



# PRODUCT/PROCESS CHANGE NOTIFICATION

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PCN APG/07/2403  
Notification Date 03/30/2007

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**LQFP 7x7x1.4: NEW LEADFREE BOM QUALIFICATION**

**APG - APG**

**Table 1. Change Identification**

Product Identification (Product Family/Commercial Product)	ALL PRODUCTS IN LQFP 7x7x1.4mm 32 & 48 leads
Type of change	Package assembly material change
Reason for change	To qualify the leadfree package to IPC/JEDEC J-STD-020C
Description of the change	New BOM qualification compliant to 260 C : - pre-plated frames NiPdAu. - glue die attach Loctite QMI9507-2C2. - molding compound SUMITOMO EME-G700L.
Product Line(s) and/or Part Number(s)	See attached
Description of the Qualification Plan	See attached
Change Product Identification	"e4" as identification of PPF frames
Manufacturing Location(s)	1]St Muar - Malaysia

**Table 2. Change Implementation Schedule**

Forecasted implementation date for change	15-Jun-2007
Forecasted availability date of samples for customer	30-Mar-2007
Forecasted date for <b>STMicroelectronics</b> change Qualification Plan results availability	30-Mar-2007
Estimated date of changed product first shipment	30-Jun-2007



## DOCUMENT APPROVAL

<b>Name</b>	<b>Function</b>
Foletto, Giovanni	Division Marketing Manager
Pengo, Tullio	Division Marketing Manager
Russo, Alfio	Division Marketing Manager
Cassani, Fabrizio	Division Product Manager
Conan-clement, Bertrand	Division Product Manager
Rivolta, Danilo	Division Product Manager
Amadeo, Matteo	Division Q.A. Manager
Mercandelli, Laura	Division Q.A. Manager
Parrino, Emanuele	Division Q.A. Manager



## LQFP 7x7x1.4: NEW LEADFREE BOM QUALIFICATION

### WHAT:

We have completed the qualification of a new leadfree BOM (Bill of Material) for our products assembled in LQFP 7x7x1.4mm (32 & 48 leads) compliant to IPC/JEDEC J-STD-020C, able to sustain 260°C as reflow temperature.

The new BOM is composed by:

- NiPdAu pre-plated lead-frame (“PPF”); (“e4” as per marking on the part).
- Loctite QMI9507 die-attach glue;
- Sumitomo G700L “green” molding compound.

The qualification of a green molding compound is also compliant to the Company roadmap towards environmentally friendly components.

### WHY:

Company roadmap and compliancy to standard spec IPC/JEDEC J-STD-020C.

### HOW:

Here attached you find three different qualification reports for the qualification of the new BOM that cover all the different front-end processes and back-finishing of the LQFP 7x7x1.4mm products.

**T.V. V341 / LQFP 48 leads - HCMOS8 report ER001107AG6053**

**T.V. UR27 / LQFP 48 leads - BCD3s report ER000707AG6053**

**T.V. US10 / LQFP 32 leads - BCD3s report ER000407AG6053**

### WHEN:

We will implement the new BOM, for leadfree production, from end Q2/07. Samples available on customer's request through our Sales offices.

We invite all the customers that have not yet switched to leadfree to do it as soon as possible.

# **Pb-FREE BOM FOR LQFP 7x7 / MUAR**

## **RELIABILITY EVALUATION REPORT**

### **TEST VEHICLE: V341 / LQFP-48**

#### ***Abstract***

Reliability results obtained from V341 are here presented. The product is one of the APG test-vehicles selected for ST qualification of the LQFP 7x7 lead-free package, in order to confirm the new BOM performance on inorganic passivation.

#### ***Conclusion***

On the basis of the results summarized in the present document, the qualification sample has met the general reliability requirements for ST/APG qualification, following the stress methods driven by AEC-Q100 and IPC/JEDEC J-STD-020C for MSL 3 classification.

Physical analysis of samples after the reliability tests has pointed out a satisfactory degree of robustness versus the dominant wear-out phenomena potentially activated during long-term exposure to environmental stress, as typical in the automotive field.

**Reliability test conditions and results**

TEST NAME	CONDITIONS [SPEC]	REJ./S.S.	NOTES
JL3	24h bake @ 125°C 192h @ 30°C / 60% RH reflow simulation (3 times) at T <sub>MAX</sub> =260°C [IPC/Jedec J-STD-020C]	0/180	1
JL3 + TCT	Ta=-50/+150°C, 1000 cycles	0/77	1, 2, 3
JL3 + PP	168h PP (2atm, 121°C)	0/77	3
HTS	Ta=150°C 1000h	0/55	2

**NOTES:**

- <sup>1</sup> SAM analysis did not show any remarkable delamination at the die-molding compound interface, on the lead tips and through the die-attach layer. Detail in attachment n.3
- <sup>2</sup> Wire bonding strength after the stress has been successfully verified through wire-pull test, performed in accordance with AEC-Q100 requirement: neither abnormal break loads, nor forbidden failure modes have been detected. Detail in attachment n.3
- <sup>3</sup> Visual and SEM inspection after the stress test have pointed out no degradation of silicon passivation, metal interconnects, stitch bonds on internal lead-tips. Detail in attachment n.3

**Construction note**

<b>Technical code</b> :	A55B*V341CAG
<b>Diffusion process</b> :	HCMOS8
<b>Wafer diameter</b> :	8"
<b>Diffusion site</b> :	ROUSSET
<b>Die size (mm<sup>2</sup>)</b> :	4.19 x 4.19
<b>Metal levels</b> :	6, Ti/Al/TiN
<b>Passivation</b> :	SiO <sub>2</sub> +SiN
<b>Back finishing</b> :	Raw Silicon
<b>Package name</b> :	LQFP 48 7x7x1.4
<b>Assembly site</b> :	MUAR
<b>Leadframe</b> :	LQFP 48L 7x7mm 5x5 FPad NiPdAu
<b>Die attach</b> :	Loctite QMI9507 2C2
<b>Wire bonding</b> :	Au,1.2mil
<b>Molding compound</b> :	SUMITOMO EME-G700L
<b>Lead finishing</b> :	NiPdAu
<b>Lot_id</b> :	996230H0

**Attachments**

- 1) Reliability tests description
- 2) List of stress equipment
- 3) Physical analysis report

## ATTACHMENT 1: RELIABILITY TESTS DESCRIPTION

<b>TEST NAME</b>	<b>DESCRIPTION</b>	<b>PURPOSE</b>
<b>JLn:</b> Jedec Level n surface mounting simulation	The device is submitted to a typical temperature profile used for surface mounting, after a controlled moisture absorption.	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.
<b>TCT:</b> Temperature Cycles Test	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, moulding compound delamination, wire-bonds failure, die-attach layer degradation.
<b>HTS:</b> High Temperature Storage	The device is stored in unbiased condition at the max. temperature allowed by the package materials, sometimes higher than the max. operative temperature.	To investigate the failure mechanisms activated by high temperature, typically wire-bonds solder joint ageing, data retention faults, metal stress-voiding.
<b>PPT:</b> Pressure Pot Test	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.



## **ATTACHMENT 2: LIST OF STRESS EQUIPMENT**

<b>EQUIPMENT</b>	<b>TYPE</b>	<b>USED FOR...</b>
MAZZALI THRMAIR	STATIC OVEN	HTS, JL3 (drying bake step)
MAZZALI CLIMATEST	CLIMATIC CHAMBER	JL3 (moisture soak step)
HERAEUS NOBLELIGHT	REFLOW FURNACE (7 zones)	JL3 (reflow simulation step)
WEISS TS130	AIR TO AIR SHOCK (2 chambers)	TCT
MAZZALI	PRESSURE POT	PPT

## ATTACHMENT 3: PHYSICAL ANALYSIS REPORT

**Technical code** : A55B\*V341CAG

**Package** : LQFP 48 7x7x1.4

**Lot(s)\_id** : 996230H0

**Evaluation subject** : New Pb-free BOM for LQFP 7x7

**Author** : D. Casiraghi

**Analysis status:**     RUNNING                       COMPLETED

### ANALYSIS PROGRAM

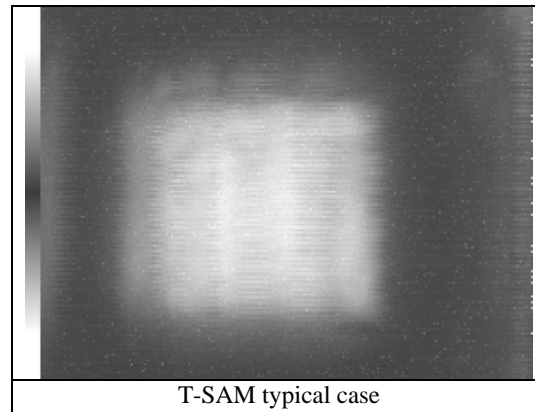
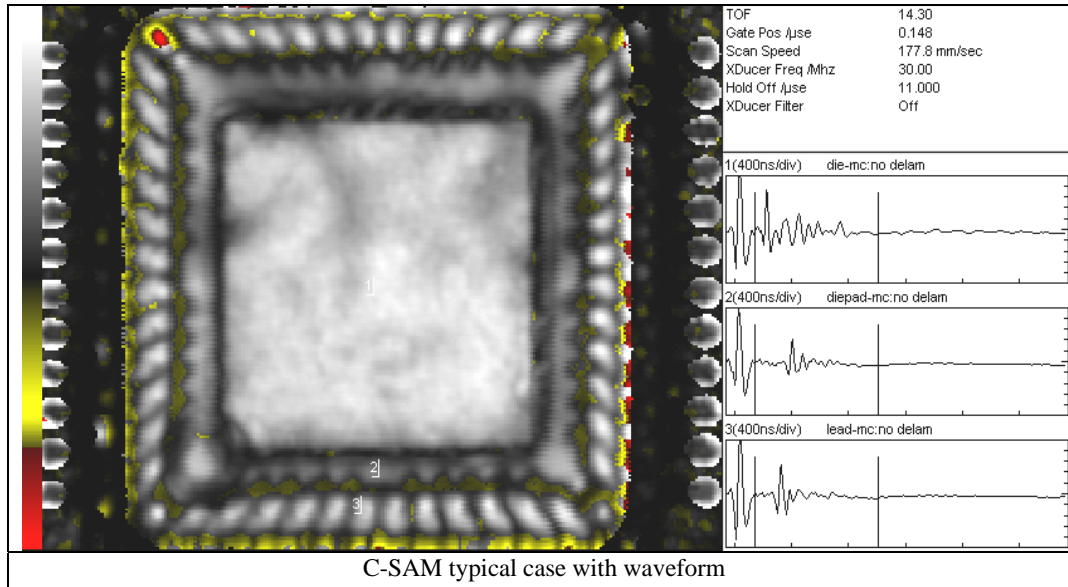
DESTRUCTIVE ITEMS				NON DESTRUCTIVE ITEMS		WHEN
Wire pull test	Ball Shear test	Internal visual	SEM inspection	SAM inspection	Other	
				X		Unstressed
				X		JL3@260°C
X		X	X	X		JL3+1000TC
		X				JL3+PP 168h
X						1000h HTS

### RESULTS SUMMARY

- SAM analysis did not show any remarkable delamination at the die-molding compound interface, on the lead tips and through the die-attach layer.
- Visual and SEM inspection after long-term TC and PP tests have pointed out no degradation of silicon passivation, metal interconnects, stitch bonds on internal lead-tips.
- Wire bonding strength after TC and HTS stress has been successfully verified through wire-pull test: neither abnormal break loads, nor forbidden failure modes have been found.

