CERTIFICATE

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

Product: **Hybrid Inverter (Battery/PV) with integrated automatic disconnection device between a generator and the public low-voltage grid**

Model: **PLENTICORE L G3**
PLENTICORE M G3
PLENTICORE S G3

Intended use:

Hybrid inverter in accordance with EN 50549-1 with three-phase parallel coupling to the distribution network. 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:
EN 50549-1:2019
Requirements for generating plants to be connected in parallel with distribution networks Part 1: Connection to a LV distribution network - Generating plants up to and including Type B

Tested according to:
EN 50549-10:2022
Requirements for generating plants to be connected in parallel with distribution networks Part 10: Tests for conformity assessment of generating units

The generating plant(s) are also considered to be compliant with the relevant Articles of Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG), provided, that all settings as provided by the DSO and the responsible party are complied with.

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: 22PP512-06_0

Certificate No: 24-424-00

Date of issue: 2024-12-19

Tanja Rottach
- Digitally signed | see http://ca.kiwa-deutschland.de for more details -

Tanja Rottach
Certification Engineer

GRID CODE COMPLIANCE EN 50549-1

Kiwa Primara GmbH
Gewerbestraße 28 - 32
87600 Kaufbeuren
Germany
Tel. +49 8341 99726-0
primara@kiwa.com
www.kiwa.de

DAkkS Deutsche Akkreditierungsstelle D-ZE-12089-01-00

	Parameter table acc. EN50549-10:2022 (Parameters as declared by the manufacturer and not according to a specific grid code. Additional testing for deviation to a specific grid code can be necessary)						
Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20					
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**		**Minimum step size**	**Considered value range**
4.4.2 Operating frequency range	47,0 – 47,5 Hz Duration		not configurable	unlimited		NA	47Hz
	47,5 – 48,5 Hz Duration		not configurable	unlimited		NA	
	48,5 – 49,0 Hz Duration		not configurable	unlimited		NA	
	49,0 – 51,0 Hz Duration		not configurable	unlimited		NA	
	51,0 – 51,5 Hz Duration		not configurable	unlimited		NA	
	51, 5 – 52 Hz Duration		not configurable	unlimited		NA	53Hz
4.4.3 Minimal requirement for active power delivery at underfrequency	Reduction threshold		not configurable	49,0 Hz		NA	
	Maximum reduction rate		not configurable	<1%/Hz		NA	<1%/Hz
4.4.4 Continuous operating voltage range	Upper limit		not configurable	120,0% U_n		NA	120% U_n
	Lower limit		not configurable	80,0% U_n		NA	80% U_n
4.5.2 Rate of change of frequency (ROCOF) immunity	ROCOF withstand capability (defined with a sliding measurement window of 500 ms) non-synchronous generating technology: synchronous generating technology:		not defined	≥ 4 Hz/s		NA	4 Hz/s
4.5.3.2 Under-voltage ride through (UVRT) Generating plant with non-synchronous generating technology	Maximum power resumption time	Service menu / UVRT/OVRT / Common / Ramp time	0 s ... 15 s	0,5 s			
	Voltage-Time-Diagram		not configurable	Time [s]	U [p.u.]		
				0,0	0,0	NA	
				1,0	0,0	NA	
				5,0	0,8	NA	
				> 5,0	0,8	NA	
4.5.3.3 Under-voltage ride through (UVRT)	Maximum power resumption time		NA	NA		NA	
	Voltage-Time-Diagram		N/A	Time [s]	U [p.u.]		

