Qualification Report

Preliminary Qualification of the 150 mm Process Using 100mm Wafers

Abstract

This report summarizes the preliminary reliability test results that has been completed to qualify TriQuint Semiconductor's conversion of its E/D MESFET GaAs wafer fabrication process from 100mm wafers to 150mm wafers. The initial qualification was performed on products produced on 100mm wafers using the proposed 150mm wafer processes.

Two product test vehicles were selected for this initial qualification.

Qualification Vehicle "A" - a Power Amplifier Product.

Qualification Vehicle "B" - a Cell Phone Receiver Product.

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Preliminary 150mm Qualification
(*Using 100mm Wafers*)

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Process Description

TriQuint's TQTRx is an advanced Gallium Arsenide (GaAs) 0.6 micron enhancement/depletion mode MESFET process with an integrated power MESFET and two thick global metal interconnect layers. This process, fabricated at TriQuint's Hillsboro, Oregon facility, supports RF applications up to Ku-band. The two metal layers are encapsulated in a high performance interlayer dielectric that allows tremendous wiring flexibility and plastic packaging simplicity. Precision nichrome resistors and very high value MIM capacitors are included.

The process is an Ion Implanted process combining 0.6 um gate length producing E, D, and D-mode MESFETs (Vp=100mV, -600mV, -2.0V), Schottky diodes, precision NiCr resistors, and MIM capacitors. Includes 2 layers of global, plated Au interconnect, but no Air Bridges.

NOTE: *The process development cycle includes multiple steps. Samples tested at this stage of the development do not necessarily represent all the expected process changes that will be made during the 150mm wafer conversion. See the conclusion section for more details on the process development.*

Product Description

Qualification Vehicle "A"

A MESFET power amplifier designed for 800MHz AMPS and DAMPS applications, using a 4.6V supply voltage. Internal circuitry compensates for temperature and process variations. This power amplifier is packaged in a QSSOP16-ED (exposed paddle) package. Assembly and encapsulation of the test samples were accomplished at supplier A. (Wafer Run #: 022257-A01)

Qualification Vehicle "B"

A 3 volt receiver RFIC designed specifically for TDMA IS-136 applications. The vehicle contains a down converter and LNA circuits for the 800 MHZ cellular band. The mixer uses a high-side LO frequency with the IF covering a range of 85-120 MHZ. This LNA is packaged in a QSOP-16 package. Assembly and encapsulation of the test samples were accomplished at supplier U. (Wafer Run #: 021728-A01)

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Test Plan:

Table 1 lists the preliminary 150 mm wafer qualification plan which is based on the requirements of REL.021
(*The present status of the tests is listed in the following section*.)

Table 1. Device Qualification Test Plan.

	Test Description	Purpose	Specification - Method or Conditions	Sample Size
HTOL	1. Bias Life test	Determine the effect of bias and temp on the device over an extended period of time	VDD biased at 2.8 V 1,000 hrs Ambient Temperature, 125°C	2 Lot 77 (1)
Environmental	1. PreConditioning		JESD22-A113 IR/Convection Reflow @ 235°C	2 Lot 240 (1)
	2. Autoclave	Determine the effect of temp, humidity & pressure on the device over time, unbiased.	JEDEC A102, Condition C 121°C, 100% RH, 15 PSIA unbiased, for 96 Hours	2 Lot 77 (1)
	3. HAST	Determine the effect of temp & humidity on the device under bias.	JESD22-A110 - 96 hr 130°C - 85% RH Non-Condensing	2 Lot 77 (1)
	4. Temperature Cycle	Determine the effect of temp on Material Thermal Mismatch.	JESD22-A104 Cond G -40°C to +125°C 1000 Cycles	2 Lot 77 (1)
Mechanical	1. Thermal Shock	Determine the effect of temp on Material Thermal Mismatch.	Similar to JESD22-A106 Cond. C *except* -40°C to +125°C - 100 Cycles	2 Lot 77 (1)

Note: HAST, Autoclave, & Temperature Cycle groups received preconditioning. Please see description of preconditioning stresses.

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Summary of Results:

Table 2 lists the status and results of the qualification testing for the preliminary 150mm qualification.
(*The present status of the tests is listed in the following section*.)

Table 2. Qualification Test Results Summary.

Test Description	Sample Size	Status	Results
♦ **Qualification Vehicle "A"**			
Bias Life test	1Lot 77 (1)	Completed 1,000hr	77(0)
PreConditioning	1 Lot 240 (1)	All Parts Passed	240(0)
Autoclave	1 Lot 77 (1)	All Parts Passed	77(0)
HAST	1 Lot 77 (1)	All Parts Passed	77(0)
Temperature Cycle	1 Lot 77 (1)	All passed after 1,000 cycles	77(0)
Thermal Shock	1 Lot 77 (1)	All passed after 100 cycles	77(0)
♦ **Qualification Vehicle "B"**			
Bias Life test	1Lot 77 (1)	Completed 1,000hr	77(0)
PreConditioning	1 Lot 240 (1)	All Parts Passed	240(0)
Autoclave	1 Lot 77 (1)	All Parts Passed	77(0)
HAST	1 Lot 77 (1)	All Parts Passed	77(0)
Temperature Cycle	1 Lot 77 (1)	All passed after 1,000 cycles	77(0)
Thermal Shock	1 Lot 77 (1)	All passed after 100 cycles	77(0)

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Test Status:

HTOL (High Temperature Operating Lifetest) TQS Test# 1107 & 1159

Procedure: In general, the life test procedure follows MIL-STD-883, Method 1005, Condition B or JESD22-A108.

