

Applicant: KOSTAL Solar Electric GmbH
Hanferstraße 6
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Germany

Product: Photovoltaic Inverter with integrated automatic disconnection device between a generator and the public low-voltage grid

Model:	PIKO IQ						PLENTICORE plus					
	3.0	4.2	5.5	7.0	8.5	10	3.0	4.2	5.5	7.0	8.5	10
							3.0	4.2	5.5	7.0	8.5	10
							G2	G2	G2	G2	G2	G2
Rating: Output Power [kW]	3,0	4,2	5,5	7,0	8,5	10,0	3,0	4,2	5,5	7,0	8,5	10,0

Intended use:

An automatic disconnection device with three-phase mains surveillance in accordance with Engineering Recommendation G98 Issue 1 – Amendment 2 for photovoltaic systems with a three-phase parallel coupling via an inverter to the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter.

Applied standards and guidelines:

SOP-9-1_15 GCC Certification Program, 09/21

Based on:

Engineering Recommendation G98 Issue 1 – Amendment 3 March 2019

Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks on or after 27 April 2019

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

Report No: 17PP205-27_3

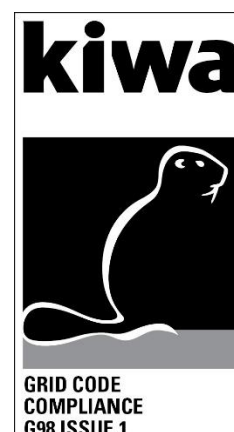
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Power Quality: Continuous voltage operation range					
Continuous frequency operation range					
Generating Unit tested to EN 50438:2013					
	U [V]	f [Hz]	Cos ϕ	P [kW]	Limit [%Sn]:
Test 1*	85%Un	47,50Hz	1,00	100%Sn	P $\geq$ 85%Sn
Measured 90min avg	195,6	47,50	0,998	-9,35	93,5
Test 2*	110%Un	51,50Hz	1,00	100%Sn	-
Measured 90min avg	253,5	51,50	0,997	-10,01	100,1
Test 3*	110%Un	52,00Hz	1,00	100%Sn	-
Measured 15min avg	253,1	52,00	0,998	-10,00	100,0



Power Quality: Harmonics				
Micro-Generator tested to BS EN 61000-3-2				
Micro-Generator rating per phase (rpp)		3,33	kW	
Harmonic	At 45-55% of Registered capacity	100% of Registered capacity		
	Measured Value (MV) in Amps	Measured Value (MV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0,019	0,030	1,080	
3	0,023	0,038	2,300	
4	0,023	0,023	0,430	
5	0,039	0,063	1,140	
6	0,046	0,042	0,300	
7	0,039	0,049	0,770	
8	0,014	0,014	0,230	
9	0,012	0,019	0,400	
10	0,010	0,012	0,184	
11	0,022	0,059	0,330	
12	0,032	0,036	0,153	
13	0,026	0,048	0,210	
14	0,014	0,014	0,131	
15	0,009	0,010	0,150	
16	0,007	0,004	0,115	
17	0,023	0,023	0,132	
18	0,007	0,012	0,102	
19	0,026	0,016	0,118	
20	0,004	0,007	0,092	
21	0,014	0,010	0,107	0,160
22	0,007	0,007	0,084	
23	0,033	0,012	0,098	0,147
24	0,006	0,006	0,077	
25	0,020	0,010	0,090	0,135
26	0,007	0,007	0,071	
27	0,010	0,004	0,083	0,124
28	0,004	0,004	0,066	
29	0,009	0,013	0,078	0,117
30	0,007	0,004	0,061	
31	0,007	0,014	0,073	0,109
32	0,009	0,006	0,058	
33	0,006	0,006	0,068	0,102
34	0,004	0,004	0,054	
35	0,007	0,013	0,064	0,096
36	0,003	0,003	0,051	
37	0,010	0,016	0,061	0,091
38	0,003	0,006	0,048	
39	0,006	0,006	0,058	0,087
40	0,003	0,004	0,046	



