SOLAR

IBC SOLAR AG
Am Hochgericht 10
96231 Bad Staffelstein
Germany

hereby certifies that its photovoltaic inverters for connection to the low-voltage grid:

IBC ServeMaster

| | | | |
|---|---|---|---|
| 8000TL | 10000TL + | 8000TL Pro | 10000TL Pro+ |
| 10000TL | 12500TL + | 10000TL Pro | 12500TL Pro+ |
| 12500TL | 15000TL + | 12500TL Pro | 15000TL Pro+ |
| 15000TL | | 15000TL Pro | |

fulfil the requirements of:

- Engineering Recommendation ER G83/1-1, Issue 1, Amendment 1, June 2008 (for IBC ServeMaster 8000TL, 8000TL Pro and IBC ServeMaster 10000TL, 10000TL +, 10000TL Pro, 10000TL Pro+)
- Engineering Recommendation ER G59/2, Issue 2, 2010 (for IBC ServeMaster 12500TL, 12500TL +, 12500TL Pro, 12500TL Pro+ and IBC ServeMaster 15000TL, 15000TL + , 15000TL Pro, 15000TL Pro+)

The test results according to ER G83/1-1 and ER G59/2 are summarised in the attached Type Verification Sheets.

Date

2011-02-25

ppa.

ppa. Christian Lieberth
Vice President
Purchasing & Product Management

Enclosures:

- G83/1-1, Appendix 4
- G59/2, Appendix A13.1
- References

Danfoss A/S declares that the ServeMaster brand of IBC Solar is identical with the Danfoss versions.

Comparison overview:

| **Danfoss** | | **IBC** |
|---|---|---|
| TripleLynx 8k | | IBC ServeMaster 8000TL |
| TripleLynx 8k Pro | | IBC ServeMaster 8000TL Pro |
| | | |
| TripleLynx 10k | | IBC ServeMaster 10000TL |
| TripleLynx + 10k | | IBC ServeMaster 10000TL + |
| TripleLynx Pro 10k | | IBC ServeMaster 10000TL Pro |
| TripleLynx Pro+ 10k | | IBC ServeMaster 10000TL Pro+ |
| | | |
| TripleLynx 12.5k | | IBC ServeMaster 12500TL |
| TripleLynx + 12.5k | | IBC ServeMaster 12500TL + |
| TripleLynx Pro 12.5k | | IBC ServeMaster 12500TL Pro |
| TripleLynx Pro+ 12.5k | | IBC ServeMaster 12500TL Pro+ |
| | | |
| TripleLynx 15k | | IBC ServeMaster 15000TL |
| TripleLynx + 15k | | IBC ServeMaster 15000TL + |
| TripleLynx Pro 15k | | IBC ServeMaster 15000TL Pro |
| TripleLynx Pro+ 15k | | IBC ServeMaster 15000TL Pro+ |

## Appendix 4: Type Verification Sheet

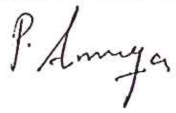
### SSEG DETAILS

| | | |
|---|---|---|
| SSEG Type reference: TLX 8k, TLX Pro 8k, TLX 10k, TLX+ 10k, TLX Pro 10k, TLX Pro+ 10k | | |
| SSEG Technology (as per Annex): PV Inverter | | |
| Manufacturer: | Tel: (+45) 7488-2222<br>Fax: (+45) 7465-2580 | Address:<br>Danfoss Solar Inverters A/S<br>Power Electronics Division<br>Ulsnaes 1, DK-6300 Graasten<br>Denmark |
| Technical file reference No:<br>[1] Danfoss Solar Inverters: Harmonics TLX (IEC 61000-3-2 and IEC61000-3-12), Danfoss Solar Inverters A/S, Gråsten, 2010-08-25.<br>[2] Danfoss Drives: Test Report DSI D163/P170 05 CE-EMC Directive, Gråsten, Denmark, 2010-08-31.<br>[3] Bureau Veritas: Report 10TH0532-G83/1_0, Tuerkheim, Germany, 2011-02-03. | | |
| Maximum export capability:<br>a) 8 kW and<br>b) 10 kW<br>(SSEG rating less parasitic load) | | |

