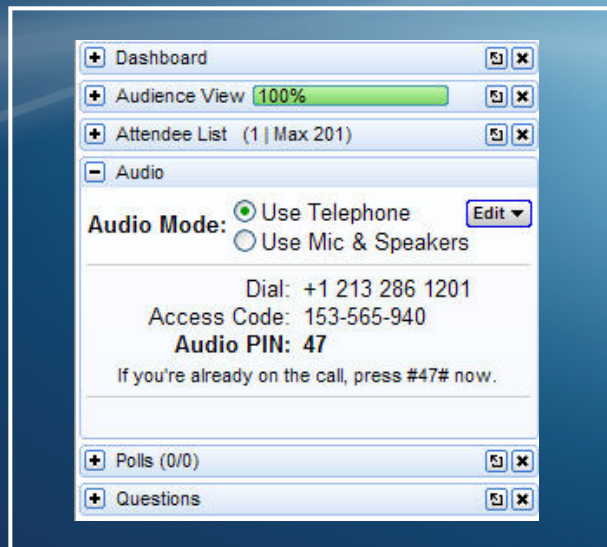


Controlling LEDs



How to Participate: AUDIO Options

It is recommended (not mandatory) to call-in via telephone as the audio quality tends to be better than individual speakers on computers / laptops. Make sure the correct audio choice is chosen when you are ready to listen in. Please note: The telephone number is different for each webinar. The number below is just a sample. Thank you!



Technical issues? Email jtucker@lutron.com or call (484) 695-5192.



How to Participate: Ask Questions

To ask a question....

- Type your question in the GoToWebinar question box on the right hand side of your screen.
- Feel free to type in questions throughout the webinar as the presenter will address them at the end of the session.

Technical issues?

- Please email jtucker@lutron.com or call the webinar support cell phone at (484) 695-5192.



Agenda

- Advantages and limitations of LEDs for general illumination
- Basics of LED Control
- Reasons why you should dim LEDs
- The questions to ask before dimming an LED product

LED Advantages

- High Efficacy
 - Fixtures can achieve 25 – 80 LPW efficacies
 - 5 – 10 LPW for incandescent
- Longevity
 - Useful life of 25,000 to >100,000 hrs
 - <1,000 for incandescent
- Environmentally Friendly
 - No hazardous materials
 - ex: mercury vapor in iCFLs



LED Limitations

- Higher Cost
 - LEDs for general illumination are high brightness - \$\$\$
 - Require electronic drivers to convert AC to discrete DC
- Limited Applications
 - No one style is universally accepted
 - LED fixtures not available for every application
- Controls Compatibility
 - Not all lamps are dimmable
 - Dimmable lamps may have limited performance



NOTE: This product may cause interference with radios, televisions, telephones or remote controllers. If interference occurs move this product away from device or plug into another outlet.

CAUTION: Risk of electric shock-do not use where directly exposed to water. This device is not intended for use with emergency exit fixtures or emergency exit lights. Not for use with dimmer circuits. Not for use with timers, photocell and motion control devices.

LIMITED WARRANTY: Product will be free of defect due to workmanship for a period of two (2) years. If product fails within the stated life, return defective product to retailer or Lights of America. Warranty terms and conditions of retailer apply. Warranty and guarantee void if product is misused per caution statement. If replacement product is not available at retail store, please return product, original package and receipt to manufacturer at: 611 Reyes Drive, Walnut CA. 91789 Attn: Consumer Affairs.

Why Dim LEDs?

- Dimming LEDs saves energy
 - 50% dimming = 50% energy savings
 - Added savings to an already efficient source
- Dimming lowers operating temperatures
 - Extends component life (electronics & phosphor)
 - Double or triple lumen maintenance
- General dimming benefits
 - Enhance ambiance
 - Space flexibility
 - Improve safety
 - Increased productivity

