

Certificate

Applicant: **Steca Elektronik GmbH**
Mammostraße 1
87700 Memmingen
Germany

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

| | | | | | | | | |
|----------------|-----------------|-----------------|-----------------|-----------------|-------------------|-----------------|-------------------|-------------------|
| Model: | Steca Grid 1511 | Steca Grid 2011 | Steca Grid 2511 | Steca Grid 3011 | Steca Grid 3011_2 | Steca Grid 3611 | Steca Grid 3611_2 | Steca Grid 4611_2 |
| Rating: | 1500W | 2000W | 2500W | 3000W | | 3680W | | 4600W |

Intended use:

An automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G59/3 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:

SOP-9-1_11 GCC Certification Program, 04/18

Based on:

Engineering Recommendation G59/3-3

Issue 3 Amendment 3 February 2018

Recommendations for the connection of generating plant to the distribution systems of licensed distribution network operators

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.

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Certification Engineer



Power Quality. Harmonics.

Generating Unit tested to BS EN 61000-3-12

| Generating Unit rating per phase (rpp) | | 4,6 | 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 | 0,008 | 0,04 | 0,020 | 0,10 | 8% | 8% |
| 3 | 0,014 | 0,07 | 0,034 | 0,17 | 21,6% | Not stated |
| 4 | 0,004 | 0,02 | 0,006 | 0,03 | 4% | 4% |
| 5 | 0,006 | 0,03 | 0,018 | 0,09 | 10,7% | 10,7% |
| 6 | 0,002 | 0,01 | 0,006 | 0,03 | 2,67% | 2,67% |
| 7 | 0,008 | 0,04 | 0,008 | 0,04 | 7,2% | 7,2% |
| 8 | 0,002 | 0,01 | 0,004 | 0,02 | 2% | 2% |
| 9 | 0,004 | 0,02 | 0,018 | 0,09 | 3,8% | Not stated |
| 10 | 0,002 | 0,01 | 0,004 | 0,02 | 1,6% | 1,6% |
| 11 | 0,006 | 0,03 | 0,016 | 0,08 | 3,1% | 3,1% |
| 12 | 0,002 | 0,01 | 0,004 | 0,02 | 1,33% | 1,33% |
| 13 | 0,010 | 0,05 | 0,010 | 0,05 | 2% | 2% |
| THD | - | 0,300 | - | 0,388 | 23% | 13% |
| PWHD | - | 0,954 | - | 1,501 | 23% | 22% |

Generating Unit tested to BS EN 61000-3-2

| Generating Unit rating per phase (rpp) | | 3,68 | kW | | | |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|----------------------------------|---|
| Harmonic | At 45-55% of rated output | | 100% of rated output | | Limit in BS EN 61000-3-2 in Amps | Higher limit for odd harmonics 21 and above |
| | Measured Value (MV) in Amps | Normalized value NV in Amps | Measured Value (MV) in Amps | Normalized value NV in Amps | | |
| 2 | 0,011 | 0,011 | 0,066 | 0,066 | 1,080 | |
| 3 | 0,030 | 0,030 | 0,062 | 0,062 | 2,300 | |
| 4 | 0,003 | 0,003 | 0,019 | 0,019 | 0,430 | |
| 5 | 0,010 | 0,010 | 0,035 | 0,035 | 1,140 | |
| 6 | 0,003 | 0,003 | 0,016 | 0,016 | 0,300 | |
| 7 | 0,005 | 0,005 | 0,019 | 0,019 | 0,770 | |
| 8 | 0,002 | 0,002 | 0,011 | 0,011 | 0,230 | |
| 9 | 0,005 | 0,005 | 0,024 | 0,024 | 0,400 | |
| 10 | 0,002 | 0,002 | 0,008 | 0,008 | 0,184 | |
| 11 | 0,003 | 0,003 | 0,018 | 0,018 | 0,330 | |
| 12 | 0,002 | 0,002 | 0,008 | 0,008 | 0,153 | |
| 13 | 0,003 | 0,003 | 0,014 | 0,014 | 0,210 | |
| 14 | 0,002 | 0,002 | 0,006 | 0,006 | 0,131 | |
| 15 | 0,003 | 0,003 | 0,011 | 0,011 | 0,150 | |
| 16 | 0,002 | 0,002 | 0,005 | 0,005 | 0,115 | |
| 17 | 0,003 | 0,003 | 0,010 | 0,010 | 0,132 | |
| 18 | 0,002 | 0,002 | 0,005 | 0,005 | 0,102 | |
| 19 | 0,003 | 0,003 | 0,010 | 0,010 | 0,118 | |
| 20 | 0,002 | 0,002 | 0,005 | 0,005 | 0,092 | |
| 21 | 0,003 | 0,003 | 0,008 | 0,008 | 0,107 | 0,160 |

