Pbin [%]	3	10	20	30	40	50	60	70	80	90	100	Max
Order	I/In	I/In	I/In	I/In	I/In	I/In	I/In	I/In	I/In	I/In	I/In	I/In
1.5	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04
2.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
3.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
4.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
5.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
6.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
7.5	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
8.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
9.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
10.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
11.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
12.5	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
13.5	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.02
14.5	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.02
15.5	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.02
16.5	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02
17.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
18.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
19.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
20.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
21.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
22.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
23.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
24.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
25.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
26.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
27.5	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
28.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
29.5	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
30.5	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.01
31.5	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.01
32.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
33.5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
34.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
35.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
36.5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
37.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38.5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
39.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43.5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
44.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
46.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.2.7 Höhere Frequenzen / Higher Frequencies components

[illegible]

3.3 Grid Control Capability

3.3.1 Wirkleistungseinspeisung in Abhängigkeit der Netzfrequenz / Active power vs frequency

Überfrequenz / overfrequency	Mittlerer Gradient der Wirkleistung sum Zeitpunkt der Frequenzüberhöhung / Mean power gradient at overfrequency	mittl. Gradient / mean gradient Test at 100%Pn: -39.98 % P _M /Hz Test at 50%Pn: -39.95 % P _M /Hz	
	Max. Einschwingzeit / Max. Settling time	0.96 s	
	Gradient der Wirkleistung nach Rückkehr aus Überfrequenz / Power gradient after recovery of over frequency	mittl. Gradient / mean gradient 8.8 %Pn/Hz max. Gradient / max. gradient 9.0 %Pn/Hz	
Unterfrequenz / underfrequency	Mittlerer Gradient der Wirkleistung sum Zeitpunkt der Frequenzunterschreitung / Mean power gradient at underfrequency	mittl. Gradient / mean gradient 40.16 % P _M /Hz	
	Max. Einschwingzeit / Max. Settling time	0.2 s	
	Gradient der Wirkleistung nach Rückkehr aus Unterfrequenz / Power gradient after recovery of under frequency	mittl. Gradient / mean gradient 8.9 %Pn/Hz max. Gradient / max. gradient 9.0 %Pn/Hz	
Die EZE kann mit reduzierter Leistung betrieben werden. / The unit is able to run at reduced power		☒ Ja / Yes	☐ Nein / No
Maximale Sollwertabweichung der Wirkleistung Max. deviation of power setting		Überschreitung / Exceeding 338.7 W	Unterschreitung / Undercut 0.0 kW
Trennung vom Nets bei Wirkleistungssollwertvorgabe von: Disconnection from the grid at external active power setpoints at:		-- % Pn No disconnection is recorded. Operation at 0%Pn is evidenced.	
Einschwingzeit der Leistung für einen Sollwertsprung mit minimalem Gradienten / Response time of the power output after a change in setpoint with minimal gradient	P0 -> Pmin	Zeit / time : 47.0 s Gradient: 0.33 % Pn / s	
	Pmin -> P0	Zeit / time : 43.8 s Gradient: 0.33 % Pn / s	
Einschwingzeit der Leistung für einen Sollwertsprung mit maximalem Gradienten / Response time of the power output after a change in setpoint with maximum gradient	P0 -> Pmin	Zeit / time : 131.0 s Gradient: 0.65 % Pn / s	
	Pmin -> P0	Zeit / time : 129.6 s Gradient: 0.66 % Pn / s	

