Certificate of compliance

Applicant: **SMA Solar Technology AG**
Sonnenallee 1
34266 Niestetal
Germany

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

Model: **SHP75-10**

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
Requirements for micro-generating plants to be connected in parallel with public 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 generator SHP75-10 is 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: **14TH0075_EN50438_0**
Certificate number: **U18-0170**
Date of issue: **2018-04-11**

Certification body

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

Holger Schaffer
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. 14TH0075_EN50438_0**

Type Approval and declaration of compliance with the requirements of EN 50438.	
Manufacturer / applicant:	SMA Solar Technology AG Sonnenallee 1 34266 Niestetal Germany
Micro-generator Type	Grid-tied photovoltaic inverter
Rated values	SHP75-10
Maximum rated capacity	75 kW
Rated voltage	400V 3P; PE
Firmware version	1.90
Measurement period:	2018-03-12 to 2018-04-03

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

The Solar converter converts DC voltage into AC voltage.
The input and output are protected by varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does provide galvanic separation from input to output (transformer). The output is switched off redundant by the high power switching bridge and a relay in series. This assures that the opening of the output circuit will also operate in case of one error.

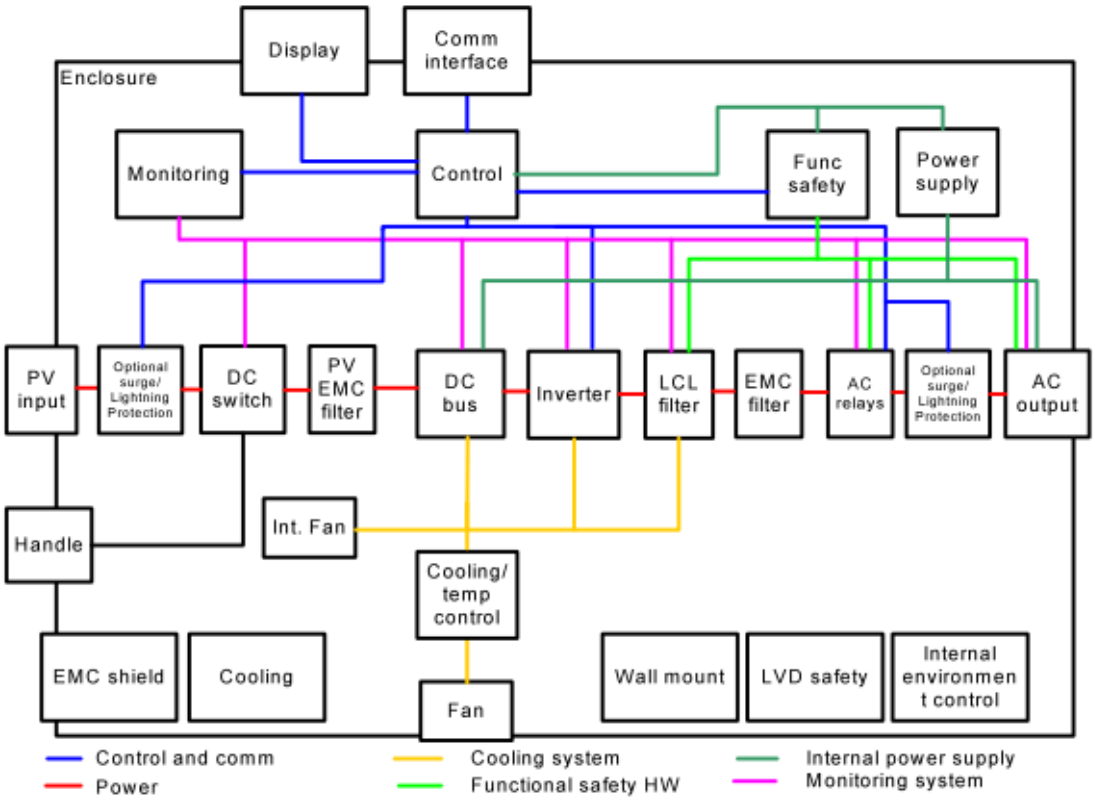

Figure 1 – Schematic structure of the power generation unit

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. 14TH0075_EN50438_0**

Type testing of the interface protection

Over-/under-voltage tests

Phase1/2

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	379*
Over-voltage stage 2	458,1	0,2	458,1	0,2	457,4	0,186
Under-voltage stage 1	338,6	1,5	338,6	1,5	338,4	1,500

Phase2/3

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	379*
Over-voltage stage 2	458,1	0,2	458,1	0,2	457,4	0,193
Under-voltage stage 1	338,6	1,5	338,6	1,5	338,6	1,500

Phase3/1

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	379*
Over-voltage stage 2	458,1	0,2	458,1	0,2	457,3	0,196
Under-voltage stage 1	338,6	1,5	338,6	1,5	338,5	1,500

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

* The over-voltage-stage 1 is a 10-min-mean-value according to EN 50160. The disconnection after detection of an overvoltage at the 10-min-mean-value takes place within 200ms.

