

# Controlling LEDs to meet customer expectations



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# Customer expectations

- Incandescent lamp performance
  - Color temperature
  - $<.1\%$  dimming
- Smooth and continuous dimming
  - No flicker
  - No shimmer
  - No pop-on
  - No drop-out
- Use standard controls



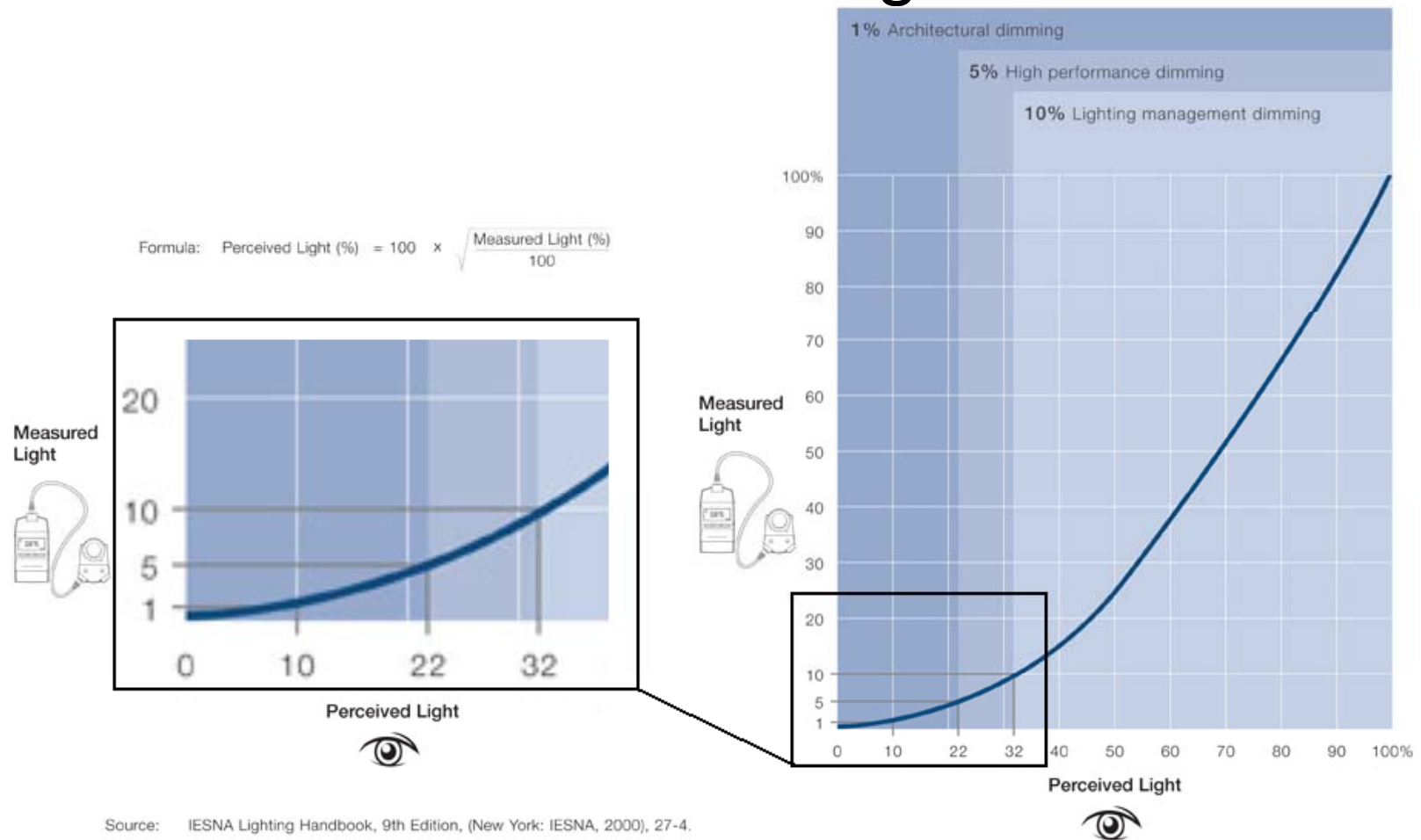
# Why Dim?

