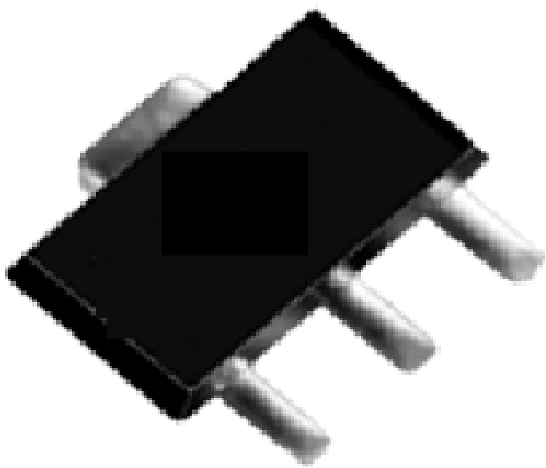
Reliability Qualification Report

SBB-2089Z

Products Qualified by Similarity

SBB-1089	SBB-1089Z
	SBB-3089Z
SBB-2089	SBB-4089Z
SBB-4089	SBB-5089Z
SBB-5089	CGB-1089Z



Initial Qualification	**Feb 2005**
Additional HAST	**June 2005**

303 S. Technology Ct, Broomfield CO, 80021 *Phone: (800) SMI-MMIC* *http://www.rfmd.com*

Document RQR-104280- Rev. F

SBB-2089Z Reliability Qualification Report

I. Qualification Overview

The SBB-2089Z has demonstrated reliable operation by passing all qualification testing in our product qualification test plan. The SBB-2089Z has been subjected to stress testing such as humidity (HAST and autoclave), extreme hot and cold environments (temperature cycling), moisture sensitivity (MSL-1 and solder reflow testing), and several others.

II. Introduction

RFMD's SBB-2089Z is a high performance InGaP/GaAs Heterojunction Bipolar Transistor MMIC Amplifier. A Darlington configuration designed with InGaP process technology provides broadband performance up to 5 GHz with excellent thermal performance. Only a single positive supply voltage, DC-blocking capacitors, a bias resistor, and an optional RF choke are required for operation.

III. Fabrication Technology

The SBB-2089Z amplifier is manufactured using a InGaP/GaAs Heterojunction Bipolar Transistor (HBT) technology. The devices are fabricated using MOCVD epitaxy technology which produces consistent and reproducible performance from lot to lot. Through the use of InGaP emitters, a mature MMIC fabrication process and rigorous in-process monitoring, excellent reliability with MTTF of greater than 7 x 10^6 hrs at 150°C have been achieved.

IV. Package Type

The SBB-2089Z power amplifier is packaged in a plastic encapsulated SOT-89 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 ground leads are fused to the paddle to provide a low thermal resistance heat conduction path.

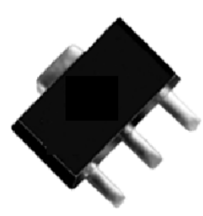


Figure 1 : Photograph of SOT-89 Encapsulated Plastic Package

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V. Qualification Methodology

The RFMD qualification process consists of a series of tests designed to stress various potential failure mechanisms. This testing is performed to ensure that RFMD 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 SBB-2089Z.

SBB-1089/SBB-1089Z/SBB-2089/SBB-3089Z/SBB-4089/SBB-4089Z/SBB-5089/SBB-5089Z/CGB-1089Z

VII. Operational Life Testing

RFMD defines operational life testing as a DC biased elevated temperature test performed at the maximum junction temperature limit. For the SBB-2089Z the absolute maximum temperature limit is 150ºC. 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.

VIII. Moisture Sensitivity Level - MSL Level 1 Device

RFMD 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 270ºC (Z versions), or at 235ºC (non-Z versions). 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 SBB-2089Z as MSL-1, the most resistant to humidity, indicating that no special anti-moisture packaging or handling is required.