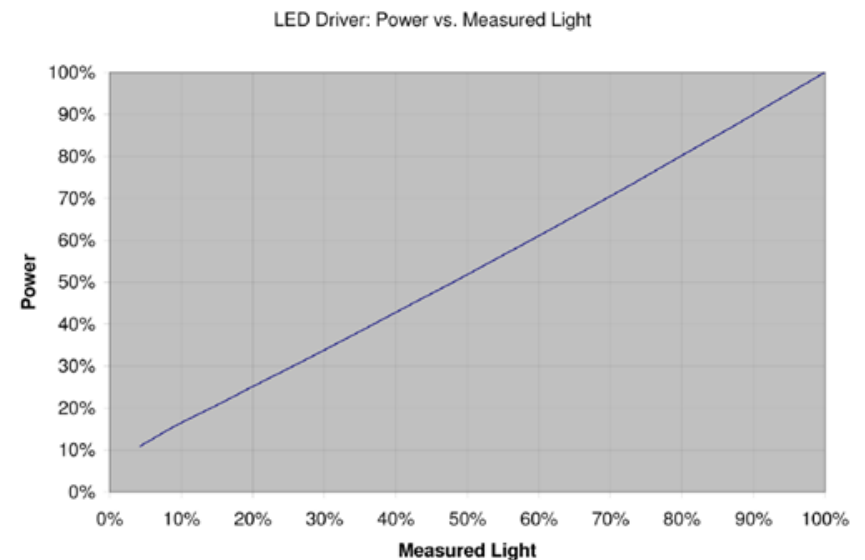


FIGURE 1:
LED Driver: Power vs. Measured Light

Dimming Challenges

- Understanding LED limitations is essential
 - New luminaire manufacturers entering market
 - Multitude of control types (some with standards, some without)
 - Performance issues (flicker, failure to turn off, etc.)
- Driver-related issues
 - LEDs are highly susceptible to flicker
 - Quality of DC output is important
 - Remote driver mounting can result in issues
 - Driver may not be designed for the same lifetime as the LEDs



Steps for a Successful System

Use the following questions to match expectations with performance:

1. What type of LED product am I using: a lamp or fixture?
2. What is the dimming range of the lamp/fixture?
3. What is the dimming performance of the product?
4. What is the minimum or maximum number of lamps/fixtures that can be connected to one dimmer?
5. What type of control does the LED product operate on?

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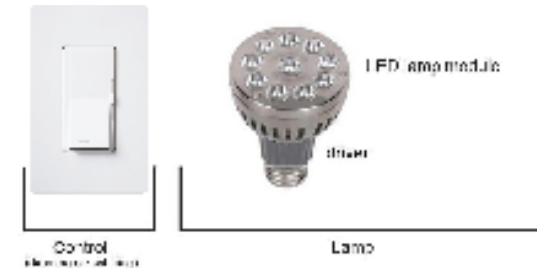
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What type of LED product am I using?

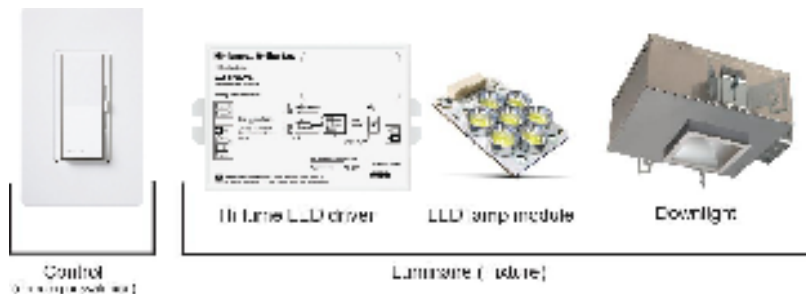
- LED Bulbs (LEDi's)

- Designed to replace standard incandescent or screw-in CFL bulbs
- Edison base sockets
- Integral drivers which determine dimming performance (if dimmable)



- LED Fixtures

- Variable in purpose (cove lights, down lights, 2x2, etc.)
- Usually have an external driver
- Some fixtures have multiple driver options to support different control technologies and applications (dim vs. non-dim, 0-10V vs. DALI)

