TEST REPORT

EN 50549-1:2019

Requirements for generating plants to be connected in parallel with distribution networks - Part 1-1: Connection to a LV distribution network - Generating plants up to and including Type B

Report reference number .... :	**PV2107WDG0438**
Date of issue .... :	2021-10-13
Total number of pages .... :	140
Testing laboratory name .... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
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Accrediation .... :	ilac-MRA; A2LA ACCREDITED Certificate # 2951.01
Applicant's name .... :	**AISWEI New Energy Technology(Jiangsu) Co.,Ltd**
Address .... :	Building 9,No.198 Xiangyang Road,215011 Suzhou,P.R.China
Test specification	
Standard... :	EN 50549-1:2019
Test Report Form No. .... :	EN 50549-1 VER.0
TRF Originator .... :	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF .... :	Dated 2019-12-11
Test item description .... :	Solar Inverter
Trademark.. :	Solplanet
Model / Type .... :	ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2,ASW40K-LT-G2, ASW45K-LT-G2, ASW50K-LT-G2,

Ratings ....:	**ASW30K-LT-G2**	**ASW33K-LT-G2**
Max. input DC voltage [V] .... :	Max.1100V	
Input DC voltage range [V]............... :	200-1000V	
Input DC current [A] .... :	3 * 26,0	3 * 26,0
Output AC voltage [V] .... :	3/N/PE ~ 400V, 50Hz	
Output AC current [A]....................... :	50,0	55,0
Nominal Output power [kW]............. :	30,0	33,0
Maximum Output power [kVA] .... :	30,0	33,0
Ratings ....:	**ASW36K-LT-G2**	**ASW40K-LT-G2**
Max. input DC voltage [V] .... :	Max.1100V	
Input DC voltage range [V]............... :	200-1000V	
Input DC current [A] .... :	3 * 26,0	4 * 26,0
Output AC voltage [V] .... :	3/N/PE ~ 400V, 50Hz	
Output AC current [A]....................... :	60,0	66,7
Nominal Output power [kW]............. :	36,0	40,0
Maximum Output power [kVA] .... :	36,0	40,0
Ratings ....:	**ASW45K-LT-G2**	**ASW50K-LT-G2**
Max. input DC voltage [V] .... :	Max.1100V	
Input DC voltage range [V]............... :	200-1000V	
Input DC current [A] .... :	4 * 26,0	5 * 26,0
Output AC voltage [V] .... :	3/N/PE ~ 400V, 50Hz	
Output AC current [A]....................... :	75,0	80,0
Nominal Output power [kW]............. :	45,0	50,0
Maximum Output power [kVA] .... :	45,0	50,0

Testing Location .... :	**AISWEI New Energy Technology(Jiangsu) Co.,Ltd**
Address .... :	Building 9,No.198 Xiangyang Road,215011 Suzhou,P.R.China
Tested by (name and signature)....................... :	Sean Tu
Approved by (name and signature)....................... :	Ken Chan
Manufacturer's name..................... :	**AISWEI New Energy Technology(Jiangsu) Co.,Ltd**
Manufacturer address .... :	Building 9,No.198 Xiangyang Road,215011 Suzhou,P.R.China
Factory's name.............................. :	**AISWEI New Energy Technology (Yangzhong) Co., Ltd**
Factory address .... :	No.588 Gangxing Road,Yangzhong, Jiangsu P.R.China

Document History

Date	Internal reference	Modification / Change / Status	Revision
2021-10-13	Sean Tu	Initial report was written	0
Supplementary information:			

Test items particulars	
Equipment mobility ....:	Permanent connection
Operating condition ....:	Continuous
Class of equipment ....:	Class I
Protection against ingress of water ..:	IP65 according to EN 60529
Mass of equipment [kg] ....:	Approx. 43,0kg
Test case verdicts	
Test case does not apply to the test object ....:	N/A
Test item does meet the requirement ....:	P(ass)
Test item does not meet the requirement ....:	F(ail)
Testing	
Date of receipt of test item ....:	2021-07-29
Date(s) of performance of test ....:	2021-07-29 to 2021-09-12

General remarks:

The test result presented in this report relate only to the object(s) tested. The report shall state compliance of the tested objects with the requirements of EN 50549-1. This report shall not be reproduced in part or in full without the written approval of the issuing testing laboratory.

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

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

This Test Report consists of the following documents:

1. Test Report
   - 4.4 Normal operating range
   - 4.5 Immunity to disturbances
   - 4.6 Active response to frequency deviation
   - 4.7 Power response to voltage variations and voltage changes
   - 4.8 EMC and power quality
   - 4.9 Interface protection
   - 4.10 Connection and starting to generate electrical power
   - 4.11 Ceasing and reduction of active power on set point
   - 4.13 Requirements regarding single fault tolerance of interface protection system and interface switch
2. Annex No. 1 – Datasheet of the relay
3. Annex No. 2 – Pictures of the unit
4. Annex No. 3 – Test equipment list

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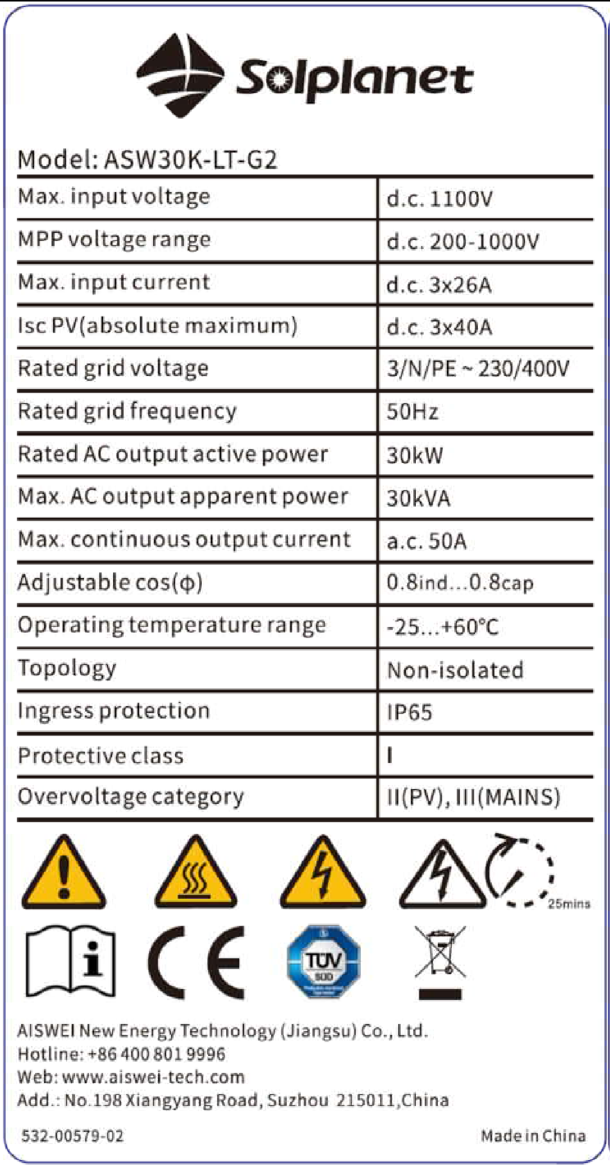

Solplanet

Model: ASW30K-LT-G2

Max. input voltage	d.c. 1100V
MPP voltage range	d.c. 200-1000V
Max. input current	d.c. 3x26A
Isc PV(absolute maximum)	d.c. 3x40A
Rated grid voltage	3/N/PE ~ 230/400V
Rated grid frequency	50Hz
Rated AC output active power	30kW
Max. AC output apparent power	30kVA
Max. continuous output current	a.c. 50A
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60℃
Topology	Non-isolated
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV), III(MAINS)

25mins

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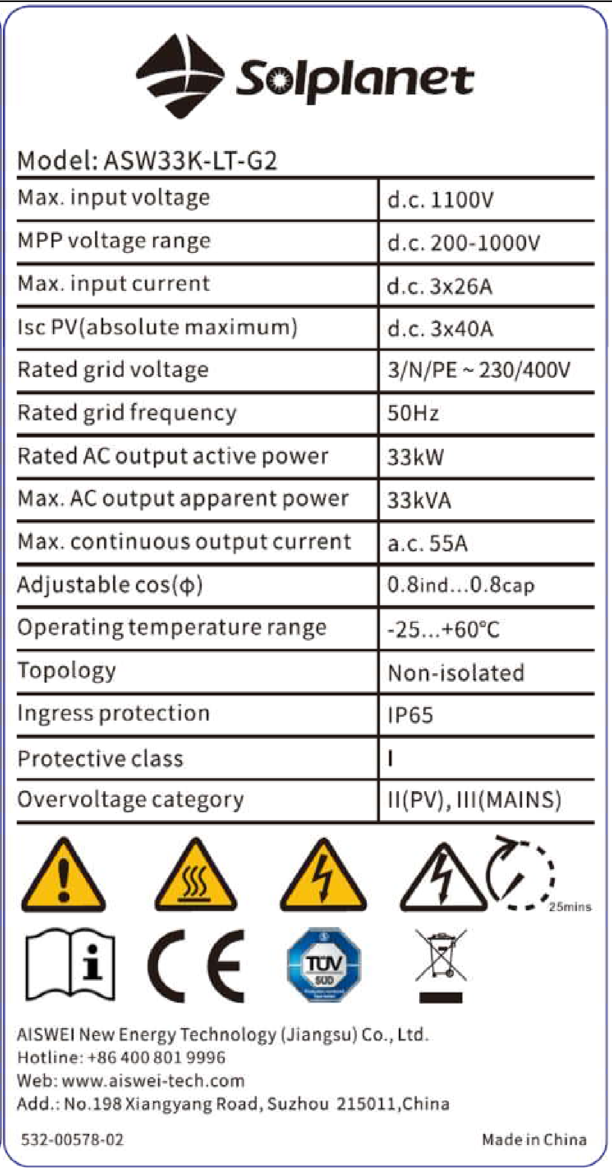

Solplanet

Model: ASW33K-LT-G2

Max. input voltage	d.c. 1100V
MPP voltage range	d.c. 200-1000V
Max. input current	d.c. 3x26A
Isc PV(absolute maximum)	d.c. 3x40A
Rated grid voltage	3/N/PE ~ 230/400V
Rated grid frequency	50Hz
Rated AC output active power	33kW
Max. AC output apparent power	33kVA
Max. continuous output current	a.c. 55A
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60℃
Topology	Non-isolated
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV), III(MAINS)

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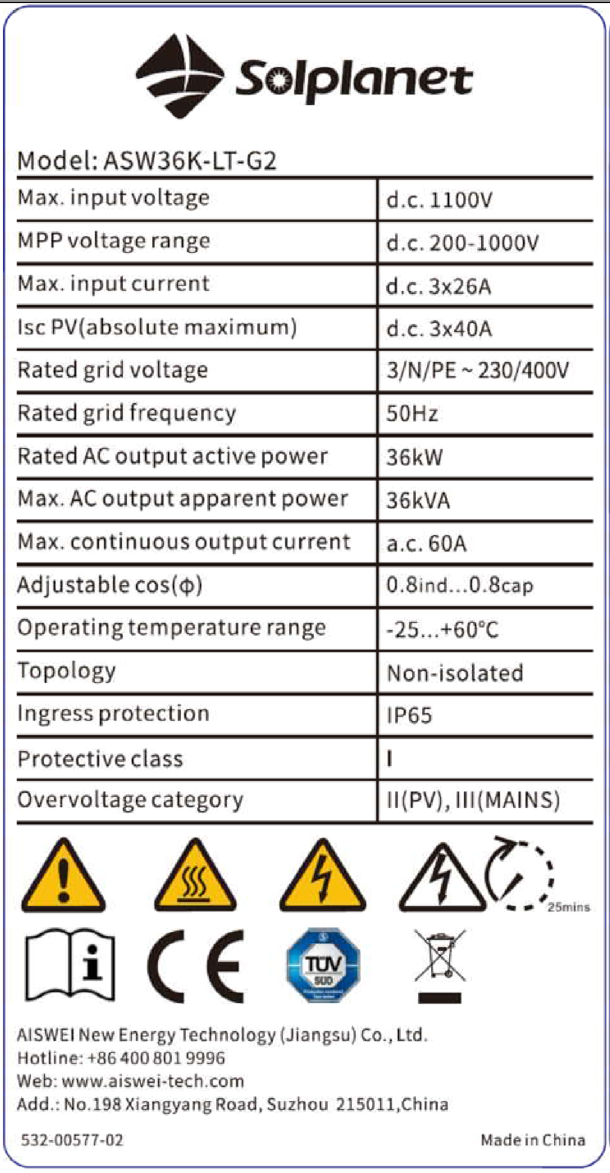

Solplanet

Model: ASW36K-LT-G2

Max. input voltage	d.c. 1100V
MPP voltage range	d.c. 200-1000V
Max. input current	d.c. 3x26A
Isc PV(absolute maximum)	d.c. 3x40A
Rated grid voltage	3/N/PE ~ 230/400V
Rated grid frequency	50Hz
Rated AC output active power	36kW
Max. AC output apparent power	36kVA
Max. continuous output current	a.c. 60A
Adjustable cos(φ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Topology	Non-isolated
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV), III(MAINS)

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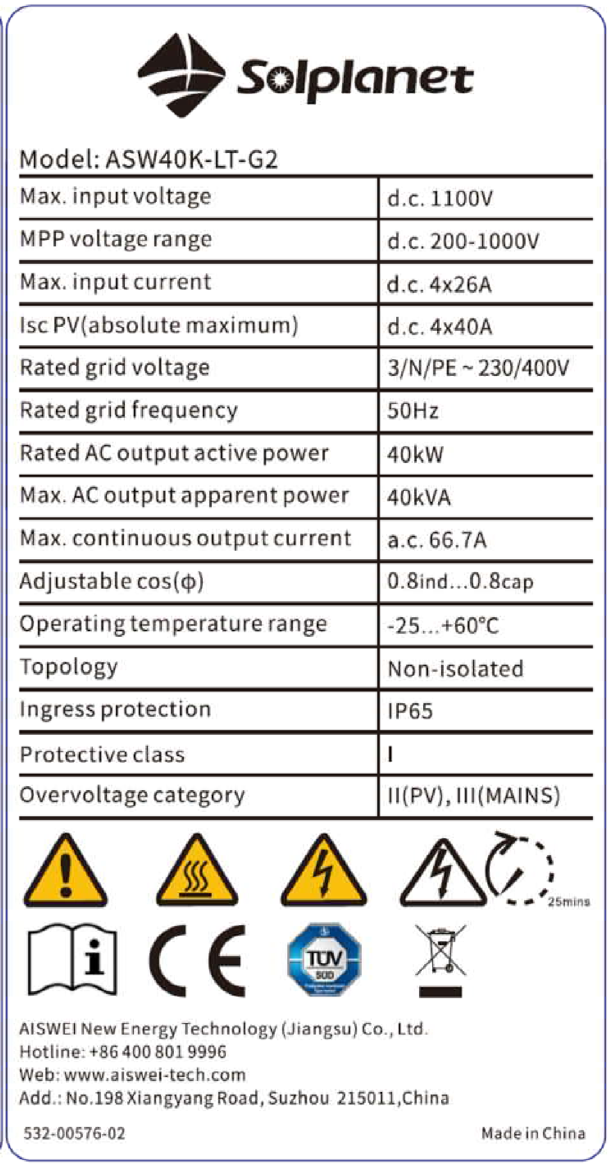

Solplanet

Model: ASW40K-LT-G2

Max. input voltage	d.c. 1100V
MPP voltage range	d.c. 200-1000V
Max. input current	d.c. 4x26A
Isc PV(absolute maximum)	d.c. 4x40A
Rated grid voltage	3/N/PE ~ 230/400V
Rated grid frequency	50Hz
Rated AC output active power	40kW
Max. AC output apparent power	40kVA
Max. continuous output current	a.c. 66.7A
Adjustable cos(φ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Topology	Non-isolated
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV), III(MAINS)

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Solplanet

Model: ASW45K-LT-G2

Max. input voltage	d.c. 1100V
MPP voltage range	d.c. 200-1000V
Max. input current	d.c. 4x26A
Isc PV(absolute maximum)	d.c. 4x40A
Rated grid voltage	3/N/PE ~ 230/400V
Rated grid frequency	50Hz
Rated AC output active power	45kW
Max. AC output apparent power	45kVA
Max. continuous output current	a.c. 75A
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Topology	Non-isolated
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV), III(MAINS)

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Solplanet

Model: ASW50K-LT-G2

Max. input voltage	d.c. 1100V
MPP voltage range	d.c. 200-1000V
Max. input current	d.c. 5x26A
Isc PV(absolute maximum)	d.c. 5x40A
Rated grid voltage	3/N/PE ~ 230/400V
Rated grid frequency	50Hz
Rated AC output active power	50kW
Max. AC output apparent power	50kVA
Max. continuous output current	a.c. 80A
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Topology	Non-isolated
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV), III(MAINS)

25mins

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General product information:

The Solar Inverter converts DC voltage into AC voltage.
The Solar Inverter is three phase type and DC input supply by PV array.
The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and a two relays. This assures that the opening of the output circuit will also operate in case of one error.

Description of the electrical circuit:
The internal control is redundant built. It consists of Master DSP (U523) and Slave DSP (U546).

The Master DSP (U523) control the relays by switching signals; measures the PV voltage, PV current, Bus voltage, grid voltage, frequency, AC current, injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Slave DSP (U546) can switch off the relays independently, and communicate with the master DSP (U523) each other to monitor the master DPS (U523).

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the DSP (U523). The DSP (U523) tests and calibrates before each start up all current sensors.

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

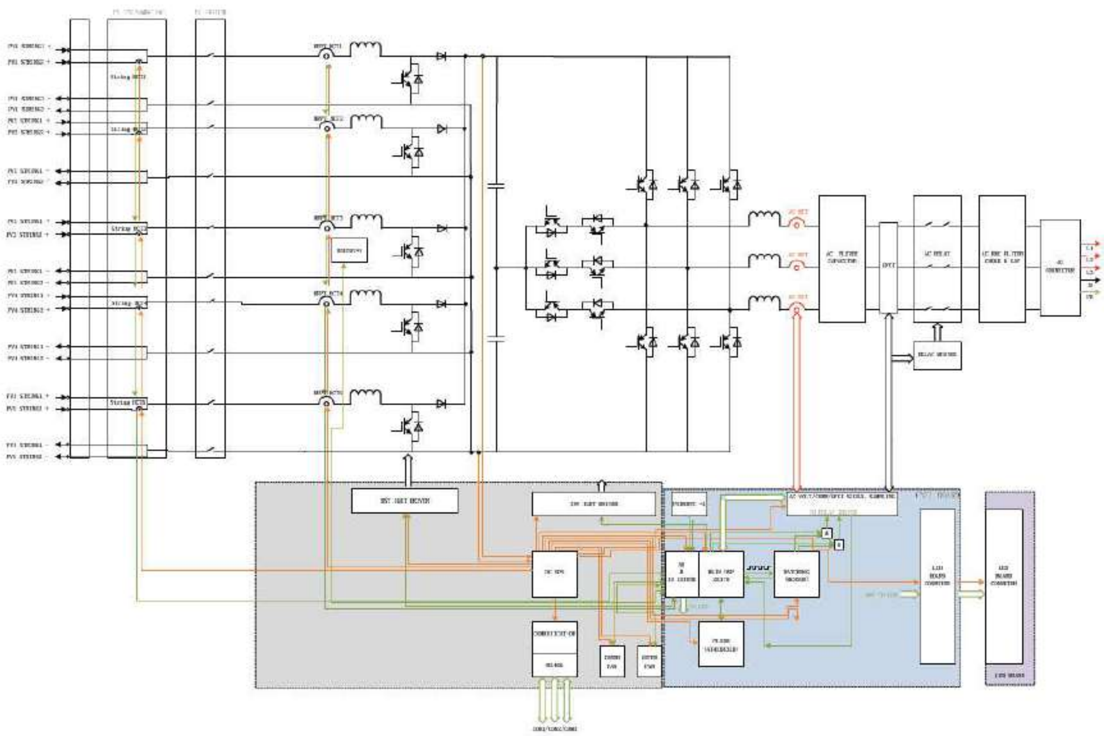

Figure 1 – Block diagram

Differences of the models:

The models ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2, ASW45K-LT-G2 and ASW50K-LT-G2 are identical in hardware and software, and the output power derated by software.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

The product was tested on:

Hardware: V1.0
Software: V1.0

General remarks:

The test results presented in this report relate only to the object(s) tested.
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"(see Annex #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

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

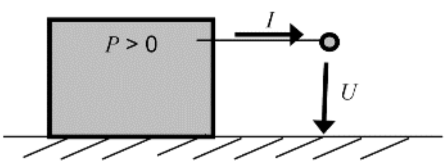
The following suffixes are used for variables in tables and figures:

- "P_n" for the nominal active power:
  $P_n = U_n \times I_n \times \cos \varphi_n$ (single-Phase); $P_n = \sqrt{3}\, U_n \times I_n \times \cos \varphi_n$ (three-Phase)
- "P_M" for the momentary power
- "(c)" for over-excited
- "(i)" for under-excited

Active and reactive power:

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

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



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

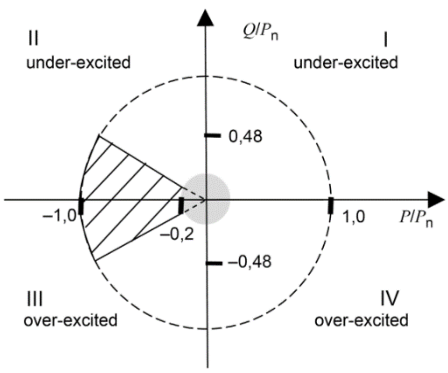


Figure 2

Default interface protection settings according EN 50549-1:2019:			
Parameter	**Max. disconnection time**	**Min. operate time**	**Trip value**
Over voltage – stage 1	3,0 s	0,1 s	230V +15% (264,5 V)
Over voltage – stage 2	0,2 s	0,1 s	230V +25% (287,5 V)
Under voltage – stage 1	5,0 s	0,1 s	230V -20% (184V)
Under voltage – stage 2	2,0 s	0,1 s	230V -50% (115V)
Over frequency – stage 1	0,5 s	0,3 s	51,5 Hz
Over frequency – stage 2	0,2 s	0,1 s	52,0 Hz
Under frequency– stage 1	0,5 s	0,3 s	47,5 Hz
Under frequency– stage 2	0,2 s	0,1 s	47,0 Hz
Reconnection settings for voltage		$0,85\ U_n \leq U \leq 1,10\ U_n$	
Connection settings for frequency (Normal operational start-up)		49,5 Hz ≤ f ≤ 50,1 Hz	
Reconnection settings for frequency (Automatic reconnection after tripping)		49,5 Hz ≤ f ≤ 50,2 Hz	
Reconnection time		≥ 60 s	
Active power gradient after reconnection		$10\%P_n$/min	
Permanent DC-injection		0,5% of rated inverter output current or 20mA	
Loss of mains according EN 62116		Inverter shall disconnect within 2 s.	
The stated currents and voltages are 'true r.m.s.'-values. The voltages in this table are - phase-to-neutral in 230 V single phase systems and 230/400 V systems, - phase-to-phase in a multiphase 230 V system.			
Tolerances on trip values: - Voltage: ± 1% of U_n - Frequency: ± 0,05 Hz - Disconnection time : ± 10%			

EN 50549:2019, clause 4: Tests		
Clause	**Test requirement (According to table C.1)**	**Result**
4.4	Normal operating range	**P**
4.5	Immunity to disturbances	**P**
4.6	Active response to frequency deviation	**P**
4.7	Power response to voltage variations and voltage changes	**P**
4.8	EMC and power quality	**P**
4.9	Interface protection	**P**
4.10	Connection and starting to generate electrical power	**P**
4.11	Ceasing and reduction of active power on set point	**P**
4.12	Remote information exchange	**N/A**
4.13	Requirements regarding single fault tolerance of interface protection system and interface switch	**P**

EN 50549-1:2019: Normal operating range			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.4.2	Power response to over-frequency	EN 50438, Annex D.3.1	**P**
4.4.3	Power response to under-frequency	G99/1-4, clause A.7.3.2	**P**
4.4.4	Continuous operating voltage range	EN 50438, Annex D.3.1	**P**

4.4.2 Operating frequency range 4.4.4 Continuous operating voltage range			P
Setting values	Over-voltage [V]:	253,0	
	Under-voltage [V]:	195,5	
	Over-frequency [Hz]:	51,5	
	Under-frequency [Hz]:	47,5	

- Test 1: U = 195,5 V; f = 47,5 Hz; P = 1,00 S_n; cosφ = 1; Period of test 30 minutes
- Test 2: U = 195,5 V; f = 48,5 Hz; P = 1,00 S_n; cosφ = 1; Period of test 30 minutes
- Test 3: U = 253,0 V; f = 51,5 Hz; P = 1,00 S_n; cosφ = 1; Period of test 30 minutes
- Test 4: U = 230,0 V; f = 50,0 Hz; Voltage Phase jumps Change +20 degrees P = 1,00 S_n; cosφ = 1
- Test 5: U = 230,0 V; f = 50,0 to 50,5 Hz;RoCoF=1Hz/s; P = 1,00 S_n; cosφ = 1; Period of test 0,5 seconds

Test result: ASW50K-LT-G2

Test sequence	Voltage [V]	Frequency [Hz]	Output power [kW]	Cos φ
Test1	196,36	47,50	47,742	0,9998
Test2	196,41	48,50	47,754	0,9998
Test3	254,05	51,50	50,218	0,9992
Test4	233,28	50,00	50,289	0,9995
Test5	233,22	50,00	50,255	0,9995

Note:

Test method refer clause D.3.1 of EN 50438:2013.

During the tests the interface protection was disabled.

Operation at reduced power is allowed during test 1, equal to the maximum power that can be supplied on reaching the maximum output current limit (P ≥ 0,85 S_n).

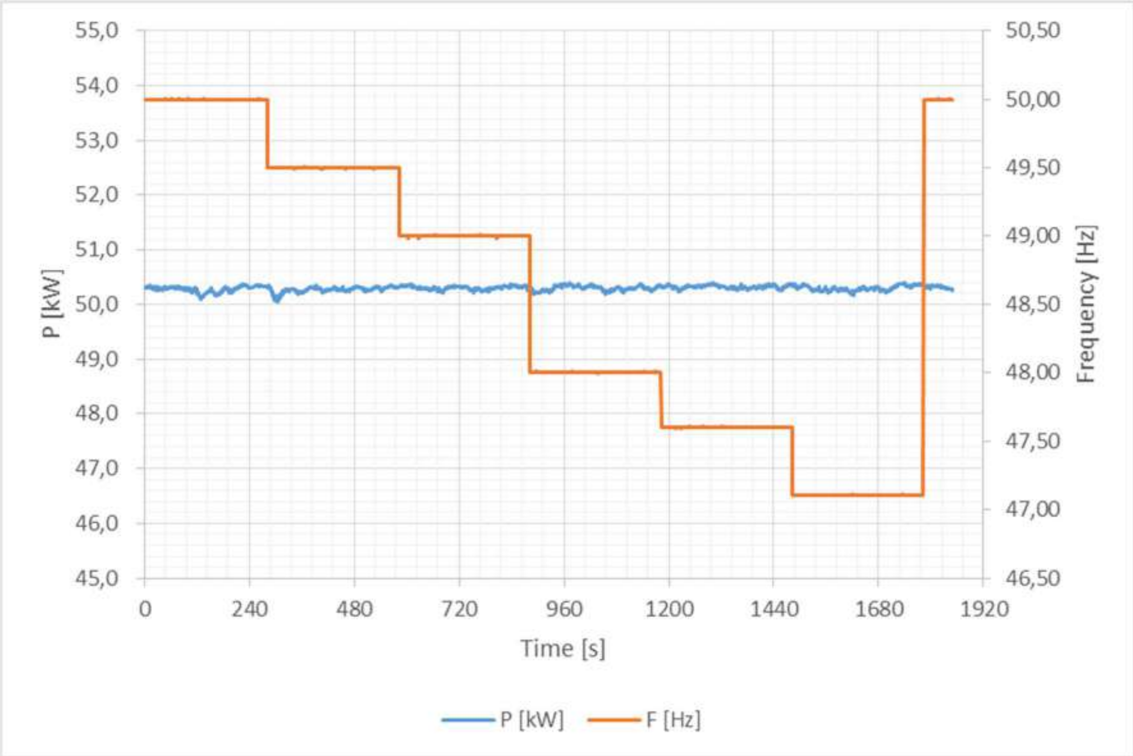
During the sequence of test 3, automatic adjustment to reduce power in the case of over-frequency was disabled.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.4.3	Minimal requirement for active power delivery at under-frequency	P

Test result: ASW50K-LT-G2

Graph of frequency a) to b) to c) to d) to e):



Test result:

	Switch to:				
5-min mean value (each)	a) 49,50 Hz	b) 49,00 Hz	c) 48,00 Hz	d) 47,60 Hz	e) 47,10 Hz
Frequency [Hz]:	49,50	49,00	48,00	47,60	47,10
Active power [kW]:	50,267	50,301	50,295	50,320	50,295
$\Delta P/P_n$ [%] :	0,534	0,602	0,590	0,640	0,590

Assessment criterion:

Test method refer clause A.7.3.2 of G99/1-4

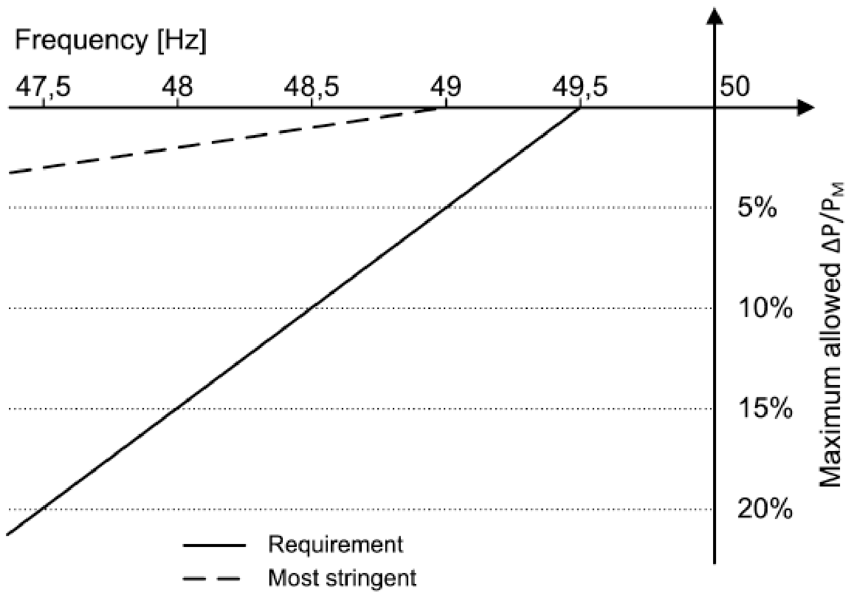
The frequency should then be set to 49,5 Hz for 5 minutes. The output should remain at 100% of registered Capacity.

The frequency should then be set to 49,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 99% of registered Capacity.

The frequency should then be set to 48,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 97% of registered Capacity.

The frequency should then be set to 47,6 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 96.2% of registered Capacity.

The frequency should then be set to 47,1 Hz and held at this frequency for 20s. The Active Power output must not be below 95,0% of registered Capacity and the Synchronous Power Generating Module must not trip in less than the 20s of the test.



Maximum allowable power reduction in case of under-frequency

Note:

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

EN 50549-1:2019: Immunity to disturbances			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.5.2	Rate of change of frequency (RoCoF) immunity	G99/1-4:2019, clause A.7.1.2.6	**P**
4.5.3	Low voltage ride through (LVRT)	VDE V 0124-100:2019-02 (Draft), clause 5.8.3.	**P**
4.5.4	High voltage ride through (HVRT)	VDE V 0124-100:2019-02 (Draft), clause 5.8.3.	**P**
4.7.4	Zero current mode for converter connected generating plants	VDE V 0124-100:2019-02 (Draft), clause 5.8.3.	**P**

4.5.2	Rate of change of frequency (ROCOF) immunity(default setting)				P

	Start Frequency	Change	End Frequency	Confirm no trip
Positive Frequency drift	49Hz	+2Hz/sec	51Hz	No trip
Negative Frequency drift	51Hz	-2Hz/sec	49Hz	No trip

Note:

Test method refer clause A.7.1.2.6 of G99/1-4:2019.

Hold for 10 s

Manufacturers considering new designs should allow for the RoCoF where stability is required to be increased to, up to 2Hz per second, as proposed in the new European network codes, which are expected to come into force over the period 2014/2015. Under these conditions RoCoF will cease to be an effective loss of mains protection and is unlikely to be permitted in future revisions of this document.

For the step change test the SSEG should be operated with a measureable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 seconds to complete the test. The SSEG should not trip during this test.

For frequency drift tests the SSEG should be operated with a measureable output at the start frequency and then the frequency changed in a ramp function at 0,95Hz per second to the end frequency. On reaching the end frequency it should be maintained for a period of at least10 seconds. The SSEG should not trip during this test.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.5.3 4.5.4 4.7.4	**Low voltage ride through (LVRT)** **High voltage ride through (HVRT)** **Zero current mode for converter connected generating plants**	**P**

General:

If the voltage on the generator terminals falls below <0.8 U_n and if the generator terminals exceed the voltage of> 1.15 U_n (start of fault), generator must pass through voltage dips without any current being drawn into the grid Network operator (limited dynamic network support).

This requirement is met if, for a voltage dip below 0.8 U_n or at a voltage increase above 1.15 U_n, the injected current of the generating unit (s) and / or the memory 60 ms after occurrence of this voltage dip in any outer conductor 20% of the rated current I_r and does not exceed> 10% I_r after 100 ms.

After the voltage returned to continuous operating voltage range of -15% U_n to +10% U_n, 90 % of pre fault power or available power whichever is the smallest shall be resumed as fast as possible, but at the latest within 1 s unless the DSO and the responsible party requires another value.

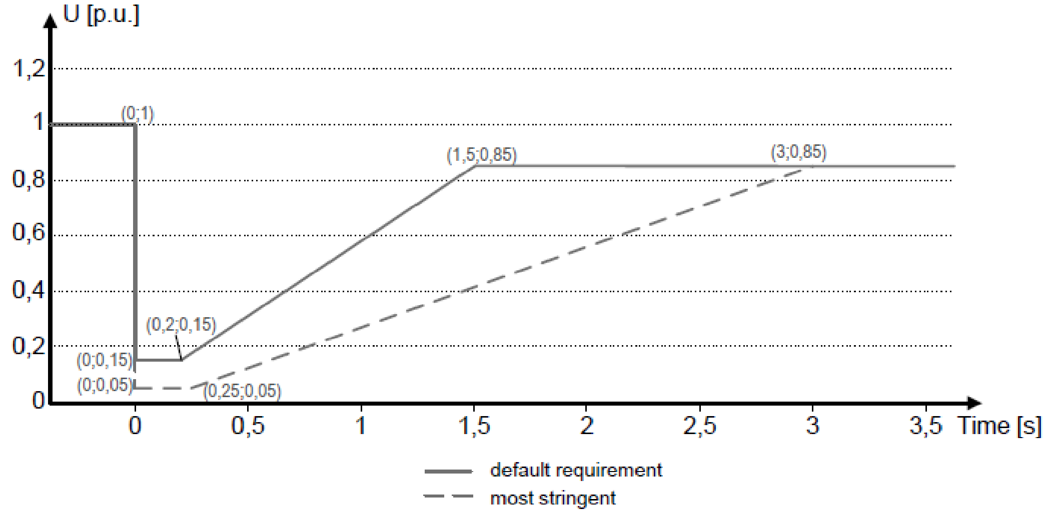


Figure 6 — Low voltage ride through capability for non-synchronous generating technology

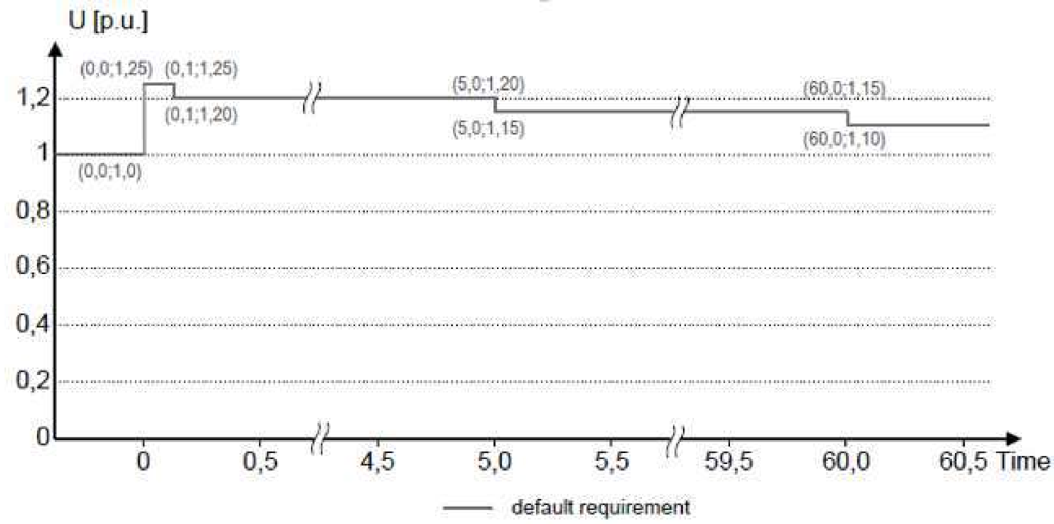


Figure 8 — Over-voltage ride through capability

Test	Drop depth requirement [p.u. U_n]	Symmetry	Fault duration [ms]	Output power level		k-factor	Test no.
				P set point (P_{rE} / p.u.)	Q set point (Q / p.u.)		
1.A.1	0,03	Symmetrical	250	1,0	0,00	0	1.A.1
1.A.2				0,2			1.A.2
1.D.1		Asymmetrical		1,0			1.D.1
1.D.2				0,2			1.D.2
1.B.1		Single phase*		1,0			1.B.1
1.B.2				0,2			1.B.2
2.A.1	0,31	Symmetrical	1300	1,0	0,00	0	2.A.1
2.A.2				0,2			2.A.2
2.D.1		Asymmetrical		1,0			2.D.1
2.D.2				0,2			2.D.2
2.B.1		Single phase*		1,0			2.B.1
2.B.2				0,2			2.B.2
3.A.1	0,82	Symmetrical	3000	1,0	0,00	0	3.A.1
3.A.2				0,2			3.A.2
3.D.1		Asymmetrical		1,0			3.D.1
3.D.2				0,2			3.D.2
3.B.1		Single phase*		1,0			3.B.1
3.B.2				0,2			3.B.2
OV1	1,25	Symmetrical	100	1,0	0,00	0	OV1
OV2	1,20		5000	1,0			OV2
OV3	1,15		60000	1,0			OV3

Note:

For every kind of voltage dip a test without load has to be performed in order to prove that the test condition was fulfilled. The voltage has to drop to AT LEAST the defined depth level. An exception can be considered in case no current is supplied during dips.

*** Single phase = "choose Typ 7 at BV-Lab Studio" ≙ LVRT Typ B**

Graph of FRT test one				
Test result:				
List of tests	**Residual amplitude of phase-to-phase voltage [p.u. U_n]**	**Duration limit [ms]**	**Duration [ms]**	**Result**
P_{Emax} in %	100% ±5%			
1.A.1- Symmetrical	0,03	250 ± 20	267	Pass
1.D.1- Asymmetrical	0,03	250 ± 20	268	Pass
1.B.1- Single phase	0,03	250 ± 20	268	Pass
2.A.1- Symmetrical	0,31	1300 ± 20	1316	Pass
2.D.1- Asymmetrical	0,31	1300 ± 20	1316	Pass
2.B.1- Single phase	0,31	1300 ± 20	1317	Pass
3.A.1- Symmetrical	0,82	3000 ± 20	3011	Pass
3.D.1- Asymmetrical	0,82	3000 ± 20	3011	Pass
3.B.1- Single phase	0,82	3000 ± 20	3000	Pass
P_{Emax} in %	20% ±5%			
1.A.2- Symmetrical	0,03	250 ± 20	264	Pass
1.D.2- Asymmetrical	0,03	250 ± 20	264	Pass
1.B.2- Single phase	0,03	250 ± 20	267	Pass
2.A.2- Symmetrical	0,31	1300 ± 20	1316	Pass
2.D.2- Asymmetrical	0,31	1300 ± 20	1316	Pass
2.B.2- Single phase	0,31	1300 ± 20	1318	Pass
3.A.2- Symmetrical	0,82	3000 ± 20	3011	Pass
3.D.2- Asymmetrical	0,82	3000 ± 20	3011	Pass
3.B.2- Single phase	0,82	3000 ± 20	3011	Pass
P_{Emax} in %	100% ±5%			
OV1- Symmetrical	1,25	100 ± 20	103	Pass
OV2- Symmetrical	1,20	5000 ± 20	5011	Pass
OV3- Symmetrical	1,15	60000 ± 20	60001	Pass

Test conditions:

Voltage simulator fall and rise time: < 20ms

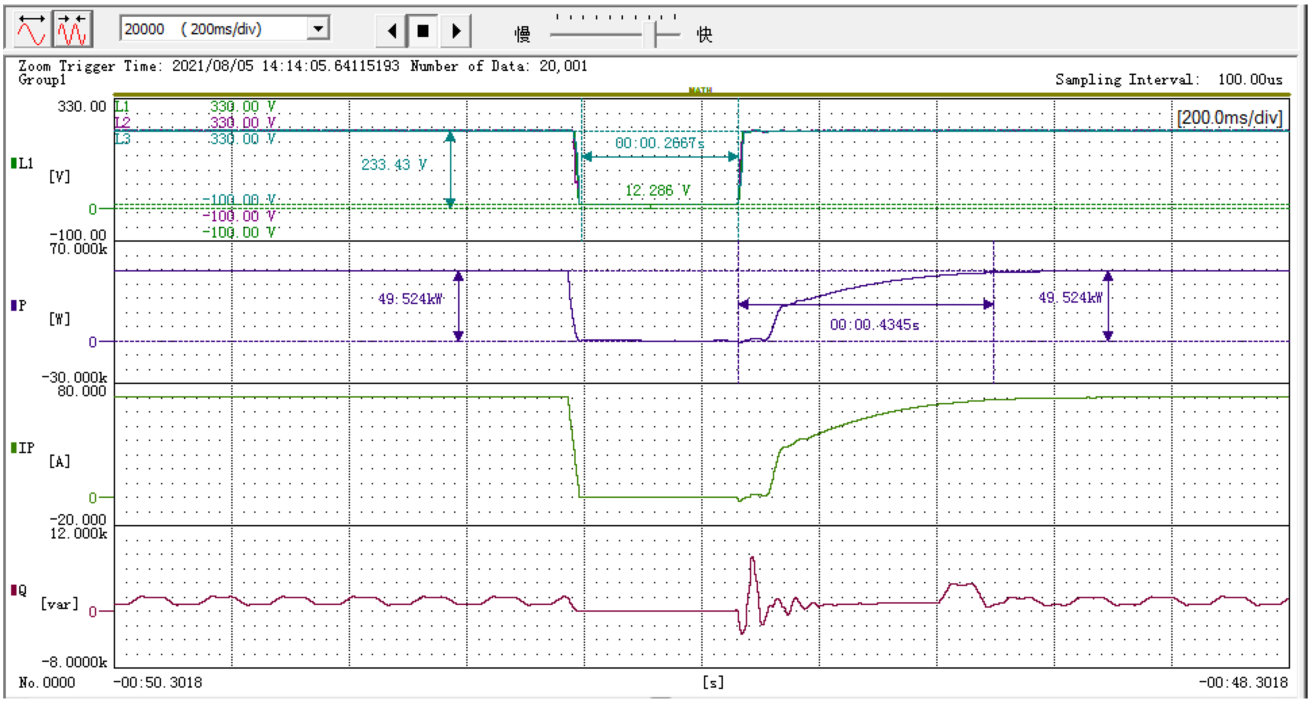
Used sample rate: 10 kHz

Note:

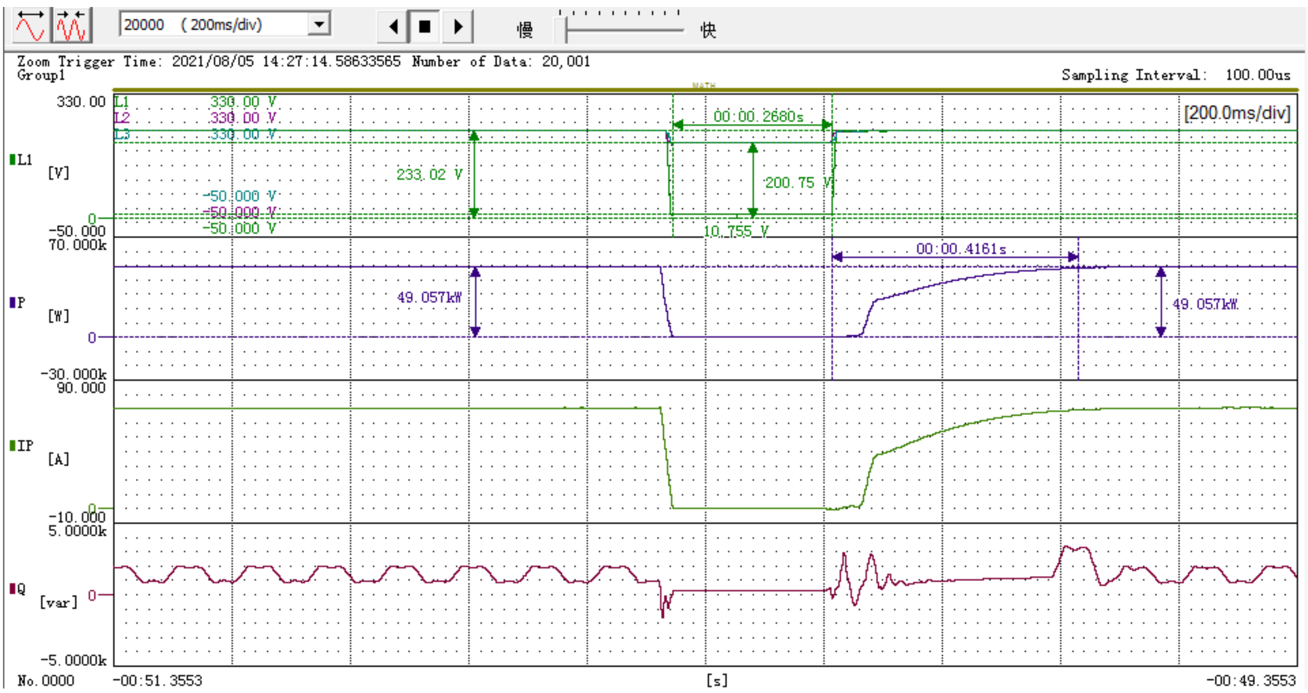
The test method refer to VDE V 0124-100:2020, clause 5.8.3.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

