

Reliability Qualification Report
ST Muar LQFP 44 Non Green to Green Mold Compound (from 7351LS TO G700LS) + Leadfree plating Conversion Project

General Information	
Product Line	UD1403
Finished Good	ST7538Q-2/
Product From	A51J*UD14EF1
Process Plan	T96-F6RTQ10D-ORT.7
Package Technology	LQFP 44 10x10

Locations	
Wafer Fab Location	AG8F - Agrate AG8
Assembly Plant Location	MU1A ST MUAR - MALAYSIA
Testing Plant	MU1T ST MUAR - MALAYSIA
Reliability Assessment	ST MUAR (QA RELIABILITY LAB)

Issued By: Mohd Ibrahim GHAZALI

Approved By: Francesco VENTURA

TABLE OF CONTENTS

1	APPLICABLE AND REFERENCE DOCUMENTS	Page: 3
2	TEST GLOSSARY	Page: 3
3	RELIABILITY EVALUATION OVERVIEW	
	3.1 OBJECTIVES	Page: 4
	3.2 CONCLUSIONS	Page: 4
4	DEVICE CHARACTERISTICS	
	4.1 BONDING DIAGRAM	Page: 5
	4.2 PACKAGE OUTLINE/MECHANICAL DATA	Page: 6 – 7
	4.3 TRACEABILITY	Page: 8
5	TEST RESULTS SUMMARY	
	5.1 LOT INFORMATION	Page: 9
	5.2 ELECTRICAL TEST RESULTS	Page: 9
	5.3 SAM ANALYSIS RESULT	Page: 10
	5.3.1 SAM IMAGES @ TIME-0	Page: 11
	5.3.2 SAM IMAGES AFTER MSL3 (3IR)	Page: 12
	5.4 DPA RESULTS (Wire Pull / Ball Shear)	Page: 13
6	TESTS DESCRIPTION	
	6.1 DIE AND PACKAGE TESTS DESCRIPTION	Page : 14

1 APPLICABLE AND REFERENCE DOCUMENTS

Document Reference	Short Description
AEC-Q100	Stress test qualification for integrated circuits
SOP 2.6.11	Project management for product development
SOP 2.6.19	Front-end technology platform development & qualification
SOP 2.6.2	Internals change management
SOP 2.6.7	Product maturity level
SOP 2.6.9	Package and process maturity management in Back End
SOP 2.7.5	Automotive products definition and status
0061692	Reliability tests and criteria for product qualification
8160601	Internal reliability evaluation report template
8161393	General specification for product development
7512807	Delamination analysis for plastic packages in reliability tests

2 TEST GLOSSARY

TEST NAME	DESCRIPTION
PC (JL3)	Preconditioning (Solder Simulation)
TC	Temperature Cycling
AC or PPT	Autoclave or Pressure Pot Test
THS	Temperature Humidity Storage
HTSL	High Temperature Storage Life

RELIABILITY EVALUATION OVERVIEW

2.1 Objectives

The aim of this report is to present the results of the reliability assessment evaluation performed on ST7538Q-2/ (A51J*UD14EF1) – ST Muar LQFP 44 Non Green to Green Mold Compound (from 7351LS TO G700LS) + Leadfree plating Conversion.

The main purpose is to qualify GREEN MOLD COMPOUND - G700LS (to replace existing non green compound 7351LS).

ST7538Q-2/ is processed in T96-F6RTQ10D-ORT.7, diffused in AG8F - Agrate AG8 and assembled in MU1A ST MUAR - MALAYSIA.

For the reliability assessment evaluation the following test were carried out:

- Preconditioning JL3 (3X Reflow)
- Thermal Cycle Test (TCT)
- Autoclave / Pressure Pot Test (PPT)
- High Temperature Storage Life (HTSL)
- Temperature Humidity Storage (THS)

2.2 Conclusions

All reliability tests have been completed with positive results. Package oriented test and destructive physical analysis (SAM + Wire pull / ball shear) also have not put in evidence any criticality to package robustness.

