



Maxim Integrated Products

120 San Gabriel Drive

Sunnyvale, CA 94086

Phone: 408-737-7600, FAX: 408-470-5841

Product Reliability Qualification

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Maxim Integrated Products

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1. TITLE: [HQ/EV][GEN] Product Reliability Qualification

2. PURPOSE:

2.1. This specification establishes reliability qualification requirements for all Maxim IC devices.

3. SCOPE:

3.1. This specification applies to all IC devices manufactured by Maxim and Maxim's contractors. This includes all new products, fab processes, packages and major engineering changes on existing products.

4. TERMS AND DEFINITIONS:

4.1. It is the responsibility of the reliability group to carry out the qualification program with help from design, testing, packaging and production groups to make the qualification program successful.

5. APPLICABLE DOCUMENTS:

5.1. Mil-STD-883C - Test Methods and Procedures for Microelectronics

5.2. Mil-M-38510 - General Specification for Microcircuits

5.3. JEDEC Standard No.22A - Test Methods and Procedures for Solid State Devices used in Transportation/Automotive Applications

6. EQUIPMENT AND MATERIALS:

6.1. As specified per test requirements.

7. GENERAL REQUIREMENTS:

7.1. QUALIFICATION PROGRAM REQUEST:

7.1.1. A written description by the submitting group of what is to be qualified shall be forwarded to Rel Department. The submission of qualification samples could be from Design, Process, Assembly/Packaging, or initiated by Reliability Group.

7.2. QUALIFICATION PLAN:

7.2.1. Upon receipt of the qualification request, Rel group shall publish a qualification plan that details:

7.2.1.1. Reliability testing required

7.2.1.2. Test condition and test duration

7.2.1.3. Sampling plan

7.2.1.4. Qualification schedule

7.2.1.5. Burn-in circuit and 85/85 test circuit if needed

7.3. QUALIFICATION SAMPLES:

7.3.1. It is the responsibility of submitting group to provide fully electrical tested (QA room) samples to the Rel group. This can be coordinated through the Product Line Managers (PLM).

7.3.2. For Major quals, 3 distinct lots are required. For Minor quals, 1 lot is required.

7.3.3. A control lot from existing qualified fab process or assembly process must be supplied along with the qualification samples, so that both groups may run in parallel through the qualification testing if necessary.

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7.4. QUALIFICATION TEST:

7.4.1. Reliability Requirements:

7.4.1.1. Appendix 12.1 and 12.2. list standard qualification tests for plastic and hermetic packages. All plastic products shall be designed to survive the tests specified in Appendix 12.1. All hermetic products shall be designed to survive the tests specified in Appendix 12.2. It is not necessary that all tests must be performed for a product/process/package qualification. Only the relevant tests will be selected per the predefined qualification plan by the Rel group.

7.4.1.2. The exact qualification requirements will be governed by the qualification plan.

7.4.1.3. Qualification by Similarity may be granted upon the discretion of the Reliability Director based upon past reliability information on closely similar packages, processes, or products.

7.4.1.4. Once qualified, a die type is considered qualified by extension to any other qualified package.

7.4.1.5. Once a core die type is fully qualified, only ESD and Latchup are required to extend qualification to die produced with other metal options.

7.4.2. Sampling Plan:

7.4.2.1. The number of samples required for qualification is defined in Appendix 12.1 and 12.2. The accept/reject criteria are also listed in Appendix 12.1 and 12.2. The sample size of the tests may be adjusted if necessary per the LTPD sampling plan.

7.4.3. Failure Definitions:

7.4.3.1. Devices which fail to meet endpoint inspection criteria shall be considered rejects. These endpoint inspections include electrical test, visual inspection, mechanical stress test, hermeticity test, destructive and non-destructive tests.

7.4.4. Special Customer Requirements:

7.4.4.1. In the event customer's requirements are more stringent than Appendix 12.1 and 12.2, the customer's requirements, as set forth in the special spec shall be followed.

7.4.5. Pre-conditioning Requirements for Surface Mount Packages:

7.4.5.1. Plastic packages in surface mount forms should be subjected to preconditioning prior to the start of the following reliability tests: 85/ 85, HAST, and temperature cycling.

7.4.5.2. Surface Mount Packages should be subjected to:

7.4.5.2.1. 85 C/85 % R.H. environment with no bias for 168 hours.

7.4.5.2.2. Follows by 3 insertions through Infrared Reflow peak temperature 240 +/- 5C/120-180 sec over 183 C.

7.4.5.3. Electrical Test Verification:

7.4.5.3.1. Following the preconditioning test, all test samples should be electrically tested per data sheet specification.

7.4.6. Duration of Reliability Test:

7.4.6.1. For qualification purpose, each reliability test duration should follow the requirements specified in Appendix 12.1 and 12.2. Reliability stress testing should be extended to longer duration in order to determine process, package margin to the stated reliability performance.

