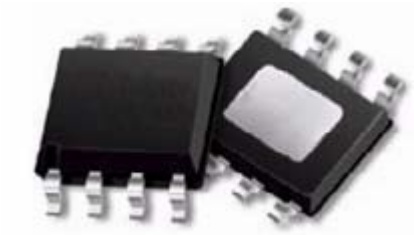
Reliability Qualification Report

CGA-3318 - SnPb Plated

CGA-3318Z - Matte Sn, RoHS Compliant



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CGA-3318/CGA-3318Z
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I. Qualification Overview

The CGA-3318 family of products has demonstrated reliable operation by passing all qualification testing outlined in our product qualification test plan. The CGA-3318 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 demonstrated reliable operation.

II. Introduction

Sirenza Microdevices CGA-3318 family of products are a high performance Silicon Germanium HBT MMIC amplifier, designed with the SiGe process technology for excellent linearity. A Darlington configuration is utilized for broadband performance. The heterojunction increases breakdown voltage and minimizes leakage currents between junctions. The package contains two amplifiers for use in wideband push-pull CATV amplifiers requiring excellent second order performance. The second and third order non-linearities are greatly improved in the push-pull configuration.

III. Fabrication Technology

The CGA-3318 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 highly reproducible Silicon wafer processing.

IV. Package Type

The CGA-3318 is packaged in a plastic encapsulated Exposed Pad 8 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 die is mounted directly to the exposed paddle to provide a low thermal resistance path for heat conduction out of the package.

Figure 1 : Photograph of Exposed Pad 8 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 JESD 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 CGA-3318/3318Z:

VII. Operational Life Testing

Sirenza Microdevices defines operational life testing as a DC biased elevated temperature test performed at the maximum junction temperature limit. For the CGA-3318 family, the absolute maximum temperature limit is 150°C. The purpose of the life test is to statistically show that the product operated at its maximum recommended ratings will be reliable by operating several devices at absolute maximum 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.

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VIII. Moisture Sensitivity Level - MSL Level 1 Device

Sirenza Microdevices classifies moisture sensitivity levels (MSL) according to the JESD 22-A113 convention. Moisture sensitivity levels are ranked from level 1 (most resistive to moisture) to level 5 (least resistive to moisture). The moisture sensitivity level is determined by a moisture soak test (temperature and humidity) for various temperatures, humidity levels, and times according to the requirements for a particular level, followed by three passes through a convection reflow oven at 270°C (Z version), or at 235°C (non-Z version). This simulates stress from storage in high humidity environments and immediate assembly. For a device to be classified level 1 (MSL-1), the device must pass manufacturing test specifications following the moisture soak and reflow test. The results of the testing classify CGA-3318 family as MSL-1, the most resistant to humidity, indicating that no special anti-moisture packaging or handling is required.

IX. 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.

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

Part Number	HBM ESD Rating
CGA-3318	Class 1B
CGA-3318Z	Class 1B

X. Operational Life Test Results

HTOL Completion Date	Test Duration	Junction Temperature	Quantity	Device-Hours
Oct 2001	**1000 hours**	**150°C**	**178**	**178,000**

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XI. Qualification Test Results

Group	Test Name	Test Condition/ Standard	Sample Size	Results
B	Preconditioning	MSL1 Reflow @ 235°C Peak JESD22-A113C (Non-Z version) MSL1 Reflow @ 270°C Peak JESD22-A113C (Z version)	478 [1] 420	Pass
B1a	Temperature Cycling	Air to Air, Soldered on PCB -65°C to 165°C 10 min dwell, 1 min transition 1000 cycles JESD22-A104B (Z version)	60	Pass
B1b	High Temperature Operating Life	T_j = 150°C 1000 hours JESD22-A108B (Non-Z version) T_j = 150°C 1000 hours JESD22-A108B (Z version)	178 120	Pass
B1c	HAST	T_{amb}=110°C, 85%RH Biased, 264 hours JESD22-A110B (Z version)	25	Pass

(1) One device was removed due to low current and gain after pre-condition. Refer to CGA-3318 analysis report FA01059 for further details.

