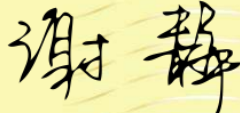



# ENA Engineering Recommendation G83

## Issue 2 2012

### Type Verification Test Report

|   |   |  |  |
|---|---|--|--|
| <b>Type Approval and manufacturer/supplier declaration of compliance with the requirements of Engineering Recommendation G83/2.</b>   |   |  |  |
| <b>SSEG Type reference number</b>   |   |  |  |
| <b>SSEG Type</b>  |   | GW3048-EM / GW3648-EM / GW5048-EM                            |  |
| <b>System Supplier name</b>   |   | Jiangsu GoodWe Power Supply Technology Co.,Ltd.              |  |
| <b>Address</b>  |   | NO.189 Kun Lun Shan Road, Suzhou New District, Jiangsu,china |  |
| <b>Tel</b>  | +86 512 6239 7998   | <b>Fax</b>   | +86 512 6239 7972  |
| <b>E:mail</b>   | service@goodwe.com.cn   | <b>Web site</b>  | http://www.goodwe.com.cn   |
| <b>Maximum rated capacity( use separate sheet if more than one connection option)</b>   | <b>Connection Option</b>  |  |  |
|   | 3   | kW single phase  |  |
|   | 3.68  | kW single phase  |  |
| 5   | kW single phase   |  |  |
| <p>SSEG manufacturer/supplier declaration.</p> <p>I certify on behalf of the company named above as a manufacturer/supplier of Small Scale Embedded Generators, that all products manufactured/supplied by the company with the above SSEG Type reference number will be manufactured and tested to ensure that they perform as stated in this Type Verification Test Report, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of G83/2.</p> |   |  |  |
| <b>Signed</b>   | <br>Xie Jing | <b>On behalf of</b>  | <br>Huang min |

| <b>Power Quality. Harmonics</b>   |                                 |                               |                             |                               |                                 | <b>P</b>                                    |
|---|---------------------------------|-------------------------------|-----------------------------|-------------------------------|---------------------------------|---|
| The requirement is specified in section 5.4.1, test procedure in Annex A or B 1.4.1 |                                 |                               |                             |                               |                                 |   |
| SSEG rating per phase (rpp)   |                                 |                               |                             |                               | NV=MV*3.68/rpp                  |   |
|   | At 45-55% of rated output<br>kW |                               | 100% of rated output<br>kW  |                               |                                 |   |
| Harmonic  | Measured Value (MV) in Amps     | Normalised Value (NV) in Amps | Measured Value (MV) in Amps | Normalised Value (NV) in Amps | Limit in BS EN61000-3-2 in Amps | Higher limit for odd harmonics 21 and above |
| 2nd   | 0.036                           | 0.036                         | 0.103                       | 0.103                         | 1.080                           |   |
| 3rd   | 0.214                           | 0.214                         | 0.267                       | 0.267                         | 2.300                           |   |
| 4th   | 0.021                           | 0.021                         | 0.036                       | 0.036                         | 0.430                           |   |
| 5th   | 0.113                           | 0.113                         | 0.145                       | 0.145                         | 1.140                           |   |
| 6th   | 0.018                           | 0.018                         | 0.030                       | 0.030                         | 0.300                           |   |
| 7th   | 0.098                           | 0.098                         | 0.132                       | 0.132                         | 0.770                           |   |
| 8th   | 0.014                           | 0.014                         | 0.021                       | 0.021                         | 0.230                           |   |
| 9th   | 0.063                           | 0.063                         | 0.067                       | 0.067                         | 0.400                           |   |
| 10th  | 0.013                           | 0.013                         | 0.026                       | 0.026                         | 0.184                           |   |
| 11th  | 0.055                           | 0.055                         | 0.060                       | 0.060                         | 0.330                           |   |
| 12th  | 0.010                           | 0.010                         | 0.018                       | 0.018                         | 0.153                           |   |
| 13th  | 0.043                           | 0.043                         | 0.041                       | 0.041                         | 0.210                           |   |
| 14th  | 0.006                           | 0.006                         | 0.010                       | 0.010                         | 0.131                           |   |
| 15th  | 0.033                           | 0.033                         | 0.035                       | 0.035                         | 0.150                           |   |
| 16th  | 0.006                           | 0.006                         | 0.014                       | 0.014                         | 0.115                           |   |
| 17th  | 0.029                           | 0.029                         | 0.030                       | 0.030                         | 0.132                           |   |
| 18th  | 0.005                           | 0.005                         | 0.008                       | 0.008                         | 0.102                           |   |
| 19th  | 0.023                           | 0.023                         | 0.029                       | 0.029                         | 0.118                           |   |
| 20th  | 0.005                           | 0.005                         | 0.010                       | 0.010                         | 0.092                           |   |
| 21th  | 0.020                           | 0.020                         | 0.024                       | 0.024                         | 0.107                           | 0.160                                       |
| 22th  | 0.006                           | 0.006                         | 0.012                       | 0.012                         | 0.084                           |   |
| 23th  | 0.017                           | 0.017                         | 0.018                       | 0.018                         | 0.098                           | 0.147                                       |
| 24th  | 0.004                           | 0.004                         | 0.006                       | 0.006                         | 0.077                           |   |
| 25th  | 0.017                           | 0.017                         | 0.019                       | 0.019                         | 0.090                           | 0.135                                       |
| 26th  | 0.004                           | 0.004                         | 0.006                       | 0.006                         | 0.071                           |   |
| 27th  | 0.015                           | 0.015                         | 0.019                       | 0.019                         | 0.083                           | 0.124                                       |
| 28th  | 0.003                           | 0.003                         | 0.006                       | 0.006                         | 0.066                           |   |
| 29th  | 0.013                           | 0.013                         | 0.013                       | 0.013                         | 0.078                           | 0.117                                       |
| 30th  | 0.004                           | 0.004                         | 0.006                       | 0.006                         | 0.061                           |   |
| 31th  | 0.014                           | 0.014                         | 0.014                       | 0.014                         | 0.073                           | 0.109                                       |
| 32th  | 0.004                           | 0.004                         | 0.005                       | 0.005                         | 0.058                           |   |
| 33th  | 0.012                           | 0.012                         | 0.014                       | 0.014                         | 0.068                           | 0.102                                       |
| 34th  | 0.003                           | 0.003                         | 0.004                       | 0.004                         | 0.054                           |   |
| 35th  | 0.011                           | 0.011                         | 0.012                       | 0.012                         | 0.064                           | 0.096                                       |

