PRODUCT / PROCESS CHANGE NOTIFICATION

1. PCN basic data	
1.1 Company	STMicroelectronics International N.V
1.2 PCN No.	AMG/17/10511
1.3 Title of PCN	Qualification of Amkor Philippines (Subcontractor) for Assembly and Test & Finishing activities of Automotive-grade products in TSSOP8 package
1.4 Product Category	See product list
1.5 Issue date	2017-10-31

2. PCN Team	
2.1 Contact supplier	
2.1.1 Name	ROBERTSON HEATHER
2.1.2 Phone	+1 8475853058
2.1.3 Email	heather.robertson@st.com
2.2 Change responsibility	
2.2.1 Product Manager	Lorenzo NASO
2.1.2 Marketing Manager	Marcello SAN BIAGIO
2.1.3 Quality Manager	Jean-Marc BUGNARD

3. Change		
3.1 Category	3.2 Type of change	3.3 Manufacturing Location
Transfer	(Not Defined)	Amkor Philippines

4. Description of change		
	Old	New
4.1 Description	- Assembly Bouskoura and T&F in Bouskoura - Assembly Amkor Philippines and T&F in Bouskoura	- Assembly Bouskoura and T&F in Bouskoura - Assembly Amkor Philippines and T&F in Bouskoura - Assembly Amkor Philippines and T&F in Amkor Phlippines
4.2 Anticipated Impact on form,fit, function, quality, reliability or processability?	No impact	

5. Reason / motivation for change	
5.1 Motivation	We will better support the customers demand by enhancing the manufacturing process for higher volume production with greater efficiency and productivity.
5.2 Customer Benefit	SERVICE IMPROVEMENT

6. Marking of parts / traceability of change	
6.1 Description	New Finished good codes

7. Timing / schedule	
7.1 Date of qualification results	2017-10-19
7.2 Intended start of delivery	2018-02-05
7.3 Qualification sample available?	Upon Request

8. Qualification / Validation			
8.1 Description	10511 Qualification report TSSOP8 Amkor -2017.pdf		
8.2 Qualification report and qualification results	Available (see attachment)	Issue Date	2017-10-31

9. Attachments (additional documentations)
10511 Public product.pdf 10511 Qualification report TSSOP8 Amkor -2017.pdf

10. Affected parts		
10. 1 Current		10.2 New (if applicable)
10.1.1 Customer Part No	10.1.2 Supplier Part No	10.1.2 Supplier Part No
	LM2903YPT	
	LM2904YPT	
	TS922IYPT	
	TS972IYPT	

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Reliability Evaluation Report

Automotive grade qualification
TSSOP8 Amkor

General Information	
Product Line	*0158, 0393, 0922*
Product Description	*Low-power dual operational amplifier, Low power dual voltage comparator, Rail-to-rail high output current dual operational amplifier*
P/N	*LM2904YPT, LM2903YPT, TS922IYPT*
Product Group	*AMG*
Product division	*General Purpose Analog*
Package	*TSSOP8*
Silicon Process technology	*BIPOLAR, HF2CMOS*

Locations	
Wafer fab	*AMK6*
Assembly plant	*Amkor ATP1 (Philippines)*
Reliability Lab	*Grenoble*

TABLE OF CONTENTS

1 APPLICABLE AND REFERENCE DOCUMENTS

Document reference	Short description
AEC-Q100	Stress test qualification for automotive grade integrated circuits
AEC-Q101	Stress test qualification for automotive grade discrete semiconductors
JESD47	Stress-Test-Driven Qualification of Integrated Circuits
0061692	Reliability tests and criteria for qualifications

2 GLOSSARY

DUT	Device Under Test
PCB	Printed Circuit Board
SS	Sample Size

3 RELIABILITY EVALUATION OVERVIEW

3.1 Objectives

To perform the automotive qualification for the TSSOP8 produced in Amkor Philippines, based on the AECQ100 specification.

3.2 Conclusion

Qualification Plan requirements have been fulfilled without exception. It is stressed that reliability tests have shown that the devices behave correctly against environmental tests (no failure). Moreover, the stability of electrical parameters during the accelerated tests demonstrates the ruggedness of the products and safe operation, which is consequently expected during their lifetime.

Reliability agreement to start Maturity 30 validation.

4 DEVICE CHARACTERISTICS

4.1 Device description

LM2904, LM2904A

Low-power dual operational amplifier

Features

- Internally frequency-compensated
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 MHz (temperature compensated)
- Very low supply current/amplifier, essentially independent of supply voltage
- Low input bias current: 20 nA (temperature compensated)
- Low input offset current: 2 nA
- Input common-mode voltage range includes negative rail
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to (V_{CC+} -1.5 V)

Description

This circuit consists of two independent, high gain, internally frequency-compensated operational amplifiers designed specifically for automotive and industrial control systems. It operates from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op-amp circuits which can now be more easily implemented in single power supply systems. For example, these circuits can be directly supplied from the standard +5 V which is used in logic systems and easily provides the required interface electronics without requiring any additional power supply.

In the linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from a single power supply.

