

# HLMP-LG70/71,HLMP-LB71 HLMP-LM71

4 mm Oval Precision Optical Performance LED



## Reliability Datasheet

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

### 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:

$$T_J(^{\circ}\text{C}) = T_A(^{\circ}\text{C}) + \theta_{JA} P_{AVG}$$

where

$T_A$  = ambient temperature in  $^{\circ}\text{C}$

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

$P_{AVG}$  = 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 activation energy of 0.43 eV (reference MIL-HDBK-217).

**Table 1. Life Tests  
Demonstrated Performance**

| Die Type | Stress Test Conditions                             | Total Device Hrs. | Units Tested | Units Failed | Point Typical Performance |                |
|----------|----------------------------------------------------|-------------------|--------------|--------------|---------------------------|----------------|
|          |                                                    |                   |              |              | Failure Rate              |                |
|          |                                                    |                   |              |              | MTBF                      | (% /1 K Hours) |
| AllnGap  | $T_A = 55^{\circ}\text{C}$<br>$I_F = 47\text{ mA}$ | 168,000           | 168          | 0            | 189200                    | 0.53           |
| InGaN    | $T_A = 55^{\circ}\text{C}$<br>$I_F = 23\text{ mA}$ | 672,000           | 672          | 0            | 747,100                   | 0.13           |

**Table 2. Reliability Predictions ( $I_F = 20$  mA)**  
**Die Type: AlInGaP**

| <b>Ambient Temperature (°C)</b> | <b>Junction Temperature (°C)</b> | <b>Point Typical Performance in Time <sup>[1]</sup> (60% Confidence)</b> |                                   | <b>Performance in Time <sup>[2]</sup> (90% Confidence) Failure Rate</b> |                      |
|---------------------------------|----------------------------------|--------------------------------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------|----------------------|
|                                 |                                  | <b>MTTF <sup>[1]</sup></b>                                               | <b>Failure Rate (%/1 K Hours)</b> | <b>MTTF <sup>[2]</sup></b>                                              | <b>(%/1 K Hours)</b> |
| 100                             | 130                              | 178300                                                                   | 0.56                              | 71000                                                                   | 1.41                 |
| 95                              | 130                              | 179500                                                                   | 0.56                              | 71400                                                                   | 1.40                 |
| 90                              | 129                              | 180600                                                                   | 0.55                              | 71900                                                                   | 1.39                 |
| 85                              | 129                              | 181800                                                                   | 0.55                              | 72400                                                                   | 1.38                 |
| 80                              | 129                              | 183000                                                                   | 0.55                              | 72900                                                                   | 1.37                 |
| 75                              | 129                              | 184200                                                                   | 0.54                              | 73300                                                                   | 1.36                 |
| 70                              | 129                              | 185500                                                                   | 0.54                              | 73800                                                                   | 1.36                 |
| 65                              | 128                              | 186700                                                                   | 0.54                              | 74300                                                                   | 1.35                 |
| 60                              | 128                              | 187900                                                                   | 0.53                              | 74800                                                                   | 1.34                 |
| 55                              | 128                              | 189200                                                                   | 0.53                              | 75300                                                                   | 1.33                 |
| 50                              | 128                              | 190400                                                                   | 0.53                              | 75800                                                                   | 1.32                 |
| 45                              | 124                              | 216200                                                                   | 0.46                              | 86100                                                                   | 1.16                 |
| 40                              | 119                              | 253800                                                                   | 0.39                              | 101000                                                                  | 0.99                 |
| 35                              | 114                              | 299300                                                                   | 0.33                              | 119100                                                                  | 0.84                 |
| 30                              | 109                              | 354400                                                                   | 0.28                              | 141100                                                                  | 0.71                 |
| 25                              | 104                              | 421500                                                                   | 0.24                              | 167800                                                                  | 0.60                 |
| 20                              | 99                               | 503700                                                                   | 0.20                              | 200500                                                                  | 0.50                 |