### TEST HOUSE DETAILS

| | |
|---|---|
| Name and address of test houses | Danfoss Drives A/S<br>Power Electronics Division<br>Ulsnaes 1, DK-6300 Graasten<br>Denmark |
| Telephone number | (+45) 7488-2222 |
| Facsimile number | (+45) 7465-2580 |
| E-mail address | danfoss@danfoss.com |

### TEST DETAILS

| | |
|---|---|
| Date of test | 10.02.2011 |
| Name of tester | Arumugarn Palaniyandi |
| Signature of tester |  |
| Test location if different from above | |

## POWER QUALITY

| Harmonic Current Emissions (A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Harmonic | $2^{nd}$ | $3^{rd}$ | $5^{th}$ | $7^{th}$ | $9^{th}$ | $11^{th}$ | $13^{th}$ | $15^{th} \le n \le 39^{th}$ |
| Limit* | 1.08 | 2.3 | 1.14 | 0.77 | 0.4 | 0.33 | 0.21 | 0.15 x (15/n) |
| Test Value | 0.048 | 0.011 | 0.014 | 0.016 | 0.322 | 0.258 | 0.126 | < limit EN61000-3-2 |

* Maximum permissible harmonic current. As per BS EN61000-3-2 Class A.

| Voltage Fluctuations and Flicker | | | | |
|---|---|---|---|---|
| | Starting | Stopping | Running | |
| Limit* | 4 % | 4 % | $P_{st} = 1.0$ | $P_{lt} = 0.65$ |
| Test Value | < 4 % | < 4 % | 0.30 | 0.26 |

* Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker. As per BS EN61000-3-3.

| | DC Injection | | | Power Factor | | |
|---|---|---|---|---|---|---|
| G83/1 Limit | 20 mA, tested at three power levels* | | | 0.95 lag - 0.95 lead at three voltage levels | | |
| Test Level | 10 % | 55 % | 100 % | 212 V | 230 V | 248 V |
| Test Value # | 20 mA | 20 mA | 19 mA | > 0.95 | > 0.95 | > 0.95 |

* Indicative values are shown for minimum, medium and maximum power levels.
# Insert maximum value recorded during testing.

### Under-Frequency / Over-Frequency Tests

| | Under-Frequency | | Over-Frequency | |
|---|---|---|---|---|
| Parameter | Frequency | Time | Frequency | Time |
| G83/1 Limit | 47 Hz | 5 s* | 50.5 Hz | 5 s* |
| Actual setting | 47 Hz | 0.5 s | 50.5 Hz | 0.5 s |
| Trip value | 47 Hz | 0.404 s | 50.5 Hz | 0.404 s |

### Under-Voltage / Over-Voltage Tests

| | Under -Voltage | | Over-Voltage | |
|---|---|---|---|---|
| Parameter | Voltage | Time | Voltage | Time |
| G83/1 Limit | 207 V | 5 s* | 264 V | 5 s* |
| Actual setting | 207 V | 1.5 s | 264 V | 1.5 s |
| Trip value | 208.8 V | 1.52 s | 259.5 V | 1.73 s |

* For SSEG units that can withstand being re-energised from a source that is 180 out of phase with the SSEG output, it is permissible to extend the operating time of the interface protection to 5.0 seconds, as described in 5.3.1. Table 1.

### Loss of Mains Test

| Method Used | Resonance Circuit Test | | |
|---|---|---|---|
| Output power level* | 10 % | 55 % | 100 % |
| Trip setting | 5 s | 5 s | 5 s |
| Trip value | 0.091 s | 0.093 s | 0.090 s |

* Indicative values are shown for minimum, medium and maximum power levels.

