

# MAXIM

## *Product Reliability Report*

*This report presents the product reliability data for Maxim's analog products. The data was acquired from extensive reliability stress testing performed in 2001-2002. It is separated into ten fabrication processes:*

- Standard Metal-Gate CMOS (SMG)
- Medium-Voltage Metal-Gate CMOS (M6HV)
- Medium-Voltage Silicon-Gate CMOS (S5HV)
- 5 um Silicon-Gate CMOS (SG5)
- 3 um Silicon-Gate CMOS (S3)
- 1.2 um Silicon-Gate CMOS (S12)
- 0.8 um Silicon-Gate CMOS (S8)
- 0.6 um Silicon-Gate CMOS (S6)
- 80V Bipolar CMOS DMOS (BCD80)
- 1.2 um BiCMOS (HV3)

Over 6 million device hours have been accumulated for products stressed at an elevated temperature (135°C) during this period. Data in this report is typical of Maxim production, and demonstrates the consistently high reliability of Maxim products.

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## Introduction

This report presents the product reliability data for Maxim's analog products. The data was acquired from extensive reliability stress testing performed in 2001-2002. Over 6 million device hours have been accumulated for products stressed at an elevated temperature (135°C) during this period. Data in this report are typical of Maxim production, and demonstrate the consistently high reliability of Maxim products.

## Fabrication Processes

Maxim currently uses the following fabrication processes, described in below.

### **SMG (Standard Metal-Gate CMOS)**

SMG is a 6-micron, 24V, metal-gate CMOS process. It has conservative design rules, but is appropriate for many SSI and MSI circuit designs. This very popular fabrication process is used to produce many of Maxim's products.

### **M6HV (Medium-Voltage Metal-Gate CMOS)**

M6HV is a 12-micron, 44V, metal-gate CMOS process, used exclusively to produce our analog switch product line. This process was previously called MV1

### **S5HV (Medium-Voltage Silicon-Gate CMOS)**

S5HV is a 5-micron, 44V, silicon-gate CMOS process, also used in our analog switch production line. This process was previously termed as MV2

### **SG5, S3, S12, S8, and S6 (3-Micron, 5-Micron, and 1.2-Micron, 0.8-Micron, and 0.6-Micron Silicon-Gate CMOS)**

SG5 is a 5micron, 20V, silicon-gate CMOS process. S3, previously named SG3, is a 3-micron, 12V, silicon-gate CMOS process. S12 is a 1.2-micron, 6V, silicon-gate CMOS process also previously named SG1.2. S8 & S6 are processes for newer products at Maxim.

### **BCD80 (80V Bipolar CMOS DMOS)**

CMOS process including Bipolar and DMOS devices capable of switching up to 80V.

### **HV3 (1.2uM 30V BiCMOS)**

1.2 micron BiCMOS process that includes 30V MOS devices allowing use of voltages up to 30V

## Reliability Methodology

Maxim's quality approach to reliability testing is conservative. Each of the seven fabrication processes has been qualified using the following industry-standard tests: Life Test, 85/85, Pressure Pot, HAST, High-Temperature Storage Life, and Temperature Cycling (Table 1). Each process has been qualified and proven to produce inherently high-quality product.

**TABLE 1. MAXIM PROCESS RELIABILITY TESTS**

Test Name	Conditions	Sampling Plan Acc/SS
Life Test	135°C, biased, 1000h	1/77
85/85	85°C, 85%RH, biased, 1000h	1/77
HAST	130°C, 85%RH, biased, 100h	0/45

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Pressure Pot	121°C,100%RH, 2 atm, unbiased, 168h	0/77
Temperature Cycling	-65°C to+150°C, air to air, unbiased, 1000 cycles	1/77
High Temperature Storage	150°C, unbiased, 1000h	1/77

Maxim's processes clearly meet or exceed the performance and reliability expectations of the semiconductor industry. Results of Maxim's long term life testing on our various process technologies are summarized in Table 2. These processes are qualified for production.

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

(Test Condition: 135 °C, 1000 Hrs. 60% UCL)

PROCESS	SAMPLE SIZE	REJECTS	FIT @ 25C	FIT @ 55C
SMG	225	0	0.94	16.8
M6HV*	802	1	2.78	15.07
S5HV	510	0	0.41	7.09
SG5	231	0	0.91	15.66
S3	915	0	0.23	3.95
S12	2093	0	0.1	1.73
S8	1722	1	0.27	4.64
S6	240	0	0.88	15.07
BCD8	207	0	1.01	17.48
HV3	417	0	0.51	8.67
<b>TOTALS</b>	<b>7362</b>	<b>2</b>	<b>0.10</b>	<b>1.67</b>

\*=This mature process also includes historical data to account for limited samples.

## ***Reliability Program***

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

### Step 1: Initial Reliability Qualification Program

Maxim's product reliability test program meets EIA-JEDEC standards and most standard OEM reliability test requirements.

Table 1 summarizes the qualification tests that are part of Maxim's reliability program. Before releasing products, we require that three consecutive 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 process to be the subjects of reliability monitor testing. Each lot is tested to 48 hours of High-Temperature Operating Life (HTOL) at 135°C. On a quarterly basis, one wafer lot per process per fab is subjected to the same long-term reliability tests as defined in Table 1, which include HTOL, 85/85, Pressure Pot, Temperature Cycling, and High Temperature Storage. 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 analog 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

## ***Reliability Data***

### **Failure-Rate History**

As a routine monitor, Maxim subjects devices to 192 hour Burn-In Testing. This results in a large population of data to compare historical failure rates. Figure 1 reflects the historical 192 hour Life Test failure rates over time for Maxim products. It also highlights the progressive improvements made in reliability, a trend that we expect to continue, due to our continuous-improvement methodology.

