Reliability Qualification Report

SGA-8343X

Products Qualified by Similarity

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SGA-8343X Reliability Qualification Report

I. Qualification Overview

The SGA-8343X family of products has demonstrated reliable operation by passing all qualification testing in our product qualification test plan. The “X’ designates a lead-free lead frame using Tin plated leads. The SGA-8343X 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

Sirenza Microdevices’ SGA-8343X is a high performance Silicon Germanium Heterostructure Bipolar Transistor (SiGe HBT) designed for operation from DC to 6 GHz. The SGA-8343X is optimized for 3V operation but can be biased at 2V for low voltage battery operated systems. The device provides high gain, low NF, and excellent linearity at a low cost. It can be operated at very low bias currents in applications where high linearity is not required.

III. Fabrication Technology

These amplifiers are manufactured using a Silicon Germanium Heterojunction Bipolar Transistor (HBT) technology. This 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-8343X power amplifier is packaged in a plastic encapsulated SOT-343 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: Image of SOT-343 Encapsulated Plastic Package

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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. No other products is qualified by similarity to this product.

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-8343X the maximum operational temperature limit is 150ºC. 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 Level 1 Device

SGA-8343X has successfully completed 168 hours of moisture soak (85ºC/85%RH) followed by three convection reflow cycles with a peak temperature of 270ºC. The successful completion of this test classifies the part as JESD 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-8343X. MSL-1 is highest level of moisture resistance that a device can be classified according to the above mentioned standard.

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VIIII. Electrostatic Discharge Classification

Sirenza Microdevices classifies Human Body Model (HBM) electrostatic discharge (ESD) according to the JESD22-A114 convention. All pin pair combinations were tested. Each pin pair is stressed at one static voltage level using 1 positive and 1 negative pulse polarity to determine the weakest pin pair combination. The weakest pin pair is tested with 3 devices below and above the failure voltage to classify the part. The Pass/Fail status of a part is determined by the manufacturing test specification. The ESD class quoted indicates that the device passed exposure to a certain voltage, but does not pass the next higher level. The following table indicates the JESD ESD sensitivity classification levels. The results of the testing indicate that SGA-8343X's HBM ESD rating is Class 1B.

Class	Passes	Fails
0	0 V	<250 V
1A	250 V	500 V
1B	500 V	1000 V
1C	1000 V	2000 V
2	2000 V	4000 V

X. Operational Life Test Results

The results for SGA-8343X High Temperature Operating Life Test are as follows

HTOL Completion Date	Test Duration	Junction Temperature	Quantity	Device Hours
Mar-04	**1000 hours**	**150°C**	**80**	**80,000**

Table 1: Summary of High Temperature Operational Life Test Cumulative Device Hours

XI. Qualification Test Results for SGA-8343X

Initial Qualification Date – March, 2004

Group A0	**Moisture preconditioning and three reflow cycles**				
Test Conditions	Temperature = 270°C Peak, Slope < 6°C/second				
Number of Devices Under Test	145	**Test Standard**	JESD22-A113(C)	**Results**	PASS

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Group A1a	**Temperature Cycling (Air to Air Thermal Shock) – Soldered on PCB**				
Test Conditions	Temperature Range -65°C to 165°C, 10 min dwell, 1 minute transition, 1000 cycles				
Number of Devices Under Test	17	**Test Standard**	JESD22-A104(B)	**Results**	Pass
Group A1b	**Temperature Cycling (Air to Air Thermal Shock)**				
Test Conditions	Temperature Range -65°C to 165°C, 10 min dwell, 1 minute transition, 1000 cycles				
Number of Devices Under Test	25	**Test Standard**	JESD22-A104(B)	**Results**	PASS
Group A2	**High Temperature Operating Life Test**				
Test Conditions	Junction Temperature = 150°C, Test Duration = 1000 hours				
Number of Devices Under Test	80	**Test Standard**	JESD22-A108(B)	**Results**	PASS
Group B	**HAST**				
Test Conditions	Temperature = 110°C, 85% Relative Humidity, Test Duration = 264 hours				
Number of Devices Under Test	15 (1)	**Test Standard**	JESD22-A110(B)	**Results**	PASS
Group C	**Autoclave**				
Test Conditions	Temperature = 121°C, Relative Humidity = 100%, Test Duration = 96 hours				
Number of Devices Under Test	40	**Test Standard**	JESD22-A102(C)	**Results**	PASS

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Group D	**Power Temperature Cycle**				
Test Conditions	Temperature = -40°C to 85°C, Asynchronous bias, Test Duration = 168 hours				
Number of Devices Under Test	20	**Test Standard**	JESD22-A109(A)	**Results**	PASS
Group E	**Low Temperature Storage**				
Test Conditions	Temperature = -40°C, Test Duration = 1000 hours				
Number of Devices Under Test	20	**Test Standard**	SMDI Internal	**Results**	PASS
Group F	**High Temperature Storage**				
Test Conditions	Temperature = 150°C, Test Duration = 1000 hours				
Number of Devices Under Test	22	**Test Standard**	JESD22-A103(B)	**Results**	PASS
Group G	**Solderability Steam Age**				
Test Conditions	Temperature = 215°C, Test Duration = 60 seconds				
Number of Devices Under Test	15	**Test Standard**	JESD22-B102(C) Condition A	**Results**	PASS
Group H	**Solderability Steam Age**				
Test Conditions	Temperature = 245°C, Test Duration = 60 seconds				
Number of Devices Under Test	15	**Test Standard**	JESD22-B102(C) Condition B	**Results**	PASS

