BS EN 62811:2015

BSI Standards Publication

AC and/or DC-supplied electronic controlgear for discharge lamps (excluding fluorescent lamps) — Performance requirements for low frequency squarewave operation

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National foreword

This British Standard is the UK implementation of EN 62811:2015. It is identical to IEC 62811:2015.

The UK participation in its preparation was entrusted by Technical Committee CPL/34, Lamps and Related Equipment, to Subcommittee CPL/34/3, Auxiliaries for lamps.

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

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Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

AC and/or DC-supplied electronic controlgear for discharge lamps (excluding fluorescent lamps) - Performance requirements for low frequency squarewave operation (IEC 62811:2015)

Appareillage électronique alimenté en courant alternatif et/ou continu pour lampes à décharge (à l'exclusion des lampes fluorescentes) - Exigences de performance pour le fonctionnement en onde carrée de basse fréquence (IEC 62811:2015)

Gleich- und/oder wechselspannungsversorgtes elektronisches Betriebsgerät für Entladungslampen (ausgenommen Leuchtstofflampen) - Anforderungen an die Arbeitsweise für Niederfrequenz-Rechteckbetrieb (IEC 62811:2015)

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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/1132/FDIS, future edition 1 of IEC 62811, 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 62811:2015.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-02-14
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-05-14

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The text of the International Standard IEC 62811:2015 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 61000-3-2:2000	NOTE	Harmonized as EN 61000-3-2:2000.
IEC 61000-4-30:2003	NOTE	Harmonized as EN 61000-4-30:2003.
IEC 61547	NOTE	Harmonized as EN 61547.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

Publication	Year	Title	EN/HD	Year
IEC 60050	series	International Electrotechnical Vocabulary	-	series
IEC 61000-4-14	1999	Electromagnetic compatibility (EMC) -- Part 4-14: Testing and measurement techniques - Voltage fluctuation immunity test	EN 61000-4-14	1999
+A1	2001		+A1	2004
+A2	2009		+A2	2009
IEC 61167	-		-	-
IEC 61347-1	-	Lamp controlgear - Part 1: General and safety requirement	EN 61347-1	-
IEC 61347-2-12	-	Lamp controlgear - Part 2-12: Particular requirements for d.c. or a.c. supplied electronic ballasts for discharge lamps (excluding fluorescent lamps)	-	-
IEC 62386	series	Digital addressable lighting interface	EN 62386	series

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

AC AND/OR DC-SUPPLIED ELECTRONIC CONTROLGEAR FOR DISCHARGE LAMPS (EXCLUDING FLUORESCENT LAMPS) – PERFORMANCE REQUIREMENTS FOR LOW FREQUENCY SQUARE WAVE OPERATION

FOREWORD

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International Standard IEC 62811 has been prepared by subcommittee 34C: Auxiliaries for lamps, of IEC technical committee 34: Lamps and related equipment.

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

FDIS	Report on voting
34C/1132/FDIS	34C/1149/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 the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This International Standard covers performance requirements for electronic controlgear for use on a.c., at 50 Hz or 60 Hz and/or d.c. supplies up to 1 000 V associated with discharge lamps as specified in IEC 61167 for low frequency square wave operation.

In order to obtain satisfactory performance of discharge lamps and electronic controlgears, it is necessary that certain features of their design be properly coordinated. 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 controlgear for discharge lamps will, in general, be made with reference lamps and, in particular, by comparing the results obtained using these lamps on the controlgear to be tested and on the reference ballast. Whereas the reference ballast for frequencies of 50 Hz or 60 Hz is a self-inductive coil, the low frequency square wave 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 CONTROLGEAR FOR DISCHARGE LAMPS (EXCLUDING FLUORESCENT LAMPS) – PERFORMANCE REQUIREMENTS FOR LOW FREQUENCY SQUARE WAVE OPERATION

1 Scope

This International Standard specifies performance requirements for electronic controlgear for use on a.c. and/or d.c. supplies up to 1 000 V and/or a.c. supplies up to 1 000 V at 50 Hz or 60 Hz, associated with discharge lamps, as specified in IEC 61167, which have information for low frequency square wave operation, where the frequency range of the low frequency is from 70 Hz to 400 Hz.

Tests in this standard are type tests. Requirements for testing individual controlgear during production are not included.

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

2 Normative references

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.

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

IEC 61000-4-14:1999, *Electromagnetic compatibility (EMC) – Part 4-14: Testing and measurement techniques – Voltage fluctuation immunity* test
IEC 61000-4-14:1999/AMD1:2001
IEC 61000-4-14:1999/AMD2:2009

IEC 61167, *Metal Halide lamps – Performance specifications*

IEC 61347-1, *Lamp controlgear – Part 1: General and safety requirements*

IEC 61347-2-12, *Lamp controlgear – Part 2-12: Particular requirements for d.c. or a.c. supplied electronic ballasts for discharge lamps (excluding fluorescent lamps)*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-845 as well as the following apply.

3.1
reference ballast
special resistive ballast for lamps, for operation on low frequency square wave 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 standardized conditions

Note 1 to entry: It is essentially characterized 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.

[SOURCE: IEC 60050:1987, 845-08-36, modified – Adapted for electronic operation of lamps.]

3.2
reference lamp
discharge lamp selected for the purpose of testing ballasts and which, when associated with a reference ballast under specified conditions, has electrical values which are close to the objective values given in a relevant specification

[SOURCE: IEC 60050:1987, 845-07-55]

3.3
calibration current of a reference ballast
value of the current on which are based the calibration and control of the reference ballast

Note 1 to entry: Such a current should preferably be approximately equal to the rated or typical current of the lamps for which the reference ballast is suitable.