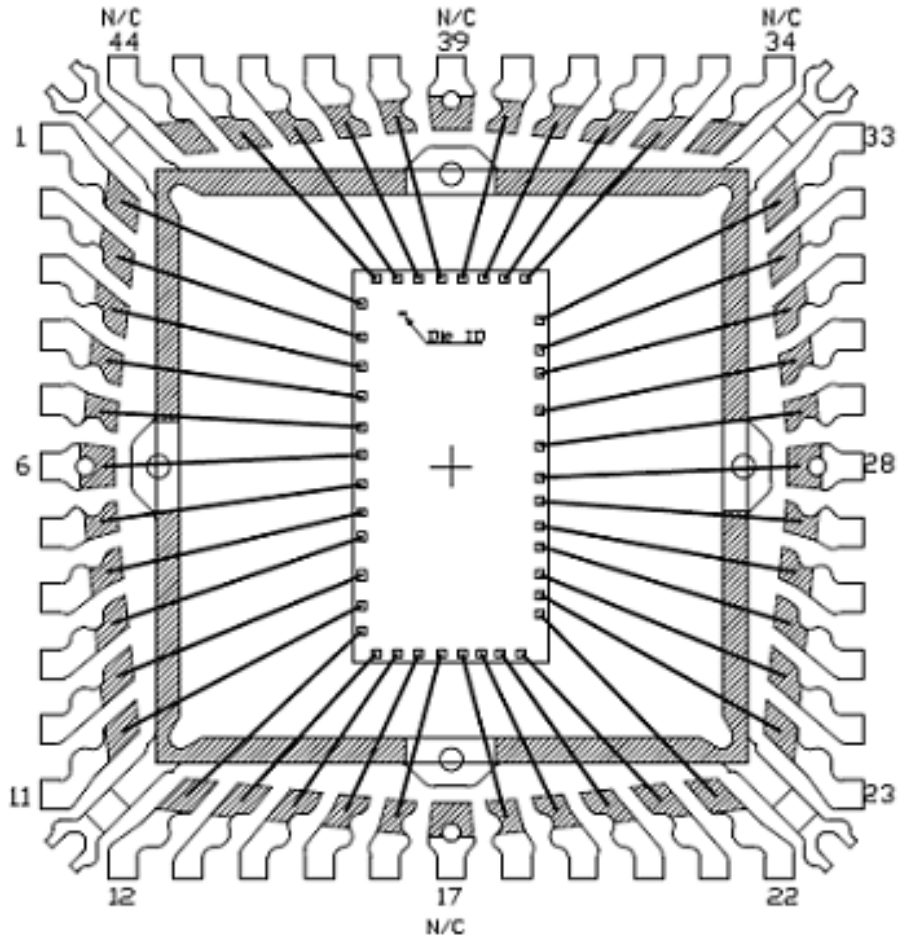
DEVICE CHARACTERISTICS

4.1 Bond Diagram

FRAME PAD $\frac{.284 \times .284 \text{ Inch}}{7,200 \times 7,200 \text{ mm}}$

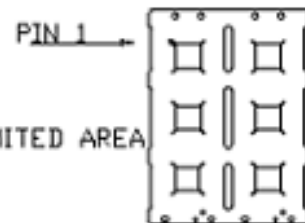
SCALE

 1mm



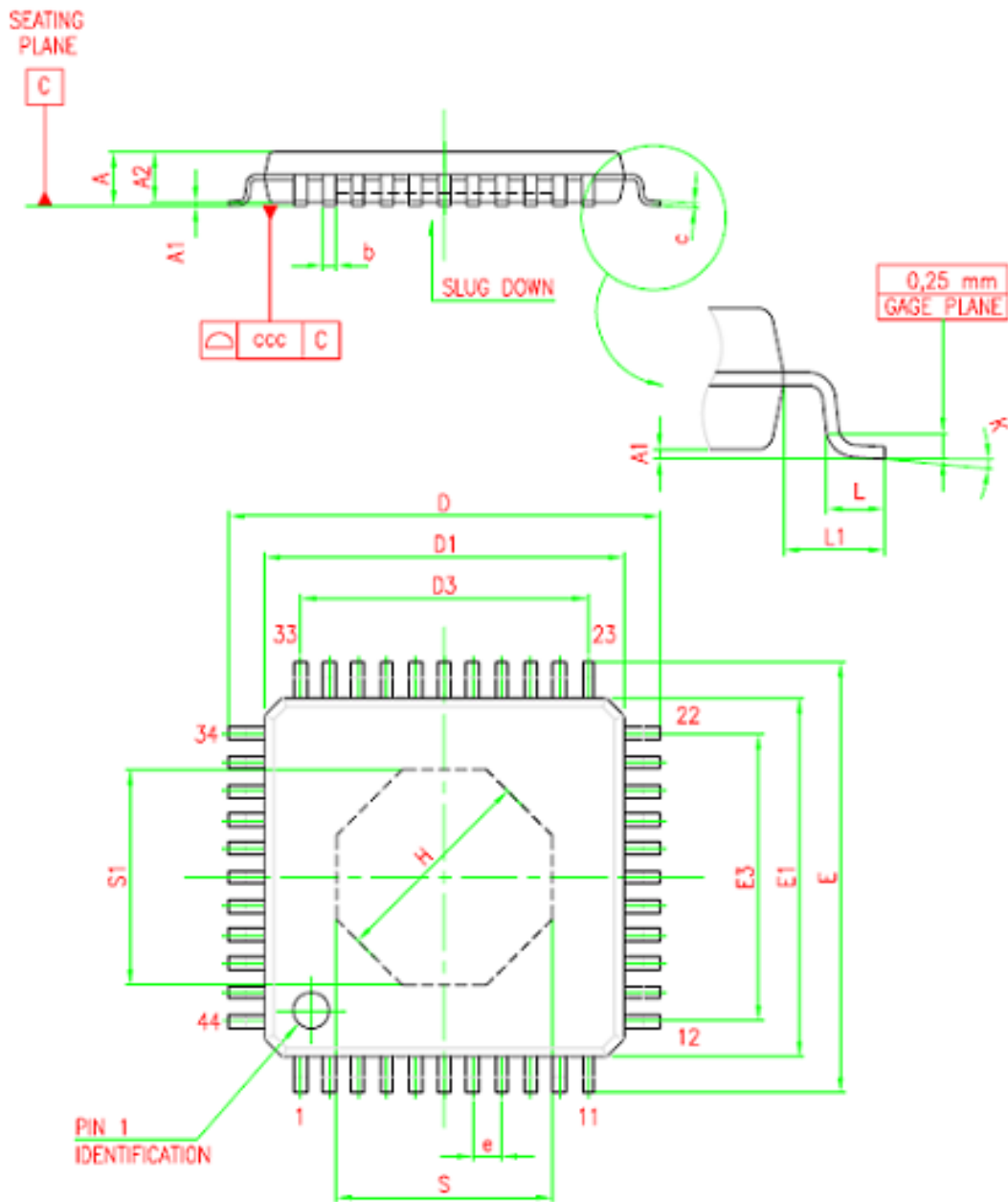
 GND BOND AUTHORIZED ONLY INTO THE DELIMITED AREA

TOFP 44L MATRIX 10x10xL40 1.0 SLUG VERSION



Package Outline / Mechanical Data

FIGURE.1: LQFP 44L BODY 10x10x1.4 FOOT PRINT 1.0 SLUG DOWN
PACKAGE CODE: 1J



4.2 Package Outline / Mechanical Data

PACKAGE OUTLINE ASSEMBLY

TITLE: LQFP 44L BODY 10x10x1.4 FOOT PRINT 1.0 SLUG DOWN

PACKAGE CODE: 1J

JEDEC/EIAJ REFERENCE NUMBER: JEDEC MS 026 BCB HD

REF.	DIMENSIONS						NOTES
	DATABOOK (mm)			DRAWING (mm)			
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
A			1.60	1.425		1.575	
A1	0.05		0.15	0.000	0.10	0.135	
A2	1.35	1.40	1.45	1.38	1.40	1.44	(1)
b	0.30	0.37	0.45	0.325	0.35	0.375	
c	0.09		0.20			0.165	
D	11.80	12.00	12.20	11.90	12.00	12.10	
D1	9.80	10.00	10.20	9.975	10.00	10.025	
D3		8.00		7.95	8.00	8.05	
E	11.80	12.00	12.20	11.90	12.00	12.10	
E1	9.80	10.00	10.20	9.975	10.00	10.025	
E3		8.00		7.95	8.00	8.05	
e		0.00		0.75	0.00	0.05	
H		5.89		5.84	5.89	5.94	
L	0.45	0.60	0.75	0.45			
L1		1.00		0.938	1.00	1.063	
S	6.00			6.00		6.05	
S1	6.00			6.00		6.05	
K	0	3.5	7	1.50	3.50	5.50	DEGREES
ccc			0.10			0.05	

NOTES:

(1) - LQFP stands for Low profile Quad Flat Package.
Low profile: Body thickness (A2=1.40mm)

(2) - Exact shape of each corner is optional.