3.3.2 Blindleistungsbereitstellung / Provision of reactive power

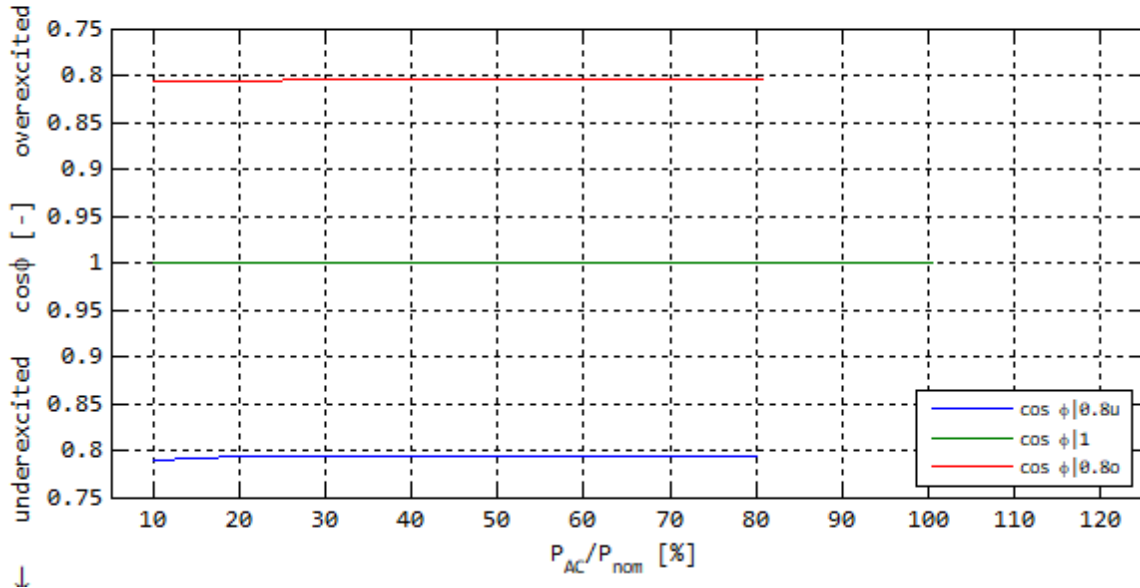
Blindleistungsregelung im Normalbetrieb und maximaler Blindleistungstellbereich / Control of reactive power in normal operation and maximum reactive power range	P/Pn	Qind	Q0	Qkap	P/Pn	Qind	Q0	Qkap
	10%	3.637	-0.026	-3.847	70%	25.642	0.153	-26.556
	20%	7.304	0.003	-7.659	80%	29.480	0.188	-30.567
	30%	11.019	0.032	-11.429	90%	29.882	0.216	-30.572
	40%	14.716	0.061	-15.300	100%	29.884	0.243	-30.575
	50%	18.318	0.091	-19.013	110%	29.885	0.253	-30.574
	60%	21.924	0.121	-22.722	120%	29.886	0.254	-30.575
Arbeitspunkte des spannungsabhängigen P-Q Diagramms / Working points of the voltage dependent P-Q diagram	Q in kVAr. Qind and Qkap values are given with Power Factor fixed to 0.8.							
	AP / WP		U/Un in %		P/Pn in %		Q in kVAr	
	See measured points and results in the following pages of this annex							
Blindleistungsregelung durch Sollwertvorgabe / Control of reactive power through set point signal	☒Verschiebungsfaktor / power factor				☒Blindleistung / reactive power			
	Pbin bei / at Qmax				Maximum PF range: 0.8 Maximum Q range: 99%Sn			
Längste Einsschwingzeit / Longest response time	Parameter				Einschwingzeit / settling time			
	T < 6 s				8.8 s (maximum measured)			
	Standardzeit / standard time				--			
	T < 60 s				79.2 s (maximum measured)			
Einstellgenauigkeit des Verschiebungsfaktors bzw. Blindleistung / Positioning accuracy of power factor or reactive power	Sollwert / setpoint. Mode tested: <i>PF Const at 100%Pn</i>				Istwert / measured value			
	PF = 0.8 (Under excited)				0.804			
	PF = 0.8 (Over excited)				-0.795			
	PF = 1.0				1.000			
	Sollwert / setpoint. Mode tested: <i>PF Const at 50%Pn</i>				Istwert / measured value			
	PF = 0.8 (Under excited)				0.805			
	PF = 0.8 (Over excited)				-0.794			
	PF = 1.0				1.000			
	Sollwert / setpoint. Mode tested: <i>VAr Const at 50%Pn</i>				Istwert / measured value			
	25.000 kVAr				25.365 kVAr			
	-25.000 kVAr				-25.000 kVAr			
	0.000 kVAr				0.175 kVAr			
	Sollwert / setpoint. Mode tested: <i>VAr Const Nominal at 50%Pn</i>				Istwert / measured value			
	50%Sn				50.9%Sn			
	-50%Sn				-49.8%sn			
	0%Sn				0.5%Sn			
Anmerkung / remark	Soweit Q(U) und Q(P)- Regelung wurde, sind diese im Prüfbericht hinterlegt / See O(U) and O(P) in test report							

FGW-TG3+SP1

In following charts, they are offered main results after performed tests included in the FGW TG3 test report.

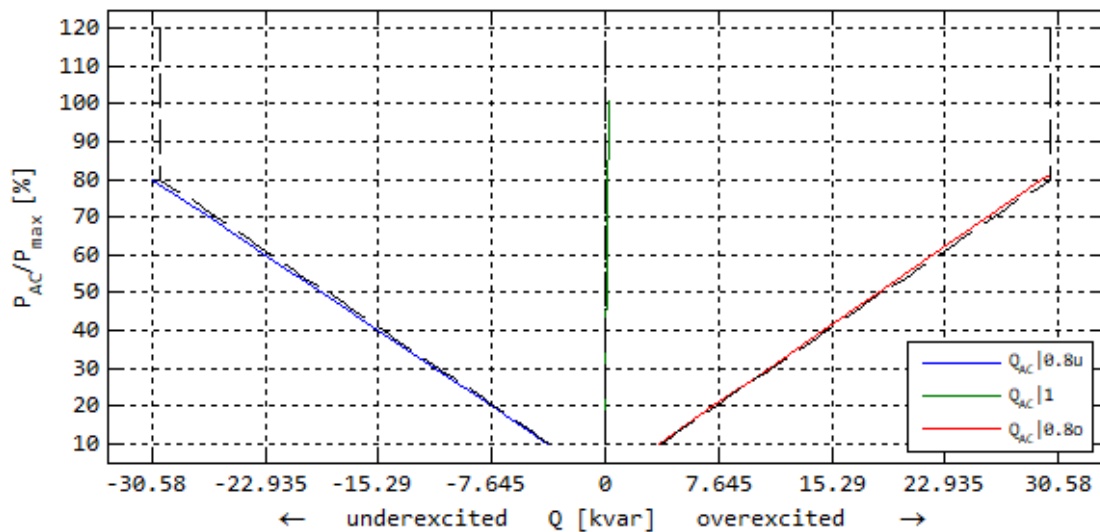
Active Power over Power Factor. Fixed Power Factor

Verification of reactive power (power factor, permitted deviation(max) = 0.01 @ $P/P_{nom} \geq 20\%$)
deviation of $\cos \phi_u$ (avg/max) = -0.006 / -0.007
deviation of $\cos \phi_g$ (avg/max) = 0.000 / 0.000
deviation of $\cos \phi_o$ (avg/max) = -0.005 / -0.006
↑ overall deviation (avg/max))= -0.003 / 0.007 → ok



