

NPN Silicon Bipolar Transistor

Reliability Data

AT-41511
AT-41533

The following cumulative test results have been obtained from testing performed at Hewlett-Packard in accordance with the latest revision of MIL-STD-883. Data was gathered from the

product qualification, reliability monitor, and engineering evaluation.

For the purpose of this reliability data sheet, a failure is any part

which fails to meet the electrical and/or mechanical specification listed in the Communications Components Designer's Catalog.

1. Life Test

A. Demonstrated Performance

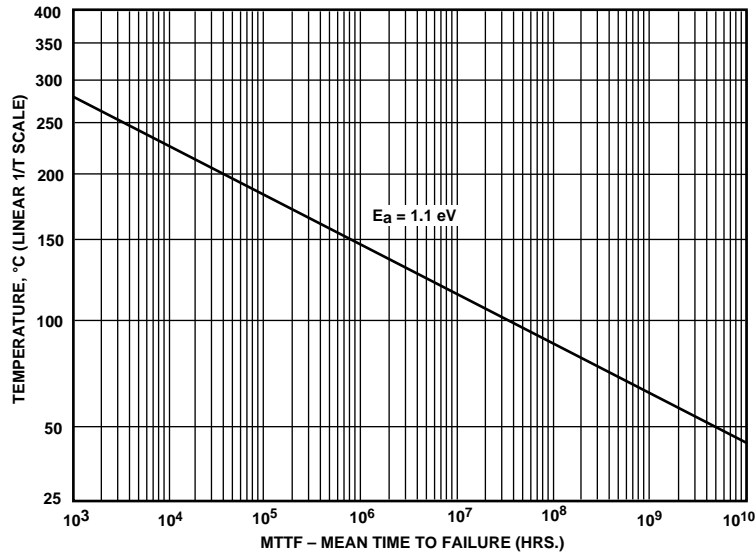
Test Name	Test Condition	Units Tested	Total Device Hrs.	Total Failed	Failure Rate (%/1K Hours)
High Temperature Operating Life (O.L.)	$T_j = 150^\circ\text{C}$	77	77,000	0	0
HTRB	$T_A = 121^\circ\text{C}$ $V_{CB} = 16\text{ V}$	76	76,000	0	0

B. Failure Rate Prediction

The failure rate will depend on the junction temperature of the device. The estimated life at different temperatures is calculated, using the Arrhenius plot with activation energy of 1.1eV, and the device thermal resistance on stress board of 130°C/W, and is listed in the following table.

Junction Temp. T_j (°C)	Point(1)		90% Confidence Level(2)	
	MTTF* (hours)	FIT(3)	MTTF (hours)	FIT(3)
175	1.3×10^5	7692	5.65×10^4	17692
150	6.94×10^5	1440	3.02×10^5	3314
125	4.57×10^6	218.8	1.68×10^7	503.3
100	3.87×10^7	25.8	1.99×10^6	59.4
55	4.13×10^9	0.242	1.79×10^9	0.56

*MTTF data calculated from high temperature Operating Life tests.



Notes:

1. The point MTTF is simply the total device hours divided by the number of failures.
2. This MTTF and failure rate represent the performance level for which there is a 90% probability of the device doing better than the stated value. The confidence level is based on the statistics of failure distribution. The assumed distribution is exponential. This particular distribution is commonly used in describing useful life failures.
3. FIT is defined as Failure in Time, or specifically, failures per billion hours. The relationship between MTTF and FIT is as follows: $FIT = 10^9 / (MTTF)$

C. Example of Failure Rate Calculation:

At 100°C with a device operating 8 hours a day, 5 days a week, the percent utilization is:

$$\% \text{ Utilization} = (8 \text{ hrs/day} \times 5 \text{ days/wk}) \div 168 \text{ hrs/wk} \cong 25\%$$

Then the point failure rate per year is:

$$(25.8 \times 10^{-9}) \times (25\%) \times (8760 \text{ hrs/yr}) = 5.65 \times 10^{-3} \% \text{ per year}$$

Likewise, the 90% confidence level failure rate per year is:

$$(59.4 \times 10^{-9}) \times (25\%) \times (8760 \text{ hrs/yr}) = 1.3 \times 10^{-2} \% \text{ per year}$$

2. Environmental and Mechanical Tests

Test Name	MIL-STD-750 Reference	Test Conditions	Units Tested	Total Failed
Thermal Shock	1056	-65°C to 150°C, 5 min. dwell, 200 cycles	77	0
Temperature Cycle	1051	-65°C to 150°C, 10 min. dwell, 200 cycles	77	0
AutoClave	HPGSS 12-109	121°C, 15 PSIG, 96 hrs	76	0

3. Flammability Test

(MIL-STD-202, Method 111):

Meets Needle Flame test per UL Category D (Flaming Time <3 sec.) under Material Classification 94VO.

4. DOD-HDBK-1686 ESD

Classification:

AT-41511/41533 Class I