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7.4.6.2. Conditional qualification may be granted after passing 500 hours BI, 85/85 500 hours (or HAST 100 hours). Pressure Pot 168 hours, Temp. cycle 500 cycles. before 1000 hours (or 1000 cycles) is completed. However, if the 1000 hour data fails the qual, customer shall be notified of qual results.

7.5. New Product/New Fab Process/New Package Qualification:

7.5.1. For the qualification of new fab process or new package or new assembly process, three manufacturing runs must satisfactorily meet the qualification requirements as defined in the qual plan. New products will be released for sampling or pre-production orders prior to the completion of the qualification plan. The qualification period will not extend longer than 90 days. The qualification results will then determine the status of continued production.

7.5.2. A new product, developed on an existing qualified process must complete successfully a life test monitor, prior to release for shipment. After three months, the product must demonstrate that its reliability performance meets Maxim's standard as outlined in Appendix 12.3 for new product qualification. If it does not, the product will be put on hold until an action plan is formulated and implemented to meet this goal. It is the responsibility of the Reliability Manager to govern and enforce this policy.

7.5.3. Qualifying product by similarity: The same die type does not need to be qualified in each available package/product configuration provided that (1) the die type has been successfully qualified in at least one package type, and (2) the same die type (process and function) has been qualified earlier in the intended package.

7.6. Major Engineering Changes:

7.6.1. Major engineering changes are changes to the products that have the potential to adversely affecting product reliability. Examples of major engineering changes include the following:

- 7.6.1.1. Mask change or redesign
- 7.6.1.2. Metallization changes
- 7.6.1.3. Passivation or Dielectric changes
- 7.6.1.4. Major fab process changes
- 7.6.1.5. Packages changes
- 7.6.1.6. Molding compound changes
- 7.6.1.7. Wire bonding changes
- 7.6.1.8. Die attach changes
- 7.6.1.9. End of Line changes - deflash or plating method

7.6.2. All these changes require product requalification and customer change notification.

7.6.3. Appendix 12.4 lists a guideline for qualification test matrix for major changes.

7.7. Burn-in Requirements:

7.7.1. Burn-in Evaluation for Qualification:

7.7.1.1. For each qualification test that requires a life test, a burn-in evaluation must be included to analyze the infant mortality of the process/product.

7.8. Failure Analysis of Qualification Failures:

7.8.1. It is the responsibility of FA Engineering to analyze qualification rejects and issue an IFAR report in a timely manner so the cause of reject can be corrected.

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- 7.9. Reliability Qualification Report:
- 7.9.1. At the conclusion of the qualification effort, Rel engineering shall issue a reliability report to the appropriate groups.
 - 7.9.2. All qualification reports will be submitted in electronic format for routing and approval. Approval shall include the originator, appropriate Rel Manager/Director, and the Executive Director of QA.
 - 7.9.3. Approved electronic reports will be converted to PDF format and filed as defined by Reliability department (current location = "Huey\Public2\Prodcnt\RelProj\PDF_RRPT\report file name").
- 7.10. PRODUCT RELIABILITY MONITOR PROGRAM
- 7.10.1. Once a product is qualified, the product will be in the monitor program. The product monitor lot selection shall be grouped by fab/process combination determined by QA and product groups.
 - 7.10.2. Once per week, 80 units from a product representative of each major semiconductor process (i.e. S3, S5, etc.) shall have a life test (135°C/192 hours) and Pressure Pot 168 hours performed as a weekly monitor.
 - 7.10.3. Once a quarter, a 1000 hours life test (150°C), a 1000 hours storage life test (150°C), a 1000 hours 85/85 test, and a 1000 cycles temperature cycle test, per Appendix 12.5, shall be performed to monitor each fab/process group.
 - 7.10.4. The reliability monitor programs will be performed dependent upon availability of samples. In a monitor period where suitable samples are unavailable, the monitor interval will be skipped.

8. **ACCEPTANCE:** N/A

9. **DISPOSITION OF MATERIAL:** N/A

10. **DATA RECORDING:**

- 10.1. All qualification samples and records shall be retained by the Rel Group for 5 years.

