



May 1, 1995

RR-11

Product Reliability Report

This report presents the product reliability data for Maxim's analog products. This data is a result of extensive reliability stress testing that we performed in 1994. It is separated into six fabrication processes: (1) Standard Metal-Gate CMOS (SMG); (2) Medium-Voltage Metal-Gate CMOS (MV1); (3) Medium-Voltage Silicon-Gate CMOS (MV2); (4) 3 μ m Silicon-Gate CMOS (SG3); (5) 5 μ m Silicon-Gate CMOS (SG5); and (6) Bipolar (BIP) processes.

Over 14,743,000 device hours have been accumulated for products stressed at an elevated temperature (135°C) during this period. The data in this report is considered typical of Maxim's production. As you will see, Maxim's products demonstrate consistently high reliability.

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Product Reliability Report

RR-1/

Table of Contents

Introduction	3
Reliability Methodology	3
Reliability Program	3
Step 1: Initial Reliability Qualification Program	4
Step 2: Ongoing Reliability Monitor Program	4
Step 3: In-Depth Failure Analysis and Corrective Action	4
Design-In High Reliability	4
Wafer Inspection	4
Failure-Rate History	5
Infant Mortality Evaluation and Product Burn-In	6
Reliability Data	6
Merits of Burn-In	6
Life Test at 135°C	6
Humidity Test	6
85/85 Test	7
Pressure Pot Test	7
HAST Test	7
Temperature Cycling Test	7
High-Temperature Storage Life Test	7
Hybrid Products Reliability Data	7
Process Variability Control	7
Process Technologies	8
Reliability Test Results	9
Appendices 1 and 2	21
Appendix 1: Determining Acceleration Factor	21
Appendix 2: Determining Failure Rate	22

Introduction

This report summarizes the qualification data for Maxim's SMG, MV1, MV2, SG3, SG5, and Bipolar processes.

Fabrication

Maxim is currently running the following six major fabrication processes:

1. SMG (Standard Metal-Gate CMOS)
2. MV1 (Medium-Voltage Metal-Gate CMOS)
3. MV2 (Medium-Voltage Silicon-Gate CMOS)
4. SG3 (3-Micron Silicon-Gate CMOS)
5. SG5 (5-Micron Silicon-Gate CMOS)
6. Bipolar (18/12-Micron)

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

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

MV2 is a 5-micron, 44V, silicon-gate CMOS process, also used in our analog switch production line.

SG3 is a 3-micron, 12V, silicon-gate CMOS process.

SG5 is a 5-micron, 20V, silicon-gate CMOS process, used to produce Maxim's next generation of MSI and LSI products. Both SG3 and SG5 have become our future process standards.

Bipolar is an 18-micron, 44V or 12-micron, 24V bipolar process, used chiefly for precision references, op amps, and A/D converters.

Reliability Methodology

Maxim's quality approach to reliability testing is conservative. Each of the six 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. Each process has been qualified and proven to produce inherently high-quality product.

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 facility, we have improved the innate product quality to the point where burn-in (BI) adds little reliability value.

Before removing BI from our standard products, we are undertaking an Infant Mortality analysis for each process. A process must demonstrate an inherent Infant Mortality failure rate of less than 300ppm. Table 4 shows the Infant Mortality evaluations undertaken. Each of the categories for failure is prioritized based on its relative frequency (Figure 3), to identify what area should be improved next. The data shown here 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.

Maxim's SMG, MV1, MV2, SG3, SG5, and Bipolar processes clearly meet or exceed the performance and reliability expectations of the semiconductor industry. These processes are qualified for production.

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 steps:

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

Tables 5–10 show the results of long-term Life Tests by process and device type. Tables 11–15 show the results of the 85/85, Pressure Pot, HAST, Temperature Cycling, and High-Temperature Storage Life tests, by device type. Tables 16 and 17 show hybrid product reliability.

Product Reliability Report

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.

TABLE 1. MAXIM RELIABILITY TEST PROGRAM

TEST NAME	CONDITIONS	SAMPLING PLAN ACC/SS
Life Test	+135°C/1000 hrs.	1/77
85/85	+85°C, 85% R.H 1000 hrs. w/Bias	1/77
Pressure Pot	+121°C, 100% R.H. 2 ATM, 168 hrs.	0/77
Temperature Cycling	-65°C to +150°C Air to Air/1000 Cycling	1/77
High Temp. Storage Life	+150°C/1000 hrs.	1/77

Step 2: Ongoing Reliability Monitor Program

Each week Maxim identifies three wafer lots per process per fab to be the subjects of reliability monitor testing. Each lot is Pressure Pot tested, and tested to 192 hours of High-Temperature Storage Life (at 135°C). On a quarterly basis, one wafer lot per process per fab is identified and subjected to the same long-term reliability tests as defined in Table 1. Test results are fed back into 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.

Design-In High 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 ± 15 kV ESD using the human-body model, ± 8 kV ESD using IEC801-2 contact discharge, or ± 15 kV ESD using IEC801-2 air-gap discharge. Maxim tests each new product for designed 50mA 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.

Product Reliability Report

RR-11

Failure-Rate History

The graph below (Figure 1) illustrates Maxim's Failures-in-Time (FIT) rate performance. It also highlights the progressive improvements made in

this FIT rate, a trend which we expect to see continue, thanks to our established continuous-improvement methodology.

FIGURE 1. MAXIM FIT RATES OVER TIME

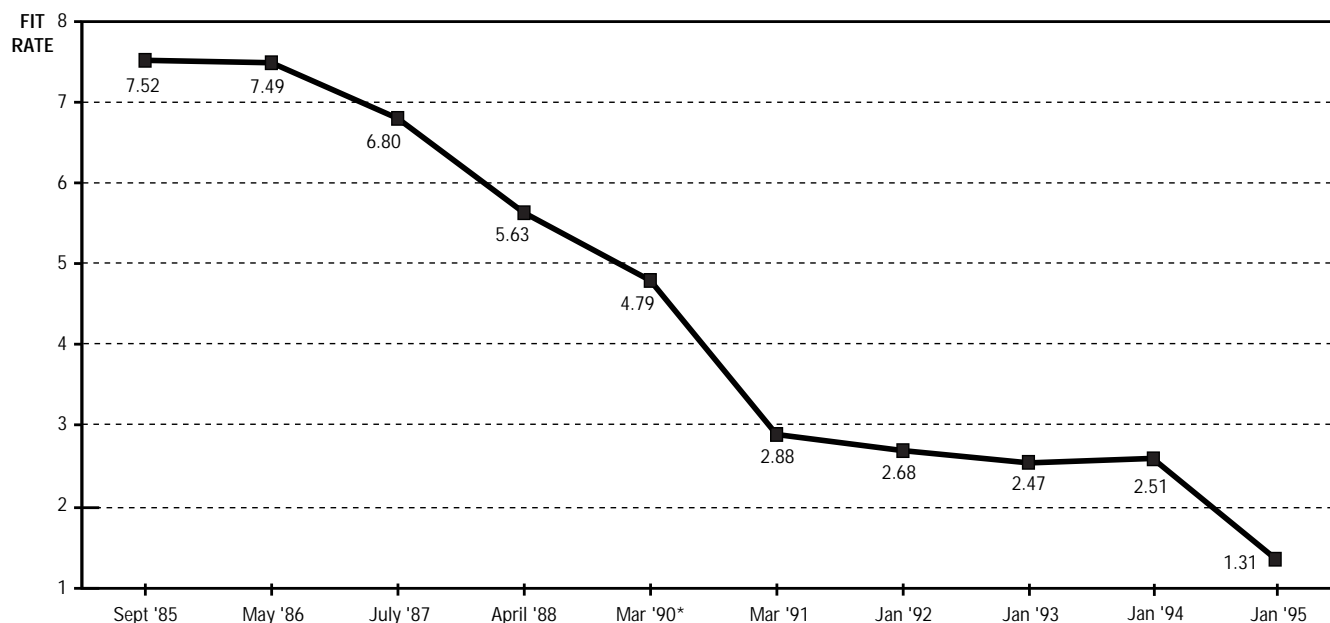


TABLE 2. LIFE TEST DATA

PRODUCT FAMILY	NUMBER OF LOTS	NUMBER OF FAILURES	TOTAL UNITS TESTED	DEGREE OF FREEDOM	X ² 60% VALUE	X ² 90% VALUE	FIT @ 25°C	
							60% CONF. LEVEL	90% CONF. LEVEL
CONVERTERS (Note 1)	99	25	7185	52	53.5	64.7	1.97	2.38
LINEAR (Note 2)	406	69	31,086	140	143	161	1.22	1.37
TIMERS/COUNTERS/ DISPLAY DRIVERS	20	1	1529	4	3.64	6.9	0.63	1.20
SUM TOTAL OF ALL PRODUCT LOTS	525	95	39,800	192	196	217	1.31	1.44

Note 1: A/D Converters, D/A Converters

Note 2: Voltage References, Operational Amplifiers, Power-Supply Circuits, Interface, Filters, Analog Switches, and Multiplexers

Product Reliability Report

Infant Mortality Evaluation and Product Burn-In

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. Our goal is to quantify the need for production burn-in. If a 300ppm level can be achieved, the product or process can be manufactured without production burn-in and still ensure an acceptable Infant Mortality rate. For an illustration of Maxim's low Infant Mortality rate, refer to Table 4.

Reliability Data

Merits of Burn-In

Figure 2 plots Failure Rate versus Time for the metal-gate CMOS process. The plot is based on Table 3's Life Test data and Table 4's Infant Mortality evaluation data, both applied to a General Reliability model. From this data, the benefit of production burn-in can be derived.

Table 3's data summarizes the reliability effect of production burn-in. Essentially, only seven units out of 14,743 were found to be outside the specification after 1000 hours of operation at 135°C. This is equal to an FIT rate of 0.13 at 25°C.

In comparison, the infant mortality rate is equal to 92 units out of 470,925 after 12 hours at 135°C, which has an equivalent FIT rate of approximately 0.828. In practical terms, 0.019%/six years (or 0.003%/year) of the total population would be found as defective through the first six years of operation, with an additional 0.009%/year failing over the remaining life of the product.

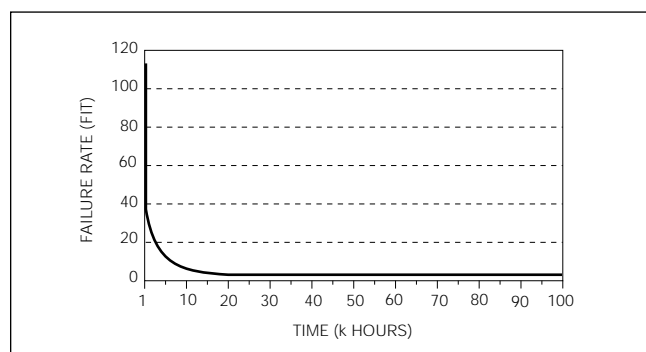
TABLE 3. LIFE TEST RESULT OF MAXIM PRODUCTS FOR EACH PROCESS (Combined Test Conditions: 135°C and 1000 Hrs.)

PROCESS	SAMPLE SIZE	REJECTS	FIT@ 25°C	FIT@ 55°C
SMG	6772	4	0.18	3.04
MV1	457	1	1.00	17.33
MV2	461	0	0.45	7.78
SG3	3921	1	0.12	2.02
SG5	1943	0	0.11	1.85
BIP	1189	1	0.39	6.66
TOTAL	14,743	7	0.13	2.23

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.

FIGURE 2. FAILURE RATE AT THE FIELD (55°C for Metal-Gate CMOS Process)



Test Used: High-Temperature Life and Dynamic Life Test (DLT)
 Test Conditions: 135°C, 1000 hrs., inputs fed by clock drivers at 50% duty cycle
 Failure Criteria: Must meet data sheet specifications
 Results: See Tables 5–10

Humidity Test

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.

