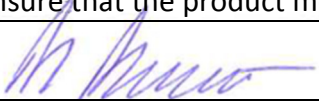




# Engineering Recommendation G83/2 Type Verification Test Report

**Type approval and manufacturer/supplier declaration of compliance with the requirements of Engineering Recommendation G83/2**

| SSEG DETAILS   |  |
|--|--|
| SSEG Type Reference:   |  |
| <b>EnaSolar 2kWGT-UK (Photovoltaic)</b><br><b>EnaSolar 2kWGT-SPUK (Domestic CHP)</b> |  |
| SSEG Type:   | Photovoltaic<br>Domestic CHP   |
| Manufacturer:  | <b>EnaSolar Ltd</b><br>66 Treffers Road, Christchurch 8042, New Zealand<br>Telephone: +64 3 366 4550, Fax:+64 3 366 0884<br><a href="http://www.enasolar.net">www.enasolar.net</a><br><a href="mailto:support@enasolar.net">support@enasolar.net</a> |
| Maximum Rated Capacity:<br>(SSEG Rating Less Parasitic Load)      2000W              |  |

| SSEG MANUFACTURER DECLARATION  |   |              |                     |
|--|---|--------------|---------------------|
| I certify on behalf of EnaSolar as the manufacturer of Small Scale Embedded Generators, that all products manufactured 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. |   |              |                     |
| Signed   |  | On behalf of | <b>EnaSolar Ltd</b> |

| <b>Power Quality. Harmonics</b>    |                                    |                                      |                                    |                                      |  |  |
|------------------------------------|------------------------------------|--------------------------------------|------------------------------------|--------------------------------------|--|--|
| <b>SSEG rating per phase (rpp)</b> |                                    |                                      | <b>2.0</b>                         | <b>kW</b>                            | <b>NV=MV*3.68/rpp</b>                  |  |
| <b>Harmonic</b>                    | <b>At 50% of rated output</b>      |                                      | <b>At 100% of rated output</b>     |                                      | <b>Limit in BS EN3100 -3-2 in Amps</b> | <b>Higher limit for odd harmonics 21 and above</b> |
|                                    | <b>Measured value (MV) in Amps</b> | <b>Normalised Value (NV) in Amps</b> | <b>Measured value (MV) in Amps</b> | <b>Normalised Value (NV) in Amps</b> |  |  |
| <b>2</b>                           | 0.005                              | 0.009                                | 0.011                              | 0.020                                | <b>1.08</b>                            |  |
| <b>3</b>                           | 0.271                              | 0.499                                | 0.344                              | 0.633                                | <b>2.3</b>                             |  |
| <b>4</b>                           | 0.005                              | 0.009                                | 0.005                              | 0.009                                | <b>0.43</b>                            |  |
| <b>5</b>                           | 0.034                              | 0.063                                | 0.039                              | 0.072                                | <b>1.14</b>                            |  |
| <b>6</b>                           | 0.011                              | 0.020                                | 0.000                              | 0.000                                | <b>0.3</b>                             |  |
| <b>7</b>                           | 0.024                              | 0.044                                | 0.023                              | 0.042                                | <b>0.77</b>                            |  |
| <b>8</b>                           | 0.003                              | 0.006                                | 0.003                              | 0.006                                | <b>0.23</b>                            |  |
| <b>9</b>                           | 0.016                              | 0.029                                | 0.018                              | 0.033                                | <b>0.4</b>                             |  |
| <b>10</b>                          | 0.003                              | 0.006                                | 0.007                              | 0.013                                | <b>0.184</b>                           |  |
| <b>11</b>                          | 0.027                              | 0.050                                | 0.033                              | 0.061                                | <b>0.33</b>                            |  |
| <b>12</b>                          | 0.006                              | 0.011                                | 0.000                              | 0.000                                | <b>0.153</b>                           |  |
| <b>13</b>                          | 0.019                              | 0.035                                | 0.024                              | 0.044                                | <b>0.21</b>                            |  |
| <b>14</b>                          | 0.012                              | 0.022                                | 0.005                              | 0.009                                | <b>0.131</b>                           |  |
| <b>15</b>                          | 0.036                              | 0.066                                | 0.035                              | 0.064                                | <b>0.15</b>                            |  |
| <b>16</b>                          | 0.005                              | 0.009                                | 0.005                              | 0.009                                | <b>0.115</b>                           |  |
| <b>17</b>                          | 0.026                              | 0.048                                | 0.036                              | 0.066                                | <b>0.132</b>                           |  |
| <b>18</b>                          | 0.002                              | 0.004                                | 0.002                              | 0.004                                | <b>0.102</b>                           |  |
| <b>19</b>                          | 0.026                              | 0.048                                | 0.057                              | 0.105                                | <b>0.118</b>                           |  |
| <b>20</b>                          | 0.016                              | 0.029                                | 0.013                              | 0.024                                | <b>0.092</b>                           |  |
| <b>21</b>                          | 0.015                              | 0.028                                | 0.034                              | 0.063                                | <b>0.107</b>                           |  |
| <b>22</b>                          | 0.006                              | 0.011                                | 0.003                              | 0.006                                | <b>0.084</b>                           |  |
| <b>23</b>                          | 0.023                              | 0.042                                | 0.049                              | 0.090                                | <b>0.098</b>                           |  |
| <b>24</b>                          | 0.003                              | 0.006                                | 0.009                              | 0.017                                | <b>0.077</b>                           |  |
| <b>25</b>                          | 0.005                              | 0.009                                | 0.014                              | 0.026                                | <b>0.09</b>                            |  |
| <b>26</b>                          | 0.003                              | 0.006                                | 0.010                              | 0.018                                | <b>0.071</b>                           |  |
| <b>27</b>                          | 0.005                              | 0.009                                | 0.010                              | 0.018                                | <b>0.083</b>                           |  |
| <b>28</b>                          | 0.004                              | 0.007                                | 0.004                              | 0.007                                | <b>0.066</b>                           |  |
| <b>29</b>                          | 0.005                              | 0.009                                | 0.001                              | 0.002                                | <b>0.078</b>                           |  |
| <b>30</b>                          | 0.004                              | 0.007                                | 0.002                              | 0.004                                | <b>0.061</b>                           |  |
| <b>31</b>                          | 0.006                              | 0.011                                | 0.000                              | 0.000                                | <b>0.073</b>                           |  |
| <b>32</b>                          | 0.003                              | 0.006                                | 0.002                              | 0.004                                | <b>0.058</b>                           |  |
| <b>33</b>                          | 0.003                              | 0.006                                | 0.002                              | 0.004                                | <b>0.068</b>                           |  |
| <b>34</b>                          | 0.002                              | 0.004                                | 0.003                              | 0.006                                | <b>0.054</b>                           |  |
| <b>35</b>                          | 0.004                              | 0.007                                | 0.003                              | 0.006                                | <b>0.064</b>                           |  |
| <b>36</b>                          | 0.001                              | 0.002                                | 0.001                              | 0.002                                | <b>0.051</b>                           |  |
| <b>37</b>                          | 0.003                              | 0.006                                | 0.002                              | 0.004                                | <b>0.061</b>                           |  |
| <b>38</b>                          | 0.003                              | 0.006                                | 0.002                              | 0.004                                | <b>0.048</b>                           |  |
| <b>39</b>                          | 0.003                              | 0.006                                | 0.003                              | 0.006                                | <b>0.058</b>                           |  |
| <b>40</b>                          | 0.009                              | 0.017                                | 0.006                              | 0.011                                | <b>0.046</b>                           |  |

