



CERTIFICATE

Applicant: Victron Energy B.V.
De Paal 35
1351 JG Almere
Netherlands

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

Model: Multi RS Solar 48/6000/100-450/100

Intended use:

Hybrid inverter in accordance with EN 50549-1 with single-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.

Limitation:

- Limited to Type A modules.
- The VRT capability was not evaluated.

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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: Europe: "EN50549-1:2019"

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	N/A	0 – 20 s	0s		Device can operate in under- and over-frequency for an unlimited time. This is ambient temperature dependent										
	47,5 – 48,5 Hz Duration	N/A	30 – 90 min	30 min												
	48,5 – 49,0 Hz Duration	N/A	30 – 90 min	30 min												
	49,0 – 51,0 Hz Duration	N/A	not configurable	unlimited												
	51,0 – 51,5 Hz Duration	N/A	30 – 90 min	30 min												
	51, 5 – 52 Hz Duration	N/A	0 – 15 min	0 s												
4.4.3 Minimal requirement for active power delivery at underfrequency	Reduction threshold	N/A	49 Hz – 49,5 Hz	49,5 Hz		Power reduction due to low frequency is lower than the most stringent allowable reduction. The long-term reduction is ambient temperature dependent.										
	Maximum reduction rate	N/A	2 – 10 % PM/Hz	10 % PM/Hz												
4.4.4 Continuous operating voltage range	Upper limit	N/A	not configurable	110% Un												
	Lower limit	N/A	not configurable	85% Un												
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:	N/A	not defined			<table border="1"> <thead> <tr> <th>Time</th> <th>Limit</th> </tr> </thead> <tbody> <tr> <td>200ms</td> <td>>3Hz/s</td> </tr> <tr> <td>500ms</td> <td>>2.25Hz/s</td> </tr> <tr> <td>1s</td> <td>>1.75Hz/s</td> </tr> <tr> <td>2s</td> <td>>1.5Hz/s</td> </tr> </tbody> </table>	Time	Limit	200ms	>3Hz/s	500ms	>2.25Hz/s	1s	>1.75Hz/s	2s	>1.5Hz/s
Time	Limit															
200ms	>3Hz/s															
500ms	>2.25Hz/s															
1s	>1.75Hz/s															
2s	>1.5Hz/s															
4.5.3.2 Under-voltage ride	Maximum power resumption time	N/A	not defined	1 s		UVRT not applicable (Type A device)										



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
through (UVRT) Generating plant with non-synchronous generating technology	Voltage-Time-Diagram	N/A	see Figure 6 of EN 50549-1:2019 and EN 50549-2:2019	Time [s]	U [p.u.]		
		N/A		0,0	0,2		
		N/A		0,15	0,2		
		N/A		1,5	0,85		
4.5.3.3 Under-voltage ride through (UVRT) Generating plant with synchronous generating technology	Maximum power resumption time	N/A	not defined	3 s			Inverter based technology
	Voltage-Time-Diagram	N/A	see Figure 7 of EN 50549-1:2019 and EN 50549-2:2019	Time [s]	U [p.u.]		
		N/A		0,0	0,3		
		N/A		0,15	0,3		
		N/A		0,15	0,7		
		N/A		0,7	0,7		
N/A	1,5	0,85					
4.5.4 Over-voltage ride through (OVRT)	Voltage-Time-Diagram	N/A	Not configurable see Figure 8 of EN 50549-1:2019 and EN 50549-2:2019	Time [s]	U [p.u.]		OVRT not applicable (Type A device)
		N/A		0,0	1,22		
		N/A		0,1	1,22		
		N/A		0,1	1,20		
		N/A		5,0	1,20		
		N/A		5,0	1,15		
		N/A		60	1,15		
		N/A		60	1,10		
4.6.1 Power response to over-frequency	Threshold frequency f1	Start freq f>	50 Hz – 55 Hz	50.2 Hz		0.025 Hz	
	Droop	Droop f>	1 % – 12.5 %	5 %		0.05 %	
	Power reference	N/A	Pmax	Pmax, for synchronous Generating technology and EESS PM for other		-	



