December 1, 1994

RR-1H

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 from January 1990 to January 1994. It is separated into six fabrication processes: (1) Standard Metal-Gate CMOS (SMG); (2) Medium-Voltage Metal-Gate CMOS (MVI); (3) Medium-Voltage Silicon-Gate CMOS (MV2); (4) 3µm Silicon-Gate CMOS (SG3); (5) 5µm Silicon-Gate CMOS (SG5); and (6) Bipolar (BIP) processes.

Over 17,859,000 device hours have been accumulated for products stressed at an elevated temperature (135°C) during this period. The data inside this report is considered typical of Maxim's production. As you will see, Maxim's products demonstrate consistently high reliability.

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Introduction

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

Fabrication

Maxim is currently running six major fabrication processes which are:

1. SMG (Standard Metal-Gate CMOS)
2. MV1 (Medium-Voltage Metal-Gate CMOS)
3. MV2 (Medium-Voltage Silicon-Gate CMOS)
4. SG3 (Silicon-Gate 3 Micron CMOS)
5. SG5 (Silicon-Gate 5 Micron 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 that is used exclusively to produce our analog switch product line.

MV2 is a 5-micron, 44V, silicon-gate, CMOS process that is 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 that is used to produce Maxim's next generation of MSI and LSI products. Both SG3 and SG5 processes have become our future process standard.

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

Reliability Methodology

Maxim's quality approach to reliability testing has been conservative. Each of the six processes has been qualified using industry standard tests and methods. These are Life Test, 85/85, Pressure Pot, HAST, and High-Temperature Storage and Temperature Cycling. Each process has been qualified and proven to produce inherently high-quality product.

Maxim's early conservative approach had been to make burn-in a standard addition to our production flow. Burn-in allowed Maxim to ensure our customers were receiving a quality product. Now, with the addition of our own sophisticated fabrication facility, we have been able to improve 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 are prioritized based on their relative frequency (see Figure 3) to identify what area should be improved next. The data shown here demonstrates the positive direction of Maxim's quality standards. It supports our continued philosophy of providing our customers with the lowest overall cost solution through superior quality products.

The Maxim 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 to build 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:

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

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

Step 1: Reliability Qualification Program

Maxim 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. We require that three consecutive manufacturing lots from a new process technology successfully meet the reliability test requirements before releasing products.

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

Maxim identifies three wafer lots per process per fab each week to perform weekly reliability monitor testing. Each lot is tested to 192 hours of High Temperature Life (at 135°C) and pressure pot test. 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

With our technical failure analysis staff, we are capable of handling in-depth analysis of every reliability test failure to the device level. If an alarming reliability failure mechanism or trend is identified, the corrective action will be 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. It is Maxim's design goal to have every pin of every product withstand ESD voltages in excess of 2000V through a unique protection structure. Engineers routinely sample wafer lots to evaluate whether this goal is being met. In many cases, products withstand ESD levels beyond 3500V. Attention is also paid to minimizing the four layer (SCR) action inherent in CMOS devices. Circuit, layout, and processing have been optimized so that latch-up does not occur in any normal operating mode. Maxim tests each new product to guarantee that the design will meet a 50mA minimum limit for latch-up tolerance.

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, well-proven processes with extremely tight control. Each wafer must pass numerous in-process check-points such as oxide thickness, alignment, critical dimensions, and defect densities, and must comply with Maxim's demanding electrical and physical specifications.

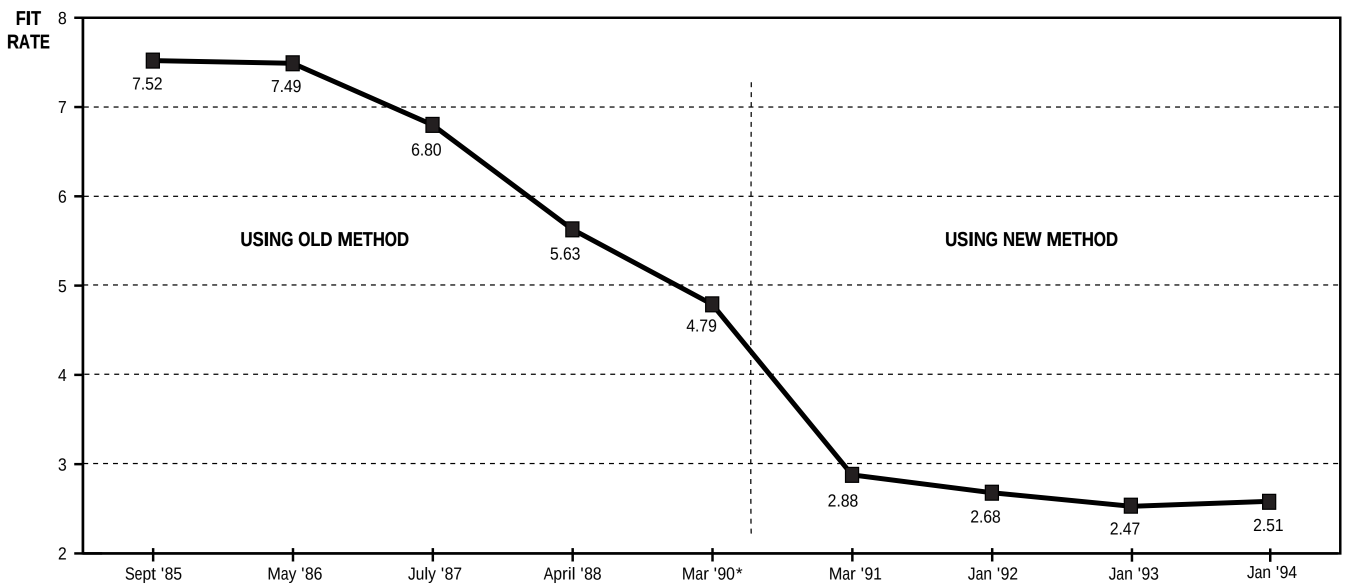
Finished wafers are inspected optically to detect any physical defects. They are then parametrically tested to ensure full conformity to Maxim's specifications. Our parametric measurement system has been designed by Maxim to make the precision measurements that are mandatory to insure reliability and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

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

Failure-Rate History

The graph shown below illustrates Maxim's failures in time (FIT) performance. It also highlights the continued improvements made in this FIT rate. A well established continuous improvement methodology is expected to continue this trend.

FIGURE 1. MAXIM FIT RATES OVER TIME (Using Old and New Methods)



** On this date the overall FIT calculation was changed from a combined yearly historical average to a single yearly total. This was done to better reflect year by year improvements instead of averaging their contribution over the past years. Both calculations are shown.*

Old Method: $\frac{\text{\# Total Fails (1985 + 1986 + ...)}}{\text{Total Tested (1985 + 1986 + ...)}}$ *New Method:* $\frac{\text{\# Total Fails (Current Year)}}{\text{Total Tested (Current Year)}}$

TABLE 2. LIFE TEST DATA

PRODUCT FAMILY	NUMBER OF LOTS	NUMBER OF FAILURES	TOTAL UNITS TESTED	DEGREES OF FREEDOM	X^2 60% VALUE	X^2 90% VALUE	FAILURE IN TIME RATE @ 25°C	
							60% CONF. LEVEL	90% CONF. LEVEL
CONVERTERS (Note 1)	99	29	6556	60	61.7	73.7	2.49	2.98
LINEAR (Note 2)	409	148	30696	298	303	329	2.62	2.84
TIMERS/COUNTERS/ DISPLAY DRIVERS	16	2	1292	6	5.8	9.8	1.19	2.01
SUM TOTAL OF ALL PRODUCT LOTS	524	179	38544	360	365	394	2.51	2.71

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

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

Infant Mortality Evaluation Product Burn-In

Maxim evaluates each process and product family's infant mortality 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 assure an acceptable infant mortality rate. To illustrate Maxim's products' low infant mortality rate, refer to Table 4 for product data.

Reliability Data

Merits of Burn-In

Figure 2 shows a plot of the 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 25 units out of 17,859 were found to be outside the specification after 1000 hours of operation at 135°C. This is equal to a FIT rate (FIT) of 0.34 at 25°C.

In comparison, the infant mortality rate is equal to 75 units out of 361,867 after 12 hours at 135°C, which has an equivalent FIT rate of approximately 0.879. In practical terms, 0.020%/6 years (or 0.003%/year) of the total population would be found as defective through the first 6 years of operation, with an additional 0.0279%/year failing over the remaining life of the product.

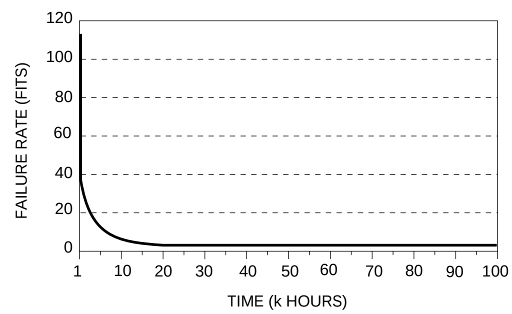
TABLE 3. LIFE TEST RESULT OF MAXIM PRODUCTS FOR EACH PROCESS (COMBINED TEST CONDITIONS: 135°C AND 1000 HRS.)

PROCESS	SAMPLE SIZE	REJECTS	FIT @25°C	FIT @55°C
SMG	7311	4	0.16	2.82
MV1	1769	1	0.26	4.48
MV2	935	0	0.22	3.83
SG3	1672	4	0.71	12.31
SG5	3891	8	0.55	9.52
BIP	2281	8	0.94	16.25
TOTAL	17859	25	0.34	5.88

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 test product is under 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 CONDITION 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 packages. Therefore, moisture and other contaminants can enter the package. Humidity testing measures the contaminants present and the resistance the product has 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, electrolytic and chemical corrosion can be detected.

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 (upper surface coat) layer, the bond pads must be exposed during bonding. Pressure Pot testing quickly determines if a potentially corrosive contaminant is present.

Test Used:	Pressure-Cooker Test (PCT)
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 Cycle 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 this test, but it typically identifies assembly quality.

Test Used:	Temperature Cycle
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
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 from 1990 to 1993. 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, to optimize process targeting, and to increase robustness.

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	10µ
2	P+ Diffusion	2µ
3	N+ Diffusion	2µ
4	Gate-Oxide Growth	900 Å
5	Threshold Implant	
6	Contact Etch	
7	Metallization	1µ (Al, Si-1%)
8	Passivation	.8µ (Si_3N_4 over SiO_2)

(2) MV1 (Refer to Figure 5.)

Layer	Description	Dimension
0	Buried Layer	10µ
1	EPI Deposit	19µ
2	P- Well Diffusion	10µ
3	P+ Diffusion	3µ
4	N+ Diffusion	3µ
5	Gate-Oxide Growth	1975 Å
6	Threshold Implant	
7	Contact	
8	Metallization	1µ (Al, Si-1%)
9	Passivation	0.8µ (Si_3N_4 over SiO_2)

(3) MV2 (Refer to Figure 6.)

