Mains-operated LED-based transfer source for luminous flux scale realization and dissemination

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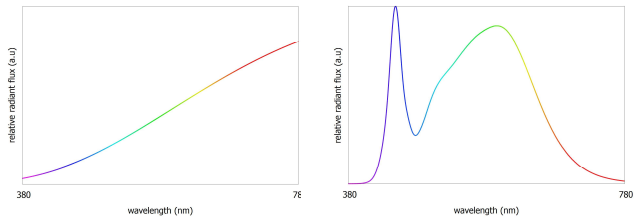
Stakeholder training
28 August, 2019; DTU Denmark

Introduction

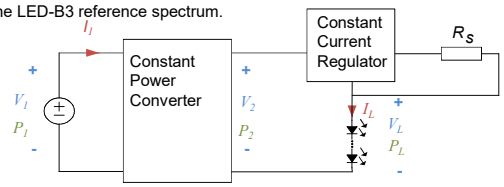
Goal:

- To reduce the uncertainties of luminous flux and luminous efficacy measurement of solid-state lighting (SSL) products at National Metrology Institutes (NMIs) to 0.5 % (k = 2) and to demonstrate that uncertainties as low as 1 % (k = 2) can be achieved in a test laboratory.



Source design and characterization

- **Source requirements:**
- Mains operated luminous flux transfer lamp with constant power consumption, optical stability better than 0.1 % and a high power factor.
- Low total harmonic distortion to enable consistent operation and measurement with different types of AC voltage sources and power meters.
- LEDs selected with spectra close to the LED-B3 reference spectrum.



AC Input
Constant power

DC Output
Constant Current

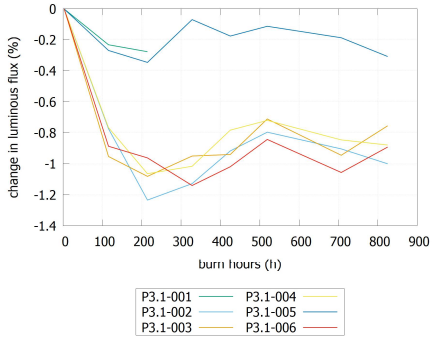
Source design and characterization

- **Source design:**
- LED PCB on heat sink with built-in constant-power controlled AC-DC converter combined with constant-current linear regulator.

Source design and characterization

- **Seasoning and stability:**
- Lamps are seasoned for 800 hours while monitoring flux every 100 hours.
- **Optical characterization:**
- Angular resolved Spectral Power Distribution (SPD) and integrated SPD have been measured for the six lamps.
- Luminous intensity distribution has been measured at six c-planes.
- **Electronic characterization:**
- Short term stability of the lamp has been assessed.
- Constant power consumption within 0.1 % after 2 minutes of stabilization time.
- Impact of power analyser bandwidth has been measured with the higher corner frequencies of the power-analyser set to 1 kHz, 2 kHz, 5 kHz, 15 kHz, 30 kHz, 45 kHz, 65 kHz, 75 kHz, 100 kHz, and 300 kHz.
- Impact of Impedance Stabilization Network (ISN) on power measurements has been determined at various higher corner frequencies of power-analyser.

Result: Seasoning



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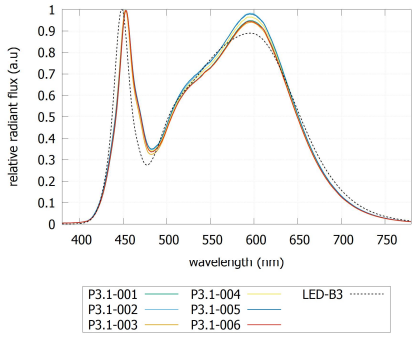
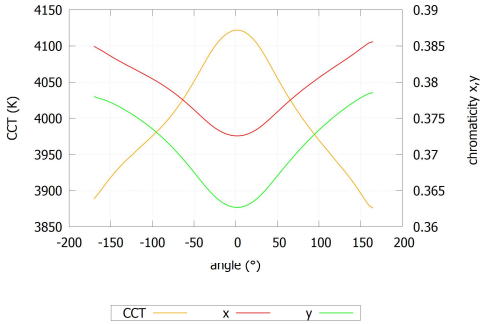
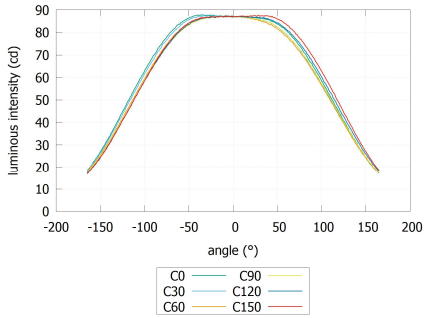
Result: Spectral power distribution



