PAKISTAN STANDARD

SELF-BALLASTED COMPACT FLUORESCENT LAMPS FOR GENERAL LIGHTING SERVICES - PERFORMANCE REQUIREMENTS

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SELF-BALLASTED COMPACT FLUORESCENT LAMPS FOR GENERAL LIGHTING SERVICES - PERFORMANCE REQUIREMENTS

0. FOREWORD

0.1 This Pakistan Standard was adopted by the authority of the Board of Directors of Pakistan Standard and Quality Control Authority after the draft prepared by the Technical Committee for **"Electric Lamps"** (TC-2)" had been approved and endorsed by the National Standards Committee on 31 January 2018.

0.2 This Pakistan Standard was adopted on the basis of IEC: 60969 since IEC Standard have been established in 2016, hence it is deemed necessary to adopt the International standard to keep abreast with the latest technology and as par with IEC standard.

0.3 This Pakistan Standard is an adoption of IEC 60969:2016 Self-ballasted compact fluorescent lamps for general lighting services - Performance requirements," and its use hereby acknowledged with thanks.

0.4 This standard is subject to periodical review in order to keep pace with the development in industry. Any suggestions for improvement shall be recorded and placed before the revising committee in due course.

0.5 This standard is intended chiefly to cover the technical provisions relating to this standard and it does not include all the necessary provisions of a Contract.

CONTENTS

SELF-BALLASTED COMPACT FLUORESCENT LAMPS FOR GENERAL LIGHTING SERVICES – PERFORMANCE REQUIREMENTS

1 Scope

This document specifies performance requirements together with test methods and conditions required to show compliance of self-ballasted compact fluorescent lamps intended for general lighting services.

This document applies to self-ballasted compact fluorescent lamps of voltages > 50 V and all power ratings with lamp caps complying with IEC 60061-1.

NOTE Some features of this document could be applicable to self-ballasted compact fluorescent lamps of voltages ≤ 50 V and to other types of self-ballasted gas discharge lamps.

The requirements of this document relate only to type testing.

The performance requirements specified in this document are additional to the safety requirements specified in IEC 60968.

It can be expected that self-ballasted compact fluorescent lamps, which comply with this document, will start and operate satisfactorily at normal conditions (voltages between 80% to 106% of rated supply voltage, ambient air temperature of between -10 °C and 40 °C and in a luminaire complying with IEC 60598-1).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60630, *Maximum lamp outlines for incandescent lamps*

IEC 60968, *Self-ballasted fluorescent lamps for general lighting services – Safety requirements*

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current <= 16 A per phase)*

IEC 61000-4-7, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC TR 61341, *Method of measurement of centre beam intensity and beam angle(s) of reflector lamps*

CIE 015-2004, *Colorimetry*

CIE 13.3, *Method of Measuring and Specifying Colour Rendering Properties of Light Source*

3 Terms and definitions

For the purposes of this document the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
self-ballasted lamp
integrated lamp
unit which cannot be dismantled without being permanently damaged, provided with a lamp cap and incorporating a light source and any additional elements necessary for starting and stable operation of the light source

Note 1 to entry: A self-ballasted lamp is referred to as a lamp in this document.

[SOURCE: IEC 60968:2015, 3.1, modified – The admitted term and note have been added]

3.2
new lamp
lamp which has not been energized since manufacture

3.3
rated value
quantity value, assigned by the supplier, for a lamp characteristic under specified operating conditions

EXAMPLE Rated luminous flux.

3.4
test voltage
input voltage at which tests are carried out

[SOURCE: IEC 62612:2013, 3.2, modified – The word "input" has been added.]

3.5
initial value
photometric and electrical characteristic measured at the end of a 100 h ageing period

3.6
lamp failure
moment at which the lamp fails to light up, fails to remain alight or delivers low light output (in case of doubt, low light output refers to less than approximately 50 % of rated light output)

3.7
lamp life
<of an individual lamp> number of operating hours to lamp failure

3.8
median of lamp life
number of operating hours elapsed at which point 50 % of a representative group of lamps have failed, when operated under specified test conditions

3.9
starting time
time required for a lamp to develop an electrically stable arc discharge, the time being measured from the moment the lamp circuit is energized

3.10
run-up time
time required for a lamp to reach a specified percentage of its (stable) luminous flux, the time being measured from the moment the lamp circuit is energized

3.11
displacement factor
cosine of the phase-angle between the fundamental harmonic current and the mains voltage

Note 1 to entry: Displacement factor is explained in Annex J.

3.12
distortion factor
factor indicating the level of harmonic current distortion

Note 1 to entry: Distortion factor is explained in Annex J.

3.13
power factor
under periodic conditions, ratio of the absolute value of the active power to the apparent power

Note 1 to entry: Alternatively, the power factor is the product of the displacement and distortion factor.

3.14
lumen maintenance
luminous flux at a given time in the life of a lamp, divided by the initial luminous flux of the lamp

Note 1 to entry: Lumen maintenance is expressed as a percentage of the initial luminous flux.

3.15
lamp type
lamps that, independent of the type of cap, have identical rated values in relation to the relevant compliance test

3.16
lamp stabilization time
time required for a lamp to reach stable conditions for measurement

3.17
type test
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

[SOURCE: IEC 60598-1:2014, 1.2.44]

3.18
type test sample
sample consisting of one or more similar units submitted by the manufacturer or responsible vendor for the purpose of a type test

[SOURCE: IEC 60598-1:2014, 1.2.45]

3.19
luminous efficacy
quotient of the lamp luminous flux by the lamp power consumption

3.20
beam angle
angle between two imaginary lines in a plane through the optical beam axis, such that these lines pass through the centre of the front face of the lamp and through points at which the luminous intensity is 50 % of the centre beam intensity

[SOURCE: IEC TR 61341:2010, 2.4]

3.21
ageing
preconditioning of lamps by operating them at controlled conditions for a specified period

3.22
supplier
manufacturer, responsible vendor or importer

3.23
dimmable lamp
lamp that is capable of producing varying levels of light when paired with a control or dimmer

3.24
inrush current
<of lamp> transient current associated with energizing a lamp

3.25
chromaticity coordinates
ratio of each of a set of three tristimulus values to their sum

[SOURCE: IEC 60050-845:1987, 845-03-33, modified – The notes have been deleted]

3.26
correlated colour temperature
CCT
temperature of the Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions

Note 1 to entry: The correlated colour temperature is expressed in K.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-845:1987, 845-03-50, modified – The abbreviated term has been added and the notes have been replaced]

3.27
colour rendering index
CRI
measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-845:1987, 845-02-61]

3.28
colour code
3-digit code expressing the rated colour rendering index and the rated correlated colour temperature as described in IEC TR 62732

Note 1 to entry: The light colour designation is detailed in IEC TR 62732.

