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TECHNICAL REPORT

colour inside

Equipment for general lighting purposes – Objective test method for stroboscopic effects of lighting equipment

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Equipment for general lighting purposes – Objective test method for stroboscopic effects of lighting equipment

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EQUIPMENT FOR GENERAL LIGHTING PURPOSES – OBJECTIVE TEST METHOD FOR STROBOSCOPIC EFFECTS OF LIGHTING EQUIPMENT

FOREWORD

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IEC TR 63158, which is a Technical Report, has been prepared by 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
34/436/DTR	34/496/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.

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- withdrawn,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.

The contents of the corrigendum of July 2018 have been included in this copy.

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 flux. 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 [1][3][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).

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 controlgear 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 stroboscopic effect are considered as poor quality lighting.

Until recently, modulation depth (MD) – also called percent flicker – and flicker index (FI) were often used to quantify flicker or stroboscopic effect. It has been shown that both these metrics are not able to objectively score the level of flicker or stroboscopic effect as actually perceived by humans [1]. Therefore, instead of MD and FI, for ‘flicker’ the IEC-standardized ‘short-term flicker severity’ (P_{st}^{LM}) is used, which is derived from the widely applied and accepted IEC-standardized P_{st}-metric to assess the impact of voltage fluctuations on flicker [5]. For the objective assessment of stroboscopic effect, the stroboscopic effect visibility measure (SVM) is available [6].

In 2013, a clear need was identified for an objective test method for testing lighting equipment against flicker caused by voltage fluctuations induced by switching loads such as household appliances. Technical committee 34 developed and verified an objective test method for flicker using the flicker metric P_{st}^{LM}. This objective flicker test method is described in IEC TR 61547-1 [5].

In recent years the interest in objective testing of stroboscopic effect has also increased considerably. In the near future, CIE will start developing a basic standard on TLA metrology including objective test methods for flicker and stroboscopic effect.

This document provides practical considerations and application examples on how to objectively quantify the stroboscopic effect performance of lighting equipment in terms of SVM.

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1 Numbers in square brackets refer to the Bibliography.

EQUIPMENT FOR GENERAL LIGHTING PURPOSES – OBJECTIVE TEST METHOD FOR STROBOSCOPIC EFFECTS OF LIGHTING EQUIPMENT

1 Scope

This document describes an objective stroboscopic effect visibility (SVM) meter, which can be applied for performance testing of lighting equipment under different operational conditions.

The stroboscopic effects considered in this document are limited to the objective assessment by a human observer of visible stroboscopic effects of temporal light modulation of lighting equipment in general indoor applications, with typical indoor light levels (> 100 lx) and with moderate movements of an observer or nearby handled object (< 4 m/s). Details on restriction of the applicability of the stroboscopic effect visibility measure is given in Clause A.1.

For assessing unwanted stroboscopic effects in other applications, such as the misperception of rapidly rotating or moving machinery in an industrial environment for example, other metrics and methods can be required.

The object of this document is to establish a common and objective reference for evaluating the performance of lighting equipment in terms of stroboscopic effect. Temporal changes in the colour of the light (chromatic effects) are not considered in this test. This document describes the methodology for SVM and does not define any limits.

The objective method and procedure described in this document are based on CIE TN 006:2016 on temporal light artefacts (TLAs).

The method described in this document can be applied to objectively assess the stroboscopic effect of lighting equipment that is powered from any type of source, AC mains, DC mains, battery fed or fed through an external dimmer.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, abbreviated terms and symbols

3.1 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

3.1.1
auxiliary equipment
AuxEq
peripheral equipment that is part of the system under test

3.1.2
equipment-under-test
EUT
equipment subjected to stroboscopic visibility tests

3.1.3
temporal light artefact
TLA
change in visual perception, induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a human observer in a specified environment

Note 1 to entry: The change of visual perception is a result of comparing the visual perception of the environment lit by the modulated light to the visual perception of the same person in the same environment, when the environment is lit by non-modulated light.

[SOURCE: CIE TN 006:2016, 2.4.1]

3.1.4
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 may be induced by the light source itself, the power source or other influencing factors.

Note 2 to entry: Flicker is a type of temporal light artefact.

[SOURCE: CIE TN 006:2016, 2.4.2, modified – Note 3 has been deleted.]

3.1.5
stroboscopic effect
change in motion perception induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a non-static environment

EXAMPLE 1 For a square periodic luminance fluctuation, moving objects are perceived to move discretely rather than continuously.

