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Certificate of compliance

Applicant: SMA Solar Technology AG
Sonnenallee 1
34266 Niestetal
Germany

Product: Photovoltaic (PV) inverter

Model: STP 50-40
STP 50-41

Use in accordance with regulations:

Automatic disconnection device with three-phase mains surveillance in accordance with Engineering Recommendation G99/1 for photovoltaic systems with a three-phase parallel coupling via an inverter in the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter. This serves as a replacement for the disconnection device with isolating function, which can be accessed the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G99/1-6:2020

Requirements for the connection of generation equipment in parallel with public distribution networks

DIN V VDE V 0126-1-1:2006-02 (4.1 Functional safety)

Automatic disconnection device between a generator and the public low-voltage grid

At the time of issue of this certificate the safety concept of an aforementioned representative product corresponds to the valid safety specifications for the specified use in accordance with regulations.

Report number: 17TH0199-G99/1-4_5

Certification program: NSOP-0032-DEU-ZE-V01

Certificate number: U21-0476

Date of issue: 2021-05-26

Certification body



Thomas Lammel

Certification body Bureau Veritas Consumer Products Services Germany GmbH accredited according to DIN EN ISO/IEC 17065

A partial representation of the certificate requires the written approval of Bureau Veritas Consumer Products Services Germany GmbH



Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99 Nr. 17TH0199-G99/1-4_5

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G99.

| | | | |
|----------------------------------|---|-----------------|-----------------|
| PGM Technology: | Photovoltaic Inverter | | |
| Manufacturer / applicant: | SMA Solar Technology AG | | |
| Address: | Sonnenallee 1 34266 Niestetal Germany | | |
| Tel | +49 5619522-0 | Fax: | +46 5619522-100 |
| Email: | info@SMA.de | Website: | www.SMA.de |

| | |
|-----------------------------------|-----------------------------|
| Rated values | STP 50-40 STP 50-41 |
| MPP DC voltage range [V] | 500 – 800 |
| Input DC voltage range [V] | Max. 1000 |
| Input DC current [A] | 6 x 20 |
| Output AC voltage [V] | 400 3 / N / PE @ 50 / 60 Hz |
| Output AC current [A] | 72,5 |
| Output power [VA] | 50000 |

| | |
|-------------------------|--------------------------|
| Firmware version | beginning with 3.00.05.R |
|-------------------------|--------------------------|

| | |
|----------------------------|--|
| Measurement period: | 2019-04-16 to 2019-04-18, 2019-08-29 to 2019-09-02 |
|----------------------------|--|

Description of the structure of the power generation unit:
 The power generation unit is equipped with a PV and line-side EMC filter. The power generation unit has no galvanic isolation between DC input and AC output. Output switch-off is performed with single-fault tolerance based on two series-connected relays in line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

Differences between Generating Units:
 The STP 50-41 is an upgrade of the STP 50-40 with the AFCI (Arc-Fault Circuit Interruption) function. A new PCB Board was added with the AFCI function, which implied minor modifications of three of the existing boards.
 None of the aforementioned changes cause a modification of the performance and behaviour, which was tested and certified for the STP 50-40 in accordance with all grid connection standards.
 Therefore testing of the PGU STP 50-40 is applicable for the PGU STP 50-41.

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G99/1. Any modification that affects the stated tests must be named by the manufacturer/supplier of the product to ensure that the product meets all requirements of the Engineering Recommendation G99/1.



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Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 17TH0199-G99/1-4_5

| Operating Range. | |
|------------------|--|
| Test 1 | Voltage = 85% of nominal (195,5V) Frequency = 47Hz Power Factor = 1 Period of test 20 s |
| Connection: | Always connected |
| Limit: | Always connected |
| Test 2 | Voltage = 85% of nominal (195,5V) Frequency = 47,5Hz Power Factor = 1 Period of test 90 minutes |
| Connection: | Always connected |
| Limit: | Always connected |
| Test 3 | Voltage = 110% of nominal (253V) Frequency = 51,5Hz Power Factor = 1 Period of test 90 minutes |
| Connection: | |
| Limit: | Always connected |
| Test 4 | Voltage = 110% of nominal (253V) Frequency = 52,0Hz Power Factor = 1 Period of test 15 minutes |
| Connection: | Always connected |
| Limit: | Always connected |
| Test 5 | Confirm that the Power Generating Module is capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500ms. Note that this is not expected to be demonstrated on site. |
| Connection: | Always connected |
| Limit: | Always connected |

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Protection. Voltage tests.