4.3 Traceability

Wafer Fab Information	
Wafer fab manufacturing location	AG8F - Agrate AG8
Wafer diameter	8 inch
Wafer thickness	375+/-20 UM
Silicon process technology	BCD5CS
Die finishing back side	CHROMIUM / NICKEL
Die finishing front side	Teos + PTeos + SiOn + PIX
Stepping Die Size(X,Y)	4970,2590 UM
Sawing Street Width(X,Y)	110,110 UM
Min Bond Pad Pitch	234.2 UM
No of Metal Layer	3

Assembly Information	
Assembly plant location	MU1A ST MUAR - MALAYSIA
Package description	LQFP 44 10x10x1.4 1.0 SLUG DOWN
Molding compound	RESIN SUMITOMO G700LS
Wire bonding materials/diameters	Au 1.3 Mils
Die attach material	GLUE HITACHI EN4900ST9
Lead frame material	FRAME LQFP 44L 10x10

Final Testing Information	
Electrical testing location	MU1T ST MUAR - MALAYSIA
Tester	A565

5. TEST RESULTS SUMMARY

5.1 Lot Information

Lot #	Diffusion Lot	Lot Details / Trace Code	Assy Lot Id	Testing Lot Id
1	V1640CCT	Control (7351LS) / 996490FW	996490FWRF	996490FWRF
2	V1640CCT	Qual (G700LS) / 996490FW	996490FW01	996490FW01

5.2 Test Plan and Results Summary (Electrical Test)

Reliability Test Status							
No	Test Name	Prec	Condition/ Method	Steps	Fails/SS		Notes
					Lot 1	Lot 2	
1	PC (JL3)		Bake 24hrs @ 125°C Soak 192hrs @ 30°C / 60%RH Reflow Profile = 260°C	Final	0 / 236	0 / 236	Pass
2	TC	Yes	Test Conditions = -65°C/150°C	500cyc	0 / 82	0 / 82	Pass
				1000cyc	0 / 77	0 / 77	Pass
3	AC	Yes	Test Conditions = Ta = 121°C / 2 ATM	96hrs	0 / 77	0 / 77	Pass
				168hrs	0 / 77	0 / 77	Pass
4	THS	Yes	Test Conditions = Ta = +150°C	500hrs	0 / 77	0 / 77	Pass
				1000hrs	0 / 77	0 / 77	Pass
5	HTS	No	Test Conditions = Ta = +150°C	500hrs	0 / 77	0 / 77	Pass
				1000hrs	0 / 77	0 / 77	Pass

NOTES

All units electrically tested good after each reliability test readout.

5.3 Test Plan and Results Summary (SAM Analysis)

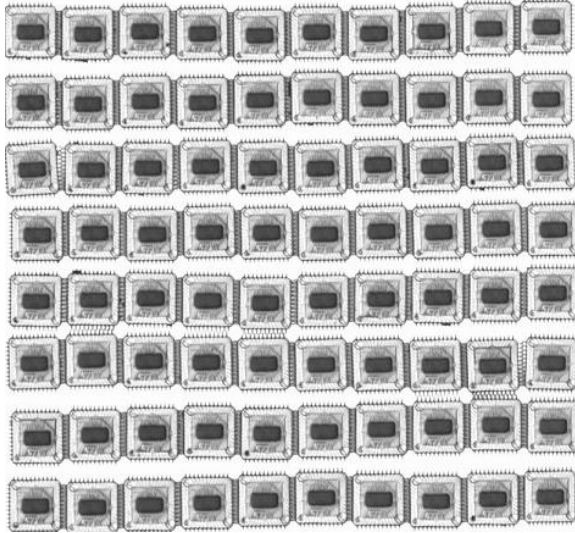
Reliability Test Status							
No	Test Name	Prec.	Condition/ Method	Steps	Fails/SS		Notes
					Lot 1	Lot 2	
1	PC (JL3)		Bake 24hrs @ 125°C Soak 192hrs @ 30°C/60%RH Reflow Profile = J-STD-020D (Tmax = 260°C)	Final	0 / 60	0 / 60	No Delam
2	TC	Yes	Test Conditions = -65°C / +150°C	500cyc	0 / 20	0 / 20	No Delam
				1000cyc	0 / 20	0 / 20	No Delam
3	AC	Yes	Test Conditions = Ta = 121°C / 2 ATM	96hrs	0 / 20	0 / 20	No Delam
				168hrs	0 / 20	0 / 20	No Delam
4	THS	Yes	Test Conditions = Ta = 85°C / 85%RH Without bias	500hrs	0 / 20	0 / 20	No Delam
				1000hrs	0 / 20	0 / 20	No Delam
5	HTSL	No	Test Conditions = Ta = +150°C Without bias	500hrs	0 / 20	0 / 20	No Delam
				1000hrs	0 / 20	0 / 20	No Delam

NOTES

SAM analysis did not reveal any delamination issue on Die Attach Material (DAM), Die / Molding Compound (Die Top) and also Die-Pad (front side) / Molding Compound & Die-Pad (back side) / Molding Compound on sampling basis 20 pcs for each reliability trial.

5.3.1 SAM IMAGES @ TIME-0 & AFTER MSL3

996490FWRF (CTRL)

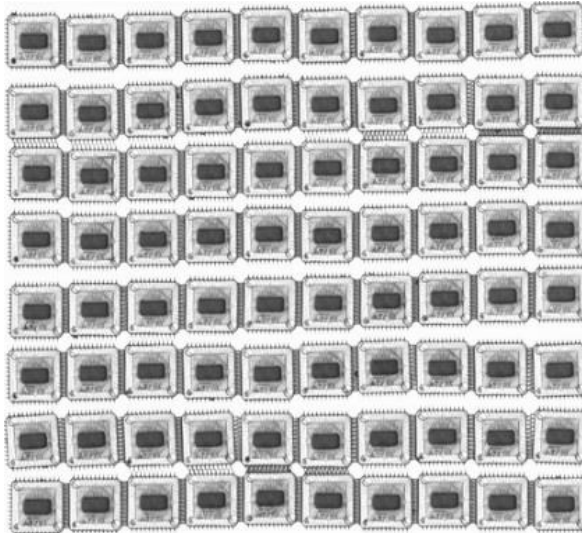


Unit Position no. 1 – 80
T-SAM (Thru Scan)
Results : No Delamination



Unit Position no. 1 – 80
C-SAM Top (Reflected Mode)
Results : No Delamination

996490FW01 (Qual)



