SAMPLE

Reliability Report

Mean-Time-Between-Failure (MTBF) Prediction
Bellcore TR332 Method
for

Telecommunications System

Broadband Subscriber Management System

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telecom_b.pdf

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Revision B

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Description of Equipment

This Mean-Time-Between-Failure Prediction has been performed for the Telecommunications System. This equipment consists of a System chassis with plug-in circuit board modules. Each sub-level unit includes it's associated circuit boards, enclosures, and cables. The following describes the equipment with it's components.

Assembly	**Part Number**
CE3	
FE1	
ENET 6U	
T1 PKT	
OC3 SMF	
OC3 MMF	
ATM DS3	
DS3 PKT	
ETH-3U	
DC Power Supply	
AC Power Supply	

Assumptions and Conditions

This calculation relates to operational hours, as opposed to elapsed hours, so this should be reflected in the overall reliability if required.

Models provided by the Telcordia (Bellcore) TR332, Issue 6, "Reliability Prediction Procedure for Electronic Equipment" specification and manufacturer's failure rate data, when available, was used.

Ambient temperature = 25 ^{o}C

Environment = Ground Benign, Controlled (G_B)

Model = Serial. Redundant paths do not exist.

Bellcore TR-332, Issue 6, Calculation Method = Limited Stress, Method I, Case 3

Component Quality Level = II

Temperature rise of components - See Appendix B.

Electrical Stress - See Appendix B.

Omitted Items

Device	Reason for omission
Assembly hardware	Stationary mechanical devices are omitted

Summary of Results

1.0 MTBF Predictions

Reliability predictions are presented below for the entire system, sub-assembly units and each circuit board per Bellcore TR-332, Issue 6.

Table I and II, shows the overall System results for DC and AC power supply configurations.

Table III shows the results for each individual circuit board.

Table 1.1

DC System Level Results

Bellcore Method, Ground Benign (G_B) at 25ºC

Assembly	Part Number	MTBF (hours)	MTBF (years)	Failure rate (FIT)
CE3		653,168	74.6	1531
FE1		683,995	78.1	1462
ENET 6U		692,521	79.1	1444
T1 PKT		1,358,696	155	736
OC3 SMF		1,497,006	171	668
CHASSIS		1,290,404	147	775
DC Power Supply		751,880	85.8	1330
System Total		125,850	14.4	7946

FIT is Failures in 10^9 hours.

Table 1.2

AC System Level Results

Bellcore Method, Ground Benign (G_B) at 25ºC

Assembly	Part Number	MTBF (hours)	MTBF (years)	Failure rate (FIT)
CE3		653,168	74.6	1531
FE1		683,995	78.1	1462
ENET 6U		692,521	79.1	1444
T1 PKT		1,358,696	155	736
OC3 SMF		1,497,006	171	668
CHASSIS		1,290,404	147	775
AC Power Supply		751,880	85.8	1330
System Total		125,850	14.4	7946

FIT is Failures in 10^9 hours.

Table 1.3

Individual Assembly Results

Bellcore Method, Ground Benign (G_B) at 25ºC

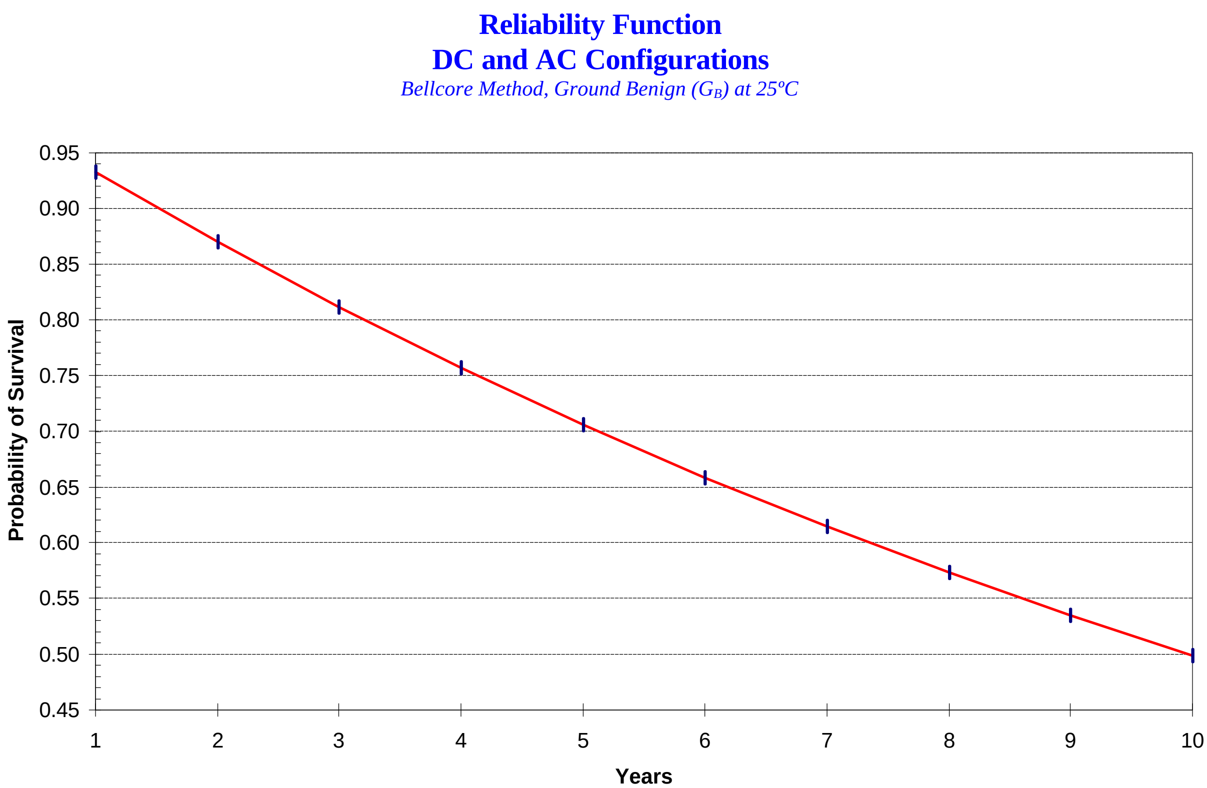
Assembly	Part Number	MTBF (hours)	MTBF (years)	Failure rate (FIT)
CE3		653,168	74.6	1531
FE1		683,995	78.1	1462
ETH-3U		3,649,635	417	274
ATM DS3		1,497,006	171	668
DS3 PKT		2,252,252	257	444
T1 PKT		692,521	79.1	1444
OC3 MMF		1,358,696	155	736
ENET 6U		3,584,229	409	279
OC3 SMF		1,355,014	155	738
ZIATECH, 6311 DC PS		751,880	85.8	1,330
ZIATECH, 6301 AC PS		751,880	85.8	1,330

FIT is Failures in 10^9 hours.

1.1 Reliability Function Plot - Probability of Survival

The following graphs show the Probability of Survival, that is the percentage of Failure Free product, as a function of time.

The graph applies to both AC and DC System configurations.



We can expect that 93.2% of product will survive year one without failure, whereas, 49.8% of the product will survive 10 years failure free.

2.0 Margin Analysis

Margin analysis where operating temperature is varied between low and high limits. MTBF and Failure Rate are presented graphically over the range of temperature.

The following graphs apply to both AC and DC System configurations.

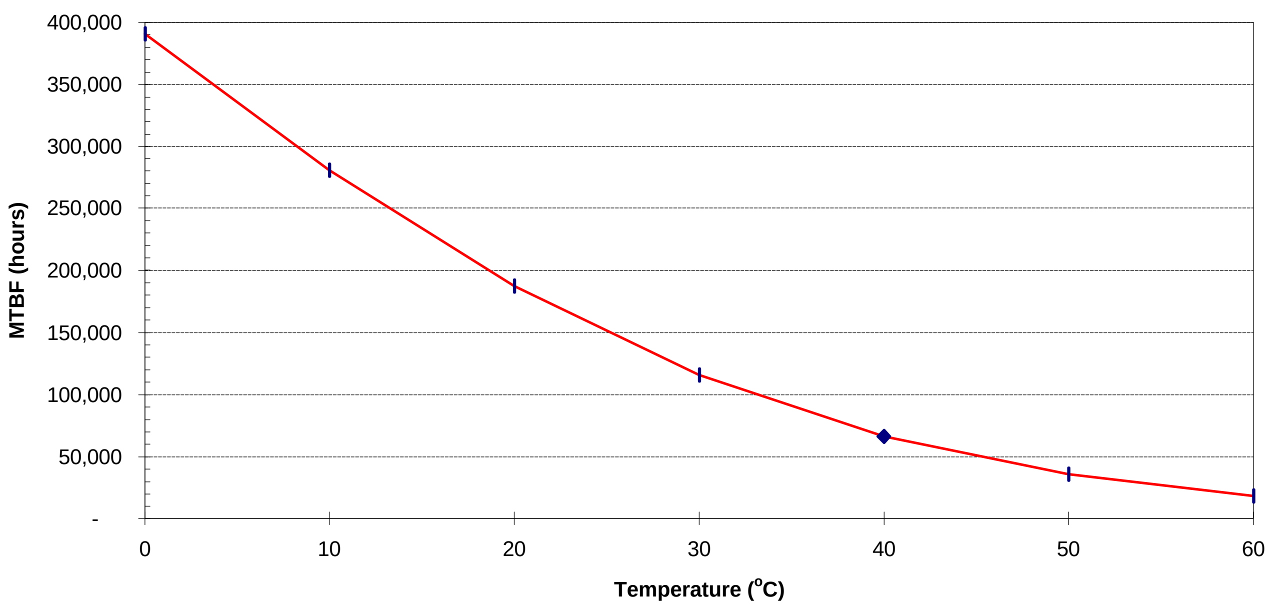
Table 2.0
DC and AC Configurations
MTBF & Failure Rate