Phase 1

| Function | Setting | | Trip test | | No trip test | |
|-------------|-------------|----------------|-------------|----------------|----------------|-----------------|
| | Voltage [V] | Time delay [s] | Voltage [V] | Time delay [s] | Voltage / time | Confirm no trip |
| UV | 184 | 2,5 | 183,7 | 2,527 | 188V / 5,0s | No trip |
| | | | | | 180V / 2,45s | No trip |
| O/V stage 1 | 262,2 | 1,0 | 264,3 | 1,027 | 258,2V 5,0s | No trip |
| O/V stage 2 | 273,7 | 0,5 | 275,7 | 0,527 | 269,7V 0,95s | No trip |
| | | | | | 277,7V 0,45s | No trip |

Phase 2

| Function | Setting | | Trip test | | No trip test | |
|-------------|-------------|----------------|-------------|----------------|----------------|-----------------|
| | Voltage [V] | Time delay [s] | Voltage [V] | Time delay [s] | Voltage / time | Confirm no trip |
| UV | 184 | 2,5 | 183,7 | 2,527 | 188V / 5,0s | No trip |
| | | | | | 180V / 2,45s | No trip |
| O/V stage 1 | 262,2 | 1,0 | 264,2 | 1,027 | 258,2V 5,0s | No trip |
| O/V stage 2 | 273,7 | 0,5 | 275,7 | 0,527 | 269,7V 0,95s | No trip |
| | | | | | 277,7V 0,45s | No trip |

Phase 3

| Function | Setting | | Trip test | | No trip test | |
|-------------|-------------|----------------|-------------|----------------|----------------|-----------------|
| | Voltage [V] | Time delay [s] | Voltage [V] | Time delay [s] | Voltage / time | Confirm no trip |
| UV | 184 | 2,5 | 183,8 | 2,527 | 188V / 5,0s | No trip |
| | | | | | 180V / 2,45s | No trip |
| O/V stage 1 | 262,2 | 1,0 | 264,3 | 1,027 | 258,2V 5,0s | No trip |
| O/V stage 2 | 273,7 | 0,5 | 275,8 | 0,527 | 269,7V 0,95s | No trip |
| | | | | | 277,7V 0,45s | No trip |

Note. For Voltage tests the Voltage required to trip is the setting $\pm 3,45V$. 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 $\pm 4V$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.



Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

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| Protection. Frequency tests. | | | | | | |
|------------------------------|----------------|----------------|----------------|----------------|------------------|-----------------|
| Function | Setting | | Trip test | | No trip test | |
| | Frequency [Hz] | Time delay [s] | Frequency [Hz] | Time delay [s] | Frequency / time | Confirm no trip |
| U/F stage 1 | 47,5 | 20 | 47,45 | 20,08 | 47,7Hz / 30s | No trip |
| U/F stage 2 | 47 | 0,5 | 46,95 | 0,586 | 47,2Hz / 19,5s | No trip |
| | | | | | 46,8Hz / 0,45s | No trip |
| O/F stage 2 | 52 | 0,5 | 51,99 | 0,580 | 51,8Hz / 120s | No trip |
| | | | | | 52,2Hz / 0,45s | No trip |

Note. For Frequency Trip tests the Frequency required to trip is the setting $\pm 0,1$ Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The "No-trip tests" need to be carried out at the setting $\pm 0,2$ Hz 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. | | | | | | |
|--|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| Inverters tested according to BS EN 62116. | | | | | | |
| Balancing load on islanded network | 33% of -5% Q Test 22 | 66% of -5% Q Test 12 | 100% of -5% P Test 5 | 33% of +5% Q Test 31 | 66% of +5% Q Test 21 | 100% of +5% P Test 10 |
| Trip time. Ph1 fuse removed [s] | 0,110 | 0,106 | 0,156 | 0,129 | 0,116 | 0,141 |
| Trip time. Ph2 fuse removed [s] | 0,110 | 0,106 | 0,156 | 0,129 | 0,116 | 0,141 |
| Trip time. Ph3 fuse removed [s] | 0,110 | 0,106 | 0,156 | 0,129 | 0,116 | 0,141 |

Note. Trip time limit is 0,5s.

