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LED Flicker

where we are with test methods and standards?

Is Flicker a problem ?

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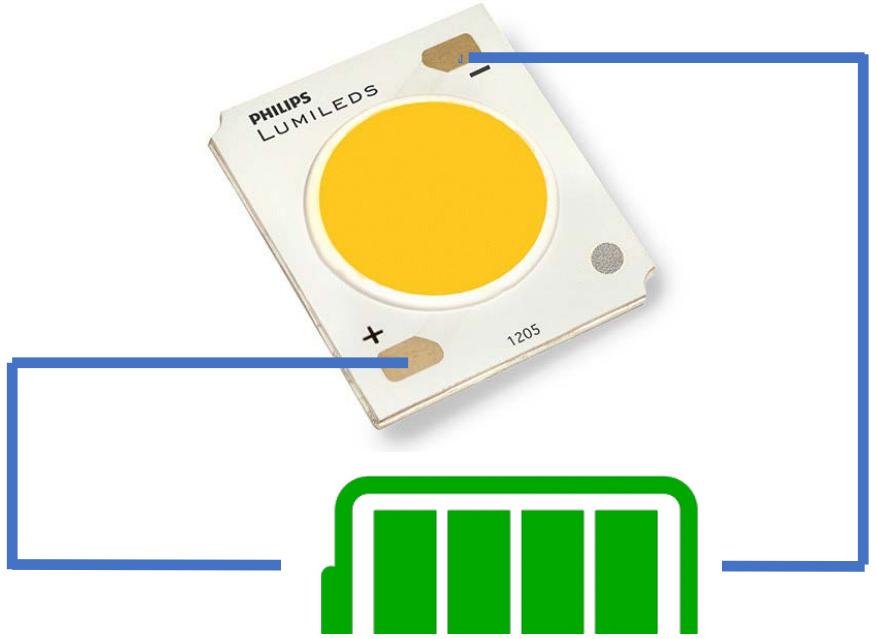
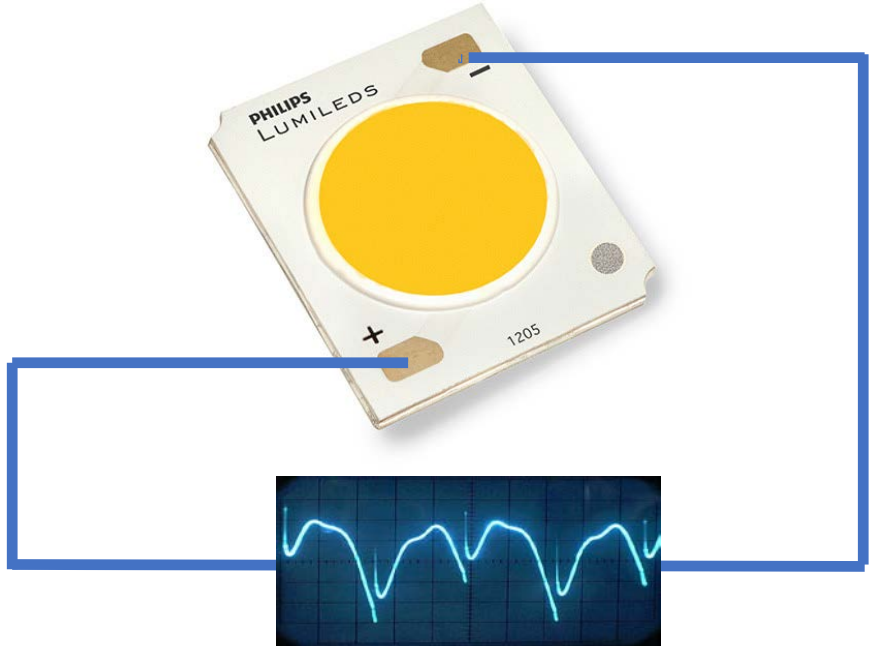
Why do LED's Flicker……

- ……They do not
- Light output is based on amount of current going through the led
- Quick reaction of current changes
- No intrinsic flicker



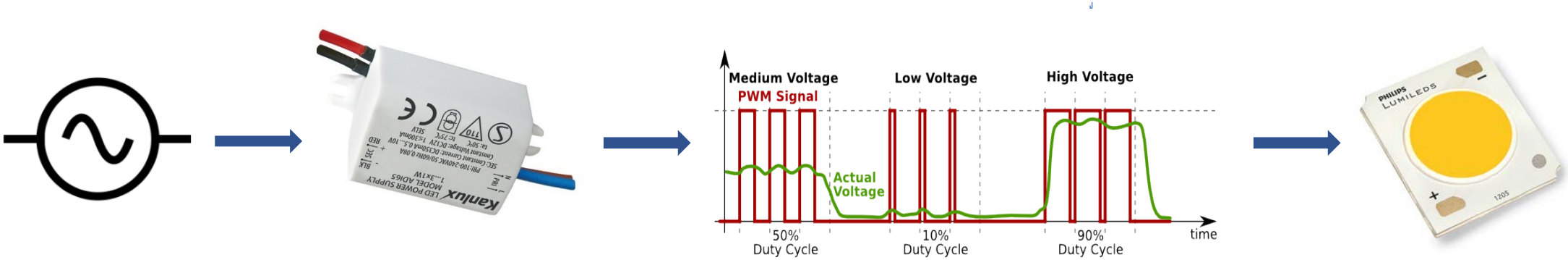
Why do LED's Flicker

- It's the drivers job to provide a nice constant current
- Electric NOISE -> LED -> optical noise out



