Panel | OLEDs – How Far Have They Come in Viability?

OLED Luminaire and Driver Development

Mike Lu

Director Electronics Engineering

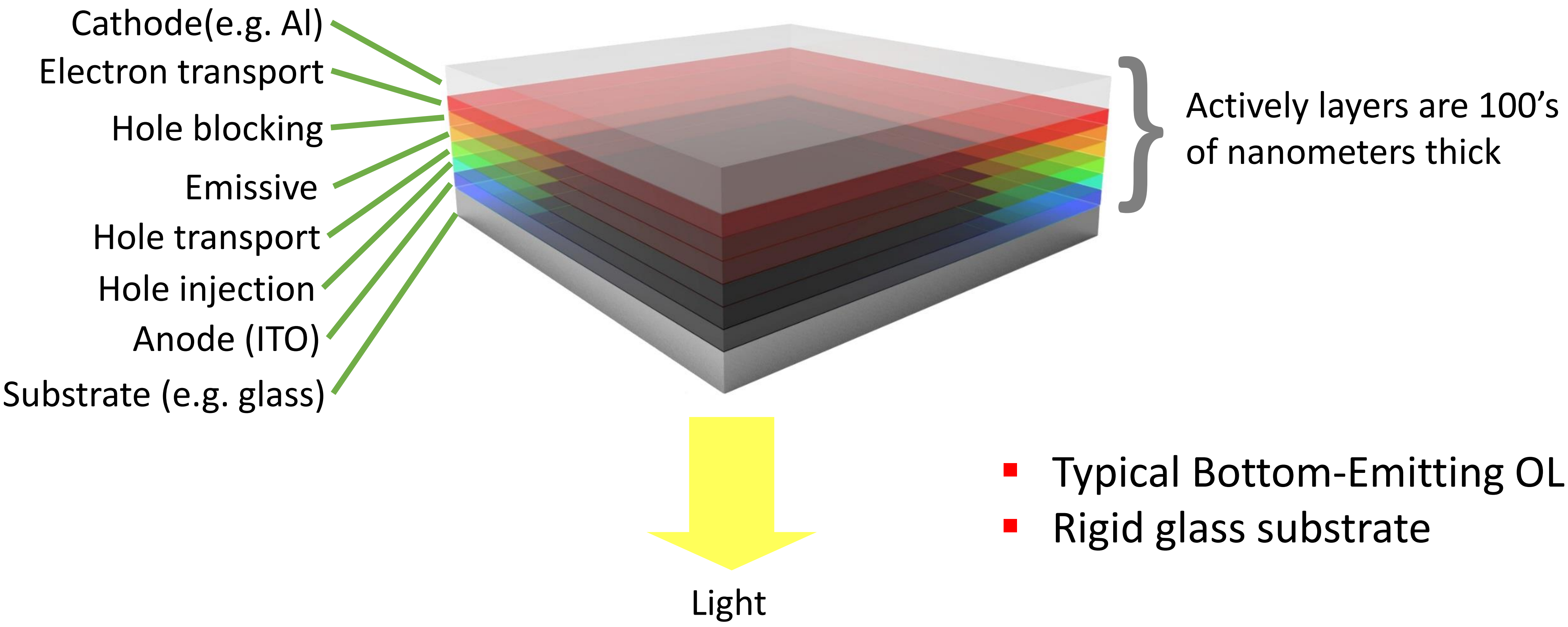
Horizon Group, Acuity Brands Lighting

Presentation Overview

1. **Introduction to OLED Technology and Panels**
2. OLED Luminaire and Lighting Design
3. OLED Installation Case Studies
4. Drivers for OLED Luminaires

Introduction to OLED Technology and Panels

OLED Device Structure and Properties

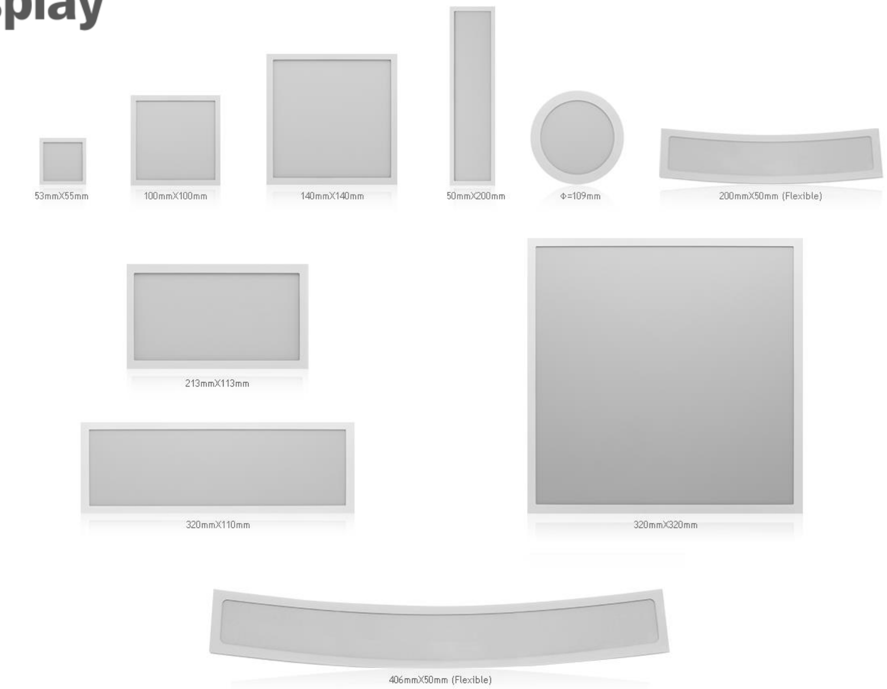


- Typical Bottom-Emitting OLED
- Rigid glass substrate

Introduction to OLED Technology and Panels

OLED Panel Suppliers

LG Display



Current Gen: 55-60 LPW; Next Gen: 75-90 LPW
2700, 3000, 3500, 4000K
3000 cd/m^2, L_{70} = 30-40Khrs
Rigid and bendable/flexible substrates

OLEDWorks
Naturally Illuminating

Brite2: 57-63 LPW
3000, 4000K
L_{70} = 50Khrs @ 2800 cd/m^2, 10 khrs @ 8300 cd/m^2
Rigid substrate