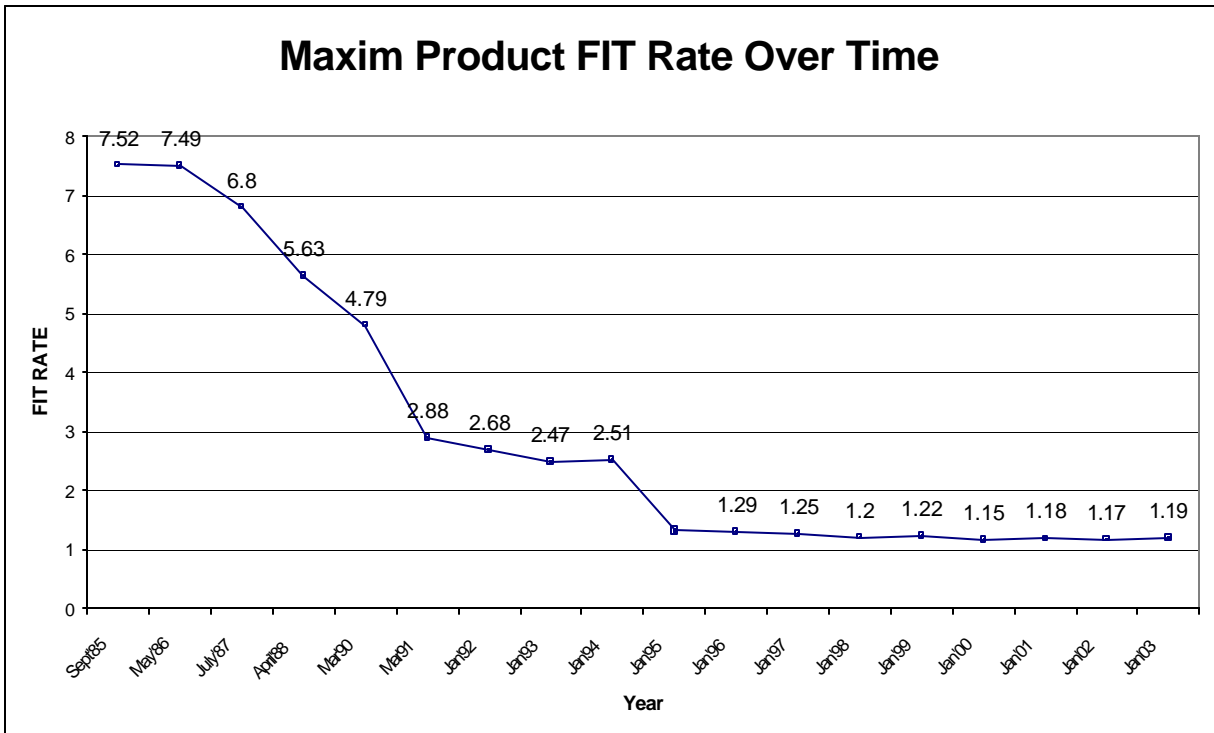


FIGURE 1. Maxim FIT Rates Over Time

### Infant Mortality Evaluation

Maxim evaluates each process and product family's Infant Mortality rate immediately after achieving qualified status. Through Infant Mortality analysis, we can identify the common defects for each process or product family. For an illustration of Maxim/s low Infant Mortality rate, refer to Table 4.

### Merits of Burn-In

Maxim's early conservative approach included burn-in as a standard stage of our production flow. Burn-in ensured that our customers were receiving a quality product. Now, with the addition of our own sophisticated fabrication facilities, we have improved the innate product quality to the point where burn-in adds little reliability value.

Each time a new fabrication process is introduced at Maxim, an Infant Mortality (burn-in) evaluation is initiated with the process qualification. Through this Infant Mortality evaluation we can identify fabrication process defects at an early stage of production. Using the data in Table 4 (Infant Mortality Evaluation Results) and Figure 9 (Infant Mortality Pareto Chart) we can determine which category should next be improved. The data shown demonstrates the positive direction of Maxim's quality standards. It illustrates our continued dedication to providing the lowest overall-cost solution to our customers, through superior quality products.

The data of Table 2 summarizes the reliability effects of production burn-in. Essentially, only one unit out of 6396 was found to be outside their specifications after 1000 hrs of operation at 135°C. This is equal to a FIT rate of 0.07 at 25°C.

In comparison, the Infant Mortality rate is equal to 10 units out of 61,291 after 12 hrs at 135°C, which has an equivalent FIT rate of approximately 3.61. In practical terms, 0.0229% of the total population would be

found as defective through the first six years of operation (below 0.004%/year), with an additional 0.014%/year failing over the remaining life of the product.

**Life Test at 135°C**

Life Test is performed using biased conditions that simulate a real-world application. This test estimates the product's field performance. It establishes the constant failure-rate level and identifies any early wearout mechanisms. The tested product is kept in a controlled, elevated-temperature environment, typically at 135°C. This test can detect design, manufacturing, silicon, contamination, metal integrity, and assembly-related defects.

<b>High-Temperature Life and Dynamic Life Test (DLT)</b>	
Test Conditions:	135°C, 1000 hrs, inputs fed by clock drivers at 50% duty cycle, or Static.
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 5-13

**Humidity Tests**

The most popular integrated circuit (IC) packaging material is plastic. Plastic packages are not hermetic; therefore, moisture and other contaminants can enter the package. Humidity testing measures the contaminants present and the product's resistance to ambient conditions. Contaminants can be introduced during both wafer fabrication and assembly, and they can negatively affect product performance. Pressure Pot, 85/85, and HAST tests are used for this evaluation.

**85/85 Test**

Maxim tests plastic-encapsulated products with an 85/85 test to determine the moisture resistance capability of our products under bias conditions. This test can detect the failure mechanisms found in Life Test. In addition, it can detect electrolytic and chemical corrosion.

<b>85/85</b>	
Test Conditions:	85°C, 85% Relative Humidity, biased, 1000 hrs
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 14

**Pressure Pot Test**

This test simulates a product's exposure to atmospheric humidity, which can be present during both wafer fabrication and assembly. Although an IC is covered with a nearly hermetic passivation layer (upper-surface coat), the bond pads must be exposed during bonding. Pressure Pot testing

<b>Pressure Pot</b>	
Test Conditions:	121°C, 100% RH, no bias, 168 hrs.
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 15

**HAST Test**

Highly Accelerated Steam and Temperature (HAST) testing often replaces 85/85 testing. It serves the same basic function as 85/85, but permits the evaluation to be completed in 10% of the time, making HAST tests useful for immediate feedback and corrective action.

<b>HAST</b>	
Test Conditions:	130°C, 85% RH, biased, 100 hrs.
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 16

**Temperature Cycling Test**

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

<b>Temperature Cycling</b>	
Test Conditions:	-65°C to +150°C, 1000 cycles
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 17

**High Temperature Storage Test**

This test evaluates product performance after being stored for a set duration (1000 hrs.) at a high temperature (150°C). It is only useful for failure mechanisms accelerated by heat.

<b>High-Temperature Storage Life</b>	
Test Conditions:	150°C, 1000 hrs. unbiased
Failure Criteria:	Must meet data sheet specifications
Results:	See Table 18

***Hybrid Products Reliability Data***

Maxim's hybrid product reliability data is presented in Tables 20 and 21. Table 20 is the Life Test data for products tested in 2000-2001. Table 21 is the Temperature Cycling test data for hybrid products.

***Process Variability Control***

Reliability testing offers little value if the manufacturing process varies widely. A standard assumption, which is often false, is that test samples pulled from production are representative of the total population. Sample variability can be lessened by increasing the number of samples studied. However, unless a process is kept "in control," major variations can invalidate reliability test results, leading to incorrect conclusions and diminishing the integrity of failure rate estimates. Uncontrolled processes also make it difficult to prove failure rates of less than 10 FIT.

Maxim monitors the stability of critical process parameters through the use of computerized Statistical Process Control (SPC). Over 125 charts are monitored in-line during wafer production. Additionally, over 100 process parameters are monitored at Wafer Acceptance. Maxim has a target Capability Coefficient (Cpk) goal of 1.3, which is nearly 32 ppm. In addition to SPC, Maxim uses Design of Experiments (DOE) to improve process capability optimize process targeting, and increase robustness.

### **Tables of Reliability Test Data**

**TABLE 4. INFANT MORTALITY EVALUATION RESULTS**

Conditions = Burn-In at 135 °C, 12 Hours

FAB PROCESS	DEVICE	LOT NUMBER	DATE CODE	SAMPLE SIZE	FAILURES	PPM
M6HV	DG201ACSE	NRCAE4099B	0239	3252	0	0
<b>SUBTOTAL</b>				<b>3252</b>	<b>0</b>	<b>0</b>
S5HV	DG411DY	NRLAFA095JR	0203	3852	0	0
S5HV	MAX4507EPN	NUFAB2012U	0249	1000	0	0
S5HV	MAX4507EPN	NUFAB2012U	0249	250	0	0
<b>SUBTOTAL</b>				<b>5102</b>	<b>0</b>	<b>0</b>
S3	MAX709LCPA	NRHABA980K#	0240	2988	0	0
<b>SUBTOTAL</b>				<b>2988</b>	<b>0</b>	<b>0</b>
S12	MAX1644EAE	NQUAG2431AA	0229	6700	3	448
S12	MAX1634EAI	NHLETA141AB	0218	4985	0	0
S12	MAX1772EEI	N3ZAC3082AB	0235	1998	1	501
S12	MAX1718EEI	N5JDB2327A	0238	3000	2	667
S12	MAX1617AMEE	S4BAJ1001D#	0224	4994	0	0
S12	MAX1644EAE	SQUAI1001D#	0229	4993	0	0
<b>SUBTOTAL</b>				<b>26670</b>	<b>6</b>	<b>225</b>
S8	MAX1607ESA	S9DAG1021G#	0211	400	0	0
S8	MAX1607ESA	S9DAG1021G#	0211	4599	0	0
S8	MAX6326CPA	S3GAC1002G#	0214	5000	0	0
S8	MAX1607ESA	S9DAGA037A	0240	4808	2	416
S8	MAX893LESA	IV8BMA144AQ	0242	3680	0	0
<b>SUBTOTAL</b>				<b>18487</b>	<b>2</b>	<b>108</b>
HV3	MAX5431AEUB	N2L0E1001C#	0224	1598	2	1252
HV3	MAX5431CEUB	N2L1E1002C#	0224	1597	0	0
HV3	MAX5431AEUB	N2L0E1008CA	0232	1597	0	0
<b>SUBTOTAL</b>				<b>4792</b>	<b>2</b>	<b>417</b>
<b>TOTAL</b>				<b>61291</b>	<b>10</b>	<b>163</b>

