



CERTIFICATE

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

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

| | | |
|-----------------------------------|--|---|
| Model: | MultiPlus-II 48/3000/35-32, MultiPlus-II 48/3000/35-32 GX | MultiPlus-II 48/5000/70-50 MultiPlus-II 48/5000/70-50 GX |
| Rating: | | |
| DC charge | 48VDCnom., 35Amax | 48VDCnom., 70Amax |
| DC discharge | 48VDCnom., 75Amax | 48VDCnom., 120Amax |
| AC charge | 187-250V, 16Amax, 50/60Hz | 187-250V, 18Amax, 50/60Hz |
| AC discharge | 230V, 11Amax, 50/60Hz, 1Ph+N+PE | 230V, 19Amax, 50/60Hz, 1Ph+N+PE |
| Pass through current | 32A | 50A |
| Output power (Feed in On-Grid) | 2,5kVA / 2,47kW | 4,5kVA / 4,4kW |
| Output power (Off-Grid) | 3,0kVA / 2,4kW | 5,0kVA / 4,0kW |

Intended use:

Battery Inverter with an automatic disconnection device with single phase mains surveillance in accordance with Engineering Recommendation G99-1 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:

Engineering Recommendation G99 Issue 1 – Amendment 6; 09 March 2020

Requirements for the connection of generation equipment in parallel with public 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.

The units are only compliant with type A Power Generating Module requirements

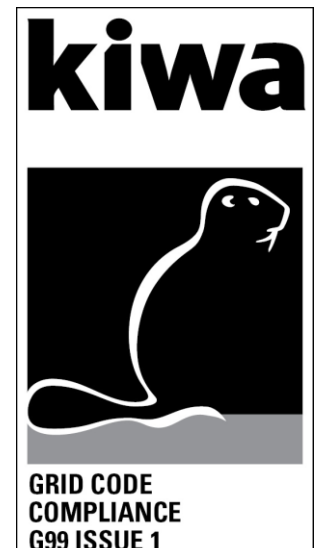
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| Power Quality – Continuous voltage operation range | | | | | |
|--|-----------------|------------|---------------|-----------------|--------------|
| Continuous frequency operation range | | | | | |
| | U [V] | f [Hz] | Cos ϕ | P [kW] | Limit [%Sn]: |
| Test 1 | 85%Un 195,5V | 47,00Hz | 1,00 | 100%Sn | - |
| Measured 20s avg | 196,5 | 47,00 | -1,000 | 86,0% | - |
| Test 2 | 85%Un 195,5V | 47,50Hz | 1,00 | 100%Sn | - |
| Measured 90min avg | 195,7 | 47,50 | -1,000 | 85,0% | - |
| Test 3 | 110%Un 253V | 51,50Hz | 1,00 | 100%Sn | - |
| Measured 90min avg | 253,5 | 51,50 | -0,999 | 98,0% | - |
| Test 4 | 110%Un 253V | 52,00Hz | 1,00 | 100%Sn | - |
| Measured 15min avg | 253,5 | 51,90 | -1,000 | 98,0% | - |
| Test 5 | Start frequency | Change | End frequency | Confirm no trip | |
| Positive frequency drift | 49,5Hz | +1,0Hz/sec | 50,0Hz | No trip | |
| Negative frequency drift | 50,5Hz | -1,0Hz/sec | 50,0Hz | No trip | |



| Power Quality – Harmonics | | | | | | |
|--|------------------------------|-------|------------------------------|-------|---|------------|
| Generating Unit tested to BS EN 61000-3-12 | | | | | | |
| Generating Unit rating per phase (rpp) | | | 2,47 | 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 | 0,067 | 0,628 | 0,044 | 0,409 | 8% | 8% |
| 3 | 0,076 | 0,707 | 0,077 | 0,717 | 21,6% | Not stated |
| 4 | 0,058 | 0,538 | 0,040 | 0,369 | 4% | 4% |
| 5 | 0,154 | 1,435 | 0,083 | 0,777 | 10,7% | 10,7% |
| 6 | 0,039 | 0,359 | 0,027 | 0,249 | 2,67% | 2,67% |
| 7 | 0,112 | 1,046 | 0,054 | 0,498 | 7,2% | 7,2% |
| 8 | 0,024 | 0,219 | 0,016 | 0,149 | 2% | 2% |
| 9 | 0,063 | 0,588 | 0,043 | 0,399 | 3,8% | Not stated |
| 10 | 0,014 | 0,130 | 0,010 | 0,090 | 1,6% | 1,6% |
| 11 | 0,054 | 0,498 | 0,026 | 0,239 | 3,1% | 3,1% |
| 12 | 0,009 | 0,080 | 0,005 | 0,050 | 1,33% | 1,33% |
| 13 | 0,036 | 0,339 | 0,014 | 0,130 | 2% | 2% |
| THD | - | 2,408 | - | 1,459 | 23% | 13% |
| PWHD | - | 3,735 | - | 1,744 | 23% | 22% |