[SOURCE: IEC 61347-1:2007, 3.4, modified — In the note to entry the words "rated running" are replaced by "rated or typical"]

3.4
total circuit power
total power dissipated by controlgear and lamp in combination, at rated voltage and frequency of the controlgear

[SOURCE: IEC 60929:2011, 3.5]

3.5
displacement factor
$\cos\varphi_1$
cosine of the phase difference between the fundamental of the mains voltage and the fundamental of the mains current

3.6
run-up current
lamp current after take-over phase until the lower limit of the lamp voltage is reached

Note 1 to entry: Lower limit is given in Annex G of IEC 61167.

3.7
take-over
time between lamp being able to conduct current until electrodes are at thermionic emission

Note 1 to entry: At the end of the take-over phase, the lamp power factor is above 0,9 and the lamp voltage stabilises and ramps up from about 20 V rms.

[SOURCE: IEC 61167:2011, 3.14]

3.8
average peak current ratio
APCR
average of the absolute ratio between the peak current and the rms current

Note 1 to entry: For measurement procedure, see 7.4.2.

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

3.9
typical lamp voltage
steady state lamp voltage expected for a lamp operating on low frequency square wave ballast

Note 1 to entry: Typical lamp current is derived from the lamp rated power and typical lamp voltage. In practice, lamps for use on low frequency square wave ballasts may be targeted to a different voltage within the allowed range for best performance, and the lamp current will be different accordingly. Typical lamp voltages and currents have been used as a basis for assigning currents at take-over and run-up.

[SOURCE: IEC 61167:2011, 3.16, modified]

3.10
typical lamp current
steady state lamp current expected for a lamp operating on low frequency square wave ballast

Note 1 to entry: Typical lamp current is derived from the lamp rated power and typical lamp voltage. In practice, lamps for use on low frequency square wave ballasts may be targeted to a different voltage within the allowed range for best performance, and the lamp current will be different accordingly. Typical lamp voltages and currents have been used as a basis for assigning currents at take-over and run-up.

[SOURCE: IEC 61167:2011, 3.16, modified]

3.11
commutation time
fall and rise time
time which is the transition time of lamp current at half cycle polarity reversals

Note 1 to entry: It is measured using lamp current waveforms between 90 % of the rms value of one half cycle to 90 % of the rms value of the opposite half cycle.

3.12
electronic controlgear life time
declared average life time at which 90 % of the electronic controlgears are still operating

Note 1 to entry: In the context of life time, an electronic controlgear is "operating" if it still fulfils its intended functions.

Note 2 to entry: The manufacturers apply suitable methods, e.g. statistical calculation and/or reliability testing.

3.13
failure rate of electronic controlgear
expected statistical failure during operation based on a MTTF calculation by manufacturer and given in percentage per 1 000 h

Note 1 to entry: For the definition of MTTF, see IEC 60050-191:1990, 12.07.

3.14
ambient temperature range
t_a
temperature range of the air surrounding the electronic controlgear declared by the manufacturer to indicate the normal operating temperature range for the electronic controlgear

Note 1 to entry: The lifetime of the electronic controlgear 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 to entry: 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.

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.

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

4.3 One controlgear is submitted to all tests unless otherwise stated.

4.4 In general, all tests are made on each type of controlgear or where a power range of similar controlgear 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 controlgear specified in this standard shall comply with the requirements of IEC 613472-12.

4.7 Attention is drawn to lamp performance standards which contain information for square wave ballast 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 controlgear.

5 Marking

5.1 Electronic controlgear shall be clearly marked with the following mandatory marking as applicable:

a) displacement factor e.g. $\cos\varphi_1$ = 0,85.

   If the displacement factor is less than $\cos\varphi_1$ = 0,95 capacitive, it shall be followed by the letter C, e.g. $\cos\varphi_1$ = 0,85 C.

   NOTE In Japan displacement factor will not be used, there power factor will be used. Power factor is power divided by the product of voltage and current.

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

a) type of control interface, in case of dimmable ballast.(e.g. D.C. type or PWM type, DALI),;
b) lifetime of the controlgear linked to the ambient temperature and the measured temperature on the reference point (t_c point).

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 point) 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. The measurement setup for measuring the ambient temperature shall be in accordance to Annex D of IEC 61347-1 at the rated voltage. After stabilisation of the ambient temperature the temperature of t_c shall be measured.

Table 1 – Controlgear life time information

Ambient temperature	40°C	50°C	60°C
Temperature measured on the reference point (t_c point) in °C	xx[a]	xx[a]	xx[a]
Lifetime in h	xxxxx[a]	xxxxx[a]	xxxxx[a]
[a] Values declared by the controlgear manufacturer			

Additional information from the controlgear manufacturer to the tabled ambient temperature and life time are allowed.

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

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

6 General statement

It may be expected that controlgear complying with this standard, when associated with lamps which comply with IEC 61167 for low frequency square wave operation, will provide satisfactory starting of the lamp and operation at an ambient temperature range as given by the controlgear manufacturer at voltages within 92 % and 106 % of the rated voltage.

NOTE 1 The electrical characteristics as given on the lamp data sheets of IEC 61167 and applying to operation on a reference controlgear at rated voltage with a frequency of 50 Hz or 60 Hz, will deviate when operating on a low frequency square wave controlgear and the conditions of item b) of 5.3 above.

NOTE 2 In some regions there are laws on EMC for luminaires. The controlgear is also contributing to this EMC behavior. See Bibliography for reference.

7 Starting conditions

7.1 General

Control gear shall start lamps at any supply voltage between 92 % and 106 % of its rated value or the rated voltage range. Compliance is checked by the tests according to 7.2 to 7.4, as appropriate, with the control gear operating at supply voltage of 92 % and 106 % of the rated value or in case of a rated voltage range at 92 % of the minimum value of the range and 106 % of the maximum value of the range.

7.2 Breakdown

The breakdown is the phase where the non-conducting gas is ignited and becomes conducting plasma. This process needs a high voltage for a minimum time.