**TABLE 5. LIFE TEST – SMG (Standard METAL -GATE CMOS PROCESS)**  
 Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX211ECAI	0238	28-SSOP	45	0	0	0
MAX211ECAI	0238	28-SSOP	45	0	0	0
MAX211ECAI	0238	28-SSOP	45	0	0	0
MAX241CAI	0238	28-SSOP	45	0	0	0
MAX241CAI	0238	28-SSOP	45	0	0	0
<b>Totals</b>			<b>225</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 6. LIFE TEST – M6HV (MEDIUM VOLTAGE METAL -GATE CMOS PROCESS)**  
 Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
DG201ACSE	0239	16-NSO	76	0	0	0
<b>Totals</b>			<b>76</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 7. LIFE TEST – S5HV (MEDIUM VOLTAGE SILICON-GATE CMOS PROCESS)**  
 Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
DG411DY	0203	16-NSO	80	0	0	0
MAX312CSE	0207	16-NSO	77	0	0	0
MAX312CSE	0207	16-NSO	77	0	0	0
MAX312CSE	0207	16-NSO	77	0	0	0
MAX4507EPN	0221	18-PDIP	18	0	0	0
MAX4507EPN	0224	18-PDIP	27	0	0	0
MAX4507EPN	0249	18-PDIP	77	0	0	0
MAX4507EPN	0249	18-PDIP	77	0	0	0
<b>TOTALS</b>			<b>510</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 8. LIFE TEST – SG5 (5uM SILICON-GATE CMOS PROCESS)**

Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX249CQH	0208	44-PLCC	77	0	0	0
MAX249CQH	0208	44-PLCC	77	0	0	0
MAX249CQH	0208	44-PLCC	77	0	0	0
<b>TOTALS</b>			<b>231</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 9. LIFE TEST – S3 (3uM SILICON-GATE CMOS PROCESS)**

Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX1697TEUT	0138	6-SOT	45	0	0	0
MAX1697TEUT	0138	6-SOT	45	0	0	0
MAX1697TEUT	0138	6-SOT	40	0	0	0
MAX1697TEUT	0240	6-SOT	44	0	0	0
MAX709LCPA	0240	8-PDIP	80	0	0	0
MAX1697TEUT	0240	6-SOT	44	0	0	0
MAX1697TEUT	0240	6-SOT	44	0	0	0
MAX691ACSE	0206	16-NSO	45	0	0	0
MAX691ACSE	0206	16-NSO	45	0	0	0
MAX691ACSE	0206	16-NSO	45	0	0	0
MAX5260BCMH	0234	44-MQFP	44	0	0	0
MAX5260BCMH	0234	44-MQFP	45	0	0	0
MAX5260BCMH	0234	44-MQFP	45	0	0	0
MAX6220ASA	0245	8-NSO	77	0	0	0
MAX6220ASA	0245	8-NSO	77	0	0	0
MAX4501EXK	0130	5-SC70	76	0	0	0
MAX4501EXK	0130	5-SC70	74	0	0	0
<b>TOTALS</b>			<b>915</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 10. LIFE TEST – S12 (1.2uM SILICON-GATE CMOS PROCESS)**  
**Conditions = Burn-In at 135 °C, 1000 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX1644EAE	0229	16-SSOP	160	0	0	0
MAX1644EAE	0229	16-SSOP	80	0	0	0
MAX1780AEGM	0214	48-QFN	45	0	0	0
MAX1634EAI	0214	28-SSOP	77	0	0	0
MAX1634EAI	0214	28-SSOP	77	0	0	0
MAX1634EAI	0218	28-SSOP	80	0	0	0
MAX1780AEGM	0219	48-QFN	45	0	0	0
MAX1780AEGM	0220	48-QFN	45	0	0	0
MAX5631AETK	0231	68-QFN	45	0	0	0
MAX5631AETK	0231	68-QFN	45	0	0	0
MAX5631AETK	0231	68-QFN	45	0	0	0
MAX1617MEE	0234	16-QSOP	45	0	0	0
MAX1617MEE	0234	16-QSOP	45	0	0	0
MAX1617MEE	0234	16-QSOP	43	0	0	0
MAX1772EEI	0235	16-QSOP	80	0	0	0
MAX1631EAI	0240	28-SSOP	45	0	0	0
MAX1631EAI	0240	28-SSOP	45	0	0	0
MAX1780AETM	0240	48-TQFN	45	0	0	0
MAX1780AETM	0240	48-TQFN	45	0	0	0
MAX1780AETM	0240	48-TQFN	45	0	0	0
MAX4473EGA	0123	8-QFN	77	0	0	0
MAX4473EGA	0123	8-QFN	70	0	0	0
MAX4473EGA	0123	8-QFN	73	0	0	0
MAX6190CEUA	0141	8-uMAX	77	0	0	0
MAX6190CEUA	0141	8-uMAX	76	0	0	0
MAX6190CEUA	0141	8-uMAX	75	0	0	0
MAX1780EGM	0150	48-QFN	45	0	0	0
MAX1780EGM	0151	48-QFN	45	0	0	0
MAX1645AEEI	0206	28-QSOP	45	0	0	0
MAX1645AEE1	0206	28-QSOP	45	0	0	0
MAX1645AEE1	0206	28-QSOP	45	0	0	0
MAX1617AMEE	0224	16-QSOP	78	0	0	0
MAX1714AEEP	0229	20-QSOP	80	0	0	0
MAX1632AEA1	0230	28-SSOP	80	0	0	0
<b>Totals</b>			<b>2093</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 11. LIFE TEST – S8 (0.8uM SILICON-GATE CMOS PROCESS)**

Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX4695EGC	0206	12-QFN	45	0	0	0
MAX4695EGC	0208	12-QFN	45	0	0	0
MAX4695EGC	0208	12-QFN	45	0	0	0
MAX4695EGC	0208	12-QFN	45	0	0	0
MAX4246AKA	0226	8-SOT	45	0	0	0
MAX4246AKA	0226	8-SOT	45	0	0	0
MAX4246AKA	0226	8-SOT	44	0	0	0
MAX4695ETC	0228	12-TQFN	44	0	0	0
MAX4695ETC	0228	12-TQFN	45	0	0	0
MAX4695ETS	0228	12-TQFN	44	0	0	0
MAX1806EUA25	0229	8-uMAX	45	0	0	0
MAX4695ETC	0230	12-TQFN	45	0	0	0
MAX4595ETC	0230	12-TQFN	45	0	0	0
MAX4695ETC	0230	12-TQFN	45	0	0	0
MAX1806EUA25	0230	8-uMAX	44	0	0	0
MAX1806EUA25	0230	8-uMAX	45	0	0	0
MAX1776EUA	0135	8-uMAX	73	0	0	0
MAX1843EGI	0150	28-QFN	45	0	0	0
MAX1843EGI	0151	28-QFN	45	0	0	0
MAX1843EGI	0151	28-QFN	45	0	0	0
MAX1843EGI	0202	28-QFN	45	0	0	0
MAX1843EGI	0202	28-QFN	45	0	0	0
MAX1843EGI	0203	28-QFN	45	0	0	0
MAX1842ETI	0233	28-TQFN	45	0	0	0
MAX1842ETI	0233	28-TQFN	45	0	0	0
MAX1842ETI	0234	28-TQFN	45	0	0	0
MAX1842ETI	0238	28-TQFN	45	0	0	0
MAX1842ETI	0238	28-TQFN	44	0	0	0
MAX1842ETI	0238	28-TQFN	45	0	0	0
MAX1607ESA	0211	8-NSO	78	1	0	0
MAX1819UAA33	0214	8-SOT	79	0	0	0
MAX6326CPA	0214	8-PDIP	80	0	0	0
MAX1790EUA	0218	8-SOT	80	0	0	0
MAX1864TEEE	0214	16-QSOP	77	0	0	0
<b>TOTALS</b>			<b>1722</b>	<b>1</b>	<b>0</b>	<b>0</b>

**TABLE 12. LIFE TEST – S6 (0.6uM SILICON-GATE CMOS PROCESS)**

Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX7408CUA	0137	8-uMAX	80	0	0	0
MAX7408CUA	0137	8-uMAX	80	0	0	0
MAX7408CUA	0137	8-uMAX	80	0	0	0
<b>TOTALS</b>			<b>240</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 13. LIFE TEST – BCD80 (80V BiCMOS CMOS DMOS)**

Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX5426AEUD	0210	14-TSSOP	79	0	0	0
MAX5426AEUD	0208	14-TSSOP	80	0	0	0
MAX6035AAUR50	0234	3-SOT	80	0	0	0
MAX5431AEUB	0224	10-uMAX	44	0	0	0
MAX5431AEUB	0224	10-uMAX	45	0	0	0
MAX5431AEUB	0232	10-uMAX	44	0	0	0
MAX5431AEUB	0213	10-uMAX	45	0	0	0
<b>Totals</b>			<b>417</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 14. LIFE TEST – HV3 (1.2 uM BiCMOS)**

Conditions = Burn-In at 135 °C, 1000 Hours

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX5913EMH	0219	44-MQFP	79	0	0	0
MAX5913EMH	0219	44-MQFP	78	0	0	0
MAX5913EMH	0219	44-MQFP	50	0	0	0
<b>Totals</b>			<b>207</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 15. 85/85 TEST (All Plastic Packages)**  
**Conditions = 85°C, 85% Relative Humidity, Biased, 1000 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX4516EUK	0208	5-SOT	43	0
MAX4599EXT	0151	6-SC70	40	0
MAX4599EXT	0151	6-SC70	43	0
MAX4599EXT	0205	6-SC70	38	0
MAX4599EXT	0205	6-SC70	43	0
MAX4599EXT	0206	6-SC70	36	0
MAX4599EXT	0206	6-SC70	44	0
MAX4714EXT	0206	6-SC70	39	0
MAX4714EXT	0206	6-SC70	45	0
MAX4714EXT	0206	6-SC70	44	0
MAX4714EXT	0207	6-SC70	37	0
MAX4624EUT	0203	6-SOT	45	0
MAX4624EUT	0203	6-SOT	45	0
MAX4624EUT	0203	6-SOT	43	0
MAX3294EUT	0248	6-SOT	45	0
MAX4624EUT	0141	6-SOT	44	0
MAX4624EUT	0149	6-SOT	44	0
MAX4624EUT	0212	6-SOT	42	0
MAX4624EUT-T	0248	6-SOT	44	0
MAX4624EUT	0248	6-SOT	41	0
MAX4624EUT-T	0248	6-SOT	41	0
MAX1036EKA	0227	8-SOT	40	0
MAX1606EUA	0244	8-uMAX	43	0
MAX4507EPN	0221	18-PDIP	45	0
MAX4507EPN	0249	18-PDIP	45	0
MAX351CSE	0227	18-PDIP	45	0
MAX5631AETK	0231	68-TQFN	44	0
MAX5631AETK	0231	68-TQFN	45	0
MAX4358ECE	0150	144-TQFP	25	0
<b>TOTALS</b>			<b>1218</b>	<b>0</b>

**TABLE 16. PRESSURE POT TEST (All Plastic Packages)**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX6035AAUR50	0234	3-SOT	79	0
MAX809LEUR	0210	3-SOT	76	0
MAX809LEUR	0210	3-SOT	75	0
MAX809LEUR	0210	3-SOT	76	0
MAX1615EUK	0221	5-SOT	76	0
MAX8863REUK	0221	5-SOT	77	0
MAX4714EXT-T	0244	6-SC70	68	0
MAX4714EXT-T	0244	6-SC70	74	0
MAX4599EXT	0151	6-SC70	75	0
MAX4599EXT	0205	6-SC70	70	0
MAX4599EXT	0206	6-SC70	57	0
MAX4714EXT	0206	6-SC70	69	0
MAX4714EXT	0206	6-SC70	72	0
MAX4714EXT	0207	6-SC70	73	0
MAX1736EUT42	0223	6-SOT	75	0
MAX1736EUT42	0224	6-SOT	75	0
MAX1736EUT42	0224	6-SOT	76	0
MAX1697TEUT	0240	6-SOT	76	0
MAX1697TEUT	0240	6-SOT	77	0
MAX1697TEUT	0240	6-SOT	77	0
MAX4624EUT-T	0248	6-SOT	77	0
MAX1833ETT30	0226	6-TDFN	77	0
MAX1833ETT30	0226	6-TDFN	75	0
MAX1833ETT30	0226	6-TDFN	76	0
MAX6220ASA-5.0	0245	8-NSO	77	0
MAX541AESA	0125	8-NSO	75	0
MAX541ACPA	0125	8-PDIP	75	0
MAX6326CPA	0214	8-PDIP	77	0
MAX709LCPA	0240	8-PDIP	80	0
MAX4246AKA	0226	8-SOT	76	0
MAX4246AKA	0226	8-SOT	76	0
MAX4246AKA	0226	8-SOT	77	0
MAX1790EUA	0232	8-SOT	76	0
MAX1790EUA	0232	8-SOT	77	0
MAX4473EUA	0237	8-SOT	77	0
MAX1792EUA15	0221	8-SOT	77	1
MAX1806EUA25	0229	8-SOT	68	0
MAX1806EUA25	0230	8-SOT	77	0
MAX1806EUA25	0230	8-SOT	73	0
MAX1790EUA	0232	8-SOT	76	0
MAX1792EUA25	0235	8-SOT	77	0
MAX1792EUA50	0243	8-SOT	77	0