Power Quality: Voltage fluctuations and flicker								
	Starting			Stopping			Running	
	d _{max}	d _c	d _(t)	d _{max}	d _c	d _(t)	P _{st}	P _{lt} 2 hours
Measured Values at test impedance	-0,907	-0,742	-	1,249	1,222	-	0,074	0,074
Normalised to standard impedance	-0,907	-0,742	-	1,249	1,222	-	0,074	0,074
Normalised to required maximum impedance	N/A							
Limits set under BS EN 61000-3-11	4%	3,3%	3,3%	4%	3,3%	3,3%	1,0	0,65
Test impedance	R	0,24	Ω	X	0,15	Ω		
Standard impedance	R	0,24* 0,4^	Ω	X	0,15* 0,25^	Ω		
Maximum impedance	R	-	Ω	X	-	Ω		
Power Quality: DC injection.								
Test power level	20%		50%		75%		100%	
Recorded value in Amps	-0,010		-0,012		-0,013		-0,015	
As % of rated AC current	-0,07		-0,08		-0,09		-0,10	
Limit	0,25%		0,25%		0,25%		0,25%	
Power Quality: Power factor.								
	216,2V		230V		253V			
20% of Registered Capacity	0,985		0,985		0,984			
50% of Registered Capacity	0,990		0,990		0,990			
75% of Registered Capacity	0,994		0,994		0,993			
100% of Registered Capacity	0,995		0,995		0,994			
Limit	>0,95		>0,95		>0,95			



Protection: Frequency tests						
Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20,0s	47,49Hz	20,4s	47,7Hz 25s	No Trip
U/F stage 2	47,0Hz	0,5s	46,99Hz	978,8ms	47,2Hz 19,98s	No Trip
					46,8Hz 0,48s	No Trip
O/F stage 1	52,0Hz	0,5s	52,00Hz	977ms	51,8Hz 89,98s	No Trip
					52,2Hz 0,48s	No Trip
Protection: Voltage tests						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage	184,0V	2,5s	184,8V	2,912s	188,0V 3,5s	No Trip
					180,0V 2,48s	No Trip
O/V stage 1	262,2V	1.0s	262,4V	1,470s	258,2V 2,0s	No Trip
O/V stage 2	273,7V	0,5s	274,3V	947 ms	269,7V 0,98s	No Trip
					277,7V 0,48s	No Trip
Protection: Loss of Mains test and single phase test						
Note as an alternative, inverters can be tested to BS EN 62116. The following sub set of tests should be recorded in the following table.						
Test power and imbalance	33%	66%	100%	33%	66%	100%
	-5% Q	-5% Q	-5% P	+5% Q	+5% Q	+5% P
	Tests 22	Test 12	Test 5	Test 31	Test 21	Test 10
Trip time. Limit is 0.5s	466 ms	435 ms	458 ms	602 ms	467 ms	395 ms
Ph 1 removed	Confirm trip	Ph 2 removed	Confirm trip	Ph 3 removed	Confirm trip	
Protection: Frequency change, Vector Shift Stability test.						
	Start frequen- ecy	Change	Confirm no trip			
Positive vector shift	49,5Hz	+50 dregrees	No Trip			
Negative vector shift	50,5Hz	-50 dregrees	No Trip			
Protection: Frequency Change, RoCoF Stability Test						
Ramp range	Test frequency ramp	Test duration	Confirm no trip			
49,0 Hz to 51,0 Hz	+0,95Hz/s	2,1 s	No Trip			
51,0 Hz to 49,0 Hz	-0,95Hz/s	2,1 s	No Trip			



