



# ***Reliability Report***

<b>Report Title:</b>	<b>PHEMT-F Process Cumulative Reliability</b>
<b>Report Number:</b>	<b>QTR2013-00269</b>
<b>Revision:</b>	<b>7</b>
<b>Date:</b>	<b>8 November 2022</b>

## Summary

This report summarizes the process qualification testing of the 0.10um PHEMT GaAs process.

### Table 1: Process Characteristics

#### Fabrication Details

Wafer Fabrication Site	WIN
Wafer Fabrication Process	PHEMT-F
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: WIN PHEMT-F Process Qualification Test Results

Test Name	Specification	Conditions	Device	Lot #	Sample Size	Qty. Failures
High Temperature Operating Life (HTOL)	JESD22-A108	T <sub>j-Stress</sub> =150°C, 1,000 Hours	HMC6445	Q12547	78	0
		T <sub>j-Stress</sub> =175°C, 1,000 Hours	HMC996	QTR2012-00027	78	0
		T <sub>j-Stress</sub> =200°C, 1,000 Hours	HMC996	QTR2012-00027	25	0
		T <sub>j-Stress</sub> =225°C, 1,000 Hours	HMC996	QTR2012-00027	25	0
		T <sub>j-Stress</sub> =205°C, 1,000 Hours	HMC996	QTR2012-00027	24	0
		T <sub>j-Stress</sub> =215°C, 1,000 Hours	HMC996	QTR2012-00027	24	0
		T <sub>j-Stress</sub> =210°C, 1,000 Hours	HMC996	QTR2012-00027	24	0
		T <sub>j-Stress</sub> =215°C, 1,000 Hours	HMC996	QTR2012-00027	24	0
		T <sub>j-Stress</sub> =175°C, 1,000 Hours	HMC383	QTR2012-00320	80	0

Test Name	Specification	Conditions	Device	Lot #	Sample Size	Qty. Failures
		T <sub>j-Stress</sub> = 175°C, 1,000 Hours	HMC814	QTR2012-00321	77	0
		T <sub>j-Stress</sub> = 175°C, 1,000 Hours	HMC451	QTR2012-00325	80	0
		T <sub>j-Stress</sub> = 150°C, 1,000 Hours	HMC2168	QTR2013-00339	81	0
		T <sub>j-Stress</sub> = 175°C, 1,000 Hours	HMC5622A	Q11814	231	0
		T <sub>j-Stress</sub> = 135°C, 1,000 Hours	ADMV1009	Q12547	77	0

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

### WIN PHEMT-F Failure Rate Estimate

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

- Die Use Junction Temperature,  $T_{j-use} = 85^{\circ}\text{C}$
- Activation Energy = 1.57 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
HMC6445	QTR2012-00021	1.97x10 <sup>8</sup>
HMC996	QTR2012-00027	2.19x10 <sup>9</sup>
HMC996	QTR2012-00027	1.02x10 <sup>9</sup>
HMC996	QTR2012-00027	8.07x10 <sup>9</sup>
HMC996	QTR2012-00027	1.46x10 <sup>9</sup>
HMC996	QTR2012-00027	3.20x10 <sup>9</sup>
HMC996	QTR2012-00027	2.17x10 <sup>9</sup>
HMC996	QTR2012-00027	3.20x10 <sup>9</sup>
HMC383	QTR2012-00320	2.25x10 <sup>9</sup>
HMC814	QTR2012-00321	2.17x10 <sup>9</sup>
HMC451	QTR2012-00325	2.25x10 <sup>9</sup>
HMC2168	QTR2013-00339	2.05x10 <sup>9</sup>
HMC5622A	Q11814	6.50x10 <sup>9</sup>
ADMV1009	Q12547.7	3.99x10 <sup>7</sup>
Total Equivalent Device Hours =		3.49x10 <sup>10</sup>

The failure rate was calculated using Chi Square Statistic:

Since there were no failures and the tests were time terminated, F=0, and R = 2F+2 = 2

$$\lambda_{CL} = \frac{\chi^2_{(\%CL, 2F+2)} \cdot 10^9}{2 \cdot (\text{Equiv. Device Hours})}$$

at 60% and 90% Confidence Level (CL) and a die use junction temp, T<sub>j-use</sub>=85°C;

Failure Rate:

$$\lambda_{60} = [(\chi^2)_{60,2} / (2 \times 3.49 \times 10^{10})] = 1.8 / 6.99 \times 10^{10} = 2.62 \times 10^{-11} \text{ failures/hour or } 0.03 \text{ FIT or MTTF} = 3.82 \times 10^{10} \text{ Hours}$$

$$\lambda_{90} = [(\chi^2)_{90,2} / (2 \times 3.49 \times 10^{10})] = 4.6 / 6.99 \times 10^{10} = 6.60 \times 10^{-11} \text{ failures/hour or } 0.07 \text{ FIT or MTTF} = 1.52 \times 10^{10} \text{ Hours}$$