IEC TR 61547-1

Edition 3.0 2020-07

TECHNICAL REPORT

This document is a preview generated by EVS

colour inside

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



IEC TR 61547-1:2020-07

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

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

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

This document is a preview generated by EVS

IEC TR 61547-1

Edition 3.0 2020-07

TECHNICAL REPORT

This document is a preview generated by EVS

colour inside

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 29.140.20

ISBN 978-2-8322-8532-9

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

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms, definitions, abbreviated terms and symbols 9
3.1 Terms and definitions 9
3.2 Abbreviated terms 10
3.3 Symbols 11
4 General 11
5 Light flickermeter 13
6 Voltage fluctuation disturbance signal 13
6.1 General 13
6.2 Mains signal parameters 14
6.3 Disturbance signal parameters and test levels 15
7 Test setup and equipment 16
7.1 General 16
7.2 Test voltage 17
7.3 Optical test environment 17
7.4 Light sensor and amplifier 18
7.5 Signals to be measured 18
7.6 Signal processing 18
7.6.1 Anti-aliasing filter 18
7.6.2 Sampling frequency 19
7.6.3 Signal resolution 19
8 Verification procedure 21
8.1 General 21
8.2 Light flickermeter 21
8.3 Mains voltage parameters without modulation 22
8.3.1 Nominal voltage level 22
8.3.2 Mains frequency 22
8.4 Voltage fluctuation level 22
8.4.1 General 22
8.4.2 Option 1: measure the actual modulation frequencies and voltage levels 22
8.4.3 Option 2: measure $P_{\mathrm{st}}^{\mathrm{V}}$ values using a flickermeter 22
8.5 Light sensor and amplifier 23
8.6 Test environment 23
8.7 Light flicker noise 23
9 Test procedure 24
9.1 General 24
9.2 Measuring the intrinsic flicker performance 25
9.3 Testing the flicker immunity against voltage fluctuations 26
9.4 Dimmer compatibility testing 26
9.5 Controlgear testing 27
10 Conditions during testing 27
11 Evaluation of the test result 28

This document is a preview generated by EVS

12 Test report 28
Annex A (informative) Specification of the light flickermeter 29
A.1 Voltage flickermeter modifications 29
A.2 Specification of the light flickermeter 30
A.2.1 General 30
A.2.2 Block a: illuminance adapter 30
A.2.3 Block b: weighting filters 30
A.2.4 Block c: squaring multiplier, sliding mean filter and scaling 31
A.2.5 Block d: statistical analysis 31
A.3 Verification of the light flickermeter 32
A.4 Example of P_{st}^{LM} implementation in MATLAB® 33
Annex B (informative) Uncertainty considerations 34
B.1 General 34
B.2 General symbols 34
B.3 Measurand 34
B.4 Influence quantities 34
B.5 Uncertainty budget 36
Annex C (informative) Examples of test results of lighting equipment 38
C.1 Test without voltage fluctuations (P_{st}^{LM}) 38
C.2 Test with (intentional) voltage fluctuations P_{st}^{LM} (I) 38
C.3 Test under dimming conditions 42
Annex D (informative) Guidance for P_{st}^{LM} testing based on test type 44
Bibliography 45

Figure 1 – Full EMC approach for mains voltage fluctuations 12
Figure 2 – Illustration of the mains test signal including a rectangular modulated voltage fluctuation (see Equation (1)) 14
Figure 3 – Block diagram voltage-fluctuation immunity test 17
Figure 4 – Example of a recorded mains voltage fluctuation and illuminance signal of a 60 W incandescent lamp 21
Figure 5 – Measuring P_{st}^{LM} 26
Figure 6 – Measuring P_{st}^{LM} (I) 26
Figure 7 – Dimmer compatibility testing 26
Figure 8 – Controlgear testing 27
Figure A.1 –Structure of the IEC 61000-4-15 flickermeter that uses voltage as input 29
Figure A.2 – Structure of the light flickermeter based on a modified voltage flickermeter 29
Figure A.3 – Flickermeter response to different waveshapes 33
Figure C.1 – Graphical $P_{st}^{LM}(I)$ results for three EUTs with rectangular modulation at five frequencies ($P_{st}^{V} = 1$) 39
Figure C.2 – EUT1: recorded signals (no mains voltage modulation) 40
Figure C.3 – EUT1: recorded signals (with modulation) 41

This document is a preview generated by EVS

Figure C.4 – EUT2: relative illuminance – Mains voltage modulation d = 0,407 % at 13,5 Hz ($P_{st}^{V} = 1$) 42

Figure C.5 – EUT3: relative illuminance – Mains voltage modulation d = 0,407 % at 13,5 Hz ($P_{st}^{V} = 1$) 42

