

BS EN 60929:2011+A1:2016



BSI Standards Publication

AC and/or DC-supplied electronic control gear for tubular fluorescent lamps — Performance requirements

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National foreword

This British Standard is the UK implementation of EN 60929:2011+A1:2016. It is identical to IEC 60929:2011, incorporating amendment 1:2015. It supersedes BS EN 60929:2011, which will be withdrawn on 26 November 2018.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

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A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Date	Text affected
30 April 2016	Implementation of IEC amendment 1:2015 with CENELEC endorsement A1:2016

**AC and/or DC-supplied electronic control gear for tubular fluorescent lamps -
Performance requirements
(IEC 60929:2011)**

Appareillages électroniques alimentés en
courant alternatif et/ou continu pour
lampes tubulaires à fluorescence -
Exigences de performances
(CEI 60929:2011)

Wechsel- und/oder gleichstromversorgte
elektronische Betriebsgeräte für
röhrenförmige Leuchtstofflampen -
Anforderungen an die Arbeitsweise
(IEC 60929:2011)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 34C/963/FDIS, future edition 4 of IEC 60929, prepared by SC 34C, Auxiliaries for lamps, of IEC TC 34, Lamps and related equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60929 on 2011-06-23.

This European Standard supersedes EN 60929:2006 + corr. Dec.2006.

The essential change with respect to EN 60929:2006 + corr. Dec.2006 is the extension to DC supplied control gear and the deletion of the requirements for digital signal control of electronic control gear.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2012-03-23 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2014-06-23 |

NOTE In this standard, the following print types are used:

- Requirements proper: in roman type.
- *Test specifications: in italic type.*
- Explanatory matter: in smaller roman type.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60929:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61000-3-2	NOTE Harmonized as EN 61000-3-2.
IEC 61000-4-30	NOTE Harmonized as EN 61000-4-30.
IEC 61547	NOTE Harmonized as EN 61547

Foreword to amendment A1

The text of document 34C/1114/CDV, future IEC 60929:2011/A1, prepared by SC 34C "Auxiliaries for lamps" of IEC/TC 34 "Lamps and related equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60929:2011/A1:2016.

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publication of an identical national
standard or by endorsement
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standards conflicting with the
document have to be withdrawn

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Endorsement notice

The text of the International Standard IEC 60929:2011/A1:2015 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

A1 The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu **A1**

Publication	Year	Title	EN/HD	Year
IEC 60081	1997	Double-capped fluorescent lamps -	EN 60081	1998
+ A1 (mod)	2000	Performance specifications	+ A1	2002
+ A2	2003		+ A2	2003
+ A3	2005		+ A3	2005
+ A4	2010		+ A4	2010
IEC 60901	1996	Single-capped fluorescent lamps -	EN 60901	1996
+ A1	1997	Performance specifications	+ A1	1997
+ A2	2000		+ corr. October	1997
+ A3	2004		+ A2	2000
+ A4	2007		+ A3	2004
			+ A4	2008
IEC 61347-1 (mod)	2007	Lamp controlgear - Part 1: General and safety requirements	EN 61347-1	2008
IEC 61347-2-3	2000	Lamp controlgear -	EN 61347-2-3	2001
+ A1	2004	Part 2-3: Particular requirements for a.c.	+ corr. July	2003
+ A2	2006	supplied electronic ballasts for fluorescent lamps	+ corr. December	2010
			+ A1	2004
			+ A2	2006
IEC 62386	Series	Digital addressable lighting interface	EN 62386	Series
A1 IEC/TR 62750	2012	Unified fluorescent lamp dimming standard calculations	-	- A1

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INTRODUCTION

This International Standard covers performance requirements for electronic control gear for use on a.c., at 50 Hz or 60 Hz, and/or d.c. supplies up to 1 000 V with operating frequencies deviating from the supply frequency, associated with tubular fluorescent lamps as specified in IEC 60081 and IEC 60901, and other tubular fluorescent lamps for high frequency operation, still to be standardised.

These control gear are intended to operate lamps at various frequencies including high frequencies and at various lamp powers. Attention is drawn to the fact that operating frequencies below 20 kHz may cause audio noise disturbance, whereas frequencies above 50 kHz may increase radio interference problems.

Some lamps may be specifically designed for high-frequency operation on high-frequency control gear. Two starting modes, preheat and non-preheat, are described.