Product Reliability Report

RR-11

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.

Test Used: 85/85
Test Conditions: 85°C, 85% Relative Humidity, biased, 1000 hrs.
Failure Criteria: Must meet all data sheet parameters
Results: See Table 11

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 quickly determines if a potentially corrosive contaminant is present.

Test Used: Pressure Pot
Test Conditions: 121°C, 100% RH, no bias, 168 hrs.
Failure Criteria: Any opened bond or visual evidence of corrosion
Results: See Table 12

HAST Test

Highly Accelerated Steam and Temperature (HAST) testing is quickly replacing 85/85 testing. It serves the same basic function as 85/85, in typically 10% of the time, making HAST tests useful for immediate feedback and corrective action.

Test Used: HAST
Test Conditions: 120°C, 85% RH, biased, 100 hrs.
Failure Criteria: Must meet all 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 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.

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

High-Temperature Storage Life Test

This test evaluates changes in a product's 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.

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

Hybrid Products Reliability Data

Maxim's hybrid product reliability data is presented in Tables 16 and 17. Table 16 is the Life Test data for products tested in 1994. Table 17 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 pulled. 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 1.5, which is equivalent to 7ppm. In addition to SPC, Maxim uses Design of Experiments (DOE) to improve process capability, optimize process targeting, and increase robustness.

Product Reliability Report

RR-1/1

Process Technologies

This section defines the layer-by-layer construction steps used in the fabrication of each process.

(1) SMG (Refer to Figure 4)

Layer	Description	Dimension
1	P-Well Diffusion	10 μ
2	P+ Diffusion	2 μ
3	N+ Diffusion	2 μ
4	Gate-Oxide Growth	900Å
5	Threshold Implant	
6	Contact Etch	
7	Metallization	1 μ (Al, Si-1%)
8	Passivation	0.8 μ (Si ₃ N ₄ over SiO ₂)

(2) MV1 (Refer to Figure 5)

Layer	Description	Dimension
0	Buried Layer	10 μ
1	EPI Deposit	19 μ
2	P-Well Diffusion	10 μ
3	P+ Diffusion	3 μ
4	N+ Diffusion	3 μ
5	Gate-Oxide Growth	1975Å
6	Threshold Implant	
7	Contact	
8	Metallization	1 μ (Al, Si-1%)
9	Passivation	0.8 μ (Si ₃ N ₄ over SiO ₂)

(3) MV2 (Refer to Figure 6)

Layer	Description	Dimension
1	Buried Layer	24.0 μ
2	P Well	10.0 μ
3	P+ Diffusion	1.5 μ
4	N+ Diffusion	1.5 μ
5	Gate-Oxide Growth	1000Å
6	P _{CH} Threshold Adjust	
7	Polysilicon	4500Å
8	NLDD	
9	PLDD	
10	N+ Ohmic	
11	Contact	
12	Metal	1.0 μ m
13	Passivation	0.8 μ m

(4) SG3 (Refer to Figure 7)

Layer	Description	Dimension
1	P Well	6.0 μ
2	PNP Base	

3	Zener Implant	
4	Active Area	1.5 μ
5	P Guard	
6	N Guard	
7	P _{CH} Threshold Adjust	
8	Poly 2	7000Å
9	Poly 1	4000Å
10	N+ Block	
11	P+ Select	
12	Thin Film	
13	CrSi Contact	
14	Contact	
15	Metal	1.0 μ
16	Passivation	0.8 μ (Si ₃ N ₄ over SiO ₂)

(5) SG5 (Refer to Figure 8)

Layer	Description	Dimension
1	P-Well Diffusion	8 μ
2	PNP Base Drive	
3	Zener Implant	
4	Active Area/Field Ox	1 μ
5	N Guard	
6	P Guard	
7	Threshold Adjust	
8	Gate-Oxide Growth	750Å
9	Polysilicon 1	4400Å
10	Cap Oxide	1000Å
11	Polysilicon 2	4400Å
12	N+ Implant (Source/Drain)	
13	P+ Implant (Source/Drain)	
14	Chrome/Si Thin-Film Deposit	
15	Contact	
16	Metallization	1 μ
17	Passivation	0.8 μ (Si ₃ N ₄ over SiO ₂)

(6) BIP (Refer to Figure 9)

Layer	Description	Dimension
1	N+ Buried Layer	4.5 μ
2	P+ Isolation	20 μ
3	P-Base	3 μ
4	N+ Emitter	2.5 μ
5	Capacitor	1500Å
6	Contact Etch	
7	Aluminum	11kÅ (Al, Si-1%)
8	Passivation	8kÅ (Si ₃ N ₄ over SiO ₂)

Product Reliability Report

Reliability Test Results

RR-1/1

TABLE 4. INFANT MORTALITY EVALUATION RESULT

PRODUCT	LOT	BI TEMP	SS	FAILURES	PPM	ANALYSIS
MV1 PROCESS						
DG201ACJ	XRCAAB184C	135°	11,698	1	85	1-MARGINAL LEAKAGE
DG211CJ	XRCAAB217Q	135°	9642	4	414	4-MARGINAL LEAKAGE
DG212CJ	XRCBAA208Q	135°	11,834	2	169	2-MARGINAL LEAKAGE
DG509ACJ	XROCAA045Q	135°	12,629	11	871	7-ISOFF CONTAMINATION, 1-HI ICC, 3 TIMING
DG508ACJ	XROBAB029Q	135°	10,216	2	195	1-IDON, IDOFF
DG508ACJ	XROBAC030Q	135°	<u>7912</u>	<u>0</u>	<u>0</u>	
SUBTOTAL			63,931	20	312.8	
MV2 PROCESS						
DG411DY	XRLADB016A	135°	10,338	1	97	1-MARGINAL LEAKAGE
	XRLADB017B	135°	10,482	0	0	
	XRLADB018B	135°	<u>10,068</u>	<u>2</u>	<u>199</u>	2-MARGINAL LEAKAGE
SUBTOTAL			30,888	3	97	
SMG PROCESS						
ICM7218CIPI	XDDCAA096A	135°	6886	0	0.0	
	XDDCAA102A	135°	6824	2	293	1-MARGINAL LEAKAGE , 1-UNKNOWN
ICM7218AIPi	XDDAAA097A	135°	6694	0	0.0	
	XDDAAA098A	135°	6927	0	0.0	
ICM7218BIPi	XDDBAA099B	135°	<u>6959</u>	<u>0</u>	<u>0.0</u>	
SUBTOTAL			34,290	2	58.3	
MAX1232CPA	XPPAJQ003BR	135°	844	0	0.0	
	XPPAJQ003C	135°	6447	2	310	1-DIE SCRATCH, 1-PACKAGE CRACK
	XPPAJQ006A	135°	12,390	0	0.0	
	XPPAJQ007B	135°	<u>13,330</u>	<u>0</u>	<u>0.0</u>	
SUBTOTAL			33,011	2	60.6	
MAX232CPE	XPWAAA039AA	150°	5324	0	0.0	
	XPWAAA040AA	150°	5627	1	177.7	1-INTERMITTENT BOND WIRE OPEN (HEEL OF WEDGE BOND)
	XPWAAA044AB	150°	5831	0	0.0	
	XPWAAA048AB	125°	5575	2	358.7	2-BOND WIRE SHORT FAILURES
	XPWAAA050AA	125°	5768	2	346.7	1-MECHANICAL DAMAGE, 1-GATE-OXIDE DEFECT
	XPWAAA074AA	150°	4643	3	646.1	1-INTERMITTENT BOND OPEN (HEEL OF WEDGE BOND) 1-GATE-OXIDE DEFECT
	XPWAAA147A	150°	10,372	2	192.8	1-MARG. HI R _{IN} THRESHOLD (CAUSE UNKNOWN) 1-BOND WIRE OPEN WEDGE BONDS @ LEADFRAME 1-HI I _{EE} DUE TO GATE-OXIDE DEFECT
	XPWAAA147B	150°	10,789	0	0.0	
	XPWBAA012A	150°	10,070	3	297.9	1-LOW R _{1IN} RESISTANCE SCRATCH ON DIE 1-HI I _{EE} GATE-OXIDE DEFECT 1-HI R _{2IN} RESISTANCE ERR. FUSE BLOWN
	XPWBAA012B	150°	10,929	3	274.5	1-HI R _{1IN} RESISTANCE ERR. FUSE BLOWN 1-T _{1OUT} STUCK HI UNKNOWN DAMAGE IN FA 1-R _{2IN} INPUT THRESHOLD MARG. FAIL
MAX232CPE	XKMAAA005Q	135°	15,727	2	127	2-UNKNOWN
MAX202CPE	XKMCAA007A	135°	6277	1	159	1-UNKNOWN
MAX232CPE	XKMAAA008A	135°	<u>30,888</u>	<u>1</u>	<u>32</u>	1-UNKNOWN
SUBTOTAL			128,330	20	155.8	

Product Reliability Report

RR-1/

TABLE 4. INFANT MORTALITY EVALUATION RESULT (continued)

PRODUCT	LOT	BI TEMP	SS	FAILURES	PPM	ANALYSIS
MAX690CPA	XPYAJA208A	150°	9443	4	423.6	1-AC FAILURE NO SCRATCH 2-MARGINAL HI RESET THRESHOLD NO SCRATCH
	XPYAJA208BA	150°	4702	3	638.0	1-FUNCTIONAL FAILURE DUE TO DIE SCRATCH 2-DIE SCRATCH ON SILICON SUBSTRATE
	XPYAJA209A	150°	9873	3	303.9	1-DIE SCRATCH ON METAL LINES 1-RESET THRESHOLD DUE TO DIE SCRATCH
	XPYAJA208B	150°	<u>4295</u>	<u>0</u>	<u>0.0</u>	1-MARGINAL I _{BAT} NO SCRATCH 1-GATE-OXIDE RUPTURE POSSIBLY ESD DAMAGE
SUBTOTAL			28,313	10	353.2	
SG3 PROCESS						
MAX485CPA	XKNACA009A	135°	8654	1	115	1-LEAKAGE
	XKNACA011A	135°	9689	2	206	2-UNKNOWN
	XKNACB016C	135°	<u>6239</u>	<u>1</u>	<u>160</u>	1-UNKNOWN
SUBTOTAL			24,582	4	162	
MAX705CPA	XTOACZ010A	135°	7026	1	142	1-HI I _{CC}
	XTOACA014Q	135°	6759	2	295	2-PARAMETRIC
	XTOACB015B	135°	<u>4895</u>	<u>0</u>	<u>0</u>	
SUBTOTAL			18,680	3	160	
MAX712CPE	XAABCA009A	135°	12,505	3	239	3-PARAMETRIC
MAX713CPE	XAAACA013A	135°	11,873	2	168	2-PARAMETRIC
	XAAACA016A	135°	<u>10,530</u>	<u>2</u>	<u>189</u>	1-FUNCTIONAL, 1-PARAMETRIC
SUBTOTAL			34,908	7	200	
SG5 PROCESS						
MAX232ACPE	XETAZZ063Q	135°	10,016	6	599	2-BOND WIRE SHORT TO DIE EDGE 1-BOND WIRE SMASH 1-DIE SCRATCH 1-HI I _{CC} , 1-LOW SLEW RATE
MAX232ACPE	XETAZZ058Q	135°	10,181	1	98	1-OXIDE DEFECT
MAX202ACPE	XETAZA075A	135°	14,977	4	267	2-DIE SCRATCH, 2-UNKNOWN
MAX232ACPE	XETAZA099Q	135°	<u>10,425</u>	<u>3</u>	<u>288</u>	3-HI I _{CC}
SUBTOTAL			45,599	14	307	
MAX452CPA	XFPAUB004A	135°	5592	2	358	2-V _{OS}
MAX454CPD	XFPAVA011Q	135°	6565	0	0	
MAX455CPP	XFPAVA009Q	135°	<u>16,236</u>	<u>5</u>	<u>308</u>	4-V _{OS} , 1 FUNCTIONAL FAILURE
SUBTOTAL			28,393	7	246.5	
COMBINED TOTAL			470,925	92	195	

