

# Reliability Qualification Report

## SGA-4463

### Products Qualified by Similarity

SGA-2163	SGA-3263	SGA-4163	SGA-5263	SGA-1163
SGA-2263	SGA-3363	SGA-4263	SGA-8343	SGA-1263
SGA-2363	SGA-3463	SGA-4363	SGA-0163	SGL-0163
SGA-2463	SGA-3563	SGA-4563	SGA-0363	SGL-0263



### Testing Summary

<b>Initial Qualification</b>	<b>April, 2000</b>
<b>Periodic Monitoring</b>	<b>Feb, 2002</b>



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## I. Qualification Overview

The SGA-4463 family of products has demonstrated reliable operation by passing all qualification testing in our product qualification test plan. The SGA-4463 has been subject to stresses such as humidity (autoclave), extreme hot and cold environments (temperature cycling), moisture sensitivity (MSL-1 and solder reflow testing), and has demonstrated reliable performance.

## II. Introduction

The SGA-4463 is a high performance SiGe HBT MMIC amplifier. A Darlington configuration provides high  $F_t$  and the heterojunction increases breakdown voltage and minimizes leakage current between junctions. Cancellation of emitter junction non-linearities results in higher suppression of intermodulation products resulting in excellent electrical performance.

## III. Fabrication Technology

These amplifiers are manufactured using a Silicon Germanium Heterojunction Bipolar Transistor (HBT) technology. This patented self-aligned emitter, double poly HBT process has been in production by our foundry since 1998. The process has been successfully used for a wide range of RFIC products including GSM PAs, DECT front end transceivers, LNAs & VCOs. This process offers comparable performance to GaAs HBTs with the added advantages of mature and high producible Silicon wafer processing.

## IV. Package Type

The SGA-4463 power amplifier is packaged in a plastic encapsulated SOT-363 package that is assembled using a highly reproducible automated assembly process. The die is mounted using an industry standard thermally and electrically conductive silver epoxy. The SOT-343 is a similar package differing only by having two fewer leads than the SOT-363.



Figure 1: Rendering of SOT-363 Encapsulated Plastic Package



# SGA-4463 Reliability Qualification Report

## V. Qualification Methodology

The Sirenza Microdevices qualification process consists of a series of tests designed to stress various potential failure mechanisms. This testing is performed to ensure that Sirenza Microdevices products are robust against potential failure modes that could arise from the various die and package failure mechanisms stressed. The qualification testing is based on JEDEC test methods common to the semiconductor industry. The manufacturing test specifications are used as the PASS/FAIL criteria for initial and final DC/RF tests.

## VI. Qualification by Similarity

A device can be qualified by similarity to previously qualified products provided that no new potential failure modes/mechanisms are possible in the new design. The following products have been qualified by similarity to SGA-4463:

SGA-2163	SGA-3263	SGA-4163	SGA-5263	SGA-1163
SGA-2263	SGA-3363	SGA-4263	SGA-8343	SGA-1263
SGA-2363	SGA-3463	SGA-4363	SGA-0163	SGL-0163
SGA-2463	SGA-3563	SGA-4563	SGA-0363	SGL-0263

## VII. Operational Life Testing

Sirenza Microdevices defines operational life testing as a DC biased elevated temperature test performed at the maximum operational junction temperature limit. For the SGA-4463 the maximum operational temperature limit is 150°C. The purpose of the operational life test is to statistically show that the product operated at its maximum operational ratings will be reliable by operating several hundred devices for a total time of 1000 hours. The results for this test are expressed in device hours that are calculated by multiplying the total number of devices passing the test by the number of hours tested.

## VIII. Moisture Sensitivity Level (MSL)

SGA-4463 has successfully completed 168 hours of moisture soak (85°C/85%RH) followed by three convection reflow cycles with a peak temperature of 235°C. The successful completion of this test classifies the part as JEDEC 22-A113B Moisture Sensitivity Level 1 (MSL-1). MSL-1 indicates that no special dry pack requirements or time limits from opening of static bag to reflow exist for the SGA-4463. MSL-1 is highest level of moisture resistance that a device can be classified according to the above mentioned standard.



