

EXTRACT FROM REPORT N. 2219 / 0121 – E1 – 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.....: **2219 / 0121 – E1 – TG3**

[] This extract from test results cancels and supersedes the document no. 2219 / 0121 – 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 25000TL-30**
Variant Models: **SUNNY TRIPOWER STP 15000TL-30**
SUNNY TRIPOWER STP 20000TL-30

APPLICANT

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

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Date of issue: 07/04/2021

Number of pages.....: 42

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Document Historical Revision:

Test Report Version	Date	Resume
Extract from report n. 2219 / 0121 – TG3	15/01/2021	First issuance
Extract from report n. 2219 / 0121 – E1 – TG3	07/04/2021	This document is modified to add reference to the updated report the 2219 / 0121 – E1 – TG3 and the updated Attachment I (2219 / 0121-Att I. Revision 1). Further editorial changes have been added. No additional tests have been performed.

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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).

This document is an extract from the test report 2219 / 0121 – E1 – TG3 compliant with the Annex B of FGW TG3 (Rev. 25 dated on 01/09/2018 + supplement 1 dated on 22/01/2019).

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2 General Information

2.1 Testing Period and Climatic conditions

The necessary testing has been performed between the 8th of June and the 23rd of November 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 25000TL-30
Serial Number: 1900809901 (*)
Software Version: 03.10.04.R (main processor)
Rated Characteristics: Input: $1000 \text{ V}_{\text{dc,max}}$ ($390\text{-}800 \text{ V}_{\text{dc,MPPT}}$); 33 A_{dc} Max/MPPT; 3 strings per MPPT; total 2 MPPT.
Output: 3~+N 230/400Vac; 50/60 Hz; $36.2 \text{ A}_{\text{ac}}$ Max.; 25 kW; 25 kVA.

Date of manufacturing: 2017

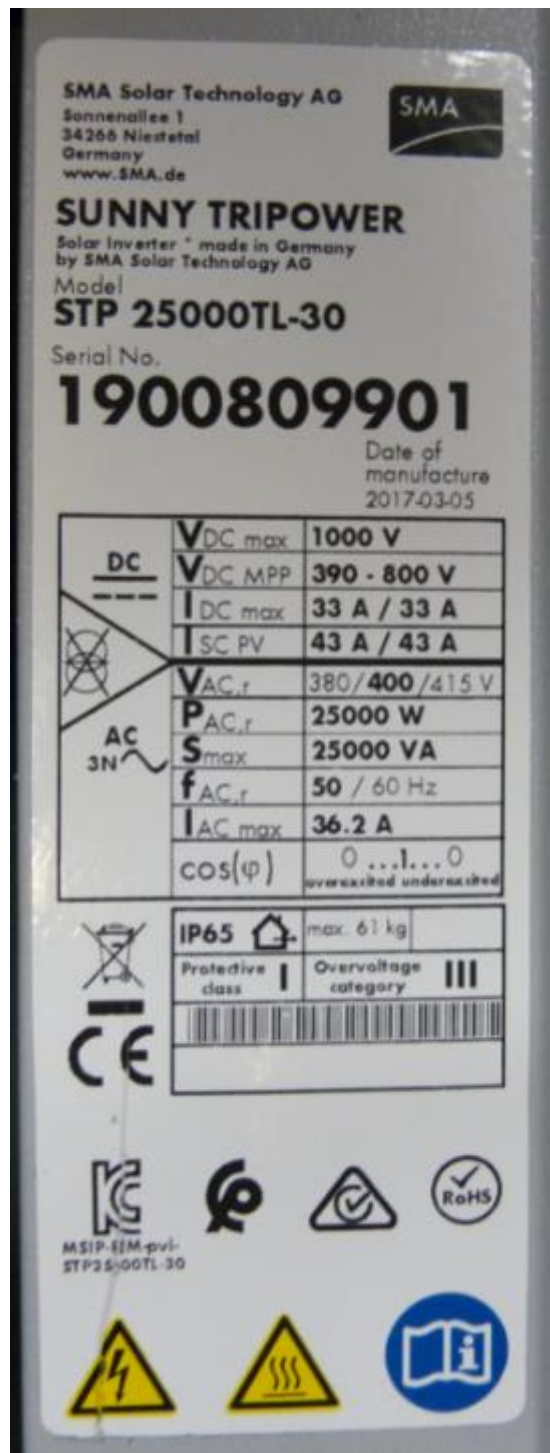
Test item particulars

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

Note: (*) Test requirements for harmonics and flickers according to FGW TG3 (rev. 25) have been repeated over variant models STP 15000TL-30 and STP 20000TL-30.
In this case, the serial number of the EUT used for these measurements has been s/n no. 1900704541. For these models the same PGU with the serial number previously mentioned has been adapted via software in order to meet with ratings of both of the mentioned variant models. In addition, these variant models share the same software and version with the fully tested model referred in this report, STP 25000TL-30.

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Copy of marking plate:



Note:

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

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Equipment under testing:

- **STP 25000TL-30**

The variants models are:

- **STP 15000TL-30**
- **STP 20000TL-30**

Model Number	STP 15000TL-30	STP 20000TL-30	STP 25000TL-30
Max. PV input voltage	1000V _{dc}		
Operating MPPT voltage range	240 V _{dc} – 800 V _{dc}	320 V _{dc} – 800 V _{dc}	390 V _{dc} – 800 V _{dc}
Rated input voltage	600 V _{dc}	600 V _{dc}	600 V _{dc}
No. Of MPP inputs	2		
Max. input current	33 A _{dc} / 33 A _{dc}	33 A _{dc} / 33 A _{dc}	33 A _{dc} / 33 A _{dc}
Rated grid voltage	3P/N/PE 220/380 V _{ac} 230/400 V _{ac} 240/415 V _{ac}		
Rated grid frequency	50Hz		
Rated output power	15000 W	20000 W	25000 W
Max. output power	15000 VA	20000 VA	25000 VA
Max. AC output Current	3x29 A _{ac}	3x29 A _{ac}	3x36.2 A _{ac}
Rated AC output Current	3x21.7 A _{ac}	3x29.0 A _{ac}	3x36.2 A _{ac}
Power factor range	1 / 0 overexcited to 0 underexcited		

All tests performed have been performed on the model STP 25000TL-30, except for 4.3.2 and 4.3.3 of FGW TG3, which have also been repeated on the models STP 15000TL-30 and STP 20000TL-30. The other test results on the model STP 25000TL-30 are essentially valid for the derived models STP 15000TL-30 and STP 20000TL-30.

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/√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.

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2.2.1 Reference Values

Reference Values STP 25000TL-30	
Rated power, P_n in kW	25
Rated apparent power, S_n in kVA	25
Rated wind speed (only WT), v_n in m/s	Not applicable
Rated current (determined), I_n in A	36.2
Rated output voltage, (phase to phase) U_n in Vac	230/400
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	

Reference Values STP 20000TL-30	
Rated power, P_n in kW	20
Rated apparent power, S_n in kVA	20
Rated wind speed (only WT), v_n in m/s	Not applicable
Rated current (determined), I_n in A	29.0
Rated output voltage, (phase to phase) U_n in Vac	230/400
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	

Reference Values STP 15000TL-30	
Rated power, P_n in kW	15
Rated apparent power, S_n in kVA	15
Rated wind speed (only WT), v_n in m/s	Not applicable
Rated current (determined), I_n in A	21.7
Rated output voltage, (phase to phase) U_n in Vac	230/400
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:

For the model Sunny Tripower STP 25000TL-30:

Nennscheinleistung S_n	25 kVA	Nennstrom I_n	36.2 A
Nennfrequenz f_n rated frequency f_n	50 Hz	Nennspannung U_n rated Voltage U_n	230 / 400 V

For the model Sunny Tripower STP 20000TL-30:

Nennscheinleistung S_n	20 kVA	Nennstrom I_n	29.0 A
Nennfrequenz f_n rated frequency f_n	50 Hz	Nennspannung U_n rated Voltage U_n	230 / 400 V

For the model Sunny Tripower STP 15000TL-30:

Nennscheinleistung S_n	15 kVA	Nennstrom I_n	21.7 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 under 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
$p_{600} = P_{600}/P_n$	25199	$p_{60} = P_{60}/P_n$	1.01	2
$p_{600} = P_{600}/P_n$	25197	$p_{60} = P_{60}/P_n$	1.01	2

Note: The MPP of the PV-generator is 28105 W corresponding to 600 Vdc. The DC Power has been varied between 20440 W and 30660 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, $k_f (\Psi_k)$	0.047	0.049	0.060	0.059
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.111	0.097	0.111	0.140

- 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, $k_f (\Psi_k)$	0.047	0.050	0.060	0.058
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.109	0.094	0.114	0.121

- 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, $k_f (\Psi_k)$	0.047	0.050	0.058	0.164
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.183	0.147	0.136	0.107

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- 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, $k_f (\Psi_k)$	0.142	0.097	0.076	0.064
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	0.945	0.739	0.468	0.199

- 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, $k_f (\Psi_k)$	0.918	0.719	0.476	0.216
Spannungsänderungsfaktor / Voltage change factor, $k_U (\Psi_k)$	1.031	0.817	0.562	0.473

