PHILIPS

sense and simplicity

CIGRE working group C4.111

Review of LV and MV compatibility levels for voltage fluctuations

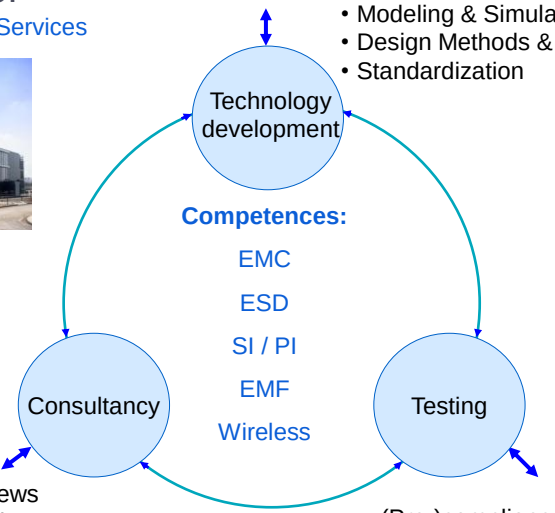
Status

P.A. Beeckman
Philips Innovation Services & NL member Cigre C4.111
Cigre NSC C4 meeting Eindhoven; June 7, 2013

PHILIPS

EMC Center

Philips Innovation Services



PHILIPS

NOTES

1. Remark: This presentation constitutes a personal interim status report; it is not the final & formal conclusion of the Cigre C4.111 working group. The final report with recommendations is expected by December 2013
2. Scope: The flicker aspects in this presentation are limited to flicker resulting from voltage fluctuations (flicker in the sense of IEC 61000-4-15). Hence no stroboscopic effects are considered!

PHILIPS

Content

- Introduction
- Standardization
- Flicker immunity tests
- Summary

PHILIPS

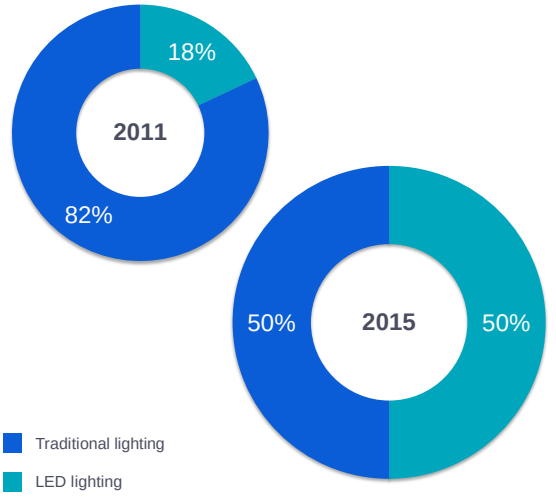
Background & scope

INTRODUCTION

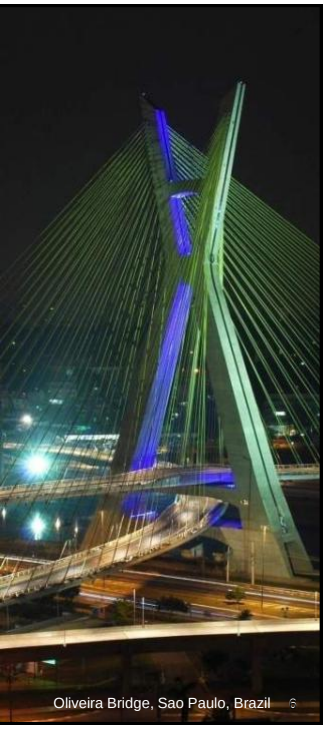
PHILIPS

The LED revolution

Digital lighting is transforming the entire landscape*



*Source: Philips Lighting global market study 2009, updated for 2010



Oliveira Bridge, Sao Paulo, Brazil

PHILIPS

Banning of Incandescent lamps

EU example

	Sep. 2009	Sep. 2010	Sep. 2011	Sep. 2012	Sep. 2013	Sep. 2014	Sep. 2015	Sep. 2016
Clear	15W 25W 40W 60W 75W 100W	15W 25W 40W 60W 75W 100W	15W 25W 40W 60W 75W 100W	15W 25W 40W 60W 75W 100W	Banning of all Incandescent Lamps			
Opal		Banning of all opal Incandescent Lamps						
Reflector	15W 25W 40W 60W 75W 100W	Directives in preparation						
Special	Special Purpose Lamps							

Significant reduction of the electrical usage of lighting equipment during the next 10 years (10% → 4% → 2%)