N
DIP8
(Plastic package)

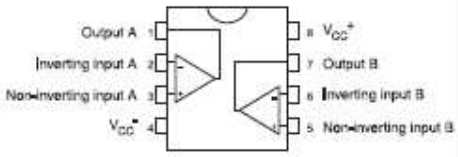
D
SO-8
(Plastic micropackage)

P
TSSOP8
(Thin shrink small outline package)

S
MiniSO-8

Q2
DFN8 2 x 2 mm
(Plastic micropackage)

Pin connections (top view)



LM2903

Low-power dual voltage comparator

Datasheet – production data

Features

- Wide single supply voltage range or dual supplies +2 V to +36 V or ±1 V to ±18 V
- Very low supply current (0.4 mA) independent of supply voltage (1 mW/comparator at +5 V)
- Low input bias current: 25 nA typ.
- Low input offset current: ±5 nA typ.
- Input common-mode voltage range includes negative rail
- Low output saturation voltage: 250 mV typ. (I_O = 4 mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs
- Automotive qualification

N
DIP8
(Plastic package)

D
SO-8
(Plastic micropackage)

P
TSSOP8
(Thin shrink small outline package)

DFN8 2x2 mm
(Plastic micropackage)

Description

This device consists of two independent low-power voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

The device also has a unique characteristic in that the input common-mode voltage range includes the negative rail even though operated from a single power supply voltage.

December 2012 Doc ID 2470 Rev 10 1/18
This is information on a product in full production. www.st.com

TS922, TS922A

Rail-to-rail high output current dual operational amplifier

Features

- Rail-to-rail input and output
- Low noise: 9 nV/ √Hz
- Low distortion
- High output current: 80 mA (able to drive 32 Ω loads)
- High-speed: 4 MHz, 1 V/µs
- Operating from 2.7 to 12 V
- Low input offset voltage: 900 µV max (TS922A)
- ESD internal protection: 2 kV
- Latch-up immunity
- Macromodel included in this specification
- Dual version available in flip-chip package

Applications

- Headphone amplifiers
- Sound cards, multimedia systems
- Line drivers, actuator drivers
- Servo amplifiers
- Mobile phones and portable equipment
- Instrumentation with low noise as key factor
- Piezoelectric speaker drivers

Description

The TS922 is a rail-to-rail dual BiCMOS operational amplifier optimized and fully specified for 3 and 5 V operation.

The device's high output current allows low-load impedances to be driven.

Very low noise, low distortion, low offset and a high output current capability make this device an excellent choice for high quality, low voltage or battery operated audio systems.

J
(Flip-chip)

D
SO-8
(Plastic micropackage)

P
TSSOP8
(Thin shrink small outline package)

N
DIP8
(Plastic package)

The device is stable for capacitive loads up to 500 pF.

4.2 Construction note

	LM2904YPT	LM2903YPT	LM2903PT	TS922IYPT	TS972YIPT
Wafer/Die fab. information					
Wafer fab manufacturing location	ST AMK6	ST AMK6	ST AMK6	ST AMK6	ST AMK6
Technology	BIPOLAR	BIPOLAR	HBIP40	HF2CMOS	HF2CMOS
Process family	BIP	BIP	BIP	BiCMOS	BiCMOS
Die finishing back side	Raw Silicon	Raw Silicon	Raw Silicon	Raw Silicon	Raw Silicon
Die size	1070x1010µm²	950x870µm²	870x590µm²	1720x1190µm²	1100x960µm²
Bond pad metallization layers	AlSiCu	AlSiCu	AlSiCu	AlSiCu	AlSiCu
Passivation type	Nitride	Nitride	Nitride	Nitride+Pvapox	Nitride+Pvapox
Poly silicon layers					
Wafer Testing (EWS) information					
Electrical testing manufacturing location	ST Singapore	ST Singapore	ST Singapore	ST Singapore	ST Singapore
Tester	ASL1K	ASL1K	ASL1K	ASL1K	ASL1K
Assembly information					
Assembly site	Amkor ATP1	Amkor ATP1	Amkor ATP1	Amkor ATP1	Amkor ATP1
Package description	TSSOP8	TSSOP8	TSSOP8	TSSOP8	TSSOP8
Molding compound	Sumitomo EME-G700	Sumitomo EME-G700	Sumitomo EME-G700	Sumitomo EME-G700	Sumitomo EME-G700
Frame material	Cu	Cu	Cu	Cu	Cu
Die attach process	Glue	Glue	Glue	Glue	Glue
Die attach material	ABLESTICK 8290	ABLESTICK 8290	ABLESTICK 8290	ABLESTICK 8290	ABLESTICK 8290
Die pad size	2.5x2.2 mm²	2.5x2.2 mm²	2.5x2.2 mm²	2.5x2.2 mm²	2.5x2.2 mm²
Wire bonding process	Wire	Wire	Wire	Wire	Wire
Wires bonding materials/diameters	Au 1 mil	Au 1 mil	Au 1 mil	Au 1 mil	Au 1 mil
Lead finishing process	Electroplating	Electroplating	Electroplating	Electroplating	Electroplating
Lead finishing/bump solder material	Matte Sn	Matte Sn	Matte Sn	Matte Sn	Matte Sn
Final testing information					
Testing location	Amkor	Amkor	Amkor	Amkor	Amkor
Tester	ASL1K	ASL1K	ASL1K	ASL1K	ASL1K

5 TESTS RESULTS SUMMARY

5.1 Test vehicle

Lot #	Techno/package	Product Line	Comments
1	Bipolar/TSSOP8	0158	
2	Bipolar/TSSOP8	0393	
3	HBIP40/TSSOP8	0393	
4	HF2CMOS/TSSOP8	0922	
5	HF2CMOS/TSSOP8	0462	

Detailed results in below chapter will refer to P/N and Lot #.