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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_1 [%]
10 %	2497.321	398.489	0.146	4.517	0.016	0.362
20 %	5003.193	398.480	0.150	9.024	0.022	0.246
30 %	7483.054	398.469	0.148	13.420	0.035	0.258
40 %	9946.802	398.463	0.151	17.910	0.038	0.211
50 %	12634.431	398.457	0.153	22.590	0.043	0.191
60 %	15100.095	398.453	0.156	27.053	0.049	0.183
70 %	17483.689	398.446	0.158	31.159	0.054	0.173
80 %	19926.048	398.441	0.161	35.551	0.063	0.176
90 %	22437.601	398.434	0.163	36.686	0.063	0.170
100 %	24909.005	398.427	0.165	36.675	0.063	0.171
110 %	25217.555	398.419	0.168	36.662	0.062	0.170
120 %	25214.180	398.417	0.171	36.655	0.062	0.170

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

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3.2.4 Flicker

Table of results for STP 25000TL-30

% Pn	3	10	20	30	40	50	60	70	80	93	97	101	max
c(30°)	2.13	2.14	2.19	2.25	2.32	2.41	2.59	2.69	2.80	3.02	3.15	2.18	3.15
c(50°)	2.11	2.10	2.13	2.18	2.25	2.27	2.32	2.33	2.45	2.52	2.59	2.15	2.59
c(70°)	2.08	2.07	2.08	2.10	2.13	2.14	2.17	2.18	2.19	2.20	2.20	2.13	2.20
c(85°)	2.08	2.07	2.07	2.07	2.09	2.08	2.09	2.09	2.08	2.09	2.08	2.11	2.11
c max	2.13	2.14	2.19	2.25	2.32	2.41	2.59	2.69	2.80	3.02	3.15	2.18	3.15
Pst(30°)	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.04	0.06
Pst(50°)	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05
Pst(70°)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Pst(85°)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Pst max	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.04	0.06

Table of results for STP 20000TL-30

% Pn	3	10	20	30	40	50	60	70	80	93	97	101	max
c(30°)	2.16	2.16	2.20	2.27	2.41	2.53	2.64	2.81	3.00	3.23	3.23	2.15	3.23
c(50°)	2.13	2.12	2.15	2.19	2.33	2.30	2.35	2.47	2.57	2.65	2.65	2.13	2.65
c(70°)	2.10	2.08	2.09	2.10	2.22	2.16	2.20	2.20	2.22	2.24	2.24	2.11	2.24
c(85°)	2.09	2.07	2.07	2.08	2.19	2.09	2.10	2.09	2.09	2.10	2.09	2.09	2.19
c max	2.16	2.16	2.20	2.27	2.41	2.53	2.64	2.81	3.00	3.23	3.23	2.15	3.23
Pst(30°)	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.04	0.06
Pst(50°)	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05
Pst(70°)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Pst(85°)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Pst max	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.04	0.06

Table of results for STP 15000TL-30

% Pn	3	10	20	30	40	50	60	70	80	93	97	101	max
c(30°)	2.27	2.21	2.23	2.30	2.41	2.67	2.79	2.95	3.22	3.52	3.59	3.75	3.75
c(50°)	2.27	2.15	2.17	2.20	2.31	2.43	2.48	2.57	2.67	2.75	2.81	2.88	2.88
c(70°)	2.25	2.10	2.10	2.11	2.18	2.31	2.28	2.28	2.29	2.27	2.27	2.30	2.31
c(85°)	2.26	2.07	2.07	2.07	2.13	2.25	2.18	2.16	2.14	2.09	2.09	2.12	2.26
c max	2.27	2.21	2.23	2.30	2.41	2.67	2.79	2.95	3.22	3.52	3.59	3.75	3.75
Pst(30°)	0.05	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.08
Pst(50°)	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
Pst(70°)	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Pst(85°)	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05
Pst max	0.05	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.08

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3.2.5 Oberschwingungsmessungen / Harmonics

Test results for STP 25000TL-30												
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	3.16	10.00	20.50	30.44	40.56	50.20	60.24	70.25	80.27	90.28	99.20	99.20
2	0.06	0.08	0.12	0.16	0.19	0.21	0.21	0.21	0.23	0.25	0.25	0.25
3	0.25	0.11	0.09	0.12	0.19	0.16	0.15	0.22	0.30	0.32	0.35	0.35
4	0.05	0.07	0.04	0.06	0.09	0.11	0.09	0.12	0.16	0.19	0.13	0.19
5	0.73	0.80	0.41	0.36	0.35	0.34	0.34	0.34	0.37	0.36	0.34	0.80
6	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.04	0.06	0.04	0.03	0.06
7	0.32	0.40	0.23	0.21	0.23	0.26	0.29	0.30	0.30	0.33	0.37	0.40
8	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03
9	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
11	0.16	0.09	0.11	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20	0.20
12	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
13	0.12	0.08	0.06	0.07	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.15
14	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
15	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
16	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
17	0.03	0.05	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.09	0.09
18	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
19	0.02	0.03	0.03	0.03	0.04	0.05	0.06	0.06	0.06	0.07	0.08	0.08
20	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	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	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	0.01	0.03	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.06	0.07	0.07
24	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	0.02	0.03	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06
26	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01
27	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
28	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
29	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.05
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.01	0.01	0.02	0.01	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04
32	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04
38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	0.01	0.01	0.01	0.01	0.01	0.01	0.01	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	0.00	0.00
41	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04
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	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05
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	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	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	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04
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	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
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	0.87	0.90	0.52	0.48	0.54	0.55	0.55	0.59	0.65	0.69	0.68	0.90

FGW-TG3+SP1

Test results for STP 20000TL-30												
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	3.05	10.02	20.58	30.63	40.66	50.43	60.46	70.44	80.62	90.52	99.85	99.85
2	0.09	0.07	0.09	0.11	0.12	0.14	0.18	0.17	0.16	0.22	0.17	0.22
3	0.14	0.12	0.15	0.20	0.27	0.27	0.27	0.23	0.22	0.22	0.14	0.27
4	0.05	0.05	0.05	0.06	0.07	0.10	0.11	0.09	0.09	0.12	0.06	0.12
5	0.30	0.41	0.39	0.41	0.42	0.41	0.40	0.39	0.38	0.37	0.31	0.42
6	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.06	0.04	0.06
7	0.19	0.23	0.18	0.22	0.23	0.25	0.27	0.26	0.26	0.27	0.29	0.29
8	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.03	0.05
9	0.04	0.04	0.05	0.06	0.06	0.07	0.07	0.06	0.06	0.06	0.04	0.07
10	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04
11	0.07	0.12	0.09	0.12	0.14	0.14	0.15	0.15	0.17	0.17	0.18	0.18
12	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04
13	0.06	0.10	0.05	0.10	0.13	0.15	0.15	0.16	0.16	0.17	0.17	0.17
14	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
15	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.03	0.05
16	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03
17	0.02	0.04	0.03	0.04	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.10
18	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
19	0.03	0.03	0.04	0.03	0.05	0.06	0.07	0.07	0.08	0.08	0.08	0.08
20	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02
21	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
22	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	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.07	0.07
24	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	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.07
26	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	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	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	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06
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	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05
32	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
33	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
34	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
35	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05
36	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
37	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05
38	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
39	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03
40	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
41	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.06
42	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
43	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06
44	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
45	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
46	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
47	0.01	0.01	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06
48	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
49	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04
50	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
THDi	0.42	0.51	0.49	0.56	0.61	0.64	0.64	0.63	0.63	0.63	0.59	0.64

FGW-TG3+SP1

Test results for STP 15000TL-30												
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	3.03	10.06	20.47	30.31	40.56	50.36	60.42	70.48	80.48	90.49	100.17	100.17
2	0.12	0.09	0.10	0.11	0.13	0.17	0.20	0.25	0.31	0.28	0.27	0.31
3	0.10	0.08	0.10	0.11	0.15	0.17	0.19	0.23	0.18	0.15	0.11	0.23
4	0.06	0.05	0.06	0.05	0.06	0.06	0.09	0.11	0.21	0.12	0.09	0.21
5	0.31	0.50	0.56	0.53	0.52	0.53	0.52	0.51	0.48	0.46	0.44	0.56
6	0.04	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.03	0.05
7	0.31	0.37	0.24	0.26	0.30	0.33	0.35	0.37	0.37	0.37	0.38	0.38
8	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.04	0.03	0.04
9	0.04	0.04	0.04	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06
10	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
11	0.09	0.10	0.11	0.11	0.15	0.17	0.18	0.19	0.19	0.20	0.20	0.20
12	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
13	0.04	0.06	0.08	0.05	0.09	0.11	0.12	0.13	0.14	0.14	0.15	0.15
14	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
15	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
16	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
17	0.02	0.02	0.06	0.02	0.03	0.05	0.06	0.07	0.08	0.08	0.08	0.08
18	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
19	0.02	0.02	0.05	0.02	0.02	0.03	0.05	0.05	0.06	0.06	0.06	0.06
20	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	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
22	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	0.02	0.02	0.04	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.06	0.06
24	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	0.01	0.02	0.03	0.02	0.02	0.03	0.04	0.05	0.05	0.05	0.06	0.06
26	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	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
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	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05
30	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
31	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04
32	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	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	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
35	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
36	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
37	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04
38	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
39	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02
40	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
41	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05
42	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
43	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04
44	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
45	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
46	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
47	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04
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	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	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	0.49	0.65	0.65	0.63	0.67	0.71	0.73	0.75	0.78	0.73	0.71	0.78

