Self ballasted lamps for general lighting services
Part 2: Test methods – Energy performance

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Self ballasted lamps for general lighting services
Part 2: Test methods – Energy performance

Foreword

This Kenya Standard was developed by the Technical Committee on Electric lamps and Wiring Accessories and is in accordance with the procedures of the Bureau.

The objective of this Standard is to specify test methods for key performance attributes of self ballasted compact fluorescent lamps (CFLs) that have integrated means for starting, controlling and stable operation. KS 2446-1:2013 specifies Minimum Energy Performance Standards requirements for compact fluorescent lamps sold in Kenya.

This Standard is structured to be suitable for reference in minimum performance standards legislation.

The Standard consists of the following parts:

KS 2446-2:2013 Self-ballasted fluorescent lamps for general lighting services, Part 2: Test methods-Energy performance (this Standard)
KS 2446-1:2013 Self-ballasted fluorescent lamps for general lighting services, Part 1: Minimum Energy Performance Standards requirements

The terms ‘normative’ and ‘informative’ are used in this Standard to define the application of the Appendix to which they apply. A normative appendix is an integral part of a Standard, whereas an informative appendix is for information and guidance.

References

For the purposes of this standard, the references to International Standards should be replaced by references to the appropriate Kenya Standards where they have been declared.

Self ballasted lamps for general lighting services
Part 1: Test methods – Energy performance

1 SCOPE

This Standard specifies the test methods and conditions for self-ballasted compact fluorescent lamps (CFLs) and other gas-discharge lamps with integrated means for controlling, starting and stable operation that are intended for domestic and similar general lighting purposes.

This Standard applies to self-ballasted lamps of all voltages and wattages irrespective of the type of lamp cap.

The requirements in this Standard relate only to type testing and exist in addition to the safety requirements that are specified in KS IEC 60968.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

KS IEC 60968	Self ballasted lamps for general lighting services-safety requirements (IEC 60968:1988, MOD)
KS IEC 60969	Self ballasted lamps for general lighting services-Performance requirements
KS IEC 61000.3.2	Electromagnetic compatibility (EMC), Part 3.2: Limits-Limits for harmonic current emissions (equipment input current ≤ 16 A per phase) (IEC 61000-3-2, Ed 3.0 (2005) MOD)
KS CISPR 15	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment.
IEC 61547	Equipment for general lighting purposes-EMC immunity requirements.
IEC 62321	Electrotechnical products – Determination of levels of six regulated substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers).
CIE 13.3	Method of measuring and specifying colour rendering properties of light sources.
CIE 15	Colorimetry
CIE 63	The spectroradiomentric measurement of light sources
CIE 84:1989	Measurement of luminous flux
CIE 121:1996	The photometry and goniophotometry of luminaires

3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

3.1

apparent power

Product of the r.m.s. voltage *U* between the terminals of a two-terminal element or two-terminal circuit and the r.m.s. electric *I* in the element of circuit:

$$S = UI$$

NOTES:
1. Under sinusoidal conditions, the apparent power is the modulus of the complex power.
2. The *SI* unit for apparent power is the voltampere.

3.2
average
The average is the arithmetic mean, which is arrived at by dividing the sum of a list of values by the number of values in the list.

3.3
ballast
An electrical unit within a compact fluorescent lamp, inserted between the supply and discharge lamp, which serves mainly to obtain the necessary conditions for starting and operating the lamp.

3.4
colour
The colour characteristics of a lamp as defined by the colour appearance and the colour rendition, incorporating the following:

(a) The actual colour of the lamp is called colour appearance and is defined in terms of the spectral tri-stimulus values (colour co-ordinates) according to the recommendations of the CIE. Correlated colour temperature (CCT) is a measure of the colour of the light emitted by a lamp.

(b) The spectral characteristics of the light emitted by the lamp have an effect on the appearance of the objects it illuminates. This effect is called colour rendition. A measure of the colour rendition is the colour rendering index (CRI), which is a figure of merit, on a scale of 0 to 100, used by manufacturers of lighting equipment to describe the visual effect of the light on colored surface. Natural daylight is assigned a color rendering index (CRI of 100. The CRI can only be used to compare two light sources that have the same color temperature.

3.5
covered lamp
(a) An A-shaped, bullet, candle, post, or similar lamp type/design.
(b) Globes: G-25, G-30, G-40, or similar lamp type/design.

3.6
displacement power factor
The Cosine of the angle between the supply voltage and the fundamental of the current drawn by the load.

3.7
efficacy (lamp)
Quotient of the final luminous flux by the measured lamp input power and expressed as lumens per watt (unit: lm/W).

3.8
energize
To apply a voltage across the terminals of the unit

3.9
final luminous flux
The luminous flux emitted after the lamp has stabilized. See Paragraph A4 for requirements on lamp stability.

3.10
illuminance (luminous intensity)
Quotient of the luminous flux incident on an element of the surface containing the point, by the area of that element and is defined by the formula-

$$E_v = \frac{\theta e}{d\lambda}$$ (Unit: lm/m^2) *3.1*

3.11
initial luminous flux
The luminous flux emitted by the lamp at the end of the 100 h ageing period. See Paragraph A4 for requirements on lamp stability.

