



Northeastern



IEEE PAR1789

“Recommended Practices of Modulating Current in High Brightness LEDs for Mitigating Health Risks to Viewers”

<http://grouper.ieee.org/groups/1789/>

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PURPOSE

Vision: *Bring together a community of lighting environmental psychologists, medical researchers, lamp designers, LED driver designers, and LED lamp users to openly discuss concerns for LED lighting.*

- There is a need to create a community where experts among the above different fields can communicate.
- Suggest a recommended practice, not a standard. Representation on IEEE PAR1789 from CIE and NEMA may later incorporate findings into standards if deemed necessary.
- IEEE Standards Association has a unique open process that **MUST** involve all interest groups including academics, national labs, industry, customers... (*current membership is ~50 with around 25% academics, 25% government labs, 50% industry/consulting*)
- International participation from members and from standards groups

PURPOSE

1. Describe some possible health risks, such as headaches, eye strain and epileptic seizure, associated with low frequency modulation of High Brightness LEDs in different applications;
2. Provide recommended practices to aid design of LED driving systems to modulate at safe frequencies for their particular applications in order to protect against the described health risks.
 - **Report Posted on IEEE PAR1789 Website 2/22/10** for public comment: Tutorial/Scientific survey on flicker in LED lighting and its health effects: <http://grouper.ieee.org/groups/1789/>
 - Literature survey only with no recommended practices or standards recommendations in report. The report is an objective scientific summary of published research on biological effects of flicker in lighting.
 - Reference List – Approximately 100 papers on topics of biological effects of flicker, flicker measurements, etc.

Questions

**What makes LEDs
different? Why the
concern about
flicker?**

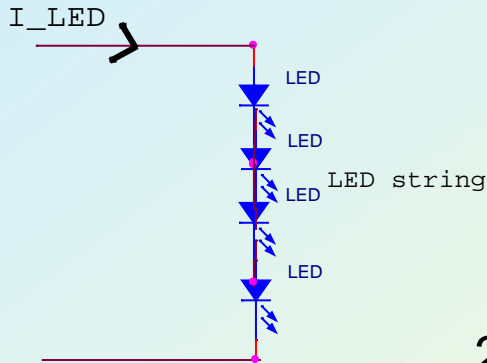


The Concern?



DC
Power

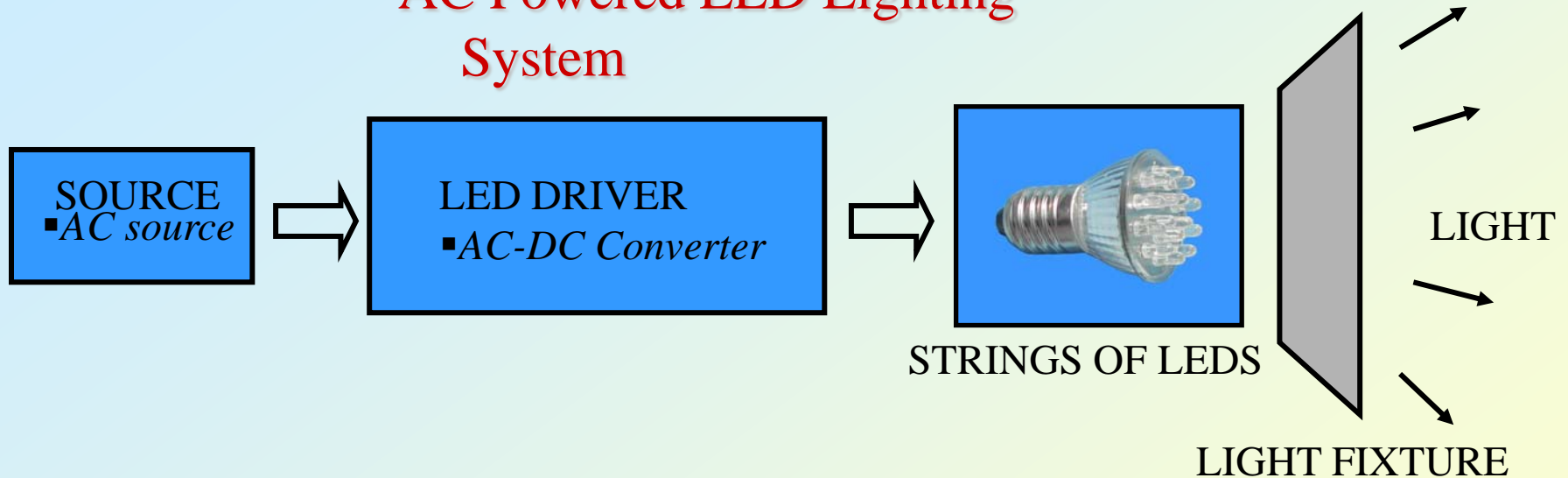
AC
Power



1. Luminous intensity in an LED is approximately proportional to the current through an LED. (*instantaneous response- no time delays that filter the ripple in presently used LED phosphors*)
2. LEDs run with constant luminous intensity when driven by pure DC current.
3. So, there should be no problem... Just put a DC current in the LED and there will be beautiful light with no flicker... **Welcome to AC electricity.**

The Concern?