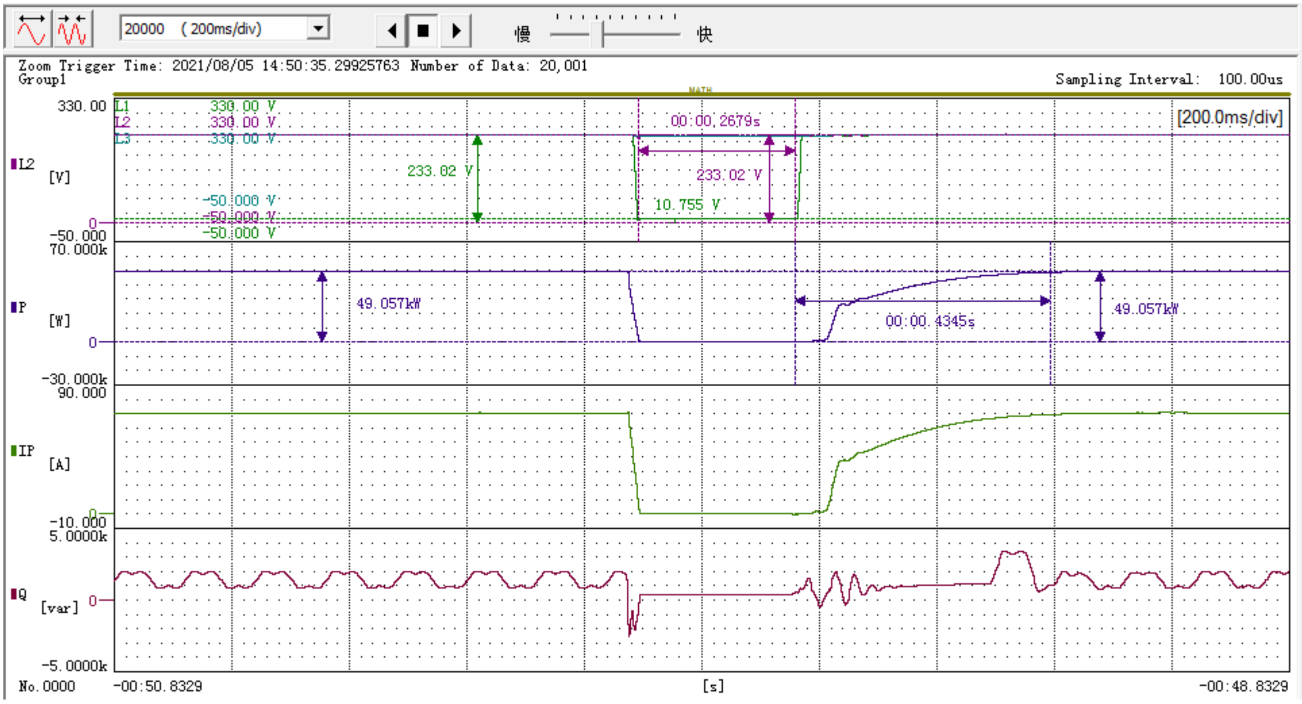
Test 1.A.1-Symmetrical fault (U/U_{nom} = 0,03); P = 100% ±5% P_n



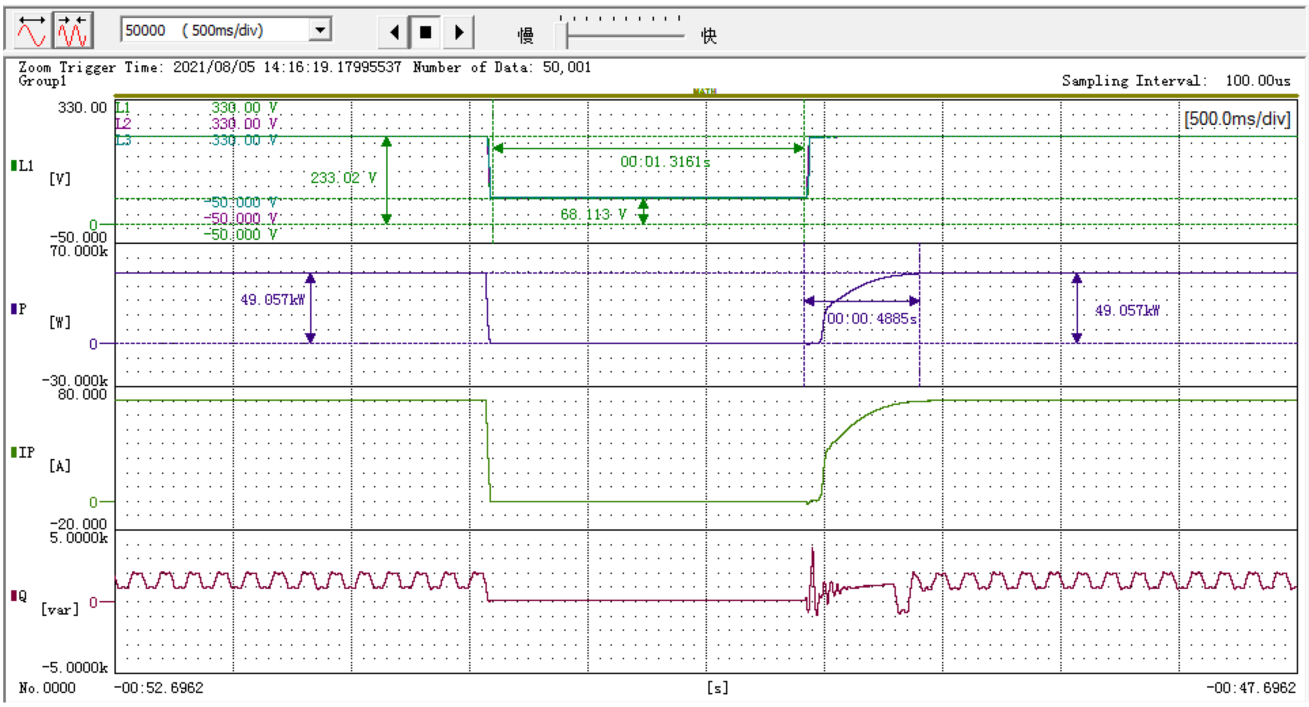
Test 1.D.1-Asymmetrical fault (U/U_{nom} = 0,03); P = 100% ±5% P_n



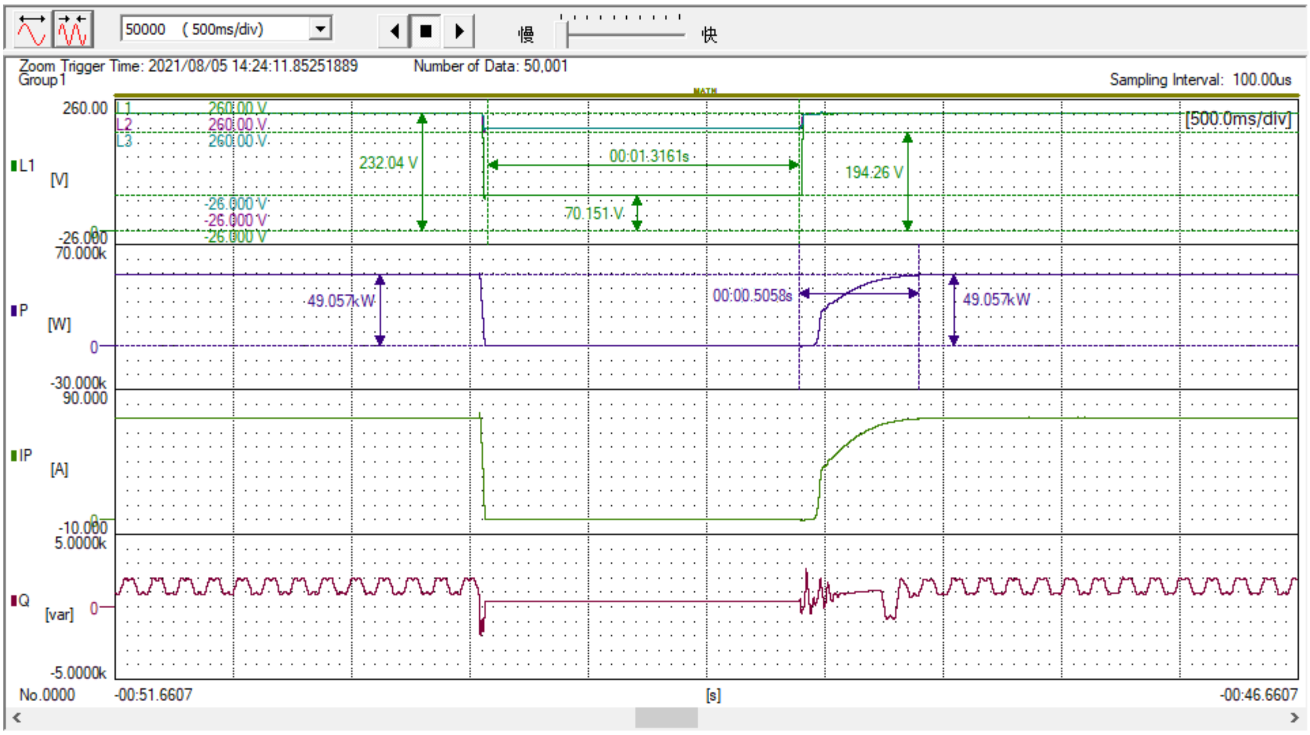
Test 1.B.1-Single phase fault (U/U_{nom} = 0,03); P = 100% ±5% P_n



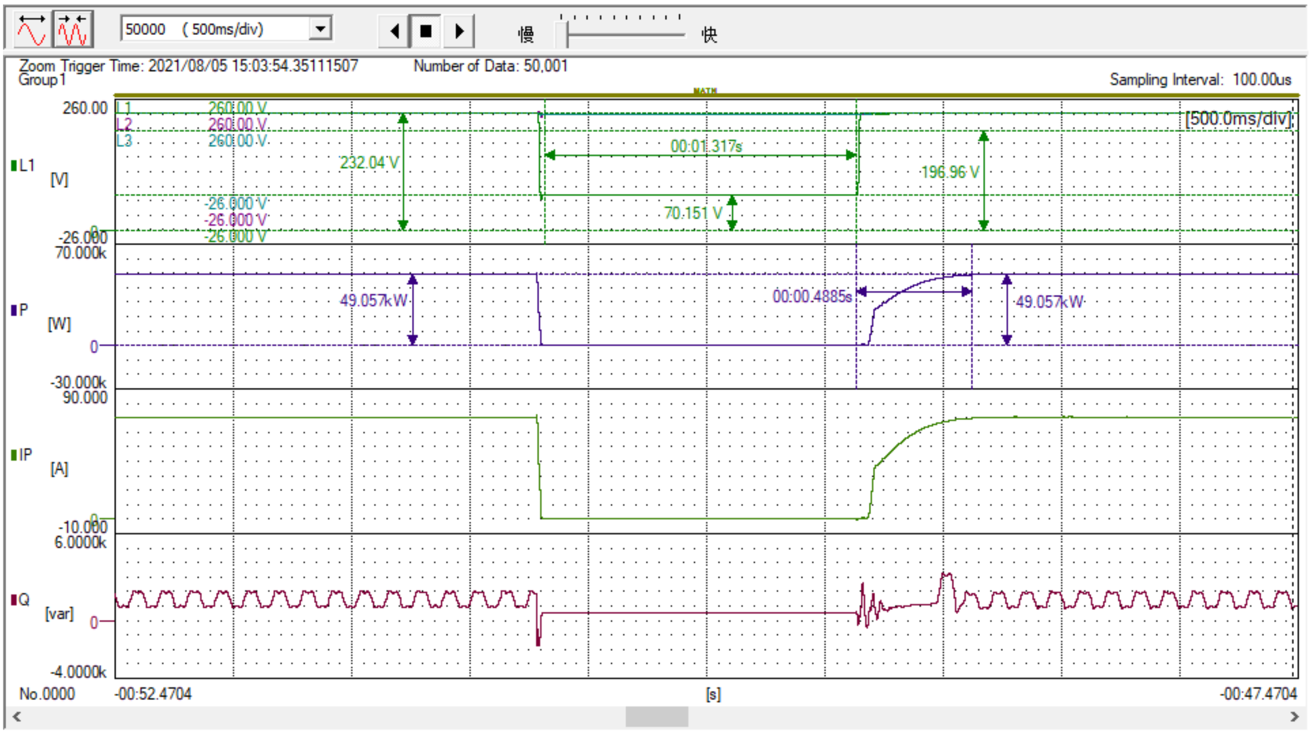
Test 2.A.1-Symmetrical fault (U/U_{nom} = 0,31); P = 100% ±5% P_n



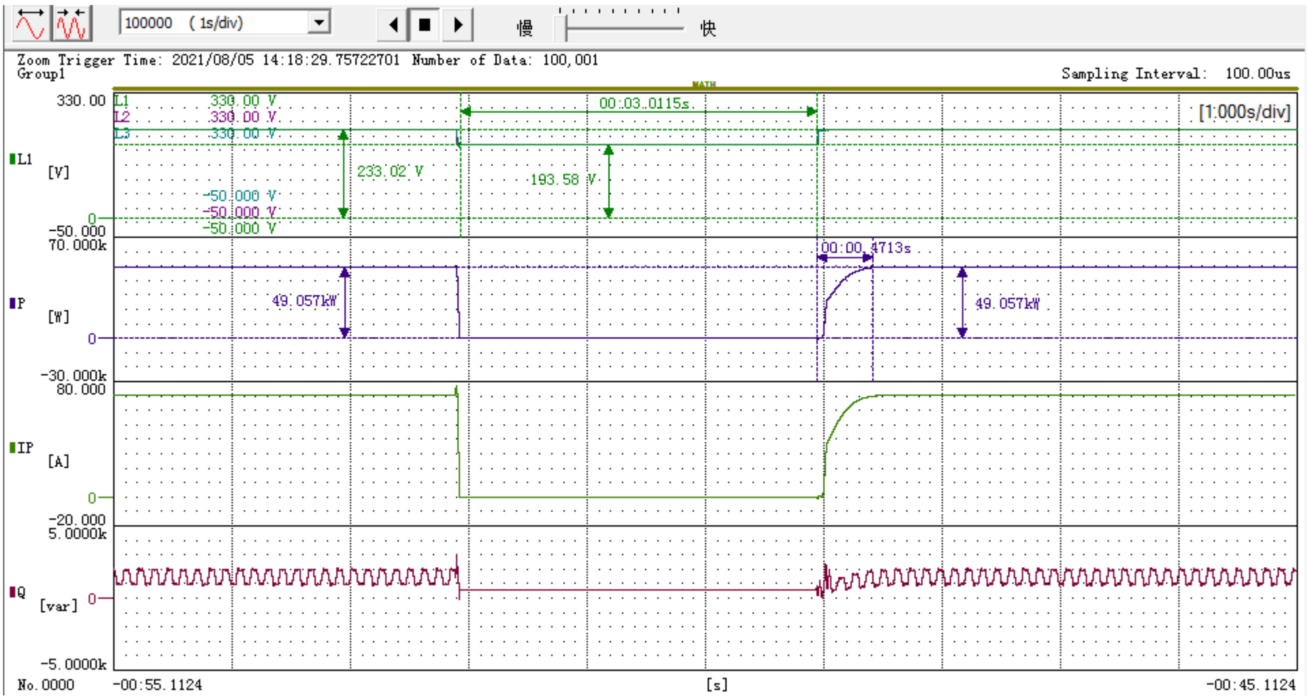
hoTest 2.D.1- Asymmetrical fault (U/U_{nom} = 0,31); P = 100% ±5% P_n



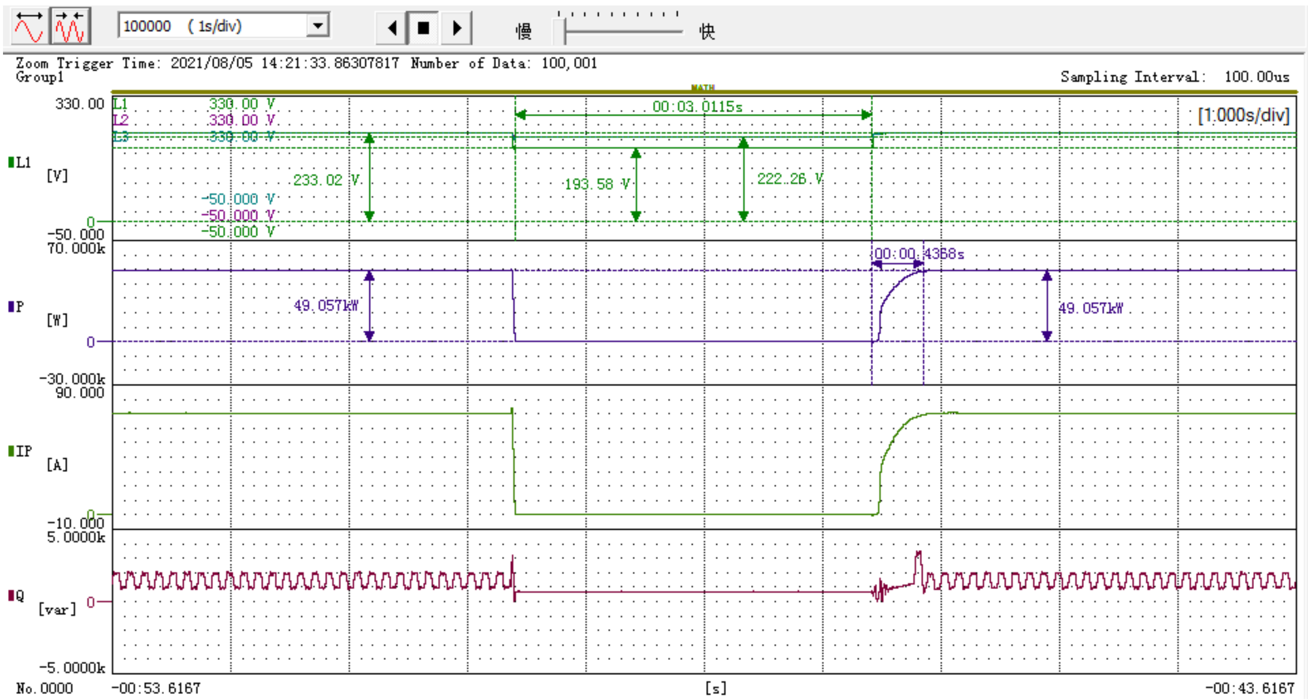
Test 2.B.1-Single phase fault (U/U_{nom} = 0,31); P = 100% ±5% P_n



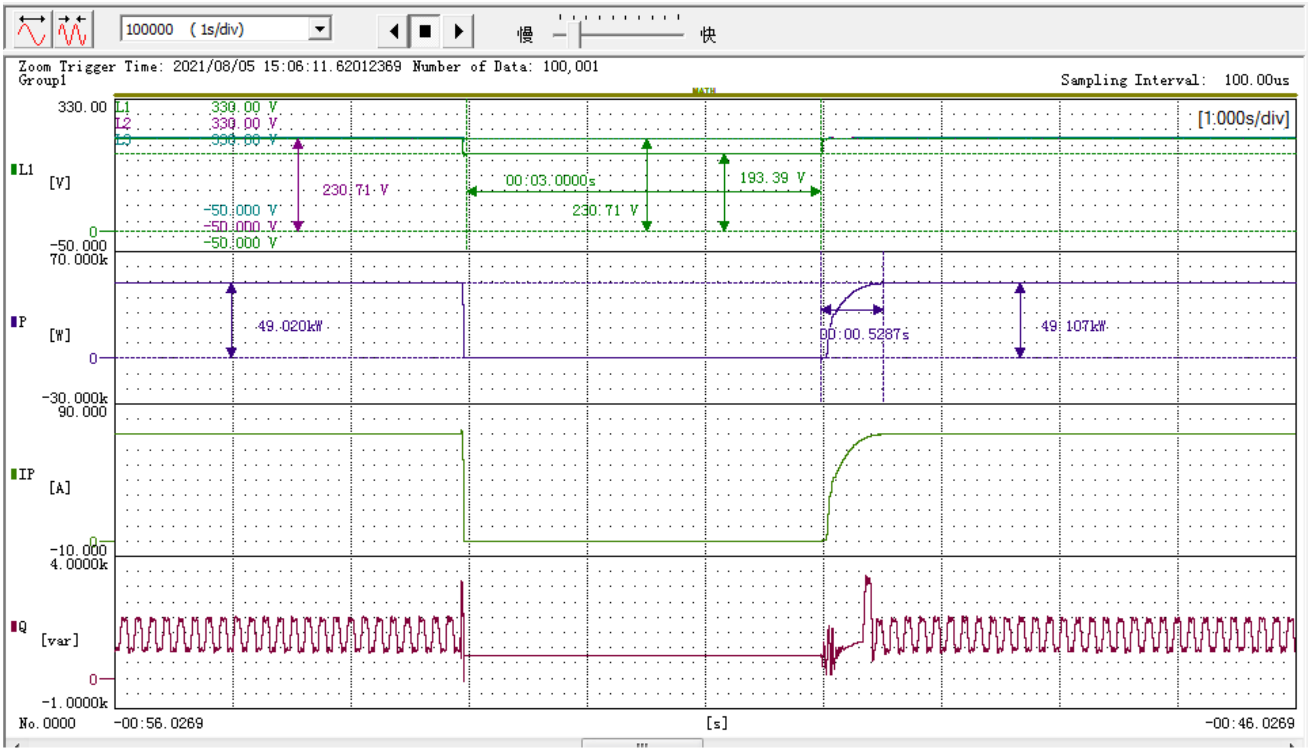
Test 3.A.1-Symmetrical fault (U/U_{nom} = 0,82); P = 100% ±5% P_n



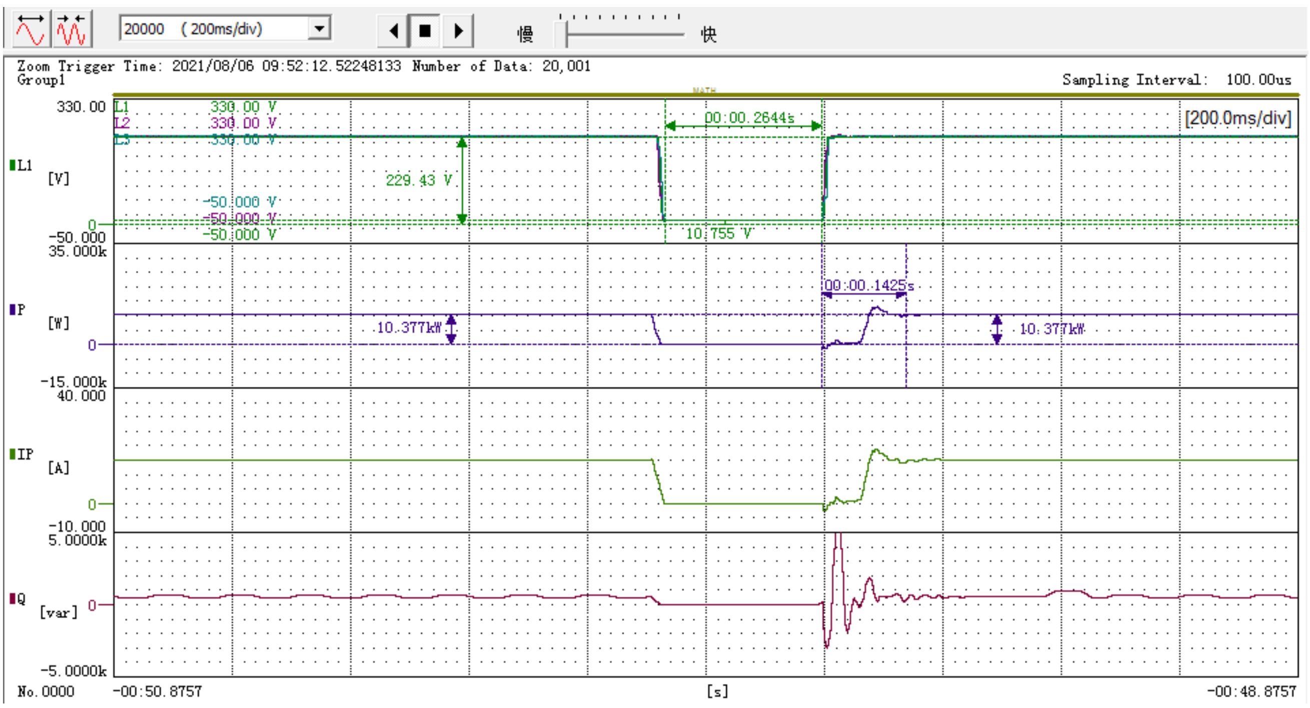
Test 3.D.1-Asymmetrical fault (U/U_{nom} = 0,82); P = 100% ±5% P_n



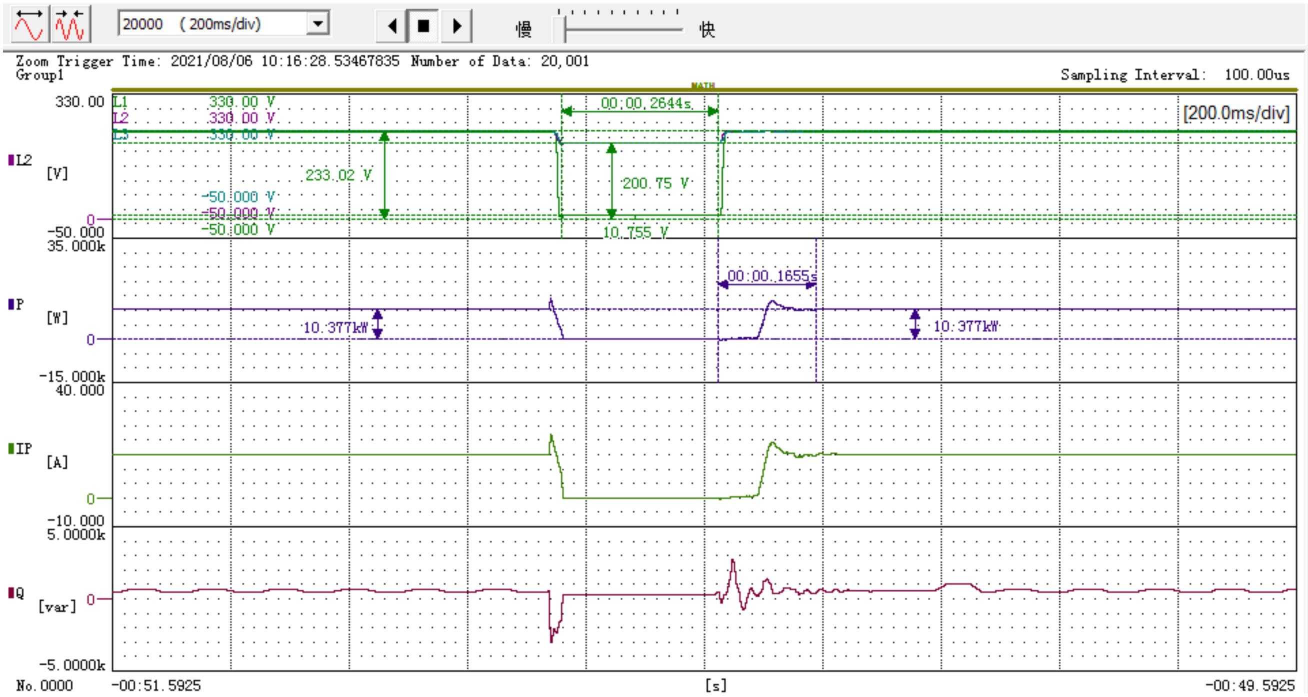
Test 3.B.1-Single phase fault (U/U_{nom} = 0,82); P = 100% ±5% P_n



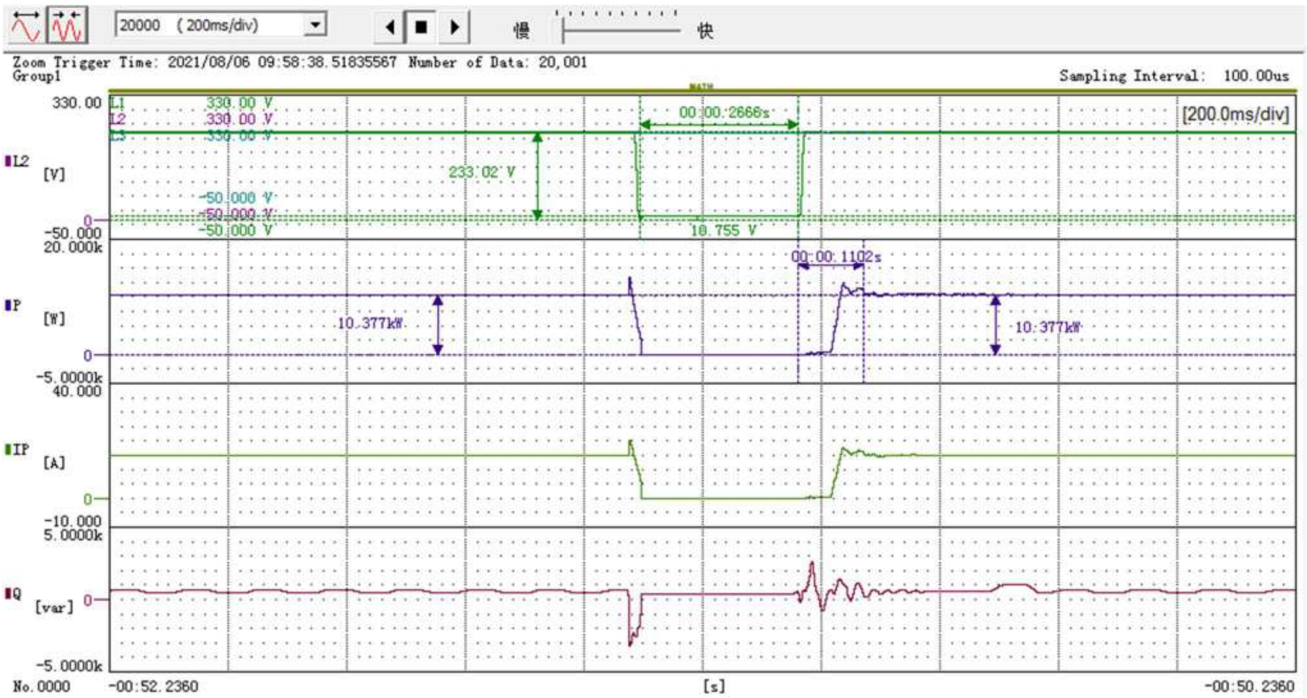
Test 1.A.2-Symmetrical fault (U/U_{nom} = 0,03); P = 20% ±5% P_n



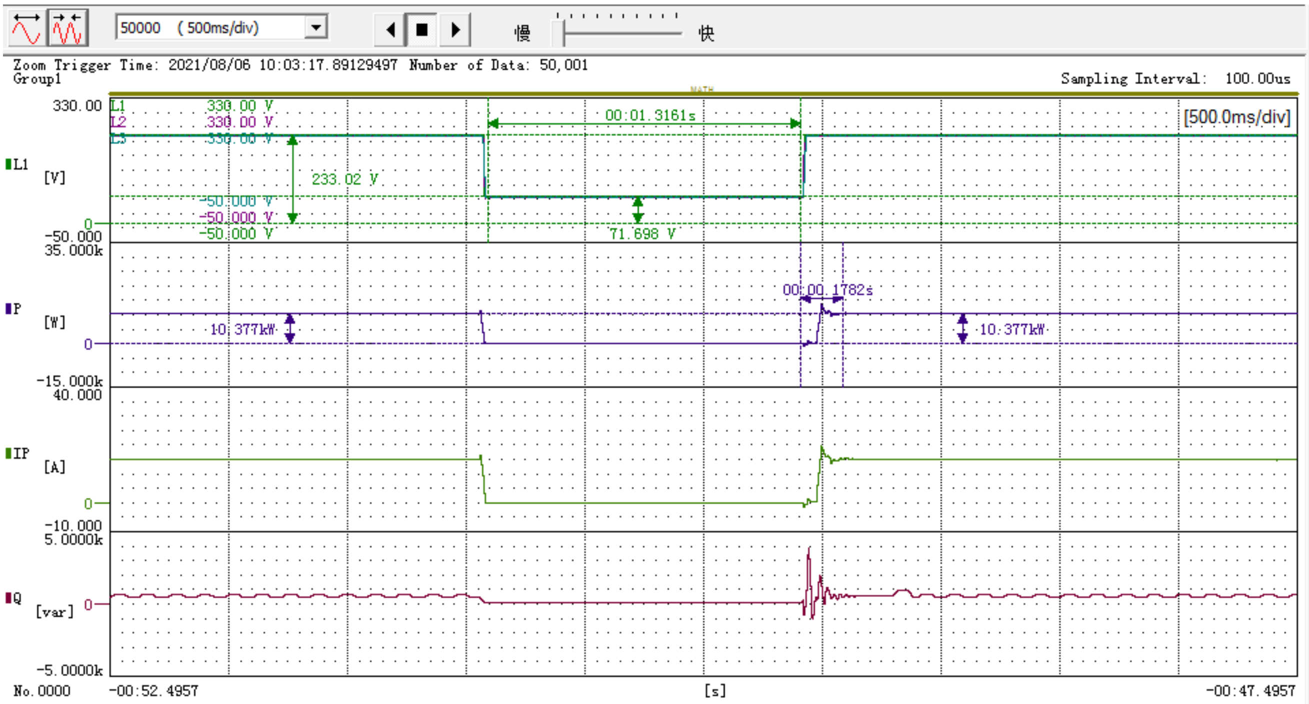
Test 1.D.2-Asymmetrical fault (U/U_{nom} = 0,03); P = 20% ±5% P_n



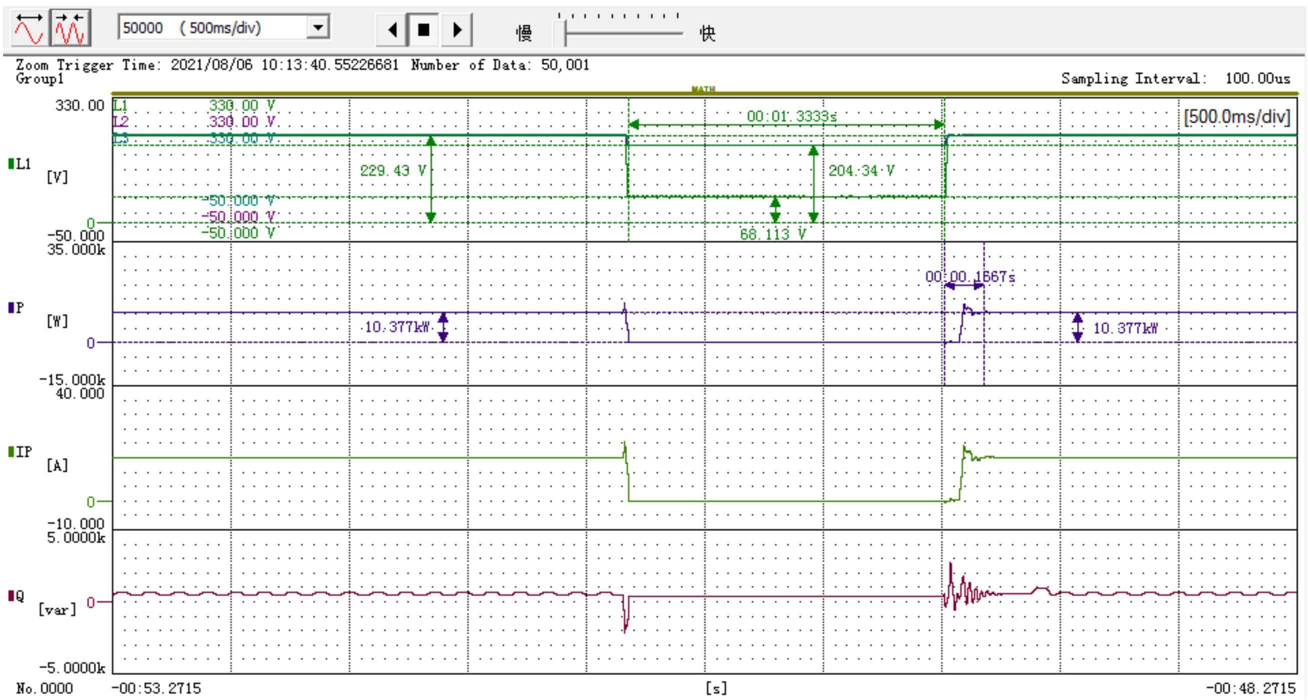
Test 1.B.2-Single phase fault (U/U_{nom} = 0,03); P = 20% ±5% P_n



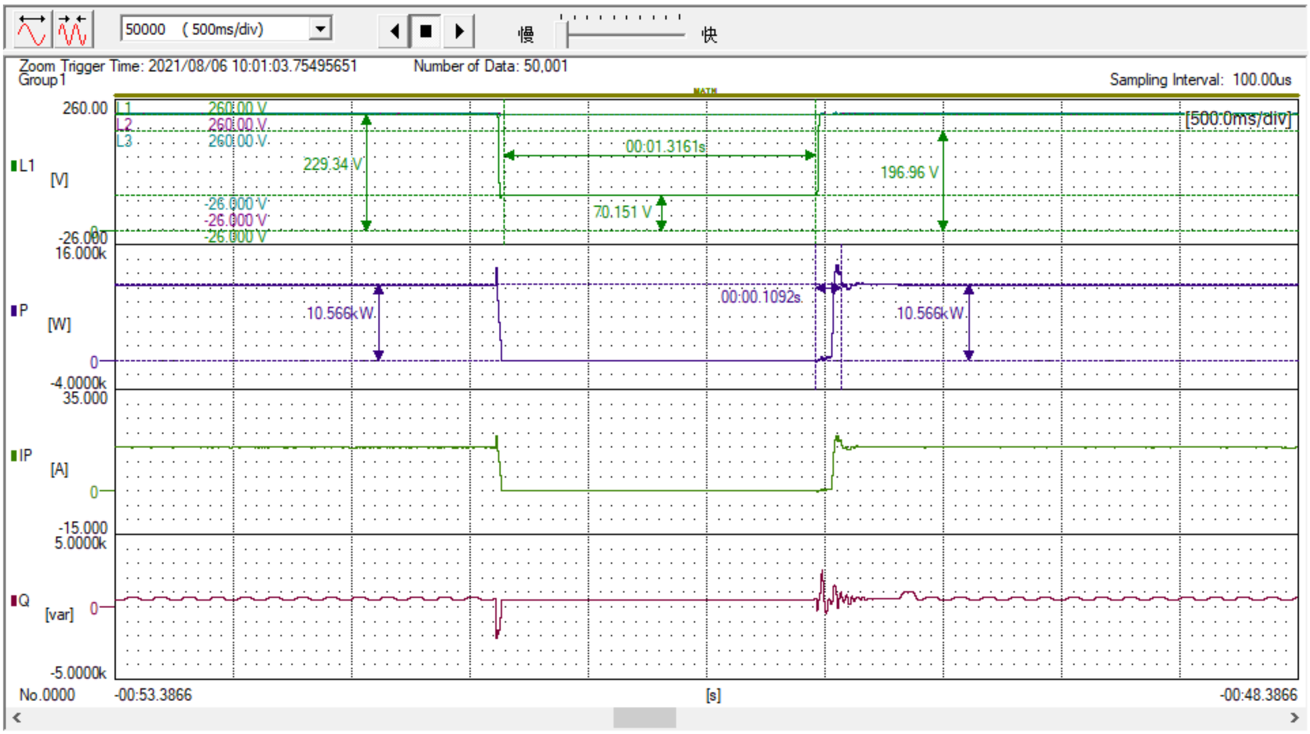
Test 2.A.2-Symmetrical fault (U/U_{nom} = 0,31); P = 20% ±5% P_n



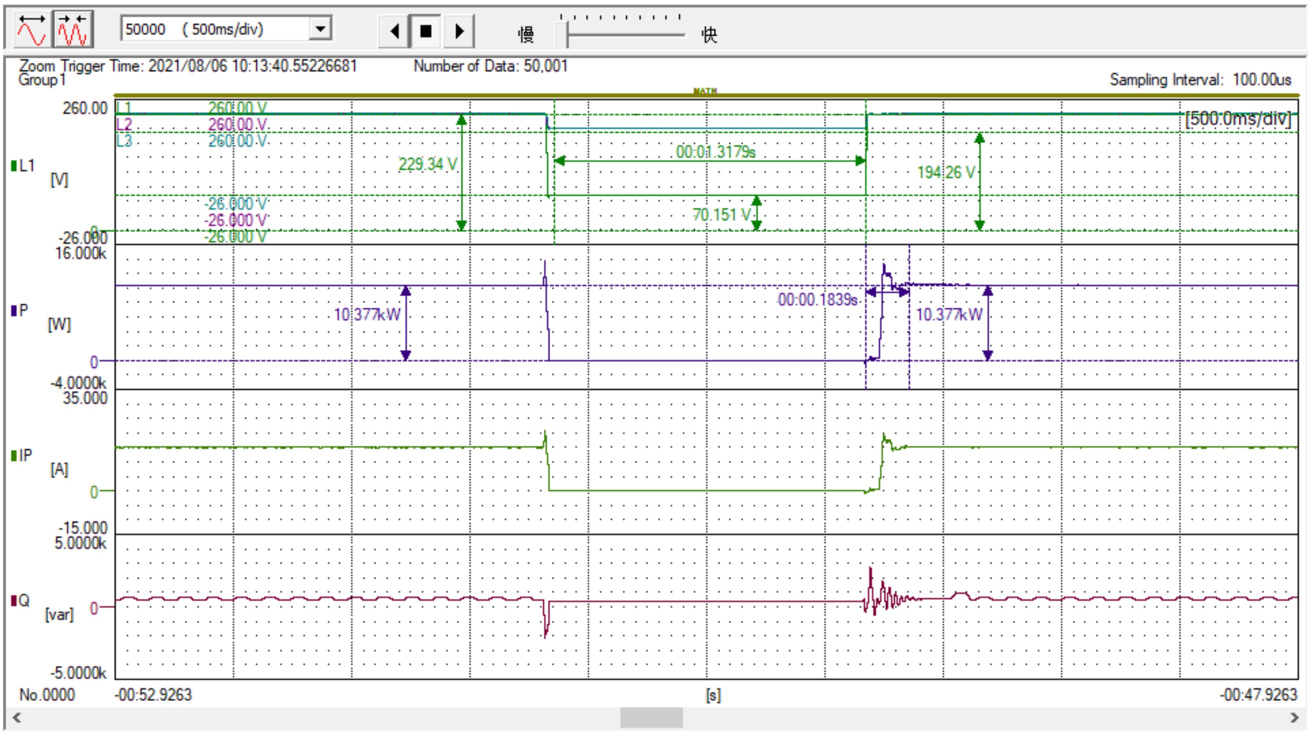
Test 2.D.2-Asymmetrical fault (U/U_{nom} = 0,31); P = 20% ±5% P_n



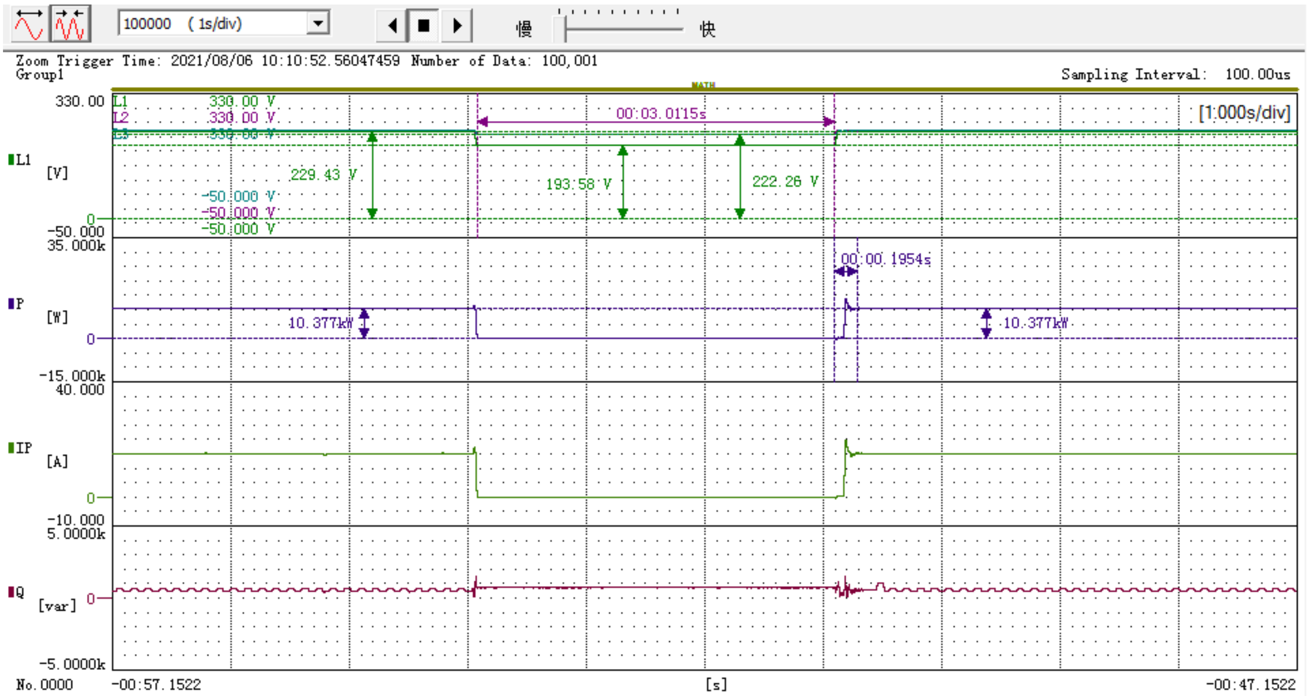
Test 2.B.2-Single phase fault (U/U_{nom} = 0,31); P = 20% ±5% P_n



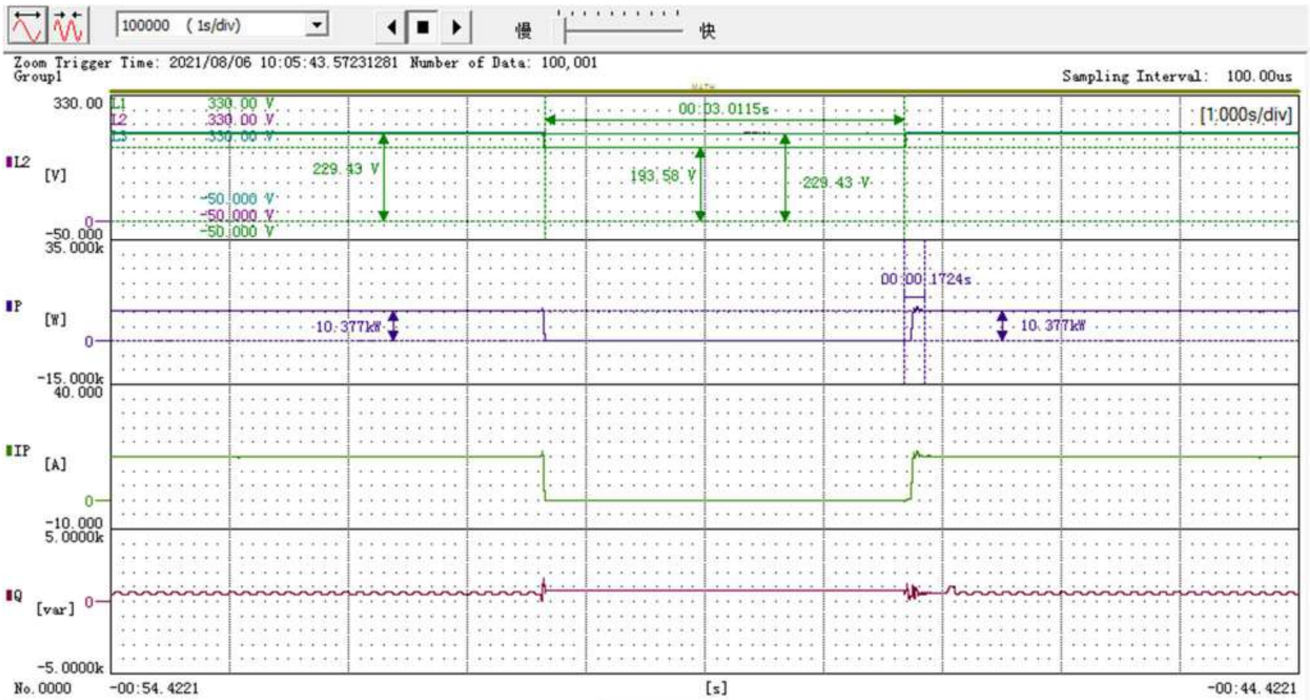
Test 3.A.2-Symmetrical fault (U/U_{nom} = 0,82); P = 20% ±5% P_n