3.2.6 Zwischenharmonische / Interharmonics

[illegible]

FGW-TG3+SP1

Test results for STP 20000TL-30												
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	0.05	0.06	0.05	0.07	0.10	0.14	0.15	0.09	0.10	0.14	0.07	0.15
2.5	0.06	0.05	0.05	0.06	0.10	0.10	0.12	0.09	0.09	0.11	0.05	0.12
3.5	0.06	0.06	0.06	0.07	0.10	0.16	0.19	0.10	0.10	0.17	0.06	0.19
4.5	0.05	0.06	0.06	0.07	0.09	0.10	0.12	0.10	0.09	0.11	0.06	0.12
5.5	0.05	0.05	0.06	0.07	0.08	0.09	0.09	0.09	0.08	0.09	0.05	0.09
6.5	0.05	0.05	0.06	0.07	0.07	0.08	0.08	0.08	0.07	0.08	0.05	0.08
7.5	0.05	0.05	0.06	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.05	0.07
8.5	0.04	0.04	0.05	0.06	0.06	0.06	0.07	0.06	0.06	0.07	0.05	0.07
9.5	0.04	0.04	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.04	0.06
10.5	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.05	0.06	0.06	0.04	0.06
11.5	0.04	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05
12.5	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.05	0.04	0.05
13.5	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04
14.5	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.04
15.5	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.04
16.5	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
17.5	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
18.5	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.03
19.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03
20.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
21.5	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
22.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
23.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
24.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
25.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
26.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
27.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02
28.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02
29.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02
30.5	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02
31.5	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02
32.5	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02
33.5	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02
34.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
35.5	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02
36.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02
37.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.02
38.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
39.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
40.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
41.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
42.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
43.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
44.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
45.5	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
46.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
47.5	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
48.5	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02
49.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02

[illegible]

3.2.7 Höhere Frequenzen / Higher Frequencies components

[illegible]

[illegible]

[illegible]

3.3 Grid Control Capability

3.3.1 Wirkleistungseinspeisung in Abhängigkeit der Netzfrequenz / Active power vs frequency

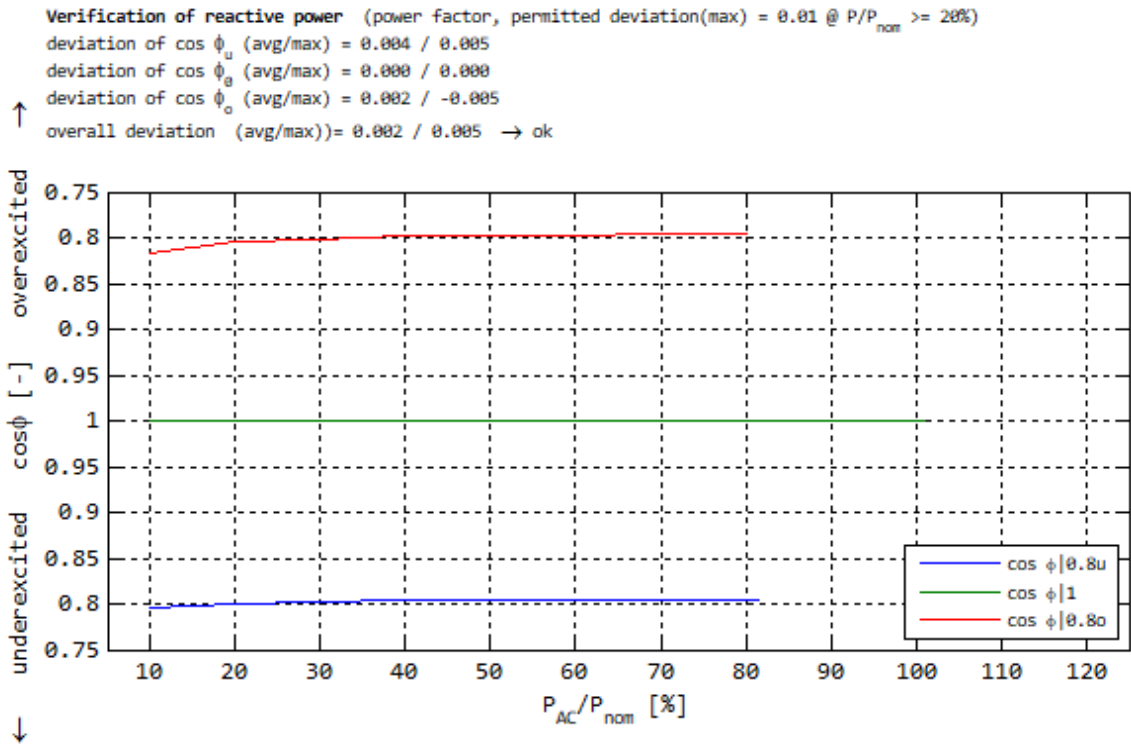
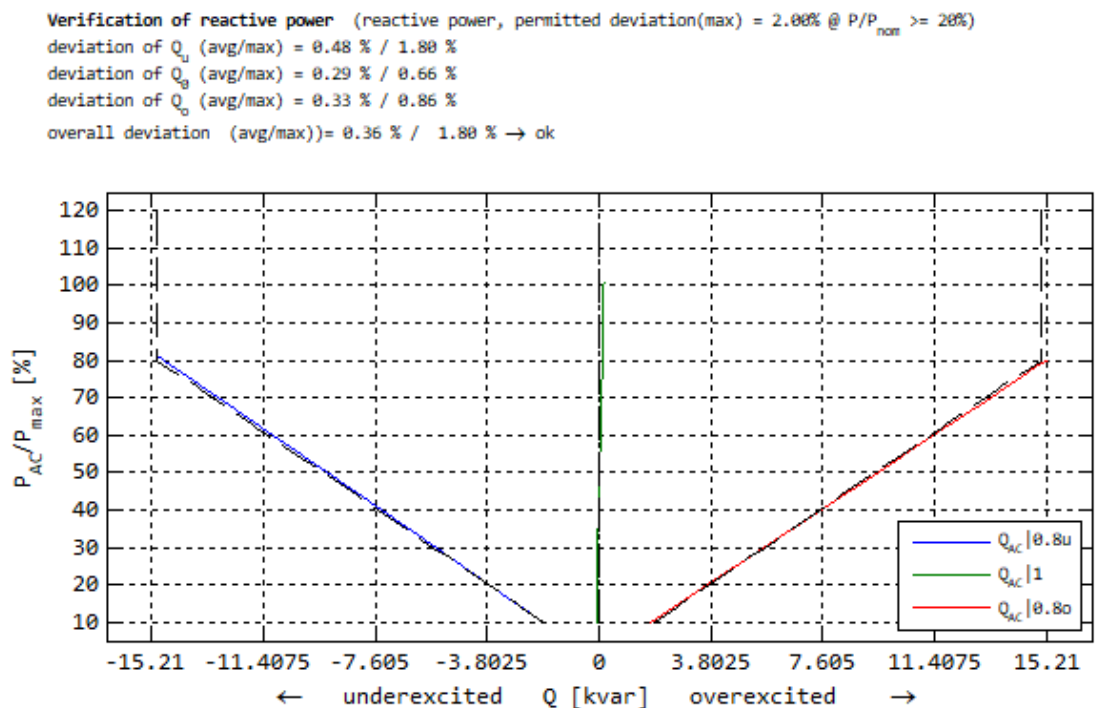
Überfrequenz / overfrequency	Mittlerer Gradient der Wirkleistung sum Zeitpunkt der Frequenzüberhöhung / Mean power gradient at overfrequency	mittl. Gradient / mean gradient Test at 100%Pn: -39.86 % P _M /Hz Test at 50%Pn: -39.62 % P _M /Hz	
	Max. Einschwingzeit / Max. Settling time	1.00 s	
	Gradient 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 38.10 % P _M /Hz	
	Max. Einschwingzeit / Max. Settling time	0.58 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 341.8 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 : 47.7 s Gradient: 0.33 % Pn / s	
	Pmin -> P0	Zeit / time : 43.1 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 : 138.3 s Gradient: 0.65 % Pn / s	
	Pmin -> P0	Zeit / time : 129.0 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%	1.750	-0.100	-1.900	70%	13.150	0.075	-12.750
	20%	3.650	-0.075	-3.725	80%	15.050	0.100	-14.550
	30%	5.550	-0.025	-5.500	90%	15.225	0.125	-15.025
	40%	7.450	0.000	-7.350	100%	15.200	0.150	-15.025
	50%	9.500	0.025	-9.250	110%	15.200	0.175	-15.000
	60%	11.375	0.050	-11.075	120%	15.200	0.175	-15.000
Arbeitspunkte des spannungsabhängigen P-Q Diagramms / Working points of the voltage dependent P-Q diagram	Q in kVAr							
	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 Einschwingzeit / Longest response time	Parameter				Einschwingzeit / settling time			
	T < 6 s				10.4 s (maximum measured)			
	Standardzeit / standard time				--			
	T < 60 s				91.6 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)				0.796			
	PF = 0.8 (Over excited)				-0.805			
	PF = 1.0				1.000			
	Sollwert / setpoint. Mode tested: <i>PF Const at 50%Pn</i>				Istwert / measured value			
	PF = 0.8 (Under excited)				0.798			
	PF = 0.8 (Over excited)				-0.805			
	PF = 1.0				1.000			
	Sollwert / setpoint. Mode tested: <i>VAr Const at 50%Pn</i>				Istwert / measured value			
	12.500 kVAr				12.625 kVAr			
	-12.500 kVAr				-12.525 kVAr			
	0.000 kVAr				0.025 kVAr			
	Sollwert / setpoint. Mode tested: <i>VAr Const Nominal at 50%Pn</i>				Istwert / measured value			
	50%Sn				50.5%Sn			
	-50%Sn				-50.1%sn			
	0%Sn				0.1%Sn			
Anmerkung / remark	Soweit Q(U) und Q(P)- Regelung wurde, sind diese im Prüfbericht hinterlegt / See Q(U) and Q(P) in test report							