AC Powered LED Lighting System

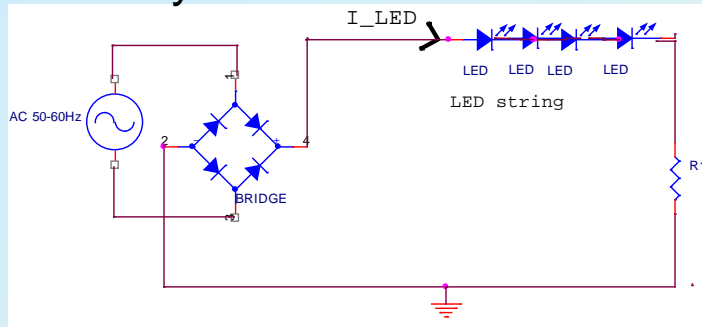


1. AC-DC converters often have 120Hz harmonics (flicker) in their current. How much is acceptable? (120Hz = twice the line frequency, which would be 100Hz in Europe.)
2. It is possible to eliminate AC-DC converter using a few special techniques: Reduce costs, eliminate capacitors, smaller size, increased lifetime. But this gives increased 100Hz/120Hz flicker.

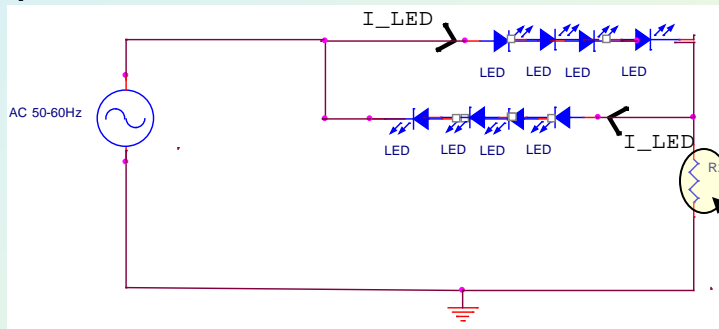
The Concern?

*Several Different Applications with Low Frequency Modulated Current.
(Described from publicly available documents)*

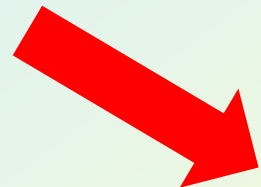
1. Rectify AC and send to LED string



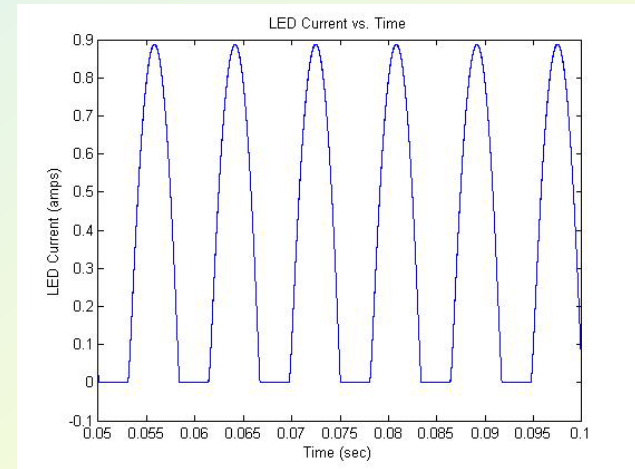
2. Directly power two LED strings with opposite Anode/Cathode connections



Or a capacitor



Luminous Intensity

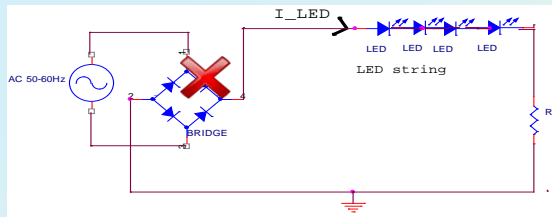


Luminous Intensity
(periodic every 1/120 sec)
is proportional to LED current

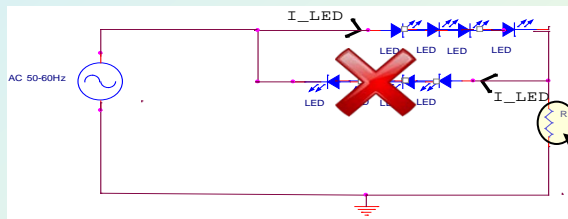
Concern?