**TABLE 16. PRESSURE POT TEST (All Plastic Packages) (cont)**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX5431AEUB	0224	10-uMAX	77	0
MAX5431CEUB	0224	10-uMAX	68	0
MAX5431AEUB	0232	10-uMAX	67	0
MAX4695EGC	0208	12-QFN	77	0
MAX4695EGC	0208	12-QFN	77	0
MAX4695EGC	0206	12-QFN	76	0
MAX4695EGC	0208	12-QFN	73	0
MAX4695ETC	0228	12-TQFN	75	0
MAX4695ETC	0228	12-TQFN	77	0
MAX4695ETC	0228	12-TQFN	77	0
MAX4695ETC	0230	12-TQFN	77	0
MAX4695ETC	0230	12-TQFN	75	0
MAX4695ETC	0230	12-TQFN	76	0
DG201ACSE	0239	16-NSO	76	0
MAX1703ESE	0248	16-NSO	77	0
MAX691ACSE	0206	16-NSO	77	0
MAX691ACSE	0206	16-NSO	77	0
MAX691ACSE	0206	16-NSO	77	0
DG411DY	0203	16-NSO	78	0
MAX312CSE	0207	16-NSO	77	0
MAX312CSE	0207	16-NSO	76	0
MAX312CSE	0207	16-NSO	76	0
MAX4691EGE	0203	16-QFN	76	0
DG412EGE	0141	16-QFN	77	0
MAX1617AMEE	0224	16-QSOP	77	0
MAX1864TEEE	0214	16-QSOP	80	0
MAX1864TEEE	0214	16-QSOP	61	0
MAX1617MEE	0234	16-QSOP	77	0
MAX1617MEE	0234	16-QSOP	77	0
MAX1617MEE	0234	16-QSOP	77	0
MAX1964TEEE	0221	16-QSOP	76	0
MAX4507EPN	0221	18-PDIP	45	0
MAX4507EPN	0249	18-PDIP	45	0
MAX1714AEEP	0229	20-QSOP	77	0
MAX3185CWP	0250	20-WSO	77	0
MAX3185CWP	0250	20-WSO	77	0
MAX3185CWP	0250	20-WSO	77	0
MAX1843EGI	0202	28-QFN	77	0
MAX1843EGI	0203	28-QFN	77	0
MAX1645AEEI	0206	28-QSOP	77	0
MAX1645AEEI	0206	28-QSOP	77	0
MAX1632AEAI	0230	28-SSOP	74	0

**TABLE 16. PRESSURE POT TEST (All Plastic Packages) (cont)**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX211ECAI	0238	28-SSOP	77	0
MAX211ECAI	0238	28-SSOP	77	0
MAX211ECAI	0238	28-SSOP	77	0
MAX241CAI	0237	28-SSOP	77	0
MAX241CAI	0238	28-SSOP	77	0
MAX241CAI	0238	28-SSOP	77	0
MAX1634EAI	0214	28-SSOP	77	0
MAX1634EAI	0214	28-SSOP	76	0
MAX1631EAI	0240	28-SSOP	77	0
MAX1631EAI	0240	28-SSOP	77	0
MAX1631EAI	0240	28-SSOP	77	0
MAX1842ETI	0233	28-TQFN	76	0
MAX1842ETI	0234	28-TQFN	76	0
MAX1842ETI	0238	28-TQFN	75	0
MAX1842ETI	0238	28-TQFN	75	0
MAX1842ETI	0238	28-TQFN	75	0
MAX3243CUI	0223	28-TSSOP	76	0
MAX3243CUI	0223	28-TSSOP	74	0
MAX3243CUI	0223	28-TSSOP	73	0
MAX3241ECGJ	0211	32-QFN	77	0
MAX3241ECGJ	0229	32-QFN	77	0
MAX3241ECGJ	0230	32-QFN	77	0
MAX3241ECAI	0148	32-SSOP	77	0
MAXENGCTJ	0217	32-TQFN	77	0
MAXENGCTJ	0217	32-TQFN	77	0
MAXENGCTJ	0217	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX781CBX	0210	36-SSOP	75	0
MAX781CBX	0210	36-SSOP	76	0
MAX781CBX	0210	36-SSOP	75	0
MAX1868EGL	0214	40-QFN	77	0
MAX1868EGL	0219	40-QFN	77	0
MAX5913EMH	0219	44-MQFP	77	0
MAX5913EMH	0219	44-MQFP	77	0
MAX5913EMH	0219	44-MQFP	77	0
MAX5260BCMh	0234	44-MQFP	76	0
MAX5260BCMh	0234	44-MQFP	77	0
MAX5260BCMh	0234	44-MQFP	77	0
MAX249CQH	0208	44-PLCC	77	0
MAX249CQH	0208	44-PLCC	76	0
MAX249CQH	0208	44-PLCC	77	0

**TABLE 16. PRESSURE POT TEST (All Plastic Packages) (cont)**  
**Conditions = 121°C, 100% Relative Humidity, 15PSIG, 168 Hours**

<b>DEVICE TYPE</b>	<b>DATE CODE</b>	<b>PACKAGE</b>	<b>SAMPLE SIZE</b>	<b>FAILURES</b>
MAX1780EGM	0150	48-QFN	69	0
MAX1780EGM	0150	48-QFN	77	0
MAX1780EGM	0151	48-QFN	77	0
MAX1780AEGM	0219	48-QFN	76	0
MAX1780AEGM	0220	48-QFN	77	0
MAX1987ETM	0226	48-TQFN	77	0
MAX1987ETM	0229	48-TQFN	77	0
MAX1780ECM	0242	48-TQFP	77	0
MAX5632AEGK	0251	68-QFN	77	0
MAX5632AEGK	0251	68-QFN	77	0
MAX5632AEGK	0251	68-QFN	77	0
MAX5631AETK	0231	68-TQFN	77	0
MAX5631AETK	0231	68-TQFN	77	0
MAX4358ECE	0150	144-TQFP	73	0
<b>TOTALS</b>			<b>10619</b>	<b>1</b>

**TABLE 17. HAST TEST (All Plastic Packages)**  
**Conditions = 130°C, 85% Relative Humidity, biased, 100 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX6035AAUR50	0234	3-SOT	43	0
MAX1697TEUT	0240	6-SOT	45	0
MAX1697TEUT	0240	6-SOT	45	0
MAX1697TEUT	0240	6-SOT	45	0
MAX6220ASA-5.0	0245	8-NSO	77	0
MAX6220ASA-5.0	0245	8-NSO	75	0
MAX1607ESA	0211	8-NSO	45	0
MAX893LESA	0242	8-NSO	72	0
MAX6326CPA	0214	8-PDIP	45	0
MAX4246AKA	0226	8-SOT	44	0
MAX4246AKA	0226	8-SOT	42	0
MAX4246AKA	0226	8-SOT	35	0
MAX1790EUA	0232	8-uMAX	45	0
MAX1792EUA15	0221	8-uMAX	45	0
MAX1792EUA15	0221	8-uMAX	45	0
MAX1792EUA50	0229	8-uMAX	45	0
MAX1806EUA25	0229	8-uMAX	45	0
MAX1806EUA25	0230	8-uMAX	45	0
MAX1806EUA25	0230	8-uMAX	45	0
MAX1790EUA	0232	8-uMAX	55	0
MAX1792EUA25	0235	8-uMAX	44	0
MAX1792EUA50	0243	8-uMAX	45	0
MAX5431CEUB	0224	10-uMAX	44	0
MAX5431AEUB	0232	10-uMAX	45	0
MAX4695EGC	0206	12-QFN	44	0
MAX4695EGC	0208	12-QFN	44	0
MAX4695EGC	0208	12-QFN	45	0
MAX4695EGC	0208	12-QFN	44	0
MAX4695ETC	0228	12-QFN	42	0
MAX4695ETC	0228	12-QFN	45	0
MAX4695ETC	0228	12-QFN	45	0
MAX4695ETC	0230	12-QFN	45	0
MAX4695ETC	0230	12-QFN	45	0
MAX4695ETC	0230	12-TQFN	44	0
MAX5426EUD	0210	14-TSSOP	44	0
MAX1703ESE	0248	16-NSO	45	0
DG201ACSE	0239	16-NSO	71	0
MAX691ACSE	0206	16-NSO	45	0
MAX691ACSE	0206	16-NSO	45	0
MAX691ACSE	0206	16-NSO	45	0
MAX691ACSE	0238	16-NSO	45	0

