

# **MAXIM**

## ***High-Speed Bipolar and BiCMOS Process Reliability Report***

*This report presents the reliability data for Maxim's bipolar and BiCMOS processes for high-speed analog and digital products. The data was acquired from extensive reliability stress testing performed between 1997 and 2002. It is separated into the following eight fabrication processes: CP1, CB2, CB3, GST1, GST2, GST3, GST4 and MB1.*

*Over 6 million device hours have been accumulated for the products stressed at an operating junction temperature of 150°C during the period. Data in this report is typical, and demonstrates the consistently high level of reliability of Maxim's high-speed products.*

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## Fabrication Processes

Maxim is currently running the following eight major high-frequency-bipolar and BiCMOS processes:

- CP1

CP1 is a recessed-oxide-isolated, high-speed, complementary bipolar process designed for superior performance and flexibility. Unique to CP1 is an optional dual-gate P-channel JFET with one extra mask. The feature which most differentiates this process from previous process technologies is the availability of vertical PNP transistors with  $f_T=5.5$  GHz at  $V_{CE}=4$  Volts.

- CB2

CB2 is a single ploy-emitter, recessed-oxide-isolated, high-speed complementary bipolar process. It is optimized for low-voltage applications and the applications from 12 volts to 20 volts. Like CP1, this process offers NPN transistors with  $f_{MAX}$  of approximately 9.4 GHz at  $V_{CE}=4$  Volts.

- CB3

CB3 is Maxim's 3rd generation complementary bipolar process which adopts the GST2 double poly self-aligned emitter architecture to realize high performance vertical NPN and PNP transistors with  $f_T$  of 18.5 GHz for NPN and 16 GHz for PNP at  $V_{CE}=4$  volts. In conjunction with a variety of thin film resistors, Schottky diodes, and MIM capacitors, CB3 establishes itself as a superior technology for op-amp and comparator, data conversion, and other high voltage applications, such as, automatic test equipment (ATE).

- GST1

GST1 ( Giga-Speed Si-Bipolar Technology ) is a high-speed, self-aligned double-polysilicon process. It is designed for building high density, high performance circuits with up to three layers of gold interconnect. The process employs many techniques, such as reactive ion etching ( RIE ) and trench isolation, to provide a silicon bipolar platform for high performance circuit applications to 12 GHz.

- GST2

Like GST1, GST2 is a high-speed, self-aligned double-polysilicon process. The platform is designed for building high-density, high performance circuits, and employs many of the same processing features as GST1. GST2, however, achieves GaAs speed up to 27 GHz without GaAs pricing for up to 200,000 transistors per die.

- GST3

GST3 is a high speed self-aligned double-polysilicon with Silicon-Germanium Epitaxial Base NPN process with the high density, excellent AC and DC characteristics, and broad selection of passive components required by today's micro-power RF ICs. GST3 employs many advanced techniques such as Silicon Germanium Epitaxial Base processing, Reactive Ion Etching (RIE), Rapid Thermal Annealing (RTA), and trench cell isolation. It features NPN peak  $f_T$  of about 33 GHz at  $V_{CE}=2$  Volts.

- GST4

GST4 process technology offers a unique combination of leading edge power and performance with a large toolbox of high quality integrated passive devices for fiber optical and wireless communication ICs. It employs cutting edge technologies, e.g., ultra high-resistivity, silicon-on-insulator ( SOI ) substrate, Silicon-Germanium NPN base processing, etc. The high-Q integrated inductors eliminate expensive external filters, oscillators, and matching networks. GST4 offers NPN transistors with  $f_T$  up to 60 GHz or higher , and  $f_{MAX}$  of 65 GHz ( at  $V_{CE}=1.5V$  or  $2.0 V$  depending on application ).

- MB1

MB1 is a high performance BiCMOS process oriented towards highly integrated RF IC designs. Fast, self-

aligned double-polysilicon NPNs are integrated with 0.8 um CMOS and a broad selection of passive components to create an extremely versatile technology required by today's micro-power RF ICs. It features NPN transistors with peak  $f_T$  of approximately 25 GHz at  $V_{CE}=2$  Volts .

## Reliability Methodology

Maxim's quality approach to reliability testing is conservative. Each of the high-frequency-bipolar-and-BiCMOS fabrication processes is qualified using the following industry-standard tests and methods as shown in **Table 1**.

**TABLE 1. MAXIM PROCESS RELIABILITY TESTS**

Test Name	Conditions	Sampling Plan Acc/SS
Life Test	+150°C, biased, 1000 hrs	1/77 or 0/45 (LTPD=5)
85/85	+85°C, 85%RH, biased, 1000 hrs	1/77 or 0/45 (LTPD=5)
Pressure Pot	+121°C, 100%RH, 2 atm, unbiased, 168 hrs	1/77 or 0/45 (LTPD=5)
Temperature Cycling	-65°C to +150°C, air to air, unbiased, 1000 cycles	1/77 or 0/45 (LTPD=5)
High Temperature Storage	+150°C, unbiased, 1000 hrs	1/77 or 0/45 (LTPD=5)

Maxim's CP1, CB2, CB3, GST1, GST2, GST3, GST4 and MB1 high-frequency-bipolar-and-BiCMOS processes meet or exceed the performance and reliability expectations of the semiconductor industry. The long term life test results are summarized in **Table 2**. Infant Mortality Evaluation (IME) results are summarized in **Table 3**.

**TABLE 2. LIFE TEST RESULT OF MAXIM PRODUCTS FOR EACH PROCESS**

(Test Condition: 150 °C Junction Temperature, 1000 Hrs 60% UCL)

PROCESS	SAMPLE SIZE	REJECTS	FIT @ 25 °C	FIT @ 55 °C
CP1	138	0	0.68	11.72
CB2	566	0	0.17	2.86
CB3	319	0	0.30	5.07
GST1	222	0	0.43	7.29
GST2	2302	1	0.09	1.55
GST3	894	1	0.23	3.99
GST4	952	0	0.10	1.70
MB1	635	1	0.33	5.62
<b>TOTAL</b>	<b>6028</b>	<b>3</b>	<b>0.07</b>	<b>1.22</b>

## Reliability Strategy

### Reliability Program

Maxim has implemented a series of Quality and Reliability programs aimed at building the highest quality, most reliable analog and digital products in the industry. All products, processes, packages and changes in manufacturing processes must be subjected to Maxim's reliability testing before being released to manufacturing for mass production. Our reliability program includes the following three steps:

- Step 1: Initial Reliability Qualification Program
- Step 2: Ongoing Reliability Monitor Program
- Step 3: In-Depth Failure Analysis and corrective Action

Tables 4-11 show the results of long-term life testing results for each major high-frequency bipolar and BiCMOS processes. Table 12-15 show the test results of 85/85, Pressure Pot, Temperature Cycling and High Temperature Storage.

### Step 1: Initial Reliability Qualification Program

Maxim's product reliability test program meets EIA-JEDEC standards.

Table 1 summarizes the qualification tests that are part of Maxim's reliability program. Before releasing products, we require that three discrete manufacturing lots from a new process technology successfully meet the reliability test requirements.

### Step 2: Ongoing Reliability Monitor Program

Every week, Maxim identifies wafer lots from each of the high-speed processes to conduct reliability monitor testing. Each selected lot is tested High-Temperature Operating Life (HTOL) at 150°C of junction temperature for 192 hours and pressure pot for 168 hrs. On a quarterly basis, one wafer lot per process is subjected to the long-term reliability tests as defined in Table 1, which include HTOL, 85/85, Pressure Pot, Temperature Cycling, and High Temperature Storage. The test results are fed back to production.

### Step 3: In-Depth Failure Analysis and corrective Action

Our technical failure-analysis staff is capable of analyzing every reliability test failure to the device level. If an alarming reliability failure mechanism or trend is identified, the corrective action is initiated automatically. This proactive response and feedback ensures that discrepancies in any device failure mechanism are corrected before becoming major problems.

## Designed-In Reliability

A disciplined design methodology is an essential ingredient of manufacturing a reliable part. No amount of finished-product testing can create reliability in a marginal design. To design-in reliability, Maxim began by formulating a set of physical layout rules that yield reliable products even under worst-case manufacturing tolerances. These rules are rigorously enforced, and every circuit is subjected to computerized Design Rule Checks (DRCs) to ensure compliance.

Special attention is paid to Electrostatic Discharge (ESD) protection. Maxim's goal is to design every pin of every product to withstand ESD voltages in excess of 2000V, through a unique protection structure. In the case of our RS-232 interface circuits, products can even withstand  $\pm 15\text{kV}$  ESD using the human-body model,  $\pm 8\text{kV}$  ESD using IEC1000-4-2 contact discharge, or  $\pm 15\text{kV}$  ESD using IEC1000-4-2 air-gap discharge. Maxim tests each new product design for 50 mA latchup protection.

Designs are extensively simulated (using both circuit and logic simulation software) to evaluate performance under worst-case conditions. Finally, every design is checked and rechecked by independent teams before being released to mask making.

## Wafer Inspection

All wafers are fabricated using stable, proven processes with extremely tight control. Each wafer must pass numerous in-process checkpoints (such as oxide thickness, alignment, critical dimensions, and defect densities), and must comply with Maxim's demanding electrical and physical specifications.