Failures may cause 60 Hz flicker: Open circuit in rectifier or in LED string

(a) Rectify AC and send to LED string

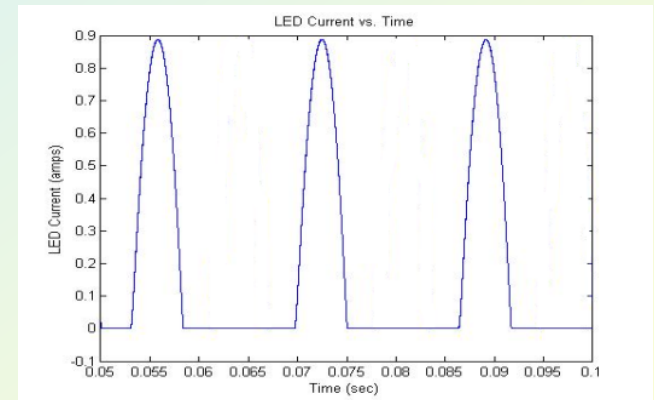


(b) Directly power two LED strings with opposite Anode/Cathode connections



Or a capacitor

Luminous Intensity



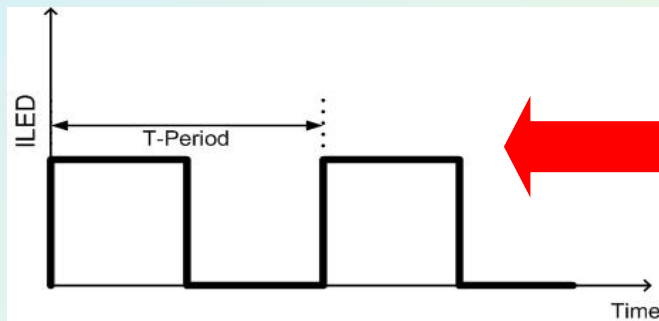
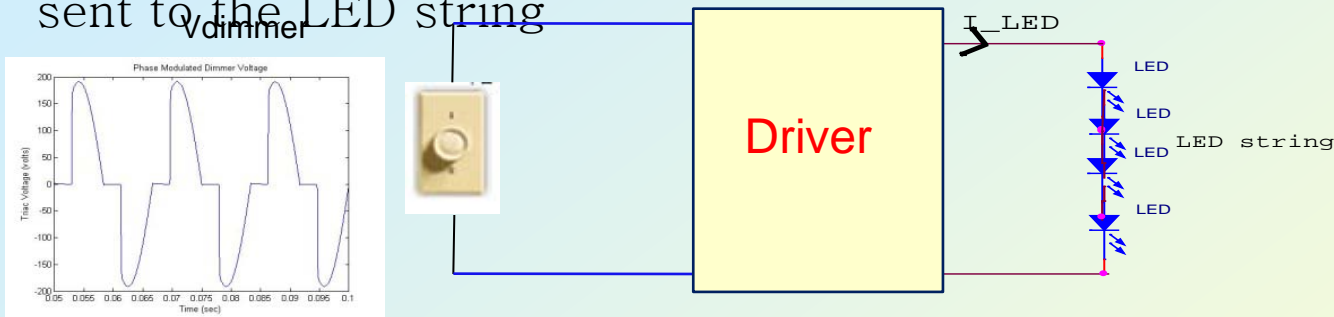
(c) Simulation of current through HB LEDs. Luminance is proportional to current, causing lamp to flicker at the AC mains line frequency (shown periodic every 1/60 sec)

IEEE PAR1789 members are suggesting to consider simple shutdown alarms circuits so that the lamp never flickers at 60 Hz/50Hz

The Concern?

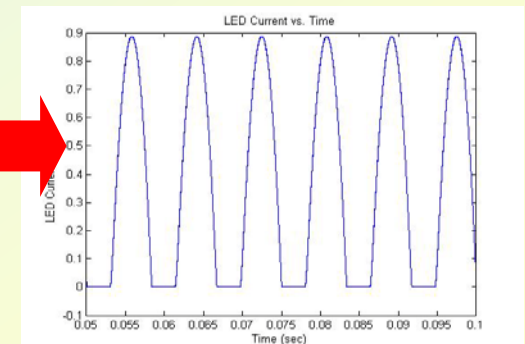
Several Different Applications with Low Frequency Modulated Current

3. Dimming from Residential AC Wall Dimmers: Dimmer chops the AC mains. When its voltage is zero, the driver turns off and no current is sent to the LED string