3.12
initial values
The photometric and electrical characteristics of a new lamp at the end of the 100 h ageing period.

3.13
lamp cap (lamp base)
The point at which power enters the lamp

3.14
lamp failure
Lamp failure is deemed to occur when the lamp fails to light up, fails to remain lit or delivers less than 50% of its rated light output. The failure is confirmed by visual inspection.

3.15
lamp life
The length of time during which a complete individual lamp operates to burn-out or to lamp failure as stated in this standard.

3.16
lamp rated power (lamp rated wattage
The normal power drawn by a lamp, as specified by the manufacturer, importer or responsible vendor.

3.17
lamp power (lamp input power) (lamp wattage)
The active input power drawn by a lamp by actual measurement, measured in Watts.

3.18
lumen maintenance
The luminous flux at a given time in the life of a lamp divided by the initial value of the luminous flux of the lamp and expressed as a percentage of the initial luminous flux.

3.19
luminous efficacy of source
Quotient of the luminous flux emitted by the power consumed by the source (unit: lm/W).

3.20
luminous flux
Quantity derived from radiant flux Φ_e by evaluating the radiation according to its action upon the CIE standard photometric observer.

For photopic vision:

$$\Phi \mathrm{v} = \mathrm{K_m} \int_y^0 \frac{d\Phi_{e(\lambda)}}{d\lambda} . V(\lambda) d\lambda$$ 3.2

Where

Km = 683lmW^{-1} for v_m – 540x1012HZ(λ_m=555nm)

$\frac{d\Phi e(\lambda)}{d\lambda}$ = Is the spectral distribution of the radiant flux

V(λ) = is the spectral luminous efficiency(unit: lm)

3.21
luminance
Luminance (in a given direction, at a given point of a real or imaginary surface) is defined by the formula-

$$L_V = \frac{d\phi_v}{dA.cos\theta.d\Omega} \quad 3.3$$

Where
$d\phi_v$ = the luminnous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle dΩ containing the given direction)unit: cd/m^2= lm/m^2/sr
dA = the area of a section of that beam containing the given point
θ = the angle between the normal to that section and the direction of the beam

3.22
lumen
Luminous flux emitted in unit solid angle (steradian) by a uniform point source having a luminous intensity of 1 candela.

Luminous flux of a beam of monochromatic radiation whose frequency is 540 x 10^{12} hz and whose radiant flux is 1/683 W.

3.23
median lamp life (Average life)
The number of operating hours after which 50% of a representative group of lamps have survived when operating under specified test conditions.

3.24
new lamp
A lamp that has not been energized since manufacture.

3.25
radiant flux
Power emitted, transmitted or received in the form of radiation (unit: W)

3.26
rated average life (rated life to 50% failures)
The life declared by the manufacturer, importer or responsible vendor as being the expected time at which no more than 50% of any large number of lamps reach the end of their individual lives.

3.27
rated values
Quantity values of a lamp for specified operating conditions. The value and the conditions are specified in this standard or assigned by the manufacturer, importer or responsible vendor.

Nominal quantity values for a characteristic of a lamp specified by the manufacturer importer or responsible vendor.

3.28
rated light output
The rated light output is the nominal lumen output of the lamp as specified by the manufacturer, import or responsible vendor.

3.29
reflector lamp
A self ballasted lamp with an integral reflector: R-30, R-40, PAR38, or similar lamp type/design.

3.30
run-up time
The time taken, after energization of the lamp, to reach 60% of its final luminous flux. This time is measured on a lamp that has been aged for 100 hours.

3.31
self ballasted compact fluorescent lamp
A unit that cannot be dismantled without being permanently damaged, provided with a lamp cap and incorporating an electric discharge tube that generates visible light through fluorescent and any additional elements necessary for starting and stable operation of the light source. A compact fluorescent lamp is also referred to as a self ballasted compact fluorescent lamp, a lamp or a CFL in this Standard.

NOTE: A self ballasted compact fluorescent lamp is often referred to by industry as a CFLi (compact fluorescent lamp with integral ballast).

3.32
stabilization time
The burning time of the lamp required to obtain stable operating electrical and photometric characteristics. See Paragraph A% for requirements on lamp stability and stabilizing procedure.

3.33
starting time
Time needed, after the supply voltage is switched on, for the lamp to start fully and remain alight. Determining the exact point at which the lamp remains alight is described in Paragraph B4.

3.34
true Power factor
Under periodic conditions, the ratio of the absolute value of the active power *P* to the apparent power *S*:

$$\lambda = \frac{|P|}{S} \qquad 3.4$$

3.35
test voltage
An alternating current voltage source used to provide the input voltage to the lmp under test. See Paragraph A2 for lamp test voltage requirements.

3.36
type
Lamps that, independent of the type of cap or base, are identical in photometric and electrical rating.

3.37
type test
A test or series of tests made on a type test sample for the purpose of checking compliance of the design of a given product with the requirements of the relevant Standard.

3.38
type test sample
A sample, consisting of one or more similar units submitted by the manufacturer, importer or responsible vendor, for the purpose of the type test.