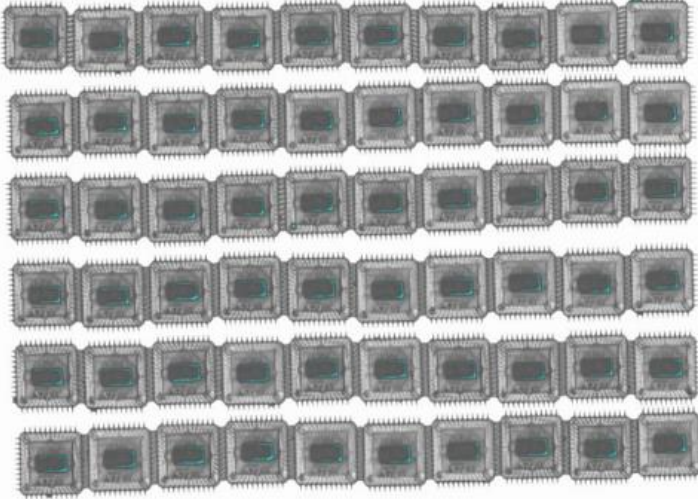
Unit Position no. 1 – 80
T-SAM (Thru Scan)
Results : No Delamination



Unit Position no. 1 – 80
C-SAM Top (Reflected Mode)
Results : No Delamination

5.3.2 SAM IMAGES After MSL3 & 3X Reflow

996490FWRF (CTRL)



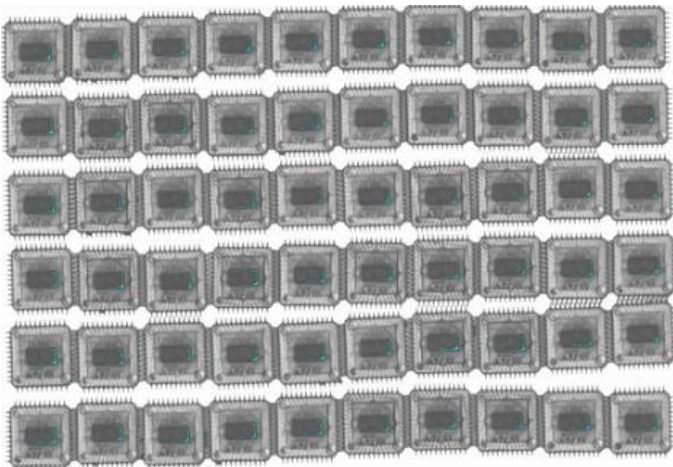
Unit Position no. 1 – 60
T-SAM (Thru Scan)

Results : DA Delam can be seen on all units in range <10%



Unit Position no. 1 – 60
C-SAM Top (Reflected Mode)
Results : No Delamination

996490FW01 (Qual)



Unit Position no. 1 – 60
T-SAM (Thru Scan)
Results : No Delamination



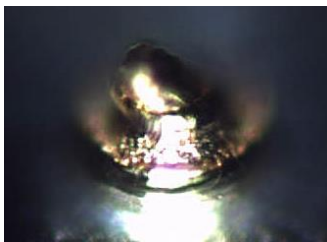
Unit Position no. 1 – 60
C-SAM Top (Reflected Mode)
Results : No Delamination

5.3 Test Plan and Results Summary (DPA ANALYSIS)

Reliability Test Status					
No	Test Name	Condition/ Method	Fails/SS		Notes
			Lot 1	Lot 2	
1	Wire Pull	After TC 500 cycle	Pass	Pass	No any failure detected.
	Stitch Pull		Pass	Pass	
	Ball Shear		Pass	Pass	
2	Wire Pull	After TC 1000 cycle	Pass	Pass	No any failure detected.
	Stitch Pull		Pass	Pass	
	Ball Shear		Pass	Pass	

NOTES

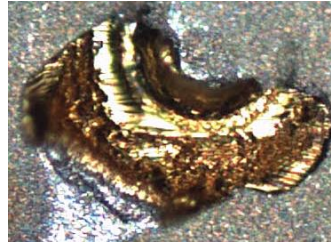
Wire bonding strength has been verified through Wire / Stitch Pull & Ball Shear Test: neither abnormal break loads, nor forbidden failure modes have been found on sampling basis 5 pcs after each reliability readout.



Ball Neck Break @ 1st Bond



Wire Break @ 1st Bond



6. TESTS DESCRIPTION

6.1 Package tests description

TEST NAME	DESCRIPTION	PURPOSE
<p>PC (JL3) Preconditioning MSL3 (solder simulation)</p>	<p>The device is submitted to a typical temperature profile used for surface mounting after storage in a control moisture absorption.</p>	<p>As stand-alone test: to investigate the level of moisture sensitivity. 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.</p>
<p>TC Temperature Cycling</p>	<p>The device is submitted to cycled temperature excursions, between a hot and a cold chamber in air atmosphere</p>	<p>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 link to metal displacement, dielectric cracking, molding compound delamination, wire bonds failure, die crack.</p>
<p>AC or PPT Autoclave / Pressure Pot Test</p>	<p>The device is stored in saturated steam, at fixed and controlled conditions of pressure and temperature</p>	<p>To investigate corrosion phenomena affecting die or package materials, related to chemical contamination and package hermeticity. To point out critical water entry paths with consequent electrochemical and galvanic corrosion.</p>
<p>HTSL High Temperature Storage Life</p>	<p>The device is stored in unbiased condition at the max temperature allowed by the package materials, sometimes higher than the max operative temperature.</p>	<p>To investigate the failure mechanisms activated by high temperature, typically wire-bonds solder joint ageing, data retention faults, metal stress-voiding</p>
<p>THS Temperature Humidity Storage</p>	<p>This test is used to identify failure mechanisms internal to the package and destructive. Bias is not applied in this test to ensure the failure mechanisms potentially overshadowed by bias can be uncovered (e.g. galvanic corrosion).</p>	<p>Evaluating the reliability of non-hermetic packaged solid state devices in humid environments. It is a highly accelerated test which employs temperature and humidity under non-condensing conditions to accelerate the penetration of moisture through the external protective material (encapsulant or seal) or along the interface between the external protective material and the metallic conductors which pass through it.</p>

Reliability Qualification Report
ST Muar LQFP 44 Non Green to Green Mold Compound (from 7351LS TO G700LS) + Leadfree plating Conversion Project