Measurement is made with an oscilloscope. The controlgear shall be measured without connecting a lamp. Capacitance (simulating the parasitic capacitance of the wires and wires towards earth) shall be added as specified by the controlgear manufacturer.

NOTE 1 Controlgear manufacturers can also define multiple capacitance values.

The absolute value of the ignition peak voltage shall comply with the value given on the relevant lamp data sheet. The measuring procedure can be found in IEC 61167, Table G.1 the section describing the breakdown.

NOTE 2 Values given in IEC 61167 are for pulse ignition, values for high frequency ignition are under consideration.

7.3 Take-over

In the take-over phase the electrodes are heated towards thermionic emission.

The take-over is measured with resistors, unless stated otherwise.

During the take-over, the controlgear shall provide power and current according to the information for ballast design of IEC 61167 (measurement method under consideration) the minimum open circuit voltage (OCV), measured at ≥1 MΩ load shall be according the values in Table 2.

Table 2 – Minimum OCV

Lamp type	Square wave or DC	Non-square wave	
		RMS	Peak
Ceramic and quartz arc tubes	280 V	235 V	332 V
Ceramic arc tubes only	250 V	235 V	332 V
These values are valid for metal halide lamps of 20 W, 35 W, 70 W and 150 W, for other lamps OCV values are given on relevant lamp data sheets.			

The time limit for the duration of the non-low frequency square wave current is maximum 10 s (under consideration), this limit is not required if the controlgear is able to detect the end of the takeover phase.

Open circuit voltage is measured according to the measuring method as described in Annex F.

7.4 Run-up

7.4.1 Run-up current

The run-up current shall be between the values given on the relevant lamp data sheet measured on resistances starting with resistance at run-up as given on the relevant lamp data sheet up to a calculated resistance at which the lamp voltage is equal to lower voltage limit as given in Annex G of IEC 61167.

7.4.2 Average peak current ratio (APCR)

The requirements of Annex G of IEC 61167 apply.

The APCR is determined by measuring the current wave form on a lamp substitution circuit representing the lamp voltage range from 20 V (under consideration) to 75 V. The substitution circuit is an ohmic variable resistor capable of regulation the lamp voltage in the required range. Determine the maximum PCR value within the measured voltage range by applying a smoothing window of 20 μs. Determine during 1 s, around the determined maximum PCR value, the PCR values for all positive half periods and average the PCR values. Determine during this same 1 s the PCR values for all negative half periods and average the PCR values.

The APCR then is the maximum absolute value of both averaged PCR values calculated above.

The peak current ratio PCR (see Figure 1) is defined as the ratio between the peak current and the rms current. The peak current is determined using the average value over a 20 μs window. All values below the rms current in the window will be set to the rms current. The window is slid across the wave shape and the maximum value is the peak current.

NOTE This averaging method will smooth out incidental peaks effectively.

Lamp current wave shape

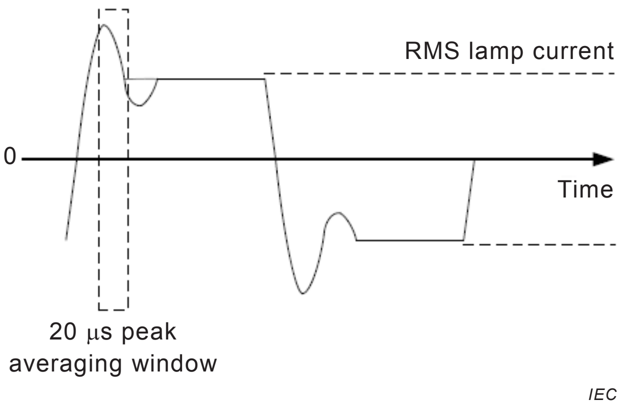


Figure 1 – Measurement of APCR during run-up and steady state

7.4.3 D.C. current

During the run-up the d.c. current shall be below 20 % of rms value. It is measured on a resistance with which a lamp voltage is between 20 V and lower limit lamp voltage as given in Annex G of IEC 61167. The d.c. current component is calculated according to equation:

$$d.c.absolute = \frac{1}{T}\left|\int_0^T i dt\right| \qquad T = 1\ \text{s}$$

8 Operating conditions

8.1 General

The tests of this clause will be done with a variable non inductive resistor or a lamp. Tests of 8.2, 8.4, 8.5, 8.6 are done with a resistor. The tests of 8.7, 8.8 and 8.10 are done with a lamp. The test according 8.3 can be done either with a lamp or a resistor.

8.2 Power control

The lamp power shall be controlled by the controlgear within 5 % of the rated lamp power.

The compliance test will be done at rated supply voltage and at a temperature of 25 °C (±5 °C).

The output power is measured with a resistive load achieving voltages between 75 V and 120 V with steps of 5 V. At each step, sufficient stabilization time is given before the measurement.

If the lamp exceeds the 120 V, the power shall be regulated according the limits given in the relevant data sheet for extended operation.

NOTE For possible future lamp designs with a different voltage range, the limits of 75 V and 120 V can be replaced with lower limit and upper limit.

8.3 Frequency range of low frequency square wave

The frequency of the low frequency square wave voltage shall be in steady state between 70 Hz and 400 Hz.

8.4 D.C. current

The d.c. component of the current shall be less than 2,5 % of the rms value of the current. See 7.4.3 for example on how to obtain the d.c. value. Use a lamp substitution resistor for the measurement. The voltage at the resistor shall be the typical lamp voltage.

8.5 Average lamp potential against earth (for quartz arc bulbs only)

For lamps with a quartz arc tube, the average lamp potential against earth shall not exceed 200 V positive. The test setup is given in Figure 2. The voltage is measured with an integration time of 0,5 s. Use a lamp substitution resistor for the measurement. The voltage at the resistor shall be the typical lamp voltage.