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Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20					
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**		**Minimum step size**	**Considered value range**
Generating plant with synchronous generating technology				NA	NA	NA	
4.5.4 Over-voltage ride through (OVRT)	Voltage-Time-Diagram		not configurable	Time [s]	U [p.u.]		
				0,0	1,3	NA	
				0,6	1,3	NA	
				0,6	1,2	NA	
				> 0,6	1,2	NA	
4.6.1 Power response to overfrequency	Threshold frequency f1	Service menu / P(f) / Overfrequency characteristic curve / Start frequency	50,0 Hz ... 52,0 Hz	50,2 Hz enabled		0,01Hz	50,1Hz ... 51Hz
	Droop	Service menu / P(f) / Overfrequency characteristic curve / Droop	1,0 % ... 12,0 %	5,0 %		0,01%	1 % ... 12 %
	Power reference	Service menu / P(f) / Overfrequency characteristic curve / Reference power relates to	P_{max} | P_{mom}	P_{mom}			P_{max} P_{mom}
	Intentional delay	Service menu / P(f) / Delay time	0 s ... 600 s	0,0 s		10ms	0s ... 10s
	Deactivation threshold fstop	Service menu / P(f) / Conditions for returning to	47,5 Hz ... 52,0 Hz	50,2 Hz		0,01 Hz	50,0Hz ... 52,0Hz

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Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20				
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**	**Minimum step size**	**Considered value range**
		normal mode / Frequency range				
	Deactivation time tstop	Service menu / P(f) / Conditions for returning to normal mode / Waiting time	0 s ... 900 s	30,0 s	0,1s	0s ... 900s
	Acceptance of staged disconnection		not configurable	N/A	NA	
4.6.2 Power response to underfrequency	Threshold frequency f1	Service menu / P(f) / Underfrequency characteristic curve / Start frequency	0,0 Hz ... 50,0 Hz	49,8 Hz enabled	0,01 Hz	49,0Hz ... 50,0Hz
	Droop	Service menu / P(f) / Underfrequency characteristic curve / Droop	1,0 % ... 12,0 %	5,0 %	0,01%	1 ... 12 %
	Power reference	Service menu / P(f) / Underfrequency characteristic curve / Reference power relates to	P_{max} | P_{mom}	P_{max}		P_{max} P_{mom}
	Intentional delay	Service menu / P(f) / Delay time	0 s ... 600 s	0,0 s	0,01s	0s ... 10s
4.7.2.2 voltage support by reactive power - Capabilities	Active factor / Reactive power range overexcited		not configurable	0,8 / 98,8 %S_n		
	Active factor / Reactive power range underexcited		not configurable	0,8 / 98,8 %S_n		
4.7.2.3 voltage support by reactive power – Control modes	Enabled control mode	Service menu / Reactive power settings /	Q setp. | Q(U) | cos φ setp. | cos φ (P)	cos φ setp.		

	Parameter table acc. EN50549-10:2022 (Parameters as declared by the manufacturer and not according to a specific grid code. Additional testing for deviation to a specific grid code can be necessary)					
Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20				
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**	**Minimum step size**	**Considered value range**
		Reactive power specification				
4.7.2.3.2 voltage support by reactive power - Set point control modes	Q setpoint and excitation	Service menu / Reactive power settings / Reactive power specification /Reactive power Q	98,8 %*S_n oe ... 98,8 %*S_n ue	0,0 % disabled	0,01%	
	cos φ setpoint and excitation	Service menu / Reactive power settings / Reactive power specification / Displacement factor cos φ	0,8 oe ... 0,8 ue	1,00 enabled	0,01	
4.7.2.3.3 voltage support by reactive power – Voltage related control modes	Characteristic curve	Service menu / Reactive power settings / Reactive power specification / Reactive power/voltage characteristic curve Q(U)	(0 % ... 120 % U_n ; 98,8 %ue ... 98,8 %oe S_n)	(93,0 % ; 43,6 % oe) (97,0 % ; 0,0 %) (103,0 % ; 0,0 %) (107,0 % ; 43,6 % ue) disabled	U: 1% U_n Q: 0,01% S_n	80% ... 120% U_n; 98,8%S_n ue ... 98,8%S_n oe
	Time constant	Service menu / Reactive power settings / Reactive power specification / Reactive power/voltage characteristic	0,2 s ... 60,0 s	10,0 s	0,01s	0,2 s ... 60 s

