TriQuint SEMICONDUCTOR

GaAs MMIC Space Qualification

GaAs MMIC Testing

TriQuint Semiconductor has advanced Lot Acceptance Testing (LAT) for High Reliability Applications of GaAs MMICs. A flowchart depicting the entire MMIC processing flow, including the Quality Conformance Inspection (QCI)/LAT process described herein and wafer-level lot acceptance testing is provided on page 3. The requirements for Standard Product Space Qualification are summarized in table form in Table 2.

Non-Recurring Engineering (NRE)

A packaged assembly will be developed and characterized to verify stability of the device, as well as to ensure a high assembly yield for the qualification Devices Under Test (DUTs). The junction temperature will be modeled for each device type, considering the device power dissipation and the packaged assembly thermal performance. Also, additional test fixtures are designed and built at this time. All required test procedures and associated documentation will be generated.

QCI/LAT FLOW

The QCI uses randomly selected MMICs from the wafer-lot to be qualified, assembled into a package. The assembly processes are mature, documented, and are performed by certified operators in environmentally controlled microelectronics assembly facilities.

Each MMIC is attached with an eutectic AuSn preform to the package carrier plate using a vacuum reflow process. The off-chip components and TFNs are attached with either eutectic solder or conductive epoxy, depending on the test fixture design. High power dissipation assemblies are then inspected for voiding beneath the FET areas using X-ray. The carrier plate assemblies are temperature cycled ten times according to MIL-STD-883, Method 1010, Condition C. Each assembly is visually inspected to MIL-STD-883, Method 2010, Condition B at 80X magnification.

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S-parameters and device currents are checked on the completed assemblies to screen for assembly defects. This initial RF test serves as the performance baseline prior to the burn-in step. For the burn-in and life test, ten DUTs are randomly designated as QCI DUTs from the population that passes the initial RF test. Also, three additional devices are selected as archive/calibration devices. These devices will not be subjected to burn-in. These reference devices will be used to verify the calibration and setup of each test stage. The QCI DUTs are then subjected to a 240-hour burn-in.

The burn-in is conducted under DC bias only, at a baseplate temperature that will result in a predetermined channel temperature for the MMIC.

Following the first burn-in, S-parameters and device currents are again measured. The failure criteria is:

- A +/-10% change in device operating current for amplifiers and mixers,
- A maximum of 100 uA of leakage current for phase shifters and attenuators
- And/or a +/-1 dB change in gain from the prior electrical test on any of the test devices.

The QCI DUTs are then subjected to a 1000-hour, steady-state life test under the same DC bias as the first burn-in. Following the steady-state life test, S-parameters and currents are again measured. The failure criteria is the same as that used for the conditioning burn-in as described above. Note that the delta parameters at the 1000 hr point are taken from the 2nd electrical test not the initial electrical test.

Data from the QCI process is summarized in a report for the customer. All S-parameter data is archived on disk at TriQuint. The DUTs are also archived at TriQuint.

Wafer LAT data and probe data are deliverable at the time of die shipment, and QCI data is typically delivered 16 weeks after delivery of die. The customer may decide to wait for completion of QCI test before accepting shipment of deliverable die.

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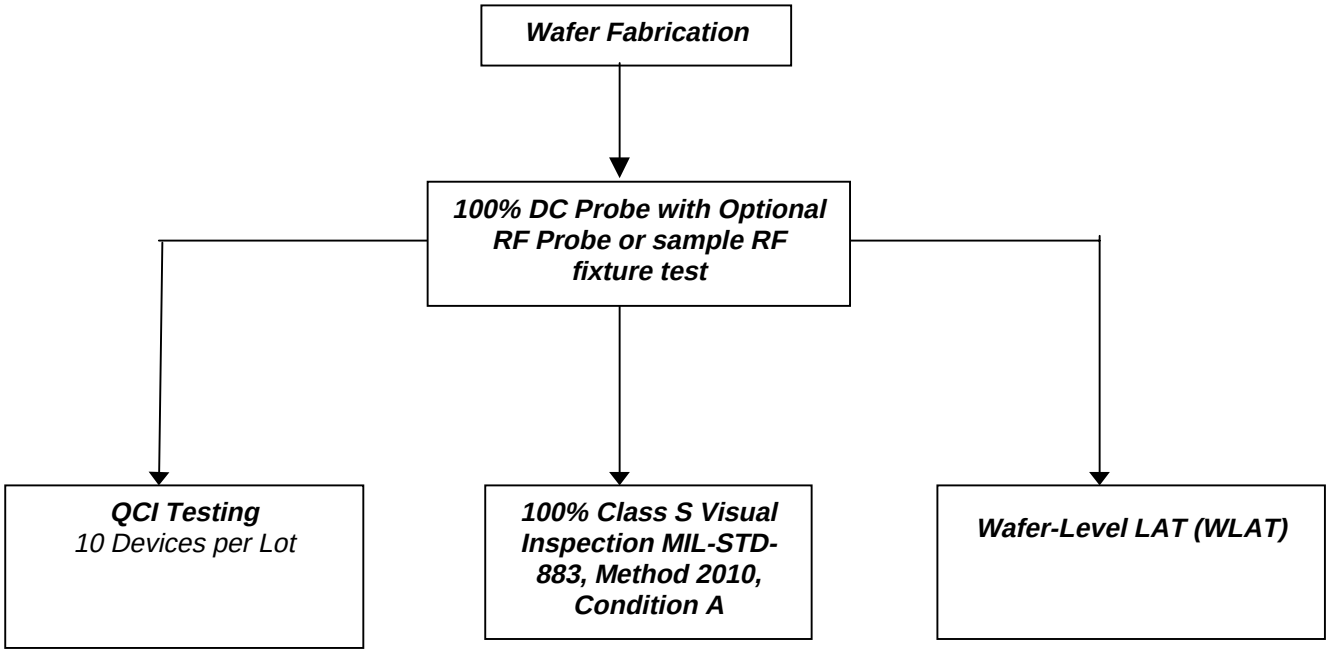
TYPICAL SPACE QUALIFICATION FLOWCHART



