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DRAFT TANZANIA STANDARD

(Draft for comments only)

Solar photovoltaic power systems – test procedures for main components – part 4: Test procedures for Inverters

TANZANIA BUREAU OF STANDARDS

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National Foreword

This draft Tanzania Standard has been prepared by the Solar Power System Technical Committee, under the supervision of the Electrical Engineering Divisional Standards Committee (EEDC)

This draft Tanzania Standard is a revision of TZS 925-4:2006 Solar photovoltaic power systems – test procedures for main components – part 4: Test procedures for Inverters.

Table of contents

DRAFT TANZANIA STANDARD

Solar photovoltaic power systems — Test procedures for main components —

Part 4:
Test procedures for inverters

1 Scope

This Part 4 of DTZS specifies the test procedures for inverters for use in photovoltaic systems. The inverters are rated at a d.c. input of 12 V* and an a.c. r.m.s. output voltage of 230 V ± 11 V at a frequency of 50 Hz ± 1.25 Hz and capable of a power output greater than 150 W.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this section of the specification. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this section of the specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

Where there is conflict between the following standards and this section of the specification, the requirements in this specification shall take precedence.

IEC 61068-2-29 *Environmental testing — Part 2: Test — Section 29: Test Eb and guidance.*

IEC 61000-4-2 *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test.*

IEC 61000-4-3 *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3: Radiated, radio frequency, electromagnetic field immunity test.*

IEC CISPR 22 *Information technology equipment — Radio disturbance characteristics — Limits and method of measurement.*

ISO 3744 *Acoustics — Determination of second power levels of noise sources using pressure — Engineering method in an essentially free field over a reflecting plane.*

3 Definitions and abbreviations

For the purposes of Tanzania Standard, the definitions and abbreviations given in TZS 876 :2006 apply.

4 Procedure

4.1 General and test circuit and measurement equipment

The test procedures are intended to verify compliance with the requirements for inverters specified in TZS 876 :2006. The recommended test circuit is given in Figure 1.

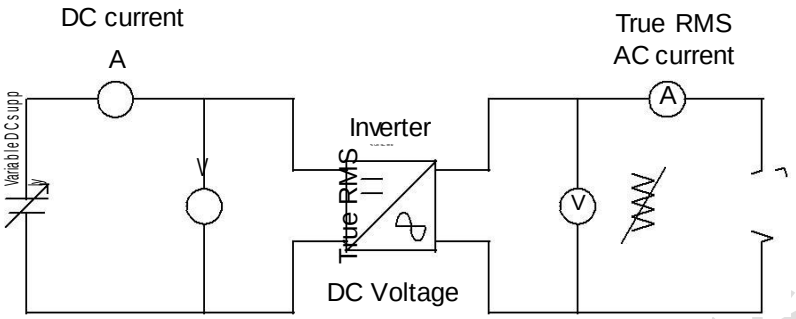

Figure 1 — Test circuit for testing inverters

When protection devices operate during electrical protection tests, they shall be either reset in the case of a manually operated circuit-breaker, or replaced, in the case of a fuse, before continuing with the next test. The replacement fuse shall be of equal rating to the fuse removed.

A resistive load shall be used when measuring voltage regulation, efficiency, input-output voltage dependency, output frequency variation and load sensing.

Switched resistors or a variable resistor connected to a constant resistive load can be used to achieve different resistive loads.

Although the individual tests are described in separate subclauses in many cases the tests can be done simultaneously at each value of the output load power.

NOTE The actual (real) power drawn by many of the loads used varies with the waveform produced by the inverter.

4.2 Voltage regulation test

This test shall be carried out with the d.c. input voltage at its rated value and repeated with the d.c. input voltage at 90 % and 120 % of its rated value.

Resistive loads of at least five, equally spaced values of up to the nominal power rating of the inverter (or optionally the overload rating) shall be used.

The variations of output voltage with output power shall be plotted.

4.3 Efficiency test

This test shall be carried out with the d.c. input voltage at its rated value.

Resistive loads of at least five, equally spaced values of up to the nominal power rating of the inverter (or optionally the overload rating) shall be used.

The efficiency, as the ratio of the input (real) power divided by the output (real) power, shall be calculated for each load.

The variation of efficiency to output power shall be plotted.

4.4 Harmonic content of the output voltage waveform test

This test shall be carried out with the d.c. input voltage at its rated value.
A spectrum analyzer (digital or analogue) shall be used to obtain the amplitudes of the significant harmonic components of the output voltage waveform as a percentage of the fundamental.