5.2 Test plan and results summary

P/N LM2904YPT, LM2903YPT, LM2903PT, TS952IYPT

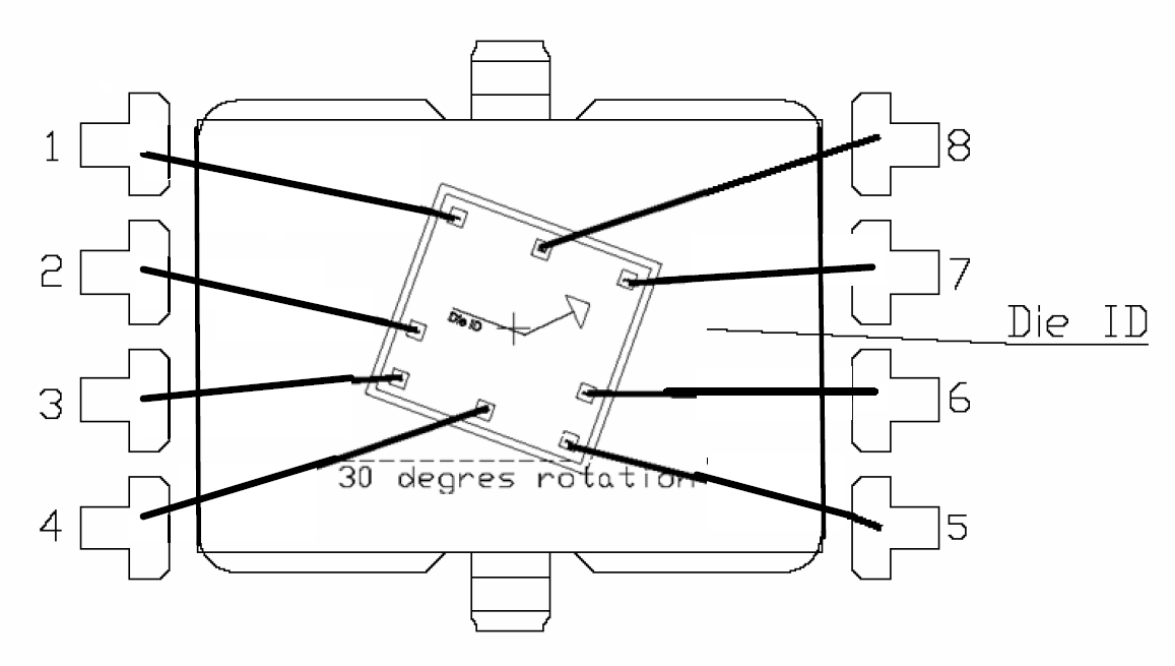
Test	PC	Std ref.	Conditions	SS	Steps	Failure/SS					Note
						Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	
Die Oriented Tests											
HTOL HTB	N	JESD22 A-108	Tj = 150°C, BIAS * Tj= 125°C BIAS		168 H	0/78	0/78	0/78		0/78	
					1000 H	0/78	0/78	0/78		0/78	(1)
					1500 H	0/78	0/78	0/78		0/78	(1)
HTSL	N	JESD22 A-103	Ta = 150°C		168 H		0/78		0/78		
					1000 H		0/78		0/78		(1)
ELFR	N	AEC Q100-008	Tj = 125°C, BIAS, 48h		48 H	0/800			0/200		(1)
PC		JESD22 A-113	Drying 24 H @ 125°C Store 168 H @ Ta=85°C Rh=85% Over Reflow @ Tpeak=260°C 3 times		Final						
AC	Y	JESD22 A-102	Pa=2Atm / Ta=121°C		96 H	0/78		0/78		0/78	
					168 H	0/78		0/78		0/78	
TC	Y	JESD22 A-104	Ta = -65°C to 150°C		100 cy	0/78		0/78		0/78	
					1000 cy	0/78		0/78		0/78	(1)
THB	Y	JESD22 A-101	Ta = 85°C, RH = 85%, BIAS 30V		168 H	0/78		0/78		0/78	
					1000 H	0/78		0/78		0/78	(1)
GL	N	AECQ100-006	Electro-thermally Induced Gate Leakage	6	96 H	0/10	0/10	0/6	0/6		

Note (1): Measurement performed before and after stress, at HOT & ambient temperature