Finished wafers are inspected optically to detect any physical defects. They are then parametrically tested to ensure full conformity to Maxim's specifications. Our parametric measurement system is designed to make the precision measurements that will ensure reliability and reproducibility in integrated circuits.

We believe our quality-control technology is the best in the industry, capable of resolving current levels below 1pA, and of producing less than 1pF capacitance. Maxim's proprietary software allows automatic measurement of subthreshold characteristics, fast surface-state density, noise, and other parameters crucial to predicting long-term stability and reliability. Every Maxim wafer is subject to this rigorous screening at no premium to our customers

### Statistical Process Control

Reliability testing offers value only if the manufacturing process is kept "in control" statistically. Major process variation or process shift can invalidate reliability test results, leading to incorrect conclusions and diminishing the integrity of failure rate estimates.

Maxim monitors the stability of critical process parameters through computerized Statistical Process Control (SPC). Over 125 charts are monitored in-line during wafer production. These charts provide our engineers with immediate feedback on process trends and thus let engineers to take immediate action if needed to keep the process under control. Additionally, over 100 process parameters are monitored at Wafer Acceptance. Maxim has a Capability Coefficient (Cpk) goal of 1.3, which makes the electrical and reliability performance of Maxim's products be well at target with very little variation.

In addition to SPC, Maxim uses Design of Experiments (DOE) to improve process capability, optimize process targeting, and increase process robustness.

### Reliability Testing

#### Infant Mortality Evaluation ( IME )

Maxim evaluates the infant mortality of all processes on an ongoing basis. Through the Infant Mortality analysis, the common defects for each process can be identified. Corrective action then will be taken to correct or optimize the manufacturing process, thus to improve reliability. For an illustration of Maxim's low Infant Mortality rate, refer to **Table 3**.

#### HTOL ( High Temperature Operational Life ) Test

Life Test is performed using biased conditions that simulate a real-world application. This test estimates the product's field performance over a long time period. It establishes the constant failure-rate level ( in FIT ) and identifies any early wearout mechanism. The device under test is operated at a controlled, elevated ambient temperature to ensure device junctions are at +150 °C. This test can detect design, manufacturing, silicon contamination, metal integrity, and assembly-related faults.

HTOL Test	
Test Conditions:	150°C operating junction temperature, 1000 hrs, Static bias, 100% duty cycle
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 1 and table 4 - 11

**85/85 (Temperature-Humidity-Bias ) Test (THB)**

The most popular integrated circuit (IC) packaging material is plastic. Plastic packages are not hermetic; therefore, moisture and other contaminants can enter the package. In addition, contaminants introduced during wafer fabrication together with the moisture can negatively impact the product reliability. Humidity testing can determine the effects of those contaminants and the product's resistance to ambient conditions. 85/85 is one of the moisture tests. Other moisture tests include Pressure Pot test and HAST ( Highly Accelerated Stress Test ).

In the 85/85 test, the device under test is placed in an atmosphere of +85 °C temperature and 85% relative humidity for a period of 1000 hours with bias applied on the device. Most of the high-performance high-speed bipolar or BiCMOS products tested in our Beaverton facility dissipate enough power so that, if operated with continuous bias, moisture would not penetrate the package. Therefore, we operate the device at 20% duty cycle ( for example, 5 minutes on, 20 minutes off ) to ensure that moisture enters the package.

<b>85/85</b>	
Test Conditions:	+85°C ambient temperature, 85% Relative Humidity, static cycled bias ( 20% duty cycle ) , 1000 hrs
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 12

**Pressure Pot Test**

Pressure Pot Test is another moisture test. It simulates a product's exposure to atmospheric humidity. The object of this test is to make any corrosive contaminants to react with bonding pads or metal line if any metal line is exposed.

<b>Pressure Pot</b>	
Test Conditions:	+121°C ambient temperature, 100% relative humidity, 15 Psig pressure, no bias, 168 hrs.
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 13

**Temperature Cycling Test**

This test measures a component's response to temperature changes and its construction quality. The test cycles devices through a predetermined temperature range (usually -65°C to +150°C). Both fabrication and assembly problems can be discovered using Temperature Cycling Test .

<b>Temperature Cycling</b>	
Test Conditions:	-65°C to +150°C, 1000 cycles
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 14

**High Temperature Storage Test**

This test evaluates changes in a product's performance following a long term storage at elevated temperature. It is only useful for failure mechanisms accelerated by heat only.

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High-Temperature Storage Life	
Test Conditions:	+150°C, 1000 hrs. unbiased
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 15

**Reliability Data**

The following tables are the reliability results collected from 1997 to 2002 on the major high speed bipolar and BiCMOS processes.

**TABLE 3 Infant Mortality Evaluation of Maxim's high-frequency bipolar Processes ( at 150°C Tj )**

Process	Part Number	Lot number	Time	Qty	Fail	Date code	raw ppm	Ppm with 60% confidence Level
<b>CP1</b>	MAX477ESA	NFJAE3006B#	12	2959	0	NR		
	MAX499CWG	NILBE2010C#	12	197	0	NR		
	MAX4145ESD	NKVBC4001B#	12	1000	0	NR		
	MAX4145ESD	NKVBC4002C#	12	846	0	0033		
	<b>Subtotal</b>			<b>5002</b>	<b>0</b>		<b>0</b>	<b>183</b>
<b>CB2</b>	MAX4016ESA	NC7AD2031B	12	2997	0	NR		
	MAX2108	NOAAB2063QC	12	1000	0	NR		
	MAX2108	NOAAB2063QD	12	996	0	NR		
	MAX2108	NOAAB2063QE	12	997	0	NR		
	MAX4323ESA	NJWDH2175B#	12	1014	0	0250		
	<b>Subtotal</b>			<b>7004</b>	<b>0</b>		<b>0</b>	<b>131</b>
<b>CB3</b>	MAX4418ESD	N3IAB2035D#	12	2281	0	NR		
	MAX4416ESA	NZTABQC001C#	12	1100	0	NR		
	MAX4417ESA	NZTBQ001E#	12	1100	0	0036		
	MAX4323ESA	NJWDH2175B#	12	1014	0	0250		
	MAX4418ESD	N3IAB2079B#	12	996	0	0216		
	MAX4418ESD	N3IAB2079B#	12	1176	0	0216		
	MAX4418ESD	N3IAB2079A#	12	3000	0	0216		
	MAX4418ESD	N3IAB2079D#	12	2999	0	0216		
	MAX4418ESD	N3IAB2079B#	12	2164	0	0216		
	<b>Subtotal</b>			<b>15830</b>	<b>0</b>		<b>0</b>	<b>58</b>
<b>GST1</b>	MAX3261	BIRAD3068EX	12	1000	0	NR		
	MAX3262	NE7AGQ001	12	1056	0	NR		
	MAX3262	NE7AGQ001	12	1059	0	NR		
	MAX2451CSE	NI0BG1004C	12	2997	0	0042		
	MAX2451	NIOAG1002	12	1996	0	NR		
	MAX3261	NIRAEQ001A	12	1000	0	NR		
	MAX3261	NIRAEQ001B	12	1996	0	NR		
	MAX2108	N0AAB2063QB	12	1000	0	0006		
	<b>Subtotal</b>			<b>12104</b>	<b>0</b>		<b>0</b>	<b>76</b>
<b>GST2</b>	MAX2108	N0AAB2063QB	12	1000	0	0006		

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	MAX2108	NOAAB2064C	12	1000	0	0006		
	MAX2108	NOAAB2064D	12	1000	0	0006		
	MAX2108	NOAAB2063Q	12	996	0	0006		
	MAX2108	NOAAB2063QA	12	997	0	0006		
	MAX2108	NOAAB2064E	12	992	0	0006		
	MAX2104	NS5A13114AB	12	2997	0	0009		
	MAX2104	NS5A13118AB	12	2987	2	0010		
	MAX2104	NS5A13118BC	12	2984	0	0010		
	MAX2104	NS5AI3114BC	12	2995	0	0009		
	MAX2104CCM	NS5ALA185CA	12	3618	2	0247		
	MAX2104CCM	NS5AL2188AQ	12	996	0	0240		
	<b>Subtotal</b>			<b>22562</b>	<b>4</b>		<b>177</b>	<b>232</b>
<b>GST3</b>	MAX2321	N8EAH409DE	12	525	0	NR		
	MAX2321	N8EAH409DF	12	525	0	NR		
	MAX2323EGI	N38AE2232A	12	996	0	0238		
	MAX2323EGI	N38AE2228B	12	1988	0	0237		
	MAX2323EGI	N38AE2235A	12	1000	0	0238		
	MAX2323EGI	N38AEA252B#	12	1926	2	0252		
	MAX2323EGI	N38AE2285AB	12	995	0	0250		
	<b>Subtotal</b>			<b>7995</b>	<b>2</b>		<b>250</b>	<b>388</b>
<b>GST4</b>	MAX3950	N22DD4242	12	1865	1	0108		
	MAX3825	NIEAF4236	12	1258	0	0109		
	MAX3825UCM	N1EAJ3503B	12	2697	0	0216		
	MAX3950EGK	N22DD3506A	12	2967	0	0208		
	MAX2538EGI	N9J3C2536DA	12	998	0	0232		
	MAX2538EGI	N9J3C2556A	12	498	0	0237		
	MAX2538EGI	N9J0B3049A	12	499	0	0252		
	MAX2538EGI	N9J3C2556A	12	499	1	0237		
	MAX2538EGI	N9J3C2557A	12	500	0	0237		
	MAX2538EGI	N9J3C2557A	12	499	0	0237		
	MAX2538EGI	N9J3C2531D	12	999	0	0231		
	MAX2538EGI	N9J0BQ001A	12	500	0	0236		
	MAX2820EGM	N7N0F2560D	12	490	0	0237		
	MAX2820EGM	N7N0F2533A	12	276	0	0236		
	MAX2841ECM	NE52C4502A	12	499	0	0219		
	MAX2104CCM	NS5ALA185CA	12	3618	2	0247		
	MAX2104CCM	NS5AL2188AQ	12	996	0	0240		
	MAX2323EGI	N38AE2232A	12	996	0	0238		
	MAX2323EGI	N38AE2228B	12	1988	0	0237		
	MAX2323EGI	N38AE2235A	12	1000	0	0238		
	MAX2323EGI	N38AEA252B#	12	1926	2	0252		
	MAX2323EGI	N38AE2285AB	12	995	0	0250		
	<b>Subtotal</b>			<b>26563</b>	<b>6</b>		<b>226</b>	<b>276</b>
<b>Totals</b>				<b>97060</b>	<b>12</b>		<b>124</b>	<b>140</b>

