Quality and Reliability Report

MT3 in CQG Package

051-06834

Marki Microwave Inc.
215 Vineyard Court,
Morgan Hill, CA 95037
Phone: (408) 778-4200 / FAX: (408) 778-4300
Email: info@markimicrowave.com

Contents

Summary

This document describes the qualification results for the MT3 Technology and CQG assembly process and materials. The reliability data was obtained through the performance of specified accelerated stress tests described. This summary shows the devices are qualified and have completed qualification testing. This report meets Marki Microwave's reliability requirements and is released for production. Products within family utilizing the same assembly materials and processes are qualified by similarity.

MT3-0113HCQG-2	MMIC T3 COTS Mixer RF 1.5 - 13
MT3-0113LCQG-2	MMIC T3 COTS Mixer RF 1.5 - 13
MT3-0113QCQG-2	MMIC T3 COTS Mixer RF 1.5 - 13
MT3-0113SCQG-2	MMIC T3 COTS Mixer RF 1.5 - 13

Scope

The qualification was performed to validate the reliability of MT3/T3 product assembly. The results of this report are not limited to the specific product described herein; they apply to a family of products designed at Marki Microwave which use the assembly materials and process.

Product Description and Information

The MT3 CQG series of Mixer assemblies use MMIC Mixer Schottky diodes in a CQG Package. This device consists of diodes on a mixer chip connected where the diode junctions are formed to assure close matching of the electrical characteristics including forward voltage, capacitance, and slope resistance. These devices are usable on all Marki Microwave Hybrid products where applicable.

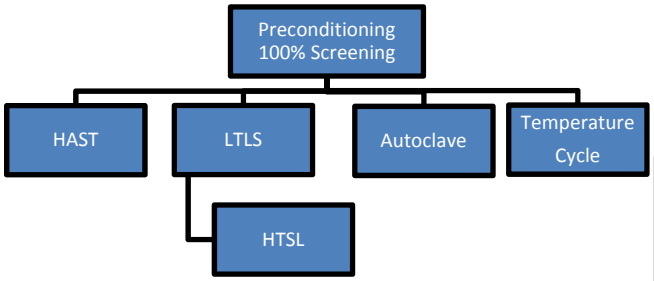
Assembly and Package Information

Package Style:	CQG
Lead Count:	3
Leadframe Material:	Rogers
Wire Bond:	0.8 mil AU Thermo compression bond
Die Attach	Silver Epoxy: Epotek H20E
Lid Material	Ceramic
Solder Material	80(Au)/20(Sn)

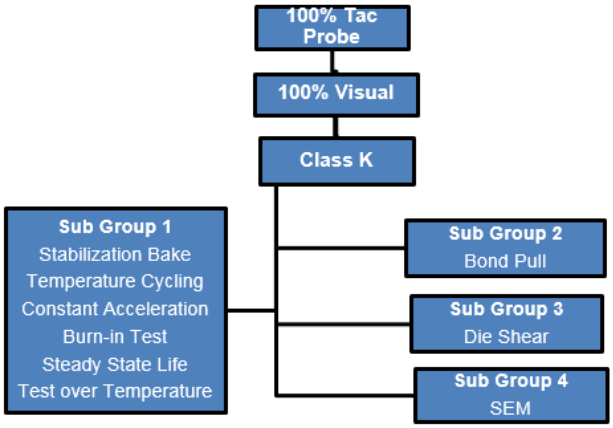
Product Qualification Requirements

Qualification testing has been performed to validate the reliable operation of Marki Microwave's MMIC die and CQG packaged products. Tests are included to specifically address failure mechanisms related to environmental stress, mechanical stress and applied electrical bias.

