



Certificate of compliance

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

Product: Photovoltaic (PV) and battery inverter

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

Use in accordance with regulations:

Automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G98/1 for photovoltaic systems with a single-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, which can be accessed the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G98/1-4:2019

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

DIN V VDE V 0126-1-1:2006-02 (4.1 Functional safety)

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

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: 18TH0316-PIKO-Hybrid-G98-1_0 **Certification program:** NSOP-0032-DEU-ZE-V01
Certificate number: U20-0636 **Date of issue:** 2020-08-06

Certification body

Thomas Lammel

*Certification body Bureau Veritas Consumer Products Services Germany GmbH accredited according to DIN EN ISO/IEC 17065
A partial representation of the certificate requires the written approval of Bureau Veritas Consumer Products Services Germany GmbH*

Appendix C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1

Nr. 18TH0316-PIKO-Hybrid-G98-1_0

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G98/1.

PGM Technology	Photovoltaic inverter		
Manufacturer	KOSTAL Solar Electric GmbH		
Address	Hanferstraße 6 79108 Freiburg i. Br. Germany		
Tel	+49 (0) 2351 16-0	Fax:	+49 (0) 2351 16-2400
Email	info@kostal.com	Website:	www.kostal.com

Rated values	PIKO MP plus 1.5-1	PIKO MP plus 2.0-1	PIKO MP plus 2.5-1	PIKO MP plus 3.0-1
MPP DC voltage range [V]	75-360	75-360	75-360	125-600
Input DC voltage range [V]	Max 450	Max 450	Max 450	Max 750
Input DC current [A]	13	13	13	13
Output AC voltage [V]	230	230	230	230
Output AC current [A]	12	12	14	14
Output power [VA]	1500	2000	2500	3000

Rated values	PIKO MP plus 3.0-2	PIKO MP plus 3.6-1	PIKO MP plus 3.6-2	-
MPP DC voltage range [V]	125-600	150-600	150-600	-
Input DC voltage range [V]	Max 750	Max 750	Max 750	-
Input DC current [A]	13	13	13	-
Output AC voltage [V]	230	230	230	-
Output AC current [A]	14	16	16	-
Output power [VA]	3000	3680	3680	-

Firmware version	PU_APP_4.1.0 and PAR_23.0.10 or higher
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Measurement period:	14-05-2020 to 04-08-2020
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Description of the structure of the power generation unit:

The power generation unit is equipped with a PV and line-side EMC filter. The power generation unit has no galvanic isolation between DC input and AC output. Output switch-off is performed with single-fault tolerance based on two series-connected relays in line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

Differences between Generating Units:

The models PIKO MP plus 1.5-1, PIKO MP plus 2.0-1 and PIKO MP plus 2.5-1 have identical hardware and software. The different power are realized by software derating. The models PIKO MP plus 3.0-1, PIKO MP plus 3.0-2_2, PIKO MP plus 3.6-1 and PIKO MP plus 3.6-2 have similar hardware and software. The models PIKO MP plus 3.0-1 and PIKO MP plus 3.6-1 have one PV string and the models PIKO MP plus 3.0-2, PIKO MP plus 3.6-2 have two PV strings. The different powers are realized by software derating. The models PIKO MP plus 1.5-1, PIKO MP plus 2.0-1 and PIKO MP plus 2.5-1 have a different AC filter then the models PIKO MP plus 3.0-1, PIKO MP plus 3.0-2, PIKO MP plus 3.6-1 and PIKO MP plus 3.6-2.

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G98/1. 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 Engineering Recommendation G98/1.

Appendix C Type Test Verification Report

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Nr. 18TH0316-PIKO-Hybrid-G98-1_0

Operating Range.	
Test 1	Voltage = 85% of nominal (195,5 V) Frequency = 47,5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 2	Voltage = 110% of nominal (253 V) Frequency = 51,5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 3	Voltage = 110% of nominal (253 V) Frequency = 52,0 Hz Power Factor = 1 Period of test 15 minutes
Connection:	Always connected
Limit:	Always connected

Protection. Voltage tests.						
Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184	2,5	185,5	2,7	188V / 5s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	259,6	1,2	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	271,1	0,7	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

Note. For Voltage tests the Voltage required to trip is the setting $\pm 3,45V$. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting $\pm 4V$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

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Protection. Frequency tests.

Function	Setting		Trip test		No trip test	
	Frequency [Hz]	Time delay [s]	Frequency [Hz]	Time delay [s]	Frequency / time	Confirm no trip
U/F stage 1	47,5	20	47,51	20,181	47,7Hz / 30s	No trip
U/F stage 2	47	0,5	47,03	0,579	47,2Hz / 19,5s	No trip
					46,8Hz / 0,45s	No trip
O/F stage 2	52	0,5	51,97	0,669	51,8Hz / 120s	No trip
					52,2Hz / 0,45s	No trip

Note. For Frequency Trip tests the Frequency required to trip is the setting $\pm 0,1\text{Hz}$. In order to measure the time delay a larger deviation than the minimum required to operate the protection can be used. The "No-trip tests" need to be carried out at the setting $\pm 0,2\text{Hz}$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Protection. Loss of Mains.