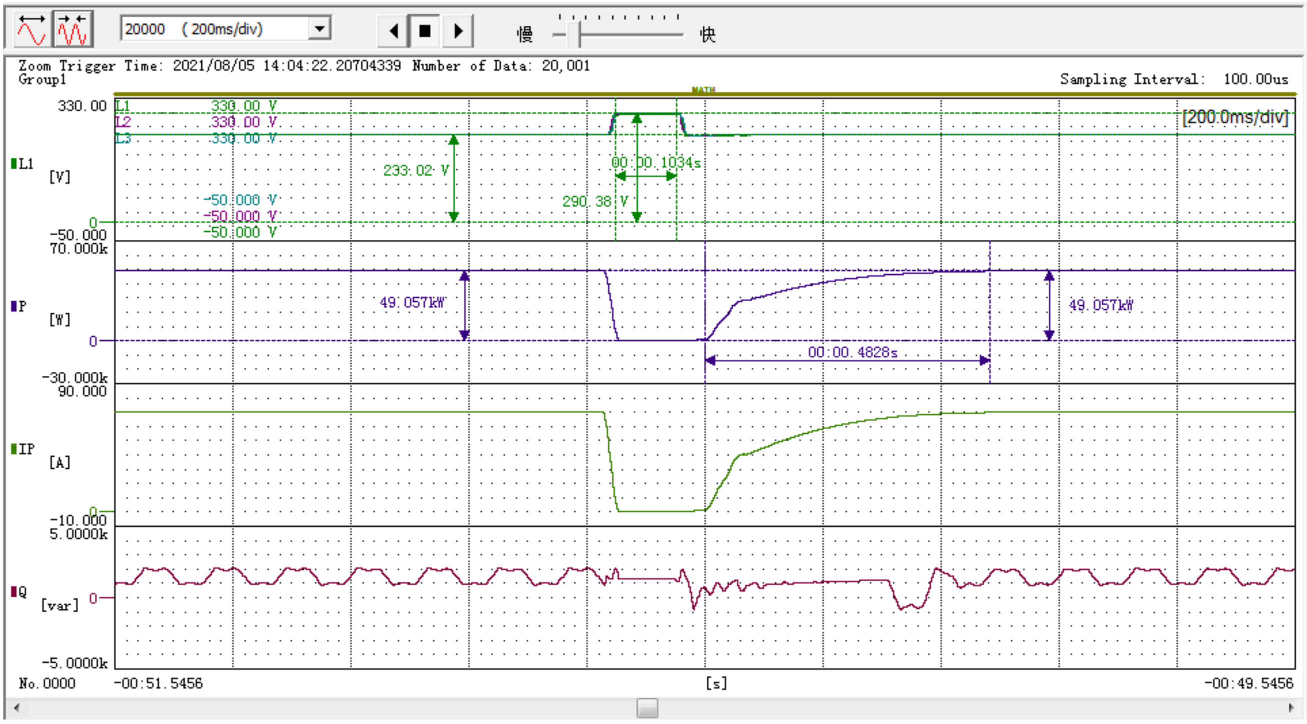
Test 3.D.2-Asymmetrical fault (U/U$_{nom}$ = 0,82); P = 20% ±5% P$_n$



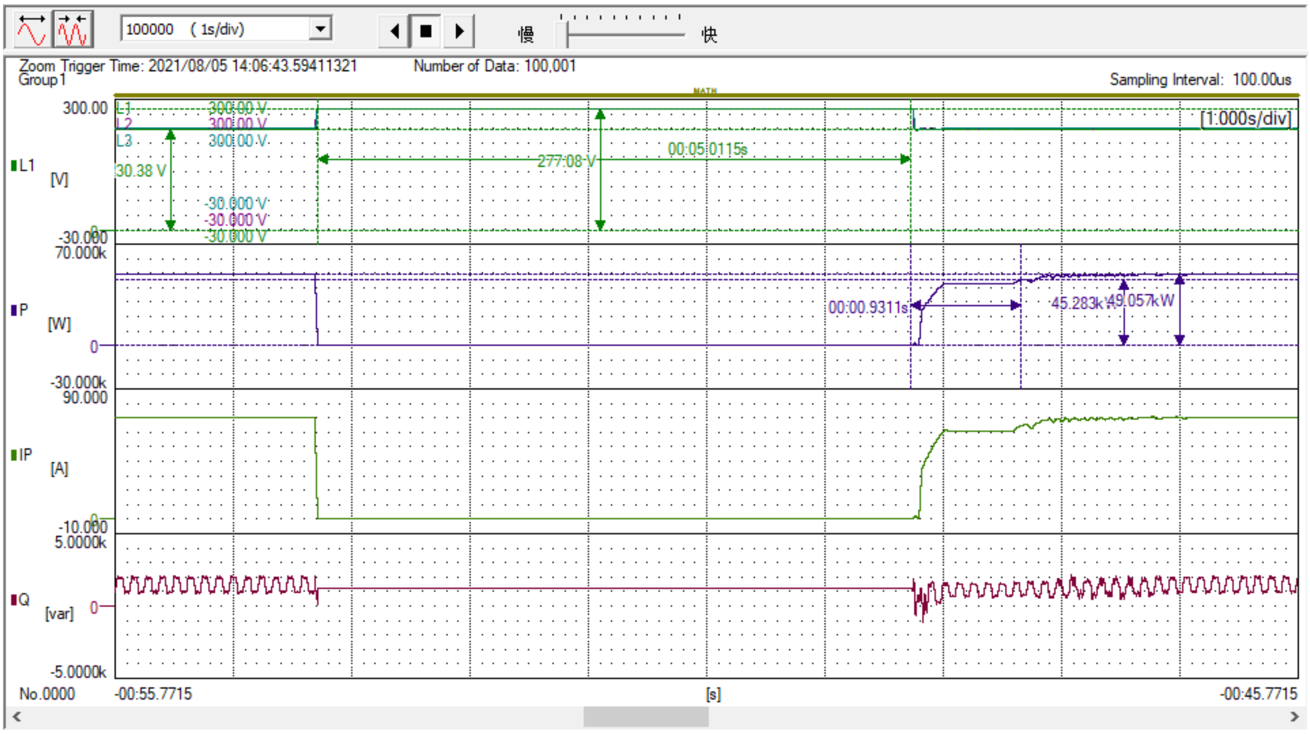
Test 3.B.2-Single phase fault (U/U$_{nom}$ = 0,82); P = 20% ±5% P$_n$



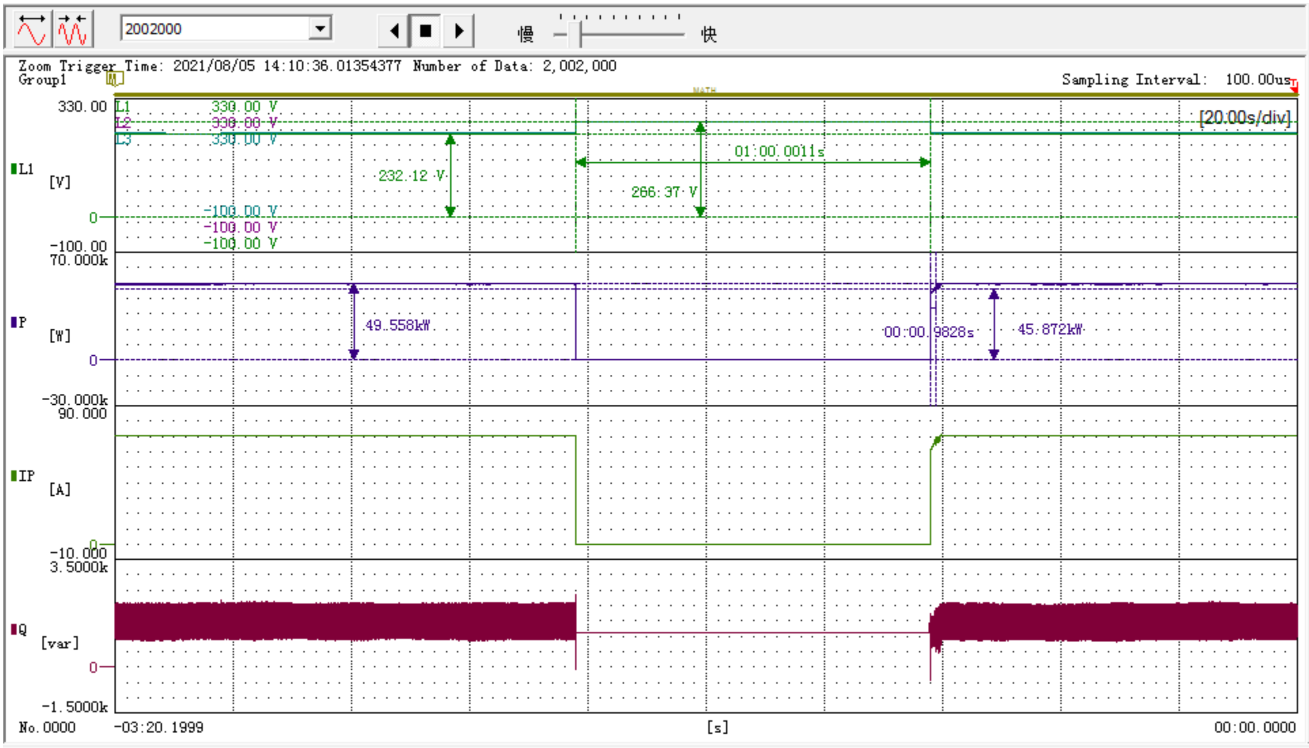
Test OV1-Symmetrical fault (U/U_{nom} = 1,25); P = 100% ±5% P_n



Test OV2-Symmetrical fault (U/U_{nom} = 1,20); P = 100% ±5% P_n

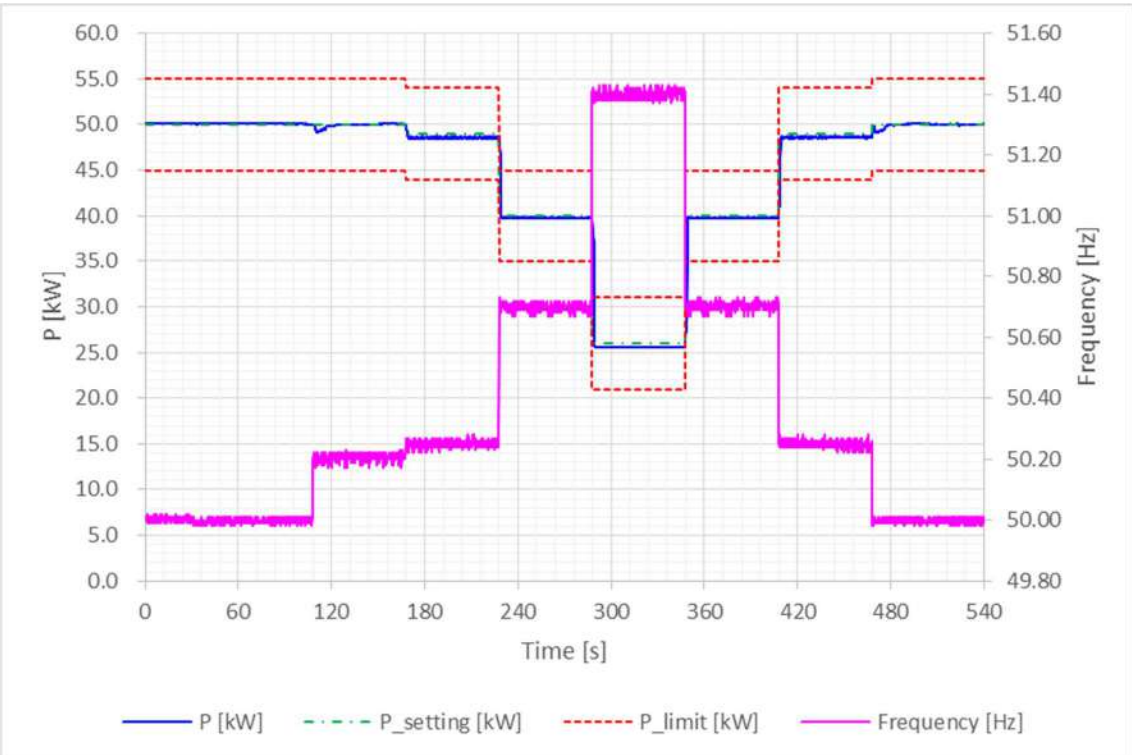


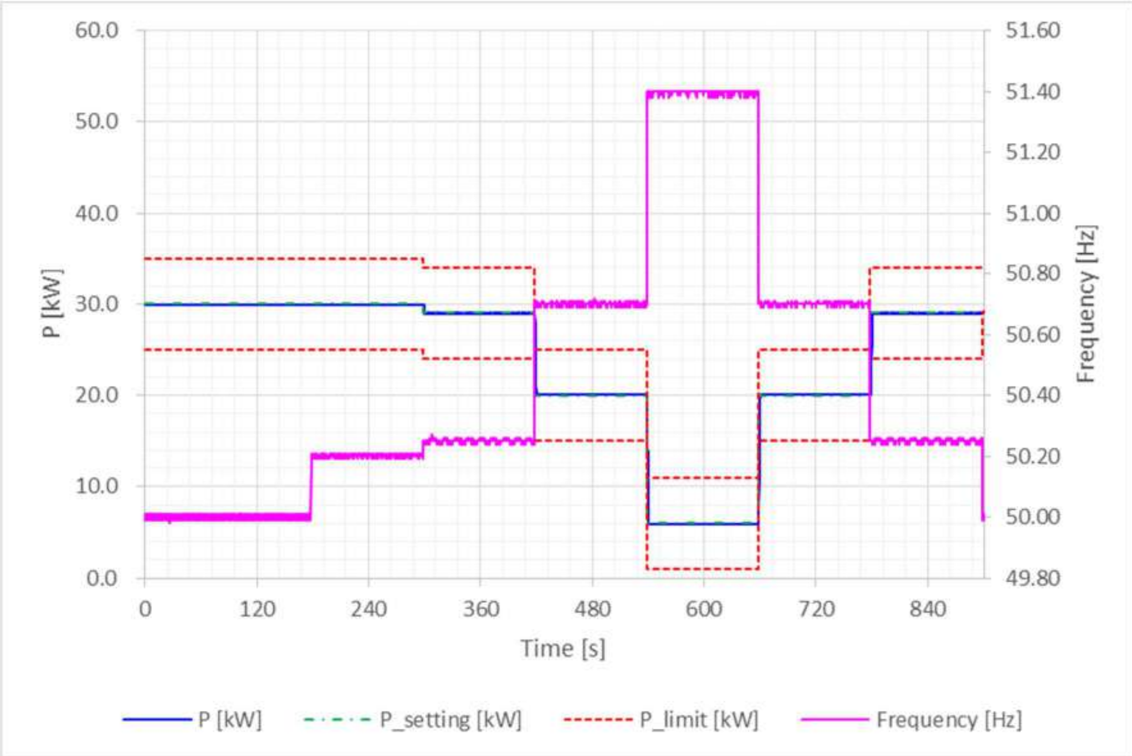
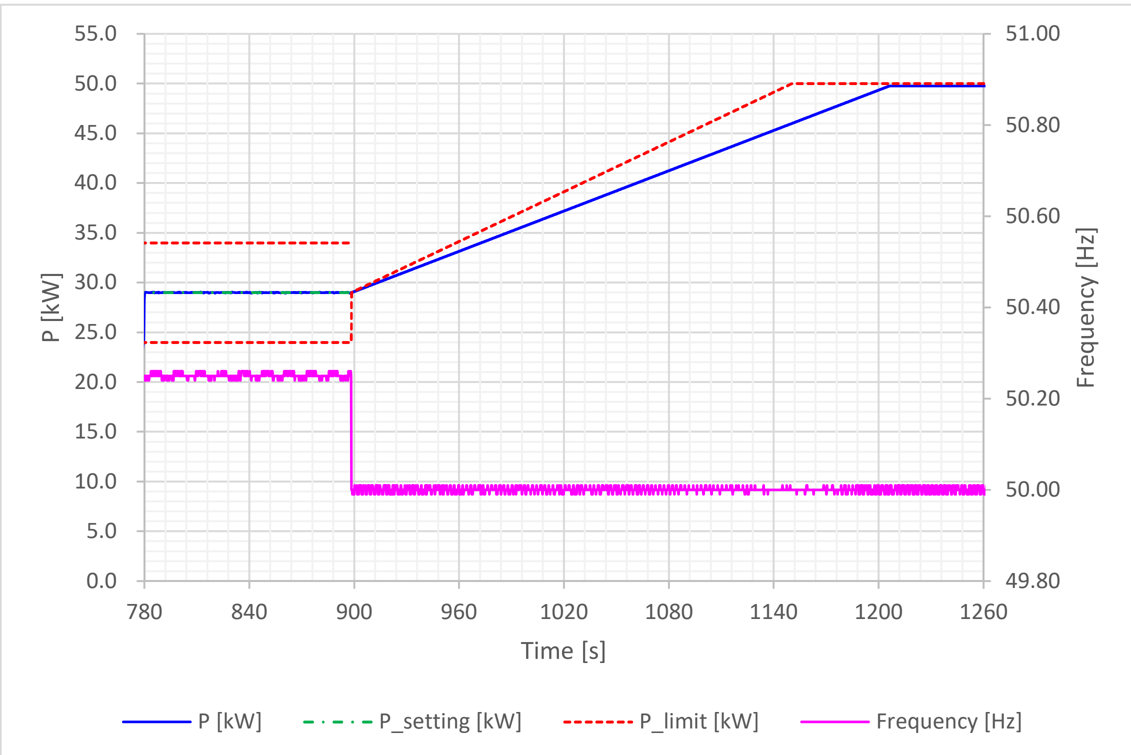
Test OV3-Symmetrical fault (U/U_{nom} = 1,15); P = 100% ±5% P_n



EN 50549-1:2019: Active response to frequency deviation			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.6.1	Power response to over-frequency	VDE V 0124-100:2019-02 (Draft), clause 5.4.4	**P**
4.6.2	Power response to under-frequency	VDE V 0124-100:2019-02 (Draft), clause 5.4.6	**N/A**

4.6.1	Power response to over-frequency						P
Test result:							
1-min mean value [Hz]:	a) 50,00	b) 50,25	c) 50,70	d) 51,40	e) 50,70	f) 50,25	g) 50,00
1. Measurement a) to g): Active power output =100% P_{Emax} s=5% (40% P_{ref} / Hz), threshold frequency for start/return: 50,2Hz							
Frequency [Hz]:	50,00	50,25	50,70	51,40	50,70	50,25	50,00
P_M [kW]:	N/A	49,00	40,00	26,00	40,00	49,00	N/A
P_{E60} [kW]:	50,112	48,594	39,976	25,839	39,54	48,45	49,94
$\Delta P_{E60}/P_M$ [%]:	N/A	-0,813	-0,049	-0,322	-0,928	-1,108	N/A
Test result:							
1-min mean value [Hz]:	a) 50,00	b) 50,25	c) 50,70	d) 51,40	e) 50,70	f) 50,25	g) 50,00
2. Measurement a) to g): Active power output 60% after freezing = 100% P_{Emax} s=5% (40% P_{ref} / Hz), threshold frequency for start/return: 50,2Hz							
Frequency [Hz]:	50,00	50,25	50,70	51,40	50,70	50,25	50,00
P_M [kW]:	N/A	29,00	20,00	6,00	20,00	29,00	N/A
P_{E60} [kW]:	29,94	29,01	20,13	6,04	19,91	28,91	29,94
$\Delta P_{E60}/P_M$ [%]:	N/A	0,012	0,268	0,082	-0,180	-0,180	N/A
Limit $\Delta P/P_{1min}$:	± 10 % of P_{Emax}						
Graph of Measurement 1.: Active power output > 80% P_{Emax}							



Graph of Measurement 2.:Active power output 40% and 60% after freezing > 80% P_n

Graph of power gradient:


Test:

The test is conducted for two powers. First, the test must start at a power =100% P_{Emax} ("Measurement 1"), and in a second test, for a power 60% P_{Emax} ("Measurement 2"). In the second test, after freezing of the P_M, the available active power output must be increased to a value =100% P_{Emax}, and after the network frequency of 50,2 Hz is fallen below, the rise of the active power gradient must be recorded.

Point g) must be held until the micro-generator is again feeding in with the active power output available.

Assessment criterion:

For f = 50,2 Hz, the value of the P_M active power currently being generated is "frozen".

a) For adjustable micro-generators when:

1) the active power reduces between measuring points b) and f) given above with the set gradient P_M per Hz for a increasing frequency (or rises for a frequency decreasing again).

2) the maximum active power gradient occurring in point is less than the configured maximum active power per minute

3) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from P_{Emax} by more than ± 10%.

4) the settling time is equal or below 2 s with an intentional delay set to zero

b) For partly adjustable micro-generators

1) when they behave as in a) within their adjustment range, and

2) when, outside the adjustable range, the power fed in on leaving the adjustment range remains constant until shutdown. Shutdown must be no later than at 51,5 Hz.

Note:

The test method refer to clause 5.4.4 of VDE V 0124-100:2019-02 (Draft).

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

EN 50549-1:2019: Power response to voltage variations and voltage changes			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.7.2.2	Capabilities	--	**P**
4.7.2.3.2	Fix control modes (cos φ setpoint mode)	FGW TG3, Revision 25, clause 4.2.2	**P**
4.7.2.3.2	Fix control modes (Q setpoint mode, 48,43%)	EN 50438:2013, Annex D.3.4.2.1	**P**
4.7.2.2	Q Response time	CEI 0-21:2019-04, Annex B.1.2.4	**P**
4.7.2.3.3	Voltage related control modes (Q (U) controls)	VDE AR 4105:2018-05, clause 5.7.2.4	**P**
4.7.2.3.4	Power related control modes (cos φ (P) curve)	VDE V 0124-100:2012, clause 5.3.6.4	**P**
4.7.3	Voltage related active power reduction (P(U) function)	CEI 0-21:2019-04, Annex B.1.3.1	**P**

4.7.2 4.7.2.2 4.7.2.3.2	Voltage support by reactive power Capabilities Fix control modes (cos φ setpoint mode)			P
Test result: ASW30K-LT-G2				
PF = 0,8 / Inducitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	3,087	-2,307	0,801	230,40
20%	5,923	-4,507	0,796	230,55
30%	9,012	-6,902	0,794	230,72
40%	12,010	-9,134	0,796	230,88
50%	15,006	-11,373	0,797	231,04
60%	17,980	-13,424	0,801	231,20
70%	21,098	-15,565	0,805	231,36
80%	23,903	-17,619	0,805	231,61
90%	24,312	-18,186	0,801	231,64
100%	24,364	-18,398	0,798	231,64
PF = 0,8 / Capacitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,995	2,224	0,803	230,41
20%	6,014	4,432	0,805	230,58
30%	9,156	6,875	0,800	230,82
40%	12,184	9,291	0,795	231,01
50%	15,109	11,475	0,796	231,20
60%	18,021	13,740	0,795	231,38
70%	21,287	15,852	0,802	231,58
80%	24,223	17,980	0,803	231,76
90%	24,473	17,911	0,807	231,78
100%	24,517	17,879	0,808	231,78
Cos phi=1 no reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,961	-0,161	0,999	230,43
20%	5,966	-0,071	0,999	230,61
30%	9,036	0,016	0,999	230,79
40%	12,102	0,109	0,999	230,97
50%	15,026	0,193	0,999	231,14
60%	17,958	0,267	0,999	231,31
70%	21,040	0,335	0,999	231,50
80%	24,042	0,333	0,999	231,68
90%	26,957	0,307	0,999	231,85
100%	29,841	0,246	0,999	232,02

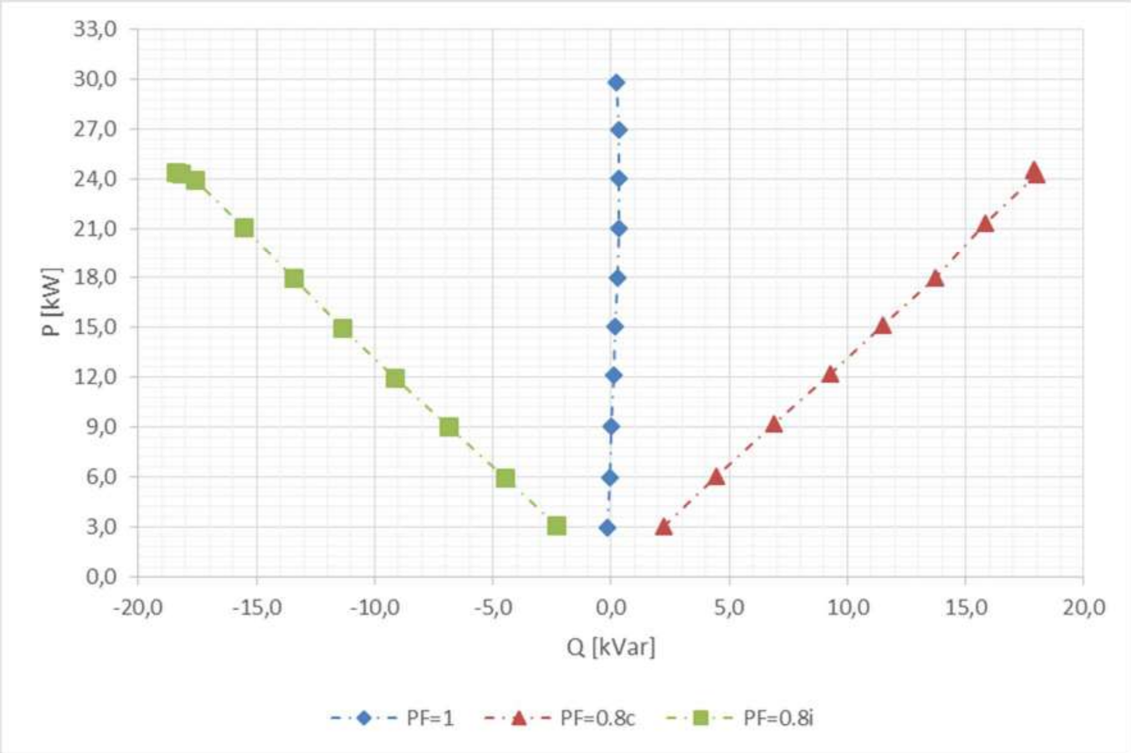
Test result: ASW50K-LT-G2				
PF = 0,8 / Inducitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	5,095	-3,796	0,802	229,27
20%	10,182	-7,632	0,800	229,50
30%	15,254	-11,364	0,802	229,70
40%	20,180	-14,780	0,807	229,94
50%	25,081	-18,585	0,803	230,16
60%	30,394	-22,645	0,802	230,40
70%	35,411	-26,406	0,802	230,61
80%	40,379	-30,219	0,801	230,82
90%	40,392	-30,219	0,801	230,81
100%	40,399	-30,207	0,801	230,78
PF = 0,8 / Capacitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	5,221	3,817	0,807	229,31
20%	10,240	7,605	0,803	229,54
30%	15,277	11,513	0,799	229,78
40%	20,451	15,239	0,802	230,02
50%	25,603	18,933	0,804	230,26
60%	30,352	22,840	0,799	230,50
70%	35,380	26,632	0,799	230,75
80%	40,223	30,163	0,800	230,99
90%	40,225	30,161	0,800	231,00
100%	40,227	30,158	0,800	231,02
Cos phi=1 no reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	5,141	0,512	0,010	230,28
20%	10,205	0,522	0,017	230,52
30%	15,240	0,490	0,027	229,76
40%	20,286	0,484	0,014	229,80
50%	25,331	0,628	0,021	230,02
60%	30,359	0,862	0,018	229,47
70%	35,365	0,345	0,016	229,71
80%	40,391	0,148	0,020	229,95
90%	45,375	-0,503	0,021	230,17
100%	49,779	1,291	0,049	230,38

Assessment criterion:

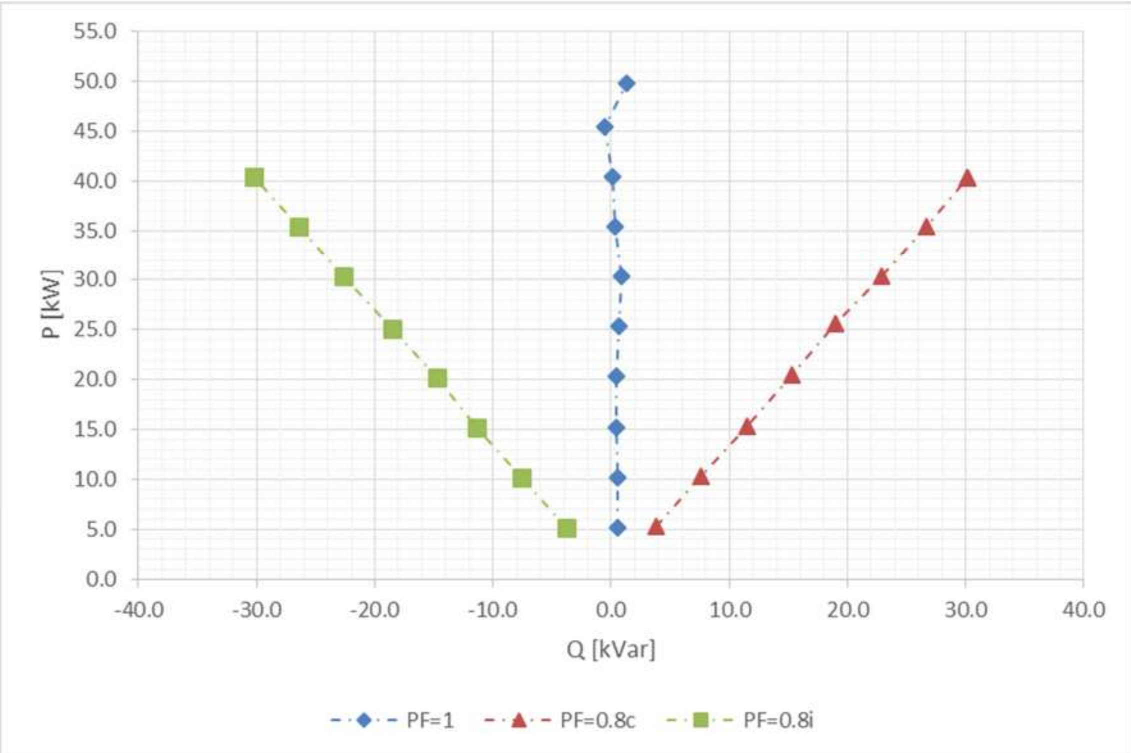
The power factor resulting in each of the measurement points between 20 % and 90 % of the nominal power is equal to or lower than 0,90 both in over excited and under excited operation.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Diagram



ASW30K-LT-G2



ASW50K-LT-G2

4.7.2 4.7.2.2 4.7.2.3.2	Voltage support by reactive power Capabilities Fix control modes (Q setpoint mode, 48,43%)	P

Test result: ASW30K-LT-G2

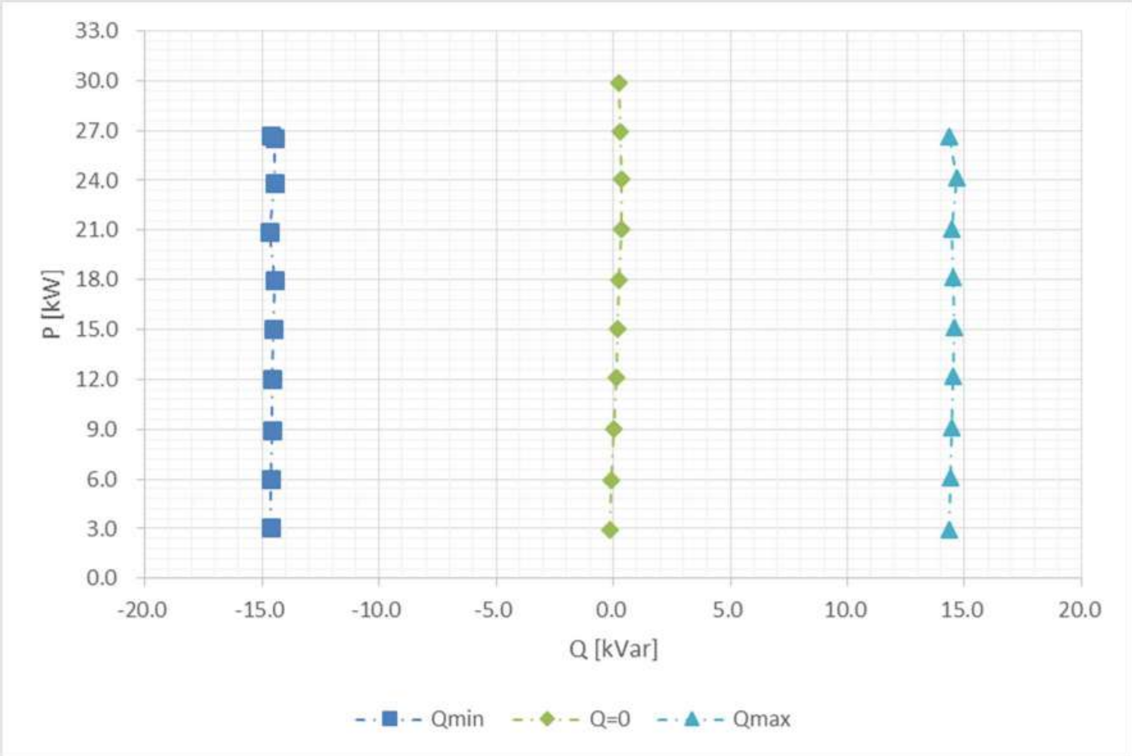
Inducitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	3,058	-14,650	0,204	230,35
20%	6,013	-14,621	0,380	230,52
30%	8,912	-14,592	0,521	230,70
40%	12,041	-14,552	0,638	230,87
50%	15,057	-14,525	0,720	231,06
60%	17,991	-14,485	0,779	231,23
70%	20,904	-14,668	0,819	231,41
80%	23,806	-14,457	0,855	231,58
90%	26,542	-14,453	0,878	231,75
100%	26,737	-14,628	0,877	231,75
Cos phi=1 no reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,961	-0,161	0,999	230,43
20%	5,966	-0,071	1,000	230,61
30%	9,036	0,016	1,000	230,79
40%	12,102	0,109	1,000	230,97
50%	15,026	0,193	1,000	231,14
60%	17,958	0,267	1,000	231,31
70%	21,040	0,335	1,000	231,50
80%	24,042	0,333	1,000	231,68
90%	26,957	0,307	1,000	231,85
100%	29,841	0,246	1,000	232,02
Capacitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	2,932	14,364	0,200	230,47
20%	6,052	14,416	0,387	230,62
30%	9,109	14,452	0,533	230,81
40%	12,184	14,518	0,643	231,00
50%	15,150	14,543	0,721	231,17
60%	18,152	14,497	0,781	231,34
70%	21,050	14,481	0,824	231,51
80%	24,180	14,692	0,855	231,68
90%	26,630	14,329	0,880	231,82
100%	26,630	14,329	0,880	231,82

Test result: ASW50K-LT-G2

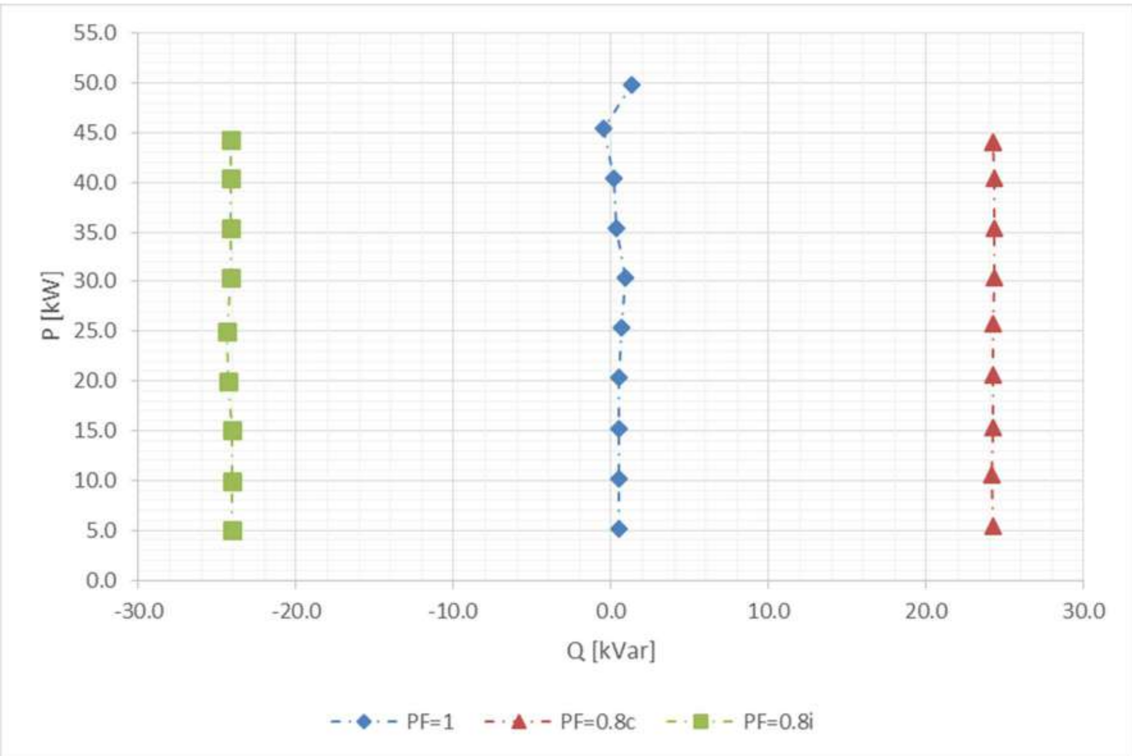
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
Inducitive reactive power supply				
10%	4,981	-24,086	0,203	229,22
20%	9,945	-24,074	0,382	229,45
30%	15,106	-24,056	0,532	229,68
40%	19,949	-24,271	0,635	229,91
50%	24,914	-24,402	0,714	230,16
60%	30,387	-24,167	0,783	230,39
70%	35,420	-24,143	0,826	230,63
80%	40,433	-24,152	0,859	230,80
90%	44,275	-24,164	0,878	231,06
100%	44,279	-24,161	0,878	231,05
Capacitive reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	5,416	24,229	0,218	230,38
20%	10,511	24,164	0,399	230,60
30%	15,312	24,238	0,534	230,82
40%	20,631	24,214	0,649	231,05
50%	25,755	24,225	0,728	231,28
60%	30,322	24,290	0,780	231,50
70%	35,330	24,290	0,824	231,74
80%	40,349	24,287	0,857	231,97
90%	44,068	24,240	0,876	231,15
100%	44,071	24,234	0,876	231,17
Cos phi=1 no reactive power supply				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
10%	5,141	0,512	0,010	230,28
20%	10,205	0,522	0,017	230,52
30%	15,240	0,490	0,027	229,76
40%	20,286	0,484	0,014	229,80
50%	25,331	0,628	0,021	230,02
60%	30,359	0,862	0,018	229,47
70%	35,365	0,345	0,016	229,71
80%	40,391	0,148	0,020	229,95
90%	45,375	-0,503	0,021	230,17
100%	49,779	1,291	0,049	230,38

Assessment criterion:
The power factor resulting in each of the measurement points between 20 % and 90 % of the nominal power is equal to or lower than 0,90 both in over excited and under excited operation,
The test method refer to clause CEI0-21 / EN 50438:2013, Annex D.3.4.2.1,
Generating plants must meet the reactive power requirement regardless of the number of feeding phases under normal steady-state operating conditions in the voltage tolerance band +10%U_n and -15%U_n.
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Diagram



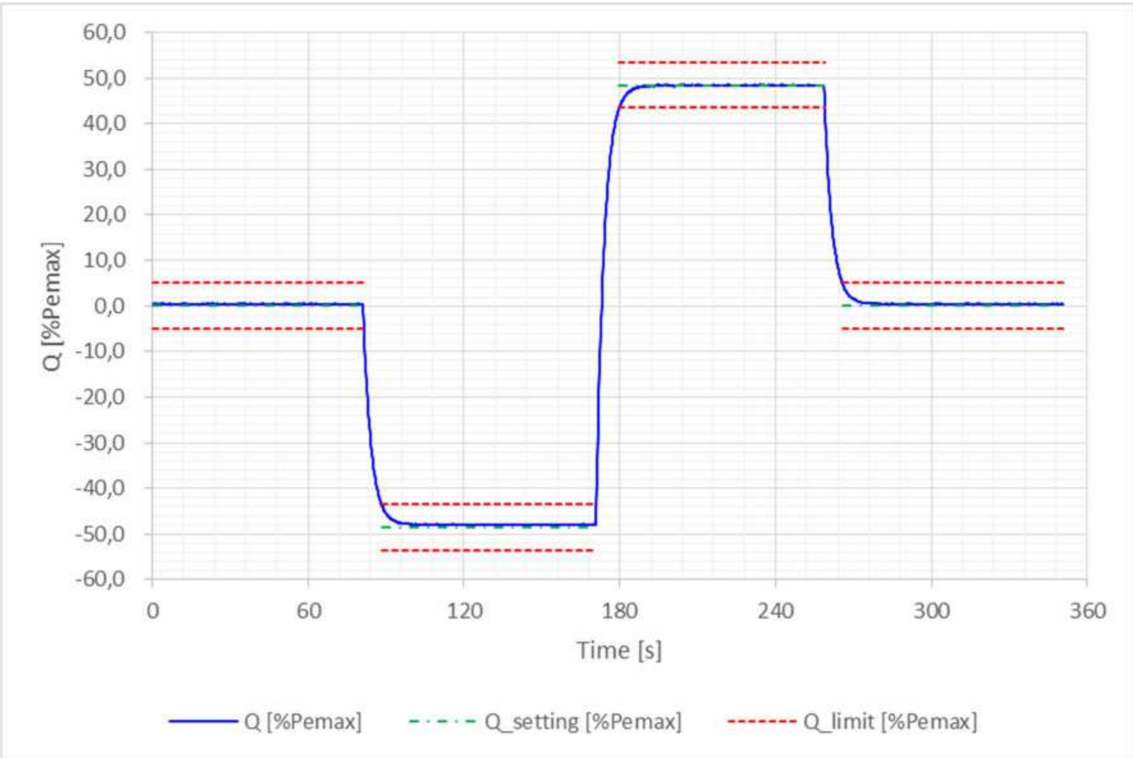
ASW30K-LT-G2



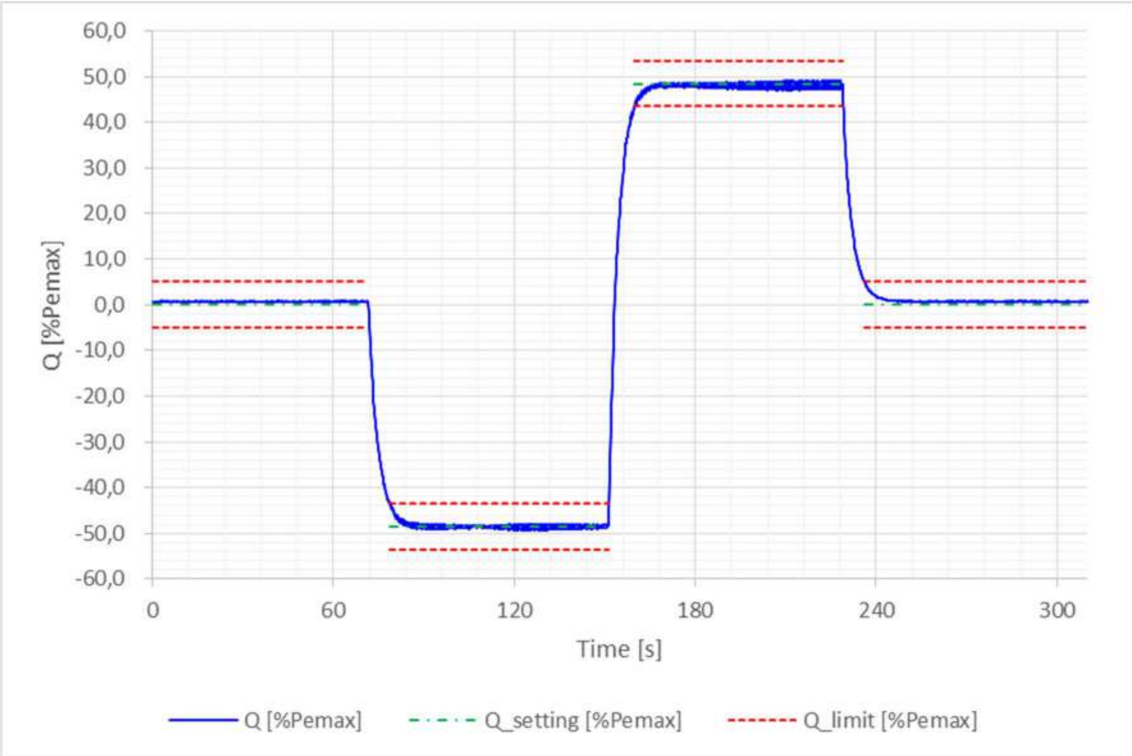
ASW50K-LT-G2

4.7.2.2 Capabilities Q Response time			P
Reaction time			
Test result: ASW50K-LT-G2			
		Time	**Result**
1.	Reaction time Q=0 to Qmin (50% test)	6,2	P
2.	Reaction time Qmin to Qmax (50% test)	8,4	P
3.	Reaction time Qmax to Q=0 (50% test)	7,2	P
4.	Reaction time Q=0 to Qmin (100% test)	6,1	P
5.	Reaction time Qmin to Qmax (100% test)	8,6	P
6.	Reaction time Qmax to Q=0 (100% test)	9,1	P
Test result:			

Graph 50%Pn



Graph 100%Pn



Assessment criterion:

DC source should be set to 50%(test1) and 100%(test2) output power micro-generator.

Starting with Q=0 then Qmin≤ -0,4843 Pn to to Qmax≥ 0,4843 Pn, and then back to Q=0 in doing so each point must be kept for at least 2 minute.