NOTE Lamps, only specified for preheat starting may be operated on other types of circuits. The control gear manufacturer should provide test data which shows satisfactory starting and operation similar as the ones stated in Clause 6.

In order to obtain satisfactory performance of fluorescent lamps and electronic control gears, it is necessary that certain features of their design be properly co-ordinated. It is essential, therefore, that specifications for them be written in terms of measurement made against some common baseline of reference, permanent and reproducible.

These conditions may be fulfilled by reference ballasts. Moreover, the testing of control gear for fluorescent lamps will, in general, be made with reference lamps and, in particular, by comparing results obtained on such lamps with control gear to be tested and with reference ballast.

Whereas the reference ballast for frequencies of 50 Hz or 60 Hz is a self-inductive coil, the high-frequency reference ballast is a resistor because of its independence of frequency and the lack of influence of parasitic capacitance.

AC and/or DC-SUPPLIED ELECTRONIC CONTROL GEAR FOR TUBULAR FLUORESCENT LAMPS – PERFORMANCE REQUIREMENTS

1 Scope

This international Standard specifies performance requirements for electronic control gear for use on a.c. at 50 Hz or 60 Hz and/or d.c. supplies, both up to 1 000 V, with operating frequencies deviating from the supply frequency, associated with fluorescent lamps as specified in IEC 60081 and IEC 60901, and other fluorescent lamps for high-frequency operation.

NOTE 1 Tests in this standard are type tests. Requirements for testing individual control gear during production are not included.

NOTE 2 There are regional standards regarding the regulation of mains current harmonics and immunity for end-products like luminaires and independent control gear. In a luminaire, the control gear is dominant in this respect. Control gear, together with other components, should comply with these standards.

 NOTE 3 Requirements for the digital addressable lighting interface of electronic control gear are given in IEC 62386. 

2 Normative references

The following referenced documents are indispensable for the application 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 60081:1997, *Double-capped fluorescent lamps – Performance specifications*
Amendment 1(2000)
Amendment 2 (2003)
Amendment 3 (2005)
Amendment 4 (2010)

IEC 60901:1996, *Single-capped fluorescent lamps – Performance specifications*
Amendment 1(1997)
Amendment 2 (2000)
Amendment 3 (2004)
Amendment 4 (2007)

IEC 61347-1:2007, *Lamp controlgear – Part 1: General and safety requirements*
Amendment 1(2010)¹

IEC 61347-2-3:2000, *Lamp controlgear – Part 2-3: Particular requirements for a.c. supplied electronic ballasts for fluorescent lamps*
Amendment 1(2004)
Amendment 2 (2006)

IEC 62386 (all parts), *Digital addressable lighting*

 IEC TR 62750:2012, *Unified fluorescent lamp dimming standard calculations* 

¹ There exists a consolidated edition 2.1 (2010) that comprises IEC 61347-1:2007 and its Amendment 1 (2010)

3 Terms and definitions

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

3.1

starting aid

a conductive strip affixed to the outer surface of a lamp, or a conductive plate which is spaced within an appropriate distance from the lamp

A starting aid is usually connected to earth potential, and can only be effective when it has an adequate potential difference from one end of the lamp.

3.2

ballast lumen factor

blf

ratio of the luminous flux of the lamp when the ballast under test is operated at its rated voltage, to the luminous flux of the same lamp operated with the appropriate reference ballast supplied at its rated voltage and frequency

3.3

reference ballast

special ballast, either inductive for lamps for operation on a.c. mains frequencies, or resistive for lamps for operation on high frequency

It is designed for the purpose of providing comparison standards for use in testing ballasts, for the selection of reference lamps and for testing regular production lamps under standardised conditions. It is essentially characterised by the fact that, at its rated frequency, it has a stable voltage/current ratio which is relatively uninfluenced by variations in current, temperature and magnetic surroundings, as outlined in this standard.

[IEC 60050-845:1987, 845-08-36, modified]

3.4

reference lamp

lamp selected for testing control gear which, when associated with a reference ballast, has electrical characteristics which are close to the nominal values as stated in the relevant lamp standard

NOTE Specified conditions are given in Annex C.