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55B*V341CAG	LQFP 48 7x7x1.4	SAM inspection	Unstressed

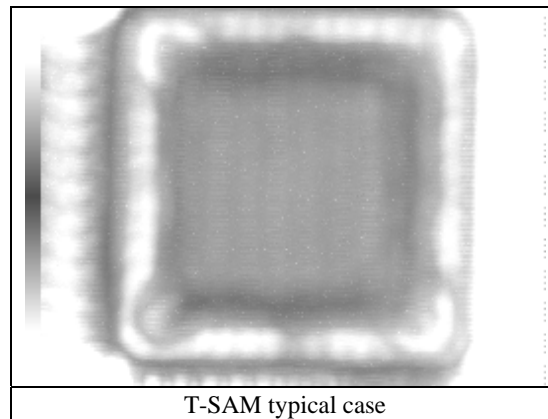
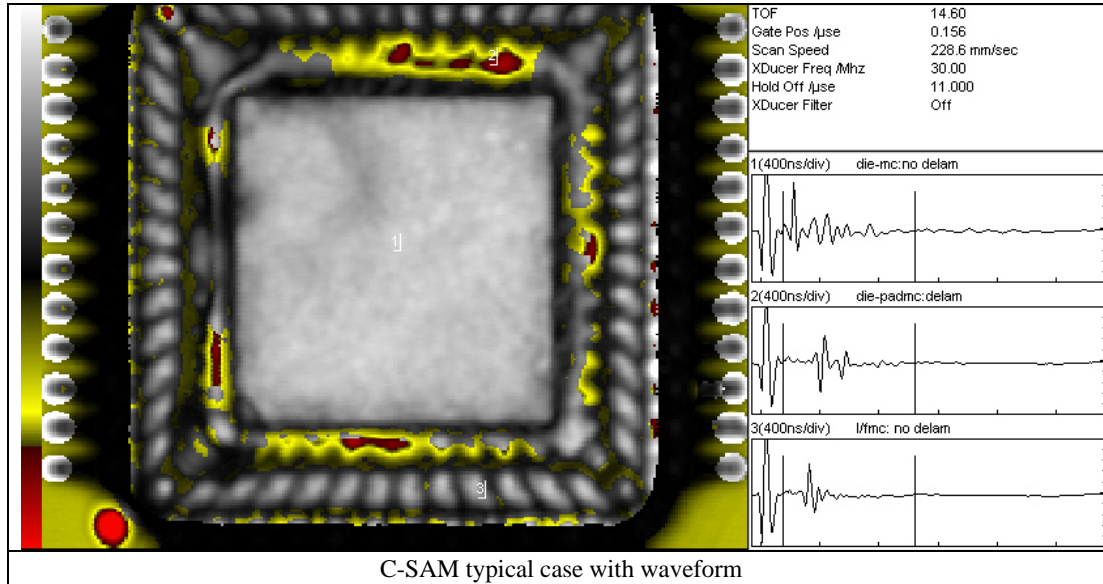
TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	I/f-mold (C-scan)	diepad-mold (C-scan)
996230H0	20	0/20	0/20	0/20	0/20
Transducer frequency (MHz)		30	30	30	30

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55B*V341CAG	LQFP 48 7x7x1.4	SAM inspection	JL3 Preconditioning @260°C

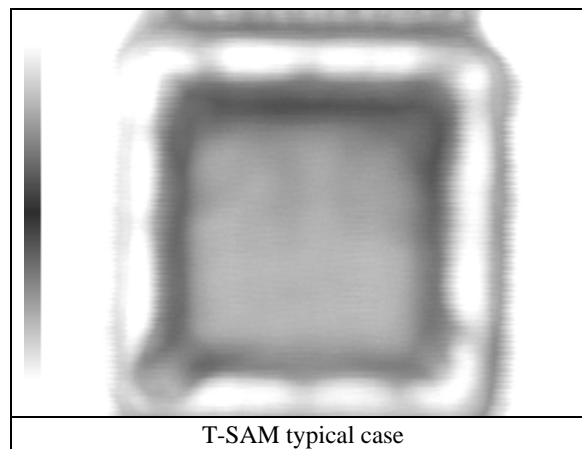
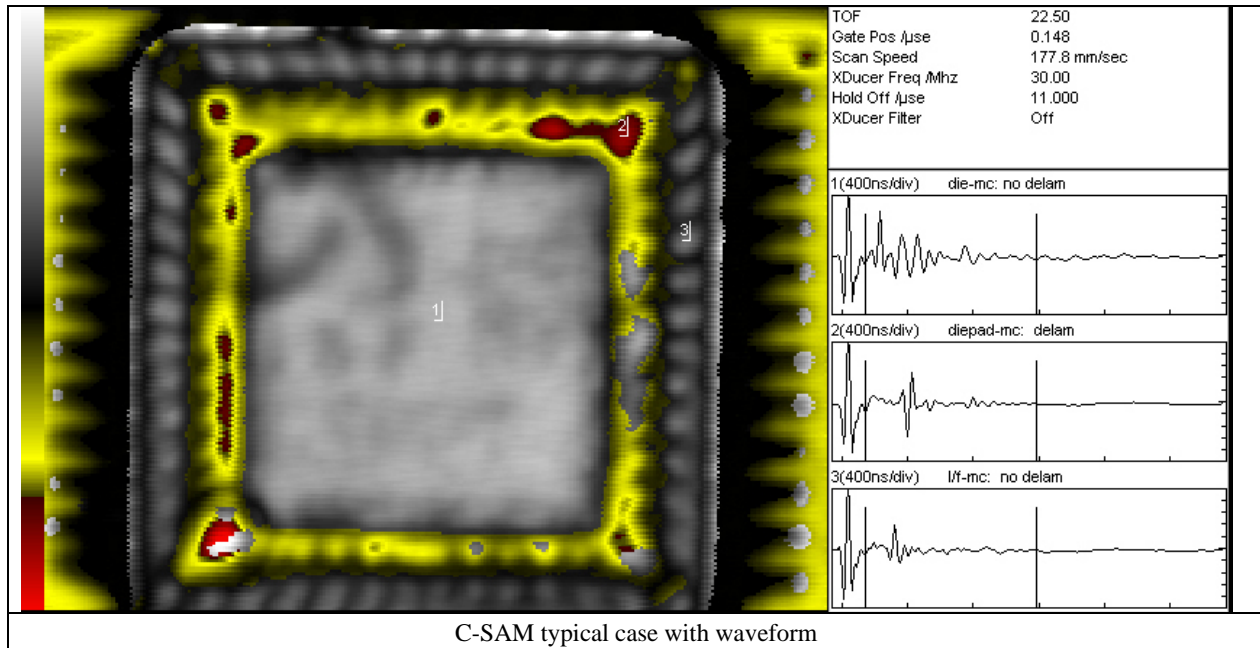
TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	l/f-mold (C-scan)	diepad-mold (C-scan)
996230H0	20	0/20	0/20	0/20	20/20
Transducer frequency (MHz)		30	30	30	30

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55B*V341CAG	LQFP 48 7x7x1.4	SAM inspection	JL3@260°C + 1000 TC

TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	I/f-mold (C-scan)	diepad-mold (C-scan)
996230H0	20	0/20	0/20	0/20	20/20
Transducer frequency (MHz)		30	30	30	30

TECHNICAL CODE	PACKAGE	LOTS	ANALYSIS ITEM
A55B*V341CAG	LQFP 48 7x7x1.4	996230H0	Internal visual

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE /LOTS	RESULT
Passivation and metal	JL3+1000TC	5pcs	No significant defect (photo 1-4)

**DOCUMENTATION:**

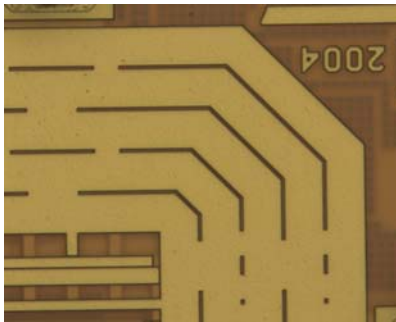


Photo 1 (20X)

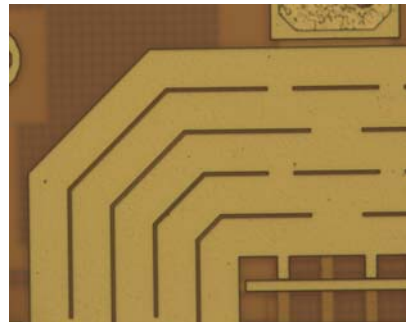


Photo 2 (20X)

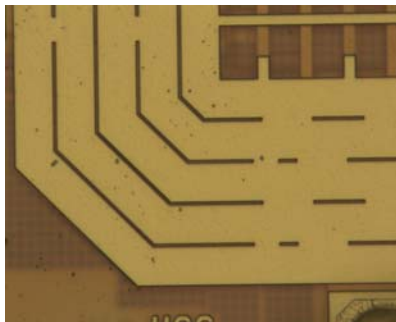


Photo 3 (20X)

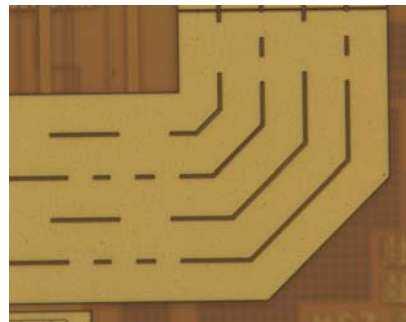


Photo 4 (20X)

**TEST EQUIPMENT:** LEICA (Optical Microscope)

TECHNICAL CODE	PACKAGE	LOTS	ANALYSIS ITEM
A55B*V341CAG	LQFP 48 7x7x1.4	996230H0	Internal visual

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE /LOTS	RESULT
Metal corrosion and oxidation	JL3+168h PP	5pcs	No visible defect (photo 1-4)