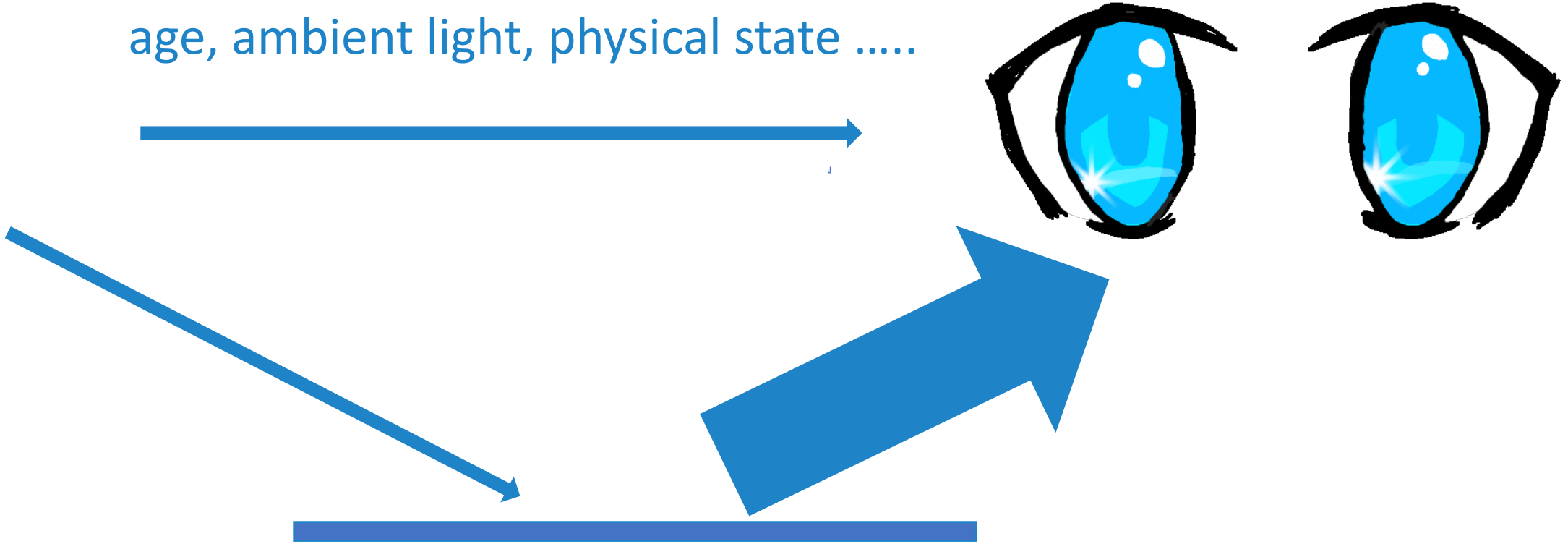
What can introduce noise

- 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

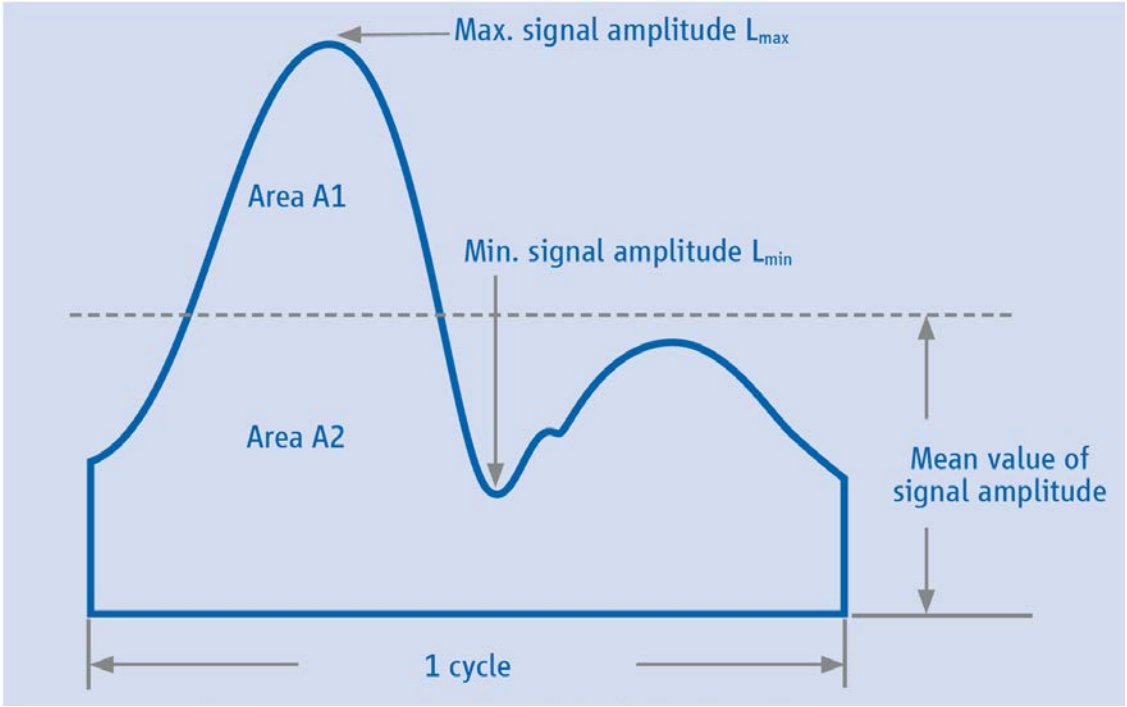
- Complex
  - RPI LRC Assist, Mp, Flicker Perceptibility
  - IEC PST
  - SVM
  - FFT Analysis