3.5

total circuit power

total power dissipated by control gear and lamp in combination, at rated voltage and frequency of the control gear

3.6

circuit power factor

λ

power factor of the combination of a control gear and the lamp or lamps for which the control gear is designed

3.7

preheat starting

type of circuit in which the lamp electrodes are brought to emission temperature before the lamp actually ignites

3.8

non-preheat starting

type of circuit which utilises a high open-circuit voltage causing secondary electron emission from electrodes

3.9

electronic control gear life time

declared average life time at which 90 % of the electronic control gears are still operating

NOTE 1 In the context of life time, an electronic control gear is “operating” if it still fulfils its intended functions.

NOTE 2 The manufacturer apply suitable methods, e.g. statistical calculation and/or reliability testing.

3.10

ambient temperature

t_a

temperature range of the air surrounding the electronic control gear declared by the manufacturer to indicate the normal operating temperature range for the electronic control gear

NOTE 1 The lifetime of the electronic control gear is given at the ambient temperature t_a ; for ease of measurement, also the corresponding temperature of the t_c point is given.

NOTE 2 The measurement test condition for the ambient temperature assigned to the DUT should be in accordance to Annex D of IEC 61347-1 at the rated voltage.

4 General notes on tests

4.1 Tests according to this standard are type tests.

NOTE The requirements and tolerances permitted by this standard are based on the testing of a type test sample submitted by the manufacturer for that purpose. In principle this type test sample should consist of units having characteristics typical of the manufacturer's production and be as close to the production centre point values as possible.

It may be expected with the tolerances given in this standard that products manufactured in accordance with the type test sample will ensure compliance with the standard for the majority of the production. However, due to the production spread, it is inevitable that there will sometimes be products outside the specified tolerances. For guidance on sampling plans and procedures for inspection by attributes, see IEC 60410.

4.2 The tests are carried out in the order of the clauses, unless otherwise specified.

4.3 One control gear is submitted to all tests, unless otherwise stated.

4.4 In general, all tests are made on each type of control gear or where a power range of similar control gear is involved, for each rated power in the range or on a representative selection from the range as agreed with the manufacturer.

4.5 The tests are made under the conditions specified in Annex A. Lamp data sheets not published in an IEC publication shall be made available by the lamp manufacturer.

4.6 All control gear specified in this standard shall comply with the requirements of IEC 61347-2-3.

4.7 Attention is drawn to lamp performance standards which contain “information for control gear design”; this should be followed for proper lamp operation; however, this standard does not require the testing of lamp performance as part of the type test approval for control gear.

5 Marking

5.1 Mandatory marking

Electronic control gear shall be clearly marked with the following mandatory marking as applicable.

- a) Circuit power factor, e.g. 0,85.

If the power factor is less than 0,95 capacitive, it shall be followed by the letter C, e.g. 0,85 C.

The following marking shall also be added, if appropriate:

- b) The symbol $\overline{Z}$ which indicates that the control gear is designed to comply with the conditions for audio-frequency impedance.

5.2 Additional mandatory Information

In addition to the above mandatory markings, the following information shall either be given on the control gear or be made available in the manufacturer's catalogue or the like.

- a) a clear indication regarding the type of starting, viz. preheat or non-preheat;
- b) indication whether a control gear needs a starting aid;
- c) ballast lumen factor if different from $1 \pm 0,05$;
- d) life time of the control gear is linked to the ambient temperature and the measured temperature on the reference point t_c .

For the information, the format of Table 1 has to be used. Corresponding to the fixed ambient temperature values 40 °C, 50 °C and 60 °C, the values of the temperature measured on the reference point t_c and the declared life time have to be inserted by the manufacturer. The value of the temperature of the t_c point given in the table shall never exceed the t_c (IEC 61347-1), therefore, in that case, the column where the temperature of t_c -point exceeds t_c will be left blank; but at least the column with ambient temperature 40 °C shall always be filled.

Table 1 – Control gear life time information

Ambient temperature	40 °C	50 °C	60 °C
Temperature measured on the reference point t_c	XX ^a	XX ^a	XX ^a
Life time	XX XXX ^b	XX XXX ^b	XX XXX ^b
^a "°C" values declared by the control gear manufacturer			
^b "h" values declared by the control gear manufacturer			

NOTE 1 Additional information from the control gear manufacturer to the ambient temperature and life time given in Table 1 is allowed.

NOTE 2 For multi power control gear the most adverse load condition or a table for each lamp-control gear combination should be given.