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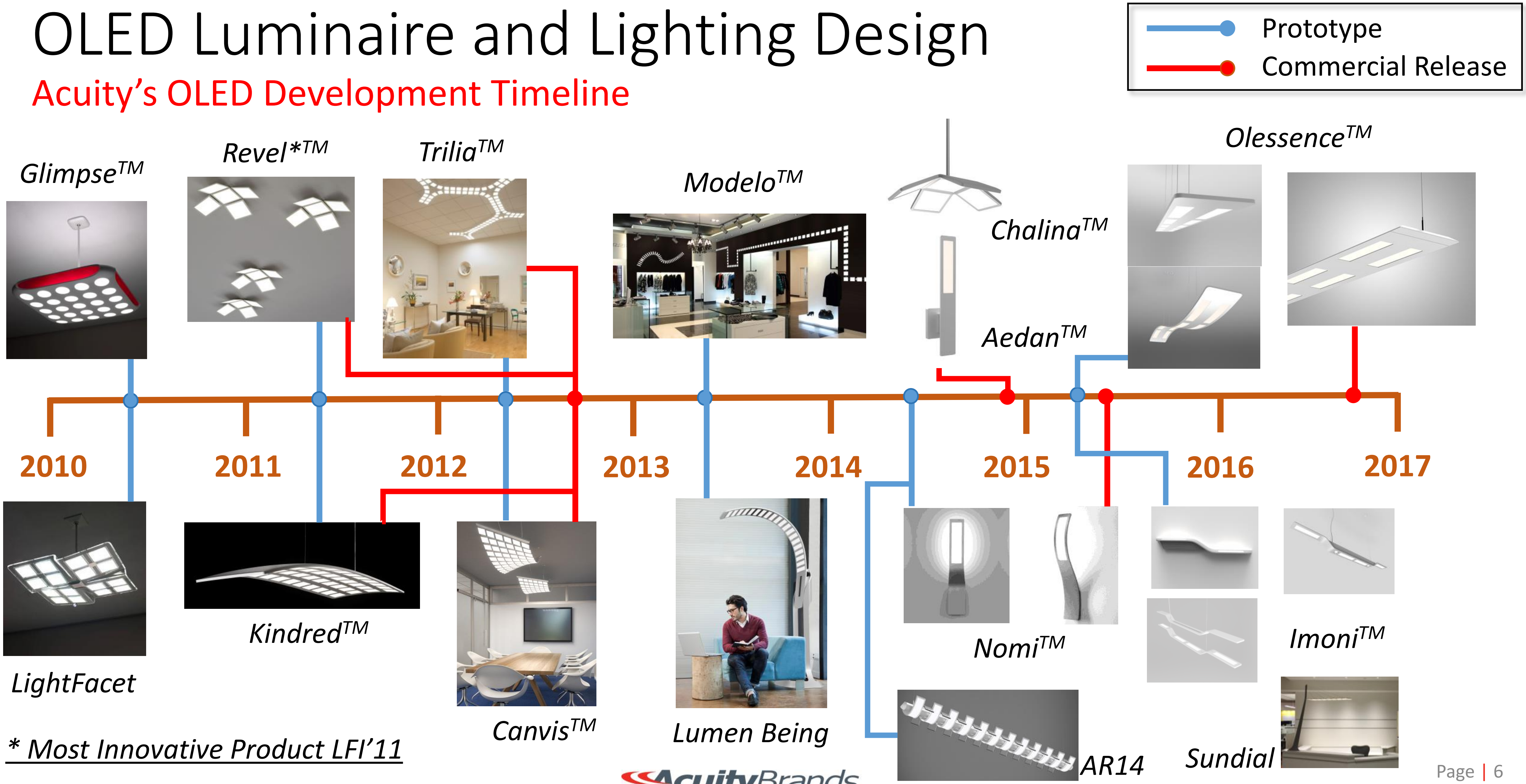
OLED Luminaire and Lighting Design