Inverters tested according to BS 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. Ph1 fuse removed [s]	0,525	0,378	0,413	0,424	0,407	0,533

Note. Trip time limit is 0,5s.

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Protection. Re-connection timer.

Test should prove that the reconnection sequence starts in no less than 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 2.

Over Voltage				
Time delay setting		Measured delay		
20s		147		
Under Voltage				
Time delay setting		Measured delay		
20s		147		
Over Frequency				
Time delay setting		Measured delay		
20s		146		
Under Frequency				
Time delay setting		Measured delay		
20s		148		
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 180,0V	At 47,4Hz	At 52,1Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Protection. Frequency change, Stability test.

	Start Frequency [Hz]	Change	Test Duration	Confirm no trip
Positive Vector Shift	49,5	+50 degrees		No trip
Negative Vector Shift	50,5	-50 degrees		No trip
Positive Frequency drift	49,0 to 51,0	+0,95Hz/sec	2,1s	No trip
Negative Frequency drift	51,0 to 49,0	-0,95Hz/sec	2,1s	No trip

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Limited Frequency Sensitive Mode – Over Frequency

1-min mean value [Hz]:	a) 50,00	b) 50,45	c) 50,70	d) 51,15	e) 50,70	f) 50,45	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P_{expected} [kW]:	N/A	3,60	3,42	3,09	3,42	3,60	N/A
P_{measured} [kW]:	3,63	3,60	3,42	3,09	3,41	3,59	3,63
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P_{expected} [kW]:	N/A	1,79	1,70	1,54	1,70	1,79	N/A
P_{measured} [kW]:	1,81	1,78	1,69	1,53	1,69	1,78	2,00

Output Power with falling 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	49,50	47,60
Active power [W]:	3625	3618	3615
ΔP/P_{max} [%]:			0,1

Note.

For a CHP the test point a) at 50,00Hz is taken as Registered capacity (P_{max}) due to limited discrete operating points of the CHP's thermal process.

Electronic inverter no power reduction take place.

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Nr. 18TH0316-PIKO-Hybrid-G98-1_0

Power Quality. Harmonics.

PIKO MP plus 3.6-1

SSEG rating per phase (rpp)						
	At 45-55% of rated output 1,78 kW		100% of rated output 3,68 kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0,023	0,149	0,016	0,103	1,080	
3rd	0,065	0,418	0,023	0,146	2,300	
4th	0,007	0,045	0,006	0,040	0,430	
5th	0,026	0,164	0,007	0,047	1,140	
6th	0,005	0,030	0,004	0,026	0,300	
7th	0,011	0,071	0,006	0,036	0,770	
8th	0,004	0,027	0,003	0,020	0,230	
9th	0,012	0,080	0,008	0,054	0,400	
10th	0,003	0,020	0,003	0,017	0,184	
11th	0,015	0,098	0,007	0,047	0,330	
12th	0,003	0,017	0,002	0,015	0,153	
13th	0,008	0,049	0,003	0,016	0,210	
14th	0,003	0,022	0,002	0,015	0,131	
15th	0,003	0,020	0,003	0,020	0,150	
16th	0,002	0,016	0,002	0,013	0,115	
17th	0,003	0,018	0,002	0,014	0,132	
18th	0,002	0,015	0,002	0,013	0,102	
19th	0,003	0,018	0,002	0,014	0,118	
20th	0,002	0,015	0,002	0,012	0,092	
21th	0,003	0,018	0,002	0,015	0,107	0,160
22th	0,003	0,018	0,002	0,014	0,084	
23th	0,003	0,019	0,002	0,014	0,098	0,147
24th	0,003	0,018	0,002	0,013	0,077	
25th	0,003	0,020	0,002	0,014	0,090	0,135
26th	0,003	0,018	0,002	0,013	0,071	
27th	0,003	0,021	0,003	0,016	0,083	0,124
28th	0,003	0,018	0,002	0,013	0,066	
29th	0,003	0,021	0,002	0,014	0,078	0,117
30th	0,003	0,017	0,002	0,013	0,061	
31th	0,003	0,019	0,002	0,014	0,073	0,109
32th	0,003	0,018	0,002	0,012	0,058	
33th	0,003	0,021	0,002	0,014	0,068	0,102
34th	0,003	0,017	0,002	0,012	0,054	
35th	0,003	0,018	0,002	0,013	0,064	0,096
36th	0,003	0,018	0,002	0,012	0,051	
37th	0,003	0,017	0,002	0,012	0,061	0,091
38th	0,003	0,017	0,002	0,011	0,048	
39th	0,003	0,016	0,002	0,011	0,058	0,087
40th	0,003	0,016	0,002	0,011	0,046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

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Power Quality. Harmonics.