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Extract from test report according to EN 50438 **Nr. 14TH0075_EN50438_0**

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	52,0	0,5	52,0	0,5	52,0	0,361
Under-frequency	47,5	0,5	47,5	0,5	47,5	0,390
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. Phase 1 fuse removed [ms]	416	396	496	426	416	466
Trip time. Phase 2 fuse removed [ms]	416	396	496	426	416	466
Trip time. Phase 3 fuse removed [ms]	416	396	496	426	416	466
Indicate additional shut down time included in above results. (Integrated interface switch)				Type of switching equipment 1: Relay with 20ms Type of switching equipment 2: Relay with 20ms		

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Extract from test report according to EN 50438	Nr. 14TH0075_EN50438_0

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	198,40	47,50	66035	0,999
2	253,30	51,50	73682	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]:	50,00	49,60	47,60
Active power [kW]:	76,30	76,30	76,30
ΔP/PM [%] per 1 Hz:			0,0

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	50,68	50,24	49,98
PM [kW]:	N/A	73,12	59,83	46,56	59,83	73,12	N/A
PE60 [kW]:	74,24	73,47	60,06	46,70	60,12	73,15	74,81
ΔPE60/PM [%]:	N/A	0,46	0,31	0,19	0,39	0,05	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	51,12	50,69	50,23	49,98
PM [kW]:	N/A	36,91	30,20	23,53	30,20	36,91	N/A
PE60 [kW]:	37,47	37,10	30,35	23,66	30,38	37,16	47,49
ΔPE60/PM [%]:	N/A	0,25	0,20	0,18	0,25	0,34	N/A
Limit ΔP/P1min:	+ 10 % of P_M						

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Reactive power			
Uncontrollable reactive power			
Test Voltage / Output power	**211,6V**	**230V**	**248,4V**
25% PN	0,999	0,999	0,999
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**

Controllable reactive power				
Inductive (supply reactive power)				
Power-BIN	**Active power [W]**	**Reactive power [Var]**	**Power factor (cos φ) [1]**	**DC Power [W]**
0% - 10%	3243,11	-33556,62	-0,10	3853,96
10% - 20%	10074,87	-33466,30	-0,29	10701,71
20% - 30%	16783,75	-33375,08	-0,45	17459,70
30% - 40%	23525,70	-33283,50	-0,58	24284,18
40% - 50%	30920,56	-33182,84	-0,68	31808,89
50% - 60%	36841,89	-33102,20	-0,74	37844,23
60% - 70%	43456,05	-33013,02	-0,80	44606,17
70% - 80%	50748,93	-32915,56	-0,84	52101,61
80% - 90%	58167,94	-32826,99	-0,87	59731,48
90% - 100%	64607,58	-32728,32	-0,89	66402,20
Capacitive (supply reactive power)				
Power-BIN	**Active power [W]**	**Reactive power [Var]**	**Power factor (cos φ) [1]**	**DC Power [W]**
0% - 10%	3184,80	32752,49	0,10	3847,36
10% - 20%	9978,21	32842,66	0,30	10658,78
20% - 30%	16920,87	32733,69	0,46	17650,34
30% - 40%	23672,20	32822,27	0,59	24486,02
40% - 50%	30914,62	32692,98	0,69	31856,50
50% - 60%	36820,96	32698,43	0,75	37878,52
60% - 70%	43583,43	32789,71	0,80	44792,91
70% - 80%	50931,88	32887,05	0,84	52345,39
80% - 90%	57413,00	32972,80	0,87	59028,32
90% - 100%	64525,55	33069,24	0,89	66402,44
Reactive power supply with set point Q = 0				
Power-BIN	**Active power [W]**	**Reactive power [Var]**	**Power factor (cos φ) [1]**	**DC Power [W]**
0% - 10%	3005,03	334,84	0,99	3093,18
10% - 20%	10500,35	236,32	1,00	10669,38
20% - 30%	17152,72	149,69	1,00	17408,43
30% - 40%	23829,14	59,89	1,00	24201,20
40% - 50%	31211,02	39,74	1,00	31739,98
50% - 60%	37638,55	123,43	1,00	38302,36
60% - 70%	45542,00	227,58	1,00	46415,98
70% - 80%	52637,23	322,68	1,00	53722,77
80% - 90%	57581,33	390,84	1,00	58841,61
90% - 100%	64133,65	479,98	1,00	65627,83

