Certificate of compliance

Applicant: **KACO new energy GmbH**
Carl-Zeiss-Straße 1
74172 Neckarsulm
Germany

Product: **Grid-tied photovoltaic (PV) inverter**

Model: **KACO blueplanet 50.0 TL3 M1 WM OD IIGM**
KACO blueplanet 50.0 TL3 M1 WM OD IIGB
KACO blueplanet 50.0 TL3 M1 WM OD IIGX
KACO blueplanet 50.0 TL3 M1 WM OD FRGX

Use in accordance with regulations:

Automatic disconnection device with three-phase mains surveillance in accordance with Engineering Recommendation G59/3 for photovoltaic systems with a three-phase parallel coupling via an inverter in the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter. This serves as a replacement for the disconnection device with isolating function that can access the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G59/3:2014
Recommendation for the Connection of Generating Plant to the Distribution Systems of licensed Distribution Network Operators.

DIN V VDE V 0126-1-1:2006-02 (Functional safety)
Automatic disconnection device between a generator and the public low-voltage grid

The KACO blueplanet 50.0 TL3 M1 WM OD IIGM, KACO blueplanet 50.0 TL3 M1 WM OD IIGB, KACO blueplanet 50.0 TL3 M1 WM OD FRGX and KACO blueplanet 50.0 TL3 M1 WM OD IIGX are rated >16A per phase and <= 50kW. The default values for “Small Power Stations” on the low-voltage grid were verified.

At the time of issue of this certificate the safety concept of an aforementioned representative product corresponds to the valid safety specifications for the specified use in accordance with regulations.

Report number: **15TH0250-G59/3_1**
Certificate number: **U17-0470**
Date of issue: **2017-09-07**

Certification body

Holger Schaffer

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

Certification body of Bureau Veritas Consumer Products Services Germany GmbH
Accredited according to DIN EN ISO/IEC 17065

Appendix E Type Verification Test Report	
Extract from test report according to EN 50438	**Nr. 15TH0250**

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	KACO blueplanet 50.0 TL3 M1 WM OD IIGM KACO blueplanet 50.0 TL3 M1 WM OD IIGB KACO blueplanet 50.0 TL3 M1 WM OD IIGX KACO blueplanet 50.0 TL3 M1 WM OD FRGX
Maximum rated capacity	50 kW
Rated voltage	400 V_{AC} (P-P) / 230 V_{AC} (3/PEN), 42-68 Hz
Firmware version	**PKT: V4.09; ARM: V5.08; CFG: V6.0572; DSP-AC: V4.09, DSP-DC: V4.02**
* The tests were performed with Firmwareversion V4.09. Changes in the Firmwareversion on position V4.x have no effect on the required electrical properties. x = could be any number or sign	
Measurement period:	**2017-09-04 to 2017-09-08**

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.

