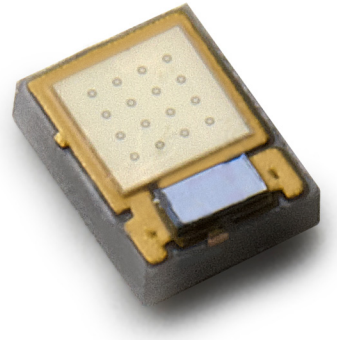
LUMILEDS

WHITE PAPER

Evolving LED Package Designs

Provide a new level of luminaire performance and design flexibility.



Introduction

The entertainment lighting market was one of the early adopters of LED technology. Initially used as accent lighting, LED-based solutions are now used throughout the market, across a variety of applications. The ongoing adoption of LEDs in the entertainment lighting market has been driven by a number of factors (e.g. increasing output, efficiency, color offerings and cost improvements) but one aspect that has had a particularly positive impact is the evolution and diversity of LED packages.

The question is "What is the next LED package design?" and "What will it enable for new applications and performance?"

LED devices provide a robust, directional light source that fixture designers have been able to apply to a number of entertainment lighting applications. Originally, most LED-based fixtures utilized what is commonly known as 5mm packages. This package supported a variety of beam control options and enabled some of the first wash and LED video display solutions. As designers targeted more mainstream, higher output applications such as LED PAR and linear border lights, however, higher power (1 Watt) devices were used. The market continued to evolve and the need for better beam control, color uniformity, and broader gamut support started to challenge the LED device package designs, leading to multi-chip, multi-color packages which delivered better lumen density and color variety.

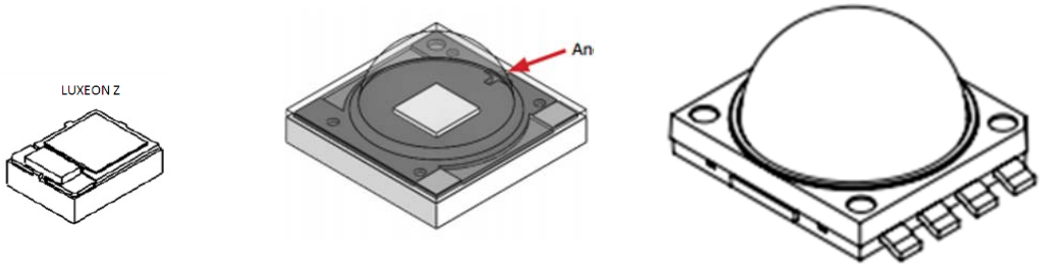


Figure 1. LUXEON Z compared to existing solutions in the industry.

So back to the first question of "What is the next LED package design?" When you poll the market to understand what features are desired for next-generation entertainment fixtures, you hear comments like "higher output, single-point color-changing, broader color gamut as well as a collimated output." Delivering any one of these features is fairly straight forward with conventional device technology, but when you begin to combine these requirements into a single system requirement, things become challenging.

Consider "single-point color-changing", which means that the perceived point where the color changing occurs is a single point. Present system architecture designs address this with multi-chip, multi-color LED devices. Traditionally these are 2x2 configurations of dies that can be run at 2–3 watts per die. This package architecture is limited in that you can only support up to four separate colors (one color per die) and the perceived source size based on the die-spacing and primary optics can be large. While multi-In addition, accommodating multiple feature requirements presents many other challenges. For instance, while the goal of higher light output is addressed with multiple source, the package and optics size that comes with this design (the spacing between each source/optic sub-system can be on the order of 1 to 2 inches center to center) detracts from the other important goal of having a single point of color change. Add on the other needs of broader gamut support and collimated output, and the system easily becomes even more complex.

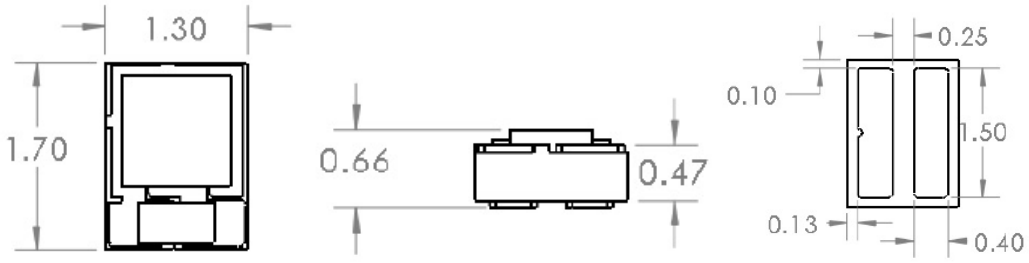


Figure 2. LUXEON Z package dimensions in millimeters.

As a result, the LED package solutions in the market now become a limiting factor as designers strive to deliver on these new requirements. The package options evolving in the market typically push to scale up the package, adding either more die or increasing the size of the die itself. This can address the needs but the packaging becomes very specialized and potentially costly. And although the entertainment lighting market can be less sensitive about price compared to the consumer or commercial markets, cost improvements are still appreciated.

Another option then is to look at the needs from more of a building-block perspective, namely, reducing the size and simplifying the package. This new package design allows you to closely pack the devices so as to achieve high lumen density, while providing a broad color offering to support various mixing combinations for broader gamut support. The expanded color offering coupled with the improved lumen density also results in a new level of color density.

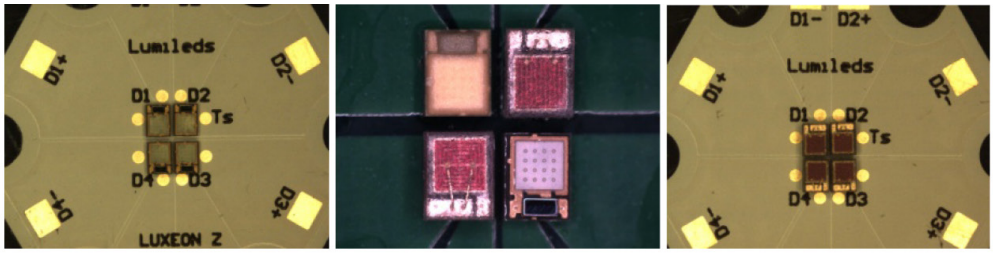


Figure 3. Building block examples demonstrating design flexibility.

Considering the question of what this new package design will enable for new applications and performance, it will provide designers a new level of design flexibility. From a lighting effects standpoint, but also from a fixture design and manufacturing flexibility standpoint, new designs are just a board layout away. This building block approach could support a linear configuration of mixed colors with color spacing as close as just 2mm. This could provide, in terms of direct view lighting effects, a 1 inch color-changing segment that can have multiple colors. It could also be coupled with an optic to provide a very granular, color-changing wash effect. Another approach would be to densely pack multiple "building blocks" into an array configuration to create a high lumen and color density source that could be coupled to a collimating and mixing optic to provide a single color changing point with a collimated output.

In the end, instead of trying to scale the package to higher outputs and color options, which in turn only specializes it, a building block approach provides more flexibility by staying with a simple, cost-effective package, the system cost is also not impacted as you scale.

About Lumileds

Lumileds is the global leader in light engine technology. The company develops, manufactures and distributes groundbreaking LEDs and automotive lighting products that shatter the status quo and help customers gain and maintain a competitive edge.

With a rich history of industry "firsts," Lumileds is uniquely positioned to deliver lighting advancements well into the future by maintaining an unwavering focus on quality, innovation and reliability.

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