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

(4) SG3 (Refer to Figure 7.)

Layer	Description	Dimension
1	P-Well	6.0µ
2	PNP Base	
3	Zener Implant	
4	Active Area	1.5µ
5	P Guard	
6	N Guard	
7	Pch Threshold Adjust	
8	Poly 2	7000 Å
9	Poly 1	4000 Å
10	N + Block	
11	P + Select	
12	Thin Film	
13	CrSi Contact	
14	Contact	
15	Metal	1.0µ
16	Passivation	0.8µ (Si_3N_4 over $Si0_2$)

(5) SG5 (Refer to Figure 8.)

Layer	Description	Dimension
1	P- Well Diffusion	8µ
2	PNP Base Drive	
3	Zener Implant	
4	Active Area/Field Ox	1µ
5	N Guard	
6	P Guard	
7	Threshold Adjust	
8	Gate-Oxide Growth	750 Å
9	Polysilicon 1	4400 Å
10	Cap Oxide	1000 Å
11	Polysilicon 2	4400 Å
12	N+ Implant (Source/Drain)	
13	P+ Implant (Source/Drain)	
14	Chrome/Si Thin Film Deposit	
15	Contact	
16	Metallization	1µ
17	Passivation	0.8µ (Si_3N_4 over SiO_2)

(6) BIP (Refer to Figure 9.)

Layer	Description	Dimension
1	N+ Buried Layer	4.5µ
2	P+ Isolation	20µ
3	P Base	3µ
4	N+ Emitter	2.5µ
5	Capacitor	1500 Å
6	Contact Etch	
7	Aluminum	11KÅ (Al, Si-1%)
8	Passivation	8KÅ (Si_3N_4 over SiO_2)

TABLE 4. INFANT MORTALITY EVALUATION RESULT

PRODUCT	LOT	BI TEMP	SS	FAILURES	PPM	ANALYSIS
MVI PROCESS						
DG201ACJ	XRCAAB184C	135°	11698	1	85	1-MARGINAL LEAKAGE
DG211CJ	XRCAAB217Q	135°	9642	4	414	4-MARGINAL LEAKAGE
DG212CJ	XRCBAA208Q	135°	11834	2	169	2-MARGINAL LEAKAGE
DG509ACJ	XROCAA045Q	135°	12629	11	871	7-IS_{OFF} CONTAMINATION, 1-HI I_{CC}, 3 TIMING
DG508ACJ	XROBAB029Q	135°	10216	2	195	1-ID_{ON}, ID_{OFF}
DG508ACJ	XROBAC030Q	135°	7912	0	0	
SUBTOTAL			63931	20	312.8	
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°	6959	0	0.0	
SUBTOTAL			34290	2	58.3	
MAX1232CPA	XPPAJQ003BR	135°	844	0	0.0	
	XPPAJQ003C	135°	6447	2	310	1-DIE SCRATCH
						1-PACKAGE CRACK
	XPPAJQ006A	135°	12390	0	0.0	
	XPPAJQ007B	135°	13330	0	0.0	
SUBTOTAL			33011	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
						1-MARG. HI R_{IN} THRESHOLD CAUSE UNKNOWN
	XPWAAA147A	150°	10372	2	192.8	1-BOND WIRE OPEN WEDGE BONDS @ LEADFRAME
						1-HI Iee DUE TO GATE-OXIDE DEFECT
	XPWAAA147B	150°	10789	0	0.0	
	XPWBAA012A	150°	10070	3	297.9	1-LOW $R1_{IN}$ RESISTANCE SCRATCH ON DIE
						1-HI Iee GATE-OXIDE DEFECT
						1-HI $R2_{IN}$ RESISTANCE ERR. FUSE BLOWN
	XPWBAA012B	150°	10929	3	274.5	1-HI $R1_{IN}$ RESISTANCE ERR. FUSE BLOWN
						1-$T1_{OUT}$ STUCK HI UNKNOWN DAMAGE IN FA
						1-$R2_{IN}$ INPUT THRESHOLD MARG. FAIL
MAX232CPE	XKMAAA005Q	135°	15727	2	127	2-unknown
MAX202CPE	XKMCAA007A	135°	6277	1	159	1-unknown
MAX232CPE	XKMAAA008A	135°	30888	1	32	1-unknown
SUBTOTAL			128.330	20	155.8	

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
						1-FUNCTIONAL FAILURE DUE TO DIE SCRATCH
	XPYAJA208BA	150°	4702	3	638.0	2-DIE SCRATCH ON SILICON SUBSTRATE
						1-DIE SCRATCH ON METAL LINES
	XPYAJA209A	150°	9873	3	303.9	1-RESET THRESHOLD DUE TO DIE SCRATCH
						1-MARGINAL I_{BAT} NO SCRATCH
						1-GATE-OXIDE RUPTURE POSSIBLY ESD DAMAGE
	XPYAJA208B	150°	4295	0	0.0	
SUBTOTAL			28313	10	353.2	
SG5 PROCESS						
MAX232ACPE	XETAZZ063Q	135°	10016	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°	10181	1	98	1-OXIDE DEFECT
MAX202ACPE	XETAZA075A	135°	14977	4	267	2-DIE SCRATCH, 2-UNKNOWN
MAX232ACPE	XETAZA099Q	135°	10425	3	288	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°	16236	5	308	4-V_{OS}, 1 FUNCTIONAL FAILURE
SUBTOTAL			28,393	7	246.5	
COMBINED TOTAL			**361,867**	**75**	**207.2**	