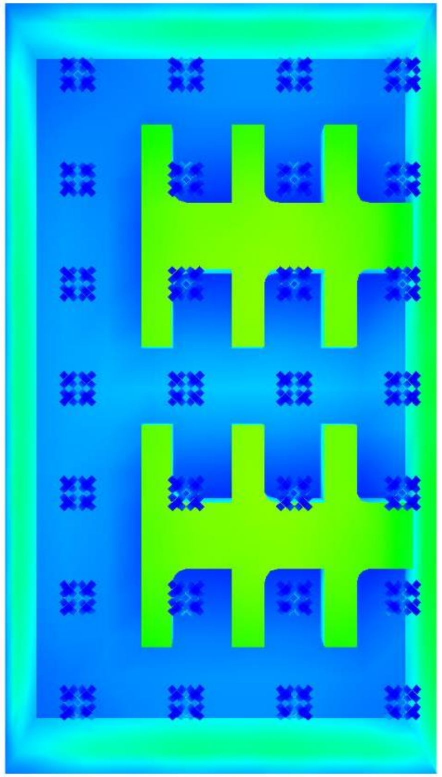
Acuity's OLED Development Timeline

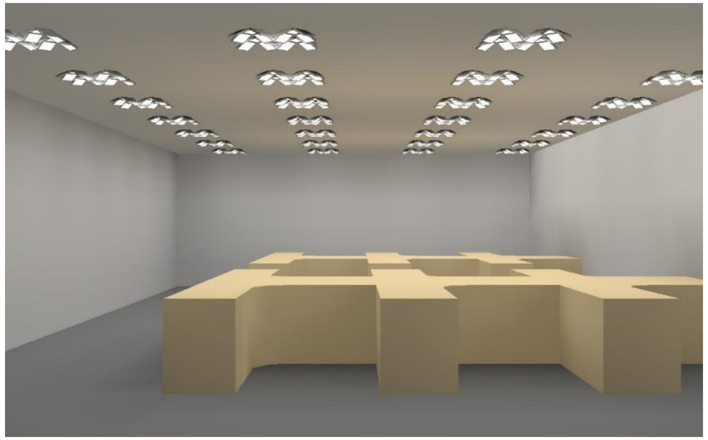


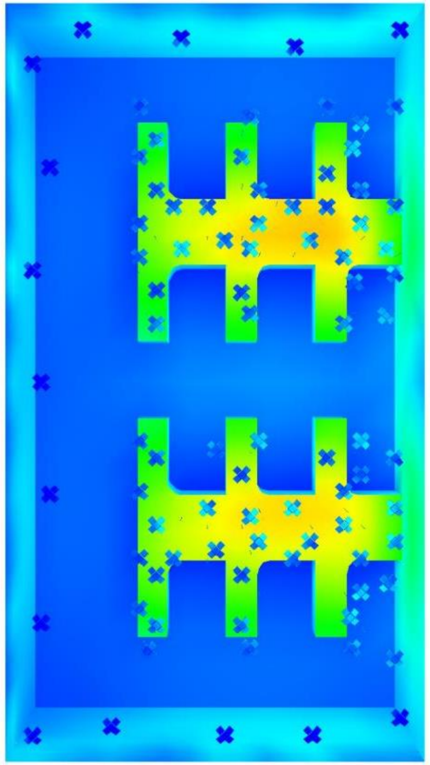
** Most Innovative Product LFI'11*

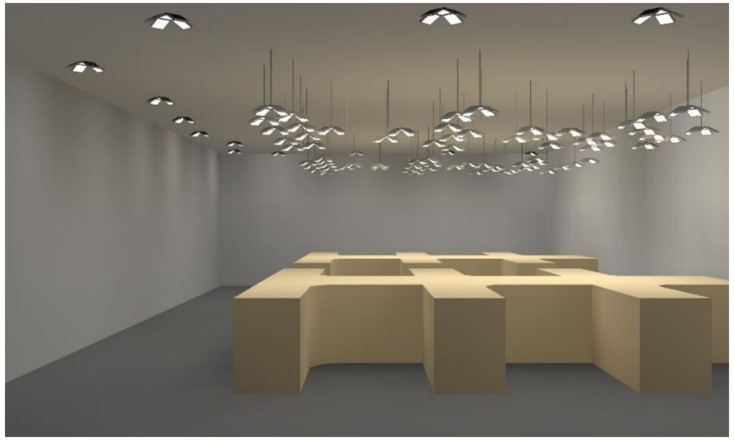
OLED Luminaire and Lighting Design

Application Efficiency – from more precise placement of luminaires







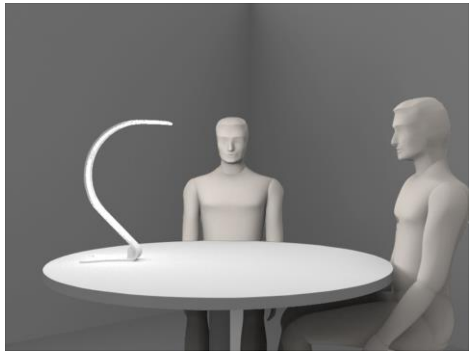


TYPICAL "STANDARD" LAYOUT
Rectilinear Layout with uniform illumination

"APPLICATION EFFICIENT" LAYOUT –
VARYING LOCATIONS & HEIGHTS

OLED Luminaire and Lighting Design

Task-Ambient-Surround



Model for Study

OLED Task Lamp with Surround Light

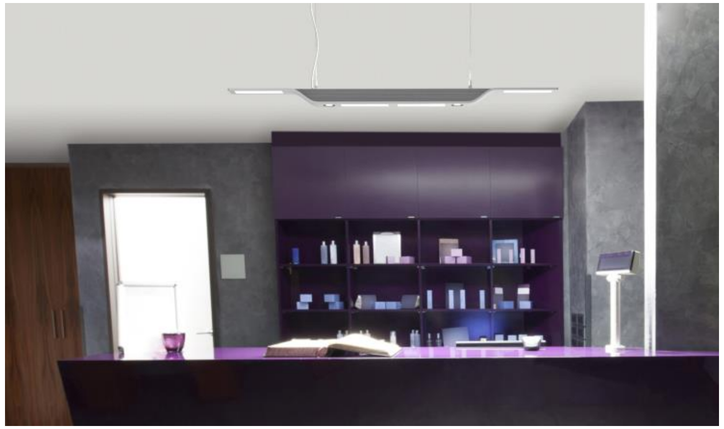
- Task-Surround-Ambient has advantages in both facial modeling and energy consumption
- The prototype used OLED/LED for the task component and a back LED for surround.

Peter Ngai, *Creating an effective lighting environment with task – surround –ambient lighting*, SID Display Week, San Jose, CA, Jun 4, 2015.
Peter Ngai, *Evaluations of a Task - Surround Lighting System in a Low Ambient Lighting Environment*, IES Annual Conference, Indianapolis, IN, Nov 10, 2015.

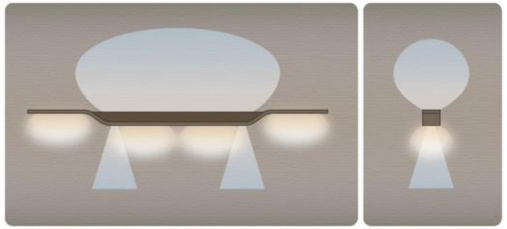
OLED Luminaire and Lighting Design

Olessence™: DuetSSL™ Technology (Hybrid OLED/LED)

- Majority LED up-light and OLED down-light
- Combine efficacy, functional luminance and ascetics



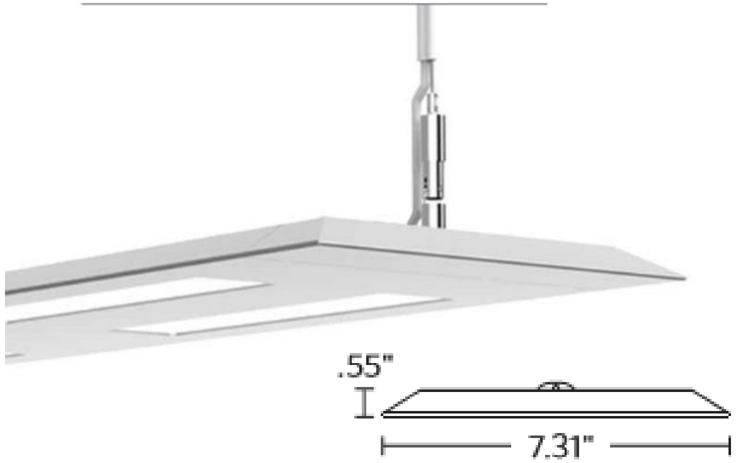
Imoni Single 2015 Prototype



Olessence Curve 2015 Prototype

Peerless

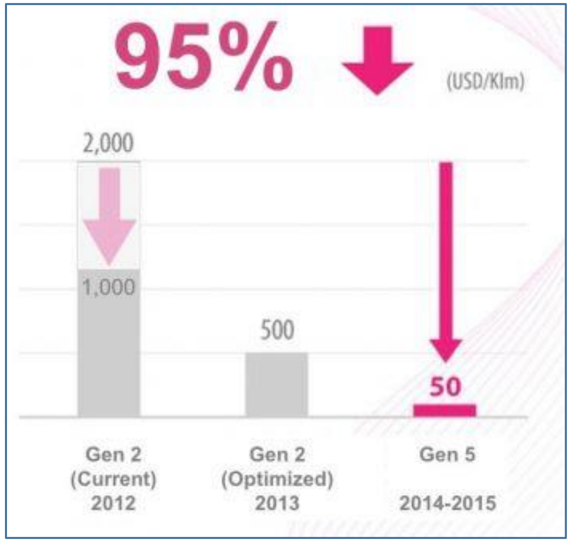
Olessence Commercial Launch
October 2016



- Up to 100 LPW, 1620 LMF
- 4', 6', and 8' sections
- Optional integrated sensors

OLED Luminaire and Lighting Design

What Does the Future Hold?



