SRI LANKA STANDARD 1239 Part 2: 2011
IEC 60929: 2011

SPECIFICATION FOR

AC AND/OR DC- SUPPLIED ELECTRONIC BALLAST FOR TUBULAR FLUORESCENT LAMPS

PART 2: PERFORMANCE REQUIREMENTS
(FIRST REVISION)

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard

SPECIFICATION FOR AC AND/OR DC- SUPPLIED ELECTRONIC BALLAST FOR TUBULAR FLUORESCENT LAMPS PART 2: PERFORMANCE REQUIREMENTS

(FIRST REVISION)

SLS 1239 Part 2: 2011
IEC 60929: 2011

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SRI LANKA STANDARDS INSTITUTION
No. 17, Victoria Place,
Elvitigala Mawatha,
Colombo – 08,
SRI LANKA.

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

Sri Lanka Standard
SPECIFICATION FOR AC AND/OR DC- SUPPLIED ELECTRONIC BALLAST FOR TUBULAR FLUORESCENT LAMPS PART 2: PERFORMANCE REQUIREMENTS

NATIONAL FOREWORD

This standard was approved by the Sectoral Committee on Electrical Appliances and Accessories and was authorized for adoption and publication as a Sri Lanka Standard by the Council of Sri Lanka Standards Institution on 2011-07-08

SLS 1239 Part 1 and **SLS 1239 Part 2** supersede **SLS 1239:** 2002 A.C. supplied electronic ballasts for tubular fluorescent lamps –Performance requirements.

SLS 1239 Specification for AC and DC- supplied electronic ballast for tubular fluorescent lamps, is published in two parts as follows:

Part 1 Safety requirements
Part 2 Performance requirements

This part of the standard supersedes **SLS 1239: 2002** and is identical with **IEC 60929: 2011,** Edition 4.0 2011-05 AC and/or DC-.supplied electronic control gear for tubular fluorescent lamps-Performance requirements, published by the International Electrotechnical Commission (IEC).

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the results of a test or an analysis shall be rounded off in accordance with **SLS 102**. The number of significant places to be retained in the rounded off value shall be the same as that of the specified value in the standard.

Terminology and conventions

The text of the International Standard has been accepted as suitable for publication without deviation, as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards; attention is therefore drawn to the following:

a) Wherever the words “International Standard” appear referring to this standard they should be interpreted as “Sri Lanka Standard”.

b) Wherever the page numbers are quoted they are page number of IEC standard.

c) The comma has been used as a decimal marker. In Sri Lanka Standard it is the current practices to use a full point on the base line as a decimal marker.

CROSS REFERENCES

CROSS REFERENCES

International Standards	Corresponding Sri Lanka Standards
IEC 60081 Double-capped fluorescent lamps –Performance specifications	SLS 566 Tubular fluorescent lamps
IEC 60901 Single-capped fluorescent lamps – Performance specifications	SLS 1232 Single-capped fluorescent lamps – Part 1: Performance requirements
IEC 60929 AC and /or DC-supplied electronic control gear for tubular fluorescent lamps –Performance requirements	SLS 1239 AC and/or DC- supplied electronic ballast for tubular fluorescent lamps- Part 2: Performance requirements
IEC 61347-1 Lamps control gear- Part 1: General and safety requirements	SLS IEC 61347-1: Lamps control gear- Part 1: General and safety requirements
IEC 61347-2-3 Lamp controgear –Part 2-3 Particular requirements for a.c. supplied electronic ballasts for fluorescent lamps	SLS 1239 AC and/or DC- supplied electronic ballast for tubular fluorescent lamps- Part 2: Safety requirements

NOTE : *Corresponding Sri Lanka Standards for other international standard listed under references in IEC 60629 are not available.*

SLS 1239-2 : 2011
IEC 60929

Edition 4.0 2011-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Appareillages électroniques alimentés en courant alternatif et/ou continu pour lampes tubulaires à fluorescence – Exigences de performances

IEC 60929:2011

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Email: csc@iec.ch
Tél.: +41 22 919 02 11
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AC and/or DC-supplied electronic control gear for tubular fluorescent lamps – Performance requirements

Appareillages électroniques alimentés en courant alternatif et/ou continu pour lampes tubulaires à fluorescence – Exigences de performances

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60929 has been prepared by subcommittee 34C: Auxiliaries for lamps, of IEC technical committee 34: Lamps and related equipment.

This fourth edition cancels and replaces the third edition published in 2006, IEC 60925 published in 1989, its Amendment 1 (1996) and its Amendment 2 (2001). This fourth edition constitutes a technical revision. The essential change with respect to the third edition is the extension to DC supplied control gear and the deletion of the requirements for digital signal control of electronic control gear.

The text of this standard is based on the following documents:

FDIS	Report on voting
34C/963/FDIS	34C/976/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

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.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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.

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*

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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 it 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 ⧾ 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 ± 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 $R_{sub(min)}$ 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 $R_{sub(max)}$ 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 $E < E_{min}$.

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:

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

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 ± 2) °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

8.3.1 Lamp cathode heating

When operating lamps at lower lumen levels than the optimum design point, care shall be taken that the control gear provides cathode heating continuously to the lamp(s) so that the lamp life is not degraded.

8.3.2 Control interfaces

Requirements are specified in Annex E of this standard and for digital addressable lighting interface in IEC 62386 series. Also the manufacturer’s specification shall be followed.

There are presently also other non-standardised interfaces which can lead to problems of interchangeability between interfaces. These have to be tested according to the manufacturer’s specifications.

8.4 Current limitation

Unless otherwise specified on the relevant lamp data sheet, the control gear at rated voltage shall limit the current delivered to a reference lamp to a value not exceeding 115 % of that delivered to the same lamp when it is operated with a reference control gear.

9 Circuit power factor

For the a.c. supplied electronic control gear, the measured circuit power factor shall not differ from the marked value by more than 0,05 when the control gear is operated with one or more reference lamp(s) and the whole combination is supplied at its rated voltage and frequency.

For controllable control gear, the power factor is measured at full power.

10 Supply current

At rated voltage, the supply current shall not differ by more than ± 10 % from the value marked on the control gear or declared in the manufacturer's literature, when the control gear is operated with (a) reference lamp(s).

For controllable control gear, the supply current shall not exceed the value marked on the control gear according to IEC 61347-1 by more than 10 % in any dimming position. The scan over all dimming positions can be replaced, if the value of the maximum supply current and the corresponding dimming positions are provided.

11 Maximum current in any lead to a cathode

In normal operation at any supply voltage between 92 % and 106 % of the rated value, the current flowing in any one of the cathode terminations shall not exceed the value given on the relevant lamp data sheet.

The measurement is made with an oscilloscope or another suitable device. The measurements shall be made with a reference lamp at all contacts to the cathodes.