4 Marking

For this performance standard the following data shall be provided (in addition to the mandatory data required by IEC 60968) by the supplier and located as specified in Table 1. The rated values refer to performance claims under the general conditions for measurement as specified in Clause A.1.

Table 1 – Locations where marking of rated values is required

Parameter (rated)	Product	Product packaging	Product datasheets or leaflets
a) Initial luminous flux of the lamp (lm) (luminous flux for reflector lamps is under consideration)	-	x	x
b) Beam angle (degrees) and centre beam intensity (cd) measured in accordance with IEC TR 61341 for reflector lamps	-	x	x
c) Initial luminous efficacy (lm/W)	-	-	x
d) Correlated colour temperature (K) For the product a colour code is permissible.	x	x	x
e) Colour rendering index For the packaging a colour code is permissible.	-	x	x
f) Chromaticity coordinates	-	-	x
g) Median lamp life (h)	-	x	x
h) Lumen maintenance (%) Including operating hours at which lumen maintenance value(s) are claimed	-	-	x
i) Switching withstand (no. of cycles)	-	-	x
j) Special operating requirements e.g. dimming, orientation (base up/down), restricted operating temperature range	-	x	x
k) Starting time (s)	-	-	x
l) Low temperature starting time (s) (and temperature if different from -10 °C)	-	-	x
m) Run-up time (s)	-	x	x
n) Displacement factor	-	-	x
o) Dimensions (mm)	-	-	x
p) Performance claims for different conditions	-	-	x
q) Location of additional information (how to find product datasheets or leaflets)	-	x	-
(x = required, – = not required but optional) NOTE In Japan, the power factor is used instead of displacement factor and the requirement on colour classification and indication is specified in JIS Z9112.			

If equivalence with an incandescent lamp is claimed, the claimed equivalent incandescent lamp power (rounded to 1 W) for lamps with CCT values less than 4 500 K shall be that

corresponding in Table 2 below unless superseded by regional requirements. The intermediate values of both the luminous flux and the claimed incandescent lamp power (rounded to 1 W) shall be calculated by linear interpolation between two adjacent values.

Table 2 – Equivalency with non-directional incandescent lamps

Claimed equivalent incandescent lamp power W	(for 220-240 V regions) **Minimum rated luminous flux** lm	(for 110-120 V regions) **Minimum rated luminous flux** lm
15	125	
25	229	250
40	432	450
60	741	800
75	970	1 100
100	1 398	1 600
150	2 253	2 550
200	3 172	

5 Test conditions

Conditions for testing are given in Annex A.

For lamps with special features for example dimming and daylight sensing, the supplier shall provide advice on how to disable these features in order to test the lamp.

Where applicable, sample sizes and compliance conditions for various requirements are given in Table 3.

Where a supplier claims suitability for operation at different conditions (for instance, at higher voltage, temperature or humidity) then:

a) lamps shall be tested under claimed different conditions; and

b) lamps shall start and operate satisfactorily under claimed different conditions; and

c) lamps shall meet the performance claims under the claimed different conditions, which may differ from the general conditions for measurement specified in Clause A.1.

6 Performance criteria: assessment and compliance

6.1 General

A lamp, on which compliance with this document is claimed, shall comply with the requirements of IEC 60968.

A lamp shall be designed so that its performance is reliable in normal and accepted use. In general this can be achieved by satisfying the requirements of 6.2.

The requirements and information given apply to 95 % of production.

NOTE It can be expected that the type test samples submitted by the supplier for type test to the requirements and tolerances of this document will, in principle, consist of units having characteristics typical of the manufacturer's production and being as close to the production centre point values as reasonably possible.

It can be expected with the tolerances given in this document that products manufactured in accordance with the type test sample will comply with this document for the majority of production. Due to the production spread

however, it is inevitable that there will sometimes be products outside the specified tolerances. For guidance on sampling plans and procedures for inspection by attributes, refer to ISO 2859 and for inspection by variables refer to ISO 3951.

6.2 Performance requirements

Lamps shall be assessed against all the parameters listed in Table 3. Minimum sample sizes for each test are specified in column C, compliance conditions for all parameters and test conditions are listed in column D and column E.