	Parameter table acc. EN50549-10:2022 **(Parameters as declared by the manufacturer and not according to a specific grid code. Additional testing for deviation to a specific grid code can be necessary)**					
Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20				
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**	**Minimum step size**	**Considered value range**
		curve Q(U) / Settling time				
	Min cos φ	Service menu / Reactive power settings / Reactive power specification / Reactive power/voltage characteristic curve Q(U) / Minimum cos φ	0,16 ... 1,0	0,90	0,01	0,16 ... 0,95
	Lock in power	Service menu / Reactive power settings / Reactive power specification / Reactive power/voltage characteristic curve Q(U) / Activation power	0 % ... 100 % P_n	disabled	0,01%	0% ... 20%
	Lock out power	Service menu / Reactive power settings / Reactive power specification / Reactive power/voltage characteristic curve Q(U) / Activation power	0 % ... 100 % P_n	disabled	0,01%	0% ... 20%
4.7.2.3.4 voltage support by reactive power –	Characteristic curve	Service menu / Reactive power settings / Reactive power	(0 % ... 100 % P_n ; 0,8 %ue ... 0,8 %oe)	(50,00 ; 1,00) (50,00 ; 1,00) (50,00 ; 1,00) (100,00 ; 0,90 ue)	P: 1% P_n cos φ: 0,01	

	Parameter table acc. EN50549-10:2022 **(Parameters as declared by the manufacturer and not according to a specific grid code. Additional testing for deviation to a specific grid code can be necessary)**					
Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20				
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**	**Minimum step size**	**Considered value range**
Power related control mode		specification / Displacement factor/power curve cos φ (P)		disabled		
4.7.3 Voltage related active power reduction	Enabling	Service menu / P(U)/ Activation	enabled | disabled	disabled		
	Characteristic curve	Service menu / P(U)/ Reduction Curve	0 % ... 200 % U_n	(110,0 %U_n; 100 %P_n) (112,0 %U_n; 0 %P_n)	0,01%U_n	100% ... 120%
	Control Logic	Service menu / P(U)/ Reduction Curve /Limitation Process	absolute limitation | relative limitation	absolute limitation		
	Time constant	Service menu / P(U) / Settling Time	0,2 s ... 60 s	1,0 s	0,01s	0,2 s ... 60 s
only EN 50549-2:2019, 4.7.4.2.1 Voltage support during faults and voltage steps – General / Generating Plant with non-synchronous generator	Enabling		NA	NA		
	Static voltage range overvoltage		NA	NA		
	Static voltage range undervoltage		NA	NA		
	Insensitivity range of ΔU50per		NA	NA		
	Gradient k1		NA	NA		
	Gradient k2		NA	NA		
only EN 50549-2:2019, 4.7.4.2.1.2 Optional Modes / Generating Plant with non-synchronous generator	Active power priority		NA	NA		
	Reactive current limitation [% rated current]		NA	NA		
	Zero current threshold		NA	NA		

