SSOP24 Plastic Package
Reliability Qualification Report

Abstract

This report summarizes qualification test results obtained on TriQuint's ASIC encapsulated in a SSOP24 plastic package. Assembly and encapsulation of the test samples were accomplished at Mutsui in Kitakyushu, Japan. Tests, test sample size and failure criteria were chosen by the customer to meet their internal reliability and quality standards. Tests performed were HAST, Thermal Shock, Temperature Cycle, 85°C/85% Relative Humidity, and HTOL. Testing has been performed as defined in JEDEC Standard No. 26-A.

For further information please contact:

TriQuint Semiconductor
3625A SW Murray Blvd.
Beaverton, OR 97005
Phone: (503) 644-3535
FAX: (503) 644-3198

TriQuint® SEMICONDUCTOR

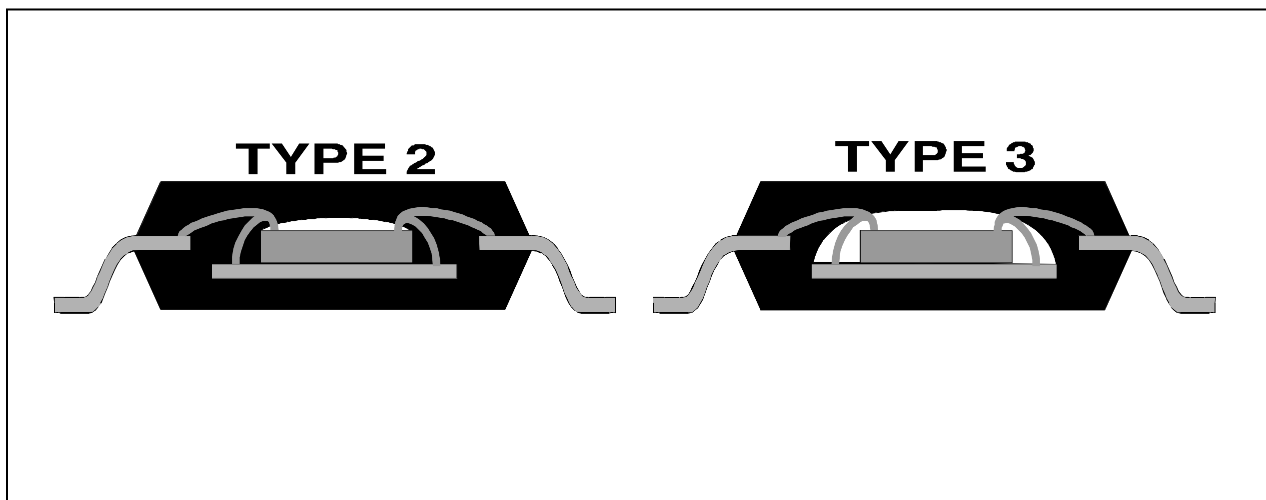
Introduction:

Various tests were performed on the Amp\Switch ASIC for the customer. The customer defined the tests to be performed, the quantity of parts to be used, and the failure criteria. Initial testing performed on the Amp\Switch with the REV B design had numerous failures in Thermal Shock, HAST and 85°C/85% Relative Humidity. These initial devices were manufactured with the Mitsui standard assembly process. Various experiments with die coat materials and various die coat thicknesses were performed to improve the performance of this package. These experiments were conducted on devices that were from circuit design revisions C and D. A die coat and die coat thickness was picked based upon preliminary test results. Two groups of Rev D1 parts were manufactured at Mitsui with different die coat profiles, see Figure 1. A Type 2 die coat profile was defined as having die coat only covering the surface of the die. The second profile, defined as Type 3, covered the whole die, the bond wires and the lead frame paddle.

Parts containing both types of die coat profiles were exposed to HAST and Thermal Shock. The best performing die coat profile was then chosen to be used for the other qualification test. The Type 2 profile was chosen for the completion of the qualification testing.

This report covers the results of qualification testing of the Amp\Switch with the Type 2 die coat profile. A thermal analysis was performed on one device to determine the operating temperature for the HTOL. Parts that were used all came from the same wafer and assembly lot.