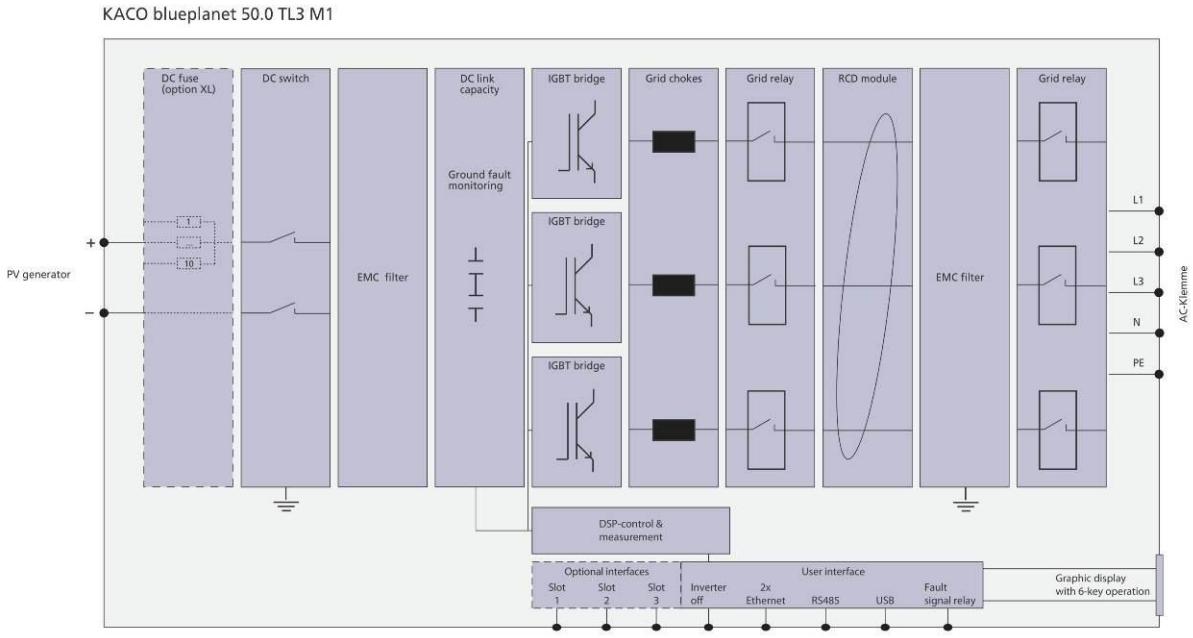


Figure 1 – Schematic structure of the power generation unit

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. 15TH0250**

Type testing of the interface protection

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	3,0	253,0	3,0	252,3	2,961
Over-voltage stage 2	264,5	0,2	264,5	0,2	263,4	0,170
Under-voltage stage 1	195,5	1,5	195,5	1,5	195,2	1,458
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	3,0	253,0	3,0	252,4	2,964
Over-voltage stage 2	264,5	0,2	264,5	0,2	263,4	0,160
Under-voltage stage 1	195,5	1,5	195,5	1,5	195,3	1,459
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	3,0	253,0	3,0	252,6	2,966
Over-voltage stage 2	264,5	0,2	264,5	0,2	263,7	0,152
Under-voltage stage 1	195,5	1,5	195,5	1,5	195,5	1,462

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

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

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	52,00	0,344
Under-frequency	47,50	0,5	47,50	0,5	47,50	0,375

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]	211,6	210,3	601,6	235,5	229,9	363,4

Indicate additional shut down time included in above results. (Integrated interface switch)	Type of switching equipment 1: Finder 67.23 with 35ms Type of switching equipment 2: Finder 67.23 with 35ms

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

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 [W]	Cos φ [1]
1	195,5	47,50	44,30	0,999
2	253,0	51,50	50,10	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]:	49,6	49,60	49,6
ΔP/PM [%] per 1 Hz:			0

Power response to over-frequency

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						

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

Reactive power			
Uncontrollable reactive power			
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**

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

Controllable reactive power

Inductive (supply reactive power)

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2478,20	22021,98	0,11	2980,81
10% - 20%	6925,19	21954,65	0,30	7429,73
20% - 30%	11370,51	21888,04	0,46	11907,90
30% - 40%	15735,82	21809,21	0,58	16336,77
40% - 50%	20069,68	21829,44	0,68	20758,09
50% - 60%	24454,56	21752,26	0,75	25229,66
60% - 70%	29248,89	21670,05	0,80	30150,18
70% - 80%	33602,72	21695,81	0,84	34627,38
80% - 90%	38336,25	21773,32	0,87	39516,68
90% - 100%	42632,39	21711,87	0,89	43955,73

Capacitive (supply reactive power)

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2479,20	-21812,24	-0,11	2988,39
10% - 20%	6910,81	-21855,21	-0,30	7433,00
20% - 30%	11334,46	-21868,20	-0,46	11893,89
30% - 40%	15728,76	-21856,42	-0,58	16341,43
40% - 50%	20094,06	-21866,24	-0,68	20781,77
50% - 60%	24437,80	-21827,81	-0,75	25220,90
60% - 70%	29248,98	-21844,27	-0,80	30166,71
70% - 80%	33570,48	-21816,89	-0,84	34619,02
80% - 90%	38367,36	-21838,97	-0,87	39563,54
90% - 100%	42629,34	-21870,99	-0,89	43980,60