Cost reduction with Gen 5 plant and beyond
- Source: LG Chem

LGD to build Gen 5 plant
- Source: LG Display, Mar'16

Thin and Flexible
Other unique properties

Luminaire as a capsule of other technology
- Design and user interface are paramount
- Illumination is secondary

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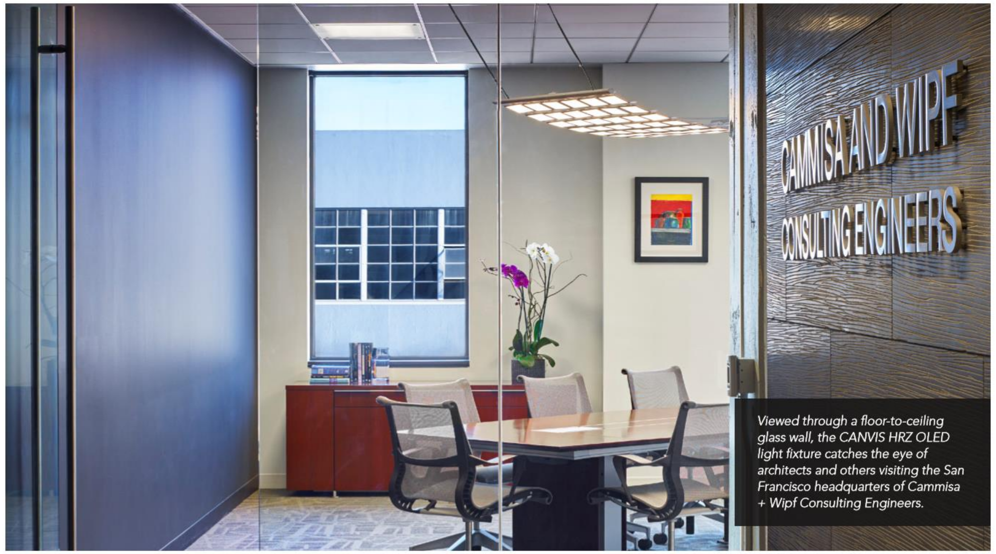
OLED Installation Case Studies

Cammisa + Wipf Consulting Engineers, San Francisco, CA



Viewed through a floor-to-ceiling glass wall, the CANVIS HRZ OLED light fixture catches the eye of architects and others visiting the San Francisco headquarters of Cammisa + Wipf Consulting Engineers.

Photo credit: John Sutton

DETAILS

Project:
Cammisa + Wipf Consulting Engineers, San Francisco

Lighting Designer:
Craig Oty, PE, IALD, Senior Associate, Director of Lighting Design, Cammisa + Wipf

Lighting Manufacturers:
Winona® Lighting, Peerless® Lighting, Acuity Controls

Products:
Winona® CANVIS™ Drape HRZ, Peerless® Mino 2x2, Acuity Controls nLight®

48 fc average, 0.70 W/ft^2

> "Everybody loves it," he explains. "They find it to be a real, eye-catching experience that is unlike anything they have ever seen before."

OLED Installation Case Studies

Irondequoit Public Library, Rochester, NY

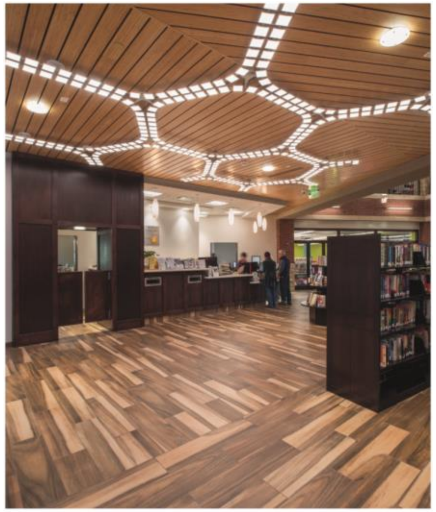
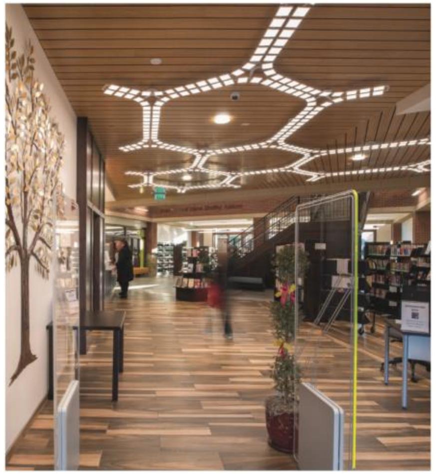


Photo credit: Don Cochran



"Most people have never seen anything like it. People love the fixtures. These fixtures are here for art's sake as much as for light."

– Terry Buford, Library Director

DETAILS

Project:
Irondequoit Public Library, Rochester, New York

Project Size:
38,700 square feet

Lighting Specifier:
Peter Wehner, AIA LEED-AP, Passero Associates

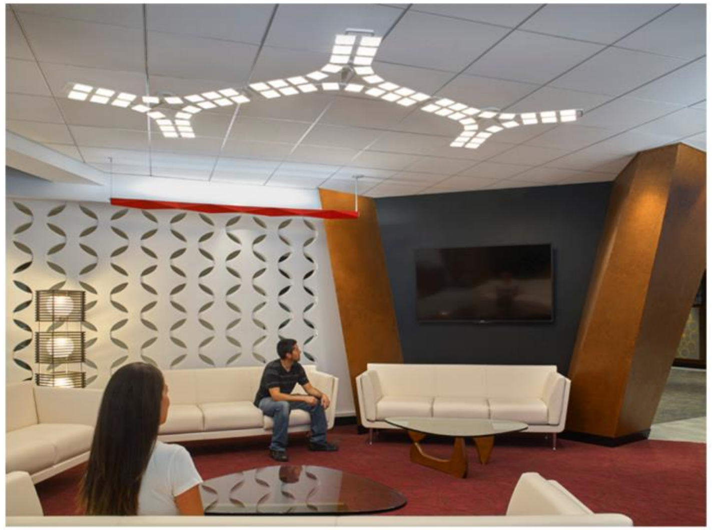
Lighting Contractor:
Concord Electric

Lighting Manufacturers:
Acuity Brands/Winona® Lighting

Products:
Trilia™ OLED

OLED Installation Case Studies

Meissner Filtration Products, Inc. Camarillo, CA



DETAILS

Project:
Meissner Filtration Products, Inc., Camarillo, California

Lighting Designer:
JMPE Electrical Engineering and Lighting Design

Architect:
Square One Architecture

Lighting Manufacturer:
Acuity Brands®, Winona®, Peerless®

Products:
Trilia™ OLED from Winona® Lighting, Origami LED from Peerless® Lighting

"This is exactly what we were looking for in the lounge," he noted. "An elegant look that is also functional."