12 Lamp operating current waveform

The control gear shall be operated with a reference lamp or lamps at its rated voltage. After lamp stabilisation, the waveform of the lamp current shall comply with the following conditions.

a) For a.c. supplied electronic control gear:

   In every successive half-cycle, the enveloping wave of the lamp current shall not differ by more than 4 % at the same time after phase zero passage of the mains supply voltage.

   NOTE The purpose of this requirement is to avoid flicker due to the inconsistency of the wave shape of the enveloping wave from half mains cycle to half mains cycle.

b) The maximum ratio of peak value to r.m.s. value of the lamp current shall not exceed 1,7.

   NOTE In Japan, a crest factor of 2,1 maximum is permitted, when additional cathode heating is applied.

13 Impedance at audio frequencies

Control gears marked with the audio-frequency symbol (see 5.1) are tested in accordance with Clause A.2.

For every signal frequency between 400 Hz and 2 000 Hz, the impedance of the control gear when operated with a reference lamp supplied at its rated voltage and frequency shall be inductive in characteristic. Its impedance in ohms shall be at least equal in value to the resistance of the resistor which would dissipate the same power as the lamp/control gear combination in question when it is supplied at its rated voltage and frequency. The control gear impedance is measured with a signal voltage equal to 3,5 % of the rated supply voltage of the control gear.

Between 250 Hz and 400 Hz, the impedance shall be at least equal to half the minimum value required for frequencies between 400 Hz and 2 000 Hz.

NOTE Radio interference suppressors consisting of capacitors of less than 0,2 μF (total value) which may be incorporated in the control gear may be disconnected for this test.

14 Operational tests for abnormal conditions

14.1 Removal of lamp(s)

During the operation of the control gear at rated voltage +10 % and in association with (an) appropriate lamp(s), the lamp(s) shall be disconnected for 1 h from the control gear without switching off the supply voltage. At the end of this period, the lamp(s) is (are) reconnected and shall start and operate normally. If the lamp(s) does (do) not start, the supply voltage shall be switched off for 1 min and switched on again. After that, the lamp(s) shall start.

14.2 Lamp fails to start

With an appropriate dummy cathode resistor as specified on the relevant data sheet connected in place of each lamp cathode, the control gear shall be operated at rated voltage +10 % for 1 h. At the end of this period, the resistors shall be removed; (an) appropriate lamp(s) is (are) connected and shall start and operate normally. If the lamp(s) does (do) not start, the supply voltage shall be switched off for 1 min and switched on again. After that, the lamp(s) shall start.

14.3 Control gear behaviour close to end of lamp life

It is permitted that the control gear may switch off or reduces the wattage to the lamp according to Subclause 17.3 of IEC 61347-2-3, if the asymmetric voltage reaches a value of 5 V d.c.

15 Endurance

15.1 General

The control gear shall be operated with an appropriate lamp(s) at rated supply voltage. All the earthing connections of the control gear shall be connected to the earth. If the electronic control gear is marked for a range of supply voltage then the supply voltage with the most adverse effect to the temperature of the electronic control gear shall be selected.

Tests are done in sequence with the same control gears.

Dimmable control gear is tested at 100 % power.

15.2 Temperature cycling

The temperature cycling test is descript as followed:

a) Test samples: 5, control gear which were not submitted to other tests

   To avoid control gear with thermal cut-off systems from switching off during the test, the cut-off device shall be disabled, so the control gear remains operating.

b) Temperature range of the test chamber

   - Minimum ambient temperature in the chamber = –20 °C
   - Maximum ambient temperature in the test chamber = + 80 °C

c) Measurement of the input current (after a stabilisation time) of the control gear at 25 °C ± 5 °C.

d) Test routine of 220 cycles

1) Connect the control gear with the mains and the lamp(s) at 25 °C ± 10 °C (maximum load) and place the control gear in a temperature test chamber. The lamp(s) are placed outside of the temperature chamber. The distance between the electronic control gears shall depends on the speed of the airflow and shall allow a homogeneous temperature around all DUT's.
2) With the control gear in off position, decrease the temperature in the test chamber with 10 K/min + 5 K/min to the minimum test temperature.
3) At the minimum temperature level, start after 50 min at –20 °C 10 switching cycles (10 s on / 50 s off).
4) Switch on the control gear.
5) Increase the temperature in the test chamber with 10 K/min + 5 K/min to the maximum test temperature.
6) At the maximum temperature level switch off the control gear after 50 min and start 10 switching cycles (50 s on / 10 s off).
7) Repeat steps 2) to 6) 219 times.

NOTE In Japan, the test chamber with 1 – 15 K/min is applied.

e) Measurement of the input current of the control gear at 25 °C ± 5 °C.

Compliance: After performing this test and after cooling down to room temperature, all control gear shall correctly start and operate an appropriate lamp(s) for 15 min. Accordingly to step e), the input current shall be measured. The maximum allowed tolerance of the input current is ± 10 % compared with the measured input current value under step c).

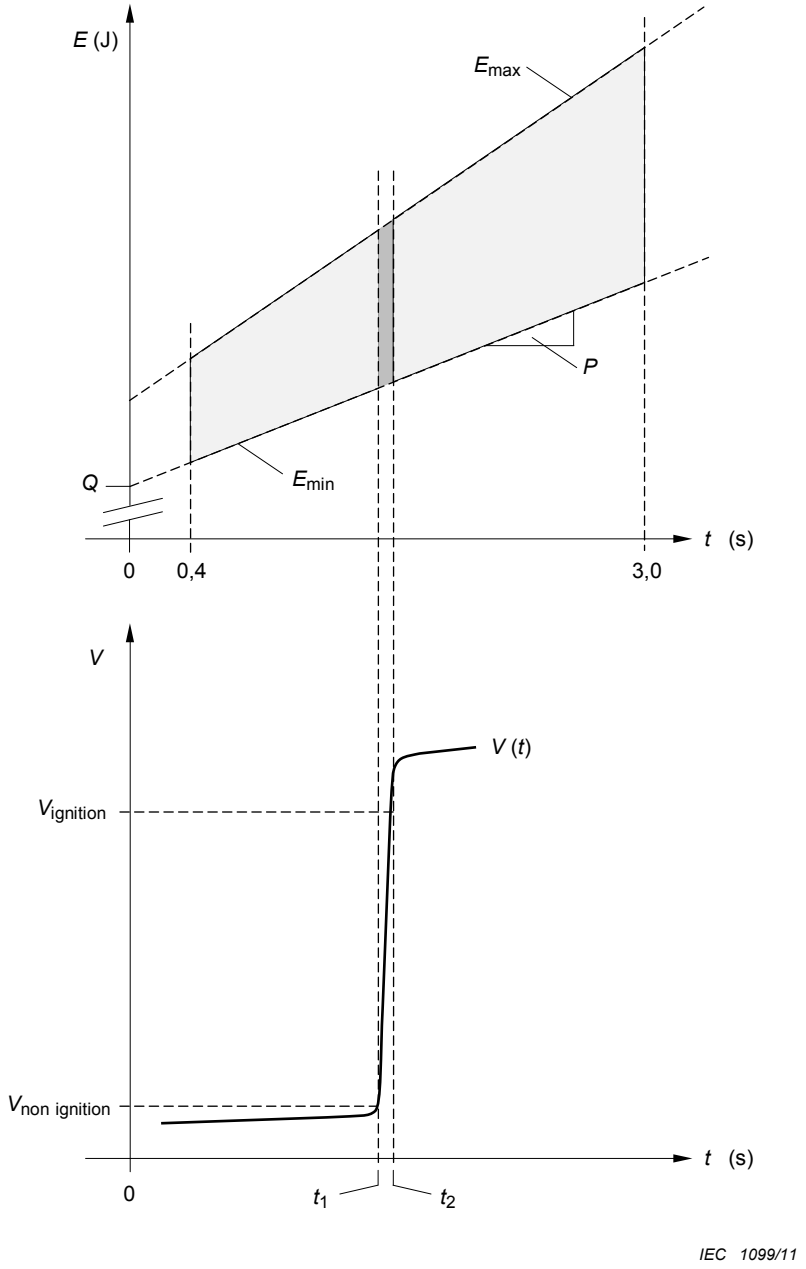
During this test, the lamp(s) are placed outside the test enclosure at an ambient temperature of 25 °C ± 10 °C.