### Reconnection Times

| Reconnection Time | Under-Voltage / Over-Voltage | Under-Frequency / Over-Frequency | Loss of Mains |
|---|---|---|---|
| Minimum value | 180 s | 180 s | 180 s |
| Actual setting | 185 s | 185 s | 185 s |
| Recorded value | > 180 s | > 180 s | > 180 s |

## Fault Level Contribution

### SSEG Short Circuit Test

This test should determine the value of short-circuit current at the SSEG terminals as described in clause 5.7 in Engineering Recommendation G83/1.

For rotating machines and linear piston machines the test should produce a 0 – 2.0 second plot of the short-circuit current as seen at the SSEG terminals.

| Parameter | Symbol | Value |
|---|---|---|
| Peak short-circuit current | $i_p$ | 22 A |
| Initial value of aperiodic component | $A$ | ** N/A |
| Initial symmetrical short-circuit current * | $I''_k$ | ** N/A |
| Decaying (aperiodic) component of short-circuit current * | $i_{DC}$ | ** N/A |
| Reactance / Resistance Ratio of source * | $X/R$ | ** N/A |

* Values for these parameters should be provided where the short-circuit duration is sufficiently long to enable interpolation of the plot.
** Not applicable to PV inverters.

### Self-Monitoring - Solid State Switching

| Test | Yes/No |
|---|---|
| It has been verified that in the event of the solid state switching device failing to disconnect the SSEG, the voltage on the output side of the switching device is reduced to a value below 50 volt within 0.5 sec. | * N/A |

** Not applicable because a redundant electro-mechanical relay solution is employed.

## Appendix A13.1 Generating Plant Type Verification Test Sheet

## Type Approved Generating Plant (>16A per phase but ≤ 50 kW 3 phase or 17 kW 1 phase)

### GENERATING PLANT DETAILS

| | | |
|---|---|---|
| Generating Plant Type reference:<br>a) TLX 12.5k, TLX+ 12.5k, TLX Pro 12.5k, TLX Pro+ 12.5k<br>b) TLX 15k, TLX+ 15k, TLX Pro 15k, TLX Pro+ 15k | | |
| Generating Plant Technology: PV inverter | | |
| Manufacturer: | Tel: (+45) 7488-2222 | Address: |
| | Fax: (+45) 7465-2580 | Danfoss Solar Inverters A/S<br>Power Electronics Division<br>Ulsnaes 1, DK-6300 Graasten<br>Denmark |
| Technical file reference No:<br>[1] Danfoss Solar Inverters: Harmonics TLX (IEC 61000-3-2 and IEC61000-3-12), Danfoss Solar Inverters A/S, Gråsten, 2010-08-25.<br>[2] Danfoss Drives: Test Report DSI D163/P170 05 CE-EMC Directive, Gråsten, Denmark, 2010-08-31.<br>[3] Bureau Veritas: Report 10TH0532-G83/1_0, Tuerkheim, Germany, 2011-02-03. | | |
| Maximum export capability:<br>a) 12.5 kW and<br>b) 15 kW<br>(Generating Plant rating less parasitic load) | | |

### TEST HOUSE DETAILS

| | |
|---|---|
| Name and address of test houses | Danfoss Drives A/S<br>Power Electronics Division<br>Ulsnaes 1, DK-6300 Graasten<br>Denmark |
| Telephone number | (+45) 7488-2222 |
| Facsimile number | (+45) 7465-2580 |
| E-mail address | danfoss@danfoss.com |

### TEST DETAILS

| | |
|---|---|
| Date of test | 10.02.2011 |
| Name of tester | Arumugarn Palaniyandi |
| Signature of tester | P. Arumuga |
| Test location if different from above | |