AcuityBrands.

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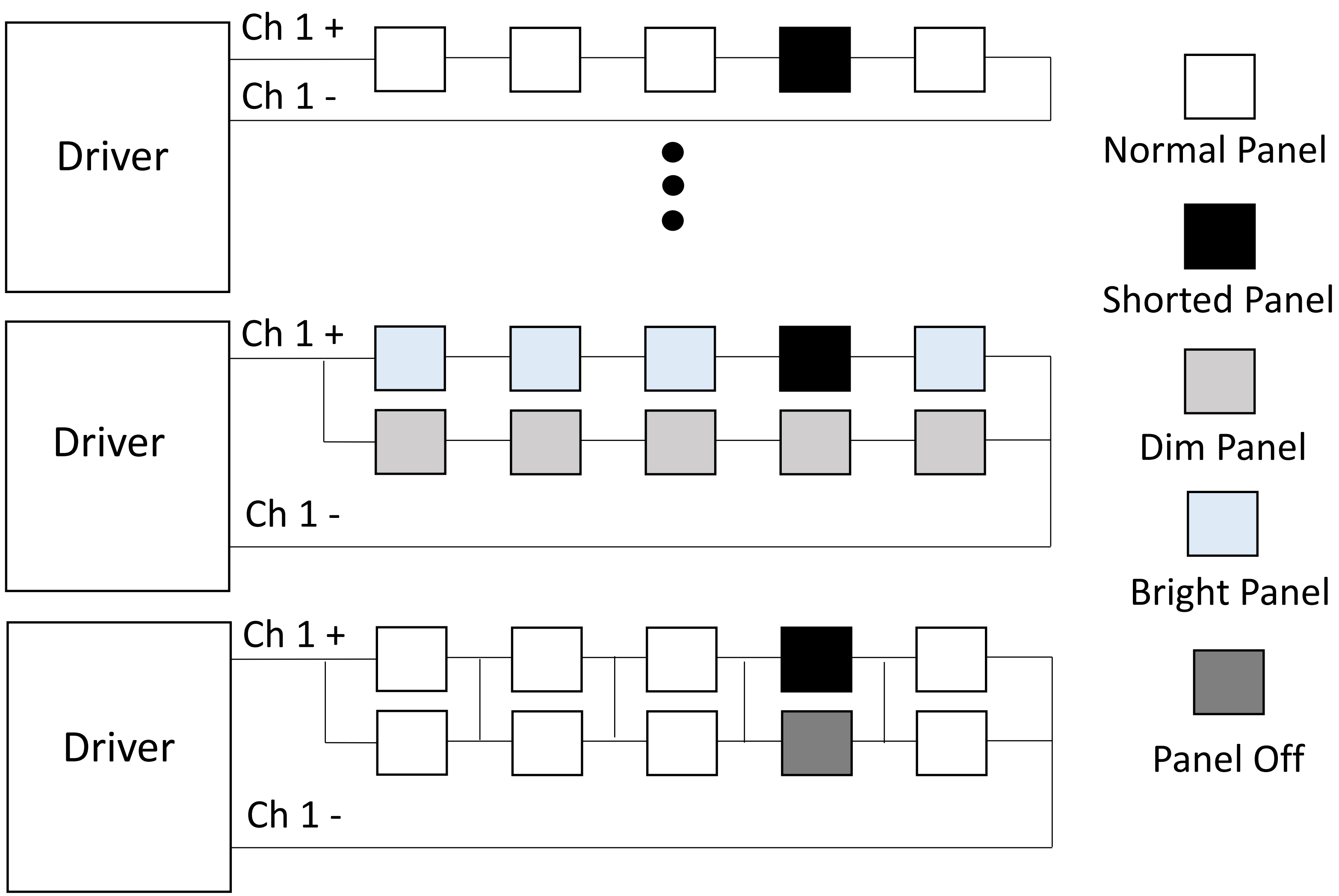
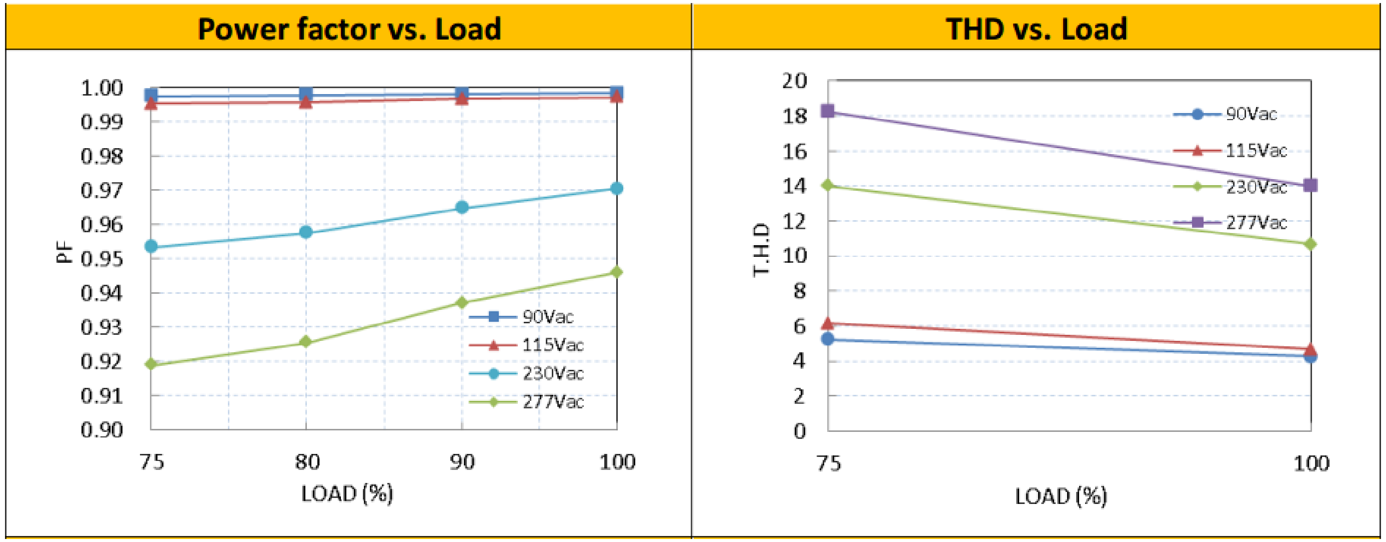
OLED Driver Challenges