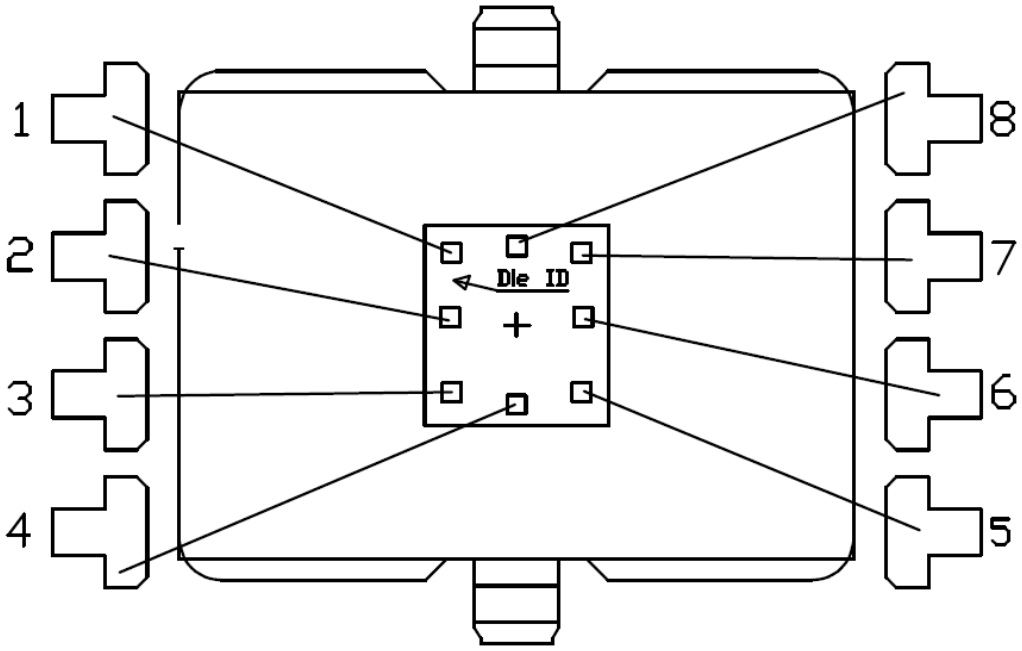
6 ANNEXES

6.1.1 Bonding diagram

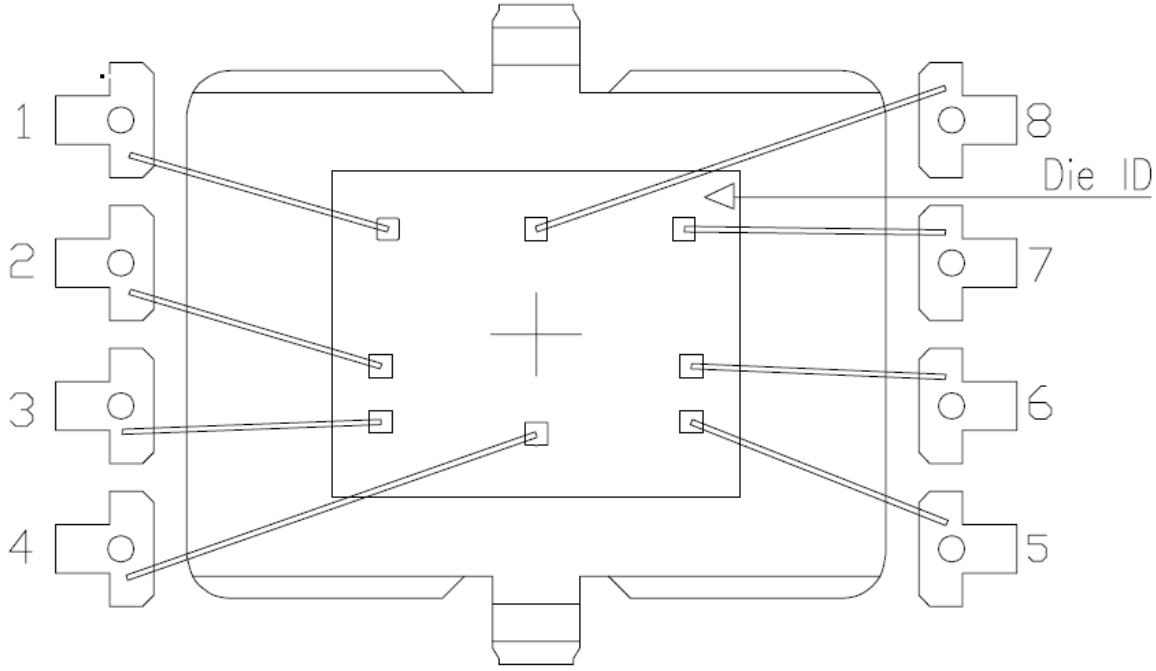
0158



0393



0922



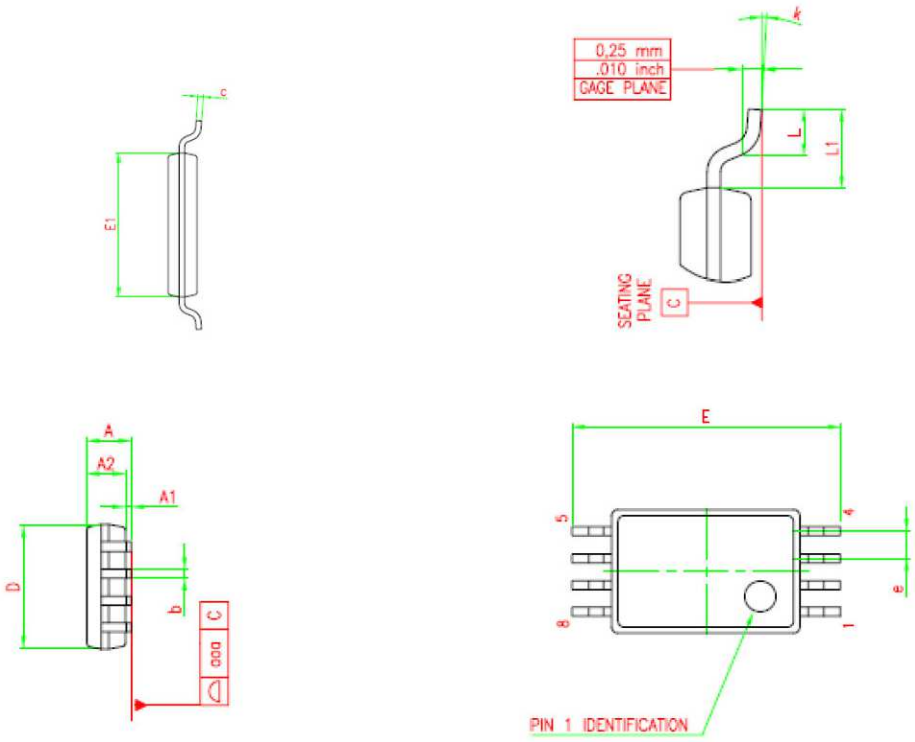
6.1.2 Package outline

APM –AMPS C811TSB1

Physical dimensions TSSOP8 Amkor Philippines

PURPOSE: To check the physical dimension of TSSOP8 package produced in Amkor Philippines.

REFERENCE: Automobile Electronics Council - Q100 - Rev.G
("Stress test qualification for packaged integrated circuits")
POA 0079397



APM Grenoble – AMPS

APM –AMPS

C811TSB1

Results:

Dimensions	Specification		Data				
items	min.	max.	Min.	Max.	Mean	StDev	Cpk
A: Pkg thickness (total)	0.90	1.10	0.98	1.02	1.00	0.012	2.72
A1 : stand-off	2.00	6.00	3.74	4.32	4.00	0.207	3.22
A2: Pkg thickness (body)	0.85	0.95	0.88	0.91	0.90	0.009	1.82
b: lead width	7.48	11.81	8.71	9.52	9.12	0.278	1.97
c: lead thickness	3.54	7.87	6.14	6.59	6.42	0.159	3.04
D : pkg length (total)	2.90	3.10	2.95	2.97	2.96	0.008	2.58
