Reliability Qualification Report

SGA-9189

Products Qualified by Similarity

SGA-9289

March, 2001

SGA-9189 Reliability Qualification Report

Introduction

Stanford Microdevices' SGA-9189 is a high performance amplifier designed for operation from DC to 3500 MHz. With optimal matching at 2 GHz, TOI = 39 dBm and P1dB=26 dBm. This RF device uses the latest Silicon Germanium Heterostructure Bipolar Transistor (SiGe HBT) process. The process has a V_{BCEO} =8V and an f_T =25 GHz. The SGA-9189 is cost-effective for applications requiring high linearity, even at moderate biasing levels.

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.

Package Type

The SGA-9189 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 die is mounted directly to the exposed paddle to provide a low thermal resistance path for heat conduction out of the package.

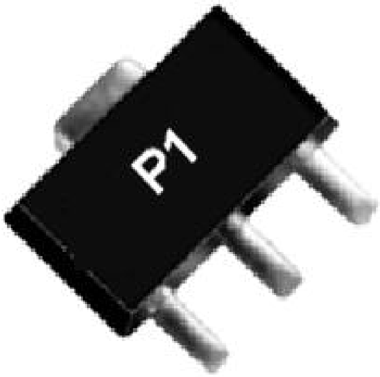

Figure 1 : Photograph of SOT 89 Encapsulated Plastic Package

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Qualification Methodology

The Stanford Microdevices Qualification Procedure consists of a series of tests designed to stress various potential failure mechanisms. This testing is performed to ensure that Stanford 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. For the tests requiring full RF and DC testing to determine PASS/FAIL, the manufacturing test specifications are used as the PASS/FAIL criteria.

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 as compared to the qualified design. The following product has been qualified by similarity to SGA-9189