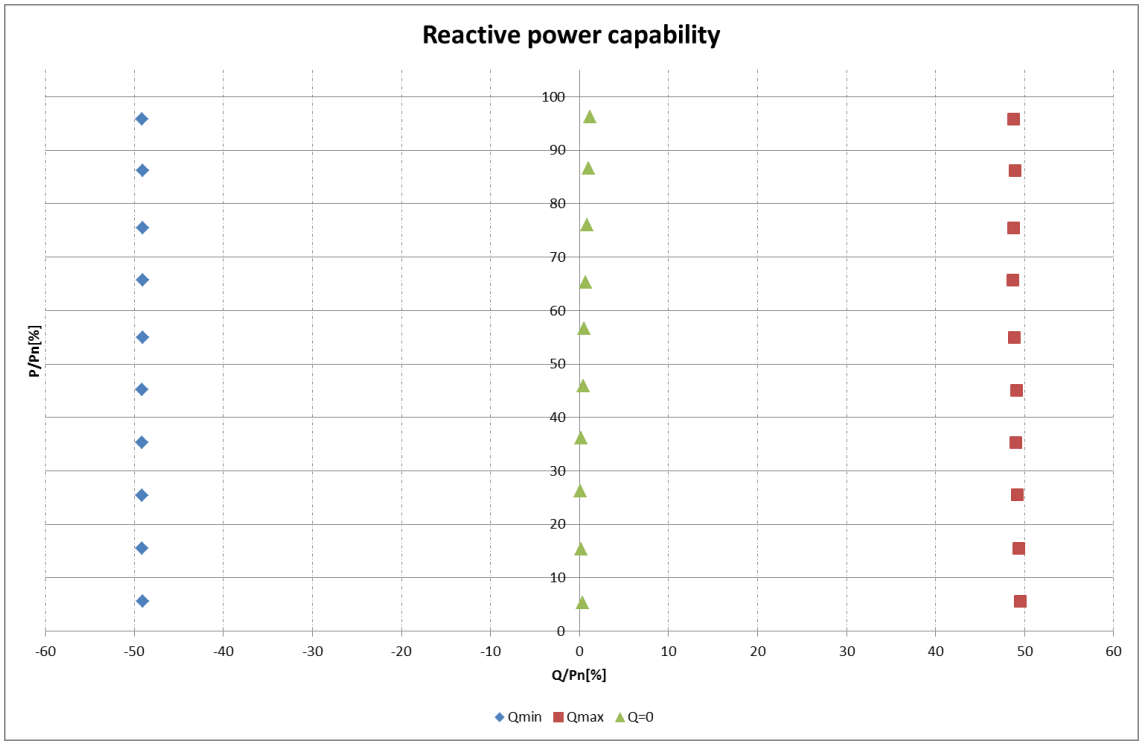
Reactive power supply with set point Q=0

Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2393,20	141,49	0,99	2487,44
10% - 20%	6848,78	100,40	1,00	6989,40
20% - 30%	11691,38	53,85	1,00	11917,69
30% - 40%	16051,04	96,13	1,00	16367,01
40% - 50%	20417,82	177,53	1,00	20846,33
50% - 60%	25189,59	249,12	1,00	25732,69
60% - 70%	29045,80	304,56	1,00	29704,15
70% - 80%	33831,39	386,88	1,00	34646,49
80% - 90%	38563,44	468,84	1,00	39558,70
90% - 100%	42831,00	532,82	1,00	43983,72

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

Diagram of inductive reactive power absorption



Q adjustment

	Reactive power set point Q [Var]	Measured reactive power Q [Var]	Measured cos φ	Deviation compared to setpoint ΔQ / PN [%]
- Qmin	-48.43	-48,52%	0,7174	-0,09%
0	0	0,47%	1,0000	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. 15TH0250**

