# Advantage of SnapLED 150 LED Product Compared to other Lighting Technologies in Automotive Signal Lamps

## Application Note 1176

### Introduction

This application note has been written to introduce the new Hewlett-Packard SnapLED 150 product to automotive customers that are responsible for automotive signal lighting.

Hewlett-Packard's new SnapLED 150 product represents the most cost-effective LED-technology light source on the market today for automotive signal lamps. Traditionally, incandescent bulbs have been the technology of choice for automotive signal lamps. LED technology has been used for over ten years in specialized automotive signal lamps – namely Center-High-Mounted Stop Lamps (CHMSL) – where a long, thin signal was desired. The SnapLED 150 product allows LED technology to be designed into mainstream applications such as Rear Combination Lamps and low-cost CHMSLs. The use of the SnapLED 150 allows spoiler-mounted CHMSLs to be constructed from three emitters and behind-the-glass CHMSLs to be constructed with six emitters. In Rear Combination Lamps, the use of the SnapLED 150 allows red SAE Stop and Turn signals to be constructed from nine emitters and amber SAE Turn Signals to be constructed from 24 emitters.

### Key Benefits of LED Technology

LED technology provides a number of benefits over incandescent bulbs in automotive signal lamps. LEDs offer a lifetime that is orders of magnitude longer than incandescent bulbs. Properly designed, the LED signal lamp should last the life of the car, which eliminates one cause of maintenance and warranty costs. LED technology is much smaller than an incandescent bulb and associated reflector. This allows the size of the signal lamp to be reduced, allowing more trunk space or a reduction in the length of the vehicle without a reduction in useful space. LED technology is more efficient at generating amber and red light so that the overall power consumption of an LED signal lamp is typically 1/10 that of an incandescent design. These power savings can result either in cost savings within the vehicle or a means to conserve electrical power to be used by higher value-added electrical accessories. However, the biggest benefit of LED technology is that the small size per LED emitter allows the stylist much more flexibility in his design. Using several small LEDs instead of one large bulb and a bulky reflector allows the stylist to design unique, vehicle differentiating light emitting shapes, or long, thin aspect ratios and allows the signal lamp to conform to the curved surface or corners of the sheet-metal. In addition, since the color of light emitted by the LED meets the SAE/ECE red and amber color requirements, the stylist is free to design with neutrally colored lens materials.

### Hewlett-Packard's LED Cost Reduction Efforts For Automotive Signal Lamps

Traditionally, the cost of LED technology for automotive signal lighting has always been high compared to bulbs. This has been primarily due to the large number of LEDs needed to generate adequate light. For example, a spoiler-mounted CHMSL can be designed using only one or two incandescent bulbs (or more if a long, thin aspect ratio is desired). The first LED signal lamps used a string of conventional 5 mm LEDs. The first 5 mm LEDs used a materials technology

(AS AlGaAs) that generated about 0.25 lm per emitter. These designs required about 76 LEDs to generate enough light for a spoiler-mounted CHMSL. The second generation of 5 mm LEDs used a brighter materials technology (TS AlGaAs) that generated about 0.35 lm per emitter. These designs required about 48 LEDs to generate enough light for a spoiler-mounted CHMSL. Compared to one or two bulbs, these designs were substantially more expensive. Thus, these CHMSL designs were primarily used in spoiler applications where the long, thin aspect ratio was needed.

Hewlett-Packard has pioneered the design of high-power LED packages that are capable of generating more light per emitter. These types of LEDs have significantly reduced the cost of LED signal lighting. The Super Flux LED package, which is currently the industry-standard LED package, was first introduced in 1994. It was capable of generating 0.8 lm using the same TS AlGaAs materials technology as used in conventional 5 mm LEDs. Using Super Flux LEDs, the same spoiler-mounted CHMSL was designed using only 20 LEDs.

To further increase the light output, the primary changes from the conventional 5 mm LEDs to the Super Flux LED package were the use of a high thermally-conductive lead-frame and a higher temperature epoxy. In general, LEDs use a transparent epoxy material for the body of the package. Each epoxy material has a recommended operating temperature range. The epoxy used in the Super Flux LED is rated for use up to 125°C, in comparison to 110°C for the epoxy used in conventional 5 mm LEDs. In addition, the use of a highly thermally-conductive lead-frame (the device pins) allows the LED die to be driven at a higher drive current without exceeding the maximum junction temperature of the device. The Super Flux LED has a thermal resistance, $R\theta_{J\text{-}PIN}$, of 125°C/W as compared to a thermal resistance, $R\theta_{J\text{-}PIN}$, of 240°C/W for conventional 5 mm LEDs. This lower thermal resistance allows the Super Flux LED to be driven at almost twice the forward current as a conventional 5 mm LED at the same temperature rise, $\Delta T_{J\text{-}PIN}$. Coupling the lower thermal resistance with the higher maximum junction temperature of the Super Flux LED, allows the Super Flux LED to be driven at 2 to 2.5X higher drive currents in automotive signal lights (roughly 60 mA versus 25 mA for conventional 5 mm LEDs).

