Сертификат за съответствие

Заявител: **KACO new energy GmbH**
Carl-Zeiss-Straße 1
74172 Neckarsulm
Германия

Продукт: **Автоматичен изключвател между генератор и обществената електроразпределителна мрежа за ниско напрежение**

Модел:
Powador 60.0 TL3 – M – INT
Powador 60.0 TL3 – XL – INT
Powador 60.0 TL3 – XL – INT – SPD 1+2
Powador 60.0 TL3 – XL – F – INT
Powador 60.0 TL3 – XL – F – SPD 1+2
Powador 72.0 TL3 – M – INT – Park
Powador 72.0 TL3 – XL – INT – Park
Powador 72.0 TL3 – XL – INT – SPD 1+2
Powador 72.0 TL3 – XL – F – INT – Park
Powador 72.0 TL3 – XL – F – SPD 1+2 – Park

Експлоатация в съответствие с нормативните актове:

Автоматичен изключвател с наблюдение на трифазна мрежа в съответствие с EN 50438:2013, БДС EN 50438:2013, DIN V VDE V 0126-1-1:2006-02, DIN V VDE V 0126-1-1/A1:2012-02 за фотоволтаични системи с трифазно паралелно свързване посредством инвертор в обществената електроразпределителна мрежа. Автоматичният изключвател е неразделна част от гореупоменатия инвертор. Същото служи за заместител на изключвателя с изолираща функция, до което операторът на електроразпределителната мрежа може да има достъп по всяко време.

Приложими правила и стандарти:

EN 50438:2013, БДС EN 50438:2013
Изисквания за свързване на микро-генератори в паралел с националната разпределителна мрежа за ниско напрежение

DIN V VDE V 0126-1-1 (VDE V 0126-1-1):2006-02
Автоматичен изключвател между генератор и обществената електроразпределителна мрежа за ниско напрежение

Концепцията за безопасност на гореупоменатия представителен продукт отговаря, към момента на издаване на този сертификат, на валидните показатели за безопасност за посоченото приложение в съответствие с нормативните актове.

Номер на протокола: **12TH0351-EN50438; 12TH0351-VDE0126**
Номер на сертификата: **U16-0310**
Дата на издаване: **2016-06-13**

Институт за Сертификация

Dieter Zitzmann

DAkkS Deutsche Akkreditierungsstelle D-ZE-12024-01-00

Институт за Сертификация Bureau Veritas Consumer Products Services Germany GmbH
Акредитирана в съответствие с DIN EN ISO/IEC 17065

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Type Approval and declaration of compliance with the requirements of EN 50438.	
Manufacturer / applicant:	**KACO new energy GmbH** Carl-Zeiss-Straße 1 74172 Neckarsulm **Germany**
Micro-generator Type	**Grid-tied photovoltaic inverter**
Rated values	**Powador 60.0 TL3 – M – INT** **Powador 60.0 TL3 – XL – INT** **Powador 60.0 TL3 – XL – INT – SPD 1+2** **Powador 60.0 TL3 – XL – F – INT** **Powador 60.0 TL3 – XL – F – SPD 1+2** **Powador 72.0 TL3 – M – INT – Park** **Powador 72.0 TL3 – XL – INT – Park** **Powador 72.0 TL3 – XL – INT – SPD 1+2** **Powador 72.0 TL3 – XL – F – INT – Park** **Powador 72.0 TL3 – XL – F – SPD 1+2 – Park**
Maximum rated capacity	**Powador 60.0 TL3 : 50 kW** **Powador 72.0 TL3: 60 kW**
Rated voltage	400 V_{AC} (P-P) / 230 V_{AC} (3/PEN), 50 Hz
Firmware version	PKT: v. 3.25 ARM: v. 3.78.2780 Rev. 10240 CFG: v. 5.1700 DSP-AC: v. 2.18 4CBA Rev. 3574 DSP-DC:v. 2.04 7740 Rev. 785
Measurement period:	2016-05-04 to 2016-06-01

Description of the structure of the power generation unit (Figure 1):

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 (transformer-less). The output is switched off redundant by the high power switching bridge and two relays in series. This assures that the opening of the output circuit will also operate in case of one error.

