**ENA EREC G98/1-4:2019**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type Approval and Manufacturer declaration of compliance with the requirements of G98.  This form should be used when making a Type Test submission to the Energy Networks  Association (ENA).  If the Micro-generator is Fully Type Tested and already registered with the ENA Type Test Verification Report Register, the Installation Document should include the Manufacturer’s Reference Number (the Product ID), and this form does not need to be submitted.  Where the Micro-generator is not registered with the ENA Type Test Verification Report  Register this form needs to be completed and provided to the DNO, to confirm that the Microgenerator has been tested to satisfy the requirements of this EREC G98. | | | | | |
| SSEG Type reference number | | HERF-1000 | | | |
| SSEG Type | | Photovoltaic Microinverter | | | |
| System Supplier name | | Xiamen E-star Energy Co., Ltd. | | | |
| Address | | 5F, Liantai Bldg, No.43 Huli Avenue, Xiamen, China | | | |
| Tel | +86 15960215407 | | Fax | | - |
| E:mail | emily@estarpower.com | | Web site | | - |
| Maximum rated capacity, use separate sheet if more than one connection option. | Connection Option | | | | |
| 0.98 | kW single phase, single, split or three phase system | | | |
| NA | kW three phase | | | |
| NA | kW two phases in three phase system | | | |
| NA | kW two phases split phase system | | | |
| SSEG manufacturer/supplier declaration | | | | | |
| Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above Type Tested reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98. | | | | | |
| Signed |  | On behalf of | | Xiamen E-star Energy Co., Ltd. | |
| Note that testing can be done by the Manufacturer of an individual component or by an external test house.  Where parts of the testing are carried out by persons or organizations other than the  Manufacturer then that person or organization shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests. | | | | | |

|  |  |
| --- | --- |
| **Operating Range** | |
|  | Test 1:195.5V~47Hz, PF=1 Period of test 20s |
| **HERF-1000** |  |
|  | Test 2:195.5V~47.5Hz, PF=1 Period of test 90min |
| **HERF-1000** |  |
|  | Test 3:253V~51.5Hz, PF=1 Period of test 90min |
| **HERF-1000** |  |
|  | Test 4:253V~52Hz, PF=1 Period of test 15min |
| **HERF-1000** |  |
|  | Test 5:230V~50Hz, PF=1 Period of test 90min |
| **HERF-1000** |  |
|  | Test 6: RoCoF withstand |
| **HERF-1000** |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Power Quality – Harmonics:** These tests should be carried out as specified in BS EN 61000-3-2. | | | | | | |
| SSEG rating per phase (rpp) | | | 0.98 | kW | NV=MV\*3.68/rpp | |
| 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 | 0.0198 | 0.0744 | 0.0410 | 0.154 | 1.080 |  |
| 3 | 0.0118 | 0.0443 | 0.0361 | 0.1356 | 2.300 |  |
| 4 | 0.0086 | 0.0323 | 0.0132 | 0.0496 | 0.430 |  |
| 5 | 0.0148 | 0.0556 | 0.0476 | 0.1787 | 1.140 |  |
| 6 | 0.0056 | 0.021 | 0.0100 | 0.0376 | 0.300 |  |
| 7 | 0.0211 | 0.0792 | 0.0405 | 0.1521 | 0.770 |  |
| 8 | 0.0050 | 0.0188 | 0.0067 | 0.0252 | 0.230 |  |
| 9 | 0.0155 | 0.0582 | 0.0407 | 0.1528 | 0.400 |  |
| 10 | 0.0036 | 0.0135 | 0.0056 | 0.021 | 0.184 |  |
| 11 | 0.0081 | 0.0304 | 0.0445 | 0.1671 | 0.450 |  |
| 12 | 0.0025 | 0.0094 | 0.0046 | 0.0173 | 0.153 |  |
| 13 | 0.0078 | 0.0293 | 0.0350 | 0.1314 | 0.210 |  |
| 14 | 0.0022 | 0.0083 | 0.0098 | 0.0368 | 0.131 |  |
| 15 | 0.0059 | 0.0222 | 0.0264 | 0.0991 | 0.150 |  |
| 16 | 0.0019 | 0.0071 | 0.0080 | 0.03 | 0.115 |  |
| 17 | 0.0088 | 0.033 | 0.0191 | 0.0717 | 0.132 |  |