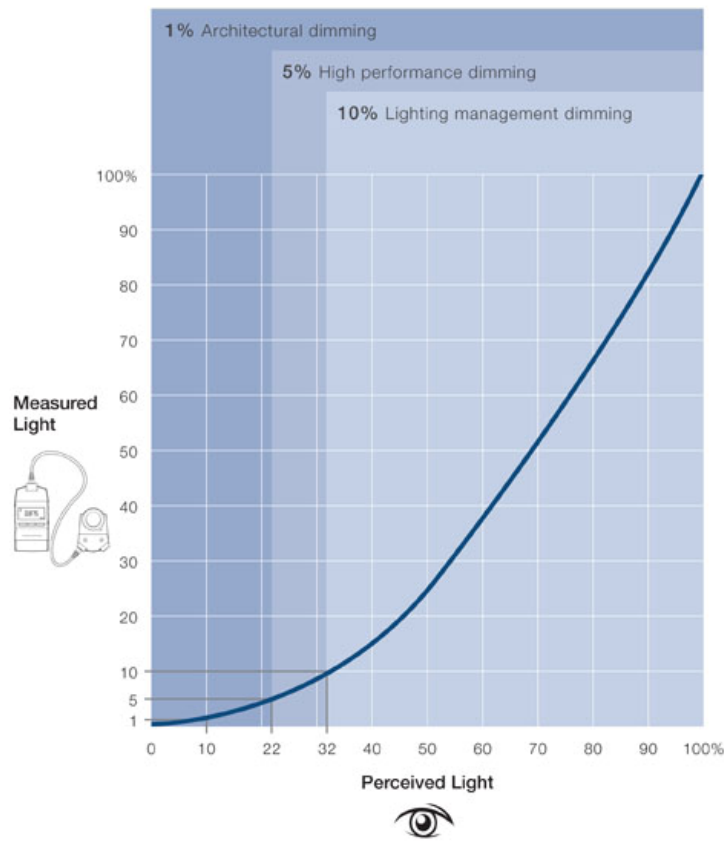


What is the dimming range of the fixture?

- Dimming range varies greatly
 - Some may dim only to 50%, others to 1%
Incandescent lamps dim to below 1%
 - (orange filament glow)
- Select a dimming range suitable for your application
 - 20% dimming: suitable for a lobby, atrium, office, etc.
 - 1% dimming: necessary for a restaurant, media room, etc.
- Measured light vs. perceived light
 - Use caution when comparing and selecting products
 - Not all manufacturers use the same standard



What is the dimming range of the fixture?



Formula: $\text{Perceived Light (\%)} = 100 \times \sqrt{\frac{\text{Measured Light (\%)}}{100}}$

Source: IESNA Lighting Handbook, 9th Edition, (New York: IESNA, 2000), 27-4.

- Difference between measured and perceived light

- **Measured light:** the amount of light as shown on a light meter
- **Perceived light:** the amount of light that your eye interprets due to dilation
- 20% measured = 45% perceived

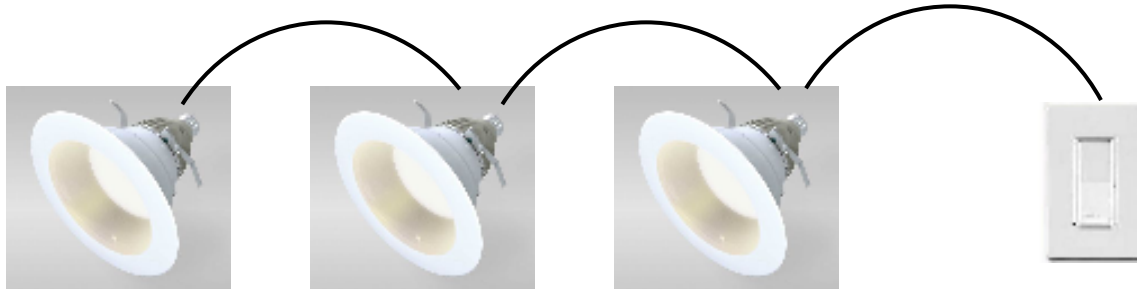
What is the dimming performance of the product?

- What to watch out for:
 - Pop-on
The level the light is at when it is turned off is the level it should return to when it is turned back on
 - Drop-out
The light should only turn off when the switch is turned off.
 - Dead-travel
Adjusting the control without a corresponding change in light level
 - Audible Noise



How many LEDs can be connected to a dimmer?