**TABLE 4. HIGH TEMP OPERATIONAL LIFE TEST – CP1 Process at 150°C Tj**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
234-1504-20	NR	44 PLCC	46	0	0	0
234-1504-20	NR	44 PLCC	46	0	0	0
234-1504-20	NR	44 PLCC	46	0	0	0
<b>Totals</b>			<b>138</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 5. HIGH TEMP OPERATIONAL LIFE TEST – CB2 Process at 150°C Tj**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX3962CEI	9747	28 QSOP	22	0	0	0
MAX3962CEI	9747	28 QSOP	22	0	0	0
MAX3962	9831	28 QSOP	44	0	0	0
MAX3962CEI	9832	28 QSOP	22	0	0	0
MAX3962CEI	9834	28QSOP	22	0	0	0
MAX3962CEI	9834	28QSOP	22	0	0	0
MAX3966	9832	24 QSOP	45	0	0	0
MAX3966CEG	9833	24 QSOP	45	0	0	0
MAX3510	9915	20 QSOP	46	0	0	0
806-0617-21	0252	48 QFN	77	0	0	0
806-0596-22	0243	56 QFN	45	0	0	0
MAX4323ESA	0146	8 NSO	77	0	0	0
MAX4323ESA	0146	8 NSO	77	0	0	0
<b>Totals</b>			<b>566</b>	<b>0</b>	<b>0</b>	<b>0</b>

TABLE 6. HIGH TEMP OPERATIONAL LIFE TEST – CB3 Process at 150°C Tj

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX4418ESD	0034	14 NSO	80	0	0	0
MAX4416ESA	0036	8 NSO	80	0	0	0
MAX4417ESA	0036	8N SO	79	0	0	0
MAX4418ESD	0123	14 NSO	80	0	0	0
MAX4418ESD	0216	14 NSO	77	0	0	0
<b>Totals</b>			<b>319</b>	<b>0</b>	<b>0</b>	<b>0</b>

TABLE 7. HIGH TEMP OPERATIONAL LIFE TEST – GST1 Process at 150°C Tj

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX3261	0021	32 TQFP	47	0	0	0
MAX3262	0018	24 QSOP	48	0	0	0
MAX2451	0022	16 NSO	50	0	0	0
MAX2451	0221	16 NSO	77	0	0	0
<b>Totals</b>			<b>222</b>	<b>0</b>	<b>0</b>	<b>0</b>

TABLE 8. HIGH TEMP OPERATIONAL LIFE TEST – GST2 Process at 150°C Tj

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX3680EAI	9706	28 SSOP	45	0	0	0
MAX3762	9709	20 SSOP	40	0	0	0
MAX3761	9709	20 SSOP	40	0	0	0
MAX2411EEI	9709	28 QSOP	48	0	0	0
MAX1002CAX	9710	36 SSOP	48	0	0	0
MAX2620EUA	9713	8 uMAX	45	0	0	0
MAX3960CEE	9714	16 QSOP	45	0	0	0
MAX2420EAI	9724	28 SSOP	48	0	0	0
MAX3961CEP	9729	20 QSOP	45	0	0	0
MAX1005CEE	9730	16 QSOP	42	0	0	0
MAX2602ESA	9740	8 NSO	15	0	0	0
MAX2602ESA	9740	8 NSO	15	0	0	0
MAX2602ESA	9740	8 NSO	15	0	0	0
MAX1002CAX	9740	36 SSOP	24	0	0	0
MAX1002CAX	9742	36 SSOP	24	0	0	0
MAX2602ESA	9804	8 NSO	30	0	0	0
MAX2430IEE	9804	16 QSOP	22	0	0	0

TABLE 8. HIGH TEMP OPERATIONAL LIFE TEST – GST2 Process at 150°C Tj (cont)

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX2430IEE	9804	16 QSOP	22	0	0	0
MAX2442EAI	9805	28 SSOP	48	0	0	0
MAX3675EHJ	9823	32 TQFP	24	0	0	0
MAX3885ECB	9824	64 TQFP	45	0	0	0
MAX3675	9824	32 TQFP	45	0	0	0
MAX3675EHJ	9827	32 TQF	48	0	0	0
MAX2690EUB	9833	10 uMAX	48	0	0	1
MAX3885ECB	9836	64 TQFP	45	0	0	0
MAX2104CCM	9840	48 TQFP	45	0	0	0
MAX3885ECB	9844	64 TQFP	45	0	0	0
MAX2104CCM	9845	48 TQFP	40	0	0	0
MAX2104CCM	9845	48 TQFP	42	0	0	0
MAX3885ECB	9850	64 TQFP	45	0	0	0
MAX3885ECB	9850	64 TQFP	45	0	0	0
MAX3885ECB	9850	64 TQFP	42	0	0	0
MAX104CHC	9851	192 BGA	20	0	0	0
MAX104CHC	9851	192 BGA	20	0	0	0
MAX104CHC	9851	192 BGA	20	0	0	0
MAX3675EHJ	9903	32 TQFP	30	0	0	0
MAX3675EHJ	9903	32 TQFP	30	0	0	0
MAX3675EHJ	9903	32 TQFP	30	0	0	0
MAX2102	9910	28 SSOP	45	0	0	0
MAX22235	9934	20 TSSOP-E	44	0	0	0
MAX22235	9934	20 TSSOP-E	41	0	0	0
MAX2104	0003	48 TQFP	44	0	0	0
MAX2104	0003	48 TQFP	45	0	0	0
MAX2104	0003	48 TQFP	44	0	0	0
MAX3269CUB	0011	10 uMAX	45	0	0	0
MAX3269	0011	10 uMAX	16	0	0	0
MAX3964	9831	20 QSOP	45	0	0	0
MAX3964CEP	9834	20 QSOP	42	0	0	0
MAX3964CEP	9834	20 QSOP	42	0	0	0
MAX2108	9913	20 QSOP	49	0	0	0
MAX2104	9918	48 TQFP-EP	45	0	0	0
AT311	9920	44 PLCC	77	0	0	0
AT307	9926	48 TQFP	77	0	0	0
806-0487-21	9944	48 TQFP	77	0	0	0
806-0500-22	9945	44 PLCC	77	0	0	0
806-0489-21	9947	48 TQFP	77	0	0	0
MAX3780CCQ	0246	100 TQFP	45	0	0	0
MAX3780CCQ	0246	100 TQFP	45	0	0	0
MAX2113UGH	0247	44 QFN	44	0	0	0

**TABLE 8. HIGH TEMP OPERATIONAL LIFE TEST – GST2 Process at 150°C Tj (cont)**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX2113UGH	0247	44 QFN	45	0	0	0
MAX2104CCM	0216	48 TQFP	45	0	0	0
MAX2104CCM	0216	48 TQFP	45	0	0	0
MAX9322ECY	0219	52 TQFP	45	0	0	0
MAX9322ECY	0219	52 TQFP	45	0	0	0
MAX2104CCM	0250	48 TQFP	45	0	0	0
MAX9322ECY	0219	52 TQFP	45	0	0	0
<b>Totals</b>			<b>2751</b>	<b>0</b>	<b>0</b>	<b>1</b>