Temperature (^oC)	MTBF (hours)	MTBF (years)	Failure Rate (FIT)
0	142.944	16.3	6.996
10	98,145	11.2	10,189
20	63,126	7.2	15,841
30	38,436	4.4	26,017
40	22,479	2.6	44,486
50	12,821	1.5	77,997

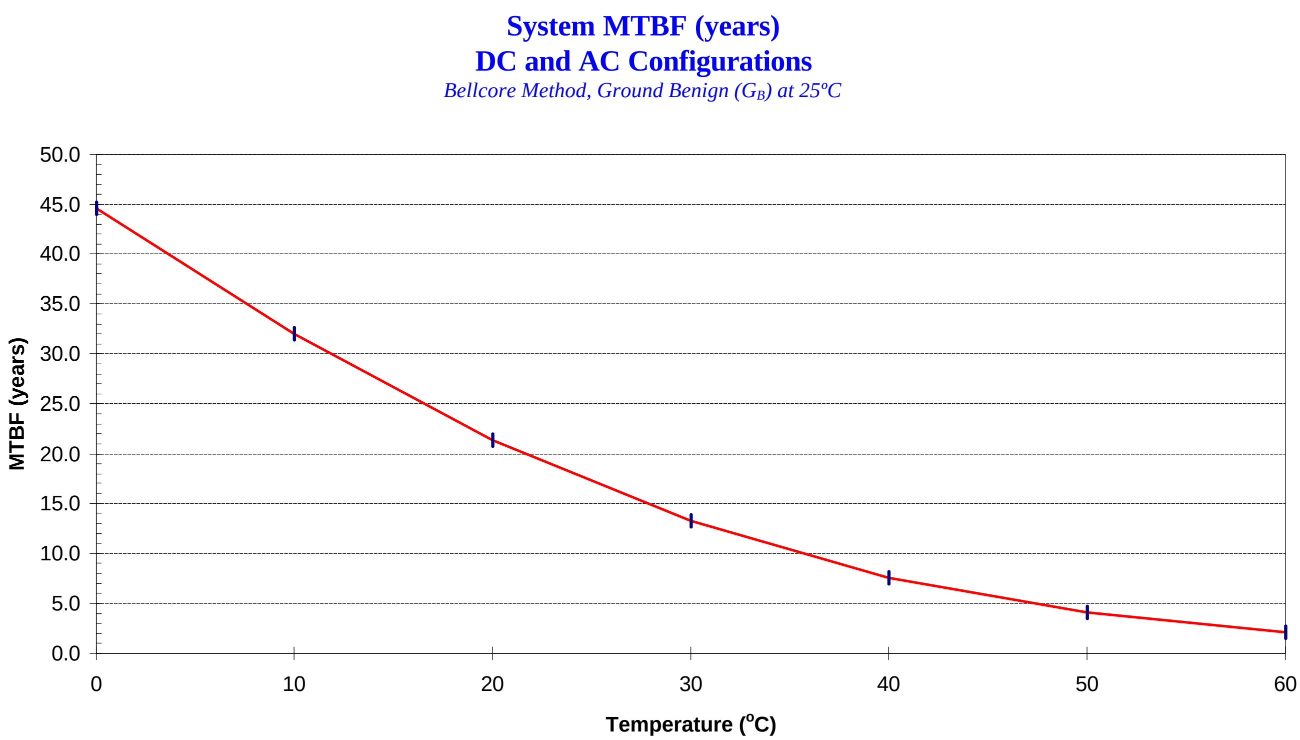
FIT is Failures in 10^9 hours.

2.1 MTBF vs. Temperature

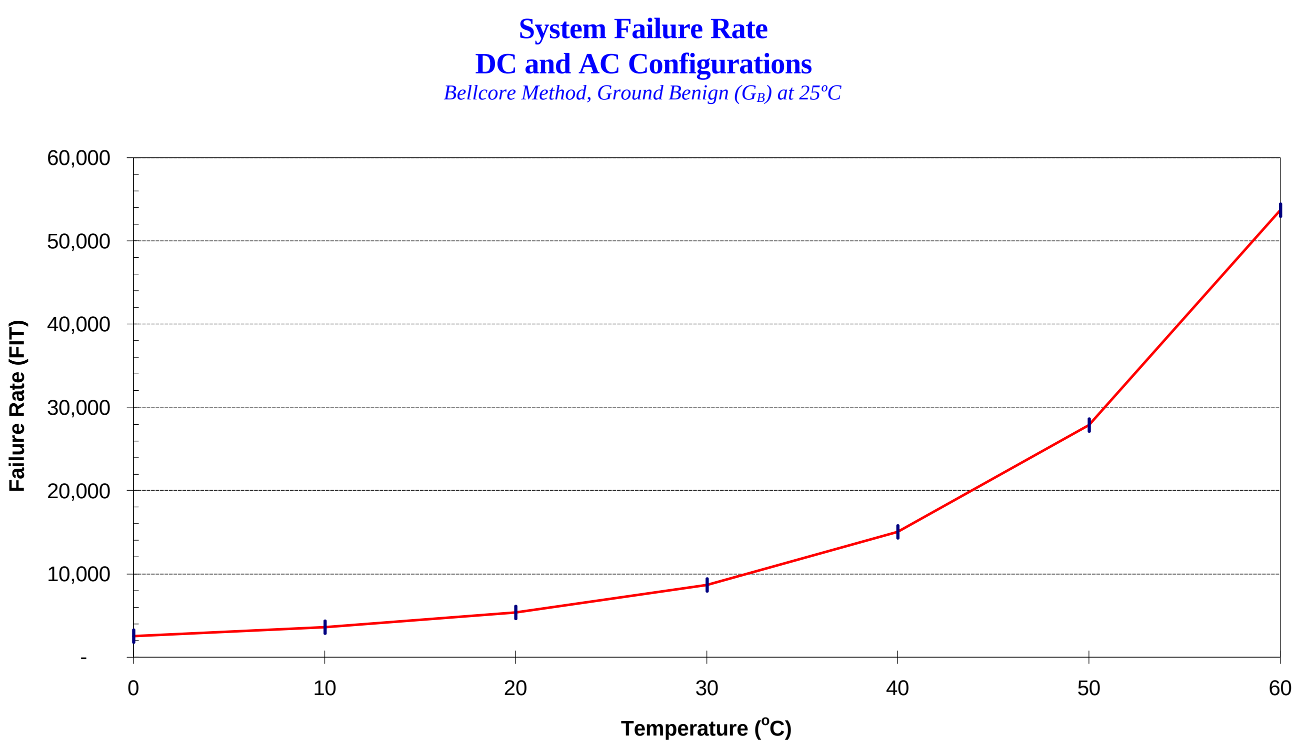
System MTBF (hours)
DC and AC Configurations
Bellcore Method, Ground Benign (G_B) at 25ºC



2.1 MTBF vs. Temperature (continued)



2.2 Failure Rate vs. Temperature

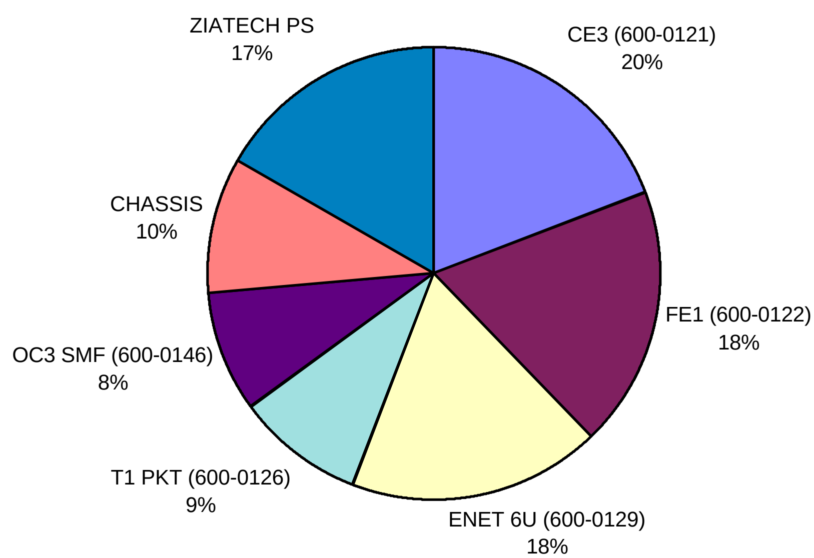


3.0 Component Failure Distribution

The following chart displays the distribution of failure rate for sub-assemblies with respect to the system failure rate.

DC and AC Configurations

Bellcore Method, Ground Benign (G_B) at 25ºC



4.0 Revision History

A. Initial release, 6/13/2000.
B. Updated, 4/25/2002.
C. Updated, 06/19/02.

Appendix A

An Overview of Reliability

Why You Need Reliability Prediction

In today's very competitive electronic products market, a commitment to product quality and reliability is a necessity: customers have high expectations for the reliability of the products they buy, and the companies that don't meet those expectations lose. You already know the advantages to your company of building reliable products: when the products you sell operate reliably, your reputation grows, your costs shrink, and your business prospers.

The most successful companies meet these market demands for quality by using design for reliability principles: integrate reliability considerations into the entire product design process, right from the start. This way reliability is designed into the product, not patched on later, when problems arise. The companies that practice design for reliability find that it results in fewer design changes and iterations, lower manufacturing costs, lower warranty and service costs, more profit, and, most importantly, happy customers.

An important element of the design for reliability process is reliability prediction, which allows you to predict product failure rates.

Uses of Reliability Prediction

Reliability predictions provide a quantitative basis for evaluating product reliability. The information a reliability prediction gives can be used to guide your design decisions throughout the development cycle.

