



Lighting and Controls for Building Solutions

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“To do something better you have to do something different”

Dr. Amar Bose, Innovator



luminaire

- Aesthetic
 - color, intensity, form, architectural integration
- Quality of illumination

source

- Efficient
- long lasting, green technology

driver

- Connectivity between LED and control
- Key component to assuring desired performance

control

- Intelligent, adaptive, simple, configurable, scalable



Light Source	Efficacy (Lumens per Watt)
Incandescent	15 - 20
Halogen	20 - 25
CFL	70 - 80
Tubular Fluorescent	85 - 100
LED (Raw white light)	100+

LED efficacy will only get better



The type below is dependent on the layout of the LEDs

Constant Current

- For 1 to 1 applications (1 driver : 1 LED Module)
- fixed current / flexible voltage
- ex. Downlights



Constant Voltage

- Assures uniform light distribution across long runs of LEDs
- fixed voltage / flexible current
 - Typically 12 or 24V
- ex. Strip lights



Dimming Issues



- Flicker
 - Visible
 - Stroboscopic
- Shimmer
- Steppiness
- Drop-out
- Pop-on
- Delayed turn on and response
- Mismatched light levels
- Natural light level intensity
- Control incompatibility
- High inrush and load ratings





- Drivers don't get paired to an LED simply on wattage
 - Need to know current and voltage
- Drivers are a **RECOGNIZED** component and are marked as such
 - Typically sold only to OEMs
- A OEM uses recognized components and the luminaire w/driver becomes **LISTED**
 - This enables the solution to be sold through distribution



Why Controls?

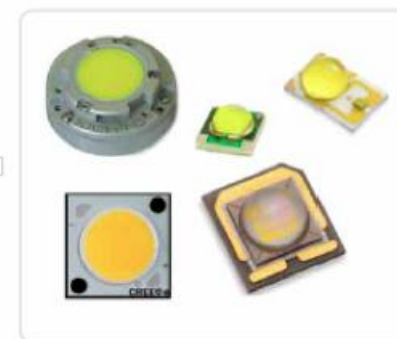
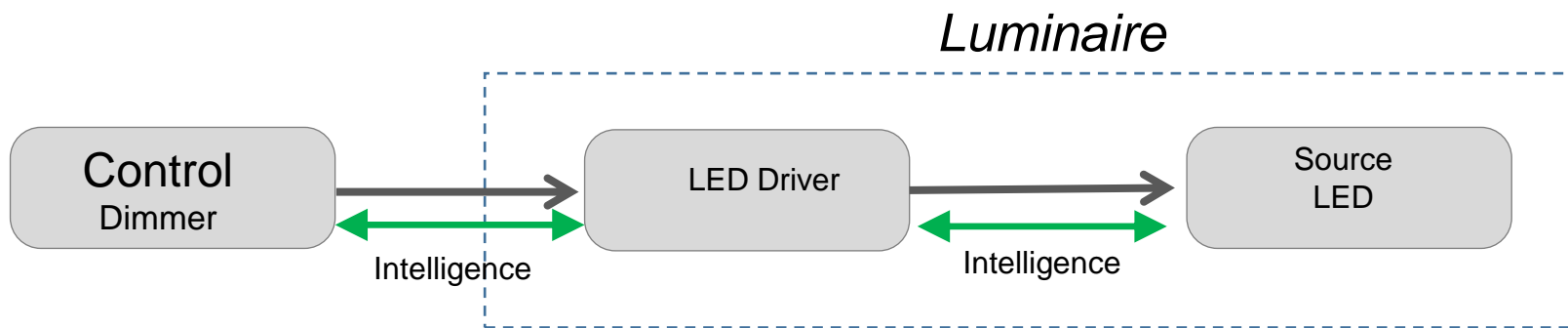


- Light is not a static thing – we want to be able to adopt light levels in different circumstances.
- Because it makes things beautiful, creates atmosphere, boosts energy, creates safety
- Energy savings: this is not a linear relationship!
- Extends life of the system
- Building codes, standards



- Load ratings of dimmers/controllers
 - How many devices can be connected to a dimmer
 - This is due to inrush and repetitive peak current
- What strategies am I trying to implement via control?
 - Code requirements?
 - Aesthetic requirements?
 - For the look and feel of the dimmer and the light in the space
 - Energy savings
- Feature set
 - Daylight harvesting
 - Occupancy setting
 - Load shedding
 - Manual control

Components of an LED System



LED Drivers



The driver delivers the desired performance in the luminaire



Like a processor in a computer



Controls





Dimming Method	Pro's	Con's
0-10V	<ul style="list-style-type: none"> • There is a standard • Installed base • Separate wiring makes it easier to optimize dimming performance 	<ul style="list-style-type: none"> • Not all follow the standard, standard also not complete • Possibility of difference in performance in large installations • No networking capabilities
Forward Phase (TRIAC)	<ul style="list-style-type: none"> • Large installed base • Power and dimming over single set of wires 	<ul style="list-style-type: none"> • Technology mismatch with LED sources, often problems • No networking capabilities
Reverse Phase (ELV)	<ul style="list-style-type: none"> • Although not optimized for LED's, less issues than forward phase 	<ul style="list-style-type: none"> • Small installed base • Requires neutral wire • No networking capabilities

Controls (Open Protocols)



Dimming Method	Pro's	Con's
DALI	<ul style="list-style-type: none">• There is a standard• Network based, offers more functionality• Simple wiring	<ul style="list-style-type: none">• Not all follow the standard, implementation is fairly complex• Commissioning can be complex
DMX	<ul style="list-style-type: none">• There is a standard• Network based, offers more functionality	<ul style="list-style-type: none">• Complex wiring and commissioning
Wireless	<ul style="list-style-type: none">• No wiring• Network based, offers more functionality	<ul style="list-style-type: none">• No standards, many initiatives• Expensive



- Understand the application
- What is required?
 - Retrofit? **Maybe phase control will be needed?**
 - New Construction? **0-10V may be the best option**
 - Will it need to be reconfigured easily? **A digital solution sounds good.**
 - Are colored LEDs going to be involved? **DMX works.**
- A driver with the inputs above will be required to work with your desired control
- Does the fixture cut sheet offer these options on the cut sheet?



AC Input

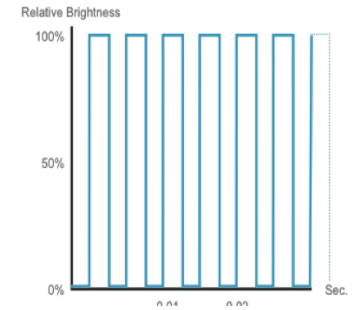


+

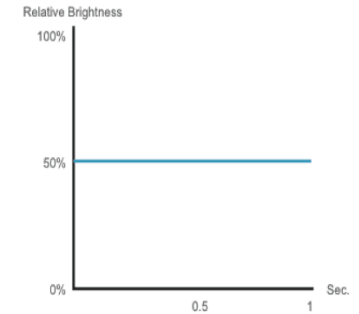
Control
0-10V, DMX,
DALI...