The average lamp potential against earth: $\overline{V_{\text{earth}}} = \frac{V_{\text{mean1}} + V_{\text{mean2}}}{2}$

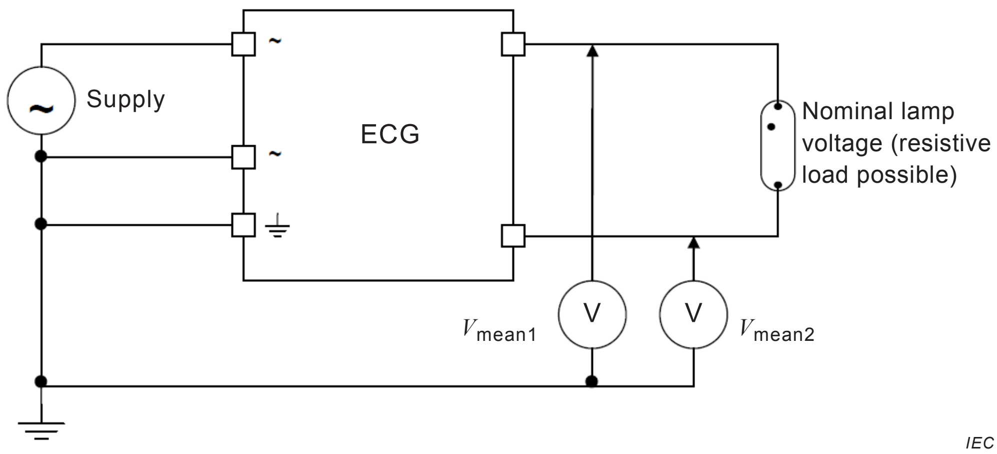


Figure 2 – Test set-up for measuring the lamp potential against earth

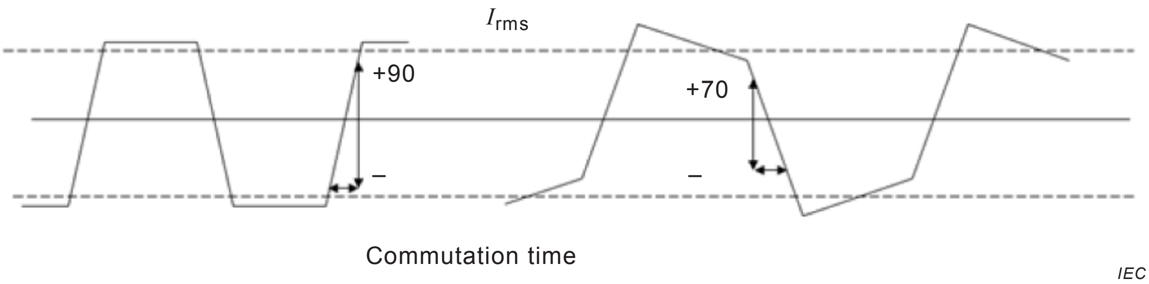
8.6 Average peak current ratio

The peak current ratio is determined according to the way described in 7.4.2, in this case the resistors will realize a lamp voltage of 75 V to 120 V. The APCR shall be lower than 1,5.

NOTE For possible future lamp designs with a different voltage range, the limits of 75 V and 120 V can be replaced with “lower limit” and “upper limit”.

8.7 Commutation time

The commutation time shall be lower than the value given in IEC 61167, Annex G in the section dealing with steady state operation. The commutation time is measured according the schemes given in Figure 3. For square waves, the time between the 90 % levels is used. For deviating waveforms, it is allowed to use the time between the 70 % levels, this value shall be multiplied by 1,3.



I_{rms} is the rms value of the current and is used as reference for the percentage.

Figure 3 – Commutation time, deviating waveform

8.8 HF ripple

The HF ripple is expressed in SPR (spectral power ratio) and the SPR shall be below 1,5. The method of determining the SPR is described in Annex E.

NOTE The limitation of the HF ripple serves as the limitation of acoustic resonance and flicker.

8.9 Control interfaces

Requirements are specified in Annex D of this standard and for digital addressable lighting interface in IEC 62386 series. The manufacturer's specification shall also be followed.

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

8.10 Operating sustainability

The associated lamp shall not extinguish, when the voltage of the power supplied to the controlgear goes down to 90 % of the rated supply voltage. Compliance is tested by the following method.

Requirements for the equipment are:

- the power supply shall be able to perform the voltage fluctuation test according to IEC 61000-4-14;
- the lamp used for this test shall have a lamp voltage in the range of the typical value up to typical value plus 10 V;
- the supply voltage is set at the rated input voltage.

The test procedure is as follows.

- Start the lamp.
- Continue operating the lamp until the controlgear and lamp reach steady state.
- Dip the supply voltage from 100 % to 90 % of rated voltage at 0° ± 10° of voltage phase.
- Hold 90 % more than 10 s to observe any extinction.
- Return the supply voltage to 100 %.
- Maintain this level for 1 min.

Compliance: lamp shall not extinguish during the 3 cycles of this test.

9 Displacement factor

For the a.c. supplied electronic controlgear, the measured or calculated displacement factor shall not be lower than the marked value minus 0,05 when the controlgear is operated with one or more reference lamp(s) and the whole combination is supplied at its rated voltage and frequency. (The calculation is based upon the measured power factor and the total harmonic distortion.)

For controllable controlgear, the displacement factor is measured or calculated at full power.

NOTE In Japan, displacement factor will not be used, there power factor will be used, where the power factor is power divided by the product of voltage and current.

10 Supply current

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

11 Endurance

11.1 General

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

Tests are done in sequence with the same controlgears.

Dimmable controlgear is tested at 100 % power.

If a thermal protection of the controlgear would operate and reduce power below 100 %, this thermal protection shall be disabled for the test. The modification shall not influence other controlgear features.