Product Reliability Report

RR-11

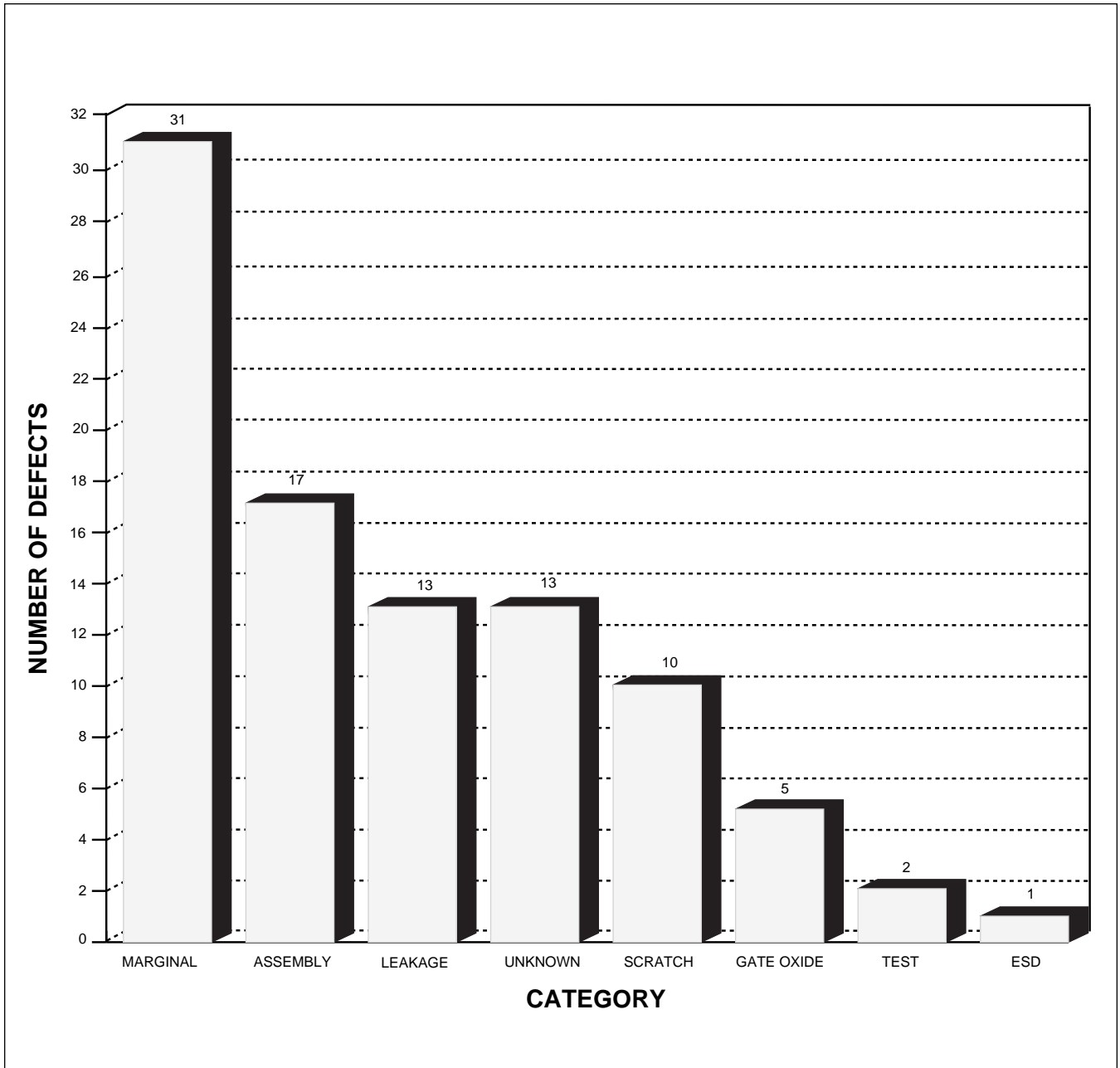


FIGURE 3. INFANT MORTALITY PARETO CHART

Product Reliability Report

RR-1/

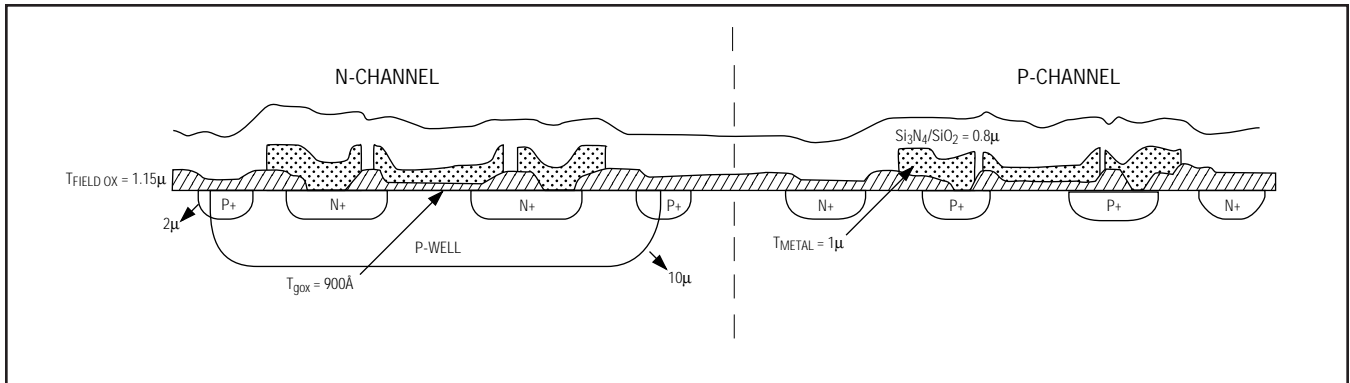


FIGURE 4. SMG PROCESS

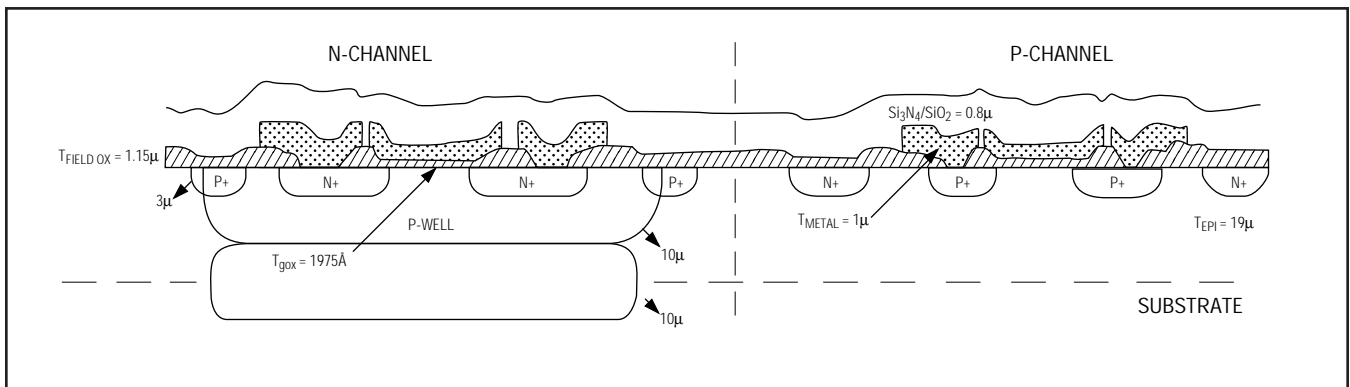


FIGURE 5. MV1 PROCESS

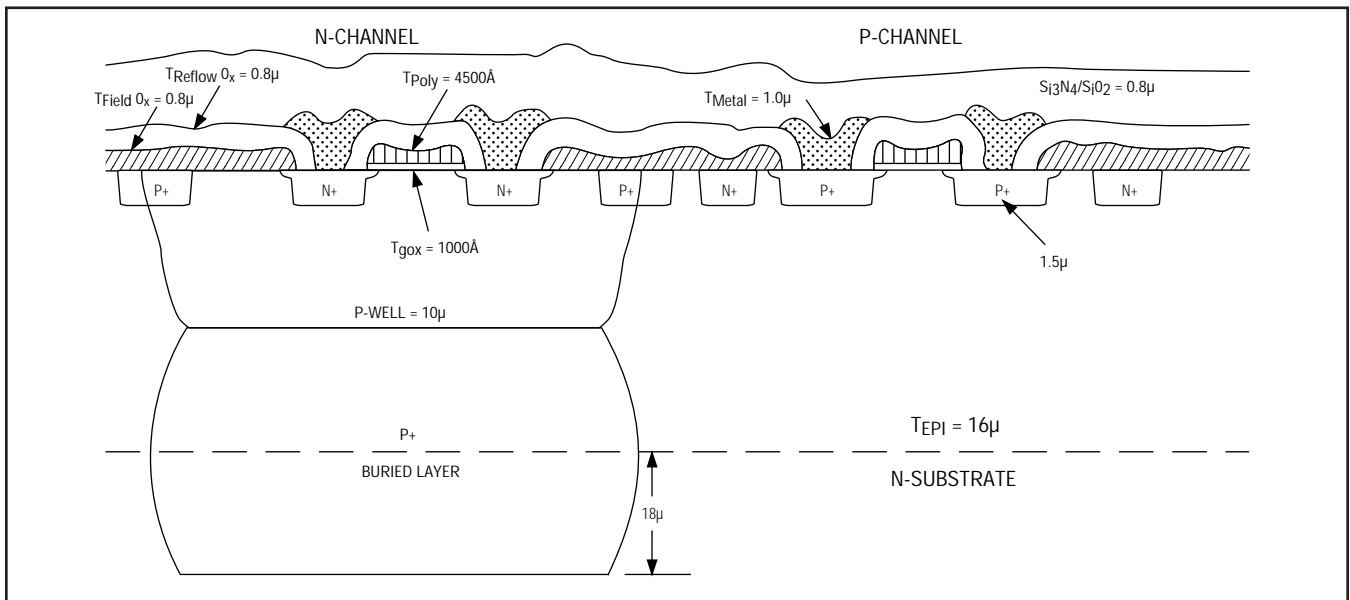


FIGURE 6. MV2 PROCESS

Product Reliability Report

RR-11

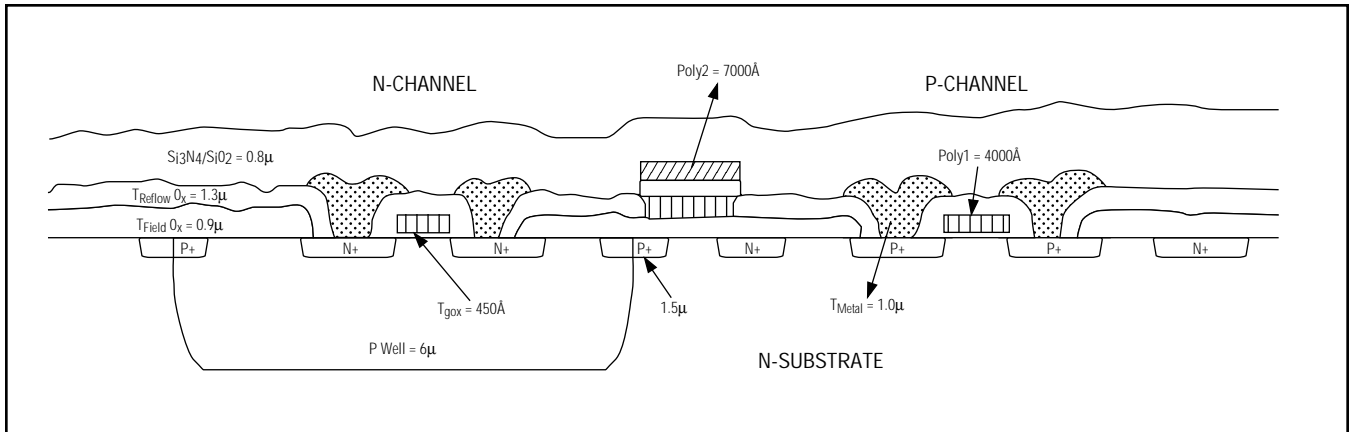


FIGURE 7. SG3 PROCESS

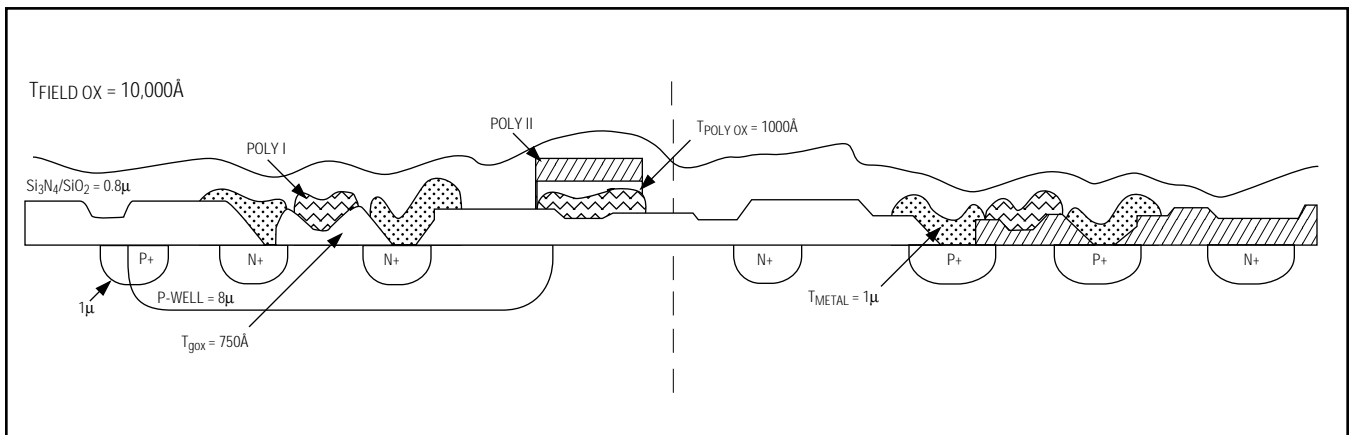


FIGURE 8. SG5 PROCESS

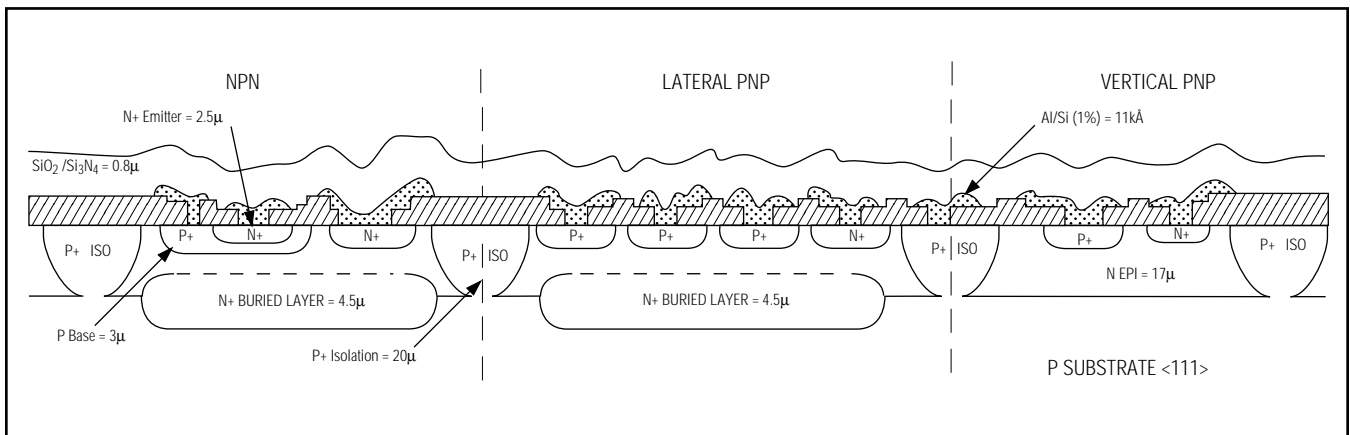


FIGURE 9. BIP PROCESS

Product Reliability Report

RR-1/1

TABLE 5. LIFE TEST AT 135°C/1000 HRS. FOR THE METAL-GATE CMOS PROCESS (SMG)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE FAILURES (HRS.)			NOTE	
			192	500	1000		
MAX691	9312	16 PDIP	77	0	0	1	AC FAILURE
MAX238	9313	24 PDIP	80	0	0	0	
MAX240	9319	44 QFP	77	0	0	0	
MAX239	9319	24 PDIP	46	0	0	0	
MAX240	9319	44 QFP	77	0	0	0	
MAX240	9319	44 QFP	66	0	0	0	
MAX8212	9319	8 PDIP	77	0	0	0	
MAX8212	9320	8 PDIP	77	0	0	0	
MAX8212	9320	8 PDIP	77	0	0	0	
MAX239	9321	24 PDIP	45	0	0	0	
MAX8212	9324	8 NSO	77	0	0	0	
MAX232	9325	16 PDIP	77	0	0	0	
MAX231	9326	14 PDIP	77	0	0	0	
MAX232	9328	16 WSO	77	0	0	0	
MAX238	9329	24 PDIP	77	0	0	0	
MAX666	9330	8 PDIP	76	0	0	1	PARAMETRIC
ICL7660	9331	8 PDIP	77	0	0	0	
MAX211E	9332	28 SSOP	60	0	0	0	
MAX232	9333	16 PDIP	77	0	0	0	
MAX211E	9333	28 SSOP	74	0	0	0	
MAX8211	9334	8 NSO	77	0	0	0	
MAX232	9334	16 WSO	72	0	0	0	
MAX8211	9334	8 PDIP	77	0	0	0	
MAX690	9335	8 PDIP	80	0	0	0	
MAX8211	9335	8 NSO	77	0	0	0	
MAX691	9335	16 PDIP	77	0	0	0	
MAX1232	9337	8 PDIP	77	0	0	0	
MAX8212	9337	8 NSO	77	0	0	0	
MAX232	9340	16 PDIP	76	0	0	0	
ICL7611	9343	8 PDIP	77	0	0	0	
MAX202	9347	16 PDIP	80	0	0	0	
MAX232	9347	16 PDIP	77	0	0	0	
MAX232	9347	16 PDIP	80	0	0	0	
MAX232	9347	16 PDIP	80	0	0	0	
MAX211E	9350	28 SSOP	80	0	0	0	
MAX238	9350	24 PDIP	77	0	0	0	
MAX8211	9352	8 NSO	77	0	0	1	PARAMETRIC
MAX211E	9401	28 WSO	80	0	0	0	
MAX241E	9404	28 SSOP	79	0	0	0	
MAX850	9405	8 NSO	80	0	0	0	
MAX692	9406	8 PDIP	80	0	0	0	
MAX693	9406	16 PDIP	80	0	0	0	
MAX693	9406	16 PDIP	80	0	0	0	
MAX853	9407	8 NSO	77	0	0	0	
MAX852	9407	8 NSO	78	0	0	0	
