FUTURE Lighting Solutions
Making LED Lighting Solutions Simple™

Developing Applications
with the optimal LED technology

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3 Criteria for Developing SSL Portfolio

From the LED vendor's perspective

Target applications (for outdoor and indoor segments)

- Street light, downlight, high bay, spotlight, wall pack, …
- Regulatory and industry targets (Energy Star, DLC, …)
- The application will establish the LED requirements

Manufacturing options

- CCT/color, CRI, binning, die size/count, package, UL, …
- The available options will link the LED to the application

Technology performance

- Flux, lm/W, Vf, hot/cold factor, droop, reliability, cost, …
- The performance will determine the LED competitiveness

Requirement of 2 Types of Power LEDs

For indoor commercial and residential lighting


Downlight


Spotlight


Track


Task


PAR


MR-16

For outdoor and indoor industrial lighting


Street


Tunnel


Parking


Flood


Wall pack


High bay

The required LED characteristics are similar for the applications within each of the two segment

LEDs for Indoor Commercial and Residential

Defining the LED portfolio:

Applications	Downlight, spotlight, track lighting, task, MR16, PAR
Lm/W	> 100 lm/W for 3000K @700mA @85°C 2013 target: > 130 lm/W for 3000K @700mA @85°C
CCTs	2700K, 3000K, 3500K, 4000K, 5000K
Min CRI	80 (for all CCTs) and 90 (for 2700K and 3000K)
Bin Size	Strong requirement for 3-step MacAdam Ellipse option 1/16th ANSI is the minimum acceptable bin size
Bin Method	Hot binning is strongly preferred
Die Size	1-2mm^2 (high efficacy) and 0.7-1mm^2 (low cost)
Die Count	1 is the first priority and 4 is a secondary need
UL Recog.	Yes

LEDs for Outdoor and Indoor Industrial

Defining the LED portfolio:

Applications	Street light, tunnel, parking, flood, high/low bay, wall pack
Lm/W	> 125 lm/W for 5700K @700mA @85°C 2013 target: > 145 lm/W for 5700K @700mA @85°C
CCTs	3000K, 4000K, 5000K, 5700K, 6500K
Min CRI	70 is the main global option and is the priority Typ. 65-70 CRI without Min. CRI can be 2nd option
Bin Size	Requirement for 5-step MacAdam Ellipse option 1/9th ANSI is the minimum acceptable bin size
Bin Method	Hot binning is preferred but cool binning is acceptable
Die Size	1-2mm² is the priority size and 0.7-1mm² is secondary
Die Count	1 is the first priority and 4 is a strong requirement
UL Recog.	Yes

Other Key Considerations

Focal length selection

- LEDs must leverage existing popular secondary optics

Color over angle (CoA)

- Luminaires with LEDs should pass the Energy Star CoA spec ($\Delta u'v'=0.004$) after secondary optics and without diffusers

CCT and CRI proliferation

- All CCTs/CRI must be available within 2-3 months of launch

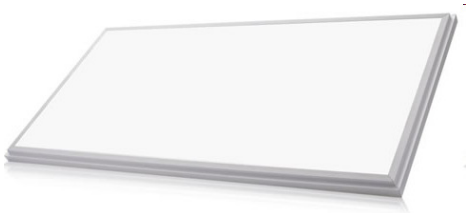
Multi-die and large die emergence

- Multi-die or large die SMT LEDs like LUXEON M and Cree XM-L are gaining market acceptance with large volume opportunities

Requirement of 2 Types of Midpower LEDs

Low cost per package at 0.2-0.4W (up to 100-120mA)

FL tube



Troffer

Under cabinet

Cove lighting

Optimized for lm/$ at 0.4-0.6W (up to ~200mA or higher)

Downlight

A19

Ceiling light

Indoor wall sconce

The required LED characteristics are similar for the applications within each of the two segment

Matrix for Positioning Mid Power LEDs

Example Applications by Lumens per LED

Customer Focus	FL tube, Troffer & Under-cabinet		Retrofit bulb & Downlight	
Efficacy	Large Die 0.2W	Large Die or Dual Die	Large Dual Die 0.6W	3 or More Die 0.8W
Cost	Small Die 0.2W	Large Die 0.4W	Dual Die 0.6W	Large Dual Die 0.8W
	20 – 40 lm < 100mA	40 – 60 lm 100 – 150mA	60 – 80 lm 150 – 200mA	> 80 lm > 200mA

Required Lumens or Current per LED

The required flux per LED for the application depends on:

- Size constraints or LED pitch for the light engine/luminaire
- Requirements for light uniformity or removing LED hot spots
- Height/area flexibility of the thermal management solution

Requirement of 2 Types of COB/Arrays

For indoor commercial and residential lighting < 40W

Downlight

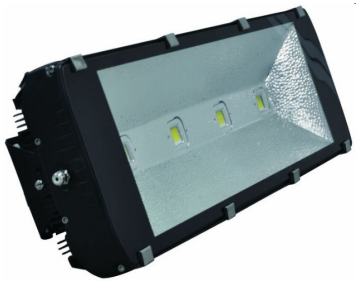
Spotlight

Track

PAR38

MR-16

For outdoor and indoor industrial lighting > 40W



Tunnel

Flood

High bay

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Technology Selecting Criteria Overview

From the lighting OEM perspective

Selection Criteria	High Power	Mid Power	Array/COB
Single light source for >> 1000 lm	✗	✗	✓
Minimized light emitting surface for >> 1000 lm	~	~	✓
Requires surface mount package	✓	✓	✗
Multi light sources with moderate/low LED pitch	✓	✓	~
Complex asymmetric lenses are required	✓	✗	✗
Very narrow beams are required (under 10°)	✓	✗	✗
Distributive lighting without hot spots	✗	✓	✗
Height/weight of luminaire must be minimized	✗	✓	✗

✓: Ideal solution ~: Possible solution ✗: Sub-optimal solution

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Thank You

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