General Information	
Product Line	V07103
Product From	294Y*V071CAL
Process Plan	T96-F6RTQ10D.4
Package Technology	LQFP 44 10x10

Locations	
Wafer Fab Location	UTEF - UMC Fab8E DIFF
Assembly Plant Location	MU1A ST MUAR - MALAYSIA
Testing Plant	MU1T ST MUAR - MALAYSIA
Reliability Assessment	ST MUAR (QA RELIABILITY LAB)

Issued By: Mohd Ibrahim GHAZALI

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TABLE OF CONTENTS

1	APPLICABLE AND REFERENCE DOCUMENTS	Page: 3
2	TEST GLOSSARY	Page: 3
3	RELIABILITY EVALUATION OVERVIEW	
	3.1 OBJECTIVES	Page: 4
	3.2 CONCLUSIONS	Page: 4
4	DEVICE CHARACTERISTICS	
	4.1 BONDING DIAGRAM	Page: 5
	4.2 PACKAGE OUTLINE/MECHANICAL DATA	Page: 6 – 7
	4.3 TRACEABILITY	Page: 8
5	TEST RESULTS SUMMARY	
	5.1 LOT INFORMATION	Page: 9
	5.2 ELECTRICAL TEST RESULTS	Page: 9
	5.3 SAM ANALYSIS RESULTS	Page: 10
	5.3.1 SAM IMAGES @ TIME-0	Page: 11
	5.3.2 SAM IMAGES AFTER MSL3 (3IR)	Page: 12
	5.4 DPA RESULTS (Wire Pull / Ball Shear)	Page: 13
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	6.1 DIE AND PACKAGE TESTS DESCRIPTION	Page: 14

1 APPLICABLE AND REFERENCE DOCUMENTS

Document Reference	Short Description
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SOP 2.6.19	Front-end technology platform development & qualification
SOP 2.6.2	Internals change management
SOP 2.6.7	Product maturity level
SOP 2.6.9	Package and process maturity management in Back End
SOP 2.7.5	Automotive products definition and status
0061692	Reliability tests and criteria for product qualification
8160601	Internal reliability evaluation report template
8161393	General specification for product development
7512807	Delamination analysis for plastic packages in reliability

2 TEST GLOSSARY

TEST NAME	DESCRIPTION
PC (JL3)	Preconditioning (Solder Simulation)
TC	Temperature Cycling
AC or PPT	Autoclave or Pressure Pot Test

RELIABILITY EVALUATION OVERVIEW

2.1 Objectives

The aim of this report is to present the results of the reliability assessment evaluation performed on ST7538Q-2/ (294Y*V071CAI& B54Y*V071CAL) – ST Muar LQFP 44 Non Green to Green Mold Compound (from 7351LS TO G700LS) + Leadfree plating Conversion.

The main purpose is to qualify GREEN MOLD COMPOUND - G700LS (to replace existing non green compound 7351LS).

ST7538Q-2/ is processed in T96-F6RTQ10D-ORT.7, diffused in AG8F - Agrate AG8 and assembled in MU1A ST MUAR - MALAYSIA.

For the reliability assessment evaluation the following test were carried out:

- Preconditioning JL3 (3X Reflow)
- Thermal Cycle Test (TCT)
- Autoclave / Pressure Pot Test (PPT)

2.2 Conclusions

All reliability tests have been completed with positive results. Package oriented test and destructive physical analysis (SAM + Wire pull / ball shear) also have not put in evidence any criticality to package robustness.