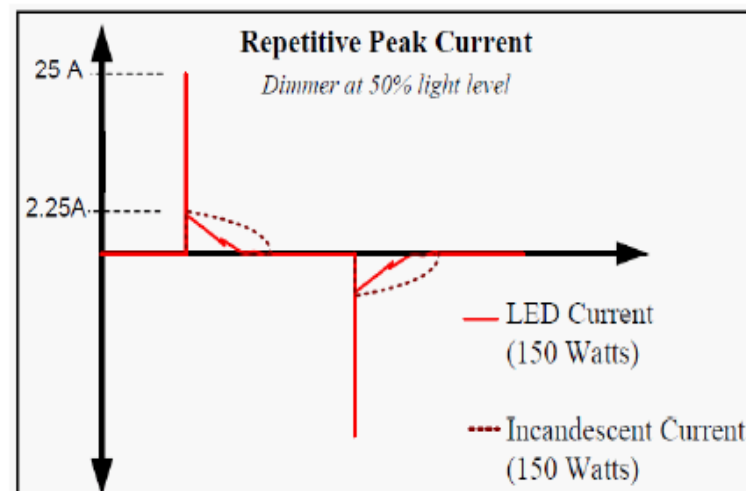
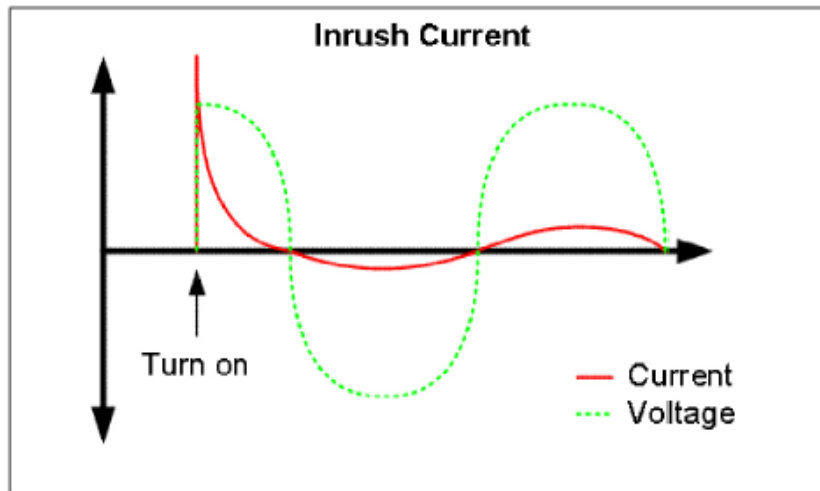
- Minimum number of lamps
 - Dimmer / driver performance may suffer with too little load
 - Most incandescent dimmers require a 25 – 40 watt minimum



- Maximum number of lamps
 - The simple calculation is wrong
 $600 \text{ watt dimmer} / 10 \text{ watt LED} = 60 \text{ LEDs per dimmer: WRONG!}$
 - Start-up inrush and repetitive current increases draw
 - Lutron observations have shown a 10 watt LED is similar to a 100w incandescent in terms of maximum current draw

How many LEDs can be connected to a dimmer?

- Start-up inrush and repetitive current
 - Lutron observations have shown a 10 watt LED is similar to a 100w incandescent in terms of maximum current draw
 - After accounting for these current draws, a 600 watt dimmer can safely support roughly 6 10-20 Watt LED lamps
 - *Note: Only applies to phase control products*



On what type of control does the LED operate?

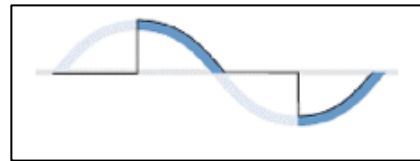
- Control type refers to the signal and wiring between the wall control and fixture / lamp
 - Lamps generally use only forward/reverse phase control
 - Fixtures can use any method
 - The LED and control MUST use the same control type!
- Control Options
 - Forward Phase
 - Reverse Phase
 - 3 Wire
 - 0-10V
 - DALI
 - DMX 512



What type of control does the LED operate on?

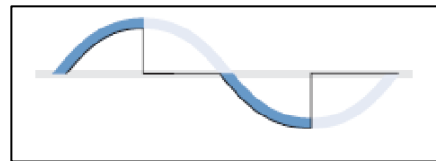
- Forward Phase

- Most Common Dimming Method (150 million dimmers in use)
- Not originally intended for use with LEDs, performance issues possible



- Reverse Phase

- Typically used for ELV loads, typically perform better with LEDs
- Smaller install base, usually require a neutral wire



- 3 Wire

- Fluorescent standard, control signal carried separate from power
- Precise, less prone to noise, but requires a third line voltage wire

What type of control does the LED operate on?