Feasibility Study: When an initial design concept is proposed, a reliability prediction can give you an idea of the feasibility of the design as far as reliability is concerned. Even though these early stage predictions are based on limited design information, and thus are approximate at best, they can give direction to your design decisions; many of these early design decisions may be critical to the success of the product. In addition, it can really pay to discover potential problems early, on paper, before time and money is spent on detailed design and development.

You will usually start with a reliability requirement, which may be given by your customer, or dictated by competitive products. You might have a requirement of a 20,000 hour MTBF for a product. If your predicted value is 3,500 hours, the current design concept may not be feasible; at this point you can modify the design concept, or revise the requirement. If your predicted value is 50,000 hours, this can give you confidence in your design concept, at least as far as reliability is concerned.

Compare Design Alternatives: As your design moves through the early stages into more detailed design, you will make many decisions on design alternatives. Reliability predictions, along with other factors such as performance and cost, can be used as a basis for your decisions. For instance, you may be able to implement a given circuit function in a number of ways, all performing and costing about the same; if one alternative is estimated to be much more reliable than the others, it would stand out.

Find Likely Problem Spots: At the detailed design level, reliability predictions can help you identify likely problem areas. As part of the prediction process, you will go over your parts lists, do stress analysis, and note part quality levels; this detailed examination can expose overstressed parts and misapplied parts. The predicted failure rates will point you to parts, or part groups, which are high contributors to the product failure rate; these problem areas can then be addressed and improved.

Trade-Off System Design Factors: There are many factors that determine the overall value of a product; functional performance, cost, size, weight, reliability, and other parameters must all be integrated for a successful design. The design process will thus involve many trade-offs among these factors; reliability predictions can offer a quantitative measure of reliability to guide your trade-off decisions.

Track Reliability Improvement: As you progress through the design, reliability predictions can offer evidence of improving reliability, allowing designers, management, and customers to track progress toward reliability goals.

Ways to Improve Reliability

As you design your product, you can improve reliability by using the following ideas; note that reliability predictions allow you to quantitatively measure the effects of improvement steps.

Reduce Part Count: In general, reducing part count will increase reliability. You can use innovative design ideas, and more highly integrated functional parts, to reduce the number of parts without affecting circuit performance; part count reduction can also lead to lower cost and less board space required.

Part Selection: The quality and reliability of the components you select for your product is very important; select suppliers that produce high quality, high reliability parts.

Derating: Part failure rates generally decrease as applied stress levels decrease. Thus, derating, or operating the part at levels below it's ratings (for current, voltage, power dissipation, temperature, etc.) can increase reliability. Part derating can be achieved by circuit design (minimize applied part stress), part selection (use part with ratings well above given applied stress), and thermal design (reduce part operating temperature).

Burn-In: Burn-in is operation in your factory, at elevated temperature, to accelerate the rate of infant mortality failures; burn-in allows you to weed out failure prone devices in your factory, rather than in the field. Note that burn-in can be done at the part, board, or system level.

Redundancy: Product reliability may also be enhanced by using redundant design techniques.

How Reliability Can Pay Off

To give you an idea of how the reliability of your product can impact your company's fortunes, consider an example. We will assume: the typical customer operates your product for 300 hours per month; your product warranty is for 1 year; an exponential reliability function. We will tabulate the expected failures of field units in one year, based on product MTBF in hours.

MTBF	Failure Free	Failure
5,000	48.7%	51.3%
10,000	69.8%	30.2%
20,000	83.5%	16.5%
40,000	91.4%	8.6%

Note that at 5,000 hours MTBF, over half of the units can be expected to fail in the one year period. When you consider that every failure costs you repair dollars, and also represents a potentially unhappy customer, you can see how your business literally depends on your product's reliability.

Ways to Do Reliability Prediction

You can use various reliability prediction techniques, depending on your knowledge of the details of your design. An early estimate can be made by comparing your product with products of similar function or complexity, of known reliability; generally, this will be a crude estimate at best, as the many differences in design details between the products are not accounted for.

As more details of your design are known, more accurate methods become available. These methods utilize part failure rate models, which predict the failure rates of parts based on various part parameters, such as technology, complexity, package type, quality level, and stress levels.

Two of the better known failure rate prediction methods are MIL-HDBK-217, and Bellcore. These handbooks offer documented procedures for predicting electronic product reliability, providing a standard basis for comparing reliability numbers.

Limitations of Reliability Prediction

To use quantitative reliability prediction methods such as MIL-HDBK-217 and Bellcore wisely, you should be aware of their limitations. Like all engineering models, the failure rate models are approximations to reality. The failure rate models are based on the best field data that could be obtained for a wide variety of parts and systems; this data is then analyzed and massaged, with many simplifying assumptions thrown in, to create usable models. Then, when you use the model, you make more assumptions for the design parameters you enter, such as stress and temperature.

<u>Thus you should not treat a reliability prediction number for your product as an absolute prediction of it's field failure rate</u>. It is generally agreed that these predictions can be very good when used for relative comparisons, such as comparing design alternatives, or comparing products. Note also that reliability predictions do not account for substandard quality control for purchased parts, bad workmanship, poor product level quality control, overstressed field operation, etc.

Many people get caught up in the numbers game, manipulating the reliability prediction numbers for one purpose or another; you will be best served if you use reliability prediction as one of the tools that can guide you to more reliable products.

Description of Methodology

The parts count method is a technique for developing an estimate or prediction of the average life, the Mean-Time-Between-Failures (MTBF), of an assembly. It is a prediction process whereby a numerical estimate is made of the ability, with respect to failure, of a design to perform its intended function. Once the failure rate is determined, MTBF is easily calculated as the inverse of the failure rate, as follows:.

$$MTBF = \frac{1}{FR_1 + FR_2 + FR_3 + \ldots\ldots\ldots\ldots FR_n}$$

where FR is the failure rate of each component of the system up to n, all components.

The general procedure for determining a board level (or system level) failure rate is to sum individual failure rates for each component. For MIL-HDBK-217, the summation is then added to a failure rate for the circuit board, which includes the affect of solder joints. Component failure rates are provided by MIL-HDBK-217, "Military Handbook, Reliability Prediction of Electronic Equipment", as standard part failure rate models or directly from the manufacturers.

The failure rates presented apply to equipment under normal operating conditions, i.e., with power on and performing its intended function in its intended environment. Consideration is given to various environments, component quality, and thermal aspects.

Reliability Standards

There are several methods and standards that provide the basic core mathematical models for reliability calculations. The standards and a description of each follows.

MIL-HDBK-217

MIL-HDBK-217 is the original standard for reliability calculations. It provides reliability math models for nearly every conceivable type of electronic device. Used by both commercial companies and the defense industry, MIL-HDBK-217 provides detailed reliability equations. MIL-HDBK-217, which is updated regularly, is currently at Revision F Notice 2.

This standard uses a series of models for various categories of electronic, electrical and electro-mechanical components to predict failure rates which are affected by environmental conditions, quality levels, stress conditions and various other parameters. These models are fully detailed in MIL-HDBK-217.

Parts Count

A section of MIL-HDBK-217, known simply as the Parts Count section, provides simpler reliability math models for the various part types. Most of the part parameters requested in the main body of MIL-HDBK-217 (also known as the Part Stress section) are automatically defaulted to average values in the Parts Count section. Parts Count reliability calculations are normally used early in a design when detailed information is not available, or when a rough estimate of reliability is all that is required.

Bellcore

The Bellcore reliability standard, Reliability Prediction Procedure for Electronic Equipment, TR-332, Issue 5, Dec. 95, is a very popular standard for commercial companies. It was originally developed at AT&T Bell Laboratories, and was based on MIL-HDBK-217. Bell Labs modified the equations from MIL-HDBK-217 to provide results which better represented what their equipment was experiencing in the field. They also added the ability to take into account burn-in testing, as well as field and laboratory testing. Bell Communications Research, formed in the divestiture of the former Bell System on January 1, 1984, is now the controlling organization of the Bellcore reliability standard.

Mechanical

The Handbook of Reliability Prediction Procedures for Mechanical Equipment, NSWC-94/L07, provides models for various types of mechanical devices including springs, bearings, seals, motors, brakes, clutches, and much more. This relatively new standard is the only one of its kind - providing detailed reliability math models for mechanical devices. This latest issue date of this mechanical standard is March 1994.

CNET

The CNET reliability standard from France T,l,com is the French reliability standard for telecommunications equipment. CNET, developed in 1983, was originally based on MIL-HDBK-217. The most recent revision of the document, RDF 93, provides many enhancements.

The Equations

A sample calculation for integrated circuits taken from MIL-HDBK-217 is as follows:

Failure Rate = (C1 * PiT + C2 * PiE) * PiQ * PiL

Each factor in this equation is dependent upon a certain part parameter. The end result of this equation is the failure rate of the integrated circuit.

Failure Rate & MTBF

For this discussion, we will assume that the resulting failure rate is shown in failures per million hours. This is simply the number of failures that you would expect to have in a million hours of operation of your equipment. Failure rates for many basic devices are well below 1 failure per million hours, so these values may seem insignificant. But if you have hundreds of parts in your design and have a thousand systems operating in the field, you can see that the failure rates will quickly add up. MTBF, or Mean Time Between Failures, is the inverse of the failure rate and is the average time between failures. It is calculated from the failure rate as follows:

MTBF = 1,000,000/Failure Rate

You can choose the units in which the failure rate is shown. Another common unit used, besides failures/million hours, is failures per billion hours which is sometimes known as FITs.

Bellcore TR332 Device Quality Levels

The device failure rates contained in this document reflect the expected field reliability performance of generic device types. The actual reliability of a specific device will vary as a function of the degree of effort and attention paid by an equipment manufacturer to factors such as device selection/application, supplier selection/control, electrical/mechanical design margins, equipment manufacture process control, and quality program requirements.