3.39
uncovered lamp (bare lamp)
A mini-spiral, spiral, 2-D, circline, twin-tube, triple-tube, quad-tube, or similar lamp type/design.

4 LAMP REQUIREMENTS

4.1 General conditions

General conditions for testing and measurement of electrical and photometric characteristics shall be as specified in Appendix A unless otherwise stated by the particular appendices.

For lamps with special features, e.g. daylight sensing, the manufacturer, importer or responsible vendor shall give advice for disabling the special features in order to test the lamp.

Where applicable, minimum sample sizes for the following requirements ar listed in Table 1.

4.2 Starting time
The starting time shall be measured as specified in Appendix B.

4.3 Run-up time
Run-up time shall be measured as specified in Appendix C.

4.4 Low temperature starting
Low temperature starting shall be measures as specified in Appendix E.

4.5 Lamp wattage
The initial wattage shall be measured in accordance with Paragraph D4.

4.6 True power factor
The lamp shall be set-up in accordance with Paragraph D4, and the true power factor determined.

4.7 Luminous flux and initial efficacy
The luminous flux and efficacy shall be measured as specified in Appendix D.

Initial efficacy shall be determined as per Paragraph D4. Initial values of all samples shall be recorded.

4.8 Colour and colour rendering index
The chromaticity co-ordinates (colour x, colour y), correlated colour temperature (CCT) and colour rendering index (CRI) tests shall be performed on lamps aged for 100h.

The chromaticity co-ordinates shall be measured with a spectroradiometer (see CIE 63) or colorimeter and in accordance with CIE 15.

CRI shall be determined by calculation in accordance with CIE 13.3

4.9 Switching withstand
Switching withstand shall be tested in accordance with Appendix F.

4.10 Lamp life and premature lamp failure

Lamp life and premature lamp failure shall be tested in accordance with appendix G.

4.11 Lumen maintenance

Lumen maintenance shall be tested in accordance with appendix D.

4.12 Light distribution ratio

If the light distribution ratio is declared, it shall be determined in accordance with Appendix H.

4.13 Harmonics and electromagnetic compatibility (EMC)

Self-ballasted lamps shall be tested for harmonic characteristics in accordance with IEC 61000.3.2:2007, including Amendment 1 (2009).

The lamps shall be tested in accordance with IEC CISPR 15 for RFI emissions. The lamps shall be tested in accordance with IEC 61547 for immunity requirements.

4.14 Mercury content determination

Tests for mercury content determination shall be carried out as per IEC 62321

5 SAMPLING

Minimum sample sizes for each test are specified in Table 1. Manufacturers can choose to test a bigger sample size, if appropriate.

TABLE 1 – SAMPLE SIZE FOR TESTS

Test	Minimum sample size
Starting time	10
Run-up time	10
Lumen maintenance	10
Premature lamp failure	10
Lifetime	10
True power factor	10
Colour (xy, CCT)	10
CRI	10
Mercury content	3
Switching withstand	10
Harmonics	1
Immunity	1
Low temperature starting	10
Lamp wattage	10
Initial luminous flux	10
Initial efficacy	10
Light distribution	1
EMC requirements	1

6 TEST REPORT

Refer to Appendix A for a list of information that is required to be included in a test report.

APPENDIX A
GENERAL CONDITIONS FOR MEASUREMENT OF PHOTOMETRIC AND ELECTRICAL CHARACTERISTICS

(Normative)

A1 AIR MOVEMENT AND TEMPERATURE

A.1.1. Test room

Measurements shall be taken with the lamp in an environment maintained at an ambient temperature of 25 ± 1^{o}C and with humidity of ≤65%. Air movement shall be in accordance with Clause 4.3.2 of CIE 121:1996.

A.1.2. Ageing room

For lamp ageing, the lamp life test and the switch withstand test, the ambient temperature of the ageing room shall be in the range of 15^{o}C to 40^{o}C. Some draught is allowed but vibration and shock should be minimized.

A2 TEST VOLTAGE

All tests unless specified elsewhere shall be carried out at rated voltage and frequency. If the rated voltage is a range, the lamp shall be aged and tested at the mean voltage of that range.

The test voltage tolerance during ageing and luminous flux maintenance testing shall be within 2%. During lamp stabilization the voltage shall be within ±0.5. At the moment of measurement the tolerance shall be within ±0.1% for voltage and ±0.1% for frequency.

A3 POSITION OF LAMP

If a supplier has declared the lamp is suitable for use in one specific orientation only, then the lamp shall be mounted in the declared orientation during all tests.

In all other circumstances, the lamp shall be mounted in the vertical cap-up position.

In all cases, the mounting position shall be such that the lamp operates in free air for all tests, including life tests (see Appendix G).

A4 LAMP STABILIZATION

All tests that require a measurement of the luminous flux of lamps, excluding starting and run-up tests, shall not commence until the lamp attains stable conditions.

In order to achieve this stability the lamp shall be operated for 15 min once lamp ageing and any conditioning specified by the manufacturer, importer or responsible vendor have been completed.