- UL Class 2 limit is 60VDC (most drivers max out at 55 VDC)
- Panel voltages are approximately 3V/stack
- Panel voltage will increase due to aging
- Limited number of serially connected panels
- Paralleling panels need to account for possible shorts

Additional Driver Requirements



Typical PF and THD vs. driver load and input voltage, source: Phihong

- PF < 0.9 for commercial, < 0.7 for residential; THD < 20%
- Driver efficiency, PF and THD tend to deteriorate with higher input voltage and lower loading
- Deep dimming, 1% or even 0.1% are becoming industry standard
- Lower wattage drivers will have lower efficiency

Flicker

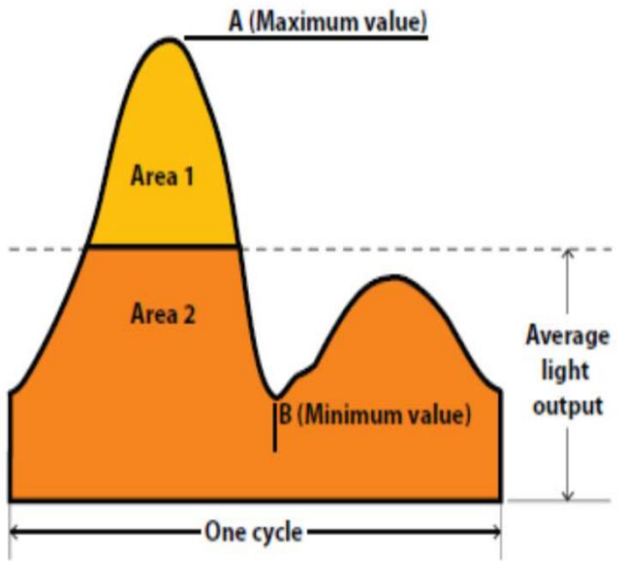
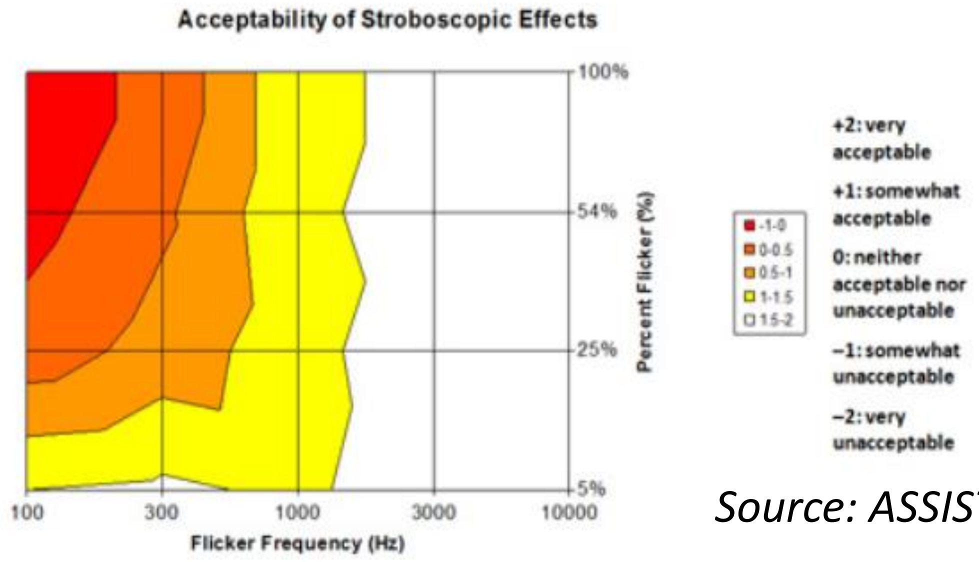


Figure 1: Periodic Waveform Reference for Traditional Flicker Metrics
Source: IES Lighting Handbook, 10th Edition

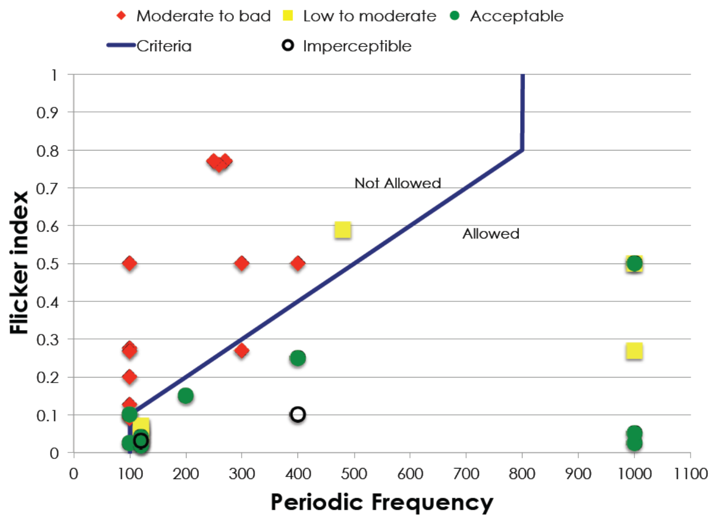
Percent Flicker = 100% x (Max-Min) / (Max + Min) = 100% x (A-B) / (A+B) Eq.1

Flicker Index = Area above Mean / Total Area = Area 1 / (Area 1 + Area 2) Eq.2

Source: Poplawski and Miller



Source: ASSIST



Note: For some SSL products, the Flicker Frequency may not be obvious. For these, we suggest an alternative criterion: **Maximum Percent Flicker of 15% to 20%**

Source: Miller

Also see IEEE PAR 1789, June 2015

Current Acuity Driver Solutions for OLED Luminaires

10 Watt

Natural Dimming to 0% for most demanding indoor applications. Different form factors are available for the perfect fit with your luminaire.

Read more →

20 Watt

20-watt SOLOdrive are ideal for small lumen package indoor applications. Offering Natural Dimming to 0% and two different form factors.

Read more →

30 Watt

Natural Dimming to 0% for most demanding indoor applications. Different form factors are available for the perfect fit with your luminaire.

Read more →

50 Watt

Ideal for higher lumen package indoor applications. Offering dual outputs and Natural Dimming to 0%. Different form factors are available for the perfect fit with your luminaire.

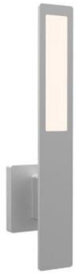
Read more →

100 Watt

Ideal for higher lumen package indoor applications. Offering four outputs and Natural Dimming to 0%. Different form factors are available for the perfect fit with your luminaire.

