Integration of Drivers and Luminaires

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DOE SSL R&D WORKSHOP
SSL: Beyond Energy Saving and Retrofitting

Remarkable Performances
Bright
Compact
Efficient

State-of-the-art Technology
Connected
Instant
Reliable

Opening New Horizons
Smart
Adaptable
Intuitive
Lighting Design in Layers for Applications

- **Task**: Specific lighting distribution in the desired direction, intensity, and pattern.
- **Accent**: Applications:
  - Retail
  - Hospitality
  - Museum
  - Conventions
  - Mall
- **Ambient**: Uniform Lighting, tends to establish mood and provide general illumination.
- **Decorative**: Applications:
  - General
  - Office
  - Industrial
Integration of Drivers and Luminaires
Low Profile is Key

OT 35/220...240/700 LTCS
CC Power supplies with LEDset

Product line drawing

Brick type drivers are hard to integrate into recessed and pendant indoor luminaires.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>123.0 mm</td>
</tr>
<tr>
<td>Width</td>
<td>79.0 mm</td>
</tr>
<tr>
<td>Mounting hole spacing, length</td>
<td>111.0 mm</td>
</tr>
<tr>
<td>Mounting hole spacing, width</td>
<td>67.0 mm</td>
</tr>
<tr>
<td>Height</td>
<td>35.0 mm</td>
</tr>
<tr>
<td>Product weight</td>
<td>220.00 g</td>
</tr>
<tr>
<td>Cable cross-section, input side</td>
<td>0.2...1.5 mm²</td>
</tr>
<tr>
<td>Cable cross-section, output side</td>
<td>0.2...1.5 mm²</td>
</tr>
<tr>
<td>Wire preparation length, input side</td>
<td>8.5...9.5 mm</td>
</tr>
</tbody>
</table>

Target height < 9 mm
Power density = 3-5 W/inch³
Integration of Drivers and Luminaires
Low Profile is Key

NPC008P-0215

Integration of Drivers and Luminaires
Low Profile is Key

Operation Frequency **27MHz** → Smaller passive components
Self-sustained oscillation principle → Very stable, Robust
No high voltage or current stress → Low failure rate
Low component count → High reliability, Low cost
Integration of Drivers and Luminaires

Low Profile is Key

NPC008P-0215

Nordic Power Converters

Efficiency > 92%
Power density > 30 W/inch³

- Electrolytic Capacitor
- Power Density

<table>
<thead>
<tr>
<th></th>
<th>NPC008P-0215</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>21 W</td>
</tr>
<tr>
<td>Efficiency</td>
<td>89.6%</td>
</tr>
<tr>
<td>Current ripple</td>
<td>15%</td>
</tr>
<tr>
<td>Power density</td>
<td>2.1 W/cm³</td>
</tr>
<tr>
<td>Dimmable</td>
<td>Down to 1%</td>
</tr>
<tr>
<td>Isolated</td>
<td>No</td>
</tr>
<tr>
<td>Input voltage</td>
<td>120 ±10%</td>
</tr>
<tr>
<td>Output current</td>
<td>350 mA</td>
</tr>
<tr>
<td>Power factor</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Integration of Drivers and Luminaires

High Power Density is Another Key

Integration of Drivers and Luminaires

High Power Density is Another Key

Toward high power density and no electrolytic capacitors

- No electrolytic capacitor
- Much higher power density

Efficiency > 91%
Power density > 400 W/inch³

Effortless Adjustment of Light Distribution
Multi-Channel Drivers

Concept
An innovative solution (luminaire, driver, and software application) which enables users to instantly and effortlessly shape light output including
- Beam angle
- Direction
- Distribution / Shape
- Intensity
with an easy and intuitive touch-screen, wireless interface

Benefits
**Better value:**
- Fewer fixtures
- No ladders needed

**Enhanced design:**
- Enables clean ceiling look
- No moving parts (silent & reliable)

**Highest flexibility:**
- 60+ individually controlled LEDs
- Infinite distribution options
- Ambient and accent light simultaneously from one luminaire
- Create multiple accents/spots & dynamic sequences
- Reconfigurable or multifunction spaces
- Live floor plan view via a WiFi camera
Multi-Channel Drivers

Direct driving vs. (Time) Multiplex

- **Direct driving**
  - 64 LEDs → Four 16-channel LED drivers
  - Diagram showing the direct driving method with separate drivers for each channel.

- **Multiplex**
  - 64 LEDs → One 16-channel LED driver
  - Diagram showing the multiplex method using a single driver with rows controlled by microcontroller or FPGA.
## Multi-Channel Drivers

### Direct driving vs. (Time) Multiplex

<table>
<thead>
<tr>
<th>Direct driving</th>
<th>Multiplex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max LED brightness can be used</td>
<td>Reduced number of driver</td>
</tr>
<tr>
<td>Modular design</td>
<td>Cost saving</td>
</tr>
<tr>
<td>Straightforward calibration</td>
<td>Fewer wires</td>
</tr>
<tr>
<td>Too many components</td>
<td>Less connector problems</td>
</tr>
<tr>
<td>Low reliability</td>
<td>Generates ghosting</td>
</tr>
<tr>
<td>Too many wires</td>
<td>Reduces max brightness</td>
</tr>
<tr>
<td>Connector problems</td>
<td>Reverse voltage across LEDs</td>
</tr>
<tr>
<td>Cooling</td>
<td>More difficult calibration</td>
</tr>
<tr>
<td>Expensive</td>
<td>Higher EMI</td>
</tr>
</tbody>
</table>
Take-Away Messages

Integration of Driver in Luminaire requires:

• Low profile
• High power density

The solution(s) for economic, efficient, reliable, high power multi-channel drivers yet to be found.
Many Thanks.