**DOCUMENTATION:**

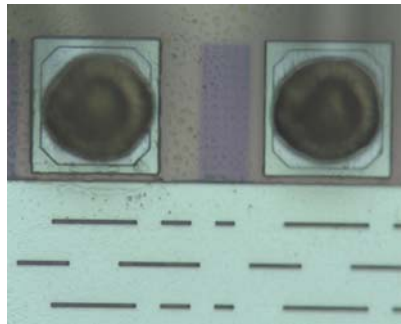


Photo 1 (20X)

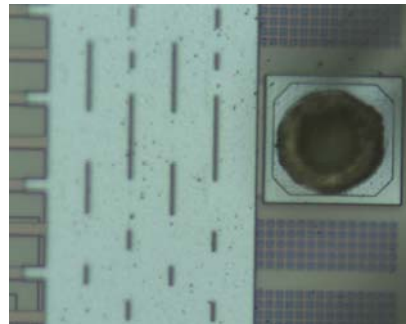


Photo 2 (20X)

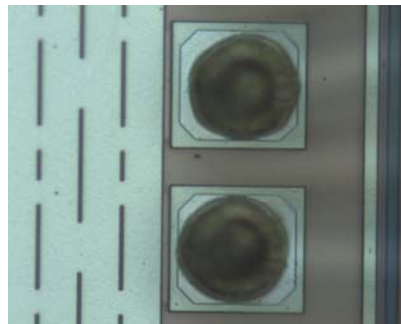


Photo 3 (20X)

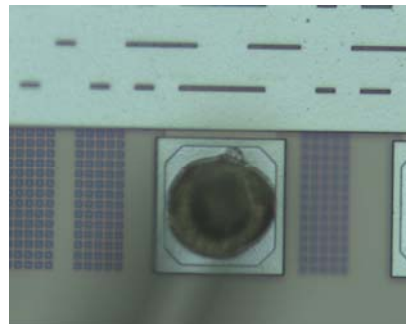


Photo 4 (20X)

**TEST EQUIPMENT:** LEICA (Optical Microscope)



TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*V341CAG	LQFP 48 7x7x1.4	996230H0	SEM inspection

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE	RESULT
Stitch-bond on lead	JL3+1000TC	5pcs/lot	No visible defect (photo 1-6)

**DOCUMENTATION:**

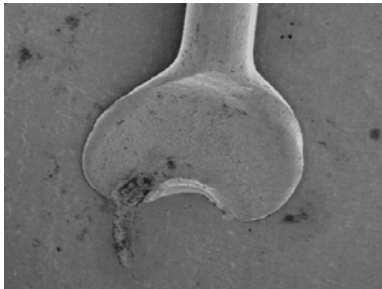


Photo 1

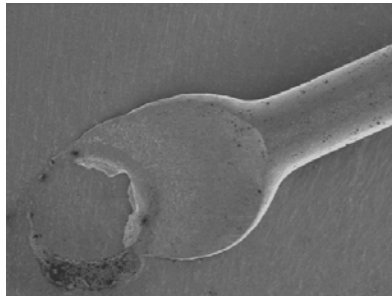


Photo 2

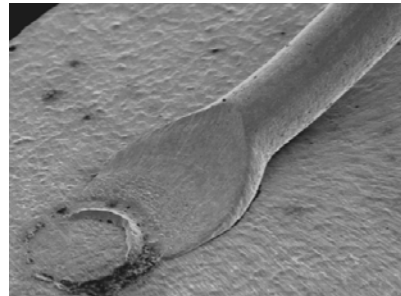


Photo 3

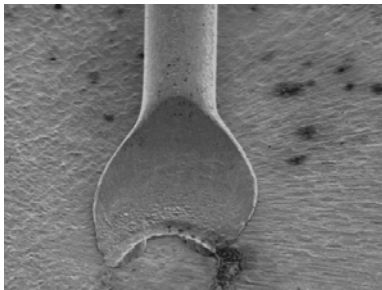


Photo 4

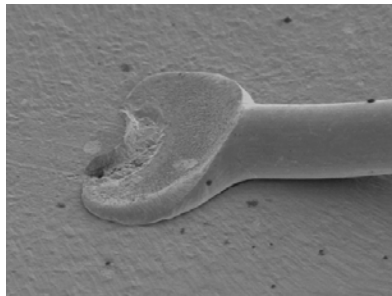


Photo 5

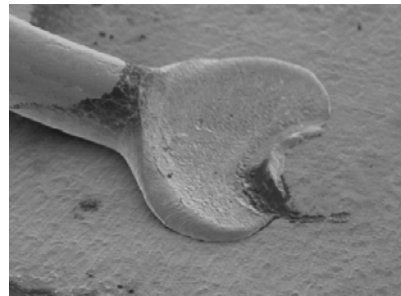


Photo 6

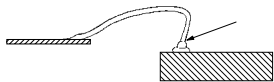
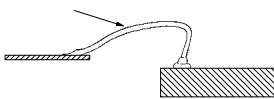
**TEST EQUIPMENT:** HITACHI (Scanning Electron Microscope)



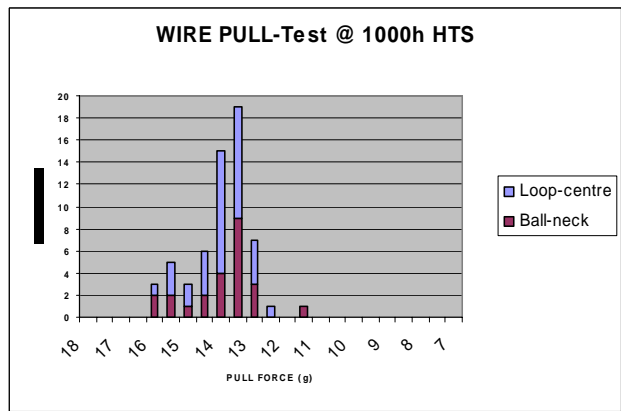
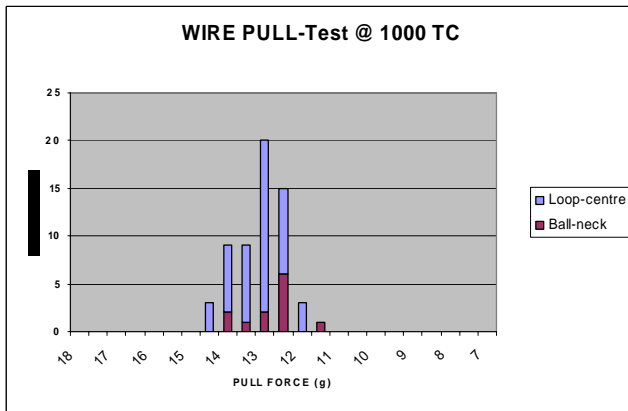
TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*V341CAG	LQFP 48 7x7x1.4	996230H0	Wire pull-test

Wire type : Au, 1,2 mil  
 LSL (g) : 4,5

Sample size (pcs) : 5  
 Sample size (wires) : 60

Failure mode		JL3+1000TC	1000h HTS 150°C
<b>2: BALL NECK</b> 	mean (g)	12.61	13,68
	stdev (g)	0.67	1,04
	min (g)	11.33	11,04
	max (g)	13.82	15,75
	occurrence	20%	40%
<b>3: LOOP CENTRE</b> 	mean (g)	12.91	13,79
	stdev (g)	0.65	0,78
	min (g)	11.72	12,43
	max (g)	14.40	15,76
	occurrence	80%	60%

**Remarks:** neither abnormal break loads, nor forbidden failure modes. AEC-Q100 criteria after TC passed.



# **Pb-FREE BOM for LQFP 7x7, MUAR**

## **RELIABILITY EVALUATION REPORT**

### ***Abstract***

The new lead-free BOM selected for LQFP 7x7x1.4 in Muar has been successfully tested from the reliability viewpoint on two assembly lots of UR27:

- NiPdAu pre-plated lead-frame (“PPF”);
- Loctite QMI9507 die-attach glue;
- Sumitomo G700L “green” molding compound.

### ***Conclusion***

On the basis of the results summarized at page 2 of the present report, the new BOM for LQFP 7x7x1.4 in Muar has successfully passed the reliability requirement for STM/APG qualification, under the stress conditions recommended in AEC-Q100 for ambient temperature “GRADE 1” devices.

The expected dominant wear-out mechanisms have been investigated by continuing THB and HTS tests until 2000h, and performing destructive physical analysis of long-term stressed devices. Wire-bonding performance has not been found to be in line with APG targets for long-term robustness, as the AuAl solder joint shows some degradation during HTS test leading to mechanical weakness (ball-lift mode at wire-pull test). This weakness has to be recovered through a wire-bonding process tuning as requested in CA-1-45-06-8240 by C. Douce, in order to optimize the ball shape and correctly fit the bond-pad opening.

Concerning moisture sensitivity, devices with front-end technological features equivalent to UR27 (see “construction note”) can be classified as Jedec MSL 3 according to J-STD-020C requirements for Pb-free components (260degC reflow peak temperature).

Released by: ALBERTO MANCALEONI

APG Back-end Q&R – Reliability Manager



**Reliability test conditions and results**

TEST NAME	CONDITIONS [SPEC]	TV1 REJ./S.S.	NOTES
JL3	24h bake @ 125°C 192h @ 30°C / 60% RH reflow simulation (3 times) at T <sub>MAX</sub> =260°C [IPC/Jedec J-STD-020C]	QHZZ: 0/200 QH01: 0/200	1
JL3 + TCT	Ta=-50/+150°C, 1000 cycles	QHZZ: 0/77 QH01: 0/77	1, 2, 3
JL3 + PP	168h PP (2atm, 121°C)	QHZZ: 0/77 QH01: 0/77	4
JL3 + THB	Ta=85°C, RH=85%, 2000h V <sub>1</sub> =5V, V <sub>2</sub> =25V, P <sub>D</sub> negligible	QHZZ: 0/30 QH01: 0/30	
HTS	Ta=150°C, 2000h	QHZZ: 0/45 QH01: 0/45	5
ESD	CDM: V <sub>pusle</sub> = ± 750V for 3 times (Q100 AEC 011)	QH01: 0/5	

**NOTES:**

- <sup>1</sup> SAM analysis did not show any remarkable delamination at the die-molding compound interface, on the lead tips and through the die-attach layer. Detail in attachment n.3
- <sup>2</sup> Wire bonding strength after the stress has been successfully verified through wire-pull test, performed in accordance with AEC-Q100 requirement: neither abnormal break loads, nor forbidden failure modes have been detected. Ball shear distribution is centered too low due to under-sized ball diameter (not in line with bond-pad opening). Detail in attachment n.3
- <sup>3</sup> Visual and SEM inspection after the stress test have pointed out no remarkable degradation of silicon passivation, metal interconnects, stitch bonds on internal lead-tips. Detail in attachment n.3.
- <sup>4</sup> Visual inspection after the stress has pointed out no significant corrosion / oxidation phenomena.
- <sup>5</sup> Wire-pull test after 1000 and 2000h has pointed out some weak ball-bonds, failing in ball lift mode with decreasing force (7.6g after 1000h and 2.6g after 2000h).

