

TECHNICAL REPORT



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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EQUIPMENT FOR GENERAL LIGHTING PURPOSES – EMC IMMUNITY REQUIREMENTS –

Part 1: An objective voltage fluctuation immunity test method

FOREWORD

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

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
34/212/DTR	34/220A/RVC

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 publication 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 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- withdrawn,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
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INTRODUCTION

Flicker perception, and the associated IEC 61000-3-3 standard for voltage fluctuations and the flickermeter IEC 61000-4-15, is 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. CIGRE working group C4.111 has assessed the impact of new lighting technologies on the existing flicker standards. Most likely, the present flicker sensitivity curve of IEC 61000-3-3 will stay as the reference, but 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. limit voltage fluctuations caused by equipment connected to the grid, and in addition establish a minimum level of flicker immunity of lighting equipment against these voltage fluctuations.

This technical report provides an objective method and procedure for testing the immunity of lighting equipment against mains voltage fluctuations. With this technical report, the lighting industry can gain experience with the flicker immunity test. Results of actual tests will be reported separately in IEC TR 61547-2.

Based on the experience with this immunity test method, the adoption of a similar test in the immunity standard for lighting equipment IEC 61547 will be considered.

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EQUIPMENT FOR GENERAL LIGHTING PURPOSES – EMC IMMUNITY REQUIREMENTS –

Part 1: An objective voltage fluctuation immunity test method

1 Scope

This Part of 61547, which is a Technical Report, establishes an objective method and procedure for testing the immunity performance of lighting equipment against voltage fluctuation disturbances on the a.c. power port.

The object of this Technical Report is to establish a common and objective reference for evaluating the immunity of lighting equipment in terms of illuminance flicker when subjected to mains voltage fluctuations. Temporal changes in the colour of the light (chromatic flicker) are not considered in this test.

This method and procedure 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 be tested also by application of a representative light source to that auxiliary.

The method and procedure described in this technical report are based on the IEC 61000-3-3 standard for voltage fluctuation limits and the flickermeter standard IEC 61000-4-15.

The test method described in this report applies to lighting equipment rated for 230 V a.c. and 50 Hz (for verification purposes).

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

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 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, abbreviations and symbols

3.1 Terms and definitions

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

3.1.1 flicker

impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[SOURCE: IEC 60050-845:1987, 845-02-49]

3.1.2 flickermeter

instrument designed to measure any quantity representative of flicker

[SOURCE: IEC 60050-604:1987, 604-01-28]

3.1.3 voltage flickermeter

instrument as specified in IEC 61000-4-15 which is designed to measure any quantity representative of flicker resulting from mains voltage fluctuations

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

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

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

[SOURCE: IEC 60050-845:1987, 845-01-38]

3.1.5 light flickermeter

instrument designed to measure flicker resulting from temporal changes in the intensity of the light in an objective way and based on the IEC 61000-4-15 specifications

3.1.6 threshold of flicker irritability

maximum value of a fluctuation of luminance or of spectral distribution which gives rise to a flicker tolerated without discomfort by a specified sample of the population

[SOURCE: IEC 60050-161:1990, 161-08-16]

3.1.7 short-term flicker indicator

P_{st}
measure of flicker evaluated over a specified time interval of a relatively short duration
definition

Note 1 to entry: The duration is typically 10 min, in accordance with IEC 61000-4-15.

[SOURCE: IEC 60050-161:1990, 161-08-18]

3.2 Abbreviations

a.c.	alternating current
AM	amplitude modulation
CFL	compact fluorescent lamp
CIE	Commission Internationale de l'Éclairage
<i>cpm</i>	changes per minute
d.c.	direct current
EUT	equipment under test
EMC	electromagnetic compatibility
EMI	electromagnetic interference
Hz	hertz
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
IEV	International Electrotechnical Vocabulary
ISO	International Organization for Standardization
I-SH	interpretation sheet
kHz	kilohertz
LED	light emitting diode
LP	low pass
ms	millisecond
rect	rectangular
rms	root mean square
TR	technical report
SSL	solid state lighting
V	voltage
W	watt

3.3 Symbols

α	multiplication factor
C_A	gain of the light amplifier
d	relative voltage change
d_E	relative change of the rectangular modulation of the illuminance
d_r	relative change of the 100 Hz-illuminance ripple
Δu	instantaneous total voltage variation after a voltage fluctuation,
ΔU	total voltage variation of the half-period rms value after a voltage fluctuation
f	mains frequency (50 Hz)
f_m	modulation frequency
m	modulation index
%	percent
pp	percentage point
P_{st}	short-term flicker indicator
P_{st}^E	P_{st} -value of the standardised illuminance waveform $E(t)$
P_{st}^{EUT}	P_{st} -value of the illuminance of an EUT measured with the light flickermeter

P_{st}^{LM}	P_{st} -value of the illuminance measured with the light flickermeter
P_{st}^V	P_{st} -value of the supply voltage measured with the voltage flickermeter
$P_{st}^{LM} _{noise}$	light flicker noise level
$P_{st}^V _{noise}$	P_{st} -noise level of the mains
s	the complex Laplace variable
\hat{u}	amplitude of the mains voltage
$u(t)$	mains voltage signal
$u_E(t)$	output voltage of the light sensor amplifier
T_m	modulation period
T_{test}	period of time over which the illuminance is measured during application of the voltage fluctuation
U	half-period rms-value

4 General

The immunity of lighting equipment to voltage fluctuations may be tested by applying specific types and levels of voltage fluctuations on the mains in accordance with the short-term flicker indicator $P_{st} = 1$ curve for the reference incandescent lamp of 60 W specified in IEC 61000-3-3. In this way, the full EMC approach is applied for flicker, i.e. voltage fluctuations caused by equipment connected to the grid are limited by the voltage fluctuation emission test of IEC 61000-3-3, while the level of flicker immunity of lighting equipment against these $P_{st} = 1$ voltage fluctuations is tested using the method and procedures specified in this technical report (see Figure 1).

During the test, the supply voltage is modulated with $P_{st} = 1$ fluctuation extracted from the threshold of flicker irritability curve and the luminous intensity variation of the lighting equipment is measured and recorded (denoted as P_{st}^V). A light flickermeter is applied to measure the value of the metric P_{st} (denoted as P_{st}^{LM} , whereas P_{st}^V would correspond to the flicker severity value measured from voltage fluctuations).

5 Voltage fluctuation disturbance signal

5.1 General

The immunity test against voltage fluctuations is carried out in accordance with the test method specified in Clause 6. The disturbances are rectangular amplitude modulations that are to be applied on the a.c. power port.