| 18 | 0.0025 | 0.0094 | 0.0098 | 0.0368 | 0.102 |  |
| 19 | 0.0055 | 0.0207 | 0.0148 | 0.0556 | 0.118 |  |
| 20 | 0.0025 | 0.0094 | 0.0048 | 0.018 | 0.092 |  |
| 21 | 0.0067 | 0.0252 | 0.0133 | 0.0499 | 0.107 |  |
| 22 | 0.0016 | 0.006 | 0.0078 | 0.0293 | 0.084 |  |
| 23 | 0.0089 | 0.0334 | 0.0155 | 0.0582 | 0.098 | 0.147 |
| 24 | 0.0024 | 0.009 | 0.0079 | 0.0297 | 0.077 |  |
| 25 | 0.0067 | 0.0252 | 0.0190 | 0.0713 | 0.090 | 0.135 |
| 26 | 0.0028 | 0.0105 | 0.0092 | 0.0345 | 0.071 |  |
| 27 | 0.0045 | 0.0169 | 0.0184 | 0.0691 | 0.083 | 0.124 |
| 28 | 0.0004 | 0.0015 | 0.0074 | 0.0278 | 0.066 |  |
| 29 | 0.0042 | 0.0158 | 0.0145 | 0.0544 | 0.078 | 0.117 |
| 30 | 0.0023 | 0.0086 | 0.0110 | 0.0413 | 0.061 |  |
| 31 | 0.0029 | 0.0109 | 0.0129 | 0.0484 | 0.073 | 0.109 |
| 32 | 0.0022 | 0.0083 | 0.0113 | 0.0424 | 0.058 |  |
| 33 | 0.0072 | 0.027 | 0.0139 | 0.0522 | 0.068 | 0.102 |
| 34 | 0.0006 | 0.0023 | 0.0072 | 0.027 | 0.054 |  |
| 35 | 0.0084 | 0.0315 | 0.0123 | 0.0462 | 0.064 | 0.096 |
| 36 | 0.0011 | 0.0041 | 0.0078 | 0.0293 | 0.051 |  |
| 37 | 0.0053 | 0.0199 | 0.0085 | 0.0319 | 0.061 | 0.091 |
| 38 | 0.0019 | 0.0071 | 0.0101 | 0.0379 | 0.048 |  |
| 39 | 0.0070 | 0.0263 | 0.0087 | 0.0327 | 0.058 | 0.087 |
| 40 | 0.0005 | 0.0019 | 0.0100 | 0.0376 | 0.046 |  |
| Note the higher limits for odd harmonics 21 and above are only allowable under certain  conditions, if these higher limits are utilized please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below. | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Power Quality. Voltage fluctuations and Flicker.** | | | | | | | | |
|  | Starting | | | Stopping | | | Running | |
| dmax [%] | dc [%] | d(t) [%] | dmax [%] | dc [%] | d(t) [%] | Pst | Plt 2 hours |
| Measured Values at  test impedance | 0.1 | 0 | 0 | 0.1 | 0 | 0 | 0.064 | 0.064 |
| Normalized to  standard impedance | 0.1 | 0 | 0 | 0.1 | 0 | 0 | 0.064 | 0.064 |
| Normalized to required maximum impedance | 0.1 | 0 | 0 | 0.1 | 0 | 0 | 0.064 | 0.064 |
| Limits set under  BS EN 61000-3-11 | 4% | 3.3% | 3.3% | 4% | 3.3% | 3.3% | 1 | 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 | 0.4 | | Ω | XI | 0.25 | | Ω |
| Test start date | | 2024-01-03 | | Test end date | 2024-01-03 | | | |
| Test location | | SHANGHAI TESTING & INSPECTION INSTITUTE  FOR ELECTRICAL EQUIPMENT CO., LTD. | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Power quality – DC injection:** This test should be carried out in accordance with EN 50438 Annex D.3.10 | | | | | |
| Test power level | 20% | 50% | 75% | 100% |  |
| Recorded value(mA) | 0.368 | 1.57 | 2.31 | 2.62 |
| as % of rated AC current | 0.01% | 0.04% | 0.05% | 0.06% |
| Limit | 0.25% | 0.25% | 0.25% | 0.25% |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power Quality – Power factor:** This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within ±1.5% of the stated level during the test. | | | | |
|  | 216.2V | 230V | 253V |  |
| 20% of Registered  Capacity | 0.9921 | 0.9916 | 0.9903 |
| 50% of Registered  Capacity | 0.9962 | 0.9956 | 0.9948 |
| 75% of Registered  Capacity | 0.9975 | 0.9967 | 0.9959 |
| 100% of Registered  Capacity | 0.9986 | 0.9982 | 0.9971 |
| Limit | >0.95 | >0.95 | >0.95 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Protection. Frequency tests** These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98 Annex A1 A 1.3.2 (Inverter connected) or Annex A2 A.2.2.2 (Synchronous) | | | | | | |
| Function | Setting | | Trip test | | “No trip tests” | |
|  | Frequency | Time delay | Frequency | Time delay | Frequency /time | Confirm  no trip |