## POWER QUALITY

| Harmonics Emissions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Minimal Short Circuit Ratio $R_{sce}$: | | | | | | | | |
| Value of Short Circuit Power $S_{sc}$ corresponding to $R_{sce}$: | | | | | | | | |
| Equipment Phases: Single Phase / Interphase / Three Phase (delete as appropriate) | | | | | | | | |
| Description | Harmonic Current % = $100I_n/I_1$ | | | | | | Harmonic Current Distortion Factors (%) | |
| Harmonic | $I_3$ | $I_5$ | $I_7$ | $I_9$ | $I_{11}$ | $I_{13}$ | THD | PWHD |
| Limit | 21.6 | 10.7 | 7.2 | 3.8 | 3.1 | 2 | 23 | 23 |
| Actual Value | 0.057 | 0.088 | 0.093 | 2.11 | 1.78 | 1.16 | 3.3 % | 5.6 % |
| Notes: Detailed requirements are specified in BSEN 61000-3-12. Where BSEN 61000-3-12 requires assessment of separate loads (i.e. for equipment with more than one rating or for hybrid equipment) then the values for each separate load shall be provided. | | | | | | | | |

| Voltage Fluctuations | | | | | |
|---|---|---|---|---|---|
| Equipment meets BS EN 61000-3-3: Yes | | | | | |
| | Voltage Disturbance | | | | |
| | $P_{st}$ | $P_{lt}$ | d(t) % | $d_c$ % | $d_{max}$ % |
| Limit (at $Z_{ref}$) | 1.0 | 0.65 | 0.5 | 3.3 | 4 |
| Actual Value (at $Z_{ref}$) | 0.47 | 0.30 | 0.0 | 1.10 | 1.70 |
| Notes:<br>Detailed requirements are specified in BSEN 61000-3-11 and BSEN 61000-3-3.<br>If the equipment requires a supply rated at ≥ 100A the maximum system impedance is deemed to be 0.15 + j0.15 ohms for each phase and 0.1 + j0.1 ohms for the neutral.<br>If the voltage disturbance values are above the limits for the specified reference impedance ($Z_{ref}$) then the manufacturer shall declare a maximum value of system impedance ($Z_{max}$) for which the equipment satisfies the voltage disturbance requirements of BSEN 61000-3-11. | | | | | |

* Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker. As per BS EN61000-3-3.

| | DC Injection | | | Power Factor | | |
|---|---|---|---|---|---|---|
| Limit | 20 mA, tested at three power levels * | | | 0.95 lag – 0.95 lead at three voltage levels | | |
| Test Point | 10 % | 55 % | 100 % | 212 V | 230 V | 248 V |
| Value Measured | 20 mA | 20 mA | 20 mA | 0.98 | 0.99 | 0.99 |

* Indicative values are shown for minimum, medium and maximum power levels for a 15 kW inverter.
# Insert maximum value of dc injection and worst case pf value recorded during testing.

| PROTECTION TESTS | | | | |
|---|---|---|---|---|
| **Protection** | **Setting** | | **Test Results *** | |
| Over-Voltage<br>Stage 1<br>L1-N or L1-L2<br>L2-N or L1-L3<br>L3-N or L1-L3 | 253 V | 1 s | 248.2 V<br>248.1 V<br>247.8 V | 0.98 s<br>0.99 s<br>1.09 s |
| Over-Voltage<br>Stage 2<br>L1-N or L1-L2<br>L2-N or L1-L3<br>L3-N or L1-L3 | 264 V | 0.5 s | 259.9 V<br>259.0 V<br>258.9 V | 592 ms<br>584 ms<br>509 ms |
| Under-Voltage<br>Stage 1<br>L1-N or L1-L2<br>L2-N or L2-L3<br>L3-N or L1-L3 | 200 V | 2.5 s | 202.7 V<br>202.0 V<br>201.3 V | 2.49 s<br>2.79 s<br>2.55 s |
| Under-Voltage<br>Stage 2<br>L1-N or L1-L2<br>L2-N or L2-L3<br>L3-N or L1-L3 | 184 V | 0.5 s | 186.8 V<br>186.8 V<br>186.1 V | 0.508 s<br>0.528 s<br>0.502 s |
| Over-Frequency<br>Stage 1 | 51.5 Hz | 90 s | 51.6 Hz | 480 ms |
| Over-Frequency<br>Stage 2 | 52 Hz | 0.5 s | 51.6 Hz | 480 ms |
| Under-Frequency<br>Stage 1 | 47.5 Hz | 20 s | 47.5 Hz | 498 ms |
| Under-Frequency<br>Stage 2 | 47 Hz | 0.5 s | 47.5 Hz | 498 ms |
| Other relevant protection | | | | |