11.2 Temperature cycling at −20 °C and at +80 °C

The temperature cycle test is as follows.

a) Test samples: 5
b) Temperature range of the test:
   - minimum test temperature = −20 °C ± 3°C,
   - maximum test temperature = +80 °C ± 2°C

   The ambient temperature in the chamber shall be measured within 200 mm from the test samples.
c) Measurement of the input current (after a stabilization time) of the controlgear at 25 °C ± 5 °C before performing the temperature cycle test.
d) Connect the controlgear with the mains and the lamp(s) at 25 °C ± 5 °C (maximum load) and place the controlgear in a temperature test chamber. The lamp(s) are placed outside of the temperature chamber. The minimum distance between the electronic controlgears shall be 5 cm.
e) The test routine of 220 cycles is as follows.

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 depend on the speed of the airflow and shall allow a homogeneous temperature around all DUTs.
2) With the control gear in off position, decrease the temperature in the test chamber to the minimum test temperature with the following conditions (see Figure 4).
   i) Initial 10 % of the transition of temperature: No requirements for temperature change rate.
   ii) Next 80 % of the transition of temperature: dt = 10 K/min to15 K/min
   iii) Final 10 % of the transition of temperature: Over/undershoot shall not exceed ±5 °C from the target ambient temperature. Total transition time (t) shall not exceed 15 min.

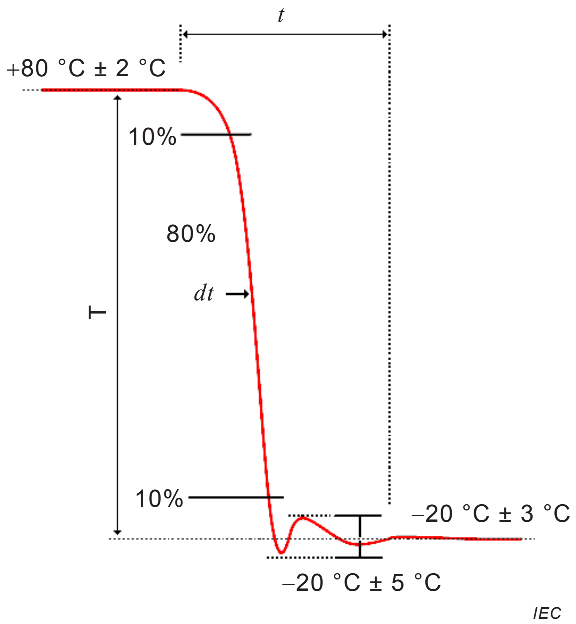


Figure 4 – Example of the cycling described under 11.2; Clause E.2

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 controlgear.
5) With the controlgear in on position, increase the temperature in the test chamber to the maximum test temperature with the following conditions.
   i) Initial 10 % of the transition of temperature: no requirements for temperature change rate.
   ii) Next 80 % of the transition of temperature: dt = 10 K/min to15 K/min
   iii) Final 10 % of the transition of temperature: over/undershoot shall not exceed ±5 °C from the target ambient temperature. Total transition time (t) shall not exceed 15 min.
6) At the maximum temperature level switch off the controlgear after 50 min and start 10 switching cycles (10 s on / 50 s off).
7) Repeat 219 times, steps 2 to 6.

f) Measurement of the input current of the controlgear at 25 °C ± 5 °C.

Compliance: After performing this test and after cooling down to room temperature, all controlgear shall correctly start and operate an appropriate lamp(s) for 15 min. According to step f), 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 ± 5 °C.

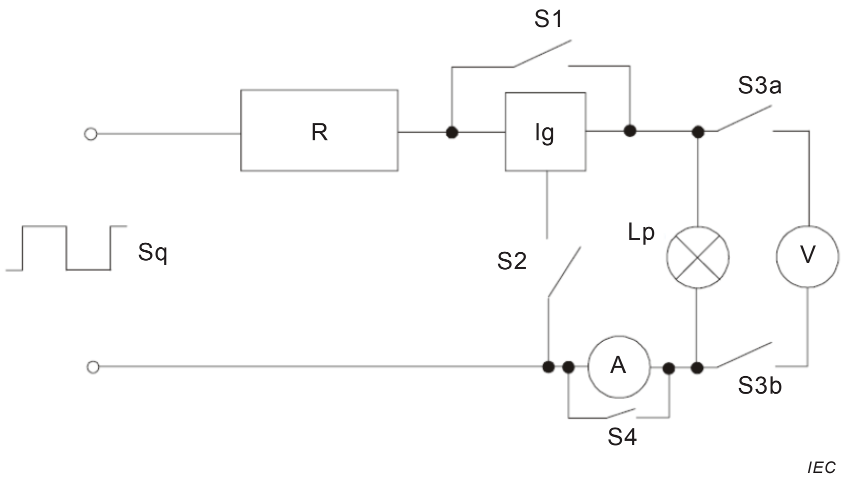
NOTE 1 In Japan, the test chamber with 1 K/min to 15 K/min is applied

NOTE 2 Paralleled lamps (for example 5 lamps) can be used if the cycle does not lead to the ignition of the lamp(s).

11.3 Test at t_c +10 K

The controlgears shall be operated at an ambient temperature which produces t_c +10 K, until a test period of 200 h has elapsed.

Compliance: After performing this test, the controlgear are disconnected from the mains and after cooling down to room temperature, all controlgear 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. If the ballast is equipped with protection devices, these are reset before performing the compliance test.



Key
Sq square wave supply
Lp lamp
R reference ballast (resistor)
Ig ignitor

Figure 5 – Low frequency square wave reference circuit

Annex A
(normative)

Tests

A.1 General requirements

A.1.1 General

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

A.1.2 Ambient temperature

Tests shall be made in a draught-free room and at an ambient temperature within the range 20 °C to 27 °C. For those tests which require constant lamp performance, the ambient temperature around the lamp shall be within the range 20 °C to 30 °C.