The total tolerance is ΔQ ≤ ±5,0% of Pn or Δcosφ ≤ ±0,01

The maximum response time is 10s.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.7.2.2 Capabilities 4.7.2.3.3 Voltage related control modes (Q (U) controls) The validation of the Q (U) regulation according to VDE-AR-N 4105: 2018-05, 5.7.2.4 is divided into two partial tests, so that on the one hand the accuracy and on the other hand the dynamics of the Q (U) control is checked. For all inverter-coupled systems, only the inverter must be tested.	P

Test result:ASW30K-LT-G2

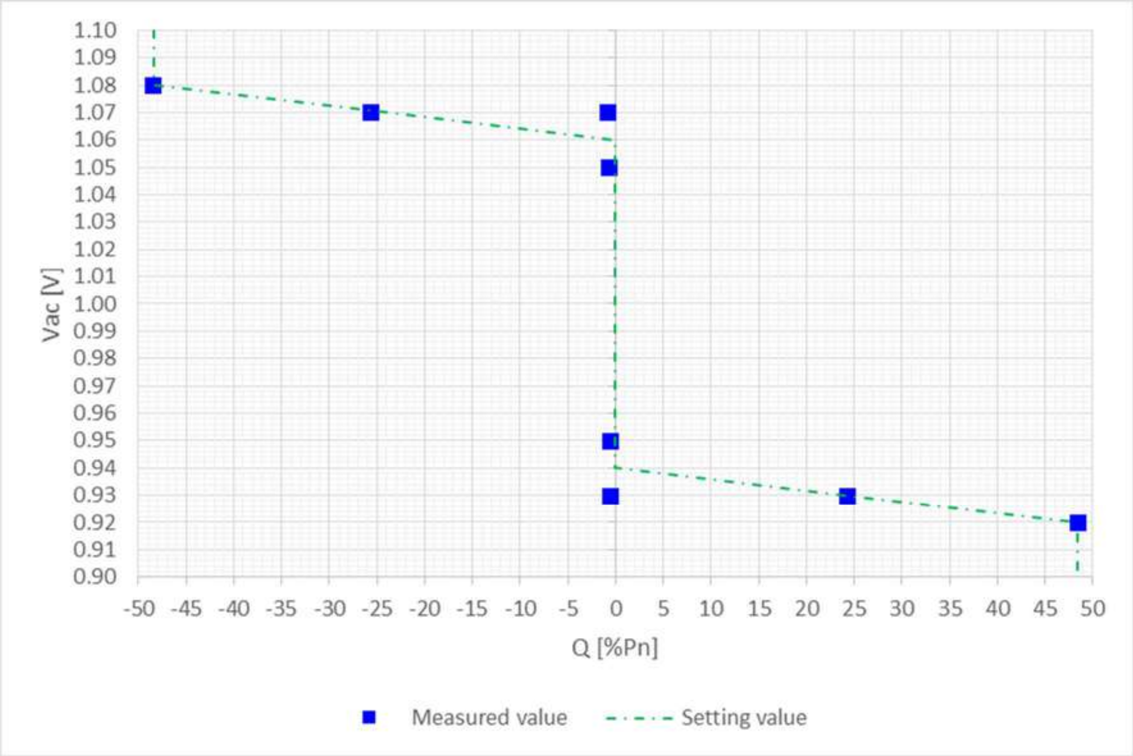
Qmin reactive power in accordance to standard characteristic curve Q=f(V)						
P/Pn	Vac [% U_n] Set point	P/Pn [%]	Vac [V] measured	Q [kVar] measured	Q [kVar] expected	ΔQ [% P_{Emax}]
< 20%	1,05Vn	16,29	241,81	-0,212	≈0(<±2,5%Pn)	-0,71
< 20%	1,07Vn	16,31	243,80	-0,215	≈0(<±2,5%Pn)	-0,72
< 20%-30%	1,07Vn	30,06	245,66	-6,933	0,5 Qmin	-1,31
40%	1,07Vn	39,86	245,70	-6,570	0,5 Qmin	-0,10
50%	1,07Vn	50,17	245,75	-6,567	0,5 Qmin	-0,09
60%	1,07Vn	59,71	245,69	-6,554	0,5 Qmin	-0,05
70%	1,07Vn	69,81	245,83	-6,543	0,5 Qmin	-0,01
80%	1,07Vn	79,87	245,69	-6,533	0,5 Qmin	0,02
90%	1,07Vn	89,94	245,84	-6,527	0,5 Qmin	0,04
100%	1,07Vn	99,80	245,79	-6,599	0,5 Qmin	-0,20
100%	1,08Vn	99,53	248,26	-13,085	Qmin	-0,02
100%-10%	1,08Vn	10,28	247,95	-12,983	Qmin	0,32
10%→ ≤5%	1,08Vn	3,99	247,92	-0,133	≈0(<±2,5%Pn)	-0,44
Qmax reactive power in accordance to standard characteristic curve Q=f(V)						
P/Pn	Vac [% U_n] Set point	P/Pn [%]	Vac [V] measured	Q [kVar] measured	Q [kVar] expected	ΔQ [% P_{Emax}]
< 20%	0,95Vn	15,33	218,32	-0,158	≈0(<±2,5%Pn)	-0,53
< 20%	0,93Vn	15,27	214,33	-0,152	≈0(<±2,5%Pn)	-0,51
< 20%-30%	0,93Vn	30,13	214,29	6,552	0,5 Qmax	0,04
40%	0,93Vn	40,14	214,36	6,563	0,5 Qmax	0,08
50%	0,93Vn	50,19	214,55	6,578	0,5 Qmax	0,13
60%	0,93Vn	60,27	214,41	6,588	0,5 Qmax	0,16
70%	0,93Vn	70,14	214,28	6,599	0,5 Qmax	0,20
80%	0,93Vn	80,25	214,27	6,489	0,5 Qmax	-0,17
90%	0,93Vn	90,17	214,25	6,585	0,5 Qmax	0,15
100%	0,93Vn	100,38	214,44	6,539	0,5 Qmax	0,00
100%	0,92Vn	100,83	212,11	13,070	Qmax	-0,03
100%-10%	0,92Vn	10,23	212,29	13,009	Qmax	-0,24
10%→ ≤5%	0,92Vn	3,29	212,10	-0,085	≈0(<±2,5%Pn)	-0,28

4.7.2.2 Capabilities **4.7.2.3.3 Voltage related control modes (Q (U) controls)** The validation of the Q (U) regulation according to VDE-AR-N 4105: 2018-05, 5.7.2.4 is divided into two partial tests, so that on the one hand the accuracy and on the other hand the dynamics of the Q (U) control is checked. For all inverter-coupled systems, only the inverter must be tested.	**P**

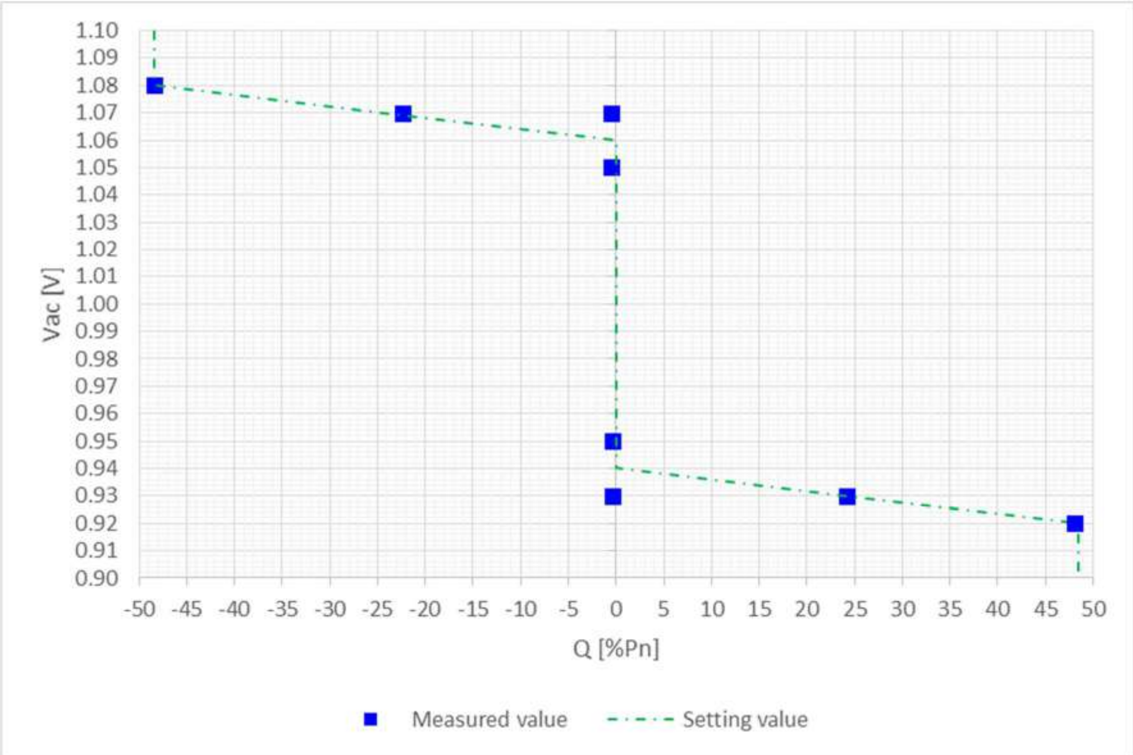
Test result:ASW50K-LT-G2

Qmin reactive power in accordance to standard characteristic curve Q=f(V)						
P/Pn	Vac [% U_n] Set point	P/Pn [%]	Vac [V] measured	Q [kVar] measured	Q [kVar] expected	ΔQ [% P_{Emax}]
< 20%	1,05Vn	16,09	241,76	-0,235	≈0(<±2,5%Pn)	-0,47
< 20%	1,07Vn	16,10	243,75	-0,239	≈0(<±2,5%Pn)	-0,48
< 20%-30%	1,07Vn	30,67	245,54	-10,914	0,5 Qmin	-0,04
40%	1,07Vn	40,77	245,79	-10,907	0,5 Qmin	-0,02
50%	1,07Vn	50,87	245,64	-10,887	0,5 Qmin	0,02
60%	1,07Vn	60,67	245,69	-10,809	0,5 Qmin	0,17
70%	1,07Vn	70,62	245,74	-10,961	0,5 Qmin	-0,13
80%	1,07Vn	80,53	245,62	-10,905	0,5 Qmin	-0,02
90%	1,07Vn	90,95	245,77	-10,929	0,5 Qmin	-0,07
100%	1,07Vn	100,14	245,70	-10,833	0,5 Qmin	0,12
100%	1,08Vn	100,10	247,96	-21,765	Qmin	0,05
100%-10%	1,08Vn	10,66	247,72	-21,836	Qmin	-0,09
10%→ ≤5%	1,08Vn	3,69	248,16	-0,157	≈0(<±2,5%Pn)	-0,31
Qmin reactive power in accordance to standard characteristic curve Q=f(V)						
P/Pn	Vac [% U_n] Set point	P/Pn [%]	Vac [V] measured	Q [kVar] measured	Q [kVar] expected	ΔQ [% P_{Emax}]
< 20%	0.95Vn	15,74	218,21	-0,150	≈0(<±2,5%Pn)	-0,30
< 20%	0,93Vn	15,70	214,20	-0,151	≈0(<±2,5%Pn)	-0,30
< 20%-30%	0,93Vn	30,53	214,37	10,892	0,5 Qmax	-0,01
40%	0,93Vn	40,41	214,25	10,925	0,5 Qmax	0,06
50%	0,93Vn	50,54	214,35	10,869	0,5 Qmax	-0,05
60%	0,93Vn	60,81	214,37	10,903	0,5 Qmax	0,02
70%	0,93Vn	71,06	214,28	10,753	0,5 Qmax	-0,28
80%	0,93Vn	80,58	214,30	10,978	0,5 Qmax	0,17
90%	0,93Vn	90,64	214,33	10,978	0,5 Qmax	0,17
100%	0,93Vn	100,20	214,35	10,914	0,5 Qmax	0,04
100%	0,92Vn	99,97	212,28	21,642	Qmax	-0,30
100%-10%	0,92Vn	10,78	212,07	21,892	Qmax	0,20
10%→ ≤5%	0,92Vn	3,15	212,05	-0,100	≈0(<±2,5%Pn)	-0,20

Graph of ASW30K-LT-G2



Graph of ASW50K-LT-G2



Test:

The verification of the accuracy of the Q (U) control of the reactive power-voltage characteristic Un shown in VDE-AR-N 4105: 2018-11, 5.7.2.4, Figure 7 is effected by a slow variation of the line voltage U_n in the range 90% U_n to 110% U_n. Depending on the type of EZE (single- or three-phase), the voltage changes must be carried out simultaneously or symmetrically on all phases.

a) In order to check the stationary accuracy, the permissible voltage range shall be passed through within steps, with a step size of 1% U_n, but not greater than 2% U_n.
   1. Pass the voltage range from 100% U_n down to the under voltage range to 90% U_n.
   2. Pass the voltage range from 90% U_n up to the over voltage range to 110% U_n.
   3. Pass the voltage range from 110% U_n down to the Nominal Voltage U_n.

The procedure is analogous to Figure 3 in Section 5.4.3.2.

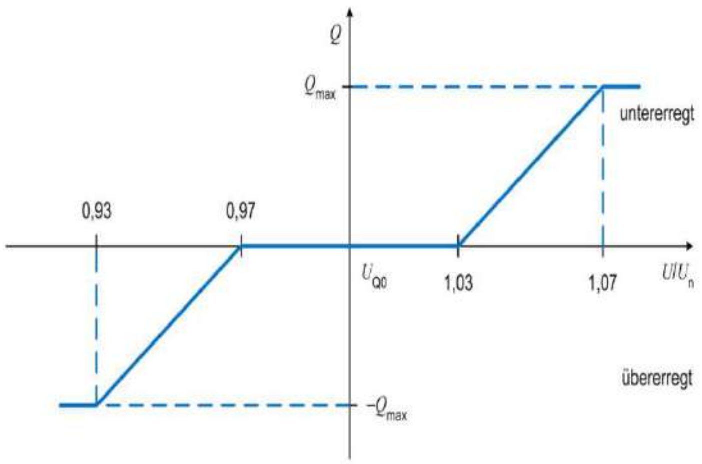


Bild 7 – Standard-Q(U)-Kennlinie

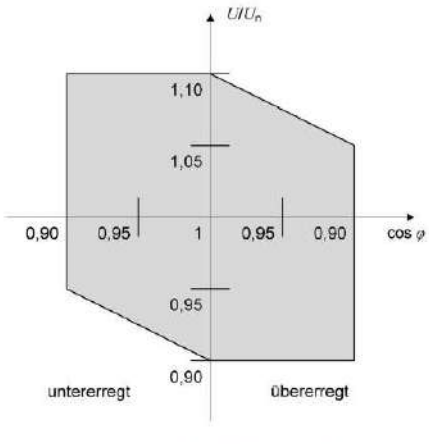


Bild 3 – Anforderungen an Erzeugungseinheiten bezüglich der Blindleistungsbereitstellung an den Generatorklemmen ($\sum S_{Emax} > 4{,}6$ kVA)

The voltages are to be set with a maximum deviation of 0.25% U_n.

Assessment criterion:

In order to pass the Q (U) accuracy test, the measured stationary value pairs U_{PGU} and Q_{PGU}, under taking account to the correct sign in the consumer metering system, must be within VDE-AR-N 4105: 2018-11, in 5.7.2.4, Figure 7 Q (U) shown characteristic. The stationary value pairs U_{PGU} and Q_{PGU} are determined by averaging over 30 seconds at the end of the respective measuring section analogously to Chapter 5.4.3.2. The permissible deviations are with the maximum measuring error of the voltage of 1% U_n stated in VDE-AR-N 4105: 2018-11 and a setting accuracy of 4% P_{EMax} at

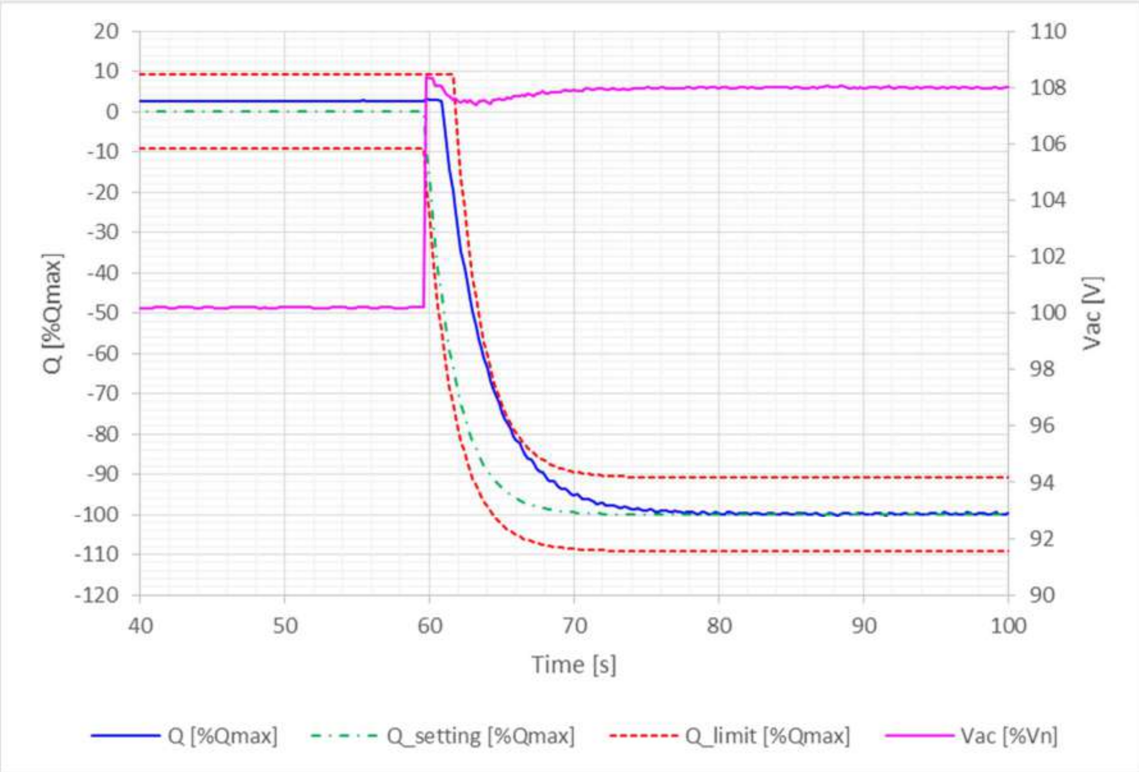
$$Q_{EZE,tol} = \pm(0.01 \cdot \mathrm{U_{N,Y}} \cdot \mathrm{k_{QU}} + 0.04 \cdot P_{EMax}) = \pm 0{,}25 \cdot P_{EMax} \cdot (\sin(\arccos(\varphi_{min})) + 0.16).$$

Note:

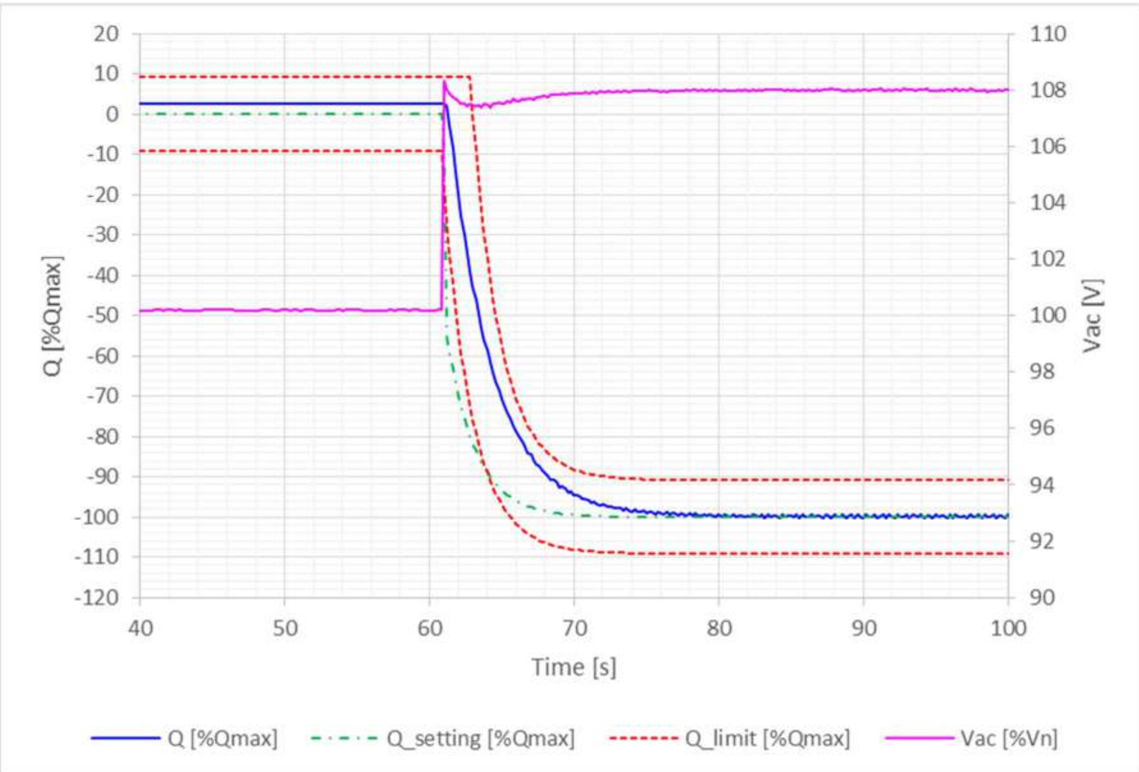
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Test of the dynamics of the Q (U) regulation			P
Test result: ASW50K-LT-G2			
Voltage jump Vac [% U_n]	Q [kVar] measured	Q [%Qmax] measured	T=3τmeasured
100 to 108	-21,737	99,76	7,0 s
	-21,743	99,78	4,8 s
	-21,734	99,74	6,6 s
100 to 92	21,846	100,26	5,6 s
	21,795	100,02	6,6 s
	21,796	100,03	6,8 s
Note: The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.			

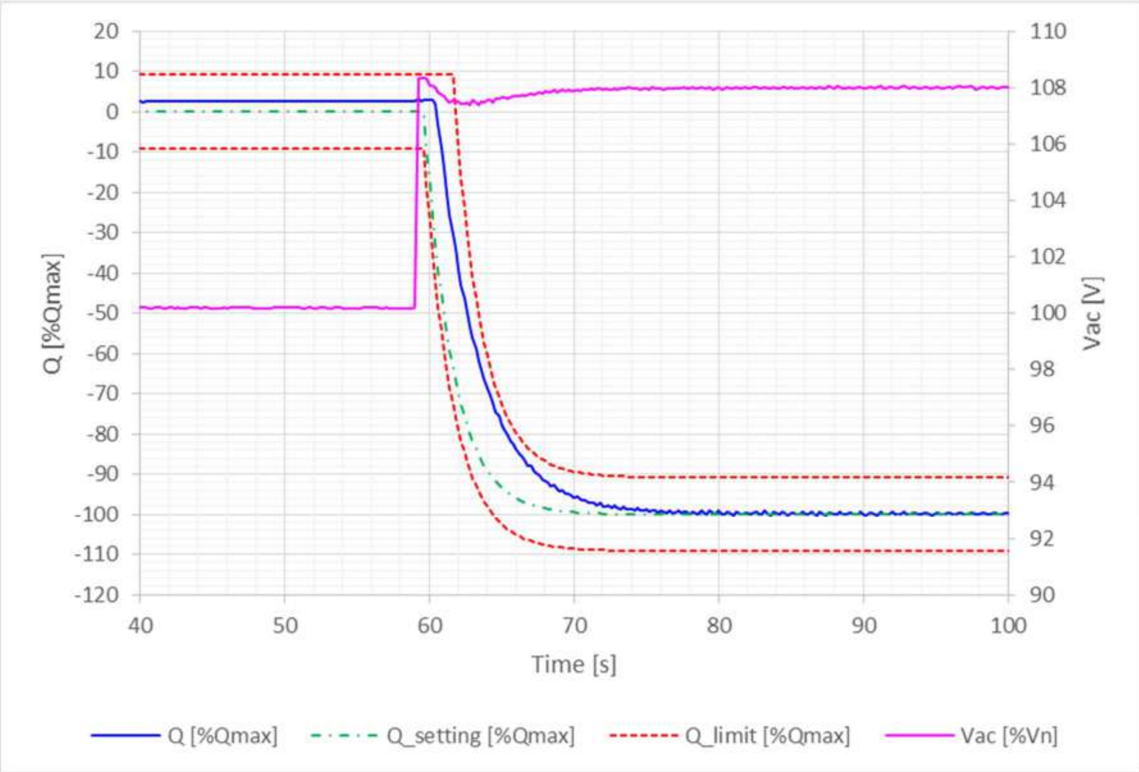
Graph of 100%U_n to 108% U_n: Test 1



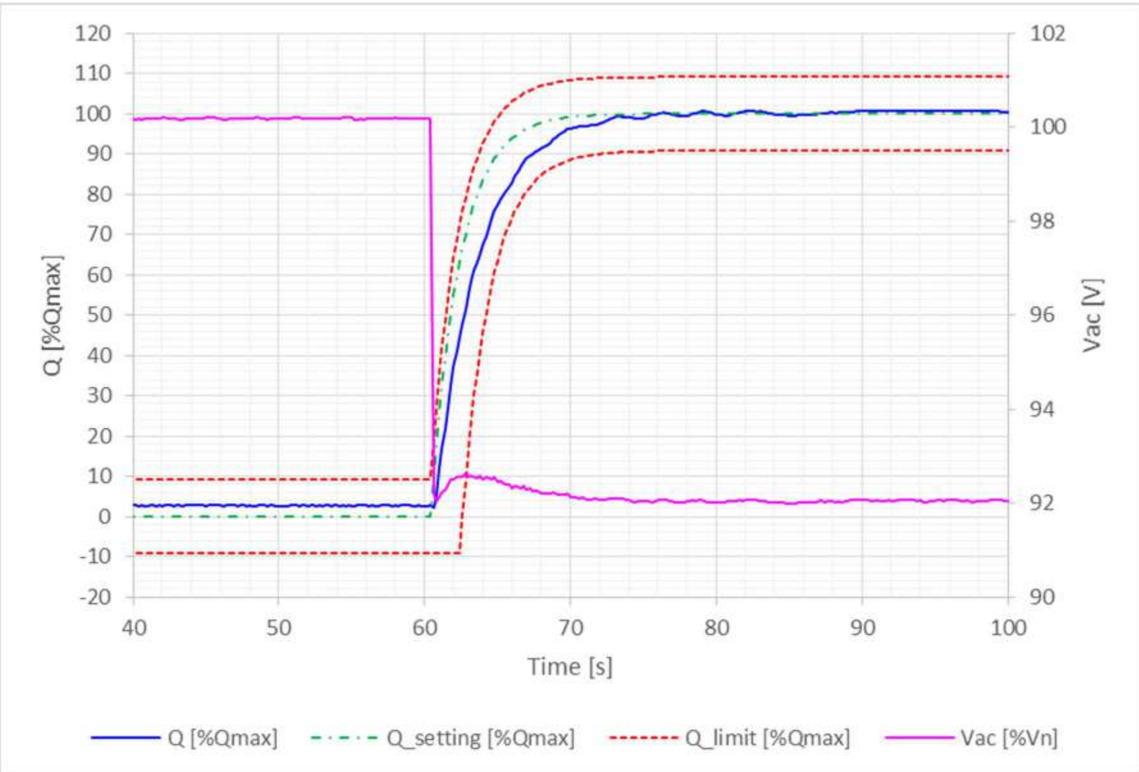
Graph of 100%U_n to 108% U_n: Test 2



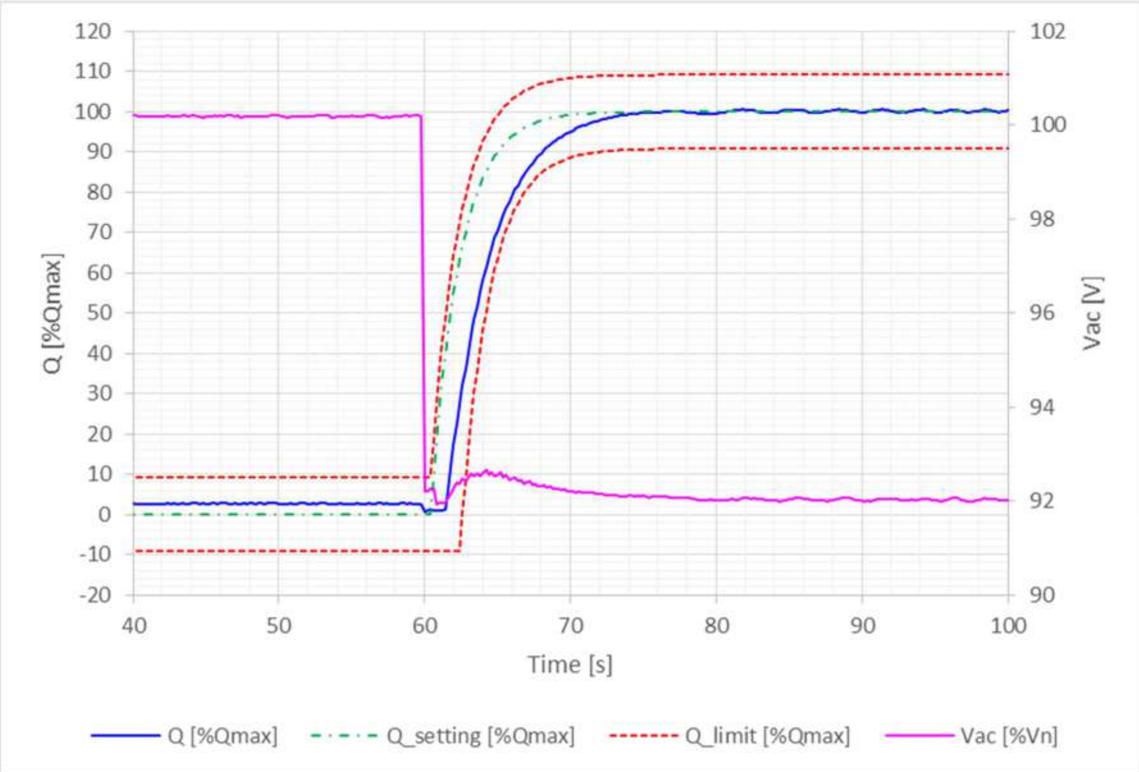
Graph of 100%U_n to 108% U_n: Test 3



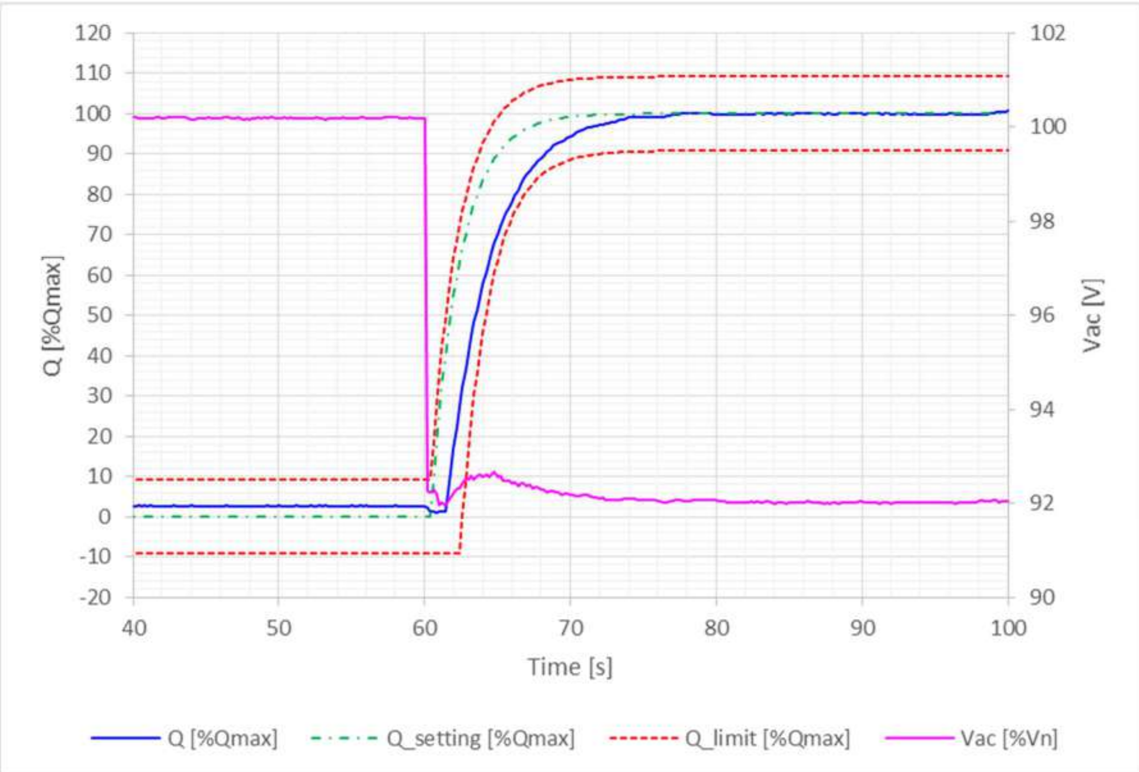
Graph of 100%U_n to 92% U_n: Test 1



Graph of 100%U_n to 92% U_n: Test 2



Graph of 100%U_n to 92% U_n: Test 3



4.7.2.2 4.7.2.3.4	**Capabilities** **Power related Control mode (cos φ (P) curve)**	**P**

Test result: ASW30K-LT-G2

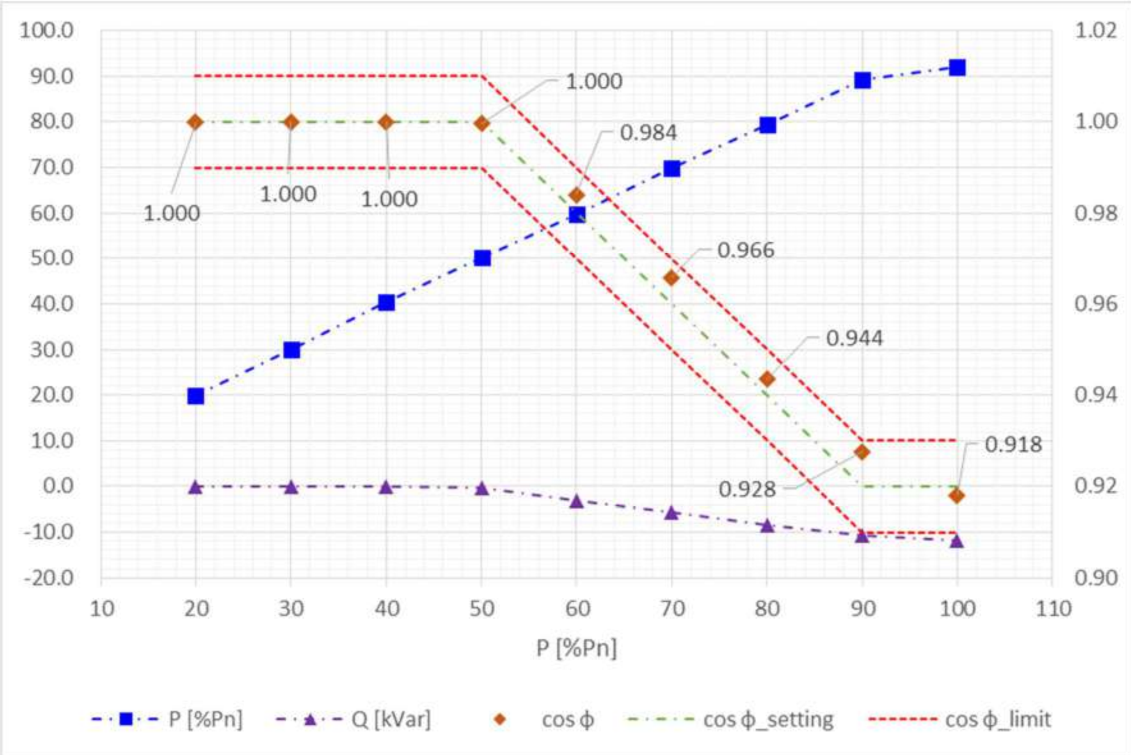
Test a):

Pn/P [%]	10	20	30	40	50	60	70	80	90	100
30 s mean value	20% to 100% P_{Emax}									
U [V]:	N/A	228,17	228.34	228.51	228.67	228.83	228.97	229.14	229.28	229.38
P_{E30} [kW]:	N/A	5,97	9.04	12.10	15.03	17.92	20.93	23.81	26.75	27.63
P_{E30} of P_n [%]:	N/A	19,91	30.13	40.33	50.09	59.72	69.76	79.37	89.18	92.10
Q_{E30} [kVar]:	N/A	-0,09	-0.02	0.06	-0.42	-3.24	-5.62	-8.36	-10.78	-11.93
cos φ_{E30}:	N/A	1,000	1.000	1.000	1.000	0.984	0.966	0.944	0.928	0.918
cos $\varphi_{setpoint}$ of P_{E30}:	N/A	1,000	1,000	1,000	1,000	0,980	0,960	0,940	0,920	0,920
Limit cos φ $_{E30}$:	cos $\varphi_{setpoint}$ ± 0,01									

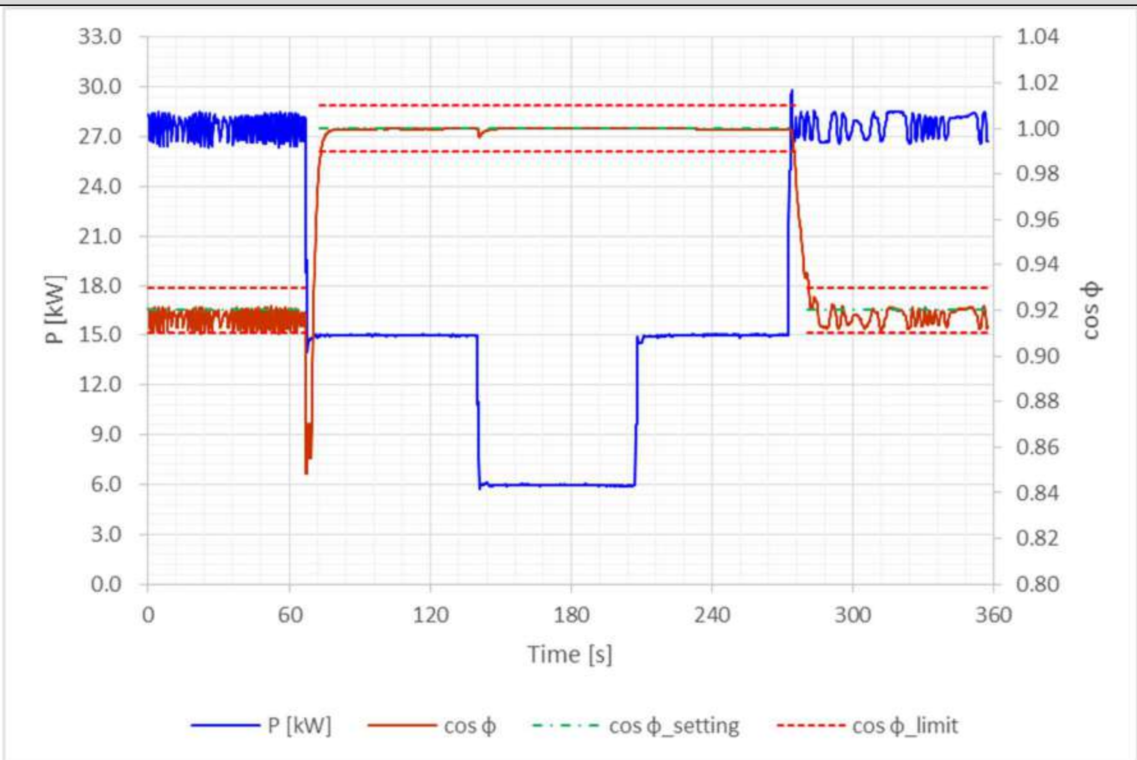
Test b):

Pn/P [%]	20	50	100
30 s mean value	20% to 50% to 100% Pn		
U [V]:	228,16	228,72	229.35
P_{E30} [kW]:	5,958	14,996	27.621
P_{E30} of Pn [%]:	19,86	49,99	92.07
Q_{E30} [kVar]:	-0,113	-0,407	-12.032
cos φ $_{E30}$:	1,000	0,999	0.917
cos $\varphi_{setpoint}$ of P_{E30}:	1,00	1,00	0.92
T_0[s]:	1,0 s		5,4s
Pn/P [%]	100	50	20
30 s mean value	100% to 50% to 20% Pn		
U [V]:	229,33	228,68	228.16
P_{E30} [kW]:	27,688	14,98	5.958
P_{E30} [%]:	92,29	49,94	19.86
Q_{E30} [kVar]:	-11,996	-0,29	-0.113
cos φ $_{E30}$:	0,917	1,000	1.000
cos $\varphi_{setpoint}$ of P_{E30}:	0,92	1,00	1.00
T_0 [s]:	5,8 s		1,0 s
Limit T_0 [s]:	10 s		
Limit cos φ $_{E30}$:	cos $\varphi_{setpoint}$ ± 0,02		

Test result:
Graph of cos φ(P): Test a)



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

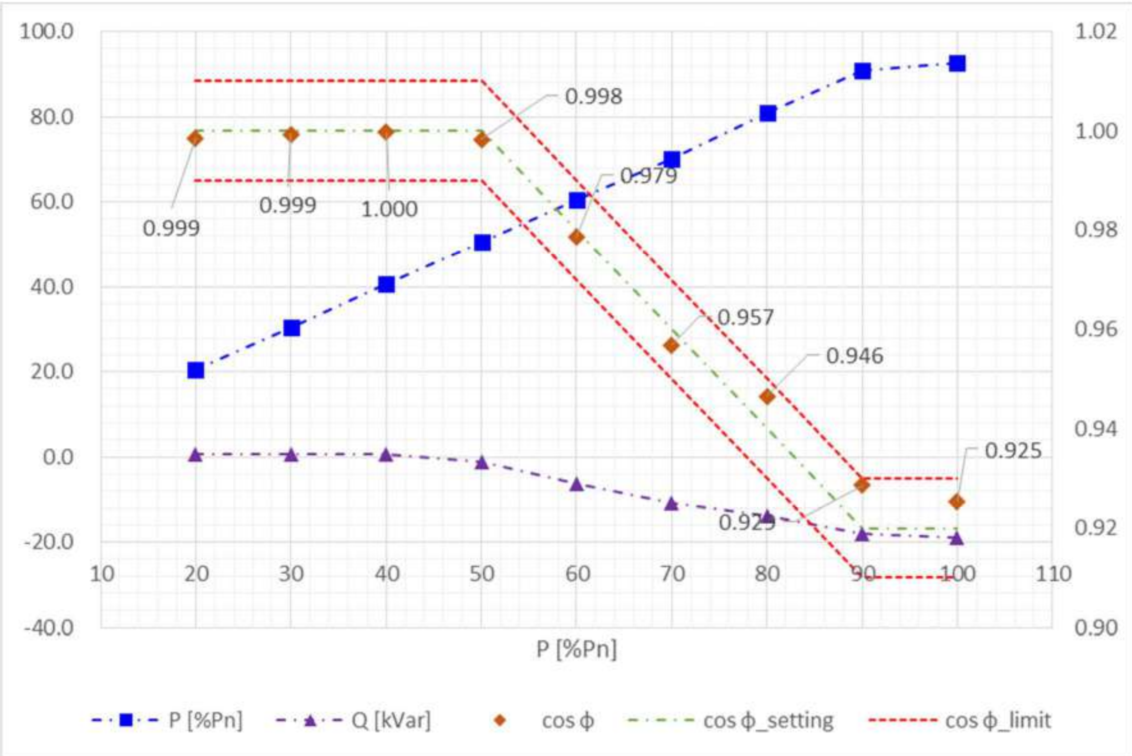


Test result: ASW50K-LT-G2										
Test a):										
Pn/P [%]	10	20	30	40	50	60	70	80	90	100
30 s mean value	20% to 100% P_{Emax}									
U [V]:	N/A	229,53	229.75	229.97	230.17	230.37	230.58	230.81	231.04	231.12
P_{E30} [kW]:	N/A	10,20	15.24	20.29	25.34	30.30	35.13	40.44	45.43	46.41
P_{E30} of P_n [%]:	N/A	20,40	30.49	40.59	50.67	60.61	70.26	80.87	90.86	92.83
Q_{E30} [kVar]:	N/A	0,54	0.51	0.51	-1.04	-6.36	-10.67	-13.79	-18.15	-19.01
cos φ_{E30}:	N/A	0,999	0.999	1.000	0.998	0.979	0.957	0.946	0.929	0.925
cos $\varphi_{setpoint}$ of P_{E30}:	N/A	1,00	1.00	1.00	1.00	0.98	0.96	0.94	0.92	0.92
Limit cos φ_{E30}:	cos $\varphi_{setpoint}$ ± 0,01									

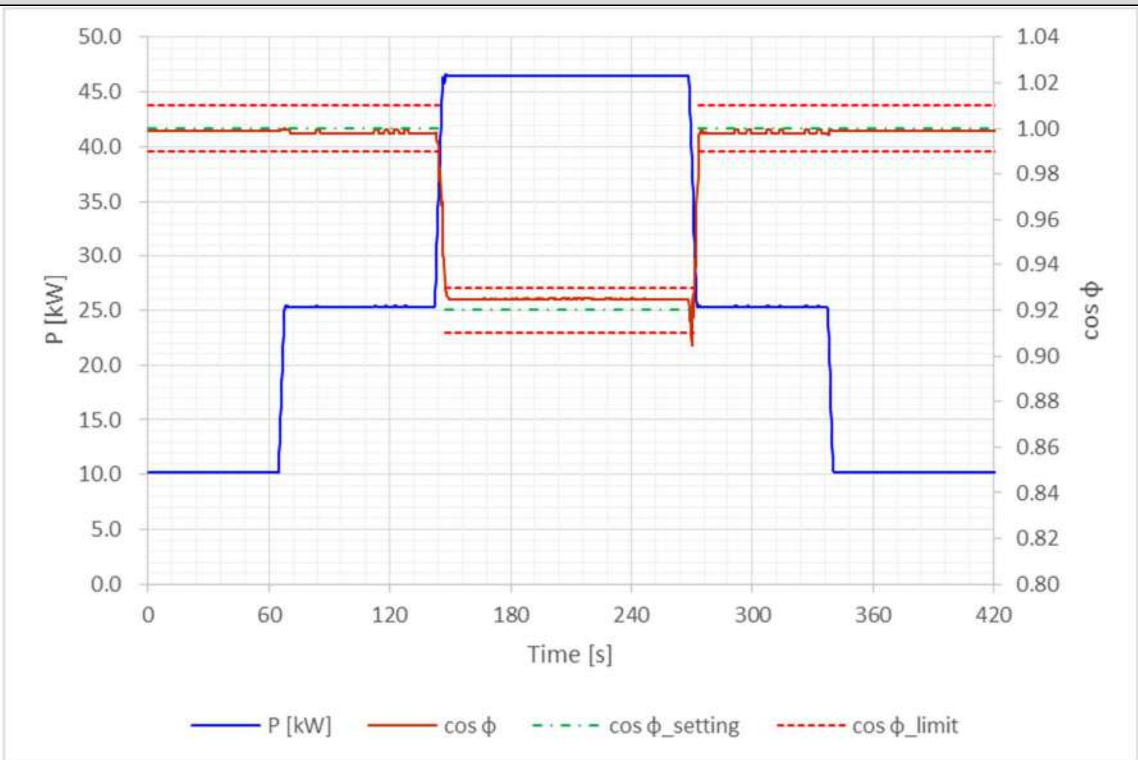
Test b):			
Pn/P [%]	20	50	100
30 s mean value	20% to 50% to 100% Pn		
U [V]:	229,54	230,18	231.07
P_{E30} [kW]:	10,203	25,337	46.503
P_{E30} of Pn [%]:	20,41	50,67	93,01
Q_{E30} [kVar]:	0,540	-1,305	-19.093
cos φ_{E30}:	0,999	0,998	0.925
cos $\varphi_{setpoint}$ of P_{E30}:	1,00	1,00	0.92
T_0[s]:	1,0		3,2s
Pn/P [%]	100	50	20
30 s mean value	100% to 50% to 20% Pn		
U [V]:	231,13	230,26	229.54
P_{E30} [kW]:	46,485	25,34	10.203
P_{E30} [%]:	92,97	50,68	20,41
Q_{E30} [kVar]:	-19,092	-1,23	0.540
cos φ_{E30}:	0,925	0,998	0.999
cos $\varphi_{setpoint}$ of P_{E30}:	0,92	1,00	1.00
T_0 [s]:	1,0		5,0 s
Limit T_0 [s]:	10 s		
Limit cos φ_{E30}:	cos $\varphi_{setpoint}$ ± 0,02		

Test result:

Graph of cos φ(P): Test a)



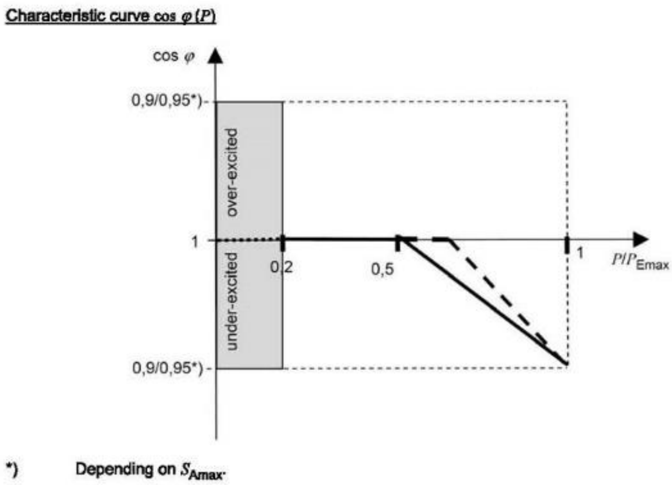
Graph of setting (T_0) time: Test b): 100% to 50% to 20% to 50% to 100%Pn



Test:

Test 1: Using the standard characteristic curve increases the active power from 20% Pn in increments of 10% Pn to P_{Emax}, The test is carried out in reverse.