**Construction note**

<b>Technical code</b> :	A55B*UR27BA6
<b>Diffusion process</b> :	BCD3S
<b>Wafer diameter</b> :	6"
<b>Diffusion site</b> :	Ang-Mokio
<b>Die size (mm<sup>2</sup>)</b> :	4.18x4.02
<b>Metal levels</b> :	3, Ti/TiN/Ti/AlSiCu
<b>Passivation</b> :	USG-PSG-SiON-PIX
<b>Back finishing</b> :	LAPPED SILICON
<b>Package name</b> :	LQFP 48 7x7x1.4
<b>Assembly site</b> :	MUAR
<b>Leadframe</b> :	LQFP 48L 7x7mm 5x5 FPad NiPdAu
<b>Die attach</b> :	Loctite QMI9507-2C2
<b>Wire bonding</b> :	Au ,1.2 mil
<b>Molding compound</b> :	SUMITOMO EME-G700L
<b>Lead finishing</b> :	NiPdAu
<b>Lot_id</b> :	996211QHZZ - 996211QH01

**Attachments**

- 1) Reliability tests description
- 2) List of stress equipment
- 3) Physical analysis report

## ATTACHMENT 1: RELIABILITY TESTS DESCRIPTION

TEST NAME	DESCRIPTION	PURPOSE
<b>JLn:</b> Jedec Level n surface mounting simulation	The device is submitted to a typical temperature profile used for surface mounting, after a controlled moisture absorption.	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.
<b>TCT:</b> Temperature Cycles Test	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, moulding compound delamination, wire-bonds failure, die-attach layer degradation.
<b>HTS:</b> High Temperature Storage	The device is stored in unbiased condition at the max. temperature allowed by the package materials, sometimes higher than the max. operative temperature.	To investigate the failure mechanisms activated by high temperature, typically wire-bonds solder joint ageing, data retention faults, metal stress-voiding.
<b>PPT:</b> Pressure Pot Test	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.
<b>THB:</b> Temperature Humidity Bias Test	The device is biased in static configuration minimizing its internal power dissipation, and stored at controlled conditions of ambient temperature and relative humidity.	To investigate failure mechanisms activated in the die-package environment by electrical field and wet conditions. Typical failure mechanisms are electro-chemical corrosion and surface effects related to the moulding compound.
<b>ESD:</b> Electrostatic Discharge	The device is submitted to a high voltage peak on all his pins simulating ESD stress according to different simulation models.	To classify the device according to his susceptibility to damage or degradation by exposure to electrostatic discharge.

**ATTACHMENT 2: LIST OF STRESS EQUIPMENT**

<b>EQUIPMENT</b>	<b>TYPE</b>	<b>USED FOR...</b>
MAZZALI THRM AIR	STATIC OVEN	HTS, JL3 (drying bake step)
MAZZALI CLIMATEST	CLIMATIC CHAMBER	JL3 (moisture soak step), THB
HERAEUS NOBLELIGHT	REFLOW FURNACE (7 zones)	JL3 (reflow simulation step)
WEISS TS130	AIR TO AIR SHOCK (2 chambers)	TC
MAZZALI	PRESSURE POT	168h PPT step

## ATTACHMENT 3: PHYSICAL ANALYSIS REPORT

**Technical code** : A55B\*UR27BA6

**Package** : LQFP 48 7x7x1.4

**Lot(s)\_id** : 996211QHZZ  
996211QH01

**Evaluation subject** : New Pb-free BOM for LQFP7x7 in MUAR

**Author** : Dario Casiraghi

**Analysis status:**     RUNNING                       COMPLETED

### ANALYSIS PROGRAM

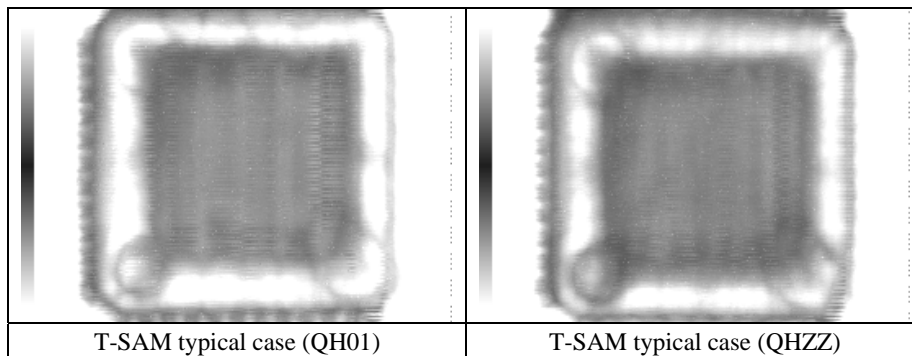
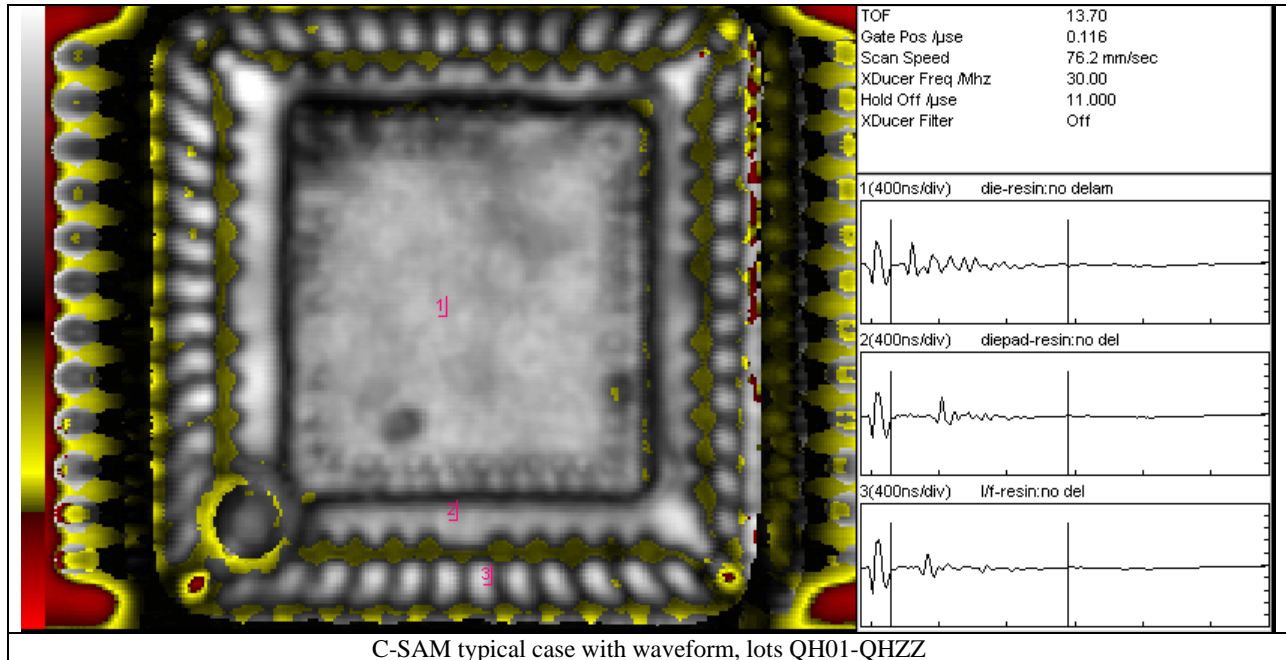
DESTRUCTIVE ITEMS				NON DESTRUCTIVE ITEMS		WHEN
Wire pull test	Ball Shear test	Internal visual	SEM inspection	SAM inspection	Other	
				X		Unstressed
				X		JL3@260°C
X		X	X	X		JL3+1000TC
		X				JL3+PP 168h
X						1000/2000h HTS

### RESULTS SUMMARY

- SAM analysis did not show any remarkable delamination at the die-molding compound interface, on the lead tips and through the die-attach layer.
- Internal visual inspection after PP test has pointed out no significant metal corrosion / oxidation.
- Visual and SEM inspection after long-term TC have pointed out no degradation of silicon passivation, metal interconnects, stitch bonds on internal lead-tips.
- Wire bonding strength after TC stress has been successfully verified through wire-pull and ball-shear test: neither abnormal break loads, nor forbidden failure modes have been found; the ball shear distribution is anyway centered too low due to under-sized ball diameter (not in line with bond-pad opening).
- Wire bonding strength after HTS stress has pointed out marginal readings with ball lift mode (min. load 7,6g after 1000h, 2,6g after 2000h).

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55B*UR27BA6	LQFP 48 7x7x1.4	SAM inspection	Unstressed

TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)