CQG Package Qualification Plan



MMIC Die Qualification Plan



CQG Package Qualification

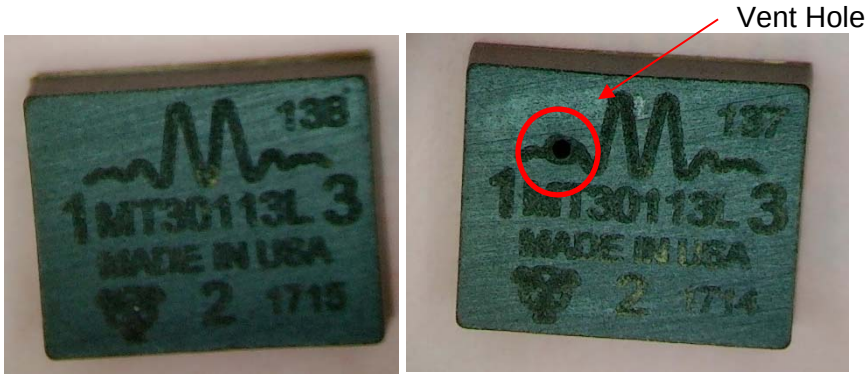
Parts were built into 2 groups. Group one passed gross leak prior to reflow consisting of 107 devices and group two that intentionally had holes added to the lid consisting of 45 devices. Both groups were subjected to 100% screening and life tests according to the following plan.

CQG Qualification Conditions

Test Method	Reference	Time / Cycles	Qty	Condition
100% Screening				
Preconditioning (Moisture Sensitivity Level)	JESD22-A22	168Hrs	152	85°C in 85%RH Environment
Lead Free Reflow Cycles	N/A	3 Cycles	152	Peak 260°C
High Temperature Storage Life (HTSL)	JESD22-A103	24Hrs	152	150°C
Temperature Cycling	JESD22-A104	10 Cycles	152	-65°C to 150°C
Constant Acceleration	MIL-STD-883 Method 2001	1 Minute	152	Y1 3,000 g's Y1 Direction
Subgroup 1				
Highly Accelerated Temperature and Humidity Stress Test (UHAST)	JESD22-A118	264 Hours	24	Unbiased Temp = 110ºC, RH = 85% Vapor Pressure = 17.7 psia
Subgroup 2				
Low Temperature Storage Life (LTSL)	JESD22-A119	240 Hours	24	Temp = -40ºC
High Temperature Storage Life (HTSL)	JESD22-A103	1000 Hours		Temp = 150ºC
Subgroup 3				
Accelerated Moisture Resistance (Autoclave)	JESD22-A102	96 Hours	24	Temp = 121ºC, RH = 100%
Subgroup 4				
Temperature Cycling (TC)	JESD22-A104	500 Cycles	24	T(min) = -65ºC T(max) = +150ºC Dwell Time = 10 minutes

CQG Package Qualification Results

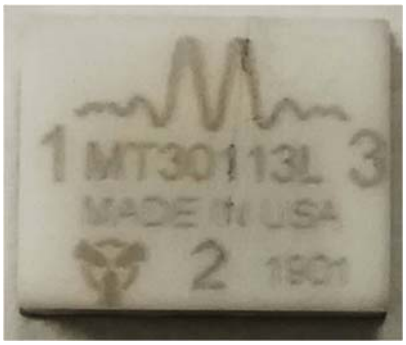
Product was split into 2 groups per Qualification plan. Group 1 passed gross leak after seal but could not pass gross leak after 3 reflows. Therefore Group 2 had a hole intentionally added to the lid. Passing Qualification demonstrates hermiticity is not a reliability issue for this product.