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| Protection. Re-connection timer. | | | | | |
|---|-----------------|---|-----------------|-----------------|-----------------|
| Test should prove that the reconnection sequence starts in no less than 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 10.1. | | | | | |
| Over Voltage | | | | | |
| Time delay setting | | Measured delay | | | |
| 20s | | 28,73s | | | |
| Under Voltage | | | | | |
| Time delay setting | | Measured delay | | | |
| 20s | | 27,21s | | | |
| Over Frequency | | | | | |
| Time delay setting | | Measured delay | | | |
| 20s | | 27,58s | | | |
| Under Frequency | | | | | |
| Time delay setting | | Measured delay | | | |
| 20s | | 27,64s | | | |
| | | Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1. | | | |
| | | At 266,2V | At 180,0V | At 47,4Hz | At 52,1Hz |
| Confirmation that the Generating Unit does not re-connect. | No reconnection | No reconnection | No reconnection | No reconnection | No reconnection |

| Protection. Frequency change, Stability test. | | | | |
|---|----------------------|-------------|---------------|-----------------|
| | Start Frequency [Hz] | Change | Test Duration | Confirm no trip |
| Positive Vector Shift | 49,5 | +50 degrees | | No trip |
| Negative Vector Shift | 50,5 | -50 degrees | | No trip |
| Positive Frequency drift | 49,0 to 51,0 | +0,95Hz/sec | 2,1s | No trip |
| Negative Frequency drift | 51,0 to 49,0 | -0,95Hz/sec | 2,1s | No trip |



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Limited Frequency Sensitive Mode – Over Frequency

| 1-min mean value [Hz]: | a) 50,00 | b) 50,45 | c) 50,70 | d) 51,15 | e) 50,70 | f) 50,45 | g) 50,00 |
|---|----------|----------|----------|----------|----------|----------|----------|
| 1. Measurement a) to g): Active power output > 80% P_n | | | | | | | |
| Frequency [Hz]: | 50,00 | 50,45 | 50,70 | 51,15 | 50,70 | 50,45 | 50,00 |
| P _{expected} [kW]: | 49,99 | 49,42 | 46,92 | 42,42 | 46,92 | 49,42 | 49,99 |
| P _{measured} [kW]: | 49,99 | 48,98 | 46,48 | 41,94 | 46,49 | 49,42 | 49,99 |
| 2. Measurement a) to g): Active power output 40% and 60% P_n | | | | | | | |
| Frequency [Hz]: | 50,00 | 50,45 | 50,70 | 51,15 | 50,70 | 50,45 | 50,00 |
| P _{expected} [kW]: | 25,00 | 24,50 | 22,00 | 17,50 | 22,00 | 24,50 | 25,00 |
| P _{measured} [kW]: | 25,00 | 24,44 | 21,93 | 17,40 | 21,98 | 24,47 | 25,00 |

Output Power with falling Frequency

| | | | | | | |
|--------------------------|-------|-------|-------|-------|-------|-------|
| Frequency setpoint [Hz]: | 50,00 | 49,50 | 49,00 | 48,00 | 47,60 | 47,10 |
| Frequency [Hz]: | 50,00 | 49,50 | 49,00 | 48,00 | 47,60 | 47,10 |
| Active power [kW]: | 50,19 | 50,22 | 50,21 | 50,22 | 50,19 | 0,00 |