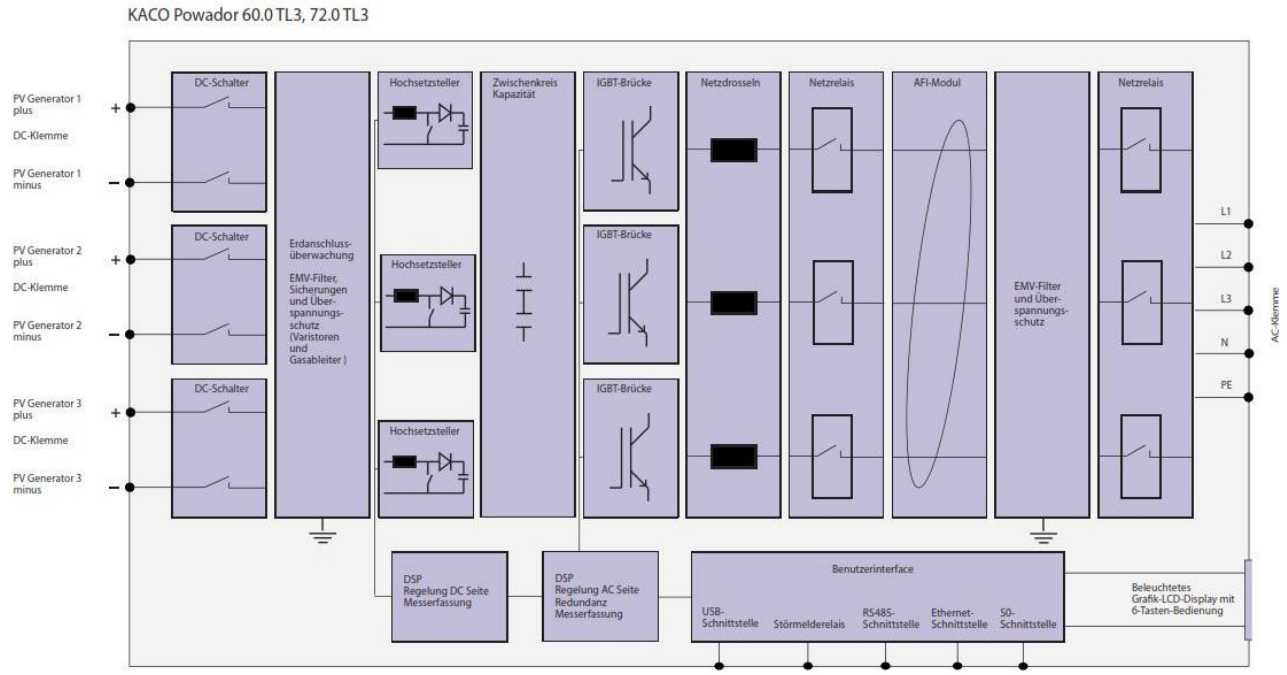


Figure 1 – Schematic structure of the power generation unit

The above stated micro-generators are tested according to the requirements in the EN 50438. Any modification that affects the stated tests must be named by the manufacturer/supplier of the product to ensure that the product meets all requirements of the EN 50438.

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Type testing of the interface protection

Powador 60.0

Over-/under-voltage tests

Phase1						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Voltage [V]	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**
Over-voltage stage 1	253,0	600*	253,0	600*	253,0	541*
Over-voltage stage 2	264,5	0,2	264,5	0,2	263,4	193
Under-voltage stage 1	195,5	1,5	195,5	1,5	196,2	1500
Phase2						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Voltage [V]	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**
Over-voltage stage 1	253,0	600*	253,0	600*	253,0	541*
Over-voltage stage 2	264,5	0,2	264,5	0,2	263,4	196
Under-voltage stage 1	195,5	1,5	195,5	1,5	196,2	1500
Phase3						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Voltage [V]	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**
Over-voltage stage 1	253,0	600*	253,0	600*	253,0	541*
Over-voltage stage 2	264,5	0,2	264,5	0,2	263,4	193
Under-voltage stage 1	195,5	1,5	195,5	1,5	196,2	1490

Note.
Minimum operation time according to default interface protection:
Over-voltage stage 1 -
Over-voltage stage 2 0,1s
Under-voltage 1,2s

*over-voltage-stage 1: 10 min-mean-value corresponding to EN 50160. The disconnection after a 10min mean value is detected takes place within 200ms.

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Type testing of the interface protection

Powador 72.0

Over-/under-voltage tests

Phase1						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Voltage [V]	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**
Over-voltage stage 1	304,70	600*	305	600*	304,8	541*
Over-voltage stage 2	318,55	0,2	318	0,2	318,6	195
Under-voltage stage 1	235,45	1,5	235	1,5	235,5	1499

Phase2						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Voltage [V]	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**
Over-voltage stage 1	304,70	600*	305	600*	304,7	541*
Over-voltage stage 2	318,55	0,2	318	0,2	318,6	199
Under-voltage stage 1	235,45	1,5	235	1,5	235,5	1500

Phase3						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Voltage [V]	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**	**Voltage [V]**	**Disconnection time [s]**
Over-voltage stage 1	304,70	600*	305	600*	304,7	541*
Over-voltage stage 2	318,55	0,2	318	0,2	318,6	191
Under-voltage stage 1	235,45	1,5	235	1,5	235,5	1500

Note.
Minimum operation time according to default interface protection:
Over-voltage stage 1 -
Over-voltage stage 2 0,1s
Under-voltage 1,2s

*over-voltage-stage 1: 10 min-mean-value corresponding to EN 50160. The disconnection after a 10min mean value is detected takes place within 200ms.

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Over-/under-frequency tests						
Parameter	**Protection limit**		**Actual setting**		**Trip value (test result)**	
	Frequency [Hz]	**Disconnection time [s]**	**Frequency [Hz]**	**Disconnection time [s]**	**Frequency [Hz]**	**Disconnection time [s]**
Over-frequency	52,00	0,5	52,00	0,5	52,01	0,49
Under-frequency	47,50	0,5	47,50	0,5	47,50	0,5

Note.
Minimum operation time according to default interface protection:
Over-frequency 0,5 s
Under-frequency 0,5 s

LoM test						
Method used	**EN 62116**					
Balancing load on islanded network	**33% of -5% Q Test 22**	**66% of -5% Q Test 12**	**100% of -5% P Test 5**	**33% of +5% Q Test 31**	**66% of +5% Q Test 21**	**100% of +5% P Test 10**
Trip time [ms]	132	138	204	193	169	159

Indicate additional shut down time included in above results. (Integrated interface switch)	Type of switching equipment 1: Relay with 30ms Type of switching equipment 2: Relay with 30ms

Appendix E Type Verification Test Report	
Extract from test report according to EN 50438	**Nr. 12TH0351**