FIGURE 1. Die Coat Types



Package Description:

The Amp\Switch is a multifunction ASIC designed here at TriQuint for the customer on the G2 process. Revision D1 devices were used for testing. The die size of this die is 65 mils square by 12 mils thick. The package is a 24 pin surface mount SSOP24 plastic package that has a 0.65 mm lead pitch. Packaging is done at Mitsui (Kitakyushu, Japan) using the material and procedures listed in Table 1. Drawings of the package and lead frame used for the qualification testing are attached to this report.

Table 1. Packaging Material and Assemble Processes.

Die coat material	Dow Corning 4939 mixed 5:1 (Base to Curing agent)
Die coat application	on die only, defined as Type 2
Die coat peak height	4-8 mils, target 7-8 mils This requirement based on two cross section lots, batch 1 had 1-4 mils, batch 2 had approx. 8 mils.
Die attach paste	Sumitomo CRM 1033C
Wire bond material	30 um diameter, Gold
Wire bond technique	thermosonic ball bonding
Plastic material	Sumitomo EME 6300HE
Lead frame material	Electro-etched Cu alloy, MF202
Lead frame plating	Spot Silver >3.81um (150u-in) (plated on die-attach and bond areas)
Lead solder plating	SnPb 90/10
Lead frame paddle size	3.683 mm X 3.683 mm
Lead frame downset	.250+/-.030 mm
Lead frame thickness	.200+/-.008 mm
Lead frame drawing #	Mitsui Bonding Diagram #: A21-1061 Mitsui Lead Frame #: 24VSOP-3636 TriQuint Bonding Diagram #: PBD.SC-2805-AK Note: See attached drawing of lead frame/wire bond diagram..
Package drawing	See attachment
Wafer	Mask Number: MX2805 Run Number: 4185 Wafer Number: 88221
Assembly Lot Number	9980
Package Markings	KYOCERA KASJG 4279980

Test Descriptions and Test Results:

Thermals

Background: Thermal analysis was done on 1 device that was mounted onto an engineering SSOP24 plastic package. The package is a standard molded SSOP24 plastic package from Mitsui that was processed without the die and bond wires. The center of the finished package is milled out to expose some of the lead frame. For the thermal analysis, a Rev E die was mounted onto the engineering package. The Rev E Amp\Switch is similar to the D1 design that was used for the qualification testing. The package was soldered down to a test board and a thermocouple was placed on Pins 16 and 17 for case

temperature measurements. Both infrared and liquid crystal thermal analyses were performed with the Amp\Switch powered up in three different configurations, Receive Mode, and Transmit Mode with and without the Charge Pump biased. Temperature measurements in Receive Mode and Transmit Mode with the Charge Pump biased were taken at bias voltages of 3.0 Volts, 3.6 Volts, 4.5 Volts and 5.0 Volts. Without the Charge Pump biased in Transmit Mode, thermal analysis was only performed at 3 Volts.

Results:

Configuration	Calculated Average Thermal Resistance	Maximum Junction Temp. @ 25°C Case [3 Volts]
Transmit Mode with Charge Pump	59.4°C/Watt	68.4°C
Transmit Mode w/o Charge Pump	62.1°C/Watt	127.9°C
Receive Mode	202.5°C/Watt	37.8°C

HAST (Highly Accelerated Temperature and Humidity Stress Test)

Procedure: JEDEC STD-22, Method A110, Condition C. 130°C at 85% Relative Humidity and 33.5 PSI for 50 hours. For this test, the Amp\Switch was biased at 3 Volts with the device in Receive Mode (Digital and LNA circuitry active).

Purpose: The purpose is to evaluate the reliability of the device in a humid environment. It employs severe conditions of temperature, humidity, and bias which accelerate the penetration of moisture through the external protective material or along the interface between the external protective material and the metallic conductors which pass through it.

Failure: A device is considered a failure if it exceeds the specified parameter limits or cannot demonstrate functionality under the normal and or worst case conditions.

Results:

Date	Sample Size	Failures
8-94	129	0

Thermal Shock (Liquid to Liquid)

Procedure: JEDEC STD-22-B, Method A-106, Condition C. 100 Cycles from -40°C to +125°C with a 5 minute dwell time at each extreme.