| | | | | | | |
|----|-------|-------|-------|-------|-------|-------|
| 22 | 0,002 | 0,002 | 0,005 | 0,005 | 0,084 | |
| 23 | 0,003 | 0,003 | 0,008 | 0,008 | 0,098 | 0,147 |
| 24 | 0,002 | 0,002 | 0,005 | 0,005 | 0,077 | |
| 25 | 0,002 | 0,002 | 0,006 | 0,006 | 0,090 | 0,135 |
| 26 | 0,002 | 0,002 | 0,005 | 0,005 | 0,071 | |
| 27 | 0,002 | 0,002 | 0,006 | 0,006 | 0,083 | 0,124 |
| 28 | 0,002 | 0,002 | 0,005 | 0,005 | 0,066 | |
| 29 | 0,002 | 0,002 | 0,006 | 0,006 | 0,078 | 0,117 |
| 30 | 0,002 | 0,002 | 0,005 | 0,005 | 0,061 | |
| 31 | 0,002 | 0,002 | 0,006 | 0,006 | 0,073 | 0,109 |
| 32 | 0,002 | 0,002 | 0,005 | 0,005 | 0,058 | |
| 33 | 0,003 | 0,003 | 0,006 | 0,006 | 0,068 | 0,102 |
| 34 | 0,002 | 0,002 | 0,005 | 0,005 | 0,054 | |
| 35 | 0,002 | 0,002 | 0,006 | 0,006 | 0,064 | 0,096 |
| 36 | 0,002 | 0,002 | 0,005 | 0,005 | 0,051 | |
| 37 | 0,003 | 0,003 | 0,006 | 0,006 | 0,061 | 0,091 |
| 38 | 0,002 | 0,002 | 0,003 | 0,003 | 0,048 | |
| 39 | 0,002 | 0,002 | 0,005 | 0,005 | 0,058 | 0,087 |
| 40 | 0,002 | 0,002 | 0,005 | 0,005 | 0,046 | |

Power Quality. Voltage fluctuations and flicker

| | Starting | | | Stopping from full load | | | Running | |
|--|------------------|----------------|------------------|-------------------------|----------------|------------------|-----------------|-------------------------|
| | d _{max} | d _c | d _(t) | d _{max} | d _c | d _(t) | P _{st} | P _{It} 2 hours |
| Measured Values at test impedance | -3,99 | -3,64 | - | 4,69 | 3,92 | 1260 | 0,16 | 0,15 |
| Normalised to standard impedance | -3,99 | -3,64 | - | 4,69 | 3,92 | 1260 | 0,16 | 0,15 |
| Normalised to required maximum impedance | -3,36 | -3,07 | - | 3,94 | 3,30 | - | 0,13 | 0,13 |
| Limits set under BS EN 61000-3-11 | 4% | 3,3% | 3,3% | 4% | 3,3% | 3,3% | 1,0 | 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 | 0,34 | Ω | XI | 0,21 | Ω |

Power Quality. DC injection.

| | | | |
|--------------------------|--------|--------|--------|
| Test power level | 10% | 55% | 100% |
| Recorded value in Amps | -0,003 | -0,006 | -0,012 |
| As % of rated AC current | -0,02 | -0,04 | -0,08 |
| Limit | 0,25% | 0,25% | 0,25% |

Power Quality. Power factor.

| | | | | |
|----------------|--------|-------|-------|---|
| | 216,2V | 230V | 253V | Measured at three voltage levels and at full output. Voltage to be maintained within + or - 1,5% of the stated level during test. |
| Measured Value | 1,000 | 1,000 | 1,000 | |
| Limit | >0,95 | >0,95 | >0,95 | |

