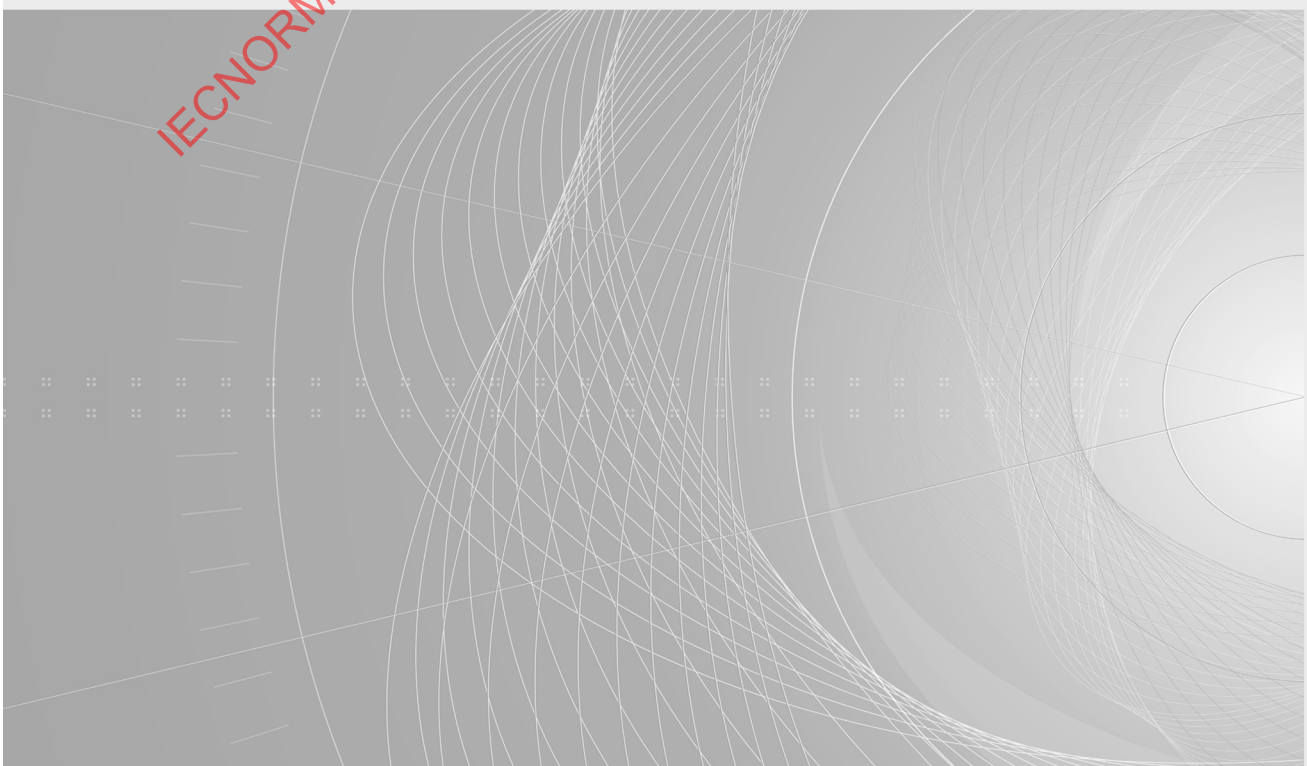
IEC TR 63130

Edition 1.0 2018-05

TECHNICAL REPORT

colour inside

Dimming and hot restrike of metal halide lamps



IEC TR 63130:2018-05(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

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

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.140.01

ISBN 978-2-8322-5750-0

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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DIMMING AND HOT RESTRIKE OF METAL HALIDE LAMPS

FOREWORD

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IEC TR 63130, which is a Technical Report, has been prepared by subcommittee 34A: Lamps, of IEC technical committee 34: Lamps and related equipment.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
34A/2012/DTR	34A/2027/RVDTR

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

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

This document is to be used in conjunction with IEC 61167:2015.

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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

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

Much work has been carried out in recent years on “advanced” properties of metal halide lamps, particularly on the subject of hot restrike and dimming. These issues have been discussed within SC 34A. However, the changes in technology and the focus of experts in the field of lighting products has meant that there is now less market relevance or interest or resources available to carry this work through with a view to publishing amendments to IEC 61167, the standard on metal halide performance.

It was therefore considered that the publication of this "state of the art" data as a Technical Report would be more useful. This document represents the current state of experts’ opinions on how metal halide lamps should be standardized to cover the relevant parameters for hot restrike and dimming.

This document contains additional comments and material with respect to IEC 61167.

This document is intended only as a guide for future standardizers and is not intended to be used normatively.

