ANALOG DEVICES

Reliability Report

Report Title: GaAs PHEMT-A Process Cumulative Reliability

Report Number: 2013-00267

Revision: 9

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Summary

This report summarizes the process qualification testing of the GaAs PHEMT-A process.

Table 1: Process Characteristics

Fabrication Details

Wafer Fabrication Process	GaAs PHEMT-A
Passivation Layer	SiN
Bond Pad Metal Composition	Au

Description / Results of Tests Performed

The following tables provide a description of the qualification tests conducted and the associated test results for products manufactured on the same technologies as described in Table 1. All devices were electrically tested before and after each stress. Any device that did not meet all electrical data sheet limits following stressing would be considered a valid (stress-attributable) failure unless there was conclusive evidence to indicate otherwise.

Table 2: Process Qualification Test Results

Test Name	Specification	Conditions	Device	Lot #	Sample Size	Qty. Failures
High Temperature Operating Life (HTOL)	JESD22-A108	$T_{j\text{-stress}}$=175°C, Biased, 1,000 Hrs	HMC966	QTR2012-00014	80	0
		$T_{j\text{-stress}}$=112°C, Biased, 5,039 Hrs	HMC6XXX	QTR2013-00340	6	0
		$T_{j\text{-stress}}$=112°C, Biased, 2,000 Hrs	HMC6XXX	QTR2013-00340	14	0
		$T_{j\text{-stress}}$=126°C, Biased, 1,000 Hrs[1]	HMC524A	Q12640.HO1	81	0
		$T_{j\text{-stress}}$=175°C, Biased, 240 Hrs[1]	ADMV1010	Q12917.8	81	0

Test Name	Specification	Conditions	Device	Lot #	Sample Size	Qty. Failures
		$T_{j\text{-stress}}$=150°C, Biased, 1,000 Hrs[1]	HMC951A	Q13238.3	82	0
		$T_{j\text{-stress}}$=125°C, Biased, 1,000 Hrs[1]	HMC524A	Q14494.HO1	80	0
			HMC524A	Q15090.15	82	0
			HMC524A	Q16585.6	82	0
			HMC524A	Q17319.18	82	0
			HMC524A	Q17994.17	82	0
High Temperature Storage Life (HTSL)	JESD22-A103	150°C, 1,000 Hours	HMC966	QTR2012-00014	77	0
			ADMV1010	Q12917.8	30	0
			HMC524A	Q17319.19	82	0
			HMC524A	Q17994.18	82	0

[1] These samples were subjected to preconditioning (per J-STD-020 Level 3) prior to the start of the stress test. Level 3 preconditioning consists of the following: Bake: 24 hrs @ 125°C, Unbiased Soak: 192 hrs @ 30°C, 60%RH, Reflow: 3 passes through an oven with a peak temperature of 260°C.

Samples of the many devices manufactured with these package and process technologies are continuously undergoing reliability evaluation as part of the ADI Reliability Monitor Program. Additional qualification data is available on Analog Devices' web site.

Approvals

Reliability Engineer: Tom Wood

Additional Information

Data sheets and other additional information are available on Analog Devices' web site

Appendix

GaAs PHEMT-A Failure Rate Estimate

The failure rate estimation was determined using the process HTOL test results and the parameters shown below:

- Die Use Junction Temperature, $T_{j\text{-use}} = 85°C$
- Activation Energy = 1.6 eV

- Acceleration Factor (AF): $$AF = \exp\left[\left(\frac{E_A}{k}\right) \cdot \left(\left(\frac{1}{T_{USE}}\right) - \left(\frac{1}{T_{STRESS}}\right)\right)\right]$$

- Equivalent hours = Device hours x Acceleration Factor

Device	Qual Number	Equivalent Device Hours
HMC966	QTR2012-00014	2.74×10^9 hours
HMC6XXX	QTR2013-00340	1.16×10^6 hours
HMC6XXX	QTR2013-00340	1.07×10^6 hours
HMC524A	Q12640.HO1	1.69×10^7 hours
ADMV1010	Q12917.8	2.77×10^9 hours
HMC951A	Q13238.3	2.41×10^8 hours
HMC524A	Q14494.HO1	1.48×10^7 hours
HMC524A	Q15090.15	1.52×10^7 hours
HMC524A	Q16585.6	1.52×10^7 hours
HMC524A	Q17319.18	1.52×10^7 hours
HMC524A	Q17994.17	1.52×10^7 hours
Total Equivalent Device Hours =		5.86×10^9 hours

The failure rate was calculated using Chi Square Statistic:

$$\lambda_{CL} = \frac{\chi^2{}_{\%CL.2f+2} \cdot 10^9}{2 \cdot t \cdot ss \cdot AF}$$

at 60% and 90% Confidence Level (CL), with 0 units out of spec

and an 85°C die junction temperature.

Failure Rate

$\lambda_{60} = [(\chi^2)_{60,2}]/(2X \quad 5.86x10^9 \ )] = 4.1/ \quad 1.17x10^{10} = 3.46x10^{10}$ failures/hour or $\quad 0.2 \quad$ FIT or MTTF = $6.40x10^9$ Hours

$\lambda_{90} = [(\chi^2)_{90,2}]/(2X \quad 5.86x10^9 \ )] = 7.8/ \quad 1.17x10^{10} = 6.64x10^{10}$ failures/hour or $\quad 0.4 \quad$ FIT or MTTF = $2.54x10^9$ Hours