PR-1

High-Reliability Rugged Plastic

In response to the increasing demand for plastic packaged products for use in critical applications, Maxim has developed a high-reliability screening flow for plastic encapsulated packages, including SOICs. Products screened to this flow can be used in high-reliability applications where hermetically sealed devices, screened to MIL-STD-883, may not be justified. SOICs with full burn-in and screening not only offer excellent reliability, but also save valuable PC board space. This screening includes many of the requirements common to –883 devices, such as burn-in at +125°C and electrical screening at -55°C to +125°C.

Benefits of Rugged Plastic Screening

The primary objective of the rugged plastic screening flow is to eliminate as many infant mortality failures as possible. All processes have an inherent failure rate, which is arrived at once the infant mortality failures are removed from the overall population. These two failure-rate components are shown graphically on the classic bathtub curve (Figure 1).

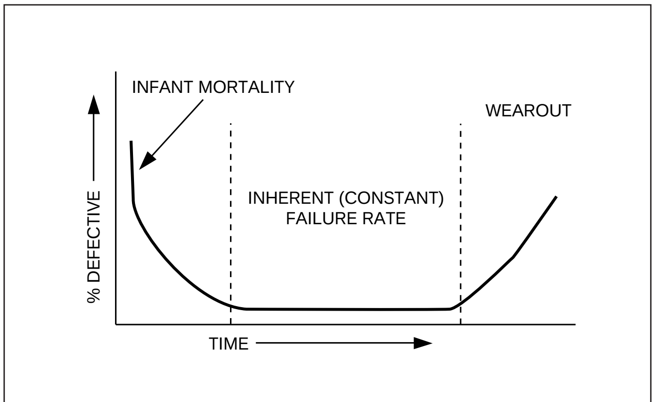

Figure 1. Bathtub Curve

Infant mortalities must be detected before the device population reaches the constant failure rate. Infant mortalities are always defect related; in other words, they occur when the component contains some substandard element that shortens its life span. The constant failure rate is defined as the percentage of product failures that occurs during the time period when failures are generally attributed to statistical chance rather than infant mortality or product wearout. For most semiconductors, wearout does not occur until the product becomes obsolete or for other reasons (usually after 10-15 years).

Table 1 illustrates Maxim's estimate of our inherent (constant) failure rate for our four major processes. This represents one of the lowest in the industry, and reflects Maxim's commitment to producing high-quality products.

Table 1. Life Test Results of Maxim Products, All Processes Combined*

PROCESS	SAMPLE SIZE	REJECTS	FIT @ +25°C	FIT @ +55°C
SMG	4,412	2	0.28	4.89
MV1	1,665	0	0.22	3.82
SG5	2,925	9	1.45	24.93
BIP	1,401	3	1.20	20.69
TOTAL	10,403	14	0.06	10.32

**Test Condition: +135°C, Duration: 1000 hours*

Table 2 summarizes an evaluation of our product infant mortality rate.

Table 2. Infant Mortality Evaluation Results

PRODUCT	BI TEMP	SS	# FAILURES
DG2XX	135	33,174	7
ICM7218	135	34,290	2
MAX1232	135	33,011	2
MAX232	150	75,428	16
MAX690	150	28,313	10
	TOTALS	**204,216**	**37 = 181.2 PPM**

A failure rate versus time plot for metal-gate CMOS process (Figure 2.) was generated based on the life-test data shown in Table 1 and the infant-mortality evaluation data listed in Table 2 applied to a general-reliability model.

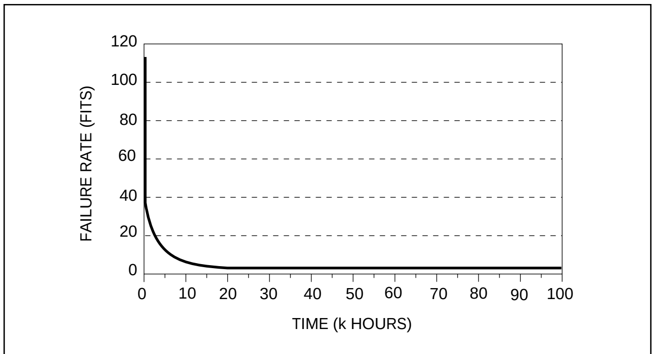

Figure 2. Failure Rate at Field Conditions (+25°C) for Metal-Gate CMOS Process

The data in Table 1 illustrates the reliability benefits of production burn-in. Essentially, 14 per 10,403 units were found to be out of specification after 1000 hours at +135°C of operation. This is equal to a failure-in-time rate (FIT) of 0.06 at +25°C.

In comparison, the infant mortality rate is equal to 37 per 204,216 after 12 hours at +135°C, which has an equivalent FIT rate of approximately 0.768. In practical terms, 0.018% per 6 years (or 0.003% per year) of the total population would be found defective through the first 6 years of operation, with an additional 0.000269% per year failing over the remaining life of the product.

Applications

The rugged plastic screening flow is ideal for applications where superior mean time between failure (MTBF) is required, yet a hermetically packaged product is either undesirable or unnecessary. Examples of such applications are:

- Avionics Systems
- Medical Equipment
- Ground-Based Military Equipment
- Portable Military Systems
- Rugged Personal Computers/Peripherals
- Critical Instrumentation

Continuous Reliability Monitoring

In order to maintain a consistent, stable process, Maxim has adopted a routine reliability monitoring program. This comprises both rapid-response monitor, and long-term evaluations. The rapid-response monitor program (shown in Table 3) allows immediate action to be taken on the process—before it affects the end product, deliveries, or production. The long-term evaluation monitors pick up from there to allow continuous appraisal of our inherent (constant) failure rate. This includes assessment of product performance in humid environments. Table 4 summarizes the long-term tests performed. You can request quarterly summaries and testing data through your local Maxim representative or distributor.