Type testing of a micro-generator				
Operating range				
Test 1: U = 195,5 V; f = 47,5 Hz; P = 1,00 Sn; cosφ = 1 **Test 2: U = 253,0 V; f = 51,5 Hz; P = 1,00 Sn; cosφ = 1**				
Test sequence	**Voltage [V]**	**Frequency [Hz]**	**Output power [kW]**	**Cos φ [1]**
Powador 60.0				
1	195,5	47,50	42,90	0,999
2	253,0	51,50	49,95	0,999

Active power at under-frequency			
5-min mean value (each)	**a) 50 ± 0,01 [Hz]**	**b) - 0,4 to – 0,5 [Hz]**	**c) - 2,4 to - 2,5 [Hz]**
Frequency [Hz]:	49,99	49,59	47,59
Active power [kW]:	49,9	49,9	49,6
ΔP/PM [%] per 1 Hz:			0

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power response to over-frequency							
Powador 60.0							
1-min mean value [Hz]:	**a) 50,00**	**b) 50,25**	**c) 50,70**	**d) 51,15**	**e) 50,70**	**f) 50,25**	**g) 50,00**
1. Measurement a) to g): Active power output > 80% Pn							
Frequency [Hz]:	50,09	50,24	50,69	51,13	50,69	50,24	49,98
PM [kW]:	N/A	48,95	40,05	31,16	40,05	48,95	N/A
PE60 [kW]:	49,70	49,27	40,46	31,55	40,12	49,02	49,25
∆PE60/PM [%]:	N/A	0,64	0,82	0,78	0,15	0,14	N/A
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% Pn							
Frequency [Hz]:	50,09	50,24	50,69	51,13	50,69	50,24	49,98
PM [kW]:	N/A	24,74	20,24	15,75	20,24	24,74	N/A
PE60 [kW]:	25,12	24,98	20,41	15,93	20,25	24,74	27,05
∆PE60/PM [%]:	N/A	0,48	0,33	0,36	0,03	0,00	N/A
Limit ΔP/P1min:	+ 10 % of P_M						

Power response to over-frequency							
Powador 72.0							
1-min mean value [Hz]:	**a) 50,00**	**b) 50,25**	**c) 50,70**	**d) 51,15**	**e) 50,70**	**f) 50,25**	**g) 50,00**
1. Measurement a) to g): Active power output > 80% Pn							
Frequency [Hz]:	50,11	50,25	50,70	51,15	50,70	50,25	50,00
PM [kW]:	N/A	58,88	48,02	37,29	48,02	58,88	N/A
PE60 [kW]:	60,02	59,33	48,53	37,72	48,13	59,06	58,92
∆PE60/PM [%]:	N/A	0,75	0,84	0,71	0,18	0,30	N/A
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% Pn							
Frequency [Hz]:	50,11	50,25	50,70	51,15	50,70	50,25	50,00
PM [kW]:	N/A	29,35	23,94	18,59	23,94	29,35	N/A
PE60 [kW]:	29,92	29,50	24,40	18,83	24,04	29,51	31,75
∆PE60/PM [%]:	N/A	0,24	0,76	0,40	0,17	0,27	N/A
Limit ΔP/P1min:	+ 10 % of P_M						

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Reactive power			
Uncontrollable reactive power			
Powador 60.0			
Test Voltage / Output power	**211,6V**	**230V**	**248,4V**
25% PN	0,999	0,999	0,998
50% PN	0,999	0,999	0,999
75% PN	0,999	0,999	0,999
100% PN	0,999	0,999	0,999
Limit	**>0,95**	**>0,95**	**>0,95**

Reactive power			
Uncontrollable reactive power			
Powador 72.0			
Test Voltage / Output power	**254,8V**	**277V**	**299,2V**
25% PN	0,999	0,999	0,998
50% PN	0,999	0,999	0,999
75% PN	0,999	0,999	0,999
100% PN	0,999	0,999	0,999
Limit	**>0,95**	**>0,95**	**>0,95**

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Controllable reactive power

Powador 60.0

Inductive (supply reactive power)

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2478	22022	0,110	2981
10% - 20%	6925	21955	0,300	7430
20% - 30%	11371	21888	0,460	11908
30% - 40%	15736	21809	0,580	16337
40% - 50%	20070	21829	0,680	20758
50% - 60%	24455	21752	0,750	25230
60% - 70%	29249	21670	0,800	30150
70% - 80%	33603	21696	0,840	34627
80% - 90%	38336	21773	0,870	39517
90% - 100%	42632	21712	0,890	43956

Capacitive (supply reactive power)

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2479	-21812	-0,110	2988
10% - 20%	6911	-21855	-0,300	7433
20% - 30%	11334	-21868	-0,460	11894
30% - 40%	15729	-21856	-0,580	16341
40% - 50%	20094	-21866	-0,680	20782
50% - 60%	24438	-21828	-0,750	25221
60% - 70%	29249	-21844	-0,800	30167
70% - 80%	33570	-21817	-0,840	34619
80% - 90%	38367	-21839	-0,870	39564
90% - 100%	42629	-21871	-0,890	43981