**TABLE 9. HIGH TEMP OPERATIONAL LIFE TEST – GST3 Process at 150°C Tj**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX3266	0002	8 NSO-EP	45	0	0	0
MAX3266	0002	8 NSO-EP	45	0	0	0
MAX2680EUT	9823	6 SOT23	45	0	0	0
MAX2640EUT	9832	6 SOT23	64	0	0	0
MAX2682	9835	6 SOT23	44	0	0	0
MAX2321EUP	9929	20 TSSOP-EP	44	0	0	0
MAX2321	0009	20 TSSO-PEP	45	0	0	0
MAX2321	0009	20 TSSOP-EP	45	0	0	0
MAX2320	0017	20 TSSOP-EP	46	0	0	1
MAX2321	9942	20 TSSO-PEP	52	0	0	0
MAX2323EGI	0238	28 QFN	50	0	0	0
MAX2323EGI	0238	28 QFN	49	0	0	0
MAX2323EGI	0237	28 QFN	50	0	0	0
MAX2388EGC	0244	28 QFN	45	0	0	0
MAX2388EGC	0244	28 QFN	45	0	0	0
MAX2388EGC	0244	28 QFN	45	0	0	0
MAX3850EGJ	0208	32 QFN	45	0	0	0
MAX3850EGJ	0208	32 QFN	45	0	0	0
MAX3850EGJ	0208	32 QFN	45	0	0	0
<b>Totals</b>			<b>894</b>	<b>0</b>	<b>0</b>	<b>1</b>

TABLE 10. HIGH TEMP OPERATIONAL LIFE TEST – GST4 Process at 150°C Tj

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX3950	0107	68QFN	44	0	0	0
MAX3825	0109	48TQFP	47	0	0	0
MAX3950	0108	68QFN	45	0	0	0
MAX2648	NR	48TQFP	45	0	0	0
MAX3950	NR	68QFN	45	0	0	0
MAX3950	NR	68QFN	50	0	0	0
MAX3950	NR	68QFN	50	0	0	0
MAX3741ETE	0249	T1633	45	0	0	0
MAX3741ETE	0249	T1633	45	0	0	0
MAX3950EGK	0208	G-6400	45	0	0	0
MAX3950EGK	0208	G-68	45	0	0	0
MAX3825UCM	0216	C-48	45	0	0	0
MAX2538ETI	0230	T-2855	44	0	0	0
MAX2538ETI	0230	T-2855	45	0	0	0
MAX2438ETI	0230	T-2855	45	0	0	0
MAX2538EGI	0236	G-2855	40	0	0	0
MAX2538EGI	0231	G-2855	45	0	1	0
MAX2820EGM	0231	G-4877	45	0	0	0
MAX2841ECM	0219	C-48	45	0	0	0
MAX9993ETP	0242	T-20	47	0	0	0
MAX9989ETP	0242	T-20	46	0	0	0
<b>Totals</b>			<b>952</b>	<b>0</b>	<b>0</b>	<b>0</b>

TABLE 11. HIGH TEMP OPERATIONAL LIFE TEST – MB1 Process at 150°C Tj

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX2685EEE	9914	16QSOP	48	0	0	0
MAX2685EEE	9917	16QSOP	48	0	0	0
MAX2685EEE	9920	16QSOP	48	0	0	0
MAX2685EEE	9952	16 TSSOPEP	61	0	0	0
MAX2685EEE	9952	16 TSSOPEP	61	0	0	0
MAX2685EEE	9952	16 TSSOPEP	61	0	0	0
MAX2115UGH	0242	44 QFN	77	0	0	0
MAX2115UGH	0241	44 QFN	77	0	0	0
MAX2115UGH	0242	44 QFN	77	0	0	0
MAX2754EUA	0220	8 uMAX	77	0	0	0
<b>Totals</b>			<b>635</b>	<b>0</b>	<b>0</b>	<b>0</b>

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**TABLE 12. 85/85 TEST (High Frequency Bipolar and BiCMOS Processes)**  
**Conditions = 85°C, 85% Relative Humidity, Biased, 1000 Hours**

Device	Lot number	Package	Date code	Sample size	Failures
MAX2680EUT	BR3AAQ001FA	6 SOT23	9823	45	0
MAX2640EUT	BT3BAQ002EC	6 SOT23	9832	32	0
MAX2682	BR3CAQ002C	6 SOT23	9835	45	0
MAX2602ESA	BNPACA004DB	8 NSO	9740	15	0
MAX2602ESA	BNPACA004DA	8 NSO	9740	15	0
MAX2602ESA	BNPACA004Q	8 NSO	9804	45	0
MAX2620EUA	BNZBBQ001A	8 uMAX	9713	35	0
MAX2754EUA	N50AC3001A#	8 uMAX	0220	77	0
MAX2690EUB	BH7ABQ002BQ	10 uMAX	9833	47	0
MAX4418ESD	N3IAB2029B#	14 NSO	0216	77	0
MAX3960CEE	BNNABQ001A	16 QSOP	9714	40	0
MAX2430IEE	BHZABQ004CE	16 QSOP	9804	22	0
MAX2430IEE	BHZABQ004CD	16 QSOP	9804	22	0
MAX2685EEE	NY4ADZ007A	16 QSOP	9914	48	0
MAX2685EEE	NY4ADZ011A	16 QSOP	9917	48	0
MAX2685EEE	NY4ADZ013A	16 QSOP	9920	48	0
MAX2685	NY4ADZ007B	16 QSOP	9952	45	0
MAX2685	NY4ADZ007C	16 QSOP	9952	45	0
MAX2685	NY4ADZ007D	16 QSOP	9952	45	0
MAX104CHC	BW6ACQ002E	192 BGA	9851	20	0
MAX104CHC	BW6ACQ002F	192 BGA	9851	20	0
MAX104CHC	BW6ACQ002G	192 BGA	9851	19	0
MAX3964	M901062AQ	20 QSOP	9831	45	0
MAX3964CEP	M902029AQ	20 QSOP	9834	36	0
MAX3964CEP	M902025AQ	20 QSOP	9834	45	0
MAX22235	BW2ADQ002A	20 TSSOP	9934	46	0
MAX22235	BW2ADQ002D	20 TSSOP	9934	46	0
MAX2321EUP	N8EAF006L	20 TSSOP	9930	36	0
MAX2321EUP	N8EAF006G	20 TSSOP	9930	45	0
MAX9989ETP	NJ00BA004D#	20 TSSOP	0242	45	0
MAX9993ETP	NB00DQ001D	20 TSSOP	0242	45	0
MAX3966	NL6AAZ006AA	24 QSOP	9832	45	0
MAX3966CEG	NL6AAZ007AQ	24 QSOP	9833	45	0
MAX2102CWI	BJKAEQ001A	28 NSO	9722	42	0
MAX3962CEI	BNOACQ002B	28 QSOP	9747	22	0
MAX3962CEI	BNOACQ002A	28 QSOP	9747	22	0
MAX3962	BN0ACQ002H	28 QSOP	9831	22	0
MAX3962CEI	BN0ACQ002I	28 QSOP	9832	22	0
MAX3962CEI	BNOACQ002K	28 QSOP	9834	45	0
MAX3962CEI	BNOACQ002J	28 QSOP	9834	45	0
MAX2420EAI	BLADCQ001B	28 SSOP	9724	40	0

**TABLE 12. 85/85 TEST (High Frequency Bipolar and BiCMOS Processes) (Cont)**  
**Conditions = 85°C, 85% Relative Humidity, Biased, 1000 Hours**

Device	Lot number	Package	Date code	Sample size	Failures
MAX3850EGJ	NM9964007A	32 QFN	0208	45	0
MAX3850EGJ	NM9964005A	32 QFN	0208	45	0
MAX3850EGJ	NM9964002E	32 QFN	0208	45	0
MAX3675EHJ	BJVAF005QA	32 TQFP	9823	18	0
MAX3675	BJVAF005QB	32 TQFP	9824	42	0
MAX3675EHJ	BJVAEQ003D	32 TQFP	9827	45	0
MAX1002CAX	BLXAFQ002C	36 SSOP	9740	24	0
MAX1002CAX	BLXAFQ002E	36 SSOP	9742	24	0
AT311	M911007B	44 PLCC	9920	77	0
MAX2113UGH	N1Y0AA089A	44 QFN	0247	45	0
MAX2104CCM	BS5ACQ002C	48 TQFP	9845	42	0
MAX2104CCM	BS5ACQ002B	48 TQFP	9845	47	0
AT307	M905012D	48 TQFP	9847	77	0
AT307	M912022D	48 TQFP	9926	77	0
MAX3825	NIEAF4236	48 TQFP	109	45	0
MAX2841ECM	NE52C4502AB	48 TQFP	0219	45	0
MAX3825UCM	N1EAJ3503B	48 TQFP	0216	45	0
MAX9322ECY	NKY0AQ001C	52 TQFP	0219	76	0
MAX9322ECY	NKY0AQ001D	52 TQFP	0219	77	0
MAX9322ECY	NKY0AQ001B	52 TQFP	0219	77	0
MAX9322ECY	NKY0AQ001E	52 TQFP	0219	77	0
MAX3885ECB	BS2AAQ001CB	64 TQFP	9824	42	0
MAX3885ECB	BS2AA1002CQ	64 TQFP	9836	18	0
MAX3885ECB	BS2ABQ002Q	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QA	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QB	64 TQFP	9850	48	0
MAX3950	N22DD4248	68 QFN	107	44	0
MAX3950	N22DD4242	68 QFN	108	42	0
MAX3950EGK	N22DD3506A	68 QFN	0208	45	0
MAX3950EGK	N22DD3506A	68 QFN	0208	45	0
<b>Total</b>				<b>2754</b>	<b>0</b>