Measurement of light output shall then be taken at least once per minute for a further period of up to 16 h. During this time, no reading of light output shall differ by more than 1% of the minimum reading taken. If this condition is met, the lamp is deemed to be stable. If stability is not attained within 16 h, the light output fluctuation shall be stated.

NOTE: During shipping and normal handling of the lamps, e.g. rotating of the lamp, any excess amount of mercury may be distributed in small droplets within the discharge tube. Stabilization is reached when all the excess mercury has been collected at the coldest spot in the tube. Experience has shown that initially this process of collecting may take up to 16 h. When a lamp, once having passed this conditioning period, is re-lit within 24 h, it will only need about 15 min for stabilizing, provided that the lamp has been kept in the same position and not

subjected to vibration or shock. If deviating from 15 min, the relevant specification of the manufacturer should be observed. In order to warm up, the lamp maybe operated in a location that is distant to the test location. When moving to the test location, a further stabilization period is necessary after reaching the test location. The interruption of the supply should be as short as possible, and the additional stabilization period should be at least 15 min.

A5 LAMP AGEING

Lamp ageing shall take place in the ageing room. Lamps shall be cycled repeatedly, such that they are on for 2 h 45min and off for 15min.

Ageing shall only be deemed to have occurred during the periods when the lamp is on. Lamps shall be aged for 100 operating hours.

A6 MEASUREMENT EQUIPMENT AND ACCURACY

A.6.1. Test voltage

During stabilization, the test voltage shall be stable within ±0.5% of the value specified in Paragraph A2. The tolerance shall be reduced to ±0.2% during measurement. The test frequency shall be within ±0.1% of the value specified in Paragraph A2.

The total harmonic content in the supply voltage for the measurements shall not exceed 3% of the fundamental. The total harmonic content is the summation of the individual frequency r.m.s. voltages using the fundamental as 100%.

A.6.2. Test voltage for ageing

The ageing voltage shall be within ±2% of the value specified in Paragraph A2. The ageing frequency shall be within ±0.1% of the value specified in Paragraph A2.

The total harmonic content in the supply voltage for ageing shall not exceed 3% of the fundamental. The total harmonic content is the summation of the individual frequency r.m.s. voltages using the fundamental as 100%.

A7 ELECTRICAL MEASUREMENT

Measurements of voltage or current should be made within true r.m.s. responding instruments with an accuracy of 0.2% with respect to the measured value, as a minimum.

Measurements of power shall be made with a suitable calibrated wattmeter or power analyser with an uncertainty of no more than 0.5% with respect to the measured value. The power measurement instrument shall read average power over one or more cycles, have a bandwidth of more than 4 kHz and be capable of measuring waveshapes with a crest factor of 3 and a power factor of at least 0.3.

A8 LUMINOUS FLUX MEASUREMENT

A.8.1. Measurement equipment for tests

All equipment shall be calibrated in a manner that provides measurements that can be traced to a national/international laboratory standard.

A.8.2. Integrating sphere

An integrating sphere of the following dimensions shall be used:

(a) For lamps where the largest dimension is ≥300 mm, the sphere shall have a diameter of at least 2.0 m.

(b) For lamps where the largest dimension is <300 mm, the sphere shall have a diameter greater than six times that dimension.

The internal surface of the sphere shall be coated with diffuse non-spectrally selective paint in accordance with CIE 84:1989.

The lampholder and supports should be as small as possible and preferably highly reflective. The sphere shall have as small a screen as possible to shield the photometer head from direct illumination. The screen shall be positioned between the centrally located light source and the photometer head port, at a distance 1/3 to 2/3 of the sphere radius from the photometer head port.

A.8.3. Goniophometer (distribution photometer)

The photometer should be designed so that the test lamp can be correctly mounted in relation to the photometer optical axes. The photometer shall also be capable of determining luminous intensity and necessary angular settings in the test planes of the lamp. In all cases the mounting apparatus should not interfere with light emitted by the lamp.

The distance from the lamp to photometer port shall be at least six times the largest dimension of the tested lamp.

Angular settings shall be reproducible with $\pm 1^{o}$.

When measuring luminous flux, tests shall be made using a sensor with the following characteristics:

(a) Deviation of the relative spectral responsivity from the V(λ) function (f_1) shall be ±1.5%.
(b) Ultraviolet (UV) and infra-red (IR) response of less than 0.2%.
(c) Linearity error (f_3) of less than 0.2%
(d) Cosine correction (f_2) of 1.0%

A.8.4. Spectroradiometer

The accuracy of the spectroradiometer shall be within ±0.5 nm over the visible spectrum (380-780 nm), and it shall have a wavelength repeatability of 0.1 nm and stray light rejection of 10^{-4}.

