



Guideline for **the Application of General Illumination ("White") Light-Emitting Diode (LED) Technologies**

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Prepared with support from
**The US Department of Energy's (DOE)
Solid State Commercialization Program**

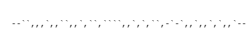


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should be directed to IES

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1.0 INTRODUCTION

1.1 General

Rapid progress in lighting technology research and development is resulting in general illumination, “white light” light emitting diodes (LEDs) that are approaching, and in some cases surpassing, the performance of traditional light sources. LEDs, however, differ from traditional light sources in important ways. Consequently, it is critical that designers understand LED properties and performance, and how these attributes provide both advantages and challenges for various lighting applications.

This Guideline is not intended to promote the use of LED or any other technology above another beyond its own natural characteristics. This guideline has been specifically prepared to provide information needed for users to be able to make rational decisions when considering LEDs as a lighting design option.

The aim of this Guideline is to provide lighting and design professionals a general understanding of LED technology as it pertains to interior and exterior illumination, as well as useful design and application guidance for effective use of LEDs. Specifically, the guideline addresses:

- LED technology and lighting performance;
- key differences in measurement methods for LEDs compared to traditional sources;
- attributes unique to LED that may provide advantages over traditional light sources in some applications
- LED application challenges that should be evaluated to ensure successful lighting designs and promote end-user satisfaction.
- Task based design guidance for general lighting applications, as well as specific space and building types where LED technology can be effectively applied.

Note that LEDs are frequently used to provide color accents and color-changing effects for indoor and outdoor lighting; however, these established applications are outside the scope of this document.

1.2 Background

LEDs have been used since the early 1960s for a variety of color signal and indicator applications. In the past few years, LEDs have made serious

advances in the general illumination market by refining white LEDs, and incorporating these sources into general illumination luminaires.

Some currently available LED products perform very well, but the quality and energy efficiency of LED products available on the market varies widely for several reasons:

- LED technology continues to evolve very quickly, with revised and improved LED devices introduced regularly.
- LEDs have particular thermal management and electrical requirements, making their integration into lighting fixtures a challenge. Although successful products exist, many early examples indicate that luminaire manufacturers face a steep learning curve in applying LED technology.
- The unique properties of LEDs reveal gaps in the industry standards and test procedures that underpin all lighting product comparisons and ratings. Appropriate Industry available standards, test procedures, and ENERGY STAR criteria are currently available and more are in development.¹ However, because these comparison aids and rating systems are new, and testing and evaluation of products takes time, useful information on all products may not be readily available. Without this data, accurate comparison can be difficult, but is nonetheless a critical part of the successful design process.

1.3 LED Technology Basics

LEDs are electronic semiconductor devices, also referred to as solid-state lighting (SSL) devices. In contrast, incandescent, fluorescent, and high-intensity discharge (HID) technologies are all based on a glass envelope (i.e., bulb) containing a filament or electrodes, with fill gases and bulb coatings of various types.

LED lighting (See **Figure 1**) starts with a tiny diode (most commonly about 1mm²) comprising layers of semi-conducting material. LED packages may contain one diode or multiple diodes, mounted on heat-conducting material and usually enclosed in a lens or encapsulant.

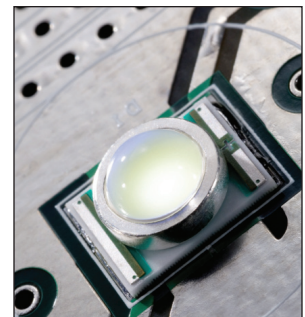


Figure 1 – LED Device

¹ IES RP-16(a) LED definitions, IES LM-79 (electrical photometric testing) and IES LM-80 (lumen depreciation) available from www.iesna.org/store. C78.377 (“White” LED color specification) available from www.nema.org/stds. ENERGY STAR criteria available from www.ssl.energy.gov/energy_star.html.