CQG Summary of Test Results

Test Method	Qty In	Results	Date
100% Screening	152	Pass	11/28/17
Subgroup 1			
Unbiased Highly Accelerated Stress Test (UHAST)	24	Pass	5/16/18
Subgroup 2			
Low Temperature Storage Life (LTSL)	24	Pass	12/19/17
High Temperature Storage Life (HTSL)	24	Pass	2/5/18
Subgroup 3			
Accelerated Moisture Resistance (Autoclave)	24	Pass	5/16/18
Subgroup 4			
Temperature Cycle (TC)	24	Pass	5/16/18

The lid was intended to be a “dust” cover to protect the die and circuitry on the board. The Diallyl Phthalate lids could not pass gross leak check as requested by some customers. The package lid cover was changed to ceramic. With the change to ceramic, parts can be tested to pass gross leak and will survive 3x reflow passing gross leak. If gross leak seal is required after preconditioning, the parts must be handled as MSL3. Please note: the catalog off-the-shelf version of the MT3 in CQG package does not implicitly guarantee gross leak seal. The findings of this study have revealed that failure to pass gross leak testing does not reduce the reliability of this part (see above “vent hole” results). Customers who require gross leak seal of the MT3 package may purchase up-screened lots of MT3 products for an added fee.



MMIC Die Qualification

MMIC die from a wafer lot were put through Class K screening. Die were built into connectorized packages to perform the tests in Subgroup 1. All units from this qualification were subjected to 100% tac probe and 100% visual inspection.

Class K Qualification Conditions

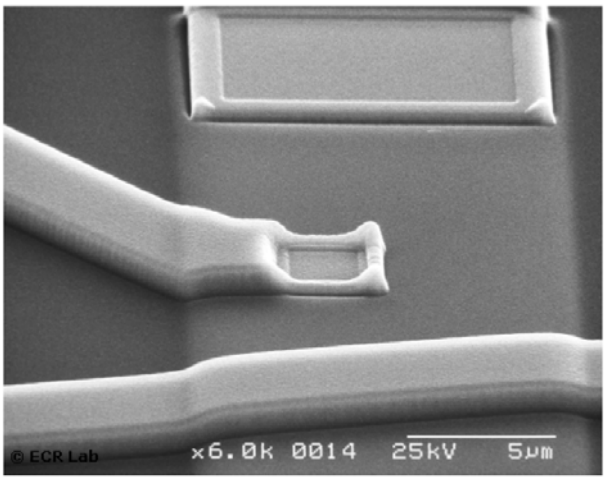
Test Method		Reference MIL-STD-883	Time / Cycles	Qty	Condition
Subgroup 1					
1	Stabilization Bake	Method 1008	24 Hours	10	Ta = 150ºC
2	Temperature Cycling	Method 1010	10 Cycles		Condition C (-65ºC, 150ºC)
3	Constant Acceleration	Method 2001	1 Minute		Y1 3,000 g's Y1 direction
4	Burn-in Test	Method 1015	320 Hours		Ta = 125ºC RF 17dB @5Ghz
5	Steady-State Life	Method 1005	1000 Hours		Ta = 125ºC RF 17dB @5Ghz
6	Test over Temperature	Data Sheet	NA		-55ºC, 25ºC, 100ºC
Subgroup 2					
	Bond Pull	Method 2011	> 2.3 Grams	10	0.8 mil Au wire
Subgroup 3					
	Die shear, chip size 0.058” by 0.091”	Method 2019	> 1.0kgf	2	52.76 x 10(-4)
Subgroup 4					
	SEM	Method 2018		4	

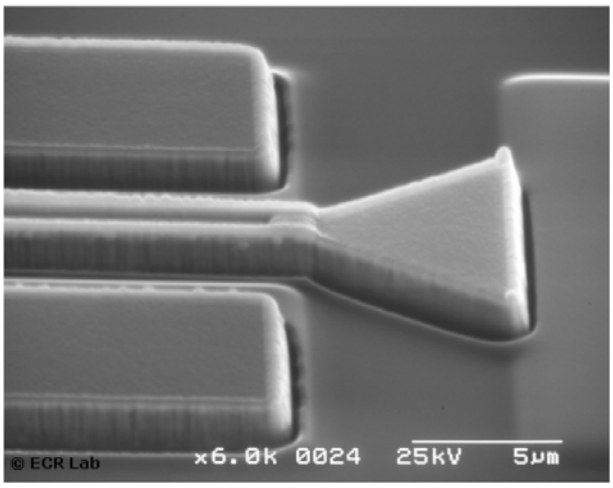
λ (FIT)	MTTF (hr)	MTTF (yr)	Use at
11.4	8.8E+07	10,007	25C
42.8	2.3E+07	2664	40C
142.6	0.70E+07	800	55C