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**TABLE 13. PRESSURE POT TEST For High Frequency Bipolar and BiCMOS Processes**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX2680EUT	BR3AAQ001FA	6 SOT23	9823	45	0
MAX2640EUT	BT3BAQ002EC	6 SOT23	9832	45	0
MAX3266	BU8BAA010QD	8 NSO	0002	77	0
MAX3266	BU8BAA010QE	8 NSO	0002	77	0
MAX2620EUA	BNZBBQ001A	8 uMAX	9713	45	0
MAX2690EUB	BH7ABQ002BQ	10 uMAX	9833	45	0
MAX3269CUB	N6LAAQ001DQ	10 uMAX	0011	76	0
MAX3268	N6LAAQ001J#	10 uMAX	0011	77	0
155-0415-02	Q907003F	100 TQFP	9906	45	0
MAX3780CCQ	N060CA004AQ	100 TQFP	0246	45	0
MAX4418ESD	N31AB2079B#	14 NSO	0216	77	0
MAX2430IEE	BHZABQ004CE	16 QSOP	9804	45	0
MAX2430IEE	BHZABQ004CD	16 QSOP	9804	45	0
MAX2685EEE	NY4ADZ007A	16 QSOP	9914	45	0
MAX2685EEE	NY4ADZ011A	16 QSOP	9917	45	0
MAX2685EEE	NY4ADZ013A	16 QSOP	9920	45	0
MAX2685	NY4ADZ007B	16 TSSOP	9952	77	0
MAX2685	NY4ADZ007C	16 TSSOP	9952	72	0
MAX2685	NY4ADZ007D	16 TSSOP	9952	77	0
155-0415-12	Q804126H	160 MQUAD	9747	45	0
155-0415-12	Q805023H	160 MQUAD	9749	45	0
155-0415-12	Q806054H	160 MQUAD	9801	45	0
155-0415-12	M902043I	160 MQUAD	9838	45	0
155-0415-12	Q903061J	160 MQUAD	9842	45	0
155-0415-12	Q903062J	160 MQUAD	9842	45	0
MAX2323EGI	N38AE2235A	18 QFN	0238	77	0
MAX3964	M901062AQ	20 QSOP	9831	45	0
MAX3964CEP	M902029AQ	20 QSOP	9834	45	0
MAX3964CEP	M902025AQ	20 QSOP	9834	45	0
MAX22235	BW2ADQ002D	20 TSSOP	9934	76	0
MAX2321EUP	N8EAF3045QB	20 TSSOP	9929	45	0
MAX2321EUP	N8EAF3045L	20 TSSOP	9930	45	0
MAX2321EUP	N8EAF3045G	20 TSSOP	9930	45	0
MAX2321	N8EAF3045QA	20 TSSOP	0009	77	0
MAX2321	N8EAF3045QB	20 TSSOP	0009	45	0
MAX2321	N8EAF3045Q	20 TSSOP	0009	77	0
MAX9989ETP	NJ00BA004D#	20 TSSOP	0242	77	0
MAX9993ETP	NB00DQ001D	20 TSSOP	0242	77	0
MAX3966	NL6AAZ006AA	24 QSOP	9832	45	0
MAX3966CEG	NL6AAZ007AQ	24 QSOP	9833	45	0
MAX2102CWI	BJKAEQ001A	28 NSO	9722	45	0

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**TABLE 13. PRESSURE POT TEST For High Frequency Bipolar and BiCMOS processes (Cont)**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX2323EGI	N38AB3003Q	28 QFN	0005	77	0
MAX2323EGI	N38AB3003QA	28 QFN	0005	77	0
MAX2323EGI	N38AB3002D	28 QFN	9948	77	0
MAX2323EGI	N38AE2228B	28 QFN	0237	77	0
MAX2323EGI	N38AE2232A	28 QFN	0238	77	0
MAX2323EGI	N38AEA252B#	28 QFN	0252	77	0
MAX3962CEI	BNOACQ002B	28 QSOP	9747	45	0
MAX3962	BN0ACQ002H	28 QSOP	9831	45	0
MAX3962CEI	BN0ACQ002I	28 QSOP	9832	45	0
MAX3962CEI	BNOACQ002J	28 QSOP	9834	45	0
MAX2420EAI	BLADCQ001B	28 SSOP	9724	45	0
MAX3850EGJ	NM9964002E	32 QFN	0208	45	0
MAX3850EGJ	NM9964005A	32 QFN	0208	45	0
MAX3850EGJ	NM9964007A	32 QFN	0208	44	0
MAX3675EHJ	BJVAFU009QA	32 TQFP	9903	45	0
MAX3675EHJ	BJVAFU005QA	32 TQFP	9823	45	0
MAX3675	BJVAFU005QB	32 TQFP	9824	45	0
MAX3675EHJ	BJVAEQ003D	32 TQFP	9827	45	0
MAX3675EHJ	BJVAFU009Q	32 TQFP	9903	45	0
MAX3675EHJ	BJVAFU009QB	32 TQFP	9903	45	0
MAX1002CAX	BLXAFQ002B	36 SSOP	9710	45	0
MAX2113UGH	N1Y0AA089A	44 QFN	0247	45	0
MAX2113UGH	N1Y0AA089C	44 QFN	0247	45	0
MAX2113UGH	N1Y0AA089D	44 QFN	0247	45	0
MAX2104CCM	BS5ACQ002C	48 TQFP	9845	45	0
MAX2104CCM	BS5ACQ001Q	48 TQFP	9840	45	0
MAX2104CCM	BS5ACQ002B	48 TQFP	9845	45	0
MAX2104	NS5AGA036Q	48 TQFP	0010	77	0
MAX2104	NS5AGA036QA	48 TQFP	0010	75	0
MAX3825	NIEAF4236	48 TQFP	0109	45	0
MAX3825UCM	N1EAJ3503B	48 TQFP	0216	45	0
MAX2841ECM	NE52C4502AB	48 TQFP	0219	45	0
MAX9322ECY	NKY0AQ001C	52 TQFP	0219	76	0
MAX9322ECY	NKY0AQ001B	52 TQFP	0219	76	0
MAX9322ECY	NKY0AQ001E	52 TQFP	0219	76	0
MAX9322ECY	NKY0AQ001D	52 TQFP	0219	77	0
806-0596-22	NM716Q003E	56 QFN	0243	45	0
806-0596-22	NM716Q003F	56 QFN	0243	45	0
806-0596-22	NM716Q002JB	56 QFN	0243	45	0
MAX3950EGK	N22DD3506AQ	64 QFN	0208	45	0

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**TABLE 13. PRESSURE POT TEST For High Frequency Bipolar and BiCMOS processes (Cont)**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX3885ECB	BS2AAQ001CB	64 TQFP	9824	45	0
MAX3885ECB	BS2AA1002CQ	64 TQFP	9836	45	0
MAX3885ECB	BS2AAQ002Q	64 TQFP	9844	45	0
MAX3885ECB	BS2ABQ002Q	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QA	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QB	64 TQFP	9850	45	0
MAX3885ECB	NS2AC3001C	64 TQFP	0215	45	0
MAX3885ECB	NS5AC3001QA	64 TQFP	0216	37	0
MAX3885ECB	NS2AC3001QB	64 TQFP	0216	45	0
MAX3885ECB	NS2AC3001B	64 TQFP	0215	45	0
MAX3885ECB	NS2AC3001A	64 TQFP	0215	45	0
MAX3885ECB	NS2AC3001Q	64 TQFP	0216	45	0
MAX3950	N22DD4248	68 QFN	0107	45	0
MAX3950	N22DD4242	68 QFN	0108	45	0
MAX3950	N22DD4308A	68 QFN	0132	45	0
MAX3950	N22DD4312A	68 QFN	0132	45	0
MAX3950	N22DD4298A	68 QFN	0132	45	0
<b>Total</b>				<b>5221</b>	<b>0</b>

