Lighting the way: LEDs in SMT production

Zachery Shook, Count On Tools, Inc., Gainesville, GA, USA

With demand growing for LEDs in consumer and commercial electronics, companies in the surface mount technology (SMT) industry are expanding their manufacturing capabilities to meet it. The range of new and potential applications for LEDs in electronics is practically endless. In order for electronics manufacturers to get these LEDs into their products, they must use one of two methods: hand assembly or automated assembly. This article discusses the challenges that EMS companies face when trying to place LED components in SMT production.

Recent growth in LED technology and solid state lighting has provided the electronics manufacturing industry with viable solutions for its addition into today's electronic devices. LEDs have become an alternative light source to conventional incandescent and fluorescent bulbs. The electronics manufacturing industry sees the greatest benefits from the small size and lower power consumption of today's LEDs.

There also is the recent trend to "go green" and use "green technology" in consumer and commercial electronics. LED components offer high brightness and power efficiency for electronics manufacturers. LEDs also offer lower carbon emissions than traditional technologies such as incandescent and halogen lighting. This aspect has made LED lighting popular with government organizations, which are now installing LED lighting in public places and government offices worldwide.

When used for illumination purposes, LEDs are more cost-effective than traditional lighting sources. Thus, the global LED component market is witnessing an increasing demand. As a result, companies in the surface mount technology (SMT) industry are expanding their manufacturing capabilities to meet this demand. High brightness LED components currently are experiencing high growth as the backlighting application in TVs is shifting from traditional CCFL technology to LED technology. The range of new and potential applications for LEDs in electronics is practically endless.

In order for electronics manufacturers to get these LEDs into their products, they must use one of two methods: hand assembly or automated assembly. Hand assembly

is where skilled technicians carefully place individual LED components onto circuit boards using specialized tooling. This is a long, tedious process that can slow the production rates of electronic devices and tie up major labor resources. On the other hand, automated assembly uses the company's existing SMT equipment to quickly and efficiently place thousands of LED components every hour. Most SMT equipment is capable of placing multiple components on a circuit board at one time, increasing the overall production rates while decreasing labor costs. Obviously, the goal of a high-volume electronics manufacturing company would be to transition assembly into automated production.

No SMT equipment can place components accurately or run efficiently without quality nozzles and feeders. These two factors are the core of the pick-and-place process. If the machine is either unable to pick parts consistently or hold on to the components during the transport from feeder to PCB, defects will result. An increase in defects means a decrease in production, costing the company more money over a short period of time. Proper feeder and nozzle selection is critical, especially with the current market growth and technological advancements in SMT equipment.

At first sight, the principle of using vacuum pressure and precision nozzles to enable component placement are basic and straightforward. It is a process that is repeated in every type of SMT equipment. There are five distinct stages of the pick-and-place process:

1. Picking—components are withdrawn from a feeder or tray by a vacuum nozzle.
2. Holding—components are steadied for rapid movement while the machine detects proper alignment.
3. Transport—components are transferred from the picking location to the PCB for assembly.
4. Placement—components are lowered to their specific location on the circuit board.
5. Release—components are released by the nozzle, which returns to the picking area to restart the process.

Nozzles are the first and last thing to touch all components placed, and they move tens of thousands of these parts every hour. With components sizes reaching microscopic proportions, nozzle manufacturers must strive to maintain precision tolerances and exact dimensions in their designs. These nozzles are required to hold the part during transport to the board while the machine is moving and/or rotating at high speeds. Electronics manufacturing service (EMS) providers must use this technology to get LED components into their customer's products.

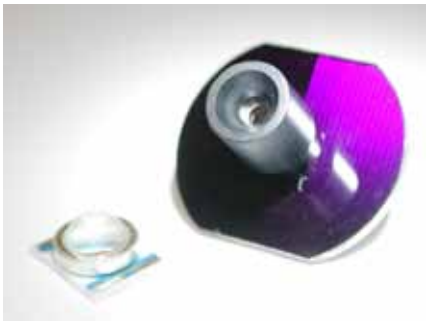
Debron Industrial Electronics, Inc., is an EMS provider specializing in high-technology electronic assemblies, printed circuit board assemblies, electronic wiring, cable assemblies and box build. The company caters to several customers specializing in cutting-edge LED technologies, who rely on Debron's expertise to develop, document, implement and sustain their manufacturing processes. When one of the company's customers needed a product that required the placement of LED components in its design, Debron decided to move forward with the automated assembly process.

Since making the transition, Debron has helped several of its customers to fully automate the production of products that previously had been assembled by hand. The company was able to do this by creating custom pick-and-place trays for LEDs that were available only in bulk for hand assembly. Debron also has been working with tooling companies such as Count On Tools to develop custom pick-and-place nozzles that enable LEDs to be picked, vision centered and placed with high-speed, automated SMT assembly equipment. Streamlining the automated placement process has allowed Debron to free needed manpower to use in other areas of the assembly process.