MAX851	9409	8 NSO	80	0	0	0	
MAX692	9410	8 PDIP	80	0	0	0	
MAX692	9410	8 PDIP	80	0	0	0	
MAX232	9412	16 PDIP	77	0	0	0	
MAX238	9413	24 PDIP	77	0	0	0	
MAX8211	9413	8 NSO	77	0	0	0	
MAX691	9415	16 PDIP	80	0	0	0	
MAX8211	9418	8 NSO	76	0	0	0	
MAX691	9420	16 PDIP	80	0	0	0	
MAX240	9420	44 QFP	70	0	0	0	
MAX240	9421	44 QFP	72	0	0	0	
MAX240	9421	44 QFP	72	0	0	0	
MAX240	9422	44 QFP	76	0	0	0	
MAX240	9423	44 QFP	72	0	0	0	
MAX238	9424	24 PDIP	77	0	0	0	
MAX1232	9427	8 PDIP	77	0	0	0	
MAX133	9428	40 PDIP	77	0	0	0	
MAX635	9430	8 PDIP	80	0	0	0	
MAX1232	9430	8 PDIP	77	0	0	0	
MAX1232	9430	8 PDIP	80	0	0	0	
MAX223	9431	28 WSO	77	0	0	0	
ICL7135	9432	24 PDIP	77	0	0	0	

TABLE 5 (continued)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE FAILURES (HRS.)			NOTE	
			192	500	1000		
MAX232	9432	16 PDIP	77	0	0	0	
MAX680	9432	8 PDIP	80	0	0	0	
MAX133	9433	40 PDIP	80	0	0	0	
MAX132	9433	24 PDIP	80	1	0	0	PARAMETRIC
MAX232	9433	16 PDIP	77	0	0	0	
MAX213	9434	28 SSOP	70	0	0	0	
ICL7621	9434	8 PDIP	76	0	0	0	
MAX691	9434	16 PDIP	77	0	0	0	
ICL7660	9435	8 PDIP	80	0	0	0	
ICL7660	9436	8 PDIP	77	0	0	0	
MAX241	9436	28 WSO	77	0	0	0	
MAX238	9437	24 PDIP	77	0	0	0	
MAX232	9438	16 PDIP	79	0	0	0	
MAX8211	9439	8 NSO	77	0	0	0	
MAX694	9439	8 PDIP	77	0	0	0	
MAX211	9439	28 SSOP	72	0	0	0	
MAX691	9439	16 WSO	61	0	0	0	
MAX232	9440	16 PDIP	77	0	0	0	
MAX693	9440	16 PDIP	77	0	0	0	
MAX232	9441	16 PDIP	77	0	0	0	
MAX202	9441	16 WSO	76	0	0	0	
MAX232	9441	16 WSO	<u>80</u>	<u>0</u>	<u>0</u>	<u>0</u>	
TOTAL			6772	1	0	3	

Note: Products included in this Life Test data are: A/D Converters, Operational Amplifiers, Power-Supply Circuits, Interface, and Display Drivers/Counters.

TABLE 6. LIFE TEST AT 135°C/1000 HRS. FOR THE MEDIUM-VOLTAGE METAL-GATE CMOS PROCESS (MV1)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE FAILURES (HRS.)			NOTE	
			192	500	1000		
DG211	9314	16 PDIP	77	0	0	0	
DG211	9321	16 NSO	36	0	0	0	
DG509	9338	16 PDIP	77	0	0	0	
DG508	9351	16 PDIP	77	0	1	0	OXIDE DEFECT
DG211	9409	16 NSO	36	0	0	0	
DG211	9413	16 PDIP	77	0	0	0	
DG506	9428	28 PDIP	<u>77</u>	<u>0</u>	<u>0</u>	<u>0</u>	
TOTAL			457	0	1	0	

Note: Products included in this Life Test data are: Analog Switches and Analog Multiplexers.

