T1-3/4 (5 mm) Super Bright Precision Optical Performance InGaN Round and Oval LEDs

Reliability Data Sheet

HLMP-CB11/HLMP-CM11/HLMP-CE11
HLMP-CB12/HLMP-CM12/HLMP-CE12
HLMP-CB26/HLMP-CM26/HLMP-CE26
HLMP-CB27/HLMP-CM27/HLMP-CE27
HLMP-CB36/HLMP-CM36/HLMP-CE36
HLMP-CB37/HLMP-CM37/HLMP-CE37
HLMP-HB57/HLMP-HM57
HLMP-AB87/HLMP-AM87

Description

The following cumulative test results have been obtained from testing performed at Avago Optoelectronics Division in accordance with the latest revision 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.

Table 1. Life Tests Demonstrated Performance

				Units	Point Typical Performance	
Colors	Stress Test Conditions	Total Device Hours	Units Tested	Failed Total	MTBF	Failure Rate (%/1K Hours)
InGaN Blue	T_A = 55°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Blue	T_A=85°C, 85%RH, I_F = 10 mA	84,000	84	0	84,000	≤1.19
InGaN Blue	T_A = 25°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Blue	T_A=-40°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Green	T_A = 55°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Green	T_A=85°C, 85%RH, I_F = 10 mA	84,000	84	0	84,000	≤1.19
InGaN Green	T_A = 25°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Green	T_A=-40°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Cyan	T_A = 55°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Cyan	T_A=85°C, 85%RH, I_F = 10 mA	84,000	84	0	84,000	≤1.19
InGaN Cyan	T_A = 25°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19
InGaN Cyan	T_A=-40°C, I_F = 30 mA	84,000	84	0	84,000	≤1.19

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:

$$T_J = T_A + \theta_{JA} \cdot P_{AVG}$$

Where
T_A = ambient temperature in °C

θ_{JA} = thermal resistance of junction-to-ambient in °C/W

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 2. Reliability Prediction
InGaN Blue (I_F = 30 mA)[4]

		Point Typical Performance in Time[1] (60% Confidence)		Performance in Time[2] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTBF [1]	Failure Rate (%/1K Hours)	MTBF[2]	Failure Rate (%/1K Hours)
85	111	28,000	3.581	12,000	8.244
75	101	40,000	2.530	17,000	5.825
65	91	57,000	1.753	25,000	4.037
55	81	84,000	1.190	36,000	2.741
45	71	127,000	0.790	55,000	1.820
35	61	195,000	0.512	85,000	1.179
25	51	310,000	0.323	135,000	0.743

InGaN Green (If = 30 mA DC)[4]

		Point Typical Performance in Time[1] (60% Confidence)		Performance in Time[2] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTBF [1]	Failure Rate (%/1K Hours)	MTBF[2]	Failure Rate (%/1K Hours)
85	109	28,000	3.624	12,000	8.344
75	99	39,000	2.551	17,000	5.874
65	89	57,000	1.761	25,000	4.055
55	79	84,000	1.190	36,000	2.741
45	69	127,000	0.787	55,000	1.811
35	59	197,000	0.507	86,000	1.167
25	49	315,000	0.318	137,000	0.732

Table 2. Reliability Prediction (Continued)

InGaN Cyan (I_F = 30mA DC)

		Point Typical Performance in Time[1] (60% Confidence)		Performance in Time[2] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTBF [1]	Failure Rate (%/1K Hours)	MTBF[2]	Failure Rate (%/1K Hours)
85	110	28,000	3.602	7,000	14.011
75	100	39,000	2.540	10,000	9.880
65	90	57,000	1.757	15,000	6.835
55	80	84,000	1.190	22,000	4.630
45	70	127,000	0.788	33,000	3.066
35	60	196,000	0.509	50,000	1.981
25	50	312,000	0.320	80,000	1.246

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 does not emit light.
4. Above calculation is based on test condition of 55°C and θ_{JA} = 240°C/W.

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:

(1.190 %/1K hours) x 0.25 X (8760 hours/year) = 2.610% per year

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

(2.741/1K hours) X 0.25 X (8760 hours/year) = 6.00% per year.

Table 3. Environmental Tests

Test Name	Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	MIL-STD-88 Method 1010	-40°C to 100°C, 15 min. dwell, 5 min. transfer, 300 cycles	4500	0
Pulse Test	Avago Requirement	55°C, 100 mA Peak, Freq 1kHz, DF 10%, 1000 hours	168	0
High Temperature Storage	MIL-STD-883 Method 1005	100°C, 1000 hours	168	0
Low Temperature Storage	MIL-STD-883 Method 1005	-40°C, 1000 hours	168	0
Humidity and High Temperature Storage	MIL-STD-883 Method 1005	85°C/85% RH, 1000 hours	168	0
Humidity Reverse Bias	Avago Requirement	85°C/85% RH, 5 Vbr, 1000 hrs	168	0
Resistance to Solder	MIL-STD-883 Method 2003	260°C for 10 sec	90	0

Table 4. Electrical Test

Test Name	Reference	Test Conditions	Units Tested	Units Failed
ESD	EIA/JESD 22-A114-A	Human body model - Class 1	18	0
	EIA/JESD 22-A115-A	Machine model - Class 1	18	0

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