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

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

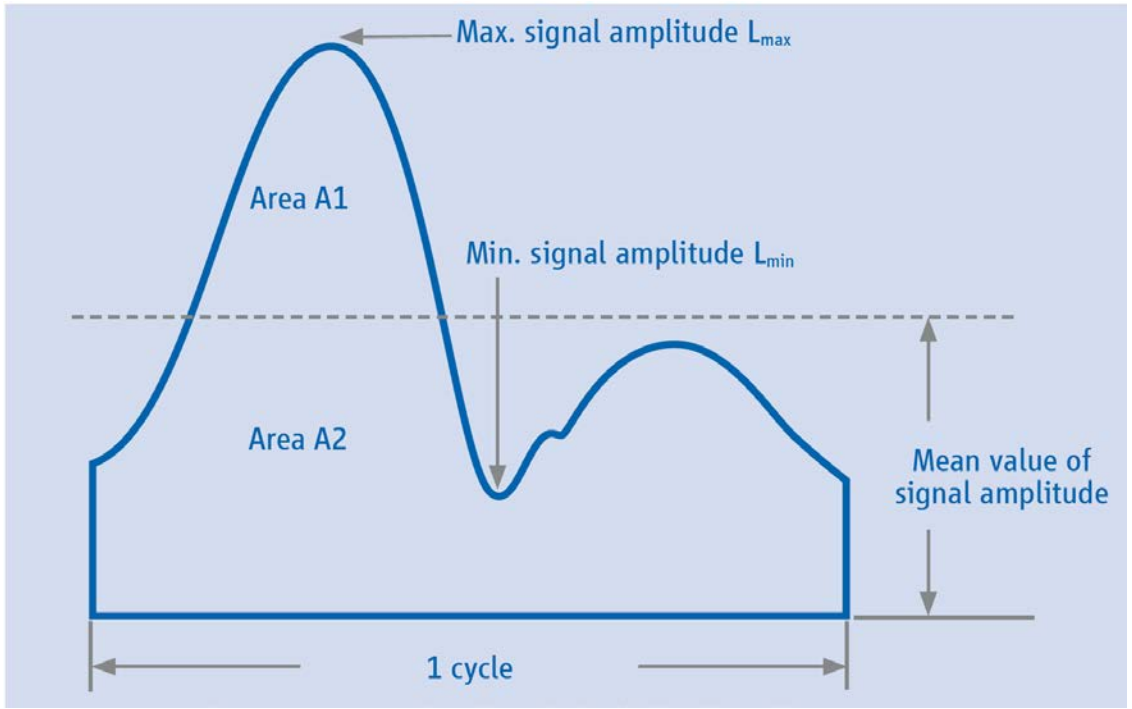
- Amplitude based calculation



Flicker index

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

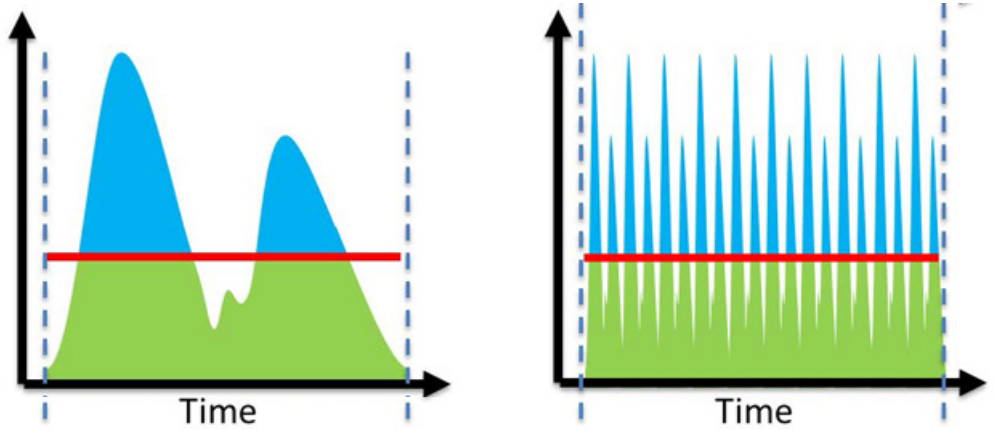
$$FI = \frac{Area\ 1}{Area\ 1 + Area\ 2}$$



- 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



Give for both

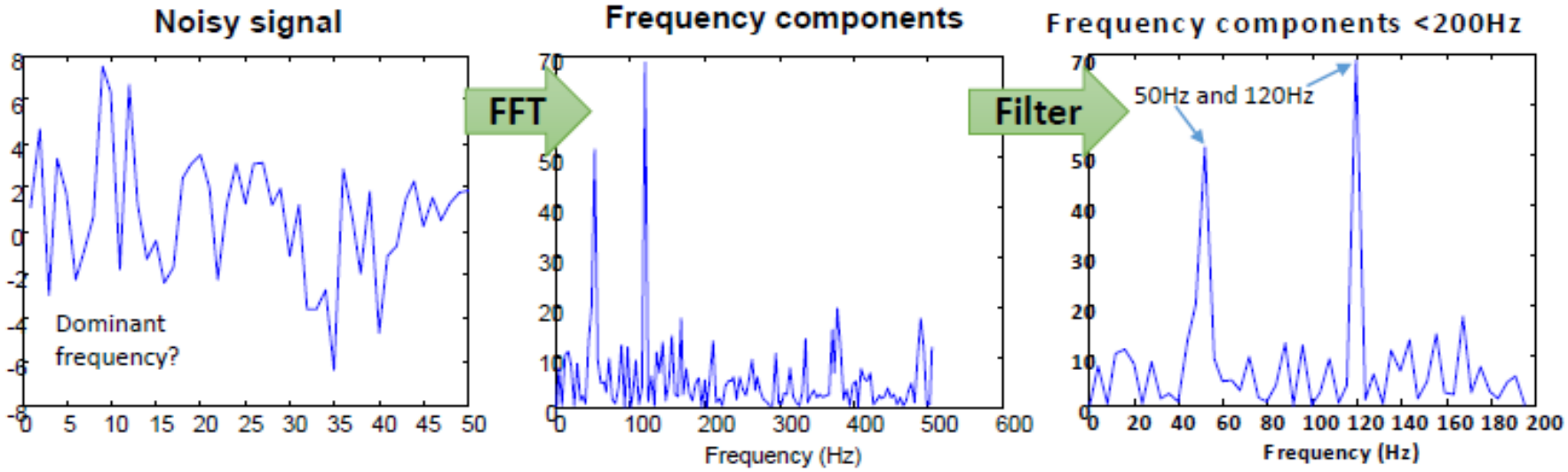
Same Percent Flicker
&
Same Flicker Index