TABLE 7. LIFE TEST AT 135°C/1000 HRS. FOR THE MEDIUM-VOLTAGE SILICON-GATE CMOS PROCESS (MV2)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE FAILURES (HRS.)			NOTE	
			192	500	1000		
DG421	9324	16 PDIP	77	0	0	0	
DG423	9325	16 PDIP	77	0	0	0	
DG441	9347	16 PDIP	77	0	0	0	
DG444	9411	16 PDIP	77	0	0	0	
DG408	9423	16 PDIP	76	0	0	0	
DG413	9432	16 PDIP	<u>77</u>	<u>0</u>	<u>0</u>	<u>0</u>	
TOTAL			461	0	0	0	

Product Reliability Report

RR-11

TABLE 8. LIFE TEST AT 135°C/1000 HRS. FOR THE 3µm SILICON-GATE CMOS PROCESS (SG3)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX691A	9305	16 CERDIP	80	0	0	0	
MAX691A	9312	16 CERDIP	77	0	0	0	
MAX270	9314	20 PDIP	77	0	0	0	
MAX792L	9315	16 PDIP	65	0	0	0	
MAX792T	9315	16 PDIP	40	0	0	0	
MAX792S	9315	16 PDIP	14	0	0	0	
MAX792R	9315	16 PDIP	38	0	0	0	
MAX708	9316	8 PDIP	77	0	0	0	
MAX690A	9317	8 PDIP	80	0	0	0	
LTC902	9323	18 WSO	45	0	0	0	
LTC902	9325	18 WSO	45	0	0	0	
LTC902	9325	18 WSO	45	0	0	0	
MAX485	9326	8 PDIP	80	0	0	0	
MAX691A	9329	16 PDIP	99	0	0	0	
MAX691A	9331	16 PDIP	77	0	0	0	
MAX691A	9331	16 WSO	79	0	0	0	
MAX483	9332	8 PDIP	79	0	0	0	
MAX485	9332	8 PDIP	80	0	0	0	
MAX691A	9333	16 WSO	142	0	0	0	
MAX691A	9334	16 PDIP	77	0	0	0	
MAX722	9334	16 NSO	77	1	0	0	PARAMETRIC
MAX481	9335	8 PDIP	80	0	0	0	
MAX735	9337	8 PDIP	70	0	0	0	
MAX706T	9339	8 PDIP	79	0	0	0	
MAX705	9341	8 PDIP	80	0	0	0	
MAX722	9341	16 NSO	77	0	0	0	
MAX690	9341	8 PDIP	80	0	0	0	
MAX708	9344	8 PDIP	77	0	0	0	
MAX705	9345	8 µMAX	77	0	0	0	
MAX705	9345	8 µMAX	76	0	0	0	
MAX749	9347	8 PDIP	77	0	0	0	
LTC902	9348	18 WSO	76	0	0	0	
MAX693A	9349	16 PDIP	80	0	0	0	
MAX791	9350	16 PDIP	80	0	0	0	
MAX782	9402	36 SSOP	52	0	0	0	
MAX782	9402	36 SSOP	52	0	0	0	
MAX705	9403	8 PDIP	80	0	0	0	
MAX691A	9404	16 PDIP	80	0	0	0	
MAX707	9409	8 PDIP	77	0	0	0	
MAX792S	9410	16 PDIP	80	0	0	0	
MAX690A	9412	8 PDIP	80	0	0	0	
MAX705	9415	8 µMAX	45	0	0	0	
MAX705	9417	8 µMAX	45	0	0	0	
MAX713	9420	16 PDIP	189	0	0	0	
MAX691A	9421	16 PDIP	203	0	0	0	
MAX691A	9421	16 NSO	100	0	0	0	
MAX511	9424	14 NSO	77	0	0	0	
MAX707	9426	8 PDIP	77	0	0	0	
MAX662	9430	8 PDIP	80	0	0	0	
MAX707	9432	8 PDIP	77	0	0	0	
TOTAL			3921	1	0	0	

TABLE 9. LIFE TEST AT 135°C/1000 HRS. FOR THE 5µm SILICON-GATE CMOS PROCESS (SG5)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX500	9305	16 PDIP	79	0	0	0	
MAX500	9305	16 PDIP	79	0	0	0	
MX7224	9314	18 PDIP	77	0	0	0	
MX7574	9334	18 PDIP	77	0	0	0	
MX7524	9337	18 PDIP	77	0	0	0	
MAX232A	9338	16 WSO	77	0	0	0	
MX7545	9340	20 PDIP	72	0	0	0	
MAX738	9346	8 PDIP	77	0	0	0	
MAX232A	9346	16 PDIP	80	0	0	0	
MX7548	9348	20 PDIP	80	0	0	0	
MAX738	9350	8 PDIP	10	0	0	0	
MAX752	9352	8 PDIP	77	0	0	0	
MX7543	9402	16 PDIP	80	0	0	0	
MX7543	9402	16 PDIP	80	0	0	0	
MX7543	9402	16 PDIP	77	0	0	0	
MX7543	9402	16 PDIP	77	0	0	0	
MAX232A	9404	16 PDIP	76	0	0	0	
MAX232A	9411	16 PDIP	80	0	0	0	
MAX232A	9415	16 PDIP	80	0	0	0	
MAX232A	9421	16 PDIP	96	0	0	0	
MX7574	9422	18 PDIP	77	0	0	0	
MAX262	9425	24 PDIP	80	0	0	0	
MAX232A	9425	16 PDIP	77	0	0	0	
MX7543	9429	16 PDIP	79	0	0	0	
MX7576	9437	18 PDIP	45	0	0	0	
MAX232A	9439	16 PDIP	77	0	0	0	
TOTAL			1943	0	0	0	

Note: Products included in this Life Test data are: A/D Converters, D/A Converters, Interface, and Switched Capacitor Filters.

TABLE 10. LIFE TEST AT 135°C/1000 HRS. FOR THE BIPOLAR PROCESS (BIP)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX400	9314	8 PDIP	77	0	0	0	
MAX400	9315	8 PDIP	45	0	0	0	
MAX400	9316	8 PDIP	77	0	0	0	
OP07	9320	8 PDIP	77	0	0	0	
LT1179	9321	14 PDIP	52	0	0	1	DIE SCRATCH
OP07	9328	8 PDIP	77	0	0	0	
REF02	9350	8 PDIP	77	0	0	0	
MAX831	9351	16 WSO	45	0	0	0	
MAX832	9351	16 WSO	45	0	0	0	
REF02	9411	8 PDIP	77	0	0	0	
MAX400	9413	8 NSO	77	0	0	0	
MAX400	9413	8 NSO	77	0	0	0	
ICL8069	9414	TO-92	77	0	0	0	
REF01	9422	8 PDIP	77	0	0	0	
ICL8069	9430	TO-92	78	0	0	0	
ICL8069	9430	TO-92	77	0	0	0	
REF01	9435	8 PDIP	77	0	0	0	
TOTAL			1189	0	0	1	

Note: Products included in this Life Test data are: Voltage References and Operational Amplifiers.

Product Reliability Report

RR-1/

TABLE 11. TEMPERATURE AND HUMIDITY (85/85) TEST RESULTS

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX400	9314	8 PDIP	36	0	0	0	
MX7224	9314	18 PDIP	77	0	0	0	
MAX400	9315	8 PDIP	45	0	0	0	
MAX235	9316	24 PDIP	77	0	0	0	
MAX708	9316	8 PDIP	77	0	0	0	
MAX400	9316	8 PDIP	45	0	0	0	
ICM7555	9317	8 PDIP	77	0	0	0	
MAX8212	9319	8 PDIP	77	0	0	0	
OP07	9320	8 PDIP	77	0	0	0	
MAX8212	9320	8 PDIP	77	0	0	0	
MAX8212	9320	8 PDIP	77	0	0	0	
MAX235	9320	24 PDIP	77	0	0	0	
DG421	9324	16 PDIP	77	0	0	0	
MAX8212	9324	8 NSO	77	0	0	0	
DG423	9325	16 PDIP	77	0	1	0	MARGINAL LEAKAGE
MAX231	9326	14 PDIP	36	0	0	0	
OP07	9328	8 PDIP	77	0	0	0	
MAX238	9329	24 PDIP	72	0	0	0	
MAX666	9330	8 PDIP	77	1	0	0	PARAMETRIC
ICL7660	9331	8 PDIP	76	0	0	0	
MAX232	9333	16 PDIP	45	0	0	0	
MAX707	9333	8 NSO	80	0	0	0	
MAX8211	9334	8 PDIP	77	0	0	0	
MX7574	9334	18 PDIP	72	0	0	0	
MAX8211	9334	8 NSO	77	0	0	0	
MAX232	9334	16 WSO	56	0	0	0	
MAX8211	9335	8 NSO	77	0	0	0	
MAX690	9335	8 PDIP	77	0	0	0	
MAX1232	9337	8 PDIP	36	0	0	0	
MAX735	9337	8 PDIP	77	0	0	0	
MAX8212	9337	8 NSO	77	0	0	0	
MX7524	9337	18 PDIP	72	0	0	0	
DG509	9338	16 PDIP	77	0	0	0	
MAX232	9340	16 PDIP	77	0	0	0	
MAX722	9341	16 NSO	61	0	0	0	
ICL7611	9343	8 PDIP	61	0	0	1	OFFSET VOLTAGE
MAX708	9344	8 PDIP	77	0	0	0	
MAX705	9345	8 µMAX	25	0	0	0	
MAX705	9345	8 µMAX	25	0	0	0	
MAX705	9345	8 µMAX	25	0	0	0	
MAX738	9346	8 PDIP	77	0	0	1	FUNCTIONAL
DG441	9347	16 PDIP	72	0	0	0	
MAX202	9347	16 PDIP	45	0	0	0	
MAX4429	9349	8 PDIP	45	0	0	0	
REF02	9350	8 PDIP	77	0	0	0	
MAX238	9350	24 PDIP	36	0	0	0	
MAX831	9351	16 WSO	45	0	0	0	
DG508	9351	16 PDIP	72	0	1	0	SUBSTRATE DEFECT
MAX832	9351	16 WSO	45	0	0	0	
MAX8211	9352	8 NSO	77	0	0	0	
MAX752	9352	8 PDIP	77	0	0	0	
MX7543	9402	16 PDIP	64	0	0	0	
MX7543	9402	16 PDIP	64	0	0	0	
MAX705	9403	8 PDIP	77	0	1	0	LEAKAGE
MAX232A	9404	16 PDIP	60	0	0	0	
MAX252	9406	40 PDIP	20	0	0	0	
MAX852	9407	8 NSO	43	0	0	0	
MAX853	9407	8 NSO	45	0	0	0	
DG412	9409	16 NSO	80	0	0	0	
MAX707	9409	8 PDIP	77	0	0	0	
MAX851	9409	8 NSO	45	0	0	0	
MAX738	9411	8 PDIP	77	0	0	0	
DG444	9411	16 PDIP	72	0	0	0	
MAX232A	9411	16 PDIP	55	0	0	0	
REF02	9411	8 PDIP	77	0	0	0	
MAX690A	9412	8 PDIP	77	0	0	0	
MAX232	9412	16 PDIP	51	0	0	0	
MAX400	9413	8 NSO	77	0	0	0	
MAX400	9413	8 NSO	75	0	0	0	
MAX238	9413	24 PDIP	36	0	0	0	
MAX8211	9413	8 NSO	77	0	0	0	
MAX232A	9415	16 PDIP	55	0	0	0	
MAX252	9415	40 PDIP	28	0	0	0	
MAX252	9415	40 PDIP	45	0	0	0	