PHILIPS

…results into various EMC/PQ issues associated with lighting applications

- Harmonics, power factor
- Inrush currents
- Voltage fluctuations & flicker
- Frequency region ‘gap’ in EMC standards (2 kHz – 9/150 kHz)
- …

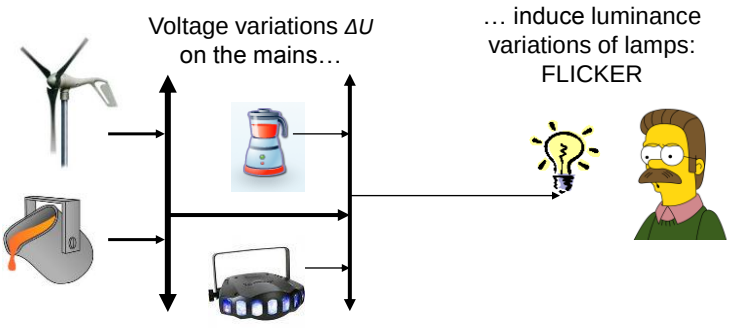
PHILIPS

Status

STANDARDIZATION

PHILIPS

Flicker induced by equipment connected to the grid

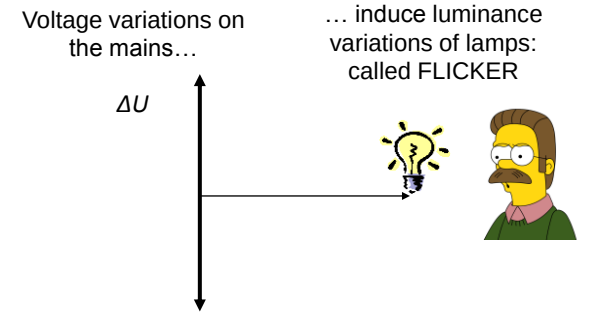


Varying & switching sources & loads

- heavy industry on the MV-grid
- appliances on the LV-grid

PHILIPS

Type of voltage variations & standards



IEC 61000-3-3
IEC 61000-4-15

Type of voltage fluctuations relevant for flicker:

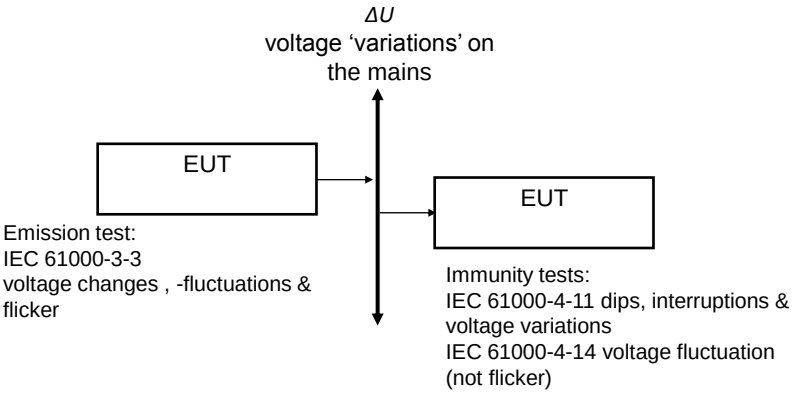
- Continuous/regular fast fluctuations in the range of 0.5 Hz – 35 Hz
- Not:
  - Occasional fast fluctuations like steps, dips (also called rapid voltage fluctuations-RVCs)
  - Slow magnitude variations

IEC 61000-4-30

EN 50160

PHILIPS

Voltage fluctuations: emission & immunity

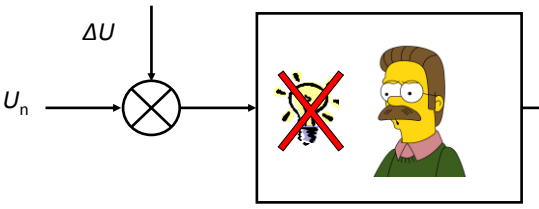


Incandescent lamp is considered the most sensitive equipment apparatus connected to a LV-mains, therefore no immunity test as counterpart of IEC 61000-3-3 exists

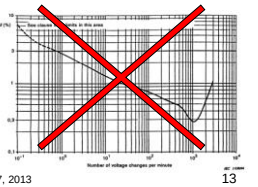
PHILIPS

Flicker meter: emulates perception of flicker of a 60 W incandescent lamp = reference

Mains voltage + variations



Various flicker metrics and limits for various product categories:
P_{st}
P_{lt}
P_{inst}
d
d_{max}
etc