What will work better

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

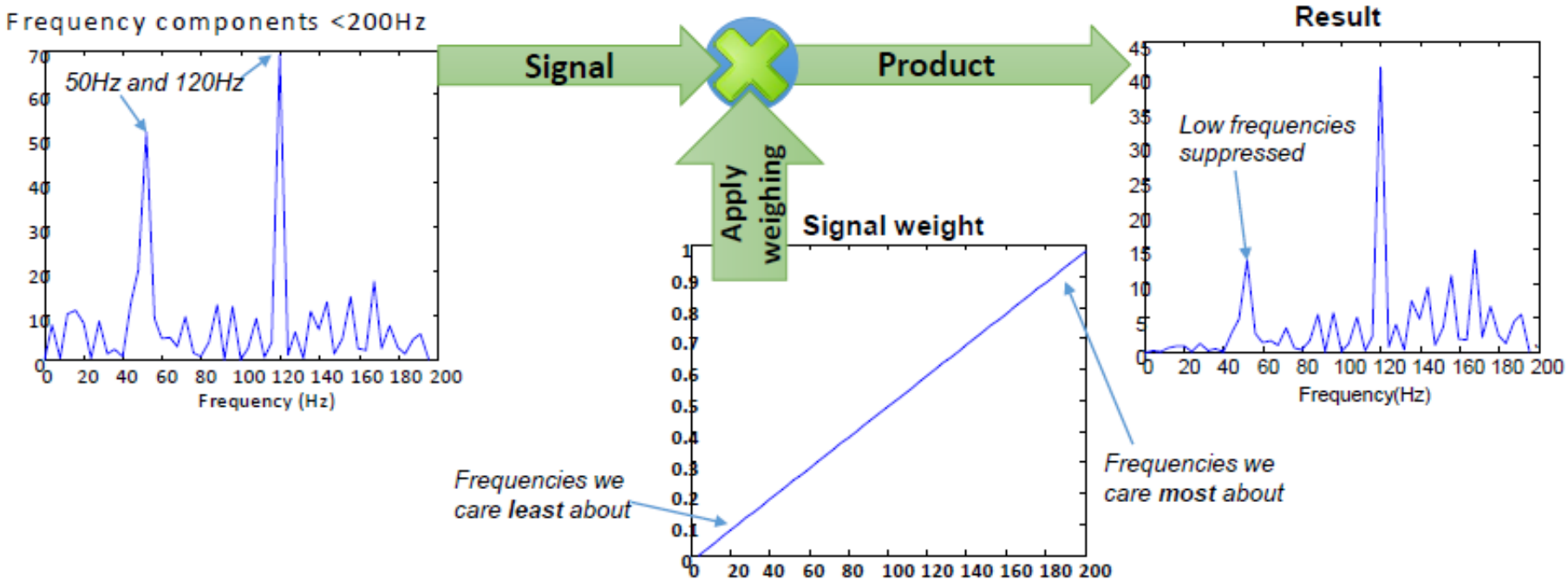
Check the frequency components

- 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)



