

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.

Table 1. Life Tests(One Chip On)

Demonstrated Performance

Colors	Stress Test Conditions	Total Device Hours	Units Tested	Total Failed	Point Typical Performance	
					MTTF (60% Confidence)	Failure Rate (% /1 K Hours)
AllnGaP	T _A = 70°C I _F = 50 mA	84000	84	0	91700	1.09
InGaN	T _A = 70°C I _F = 30 mA	84000	84	0	91700	1.09

Table 2. Life Tests(Three Chip On)

Demonstrated Performance

Colors	Stress Test Conditions	Total Device Hours	Units Tested	Total Failed	Point Typical Performance	
					MTTF (60% Confidence)	Failure Rate (% /1 K Hours)
AllnGaP	T _A = 25°C I _F = 50 mA	84000	84	0	91700	1.09
InGaN	T _A = 55°C I _F = 30 mA	84000	84	0	91700	1.09

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:

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

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 Watt

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 3. One Chip On- AlInGaP(Calculated from data generated at 70°C, 50mA)

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance ^[1] in Time (60% Confidence)		Point Typical Performance ^[2] in Time (90% Confidence)	
		MTTF ^[1]	Failure Rate (%/1K Hours)	MTTF ^[2]	Failure Rate (%/1K Hours)
110	121	54500	1.83	21700	4.61
105	119	58000	1.72	23100	4.33
100	117	61800	1.62	24600	4.07
95	115	65900	1.52	26200	3.82
90	113	70300	1.42	28000	3.57
85	111	75100	1.33	29900	3.34
80	109	80200	1.25	31900	3.13
75	107	85700	1.17	34100	2.93
70	105	91700	1.09	36500	2.74
65	100	109400	0.91	43500	2.30
60	95	131200	0.76	52200	1.92
55	90	158100	0.63	62900	1.59
50	85	191600	0.52	76300	1.31
45	80	233400	0.43	92900	1.08
40	75	286000	0.35	113800	0.88
35	70	352500	0.28	140300	0.71

Table 4. One Chip On- InGaN(Calculated from data generated at 70°C, 30mA)

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance ^[1] in Time (60% Confidence)		Point Typical Performance ^[2] in Time (90% Confidence)	
		MTTF ^[1]	Failure Rate (%/1K Hours)	MTTF ^[2]	Failure Rate (%/1K Hours)
110	121	51100	1.96	20300	4.93
105	119	54800	1.82	21800	4.59
100	117	58800	1.70	23400	4.27
95	115	63200	1.58	25200	3.97
90	113	68000	1.47	27000	3.70
85	110	73100	1.37	29100	3.44
80	108	78800	1.27	31400	3.18
75	106	84900	1.18	33800	2.96
70	104	91700	1.09	36500	2.74
65	99	109500	0.91	43600	2.29
60	94	131500	0.76	52300	1.91
55	89	158700	0.63	63200	1.58
50	84	192500	0.52	76600	1.31
45	79	234800	0.43	93500	1.07
40	74	288100	0.35	114700	0.87
35	69	355500	0.28	141500	0.71

Table 5. Three Chip On- AlInGaP(Calculated from data generated at 25°C, 50mA)

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance ^[1] in Time (60% Confidence)		Point Typical Performance ^[2] in Time (90% Confidence)	
		MTTF ^[1]	Failure Rate (%/1K Hours)	MTTF ^[2]	Failure Rate (%/1K Hours)
100	112	36500	2.74	14500	6.90
95	111	38700	2.58	15400	6.49
90	109	41000	2.44	16300	6.13
85	107	43500	2.30	17300	5.78
80	106	46100	2.17	18400	5.43
75	104	49000	2.04	19500	5.13
70	102	52000	1.92	20700	4.83
65	100	55200	1.81	22000	4.55
60	99	58700	1.70	23400	4.27
55	97	62500	1.60	24900	4.02
50	95	66500	1.50	26500	3.77
45	94	70800	1.41	28200	3.55
40	92	75500	1.32	30000	3.33
35	90	80500	1.24	32000	3.13
30	89	85900	1.16	34200	2.92
25	87	91700	1.09	36500	2.74

