The Quest for Dimmable LEDs

BY AMANDA BEEBE

Widespread adoption of LEDs requires reliable high-performance dimming. But controlling LEDs is not as simple as controlling an incandescent light. There are a number of factors to consider to ensure that an installation of dimmed LED fixtures or lamps performs to your expectations and those of your customers.

Before you commit to investing in dimming LEDs, you must understand the requirements for optimum performance. Many LED luminaire manufacturers are new to the lighting industry and are not familiar with the multitude of control types and the corresponding product design requirements that accompany them. This has resulted in "dimmable" products that do not work as claimed, that never turn off completely or that flicker.

These are major problems that need to be addressed so that consumers do not associate all LEDs with poor performance and become averse to using them. High-performing LED products do exist, but you need to ask the right questions to make sure you have chosen one of those products appropriately.

Let's consider each of these factors in detail.

LED lamps vs. LED fixtures. LED luminaires come in two distinct types: an LED bulb (also called an LEDi or retrofit lamp) and LED fixtures.

LED bulbs have Edison base sockets and are meant to replace standard incandescent or screw-in CFL bulbs. The bases of these bulbs have integral drivers that determine if they are dimmable, and if so, what the dimming performance is.

LED fixtures can vary from cove lights to downlights and usually have an external driver. Some fixture manufacturers offer different driver options on the same fixture to support different control technologies or applications (such as dimmable vs. non-dimmable or dimmable via a 0-10V signal or DALI).

There are two different types of drivers. LED drivers may be constant voltage types (usually 10V, 12V and 24V) or constant current types (350mA, 700mA and 1A). These two types of drivers are not interchangeable, and it is the design of the LED array that determines which driver is appropriate. Some drivers are manufactured to operate specific LED devices or arrays, while others can operate most commonly available LEDs. The long-life benefits of LEDs would be reduced if the driver was not designed for an equally long life.

One of the most important LED driver features to examine is the quality of the DC output voltage of the driver. That's because the instantaneous response of LEDs to changing current makes them highly susceptible to flicker, especially compared to incandescent sources.

Finally, be cautioned that remote mounting of the driver could result in potential voltage drops, power losses or noise susceptibility on the DC wiring that must be properly accounted for.

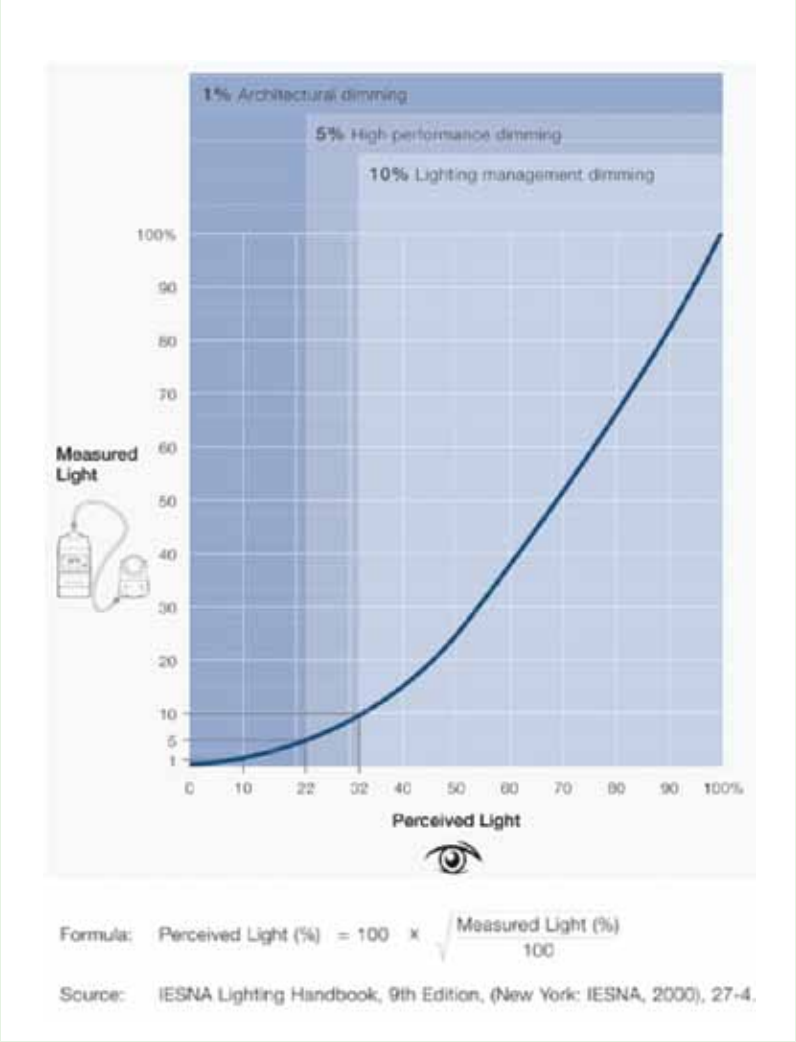
Dimming range. The dimming range of an LED lamp or fixture can vary greatly from one device to another. Some may dim to a minimum level of only 50 percent, while a different product may dim to 1 percent. You need to select the dimming range of your fixture or lamp that will be suitable for your application. A product that dims to 20 percent measured light (45 percent perceived) wouldn't make sense in a media room, but may be the energy-saving solution necessary for an office (**Table 1**).

Dimming performance. Experience with incandescent dimming means customers expect smooth and continuous performance. A change in the dimmer position should be reflected by an equal change in light level. There should be no abrupt change in light level as the light source is being dimmed. Additionally, there should be no points of flicker in the dimming range.