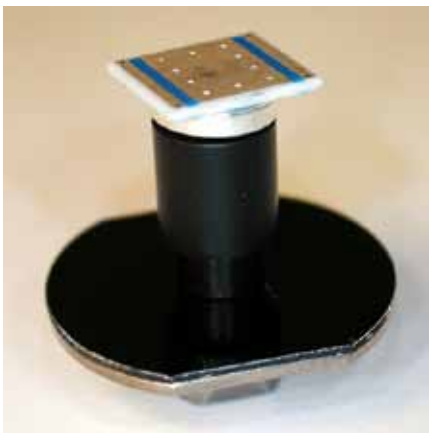
As with any new project, there are some challenges associated with the placement of LED components in the SMT production environment. It is the goal of the EMS provider to overcome each of these obstacles to cut production costs and provide quality product to its customers and their end users. Some of the major challenges that EMS companies face when trying to place LED components in SMT production include:

Component handling in the feeder.

During the picking process, LED components are withdrawn from the feeder by a vacuum nozzle. SMT technicians must ensure that the LED components are correctly positioned in the feeder pocket to guarantee that pick-up is achieved and that the LED is properly handled during the transport stages. Slop in the pocket may require nozzle centering during the picking process while excessively fast advancements of the feeder may skew the part in the pocket, preventing component pick-up.



LED nozzle.



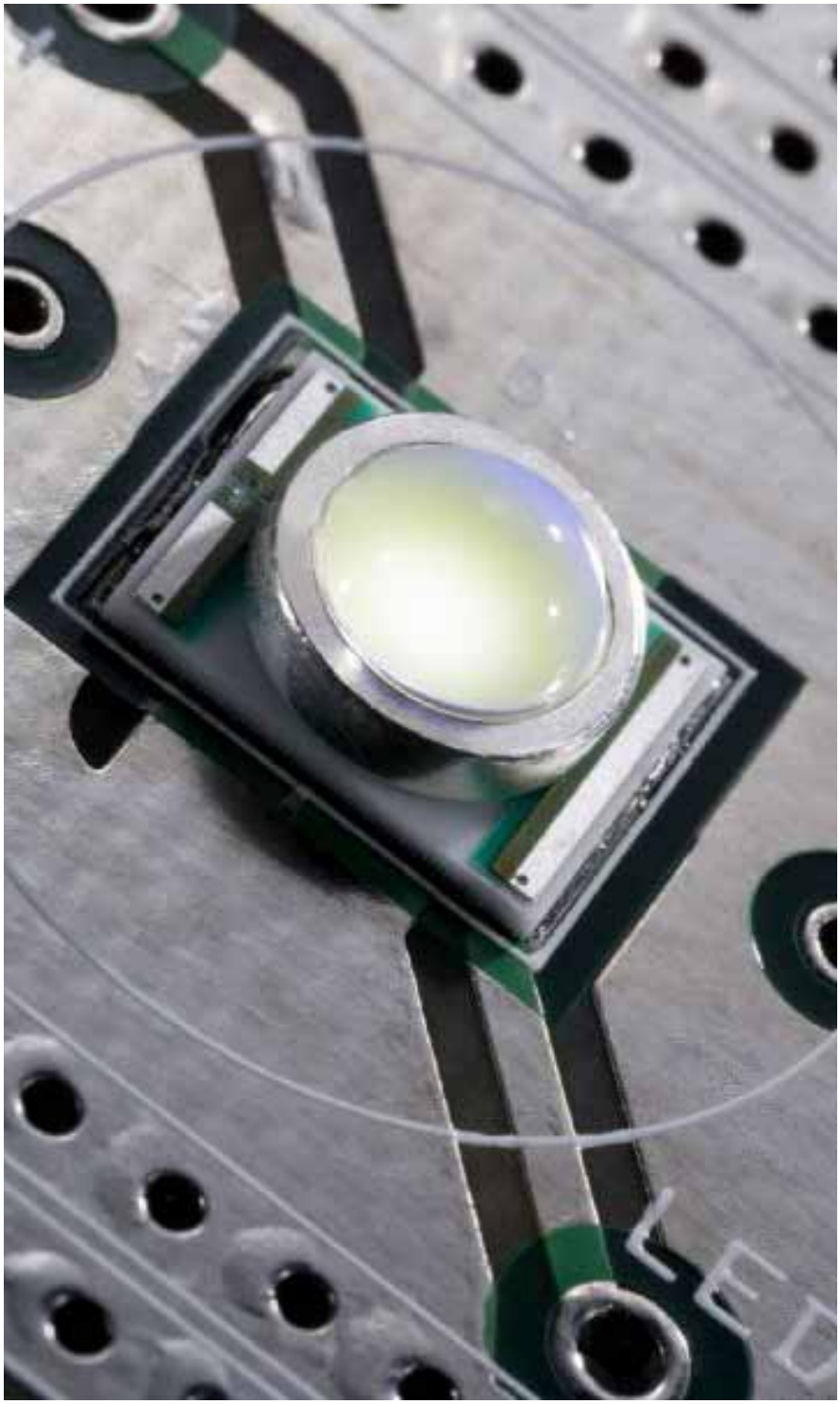
LED nozzle.