| Power Quality – Voltage Fluctuations and Flicker | | | | | | | | |
|--|----------|-----------------|---------------|----------|------------------|---------------|---------|-------------|
| Model MultiPlus-II 48/3000/35-32 and MultiPlus-II 48/3000/35-32 GX | | | | | | | | |
| | Starting | | | Stopping | | | Running | |
| | dmax | dc | d(t) | dmax | dc | d(t) | Pst | Plt 2 hours |
| Measured Values | 0,313% | 0,313% | 0,0ms | 0,388% | 0,274% | 0,0ms | 0,021 | 0,021 |
| Normalised to standard impedance | 0,313% | 0,313% | 0,0ms | 0,388% | 0,274% | 0,0ms | 0,021 | 0,021 |
| Normalised to required maximum impedance | - | - | - | - | - | - | - | - |
| Limit set under BS EN 61000-3-11 | 4% | 3,3% | 3,3% | 4% | 3,3% | 3,3% | 1,0 | 0,65 |
| Limits | 4% | 3,3% | 3,3% 500ms | 4% | 3,3% | 3,3% 500ms | 1,0 | 0,65 |
| Test Impedance | R | 0,4 | Ω | X | 0,25 | Ω | | |
| Standard Impedance | R | 0,24 * 0,4 ^ | Ω | X | 0,15 * 0,25 ^ | Ω | | |
| Maximum Impedance | R | - | Ω | X | - | Ω | | |
| * Applies to three phase and split single phase Power Generating Modules. | | | | | | | | |
| ^ Applies to single phase Power Generating Module and Power Generating Modules using two phases on a three phase system. | | | | | | | | |



| Power Quality – Voltage Fluctuations and Flicker | | | | | | | | |
|--|----------|-----------------|---------------|----------|------------------|---------------|---------|-------------|
| Model MultiPlus-II 48/5000/70-50 | | | | | | | | |
| | Starting | | | Stopping | | | Running | |
| | dmax | dc | d(t) | dmax | dc | d(t) | Pst | Plt 2 hours |
| Measured Values | 3,344% | 3,344% | 150,0ms | 3,469% | 3,377% | 0,0ms | 0,027 | 0,027 |
| Normalised to standard impedance | 3,344% | 3,344% | 150,0ms | 3,469% | 3,377% | 0,0ms | 0,027 | 0,027 |
| Normalised to required maximum impedance | 3,268% | 3,268% | 0,0 | 3,390% | 3,300% | 0,0ms | 0,026 | 0,026 |
| Limit set under BS EN 61000-3-11 | 4,0% | 3,3% | 3,3% | 4,0% | 3,3% | 3,3% | 1,00 | 0,65 |
| Limits | 4% | 3,3% | 3,3% 500ms | 4% | 3,3% | 3,3% 500ms | 1,0 | 0,65 |
| Test Impedance | R | 0,4 | Ω | X | 0,25 | Ω | | |
| Standard Impedance | R | 0,24 * 0,4 ^ | Ω | X | 0,15 * 0,25 ^ | Ω | | |
| Maximum Impedance | R | 0,39 | Ω | X | 0,24 | Ω | | |
| * Applies to three phase and split single phase Power Generating Modules. | | | | | | | | |
| ^ Applies to single phase Power Generating Module and Power Generating Modules using two phases on a three phase system. | | | | | | | | |

| Power Quality – DC injection | | | |
|------------------------------|-------|--------|--------|
| Test power level | 10% | 55% | 100% |
| Recorded value in Amps | 0,002 | -0,002 | -0,006 |
| As % of rated AC current | 0,07% | -0,06% | -0,16% |
| Limit | 0,25% | 0,25% | 0,25% |

| Power Factor | | | |
|--------------------|-------------------|----------------|----------------|
| Voltage | 0,94 pu (216.2 V) | 1,0 pu (230 V) | 1,1 pu (253 V) |
| Measured Value | 1,000 | 1,000 | 1,000 |
| Power Factor Limit | >0,95 | | |



| Protection – Frequency Tests | | | | | | |
|------------------------------|-----------|------------|-----------|------------|-------------------|-----------------|
| Function | Setting | | Trip test | | No trip test | |
| | Frequency | Time delay | Frequency | Time delay | Frequency time | Confirm no trip |
| U/F stage 1 | 47,5 Hz | 20 s | 47,40 Hz | 20,12 s | 47,7Hz 30s | No trip |
| U/F stage 2 | 47,0 Hz | 0,5 s | 46,90 Hz | 0,58 s | 47,2 Hz 19,5s | No trip |
| | | | | | 46,8 Hz 0,45 s | No trip |
| O/F | 52,0 Hz | 0,5 s | 52,00 Hz | 0,56 s | 51,8 Hz 120 s | No trip |
| | | | | | 52,2Hz 0,45s | No trip |