Active Power over Reactive Power. Fixed Power Factor

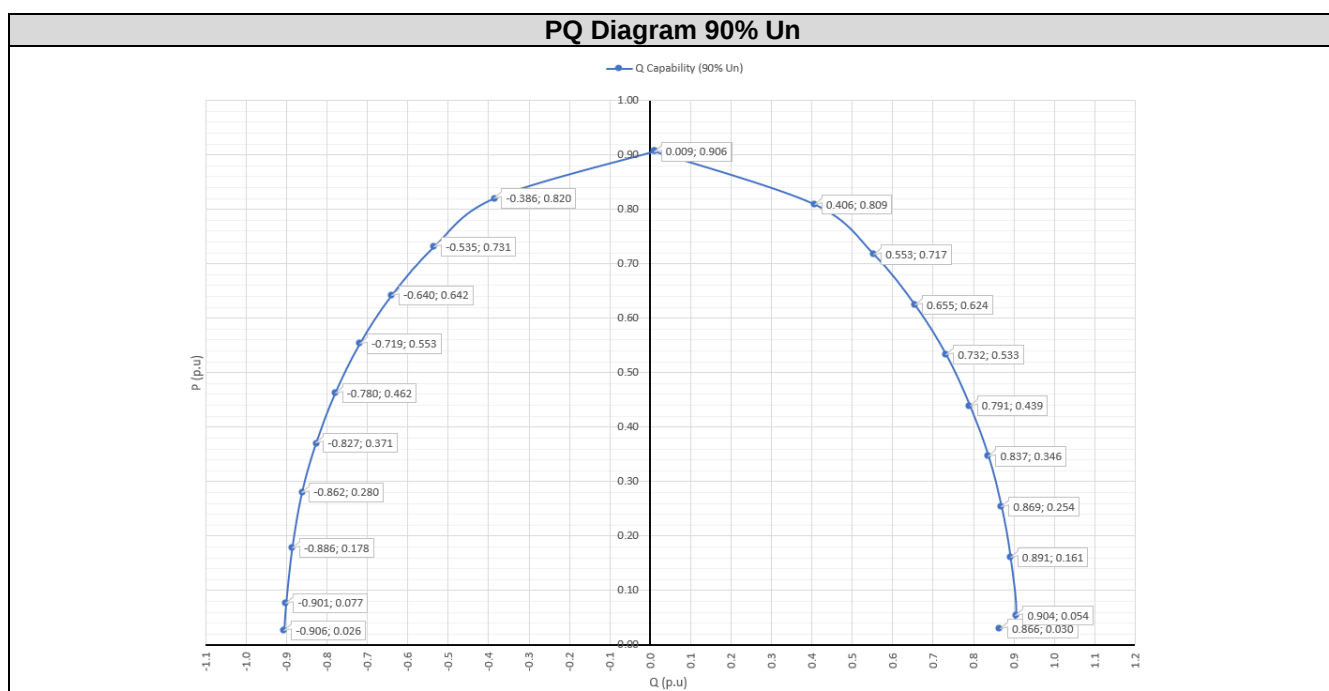
Verification of reactive power (reactive power, permitted deviation(max) = 2.00% @ $P/P_{nom} \geq 20\%$)
deviation of Q_u (avg/max) = -0.79 % / -1.15 %
deviation of Q_g (avg/max) = 0.30 % / 0.51 %
deviation of Q_o (avg/max) = -0.60 % / -1.22 %
overall deviation (avg/max))= -0.37 % / -1.22 % → ok



FGW-TG3+SP1

The table below shows measured values for each power step tested to verify the voltage-dependent PQ diagram:

PQ Diagram 90% Un								
Step	V _{AC} (V)	P measured (kW)	P meas. (P/Sn)	S meas. (kVA)	S meas. (P/Sn)	Q meas. (kVar)	Q meas. (P/Sn)	PF
1	358.4	1.500	0.030	43.350	0.867	43.300	0.866	0.034
2	358.4	2.700	0.054	45.250	0.905	45.200	0.904	0.059
3	358.4	8.050	0.161	45.250	0.905	44.550	0.891	0.178
4	358.4	12.700	0.254	45.250	0.905	43.450	0.869	0.281
5	358.4	17.300	0.346	45.250	0.905	41.850	0.837	0.382
6	358.4	21.950	0.439	45.250	0.905	39.550	0.791	0.485
7	358.4	26.650	0.533	45.250	0.905	36.600	0.732	0.588
8	358.4	31.200	0.624	45.250	0.905	32.750	0.655	0.690
9	358.4	35.850	0.717	45.250	0.905	27.650	0.553	0.792
10	358.4	40.450	0.809	45.250	0.905	20.300	0.406	0.894
11	358.4	45.300	0.906	45.300	0.906	0.550	0.011	1.000
12	358.4	45.300	0.906	45.300	0.906	0.450	0.009	1.000
13	358.4	41.000	0.820	45.300	0.906	-19.300	-0.386	0.905
14	358.4	36.550	0.731	45.300	0.906	-26.750	-0.535	0.807
15	358.4	32.100	0.642	45.350	0.907	-32.000	-0.640	0.708
16	358.4	27.650	0.553	45.350	0.907	-35.950	-0.719	0.610
17	358.4	23.100	0.462	45.350	0.907	-39.000	-0.780	0.510
18	358.4	18.550	0.371	45.350	0.907	-41.350	-0.827	0.409
19	358.4	14.000	0.280	45.300	0.906	-43.100	-0.862	0.309
20	358.4	8.900	0.178	45.200	0.904	-44.300	-0.886	0.196
21	358.4	3.850	0.077	45.250	0.905	-45.050	-0.901	0.085
22	358.4	1.300	0.026	45.300	0.906	-45.300	-0.906	0.029

