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DRAFT TANZANIA STANDARD

(Draft for comments only)

Solar photovoltaic power systems – test procedures for main components – part 5: Test procedures for Luminaires

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 925-5:2006 Solar photovoltaic power systems – test procedures for main components – part 5: Test procedures for luminaires.

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Solar photovoltaic power systems — Test procedures for main components —

Part 5:
Test procedures for luminaires

1 Scope

This Part 5 of DTZS specifies the test procedures for luminaires for use in photovoltaic 12 V systems.

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 section of the specification shall take precedence.

CIE 84:1989, *Measurement of luminous flux.*

IEC CISPR 14 *Limits and methods of measurement of radio disturbance characteristics of electrical motor-operated and thermal appliances for household and similar purposes, electric tools and electric apparatus.*

IEC 60925, *D.C. supplied electronic ballasts for tubular fluorescent lamps. Performance requirements.*

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

IEC 60598, *Standard specification for tubular fluorescent lamps for general service.*

3 Definitions and abbreviations

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

4 Procedures

4.1 Testing d.c. luminaires

The combination of luminaire and lamp shall be tested for life expectancy and for operation within a d.c. voltage range of 10.6 V to 15 V, at ambient temperatures of 0 ºC and 35 ºC, by an accredited testing facility.

4.2 Testing for the percentage lumen depreciation

This test will determine the percentage lumen depreciation with age from 100 h up to and including 6000 h. The depreciation shall not exceed the standard acceptance criterion of 20 % as specified in IEC 60598.

The following shall be carried out, in accordance with IEC 60598, at the nominal system voltage of d.c. 12 V ± 1 V:

a) the light output shall be measured after 100 h operation;

b) a switching cycle of 8 times every 24 h with an off-period of at least 15 min;

c) the light output shall be measured after 6000 h; a 20 % lumen depreciation from the values in **4.2(a)** will be allowed;

d) a sample of 10 lamps shall be tested and the test shall be terminated after 6000 h. The average life of the sample shall be calculated. The acceptance criterion shall be an average lamp life of 5000 h.

NOTE The requirement specified in IEC 60598 to test lamps for a minimum of 7500 h and an acceptance criterion of an average life of 2000 h has been modified because lamps that pass the 2000 h point should not fail before 7500 h.

4.3 Tests for luminaire operation within a d.c. voltage range of 10.6 V to 14.5 V at ambient temperatures of 0 °C and 35 °C

These tests are to determine the operation of the lamp and luminaire inverter within a d.c. voltage range of 10.6 V to 14.5 V, at ambient temperatures of 0 °C and 35 °C before and after aging for 6000 h. The tests shall be carried out in an environmental chamber where temperatures can be set at 0 °C and 35 °C.

a) The lamp shall be switched off for 15 min after aging for 100 h at a d.c. voltage of 12 V ± 1 V. This is to allow the lamp's electrical properties to stabilize. The lamp shall be placed in the environmental chamber with the temperature set at 0 °C. A d.c. voltage of 10.6 V shall be applied and the lamp switched on for 15 min.

b) Repeat (a) 0 °C with a voltage of 14.5 V.

c) Repeat (a) at 35 °C with a voltage 10.6 V.

d) Repeat (a) at 35 °C with a voltage 14.5 V.

f) The tests shall be repeated after (d) above i.e. after the life test of 6000 h.

NOTE The lumen output at ambient temperatures above or below 25 °C is expected to be less than that at 25 °C.

4.4 Test for lamp current and luminous flux

This test determines the luminous flux output of the combination of the supplied luminaire voltage inverter and a lamp. The test shall be carried out in accordance with the procedure set out in clause **8** of IEC 60925.

4.5 Polarity reversal

The luminaires shall be connected to a d.c. 12 V supply with the positive and negative inputs reversed for a period of 1 min. The luminaires shall then be correctly connected to confirm that they still function and that the reversed polarity protection works satisfactorily.

4.6 Testing the electrical performance of the luminaire voltage inverter

The crest factor shall be determined using suitable instrumentation and shall not exceed 1.7.

The electromagnetic interference of the luminaire voltage inverter shall be tested in accordance with procedure set out in IEC CISPR 14.

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

4.7 Determining of the initial luminous efficacy of a lamp

The initial luminous efficacy of the lamp shall be determined in accordance with the guidelines set out in the 84th publication of the “Commission Internationale de L’Eclerage (CIE 84).

Annex A — Lamp reception and tests

A.1 Reception

Reception of two identical luminaries, one destined for electrical behaviour tests and the other for the ageing processes. An electrical scheme as the observed in figure A1 is drawn to indicate the most important parameters to measure.

