High Performance Surface Mount LEDs

Reliability Data Sheet

Description

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

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) + θ_{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 1. Life Tests
Demonstrated Performance

					Point Typical Performance	
Colors	Stress Test Conditions	Total Device Hrs.	Units Tested	Units Failed	MTBF	Failure Rate (% /1K Hours)
Red/amber/ Red-orange	T_A = 25°C I_F = 70 mA	84,000	84	0	84,000	≤ 1.190
Red/amber/ Red-orange	T_A = 55°C I_F = 70 mA	84,000	84	0	84,000	≤ 1.190
Red/amber/ Red-orange	T_A = -40° I_F = 70 mA	84,000	84	0	84,000	≤ 1.190

Table 2. Failure Rate Prediction (I_F = 70 mA)
Demonstrated Performance

		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	119	30,000	3.339	13,000	7.688
75	109	42,000	2.393	18,000	5.510
65	99	59,000	1.684	26,000	3.878
55	89	86,000	1.163	37,000	2.677
45	79	127,000	0.786	55,000	1.810
35	69	193,000	0.519	84,000	1.196
25	59	299,000	0.335	130,000	0.771

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.

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 25°C ambient temperature is:

(0.335% / 1K hours) x (0.25) x (8760 hours/year) = 0.733% per year

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

(0.771% / 1K hours) x (0.25) x (8760 hours/year) = 1.688% per year

Table 3. Environmental Tests

Test Name	Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	MIL-STD-883 Method 1010	-55 to 100°C 15 min. dwell, 5 min. transfer, air to air storage, 100 cycles	4500	0
Solderability	MIL-STD-883 Method 2003 and JIS C 5033 Method A-2	8 hours aging and solder dip at 240°C for 5 seconds	15	0
High Temperature Storage	JIS 7021 Method B-11	100°C	84	0
Humidity Storage	JIS 7021 Method B-11	85°C/85% RH, 1000 hrs	84	0
Humidity Forward Bias	JIS C 7021 Method B-11, Cond. C	85°C/85% RH, 30 mA, 1000 hrs	224	0
Pulse Tests		25°C, 100 mA Frequency = 1 kHz, duty factor = 10%	84	0
Solder Heat Resistance	JESD22 B-106	260°C, for 10 seconds	50	0

Table 4. Characterization Tests

Test Name	Reference	Test Conditions	Units Tested	Units Failed
TMCL (Pb-Free)	MIL-STD-883 Method 1010	-55 to 100°C 15 min. dwell, 5 min. transfer, air to air storage, 100 cycles	112	0
Moisture Sensitivity (Level 2a)		Precondition for 120 hrs @ 60°C/60% RH, 3xIR 230 ± 5°C for 10 seconds, -40°C/100°C, 15 min. dwell, 5 min. transfer, 100 cycles	84	0

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