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| Power Quality. Harmonics. | | | | | | |
|--|-------------------------------------|-------------------------------|---------------------------------|-------------------------------|----------------------------------|---------|
| Phase 1 | | | | | | |
| Generating Unit rating per phase (rpp) | | | | | | |
| | At 45-55% of rated output 8,3 kW | | 100% of rated output 16,5 kW | | | |
| Harmonic | Measured Value (MV) in [A] | Measured Value (MV) in [%] | Measured Value (MV) in [A] | Measured Value (MV) in [%] | Limit in BS EN61000-3-12 in % | |
| | | | | | 1 phase | 3 phase |
| 2nd | 0,128 | 0,181 | 0,108 | 0,152 | 8% | 8% |
| 3rd | 0,015 | 0,021 | 0,013 | 0,018 | 21,6% | N/A |
| 4th | 0,062 | 0,088 | 0,058 | 0,082 | 4% | 4% |
| 5th | 0,290 | 0,410 | 0,323 | 0,456 | 10,7% | 10,7% |
| 6th | 0,035 | 0,049 | 0,036 | 0,050 | 2,67% | 2,67% |
| 7th | 0,179 | 0,253 | 0,283 | 0,401 | 7,2% | 7,2% |
| 8th | 0,062 | 0,088 | 0,054 | 0,077 | 2% | 2% |
| 9th | 0,018 | 0,026 | 0,020 | 0,028 | 3,8% | N/A |
| 10th | 0,031 | 0,043 | 0,019 | 0,026 | 1,6% | 1,6% |
| 11th | 0,080 | 0,113 | 0,113 | 0,159 | 3,1% | 3,1% |
| 12th | 0,068 | 0,096 | 0,068 | 0,097 | 1,33% | 1,33% |
| 13th | 0,069 | 0,097 | 0,098 | 0,139 | 2% | 2% |
| 14th | 0,015 | 0,021 | 0,013 | 0,019 | N/A | N/A |
| 15th | 0,012 | 0,017 | 0,014 | 0,020 | N/A | N/A |
| 16th | 0,025 | 0,036 | 0,032 | 0,046 | N/A | N/A |
| 17th | 0,036 | 0,050 | 0,065 | 0,092 | N/A | N/A |
| 18th | 0,017 | 0,024 | 0,016 | 0,023 | N/A | N/A |
| 19th | 0,027 | 0,038 | 0,048 | 0,068 | N/A | N/A |
| 20th | 0,009 | 0,012 | 0,008 | 0,011 | N/A | N/A |
| 21th | 0,007 | 0,010 | 0,008 | 0,012 | N/A | N/A |
| 22th | 0,013 | 0,019 | 0,014 | 0,020 | N/A | N/A |
| 23th | 0,020 | 0,029 | 0,044 | 0,062 | N/A | N/A |
| 24th | 0,007 | 0,010 | 0,006 | 0,008 | N/A | N/A |
| 25th | 0,015 | 0,021 | 0,031 | 0,044 | N/A | N/A |
| 26th | 0,008 | 0,011 | 0,010 | 0,014 | N/A | N/A |
| 27th | 0,005 | 0,007 | 0,006 | 0,009 | N/A | N/A |
| 28th | 0,004 | 0,006 | 0,006 | 0,008 | N/A | N/A |
| 29th | 0,012 | 0,017 | 0,026 | 0,036 | N/A | N/A |
| 30th | 0,004 | 0,005 | 0,004 | 0,006 | N/A | N/A |
| 31th | 0,013 | 0,019 | 0,022 | 0,031 | N/A | N/A |
| 32th | 0,005 | 0,007 | 0,004 | 0,005 | N/A | N/A |
| 33th | 0,004 | 0,006 | 0,005 | 0,007 | N/A | N/A |
| 34th | 0,003 | 0,005 | 0,003 | 0,004 | N/A | N/A |



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| | | | | | | |
|-----------------------|--------|-------|--------|-------|-----|-----|
| 35th | 0,007 | 0,011 | 0,016 | 0,022 | N/A | N/A |
| 36th | 0,004 | 0,005 | 0,004 | 0,005 | N/A | N/A |
| 37th | 0,007 | 0,010 | 0,013 | 0,019 | N/A | N/A |
| 38th | 0,003 | 0,005 | 0,003 | 0,004 | N/A | N/A |
| 39th | 0,003 | 0,004 | 0,004 | 0,006 | N/A | N/A |
| 40th | 0,003 | 0,005 | 0,002 | 0,004 | N/A | N/A |
| THD ₄₀ [%] | 1,13 | | 0,70 | | 23% | 13% |
| PWHD [%] | 0,0006 | | 0,0005 | | 23% | 22% |