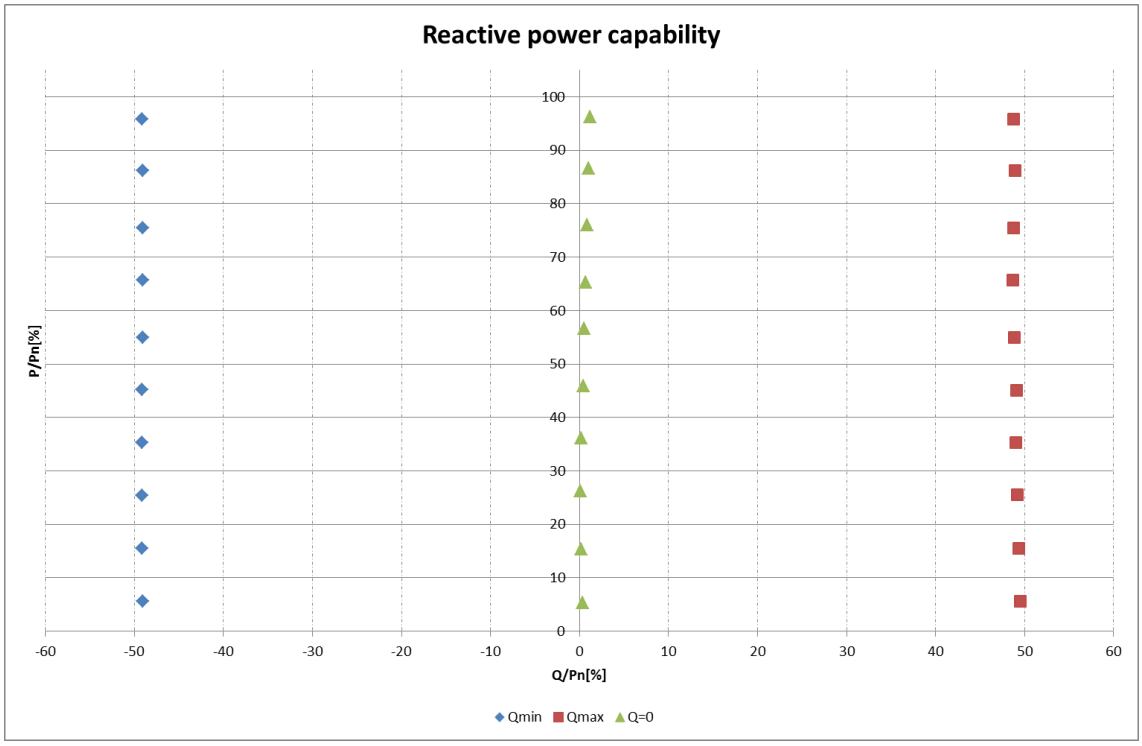
Reactive power supply with set point Q=0

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2393	141	0,99	2487
10% - 20%	6849	100	1	6989
20% - 30%	11691	54	1	11918
30% - 40%	16051	96	1	16367
40% - 50%	20418	178	1	20846
50% - 60%	25190	249	1	25733
60% - 70%	29046	305	1	29704
70% - 80%	33831	387	1	34646
80% - 90%	38563	469	1	39559
90% - 100%	42831	533	1	43984

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Diagram of inductive reactive power absorption



Q adjustment				
	Reactive power set point Q [kVar]	Measured reactive power Q [kVar]	Measured cos φ	Deviation compared to setpoint ΔQ / PN [%]
- Qmin	-48.43	-48,52	0,7174	-0,09%
0	0	0,47	1,00	0,47%
+ Qmax	+48,43	48,52	0,7182	0,09%

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Controllable reactive power

Powador 72.0

Inductive (supply reactive power)

Power-BIN	Active power [kW]	Reactive power [kVar]	Power factor (cos φ)	DC power [kW]
0% - 10%	2,94	-59,9	-0,049	4,5
10% - 20%	6,06	-59,6	-0,101	7,1
20% - 30%	13,20	-57,7	-0,223	14,7
30% - 40%	18,60	-56,6	-0,312	20,0
40% - 50%	24,60	-54,1	-0,414	26,0
50% - 60%	31,20	-50,8	-0,523	32,7
60% - 70%	36,60	-47,3	-0,612	38,1
70% - 80%	42,60	-42,5	-0,708	44,1
80% - 90%	48,60	-35,1	-0,811	50,1
90% - 100%	54,60	-25,2	-0,908	55,7

Capacitive (supply reactive power)

Power-BIN	Active power [kW]	Reactive power [kVar]	Power factor (cos φ)	DC power [kW]
0% - 10%	3,00	59,9	0,050	5,0
10% - 20%	6,30	59,7	0,105	7,8
20% - 30%	12,00	59,8	0,197	13,4
30% - 40%	18,00	57,8	0,297	19,4
40% - 50%	24,00	55,6	0,396	25,4
50% - 60%	30,00	52,4	0,497	31,4
60% - 70%	36,00	48,8	0,594	37,5
70% - 80%	42,00	43,4	0,695	43,5
80% - 90%	48,00	36,8	0,793	49,5
90% - 100%	54,00	27,1	0,894	55,5