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Group J	Tin Whiskering Biased				
Test Conditions	Temperature 51°C/85% humidity. Test Duration 1000 hours.				
Number of Devices Under Test	15	**Test Standard**	SMDI Internal	**Results**	PASS
Group K	**Tin Whiskering Unbiased**				
Test Conditions	Temperature 51°C/85% humidity. Test Duration 1000 hours.				
Number of Devices Under Test	15	**Test Standard**	SMDI Internal	**Results**	PASS

(1)

1 device removed for improper assembly. See CAR number 350; Reference FA04032.

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XII. Junction Temperature Determination

One key issue in performing qualification testing is to accurately determine the junction temperature of the device. Sirenza Microdevices uses a 3um spot size emissivity corrected infrared camera measurement to resolve the surface temperature of the device at the maximum operational power dissipation. The results are displayed below for the device running at operational current of 50mA, a device voltage of 4V, and a lead temperature of 85°C.

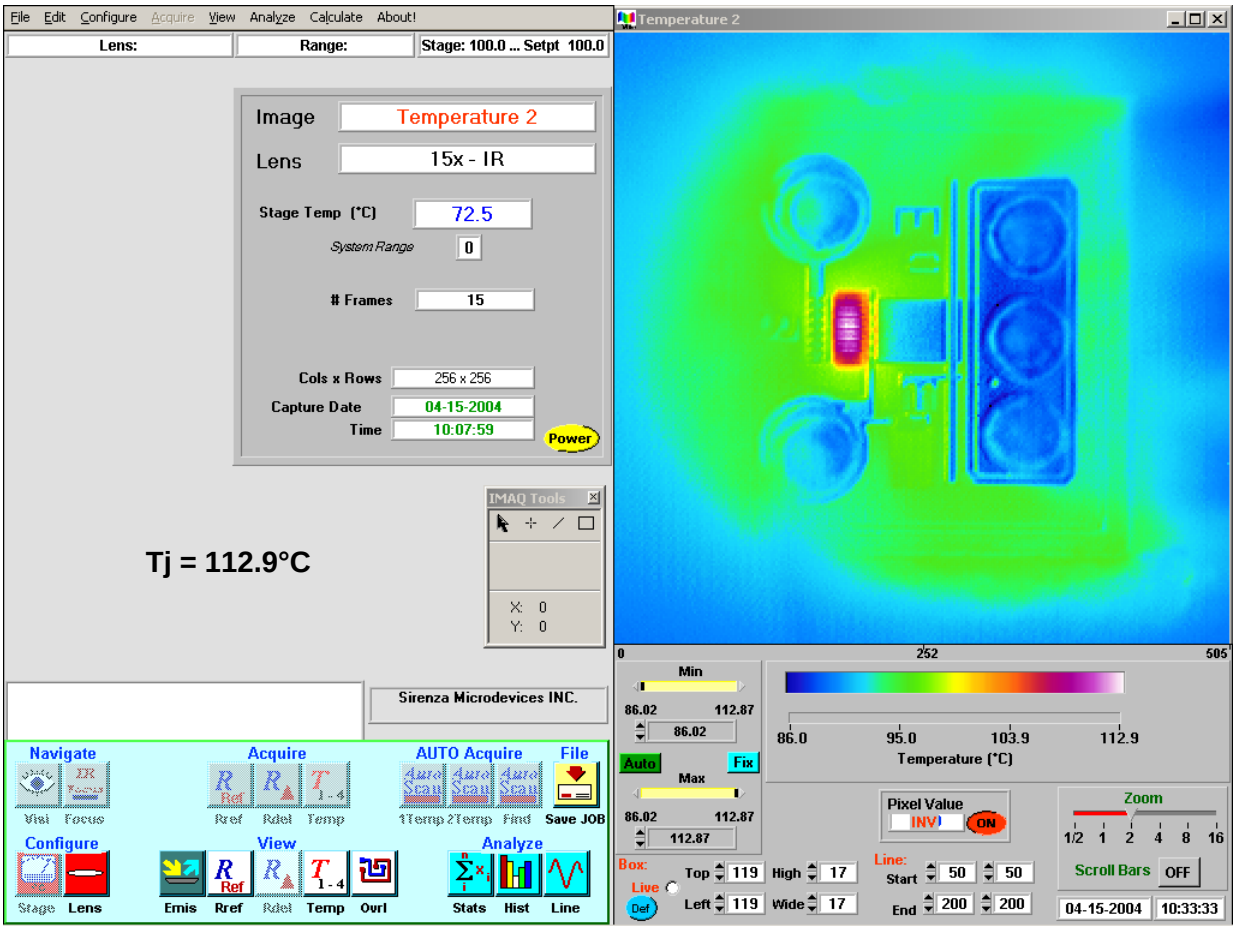

Figure 2: Infrared Thermal Image of SGA-8343X, Vd =4V, Id =50 mA, T lead = 85°C

XII. Median Time to Failure Extrapolation from Accelerated Life Test Data

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.

Table 3: Median Time to Failure and Activation Energy for SGA-8343X.