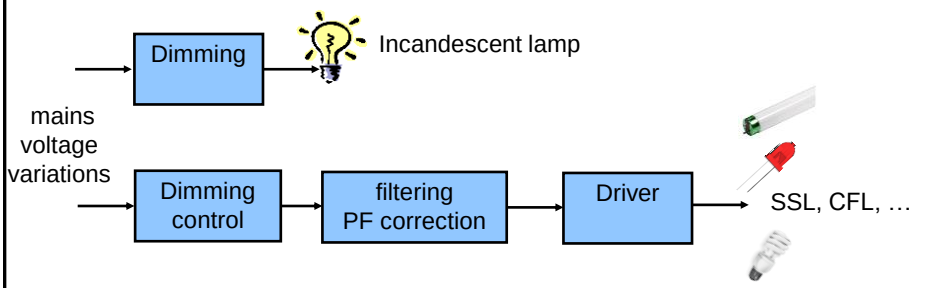


Flicker meter i.a.w. IEC 61000-4-15 emulating 60 W lamp + eye/brain response

Limits & test conditions in IEC 61000-3-3

PHILIPS

Flicker influence quantities



Future lighting equipment: much more flicker influence quantities involved (compared to incandescent) due to diversity of

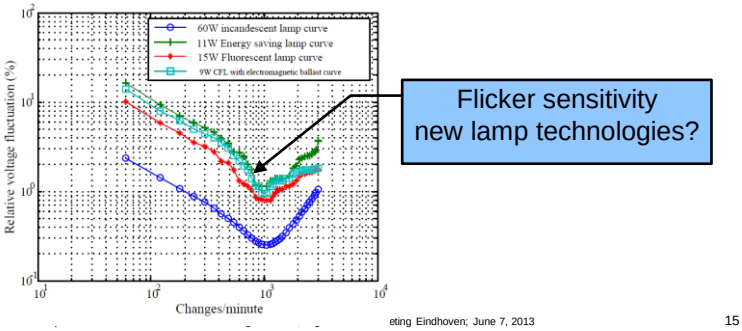
- lamp types
- driver- and dimming/control-, PF-correction/filtering-technologies

PHILIPS

New flicker requirements possible/needed?

More relaxed requirement (allowance of higher voltage fluctuations) possible?:

- Other, than lighting equipment may experience malfunction
- New lamp technologies and driver/control topologies and dimming (installed base!) may be also more sensitive to flicker



PHILIPS

IEC SC 77A & CIGRE C4.111

C4.111 → SC 77A/WG2

- IEC SC77A requested CIGRE[1)] for advice
- CIGRE task force C4.111
  - has reviewed the adequacy of the present IEC flicker meter & limits
  - will provide recommendations to IEC SC77A by end of 2013
  - anticipated recommendations:
    - no or minor change of the flicker limit line
    - development of a flicker-immunity test for lighting equipment
- Subsequently IEC SC77A/WG2 might start maintenance of the associated standards
  - IEC 61000-3-3 = the 'IEC-flicker standard' (testing level of induced of voltage fluctuations)
  - IEC 61000-4-15 = the IEC flicker meter specification
  - also WG8 (responsible for compatibility levels) might be tasked

PHILIPS

CIGRE C4.111 activities

- TOR, see http://c4.cigre.org/WG-Area/WG-C4.111-Review-of-LV-and-MV-Compatibility-Levels-for-Voltage-Fluctuation
- Convenor prof Mark Halpin
- Meetings:
  - June, November 2011
  - February, June, December 2012
  - March, July, December 2013
- Work left: to collate inputs and edit the final report (due end of 2013)

PHILIPS

CIGRE questionnaire issued in August 2011

- Q: What are consequences if the flicker curve would be raised 1.25 – 3 times
- 32 responses received from utilities, equipment- and lighting manufacturers
- Results categorized: support, no support, etc
- Results tend in one direction, i.e. no major change of the flicker curve
- Reasons
  - Incandescent/ halogen lamps are still in operation for several years
  - Fear of raise of complaints
- Instead: a real EMC approach needed by introducing an immunity test as a counterpart of the flicker emission test
- Results have been formally submitted to IEC (2012-Q1) as an intermediate result

