

Reliability Data

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 and JIS C 7021.

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.

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:

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

where

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

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

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

Colors	Stress Test Conditions	Total Device Hrs.	Units Tested	Total Failed	Point Typical Performance	
					MTBF	Failure Rate (% /1K Hours)
HER, Orange, Emerald Green and Green	$T_A = 55^\circ\text{C}$ $I_F = 30 \text{ mA}$	17,232,000	7,152	0	17,232,000	0.006
Yellow	$T_A = 55^\circ\text{C}$ $I_F = 20 \text{ mA}$	7,849,000	2,688	0	7,849,000	0.013
STD Red	$T_A = 55^\circ\text{C}$ $I_F = 50 \text{ mA}$	1,540,000	1,540	0	1,540,000	0.065

Table 2A. HER, Orange, Emerald Green and Green, 55°C @ 30 mA

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance ^[1] in Time		Performance in Time ^[2] (90% Confidence)	
		MTBF ^[1]	Failure Rate (%/1K Hours)	MTBF ^[2]	Failure Rate (%/1K Hours)
+85	+116	5,900,000	0.017	1,517,000	0.066
+75	+106	8,276,000	0.014	2,128,000	0.047
+65	+96	11,824,000	0.010	3,040,000	0.033
+55	+86	17,232,000	0.006	4,430,000	0.023
+45	+76	25,662,000	0.004	6,598,000	0.015
+35	+66	39,125,000	0.003	10,059,000	0.010
+25	+56	61,200,000	0.002	15,735,000	0.006

Table 2B. Yellow, 55°C @ 20 mA

Ambient Temperature (°C)	Junction Temperature (°C)	MTBF ^[1]	Failure Rate (%/1K Hours)	MTBF ^[2]	Failure Rate (%/1K Hours)
+95	+113	1,761,000	0.057	453,000	0.221
+85	+103	2,484,000	0.040	639,000	0.157
+75	+93	3,569,000	0.028	918,000	0.109
+65	+83	5,235,000	0.019	1,346,000	0.074
+55	+73	7,849,000	0.013	2,018,000	0.050
+45	+63	12,056,000	0.008	3,100,000	0.032
+35	+53	19,013,000	0.005	4,888,000	0.020
+25	+43	30,861,000	0.003	7,934,000	0.013

Table 2C. STD Red, 55°C @ 50 mA

Ambient Temperature (°C)	Junction Temperature (°C)	MTBF ^[1]	Failure Rate (%/1K Hours)	MTBF ^[2]	Failure Rate (%/1K Hours)
+75	+109	784,000	0.134	325,000	0.308
+65	+99	1,063,000	0.094	462,000	0.217
+55	+89	1,540,000	0.065	669,000	0.150
+45	+79	2,278,000	0.044	989,000	0.101
+35	+69	3,448,000	0.029	1,498,000	0.067
+25	+59	5,351,000	0.019	2,324,000	0.043

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:

$$(8 \text{ hours/day}) \times (5 \text{ days/week}) / (168 \text{ hours/week}) = 0.25$$

For HER, Orange, Emerald Green and Green, 55°C @ 30 mA:

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

$$(0.017\% / 1\text{K hours}) \times 0.25 \times (8760 \text{ hours/year}) = 0.037\% \text{ per year}$$

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

$$(0.066\% / 1\text{K hours}) \times 0.25 \times (8760 \text{ hours/year}) = 0.145\% \text{ per year}$$

Table 3. Environmental Tests

Test Name	MIL-STD-883C Reference	JIS C 7021 Ref.	Test Conditions	Units Tested	Units Failed
Temperature Cycle	1010	Method A-4	-55°C to 100°C; 15 minute dwell, 5 minute transfer, 100 cycles	43,310	1
Resistance to Soldering Heat	2003	Method A-1 Cond. A	260°C for 5 seconds/2x dip	203,310	0
Solderability	2003	Method A-2	230°C for 5 sec. 1 to 1.5 mm from body, 95% solder coverage of immersed area	440	0
Humidity Storage	Avago Technologies Req.	Avago Technologies Req.	85°C, 85% RH, 1000 hours	672	0
Humidity Life	Avago Technologies Req.	Avago Technologies Req.	85°C, 85% RH, 20 mA, 1000 hours	5,460	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. Semiaqueous solvent with a minimum of 60% limonene and Skysol 600.	224	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

For product information and a complete list of distributors, please go to our web site: www.avagotech.com

Avago, Avago Technologies, and the A logo are trademarks of Avago Technologies, Pte. in the United States and other countries.
Data subject to change. Copyright © 2006 Avago Technologies Pte. All rights reserved.
5965-9643EN - June 12, 2006