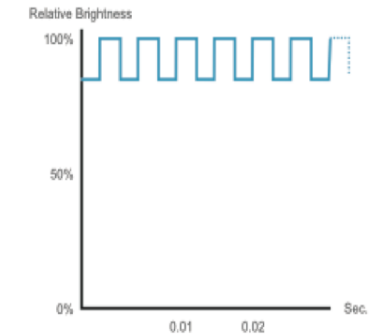
Pulse Width
Modulation
(PWM)



Constant
Current
Reduction
(CCR)



Hybrid

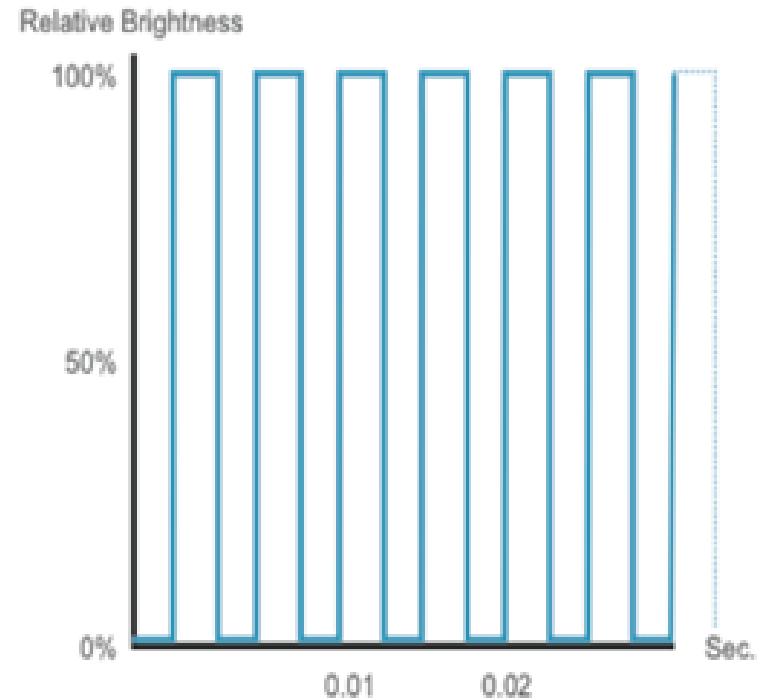


LED Drivers: Pulse Width Modulation (PWM)



- Constant LED current, varying LED on/off times

- ✓ Good dimming regulations at deep dimming (same current) levels
- ✓ Little color shift
- ✗ Potential noise generation
- ✗ Potentially undesirable flicker, depending on frequency

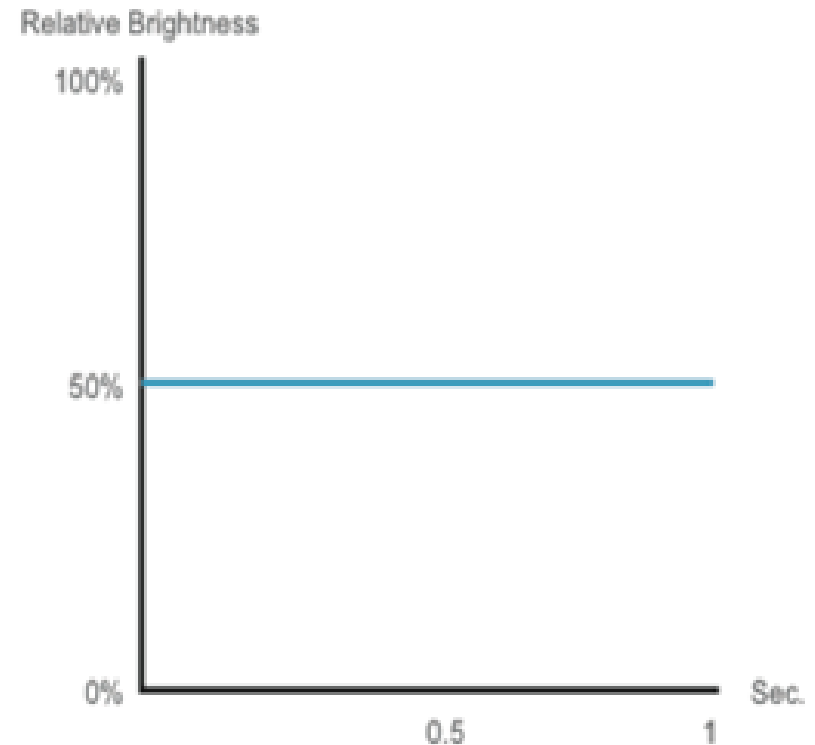


LED Drivers: Constant Current Reduction (CCR)



- Varying LED current, LED always on

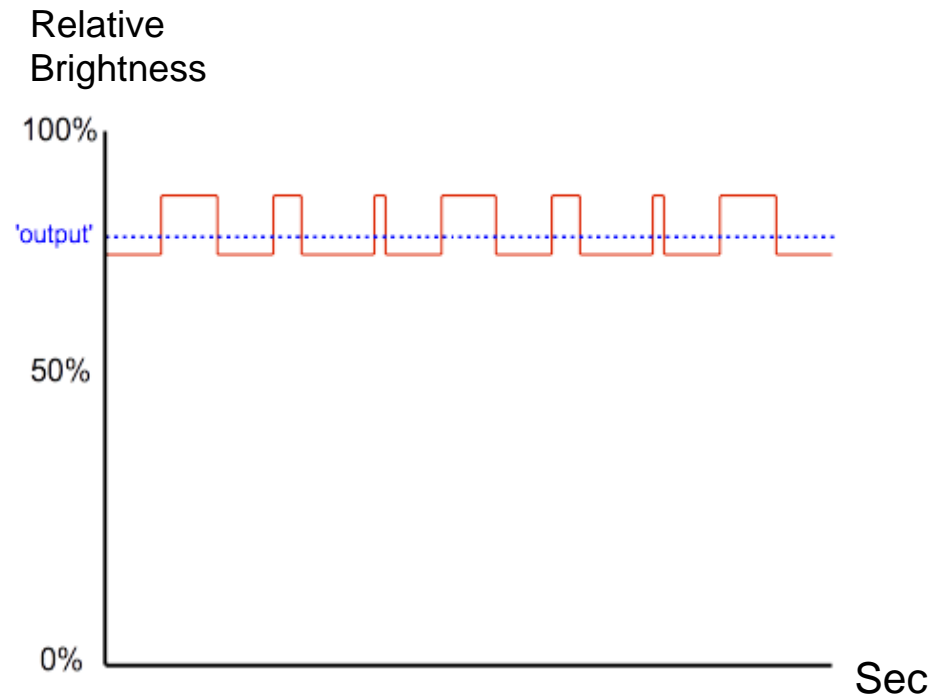
- ✓ No flicker
- ✓ Higher LED efficacy at lower dimming levels
- ✓ No noise generation
- ✗ Poor dimming regulation at deep dimming (low current) levels
- ✗ Color Shift with phosphor converted LEDs