A.1.3 Supply voltage and frequency

A.1.3.1 Test voltage and frequency

Unless otherwise specified, the controlgear to be tested shall be operated at its rated voltage and the reference ballast at its rated voltage and frequency. When a controlgear is marked for use on a rated supply voltage range or different separate rated supply voltages, any voltage(s) for which it is intended may be chosen as the rated voltage used in the tests.

A.1.3.2 Stability of supply and frequency

For most of the tests, the supply voltage and, where appropriate for the reference controlgears 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.1.3.3 Supply voltage waveform

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

A.1.4 Magnetic effects

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

A.1.5 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 according its intended use.

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

A.1.6 Reference lamp stability

Before doing measurements with the reference lamp it shall be ensured that the reference lamp is stable.

- A lamp shall be brought to a condition of stable operation before carrying out measurements. Operational stability is achieved when three consecutive measurements of the lamp's electrical characteristics (V, I, W), are within ±2,5 % of its preceding value over a 5 min period.
- The characteristics of a lamp shall be checked immediately before and immediately after each series of tests in accordance with Annex C.

A.1.7 Reference ballast

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

A.1.8 Instrument characteristics

A.1.8.1 Potential circuits

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

A.1.8.2 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.

A.1.8.3 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, this should only be done if the mains is floating.

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 "low frequency square wave 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 Reference ballast for frequencies of 70 Hz to 400 Hz

The requirements for a reference low frequency square wave ballast can be found in Table E.1 of IEC 61167. This ballast is used for the operating characteristics of Clause B.3.

Since the type of low frequency square wave 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.

A low frequency square wave 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.2.2 Protection

The controlgear 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 change 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 controlgear enclosure.

Moreover, the controlgear shall be protected against mechanical damage.

B.3 Operating characteristics for low frequency square wave

B.3.1 General

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

B.3.2 Impedance

The impedance of a low frequency square wave reference ballast shall have the value given on the relevant lamp data sheets in IEC 61167, 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.3.3 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.4 Circuit for frequencies of low frequency square wave (see Figure 5)

B.4.1 Power supply

The low frequency square wave voltage supply used for the adjustment of or test with the low frequency square wave reference ballast shall be such that at full load the commutation time is smaller than 200 µs.

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.4.2 Instruments

All instruments used in low frequency square wave reference ballast measurements should be suitable for high frequency operation.

Details are under consideration.

B.4.3 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.

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 3.2 if, when associated with a reference ballast under the conditions defined in Annex A and operating in an ambient temperature of (25 ± 5) °C, the lamp voltage does not deviate by more than 5 % from the corresponding typical value given in IEC 61167.

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

The waveform of the current passed by a stabilized reference lamp associated with 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
(normative)

Control interface for controllable controlgear

D.1 Overview

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

If the control signal is not connected, the controlgear shall give the maximum value of output power or the system failure level, if applicable.

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

D.2 Control by d.c. voltage

D.2.1 Circuit diagram – Functional specification for d.c. voltage control (see Figure D.1)

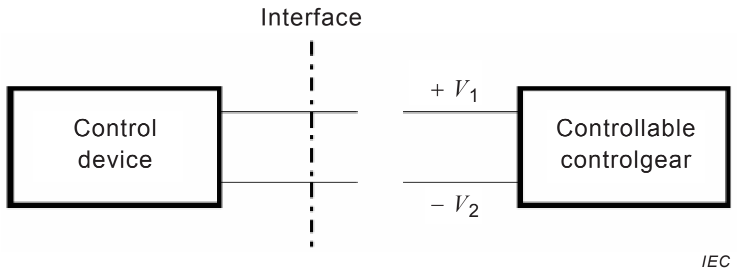


Figure D.1 – Schematic representation of the interface for 1 V to 10 V

The arc power of a controllable controlgear is controlled by the d.c. voltage on the control input of the controllable controlgear. 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.

D.2.2 Connection diagram

Depending on current-carrying capacity, several controllable controlgear can be connected to one control device, as shown in Figure D.2.

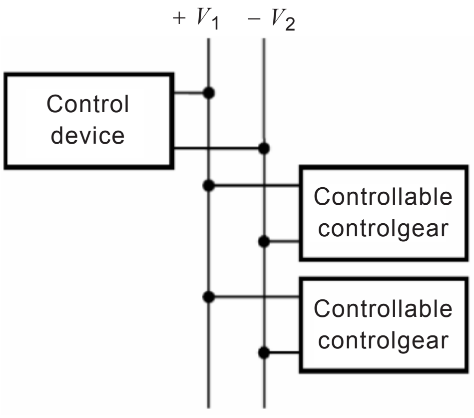


Figure D.2 – Control device for multiple controlgear, for 1 V to 10 V

D.2.3 Electrical specifications

D.2.3.1 Circuit diagram

The controllable controlgear is current sourcing (see Figure D.3).

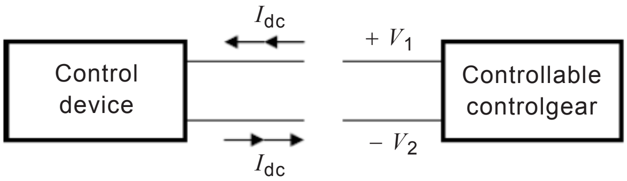


Figure D.3 – Control device is a current source

D.2.3.2 Control input voltage limits

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

D.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 controlgear.

D.2.3.4 Switch-on

Switch-on is allowed at any dimming position.