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. 15TH0250**

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. 15TH0250**

Power Quality. Harmonic current emission					
EUT		**KACO blueplanet 50.0 TL3 M1 WM OD IIGM**			
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	72,813	100,000	Phase 1	-	-
2nd	0,317	0,436	Phase 1	8	8
3rd	0,186	0,255	Phase 1	21,6	N/A
4th	0,145	0,199	Phase 1	4	4
5th	0,362	0,496	Phase 1	10,7	10,7
6th	0,074	0,102	Phase 1	2,67	2,67
7th	0,265	0,364	Phase 1	7,2	7,2
8th	0,056	0,077	Phase 1	2	2
9th	0,058	0,079	Phase 1	3,8	N/A
10th	0,049	0,068	Phase 1	1,6	1,6
11th	0,203	0,279	Phase 1	3,1	3,1
12th	0,044	0,060	Phase 1	1,33	1,33
13th	0,167	0,229	Phase 1	2	2
14th	0,043	0,060	Phase 1	N/A	N/A
15th	0,046	0,064	Phase 1	N/A	N/A
16th	0,038	0,052	Phase 1	N/A	N/A
17th	0,152	0,209	Phase 1	N/A	N/A
18th	0,042	0,057	Phase 1	N/A	N/A
19th	0,154	0,212	Phase 1	N/A	N/A
20th	0,047	0,064	Phase 1	N/A	N/A
21th	0,052	0,071	Phase 1	N/A	N/A
22th	0,042	0,058	Phase 1	N/A	N/A
23th	0,154	0,212	Phase 1	N/A	N/A
24th	0,048	0,065	Phase 1	N/A	N/A
25th	0,167	0,229	Phase 1	N/A	N/A
26th	0,053	0,073	Phase 1	N/A	N/A
27th	0,063	0,086	Phase 1	N/A	N/A
28th	0,049	0,067	Phase 1	N/A	N/A
29th	0,160	0,219	Phase 1	N/A	N/A
30th	0,048	0,066	Phase 1	N/A	N/A
31th	0,146	0,200	Phase 1	N/A	N/A
32th	0,046	0,063	Phase 1	N/A	N/A
33th	0,055	0,076	Phase 1	N/A	N/A
34th	0,041	0,056	Phase 1	N/A	N/A
35th	0,105	0,144	Phase 1	N/A	N/A
36th	0,035	0,048	Phase 1	N/A	N/A
37th	0,095	0,131	Phase 1	N/A	N/A
38th	0,029	0,040	Phase 1	N/A	N/A
39th	0,038	0,052	Phase 1	N/A	N/A
40th	0,026	0,036	Phase 1	N/A	N/A
THD_{40}	-	1,114	Phase 1	13	13
PWHD	-	0,006	Phase 1	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

Power Quality. Harmonic current emission					
EUT		**KACO blueplanet 50.0 TL3 M1 WM OD IIGM**			
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	72,834	100,000	Phase 2	-	-
2nd	0,255	0,350	Phase 2	8	8
3rd	0,099	0,136	Phase 2	21,6	N/A
4th	0,079	0,109	Phase 2	4	4
5th	0,369	0,506	Phase 2	10,7	10,7
6th	0,041	0,057	Phase 2	2,67	2,67
7th	0,241	0,330	Phase 2	7,2	7,2
8th	0,034	0,047	Phase 2	2	2
9th	0,050	0,069	Phase 2	3,8	N/A
10th	0,031	0,042	Phase 2	1,6	1,6
11th	0,198	0,272	Phase 2	3,1	3,1
12th	0,021	0,028	Phase 2	1,33	1,33
13th	0,173	0,238	Phase 2	2	2
14th	0,028	0,038	Phase 2	N/A	N/A
15th	0,033	0,046	Phase 2	N/A	N/A
16th	0,027	0,037	Phase 2	N/A	N/A
17th	0,161	0,222	Phase 2	N/A	N/A
18th	0,026	0,036	Phase 2	N/A	N/A
19th	0,159	0,219	Phase 2	N/A	N/A
20th	0,030	0,042	Phase 2	N/A	N/A
21th	0,036	0,050	Phase 2	N/A	N/A
22th	0,030	0,042	Phase 2	N/A	N/A
23th	0,168	0,231	Phase 2	N/A	N/A
24th	0,037	0,050	Phase 2	N/A	N/A
25th	0,169	0,232	Phase 2	N/A	N/A
26th	0,034	0,047	Phase 2	N/A	N/A
27th	0,043	0,058	Phase 2	N/A	N/A
28th	0,034	0,046	Phase 2	N/A	N/A
29th	0,185	0,254	Phase 2	N/A	N/A
30th	0,039	0,053	Phase 2	N/A	N/A
31th	0,157	0,216	Phase 2	N/A	N/A
32th	0,029	0,040	Phase 2	N/A	N/A
33th	0,040	0,055	Phase 2	N/A	N/A
34th	0,027	0,037	Phase 2	N/A	N/A
35th	0,127	0,174	Phase 2	N/A	N/A
36th	0,026	0,036	Phase 2	N/A	N/A
37th	0,101	0,139	Phase 2	N/A	N/A
38th	0,019	0,026	Phase 2	N/A	N/A
39th	0,028	0,039	Phase 2	N/A	N/A
40th	0,017	0,024	Phase 2	N/A	N/A
THD_{40}	-	1,039	Phase 2	13	13
PWHD	-	0,007	Phase 2	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