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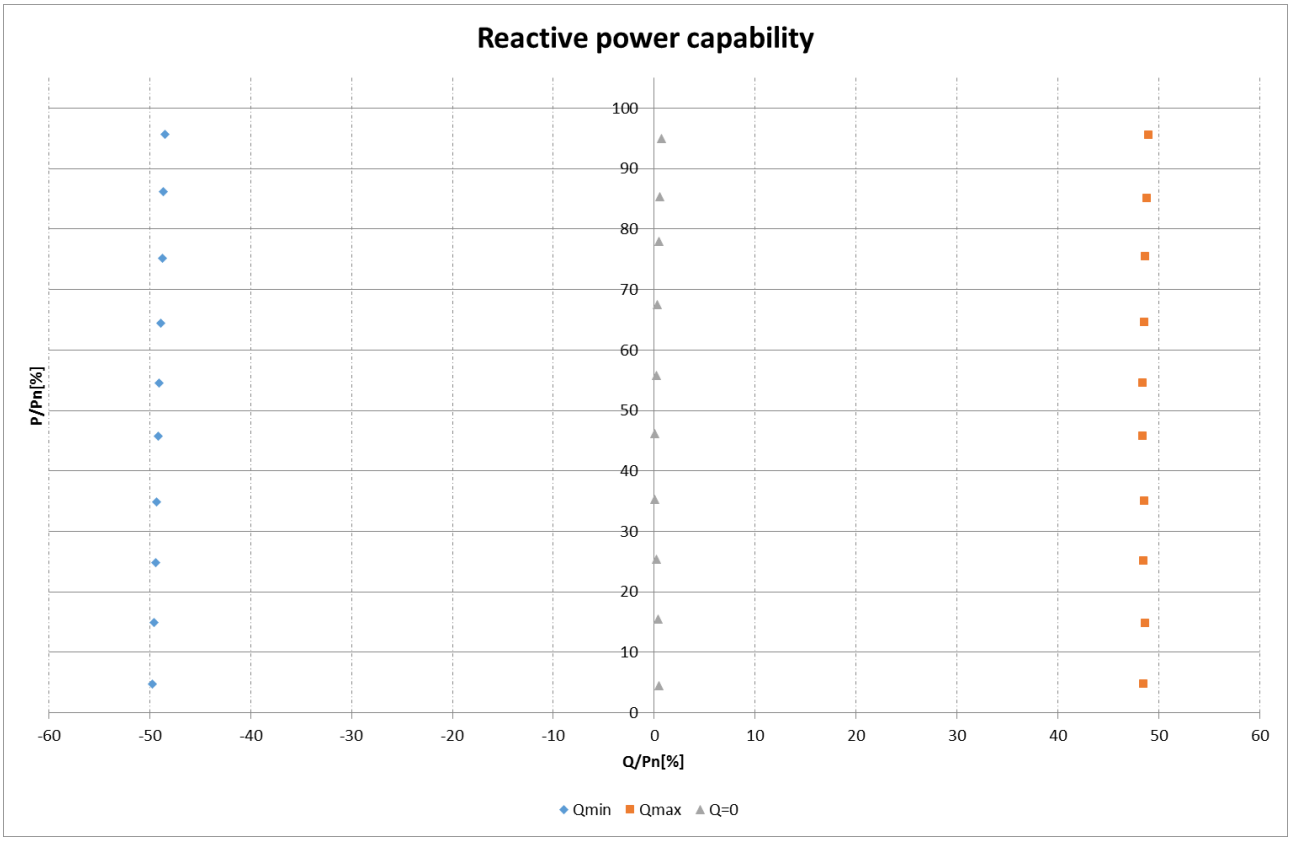
Diagram of inductive reactive power absorption



Q adjustment			
	Reactive power set point Q [%]	**Measured reactive power Q/Pn [%]**	**Deviation compared to setpoint ΔQ / PN [%]**
- Qmin	-48,43	-48,33%	0,10%
0	0	0,76%	0,76%
+ Qmax	+48,43	49,85%	1,42%

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Extract from test report according to EN 50438 **Nr. 14TH0075_EN50438_0**

Connection and starting to generate electrical power		
Test according EN 50438 with standard setting	**Min. voltage for connection to grid:**	196V
	Max. voltage for connection to grid:	253V
	Min. frequency for connection to grid:	47,50Hz
	Max. frequency for connection to grid:	50,05Hz
	Observation time (≥60s)	60s

Test		
	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]	61	61
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.	
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]	61	61
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.	
	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]	62	61
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.	

