Processing of OSRAM Opto Semiconductors LEDs

Application Note

This application note shows how radial and SMT LEDs can be processed, from the initial tape or reel to the soldering process.

Automatical SMT Assembly

The technology is heading the direction of pure SMT assembly, however, since the components are considerably smaller and can be assembled more quickly.

SMT LEDs are delivered in tapes on reels (Figure 1).

For the large selection of SMT LEDs available, please refer to the short form catalog of OSRAM Opto Semiconductors.

In order to guarantee the best possible mechanical and thermal characteristics for solder connections on standard circuit board substrates (FR4, FR2, CEM1 etc.) or metal core substrates, the design of the solder pad and the subsequent solder technique must be carefully considered.

To assist in printed circuit board layout, the recommended solder pad design for each LED type can be found in the associated data sheet (Figure 2).

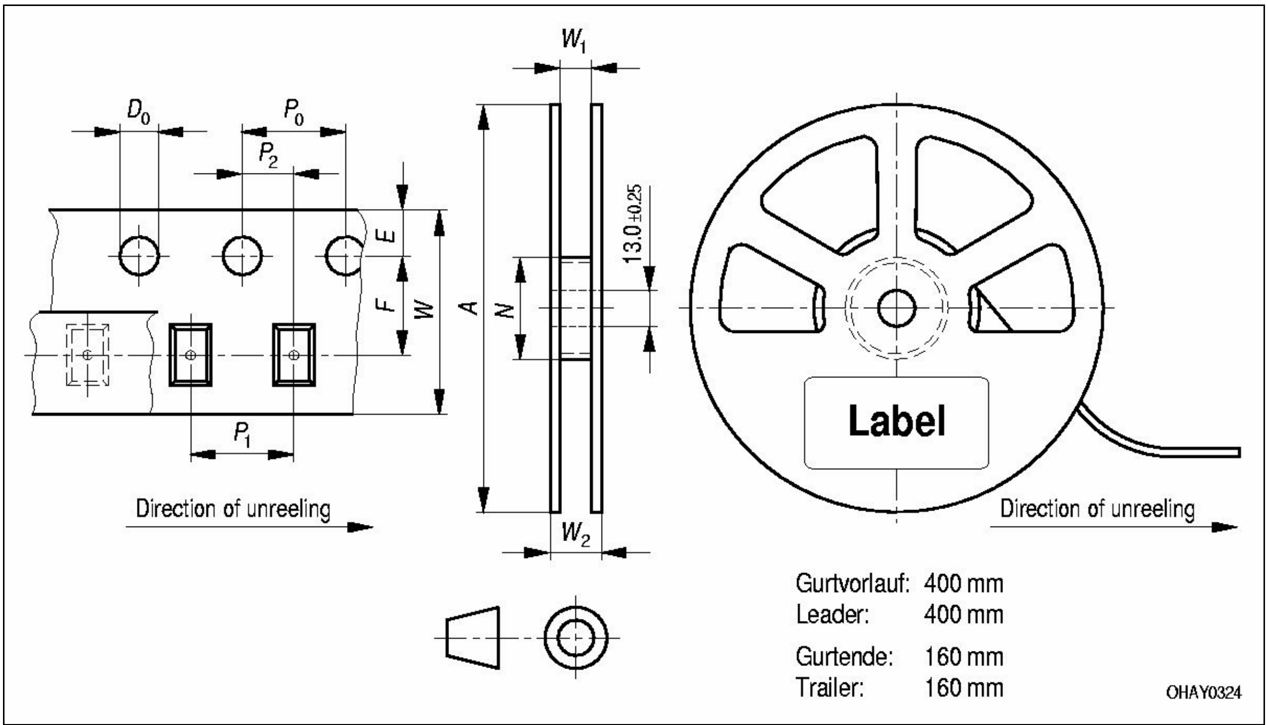


Fig. 1 Tape for SMT components, example

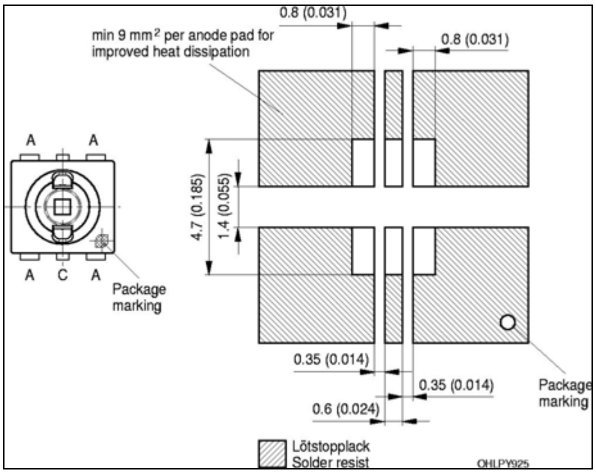
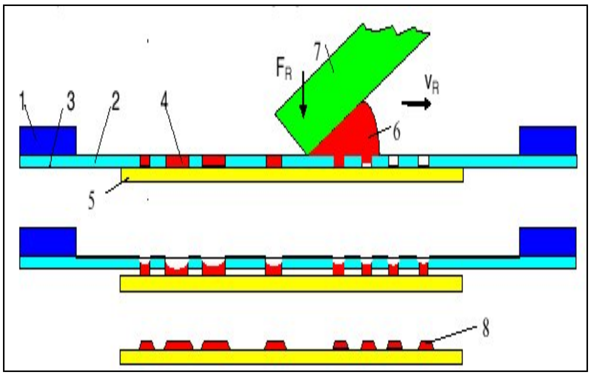


Figure 2: IR-solder pad design,
e.g.: the LA G67F (Advanced Power Topled)

SMT Process

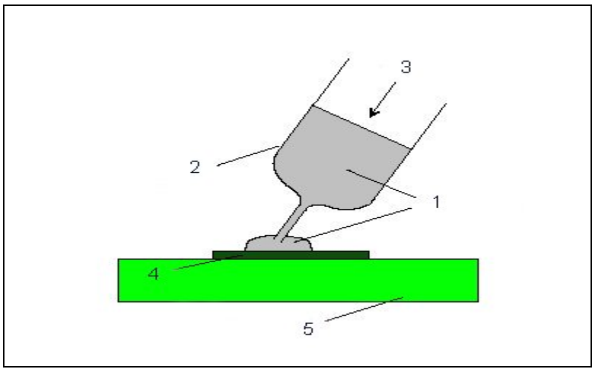
Prior to automated insertion of the LEDs, solder paste (Figure 3) is applied to the circuit board using a silk-screening process.



1-Printing plate
2-Stencil