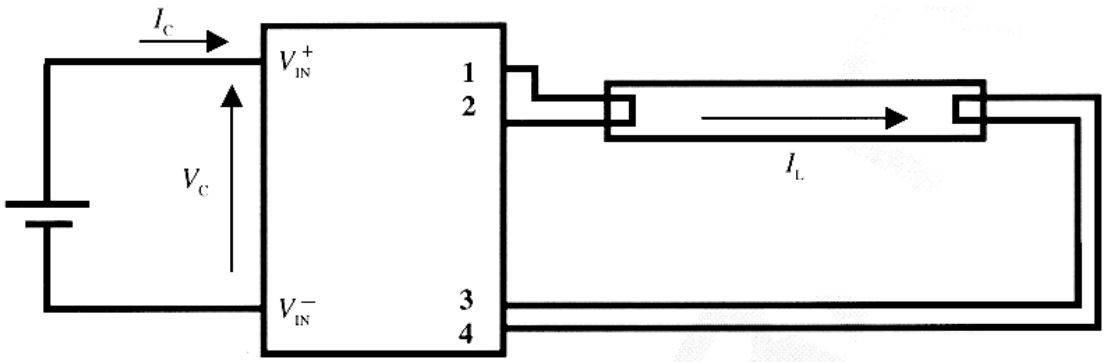

Figure A.1 — Electrical scheme of the luminary.

Procedure 0: Visual inspection

The objective of this test is to check if the luminary, just as it is delivered by the manufacturer, fulfil the following requirements:

- None of the active parts of the ballast should be in contact with lighting fixtures (CL9)

- Lamp lenses, cover grids, etc. (if used) must be insect proof (CL10)

- Lamp lenses, cover grids, etc. (if used) must be easily removable by the users for tube replacement or for cleaning (CL11)

- The fluorescent tube must be of a widely available type (CL12)

- It will be highly valued the addition of a reflector to the tube mountings (SL1)

- The luminaries must be properly labelled (CS2)

A.2 Electrical characteristics

The objective of this test is to determine, first, the electrical characteristics of the ballast (such as the efficiency, the crest factor that quantifies the form of the current and voltage waves given to the tube, etc.), and second, the voltage peaks used by the ballast in the starting-point and the existence of preheating of tube electrodes, characteristics which are determinant for a long life of the luminary.

Procedure 1: Normal operation

After 2 hours of uninterrupted operation, the parameters I_C, V_C, $I_L(t)$ and $V_L(t)$ are measured varying the supply voltage from 10.3V to 15V in steps of 0.5 V (with 4 minutes of stabilisation in each step). The result of the test will be considered as “positive” when the ballast efficiency is over 70% (norm CL5), when the current waveform through the tube is symmetrical (norm CL7) and when the crest factor is less than 2 (norm CL8). It will be highly valued if the ballast fulfil that the DC component of the current through the tube is 0 (norm RL3) and that the crest factor is less than 1.7 (norm RL4).

Procedure 2: Switching on

Start of the luminary varying the supply voltage from 10.3 to 15 V in steps of 0.5V. The lamp must be switched off during 4 minutes in every step. The waveforms of the current and the voltage are recorded with an oscilloscope in the period of time going from the starting-point to the complete switching on of the tube. The result of the test will be considered as "positive" when the luminary switches on in the specified supply voltage range (norm CL1). It will be highly valued if the ballast includes the preheating of the tube electrodes (norm RL5).

Instrumentation

Power source, Oscilloscope, Multimeter, Current probe.

A.3 Protections

The objective of this test is to determine if the luminary has the protection mechanisms to avoid damages to people or to the luminary itself in situations that can be very common during its operation in a SHS.

Procedure 3: Operation without lamp (Case 1)

The ballast is polarised at 12 V without tube during 2 minutes while the supply current I_C and the strange effects produced by the ballast (high temperature, buzzing, …) are registered. Afterward, the tube is replaced and it must be checked if the luminary operates correctly (norm CL2). It will be highly valued if the consumption of the ballast is less than 20% of its nominal power (norm RL1).

Procedure 4: Operation without lamp (Case 2)

The ballast is polarised at 12 V with tube. While the luminary continues operating, the tube is taken out and this situation is maintained during 2 minutes, registering the supply current I_C and the strange effects produced by the ballast (high temperature, buzzing, …). Afterwards, the tube is replaced and it is checked if the luminary operates correctly (norm CL2).

