

TECHNICAL REPORT



**Equipment for general lighting purposes – EMC immunity requirements–
Part 1: An objective light flickermeter and voltage fluctuation immunity test
method**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.140.20

ISBN 978-2-8322-4904-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms, definitions, abbreviated terms and symbols.....	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms.....	9
3.3 Symbols.....	9
4 General	10
5 Light flickermeter	11
6 Voltage fluctuation disturbance signal.....	11
6.1 General.....	11
6.2 Mains signal parameters	13
6.3 Disturbance signal parameters and test levels	13
7 Test setup and equipment	15
7.1 General.....	15
7.2 Test voltage	15
7.3 Optical test environment	16
7.4 Light sensor and amplifier.....	16
7.5 Signals to be measured	16
7.6 Signal processing.....	17
7.6.1 Anti-aliasing filter.....	17
7.6.2 Sampling frequency.....	17
7.6.3 Signal resolution.....	18
8 Verification procedure.....	19
8.1 General.....	19
8.2 Light flickermeter	19
8.3 Mains voltage parameters without modulation	20
8.3.1 Nominal voltage level	20
8.3.2 Mains frequency	20
8.4 Voltage fluctuation level.....	20
8.4.1 General	20
8.4.2 Option 1: measure the actual modulation frequencies and voltage levels	20
8.4.3 Option 2: measure P_{st}^V -values using a flickermeter	20
8.5 Light sensor and amplifier	21
8.6 Test environment	21
8.7 Light flicker noise.....	21
9 Test procedure	21
10 Conditions during testing	22
11 Evaluation of the test result	22
12 Test report.....	23
Annex A (informative) Specification of the light flickermeter	24
A.1 Voltage flickermeter	24
A.2 Specification of the light flickermeter.....	25
A.2.1 General	25

A.2.2	Block a: illuminance adapter	25
A.2.3	Block b: weighting filters	25
A.2.4	Block c: squaring multiplier, sliding mean filter and scaling	26
A.2.5	Block d: statistical analysis	26
A.3	Verification of the light flickermeter	27
A.4	Example of P_{st}^{LM} implementation in MATLAB®	27
Annex B	(informative) Uncertainty considerations	28
B.1	General	28
B.2	General symbols	28
B.3	Measurand	28
B.4	Influence quantities	28
B.5	Uncertainty budget	30
Annex C	(informative) Examples of test results of lighting equipment	32
C.1	Test without voltage fluctuations	32
C.2	Test with (intentional) voltage fluctuations	32
C.3	Test under dimming conditions	36
Bibliography	38
Figure 1	– Full EMC approach for mains voltage fluctuations	11
Figure 2	– Definition of the mains test signal including a rectangular modulated voltage fluctuation (see Equation (1))	13
Figure 3	– Block diagram voltage-fluctuation immunity test	15
Figure 4	– Example of a recorded mains voltage fluctuation and illuminance signal of a 60 W incandescent lamp	19
Figure A.1	– Structure of the IEC 61000-4-15 flickermeter which uses voltage as input	24
Figure A.2	– Structure of the light flickermeter	24
Figure C.1	– Graphical P_{st}^{LM} results for three EUTs with rectangular modulation at five frequencies ($P_{st}^V = 1$)	33
Figure C.2	– EUT1: recorded signals (no mains voltage modulation)	34
Figure C.3	– EUT1: recorded signals (with modulation)	35
Figure C.4	– EUT2: relative illuminance: mains voltage modulation $d = 0,407\%$ at 13,5 Hz ($P_{st}^V = 1$)	36
Figure C.5	– EUT3: relative illuminance: mains voltage modulation $d = 0,407\%$ at 13,5 Hz ($P_{st}^V = 1$)	36
Figure C.6	– Graphical P_{st}^{LM} results for four EUTs under dimming conditions	37
Table 1	– Voltage fluctuations – Test specification of voltage fluctuations applied at input AC power ports 120/230 V; 50/60 Hz	14
Table A.1	– Test specification of illuminance fluctuations for lightmeter classifier	27
Table B.1	– Influence quantities and their recommended tolerances	29
Table B.2	– Uncertainty budget of the voltage fluctuation immunity test	31
Table C.1	– Numerical results P_{st}^{LM} calculations for three EUTs without voltage modulation	32
Table C.2	– Numerical results P_{st}^{LM} calculations for three EUTs with voltage modulation	32
Table C.3	– Numerical results P_{st} calculations for four EUTs under dimming conditions	37

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**EQUIPMENT FOR GENERAL LIGHTING PURPOSES –
EMC IMMUNITY REQUIREMENTS–****Part 1: An objective light flickermeter and voltage fluctuation
immunity test method**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 61547-1, which is a Technical Report, has been prepared by technical committee 34: Lamps and related equipment.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the title of Part 1 has been changed to reflect the more general application of the objective flickermeter;
- b) the specific voltage fluctuation immunity test method has been extended for lighting equipment rated for 120 V AC and 230 V AC, 50 Hz and 60 Hz.