EXAMPLE 2 If the frequency of a periodic luminance fluctuation coincides with the frequency of a rotating object, the rotating object is perceived as static.

Note 1 to entry: The stroboscopic effect is a type of temporal light artefact.

[SOURCE: CIE TN 006:2016, 2.4.3]

3.1.6
static observer
observer who does not move her/his eye(s)

Note 1 to entry: Only large eye movements (saccades) fall under this definition. An observer who only does involuntary micro-saccades is considered static.

[SOURCE: CIE TN 006:2016, 2.4.5]

3.1.7
static environment
environment that does not contain perceivable motion under non-modulated lighting conditions

[SOURCE: CIE TN 006:2016, 2.4.6]

3.1.8
average observer
observer representing the mean characteristics of a specified population of sighted individuals

Note 1 to entry: The population in question depends on the application a lighting system is designed for. It can also include specific groups of observers as for example migraine sufferers. A general average observer is based on data aggregated across gender and age but specific observers can be defined for subgroups.

[SOURCE: CIE TN 006:2016, 2.3.1]

3.1.9
visible artefact
perceptual effect of a light modulation detected by an average observer with a probability higher than 50 %

[SOURCE: CIE TN 006:2016, 2.3.2]

3.1.10
visibility threshold
level of light modulation, at which an average observer, when presented with and questioned about the visibility of an artefact, can detect the artefact with a probability of 50 %

[SOURCE: CIE TN 006:2016, 2.3.3]

3.1.11

stroboscopic effect visibility
measuremeasure of stroboscopic effect evaluated over a specified time interval of a relatively short duration

Note 1 to entry: The duration is typically 1 s, in accordance with CIE TN 006.

3.1.12
modulation depth
property of waveform calculated by taking the ratio of the difference between the maximum and minimum intensity to the sum of the maximum and minimum intensity

Note 1 to entry: Often, MD is calculated over one fundamental period of waveform modulation, however it can be calculated also over a much longer time over a multiple number of periods.

Note 2 to entry: MD is also often expressed as a percentage, by multiplying the ratio by 100 %.

3.2 Abbreviated terms

AC	alternating current
ADC	analog to digital converter
CIE	Commission Internationale de l'Éclairage
DC	direct current
DFT	discreet Fourier transform
EUT	equipment under test
FFT	fast Fourier transform
Hz	hertz
IEEE	Institute of Electrical and Electronics Engineers
kHz	kilohertz
LED	light emitting diode
MD	modulation depth
TLA	temporal light artefact

PoE power over Ethernet
RMS root mean square
TN technical note
SNR signal to noise ratio
SSL solid state lighting
SVM stroboscopic effect visibility measure
THD total harmonic distortion
TLD tapped linear driver

3.3 Symbols

C_{A} gain of the light amplifier
$C(f)$ spectrum of normalized signal
$E(t)$ illuminance
m_{ver} modulation depth of the modulation of the verification waveform
f_{m} modulation frequency
$P_{\text{st}}^{\text{LM}}$ short-term flicker severity
SVM^{E} SVM-value of the standardized illuminance waveform $E(t)$
SVM^{EUT} SVM-value of the illuminance of an EUT measured with the SVM-meter
$SVM|_{\text{noise}}$ stroboscopic effect visibility measure noise level
T_{test} measuring period
$u(t)$ mains voltage signal
$u_{\text{E}}(t)$ output voltage of the light sensor amplifier

4 General

The generic schematic diagram of the stroboscopic effect measurement setup is depicted in Figure 1.

The light output of the system under test is measured. Subsequently SVM is calculated from the measured light waveform. Details on the test setup and equipment are given in Clause 5. The specification of the objective stroboscopic effect meter to calculate SVM is given in Clause 6.