- Used in LED luminaires, equally applicable to OLED luminaires 7-100 W
- eldoLED programmable drivers (150-1400mA), 55V max, up to 87% efficient, Hybrid HydraDrive

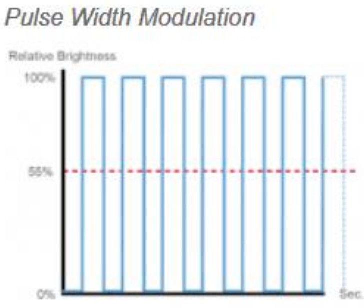
- For low wattage OLED luminaires <5W
- 0-10V, phase cut dual dimming, CCR
- PF > 0.9, THD < 20%, 120-277V input
- Fits in a 2” x 4” single gang switch box



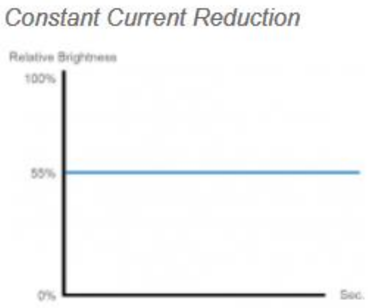
Aedan Sconce

2nd Gen

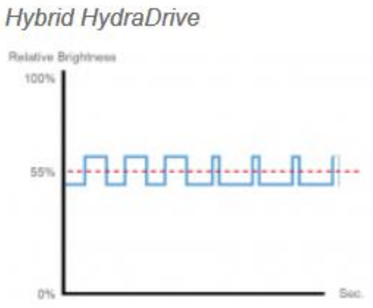
Hybrid HydraDrive



0-100 PWM



CCR



Hybrid HydraDrive

Driver	Dim Level	Percent Flicker	Flicker Index	Frequency
eldoLED	100%	3.9%	0.01	305 Hz
eldoLED	80%	9.2%	0.03	306 Hz
eldoLED	50%	4.0%	0.01	307 Hz
eldoLED	30%	11%	0.03	2450 Hz
eldoLED	20%	4.0%	0.01	832 Hz

As measured by VISO Systems Flicker Checker App

Trilia driven by eldoLED drivers, dimmed to 2.5%

Flicker checker

DOE Project

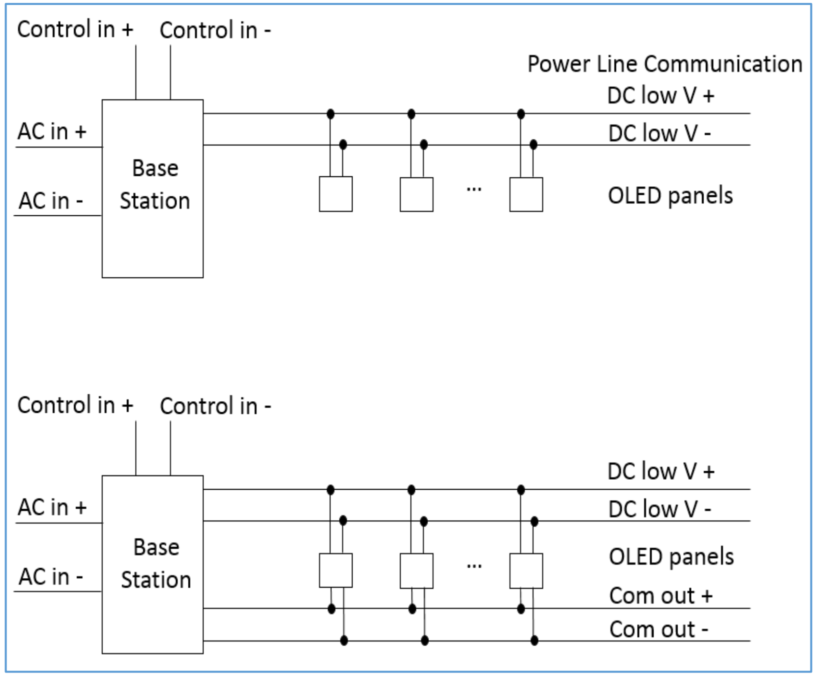
- DE-EE0007073 “OLED Luminaire with Panel Integrated Drivers and Advanced Controls”
- Work spans 9/1/2015-10/31/2016, with OLEDWorks as subcontractor
- The proposed architecture is to have a base station that performs AC/DC voltage conversion and integrated driver at each panel that performs DC/DC current regulation.
- But how about dimming?

Proposed Deliverable

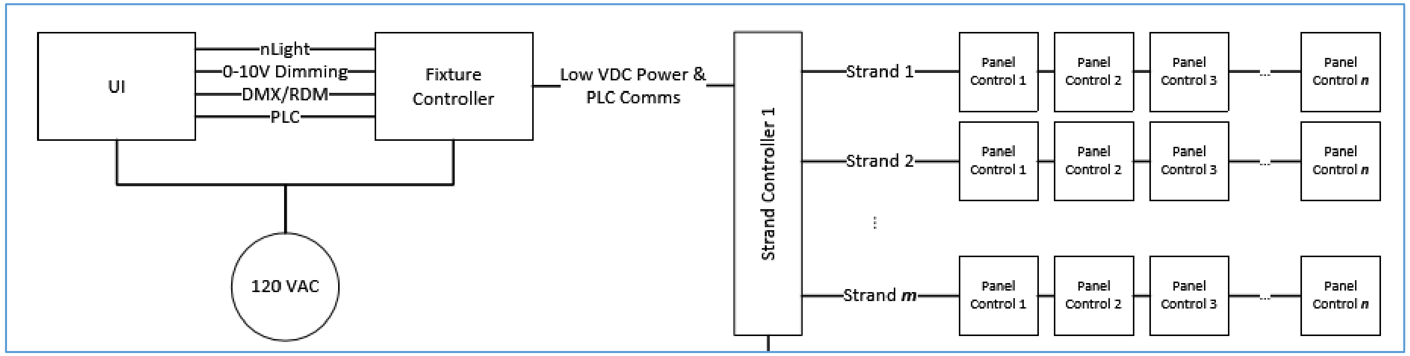
Luminaire Platform: Canvis

Panel CCT	3000K (3500/4000K optional)
Panel Luminance	2500-3000 cd/m^2
Panel CRI	>85
Panel Lifetime (L_{70})	>25,000 hrs
Panel Efficacy	80 lm/W
Total Luminous Output	4000-5000 lm
Luminaire Efficacy	65 lm/W
Luminaire Control (option 1)	0-10V dimming, global
Luminaire Control (option 2)	DMX or other protocols, individual panel addressable