D1: pkg length (body)	2.90	3.10	2.95	2.97	2.96	0.008	2.58
D2 : epad,slug length	NA	NA	NA	NA	NA	NA	NA
E : pkg width (total)	6.25	6.50	6.38	6.42	6.40	0.014	2.31
E1: pkg width (body)	4.30	4.50	4.38	4.40	4.39	0.006	5.11
E2 : epad,slug width	2.15	2.25	NA	NA	NA	NA	NA
e: lead pitch	0.60	0.70	0.64	0.65	0.65	0.005	3.00
L: foot length	18.00	30.00	20.33	22.75	21.96	0.721	1.83
L1: lead length	0.94	1.06	0.99	1.02	1.00	0.011	1.82
K: foot angle	0.00	8.00	1.53	1.97	1.76	0.151	3.89
ccc: coplanarity	-	3.00	0.42	0.88	0.68	0.164	4.72

Results conform to ST specification.

Performed on 30 units from lot CZ8410XK

6.1.3 Bonding strength (WBS/WBP)

APM –AMPS C811BAB1

Bonding Pull Test for TSSOP8 package assembled in Amkor ATP Philippines

PURPOSE : To evaluate the gold wire bonding in TSSOP8 package produced in Amkor.

REFERENCE : Automobile Electronics Council - Q100 - RevF (July 18th , 2003)
("Stress test qualification for packaged integrated circuits")