NOTE The humidity inside the test chamber should be limited to a value which does not cause any condensation on the DUT's.

15.3 Test at t_c +10 K

The control gears shall operate at an ambient temperature which produces t_c + 10 K, until a test period of 200 h has elapsed.

Compliance: After performing this test and after cooling down to room temperature, all control gear shall correctly start and operate an appropriate lamp(s) for 15 min. During this test, the lamp(s) are placed outside the test enclosure at an ambient temperature of 25 °C ± 5 °C.

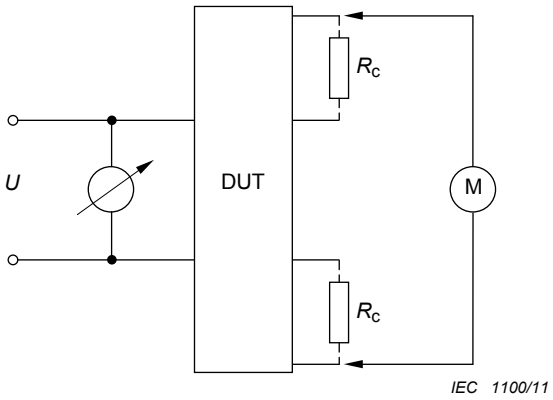


Key

Grey area	energy supply to the cathode permitted
Dark grey area	ignition permitted
E	energy supplied to the electrode for preheating (J)
E_{min} =	$Q_{min} + P_{min} \cdot t$ = minimum cathode preheat energy
E_{max} =	$Q_{max} + P_{max} \cdot t$ = maximum cathode preheat energy
$V(t)$	voltage, measured at the output terminals of the control gear
t_1 =	t (V non-ignition)
t_2 =	t (V ignition)

NOTE For the values of Q_{min}(J), Q_{max}(J), P_{min}(W), P_{max}(W), V non ignition (V) and V ignition (V), see lamp data sheet.

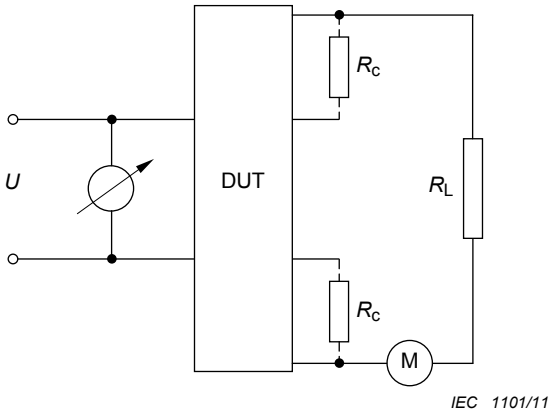
Figure 1 – Schematic illustration of the energy required for preheating and starting



Key

U	supply	M	measuring device
DUT	device (control gear) under test	R_c	See 7.3.2

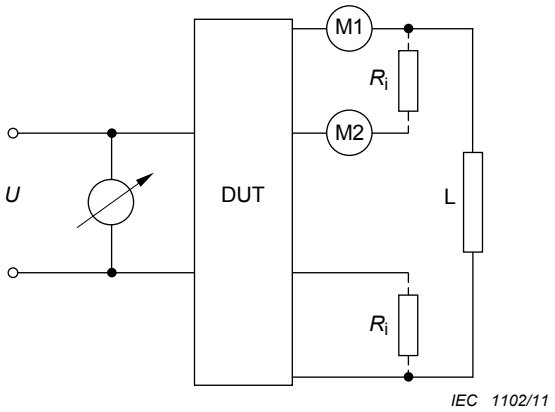
Figure 2a – Test circuit for open-circuit voltage



Key

U	supply	R_c	See 7.3.3
DUT	device (control gear) under test	R_L	See 7.3.3
M	measuring device		

Figure 2b – Test circuit for control gear impedance



Key

U	supply	R_i	See 7.3.4
DUT	device (control gear) under test	L	lamp
M	measuring device		

Figure 2c – Test circuit for cathode current

Figure 2 – Test circuits for non-preheat starting mode

Annex A
(normative)

Tests

A.1 General requirements

Tests are type tests. One sample shall be submitted to all tests.

A.1.1 Ambient temperature

Tests shall be made in a draught-free room and at an ambient temperature within the range 20 °C to 27 °C unless otherwise stated.

For those tests which require constant lamp performance, the ambient temperature around the lamp shall be within the range 23 °C to 27 °C and shall not vary by more than 1 °C during the test.

A.1.2 Supply voltage and frequency

A.1.2.1 Test voltage and frequency

Unless otherwise specified, the control gear to be tested shall be operated at its rated voltage and the reference ballast at its rated voltage and frequency.

When a control gear is marked for use on a range of supply voltages or has different separate rated supply voltages, any voltage for which it is intended may be chosen as the rated voltage.

A.1.2.2 Stability of supply and frequency

For most of the tests, the supply voltage and, where appropriate for the reference control gears the frequency, shall be maintained within ± 0,5 %. However, during the actual measurement, the voltage shall be adjusted to within ± 0,2 % of the specified testing value.

A.1.2.3 Supply voltage waveform

The total harmonic content of the supply voltage shall not exceed 3 %; harmonic content is defined as the root-mean-square (r.m.s.) summation of the individual components using the fundamental as 100 %.