- Ambiance
- Energy Savings
- Increased productivity
- Space flexibility

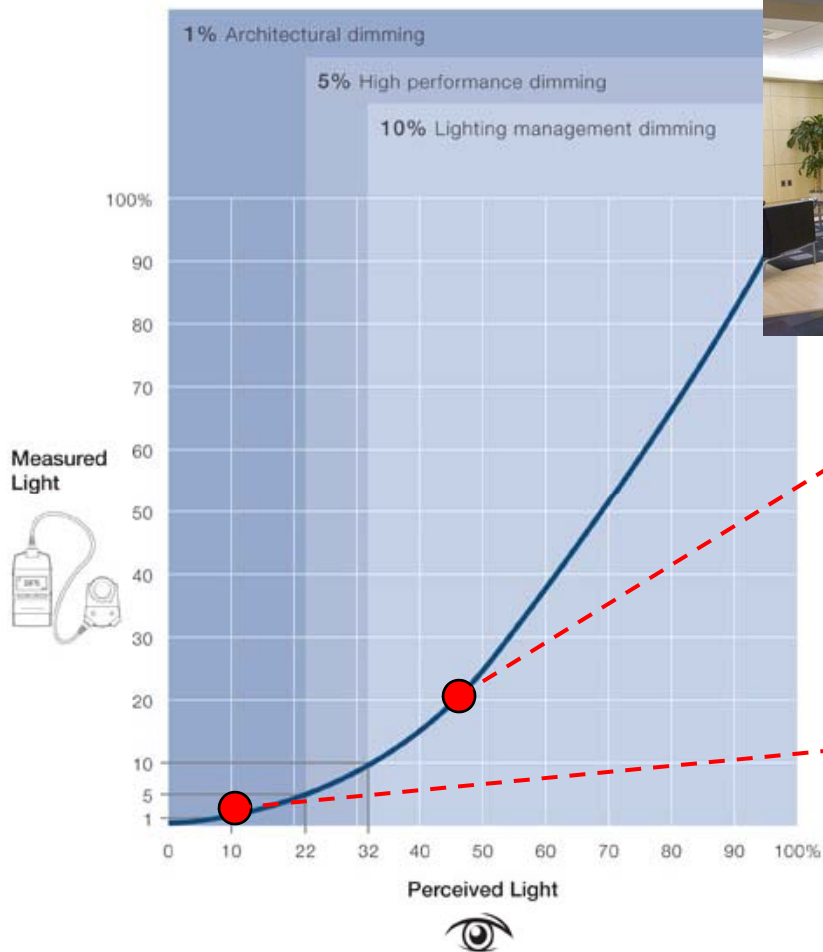


# What does “dimmable” mean

- Specified lowest light level (ex: 1%)
- Measured vs. Perceived light



# What does “dimmable” mean



Lobby or Atrium:  
Controlable - A  
20% light level is  
acceptable for  
this application



Restaurants: Dimmable - A  
1% light level is necessary  
for this application

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

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

# Dimming problems to avoid

**Flicker:** The unexpected modulation of light level that is visible to the human eye.

- Easy to perceive at  $<100\text{Hz}$
- It can be caused by:
  - line noise
  - circuit noise
  - component tolerance
  - circuit design