D.3 Control by pulse width modulation (PWM)

D.3.1 Circuit diagram – Functional specification for PWM control (see Figure D.4)

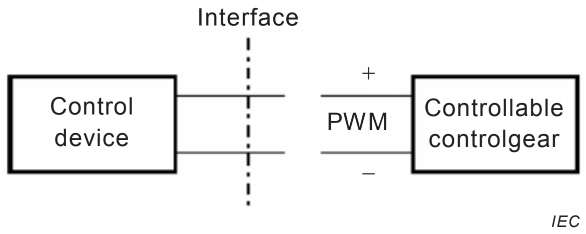


Figure D.4 – Schematic representation of the interface for PWM dimming

The arc power of a controllable controlgear is controlled by the PWM signal on the control input of the controllable controlgear. 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, as shown in Figure D.5:

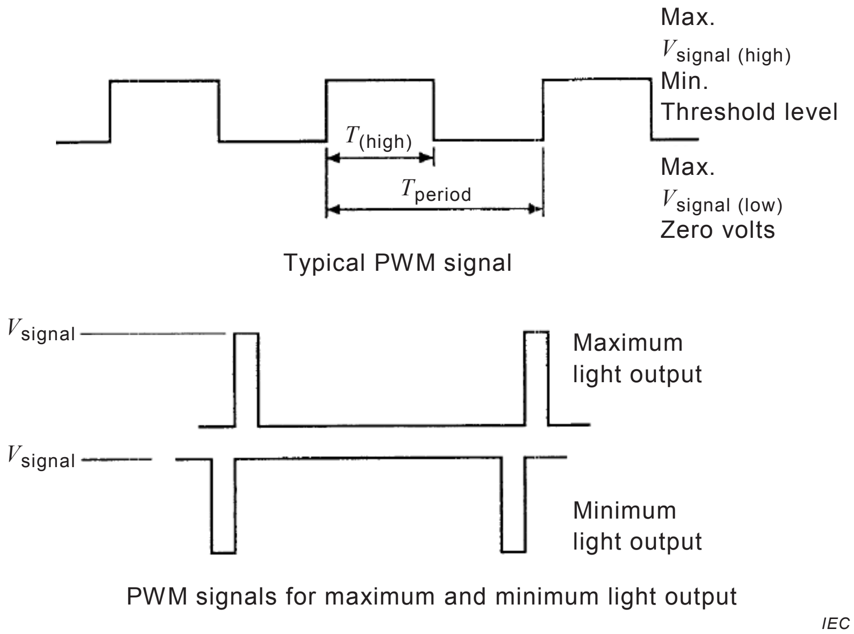


Figure D.5 – Some typically PWM signals

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.

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 %.

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

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

D.3.2 Connection diagram

Depending on current-carrying capacity, several controllable controlgear can be connected to one control unit, as shown in Figure D.6.

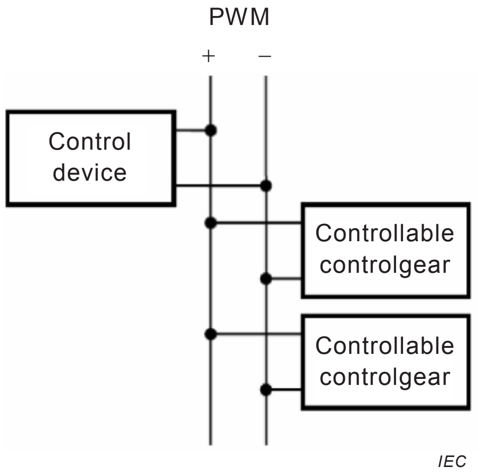


Figure D.6 – Control device for multiple controlgear, for PWM

D.3.3 Electrical specifications

D.3.3.1 General

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

D.3.3.2 Signal voltage limits

The controlgear 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 controlgear shall not operate.

D.3.3.3 Control terminals impedance

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

D.3.3.4 Input current

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

D.4 Control by DALI

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

Annex E
(normative)

Spectral analysis of power ripple: calculation procedure for amplitude spectrum ratio and guidance

E.1 General

This annex is applicable to measurements of the power ripple of lamps.

E.2 Mathematical background

In this subclause, the algorithm is described which is used to calculate the spectral power ratio of lamps. The measurement procedure stated in Clause E.4 is based on this algorithm and uses specific settings (listed under Clause E.4).

E.3 Description of the algorithm

Suppose that the instantaneous power signal is represented by a time sequence $x(k), \quad k = 0....N-1$,

where N is its length. N can be expressed as $N = T_{\text{rec}} \cdot F_{\text{s}}$ with T_{rec} being the whole time interval of the power signal and F_{s} being the sampling frequency. The sequence is divided into K segments of length $T_{\text{seg}} = 1ms$, which are $L = T_{\text{seg}} \cdot F_{\text{s}}$ points each. A Blackman window function

$w(k+1) = 0{,}42 - 0{,}5 \cdot \cos(2 \cdot \pi \cdot k \cdot (L-1)) + 0{,}08 \cdot \cos(4 \cdot \pi \cdot k \cdot (L-1)), \quad k = 0{,}1,......,L-1$ is applied to each segment. The segments shall have 50 % overlap ($M = 0{,}5 \cdot T_{\text{seg}} \cdot F_{\text{s}}$ points).

The number of segments can be found as

$$K = \frac{N-M}{L-M}. \quad \text{(E.1)}$$

The segments partitioned from the entire N data points are represented by sequences

$$x_m(k) = x(k + (m-1)(L-M)) \quad \text{(E.2)}$$

for k = 0, 1, · , L − 1 and m = 1, · , K . The averaged amplitude spectrum can be written as

$$\overline{S}_x(n) = \frac{1}{K} \sum_{m=1}^{K} \left| \sum_{k=0}^{L-1} w(k) x(k + (m-1)(L-M)) e^{-jn\frac{2\pi k}{L}} \right| \quad \text{(E.3)}$$

for n = 0, 1,....., L − 1. The outer summation in Equation (E.3) represents averaging operation over the segments, and its argument is the Discrete Fourier Transform of a segment. The averaged amplitude spectrum (Equation (E.3)) can be computed as

$$\overline{S}_x(n) = \frac{1}{K}\sum_{m=1}^{K}\left|FFT(X_w(m))\right| \qquad \text{(E.4)}$$

for $n = 0, 1, \ldots\ldots, L-1$ and with the vector $X_w(m)$ obtained using Equation E.2 as

$$X_w(m) = \left[w(0)x_m(0) \quad w(1)x_m(1) \quad \ldots \quad w(L-1)x_m(L-1)\right]$$