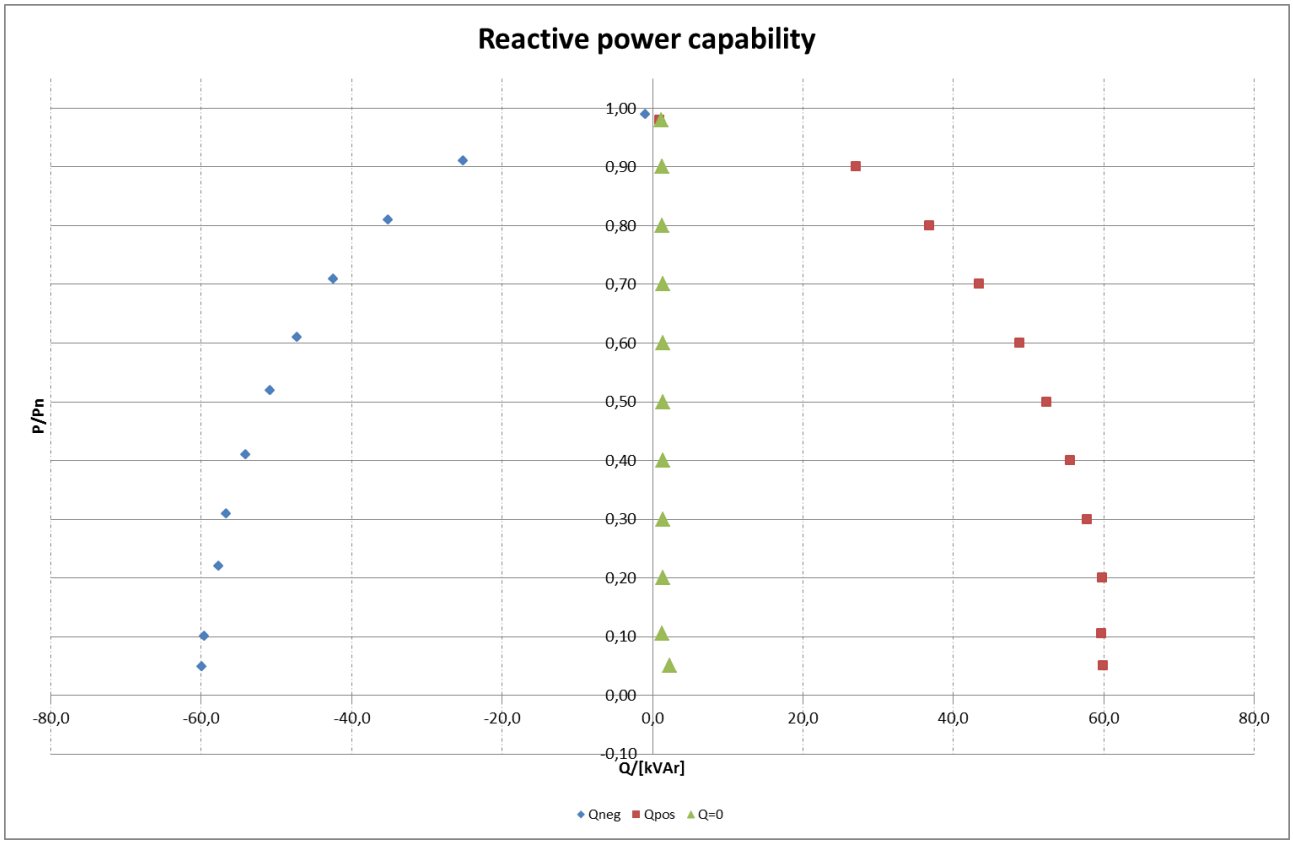
Reactive power supply with set point Q=0

Power-BIN	Active power [kW]	Reactive power [kVar]	Power factor (cos φ)	DC power [kW]
0% - 10%	3,06	2,3	0,798	4,7
10% - 20%	6,43	1,3	0,981	7,6
20% - 30%	12,24	1,4	0,994	13,7
30% - 40%	18,36	1,4	0,997	19,8
40% - 50%	24,48	1,4	0,998	25,9
50% - 60%	30,60	1,4	0,999	32,1
60% - 70%	36,72	1,4	0,999	38,2
70% - 80%	42,84	1,4	1,000	44,3
80% - 90%	48,96	1,3	1,000	50,5
90% - 100%	55,08	1,3	1,000	56,2

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Diagram of inductive reactive power absorption



Appendix E Type Verification Test Report	
Extract from test report according to EN 50438	**Nr. 12TH0351**

Connection and starting to generate electrical power		
	Voltage conditions	
a) Start up for voltage range	**<84% Un for twice of observation time**	**>111% Un for twice of observation time**
Connection:	no connection	no connection
Limit:	No connection allowed	
b) In voltage range at start-up	**≥84% Un within twice setting observation time**	**≤111% Un within twice setting observation time**
Reconnection time [s]	78	89
Limit:	Connected 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%Pn/min. For recorded gradient see diagram below.	
c) In voltage range after voltage failure	**≥84% Un for twice of setting observation time**	**≤111% Un for twice of setting observation time**
Reconnection time [s]	81	91
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%Pn/min. For recorded gradient see diagram below.	
	Frequency conditions	
d) Start up for frequency range	**<47,45 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	**≥47,45 Hz within twice of setting observation time**	**≤51,15 Hz within twice of setting observation time**
Reconnection time [s]	89	84
Limit:	Connected after setting delay 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%Pn/min. For recorded gradient see diagram below.	
f) In frequency range after frequency failure	**≥47,45 Hz for twice of setting observation time**	**≤51,15 Hz for twice of setting observation time**
Reconnection time [s]	91	84
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%Pn/min. For recorded gradient see diagram below.	