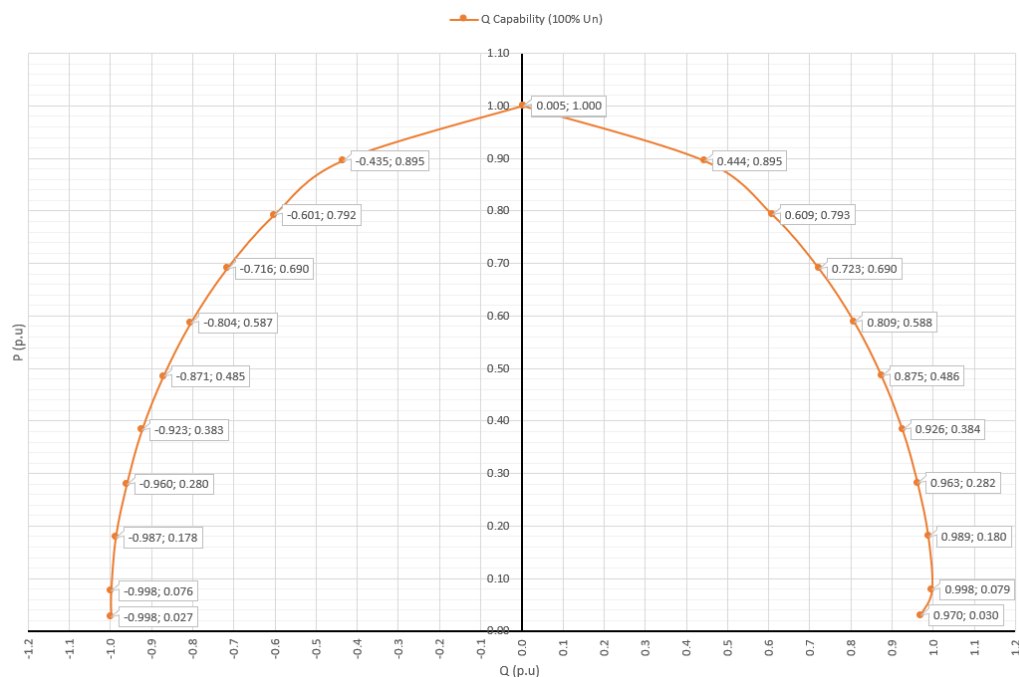


FGW-TG3+SP1

PQ Diagram 100% Un

Step	V _{AC} (V)	P measured (kW)	P meas. (P/Sn)	S meas. (kVA)	S meas. (P/Sn)	Q meas. (kVAr)	Q meas. (P/Sn)	PF
1	398.4	1.500	0.030	48.500	0.970	48.500	0.970	0.031
2	398.4	3.950	0.079	50.050	1.001	49.900	0.998	0.079
3	398.4	9.000	0.180	50.250	1.005	49.450	0.989	0.179
4	398.4	14.100	0.282	50.150	1.003	48.150	0.963	0.281
5	398.4	19.200	0.384	50.150	1.003	46.300	0.926	0.383
6	398.4	24.300	0.486	50.050	1.001	43.750	0.875	0.486
7	398.4	29.400	0.588	50.000	1.000	40.450	0.809	0.588
8	398.4	34.500	0.690	50.000	1.000	36.150	0.723	0.690
9	398.4	39.650	0.793	50.000	1.000	30.450	0.609	0.793
10	398.4	44.750	0.895	49.950	0.999	22.200	0.444	0.896
11	398.4	49.950	0.999	49.950	0.999	0.250	0.005	1.000
12	398.4	50.000	1.000	50.000	1.000	0.250	0.005	1.000
13	398.4	44.750	0.895	49.750	0.995	-21.750	-0.435	0.899
14	398.4	39.600	0.792	49.700	0.994	-30.050	-0.601	0.797
15	398.4	34.500	0.690	49.750	0.995	-35.800	-0.716	0.694
16	398.4	29.350	0.587	49.750	0.995	-40.200	-0.804	0.590
17	398.4	24.250	0.485	49.850	0.997	-43.550	-0.871	0.487
18	398.4	19.150	0.383	49.950	0.999	-46.150	-0.923	0.384
19	398.4	14.000	0.280	50.000	1.000	-48.000	-0.960	0.280
20	398.4	8.900	0.178	50.150	1.003	-49.350	-0.987	0.177
21	398.4	3.800	0.076	50.050	1.001	-49.900	-0.998	0.076
22	398.4	1.350	0.027	49.900	0.998	-49.900	-0.998	0.027