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Extract from test report according to EN 50438	**Nr. 14TH0075_EN50438_0**

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]	61	62
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.	

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	50,8	38,7
Initial Value of aperiodic current	A	N/A	100ms	50,6	36,3
Initial symmetrical short-circuit current*	I_k	N/A	250ms	50,3	57,3
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	50,3	64,6
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to trip**	0,526	In seconds

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Extract from test report according to EN 50438 **Nr. 14TH0075_EN50438_0**

Power Quality. Harmonic current emission					
micro-generator		SHP75-10			
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	109,086	100,000	Phase 1	-	-
2nd	0,598	0,548	Phase 1	8	8
3rd	1,907	1,748	Phase 1	21,6	N/A
4th	0,428	0,393	Phase 1	4	4
5th	0,565	0,518	Phase 1	10,7	10,7
6th	0,269	0,247	Phase 1	2,67	2,67
7th	0,239	0,219	Phase 1	7,2	7,2
8th	0,140	0,128	Phase 1	2	2
9th	0,289	0,265	Phase 1	3,8	N/A
10th	0,107	0,098	Phase 1	1,6	1,6
11th	0,151	0,139	Phase 1	3,1	3,1
12th	0,071	0,065	Phase 1	1,33	1,33
13th	0,123	0,113	Phase 1	2	2
14th	0,053	0,048	Phase 1	N/A	N/A
15th	0,082	0,075	Phase 1	N/A	N/A
16th	0,054	0,049	Phase 1	N/A	N/A
17th	0,158	0,145	Phase 1	N/A	N/A
18th	0,034	0,031	Phase 1	N/A	N/A
19th	0,118	0,108	Phase 1	N/A	N/A
20th	0,031	0,028	Phase 1	N/A	N/A
21th	0,047	0,043	Phase 1	N/A	N/A
22th	0,029	0,027	Phase 1	N/A	N/A
23th	0,086	0,078	Phase 1	N/A	N/A
24th	0,028	0,026	Phase 1	N/A	N/A
25th	0,071	0,065	Phase 1	N/A	N/A
26th	0,028	0,025	Phase 1	N/A	N/A
27th	0,043	0,039	Phase 1	N/A	N/A
28th	0,023	0,021	Phase 1	N/A	N/A
29th	0,055	0,050	Phase 1	N/A	N/A
30th	0,027	0,025	Phase 1	N/A	N/A
31th	0,045	0,041	Phase 1	N/A	N/A
32th	0,031	0,028	Phase 1	N/A	N/A
33th	0,033	0,031	Phase 1	N/A	N/A
34th	0,025	0,023	Phase 1	N/A	N/A
35th	0,051	0,046	Phase 1	N/A	N/A
36th	0,039	0,035	Phase 1	N/A	N/A
37th	0,037	0,034	Phase 1	N/A	N/A
38th	0,036	0,033	Phase 1	N/A	N/A
39th	0,043	0,039	Phase 1	N/A	N/A
40th	0,056	0,051	Phase 1	N/A	N/A
THD_{40}	-	2,03	Phase 1	13	13
PWHD	-	0,001	Phase 1	22	22

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Power Quality. Harmonic current emission					
micro-generator		SHP75-10			
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	109,061	100,000	Phase 2	-	-
2nd	0,624	0,572	Phase 2	8	8
3rd	1,821	1,670	Phase 2	21,6	N/A
4th	0,473	0,434	Phase 2	4	4
5th	0,555	0,509	Phase 2	10,7	10,7
6th	0,205	0,188	Phase 2	2,67	2,67
7th	0,167	0,153	Phase 2	7,2	7,2
8th	0,142	0,130	Phase 2	2	2
9th	0,290	0,265	Phase 2	3,8	N/A
10th	0,133	0,122	Phase 2	1,6	1,6
11th	0,144	0,132	Phase 2	3,1	3,1
12th	0,128	0,117	Phase 2	1,33	1,33
13th	0,149	0,137	Phase 2	2	2
14th	0,072	0,066	Phase 2	N/A	N/A
15th	0,104	0,096	Phase 2	N/A	N/A
16th	0,048	0,044	Phase 2	N/A	N/A
17th	0,167	0,153	Phase 2	N/A	N/A
18th	0,040	0,037	Phase 2	N/A	N/A
19th	0,120	0,110	Phase 2	N/A	N/A
20th	0,037	0,034	Phase 2	N/A	N/A
21th	0,064	0,059	Phase 2	N/A	N/A
22th	0,040	0,037	Phase 2	N/A	N/A
23th	0,083	0,076	Phase 2	N/A	N/A
24th	0,037	0,034	Phase 2	N/A	N/A
25th	0,079	0,072	Phase 2	N/A	N/A
26th	0,028	0,026	Phase 2	N/A	N/A
27th	0,050	0,045	Phase 2	N/A	N/A
28th	0,024	0,022	Phase 2	N/A	N/A
29th	0,055	0,051	Phase 2	N/A	N/A
30th	0,028	0,025	Phase 2	N/A	N/A
31th	0,058	0,053	Phase 2	N/A	N/A
32th	0,041	0,038	Phase 2	N/A	N/A
33th	0,056	0,051	Phase 2	N/A	N/A
34th	0,058	0,053	Phase 2	N/A	N/A
35th	0,035	0,032	Phase 2	N/A	N/A
36th	0,040	0,037	Phase 2	N/A	N/A
37th	0,043	0,039	Phase 2	N/A	N/A
38th	0,031	0,029	Phase 2	N/A	N/A
39th	0,034	0,031	Phase 2	N/A	N/A
40th	0,032	0,030	Phase 2	N/A	N/A
THD_{40}	-	1,97	Phase 2	13	13
PWHD	-	0,001	Phase 2	22	22