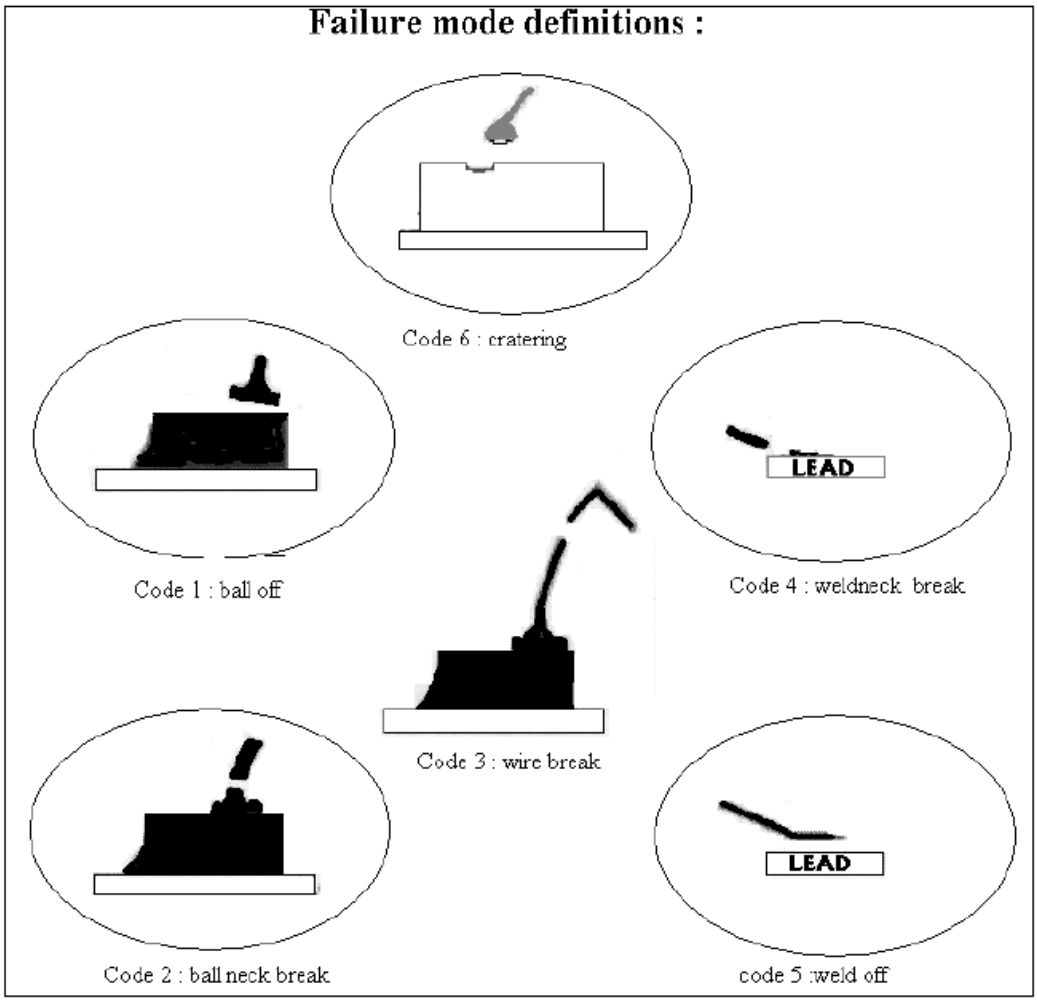
METHOD :
Bond Pull strength (reference M2011). :
ST microelectronics reference : 0074539 "standard pull test procedure"
Sample size : 30 bonds from a minimum of 5 devices
Chemical etching.

Test Vehicle description:

	TV1
Line	0158
Plant	Amkor Philippines
Sales Type	LM2904PT
FE process	Bipolar Ang Mo Kio
Package	TSSOP8
Die size (µm)	1070 x 1010
Metallisation	AlSiCu
Plating	Sn
Molding compoud	SUMITOMO G700A
Wire	Gold 1 Mil
Leadframe	Copper + Ag spot
Die attach	ABLESTICK 8290
Assy lot	S6134ZAF