The quality levels described below are not intended to characterize or quantify all of the factors that may influence device reliability. They provide an indication of the total effort an equipment manufacturer considers reasonable to expend to control these factors. These quality levels also reflect the scope and depth of the particular equipment manufacturer's component engineering program.

QUALITY LEVEL 0

This level shall be assigned to commercial-grade, reengineered, remanufactured, reworked, salvaged, or gray-market components that are procured and used without device qualification, lot-to-lot controls, or an effective feedback and corrective action program by the primary equipment manufacturer or its outsourced lower-level design or manufacturing subcontractors. However, steps must have been taken to ensure that the components are compatible with the design application.

QUALITY LEVEL I

This level shall be assigned to commercial-grade components that are procured and used without thorough device qualification or lot-to-lot controls by the equipment manufacturer. However, (a) steps must have been taken to ensure that the components are compatible with the design application and manufacturing process; and (b) an effective feedback and corrective action program must be in place to identify and resolve problems quickly in manufacture and in the field.

QUALITY LEVEL II

This level shall be assigned to components that meet requirements (a) and (b) of Quality Level I, plus the following: (c) purchase specifications must explicitly identify important characteristics (electrical, mechanical, thermal, and environmental) and acceptable quality levels (i.e., AQLs, DPMs, etc.) for lot control; (d) devices and device manufacturers must be qualified and identified on approved parts/manufacturer's lists (device qualification must include appropriate life and endurance tests); (e) lot-to-lot controls, either by the equipment manufacturer or the device manufacturer, must be in place at adequate AQLs/DPMs to ensure consistent quality.

QUALITY LEVEL III

This level shall be assigned to components that meet requirements (a) through (e) of Quality Levels I and II, plus the following: (f) device families must be requalified periodically; (g) lot-to-lot controls must include early life reliability control of 100 percent screening (temperature cycling and burn-in), which, if the results warrant it, may be reduced to a “reliability audit” (i.e., a sample basis) or to an acceptable “reliability monitor” with demonstrated and acceptable 11-3umulative early failure values of less than 200 ppm out to 10,000 hours; (h) where burn-in screening is used, the percent defective allowed (PDA) shall be specified and shall not exceed 2%; and (i) an ongoing, continuous reliability improvement program must be implemented by both the device and equipment manufacturers.

Bellcore TR332 Environmental Conditions and Multiplying Factors (π_E)

Ground, Fixed, Controlled G_B, π_E = 1.0
Nearly zero environmental stress with optimum engineering operation and maintenance. Typical applications are central office, environmentally controlled vaults, environmentally controlled remote shelters, and environmentally controlled customer premise areas.

Ground, Fixed, Uncontrolled G_F, π_E = 2.0
Some environmental stress with limited maintenance. Typical applications are manholes, poles, remote terminals, customer premise areas subject to shock, vibration, temperature, or atmospheric variations.

Ground, Mobile (both vehicular mounted and portable) G_M, π_E = 6.0
Conditions more severe than G_F , mostly for shock and vibration. More maintenance limited and susceptible to operator abuse. Typical applications are mobile telephone, portable operating equipment, and test equipment.

Airborne, Commercial A_C, π_E = 10
Conditions more severe than for G_F , mostly for pressure, temperature, shock, and vibration. In addition, the application is more maintenance limited than for G_F . Typical applications are in the passenger compartment of commercial aircraft.

Spacebased, Commercial S_C, π_E = 15
Low earth orbit. Conditions as for A_C, but with no maintenance. Typical applications are commercial communication satellites.

Appendix B

Assembly and Component Failure Data

MTBF Prediction Report

P/N Detail, Sorted by TFR

ASSM, FE1

P/N:

Environment: GB,GC - Ground Benign, Controlled, Temperature: 25°C

Category	P/N	Description	Mfgr. P/N	Ref. Des.	Qty.	FR, Unit	TFR	T Rise (C)	Stress (%)
IC	160-0107	PROC.,PENT,SPGA321,233MHZ	FV8050366-233	U3	1	337.2754	337.2754	62.0	na
Capacitor	110-0127	CAP, 68UF, 6.3V	TAJC686K006R	C117-C174	29	318.8816	10.9959	2.0	79.4
Connector	140-0108	CONN, 352009-1	352009-1	U4	1	225.2175	225.2175	na	na
IC	170-0107	SRAM 256X18	GVT71256E18T-7.5	U10-U26	17	184.4402	10.8494	3.0	na
transistor	157-0105	NCHAN-MOSFET	MMSF5N02HD	M1,M2,M3,M4	4	70.0813	17.5203	10.0	50.0
Fan	218-0101	FAN/ HEATSINK, INTEL PROC.	109P4412H8026	U3	1	50.0000	50.0000	na	na
IC	155-0111	3.3V 18-BIT BIDIREC BFFR/LTCH/REGISTER	IDT74FCT163501CPV	U31,U32,U33,U34	4	41.4066	10.3517	5.0	na
Resistor	100-0123	RES 10 OHM 0805 1/4W	MCR10EZHF10R0	R115-R272,	91	35.7589	0.3930	2.0	50.0
Resistor	100-0124	RES 0805 33.2, 1%, 1/4W	CRCW080533R2FT	R1-R248	84	33.0082	0.3930	2.0	50.0
Capacitor	110-0114	CAP 0.1U SMD0805	CC0805HX7R104K	C1-C66	130	23.2715	0.1790	2.0	10.0
Connector	140-0119	CONN, J1 ASSEMBLY	352068-1	J1,J4	2	20.8623	10.4311	na	na
Resistor	100-0106	RES 10K 0805	9C08052A1002F	R35-R270	49	19.2548	0.3930	2.0	50.0
Resistor	100-0105	RES_0805_1K	9C08052A1001F	R16-R342	46	18.0759	0.3930	2.0	50.0
Resistor	100-0111	RES 22 0805	9C08052A22ROJL	R9-R179	44	17.2900	0.3930	2.0	50.0
Capacitor	110-0118	CAP POLAR 10UF 16V	TAJC106K016R	C141,C142,C166	3	11.7886	3.9295	2.0	50.0
IC	155-0114	16-Bit Non-Inverted Registered XCVR	PI74LPT16952VC	U28,U36	2	10.4277	5.2138	5.0	na
IC	155-0110	3.3V 16-BIT REGISTER	IDT74FCT163374CPV	U7	1	9.2029	9.2029	5.0	na
IC	158-0106	SP232ACN (16PIN SOIC)	SP232ACN (16PIN SOIC)	U2	1	8.4147	8.4147	5.0	na
LED	115-0102	LED_BI_10MA_GG	553-0122-300	D1,D2,D3,D4,D5	5	5.3319	1.0664	3.0	na
Resistor	100-0116	RES 50 0805	9C08052A49R9F	R96-R104,R335-R337	12	4.7155	0.3930	2.0	50.0
Resistor	100-0110	RES 220 OHM 0805	9C08052A2200F	R4,R106-R114	10	3.9295	0.3930	2.0	50.0
IC	155-0112	3.3V & 5V PLL Clock Generators	IDT74FCT388915T-133PY	U29,U30	2	3.5085	1.7542	5.0	na
Connector	157-0112	POWER IC, MIC5158BM	MIC5158BM	U5	1	2.1522	2.1522	10.0	na
Capacitor	110-0108	CAP 0.001U SMD0805	C0805C102K5RAC	C105-C114,C143,C144	12	2.1481	0.1790	2.0	10.0
Connector	140-0104	POSTS 2X5 W SHROUD	103308-1	P1,P2	2	1.8966	0.9483	na	na
Resistor	100-0117	RES 511 0805	9C08052A5110FK	R32,R84,R339,R340	4	1.5718	0.3930	2.0	50.0
Resistor	100-0103	RES ZERO OHM 0805	9C08052A0R00JL	R31,R85,R343,R344	4	0.8206	0.2051	2.0	0.0
IC	175-0105	PAL	EPM7128SQC100-7	U1,U37,U38,U40-U48	12	0.7956	0.0663	3.0	na
IC	175-0101	PLA	EPF10K30BC356-3	U6	1	0.6007	0.6007	3.0	na
IC	175-0123	1024-Bit Serial EEPROM	NM93C46ALM8	U39	1	0.2325	0.2325	3.0	na
IC	175-0104	PLA	EPM7064STC44-7	U8,U9	2	0.1326	0.0663	3.0	na