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Short-circuit current contribution					
Short-circuit current parameters					
For a directly coupled micro-generator			**For a Inverter micro-generator**		
Parameter	**Symbol**	**Value**	**Time after fault**	**Volts**	**Amps**
Peak Short Circuit current	I_p	N/A	20ms	46,9	94,6
Initial Value of aperiodic current	A	N/A	100ms	47,0	96,8
Initial symmetrical short-circuit current*	I_k	N/A	250ms	47,2	96,7
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	47,1	96,4
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to trip**	0,555	In seconds

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power Quality. Harmonic current emission

EUT		KACO Powador 60.0			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	72,486	100,000	Phase 1	-	-
2nd	0,496	0,685	Phase 1	8	8
3rd	0,171	0,236	Phase 1	21,6	N/A
4th	0,126	0,174	Phase 1	4	4
5th	0,437	0,603	Phase 1	10,7	10,7
6th	0,064	0,088	Phase 1	2,67	2,67
7th	0,264	0,365	Phase 1	7,2	7,2
8th	0,055	0,076	Phase 1	2	2
9th	0,046	0,063	Phase 1	3,8	N/A
10th	0,042	0,058	Phase 1	1,6	1,6
11th	0,211	0,291	Phase 1	3,1	3,1
12th	0,021	0,028	Phase 1	1,33	1,33
13th	0,212	0,293	Phase 1	2	2
14th	0,035	0,048	Phase 1	N/A	N/A
15th	0,033	0,046	Phase 1	N/A	N/A
16th	0,034	0,047	Phase 1	N/A	N/A
17th	0,215	0,297	Phase 1	N/A	N/A
18th	0,029	0,040	Phase 1	N/A	N/A
19th	0,218	0,300	Phase 1	N/A	N/A
20th	0,040	0,055	Phase 1	N/A	N/A
21th	0,029	0,040	Phase 1	N/A	N/A
22th	0,028	0,039	Phase 1	N/A	N/A
23th	0,205	0,283	Phase 1	N/A	N/A
24th	0,033	0,045	Phase 1	N/A	N/A
25th	0,202	0,279	Phase 1	N/A	N/A
26th	0,022	0,030	Phase 1	N/A	N/A
27th	0,042	0,058	Phase 1	N/A	N/A
28th	0,045	0,062	Phase 1	N/A	N/A
29th	0,187	0,258	Phase 1	N/A	N/A
30th	0,035	0,048	Phase 1	N/A	N/A
31th	0,182	0,251	Phase 1	N/A	N/A
32th	0,022	0,030	Phase 1	N/A	N/A
33th	0,026	0,036	Phase 1	N/A	N/A
34th	0,023	0,031	Phase 1	N/A	N/A
35th	0,138	0,190	Phase 1	N/A	N/A
36th	0,025	0,035	Phase 1	N/A	N/A
37th	0,130	0,179	Phase 1	N/A	N/A
38th	0,048	0,066	Phase 1	N/A	N/A
39th	0,062	0,086	Phase 1	N/A	N/A
40th	0,053	0,073	Phase 1	N/A	N/A
THD_{40}	-	1,361	Phase 1	13	13
PWHD	-	0,010	Phase 1	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power Quality. Harmonic current emission

EUT		KACO Powador 60.0			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	72,465	100,000	Phase 2	-	-
2nd	0,602	0,831	Phase 2	8	8
3rd	0,252	0,348	Phase 2	21,6	N/A
4th	0,161	0,222	Phase 2	4	4
5th	0,430	0,593	Phase 2	10,7	10,7
6th	0,111	0,154	Phase 2	2,67	2,67
7th	0,276	0,381	Phase 2	7,2	7,2
8th	0,073	0,101	Phase 2	2	2
9th	0,066	0,091	Phase 2	3,8	N/A
10th	0,058	0,080	Phase 2	1,6	1,6
11th	0,212	0,293	Phase 2	3,1	3,1
12th	0,061	0,084	Phase 2	1,33	1,33
13th	0,220	0,304	Phase 2	2	2
14th	0,056	0,078	Phase 2	N/A	N/A
15th	0,044	0,061	Phase 2	N/A	N/A
16th	0,041	0,056	Phase 2	N/A	N/A
17th	0,215	0,297	Phase 2	N/A	N/A
18th	0,036	0,050	Phase 2	N/A	N/A
19th	0,217	0,300	Phase 2	N/A	N/A
20th	0,050	0,069	Phase 2	N/A	N/A
21th	0,039	0,054	Phase 2	N/A	N/A
22th	0,052	0,071	Phase 2	N/A	N/A
23th	0,209	0,289	Phase 2	N/A	N/A
24th	0,029	0,040	Phase 2	N/A	N/A
25th	0,206	0,284	Phase 2	N/A	N/A
26th	0,042	0,058	Phase 2	N/A	N/A
27th	0,042	0,058	Phase 2	N/A	N/A
28th	0,045	0,062	Phase 2	N/A	N/A
29th	0,179	0,247	Phase 2	N/A	N/A
30th	0,040	0,055	Phase 2	N/A	N/A
31th	0,177	0,244	Phase 2	N/A	N/A
32th	0,030	0,042	Phase 2	N/A	N/A
33th	0,027	0,038	Phase 2	N/A	N/A
34th	0,033	0,046	Phase 2	N/A	N/A
35th	0,132	0,182	Phase 2	N/A	N/A
36th	0,036	0,049	Phase 2	N/A	N/A
37th	0,112	0,154	Phase 2	N/A	N/A
38th	0,025	0,035	Phase 2	N/A	N/A
39th	0,054	0,075	Phase 2	N/A	N/A
40th	0,047	0,064	Phase 2	N/A	N/A
THD_{40}	-	1,486	Phase 2	13	13
PWHD	-	0,009	Phase 2	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power Quality. Harmonic current emission