Protection. Frequency tests

| Function | Setting | | Trip test | | "No trip tests" | |
|-------------|-----------|------------|-----------|------------|------------------|-----------------|
| | Frequency | Time delay | Frequency | Time delay | Frequency / time | Confirm no trip |
| U/F stage 1 | 47,5Hz | 20,0s | 47,54Hz | 20,22s | 47,7Hz 25s | No trip |
| U/F stage 2 | 47,0Hz | 0,5s | 47,04Hz | 0,75s | 47,2Hz 19,98s | No trip |
| | | | | | 46,8Hz 0,48s | No trip |
| O/F stage 1 | 51,5Hz | 90,0s | 51,46Hz | 90,21s | 51,3Hz 95s | No trip |
| O/F stage 2 | 52,0Hz | 0,5s | 51,95Hz | 0,72s | 51,8Hz 89,98s | No trip |
| | | | | | 52,2Hz 0,48s | No trip |

Protection. Voltage tests

| Function | Setting | | Trip test | | "No trip tests" | |
|-------------|---------|------------|-----------|------------|-----------------|-----------------|
| | Voltage | Time delay | Voltage | Time delay | Voltage / time | Confirm no trip |
| U/V stage 1 | 200,1V | 2,5s | 201,9V | 2,75s | 204,1V 3,5s | No trip |
| U/V stage 2 | 184,0V | 0,5s | 186,3V | 0,75s | 188,0V 2,48s | No trip |
| | | | | | 180,0V 0,48s | No trip |
| O/V stage 1 | 262,2V | 1,0s | 260,1V | 1,24s | 258,2V 2,0s | No trip |
| O/V stage 2 | 273,7V | 0,5s | 271,6V | 0,75s | 269,7V 0,98s | No trip |
| | | | | | 277,7V 0,48s | No trip |

a) Protection. Loss of Mains test and single phase test

Note as an alternative, inverters can be tested to BS EN 62116. The following sub set of tests should be recorded in the following table.

| | | | | | | |
|--------------------------|--------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| Test power and imbalance | 33% -5% Q Tests 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 | 0,09s | 0,16s | 0,15s | 0,11s | 0,09s | 0,12s |

Single phase test for multi phase **Generating Units**. Confirm that when generating in parallel with a network operating at around 50Hz with no network disturbance, that the removal of a single phase connection to the **Generating Unit**, with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.

| | | | | | |
|--------------|--------------|--------------|---|--------------|---|
| Ph 1 removed | Confirm trip | Ph 2 removed | - | Ph 3 removed | - |
|--------------|--------------|--------------|---|--------------|---|

b) 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 |
| Negative frequency drift | 50,5Hz | -0,19Hz/sec | 47,5Hz | No trip |

c) Protection. Re-connection timer.

| Time delay settings (s) | Measured delay (s) | Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 10.5.7.1 | | | |
|--|--------------------|---|------------------|------------------|------------------|
| 20 | 77,4 | At 266,2V | At 196,1V | At 47,4Hz | At 51,6Hz |
| Confirmation that the Generating Unit does not re-connect | | No re-connection | No re-connection | No re-connection | No re-connection |

d) Fault Level contribution.

| For machines with electro-magnetic output | | | For inverter output | | |
|---|----------|-------|---------------------|-------|------------|
| Parameter | Symbol | Value | Time after fault | Volts | Amps |
| Peak Short Circuit current | i_p | N/A | 20ms | 40,3 | 14,99 |
| Initial Value of aperiodic current | A | N/A | 100ms | 22,5 | 0,03 |
| Initial symmetrical short-circuit current | I_k | N/A | 250ms | 22,2 | 0,03 |
| Decaying (aperiodic) component of short-circuit current | i_{dc} | N/A | 500ms | 22,3 | 0,03 |
| Reactance/Resistance Ratio of source | X/R | N/A | Time to trip | 0,031 | In seconds |

e) Self Monitoring solid state switching.

It has been verified that in the event of the solid state switching device failing to disconnect the Generating Plant, the voltage on the output side of the switching device is reduced to a value below 50 volt within 0,5s. | N/A