“SMT Lamps”: Merging Through-Hole and Surface-Mount LED Technology

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Over the last 15 years, through-hole LEDs have dominated the market of high-brightness LEDs for outdoor video wall applications. Because of their highly reflective design with primary optics, it was difficult to replace them with SMT LEDs if video wall manufacturers wanted to streamline their assembly and manufacturing process. Over the last several years, this technology has evolved with the arrival of an innovative package platform, the SMT Lamp, which combines the benefits of the two LEDs. This article looks at the advantages of this new SMT Lamp package.

Through-hole LEDs, or LED lamps, are widely used in outdoor applications because they offer several benefits over conventional surface-mount (SMT) LEDs. LED lamps are brighter, can be as clear, come tinted or tint-diffused for higher contrast ratios, and have a wide range of different primary optic designs.The last point makes through-hole LEDs quite unique for outdoor applications because of regulation by local laws in some cases. For example, EN12966 requires well-defined viewing angles in variable messaging sign applications, like traffic information panels. With their primary optics, LED lamps are the best choice in terms of brightness, definition and controlled viewing angle.

Conversely, a disadvantage of conventional LED lamps is the mounting and processing of these components during assembly. As an example, through-hole LEDs are mounted on a PCB through auto-insertion machines. After assembly, the PCB is put through a wave soldering machine, preheated and touched by a wave of hot solder to create electrical connections. This must be the last step in the production of a board with through-hole LEDs. Any surface-mount components (such as driver ICs, resistors, microcontrollers, etc.) have to be reflow-soldered before the LEDs are inserted and then sent through the wave soldering process. This significantly complicates the manufacturing process and cycle time, adding cost to the final product.

Additionally, the board space for SMT components is limited, as they must be mounted on the upper side of the PCB to avoid damage or short-circuits during wave-soldering, which further complicates manufacturing.

In contrast, boards populated with SMT LEDs can be processed and reflow-soldered in one run, because SMT LEDs are suitable for reflow-soldering. This helps to avoid mechanical stress to the board assembly, accelerates the production cycle, and saves cost on connectors, cables and frames. However, there are tradeoffs in choosing SMT technology. SMT LEDs come in a limited range of packages and viewing angles, as is the case with conventional plastic leaded chip carrier (PLCC) packages. For example, previously tinted LEDs with an oval radiation pattern could only be found in through-hole LED packages.

The recent development of the surface-mount lamp (SMT lamp) package has provided designers a new tool that unites the benefits of through-hole and SMT LED technology while reducing the tradeoffs.

Figure 1: Through-hole and SMT LED technologies have merged in the new SMT lamp package

As an example, the Avago SMT lamp package shown in Figure 1 has a thermal resistance (junction-to-pin) of 130K/W, which is comparable to surface-mount PLCC-4 LEDs (110K/W), and it delivers high brightness performance on the same level as through-hole LEDs.

PLCC-4 LEDs have been preferred for outdoor display panel applications due to their primary optics, but SMT lamps offer an advantage here as well. Conventional PLCC LEDs are made from two different kinds of plastic whose thermal expansion coefficients can be slightly different, leading to small gaps between the housing and encapsulant over time. For outdoor display applications requiring high-reliability, additional protection against water ingress is considered mandatory. SMT lamps are made from a single plastic package material (epoxy), which protects the LED package from water ingress just as with through-hole lamps. Thus, SMT lamps provide an optimal solution for outdoor applications that eliminates the need for additional covers, aside from the coating of the leads to avoid corrosion and short-circuits.

Now let’s consider optical performance. SMT lamps can also be manufactured with a wide range of primary optics because the package uses a reflector made from shiny metal, similar to through-hole lamp technology. The first SMT lamps to hit the market offer the most popular viewing angles. For variable messaging signs (VMS),

the commonly used viewing angle is 30° round, because it is compliant to EN12966. For outdoor full-color video walls, the most widely used viewing angle is an oval one with a 40° x 100° radiation pattern (40° in vertical, 100° in horizontal direction). LEDs with a wide viewing angle in the horizontal direction are widely used in video screens in sporting arenas and media displays for concerts.

Due to the small package outlines of SMT lamps, it is possible to achieve a small pixel pitch down to 12mm (RGB or RRGB), as is shown in Figure 2. This is comparable to displays based on discrete through-hole or surface-mount LEDs (one color per package).