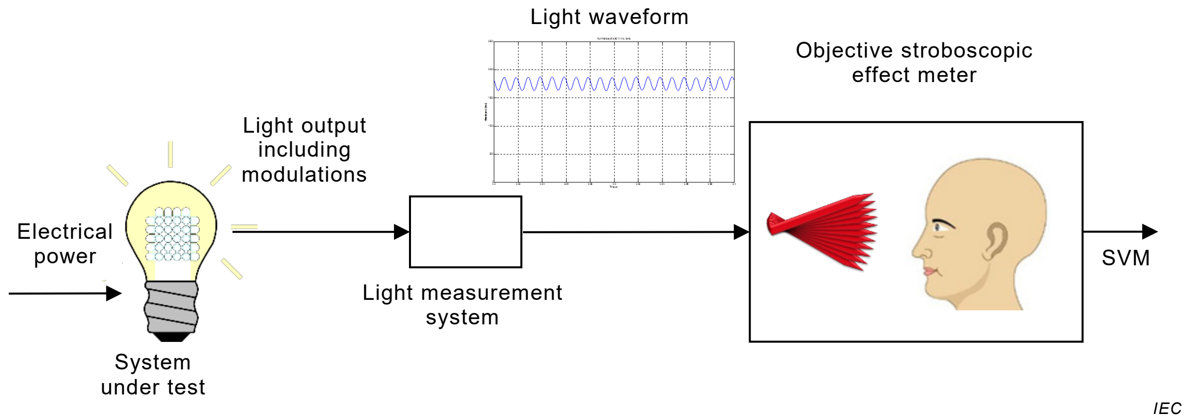


Figure 1 – Schematic of the stroboscopic effect measurement method

The type of equipment under test (EUT) may depend on the purpose of the test. For instance the following different application tests may be considered (see Figure 2):

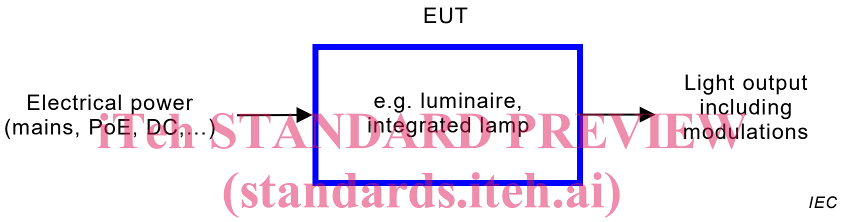
– testing the intrinsic performance of lighting equipment such as luminaires, controlgear or integrated lamps;
– testing the performance of lighting equipment under dimming conditions.

Note that in each of these different test applications, there is a difference between the EUT and the auxiliary equipment, which is peripheral equipment that is part of the system under test (to enable testing), but not part of the test. Application-specific setup and equipment requirements are given in Clause 9.

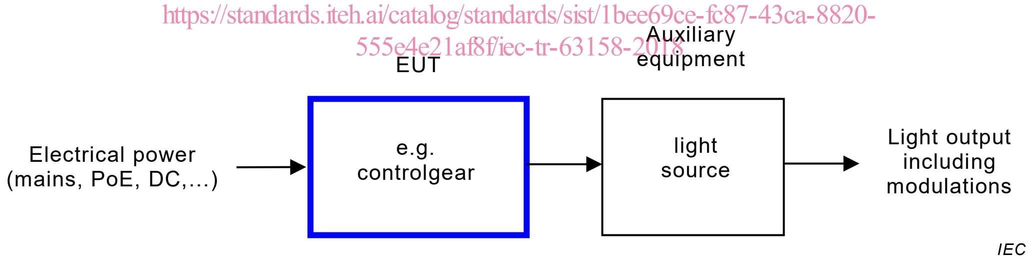
5 Laboratory and equipment requirements

5.1 Schematic of the measurement setup

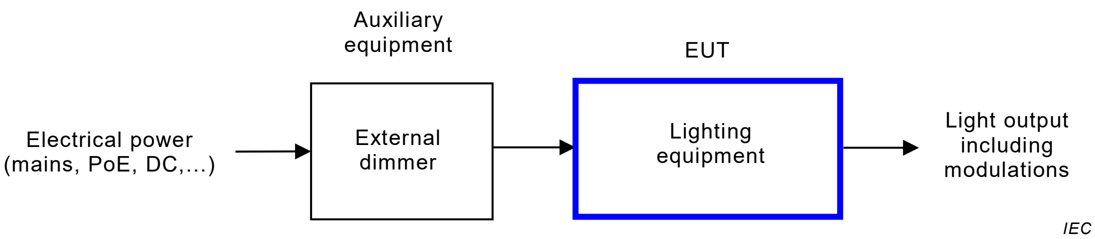
The general schematic diagram of the SVM measurement setup is depicted in Figure 3. General requirements for the equipment and laboratory are given in the subsequent subclauses. Application-specific (auxiliary) equipment is specified in Clause 9.



a) Light source as EUT



b) Control gear as EUT



c) Setup with external dimmer

Figure 2 – Different possible applications for an SVM test