TABLE 11 (continued)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX8211	9418	8 NSO	77	0	0	0	
MX7574	9422	18 PDIP	72	0	0	0	
REF01	9422	8 PDIP	77	0	0	0	
MAX235	9424	24 PDIP	56	0	0	0	
MAX430	9424	8 PDIP	77	0	0	0	
MAX707	9426	8 PDIP	77	0	0	0	
MAX133	9428	40 PDIP	45	0	0	0	
MAX1232	9430	8 PDIP	45	0	0	0	
ICL8069	9430	TO-92	71	0	0	0	
MAX223	9431	28 WSO	45	0	0	0	
DG413	9432	16 PDIP	77	0	0	0	
MAX232	9432	16 PDIP	44	0	0	0	
MAX707	9432	8 PDIP	77	0	0	0	
MAX232	9433	16 PDIP	45	0	0	0	
ICL7109	9433	40 PDIP	45	0	0	0	
ICL7621	9434	8 PDIP	45	0	0	0	
MAX213	9434	28 WSO	45	0	0	0	
MAX691	9434	16 PDIP	45	0	0	0	
REF01	9435	8 PDIP	76	0	0	0	
ICL7660	9436	8 PDIP	45	0	0	0	
MAX241	9436	28 WSO	26	0	0	0	
MX7576	9437	18 PDIP	34	0	0	0	
MAX211	9439	28 WSO	45	0	0	0	
MAX694	9439	8 PDIP	45	0	0	0	
MAX8211	9439	8 NSO	77	0	0	0	
MAX691	9439	16 WSO	45	0	0	0	
MAX693	9440	16 PDIP	45	0	0	0	
TOTAL			6187	1	3	2	

TABLE 12. PRESSURE POT TEST AT 121°C/100% RH 15 PSIG/168 HRS. (ALL PLASTIC PACKAGES)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)		NOTE
				168		
MAX782	9312	36 SSOP	43		0	
DG211	9314	16 PDIP	45		0	
MX7224	9314	18 PDIP	44		0	
MAX270	9314	20 PDIP	45		0	
MAX400	9314	8 PDIP	36		0	
MAX792R	9315	16 PDIP	10		0	
MAX792T	9315	16 PDIP	20		0	
MAX400	9315	8 PDIP	36		0	
MAX792L	9315	16 PDIP	20		0	
MAX792S	9315	16 PDIP	9		0	
MAX400	9316	8 PDIP	45		0	
MAX708	9316	8 PDIP	45		0	
MAX8212	9319	8 PDIP	45		0	
MAX240	9319	44 QFP	77		0	
MAX240	9319	44 QFP	77		0	
MAX240	9319	44 QFP	76		0	
OP07	9320	8 PDIP	45		0	
MAX8212	9320	8 PDIP	45		0	
MAX8212	9320	8 PDIP	45		0	
MAX8212	9324	8 NSO	45		0	
LTC902	9324	18 WSO	45		0	
DG421	9324	16 PDIP	45		0	
LTC902	9325	18 WSO	45		0	
DG423	9325	16 PDIP	45		0	
MAX232	9325	16 PDIP	45		0	
LTC902	9325	18 WSO	45		0	
OP07	9328	8 PDIP	45		0	
MAX232	9328	16 WSO	46		0	
MAX238	9329	24 PDIP	77		0	
MAX666	9330	8 PDIP	77		0	
ICL7660	9331	8 PDIP	44		0	
MAX691A	9331	16 WSO	45		0	
MAX707	9333	8 NSO	45		0	
MAX232	9333	16 PDIP	77		0	
MAX8211	9334	8 PDIP	77		0	
MX7574	9334	16 PDIP	45		0	

Product Reliability Report

RR-11

TABLE 12 (continued)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 168	NOTE
MAX232	9334	16 WSO	77	0	
MAX8211	9334	8 NSO	76	0	
MAX8211	9335	8 NSO	77	0	
MAX690	9335	8 PDIP	77	0	
MAX782	9336	36 SSOP	45	0	
MAX1232	9337	8 PDIP	42	0	
MAX8212	9337	8 NSO	45	0	
MX7524	9337	18 PDIP	44	0	
MAX735	9337	8 PDIP	45	0	
DG509	9338	16 PDIP	45	0	
MAX232A	9338	16 WSO	45	0	
MAX708	9339	8 NSO	20	0	
MAX706T	9339	8 NSO	20	0	
MAX707	9339	8 NSO	20	0	
MAX232	9340	16 PDIP	45	0	
MAX722	9341	16 NSO	45	0	
ICL7611	9343	8 PDIP	45	0	
MAX708	9344	8 PDIP	45	0	
MAX705	9345	8 µMAX	77	0	
MAX705	9345	8 µMAX	68	0	
MAX705	9345	8 µMAX	77	0	
MAX738	9346	8 PDIP	45	0	
MAX232	9347	16 PDIP	45	0	
DG441	9347	16 PDIP	45	0	
MAX232	9347	16 PDIP	45	0	
MAX232	9347	16 PDIP	45	0	
MAX202	9347	16 PDIP	45	0	
MAX4429	9349	8 PDIP	45	0	
MAX238	9350	24 PDIP	45	0	
REF02	9350	8 PDIP	45	0	
MAX832	9351	16 WSO	44	0	
DG508	9351	16 PDIP	45	0	
MAX8211	9352	8 NSO	45	0	
MAX752	9352	8 PDIP	45	0	
MAX782	9402	36 SSOP	45	0	
MX7543	9402	16 PDIP	45	0	
MX7543	9402	16 PDIP	45	0	
MAX782	9402	36 SSOP	45	0	
MAX705	9403	8 PDIP	45	0	
MAX232A	9404	16 PDIP	45	0	
MAX782	9407	36 SSOP	45	0	
MAX852	9407	8 NSO	45	0	
MAX853	9407	8 NSO	45	0	
MAX707	9409	8 PDIP	45	0	
MAX782	9409	36 SSOP	45	0	
DG412	9409	16 NSO	45	0	
MAX851	9409	8 NSO	45	0	
MAX792S	9410	16 PDIP	45	0	
DG444	9411	16 PDIP	45	0	
REF02	9411	8 PDIP	45	0	
MAX738	9411	8 PDIP	45	0	
MAX690A	9412	8 PDIP	45	0	
MAX232	9412	16 PDIP	45	0	
DG211	9413	16 PDIP	45	0	
MAX400	9413	8 NSO	77	0	
MAX238	9413	24 PDIP	45	0	
MAX400	9413	8 NSO	77	0	
MAX8211	9413	8 NSO	45	0	
ICL8069	9414	TO-92	39	0	
MAX705	9415	8 µMAX	45	0	
MAX232A	9415	16 PDIP	45	0	
MAX705	9417	8 µMAX	45	0	
MAX233A	9418	20 WSO	45	0	
MAX233A	9418	20 WSO	45	0	
MAX233A	9418	20 WSO	45	0	
MAX8211	9418	8 NSO	45	0	
MAX223	9419	28 SSOP	45	0	
MAX560	9419	28 SSOP	45	0	
MAX240	9420	44 QFP	45	0	
MAX240	9421	44 QFP	45	0	
MAX240	9421	44 QFP	45	0	
MX7574	9422	18 PDIP	45	0	
REF01	9422	8 PDIP	45	0	
MAX240	9422	44 QFP	45	0	
DG408	9423	16 PDIP	45	0	

TABLE 12 (continued)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 168	NOTE
MAX240	9423	44 QFP	39	0	
MAX233	9423	20 PDIP	45	0	
MAX511	9424	14 NSO	45	0	
MAX235	9424	24 PDIP	45	0	
MAX430	9424	8 PDIP	45	0	
MAX235	9424	24 PDIP	45	0	
MAX238	9424	24 PDIP	45	0	
MAX232A	9425	16 PDIP	45	0	
MAX707	9426	8 PDIP	45	0	
MAX1232	9427	8 PDIP	45	0	
DG506	9428	28 PDIP	45	0	
MAX133	9428	40 PDIP	77	0	
MAX691	9430	16 WSO	77	0	
MAX1232	9430	8 PDIP	77	0	
ICL8069	9430	TO-92	45	0	
MAX223	9431	28 WSO	77	0	
MAX707	9432	8 PDIP	45	0	
MAX232	9432	16 PDIP	77	0	
ICL7139	9432	28 PDIP	62	0	
MAX232	9433	16 PDIP	77	0	
MAX213	9434	28 WSO	77	0	
MAX691	9434	16 PDIP	77	0	
ICL7621	9434	8 PDIP	77	0	
REF01	9435	8 PDIP	45	0	
ICL7660	9436	8 PDIP	77	0	
MAX241	9436	28 WSO	77	0	
MAX238	9437	24 PDIP	45	0	
MX7576	9437	18 PDIP	45	0	
MAX211	9438	28 WSO	77	0	
MAX211	9439	28 WSO	77	0	
MAX232A	9439	16 PDIP	45	0	
MAX694	9439	8 PDIP	77	0	
MAX695	9439	16 WSO	77	0	
ICL8069	9439	TO-92	45	0	
MAX693	9440	16 PDIP	77	0	
MAX232	9440	16 PDIP	77	0	
MAX202	9441	16 WSO	77	0	
MAX232	9441	16 PDIP	45	0	
DG211	9442	16 PDIP	45	0	
TOTAL			7610	0	

TABLE 13. HAST TEST RESULTS
120°C/85% RH/ BIASED/100 HRS.

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 100	NOTE
MAX782	9336	36 SSOP	25	0	
MAX705	9345	8 µMAX	25	0	
MAX705	9345	8 µMAX	25	0	
MAX705	9345	8 µMAX	25	0	
MAX782	9402	36 SSOP	27	0	
MAX782	9402	36 SSOP	25	0	
MAX782	9407	36 SSOP	25	0	
MAX782	9408	36 SSOP	25	0	
MAX782	9409	36 SSOP	25	0	
MAX705	9415	8 µMAX	25	0	
MAX705	9417	8 µMAX	25	0	
MAX233A	9418	20 WSO	25	0	
MAX233A	9418	20 WSO	25	0	
MAX223	9419	28 SSOP	25	0	
MAX560	9419	28 SSOP	25	0	
MAX240	9422	44 QFP	25	0	
MAX233	9423	20 PDIP	25	0	
MAX240	9423	44 QFP	25	0	
ICL8069	9430	TO-92	25	0	
TOTAL			477	0	