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
				nonsynchronous Generating technology		
	Intentional delay	Start delay f>	0 – 3.1 s	0 s	0.1 s	
	Deactivation threshold fstop	Stop freq f>	50.0 Hz – f1	Equal to start freq	0.025 Hz	
	Deactivation time tstop	Stop delay f>	0 – 600 s	30 s	0.5 s	
	Acceptance of staged disconnection	N/A	yes no	yes		
4.6.2 Power response to underfrequency	Threshold frequency f1	Start freq f<	50 Hz – 46 Hz	49.8 Hz	0.025 Hz	
	Droop	Droop f<	1 – 12.5 %	5 %	0.05%	
	Power reference	N/A	Pmax	Pmax	-	
	Intentional delay	Start delay f<	0 – 3.1 s	0 s	0.1 s	
4.7.2.2 voltage support by reactive power - Capacibilities	Active factor / Reactive power (%Sr) range overexcited	Cos phi / Q	0,8 – 1 / 60% Sr - 0	1.0 / 0	0.01 / 0.1% Sr	
	Active factor / Reactive power (%Sr) range underexcited	Cos phi / Q	-0,8 – 1 / -60% Sr - 0	1.0 / 0	0.01 / 0.1% Sr	
4.7.2.3 voltage support by reactive power – Control modes	Enabled control mode	Reactive power regulation	Q setp. Q (U) cos φ setp. cos φ (P)	cos φ setp. cos phi = 1		
4.7.2.3.2 voltage support by reactive power - Set point control modes	Q setpoint and excitation	Use a fixed Q	0 – 60 % Sr	0	0.1 % Sr	
	cos φ setpoint and excitation	Use a fixed cos phi	1 – 0.8	1	0.01	
	Time constant	Filter time reactive power	1 – 60 s	3.3 s	0.1 s	
4.7.2.3.3 voltage support by reactive power – Voltage related control modes	Characteristic curve	Q as function of input voltage	0 – 60% Sr / 80 – 120% Un	43.6%Sr 93%Un 0.0%Sr 97%Un 0.0%Sr 103%Un -43.6%Sr 107%Un	0.1% Sr / 0.25% Un	
	Time constant	Filter time reactive power	1 – 60 s	3.3 s	0.1 s	
	Min cos φ	Min. Cos phi	0.1 – 1	0	0.01	
	Lock in power	P Lock-in	0 – 100% Pn	0% (deactivated)	0.5% Pn	
	Lock out power	P Lock-out	0 – 100% Pn	0% (deactivated)	0.5% Pn	
4.7.2.3.4 voltage support by	Characteristic curve	cos phi as function of power	1 – 0.8 / 10 – 100% Pn	1.00 20%Pn 1.00 30%Pn	0.01 / 0.5% Pn	



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 – Power related control mode				1.00 50%P _n -0.95 100%P _n		
	Time constant	Filter time reactive power	1 – 60 s	3.3 s	0.1 s	
	Use voltage lock-in/out	Use lock-in/out	enable disable	disabled		
	Lock in voltage	U Lock-in	70 – 130% U _n	105%	0.25% U _n	
	Lock out voltage	U Lock-out	70 – 130% U _n	100%	0.25% U _n	
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	N/A	enable disable	disabled		UVRT not available
	Static voltage range overvoltage	N/A	100 % U _c – 120 % U _c	110 % U _c		
	Static voltage range undervoltage	N/A	80 % U _c – 100 % U _c	90 % U _c		
	Insensitivity range of ΔU50per	N/A	0 % – 15 %	5 %		
	Gradient k1	N/A	0 – 6	2		
	Gradient k2	N/A	0 – 6	2		
only EN 50549-2:2019, 4.7.4.2.1.2 Optional Modes / Generating Plant with non-synchronous generator	Active power priority	N/A	enable disable	disable		Not supported (Type A device)
	Reactive current limitation [% rated current]	N/A	0 %–100 %	disable		
	Zero current threshold	N/A	20 % U _c – 100 % U _c	disable		
4.7.4.2.2 Zero current mode for converter connected generating technology / Generating Plant with non-synchronous generator	Enabling	N/A	enable disable	disable		UVRT is not supported
	Static voltage range overvoltage	N/A	100 % U _n – 120 % U _n	120 % U _n		
	Static voltage range undervoltage	N/A	20 % U _n – 100 % U _n	50 % U _n		
4.9.2 Requirements on voltage and frequency protection	Threshold for protection as dedicated device [in A or kW, kVA]	N/A	-	-	-	
	Undervoltage threshold stage 1	U<	78 – 100 % U _n	85 % U _n	0.25 %	
	Undervoltage operate time stage 1	Trip delay U<	0 – 200 s	0.5 s	0.05 s	
	Undervoltage threshold stage 2	U<	77.75 – 100 % U _n	80 % U _n	0.25 %	



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	Trip delay U<	0 – 6.5 s	0.2 s	0.05 s	
	Overvoltage threshold stage 1	U>	100 – 120 % Un	115 % Un	0.25 %	
	Overvoltage operate time stage 1	Trip delay U>	0 – 200 s	0.5 s	0.05 s	
	Overvoltage threshold stage 2	U>	100 – 120 % Un	120 % Un	0.25 %	
	Overvoltage operate time stage 2	Trip delay U>	0 – 6.5 s	0.2 s	0.05 s	
	Overvoltage threshold 10 min mean protection	Over voltage U> (10 min. running mean)	100 – 120 % Un	110 % Un	0.25 %	
	Underfrequency threshold stage 1	f<	45.1 – 50.0 Hz	47.5 Hz	0.025 Hz	
	Underfrequency operate time stage 1	Trip delay f<	0 – 200 s	30 s	0.05 s	
	Underfrequency threshold stage 2	f<	45.1 – 50,0 Hz	47.0 Hz	0.025 Hz	
	Underfrequency operate time stage 2	Trip delay f<	0 – 6.5 s	0.2 s	0.05 s	
	Overfrequency threshold stage 1	f>	50.0 – 54.9 Hz	52.7 Hz	0.025 Hz	
	Overfrequency operate time stage 1	Trip delay f>	0 – 200 s	30 s	0.05 s	
	Overfrequency threshold stage 2	f>	50.0 – 54.9 Hz	53.0 Hz	0.025 Hz	
	Overfrequency operate time stage 2	Trip delay f>	0 – 6.5 s	0.2 s	0.05 s	
only EN 50549-2:2019, 4.9.3 Requirements on voltage and frequency protection	Positive sequence under-voltage protection threshold	N/A	20 % – 100 %			
	Positive sequence under-voltage protection operate time	N/A	0,2 s – 100 s			
	Negative sequence over-voltage protection threshold	N/A	1 % – 100 %			
	Negative sequence over-voltage protection operate	N/A	0,2 s – 100 s			



