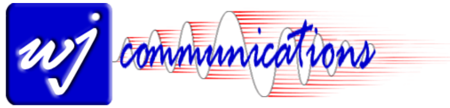

MH302 and MH303 QUALIFICATION REPORT

I. SUMMARY

The MH302 (PCS band) and MH303 (Cell band) are Quad-FET based mixers that offer excellent dynamic range and isolation. These mixers are produced at a CMOS foundry using Ultra-Thin Silicon on Sapphire process, optimized for high performance RF applications. The parts are assembled in a 6-lead DFN 3x3mm package.

II. SCOPE

This report summarizes the reliability qualifications of the MH302 and MH303 mixers. Part reliability was verified using the accelerated stress tests that are described in this document.

III. APPLICABLE DOCUMENTS

The following documents form a part of this report to the extent specified herein:

J-STD-020B	Moisture/Reflow Sensitivity Classification for Non-hermetic Solid-state Surface-mount Devices
JESD22-A110-B	Highly-Accelerated Temperature and Humidity Stress Test (HAST)
JESD22-A113-B	Preconditioning of Non-hermetic Surface Mount Devices Prior to Reliability Testing
JESD28	Procedure for Measuring N-Channel MOSFET Hot-Carrier-Induced Degradation Under DC Stress
JESD35	Procedure for the Wafer-Level Testing of Thin Dielectrics
MIL-STD-883	Test Methods and Procedures for Microelectronics

IV. QUALIFICATION TEST PLAN AND RESULTS

The MH302 and MH303 qualification is based on a comprehensive test program that separately verified the reliability of the process, device, and package assembly. In most cases, other devices were used as the test articles. However through detailed analyses of the tested devices and test conditions, these test results were concluded to be applicable and perspective of the MH302 and MH303 reliability.

The MH302 and MH303 die are designed around the same quad MOSFET. Different passive components are implemented on the chip to tune the mixer to the desired operational band. For purposes of the qualification the MH302 and MH303 are considered the same.

The MH302 and MH303 are packaged in a DFN 3x3mm package. The same die used in the MH302 was packaged in an 8-lead TSSOP package and will be called as the MH302S8. Because the qualification testing was targeted at this die in a different package, the reliability of the DFN 3x3mm package was validated separately. The DFN 3x3mm package was qualified as part of the SW301 product qualification. The SW301 is a MOSFET RF switch manufactured on the same wafer production line as the MH303 and MH302. The only difference in the construction of the parts is the MH302 and MH303 include a third, slightly thicker metal layer. However, all the die use the same material for the passivation layer, so the interfaces between the die, epoxy, and molding compound are the same. Table 1 compares the die sizes of the MH302, MH303, and MH302S8 package qualification part.

The primary failure mechanism associated with a package qualification is die de-attachment from the paddle, and molding compound to paddle delamination. Because the MH302 and MH303 are larger, there is more surface area for contact with the die paddle. Using the SW301, which is a smaller die, to qualify the packaging process provides for a more stringent test. Figure 1 illustrates the product qualification testing used to validate the reliability of the MH302 and MH303 mixers.

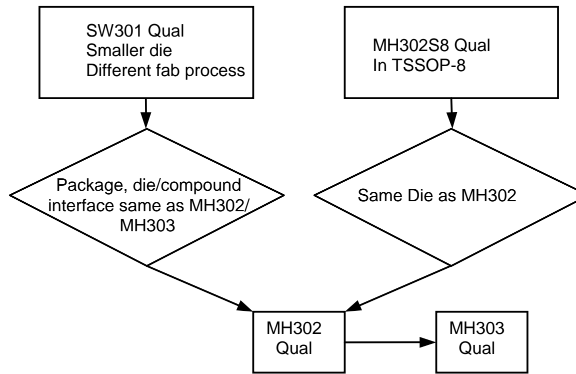

Figure 1. Similarity Argument

Table 2 summarizes the test conditions used to qualify the MH302 and MH303 products. Table 3 summarizes the test conditions used qualify the MH302 and MH303's DFN 3x3mm package. Table 4 summarizes the test conducted to qualify the FC process, which used in manufacturing the MH302 and MH303.

Table 2: MH302 and MH303 Product Qualification

Stress or Test	**Procedures/Conditions**	**Device Hours/Cycles**	**Sample Size**	**Failed Units**	**Date**	**Reference Document**	**Part Tested**
Preconditioning	Level 1: 40X visual inspection, 24 hr bakeout at 125C, 85%C/85%RH soak for 168 hrs Reflow Simulation at 235C	N/A	45 (for HAST)	0	9/01	JESD22-A113-B	MH302S8
Temperature Cycle	Temp. -65°C (0, -10C) to 150C (+15, -0C), unbiased	1000 cycles	45	0	9/01	MIL-STD-883; M1010C	MH302S8
ESD	Human Body Model (HBM)	N/A	12	0	9/01	MIL-STD-883; M3015C1	MH302S8
Highly-Accelerated Temperature & Humidity Stress Test (HAST)	Test Condition A, Devices Preconditioned Temp. 130°C (+/- 2°C), Pressure = 33.3 +/- 1psig, Relative Humidity = 85%	96 (-0, +2) hours	45	0	9/01	JESD22-A110-B	MH302S8
High Temp Op Life (HTOL)	Temp. 125°C, 3.3V applied to Pins 1, 3, 5 and 7. Pins 2, 4, 6, and 8 grounded.	1,000 hours	232 (see Note 2)	0	9/01	MIL-STD-883; M1015D	MH302S8