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



Assessment criterion:

Test 1: cos φ accuracy cos φ (±0,01)

Test 2: cos φ accuracy cos φ (±0,02)

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

Note:

The test method refer to clause 5,3,6,4 of VDE V 0124-100:2012-07.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.7.3	Voltage related active power reduction (P(U) function)	P

Test result:	
5-min mean value / P/ P_n [%]	100% to 20%
Settling time [s]:	300
P_{E60} [%]:	16,7%
$\Delta P_{E60}/P_{Setpoint}$ [%]:	20 % or less of P_{Emax}
Limit settling time:	600s

Test:

a) Set the voltage to 2% Vn lower than the activation threshold stated by the manufacturer.

b) Set the voltage to 112%Vn, The inverter now has to reduce its output power to value lower than 20%Pn within 5min.

c) Set the voltage back to 2%Vn lower than the activation threshold, Check that the active power will return to the value consistent with the power available from the primary source or simulated.

Assessment criterion:

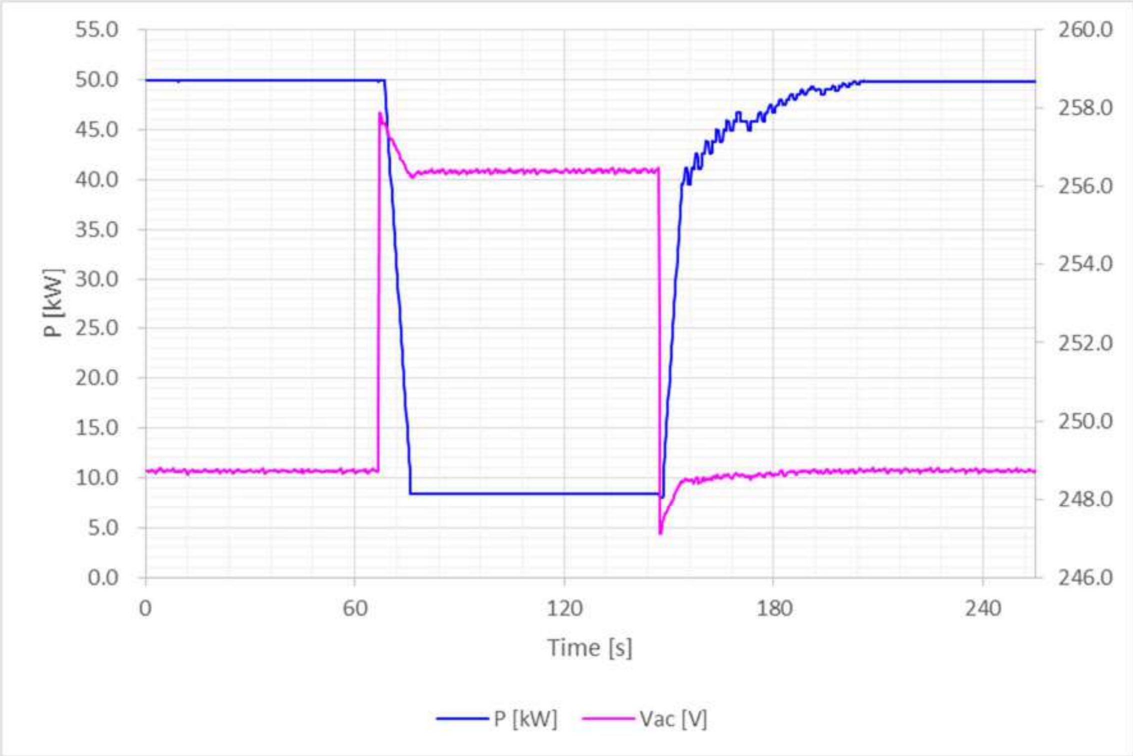
for adjustable PGUs:

- no network disconnection
- the active power value does not exceed the setpoint of 20% P_{Emax}
- the setting time determind is equal or less than 600s

Note:

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Graph:



55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
P [kW]
260.0
258.0
256.0
254.0
252.0
250.0
248.0
246.0
0
60
120
180
240
Time [s]
P [kW]
Vac [V]

EN 50549-1:2019: Power quality			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.8	EMC and power quality	--	**P**
	Harmonic current emission	EN 61000-3-2, EN 61000-3-12	**P**
	Harmonic current emission	EN 61000-4-7	**P**
	Switching operations	IEC 61400-21	**P**
	Voltage fluctuation and flicker	EN 61000-3-3, EN 61000-3-11	**P**
	Flicker and voltage fluctuations	IEC 61400-21	**P**
	DC injection	EN 50438, Annex D,3,10	**P**
	Immunity to voltage dips and short interruptions	G59/3-4:2018-05, clause 13.8.4.5	**P**
	Unbalance	BDEW TG3, Revision 25, clause 4.3.5	**P**

4.8	EMC and power quality Harmonic current emission (EN 61000-3-12)	P

Test result: ASW30K-LT-G2

Watts [KW]	9,940	10,064	9,973
Vrms [V]	232,51	232,72	231,71
Arms [A]	42,760	43,249	43,043
Frequency [Hz]	50,000	50,000	50,000
THD50* (100% output power)	1,102	1,119	1,170

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	--	--
1st	42,756	43,244	43,038	--	--	--	Three Phase	--
2nd	0,015	0,014	0,019	0,035	0,032	0,044	Three Phase	8,000
3rd	0,151	0,081	0,070	0,353	0,187	0,163	Three Phase	21,600
4th	0,138	0,125	0,138	0,323	0,289	0,321	Three Phase	4,000
5th	0,193	0,236	0,189	0,451	0,546	0,439	Three Phase	10,700
6th	0,016	0,013	0,021	0,037	0,030	0,049	Three Phase	2,667
7th	0,098	0,117	0,100	0,229	0,271	0,232	Three Phase	7,200
8th	0,035	0,029	0,044	0,082	0,067	0,102	Three Phase	2,000
9th	0,066	0,032	0,064	0,154	0,074	0,149	Three Phase	3,800
10th	0,023	0,024	0,030	0,054	0,055	0,070	Three Phase	1,600
11th	0,020	0,017	0,018	0,047	0,039	0,042	Three Phase	3,100
12th	0,009	0,009	0,011	0,021	0,021	0,026	Three Phase	1,333
13th	0,039	0,030	0,032	0,091	0,069	0,074	Three Phase	2,000
14th	0,026	0,018	0,026	0,061	0,042	0,060	Three Phase	N/A
15th	0,034	0,018	0,041	0,080	0,042	0,095	Three Phase	N/A
16th	0,018	0,023	0,028	0,042	0,053	0,065	Three Phase	N/A
17th	0,146	0,146	0,175	0,341	0,338	0,407	Three Phase	N/A
18th	0,008	0,009	0,013	0,019	0,021	0,030	Three Phase	N/A
19th	0,151	0,169	0,184	0,353	0,391	0,428	Three Phase	N/A
20th	0,021	0,015	0,021	0,049	0,035	0,049	Three Phase	N/A
21th	0,030	0,010	0,039	0,070	0,023	0,091	Three Phase	N/A
22th	0,018	0,024	0,027	0,042	0,055	0,063	Three Phase	N/A
23th	0,119	0,113	0,141	0,278	0,261	0,328	Three Phase	N/A
24th	0,008	0,009	0,012	0,019	0,021	0,028	Three Phase	N/A
25th	0,133	0,153	0,160	0,311	0,354	0,372	Three Phase	N/A
26th	0,021	0,016	0,020	0,049	0,037	0,046	Three Phase	N/A
27th	0,024	0,012	0,031	0,056	0,028	0,072	Three Phase	N/A
28th	0,017	0,025	0,026	0,040	0,058	0,060	Three Phase	N/A
29th	0,112	0,101	0,125	0,262	0,234	0,290	Three Phase	N/A
30th	0,007	0,008	0,011	0,016	0,018	0,026	Three Phase	N/A
31th	0,108	0,130	0,130	0,253	0,301	0,302	Three Phase	N/A
32th	0,020	0,017	0,020	0,047	0,039	0,046	Three Phase	N/A
33th	0,021	0,011	0,027	0,049	0,025	0,063	Three Phase	N/A
34th	0,022	0,032	0,028	0,051	0,074	0,065	Three Phase	N/A
35th	0,093	0,081	0,101	0,218	0,187	0,235	Three Phase	N/A
36th	0,007	0,009	0,010	0,016	0,021	0,023	Three Phase	N/A
37th	0,083	0,102	0,097	0,194	0,236	0,225	Three Phase	N/A
38th	0,020	0,019	0,019	0,047	0,044	0,044	Three Phase	N/A
39th	0,019	0,015	0,024	0,044	0,035	0,056	Three Phase	N/A
40th	0,038	0,054	0,039	0,089	0,125	0,091	Three Phase	N/A

4.8	EMC and power quality Harmonic current emission (EN 61000-3-12)	P

Test result: ASW33K-LT-G2

Watts [KW]	10,952	11,087	10,982
Vrms [V]	232,72	232,96	231,87
Arms [A]	47,069	47,599	47,368
Frequency [Hz]	50,000	50,000	50,000
THD50* (100% output power)	0,982	0,997	1,031

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	L2	L3	L1	L2	L3	--	--
1st	47,066	47,594	47,364	--	--	--	Three Phase	--
2nd	0,015	0,018	0,021	0,032	0,038	0,044	Three Phase	8,000
3rd	0,171	0,092	0,077	0,363	0,193	0,163	Three Phase	21,600
4th	0,137	0,125	0,140	0,291	0,263	0,296	Three Phase	4,000
5th	0,193	0,241	0,191	0,410	0,506	0,403	Three Phase	10,700
6th	0,019	0,014	0,023	0,040	0,029	0,049	Three Phase	2,667
7th	0,094	0,113	0,097	0,200	0,237	0,205	Three Phase	7,200
8th	0,034	0,029	0,043	0,072	0,061	0,091	Three Phase	2,000
9th	0,061	0,028	0,060	0,130	0,059	0,127	Three Phase	3,800
10th	0,023	0,025	0,030	0,049	0,053	0,063	Three Phase	1,600
11th	0,018	0,016	0,016	0,038	0,034	0,034	Three Phase	3,100
12th	0,009	0,009	0,012	0,019	0,019	0,025	Three Phase	1,333
13th	0,036	0,027	0,024	0,076	0,057	0,051	Three Phase	2,000
14th	0,025	0,018	0,027	0,053	0,038	0,057	Three Phase	N/A
15th	0,032	0,018	0,036	0,068	0,038	0,076	Three Phase	N/A
16th	0,018	0,024	0,028	0,038	0,050	0,059	Three Phase	N/A
17th	0,137	0,146	0,165	0,291	0,307	0,348	Three Phase	N/A
18th	0,008	0,009	0,013	0,017	0,019	0,027	Three Phase	N/A
19th	0,146	0,159	0,176	0,310	0,334	0,372	Three Phase	N/A
20th	0,020	0,014	0,021	0,042	0,029	0,044	Three Phase	N/A
21th	0,028	0,009	0,036	0,059	0,019	0,076	Three Phase	N/A
22th	0,016	0,023	0,026	0,034	0,048	0,055	Three Phase	N/A
23th	0,108	0,105	0,131	0,229	0,221	0,277	Three Phase	N/A
24th	0,008	0,008	0,012	0,017	0,017	0,025	Three Phase	N/A
25th	0,122	0,140	0,147	0,259	0,294	0,310	Three Phase	N/A
26th	0,021	0,015	0,020	0,045	0,032	0,042	Three Phase	N/A
27th	0,023	0,010	0,030	0,049	0,021	0,063	Three Phase	N/A
28th	0,017	0,025	0,025	0,036	0,053	0,053	Three Phase	N/A
29th	0,104	0,095	0,119	0,221	0,200	0,251	Three Phase	N/A
30th	0,007	0,008	0,011	0,015	0,017	0,023	Three Phase	N/A
31th	0,104	0,124	0,126	0,221	0,261	0,266	Three Phase	N/A
32th	0,020	0,017	0,019	0,042	0,036	0,040	Three Phase	N/A
33th	0,022	0,011	0,026	0,047	0,023	0,055	Three Phase	N/A
34th	0,022	0,031	0,026	0,047	0,065	0,055	Three Phase	N/A
35th	0,090	0,080	0,101	0,191	0,168	0,213	Three Phase	N/A
36th	0,007	0,010	0,010	0,015	0,021	0,021	Three Phase	N/A
37th	0,082	0,101	0,098	0,174	0,212	0,207	Three Phase	N/A
38th	0,020	0,017	0,019	0,042	0,036	0,040	Three Phase	N/A
39th	0,020	0,014	0,025	0,042	0,029	0,053	Three Phase	N/A
40th	0,039	0,055	0,040	0,083	0,116	0,084	Three Phase	N/A

4.8	EMC and power quality Harmonic current emission (EN 61000-3-12)	P

Test result: ASW36K-LT-G2

Watts [KW]	11,963	12,103	11,989
Vrms [V]	232,94	233,18	232,02
Arms [A]	51,364	51,913	51,674
Frequency [Hz]	50,000	50,000	50,000
THD50* (100% output power)	0,888	0,908	0,931

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	L2	L3	L1	L2	L3	--	--
1st	51,360	51,909	51,670	--	--	--	Three Phase	--
2nd	0,016	0,021	0,024	0,031	0,040	0,046	Three Phase	8,000
3rd	0,168	0,078	0,088	0,327	0,150	0,170	Three Phase	21,600
4th	0,139	0,128	0,142	0,271	0,247	0,275	Three Phase	4,000
5th	0,208	0,261	0,207	0,405	0,503	0,401	Three Phase	10,700
6th	0,017	0,014	0,023	0,033	0,027	0,045	Three Phase	2,667
7th	0,081	0,099	0,085	0,158	0,191	0,165	Three Phase	7,200
8th	0,034	0,029	0,045	0,066	0,056	0,087	Three Phase	2,000
9th	0,054	0,025	0,053	0,105	0,048	0,103	Three Phase	3,800
10th	0,024	0,024	0,030	0,047	0,046	0,058	Three Phase	1,600
11th	0,020	0,018	0,019	0,039	0,035	0,037	Three Phase	3,100
12th	0,010	0,009	0,013	0,019	0,017	0,025	Three Phase	1,333
13th	0,035	0,027	0,027	0,068	0,052	0,052	Three Phase	2,000
14th	0,026	0,019	0,028	0,051	0,037	0,054	Three Phase	N/A
15th	0,031	0,021	0,033	0,060	0,040	0,064	Three Phase	N/A
16th	0,018	0,024	0,027	0,035	0,046	0,052	Three Phase	N/A
17th	0,131	0,143	0,154	0,255	0,275	0,298	Three Phase	N/A
18th	0,008	0,009	0,014	0,016	0,017	0,027	Three Phase	N/A
19th	0,146	0,154	0,173	0,284	0,297	0,335	Three Phase	N/A
20th	0,021	0,015	0,021	0,041	0,029	0,041	Three Phase	N/A
21th	0,025	0,009	0,032	0,049	0,017	0,062	Three Phase	N/A
22th	0,016	0,022	0,025	0,031	0,042	0,048	Three Phase	N/A
23th	0,102	0,099	0,123	0,199	0,191	0,238	Three Phase	N/A
24th	0,007	0,008	0,012	0,014	0,015	0,023	Three Phase	N/A
25th	0,113	0,131	0,138	0,220	0,252	0,267	Three Phase	N/A
26th	0,021	0,015	0,019	0,041	0,029	0,037	Three Phase	N/A
27th	0,022	0,009	0,029	0,043	0,017	0,056	Three Phase	N/A
28th	0,017	0,025	0,026	0,033	0,048	0,050	Three Phase	N/A
29th	0,097	0,090	0,112	0,189	0,173	0,217	Three Phase	N/A
30th	0,007	0,009	0,011	0,014	0,017	0,021	Three Phase	N/A
31th	0,100	0,119	0,120	0,195	0,229	0,232	Three Phase	N/A
32th	0,021	0,017	0,019	0,041	0,033	0,037	Three Phase	N/A
33th	0,020	0,010	0,024	0,039	0,019	0,046	Three Phase	N/A
34th	0,022	0,031	0,027	0,043	0,060	0,052	Three Phase	N/A
35th	0,088	0,078	0,098	0,171	0,150	0,190	Three Phase	N/A
36th	0,007	0,009	0,010	0,014	0,017	0,019	Three Phase	N/A
37th	0,081	0,100	0,097	0,158	0,193	0,188	Three Phase	N/A
38th	0,021	0,019	0,019	0,041	0,037	0,037	Three Phase	N/A
39th	0,020	0,015	0,024	0,039	0,029	0,046	Three Phase	N/A
40th	0,040	0,056	0,041	0,078	0,108	0,079	Three Phase	N/A

4.8	EMC and power quality Harmonic current emission (EN 61000-3-12)	P

Test result: ASW40K-LT-G2

Watts [KW]	13,304	13,462	13,334
Vrms [V]	233,13	233,45	232,34
Arms [A]	57,074	57,675	57,395
Frequency [Hz]	50,000	50,000	50,000
THD50* (100% output power)	0,794	0,817	0,825

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	L2	L3	L1	L2	L3	--	--
1st	57,070	57,670	57,390	--	--	--	Three Phase	--
2nd	0,019	0,022	0,025	0,033	0,038	0,044	Three Phase	8,000
3rd	0,161	0,078	0,083	0,282	0,135	0,145	Three Phase	21,600
4th	0,146	0,133	0,149	0,256	0,231	0,260	Three Phase	4,000
5th	0,225	0,278	0,224	0,394	0,482	0,390	Three Phase	10,700
6th	0,018	0,015	0,023	0,032	0,026	0,040	Three Phase	2,667
7th	0,068	0,090	0,076	0,119	0,156	0,132	Three Phase	7,200
8th	0,036	0,029	0,044	0,063	0,050	0,077	Three Phase	2,000
9th	0,044	0,021	0,047	0,077	0,036	0,082	Three Phase	3,800
10th	0,024	0,025	0,031	0,042	0,043	0,054	Three Phase	1,600
11th	0,020	0,022	0,018	0,035	0,038	0,031	Three Phase	3,100
12th	0,010	0,009	0,012	0,018	0,016	0,021	Three Phase	1,333
13th	0,026	0,025	0,022	0,046	0,043	0,038	Three Phase	2,000
14th	0,025	0,021	0,028	0,044	0,036	0,049	Three Phase	N/A
15th	0,032	0,022	0,032	0,056	0,038	0,056	Three Phase	N/A
16th	0,020	0,025	0,028	0,035	0,043	0,049	Three Phase	N/A
17th	0,126	0,138	0,143	0,221	0,239	0,249	Three Phase	N/A
18th	0,008	0,009	0,012	0,014	0,016	0,021	Three Phase	N/A
19th	0,141	0,144	0,165	0,247	0,250	0,288	Three Phase	N/A
20th	0,022	0,015	0,020	0,039	0,026	0,035	Three Phase	N/A
21th	0,022	0,011	0,028	0,039	0,019	0,049	Three Phase	N/A
22th	0,017	0,024	0,026	0,030	0,042	0,045	Three Phase	N/A
23th	0,099	0,097	0,118	0,173	0,168	0,206	Three Phase	N/A
24th	0,008	0,009	0,013	0,014	0,016	0,023	Three Phase	N/A
25th	0,107	0,124	0,130	0,187	0,215	0,227	Three Phase	N/A
26th	0,021	0,016	0,019	0,037	0,028	0,033	Three Phase	N/A
27th	0,021	0,008	0,028	0,037	0,014	0,049	Three Phase	N/A
28th	0,017	0,025	0,025	0,030	0,043	0,044	Three Phase	N/A
29th	0,092	0,084	0,106	0,161	0,146	0,185	Three Phase	N/A
30th	0,007	0,009	0,012	0,012	0,016	0,021	Three Phase	N/A
31th	0,095	0,114	0,114	0,166	0,198	0,199	Three Phase	N/A
32th	0,022	0,018	0,020	0,039	0,031	0,035	Three Phase	N/A
33th	0,019	0,010	0,024	0,033	0,017	0,042	Three Phase	N/A
34th	0,023	0,033	0,028	0,040	0,057	0,049	Three Phase	N/A
35th	0,086	0,076	0,095	0,151	0,132	0,166	Three Phase	N/A
36th	0,007	0,011	0,012	0,012	0,019	0,021	Three Phase	N/A
37th	0,081	0,099	0,095	0,142	0,172	0,166	Three Phase	N/A
38th	0,021	0,020	0,019	0,037	0,035	0,033	Three Phase	N/A
39th	0,020	0,015	0,023	0,035	0,026	0,040	Three Phase	N/A
40th	0,040	0,056	0,041	0,070	0,097	0,071	Three Phase	N/A

4.8	EMC and power quality Harmonic current emission (EN 61000-3-12)	P

Test result: ASW45K-LT-G2

Watts [KW]	14,960	15,133	14,985
Vrms [V]	233,47	233,77	232,58
Arms [A]	64,093	64,750	64,437
Frequency [Hz]	50,000	50,000	50,000
THD50* (100% output power)	0,840	0,957	0,865

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	--	--
1st	64,026	64,673	64,357	--	--	--	Three Phase	--
2nd	0,219	0,286	0,223	0,342	0,442	0,347	Three Phase	8,000
3rd	0,165	0,173	0,147	0,258	0,267	0,228	Three Phase	21,600
4th	0,169	0,181	0,166	0,264	0,280	0,258	Three Phase	4,000
5th	0,279	0,327	0,266	0,436	0,506	0,413	Three Phase	10,700
6th	0,053	0,064	0,061	0,083	0,099	0,095	Three Phase	2,667
7th	0,053	0,083	0,061	0,083	0,128	0,095	Three Phase	7,200
8th	0,045	0,058	0,061	0,070	0,090	0,095	Three Phase	2,000
9th	0,039	0,043	0,046	0,061	0,066	0,071	Three Phase	3,800
10th	0,030	0,044	0,039	0,047	0,068	0,061	Three Phase	1,600
11th	0,039	0,050	0,033	0,061	0,077	0,051	Three Phase	3,100
12th	0,021	0,032	0,025	0,033	0,049	0,039	Three Phase	1,333
13th	0,027	0,038	0,031	0,042	0,059	0,048	Three Phase	2,000
14th	0,031	0,035	0,031	0,048	0,054	0,048	Three Phase	N/A
15th	0,032	0,032	0,031	0,050	0,049	0,048	Three Phase	N/A
16th	0,026	0,034	0,032	0,041	0,053	0,050	Three Phase	N/A
17th	0,119	0,128	0,129	0,186	0,198	0,200	Three Phase	N/A
18th	0,012	0,020	0,018	0,019	0,031	0,028	Three Phase	N/A
19th	0,137	0,139	0,157	0,214	0,215	0,244	Three Phase	N/A
20th	0,022	0,026	0,024	0,034	0,040	0,037	Three Phase	N/A
21th	0,018	0,021	0,025	0,028	0,032	0,039	Three Phase	N/A
22th	0,020	0,029	0,028	0,031	0,045	0,044	Three Phase	N/A
23th	0,099	0,096	0,110	0,155	0,148	0,171	Three Phase	N/A
24th	0,012	0,017	0,015	0,019	0,026	0,023	Three Phase	N/A
25th	0,107	0,122	0,128	0,167	0,189	0,199	Three Phase	N/A
26th	0,024	0,021	0,022	0,037	0,032	0,034	Three Phase	N/A
27th	0,019	0,017	0,027	0,030	0,026	0,042	Three Phase	N/A
28th	0,020	0,028	0,027	0,031	0,043	0,042	Three Phase	N/A
29th	0,092	0,081	0,102	0,144	0,125	0,158	Three Phase	N/A
30th	0,008	0,015	0,014	0,012	0,023	0,022	Three Phase	N/A
31th	0,092	0,111	0,110	0,144	0,172	0,171	Three Phase	N/A
32th	0,021	0,022	0,022	0,033	0,034	0,034	Three Phase	N/A
33th	0,018	0,015	0,025	0,028	0,023	0,039	Three Phase	N/A
34th	0,024	0,033	0,029	0,037	0,051	0,045	Three Phase	N/A
35th	0,087	0,076	0,092	0,136	0,118	0,143	Three Phase	N/A
36th	0,010	0,014	0,012	0,016	0,022	0,019	Three Phase	N/A
37th	0,082	0,100	0,096	0,128	0,155	0,149	Three Phase	N/A
38th	0,022	0,022	0,021	0,034	0,034	0,033	Three Phase	N/A
39th	0,019	0,018	0,024	0,030	0,028	0,037	Three Phase	N/A
40th	0,043	0,058	0,042	0,067	0,090	0,065	Three Phase	N/A

4.8	EMC and power quality Harmonic current emission (EN 61000-3-12)	P

Test result: ASW50K-LT-G2

Watts [KW]	16,589	16,550	16,648
Vrms [V]	230,30	230,38	230,38
Arms [A]	72,057	71,864	72,287
Frequency [Hz]	49,999	49,999	49,999
THD50* (100% output power)	1,507	1,631	1,376

Harmonic order n	Current Magnitude [A] at 100% rated output power			% of Fundamental			Phase	Harmonic Current Limits [%]
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	--	--
1st	72,032	71,838	72,266	--	--	--	Three Phase	--
2nd	0,097	0,046	0,108	0,135	0,064	0,149	Three Phase	8,000
3rd	0,397	0,646	0,303	0,551	0,899	0,419	Three Phase	21,600
4th	0,349	0,293	0,338	0,485	0,408	0,468	Three Phase	4,000
5th	0,477	0,489	0,406	0,662	0,681	0,562	Three Phase	10,700
6th	0,060	0,062	0,071	0,083	0,086	0,098	Three Phase	2,667
7th	0,151	0,147	0,139	0,210	0,205	0,192	Three Phase	7,200
8th	0,352	0,293	0,338	0,489	0,408	0,468	Three Phase	2,000
9th	0,078	0,081	0,091	0,108	0,113	0,126	Three Phase	3,800
10th	0,188	0,189	0,167	0,261	0,263	0,231	Three Phase	1,600
11th	0,098	0,101	0,089	0,136	0,141	0,123	Three Phase	3,100
12th	0,055	0,049	0,056	0,076	0,068	0,077	Three Phase	1,333
13th	0,070	0,058	0,057	0,097	0,081	0,079	Three Phase	2,000
14th	0,107	0,104	0,124	0,149	0,145	0,172	Three Phase	N/A
15th	0,073	0,058	0,053	0,101	0,081	0,073	Three Phase	N/A
16th	0,214	0,244	0,224	0,297	0,340	0,310	Three Phase	N/A
17th	0,297	0,281	0,276	0,412	0,391	0,382	Three Phase	N/A
18th	0,060	0,055	0,052	0,083	0,077	0,072	Three Phase	N/A
19th	0,135	0,156	0,142	0,187	0,217	0,196	Three Phase	N/A
20th	0,190	0,174	0,170	0,264	0,242	0,235	Three Phase	N/A
21th	0,057	0,057	0,057	0,079	0,079	0,079	Three Phase	N/A
22th	0,124	0,116	0,107	0,172	0,161	0,148	Three Phase	N/A
23th	0,088	0,078	0,080	0,122	0,109	0,111	Three Phase	N/A
24th	0,055	0,053	0,056	0,076	0,074	0,077	Three Phase	N/A
25th	0,240	0,236	0,225	0,333	0,329	0,311	Three Phase	N/A
26th	0,093	0,115	0,089	0,129	0,160	0,123	Three Phase	N/A
27th	0,051	0,055	0,059	0,071	0,077	0,082	Three Phase	N/A
28th	0,092	0,087	0,093	0,128	0,121	0,129	Three Phase	N/A
29th	0,090	0,106	0,075	0,125	0,148	0,104	Three Phase	N/A
30th	0,058	0,055	0,050	0,081	0,077	0,069	Three Phase	N/A
31th	0,186	0,197	0,185	0,258	0,274	0,256	Three Phase	N/A
32th	0,084	0,086	0,090	0,117	0,120	0,125	Three Phase	N/A
33th	0,060	0,057	0,055	0,083	0,079	0,076	Three Phase	N/A
34th	0,158	0,174	0,154	0,219	0,242	0,213	Three Phase	N/A
35th	0,168	0,145	0,148	0,233	0,202	0,205	Three Phase	N/A
36th	0,052	0,053	0,048	0,072	0,074	0,066	Three Phase	N/A
37th	0,089	0,071	0,087	0,124	0,099	0,120	Three Phase	N/A
38th	0,095	0,103	0,090	0,132	0,143	0,125	Three Phase	N/A
39th	0,052	0,051	0,050	0,072	0,071	0,069	Three Phase	N/A
40th	0,073	0,084	0,077	0,101	0,117	0,107	Three Phase	N/A

Note: The tests should be based on the limits of the EN 61000-3-12 for more than 16A.

4.8	EMC and power quality Harmonic current emission (EN 61000-4-7)	P

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

Test result: ASW30K-LT-G2

Harmonics

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	4,460	10,557	20,942	31,224	41,584	51,647	61,195	72,077	81,729	91,644	101,431
2	0,147	0,156	0,174	0,177	0,173	0,169	0,168	0,167	0,194	0,181	0,189
3	0,384	0,126	0,594	0,504	0,531	0,581	0,407	0,435	0,488	0,417	0,424
4	0,102	0,111	0,058	0,105	0,103	0,127	0,142	0,175	0,222	0,174	0,184
5	0,299	0,330	0,353	0,382	0,469	0,469	0,490	0,532	0,527	0,521	0,522
6	0,060	0,048	0,071	0,049	0,040	0,036	0,041	0,059	0,084	0,047	0,042
7	0,083	0,161	0,140	0,151	0,134	0,212	0,193	0,186	0,213	0,233	0,237
8	0,046	0,050	0,067	0,048	0,055	0,036	0,041	0,053	0,068	0,056	0,059
9	0,087	0,113	0,111	0,098	0,118	0,167	0,103	0,085	0,092	0,110	0,108
10	0,042	0,043	0,027	0,041	0,035	0,028	0,033	0,201	0,169	0,048	0,049
11	0,114	0,086	0,108	0,098	0,091	0,061	0,068	0,088	0,086	0,178	0,138
12	0,039	0,030	0,034	0,033	0,032	0,026	0,029	0,238	0,206	0,033	0,031
13	0,180	0,180	0,152	0,068	0,140	0,097	0,084	0,096	0,102	0,169	0,140
14	0,037	0,034	0,041	0,029	0,041	0,033	0,033	0,035	0,044	0,045	0,047
15	0,079	0,044	0,095	0,102	0,024	0,134	0,094	0,073	0,087	0,091	0,114
16	0,024	0,026	0,024	0,030	0,028	0,025	0,029	0,036	0,044	0,047	0,050
17	0,485	0,395	0,248	0,414	0,413	0,311	0,195	0,198	0,214	0,238	0,278
18	0,026	0,022	0,029	0,041	0,027	0,022	0,025	0,023	0,028	0,025	0,028
19	0,453	0,514	0,381	0,491	0,292	0,285	0,189	0,179	0,192	0,222	0,270
20	0,031	0,022	0,039	0,037	0,020	0,026	0,026	0,029	0,037	0,038	0,040
21	0,111	0,078	0,155	0,049	0,067	0,059	0,059	0,059	0,075	0,077	0,081
22	0,024	0,028	0,035	0,020	0,017	0,028	0,029	0,034	0,042	0,048	0,051
23	0,358	0,318	0,322	0,257	0,163	0,182	0,143	0,150	0,167	0,190	0,207
24	0,025	0,023	0,024	0,018	0,019	0,020	0,020	0,021	0,026	0,023	0,024
25	0,392	0,404	0,273	0,206	0,172	0,168	0,135	0,136	0,159	0,189	0,206
26	0,034	0,025	0,034	0,021	0,017	0,026	0,026	0,031	0,038	0,040	0,040
27	0,091	0,102	0,110	0,083	0,073	0,016	0,031	0,047	0,060	0,068	0,069
28	0,031	0,027	0,034	0,018	0,014	0,029	0,029	0,034	0,043	0,048	0,052
29	0,308	0,290	0,266	0,189	0,173	0,099	0,106	0,117	0,133	0,151	0,168
30	0,020	0,021	0,022	0,019	0,017	0,020	0,017	0,020	0,026	0,021	0,022
31	0,336	0,302	0,314	0,223	0,188	0,104	0,103	0,111	0,135	0,160	0,178
32	0,025	0,030	0,027	0,019	0,019	0,024	0,026	0,031	0,039	0,038	0,040
33	0,050	0,062	0,039	0,038	0,044	0,039	0,030	0,037	0,054	0,054	0,064
34	0,028	0,032	0,027	0,024	0,021	0,030	0,030	0,034	0,041	0,045	0,050
35	0,239	0,258	0,199	0,154	0,152	0,109	0,114	0,113	0,123	0,144	0,158
36	0,025	0,021	0,020	0,019	0,023	0,019	0,022	0,026	0,033	0,021	0,024
37	0,250	0,211	0,210	0,112	0,121	0,077	0,081	0,091	0,115	0,126	0,142
38	0,032	0,038	0,029	0,025	0,027	0,030	0,031	0,034	0,040	0,038	0,044
39	0,137	0,174	0,127	0,115	0,121	0,121	0,122	0,120	0,119	0,142	0,141
40	0,033	0,039	0,032	0,020	0,031	0,026	0,032	0,036	0,044	0,047	0,046

4.8	EMC and power quality Harmonic current emission (EN 61000-4-7)	P

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

Test result: ASW30K-LT-G2

Interharmonics

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0,091	0,099	0,172	0,234	0,301	0,354	0,413	0,548	0,754	0,657	0,714
125	0,089	0,098	0,169	0,239	0,291	0,352	0,425	0,543	0,651	0,646	0,708
175	0,041	0,042	0,048	0,068	0,073	0,075	0,084	0,110	0,152	0,133	0,127
225	0,039	0,037	0,047	0,055	0,056	0,063	0,065	0,098	0,122	0,091	0,092
275	0,057	0,049	0,055	0,053	0,047	0,044	0,034	0,051	0,059	0,049	0,048
325	0,101	0,068	0,109	0,096	0,060	0,049	0,050	0,057	0,063	0,053	0,055
375	0,062	0,046	0,063	0,058	0,056	0,044	0,032	0,039	0,044	0,035	0,035
425	0,088	0,066	0,097	0,089	0,063	0,048	0,047	0,051	0,050	0,047	0,046
475	0,047	0,032	0,034	0,030	0,031	0,034	0,032	0,034	0,038	0,035	0,031
525	0,029	0,025	0,032	0,023	0,026	0,027	0,026	0,032	0,039	0,032	0,033
575	0,049	0,043	0,047	0,032	0,041	0,037	0,029	0,066	0,085	0,034	0,033
625	0,101	0,073	0,083	0,079	0,097	0,067	0,055	0,052	0,056	0,114	0,122
675	0,051	0,042	0,046	0,037	0,045	0,040	0,031	0,073	0,095	0,040	0,038
725	0,102	0,084	0,087	0,071	0,089	0,068	0,058	0,051	0,050	0,110	0,120
775	0,047	0,038	0,030	0,027	0,026	0,032	0,034	0,026	0,029	0,026	0,028
825	0,031	0,028	0,026	0,022	0,021	0,027	0,031	0,024	0,026	0,022	0,027
875	0,066	0,063	0,054	0,065	0,047	0,066	0,048	0,042	0,040	0,038	0,044
925	0,078	0,065	0,073	0,063	0,055	0,054	0,046	0,037	0,037	0,040	0,043
975	0,070	0,059	0,074	0,066	0,041	0,067	0,052	0,047	0,044	0,047	0,050
1025	0,085	0,077	0,075	0,075	0,053	0,059	0,050	0,042	0,043	0,041	0,044
1075	0,046	0,029	0,032	0,026	0,023	0,027	0,031	0,024	0,025	0,029	0,029
1125	0,029	0,024	0,021	0,019	0,019	0,020	0,027	0,023	0,026	0,024	0,022
1175	0,085	0,049	0,055	0,040	0,037	0,058	0,046	0,042	0,045	0,048	0,047
1225	0,078	0,065	0,066	0,052	0,036	0,051	0,046	0,038	0,039	0,046	0,042
1275	0,077	0,049	0,051	0,042	0,045	0,056	0,051	0,046	0,047	0,056	0,053
1325	0,083	0,074	0,072	0,055	0,040	0,055	0,051	0,044	0,046	0,047	0,045
1375	0,078	0,062	0,026	0,022	0,023	0,024	0,028	0,030	0,029	0,037	0,030
1425	0,026	0,021	0,018	0,020	0,018	0,018	0,024	0,023	0,028	0,023	0,022
1475	0,074	0,082	0,050	0,046	0,051	0,044	0,047	0,048	0,054	0,053	0,050
1525	0,066	0,056	0,057	0,050	0,045	0,047	0,047	0,041	0,042	0,042	0,047
1575	0,094	0,060	0,055	0,056	0,060	0,046	0,050	0,056	0,068	0,058	0,058
1625	0,070	0,055	0,072	0,062	0,050	0,047	0,047	0,043	0,045	0,045	0,048
1675	0,069	0,112	0,148	0,130	0,145	0,123	0,119	0,084	0,131	0,095	0,094
1725	0,024	0,032	0,025	0,032	0,026	0,031	0,028	0,025	0,034	0,025	0,032
1775	0,295	0,477	0,431	0,439	0,445	0,442	0,438	0,369	0,315	0,402	0,429
1825	0,055	0,057	0,055	0,054	0,054	0,048	0,052	0,049	0,050	0,049	0,053
1875	0,164	0,078	0,052	0,050	0,050	0,045	0,051	0,151	0,104	0,057	0,059
1925	0,059	0,049	0,052	0,050	0,051	0,042	0,047	0,042	0,056	0,048	0,049
1975	0,630	0,792	0,573	0,560	0,564	0,585	0,596	0,523	0,470	0,616	0,627

4.8	EMC and power quality Harmonic current emission (EN 61000-4-7)	P

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

Test result: ASW30K-LT-G2

Higher Frequencies

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2,1	0,671	0,750	0,530	0,533	0,513	0,518	0,523	0,519	0,465	0,596	0,589
2,3	0,415	0,571	0,516	0,514	0,516	0,505	0,488	0,433	0,428	0,476	0,490
2,5	0,178	0,159	0,098	0,084	0,077	0,084	0,092	0,119	0,119	0,117	0,124
2,7	0,194	0,174	0,138	0,099	0,100	0,091	0,093	0,092	0,103	0,118	0,124
2,9	0,159	0,142	0,092	0,075	0,065	0,062	0,063	0,063	0,074	0,083	0,091
3,1	0,148	0,130	0,086	0,085	0,062	0,062	0,066	0,069	0,074	0,082	0,088
3,3	0,143	0,127	0,062	0,065	0,056	0,063	0,072	0,075	0,081	0,091	0,099
3,5	0,105	0,082	0,046	0,061	0,074	0,084	0,089	0,091	0,090	0,096	0,098
3,7	0,081	0,074	0,044	0,048	0,044	0,046	0,049	0,047	0,050	0,051	0,053
3,9	0,073	0,068	0,053	0,054	0,046	0,045	0,043	0,041	0,049	0,042	0,043
4,1	0,063	0,050	0,053	0,049	0,041	0,040	0,037	0,037	0,039	0,036	0,038
4,3	0,056	0,049	0,051	0,047	0,039	0,038	0,036	0,036	0,040	0,038	0,038
4,5	0,040	0,034	0,040	0,040	0,035	0,036	0,036	0,036	0,036	0,034	0,034
4,7	0,036	0,030	0,033	0,032	0,031	0,031	0,031	0,032	0,031	0,030	0,032
4,9	0,032	0,021	0,026	0,026	0,031	0,032	0,030	0,027	0,027	0,026	0,026
5,1	0,028	0,018	0,024	0,026	0,024	0,026	0,027	0,027	0,027	0,025	0,026
5,3	0,022	0,016	0,023	0,022	0,020	0,023	0,024	0,024	0,024	0,023	0,023
5,5	0,022	0,015	0,021	0,021	0,019	0,022	0,023	0,023	0,023	0,021	0,021
5,7	0,018	0,015	0,020	0,021	0,018	0,022	0,021	0,021	0,022	0,021	0,021
5,9	0,016	0,015	0,018	0,019	0,018	0,020	0,021	0,021	0,021	0,020	0,020
6,1	0,018	0,016	0,018	0,019	0,018	0,019	0,021	0,021	0,021	0,020	0,021
6,3	0,017	0,016	0,017	0,019	0,017	0,020	0,020	0,022	0,021	0,021	0,022
6,5	0,018	0,018	0,016	0,018	0,016	0,020	0,019	0,020	0,020	0,020	0,021
6,7	0,021	0,017	0,018	0,018	0,016	0,018	0,018	0,019	0,018	0,019	0,019
6,9	0,022	0,018	0,023	0,019	0,017	0,020	0,018	0,019	0,019	0,020	0,020
7,1	0,024	0,029	0,025	0,030	0,031	0,031	0,032	0,030	0,030	0,034	0,034
7,3	0,017	0,016	0,016	0,017	0,016	0,018	0,018	0,021	0,020	0,020	0,021
7,5	0,022	0,023	0,027	0,028	0,026	0,026	0,027	0,025	0,024	0,027	0,029
7,7	0,016	0,016	0,018	0,017	0,015	0,016	0,018	0,019	0,019	0,018	0,019
7,9	0,016	0,016	0,017	0,017	0,016	0,018	0,018	0,019	0,018	0,018	0,019
8,1	0,016	0,016	0,016	0,016	0,016	0,018	0,017	0,018	0,018	0,018	0,020
8,3	0,017	0,016	0,016	0,017	0,016	0,018	0,017	0,017	0,017	0,017	0,019
8,5	0,017	0,017	0,015	0,017	0,015	0,017	0,018	0,018	0,018	0,018	0,019
8,7	0,018	0,018	0,015	0,017	0,015	0,017	0,017	0,018	0,018	0,018	0,020
8,9	0,020	0,018	0,016	0,018	0,016	0,017	0,017	0,021	0,022	0,020	0,021

Note: The normalization current is 43,478A.

