# 5 mm AlInGaP Flat Top Precision Optical Plastic Lamps

## Reliability Data Sheet

### Description

The following cumulative test results have been obtained from testing performed at Avago Technologies in accordance with the latest revisions of MIL-STD-883 and JIS C 7021.

Avago tests parts at the absolute maximum rated conditions recommended for the device. The actual performance you obtain from Avago parts depends on the electrical and environmental characteristics of your application but will probably be better than the performance outlined in Table 1.

### Failure Rate Prediction

The failure rate of semiconductor devices is determined by the junction temperature of the device. The relationship between ambient temperature and actual junction temperature is given by the following:

$T_J$ (°C) = $T_A$ (°C) + $\theta_{JA}$ $P_{AVG}$

where $T_A$ = ambient temperature in °C

$\theta_{JA}$ = thermal resistance of junction-to-ambient in °C/watt

$P_{AVG}$ = average power dissipated in watts

The estimated MTBF and failure rate at temperatures lower than the actual stress temperature can be determined by using an Arrhenius model for temperature acceleration. Results of such calculations are shown in the table on the following page using an activation energy of 0.43 eV (reference MIL-HDBK-217).

**Table 1. Life Tests**
**Demonstrated Performance**

| | | | | | Point Typical Performance | |
|---|---|---|---|---|---|---|
| **Colors** | **Stress Test Conditions** | **Total Device Hrs.** | **Units Tested** | **Units Failed** | **MTBF** | **Failure Rate (% /1K Hours)** |
| As/Ts AlInGaP (Red/Amber) | $T_A$ = 55°C<br>$I_F$ = 50 mA | 112,000 | 112 | 0 | 112,000 | 0.893 |
| As/Ts AlInGaP (Red/Amber) | $T_A$ = -40°C<br>$I_F$ = 50 mA | 112,000 | 112 | 0 | 112,000 | 0.893 |

**Table 2. Reliability Predictions ($I_F$ = 50 mA [4] )**

| Ambient Temperature (°C) | Junction Temperature (°C) | Point Typical Performance in Time [1] (60% Confidence) MTBF [1] | Failure Rate (%/1K Hours) | Performance in Time [2] (90% Confidence) MTBF [2] | Failure Rate (%/1K Hours) |
|---|---|---|---|---|---|
| +85 | +129 | 41,000 | 2.424 | 11,000 | 9.430 |
| +75 | +119 | 57,000 | 1.768 | 15,000 | 6.875 |
| +65 | +109 | 79,000 | 1.268 | 20,000 | 4.930 |
| +55 | +99 | 112,000 | 0.893 | 29,000 | 3.473 |
| +45 | +89 | 162,000 | 0.617 | 42,000 | 2.399 |
| +35 | +79 | 240,000 | 0.417 | 62,000 | 1.623 |
| +25 | +69 | 362,000 | 0.276 | 93,000 | 1.074 |

**Notes:**

[1] The point typical MTBF (which represents 60% confidence level) is the total device hours divided by the number of failures. In the case of zero failures, one failure is assumed for this calculation.

[2] The 90% Confidence MTBF represents the minimum level of reliability performance which is expected from 90% of all samples. This confidence interval is based on the statistics of the distribution of failures. The assumed distribution of failures is exponential. This particular distribution is commonly used in describing useful life failures. Refer to MIL-STD-690B for details on this methodology.

[3] A failure is any LED which is open, shorted, or fails to emit light.

[4] Calculated from data generated at 55°C biased at 50 mA.

### Example of Failure Rate Calculation

Assume a device operating 8 hours/day, 5 days/week. The utilization factor, given 168 hours/week is:

(8 hours/day) x (5 days/week) / (168 hours/week) = 0.25

The point failure rate per year (8760 hours) at 55°C ambient temperature is:

(0.893% / 1K hours) x (0.25) x (8760 hours/year) = 1.957% per year

Similarly, 90% confidence level failure rate per year at 55°C:

(3.473% / 1K hours) x (0.25) x (8760 hours/year) = 7.606% per year

**Table 3. Environmental Tests**

| Test Name | MIL-STD-883 Reference | JIS C 7021 Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|---|
| Temperature Cycle | 1010 | Method A-4 | -40°C to +120°C, 30 min. dwell, 5 min. transfer, 100 cycles | 2,300 | 0 |
| Resistance to Soldering Heat | 2003 | Method A-1 Condition A | 260°C for 10 sec. | 28 | 0 |
| Solderability | 2003 | Method A-2 | 230°C for 5 sec, 1 to 1.5 mm from body, 95% solder coverage of immersed area | 40 | 0 |
| Pulse Test | Avago Req. | Avago Req. | 55°C, 100 mA Peak, Freq. 1 kHz, DF 30%, 1,000 hours | 112 | 0 |
| Humidity Life | Avago Req. | Avago Req. | 85°C/85% RH, $I_F$ = 20 mA, 1,000 hours | 112 | 0 |
| Humidity Storage | Avago Req. | Avago Req. | 85°C/85% RH, 1,000 hours | 112 | 0 |
| Humidity Reverse Bias | Avago Req. | Avago Req. | 85°C/85%RH, 5 Vbr, 1,000 hours | 64 | 0 |
| Temperature Shock | Avago Req. | Avago Req. | -40°C to +110°C, 20 min. dwell time, 100 cycles | 112 | 0 |
| Temperature Humidity Cycle | 1004 | Method A-5 Method II | -10°C to +65°C, 90-98% RH, 100 cycles | 112 | 0 |
| Low Temperature Storage | 1005 | Method B-12 | -40°C for 1,000 hours | 112 | 0 |

**Table 4. Mechanical Tests**

| Test Name | MIL-STD-883 Reference | JIS C 7021 Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|---|
| Mechanical Shock | 2002 | Method A-7 Condition F | Max. acceleration: 14,700 m/s$^2$ with 0.5 m/s pulse width, 3x each direction | 20 | 0 |
| Vibration Variable Frequency | 2007 | Method A-10 Condition D | 100-2000-100 Hz frequency range in 4 min., 196 m/s$^2$ peak to peak acceleration, 48 min. total | 20 | 0 |
| Free Drop Test | N/A | Method A-8 | Drop from 75 cm 3x | 20 | 0 |
| Termination Strength | 2004 | Method A-11 Tests I and III | 1 kg load for 30 sec, 5N, load on lead with ±90° bend | 20 | 0 |
| Constant Acceleration | 2001 | Method A-9 Condition D | 1 min. each 6 directions, 196,000 m/s$^2$ | 20 | 0 |

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