* Values of a 15 kW inverter are applied; tolerance for the trip times are extended by 100 ms according to G59/2; trip times are in conformity with +/- 10 % tolerance according to EN 50438.

## Loss of Mains Test

| | | | |
|---|---|---|---|
| Method Used | Resonance Circuit Test | | |
| Output power level* | 10 % | 55 % | 100 % |
| Trip setting | 2.5 s | 2.55 s | 2.5 s |
| Trip value | 0.091 s | 0.093 s | 0.090 s |

* Indicative values are shown for minimum, medium and maximum power levels.

## Reconnection Times

| Reconnection Time | Under-Voltage / Over-Voltage | Under-Frequency / Over-Frequency | Loss of Mains |
|---|---|---|---|
| Minimum value | 180 s | 180 s | 180 s |
| Actual setting | 185 s | 185 s | 185 s |
| Recorded value | > 180 s | > 180 s | > 180 s |

## FAULT LEVEL CONTRIBUTION

### Short-Circuit Test

This test should determine the value of short-circuit current at the **Generating Plant** terminals.
The **Generator** shall declare, to the **DNO**, the maximum short-circuit current contribution from the **Generating Unit** and the conditions under which this exists.
One method for determining the short-circuit current contribution is described below.
The short circuit current contribution of the **Generating Unit** shall be measured upon application of a short-circuit on the **Generating Unit** terminals (all phases / phase to neutral) with the machine operating at full load output steady state conditions.
Current measurements shall be taken from application of fault until the time the fault has been disconnected, following operation of the **Generating Unit** protection. A current decay plot shall be produced for each phase from inception of the fault until the **Generating Unit** has been disconnected. The plot will need to show the highest value of peak short-circuit current, e.g. for a **Generating Unit** supplying a purely inductive load the highest value of peak short-circuit current will result when the fault is applied at a voltage zero. Where practicable the tests will need to determine values for all of the relevant parameters listed in the table below. These parameters are described in IEC 60909[1] whilst this standard is primarily for three-phase generators the methodology for determining these parameters can be applied to single-phase generators.

For rotating machines and linear piston machines the test should produce a 0 – 2.0s plot of the short-circuit current as seen at the **Generating Plant** terminals.

| Parameter | Symbol | Value |
|---|---|---|
| Peak short-circuit current | $i_p$ | 22 A |
| Initial value of aperiodic component | $A$ | ** N/A |
| Initial symmetrical short-circuit current * | $I''_k$ | ** N/A |
| Decaying (aperiodic) component of short-circuit current * | $i_{DC}$ | ** N/A |
| Reactance / Resistance Ratio of source * | $X/R$ | ** N/A |

* Values for these parameters should be provided where the short-circuit duration is sufficiently long to enable interpolation of the plot.
** Not applicable to PV inverters.

### Self-Monitoring - Solid State Switching

| Test | Yes/No |
|---|---|
| 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 0.5 s. | * N/A |

** Not applicable because a redundant electro-mechanical relay solution is employed.

1) **IEC 60909-0: 2001** - Short-circuit currents in three-phase AC systems. Calculation of currents.