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**Table 14. TEMPERATURE CYCLING TEST For High Frequency Bipolar and BiCMOS Processes  
Conditions = -65°C to +150°C/ 1000 Cycles**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX2682	BR3CAQ002C	6 SOT23	9835	45	0
MAX2680EUT	BR3AAQ001FA	6 SOT23	9823	45	0
MAX2640EUT	BT3BAQ002EC	6 SOT23	9832	45	0
MAX2602ESA	BNPACA004DB	8 NSO	9740	45	0
MAX2602ESA	BNPACA004DA	8 NSO	9740	45	0
MAX2602ESA	BNPACA004Q	8 NSO	9804	45	0
MAX3266	BU8BAA010QD	8 NSO	0002	45	0
MAX3266	BU8BAA010QE	8 NSO	0002	45	0
MAX2620EUA	BNZBBQ001A	8 uMAX	9713	45	0
MAX2754EUA	N50AC3001A#	8 uMAX	0220	77	0
MAX3269CUB	N6LAAQ001DQ	10 uMAX	0011	45	0
MAX2101CMQ	BHNAAA017B	100 TQFP	9701	30	1
155-0415-02	Q907003F	100 TQFP	9906	45	0
MAX3780CCQ	N060CA004AQ	100 TQFP	0246	77	0
MAX2388EGC	N22DX3005AQ	12 QFN	0235	77	0
MAX2388EGC	N22DX3005AR	12 QFN	0235	77	0
MAX4418ESD	N3IAB2079B#	14 NSO	0216	76	0
MAX3741ETE	NMB0AQ001FB	16 QFN	0249	77	0
MAX3741ETE	NMB0AQ001DA	16 QFN	0249	77	0
MAX3741ETE	NMB0AQ001FA	16 QFN	0249	77	0
MAX2430IEE	BHZABQ004CE	16 QSOP	9804	45	0
MAX2430IEE	BHZABQ004CD	16 QSOP	9804	45	0
MAX2685EEE	NY4ADZ007A	16 QSOP	9914	45	0
MAX2685EEE	NY4ADZ011A	16 QSOP	9917	45	0
MAX2685EEE	NY4ADZ013A	16 QSOP	9920	45	0
MAX2685	NY4ADZ007C	16 TSSOP	9952	45	0
MAX2685	NY4ADZ007B	16 TSSOP	9952	45	0
MAX2685	NY4ADZ007D	16 TSSOP	9952	45	0
155-0415-12	M902043I	160 MQUAD	9838	45	0
155-0415-12	Q903061J	160 MQUAD	9842	45	0
155-0415-12	Q903062J	160 MQUAD	9842	45	0
155-0415-12	Q804126H	160 MQUAD	9747	45	0
155-0415-12	Q805023H	160 MQUAD	9749	45	0
155-0415-12	Q806054H	160 MQUAD	9801	45	0
MAX104CHC	BW6ACQ002E	192 BGA	9851	20	0
MAX104CHC	BW6ACQ002F	192 BGA	9851	20	0
MAX104CHC	BW6ACQ002G	192 BGA	9851	20	0
MAX3964	M901062AQ	20 QSOP	9831	45	0
MAX3964CEP	M902029AQ	20 QSOP	9834	45	0
MAX3964CEP	M902025AQ	20 QSOP	9834	45	0

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**Table 14. TEMPERATURE CYCLING TEST For High Frequency Bipolar & BiCMOS Processes  
(Cont)  
Conditions = -65°C to +150°C/ 1000 Cycles**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX22235	BW2ADQ002A	20 TSSOP	9934	45	0
MAX22235	BW2ADQ002D	20 TSSOP	9934	45	0
MAX2321EUP	N8EAF006QB	20 TSSOP	9929	45	0
MAX2321EUP	N8EAF006L	20 TSSOP	9930	45	0
MAX2321EUP	N8EAF006G	20 TSSOP	9930	45	0
MAX9989ETP	NJ00BA004D#	20 TSSOP	0242	45	0
MAX9989ETP	NJ00BA004D#	20 TSSOP	0242	45	0
MAX9989ETP	NJ00BA004D#	20 TSSOP	0242	45	0
MAX9993ETP	NB00DQ001D	20 TSSOP	0242	45	0
MAX9993ETP	NB00DQ001D	20 TSSOP	0242	45	0
MAX9993ETP	NB00DQ001D	20 TSSOP	0242	45	0
MAX2321	N8EAF3045QA	20 TSSOP	0009	45	0
MAX3966CEG	NL6AAZ007AQ	24 QSOP	9833	45	0
MAX3966	NL6AAZ006AA	24 QSOP	9832	45	0
MAX2102CWI	BJKAEQ001A	28 NSO	9722	45	0
MAX2323EGI	N38AB3003Q	28 QFN	0005	57	0
MAX2323EGI	N38AB3003QA	28 QFN	0005	77	0
MAX2538EGI	N9J3CA528AR	28 QFN	0230	45	0
MAX2388EGC	N22DXA004HE	28 QFN	0244	77	0
MAX2538EGI	N9J0BQ001A	28 QFN	0236	100	0
MAX2538EGI	N9J3C2536DA	28 QFN	0232	100	0
MAX2538EGI	N9J0B3049A	28 QFN	0252	45	0
MAX2438ETI	N9J3CA519QA	28 QFN	0230	77	0
MAX2438ETI	N9J3CA519QB	28 QFN	0230	77	0
MAX2438ETI	N9J3CA519Q	28 QFN	0230	77	0
MAX3962CEI	BNDACQ002B	28 QSOP	9747	45	0
MAX3962CEI	BN0ACQ002I	28 QSOP	9832	45	0
MAX3962CEI	BNOACQ002DA	28 QSOP	9908	100	0
MAX3962CEI	BNAOCQ002FA	28 QSOP	9908	100	0
MAX2420EAI	BLADCQ001B	28 SSOP	9724	45	0
MAX3935EGJ	N041D4502B	32 QFN	0220	45	0
MAX3850EGJ	NM9964007A	32 QFN	0208	45	0
MAX3850EGJ	NM9964002E	32 QFN	0208	45	0
MAX3850EGJ	NM9964005A	32 QFN	0208	45	0
MAX3675EHJ	BJVAFU009Q	32 TQFP	9903	45	0
MAX3675EHJ	BJVAFU009QA	32 TQFP	9903	45	0
MAX3675EHJ	BJVAFU009QB	32 TQFP	9903	45	0
MAX3675	BJVAF005QB	32 TQFP	9824	45	0
MAX3675EHJ	BJVAF005QA	32 TQFP	9823	45	0
MAX3675EHJ	BJVAEQ003D	32 TQFP	9827	45	0
MAX1002CAX	BLXAFQ002C	36 SSOP	9740	30	0
MAX1002CAX	BLXAFQ002E	36 SSOP	9742	30	0

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**Table 14. TEMPERATURE CYCLING TEST For High Frequency Bipolar & BiCMOS Processes  
(Cont)  
Conditions = -65°C to +150°C/ 1000 Cycles**

Part Number	Lot number	Package	Date code	Sample size	Failures
806-0500-22	NM960A102A	44 PLCC	9945	37	0
234-1504-20	CE10231A	44 PLCC	N/A	45	0
234-1504-20	CE10222A	44 PLCC	N/A	45	0
234-1504-20	CE10269	44 PLCC	N/A	45	0
MAX2115UGH	N262A2044CR	44 QFN	0242	77	0
MAX2115UGH	N262A2039AR	44 QFN	0241	77	0
MAX2113UGH	N1Y0AA089A	44 QFN	0247	77	0
MAX2113UGH	N1Y0AA089A	44 QFN	0247	77	0
MAX2113UGH	N1Y0AA057BX	44 QFN	0221	989	0
MAX2361EGM	N33BEA034A	48 QFN	0242	77	1
MAX2361EGM	N33BEA034A	48 QFN	0242	77	0
MAX2361EGM	N33BEA085B	48 QFN	0242	77	0
MAX2820EGM	N7N0F2531B	48 QFN	0231	43	0
MAX2820EGM	N7N0F2534C	48 QFN	0232	45	0
MAX2820EGM	N7N0F2533B	48 QFN	0236	43	0
MAX2104CCM	BS5ACQ001Q	48 TQFP	9840	45	0
MAX2104CCM	BS5ACQ002C	48 TQFP	9845	45	0
MAX2104CCM	BS5ACQ002B	48 TQFP	9845	45	0
AT307	M905012D	48 TQFP	9847	77	0
AT307	M912022D	48 TQFP	9926	38	0
806-0487-21	EU8669BB	48 TQFP	9944	40	0
806-0489-21	NM954A100C	48 TQFP	9947	38	0
MAX3825UCM	N1EAJ3503B	48 TQFP	0216	45	0
MAX2291CCM	N4P0A4384B	48 TQFP	0219	43	1
MAX2291CCM	N4P0A4383A	48 TQFP	0219	44	0
MAX2841ECM	NE52C4502AB	48 TQFP	0219	45	0
MAX2841ECM	NE52C4502AB	48 TQFP	0219	45	0
MAX2841ECM	NE52C4502AB	48 TQFP	0219	45	0
MAX2104CCM	NS5ALY194C	48 TQFP	0250	77	0
MAX2104CCM	NS5ALY194D	48 TQFP	0250	77	0
MAX2104CCM	NS5ALA185D	48 TQFP	0250	77	0
MAX2104CCM	NS5ALA185B	48 TQFP	0250	77	1
MAX2104CCM	NS5ALY194A	48 TQFP	0250	77	0
MAX2104CCM	NS5ALA185D	48 TQFP	0250	77	0
MAX2104CCM	NS5AJ3036FQ	48 TQFP	0216	77	0
MAX2104CCM	NS5AJ3036B	48 TQFP	0215	77	0
MAX2104CCM	NS5AJ3036EQ	48 TQFP	0216	77	0
MAX9322ECY	NKY0AQ001E	52 TQFP	0219	77	0
MAX9322ECY	NKY0AQ001B	52 TQFP	0219	72	0
MAX9322ECY	NKY0AQ001D	52 TQFP	0219	77	0
MAX9322ECY	NKY0AQ001C	52 TQFP	0219	77	0