# SGA-4463 Reliability Qualification Report

## IX. Qualification Test Details for SGA-4463

Test Description	Test Condition	Test Standard	Failure Criteria
Moisture Preconditioning /Reflow Simulation (MSL -1 condition)	85°C/85°C RH, 168 hrs, 3 cycles in convection reflow oven	JEDEC 22-A113	Functional test specification according to manufacturing test specification.
Temperature Cycle (Air to Air Thermal Shock)	-65°C to 150°C, 1000 cycles, dwell time = 10 min., transistion time <1 min.	JEDEC 22-A104	Functional test specification according to manufacturing test specification.
High Temperature Operating Life Test	T <sub>j</sub> = 150°C, 1000 hrs	JEDEC 22-A108	Thermal junction limits according to specification
Autoclave (Pressure Pot)	121°C, 15PSI, 96 hrs	JEDEC 22-A102	Functional test specification according to manufacturing test specification.
Solderability Steam Age	215°C, 60 Seconds	JEDEC 22-B102	Visual inspection solder according to manufacturing specification. (Coverage > 95%)
High Temperature Storage	150°C, 1000 hrs.	JEDEC 22-A103	Functional test specification according to manufacturing test specification.

Table 1: Summary of Qualification Testing



# SGA-4463 Reliability Qualification Report

## X. Operational Life Test Results

The results for SGA-4463 High Temperature Operating Life Test are as follows:

Test Date	Qualification Type	Test Time (hours)	Junction Temperature	Quantity In	Quantity Out	Device Hours
Mar-00	Initial Qualification	1000	150	329	329	329,000
<b>Cumulative Device Hours</b>						<b>329,000</b>

Table 2: Summary of High Temperature Operational Life Test Cumulative Device Hours

## XI. Cumulative Qualification Test Results

The following table summaries the qualification results for SGA-4463.

Mar-00	SGA-6486 Initial Qualification	Test Standard	Qty In	Qty Out	Qty Pass	
A0	Moisture Preconditioning / IR Reflow Simulation (MSL -1)	JEDEC 22-A113B	650	650	650	PASS
A1	Temperature Cycle (-65°C to 150C 1000 cycles)	JEDEC 22-A104A	94	94	92*	PASS
A2	High Temp Operating Life 1000 hrs (Tj=150C, 1000hrs)	JEDEC 22-A108A	329	329	329	PASS
C	Autoclave (121°C, 15 PSI, 96 hrs)	JEDEC 22-A102B	73	73	73	PASS
E	Solderability Steam Age	JEDEC 22-B102C	60	60	60	PASS
G	High Temp Storage (1000 hrs T= 150°C)	JEDEC 22-A103A	43	43	43	PASS
<b>Feb-02 SGA-8343** Periodic Monitor</b>						
A0	Moisture Preconditioning / IR Reflow Simulation (MSL -1)	JEDEC 22-A113B	128	128	128	PASS
A1	Temperature Cycle (-65°C to 150C 1000 cycles)	JEDEC 22-A104B	45	45	45	PASS
C	Autoclave (121°C, 15 PSI, 96 hrs)	JEDEC 22-A102C	32	32	32	PASS
G	High Temp Storage (1000 hrs T= 150°C)	JEDEC 22-A103B	22	22	22	PASS

\*2 Devices removed to mishandling during RF test (leads broken in test fixture)

\*\*SGA-8343 was used for the first periodic monitor for this family.

Table 3: Qualification and Monitoring Test Results for SGA-4463.



# SGA-4463 Reliability Qualification Report

## XII. Junction Temperature Determination

One key issue in performing the qualification testing is to accurately determine the junction temperature of the device. Sirenza Microdevices uses a 3um spot size infrared camera that allows a device to be measured at its normal operational parameters. The 3um spot size allows for very good resolution compared to the heated area of the transistor, which in this case is approximately 2-3um. The results for the SGA-4463 device, running at maximum operational current of 45mA, a device voltage of 3.2V, and a base plate lead temperature of 85°C.