3-Stencil mounting
4-Printing pattern
5-Substrate
6-Solder paste
7-Spreader
8-Printed pattern
V_R-Spreader speed
F_R-Spreader force

Figure 3: Model of paste application during silk-screening

As a rule, solder is applied in the form of a paste and consists of a mixture of solder beads and flux material. In addition to the application of the solder paste during the silk-screening process, specific components can be processed by means of a dispenser (Figure 4), similar to a syringe used for medical purposes. The amount to be applied is controlled by varying the air pressure and duration. This permits an exact amount of solder paste and adhesive to be applied.



1-Solder paste
2-Syringe
3-Air pressure
4-Solder pad
5-Substrate

Figure 4: Dispenser Model

The greatest advantage of SMT LEDs is that they can be assembled by high-speed pick and place machines (Figure 5). The LEDs are placed on the circuit board along with other SMT components.

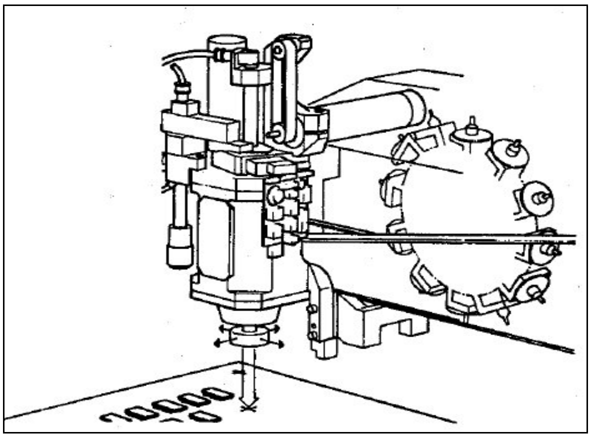


Figure 5: Pick and Place (Revolver) Model

The components are picked up from the tapes and placed on a revolver head. The LEDs are held on the individual pipettes by vacuum.
As the revolver rotates, the components are optically checked and to some extent, also electrically measured, aligned and finally placed on the circuit board.

Capacities of 10,000 to 12,000 components per hour can be realistically achieved with this approach.