FGW-TG3+SP1

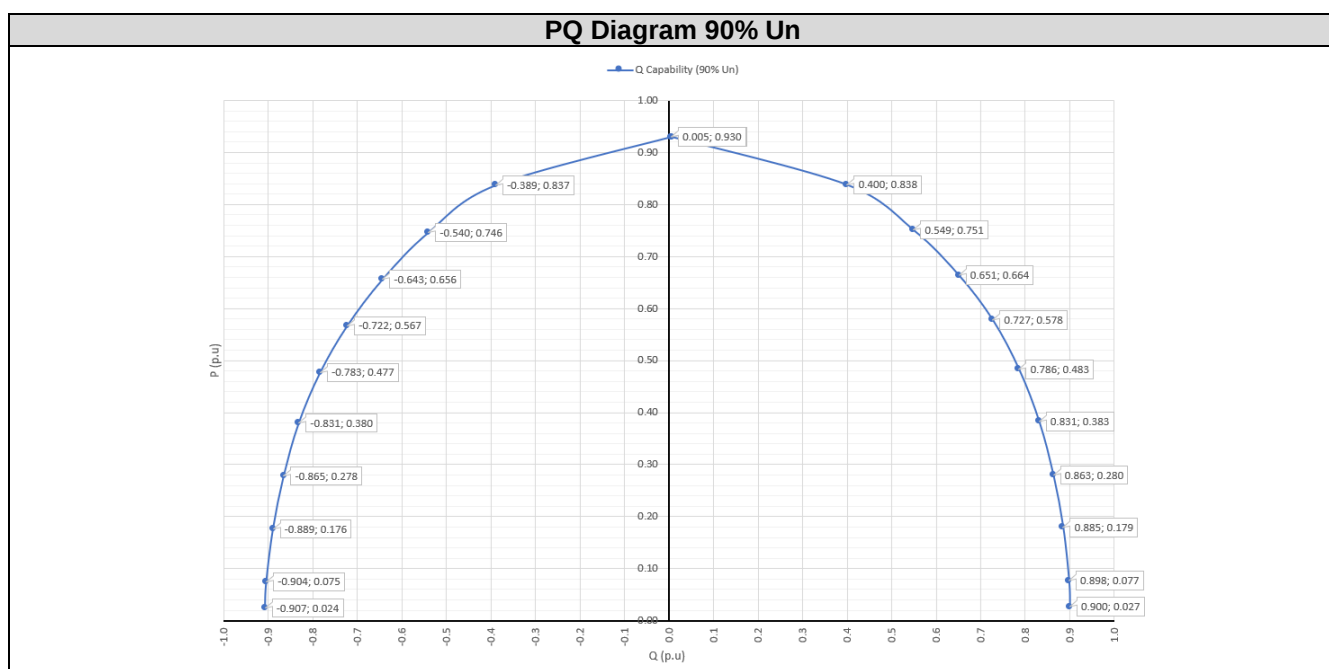
In following charts, they are offered main results after performed tests included in the FGW TG3 test report.

Active Power over Power Factor. Fixed Power Factor

Active Power over Reactive Power. Fixed Power Factor


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The tables below show 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	0.675	0.027	22.525	0.901	22.500	0.900	0.030
2	358.4	1.925	0.077	22.525	0.901	22.450	0.898	0.086
3	358.4	4.475	0.179	22.575	0.903	22.125	0.885	0.198
4	358.4	7.000	0.280	22.700	0.908	21.575	0.863	0.308
5	358.4	9.575	0.383	22.900	0.916	20.775	0.831	0.419
6	358.4	12.075	0.483	23.075	0.923	19.650	0.786	0.523
7	358.4	14.450	0.578	23.225	0.929	18.175	0.727	0.622
8	358.4	16.600	0.664	23.250	0.930	16.275	0.651	0.714
9	358.4	18.775	0.751	23.250	0.930	13.725	0.549	0.807
10	358.4	20.950	0.838	23.225	0.929	10.000	0.400	0.902
11	358.4	23.250	0.930	23.250	0.930	0.175	0.007	1.000
12	358.4	23.250	0.930	23.250	0.930	0.125	0.005	1.000
13	358.4	20.925	0.837	23.075	0.923	-9.725	-0.389	0.907
14	358.4	18.650	0.746	23.025	0.921	-13.500	-0.540	0.810
15	358.4	16.400	0.656	22.975	0.919	-16.075	-0.643	0.714
16	358.4	14.175	0.567	22.950	0.918	-18.050	-0.722	0.618
17	358.4	11.925	0.477	22.925	0.917	-19.575	-0.783	0.520
18	358.4	9.500	0.380	22.825	0.913	-20.775	-0.831	0.416
19	358.4	6.950	0.278	22.700	0.908	-21.625	-0.865	0.306
20	358.4	4.400	0.176	22.650	0.906	-22.225	-0.889	0.194
21	358.4	1.875	0.075	22.675	0.907	-22.600	-0.904	0.082
22	358.4	0.600	0.024	22.675	0.907	-22.675	-0.907	0.026

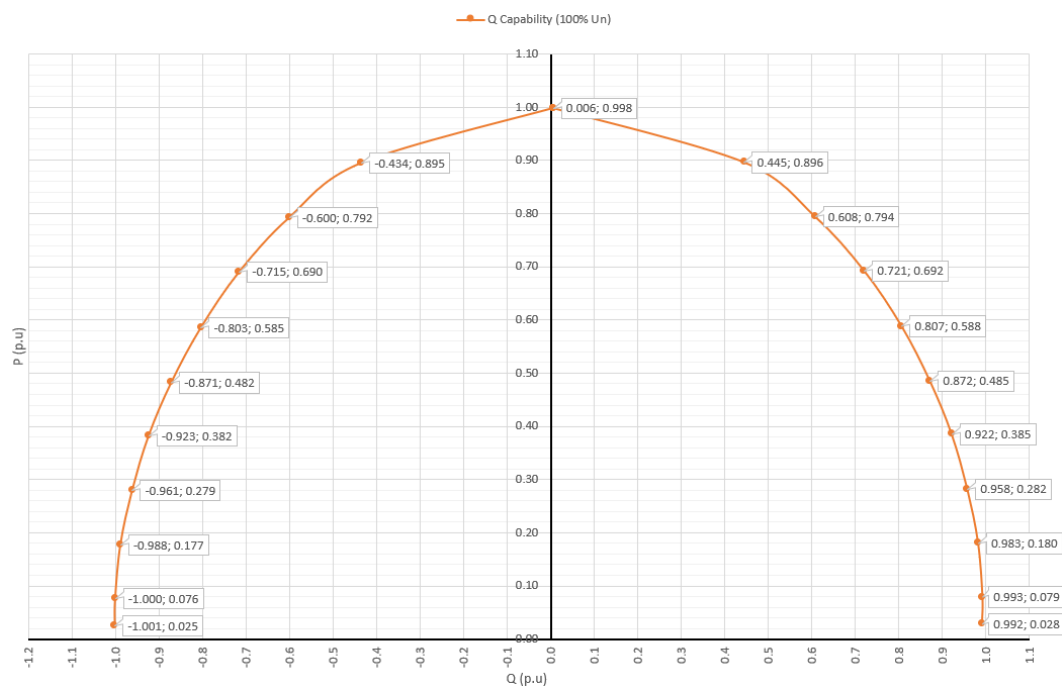


FGW-TG3+SP1

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	0.700	0.028	24.825	0.993	24.800	0.992	0.029
2	398.4	1.975	0.079	24.900	0.996	24.825	0.993	0.080
3	398.4	4.500	0.180	24.975	0.999	24.575	0.983	0.180
4	398.4	7.050	0.282	24.975	0.999	23.950	0.958	0.283
5	398.4	9.625	0.385	24.975	0.999	23.050	0.922	0.385
6	398.4	12.125	0.485	24.950	0.998	21.800	0.872	0.486
7	398.4	14.700	0.588	24.950	0.998	20.175	0.807	0.589
8	398.4	17.300	0.692	25.000	1.000	18.025	0.721	0.692
9	398.4	19.850	0.794	25.000	1.000	15.200	0.608	0.794
10	398.4	22.400	0.896	25.000	1.000	11.125	0.445	0.896
11	398.4	24.950	0.998	24.950	0.998	0.150	0.006	1.000
12	398.4	24.950	0.998	24.950	0.998	0.150	0.006	1.000
13	398.4	22.375	0.895	24.875	0.995	-10.850	-0.434	0.900
14	398.4	19.800	0.792	24.825	0.993	-15.000	-0.600	0.797
15	398.4	17.250	0.690	24.850	0.994	-17.875	-0.715	0.694
16	398.4	14.625	0.585	24.850	0.994	-20.075	-0.803	0.589
17	398.4	12.050	0.482	24.875	0.995	-21.775	-0.871	0.484
18	398.4	9.550	0.382	24.975	0.999	-23.075	-0.923	0.382
19	398.4	6.975	0.279	25.025	1.001	-24.025	-0.961	0.279
20	398.4	4.425	0.177	25.100	1.004	-24.700	-0.988	0.177
21	398.4	1.900	0.076	25.075	1.003	-25.000	-1.000	0.075
22	398.4	0.625	0.025	25.025	1.001	-25.025	-1.001	0.025