DEVICE CHARACTERISTICS


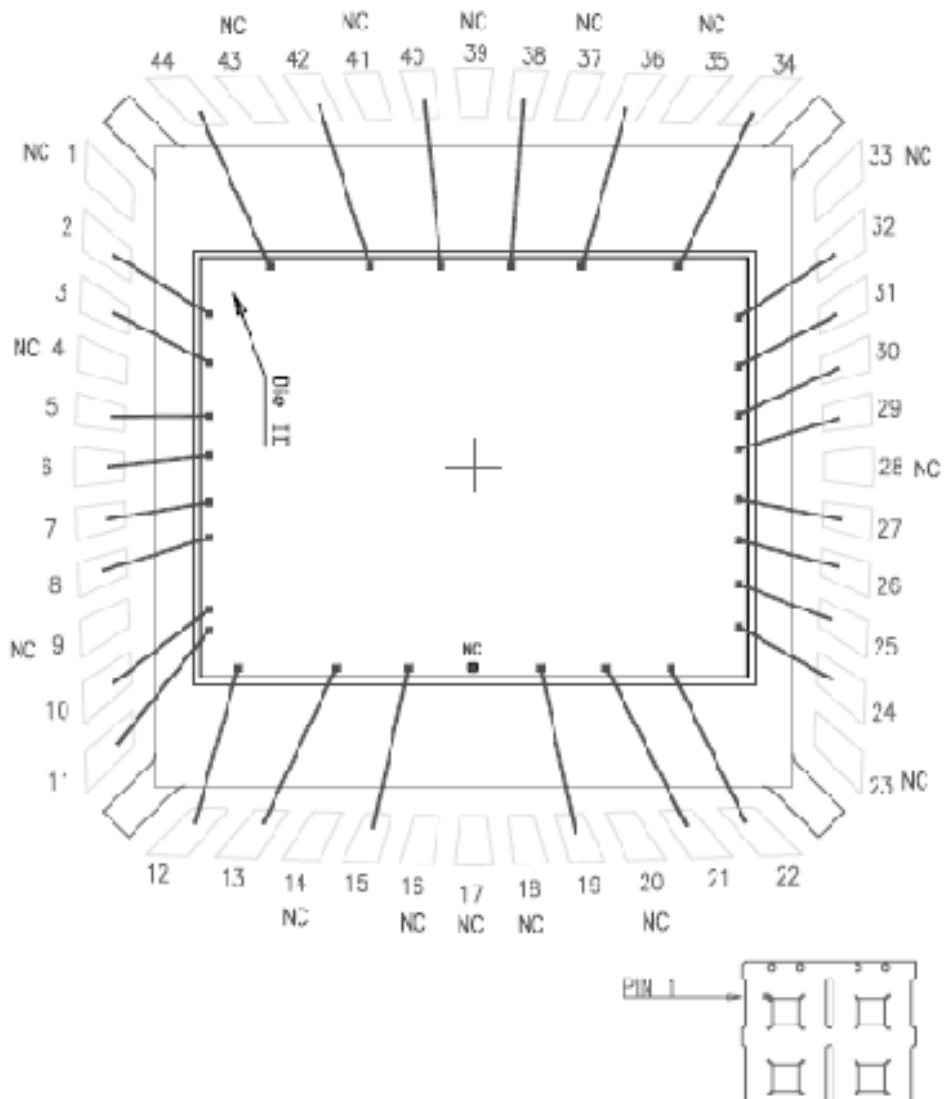
4.1 Bond Diagram

BONDING DIAGRAM FOR LINE : V071

PACKAGE : 4Y

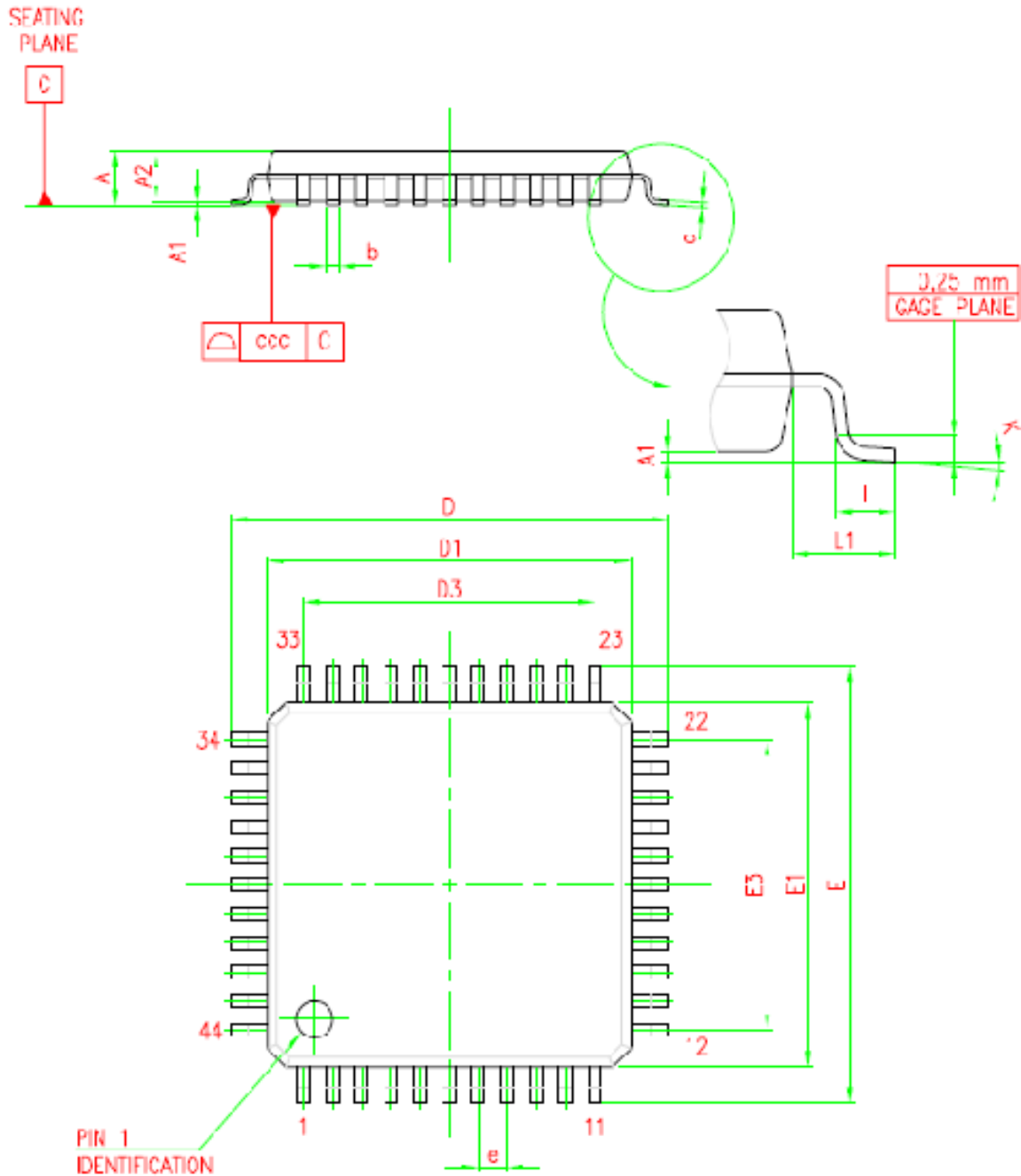
FRAME PAD : $\frac{.236 \times .236}{6,000 \times 6,000}$ inch
mm

SCALE
1mm

Package Outline / Mechanical Data

FIGURE 1: LQFP 44L BODY 10x10x1.4 FOOT PRINT 1.0
PACKAGE CODE: 4Y



4.2 Package Outline / Mechanical Data

TITLE: LQFP 44L BODY 10x10x1.4 FOOT PRINT 1.0

PACKAGE CODE: 4Y

JEDEC/EIAJ REFERENCE NUMBER: JEDEC MS-026-BCB

DIMENSIONS							
REF.	DATABOOK (mm)			DRAWING (mm)			NOTES
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
A			1.60	1.425		1.575	
A1	0.05		0.15	0.065	0.10	0.135	
A2	1.35	1.40	1.45	1.36	1.40	1.44	
b	0.300	0.370	0.45	0.325	0.35	0.375	
c	0.09		0.20			0.165	
D	11.80	12.00	12.20	11.90	12.00	12.100	
D1	9.80	10.00	10.20	9.975	10.00	10.025	
D3		8.00		7.95	8.00	8.05	
E	11.80	12.00	12.20	11.90	12.00	12.10	
E1	9.80	10.00	10.20	9.975	10.00	10.025	
E3		8.00		7.95	8.00	8.05	
e		0.80		0.75	0.80	0.85	
L	0.45	0.60	0.75	0.45			
L1		1.00		0.938	1.00	1.063	
K	0	3.5	7	1.50	3.50	5.50	DEGREES
ccc			0.10			0.05	

NOTES:

- (1) – LQFP stands for Low profile Quad Flat Package.
Low profile: Body thickness (A2=1.40mm)
- (2) – Exact shape of each corner is optional.