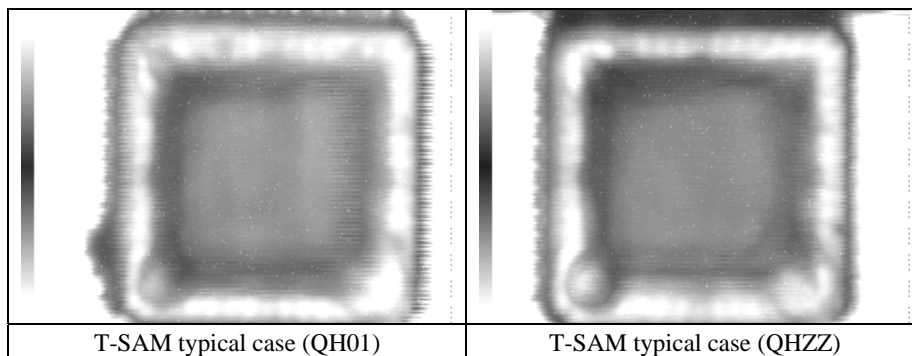
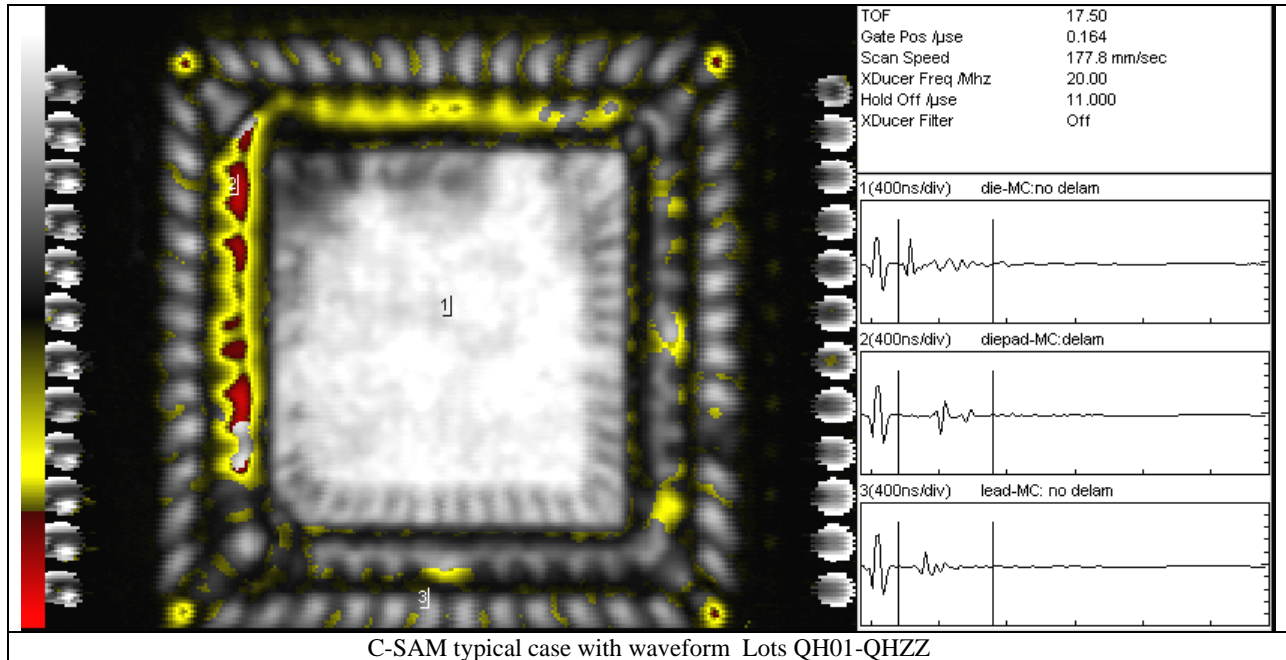


Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	l/f-mold (C-scan)	diepad-mold (C-scan)
QH01	10	0/10	0/10	0/10	0/10
QHZZ	10	0/10	0/10	0/10	0/10
Transducer frequency (Hz)		30	30	30	30



TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55B*UR27BA6	LQFP 48 7x7x1.4	SAM inspection	JL3 Preconditioning @260°C

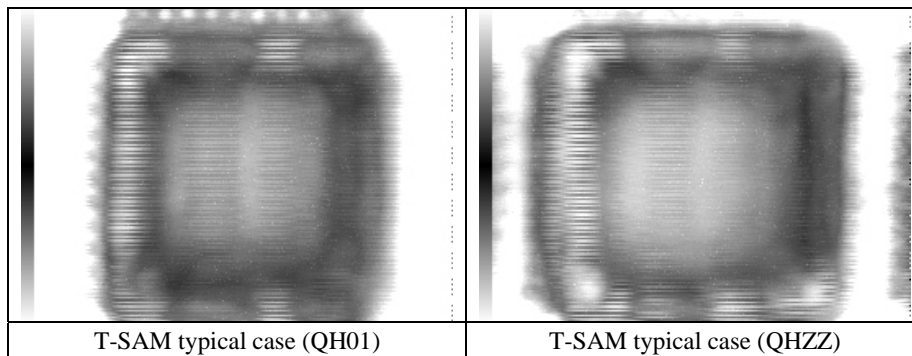
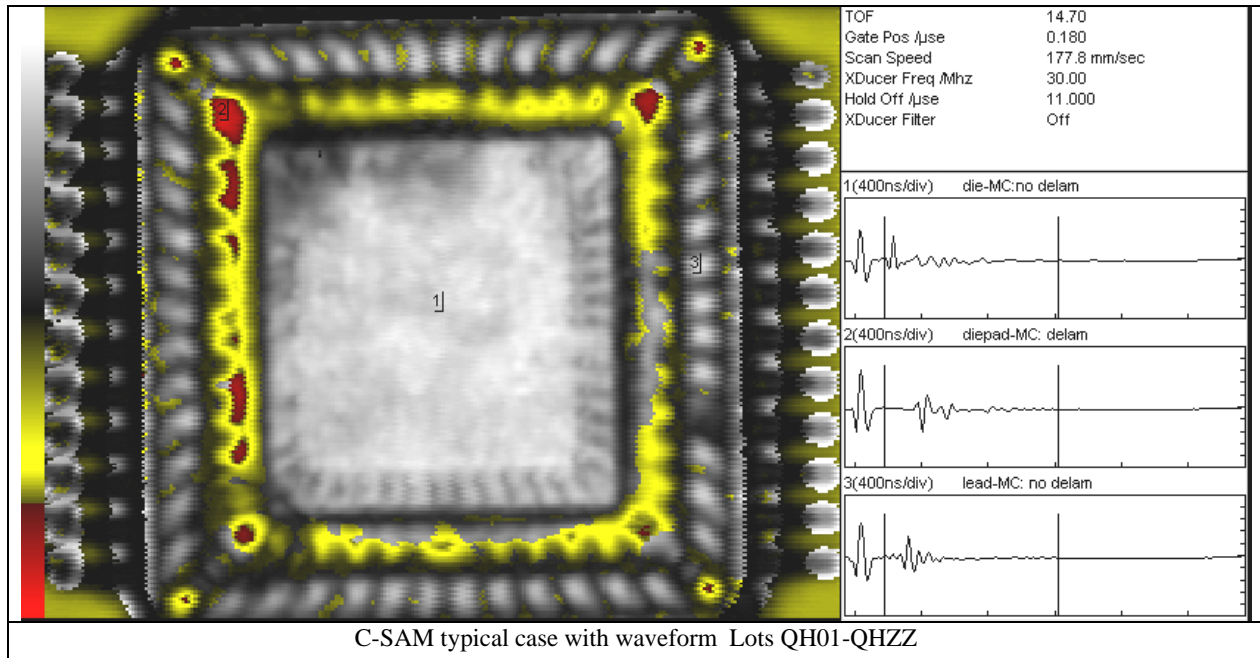
TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	l/f-mold (C-scan)	diepad-mold (C-scan)
QH01	10	0/10	0/10	0/10	10/10
QHZZ	10	0/10	0/10	0/10	10/10
Transducer frequency (Hz)		20	20	20	20

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55B*UR27BA6	LQFP 48 7x7x1.4	SAM inspection	JL3 +1000 TC (-50/+150°C)

TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	l/f-mold (C-scan)	diepad-mold (C-scan)
QH01	10	0/10	0/10	0/10	10/10
QHZZ	10	0/10	0/10	0/10	10/10
Transducer frequency (Hz)		30	30	30	30

TECHNICAL CODE	PACKAGE	LOTS	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QHZZ / 996211QH01	Internal visual

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE /LOTS	RESULT
Passivation and metal	JL3+1000TC	5pcs-QH01	Minor passivation cracks / no metal displacement (photo1-3)
Passivation and metal	JL3+1000TC	5pcs-QHZZ	Minor passivation cracks / no metal displacement (photo 4-6)

**DOCUMENTATION:**

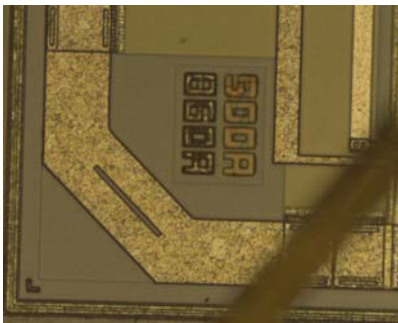


Photo 1 (20X)

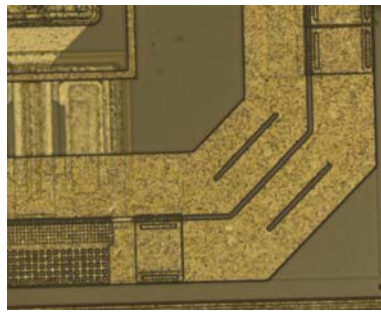


Photo 2 (20X)

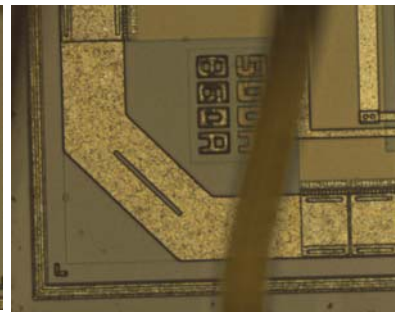


Photo 3 (20X)

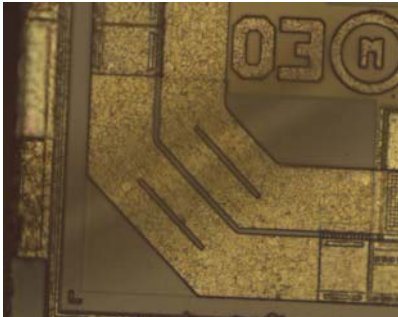


Photo 4 (20X)

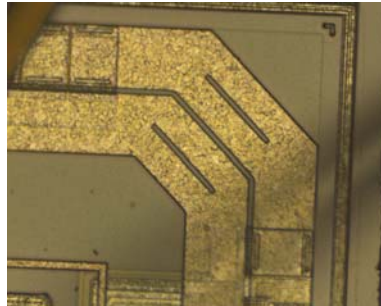


Photo 5 (20X)



Photo 6 (50X)

**TEST EQUIPMENT:** LEICA (Optical Microscope)

TECHNICAL CODE	PACKAGE	LOTS	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QHZZ / 996211QH01	Internal visual

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE /LOTS	RESULT
Metal corrosion and oxidation	JL3+168h PP	5pcs-QH01	No major defect (photo 1-3)
Metal corrosion and oxidation	JL3+168h PP	5pcs-QHZZ	No major defect (photo 4-6)

**DOCUMENTATION:**

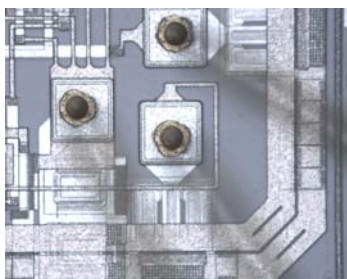


Photo 1 (10X)

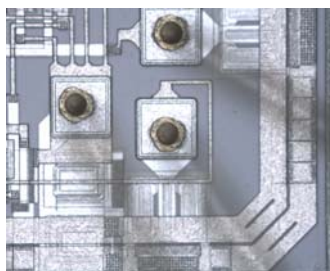


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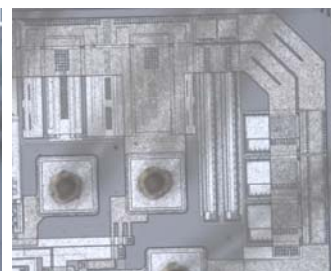