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
	time					
	Zero sequence overvoltage protection threshold	N/A	1 % – 100 %			
	Zero sequence overvoltage protection operate time	N/A	0,2 s – 100 s			
4.10.2 Automatic reconnection after tripping	Lower frequency	Low frequency	45.0 – 50.0 Hz	49,5 Hz	0.025 Hz	
	Upper frequency	High frequency	50.0 – 55.0 Hz	50,2 Hz	0.025 Hz	
	Lower voltage	Low voltage	78 – 100 % Un	85 % Un	0.25 %	
	Upper voltage	High voltage	100 – 120 % Un	110 % Un	0.25 %	
	Observation time	Waiting time	15 – 1200 s	60 s	1 s	
	Active power increase gradient	Power rate. 100%per xx s	0 – 1200 %/min	10 % /min	0.5 s	
4.10.3 Starting to generate electrical power	Lower frequency	Low frequency	45.0 – 50.0 Hz	49,5 Hz	0.025 Hz	
	Upper frequency	High frequency	50.0 – 55.0 Hz	50,1 Hz	0.025 Hz	
	Lower voltage	Low voltage	78 – 100 % Un	85 % Un	0.25 %	
	Upper voltage	High voltage	100 – 120 % Un	110 % Un	0.25 %	
	Observation time	Waiting time	15 – 1200 s	60 s	1 s	
	Active power increase gradient	Power rate. 100%per xx s	0– 1200 %/min	disabled	0.5 s	
4.11.1 Ceasing active power	Remote operation of the logic interface	Use Aux 1 as disable FeedIn signal	yes no	Yes	-	
4.11.2 Reduction of active power on set point	Remote operation	N/A				
4.12 Remote information exchange	Remote information exchange required	N/A				



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		PASS
4.5.2 Rate of change of frequency (ROCOF) immunity	5.3.1 Immunity to disturbances - Rate of change of frequency (ROCOF)		PASS
	5.3.2 Phase jump	Not required in EN50549-1	N/A
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)	Non-synchronous generating technology	N/A
4.6.1 Power response to overfrequency	5.4.3.2 Power response to over-frequencies		PASS
4.6.2 Power response to underfrequency	5.4.3.3 Power response to under-frequency		PASS
4.7.2.2 Voltage support by reactive power, Capabilities	5.5.1 Power capabilities assessment - voltage support by reactive power		PASS



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
4.7.2.2 Voltage support by reactive power, Capabilities	5.5.1.6 Verification procedure for reactive power capability considering voltage range		PASS
4.7.2.3.2 Set point control modes	5.5.2.3 Verification procedure for Set point control	Q-control Cos ϕ - control	PASS
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)	PASS
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	Cos ϕ (P)	PASS
4.7.3 Voltage related active power reduction	5.6 Voltage related active power reduction - P(U)	P(U)	PASS
4.8 EMC and power quality	5.7.1 EMC	See Reference [R3]	PASS
	5.7.2.2 Verification procedure for harmonics, interharmonics and higher frequencies up to 9 kHz		PASS
	5.7.2.3 Verification procedure for flicker and rapid voltage changes		PASS
	5.7.2.4 Verification procedure for DC injection		PASS
4.9.3 Requirements on voltage and frequency protection	5.8.3.2 Voltage and frequency protections		PASS



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
4.9.3 Requirements on voltage and frequency protection	5.8.3.3 Overvoltage 10 min mean protection		PASS
4.9.3 Requirements on voltage and frequency protection	5.8.3.4 ROCOF protection		PASS
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	Active anti islanding detection	PASS
4.10.2 Automatic reconnection after tripping	5.9.3 Automatic reconnection after tripping		PASS
4.10.3 Starting to generate electrical power	5.9.4 Starting to generate electrical power		PASS
4.10.4 Synchronization	5.9.7 Synchronization	-	N/A
4.11.1 Ceasing active power	5.10 Active power reduction on set point	-	N/A
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 [R2]	PASS



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
-	5.13 Model definition and model validation for generating units of synchronous generating technology	-	N/A