Power Quality. Harmonic current emission					
EUT		**KACO blueplanet 50.0 TL3 M1 WM OD IIGM**			
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	72,773	100,000	Phase 3	-	-
2nd	0,258	0,354	Phase 3	8	8
3rd	0,129	0,177	Phase 3	21,6	N/A
4th	0,091	0,125	Phase 3	4	4
5th	0,374	0,514	Phase 3	10,7	10,7
6th	0,064	0,088	Phase 3	2,67	2,67
7th	0,271	0,372	Phase 3	7,2	7,2
8th	0,039	0,054	Phase 3	2	2
9th	0,049	0,067	Phase 3	3,8	N/A
10th	0,034	0,046	Phase 3	1,6	1,6
11th	0,188	0,258	Phase 3	3,1	3,1
12th	0,040	0,055	Phase 3	1,33	1,33
13th	0,187	0,258	Phase 3	2	2
14th	0,031	0,042	Phase 3	N/A	N/A
15th	0,034	0,047	Phase 3	N/A	N/A
16th	0,029	0,040	Phase 3	N/A	N/A
17th	0,148	0,204	Phase 3	N/A	N/A
18th	0,034	0,047	Phase 3	N/A	N/A
19th	0,173	0,237	Phase 3	N/A	N/A
20th	0,036	0,049	Phase 3	N/A	N/A
21th	0,037	0,051	Phase 3	N/A	N/A
22th	0,034	0,047	Phase 3	N/A	N/A
23th	0,149	0,205	Phase 3	N/A	N/A
24th	0,034	0,047	Phase 3	N/A	N/A
25th	0,172	0,237	Phase 3	N/A	N/A
26th	0,041	0,056	Phase 3	N/A	N/A
27th	0,045	0,062	Phase 3	N/A	N/A
28th	0,039	0,054	Phase 3	N/A	N/A
29th	0,161	0,222	Phase 3	N/A	N/A
30th	0,033	0,046	Phase 3	N/A	N/A
31th	0,148	0,204	Phase 3	N/A	N/A
32th	0,038	0,052	Phase 3	N/A	N/A
33th	0,043	0,058	Phase 3	N/A	N/A
34th	0,034	0,046	Phase 3	N/A	N/A
35th	0,114	0,156	Phase 3	N/A	N/A
36th	0,024	0,033	Phase 3	N/A	N/A
37th	0,089	0,122	Phase 3	N/A	N/A
38th	0,023	0,032	Phase 3	N/A	N/A
39th	0,029	0,039	Phase 3	N/A	N/A
40th	0,020	0,027	Phase 3	N/A	N/A
THD_{40}	-	1,055	Phase 3	13	13
PWHD	-	0,006	Phase 3	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 15TH0250**

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} (362mA)			
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