NEMA SSL-7A and SSL-7B: Improving phase-control dimming of LEDs

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Agenda

• Background of SSL-7A
  – History
  – Purpose
  – Limitations

• Status of SSL-7B

• Next steps
  – Adoption agents
  – Related efforts
SSL-7 Inception

• Development started in 2011 to address emerging need for improved dimming compatibility
  – Lamp and control manufacturers participated

• Standards development broken into two phases:
  – Part A: Interoperability and Basic Compatibility
  – Part B: Performance

• Covers forward-phase dimming only (100-277V)

• Targeted at screw-in LED lamps, but could be used on any LED fixture (LLEs: LED Light Engines)
SSL-7A History

- Built off of NEMA SSL-6
  - Described existing base of lamps and dimmers
- First published in 2013
- Forward-looking
  - Applies only to new products
- Technical revision in 2015
  - Clarified some technical ambiguities
  - Removed the confusing “Type 1” dimmers and lamps
Phase-cut Dimming User Problems

- Dimming range
- Dead travel
- Pop-on
- Drop-out
- Popcorn
- Ghosting
- Flashing/Strobing
- Flicker
- Audible noise
- Dimming smoothness
- Dimming monotonicity
- Dimming up/down symmetry
- Dimmer loading
- LED load - dimmer inoperability
- Premature failure of dimmer and/or LED load
NEMA SSL-7 Scope

- Designed as an *interface* standard for compatibility
  - Sets criteria for LLEs (LED Light Engine, a.k.a. lamps) and dimmers
  - Provides a specified *minimum* level of operation when SSL-7 compliant products are used together

- “Compatibility” means:
  - Reliability of the dimmer and LLE are not affected by combining them
  - Dimming behavior meets or exceeds specified functionality
SSL7 Test Philosophy

- Synthetic Test Circuits are used to produce defined characteristics or waveforms for testing the Device Under Test (DUT: LLE or Dimmer)
- Components in Test Circuits are usually adjusted for:
  - Power rating of Dimmer/LLE being tested
  - Mains voltage of DUT
- If the DUT works with the Synthetic Test Circuit, representing a worst-case scenario, it will work with any device whose characteristics do not exceed that worst-case
Summary of Tests

**Dimmer Tests**
- Waveform stability
- Inrush
- Repetitive Peak Current
- Overload
- Repetitive Ring-up Voltage
- Min. Conduction Angle
- Max. Conduction Angle
- Off-state Current
- On-state Current

**LLE Tests**
- Inrush
- Repetitive Peak Current
- Maximum RMS Current
- Repetitive Ring-up Voltage
- Minimum Light Level
- Maximum Light Level
- Off-state Current
- On-state Current
SSL-7A Limitations

**DOES**

- Ensure dimmer power supply can operate properly, without lamp “ghosting”
- Provide defined ranges for allowable max and min dimmer phase angles
- Set limits for inrush current, preventing premature switch failure
- Set limits for repetitive peak current, minimizing dimmer buzzing

**DOES NOT**

- Define a “worst-case” level of dimming performance that most would find satisfactory
- Set limits on the level of reliability (it’s determined by the manufacturer)
- Require independent third-party testing
- Eliminate the need for compatibility testing
How is SSL-7A Useful?

- For lamp manufacturers:
  - Gives guidance on how much dimmer leakage to expect
  - Sets limits on how much inrush and repetitive peak current is allowed
  - Specifies ranges of expected phase angles
- For dimmer manufacturers:
  - Sets limits on how much power supply leakage is allowed
  - Provides design limits for maximum amount of expected inrush and repetitive peak current
  - Defines ranges of phase angles that must be supported
- For end users:
  - Gives a baseline standard they can ask for when requesting dimming capability
SSL-7A Adoption

- Some manufacturers are beginning to show SSL-7A compliance on their spec sheets.
- Many manufacturers are using SSL-7A as an internal design requirement.
- No known lamps marked as SSL-7A compliant yet.
SSL-7B History

• Work started in 2014; targeted publication date is first half of 2017
• Adds additional tests beyond SSL-7A
• Final scope *MAY* include things such as:
  – Dimming curve definition
  – Flicker limits
  – Acoustic noise limits
  – Turn-on time measurements
  – Max/min light output
• Based significantly off of other standards
SSL-7B Challenges

• Manufacturers do not want any increased test burden
  – Many proposed tests are based off of existing industry tests (e.g., ENERGY STAR)

• “Performance” can cover many facets of dimming
  – Tests were selected based on known issues customers complain about

• Setting the bar too high on performance minimizes product differentiation
  – Limits are set at levels considered to be currently acceptable by customers
Current Industry Usage of SSL-7A

- **ENERGY STAR**
  - Alternate compliance path for dimmer testing

- **California Title 24**
  - All phase-control *dimmers* and *LED lamps* used in new construction must be SSL-7A compliant

- **California Title 20 Joint Appendix 8 (JA8)**
  - All phase-control *LED lamps* sold in the state of CA must be SSL-7A compliant (and dim to 10%, and...)

- **DLC Networked Lighting Control Systems Spec**
  - Phase-cut dimming must be in compliance with NEMA SSL 7A

- **Zhaga**
Future Usage of SSL-7B

• Several *potential* uses possible, once standard is complete
  – “Independent” quality metric for manufacturers
  – Regulatory bodies (e.g., CA)
  – Efficiency standards (e.g., ENERGY STAR, DLC)
  – Utility rebate programs
Related Standards Work

- **NEMA TLA working group**
  - Defining a method of measurement and proposed limits for flicker (visible and stroboscopic)
  - Referenced by SSL-7B

- **IEC JAHG 17**
  - Joint effort between Lamps and Controls committees within the IEC
  - Similar goal to SSL-7A and -7B, but also includes reverse-phase dimmers
  - Likely several years from publication into existing standards