Table 3 – Sample sizes, compliance criteria and test conditions

A	B	C	D	E
Row	**Parameter for test**	**Minimum type test sample size**	**Compliance**	**Test condition for compliance**
1	Initial power	10	Mean measured value shall not exceed 108 % of rated value, and all samples shall measure below 115 % of rated value.	Annex A
2	Displacement factor [a]	10	All samples shall measure equal to or greater than the rated displacement factor value minus 0,05. NOTE In Japan, the power factor instead of displacement factor is used.	Annex I
3	Distortion factor (harmonics) [a]	10	All samples shall be within limits for harmonics according to IEC 61000-3-2.	IEC 61000-3-2
4	Initial luminous flux	10	Mean measured value shall be greater than or equal to 90 % of rated value, and all samples shall measure greater than or equal to 85 % of rated value.	Annex D
5	Beam angle (reflector lamps)	1	Measured beam angle shall be within ±25 % of rated value.	IEC TR 61341
6	Centre beam intensity (reflector lamps)	1	Mean measured centre beam intensity shall be equal to or greater than 75 % of the rated value.	IEC TR 61341
7	Chromaticity coordinates[b]	10	Chromaticity coordinates of at least 90 % of the samples shall measure less than or equal to 5 SDCM (standard deviation of colour matching) from the rated value.	CIE 015
8	Colour rendering index (CRI)	10	All samples shall measure equal to or greater than the rated CRI value minus 3.	CIE 13.3
9	Starting time	6	Mean measured value shall be less than or equal to 1,5 s, and all samples shall start within 2,0 s. Mean measured value shall be ≤110% of rated value.	Annex B
10	Low temperature and low supply voltage starting	6	All lamps shall start within the time if specified by the supplier or within 10 s maximum.	Annex E
11	Run-up time	6	The mean measured time, to reach 60% of initial luminous flux, shall be less than or equal to 110 % of the rated time. All samples shall reach 60% of initial luminous flux within 150 % of the rated time.	Annex C
12	Lumen maintenance	10	Mean measured value(s) shall be equal to or greater than 90 % of the rated value(s). All samples shall measure equal or greater than 85 % of the rated value(s).	Annex D

A	B	C	D	E
Row	**Parameter for test**	**Minimum type test sample size**	**Compliance**	**Test condition for compliance**
13	Premature lamp failure rate (if claimed)	10	After the operating hours specified by the supplier have elapsed, the proportion of lamp failures shall be less than or equal to the rated value.	Annex G
14	Lifetime	10 or 20	Assess lifetime based on either of the following tests (Based on Weibull shape factor 3[c]): Test 10 samples to 100 % of rated life Pass if less than or equal to 6 failures Fail if equal or greater than 7 failures. Test 20 samples to 90 % of rated life Pass if less than or equal to 10 failures Fail if equal or greater than 11 failures.	Annex G
15	Switching withstand	10	Assess switching withstand based on the following test (Based on Weibull shape factor 3 [c]): Test 10 samples to the rated number of switching cycles Pass if less than or equal to 6 failures Fail if equal or greater than 7 failures.	Annex F
16	Dimensions	6	All samples shall comply with rated minimum and maximum specifications. Mean measured dimension shall be within 90 % and 110 % of rated value. [d] If dimensional equivalence with incandescent lamps is claimed then lamps shall comply with IEC 60630.	Physical measurements
17	Inrush current	1	Inrush current shall not exceed given limits.	Annex H
18	Performance under different conditions	In accordance with the relevant type test in this table	Claims for performance at different conditions (voltages or temperatures outside of normal conditions, including high humidity) shall be tested under those conditions using the relevant annexes to this document (altering test conditions to suit different conditions). Under these conditions: a) lamps shall start and operate satisfactorily, and b) lamps shall meet all performance claims, which may differ from the performance claims under the general conditions for measurement specified in Clause A.1.	In accordance with the relevant type test in this table

NOTE There are local and regional regulations for many of these and other parameters.

[a] The relationship between power factor, displacement and distortion factors are explained in Annex J.

[b] Preferred rated chromaticity coordinates are the standardised chromaticity coordinates for 2 700 K, 3 000 K, 3 500 K, 4 000 K, 5 000 K and 6 500 K as defined in IEC 60081, Annex D.

[c] Statistical tools, such as Weibull analysis and parametric fits may be used to estimate median lamp life of the sample.

[d] Supplier should advise sizes to allow assessment, and these should be clear if maximum or rated dimensions.

Annex A
(normative)

General conditions for measurement of photometric and electrical characteristics and requirements for test equipment

A.1 Method of measuring lamp characteristics

Sample sizes and compliance conditions are given in Table 3.

The visual appearance of all samples shall be checked before testing, and if required all samples shall be cleaned before photometric testing.

Unless specified elsewhere all tests shall:

a) be made in a draught-free atmosphere at an ambient temperature of (25 ± 1) °C and a relative humidity of 65 % maximum. If lamp operation under different conditions is claimed by the supplier, operation at this atmosphere shall also be tested. Air movement shall be in accordance with CIE 121. For lamp ageing, the lamp life test and the switch withstand test, the ambient temperature of the room shall be in the range of 15 °C to 40 °C, and some draught is allowed but vibration and shock should be minimized.

b) be carried out at rated voltage and frequency if a single value is declared. If the rated voltage is a range, the lamp shall be aged and tested at the mean voltage of that range. For dual-voltage lamps, for example those intended for operation at 110 V to 130 V and 180 V to 240 V, ageing and testing shall be conducted at the mean voltage of each voltage range.

c) have a test voltage tolerance during ageing and luminous flux maintenance testing within 2 %. During lamp stabilization the voltage shall be within ±0,5 %. At the moment of measurement the tolerance shall be within ±0,2 % for voltage and ±0,2 % for frequency. The total harmonic content of the supply voltage shall not exceed 3 %. The harmonic content is defined as the R.M.S. summation of the individual harmonic components using the fundamental as 100 %. IEC 61000-3-2, Annex A, provides guidance on the supply voltage source.

d) be conducted with lamps operated in free air in a vertical base-up position for all tests including lumen maintenance tests. If a supplier has declared the lamp is suitable for use in a specific orientation only, then the lamp shall be mounted in the declared orientation during all tests.

A.2 Lamp stabilization

Measurements shall be made after the lamp stabilization time.

NOTE During shipping and normal handling of the lamps, for example rotating of the lamp, any excess amount of mercury could be distributed in small droplets within the discharge tube. Proper conditioning 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 lamp conditioning can take up to 16 h. When a lamp has passed this conditioning period it is ready for measurement.

For conditioning and warming up the lamp may be operated in a location, distant to the test location. When moving to the test location, provided that the lamp has been kept in the same orientation, not subjected to vibration or shock and no warm glass parts are touched (i.e. creating a parasitic cold spot), a stabilization period of 15 min to 60 min is necessary in the test location. To avoid cooling down of warm glass parts during moving the lamp to test location thermally insulating gloves or similar technique shall be used. The interruption of the supply should be as short as possible. If deviating from the values in Table A.1, the relevant specification of the supplier should be observed.