A.1.3 Magnetic effects

Unless otherwise specified, no magnetic object shall be allowed within 25 mm of the face of the reference ballast gear or the control gear under test.

A.1.4 Mounting and connection of reference lamps

In order to ensure that the electrical characteristics of the reference lamps are consistent, they shall be mounted as indicated on the relevant lamp data sheet. Where no mounting instructions are given on the relevant lamp data sheet, lamps shall be mounted horizontally.

It is recommended that lamps are allowed to remain permanently undisturbed in their test lampholders.

A.1.5 Reference lamp stability

A.1.5.1 A lamp shall be brought to a condition of stable operation before carrying out measurements. No swirling shall be present.

A.1.5.2 The characteristics of a lamp shall be checked immediately before and immediately after each series of tests in accordance with Annex C.

A.1.6 Reference ballast

The reference ballast used shall be that indicated on the relevant lamp data sheet.

A.1.7 Instrument characteristics

The characteristics of the instrument are given with the following:

a) Potential circuits

Potential circuits of instruments connected across the lamp shall not pass more than 3 % of the rated lamp current.

b) Current circuits

Instruments connected in series with the lamp shall have sufficiently low impedance such that the voltage drop shall not exceed 2 % of the objective lamp voltage.

Where measuring instruments are inserted into parallel heating circuits, the total impedance of the instruments shall not exceed 0,5 Ω.

c) RMS measurements

Instruments shall be essentially free from errors due to waveform distortion and shall be suitable for the operating frequencies.

Care shall be taken to ensure that the earth capacitance of instruments does not disturb the operation of the unit under test. It may be necessary to ensure that the measuring point of the circuit under test is at earth potential.

A.2 Measurement of impedance at audio frequencies

The circuit in Figure A.1 illustrates a bridge which serves for the determination of the audio-frequency impedance $\underline{Z}$ of the lamp/control gear assembly.

Let R' and R'' represent the values of the resistors shown in Figure A.1 by the values of 5 Ω and 200 kΩ respectively (the latter at least not being critical). When by adjustments of R and C a balance is obtained for a given audio-frequency selected on the wave analyser (or any other suitable selective detector), we have in general:

$$\underline{Z} = R'R''(1/R + i\Omega C)$$

If the resistors R' and R'' have precisely the indicated values, the equation becomes:

$$\underline{Z} = 10^6(1/R + i\Omega C)$$

NOTE The impedances Z_1 and/or Z_2 are not necessary if the corresponding source has a low internal impedance for the currents of the other.

A.3 Measurements during preheat

A.3.1 Test equipment and measurement sequence

The test equipment shall be arranged to contain the control gear under test, the cathode substitution resistors (R) specified on the relevant lamp data sheet and a measuring device. The measuring device may be an oscilloscope provided with a voltage and/or current probe (see Figure A.2).

If applicable, connect the secondary output winding of the isolating transformer to ground at one side. If no isolating transformer is included in the control gear, then an isolating transformer shall be inserted at the input side.

For measurement of the total open-circuit voltage: this voltage is measured between both cathode substitution resistors.

The voltage to the starting aid, if any, shall comply with the specified voltage.

A.3.2 Particular conditions for measurement and data processing with preheat circuits

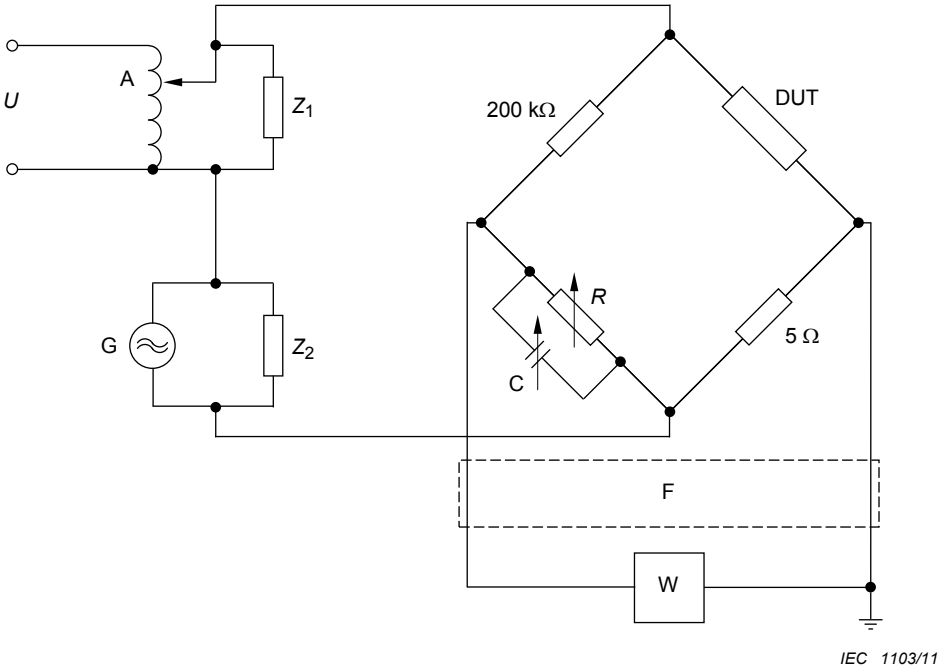
With the aid of the measuring device, the heating current and open-circuit voltage are determined in relation to time.

For a steady state r.m.s. current or r.m.s. voltage respectively, the effective value of the heating current/voltage is determined by observation of one single HF period from which the effective value and the crest factor are determined.

A direct measurement of the effective value might be possible with suitable instrumentation.

For a varying current, the effective value of the heating current is defined as such value which is equivalent to a steady state r.m.s. current of the same heating effect.

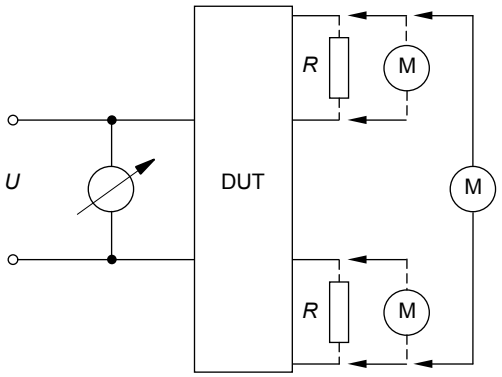
With the aid of the formula given on the lamp data sheets the time to emission is calculated (see 7.2.2).