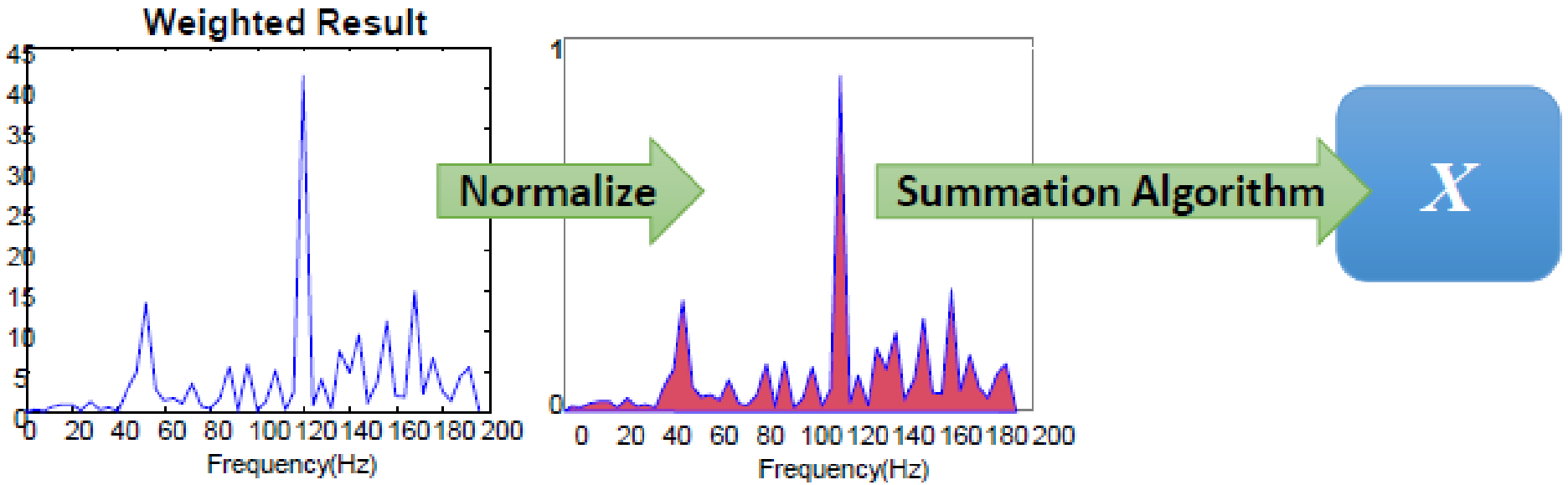
Determine frequency of interest

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



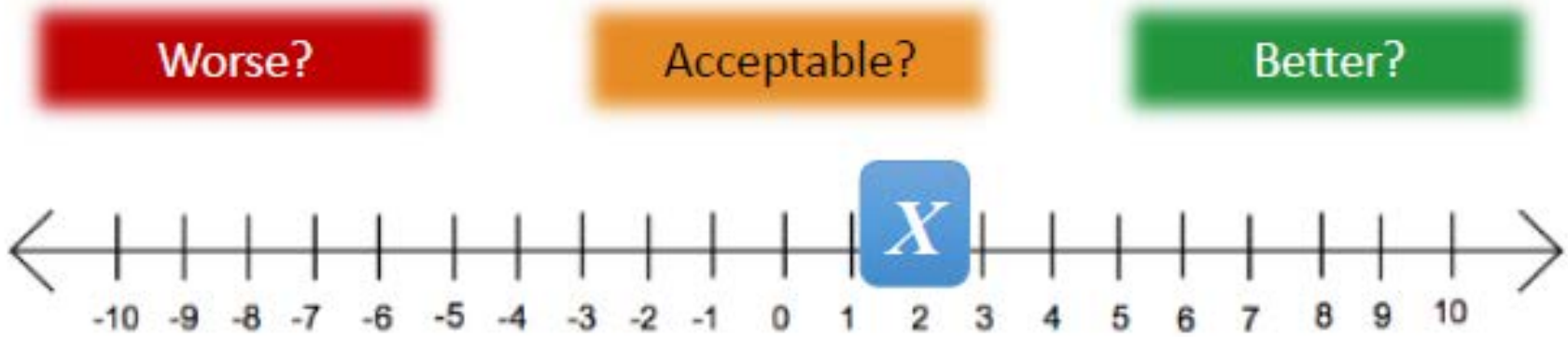
Combine the results

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



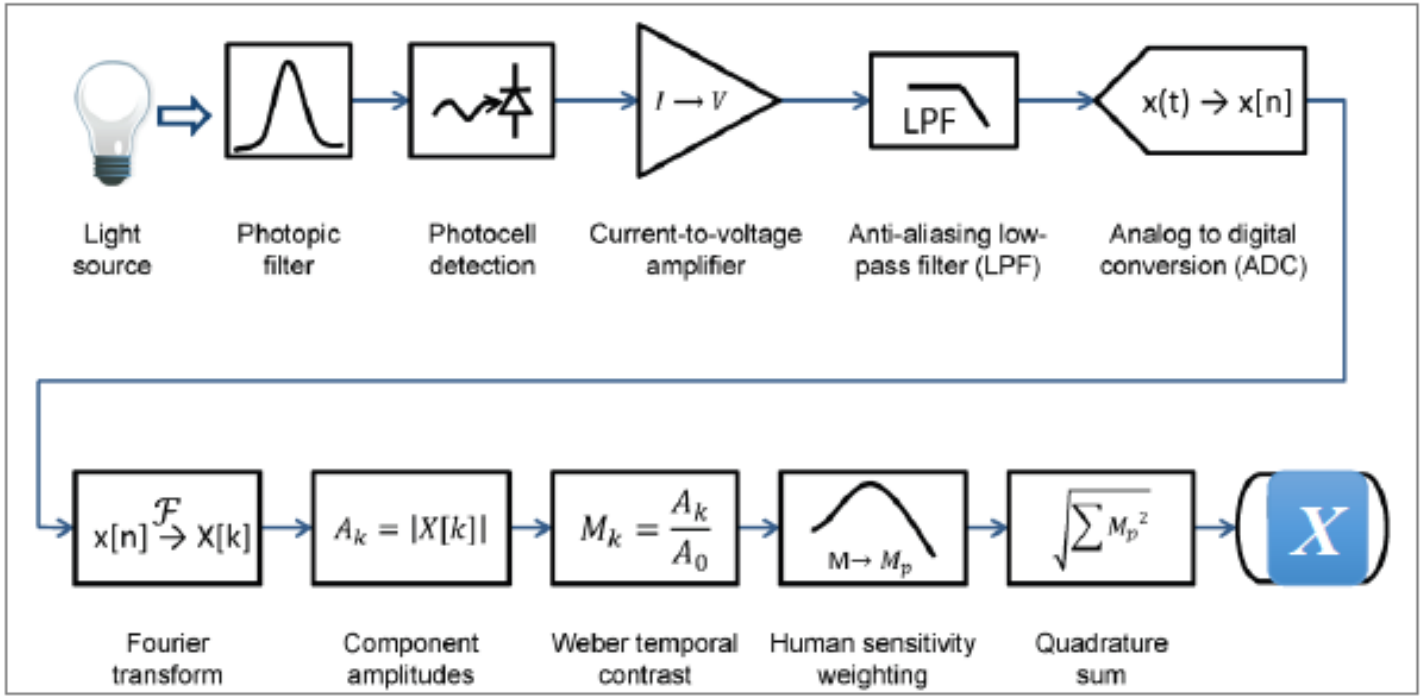
Compare result against a standard

- Is lower or higher “better”?
- What’s an acceptable range?
- Does it vary based on application?



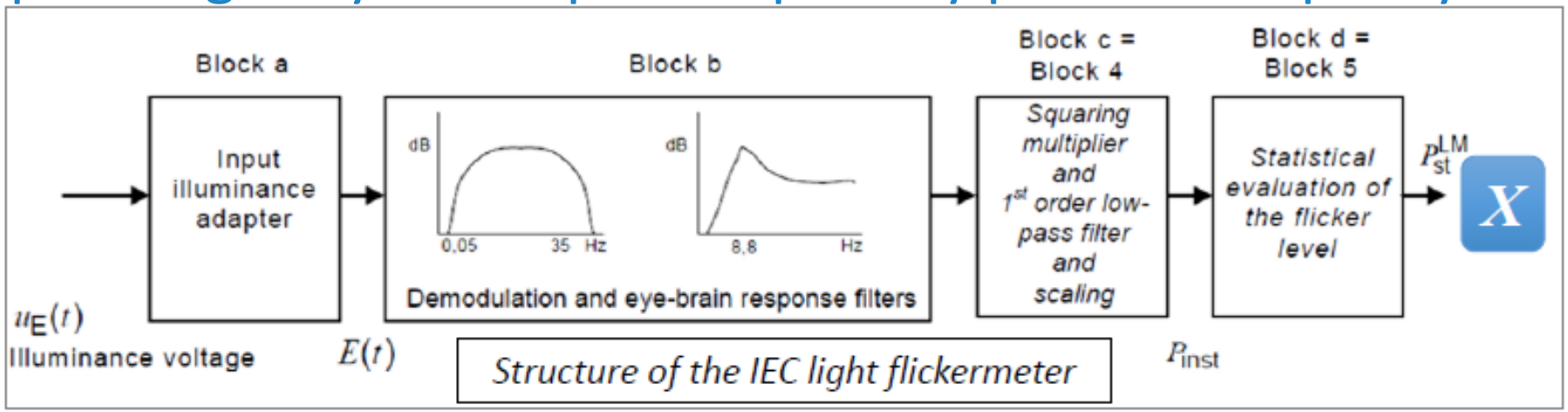
Example: RPI LRC ASSIST metric (more USA)