5.3 Non-mandatory information

Non-mandatory information which may be made available by the manufacturer:

- a) rated output frequency at rated voltage, with and without lamp operating;
- b) limits of the ambient temperature range within which the control gear will operate satisfactorily at the declared voltage (range);
- c) total circuit power.

6 General statement

It may be expected that control gear complying with this standard, when associated with lamps which comply with IEC 60081 or IEC 60901 or other fluorescent lamps for high-frequency operation, will provide satisfactory starting of the lamp at an air temperature immediately around the lamp between 10 °C and 35 °C and operation between 10 °C and 50 °C at voltages within 92 % and 106 % of the rated voltage.

NOTE 1 The electrical characteristics as given on the lamp data sheets of IEC 60081 and IEC 60901, and applying to operation on a reference control gear at rated voltage with a frequency of 50 Hz or 60 Hz, may deviate when operating on a high frequency control gear and the conditions of item b) of 5.3 above.

NOTE 2 In some regions, there are laws on EMC for luminaires. The control gear is also contributing to this EMC behaviour. See Bibliography for reference.

7 Starting conditions

7.1 General

Control gear shall start lamps without adversely affecting the performance of the lamp when operated according to intended use. An explanation of the starting conditions is given in Annex D.

Compliance is checked by the tests according to 7.2 to 7.4, as appropriate, with the control gear operating at any supply voltage between 92 % and 106 % of its rated value.

7.2 Conditions for control gear with preheating

7.2.1 General

Control gear shall be tested according to the following requirements and in line with the requirements of Clause A.3. The same requirements for preheating also apply to controllable control gear at starting in any dimming position.

The lamp data sheet provides one substitution resistor $R_{\text{sub}(\text{min})}$ which is used with the control gear in order to test its capability to produce the minimum energy according to the lamp data sheet. If the control gear does not provide at least the minimum energy, it has failed. The maximum energy line has to be tested with another substitution resistor $R_{\text{sub}(\text{max})}$ which corresponds to the upper energy. If the control gear generates too high energy, it has failed. The value of the second resistor is also given on the lamp data sheet. In cases where no value is given, preliminary values may be obtained from the lamp manufacturer.

7.2.2 Preheat energy

The control gear shall deliver at least the minimum total heating energy E_{min} at t_1 according to the time/energy limits on the relevant lamp data sheets (see Figure 1). Within the interval (t_1 , t_2) the total heating energy shall be between E_{min} and E_{max} according to the relevant lamp data sheet (see Figure 1).

The maximum heating energy shall not exceed the limits specified on the relevant lamp data sheet at any time before t_2 . This does not apply in the interval (t_1 , t_2), if $t_2 - t_1 < 0,1$ s.

The absolute minimum preheat time shall be 0,4 s unless otherwise specified on the relevant lamp data sheet.

In order to prevent arcing, the voltage supplied to the substitution resistor should remain below 11 V r.m.s., for $E < E_{\text{min}}$.

If a lamp data sheet does not give any energy data for preheating, and the preheat current requirements are not applicable, the lamp manufacturer shall provide appropriate preheat data.

Compliance with the requirements for the cathode preheat current can be tested as follows.

With a non-inductive substitution resistor of the value specified on the relevant lamp data sheet, substituted for each lamp cathode, the control gear shall deliver a minimum and maximum total heating current according to the time/current limits specified on the relevant lamp data sheet. The minimum preheat current i_k is defined as

$$i_k = \sqrt{\frac{a}{t_e} + i_m^2}$$

where

- a is the constant ($A^2 s$) for a specific cathode type;
- i_m is the absolute minimum value of the effective heating current (A) to achieve emission, if application time is of sufficiently long duration (e.g. ≥ 30 s from cold);
- t_e is the time (s) to emission.

NOTE Emission time less than 0,4 s is normally not acceptable because experience has shown that satisfactory cathode preheating is not always achievable in practice.

Values for a and i_m are given on the lamp data sheet.

Measurements are conducted with a non-inductive substitution resistor for testing cathode preheat requirements of the value specified on the relevant lamp data sheet, substituted for each lamp cathode, also in case of two or more lamps simultaneously operated.

