

Certificate

Applicant: **KOSTAL Solar Electric GmbH**
Hanferstr. 6
79108 Freiburg i. Br.
Germany

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

Model:	PIKO MP plus 1.5-1	PIKO MP plus 2.0-1	PIKO MP plus 2.5-1	PIKO MP plus 3.0-1	PIKO MP plus 3.0-2	PIKO MP plus 3.6-1	PIKO MP plus 3.6-2	PIKO MP plus 4.6-2
Rating:	1500W	2000W	2500W	3000W		3680W		4600W

Intended use:

An automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G59/3 for photovoltaic systems with a single-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_11 GCC Certification Program, 04/18

Based on:

Engineering Recommendation G59/3-3

Issue 3 Amendment 3 February 2018

Recommendations for the connection of generating plant to the distribution systems of licensed distribution network operators

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.

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Tanja Rottach
Certification Engineer



Power Quality. Harmonics.

Generating Unit tested to BS EN 61000-3-12

Generating Unit rating per phase (rpp)			4,6	kVA	Harmonics % = Measured Value (Amps) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of rated output		100% of rated output		Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps*	%	Measured Value (MV) in Amps*	%	1 phase	3 phase
2	0,008	0,04	0,020	0,10	8%	8%
3	0,014	0,07	0,034	0,17	21,6%	Not stated
4	0,004	0,02	0,006	0,03	4%	4%
5	0,006	0,03	0,018	0,09	10,7%	10,7%
6	0,002	0,01	0,006	0,03	2,67%	2,67%
7	0,008	0,04	0,008	0,04	7,2%	7,2%
8	0,002	0,01	0,004	0,02	2%	2%
9	0,004	0,02	0,018	0,09	3,8%	Not stated
10	0,002	0,01	0,004	0,02	1,6%	1,6%
11	0,006	0,03	0,016	0,08	3,1%	3,1%
12	0,002	0,01	0,004	0,02	1,33%	1,33%
13	0,010	0,05	0,010	0,05	2%	2%
THD	-	0,300	-	0,388	23%	13%
PWHD	-	0,954	-	1,501	23%	22%

Generating Unit tested to BS EN 61000-3-2

Generating Unit rating per phase (rpp)			3,68	kW		
Harmonic	At 45-55% of rated output		100% of rated output			
	Measured Value (MV) in Amps	Normalized value NV in Amps	Measured Value (MV) in Amps	Normalized value NV in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0,011	0,011	0,066	0,066	1,080	
3	0,030	0,030	0,062	0,062	2,300	
4	0,003	0,003	0,019	0,019	0,430	
5	0,010	0,010	0,035	0,035	1,140	
6	0,003	0,003	0,016	0,016	0,300	
7	0,005	0,005	0,019	0,019	0,770	
8	0,002	0,002	0,011	0,011	0,230	
9	0,005	0,005	0,024	0,024	0,400	
10	0,002	0,002	0,008	0,008	0,184	
11	0,003	0,003	0,018	0,018	0,330	
12	0,002	0,002	0,008	0,008	0,153	
13	0,003	0,003	0,014	0,014	0,210	
14	0,002	0,002	0,006	0,006	0,131	
15	0,003	0,003	0,011	0,011	0,150	
16	0,002	0,002	0,005	0,005	0,115	
17	0,003	0,003	0,010	0,010	0,132	
18	0,002	0,002	0,005	0,005	0,102	
19	0,003	0,003	0,010	0,010	0,118	
20	0,002	0,002	0,005	0,005	0,092	
21	0,003	0,003	0,008	0,008	0,107	0,160

22	0,002	0,002	0,005	0,005	0,084	
23	0,003	0,003	0,008	0,008	0,098	0,147
24	0,002	0,002	0,005	0,005	0,077	
25	0,002	0,002	0,006	0,006	0,090	0,135
26	0,002	0,002	0,005	0,005	0,071	
27	0,002	0,002	0,006	0,006	0,083	0,124
28	0,002	0,002	0,005	0,005	0,066	
29	0,002	0,002	0,006	0,006	0,078	0,117
30	0,002	0,002	0,005	0,005	0,061	
31	0,002	0,002	0,006	0,006	0,073	0,109
32	0,002	0,002	0,005	0,005	0,058	
33	0,003	0,003	0,006	0,006	0,068	0,102
34	0,002	0,002	0,005	0,005	0,054	
35	0,002	0,002	0,006	0,006	0,064	0,096
36	0,002	0,002	0,005	0,005	0,051	
37	0,003	0,003	0,006	0,006	0,061	0,091
38	0,002	0,002	0,003	0,003	0,048	
39	0,002	0,002	0,005	0,005	0,058	0,087
40	0,002	0,002	0,005	0,005	0,046	