APM - AMPS

APM –AMPS C811BAB1

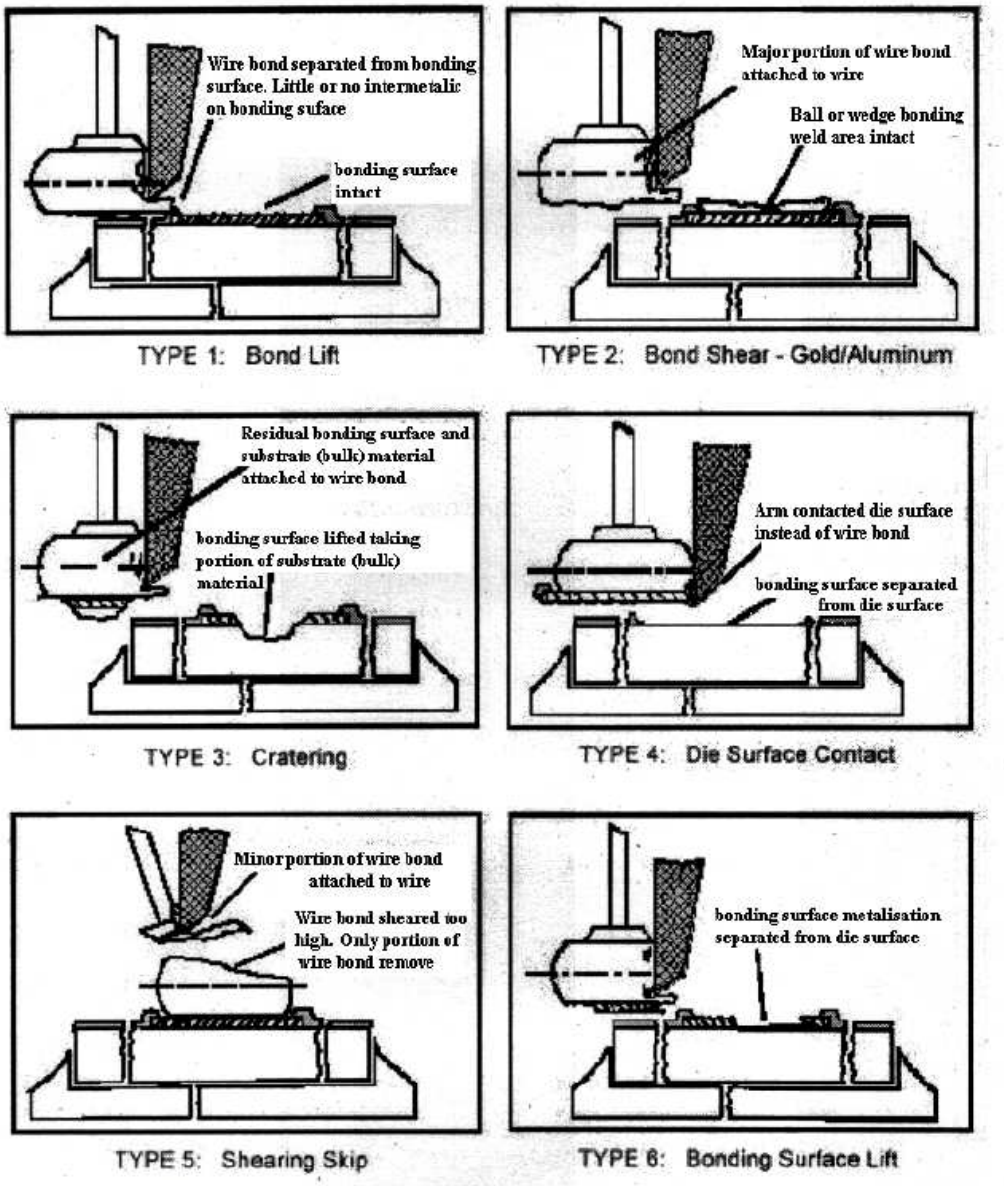


Bond shear test

ST microelectronics reference : 0040516 "Ball shear test procedure "
Opening method : Chemical etching,
Wire bonding material : gold 1mil

APM –AMPS C811BAB1

Wire Bond shear type :



Results : Pull Test : 100% code 2
Shear test : 100% code 2.

Performed after thermal cycling 1000cycles (-65/+150°C)

APM –AMPS C811BAB1

No.	Pull(g)	Failure mode (Pull)	Shear(g)	Failure mode (Shear)
1	8.96	Bond shear Gold/Alu	46.01	Ball neck break
2	8.83	Bond shear Gold/Alu	44.35	Ball neck break
3	8.95	Bond shear Gold/Alu	44.36	Ball neck break
4	8.92	Bond shear Gold/Alu	44.38	Ball neck break
5	8.98	Bond shear Gold/Alu	44.38	Ball neck break
6	9.05	Bond shear Gold/Alu	44.54	Ball neck break
7	8.94	Bond shear Gold/Alu	44.61	Ball neck break
8	8.87	Bond shear Gold/Alu	45.01	Ball neck break
9	9.10	Bond shear Gold/Alu	45.11	Ball neck break
10	8.91	Bond shear Gold/Alu	45.23	Ball neck break
11	9.61	Bond shear Gold/Alu	45.32	Ball neck break
12	9.32	Bond shear Gold/Alu	45.53	Ball neck break
13	9.57	Bond shear Gold/Alu	45.65	Ball neck break
14	9.45	Bond shear Gold/Alu	45.66	Ball neck break
15	9.56	Bond shear Gold/Alu	45.78	Ball neck break
16	9.64	Bond shear Gold/Alu	45.92	Ball neck break
17	9.63	Bond shear Gold/Alu	46.10	Ball neck break
18	9.60	Bond shear Gold/Alu	46.29	Ball neck break
19	9.58	Bond shear Gold/Alu	46.43	Ball neck break
20	9.43	Bond shear Gold/Alu	46.44	Ball neck break
21	8.22	Bond shear Gold/Alu	46.88	Ball neck break
22	8.33	Bond shear Gold/Alu	47.07	Ball neck break
23	8.26	Bond shear Gold/Alu	47.17	Ball neck break
24	8.30	Bond shear Gold/Alu	47.21	Ball neck break
25	8.33	Bond shear Gold/Alu	47.34	Ball neck break
26	8.24	Bond shear Gold/Alu	47.35	Ball neck break
27	8.47	Bond shear Gold/Alu	47.38	Ball neck break
28	8.39	Bond shear Gold/Alu	47.42	Ball neck break
29	8.59	Bond shear Gold/Alu	47.42	Ball neck break
30	8.31	Bond shear Gold/Alu	47.48	Ball neck break
Min	**8.220**		**44.350**	
Max	**9.640**		**47.480**	
Average	**8.945**		**45.99**	
Stdev	**0.506**		**1.099**	
Min Lim	**3.500**		**12.600**	
Cpk	**3.59**		**10.13**	