LED Drivers: Hybrid Dimming



- Varying LED current, duty cycle and frequency on small current range. No LED on/off times
- ✓ Best dimming regulation at deep dimming levels
- ✓ High frequency operation (mixing frequencies between 1 KHz and 20 KHz)
 - ✓ No flicker
 - ✓ Dimming to Dark
- ✓ Increasing LED efficacy when dimming
- ✓ Low noise generation
- ✓ No color shift when dimming



eldoLED's patented
Hybrid Hydradrive

Why Hybrid Dimming: Dimming to Dark



Measured Light



Light level was not a concern of incandescent dimming because it dimmed to off

Square law dimming:

10% measured = **32% Perceived**

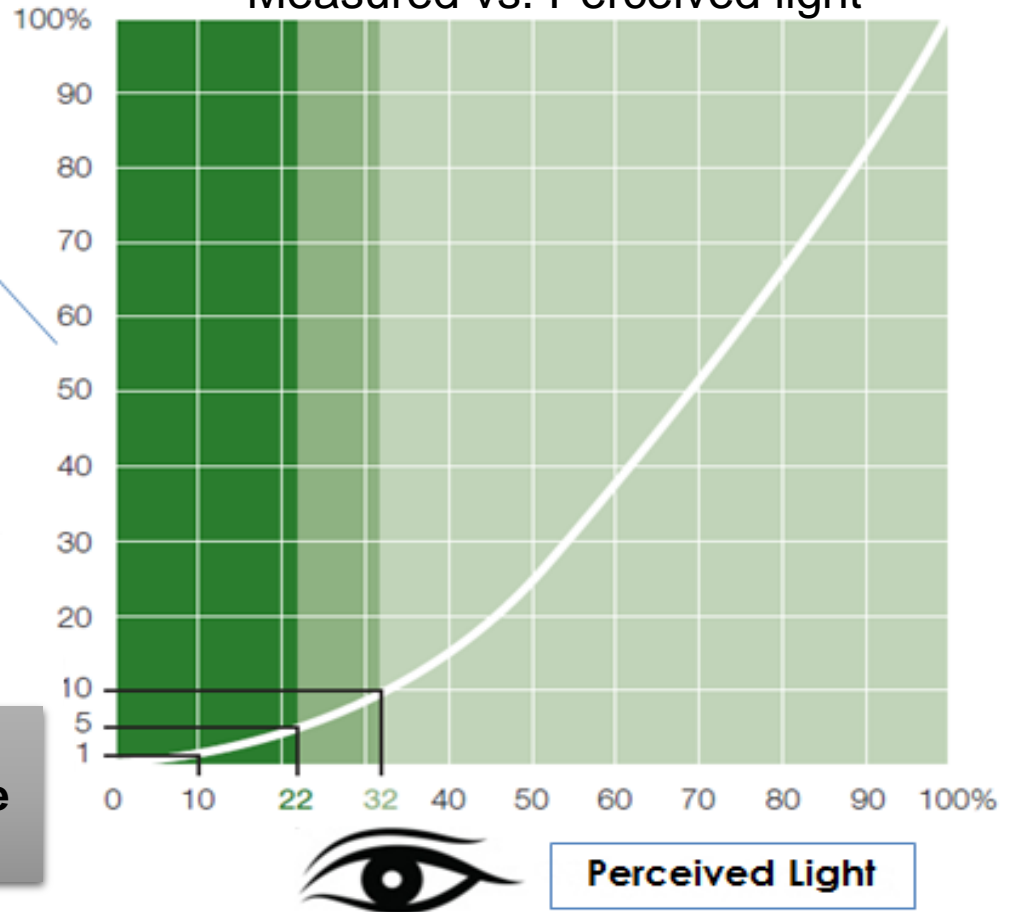
5% measured = **22% Perceived**

1% measured = **10% Perceived**

0% measured = **0% Perceived**

Shouldn't this great technology we have in LEDs meet, if not exceed, the performance of older light sources?

Source: IESNA Handbook, 9th edition, Measured vs. Perceived light





Flicker is increasingly becoming a concern in the lighting industry.

Potential flicker-induced problems:

- Headaches, fatigue, blurred vision, eyestrain
- Neurological problems, including epileptic seizure
- Increased autistic behaviors, especially in children
- 'Unstable light output' in video applications



LED bulb at 100% output



Your personal flicker detector!

Flicker can often be seen on your smartphone camera.

It shows up as lines in your picture.

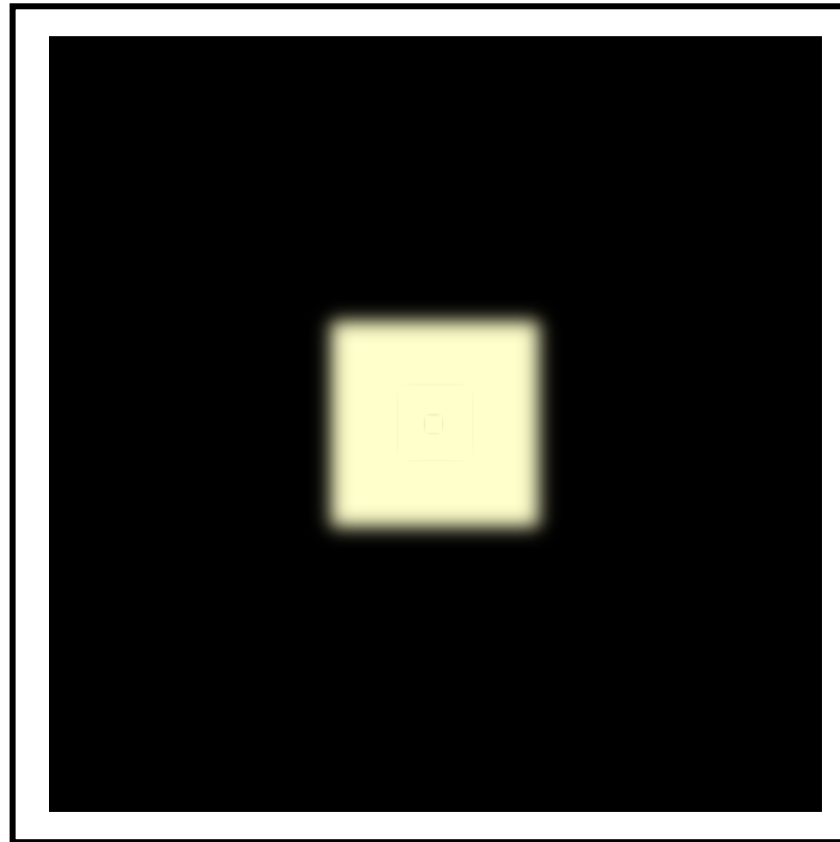
Why eldoLED?