Power Quality. Voltage fluctuations and flicker

	Starting			Stopping from full load			Running	
	d _{max}	d _c	d _(t)	d _{max}	d _c	d _(t)	P _{st}	P _{It} 2 hours
Measured Values at test impedance	-3,99	-3,64	-	4,69	3,92	1260	0,16	0,15
Normalised to standard impedance	-3,99	-3,64	-	4,69	3,92	1260	0,16	0,15
Normalised to required maximum impedance	-3,36	-3,07	-	3,94	3,30	-	0,13	0,13
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	0,4	Ω	XI	0,25	Ω
Standard impedance	R	0,24* 0,4^	Ω	XI	0,15* 0,25^	Ω
Maximum impedance	R	0,34	Ω	XI	0,21	Ω

Power Quality. DC injection.

Test power level	10%	55%	100%
Recorded value in Amps	-0,003	-0,006	-0,012
As % of rated AC current	-0,02	-0,04	-0,08
Limit	0,25%	0,25%	0,25%

Power Quality. Power factor.

	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within + or - 1,5% of the stated level during test.
Measured Value	1,000	1,000	1,000	
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	47,54Hz	20,22s	47,7Hz 25s	No trip
U/F stage 2	47,0Hz	0,5s	47,04Hz	0,75s	47,2Hz 19,98s	No trip
					46,8Hz 0,48s	No trip
O/F stage 1	51,5Hz	90,0s	51,46Hz	90,21s	51,3Hz 95s	No trip
O/F stage 2	52,0Hz	0,5s	51,95Hz	0,72s	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 1	200,1V	2,5s	201,9V	2,75s	204,1V 3,5s	No trip
U/V stage 2	184,0V	0,5s	186,3V	0,75s	188,0V 2,48s	No trip
					180,0V 0,48s	No trip
O/V stage 1	262,2V	1,0s	260,1V	1,24s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	271,6V	0,75s	269,7V 0,98s	No trip
					277,7V 0,48s	No trip

a) 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% -5% Q Tests 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5s	0,09s	0,16s	0,15s	0,11s	0,09s	0,12s

Single phase test for multi phase **Generating Units**. Confirm that when generating in parallel with a network operating at around 50Hz with no network disturbance, that the removal of a single phase connection to the **Generating Unit**, with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.

Ph 1 removed	Confirm trip	Ph 2 removed	-	Ph 3 removed	-
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b) Protection. Frequency change, Stability test.

	Start frequency	Change	End frequency	Confirm no trip
Positive vector shift	49,5Hz	+9 degrees		No trip
Negative vector shift	50,5Hz	-9 degrees		No trip
Positive frequency drift	49,5Hz	+0,19Hz/sec	51,5Hz	No trip
Negative frequency drift	50,5Hz	-0,19Hz/sec	47,5Hz	No trip

c) 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	77,4	At 266,2V	At 196,1V	At 47,4Hz	At 51,6Hz
Confirmation that the Generating Unit does not re-connect		No re-connection	No re-connection	No re-connection	No re-connection

d) Fault Level contribution.

For machines with electro-magnetic output			For inverter output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	40,3	14,99
Initial Value of aperiodic current	A	N/A	100ms	22,5	0,03
Initial symmetrical short-circuit current	I_k	N/A	250ms	22,2	0,03
Decaying (aperiodic) component of short-circuit current	i_{DC}	N/A	500ms	22,3	0,03
Reactance/Resistance Ratio of source	X/R	N/A	Time to trip	0,031	In seconds

e) Self Monitoring solid state switching.

It has been verified that in the event of the solid state switching device failing to disconnect the Generating Plant, the voltage on the output side of the switching device is reduced to a value below 50 volt within 0,5s.

N/A