	Parameter table acc. EN50549-10:2022 **(Parameters as declared by the manufacturer and not according to a specific grid code. Additional testing for deviation to a specific grid code can be necessary)**					
Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20				
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**	**Minimum step size**	**Considered value range**
4.7.4.2.2 Zero current mode for converter connected generating technology / Generating Plant with non-synchronous generator	Enabling	Service menu / UVRT/OVRT / LVRT/HVRT configuration	enabled | disabled	disabled		
	Static voltage range overvoltage	Service menu / UVRT/OVRT / OVRT / Entry threshold	105 % ... 150 % U_n	120,0 %	0,1 %	105 % ... 125 %
	Static voltage range undervoltage	Service menu / UVRT/OVRT / UVRT / Entry threshold	0 % ... 95 % U_n	50,0 %	0,1 %	10 % ... 95 %
4.9.2 Requirements on voltage and frequency protection	Threshold for protection as dedicated device [in A or kW, kVA]	NA	16 A – 250 kVA	NA	NA	
	Undervoltage threshold stage 1	Service menu / Grid and system protection / Shutdown limits for voltage / Lower limits / L-N min.	0,0 V ... 310,5 V	195,5 V	0,01 V	15%...100%
	Undervoltage operate time stage 1	Service menu / Grid and system protection / Shutdown limits for voltage / Lower limits / Time	0,0 s ... 3600 s	1,50 s	0,01 s	0,0s…10,0s
	Undervoltage threshold stage 2	Service menu / Grid and system protection / Shutdown limits for voltage / Lower limits / L-N min.	0,0 V ... 310,5 V	disabled	0,01 V	15%…100%

	Parameter table acc. EN50549-10:2022 (Parameters as declared by the manufacturer and not according to a specific grid code. Additional testing for deviation to a specific grid code can be necessary)					
Parameter setting name in the generating unit:		EN50549-1 2019 ≥SW3.03.20				
Clause(s) / subclause(s) of EN50549-1 or EN 50549-2:2019	**Parameter**	**Parameter name in the generating unit**	**Configurable range**	**Default value**	**Minimum step size**	**Considered value range**
	Undervoltage operate time stage 2	Service menu / Grid and system protection / Shutdown limits for voltage / Lower limits / Time	0,0 s ... 3600 s	disabled	0,01 s	0,0s…10,0s
	Overvoltage threshold stage 1	Service menu / Grid and system protection / Shutdown limits for voltage / Upper limits / L-N max.	0,0 V ... 310,5 V	disabled	0,01 V	100%…130%
	Overvoltage operate time stage 1	Service menu / Grid and system protection / Shutdown limits for voltage / Upper limits / L-N max.	0,0 s ... 3600 s	disabled	0,01 s	0,0s…10,0s

	Overvoltage threshold stage 2	Service menu / Grid and system protection / Shutdown limits for voltage / Upper limits / L-N max.	0,0 V ... 310,5 V	264,5 V	0,01 V	100%…130%
	Overvoltage operate time stage 2	Service menu / Grid and system protection / Shutdown limits for voltage / Upper limits / Time	0,0 s ... 3600 s	0,20 s	0,01 s	0,0s…10,0s
	Overvoltage threshold 10 min mean protection	Service menu / Grid and system protection / Shutdown limits for voltage / Use 10-minute average value	0,0 V ... 310,5 V	253,0 V	0,01 V	100%...130%
	Underfrequency threshold stage 1	Service menu / Grid and system protection / Shutdown limits for frequency / Lower limits / L-N min.	0,0 Hz ... 65,0 Hz	47,50 Hz	0,01 Hz	
	Underfrequency operate time stage 1	Service menu / Grid and system protection / Shutdown limits for frequency / Lower limits / Time	0,0 s ... 3600 s	0,50 s	0,01 s	0,0s…10,0s

	Underfrequency threshold stage 2	Service menu / Grid and system protection / Shutdown limits for frequency / Lower limits / L-N min.	0,0 Hz ... 65,0 Hz	disabled	0,01 Hz	
	Underfrequency operate time stage 2	Service menu / Grid and system protection / Shutdown limits for frequency / Lower limits / Time	0,0 s ... 3600 s	disabled	0,01 s	0,0s…10,0s
	Overfrequency threshold stage 1	Service menu / Grid and system protection / Shutdown limits for frequency / Lower limits / Time	0,0 Hz ... 65,0 Hz	52,00 Hz	0,01 Hz	
	Overfrequency operate time stage 1	Service menu / Grid and system protection / Shutdown limits for frequency / Upper limits / Time	0,0 s ... 3600 s	0,50 s	0,01 s	0,0s…10,0s
	Overfrequency threshold stage 2	Service menu / Grid and system protection / Shutdown limits for frequency / Upper limits / L-N max.	0,0 Hz ... 65,0 Hz	disabled	0,01 Hz	