- Natural Dimming
- Best flicker-free dimming range
- Expanding portfolio of flexible, programmable drivers
- Symbiosis: providing electronic building blocks for the intelligent luminaire (Smart & Simple)
- Electrical performance: Low inrush current/Low EMI/High efficiency



2014: Dim to Dark (<0.1%) Spec Grade



eldoLED

Dimming Performance: Measured vs. Perceived Light



Measured Light

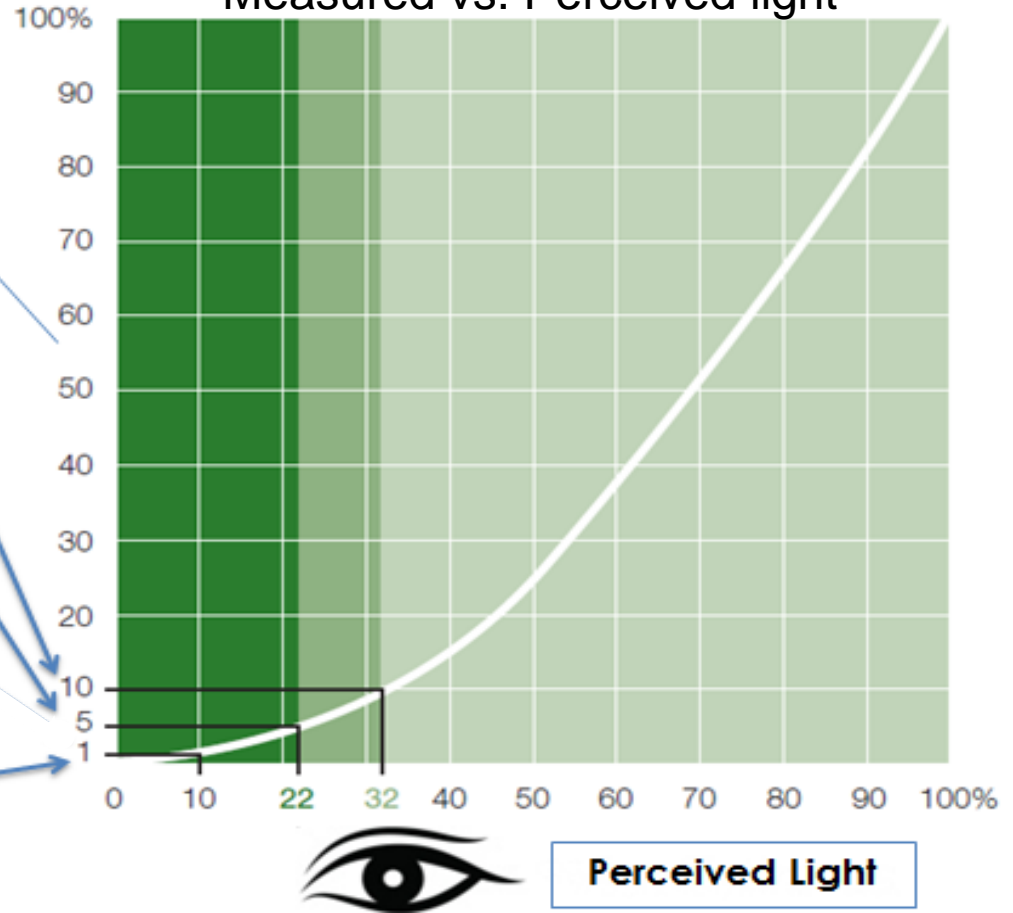


Outdoor, Industrial – Dimming to 10%
32% perceived

Living, Working, Learning – Dimming to 1%
EZ1 - 10% perceived

Entertaining – Dimming to 0%
EZB - 0% perceived

Source: IESNA Handbook, 9th edition,
Measured vs. Perceived light



LED Dimming Made Beautiful



- eldoLED focus is on best-in-class, ***Natural Dimming***
- ***Dim to Dark*** with no flicker, regardless of input
 - 0-10V
 - DALI
 - nLight
 - DMX/RDM
- Color stability even at the lowest light levels

**LED dimming
made beautiful**

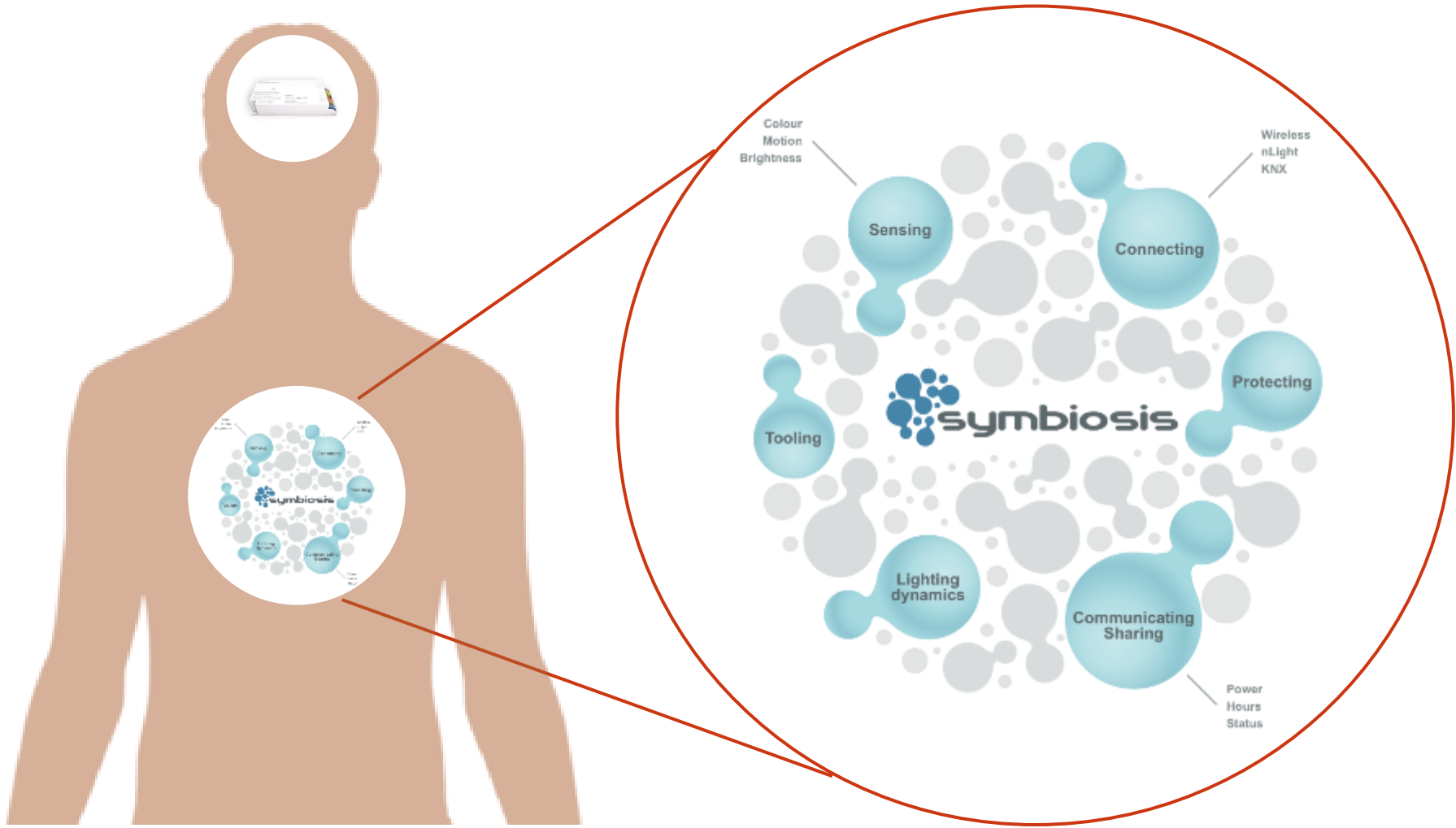
SOLOdrive 50W
Smoothest dimming all the way down to 0 - like incandescent. With any dimmer, in any application. In addition, you can choose your type of dimming curve and minimum dimming level for a perfect fit with your lighting application.