- Accounts for wave shape and frequency
- Based off of (limited) human perception trials
- Focuses on perceptible flicker: <100Hz
- Complex measurement and analysis



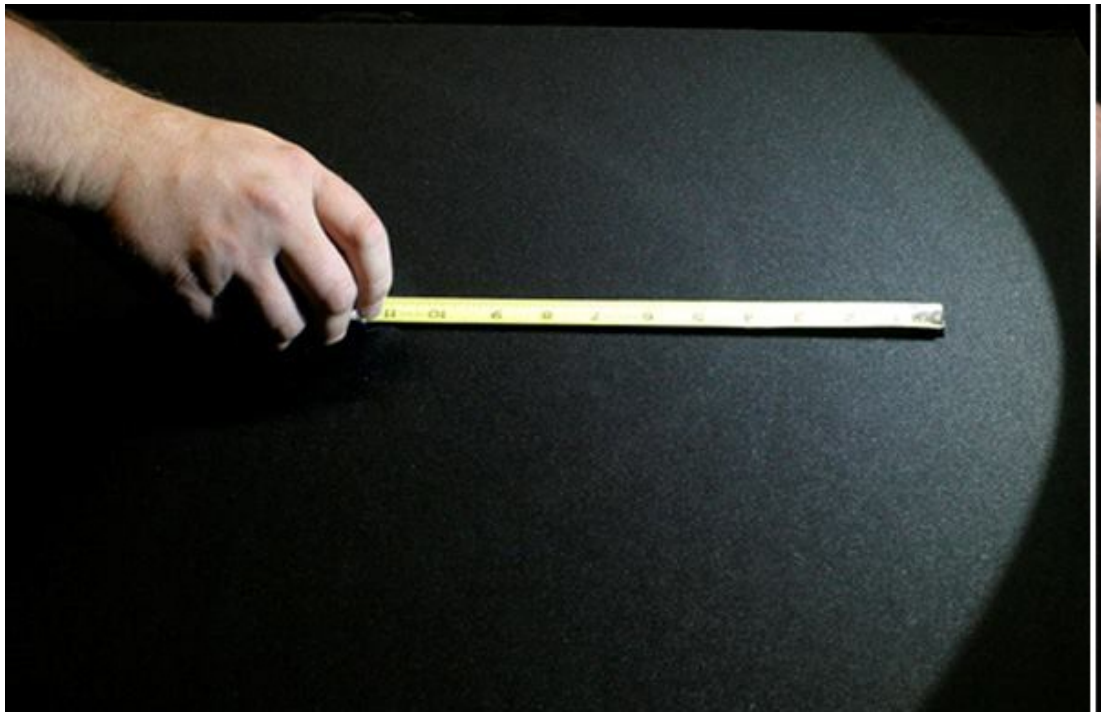
Example: P_{st} ,IEC flicker testing

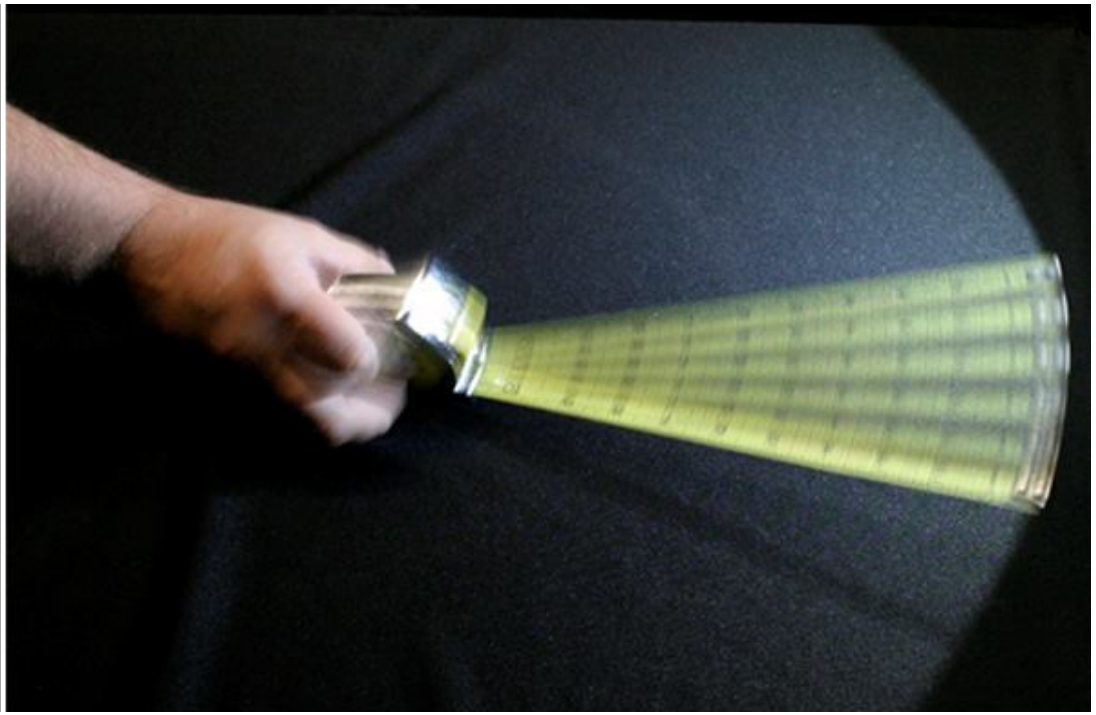
- IEC 61000-4-15
  - Flickermeter – Functional and design specifications
- IEC 61000-3-3
  - Limitation of voltage changes, fluctuations and flicker in public low voltage supply systems
- IEC TR 61547-1 (Adopts IEC 61000 for use with light)
- Complex originally developed to quantify power line quality



