Lighting Control Technology for Digital and Dynamic Luminaires

Jim Phelan
Senior Market Development Manager
Acuity Controls
Acuity Brands
Learning Objectives:

• Appreciate the intended use for particular lighting control technologies
• Understand how to best deploy these technologies
• Learn strengths and challenges with control technologies
• Unlearn traditional thinking regarding controls design
High performance lighting controls should address the dynamic lighting requirements in architectural and entertainment spaces
The spaces
The strategies

Energy
- Motion Sensing
- Daylighting

Dimming
- Long Fades
- Timed Events

Architectural
- Sequences
- Room Combine

Entertainment
- Tunable White
- RGB
- Cue Lists
- Moving Fixtures
- Pixel Maps
Challenges of lighting controls (design)

- End user expectations
- Control choices
- Compatibility concerns
- Cost
- Code requirements
- Integration
Challenges of lighting controls (installation)

- Education
- Wiring limitations
- Cost
- Commissioning
Challenges of lighting controls (end user)

- Education
- Training
- User interface
- Making changes
- Cost/ROI
The technology evolution
Technology meet convenience
Lighting innovation

Multiple images courtesy of David DiLaura
“A History of Light and Lighting”
Analog to digital lighting evolution

1960s Initial commercialization of LED light source

1980s Signs and signals

1990s Decorative and accent

2000s White Light LEDs

2000s LED “lamps”, “fixtures”

2010s Optimized LED luminaires

2010s Digital Lighting Systems

2010s Smart Grid Solutions

We are here
The digital control solution
Key Components of Smart Lighting Systems

#1: LED Luminaires & Lamps

#2: Digital Controls

#3: Daylight

#4: Software
#1: Solid-State Lighting Sources

**Obvious Benefits**
- Low energy consumption
- Long-life (50,000+ hours)
- Dimmability
- Lower temperature
- Color-control
- Instant start

**Other Benefits:**
- New form factors
- Next generation (i.e., OLED)
- Redefining the meaning of a light fixture
#2. Smart and Integrated Controls

![Graph showing energy savings and luminaire life for different control strategies.](chart.png)
#3. Daylighting

- Dual benefit:
  - Reduce energy by 40% when daylight is harvested
  - Improves occupant well being

- Studies link daylight and views to higher levels of satisfaction and productivity

- On average, hospital patients who stay in rooms with daylight stay fewer days and required less pain medicine
#4. Useful and Usable Software

- Desktop applications
- Software to service
- Mobile apps
- BMS compatible
The static to dynamic shift
From Static Settings to Dynamic Experiences
dynamic luminaires

- LED
- RGB
- Tunable white
- Motorized
truly dynamic luminaire
dynamic control

- Phase control
- 0-10V
- DALI
- DMX/RDM
- Integrated
- Wireless
# Dimming Controls – a primer

<table>
<thead>
<tr>
<th>Dimming Method</th>
<th>Pro’s</th>
<th>Con’s</th>
</tr>
</thead>
</table>
| 0-10V              | • There is a standard  
                    • Installed base  
                    • Separate wiring makes it easier to optimize dimming performance | • Not all follow the standard, standard also not complete  
                    • Possibility of difference in performance in large installations  
                    • No networking capabilities |
| Forward Phase (TRIAC) | • Large installed base  
                      • Power and dimming over single set of wires | • Technology mismatch with LED sources, often problems  
                      • No networking capabilities |
| Reverse Phase (ELV)   | • Although not optimized for LED’s, less issues than forward phase | • Small installed base  
                      • Requires neutral wire  
                      • No networking capabilities |
# Dimming Controls – a primer

<table>
<thead>
<tr>
<th>Dimming Method</th>
<th>Pro’s</th>
<th>Con’s</th>
</tr>
</thead>
</table>
| DALI           | • There is a standard  
• Network based, offers more functionality  
• Simple wiring | • Not all follow the standard, implementation is fairly complex  
• Commissioning can be complex |
| DMX            | • There is a standard  
• Network based, offers more functionality | • Complex wiring and commissioning |
| Wireless       | • No wiring  
• Network based, offers more functionality | • No standards, many initiatives  
• Expensive |
Dimming Issues

- Flicker
  - Visible
  - Stroboscopic
- Shimmer
- Steppiness
- Drop-out
- Pop-on
- Delayed turn on and response
- Mismatched light levels
- Control incompatibility and load ratings
Components of an LED System

- **Dimmer**
  - 0-10V
  - Forward Phase
  - Reverse Phase
  - DMX
  - DALI
  - Wireless

- **LED Driver**
  - Current Reduction (CCR)
  - Pulse Width Mod. (PWM)
  - Hybrid

- **LED**
  - Light source

- **Human Eye Response**
  - Perceived Brightness

Driver “makes or breaks” the performance of the system.
Smooth Dimming

Dim to 0.1% is 3% Perceived
Highest-Performance Spaces

Dim to 1% is 10% Perceived
Daylight & Conference Rooms

Dim to 5% is 22% Perceived
Energy Management Dimming

Dim to 10% is 32% Perceived
Load Shedding – High/Low
Flicker-free Operation

Courtesy of the LRC
LED Drivers
Warm white dimming

- Single control input (0-10V, DALI, DMX/RDM)
- Linear dimming curve white LED’s
- Non-linear low-end dimming curve for amber LED’s*

*when dimming down, amber content will increase before dimming to 0%
Tunable white

- Intuitive color temperature and intensity control
- Define dimming curve and input-output relation
- Works with majority of tunable white LED configurations
Delivering Enriched Experiences with Gamut Control
Tailored Optics & Task Tuning

**NEMA Definition** – A lighting control strategy in which the maximum light output of an individual or group of luminaires is set to provide the appropriate amount of light for a space or area.
Design with color
RGB/DMX control

- Shift from theatrical to architectural spaces
- Controlled by DMX 512A protocol
- Create static and active “shows/sequences”
- Achieve 16 million colors with a basic RGB luminaire
- Control dynamic/tunable white with high resolution
- DMX controllers allow user to setup events/scenes/shows
- Greatest opportunity for growth (costs, tools, compatibility, availability, expectations)
Multi-dimensional lighting

- DMX controls multiple attributes for a single luminaire
Tools to scale capabilities
Make it easy
Networked Controls-Analog

Controller → Network → Lighting Panel
Combined control strategies of occupancy, tuning, daylighting and lumen maintenance can deliver 50% or more savings.
• As fixtures get more efficient, the magnitude of savings from controls is reduced
• Savings from multiple strategies are multiplicative, costs historically are additive
  – Lumen Maintenance, Occupancy Sensing and Task Tuning, each saving 15%, deliver a combined savings of $0.85^3$ or 39% … not 45% (15% x 3)
Networked Controls
Controls that allow multiple zones delivering scenes for enhanced quality of light to optimize the functions taking place
Classroom Wired Networks

…for focused attention
Classroom Wired Networks

…for challenging visual tasks requiring contrast control.
Cut the wires
Covered Parking Wireless Networks

Enriched full-spectrum color
Covered Parking Wireless Networks

...with responsive integral sensors
...that wirelessly network to light the entire field of view and deliver safe and secure visual setting.
Evolving Better Lighting Solutions
Enhanced...
Enriched...
While Using Fewer Resources.
Thank You!

Jim Phelan
Senior Market Development Manager
Acuity Controls

Expanding the boundaries of lighting™