*based on the complete family of mixer die in addition to those qualified to Class H and K

MMIC Die Qualification Results

Test Method	Lot	Qty	Date	Results
Subgroup 1	**Class K**			
Stabilization Bake	901E	10	11/14/17	Pass
	202E	10	07/30/18	Pass
Temperature Cycling (TC)	901E	10	11/20/17	Pass
	202E	10	08/01/18	Pass
Constant Acceleration	901E	10	12/06/17	Pass
	202E	10	08/15/18	Pass
Burn-in Test	901E	10	12/26/17	Pass
	202E	10	09/04/18	Pass
Steady-State Life	901E	10	02/06/18	Pass
	202E	10	10/23/18	Pass
Subgroup 2				
Bond Pull (4 die, 10 bond wires)	901E-74	10	02/07/18	Pass
	202E	10	04/12/18	Pass
	121D	10	01/25/18	Pass
	901E-73	10	01/12/18	Pass
Subgroup 3				
Die shear	901E-74	2	2/9/18	Pass
	202E	2	04/11/18	Pass
	121D	2	01/30/18	Pass
	901E-73	2	01/18/18	Pass
Subgroup 4				
Scanning Electron Microscope (SEM)	901E	4	11/22/17	Pass
	202E	4	04/20/18	Pass





Moisture Sensitivity Level (MSL) Determination for Packages

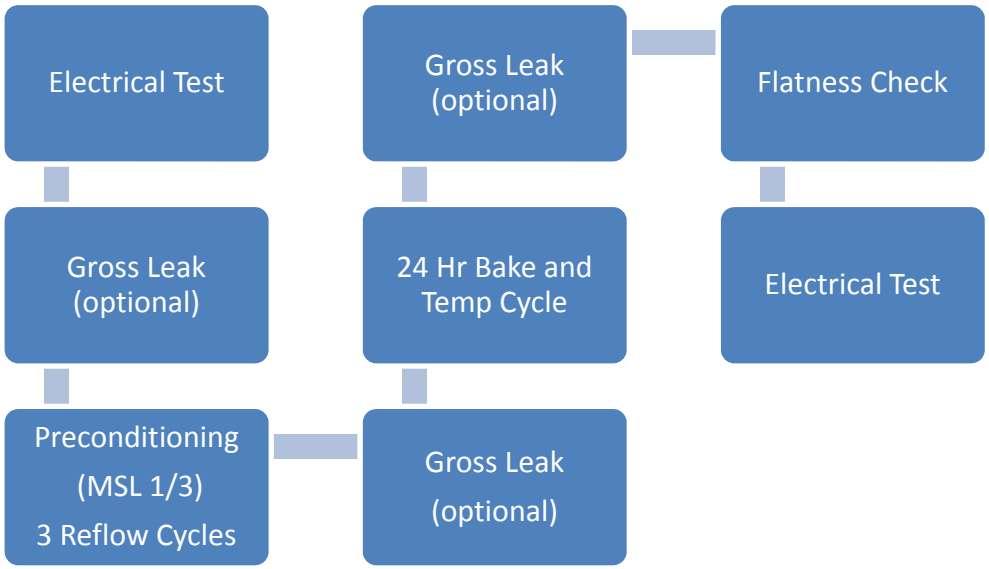
Determination Description

Units were subject to a series of environmental tests to determine their moisture sensitivity level (MSL). Units also underwent gross leak tests to verify if packages are sealed before and after environmental testing. Gross leak is not a condition of MSL determination. Devices can pass MSL 1 without the requirement of gross leak. If required to have passing gross leak after preconditioning the parts must be gross leak tested (optional services) and handled as MSL3.