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| Power Quality. Harmonics. | | | | | | |
|--|-------------------------------------|-------------------------------|---------------------------------|-------------------------------|----------------------------------|---------|
| Phase 2 | | | | | | |
| Generating Unit rating per phase (rpp) | | | | | | |
| | At 45-55% of rated output 8,3 kW | | 100% of rated output 16,5 kW | | | |
| Harmonic | Measured Value (MV) in [A] | Measured Value (MV) in [%] | Measured Value (MV) in [A] | Measured Value (MV) in [%] | Limit in BS EN61000-3-12 in % | |
| | | | | | 1 phase | 3 phase |
| 2nd | 0,131 | 0,184 | 0,177 | 0,250 | 8% | 8% |
| 3rd | 0,016 | 0,023 | 0,022 | 0,031 | 21,6% | N/A |
| 4th | 0,029 | 0,041 | 0,025 | 0,035 | 4% | 4% |
| 5th | 0,282 | 0,398 | 0,311 | 0,439 | 10,7% | 10,7% |
| 6th | 0,036 | 0,050 | 0,040 | 0,056 | 2,67% | 2,67% |
| 7th | 0,184 | 0,260 | 0,289 | 0,408 | 7,2% | 7,2% |
| 8th | 0,057 | 0,081 | 0,045 | 0,063 | 2% | 2% |
| 9th | 0,013 | 0,019 | 0,017 | 0,023 | 3,8% | N/A |
| 10th | 0,081 | 0,115 | 0,074 | 0,105 | 1,6% | 1,6% |
| 11th | 0,084 | 0,119 | 0,117 | 0,165 | 3,1% | 3,1% |
| 12th | 0,036 | 0,051 | 0,034 | 0,049 | 1,33% | 1,33% |
| 13th | 0,071 | 0,100 | 0,102 | 0,143 | 2% | 2% |
| 14th | 0,057 | 0,080 | 0,059 | 0,084 | N/A | N/A |
| 15th | 0,012 | 0,017 | 0,014 | 0,020 | N/A | N/A |
| 16th | 0,024 | 0,034 | 0,035 | 0,050 | N/A | N/A |
| 17th | 0,035 | 0,050 | 0,066 | 0,093 | N/A | N/A |
| 18th | 0,016 | 0,023 | 0,016 | 0,023 | N/A | N/A |
| 19th | 0,026 | 0,037 | 0,047 | 0,067 | N/A | N/A |
| 20th | 0,011 | 0,015 | 0,012 | 0,017 | N/A | N/A |
| 21th | 0,008 | 0,011 | 0,009 | 0,012 | N/A | N/A |
| 22th | 0,012 | 0,018 | 0,008 | 0,011 | N/A | N/A |
| 23th | 0,022 | 0,031 | 0,044 | 0,061 | N/A | N/A |
| 24th | 0,014 | 0,020 | 0,014 | 0,020 | N/A | N/A |
| 25th | 0,016 | 0,022 | 0,034 | 0,048 | N/A | N/A |
| 26th | 0,006 | 0,009 | 0,009 | 0,013 | N/A | N/A |
| 27th | 0,005 | 0,006 | 0,006 | 0,009 | N/A | N/A |
| 28th | 0,005 | 0,007 | 0,006 | 0,008 | N/A | N/A |
| 29th | 0,014 | 0,020 | 0,027 | 0,038 | N/A | N/A |
| 30th | 0,006 | 0,008 | 0,006 | 0,008 | N/A | N/A |
| 31th | 0,013 | 0,018 | 0,022 | 0,031 | N/A | N/A |
| 32th | 0,006 | 0,008 | 0,005 | 0,007 | N/A | N/A |
| 33th | 0,004 | 0,006 | 0,005 | 0,007 | N/A | N/A |
| 34th | 0,004 | 0,006 | 0,003 | 0,005 | N/A | N/A |
| 35th | 0,008 | 0,011 | 0,016 | 0,023 | N/A | N/A |



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| | | | | | | |
|-----------------------|--------|-------|--------|-------|-----|-----|
| 36th | 0,003 | 0,004 | 0,003 | 0,004 | N/A | N/A |
| 37th | 0,009 | 0,013 | 0,015 | 0,021 | N/A | N/A |
| 38th | 0,004 | 0,005 | 0,005 | 0,007 | N/A | N/A |
| 39th | 0,003 | 0,004 | 0,004 | 0,006 | N/A | N/A |
| 40th | 0,004 | 0,005 | 0,004 | 0,005 | N/A | N/A |
| THD ₄₀ [%] | 1,13 | | 0,73 | | 23% | 13% |
| PWHD [%] | 0,0011 | | 0,0006 | | 23% | 22% |

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Power Quality. Harmonics.