|      |       |       |       |       |       |       |
|------|-------|-------|-------|-------|-------|-------|
| 36th | 0.003 | 0.003 | 0.005 | 0.005 | 0.051 |       |
| 37th | 0.011 | 0.011 | 0.012 | 0.012 | 0.061 | 0.091 |
| 38th | 0.004 | 0.004 | 0.005 | 0.005 | 0.048 |       |
| 39th | 0.009 | 0.009 | 0.010 | 0.010 | 0.058 | 0.087 |
| 40th | 0.003 | 0.003 | 0.006 | 0.006 | 0.046 |       |

**Note:**

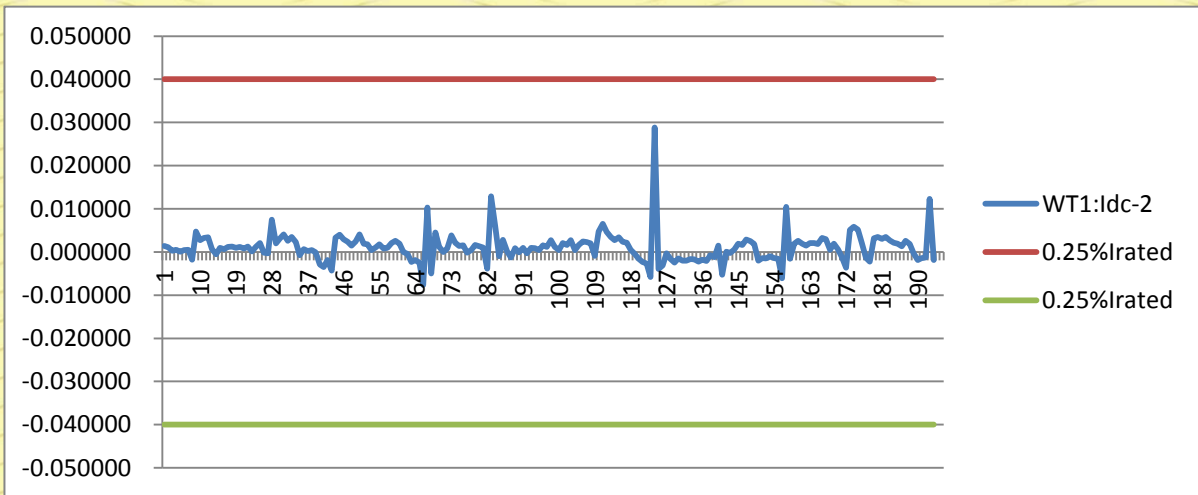
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