	Overfrequency operate time stage 2	Service menu / Grid and system protection / Shutdown limits for frequency / Upper limits / Time	0,0 s ... 3600 s	disabled	0,01 s	0,0s…10,0s

only EN 50549-2:2019, 4.9.3 Requirements on voltage and frequency protection	Positive sequence under-voltage protection threshold	NA	NA			
	Positive sequence under-voltage protection operate time	NA	NA			
	Negative sequence over-voltage protection threshold	NA	NA			
	Negative sequence over-voltage protection operate time	NA	NA			
	Zero sequence overvoltage protection threshold	NA	NA			
	Zero sequence overvoltage protection operate time	NA	NA			
4.10.2 Automatic reconnection after tripping	Lower frequency	Service menu / Grid and system protection / Conditions for starting up after a grid error / Starting min.	0,0 Hz ... 65,0 Hz	49,50 Hz	0,01 Hz	
	Upper frequency	Service menu / Grid and system protection / Conditions for starting up after a grid error / Starting max.	0,0 Hz ... 65,0 Hz	50,20 Hz	0,01 Hz	
	Lower voltage	Service menu / Grid and system protection / Conditions for starting up after a grid error / Starting L-N min	0,0 V ... 310,5 V	195,5 V	0,01 V	
	Upper voltage	Service menu / Grid and system protection /	0,0 V ... 310,5 V	253,0 V	0,01 V	

		Conditions for starting up after a grid error / Starting L-N max.				
	Observation time	Service menu / Grid and system protection / Conditions for starting up after a grid error / Waiting time	0,0 s ... 3600 s	60 s	0,01 s	
	Active power increase gradient	Service menu / Start-up ramp / Ramp after grid error / Gradient	1 %/min ... 6000%/min	10 %/min	1 %/min	
4.10.3 Starting to generate electrical power	Lower frequency	Service menu / Grid and system protection / Start-up conditions / Starting min.	0,0 Hz ... 65,0 Hz	49,50 Hz	0,01 Hz	
	Upper frequency	Service menu / Grid and system protection / Start-up conditions / Starting max.	0,0 Hz ... 65,0 Hz	50,10 Hz	0,01 Hz	
	Lower voltage	Service menu / Grid and system protection / Start-up conditions / Starting L-N min.	0,0 V ... 310,5 V	195,5 V	0,01 V	
	Upper voltage	Service menu / Grid and system protection / Start-up conditions / Starting L-N max.	0,0 V ... 310,5 V	253,0 V	0,01 V	
	Observation time	Service menu / Grid and system protection / Start-up conditions / Waiting time	0,0 s ... 3600 s	60 s	0,01 s	
	Active power increase gradient	Service menu / Start-up ramp / Ramp after	1 %/min ... 6000%/min	disabled	1%/min	

		normal start / Gradient				
4.11.1 Ceasing active power	Remote operation of the logic interface		Digital Input; ModBus; Sunspec (TCP)			
4.11.2 Reduction of active power on set point	Remote operation		Digital Input; ModBus; Sunspec (TCP)			
	Active power gradient high priority	Service menu / settling time / high priority	0,001 %/s ... 6000 %/s	Ramp: 0,5 %/s enabled	0,001%/s	
	Active power gradient low priority	Service menu / settling time / low priority	0,001 %/s ... 100 %/s	Ramp: 0,5 %/s enabled	0,001%/s	
4.12 Remote information exchange	Remote information exchange required		ModBus; Sunspec (TCP)			

