

# Rewarding brightness

The general problem of light flickering is well known. In the modern LED lighting it seems as if there are more problems with flickering. Users generally think that it is a problem of the LED luminaire. That is not true: Illuxtron luminaires do not flicker. The LED luminaire is more sensitive to bad quality of the electric power that is supplied to the luminaire. If the electric power is "clean" there is no flickering. In most cases the electric power is *not* clean, or there is a device like a dimmer that pollutes the power that is supplied to the luminaire. This paper describes the flicker phenomena, the causes and the remedies.

Four kinds of flicker are described:

- a. Irregular, load induced disturbances on the 230V power line
- b. Power line communication (CAB) disturbances
- c. Dimmer induced flicker
- d. Stroboscopic flicker

Each kind of flicker has its own solution which is presented in this paper.

The general conclusion is that even with a bad power grid there is a solution for every flicker problem.

This gives us the possibility of having maximum profit of modern LED lighting

## 1. Introduction

Everybody knows the general problem of flickering of light. As it is the light source that flickers one tends to think that there is something wrong with the luminaire. In most cases this is not true.

Illuxtron luminaires do not flicker! In all cases the flickering is caused by the electrical environment.

That means that the 230 Volt 50 or 60 Hz power grid does not supply "clean" power.

In other cases if a dimmer is used, there is a possibility that the *combination* of dimmer and luminaire does not operate properly.

This paper discusses the types of flicker, the causes and the remedies.

Flicker may be defined as:

*Variable light production from a light source, generally caused by voltage or current variations in the electric power source [1]*

In the incandescent lamps era there were already some effects that could be designated as flicker.

It is described as slow variations of light intensity.

Today's lighting devices like LED luminaires have faster response to electrical variations so there is more nuisance possible. The variations that a human eye can observe depend on the view field angle and the age of the observing person.

In the direct view angle (that is a small angle of a few degrees in which one sees a sharp image) one can see the slower variations, in the peripheral view (up to 45 degrees) one can see the faster variations. Younger persons see faster variations, older people see only slower variations.

In general one can say that the human eye can follow variations of light up to 30 to 60 variations per second.

Basically, LED lighting, supplied by the AC power grid ( 50 or 60 Hz) show variations of 2 times the power line frequency (so 100 or 120 Hz ). So nobody will have problems with that.

Lighting control systems like dimmers may cause variations of lower frequency, as low as a few Hz.

In that case a noticeable flicker may be possible.

## 2. Types of flicker

In general there are four essentially different types of flicker:

- a. Load induced flicker  
Incidental variations of the light intensity that cannot be directly related to regular events happening in the electric power grid. The duration and flicker interval are varying from tens of milliseconds to seconds or minutes.
- b. CAB induced flicker  
Events that happen regularly, several times per day at well-defined times. It happens in combination with dimmer circuits. The duration and interval are in the order of a few seconds.
- c. Dimmer incompatibility flicker  
Continuous flickering at intervals of 2 to 10 variations per second, in combination with a dimmer circuit.
- d. Stroboscopic flicker  
Continuous flickering at intervals of 100 or 120 variations per second.

## 3. Causes of flicker and remedies therefor

### Type a. Load induced flicker:

This is mostly caused by large power electrical equipment that is switched on and off like elevator motors or large copying machines. The power grid voltage has sudden variations that make the light intensity vary with them. This is named electric power source pollution.

One cannot prevent this type of flicker. The only solution is splitting the lighting power supply at the switchboard of the building. In this case the power source for the lighting is "clean"

### Type b. CAB induced flicker:

In several countries the electric power line is used for remote control of connected electrical equipment like boilers and street lighting. This is done by adding an AC voltage of higher frequency (between 250 and 1500 Hz). In Belgium the remote control is done many times during the whole day. In the Netherlands this type of control will not be used any more in the future.

So far, even with these power line control signals the light will not flicker.

If the luminaires are controlled by a dimmer, there can be interference in such a way that the dimmer cannot operate properly. It varies the light output several times during the operation of the remote control. [3] Mind you this is a dimmer problem! Not the luminaire!