**TABLE 17. HAST TEST (All Plastic Packages) (cont)**  
**Conditions = 130°C, 85% Relative Humidity, biased, 100 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX691ACSE	0238	16-NSO	45	0
MAX691ACSE	0238	16-NSO	45	0
MAX1617MEE	0234	16-QSOP	44	0
MAX1617MEE	0234	16-QSOP	44	0
MAX1617MEE	0234	16-QSOP	44	0
MAX1864TEEE	0214	16-QSOP	44	0
MAX4507EPN	0221	18-PDIP	45	0
MAX4507EPN	0249	18-PDIP	76	0
MAX1714AEEP	0229	20-QSOP	43	0
MAX1645AEEI	0206	20-QSOP	44	0
MAX1645AEEI	0206	20-QSOP	44	0
MAX3185CWP	0250	20-WSO	40	0
MAX3185CWP	0250	20-WSO	40	0
MAX3185CWP	0250	20-WSO	40	0
MAX1843EGI	0202	28-QFN	45	0
MAX1632AEAI	0230	28-SSOP	44	0
MAX1634EAI	0214	28-SSOP	45	0
MAX1634EAI	0214	28-SSOP	43	0
MAX1634EAI	0214	28-SSOP	41	0
MAX1631EAI	0240	28-SSOP	44	0
MAX1631EAI	0240	28-SSOP	45	0
MAX1631EAI	0240	28-SSOP	43	0
MAX211ECAI	0238	28-SSOP	45	0
MAX211ECAI	0238	28-SSOP	45	0
MAX211ECAI	0238	28-SSOP	45	0
MAX1842ETI	0233	28-TQFN	45	0
MAX1842ETI	0234	28-TQFN	45	0
MAX1842ETI	0238	28-TQFN	45	0
MAX1842ETI	0238	28-TQFN	45	0
MAX1842ETI	0238	28-TQFN	45	0
MAX3243CUI	0223	28-TSSOP	44	0
MAX3243CUI	0223	28-TSSOP	44	0
MAX3243CUI	0223	28-TSSOP	44	0
MAX3241ECTJ	0230	32-TQFN	45	0
MAX3241ECTJ	0230	32-TQFN	44	0
MAX3241ECTJ	0230	32-TQFN	45	0
MAX3241ECTJ	0230	32-TQFN	45	0
MAX781CBX	0210	36-SSOP	45	0
MAX781CBX	0210	36-SSOP	45	0
MAX781CBX	0210	36-SSOP	44	0
MAX5260BCMh	0234	44-MQFP	43	0
MAX5260BCMh	0234	44-MQFP	42	0
MAX5260BCMh	0234	44-MQFP	42	0

**TABLE 17. HAST TEST (All Plastic Packages) (cont)**  
**Conditions = 130°C, 85% Relative Humidity, biased, 100 Hours**

<b>DEVICE TYPE</b>	<b>DATE CODE</b>	<b>PACKAGE</b>	<b>SAMPLE SIZE</b>	<b>FAILURES</b>
MAX249CQH	0208	44-PLCC	45	0
MAX249CQH	0208	44-PLCC	45	0
MAX249CQH	0208	44-PLCC	45	0
MAX1987ETM	0249	44-TQFN	44	0
MAX1987ETM	0250	44-TQFN	45	0
MAX1780EGM	0150	48-QFN	38	0
MAX1780EGM	0150	48-QFN	43	0
MAX1780AETM	0249	48-QFN	37	0
MAX1780AETM	0249	48-QFN	42	0
MAX1780AETM	0249	48-QFN	36	0
MAX1987ETM	0226	48-TQFN	44	0
MAX1987ETM	0229	48-TQFN	41	0
<b>TOTALS</b>			<b>4369</b>	<b>0</b>

**Table 18. TEMPERATURE CYCLING TEST (All Plastic Packages)**  
**Conditions = -65°C to +150°C/ 1000 Cycles**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX6035AAUR50	0234	3-SOT	80	0
MAX809LEUR	0210	3-SOT	77	0
MAX809LEUR	0210	3-SOT	75	0
MAX809LEUR	0210	3-SOT	76	0
MAX4501EXK	0130	5-SC70	72	0
MAX4714EXT-T	0244	6-SC70	77	0
MAX4714EXT-T	0244	6-SC70	73	0
MAX4714EXT-T	0244	6-SC70	76	0
MAX4599EXT	0151	6-SC70	75	0
MAX4599EXT	0205	6-SC70	76	0
MAX4599EXT	0206	6-SC70	72	0
MAX4714EXT	0206	6-SC70	77	0
MAX4714EXT	0206	6-SC70	76	0
MAX4714EXT	0207	6-SC70	77	0
MAX4642EUT	0203	6-SOT	76	0
MAX4624EUT	0203	6-SOT	77	0
MAX4624EUT	0203	6-SOT	70	0
MAX4625EUT	0203	6-SOT	77	0
MAX1736EUT42	0224	6-SOT	77	0
MAX1697TEUT	0240	6-SOT	76	0
MAX1697TEUT	0240	6-SOT	76	0
MAX1697TEUT	0240	6-SOT	77	0
MAX4624EUT	0248	6-SOT	77	0
MAX4624EUT-T	0248	6-SOT	74	0
MAX4624EUT-T	0248	6-SOT	77	0
MAX1833ETT30	0226	6-TDFN	77	0
MAX1833ETT30	0226	6-TDFN	77	0
MAX1833ETT30	0226	6-TDFN	77	0
MAX541AESA	0125	8-NSO	74	0
MAX6220ASA-5.0	0245	8-NSO	77	0
MAX6220ASA-5.0	0245	8-NSO	77	0
MAX1607ESA	0211	8-NSO	77	3
MAX541ACPA	0125	8-PDIP	75	0
MAX6326CPA	0214	8-PDIP	77	0
MAX709LCPA	0240	8-PDIP	77	0
MAX4246AKA	0226	8-SOT	77	0
MAX4246AKA	0226	8-SOT	76	0
MAX4246AKA	0226	8-SOT	77	0
MAX1792EUA15	0221	8-uMAX	77	0
MAX1792EUA15	0221	8-uMAX	77	0
MAX1792EUA50	0229	8-uMAX	77	0

**Table 18. TEMPERATURE CYCLING TEST (All Plastic Packages) (cont)**  
**Conditions = -65°C to +150°C/ 1000 Cycles**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX1806EUA25	0229	8-uMAX	77	0
MAX1806EUA25	0230	8-uMAX	69	0
MAX1806EUA25	0230	8-uMAX	72	0
MAX1792EUA25	0235	8-uMAX	77	0
MAX1792EUA25	0235	8-uMAX	76	0
MAX1792EUA50	0243	8-uMAX	77	0
MAX5431CEUB	0224	10-uMAX	77	0
MAX5431AEUB	0224	10-uMAX	76	0
MAX5431AEUB	0232	10-uMAX	77	0
MAX4695EGC	0208	12-QFN	77	0
MAX4695EGC	0206	12-QFN	77	0
MAX4695EGC	0208	12-QFN	76	0
MAX4695EGC	0208	12-QFN	77	0
MAX4695ETC	0228	12-TQFN	77	0
MAX4695ETC	0228	12-TQFN	76	0
MAX4695ETC	0228	12-TQFN	77	0
MAX4695ETC	0230	12-TQFN	76	0
MAX4695ETC	0230	12-TQFN	76	0
MAX4695ETC	0230	12-TQFN	74	0
MAX1563ETC	0252	12-TQFN	76	0
DG201ACSE	0239	16-NSO	50	0
MAX1703ESE	0248	16-NSO	77	0
MAX691ACSE	0206	16-NSO	77	0
MAX691ACSE	0206	16-NSO	77	0
MAX691ACSE	0206	16-NSO	77	0
DG411DY	0203	16-NSO	77	0
MAX312CSE	0207	16-NSO	77	0
MAX312CSE	0207	16-NSO	77	0
MAX312CSE	0207	16-NSO	77	0
MAX4691EGE	0203	16-QFN	76	0
MAX1617AMEE	0224	16-QSOP	77	0
MAX1864TEEE	0214	16-QSOP	77	0
MAX1617MEE	0234	16-QSOP	77	0
MAX1617MEE	0234	16-QSOP	77	0
MAX1617MEE	0234	16-QSOP	77	0
MAX4507EPN	0221	18-PDIP	45	0
MAX4507EPN	0221	18-PDIP	77	0
MAX4507EPN	0224	18-PDIP	43	0
MAX4507EPN	0249	18-PDIP	75	0
MAX1714AEEP	0229	20-QSOP	77	0
MAX3185CWP	0250	20-WSO	77	0
MAX3185CWP	0250	20-WSO	77	0