Product Reliability Report

RR-1/1

**TABLE 14. TEMPERATURE CYCLING
-65°C TO +150°C 1000 CYCLES
(ALL PACKAGE TYPES)**

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				200 x	500 x	1000 x	
MAX782	9312	36 SSOP	45	0	0	0	
MX7224	9314	18 PDIP	77	0	0	0	
MAX270	9314	20 PDIP	77	0	0	1	PARAMETRIC
DG211	9314	16 PDIP	77	0	0	0	
MAX400	9314	8 PDIP	77	0	0	0	
MAX400	9315	8 PDIP	69	0	0	0	
MAX400	9316	8 PDIP	77	0	0	0	
MAX708	9316	8 PDIP	77	0	0	0	
MAX240	9319	44 QFP	77	0	0	0	
MAX240	9319	44 QFP	77	0	0	0	
MAX626	9319	8 PDIP	77	0	0	0	
MAX8212	9319	8 PDIP	77	0	0	0	
MAX240	9319	44 QFP	77	0	0	0	
MAX8212	9320	8 PDIP	77	0	0	0	
MAX8212	9320	8 PDIP	77	0	0	0	
MAX8212	9324	8 NSO	77	0	0	0	
DG421	9324	16 PDIP	77	0	0	0	
DG423	9325	16 PDIP	77	0	0	0	
MAX232	9325	16 PDIP	77	0	0	0	
MAX231	9326	14 PDIP	77	0	0	0	
MAX485	9326	8 PDIP	77	0	1	0	DIE SCRATCH
MAX232	9328	16 WSO	77	0	0	0	
OP07	9328	8 PDIP	77	0	0	0	
MAX238	9329	24 PDIP	77	0	0	0	
MAX782	9330	36 SSOP	45	0	0	0	
MAX666	9330	8 PDIP	77	0	0	0	
ICL7660	9331	8 PDIP	77	0	0	0	
MAX232	9333	16 PDIP	77	0	0	0	
MAX707	9333	8 NSO	77	0	0	0	
MX7574	9334	18 PDIP	77	0	0	0	
MAX8211	9334	8 PDIP	77	0	0	0	
MAX232	9334	16 WSO	76	0	0	0	
MAX8211	9334	8 NSO	77	0	0	0	
MAX8211	9335	8 NSO	77	0	0	0	
MAX690	9335	8 PDIP	77	0	0	0	
MAX782	9336	36 SSOP	45	0	0	0	
MAX1232	9337	8 PDIP	77	0	0	0	
MX7524	9337	18 PDIP	77	0	0	0	
MAX8212	9337	8 NSO	77	0	0	0	
MAX735	9337	8 PDIP	77	0	0	0	
MAX232A	9338	16 WSO	32	0	0	0	
DG509	9338	16 PDIP	77	0	0	0	
MX7545	9340	20 PDIP	54	0	0	0	
MAX232	9340	16 PDIP	77	0	0	0	
MAX722	9341	16 NSO	61	0	0	0	
MAX691A	9343	16 PDIP	77	0	0	0	
ICL7611	9343	8 PDIP	58	0	0	0	
MAX708	9344	8 PDIP	77	0	0	0	
MAX705	9345	8 µMAX	76	0	0	0	
MAX705	9345	8 µMAX	76	0	0	0	
MAX705	9345	8 µMAX	77	0	0	0	
MAX738	9346	8 PDIP	77	0	0	0	
MAX232	9347	16 PDIP	77	0	0	0	
DG441	9347	16 PDIP	77	0	0	0	
MAX232	9347	16 PDIP	77	0	0	0	
MAX232	9347	16 PDIP	77	0	0	0	
MAX749	9347	8 PDIP	77	0	0	0	
MAX202	9347	8 PDIP	77	0	0	0	
MAX4429	9349	8 PDIP	77	0	0	0	
REF02	9350	8 PDIP	77	0	0	0	
MAX238	9350	24 PDIP	77	0	0	0	
MAX831	9351	16 WSO	30	0	0	0	
MAX832	9351	16 WSO	45	0	0	0	
DG508	9351	16 PDIP	77	0	0	0	
MAX8211	9352	8 NSO	77	0	0	0	
MAX752	9352	8 PDIP	77	0	0	0	
MAX782	9402	36 SSOP	77	0	0	0	
MX7543	9402	16 PDIP	58	0	0	0	
MX7543	9402	16 PDIP	58	0	0	0	
MAX782	9402	36 SSOP	77	0	0	0	
MAX705	9403	8 PDIP	77	0	0	0	
MAX232A	9404	16 PDIP	58	0	0	0	

TABLE 14 (continued)

DEVICE TYPE	DATE CODE	PKG. SIZE	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				200 x	500 x	1000 x	
MAX782	9407	36 SSOP	76	0	0	0	
MAX852	9407	8 NSO	45	0	0	0	
MAX853	9407	8 NSO	45	0	0	0	
DG412	9409	16 NSO	77	0	0	0	
MAX782	9409	36 SSOP	77	0	0	0	
MAX851	9409	8 NSO	45	0	0	0	
MAX707	9409	8 PDIP	77	0	0	0	
MAX692	9410	8 PDIP	77	0	0	0	
MAX692	9410	8 PDIP	77	0	0	0	
MAX792S	9410	16 PDIP	77	0	0	0	
DG444	9411	16 PDIP	77	0	0	0	
REF02	9411	8 PDIP	77	0	0	0	
MAX232A	9411	16 PDIP	45	0	0	0	
MAX738	9411	8 PDIP	77	0	0	0	
MAX232	9412	16 PDIP	77	0	0	0	
MAX8211	9413	8 NSO	77	0	0	0	
MAX238	9413	24 PDIP	77	0	0	0	
MAX400	9413	8 NSO	77	0	0	0	
MAX400	9413	8 NSO	77	0	0	0	
DG211	9413	16 PDIP	77	0	0	0	
ICL8069	9414	TO-92	45	0	0	0	
MAX705	9415	8 µMAX	45	0	0	0	
MAX691	9415	16 PDIP	77	0	0	0	
MAX232A	9415	16 PDIP	77	0	0	0	
MAX705	9417	8 µMAX	43	0	0	0	
MAX8211	9418	8 NSO	77	0	0	0	
MAX223	9419	28 SSOP	75	0	0	0	
MAX560	9419	28 SSOP	77	0	0	0	
MAX691	9420	16 PDIP	72	0	0	0	
MAX713	9420	16 PDIP	77	0	0	1	PARAMETRIC
MAX240	9420	44 QFP	45	0	0	0	
MAX240	9421	44 QFP	77	0	0	0	
MAX240	9421	44 QFP	43	0	0	0	
MAX691A	9421	16 PDIP	77	0	0	0	
MAX232A	9421	16 PDIP	77	0	0	0	
MX7574	9422	18 PDIP	77	0	0	0	
REF01	9422	8 PDIP	77	0	0	0	
MAX240	9422	44 QFP	45	0	0	0	
DG408	9423	16 PDIP	77	0	0	0	
MAX240	9423	44 QFP	77	0	0	0	
MAX238	9424	24 PDIP	77	0	0	0	
MAX235	9424	24 PDIP	45	0	0	0	
MAX511	9424	14 NSO	45	0	0	0	
MAX232A	9425	16 PDIP	77	0	0	0	
MAX707	9426	8 PDIP	77	0	0	0	
MAX1232	9427	8 PDIP	77	0	0	0	
MAX133	9428	40 PDIP	45	0	0	1	PARAMETRIC
DG506	9428	28 PDIP	77	0	0	0	
MX7543	9429	16 PDIP	77	0	0	0	
ICL8069	9430	TO-92	77	0	0	0	
ICL8069	9430	TO-92	74	0	0	0	
MAX1232	9430	8 PDIP	45	0	0	0	
MAX635	9430	8 PDIP	77	0	0	0	
MAX1232	9430	8 PDIP	77	0	0	0	
MAX223	9431	28 WSO	44	0	0	0	
DG413	9432	16 PDIP	77	0	0	0	
MAX707	9432	8 PDIP	76	0	0	0	
MAX232	9432	16 PDIP	45	0	0	0	
ICL7135	9432	28 PDIP	45	0	0	0	
MAX232	9433	16 PDIP	45	0	0	0	
MAX213	9434	28 WSO	45	0	0	0	
ICL7621	9434	8 PDIP	45	0	0	0	
MAX691	9434	16 PDIP	45	0	0	0	
REF01	9435	8 PDIP	77	0	0	0	
MAX241	9436	28 WSO	45	0	0	0	
ICL7660	9436	8 PDIP	45	0	0	0	
MAX238	9437	14 PDIP	77	0	0	0	
MX7576	9437	18 PDIP	34	0	0	0	
MAX8211	9439	8 NSO	77	0	0	0	
MAX691	9439	16 WSO	44	0	0	0	
MAX211	9439	28 WSO	45	0	0	0	
MAX695	9439	16 WSO	45	0	0	0	

Product Reliability Report

RR-11

TABLE 14 (continued)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				200 x	500 x	1000 x	
MAX232A	9439	16 PDIP	77	0	0	0	
MAX694	9439	8 PDIP	45	0	0	0	
MAX232	9440	16 PDIP	45	0	0	0	
MAX693	9440	16 PDIP	45	0	0	0	
MAX202	9441	16 WSO	45	0	0	0	
MAX232	9441	16 PDIP	77	0	0	0	
DG211	9442	16 PDIP	77	0	0	0	
TOTAL			10,260	0	1	3	

TABLE 15 (continued)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX782	9402	36 SSOP	45	0	0	0	
MAX705	9403	8 PDIP	45	0	0	0	
MAX232A	9404	16 PDIP	45	0	0	0	
MAX782	9407	36 SSOP	45	0	0	0	
MAX852	9407	8 NSO	44	0	0	0	
MAX853	9407	8 NSO	45	0	0	0	
MAX782	9408	36 SSOP	45	0	0	0	
MAX707	9409	8 PDIP	45	0	0	0	
MAX782	9409	36 SSOP	45	0	0	0	
MAX851	9409	8 NSO	45	0	0	0	
DG412	9409	16 NSO	45	0	0	0	
MAX792S	9410	16 PDIP	44	0	0	0	
DG444	9411	16 PDIP	45	0	0	0	
REF02	9411	8 PDIP	45	0	0	0	
MAX738	9411	8 PDIP	45	0	0	0	
MAX690A	9412	8 PDIP	45	0	0	0	
MAX232	9412	16 PDIP	45	0	0	0	
MAX8211	9413	8 NSO	45	0	0	0	
MAX238	9413	24 PDIP	45	0	0	0	
MAX400	9413	8 NSO	45	0	0	0	
MAX400	9413	8 NSO	45	0	0	0	
DG211	9413	16 PDIP	45	0	0	0	
ICL8069	9414	TO-92	20	0	0	0	
MAX252	9415	40 PDIP	25	0	0	0	
MAX252	9415	40 PDIP	12	0	0	0	
MAX252	9415	40 PDIP	12	0	0	0	
MAX705	9415	8 µMAX	25	0	0	0	
MAX232A	9415	16 PDIP	45	0	0	0	
MAX705	9417	8 µMAX	25	0	0	0	
MAX8212	9418	8 NSO	45	0	0	0	
MAX233A	9418	20 WSO	45	0	0	0	
MAX233A	9418	20 WSO	45	0	0	0	
MAX233A	9418	20 WSO	45	0	0	0	
MAX560	9419	28 SSOP	45	0	0	0	
MAX223	9419	28 SSOP	45	0	0	0	
MAX1480	9420	28 PDIP	20	0	0	0	
MAX240	9420	44 QFP	45	0	0	0	
MAX240	9421	44 QFP	45	0	0	0	
MAX240	9421	44 QFP	25	0	0	0	
REF01	9422	8 PDIP	45	0	0	0	
MX7574	9422	18 PDIP	45	0	0	0	
MAX240	9422	44 QFP	23	0	0	0	
MAX233	9423	20 PDIP	45	0	0	0	
DG408	9423	16 PDIP	45	0	0	0	
MAX240	9423	44 QFP	45	0	0	0	
MAX511	9424	14 NSO	45	0	0	0	
MAX235	9424	24 PDIP	25	0	0	0	
MAX238	9424	24 PDIP	45	0	0	0	
MAX235	9424	24 PDIP	45	0	0	0	
MAX430	9424	8 PDIP	45	0	0	0	
MAX232A	9425	16 PDIP	45	0	0	0	
MAX707	9426	8 PDIP	45	0	0	0	
MAX1232	9427	8 PDIP	44	0	0	0	
MAX133	9428	40 PDIP	77	0	0	0	
DG506	9428	28 PDIP	45	0	0	0	
MX7543	9429	16 PDIP	77	0	0	0	
MAX1232	9430	8 PDIP	77	0	0	0	
ICL8069	9430	TO-92	45	0	0	0	
MAX223	9431	28 SSOP	75	0	0	0	
DG413	9432	16 PDIP	45	0	0	0	
ICL7135	9432	28 PDIP	77	0	0	0	
MAX232	9432	16 PDIP	77	0	0	0	
MAX707	9432	8 PDIP	45	0	0	0	
MAX232	9433	16 PDIP	77	0	0	0	
MAX213	9434	28 WSO	77	0	0	0	
MAX691	9434	16 PDIP	77	0	0	0	
ICL7660	9434	8 PDIP	77	0	0	0	
REF01	9435	8 PDIP	45	0	0	0	
MAX241	9436	28 WSO	77	0	0	0	
ICL7621	9436	8 PDIP	77	0	0	0	
MAX238	9437	24 PDIP	45	0	0	0	
MX7576	9437	18 PDIP	45	0	0	0	
MAX8211	9439	8 NSO	45	0	0	0	

