

WITH A FLICK OF MY BIC

Richard P. Bingham, Dranetz-BMI

Flickering of the lights in an office, factory, or residential home isn't a new power quality phenomena, but is one that is receiving more attention lately. Historically, flicker has not received the same attention that sags and transients have, as the voltage fluctuations that result in the light flickering generally do not interrupt a process or cause equipment failures. However, as businesses realize that their employees are their most valuable assets, keeping those "knowledge assets" running at fully productivity is increasingly important. Some people are reconsidering the "sick building syndrome" as not always being related to the air quality and the HVAC system, but the "silent nauseator". The flicker phenomena can be so subtle enough as to not be consciously detected by those effected, but can induce discomfort, nausea, and in extreme case, epileptic seizures.

Working with a number of electric utility power quality engineers in the past year has revealed a number of cases where they tried to solve customer complaints of blinking lights with all of the traditional methods and tools without success. Most conventional power quality monitors are not capable of detecting the relative small voltage modulations or variations in amplitude at subharmonic frequencies (below 30Hz) that result in light flicker. It either takes a flicker meter or special software, such as the Flicker TASKCard for the Dranetz-BMI Power Platform, to properly detect and determine the source of the flicker.

WHAT IT IS

- flicker is the perceived change in light output from a lamp,
- caused by the fluctuation of the supply voltage in the frequency range of 0.5 to 30 Hz
 - as little as a quarter of a percent voltage fluctuation at 9Hz can be perceived
- voltage fluctuations or modulations of the RMS envelope
 - follows the same basic rules as the RMS variations that result in sags (dips) or swells.
- usually the result of a change in load current
 - which causes a change in the voltage drop across the source impedance,
 - which then results in a change in the voltage supply
- The frequency of the voltage fluctuation can be
 - the direct result of the frequency of the current draw by the load
 - the result of folding back of higher frequencies modulating with 50/60 Hz fundamental or their harmonics, which produces sidebands around the fundamental or harmonic frequency

FACTORS AFFECTING SEVERITY

- frequency of the voltage fluctuation (how often it occurs)
- magnitude of the voltage fluctuation (how much of a change)
- type of lighting (incandescent, fluorescent, HID)
- ambient light level
- amount of the surface illuminated,
- type of activity and the eye-brain characteristics of the individual person

EFFECTS

- normally perceived as an annoyance and distraction.
- may induce discomfort in the form of nausea or headaches.
- usually are not severe enough to disrupt most manufacturing processes, though
 - may cause different colors (light shades) of woven fabric
 - may vary pipe diameter in plastic extrusion processes.

HOW IS IT MEASURED

The perception of the light flickering is usually measured by two parameters, Pst and Plt.

- Pst is the short term perception index,
- Plt is the long term perception index.
- A value of 1 being assigned to the lower bound of the observable flicker perception curve for 60W incandescent light bulbs.
- The larger the number, the more perceptible it is.

Monitoring for flicker is usually done for one of two reasons:

- determining the source,
- determining compliance with limits
- generally begins at the point of common coupling
- change in current vrs change in voltage help determine upstream or downstream from the source

SOURCES

Common sources of flicker include:

- lamp dimmers
- resistance welding machines
- rolling mills
- large electric motors with variable loads
- arc furnaces and arc welders
- switching on and off of PF correction capacitors
- medical imaging machines (X-ray, MRI, CAT Scan)
- large capacity copy machines
- motors in heat-pumps or air conditioning, including refrigerator chambers for meat storage

- household appliances

SOLUTIONS

- reducing the magnitude and/or changing the frequency of the current draw,
- reducing the source impedance,
- changing the type of lighting

STANDARDS

In the United States,

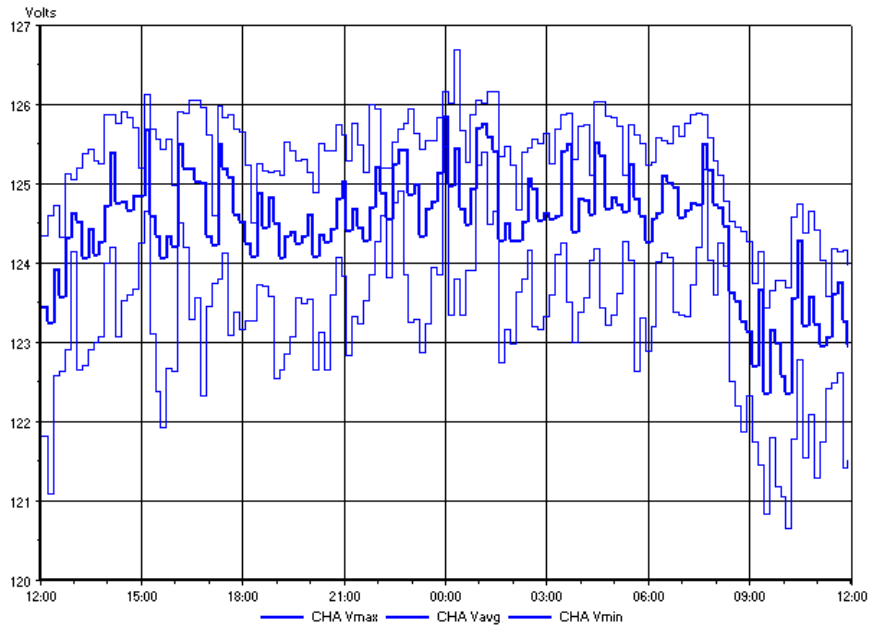
- IEEE/ANSI Std 141 Recommended Practice for Electric Power Distribution for Industrial Plants (the Red Book)
- IEEE 519-1992 Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
- based on work by General Electric in the 1930's, and Westinghouse and Consolidated Edison in the late 50's.

In the European community places limits flicker as "value to be less than the limit for 95% of the time".

- UIE "Flicker Measurement and Evaluation" document in 1986
- IEC 868 (1986), "Flickermeter, Functional and design specifications" and the IEC 1000-4-15
- IEC 1000-3-3 and EN6100-3-3 address limits on voltage fluctuations and flicker.
- US-based standards groups adopting compatible documents as standards.

Voltage modulation (V_{max} , $V_{average}$, and V_{min}) vrs the Pst and Plt values measured on a 120V single phase circuit inside a facility that resulted in light flicker. Cause was an electric arc furnace located 12 miles away, fed from 230 KV circuit. Note the 74 minute cycle time of the arc furnace, which is clearly visible in the Pst graph, but difficult to detect in the V_{rms} plot.

Timeplot



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Timeplot