PQ Diagram 100% Un

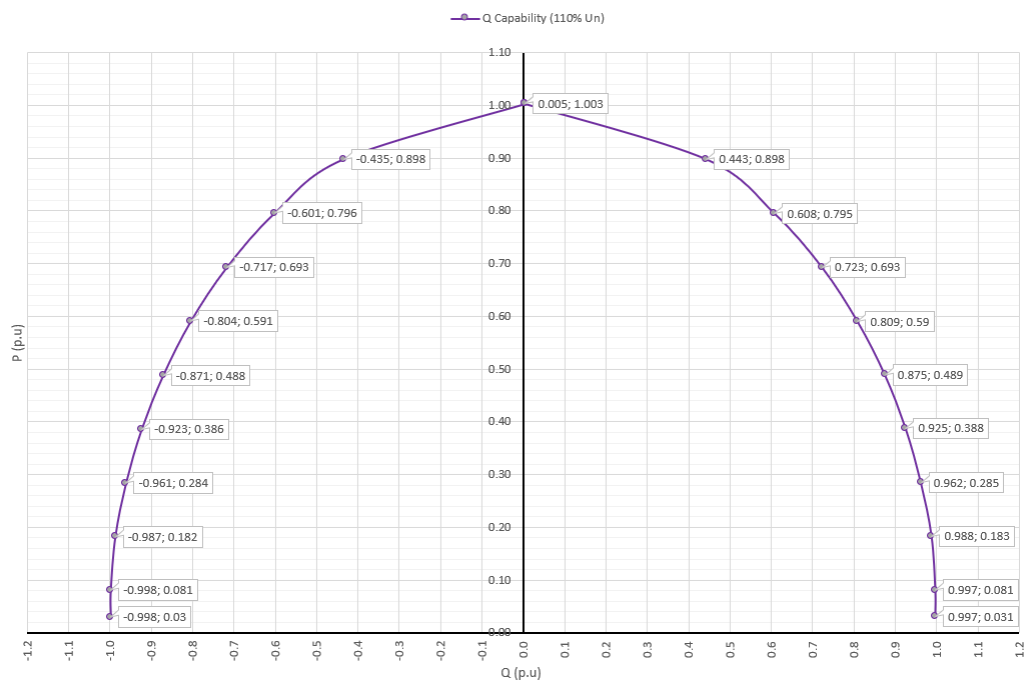


FGW-TG3+SP1

PQ Diagram 110% Un

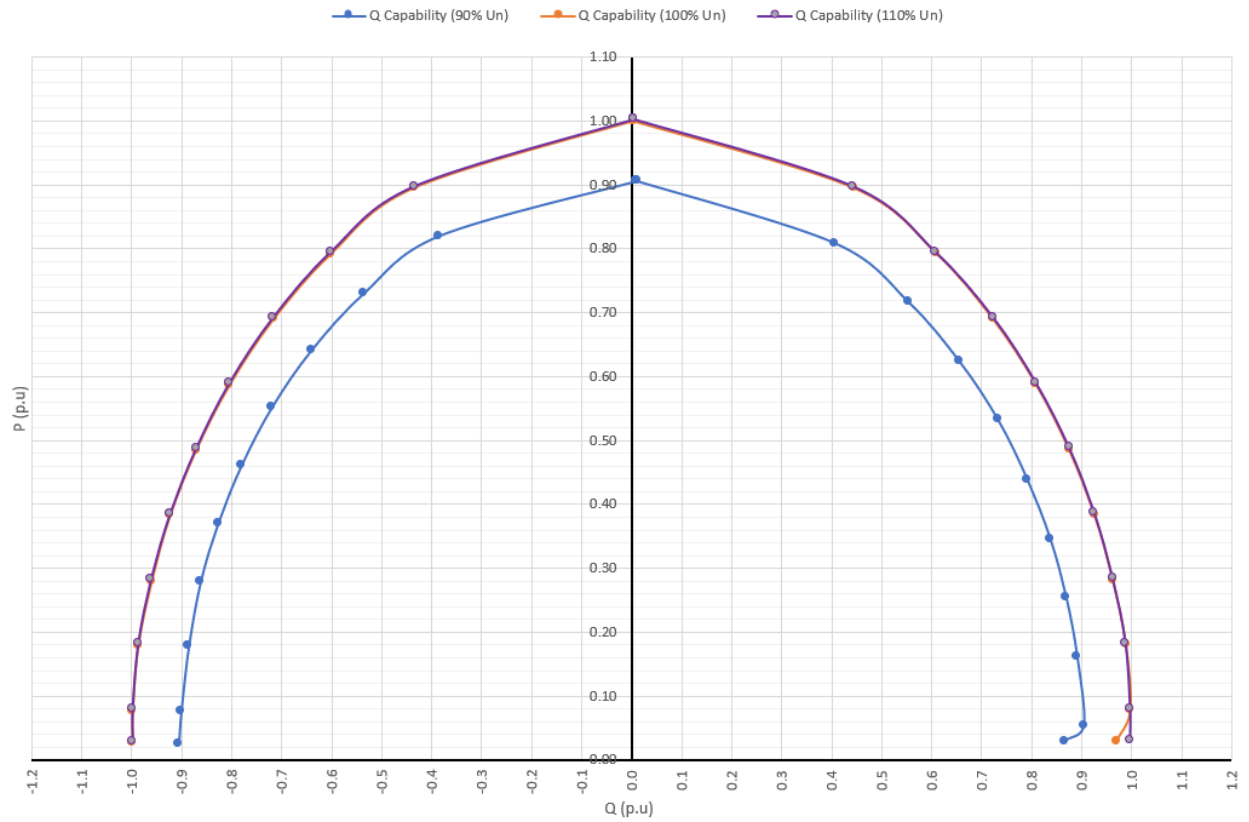
Step	V _{AC} (V)	P measured (kW)	P meas. (P/Sn)	S meas. (kVA)	S meas. (P/Sn)	Q meas. (kVAr)	Q meas. (P/Sn)	PF
1	438.0	1.550	0.031	49.900	0.998	49.850	0.997	0.031
2	438.0	4.050	0.081	50.050	1.001	49.850	0.997	0.081
3	438.0	9.150	0.183	50.250	1.005	49.400	0.988	0.182
4	438.0	14.250	0.285	50.200	1.004	48.100	0.962	0.284
5	438.0	19.400	0.388	50.150	1.003	46.250	0.925	0.386
6	438.0	24.450	0.489	50.100	1.002	43.750	0.875	0.488
7	438.0	29.500	0.590	50.050	1.001	40.450	0.809	0.589
8	438.0	34.650	0.693	50.050	1.001	36.150	0.723	0.692
9	438.0	39.750	0.795	50.050	1.001	30.400	0.608	0.794
10	438.0	44.900	0.898	50.050	1.001	22.150	0.443	0.897
11	438.0	50.150	1.003	50.150	1.003	0.250	0.005	1.000
12	438.0	50.150	1.003	50.150	1.003	0.250	0.005	1.000
13	438.0	44.900	0.898	49.900	0.998	-21.750	-0.435	0.900
14	438.0	39.800	0.796	49.850	0.997	-30.050	-0.601	0.798
15	438.0	34.650	0.693	49.850	0.997	-35.850	-0.717	0.695
16	438.0	29.550	0.591	49.900	0.998	-40.200	-0.804	0.592
17	438.0	24.400	0.488	49.900	0.998	-43.550	-0.871	0.489
18	438.0	19.300	0.386	50.050	1.001	-46.150	-0.923	0.386
19	438.0	14.200	0.284	50.100	1.002	-48.050	-0.961	0.283
20	438.0	9.100	0.182	50.200	1.004	-49.350	-0.987	0.181
21	438.0	4.050	0.081	50.050	1.001	-49.900	-0.998	0.081
22	438.0	1.500	0.030	49.950	0.999	-49.900	-0.998	0.030

