Long Term Reliability Data for AlInGaP Technology T-1 3/4 LED Lamps

Application Brief I-021

Introduction

The following cumulative test results have been obtained from testing performed at Avago Technologies and at contracted service sites in accordance with the latest revisions of MIL-STD-883, JIS C7021, and ASTM G90 Standards. The performance you can expect from AlInGaP LED lamp components depends on the actual electrical and environmental characteristics of your application. These data should be used as a guide to estimate the expected performance in a given set of operating conditions.

Avago Technologies is constantly looking at and evaluating customer use environments to understand and predict AlInGaP LED product performance in real world operating conditions. The goal is to provide our customers with reliable products that meet the requirements of actual application environments.

Operational Life Tests

Four long term operating life tests, listed in Table 1, are performed on AlInGaP LED lamp devices. Each operational life test represents eight randomly selected wafers with 112 total parts per test. MIL-STD-883 is used as the controlling document.

All operating life tests are performed with continuous on-time dc bias (20 mA) at the ambient temperatures listed below. Figure 1 shows the light output degradation over time at various stress operational life tests have light output degradation of less than -12% at 16 thousand hours.

It is important to note that the AlInGaP lamps display exceptional resistance to moisture and temperature when tested at +85°C and 85% relative humidity. Eight thousand hour WHTOL data demonstrates the high resistance these AlInGaP T-1 3/4 plastic lamps have to deterioration from long term exposure to a high moisture environment.

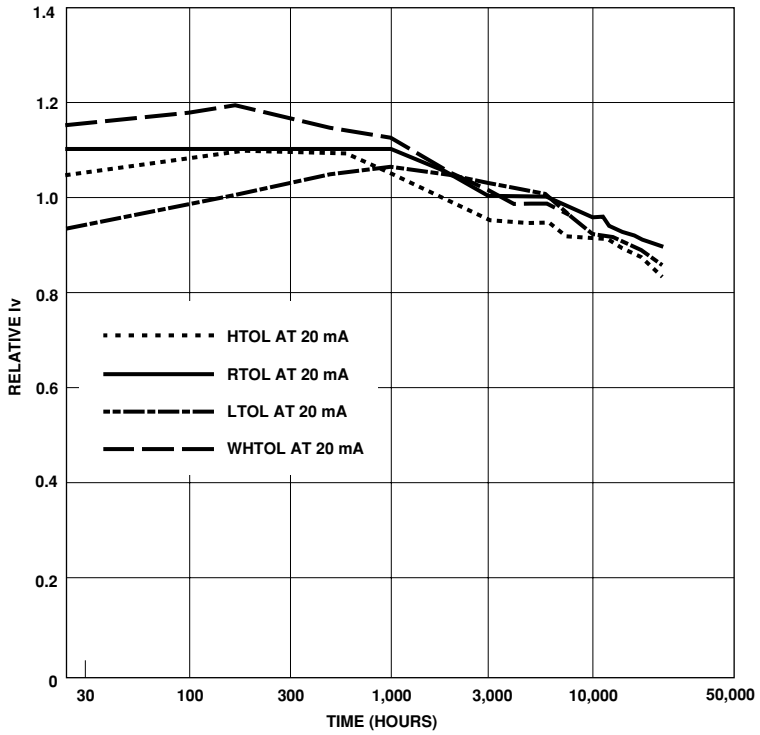

Figure 1. AlInGaP Light Output Degradation Data at 20,000 hours for Various Environmental Conditions. Lamps Under Test are stressed and tested at 20 mA dc. Light Output Data is measured at 25°C, referenced to Time Point Zero.

Table 1. Long Term Performance Test Conditions

Test Name	Test Description	Test Conditions	Current
HTOL	High Temperature Operating Life	+55°C	20 mA dc
RTOL	Room Temperature Operating Life	+25°C	20 mA dc
LTOL	Low Temperature Operating Life	-40°C	20 mA dc
WHTOL	Wet High Temperature Operating Life	85°C/85% R/H	20 mA dc

Note: For Figure 2, 10 mA, 50 mA, and 70 mA are also used.

Data from AlInGaP LED lamps under test also demonstrate that forward voltage (V_F) characteristics and the color of the emitted light, dominant wavelengths (λ_d nm), do not change for any of the long term operating life test conditions.