MTBF Prediction Report

P/N Detail, Sorted by TFR

DS3 PACKET

P/N:
Environment: GB,GC - Ground Benign, Controlled, Temperature: 25^{o}C

Category	P/N	Description	Mfgr. P/N	Ref. Des.	Qty.	FR, Unit	TFR	T Rise (C)	Stress (%)
IC	155-0113	IC,BUS SWITCHS,10 BIT,SO24-9,TSSOP24	IDT74FST3384PG	U58-,U63	6	82.3231	13.7205	5.0	na
Oscillator	150-0104	OSC 44.736mHz VECTRON	HGTCCR44.736	Y1	1	60.0000	60.0000	na	na
Transistor	157-0113	IRL-3103S	IRL-3103S	M3	1	25.7434	25.7434	25.0	50.0
IC	155-0117	DS3/E3/STS-1 Line Interface	78P7200-IH	U30	1	25.4128	25.4128	25.0	na
IC	158-0103	DS3 FRAMER - BROOKTREE	BT8330EPJC	U29	1	25.4128	25.4128	25.0	na
IC	158-0105	DSCC4	PEB20534H52-V20	U52	1	25.4128	25.4128	25.0	na
IC	170-0104	IC, CLK BUFFER, 24 PIN, SOIC	CY7B9910-2SC	U39	1	15.5602	15.5602	3.0	na
Inductive	130-0101	IND_180MA_6P8UH	NL322522T-6R8J	L2	1	14.9323	14.9323	2.0	na
Inductive	130-0102	IND_450MA_OP47UH	NL322522T-R47J	L1	1	14.9323	14.9323	2.0	na
IC	157-0104	DUAL 4 INPUT MUX	MC7153D	U70	1	13.8825	13.8825	5.0	na
IC	157-0109	QUAD OR	MC74F32D	U10	1	13.5515	13.5515	5.0	na
IC	157-0111	IC,QUAD TRI STATE BFFR, 5V,16PIN, SOP	MC74F125D	U76	1	12.3970	12.3970	3.0	na
Resistor	100-0146	RES, 0805, 33.2	CRCW080533R2	R38-R286	31	12.1816	0.3930	2.0	50.0
Inductive	130-0106	CMODE_CHOKE	23Z428SM	L6,L7	2	11.0027	5.5014	2.0	na
Connector	140-0119	CONN, J1 ASSEMBLY	352068-1	J1	1	10.4311	10.4311	na	na
IC	155-0119	FAST CMOS BUF/CLK DRV	74FCT810CTSO20-2	U2	1	8.4644	8.4644	5.0	na
IC	175-0107	EPROM 93C46 (5 VOLT PART)	AT93C46-10SC	U40	1	7.3076	7.3076	5.0	na
IC	155-0128	IC, 5-Tap Silicon Delay Line	DS1000Z-25	U79,U80	2	6.5497	3.2749	3.0	na
Inductive	130-0103	TRANSF_ MINI	ST5045	T1,T2	2	6.4096	3.2048	3.0	na
Resistor	100-0110	RES 220 OHM SMD0805	9C08052A2200F	R4-R67	16	6.2873	0.3930	2.0	50.0
Capacitor	110-0108	CAP .001U SMD0805	C0805C102K5RAC	C47-C169	29	5.1913	0.1790	2.0	10.0
Capacitor	110-0114	CAP .1U SMD0805	CC0805HX7R104K	C11-C165	29	5.1913	0.1790	2.0	10.0
Capacitor	110-0105	CAP__TANT_4P7UF	AVX_TAJD475M050R	C41,C42,C44,C46,C126	5	4.9393	0.9879	3.0	10.0
Capacitor	110-0125	CAP TANT 22UF 25V	TPSD226025R0200	C70,C156,C157	3	4.2056	1.4019	3.0	20.0
Resistor	100-0103	RES_0805_ZERO_OHM	9C08052A0R00JL	R47-R275	11	4.1575	0.3780	0.0	0.0
LED	115-0104	LED, BI 10MA GY	553-0132-300	CR2	1	3.1992	3.1992	3.0	na
Resistor	100-0106	RES_0805_10K	9C08052A1002F	R19-R82	11	2.9266	0.2661	2.0	20.0
Capacitor	110-0104	CAP__TANT_1UF_50V	AVX_TAJC105M050R	C10,C163	2	1.9757	0.9879	3.0	10.0
Resistor	100-0105	RES_0805_1K	9C08052A1001F	R39,R40,R83,R84, R285,R361	6	1.5963	0.2661	2.0	20.0
Resistor	100-0114	RES_0805_422	9C08052A4220F	R1,R193,R194,R198,-R200	6	1.5963	0.2661	2.0	20.0

Appendix C

Manufacturer’s Reliability Data

Reliability Report No. 33

Q2 2000

M-RR-33-01

Lifetest Results

Lifetest Results are reported by Product Family. Where a product family is produced on different wafer fabrication technologies the results are reported separately for each fabrication technology. Within a product family the same logic configuration elements, macrocells, and programmable interconnect are used. The only variable is the size of the product, with each family having 3 to 10 different numbers of macrocells or logic elements. A brief description of the product family and process technology is included in each section.

FLEX 0.5µ./0.42µ Products

FLEX 8000, FLEX 10K, and FLEX 6000 products are fabricated on a 0.5µ process technology or a linear shrink 0.42µ feature size on the same process technology. This technology supports 3 layers of metallization. Lifetests are conducted at 6.0V, which is a 20% overvoltage.

FLEX 0.5µ./0.42µ Lifetest Results

REL LOT #	DEVICE	PACKAGE TYPE	TA	# UNITS	L.T. HOURS	# FAIL		DEVICE HOURS	Dielectric EQUIV. HRS.
2262A	EPF10K100	503L PGA	130	22	1996	0		43912	8.50E+06
2495A	EPF10K10	208L PQFP	120	45	2025	0		91125	2.86E+07
2336A	EPF10K50	356L BGA	125	25	2070	1	**a**	51750	9.48E+05
2346A	EPF10K50 *	240L RQFP	125	45	2000	0		90000	1.53E+07
2361A	EPF10K50 *	240L RQFP	130	45	2003	0		90135	1.97E+07
2436A	EPF10K50 *	240L RQFP	125	45	2005	0		90225	1.53E+07
2366A	EPF10K50 *	240L RQFP	125	45	2019	0		90855	1.54E+07
2273	EPF10K70	240L RQFP	130	20	1997	0		39940	6.68E+06
2325A	EPF10K70	240L RQFP	125	45	2001	0		90045	1.17E+07
2467A	EPF6016 *	208L PQFP	125	45	1997	0		89865	2.54E+07
2420A	EPF6016	208L PQFP	120	45	2041	1	**b**	91845	2.00E+07
2202A	EPF81188A	240L PQFP	130	22	1991	0		43802	2.42E+07
2384A	EPF81188A	240L RQFP	130	45	1998	0		89910	6.94E+07
2281A	EPF8820A	144L TQFP	130	45	2009	0		90405	4.63E+07
Totals						2		1.08E+06	3.07E+08

Activation Energy / Failure Mechanism	**# Fail**	**Chi Sq.**	**Equiv. Hrs.**	**FITs @ 55C**
Dielectric Breakdown	2	6.21	3.07E+08	**10.1**

a - Ram failure, non visual defect, 500hrs.
b - Functional failure, due to oxide breakdown, 480 hrs.

* 0.42µ Feature Size

FLEX 0.3/0.35µ Products

FLEX 10KA and FLEX 6000A products are fabricated on a 0.3/0.35µ process technology that supports up to 4 layers of metallization. The process technology operates with a 3.3V supply voltage and has I/O's that are 2.5V and 5.0V tolerant. Devices are available in TQFP, QFP, RQFP, FBGA and BGA packages with logic density ranging from 576 LEs to 12,160 LEs. Lifetests are conducted at 4.0V, which is a 20% overvoltage.

FLEX 0.3/0.35µ Lifetest Results

REL LOT #	DEVICE	PACKAGE TYPE	TA	# UNITS	L.T. HOURS	# FAIL		DEVICE HOURS	Dielectric EQUIV. HRS.	Pkg. Fail. EQUIV. HRS.
2291A	EPF10K100A	240L RQFP	130	22	2007	0		44154	6.12E+07	1.41E+07
2213A	EPF10K100A	240L RQFP	130	45	1983	1	**c**	89235	1.24E+08	2.84E+07
2264A	EPF10K100A	240L RQFP	130	45	1990	1	**d**	89550	1.24E+08	2.85E+07
2267A	EPF10K100A	240L RQFP	130	45	2046	0		92070	1.28E+08	2.93E+07
2501A	EPF10K100A	240L RQFP	125	25	1998	0		49950	5.39E+07	1.11E+07
2404A	EPF10K100A	356L BGA	125	25	2004	0		50100	4.71E+07	9.16E+06
2276C	EPF10K100A	484L FBGA	130	22	1824	0		40128	3.59E+07	6.83E+06
2337A	EPF10K100A	600L BGA	125	25	2001	1	**e**	50025	5.15E+07	1.04E+07
2122A	EPF10K130V	599L PGA	130	22	1997	0		43934	6.38E+07	1.49E+07
2256A	EPF10K30A	484L FBGA	125	36	1109	0		39924	5.78E+07	1.35E+07
2256F	EPF10K30A	484L FBGA	125	41	1502	0		61582	8.91E+07	2.09E+07
2256F	EPF10K30A	484L FBGA	125	41	2051	0		84091	1.22E+08	2.85E+07
2351A	EPF10K30A	484L FBGA	125	25	2047	0		51175	7.41E+07	1.73E+07
2397A	EPF10K50V	240L PQFP	130	45	2064	1	**f**	92880	8.51E+07	1.64E+07
2217A	EPF10K50V	240L RQFP	130	45	2013	0		90585	1.47E+08	3.62E+07
2260A	EPF10K50V	240L RQFP	130	45	1992	0		89640	1.46E+08	3.59E+07
2206A	EPF10K50V	240L RQFP	130	45	1997	0		89865	1.46E+08	3.60E+07
2193A	EPF10K50V	240L RQFP	130	45	2050	0		92250	1.50E+08	3.69E+07
2179A	EPF10K50V	240L RQFP	130	45	2007	0		90315	1.47E+08	3.61E+07
2211A	EPF10K50V	356L BGA	130	45	1996	0		89820	1.32E+08	3.12E+07
2189	EPF6016A	144L TQFP	130	77	1993	0		153461	2.97E+08	7.87E+07
2355A	EPF6016A	144L TQFP	120	45	2053	0		92385	1.08E+08	2.32E+07
2222A	EPF6024A	208L PQFP	130	45	2036	0		91620	1.93E+08	5.31E+07
2263A	EPF6024A	208L PQFP	130	45	1033	0		46485	9.80E+07	2.69E+07
2350A	EPF6024A	208L PQFP	125	45	2002	0		90090	1.48E+08	3.64E+07
2460	EPF6024A	208L PQFP	125	100	164	0		16400	2.69E+07	6.63E+06
						4		1.91E+06	2.86E+09	6.87E+08

Activation Energy / Failure Mechanism	# Fail	Chi Sq.	Equiv. Hrs.	FITs @ 55C
Dielectric Breakdown	1	4.04	2.86E+09	**0.7**
Package Failure(Ea=1.0,C=0)	3	8.35	6.87E+08	**6.1**
Combined Failure Rate				**6.8**

c - Input/output short, due to shorted package leadframe, 168 hrs.

d - Functional failure, due to oxide breakdown, 42 hrs.

e - RAM failure, non-visual defect, 408 hrs.

f - Input Short, non visual defect, 2064 hrs.

