

## 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 and JEDEC.

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 junction temperature of the device determines the failure rate of semiconductor devices. The relationship between ambient temperature and actual junction temperature is given by the following:

$$T_J(^{\circ}\text{C}) = T_A(^{\circ}\text{C}) + \theta_{JA} P_{AVG}$$

Where;

$T_A$  = ambient temperature in ( $^{\circ}\text{C}$ )

$\theta_{JA}$  = thermal resistance of junction-to ambient in  $^{\circ}\text{C}/\text{watt}$

$P_{AVG}$  = average power dissipated in watts

The estimated MTTF 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 below using activation energy of 0.43eV (reference MIL-HDBK-217).

**Table 1. Life Tests Demonstrated Performance**

Colors	Stress Test Conditions	Total Device Hours	Units Tested	Units Failed	Point Typical Performance	
					MTBF (60% Confidence)	Failure Rate (%/1K Hrs)
Green	$T_A = 55^{\circ}\text{C}$ , $I_F = 20 \text{ mA}$	56,000	56	0	61,100	1.64
Blue / Ice Blue / Cool White	$T_A = 55^{\circ}\text{C}$ , $I_F = 18 \text{ mA}$	56,000	56	0	71,700	1.39

## Reliability Prediction

Table 2a. Green ( $I_f = 20\text{mA}$ )

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance in Time <sup>[1-5]</sup> (60% Confidence)		Performance in Time <sup>[1-5]</sup> (90% Confidence)	
		MTTF	Failure Rate (%/1K Hours)	MTTF	Failure Rate (%/1K Hours)
100	125	38500	2.60	15300	6.54
95	125	39200	2.55	15600	6.41
90	124	40000	2.50	15900	6.29
85	123	40700	2.46	16200	6.17
80	123	41500	2.41	16500	6.06
75	122	42300	2.36	16800	5.95
70	122	43100	2.32	17200	5.81
65	121	43900	2.28	17500	5.71
60	116	51700	1.93	20600	4.85
55	111	61100	1.64	24300	4.12
50	106	72500	1.38	28900	3.46
45	101	86500	1.16	34400	2.91
40	96	103600	0.97	41200	2.43
35	91	124700	0.80	49600	2.02
30	86	151000	0.66	60100	1.66
25	81	183700	0.54	73100	1.37

Table 2b. Blue / Ice Blue / Cool White ( $I_f = 18\text{mA}$ )

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance in Time <sup>[1-5]</sup> (60% Confidence)		Performance in Time <sup>[1-5]</sup> (90% Confidence)	
		MTTF	Failure Rate (%/1K Hours)	MTTF	Failure Rate (%/1K Hours)
100	108	63800	1.57	25400	3.94
95	108	64600	1.55	25700	3.89
90	107	65400	1.53	26000	3.85
85	107	66300	1.51	26400	3.79
80	107	67100	1.49	26700	3.75
75	106	68000	1.47	27100	3.69
70	106	68900	1.45	27400	3.65
65	106	69800	1.43	27800	3.60
60	105	70700	1.41	28200	3.55
55	105	71700	1.39	28500	3.51
50	104	72600	1.38	28900	3.46
45	99	86700	1.15	34500	2.90
40	94	104100	0.96	41400	2.42
35	89	125600	0.80	50000	2.00
30	84	152200	0.66	60600	1.65
25	79	185600	0.54	73900	1.35

Notes:

1. The 60% or 90% confidence MTTF represents the minimum level of reliability performance which is expected from 60% or 90% of all samples. The confidence level is established based on the chi-square distribution.
2. Failure rate (FIT) is  $1/\text{MTTF} \times 10^5$ , assuming the failures are exponentially distributed
3. A failure is any LED that is open, shorted or fails to emit light.
4. Calculated from data generated at 55°C biased at 20mA (Green) 18mA (Blue/Ice Blue/Cool White).
5. Junction temperature is calculated based on  $\theta_{JA} = 850^\circ\text{C/W}$

## Example of Failure Rate Calculation

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

$$(8 \text{ hours/day}) \times (5 \text{ days/week}) / (168 \text{ hours/week}) = 0.24$$

The point failure rate per year (8760 hours) at 25°C ambient temperature is (60% confidence level):

$$(0.54\%/1\text{K hours}) \times 0.24 \times (8760 \text{ hours/year}) = 1.13\% \text{ per year}$$

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

$$(1.35\%/1\text{K hours}) \times 0.24 \times (8760 \text{ hours/year}) = 2.84\% \text{ per year.}$$

**Table 3. Environmental Tests**

Test Name	Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	Avago Req.	-40/100°C 15 min dwell, 5 min transfer, 1000 cycles	468	0
Resistance to Soldering Heat	JESD 22-B106	260°C for 10 seconds, 2x	30	0
Temperature Humidity Power Cycle	Avago Req.	25/65°C, 95%RH Dwell time: 3 6 3 hrs I <sub>F</sub> = 15mA, 5 mins on/off for 100cyc	231	0
Power Temperature Cycle	Avago Req.	-40/85°C, Dwell time: 15 15 15 Min I <sub>F</sub> = 8mA, 5 mins on/off for 1000cyc	231	0
Unbiased AutoClave	JESD22-A102	T <sub>A</sub> = 121°C, 100%RH, Vapor Pressure = 205kPa for 96 hours	231	0
Temperature Humidity Storage Life	Avago Req.	T <sub>A</sub> = 85°C, 85%RH, for 1000 hours	168	0
Temperature Humidity Operating Life	JESD22-A101	T <sub>A</sub> = 85°C, 85%RH, I <sub>F</sub> = 13 mA for 1000 hours	84	0
High Temperature Operating Life	JESD22-A108	T <sub>A</sub> = 85°C, I <sub>F</sub> = 8 mA for 1000 hours	84	0
Room Temperature Operating Life	JESD22-A108	T <sub>A</sub> = 25°C, I <sub>F</sub> = 20 mA for 1000 hours	84	0

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