EUT		KACO Powador 60.0			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	72,526	100,000	Phase 3	-	-
2nd	0,739	1,019	Phase 3	8	8
3rd	0,358	0,493	Phase 3	21,6	N/A
4th	0,249	0,343	Phase 3	4	4
5th	0,410	0,565	Phase 3	10,7	10,7
6th	0,148	0,204	Phase 3	2,67	2,67
7th	0,313	0,431	Phase 3	7,2	7,2
8th	0,111	0,153	Phase 3	2	2
9th	0,102	0,141	Phase 3	3,8	N/A
10th	0,086	0,118	Phase 3	1,6	1,6
11th	0,243	0,335	Phase 3	3,1	3,1
12th	0,069	0,096	Phase 3	1,33	1,33
13th	0,225	0,311	Phase 3	2	2
14th	0,073	0,101	Phase 3	N/A	N/A
15th	0,072	0,099	Phase 3	N/A	N/A
16th	0,059	0,082	Phase 3	N/A	N/A
17th	0,238	0,329	Phase 3	N/A	N/A
18th	0,052	0,072	Phase 3	N/A	N/A
19th	0,215	0,296	Phase 3	N/A	N/A
20th	0,078	0,107	Phase 3	N/A	N/A
21th	0,055	0,076	Phase 3	N/A	N/A
22th	0,067	0,092	Phase 3	N/A	N/A
23th	0,239	0,329	Phase 3	N/A	N/A
24th	0,054	0,074	Phase 3	N/A	N/A
25th	0,190	0,262	Phase 3	N/A	N/A
26th	0,050	0,068	Phase 3	N/A	N/A
27th	0,054	0,074	Phase 3	N/A	N/A
28th	0,058	0,080	Phase 3	N/A	N/A
29th	0,218	0,301	Phase 3	N/A	N/A
30th	0,055	0,076	Phase 3	N/A	N/A
31th	0,152	0,209	Phase 3	N/A	N/A
32th	0,037	0,052	Phase 3	N/A	N/A
33th	0,037	0,051	Phase 3	N/A	N/A
34th	0,036	0,049	Phase 3	N/A	N/A
35th	0,159	0,219	Phase 3	N/A	N/A
36th	0,041	0,056	Phase 3	N/A	N/A
37th	0,115	0,158	Phase 3	N/A	N/A
38th	0,037	0,051	Phase 3	N/A	N/A
39th	0,042	0,057	Phase 3	N/A	N/A
40th	0,047	0,065	Phase 3	N/A	N/A
THD_{40}	-	1,714	Phase 3	13	13
PWHD	-	0,011	Phase 3	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power Quality. Harmonic current emission

EUT		KACO Powador 72.0			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	72,016	100,00	Phase 1	-	-
2nd	0,042	0,058	Phase 1	8	8
3rd	0,026	0,036	Phase 1	21,6	N/A
4th	0,404	0,561	Phase 1	4	4
5th	0,028	0,039	Phase 1	10,7	10,7
6th	0,291	0,404	Phase 1	2,67	2,67
7th	0,032	0,044	Phase 1	7,2	7,2
8th	0,043	0,059	Phase 1	2	2
9th	0,034	0,047	Phase 1	3,8	N/A
10th	0,215	0,298	Phase 1	1,6	1,6
11th	0,024	0,033	Phase 1	3,1	3,1
12th	0,223	0,309	Phase 1	1,33	1,33
13th	0,036	0,050	Phase 1	2	2
14th	0,032	0,044	Phase 1	N/A	N/A
15th	0,022	0,030	Phase 1	N/A	N/A
16th	0,228	0,317	Phase 1	N/A	N/A
17th	0,022	0,030	Phase 1	N/A	N/A
18th	0,197	0,274	Phase 1	N/A	N/A
19th	0,023	0,032	Phase 1	N/A	N/A
20th	0,029	0,040	Phase 1	N/A	N/A
21th	0,031	0,043	Phase 1	N/A	N/A
22th	0,217	0,301	Phase 1	N/A	N/A
23th	0,023	0,032	Phase 1	N/A	N/A
24th	0,206	0,287	Phase 1	N/A	N/A
25th	0,027	0,037	Phase 1	N/A	N/A
26th	0,026	0,037	Phase 1	N/A	N/A
27th	0,030	0,041	Phase 1	N/A	N/A
28th	0,223	0,310	Phase 1	N/A	N/A
29th	0,026	0,036	Phase 1	N/A	N/A
30th	0,184	0,256	Phase 1	N/A	N/A
31th	0,026	0,036	Phase 1	N/A	N/A
32th	0,038	0,052	Phase 1	N/A	N/A
33th	0,027	0,038	Phase 1	N/A	N/A
34th	0,181	0,252	Phase 1	N/A	N/A
35th	0,024	0,033	Phase 1	N/A	N/A
36th	0,157	0,218	Phase 1	N/A	N/A
37th	0,023	0,031	Phase 1	N/A	N/A
38th	0,024	0,033	Phase 1	N/A	N/A
39th	0,021	0,029	Phase 1	N/A	N/A
40th	0,248	0,345	Phase 1	N/A	N/A
THD_{40}	-	1,20	Phase 1	13	13
PWHD	-	0,011	Phase 1	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power Quality. Harmonic current emission