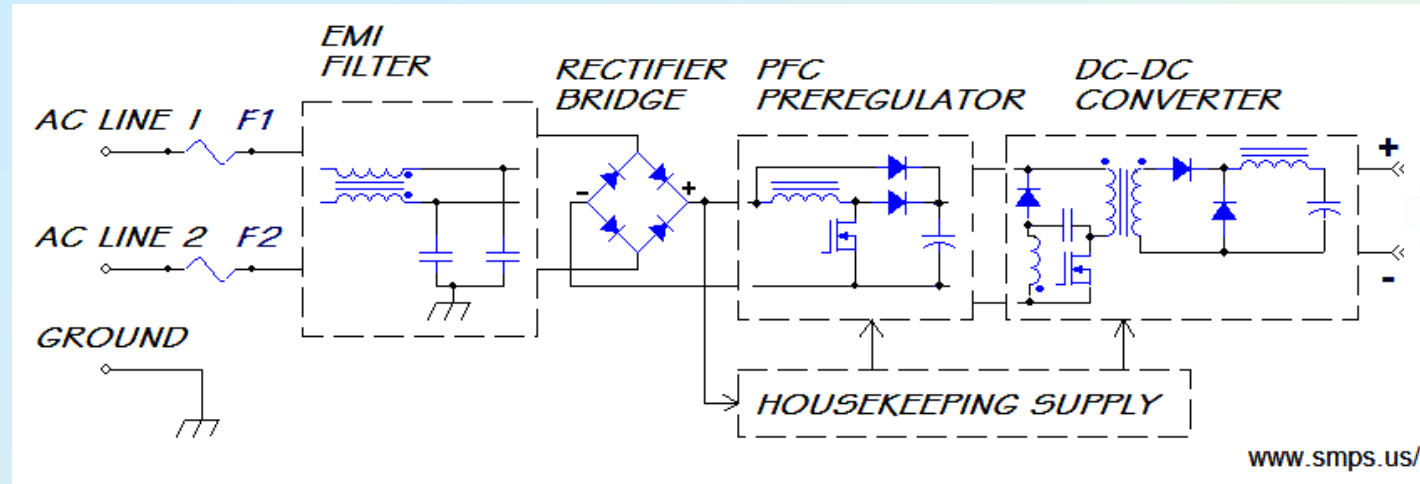
Common LED Currents

$$(1/T=f=100\sim 120\text{Hz})$$



A few LED lamps will visually flicker on AC wall dimmers (3Hz~25Hz) because they fail to work properly.

Solutions = Cost?



Various AC/DC switching power supplies (with power factor correction) give reduced flicker.

- Increased parts count – lower reliability, more space required inside Edison socket
- Higher cost
- Sometimes lower power efficiency
- Lower lifetime due to capacitance added
- Possible to design so that 120Hz/100Hz flicker is minimal (depends on part selection: may still keep flicker)

Complicated Balance



- **Cost, size, efficiency, reliability, lifetime vs. Low flicker ?**

IEEE PAR1789 Schedule/Timelines

1. **Report Posted on IEEE PAR1789 Website 2/22/10** for public comment: Tutorial/Scientific survey on flicker in LED lighting and its health effects:

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2. Creating several new documents, each will be subsection of final recommended practice report:
 - a) Method to “**characterize/measure**” flicker in LED lighting: create definitions for flicker that are frequency dependent. These do not exist now for lighting designers.
 - b) **Risk matrix hazard analysis** for different ranges of flicker (severity of health effect, confidence level, probability of occurrence).
 - c) **Recommended practices** (if needed)
 - *Streetlight recommendations might be different than kindergarten classroom lighting.*
 - *Safeguard against certain types of lamp “failures”*
3. Goal: Assemble all these different reports into draft by 12/10 (optimisitic).
4. All reports will be posted for public comment.

Few Comments

- Recent events have made this committee “high profile.”
 - We are being very careful with our recommendations: profits, jobs, innovation may depend on what is written
- Is there enough research to make conclusions?:
 - Yes in some areas, maybe no in others. We will openly discuss this in all reports.

Typical Risk Matrix Example (Mil-Std 882)

Probability of Occurrence	Severity Ranking				
	Catastrophic (5)	Critical/Serious (4)	Moderate (3)	Slight (2)	Minimal (1)
Improbable (1)	5	4	3	2	1
Remote (2)	10	8	6	4	2
Occasional (3)	15	12	9	6	3
Frequent (4)	20	16	12	8	4

- Should include “confidence level” of data/research into any assessment of probability of occurrence
- Just an example table (above) and not necessarily the format of table IEEE PAR1789 will derive