Measurements shall not start before stabilization is reached. Stabilization is achieved if the difference of maximum and minimum light output readings, taken at least once per minute, is less than 1 % within a 15 min observation period. If stabilization is not reached in the minimum period, the period is extended until 15 successive readings at 1 min intervals fulfil the requirement. If this cannot be achieved within 60 min, the measurement can be started and the fluctuation shall be stated. Table A.1 summarizes the relevant time periods.

Table A.1 – Conditioning, off time and stabilization time

Minimum conditioning time (hours)[a]	16
Maximum off time (transport to test location) (minutes)	5
Stabilization time (minutes)	15 to 60
[a] This can be part of ageing.	

A.3 Lamp ageing and life test

Unless specified elsewhere, lamp ageing shall take place in the ageing facility for the specified number of hours of operation.

For testing details, see Annex G.

Ageing hours and life hours shall only be deemed to have occurred during the periods when the lamp is ON.

A.4 Electrical measurement

Electrical measurements (power, current and power quality) shall be conducted on lamps aged for 100 h.

Instruments shall be of the true r.m.s. type, essentially free from waveform errors and of a precision appropriate to the requirements.

A.5 Photometric measurements

Photometric characteristics shall be measured in accordance with the relevant recommendations of the CIE (Commission Internationale de l'Eclairage).

Measurement of initial luminous flux, beam angle (reflector lamps), centre beam intensity (reflector lamps), chromaticity coordinates, colour rendering index (CRI) shall be conducted on lamps aged for 100 h.

A.6 Time and cycles measurement

Appropriate accuracy for time and cycle measurements are:

Starting time: ±0,1 s

Run-up time: ±3 s

Lamp life: ±100 h

Lumen maintenance: ±100 h

Ageing: ±5 h

Switching cycle time: ±3 s

Switching withstand cycles: ±200 cycles

Annex B
(normative)

Test for starting time

B.1 General

The starting time test shall be conducted on lamps aged for 100 h.

Prior to the test the lamps shall be stored in the planned test position for at least 22 h at 20 °C to 27 °C ambient temperature, and additional storing shall be at least 2 h at 25 °C ± 1 °C ambient temperature.

Sample sizes and compliance conditions are given in Table 3.

B.2 Test conditions

The test voltage for the starting test shall be the rated voltage using a supply as defined in A.1 c).

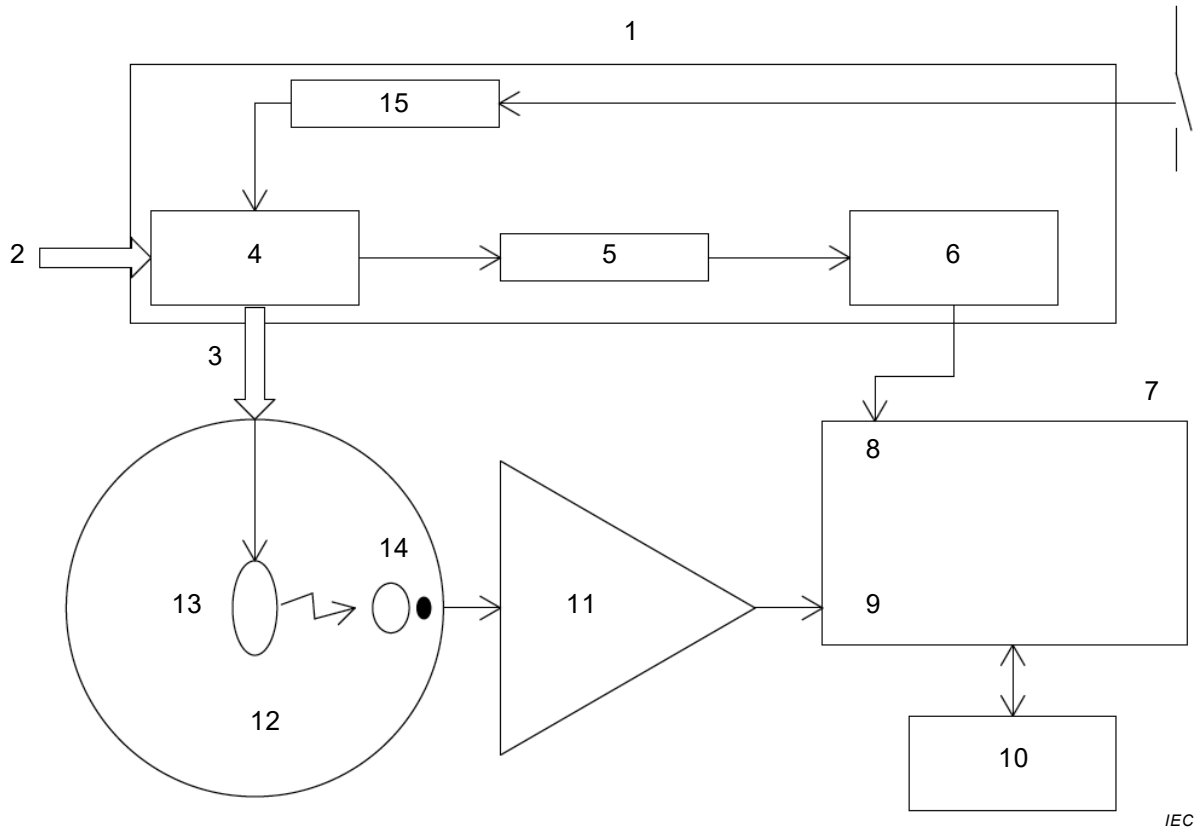
Additional tests for dimmable lamps are under consideration.

B.3 Test procedure

A typical test procedure is:

a) The test equipment and the measurement device(s) shall be in a state such that the lamp test can immediately be started.
b) Switch on power to the lamp and triggering equipment as required.
c) Record ambient temperature and relative humidity.
d) Record luminous flux over time.
e) 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.

A typical test setup and equipment is shown in Figure B.1. Alternatively a picoammeter may be used to store sensor values.



