

## Position Paper on Temporal Light Artefacts i.e. flicker and stroboscopic effect

### Introduction

Temporal Light Artefacts (TLA) are undesired changes in visual perception of an observer in a certain environment, induced by a light stimulus whose luminance or spectral distribution fluctuates with time. Depending of the root cause, TLA consist of Flicker<sup>1</sup> and/or Stroboscopic effect<sup>2</sup>. Flicker may occur as a result of mains-voltage fluctuations or product / system (e.g. lamp with either internal dimming function or an external dimmer) properties. Stroboscopic effect generally only occurs as a result of product / system properties.

During the past years, scientific committees (e.g. EC SCENIHR [1]) have associated these TLA with potential health, performance and safety-related effects. As a consequence, the European Commission (EC) has issued M/519/EN [2] in which the need for new or enhanced TLA assessment methods has been identified.

The appropriate CIE and IEC standardization committees have however concluded that the current TLA performance standardization is hampered by lack of adequate TLA assessment methods<sup>3</sup> and have therefore started projects on the development of appropriate TLA assessment methods.

### Position

In view of anticipated future European TLA standardization and regulation, Philips recommends to wait for the CIE and IEC publications of the proper TLA assessment methods and to avoid the adaptation of improper metrics, such as Modulation Depth (also called Flicker Percentage) and Flicker Index.

### Introduction of the proper TLA assessment methods

Depending of the TLA root cause, specific TLA assessment methods have to be distinguished in two application areas. The first area is related to the TLA assessment of lighting apparatus to mains-voltage fluctuations, and the second area is related to TLA performance assessment of the product or system. Furthermore, for each specific TLA assessment method, also specific metrics must be applied which take into account the total frequency content (wave-shape) of the luminance.

<sup>1</sup> Perception of visual unsteadiness induced by a light stimulus whose luminance or spectral distribution fluctuates with time, for a static observer in a static environment. The typical frequency range is: few Hz up to 80 Hz.

<sup>2</sup> Change in motion perception induced by a light stimulus whose luminance or spectral distribution fluctuates with time, for a static observer in a non-static environment. The typical frequency range is: 80 Hz up to 2000 Hz.

<sup>3</sup> E.g. the currently applied metrics Modulation Depth (also called Flicker Percentage) and Flicker Index do not quantify TLA correctly because none of these metrics account for the root cause, the effect of the frequency nor wave shape of the light stimulus. Consequently, these incorrect metrics and the associated pass / fail criteria may wrongly include or exclude certain LED topologies.

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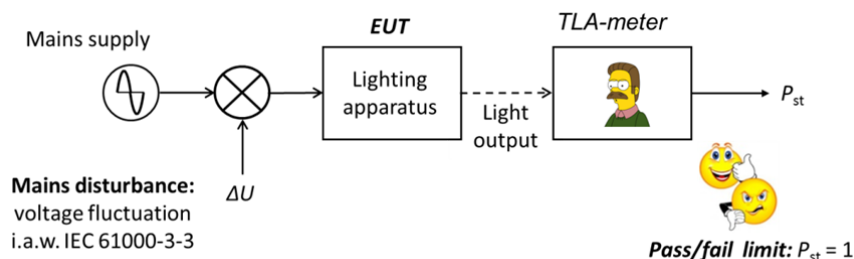
**Area 1: TLA assessment of lighting apparatus to mains voltage fluctuations**

**Metric**

The recommended TLA assessment of lighting apparatus to mains voltage fluctuations is based on the IEC short-term flicker metric  $P_{st}^4$  which has been widely used for many decades in the IEC power quality standards.

**Measurement setup**

The  $P_{st}$  measurement setup is standardized in IEC TR 61547-1 [3] and is schematically depicted in Figure 1.



**Figure 1: Schematic of the objective voltage-fluctuation immunity test**

**Limit**

The limit to be applied is:  $P_{st}$  equal 1. This limit is based on a visibility probability of 50% and has been used for many decades in the IEC 61000-3-3 standard [4] in which electronic equipment is tested for the level of voltage fluctuations (and thereby flicker) they may induce.

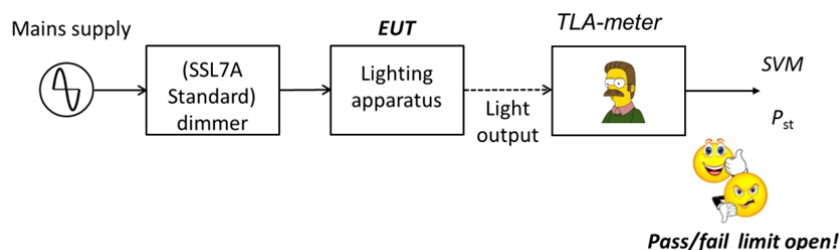
**Area 2: Future TLA Performance Standards**

**Metrics**

For quantification of the TLA performance of a product or system (e.g. lamp with either internal dimming function or an external dimmer) two different effects should be distinguished [5], i.e. flicker and stroboscopic effect. The Stroboscopic Visibility Measure (SVM) metric is recommended for the quantification of stroboscopic effect, while for flicker again the existing IEC short-term flicker metric  $P_{st}$  is recommended.

**Measurement method**

The SVM measurement setup will be standardized in a CIE TR, which is currently being defined in CIE TC1.83. The  $P_{st}$  measurement setup is standardized in IEC TR 61547-1 [3]. A schematically overview is depicted in Figure 2.



**Figure 2: Schematic of the objective TLA-performance test**

<sup>4</sup>  $P_{st}$ -value of the illuminance measured with the TLA meter is also called  $P_{st}^{LM}$

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Because the future TLA performance standards will require an unambiguous assessment of the Lighting apparatus (EUT), reference is made to the standardized NEMA SSL7A dimmer [6]. For additional dimmer compatibility assessments, however, it is also permitted to use a specific dimmer.

#### Limit

In general, inclusion of any limit in performance standards is not customary. This also applies for TLA limits. In case limits are to be included, these limits shall be minimum performance levels. It is emphasized that both the SVM and  $P_{st}$  acceptability levels may differ for specific applications and/or the actual dimming levels. This is a subject of the ongoing CIE and IEC work.

#### References

- [1] EC SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), Health Effects of Artificial Light, adopted on 19 March 2012: [http://ec.europa.eu/health/effects\\_of\\_artificial\\_light](http://ec.europa.eu/health/effects_of_artificial_light)
- [2] M/519/EN, Mandate addressed to CEN, CENELEC and ETSI to develop standardisation in the field of light emitting diodes (LEDs), 12 February 2013: [http://ec.europa.eu/enterprise/standards\\_policy/M519](http://ec.europa.eu/enterprise/standards_policy/M519)
- [3] IEC/TR 61547-1, Equipment for general lighting purposes – EMC immunity, Part 1: An objective voltage fluctuation immunity test method, publication expected in 2015-01.
- [4] IEC 61000-3-3 Ed. 3.0, 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  $\leq 16$  A per phase and not subject to conditional connection, 2013-05.
- [5] Modeling the visibility of the stroboscopic effect occurring in temporally modulated light systems, Lighting Research and Technology published online at <http://lrt.sagepub.com/>, 13 May 2014, M Perz, IMLC Vogels, D Sekulovski, L Wang, Y Tu and IEJ Heynderickx.
- [6] NEMA SSL 7A-2013 Phase Cut Dimming for Solid State Lighting: Basic Compatibility.

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