TABLE 15. HIGH TEMPERATURE LIFE TEST, 150°C/1000 HRS. (ALL PACKAGE TYPES)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX240	9313	44 QFP	45	0	0	0	
MX7224	9314	18 PDIP	45	0	0	0	
DG211	9314	16 PDIP	45	0	0	0	
MAX270	9314	20 PDIP	45	0	0	0	
MAX708	9316	8 PDIP	45	0	0	0	
MAX240	9319	44 QFP	45	0	0	0	
MAX8212	9319	8 PDIP	45	0	0	0	
MAX240	9319	44 QFP	45	0	0	0	
OP07	9320	8 PDIP	45	0	0	0	
MAX8212	9320	8 PDIP	45	0	0	0	
MAX8212	9324	8 NSO	45	0	0	0	
DG421	9324	16 PDIP	45	0	0	0	
DG423	9325	16 PDIP	45	0	0	0	
MAX232	9325	16 PDIP	45	0	0	0	
OP07	9328	8 PDIP	45	0	0	0	
MAX238	9329	24 PDIP	45	0	0	0	
MAX666	9330	8 PDIP	45	0	0	0	
MAX707	9333	8 NSO	40	0	0	0	
MAX8211	9334	8 PDIP	45	0	0	0	
MAX232	9334	16 WSO	45	0	0	0	
MX7574	9334	18 PDIP	45	0	0	0	
MAX8211	9334	8 NSO	45	0	0	0	
MAX8211	9335	8 NSO	45	0	0	0	
MAX690	9335	8 PDIP	45	0	0	0	
MAX782	9336	36 SSOP	45	0	0	0	
MAX1232	9337	8 PDIP	45	0	0	0	
MX7524	9337	18 PDIP	45	0	0	0	
MAX8212	9337	8 NSO	45	0	0	0	
MAX735	9337	8 PDIP	45	0	0	0	
MAX232A	9338	16 WSO	46	0	0	0	
DG509	9338	16 PDIP	44	0	0	0	
MX7545	9340	20 PDIP	45	0	0	0	
MAX232	9340	16 PDIP	45	0	0	0	
MAX722	9341	16 NSO	45	0	0	0	
MAX691A	9343	16 PDIP	77	0	0	0	
ICL7611	9343	8 PDIP	45	0	0	0	
MAX708	9344	8 PDIP	45	0	0	0	
MAX738	9346	8 PDIP	45	0	0	0	
MAX232	9347	16 PDIP	45	0	0	0	
DG441	9347	16 PDIP	45	0	0	0	
MAX749	9347	8 PDIP	77	0	0	0	
LTC902	9348	18 WSO	77	0	0	0	
MAX4429	9349	8 PDIP	45	0	0	0	
MAX238	9350	24 PDIP	45	0	0	0	
REF02	9350	8 PDIP	45	0	0	0	
MAX831	9351	16 WSO	39	0	0	0	
MAX832	9351	16 WSO	45	0	0	0	
DG508	9351	16 PDIP	45	0	0	0	
MAX8211	9352	8 NSO	45	0	0	0	
MAX752	9352	8 PDIP	45	0	0	0	
MAX782	9402	36 SSOP	45	0	0	0	
MX7543	9402	16 PDIP	45	0	0	0	
MX7543	9402	16 PDIP	45	0	0	0	

Product Reliability Report

TABLE 15 (continued)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX691	9439	16 WSO	77	0	0	0	
MAX211	9439	28 WSO	77	0	0	0	
MAX695	9439	16 WSO	77	0	0	0	
MAX232A	9439	16 PDIP	45	0	0	0	
MAX694	9439	8 PDIP	77	0	0	0	
MAX232	9440	16 PDIP	77	0	0	0	
MAX693	9440	16 PDIP	77	0	0	0	
MAX202	9441	16 WSO	77	0	0	0	
MAX232	9441	16 PDIP	45	0	0	0	
DG211	9442	16 PDIP	<u>45</u>	<u>0</u>	<u>0</u>	<u>0</u>	
TOTAL			6570	0	0	0	

TABLE 17. HYBRID PRODUCTS
TEMPERATURE CYCLING -65°C TO +150°C/1000 CYCLES

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				200 X	500 X	1000 X	
MAX235	9320	24 PDIP	77	0	0	0	
MAX235	9321	24 PDIP	77	0	0	0	
MAX252	9415	40 PDIP	17	0	0	0	
MAX233A	9418	20 WSO	76	0	0	0	
MAX1480	9420	28 PDIP	20	0	0	0	
MAX233	9423	20 PDIP	77	0	0	0	
MAX430	9424	8 PDIP	76	0	0	0	
MAX235	9424	24 PDIP	<u>77</u>	<u>0</u>	<u>0</u>	<u>0</u>	
TOTAL			497	0	0	0	

TABLE 16. HYBRID PRODUCTS
LIFE TEST 135°C/1000 HRS

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.)			NOTE
				192	500	1000	
MAX235	9320	24 PDIP	80	0	0	0	
MAX235	9321	24 PDIP	77	0	0	0	
MAX252	9406	40 PDIP	45	0	0	0	
MAX252	9415	40 PDIP	76	0	0	0	
MAX233A	9418	20 WSO	77	0	0	0	
MAX233A	9418	20 WSO	76	0	0	0	
MAX233A	9418	20 WSO	49	0	0	0	
MAX1480	9420	28 PDIP	30	0	0	0	
MAX1480	9420	28 PDIP	50	0	0	0	
MAX233	9423	20 PDIP	80	0	0	0	
MAX430	9424	8 PDIP	76	0	0	0	
MAX235	9424	24 PDIP	77	0	0	0	
MAX235	9424	24 PDIP	76	0	0	0	
BB3553	9425	TO-3	<u>47</u>	<u>0</u>	<u>0</u>	<u>0</u>	
TOTAL			916	0	0	0	

Appendix 1 Determining Acceleration Factor

Definition of Terms

An acceleration factor is a constant used in reliability prediction formulas that expresses the enhanced effect of temperature on a device's failure rate. It is usually used to show the difference (or acceleration effect) between the failure rate at two temperatures. In simple terms, a statement such as, "The failure rate of these devices operating at 150°C is five-times greater than the failure rate at 25°C," implies an acceleration factor of 5.

The acceleration factor used in the semiconductor industry is a result of the Arrhenius equation stated below:

$$\text{Acceleration Factor} = K e^{\frac{E_a}{k} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$$

Where:

K = an experimentally determined constant

E_a = the activation energy

k = Boltzmann's constant

T₁ = actual use temp. in degrees Kelvin

T₂ = test temp. in degrees Kelvin

How to Use the Arrhenius Equation

The first step in using the Arrhenius equation given above is to determine an activation energy (E_a), which may be done in one of two ways.

The first method involves using failure analysis techniques to determine the actual failure mechanism. The activation energies for many failure mechanisms have already been determined, and tabulated in published literature. Although all processes are not exactly the same, the activation energy of a particular failure mechanism is mainly determined by physical principles. A published activation energy will not be the exact figure associated with a particular process, but it will be a very close approximation.

The dominant failure mechanisms in Maxim's Life Tests have activation energies in the range of 0.8eV to 1.2eV. We have conservatively chosen 0.8eV for

the purposes of computing the acceleration factors used in this report. Actual acceleration factors are probably greater than those quoted.

The second method of determining an activation energy is empirical. Two groups of devices are tested at different temperatures, and the difference between their failure rates is measured. An example is shown below:

Group 1 = 9822 failures after 100 hrs. of operation at 150°C.

Group 2 = 1 failure after 100 hrs. of operation at 25°C.

The acceleration factor for this particular failure mechanism between these two temperatures is, therefore, 9822.

$$9822 = e^{\frac{E_a}{k} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$$

Where:

E_a = the unknown activation energy

k = 8.63 x 10⁻⁵eV/°K

T₁ = 25°C + 273°C or 298°K

T₂ = 150°C + 273°C or 423°K

Substituting:

$$9822 = e^{\frac{E_a}{8.63 \times 10^{-5}} \left(\frac{1}{298} - \frac{1}{423} \right)}$$

$$9822 = e^{E_a \times 11.49}$$

Taking the natural log of both sides:

$$\text{Log}_e 9822 = E_a \times 11.49$$

$$\frac{\text{Log}_e 9822}{11.49} = E_a$$

Therefore, E_a = 0.8eV

Assuming that this activation energy represents the dominant failure mechanism of the device under consideration, it may then be used to determine the

Product Reliability Report

acceleration factor between any two temperatures as follows:

Between 150°C and 70°C, for example:

$$\text{Acceleration Factor} = e^{\frac{0.8}{8.63 \times 10^{-5}} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$$

$$T_1 = 70^\circ\text{C} + 273^\circ\text{C} = 343^\circ\text{K}$$

$$T_2 = 150^\circ\text{C} + 273^\circ\text{C} = 423^\circ\text{K}$$

Substituting for $T_1 + T_2$ and solving for e yields the result:

$$\text{Acceleration Factor} = 165$$

The acceleration factor between 150°C and 70°C is 165.

Appendix 2 Determining Failure Rate

Definition of Terms

The Mean Time Between Failures (MTBF) is the average time it takes for a failure to occur. For example, assume a company tests 100 units for 1000 hrs. The total device-hours accrued would be 100 x 1000, or 100,000 device-hours. Now assume two units were found to be failures. Roughly, it could be said that the MTBF would equal:

$$\text{MTBF} = \frac{\text{Total Device Hrs.}}{\text{Total \# of Failures}} = \frac{100,000}{2} = 50,000 \text{ hrs.}$$

The Failure Rate (FR) is equal to the reciprocal of the MTBF, or:

$$\text{FR} = \frac{1}{\text{MTBF}} = \frac{1}{50,000} = 0.00002$$

If this number is multiplied by 1×10^5 , the failure rate in terms of percent per 1000 hrs. is obtained; i.e., 2%.

A common reliability term also used to express the failure rate is Failures-in-Time, or FIT. This is the number of failures per billion device-hours, and is obtained by dividing the Failure Rate by 10^{-9} :

$$\frac{\text{FR}}{10^{-9}} = \text{FIT.}$$

Using the above example:

$$\begin{aligned} \text{FIT} &= 0.00002/10^{-9} \\ &= 20,000 \end{aligned}$$

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.

Calculating Failure Rates and FITs

The failure rate can be expressed in terms of the following four variables:

- A = The number of failures 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 2, a failure rate at 25°C can now be calculated:

- A = 95
- B = 192
- C = 39,800
- D = 9822 (Assuming $E_a = 0.8\text{eV}$, and a test temperature of 150°C)

Substituting:

$$\text{FR} = \frac{95}{192 \times 39,800 \times 9822} = 1.26 \times 10^{-9}$$

Expressing this in terms of the FIT rate:

$$\text{FIT} = 1.26$$

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 small random sample is being chosen from each lot, the statistical effects are significant enough to mention. With most published failure rate figures, there is an associated confidence level number. This number expresses the confidence level that the actual failure rate of the lot will be equal to or lower than the predicted failure rate.

Product Reliability Report

RR-11

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

$$FR = \frac{x^2}{2DH}$$

Where:

- X^2 = the Chi square value
- 2DH = 2 times the total device hours
- = 2 x (B x C x D)

The Chi square value is based on a particular type of statistical distribution. However, all that is required to arrive at this value is knowing the number of failures. In this example, there were 179 failures. The Chi square value is found using a standard X^2 distribution table. The tabular values are found using the factors (1 - CL), where CL is the desired confidence level, and $2(N + 1)$ is the degree of freedom.

The value of (1 - CL) for a 60% confidence level is:
(1 - 0.60) = 0.40.

The number of degrees of freedom equals:
 $2(95 + 1) = 192$.

The Chi square value found under the values of 0.40 and 192 degrees of freedom is: 196.

Therefore, the failure rate found using a 60% confidence level is:

$$FR = \frac{196}{1.50 \times 10^{11}} = 1.31 \times 10^{-9}$$

Expressed as Failure-in-Time rate:

$$FIT = 1.31$$

Referring to Table 2, one can see that for Maxim's product, there is a 60% confidence level that no more than 1.31 units will fail per billion (10^9) device-hours of operation at 25°C.