**Power Quality. Voltage fluctuations and flicker**

|   | Starting  |   |                       | Stopping             |             |                       | Running    |                  |
|---|-----------|---|-----------------------|----------------------|-------------|-----------------------|------------|------------------|
|   | $d_{max}$ | $d_c$   | $d_{(t)}$             | $d_{max}$            | $d_c$       | $d_{(t)}$             | $P_{st}$   | $P_{lt}$ 2 hours |
| <b>Measured Values</b>  | 1.92%     | 1.88%   | 0%                    | 1.35%                | 1.3%        | 0.15%                 | 0.204      | 0.176            |
| <b>Normalised to standard impedance and 3.68kW for multiple units</b> | 3.36%     | 3.29%   | 0%                    | 2.48%                | 2.39%       | 0.28%                 | 0.227      | 0.196            |
| <b>Limits in BS EN61000-3-3</b>                                       | <b>4%</b> | <b>3.3%</b>   | <b>3.3%<br/>500ms</b> | <b>4%</b>            | <b>3.3%</b> | <b>3.3%<br/>500ms</b> | <b>1.0</b> | <b>0.65</b>      |
| <b>Test start date</b>  |           | 15/01/2014  |                       | <b>Test end date</b> |             | 16/01/2014            |            |                  |
| <b>Test location</b>  |           | EnaSolar, 66 Treffers Road, Christchurch, New Zealand |                       |                      |             |                       |            |                  |

| <b>Power Quality. DC injection</b> |              |              |              |
|------------------------------------|--------------|--------------|--------------|
| <b>Test Power Level</b>            | <b>10%</b>   | <b>55%</b>   | <b>100%</b>  |
| <b>Recorded value</b>              | 7mA          | 7mA          | 6mA          |
| <b>% of rated AC current</b>       | 0.08%        | 0.08%        | 0.07%        |
| <b>Limit</b>                       | <b>0.25%</b> | <b>0.25%</b> | <b>0.25%</b> |