A.8.5. Colorimeter

A tristimulus colorimeter can be used for luminous flux and colour measurement. Luminous flux measurement shall be performed using the Y channel of the instrument. When measuring luminous flux, tests shall be made with an instrument possessing the following characteristics:

(a) x(λ) adaptation flu_x<1.5%
(b) y(λ) adaptation $flux_y$<1.0%
(c) z(λ) adaptation $flux_z$<2.0%
(d) UV and IR response of less than 0.2%.
(e) Linearity error (f_3) of less than 0.2%.
(f) Cosine correction f_2 of 1.0%

A9 TIME MEASUREMENT

Equipment and procedures used to measure time shall be able to determine the results as below:
(a) Starting time: ±0.1 s
(b) Run-up time: ±3 s
(c) Lamp life: ±100 h

APPENDIX B
TEST FOR STARTING TIME
(Normative)

B1 GENERAL

The starting time test shall be conducted on lamps aged for 100 h. Prior to the test the lamps shall be stored for at least 24 h in planned test position at 25±1^{o}C (the ambient temperature).

Sample sizes for this test are given in Table 1

For the starting time test, the integrating sphere in Paragraph A8.2 is preferred as lamps do not illuminate evenly during starting.

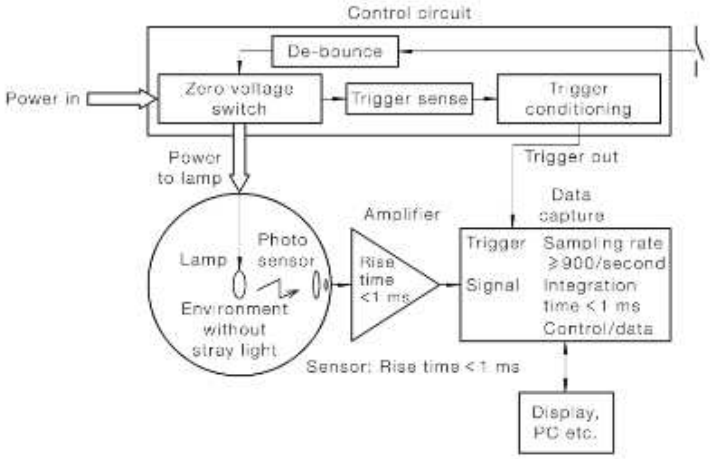
NOTE: Laboratories may use alternatives but these should be validated against the dimensions in Paragraph A8.2. Corrections and/or uncertainty statements should be made accordingly.

B2 TEST CONDITIONS

The test voltage for the starting test shall be equal to 92% of rated lamp voltage. Where the lamp is rated for a range of voltages, the test voltage shall be 92% of the minimum value of that range.

A typical test set-up is shown, with equipment, in Figure B1.

The equipment shall attain a stable condition in the test room for a period of 30 minutes prior to commencement of the test.



NOTE: Alternatively, picoammeters can be used to store sensor values.

FIGURE B1 – TYPICAL SET-UP FOR STARTING TIME TEST

B3 TEST PROCEDURE

The equipment shall be set up as in Figure B1 and the procedure shall be as follows:

(a) Switch on power to measuring device(s)
(b) Switch on power to the lamp and triggering equipment simultaneously
(c) The test shall run until the lamp starts fully and remains alight. If after a reasonable period, the lamp does not start, cease the test.
(d) Record luminous flux and time measurements taken during the test, and details of ambient conditions.

B4 CALCULATIONS

The starting time is determined as the period from the start of the test to when the lumen output reaches the first peak point after which the lamp shall start fully and remain alight. The starting time shall be determined according to Figure B2 where there are pulses before the continual luminous flux or Figure B3 where three are no pulses before the stable luminous flux.

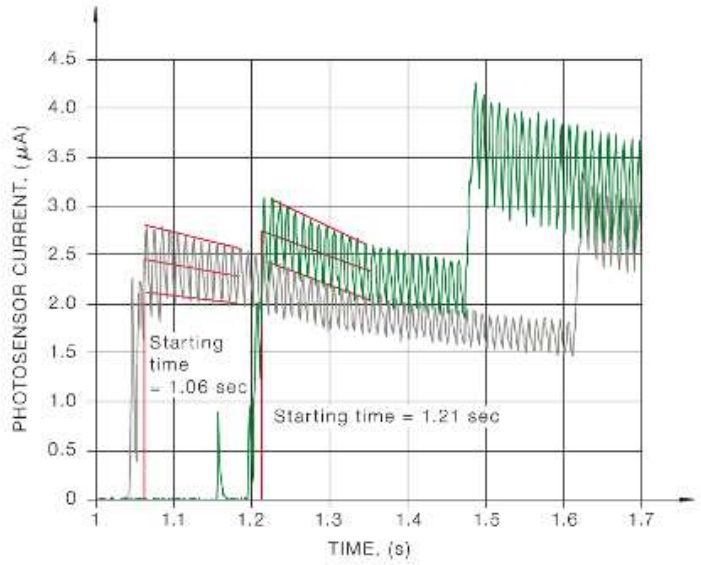


FIGURE B2 – DIAGRAM FOR STARTING TIME (EXAMPLES 1& 2)

