



**BUREAU
VERITAS**

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

Use in accordance with regulations:

Automatic disconnection device with three-phase mains surveillance in accordance with EN 50438:2013 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.

Applied rules and standards:

EN 50438:2013; CYS EN 50438:2013

Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks

Technical Guide Electricity Authority of Cyprus:2014

Technical Provision, Conditions and Requirements for the Interface and Operation of Photovoltaic Systems with the low Voltage Distribution Network (EAC)

VDE-AR-N 4105:2011-08 – Power generation systems connected to the low-voltage distribution network

Technical minimum requirements for the connection to and parallel operation with low-voltage distribution networks.

DIN VDE V 0124-100 (VDE V 0124-100): 2012-07 – Grid integration of power generation systems – low voltage

Test requirements for power generation units to be connected and operated parallel with the low-voltage distribution networks

DIN V VDE V 0126-1-1:2006-02 (Functional safety)

Automatic disconnection device between a generator and the public low-voltage grid

The generators KACO blueplanet 50.0 TL3 M1 WM OD IIGM, KACO blueplanet 50.0 TL3 M1 WM OD IIGB and KACO blueplanet 50.0 TL3 M1 WM OD IIGX are rated >16A per phase. However all requirements of the EN 50438:2013 are fulfilled.

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-EN50438
Certificate number: U16-0083
Date of issue: 2016-02-26

Certification body

Dieter Zitzmann



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
Maximum rated capacity	50 kW
Rated voltage	400 V _{AC} (P-P) / 230 V _{AC} (3/PEN), 42-68 Hz
Firmware version	PKT: V3.12; ARM: V3.70; CFG: V5.1608; DSP: V2.11
Measurement period:	2015-10-26 to 2016-01-26

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.

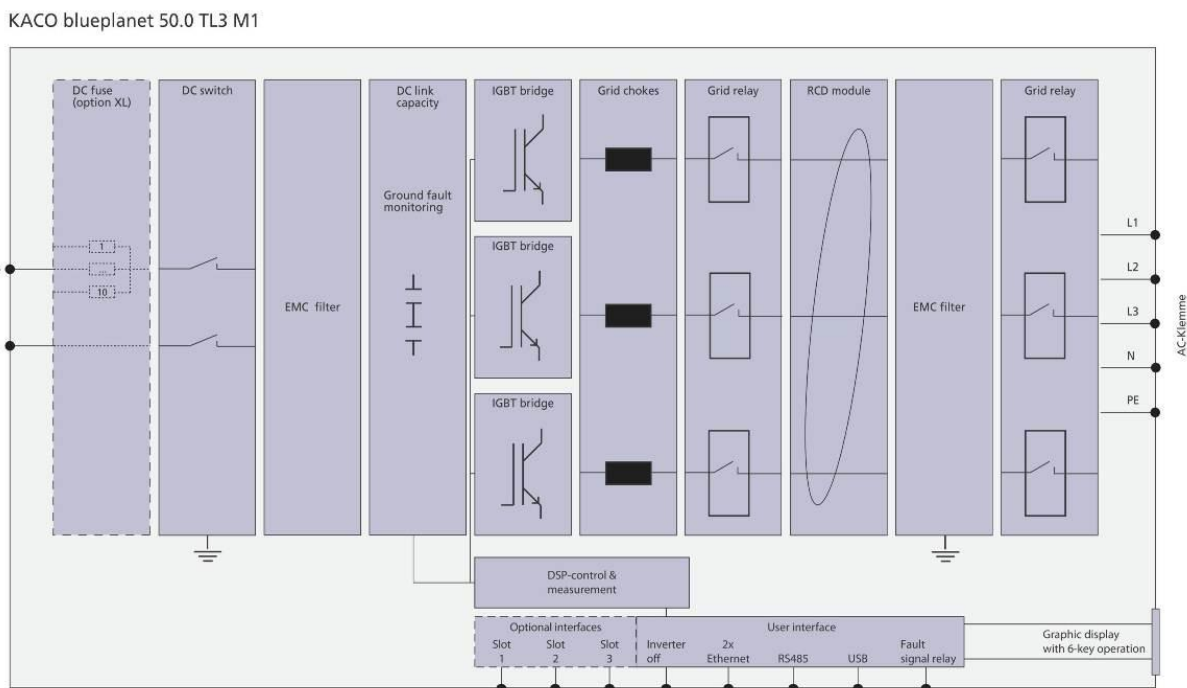


Figure 1 – Schematic structure of the power generation unit

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.

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Type testing of the interface protection

Over-/under-voltage tests (EN50438)						
Phase1						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [ms]
Over-voltage stage 1	253	0,5	253	0,5	252,2	492
Under-voltage stage 1	207,0	0,5	207,0	0,5	207,2	500
Phase2						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [ms]
Over-voltage stage 1	253	0,5	253	0,5	252,2	496
Under-voltage stage 1	207,0	0,5	207,0	0,5	207,3	496
Phase3						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [ms]
Over-voltage stage 1	253	0,5	253	0,5	252,4	500
Under-voltage stage 1	207,0	0,5	207,0	0,5	207,3	500
Note.						