The result in Equation (E.4) is a so-called two-sided amplitude spectrum. The averaged amplitude spectrum ratio with respect to the d.c. component S_x (0) is a sequence

$$\left\{1 \quad \frac{S_x(1)}{S_x(0)} \quad \ldots \quad \frac{S_x(n)}{S_x(0)}\right\} \qquad \text{(E.5)}$$

with the corresponding frequency vector $f_x = \left[0 \quad 1 \quad \ldots \quad n\right] \cdot F_s / L$ till $n =$ $(L/2) - 1$. Note that the window function $w(k)$ does not have to be normalized to obtain Equation (E.5).

E.4 Measurement procedure

The electronic gear is connected to the mains voltage supply. The output terminals are connected to the intended lamp.

The procedure and settings are as follows.

The mains voltage is switched on and the ballast is left for stabilizing during 15 min.

A digital scope is used to measure the current and voltage. The scope shall be able to sample two channels simultaneously with at least 200 000 points at a sampling frequency of 2 MHz, as given in Table E.1. After 15 min, the current and voltage waveforms are recorded with the scope using the settings listed in the table below. The signals shall be acquired on a full vertical scale with at least 8 bit resolution. The sampled current and voltage values are multiplied point by point to get the power signal, which is then analyzed with the algorithm described under Equation (E.2), using these parametric values:

Table E.1 – Settings for the analysis

Sampling frequency (F_s) minimum	2 MHz (Sampling time T_s = 0,5 µs)
Total recorded time (T_{rec})	minimum 100 ms (N = 200 000 samples)
Window time (T_{seg})	1 ms (2 000 samples)
Window overlap time (T_{over})	0,5 ms (1 000 samples)
Window function ($w(k)$)	Blackman window

E.5 Test signal

E.5.1 General

In order to test different implementations of the SPR measurement method in Clause E.2 a test signal (a current and a voltage waveform) will be described. The settings of the analyzing scope as in Clause E.3 are used.

E.5.2 Description of the test signal

The voltage form is constructed as follows.

An ideal square wave voltage of 100 V_{rms} and a frequency of 100 Hz is sampled at a sampling rate of 2 MHz. The sampling starts at the rising edge of the square wave. A sine voltage wave is superimposed on this square wave. The sine wave has an amplitude of 1 V and a frequency of 50 kHz, representing a 1 % voltage ripple.

$$V_{square}[k] = (-1)^x \cdot 100 \quad \text{with } x = \begin{cases} 2 \text{ if } k = (l + 20\,000 \cdot m) \\ \qquad\qquad \text{and } l = 0 \ldots 9\,999 \text{ and } m = 0 \ldots 4 \\ 1 \text{ if } k = (10\,000 + l + 20\,000 * m) \end{cases}$$

$V_{ripple}(k) = 1 \cdot \sin(50 * \pi * 10^{-3} \cdot s)$ with $s = 0 \ldots 2 \cdot 10^5 - 1$

$V_{testsignal} = V_{square}[k] + V_{ripple}[k]$

The current waveform is constructed as follows.

An ideal square wave current of 1 A_{rms} and a frequency of 100 Hz is sampled at a sampling rate of 2 MHz. The sampling starts at the rising edge of the square wave. A sine current wave is superimposed on this square wave. The sine wave has an amplitude of 0,01 A and a frequency of 50 kHz, representing a 1 % current ripple.

$$I_{square}[k] = (-1)x \cdot 100 \quad \text{with } x = \begin{cases} 2 \text{ if } k = (l + 20\,000 \cdot m) \\ \qquad\qquad \text{and } l = 0 \ldots 9999 \text{ and } m = 0 \ldots 4 \\ 1 \text{ if } k = (10\,000 + l + 20\,000 * m) \end{cases}$$

$I_{ripple}(k) = 0,1 \cdot \sin(50 * \pi * 10^{-3} \cdot s)$ with $s = 0 \ldots 2.10^5 - 1$

$I_{testsignal} = I_{square}[k] + I_{ripple}[k]$

E.5.3 Outcome of the test signal

If the calculation of the SPR is done as explained in Clause E.2, the outcome for the here described test signal should be an SPR value of 0,90 %.

Annex F
(normative)

Open circuit voltage method of measurement for pulse ignition

The open circuit voltage is defined by two parameters:

- rms voltage,
- peak voltage.

The open circuit voltage shall be determined when the controlgear is operating at supply voltage of 92 % and 106 % of the rated value or in case of a rated voltage range at 92 % of the minimum value of the range and 106 % of the maximum value of the range as defined on the controlgear label, measured on the lamp terminals of the controlgear with at least 1 MΩ connected, including the impedance of the measuring instruments.

RMS voltage

The rms open circuit voltage measurement shall include at least five full periods of voltage waveforms of the OCV. The instantaneous voltage to be considered shall be limited (clipped) in a window defined by ± 500 V.

Peak voltage

The OCV is considered to be the voltage on which the ignition pulse is superimposed.

The ignition pulses shall not be included in the measurement.

In case the ignition pulse is at the maximum level of the OCV, the OCV value is the average value of the OCV before ignition pulse and the OCV value just after the ignition pulse.

NOTE 1 The testing instrumentation can be subjected to high voltage pulses which could lead to its damage. This can be avoided by the use of a HV probe for example.

Limiting the input voltage range might result in input amplifier use outside specified range, special care should be taken that wave forms are not deformed.

NOTE 2 The proper RMS measuring instruments can be used instead of oscilloscope, as long as the voltages are clipped to ± 500 V.

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