4.8	EMC and power quality Harmonic current emission (EN 61000-4-7)	P

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

Test result: ASW50K-LT-G2

Harmonics

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	2,418	10,495	20,717	30,581	40,853	50,826	60,867	70,702	80,676	90,547	98,216
2	0,110	0,106	0,110	0,128	0,109	0,111	0,106	0,108	0,117	0,126	0,140
3	0,173	0,328	0,413	0,341	0,281	0,252	0,342	0,243	0,251	0,265	0,268
4	0,158	0,028	0,069	0,091	0,091	0,123	0,103	0,123	0,144	0,161	0,180
5	0,227	0,267	0,245	0,306	0,300	0,320	0,325	0,330	0,341	0,339	0,343
6	0,027	0,032	0,039	0,058	0,019	0,016	0,021	0,021	0,025	0,037	0,039
7	0,073	0,045	0,074	0,094	0,118	0,122	0,121	0,125	0,120	0,135	0,140
8	0,197	0,022	0,028	0,052	0,021	0,026	0,032	0,038	0,045	0,056	0,064
9	0,039	0,110	0,032	0,105	0,060	0,058	0,065	0,076	0,067	0,072	0,071
10	0,163	0,018	0,018	0,030	0,019	0,021	0,028	0,031	0,036	0,046	0,051
11	0,143	0,063	0,059	0,044	0,043	0,047	0,101	0,117	0,110	0,099	0,094
12	0,025	0,018	0,030	0,027	0,015	0,012	0,020	0,020	0,027	0,030	0,027
13	0,100	0,097	0,063	0,074	0,049	0,058	0,099	0,114	0,115	0,107	0,105
14	0,092	0,018	0,029	0,025	0,017	0,020	0,027	0,030	0,040	0,066	0,100
15	0,050	0,088	0,047	0,121	0,054	0,050	0,068	0,072	0,074	0,080	0,074
16	0,162	0,013	0,017	0,019	0,017	0,024	0,029	0,031	0,041	0,066	0,100
17	0,644	0,221	0,162	0,173	0,116	0,115	0,167	0,201	0,207	0,247	0,266
18	0,018	0,014	0,022	0,015	0,013	0,012	0,015	0,016	0,019	0,023	0,023
19	0,124	0,304	0,195	0,157	0,095	0,114	0,163	0,197	0,226	0,244	0,281
20	0,088	0,018	0,019	0,015	0,015	0,018	0,023	0,028	0,034	0,039	0,043
21	0,066	0,065	0,044	0,033	0,041	0,046	0,048	0,058	0,060	0,063	0,060
22	0,040	0,015	0,016	0,015	0,018	0,023	0,029	0,035	0,041	0,049	0,053
23	0,116	0,153	0,157	0,098	0,086	0,106	0,125	0,151	0,176	0,193	0,204
24	0,016	0,011	0,013	0,011	0,012	0,012	0,012	0,015	0,019	0,023	0,022
25	0,222	0,166	0,154	0,092	0,077	0,096	0,123	0,159	0,188	0,213	0,228
26	0,138	0,018	0,012	0,013	0,016	0,021	0,023	0,029	0,035	0,040	0,043
27	0,054	0,055	0,025	0,011	0,028	0,039	0,042	0,044	0,051	0,051	0,053
28	0,117	0,018	0,013	0,014	0,019	0,025	0,030	0,034	0,042	0,049	0,053
29	0,190	0,164	0,096	0,053	0,068	0,082	0,101	0,116	0,139	0,155	0,166
30	0,023	0,012	0,015	0,012	0,012	0,011	0,012	0,014	0,017	0,021	0,021
31	0,282	0,139	0,092	0,052	0,061	0,085	0,105	0,128	0,153	0,174	0,188
32	0,105	0,018	0,016	0,013	0,016	0,021	0,024	0,028	0,033	0,038	0,042
33	0,054	0,052	0,028	0,019	0,027	0,038	0,038	0,041	0,042	0,045	0,045
34	0,134	0,017	0,018	0,017	0,021	0,026	0,028	0,032	0,039	0,045	0,050
35	0,168	0,143	0,081	0,068	0,075	0,090	0,095	0,107	0,122	0,140	0,148
36	0,027	0,013	0,020	0,014	0,015	0,012	0,013	0,014	0,018	0,020	0,020
37	0,175	0,128	0,084	0,038	0,047	0,068	0,084	0,100	0,119	0,137	0,148
38	0,048	0,019	0,026	0,017	0,021	0,024	0,024	0,028	0,034	0,036	0,040
39	0,051	0,086	0,068	0,091	0,092	0,091	0,086	0,087	0,094	0,102	0,098
40	0,073	0,021	0,032	0,020	0,021	0,023	0,029	0,033	0,035	0,043	0,046

4.8	EMC and power quality Harmonic current emission (EN 61000-4-7)	P

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

Test result: ASW50K-LT-G2

Interharmonics

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0,054	0,077	0,272	0,291	0,272	0,345	0,417	0,478	0,547	0,630	0,696
125	0,056	0,075	0,281	0,318	0,269	0,350	0,411	0,465	0,539	0,613	0,688
175	0,033	0,023	0,072	0,095	0,053	0,058	0,070	0,080	0,091	0,135	0,162
225	0,029	0,021	0,049	0,160	0,036	0,046	0,055	0,061	0,074	0,134	0,158
275	0,031	0,028	0,048	0,046	0,024	0,027	0,028	0,032	0,038	0,089	0,092
325	0,044	0,049	0,074	0,077	0,036	0,034	0,032	0,038	0,045	0,074	0,068
375	0,028	0,031	0,044	0,039	0,022	0,021	0,019	0,024	0,025	0,070	0,053
425	0,040	0,041	0,066	0,049	0,030	0,031	0,026	0,028	0,031	0,042	0,049
475	0,022	0,016	0,029	0,027	0,019	0,018	0,019	0,019	0,020	0,052	0,060
525	0,017	0,016	0,016	0,020	0,013	0,014	0,018	0,018	0,020	0,025	0,032
575	0,024	0,021	0,029	0,082	0,017	0,017	0,022	0,026	0,031	0,040	0,052
625	0,036	0,039	0,055	0,041	0,031	0,027	0,124	0,126	0,169	0,073	0,052
675	0,022	0,023	0,092	0,109	0,018	0,017	0,025	0,030	0,035	0,033	0,039
725	0,041	0,048	0,052	0,045	0,031	0,028	0,118	0,119	0,168	0,075	0,061
775	0,021	0,019	0,132	0,115	0,019	0,017	0,016	0,020	0,022	0,209	0,198
825	0,018	0,013	0,020	0,025	0,013	0,013	0,016	0,016	0,017	0,038	0,038
875	0,031	0,035	0,032	0,037	0,023	0,023	0,026	0,028	0,029	0,216	0,205
925	0,030	0,038	0,032	0,028	0,021	0,019	0,025	0,031	0,031	0,041	0,039
975	0,026	0,037	0,039	0,035	0,027	0,026	0,028	0,031	0,035	0,041	0,042
1025	0,032	0,042	0,037	0,028	0,022	0,024	0,027	0,035	0,037	0,040	0,043
1075	0,027	0,027	0,018	0,020	0,019	0,015	0,017	0,018	0,019	0,019	0,020
1125	0,017	0,012	0,017	0,013	0,014	0,013	0,013	0,016	0,015	0,017	0,019
1175	0,032	0,035	0,029	0,035	0,025	0,025	0,026	0,032	0,032	0,035	0,041
1225	0,034	0,037	0,030	0,025	0,022	0,022	0,026	0,030	0,035	0,038	0,038
1275	0,024	0,030	0,035	0,034	0,030	0,028	0,030	0,033	0,039	0,042	0,045
1325	0,031	0,041	0,034	0,027	0,024	0,026	0,028	0,035	0,040	0,046	0,046
1375	0,036	0,024	0,019	0,022	0,017	0,016	0,018	0,017	0,020	0,019	0,020
1425	0,016	0,012	0,016	0,011	0,013	0,013	0,013	0,014	0,015	0,020	0,018
1475	0,034	0,036	0,034	0,035	0,026	0,026	0,030	0,031	0,036	0,036	0,042
1525	0,031	0,032	0,026	0,023	0,024	0,023	0,027	0,028	0,035	0,038	0,038
1575	0,022	0,029	0,042	0,033	0,031	0,028	0,034	0,033	0,040	0,041	0,044
1625	0,026	0,035	0,030	0,023	0,024	0,027	0,028	0,033	0,038	0,044	0,046
1675	0,200	0,107	0,044	0,084	0,085	0,082	0,063	0,068	0,070	0,067	0,060
1725	0,018	0,015	0,021	0,018	0,021	0,023	0,016	0,019	0,019	0,021	0,023
1775	0,249	0,293	0,178	0,296	0,306	0,317	0,259	0,269	0,274	0,275	0,279
1825	0,033	0,032	0,033	0,028	0,032	0,029	0,032	0,033	0,036	0,041	0,039
1875	0,025	0,036	0,091	0,030	0,028	0,029	0,033	0,033	0,040	0,041	0,043
1925	0,027	0,024	0,034	0,024	0,027	0,028	0,029	0,033	0,039	0,042	0,045
1975	0,183	0,373	0,338	0,413	0,423	0,431	0,370	0,390	0,401	0,423	0,451

4.8	EMC and power quality Harmonic current emission (EN 61000-4-7)	P

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

Test result: ASW50K-LT-G2

Higher Frequencies

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2,1	0,273	0,358	0,332	0,376	0,388	0,399	0,351	0,359	0,377	0,403	0,423
2,3	0,354	0,354	0,232	0,358	0,365	0,376	0,300	0,312	0,325	0,327	0,331
2,5	0,163	0,078	0,069	0,045	0,051	0,062	0,074	0,083	0,094	0,109	0,117
2,7	0,124	0,082	0,063	0,047	0,054	0,064	0,072	0,083	0,094	0,107	0,116
2,9	0,121	0,074	0,048	0,035	0,042	0,045	0,054	0,061	0,066	0,074	0,082
3,1	0,087	0,065	0,050	0,031	0,044	0,050	0,051	0,064	0,070	0,078	0,087
3,3	0,109	0,057	0,044	0,032	0,047	0,056	0,057	0,066	0,076	0,083	0,089
3,5	0,081	0,037	0,043	0,042	0,051	0,054	0,055	0,063	0,072	0,078	0,084
3,7	0,065	0,035	0,030	0,024	0,031	0,032	0,031	0,035	0,041	0,047	0,054
3,9	0,057	0,031	0,031	0,023	0,028	0,029	0,026	0,028	0,029	0,033	0,033
4,1	0,037	0,024	0,026	0,019	0,027	0,029	0,022	0,030	0,032	0,038	0,041
4,3	0,037	0,023	0,022	0,019	0,028	0,031	0,022	0,029	0,031	0,037	0,039
4,5	0,033	0,021	0,019	0,017	0,021	0,020	0,020	0,024	0,025	0,026	0,025
4,7	0,025	0,019	0,019	0,018	0,021	0,020	0,019	0,023	0,025	0,025	0,025
4,9	0,021	0,017	0,018	0,017	0,017	0,015	0,016	0,020	0,022	0,022	0,021
5,1	0,021	0,017	0,017	0,017	0,017	0,014	0,015	0,019	0,021	0,022	0,021
5,3	0,017	0,017	0,017	0,017	0,017	0,015	0,014	0,018	0,019	0,022	0,020
5,5	0,014	0,017	0,018	0,017	0,017	0,014	0,013	0,017	0,018	0,021	0,019
5,7	0,014	0,018	0,018	0,018	0,016	0,014	0,013	0,017	0,018	0,020	0,019
5,9	0,013	0,019	0,019	0,019	0,017	0,016	0,013	0,017	0,018	0,019	0,018
6,1	0,013	0,019	0,019	0,019	0,018	0,015	0,012	0,018	0,019	0,020	0,019
6,3	0,013	0,019	0,019	0,019	0,016	0,015	0,012	0,017	0,018	0,020	0,019
6,5	0,014	0,020	0,020	0,019	0,017	0,015	0,012	0,017	0,018	0,019	0,018
6,7	0,014	0,019	0,018	0,019	0,017	0,014	0,013	0,018	0,019	0,018	0,018
6,9	0,015	0,019	0,018	0,018	0,017	0,014	0,014	0,018	0,018	0,018	0,018
7,1	0,018	0,021	0,020	0,022	0,023	0,022	0,018	0,024	0,024	0,024	0,025
7,3	0,021	0,019	0,017	0,017	0,018	0,015	0,012	0,020	0,018	0,018	0,019
7,5	0,020	0,021	0,018	0,021	0,023	0,022	0,018	0,023	0,024	0,024	0,024
7,7	0,013	0,017	0,016	0,016	0,019	0,015	0,011	0,018	0,019	0,018	0,019
7,9	0,013	0,016	0,016	0,016	0,018	0,015	0,011	0,018	0,019	0,018	0,019
8,1	0,012	0,016	0,016	0,017	0,019	0,015	0,011	0,018	0,019	0,018	0,020
8,3	0,012	0,016	0,017	0,017	0,019	0,017	0,011	0,018	0,019	0,018	0,019
8,5	0,012	0,016	0,017	0,017	0,018	0,016	0,011	0,018	0,019	0,018	0,019
8,7	0,012	0,016	0,017	0,017	0,019	0,016	0,011	0,019	0,019	0,020	0,019
8,9	0,013	0,017	0,018	0,017	0,018	0,016	0,012	0,019	0,019	0,021	0,020

Note: The normalization current is 72,464 A.
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.8	EMC and power quality Switching operation (Refer IEC 61400-21)			P
Test result:				
Max. number of switching operations, N_{10}	10			
Max. number of switching operations, N_{120}	120			
Case of switching operation	Cut-in at 10%P_{Emax}			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0,018	0,012	0,010	0,009
Voltage change factor, $k_u(\psi_k)$	0,207	0,218	0,214	0,215
Maximum inrush current factor k_{imax}	0,14			
Case of switching operation	Cut-in at 100%P_{Emax}			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0,032	0,021	0,017	0,016
Voltage change factor, $k_u(\psi_k)$	0,207	0,209	0,208	0,202
Maximum inrush current factor k_{imax}	0,38			
Case of switching operation	Service disconnection at rated power			
Grid impedance angle, ψ_k	30°	50°	70°	85°
Flicker step factor, $k_f(\psi_k)$	0,010	0,008	0,006	0,005
Voltage change factor, $k_u(\psi_k)$	0,213	0,241	0,230	0,219
Maximum inrush current factor k_{imax}	0,70			
Worst case over all switching operations, k_{imax}	0,70			

Note:

$S_{k,fic}/S_n$ in the fictitious grid was set to:20.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.8	Voltage fluctuation and flicker					P
Test result:						
Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-3 and/or EN 61000-3-11.					
Test:ASW50K-LT-G2						
Value	P_{st}	P_{lt} 2 hours	d(t) 500ms	d_c	d_{max}	
Limit	1,0	0,65	3,3%	3,3%	4%	
Test value	See below					
Inverter >16A						

L1 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.11 Pass	0.22 Pass	0 Pass	0.15 Pass	
2	0.11 Pass	0.20 Pass	0 Pass	0.15 Pass	
3	0.11 Pass	0.21 Pass	0 Pass	0.15 Pass	
4	0.10 Pass	0.25 Pass	0 Pass	0.15 Pass	
5	0.11 Pass	0.19 Pass	0 Pass	0.15 Pass	
6	0.11 Pass	0.20 Pass	0 Pass	0.15 Pass	
7	0.11 Pass	0.21 Pass	0 Pass	0.15 Pass	
8	0.11 Pass	0.21 Pass	0 Pass	0.15 Pass	
9	0.12 Pass	0.20 Pass	0 Pass	0.15 Pass	
10	0.11 Pass	0.20 Pass	0 Pass	0.15 Pass	
11	0.10 Pass	0.20 Pass	0 Pass	0.15 Pass	
12	0.11 Pass	0.20 Pass	0 Pass	0.15 Pass	
Result	Pass	Pass	Pass	Pass	0.15 Pass

L2 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.11 Pass	0.77 Pass	0 Pass	0.17 Pass	
2	0.11 Pass	0.77 Pass	0 Pass	0.18 Pass	
3	0.11 Pass	0.81 Pass	0 Pass	0.17 Pass	
4	0.10 Pass	0.83 Pass	0 Pass	0.18 Pass	
5	0.11 Pass	0.83 Pass	0 Pass	0.18 Pass	
6	0.11 Pass	0.87 Pass	0 Pass	0.18 Pass	
7	0.11 Pass	0.87 Pass	0 Pass	0.17 Pass	
8	0.11 Pass	0.87 Pass	0 Pass	0.18 Pass	
9	0.12 Pass	0.87 Pass	0 Pass	0.18 Pass	
10	0.11 Pass	0.87 Pass	0 Pass	0.18 Pass	
11	0.10 Pass	0.87 Pass	0 Pass	0.18 Pass	
12	0.11 Pass	0.87 Pass	0 Pass	0.18 Pass	
Result	Pass	Pass	Pass	Pass	0.18 Pass

L3 phase

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.08 Pass	0.30 Pass	0 Pass	0.20 Pass	
2	0.08 Pass	0.26 Pass	0 Pass	0.20 Pass	
3	0.07 Pass	0.25 Pass	0 Pass	0.20 Pass	
4	0.08 Pass	0.25 Pass	0 Pass	0.20 Pass	
5	0.08 Pass	0.28 Pass	0 Pass	0.20 Pass	
6	0.08 Pass	0.25 Pass	0 Pass	0.20 Pass	
7	0.07 Pass	0.31 Pass	0 Pass	0.20 Pass	
8	0.06 Pass	0.25 Pass	0 Pass	0.20 Pass	
9	0.06 Pass	0.26 Pass	0 Pass	0.20 Pass	
10	0.05 Pass	0.25 Pass	0 Pass	0.20 Pass	
11	0.08 Pass	0.24 Pass	0 Pass	0.20 Pass	
12	0.07 Pass	0.31 Pass	0 Pass	0.20 Pass	
Result	Pass	Pass	Pass	Pass	0.20 Pass

Note:

*The stationary deviance of dc% is more relevant than the dynamic deviance of dmax at starting and stopping, Mains Impedance according EN61000-3-11:

Rmax = 0,24Ω; jXmax= 0,15Ω @50Hz (|Zmax| = 0,283/0,4717Ω) for single phase inverter use also

R_n = 0,16Ω; jX_n= 0,1Ω.

Calculation of the maximum permissible grid impedance at the point of common coupling based on dc:

$Z_{max} = Z_{ref} * 3{,}3\% / d_c(P_n)$.

The tests should be based on the limits of the EN 61000-3-11 for more than 16A.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

4.8	EMC and power quality Flicker and voltage fluctuations	P

Method: Measurement and evaluation was carried out according to the procedure in IEC 61400-21.

Test result:

Grid impedance angle, ψ_k	30°	50°	70°	85°
Operating point, P_a/P_{Emax} [%]	Flicker coefficient, $c(\psi_k)$			
3	0,170	0,170	0,155	0,155
10	0,180	0,180	0,164	0,164
20	0,170	0,170	0,155	0,155
30	0,180	0,180	0,164	0,164
40	0,180	0,180	0,164	0,164
50	0,180	0,180	0,164	0,164
60	0,170	0,170	0,155	0,155
70	0,180	0,180	0,164	0,164
80	0,180	0,180	0,164	0,164
90	0,180	0,180	0,164	0,164
100	0,180	0,180	0,164	0,164
Max. Flicker coefficient, c(ψk)	1,14	0,75	0,61	0,57
Max. Short-term flicker, Pst	0,180	0,180	0,164	0,164

Reactive power setpoint during testing [kVar]	0

P [%P_{Emax}]	3	10	20	30	40	50	60	70	80	90	100
Number of data sets	1	1	1	1	1	1	1	1	1	1	1

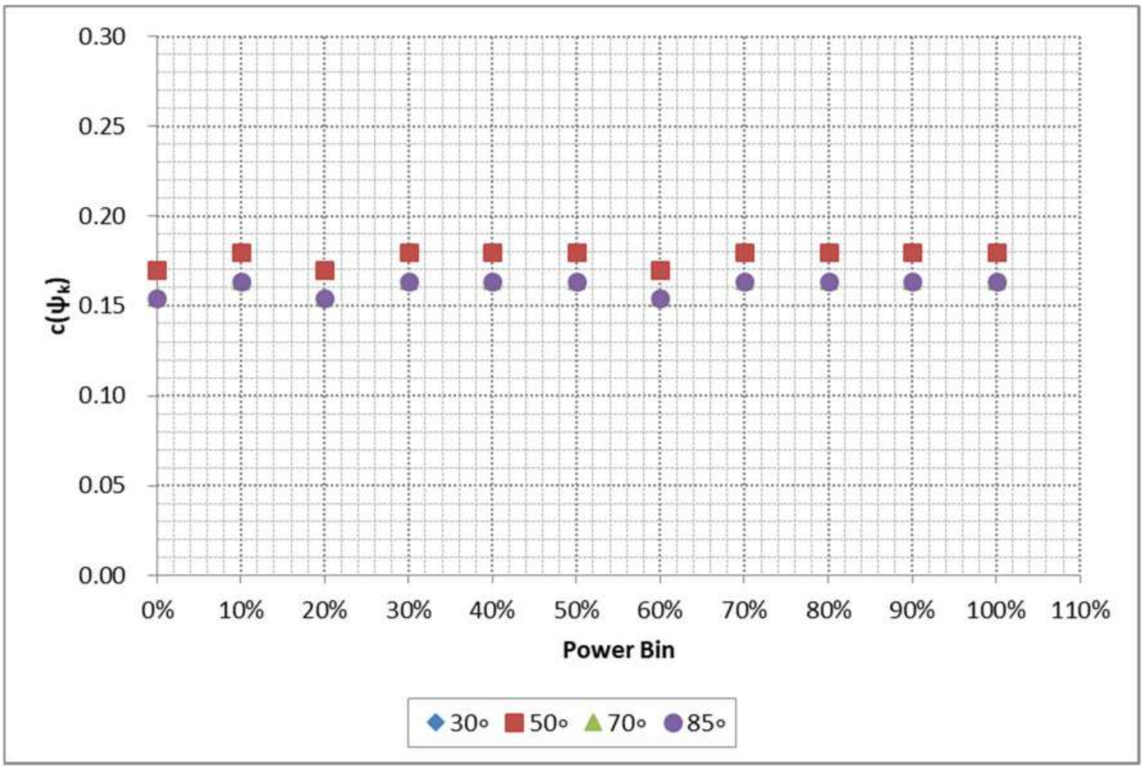
Note:

The table entries are worst case values.

$S_{k,fic}/S_n$ in the fictitious grid was set to:20.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Maximum Flicker coefficients c(ψ$_k$) vs. power bins



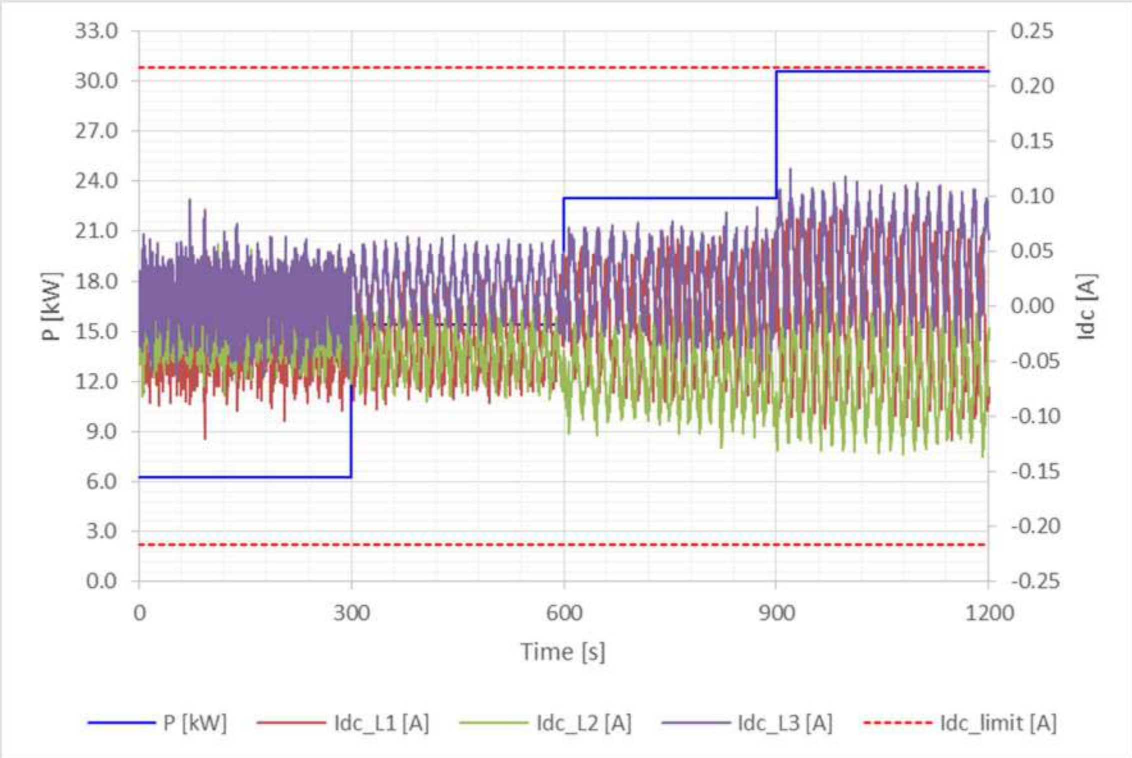
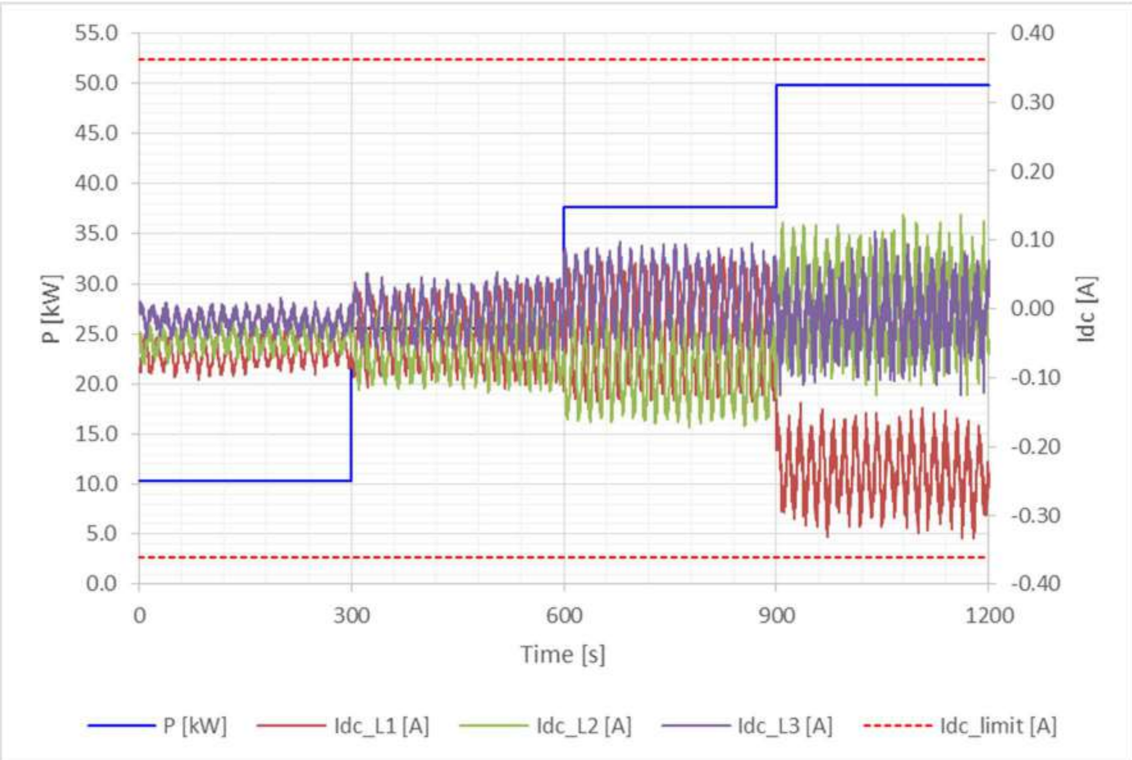
4.8	EMC and power quality DC-Injection			P
Test result: ASW30K-LT-G2				
Protection limit	**Tested at four power levels limit 0,5% of $I_{AC;nom}$ (217mA)**			
Output power	~25%	~50%	~70%	~100%
Abs. Max. Test Value:L1 [A]	0,120	0,093	0,097	0,121
Abs. Ave. Test Value:L1 [A]	0,036	0,032	0,034	0,045
Abs. Max. Test Value:L2 [A]	0,082	0,086	0,128	0,136
Abs. Ave. Test Value:L2 [A]	0,022	0,043	0,062	0,068
Abs. Max. Test Value:L3 [A]	0,097	0,065	0,09	0,125
Abs. Ave. Test Value:L3 [A]	0,023	0,023	0,030	0,047
Test result: ASW50K-LT-G2				
Protection limit	**Tested at four power levels limit 0,5% of $I_{AC;nom}$ (362mA)**			
Output power	~25%	~50%	~70%	~100%
Abs. Max. Test Value:L1 [A]	0,102	0,115	0,135	0,333
Abs. Ave. Test Value:L1 [A]	0,064	0,045	0,059	0,236
Abs. Max. Test Value:L2 [A]	0,081	0,122	0,172	0,137
Abs. Ave. Test Value:L2 [A]	0,044	0,061	0,091	0,049
Abs. Max. Test Value:L3 [A]	0,050	0,072	0,098	0,126
Abs. Ave. Test Value:L3 [A]	0,018	0,026	0,039	0,036

Note:

Test method and setting value refer Annex D.3.10 of EN 50438:2013.

Testing must be performed according to WI 10.4.-03.doc rev D. The internal temperature of the EUT must be stabilized, No temperature drift of more than 2K within 1 hour is allowed.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Diagram of permanent dc-injection
ASW30K-LT-G2 
ASW50K-LT-G2 

4.8	Immunity to voltage dips and short interruptions				P
For a directly coupled SSEG			For a Inverter SSEG		
L1					
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	24,65Vac	11,99A
Initial Value of aperiodic current	A	N/A	100ms	14,19Vac	7,99A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	N/A	N/A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	N/A	N/A
L2					
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	55,88Vac	26,91A
Initial Value of aperiodic current	A	N/A	100ms	26,65Vac	13,64A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	N/A	N/A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	N/A	N/A
L3					
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	I_p	N/A	20ms	34,79Vac	25,55A
Initial Value of aperiodic current	A	N/A	100ms	17,99Vac	11,81A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	N/A	N/A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	N/A	N/A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,033s	In seconds

Note:

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the Generating Unit terminals.

* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Graphs:


CH8 : 50.00A/div
Position : 0.00 div
Display Group
100kS/s 1s/div
50kS/s 2s/div
<Main>
<Zoom1>
50ms/div
X1 -4.41799s
X2 -4.38499s
ΔX 33.00ms
Stopped
2021/08/20 15:31:54.89267285
Auto
2021/08/20 15:45:23

4.8	Unbalance							P
Test: cos φ = 1								
P [% P_{max}]	P* [kW]	U_{1+}* [V]	U_{1-}* [V]	I_{1+}* [A]	I_{1-}* [A]	u_i* [% I_{1+}]	$u_{i\,abs}$* [% I_n]	Number of data sets
0 - 5	0,194	230,03	0,087	0,280	0,089	31,79	0,123	3
10	5,376	229,32	0,087	7,815	0,066	0,84	0,091	3
20	10,592	229,53	0,464	15,381	0,186	1,21	0,257	3
30	15,806	228,95	0,102	23,012	0,176	0,76	0,243	3
40	20,959	229,28	0,109	30,471	0,199	0,65	0,275	3
50	26,045	229,60	0,12	38,813	0,197	0,51	0,272	3
60	31,05	229,93	0,117	45,014	0,223	0,50	0,308	3
70	35,957	230,25	0,120	52,054	0,227	0,44	0,313	3
80	40,754	230,58	0,124	58,916	0,216	0,37	0,298	3
90	45,371	230,89	0,137	65,502	0,240	0,37	0,331	3
100	49,342	231,12	0,126	71,162	0,187	0,26	0,258	3
Maximum unsymmetry u_{imax} (≥10%Pn)						0,002		

Note:

*1 min-average values of positive and negative sequence data.

The unsymmetry is calculated according to following equation:

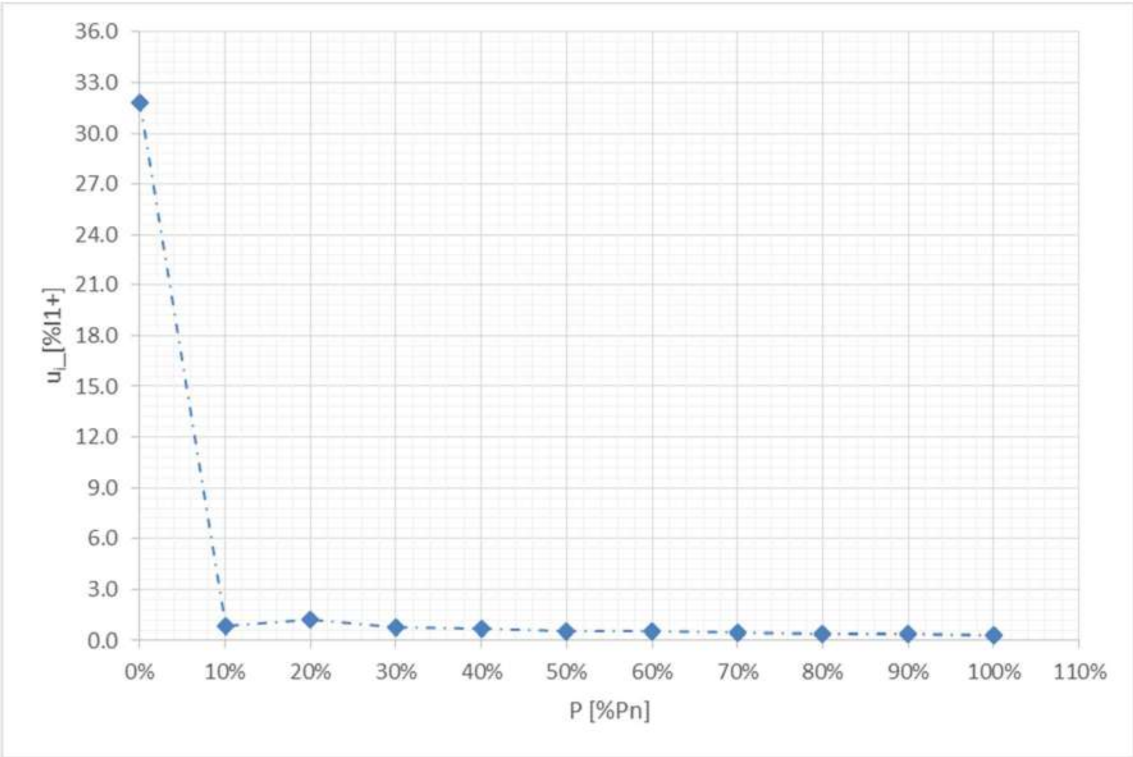
$$u_i = \frac{I_{1-}}{I_{1+}} \cdot 100\%$$

Additionally the unsymmetry is calculated relative to nominal current according to following equation:

$$u_{iabs} = \frac{I_{1-}}{I_n} \cdot 100\%$$

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Diagram



36.0
33.0
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0.0
u_i_[%I1+]
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
110%
P [%Pn]

EN 50549-1:2019: Interface protection			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.9.3	Requirements on voltage and frequency protection	CEI 0-21:2019-04, Annex A.3.1 to A.3.4	**P**
4.9.3.1	Undervoltage protection	EN 50438, Annex D.2.3	**P**
	Overvoltage protection	EN 50438, Annex D.2.3	**P**
	Overvoltage 10 min mean protection	EN 50160	**P**
	Underfrequency protection	EN 50438, Annex D.2.4	**P**
	Overfrequency protection	EN 50438, Annex D.2.4	**P**
4.9.4.2	Loss of Mains (LoM) detection	IEC 62116:2014	**P**

<table>
<tr><td>4.9.3</td><td colspan="6">Requirements on voltage and frequency protection Checklist</td><td>P</td></tr>
<tr><td colspan="8">Several points to check</td></tr>
<tr><td>Clause 4.9.3.1 to 4.9.3.6</td><td colspan="6">All thresholds must be adjustable</td><td>P</td></tr>
<tr><td colspan="8">Voltage values</td></tr>
<tr><td rowspan="2">Threshold</td><td colspan="3">Stage 1 [27 <]</td><td colspan="4">Stage 2 [27 <<]</td></tr>
<tr><td>Operate voltage</td><td colspan="2">Operate time</td><td colspan="2">Operate voltage</td><td colspan="2">Operate time</td></tr>
<tr><td>Range</td><td>0,2-1,0 U_n</td><td colspan="2">0,1-100s</td><td colspan="2">0,2-1,0 U_n</td><td colspan="2">0,1-5s</td></tr>
<tr><td>Steps</td><td>0,01 U_n</td><td colspan="2">0,1 s</td><td colspan="2">0,01 U_n</td><td colspan="2">0,05s</td></tr>
<tr><td rowspan="2">Threshold</td><td colspan="2">Stage 1 [59 >]</td><td colspan="2">Stage 2 [59 >>]</td><td colspan="3">Overvoltage 10 min mean protection</td></tr>
<tr><td>Operate voltage</td><td>Operate time</td><td>Operate voltage</td><td>Operate time</td><td>Operate voltage</td><td colspan="2">Operate time</td></tr>
<tr><td>Range</td><td>1,0-1,2 U_n</td><td>0,1-100s</td><td>1,0-1,3 U_n</td><td>0,1-5s</td><td>1,0-1,15 U_n</td><td colspan="2">3s not adjustable</td></tr>
<tr><td>Steps</td><td>0,01 U_n</td><td>0,1s</td><td>0,01 U_n</td><td>0,05s</td><td>0,01 U_n</td><td colspan="2">--</td></tr>
<tr><td colspan="8">Frequency values</td></tr>
<tr><td rowspan="2">Threshold</td><td colspan="3">Stage 1 [81 <]</td><td colspan="4">Stage 2 [81 <<]</td></tr>
<tr><td>Operate frequency</td><td colspan="2">Operate time</td><td colspan="2">Operate frequency</td><td colspan="2">Operate time</td></tr>
<tr><td>Range</td><td>47,0-50,0Hz</td><td colspan="2">0,1-100s</td><td colspan="2">47,0-50,0Hz</td><td colspan="2">0,1-5s</td></tr>
<tr><td>Steps</td><td>0,1 Hz</td><td colspan="2">0,1 s</td><td colspan="2">0,1 Hz</td><td colspan="2">0,05s</td></tr>
<tr><td rowspan="2">Threshold</td><td colspan="3">Stage 1 [81 >]</td><td colspan="4">Stage 2 [81 >>]</td></tr>
<tr><td>Operate frequency</td><td colspan="2">Operate time</td><td colspan="2">Operate frequency</td><td colspan="2">Operate time</td></tr>
<tr><td>Range</td><td>50,0-52,0Hz</td><td colspan="2">0,1-100s</td><td colspan="2">50,0-52,0Hz</td><td colspan="2">0,1-5s</td></tr>
<tr><td>Steps</td><td>0,1 Hz</td><td colspan="2">0,1 s</td><td colspan="2">0,1 Hz</td><td colspan="2">0,05s</td></tr>
<tr><td>4.9.2.6</td><td colspan="6">Insensitive against 40ms frequency transients, so that the unit will not trip</td><td>P</td></tr>
<tr><td colspan="8">Note:</td></tr>
</table>

4.9.3 4.9.3.1	Requirements on voltage and frequency protection General (Interface protection: Over/under voltage) (Setting value refer EN 50549-1 for default settings)	P

Test conditions			Output power: 20,0kW Frequency: 50+/-0,2Hz		
Phase	**Limit [V]**	**Trip value [V]**	**Voltage step [V]**	**Disconnection time [s]**	**Limit [s]**
L1	Stage 1 115% of U_n = 264,5	264,0	230 to 269	0,135	≤3,0s
		263,9	230 to 269	0,130	
		263,9	230 to 269	0,133	
		264,1	230 to 269	0,153	
		263,9	230 to 269	0,138	
	Stage 2 125% of U_n = 287,5	287,8	230 to 292	0,128	0,1s ≤ t ≤ 0,2s
		287,6	230 to 292	0,124	
		287,5	230 to 292	0,129	
		287,7	230 to 292	0,129	
		287,8	230 to 292	0,129	
	Stage 80% of U_n = 184	184,4	230 to 189	2,547	2,0s ≤ t ≤ 5,0s
		184,4	230 to 189	2,512	
		184,3	230 to 189	2,542	
		184,2	230 to 189	2,547	
		184,4	230 to 189	2,522	
	Stage 2 50% of U_n = 115	115,9	230 to 120	0,135	0,1s ≤ t ≤ 2,0s
		115,7	230 to 120	0,140	
		115,9	230 to 120	0,135	
		115,8	230 to 120	0,125	
		115,8	230 to 120	0,115	
L2	Stage 1 115% of U_n = 264,5	263,9	230 to 269	0,153	≤3,0s
		263,8	230 to 269	0,143	
		263,9	230 to 269	0,148	
		263,8	230 to 269	0,138	
		263,8	230 to 269	0,163	
	Stage 2 125% of U_n = 287,5	287,3	230 to 292	0,134	0,1s ≤ t ≤ 0,2s
		287,5	230 to 292	0,124	
		287,2	230 to 292	0,132	
		287,3	230 to 292	0,143	
		287,4	230 to 292	0,128	
	Stage 80% of U_n = 184	184,1	230 to 189	2,522	2,0s ≤ t ≤ 5,0s
		184,3	230 to 189	2,522	
		184,2	230 to 189	2,522	
		184,2	230 to 189	2,542	
		184,1	230 to 189	2,532	
	Stage 2 50% of U_n = 115	115,7	230 to 120	0,125	0,1s ≤ t ≤ 2,0s
		115,5	230 to 120	0,125	
		115,8	230 to 120	0,135	
		115,6	230 to 120	0,135	
		115,7	230 to 120	0,125	

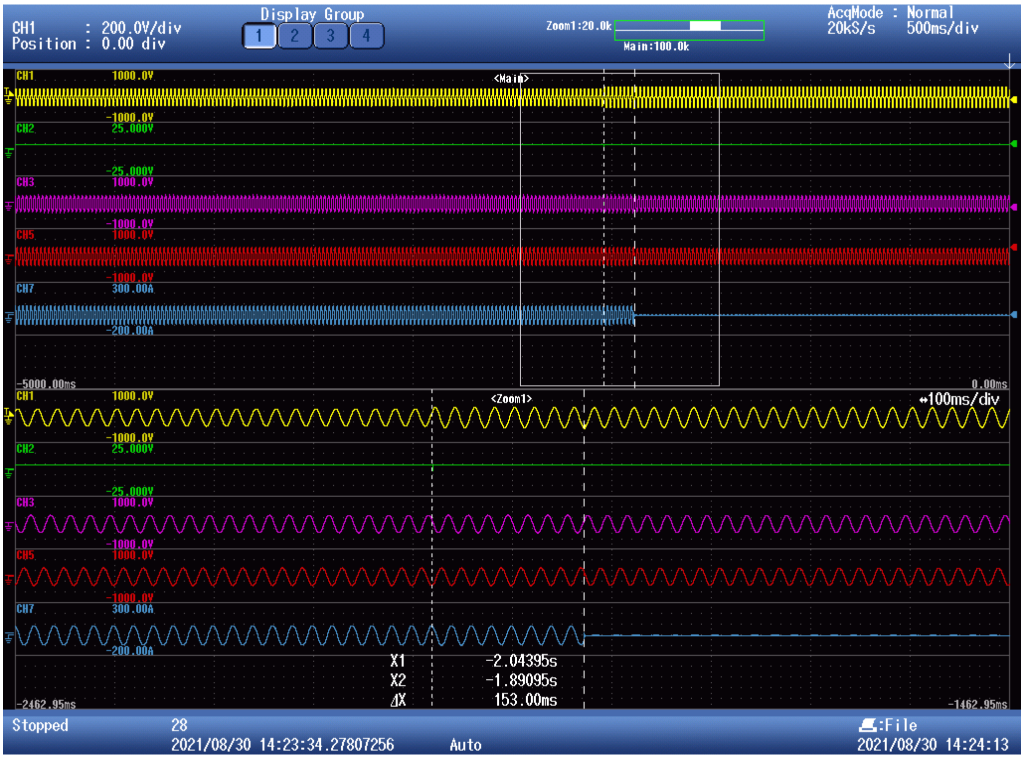
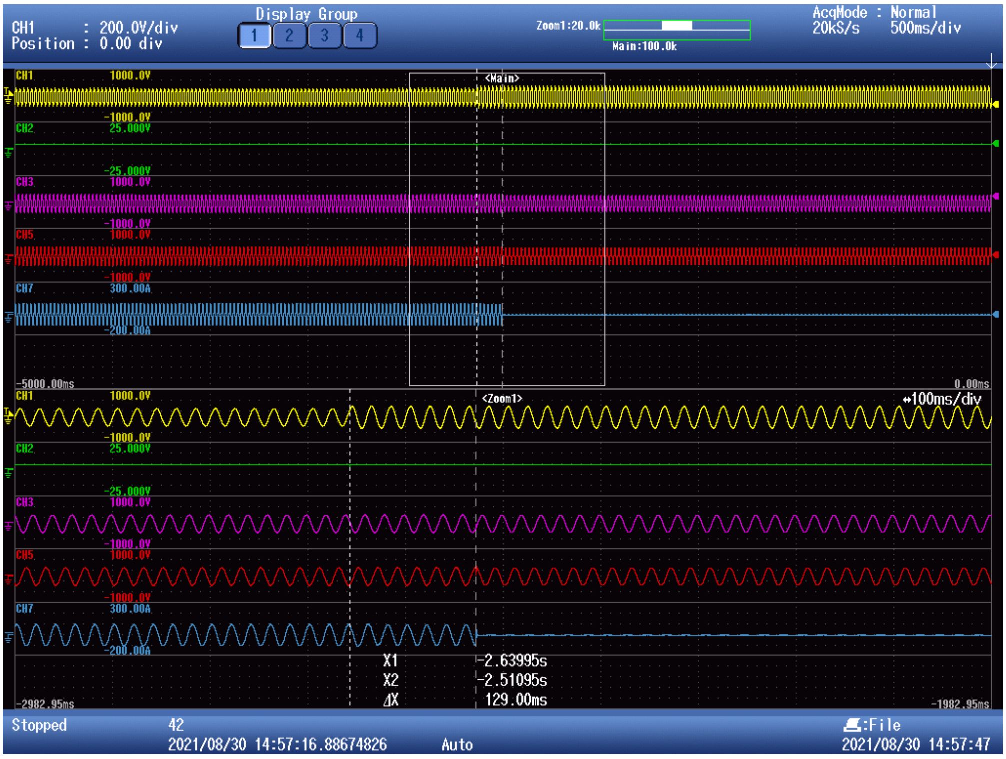
4.9.3 4.9.3.1	**Requirements on voltage and frequency protection** **General (Interface protection: Over/under voltage)** **(Setting value refer EN 50549-1 for default settings)**	**P**

Test conditions			Output power: 20,0kW Frequency: 50+/-0,2Hz		
Phase	**Limit [V]**	**Trip value [V]**	**Voltage step [V]**	**Disconnection time [s]**	**Limit [s]**
L3	Stage 1 115% of U_n = 264,5	263,4	230 to 269	0,133	≤3,0s
		263,5	230 to 269	0,133	
		263,5	230 to 269	0,148	
		263,8	230 to 269	0,143	
		263,8	230 to 269	0,138	
	Stage 2 125% of U_n = 287,5	287,7	230 to 292	0,138	0,1s ≤ t ≤ 0,2s
		287,9	230 to 292	0,133	
		287,6	230 to 292	0,138	
		287,7	230 to 292	0,138	
		287,8	230 to 292	0,138	
	Stage 80% of U_n = 184	184,4	230 to 189	2,532	2,0s ≤ t ≤ 5,0s
		184,5	230 to 189	2,557	
		184,3	230 to 189	2,537	
		184,6	230 to 189	2,537	
		184,5	230 to 189	2,537	
	Stage 2 50% of U_n = 115	115,2	230 to 120	0,130	0,1s ≤ t ≤ 2,0s
		115,5	230 to 120	0,130	
		115,4	230 to 120	0,135	
		115,6	230 to 120	0,135	
		115,5	230 to 120	0,140	

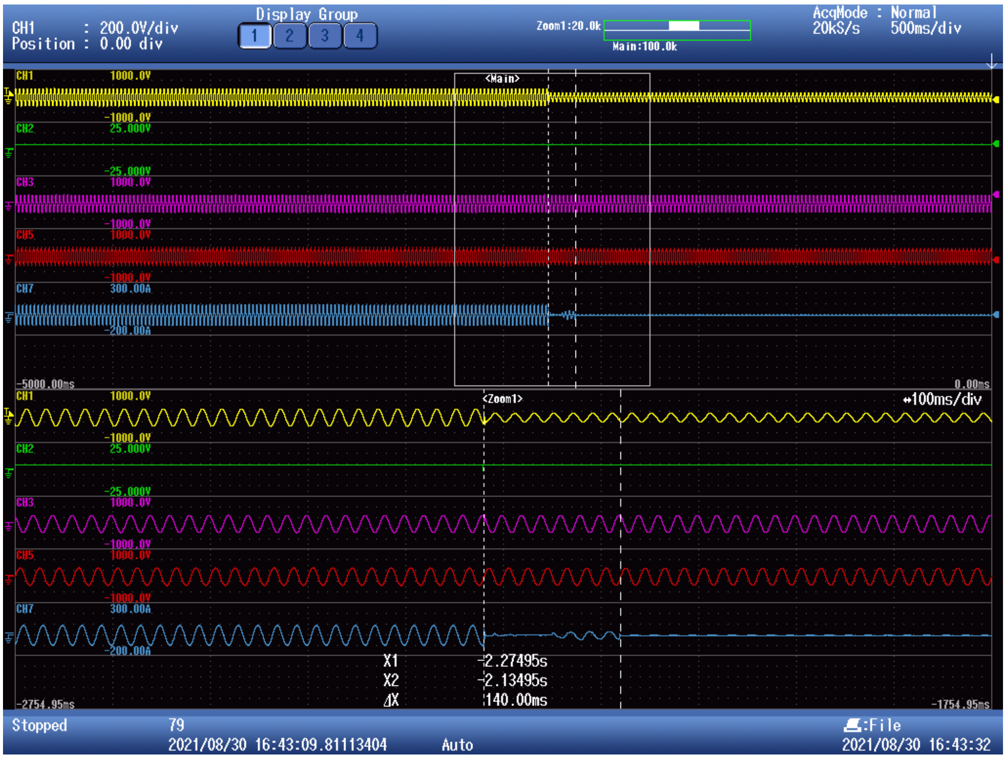
Note:

The trip values were evaluated by varying the applied voltage from U_n down to $U_{th\text{-}low}$ - 2% of U_n in steps of 0,5% of U_n for under-voltage testing as well as from U_n up to $U_{th\text{-}high}$ + 2% of U_n in steps of 0,5% of U_n for over-voltage testing, Lower and upper threshold voltage shall not fall or rise below or above 2,3V of the trip value itself, The disconnection time was measured by application of a negative voltage step from U_n to the operate value -5% of U_n as well as positive voltage step from U_n to the operate value +5% of U_n.