Purpose: Lifetesting is performed for the purpose of demonstrating that device failure rates do not exceed 100 FIT (FIT = Failure unIT = failures per billion device hours) for the first 20 years of life at the specified maximum rated operating temperature.

Results: **Qualification Vehicle "A"**
77 parts from lot# 9244 were subjected to HTOL testing. All parts passed electrical test after 250 hr, 500 hr and 1,000 hr.
Qualification Vehicle "B"
77 parts from lot# 0053 were subjected to HTOL testing. All parts passed electrical test after 250 hr, 500 hr and 1,000 hr.

♦ Environmental Test Group

Preconditioning TQS Test# 1106 & 1158

Procedure: Preconditioning is performed according to JEDEC Methods A101 & A113.

Purpose: The purposes of preconditioning are:

(1) to determine if any trapped moisture around the device leads will explode the plastic around the leads (popcorning) or cause delamination of the plastic from the chip during the soldering process.

(2) to determine if the solder reflow will have any long-term effect on reliability.

Results: **Qualification Vehicle "A"**
240 parts from lot# 9244 were subjected to level 1 preconditioning with no electrical failures.
Qualification Vehicle "B"
240 parts from lot# 0053 were subjected to level 1 preconditioning with no electrical failures.

Autoclave TQS Test# 1106 & 1158

Procedure: Un-Biased Autoclave is performed per JESD22-A102

Purpose: The purpose of unbiased autoclave (Accelerated Moisture Resistance Test) is to evaluate the moisture resistance of non-hermetic packaged solid state devices.

Results: **Qualification Vehicle "A"**
77 parts from lot 9244 were subjected to 96 hr of Autoclave - All passed electrical test.
Qualification Vehicle "B"
77 parts from lot 0053 were subjected to 96 hr of Autoclave - All passed electrical test.

HAST (Highly Accelerated Temperature & Humidity Stress Test) TQS Test# 1106 & 1158

Procedure: HAST is performed according to JESD22-A110; with the parts biased and an environment of 131°C 85% RH for 96 hrs.

Purpose: The purpose of the test is to evaluate the reliability of non-hermetic packaged solid state devices in a biased humid environment. This test usually activates the same type of failures as does biased 85/85 but accelerated by temperature, pressure and humidity.

Results: **Qualification Vehicle "A"**
77 parts from lot# 9244 were subjected to 96 hr of HAST - All passed electrical test.
Qualification Vehicle "B"
77 parts from lot# 0053 were subjected to 96 hr of HAST - All passed electrical test.

Temperature Cycle TQS Test#1106 & 1158

Procedure: Temperature cycle is performed according to JESD22-A104 Condition G, -40°C to +125°C, for 1000 cycles.

Purpose: The purpose of the test is to determine the resistance of the part to extremes of high and low temperature and the effect of alternate exposures to these extremes.

Results: **Qualification Vehicle "A"**
77 parts from lot# 9244 were subjected to 1,000 temperature cycles from -40ºC to +125ºC
All 77 parts passed electrical tests after 500 cycles and after 1,000 cycles.
Qualification Vehicle "B"
77 parts from lot# 0053 were subjected to 1,000 temperature cycles from -40ºC to +125ºC
All 77 parts passed electrical tests after 500 cycles and after 1,000 cycles.

♦ Mechanical Test Group

Thermal Shock (Liquid to Liquid) TQS Test# 708

Procedure: The test shall be performed according to JESD22-A106 Condition C except –40°C to +125°C

Purpose: The purpose of the test is to determine the resistance of a part to sudden exposure to extreme changes in temperature and to the affect of alternate exposures to these extremes.

Results: **Qualification Vehicle "A"**
77 parts from lot# 9244 were subjected to 100 thermal shock cycles between -40ºC to +125ºC. All parts passed electrical test.
Qualification Vehicle "B"
77 parts from lot# 0053 were subjected to 100 thermal shock cycles between -40ºC to +125ºC. All parts passed electrical test.

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❑ Conclusion

All of the tests specified in the test plan were successfully completed and there were no (0) failures detected during any of the qualification tests.

Based on the results of this preliminary qualification testing the 150mm process , produced on 100mm wafers successfully completed the qualifications per the requirements specified in REL.021.

The following changes have occurred in the process since the test vehicles were produced. Additional qualification testing, on material produced on 150mm wafers, will be performed to fully qualify the 150mm process.

- **Minor Changes:**
  The following changes are equipment related but are not a fundamental change to the process recipes:
  - New plating equipment.
  - New Implanters
  - New RTA manufacturer.