In mass production and serial manufacturing, the SMT LEDs and other components are predominantly soldered using a reflow solder process.
The most widely used method is convection soldering.
The main advantage with this method is the even distribution of heat by gas, particularly when the gas is circulated (convection).
With this procedure, the components are heated, soldered and cooled in various temperature zones. For this type of forced convection, a mixture of air and nitrogen is typically used.

Infrared soldering is based on IR radiation in the range of 1 to 8µm. Low energy long wave IR is delivered by hot plates; short wave high energy IR is emitted by quartz radiators. In serial manufacturing, several preheated zones permit a thorough warming of the base material and components to around 150 to 160°C. The infrared radiators are located above and below the transport mechanism. In the melting zone, in which the solder paste becomes liquid, the heat supply is predominantly from above.
By varying the individual temperature zones and the speed of the transport mechanism, a typical temperature profile (Figure 6) is obtained which can be individually tailored to the base material and components employed.

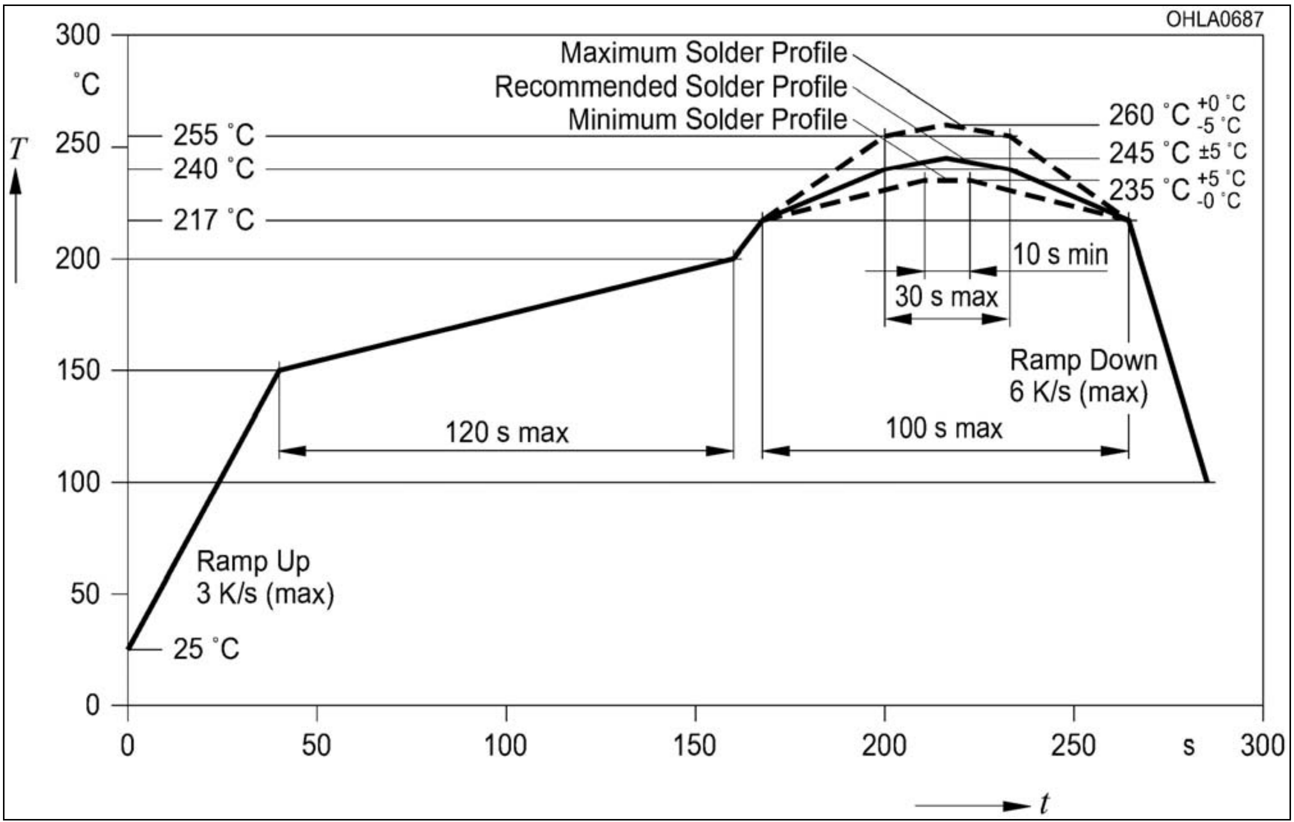


Fig. 6 Typical Reflow Profile for Lead Free Soldering

Better yet is heat transfer by vapor (Vapor Phase Soldering). This procedure is predominantly used in batch systems and is not used in serial manufacturing.