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Over-/under-voltage tests (EAC:2014)						
Phase1						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [ms]
Over-voltage stage 1	253	0,5	253	0,5	252,2	492
Under-voltage stage 1	207,0	0,5	207,0	0,5	207,2	500
Phase2						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [ms]
Over-voltage stage 1	253	0,5	253	0,5	252,2	496
Under-voltage stage 1	207,0	0,5	207,0	0,5	207,3	496
Phase3						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [s]	Voltage [V]	Disconnection time [ms]
Over-voltage stage 1	253	0,5	253	0,5	252,4	500
Under-voltage stage 1	207,0	0,5	207,0	0,5	207,3	500
Note.						

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Over-/under-frequency tests (EN50438)						
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	52,0	0,5	52,0	0,5	52,00	0,5
Under-frequency	47,0	0,5	47,0	0,5	46,99	0,5
Note. Minimum operation time according to default interface protection: Over-frequency 0,5 s Under-frequency 0,5 s						
Over-/under-frequency tests (EAC:2014)						
Parameter	Protection limit		Actual setting		Trip value (test result)	
	Frequency [Hz]	Disconnection time [ms]	Frequency [Hz]	Disconnection time [ms]	Frequency [Hz]	Disconnection time [ms]
Over-frequency	51,5	1000	51,5	1000	51,50	173
Under-frequency	47,5	1000	47,5	1000	47,50	174
Note.						

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		

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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
ΔPE60/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
ΔPE60/PM [%]:	N/A	0,48	0,33	0,36	0,03	0,00	N/A
Limit ΔP/P1min:	+ 10 % of P _M						

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Reactive power			
Uncontrollable reactive power			
Test Voltage	211,6V	230V	248,4V
Output power			
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

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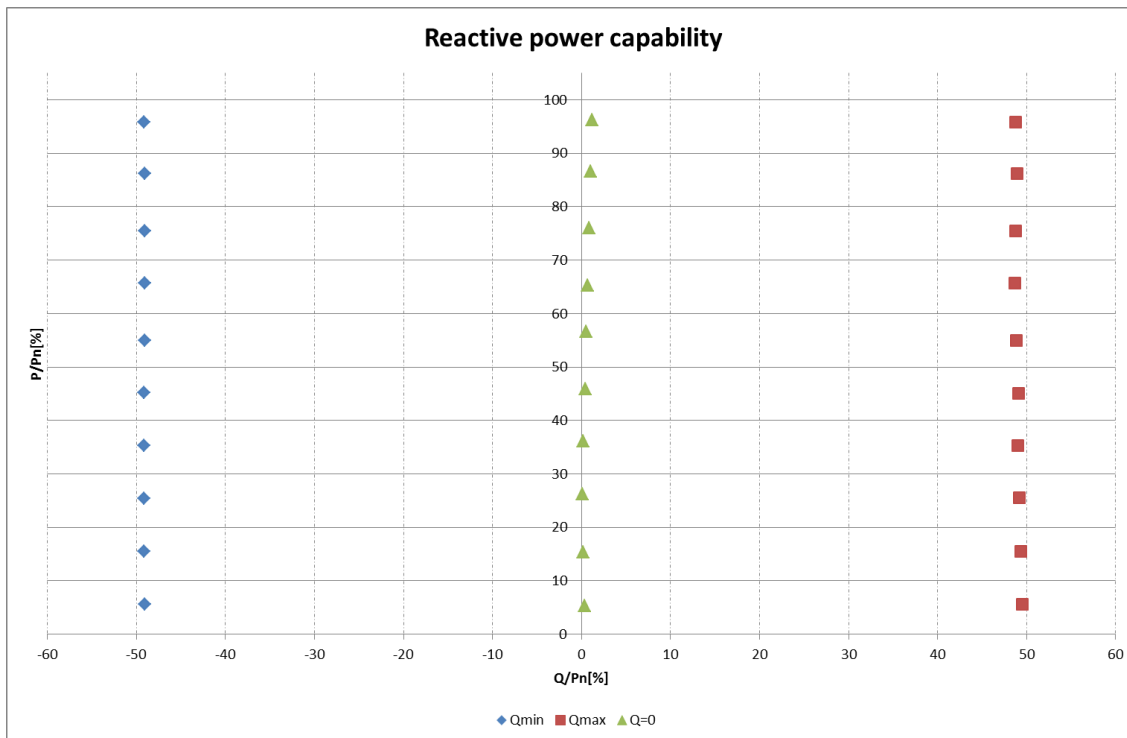
Controllable reactive power				
Inductive (supply reactive power)				
Power-BIN	Active power [W]	Reactive power [Var]	Power factor (cos φ)	DC power [W]
0% - 10%	2478,20	22021,98	0,11	2980,81
10% - 20%	6925,19	21954,65	0,30	7429,73
20% - 30%	11370,51	21888,04	0,46	11907,90
30% - 40%	15735,82	21809,21	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

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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 $\Delta Q / PN$ [%]
- 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%

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Connection and starting to generate electrical power (EN50438)		
	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.	

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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

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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

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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

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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}			
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