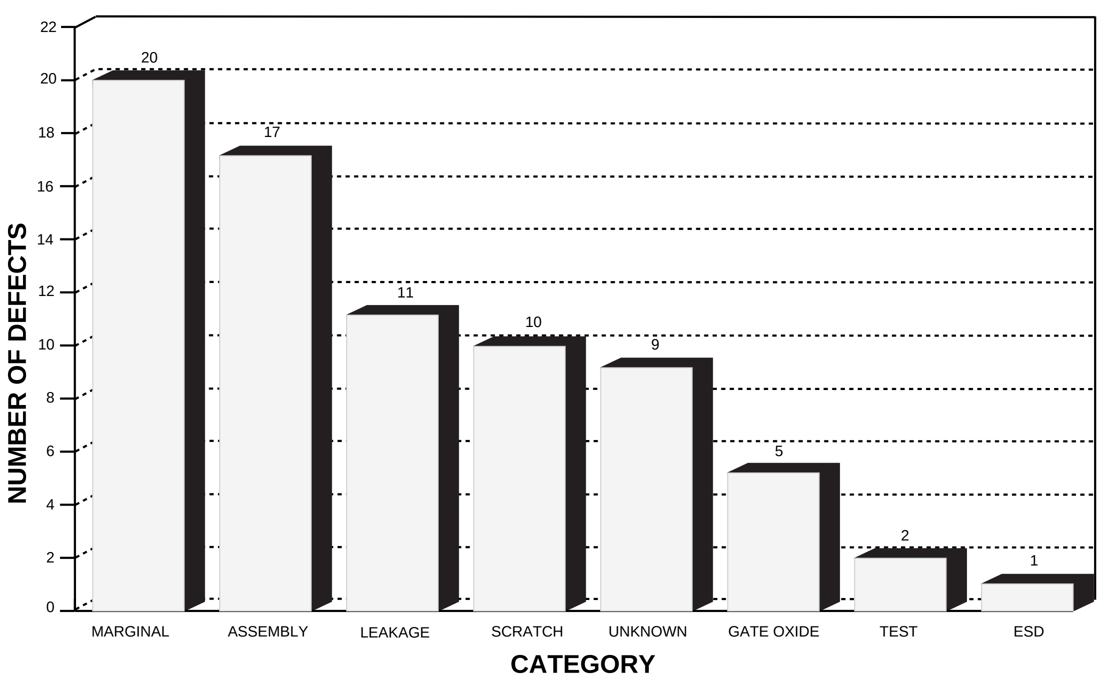


FIGURE 3. INFANT MORTALITY PARETO CHART

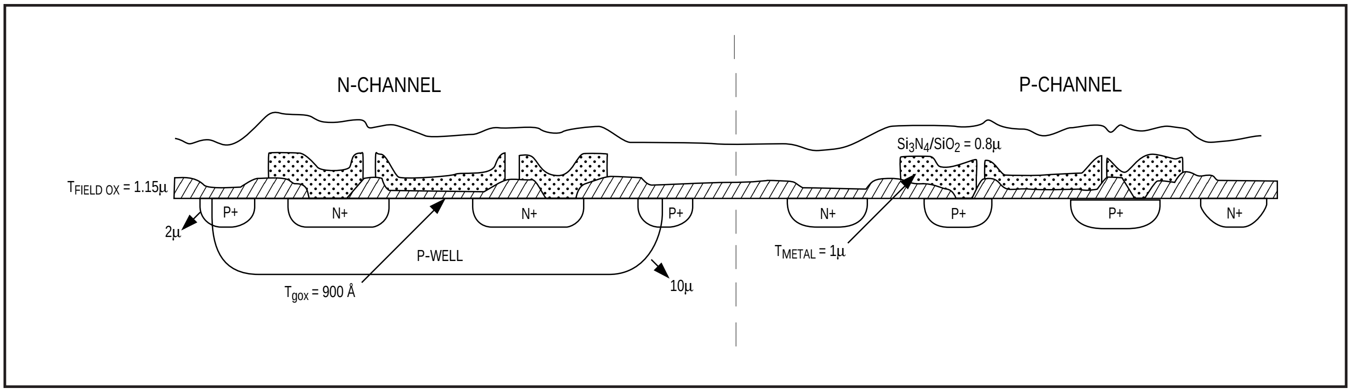


FIGURE 4. SMG PROCESS

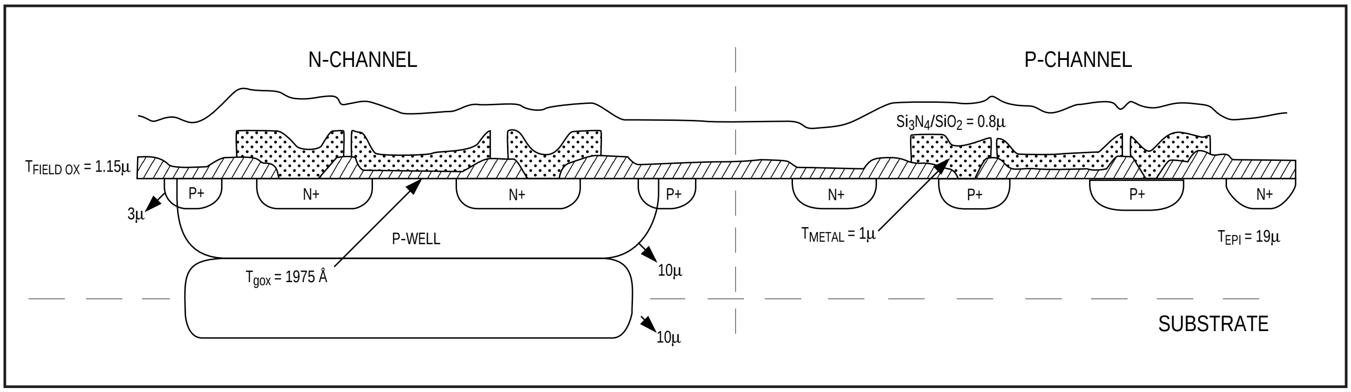


FIGURE 5. MV1 PROCESS

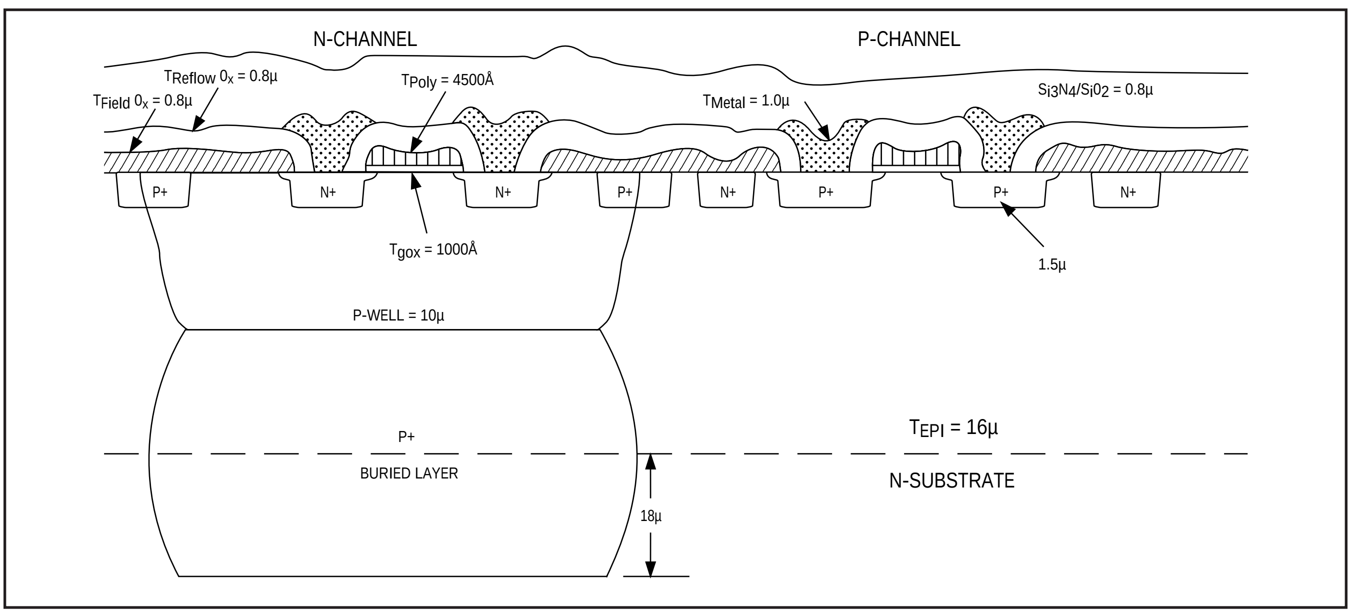


FIGURE 6. MV2 PROCESS

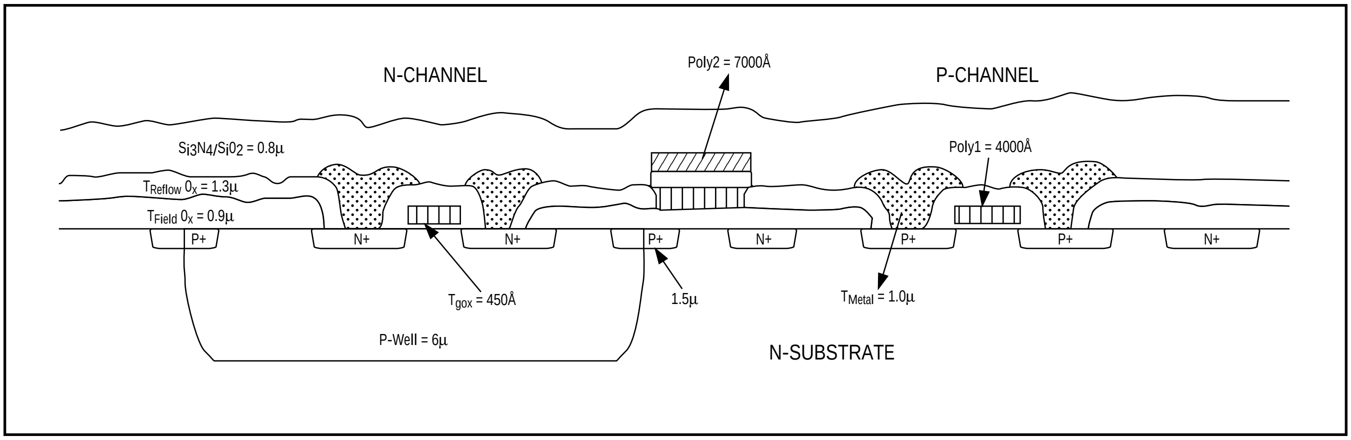


FIGURE 7. SG3 PROCESS

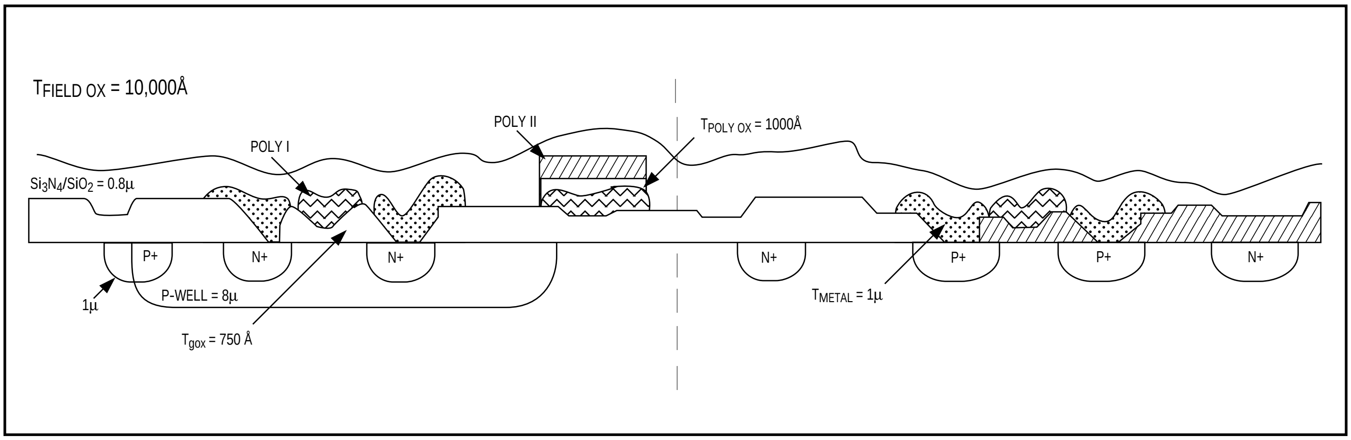


FIGURE 8. SG5 PROCESS

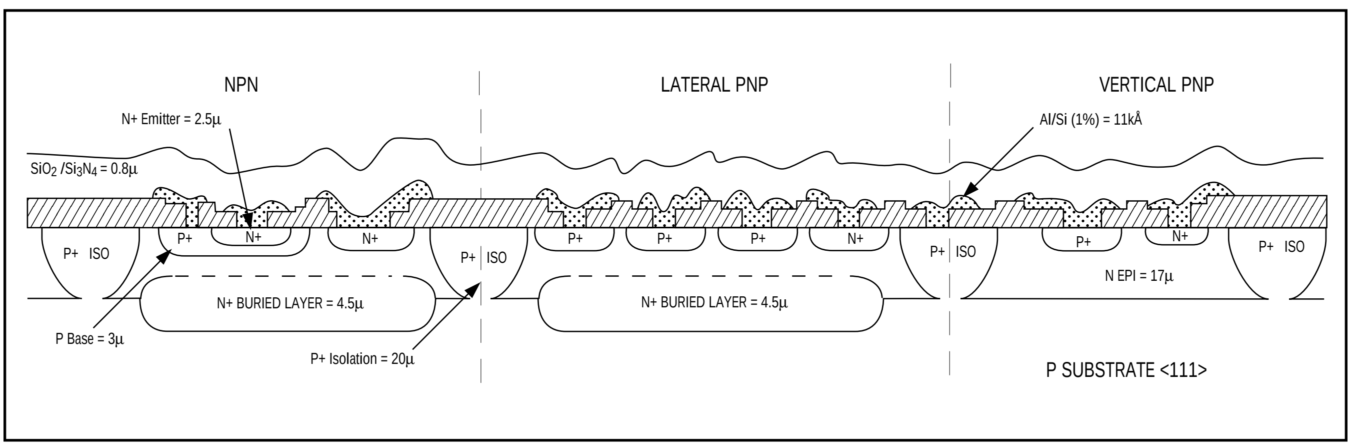


FIGURE 9. BIP PROCESS

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MAX232	9032	16 PDIP	77	0	0	0	
MAX690	9032	8 PDIP	77	0	0	0	
MAX691	9033	16 PDIP	77	0	0	0	
ICL7109	9033	40 PDIP	77	0	0	0	
MAX690	9033	8 PDIP	77	0	0	0	
MAX232	9033	16 PDIP	73	0	0	0	
MAX690	9034	8 CERDIP	77	0	0	0	
MAX238	9034	24 CERDIP	75	0	0	0	
ICL7109	9034	40 CERDIP	77	0	0	0	
MAX690	9034	8 PDIP	80	0	0	0	
MAX232	9036	16 PDIP	77	0	0	0	
MAX232	9036	16 WSO	76	0	0	0	
MAX232	9041	16 PDIP	80	0	0	0	
MAX690	9041	8 PDIP	77	0	0	0	
MAX690	9042	8 PDIP	80	0	0	0	
MAX690	9042	8 PDIP	79	0	0	0	
MAX8211	9043	8 PDIP	157	0	0	0	
MAX690	9043	8 PDIP	77	0	0	0	
MAX238	9043	24 PDIP	77	0	0	0	
ICM7212	9043	40 PDIP	77	0	0	0	
MAX232	9045	16 PDIP	77	0	0	0	
MAX232	9046	16 PDIP	77	0	0	0	
MAX691	9046	16 WSO	72	0	0	0	
MAX691	9049	16 WSO	72	0	0	0	
ICL7664	9049	8 PDIP	77	0	0	0	
MAX7231	9105	40 PDIP	79	0	0	0	
MAX8211	9108	8 SO	76	0	0	0	
MAX8211	9108	8 SO	77	0	0	0	
MAX231	9109	14 PDIP	80	0	0	0	
MAX232	9110	16 PDIP	80	0	0	0	
MAX238	9113	24 CERDIP	77	0	0	0	
MAX690	9113	8 CERDIP	77	0	0	0	
ICL7109	9114	40 CERDIP	76	0	0	0	
ICM7212	9115	40 PDIP	77	0	0	0	
MAX420	9119	8 PDIP	80	0	0	0	
MAX250	9120	14 PDIP	200	0	0	0	
MAX422	9121	8 PDIP	77	0	0	0	
MAX232	9125	16 WSO	77	0	0	0	
MAX420	9125	8 PDIP	77	0	0	0	
ICL7611	9137	8 PDIP	300	0	0	0	
MAX690	9138	8 PDIP	77	0	0	0	
MAX232	9140	16 PDIP	80	0	1	0	PARAMETRIC
MAX232	9140	16 PDIP	77	1	0	0	PARAMETRIC
MAX232	9140	16 WSO	77	0	0	0	
ICL7129	9149	40 PDIP	45	0	0	0	
MAX232	9201	16 WSO	77	0	0	0	
MAX423	9202	14 PDIP	80	0	0	0	
MAX232	9203	16 PDIP	77	0	0	0	
ICL7611	9206	8 PDIP	80	0	0	0	
MAX420	9208	8 PDIP	80	0	0	0	
ICL7664	9210	TO99	76	0	0	0	
MAX232	9214	16 WSO	77	0	0	0	
MAX420	9112	8 PDIP	80	0	0	0	
MAX667	9140	8 PDIP	80	1	0	0	PARAMETRIC
MAX232	9206	16 PDIP	77	0	0	0	
ICL7109	9206	40 PDIP	77	0	0	0	
MAX690	9206	8 PDIP	77	0	0	0	
ICL7109	9207	40 PDIP	77	0	0	0	
MAX690	9207	8 PDIP	77	0	0	0	
MAX232	9207	16 PDIP	77	0	0	0	
ICL7106	9208	40 PDIP	77	0	0	0	
ICM7211	9208	40 PDIP	77	0	0	0	
ICL7109	9208	40 PDIP	77	0	0	0	
MAX241	9211	28 SSOP	65	0	0	0	
MAX232	9215	16 PDIP	77	0	0	0	
MAX232	9215	16 WSO	77	0	0	0	
MAX691	9216	16 PDIP	80	0	0	0	
MAX241	9220	28 SSOP	63	0	0	0	
MAX232	9222	16 PDIP	80	0	0	0	
MAX232	9222	16 WSO	77	0	0	0	
MAX667	9224	8 CERDIP	77	0	0	0	
MAX690	9225	8 PDIP	77	0	0	0	
MAX667	9226	8 PDIP	77	0	0	0	

TABLE 5 *(continued)*

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MAX690	9227	8 PDIP	77	0	0	0	
MAX690	9229	8 PDIP	77	0	0	0	
MAX232	9231	16 PDIP	80	0	0	0	
MAX232	9237	16 PDIP	77	0	0	0	
MAX663	9238	8 NSO	77	0	0	0	
MAX691	9243	16 PDIP	80	0	0	0	
MAX213	9245	28 WSO	80	0	0	0	
MAX232	9249	16 PDIP	77	0	0	0	
ICL7660	9251	8 PDIP	50	0	0	0	
MAX213	9251	28 WSO	80	0	0	0	
MAX8212	9301	8 NSO	76	0	0	0	
MAX241	9307	28 WSO	80	0	0	0	
MAX232	9311	16 PDIP	77	0	0	0	
MAX232	9314	16 WSO	77	0	0	0	
MAX8212	9314	8 NSO	77	0	0	0	
MAX232	9315	16 WSO	77	1	0	0	FUNCTIONAL
MAX8212	9315	8 NSO	77	0	0	0	

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

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
DG211	9011	16 PDIP	73	0	0	0	
DG509	9016	16 PDIP	67	0	0	0	
DG303	9025	14 PDIP	80	0	0	0	
DG211	9052	16 NSO	80	0	0	0	
DG212	9052	16 PDIP	45	0	0	0	