eldoLED
your product | our drive

www.eldoled.com/solodrive50W

Symbiosis – Delivering more than just illumination in a luminaire

Smart and Simple – The Acuity solution for intelligent luminaires



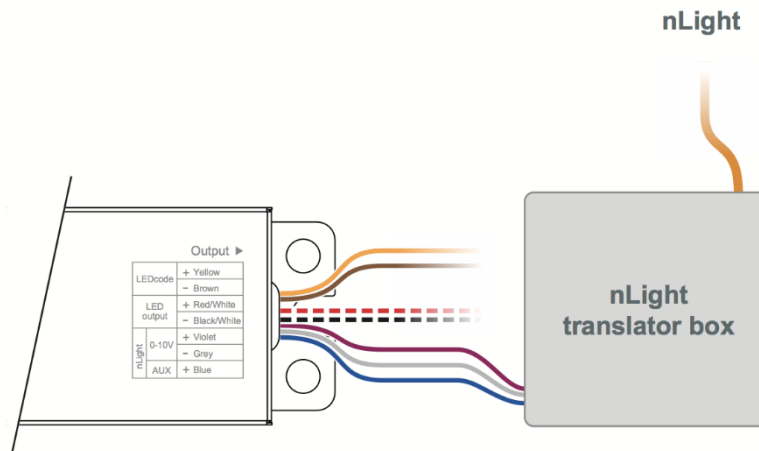


- eldoLED's Symbiosis technology enables the use of many dimming protocols and extends the functionality of the luminaire through LEDcode:
 - Visual Light Communication
 - Energy Usage Feedback, Monitoring
 - Two-Way Communication
 - Compatible with a variety of Fixture and Control Manufacturers
 - Self-identification of LED and driver

Symbiosis: Connecting to External Networks

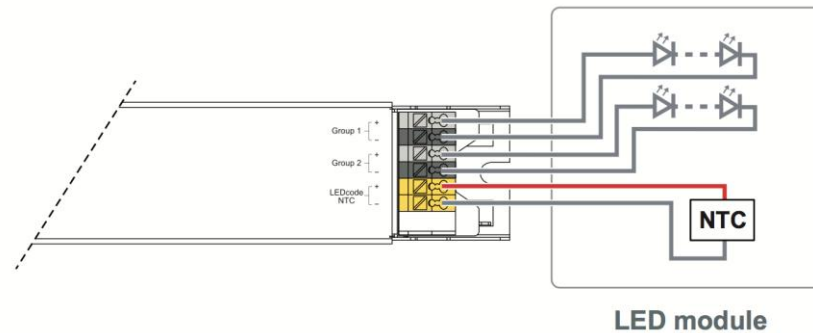


- Robust and digital connection to global network protocols like KNX, wireless and nLight





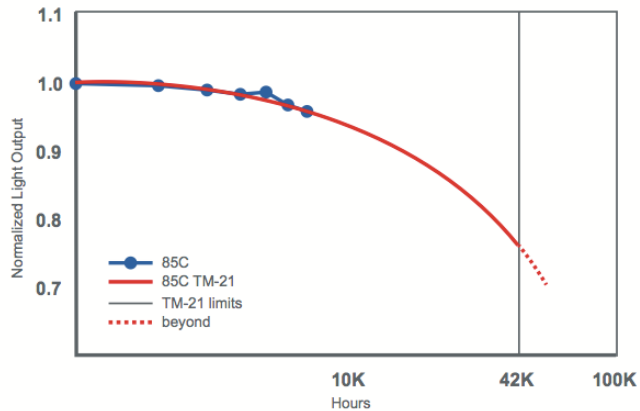
- Relates to safety, reliability and lifetime:
 - Thermal foldback: NTC
 - Safety: Emergency lighting and battery backup



Symbiosis: Constant Lumen Output



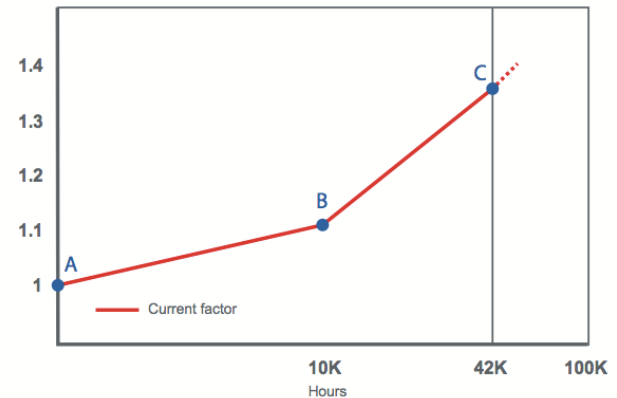
Lumen maintenance



TM-21 recommends extrapolations of $\leq 6x$ the test time
Source: Lumileds

Depreciation depends on LED and application

Drive current



TM-21 recommends extrapolations of $\leq 6x$ the test time

Programmable curve through parameters A, B, and C (x,y)

Good, Better, Best



	Good	Better	Best
Entertaining	ECOdrive	SOLOdrive POWER/LINEARdrive	SOLOdrive POWER/LINEARdrive
Living	ECOdrive	ECOdrive	SOLOdrive POWER/LINEARdrive
Working	ECOdrive	ECOdrive	SOLOdrive POWER/LINEARdrive
Learning	ECOdrive	ECOdrive	SOLOdrive POWER/LINEARdrive
Outdoor/Industrial	Roadmap	Roadmap	ECOdrive