Key

1 Control circuit
2 Power in
3 Power to lamp
4 Zero voltage switch
5 Trigger sense
6 Trigger conditioning
7 Data capture
8 Trigger
9 Signal
10 Display and PC
11 Amplifier – Sensor. Rise time less than 1 ms
12 Environment without stray light
13 Lamp
14 Photo sensor
15 De-bounce circuit

NOTE Data capture sampling rate equal or greater than 900/s and integration time less than 1 ms.

Figure B.1 – Typical setup for starting time test

B.4 Calculations

The starting time is determined as the period from the start of the test to when the lamp has fully completed the starting sequence (lamp is fully started and remains alight) as observed by the front edge of the first plateau in the envelope of the light output signal.

Annex C
(normative)

Test for run-up time

C.1 General

The run-up time test shall be conducted on lamps aged for 100 h.

Prior to the test the lamps shall be stored in the planned test position for at least 22 h at 20 °C to 27 °C ambient temperature, and additional storing shall be at least 2 h at 25 °C ± 1 °C ambient temperature.

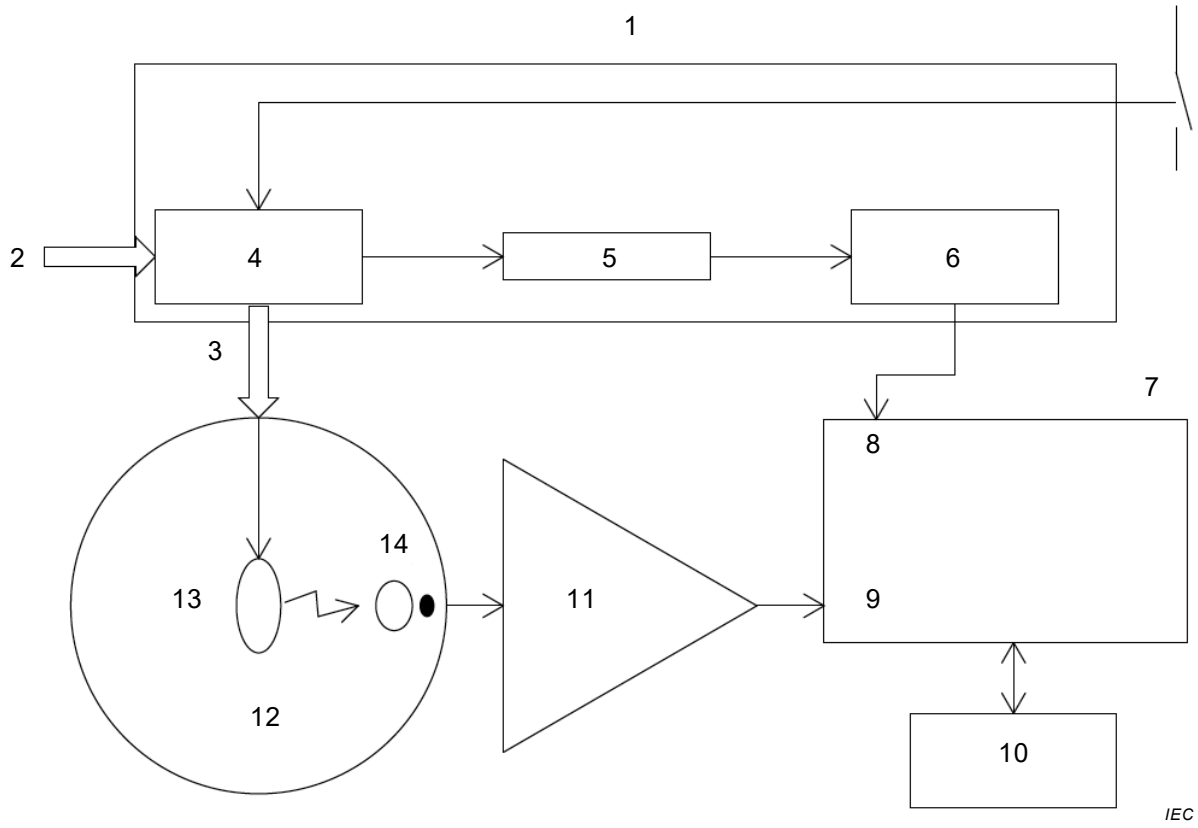
Sample sizes and compliance conditions are given in Table 3.

For the run-up time test an integrating sphere as per CIE 84 is the preferred method.

C.2 Test conditions

The test conditions and equipment shall be as specified in Annex A.

A typical test setup and equipment is shown in Figure C.1.



Key

1 Control circuit
2 Power in
3 Power to lamp
4 Zero voltage switch
5 Trigger sense
6 Trigger conditioning
7 Data capture
8 Trigger
9 Signal
10 Display and PC
11 Amplifier – Sensor. Rise time less than 1 ms
12 Environment without stray light
13 Lamp
14 Photo sensor

NOTE Data capture sampling rate equal or greater than 1/s and integration time less than n, multiplied by the mains period (ms), where n equals any integer from 1 to 40.

Figure C.1 – Typical setup for run-up time test

C.3 Test procedure

An example of test equipment setup is given in Figure C.1.

a) The test equipment and the measurement device(s) shall be in a state that the lamp test can immediately be started.

b) Switch on power to the lamp and triggering equipment as required.

c) Record ambient temperature and relative humidity.

d) Record luminous flux over time.

e) The test shall run until the lamp light output is stable as defined in Clause A.2.

C.4 Calculations

From the test data, determine the time taken from the start of the test, to when the lamp achieves the required percentage of its initial luminous flux.