DG211	9108	16 NSO	72	0	0	0	
DG211	9109	16 NSO	77	0	0	0	
DG509	9112	16 PDIP	80	0	0	0	
DG508	9122	16 PDIP	77	0	0	0	
DG211	9129	16 SO	35	0	0	0	
DG211	9132	16 PDIP	77	0	0	0	
DG211	9132	16 PDIP	77	0	0	0	
MAX333	9133	20 PDIP	77	0	0	0	
MAX333	9133	20 PDIP	77	0	0	0	
MAX333	9133	20 PDIP	77	0	0	0	
MAX333	9133	20 PDIP	77	0	0	0	
DG211	9138	16 PDIP	77	0	0	0	
DG211	9141	16 PDIP	74	0	0	0	
DG411	9144	16 PDIP	77	0	0	0	
DG211	9207	16 NSO	36	0	0	0	
DG211	9212	16 PDIP	77	0	0	1	MARGINAL LEAKAGE
DG211	9231	16 PDIP	77	0	0	0	
DG211	9232	16 PDIP	77	0	0	0	
DG211	9236	16 PDIP	77	0	0	0	
DG211	9243	16 NSO	36	0	0	0	
DG211	9249	16 PDIP	77	0	0	0	
DG508	9309	16 PDIP	77	0	0	0	

** 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.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
DG411	9144	16 PDIP	77	0	0	0	
DG412	9144	16 PDIP	77	0	0	0	
DG413	9145	16 PDIP	80	0	0	0	
DG444	9149	16 PDIP	80	0	0	0	
DG445	9149	16 PDIP	80	0	0	0	
DG412	9210	16 PDIP	77	0	0	0	
DG444	9210	16 PDIP	77	0	0	0	
DG411	9234	16 PDIP	77	0	0	0	
DG411	9240	16 PDIP	73	0	0	0	
DG441	9249	16 PDIP	80	0	0	0	
DG411	9250	16 PDIP	80	0	0	0	
DG405	9302	16 PDIP	77	0	0	0	

TABLE 8. LIFE TEST AT 135°C/1000 HRS. FOR THE 5µm SILICON-GATE CMOS PROCESS (SG5)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MX7533	9002	16 PDIP	80	0	0	0	
MX7628	9005	20 PDIP	77	0	0	0	
MX7572	9010	24 PDIP	45	0	0	0	
MX7226	9012	20 PDIP	77	0	0	0	
MAX172	9021	24 PDIP	70	0	0	0	
MAX172	9035	24 PDIP	77	0	1	0	PARAMETRIC
MAX271	9043	24 PDIP	24	0	0	0	
MAX154	9044	24 PDIP	77	0	0	0	
MAX456	9048	40 PDIP	50	0	0	0	
MX7541	9050	18 PDIP	71	0	0	0	
MX7524	9102	16 PDIP	77	0	0	0	
MX7245	9106	24 PDIP	80	0	1	0	PARAMETRIC
MX7824	9106	24 PDIP	77	0	0	0	
MX7248	9107	20 PDIP	77	0	0	0	
MX7845	9108	24 PDIP	74	0	0	0	
MAX732	9110	8 PDIP	80	0	0	0	
MX7845	9117	24 PDIP	61	0	0	0	
MAX500	9118	16 PDIP	75	0	0	0	
MX7582	9122	28 PDIP	77	0	0	0	
MAX232A	9123	16 PDIP	77	0	0	0	
MX7245	9133	24 PDIP	77	0	2	2	4 PARAMETRIC
MAX172	9136	24 PDIP	77	0	0	0	
MAX243	9137	16 PDIP	80	0	0	0	
MX7245	9138	24 PDIP	77	0	0	0	
MAX162	9139	24 PDIP	80	0	1	0	MASKING DEFECT
MAX232A	9141	16 PDIP	80	0	0	0	
MAX172	9144	24 PDIP	80	0	0	0	
MX7543	9144	16 PDIP	80	0	0	0	
MX7820	9148	20 PDIP	80	0	0	0	
MAX232A	9149	16 PDIP	80	0	0	0	
MAX406	9207	8 PDIP	80	0	0	0	
MX7245	9202	24 PDIP	77	0	0	0	
MX7226	9210	20 PDIP	77	0	0	0	
MX7528	9217	20 PDIP	77	0	0	0	
MAX406	9217	8 PDIP	80	0	0	0	
MAX232A	9221	16 PDIP	80	0	0	0	
MX574	9221	28 S. BRAZE	45	0	0	0	
MAX406	9221	8 PDIP	77	0	0	0	
MAX626	9222	8 PDIP	77	0	0	0	
MX7225	9223	24 PDIP	65	0	0	0	
MAX232A	9223	16 PDIP	80	0	0	0	
MAX232A	9231	16 PDIP	80	0	0	0	
MAX4420	9232	8 PDIP	77	0	0	0	
MAX244	9233	44 PLCC	80	0	0	0	
MAX626	9235	8 PDIP	77	0	0	0	
MX7524	9242	16 PDIP	77	0	0	0	
MX7543	9244	16 PDIP	80	0	0	0	
MX7543	9244	16 PDIP	80	0	0	0	
MAX454	9248	14 PDIP	77	0	0	0	
MX574	9249	28 PDIP	50	0	0	0	
MX574	9304	28 PDIP	50	0	0	0	
MX7524	9306	16 PDIP	77	0	0	0	
MAX261	9309	24 PDIP	77	0	1	0	FUNCTIONAL

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

TABLE 9. LIFE TEST AT 135°C/1000 HRS. FOR THE 3µm SILICON-GATE CMOS PROCESS (SG3)

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MAX707	9212	8 PDIP	77	0	2	0	PARAMETRIC
MAX708	9218	8 PDIP	77	0	0	0	
MAX703	9222	8 PDIP	80	0	0	0	
MAX722	9222	16 WSO	80	0	0	0	
MAX690A	9222	8 PDIP	77	0	0	0	
MAX735	9227	8 PDIP	77	0	0	0	
MAX661	9238	8 PDIP	40	0	0	0	
MAX717	9239	16 WSO	77	0	0	0	
MAX485	9240	8 PDIP	80	0	0	0	
MAX730	9248	8 PDIP	77	0	0	0	
MAX662	9249	8 PDIP	40	0	0	0	
LTC902	9250	18 WSO	50	0	0	0	
MAX485	9303	8 PDIP	77	0	0	0	
MAX662	9308	8 PDIP	77	0	0	0	
MAX708	9309	8 PDIP	77	0	0	0	
LTC902	9311	18 WSO	52	0	0	0	
LTC902	9316	18 WSO	66	0	0	0	