Independent OEMs

- | | | | |
|------------------------------|------------------------------|---------------------------|-------------------------------------|
| 3G Lighting | Electrix, Inc | Litecontrol | Selux Corp |
| Aion LED | ERCO Lighting, Inc. | Liton Lighting | Senso Lighting |
| Altman Lighting, Co. Inc. | Evolucia Lighting | LRI Lighting | Sensocal |
| Amerlux Lighting | Fiatlux Lighting | Lucebella Inc | Sistemalux |
| Archetype Lighting | Finelite | Lucifer Lighting Company | Solavanti Lighting |
| Architectural Lighting Works | Fluxwerx Illumination Inc | Lumastream Canada | Specialty Lighting Industries, Inc. |
| Artec Lighting Products Inc. | Focal Point LLC | Luminas Lighting LLC | Spectra |
| Axis Lighting Inc. | Focus Lighting Inc. | Luminus Devices | Spectrum Lighting |
| BEGA US | Fusion Optix | Moda Light | SPI Lighting |
| Benchmark | Green LED Lighting Solutions | MP Lighting | Standard Vision, LLC |
| Beta-Calco Inc. | H.E. Williams Inc. | Nemalux | Swarovski Lighting, Ltd. |
| BetaLED | HMS Inc. | Noribachi | SWM Designs |
| Birchwood Lighting Inc. | iGuzzini North America | Optic Arts | The Bright Group |
| Blom Lighting International | Ilumina | OptoLum, Inc. | Tealighting Inc. |
| Canlyte | Ilumento LLC | Organic Lighting Systems | TMS Lighting |
| Chicago Fountain | Impact Lighting Inc | Pathway Lighting | USAI, LLC |
| Coloronix | Insight Lighting | Peachtree Lighting | v2 Lighting Group |
| Crystal Fountains | Integrated Illumination | Phoster Industries | Vantage |
| Dasal Industries | Intense Lighting, LLC | PMRi LLC | Vision Engineering |
| Delta Light Canada Inc | Inter-lux | Production Resource Group | Vision Quest Lighting, Inc. |
| Designplan Lighting, Inc. | Kreon Inc. | projectLUCE | Visual Lighting Technologies |
| Dialight | Kurt Versen Co. | Prudential Lighting | Vode Lighting LLC |
| DigitalLumens | LED Linear North America | Pure Lighting | Walt Disney Imagineering |
| Edge Lighting | Light Beam Industries | Rambusch | Westburne |
| Edison Price Lighting | Light Forms | Roman Fountains | WET Design |
| Eclipse Lighting | Light-Based Technologies | | Zumtobel Lighting Inc. |
| | Lighting Services Inc. | | |

eldoLED is the industry standard



Innovation

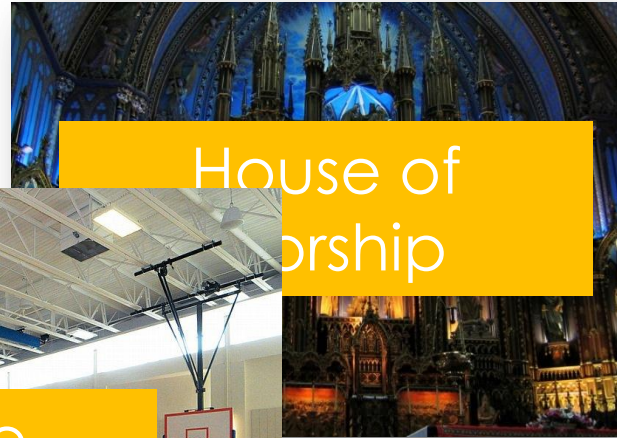
*No amount of hard work can compensate
for a stupid idea*

Deliver high performance lighting controls that address the dynamic lighting requirements in architectural and entertainment spaces

the spaces



Ballroom



House of
Worship



Multi-Use



Meeting Room



Restaurant &
Retail

the challenges

DESIGNER

- End user expectations
- Choices
- Compatibility concerns
- Cost
- Code requirements
- Cooks in the kitchen
- Time

