RELIABILITY QUALIFICATION REPORT FOR LEAD-FREE/RoHS-COMPLIANT/GREEN SOT-86 PACKAGED AG SERIES SEMICONDUCTORS

I. SUMMARY

The SOT-86 package using AG Series InGaP HBT devices has been lead-free/RoHS qualified to a maximum reflow profile of 260 °C, and the MSL rating at this reflow profile is level 3. The lead finish is annealed matte tin over copper. The AG604-86G gain block was selected to qualify the AG Series amplifier family of devices. It has the highest DC power consumption, the highest RF output power and the highest current density of the AG series amplifier family in the SOT-86 package. The parameters monitored for the qualification tests were Supply Current and Gain. Failures are defined as any variation of 10% or greater for Supply Current and a variation of 1 dB or greater for Gain as compared to the initial pre-stressed testing.

II. SCOPE

This report summarizes the reliability qualification of the AG604-86G. Other devices that are qualified by similarity at the time of this published report are AG201-86G, AG202-86G, AG203-86G, AG302-86G, AG303-86G, AG402-86G, AG403-86G, AG503-86G, AG602-86G and AG603-86G. The Application Note "*453654 Solderability Test Report for WJ Products With Lead-Free Package Finish*" has a detailed description of the lead-free solderability tests; results of the solderability testing are shown in Section IV. The reliability data are obtained through the performance of specified accelerated stress tests described in this document.

III. APPLICABLE DOCUMENTS

All the test procedures and test methods are consistent with industry standards. The standards referenced in this document are JEDEC standard 22.

IV. QUALIFICATION TEST PLAN

Stress or Test	**Procedures/Conditions**	**Device Hours/ Cycles**	**Sample Size**	**Failed Units**	**Reference Document**	**Part Tested**
Preconditioning Level 3 Lead Free	External visual 40x High Temp. Storage Life 24 hrs @+125°C Temp. & Humidity Test 192 hrs. @ +30°C/ 60% RH Convection Solder Reflow test 3 cycles w/flux immersion, peak temperature 260°C	N/A	3 lots, a total of 675 parts	0	JESD22-A113D JESD22-A101-B JESD22-B101A JESD22-A103C J-STD-020C	AG604-86G
Temperature Cycle	Test Condition C Temp. -55°C (+0°/-10°C) to +125°C (+10°/-0°C) Dwell time = 15 min.	1000 cycles	3 lots, a total of 135 parts	0	JESD22-A104-B	AG604-86G

Stress or Test	Procedures/Conditions	Device Hours/ Cycles	Sample Size	Failed Units	Reference Document	Part Tested
Highly-Accelerated Temperature and Humidity Stress Test (HAST)	Test Condition A Temp. 130°C (+/- 2°C) Pressure = 33.3 +/-1psia Relative Humidity = 85%	96 (-0, +2) hours	3 lots, a total of 135 parts	0	JESD22-A110-B	AG604-86G
Solderability Lead-Free solder	Lead-Free Solder: Sn96Ag4 Flux Type: R145 Solder Bath Requirements: 260°C	N/A	3 lots, a total of 10 parts, 40 pins	0	IPC/EIA/JEDEC J-STD-002B Method 2003)	AG604-86G
Solderability Lead solder	Lead-Free Solder: Sn63Pb37 Flux Type: R145 Solder Bath Requirements: 245°C	N/A	3 lots, a total of 10 parts, 40 pins	0	IPC/EIA/JEDEC J-STD-002B Method 2003)	AG604-86G
Moisture/Reflow Sensitivity (MSL) MSL level 3 lead free	Electrical test External Visual C-SAM Die, Paddle and leads Dry Bake 125°C, 24 hours 30°C/60 RH, 192 hours Convection reflow 260°C, 3X External Visual Electrical test C-SAM Die, Paddle and leads	N/A	1 lot, a total of 120 parts	0	J-STD-20C	AG604-86G
Unbiased High Temperature Storage (HTB)	Temp. 150°C (+ 5°C, -0°C)	1000 hours	1 lot, a total of 60 parts	0	JESD22-A103-C	AG604-86G
Physical Dimensions	N/A	N/A	2 lots, a total of 2 parts	0	JESD22-B100-B	AG604-86G
High Temp Op Life (HTOL)	Test Condition B Temp. 125°C (+5, -0°C)	1,000 (-0, +10) hours	3 lots, a total of 180 parts	0	JESD22-A108-B	AG604-86G
Electrostatic Discharge (ESD)	Charged Device Model (CDM)	N/A	18 total parts	Level 4	JESD22-C101-A	AG303-86
	Human Body Model (HBM)	N/A	15 total parts	Class 1C	JESD22-A114	AG303-86
Unbiased Autoclave	Test Condition C Temp. 121°C (+/-1°C) Pressure = 15 +/-1psig Relative Humidity = 100%	96 (-1, +5) hours	3 lots, a total of 135 parts	0	JESD22-A102-C	AG604-86G

