LED Flicker

where we are with test methods and standards?
Is Flicker a problem?
Why do LED’s Flicker......

• ......They do not
• Light output is based on amount of current going through the led
• Quick reaction of current changes
• No intrinsic flicker
Why do LED’s Flicker

• It’s the drivers job to provide a nice constant current

• Electric NOISE -> LED -> optical noise out
What can introduce noise

- Input voltage changes
- External noise on input voltage
- Phase angle instabilities from dimmer (when used)
- Driver instabilities
- Driver operation (intended)
How do we notice Flicker

- Flicker is best noticed by reflection less by direct view into the source
- appearance depends on numerous factors like: age, ambient light, physical state .....
Current Flicker metrics

• Simple
  • Percent Flicker
  • Flicker Index

• Complex
  • RPI LRC Assist, Mp, Flicker Perceptibility
  • IEC PST
  • SVM
  • FFT Analysis
Percent Flicker or % Modulation, or Modulation depth

- Easy to calculate
- Easy to understand
- Does not account for Wave shape and or Frequency
- Assumes periodic waveform

\[ PF = \frac{A - B}{A + B} \times 100\% \]

- Amplitude based calculation
Flicker index

- Easy to understand
- Assumes periodic waveform
- Frequency is not taken into account

\[ FI = \frac{\text{Area 1}}{\text{Area 1} + \text{Area 2}} \]

- Surface Area based Calculation
Percent Flicker & Flicker Index

- for both no relation to human perception
- To be used to compare lamp which work under same conditions
- Frequency independence
What will work better

• Check the frequency components
• Determine frequency of interest
• Combine the results
• Compare this to a standard or baseline
Check the frequency components

- Most “real” waveforms can be mathematically represented by a combination of several simpler waveforms.
- The mathematical operation to determine these source waveforms is the Fast Fourier Transform (FFT)
Determine frequency of interest

- Remove (filter) frequencies that are irrelevant
  - For example, those above human perception
- Apply weighting factor to remaining frequencies
Combine the results

- Normalize and perform a summation algorithm over the resulting weighted frequencies
- Result is an integer value
Compare result against a standard

• Is lower or higher “better”?
• What’s an acceptable range?
• Does it vary based on application?
Example: RPI LRC ASSIST metric (more USA)

- Accounts for wave shape and frequency
- Based off of (limited) human perception trials
- Focuses on perceptible flicker: <100Hz
- Complex measurement and analysis
Example: $P_{st}$, IEC flicker testing

- IEC 61000-4-15
  - Flickermeter – Functional and design specifications
- IEC 61000-3-3
  - Limitation of voltage changes, fluctuations and flicker in public low voltage supply systems
- IEC TR 61547-1 (Adopts IEC 61000 for use with light)
  - Complex originally developed to quantify power line quality
Example:

Stroboscopic Visibility Measure (SVM)

- Measures primarily stroboscopic effects >80Hz (for moving objects), not necessarily static flicker
- Not yet well known or widely used in industry
- Based off of human perception trails
IEEE 1789-2015

- IEEE recommended practices for Modulating Current in High-Brightness LEDs for mitigating Health Risks to Viewers
- Results drawn from multiple studies
- Results are somewhat controversial
Comparison of several TLA metric limits
# Points of concern
## Analysis of an industry standard

<table>
<thead>
<tr>
<th>WHAT</th>
<th>HOW Is it measured?</th>
<th>HOW Is it analyzed?</th>
<th>WHAT are the limits?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you measure?</td>
<td>Sensor specs?</td>
<td>ASSIST?</td>
<td>&lt;1?</td>
</tr>
<tr>
<td>Light?</td>
<td>Sensitivity?</td>
<td>PST?</td>
<td>&gt;1?</td>
</tr>
<tr>
<td>Current?</td>
<td>Frequency?</td>
<td>Flicker Index?</td>
<td>&gt;1.6?</td>
</tr>
<tr>
<td>Voltage?</td>
<td></td>
<td>SVM</td>
<td></td>
</tr>
</tbody>
</table>

Know what you are doing
NEMA LSD-75 (Temporal Light Artefacts) – CIE proposed to ad

- A single value does not accurately capture all application-specific requirements
  - Some applications may be more sensitive to visible flicker (task-based work)
  - Some may need minimal stroboscopic flicker (video, motion based work)
- A dual-value metric is most suitable
CIE tech note

• Visual Aspects of Time-Modulated Lighting Systems – Definitions and Measurement Models
Unintended consequence

• Adding stroboscopic measurements to flicker tests may cause otherwise “good” lamps to fail
• Poor testing procedures may cause invalid results, or incorrectly attribute flicker to the control or drive
• Improper use of flicker metrics may mandate high-levels of performance, even when unnecessary
Now we know, can we measure Flicker?

Suffice it to say that we currently expect
* TLA
* ASSIST Mp (for US Market)

* Pst (short term flicker)
* SVM (Stroboscopic Visibility Measure) to be endorsed as the most appropriate

these metrics will be measured with the BTS256-EF in combination with Software package.
Odacon & Te Lintelo Systems invites you to see the demo at our booth
Exclusive distributor BeNeLux for:

Instrument Systems
light measurement

Gigahertz-Optik

Thank you!

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photonics is our passion!

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References:

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