Agilent Technologies
Innovating the HP Way

Autoinsertable 3 mm LED Lamps

Reliability Data

HLMP-N10X HLMP-N60X
HLMP-N20X HLMP-NL05
HLMP-N30X HLMP-NH01
HLMP-N40X HLMP-NG05
HLMP-N50X

Description

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

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.

Table 1. Life Tests

Demonstrated Performance

					Point Typical Performance	
Colors	**Stress Test Conditions**	**Total Device Hrs.**	**Units Tested**	**Total Failed**	**MTBF**	**Failure Rate (% /1K Hours)**
HER, Orange, Emerald Green, Green and Yellow	T_A = 85°C I_F = 13 mA	672,000	672	0	672,000	0.149
DH AS AlGaAs (Red)	T_A = 85°C I_F = 15 mA	112,000	112	0	112,000	0.893
AS AlInGaP (Amber, R/O & Red)	T_A = 85°C I_F = 15 mA	336,000	336	0	336,000	0.298

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

θ_{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 2A. HER, Orange, Emerald Green and Green, 85°C @ 13 mA

		Point Typical Performance [1] in Time		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	+94	672,000	0.149	292,000	0.343
+75	+84	983,000	0.102	427,000	0.234
+65	+74	1,471,000	0.068	639,000	0.156
+55	+64	2,254,000	0.044	979,000	0.102
+45	+54	3,545,000	0.028	1,540,000	0.065
+35	+44	5,737,000	0.017	2,492,000	0.040
+25	+34	9,580,000	0.010	4,161,000	0.024

Table 2B. DH AlGaAs, 85°C @ 15 mA

Ambient Temperature (°C)	Junction Temperature (°C)	MTBF [1]	Failure Rate (%/1K Hours)	MTBF [2]	Failure Rate (%/1K Hours)
+85	+94	112,000	0.893	49,000	2.065
+75	+84	164,000	0.610	71,000	1.405
+65	+74	245,000	0.408	106,000	0.939
+55	+64	376,000	0.266	163,000	0.613
+45	+54	591,000	0.169	257,000	0.390
+35	+44	956,000	0.105	415,000	0.241
+25	+34	1,597,000	0.063	693,000	0.144

Table 2C. AS AlInGaP, 55°C @ 15 mA

Ambient Temperature (°C)	Junction Temperature (°C)	MTBF [1]	Failure Rate (%/1K Hours)	MTBF [2]	Failure Rate (%/1K Hours)
+85	+93	336,000	0.298	146,000	0.685
+75	+83	493,000	0.203	214,000	0.467
+65	+73	739,000	0.135	321,000	0.312
+55	+63	1,135,000	0.088	493,000	0.203
+45	+53	1,790,000	0.056	777,000	0.129
+35	+43	2,905,000	0.034	1,262,000	0.079
+25	+33	4,867,000	0.021	2,114,000	0.047

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.

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

For HER, Orange, Emerald Green, Green and Yellow, 85°C @ 13 mA:

The point failure rate per year (8760 hours) at 85°C ambient temperature is:

(0.149% / 1K hours) x 0.25 x (8760 hours/year) = 0.33% per year

Similarly, 90% confidence level failure rate per year at 85°C:

(0.343% / 1K hours) x 0.25 x (8760 hours/year) = 0.75% per year

Table 3. Environmental Tests

Test Name	MIL-STD-883C Reference	JIS C 7021 Ref.	Test Conditions	Units Tested	Units Failed
Autoinsertion, Wave Solder and Temperature Cycle	1010	Method A-4	A/I, IR exposure (130°C to 150°C for 90 to 120 sec.), Wave solder (250°C ±10°C for 5 sec.) and TMCL (-40°C to 85°C; 30 min. dwell, 5 min. transfer) for 5 cycles	55,309	7
Temperature Cycle	1010	Method A-4	TMCL (-40°C to 85°C; 30 min. dwell, 5 minute transfer) for 1500 cycles	500	0
Resistance to Soldering Heat	2003	Method A-1 Cond. A	250°C for 5 seconds/2x dip	55,309	0
Solderability	2003	Method A-2	230°C for 5 sec. 1 to 1.5 mm from body, 95% solder coverage of immersed area	120	0
Humidity Operational Life	Agilent Req.	Agilent Req.	85°C, 85% RH, @ 13 mA, 1000 hours	448	0
Humidity Storage Life	Agilent Req.	Agilent Req.	85°C, 85% RH, 1000 hours	560	0
Resistance to Solvents	2015	N/A	1. Z Propanol/mineral spirit solution (1:3 by volume). 2. Propylene glycol monomethylether/monoethanolamine/DI water solution (1:1:42 by volume). 3. Semiaquous solvent with a minimum of 60% limonene and Skysol 600.	60	0
ESD		EIAJ ED-4701	Method C-111, Condition A	60	0

Table 4. Mechanical Tests

Test Name	MIL-STD-883C Reference	JIS C 7021 Ref.	Test Conditions	Units Tested	Units Failed
Mechanical Shock	2002	Method A-7 Condition F	Max. Acceleration: 14700 m/s^2 with 0.5 m/s pulse width, 3X each direction	60	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	60	0
Free Drop Test	N/A	Method A-8	Drop from 75 cm 3X	60	0
Termination Strength	2004	Method A-11 Tests I and III	1 kg. load for 30 sec. 5 N. load on lead with ±90° bend	60	0
Constant Acceleration	2001	Method A-9 Condition D	1 min. each 6 directions, 196,000 m/s^2	60	0

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