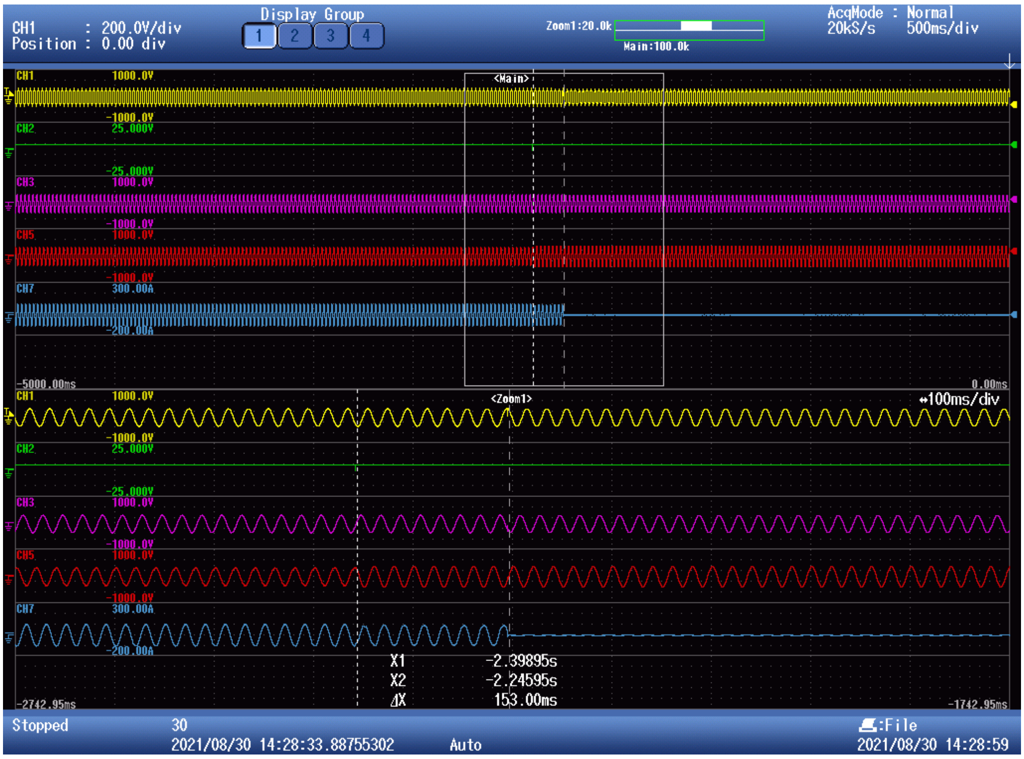
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Scope pictures of the disconnection time
Over-voltage - Stage 1 (L1 phase)

Over-voltage - Stage 2 (L1 phase)


Scope pictures of the disconnection time
Under-voltage - Stage 1 (L1 phase)

Under-voltage - Stage 2 (L1 phase)


Scope pictures of the disconnection time
Over-voltage - Stage 1 (L2 phase)



Over-voltage - Stage 2 (L2 phase)

Scope pictures of the disconnection time

Under-voltage - Stage 1 (L2 phase)

Under-voltage - Stage 2 (L2 phase)

Scope pictures of the disconnection time
Over-voltage - Stage 1 (L3 phase)

Over-voltage - Stage 2 (L3 phase)


Scope pictures of the disconnection time
Under-voltage - Stage 1 (L3 phase)

Under-voltage - Stage 2 (L3 phase)


4.9.3 **4.9.3.1**	**Requirements on voltage and frequency protection** **General** **(Maximum voltage 10 min mean protection according to EN 50160)** **(Setting value refer EN 50438 for default settings)**		**P**

Setting values of the protection:		Trip value Setting [V]	253
		Setting $T_{disconnection\ trip\ value}$ [s]	600
		Setting $T_{disconnection}$ [ms]	200
Test:			
		Disconnection time [s]	Limit [s]
a)	The voltage is set to 100% U_n and held for 600 s, Thereafter the voltage is set to 112% U_n, Disconnection must take place within 600 s,		
	Phase 1:	470 s	≤ 600 s
	Phase 2:	461 s	
	Phase 3:	461 s	
b)	The voltage is set to U_n for 600 s and then to 108% U_n for 600 s, No disconnection should take place,		
	Phase 1:	No Disconnection	Disconnection should not take place,
	Phase 2:	No Disconnection	
	Phase 3:	No Disconnection	
c)	The voltage is set to 106 % U_n and held for 600 s, Thereafter the voltage is set to 114 % U_n, The disconnection should last for half the period as in Point a)*		
	Phase 1:	286 s	The disconnection time should be about 50 % of the value measured in a), *
	Phase 2:	253 s	
	Phase 3:	252 s	

Test:
a) This test serves as proof of the measurement accuracy and the maximum set time.
b) This test serves as proof of the measurement accuracy.
c) This test serves as proof of the correct formation of the 1 minute running mean value.

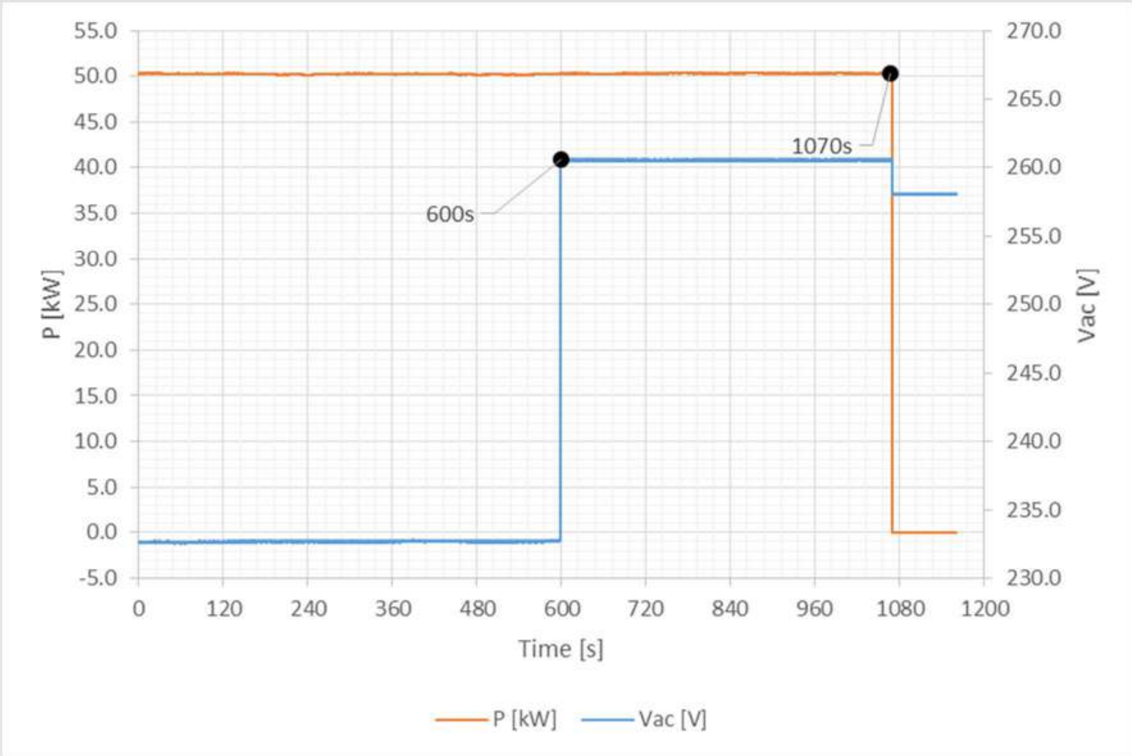
Assessment criterion:
The permitted tolerance between setting value and trip value of the voltage may not exceed ± 1 % of U_N.

Limit values:
Rise-in voltage protection 1,1 U_N after a max. 600 s, the switch off after 200 ms.

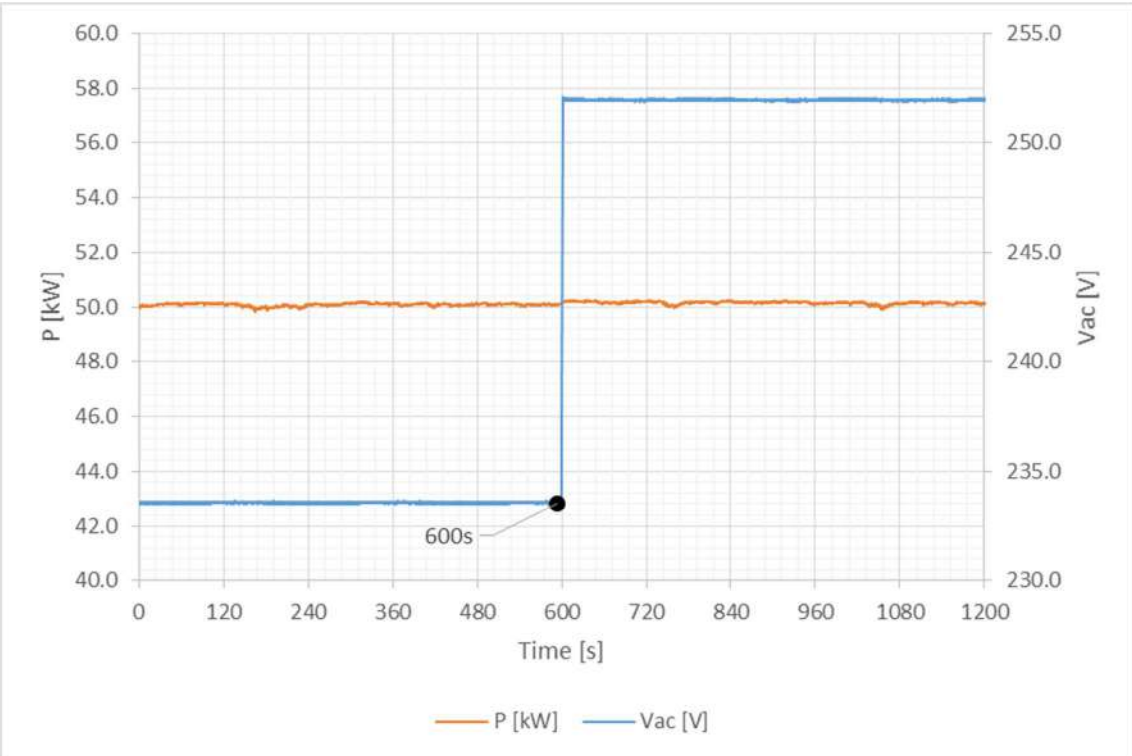
Note:
If only one integrated protection is used for the power generation systems, the value of the rise-in voltage protection of 1,1 U_N may not be changed.
*If the setting value is set to 600 s, then the disconnection time can be in the range between 225 s and 375 s.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

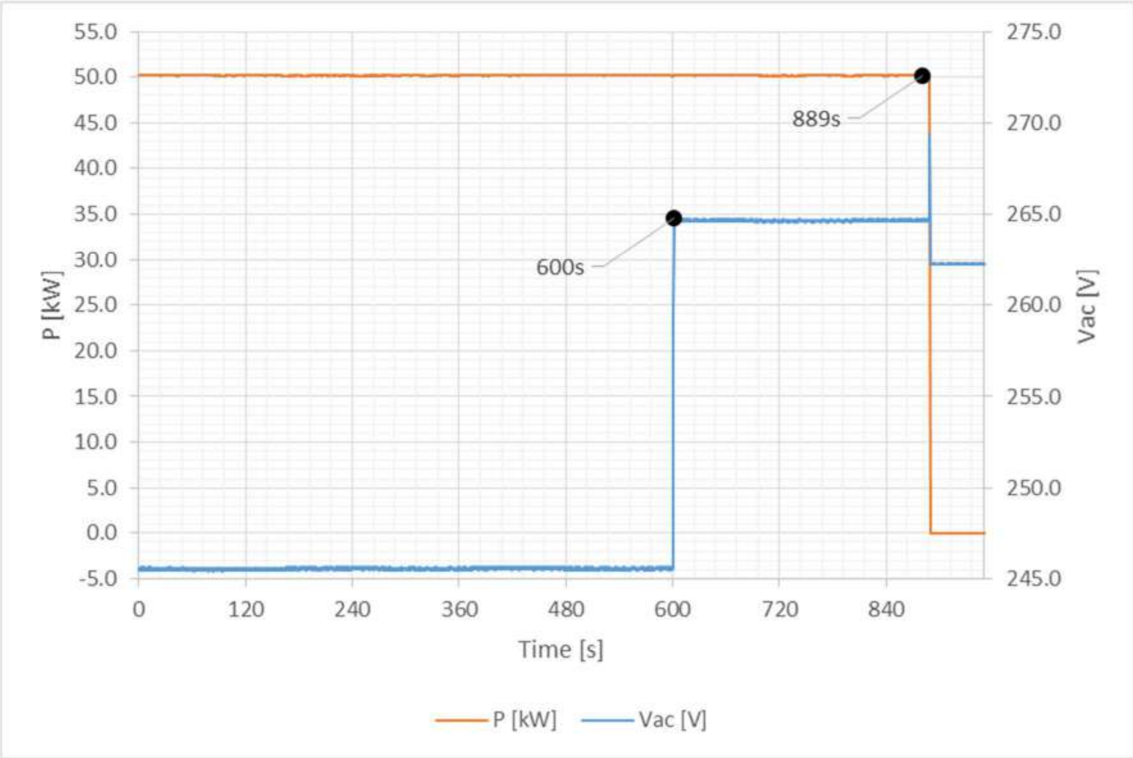
a) Voltage set to 112 % U_n:



b) Voltage set to 108% U_n:



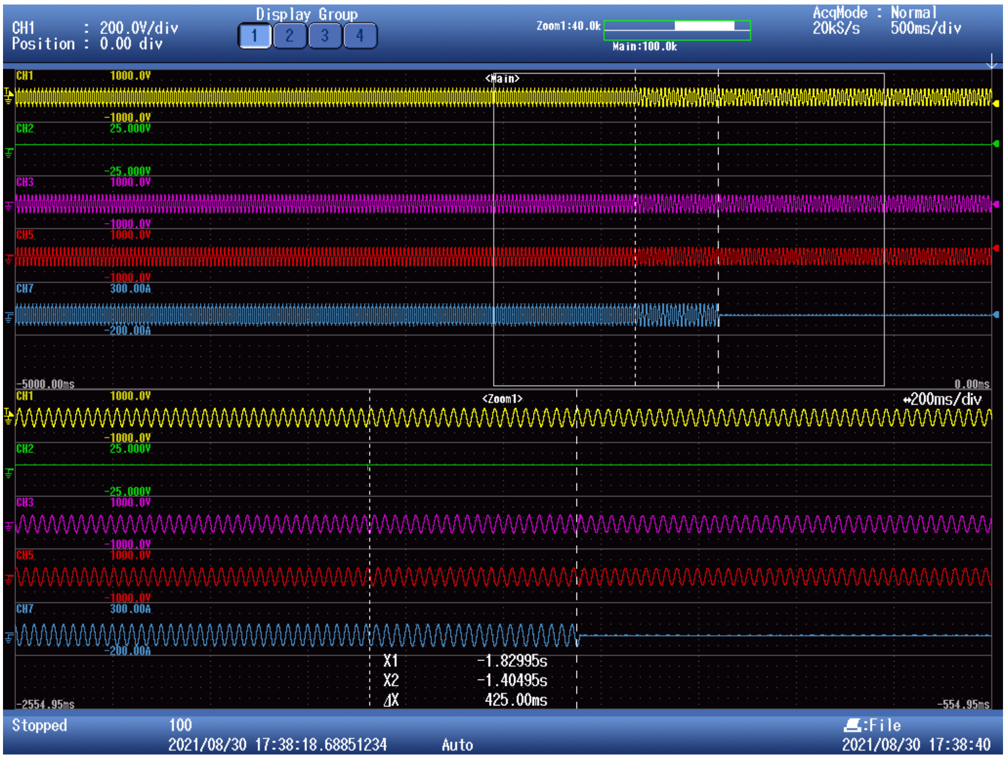
c) Voltage set to 106 % U_n, thereafter 114% U_n:



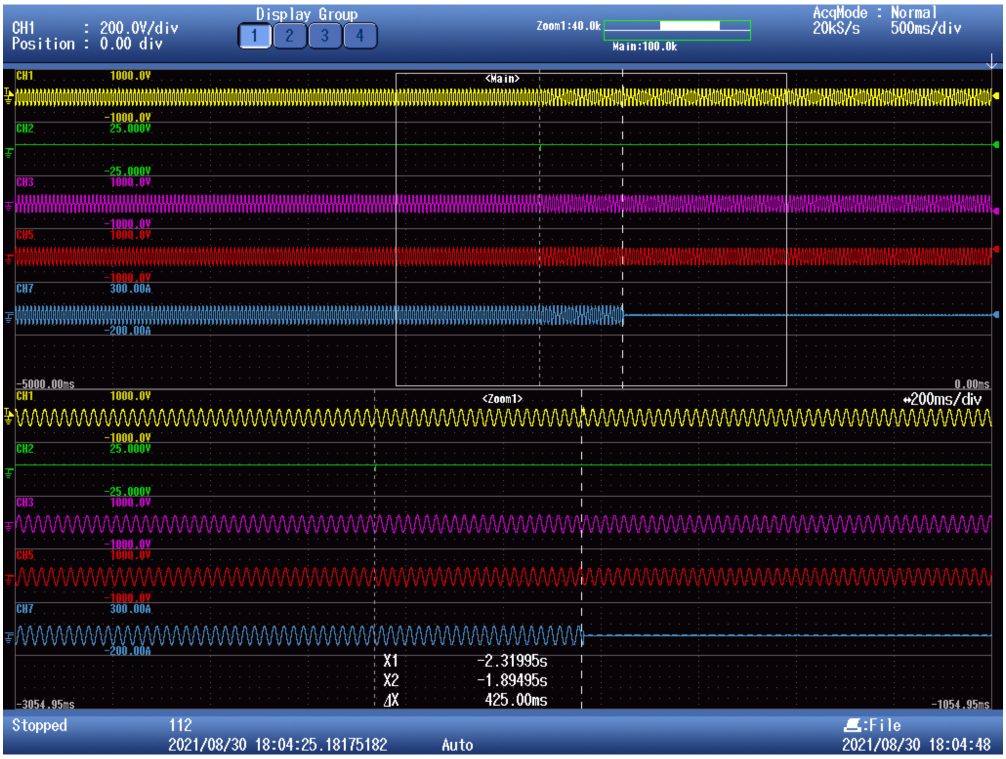
4.9.3 4.9.3.1	Requirements on voltage and frequency protection General (Interface protection: Over/under frequency)			P
Test conditions	Output power: 20,0kW U_n = 230Vac			
	Under-frequency		**Over-frequency**	
Parameter	**Stage 1 Under-Frequency**	**Time**	**Stage 1 Over-Frequency**	**Time**
Limit	47,50 Hz	0,3 ≤ t ≤ 0,5 s	51,50 Hz	0,3 ≤ t ≤ 0,5 s
Trip value [Hz]	47,49		51,50	
	47,49		51,50	
	47,49		51,50	
	47,49		51,50	
	47,49		51,50	
Disconnection time [s]	50,00 Hz to 47,40 Hz	0,425	50,00 Hz to 51,60 Hz	0,425
		0,425		0,420
		0,425		0,420
		0,425		0,410
		0,425		0,420
Parameter	**Stage 2 Under-Frequency**	**Time**	**Stage 2 Over-Frequency**	**Time**
Limit	47,00 Hz	0,1 ≤ t ≤ 0,2 s	52,00 Hz	0,1 ≤ t ≤ 0,2 s
Trip value [Hz]	47,00		52,01	
	47,00		52,01	
	47,00		52,01	
	47,00		52,01	
	47,00		52,01	
Disconnection time [s]	50,00 Hz to 46,90 Hz	0,135	50,00 Hz to 52,10 Hz	0,140
		0,150		0,140
		0,130		0,145
		0,130		0,135
		0,155		0,145

Note:
For under-frequency testing the applied frequency is varied from f_n down to $f_{th\text{-}low}$ -0,1 Hz in steps of 0,025 Hz with a time duration per step exceeding the configured disconnection time, The operate value is the value of the applied frequency at switch the protection function trips and shall be within $f_{th\text{-}low}$ ± 0,05 Hz.
For over-frequency testing the applied frequency is varied from f_n up to $f_{th\text{-}high}$ + 0,1 Hz in steps of 0,025 Hz with a time duration per step exceeding the configured disconnection time, The operate value is the value of the applied frequency at which the protection function trips and shall be within $f_{th\text{-}high}$ ± 0,05 Hz.
The disconnection time was measured by applying a negative or positive frequency ramp from f_n to the operate value -0,1 Hz or +0,1 Hz, e,g, from 50 Hz to 47,4 Hz, The time elapsed between the application of the frequency ramp and the opening of the interface switch was calculated by the measured time minus the 2500 ms from 50,0 Hz to 47,5 Hz.
The oscilloscope pictures below show the measured worst case disconnection times.
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

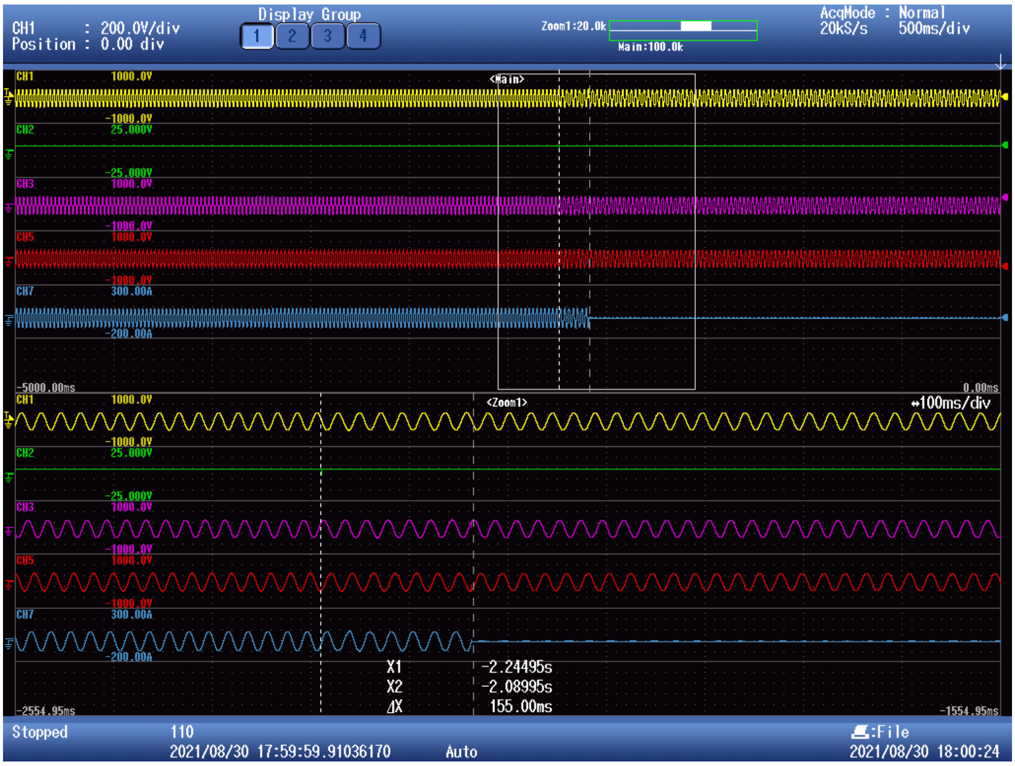
Scope pictures of the disconnection time
Under-frequency - Stage 1



Over-frequency - Stage 1



Under-frequency - Stage 2



Over-frequency - Stage 2

4.9.4.2 Loss of Mains (LoM) detection

Test circuit and parameters

Parameter	Symbol	Units
EUT DC Input		
DC voltage	V_{DC}	V
DC Current	I_{DC}	A
DC Power	P_{DC}	W
EUT AC ouput		
AC voltage	V_{EUT}	V
AC current	I_{EUT}	A
Real power	P_{EUT}	W
Reactive power	Q_{EUT}	VAr
Test Load		
Resistive load current	I_R	A
Inductive load current	I_L	A
Capacitive load current	I_C	A
AC (utility) power source		
Utility real power	P_{AC}	W
Utility reactive power	Q_{AC}	VAr
Utility current	I_{AC}	A

Block diagram test circuit IEC 62116:2014

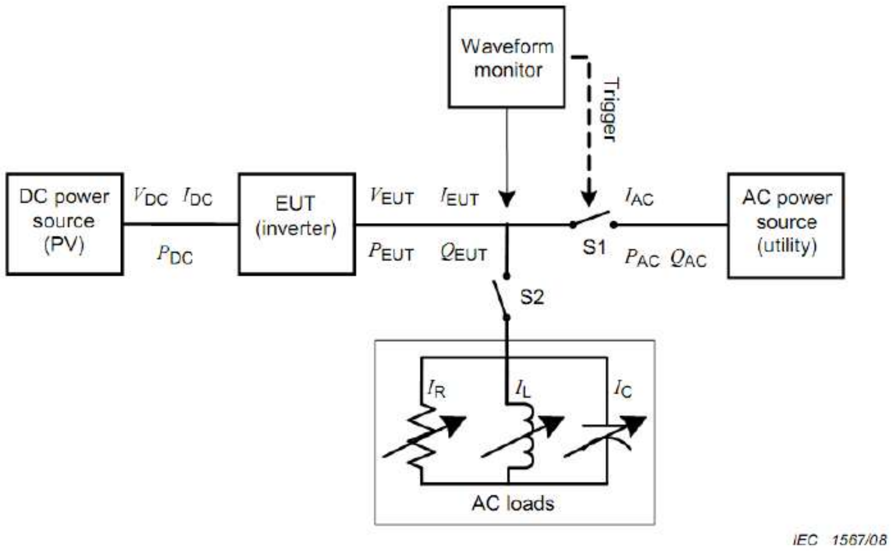


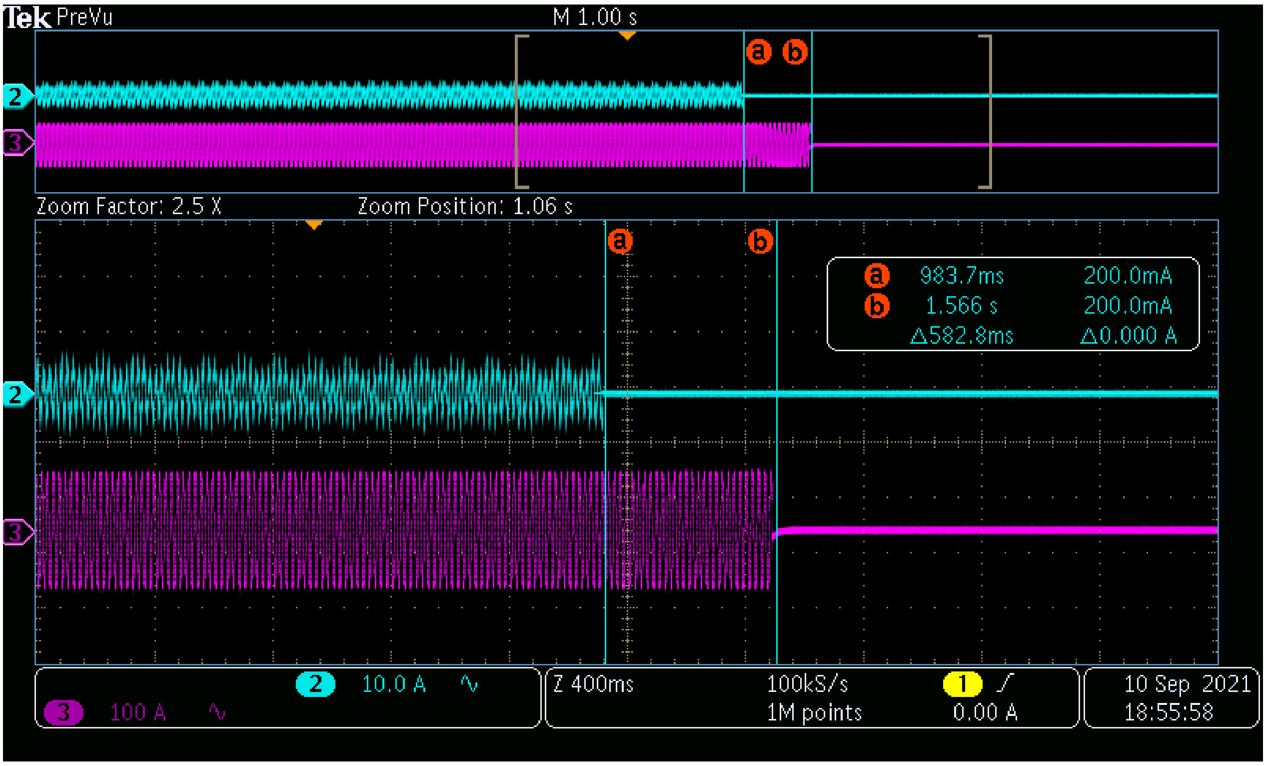
Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)

Load imbalance (real, reactive load) for test condition A (EUT output = 100%)										P
Test :										
Test conditions			Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality = 1							
Disconnection limit			2s (IEC 62116)							
No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6,1,d) 1)	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f	Run on Time [ms]	Remarks 5)
1	100	100	0	0	0,225	16,395	740	0,999	582	BL
2	100	100	-10	-10	6,744	16,395	740	1,053	487	IB
3	100	100	-10	-5	7,131	16,395	740	1,082	497	IB
4	100	100	-10	0	7,327	16,395	740	1,110	561	IB
5	100	100	-10	+5	7,331	16,395	740	1,138	521	IB
6	100	100	-10	+10	7,143	16,395	740	1,165	573	IB
7	100	100	-5	-10	3,212	16,395	740	0,998	492	IB
8	100	100	-5	-5	3,578	16,395	740	1,025	580	IB
9	100	100	-5	0	3,764	16,395	740	1,052	519	IB
10	100	100	-5	+5	3,768	16,395	740	1,078	580	IB
11	100	100	-5	+10	3,590	16,395	740	1,103	400	IB
12	100	100	0	-10	0,774	16,395	740	0,948	559	IB
13	100	100	0	-5	0,425	16,395	740	0,974	573	IB
14	100	100	0	+5	0,245	16,395	740	1,024	573	IB
15	100	100	0	+10	0,415	16,395	740	1,048	560	IB
16	100	100	+5	-10	4,312	16,395	740	0,903	492	IB
17	100	100	+5	-5	3,980	16,395	740	0,928	547	IB
18	100	100	+5	0	3,812	16,395	740	0,952	583	IB
19	100	100	+5	+5	3,808	16,395	740	0,975	505	IB
20	100	100	+5	+10	3,970	16,395	740	0,998	525	IB
21	100	100	+10	-10	7,853	16,395	740	0,862	541	IB
22	100	100	+10	-5	7,535	16,395	740	0,885	553	IB
23	100	100	+10	0	7,375	16,395	740	0,908	557	IB
24	100	100	+10	+5	7,371	16,395	740	0,931	549	IB
25	100	100	+10	+10	7,526	16,395	740	0,953	539	IB
Parameter at 0% per phase			L= 10,28mH			R= 3,23Ω			C= 985,53µF	

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power.
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility, Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility, Nominal is the 0 % test condition value.
4) Fundamental of I_{AC} when RLC is adjusted.
5) BL: Balance condition, IB: Imbalance condition.
Condition A:
EUT output power P_{EUT} = Maximum 6)
EUT input voltage 6) = >75% of rated input voltage range
6) Maximum EUT output power condition should be achieved using the maximum allowable input power, Actual output power may exceed nominal rated output.
7) Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 75 % of range =X + 0,75 × (Y – X), Y shall not exceed 0,8 × EUT maximum system voltage (i,e,, maximum allowable array open circuit voltage), In any case, the EUT should not be operated outside of its allowable input voltage range.
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Scope pictures of the disconnection time

Disconnection at No. 18



Load imbalance (reactive load) for test condition B (EUT output = 50 % – 66 %)											P
Test :											
Test conditions			Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1								
Disconnection limit			2s (IEC 62116)								
No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6,1,d) 1)	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f	Run on Time [ms]	Remarks 5)	
1	66	66	0	-5	0,295	10,928	500	0,984	495	IB	
2	66	66	0	-4	0,272	10,928	500	0,989	515	IB	
3	66	66	0	-3	0,255	10,928	500	0,994	524	IB	
4	66	66	0	-2	0,243	10,928	500	0,999	536	IB	
5	66	66	0	-1	0,235	10,928	500	1,004	569	IB	
6	66	66	0	0	0,232	10,928	500	1,009	609	BL	
7	66	66	0	+1	0,234	10,928	500	1,014	553	IB	
8	66	66	0	+2	0,241	10,928	500	1,019	532	IB	
9	66	66	0	+3	0,252	10,928	500	1,024	506	IB	
10	66	66	0	+4	0,269	10,928	500	1,029	492	IB	
11	66	66	0	+5	0,290	10,928	500	1,034	479	IB	
Parameter at 0% per phase			L= 15,27mH			R= 4,84Ω			C= 663,48µF		

Note:

RLC is adjusted to min. +/-1% of the inverter rated output power

1) P_{EUT}: EUT output power.

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

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

4) Fundamental of I_{AC} when RLC is adjusted.

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

Condition B:

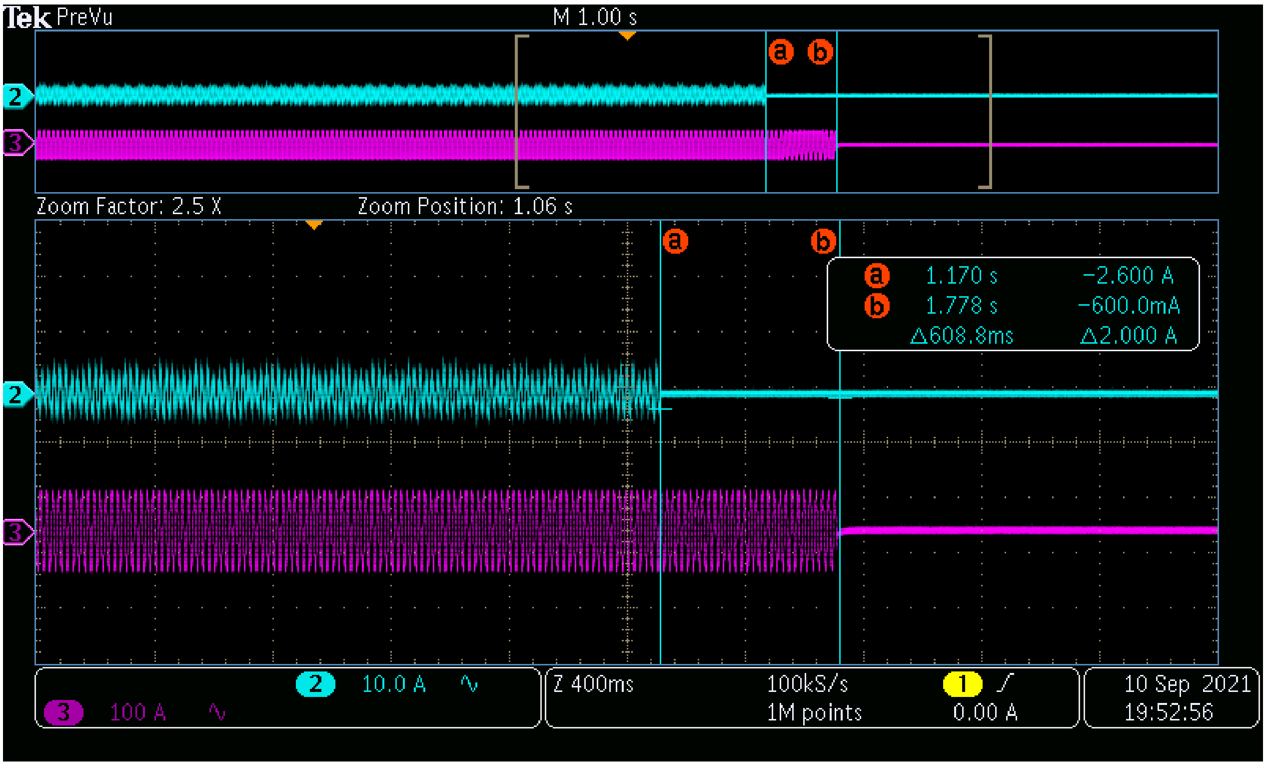
EUT output power P_{EUT} = 50 % – 66 % of maximum

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

6) Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 50 % of range =X + 0,5 × (Y – X), Y shall not exceed 0,8 × EUT maximum system voltage (i,e,, maximum allowable array open circuit voltage), In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

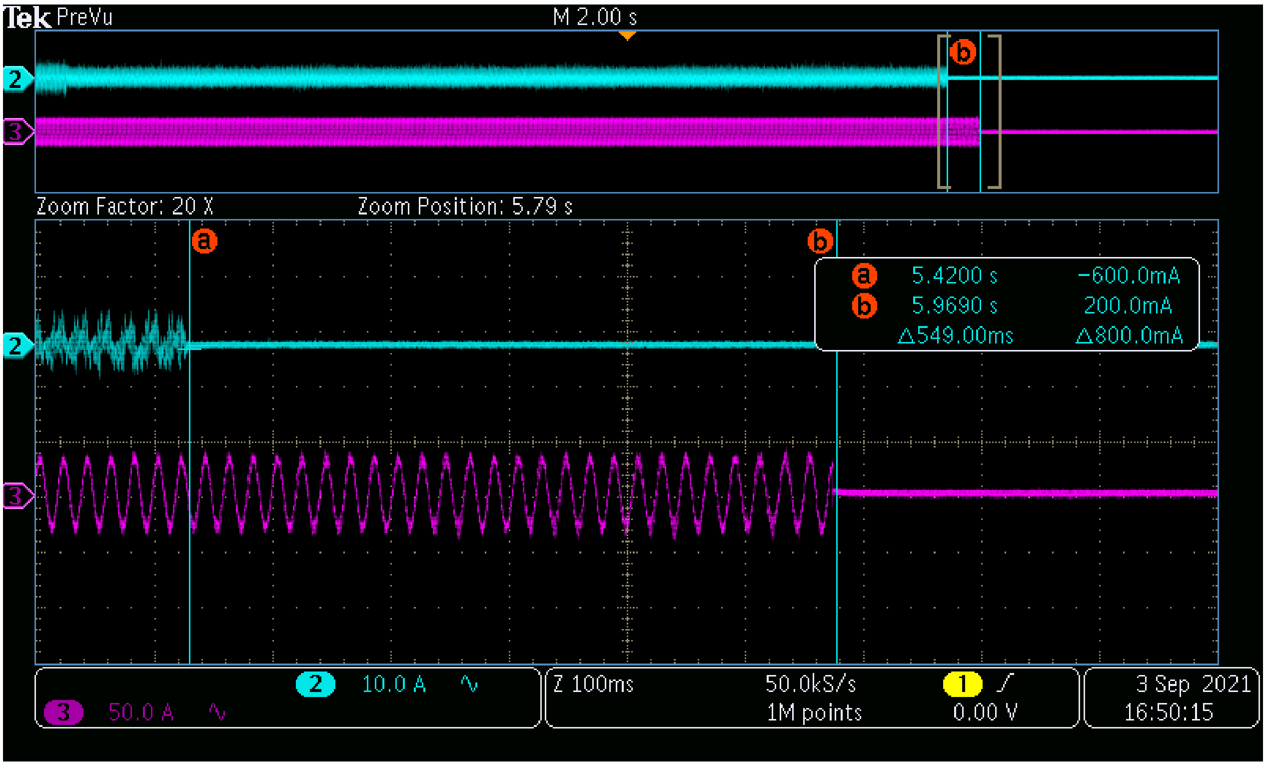
Scope pictures of the disconnection time
Disconnection at No, 6



Load imbalance (reactive load) for test condition C (EUT output = 25 % – 33 %)										P
Test :										
Test conditions			Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1							
Disconnection limit			2s (IEC 62116)							
No	P_{EUT} 1) [% of EUT rating]	Reactive load [% of Q_L in 6,1,d) 1)	P_{AC} 2) [% of nominal]	Q_{AC} 3) [% of nominal]	I_{AC} 4) [A]	P_{EUT} [kW per phase]	V_{DC} [V]	Q_f	Run on Time [ms]	Remarks 5)
1	33	33	0	-5	0,165	4,980	260	0,979	455	IB
2	33	33	0	-4	0,155	4,980	260	0,984	479	IB
3	33	33	0	-3	0,147	4,980	260	0,989	494	IB
4	33	33	0	-2	0,142	4,980	260	0,994	492	IB
5	33	33	0	-1	0,138	4,980	260	0,999	513	IB
6	33	33	0	0	0,137	4,980	260	1,004	549	BL
7	33	33	0	+1	0,138	4,980	260	1,009	533	IB
8	33	33	0	+2	0,141	4,980	260	1,014	502	IB
9	33	33	0	+3	0,146	4,980	260	1,019	483	IB
10	33	33	0	+4	0,154	4,980	260	1,024	452	IB
11	33	33	0	+5	0,164	4,980	260	1,029	328	IB
Parameter at 0% per phase			L= 33,68mH		R= 10,62Ω			C= 300,86µF		

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power.
2) P_{AC}: Real power flow at S1 in Figure 1, Positive means power from EUT to utility, Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1, Positive means power from EUT to utility, Nominal is the 0 % test condition value.
4) Fundamental of I_{AC} when RLC is adjusted.
5) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power P_{EUT} = 25 % – 33 % 6) of maximum
EUT input voltage 7) = <20 % of rated input voltage range
6) Or minimum allowable EUT output level if greater than 33 %.
7) Based on EUT rated input operating range, For example, If range is between X volts and Y volts, 20 % of range =X + 0,2 × (Y – X), Y shall not exceed 0,8 × EUT maximum system voltage (i,e,, maximum allowable array open circuit voltage), In any case, the EUT should not be operated outside of its allowable input voltage range.
The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Scope pictures of the disconnection time
Disconnection at No, 6



EN 50549-1:2019: Connection and starting to generate electrical power			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.10.2	Automatic reconnection after trippin	EN 50438, Annex D.3.6	**P**
4.10.3	Starting to generate electrical power	EN 50438, Annex D.3.6	**P**

4.10 4.10.2 4.10.3	**Connection and starting to generate electrical power** **Automatic reconnection after tripping** **Starting to generate electrical power**		**P**
Setting value	Min. voltage for connected to grid :	195,5	
	Max. voltage for connected to grid :	253,0	
	Min. frequency for connected to grid :	49,50	
	Max. frequency for connected to grid (Normal operational start-up) :	50,15	
	Max. frequency for connected to grid (Automatic reconnection after tripping) :	50,15	
	Observation time (≥60s) :	60,00	

Test:

	Voltage conditons	
a) Start up for voltage range	<85% Un for twice of observation time	>110% Un for twice of observation time
Connection:	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	≥85% Un within twice setting observation time	≤110% Un within twice setting observation time
Reconnection time [s]	75,0 s	63,0 s
Limit:	Connected after setting observation time (≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: disable, For recorded gradient see diagram below,	
c) In voltage range after voltage failture	≥85% Un for twice of setting observation time	≤110% Un for twice of setting observation time
Reconnection time [s]	63,0 s	62,0 s
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_{Emax}/min. For non or partly adjustable generators the connection after trip of the interface protection is delayed by a randomised value between 1 min and 10 min. For recorded gradient see diagram below.	
	Frequency conditions	
d) Start up for frequency range	<49,50 Hz for twice of setting observation time	>50,15 Hz for twice of setting observation time
Connection:	No connection	No connection
Limit	No connection allowed	

e) In frequency range at start-up	≥49,50 Hz within twice of setting observation time	≤50,15 Hz within twice of setting observation time
Reconnection time [s]	63,0 s	63,0 s
Limit:	Connected after setting delay time(≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: disable. For recorded gradient see diagram below.	
f) In frequency range after frequency failture	≥49,50 Hz for twice of setting observation time	≤50,15 Hz for twice of setting observation time
Reconnection time [s]	63,0 s	62,0 s
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	For adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_{Emax}/min. For non or partly adjustable generators the connection after trip of the interface protection is delayed by a randomised value between 1 min and 10 min. For recorded gradient see diagram below.	

Test:

Test condition b) and c): voltage within the limits of 85% to 110%U_n.

Test condition e): frequency within the limits of 49,50Hz to 50,15Hz.

Test condition f): frequency within the limits of 49,50Hz to 50,15Hz.

In order to avoid continuous starting and disengaging operations of the interface protection relay, the disengaging value of frequency and voltage functions shall be above 2 % deviating from the operate value.

Assessment criterion:

d) the micro generator connects respectively starts generating electrical power only in the permitted range of voltage and frequency and

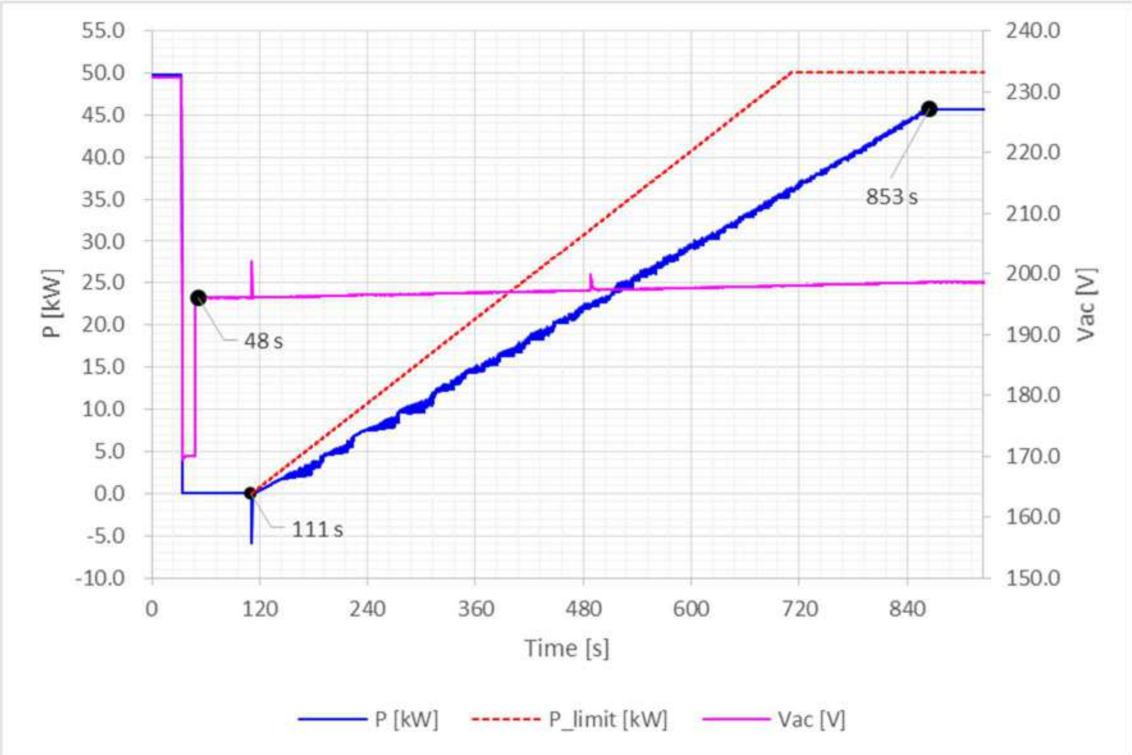
e) for adjustable micro generators the maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute and

f) for non or partly adjustable generators the connection after trip of the interface protection is delayed by a randomised value between 1 min and 10 min.