**Table 3. Reliability Predictions ( $I_F = 20$  mA)**  
**Die Type: InGaN**

| Ambient Temperature (°C) | Junction Temperature (°C) | Point Typical Performance in Time <sup>[1]</sup><br>(60% Confidence) |                            | Performance in Time <sup>[2]</sup><br>(90% Confidence)<br>Failure Rate |               |
|--------------------------|---------------------------|----------------------------------------------------------------------|----------------------------|------------------------------------------------------------------------|---------------|
|                          |                           | MTTF <sup>[1]</sup>                                                  | Failure Rate (%/1 K Hours) | MTTF <sup>[2]</sup>                                                    | (%/1 K Hours) |
| 85                       | 108                       | 742500                                                               | 0.13                       | 295600                                                                 | 0.34          |
| 80                       | 108                       | 743300                                                               | 0.13                       | 295900                                                                 | 0.34          |
| 75                       | 108                       | 744100                                                               | 0.13                       | 296200                                                                 | 0.34          |
| 70                       | 108                       | 744800                                                               | 0.13                       | 296500                                                                 | 0.34          |
| 65                       | 108                       | 745600                                                               | 0.13                       | 296800                                                                 | 0.34          |
| 60                       | 108                       | 746300                                                               | 0.13                       | 297100                                                                 | 0.34          |
| 55                       | 108                       | 747100                                                               | 0.13                       | 297400                                                                 | 0.34          |
| 50                       | 108                       | 747900                                                               | 0.13                       | 297700                                                                 | 0.34          |
| 45                       | 108                       | 748600                                                               | 0.13                       | 298000                                                                 | 0.34          |
| 40                       | 108                       | 749400                                                               | 0.13                       | 298300                                                                 | 0.34          |
| 35                       | 105                       | 831800                                                               | 0.12                       | 331100                                                                 | 0.30          |
| 30                       | 100                       | 992700                                                               | 0.10                       | 395200                                                                 | 0.25          |
| 25                       | 95                        | 1190500                                                              | 0.08                       | 473900                                                                 | 0.21          |
| 20                       | 90                        | 1434900                                                              | 0.07                       | 571200                                                                 | 0.18          |
| 15                       | 85                        | 1738500                                                              | 0.06                       | 692000                                                                 | 0.14          |
| 10                       | 80                        | 2117700                                                              | 0.05                       | 843000                                                                 | 0.12          |
| 5                        | 75                        | 2594400                                                              | 0.04                       | 1032700                                                                | 0.10          |

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.

### Failure Rate Calculation (Example AlInGaP Die Type Package):

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

$$(8 \text{ hours/day}) \times (5 \text{ days/week}) / (168 \text{ hours/week}) = 0.24$$

The point failure rate per year (8760 hours) at 25° C ambient temperature is: (60% confidence level) :

$$(0.24\%/1 \text{ K hours}) \times (0.24) \times (8760 \text{ hours/year}) = 0.5\% \text{ per year}$$

Similarly, 90% confidence level failure rate per year at 25° C:

$$(0.6\%/1 \text{ K hours}) \times (0.24) \times (8760 \text{ hours/year}) = 1.26\% \text{ per year}$$

**Table 4. Environmental/ Operating Tests**

| Test Name                           | MIL-STD/JEDEC Reference | Test Conditions                                                                                    | Units Tested | Units Failed |
|-------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------|--------------|--------------|
| Temperature Cycle                   | JESDA104                | -40°C/100°C, 30 min dwell, 5 min transfer, 100 cycles                                              | 3744         | 0            |
| Temperature Humidity Operating Life | JESD 22-A101            | T <sub>A</sub> = 85° C, RH = 85%RH, 1000 hrs<br>AlInGaP 28 mA, InGaN 10 mA                         | 84           | 0            |
| High Temperature Operating Life     | JESDA103                | T <sub>A</sub> = 55° C, 1000 hrs<br>AlInGaP 47 mA, InGaN 23 mA                                     | 168          | 0            |
| Low Temperature Operating Life      | JESD 22-A108            | T <sub>A</sub> = -40° C, 1000 hrs<br>AlInGaP 50 mA, InGaN 30 mA                                    | 84           | 0            |
| Temperature Humidity Storage Life   | Avago Requirement       | T <sub>A</sub> = 85° C, RH = 85%RH, 1000 hrs                                                       | 672          | 0            |
| Pulse Test                          | Avago Requirement       | T <sub>A</sub> = 85° C, I <sub>f</sub> = 100 mA, Peak, Freq: 1 Khz, AlInGaP DF: 30%; InGaN DF: 10% | 84           | 0            |
| Resistance to Solder heat           | JESDB106                | 260+/-5° C, 10+/-2 second, 2x                                                                      | 30           | 0            |

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