Key

U	supply 50 Hz (60 Hz)
G	generator 250 Hz…2 000 Hz
A	supply transformer 50 Hz or 60 Hz
DUT	device (control gear) under test
Z_1	impedance of value sufficiently high for 50 Hz or 60 Hz, sufficiently low for 250 Hz to 2 000 Hz (e.g. resistance 15 Ω + capacitance 16 μF)
Z_2	impedance of value sufficiently low for 50 Hz or 60 Hz, sufficiently high for 250 Hz to 2 000 Hz (e.g. inductance 20 mH)
F	filter 50 Hz or 60 Hz
W	selective voltmeter or wave analyser
R	variable bridge resistor (*R*' = 5 Ω; *R*'' = 200 kΩ)
	NOTE The value of 200 kΩ for one branch of the bridge is not critical.
C	variable bridge capacitor

Figure A.1 – Measurement of impedance at audio frequencies



Key

U	supply
DUT	device (control gear) under test
M	measuring device
R	See lamp data sheets, substitution resistor for testing cathode preheat requirements

Figure A.2 – Test circuit for control gear for preheat starting mode

Annex B
(normative)

Reference ballasts

B.1 Marking

The reference ballast shall be provided with durable legible marking as follows:

– the words “reference ballast” or “HF reference ballast” as applicable, in full;
– identification of the responsible vendor;
– serial number;
– rated lamp wattage and calibration current;
– rated supply voltage and frequency.

B.2 Design characteristics

B.2.1 General design for frequencies of 50 Hz or 60 Hz

A reference ballast is a self-inductive coil, with or without an additional resistor, designed to give the operating characteristics of Clause B.3.

It may be used either in a circuit employing a starter or, where applicable, in a circuit including separate power sources to heat the lamp cathodes.

B.2.2 Reference ballast for frequencies of 25 kHz

A HF reference ballast is a resistor designed to give the operating characteristics of Clause B.4.

Since the type of HF reference ballast is intended to serve as a permanent baseline of reference, it is vitally important that the ballast be so constructed as to provide permanence of impedance under normal conditions of use.

For this purpose, it may be provided with suitable means of restoring the reference resistance.

An HF reference ballast shall be enclosed in a case for mechanical and electrical protection. Care should however be taken for proper conduction of the dissipated wattage losses.

B.2.3 Protection

The control gear shall be protected, for example by means of a suitable steel case, against magnetic influence in such a way that its ratio of voltage to current at the calibration current shall not be changed by more than 0,2 % when a 12,5 mm thick plate of ordinary mild steel is placed at 25 mm from any face of the control gear enclosure.

Moreover, the control gear shall be protected against mechanical damage.

B.3 Operating characteristics for frequencies of 50 Hz or 60 Hz

B.3.1 Rated supply voltage and frequency

The rated supply voltage and frequency of a reference ballast shall be in accordance with the values given in IEC 60081 or 60901 on the relevant lamp data sheets.

B.3.2 Ratio of voltage to current

The ratio of voltage to current of a reference ballast shall have the value given in IEC 60081 or IEC 60901 on the relevant lamp data sheet, subject to the following tolerances:

- ± 0,5 % at the calibration current value;
- ± 3 % at any other value of current from 50 % to 115 % of the calibration current.

B.3.3 Power factor

The power factor of the reference ballast determined at the calibration current shall be as shown in IEC 60081 or IEC 60901 on the relevant lamp data sheets, subject to a tolerance of ± 0,005.

B.3.4 Temperature rise

When the reference ballast is operated in an ambient air temperature of between 20 °C and 27 °C, at calibration current and rated frequency, and after thermal stabilisation, the temperature rise of the ballast winding shall not exceed 25 K, when measured by the “change in resistance” method.

B.4 Operating characteristics for frequencies of 25 kHz

B.4.1 General

The following specifications apply to measurements made at rated input voltage and rated frequency of the HF reference ballast and with a room temperature of 25 °C ± 5 °C and with stabilised temperature of the reference ballast.

B.4.2 Impedance

The impedance of an HF reference ballast shall have the value given on the relevant lamp data sheets in IEC 60081 or IEC 60901, subject to the following tolerances:

- ± 0,5 % at the calibration current value;
- ± 1 % at any other value of current between 50 % and 115 % of the calibration current.

B.4.3 Series inductance and parallel capacitance

The series inductance of a reference resistor shall be less than 0,1 mH and its parallel capacitance shall be less than 1 nF.

B.5 Circuit for frequencies of 25 kHz (see Figure B.1)

B.5.1 Cathode heating

HF reference ballasts may be used in a circuit employing separate power sources to heat the lamp cathodes for proper starting of the lamp. These power sources shall be disconnected when measuring a lamp.

B.5.2 Power supply

The HF voltage supply used for the adjustment of or test with the HF reference ballast shall be such that at full load the r.m.s. summation of the harmonic contents shall not exceed 3 % of the fundamental component.

This supply shall be as steady and free from sudden changes as possible. For best results the voltage should be regulated to within 0,2 %.

For resistor type reference ballasts the frequency shall be within 2 %.

B.5.3 Instruments

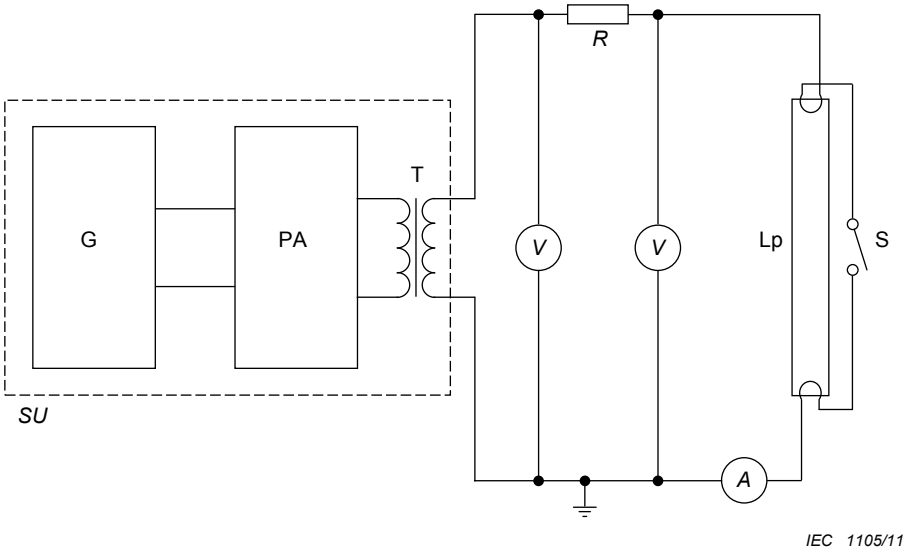
All instruments used in HF reference ballast measurements should be suitable for high frequency operation.

Details are under consideration.

B.5.4 Wiring

Connecting cables should be as short and straight as possible to avoid parasitic capacitance.

The parasitic capacitance parallel to the lamp shall be less than 1 nF.