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
REF01	9003	8 PDIP	80	1	0	0	OXIDE DEFECT
MX584	9019	8 PDIP	55	0	0	0	
MAX901	9019	16 PDIP	77	0	0	0	
MAX9687	9033	16 PDIP	50	0	0	0	
OP290	9034	8 PDIP	77	0	0	0	
MX584	9047	8 TO	74	0	0	0	
REF02	9049	8 PDIP	77	0	0	0	
MAX400	9049	8 PDIP	77	0	0	0	
MAX400	9049	8 PDIP	77	0	0	0	
MX584	9047	8 TO	45	0	0	0	
MAX902	9112	14 PDIP	80	0	0	0	
MAX902	9112	14 PDIP	80	0	0	0	
OP07	9118	8 PDIP	77	0	0	0	
MAX9685	9124	16 PDIP	77	0	0	0	
OP07	9130	8 PDIP	77	0	0	0	
MAX412	9136	8 PDIP	77	0	0	0	
MAX9690	9139	8 SB	24	0	0	0	
MAX9687	9141	16 SB	28	0	0	0	
MAX9690	9141	8 PDIP	77	0	0	0	
MAX9687	9142	16 PDIP	38	0	0	0	
OP07	9152	8 PDIP	77	0	2	0	PARAMETRIC
REF01	9224	8 PDIP	77	0	0	0	
MAX480	9237	8 PDIP	77	0	0	0	
MAX1074	9240	TO220	45	1	0	0	PARAMETRIC
LT1074	9241	TO220	45	0	0	0	
OP07	9246	8 PDIP	77	0	0	0	
LT1074	9248	TO220	45	0	0	0	
MAX435	9250	14 PDIP	77	0	0	1	PARAMETRIC
MAX412	9252	8 PDIP	77	0	2	0	PARAMETRIC
MAX901	9302	16 CERDIP	77	0	0	0	
MAX412	9302	8 PDIP	77	0	0	1	PARAMETRIC
MAX410	9302	8 PDIP	77	0	0	0	
REF02	9308	8 PDIP	77	0	0	0	
LT1179	9314	14 PDIP	52	0	0	0	

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

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MAX232	9032	16 PDIP	45	0	0	0	
MAX690	9032	8 PDIP	69	0	0	0	
ICL7109	9033	40 PDIP	75	0	0	0	
MAX690	9033	8 PDIP	77	0	0	0	
MAX232	9033	16 PDIP	60	0	0	1	OXIDE DEFECT
MAX691	9033	16 PDIP	70	0	0	0	
OP290	9034	8 PDIP	24	0	0	0	
MAX172	9035	24 PDIP	35	0	0	0	
MAX232	9036	16 PDIP	45	0	0	1	OXIDE DEFECT
MAX232	9036	16 WSO	45	0	0	0	
MAX690	9041	8 PDIP	39	0	0	0	
MAX690	9043	8 PDIP	77	0	0	0	
MAX238	9043	24 PDIP	72	0	0	0	
ICM7212	9043	40 PDIP	77	0	0	0	
MAX154	9044	24 PDIP	69	0	0	0	
MAX232	9045	16 PDIP	44	0	0	0	
MAX232	9046	16 PDIP	44	0	0	0	
REF02	9049	8 PDIP	76	0	0	0	
MAX400	9049	8 PDIP	76	0	0	0	
MAX400	9049	8 PDIP	76	0	0	0	
ICL7664	9049	8 PDIP	76	0	0	0	
MX7541	9050	18 PDIP	72	0	0	0	
DG212	9052	16 PDIP	76	0	0	1	MARG. LEAKAGE
DG211	9052	16 NSO	45	0	0	0	
MAX7231	9105	40 PDIP	80	0	0	0	
MX7245	9106	24 PDIP	45	0	0	0	
MX7824	9106	24 PDIP	58	0	0	0	
DG211	9108	16 NSO	45	0	0	0	
MX7845	9108	24 PDIP	68	0	0	0	
MAX8211	9108	8 SO	77	0	0	0	
MAX8211	9108	8 SO	77	0	2	1	2 DIE SCRATCH, 1 SHORT
DG211	9109	16 NSO	45	0	0	0	
MAX231	9109	14 PDIP	80	0	0	0	
MAX275	9110	20 PDIP	41	0	0	0	
MAX732	9110	8 PDIP	77	0	0	0	
MAX232	9110	16 PDIP	80	0	0	0	
DG509	9112	16 PDIP	80	0	0	0	
MAX902	9112	14 PDIP	48	0	0	0	
ICM7212	9115	40 PDIP	45	0	0	0	
MX7845	9117	24 PDIP	58	0	0	0	
OP07	9118	8 PDIP	77	0	0	0	
MAX1000	9119	24 WSO	77	1	0	0	MARG. LEAKAGE
MAX730	9119	8 PDIP	76	0	0	0	
DG508	9122	16 PDIP	77	0	0	1	MARG. LEAKAGE
MX7582	9122	28 PDIP	45	0	0	0	
MAX232A	9123	16 PDIP	77	0	0	0	
ICL7106	9125	44 PLCC	30	0	0	0	
MAX292	9125	8 PDIP	77	0	0	0	
MAX232	9125	16 WSO	56	0	0	0	
OP07	9130	8 PDIP	77	0	0	1	MASKING DEFECT
MX7245	9133	24 PDIP	72	0	0	0	
MAX690	9138	8 PDIP	77	0	0	0	
MX7245	9138	24 PDIP	76	0	0	0	
DG211	9138	16 PDIP	77	0	0	1	MARG. LEAKAGE
MAX232	9140	16 WSO	75	0	0	0	
MAX730	9140	8 PDIP	77	0	1	0	PARAMETRIC
DG211	9141	16 PDIP	77	0	0	0	
DG411	9144	16 PDIP	77	0	1	1	2 MARG. LEAKAGE
DG413	9145	16 PDIP	77	0	0	0	
MAX690	9147	8 PDIP	100	0	0	0	
DG455	9149	16 PDIP	72	0	0	0	
OP07	9152	8 PDIP	77	0	0	0	
MAX232	9201	16 WSO	77	0	0	0	

TABLE 11 *(continued)*

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MAX232	9203	16 PDIP	76	0	0	0	
MX7245	9202	24 PDIP	72	0	0	0	
REF01	9204	8 NSO	77	0	0	0	
MAX232	9206	16 PDIP	77	0	0	0	
MAX690	9206	8 PDIP	77	0	0	0	
ICL7109	9206	40 PDIP	77	0	0	0	
ICL7109	9207	40 PDIP	56	0	0	0	
MAX690	9207	8 PDIP	77	0	0	0	
ICL7106	9208	40 PDIP	28	0	0	0	
ICM7211	9208	40 PDIP	28	0	0	0	
ICL7109	9208	40 PDIP	56	0	0	0	
DG444	9210	16 PDIP	77	0	1	0	MARG. LEAKAGE
DG412	9210	16 PDIP	75	0	0	0	
MAX241	9211	28 SSOP	30	0	0	0	
DG211	9212	16 PDIP	77	0	1	0	MARG. LEAKAGE
MAX707	9212	8 PDIP	76	0	0	0	
MAX232	9214	16 WSO	56	0	0	0	
MAX232	9215	16 WSO	45	0	0	0	
MAX232	9215	16 PDIP	77	0	0	0	
MAX241	9220	28 SSOP	30	0	0	0	
MAX406	9221	8 PDIP	73	0	0	0	
MAX232	9221	16 PDIP	76	0	0	0	
MAX232	9222	16 WSO	56	0	0	0	
MAX626	9222	8 PDIP	76	0	0	0	
REF01	9224	8 PDIP	76	0	0	0	
MAX667	9226	8 PDIP	45	0	0	0	
MAX735	9227	8 PDIP	77	0	0	0	
MAX4420	9232	8 PDIP	77	0	0	0	
DG411	9234	16 PDIP	76	0	0	0	
MAX626	9235	8 PDIP	77	0	0	0	
DG211	9236	16 PDIP	77	0	1	0	MARG. LEAKAGE
MAX232	9237	16 PDIP	77	0	0	0	
MAX480	9237	8 PDIP	77	0	0	0	
MAX663	9238	8 NSO	77	0	1	0	FUNCTIONAL
MAX661	9238	8 PDIP	45	0	0	0	
MAX1074	9240	TO220	25	0	0	0	
DG411	9240	16 PDIP	77	0	0	0	
MX7524	9242	16 PDIP	77	0	0	0	
MAX623	9246	16 PDIP	36	0	0	0	
OP07	9246	8 PDIP	77	0	0	0	
MAX730	9248	8 PDIP	77	0	0	0	
LT1074	9248	TO220	25	0	1	0	PARAMETRIC
MAX232	9249	16 PDIP	77	0	0	1	OXIDE DEFECT
DG211	9249	16 PDIP	77	0	0	0	
MAX662	9249	8 PDIP	45	0	0	0	
MAX8212	9251	8 NSO	77	0	0	0	
MAX903	9252	8 NSO	77	0	0	0	
MAX412	9252	8 PDIP	36	0	0	0	
MAX8212	9301	8 NSO	77	0	0	0	
DG405	9302	16 PDIP	77	0	0	1	PARAMETRIC
MAX412	9302	8 PDIP	36	0	0	0	
MAX410	9302	8 PDIP	36	0	0	0	
MAX708	9303	8 PDIP	77	0	0	0	
MX7524	9306	16 PDIP	77	0	0	0	
REF02	9308	8 PDIP	77	0	1	0	PARAMETRIC
MAX662	9308	8 PDIP	45	0	0	0	
DG508	9309	16 PDIP	77	0	2	0	1 CORROSION; 1 MARG. LEAKAGE
MAX232	9311	16 PDIP	77	0	0	0	
MAX232	9314	16 WSO	45	0	0	0	
MAX8212	9314	8 NSO	77	0	0	0	
MAX232	9315	16 WSO	45	0	0	0	
MAX8212	9315	8 NSO	77	0	0	0	