In addition to these changes which reduced the number of LEDs needed for an automotive signal lamp, the Super Flux LED uses a low profile package, further reducing the thickness of the automotive signal lamp.

Since the introduction of the first Super Flux LED, Hewlett-Packard has improved the lighting efficiency of its LED materials technology with the advent of AlInGaP materials technology. This technology provides amber lighting that meets the SAE and ECE color and luminous flux requirements for automotive signal lighting. AlInGaP materials technology also generates a reddish-orange lighting color and a red lighting color, both of which are more efficient than the deep-red AlGaAs materials technology. AlInGaP materials technology is offered in two versions – AS (“absorbing substrate”) AlInGaP and TS (“transparent substrate”) AlInGaP. Today’s reddish-orange Super Flux LEDs generate about 1.5 lm (HPWA-xH00) for AS AlInGaP and about 3.75 lm (HPWT-xH00) for TS AlInGaP. Using these materials, the number of LEDs needed for the benchmark spoiler-mounted CHMSL can be reduced to 12 (AS AlInGaP) or 6 emitters (TS AlInGaP).

In parallel with these advances in LED materials technology, in 1996 Hewlett-Packard introduced a version of the Super Flux LED called the SnapLED. While the Super Flux LED was designed for conventional soldering on printed circuit boards, the SnapLED was designed to be assembled into a formable metal substrate with a patented solderless clinch technology. The major benefit of the SnapLED package is the ability to create a three dimensional lighting array by bending the metal substrate into any desired shape. The SnapLED and Super Flux LED both use the same materials and manufacturing processes. However, instead of forming the lead-frame into pins compatible with a pcb, the lead-frame is formed into two large metal pads.

The latest member of the Super Flux LED family is the SnapLED 150 product. The SnapLED 150 uses the same materials and manufacturing processes as the existing Super Flux LED and SnapLED products. However, the SnapLED 150 uses a larger AlInGaP die and a heavier lead-frame in order to further increase the drive current and light output of the product. For CY2000 production, the reddish-orange SnapLED 150 provides a minimum light output of 6 lm and the amber SnapLED 150 provides a minimum light output of 3 lm. Using the SnapLED 150, the benchmark spoiler-mounted CHMSL can be constructed using only 3 emitters.

The target applications for the SnapLED 150 product are main-stream Rear Combination Lamps. Using 6 lm reddish-orange SnapLED 150 products, SAE Rear Stop and Rear Turn Signals can be constructed from nine emitters. Amber SAE Rear Turn Signals would require about twenty-four 3 lm amber SnapLED 150 products.

## SnapLED 70 and SnapLED 150 Products

Hewlett-Packard's SnapLED 150 LED emitter is functionally equivalent to the SnapLED LED emitter in most respects. However, the SnapLED 150 LED emitter is designed to operate at a higher drive current than the SnapLED emitter and generates twice as much luminous flux. In order to generate this higher luminous flux output with the same product reliability, the SnapLED 150 uses a larger LED die that is designed to operate up to 150 mA. In addition, the SnapLED 150 has a lower thermal resistance package. For best results, it is recommended that the user reduce the thermal resistance, $R\theta_{PIN-AIR}$, of the SnapLED 150 LED signal lamp design in order to take full advantage of the improved thermal performance of the SnapLED 150 package. The SnapLED 150 emitter uses the same luminous flux, dominant wavelength, and forward voltage category methodology as the SnapLED and Super Flux LED emitters except that the SnapLED 150 is tested at 150 mA, while the SnapLED and Super Flux are tested at 70 mA. The detailed differences between the SnapLED 150, SnapLED, and Super Flux LED emitters are summarized in the Hewlett-Packard Application Note #1177, titled: "Differences Between the SnapLED 150 and Super Flux/SnapLED Products", (publication #5968-6344E).

Hewlett-Packard's new SnapLED 70 package incorporates the same package outline and improved thermal resistance as the SnapLED 150 with the same size LED die as the SnapLED and Super Flux LED product families. The SnapLED 70 is tested at 70 mA with the same luminous flux, dominant wavelength, and forward voltage categories as the SnapLED and Super Flux LED product families. For future SnapLED designs, the SnapLED 70 package is highly recommended. Hewlett-Packard does not intend to support the SnapLED product in new designs.

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Data Subject to Change



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