**Table 14. TEMPERATURE CYCLING TEST For High Frequency Bipolar & BiCMOS Processes  
(Cont)**

**Conditions = -65°C to +150°C/ 1000 Cycles**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX3885ECB	BS2AAQ002Q	64 TQFP	9844	45	0
MAX3885ECB	BS2ABQ002Q	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QA	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QB	64 TQFP	9850	45	0
MAX3885ECB	BS2AAQ001CB	64 TQFP	9824	45	0
MAX3885ECB	BS2AA1002CQ	64 TQFP	9836	45	0
MAX3885ECB	NS2AC3001QB	64 TQFP	0216	77	0
MAX3885ECB	NS2AC3001Q	64 TQFP	0216	77	0
MAX3885ECB	NS2AC3001C	64 TQFP	0215	76	0
MAX3885ECB	NS2AC3001QA	64 TQFP	0216	77	0
<b>Total</b>				<b>8216</b>	<b>4</b>

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**Table 15. HIGH TEMPERATURE STORAGE TEST For High Frequency Bipolar & BiCMOS Processes**  
**Conditions = 150°C, 1000 Hours**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX2682	BR3CAQ002C	6 SOT23	9835	45	0
MAX2680EUT	BR3AAQ001FA	6 SOT23	9823	45	0
MAX2640EUT	BT3BAQ002EC	6 SOT23	9832	45	0
MAX2602ESA	BNPACA004DC	8 NSO	9740	45	0
MAX2602ESA	BNPACA004DB	8 NSO	9740	45	0
MAX2602ESA	BNPACA004DA	8 NSO	9740	45	0
MAX2602ESA	BNPACA004Q	8 NSO	9804	45	0
MAX3266	BU8BAA010Q	8 NSO	2	45	0
MAX3266	BU8BAA010QD	8 NSO	2	45	0
MAX3266	BU8BAA010QE	8 NSO	2	45	0
MAX2620EUA	BNZBBQ001A	8 uMAX	9713	45	0
MAX2690EUB	BH7ABQ002BQ	10 uMAX	9833	45	0
MAX3269	N6LAAQ001BQ	10 uMAX	11	45	0
155-0415-02	Q907003F	100 TQFP	9906	45	0
155-0415-02	Q907004F	100 TQFP	9906	45	0
155-0415-02	Q907005F	100 TQFP	9906	45	0
MAX2388EGC	N22DX3005AQ	12 QFN	0235	77	0
MAX2388EGC	N22DX3005AR	12 QFN	0235	45	0
MAX2430IEE	BHZABQ004CE	16 QSOP	9804	45	0
MAX2430IEE	BHZABQ004CD	16 QSOP	9804	45	0
MAX3960CEE	BNNABQ001A	16 QSOP	9714	45	0
MAX2685EEE	NY4ADZ007A	16 QSOP	9914	45	0
MAX2685EEE	NY4ADZ011A	16 QSOP	9917	45	0
MAX2685EEE	NY4ADZ013A	16 QSOP	9920	45	0
MAX2685	NY4ADZ007B	16 TSSOP	9952	45	0
MAX2685	NY4ADZ007C	16 TSSOP	9952	45	0
MAX2685	NY4ADZ007D	16 TSSOP	9952	45	0
155-0415-12	Q804126H	160 MQUAD	9747	45	0
155-0415-12	Q805023H	160 MQUAD	9749	45	0
155-0415-12	Q806054H	160 MQUAD	9801	45	0
155-0415-12	M902043I	160 MQUAD	9838	45	0
155-0415-12	Q903061J	160 MQUAD	9842	45	0
155-0415-12	Q903062J	160 MQUAD	9842	45	0
MAX104CHC	BW6ACQ002E	192 BGA	9851	20	0
MAX104CHC	BW6ACQ002F	192 BGA	9851	20	0
MAX104CHC	BW6ACQ002G	192 BGA	9851	20	0
MAX9989ETP	NJ00BA004D#	20 QFN	0242	45	0
MAX3964	M901062AQ	20 QSOP	9831	45	0
MAX3964CEP	M902029AQ	20 QSOP	9834	45	0
MAX3964CEP	M902025AQ	20 QSOP	9834	45	0

**Table 15. HIGH TEMPERATURE STORAGE TEST For High Frequency Bipolar & BiCMOS Processes (Cont)**  
**Conditions = 150°C, 1000 Hours**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX22235	BW2ADQ002A	20 TSSOP	9934	45	0
MAX22235	BW2ADQ002D	20 TSSOP	9934	45	0
MAX2321EUP	N8EAF006QB	20 TSSOP	9929	45	0
MAX2321EUP	N8EAF006L	20 TSSOP	9930	45	0
MAX2321EUP	N8EAF006G	20 TSSOP	9930	45	0
MAX2321	N8EAF3045QA	20 TSSOP	9	45	0
MAX2321	N8EAF3045QB	20 TSSOP	9	45	0
MAX2321	N8EAF3045Q	20 TSSOP	9	45	0
MAX3966	NL6AAZ006AA	24 QSOP	9832	45	0
MAX3966CEG	NL6AAZ007AQ	24 QSOP	9833	45	0
MAX2102CWI	BJKAEQ001A	28 NSO	9722	45	0
MAX2323EGI	N38AB3003Q	28 QFN	5	77	0
MAX2323EGI	N38AB3003QA	28 QFN	5	77	0
MAX2323EGI	N38AB3002D	28 QFN	9948	77	0
MAX2323EGI	N38AEA252B#	28 QFN	0252	77	0
MAX2538ETI	N9J3CA509DD	28 QFN	0217	45	0
MAX2388EGC	N22DXA004HF	28 QFN	0244	45	0
MAX3962CEI	BNOACQ002A	28 QSOP	9747	45	0
MAX3962CEI	BNOACQ002B	28 QSOP	9747	45	0
MAX3962	BN0ACQ002H	28 QSOP	9831	45	0
MAX3962CEI	BN0ACQ002I	28 QSOP	9832	45	0
MAX3962CEI	BNOACQ002K	28 QSOP	9834	25	0
MAX3962CEI	BNOACQ002J	28 QSOP	9834	45	0
MAX3850EGJ	NM9964007A	32 QFN	0208	45	0
MAX3850EGJ	NM9964005A	32 QFN	0208	45	0
MAX3850EGJ	NM9964002E	32 QFN	0208	45	0
MAX3675EHJ	BJVAFU009Q	32 TQFP	9903	45	0
MAX3675EHJ	BJVAFU009QA	32 TQFP	9903	45	0
MAX3675EHJ	BJVAFU009QB	32 TQFP	9903	45	0
MAX3675	BJVAF005QB	32 TQFP	9824	45	0
MAX3675EHJ	BJVAF005QA	32 TQFP	9823	45	0
MAX3675EHJ	BJVAEQ003D	32 TQFP	9827	45	0
MAX1002CAX	BLXAFQ002C	36 SSOP	9740	11	0
MAX1002CAX	BLXAFQ002E	36 SSOP	9742	33	0
MAX2113UGH	N1Y0AA089C	44 QFN	0247	45	0
MAX2115UGH	N262A2044CR	44 QFN	0242	45	0
MAX2115UGH	N262A2040AR	44 QFN	0242	45	0
MAX2113UGH	N1Y0AA089D	44 QFN	0247	45	0
MAX2113UGH	N1Y0AA089A	44 QFN	0247	45	0
MAX2115UGH	N262A2039AR	44 QFN	0241	45	0
MAX2113UGH	N1Y0AA043AQ	48 QFN	0205	45	0

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**Table 15. HIGH TEMPERATURE STORAGE TEST For High Frequency Bipolar & BiCMOS Processes (Cont)**  
**Conditions = 150°C, 1000 Hours**

Part Number	Lot number	Package	Date code	Sample size	Failures
MAX2104CCM	BS5ACQ001Q	48 TQFP	9840	45	0
MAX2104CCM	BS5ACQ002C	48 TQFP	9845	45	0
MAX2104CCM	BS5ACQ002B	48 TQFP	9845	45	0
MAX2841EGM	NES2C4502AB	48 TQFP	0219	45	0
MAX2104CCM	NS5ALU131AX	48 TQFP	0207	100	0
MAX3825UCM	N1EAJ3503B	48 TQFP	0216	45	0
MAX2104CCM	NS5AJ3036EQ	48 TQFP	0216	45	0
MAX2104CCM	NS5AJ3036FQ	48 TQFP	0216	45	0
MAX2104CCM	NS5AJ3036DQ	48 TQFP	0216	45	0
MAX3950EGK	N22DD3506AQ	64 QFN	0208	45	0
MAX3885ECB	BS2AAQ002Q	64 TQFP	9844	45	0
MAX3885ECB	BS2ABQ002Q	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QA	64 TQFP	9850	45	0
MAX3885ECB	BS2ABQ002QB	64 TQFP	9850	45	0
MAX3885ECB	BS2AAQ001CB	64 TQFP	9824	45	0
MAX3885ECB	BS2AA1002CQ	64 TQFP	9836	30	0
MAX3885ECB	NS2AC3001B	64 TQFP	0215	45	0
MAX3885ECB	NS2AC3001B	64 TQFP	0215	77	0
MAX3885ECB	NS2AC3001C	64 TQFP	0215	45	0
MAX3950EGK	N22DD3506A	68 QFN	0208	45	0
<b>Total</b>				<b>4636</b>	<b>0</b>

## Appendix 1: Acceleration Factor Calculation

The thermal acceleration factor represents the temperature enhancement of the failure rate, and expresses the ratio of the failure rates at two temperatures. The Arrhenius equation is used to calculate the acceleration factor, given as A below:

$$A = \exp [ (E_a / k_B) \times \{ (1/T_u) - (1/T_s) \} ]$$

where:

- $E_a$  = the activation energy in eV
- $k_B$  = the Boltzmann constant,  $8.617 \times 10^{-5}$  eV/K
- $T_u$  = use temperature, in Kelvin
- $T_s$  = stress test temperature in Kelvin

In using the formula above, we must know the activation energy,  $E_a$ , which may be done in one of two ways.