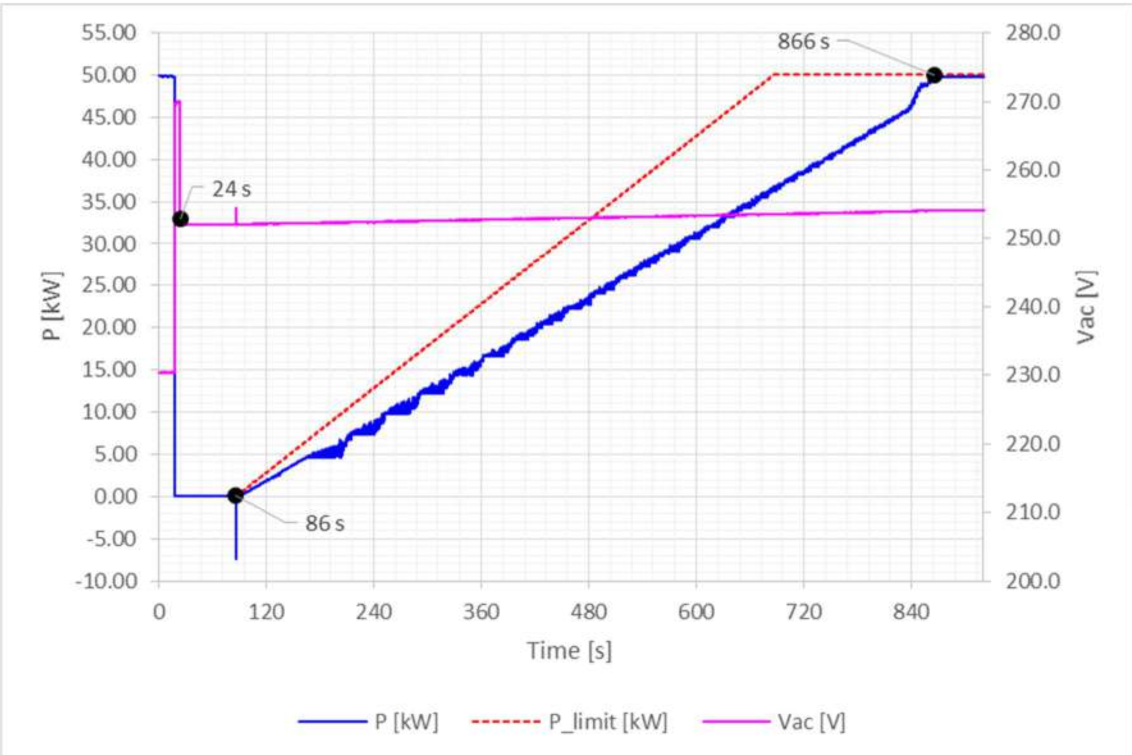
Note:

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

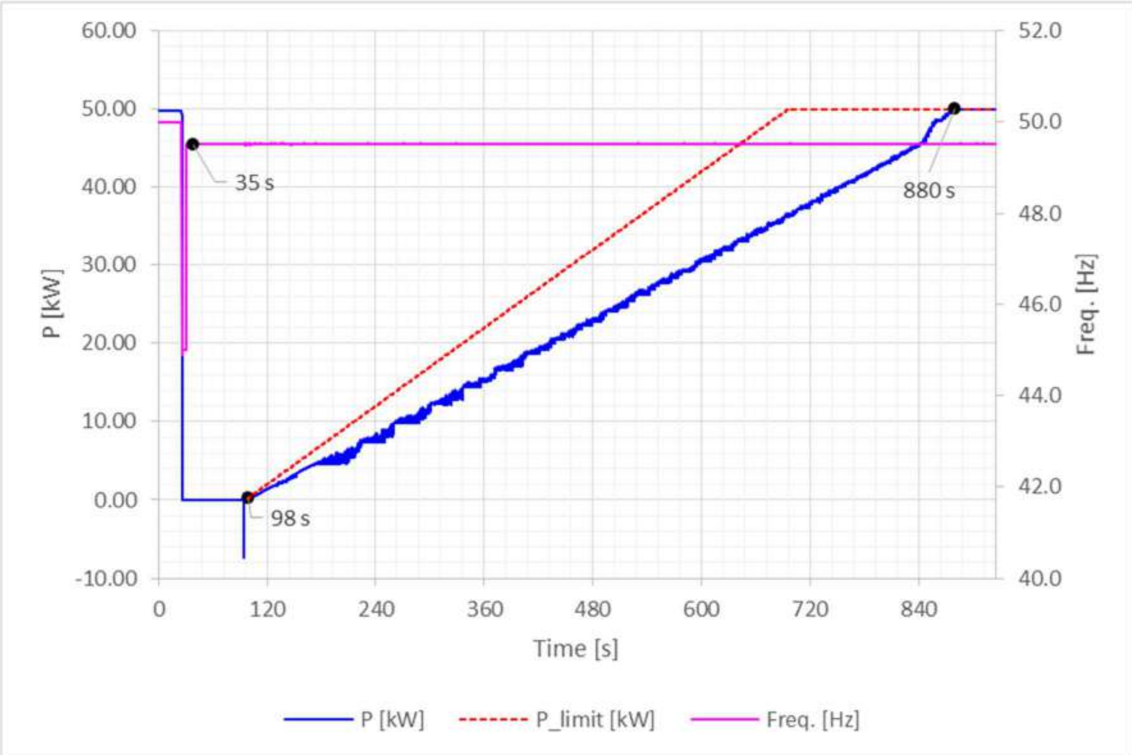
Graph of the gradual power supply : Test c) for ≥ 85% U_n



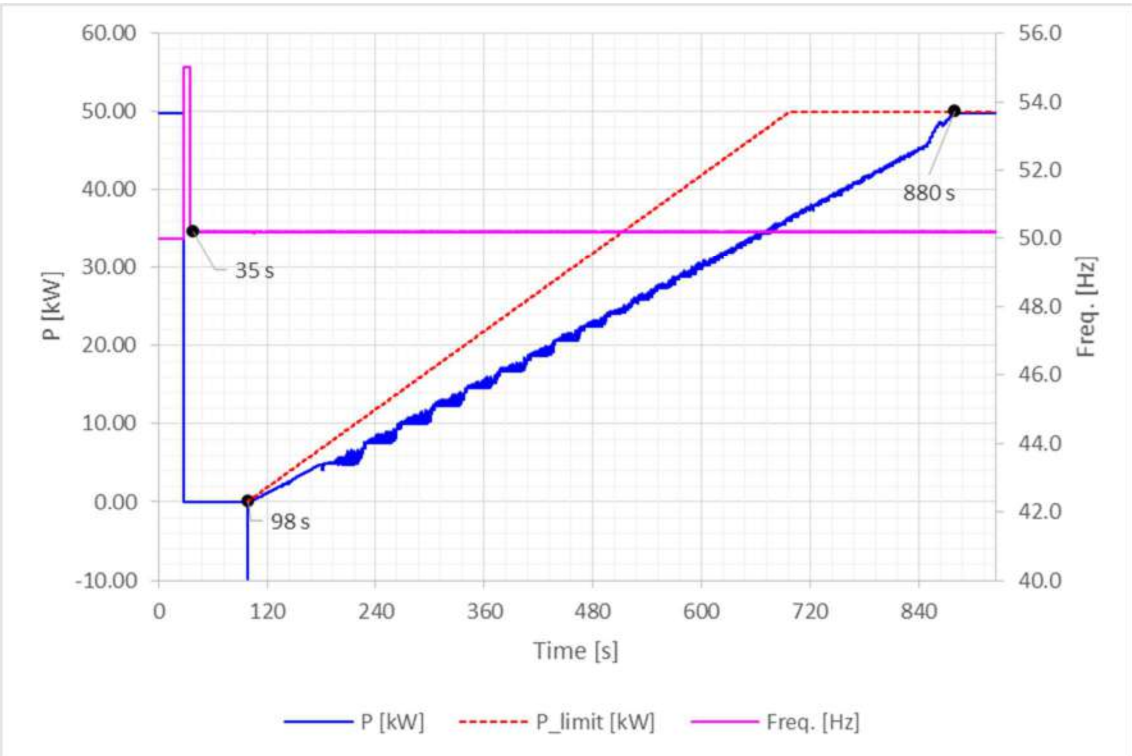
Graph of the gradual power supply : Test c) for ≤ 110% U_n



Graph of the gradual power supply : Test f) for ≥ 49,50Hz



Graph of the gradual power supply : Test f) for ≤ 50,15Hz



EN 50549-1:2019: Ceasing and reduction of active power on set point			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.11.1	Ceasing active power	CEI 0-21:2019-04, Annex A.4.3.3.2	**P**
4.11.2	Reduction of active power on a set point	FGW TG3, Revision 25, clause 4.1.2	**P**

4.11.1 Ceasing active power	P
Operating time of the monitoring device	
Test:	Remote tripping signal for the external disconnection
Limit [s]:	5 s
Reaction time of the tripping value [s]:	0,350 s

Note:

The test method refer to Annex A,4,3,2 of CEI 0-21:2019-04,
Generating plants shall be equipped with a logic interface (input port) in order to cease active power output within five seconds following an instruction being received at the input port, If required by the DSO, this includes remote operation.

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Graph of Remote trip signal :

4.11.2	Reduction of active power on set point		P

Test result: ASW50K-LT-G2

Setpoint power bin [%Pn]	P_{set} [kW]	P_{60} [kW]	Deviation [%Pn]
100%	50,00	49,593	-0,81
90%	45,00	45,631	1,26
80%	40,00	40,610	1,22
70%	35,00	35,551	1,10
60%	30,00	30,513	1,03
50%	25,00	25,422	0,84
40%	20,00	20,340	0,68
30%	15,00	15,253	0,51
20%	10,00	10,169	0,34
10%	5,00	5,070	0,14

	Setpoint power bin [%Pn]	Deviation [%Pn]
Max. deviation	90%	1,26
Limit $\Delta P_{E60}/P_{Setpoint}$:	+ 5 % of P_{Emax}	

Test:

The setpoint signal must be reduced from 100% to 0% Pn:

a) for adjustable PGUs in increments of 10% Pn, 1 minute must elapse after every change to the setpoint setting so that the PGU can settle at the new setpoint, Then the active power of the PGU must be measured as a 1-min mean value.

b) For all other PGUs, in line with their adjustable steps, 5 minutes must elapse after the setpoint setting is changed so that the PGU can settle at the new setpoint, Then the active power of the PGU must be measured as a 1-min mean value.

Assessment criterion:

a) for adjustable PGUs:

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

b) For all other PGUs:

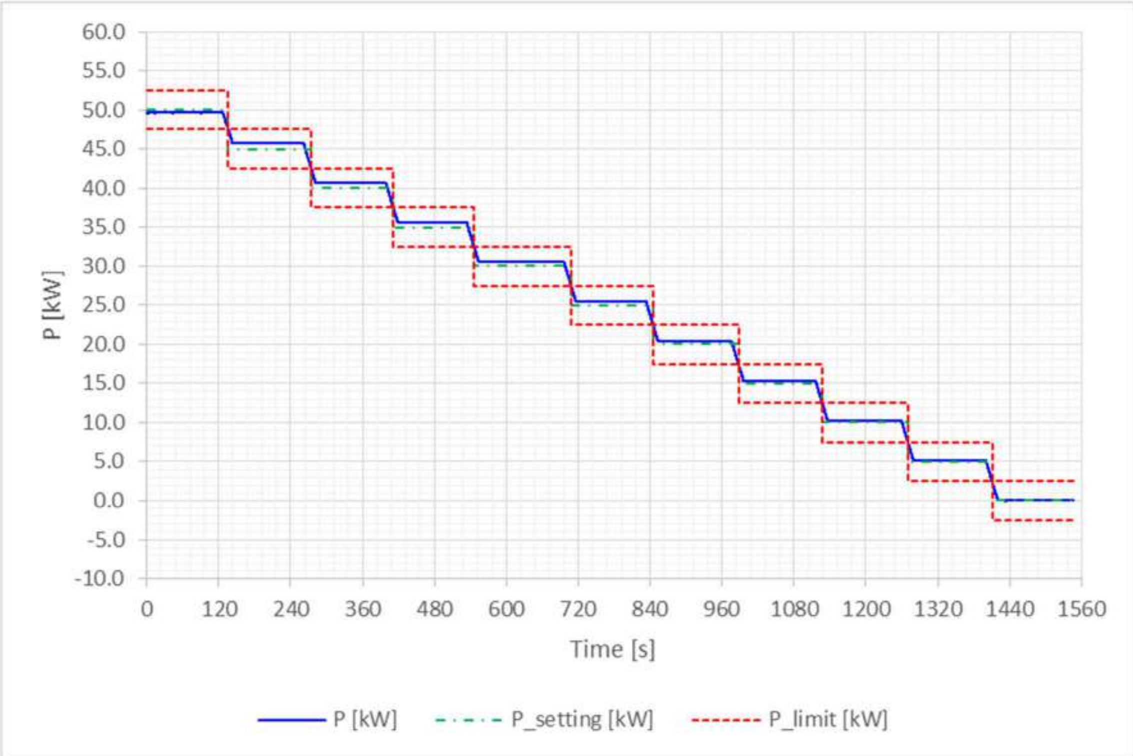
- the active power value does not exceed the setpoint by more than 5% P_{Emax} or
- the setpoint is fallen below within 5 minutes or the PGU has switched off

Note:

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

The tests had been performed on the ASW50K-LT-G2 are valid for the ASW30K-LT-G2, ASW33K-LT-G2, ASW36K-LT-G2, ASW40K-LT-G2 and ASW45K-LT-G2 since it is same as in hardware and just power derated by software.

Graph of active power on set point



EN 50549-1:2019			
Clause	**Test requirement**	**Test procedure according standard**	**Result**
4.13	Requirements regarding single fault tolerance of interface protection system and interface switch	VDE V 0124-100:2019-02 (Draft), clause 5.5.2	**P**

4.13	Requirements regarding single fault tolerance of interface protection system and interface switch							P
Component No.	Fault	Test condition		Test time	Fuse No,	Fault condition		Result
		AC	DC			AC	DC	
RY501 defect	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error code E03" Relay check Fail" No damage, No hazard.
RY502 defect	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error code E03" Relay check Fail" No damage, No hazard.
RY503 defect	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error code E03" Relay check Fail" No damage, No hazard.
RY504 defect	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error code E03" Relay check Fail" No damage, No hazard.
RY505 defect	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error code E03" Relay check Fail" No damage, No hazard.
RY506 defect	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error code E03" Relay check Fail" No damage, No hazard.
L1 grid voltage monitor R501 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 "grid voltage fault" No damage, no hazard.
L1 grid voltage monitor R503 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 "grid voltage fault" No damage, no hazard.
L1 grid voltage monitor R544 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 "grid voltage fault" No damage, no hazard.
L1 grid voltage monitor R543 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 "grid voltage fault" No damage, no hazard.

4.13	Requirements regarding single fault tolerance of interface protection system and interface switch							P
Component No.	Fault	Test condition		Test time	Fuse No,	Fault condition		Result
		AC	DC			AC	DC	
L2 grid voltage monitor R505 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L2 grid voltage monitor R508 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L2 grid voltage monitor R545 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L2 grid voltage monitor R547 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L3 grid voltage monitor R509 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L3 grid voltage monitor R512 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L3 grid voltage monitor R548 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
L3 grid voltage monitor R550 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error code E34 “grid voltage fault” No damage, no hazard.
PV voltage monitor R107 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV voltage monitor R106 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.

4.13	Requirements regarding single fault tolerance of interface protection system and interface switch							P
Component No.	Fault	Test condition		Test time	Fuse No,	Fault condition		Result
		AC	DC			AC	DC	
PV voltage monitor R102 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV voltage monitor R133 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV voltage monitor R137 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV voltage monitor R136 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV voltage monitor R128 defect	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV voltage monitor R130 defect	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error cord E36 “PV input voltage fault” No damage, no hazard.
PV array insulation resistance monitoring, Q114, C to E	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 ” PV array’s insulation” No damage, No hazard.
PV array insulation resistance monitoring, R364	Open before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 ” PV array’s insulation” No damage, No hazard.
PV array insulation Resistance monitoring, R365	Open before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 ” PV array’s insulation” No damage, No hazard.
PV array insulation resistance monitoring, R343	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 ” PV array’s insulation” No damage, No hazard.

4.13	Requirements regarding single fault tolerance of interface protection system and interface switch							P
Component No.	Fault	Test condition		Test time	Fuse No,	Fault condition		Result
		AC	DC			AC	DC	
PV array insulation resistance monitoring, R352	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 " PV array's insulation" No damage, No hazard.
PV array insulation resistance monitoring, R348	open before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 " PV array's insulation" No damage, No hazard.
PV array insulation resistance monitoring, RY101(Pin5.8)	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 " PV array's insulation" No damage, No hazard.
PV array insulation resistance monitoring, RY102(Pin3.4)	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 " PV array's insulation" No damage, No hazard.
PV array insulation resistance monitoring, C275	Short before start-up	230V 0,5A	850V 0,1A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord E38 " PV array's insulation" No damage, No hazard.
GFCI detect, Q501(Pin C-E)	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord 163 " GFCI Redundancy check" No damage, No hazard.
GFCI detect, R515	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord 163 " GFCI Redundancy check" No damage, No hazard.
GFCI detect, R515	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord 163 " GFCI Redundancy check" No damage, No hazard.
GFCI detect, C522	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord 163 " GFCI Redundancy check" No damage, No hazard.
GFCI detect, C522	Open	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord 163 " GFCI Redundancy check" No damage, No hazard.

4.13	Requirements regarding single fault tolerance of interface protection system and interface switch							P
Component No.	Fault	Test condition		Test time	Fuse No,	Fault condition		Result
		AC	DC			AC	DC	
GFCI detect, CT501 Pin5-6	Short	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter can not start-up. Error cord 163 " GFCI Redundancy check" No damage, No hazard.
Main CPU, U523	Short +3,3V power supply pin to GND	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error message "167 CPU self-test --RAM abnormal". No damage, No hazard.
Main CPU, U516	Short +1,2V power supply pin to GND	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error message "167 CPU self-test --RAM abnormal". No damage, No hazard.
Main CPU, U516	Oscillat orshort	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error message "167 CPU self-test --RAM abnormal". No damage, No hazard.
Communication between DSPs	open R962	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error message "167 CPU self-test --RAM abnormal". No damage, No hazard.
Slave CPU, U546	Short +3,3V power supply pin to GND	230V 59,4A	850V 52,0A	2min	--	230V 0,5A	850V 0,1A	PV inverter disconnected from grid immediately. Error message "167 CPU self-test --RAM abnormal". No damage, No hazard.
The errors in the control circuit simulate that the safety is even under one error ensured,								
Addendum – Shutdown device								
Each active phase can be switched, (L and N)								Yes
If no galvanic separation between AC and DC (PV): Two relays in series on each active phase are necessary to fulfil the basic insulation or simple separation based on the PV working voltage,								Two relays in series on each active phase
Note:								

Annex No. 1

Datasheet of the relay

G7EB

功率继电器

实现AC480V 100A开关的高温支持型大容量功率继电器

- 实现最大AC480V·100A的大容量开关
- 最高环境温度可达85℃
- 实现高耐冲击电压(线圈和接点之间)10kV
- 接点间隔3.6mm以上(符合VDE0126)
- 实现初始5mΩ以下的低接触电阻

符合RoHS

型号标准

G7EB-□ □ □

① ② ③

①接点极数
1: 1极

②接点构成
A: a接点

③端子形状
无标记：标准型
P1: 特殊端子型

用途示例

- 太阳能变频器
- 工业变频器
- UPS(不间断电源)

G7EB

种类

端子形状	接点构成	保护结构	型号	线圈额定电压(V)	最小包装单位
标准型	1a	耐助焊剂型	G7EB-1A	DC12 DC24	60个/箱
特殊端子型			G7EB-1AP1		

注. 订购时，请注明线圈额定电压(V)。

例：G7EB-1A DC12
└── 额定线圈电压

此外，交付时的包装标记及标注的电压规格为□□VDC。

额定值/性能

额定值

●操作线圈

项目	额定电流(mA)	线圈电阻(Ω)	动作电压(V)	复位电压(V)	最大容许电压(V)	功耗(mW)
			额定电压的百分比			
DC12	约235.3	51	75%以下*	5～32%	120% (23℃时)	约2,800 约575*
DC24	约116.5	206				

注1. 额定电流、线圈电阻的值指的是线圈温度为+23℃时的值，公差±10%。
注2. 动作特性指的是线圈温度为+23℃时的值。
注3. 最大许容电压指的是在环境温度为+23℃时继电器线圈操作电源的电压容许变化范围内的最大值。
* 使用保持电压时的线圈功耗约为575mW(保持电压45%时)。详情请参阅第4页的"●关于继电器动作后的线圈电压降低(保持电压)"。
* 部分安装方向不在保证范围内。详情请参阅第4页的"●安装方向性"。

●开关部(接点部)

项目	阻性负载
接点结构	双断开
接点材质	Ag合金
额定负载	AC480V 100A/AC800V 40A
额定通电电流	100A
接点电压的最大值	AC800V
接点电流最大值	100A

G7EB

功率继电器

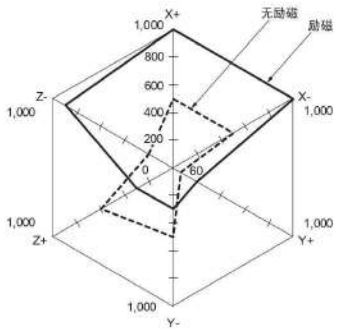
性能

项目		型号 G7EB-1A、G7EB-1AP1
接触电阻 *1		5mΩ以下
动作时间 *2		30ms以下
复位时间 *2		10ms以下
绝缘电阻 *3		1,000MΩ以上
耐电压	线圈和接点间	AC5,000V 50/60Hz 1min
	同极接点间	AC2,000V 50/60Hz 1min
耐冲击电压		线圈和接点间 10kV(1.2×50μs)
振动	耐久	10～55～10Hz 单振幅0.75mm(双振幅1.5mm)
	误动作	励磁： 10～55～10Hz 单振幅0.75mm(双振幅1.5mm) 无励磁：10～55～10Hz 单振幅0.15mm(双振幅0.3mm)
冲击	耐久	1,000m/s²
	误动作	励磁： 100m/s² 无励磁：50m/s²
耐久性	机械	100万次以上(开关频率10,800次/h)
	电气(阻性负载) *4	①AC480V 100A 300次 85℃ ②AC800V 40A 冲击、通电100A、断路40A 30,000次 85℃ (开关频率1秒ON-9秒OFF)
故障率P水准(参考值) *5		DC5V 1A
使用条件	线圈保持电压 *6	线圈额定电压的45～65%
	使用环境温度	-40℃～85℃(不结冰、凝露)
	使用环境湿度	5～85%RH
重量		约100g

G7EB

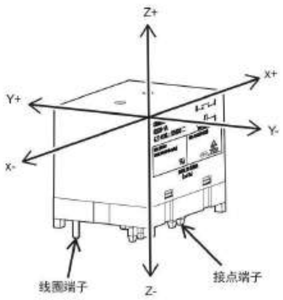
注. 上述值为23℃的初始值。(电气耐久性除外)
*1. 测量条件：DC6V 20A 电压下降法。
*2. 测量条件：外加额定操作电压时不包括接点跳动。
*3. 测量条件：用DC1000V 绝缘电阻计测量与耐电压项目中相同的部位。
*4. 使用二极管与齐纳二极管时。请将二极管和齐纳二极管接至继电器线圈。
详情请参阅4页的"关于操作线圈与二极管连接"。
*5. 此值为开关频率180次/min时的值。
*6. 使用保持电压的详情请参阅第4页的"●关于继电器动作后的线圈电压降低(保持电压)"。

误动作冲击



测量： 往3轴6个方向各加3次冲击，测定接点产生误动作的值。
但是，励磁电压须在保持电压额定值范围内。
规格值： 励磁 100m/s²
无励磁 50m/s²

冲击方向



G7EB

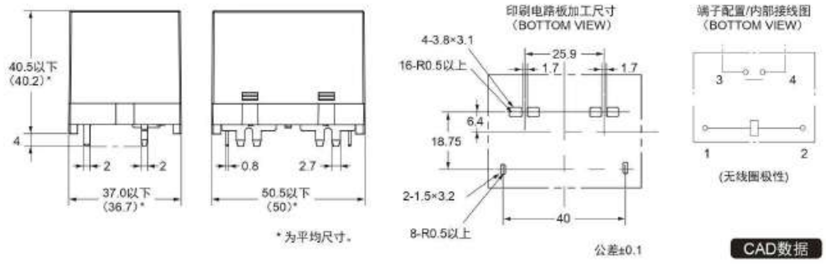
功率继电器

外形尺寸

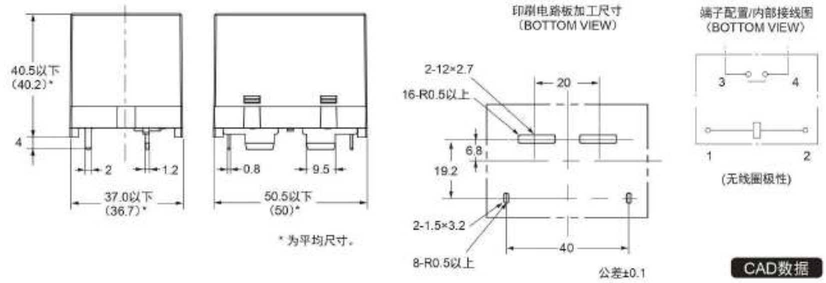
CAD数据 标记的商品备有2维CAD图、3维CAD模型的数据。
CAD数据可从网站 https://www.ecb.omron.com.cn下载。

(单位：mm)

标准型 G7EB-1A



特殊端子型 G7EB-1AP1



国际标准认证额定值

国际标准认证的额定值与个别指定的性能值不同，请仔细确认后再使用。

UL标准认证型号：(文件No.E41515)

型号	接点构成	操作线圈额定值	接点额定值	认证开关次数
G7EB-1A G7EB-1AP1	1a	12、24V DC	800VAC 100A通电、55A 断路85℃	6,000次

EN/IEC、TÜV标准认证型号 (批准No. R50416743)

型号	接点构成	操作线圈额定值	接点额定值	认证开关次数
G7EB-1A G7EB-1AP1	1a	12、24V DC	800VAC 100A (Resistive)	200次

CQC标准认证型号 (批准No. CQC18002207225)

型号	接点构成	操作线圈额定值	接点额定值	认证开关次数
G7EB-1A G7EB-1AP1	1a	12、24V DC	800VAC 100A (Resistive)	200次

G7EB

G7EB

功率继电器

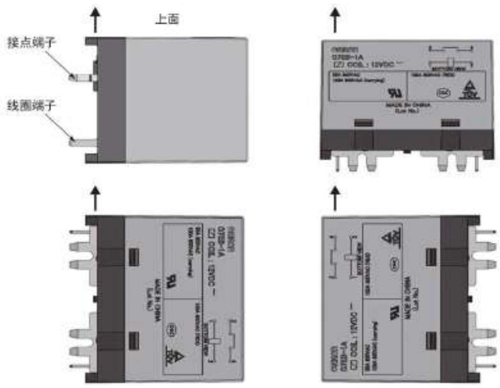
请正确使用

●有关如何正确使用，请参见“印刷基板用继电器共通注意事项”部分。

使用注意事项

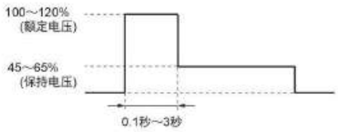
●安装方向性

• 根据动作特性和电气耐久性能，本继电器的安装方向有一定限制。
请勿在非下图指定的方向安装使用。
非指定的安装可能会导致动作不良和非预期老化引起的烧损。



●关于继电器动作后的线圈电压降低(保持电压)

• 该继电器请务必在保持电压下使用。
• 请如下图所示，首先对线圈施加额定电压0.1秒～3秒。
• 请将线圈的额定电压设定为额定电压的 100 ～ 120%、保持电压设定为额定电压的45～65%，避免因线圈电压变动等而超出上述范围。

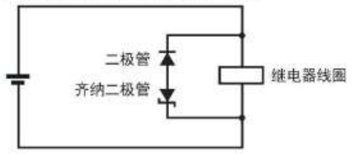


	线圈施加电压	线圈电阻*	线圈功耗
额定电压	100～120%	51Ω	约2.8～4.0W
保持电压	45～65%		约0.57～1.2W

* 线圈电阻值指的是线圈温度为+23℃时的值，公差±10%。

●关于操作线圈与二极管连接

• 请将二极管及齐纳二极管(或可变电阻)接至继电器线圈(见下图)。二极管为线圈浪涌吸收用。仅使用二极管可能会影响开关性能，因此请与齐纳二极管组合使用。
• 线圈无极性，因此安装二极管时，请使其极性与线圈的施加电压相反。
• 齐纳二极管的推荐齐纳电压是线圈额定电压的3倍。
• 二极管的反向耐压为线圈额定电压的 10 倍以上，因此请使用正向电流超过线圈额定电流的二极管。



●关于印刷基板端子的焊接

• 请使用焊接槽在290℃下、 20秒内完成焊接。
• 并非密封结构，因此继电器不可整体清洗。

●关于安装

• 应尽可能选择在干燥且尘埃、有毒气体较少的场所进行安装。
• 高温多湿和有毒气体环境中，会因结露和腐蚀生成物的影响，导致性能劣化。从而导致继电器主体故障与烧损。
• 产品的重量约为100g。请充分注意印刷基板的强度。
并且为了减少热应力导致的焊接裂缝，请使用双面通孔印刷基板。

●关于坠落

• 本继电器发生坠落时，请勿使用。

●关于电气耐久性

• 本继电器为交流高压规格，在超出记载的接点额定值、电气耐久性规格范围的状态下持续使用时，可能会导致异常发热、起火。
请勿在超出记载范围的条件下使用或用于非交流高压的用途。
• 本产品的电气耐久性是在本公司规定的标准试验状态下使用阻性负载时的负载开关次数。
根据线圈驱动电路、周围环境、开关频率、负载条件(在感性负载和电容负载下使用)，也可能会发生寿命降低、断路不良，请务必在实际设备上进行确认。

●关于微小负载开关

• 本继电器为功率继电器，适用于交流高压的开关用途。请勿用于信号用途等微小负载开关。

G7EB

订购前请务必阅读我司网站上的“注意事项”。

欧姆龙电子部品 (中国) 统辖集团

网站
欧姆龙电子部件贸易 (上海) 有限公司

https://www.ecb.omron.com.cn

Cat. No. J236-CN5-02 2019年12月

Annex No. 2

Pictures of the unit

Photo of EUT
Enclosure front view

Enclosure side view


Photo of EUT
Enclosure side view

Enclosure side view


Photo of EUT
Enclosure bottom view

Enclosure rear view

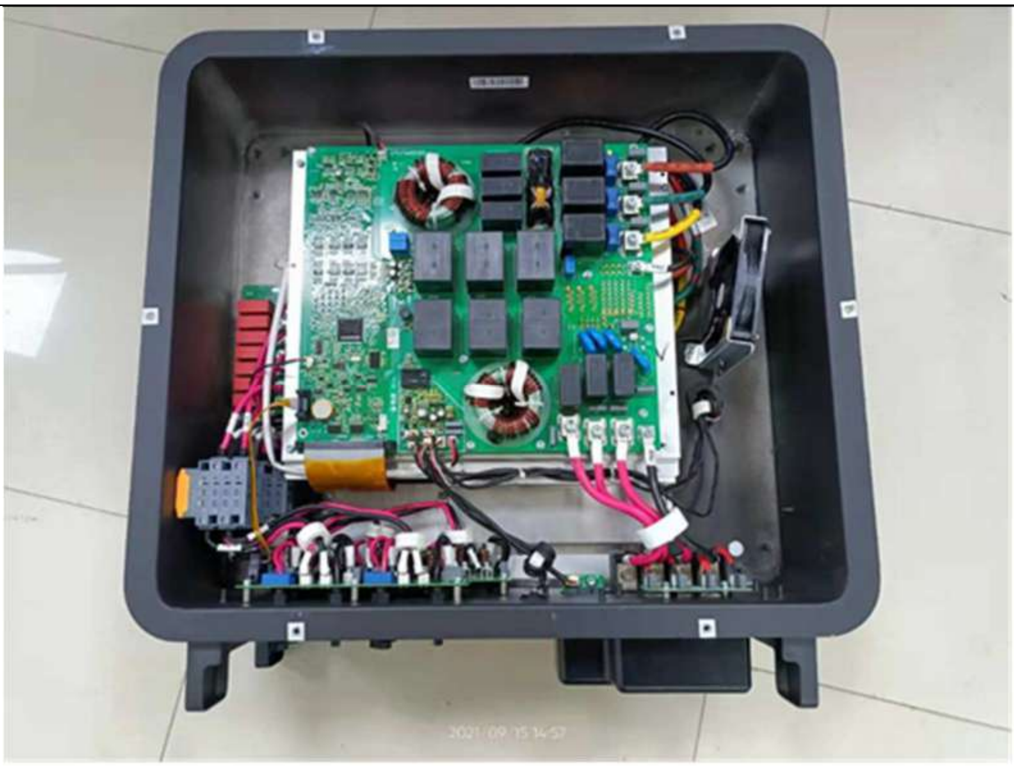

Photo of EUT
Internal view - 1

Internal view - 2

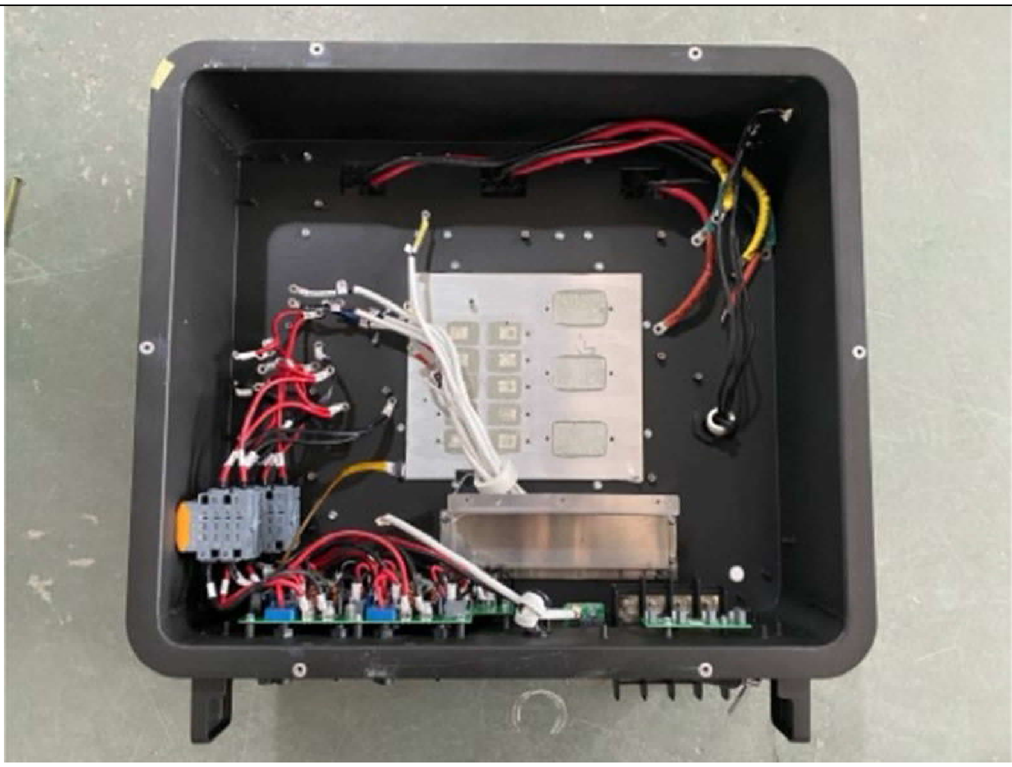
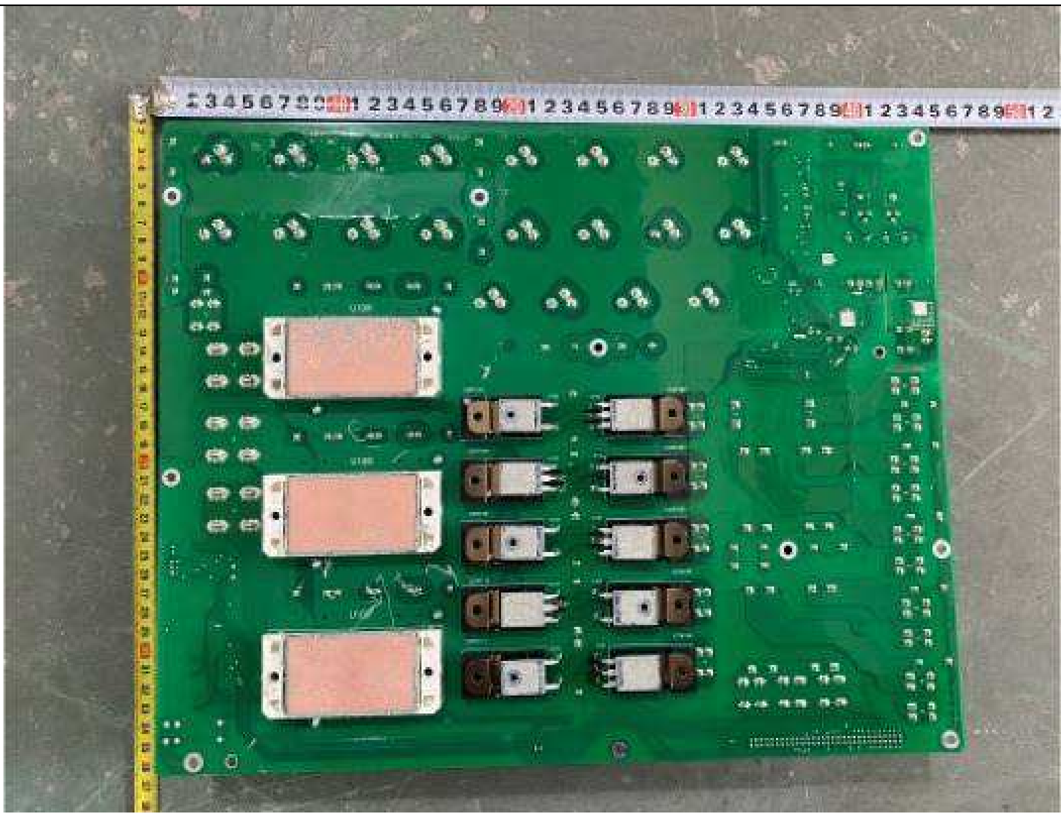

Photo of EUT
Internal view - 3

PCB view - 1


Photo of EUT

PCB view – 2



PCB view – 3

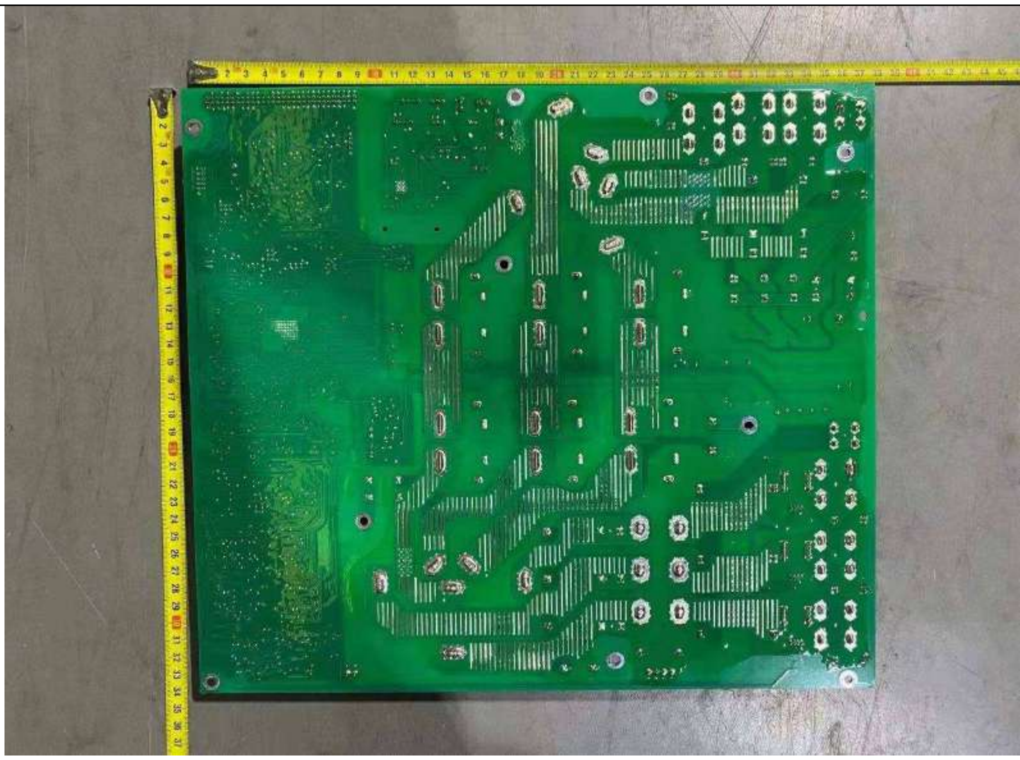
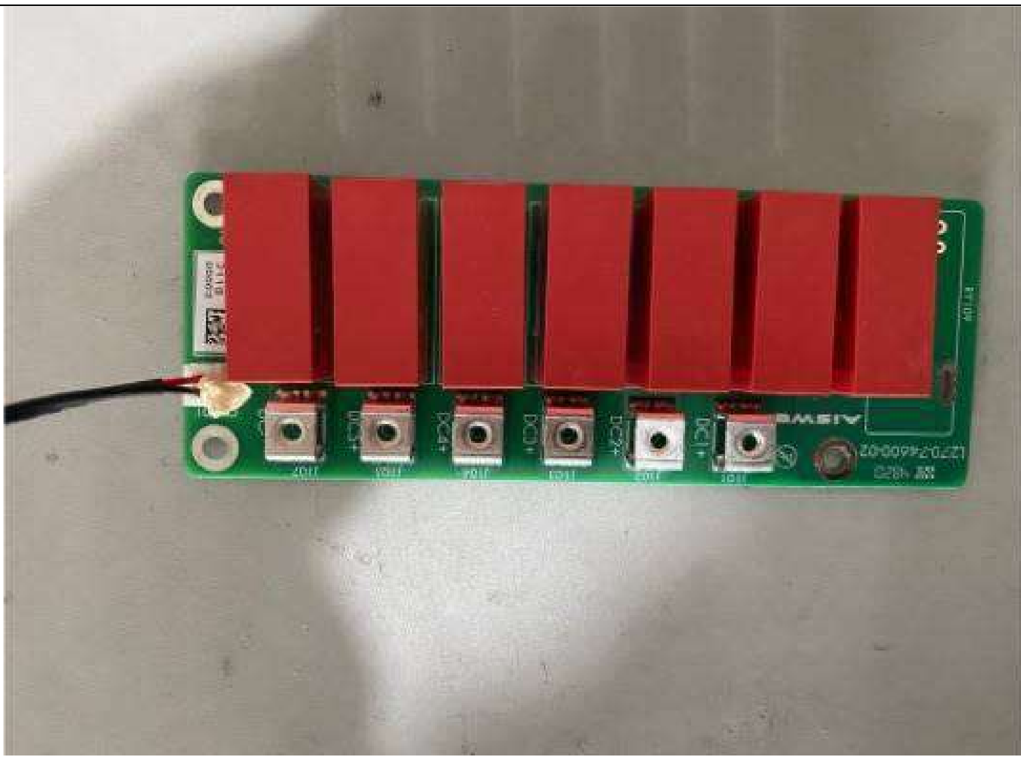
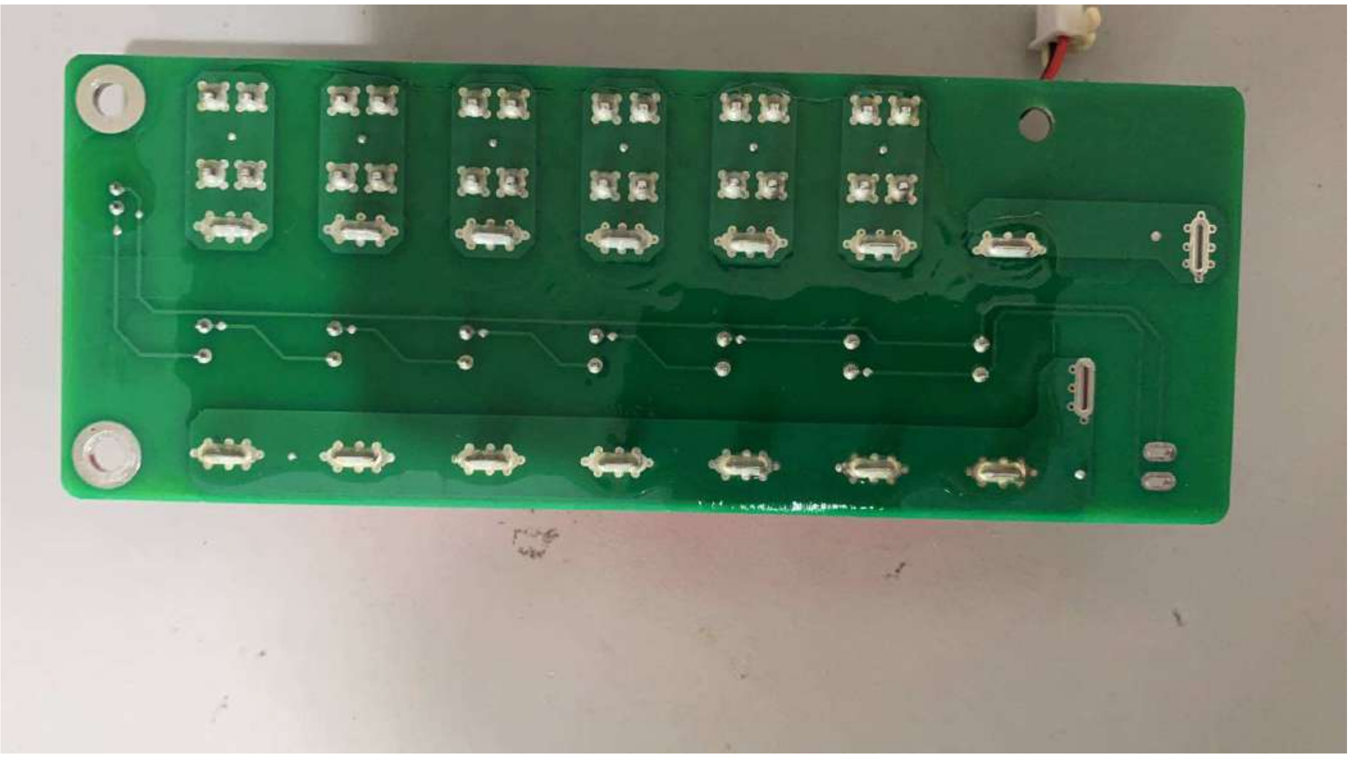
Photo of EUT
PCB view – 2

PCB view – 5


Photo of EUT
PCB view – 6



Annex No. 3

Test Equipment list

Date(s) of performance test: 2021-07-29 to 2021-09-12

Equipment	Internal No,	Manufacturer	Type	Serial No,	Calibration is valid to
ScopeCorder	ZSCG30466	YOKOGAWA	DL850E	//	June, 07, 2022
Power analyzer	C3RB17008E	YOKOGAWA	WT1800	//	June, 09, 2022
AC Source	SCGJ110	CHROMA	61512	//	Monitored by Power analyzer
DC Simulation Power supply	62150EF01657	CHROMA	62150H-1000S	//	
	ESCGJ770	CHROMA	62180H-1800S	//	
	ESCGJ771	CHROMA	62180H-1800S	//	
	ESCGJ772	CHROMA	62180H-1800S	//	
	ESCGJ773	CHROMA	62180H-1800S	//	
	ESCGJ774	CHROMA	62180H-1800S	//	
AC/DC Current probel	SCGJ347	Tektronix	A622	//	June, 07, 2022
Temp. & Humi. Recorder	2	//	HTC-1	//	2022-06-21
Power analyzer	SCGJ025	YOKOGAWA	WT3000	//	June, 09, 2022

End of Test Report