FLEX and APEX 0.22/0.25µ Products

FLEX 10KB, 10KE, and APEX 20K products are fabricated on a 0.22/0.25µ process technology that supports up to 5 layers of metallization. Devices are available in TQFP, QFP, RQFP, FBGA and BGA packages with logic density ranging from 1728 LEs to 16,640 LEs. The process technology operates with a 2.5V supply. Lifetests are conducted at 3.0V, which is a 20% overvoltage

FLEX and PEX 0.22/0.25µ Lifetest Results

REL LOT #	DEVICE	PACKAGE TYPE	TA	# UNITS	L.T. HOURS	# FAIL		DEVICE HOURS	Dielectric EQUIV. HRS.
2422A	EP20K100	240L PQFP	125	25	2016	0		50400	4.41E+07
2456A	EP20K400	652L BGA	125	25	2009	0		50225	1.61E+07
2288B	EPF10K100B	208L PQFP	130	22	1996	0		43912	6.32E+07
2309A	EPF10K100B	208L PQFP	130	24	2048	0		49152	7.08E+07
2220A	EPF10K100B	240L PQFP	130	22	2021	1	**g**	44462	6.40E+07
2324A	EPF10K100B	240L PQFP	125	45	2003	0		90135	1.01E+08
2329A	EPF10K100B	240L PQFP	125	45	2015	1	**h**	90675	1.01E+08
2284A	EPF10K100B	256L FBGA	130	25	1045	0		26125	3.14E+07
2415A	EPF10K100E	240L RQFP	125	25	2008	0		50200	4.63E+07
2446A	EPF10K100E	240L RQFP	125	24	1999	0		47976	4.43E+07
2388A	EPF10K130E	240L PQFP	125	24	1996	0		47904	5.48E+07
2413A	EPF10K130E	240L PQFP	125	25	2010	0		50250	5.75E+07
2445A	EPF10K130E	240L PQFP	125	25	2063	0		51575	5.90E+07
2301	EPF10K50E	240L PQFP	130	25	2008	0		50200	9.30E+07
2378A	EPF10K50E	240L PQFP	125	45	1997	0		89865	1.29E+08
						2		8.33E+05	9.76E+08

Activation Energy / Failure Mechanism	# Fail	Chi Sq.	Equiv. Hrs.	FITs @ 55C
Dielectric Breakdown	2	6.21	9.76E+08	**3.2**

g - Functional failure, due to a tungsten particle, 162 hrs

h - Lookup table Failure, non-visual defect, 1060hrs.

MAX 7000S and MAX 9000 - Third Generation

These MAX 7000 and MAX 9000 products are fabricated on a 0.5µ triple layer metal CMOS EEPROM process. Devices are available in logic densities from 32 to 560 macrocells and in PLCC, TQFP, PQFP, RQFP, and PGA packages. Lifetests are conducted at 6.0V, which is a 20% overvoltage.

Third Generation MAX 7000 & MAX 9000 Lifetest Results

REL LOT#	DEVICE	PACKAGE TYPE	TA	# UNITS	L.T. HOURS	# Fail		DEVICE HOURS	Dielectric Equiv. Hrs.	C.L. Equiv Hrs.
2274A	EPM7032S	44L PLCC	120	77	2032	0		156464	9.45E+07	4.22E+06
2367A	EPM7032S	44L TQFP	120	77	1992	0		153384	9.61E+07	4.27E+06
2269A	EPM7064S	44L PLCC	120	77	1976	0		152152	9.76E+07	4.32E+06
2233A	EPM7064S	44L TQFP	120	77	2088	0		160776	9.85E+07	4.39E+06
2234A	EPM7128E	100L TQFP	120	77	2007	0		154539	3.17E+07	1.65E+06
2250A	EPM7128E	160L PQFP	120	45	2004	0		90180	5.14E+07	2.32E+06
2363A	EPM7128S	100L PQFP	120	77	2004	0		154308	7.82E+07	3.58E+06
2313	EPM7128S	84L PLCC	120	60	1000	0		60000	3.42E+07	1.54E+06
2314	EPM7128S	84L PLCC	120	60	1000	0		60000	3.42E+07	1.54E+06
2315	EPM7128S	84L PLCC	120	60	1000	0		60000	3.42E+07	1.54E+06
2334A	EPM7128S	84L PLCC	120	77	1997	0		153769	8.77E+07	3.95E+06
2371A	EPM7128S	84L PLCC	120	77	2068	0		159236	9.08E+07	4.09E+06
2437A	EPM7128S	84L PLCC	125	77	2001	0		154077	1.10E+08	4.78E+06
2257A	EPM7160E	84L PLCC	120	77	2003	0		154231	1.98E+07	1.11E+06
2470A	EPM7192S	160L PQFP	125	45	1001	2	**I**	45045	4.64E+06	2.67E+05
2343A	EPM7256S	208L PQFP	120	44	2002	0		88088	1.87E+07	9.70E+05
2403A	EPM7256S	208L PQFP	125	45	2010	0		90450	2.44E+07	1.22E+06
2200A	EPM9320A	208L RQFP	120	45	2002	0		90090	2.41E+07	1.21E+06
2466A	EPM9320A	208L RQFP	125	45	2094	0		94230	3.22E+07	1.56E+06
2356A	EPM9560A	208L RQFP	120	45	1998	0		89910	2.43E+07	1.22E+06
2465A	EPM9560A	356L BGA	125	24	2094	0		50256	1.36E+07	6.81E+05
Totals						2		2.37E+06	1.10E+09	5.04E+07

Activation Energy / Failure Mechanism	# Fail	Chi Sq.	Equiv. Hrs.	FITs
Dielectric Breakdown	0	1.83	1.10E+09	**0.8**
0.6eV / Charge Loss	2	6.21	5.04E+07	**61.6**
Combined Failure Rate				**62.4**

I - 2 parametric failures due to charge loss, 1001hrs

MAX 7000A - Fourth Generation

The MAX 7000A products are fabricated on a 0.35µ CMOS EEPROM process. This process supports up to four layers of metallization, which supports a 3.3V operating voltage. Devices are available in logic densities from 32 to 512 macrocells and in PLCC, TQFP, PQFP, BGA, and FBGA packages. Lifetests are conducted at 4.0V, which is a 20% overvoltage.

Fourth Generation MAX 7000 Lifetest Results

REL LOT#	DEVICE	PACKAGE TYPE	TA	# UNITS	L.T. HOURS	# Fail		DEVICE HOURS	Dielectric Equiv. Hrs.
2405A	EPM3256A	144L TQFP	125	70	2006	0		140420	1.95E+07
2405B	EPM3256A	144L TQFP	125	35	2032	0		71120	1.21E+07
2332A	EPM7032AE	44L PLCC	120	77	2004	0		154308	2.89E+07
2332C	EPM7032AE	44L PLCC	120	45	2063	0		92835	1.74E+07
2448A	EPM7032AE	44L TQFP	125	77	2000	0		154000	3.51E+07
2285A	EPM7064AE	44L PLCC	120	77	487	0		37499	5.31E+06
2285A	EPM7064AE	44L PLCC	120	77	2023	0		155771	2.21E+07
2285C	EPM7064AE	44L PLCC	120	77	559	0		43043	6.10E+06
2285C	EPM7064AE	44L PLCC	120	77	2000	0		154000	2.18E+07
2210A	EPM7128A	100L TQFP	120	77	2000	0		154000	1.93E+07
2344A	EPM7128A	100L TQFP	120	77	1495	0		115115	1.44E+07
2344A	EPM7128A	100L TQFP	120	77	1995	0		153615	1.92E+07
2268A	EPM7128A	144L TQFP	120	45	2002	0		90090	1.32E+07
2268C	EPM7128A	144L TQFP	120	69	2020	0		139380	2.04E+07
2268J	EPM7128A	144L TQFP	120	35	2037	0		71295	1.05E+07
2386A	EPM7128A	144L TQFP	120	45	2048	0		92160	1.35E+07
2517A	EPM7128A	144L TQFP	120	45	2006	0		90270	1.32E+07
2194A	EPM7128A	84L PLCC	120	77	2154	0		165858	2.36E+07
2194B	EPM7128A	84L PLCC	120	77	2034	0		156618	2.23E+07
2223A	EPM7128A	84L PLCC	120	77	2008	0		154616	2.20E+07
2223B	EPM7128A	84L PLCC	120	77	2066	0		159082	2.27E+07
2401A	EPM7128A	84L PLCC	125	77	1981	0		152537	2.78E+07
2401B	EPM7128A	84L PLCC	125	77	2002	0		154154	2.81E+07
2266A	EPM7256A	144L TQFP	120	45	2010	0		90450	6.10E+06
2266C	EPM7256A	144L TQFP	120	45	1530	0		68850	4.64E+06
2266C	EPM7256A	144L TQFP	120	45	2017	0		90765	6.12E+06
2230A	EPM7256A	208L PQFP	120	45	2005	0		90225	5.67E+06
2230C	EPM7256A	208L PQFP	120	22	2016	0		44352	2.79E+06
2293A	EPM7256A	208L PQFP	120	45	2007	0		90315	5.67E+06
2478A	EPM7256A	256L BGA	125	25	2016	0		50400	5.23E+06
2349A	EPM7256A	256L FBGA	120	45	1008	0		45360	2.95E+06
2349A	EPM7256A	256L FBGA	120	45	1526	0		68670	4.47E+06
2381A	EPM7256A	256L FBGA	120	45	997	0		44865	2.92E+06
2316A	EPM7512AE	208L PQFP	120	21	2033	1	J	42693	2.69E+06
2316C	EPM7512AE	208L PQFP	120	24	1995	0		47880	2.95E+06
2353A	EPM7512AE	208L PQFP	120	45	1501	0		67545	4.17E+06
2353A	EPM7512AE	208L PQFP	120	45	2013	0		90585	5.59E+06
2369A	EPM7512AE	208L PQFP	120	35	2018	0		70630	4.36E+06
2374B	EPM7512AE	208L PQFP	120	45	163	0		7335	4.52E+05
2374B	EPM7512AE	208L PQFP	120	45	2032	0		91440	5.64E+06
2452A	EPM7512AE	208L PQFP	125	35	2000	0		70000	5.49E+06
2402A	EPM7512AE	256L BGA	125	25	2048	0		51200	5.17E+06
2383A	EPM7512AE	256L FBGA	120	38	2009	0		76342	5.70E+06
Totals						1		4.15E+06	5.28E+08