The harmonic content shall be measured with:
a) no load (if there is no load sensing device);

b) minimum load (if there is a load sensing device); and

c) at nominal power rating (resistive).

4.5 Input-output voltage dependency test

This test shall be done with no load (if there is no load sensing device) or at minimum load (if there is a load sensing device) as well as at the nominal power rating of the inverter.

Measure the output r.m.s. voltage as a function of the d.c. input voltage as the input d.c. voltage is varied over a particular range. Take at least five equally spaced readings.

If the inverter has an automatic d.c. undervoltage or d.c. overvoltage disconnection facility or both, note the threshold levels for both d.c. voltage increasing and d.c. voltage decreasing conditions in order to characterize the operating voltage range of the inverter.

4.6 Output frequency variation test

This test shall be done with the d.c. input voltage at its rated value.

Take readings with no load (if there is no load sensing device), with minimum load (if there is a load sensing device) and at the nominal power rating of the inverter.

Plot the variation of the output frequency with output (real) power.

4.7 Short-circuit survival test

This test shall be done with the d.c. input voltage at its rated value.

Apply a short-circuit across the output terminals for 1 min. When the short-circuit is removed, the inverter shall continue to function normally after it has been reset. The protective mechanism should be activated.

4.8 Load sensing test

This test shall be carried out with the d.c. input voltage at its rated value.

Remove any load to determine whether the input current drops to a low value – as specified for the standby mode.

When the load is reconnected (5 W minimum) the inverter shall revert to normal operation.

The load sensing device shall be able to sense the presence of an a.c. 240 V fluorescent lamp connected to the output of the inverter.

4.9 Standby current test

This test shall be carried out with the d.c. input voltage at its rated value.

The d.c. input current drawn when the inverter is in standby mode (with no load connected to the output) shall be noted.

4.10 Acoustic noise emission test

The acoustic noise generated by the inverter shall be tested in accordance with the procedure set out in ISO 3744.

4.11 Electromagnetic interference test

The inverter shall be tested for electromagnetic emissions in accordance with the procedures set out in IEC CISPR 22.

4.12 Radiated susceptibility test

The inverter shall be tested for radiated susceptibility in accordance with the test procedure specified in IEC 61000-4-3 and shall be fully functional thereafter.

4.13 Electrostatic discharge test

The inverter shall be tested for electrostatic discharge in accordance with the test procedure specified in IEC 61000-4-2 and shall be fully functional thereafter.

4.14 Indicators and alarms

All indicators that are mounted on the inverter enclosure shall be recorded.

Any alarm function shall be recorded.

4.15 Built-in protection

All built-in protection features, such as overtemperature, overload and overvoltage, shall be recorded

4.16 Figures of merit: weighted efficiency

The weighted efficiency is calculated as follows:

$$\eta_W = W_{10} \times \eta_{10} + W_{40} \times \eta_{40} + W_{70} \times \eta_{70} + W_{100} \times \eta_{100}$$

where

W_n is the weighting function at n % of the nominal power rating (resistive).

η_n is the measured efficiency (in percent) at n % of the nominal power rating (resistive).

Value of W_n

W_{10} : 0.1
W_{40} : 0.3
W_{70} : 0.4
W_{100} : 0.2

Worked example: If the measured efficiencies are

η_{10} = 50 %, η_{40} = 75 %, η_{70} = 80 %, η_{100} = 78 %

then

η_W = 0.1 × 50 % + 0.3 × 75 % + 0.4 × 80 % + 0.2 × 78 %
= 5 % + 22.5 % + 32 % + 15.6 %
= 75.1 %

4.17 Load test

It is recommended that the inverter manufacturers test their inverters for capability to start and run a combination of the intended loads namely the TV set, VCR and HI-FI set. The intention is to verify that the inverter starts and runs a range (in terms of power rating) of a combination of the appliances. This can be achieved by selecting a combination of appliances with a low, medium and high power rating. When this test is carried out the appliances shall be connected in parallel to the output terminals of

the inverter. Where a manufacturer has designed the inverter to include luminaires, in the load the test should include as part of the test load luminaires of the rated power and in the rated number.

NOTE In the context used luminaires include lamps.

4.18 Mechanical test

The inverter shall be tested for mechanical robustness in accordance with test Eb of IEC 60068-2-29.

The inverter shall be packed, as for transportation, in a casing/packaging box provided by the inverter manufacturer.

1000 bumps each with a peak acceleration of 100 m/s^2 and a pulse duration of 10 ms shall be applied on all the three principal axes of the inverter.

The inverter shall be subjected to the functional performance test after the application of the 3000 bumps to verify that its normal operation has not been impaired by this bumping.