Table 5-1 Moisture Sensitivity Levels

			SOAK REQUIREMENTS				
					ACCELERATED EQUIVALENT[1]		
	FLOOR LIFE		STANDARD		eV 0.40-0.48	eV 0.30-0.39	
LEVEL	TIME	CONDITION	TIME (hours)	CONDITION	TIME (hours)	TIME (hours)	CONDITION
1	Unlimited	≤30 °C/85% RH	168 +5/-0	85 °C/85% RH	NA	NA	NA
2	1 year	≤30 °C/60% RH	168 +5/-0	85 °C/60% RH	NA	NA	NA
2a	4 weeks	≤30 °C/60% RH	696[2] +5/-0	30 °C/60% RH	120 +1/-0	168 +1/-0	60 °C/60% RH
3	168 hours	≤30 °C/60% RH	192[2] +5/-0	30 °C/60% RH	40 +1/-0	52 +1/-0	60 °C/60% RH
4	72 hours	≤30 °C/60% RH	96[2] +2/-0	30 °C/60% RH	20 +0.5/-0	24 +0.5/-0	60 °C/60% RH
5	48 hours	≤30 °C/60% RH	72[2] +2/-0	30 °C/60% RH	15 +0.5/-0	20 +0.5/-0	60 °C/60% RH
5a	24 hours	≤30 °C/60% RH	48[2] +2/-0	30 °C/60% RH	10 +0.5/-0	13 +0.5/-0	60 °C/60% RH
6	Time on Label (TOL)	≤30 °C/60% RH	TOL	30 °C/60% RH	NA	NA	NA

MSL Determination Flow



MSL Test Summary

JESD22-A113

PURPOSE: This Test Method establishes an industry standard preconditioning flow for non-hermetic solid state SMDs (surface mount devices) that is representative of a typical industry multiple solder reflow operation. These SMDs should be subjected to the appropriate preconditioning sequence of this document by the semiconductor manufacturer prior to being submitted to specific inhouse reliability testing (qualification and reliability monitoring) to evaluate long term reliability (which might be impacted by solder reflow).

*NOTE Correlation of moisture-induced stress sensitivity (per J-STD-020 and JESD22-A113) and actual reflow conditions used are dependent upon identical temperature measurement by both the semiconductor manufacturer and the board assembler. Therefore, it is recommended that the top of package temperature on the hottest moisture-sensitive SMD during assembly be monitored to ensure that it does not exceed the temperature at which the components are evaluated.

Test Results: MSL1
Qualified to MSL1 visually and electrically, passing Autoclave and HAST if gross leak seal is not required
MSL3 if passing gross leak is required after 60C/60%RH and 3X Reflows)
*Gross leak testing is available as a chargeable event.

Part	Description	Condition	Gross Leak after Reflow	Sample Size	Date	Results
MT3-0113LCQG-2 with Ceramic Package	MMIC T3 Mixer RF 1.5 - 13	MSL 1	No	8	7/26/18	Pass
MT3-0113LCQG-2 with Ceramic Package	MMIC T3 Mixer RF 1.5 - 13	MSL 3	Yes	22	7/10/18	Pass
MT3-0113LCQG-2 with Ceramic Package	MMIC T3 Mixer RF 1.5 - 13	MSL 3	Yes	22	9/24/18	Pass
MT3-0113LCQG-2 with Ceramic Package	MMIC T3 Mixer RF 1.5 - 13	MSL 3	Yes	24	10/30/18	Pass
MT3-0113LCQG-2 with Ceramic Package	MMIC T3 Mixer RF 1.5 - 13	MSL 1	No	22	12/27/18	Pass
MT3-0113LCQG-2 with Ceramic Package	MMIC T3 Mixer RF 1.5 - 13	MSL 3	Yes	7	1/11/19	Pass

DPA: Pass

Post MSL DPA.
Solder, Wires and Bonds Intact.
(MT3-0113LCQG)

Revision History

Rev -