### *Use existing activation energy information:*

The first method is to use an existing estimate of the activation energy. Activation energies for many failure mechanisms have been tabulated and published in the technical literature. The dominant failure mechanisms in have activation energies in the range of 0.7eV to 1.2eV. We have chosen 0.8eV for the purposes of computing the acceleration factors used in this report. Many failure processes have larger activation energies.

### *Measure the activation energy.*

The second method of determining an activation energy is empirical. The failure rates of two groups of devices are tested at different temperatures, and the ratio A of their failure rates is calculated. An example is shown below:

Group 1 = 60/1000 failures after 100 hrs. of operation at 150°C.

Group 2 = 15/1000 failures after 100 hrs. of operation at 125°C.

The acceleration factor between these two temperatures is, therefore,  $A = 60/15 = 4$ . The activation energy  $E_a$  is given by:

$$E_a = k_B \times \ln[A] / \{ (1/T_u) - (1/T_s) \} = 0.8 \text{ eV}$$

where:

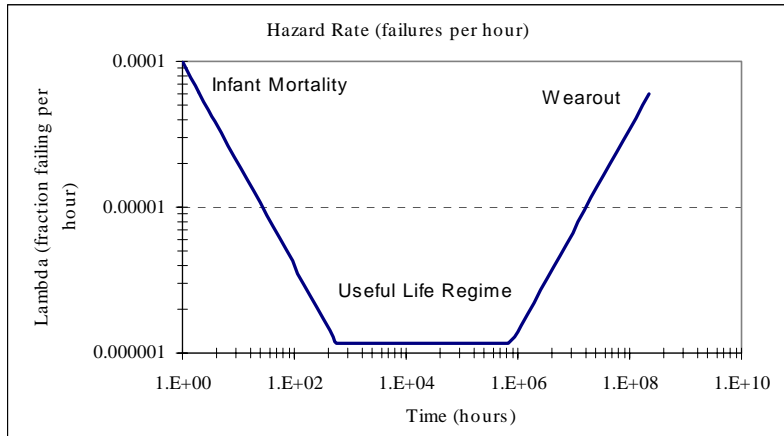
- $E_a$  = the unknown activation energy
- $T_u = 125^\circ\text{C} + 273^\circ\text{C} = 398^\circ\text{K}$
- $T_s = 150^\circ\text{C} + 273^\circ\text{C} = 423^\circ\text{K}$

and **ln** is the natural logarithm function. The other terms are as defined above.

Assuming that this activation energy represents the dominant failure mechanism of the device under consideration, it may then be used to determine the acceleration factor between any two temperatures. For example, to find out the acceleration factor between 150 °C and 70 °C, substitute  $T_u = 70^\circ\text{C} + 273^\circ\text{C} = 343^\circ\text{K}$  and  $T_s = 150^\circ\text{C} + 273^\circ\text{C} = 423^\circ\text{K}$ . Acceleration Factor = 165.

## Appendix 2: Determining Failure Rates

In describing semiconductor reliability, we must first define a few basic terms<sup>1</sup>. We define the total fraction of failures versus time to be the cumulative distribution function  $F(t)$ . The survivor function  $S(t) = 1-F(t)$ . The instantaneous failure rate  $f(t)$  is the time derivative  $dF(t)/dt$ . Finally, the hazard rate  $\lambda(t)$  is the instantaneous failure rate  $f(t)$  normalized to the surviving population  $S(t)$ ;  $\lambda(t)=f(t)/S(t)$ .



It is the hazard rate, plotted versus time  $t$ , that shows the characteristic bathtub curve behavior shown above. The three major regimes of this curve are the infant mortality regime, the useful life regime, and the wearout regime. We discuss each regime separately below.

Initially, the hazard rate is seen to decrease steadily over time, which defines the infant mortality phase. In the infant mortality regime, the hazard rate commonly follows a Weibull function, given by:

$$\lambda(t) = \lambda_0 \cdot t^{-\alpha}$$

where  $\lambda_0$  and  $\alpha$  are constant parameters. Maxim tests the infant mortality failure rate with short (12 to 24 hour) burn-in tests, which are shown in Table 4 of this report.

The infant mortality period is found to eventually give way to a rather constant hazard rate, in the “useful life regime.” This period is still described by the Weibull function, with the parameter  $\alpha= 0$ . The constant hazard rate function is also known as the “exponential distribution.” During the useful life period, the Mean Time To Failure (MTTF), which is the average time for a failure to occur, is simply equal to the inverse of the hazard rate. For example, assume a company tests 100 units to 1000 hrs. The total device-hours accrued would be 100,000 device-hours. If two units were found to be failures, the MTTF would be:

$$\text{MTTF} = \text{Total Device Hrs} / \text{Total Failures} = 100,000 \text{ hr} / 2 = 50,000 \text{ hr}$$

and the hazard ( $\lambda$ ) rate is

$$\lambda = 1/\text{MTTF} = 1/50,000 = 0.00002$$

If this number is multiplied by  $10^5$  the failure rate in terms of percent per 1000 hrs is obtained; i.e., 2% per 1000 hrs.

As failure rates are usually so small, they are commonly describe in terms of the FIT rate. The term FIT is short for Failure-in-Time, and specifically this is defined to be the number of failure per billion device-hours. Thus, the FIT rate is obtained by multiplying the Failure Rate per hour by  $10^9$ :

$$\lambda \text{ in FITs} = \lambda \text{ per hour} \times 10^9$$

Using the above example:

$$\lambda \text{ in FITs} = 0.00002/10^{-9} = 20,000 \text{ FITs}$$

The FIT rate is, therefore, shorthand for the number of units predicted to fail in a billion ( $10^9$ ) device-hours at the specified temperature.

<sup>1</sup> In this discussion, we employ the terminology of semiconductor reliability found in D.J.Klinger, Y. Nakada, and M. A. Menendez, **AT&T Reliability Manual**, Van Nostrand Reinhold, New York, 1990.

## Calculating Failure Rates and FITs

The failure rate can be determined from the following four variables:

- A = The number of failure observed after test
- B = The number of hours the test was run
- C = The number of devices used in the test
- D = The temperature acceleration factor (see Appendix 1)

Using data in Table 3, a failure rate at 25 °C can now be calculated:

- A = 49
- B = 192
- C = 22,850
- D = 9822 (Assuming  $E_a=0.8eV$ , and a test temperature of 150 °C.)

Substituting:

$$\lambda = 49/(192 \times 22,850 \times 9822) = 1.13 \times 10^{-9} \text{ per hour}$$

Expressing this in terms of the FIT rate:

$$\lambda = 1.13 \text{ FITs}$$

To determine the FIT rate at a new temperature, the acceleration factor (D) must be recalculated from the Arrhenius equation given in Appendix 1.

## Including Statistical Effects in the FIT Calculation

Because a number of failures observed from a reliability test sample is usually small, there is a statistical likelihood that the actual failure rate may be higher or lower than the raw value calculated above. We therefore can calculate the failure rate for any given required confidence level. Common confidence levels are 60%, or 90%. We are usually concerned with determining the upper confidence level, or "UCL." The 60% UCL expresses the highest failure rate that would be found rate 60% of the time, based on a random sample from the Chi-square distribution.

The failure rate calculation, including a confidence level, is determined as follows:

$$\lambda = \chi^2/2DH$$

where:

$$\begin{aligned} \chi^2 &= \text{the Chi square value} \\ 2DH &= 2 \text{ times the total device hours} \\ &= 2 \times (B \times C \times D) \end{aligned}$$

The Chi square distribution may be found from standard statistical tables. The Chi-square distribution has as parameters the degrees of freedom (df) and the confidence fraction. The degrees of freedom is  $2 \times (\text{failures} + 1)$ . In the example above, the number of degree of freedom is  $df = 2 \times (49+1) = 100$ . If we desire a 60% UCL, the tabulated Chi square value found under the values of  $(1-60\%)=0.40$  and 100 degrees of freedom is 102.5. Therefore, the failure rate found using a 60% confidence level is:

$$\lambda = 102.5/(8.61 \times 10^{10}) = 1.18 \times 10^{-9}$$

or:

$$\lambda = 1.18 \text{ FITs}$$

Referring to Table 3, one can see that for Maxim's products, to a 60% confidence level, we find the estimate that 1.18 units will fail per billion ( $10^9$ ) device-hours of operation at 25 °C.