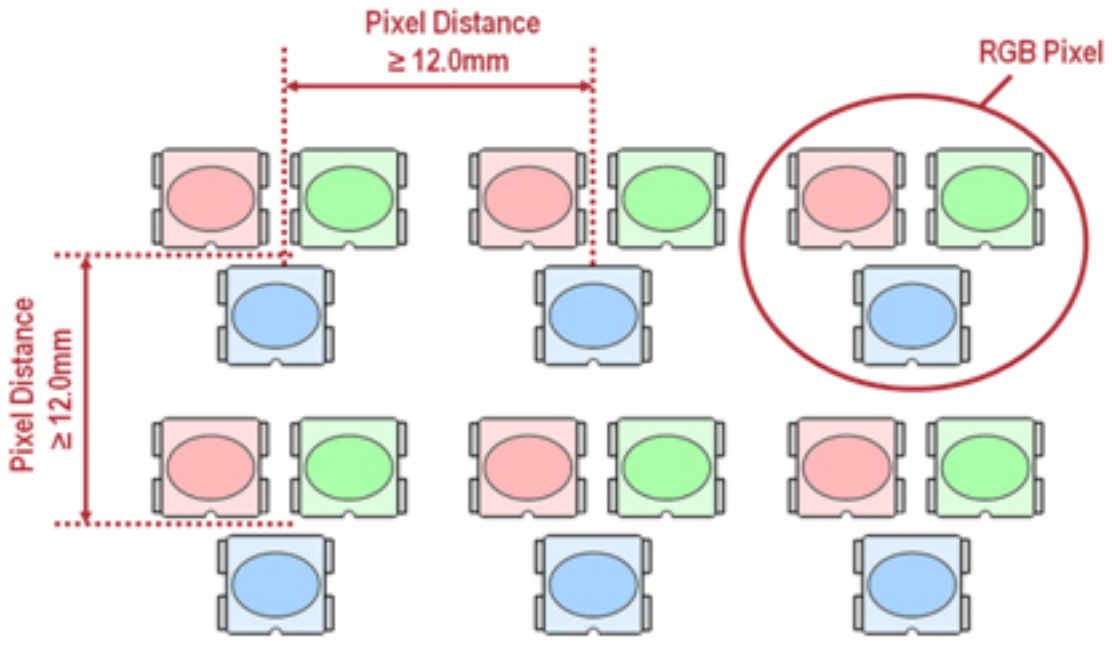

Figure 2: Achieving 12mm RGB pixel pitch with SMT lamp packages

Full-color video media displays such as the one depicted in Figure 3 can be found with various resolutions, depending on target usage (e.g. sporting arena, video façade, concert, etc.). With 12mm pixel pitch, for example, concert attendees and sports fans viewing an event will have the impression of a perfect video picture starting from a distance of 12m to the screen.

Figure 3: An LED-based full-color video media display enhancing the sporting arena experience

The merger of through-hole and surface-mount LED technologies gives designers the opportunity to optimize overall display panel designs. First, as with through-hole lamps, SMT lamps are also designed for harsh ambient conditions. For example, the robust epoxy material used in Avago SMT lamps is resistant to sunlight and supports a wide operating temperature range from -40°C to +85°C. This means SMT lamps can be used in various places and operational environments around the world, delivering similar performance and reliability when compared to their through-hole counterparts. Second, SMT lamps have a small height of 3.4mm (from pin to primary optics), which saves up to 2mm of potting material height when compared to messaging panels made from conventional through-hole LEDs with stand-offs. This small 2mm savings adds up to be significant, as it saves 120 liters of potting material on a 60m² LED screen. This reduction lowers system-level thickness and weight, helping to achieve potential cost savings on the screen’s mechanical supporting structure.