| <b>Power Quality. Power Factor</b> |                 |                 |                 |
|------------------------------------|-----------------|-----------------|-----------------|
|                                    | <b>216.2V</b>   | <b>230V</b>     | <b>253V</b>     |
| <b>Recorded value</b>              | 0.9978          | 0.9974          | 0.9964          |
| <b>Limit</b>                       | <b>&gt;0.95</b> | <b>&gt;0.95</b> | <b>&gt;0.95</b> |

| <b>Protection. Frequency tests.</b> |               |             |           |            |                          |                 |
|-------------------------------------|---------------|-------------|-----------|------------|--------------------------|-----------------|
| Function                            | Setting       |             | Trip test |            | "No trip test"           |                 |
|                                     | Frequency     | Time delay  | Frequency | Time delay | Frequency /time          | Confirm no trip |
| <b>U/F stage 1</b>                  | <b>47.5Hz</b> | <b>20s</b>  | 47.45Hz   | 20.1s      | <b>47.7Hz<br/>25s</b>    | No trip         |
| <b>U/F stage 2</b>                  | <b>47Hz</b>   | <b>0.5s</b> | 46.95Hz   | 0.6s       | <b>47.2Hz<br/>19.98s</b> | No trip         |
|                                     |               |             |           |            | <b>46.8Hz<br/>0.48s</b>  | No trip         |
| <b>O/F stage 1</b>                  | <b>51.5Hz</b> | <b>90s</b>  | 51.55Hz   | 90.1s      | <b>51.3Hz<br/>95s</b>    | No trip         |
| <b>O/F stage 2</b>                  | <b>52Hz</b>   | <b>0.5s</b> | 52.05Hz   | 0.66s      | <b>51.8Hz<br/>89.98s</b> | No trip         |
|                                     |               |             |           |            | <b>52.2Hz<br/>0.48s</b>  | 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 stage 1                | 200.1V  | 2.5s       | 199.1V    | 2.6s       | 204.1V<br>3.5s  | No trip         |
| U/V stage 2                | 184V    | 0.5s       | 182.6V    | 0.51s      | 188V<br>2.48s   | No trip         |
|                            |         |            |           |            | 180V<br>0.48s   | No trip         |
| O/V stage 1                | 262.2V  | 1.0s       | 262.2V    | 1s         | 258.2V<br>2s    | No trip         |
| O/V stage 2                | 273.7V  | 0.5s       | 275.1V    | 0.51s      | 269.7V<br>0.98s | No trip         |
|                            |         |            |           |            | 277.7V<br>0.48s | No trip         |

| Protection. Loss of mains test.    |        |       |       |        |       |       |
|------------------------------------|--------|-------|-------|--------|-------|-------|
| Test Power                         | 33%    | 66%   | 100%  | 33%    | 66%   | 100%  |
| Balancing load on islanded network | -5% Q  | -5% Q | -5% P | -5% Q  | -5% Q | -5% P |
| Trip Time                          | 0.189s | 0.25s | 0.18s | 0.209s | 0.19s | 0.15s |
| Limit                              | 0.5s   | 0.5s  | 0.5s  | 0.5s   | 0.5s  | 0.5s  |

| Protection. Frequency change, Stability test. |                 |             |               |                 |
|---|-----------------|-------------|---------------|-----------------|
|   | 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         |
| Positive Frequency drift                      | 50.5Hz          | -0.19Hz/Sec | 47.5Hz        | No trip         |

| Protection. Re-connection timer.               |                |                 |                  |                    |                   |
|--|----------------|-----------------|------------------|--------------------|-------------------|
| Time delay setting                             | Measured Delay |                 |                  |                    |                   |
| 20 Seconds                                     | >20 Sec        | At 266.2V       | At 196.1V        | At 47.4Hz          | At 51.6Hz         |
| Confirmation that the SSEG does not re-connect |                | AC over voltage | AC under voltage | AC under Frequency | AC over Frequency |

| Fault level contribution – Inverter SSEG. |       |            |
|---|-------|------------|
| Time after fault                          | Volts | Amps       |
| 20ms                                      | 105.5 | 8.66       |
| 100ms                                     | 28.86 | 5.23       |
| 250ms                                     | 54.85 | 0          |
| 500ms                                     | 54.85 | 0          |
| Time to trip                              | 0.2   | In seconds |

| Self Monitoring – Solid state switching.              |
|---|
| Not applicable as electro-mechanical relays are used. |