

## **B24 Process Qualification**

*(Test Vehicles SC3918 & TQ9222)*

### **Abstract**

This report summarizes the reliability testing that was completed to qualify the new process TQTRx-(B24). The products used to qualify this new process consisted of one (1) lot of SC-3918 and two (2) lots of TQ-9222 products fabricated by TriQuint Semiconductor.

The SC-3918 is fabricated on TriQuint's 0.6 $\mu$ m E/D MESFET GaAs TQTRx process and is packaged in a QSOP-16 package. Assembly and encapsulation of the test samples were accomplished at supplier U.

The TQ-9222 is fabricated on TriQuint's 0.6 $\mu$ m E/D MESFET GaAs TQTRx and is packaged in a QSOP-24 package. Assembly and encapsulation of the test samples were accomplished at supplier U.

Tests, test sample size and failure criteria were defined from TriQuint's Specification REL.021 (Policy and Procedure for Reliability Qualifications of ICs). Most tests outlined in this procedure follow the JEDEC Standard Number 26-A or MIL-STD-883 when applicable.

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## Process Description

TriQuint's TQTRx-(B24) 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. The B24 variant of TQTRx is an evolutionary development of the B16 and B08 versions. It has been improved for manufacturability. This process and one thin local metal, fabricated at TriQuint's Hillsboro, Oregon facility, supports RF applications up to Ku-band and mixed mode applications up to LSI complexity. The three 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.

## Product Description

### SC-3918 Down Converter

The SC-3918 is a 3 volt receiver RFIC designed specifically for TDMA IS-136 applications. The SC-3918 contains 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.

### TQ-9222 LNA/Mixer

TQ9222 is a 3 volt, RF receiver IC designed specifically for dual-band TDMA applications. Its RF performance meets the requirements of products designed to the IS-136 and GSM standards. The TQ9222 contains two separate LNA+Mixer circuits to handle both the 800 MHz cellular band and the 1900 MHz PCS band. The mixers use a high-side LO frequency, with the IF covering a range of 70-140 MHz. The IF frequencies below 120 MHz are possible due to the 1/2 -IF spurious signal rejection in the 1900 MHz LNA+Mixer. The IF outputs are designed for use of a common IF frequency. Most RF ports are internally matched to 50 Ohms.

**Test Plan:**

Table 1 lists the qualification plan for TQTRx - B24 using SC3918 and TQ-9222 as the test vehicles. This plan is based on the requirements of REL.021

**Table 1. Process Qualification Test Plan.**

	Test Description	Purpose	Specification - Method or Conditions	Sample Size
<b>HTOL</b>	1. Bias Life test	Determine the effect of bias and temp on the device over an extended period of time	JESD22-A108 150°C Junction - 1000 Hours Min	3 Lot each 77 (1)
<b>Environmental</b>	1. PreConditioning		JESD22-A113 IR/Convection Reflow @ 235°C	3 Lot each 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	3 Lot each 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	3 Lot each 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	3 Lot each 77 (1)
<b>Mechanical</b>	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	3 Lot each 77 (1)

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



## Summary of Results:

Table 2 lists the status and results of the qualification testing using the SC-3918 as the test vehicle.

**Table 2. Qualification Test Results Summary.**

Test Description	Sample Size	Status	
Bias Life test	1Lot 77 (1)	77 parts were subjected to 1,000 hr of HTOL testing. All parts passed electrical testing at 500 hr and 1,000 hr	77(0)
PreConditioning	1 Lot 240 (1)	240 parts were subjected to level 1 Preconditioning All passed electrically after the stress .	240(0)
Autoclave	1 Lot 77 (1)	All 77 parts passed	77(0)
HAST	1 Lot 77 (1)	76 parts passed, one (1) part was damaged in the handler	76(0)
Temperature Cycle	1 Lot 77 (1)	All 77 parts passed electrical test after stress	77(0)
Thermal Shock	1 Lot 77 (1)	All 77 parts passed	77(0)

## Detail Test Results from SC-3918:

### HTOL (High Temperature Operating Lifetest)

TQS Test#1177

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

Purpose: Life testing 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: 77 parts from lot 0799 were subjected to 1,000 hr of HTOL stress.  
All parts pass electrical test after 500 and 1,000 hr.

### ◆ Environmental Test Group

#### Preconditioning

TQS Test#1176

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: 240 parts from lot 0799 were subjected to level 1 preconditioning with no electrical failures.

**Autoclave**

TQS Test#1176

- 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: 77 parts from lot 0799 were subjected to 96 hr of Autoclave - All passed electrical test.

**HAST (Highly Accelerated Temperature & Humidity Stress Test)**

TQS Test#1176

- Procedure: HAST is performed according to JESD22-A110; with the parts biased and an environment of 130°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: 77 parts from lot 0799 were subjected to 96 hr of HAST - 76 parts passed electrical test. One (1) part was damaged by the handler and was untestable.

**Temperature Cycle**

TQS Test#1176

- 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: 77 parts from lot 0799 were subjected to 1,000 temperature cycles from -40°C to +125°C. All parts passed electrical tests.