Key

SU	supply
G	sine generator
PA	power amplifier
T	isolating transformer
R	reference resistor
Lp	lamp
S	starting switch

Figure B.1 – HF reference circuit

Annex C
(normative)

Conditions for reference lamps

A lamp which has been aged for at least 100 h is considered to be a reference lamp according to 3.4 if, when associated with a reference ballast under the conditions defined in Annex A and operating in an ambient temperature of 25 °C, the lamp wattage, voltage at lamp terminals or lamp operating current do not deviate by more than 2,5 % from the corresponding rated values, as appropriate, given in IEC 60081 and IEC 60901.

For reference lamps operated without a starter, if the cathode resistance is higher than 10 % over the rated value of the lamp data sheet, it may be reduced by using a shunt resistor.

A reference lamp of a type suitable for the ballast under test shall always be used.

The waveform of the current passed by a stabilised reference lamp associated with a reference ballast shall show substantially the same waveform in successive half-cycles.

NOTE This limits the possible generation of even harmonics by any rectifying effect.

Annex D
(informative)

Explanation of starting conditions

D.1 General

The requirements for starting conditions given in Clause 7, and the associated data given in lamp data sheets in IEC publications, have been specified to encompass the different lamp starting methods which can be employed by electronic control gear.

As these starting methods can be more complex than those of conventional 50 Hz or 60 Hz circuits, this annex is provided to assist the interpretation of the requirements of this standard and the data specified on lamp data sheets.

D.2 Characteristics which affect lamp starting

There are five main physical characteristics which influence the starting mechanism of a fluorescent lamp:

- cathode heating: Energy supplied for preheating and time of application;
- open circuit voltage: Voltage across lamp and to starting aid both during preheating and at the moment of lamp ignition;
- environmental conditions: Ambient temperature, relative humidity;
- lamp physical conditions: Type of filling gas and its pressure, lamp dimensions, the inclusion of an internal conducting film;
- supply and luminaire conditions: Operating frequency, starting aid dimension and spacing.

All of these characteristics interact with each other in a complex manner and if the correct combination is not obtained for a chosen method of starting, poor lamp performance can result (e.g. reduced lamp life, reduced number of starting cycles for a given lamp life, excessive end blackening of the lamp).

D.3 Principal methods of lamp starting

Traditionally, there have been two principal methods of starting fluorescent lamps associated with 50 Hz or 60 Hz control gear, preheated cathode starting and non-preheated cathode starting.

Both of these methods can be used with electronic control gear, but due to the higher technological features that can be built into electronic control gear, revised methods of specifying, measuring and assessing the starting characteristics often have to be adopted.

Although electronic control gear may produce lamp starting conditions in a more complex way than conventional 50 Hz or 60 Hz control gear, the same principles apply if good lamp performance is to be obtained.

D.4 Particular methods of lamp starting

D.4.1 Preheat starting

Different methods of providing preheated cathode lamp starting are normally used, but all can be summarised in that a sufficient amount of energy has to be supplied to the cathode. Particular solutions may exist on basis of more or less constant current or voltage controlled preheat mode.

With all of these methods, the following requirements must be satisfied during the starting period if satisfactory lamp performance is to be obtained.

a) Prior to cathodes reaching emission, open-circuit voltages across the lamp and/or from lamp to starting aid must be kept below the level which causes cathode-damaging lamp glow currents.

b) After cathodes have reached emission, open-circuit voltages must be adequate to start the lamp quickly and without repeated starting attempts.

c) If open-circuit voltages have to be elevated to achieve lamp starting, once cathodes have reached emission, the transition from low to high open-circuit voltage must occur whilst the cathodes are still at emission temperature.

d) During the cathode preheating period, the heating current or voltage must not be so excessive that the emissive material on the cathodes is damaged by overheating.

As the required open-circuit voltages for preheat starting are relatively low, multilamp series circuits can be utilised for some types of lamps.

In such a scheme, starting capacitor(s) are sometimes employed to shunt part of the combination of lamps while full open-circuit voltage is applied to the unshunted lamp. The size of the starting capacitor relates to the potentially troublesome glow current during the initial phase of starting. Attention is necessary to balance starting capacitor size with ease of starting and other lamp and control gear performance attributes.

D.4.2 Non-preheat starting

This method of lamp starting takes advantage of the field emission that occurs at the unheated cathodes of a lamp when a high open-circuit voltage is instantaneously applied across the lamp.

The level of open-circuit voltage and the source impedance of the control gear determine the time it takes for the lamp to pass through the glow current stage of the discharge to the full arc state.

One of the major reasons for excessive lamp end blackening and subsequent early lamp failure is due to unduly high and/or long-lasting glow discharge currents during the starting process. To minimise the damaging effects of the glow discharge current it is necessary to ensure that a minimum value of open-circuit voltage is provided and that the control gear has the ability to “drive’” the lamp rapidly through this phase without making repeated attempts at lamp starting which extend for greater than 100 ms.

Some control gear may make use of currents in the lamp cathodes for purposes other than adequate cathode heating (e.g. for supporting starting with reduced starting voltages). In such instances the limitations on maximum cathode current must be observed to avoid cathode overheating.

D.5 Interpretation of the requirements of Clause 7 and the information given on lamp data sheets

D.5.1 Preheat starting

D.5.1.1 Heating energy and emission time (t_s)

D.5.1.1.1 Minimum values for the heating energy

The amount of heat necessary to bring a given cathode type to the minimum emission temperature can be stated in terms of time and two constants, Q and P, which are determined by the physical properties of the given cathode type.

This relationship can be expressed by the following equation:

$$E_{min} = Q_{min} + P_{min} \times t$$

$$E_{max} = Q_{max} + P_{max} \times t$$

where

$t = t_s$ is the time to starting (s). Lamp standards use the parameter t_s as a certain, distinct point of time. In reality, however, this is a value between t_1 and t_2. The interval (t_1, t_2) is depicted in Figure 1;

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.

Q_{min} is a constant dependent on the cathode type (J);

P_{min} is a constant dependent on the cathode type (W);

E_{min} is the minimum value of the heating energy (J);

Q_{max} is a constant dependent on the cathode type (J);

P_{max} is a constant dependent on the cathode type (W);

E_{max} is the maximum value of the heating energy (J).

The values of the constants Q and P are given on each relevant lamp data sheet, together with the value of the cathode substitution resistor. Elementary calculations can of course be done in order to transform energy values into current or voltage values, if needed for the special type of control gear.

The value of the effective heating energy E_{min} can be calculated by inserting the measured value of t_s into the above equation which is also given on each lamp data sheet.

D.5.1.1.2 Maximum values of heating energy

Maximum levels of heating energy are calculated from the formula for E_{max} and the values given on each lamp data sheet, measured with the required value of the substitution resistor.

A schematic representation of these requirements is given in Figure 1.