PQ Diagram 100% Un

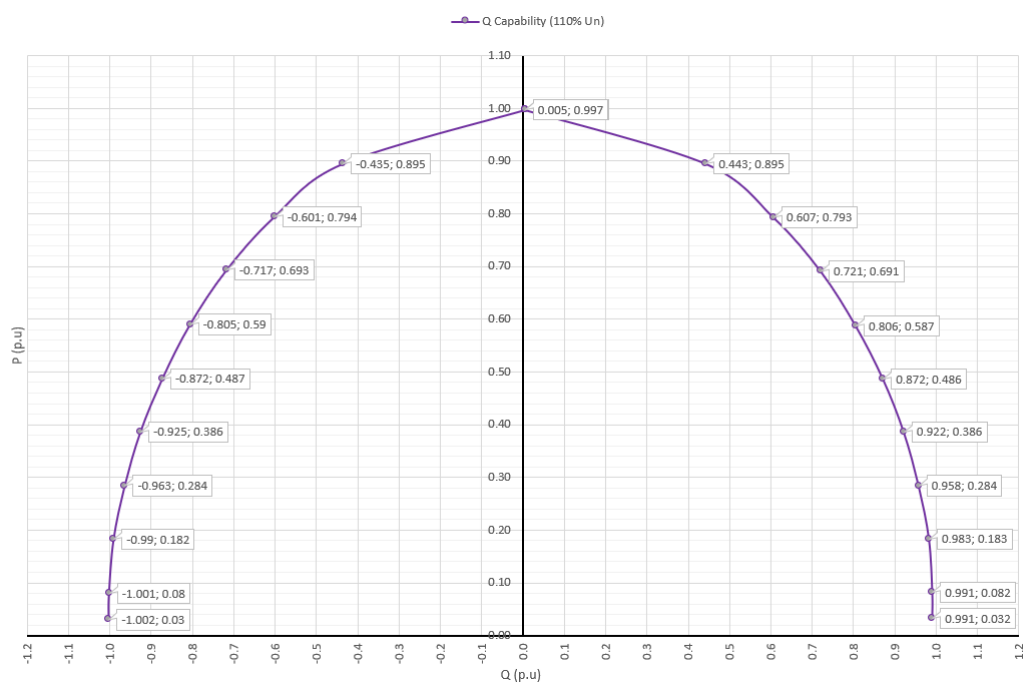


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PQ Diagram 110% Un

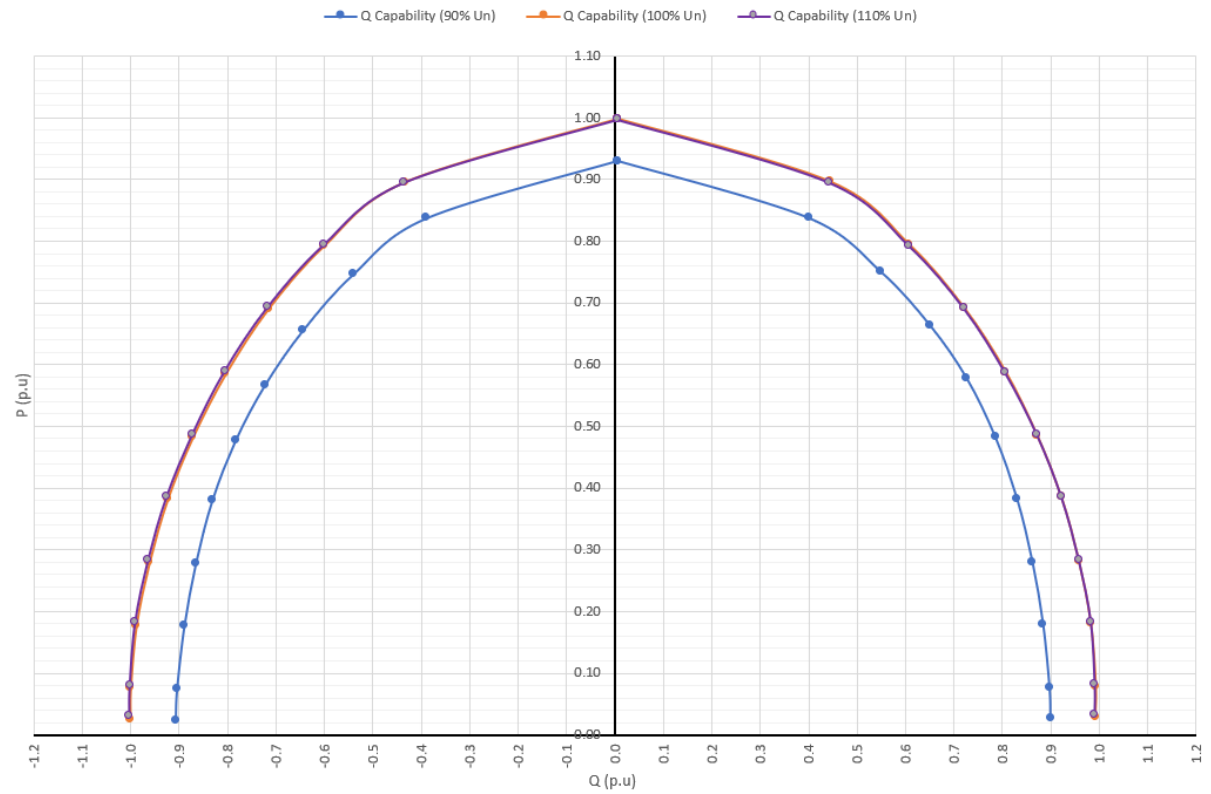
Step	V _{AC} (V)	P measured (kW)	P meas. (P/Sn)	S meas. (kVA)	S meas. (P/Sn)	Q meas. (kVAr)	Q meas. (P/Sn)	PF
1	438.0	0.800	0.032	24.775	0.991	24.775	0.991	0.032
2	438.0	2.050	0.082	24.875	0.995	24.775	0.991	0.083
3	438.0	4.575	0.183	25.000	1.000	24.575	0.983	0.183
4	438.0	7.100	0.284	24.975	0.999	23.950	0.958	0.284
5	438.0	9.650	0.386	24.975	0.999	23.050	0.922	0.386
6	438.0	12.150	0.486	24.950	0.998	21.800	0.872	0.487
7	438.0	14.675	0.587	24.950	0.998	20.150	0.806	0.589
8	438.0	17.275	0.691	24.975	0.999	18.025	0.721	0.692
9	438.0	19.825	0.793	24.975	0.999	15.175	0.607	0.794
10	438.0	22.375	0.895	24.975	0.999	11.075	0.443	0.896
11	438.0	24.925	0.997	24.925	0.997	0.150	0.006	1.000
12	438.0	24.925	0.997	24.925	0.997	0.125	0.005	1.000
13	438.0	22.375	0.895	24.875	0.995	-10.875	-0.435	0.899
14	438.0	19.850	0.794	24.900	0.996	-15.025	-0.601	0.797
15	438.0	17.325	0.693	24.925	0.997	-17.925	-0.717	0.695
16	438.0	14.750	0.590	24.950	0.998	-20.125	-0.805	0.591
17	438.0	12.175	0.487	24.975	0.999	-21.800	-0.872	0.487
18	438.0	9.650	0.386	25.050	1.002	-23.125	-0.925	0.385
19	438.0	7.100	0.284	25.100	1.004	-24.075	-0.963	0.283
20	438.0	4.550	0.182	25.175	1.007	-24.750	-0.990	0.181
21	438.0	2.000	0.080	25.100	1.004	-25.025	-1.001	0.080
22	438.0	0.750	0.030	25.050	1.002	-25.050	-1.002	0.030

PQ Diagram 110% Un



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PQ Diagram Summary



The certified PV inverter fulfils the following P-Q diagram at different voltage levels, as stated in the Manufacturer Declaration: "SUNNY TRIPOWER STP xx000TL-30. Reactive Power Capability"

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Amtsgericht Kassel (District court) Kassel HRB (registration number) 3972
Vorsitzender des Aufsichtsrats (Chairman of the Supervisory Board): Uwe Kleinkauf
Vorstand (Managing Board): Dr.-Ing. Jürgen Reinert (CEO), Ulrich Hadding