4.3 Traceability

Wafer Fab Information	
Wafer fab manufacturing location	UTEF - UMC Fab8E DIFF
Wafer diameter	8 inch
Wafer thickness (XUL25CB5)	375+/-20 UM
Silicon process technology	HCMOS6
Die finishing back side	RAW SILICON
Die finishing front side	P-VAPOX(SiO ₂) / NITRIDE (SiN)
Stepping Die Size(X,Y)	5270,4070 UM
Sawing Street Width(X,Y)	110,110 UM
Min Bond Pad Pitch	85 UM
No of Metal Layer	5

Assembly Information	
Assembly plant location	MU1A ST MUAR - MALAYSIA
Package description	LQFP 44 10x10x1.4
Molding compound	RESIN SUMITOMO EME7351LS
Wire bonding materials/diameters	Au 1.2 Mils
Die attach material	GLUE HITACHI EN4900ST9
Lead frame material	FRAME LQFP 44L 10x10

Final Testing Information	
Electrical testing location	Plant MU1T ST MUAR - MALAYSIA
Tester	CATALYST

5. TEST RESULTS SUMMARY

5.1 Lot Information

Lot #	Diffusion Lot	Lot Details / Trace Code	Assy Lot Id	Testing Lot Id
1	LE628005	Control (7351LS) / 9970211Y	9970211Y01	9970211Y01
2	LE628005	Qual (G700LS) / 9970211Y	9970211Y02	9970211Y02

5.2 Test Plan and Results Summary (Electrical Test)

Reliability Test Status							
No	Test Name	Prec	Condition/ Method	Steps	Fails/SS		Notes
					Lot 1	Lot 2	
1	PC (JL3)		Bake 24hrs @ 125°C Soak 192hrs @ 30°C/60%RH Reflow Profile = J-STD-020D (Tmax = 260°C)	Final	0 / 159	0 / 159	Pass
2	TC	Yes	Ambient Temp Range = -65°C / +150°C	500cyc	0 / 82	0 / 82	Pass
				1000cyc	0 / 77	0 / 77	Pass
3	AC	Yes	Test Conditions = Ta = 121°C / 2 ATM	96hrs	0 / 77	0 / 77	Pass
				168hrs	0 / 77	0 / 77	Pass
				1000hrs	0 / 77	0 / 77	Pass

NOTES

All units electrically tested good after each reliability test readout.

5.3 Test Plan and Results Summary (SAM Analysis)

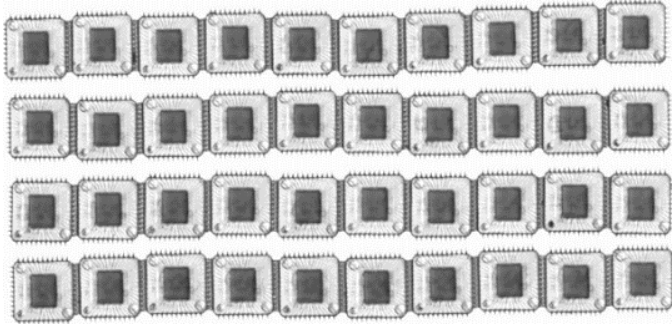
Reliability Test Status							
No	Test Name	Prec	Condition/ Method	Steps	Fails/SS		Notes
					Lot 1	Lot 2	
1	PC (JL3)		Bake 24hrs @ 125°C Soak 192hrs @ 30°C/60%RH Reflow Profile = J-STD-020D (Tmax = 260°C)	Final	0 / 60	0 / 60	No Delam
2	TC	Yes	Test Conditions = -65°C / +150°C	500cyc	0 / 20	0 / 20	No Delam
				1000cyc	0 / 20	0 / 20	No Delam
3	AC	Yes	Test Conditions = Ta = 121°C / 2 ATM	96hrs	0 / 20	0 / 20	No Delam
				168hrs	0 / 20	0 / 20	No Delam

NOTES

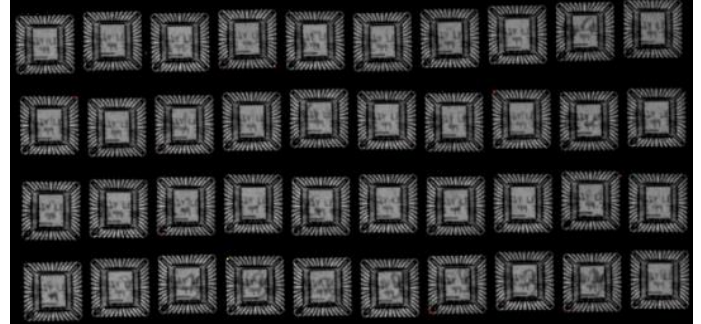
SAM analysis did not reveal any delamination issue on Die Attach Material (DAM), Die / Molding Compound (Die Top) and also Die-Pad (front side) / Molding Compound & Die-Pad (back side) / Molding Compound on sampling basis 20 pcs for each reliability trial.

5.3.1 SAM IMAGES @ TIME-0

9970211Y01 (QUAL LOT)

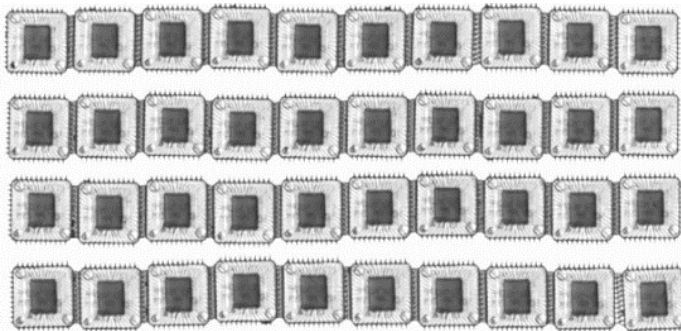


Unit Position no. 1 – 40
T-SAM (Thru Scan)
Results : No Delamination

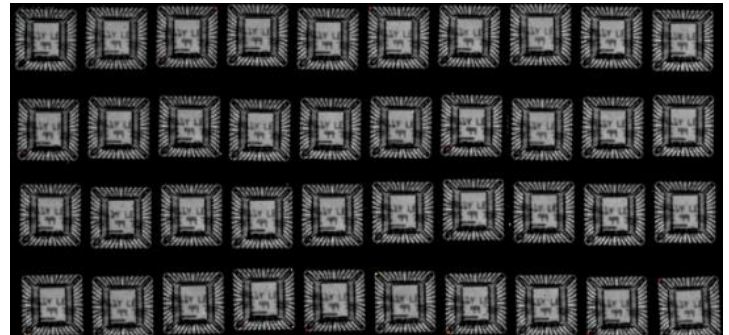


Unit Position no. 1 – 40
C-SAM Top (Reflected Mode)
Results : No Delamination

9970211Y02 (CTRL)