For wave soldering surface mounted components can also be mounted on the solder side. During the wave solder process, they are completely immersed in the flowing solder. This procedure requires the SMTs to be fixed to the circuit board prior to the soldering process.
In practice, epoxy resins can be used, which harden within two to five minutes under the influence of temperature (80-150°C). However, this technique requires a fairly involved double-wave soldering process and an appropriate solder pad design.

Hand soldering of SMT components

For demonstrators or rework hand soldering can be used. Soldering of SMT LEDs can be accomplished with normal techniques using a soldering iron and solder (lead-tin based now pb-free). A non-conducting adhesive should be used on the substrate in order to prevent component slippage during soldering. For high power LEDs, like e.g. the Golden Dragon a hand soldering process is quite difficult due to the necessary contact of the components heat sink to the external. For prototyping and mock-up it is possible to use a temperature regulated heater plate to warm up the module to solder temperature where the Golden Dragon will be placed.

Processing of radial LEDs.

This kind of LEDs are standard packaged in bulk and can also be optionally available in reels (Figure 7) or Ammopack (Figure 7) which are processed by the automated placement equipment.

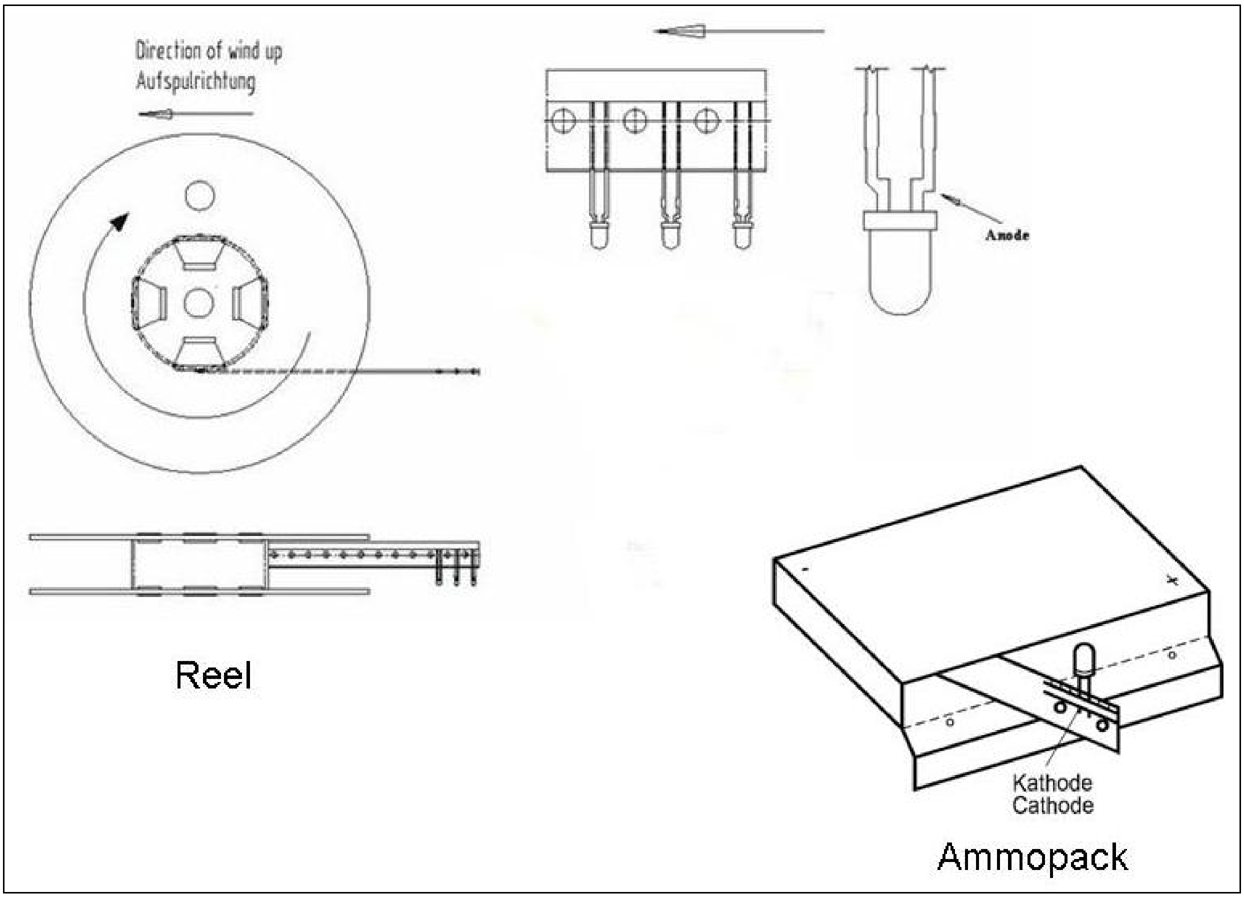


Figure 7: Reel and Ammopack for radial packages

Leaded LEDs are typically available in 3 and 5 mm (exactly 5.08mm) radial packages, as well as special Argus format.
Additional information can be obtained from the data sheet or short form catalog.

It should be noted that the LEDs remain in a rigid package (cardboard) up to the point of insertion in order to prevent bending of the leads during transport.

Automatic placement of radial LEDs

Processing occurs by means of axial automatic placement equipment, in which the leads are inserted into the holes of the printed circuit board, bent underside of the board and then cut. Components with a lead spacing of 5,08mm have the advantage that automatic placement devices can insert the component by grasping both leads; components with a lead spacing of 2.5 mm must be inserted by grasping only one lead, due to space restrictions.

If the leads are not exactly parallel in case of damage during wrong transportation, there is the danger that they will not align with the designated holes in the circuit board, resulting in errors during assembly.

In order to avoid errors when assembling components from bulk by hand, care should be taken to ensure that all LEDs are properly aligned with respect to the cathode or anode.

These leaded components are typically soldered by a wave soldering machine (Figure 8).

For circuit boards with leaded components, the solder can flow practically uninhibited around the lead ends (Figure 9) in order to create a good solder connection.