Activation Energy / Failure Mechanism	**# Fail**	**Chi Sq.**	**Equiv. Hrs.**	**FITs**
Dielectric Breakdown	1	4.04	5.28E+08	**3.8**

J - Intermetatic leakage failure, 168hrs.

ZT 6301

150 WATT HOT SWAP AC POWER SUPPLY

CompactPCI®

Load sharing AC input power supply provides 150 watts in a modular 3U format.

The ZT 6301 hot swap AC power supply is a highly-reliable modular package designed for AC power input systems. These highly dense, redundant supplies are ideally suited for telecommunications, industrial automation and a variety of embedded computer applications requiring CompactPCI® 3U form factor.

The universal input voltage range is 90 to 254VAC @47-63 Hz with power factor correction. Four outputs are capable of providing a total of 150 watts for +3.3VDC, +5VDC, and±12VDC with independent output regulation. The low cost units meet the electrical and mechanical requirements of the PICMG® specification for CompactPCI systems.

The ZT 6301 power supply uses a DIN power connector to provide efficient, effective DC sources that meets UL, CSA, IEC, TUV and CE certifications.

The ZT 6311 150 Watt Hot Swap DC Power Supply is the DC power supply alternative.

- **Hot swap N+1 sharing**
- **DIN input/output connector**
- **Protection features:**
  - **-Overvoltage**
  - **-Short circuit—all outputs**
  - **-Overtemperature protecton**
- **Status LEDs—Fault, Input OK**
- **Status signals—(DEG#), (FAL#)**
- **Main output remote sense (+3.3V, +5V)**
- **Built-in EMI filter**
- **Eurorack-compatible module**
- **Front drawer-style handle**

ZIATECH CORPORATION

150 WATT HOT SWAP AC POWER SUPPLY

CompactPCI®

Environmental

Operating Temperature	0° to 70° Celsius
Storage Temperature	-40° to +85° Celsius
Non-Condensing Relative Humidity	less than 95% at 40° Celsius

Specifications

The ZT 6301 is compliant with the following specification:

- CompactPCI Specification, PICMG 2.0, ver 2.1

Electrical

Input Specifications

Input Voltage Range: 90-254VAC

Input Filter Type: .... Common and Differential mode

Input Frequency Range

.... AC: 47 to 63 Hz

Input Current

Maximum Continuous:2.2A@115VAC

Single Cycle, Surge Max.: .... <10A

Power Factor: .... Yes, >.99

Output Specifications

Total Voltage Accuracy (load, cross and line regulation across temperature):

+3.3V* @ 20A .... ±2%

+5V @ 25A (2A minimum)* .... ±2%

+12V @ 5.5A .... ±2%

-12V @ 0.5A .... ±4%

* Combined current not to exceed 25A.

Total Output Power (max. continuous @ 30° C): 150W

Ripple and Noise (measured at full load with 20 MHz bandwidth and 22 µF capacitor at load, or 50mV, whichever is greater):

+3.3V .... <1.0% P-P

+5V .... <1.0% P-P

+12V .... <1.0% P-P

-12V .... <1.0% P-P

Short Circuit Protection: Auto recovery

Overvoltage Protection (+3.3V, +5V):

.... 135% maximum

Hold-Up Time: ...... 12ms @ 90V input (full load)

General Specifications

Efficiency: ...... >69% at 20 to 80% max. load

Environmental Specifications

Overtemp Shutdown: .... yes, with output shutdown

Cooling Requirement:

Note: Cooling requirements at sea level.

See Figure 2.

Shock and Vibration (pending): MIL-STD-810E

Vibration, Operating (pending): .... 20 to 2000 Hz @ 0.01g²/Hz

Vibration, Non-Operating (pending): 20 to 2000 Hz @ 0.01g²/Hz

Shock, Operating: .... 15g @ 3ms

Shock, Non-Operating: 2.48lbs @ 6ms

Altitude: .... 21,000 feet (6.4 Km)

Note: Derate output load in Figure 2 by 15% per 6,000 feet.

Weight: .... 2.48 lbs (1.12 Kg)

Agency Approvals

Note: Always connect chassis ground (CG) on the supply to earth ground through a low impedance path.

- Safety Agencies: Most models are approved to UL 1950; CSA 22.2 #234; IEC 950 and TUV EN60950, Class 1 SELV., CE 72/23/EEC/93/68EEC (low voltage directive)
- Conducted RFI: Meets FCC Part 15, Subpart J, Class A; EN55022 Class B; CISPR 22 Class B
- Leakage current is <1.5mA @ 120VAC, 60 Hz and <3mA @ 240VAC, 50 Hz

Reliability

- MTBF: 450,000 hours (per MIL-HDBK-217E)
- MTTR: one minute (based on module replacement)

Ordering Information

ZT 6301	150W Hot Swap AC Power Supply

ZIATECH CORPORATION

150 WATT HOT SWAP DC POWER SUPPLY

CompactPCI®

The Ziatech ZT 6311 Hot Swap DC Power Supply is a highly reliable modular package designed for DC power input systems. These highly dense, redundant supplies are ideally suited for telecommunications, industrial automation and a variety of embedded computer applications requiring CompactPCI® 3U form factor.

The input voltage range is 36 to 72VDC. Four outputs are capable of providing a total of 150W for +3.3VDC, +5VDC and ±12VDC with independent output regulation. The low cost units meet the electrical and mechanical requirements of the PICMG® specification for CompactPCI systems.

The ZT 6311 power supply uses a DIN power connector to provide efficient, effective DC sources that meets UL, CSA, IEC, TUV and CE certification.

The ZT 6301 150 Watt Hot Swap AC Power Supply is the AC power supply alternative.

Load sharing DC input power supply provides 150 watts in a modular 3U format.

- **Hot swap N+1 sharing**
- **DIN input/output connector**
- **Protection features:**
  - **-Overvoltage**
  - **-Short circuit—all outputs**
  - **-Overtemperature protection**
- **Status LEDs—Fault, Input OK**
- **Status signals—(DEG#), (FAL#)**
- **Main output remote sense (+3.3V, +5V)**
- **Built-in EMI filter**
- **Eurorack-compatible module**
- **Front drawer-style handle**

ZIATECH CORPORATION

150 WATT HOT SWAP DC POWER SUPPLY

CompactPCI®

Environmental

Operating Temperature	0° to 70° Celsius
Storage Temperature	-40° to +85° Celsius
Non-Condensing Relative Humidity	less than 95% at 40° Celsius

Specifications

The ZT 6311 is compliant with the following specification:

- CompactPCI Specification, PICMG 2.0, ver. 2.1

Electrical

Input Specifications

Input Voltage Range: 36-72VDC

Input Filter Type: .... Common and Differential mode

Input Current

Maximum Continuous: 230W

Cold Start, Surge Maximum: 10A

(typically 110% of the static source current, lasting <20ms)

Output Specifications

Total Voltage Accuracy (load, cross and line regulation across temperature):

+3.3V* @ 20 A .... ±2%

+5V @25A (2A minimum)* .... ±2%

+12V @ 5.5A .... ±2%

-12V @ 0.5A .... ±4%

* Combined current not to exceed 25A.

Total Output Power (max. continuous @ 35° C with 15cfm): 150W

Ripple and Noise (measured at full load with 20 MHz bandwidth and 22 µF capacitor at load, or with 50mV, whichever is greater):

+3.3V .... <1.0% P-P

+5V .... <1.0% P-P

+12V .... <1.0% P-P

-12V .... <1.0% P-P

Short Circuit Protection: Auto recovery

Overvoltage Protection (+3.3V, +5V): .... 135% maximum

General Specifications

Efficiency:>69% at 20 to 80% max. load

Environmental Specifications

Overtemp Shutdown: ....

yes, with output shutdown

Cooling Requirement:

Note: Cooling requirements at sea level.

See Figure 2.

Shock and Vibration (pending): MIL-STD-810E

Vibration, Operating (pending): ....

20 to 2000 Hz @ 0.01g²/Hz

Vibration, Non-Operating (pending):

20 to 2000 Hz @ 0.01g²/Hz

Shock, Operating: .... 15g @ 3ms

Shock, Non-Operating: 2.48lbs @ 6ms

Altitude: .... 21,000 feet (6.4 Km)

Note: Derate output load in Figure 1 by 15% per 6,000 feet.

Weight: .... 2.48 lbs (1.12 Kg)

Agency Approvals

Note: Always connect chassis ground (CG) on the supply to earth ground through a low impedance path.