7.2.3 Open-circuit voltage

During the preheat period, the open-circuit voltage between any pair of substitution resistors shall not exceed the maximum value specified on the lamp data sheet, including the DC-offset according to Clause E.4 of IEC 60081, and Clause D.3 of IEC 60901. After the preheat period, it shall be, or rise to a value, not less than the minimum value equal to the ignition voltage as specified on the lamp data sheet.

Where two or more lamps are operated in series or parallel circuits, each position is measured in turn. The positions where not to measure are equipped with reference lamps, the position where to measure is equipped with a pair of substitution resistors for testing open-circuit voltage.

The open-circuit voltage is measured between the substitution resistors and shall comply in all cases with the value specified on the relevant lamp data sheet for one lamp.

Measurement is made with an oscilloscope. Measurements are conducted with a non-inductive substitution resistor for testing open-circuit voltages as specified on the relevant lamp data sheet.

The control gear manufacturer provides on request the value of the cathode substitution resistor within the specified range which results in the lowest open-circuit voltage for ignition.

7.3 Conditions for control gear without preheating

7.3.1 General

Control gear in accordance with definition 3.8 shall be so designed that the cumulated glow discharge periods during starting do not exceed 100 ms when measured with a reference lamp and without any earthed metal parts close by which might act as a starting aid. The glow discharge period is deemed to have finished if the lamp current is at least 80 % of the rated lamp current.

A control gear is deemed to conform with the above requirements when the following conditions are fulfilled.

7.3.2 Open-circuit voltage

Measurement is made with an oscilloscope. With a non-inductive substitution resistor R_C of the value specified on the relevant lamp data sheet, substituted for each lamp cathode (see Figure 2a), the open-circuit voltage shall comply with the value specified on the relevant lamp data sheet.

Where two or more lamps are operated in series or parallel, each position is measured in turn. The positions where not to measure are equipped with reference lamps, the position where to measure is equipped with a pair of cathode substitution resistors.

The open-circuit voltage is measured between the substitution resistors and shall comply in all cases with the value specified on the relevant lamp data sheet for one lamp.

NOTE In the case of additional cathode heating during the starting process, lower values may be sufficient provided the glow discharge period does not exceed 100 ms.

7.3.3 Control gear impedance test

With a non-inductive lamp substitution resistor R_L of the value specified on the relevant lamp data sheet, substituted for the lamp and a non-inductive resistor R_C of the value specified on the relevant lamp data sheet, substituted for each lamp cathode, (see Figure 2b), and at 92 % of the rated voltage, the control gear shall deliver a current not less than the minimum value specified on that data sheet.

7.3.4 Cathode current

Control gear of the non-preheat start type may supply some cathode heating during the starting process. In Figure 2c, the cathode (heating) current is measured in M1 and M2 as the lower current.

The cathode current, if any, shall not exceed the maximum value specified on the relevant lamp data sheet.

The measurement is carried out with substitution resistors R_i (see Figure 2c), the value of which is calculated as follows:

$$R_i = \frac{11V}{2,1 \times I_r}$$

where I_r is the rated value of the lamp operating current.

This requirement does also apply to electronic control gear with output terminals for more than one lamp. The positions where not to measure are equipped with reference lamps, the position where to measure is equipped as shown in Figure 2c.

7.4 Starting aid and distances

Lamps operated with electronic control gear complying with this standard may require a starting aid as specified in IEC 60081 or 60901. The open-circuit voltage and voltage to starting aid, during preheat and starting, shall be within the limits specified in the information for control gear design on the relevant lamp data sheet.

8 Operating conditions

8.1 Ballast lumen factor

At rated voltage and ambient temperature of $(25 \pm 2) ^\circ\text{C}$, the ballast lumen factor shall not be less than 95 % of the value declared by the manufacturer or not less than 0,95 if not declared.

NOTE The luminous flux of a lamp is usually measured with an integrating photometer. For ratio measurements, a suitable luxmeter is sufficient as there is close relationship between flux and luminous intensity at a fixed point.

If the declared lumen factor of the control gear is less than 0,9, evidence shall be given that the performance of lamps operated on that control gear is not impaired.

The requirements of Subclause 8.3 shall be complied.

8.2 Total circuit power

At rated voltage, the total circuit power shall be not more than 110 % of the value declared by the manufacturer, when the control gear is operated with (a) reference lamp(s).

