HSMF-C15x

Bicolor Surface Mount Chip LEDs

Reliability Data Sheet

HSMF-C153, HSMF-C155, HSMF-C156 and HSMF-C157

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.

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 Table 1.

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)**
GaP HER/Yellow, AlInGaP Amber/ Green, GaP Her/Green, GaP Yellow/Green, GaP Orange/Green	T_A = 25°C I_F = 25 mA	32,000	32	0	32,000	≤ 3.125
GaP HER/Yellow, AlInGaP Yellow/ Green, GaP Her/Green, GaP Yellow/Green, GaP Orange/Green	T_A = 55°C I_F = 5 mA	88,000	88	0	88,000	≤ 1.14
GaP HER/Yellow, AlInGaP Yellow/ Green, GaP Her/Green, GaP Yellow/Green, GaP Orange/Green	T_A = -40°C I_F = 25 mA	32,000	32	0	32,000	≤ 3.125

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 2. Reliability Predictions (I_F = 25 mA DC)

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	90	67,500	1.48	26,900	3.72
75	85	81,000	1.23	32,200	3.11
65	81	97,800	1.02	38,900	2.57
55	76	118,600	0.84	47,200	2.12
45	66	180,800	0.55	72,000	1.39
35	56	282,900	0.35	112,600	0.89
25	46	455,300	0.22	181,200	0.55

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 and maximum percent I_V degradation is >50%.

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:

(0.22% / 1K hours) x (0.25) x (8760 hours/year) = 0.482 % per year

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

(0.55% / 1K hours) x (0.25) x (8760 hours/year) = 1.20% per year

Table 3. Environmental Tests

(IR reflow solder processed at 230 ±5°C for 10 seconds)

Test Name	Reference	Test Conditions		Units Tested	Units Failed
Temperature Cycle	MIL-STD-883 Method 1010	-40°C to 85°C, 15 min. dwell, 5 min. transfer, air to air storage			
			5 cycles	2300	0
			20 cycles	2300	0
			50 cycles	2300	0
			100 cycles	2800	2 open
			300 cycles	2298	0
Humidity Temperature Cycle		60°C, 90% RH, 10 mA			
			240 hours	32	0
			500 hours	32	0
			1000 hours	32	0
Temperature/Humidity Storage	JIS C 7021 Meth. B-11, cond. B	60°C, 90% RH, unbias			
			500 hours	50	0
High Temperature Storage	JIS C 7021 Meth. B-10, cond. C	85°C, unbias			
			1000 hours	50	0
Low Temperature Storage	JIS C 7021 Meth. B-12	-40°C, unbias			
			1000 hours	50	0
Solderability Test	JIS C 7021 Method A-2	230°C ±5°C, dwell time = 5 sec. ±1 sec.		50	0
Solder Resistance Test		250°C ±15°C, dwell time = 5 sec. ±1 sec.		50	0

Table 4. Moisture Sensitivity Level Characterization

TEST MATRIX

(a) Visual Inspection Data

					Floor Life	
Level	**Reference**	**Precondition**	**Soak Time**	**3xIR**	**Time**	**Conditions**
1	J-STD-020A	85°C/85% RH	168 hours	4 Minor lifted DA	1 year	- 30°C/85% RH
2a	J-STD-020A	85°C/60% RH	120 hours	0	4 weeks	- 30°C/60% RH
3	J-STD-020A	60°C/60% RH	40 hours	0	168 hours	- 30°C/60% RH
4	J-STD-020A	60°C/60% RH	20 hours	0	72 hours	- 30°C/60% RH

(b) Electrical Test Data

			TMCL@ -40°C / 85°C		Floor Life	
Level	**Reference**	**3xIR**	**5x**	**20x**	**Time**	**Conditions**
1	J-STD-020A	0	0	0	1 year	- 30°C/85% RH
2a	J-STD-020A	0	0	0	4 weeks	- 30°C/60% RH
3	J-STD-020A	0	0	0	168 hours	- 30°C/60% RH
4	J-STD-020A	0	0	0	72 hours	- 30°C/60% RH

Conclusion:

No functional failures were detected in all levels up to 20xTMCL. However, based on visual inspection data, minor lifted die-attach was found in lots that precondition with JEDEC Level 1 which potentially can affect long term reliability. Therefore, Chip LED was classified as a Level 2a product.