Clause(s) / subclause(s) of EN50549-1:2019 or EN50549-2:2019	Applicable Clause(s) / subclause(s) of EN 50549-10:2022	Remarks, optional modes and constraints	Verdict
4.4.2 Operating frequency range 4.4.3 Minimal requirement for active power delivery at underfrequency 4.4.4 Continuous operating voltage range	5.2.1 Voltage operating range 5.2.2 Frequency operating range		**P**
4.5.2 Rate of change of frequency (ROCOF) immunity	5.3.1 Immunity to disturbances - Rate of change of frequency (ROCOF)		**P**
-	5.3.2 Phase jump		**P**
4.5.3.2 Generating plant with non-synchronous generating technology 4.5.3.3 Generating plant with synchronous generating technology 4.5.4 Over-voltage ride through (OVRT)	5.3.3 Immunity to disturbances - Fault ride through, over-voltage (OVRT) and under-voltage (UVRT)	zero current mode	**P**
4.6.1 Power response to overfrequency	5.4.3.2 Power response to over-frequencies		**P**
4.6.2 Power response to underfrequency	5.4.3.3 Power response to under-frequency		**P**
4.7.2.2 Voltage support by reactive power, Capabilities	5.5.1 Power capabilities assessment - voltage support by reactive power		**P**
4.7.2.2 Voltage support by reactive power, Capabilities	5.5.1.6 Verification procedure for reactive power capability considering voltage range		**P**
4.7.2.3.2 Set point control modes	5.5.2.3 Verification procedure for Set point control	Q-Control Cosphi-Control	**P**

Clause(s) / subclause(s) of EN50549-1:2019 or EN50549-2:2019	Applicable Clause(s) / subclause(s) of EN 50549-10:2022	Remarks, optional modes and constraints	Verdict
4.7.2.3 Voltage support by reactive power, Control modes	5.5.2.4 Verification procedure for voltage related control mode for reactive power Q(U)	Q(U)	**P**
4.7.2.3.3 Voltage related control Modes 4.7.2.3.4 Power related control mode	5.5.2.5 Verification procedure for power related control modes for reactive power	Cosphi(P)	**P**
4.7.3 Voltage related active power reduction	5.6 Voltage related active power reduction - P(U)	P(U)	**P**
4.8 EMC and power quality	5.7.1 EMC	See reference report [R1]	**P**
	5.7.2.2 Verification procedure for harmonics, interhamonics and higher frequencies up to 9 kHz		**P**
	5.7.2.3 Verification procedure for flicker and rapid voltage changes		**P**
	5.7.2.4 Verification procedure for DC injection		**P**
4.9.3 Requirements on voltage and frequency protection	5.8.3.2 Voltage and frequency protections		**P**
4.9.3 Requirements on voltage and frequency protection	5.8.3.3 Overvoltage 10 min mean protection		**P**
4.9.3 Requirements on voltage and frequency protection	5.8.3.4 ROCOF protection		**P**
4.9.3 Requirements on voltage and frequency protection	5.8.4 Verification procedure for generating plants to be connected to a LV distribution network with Interface protection as dedicated device		**N/A**
	5.8.5 Verification procedure for generating plants to be connected to a MV distribution network		**N/A**
4.9.4 Means to detect island situation	5.8.6 Islanding detection	See reference report [R3]	**P**

Clause(s) / subclause(s) of EN50549-1:2019 or EN50549-2:2019	Applicable Clause(s) / subclause(s) of EN 50549-10:2022	Remarks, optional modes and constraints	Verdict
4.10.2 Automatic reconnection after tripping	5.9.3 Automatic reconnection after tripping		**P**
4.10.3 Starting to generate electrical power	5.9.4 Starting to generate electrical power		**P**
4.10.4 Synchronization	5.9.7 Synchronization		**N/A**
4.11.1 Ceasing active power	5.10 Active power reduction on set point		**P**
4.13 single fault tolerance of interface protection system and interface switch	5.12.2 Single fault tolerance of the interface protection system	See reference report [R2]	**P**
	5.13 Model definition and model validation for generating units of synchronous generating technology		**N/A**