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IX. Electrostatic Discharge Classification

RFMD 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 SBB-2089Z's HBM ESD rating is Class 2.

HBM 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

MM Class	Passes	Fails
A		<200 V
B	200 V	400 V
C	400 V	

Part Number	HBM ESD Rating
SBB-2089Z	Class 2
SBB-3089Z	Class 2
SBB-5089Z	Class 1C
CGB-1089Z	Class 2

Part Number	MM ESD Rating
SBB-5089Z	Class A

X. Operational Life Test Results

The results for SBB-2089Z High Temperature Operating Life Test are as follows:

HTOL Completion Date	Test Duration	Junction Temperature	Device-Hours	Passing Units/Sample Size
Dec. 2004	**1000 hours**	**150°C**	**80,000**	**80/80**

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XI. Qualification Test Results

Group	Test Name	Test Condition/ Standard	Sample Size	Results
B	Preconditioning	MSL1 Reflow @ 270ºC Peak JESD22-A113C	262	Pass
B1a	Temperature Cycling	Air to Air, Soldered on PCB -65ºC to 150ºC 10 min dwell, 1 min transition 1000 cycles JESD22-A104B	20	Pass
B1b	High Temperature Operating Life	Tj = 150°C 1000 hours JESD22-A108B	80	Pass
B1c	HAST	Tamb=110°C, 85%RH Biased, 264 hours JESD22-A110B	87	Pass
B1d	Power Temperature Cycle	-40°C to +85°C Cycled bias (5' on/5'off) 1000 cycles JESD22-A109A	10	Pass
B2	Autoclave	Tamb=121°C, 100%RH Un-Biased, 96 hours JESD22-A102C	30	Pass
B3	Temperature Cycle	Air to Air -65°C to +150°C 10 min dwell, 1 min transition 1000 cycles JESD22-A104B	30	Pass

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XI. Qualification Test Results

Group	Test Name	Test Condition/ Standard	Sample Size	Results
C	Low Temperature Storage	Tamb=-40°C 1000 hours JESD22-A119	20	Pass
D	High Temperature Storage	Tamb=150°C 1000 hours JESD22-A103B	20	Pass
F	Tin Whisker	Tamb=60°C, 90%RH 2000 hours NEMI	10	Pass
G	Solderability	Dip & Look Sn/Pb solder Steam Age Condition C Dip Condition A, 215°C JESD22-B102C Dip & Look Sn/Ag/Cu solder Steam Age Condition C Dip Condition B, 245°C JESD22-B102C	15 15	Pass Pass
H	ESD – Human Body Model	JESD22-A114	27	Class 2

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XII. Junction Temperature

One key issue in performing qualification testing is to accurately determine the junction temperature of the device. RFMD 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 SBB-2089Z device running at operational current of 88.1mA, a device voltage of 4.9V, a stage temperature of 81.9°C, and a lead temperature of 85.0°C.