EUT		KACO Powador 72.0			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	72,011	100,00	Phase 2	-	-
2nd	0,115	0,160	Phase 2	8	8
3rd	0,027	0,038	Phase 2	21,6	N/A
4th	0,065	0,090	Phase 2	4	4
5th	0,419	0,582	Phase 2	10,7	10,7
6th	0,035	0,049	Phase 2	2,67	2,67
7th	0,289	0,402	Phase 2	7,2	7,2
8th	0,030	0,042	Phase 2	2	2
9th	0,025	0,035	Phase 2	3,8	N/A
10th	0,030	0,042	Phase 2	1,6	1,6
11th	0,190	0,264	Phase 2	3,1	3,1
12th	0,019	0,026	Phase 2	1,33	1,33
13th	0,223	0,309	Phase 2	2	2
14th	0,028	0,038	Phase 2	N/A	N/A
15th	0,020	0,028	Phase 2	N/A	N/A
16th	0,020	0,028	Phase 2	N/A	N/A
17th	0,208	0,288	Phase 2	N/A	N/A
18th	0,019	0,026	Phase 2	N/A	N/A
19th	0,217	0,301	Phase 2	N/A	N/A
20th	0,023	0,032	Phase 2	N/A	N/A
21th	0,021	0,029	Phase 2	N/A	N/A
22th	0,028	0,039	Phase 2	N/A	N/A
23th	0,217	0,301	Phase 2	N/A	N/A
24th	0,021	0,029	Phase 2	N/A	N/A
25th	0,228	0,316	Phase 2	N/A	N/A
26th	0,023	0,032	Phase 2	N/A	N/A
27th	0,022	0,030	Phase 2	N/A	N/A
28th	0,026	0,036	Phase 2	N/A	N/A
29th	0,217	0,301	Phase 2	N/A	N/A
30th	0,022	0,031	Phase 2	N/A	N/A
31th	0,214	0,297	Phase 2	N/A	N/A
32th	0,022	0,031	Phase 2	N/A	N/A
33th	0,024	0,033	Phase 2	N/A	N/A
34th	0,028	0,038	Phase 2	N/A	N/A
35th	0,170	0,236	Phase 2	N/A	N/A
36th	0,023	0,031	Phase 2	N/A	N/A
37th	0,161	0,223	Phase 2	N/A	N/A
38th	0,022	0,031	Phase 2	N/A	N/A
39th	0,030	0,041	Phase 2	N/A	N/A
40th	0,023	0,032	Phase 2	N/A	N/A
THD_{40}	-	1,17	Phase 2	13	13
PWHD	-	0,012	Phase 2	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Power Quality. Harmonic current emission

EUT		KACO Powador 72.0			
Harmonic order n	Current Magnitude [A] at 100% rated output power	% of Fundamental	Phase	Harmonic current limit EN61000-3-12 [%]	
				1 phase	3 phase
1st	72,038	100,00	Phase 3	-	-
2nd	0,331	0,459	Phase 3	8	8
3rd	0,057	0,079	Phase 3	21,6	N/A
4th	0,059	0,082	Phase 3	4	4
5th	0,417	0,579	Phase 3	10,7	10,7
6th	0,030	0,042	Phase 3	2,67	2,67
7th	0,318	0,441	Phase 3	7,2	7,2
8th	0,025	0,035	Phase 3	2	2
9th	0,022	0,030	Phase 3	3,8	N/A
10th	0,025	0,034	Phase 3	1,6	1,6
11th	0,180	0,250	Phase 3	3,1	3,1
12th	0,022	0,030	Phase 3	1,33	1,33
13th	0,224	0,311	Phase 3	2	2
14th	0,032	0,045	Phase 3	N/A	N/A
15th	0,025	0,035	Phase 3	N/A	N/A
16th	0,020	0,028	Phase 3	N/A	N/A
17th	0,211	0,293	Phase 3	N/A	N/A
18th	0,020	0,028	Phase 3	N/A	N/A
19th	0,216	0,300	Phase 3	N/A	N/A
20th	0,021	0,029	Phase 3	N/A	N/A
21th	0,019	0,027	Phase 3	N/A	N/A
22th	0,028	0,039	Phase 3	N/A	N/A
23th	0,214	0,297	Phase 3	N/A	N/A
24th	0,021	0,029	Phase 3	N/A	N/A
25th	0,213	0,296	Phase 3	N/A	N/A
26th	0,025	0,035	Phase 3	N/A	N/A
27th	0,023	0,031	Phase 3	N/A	N/A
28th	0,026	0,035	Phase 3	N/A	N/A
29th	0,216	0,300	Phase 3	N/A	N/A
30th	0,022	0,031	Phase 3	N/A	N/A
31th	0,195	0,270	Phase 3	N/A	N/A
32th	0,023	0,031	Phase 3	N/A	N/A
33th	0,024	0,033	Phase 3	N/A	N/A
34th	0,026	0,036	Phase 3	N/A	N/A
35th	0,191	0,266	Phase 3	N/A	N/A
36th	0,023	0,032	Phase 3	N/A	N/A
37th	0,155	0,215	Phase 3	N/A	N/A
38th	0,022	0,031	Phase 3	N/A	N/A
39th	0,035	0,049	Phase 3	N/A	N/A
40th	0,025	0,035	Phase 3	N/A	N/A
THD_{40}	-	1,25	Phase 3	13	13
PWHD	-	0,011	Phase 3	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 12TH0351**

Voltage fluctuation and Flicker.					
	Maximum permissible flicker and voltage fluctuation as per EN 61000-3-11				
Value	**Pst**	**Plt 2 hours**	**d(t) $_{500ms}$**	**dc**	**dmax**
Limit	1,0	0,65	3,3%	3,3%	4%
Test value	0,086	0,086	0,0%	3,3%	0,33%

DC-Injection.				
Protection limit	Tested at four power levels limit 0,5% of IAC_{nom}			
Output power	**~20%**	**~50%**	**75%**	**~100%**
Max. test value (phase L1) [mA]	48,33	54,83	48,79	25,72
Max. test value (phase L2) [mA]	11,83	18,13	20,72	29,41
Max. test value (phase L3) [mA]	66,91	71,52	59,57	29,74