PIKO MP plus 1.5-1

SSEG rating per phase (rpp)						
	At 45-55% of rated output 0,75 kW		100% of rated output 1,50 kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0,014	0,216	0,009	0,146	1,080	
3rd	0,041	0,638	0,019	0,296	2,300	
4th	0,005	0,080	0,003	0,048	0,430	
5th	0,013	0,196	0,005	0,084	1,140	
6th	0,003	0,053	0,002	0,033	0,300	
7th	0,011	0,177	0,004	0,058	0,770	
8th	0,003	0,043	0,002	0,027	0,230	
9th	0,003	0,048	0,004	0,064	0,400	
10th	0,002	0,034	0,002	0,025	0,184	
11th	0,004	0,064	0,002	0,028	0,330	
12th	0,002	0,031	0,001	0,023	0,153	
13th	0,002	0,033	0,002	0,029	0,210	
14th	0,002	0,031	0,002	0,024	0,131	
15th	0,004	0,064	0,003	0,041	0,150	
16th	0,002	0,028	0,001	0,020	0,115	
17th	0,002	0,038	0,004	0,065	0,132	
18th	0,002	0,027	0,001	0,021	0,102	
19th	0,004	0,062	0,005	0,074	0,118	
20th	0,002	0,025	0,001	0,019	0,092	
21th	0,003	0,045	0,002	0,038	0,107	0,160
22th	0,001	0,023	0,001	0,019	0,084	
23th	0,002	0,035	0,002	0,034	0,098	0,147
24th	0,001	0,022	0,001	0,017	0,077	
25th	0,002	0,029	0,002	0,027	0,090	0,135
26th	0,001	0,023	0,001	0,018	0,071	
27th	0,002	0,025	0,001	0,023	0,083	0,124
28th	0,001	0,021	0,001	0,016	0,066	
29th	0,001	0,021	0,001	0,018	0,078	0,117
30th	0,001	0,023	0,001	0,019	0,061	
31th	0,001	0,019	0,001	0,015	0,073	0,109
32th	0,001	0,019	0,001	0,015	0,058	
33th	0,001	0,022	0,001	0,019	0,068	0,102
34th	0,001	0,018	0,001	0,015	0,054	
35th	0,001	0,019	0,001	0,016	0,064	0,096
36th	0,001	0,019	0,001	0,014	0,051	
37th	0,001	0,018	0,001	0,015	0,061	0,091
38th	0,001	0,017	0,001	0,014	0,048	
39th	0,001	0,018	0,001	0,016	0,058	0,087
40th	0,001	0,017	0,001	0,014	0,046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

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Nr. 18TH0316-PIKO-Hybrid-G98-1_0

Power Quality. Power factor.

Output power	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1,5\%$ of the stated level during the test.
20%	0,998	0,999	0,998	
50%	0,999	0,999	0,999	
75%	0,998	0,998	0,999	
100%	0,999	0,999	0,998	
Limit	>0,95	>0,95	>0,95	

Power Quality. Voltage fluctuation and Flicker.

	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured values at test impedance	2,78	1,98	0,0	2,78	1,98	0,0	0,455	0,439
Measured values at standard impedance	2,78	1,98	0,0	2,78	1,98	0,0	0,455	0,439
Values for maximum impedance	4,00	2,85	0,0	4,00	2,85	0,0	0,65	0,632
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65
Test impedance	R	0,4	Ω	XI		0,25	Ω	
	Z	0,472	Ω					
Standard impedance	R	0,4	Ω	XI		0,25	Ω	
	Z	0,472	Ω					
Maximum impedance	R	0,576	Ω	XI		0,360	Ω	
	Zmax	0,679	Ω					

Power Quality. DC injection.

PIKO MP plus 1.5-1

Test level power [%]	20	50	75	100
Recorded value [mA]	6,8	6,8	7,0	6,7
Recorded value [%]	0,04	0,04	0,04	0,04
Limit [%]	0,25	0,25	0,25	0,25

PIKO MP plus 3.6-1

Test level power [%]	20	50	75	100
Recorded value [mA]	3,6	2,8	2,6	2,3
Recorded value [%]	0,02	0,02	0,02	0,01
Limit [%]	0,25	0,25	0,25	0,25

Note. DC-injection is tested at each phase of the inverter and a limit of 0,25% per phase was used as pass criteria.

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Fault level Contribution.

For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts [V]	Amps [A]
Peak Short Circuit current	I_p	N/A	20ms	27,7	0,94
Initial Value of aperiodic current	A	N/A	100ms	27,7	0,94
Initial symmetrical short-circuit current*	I_k	N/A	250ms	27,7	0,04
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	27,7	0,04
Reactance/Resistance Ratio of source*	X/R	N/A	Time to Trip [s]	0,02	

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the Generating Unit terminals.

* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.

Self Monitoring – Solid state switching.	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the Generating Unit, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
Note. Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open (Functional safety of the internal automatic disconnection device according to VDE 0126-1-1).	

Logic Interface (input port) Required by paragraph 11.1.3	P
Confirm that an input port is provided and can be used to shut down the module.	Yes