**◆ Mechanical Test Group****Thermal Shock (Liquid to Liquid)**

TQS Test# 1178

- 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: 77 parts from lot 0799 were subjected to 100 thermal shock cycles between -40°C to +125°C. All parts passed electrical test.



## Summary of Results:

Table 3 lists the status and results of the qualification testing using the TQ-9222 as the test vehicle.

**Table 3. Qualification Test Results Summary.**

Test Description	Sample Size	Status	
Bias Life test	2 Lots 77 (1)	77 parts were subjected to 1,000 hr of HTOL testing. All 77 parts passed electrical testing at 500 hr and 1,000 hr.	77(0) 77(0)
PreConditioning	2 Lots 240 (1)	240 parts were subjected to level 1 Preconditioning and all passed electrically after the stress test.	240(0) 240(0)
Autoclave	2 Lots 77 (1)	All 77 parts passed 76 parts passed, one (1) was damaged in the handler	77(0) 76(0)
HAST	2 Lots 77 (1)	All 77 parts passed	77(0) 77(0)
Temperature Cycle	2 Lots 77 (1)	All 77 parts passed electrical test after stress	77(0) 77(0)
Thermal Shock	2 Lots 77 (1)	All parts passed	77(0) 77(0)

## Detail Test Results from TQ-9222:

### HTOL (High Temperature Operating Lifetest)

TQS Test#1165 & 1184

- Procedure:** In general, the life test procedure follows MIL-STD-883, Method 1005, Condition B or JESD22-A108.
- Purpose:** Life testing 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:** Test # 1165 - 77 parts from lot 0245 were subjected to 1,000 hr of HTOL stress. All parts pass electrical test after 500 and 1,000 hr.  
Test # 1184 - 77 parts from lot 0811 were subjected to 1,000 hr of HTOL stress. All parts pass electrical test after 500 and 1,000 hr.

## ◆ Environmental Test Group

### Preconditioning

TQS Test#1163 &amp; 1183

- Procedure: Preconditioning is performed according to JEDEC Methods A101 & A113.
- Purpose: The purposes of preconditioning are:
- (3) 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.
  - (4) to determine if the solder reflow will have any long-term effect on reliability.
- Results: Test# 1163 - 240 parts from lot 0245 were subjected to level 1 preconditioning with no electrical failures.
- Test# 1183 - 240 parts from lot 0811 were subjected to level 1 preconditioning with no electrical failures.

### Autoclave

TQS Test#1163 &amp; 1183

- 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: Test# 1163 - 77 parts from lot 0245 were subjected to 96 hr of Autoclave  
- All passed electrical test.
- Test# 1183 - 77 parts from lot 0811 were subjected to 96 hr of Autoclave  
- 76 passed electrical test, one (1) part was damaged in the test handler.

### HAST (Highly Accelerated Temperature & Humidity Stress Test)

TQS Test#1163 &amp; 1183

- Procedure: HAST is performed according to JESD22-A110; with the parts biased and an environment of 130°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: Test# 1163 - 77 parts from lot 0811 were subjected to 96 hr of HAST  
- All parts passed electrical test.
- Test# 1183 - 77 parts from lot 0811 were subjected to 96 hr of HAST  
- All parts passed electrical test.

### Temperature Cycle

TQS Test#1163 &amp; 1183

- 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: Test # 1163 - 77 parts from lot 0811 were subjected to 1,000 temperature cycles from -40°C to +125°C - All parts passed electrical tests
- Test # 1183 - 77 parts from lot 0245 were subjected to 1,000 temperature cycles from -40°C to +125°C - All parts passed electrical tests



### ◆ Mechanical Test Group

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#### Thermal Shock (Liquid to Liquid)

TQS Test# 1178 &amp;1185

- Procedure: The test shall be performed according to JESD22-A106 Condition C except  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- 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: Test# 1178 - 77 parts from lot 0799 were subjected to 100 thermal shock cycles between  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . All parts passed electrical test.  
 Test# 1178 - 77 parts from lot 0811 were subjected to 100 thermal shock cycles between  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . All parts passed electrical test.

### □ Conclusion

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- ◆ The SC-3918 is fabricated using TriQuint's new B24  $0.6\mu\text{m}$  E/D MESFET GaAs TQTRx process and is packaged in a QSOP-16 package. Subcontractor "U" performed the assembly and encapsulation of the test samples.
- ◆ The TQ-9222 is fabricated using TriQuint's new B24  $0.6\mu\text{m}$  E/D MESFET GaAs TQTRx process and is packaged in a SSOP-24 package. Subcontractor "U" performed the assembly and encapsulation of the test samples.

The series of tests described in this report were conducted to qualify the new B24 - TQTRx E/D MESFET process.

All testing required to qualify a new process, using an existing product as required in TriQuint's reliability qualification specification REL.021, was successfully completed. No reliability issues were identified during the qualification testing.

Based on the results of this series of tests the B24 process is qualified.