Table 3: MH302 and MH303 DFN 3x3mm Package Qualification

Stress or Test	**Procedures/Conditions**	**Device Hours/ Cycles**	**Sample Size**	**Failed Units**	**Date**	**Reference Document**	**Part Tested**
Preconditioning	Level 1: 40X visual inspection, 24 hr bakeout at 125C, 85%C/85%RH soak for 168 hrs Reflow Simulation at 235C	N/A	45 (for HAST)	0	9/01	JESD22-A113-B	SW301
High Temp Storage	T_a = 150C; unbiased	1000 hrs	116	0	3/02	MIL-STD-883; M1008C	SW301
Temperature Cycle	Temp. -65°C (0, -10C) to 150C (+15, -0C)	1000 cycles	45	0	3/02	MIL-STD-883; M1010C	SW301
Thermal Shock	-55C to 125C	100 cycles	45	0	3/02	MIL-STD-883; M1011B	SW301
Highly-Accelerated Temperature & Humidity Stress Test (HAST)	Test Condition A, Devices Preconditioned MSL 1, Temp. 130°C (+/- 2°C), Pressure = 33.3 +/- 1psig, Relative Humidity = 85% Continuous Bias: RF1, RF1, RF Common, and Vdd biased at 3.3V; Control Pin is grounded.	96 (-0, +2) hours	45	0	3/02	JESD22-A110-B	SW301
High Temp Op Life (HTOL)	Temp. 125°C, Vdd biased at 3.3V; Control Pin exposed to 100 Hz square wave (0 to 3.3V); all other pins grounded.	1,000 hours	116	0	3/02	MIL-STD-883; M1015D	SW301
Physical Dimensions	Per Outline Drawing	N/A	3	0	3/02	JESD22-B100-A	SW301
Solderability	Per Standard	N/A	3	0	3/02	JESD22-B102	SW301

Stress or Test	Procedures/Conditions	Device Hours/ Cycles	Sample Size	Failed Units	Date	Reference Document	Part Tested
Package Physical Dimensions	Per Outline Drawing	N/A	3	0	3/02	MIL-STD-883; M2016	SW301
Package External Visual	Per Standard	N/A	3	0	3/02	MIL-STD-883; M2009	SW301
Destructive Wire Pull	Per Standard	N/A	3	0	3/02	MIL-STD-883; M2011C	SW301
Die Shear	Per Standard	N/A	3	0	3/02	MIL-STD-883; M2019	SW301
Package Lead Integrity	Per Standard	N/A	3	0	3/02	MIL-STD-883; M2004	SW301
Package Lead Solderability	Per Standard	N/A	3	0	3/02	MIL-STD-883; M2003	SW301

Table 4: FC Process Qualification

Stress or Test	Procedures/Conditions	Device Hours/Cycles	Sample Size	Failed Units	Date	Reference Document	Part Tested
Electromigration	175-225C; 1-3 MA/cm^2	N/A	20 units/ structure/ wafer/lot	0	9/01		MH302S8
Passivation Integrity	minimum l_{eff} wafer; 25C	N/A	1 wafer	0	9/01		MH302S8
Hot Electrons	at 3 stress levels; minimum l_{eff} wafer	Run for 100,000 sec	5	0	9/01	JESD 28	MH302S8
Time-dependent dielectric breakdown	Per Standard	N/A	2 wafers / lot	0	9/01	JESD 35	MH302S8

V. DISCUSSION OF RESULTS

The following is a summary of the reliability tests and results. Five control units were testing before and after each pre and post environmental test to ensure measurement accuracy and repeatability of the test station.

1. Electrostatic Discharge (Human Body Model)

To determine the HBM ESD classification level, three MH302S8 parts were exposed to voltage discharge levels of 250V, 500V, and 1000V. All units (3 per level) passed voltage discharge levels of 250 V and 500 V. One unit failed at the 1000V discharge level. Because the highest threshold voltage survived was 500V, the MH302 and MH303 classify as Class 1B devices.

2. Moisture Sensitivity Level Rating

45 SW301 parts underwent MSL1 preconditioning for lead-based soldering. 10 out of 45 units underwent C-SAM before and after exposure. 2 of the 10 units showed evidence of increased delamination between the lead-frame and molding compound, and around the perimeter of the die, as a result of preconditioning. However, all 45 MSL1 preconditioned units passed HAST, justifying its MSL1 rating per J-STD-20B.

3. HTOL.

232 MH302S8 parts were stressed for 1000 hours at 125C, in an attempt to expose oxide contamination, pin holes, and photomasking defects. Although the MH302 and MH303 normally operate without bias, HTOL was performed with a 3.3V bias applied to the RF, LO, and IF1 pins. All other pins were grounded. The typical current draw during HTOL was 0.65mA. At the conclusion of the 1000 hours exposure no failures were found.

HTOL was also performed on the SW301 to qualify the DFN 3x3 package. In this case, 3.3V was applied to the bias pin and a 100Hz clock signal ranging from 0 to 3.3V was applied to the control voltage pin, all other pins were grounded. Again, no failures were detected.

4. HAST.

A HAST was performed on the 90 parts that were preconditioned to MSL 1 levels and lead soldered to the qualification board. In both the device and package HAST, the tested parts were biased on the RF, LO, and IF1 pins with all other pins grounded. The conditions of this test accelerate moisture penetration in an attempt to induce failure. The 96-hour exposure is intended to be representative of the amount of moisture absorbed over a part's lifetime. In both the package and product HAST, no failures were detected.

VII. CONCLUSIONS

The tests performed in this Qualification effort were selected in compliance with industry standards as set forth by the JEDEC. It is accepted in the industry that the successful completion of these tests demonstrates that the semiconductor materials, processes, and techniques used in manufacture of the WJ MH302 and MH303 have met requirements that establish a level of confidence for the long-term reliability and performance of the device in real life application. The tests used in this qualification report support that the MH302 and MH303 will operate with high reliability and quality levels.