# HSMX-A1xx-xxxx

Surface Mount LED Indicator PLCC-2 SMT LED

# Reliability Data Sheet

## Description

The following cumulative test results have been obtained from testing performed at Agilent Technologies in accordance with the latest revision of MIL-STD-883. Agilent tests parts at the absolute maximum rated conditions recommended for the device. The actual performance you obtain from Agilent 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 0.43eV(reference MIL-HDBK-217).

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

| | | | | | Point Typical Performance | |
|---|---|---|---|---|---|---|
| **Die Type** | **Stress Test Conditions** | **Total Device Hrs.** | **Units Tested** | **Units Failed** | **MTBF** | **Failure Rate (%/1K Hours)** |
| InGaN | TA = 100°C, IF = 5mA | 140,000 | 140 | 0 | 140,000 | ≤0.71 |
| InGaN | TA = 55°C, IF = 25mA | 149,000 | 140 | 0 | 140,000 | ≤0.71 |
| InGaN | TA =-40°C, IF = 30mA | 140,000 | 140 | 0 | 140,000 | ≤0.71 |
| InGaN | TA = 25°C, IF = 30mA | 140,000 | 140 | 0 | 140,000 | ≤0.71 |
| As AlInGaP | TA = 100°C, IF = 10mA | 56,000 | 56 | 0 | 56,000 | ≤1.78 |
| As AlInGaP | TA = 55°C, IF = 30mA | 56,000 | 56 | 0 | 56,000 | ≤1.78 |
| As AlInGaP | TA =-40°C, IF = 30mA | 56,000 | 56 | 0 | 56,000 | ≤1.78 |
| As AlInGaP | TA = 25°C, IF = 30mA | 56,000 | 56 | 0 | 56,000 | ≤1.78 |
| Ts AlInGaP | TA = 100°C, IF = 10mA | 112,000 | 112 | 0 | 112,000 | ≤0.89 |
| Ts AlInGaP | TA = 55°C, IF = 30mA | 112,000 | 112 | 0 | 112,000 | ≤0.89 |
| Ts AlInGaP | TA =-40°C, IF = 30mA | 84,000 | 84 | 0 | 84,000 | ≤1.19 |
| Ts AlInGaP | TA = 25°C, IF = 30mA | 112,000 | 112 | 0 | 112,000 | ≤0.89 |
| GaP | TA = 100°C, IF = 10mA | 112,000 | 112 | 0 | 112,000 | ≤0.89 |
| GaP | TA = 55°C, IF = 30mA | 112,000 | 112 | 0 | 112,000 | ≤0.89 |
| GaP | TA =-40°C, IF = 30mA | 84,000 | 84 | 0 | 84,000 | ≤1.19 |
| GaP | TA = 25°C, IF = 30mA | 112,000 | 112 | 0 | 112,000 | ≤0.89 |

**Table 2. Reliability Prediction**

InGaN IF=25mA

| Ambient Temperature (°C) | Junction Temperature (°C) | Performance in Time ( 60% Confidence ) | | Performance in Time ( 90% Confidence) | |
|---|---|---|---|---|---|
| | | MTBF | Failure Rate (%/1K Hours ) | MTBF | Failure Rate (%/1K Hours ) |
| 100 | 109 | 118600 | 0.84 | 47200 | 2.12 |
| 95 | 108 | 123800 | 0.81 | 49300 | 2.03 |
| 90 | 107 | 129300 | 0.77 | 51500 | 1.94 |
| 85 | 105 | 135000 | 0.74 | 53700 | 1.86 |
| 80 | 104 | 141100 | 0.71 | 56100 | 1.78 |
| 75 | 103 | 147400 | 0.68 | 58700 | 1.7 |
| 70 | 102 | 154100 | 0.65 | 61300 | 1.63 |
| 65 | 100 | 161100 | 0.62 | 64100 | 1.56 |
| 60 | 99 | 168500 | 0.59 | 67100 | 1.49 |
| 55 | 98 | 176300 | 0.57 | 70200 | 1.42 |
| 50 | 97 | 184500 | 0.54 | 73500 | 1.36 |
| 45 | 95 | 193200 | 0.52 | 76900 | 1.3 |
| 40 | 94 | 202300 | 0.49 | 80500 | 1.24 |
| 35 | 89 | 244100 | 0.41 | 97200 | 1.03 |
| 30 | 84 | 296100 | 0.34 | 117900 | 0.85 |
| 25 | 79 | 361100 | 0.28 | 143800 | 0.7 |