Photo 3 (10X)

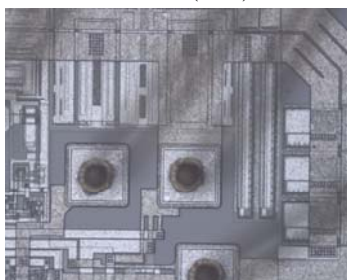


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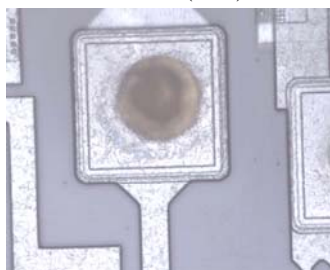


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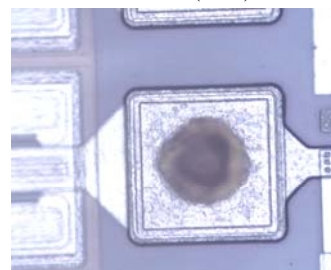


Photo 6 (20X)

**TEST EQUIPMENT:** LEICA (Optical Microscope)



TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QH01 / 996211QHZZ	SEM inspection

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE	RESULT
Stitch-bond on lead	JL3+1000TC	5pcs-QH01	No visible degradation (photo 1-3)
Stitch-bond on lead	JL3+1000TC	5pcs-QHZZ	No visible degradation (photo 4-6)

**DOCUMENTATION:**

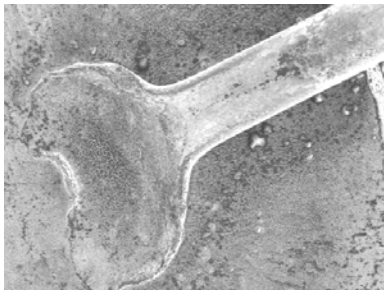


Photo 1



Photo 2

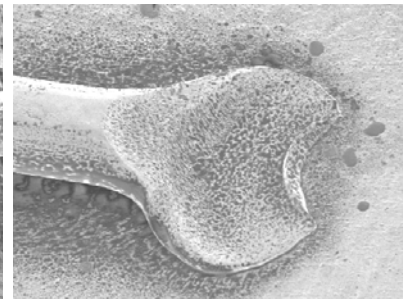


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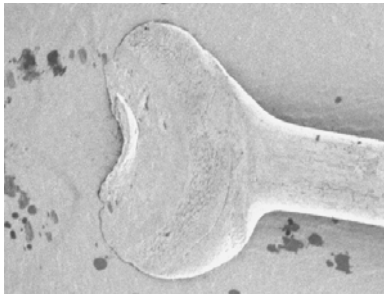


Photo 4

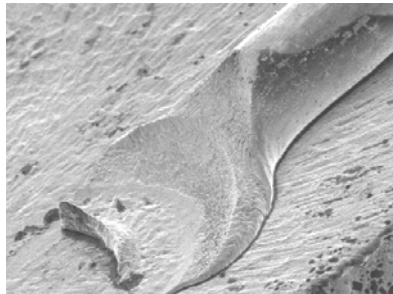


Photo 5

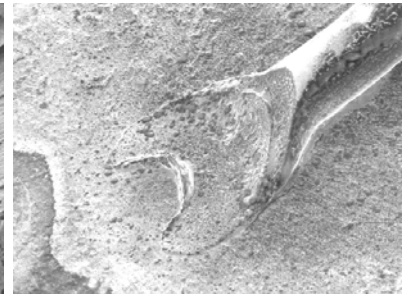


Photo 6

**TEST EQUIPMENT:** HITACHI (Scanning Electron Microscope)

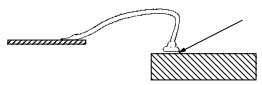
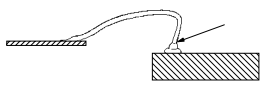
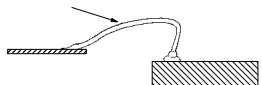
TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QH01 / 996211QHZZ	Wire pull-test

Wire type : Au, 1.2mil

Sample size (pcs) : 5

LSL (g) : 4,5g

Sample size (wires) : 60

Failure mode		1000 TC (-50/+150°C)		1000h HTS @150°C	
		QH01	QHZZ	QH01	QHZZ
<b>1: BALL LIFT</b> 	mean (g)	-	-	-	-
	stdev (g)	-	-	-	-
	min (g)	-	-	-	7,58
	max (g)	-	-	-	10,45
	occurrence	-	-	-	2%
<b>2: BALL NECK</b> 	mean (g)	12,64	12,41	12,14	12,56
	stdev (g)	0,41	1,03	0,32	0,41
	min (g)	11,75	11,11	11,59	11,97
	max (g)	13,05	13,49	12,64	13,15
	occurrence	20%	7%	7%	10%
<b>3: LOOP CENTRE</b> 	mean (g)	12,25	12,13	12,17	11,99
	stdev (g)	0,65	0,65	0,61	0,88
	min (g)	10,83	10,50	10,99	9,07
	max (g)	13,29	13,46	13,79	13,47
	occurrence	80%	93%	93%	88%

**Remarks:** TC: neither abnormal break loads, nor forbidden failure modes. AEC-Q100 criteria passed.  
 HTS: 2% ball-lift failures (medium pull load).

TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QHZZ	SEM inspection after wire pull-test

WHAT	WHEN	LOT	RESULT
Lifted bond after wire pull	1000h HTS	QHZZ	Intermetallic failure (photo 1-6)

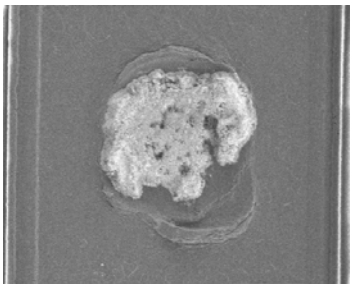


Photo 1

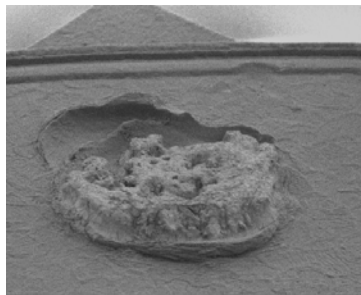


Photo 2

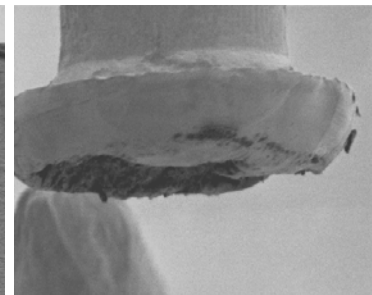


Photo 3

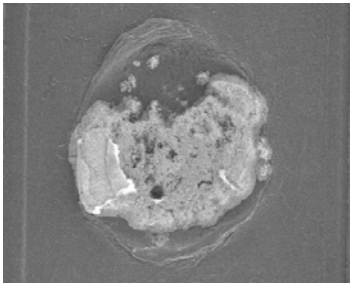


Photo 4



Photo 5

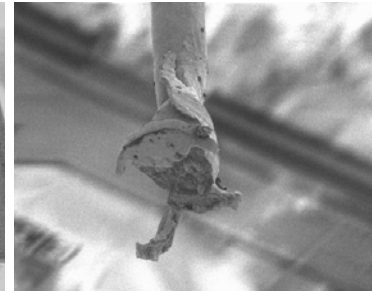
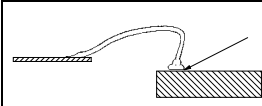
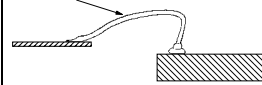


Photo 6

TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QH01 / 996211QHZZ	Wire pull-test

Wire type : Au, 1.2 mil  
 LSL (g) : 4,5g

Sample size (pcs) : 5  
 Sample size (wires) : 60

Failure mode		2000h HTS @150°C	
		QH01	QHZZ
<b>1: BALL LIFT</b> 	mean (g)	5.15	-
	stdev (g)	2.30	-
	min (g)	2.55	4.24
	max (g)	6.94	4.24
	occurrence	5%	2%
<b>3: LOOP CENTRE</b> 	mean (g)	10.82	11.03
	stdev (g)	0.58	0.65
	min (g)	9.55	9.77
	max (g)	12.13	12.98
	occurrence	95%	98%

Remarks: 2-5% ball lift failure with low pull force.



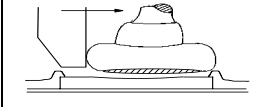
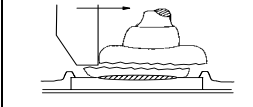
TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55B*UR27BA6	LQFP 48 7x7x1.4	996211QH01 / 996211QHZZ	Ball shear test

Wire type : Au, 1.2 mil

Sample size (pcs) : 5

LSL (g) : 35g

Sample size (wires) : 60

Failure mode		1000 TC (-50/+150°C)	
		QH01	QHZZ
<b>2: PAD SHEAR</b> 	mean (g)	38.44	40.02
	stdev (g)	2.39	2.63
	min (g)	32.81	36.31
	max (g)	43.88	47.60
	occurrence	62%	52%
<b>3: BALL SHEAR</b> 	mean (g)	38.59	40.73
	stdev (g)	2.59	1.58
	min (g)	35.35	37.34
	max (g)	45.54	43.85
	occurrence	38%	48%

**Remarks:** Distribution out of target due to small ball diameter compared to bond-pad opening.

# **Pb-FREE BOM FOR LQFP 7x7x1.4 / MUAR**

## **RELIABILITY EVALUATION REPORT**

### **TEST VEHICLE: US10 / LQFP-32**

#### *Abstract*

Reliability results obtained from US10 are here presented. The product is one of the APG test-vehicles selected for ST-RB joint qualification of the LQFP 32 7x7x1.4 lead-free package.

#### *Conclusion*

On the basis of the results summarized in the present document, the qualification sample has met the general reliability requirements for ST/APG qualification, following the stress methods driven by AEC-Q100 and IPC/JEDEC J-STD-020C for MSL 3 classification.

Physical analysis of samples after the reliability tests has pointed out a satisfactory degree of robustness versus the dominant wearout phenomena potentially activated during long-term exposure to environmental stress, as typical in the automotive field.