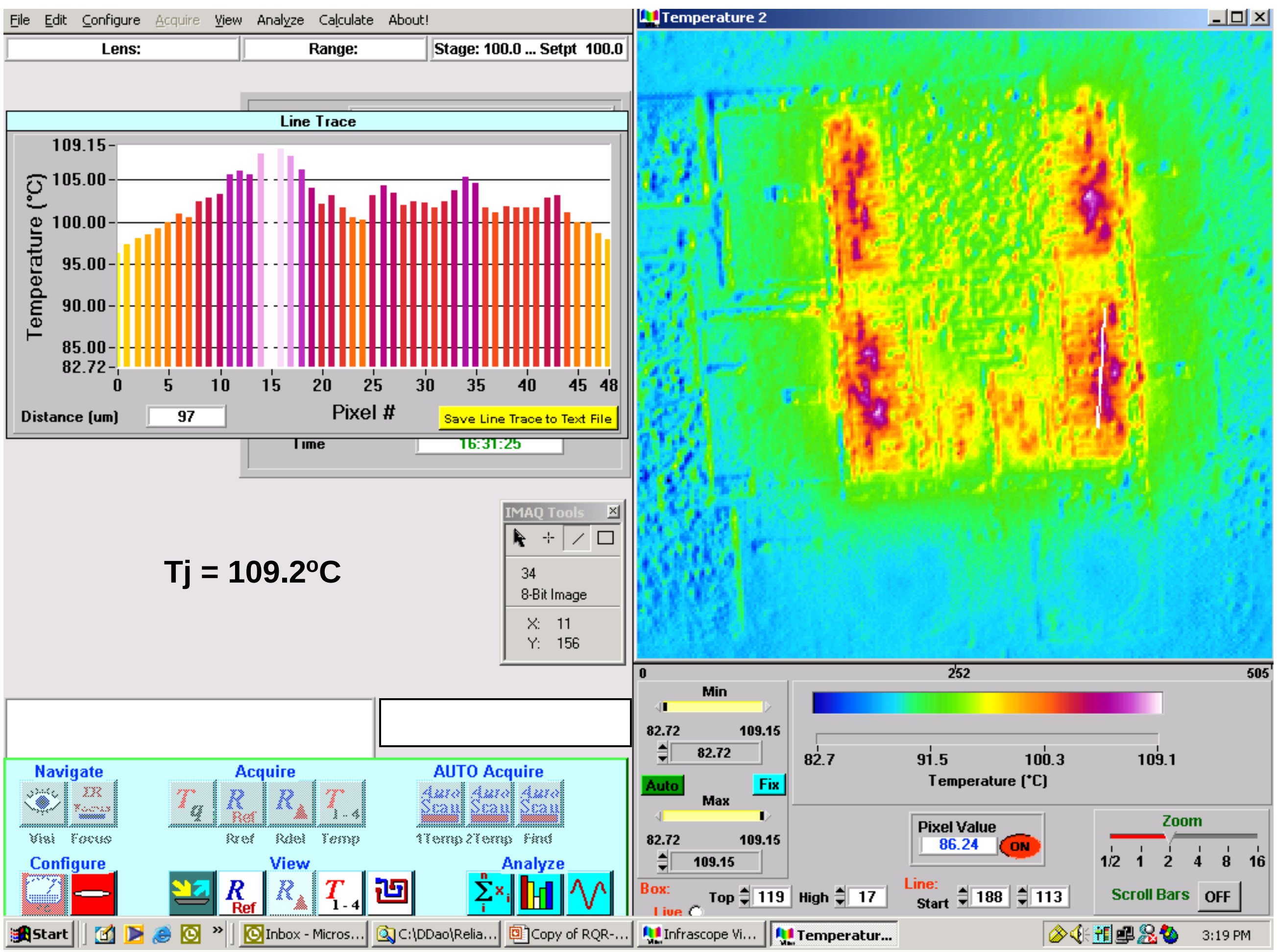

Figure 2: Infrared Thermal Image of SBB-2089Z, Vd =4.9V, Id =88.1 mA,
Lead Temp = 85.0°C

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Below are results for the SBB-4089Z device running at operational current of 85.4mA, a device voltage of 5.0V, a stage temperature of 81.9°C, and a lead temperature of 85.0°C.