Annex D
(normative)

Measurement of initial luminous efficacy and lumen maintenance

D.1 General

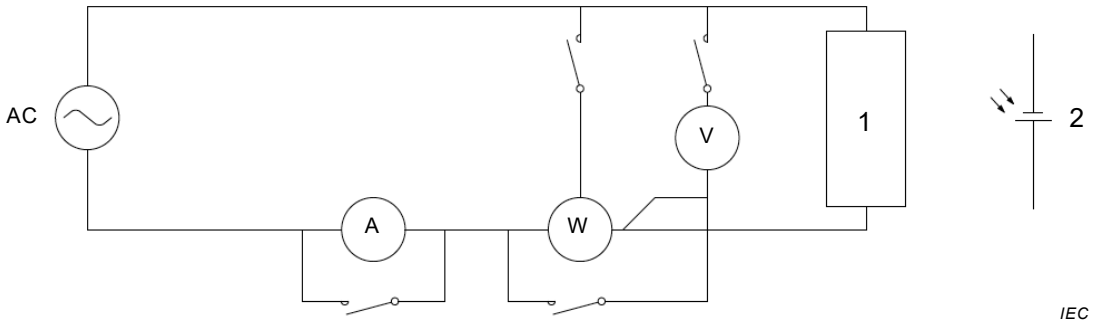
The measurement of initial luminous flux shall be conducted on lamps aged for 100 h.

Sample sizes and compliance conditions are given in Table 3.

D.2 Test conditions

The test conditions and equipment shall be as specified in Annex A.

The circuit in Figure D.1 should be used:



Key

1 Lamp

2 Photocell

Figure D.1 – Measurement of luminous flux

D.3 Test procedure

The lamp shall be left to reach a stable condition as defined in Clause A.2.

D.4 Initial luminous efficacy test

D.4.1 Test procedure

The test shall be conducted on lamps aged for 100 h.

Sample sizes and compliance conditions are given in Table 3.

During the procedure for measurement of luminous flux, simultaneously measure lamp power and record the data.

The luminous flux and the lamp power shall be measured from the same test lamp.

D.4.2 Calculations

Calculate the luminous efficacy as follows:

Luminous flux/lamp power. Units: lm/W.

D.5 Lumen maintenance test

The sample of lamps that underwent initial luminous efficacy tests, or new lamps shall be aged under the same conditions as described in Clause A.3 for the specified number of hours.

The luminous flux shall be measured after 100 h ageing and after other elapsed periods as required to demonstrate compliance with rated values.

The mean value at each specified elapsed period shall be calculated for the remaining, still-working lamps and the number of any non-working lamps shall be reported.

Annex E
(normative)

Test for low temperature and low supply voltage starting

E.1 General

The low temperature and low supply voltage starting test shall be conducted on lamps that have been aged for 100 h.

Sample sizes and compliance conditions are given in Table 3.

E.2 Test conditions

The test voltage shall be equal to 80 % of the lowest given rated voltage using a supply as defined in A.1 c)

Prior to the test, the lamps shall be stored in the planned test position for at least 20 h at or near the test temperature and additional storing shall be at least 4 h at the test temperature ±1 °C. If the lamp is to be moved to a test location, thermally insulating gloves or similar technique shall be used to avoid warming of cool parts.

The test temperature is the supplier's rated minimum starting temperature or, if a rated minimum starting temperature is not supplied, then the test temperature shall be –10 °C.

E.3 Test procedure

The test procedure is:

a) The lamp shall be switched on and a timing device used to record the time when the lamp starts fully and remains alight.
b) The ability of the lamp to start at the specified temperature shall be confirmed by visual inspection or other methods.
c) Cease the test if the lamp fails to start within 10 s.

Annex F
(normative)

Test for switching withstand

Sample sizes and number of cycles compliance conditions are given in Table 3.

The test conditions and equipment shall be as specified in Annex A for lamp ageing and life test. The switching cycle used for the switching withstand test shall be 1 min ON and 3 min OFF.

Annex G
(normative)

Test for lamp life

Sample sizes and compliance conditions are given in Table 3.

The sample of lamps shall be new or aged for a maximum of 100 h.

For lamp ageing and life testing, lamps shall be repeatedly cycled for 2 h 45 min ON followed by 15 min OFF.

The hours of operation until lamp failure occurs shall be recorded for each lamp. The lamp is deemed to have failed if it fails to light up, fails to remain alight or delivers less than approximately 50 % of its rated luminous flux as confirmed by visual inspection.

The hours of operation recorded shall only include the periods of the cycle when the lamp was switched ON. The hours of operation shall include any initial ageing period.

Annex H
(normative)

Tests for compatibility with dimmers and switches

H.1 Inrush current

The inrush current shall be limited to avoid damage to dimmers or switches.

For maximum allowed values and test conditions, see Table H.1 and Figures H.1, H.2 and H.3.

The waveform generator circuit for determining the inrush current is shown in Figure H.3.

The lamp shall be tested at rated voltage, as specified in A.1 b).

Table H.1 – Inrush current limitations and test conditions

Device under test		Test condition; source impedance		Compliance	
Lamp power W	**Lamp rated voltage** V rms	**Maximum resistance** Ω	**Maximum inductance** µH	**Maximum peak current** I_{peak} A	**Maximum inrush energy** I^2t A^2 s
P≤15	100-130	0,450	100	60	0,50
P≤15	200-250	0,2	400	20	0,08
15<P≤25	100-130	0,450	100	60	0,50
15<P≤25	200-250	0,2	400	35	0,15

