Integrating LED Light Engines in Luminaires

2010 ENERGY STAR® Products Partner Meeting
Solid State Lighting Technology Updates Session

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Outline

Topics:
• LED Luminaire design options
  • Retrofit vs. new design
  • Considering a component-based approach
• Critical integration and design factors
• Ways to use LED Light Engines in luminaires
• ENERGY STAR® considerations
• Ongoing SSL Luminaire industry issues
Two primary ways a luminaire manufacturer can approach SSL luminaire design:

• Retrofit existing design

• New LED luminaire design
Retrofit Design approach

Assumed advantages:
• Established market for aesthetics
• No need for new tooling
• Quicker to market

Challenges:
• Thermal performance
• Maximizing light output from incumbent style design
• Utilization of proper light engines
Luminaire Design Options

New Design approach

Assumed advantages:
- Maximize design for performance and cost

Challenges:
- Costs for new tooling
- Market acceptance of new design
- Speed to market
- Utilization of proper light engines
Retrofit LED Wallpack

- Much of housing is wasted space and acts as “oven” trapping heat
- Market accepted aesthetics
- Quick to market

New Design LED “Wallpack”

- Requires market acceptance of new design
- Directional light
- Maximizes light/thermal performance
Luminaire Design Options

• Most luminaire manufacturers are not positioned for LED luminaire development
  • Limited equipment, expertise, and proper QC measures for SSL products
• SSL requires a complete system approach to the luminaire design taking thermal, optical, and performance considerations into account at the beginning of the design phase
Luminaire Design Options

• All SSL luminaires need a light engine
  • By definition, a Light Engine is comprised of three components:
    1. LED Module
    2. LED Driver
    3. Heat Sink

• Manufacturers have the option to:
  • Make their own LED modules, drivers, and heat sinks
  • Acquire the light engine components from suppliers
Luminaire Design Options

Manufacturer, “in-house” produced Light Engines

Assumed advantages:
  • Exact engine for fixture need
  • Minimize costs for high volume products

Challenges:
  • Design expertise required in electrical, mechanical, and optical
  • Speed to market
  • Managing inventory of LED packages
  • Managing MOQs for manufacturing and inventory
  • Listing costs for components
  • Complexity of various engines needed
  • Supply-chain issues
Luminaire Design Options

Supplier-provided LED Light Engines

Assumed advantages:
- No need for high MOQs
- In-house engineering expertise not needed
- Lower cost due to volume
- No need to deal with LED inventory
- Components already safety listed
- Speed to market

Challenges:
- At high volumes maybe lower cost can be obtained from in-house production
- Exact configuration needed may not be available
- Uniqueness of product design

Brillia BEH09 BD Series
9-LED, 12W, 595 lumen (@3500K), Dimmable Standard LED Light Engine
Critical integration and design factors for LED light engine components
The most important factor in the life and performance of LED light engines is maintaining proper thermal conditions. When the luminaire is in operation, it is important to maintain the temperature on and around the LED driver and LED module at or below the recommended maximum levels. Component mfr. documentation should be configured to assist luminaire mfrs. on how to design to proper performance targets.
Integration and Design Considerations

- LED modules should feature a specified $T_s$ point on the datasheet. This point is called the solder point temperature, and allows calculation of the internal operating temperature of the LED package, known as Junction Temperature ($T_j$).

- Exceeding this value would overheat LEDs and lead to decreased life and performance.
Integration and Design Considerations

- LED drivers should feature a specified TMP point on the datasheet. This point is called the temperature measurement point, and corresponds to maximum case temperature of the LED driver.

- Exceeding this value would overheat critical electronic components and potentially lead to decreased life and performance.
Integration and Design Considerations

• Additionally, LED drivers should specify a maximum ambient operating temperature (air temp surrounding the driver) value on the datasheet.

• This represents limits for proper lifetime and performance.

Maximum Operating Range Ambient Temperature (Ta) ........................................... -30 to +60°C
Using LED Light Engines in Luminaires

Integral Engine Designs

(2) Conducting screws provide mechanical and electrical attachment

Metal fixture body acts as heat sink “Sandwiched” between LED module & Driver

Brillia LED Module

Brillia 120VAC to 12VDC LED Driver

Wall/steplight LED light engine

Brillia 3-LED, 250 lumen* Light Engine

* Sample values measured at 3500K
Remote Designs

• LED modules MUST be mounted to a flat metal heat sink surface.

• For best performance this heat sink is thermally contiguous with the body of the luminaire and provides not only conductive cooling to the LED modules, but convective cooling (due to air circulation around the heat sink or luminaire body)
Using LED Light Engines in Luminaires

Remote Designs

- The remote LED driver should be mounted in an area that allows maximum thermal isolation from the heat that will be generated by the LEDs and associated heat sink.
ENERGY STAR Considerations

• When designing for ENERGY STAR, minimum lumen levels (as well as efficacy) are critical factors in design consideration.

• Cost of components to reach lumen targets and testing costs must be carefully considered.
ENERGY STAR Considerations

ENERGY STAR example

Ceiling-mounted Luminaire with Diffuser > 8”

Qualification requirement:
750lm min.
30 lpw
2700K, 3000K, 3500K only

• Since LEDs are high cost item, must work backwards and have idea of luminaire light loss and determine min. qty of LEDs needed to meet qualification

• For the LED package alone, a customer could pay up to 2 cents per lumen for popular high brightness low cost LEDs (which are approx. 80-90lm each)

• Cost of product can be considerably higher than incumbent technology

LED Module
1500lm needed

Assuming up to 50% loss of light in glass

LED Luminaire
750lm target

Trans Globe® Lighting
Oct. 5, 2010 - ENERGY STAR Products Partner Meeting
Ongoing SSL Luminaire issues:

- **Price**
  - Continues to get better
- **Color consistency**
  - Binning issues not as bad as before, but still present
- **Standards**
  - Testing, reporting, labeling, interconnects, etc.
- **Dimming compatibility**
  - Technology of dimmers and LED drivers don’t always “get along”
- **Electronic component shortages**
  - Component shortages industry-wide not common in traditional luminaire industry
  - Are suppliers interested in lighting business vs. other opportunities?
  - Forecasting LED products continues to be an issue
## Component lead time issues

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THANK YOU!

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