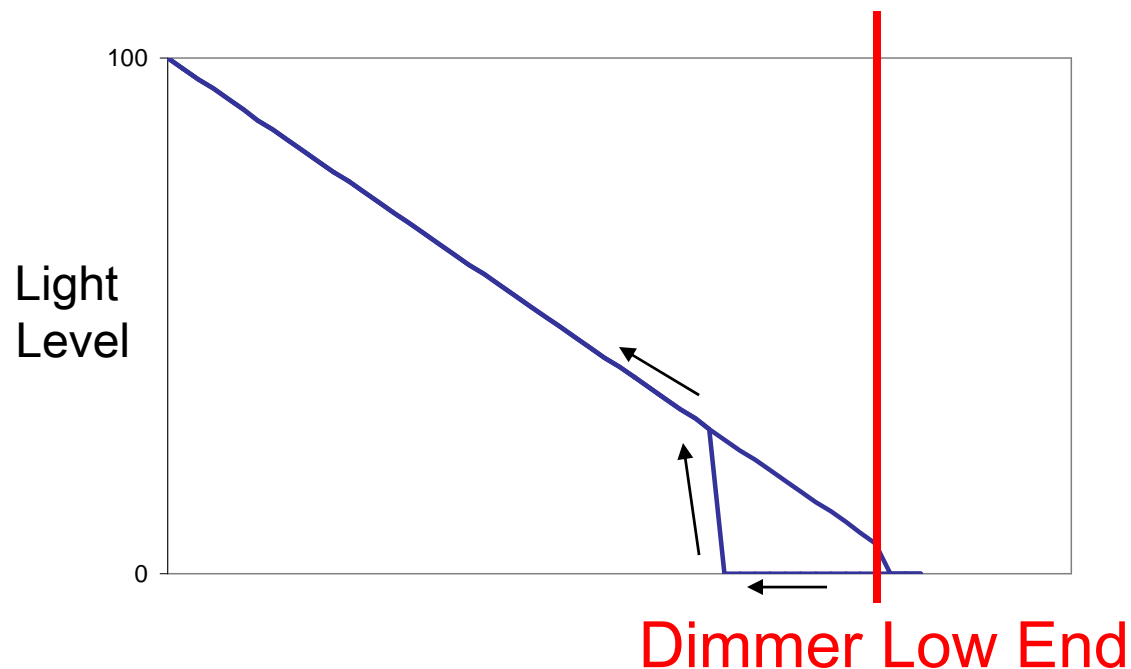
# Dimming problems to avoid

**Shimmer:** small fluctuation in light level which occurs at a frequency of 30 to 60Hz.

- Any LED system without energy storage is susceptible
- It can be caused by:
  - Asymmetrical output of an incandescent dimmer
  - A transformer that is starting to saturate
  - Different LEDs operating in each half cycle

# Dimming problems to avoid

**Pop-on:** When the dimmer is turned on at or near low-end (from off) and the lights do not turn on. As the slider/knob moves toward the maximum setting the lights suddenly “pop-on.”





