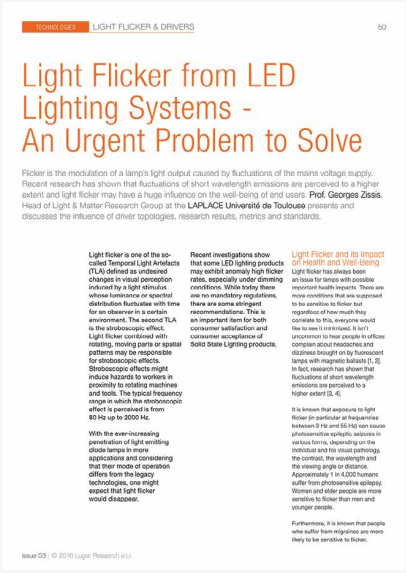

TECHNOLOGIES LIGHT FLICKER & DRIVERS 50

Light Flicker from LED Lighting Systems - An Urgent Problem to Solve

Flicker is the modulation of a lamp's light output caused by fluctuations of the mains voltage supply. Recent research has shown that fluctuations of short wavelength emissions are perceived to a higher extent and light flicker may have a huge influence on the well-being of end users. Prof. Georges Zissis, Head of Light & Matter Research Group at the LAPLACE Université de Toulouse presents and discusses the influence of driver topologies, research results, metrics and standards.

Light flicker is one of the so-called Temporal Light Artefacts (TLA) defined as undesired changes in visual perception induced by a light stimulus whose luminance or spectral distribution fluctuates with time for an observer in a certain environment. The second TLA is the stroboscopic effect. Light flicker combined with rotating, moving parts or spatial patterns may be responsible for stroboscopic effects. Stroboscopic effects might induce hazards to workers in proximity to rotating machines and tools. The typical frequency range in which the stroboscopic effect is perceived is from 80 Hz up to 2000 Hz.

With the ever-increasing penetration of light emitting diode lamps in more applications and considering that their mode of operation differs from the legacy technologies, one might expect that light flicker would disappear.

Recent investigations show that some LED lighting products may exhibit anomaly high flicker rates, especially under dimming conditions. While today there are no mandatory regulations, there are some stringent recommendations. This is an important item for both consumer satisfaction and consumer acceptance of Solid State Lighting products.

Light Flicker and its Impact on Health and Well-being

Light flicker has always been an issue for lamps with possible important health impacts. There are more conditions that are supposed to be sensitive to flicker but regardless of how much they correlate to this, everyone would like to see it minimized. It isn't uncommon to hear people in offices complain about headaches and dizziness brought on by fluorescent lamps with magnetic ballasts [1, 2]. In fact, research has shown that fluctuations of short wavelength emissions are perceived to a higher extent [3, 4].

It is known that exposure to light flicker (in particular at frequencies between 3 Hz and 55 Hz) can cause photosensitive epileptic seizures in various forms, depending on the individual and his visual pathology, the contrast, the wavelength and the viewing angle or distance. Approximately 1 in 4,000 humans suffer from photosensitive epilepsy. Women and elder people are more sensitive to flicker than men and younger people.

Furthermore, it is known that people who suffer from migraines are more likely to be sensitive to flicker.

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The article about flicker issues and drivers by Prof. Georges Zissis was the object of some discussions. Dr. Walter Werner had a very interesting point of view

THERE IS MORE TO FLICKER THAN VISIBLE PERCEPTION

by Dr. Walter Werner, Werner Consulting

In his excellent article in the Jan/Feb 2016 LpR 53 issue, Georges Zisses showed that flicker needs to be limited according to existing standards to stay well out of the perceivable range.

The main research and arguments, however, are focused on visible perception. This is sufficient if we assume that what cannot be perceived does not cause any harm. But this has not been proven, and not much research is available about long-term effects of unperceivable flicker.
Very likely, science and regulations need to rethink this type of assumption; just look at x-rays and radioactivity.

Wilkins et al. investigated medium to longer-term effects in the late 1980's (as part of the "sick building" syndrome research). The research focused on 100 Hz modulation [1]. He showed that a switch from a longer exposition (multiple months) with substantially modulated light (60%) to low modulated light (6%) reduces headaches and eyestrain within a few weeks.
These results are statistically significant. Most of the lighting industry ignored the results because the opposite effect (increased eyestrain and headaches) could not be shown within the four weeks of exposition that the research campaign allowed for.

Research on blind people that regained their sight as adults (Project Prakash [2]), showed that the visual apparatus and object recognition ability adapt to a mostly normal view after a while in adults but does not gain some of the more advanced abilities. This could point to the fact that the complex analysis ability is trained and formed during childhood.

There is also evidence that there is some influence up to about 400 Hz, and transitional effects of flicker have been claimed to be detectable up to 800 Hz.

While the latter observation has been researched with moving sources and could well be an artifact caused by the interference of the moving sources with some eye-movements, H. Lindner's research [3] proved a reduction of the ability to resolve very fine structures up to a modulation frequency of 400 Hz. This seems to be very high, given the bio-chemical nature of the sensors and the relatively low fusion frequency of our visual system. One quite obvious reason for this could be that the neural network can use the fast signals to enhance the quality of the received visual signal.

What does this tell us about flicker with frequencies below 400 Hz, and what would be the logical consequences?

- Short term exposure to higher frequency flicker seems to be no trouble, as long as no advanced visual tasks need to be performed
- Longer term exposure to higher frequency flicker should be avoided, as research cannot give evidence about the thresholds to maintain. The existing research is poor but suggests strongly that there are negative effects like stress or wear-out to the visual apparatus
- Flicker should be avoided wherever (younger) children stay longer, to make sure the possibility of interference with their later visual abilities is minimized

As a clear conclusion, we can say that there is enough evidence that flicker up to 400Hz is not harmless with longer term exposition and responsible manufacturers should keep out of this range to keep lighting that is intended to be used in offices, work areas, baby and children's' rooms, kindergarten installations and screen illumination of small children's' toys safe. As a result, more research is needed to understand where the safe zone really is. ■

W.W., February 2016

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