11. **MAINTENANCE:** N/A

12. **APPENDICES:**

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12.1. **RELIABILITY QUALIFICATION REQUIREMENTS FOR IC'S IN PLASTIC PACKAGES**

STRESS TEST NAME	CONDITION	SAMPLING PLAN		END POINTS
		SS / Acc	or LTPD	
Life Test, Dynamic preferable	135°C/ 1000 hrs with virgin production units only extend to 2000 hrs for information only	77 / 1	5%	Electrical
85/85 Temperature & Humidity Bias (THB) (Note 5)	85°C/85% RH, 1000 hrs extend to 2000 hrs for information only (note 1)	77 / 1	5%	Electrical
Pressure Pot (Autoclave)	121°C / 15 psig 168 hrs (note 3)	77 / 0	3%	Electrical
HAST (Note 5)	130°C / 85% RH 100 hrs (note 1)	45 / 0	5%	Electrical
Temperature Cycle	-65°C to 150°C 1000 X (note 1) Extended to 2000 X. For information only. (note 1)	77 / 1	5%	Electrical
High Temperature Storage	150°C/ 1000 hrs extend to 2000 hrs for information only	77 / 1	5%	Electrical
ESD	Human body model 1.5K ohm 100pF cap 2000V or actual Voltage	5 / 0		Electrical
Latch-up	+ / -200 mA or actual rating, using 1.5X VCC or absolute max ratings.	5 / 0		Electrical: requires post Latchup ATE tests
Power Cycle	Power On and off to cycle Tj between ambient and 150°C. 10k cycles minimum.	45/0	5%	Electrical
Solder Shock	260°C / 10 sec solder dip	15 / 0	15%	Electrical
Resist to Soldering Heat	300°C / 10 seconds	15 / 0	15%	Electrical
Wire Bond Pull	20 samples minimum pull all wires 5 grams minimum	20/0		accept no bond crater or oxide crack

STRESS TEST NAME	CONDITION	SAMPLING PLAN SS / Acc or LTPD		END POINTS
Bond Crater Check	bake 125 C/24 hrs +IR Reflow +bond crater check	150/0 20/0		Post IR QA hot & room test Bond Crater & Visual test accept no crater or oxide crack
Die Shear	per Mil spec 883 method 2019.5	5 / 0		Must be provided by Assembly group
Physical Dimensions	per drawing	15 / 0	15%	Visual
Lead Fatigue	>3 90 degree bends	15 / 0	15%	Visual
Tensile Strength	8 oz weight / 30 sec	15 / 0	15 %	Visual
Solderability	minimum 8 hrs steam aging	15 / 0	15%	Visual
Resistance to Solvents		15 / 0	15%	Visual
Adhesion of Lead Finish		15 / 0	15%	Visual
Salt Atmosphere		15 / 0	15%	Visual
External Visual		15 / 0	15%	Visual
Plating Thickness	200u - inch min- Solder dip 300u- inch min- Solder plating	10 / 0		
Infrared Solder Reflow	85C/85% RH soak 168 hrs +Infrared 240+/-5C peak 120-180 sec over 183C +SAM +Bond crater check	150/0 20/0 20/0		hot & room test evaluate pkg delam accept no bond crater or oxide crack
Moisture Torture Test (Note 4)	85/85 168 hours (no bias) + solder dip 260°C/ 5 seconds, 3 times. + pressure pot 96 hours	20 / 0		Electrical

NOTE:

1. Preconditioning is required for these tests per section 7.4.5 requirements.
2. High power devices only/
3. Preconditioning not required for Pressure Pot.
4. Information only, not required for qualification.
5. Either HAST or 85/85 may be chosen.

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12.2. **RELIABILITY QUALIFICATION REQUIREMENTS FOR IC'S IN HERMETIC PACKAGES**

STRESS TEST NAME	CONDITION	SAMPLING PLAN		END POINTS
		SS / Acc or LTPD		
Life Test, Dynamic	135 ⁰ C/ 1000 hrs extend to 2000 hours for information only	77 / 1	5%	Electrical
Temperature Cycle	-65 ⁰ C to +150 ⁰ C/1000X extend to 2000 X for information only	77 / 1	5%	Electrical + Seal
Thermal Shock	0 ⁰ C to +100 ⁰ C 200 cycles	77 / 1	5%	Electrical + Seal
High Temperature Storage	150 ⁰ C/1000 hours Extend to 2000 hrs for information only	77 / 1	5%	Electrical
ESD	Human body model 2000V or actual Voltage	5 / 0		Electrical
Latch-up	+/-200 mA or actual rating, using 1.5x Vcc or absolute max ratings	5 / 0		Electrical
Solder Shock	260 ⁰ C/10 seconds solder dip	15 / 0	15%	Electrical + Seal
Resist to Soldering Heat	300 ⁰ C/ 10 seconds	15 / 0	15%	Electrical
Wire Bond Pull	5 grams minimum	45 / 0	5%	
Die Shear	per Mil 883 method 2019.5	5 / 0		
Physical Dimensions	Per drawing	15 / 0	15%	Visual
Lead Fatigue	>3 90 degree bends	15 / 0	15%	Visual
Tensile Strength	8 oz weight/30 seconds	15 / 0	15%	Visual
Solderability	minimum 8 hours steam aging	15 / 0	15%	Visual