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**Table 18. TEMPERATURE CYCLING TEST (All Plastic Packages) (cont)**  
**Conditions = -65°C to +150°C/ 1000 Cycles**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX3185CWP	0250	20-WSO	77	0
MAX1843EGI	0202	28-QFN	77	1
MAX1843EGI	0203	28-QFN	77	0
MAX1645AEEI	0206	28-QSOP	77	0
MAX1645AEEI	0206	28-QSOP	77	0
MAX1645AEEI	0206	28-QSOP	77	0
MAX1632AEAI	0230	28-SSOP	77	0
MAX211ECAI	0238	28-SSOP	77	0
MAX211ECAI	0238	28-SSOP	77	0
MAX211ECAI	0238	28-SSOP	77	0
MAX241CAI	0237	28-SSOP	77	0
MAX241CAI	0238	28-SSOP	77	0
MAX241CAI	0238	28-SSOP	77	0
MAX1634EAI	0214	28-SSOP	77	0
MAX1634EAI	0214	28-SSOP	75	0
MAX1634EAI	0218	28-SSOP	77	0
MAX1631EAI	0240	28-SSOP	77	0
MAX1631EAI	0240	28-SSOP	77	0
MAX1631EAI	0240	28-SSOP	77	0
MAX1842ETI	0233	28-TQFN	77	0
MAX1842ETI	0233	28-TQFN	77	0
MAX1842ETI	0234	28-TQFN	77	0
MAX1842ET1	0238	28-TQFN	77	0
MAX1842ET1	0238	28-TQFN	77	0
MAX1842ET1	0238	28-TQFN	77	0
MAX3243CUI	0223	28-TSSOP	75	0
MAX3243CUI	0223	28-TSSOP	76	0
MAX3243CUI	0223	28-TSSOP	77	0
MAX505CTJ	0217	32-TQFN	77	0
MAX505CTJ	0217	32-TQFN	56	0
MAX505CTJ	0217	32-TQFN	77	0
MAX505CTJ	0217	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX3241ECTJ	0230	32-TQFN	77	0
MAX781CBX	0210	36-SSOP	77	0
MAX781CBX	0210	36-SSOP	76	0
MAX5913EMH	0219	44-MQFP	76	0
MAX5913EMH	0219	44-MQFP	77	0

**Table 18. TEMPERATURE CYCLING TEST (All Plastic Packages) (cont)**  
**Conditions = -65°C to +150°C/ 1000 Cycles**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX5913EMH	0219	44-MQFP	78	0
MAX5260BCMh	0234	44-MQFP	77	0
MAX5260BCMh	0234	44-MQFP	77	0
MAX547AEQH-D	0150	44-PLCC	80	0
MAX249CQH	0208	44-PLCC	77	0
MAX249CQH	0208	44-PLCC	77	0
MAX249CQH	0208	44-PLCC	77	0
MAX1987ETM	0249	44-TQFN	74	0
MAX1987ETM	0250	44-TQFN	75	0
MAX1780EGM	0150	48-QFN	77	0
MAX1780EGM	0150	48-QFN	75	0
MAX1780EGM	0151	48-QFN	75	0
MAX1780AEGM	0214	48-QFN	77	0
MAX1780AEGM	0219	48-QFN	68	0
MAX1780AEGM	0220	48-QFN	77	0
MAX1780AETM	0249	48-QFN	77	0
MAX1780AETM	0249	48-QFN	77	0
MAX1780AETM	0249	48-QFN	77	0
MAX1780ECM	0242	48-TQFP	77	0
MAX5632AEGK	0251	68-QFN	77	0
MAX5632AEGK	0251	68-QFN	77	0
MAX5632AEGK	0251	68-QFN	77	0
MAX5631AETK	0231	68-TQFN	77	0
MAX5631AETK	0231	68-TQFN	77	0
MAX4358ECE	0150	144-TQFP	45	0
<b>TOTAL</b>			<b>11395</b>	<b>4</b>

**Table 19. HIGH TEMPERATURE STORAGE TEST (Plastic Packages)**  
**Conditions = 150°C, 1000 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES	
				500Hrs	1000 Hrs
MAX6035AAUR50	0234	3-SOT	76	0	0
MAX4599EXT	0151	6-SC70	70	0	0
MAX4599EXT	0205	6-SC70	46	0	0
MAX4599EXT	0206	6-SC70	69	0	0
MAX4714EXT	0206	6-SC70	45	0	0
MAX4714EXT	0206	6-SC70	38	0	0
MAX4714EXT	0207	6-SC70	44	0	0
MAX4624EUT	0203	6-SOT	77	0	0
MAX4624EUT	0203	6-SOT	77	0	0
MAX4642EUT	0203	6-SOT	77	0	0
MAX1697EUT	0240	6-SOT	70	0	0
MAX1697TEUT	0240	6-SOT	77	0	0
MAX1697TEUT	0240	6-SOT	76	0	0
MAX1607ESA	0211	8-NSO	75	0	0
MAX6326CPA	0214	8-PDIP	77	0	0
MAX709LCPA	0240	8-PDIP	77	0	0
MAX4246AKA	0226	8-SOT	75	0	0
MAX4246AKA	0226	8-SOT	75	0	0
MAX4246AKA	0226	8-SOT	75	0	0
MAX1806EUA25	0229	8-uMAX	66	0	0
MAX1806EUA25	0230	8-uMAX	70	0	0
MAX1806EUA25	0230	8-uMAX	73	0	0
MAX5431CEUB	0224	10-uMAX	76	0	0
MAX5431AEUB	0224	10-uMAX	76	0	0
MAX5431AEUB	0232	10-uMAX	77	0	0
MAX4695EGC	0208	12-QFN	77	0	0
MAX4695EGC	0206	12-QFN	76	0	0
MAX4695EGC	0208	12-QFN	77	0	0
MAX4695EGC	0208	12-QFN	77	0	0
MAX4695ETC	0228	12-QFN	76	0	0
MAX4695ETC	0228	12-QFN	77	0	0
MAX4595ETC	0228	12-QFN	77	0	0
MAX4695ETC	0230	12-QFN	77	0	0
MAX4695ETC	0230	12-QFN	77	0	0
MAX4695ETC	0230	12-QFN	76	0	0
DG201ACSE	0239	16-NSO	76	0	0
MAX691ACSE	0206	16-NSO	75	0	0
MAX691ACSE	0206	16-NSO	77	0	0

