Reliability Data

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:

$T_J (°C) = T_A (°C) + \theta_{JA} P_{AVG}$

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 1. Life Tests
Demonstrated Performance

Test Name	Stress Test Conditions	Total Device Hrs.	Units Tested	Total Failed	Point Typical Performance	
					MTBF	Failure Rate (% /1K Hours)
High Temperature Operating Life	V_{CC} = 5.5 V, $V_A = V_B$ = 3.5 V T_A = 100°C 1000 hours	1,405,000	1,405	2	702,500	0.142
Temperature Humidity Operating Life	V_{CC} = 5.5 V $V_A = V_B$ = 3.5 V 1,000 hours T_A = 85°C RH = 85%	1,495,000	1,495	10	149,500	0.669

Table 2.

		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)
+100	+110	703,000	0.142	264,000	0.379
+90	+100	996,000	0.100	374,000	0.267
+80	+90	1,440,000	0.069	541,000	0.185
+70	+80	2,126,000	0.047	799,000	0.125
+60	+70	3,210,000	0.031	1,206,000	0.083
+50	+60	4,968,000	0.020	1,867,000	0.054
+40	+50	7,901,000	0.013	2,969,000	0.034
+30	+40	12,942,000	0.008	4,863,000	0.021
+20	+30	21,903,000	0.005	8,230,000	0.012

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. Failures are catastrophic or parametric. Catastrophic failures are open, short, no logic output, no dynamic parameters while parametric failures are failures to meet an electrical characteristic as specified in product catalog such as output voltage, duty or state errors.

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 50°C ambient temperature is:

(0.020% / 1K hours) x 0.25 x (8760 hours/year) = 0.044% per year

Similarly, 90% confidence level failure rate per year at 50°C:

(0.054% / 1K hours) x 0.25 x (8760 hours/year) = 0.118% per year

Table 3. Environmental Tests

Test Name	MIL-STD-883C Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	1010	-40°C to +100°C, 15 minute dwell, 5 minute transfer,		
		5 cycles	9,512	0
		200 cycles	1,570	3
		500 cycles	1,570	9
Solder Heat Resistance	2003	Sn/Pb 60/40 Solder; 260°C peak; 10 sec., 20 temp cycles @ -40°C to 85°C	38	0
High Temperature	N/A	T_A = +105°C	77	0
Storage Life		2,000 hours		

Table 4. Mechanical Tests

Test Name	MIL-STD-883C Reference	Test Conditions	Units Tested	Units Failed
Mechanical Shock	2002	5 blows; X, Y, Z axes, 1500 g, 0.5 msec.	5	0
Vibration Variable Frequency	2007	3 cycles, 4 min. each X, Y, Z axes, 20 g min.		
		20 to 2000 Hz	26	0
		5 to 1000 Hz	10	0
Terminal Strength	2004 Condition A	1 lb. for 30 seconds	15	0
Lead Fatigue	2004, Cond. B	3 bends, 15° minimum	15	0

Table 5. Electrical Tests

Test Name	MIL-STD-883C Reference	Test Conditions	Units Tested	Units Failed
ESD - Human Body Model	3015.2	1.5 KΩ, 100 pF, 5 positive and 5 negative discharges per pin. V_Z = 3.0 KV	35	0

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

5965-9642E - December 11, 2006