PHILIPS

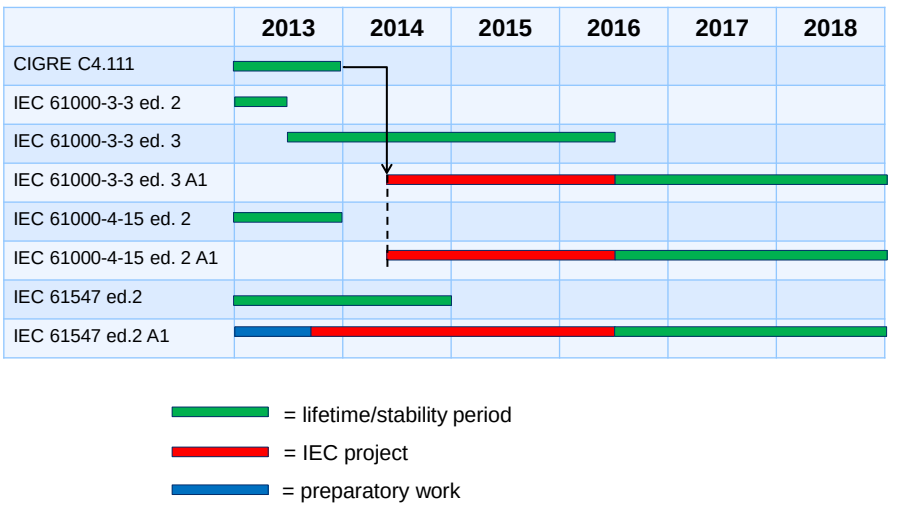
IEC SC 77A & IEC TC34

- October 3012: Mr. Deter member of the joint-TC34/SC77A-forum pro-actively initiated the development of voltage-fluctuation immunity standard for lighting equipment
- This informal request is to be formalized i.a.w. the IEC procedures
- Goal is to amend the EMC immunity standard IEC 61547 for lighting equipment
- Work to be performed by a PT & MT1 of IEC TC34
- Liaison of SC77A-WG2 member Johan Wijntjens (Philips)
- PInS EMC Center is setting up a demonstrator for an immunity test

SC 77A/WG2 ⟶ TC34/MT1

PHILIPS

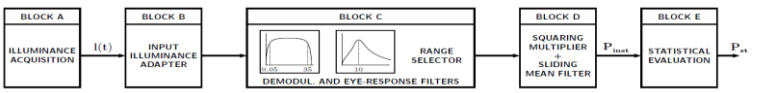
Overview/timeline IEC-flicker developments



PHILIPS

PInS project: development of an objective IEC-flicker immunity test for lighting equipment

- Goal: tool to support IEC TC34 standardization
- h/w for test
  - Chroma 61602
  - 33250A waveform generator Agilent
  - 50 Hz AFG R&S
  - Illuminance sensor
- control & data acquisition via Matlab
- Investigation of various flicker metrics for various types of lamps



PHILIPS

EU/Cenelec actions

- EC Mandate M/519 issued February 2013: http://ec.europa.eu/enterprise/policies/european-standards/standardisation-requests/index_en.htm
- European standards for flicker and stroboscopic effects to be enhanced or to be developed!

PHILIPS

FLICKER IMMUNITY TESTS

PHILIPS

Quantitative tests @ Bilbao University

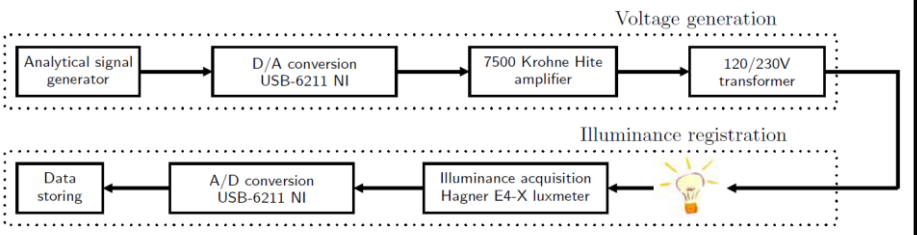
- Aug/Sep 2011: a limited # of samples of using various types of lamps, different driver technologies & different types of dimmers
- Hypothesis: future lamp technologies may be as flicker sensitive as incandescent lamps = justification for not changing the flicker meter/limits

Lamp type	Power	Brightness control	Remark
Incandescent	60 W		
LED	8 W	analog	optimized for LE dimmers
LED	12 W	digital	LE and TE dimmable
CFL	12 W	analog	LE and TE dimmable
CFL	11 W	supposedly analog	LE and TE dimmable with dimmer detection

Manufacturer	Technology
Busch-Jaeger	Leading Edge (LE)
Merten	Trailing Edge (TE)