Released by: ALBERTO MANCALEONI

APG Back-end Q&R – Reliability Manager



**Reliability test conditions and results**

TEST NAME	CONDITIONS [SPEC]	TV1 REJ./S.S.	NOTES
JL3	24h bake @ 125°C 192h @ 30°C / 60% RH reflow simulation (3 times) at T <sub>MAX</sub> =260°C [IPC/Jedec J-STD-020C]	0/220	1, 4
JL3 + TCT	Ta=-50/+150°C, 1000 cycles	0/77	1, 2, 3
JL3 + ES	100TC (-50/+150°C) + 96h PP (2atm, 121°C)	0/77	2, 3
JL3 + HTS	Ta=150°C, 1000h	0/45	2

**NOTES:**

- <sup>1</sup> SAM analysis did not show any remarkable delamination at the die-molding compound interface, on the lead fingers and through the die-attach layer. Detail in attachment n. 3.
- <sup>2</sup> Wire bonding strength after the stress has been successfully verified through wire-pull and/or ball-shear test (also complying with AEC-Q100 requirement after TC). Neither abnormal break loads, nor forbidden failure modes have been detected. Detail in attachment n. 3.
- <sup>3</sup> Visual and/or SEM inspection after the stress test have pointed out no degradation of silicon passivation, metal interconnects, stitch bonds on internal lead-tips. Detail in attachment n.3.
- <sup>4</sup> Reflow profile according to Bosch requirement (see attachment n.4), executed at RB facilities in Reutlingen.

**Construction note**

	<b>TV1</b>
<b>Technical code</b> :	A55V*US10AA6
<b>Diffusion process</b> :	BCD3S
<b>Wafer diameter</b> :	6"
<b>Diffusion site</b> :	Ang-Mo Kio
<b>Die size (mm<sup>2</sup>)</b> :	3,31x3,40
<b>Metal levels</b> :	3, Al/Si/Cu
<b>Passivation</b> :	SiN
<b>Back finishing</b> :	Cr/Ni/Au
<b>Package name</b> :	LQFP 32 7x7x1.4 1
<b>Assembly site</b> :	Muar
<b>Leadframe</b> :	LQFP 32L 7x7mm 5x5 FPad NiPdAu
<b>Die attach</b> :	Loctite QMI9507-2C2
<b>Wire bonding</b> :	Au,1.2 mils
<b>Molding compound</b> :	SUMITOMO EME-G700L
<b>Lead finishing</b> :	NiPdAu
<b>Lot_id</b> :	996021

**Attachments**

- 1) Reliability tests description
- 2) List of stress equipment at ST
- 3) Physical analysis report
- 4) Reflow profile

## ATTACHMENT 1: RELIABILITY TESTS DESCRIPTION

TEST NAME	DESCRIPTION	PURPOSE
<b>JLn:</b> Jedec Level n surface mounting simulation	The device is submitted to a typical temperature profile used for surface mounting, after a controlled moisture absorption.	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.
<b>TCT:</b> Temperature Cycles Test	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, moulding compound delamination, wire-bonds failure, die-attach layer degradation.
<b>HTS:</b> High Temperature Storage	The device is stored in unbiased condition at the max. temperature allowed by the package materials, sometimes higher than the max. operative temperature.	To investigate the failure mechanisms activated by high temperature, typically wire-bonds solder joint ageing, data retention faults, metal stress-voiding.
<b>ES:</b> Environmental Sequence	The device is submitted in sequence to TCT and PPT, sometimes preceded by JLn preconditioning.	To simulate the actual combination of environmental stresses interacting in the field application. The typical failure modes are those reported for JLn, TCT and PPT.

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## **ATTACHMENT 2: LIST OF STRESS EQUIPMENT AT ST**

<b>EQUIPMENT</b>	<b>TYPE / LOCATION</b>	<b>USED FOR...</b>
MAZZALI THRMAIR	STATIC OVEN / STM Agrate	HTS
HORO 046A	STATIC OVEN / RB Reutlingen	JL3 (dry bake step)
CTS C+10/200	CLIMATIC CHAMBER / RB Reutlingen	JL3 (moisture soak step)
REHM V8	REFLOW FURNACE / RB Reutlingen	JL3 (reflow simulation step)
WEISS TS130	AIR TO AIR SHOCK (2 chambers) / STM Agrate	TC, ES (100 TC step)
MAZZALI	PRESSURE POT / STM Agrate	ES (96h PPT step)

## ATTACHMENT 3: PHYSICAL ANALYSIS REPORT

**Technical code** : A55V\*US10AA6

**Package** : LQFP 32 7x7x1.4

**Lot(s)\_id** : 996021

**Evaluation subject** : Pb-free Joint qualification with BOSCH

**Author** : Dario Casiraghi

**Analysis status:**     RUNNING                       COMPLETED

### ANALYSIS PROGRAM

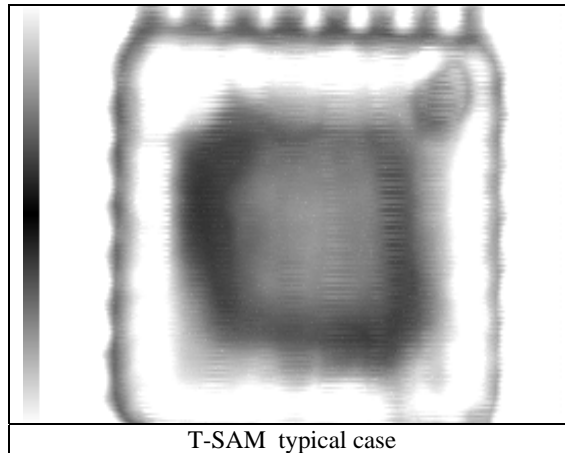
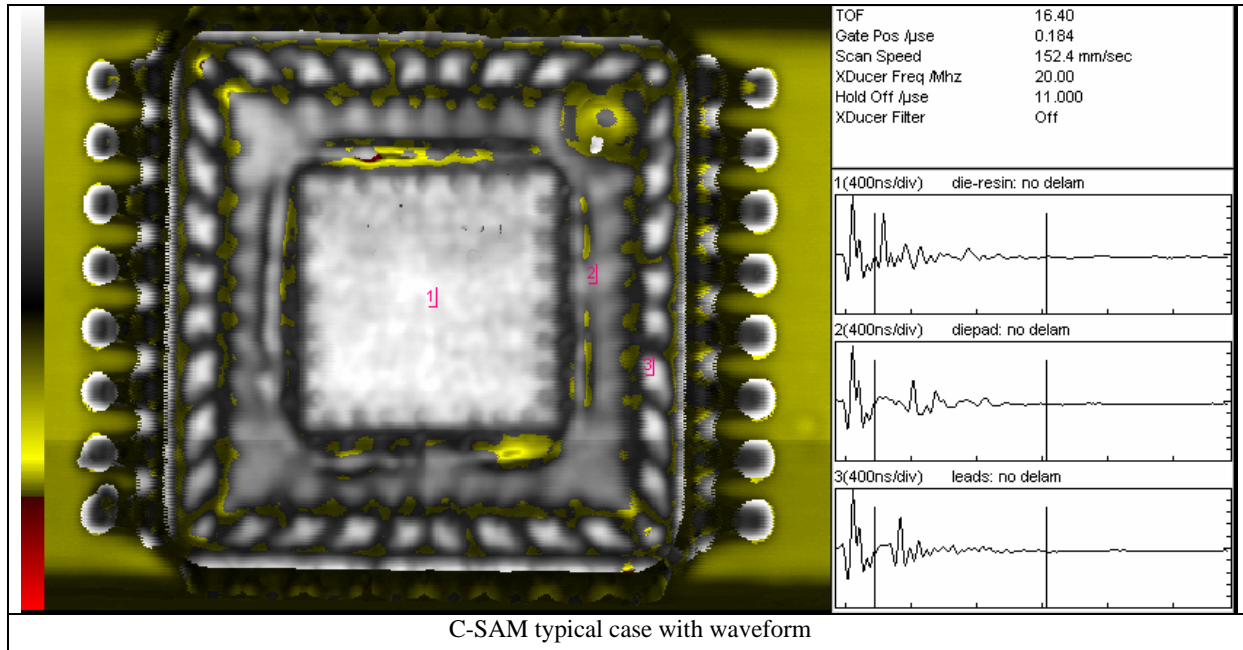
DESTRUCTIVE ITEMS				NON DESTRUCTIVE ITEMS		WHEN
Wire pull test	Ball Shear test	Internal visual	SEM inspection	SAM inspection	Other	
				X		JL3@260°C
X	X	X	X	X		JL3+1000TC
X		X				JL3+ES
X	X					JL3+ 1000h HTS

### RESULTS SUMMARY

- SAM analysis: no delamination at die surface, die-attach and lead-fingers after JL3 and TC.
- Wire-pull / ball-shear tests: no abnormal reading after ES and long-term TC / HTS.
- Internal inspection (optical + SEM) after TC and ES: no significant defect.

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55V*US10AA6	LQFP 32 7x7x1.4	SAM inspection	JL3 Preconditioning @260°C

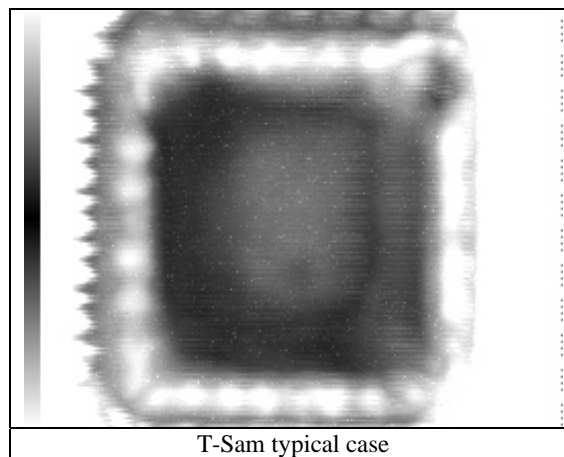
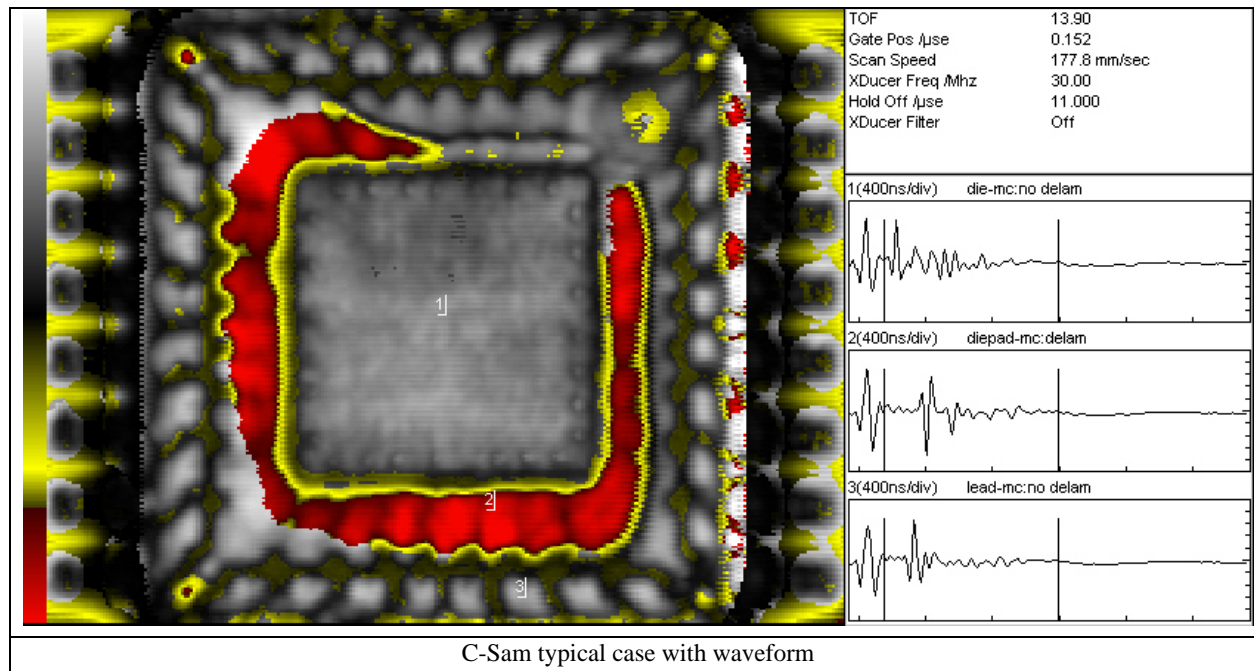
TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	l/f-mold (C-scan)	diepad-mold (C-scan)
996021	10	0/10	0/10	10/10	0/10
Transducer frequency (MHz)		20	20	20	20