Figure C.6 – Graphical P_{st}^{LM} (C) results for four EUTs under dimming conditions 43

Table 1 – Voltage fluctuations – Test specification of voltage fluctuations applied at input AC mains 120/230 V and 50/60 Hz 16

Table 2 – Guidance for P_{st}^{LM} testing 25

Table A.1 – Test specification of illuminance fluctuations for lightmeter classifier 32

Table B.1 – Influence quantities and their recommended tolerances 35

Table B.2 – Uncertainty budget of the voltage fluctuation immunity test 37

Table C.1 – Numerical results P_{st}^{LM} calculations for three EUTs without voltage modulation 38

Table C.2 – Numerical results P_{st}^{LM} (I) calculations for three EUTs with voltage modulation 38

Table C.3 – Numerical results P_{st}^{LM} (C) calculations for four EUTs under dimming conditions 43

Table D.1 – Guidance for P_{st}^{LM} testing based on test conditions 44

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

EQUIPMENT FOR GENERAL LIGHTING PURPOSES – EMC IMMUNITY REQUIREMENTS –

Part 1: Objective light flickermeter and voltage fluctuation immunity test method

This document is a preview generated by EVS

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 IEC technical committee 34: Lighting.

This third edition cancels and replaces the second edition published in 2017. This edition constitutes a technical revision.

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

a) the scope of this document has been clarified to make a distinction between flicker testing without voltage fluctuations to measure the intrinsic performance of lighting equipment and flicker testing in which a specific set of voltage fluctuations are applied in order to measure the immunity of the lighting equipment to voltage fluctuations present on the mains;
b) the test procedure for flicker testing has been clarified.

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

Draft TR	Report on voting
34/668/DTR	34/701/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.

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.

This document is a preview generated by EVS

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. These changes in the perception of the environment are called "temporal light artefacts" (TLAs) and 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 health problems like epileptic seizures and migraine episodes [17][18][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 [26]).

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;
– light regulation technology of externally applied light level regulators 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 are considered as poor-quality lighting.

This document provides a description of an objective light flickermeter and a method for measuring the intrinsic flicker of lighting equipment as well as 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 the 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 [16]. 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.

This document is a preview generated by EVS

---

1 Numbers in square brackets refer to the Bibliography.

EQUIPMENT FOR GENERAL LIGHTING PURPOSES – EMC IMMUNITY REQUIREMENTS –

Part 1: Objective light flickermeter and voltage fluctuation immunity test method

This document is a preview generated by EVS

1 Scope

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

– measuring the intrinsic performance of all lighting equipment without the application of voltage fluctuations in terms of illuminance flicker; during this measurement, the lighting equipment is supplied with a stable mains;

– testing the immunity performance of lighting equipment against (unintentional) voltage fluctuation disturbance on the AC mains in terms of illuminance flicker; during this test a set of defined voltage fluctuations are applied to the AC mains and the immunity of the lighting equipment to the disturbance is determined.

Apart from the above two purposes, the immunity performance of lighting equipment can also be tested against intentional voltage fluctuation on the AC mains arising for example from mains signalling. This is however not described in further detail in this document.

NOTE 1 IEC 61000-4-13:2015 [24] provides guidance regarding test levels and frequencies for mains signalling.

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 light level regulator. 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 2 The principle of the method can be applied for other nominal voltages 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*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61000-3-3 and IEC 61000-4-15 and the following 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

3.1.1
flicker
perception of visual unsteadiness induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a static environment

Note 1 to entry: The fluctuations of the light stimulus with time include periodic and non-periodic fluctuations and can be induced by the source itself, the power source or other influencing factors.

[SOURCE: CIE TN 006:2016]

3.1.2
flickermeter
instrument designed to measure any quantity representative of flicker

[SOURCE: IEC 60050-614:2016, 614-01-30]

3.1.3
voltage flickermeter
instrument which is designed to measure any quantity representative of flicker resulting from mains voltage fluctuations

Note 1 to entry: Specifications of the voltage flickermeter can be found in IEC 61000-4-15.

3.1.4
illuminance
quotient of the luminous flux $d\Phi_v$ incident on an element of the surface containing the point, by the area dA of that element

Equivalent definition. Integral, taken over the hemisphere visible from the given point, of the expression $L_v \cdot \cos\theta \cdot d\Omega$ where L_v is the luminance at the given point in the various directions of the incident elementary beams of solid angle $d\Omega$, and θ is the angle between any of these beams and the normal to the surface at the given point

$$E_v = \frac{d\Phi_v}{dA} = \int_{2\pi\ sr} L_v \cdot \cos\theta \cdot d\Omega$$

Note 1 to entry: Illuminance is expressed in lx or $lm \cdot m^{-2}$.

This document is a preview generated by EVS