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 168	NOTE
MX7628	9005	20 PDIP	77	0	
MAX699	9006	8 SO	20	0	
MAX236	9008	24 PDIP	45	0	
MAX232	9013	16 PDIP	77	0	
MAX239	9011	24 PDIP	45	0	
MX7533	8950	20 PLCC	45	0	
MX7572	8938	24 PDIP	28	0	
MAX239	9012	24 PDIP	45	0	
MAX239	9010	24 PDIP	45	0	
ICL7660	9013	8 PDIP	45	0	
MAX236	9012	24 PDIP	44	0	
MAX236	9010	24 PDIP	30	0	
ICL7660	9010	8 PDIP	44	0	
DG212	9011	16 PDIP	45	0	
MAX901	9019	16 PDIP	45	0	
MAX8211	9023	8 SO	77	0	
DG303	9025	14 PDIP	77	0	
MAX232	9032	16 PDIP	77	0	
ICL7660	9021	8 SO	45	0	
ICL7109	9033	40 PDIP	77	0	
MAX690	9033	8 PDIP	76	0	
MAX232	9036	16 PDIP	65	0	
MAX232	9036	16 WSO	77	0	
MAX9687	9033	16 PDIP	45	0	
MAX690	9043	8 PDIP	70	0	
MAX238	9043	24 PDIP	77	0	
ICM7212	9043	40 PDIP	77	0	
MAX400	9049	8 PDIP	77	0	
MAX400	9049	8 PDIP	77	0	
ICL7664	9049	8 PDIP	77	0	
MX7524	9102	16 PDIP	77	0	
MX7245	9106	24 PDIP	20	0	
MX7824	9106	24 PDIP	45	0	
MX7824	9106	24 PDIP	45	0	
MX7248	9107	20 PDIP	77	0	
DG211	9108	16 WSO	77	0	
MX7845	9108	24 PDIP	77	0	
MAX8211	9108	8 SO	76	0	
MAX8211	9108	8 SO	76	0	
DG211	9109	16 WSO	45	0	
MAX275	9110	20 PDIP	77	0	
MAX638	9110	8 SO	35	0	
MAX696	9114	16 WSO	35	0	
ICM7212	9115	40 PDIP	45	0	
MX7845	9117	24 PDIP	45	0	
OP07	9118	8 PDIP	45	0	
MAX500	9119	16 WSO	45	0	
MAX1000	9119	24 WSO	77	0	
MAX730	9119	8 PDIP	77	0	
MAX422	9121	8 PDIP	45	0	
DG508	9122	16 PDIP	45	0	
MX7582	9122	28 PDIP	45	0	
MAX232A	9123	16 PDIP	45	0	
MAX232	9125	16 WSO	45	0	
MAX292	9125	8 PDIP	77	0	
MAX7219	9125	24 PDIP	77	0	
MAX420	9125	8 PDIP	77	0	
ICL7660	9125	8 PDIP	77	0	
ICL7660	9125	8 PDIP	77	0	
OP07	9130	8 PDIP	45	0	
MAX292	9131	8 PDIP	45	0	
MX7245	9133	24 PDIP	45	0	
MAX412	9136	8 PDIP	45	0	
MAX172	9136	24 PDIP	45	0	
MAX690	9138	8 PDIP	45	0	
MX7245	9138	24 PDIP	45	0	
DG211	9138	16 PDIP	45	0	
MX7245	9138	24 PDIP	45	0	
MAX730	9140	8 PDIP	45	0	
MAX232	9140	16 WSO	45	0	
MAX232	9140	16 PDIP	100	0	

TABLE 12 *(continued)*

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 168	NOTE
DG211	9141	16 PDIP	45	0	
DG411	9144	16 PDIP	45	0	
DG412	9144	16 PDIP	20	0	
MAX232	9145	16 PDIP	100	0	
DG413	9145	16 PDIP	45	0	
MAX690	9147	8 PDIP	77	0	
MX7820	9148	20 PDIP	45	0	
DG445	9149	16 PDIP	44	0	
OP07	9152	8 PDIP	44	0	
MAX232	9201	16 PDIP	100	0	
MAX232	9201	16 WSO	45	0	
MX7245	9202	24 PDIP	45	0	
MAX639	9202	8 PDIP	45	0	
MAX232	9203	16 PDIP	44	0	
MX7541	9208	18 PDIP	45	0	
MAX232	9209	16 PDIP	100	0	
MAX690A	9212	8 PDIP	45	0	
MAX232	9214	16 WSO	45	0	
MAX232	9215	16 PDIP	45	0	
MAX543	9223	8 PDIP	45	0	
MAX660	9223	8 PDIP	45	0	
REF01	9204	8 NSO	77	0	
ICL7109	9206	40 PDIP	77	0	
MAX232	9206	16 PDIP	77	0	
MAX690	9206	8 PDIP	77	0	
MAX232	9207	16 PDIP	77	0	
ICL7109	9207	40 PDIP	77	0	
MAX690	9207	8 PDIP	77	0	
ICM7211	9208	40 PDIP	77	0	
ICL7106	9208	40 PDIP	77	0	
ICL7109	9208	40 PDIP	77	0	
DG444	9210	16 PDIP	45	0	
MAX241	9211	28 SSOP	45	0	
DG211	9212	16 PDIP	44	0	
DG211	9212	16 PDIP	45	0	
MAX708	9218	8 PDIP	44	0	
MAX241	9220	28 SSOP	39	0	
MAX560	9221	28 SSOP	45	0	
MAX232	9222	16 WSO	45	0	
MAX560	9222	28 SSOP	45	0	
MAX626	9222	8 PDIP	45	0	
MAX703	9222	8 PDIP	45	0	
MAX690A	9222	8 PDIP	45	0	
MAX232	9222	16 PDIP	76	0	
REF01	9224	8 PDIP	45	0	
MAX241	9225	28 SSOP	45	0	
MAX667	9226	8 PDIP	45	0	
MAX735	9227	8 PDIP	45	0	
MAX4420	9232	8 PDIP	45	0	
DG411	9234	16 PDIP	45	0	
MAX626	9235	8 PDIP	45	0	
DG211	9236	16 PDIP	45	0	
MAX232	9237	16 PDIP	45	0	
MAX480	9237	8 PDIP	45	0	
MAX663	9238	8 NSO	45	0	
MAX661	9238	8 PDIP	45	0	
MAX900	9240	20 PDIP	77	0	
DG411	9240	16 PDIP	45	0	
MAX1074	9240	TO220	44	0	
LT1074	9241	TO220	45	0	
MX7524	9242	16 PDIP	45	0	
OP07	9246	8 PDIP	45	0	
MAX454	9248	14 PDIP	45	0	
MAX730	9248	8 PDIP	45	0	
LT1074	9248	TO220	25	0	
DG211	9249	16 PDIP	45	0	
MAX662	9249	8 PDIP	45	0	
DG441	9249	16 PDIP	45	0	
MAX232	9249	16 PDIP	45	0	
MAX435	9250	14 PDIP	77	0	
DG411	9250	16 PDIP	45	0	

TABLE 12 *(continued)*

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 168	NOTE
MAX8212	9251	8 NSO	45	0	
MAX903	9252	8 NSO	77	0	
MAX412	9252	8 PDIP	45	0	
MAX8212	9301	8 NSO	45	0	
DG405	9302	16 PDIP	45	0	
MAX410	9302	8 PDIP	45	0	
MAX412	9302	8 PDIP	45	0	
MAX708	9303	8 PDIP	45	0	
MX7524	9306	16 PDIP	45	0	
MAX241	9307	28 WSO	20	0	
REF02	9308	8 PDIP	45	0	
MAX662	9308	8 PDIP	45	0	
MAX261	9309	24 PDIP	45	0	
DG508	9309	16 PDIP	45	0	
MAX232	9311	16 PDIP	45	0	
MAX232	9314	16 WSO	45	0	
MAX8212	9314	8 NSO	45	0	
MAX232	9315	16 WSO	45	0	
MAX8212	9315	8 NSO	45	0	

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 100	NOTE
MAX232	8805	16 PDIP	36	0	
MAX448	8910	14 PDIP	25	0	
MX7572	8932	24 PDIP	24	0	
MX7226	8930	20 PDIP	30	0	
MAX232	8924	16 PDIP	30	0	
MAX232	8925	16 PDIP	30	0	
MAX236	9008	24 PDIP	45	0	
MAX232	9013	16 PDIP	25	0	
MAX239	9011	24 PDIP	25	0	
MAX239	9010	24 PDIP	24	0	
ICL7109	9207	40 PDIP	25	0	
MAX232	9207	16 PDIP	25	0	
MAX233	9207	20 PDIP	25	0	
MAX241	9211	28 SSOP	30	0	
MAX690A	9212	8 PDIP	45	0	
MAX225	9216	28 SSOP	25	1	CAPACITOR OPEN
MAX235	9219	24 PDIP	28	1	CORROSION
MAX500	9220	16 PDIP	45	0	
MAX241	9220	28 SSOP	30	0	
MAX232	9222	16 PDIP	25	0	
MAX233A	9223	20 WSO	25	0	
MAX667	9240	8 PDIP	25	0	
MAX782	9319	36 SSOP	24	0	
MAX241	9329	28 SSOP	30	0	
MAX782	9330	36 SSOP	24	0	

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 200 x	500 x	1000 x	NOTE
ICL7660	9021	8 SO	10	0	0	0	
MAX690	9026	8 PDIP	67	0	0	0	
ICL7621	9029	8 TO	77	0	0	0	
MAX232	9032	16 PDIP	77	0	0	0	
MAX690	9032	8 PDIP	70	0	0	0	
ICL7109	9033	40 PDIP	71	0	0	0	
MAX690	9033	8 PDIP	77	0	0	0	
MAX691	9033	16 PDIP	70	0	0	0	
MAX232	9033	16 PDIP	77	0	0	0	
MAX9687	9033	16 PDIP	45	0	0	0	
MAX690	9034	8 CERDIP	77	0	0	0	
MAX238	9034	24 CERDIP	74	0	0	1	OXIDE OVERETCH
ICL7109	9034	40 CERDIP	77	0	0	0	
OP290	9034	8 PDIP	24	0	0	0	
MAX172	9035	24 PDIP	60	0	0	0	
MAX232	9036	16 PDIP	77	0	0	0	
MAX232	9036	16 WSO	76	0	0	0	
MAX690	9041	8 PDIP	39	0	0	0	
MAX690	9043	8 PDIP	77	0	0	0	
MAX238	9043	24 PDIP	77	0	0	0	
ICM7212	9043	40 PDIP	75	0	0	0	
MAX154	9044	24 PDIP	77	0	0	0	
MAX232	9045	16 PDIP	77	0	0	0	
MAX235	9045	24 SB	20	0	0	0	
MAX232	9046	16 PDIP	77	0	0	0	
MAX584	9047	8 TO	76	0	0	0	
MAX584	9047	8 TO	45	0	0	0	
REF02	9049	8 PDIP	77	0	0	0	
MAX400	9049	8 PDIP	71	0	0	0	
MAX400	9049	8 PDIP	77	0	1	0	OXIDE OVERETCH
ICL7664	9049	8 PDIP	77	0	0	0	
MX7541	9050	18 PDIP	75	0	0	0	
DG212	9052	16 PDIP	76	0	0	0	
MX7524	9102	16 PDIP	45	0	0	0	
MAX233	9105	20 PDIP	45	0	0	0	
MAX233	9105	20 PDIP	45	0	0	0	
MAX7231	9105	40 PDIP	43	0	0	0	
MX7245	9106	24 PDIP	77	0	0	0	
MX7824	9106	24 PDIP	77	0	0	0	
MAX235	9107	24 PDIP	43	0	0	0	
MX7248	9107	20 PDIP	77	0	0	0	
DG211	9108	16 NSO	77	0	0	0	
MX7845	9108	24 PDIP	77	0	0	0	
MAX8211	9108	8 SO	72	0	0	0	
MAX8211	9108	8 SO	76	0	0	0	
DG211	9109	16 SO	76	0	0	0	
MAX231	9109	14 PDIP	80	0	0	0	
MAX232	9110	16 PDIP	80	0	0	0	
MAX902	9112	14 PDIP	80	0	0	0	
DG509	9112	16 PDIP	80	0	0	0	
MAX238	9113	24 CERDIP	77	0	0	0	
MAX690	9113	8 PDIP	77	0	0	0	
ICM7212	9115	40 PDIP	77	0	0	0	
MX7845	9117	24 PDIP	77	0	0	0	
MAX400	9118	8 PDIP	77	0	0	0	
OP07	9118	8 PDIP	77	0	0	0	
MAX1000	9119	24 WSO	77	0	0	0	
MAX500	9119	16 WSO	45	0	0	0	
MAX252	9119	40 PDIP	40	0	0	0	
MAX730	9119	8 PDIP	77	0	0	0	
MAX422	9121	8 PDIP	45	0	0	0	
MAX400	9122	8 PDIP	80	0	1	0	LEAKAGE
DG508	9122	16 PDIP	77	0	0	0	
MX7582	9122	28 PDIP	77	1	0	0	LEAKAGE
MAX232A	9123	16 PDIP	77	0	0	0	
MAX232	9125	16 WSO	77	0	0	0	
MAX292	9125	8 PDIP	77	0	0	0	
MAX7219	9125	24 PDIP	77	0	0	0	
MAX400	9130	8 PDIP	80	0	0	0	
MAX400	9130	8 PDIP	80	0	0	0	
OP07	9130	8 PDIP	77	0	1	0	FUNCTIONAL
DG211	9132	16 PDIP	45	0	0	0	