System Architecture

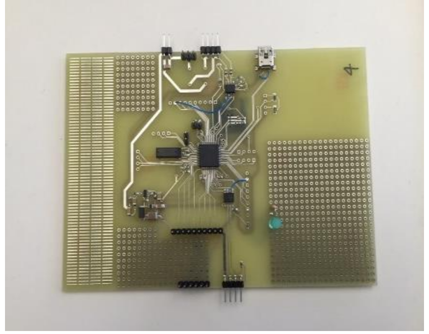


Original proposal, options for wired control and PLC (power line communication)

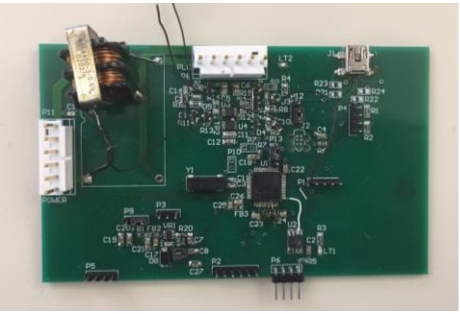


Current system architecture: PLC communication, with strand controllers to expand the number of panels in the system

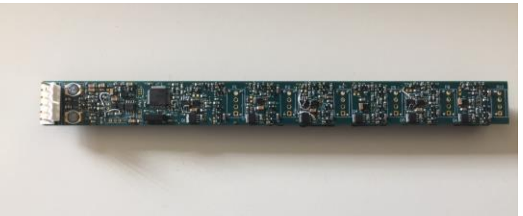
Hardware Development



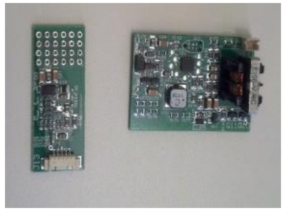
Gen 1 base station transceiver



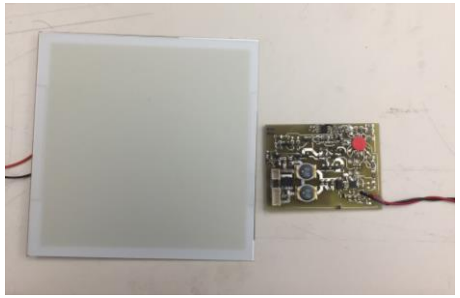
Gen 2 base station transceiver



Strand controller



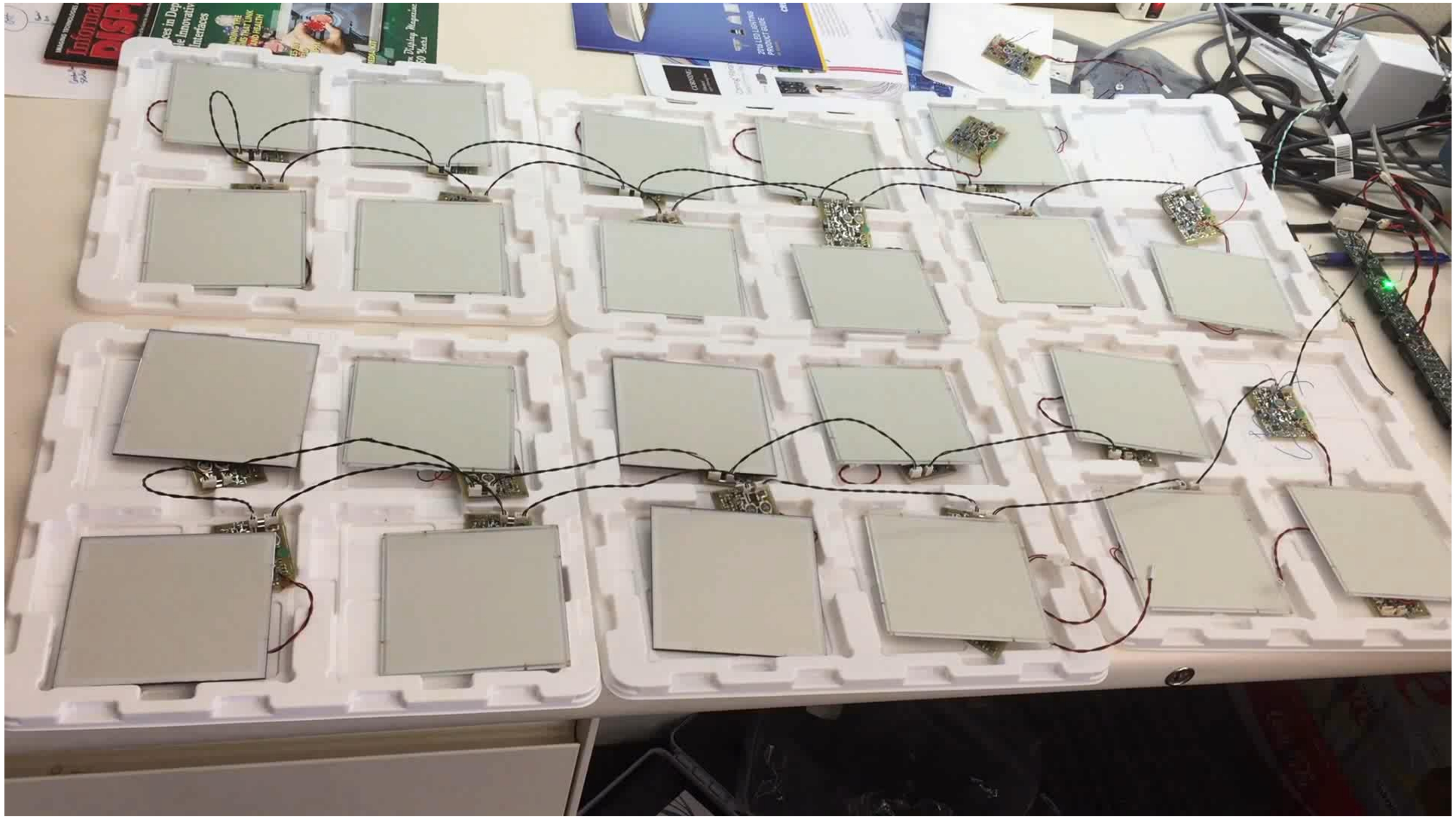
Gen 1 panel transceiver and driver



Gen 2 panel integrated driver (next to a 4” square panel)

Gen 3 panel integrated driver (~0.25” total thickness)

Individually Addressable Dimming



- 2 strands x 11 panels
- 3 dimming patterns
  - Sequential
  - Checker board
  - Random

Thank You!

http://www.acuitybrands.com/oled

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