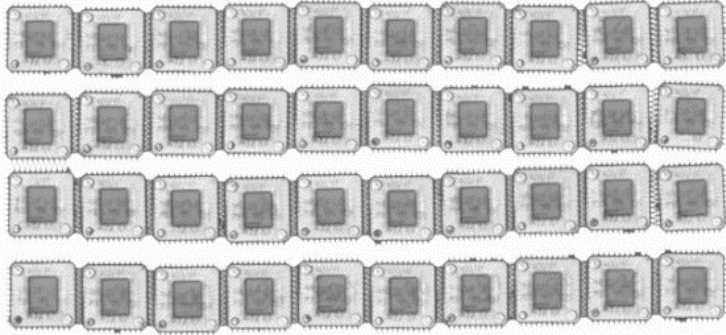
Unit Position no. 1 – 40
T-SAM (Thru Scan)
Results: No Delamination



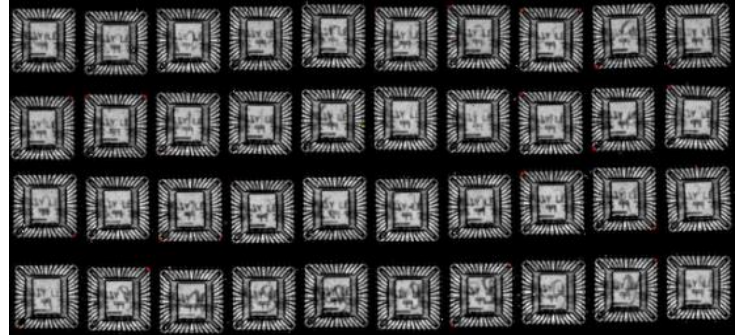
Unit Position no. 1 – 40
C-SAM Top (Reflected Mode)
Results: No Delamination

5.3.2 SAM IMAGES After MSL3 & 3X Reflow

9970211Y01 (QUAL)

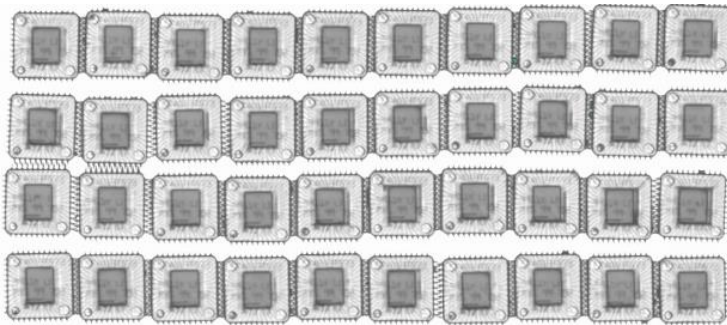


Unit Position no. 1 – 40
T-SAM (Thru Scan)
Results: No Delamination

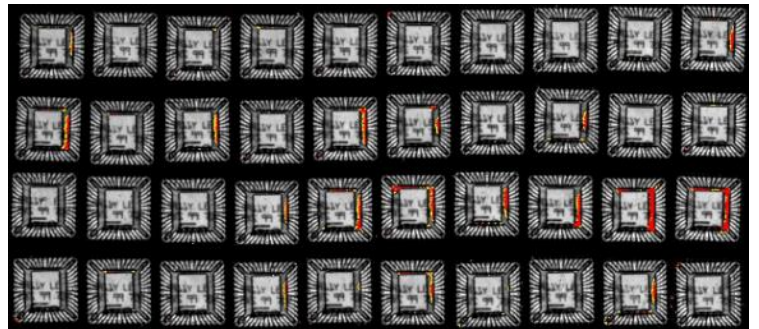


Unit Position no. 1 – 40
C-SAM Top (Reflected Mode)
Results: No Delamination

9970211Y02 (CTRL)



Unit Position no. 1 – 40
T-SAM (Thru Scan)
Results: No Delamination



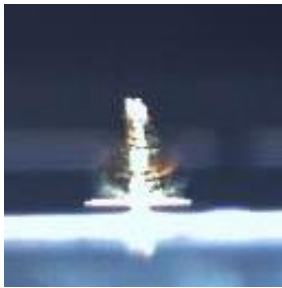
Unit Position no. 1 – 40
C-SAM Top (Reflected Mode)
Results: No Delamination

5.4 Test Plan and Results Summary (Physical Analysis – Wire Pull & Ball Shear Test)

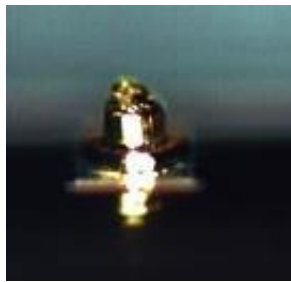
Reliability Test Status					
No	Test Name	Condition/ Method	Fails/SS		Notes
			Lot 1	Lot 2	
1	Wire Pull	After TC 500 cycle	Pass	Pass	No any failure detected.
	Stitch Pull		Pass	Pass	
	Ball Shear		Pass	Pass	
2	Wire Pull	After TC 1000 cycle	Pass	Pass	No any failure detected.
	Stitch Pull		Pass	Pass	
	Ball Shear		Pass	Pass	

NOTES

Wire bonding strength has been verified through Wire / Stitch Pull & Ball Shear Test: neither abnormal break loads, nor forbidden failure modes have been found on sampling basis 5 pcs after each reliability readout.



Wire Break @ 1st Bond



Ball Neck Break @ 1st Bond



Weld Neck Break @ 2nd Bond



6. TESTS DESCRIPTION

6.1 Package tests description

TEST NAME	DESCRIPTION	PURPOSE
<p>PC (JL3) Preconditioning MSL3 (solder simulation)</p>	<p>The device is submitted to a typical temperature profile used for surface mounting after storage in a control moisture absorption.</p>	<p>As stand-alone test: to investigate the level of moisture sensitivity. 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.</p>
<p>TC Temperature Cycling</p>	<p>The device is submitted to cycled temperature excursions, between a hot and a cold chamber in air atmosphere.</p>	<p>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 link to metal displacement, dielectric cracking, molding compound delamination, wire bonds failure, die crack.</p>
<p>AC or PPT Autoclave / Pressure Pot Test</p>	<p>The device is stored in saturated steam, at fixed and controlled conditions of pressure and temperature</p>	<p>To investigate corrosion phenomena affecting die or package materials, related to chemical contamination and package hermeticity. To point out critical water entry paths with consequent electrochemical and galvanic corrosion.</p>