NOTE If the preheat energy supply is interrupted, the energy transfer to the electrodes is zero. Since Figure 1 shows the energy supplied (and not the energy content of the electrodes), at the time of supply interruption, the energy curve remains constant, i.e. a horizontal line. The energetic behaviour of the electrodes, e.g. losses due to cooling down, are described by the slope P of the equation $E = Q + P \times t$.

D.5.1.2 Open-circuit voltages

The data in the relevant lamp data sheets is given for systems that require the use of a starting aid and for systems that do not require a starting aid. It is essential that the correct system is identified before the testing.

For some lamp types, the relevant lamp data sheets specify values of maximum open-circuit voltage prior to time t_e being reached which are higher than, or the same as, the minimum values of open-circuit voltage specified after time t_e has been reached. Control gear designed for these lamp types do not necessarily have to elevate the open-circuit voltage to start these lamps correctly.

D.5.2 Non-preheat starting

Open-circuit voltage measurement alone does not necessarily ensure that a control gear will start a lamp cleanly and with the required minimal glow current period. Some control gear are initially unable to supply the current necessary to drive the lamp quickly through the glow state and into the arc state.

To avoid this situation a control gear impedance test is made with a lamp substitution resistor.

The values of the lamp substitution resistor and the minimum current level which must be obtained in this resistor are shown on the relevant lamp data sheet.

D.6 Measurement requirements

As the pre-start and starting characteristics of electronic control gear do not necessarily provide steady state voltage and currents, it is necessary to apply measuring devices and techniques that will cope with these conditions.

Annex E
(normative)

Control interface for controllable control gear

E.1 Overview

This annex specifies the control interface for controllable control gear. The arc power of the electronic control gear is controlled between minimum/off and maximum values by the control signal applied to the control terminals of the control gear.

If the control signal is not connected, the control gear shall give the maximum value of arc power as defined in IEC 61347-1 and IEC 61347-2-3 or the system failure level, if applicable.

This annex does not cover any requirements for the control unit.

E.2 Control by d.c. voltage

E.2.1 Circuit diagram

A functional specification for d.c. voltage control is shown in Figure E.1.

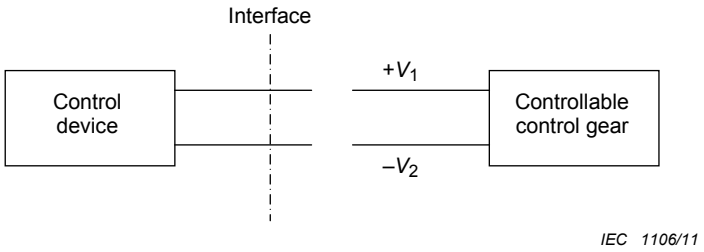


Figure E.1 – Functional specification for d.c. voltage control

The arc power of a controllable control gear is controlled by the d.c. voltage on the control input of the controllable control gear. The d.c. voltage has the following characteristics:

Control signal range

$V_{1,2}$ = between 10 V and 11 V: maximum value of arc power
$V_{1,2}$ = between 0 V and 1 V: minimum value of arc power / minimum light output
$V_{1,2}$ = between 1 V and 10 V: arc power rising from minimum to maximum value
$V_{1,2}$ = between 0 V and 11 V: stable lamp operation with stable light output

E.2.2 Connection diagram

Depending on current-carrying capacity, several controllable control gear can be connected to one control device in the following way (see Figure E.2):

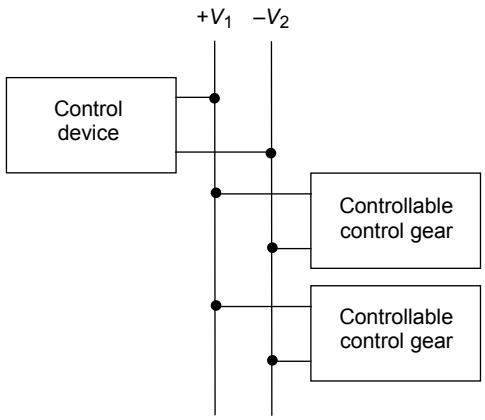


Figure E.2 – Connection diagram for several controllable control gear

E.2.3 Electrical specifications

E.2.3.1 Circuit diagram

The controllable control gear is current sourcing (see Figure E.3).

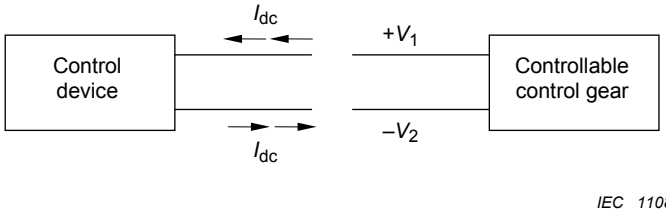


Figure E.3 – Circuit diagram with current sourcing

E.2.3.2 Control input voltage limits

The control gear shall not be damaged when the control input voltage $V_{1,2}$ is between –20 V and +20 V.

The control gear shall not produce voltages that exceed the limiting values for the control unit and under no circumstances shall exceed the following:

$V_{1,2}$ between –20 V and +20 V.

The control terminals shall be reverse polarity protected. In that case, the control gear shall operate with minimum light output or shall not operate.

At control input voltages between 0 V and 11 V, there shall be stable light output.

This shall be tested by visual inspection.

E.2.3.3 Control input current limits

Limits for the control input current, to be supplied to the control unit, are 10 μA minimum and 2 mA maximum.

The value of the control input current shall be declared or stated on the control gear.

E.2.3.4 Switch-on

Switch-on is allowed at any dimming position.

E.3 Control by pulse width modulation (PWM)

E.3.1 Circuit diagram – functional specification for PWM control

The schematic circuit diagram of the functional specification for PWM is shown in Figure E.4 and Figure E.5.

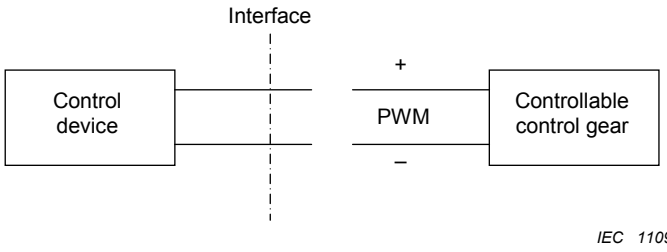


Figure E.4 – Functional specification for PWM control

The arc power of a controllable control gear is controlled by the PWM signal on the control input of the controllable control gear. The arc power is changed by varying the percentage of time for which the PWM signal is at V_{signal}. The PWM signal has the following characteristics:

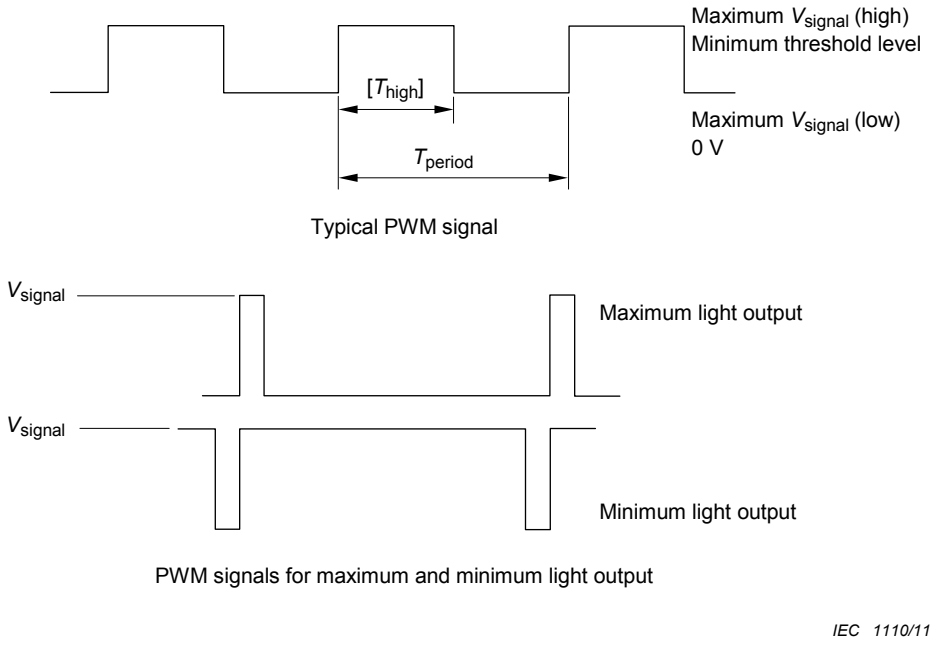


Figure E.5 – PWM signal characteristics

The voltage of the signal is between V_{signal}(low) and V_{signal}(high), where:

V_{signal}(low) minimum is 0 V;

V_{signal}(low) maximum is 1,5 V;

V_{signal}(high) minimum is 10 V;

V_{signal}(high) maximum is 25 V;

T_{period}(cycle time) is 1 ms minimum and 10 ms maximum.

For the light output, the following specification are defined:

– full light output when signal width - $T_{(high)}$ - is 0 % to 5 % ± 1 %;

– 1 % or minimum light output when signal width - $T_{(high)}$ - is 95 % ± 1 %;

– switch-off when signal width - $T_{(high)}$ - is >95 %;

NOTE This part of the signal is reserved for switch-off. However, if a control gear does not possess this feature its output should remain at minimum.

– no switch-off when signal width - $T_{(high)}$ - is <95 %.

E.3.2 Connection diagram

Depending on current-carrying capacity, several controllable control gear can be connected to one control unit in the way present in Figure E.6.

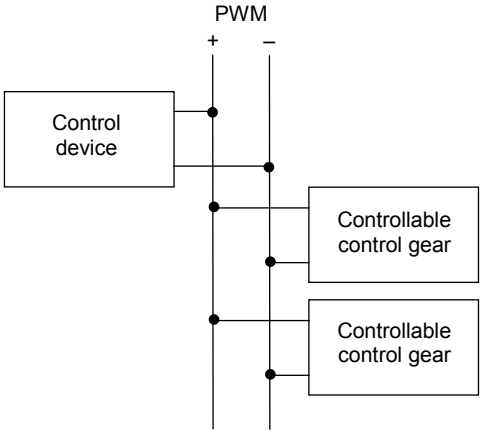


Figure E.6 – Connecting diagram for PWM controllable control gear

E.3.3 Electrical specifications

The control unit is current-sourcing and the control gear is current-sinking.

E.3.3.1 Signal voltage limits

The control gear shall not be damaged when the signal voltage V_{signal} is below 25 V.

The control terminals shall be reverse polarity protected. In that case, the control gear shall not operate.

E.3.3.2 Control terminals impedance

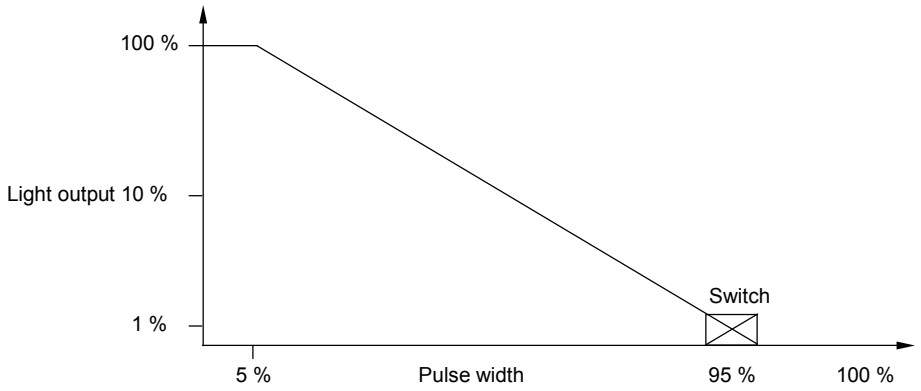
The control terminal impedance shall be between 1 kΩ and 10 kΩ.

E.3.3.3 Input current

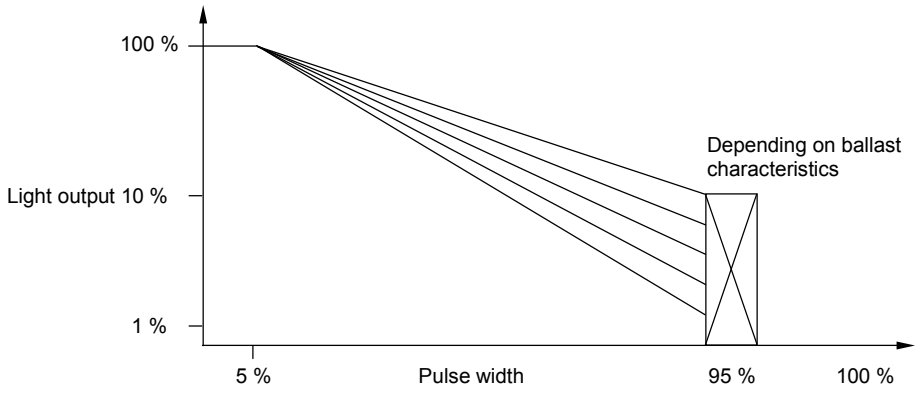
The value of the input current at 12 V stable shall be declared or stated on the control gear.

E.3.4 Examples of control characteristics

Figure E.7 gives examples of control characteristics.



Dimming curve for controllable control gear with minimum light output 1 %



Dimming curve for controllable control gear with minimum light output higher than 1 %

IEC 1112/11

Figure E.7 – Dimming curve for controllable control gear

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch

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