SUNNY TRIPOWER STP xx000TL-30 Reactive Power Capability

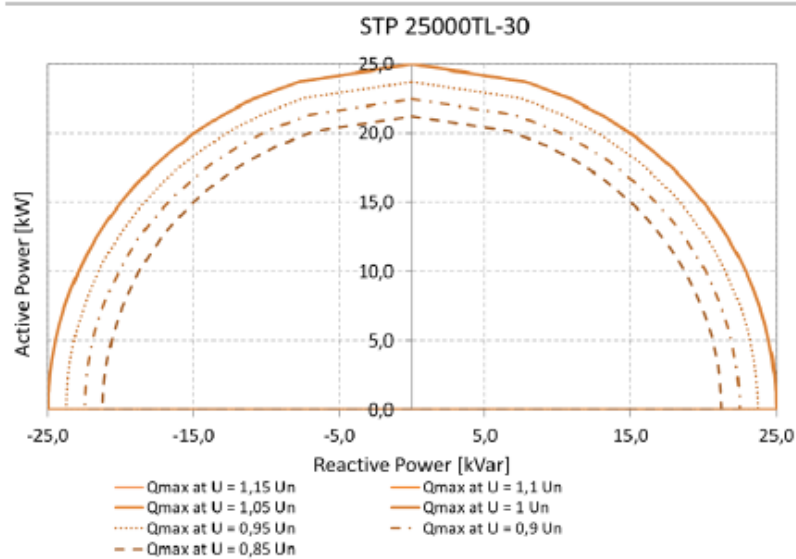


Figure 1: STP 25000TL-30 operating range depending on the grid voltage

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$U_{grid} = 0,85 \text{ p.u. } U_n$					$U_{grid} = 0,90 \text{ p.u. } U_n$				
P_{in} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]	P_{in} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]
21,2	0,0	21,2	0,0	21,2	22,5	0,0	22,5	0,0	22,5
20,2	6,6	20,2	-6,6	20,2	21,4	7,0	21,4	-7,0	21,4
19,1	9,3	19,1	-9,3	19,1	20,2	9,8	20,2	-9,8	20,2
18,0	11,2	18,0	-11,2	18,0	19,1	11,8	19,1	-11,8	19,1
17,0	12,7	17,0	-12,7	17,0	18,0	13,5	18,0	-13,5	18,0
15,9	14,0	15,9	-14,0	15,9	16,9	14,9	16,9	-14,9	16,9
14,9	15,2	14,9	-15,2	14,9	15,7	16,1	15,7	-16,1	15,7
13,8	16,1	13,8	-16,1	13,8	14,6	17,1	14,6	-17,1	14,6
12,7	17,0	12,7	-17,0	12,7	13,5	18,0	13,5	-18,0	13,5
11,7	17,7	11,7	-17,7	11,7	12,4	18,8	12,4	-18,8	12,4
10,6	18,4	10,6	-18,4	10,6	11,2	19,5	11,2	-19,5	11,2
9,6	19,0	9,6	-19,0	9,6	10,1	20,1	10,1	-20,1	10,1
8,5	19,6	8,5	-19,6	8,5	9,0	20,6	9,0	-20,6	9,0
7,4	19,9	7,4	-19,9	7,4	7,9	21,1	7,9	-21,1	7,9
6,4	20,3	6,4	-20,3	6,4	6,7	21,4	6,7	-21,4	6,7
5,3	20,6	5,3	-20,6	5,3	5,6	21,8	5,6	-21,8	5,6
4,2	20,8	4,2	-20,8	4,2	4,5	22,0	4,5	-22,0	4,5
3,2	21,0	3,2	-21,0	3,2	3,4	22,2	3,4	-22,2	3,4
2,1	21,1	2,1	-21,1	2,1	2,2	22,4	2,2	-22,4	2,2
1,1	21,2	1,1	-21,2	1,1	1,1	22,5	1,1	-22,5	1,1
0,0	21,2	0,0	-21,2	0,0	0,0	22,5	0,0	-22,5	0,0

$U_{grid} = 0,95 \text{ p.u. } U_n$					$U_{grid} = 1,00 \text{ p.u. } U_n$				
P_{in} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]	P_{in} [kW]	$Q_{undershot}$ [kVar]	$P_{available}$ [kW]	$Q_{overshot}$ [kVar]	$P_{available}$ [kW]
23,7	0,0	23,7	0,0	23,7	25,0	0,0	25,0	0,0	25,0
22,5	7,4	22,5	-7,4	22,5	23,7	7,8	23,7	-7,8	23,7
21,4	10,3	21,4	-10,3	21,4	22,5	10,9	22,5	-10,9	22,5
20,2	12,5	20,2	-12,5	20,2	21,2	13,2	21,2	-13,2	21,2
19,0	14,2	19,0	-14,2	19,0	20,0	15,0	20,0	-15,0	20,0
17,8	15,7	17,8	-15,7	17,8	18,7	16,5	18,7	-16,5	18,7
16,6	16,9	16,6	-16,9	16,6	17,5	17,8	17,5	-17,8	17,5
15,4	18,0	15,4	-18,0	15,4	16,2	19,0	16,2	-19,0	16,2
14,2	19,0	14,2	-19,0	14,2	15,0	20,0	15,0	-20,0	15,0
13,1	19,8	13,1	-19,8	13,1	13,7	20,9	13,7	-20,9	13,7
11,9	20,6	11,9	-20,6	11,9	12,5	21,6	12,5	-21,6	12,5
10,7	21,2	10,7	-21,2	10,7	11,2	22,3	11,2	-22,3	11,2
9,5	21,7	9,5	-21,7	9,5	10,0	22,9	10,0	-22,9	10,0
8,3	22,2	8,3	-22,2	8,3	8,7	23,4	8,7	-23,4	8,7
7,1	22,6	7,1	-22,6	7,1	7,5	23,8	7,5	-23,8	7,5
5,9	23,0	5,9	-23,0	5,9	6,2	24,2	6,2	-24,2	6,2
4,7	23,2	4,7	-23,2	4,7	5,0	24,5	5,0	-24,5	5,0
3,6	23,5	3,6	-23,5	3,6	3,7	24,7	3,7	-24,7	3,7
2,4	23,6	2,4	-23,6	2,4	2,5	24,9	2,5	-24,9	2,5
1,2	23,7	1,2	-23,7	1,2	1,2	24,9	1,2	-24,9	1,2
0,0	23,7	0,0	-23,7	0,0	0,0	25,0	0,0	-25,0	0,0

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

Table 1: STP 25000TL-30 P/Q operating range at different grid voltages between 0,85 and 1,15 p.u.