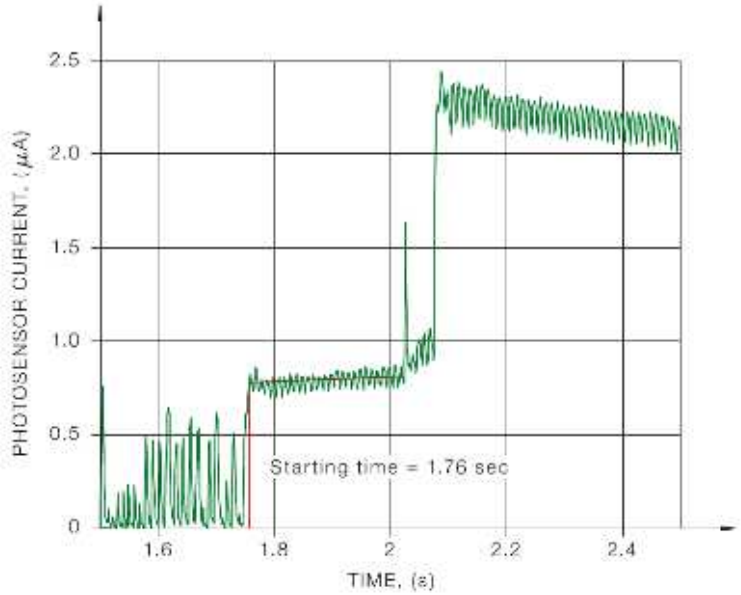


FIGURE B3 – DIAGRAM FOR STARTING TIME (EXAMPLE 3)

APPENDIX C
TEST FOR RUN-UP TIME

(Normative)

C1 GENERAL

Sample sizes for this test are given in Table 1

For the starting time test, an integrating sphere according to Paragraph A8.2 is preferred.

NOTE: Laboratories may use other alternatives but these should be validated against dimensions in Paragraph A8.2. Corrections and/or uncertainty statements should be made accordingly.

C2 TEST CONDITIONS

The typical test set-up and equipment is shown in Figure C1.

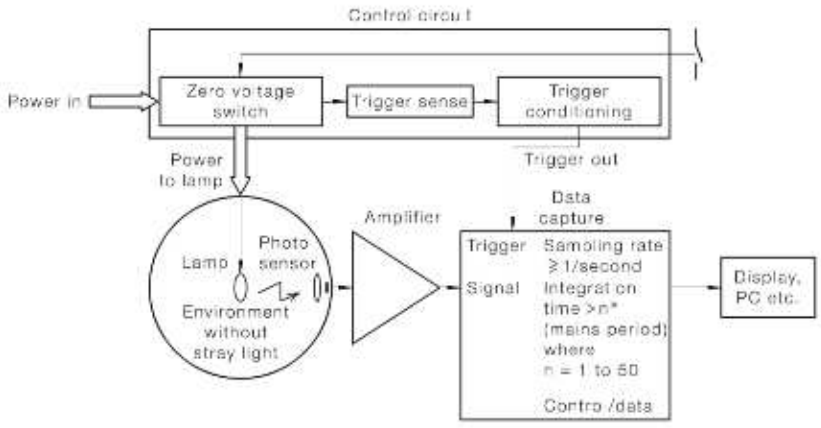


FIGURE C1 – TYPICAL SET-UP FOR RUN-UP TIME TEST

C3 PREPARATION OF APPARATUS

The equipment shall be set up as in Figure C1.

The run-up time test shall be conducted on lamps aged for 100 h. Prior to the test the lamps shall be stored for at least 24 h in planned test position at 25±1^{o}C ambient temperature.

The equipment shall attain a stable condition in the test room for a period of 30 min prior to commencement of the test.

C4 TEST PROCEDURE

The procedure shall be as follows:

(a) Switch on power to measuring device(s)
(b) Switch on power to the lamp and triggering equipment simultaneously.
(c) Run the test until the lamp output is stable. A stable lamp output is specified in Paragraph A4
(d) Record luminous flux and time measurements taken during the test, and details of ambient conditions.

C5 CALCULATIONS

Form the test data, determine-

(a) The maximum relative luminous flux during the test and
(b) The time taken from the start of the test to when the lamp achieves the stable luminous flux.

NOTE: See Clause 3.30

APPENDIX D
MEASUREMENT OF INITIAL LUMINOUS FLUX, EFFICACY AND LUMEN MAINTENANCE

(Normative)

D1 GENERAL

The measurement of luminous flux shall be conducted on lamps aged for 100 h. Sample sizes for this test are given in Table 1.

D2 TEST CONDITIONS AND PREPARATION OF APPARATUS

D.2.1. All methods

Four optional methods can be used for the measurement of luminous flux (see Paragraph A8). For all lamp types other than reflector lamps, Method A1 using an integrating sphere shall be the preferred method used. This sphere is fully described in Figure 6 of CIE 84:1989.

For reflector lamps, a method is under consideration.

NOTE: Laboratories may use the other methods described here but these should be validated against the measurement in Method A1. Corrections and/or uncertainty statements should be made accordingly.