DIMMING AND HOT RESTRIKE OF METAL HALIDE LAMPS

1 Scope

This document describes the current state of experts' opinions on the standardization of metal halide lamps to cover the relevant parameters for hot restrike and for dimming in combination with low frequency square wave ballasts. It provides guidelines for supplementing or modifying IEC 61167 in order that these conditions are covered.

2 Normative references

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

IEC 61167:2015[1], *Metal halide lamps – Performance specification*

3 Terms and definitions

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

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

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

3.1
hot-restrike
ability of a lamp to restart immediately at any moment after switching off the lamp

3.2
superimposed symmetric pulse ignition
to be updated

Note 1 to entry: To update IEC 61167, a new definition is required, complying with the definition of ignition pulse voltage in IEC 61347-1:2015.

3.3
pulse width
to be updated

Note 1 to entry: To update IEC 61167, a new definition is required, see also Figure 1 proposed for Annex G.

3.4
pulse repetition frequency
to be updated

Note 1 to entry: To update IEC 61167, a new definition is required, see description in Annex G.

[1] Withdrawn.

3.5
pulse symmetry
to be updated

Note 1 to entry: To update IEC 61167, a new definition is required, see description in Annex G.

3.6
polarized base
base allowing for specified voltage behaviour with one pin defined as reference

4 Changes to IEC 61167 to specify hot restrike

4.1 General

The following additions and/or modifications to IEC 61167:2015 are expected to be necessary in order to make the standard suitable for specifying lamps for hot restrike and to give adequate information on low frequency ballast design.

Hot restrike of metal halide lamps is distinguished from the more common warm restrike situation where the lamp needs to cool down after switching off for a period long enough that the normal ignition circuit is sufficient to restart the lamp. Special lamp caps and controlgear are needed.

4.2 Lamp caps

At the time of publication of this document, lamps with caps G(X)14.5 are envisioned.

4.3 Starting and warm-up characteristics

Add the following subclause to IEC 61167:2015, 4.5:

Lamps suitable for hot-restrike on low frequency square wave ballasts only

In addition to the requirements of IEC 61167:2015, 4.5.2, the lamp shall be able to restart immediately at any moment after switching off the lamp.

4.4 Information on ballast, ignitor and luminaire design

Add the following content to IEC 61167:2015, Clause 5:

A remark on allowed re-ignition behaviour when lamps are switched off due to lamp fault and a statement that electrical interaction parameters are specified at the lamp terminals should be provided.

4.5 Data sheets

Add the following data sheets to IEC 61167:2015, Clause 6.

Values where given are based on the state of the art investigations made on lamps with G(X)14.5 caps. Several parameters related to hot restrike are still open and are marked "under consideration". Some other parameters are marked as “xx”, indicating that they relate to other lamp characteristics not concerned with hot-restrike behaviour.

	METAL HALIDE LAMP **DATA SHEET**	Page 1

Nominal wattage	Correlated colour temperature (nominal)	Version	Cap
xx	xx	Single-capped	G(X)14.5

Dimensions (mm)			
A (max.)	B (max.)	C	D (nom.)
xx	xx	xx	xx

See sheet …

Run-up characteristics at rated supply voltage [1]		
Max. time to 90 % lumens	min	xx

Restarting characteristics [1]		
Maximum time to hot re-strike	s	5

Electrical characteristics under square wave conditions in steady state operation [1]		
Rated wattage for ballast design W	Typical lamp voltage V	Typical lamp current A
xx	xx	xx
This lamp is suitable for operation on low frequency square wave ballasts only. Initial lamp voltages shall be in the range of 75 V to 110 V. Manufacturers may have different target values for lamp voltage and the current will vary accordingly.		

Colour characteristics (nominal) [1]		
Correlated colour temperature	K	xx
Chromaticity co-ordinate x		xx
Chromaticity co-ordinate y		xx
Colour rendering index Ra		xx

Information on reference ballast (see Annex E)		
Series resistor of the low frequency square wave reference ballast	Ω	xx

[1] Values after 100 h ageing. Test position: vertical cap-up ± 5°.
* Under consideration

Values with xx refer to other lamp parameters, not specifically aiming at the hot-restrike behaviour.