Component handling on the nozzle and proper nozzle selection.

Some LED technologies, such as CREE® LED components, require special handling operations to prevent damage to the optical lens. They must avoid placing mechanical stress on the LED lens by not touching the optical surface during the component picking or placement processes. This eliminates the possibility of degraded performance from the LED after the circuit board is assembled. Proper nozzle selection also is important for the transport and placement processes. Not only does the SMT nozzle have to pick the component, it also must move it to the board and accurately place it. Most LED suppliers work directly with nozzle and tooling manufacturers, like Count On Tools, to develop nozzle designs that meet their individual process requirements.

LED sensitivity.

The fragile optical surface is not the only issue with the use of LEDs in SMT production. Early LED designs were very temperature-sensitive, forcing assembly using unconventional methods, such as hand assembly. LEDs often were bonded to heat dissipative substrates using conductive epoxies or low-temperature solders. This



required special assembly processes that lengthened the manufacturing process, increasing product build costs.

Scaling up to high-volume production. As LEDs become more robust, assembly via means of more conventional assembly processes, such as automated SMT equipment, allows EMS companies like Debron to focus on other challenges, such as repeatable part picking and vision centering, as well as effectively increasing throughput and minimizing defects. Repeatable performance is the major challenge with scaling up to high-volume production. EMS providers must strive to maintain a high level of performance to keep their production on track to meet customer demands. This requires fine tuning the assembly process.

As with any problems in a production environment, there is always a solution. By capitalizing on its current knowledge of SMT production and partnerships with quality suppliers, Debron was able to overcome most of the challenges associated with this process. Debron developed custom trays for the LED components to allow for more accurate picking and transport processes while eliminating issues with component handling in the feeder. It also worked with its equipment manufacturers and custom tooling manufacturers such as Count On Tools, Inc. to develop custom SMT pick-and-place nozzles that increase LED/nozzle compatibility, allowing for greater placement accuracy and increased throughput.

Due to the partnership with Count On Tools, Inc., Debron was able to fine tune its automated assembly process and scale up to high-volume production of LEDs. Using the custom nozzle that it purchased from Count On Tools, Inc., Debron was able to reduce LED fallout to 2.3 percent. Defect rates dropped significantly and first pass yields increased steadily up to 99.4 percent.

The latest LED technology opens up wide areas for new applications, new technical possibilities and reduced costs in both the SMT and electronics manufacturing industries. Today, many companies are crossing traditional business boundaries and streaming into the LED lighting market. This, in turn, has created a large demand for LED use in general markets and not the traditional niche applications. By partnering with component manufacturers and nozzle/tooling suppliers, EMS companies like Debron can guarantee success by lighting the way for customers seeking LEDs in their SMT production.

Process Diversity in the LED Industry

The advantages of LEDs over traditional light bulbs turned a small signal element into a fast growing lighting industry. THT LEDs have been replaced by SMD LEDs, flip chips and COBs that can be produced and assembled automatically and at low cost.

Whether the LED product is a lamp, sensor, monitor or something else, it requires different manufacturing processes at high quality levels. Standard dispensing machines, pick-and-place systems, printers, soldering and curing systems often are not good enough. As a result, leading machine manufacturers such as Essemtec Switzerland have optimized production and assembly technologies to meet the special requirements of the LED industry.

Dispensing machines and valves often are used in LED production. From all available dispensing technologies, the Jet valve has proven to be especially versatile and useful. It features high accuracy, reproducibility, independency from thixotropic behavior and is a fully non-contact technology. Jet valves produce LED lenses or the phosphor encapsulation, dispense capillary underfill for flip chips, encapsulate modules, create protective coatings, dispense glue, and more. New valves such as the CDS-JET-DS30/32 from Essemtec can even dispense filled adhesives.

For LEDs and OLEDs, screen and stencil printers are used for solder paste or adhesive printing on PCBs. However, new applications also require the ability to build multiple layers or electrical connections on wafers, glass, foils and other substrates. This pushes the traditional squeegee pressure-controlled process to its limit. Therefore, Essemtec has developed a new printing method suitable for such demanding tasks: The exact control of the distance between the squeegee and the substrate. The reproducibility and accuracy of this process are better and it allows multiple layers to be printed precisely on top of each other.

In the LED Industry, the three most important quality specifications are LED position and alignment, and the integrity of the component and surfaces. This is important for all processes including placement, soldering and curing. The LED industry, therefore, requires specific process know-how and optimized machinery. It is advantageous to collaborate with a partner that can supply machines, process know-how, training and support from one source, such as Essemtec.

Essemtec's Real Turnkey Solutions simplify machine selection, making installation, education and support easier than with patchwork lines from different manufacturers. Essemtec develops and manufactures all machines, takes responsibility for all processes, and knows machines and technology.