Procedure 5: Polarity reversing

The luminary is reverse-poled at 12 V during 2 minutes while the supply current I_C and the strange effects produced by the ballast are registered. Afterwards, it is polarised correctly and it is checked if the luminary operates normally (norm CL2).

Procedure 6: Short-circuited output

The ballast is polarised at 12 V without tube and with its output short-circuited during 2 minutes, while the supply current I_C and the strange effects produced by the ballast are registered. Afterwards, the tube is replaced and it is checked if the luminary operates correctly (norm CL2).

Procedure 7: Radio frequency interference

The luminary is polarised at 12 V and a radio is placed at different distances (1, 2 and 3 m), checking if there are any kind of interferences (norm CL3).

Instrumentation

Power source, Multimeter, Radio.

A.4 Durability

The objective of this test is to check the lifetime of the luminaries when they are switched on and switched off like in real operation in a SHS, and consequently, to check the frequency of maintenance due to the replacement of the tube, or, much more serious, to the death of the ballast.

Procedure 8: Cycling resistance

The luminary is subjected to a cycling test consisting on 60 seconds switched on and 150 seconds switched off, with a supply voltage V_C of 12V and the ambient temperature (approximately 20 ºC). The incidences are registered (blackening of the electrodes, flicker, death of the luminary, ...) and in order to observe the evolution of the luminary, approximately every 500 cycles, it is photographed with the tube switched on. The cycling resistance is considered high when the luminary reaches 10000 cycles without damage.

Procedure 9: Continuous operation

The luminary is polarized at 12V continuously during 1000 hours. The incidences are registered in the corresponding table of results (blackening of the electrodes, flicker, death of the luminary, ...) and in order to observe the evolution of the luminary, approximately every 250 hours, it is photographed. The result of the test is considered as "positive" when it is not possible to observe any blackening.

Instrumentation

Power source, Camera, Timer, Relay and Counter (the latter is optional).

A.5 Extreme conditions

The objective of this test is to check basic characteristics of the luminary when it is operating under severe atmospheric conditions. This test has special sense when the place where the luminary is going to be installed (and obviously, its specific climatic conditions) is known.

Procedure 10: High temperatures (Case 1)

Under an ambient temperature of 50 ºC, the luminary is polarised with a supply voltage that varies from 10.5 to 15 V in steps of 0.5V (the lamp must be switched off during 4 minutes in every step). It must be checked that the luminary switches on correctly.

Procedure 11: High temperatures (Case 2)

Under an ambient temperature of 50ºC and with a supply voltage of 12V, the luminary is switched on continuously during 1 hour. The result of the test is considered as "positive" when the luminary operation is normal and there is no destruction.

Procedure 12: Low Temperatures (Case 1)

Under an ambient temperature between -20 ºC and 10 ºC, the luminary is polarised with a supply voltage that varies from 10.5 to 15 V in steps of 0.5V (the lamp must be switched off during 4 minutes in every step). It must be checked that the luminary switches on correctly.

Procedure 13: Low temperatures (Case 2)

Under an ambient temperature between -20 ºC and 10 ºC, and with a supply voltage of 12V, the luminary is switched on continuously during 1 hour. The result of the test is considered as "positive" when the luminary operation is normal and there is no destruction.

Instrumentation

Power source, Multimeter, Domestic Refrigerator, Domestic Oven.

A.6 Luminosity

The objective of this test is to determine, on one hand, the luminous yield of the lamp, and on the other hand, if the luminous flux is enough according to the norm.

Procedure 14: Lighting behaviour (Case 1)

The luminary is introduced inside a black box, at a height of 1 meter, and is switched on with a supply voltage of 12 V. After 10 minutes operating, the density of luminous flux in one point of the floor of the box is registered with a luxometer. Using the formula 1 it is possible to calculate the luminous flux of the luminary.

$$Luminous\ Flux\ (\text{lm}) = \pi^2 \times h^2 \times density \quad (1)$$

where *h* is the height in meters (in our case 1) and the *density* is the value of density luminous flux in luxes measured in the central point of the floor just in the vertical of the tube.

The result of the test will be considered as "positive" when the luminous flux is over 80% of the nominal value (norm CL4), and when the luminous yield is at least 25 lm/W (norm CL6). It will be highly valued if the luminous yield of the luminary reaches 35 (norm RL2) or even 50 lm/W (norm SL2).

Procedure 15: Lighting behaviour (Case 2)

The procedure is identical to the procedure 14 but it is carried out when the luminary has experimented 1000 cycles of switching on and switching off.

Instrumentation

Power source, Multimeter, Black box and luxometer.