For all methods, the circuit Figure D1 should be used:

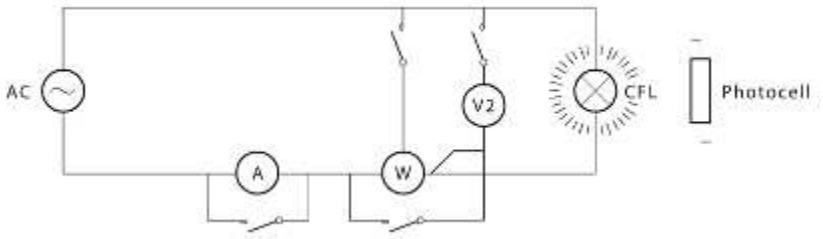


FIGURE D1 – MEASUREMENT OF LUMINOUS FLUX

D.2.2. Method A1 (Integrating sphere measurement: spectral photometry) and Method A2 (Integrating sphere measurement: integrating method)

The lamp shall be properly mounted inside a sphere as specified in Paragraph A8.2.

D.2.3. Method B (Goniophotometer: distribution photometer)

The lamp shall be mounted within a goniophotometer as specified in Paragraph A8.3.

The light centre of the test lamp, i.e. the geometric centre of all discharge tubes shall be mounted at the centre of the goniophotometer.

The original orientation of the lamp shall be selected so that the vertical plane passing the two cathodes is parallel to the 0-degree test plane.

D3 TEST PROCEDRUE

D.3.1. All methods

In all methods, the lamp shall be left to reach a stable condition as defined in Paragraph A4.

The test shall be conducted immediately after proper stabilization of the lamp.

D.3.2. Method A1 (Integrating sphere measurement: spectral photometry) and Method A2 (Integrating sphere measurement: integrating method)

The procedure shall be as follows:

(a) The measurement equipment and the lamp shall be switched on.
(b) Maintain the temperature around the lamp in accordance with Clause A1.1
(c) After stabilization, measurements of all required variables detailed in Paragraphs D3.4.1 or D3.4.2 (dependent upon calculation method to be used) shall be taken and recorded.

D.3.3. Method B (Goniophotometer: distribution photometer)

D.3.3.1. Angles and planes for measurement

The vertical angle range shall be from nadir (0^o) to zenith (180^o). The vertical angle spaces shall be no more than 10^o.

Reading shall be taken in at least 36 vertical half-planes. i.e. the horizontal angle spaces shall be no more than 10^o. The horizontal angles shall be arranged counter-clockwise when looking down at the lamp.

D.3.3.2. Stray light measurement

Stray light shall be measured and subtracted form the original test readings.

D.3.3.3. Data processing

All data shall be recorded including –

(a) a sketch to indicate the lamp's centre and the lamp's original orientation corresponding to the goniophotometer;
(b) the test distance (i.e. the distance covered by the light transmitted from the goniophotometer centre to the detector); and
(c) all lamp and stray light readings.

D.3.4. Calculations

D.3.4.1. Method A1 (Integrating sphere measurement: spectral photometry)

Luminous flux (1m) can be obtained from the total spectrum radiant flux (absolute unit).
The luminous flux of the test source, represented by F_t, is calculated by -

$$F_t = K_m \int_{380}^{780} Fs(\lambda)\, V(\lambda)\, d\lambda$$

Where

$V(\lambda)$ = spectral luminous efficiency
K_m = the maximum luminous efficacy, 683 1m/W
$F_s(\lambda)$ - the total special radiant flux of the test source as a function of wavelength.

D.3.4.2. Method A2 (Integrating sphere measurement: integrating method)

Luminous flux (F_t) can be calculated by –

$$F_t = \left(\frac{I_t}{I_s}\right) \times F_s \times K \times \alpha \qquad \text{D2}$$

Where
K = the coefficient of colour correction
F_t, F_s = the luminous flux of the test source and the standard source respectively
I_t, I_s = the photocurrent of the test source and the standard source respectively
α = coefficient of absorption correction

If the spectral energy distribution of the test source differs from that of the standard source, a colour correction shall be undertaken as follows:

$$K = \frac{\int P_t(\lambda)V(\lambda)d\lambda}{\int P_s(\lambda)V(\lambda)d\lambda} \times \frac{\int P_s(\lambda)\rho(\lambda)\times S(\lambda)d\lambda}{\int P_t(\lambda)\rho(\lambda)\times S(\lambda)d\lambda} \qquad \text{... D3}$$

Where
$P_t(\lambda)$ = the relative spectral power distribution of the test source
Ps(λ) = the standard source
$V(\lambda)$ = spectral luminous efficiency
$p(\lambda)$ = the spectral selectivity of the sphere wall
$S(\lambda)$ = the relative spectral sensitivity of detector

When the test lamps and the standard source are not of the same size and shape, absorption correction shall be made as follows:

$$F_t = \left(\frac{I_t}{I_s}\right) \times F_S \times K \times \propto \qquad \text{... D4}$$

Where
F_t, F_s = the luminous flux of the test source and the standard source respectively
I_t, I_s = the photocurrent of the test source and the standard source respectively

$$\propto = \frac{AUX_{ref\ lamp}}{AUX_{test\ lamp}} \qquad \text{...D5}$$

Where

$AUX_{ref\ lamp}$ = the measured flux of the auxiliary lamp with the unlighted reference lamp in the sphere test socket
$AUX_{test\ lamp}$ = the measured flux of the auxiliary lamp with the unlighted test lamp in the sphere test socket.