8.3 Requirements for dimming

A1 8.3.1 Heating of the lamp cathodes

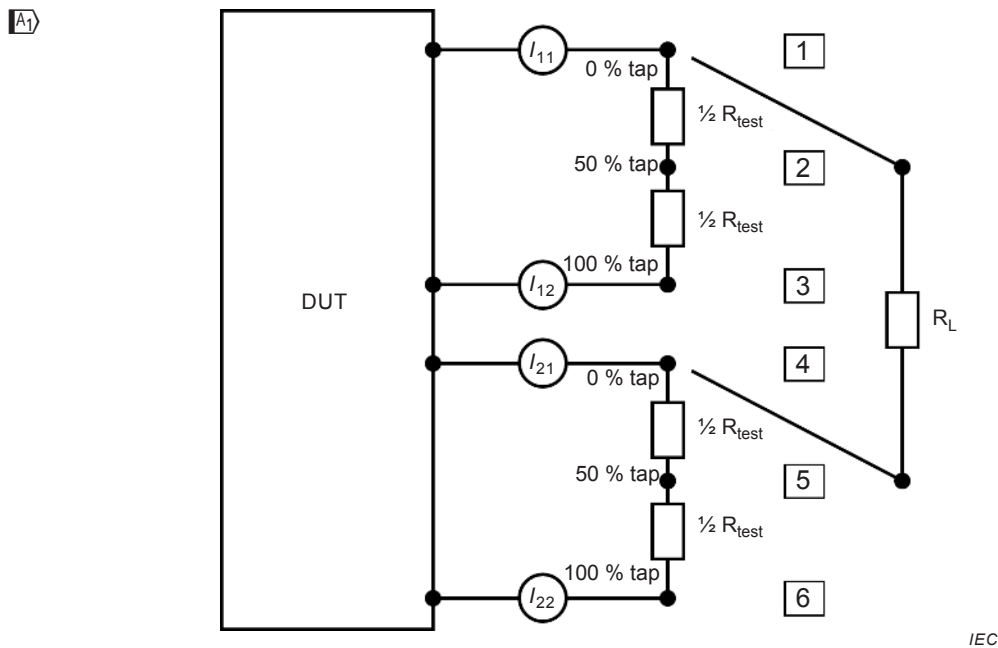
8.3.1.1 General

Fluorescent lamps operated in dimming mode (to reduce luminous flux by reducing discharge current) need their cathodes adequately heated by the electronic control gear. It has been found that measuring the currents through the two lead-in wires to the cathode and calculating the sum of the squares (SoS) of these two currents as a function of the discharge current can estimate the cathode heating. Alternatively, it has also been found that it is possible to estimate cathode heating by measuring the voltage applied across the cathode (CV) while dimming. The heating requirements are described in IEC TR 62750:2012.

The control gear is tested at lamp discharge currents (dim levels) of I_{Dmin} , I_{D30} and I_{D60} . The measurements are conducted with substitution resistors for the cathodes (R_{test}) and for the discharge, the latter dependent on the dim level (R_L , having nominal values of R_{L10Max} and R_{L10Min} as well as R_{L30} and R_{L60}). The lamp substitution resistor values shall be taken from the IEC lamp data sheets. Take care that the substitution resistors are capable of carrying the current, voltage and power occurring in the circuit.

All positions that on control gear that would be connected to a lamp shall instead be connected to substitution resistors. Wherever in this procedure a reference is made to "lamp", it is intended to mean a set of substitution resistors that represent a lamp.

The hot spot location may vary on the lamp cathode during operation. This effect is simulated in the test by connecting the cathode substitution resistors in different circuit configurations. For this purpose, taps in the middle and at the ends of the cathode substitution resistor networks are equipped with switches (0 – 50 – 100 method), which allow all possible combinations of connection to be realized. The fundamental test set-up is shown in Figure 3. **A1**