PHILIPS

Quantitative tests @ Bilbao University



Gain curves(f_m): (relative illuminance variation/relative voltage fluctuation)=

$$gain = \frac{\Delta L / L}{\Delta V / V}$$

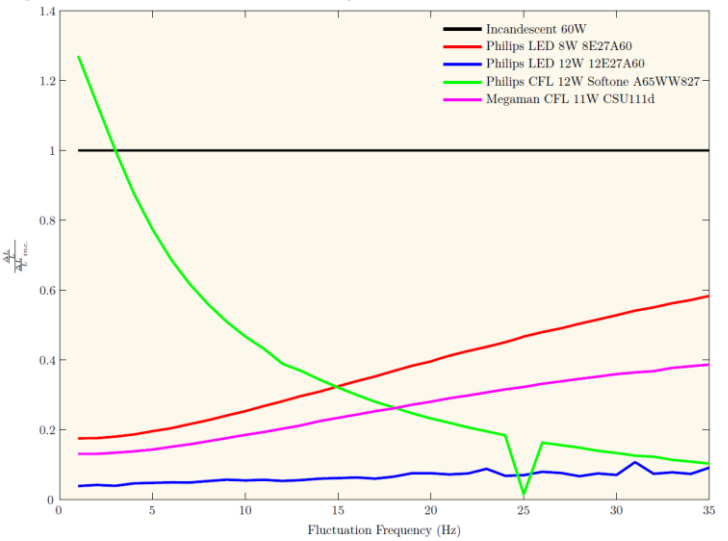
Results shown in terms of normalized gain curves
(relative to incandescent lamp)

$$normalised\ gain = \frac{\Delta L_{EUT} / L_{EUT}}{\Delta L_{INC} / V_{INC}}$$

=1 =reference =incandescent lamp
>1 more sensitive
<1 less sensitive

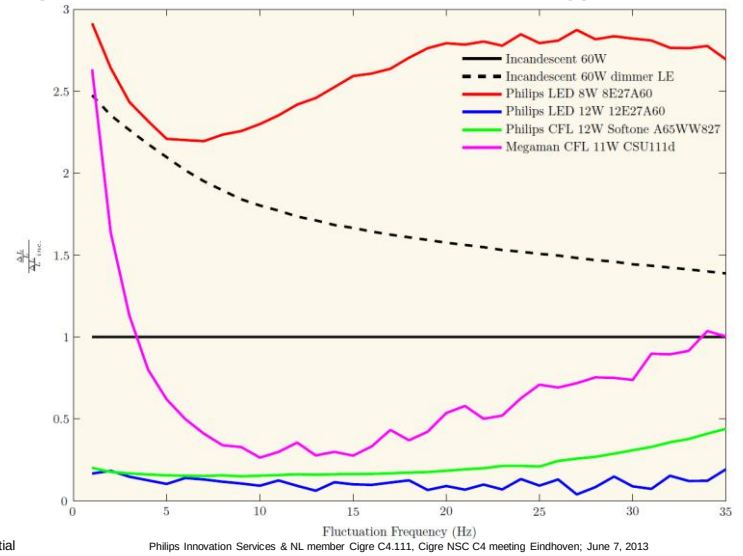
PHILIPS

Quantitative tests @ Bilbao University: results (lamps without dimmer)



PHILIPS

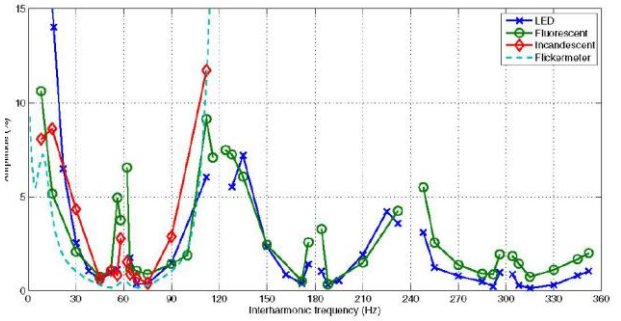
Quantitative tests @ Bilbao University: results (lamps with dimmer; 15 % dimming)



PHILIPS

Flicker immunity against 'high-frequency' variations

- CFL & LED lighting may be sensitive beyond the modulation frequencies of the flicker curve
- Due to diode bridge, inter-modulation frequencies result from intentional signals in addition to the mains frequency e.g. PLT, mains signalling



PHILIPS

Summary
(this is not the final & formal conclusion of C4.111!)

- Flicker sensitivity of lighting applications has become much more diverse (either more or less sensitive than the 60 W incandescent lamp)
- Technical influence quantities for flicker sensitivity are:
  - Lighting technology
  - Electronics (driver/PFC/filter) topology
  - Dimming technology
  - Dimming level
  - The reference impedance
  - Frequency of modulation
- New flicker compatibility-levels and immunity test will be defined within IEC standards in the coming years

PHILIPS

Acknowledgement

This work is supported by the Eniac Joint Undertaking project Enlight:
Energy efficient and intelligent lighting systems

31