D.3.4.3. Method B (Goniophotometer: distribution photometer

The stray light data shall be subtracted from the original test readings. Luminous flux can then be calculated as follows:

$$F_t = R^2 \int_0^{\pi} \int_0^{2\pi} E(\theta, \varphi) sin\theta \; d\theta \; d\varphi \qquad \text{...D6}$$

Where

$E(\theta, \varphi)$ the illuminance value of the sport indicated by the horizontal angle φ and the vertical angle θ

F_t = the luminous flux of the test lamp

θ = the vertical angle

φ = the horizontal angle

R = the test distance

D4 INITIAL EFFICACY TEST

D.4.1. Test procedure

Sample sizes for this test are given in Table 1

During the procedure for measurement of initial luminous flux, simultaneously measure lamp power and record the data. If luminous flux is measured repeatedly (over an extended time) regular lamp power shall be measured accordingly and the average calculate.

Following this, the True Power factor shall be measured.

D.4.2. Calculations

Following the calculation of luminous flux, initial efficacy is determined as follows:

Initial efficacy = Initial luminous flux/average lamp power (1m/W)

D5 LUMEN MAINTENANCE AND MAINTAINED EFFICACY TESTS

The sample of lamps that underwent initial efficacy tests shall be aged in the ageing room, as described in Paragraph A5, for the specified number of hours.

The luminous flux shall be measured after 100 h, 2000 h and 5000 h of operation, and after the lamp has operated for 40% of its rated lamp life hours.

In addition, where required to demonstrate compliance with KS 2446-1:2013, the luminous flux shall be measured at the operating hours specified in KS 2446-1:2013 in relation to minimum lumen maintenance requirements.

Luminous flux and efficacy values for all measurements shall be recorded.

APPENDIX E
TEST FOR LOW TEMPERATURE STARTING TIME

(Normative)

E1 GENERAL

The low-temperature starting time test shall be conducted on lamps that have been aged for 100 h.

Sample sizes for this test are given in Table 1

E2 TEST CONDITIONS

Prior to the test, the lamps shall be stored in a cabinet for at least 22 h at 20 to 27^{o} C ambient temperature, and additional storing shall be at least 2 h in planned test position at 10±1^{o} ambient temperature of at a lower stable temperature as rated by the manufacturer, importer or responsible vendor if lower.

E3 TEST PROCEDURE

The lamp shall be switched on and a timing device used to record the time when the lamp starts fully and remains alight.

The ability of the lamp to start at the specified temperature shall be confirmed by visual inspection or other methods.

The lamp fails to start within 10 s, cease the test.

APPENDIX F
TEST FOR SWITCHING WITHSTAND

(Normative)

Sample sizes for this test are given in Table 1

Lamps shall be aged for 100 h.

The test conditions and equipment shall be as specified in the lamp life test (see Appendix G).

The switching cycle used for the switching withstand test shall be 30s on, 270s off.
NOTE: A manufacturer's test that features a switching cycle with OFF periods of at least 270s is acceptable.

Perform the test until lamp failure occurs as defined in Clause 3.14 or until the number of switchings is equal to twice the rated lifetime in hours.

APPENDIX G
TEST FOR LAMP LIFE AND PREMATURE LAMP FAILURE

(Normative)

Sample sizes for this test are given in Table 1.

The sample of lamps that underwent initial efficacy tests (Paragraph D4) shall be aged in the ageing room as described in Paragraph A5 for the specified number of hours.

The hours of operation shall be recorded for each lamp until lamp failure occurs, as defined in Clause 3.14.
Recorded hours of operation shall only include the periods of the cycle when the lamp was on. Hours of operation shall include the initial ageing period.

APPENDIX H
TEST FOR LIGHT DISTRIBUTION

(Normative)

Sample sizes for this test are given in Table 1

The light distribution test shall be performed on lamps aged for 100h using a goniophotometer as described in Paragraph A8.3

APPENDIX I
TEST REPORT

(Normative)

The following information shall be reported for each lamp tested:

(a) Name of test lab
(b) Lamp manufacturer or brand
(c) Lamp model name
(d) Lamp model number
(e) Lamp country of manufacture
(f) Date of lamp manufacture
(g) Whether the lamp is a covered or uncovered lamp, reflector or non- reflector lamp.
(h) Lamp cap type
(i) Other information as marked on the lamp, packaging or data sheet.
(j) Date and location of test
(k) Name of technician/s performing the test.
(l) Description of test equipment used with most recent calibration date and type of calibration
(m) Rated and test values for each lamp sample, for all lamp attributes covered by each test.

APPENDIX J

ABBREVIATIONS

(Informative)

The following abbreviations are used in this Standard:

DKS Draft Kenya Standards
CFLi Compact Fluorescent Lamp with integral ballast
CFL Compact Fluorescent Lamp
CIE International Commission on Illumination (Commission international de l'eclairage)
CRI Colour Rendering Index
EMC Electromagnetic compatibility
IEC International Electrotechnical Commission
r.m.s. Root Mean Squared