Conclusion

Maxim's rugged plastic flow effectively screens out infant mortality failures, thereby allowing the user to experience only long-term inherent failures at a lower rate.

Availability

Any plastic DIP product with military temperature range specifications offered in the Maxim catalog can be considered as a candidate for this flow. Special burn-in considerations must be given to SOIC plastic packages. Contact the factory for lead times, prices, and availability.

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Table 3. Rapid-Response Reliability Monitors

TEST	METHOD	CONDITIONS	TEST DURATION	SAMPLE SIZE	LTPD, ACC. #	FREQUENCY
Operating Life Test	MIL-STD-883 Method 1005	T_A = +135°C, Biased	192 Hours	80	5/1	Weekly
Pressure Pot	JEDEC Spec 22	T_A = +121°C, RH = 100%	96 Hours	22	10/0	Weekly
X-Ray	MIL-STD-883 Method 2012	Top View Only	N/A	125	2/0	Daily
Solderability	MIL-STD-883 Method 2003	N/A	N/A	15	15/0	Monthly
Mark Permanency	MIL-STD-883 Method 2015	N/A	N/A	12	N/A/0	Monthly
Solder Thickness	ANSI Std.	Cross Section	N/A	3	N/A/0 Min 200 µinches	Monthly
Open Short Test	N/A	Automated Test	N/A	>10k Units	PPM<1000	Quarterly

Table 4. Long-Term Reliability Monitor Program

TEST	METHOD	CONDITIONS	TEST DURATION	SAMPLE SIZE	LTPD, ACC. #
Operating Life Test (Op Life)	MIL-STD-883 Method 1005	Continuous Operation at Max Rated Supply Voltage, T_A = +125°C or T_A = +150°C	1000 Hours	77	5%, Acc. = 1
Biased Moisture Life Test (85/85)	JEDEC Spec 22	Continuous Operation at Max Rated Supply Voltage, Min Supply Current, T_A = +85°C, 85% RH	1000 Hours	77	5%, Acc. = 1
or					
Highly Accelerated Stress Test (HAST)	JEDEC Spec 22	Continuous Operation at Max Rated Supply Voltage, Min Supply Current, T_A = +120°C, 85% RH, 24.4 PSIA	100 Hours	77	5%, Acc. = 1
Temperature Cycle	MIL-STD-883 Method 1010 Cond. C	Air-to-Air, -65°C to +150°C, >10 Min. Dwell Time	1000 Cycles	77	5%, Acc. = 1
High-Temperature Storage	MIL-STD-883 Method 1008	Storage at +150°C, Unbiased	1000 Hours	77	5%, Acc. = 1
Autoclave (Pressure Pot w/o Bias) (PPT)	JEDEC Spec 22	Continuous Storage at T_A = +121°C, 100% RH, 2 Atm.	168 Hours	77	5%, Acc. = 1

Rugged Plastic Ordering Information

The ordering designation for rugged plastic screened products is the suffix /PR, which stands for “plastic reliability” processing.

Part Number Suffixes

Three-Letter Suffixes

EXAMPLE: MAX232MPE/PR

- /PR → Rugged Plastic Flow Identifier
- E → Pin Count
- P → Package Designator
- M → Operating Temperature

Temperature Range

“M”	-55°C to +125°C

Package

“M”	Plastic Flat Pack
“N”	Narrow Plastic Dual-In-Line
“P”	Plastic Dual-In-Line
“Q”	Plastic Chip Carrier (Quad Pack)
“S”	Small Outline, Slim (8 or more pins), 150 mil.
“S”	TO-52 (2 or 3 pins)
“W”	Small Outline, Wide (300 mil)

Number of Pins

“A”	8	“P”	20
“B”	10	“Q”	2
“C”	12	“R”	3
“D”	14	“S”	4
“E”	16	“T”	6
“F”	22	“U”	60

Four-Letter Suffixes

The first letter of the suffix is used to denote product grade; for example, MAX631ACPA means 5% output accuracy (A), the remaining three letters denote temperature range, package type, and number of pins. Therefore, the MAX631ACPA operates over the 0°C to +70°C and is in a Plastic Dual-In-Line package and has eight pins. Sometimes space considerations must be made, especially when dealing with SOICs. In these cases, the part number may be shortened to accommodate the most important product information.

Second-Source Products

In most cases, Maxim's part number for a multiple-source product follows the numbering system that is most widely accepted in the industry for that particular part, rather than our own convention. This includes original designators for package type, temperature range, and performance grades as well as the most commonly recognized prefix.

Multiple-source products are frequently supplied by Maxim in packages or temperature ranges that are not supplied by other manufacturers. Whenever possible, such a device is given the part number that it would have if the original numbering convention were followed. For example, if a military temperature grade of a product is not supplied by other sources, but is available from Maxim, the original manufacturer's design designation for military temperature will be used. As a result, a specific part number supplied by Maxim may not be listed by the original manufacturer.

Maxim High-Reliability Plastic Flow