	METAL HALIDE LAMP **DATA SHEET**	Page 2

Information for square wave ballast design (see Annex G)			
Superimposed symmetrical pulse ignition			
		Min.	Max.
Pulse height (pin-to-pin, measured with respect to reference pin)			
(positive) **AND** 1st half period	kV	9*	13 [2]
(negative) 2nd half period	kV	10*	13 [2]
Pulse width at 90 % peak (for T_pos and T_neg each)	ns	80	150
Pulse repetition frequency	Hz	200	
Ignition duration	s	5*	30*
Number of pulses during minimum ignition duration		1 000	
Voltage pin-to-ground	kV		8
Other wave shape parameters (t.b.d.)			
Open circuit voltage at breakdown	V	500	
Open circuit voltage during take-over (OCV_to)	V	*	* [3]
Duration OCV_to	s	*	*
Resistance at take-over	Ω	xx	
Resistance at run-up	Ω	xx	
The resistors for take-over and run-up are part of the set-up in order to measure the current.			
Run-up current: $I_{run\text{-}up}$	A	xx	xx
Steady state operation			
High frequency ripple limitation range	kHz	xx	xx
Performance limits of rated power for extended operation			
120 V to 135 V lamp voltage	%	xx	xx
>135 V to 150 V lamp voltage	%	xx	xx
Because of a possible risk that abnormal operating conditions may occur at the end of lamp life which can lead to ballast overheating, suitably protected circuits shall be used for the operation of this lamp.			

[2] This limit is for safety reasons.
[3] Related to end of life behaviour.
* Under consideration

Values with xx refer to other lamp parameters, not specifically aiming at the hot-restrike behaviour

4.6 Additions to IEC 61167:2015, Annex G (Low frequency square wave operation)

Add descriptions for the new parameters in the proposed data sheets, with explanatory diagrams such as Figure 1.

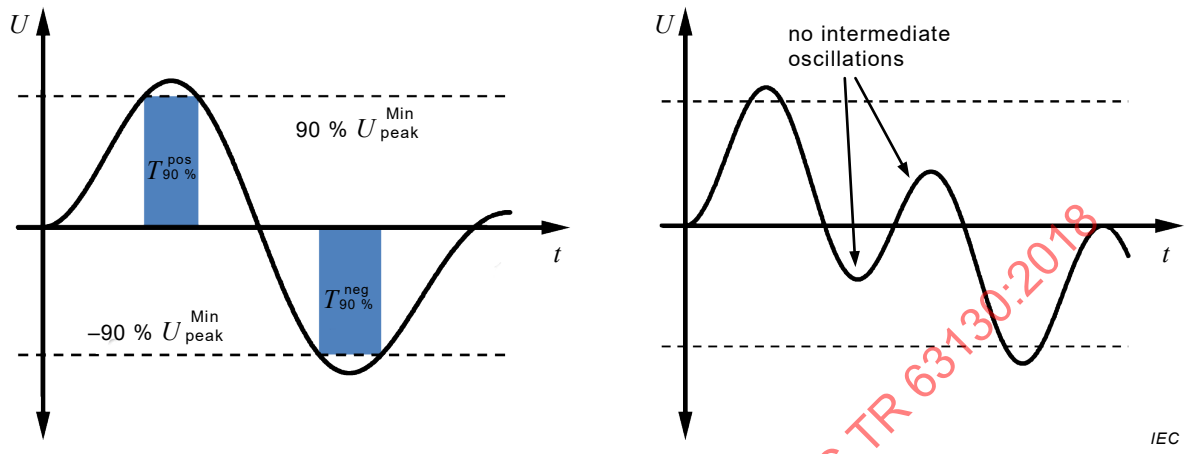

Figure 1 – Explanatory diagrams

5 Changes to IEC 61167 to specify dimming

5.1 General

In order to make IEC 61167 suitable for specifying lamps for dimming and to give adequate information for low frequency ballast design it would be necessary to append an extra clause to the current informative Annex G (Low frequency square wave operation) describing a new operating phase “Dimming operation”. In addition, new data sheets would be required for lamps declared as dimmable, incorporating data for all the parameters given in the new clause.

A proposed text to be added to IEC 61167:2015, Annex G is given in 5.2.

To give some background, clarification and reasoning to the choice of parameters in the proposed text, a more detailed description of each of the new parameters is given in 5.3.

5.2 Text for IEC 61167:2015, Annex G

Add the following content to IEC 61167:2015, Annex G:

Dimming operation

After starting the lamp, the lamps shall be allowed to run-up normally until the run-up time as specified on the data sheet, before dimming.

Add a new table (Table 1) giving information on dimming operation.