Fixture Samples

Assembly screens

DC and RF tests

240-hour burn-in

DC and RF tests

1000-hr life test

DC and RF tests

Bond pull testing

Backside bond pull testing

Lot Process Monitor evaluation

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In an effort to support customer need for quick-turn space level devices, several standard products are available for purchase as off-the-shelf space-qualified devices (subject to current inventory). These products are listed in the Table 1 and in all cases the NRE required for qualification has been previously completed. In addition, any of our other standard products or devices produced with our Foundry wafer processes can be space use qualified. For additional information on these devices, visit the TriQuint website at www.triquint.com

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Table 1. Space Qualified Standard Products

Function	Device	Application Frequency (GHz)	Description	Process
Power Amp	TGA8014	6 - 18	Power Amp	0.5um MESFET
	TGA8334	2 - 20	Power Amp	0.5um MESFET
	TGA2502	13 - 15	Power Amp	0.5um PHEMT 3MI
	TGA9083	6.5 - 11.5	Power Amp	0.25um PHEMT 2MI
	TGA9070	23 - 29	Power Amp	0.25um PHEMT 2MI
	TGA4505	24 - 31	Power Amp	0.25um PHEMT 2MI
	TGA9088A	6 - 18	Power Amp	0.25um PHEMT 2MI
Driver Amp	TGA8399C	6 - 13	Driver Amp	0.25um PHEMT 2MI
	TGA2507	12 - 18	Driver Amp	0.5um PHEMT 3MI
Gain Block	TGA8300	2 - 18	Gain Block	0.5um MESFET
	TGA8622	2 - 20	Gain Block	0.5um MESFET
	TGA8810	2 - 10	Gain Block	0.5um MESFET
	TGA6345	2 - 18	Gain Block	0.5um MESFET
	TGA4832	DC - 35	Wideband Amp	0.15um PWR-PHEMT 3MI
LNA	TGA8310	2 - 20	LNA	0.5um MESFET
	TGA8344	2 - 20	LNA	0.5um MESFET
	TGA8349	DC - 14	LNA	0.5um MESFET
	TGA8399B	6 - 13	LNA	0.25um PHEMT 2MI
	TGA1342	2 - 20	LNA	0.5um MESFET
	TGA4506	20 - 27	LNA	0.15um LN-PHEMT 3MI
Control	TGL6425	0.5 - 18	Digital Atten	0.5um MESFET
	TGL8784	2 - 20	Analog Atten	0.5um MESFET
	TGL4203	DC - 50	Analog Atten	0.25um PHEMT 3MI
	TGS8250	DC - 18	SPDT Switch	0.5um MESFET
	TGS8422	DC - 18	SP4T Switch	0.5um MESFET
Discrete	TGF4350	DC - 22	0.3mm FET	0.25um PHEMT 2MI
Other Experience	Numerous Custom	DC - 40 GHz	Amps	0.25um PHEMT 2MI & 3MI
			Amps	HFET
			Mixers	0.25um PHEMT 2MI
			Phase Shifter	0.25um PHEMT 3MI
			Phase Shifter	0.5um PHEMT 2MI
			Pin Diode Attn.	VPIN

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Table 2. Standard Space Qualification Flow

TEST	CONDITIONS	SAMPLE
Element Visual Inspection	MIL-STD-883, Method 2010, Condition A.	100%
FIRST METAL, GATE METAL, GLASSIVATION, BACKSIDE METALLIZATION AND WAFER THICKNESS MEASUREMENTS	Lot Process Monitor Engineering Data- FIRST METAL thickness, GATE METAL thickness, GLASSIVATION thickness, BACKSIDE METAL thickness, WAFER THICKNESS.	LOT PROCESS MONITORS
Wire Bond Evaluation/ Bond Pull	MIL-STD-883, Method 2011	10 (0) wires per wafer or 20 (1) wires per wafer
Backside Metallization/ Bond Pull	1 mil gold wirebonds bonded to the backside of the die in two corners, no further than 5 mils from either edge. Wires will be pulled to destruction, with a 3g failure strength from MIL-STD-883, Method 2011, Condition D.	10 (0) or 20 (1) per wafer
Internal Visual (Fixtured QCI Samples)	MIL-STD-883, Method 2010, Condition B at 80x	10 (0) per lot
Temperature Cycling	10 Cycles, -65 C TO +150 C, 15 Minute minimum dwells.	10 (0) per lot
Pre-Burn In Electrical (+25 C)		10 (0) per lot
Burn In	240 hours min, Ta = +125 C min*	10 (0) per lot
Post Burn In Electrical (+25 C)	Spec: S21 of +/- 1 dB from Pre-Burn in Electrical	10 (0) per lot
Steady State Life	1000 hours min, Ta = +125 C min*	10 (0) per lot
Post Life Electrical (+25 C)	Spec: S21 of +/- 1 dB from Post burn-in electrical	10 (0) per lot
DELIVERABLE DATA:		
Wafer LAT Report	Process Monitor Data, Bond Pull Data, Backside Bond Pull Data.	
Element Evaluation/QCI Data	Traveler and Test Data from QCI test.	

*Ta may be adjusted such that Tj does not exceed 150 C.