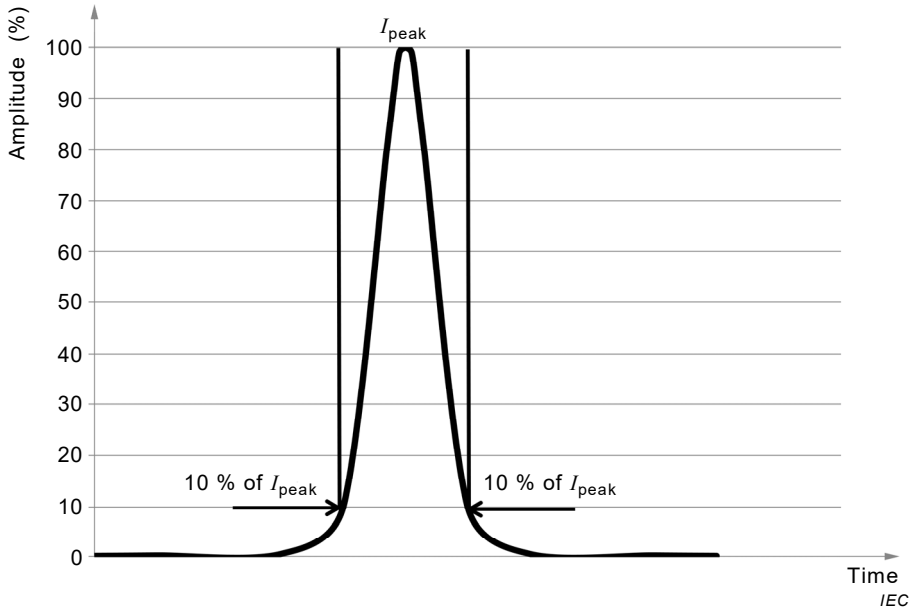


Figure H.1 – Typical inrush current profile

Only currents greater than 10 % of I_{peak} shall be included in the inrush energy integral. See Figure H.1.

When measuring the inrush current of self-ballasted lamps, prior to the occurrence of I_{peak}, one or more current spikes may be observed which exceed the subsequent I_{peak}. These spikes typically have durations of a few microseconds, where the actual inrush current has a duration of approximately 100 µs. Such spike(s) do not significantly contribute to the inrush current and can be neglected by use of a digital filter with 5 µs window or low pass filter with 5 µs time constant or equivalent means. See Figure H.2.

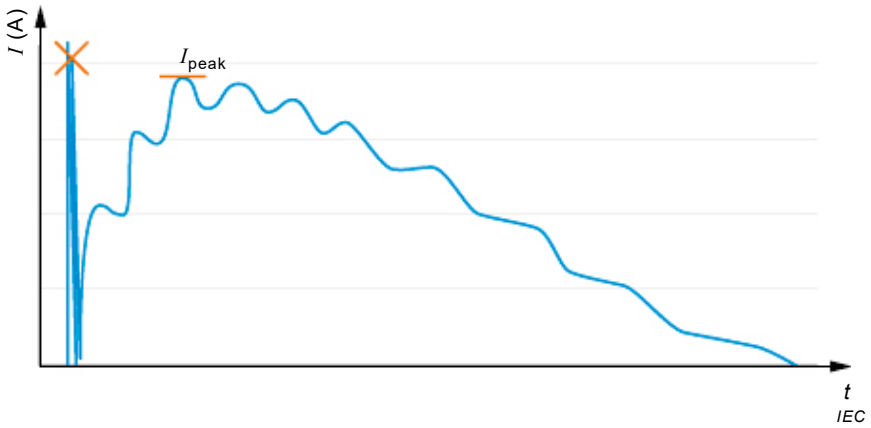
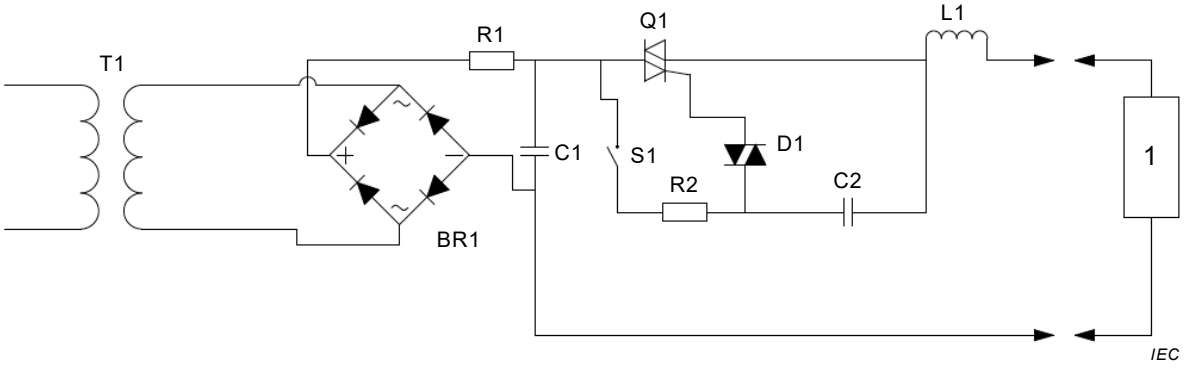


Figure H.2 – Current spikes before I_{peak} are ignored



Key

1	Lamp
BR1	Rectifier – suitable for voltage and current
C1	Capacitor > 750 µF and > 4 × lamp capacitance
C2	Capacitor 47 nF
D1	Diac DB3 or equivalent
L1	Inductor to match typical mains line characteristics. See Table H.1
Q1	Triac Q8025R5 or equivalent
R1	Resistor < 1 s / C1
	NOTE Full charging time between tests > 10 s
R2	Resistor 1 kΩ
S1	Switch – suitable for voltage and current
T1	Transformer Isolation – suitable for voltage and current

SOURCE: Adapted from NEMA SSL 7A -2013 Clause 4.5

Figure H.3 – Waveform generator circuit for inrush current

H.2 Specific requirements for dimmable lamps

Under consideration.

Annex I
(normative)

Measurement of displacement factor

I.1 General

The phase-angle (φ_1) of the displacement factor (cos φ_1) of 3.11 shall be measured according to the definition of Clause I.2 and with the measurement requirements of Clause I.3.

I.2 Phase-angle definition

The phase-angle (φ_1) between the fundamental harmonic current (I_1) and the mains-voltage (U_{mains}) is determined as described in Figures I.1 and I.2.