INSTALLER

- Education
- System limitations
- Cost
- Commissioning
- Time

USER

- Training
- Making changes
- Cost/ROI

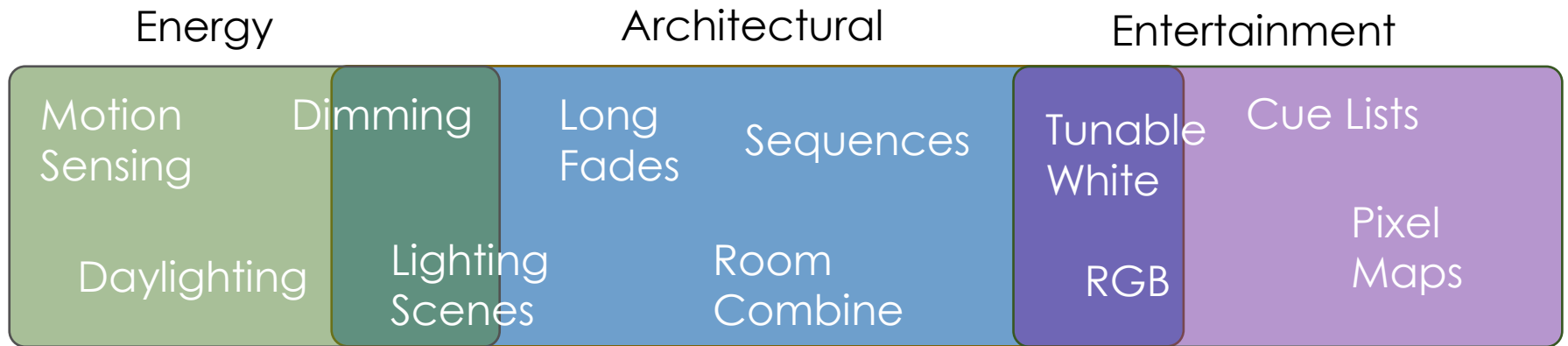
Make it easy



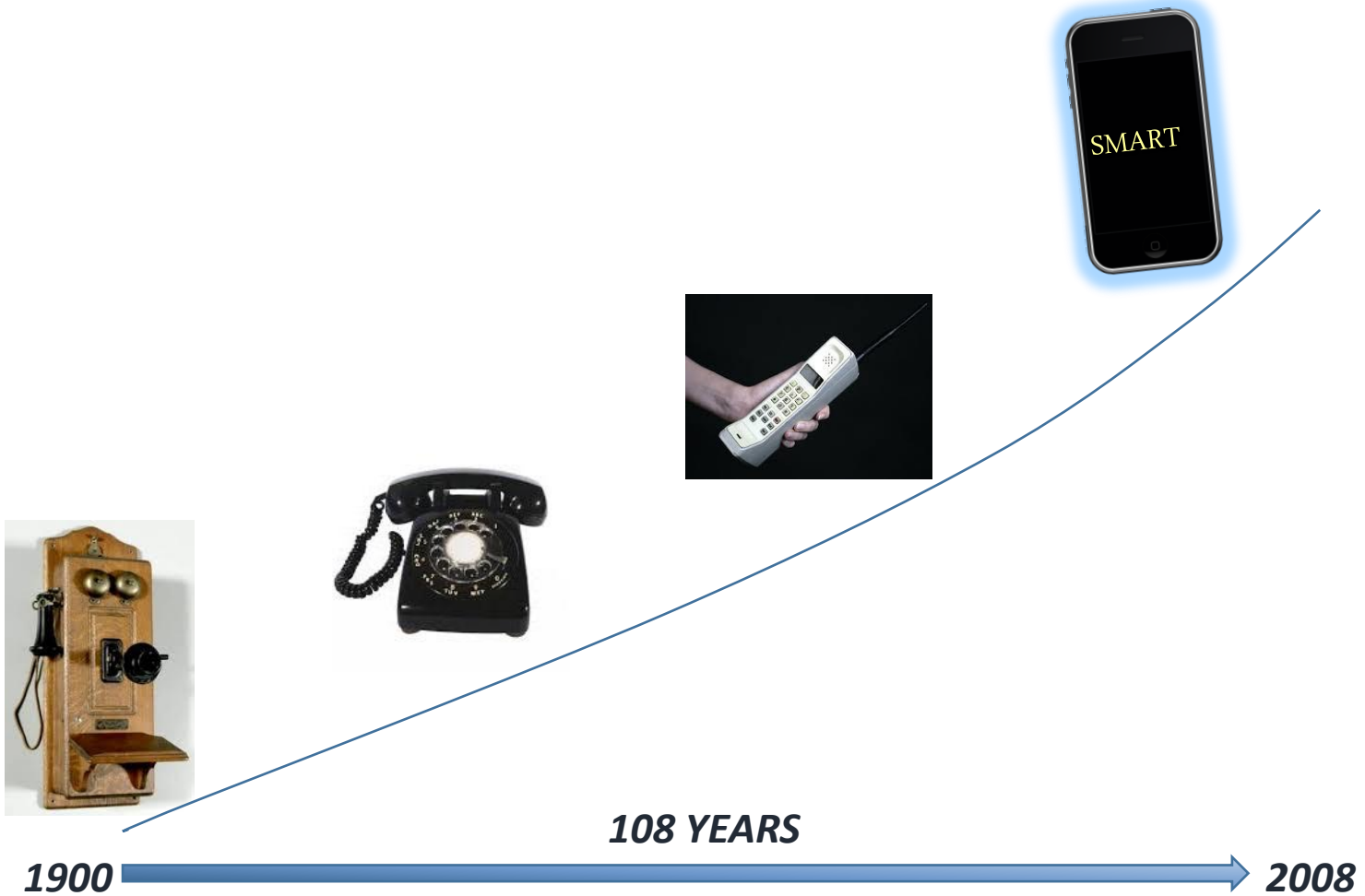
what's considered easy?



the strategies



technology meets convenience



world of convenience



it's easier than you think



what makes the fresco touchscreen unique?



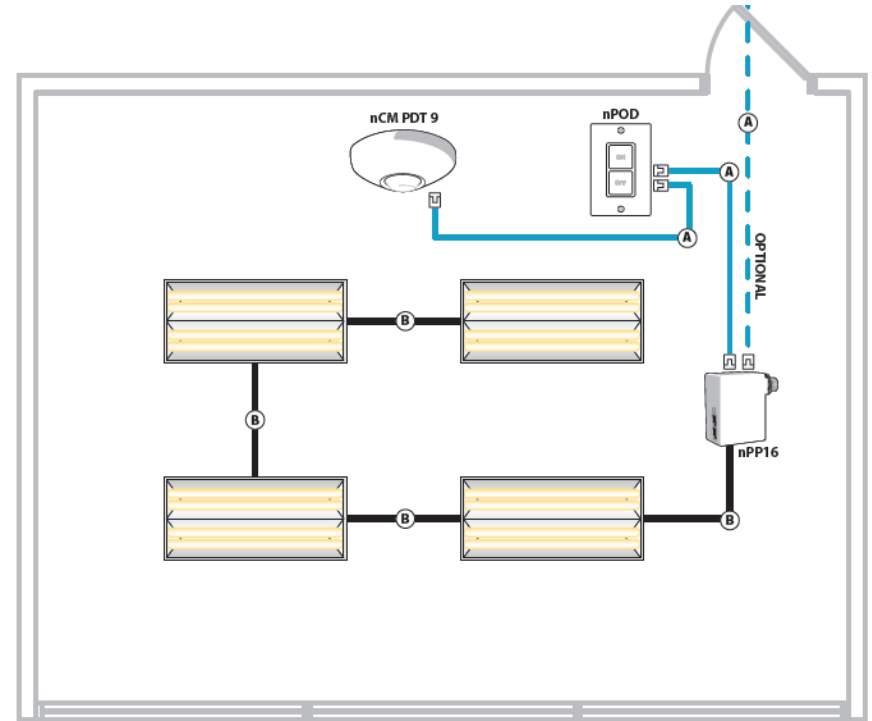
digitally control every lighting load

- LED
- Incandescent/MLV
- ELV
- 0-10V
- DALI
- DMX
- nLight® devices
- nLight® enabled luminaires



