

---

---

# PHEMT Product Qualification Report

## TGC4703-FC, TGC4704-FC

## TGA4705-FC, TGA4706-FC

---

---

### **Abstract**

This report summarizes the reliability testing that was completed to qualify TriQuint's TGC4703-FC, TGC4704-FC, TGA4705-FC, TGA4706-FC.

These products are fabricated at TriQuint Oregon, on the pHEMT GaAs process flow K46B. The products are sold as die sales with bumped die for flip chip applications. The primary customer are automotive electronics, in support of automotive radar applications. The products are general market offerings.

The Qualification Plan was based on Automotive AECQ100 Specification for grade 3 automotive products.

### **Process Description**

TriQuint's K46B pHEMT process flow is a 0.13um Gallium Arsenide (GaAs) semiconductor process fabricated at TriQuint's Oregon facility. The products also use the front-side Cu / Sn pillar technology for flip-chip application.

Mask set K8287 – TGC4703-FC

Mask set K8286 – TGA4705-FC

Mask set K8422 – TGC4704-FC

Mask set K8423 – TGA4706-FC

### **Product Description**

<u>TQNT Part #</u>	<u>Description</u>	<u>Process</u>
TGC4703	19 to 38 GH X2	pHEMT – K46B
TGC4704	38 to 77 GHz X2/ MPA	pHEMT – K46B
TGA4705	77 GHz LNA	pHEMT – K46B
TGA4706	77 GHz MPA	pHEMT – K46B

## **Product Description**

### **TGC4703-FC**

The TriQuint TGC4703-FC is a flip-chip frequency doubler. It combines an input and output buffer amplifier and a frequency doubler for use in automotive radar. The TGC4703-FC is designed using TriQuint's proven 0.13  $\mu\text{m}$  pHEMT process and front-side Cu / Sn pillar technology for simplified assembly and low interconnect inductance. Die reliability is enhanced by using TriQuint's BCB polymeric passivation process. The TGC4703-FC typically provides 14 dBm saturated output power with 8 dB conversion gain. Lead-free and RoHS compliant.

### **TGC4704-FC**

The TriQuint TGC4704-FC is a flip-chip frequency doubler. It combines an output medium power amplifier and a frequency doubler at frequencies in the automotive radar frequency band. The TGC4704-FC is designed using TriQuint's proven 0.13  $\mu\text{m}$  pHEMT process and front-side Cu / Sn pillar technology for simplified assembly and low interconnect inductance. Die reliability is enhanced by using TriQuint's BCB polymeric passivation process. The TGC4704-FC typically provides 14 dBm saturated output power with 5 dB conversion gain. Lead-free and RoHS compliant.

### **TGA4705-FC**

The TriQuint TGA4705-FC is a flip-chip low noise amplifier designed to operate at frequencies that target the automotive RADAR market. The TGA4705-FC is designed using TriQuint's proven 0.13  $\mu\text{m}$  pHEMT process and front-side Cu / Sn pillar technology for reduced source inductance and superior noise performance at frequencies of 72 – 80 GHz. Die reliability is enhanced by using TriQuint's BCB polymeric passivation process. The TGA4705-FC is a low noise amplifier that typically provides 23 dB small signal gain with 5 dB noise figure at 77 GHz. The TGA4705-FC is an excellent choice for applications requiring low noise in receive chain architectures. Lead-free and RoHS compliant.

### **TGA4706-FC**

The TriQuint TGA4706-FC is a flip-chip medium power amplifier designed to operate at the automotive radar frequencies band. The TGA4706-FC is designed using TriQuint's proven 0.13  $\mu\text{m}$  pHEMT process and front-side Cu / Sn pillar technology for simplified assembly and low interconnect inductance. Die reliability is enhanced by using TriQuint's BCB polymeric passivation process. The TGA4706-FC typically provides 14 dBm saturated output power with 15 dB small signal gain at 77 GHz. Lead-free and RoHS compliant.

## **Reliability Test Plan**

The table below lists the qualification plan for the TGC4703/4 and TGA4705/6 devices. The plan is based on the AEC Q100 specification for grade 3 automotive products.

<b>Test:</b>	<b>Device:</b>	<b>Conditions:</b>	<b>Sample Size:</b>	<b># of Lots:</b>	<b>Total Units:</b>
HAST	TGC4705 (LNA)	121C/85%/15psig, 96hr Vd = 2.5V, Vg = -1.0V	77	1	77
Temperature Cycle	TGC4703 (X2)	-50C/125C, 500 cycles	77	1	77
HTOL	TGC4704 (X2/MPA)	TA=105C, 408hr Vd = 3.75V, Vg1 = -0.6V, Vg2 = 0.2V	77	2	154
ESD - HBM	TGC4703, TGC4704, TGA4705, TGA4706	EIA/JESD22-A114	3	1	3
ESD - MM	TGC4703, TGC4704, TGA4705, TGA4706	EIA/JESD22-A115	3	1	3

\* Note that not all devices were used for all reliability tests. Parts not stressed were qualified by similarity.

### **TGC4704 Pre and Post HTOL Test Conditions**

#### **Bias On and Pout Conditions:**

Temperature Testing 25C and 85C

Vd = 5.2V (6.75 V through a 20  $\Omega$  series resistor off-chip)

Vg1 = -0.4V; Vg2 = 0.2V

Measure Pout for +10dBm Pin @ 38.5GHz

Measure Id total with NO RF drive

#### **Pinch-Off Conditions:**

Temperature Testing 25C and 85C

Vd = 5.2V (6.75 V through a 20  $\Omega$  series resistor off-chip);

Vg1 and Vg2 = -0.8V

Measure Ig total

-----

**TGA4705 Pre and Post HAST Test Conditions**

Vd = 2.0V

Vg = sweep from -0.8V to -0.1V

Measure pinch-off voltage at Id = 300uA

**TGC4703 Pre and Post Temp Cycle Test Conditions**

Vd = 3.5V, Vg = -1.0V

Measure total Id and total Ig

Vd = 3.5V, Vg = 0.2V

Measure total Id and total Ig

**Acceptance Criteria:**

Parts must meet customer specification and parts serialized such that “Delta” calculations may be made.

**Summary of Results**

Acceptance criteria was based on the product meeting customer specification and an acceptable parameter shift of <10%.

<b>Test:</b>	<b>Device:</b>	<b>Results (Total/Fail)</b>
HAST	TGC4705 (LNA)	77/0
Temperature Cycle	TGC4703 (X2)	77/0
HTOL	TGC4704 (X2/MPA)	154/0
ESD - HBM	TGC4703 (X2)	50V
ESD - MM	TGC4703 (X2)	<50V
ESD - HBM	TGC4704 (X2/MPA)	100V
ESD - MM	TGC4704 (X2.MPA)	<50V
ESD - HBM	TGA4706 (MPA)	100V
ESD - MM	TGA4706 (MPA)	<50V
ESD - HBM	TGA4705 (LNA)	<50 V
ESD - MM	TGA4705 (LNA)	<50 V