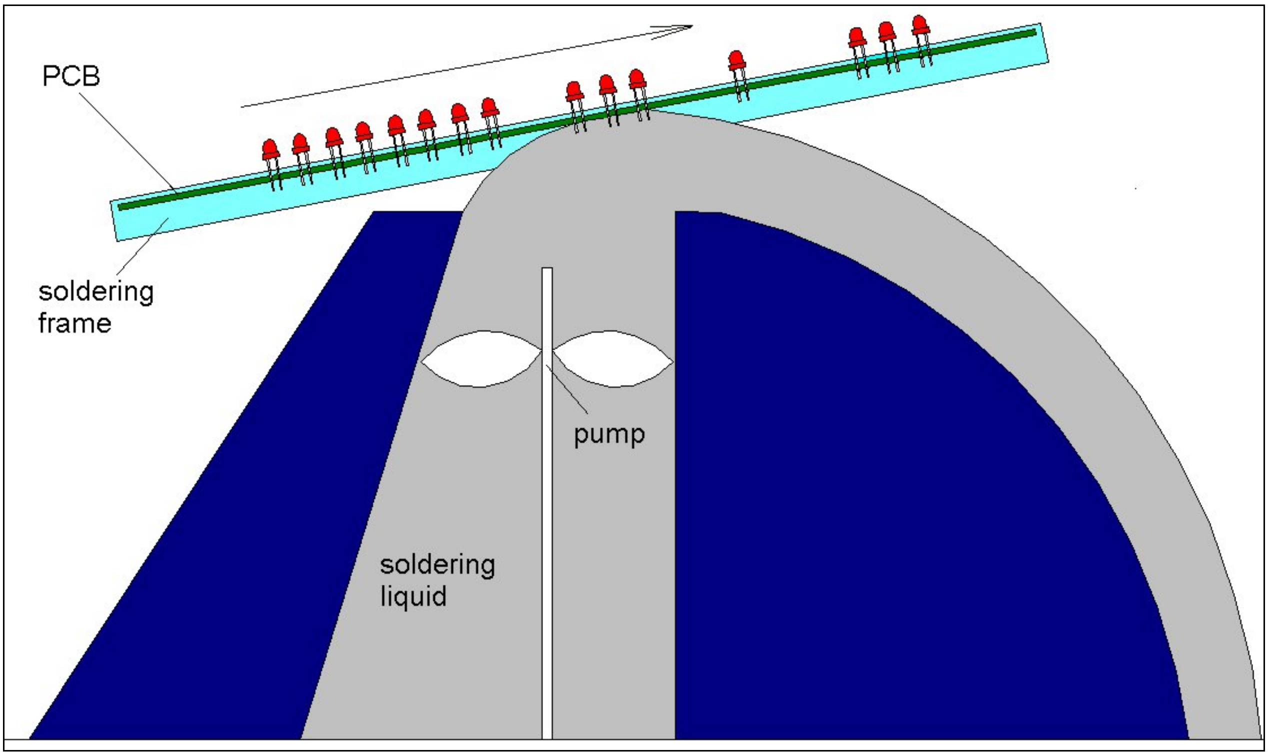


Figure 8: Principle of wave soldering

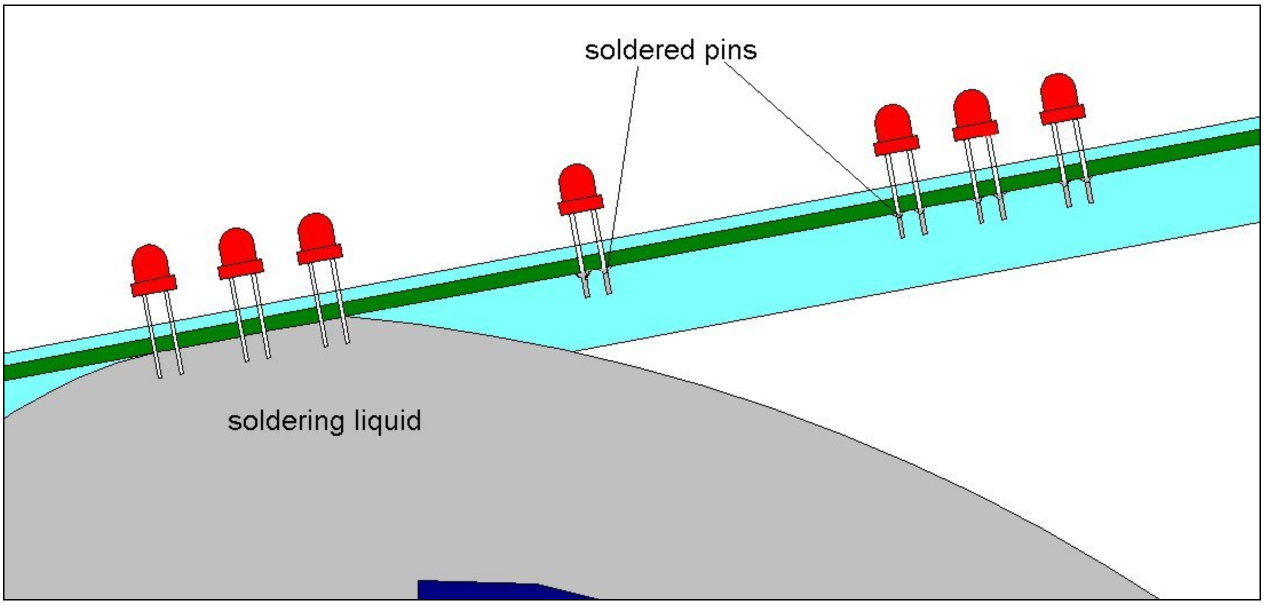


Figure 9: Wave soldering detail

All of the information regarding the processing of LEDs e.g.: packaging and transport and their provisions, solder pad design, solder profile etc. can be found in the data sheet for each LED or in the short form catalog.

Conclusion

Beside few radial LED types the product portfolio of OSRAM Opto Semiconductors is aligned to the SMD technology. The large advantages are the uniform soldering and assembly processes of all devices, connected with a cost reduction and saving of time. Beyond that it permits a clear miniaturization by higher component densities and minimum overall heights.

In general the complete processing of all Osram Opto Semiconductors LEDs can be done with standard high speed production machines state of the art.

If special requirements concerning the solder pad design, thermal management or machining of high power LEDs are necessary and for further questions please see other application notes to get more detailed information or get contact to OSRAM Opto Semiconductors.

Author: Michael Sailer

About Osram Opto Semiconductors

Osram Opto Semiconductors GmbH, Regensburg, is a wholly owned subsidiary of Osram GmbH, one of the world's three largest lamp manufacturers, and offers its customers a range of solutions based on semiconductor technology for lighting, sensor and visualisation applications. The company operates facilities in Regensburg (Germany), San José (USA) and Penang (Malaysia). Further information is available at www.osram-os.com.