Ts AlInGaP and GaP IF=30mA

| Ambient Temperature (°C) | Junction Temeprature (°C) | Performance in Time ( 60% Confidence ) | | Performance in Time ( 90% Confidence) | |
|---|---|---|---|---|---|
| | | MTBF | Failure Rate (%/1K Hours ) | MTBF | Failure Rate (%/1K Hours ) |
| 100 | 110 | 62800 | 1.59 | 25000 | 4.00 |
| 95 | 109 | 64100 | 1.56 | 25500 | 3.93 |
| 90 | 108 | 65400 | 1.53 | 26000 | 3.85 |
| 85 | 108 | 66700 | 1.5 | 26600 | 3.76 |
| 80 | 107 | 68100 | 1.47 | 27100 | 3.69 |
| 75 | 107 | 69600 | 1.44 | 27700 | 3.61 |
| 70 | 106 | 71000 | 1.41 | 28300 | 3.53 |
| 65 | 101 | 84700 | 1.18 | 33700 | 2.97 |
| 60 | 96 | 101500 | 0.99 | 40400 | 2.48 |
| 55 | 91 | 122200 | 0.82 | 48600 | 2.06 |
| 50 | 86 | 147900 | 0.68 | 58900 | 1.70 |
| 45 | 81 | 180000 | 0.56 | 71600 | 1.40 |
| 40 | 76 | 220300 | 0.45 | 87700 | 1.14 |
| 35 | 71 | 271200 | 0.37 | 107900 | 0.93 |
| 30 | 66 | 335900 | 0.3 | 133700 | 0.75 |
| 25 | 61 | 418700 | 0.24 | 166600 | 0.60 |

As AlInGaP IF=30mA

| Ambient Temperature (°C) | Junction Temeprature (°C) | Performance in Time ( 60% Confidence ) | | Performance in Time ( 90% Confidence) | |
|---|---|---|---|---|---|
| | | MTBF | Failure Rate (%/1K Hours ) | MTBF | Failure Rate (%/1K Hours ) |
| 100 | 110 | 27700 | 3.61 | 11000 | 9.09 |
| 95 | 110 | 27700 | 3.61 | 11000 | 9.09 |
| 90 | 110 | 27700 | 3.61 | 11000 | 9.09 |
| 85 | 110 | 27700 | 3.61 | 11000 | 9.09 |
| 80 | 110 | 27600 | 3.62 | 11000 | 9.09 |
| 75 | 108 | 29600 | 3.38 | 11800 | 8.47 |
| 70 | 103 | 35200 | 2.84 | 14000 | 7.14 |
| 65 | 98 | 42100 | 2.38 | 16800 | 5.95 |
| 60 | 93 | 50600 | 1.98 | 20100 | 4.98 |
| 55 | 88 | 61100 | 1.64 | 24300 | 4.12 |
| 50 | 83 | 74200 | 1.35 | 29500 | 3.39 |
| 45 | 78 | 90600 | 1.1 | 36100 | 2.77 |
| 40 | 73 | 111300 | 0.9 | 44300 | 2.26 |
| 35 | 68 | 137500 | 0.73 | 54700 | 1.83 |
| 30 | 63 | 170900 | 0.59 | 68000 | 1.47 |
| 25 | 58 | 213900 | 0.47 | 85100 | 1.18 |

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 failure, 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 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 failures is any LED which is open, shorted, or failed to emit light.
4. Calculated from data generated at 55'C biased at 25mA for InGaN

## Example of Failure Rate Calculation

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

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

The point failure rate per year (8760 hours) at 55oC for InGaN at 60% confidence level is:

(0.57% / 1K hours) x 0.25 x (8760 hours/year) = 1.24% per year

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

(1.42% / 1K hours) x 0.25 x (8760 hours/year) = 3.11% per year.

**Table 3. Environmental Tests**

| Test | Reference | Test Conditions | Units Tested | Unit Failed |
|---|---|---|---|---|
| Temperature Cycle | Agilent Req. | -55/100°C 15 min dwell<br>5 min transfer, 1000 cycles | 5168 | 0 |
| Resistence to Soldering Heat | MIL-Std-883 Ref. 2003 | 260 °C for 10seconds | 72 | 0 |
| Solderability | MIL-STD-883 Ref.2003 | 240 °C for 5 seconds,<br>>95% solder coverage of lead | 22 | 0 |
| Pulse Test | Agilent Req. | Ta=25 °C, Duty factor=10%,<br>100mA, Freq=1kHz, 1000hours | 252 | 0 |
| High Temperature Storage | MIL-STD-883 Ref. 1005 | 100 °C for 1000hours | 693 | 0 |
| Moisture Sensitivity Test | EIA/JESD 22-A112-A: Level 2a | | 28 | 0 |
| ESD Characterization | HBM: EIA/JESD 22-A114-A: Class 2,<br>MM: EIA/JESD 22-A115-A: Class C | | 10<br>10 | 0<br>0 |



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AV01-0138EN - May 2, 2006