Other undesired behavior can occur when dimming an LED driver. A properly designed driver should not have any of the following problems:

- 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: There should be no drop-out, so the light should only turn off when the switch is turned off. This can be achieved

Table 1



by utilizing the low-end trim settings available on many wallbox and system level dimmers to ensure that the lights remain on at their lowest light level at the bottom of the dimmer's travel.

- Dead-travel: Adjusting the control without a corresponding change in light level is undesirable.
- Audible Noise

Selecting the number of fixtures or lamps per dimmer. The number of lamps able to be installed on a single dimmer may seem like an easy question to answer. However, it is not as simple as looking at a 600-W dimmer and dividing 600 by the 10-W LED lamp to determine that 60 lamps can be used on a circuit. While the LED lamp may only draw 10 watts continuously, it may have a start-up inrush current or repetitive current during every half-cycle that makes it appear much worse. Neglecting this transient current can put significant stress on the dimmer and can cause premature product failure or undesired system performance (such as excessive noise).

A minimum number of fixtures may be required to operate a dimmer because of the 25-W to 40-W minimum load that most incandescent dimmers require to operate correctly under all conditions. When using incandescent bulbs, the minimum load requirement is easily met with usually only a single bulb. However, with LEDs, four or more loads may be needed on a dimmer in order to meet the required minimum load.

Another common problem with LED system operation involves overloading the driver. LED drivers are rated for a maximum load (in volts, amps, and/or watts) that must not be exceeded. Similarly, some LED drivers may not perform well if too little load is put on them.

Control types. Control technology is a term that refers to the signal and wiring between the control on the wall and the fixture or lamp. LED retrofit lamps generally only use forward or reverse phase control methods. LED fixtures may use any method, and it is independent of the driver type.

The compatibility of a dimmer with a particular LED fixture begins with making sure they both use the same control method. These control technologies are used in stand-alone applications and control systems as well as in wired and wireless lighting control systems. Controls that use phase control to control a lamp may also use a wireless technology to communicate between loads or within an entire home lighting control system.

THE PROOF IS IN THE TEST

The only way to know for sure if a particular LED lamp or fixture will work with a particular dimmer is

to test it. Whether that testing is a mock-up or testing by the manufacturer, it is necessary to determine if negative behavior, such as flicker, pop-on, dead travel, etc. will occur. Keep in mind that you will not be able to visually determine what the inrush current of an LED product is so you must find out from the manufacturer or limit the number of lamps you are using to avoid overloading the dimmer.

Many manufacturers (both LED luminaire manufacturers and control manufacturers) conduct compatibility testing of their products. It is up to you to determine if that manufacturer's assessment of "good dimming" will meet your customer's needs.

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eye on THE BOOMERS

BY EUNICE NOELL-WAGGONER AND ROBERT J. DUPUY

As design and development professionals juggle the increasing regulations caused by our society's conviction to decrease energy use, we are challenged to find ways to meet the growing number of requirements and, at the same time, the needs of low-vision users.

The special needs of older people and young people with low vision were the focus of a two-day meeting convened in Washington, D.C., in September 2010, which we attended. "The Workshop on Improving Building Design for Low Vision Persons" was organized by the U.S. General Services Administration and the National Institute of Building Sciences. "Low vision" is defined as "chronic visual impairments that cause functional limitations or disability."

The goal of the workshop was to begin the process of having low vision included in the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA) to allow equal access for the 38 million Americans age 40 and older with vision problems. But don't hold your breath—this will not happen over night. There is much work that needs to be done before low vision is part of the ADA and the ABA.

Some controls are simple and others beyond complex. This also applies to the environments that serve the low-vision and elderly segments of the population

Currently, the ABA requires federal buildings or all buildings built, remodeled or leased with federal funds to accommodate the needs of workers to do their job. However, it does not require that they be able to find their way to their office, the restroom or the cafeteria. The ADA does address the needs of people who are blind, but not the partially sighted.

This workshop brought together participants from the fields of medicine (specialists in ophthalmology and low vision), architecture, engineering, interior design, lighting design, professional associations, government, academia, advocacy, research and development, and federal agencies, including the Access Board (the gatekeeper of the ADA).

The low-vision workshop came about through the efforts of the GSA's Vijay Gupta, who knows first-hand the problems that he and others with low vision experience. It is encouraging to have members of ASHRAE concerned about people with low vision and the problems they experience when lighting levels are adjusted downward to comply with energy restrictions.

SHORT-TERM STRATEGIES

Having low vision included as a qualifying disability in the ADA regulations will be a real game-changer, but until that happens, we need to develop strate-

gies to provide adequate light levels and a visual environment that meets the needs of people with low vision without exceeding the energy code.

Sometimes it seems to be a daunting task to comply with all the building and energy codes that are required to build or remodel. Add to that list the growing requirements to implement lighting controls as part of the design process. As the nation grapples with how to save energy, controls have floated to the top of the pile of solutions. Some controls are simple and others beyond complex. This also applies to the environments that serve the low-vision and elderly segments of the population. Let's take a quick look at what all of this means.

In simple terms, it means finding some way of turning off lights that are not needed or dimming lights when sufficient daylight is present. An example would be night lighting in a senior community or an office building. Do all the corridor lights have to be on at full output all night or when no one is in the space? In these areas, controls can indeed make the greatest impact. In multiple-lamp luminaires it is fairly easy to control lamps independently either by automatic dimming or step dimming. Even downlights can have multi-step control with one lamp on and one off or automatic dimming. The main thrust of controls should be to save energy while still providing adequate lighting. It is clear that control regulations will continue to grow to the point where they are the norm.

To provide for the needs of low-vision people, it is best to understand how controls work and where they are best suited. It is also clear that there may need to be some exemptions for areas frequently visited by those with aging eyes, such as parking garages. We urge you to view lighting controls as a creative opportunity and find ways to meet the requirement and the needs of users at the same time.

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