

## Foundry and Custom Design Capabilities Overview

### INTRODUCTION

For over 13 years, TriQuint Semiconductor Texas (TQT) has offered foundry and custom design services which provide external customers with complete monolithic or discrete, hybrid solutions to their microwave integrated circuit and module needs. Today, we have more GaAs process technologies, products, and microwave design and assembly experience than any other foundry. Our worldwide design and foundry support is in Dallas, USA; Northampton, England; Nice, France; and Tokyo, Japan.

TQT's support services include monolithic microwave integrated circuit (MMIC) foundry training; MMIC design, modeling, simulation, layout, test, and assembly consulting; layout, design rule checking, producibility reviews, mask generation, and GaAs processing services.

GaAs MMICs are known for their exceptional quality, reliability, performance, and affordability. As an ISO9001 certified facility, we are a preferred MMIC foundry service and custom design supplier for several leading commercial and military companies. Our foundry, custom design and standard products can be found in cellular phones, optical fiber links and switching networks, short- and medium-haul radios, missiles, military and weather radars, satellite ground transmitters and receivers, and a wide variety of commercial and military satellites. TQT's space heritage is one of the longest and most accomplished in the industry.

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### GaAs PROCESS TECHNOLOGIES

Offering proven, reliable GaAs circuits for challenging commercial and military applications at frequencies to 45 GHz, our 100-mm wafer process technologies include:

- GaAs ion-implanted 0.5 $\mu$ m-gate depletion-mode MesFETs in two profiles: low-noise-low-current (LNLC) and intermediate profile high current (IPHC) for high performance, low cost monolithic microwave integrated circuit (MMIC) applications
- AlGaAs/GaAs 0.5 $\mu$ m-gate heterostructure FETs (power HFETs), for discrete or MMIC high power amplifier applications which demand the ultimate in reliability ( $10^8$  hour median life at 140°C channel temperature) and ruggedness (22V breakdown)
- AlGaAs/GaAs 0.25 $\mu$ m-T-gate pseudomorphic high electron mobility transistors (power pHEMTs), for MMIC applications through 45 GHz demanding the highest gain and most efficient parts possible (for example: 7- to 11-GHz amplifiers with 40% bandwidth, >40% power-added efficiency, 5 and 10 Watts output power, or pHEMTs with less than 2-dB minimum noise figure and 8-dB associated gain at 26 GHz)
- GaAs PIN diodes for switches, attenuators, phase shifters, and limiters which require the lowest insertion loss (<1-dB insertion loss multipoint switches through 20 GHz), and low operating current through 45 GHz
- AlGaAs/GaAs heterojunction bipolar transistors (power HBTs) for the highest power density MMIC transmitters ( $\geq$  20-W power amplifier MMICs through X-band)

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**STANDARD CELL LIBRARY  
AND DEVICE MODELS:  
EM SIMULATION**

Our standard cell library offers linear and nonlinear (modified Materka) models for MesFETs, HFETs, and pHEMTs, in a variety of device sizes and bias conditions. Load-pull impedance information (power, efficiency, gain and noise contours) is available for all device types, including power HBT. Power HBT nonlinear models will be available in the second half of 2000.

Custom device modeling and characterization services are TQT strengths. We also offer on-wafer RF/DC probe test devices and MMICs with s-parameter characterization capabilities to >40 GHz and load-pull characterization capabilities to 30 GHz. Active device models and layouts support HP/EEsof.

TQT provides layouts and models for spiral inductors (100 and 150um substrate thicknesses); metal-insulator-metal (MIM, 2000 A silicon nitride, 300 pF/mm<sup>2</sup>) capacitors; and GaAs (100 to 400 ohms/sq., profile dependent), TaN (50 ohms/sq.), and AuGeNi-based (0.31 to 2 ohms/sq.) thin-film resistors.

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**RELIABILITY AND STABILITY**

Our engineers began their GaAs research in 1965, mainly to support the company's defense electronics business. This vast semiconductor processing expertise has given us a leadership position in the microwave community in developing advanced technology microwave products. This technology is available to support external customer requirements.

Formal reliability studies have been continuously funded, leading to capabilities ranging from ESD tests, infrared temperature measurements, high-temperature life-tests, and advanced device reliability characterization. Over 29 million accelerated life-test device hours have been accumulated on GaAs devices since 1982. These tests, as well as continuous monitoring of the process, have led to a very stable and reliable GaAs processing line. Since our first MMIC qualification for a missile program in 1987, we have built standard and custom space-qualified devices of the highest quality.

We have thirty-plus years of designing and producing microwave modules and components for EW, radar, communications, missile, and space applications. Using both discrete and hybrid methods of construction, access to this experience base and assembly capability is available through either a full custom design or foundry services.

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**FOUNDRY AND  
CUSTOM DESIGN  
SERVICES**

Design library; standard cell models, custom models; HP EEsof Libra support  
Design-to-Specification; design consulting and training  
Circuit synthesis and analysis  
Sensitivity and yield analyses and optimization; design centering  
Design rule checking and verification  
Producibility Reviews  
Linear and nonlinear simulation and models  
EM simulation  
Second-sourcing of MMIC designs  
100-mm wafer processing  
MesFET, HFET, pHEMT, PIN, & HBT Processes; 0.5 and 0.25 um gate lengths  
Wafer PCM/SFC pass/fail testing  
MMIC DC pass/fail testing  
MMIC RF on-wafer probe testing  
Die or wafer deliverables  
Reliability testing; failure analysis  
Thermal Analysis  
Space qualification