TABLE 14 *(continued)*

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 200 x	500 x	1000 x	NOTE
MAX333	9133	20 PDIP	45	0	0	0	
MAX333	9133	20 PDIP	45	0	0	0	
MX7245	9133	24 PDIP	77	0	0	0	
MAX412	9136	8 PDIP	77	0	0	0	
MAX690	9138	8 PDIP	77	0	0	0	
MX7245	9138	24 PDIP	77	0	0	0	
DG211	9138	16 PDIP	77	0	0	0	
MAX232	9140	16 WSO	77	0	0	0	
MAX730	9140	8 PDIP	77	0	0	0	
MAX9690	9141	8 PDIP	45	0	0	0	
DG211	9141	16 PDIP	77	0	0	0	
MAX9687	9142	16 PDIP	45	0	0	0	
DG411	9144	16 PDIP	77	0	0	0	
DG413	9145	16 PDIP	77	1	0	0	PARAMETRIC
DG445	9149	16 PDIP	77	0	0	0	
ICL7129	9149	40 PDIP	45	0	0	0	
OP07	9152	8 PDIP	77	0	0	0	
MAX232	9201	16 WSO	77	0	0	0	
MAX232	9203	16 PDIP	77	0	0	0	
MAX705	9206	8 PDIP	45	0	0	0	
MAX706	9206	8 PDIP	45	0	0	0	
ICL7664	9210	TO99	77	0	0	0	
MAX232	9215	16 PDIP	77	0	0	0	
MAX292	9131	8 PDIP	77	0	1	0	MASKING DEFECT
MX7820	9148	20 PDIP	77	0	0	0	
MX7245	9202	24 PDIP	77	0	0	0	
REF01	9204	8 NSO	76	0	0	0	
MAX690	9206	8 PDIP	77	0	0	0	
ICL7109	9206	40 PDIP	77	0	0	0	
MAX232	9206	16 PDIP	77	0	0	0	
ICL7109	9207	40 PDIP	45	0	0	0	
MAX690	9207	8 PDIP	77	0	0	0	
MAX232	9207	16 WSO	77	0	0	0	
ICL7109	9208	40 PDIP	77	0	0	0	
ICL7106	9208	40 PDIP	45	0	0	0	
ICM7211	9208	40 PDIP	45	0	0	0	
DG444	9210	16 PDIP	77	0	0	0	
MAX241	9211	28 SSOP	77	0	1	0	PASSIVATION CRACK
MAX232	9214	16 WSO	77	0	0	0	
MAX232	9215	16 WSO	77	0	0	0	
MAX241	9220	28 SSOP	76	0	0	0	
MX574	9221	28 SB	30	0	0	0	
MAX406	9221	8 PDIP	77	0	0	0	
MAX560	9221	28 SSOP	45	0	0	0	
MAX232	9221	16 PDIP	77	0	0	0	
MAX690A	9222	8 PDIP	45	0	0	0	
MAX703	9222	8 PDIP	45	0	0	0	
MAX626	9222	8 PDIP	77	0	0	0	

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 200 x	500 x	1000 x	NOTE
MAX232	9222	16 PDIP	45	0	0	0	
MAX232	9222	16 WSO	77	0	0	0	
MAX667	9224	8 CERDIP	45	0	0	0	
REF01	9224	8 PDIP	77	0	0	0	
MAX743	9225	16 PDIP	29	0	0	0	
MX574	9226	24 S. BRAZE	30	0	0	0	
MAX735	9227	8 PDIP	76	0	0	0	
MAX4420	9232	8 PDIP	77	0	0	0	
DG411	9234	16 PDIP	77	0	0	0	
MAX626	9235	8 PDIP	77	0	0	1	DIE SCRATCH
DG211	9236	16 PDIP	77	0	0	0	
MAX480	9237	8 PDIP	77	0	0	0	
MAX232	9237	16 PDIP	77	0	0	0	
MAX661	9238	8 PDIP	45	0	0	0	
MAX663	9238	8 NSO	77	0	0	0	
MAX1074	9240	TO220	44	0	0	1	BOND WIRE OPEN
DG411	9240	16 PDIP	77	0	0	0	
LT1074	9241	TO220	44	0	0	0	
MX7524	9242	16 DPIP	77	0	0	0	
OP07	9246	8 PDIP	77	0	0	0	
LT1074	9248	TO220	45	0	0	0	
MAX454	9248	14 PDIP	77	0	0	0	
MAX730	9248	8 PDIP	77	0	0	0	
DG211	9249	16 PDIP	77	0	0	0	
DG441	9249	16 PDIP	76	0	0	0	
MAX662	9249	8 PDIP	45	0	0	0	
MAX232	9249	16 PDIP	77	0	0	0	
DG411	9250	16 PDIP	77	0	0	0	
MAX8212	9251	8 NSO	77	0	0	0	
MAX903	9252	8 NSO	77	0	0	0	
MAX412	9252	8 PDIP	45	0	0	0	
MAX8212	9301	8 NSO	77	0	0	0	
MAX410	9302	8 PDIP	45	0	0	0	
MAX901	9302	16 CERDIP	45	0	0	0	
DG405	9302	16 PDIP	77	0	0	0	
MAX412	9302	8 PDIP	45	0	0	0	
MAX708	9303	8 PDIP	77	0	0	0	
MX7524	9306	16 PDIP	77	0	0	0	
REF02	9308	8 PDIP	77	0	0	0	
MAX662	9308	8 PDIP	45	0	0	0	
DG508	9309	16 PDIP	77	0	0	0	
MAX261	9309	24 PDIP	77	0	0	0	
MAX232	9311	16 PDIP	77	0	0	0	
MAX8212	9314	8 NSO	77	0	0	0	
MAX232	9314	16 WSO	77	0	0	0	
MAX8212	9315	8 NSO	77	0	0	0	
MAX232	9315	16 WSO	77	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.) 192	500	1000	NOTE
DG303	9025	14 PDIP	45	0	0	0	
ICL7621	9029	8 TO	45	0	0	0	
MAX232	9032	16 PDIP	77	0	0	0	
ICL7109	9033	40 PDIP	45	0	0	0	
MAX690	9033	8 PDIP	45	0	0	0	
MAX9687	9033	16 PDIP	37	0	0	0	
MAX690	9034	8 CERDIP	38	0	0	0	
MAX238	9034	24 CERDIP	77	0	0	0	
ICL7109	9034	40 CERDIP	77	0	0	0	
MAX232	9036	16 PDIP	77	0	0	0	
MAX232	9036	16 WSO	77	0	0	0	
MAX690	9043	8 PDIP	70	0	0	0	
MAX238	9043	24 PDIP	77	0	0	0	
ICM7212	9043	40 PDIP	77	0	0	0	
MAX584	9047	8 TO	45	0	0	0	
MAX584	9047	8 TO	45	0	0	0	
MAX400	9049	8 PDIP	44	0	0	0	
MAX400	9049	8 PDIP	45	0	0	0	
ICL7664	9049	8 PDIP	45	0	0	0	
MX7245	9106	24 PDIP	45	0	1	0	PARAMETRIC
MX7824	9106	24 PDIP	45	0	0	0	
MX7248	9107	20 PDIP	45	0	0	0	
DG211	9108	16 NSO	45	0	0	0	
MX7845	9108	24 PDIP	45	0	0	0	
MAX8211	9108	8 SO	45	0	0	0	
MAX8211	9108	8 SO	45	0	0	0	
DG211	9109	16 NSO	45	0	0	0	
MAX275	9110	20 PDIP	45	0	0	0	
MAX238	9113	24 CERDIP	45	0	0	0	
MAX690	9113	8 PDIP	45	0	0	0	
ICL7109	9114	40 CERDIP	43	0	0	0	
ICM7212	9115	40 PDIP	45	0	0	0	
MAX7845	9117	24 PDIP	45	0	0	0	
OP07	9118	8 PDIP	45	0	0	0	
MAX1000	9119	24 WSO	45	0	0	0	
MAX730	9119	8 PDIP	45	0	0	0	
DG508	9122	16 PDIP	45	0	0	0	
MX7582	9122	28 PDIP	45	0	0	0	
MAX232A	9123	16 PDIP	45	0	0	0	
MAX232	9125	16 WSO	42	0	0	0	
MAX292	9125	8 PDIP	45	0	0	0	
MAX7219	9125	24 PDIP	45	0	0	0	
MAX233	9130	20 PDIP	28	0	0	0	
OP07	9130	8 PDIP	45	0	0	0	
MX7245	9133	24 PDIP	45	0	0	0	
MAX412	9136	8 PDIP	45	0	0	0	
MAX690	9138	8 PDIP	45	0	0	0	
MX7245	9138	24 PDIP	45	0	0	0	
DG211	9138	16 PDIP	45	0	0	0	
MAX232	9139	16 PDIP	77	0	0	0	
MAX232	9140	16 WSO	45	0	0	0	
MAX730	9140	8 PDIP	45	0	0	0	
DG211	9141	16 PDIP	45	0	0	0	
DG411	9144	16 PDIP	45	0	0	0	
DG413	9145	16 PDIP	45	0	0	0	
DG445	9145	16 PDIP	45	0	0	0	
MX7820	9148	20 PDIP	45	0	0	0	
ICL7129	9149	40 PDIP	45	0	0	0	
OP07	9152	8 PDIP	45	0	0	0	
MAX232	9201	16 WSO	45	0	0	0	
MX7245	9202	24 PDIP	45	0	0	0	
MAX232	9203	16 PDIP	45	0	0	0	
DG444	9210	16 PDIP	45	0	0	0	
DG211	9212	16 PDIP	45	0	0	0	
MAX232	9214	16 WSO	45	0	0	0	
MAX232	9215	16 PDIP	45	0	0	0	
MAX292	9131	8 PDIP	45	0	0	0	
MX7820	9148	20 PDIP	45	0	0	0	
OP07	9152	8 PDIP	45	0	0	0	
MX7245	9202	24 PDIP	45	0	0	0	
REF01	9204	8 NSO	45	0	0	0	