Table 6. Three Chip On- InGaN(Calculated from data generated at 55°C, 30mA)

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance ^[1] in Time (60% Confidence)		Point Typical Performance ^[2] in Time (90% Confidence)	
		MTTF ^[1]	Failure Rate (%/1K Hours)	MTTF ^[2]	Failure Rate (%/1K Hours)
100	120	77400	1.29	30800	3.25
95	119	78900	1.27	31400	3.18
90	119	80300	1.25	32000	3.13
85	118	81800	1.22	32600	3.07
80	118	83400	1.20	33200	3.01
75	117	85000	1.18	33800	2.96
70	116	86600	1.15	34500	2.90
65	116	88200	1.13	35100	2.85
60	115	89900	1.11	35800	2.79
55	115	91700	1.09	36500	2.74
50	110	108400	0.92	43200	2.31
45	105	128900	0.78	51300	1.95
40	100	153800	0.65	61200	1.63
35	95	184500	0.54	73500	1.36
30	90	222500	0.45	88600	1.13
25	85	269700	0.37	107300	0.93

Notes:

1. The 60% or 90% confidence MTBF 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 (%/1K hours) is $1/\text{MTBF} \times 10^5$, assuming the failures are exponentially distributed.
3. Failure criteria: open, short, dim or parametric failure.
4. Junction temperature is calculated based on $\theta_{JA} = 340^\circ\text{C/W}$ (1 chip on) and $\theta_{JA} = 600^\circ\text{C/W}$ (3 chip on)

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 35 °C ambient temperature is(60% confidence level) :

$$(0.28\% / 1\text{K hours}) \times 0.24 \times (8760 \text{ hours/year}) = 0.589\% \text{ per year (AlInGaP, one chip on)}$$

Similarly, 90% confidence level failure rate per year at 35 °C:

$$(0.71\% / 1\text{K hours}) \times 0.24 \times (8760 \text{ hours/year}) = 1.49\% \text{ per year (AlInGaP, one chip on)}$$

Table 7. Environmental Tests

Test Name	MIL-STD/JEDEC Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	JESDA104	-40°C/110°C, 15 min dwell, 5 min transfer, 200 cycles	8216	0
Low Temperature Operating Life	JESDA108	Ta=-40°C, 1000hrs If= 50mA(AlInGaP), 30mA(InGaN)	84	0
High Temperature Operating Life	JESDA108	Ta=110°C, 1000hrs(1 Chip On) If= 15mA(AlInGaP), 10mA(InGaN) Ta=100°C, 1000hrs (3 Chip On) If= 10mA(AlInGaP, InGaN)	84	0
Temperature Humidity Operating Life	JESDA101	Ta= 85°C,RH = 85%RH 1000hrs(1 Chip On) If= 35mA(AlInGaP), 25mA(InGaN) Ta= 85°C, RH = 85%RH, 1000hrs(3 Chip On) If= 17mA(AlInGaP,InGaN)	84	0
Temperature Humidity Storage Life	JESDA101	Ta= 85°C, RH = 85%RH, 1000hrs	84	0
High Temperature Storage Life	JESDA103	Ta = 110°C, 1000hrs	84	0
Low Temperature Storage Life	JESDA108	Ta = -40°C, 1000hrs	84	0
Pulse Test	Auto Req	Ta=25°C, DF=0.5%, Freq= 500Hz, 1000hrs (3 Chip On) If= 300mA(AlInGaP), 100mA(InGaN)	84	0

Table 8. Mechanical Tests

Test Name	MIL-STD/JEDEC Reference	Test Conditions	Units Tested	Units Failed
Mechanical shock	JESDB104	5 shocks each X1, X2, Y1, Y2, Z1, Z2, 1500G, 0.5msec pulse	30	0

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