|   |                 |       |               |                 |       |               |                 |          |  |
|---|-----------------|-------|---------------|-----------------|-------|---------------|-----------------|----------|--|
| <b>Flicker</b>  |                 |       |               |                 |       |               |                 | <b>P</b> |  |
| The requirement is specified in section 5.4.2, test procedure in Annex A or B 1.4.3 |                 |       |               |                 |       |               |                 |          |  |
|   | <b>Starting</b> |       |               | <b>Stopping</b> |       |               | <b>Running</b>  |          |  |
|   | $d_{max}$       | $d_c$ | $d_{(t)}$     | $d_{max}$       | $d_c$ | $d_{(t)}$     | $d_{max}$       | $d_c$    |  |
| Measured values   | 0               | 0     | 0             | 0               | 0     | 0             | 0               | 0        |  |
| Normalised to standard impedance and 3.68kW for multiple units                      | 0               | 0     | 0             | 0               | 0     | 0             | 0               | 0        |  |
| Limits set under BS EN 61000-3-2  | 4%              | 3.3%  | 3.3%<br>500ms | 4%              | 3.3%  | 3.3%<br>500ms | 4%              | 3.3%     |  |
| Test start date   | 2014/1/10 8:45  |       |               | Test end date   |       |               | 2014/1/10 10:45 |          |  |

|   |        |       |          |
|---|--------|-------|----------|
| <b>Power quality. DC injection</b>  |        |       | <b>P</b> |
| The requirement is specified in section 5.5, test procedure in Annex A or B 1.4.4 |        |       |          |
| Test level power  | 10%    | 55%   | 100%     |
| Recorded value  | 28.8mA | 22 mA | 36.94 mA |
| As % of rated AC current  | 0.18%  | 0.14% | 0.23%    |
| Limit   | 0.25%  | 0.25% | 0.25%    |

Diagramm of permanent DC-Injec

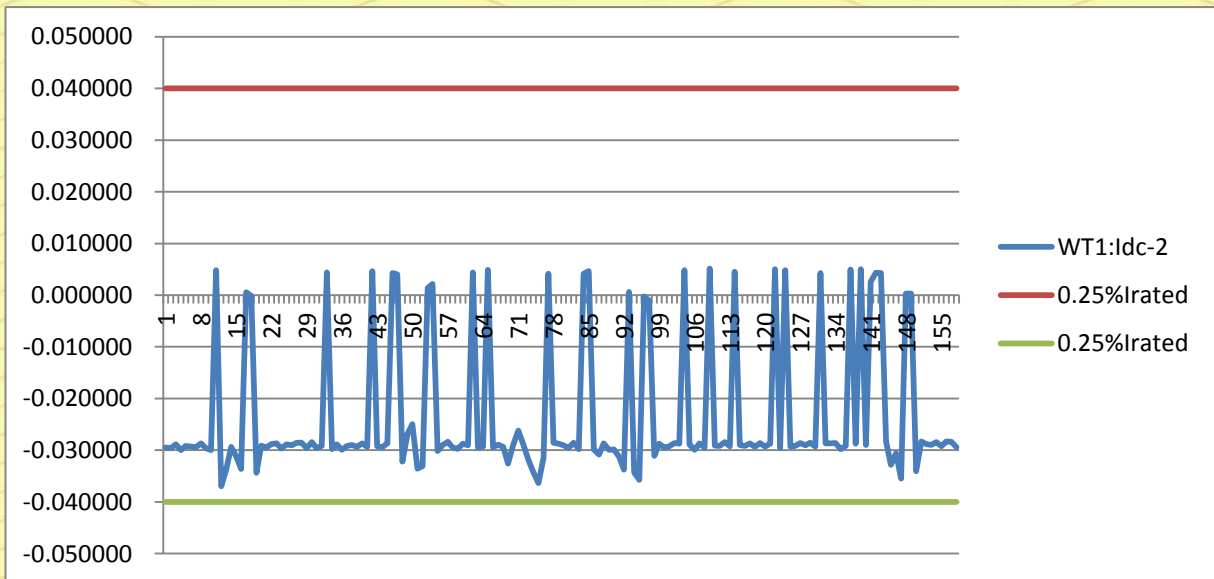
10%



55%



100%



| <b>Power Quality. Power factor</b>  |         |       |       |   | <b>P</b> |
|---|---------|-------|-------|---|----------|
| The requirement is specified in section 5.6, test procedure in Annex A or B 1.4.2 |         |       |       |   |          |
|   | 216.2 V | 230 V | 253 V | Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test. |          |
| Measured value  | 0.998   | 0.998 | 0.998 |   |          |
| Limit   | >0.95   | >0.95 | >0.95 |   |          |

| <b>Protection. Frequency test</b>   |           |            |           |            |                       | <b>P</b>        |
|---|-----------|------------|-----------|------------|-----------------------|-----------------|
| The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.3 |           |            |           |            |                       |                 |
| 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       | 47.49 Hz  | 20.25 s    | 47.7Hz / 25s          | no trip         |
| U/F stage 2   | 47 Hz     | 0.5 s      | 46.99 Hz  | 832ms      | 47.2Hz / 19.98s/20.4  | no trip         |
|   |           |            |           |            | 46.8Hz / 0.48s/819ms  | no trip         |
| O/F stage 1   | 51.5 Hz   | 90 s       | 51.52 Hz  | 90.2 s     | 51.3Hz / 95s          | no trip         |
| O/F stage 2   | 52 Hz     | 0.5 s      | 52.01 Hz  | 908 ms     | 51.8Hz / 89.98s/90.3s | no trip         |
|   |           |            |           |            | 52.2Hz / 0.48s/897ms  | no trip         |