- Safety Agencies: Most models are approved to UL 1950; CSA 22.2 #234; IEC 950 and TUV EN60950, Class 1 SELV., CE 72/23/EEC/93/68EEC (low voltage directive)
- Conducted RFI: Meets FCC Part 15, Subpart J, Class A; EN55022 Class B; CISPR 22 Class B

Reliability

- MTBF: 450,000 hours (MIL-HDBK-217E)
- MTTR: One minute (based on module replacement)

Ordering Information

ZT 6311	150W Hot Swap DC Power Supply

ZIATECH CORPORATION

ANALOG DEVICES

ADI Quality Systems

How to search for Process Technology Data

Having found the Process Technology of the device you are looking for from the PRODUCT CROSS REFERENCE, please select the Process Technology of interest in the table below.

PLEASE NOTE:
Where a device of interest is not sampled, it is valid to use the reliability data of the particular process technology to which the part belongs, since all parts within the same family are designed to the same rules and manufacturing is controlled by SPC.

ADI Overall Life-Test Data Summary

Overall Sample Size	48563
Total Qty. Fail	27
Total Device Hrs.	46094550
Equivalent Device Hrs. @ 55° C	5318469372
FIT Rate (55° C, 60% CL)	5
MTTF (55° C, 60% CL)	183268464
FIT Rate (55° C, 90% CL)	7
MTTF (55° C, 90% CL)	152133345

Calculation assumes 0.7eV Activation Energy

Details of Reliability Calculations

Life-Test Data Summary by Process Technology

Process Technology	Brief Technology Description	S-Size	Qty Fail	Total Device Hrs	FIT Rate 55C 60% CL	MTTF 55C 60%CL	FIT Rate 55C 90%CL	MTTF 55C 90%CL
BiCMOS	Bipolar + CMOS with minimum MOSFET feature size greater than 0.6um	13726	14	13415474	10	102934128	12	80074263
Bipolar <2.5um^2	Minimum emitter area <2.5um^2	3166	1	3122500	4	257661841	7	133961674
Bipolar >2.5um^2	Minimum emitter area >2.5um^2	10152	2	9578048	4	273435337	6	159539521
CMOS 0.35um	Minimum MOSFET gate length 0.35um	111	0	55500	64	15627147	161	6218655
CMOS 0.5um	Minimum MOSFET gate length 0.5um	1249	1	1363000	14	70455943	27	36630943
CMOS 0.6um	Minimum MOSFET gate length 0.6um	8381	2	8764000	4	273570849	6	159618588
CMOS 0.8 - 2.0um	Minimum MOSFET gate length 0.8 - 2.0um	7298	1	5534038	3	303100483	6	157585804
CMOS >2.0um	Minimum MOSFET gate length >2.0um	4480	6	4261990	10	97680383	15	68099864

FAIRCHILD
SEMICONDUCTOR

Fairchild Semiconductor Product Reliability (FIT)

Calculated using Arrhenius Equation with Ea = 0.7eV and Ta = 55C

FIT levels calcualted with 12 months data, up to/including month shown

PRODUCT FAMILY		9710	9711	9712	9801	9802
FAST	SAMPLE SIZE AT FIRST TIME POINT	3280	3200	2820	2740	2060
	TOTAL ACCELERATED DEVICE HOURS	231278942.8	225043664.5	201910782.0	195675503.7	155645017.0
	TOTAL REL REJECTS	0	0	0	0	0
	FITS (60%)	3.96	4.07	4.54	4.68	5.89
	FITS (90%)	9.96	10.23	11.40	11.77	14.79
AS/ALS	SAMPLE SIZE AT FIRST TIME POINT	4422	4342	3362	3282	2702
	TOTAL ACCELERATED DEVICE HOURS	571924896.6	565689618.3	416228352.6	409993074.3	349800660.4
	TOTAL REL REJECTS	0	0	0	0	0
	FITS (60%)	1.60	1.62	2.20	2.24	2.62
	FITS (90%)	4.03	4.07	5.53	5.62	6.58
LS/S/TTL	SAMPLE SIZE AT FIRST TIME POINT	3718	3558	3218	3138	2758
	TOTAL ACCELERATED DEVICE HOURS	342175738.8	329705182.2	286944672.9	280709394.6	246558069.3
	TOTAL REL REJECTS	0	0	0	0	0
	FITS (60%)	2.68	2.78	3.19	3.26	3.72
	FITS (90%)	6.73	6.98	8.02	8.20	9.34
ABT	SAMPLE SIZE AT FIRST TIME POINT	790	790	690	690	690
	TOTAL ACCELERATED DEVICE HOURS	62271724.4	62271724.4	46683528.7	46683528.7	46683528.7
	TOTAL REL REJECTS	0	0	0	0	0
	FITS (60%)	14.72	14.72	19.63	19.63	19.63
	FITS (90%)	36.98	36.98	49.32	49.32	49.32

RELIABILITY MONITOR

DS1000M-25 FEB '98 MONITOR-OMEDATA

DEVICE	**REVISION**	**DATE CODE**	**LOT NUMBER**	**PACKAGE**	**ASSEMBLY SITE**
DS1000	E3	9750	DD740614ABA	8 PIN PDIP	OMEDATA

PROCESS Single Poly, Single Metal 1.2 µ Standard Process

Summary Data with Chi-Square Distribution Assumed.
Stress Ambient Temperature and Voltage to
Field Ambient Temperature And Voltage

Cf: 60% Tuse: 55 °C
Ea: 0.7 Vuse: 5.5 Volts
β: 1

JOB NO	DESCRIPT	CONDITION		QUANTITY	READPOINT	UNITS	NO OF FAILS
P21467	INFANT LIFE	125°C, 7.0 VOLTS		234	48	HOUR	0
P21488	HIGH VOLTAGE LIFE	125°C, 7.0 VOLTS		77	336	HOUR	0
		125°C, 7.0 VOLTS		77	1000	HOUR	0
		TOTALS:	FAIL RATE (Fits):	30	DEVICE HRS:	3.08E+07	0
P21489	TEMP CYCLE	-55 TO 125°C		40	300	CYCL	0
				40	1000	CYCL	0
		TOTAL:					0
P21490	BIASED MOISTURE	85/85, 5.5 VOLTS		77	274	HOUR	0
				77	959	HOUR	0
		TOTAL:					0
P21491	AUTOCLAVE	121°C STEAM, UNBIASED		40	96	HOUR	0
		TOTAL:					0

RELIABILITY DATA
LT1020 / LT1120 / LT1121 / LT1129
12/28/99

• OPERATING LIFE TEST

PACKAGE TYPE	SAMPLE SIZE	OLDEST DATE CODE	NEWEST DATE CODE	K DEVICE HOURS (1) AT +125°C	NUMBER OF (2) FAILURES
CERDIP	540	8601	9407	1,669.74	0
PLASTIC DIP	1,038	8601	9805	1,354.89	0
SOIC/SOT/MSOP	386	9201	9404	1,632.16	0
SSOP/TSSOP	162	9901	9903	199.59	0
TO-92	199	9325	9433	613.49	0
	2,325			5,469.87	0

• HIGHLY ACCELERATED STRESS TEST AT +131°C/85%RH

PACKAGE TYPE	SAMPLE SIZE	OLDEST DATE CODE	NEWEST DATE CODE	K DEVICE HOURS AT +85°C (4)	NUMBER OF FAILURES
SOIC/SOT/MSOP	169	9221	9437	139.32	0
TO-92	139	9225	9439	106.32	0
	308			245.64	0

• PRESSURE COOKER TEST AT 15 PSIG, +121°C

PACKAGE TYPE	SAMPLE SIZE	OLDEST DATE CODE	NEWEST DATE CODE	K DEVICE HOURS	NUMBER OF FAILURES
PLASTIC DIP	3,466	9119	9903	115.16	0
SOIC/SOT/MSOP	15,416	9119	9935	918.65	0
SSOP/TSSOP	1,041	9841	9935	223.51	0
DD PACK	550	9305	9937	20.40	0
TO-220	395	9228	9932	17.32	0
TO-92	686	9225	9636	27.62	0
	21,554			1,322.65	0

• TEMP CYCLE FROM -65°C to +150°C

PACKAGE TYPE	SAMPLE SIZE	OLDEST DATE CODE	NEWEST DATE CODE	K DEVICE CYCLES	NUMBER OF FAILURES
CERDIP	30	9130	9418	3.00	0
PLASTIC DIP	895	9207	9852	89.50	0
SOIC/SOT/MSOP	9,755	9226	9935	2,138.21	0
SSOP/TSSOP	851	9841	9935	493.31	0
DD PACK	3,850	9531	9911	385.00	0
TO-220	600	9306	9725	75.00	0
TO-92	345	9225	9636	42.50	0
	16,326			3,226.52	0

• THERMAL SHOCK FROM -65°C to +150°C

PACKAGE TYPE	SAMPLE SIZE	OLDEST DATE CODE	NEWEST DATE CODE	K DEVICE CYCLES	NUMBER OF FAILURES
CERDIP	30	9130	9418	0.45	0
PLASTIC DIP	912	9207	9852	91.20	0
SOIC/SOT/MSOP	4,739	9239	9923	991.78	0
SSOP/TSSOP	610	9841	9903	475.15	0
DD PACK	933	9350	9919	103.30	0
TO-220	450	9546	9928	45.00	0
TO-92	50	9539	9539	5.00	0
	7,724			1,711.88	0

(1) Assumes Activation Energy = 1.0 Electron Volts
(2) Failure Rate Equivalent to +55°C, 60% Confidence Level = 0.34 FITS
(3) Mean Time Between Failures in Years = 335,521
(4) Assumes 20X Acceleration from 85C to +131C
Note: 1 FIT = 1 Failure in One Billion Hours.