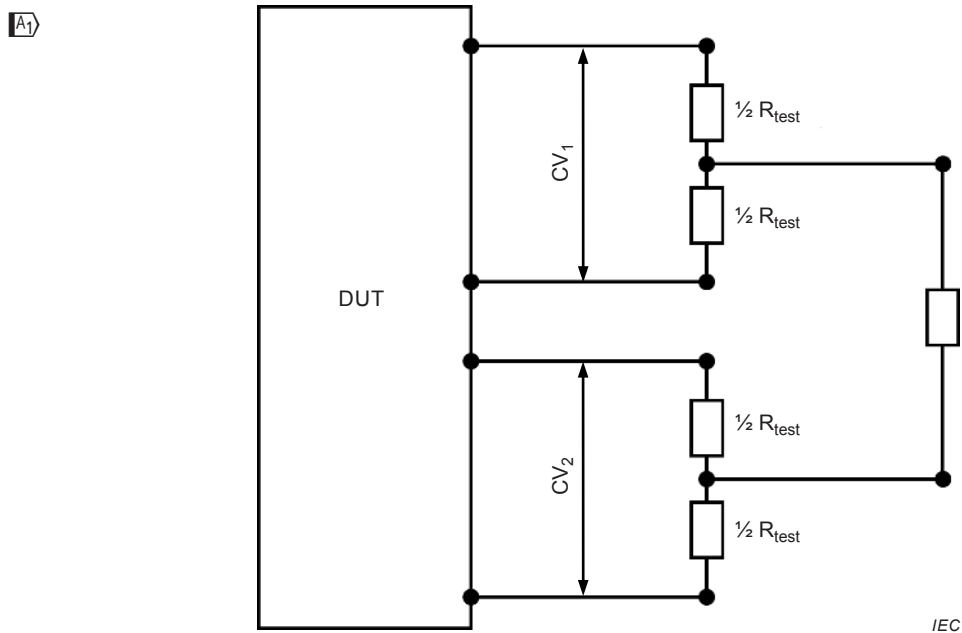
Key

DUT	control gear device under test
R_L	lamp substitution resistor
I_{nn}	measured current
1...6	switch positions

Figure 3 – Fundamental test set-up for the SoS-test

In cases where the discharge current is much smaller than the auxiliary heating current, i.e. for the upper and lower heating limits at very low discharge current values (= 10 % of the test current), the cathode lead wire currents are found to be nearly equal.

Thus, for the CV-test, only the centre tap position is required for testing. The CV-test setup shown in Figure 4 is a simplified version of the SoS-test circuit. ^(A1)



Key

DUT control gear device under test
 R_L lamp substitution resistor
 CV_1 and CV_2 measured cathode voltages

Figure 4 – Fundamental test set-up for the CV-test

8.3.1.2 Basic test conditions

Due to the lamps being operated at high frequency, the test set-up with substitution resistors should be comparable to the set-up of the real luminaire. Relevant examples are given in Annex F.

Check the suitability of the lamp and cathode substitution resistor set-up at high frequencies for the frequency range used by the control gear.

Maintain the maximum contact resistances, parasitic inductances and coupling capacitances of the cathode circuits in test with the lamp dummy inserted (see Table 2).

Table 2 – Maximum permitted parasitic inductances, capacitances and contact resistances of a test circuit set-up according to Figures 3 and 4

Parameter	Maximum value
L (for each heating circuit)	2 μ H
R (contact resistances for each heating circuit)	100 n Ω
C_1 (from heating circuit to heating circuit)	20 pF
C_2 (heating circuit to earth)	150 pF

The values of L , R , C_1 , and C_2 are measured at the lamp wires next to the electronic control gear's lamp terminals. For this purpose, instead of a lamp, the cathode substitution resistors R_{test} are inserted in the test set-up. **A1**

A1 Output circuits of electronic control gears, designed for multi-lamp operation, are each tested separately. The output circuits not involved in the test shall be connected to the substitution resistors with equal value to the output circuit which is under test. The variations of the cathode terminal switch take place only with the output circuit under test. For the other circuit(s), the switch is connected to the middle position (positions 2 and 5 in Figure 3).

Lamp substitution circuits, supplied from multi-lamp electronic control gears (i.e. gears which operate more than one lamp simultaneously), shall each be wired separately when connected with the DUT (device under test). This means that each electrode substitution resistor is equipped with 2 cables, leading to the terminal of the electronic control gear and having an immediate connection according to the electrical circuit design. Each pair of one electrode substitution resistor's cables shall be installed together.

For wiring of the test set-up, H05V-U cables (or equivalent) shall be used. When designing the wiring layout, the values of the parasitic losses shall be in the same order for all lamp circuits. This can be achieved only if the wiring of the lamp circuits is comparable in distances, lengths, etc. and each pair of lamp circuits is located symmetrical to the axis of the device.

Check the suitability of the instruments, i.e. the tolerance at the range of expected frequency and amplitude.