SGA-9289

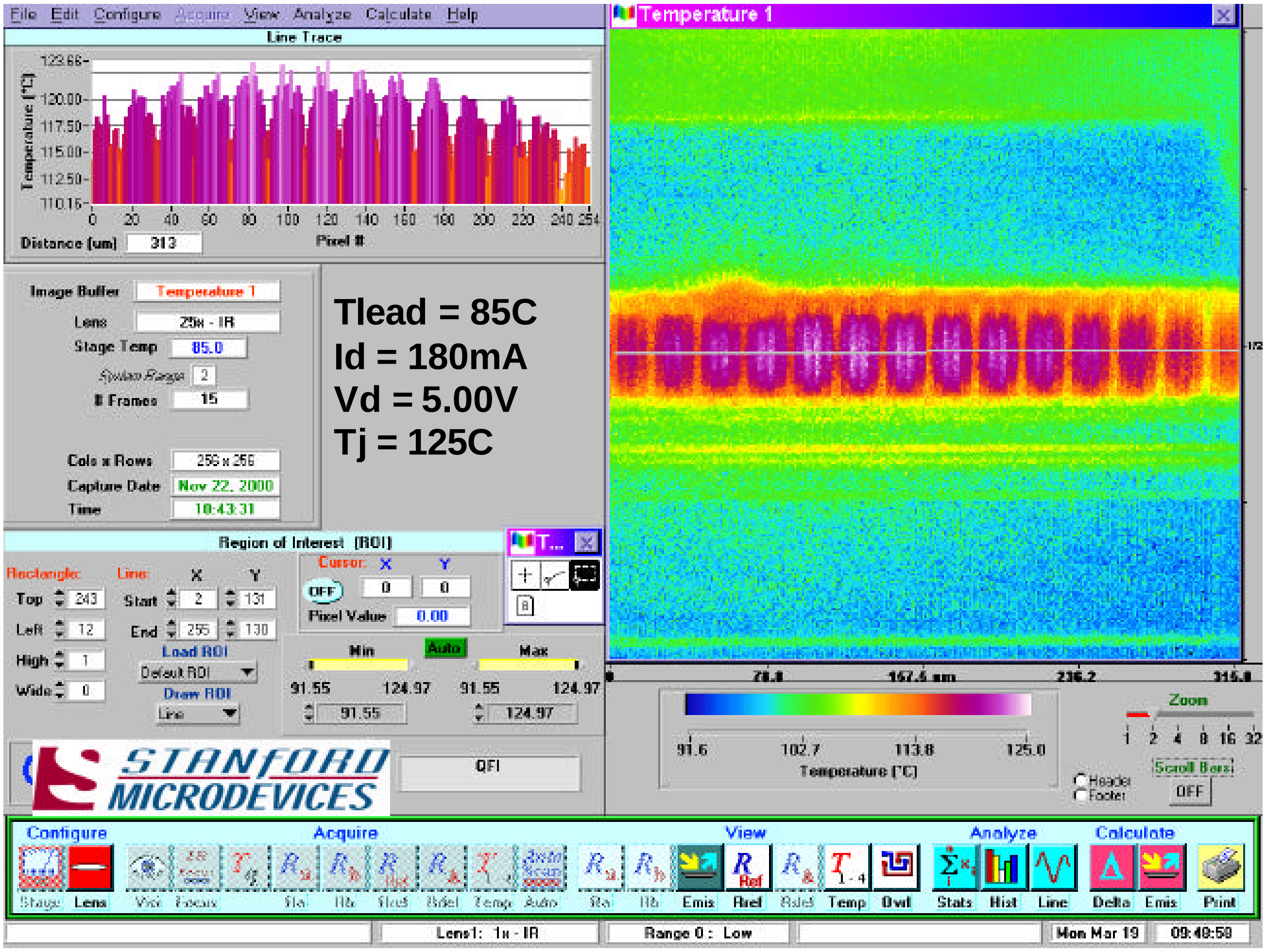
Qualification Results

Group	Test Description	Test Standard	Quantity In	Quantity Out	Results
A0	Moisture Preconditioning / IR Reflow Simulation	JEDEC 22-A113B	650	650	PASS
A1	Temp Cyle -65°c to 150°c 1000 cycles	JEDEC 22-A104A	120	120	PASS
A2	High Temp Operating Life 1000 hrs.	JEDEC 22-A108A	189	189	PASS
C	Autoclave 121°c 15 PSI 96 hrs.	JEDEC 22-A102B	80	80	PASS
E	Solderbility Steam Age	JEDEC 22-B102C	44	44	PASS
G	High Temp Storage 1000 hrs T= 150°C	JEDEC 22-A103A	83	83	PASS

Table 1: Qualification Test Results for SGA-9189.

Junction Temperature Determination

One key issue in performing the qualification testing is to accurately determine the junction temperature of the device. Stanford Microdevices uses a 3µm spot size infrared camera that allows a device to be measured at its normal operational parameters. The 3µm spot size allows for very good resolution compared to the heated area of the transistor, which in this case is approximately 1-2µm. The results for the device, running at maximum operational current of 180mA, a device voltage of 5.0V, and a base plate lead temperature of 85.5°C.



Distance (um): 313

Image Buffer: Temperature 1
Lens: 25x - IR
Stage Temp: 85.0
Spatial Range: 2
Frames: 15
Cols x Rows: 256 x 256
Capture Date: Nov 22, 2000
Time: 10:43:31

Tlead = 85C
Id = 180mA
Vd = 5.00V
Tj = 125C

		X	Y
Top: 243	Start	2	131
Left: 12	End	255	130
High: 1			
Wide: 0			

Load ROI: Default ROI
Draw ROI: Line
Cursor: X 0, Y 0
Pixel Value: 0.00
Min: 91.55 – 124.97; 91.55
Max: 91.55 – 124.97; 124.97

Lens1: 1x - IR
Range 0 : Low
Mon Mar 19
09:48:58

Figure 2: Infrared Thermal Image of SGA 9189, Vd = 5.0V, Id = 180mA, Tlead = 85C

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Operational and Accelerated Life Testing

The purpose of the operational life test is to statistically show that the product operated at 125°C will be reliable. This is accomplished by operating several hundred devices for a total test time of 1000 hours. The results for this test are expressed in device hours which are calculated by multiplying the total number of devices passing by the number of hours tested.

Operational Life Test Results

The results for SGA-9189 High Temperature Operating Life Test are as follows:

Group	Test Time (hours)	Quantity In	Quantity Out	Device Hours
A2	1000	189	189	189,000

Table 2: High Temperature Operational Life Test Results

Accelerated Life Test Results

The following data demonstrates the results from accelerated life tests performed on the Stanford 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.

Stanford Microdevices Process 4ASiGe 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 electomigration which is assumed to be the primary failure mechanism for the SiGe process.

**Stanford Microdevices does not assume any liability arising from the use of this data.