| Protection – Voltage Tests. | | | | | | |
|-----------------------------|---------------------|------------|-----------|------------|-------------------|-----------------|
| Function | Setting | | Trip test | | No trip test | |
| | Voltage | Time delay | Voltage | Time delay | Voltage time | Confirm no trip |
| U/V | 0,8 pu (184V) | 2,5s | 182,5 V | 2,54 s | 188 V 5 s | No trip |
| | | | | | 180V 2,45 s | No trip |
| O/V stage 1 | 1,14 pu (262,2V) | 1,0s | 261,2 V | 1,07 s | 258,2 V 5,0 s | No trip |
| O/V stage 2 | 1,19 pu (273,7V) | 0,5s | 273,0 V | 0,59 s | 269,7 V 0,95 s | No trip |
| | | | | | 277,7 V 0,45 s | No trip |



| Protection – Loss of Mains Test according BS EN 62116 for Inverters. | | | | | | |
|--|--|----------------|--------------------------------------|---------------------------|--------------|---------------|
| Test Power and imbalance | 33% -5% Q | 66% -5% Q | 100% -5% Q | 33% +5% Q | 66% +5% Q | 100% +5% Q |
| Trip time (s) | 1,020 | 1,028 | 1,051 | 0,976 | 0,978 | 0,958 |
| Protection – Frequency change, Vector Shift Stability test. | | | | | | |
| | Start frequency | Change | Confirm no trip | | | |
| Positive vector shift | 49,5Hz | +50 degrees | No Trip | | | |
| Negative vector shift | 50,5Hz | - 50 degrees | 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 | +0,95 Hzs ⁻¹ | 2,1 s | No trip | | | |
| 51,0 Hz to 49,0 Hz | -0,95 Hzs ⁻¹ | 2,1 s | No trip | | | |
| Protection – Limited Frequency Sensitive Mode – Over frequency Test | | | | | | |
| Active Power response to rising frequency/time plots are attached | | | | | | N |
| Test sequence at registered capacity >80% | Measured Active Power output [kW] | Frequency [Hz] | Primary power source (if applicable) | Active Power Gradient | | |
| Step a) 50,00Hz ± 0,01Hz | -2,38 | 50,00 | — | — | | |
| Step b) 50,45Hz ± 0,05Hz | -2,34 | 50,45 | | — | | |
| Step c) 50,70Hz ± 0,10Hz | -2,22 | 50,70 | | — | | |
| Step d) 51,15Hz ± 0,05Hz | -2,00 | 51,15 | | — | | |
| Step e) 51,70Hz ± 0,10Hz | -2,22 | 50,70 | | — | | |
| Step f) 50,45Hz ± 0,05Hz | -2,34 | 50,45 | | — | | |
| Step g) 50,00Hz ± 0,01Hz | -2,38 | 50,00 | | ≤10,0%P _n /min | | |
| Test sequence at registered capacity 40% - 60% | Measured Active Power output [kW] | Frequency [Hz] | Primary power source (if applicable) | Active Power Gradient | | |
| Step a) 50,00Hz ± 0,01Hz | -1,22 | 50,00 | — | — | | |
| Step b) 50,45Hz ± 0,05Hz | -1,17 | 50,45 | | — | | |
| Step c) 50,70Hz ± 0,10Hz | -1,11 | 50,70 | | — | | |
| Step d) 51,15Hz ± 0,05Hz | -1,00 | 51,15 | | — | | |
| Step e) 50,70Hz ± 0,01Hz | -1,11 | 50,70 | | — | | |
| Step f) 50,45 Hz ± 0,05Hz | -1,17 | 50,45 | | ≤10,0%P _n /min | | |
| Step g) 50,00 Hz ± 0,01Hz | -2,35 | 50,00 | | ≤10,0%P _n /min | | |



| Protection – Reconnection Timer | | | | | |
|---|-----------------|--|-----------------------|-----------------|-----------------|
| Time delay setting | Measured delay | Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1. | | | |
| 20 s | 25,2 s – 26,8 s | At 1,16 pu (266,2V) | At 0,78pu (180,0V) | At 47,4 Hz | At 52,1 Hz |
| Confirmation that the Power Generating Module does not re-connect. | | No reconnection | No reconnection | No reconnection | No reconnection |
| Fault Level Contribution | | | | | |
| For Inverter Output | | | | | |
| Time after fault | | Volts | | Amps | |
| 20ms | | 85,1 | | 19,27 | |
| 100ms | | - | | - | |
| 250ms | | - | | - | |
| 500ms | | - | | - | |
| Time to trip | | 0,03 | | In seconds | |
| As SSEGs (small-scale embedded generators) for PV are inverter-connected the max. short circuit current is the max. AC current. | | | | | |

| Self-Monitoring Solid state switching | |
|---|-----|
| It has been verified that in the event of the solid state switching device failing to disconnect the Power Park Module, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s. | NA* |
| *there are no solid state switching devices in the unit, mechanical relays are provided | |

| Wiring functional Tests | |
|---|----|
| Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning) | NA |

| Logic interface (input port) | |
|---|------|
| Confirm that an input port is provided and can be used to shut down the module. | YES* |
| *An input port is available and can be used to shut down the module | |
| Additional Comments | |
| — | |