STRESS TEST NAME	CONDITION	SAMPLING PLAN		END POINTS
		SS / Acc	or LTPD	
Resistance to Solvents		15 / 0	15%	Visual
Power Cycle	Power On and Off to cycle Tj between ambient and 150°C 10K cycles minimum	45 / 0	5%	Electrical
Salt Atmosphere		15 / 0	15%	Visual
RGA, Moisture Content	< 5000 PPM H2O	3 / 0		
Mechanical Shock		15 / 0	15%	Electrical + Seal
Plating Thickness	200 u - inch min- Solder dip 300u- inch min Solder plating	10 / 0		
Lid Torque		5 / 0		Visual
Adhesion of Lead Finish		15 / 0	15%	Visual
External Visual		15 / 0	15%	Visual
Mil-Std-883, D-3 Thermal Sequence Thermal shock Temp cycle Moisture resistance Fine/Gross leak Visual Electrical	-55°C to +125°C, 15X -65°C to +150°C, 100X	45/0	5%	Seal + Visual + Electrical
Mil-Std-883, D-4 Mechanical Sequence Mechanical shock Vibration Const acceleration Fine/Gross leak Visual Electrical	Cond B Cond A Cond E	45 / 0	5%	Seal + Visual + Electrical

12.3. **RELIABILITY QUALIFICATION GUIDELINE FOR NEW PRODUCT/ FAB PROCESS/ PACKAGE**

TEST NAME	NEW PRODUCT		NEW FAB PROCESS		NEW PACKAGE/ ASSEMBLY PROCESS	
	TEST CONDITION	SAMPLING PLAN	TEST CONDITION	SAMPLING PLAN	TEST CONDITION	SAMPLING PLAN
Life Test	135°C/192 hrs *2	77 / 1	135°C/1000 hrs	77 / 1	135°C/1000 hrs	77 / 1
85 / 85 Test *1			1000 hrs	77 / 1	1000 hrs	77 / 1
Pressure Pot *1			168 hrs	77 / 0	168 hrs	77 / 0
Temp Cycle -65 to +150°C			1000 X	77 / 1	1000 X	77 / 1
HAST *1 130°C/85% R.H.			100 hrs	45 / 0	100 hrs	45 / 0
ESD	YES					
Latch-up	YES					
Bondwire Pull			Yes	20/0	Yes	20/0
Bond Crater Check			Yes	20/0	Yes	20/0

*1 Plastic packages only

*2 Standard Burn In temperature is Ta = 135°C. Other temperatures and durations may be substituted for products with high power dissipation, or with component limitation to high temperature performance.

12.4. **GUIDELINE FOR QUALIFICATION TEST MATRIX FOR MAJOR CHANGES**

	New Fab Location	New Fab Process	Passivation	Metal	Dielectric	Starting Wafer	New Assembly	New Package	Plastic Molding Compound	Die Attach	Wire Bond	Die coating	Lead Finish
Life Test	X	X	X	X	X	X	X	X	X	X	X	X	
85/85	X	X	X	X	X		X	X	X	X		X	X
Pressure Pot	X	X	X	X	X		X	X	X	X		X	X
Temp. Cycle	X	X	X	X	X		X	X	X	X	X	X	
High Temp. Storage	X	X	X	X			X	X	X		X	X	
Hast *1	X	X	X	X	X		X	X	X	X		X	X
Power Cycle	X*2	X*2		X*2			X*2	X2		X*2	X		
ESD	X	X				X							
Latch-Up	X	X				X							
Solder Reflow							X	X	X	X	X	X	
Solderability							X	X					X
Resist to Solvents							X	X	X				
Solder Shock							X	X	X	X	X	X	
Wire Bond Pull	X	X		X			X	X	X	X	X	X	
Bond Crater Check	X	X		X	X		X	X	X	X	X		
Shock, Vibration Centrifuge *3							X	X		X	X		

Note: X = Mandatory
 *1 = Optional
 *2 = Power devices only
 *3 = Hermetic only

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12.5. **PRODUCT RELIABILITY MONITOR PROGRAM**

12.5.1. LONG TERM RELIABILITY MONITOR

TEST	TEST CONDITIONS	SAMPLING PLAN SS/Acc	FREQUENCY
Life Test	135°C/1000 hrs	77/1	per quarter
85 / 85 Test	1000 hrs	77 / 1	per quarter
Pressure Pot	168 hrs	77/0	per quarter
Temp Cycle	1000 cycles	77 / 1	per quarter
High Temp Storage Life	150°C/1000 hrs	77 / 1	per quarter

12.5.2. SHORT TERM RELIABILITY MONITOR

TEST	TEST CONDITIONS	SAMPLING PLAN SS/Acc	FREQUENCY
Life Test	135°C/192 hrs	77/1	per week
Pressure Pot	168 hrs	77/0	per week

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