PQ Diagram 110% Un



FGW-TG3+SP1

PQ Diagram Summary



FGW-TG3+SP1

The certified PV inverter fulfils the following P-Q diagram at different voltage levels, as stated in the Manufacturer Declaration: "SUNNY TRIPOWER CORE1 (STP 50-40). Reactive Power Capability"

SMA Solar Technology AG | Sonnenallee 1 | 34266 Niestetal | Germany
Phone: +49 561 9522-0 | Fax: +49 561 9522-100 | Internet: www.SMA.de | E-Mail: info@SMA.de
Amtsgericht Kassel (District court) Kassel HRB (registration number) 3972
Vorstand des Aufsichtsrats (Chairman of the Supervisory Board): Uwe Kleinkauf
Vorstand (Managing Board): Dr.-Ing. Jürgen Reinert (CEO), Ulrich Hadding



SUNNY TRIPOWER CORE1 (STP 50-40)
Reactive Power Capability

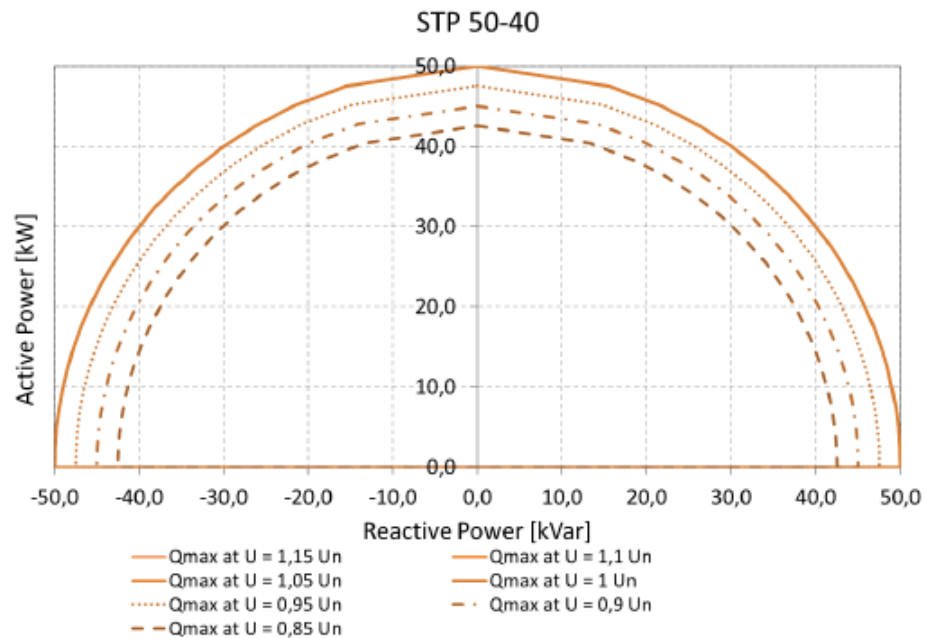


Figure 1: STP 50-40 operating range depending on the grid voltage

FGW-TG3+SP1

$U_{grid} = 0,85 \text{ p.u. } U_n$					$U_{grid} = 0,90 \text{ p.u. } U_n$				
P_{bin} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]	P_{bin} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]
42,5	0,0	42,5	0,0	42,5	45,0	0,0	45,0	0,0	45,0
40,4	13,3	40,4	-13,3	40,4	42,8	14,1	42,8	-14,1	42,8
38,3	18,5	38,3	-18,5	38,3	40,5	19,6	40,5	-19,6	40,5
36,1	22,4	36,1	-22,4	36,1	38,3	23,7	38,3	-23,7	38,3
34,0	25,5	34,0	-25,5	34,0	36,0	27,0	36,0	-27,0	36,0
31,9	28,1	31,9	-28,1	31,9	33,8	29,8	33,8	-29,8	33,8
29,8	30,4	29,8	-30,4	29,8	31,5	32,2	31,5	-32,2	31,5
27,6	32,3	27,6	-32,3	27,6	29,3	34,2	29,3	-34,2	29,3
25,5	34,0	25,5	-34,0	25,5	27,0	36,0	27,0	-36,0	27,0
23,4	35,5	23,4	-35,5	23,4	24,8	37,6	24,8	-37,6	24,8
21,3	36,8	21,3	-36,8	21,3	22,5	39,0	22,5	-39,0	22,5
19,1	38,0	19,1	-38,0	19,1	20,3	40,2	20,3	-40,2	20,3
17,0	39,0	17,0	-39,0	17,0	18,0	41,3	18,0	-41,3	18,0
14,9	39,8	14,9	-39,8	14,9	15,8	42,2	15,8	-42,2	15,8
12,8	40,6	12,8	-40,6	12,8	13,5	42,9	13,5	-42,9	13,5
10,6	41,2	10,6	-41,2	10,6	11,3	43,6	11,3	-43,6	11,3
8,5	41,7	8,5	-41,7	8,5	9,0	44,1	9,0	-44,1	9,0
6,4	42,0	6,4	-42,0	6,4	6,8	44,5	6,8	-44,5	6,8
4,3	42,3	4,3	-42,3	4,3	4,5	44,8	4,5	-44,8	4,5
2,1	42,5	2,1	-42,5	2,1	2,3	45,0	2,3	-45,0	2,3
0,0	42,5	0,0	-42,5	0,0	0,0	45,0	0,0	-45,0	0,0

$U_{grid} = 0,95 \text{ p.u. } U_n$					$U_{grid} = 1,00 \text{ p.u. } U_n$				
P_{bin} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]	P_{bin} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]
47,5	0,0	47,5	0,0	47,5	50,0	0,0	50,0	0,0	50,0
45,1	14,8	45,1	-14,8	45,1	47,5	15,6	47,5	-15,6	47,5
42,8	20,7	42,8	-20,7	42,8	45,0	21,8	45,0	-21,8	45,0
40,4	25,0	40,4	-25,0	40,4	42,5	26,3	42,5	-26,3	42,5
38,0	28,5	38,0	-28,5	38,0	40,0	30,0	40,0	-30,0	40,0
35,6	31,4	35,6	-31,4	35,6	37,5	33,1	37,5	-33,1	37,5
33,3	33,9	33,3	-33,9	33,3	35,0	35,7	35,0	-35,7	35,0