MTBF

The expected mean time between (possible) catastrophic failure (MTBF) is in millions of hours and is detailed in the Avago Technologies *T-1 3/4 High Performance AlInGaP Reliability Data Sheet*, Avago Publication 5965-7846E.

Light Output Performance vs. dc Drive Currents

Figure 2 demonstrates the effects of current density on long term light output degradation. These evaluations are stressed at 55°C, dc biased at 10 mA, 20 mA, 50 mA, and 70 mA.

Depending on your application, the drive current used will determine the useful life of the end product. For traffic signal applications, it is recommended that the drive current is limited to 20 mA to 30 mA dc and up to 50 mA for automotive applications.

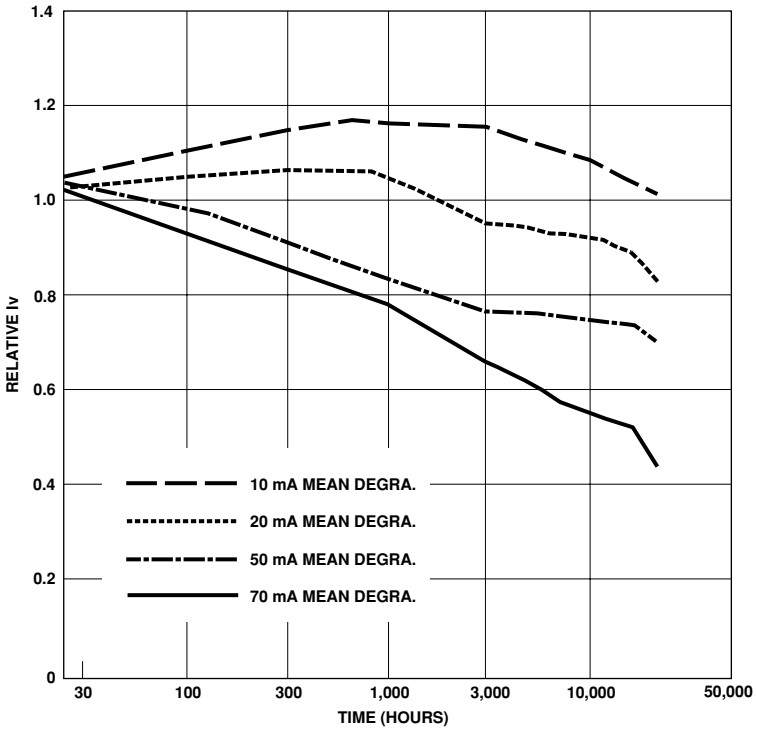

Figure 2. AlInGaP Light Output Degradation at Various dc Drive Currents. Lamps Under Test are stressed and tested at Stated dc Drive Current. Light Output Data is measured at 25°C, referenced to Time Point Zero.

Accelerated Outdoor Environmental Testing

Accelerated outdoor environmental testing provides information on the weatherability of Avago Technologies' AlInGaP LED lamp products under severe environmental conditions. An outdoor weather testing facility, located in the Arizona desert, is used to achieve accelerated sun irradiance (SUN 10) testing. The SUN 10 station uses ten Fresnel reflectors to focus the sun's radiant energy

on AlInGaP LED lamp test samples, providing an exposure acceleration factor of 6.3X during daylight hours. A one year exposure to SUN 10 testing is equivalent to 6.3 years of accumulated exposure to worst case direct sunlight conditions. ASTM G90 is used as the controlling document for SUN 10 exposure testing. Effects of both uv-a and uv-b are evaluated on the test samples.

The AlInGaP LED lamps under test are continuously biased at 20 mA dc. The SUN 10 testing exposes the LED lamps to a peak day time temperature of +75°C and night time temperatures as low as -1°C. AlInGaP LED lamps with 11,000 hours of exposure to SUN 10 testing, which is equivalent to 69,300 accumulated hours (≅ 8 years) of normal exposure to worst case direct sunlight, exhibit no deterioration of the lamp epoxy packages.

The light output degradation measurements on the AlInGaP LED lamps under test follow the same trend as graphed in Figure 1, indicating no negative impact on long term light output performance from exposure to uv-a, uv-b, and ambient temperature extremes.

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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