



# RELIABILITY QUALIFICATION REPORT FOR LEAD-FREE/ROHS-COMPLIANT/GREEN SOT-89 PACKAGED AG SERIES SEMICONDUCTORS

## I. SUMMARY

The SOT-89 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 NiPdAu. The AG604-89G 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 amplifier family in the SOT-89 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 AG604-89G. Other devices that are qualified by similarity at the time of this published report are AG402-89G, AG403-89G, AG503-89G, AG602-89G and AG603-89G. 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 645 parts	0	JESD22-A113D JESD22-A101-B JESD22-B101A JESD22-A103C J-STD-020C	AG604-89G
Temperature Cycle	Test Condition C Temp. -65°C (+0°/-10°C) to +150°C (+10°/-0°C) Dwell time = 10 to 15 min.	500 cycles	3 lots, a total of 135 parts	0	JESD22-A104-B	AG604-89G



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Stress or Test	Procedures/Conditions	Device Hours/ Cycles	Sample Size	Failed Units	Reference Document	Part Tested
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	AG604-89G
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	AG604-89G
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, 30 pins	0	IPC/EIA/JEDEC J-STD-002B (Method 2003)	AH102A-G
Solderability Lead solder	Lead-Tin Solder: Sn63Pb37 Flux Type: R145 Solder Bath Requirements: 245°C	N/A	3 lots, a total of 10 parts, 30 pins	0	IPC/EIA/JEDEC J-STD-002B (Method 2003)	AH102A-G
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 77 parts	0	J-STD-20C	AH102A-G
Unbiased High Temperature Storage (HTB)	Temp. 150°C (+ 5°C, -0°C)	1000 hours	1 lot, a total of 45 parts	0	JESD22-A103-C	AH102A-G
Physical Dimensions	N/A	N/A	2 lots, a total of 2 parts	0	JESD22-B100-B	AH102A-G
High Temp Op Life (HTOL)	Test Condition B Temp. 125°C (+5, -0°C)	1,000 (-0, +10) hours	3 lots, a total of 135 parts	0	JESD22-A108-B	AG604-89G
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	AG604-89G

## 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 21 times on one large PCB for the qualification testing. A control board consisting of 21 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 AG604-89-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 215, a total of 645 AG604-89 devices, completed pre-conditioning with no electrical failures. 45 of the 645 devices underwent pre and post stress Scanning Acoustic Microscope inspection with no failures.



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3. Temperature Cycle

A total of 135 AG604-89G devices from three lots completed 500 temperature cycles with no failures.

4. Unbiased Autoclave

A total of 135 AG604-89G devices from three lots completed Autoclave with no failures.

5. Highly Accelerated Temperature and Humidity (HAST)

A total of 135 AG604-89G devices from three lots completed HAST with no failures.

6. Solderability

The Solderability test is qualified by similarity to the AH102A-G. The AH102A-G is in same package and it is packaged at the same packaging house. See Solderability Test Report for WJ Products With Lead-Free Packaging Finish on the WJ web site.

7. Moisture/Reflow Sensitivity Classification (MSL)

The MSL test is qualified by similarity to the AH102A-G. The AH102A-G is in same package and it is packaged at the same packaging house. A total of 77 AH102A-G devices from one lot 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 24 pre-conditioned AH102A-G devices underwent (MSL level 3 lead free profile, 260 °C peak Temperature).

8. Unbiased High Temperature Storage (HTB)

The HTB test is qualified by similarity to the AH102A-G. The AH102A-G is in same package and it is packaged at the same packaging house. A total of 45 AH102A-G devices from one lot completed 1000 hours of Unbiased High Temperature Storage with no failures.

9. Physical Dimensions

The Physical Dimensions test is qualified by similarity to the AH102A-G. The AH102A-G is in same package and it is packaged at the same packaging house. A total of 2 AH102A-G devices from two lots completed Inspection with no failures.

10. High Temp Op Life (HTOL)

A total of 135 AG604-89G devices from three lots completed 1,000 hours of HTOL with no failures.

VII. CONCLUSIONS

The Reliability Qualification Data demonstrates that the AG604-89G device assembled in a lead-free/RoHS-compliant/green SOT-89 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-89 package by similarity. This includes the following device models: AG402-89G, AG403-89G, AG503-89G, AG602-89G and AG603-89G.



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DWG. NO.

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3