TABLE 15 *(continued)*

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
ICL7109	9206	40 PDIP	77	0	0	0	
MAX232	9206	16 PDIP	77	0	0	0	
MAX690	9206	8 PDIP	77	0	0	0	
MAX690	9207	8 PDIP	77	0	0	0	
ICL7109	9207	40 PDIP	77	0	0	0	
MAX232	9207	16 WSO	77	0	0	0	
ICL7109	9208	40 PIDP	77	0	0	0	
ICL7106	9208	40 PDIP	77	0	0	0	
ICM7211	9208	40 PDIP	77	0	0	0	
DG444	9210	16 PDIP	45	0	0	0	
MAX241	9211	28 SSOP	45	0	0	0	
DG211	9212	16 PDIP	45	0	0	0	
MAX232	9214	16 WSO	45	0	0	0	
MAX232	9215	16 PDIP	45	0	0	0	
MAX232	9215	16 WSO	45	0	0	0	
MAX708	9218	8 PDIP	45	0	0	0	
MAX235	9219	24 PDIP	45	0	0	0	
MAX233	9219	20 PDIP	45	0	0	0	
MAX241	9220	28 SSOP	45	0	0	0	
MAX232	9221	16 PDIP	45	0	0	0	
MAX406	9221	8 PDIP	45	0	0	0	
MAX560	9221	28 SSOP	45	0	0	0	
MAX626	9222	8 PDIP	45	0	0	0	
MAX232	9222	16 WSO	45	0	0	0	
MAX690	9222	8 PDIP	45	0	0	0	
MAX703	9222	8 PDIP	45	0	0	0	
MAX667	9224	8 CERDIP	45	0	0	0	
REF01	9224	8 PDIP	45	0	0	0	
MAX735	9227	8 PDIP	45	0	0	1	PARAMETRIC
MAX4420	9232	8 PDIP	45	0	0	0	
DG411	9234	16 PDIP	45	0	0	0	
MAX626	9235	8 PDIP	45	0	0	0	
DG211	9236	16 PDIP	45	0	0	0	
MAX480	9237	8 PDIP	45	0	0	1	PARAMETRIC
MAX232	9237	16 PDIP	45	0	0	0	
MAX205	9237	24 PDIP	11	0	0	0	
MAX663	9238	8 NSO	45	0	0	0	
MAX661	9238	8 PDIP	45	0	0	0	
DG411	9240	16 PDIP	45	0	0	0	
MAX900	9240	20 PDIP	45	0	0	0	
LT1074	9241	TO220	45	0	0	0	
MX7524	9242	16 PDIP	45	0	0	0	
OP07	9246	8 PDIP	45	0	0	0	
MAX454	9248	14 PDIP	45	0	0	0	
MAX730	9248	8 PDIP	45	0	0	0	
LT1074	9248	TO220	45	0	0	0	
DG441	9249	16 PDIP	45	0	0	0	
MAX662	9249	8 PDIP	45	0	0	0	
DG211	9249	16 PDIP	45	0	0	0	
MAX232	9249	16 PDIP	45	0	0	0	
MAX435	9250	14 PDIP	77	0	0	0	
DG411	9250	16 PDIP	45	0	0	0	
MAX8212	9251	8 NSO	45	0	0	0	
MAX412	9252	8 PDIP	45	0	0	0	
MAX8212	9301	8 NSO	45	0	0	0	
DG405	9302	16 PDIP	45	0	0	0	
MAX410	9302	8 PDIP	45	0	0	0	
MAX901	9302	16 CERDIP	45	0	1	0	BOND WIRE OPEN
MAX412	9302	8 PDIP	45	0	0	0	
MAX708	9303	8 PDIP	45	0	0	0	
MX7524	9306	16 PDIP	45	0	0	0	
REF02	9308	8 PDIP	45	0	0	0	
MAX662	9308	8 PDIP	45	0	0	0	
MAX261	9309	24 PDIP	44	0	0	0	
DG508	9309	16 PDIP	45	0	0	0	
MAX232	9311	16 PDIP	45	0	0	0	
MAX232	9314	16 WSO	45	0	0	0	
MAX8212	9314	8 NSO	45	0	0	0	
MAX232	9315	16 WSO	45	0	0	0	
MAX8212	9315	8 NSO	45	0	0	0	

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

DEVICE TYPE	DATE CODE	PKG.	SAMPLE SIZE	FAILURES (HRS.) 192	500	1000	NOTE
MAX252	9013	40 PDIP	20	0	0	0	
MAX252	9017	40 PDIP	20	0	1	1	LED OPEN
MAX235	9021	40 PDIP	77	0	0	0	
MAX171	9024	16 PDIP	45	0	0	0	
MAX252	9029	40 PDIP	20	0	0	0	
MAX252	9031	40 PDIP	20	0	0	0	
MAX252	9036	40 PDIP	77	1	0	0	WIRE OPEN
MAX252	9044	40 PDIP	77	0	1	1	LED OPEN
MAX235	9045	40 SB	22	0	0	0	
MAX233	9105	20 PDIP	77	0	0	0	
MAX233	9105	20 PDIP	50	0	0	0	
MAX252	9107	40 PDIP	77	0	0	0	
MAX1025	9113	28 PLCC	77	0	0	0	
MAX252	9119	40 PDIP	76	0	0	1	CAP OPEN
MAX233	9130	20 PDIP	77	0	0	0	
MAX233A	9134	20 WSO	77	0	0	0	
MAX233A	9201	20 WSO	77	1	0	0	EPOXY SHORT
MX2700	9202	24 SB	25	0	0	3	PARAMETRIC
LH0033	9202	TO 8	40	0	0	0	
LH0033	9203	TO 8	44	0	0	0	
PGA100	9206	24 SB	45	0	3	2	PARAMETRIC
MAX233A	9214	20 WSO	49	0	0	0	
MAX233A	9214	20 WSO	77	0	0	0	
MAX225	9216	28 WSO	77	1	0	0	CAP SHORTED
MAX233	9218	20 PDIP	50	0	0	0	
MAX205	9237	24 PDIP	45	0	0	0	
MAX233A	9307	20 WSO	45	0	0	0	
MAX233A	9308	20 WSO	40	0	0	0	
MAX252	9309	40 PDIP	45	0	0	0	
MAX235	9316	24 PDIP	80	0	0	1	PARAMETRIC
MAX235	9320	24 PDIP	77	0	0	0	
MAX235	9321	24 PDIP	77	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.) 200 X	500 X	1000 X	NOTE
MAX252	9005	40 PDIP	20	0	0	0	
MAX252	9013	40 PDIP	20	0	1	0	XFORMER WIRE
MAX235	9021	40 PDIP	77	0	0	0	
MAX171	9024	16 PDIP	20	0	0	0	
MAX235	9045	40 SB	20	0	0	0	
MAX233	9105	20 PDIP	45	0	0	0	
MAX252	9107	40 PDIP	45	0	1	1	XFORMER OPEN
MAX1025	9113	28 PLCC	45	0	0	0	
MAX252	9119	40 PDIP	40	0	0	0	
MAX233	9130	20 PDIP	45	0	0	0	
MAX233A	9134	20 WSO	45	0	0	1	CAP OPEN
MX2700	9149	14 SB	23	0	0	0	
MAX430	9152	8 PDIP	45	1	1	0	CAP OPEN, UNKNOWN
LH0033	9202	TO 8	25	0	0	0	
MAX430	9213	8 PDIP	45		2	0	PARAMETRIC
MAX233A	9214	20 WSO	45	0	0	0	
MAX233A	9214	20 WSO	44	0	0	0	
MAX681	9215	14 PDIP	77	0	0	0	
MAX430	9218	8 PDIP	45		1	0	PARAMETRIC
MAX233A	9214	20 WSO	45	0	0	0	
MAX225	9216	28 WSO	77	0	0	0	
MAX233	9218	20 PDIP	77	0	0	0	
MAX233	9219	20 PDIP	77	0	1	0	CAP OPEN
MAX235	9219	24 PDIP	45	0	0	0	
MAX233A	9223	20 WSO	45	0	0	0	
MAX205	9237	24 PDIP	45	0	0	0	
MAX233A	9246	20 WSO	77	0	0	0	
MAX233A	9307	20 WSO	30	0	0	0	
MAX233	9308	20 PDIP	77	0	0	0	
MAX233A	9308	20 WSO	45	0	0	0	
MAX235	9316	24 PDIP	77	0	0	0	
MAX235	9320	24 PDIP	77	0	0	0	
MAX235	9321	24 PDIP	77	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 5 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:

$$\text{Acceleration Factor} = Ke^{\frac{Ea}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)}$$

Where:

K = an experimentally determined constant

Ea = the activation energy

k = Boltzmann's constant

T_1 = actual use temp. in degrees Kelvin

T_2 = test temp. in degrees Kelvin

How to Use This Equation

The first step is to determine an activation energy, which may be done in one of two ways. The first method involves using failure analysis techniques to determine the actual failure mechanism. Many failure mechanisms have had their activation energies already determined, and these are 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. Using published activation energies will not give the exact activation energy that is associated with a particular process, but it will give 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 to determine an activation energy (Ea) 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 is, therefore, 9822 for this particular failure mechanism between these two temperatures.

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

Where:

Ea = the unknown activation energy

k = 8.63×10^{-5}eV/°K

T_1 = 25°C + 273°C or 298°K

T_2 = 150°C + 273°C or 423°K

Substituting:

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

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

Taking the natural log of both sides:

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

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

Therefore, Ea = 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 acceleration factor between any two temperatures as follows:

Between 150°C and 70°C, for example:

$$\text{Acceleration Factor} = e^{\frac{0.8}{8.63 \times 10^{-5}}\left(\frac{1}{T1} - \frac{1}{T2}\right)}$$

T1 = 70°C + 273°C = 343°K

T2 = 150°C + 273°C = 423°K

Substituting for T1 + T2 and solving for e yields the result:

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 2 units were found to be failures. Roughly, it could be said that the Mean Time Between Failure (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 x 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:

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

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 = 179

B = 192

C = 38,544

D = 9822 (Assuming Ea = 0.8eV, and a test temperature of 150°C)

Substituting:

$$\text{FR} = \frac{179}{192 \times 38544 \times 9822} = 2.46 \times 10^{-9}$$

Expressing this in terms of the FIT rate:

FIT = 2.46

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.

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 (BxCxD)

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(179 x 1) = 360.

The Chi square value found under the values of 0.40 and 360 degrees of freedom is: 365.

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

$$FR = \frac{365}{1.45 \times 10^{11}} = 2.51 \times 10^{-9}$$

Expressed as Failure-in-Time rate:

FIT = 2.51

Referring to Table 2, one can see that for Maxim's product, there is a 60% confidence level that no more than 2.51 units will fail per billion (10^9) device-hours of operation at 25°C.