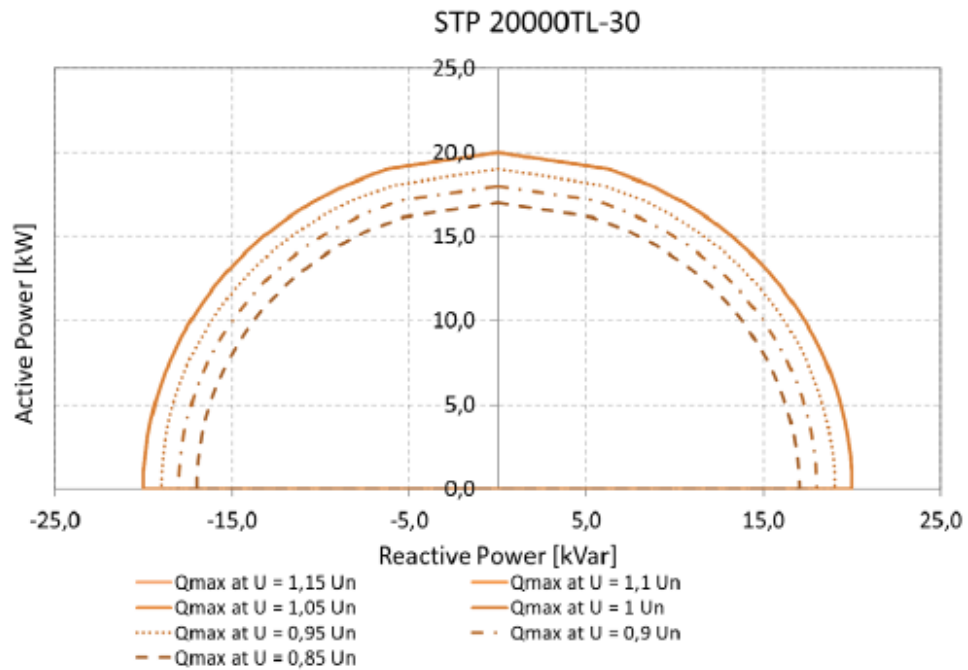


Figure 2: STP 20000TL-30 operating range depending on the grid voltage

FGW-TG3+SP1

$U_{grid} = 0,85 \text{ p.u. } U_n$					$U_{grid} = 0,90 \text{ p.u. } U_n$				
P _{in} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]	P _{in} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]
17,0	0,0	17,0	0,0	17,0	18,0	0,0	18,0	0,0	18,0
16,2	5,3	16,2	-5,3	16,2	17,1	5,6	17,1	-5,6	17,1
15,3	7,4	15,3	-7,4	15,3	16,2	7,8	16,2	-7,8	16,2
14,5	9,0	14,5	-9,0	14,5	15,3	9,5	15,3	-9,5	15,3
13,6	10,2	13,6	-10,2	13,6	14,4	10,8	14,4	-10,8	14,4
12,8	11,3	12,8	-11,3	12,8	13,5	11,9	13,5	-11,9	13,5
11,9	12,1	11,9	-12,1	11,9	12,6	12,9	12,6	-12,9	12,6
11,1	12,9	11,1	-12,9	11,1	11,7	13,7	11,7	-13,7	11,7
10,2	13,6	10,2	-13,6	10,2	10,8	14,4	10,8	-14,4	10,8
9,4	14,2	9,4	-14,2	9,4	9,9	15,0	9,9	-15,0	9,9
8,5	14,7	8,5	-14,7	8,5	9,0	15,6	9,0	-15,6	9,0
7,7	15,2	7,7	-15,2	7,7	8,1	16,1	8,1	-16,1	8,1
6,8	15,6	6,8	-15,6	6,8	7,2	16,5	7,2	-16,5	7,2
6,0	15,9	6,0	-15,9	6,0	6,3	16,9	6,3	-16,9	6,3
5,1	16,2	5,1	-16,2	5,1	5,4	17,2	5,4	-17,2	5,4
4,3	16,5	4,3	-16,5	4,3	4,5	17,4	4,5	-17,4	4,5
3,4	16,7	3,4	-16,7	3,4	3,6	17,6	3,6	-17,6	3,6
2,6	16,8	2,6	-16,8	2,6	2,7	17,8	2,7	-17,8	2,7
1,7	16,9	1,7	-16,9	1,7	1,8	17,9	1,8	-17,9	1,8
0,9	17,0	0,9	-17,0	0,9	0,9	18,0	0,9	-18,0	0,9
0,0	17,0	0,0	-17,0	0,0	0,0	18,0	0,0	-18,0	0,0
$U_{grid} = 0,95 \text{ p.u. } U_n$					$U_{grid} = 1,00 \text{ p.u. } U_n$				
P _{in} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]	P _{in} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]	Q _{underscotted} [kVar]	P _{available} [kW]
19,0	0,0	19,0	0,0	19,0	20,0	0,0	20,0	0,0	20,0
18,1	5,9	18,1	-5,9	18,1	19,0	6,2	19,0	-6,2	19,0
17,1	8,3	17,1	-8,3	17,1	18,0	8,7	18,0	-8,7	18,0
16,2	10,0	16,2	-10,0	16,2	17,0	10,5	17,0	-10,5	17,0
15,2	11,4	15,2	-11,4	15,2	16,0	12,0	16,0	-12,0	16,0
14,3	12,6	14,3	-12,6	14,3	15,0	13,2	15,0	-13,2	15,0
13,3	13,6	13,3	-13,6	13,3	14,0	14,3	14,0	-14,3	14,0
12,4	14,4	12,4	-14,4	12,4	13,0	15,2	13,0	-15,2	13,0
11,4	15,2	11,4	-15,2	11,4	12,0	16,0	12,0	-16,0	12,0
10,5	15,9	10,5	-15,9	10,5	11,0	16,7	11,0	-16,7	11,0
9,5	16,5	9,5	-16,5	9,5	10,0	17,3	10,0	-17,3	10,0
8,6	17,0	8,6	-17,0	8,6	9,0	17,9	9,0	-17,9	9,0
7,6	17,4	7,6	-17,4	7,6	8,0	18,3	8,0	-18,3	8,0
6,7	17,8	6,7	-17,8	6,7	7,0	18,7	7,0	-18,7	7,0
5,7	18,1	5,7	-18,1	5,7	6,0	19,1	6,0	-19,1	6,0
4,8	18,4	4,8	-18,4	4,8	5,0	19,4	5,0	-19,4	5,0
3,8	18,6	3,8	-18,6	3,8	4,0	19,6	4,0	-19,6	4,0
2,9	18,8	2,9	-18,8	2,9	3,0	19,8	3,0	-19,8	3,0
1,9	18,9	1,9	-18,9	1,9	2,0	19,9	2,0	-19,9	2,0
1,0	19,0	1,0	-19,0	1,0	1,0	20,0	1,0	-20,0	1,0
0,0	19,0	0,0	-19,0	0,0	0,0	20,0	0,0	-20,0	0,0

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

Table 2: STP 20000TL-30 P/Q operating range at different grid voltages between 0,85 and 1,15 p.u.

FGW-TG3+SP1

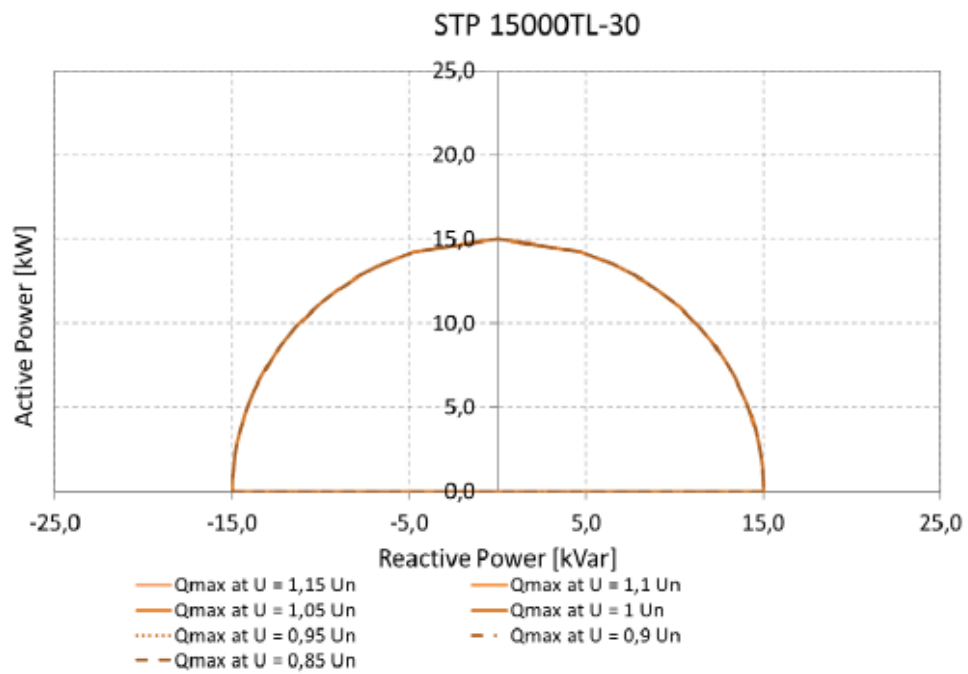


Figure 3: STP 15000TL-30 operating range depending on the grid voltage

FGW-TG3+SP1

$U_{grid} = 0,85 \text{ p.u. } U_n$					$U_{grid} = 0,90 \text{ p.u. } U_n$				
P_{bin} [kW]	$Q_{underecited}$ [kVar]	$P_{available}$ [kW]	$Q_{overexcited}$ [kVar]	$P_{available}$ [kW]	P_{bin} [kW]	$Q_{underecited}$ [kVar]	$P_{available}$ [kW]	$Q_{overexcited}$ [kVar]	$P_{available}$ [kW]
15,0	0,0	15,0	0,0	15,0	15,0	0,0	15,0	0,0	15,0
14,3	4,7	14,3	-4,7	14,3	14,3	4,7	14,3	-4,7	14,3
13,5	6,5	13,5	-6,5	13,5	13,5	6,5	13,5	-6,5	13,5
12,8	7,9	12,8	-7,9	12,8	12,8	7,9	12,8	-7,9	12,8
12,0	9,0	12,0	-9,0	12,0	12,0	9,0	12,0	-9,0	12,0
11,3	9,9	11,3	-9,9	11,3	11,3	9,9	11,3	-9,9	11,3
10,5	10,7	10,5	-10,7	10,5	10,5	10,7	10,5	-10,7	10,5
9,8	11,4	9,8	-11,4	9,8	9,8	11,4	9,8	-11,4	9,8
9,0	12,0	9,0	-12,0	9,0	9,0	12,0	9,0	-12,0	9,0
8,3	12,5	8,3	-12,5	8,3	8,3	12,5	8,3	-12,5	8,3
7,5	13,0	7,5	-13,0	7,5	7,5	13,0	7,5	-13,0	7,5
6,8	13,4	6,8	-13,4	6,8	6,8	13,4	6,8	-13,4	6,8
6,0	13,7	6,0	-13,7	6,0	6,0	13,7	6,0	-13,7	6,0
5,2	14,1	5,2	-14,1	5,2	5,2	14,1	5,2	-14,1	5,2
4,5	14,3	4,5	-14,3	4,5	4,5	14,3	4,5	-14,3	4,5
3,7	14,5	3,7	-14,5	3,7	3,7	14,5	3,7	-14,5	3,7
3,0	14,7	3,0	-14,7	3,0	3,0	14,7	3,0	-14,7	3,0
2,2	14,8	2,2	-14,8	2,2	2,2	14,8	2,2	-14,8	2,2
1,5	14,9	1,5	-14,9	1,5	1,5	14,9	1,5	-14,9	1,5
0,7	15,0	0,7	-15,0	0,7	0,7	15,0	0,7	-15,0	0,7
0,0	15,0	0,0	-15,0	0,0	0,0	15,0	0,0	-15,0	0,0