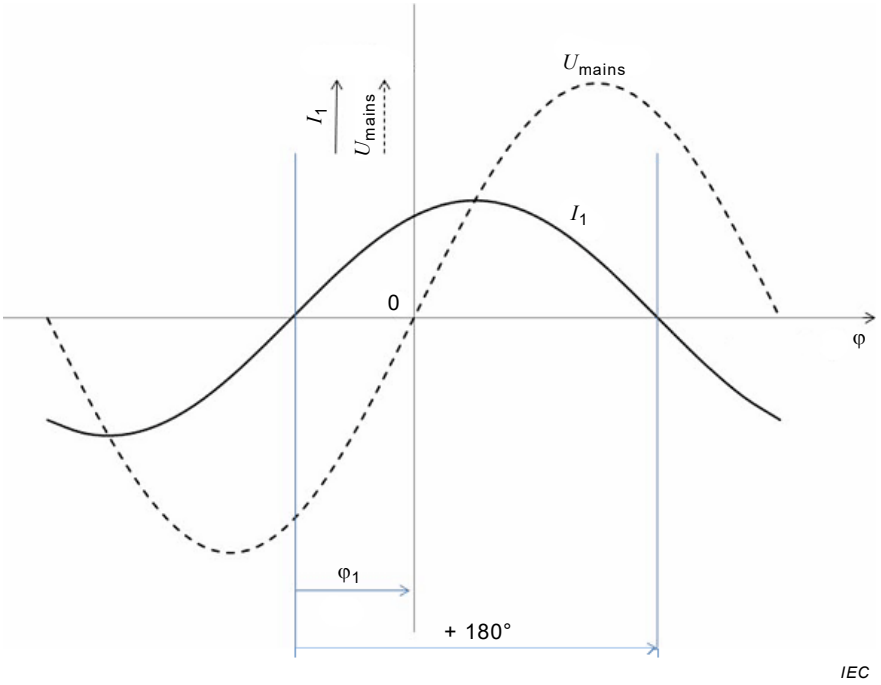


Figure I.1 – Definition of the first harmonic current phase-angle (φ_1) (I_1 leads U_{mains}), $\varphi_1 > 0$)

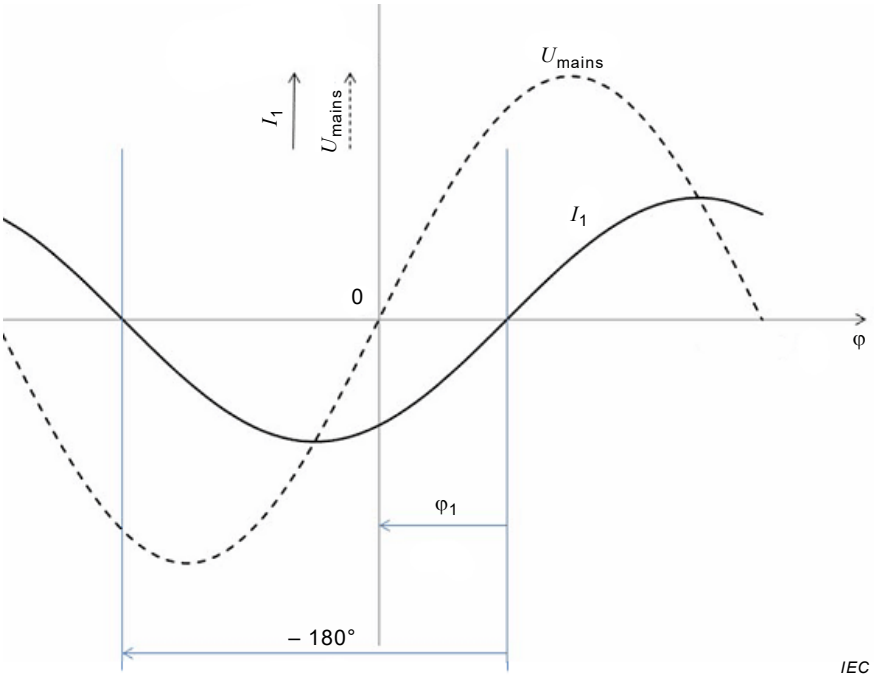


Figure I.2 – Definition of the first harmonic current phase-angle (φ_1) (I_1 lags U_{mains}), $\varphi_1 < 0$)

I.3 Measurements requirements

I.3.1 Measurement circuit and supply source

The measurement circuit and the supply source are defined in Annex A of IEC 61000-3-2:2014.

I.3.2 Requirements for measurement equipment

The requirements for measurement equipment are defined in IEC 61000-4-7.

I.3.3 Test conditions

The test conditions for the measurements of the displacement/phase-angle associated with some types of equipment are given in Clause C.5 of IEC 61000-3-2:2014.

Annex J
(informative)

Explanation of displacement and distortion factors

J.1 General

The metric power factor (λ) is a composite metric and consists of the primary metrics displacement factor ($\kappa_{\text{displacement}}$) and distortion factor ($\kappa_{\text{distortion}}$).

The relation between the composite metric λ and its primary metrics $\kappa_{\text{displacement}}$ and $\kappa_{\text{distortion}}$ is:

$$\lambda = K_{\text{displacement}} \cdot K_{\text{distortion}}$$

with

$$K_{\text{displacement}} = \cos\varphi_1$$

and

$$K_{\text{distortion}} = \frac{1}{\sqrt{1+THD^2}}$$

resulting in

$$\lambda = \frac{\cos\varphi_1}{\sqrt{1+THD^2}}$$

Angle φ_1 is the phase angle between the fundamental of the supply voltage and the fundamental of the mains current. The total harmonic distortion (THD) is quantified by the harmonics of the mains current, according to IEC 61000-3-2. The relation between the individual harmonics of the mains current and the THD is in the below equation:

$$THD = \sqrt{\sum_{n=2}^{40}\left(\frac{I_n}{I_1}\right)^2}$$

Where I_n is the amplitude of the n^{th} harmonic of the mains current.

J.2 Recommended values for displacement factor

No negative effects on the power grid are to be expected from self-ballasted compact fluorescent lamps when complying with the recommendations in Table J.1.

Table J.1 – Recommended values for displacement factor

Metric	P ≤ 2 W	2 W < P≤ 5 W	5 W < P ≤ 25 W	P > 25 W
$\kappa_{\text{displacement}}$ ($\cos\varphi_1$)	No limit	≥ 0,4	≥ 0,7	≥ 0,9
NOTE The values are practical examples and give guidance.				