| U/F stage 1 | 47.5Hz | 20s | 47.5Hz | 20.01s | 47.7Hz/ 30s | Confirmed |
| U/F stage 2 | 47Hz | 0.5s | 47Hz | 0.52s | 47.2Hz/ 19.5s | Confirmed |
|  | | | | | 46.8Hz/ 0.45s | Confirmed |
| O/F stage 2 | 52Hz | 0.5s | 52Hz | 0.51s | 51.8Hz/ 120s | Confirmed |
|  | | | | | 52.2Hz/ 0.45s | Confirmed |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Protection. Voltage tests** These tests should be carried out in accordance with EN 50438 Annex D.2.3 and the notes in EREC G98 Annex A1 A 1.3.1 (Inverter connected) or Annex A2 A.2.2.1 (Synchronous) | | | | | | |
| Function | Setting | | Trip test | | “No trip tests” | |
|  | Voltage | Time delay | Voltage | Time delay | Voltage /time | Confirm  no trip |
| U/V | 184V | 2.5s | 183.8V | 2.52s | 188V/5.0s | Confirmed |
|  | | | | | 180V/2.45s | Confirmed |
| O/V stage 1 | 262.2V | 1.0s | 262.6V | 1.01s | 258.2V/5.0s | Confirmed |
| O/V stage 2 | 273.7V | 0.5s | 274.2V | 0.51s | 269.7V/0.95s | Confirmed |
|  | | | | | 277.7V/0.45s | Confirmed |
| Note for Voltage tests the Voltage required to trip is the setting ±3.45 V. 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 ±4 V 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 test.** For PV Inverters shall be tested in accordance with BS EN62116. Other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%,55% and 100% of rated power. | | | | | | |
| Note: Inverter tested according to BS EN 62116. | | | | | | |
| Test Power and  imbalance | 33%  -5% Q  Test 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 | 91.2ms | 113.8ms | 160.4ms | 91.3ms | 113.6ms | 172.1ms |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Protection. Frequency change, Stability test** This test should be carried out in  accordance with EREC G98 Annex A1 A 1.3.5 (Inverter connected) or Annex A2 A.2.2.5 (Synchronous). | | | | |
|  | Start Frequency | Change | End Frequency | Confirm no trip |
| Positive Vector Shift | 49Hz | +50 degrees |  | Confirmed |
| Negative Vector Shift | 50Hz | - 50degrees |  | Confirmed |
| **Protection – Frequency change, RoCoF Stability test:** The requirement is specified in section 11.3, test procedure in Annex A 1.3.5 (Inverter connected) or Annex A2 A.2.2.5 (Synchronous). | | | | |
|  | Ramp range | Test frequency ramp: | Test Duration | Confirm no trip |
| Positive Frequency drift | 49Hz to 51Hz | +0.95Hz/sec | 2.1s | Confirmed |
| Negative Frequency drift | 51Hz to 49Hz | -0.95Hz/sec | 2.1s | Confirmed |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Protection – Limited Frequency Sensitive Mode – Overfrequency test:** This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over- frequency. The test should be carried out using the specific threshold frequency of 50.4 Hz and droop of 10%. | | | | |
| Test sequence at Registered  Capacity >80% | Measured  Active Power  Output (W) | Frequency (Hz) | Primary Power Source | Active Power  Gradient |
| Step a) 50.00 Hz ±0.01Hz | 982.16 | 50 |  | - |
| Step b) 50.45 Hz ±0.05Hz | 972.47 | 50.45 | - |
| Step c) 50.70 Hz ±0.10Hz | 924.34 | 50.7 | - |
| Step d) 51.15 Hz ±0.05 Hz | 838.48 | 51.15 | - |
| Step e) 50.70 Hz ±0.10Hz | 924.62 | 50.7 | - |
| Step f) 50.45 Hz ±0.05Hz | 972.64 | 50.45 | - |
| Step g) 50.00 Hz ±0.10Hz | 982.16 | 50 | - |
| Test sequence at Registered Capacity  40% - 60% | Measured  Active Power  Output (W) | Frequency (Hz) | Primary Power Source | Active Power  Gradient |
| Step a) 50.00 Hz ±0.01Hz | 494.77 | 50 |  | - |
| Step b) 50.45 Hz ±0.05Hz | 486.72 | 50.45 | - |
| Step c) 50.70 Hz ±0.10Hz | 438.13 | 50.7 | - |
| Step d) 51.15 Hz ±0.05 Hz | 350.32 | 51.15 | - |