| <b>Protection. Voltage test</b>   |         |            |           |            |                           | <b>P</b>        |
|---|---------|------------|-----------|------------|---------------------------|-----------------|
| The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.2 |         |            |           |            |                           |                 |
| Function  | Setting |            | Trip test |            | No trip test              |                 |
|   | Voltage | Time delay | Voltage   | Time delay | Voltage / time            | Confirm no trip |
| U/V stage 1   | 200.1 V | 2.5 s      | 199.91 V  | 2.94 s     | 204.1V / 3.5s             | no trip         |
| U/V stage 2   | 184 V   | 0.5 s      | 183.93V   | 940 ms     | 188V / 187.97 2.48s/2.95s | no trip         |
|   |         |            |           |            | 180V / 179.96 0.48s/940ms | no trip         |
| O/V stage 1   | 262.2 V | 1.0 s      | 262.71 V  | 1.44s      | 258.2V 2.0s               | no trip         |
| O/V stage 2   | 273.7 V | 0.5 s      | 275.4 V   | 952 ms     | 269.7V/269.7 0.98s/1.432s | no trip         |
|   |         |            |           |            | 277.7V/277.7 0.48s/928ms  | no trip         |

**Protection. Loss of Mains test**

inverters can be tested to BS EN 62116.

|                          |              |              |               |              |              |               |
|--------------------------|--------------|--------------|---------------|--------------|--------------|---------------|
| Test Power and imbalance | 33%<br>-5% Q | 66%<br>-5% Q | 100%<br>-5% P | 33%<br>+5% Q | 66%<br>+5% Q | 100%<br>+5% P |
| Trip time. Limit is 0.5s | 220ms        | 246ms        | 400ms         | 230ms        | 260ms        | 284ms         |

**Protection. Frequency change, Stability test**

The requirement is specified in section 5.3.3, test procedure in Annex A or B 1.3.6

**P**

|                          | Start Frequency | Change      | End Frequency | Confirm no trip |
|--------------------------|-----------------|-------------|---------------|-----------------|
| Positive Vector Shift    | 49.5Hz          | +9 degrees  |               | no trip         |
| Negative Vector Shift    | 50.5Hz          | - 9 degrees |               | no trip         |
| Positive Frequency drift | 49.5Hz          | +0.19Hz/sec | 51.5Hz        | no trip         |
| Negative Frequency drift | 50.5Hz          | -0.19Hz/sec | 47.5Hz        | no trip         |

**Protection. Re-connection time**

The requirement is specified in section 5.3.4 Automatic Reconnection, test procedure in Annex A or B 1.3.5

**P**

Test should prove that the reconnection sequence starts after a minimum delay of 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 1.

| Voltage   |   |                 |                 |                 |
|---|---|-----------------|-----------------|-----------------|
| Time delay setting                              | Measured delay time(s)  |                 |                 |                 |
| 20s   | 46.6 s  |                 |                 |                 |
| Frequency                                       |   |                 |                 |                 |
| Time delay setting                              | Measured delay time(s)  |                 |                 |                 |
| 20s   | 46.6 s  |                 |                 |                 |
|   | Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1. |                 |                 |                 |
|   | At 266.2V   | At 196.1V       | At 47.4Hz       | At 51.6Hz       |
| Confirmation that the SSEG does not re-connect. | no reconnection   | no reconnection | no reconnection | no reconnection |

| <b>Fault level contribution</b>   |        |       |                     | <b>P</b> |            |
|---|--------|-------|---------------------|----------|------------|
| 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  | -      | -     | 20ms                | -6.9 V   | 2.7A       |
| Initial Value of aperiodic current  | -      | -     | 100ms               | -7.2 V   | -600mA     |
| Initial symmetrical short-circuit current*  | -      | -     | 250ms               | -6.7V    | -600mA     |
| Decaying (aperiodic) component of short circuit current*                          | -      | -     | 500ms               | -7 V     | -600mA     |
| Reactance/Resistance Ratio of source*   | -      | -     | Time to trip        | 58ms     | In seconds |

| <b>Self Monitoring – Solid state Disconnection</b>                             | <b>N/A</b> |
|--|------------|
| The requirement is specified in section 5.3.1, No specified test requirements. |            |
| Not applicable since electro-mechanical relays are used.                       |            |

| <b>Additional comments</b>  |
|---|
| GW3648D-ES is similar to GW3648S-ES in circuit and construction except for dual mppt. The test result can refer to GW3648S-ES . |