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

Draft TR	Report on voting
34/387/DTR	34/398A/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.

A list of all parts in the IEC 61547 series, published under the general title *Equipment for general lighting purposes – EMC immunity requirements*, can be found on the IEC website.

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

The fast rate at which solid state light (SSL) sources can change their intensity is one of the main drivers behind the revolution in the lighting world and applications of lighting. Linked to the fast rate of the intensity change is a direct transfer of the modulation of the driving current, both intended and unintended, to a modulation of the luminous output. This light modulation can give rise to changes in the perception of the environment. While in some very specific entertainment, scientific or industrial applications, a change of perception due to light modulation is desired, for most everyday applications and activities the change is detrimental and undesired. The general term used for these changes in the perception of the environment is “temporal light artefacts” (TLAs) and these can have a large influence on the judgment of the light quality. Moreover, the visible modulation of light can lead to a decrease in performance, increased fatigue as well as acute health problems like epileptic seizures and migraine episodes [18][19]¹.

Different terms exist to describe the different types of TLAs that may be perceived by humans. The term ‘flicker’ refers to light variation that may be directly perceived by an observer. ‘Stroboscopic effect’ is an effect which may become visible for an observer when a moving or rotating object is illuminated (CIE TN 006:2016[22]).

Possible causes for light modulation of lighting equipment that may give rise to flicker or stroboscopic effect are:

- AC supply combined with light source technology and its driver topology;
- dimming technology of externally applied dimmers or internal light level regulators;
- mains voltage fluctuations caused by electrical apparatus connected to the mains (conducted electromagnetic disturbances) or intentionally applied for mains-signalling purposes.

Lighting products that show unacceptable flicker or stroboscopic effect are considered as poor quality lighting.

This document provides an objective light flickermeter and a method for testing the immunity of lighting equipment against mains voltage fluctuations caused by electrical apparatus connected to the mains at levels that are allowed through IEC 61000-3-3.

Flicker perception, as well as IEC 61000-3-3 and IEC 61000-4-15, the associated standards for voltage fluctuations and flickermeter, are based on the 60 W incandescent lamp. As a result of the phasing out of incandescent lamps and the widespread introduction of alternative lighting equipment technologies, a new reference lamp was considered. It has been demonstrated that new lighting technologies are in general less but sometimes also more sensitive to supply voltage fluctuations than the current 60 W incandescent lamp. A CIGRE working group has assessed the impact of new lighting technologies on the existing flicker standards [17]. For the moment, the present flicker sensitivity curve of IEC 61000-3-3 remains as the reference. However, because of the increased diversity of sensitivity of lighting equipment to voltage fluctuations, there is a future need for a voltage-fluctuation immunity test specifically for lighting equipment. In this way, the full EMC approach (Figure 1) is introduced for flicker, i.e. with a view to limiting voltage fluctuations caused by equipment connected to the grid, and in addition to establishing a minimum level of flicker immunity of lighting equipment against these voltage fluctuations.

This document will allow the lighting industry to gain experience in flicker immunity test methods. Results of actual tests will be reported in a separate IEC Technical Report. Based on the experience gained on this immunity test method, the adoption of a similar test to be applied for IEC 61547, the immunity standard for lighting equipment, will be considered.

¹ Numbers in square brackets refer to the Bibliography.

EQUIPMENT FOR GENERAL LIGHTING PURPOSES – EMC IMMUNITY REQUIREMENTS –

Part 1: An objective light flickermeter and voltage fluctuation immunity test method

1 Scope

This part of IEC 61547 describes an objective light flickermeter, which can be applied for, amongst others, the following purposes:

- testing the intrinsic performance of all lighting equipment without voltage fluctuations;
- testing the immunity performance of lighting equipment against (unintentional) voltage fluctuation disturbance on the AC power port;
- testing the immunity performance of lighting equipment against intentional voltage fluctuation on the AC power port arising for example from ripple control systems.

The object of this document is to establish a common and objective reference for evaluating the performance of lighting equipment in terms of illuminance flicker. Temporal changes in the colour of light (chromatic flicker) are not considered in this test.

This method can be applied to lighting equipment which is within the scope of IEC technical committee 34, such as lamps and luminaires, intended for connection to a low voltage electricity supply. Independent auxiliaries such as drivers can also be tested by application of a representative light source to that auxiliary.

The objective light flickermeter and voltage fluctuation immunity method described in this document are based on the IEC 61000-3-3 standard for voltage fluctuation limits and the flickermeter standard IEC 61000-4-15.

The objective light flickermeter described in this document can be applied to objectively assess flicker of lighting equipment that is powered from any type of source, AC mains, DC mains, battery fed or fed through an external dimmer. The specific voltage fluctuation immunity test method described in this document applies to lighting equipment rated for 120 V AC and 230 V AC, 50 Hz and 60 Hz.

NOTE The principle of the method can be applied for other nominal voltage and frequency ratings.

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 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-4-15:2010, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*