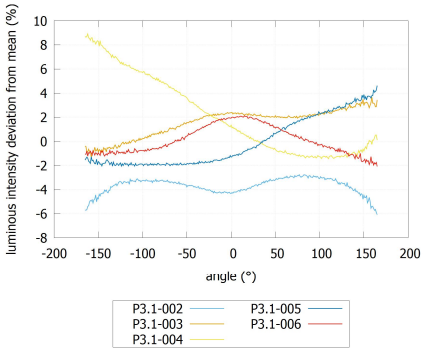
Result: CCT, x and y measured along a c-plane of lamp P3.1-002



Result: Luminous intensity distributions of lamp P3.1-002



Result: Variation of luminous intensity distribution



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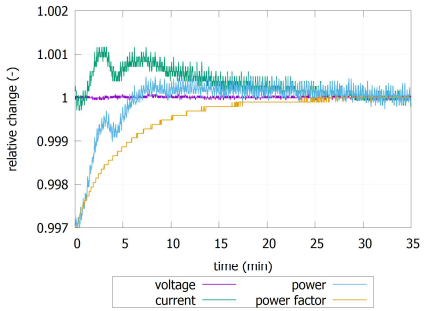
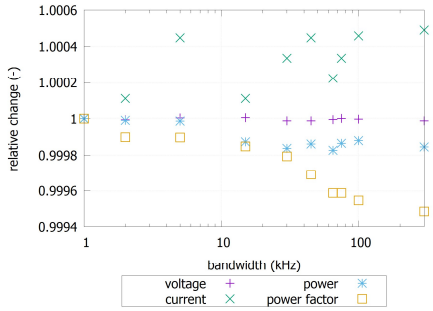
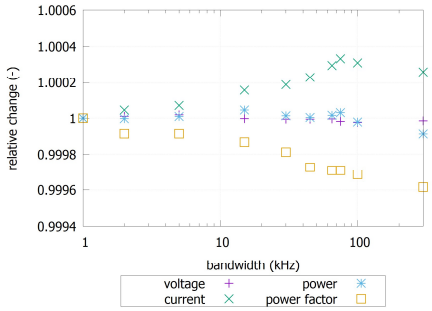
Result: Stability of lamp P3.1-001



Result: Electronic characterization of lamp P3.1-001 without ISN



Result: Electronic characterization of lamp P3.1-001 with ISN



Result: Typical electronic performance

Voltage	230.0 V	**apparent power**	(20.57 ± 0.03) VA
Frequency	50.0 Hz	**active power**	(19.97 ± 0.20) W
Current	(89.44 ± 0.21) mA	**power factor**	0.971 ± 0.016

Conclusion

Performance after ageing:

- Input power variation can be restricted to 0.1 %.
- Short term luminous flux stability better than 0.1 %.
- Long term luminous flux stability measured during seasoning better than 0.2 %.
- Power factors higher than 0.97.
- THD of current lower than 4 %.
- When powered through an ISN the relative difference in power consumption
  measured at bandwidths from 1 kHz to 300 kHz is within 0.017 %.

Their performance shows that these lamps are highly suitable for realization, transfer and verification of the luminous flux and luminous efficacy scale.

Thank you

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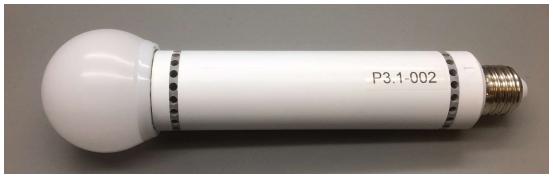
10.25039/x46.2019.PO067



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