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XI. Qualification Test Results

Group	Test Name	Test Condition/ Standard	Sample Size	Results
B1d	Power Temperature Cycle	-40°C to +85°C Cycled bias (5' on/5'off) 1000 cycles JESD22-A109A (Z version)	60	Pass
B3	Temperature Cycle	-65°C to +150°C 10 min dwell, 1 min transition 1000 cycles JESD22-A104B (Non-Z version)	100	Pass
		-65°C to +150°C 10 min dwell, 1 min transition 1000 cycles JESD22-A104B (Z version)	86	
C	Autoclave	T_{amb}=121°C, 100%RH Un-Biased, 96 hours JESD22-A102C (Non-Z version)	90	Pass
		T_{amb}=121°C, 100%RH Un-Biased, 96 hours JESD22-A102C (Z version)	60	

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XI. Qualification Test Results

Group	Test Name	Test Condition/ Standard	Sample Size	Results
E	High Temperature Storage	T_{amb}=150°C 1000 hours JESD22-A103B (Non-Z version)	50	Pass
		T_{amb}=150°C 1000 hours JESD22-A103B (Z-version)	40	
F	Tin Whisker	T_{amb}=60°C, 90%RH 3500 hours NEMI (Z version)	9	Pass
G	Solderability	Dip & Look Steam Age Condition C Dip Condition B, 245°C JESD22-B102C (Z-version)	15	Pass

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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 CGA-3318 device running at operational current of Iq= 160mA, a device voltage of 4.8V, lead temperature of 85°C.

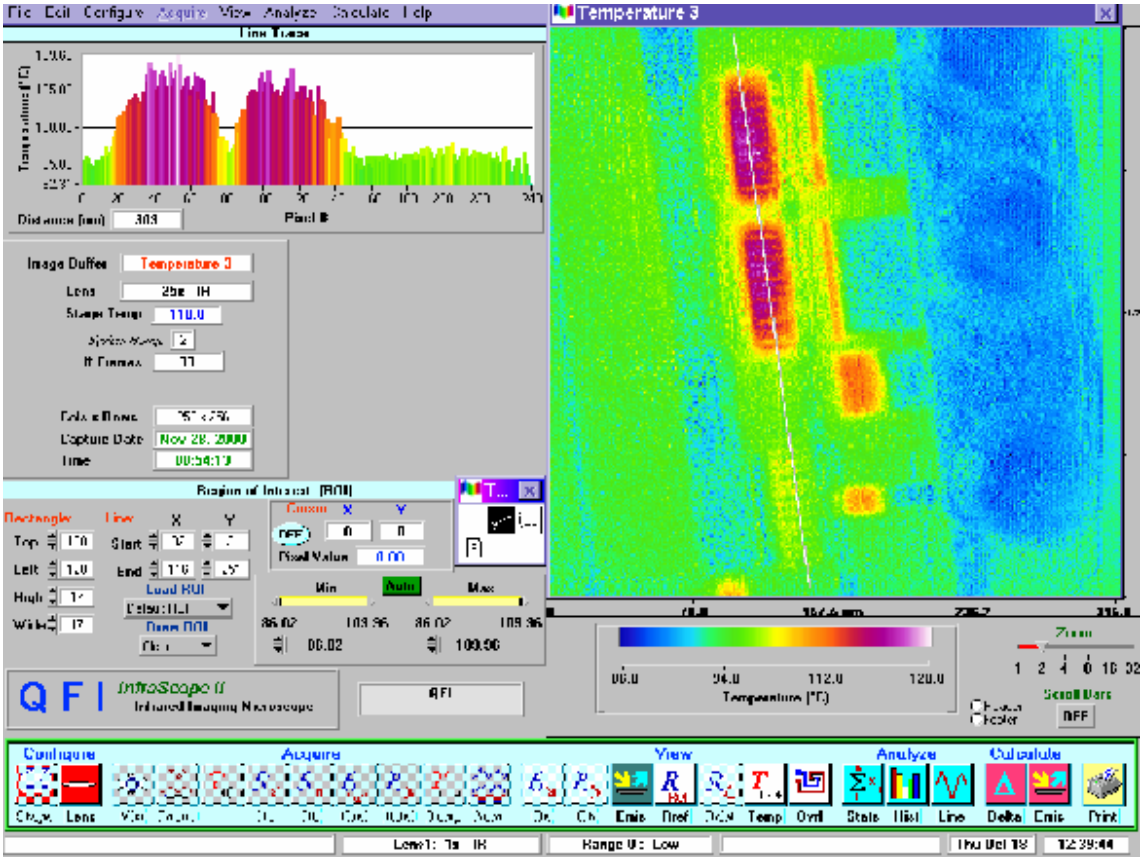

Figure 2: Infrared Thermal Image of CGA-3318, Vd = 4.8V, Id = 160mA, Tc = 85C

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XIII. 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 MTTF calculation can be found below.

Sirenza Microdevices Process 4ASiGe HBT
MTTF Calculation

Parameters

*Ea = 0.7 eV

Junction Temp C	MTTF (hrs)
55	1.89E+10
125	2.42E+08

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