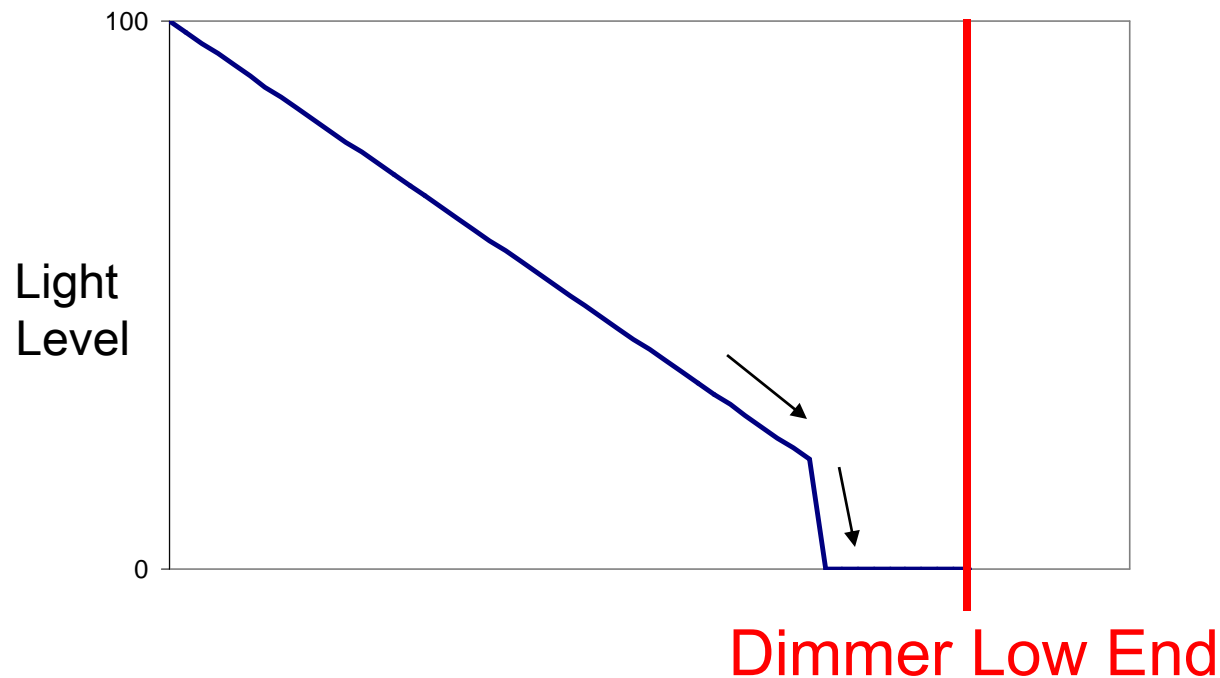
# Dimming problems to avoid

**Pop-on:** When the dimmer is turned on at or near low-end (from off) and the lights do not turn on. As the slider/knob moves toward the maximum setting the lights suddenly “pop-on.”

- Occurs when the voltage at which a light source begins operation is higher than the voltage of the dimmer’s lowest setting

# Dimming problems to avoid

**Drop-out:** When the lights turn off before the slider or knob on the dimmer reaches the minimum setting.



# Dimming problems to avoid

**Drop-out:** When the lights turn off before the slider or knob on the dimmer reaches the minimum setting.

- Occurs when the voltage at which a light source stops operating is higher than the lowest setting on the dimmer

# Standard Control Options

- Eliminating these problems is a huge step, but only if the product can still work on a standard dimmer
- Customers need a broad range of controls to choose from, not a control specific to one LED fixture or a control that is not scalable

# Standard Control Options

- Line Voltage
  - Forward Phase (incandescent + Magnetic Low Voltage)
  - Reverse Phase (Electronic Low Voltage)
- Low Voltage
  - 0-10V
  - DALI
  - DMX



# Forward Phase Control

- **Used for Incandescent and Magnetic Low Voltage loads**
- Most are two-wire construction, meaning that loads have impact on the dimming performance
- Works well when the load is resistive (incandescent), but when the load becomes complex it affects the dimmer
- MLV requires symmetry, which may reduce shimmer in LEDs depending on the driver

# Reverse Phase Control

- **Used for Electronic Low Voltage loads**
- ELV loads are capacitive and have large impedance changes.
  - High impedance until oscillator in transformer or driver starts to run, then switches to lower impedance.
- Require a neutral connection which addresses the impedance changes but may be challenging to install (if neutral isn't available in the wallbox)

# 0-10V

- IEC standard 60929
  - 2 power wires, 2 control wires
  - 0-1V: minimum light
  - 1-10V: rising light level
  - 10-11V: max light
  - Driver is the current source
    - 1mA to 2mA max
- Provides uniformity
- Ambiguity about what is low end (off or minimum light level)



# DALI

- Used for fluorescent lights
- IEC standard 60929
- 2 power wires, 2 control wires
- Provides individual fixture control for up to 64 devices on a bus supply

# DMX

- ANSI Standard (USITT DMX 512-A)
- Protocol used primarily for mixing colors and varying color intensity
- Multiple channels required
- Applications: Theatrical

# How to meet customer expectations

- Consider customer expectations in the design phase
- Understand the marketplace
  - Knowledge base
  - Installed base
  - Educational information
  - Customer confusion
- Come to “Incorporating Control into Your LED Product” on Thursday at 10:45am
- Call 1-877-DIM-LED8 for questions on controlling LEDs