By selecting the right kind of dimmer this problem can be solved. Another way of solving this, is the insertion of a power line (CAB) filter that takes away the control signals from the power grid.

### Type c. Dimmer incompatibility flicker:

Many dimmers are originally planned for incandescent lamps. If these lamps are replaced by LED luminaires, very often the dimmer will not operate properly and the light will flicker. The flickering is reproducible, that means that at the same setting of the dimmer, the flickering is the same.

In some cases the problem can be solved by inserting a so called "dimmer cable" that preloads the dimmer so that it can operate properly. In other cases the only solution is selecting a well suited dimmer. The Illuxtron catalog contains a list of preferred dimmers for the combination with the Illuxtron luminaires.

Not all possible configurations of dimmers and number of luminaires can be tested before so there is still some uncertainty about the operation in a specific situation.

### Type d. Stroboscopic flicker:

Although this type of flicker is not perceptible under normal circumstances, it can be a nuisance if one quickly moves hands with spreaded fingers in the peripheral sight. A kind of stroboscopic phenomenon is perceived. Very few people do experience this kind of flicker, even if it is there.

This kind of flicker will only happen with high voltage luminaires supplied directly by the AC power line voltage of 50 or 60 Hz. The frequency of the light variations will be 100 or 120 Hz.

This kind of stroboscopic effects can also occur when there is another light source with a frequency near that of the primary light source.

This can only be solved by supplying the LED luminaire with a pure DC.

Illuxtron has two solutions for that. One solution is using the low voltage version of the luminaires, the other solution is using the specially developed AC/DC cable in combination with the HV luminaire.

Although this kind of flicker is not directly visible, it can be a problem in the above mentioned cases.

International standards and new terms and definitions are coming into being [5], [6]

#### 4. Measurement of light flicker

With respect to measuring of flicker of LED luminaires it is not directly necessary to use an optical measurement system. In most cases a measurement of the supply voltage of the luminaire will also give a sufficient result. Most available power quality analyzers will do the job.

However the ultimate verification of light flickering is the optical measurement.

Equipment for optical measurement vary from apps on a smartphone [4] to combinations of photodiodes in combination with an oscilloscope.

## 5. Conclusion and overview table

In general it can be stated that there is a solution for every flicker problem. Even with a bad power grid.

	Flicker type	Possible cause	Remedy
1	Incidental flicker, at irregular moments, not related to the regular electric environment. It can be a short or longer variation of the light intensity	Variation of the power line voltage due to switching of large loads, like elevator motors , large copiers etc.	Separate the electric power for the lighting
2	Flickering, several times per day at a rhythm of 1 to 2 per second. It occurs mostly at the same time of the day or week. It is not continuous. It is always in combination with a dimmer which is set at a low output value. It is generally <b>not</b> reproducible with the dimmer setting	Remote control of electric equipment. The control signal is transmitted over the power line. (TF or CAB control)	Remove the control signals from the power line. Use a special power line filter or select a dimmer with a built-in power line filter.
3	Continuous flickering 1 to 10 times per second. Flickering is reproducible at the same dimmer setting	Dimmer is not suitable for this application	Select another dimmer
4	Continuous flickering with a frequency of 100Hz (120 Hz USA) Is not perceivable under normal circumstances. Only perceivable with moving objects or in the vicinity of other varying light sources. ( stroboscopic effects)	Interference with other light sources or fast moving objects.	Use pure DC power supply instead of AC



## 6. References

- [1] Voltage Fluctuation and flicker  
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- [2] IEC61000-4-15 Flicker definitions and measurement procedures
- [3] Video showing CAB induced flicker
- [4] App store: Flicker Tester ( only available for iOS)
- [5] Flicker definitions explained:  
<http://www.ledsmagazine.com/articles/print/volume-12/issue-11/features/flicker/understand-the-lighting-flicker-frustration.html>
- [6] Safe flicker level recommendations: IEEE standard 1789  
<http://www.ledsmagazine.com/articles/2015/06/ieee-par1789-makes-recommendations-on-safe-levels-of-flicker-in-led-based-lighting.html>