Example:
Stroboscopic Visibility Measure (SVM)

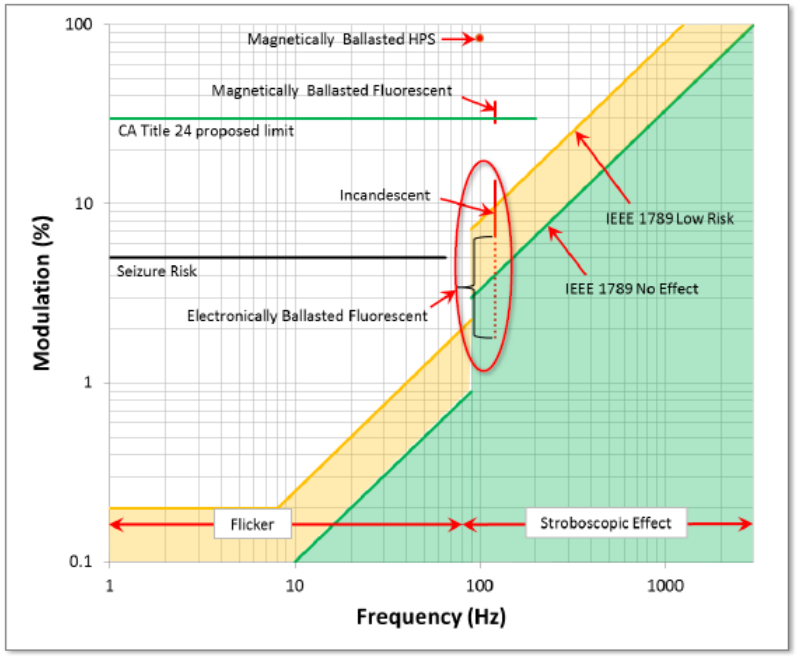
- Measures primarily stroboscopic effects >80Hz (for moving objects), not necessarily static flicker
- Not yet well known or widely used in industry
- Based off of human perception trails

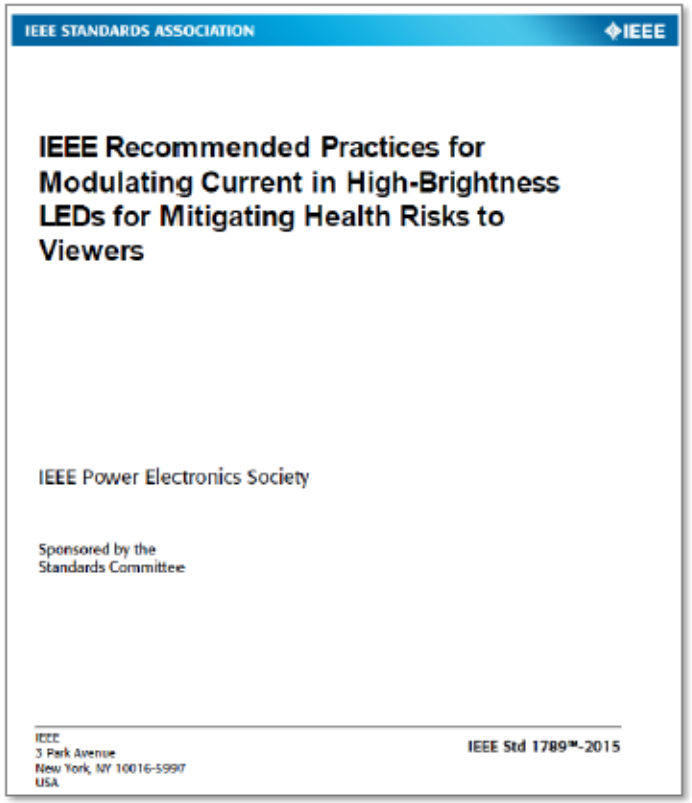




IEEE 1789-2015

- IEEEE recommended practices for Modulating Current in High-Brightness LEDs for mitigating Health Risks to Viewers
- Results drawn from multiple studies
- Results are somewhat controversial