30,9	36,1	30,9	-36,1	30,9	32,5	38,0	32,5	-38,0	32,5
28,5	38,0	28,5	-38,0	28,5	30,0	40,0	30,0	-40,0	30,0
26,1	39,7	26,1	-39,7	26,1	27,5	41,8	27,5	-41,8	27,5
23,8	41,2	23,8	-41,2	23,8	25,0	43,3	25,0	-43,3	25,0
21,4	42,4	21,4	-42,4	21,4	22,5	44,7	22,5	-44,7	22,5
19,0	43,6	19,0	-43,6	19,0	20,0	45,8	20,0	-45,8	20,0
16,6	44,5	16,6	-44,5	16,6	17,5	46,8	17,5	-46,8	17,5
14,3	45,3	14,3	-45,3	14,3	15,0	47,7	15,0	-47,7	15,0
11,9	46,0	11,9	-46,0	11,9	12,5	48,4	12,5	-48,4	12,5
9,5	46,6	9,5	-46,6	9,5	10,0	49,0	10,0	-49,0	10,0
7,1	47,0	7,1	-47,0	7,1	7,5	49,4	7,5	-49,4	7,5
4,8	47,3	4,8	-47,3	4,8	5,0	49,7	5,0	-49,7	5,0
2,4	47,5	2,4	-47,5	2,4	2,5	49,9	2,5	-49,9	2,5
0,0	47,5	0,0	-47,5	0,0	0,0	50,0	0,0	-50,0	0,0

*Also applicable to $U_{grid}=1,05 - 1,15 \text{ pu}$ *Also applicable to $U_{grid}=1,05 - 1,15 \text{ pu}$

Table 1: STP 50-40 P/Q operating range at different grid voltages between 0,85 and 1,15 p.u.

3.4 Protection system

3.4.1 Trennung der EZE vom Netz / Cut-off from grid

☒ Die Überprüfung der Gesamtschaltkette führte zu einer erfolgreichen Abschaltung. The test of the whole trip circuit led to a successful shut down							
	Einstellwert Setting In pu oder/or [Hz]		Auslösewert / Release value In pu oder/or [Hz]		Abschaltzeit / Disconnection time [ms]		Rückfallverhältnis Disengaging ratio
	Schwelle / value	Zeit / Time (ms)	Min.	Max.	Min.	Max.	
Spannungssteigerungsschutz/ Overvoltage protection: U>	1.000	180000	1.009	1.010	179970	179970	☑≥0.98 ☐<0.98
	1.200	50	1.208	1.210	37	37	
Spannungssteigerungsschutz/ Overvoltage protection: U>>	1.000	59000	1.004	1.005	58970	58980	---
	1.300	50	1.299	1.305	37	37	
Spannungsrückgangsschutz/ Undervoltage protection: U<	0.200	50	0.197	0.201	37	37	☑≤1.02 ☐>1.02
	1.000	10000	1.000	1.006	9970	9970	
Spannungsrückgangsschutz/ Undervoltage protection: U<<	0.200	50	0.198	0.201	37	37	☑≤1.02 ☐>1.02
	1.000	10000	1.004	1.005	9970	9970	
Frequenzsteigerungsschutz/ Overfrequency protection: F>	50.00	10000	50.00		9970		---
	55.00	50	54.99		32		
Frequenzsteigerungsschutz/ Overfrequency protection: F>>	50.00	10000	50.00		9960		---
	55.00	50	54.99		36		
Frequenzrückgangsschutz/ Underfrequency protection: F<	44.00	10000	44.00		9970		---
	50.00	50	50.00		38		
Eigenzeit der Abschalteinheit / Operating time of a circuit breaker:	☐ aus Messung by measurement				☒ aus Prützertifikat by test certificate		
	According to the relay specification, the operation time of circuit breaker is: - Declared operate time given by the supplier: 40 ms at nominal coil voltage. - Declared release time given by the supplier: 5 ms at nominal coil voltage. See next page.						