**Table 19. HIGH TEMPERATURE STORAGE TEST (All Plastic Packages) (cont)**  
**Conditions = 150°C, 1000 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES	
				500Hrs	1000 Hrs
MAX691ACSE	0206	16-NSO	77	0	0
DG411DY	0203	16-NSO	76	0	0
MAX312CSE	0207	16-NSO	77	0	0
MAX312CSE	0207	16-NSO	77	0	0
MAX312CSE	0207	16-NSO	76	0	0
MAX4691EGE	0203	16-QFN	77	0	0
MAX1617AMEE	0224	16-QSOP	77	0	0
MAX1864TEEE	0214	16-QSOP	54	0	0
MAX1617MEE	0234	16-QSOP	77	0	0
MAX1617MEE	0234	16-QSOP	77	0	0
MAX4507EPN	0221	18-PDIP	24	0	0
MAX4507EPN	0221	18-PDIP	77	0	0
MAX4507EPN	0224	18-PDIP	45	0	0
MAX4507EPN	0249	18-PDIP	77	0	0
MAX1714AEEP	0229	20-QSOP	77	0	0
MAX1843EGI	0202	28-QFN	77	0	0
MAX1843EGI	0202	28-QFN	74	0	0
MAX1843EGI	0202	28-QFN	75	0	0
MAX1843EGI	0203	28-QFN	76	0	0
MAX1842ET1	0233	28-QFN	77	0	0
MAX1842ET1	0233	28-QFN	73	0	0
MAX1842ET1	0234	28-QFN	77	0	0
MAX1842ETI	0238	28-QFN	77	0	0
MAX1842ETI	0238	28-QFN	77	0	0
MAX1842ETI	0238	28-QFN	77	0	0
MAX1645AEE1	0206	28-QSOP	76	0	0
MAX1645AEE1	0206	28-QSOP	77	0	0
MAX1645AEE1	0206	28-QSOP	77	0	0
MAX1632AEAI	0230	28-SSOP	77	0	0
MAX211ECAI	0238	28-SSOP	77	0	0
MAX211ECAI	0238	28-SSOP	77	0	0
MAX211ECAI	0238	28-SSOP	77	0	0
MAX241CAI	0237	28-SSOP	77	0	0
MAX241CAI	0238	28-SSOP	77	0	0
MAX241CAI	0238	28-SSOP	77	0	0
MAX1634EAI	0214	28-SSOP	77	0	0
MAX1634EAI	0214	28-SSOP	77	0	0
MAX1634EAI	0218	28-SSOP	77	0	0

**Table 19. HIGH TEMPERATURE STORAGE TEST (All Plastic Packages) (cont)**  
**Conditions = 150°C, 1000 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES	
				500Hrs	1000 Hrs
MAX1631EAI	0240	28-SSOP	76	0	0
MAX1631EAI	0240	28-SSOP	77	0	0
MAX1631EAI	0240	28-SSOP	75	0	0
MAX3241ECTJ	0230	32-QFN	77	0	0
MAX3241ECTJ	0230	32-QFN	77	0	0
MAX781CBX	0210	36-SSOP	74	0	0
MAX781CBX	0210	36-SSOP	77	0	0
MAX5913EMH	0219	44-MQFP	50	0	0
MAX5913EMH	0219	44-MQFP	50	0	0
MAX5913EMH	0219	44-MQFP	80	0	0
MAX5260BCMh	0234	44-MQFP	77	0	0
MAX5260BCMh	0234	44-MQFP	77	0	0
MAX5269BCMh	0234	44-MQFP	77	0	0
MAX249CQH	0208	44-PLCC	77	0	0
MAX249CQH	0208	44-PLCC	77	0	0
MAX249CQH	0208	44-PLCC	77	0	0
MAX1987ETM	0250	44-QFN	76	0	0
MAX1780EGM	0150	48-QFN	77	0	0
MAX1780EGM	0150	48-QFN	75	0	0
MAX1780EGM	0151	48-QFN	77	0	0
MAX1780AEGM	0214	48-QFN	40	0	0
MAX1780AEGM	0219	48-QFN	74	0	0
MAX1780AEGM	0220	48-QFN	76	0	0
MAX5631AETK	0231	68-QFN	77	0	0
MAX5631AETK	0231	68-QFN	77	0	0
MAX5631AETK	0231	68-QFN	45	0	0
MAX4358ECE	0150	144-TQFP	45	0	0
<b>TOTAL</b>			<b>7448</b>	<b>0</b>	<b>0</b>

**TABLE 20. HYBRID PRODUCTS-LIFE TEST RESULTS**  
**Conditions = Burn-In at 135 °C, 1000 Hours**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES		
				192Hrs	500 Hrs	1000 Hrs
MAX203CWP	0241	20-WSO	70	0	0	0
MAX203CWP	0241	20-WSO	70	0	0	0
MAX203CWP	0241	20-WSO	70	0	0	0
<b>TOTALS</b>			<b>210</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 21. HYBRID PRODUCTS-TEMPERATURE CYCLING TEST RESULTS**  
**Conditions = -65°C to +150°C/ 1000 Cycles**

DEVICE TYPE	DATE CODE	PACKAGE	SAMPLE SIZE	FAILURES
MAX1480ACPI	0251	28-PDIP	73	0
MAX1480ACPI	0251	28-PDIP	75	0
MAX1480AEPI	0251	28-PDIP	76	0
MAX203CWP	0241	20-WSO	44	0
MAX203CWP	0241	20-WSO	45	0
MAX203CWP	0241	20-WSO	45	0
MAX1480AEPI	0251	28-PDIP	76	0
MAX1480BEPI	0251	28-PDIP	75	0
MAX1480BEPI	0251	28-PDIP	76	0
MAX1480BCPI	0251	28-PDIP	75	0
<b>TOTALS</b>			<b>660</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:

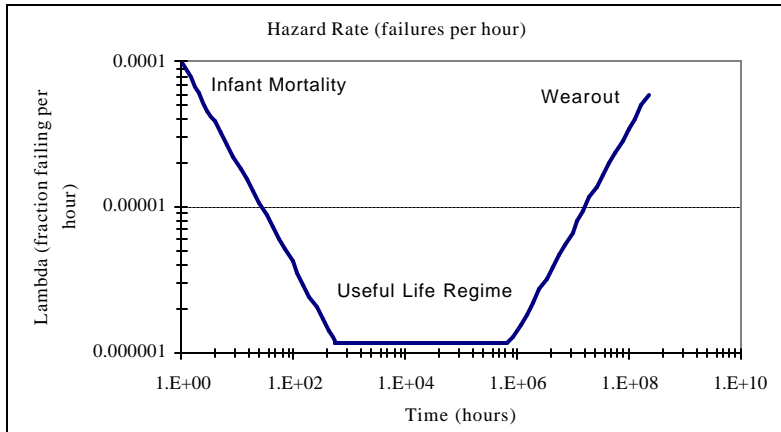
- $E_a$  = the unknown activation energy
- $T_u = 125^\circ\text{C} + 273^\circ\text{C} = 398^\circ\text{K}$
- $T_s = 150^\circ\text{C} + 273^\circ\text{C} = 423^\circ\text{K}$

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:

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

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  $10^9$ :

$$1 \text{ in FITs} = 1 \text{ per hour} \times 10^9$$

Using the above example:

$$1 \text{ in FITs} = 0.00002/10^{-9} = 20,000 \text{ FITs}$$

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  $E_a=0.8\text{eV}$ , and a test temperature of 150 °C.)

Substituting:

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

Expressing this in terms of the FIT rate:

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

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:

$$I = c^2/2DH$$

where:

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

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 102.5 degrees of freedom is 57.64. Therefore, the failure rate found using a 60% confidence level is:

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

or:

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

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.