nLight[®] control

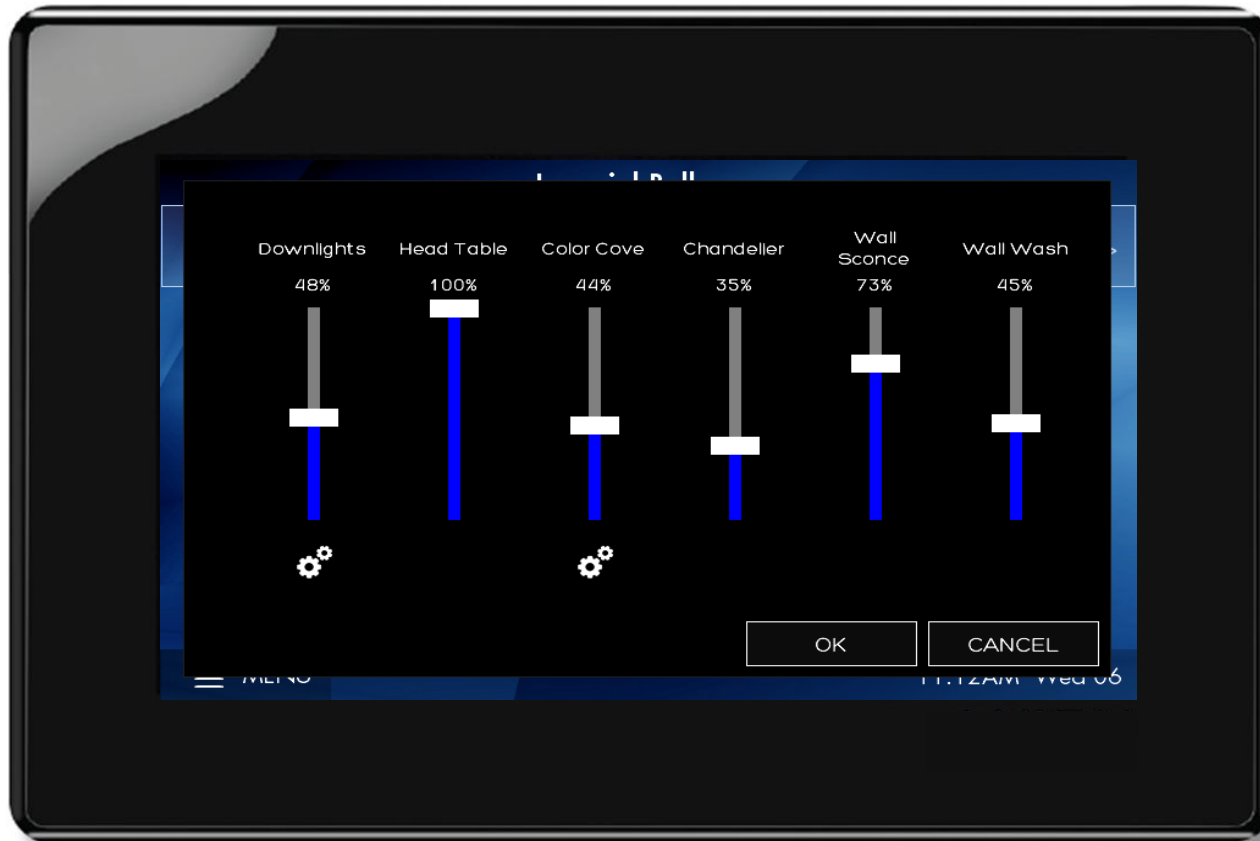
- Digital control network
- Distributed intelligence
- Energy management
- Easy installation
- Flexible/Scalable
- Direct luminaire control



customization through personalization



control your zones



dynamic color changing



dynamic white control



fresco wirelessly connected



fresco on the wall



fresco in your hands



where should I use fresco?

boardroom/meeting room



boardroom/meeting room



use of space

- multiple lighting zones
- scene control
- occupancy control
- 3rd party integration
- wireless control

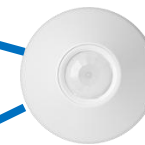
fresco features

- 36 lighting zones
- 36 lighting scenes
- nLight sensor integration
- nLight RS-232 integration
- Bluetooth and Wi-Fi iPad app



nLight solution

nLight



iPad App

nLight solution

restaurant



restaurant



use of space

- multiple lighting zones
- scene control
- time clock
- schedules
- centralized equipment

fresco features

- 36 lighting zones
- 36 lighting scenes
- nLight sensor and fixture integration
- integrated time clock
- scheduling tool included
- fresco lighting panel



fresco



phase dimming
switching



fresco solution

fresco lighting management panel



- line voltage dimming
- relay switching
- 0-10v
- DALI

industry unique features

- phase detection dimming
- zero minimum load needed
- DMX/RDM controlled and responders

ballroom



ballroom



use of space

- multiple lighting zones
- multiple entry points
- occupancy control
- partition control
- RGB lighting integration
- wireless control

fresco features

- 36 lighting zones
- connect 8 fresco stations on single network
- nLight sensor and fixture integration
- DMX control
- iPad app



multi-use space



multi-use space



use of space

- multiple lighting zones
- secured access
- occupancy control
- time clock
- RGB lighting integration

fresco features

- 36 lighting zones
- user profiles for security
- nLight sensor and fixture integration
- DMX control



house of worship



house of worship

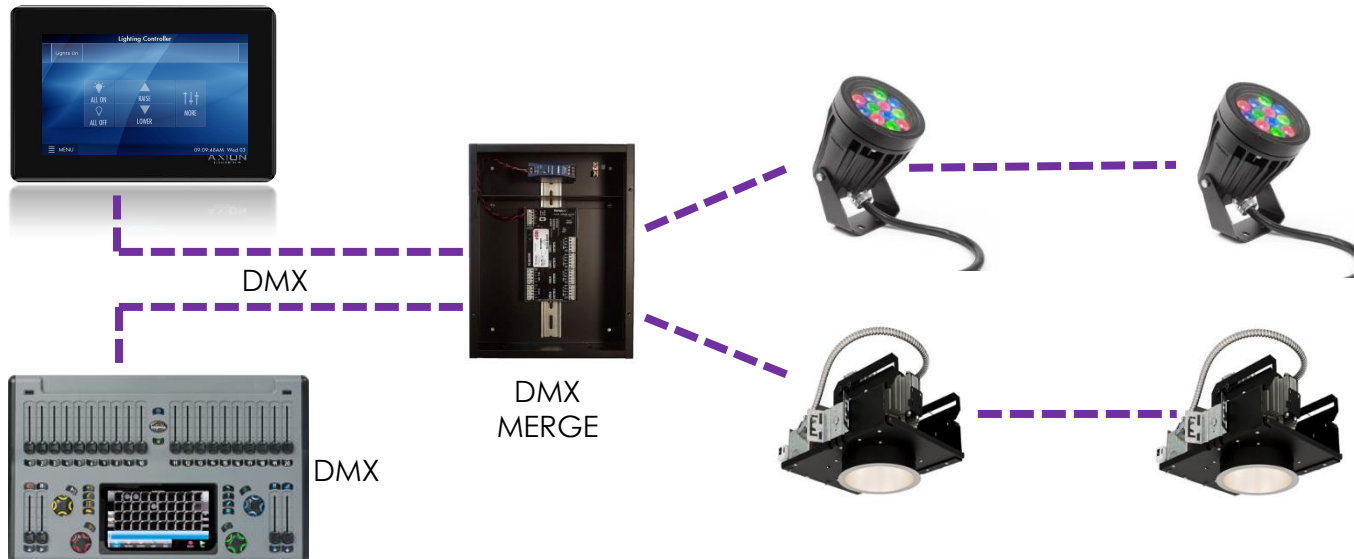


use of space

- multiple lighting zones
- scene control
- RGB integration
- 3rd party lighting console

fresco features

- 36 lighting zones
- 36 lighting scenes
- DMX control
- DMX distribution capable



dynamic control



dynamic spaces

Thank you for your time.

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