IEEE STANDARDS ASSOCIATION IEEE

IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers

IEEE Power Electronics Society

Sponsored by the Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 1789™-2015

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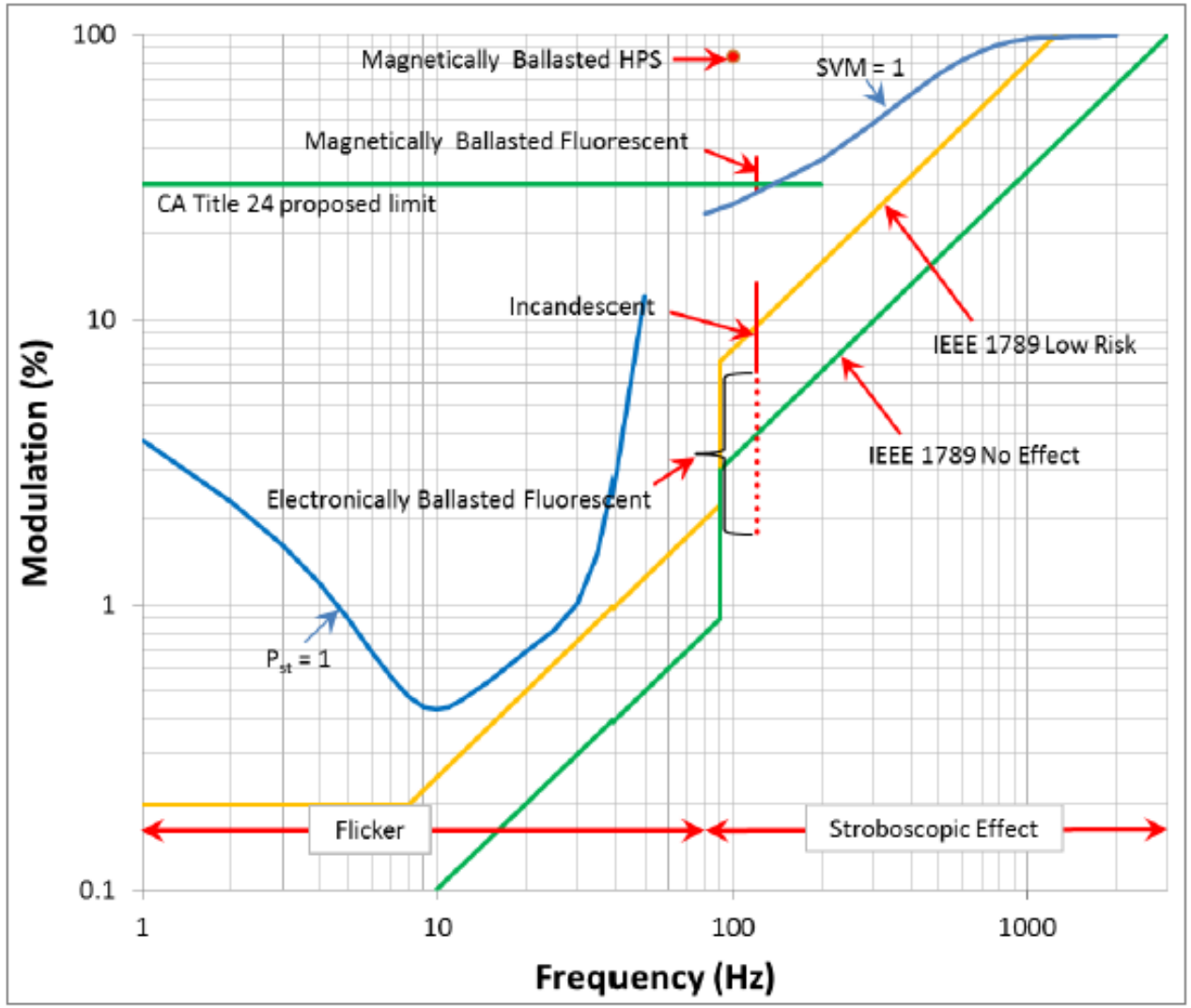
Comparison of several TLA metric limits



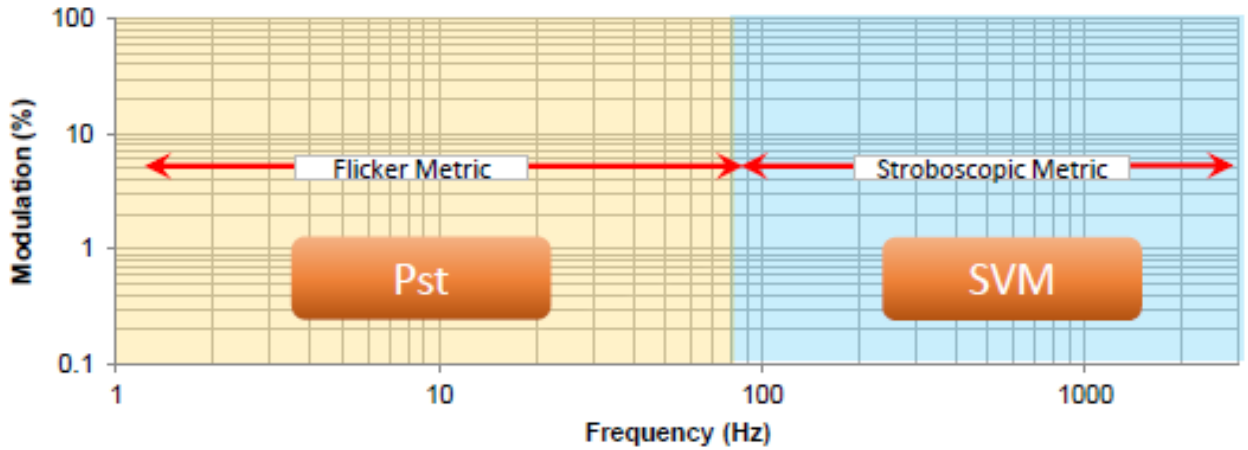
Points of concern
Analysis of an industry standard

WHAT Do you measure?	HOW Is it measured?	HOW Is it analyzed?	WHAT are the limits?
Light? Current? Voltage?	Sensor specs? Sensitivity? Frequency?	ASSIST? PST? Flicker Index? SVM	<1? >1? >1.6?

Know what you are doing

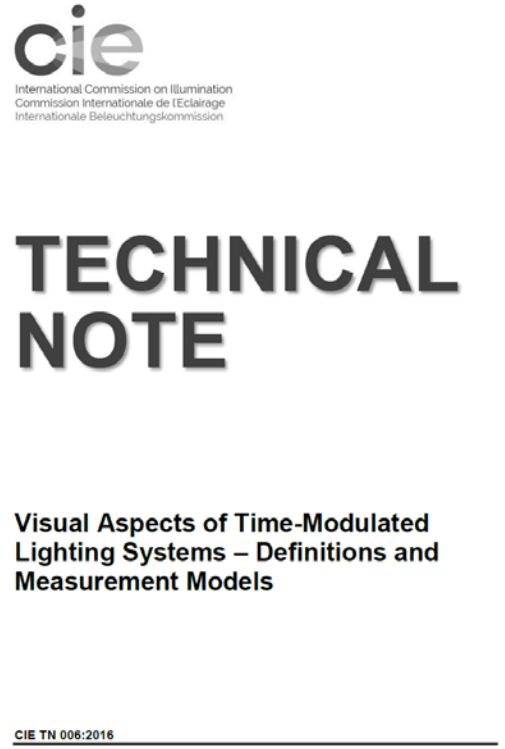
NEMA LSD-75 (Temporal Light Artefacts) – CIE proposed to ad

- 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

LED EVENT 2017 BE 29-11-17 NL 30-11-17

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