Purpose: To check the mechanical integrity of the packaged device, including the die attach, wire bonds, and leads.

Failure: Any device that does not meet the electrical end point parameters, and/or has visual defects on the case or the leads.

Results:

Date	Sample Size	Failures
8-94	77	0

Temperature Cycling (Air to Air)

Procedure: JEDEC STD-22-B, Method A-104, Condition G. 1000 Cycles from -40°C to +125°C with a dwell time of no less than 10 minutes. Interim test points were at 0, 100, 500, and 1000 cycles.

Purpose: This test checks the mechanical integrity of the packaged device including the die attach, wire bonds, and leads.

Failure: Any device that does not meet the electrical end point parameters, and or has visual defects on the case or the leads.

Results:

Date	Sample Size	Failures
9-94	77	0

85°C/85% Relative Humidity Lifetest

Procedure: JEDEC STD-22, Method A101. 85°C at 85% Relative Humidity, biased for a minimum of 1000 hours. Interim test points were at 0, 24, 168, 500 and 1000 hours. For this test, the Amp\Switch was biased at 3 Volts with the device in Receive Mode (Digital and LNA circuitry active).

Purpose: The purpose is to evaluate the reliability of non-hermetic solid state devices in humid environment.

Failure: A device is considered a failure if it exceeds the specified parameter limits or cannot demonstrate functionality under the normal and/or worst case conditions.

Results:

Date	Sample Size	Failures
9-94	75 *	0

* **2 failures occurred after the 1000 test point. It was determined that the failures were due to the part being mis-aligned in the RF test fixture. Mis-alignment caused the device to be electrically overstressed during the RF functional test, thus the failures were not related to the 85°C/85% Relative Humidity Lifetest. A failure analysis report was generated and is available.**

HTOL (High Temperature Operating Lifetest)

Procedure: JEDEC-STD-22-B, Method A-108. 150°C channel temperature under bias for 1000 hours, with interim test points at 0, 24, 168 ,500, and 1000 hours. For this test, the Amp\Switch was biased at 3 Volts in Transmit Mode without the charge pump biased (Digital and Power Amplifier active). The oven was adjusted so that the average case temperature of the device was maintained at 50°C.

Purpose: To determine the long term effects of bias conditions and temperature.

Failure: A device is considered a failure if it exceeds the specified parameter limits or cannot demonstrate functionality under the normal and/or worst case conditions.

Results:

Date	Sample Size	Failures
10-94	74 *	0

* **3 failures occurred after the 500 test point. It was determined that the failures were due to the part being mis-aligned in the RF test fixture. Mis-alignment caused the device to be electrically overstressed during the RF functional test, thus the failures were not related to the HTOL test. A failure analysis report was generated and is available.**

Summary

Tests were performed on an SSOP24 plastic package. The vehicle for the tests was an Amp\Switch. The tests that were performed were defined by the customer to meet their internal reliability and quality standards. HAST, Thermal Shock, Temperature Cycling, 85°C/85% Relative Humidity Lifetest and HTOL were performed on the Amp\Switch in an SSOP24 plastic package.

Thermal Shock and Temperature Cycling tests are performed with parts unbiased. These tests are used to look for any mechanical weakness of the package, die-attach and bond wires. There were no mechanical or electrical test failures from these tests.

HAST, 85°C/85% Relative Humidity Lifetest and HTOL were performed with the parts biased. These tests are use to detect any weakness in the design of the device. During HAST and 85°C/85% Relative Humidity Lifetest, the Amp\Switch was biased in Receive Mode. In Receive Mode, the Amp\Switch draws the least amount of power, which allows humidity to penetrate through the package and onto the surface of the die. In HTOL, the Amp\Switch was biased in Transmit Mode without the charge pump biased. In this biased state, the Amp\Switch draws the maximum amount of power. The devices in HTOL were operating at a junction temperature of 150°C. No electrical test failures occurred that were related to the stress tests.

By successfully completing this series of tests, the Amp\Switch in an SSOP24 plastic package is considered qualified as defined by the customer.