
Projection of Long Term Light Output Performance for AS AlInGaP LED Technology

Application Brief I-007

Long Term Light Output Performance is Different than MTBF

The long term reliability of AS AlInGaP (absorbing substrate, aluminum-indium-gallium-phosphide) LEDs is an important consideration for those who specify LED variable message signs (VMS) and LED traffic signals. The expectation is that an LED VMS or LED traffic signal should operate for a period of 100,000 hours without need for replacement of an LED lamp due to either catastrophic failure or excessive light output degradation. The maximum ambient temperature for an LED VMS or LED traffic signal is +71°C (+160°F). Realizing that at an ambient temperature of +71°C (+160°F), the Mean Time Between (possible catastrophic) Failure, MTBF, for LED lamps is on the order of 1.2 million hours, MTBF is rarely if ever a concern. Of greater interest to transportation engineers and VMS/signal maintenance engineers is the long term light output characteristics (long term degradation) for AS AlInGaP LEDs. This Application Brief presents a projection

of the long term light output performance that may be expected for AS AlInGaP LED technology.

There is no known acceleration test method available to gain long term light output performance for LEDs over a short test period. To gain long term light output performance data, LED devices must be tested at the specified drive current, in the specified ambient temperature, for the elapsed time duration of interest. Light output measurements are taken at defined intervals of time and compared to an initial zero time base measurement to determine the light output performance. Once sufficient data has been collected, projections out to longer periods of time may be extrapolated based on agreed upon assumptions.

Projected 100,000 Hour High Temperature Operating Life Performance

AlInGaP amber and reddish-orange lamps built during calendar year 1994 have been assembled with high performance AS AlInGaP LED chips

that are approximately 10 mils square in size. Use of these LED chips has allowed Hewlett-Packard to provide devices with superior cost effective performance for use in LED VMS and LED traffic signals. High temperature operating life, HTOL, light output performance data has been collected for these AS AlInGaP LED devices out to 10,000 hours of continuous on-time operation in an operating ambient temperature of +55°C. A projection out to 100,000 hours of continuous on-time operation may be made from these data based on the following assumptions:

- This projection is an estimate, extrapolated from existing 10,000 hour HTOL data.
- The small amount of light output change for each 1000 hour time period within the collected HTOL 10,000 hour data is near the limits of measurement accuracy, $\pm 5\%$.
- This projection assumes light output degradation is a logarithmic function of operating on-time.

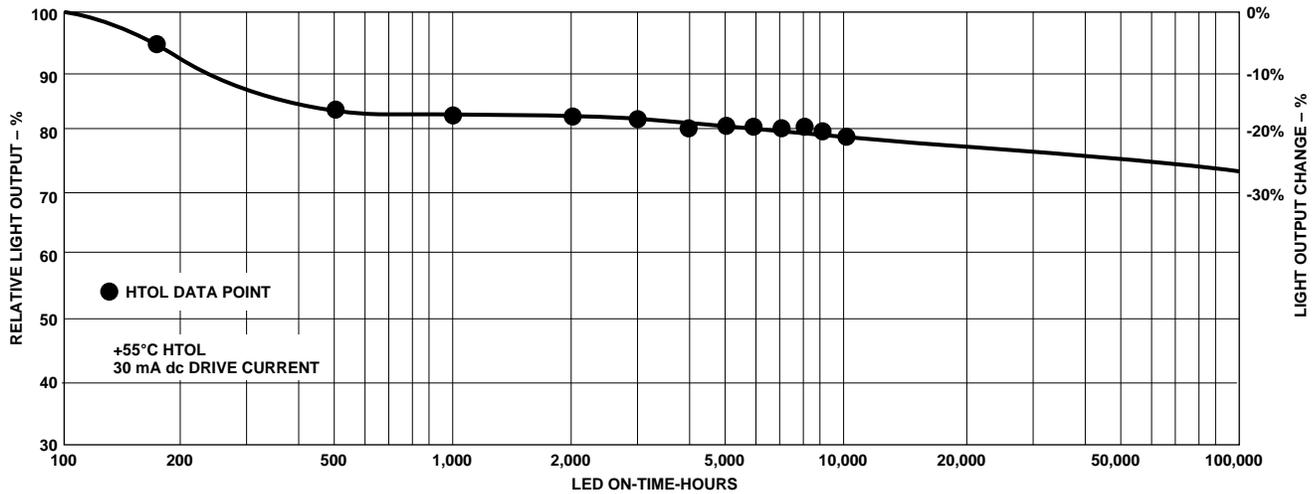


Figure 1. Projection of Statistical Average Light Output Degradation Performance for AS AlInGaP LED Technology to 100,000 Hours, extrapolated from 10,000 hour HTOL data.

- This projection predicts the combined statistical average light output performance for both amber and reddish-orange AS AlInGaP devices over many different LED wafer lots, with the electrical drive current and ambient temperature conditions remaining constant out to the 100,000 hour point.

The projection of the statistical average light output performance for AS AlInGaP LEDs out to 100,000 hours of continuous on-time, operating in a +55°C (+131°F) ambient temperature at a dc drive current of 30 mA dc, is graphed on the semi-log plot shown in Figure 1. The HTOL data shows an initial statistical average light output degradation of -15% at 1,000 hours. Light output stability is established between 4,000 hours and 10,000 hours, resulting in a

statistical average degradation of -20% at 10,000 hours. The projection from the 10,000 hour point predicts a statistical average light output degradation of -25% at 100,000 hours.

As with any extrapolation of data, there is no assurance that this projection is accurate. However, from this projection, transportation engineers can gain a reasonable understanding of the long term statistical average light output performance of AS AlInGaP LED lamps used in LED changeable message signs and LED traffic signals.

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Data Subject to Change

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