For the r.m.s. current measurement, the measurement period shall be an integer multiple of the mains half wave period.

If the electronic control gear allows operation of different lamps with varying operating parameters, then safeguard with suitable means so that during operation at the lamp dummy the correct choice of parameters for that lamp(s) has been made.

Compliance with the cathode heating conditions shall be tested with each alternative lamp type.

To ensure that control gear reaches the operating state (to "start" the substitution resistors), the procedure may be modified and/or a special prepared control gear may be used, provided the cathode heating would be the same as a production control gear.

8.3.1.3 General test sequence

Table 3 gives an overview of the values for the different dimming levels which shall be measured and controlled. If an electronic control gear is designed for more than one lamp, then the same measurements and tests shall be conducted as for Lamp 1. Table 3 includes also the switching position for the simulation of the arc spot and the correlation to the test method (CV or SoS). **A1**

Table 3 – Dimming levels and measured values

Subclause	Discharge current	Lamp substitution resistor	Cathode substitution value	Arc spot simulation switch position	Values to be checked
8.3.1.4.2.2	I_{10}	R_{L10min}	R_{test3}	2-5	$CV_1 \geq CV_{min}$, etc
8.3.1.4.2.3	I_{10}	R_{L10min}	R_{test2}	2-5	$CV_1 \leq CV_{max}$, $I_{11} \leq I_{LHmax}$, etc
8.3.1.4.2.4	I_{10}	R_{L10max}	R_{test3}	2-5	$CV_1 \geq CV_{min}$, etc
8.3.1.4.2.5	I_{10}	R_{L10max}	R_{test2}	2-5	$CV_1 \leq CV_{max}$, $I_{11} \leq I_{LHmax}$, etc
8.3.1.4.3.2	I_{30}	R_{L30}	R_{test1}	2-5	$I_{11}^2 + I_{21}^2 \geq SoS_{30}$, etc
8.3.1.4.3.3	I_{30}	R_{L30}	R_{test2}	2-5	$CV_1 \leq CV_{max}$, $I_{11} \leq I_{LHmax}$, etc
8.3.1.4.4.2	I_{60}	R_{L60}	R_{test1}	2-5	$I_{11}^2 + I_{21}^2 \geq SoS_{30}$, etc
8.3.1.4.4.3	I_{60}	R_{L60}	R_{test2}	2-5	$CV_1 \leq CV_{max}$, $I_{11} \leq I_{LHmax}$, etc
8.3.1.5.2	I_{30}	R_{L30}	R_{test1}	1-4	$I_{11}^2 + I_{21}^2 \geq SoS_{30}$, etc
8.3.1.5.3	I_{30}	R_{L30}	R_{test1}	3-6	$I_{11}^2 + I_{21}^2 \geq SoS_{30}$, etc
8.3.1.5.4	I_{30}	R_{L30}	R_{test1}	1-6	$I_{11}^2 + I_{21}^2 \geq SoS_{30}$, etc
8.3.1.5.5	I_{30}	R_{L30}	R_{test1}	3-4	$I_{11}^2 + I_{21}^2 \geq SoS_{30}$, etc

8.3.1.4 Test sequence “arc attachment – middle”

8.3.1.4.1 General

All tests in 8.3.1.4 are performed with cathode tap 50 % – Figure 3 (equivalent switch positions 2 and 5) or Figure 4.

Values of the lamp and cathode substitution resistors, test current and limit values shall be those from the relevant IEC lamp data sheets.

8.3.1.4.2 Dim level I_{Dmin}

8.3.1.4.2.1 General

The control terminal of the electronic control gear is used to adjust the lamp discharge current I_D (current through the lamp substitution resistors) to I_{Dmin} as indicated on the relevant IEC lamp datasheet.

8.3.1.4.2.2 Minimum heating for minimum lamp substitution resistor R_{L10min}

This test shall be carried out with a lamp substitution resistor value R_{L10min} and filament substitution resistor value R_{test3} .

Measure CV_1 and CV_2 , and then compare the achieved values with the limit values according to the formulas:

$$CV_1 \geq CV_{min} \text{ and } CV_2 \geq CV_{min}$$

Electronic control gear, operating more than one lamp:

Repeat the measurement procedure of CV_1 and CV_2 for each other lamp of multi lamp control gear. **A1**