V. DISCUSSION OF RESULTS

1. Testing procedures

All of the qualification tests were performed using loose parts except HAST and the HTOL which were mounted to a PCB. The PCB layout is the same as the application circuit published in the WJ Communications Data Sheet, including the recommended via pattern. The application circuit was duplicated 20 times on one large PCB for the qualification testing. A control board consisting of 20 devices was tested before and after each set of the stressed devices to ensure measurement accuracy and repeatability.

Components are considered to have failed if any of the following occurs after being tested post-stress and compared to respective pre-stressed testing parameters for the AG604-86-G: variation of 10% or greater for Supply Current and a variation of 1 dB or greater for Gain. Acceptance criterion consists of having zero failures out of 45 parts to meet WJ's requirement of LTPD=5 for each test.

2. Pre-Conditioning

Three lots of 225, a total of 675 AG604-86 devices, completed pre-conditioning with no electrical failures. 30 of the 675 devices underwent pre and post stress Scanning Acoustic Microscope inspection with no failures.

3. Temperature Cycle

A total of 135 AG604-86G devices from three lots completed 1000 temperature cycles with no failures.

4. Unbiased Autoclave

A total of 135 AG604-86G devices from three lots completed Autoclave with no failures.

5. Highly Accelerated Temperature and Humidity (HAST)

A total of 135 AG604-86G devices from three lots completed HAST with no failures.

6. Solderability

See Solderability Test Report for WJ Products With Lead-Free Packaging Finish on the WJ web site.

7. Moisture/Reflow Sensitivity Classification (MSL)

A total of 120 AG604-86G devices completed MSL level 3 lead free testing with no failures. The MSL results are confirmed by the pre and post preconditioning Scanning Acoustic Microscope testing of 32 pre-conditioned AG604-86G devices underwent (MSL level 3 lead free profile, 260 °C peak Temperature).

8. Unbiased High Temperature Storage (HTB)

A total of 60 AG604-86G devices from one lot completed 1000 hours of Unbiased High Temperature Storage with no failures.

9. Physical Dimensions

A total of 2 AG604-86G devices from two lots completed Inspection with no failures.

10. High Temp Op Life (HTOL)

A total of 180 AG604-86G devices from three lots completed 1,000 hours of HTOL with no failures.

11. Electrostatic Discharge

Both DC I-V characterization and RF gain measurements were made on all devices before and after the specific stress was applied. The RF testing is used for determining functionality of the device pre and post stress. The DC testing will not only detect degradation in a part, but it will also indicate which stage in the circuit has been compromised. For this testing both input and output to ground pins were stressed with both polarities.

a. AG303-86 Human Body Model
   Three parts per voltage (15 total parts) were stressed at the following voltage levels: 250, 500, 750, 1000, and 1250 V. No failures were observed in any case. This results in a Class 1C classification.

b. AG303-86 Charged Device Model
   Three parts per voltage (18 total parts) were stressed at the following voltage levels: 200, 500, 750, 1000, 1500, 2000 V. No failures were observed in any case. This results in a Level 4 classification.

VII. CONCLUSIONS

The Reliability Qualification Data demonstrates that the AG604-86G device assembled in a lead-free/RoHS-compliant/green SOT-86 surface-mount package demonstrates high reliability and quality levels. Other products in the AG Series amplifier family are also qualified in the lead-free/RoHS-compliant/green SOT-86 package by similarity. This includes the following device models: AG201-86G, AG202-86G, AG203-86G, AG302-86G, AG303-86G, AG402-86G, AG403-86G, AG503-86G, AG602-86G and AG603-86G.