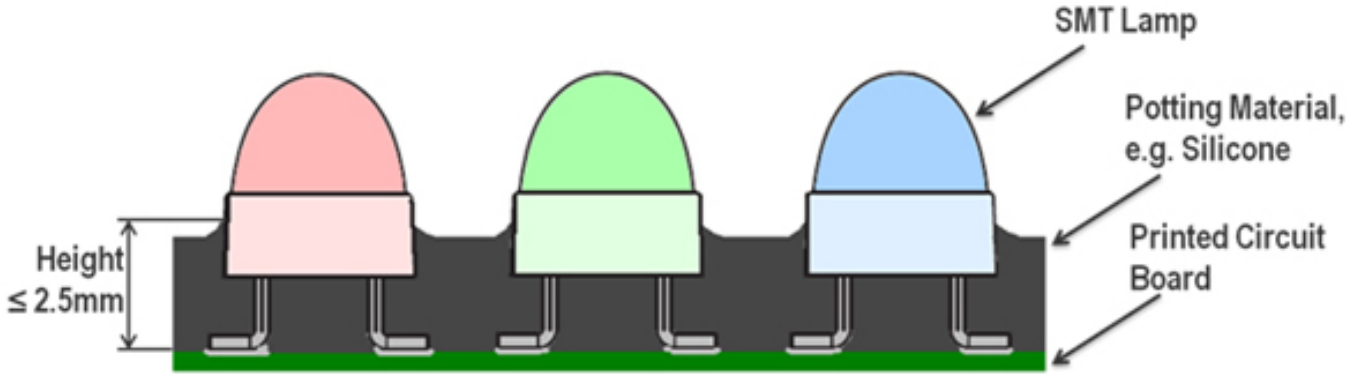

Figure 4: The reduced amount of potting material required for SMT lamps adds up

Another advantage of using SMT instead of through-hole lamps is that multilayer PCBs can be utilized to make more compact board designs. This is accomplished by distributing the electrical connections across multiple layers within the PCB.

SMT lamps can be reflow-soldered just like conventional surface-mount LEDs. The package is designed to support a production floor life of up to 4 weeks at < 30° C/60% RH before soldering, without absorbing a critical amount of moisture into the package (meeting MSL 2A specifications according to JEDEC). After the LEDs have been removed from the moisture barrier bag, the reel can be inserted into a pick-and-place machine which automatically populates the PCB. As with any SMT component, designers should use the nozzle tip specified in the datasheet for the pick-and-place process. This helps ensure optimal optical performance in the application. After mounting, the LEDs can be reflow-soldered at a temperature of up to 260°C for 10-30 seconds (acc. to J-STD-020), as is shown in Figure 5. Again, this is comparable to other surface-mount LED components.

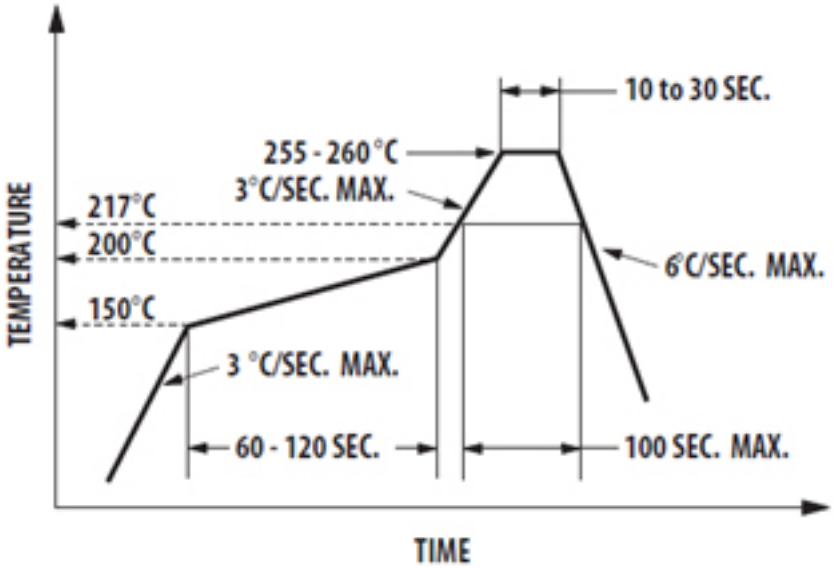

Figure 5: SMT Lamps can be efficiently reflow-soldered at temperatures up to 260°C

For indoor and outdoor electronic signage, SMT lamps offer the best benefits of two technologies, with the superior brightness of through-hole LEDs and the simplified manufacturing of SMT LEDs. This new package platform can help designers streamline production processes, save cost and accelerate the manufacturing of media and traffic information video panels.

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