Protection: Limited Frequency Sensitive Mode – Overfrequency test					
Test sequence at Registered Capacity >80%		Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50,00 Hz± 0,01Hz		-10,01 kW	50,00 Hz	Network Simulator	-
Step b) 50,45 Hz± 0,05Hz		-9,90 kW	50,45 Hz		-0,1 %
Step c) 50,70 Hz± 0,10Hz		-9,40 kW	50,70 Hz		-0,1 %
Step d) 51,15 Hz± 0,05Hz		-8,51 kW	51,15 Hz		0,0 %
Step e) 50,70 Hz± 0,10Hz		-9,40 kW	50,70 Hz		-0,1 %
Step f) 50,45 Hz± 0,05Hz		-9,90 kW	50,45 Hz		-0,1 %
Step g) 50,00 Hz± 0,01Hz		-10,01 kW	50,00 Hz		-
Test sequence at Registered Capacity 40% - 60%		Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50,00 Hz± 0,01Hz		-5,00 kW	50,00 Hz	Network Simulator	-
Step b) 50,45 Hz± 0,05Hz		-4,95 kW	50,45 Hz		0,0 %
Step c) 50,70 Hz± 0,10Hz		-4,70 kW	50,70 Hz		0,0 %
Step d) 51,15 Hz± 0,05Hz		-4,25 kW	51,15 Hz		0,0 %
Step e) 50,70 Hz± 0,10Hz		-4,70 kW	50,70 Hz		0,0 %
Step f) 50,45 Hz± 0,05Hz		-4,96 kW	50,45 Hz		0,1 %
Step g) 50,00 Hz± 0,01Hz		-9,94 kW	50,00 Hz		-
Protection: Power output with falling frequency test					
Test sequence		Measured Active Power output	Frequency	Primary power source	
Test a) 50 Hz ± 0,01 Hz		9,79 kW	50,00 Hz	Network Simulator	
Test b) Point between 49,5 Hz and 49,6 Hz		9,79 kW	49,55 Hz	Network Simulator	
Test c) Point between 47,5 Hz and 47,6 Hz		9,79 kW	47,55 Hz	Network Simulator	
Protection: Re-connection timer.					
Time delay settings (s)	Measured delay (s)	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 10.5.7.1			
20	Max. 59,0	At 266,2V	At 180,0V	At 47,4Hz	At 52,1Hz
Confirmation that the Micro-generator does not re-connect		No Reconnection	No Reconnection	No Reconnection	No Reconnection



Fault Level contribution.					
For machines with electro-magnetic output			For inverter output		
L1					
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i _p	-	20ms	68,8	7,48
Initial Value of aperiodic current	A	-	100ms	23,6	0,41
Initial symmetrical short-circuit current	I _k	-	250ms	23,6	0,31
Decaying (aperiodic) component of short-circuit current	i _{DC}	-	500ms	23,4	0,39
Reactance/Resistance Ratio of source	X/R	-	Time to trip	0,024	In seconds
L2					
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i _p	-	20ms	44,8	6,56
Initial Value of aperiodic current	A	-	100ms	23,8	0,45
Initial symmetrical short-circuit current	I _k	-	250ms	23,4	0,42
Decaying (aperiodic) component of short-circuit current	i _{DC}	-	500ms	23,4	0,43
Reactance/Resistance Ratio of source	X/R	-	Time to trip	0,025	In seconds
L3					
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i _p	-	20ms	71,4	7,60
Initial Value of aperiodic current	A	-	100ms	23,7	0,35
Initial symmetrical short-circuit current	I _k	-	250ms	23,6	0,34
Decaying (aperiodic) component of short-circuit current	i _{DC}	-	500ms	23,65	0,34
Reactance/Resistance Ratio of source	X/R	-	Time to trip	0,024	In seconds
Self Monitoring solid state switching					
It has been verified that in the event of the solid state switching device failing to disconnect the Micro-Generator, the voltage on the output side of the switching device is reduced to a value below 50 volt within 0,5s.					N/A*
*There are no solid state switches in the unit. Mechanical relays are provided.					