Appendix E Type Verification Test Report

Extract from test report according to EN 50438 **Nr. 14TH0075_EN50438_0**

Power Quality. Harmonic current emission					
micro-generator		SHP75-10			
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	109,104	100,000	Phase 3	-	-
2nd	0,617	0,566	Phase 3	8	8
3rd	1,850	1,696	Phase 3	21,6	N/A
4th	0,391	0,358	Phase 3	4	4
5th	0,537	0,492	Phase 3	10,7	10,7
6th	0,183	0,167	Phase 3	2,67	2,67
7th	0,163	0,150	Phase 3	7,2	7,2
8th	0,142	0,130	Phase 3	2	2
9th	0,279	0,256	Phase 3	3,8	N/A
10th	0,120	0,110	Phase 3	1,6	1,6
11th	0,140	0,128	Phase 3	3,1	3,1
12th	0,098	0,090	Phase 3	1,33	1,33
13th	0,136	0,124	Phase 3	2	2
14th	0,052	0,048	Phase 3	N/A	N/A
15th	0,081	0,074	Phase 3	N/A	N/A
16th	0,045	0,041	Phase 3	N/A	N/A
17th	0,161	0,147	Phase 3	N/A	N/A
18th	0,040	0,037	Phase 3	N/A	N/A
19th	0,106	0,097	Phase 3	N/A	N/A
20th	0,028	0,026	Phase 3	N/A	N/A
21th	0,048	0,044	Phase 3	N/A	N/A
22th	0,029	0,027	Phase 3	N/A	N/A
23th	0,071	0,065	Phase 3	N/A	N/A
24th	0,029	0,027	Phase 3	N/A	N/A
25th	0,057	0,052	Phase 3	N/A	N/A
26th	0,025	0,023	Phase 3	N/A	N/A
27th	0,043	0,039	Phase 3	N/A	N/A
28th	0,020	0,019	Phase 3	N/A	N/A
29th	0,042	0,038	Phase 3	N/A	N/A
30th	0,022	0,020	Phase 3	N/A	N/A
31th	0,045	0,041	Phase 3	N/A	N/A
32th	0,032	0,029	Phase 3	N/A	N/A
33th	0,048	0,044	Phase 3	N/A	N/A
34th	0,051	0,047	Phase 3	N/A	N/A
35th	0,043	0,039	Phase 3	N/A	N/A
36th	0,047	0,043	Phase 3	N/A	N/A
37th	0,044	0,040	Phase 3	N/A	N/A
38th	0,037	0,034	Phase 3	N/A	N/A
39th	0,030	0,028	Phase 3	N/A	N/A
40th	0,031	0,029	Phase 3	N/A	N/A
THD_{40}	-	1,96	Phase 3	13	13
PWHD	-	0,001	Phase 3	22	22

Appendix E Type Verification Test Report	
Extract from test report according to EN 50438	**Nr. 14TH0075_EN50438_0**

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	3,3%	3,3%	4,0%

DC-Injection.				
Protection limit	Tested at four power levels, limit 0,5% of IAC_{nom} (543mA)			
Output power	**~20%**	**~50%**	**75%**	**~100%**
Max. test value (phase L1) [mA]	1,48	5,09	3,85	13,02
Max. test value (phase L2) [mA]	25,76	24,35	23,91	19,44
Max. test value (phase L3) [mA]	38,99	37,64	39,97	38,37