PRODUCT RELIABILITY REPORT

Product: MPC22167

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1. Device Information

Product:	MPC22167
Report Date:	12/14/2023

2. Summary of Test Results

Test	Test Condition	Lot# or Date Code	Test Results (S.S./Rej)	Comment
Solder Attachment	IPC9701, -40°C to 125°C, dwell time=15mins, ramp time=15mins, 1hour/cycle, for 1000 cycles. 12 layer board. • 1oz for top/2/3/4 layer. • 2oz for 5/6/7/8 layer. • 1oz for 9/10/11/bottom layer.	N33K597 N43N561 P534962	15/0 15/0 15/0	
Temperature, Bias, and Operating Life	JESD22-A108, @+125°C for 1000 hours	N33K597 N43N561 P534962	77/0 77/0 77/0	
Power Temperature Cycling	IPC9592, from -40°C to 125°C for 1000 cycles.	N33K597 N43N561 P534962	45/0 45/0 45/0	
Electrostatic Discharge Human Body Model (HBM)	ANSI/ESDA/JEDEC JS-001	PC38217	3/0	>2000V
Electrostatic Discharge Charged Device Model (CDM)	ANSI/ESDA/JEDEC JS-002	PC38217	3/0	>750V
Latch-up (LU)	EIA/JESD78	PC38217	6/0	>+/-100mA & >1.5Vccmax
Moisture/Reflow Sensitivity, prior to HTSL, LTSL, TC and THB	JESD22-A113 J-STD-020 125°C for 24 hours, 30°C/60%RH for 192 hours, 3 times Reflow.	2309 2319 2327	308/0 308/0 308/0	MSL = 3

High Temperature Storage Life	JESD22-A103, @150°C for 1000 hours	2309 2319 2327	77/0 77/0 77/0	
Low Temperature Storage Life	JESD22-A119, @-65°C for 1000 hours	2309 2319 2327	77/0 77/0 77/0	
Temperature Cycling	IPC9592, -40°C to 125°C, dwell time=15mins, ramp time=15mins, 1hour/cycle, for 1000 cycles.	2309 2319 2327	77/0 77/0 77/0	
Steady State Temperature Humidity Bias Life Test	IPC9592, @85°C/85%RH static bias at Vinmax for 1000 hours	2309 2319 2327	77/0 77/0 77/0	

3. Failure Rate Calculation

For modules, the calculation is based on Telcordia SR-332, Issue 4.

Failure Rate (FIT@60%CL):	7.64 FIT
MTBF (years):	14,941 Years

Revision / Update History

Revision	Reason for Change	Date	Rel Engineer
1.0	Initial release	December 2023	Colin Tang

Appendix: Description of Reliability Test and Failure Rate Calculation

High Temperature Operating Life Test

Purpose: This test is a worst-case life test that checks the integrity of the product. The high temperature testing is for acceleration of any potential failures over time. The calculation for failure rate (FIT) is completed using the Arrhenius equation.
Condition: 125°C @ Vinmax
Pass Criteria: All units must pass the min/max limits of the datasheet.

Power Temperature Cycle Test

Purpose: This test is used to determine the ability of a device to withstand alternate exposures at high and low temperature extremes with operating biases periodically applied and removed. It is intended to simulate worst case conditions encountered in typical applications.
Condition: -45°C to 125°C
Pass Criteria: All units must pass min/max limits of the datasheet

ESD Test

Purpose: The purpose of the ESD test is to guarantee that the device can withstand electrostatic voltages during handling.
Condition: Human Body Model and Charged Device Model
Pass Criteria: ESD Testing on every pin. The device must be fully functional after testing and pass the min/max limits in the datasheet.

IC Latch-Up Test

Purpose: The purpose of this specification is to establish a method for determining IC latch-up characteristics and to define latch-up failure criteria. Latch-up characteristics are extremely important in determining product reliability and minimizing No Trouble Found (NTF) and Electrical Overstress (EOS) failures due to latch-up.
Condition: Voltage and current injection
Pass criteria: All pins with the exception of "no connect" pins and timing related pins, shall be latch-up tested. The device must be fully functional after testing and pass the min/max limits in the datasheet.

Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

Purpose: The purpose of this standard is to identify the classification level of nonhermetic solid state surface mount devices (SMDs) that are sensitive to moisture-induced stress so that they can be properly packaged, stored, and handled to avoid damage during assembly solder reflow attachment and/or repair operations.
Condition: Bake + moisture sock + 3X reflow at 260°C
Pass criteria: All units must pass the min/max limits of the datasheet

High Temperature Storage Life

Purpose: The test is typically used to determine the effect of time and temperature, under storage conditions, for thermally activated failure mechanisms of solid state electronic devices, including nonvolatile memory devices (data retention failure mechanisms).
Condition: Bake at 150°C
Pass Criteria: All units must pass min/max limits of the datasheet

Low Temperature Storage Life

Purpose: The test is typically used to determine the effects of time and temperature, under storage conditions, for thermally activated failure mechanisms and time-to-failure distributions of solid state electronic devices, including nonvolatile memory devices (data retention failure mechanisms).
Condition: Bake at -65°C
Pass Criteria: All units must pass min/max limits of the datasheet

Temperature Cycle Test

Purpose: This test is used to evaluate the die attach integrity and bond integrity. This is similar to the Thermal Shock test, but can generate different failure modes due to the longer dwell time and gradual temperature change.

Condition: -45°C to 125°C

Pass Criteria: All units must pass min/max limits of the datasheet

Steady State Temperature Humidity Bias Life Test

Purpose: This is to check the performance of the device in humid environments. This test checks the integrity of the passivation, poor metal to plastic seal and contamination level during assembly and material compatibility.

Condition: 85%RH at 85°C with Vin=Vinmax

Pass Criteria: All units must pass min/max limits of the datasheet

Failure Rate Calculation

1. Failure Rate for Chips

The failure rate is gauged by a Failures-In-Time (FIT) based upon accelerated stress data. The unit for FIT is failure per billion device hour.

$$FIT\ Rate = \frac{(\chi^2/2) \times 10^9}{EDH}$$

Where

$\chi 2$ (Chi-Squared) is the goodness-of-fit test statistic at a specified level of confidence;
EDH= Equivalent Device Hours = AF × (Life test sample size) × (test duration);
AF= Acceleration Factor.

High Temperature Operating Life (HTOL) test is usually done under acceleration of temperature and voltage. The total number of failures from the stress test determines the chi-squared factor.

$$AF = AF_T \times AF_V$$

The Temperature Acceleration Factor AF_T:

$$AF_T = \exp\left(\frac{E_a}{K}\left(\frac{1}{T_{J(use)}} - \frac{1}{T_{J(stress)}}\right)\right)$$

T_{Juse} = Junction temp under typical operating conditions;
$T_{Jstress}$ =Junction temp under accelerated test conditions;
Ea is Activation energy=0.7eV;
K=Boltzmann's constant=8.62×10^{-5} eV/K.

The voltage Acceleration Factor AF_V:

$$AF_V = e^{\beta\times[V_{stress}-V_{use}]}$$

V_{use} = Gate voltage under typical operating conditions;
V_{stress} = Gate voltage under accelerated test conditions;
β = Voltage acceleration factor (in 1/Volts) and specified by technology.
Note: For calculation in the report, AF_V = 1 for simplicity.

2. Failure Rate for Multiple-Chip Modules/Systems

Based on Telcordia SR-332, Issue 4, a module/system failure rate is the sum of the failures of all individual components, as defined by:

$$\lambda_{SYS} = \sum_{j=1}^{M} \lambda_{SS_{(j)}}$$

Where

$\lambda_{SS_i} = \lambda_{BB_i} = \lambda_{G_i}\pi_{Q_i}\pi_{S_i}\pi_{T_i}$ mean black box steady-state failure rate

λ_{G_i} = *mean generic steady-state failure rate* for device i

π_{Q_i} = *Quality Factor* for device i

π_{S_i} = *Electrical Stress Factor* for device i

π_{T_i} = *Temperature Factor* for device i

MTBF (Mean Time Between Failure) equals to 10^9/FIT (in hours).