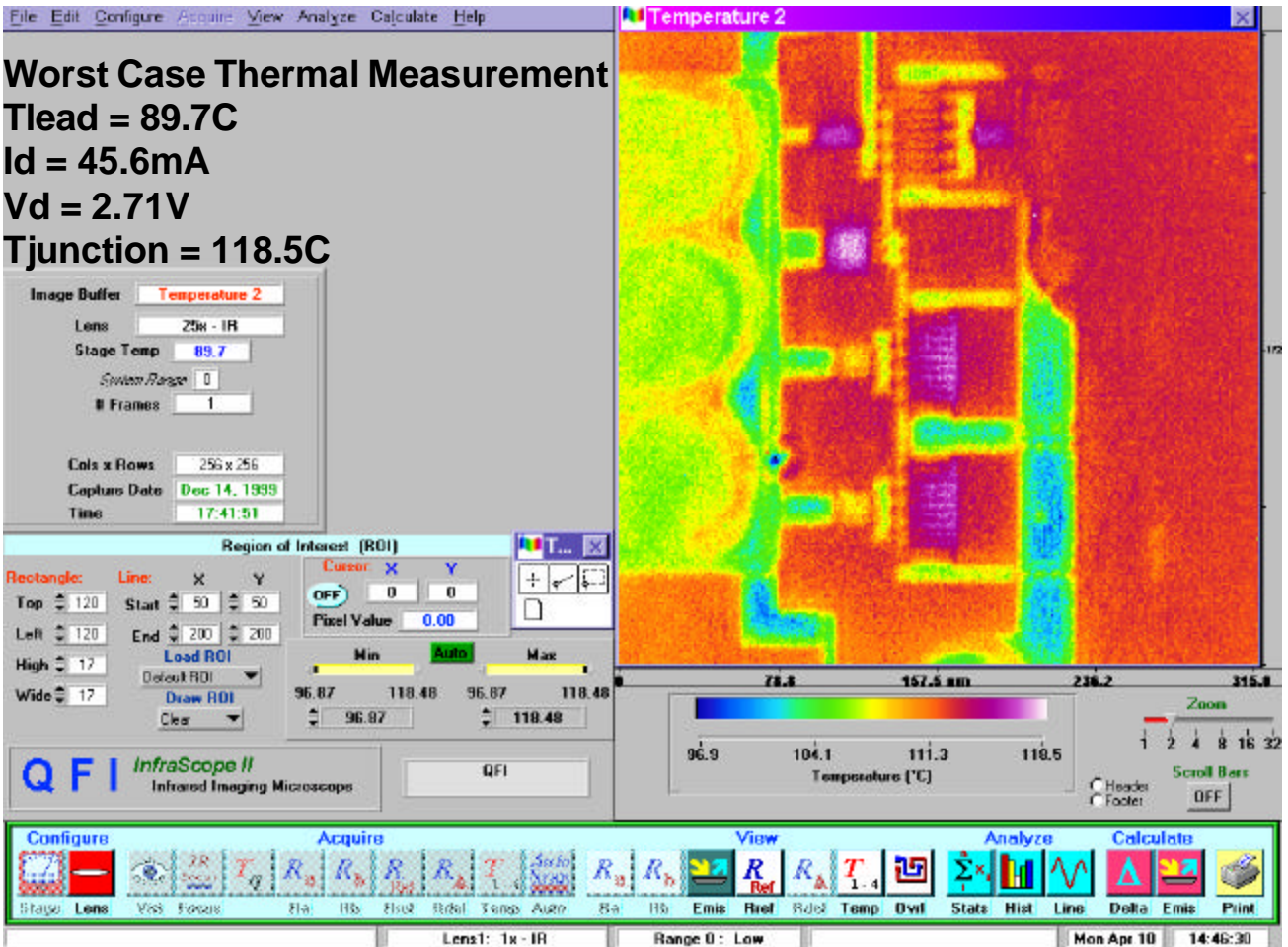


Figure 2: Infrared Thermal Image of SGA-4463, Vd = 3.2V, Id = 45mA, Tlead = 85C





# SGA-4463 Reliability Qualification Report

## XIII. Accelerated Life Test Results

The following data demonstrates the results from accelerated life tests performed on the Sirenza 4A SiGe HBT Process. The test was performed on 77 units running at a peak junction temperature of 195°C. The test exceeded 10,000 hours (1.14 years) with no failures. The FIT rate / MTTF calculation can be found below. The FIT rates were generated assuming 1 failure. In reality, there were no failures, making this a very conservative calculation.

### Sirenza Microdevices Process 4A SiGe HBT FIT Rate / MTTF Calculation SGA Series Devices

#### Parameters

\*Ea = 0.7 eV

Junction Temp C	FIT Rate	MTTF (hrs)
55	0.053	1.89E+10
125	4.136	2.42E+08

•The Ea of 0.7eV is conservative, 0.85eV is the activation energy for electromigration which is assumed to be the primary failure mechanism for the SiGe process.

•Sirenza Microdevices does not assume any liability arising from the use of this data.