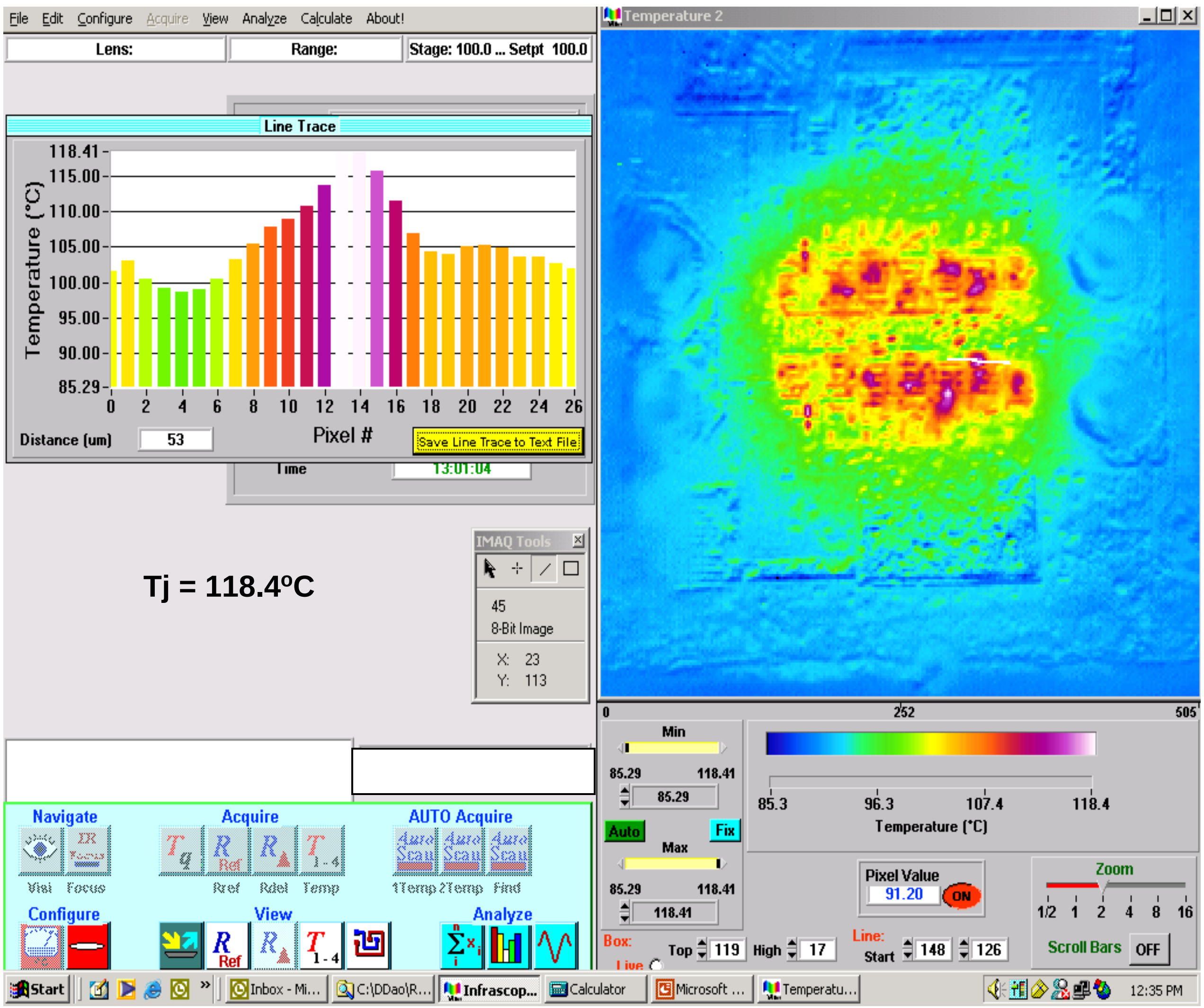

Figure 3: Infrared Thermal Image of SBB-4089Z, Vd =5.0V, Id =85.4 mA, Lead Temp = 85.0°C

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

The median time to failure and activation energy for the SBB-2089Z is detailed in the following table. The extrapolation is determined by performing a regression on empirical accelerated life test (ALT) data. The criteria of failure for the ALT was a 20% reduction in beta (current gain) for the transistor.

Activation Energy	1.38eV
Median Time to Failure @ 85°C lead, 4.9V, 88.1mA	$7x10^6$ Hours

Table 4: Median Time to Failure and Activation Energy for SBB-2089Z.