



# Flicker measurement NEMA77 and IEEE1789

White paper

## Executive summary

Temporal light artifacts (TLA) is the general term for visual effects that are caused by a rapidly fluctuating light source causing an undesired effect for the observer. The two most important effects are flicker and stroboscopic effect. When an observer looks at a light source or at non-moving objects in a lit space and sees a rapid changing of the intensity, this can be described as flicker. Its typical range is between 0.1Hz up to 80Hz. When an observer looks at a moving object and instead of a fluid motion observes a number of steps as shown below, this can be denoted as stroboscopic effect.

Contrary to flicker, this is observed for light fluctuation at much higher frequencies (80Hz up to 2000Hz). Unlike flicker, stroboscopic effect can only be observed when objects are moving. When looking at a static scene, the effect will not be visible.

## 1.1 Flicker definitions and indicators

There are many ways to measure or describe flicker. Standard NEMA77 (2017) describes most of the terms. All definitions are copied here: Flicker, Flicker index, Jitter, Maximum Light Output Waveform (MLOW), Modulation depth, Percent Flicker, Phantom Array Effect, Short Term Flicker Indicator (Pst), Stroboscopic Effect, Stroboscopic Visibility Measure (SVM) and Temporal Light Artefact (TLA). For detail of each definition, please refer to NEMA77 (2017)

## 1.2 Policy, regulation and standards

### 1.2.1 California Title 24

California Title 24 JA10 defines a flicker measurement method. JA 8 defines the corresponding flicker limits.

Please refer to JA10 for measuring flickering to comply with CA Title 24

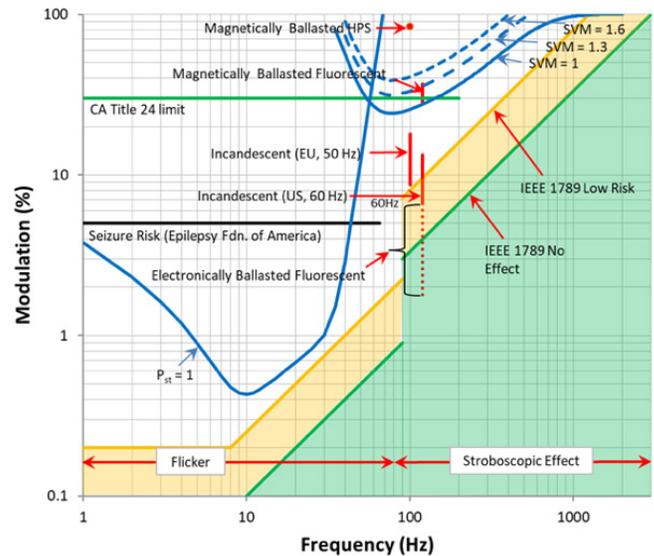
The limits in JA8 are:

“(c) Light source in combination with specified control shall provide “reduced flicker operation” when tested at 100 percent and 20 percent of full light output, where reduced flicker operation is defined as having percent amplitude modulation (percent flicker) less than 30 percent at frequencies less than 200Hz, tested according to the requirements in Joint Appendix JA-10.”

### 1.2.2 IEEE1789

IEEE 1789 discussed many aspects of flicker. It is not a mandatory standard, but a recommended specification. IEEE1789 divides light modulation vs. frequency (1-2000Hz) into areas: “No effect”, “low risk” as shown in the graph below. Some LED driver manufacturers plot their driver measurement on the Graph to show how their drivers perform, but there are discussions whether the IEEE 1789 is considering all applications. One critical point is that the

traditional incandescent lamp falls outside of the ‘low risk’ and ‘no risk’ areas. Realistically, people have not complained about TLA from incandescent lamp for over 100 years.



### 1.2.3 NEMA77 (2017)

NEMA77 (2017) also discussed flicker issue in detail. Different from IEEE1789, NEMA77 provides a Pst and SVM acceptance criteria table as shown below. The measurement method of Pst and SVM follows standard IEC TR 61547-1

These criteria are also plotted in the above IEEE1789 graph, in the NEMA 77, incandescent lamp powered by regular mains is acceptable.

## Guidelines for Pst and SVM acceptance criteria

Application Area	P <sub>st</sub> Limit	SVM Limit
Outdoor	≤ 1.0	None
Indoor	≤ 1.0	≤ 1.6