AZSR235/250

50 A (35 A) POWER RELAY

FEATURES

- 50 Amp switching (AZSR250)
- 35 Amp switching (AZSR235)
- Wide contact gap > 1.85mm (AZSR250)
- Wide contact gap > 2.05mm (AZSR235)
- Holding power <100 mW
- Dielectric strength 5000 Vrms
- Isolation spacing greater than 10 mm
- Reinforced insulation, EN 60730-1 (VDE 0631, part 1), EN 60335-1 (VDE 0700, part 1)
- UL, CUR file E44211
- VDE certificate 40033251

CONTACTS

Arrangement	SPST (1 Form A) DPST (2 Form A)
Ratings	Resistive load: AZSR235 Max. switched power: 1050 W or 9695 VA Max. switched current: 35 A Max. switched voltage: 150 VDC* or 440 VAC AZSR250 Max. switched power: 1500 W or 13850 VA Max. switched current: 50 A Max. switched voltage: 150 VDC* or 440 VAC * Note: If switching voltage is greater than 30 VDC, special precautions must be taken. Please contact the factory.
Rated Load UL	AZSR235 35 A at 277 VAC, resistive AZSR250 50 A at 277 VAC, resistive
VDE	AZSR235 35 A at 263 VAC, test referring to AC-7a, 85°C AZSR250 50 A at 263 VAC, test referring to AC-7a, 85°C
Material	Silver tin oxide
Resistance	< 50 milliohms initially

COIL

Power At Pickup Voltage (typical)	270 mW (AZSR250)
Max. Continuous Dissipation	2.0 W at 20°C (68°F) ambient
Temperature Rise	15°C (27°F) at nominal coil voltage
Temperature	Max. 155°C (311°F) Class F

RoHS compliant !



GENERAL DATA

Life Expectancy	Minimum operations
Mechanical	1 x 10 ⁶
Electrical	5 x 10 ⁴ at 35 A 250 VAC Res. (AZSR235) 5 x 10 ⁴ at 50 A 250 VAC Res. (AZSR250)
Operate Time (typical)	40 ms at nominal coil voltage
Release Time (typical)	5 ms at nominal coil voltage (with no coil suppression)
Dielectric Strength (at sea level for 1 min.)	5000 Vrms coil to contact 2500 Vrms between contact sets 2500 Vrms between open contacts
Insulation Resistance	1000 megohms min. at 20°C 500 VDC 50% RH
Insulation (according to DIN VDE 0110, IEC 60664-1)	C250 Overvoltage category: III Pollution degree: 3 Nominal voltage: 250 VAC
Dropout	Greater than 5% of nominal coil voltage
Ambient Temperature Operating	At nominal coil voltage -40°C (-40°F) to 85°C (185°F)
Vibration	0.062" (1.5 mm) DA at 10–55 Hz
Shock	10 g
Enclosure	PA
Terminals	Tinned copper alloy, P.C.
Max. Solder Temp.	270°C (518°F)
Max. Solder Time	5 seconds
Weight	105 grams
Packing unit in pcs	10 per inner carton / 100 per carton box

NOTES

1. All values at 20°C (68°F).
2. Relay may pull in with less than "Must Operate" value.
3. Specifications subject to change without notice.

ZETTLER electronics GmbH - A ZETTLER GROUP Company

Junkersstr. 3, D-82178 Puchheim, Germany

phone: +49 89 800 97-0 office@ZETTLERelectronics.com
fax: +49 89 800 97-200 www.ZETTLERelectronics.comThis product specification is to be used only together with the application notes which can be downloaded from <http://www.ZETTLERelectronics.com/pdfs/relais/ApplicationNotes.pdf>

2015-03-31

FGW-TG3+SP1

3.4.2 Zuschaltbedingungen / Cut-in conditions

Since this is optional testing, this test has not been performed as is an optional measurement according to point 4.5.1.1 of the standard.

3.4.3 Zuschaltbedingungen nach Auslösung des Entkupplungsschutzes / Cut-in conditions after tripping of protection

	Bereich / range In pu order/ or [Hz]	Zuschaltung erfolgte im angegebenen Bereich cut in occurred within the given range
Unterspannung / Undervoltage:	> 0,95	☐ nein / no ☒ ja / yes
Unterfrequenz / Underfrequency:	≥ 49,9	☐ nein / no ☒ ja / yes
Überfrequenz / Overfrequency:	≤ 50,1	☐ nein / no ☒ ja / yes

As evidenced in the evaluated documentation, the certified unit is able to follows a ramp gradient inside of the range 33%P_n/s – 66%P_n/s after the reconnection occurs.

3.5 Response during grid faults

The compliance with these requirements including all calculations defined in the FGW TR3 standard is stated in the attachement to the test report:

- **2220 / 0183-Att1 (Rev.2) : FGW-TG3: Grid Fault Tests Results**

--- END OF THE EXTRACT OF THE TEST REPORT ---