$U_{grid} = 0,95 \text{ p.u. } U_n$					$U_{grid} = 1,00 \text{ p.u. } U_n$				
P_{bin} [kW]	$Q_{underecited}$ [kVar]	$P_{available}$ [kW]	$Q_{overexcited}$ [kVar]	$P_{available}$ [kW]	P_{bin} [kW]	$Q_{underecited}$ [kVar]	$P_{available}$ [kW]	$Q_{overexcited}$ [kVar]	$P_{available}$ [kW]
15,0	0,0	15,0	0,0	15,0	15,0	0,0	15,0	0,0	15,0
14,3	4,7	14,3	-4,7	14,3	14,3	4,7	14,3	-4,7	14,3
13,5	6,5	13,5	-6,5	13,5	13,5	6,5	13,5	-6,5	13,5
12,8	7,9	12,8	-7,9	12,8	12,8	7,9	12,8	-7,9	12,8
12,0	9,0	12,0	-9,0	12,0	12,0	9,0	12,0	-9,0	12,0
11,3	9,9	11,3	-9,9	11,3	11,3	9,9	11,3	-9,9	11,3
10,5	10,7	10,5	-10,7	10,5	10,5	10,7	10,5	-10,7	10,5
9,8	11,4	9,8	-11,4	9,8	9,8	11,4	9,8	-11,4	9,8
9,0	12,0	9,0	-12,0	9,0	9,0	12,0	9,0	-12,0	9,0
8,3	12,5	8,3	-12,5	8,3	8,3	12,5	8,3	-12,5	8,3
7,5	13,0	7,5	-13,0	7,5	7,5	13,0	7,5	-13,0	7,5
6,8	13,4	6,8	-13,4	6,8	6,8	13,4	6,8	-13,4	6,8
6,0	13,7	6,0	-13,7	6,0	6,0	13,7	6,0	-13,7	6,0
5,2	14,1	5,2	-14,1	5,2	5,2	14,1	5,2	-14,1	5,2
4,5	14,3	4,5	-14,3	4,5	4,5	14,3	4,5	-14,3	4,5
3,7	14,5	3,7	-14,5	3,7	3,7	14,5	3,7	-14,5	3,7
3,0	14,7	3,0	-14,7	3,0	3,0	14,7	3,0	-14,7	3,0
2,2	14,8	2,2	-14,8	2,2	2,2	14,8	2,2	-14,8	2,2
1,5	14,9	1,5	-14,9	1,5	1,5	14,9	1,5	-14,9	1,5
0,7	15,0	0,7	-15,0	0,7	0,7	15,0	0,7	-15,0	0,7
0,0	15,0	0,0	-15,0	0,0	0,0	15,0	0,0	-15,0	0,0

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

Table 3: STP 15000TL-30 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 Gesamtwirkungskette 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	1.005	1.006	179900	179900	☒ ≥0.98 ☐ <0.98
	1.200	50	1.200	1.200	36	36	
Spannungssteigerungsschutz/ Overvoltage protection: U>>	1.000	59000	1.000	1.001	58950	58950	---
	1.300	50	1.300	1.301	36	36	
Spannungsrückgangsschutz/ Undervoltage protection: U<	0.200	50	0.199	0.200	36	36	☒ ≤1.02 ☐ >1.02
	1.000	10000	1.005	1.005	9960	9960	
Spannungsrückgangsschutz/ Undervoltage protection: U<<	0.200	50	0.200	0.200	36	36	☒ ≤1.02 ☐ >1.02
	1.000	10000	1.005	1.006	9960	9960	
Frequenzsteigerungsschutz/ Overfrequency protection: F>	50.00	10000	50.00		9970		---
	55.00	50	55.00		32		
Frequenzsteigerungsschutz/ Overfrequency protection: F>>	50.00	10000	50.00		9960		---
	55.00	50	55.00		32		
Frequenzrückgangsschutz/ Underfrequency protection: F<	44.00	10000	44.00		9970		---
	50.00	50	50.03		37		
Eigenzeit der Abschalteinheit / Operating time of a circuit breaker:	☐ aus Messung by measurement				☒ aus Prüfzertifikat by test certificate		
	The PGU can either be assembled with following alternatives of the circuit breaker:						
	- Alternative 1: Power Relay OMRON G7L-2A-PPV with: - Declared operate time given by the supplier: 30 ms as maximum. - Declared release time given by the supplier: 30 ms as maximum. - Alternative 2: Power Relay ZETTLER AZSR250 (50 A) with: - 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 pages.							

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 Mechanical Electrical	Minimum operations 1 x 10 ⁶ 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.

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This 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

Power Relay G7L-PV

CSM_G7L-PV_DS_E_1_1

Two-pole Power Relay That Is Ideal for Power Conditioners in Solar Power Systems

- High switching capacity with contact rating of 30 A at 280 VAC (AC7a class).
- Power consumption reduced by lowering coil voltage after relay operation (low power consumption of approx. 320 mW at 37.5% reduced coil voltage).
- Ambient operating temperature of up to 85°C.
- Contact gap of 3.0 mm for safety.
- UL and VDE class F certification for coil insulation.



Model Number Legend

G7L-2A-P-PV
1 2 3

1. Contact Configuration 2. Terminal Shape 3. Relay Application
2A: DPST-NO P: PCB terminals PV: Photovoltaic power systems

Ordering Information

PCB Terminals

Number of poles	Model	Rated coil voltage (V)	Minimum order (Relays)
2 poles	G7L-2A-P-PV	DC 12 or 24	20 Relays/tray

Application Examples

Grid Connection Control of Power Conditioners for Solar Power Systems

Consult with your OMRON representative for any applications other than solar power systems.

Specifications

■ Ratings

Coil

Rated voltage (V)	Rated current (mA)	Coil resistance (Ω)	Must-operate voltage	Must-release voltage	Maximum permissible voltage	Power consumption
			Percentage of rated voltage			Approx. 2.3 W
DC 12	191.7	63	75% max.	10% min.	110%	
DC 24	95.8	250				

- Note:** 1. The rated current and coil resistance were measured at a coil temperature of 23°C with tolerances of ±15%.
2. Performance characteristics are measured at a coil temperature of 23°C.
3. The maximum permissible voltage is the maximum value of the fluctuation range for the Relay coil operating power supply and was measured at an ambient temperature of 23°C.

FGW-TG3+SP1

G7L-PV

Contacts

Item	Model Load	G7L-2A-P-PV	
		Resistive load	Inductive load (cosφ = 0.8)
Contact structure		Double break	
Contact material		Ag alloy	
Rated load		30 A at 280 VAC	
Rated carry current		30 A	
Maximum contact voltage		280 VAC	
Maximum contact current		30 A	

■ Characteristics

Contact resistance (See note 2.)		100 mΩ max.
Operate time (See note 3.)		30 ms max.
Release time (See note 3.)		30 ms max.
Maximum operating frequency	Mechanical	1,800 operations/h
	Rated load	360 operations/h
Insulation resistance (See note 4.)		1,000 MΩ min.
Dielectric strength	Between coil and contacts	4,000 VAC, 50/60 Hz for 1 min
	Between contacts of the same polarity	2,000 VAC, 50/60 Hz for 1 min
	Between contacts of different polarity	2,000 VAC, 50/60 Hz for 1 min
Impulse withstand voltage (See note 5.)		10,000 V between coil and contacts
Vibration resistance	Destruction	10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)
	Malfunction	10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)
Shock resistance	Destruction	1,000 m/s ²
	Malfunction	100 m/s ²
Endurance	Mechanical	1,000,000 operations min. (at 1,800 operations/h)
	Electrical (See note 6.)	30,000 operations min. (at 360 operations/h under rated load, ON for 1 s and OFF for 9 s)
Ambient operating temperature		-25 to 85°C (with no icing or condensation)
Ambient operating humidity		5% to 85%
Failure rate (P level)(reference value) (See note 7.)		100 mA at 5 VDC
Weight		Approx. 100 g

Note: 1. The values given above are initial values.

2. Measurement conditions: 1 A at 5 VDC using the voltage drop method.

3. Measurement conditions: At rated operating voltage, not including contact bounce.

Ambient temperature: 23°C

4. Measurement conditions: The insulation resistance was measured with a 500-VDC megohmmeter at the same places as those used for measuring the dielectric strength.

5. JEC-212 (1981) Standard Impulse Wave Type (1.2 × 50 μs).

6. Ambient temperature: 23°C

7. This value was measured at a switching frequency of 60 operations per minute.

■ Approved Standards

UL Approval UL508,  (File No. E41643)

EN/IEC and VDE Approval  (Approval No. 1530)

Model	Coil	Contact ratings	Number of test operations
G7L-2A-P-PV	12 VDC or 24 VDC	30 A 280 VAC (0.8 PF) 65°C	30,000 operations

Model	Coil	Contact ratings	Number of test operations
G7L-2A-P-PV	12 VDC or 24 VDC	30 A 280 VAC (cosφ=0.8) 85°C	30,000 operations

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:

- **2219 / 0121-Att1 (Revision 1) : FGW-TG3: Grid Fault Tests Results**

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