6.1.4 Solderability

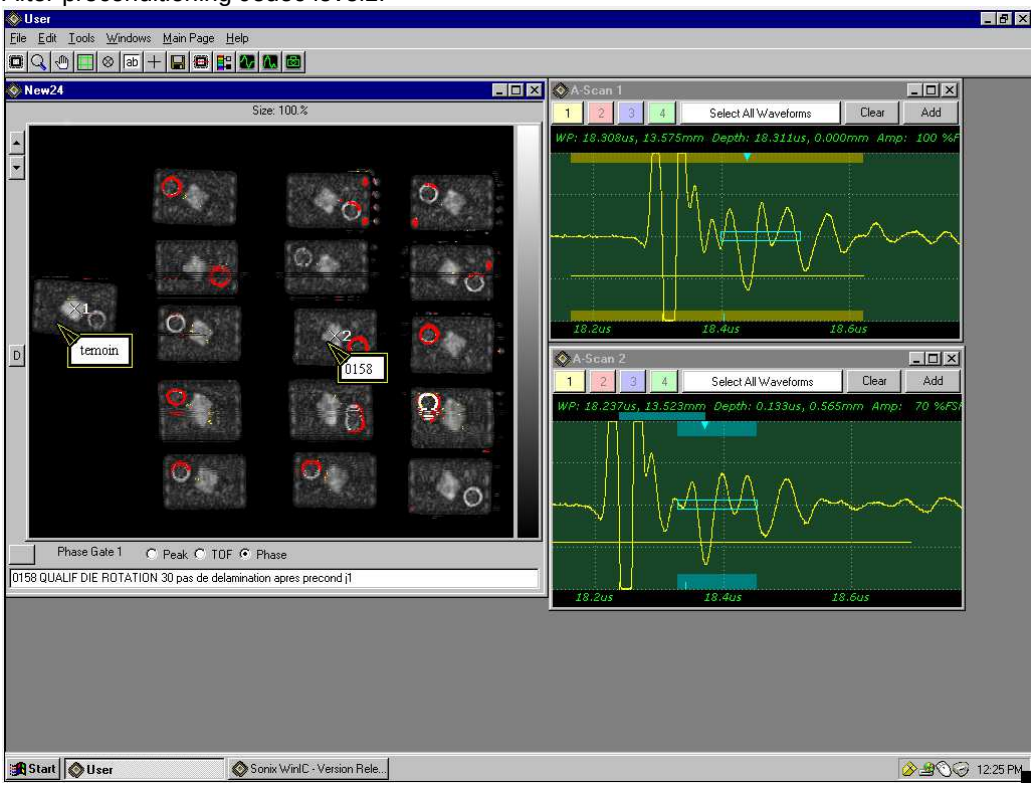
TSSOP8 solderability monitoring internal spec (90°C/90%RH 8h) solder pot SnAgCu 245°C

ST Customer Solderability Test Data

Category	WW	PackageLdct	Date Plated	S.plate Machine	Customer	Internal Lot No.	Steam age in	Steam age out	Plating Chemistry	Solder Pot Temp	Tested By	Result
LeadFree FOI	WW30	TM 44028	07/29/12 A	MECO-05	ST MMS	230G1475	0300	1100	Matte Tin	245 °C	Nelia Ching	0/5 Passed
LeadFree FOI	WW34	TM 44028	8/23/2012 A	MECO-07	ST AMS	233G2973	15:05	23:05	Matte Tin	245 °C	Cel Nicolas	0/5 Passed
LeadFree FOI	WW34	TM 44028	08/26/12 A	MECO 04	ST AMS	234G1838	14:45	22:45	Matte Tin	245 °C	Cel Nicolas	0/5 Passed
LeadFree FOI	WW35	TM 44028	08/27/12 A	Meco 07	ST AMS	234G2301	14:45	22:45	Matte Tin	245 °C	Cel Nicolas	0/5 Passed
LeadFree FOI	WW35	TM44028	9/2/2012 A	Meco 07	ST AMS	235G1397	14:30	22:30	Matte Tin	245 °C	Tats Vergara	0/5 Passed
LeadFree FOI	WW35	TM4H020	9/6/2012 A	Meco 05	ST AMS	235G2107	14:30	22:30	Matte Tin	245 °C	Nelia Ching	0/5 Passed
LeadFree FOI	WW35	TM44024	9/26/2012 A	Meco 07	ST IPD	238G0991	22:55	0655	Matte Tin	245 °C	Cel Nicolas	0/5 Passed

6.1.5 Scanning acoustic microscopy

Test vehicle LM2904YPT
After preconditioning Jedec level1:



>Scan focused on die surface, no delamination at die surface.

Tests Description

Test name	Description	Purpose
Die Oriented		
HTOL Higt Temperature Operating Life **HTB** High Temperature Bias	The device is stressed in static or dynamic configuration, approaching the operative max. absolute ratings in terms of junction temperature and bias condition.	To determine the effects of bias conditions and temperature on solid state devices over time. It simulates the devices' operating condition in an accelerated way. The typical failure modes are related to, silicon degradation, wire-bonds degradation, oxide faults.
Package Oriented		
PC Preconditioning	The device is submitted to a typical temperature profile used for surface mounting devices, after a controlled of moisture absorption.	As stand-alone test: to investigate the moisture sensitivity level. As preconditioning before other reliability tests: to verify that the surface mounting stress does not impact on the subsequent reliability performance. The typical failure modes are "pop corn" effect and delamination.
AC Auto Clave (Pressure Pot)	The device is stored in saturated steam, at fixed and controlled conditions of pressure and temperature.	To investigate corrosion phenomena affecting die or package materials, related to chemical contamination and package hermeticity.
TC Temperature Cycling	The device is submitted to cycled temperature excursions, between a hot and a cold chamber in air atmosphere.	To investigate failure modes related to the thermo-mechanical stress induced by the different thermal expansion of the materials interacting in the die-package system. Typical failure modes are linked to metal displacement, dielectric cracking, molding compound delamination, wire-bonds failure, die-attach layer degradation.
THB Temperature Humidity Bias	The device is biased in static configuration minimizing its internal power dissipation, and stored at controlled conditions of ambient temperature and relative humidity.	To evaluate the package moisture resistance with electrical field applied, both electrolytic and galvanic corrosion are put in evidence.
Other		
ESD Electro Static Discharge	The device is submitted to a high voltage peak on all his pins simulating ESD stress according to different simulation models. **CBM**: Charged Device Model **HBM**: Human Body Model **MM**: Machine Model	To classify the device according to his susceptibility to damage or degradation by exposure to electrostatic discharge.