| Step e) 50.70 Hz ±0.10Hz | 436.57 | 50.7 | - |
| Step f) 50.45 Hz ±0.05Hz | 485.49 | 50.45 | - |
| Step g) 50.00 Hz ±0.10Hz | 494.54 | 50 | - |
| Steps as defined in EN 50438 | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Protection – Power output with falling frequency test:** This test should be carried out in accordance with EN 50438 Annex D.3.2 active power feed -in at under-frequency. | | | |
| Test sequence | Measured Active Power Output (W) | Frequency (Hz) | Primary power source |
| Test a) 50 Hz ± 0.01 Hz | 980.7 | 50 | DC Supply |
| Test b) Point between 49.5  Hz and 49.6 Hz | 981.1 | 49.55 | DC Supply |
| Test c) Point between 47.5  Hz and 47.6 Hz | 980.6 | 47.55 | DC Supply |
| NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Protection. Re-connection timer.** | | | | | |
| Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 2. | | | | | |
| Time delay setting | Measured  delay | No reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1. | | | |
| 20.0s | 30.1s | At 266.2V | At 180V | At 47.4Hz | At 52.1Hz |
| Confirmation that the SSEG does not re-connect. | | Confirmed | Confirmed | Confirmed | Confirmed |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Fault level contribution.** The requirement is specified in section 5.7, test procedure in Annex A or B 1.4.6 | | | | | |
| For a directly coupled SSEG | | | For a Inverter SSEG | | |
| Parameter | Symbol | Value | Time after fault | Volts | Amps |
| Peak Short Circuit current | ip | N/A | 20ms | 18.98V | 0.464A |
| Initial Value of aperiodic current | A | N/A | 100ms | 11.63V | 0.216A |
| Initial symmetrical short-circuit current\* | Ik | N/A | 250ms | 9.37V | 0.105A |
| Decaying (aperiodic) component of short circuit current\* | iDC | N/A | 500ms | 5.37V | 0.082A |
| Reactance/Resistance Ratio of source\* | X/R | N/A | Time to trip | 0.005s | (in seconds) |

|  |  |
| --- | --- |
| **Self-Monitoring solid state switching** :No specified test requirements. Refer to EREC G98 Annex A1 A 1.4.6 (Inverter connected). | Yes/or NA |
| It has been verified that in the event of the solid state switching device failing to disconnect the Micro-generator, the voltage on the output side of the switching device is reduced to a value below 50 V within 0.5 s. | N/A |

|  |  |
| --- | --- |
| **Logic interface (input port)** | Yes/or NA |
| Confirm that an input port is provided and can be used to shut down the module. | Yes |
| Provide high level description of logic interface, e.g. details in 9.4.3 such as AC or **DC** signal (the additional comments box below can be used) | Yes |

|  |
| --- |
| Additional comments |
| Following is the description of remote control or telecontrol interface.    microinverters feature module-level monitoring. Microinverter data are collected by gateway (named as DTU) via wireless transmission and are sent to motoring platform S-Miles Cloud. Remote control command to change or cease active power output can also be sent via Ethernet or RS485(with Modbus protocol) to gateway. Then gateway will deliver the command to microinverter. |

|  |  |
| --- | --- |
| **Cyber security** | Yes / NA |
| Confirm that the **Manufacturer** or **Installer** of the **Micro-generator** has provided a statement describing how the **Micro-generator** has been designed to comply with cyber security requirements, as detailed in 9.7.  This inverter and the associated equipment (such as the gateway and the database of the Cloud) are all designed and developed complied with the cyber security requirements of IEEE1547. | Yes |

|  |
| --- |
| Additional comments |
|  |