Phase 3

Generating Unit rating per phase (rpp)

At 45-55% of rated output
8,3 kW100% of rated output
16,5 kW

| Harmonic | Measured Value (MV) in [A] | Measured Value (MV) in [%] | Measured Value (MV) in [A] | Measured Value (MV) in [%] | Limit in BS EN61000-3-12 in % | |
|----------|----------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|---------|
| | | | | | 1 phase | 3 phase |
| 2nd | 0,090 | 0,127 | 0,118 | 0,167 | 8% | 8% |
| 3rd | 0,012 | 0,016 | 0,020 | 0,028 | 21,6% | N/A |
| 4th | 0,035 | 0,050 | 0,037 | 0,052 | 4% | 4% |
| 5th | 0,278 | 0,393 | 0,310 | 0,439 | 10,7% | 10,7% |
| 6th | 0,030 | 0,043 | 0,030 | 0,042 | 2,67% | 2,67% |
| 7th | 0,169 | 0,239 | 0,273 | 0,386 | 7,2% | 7,2% |
| 8th | 0,064 | 0,091 | 0,055 | 0,078 | 2% | 2% |
| 9th | 0,018 | 0,025 | 0,018 | 0,025 | 3,8% | N/A |
| 10th | 0,077 | 0,109 | 0,072 | 0,102 | 1,6% | 1,6% |
| 11th | 0,081 | 0,115 | 0,112 | 0,158 | 3,1% | 3,1% |
| 12th | 0,038 | 0,054 | 0,037 | 0,052 | 1,33% | 1,33% |
| 13th | 0,060 | 0,084 | 0,089 | 0,125 | 2% | 2% |
| 14th | 0,052 | 0,074 | 0,053 | 0,075 | N/A | N/A |
| 15th | 0,013 | 0,018 | 0,015 | 0,021 | N/A | N/A |
| 16th | 0,024 | 0,034 | 0,030 | 0,042 | N/A | N/A |
| 17th | 0,038 | 0,054 | 0,070 | 0,098 | N/A | N/A |
| 18th | 0,016 | 0,023 | 0,017 | 0,024 | N/A | N/A |
| 19th | 0,026 | 0,037 | 0,042 | 0,060 | N/A | N/A |
| 20th | 0,010 | 0,014 | 0,012 | 0,017 | N/A | N/A |
| 21th | 0,007 | 0,011 | 0,009 | 0,013 | N/A | N/A |
| 22th | 0,014 | 0,020 | 0,014 | 0,020 | N/A | N/A |
| 23th | 0,024 | 0,034 | 0,045 | 0,064 | N/A | N/A |
| 24th | 0,014 | 0,020 | 0,014 | 0,020 | N/A | N/A |
| 25th | 0,015 | 0,021 | 0,031 | 0,044 | N/A | N/A |
| 26th | 0,006 | 0,009 | 0,005 | 0,008 | N/A | N/A |
| 27th | 0,005 | 0,008 | 0,006 | 0,009 | N/A | N/A |
| 28th | 0,005 | 0,007 | 0,004 | 0,006 | N/A | N/A |
| 29th | 0,013 | 0,019 | 0,024 | 0,033 | N/A | N/A |
| 30th | 0,005 | 0,007 | 0,004 | 0,006 | N/A | N/A |
| 31th | 0,012 | 0,017 | 0,020 | 0,029 | N/A | N/A |
| 32th | 0,005 | 0,008 | 0,004 | 0,006 | N/A | N/A |
| 33th | 0,004 | 0,006 | 0,005 | 0,007 | N/A | N/A |
| 34th | 0,004 | 0,006 | 0,004 | 0,005 | N/A | N/A |
| 35th | 0,008 | 0,011 | 0,017 | 0,024 | N/A | N/A |



BUREAU
VERITAS

Annex to the G99/1 certificate of compliance No. U21-0476

Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 17TH0199-G99/1-4_5

| | | | | | | |
|-----------------------|--------|-------|--------|-------|-----|-----|
| 36th | 0,003 | 0,005 | 0,003 | 0,005 | N/A | N/A |
| 37th | 0,009 | 0,012 | 0,014 | 0,020 | N/A | N/A |
| 38th | 0,004 | 0,005 | 0,005 | 0,007 | N/A | N/A |
| 39th | 0,002 | 0,003 | 0,005 | 0,006 | N/A | N/A |
| 40th | 0,003 | 0,005 | 0,003 | 0,004 | N/A | N/A |
| THD ₄₀ [%] | 1,07 | | 0,68 | | 23% | 13% |
| PWHD [%] | 0,0010 | | 0,0005 | | 23% | 22% |



Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 17TH0199-G99/1-4_5

| Power Quality. Power factor. | | | | |
|------------------------------|--------|-------|-------|---|
| Output power | 216,2V | 230V | 253V | Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1,5\%$ of the stated level during the test. |
| 20% | 1,000 | 1,000 | 1,000 | |
| 50% | 1,000 | 1,000 | 1,000 | |
| 75% | 1,000 | 1,000 | 1,000 | |
| 100% | 1,000 | 1,000 | 1,000 | |
| Limit | >0,95 | >0,95 | >0,95 | |

| Power Quality. Voltage fluctuation and Flicker. | | | | | | | | |
|---|----------|-------|---------------|----------|-------|---------------|---------|-------------|
| | Starting | | | Stopping | | | Running | |
| | dmax | dc | d(t) | dmax | dc | d(t) | Pst | Plt 2 hours |
| Measured values at test impedance | 4,79% | 4,79% | 0,00ms | 5,81% | 5,13% | 0,00ms | 0,15 | 0,12 |
| Measured values at standard impedance | 5,58% | 6,39% | 0,00ms | 7,74% | 6,84% | 0,00ms | 0,20 | 0,16 |
| Values for maximum impedance | 3,40% | 3,35% | 0,00ms | 3,77% | 3,30% | 0,00ms | 0,09 | 0,07 |
| Limits set under BS EN 61000-3-11 | 4% | 3,3% | 3,3% 500ms | 4% | 3,3% | 3,3% 500ms | 1,0 | 0,65 |
| Test impedance | R | 0,15 | Ω | XI | 0,15 | Ω | | |
| | Z | 0,21 | Ω | | | | | |
| Standard impedance | R | 0,24 | Ω | XI | 0,15 | Ω | | |
| | Z | 0,28 | Ω | | | | | |
| Maximum impedance | R | 0,10 | Ω | XI | 0,06 | Ω | | |
| | Zmax | 0,12 | Ω | | | | | |



Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 17TH0199-G99/1-4_5

| Power Quality. DC injection. | | | |
|------------------------------|-------|-------|-------|
| Phase 1 | | | |
| Test level power [%] | 10 | 55 | 100 |
| Recorded value [mA] | 21,95 | 42,79 | 45,45 |
| Recorded value [%] | 0,03 | 0,06 | 0,06 |
| Limit [%] | 0,25 | 0,25 | 0,25 |
| Phase 2 | | | |
| Test level power [%] | 10 | 55 | 100 |
| Recorded value [mA] | 66,61 | 38,09 | 43,84 |
| Recorded value [%] | 0,09 | 0,05 | 0,06 |
| Limit [%] | 0,25 | 0,25 | 0,25 |
| Phase 3 | | | |
| Test level power [%] | 10 | 55 | 100 |
| Recorded value [mA] | 66,89 | 38,15 | 35,51 |
| Recorded value [%] | 0,09 | 0,05 | 0,05 |
| Limit [%] | 0,25 | 0,25 | 0,25 |

Note. DC-injection is tested at each phase of the inverter and a limit of 0,25% per phase was used as pass criteria.

| Fault level Contribution. | | | | | |
|--|----------|-------|---------------------|-----------|----------|
| For a directly coupled SSEG | | | For a Inverter SSEG | | |
| Parameter | Symbol | Value | Time after fault | Volts [V] | Amps [A] |
| Peak Short Circuit current | I_p | N/A | 20ms | 229,97 | 80,25 |
| Initial Value of aperiodic current | A | N/A | 100ms | 13,98 | 72,58 |
| Initial symmetrical short-circuit current* | I_k | N/A | 250ms | 13,91 | 72,92 |
| Decaying (aperiodic) component of short circuit current* | i_{dc} | N/A | 500ms | 13,87 | 73,44 |
| Reactance/Resistance Ratio of source* | X/R | N/A | Time to Trip [s] | 2,52 | |

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the Generating Unit terminals.

* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.

| Self Monitoring – Solid state switching. | N/A |
|---|-----|
| 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 seconds. | N/A |

Note. Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open (Functional safety of the internal automatic disconnection device according to VDE 0126-1-1).



Appendix A2-3 Compliance Verification Report for Inverter Connected Power Generating Modules

Extract from test report according to the Engineering Recommendation G99

Nr. 17TH0199-G99/1-4_5

| Wiring functional tests if required by para. 15.2.1 | N/A |
|---|------------|
| Type test of components wired correct together on site is part of the commissioning test. | |

| Logic Interface (input port) | P |
|---|----------|
| Confirm that an input port is provided and can be used to shut down the module. | Yes |
| Note: A Modbus signal can be used to cease Active Power output within 5 s | |