Table 1 – Requirements for dimming

Quantity	Description	Unit	Min.	Typ.	Max.
P_dim	**Lamp power to sustain dimmed operation**	W	[a]		
T_delay_dim	**Time to wait before dimming of the lamp**				
	Option 1: Time to wait before dimming using take-over as a reference	min	[a]		
	Option 2: Time to wait before dimming using lamp voltage as a reference	min	[a]		
	Dimming dynamics Power variation rate (maximum slope of power variation); to prevent extinguishing due to sudden re-ignition voltage peak rise two ranges are needed (split at x)				
x	Transition point	W		[a]	
	Dimming rate Rate of power decrease				
R_dim_1	100 % to x (%) of rated lamp power	W/s			[a]
R_dim_2	x (%) to P_dim_min of rated lamp power	W/s			[a]
	Commutation behaviour				
T_zc	Time to zero current From 70 % RMS current to 0 (see also IEC 61167:2015, Table G.1)	µs			[a]
P_comm	Instantaneous lamp power after commutation[b] Between 50 µs and 250 µs after current zero crossing for instantaneous lamp voltages up to 200 V and at all dimming power levels	W	[a]		
f_dim	Frequency for dimmed lamp operation	Hz	[a]		[a]
	Lamp power tolerance				
	Power tolerance – steady state				
	Lamp voltage range for power regulation	V	[a]		[a]
	Lamp power tolerance at demanded power level, as a percentage of rated lamp power	%	[a]		[a]
	Lamp power during first 60 s after achieving demanded power level				
	Lamp voltage range for power regulation	V	[a]		[a]
	Lamp power tolerance from demanded power level, as a percentage of rated lamp power	%	[a]		[a]
	High frequency ripple				
SPR	SPR	%			[a]
HF_rip	High frequency current ripple[b] For frequency range 20 kHz to 200 kHz Peak-to-peak / RMS value	%			[a]

[a] For values, see lamp data sheet.

[b] Further detailing under consideration.

5.3 Explanation of new parameters

Table 2 provides complementary information to Table 1. This could be given as an explanatory annex in IEC 61167.

Table 2 – Explanation of new parameters

Quantity	Description	Explanation
P_dim	Lamp power to sustain dimmed operation	Power applied to the lamp when the lamp is dimmed. The minimum dimming level is the lowest power level at which stable operation of the lamp can be ensured.
T_delay_dim	Time to wait before dimming of the lamp	An HID lamp needs to warm up before being dimmed to avoid becoming unstable, extinguishing or even suffering damage. To ensure the lamp has warmed up sufficiently, a delay time is specified. Two options are given:
	Option 1: Time to wait before dimming using take-over as a reference	The minimum time the lamp shall be operated after take-over before dimming can be applied.
	Option 2: Time to wait before dimming using lamp voltage as a reference	The minimum time the lamp shall be operated after attaining the minimum voltage for power regulation (see IEC 61167:2015, G.x.x) before dimming.
	Dimming dynamics Power variation rate (maximum slope of power variation); to prevent extinguishing due to sudden re-ignition voltage peak rise two ranges are needed (split at x)	During the process of dimming the lamp is not in thermal equilibrium and thus the discharge can be unstable. If the rate of power decrease is too fast, transitional states with high re-ignition voltage can occur and cause the lamp to extinguish. Staying below the maximum slope of power variation ensures that the lamp remains close to equilibrium at all times. Since the susceptibility of the lamp to these transitional states increases as the power level is reduced, initially (above a power level of x W) a faster power variation is permissible. For increasing power, the transitional states are not an issue allowing for faster rates.
x	Transition point	This point specifies the power level above which the faster fade-down rate may be applied. Below the point, the slower fade-down rate shall not be exceeded.
	Dimming rate Rate of power decrease	Speed of power decrease allowed during dimming.
R_dim_1	100 % to x (%) of rated lamp power	Maximum dimming rate between rated lamp power and transition point x.
R_dim_2	x (%) to P_dim_min of rated lamp power	Maximum dimming rate between transition point x and minimum power level P_dim_min.
	Commutation behaviour	During commutation (the reversal of polarity) the lamp current decreases to zero and then increases again with the opposite polarity. During dimming, the lamp is more susceptible to commutation dynamics, specifically the interruption of lamp current during commutation. This is affected by the effective off-time of the lamp current (T_zc + time to re-ignition) and the ability of the controlgear to provide power to the lamp at the increased voltage level after re-ignition.
T_zc	Time to zero current From 70 % RMS current to 0 (see also IEC 61167:2015, Table G.1)	Time to reach zero current has to be as short as possible to minimize cooling of arc plasma and/or electrodes.
P_comm	Instantaneous lamp power after commutation[a] Between 50 µs and 250 µs after current zero crossing for instantaneous lamp voltages up to 200 V and at all dimming power levels	During commutation, the lamp impedance increases considerably due to cooling of the arc and the electrodes. The controlgear should be capable of ensuring continued lamp operation. This is done by providing sufficient instantaneous power in the time range immediately after commutation at specified lamp voltages, independent of the dimming power level.