LED MR16 Lamps: By the Numbers and Beyond

by James Brodrick

While they have carved out some market share, LED MR16s still face stiff competition from conventional halogen products

The MR16 lamp is the darling of lighting designers, not only because of its optical precision, but because it comes in a wide range of wattages (from 20-75 watts) and beam angles (from 7-60 deg) and can be used with various accessories (e.g., spread lenses)—which means that a single MR16 fixture can be customized in dozens of different ways. That's one reason why MR16 lamps are mainstays in retail, hospitality, residential and museum settings, where they're used in track heads, monopoints and recessed downlights.

According to the 2013 U.S. Department of Energy (DOE) report *Adoption of Light-Emitting Diodes in Common Lighting Applications*, LED MR16s had the highest penetration rate (about 10 percent) of all LED lamps in 2012, and they certainly haven't slipped in popularity since then. But conventional halogen MR16s—which have good color quality and work well with controls—make for formidable competition, and their LED replacements still have a number of issues. That's why DOE has launched a series of investigations into LED MR16 performance, to see what the numbers show us and what we can learn by looking beyond those numbers.

WHAT THE NUMBERS SHOW

A *Snapshot on LED MR16 lamps*, released earlier this year by DOE's CALiPER program, analyzed data on the LED MR16s listed with DOE's LED Lighting Facts program. Results showed that despite considerable improvements in performance, few of the LED MR16s could be considered true one-for-one replacements for a 12V/50-W halogen MR16—despite no shortage of manufacturer claims stating otherwise. An increasing number of LED MR16 lamps were comparable in lumen output to 12V/35-W halogen MR16s, but a doubling in mean lumen output of LED MR16s over the previous four years was accompanied by only modest gains in mean efficacy. Few of the LED MR16s reporting center beam candle power (CBCP) met the Energy Star CBCP requirements for a 35-W or 50-W MR16 halogen, while only one product that reported beam angle claimed it was less than 15 deg—even though narrow-beam accent lighting is a common use for MR16s. As for CRI, 83 percent of the LED MR16s were in the 80s, with about 10 percent exceeding 90.

More recently, CALiPER released an *Application Summary Report* that focused on the photometric performance of 27 LED MR16 lamps, targeting three specific types. Among 3,000K lamps that had an output of at least 500 lumens or claimed to be at least equivalent to a 50-W halogen MR16, the test results showed that despite across-the-board performance improvements, such products still don't match the lumen output and CBCP of typical 50-W halogen MR16s—and in fact, most didn't even match a typical 35-W halogen MR16. Most of the LED MR16s had a CRI in the low 80s—generally acceptable for ambient lighting but not always for focal lighting—but those with a CRI of 90 or greater performed comparably to the rest of the tested products on other parameters, despite the fundamental trade-off between CRI and efficacy for typical LED packages. None of the LED MR16s with a beam angle less than 15 deg had an output of 500 lumens or greater, a CRI of 90 or greater and an efficacy greater than

Photo: George Gruel

This renovation features 2,700K LED MR16 lamps from Soraa and Dauer, housed in integral module recessed linear lighting at the kitchen cabinets and as replacement lamps in adjustable recessed fixtures in the family room.

60 lumens per watt—a combination that would give them a big leg up over their halogen counterparts.

Although LED MR16s producing up to 600 lumens are widely available—a big improvement over earlier studies—every lamp tested that claimed equivalency to a specific halogen-lamp wattage emitted fewer lumens and had lower CBCP than would be predicted using the Energy Star center beam intensity tool. And while all of the LED products tested were more efficacious than the halogen benchmarks, the range in efficacy was quite large (38-90 lumens per watt). What's more, it was difficult to find LED MR16s that had a narrow distribution, with only five in the CALiPER group having beam angles between 7 deg and 18 deg—though even narrower distributions would make such products attractive for more applications.

BEYOND THE PHOTOMETRY

CALiPER plans to conduct additional testing on these same lamps, to cover characteristics that aren't captured by LM-79 testing, with the results to be published in subsequent reports. That's because photometry doesn't tell the whole story. For example, one of the issues LED MR16s face is transformer compatibility, which can result in flicker and other kinds of odd and unwanted behavior. Halogen MR16s operate at 12 volts, which provides optical precision by allowing them to have a small filament but also requires a transformer to reduce the incoming 120 volts. There are two types of transformers currently in use, magnetic and electronic, and while LED MR16s tend to work better with magnetic transformers than with electronic ones, both types can cause problems. The best thing to do is check with the lamp manufacturer about transformer compatibility, although not all manufacturers supply this information. Adding a dimmer to the mix complicates the compatibility question even further, but more and more LED lamp manufacturers are providing dimmer-compatibility information.

Another issue is color, which can't be nailed down using CRI alone, because two MR16s with the same CRI but different spectral power distributions can make the same shade of white (or any other color) look very different—so trying the lights out for yourself is the only way to tell for sure. And size is yet another problem; some LED MR16s are too large to fit into existing fixtures, because it's not easy to fit all of the electronics an LED lamp requires into such a small form factor. Then there's the backlight emitted by halogen MR16s, which looks appealing in some applications, but which most LED MR16s don't duplicate because of the directional nature of LEDs.

The bottom line is that LED MR16s have come a long way and offer much higher efficacy than their halogen counterparts, not to mention color quality that ranges from good to excellent, but they vary considerably from product to product and still face a number of issues, so buyers and specifiers need to evaluate each product based on its own merits and the requirements of the application.

DOE's growing collection of reports and analysis on LED MR16s, plus a video and Fact Sheet on the topic, can be found at *www.ssl.energy.gov/led_mr16_lamps.html*.

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