- 0-10V
 - Analog control standard, low voltage (simplified wiring)
 - IEC standard exists for general illumination, not always followed
- DALI
 - Digital addressing of individual fixtures & status feedback
 - Easy to assign occ. sensors, timeclocks and control to one or many fixtures without added wiring
 - IEC standard exists
- DMX-512
 - Popular in theater applications & RGB LED control
 - Multiple channels for individual color control
 - Possible to use for single color general applications
 - Complicated wiring for general illumination

Steps for a Successful System

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LED Product Selection Tool

LED Product Selection Tool

Share   

While LEDs have shown great potential within the lighting industry, they – like all lights – benefit from the proper control. Use the dropdown choices to search for tested LED solutions that will ensure compatibility between controls and drivers with other LED products.

Fixture/Lamp Type	Manufacturer	Control Technology 	Lutron Control
Select ▼	Select ▼	Select ▼	Select ▲  Ariadni Dimmer  Ceana Dimmer  Diva Dimmer


Show only Lutron drivers (removes any non-Lutron driver options)

If you would like your product added to this list or you would like more information about please e-mail LEDs@lutron.com.


LED Testing Program

Lutron Recommended Compatible Products

Product	Part Number	Fixtures per Dimmer	Measured Light Output Range ⁽¹⁾	Comments
Diva	DVELV-300P	1 – 15	9% - 99%	Delay at low-end possible
Maestro	MAELV-600	1 – 30	12% - 99%	Delay at low-end possible
Nova	NLV-600	1 – 5	9% - 100%	Low end trim required



LED Product Report Card



Manufacturer: Cooper / Halo
Applicable Model Numbers: ML706830

Manufacturer's Description
 Type of Fixture: Recessed Downlight
 Operating Voltage: 120 Vac
 Input Power: 14.8 W
 Current: 123 mA
 Frequency: 50/60 Hz
 Control Types: Standard Incandescent Dimming, Electronic Low Voltage, Fluorescent
 Dimming Range: 5% - 100% with incandescent dimmer
 Output Power: N/A
 Lumens: 682 lm (with the White Reflector trim ring)

Lutron Test Results
 Date Tested: May 13, 2009
 Model Number Tested: ML706830
 Smooth and Continuous: Yes
 Test Notes: Testing and Recommendations based on 60 Hz frequency

Lutron Recommended Compatible Products

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Maestro	MAELV-600	1 – 30	12% - 99%	Delay at low-end possible
Nova	NLV-600	1 – 5	9% - 100%	Low end trim required
Nova T*	NTELV-1600	1 – 7	10% - 99%	
Nova T*	NTELV-600	1 – 30	10% - 99%	
Skyark	SF-10P	1 – 8	15% - 99%	Low end trim required
Vier*	VTELV-600M	1 – 30	9% - 99%	Low end trim required
Incandescent Dimmers	See comments below			
Homeworks	HW-RPM-4A-120	1 – 60 per output	5% - 100%	Reverse Phase Control Max. 96 fixtures per module Low end trim required
	HW-RPM-4U-120	3 – 14 per output	5% - 100%	Max. 14 fixtures per module Low end trim required
	HWD-5NE, HRD-5NE	1 – 25	5% - 100%	Low end trim required
Commercial Systems	LP-RPM-4A-120	1 – 60 per output	5% - 100%	Reverse Phase Control Max. 96 fixtures per module Low end trim required
	Interfaces			
	PHPM-WBX ⁽²⁾	1 – 96	5% - 100%	Low end trim required
	PHPM-PA ⁽²⁾	1 – 96	5% - 100%	Low end trim required

⁽¹⁾ Values are based on light output using the specified dimming control, and may not be an indication of the fixture's full capability.
⁽²⁾ Controlled with Acadni, Diva, Lynco LX, Maestro, Nova, Nova T*, Skyark, or Vario 3-Wire Fluorescent dimmers, or GraffEye.

LED Control Center of Excellence

- A resource for you and your customers to get answers on any LED control question, including:
 - Control Options
 - System Compatibility
 - Tested/Non-tested products
 - Educational information to share with a customer
- Ways to reach us:
 - 1-877-DIM-LED8
 - LEDs@lutron.com
 - www.lutron.com/LED