TECHNICAL CODE	PACKAGE	ANALYSIS ITEM	STRESS TEST
A55V*US10AA6	LQFP 32 7x7x1.4	SAM inspection	JL3+1000 TC (-50/+150°C)

TEST EQUIPMENT: SONOSCAN D9000 (Scanning Acoustic Microscope)



Lot	Sample size	Defective parts (delamination)			
		die-mold (C-scan)	die-attach (T-scan)	l/f-mold (C-scan)	diepad-mold (C-scan)
996021	10	0/10	0/10	0/10	10/10
Transducer frequency (MHz)		30	30	30	30



TECHNICAL CODE	PACKAGE	LOTS	ANALYSIS ITEM
A55V*US10AA6	LQFP 32 7x7x1.4	996021	Internal visual

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE	RESULT
Passivation and metal	JL3+1000TC (-50/+150°C)	5pcs	Minor passivation cracks / no metal displacement

**DOCUMENTATION:**

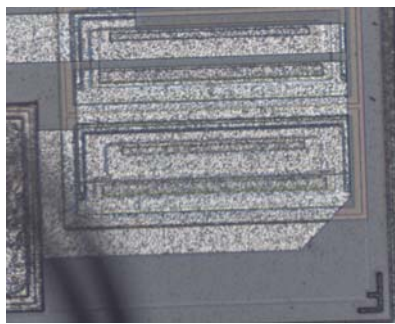


Photo 1 (20X)

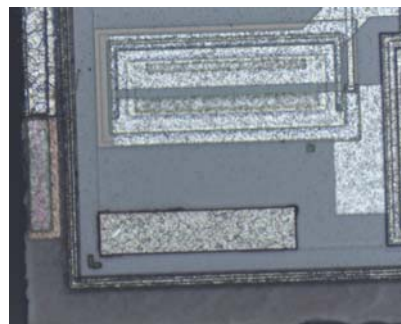


Photo 2 (20X)

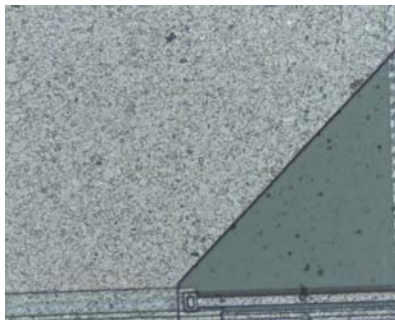


Photo 3 (50X)

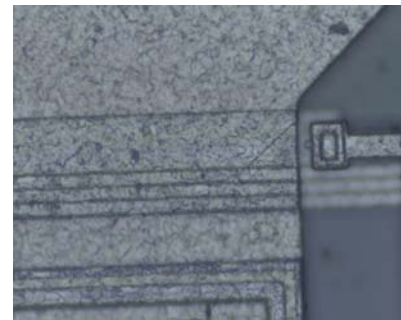


Photo 4 (50X)

**TEST EQUIPMENT:** LEICA DMRE (Optical Microscope)

TECHNICAL CODE	PACKAGE	LOTS	ANALYSIS ITEM
A55V*US10AA6	LQFP 32 7x7x1.4	996021	Internal visual

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE	RESULT
Metal corrosion and oxidation	JL3+ES	5pcs	No visible defect (photo 1-4)

**DOCUMENTATION:**

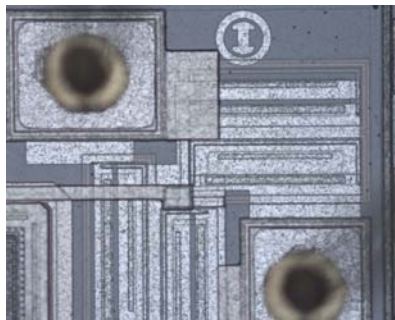


Photo 1 (10X)

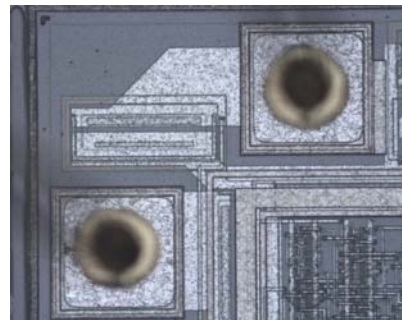


Photo 2 (10X)

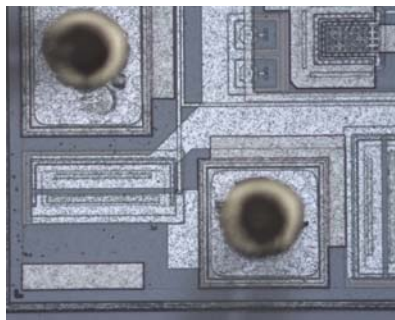


Photo 3 (10X)

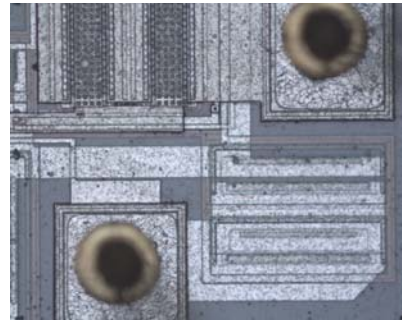


Photo 4 (10X)

**TEST EQUIPMENT:** LEICA DMRE (Optical Microscope)

TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55V*US10AA6	LQFP 32 7x7x1.4	996021	SEM inspection

**ANALYSIS SUMMARY:**

WHAT	WHEN	SAMPLE SIZE	RESULT
Stitch-bond on lead	JL3+1000TC (-50/+150°C)	5pcs	No visible defect (photo 1-6)

**DOCUMENTATION:**

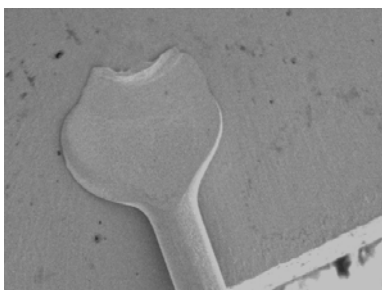


Photo 1

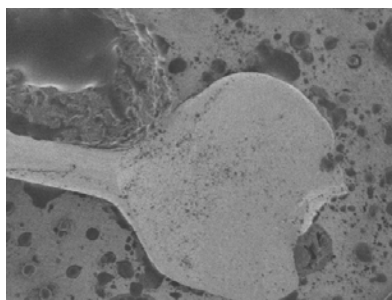


Photo 2

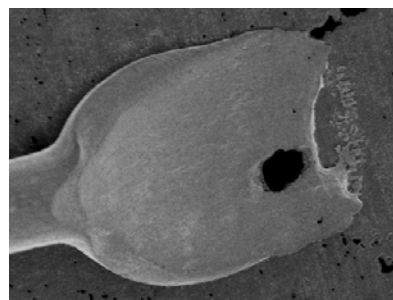


Photo 3

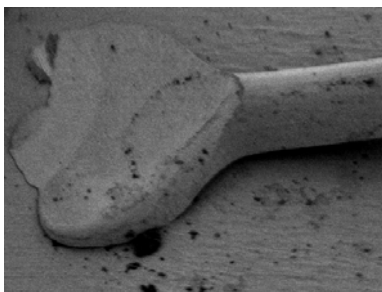


Photo 4

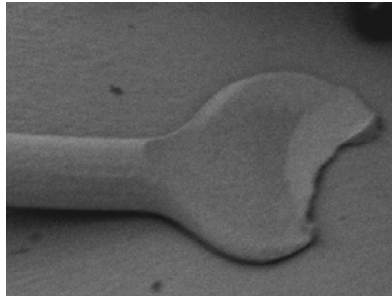


Photo 5

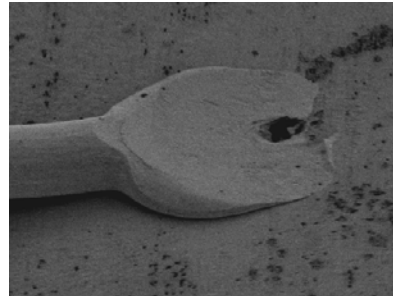


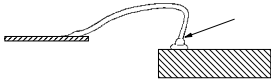
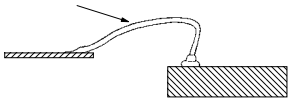
Photo 6

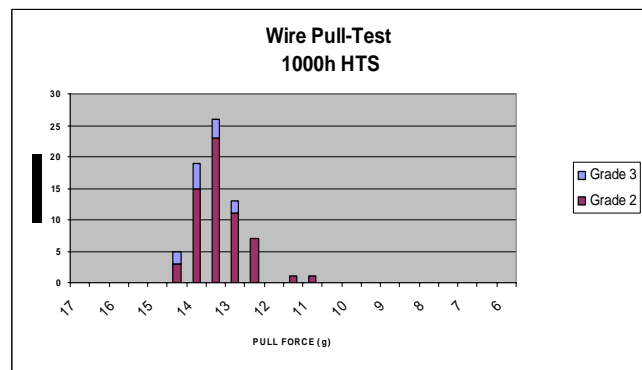
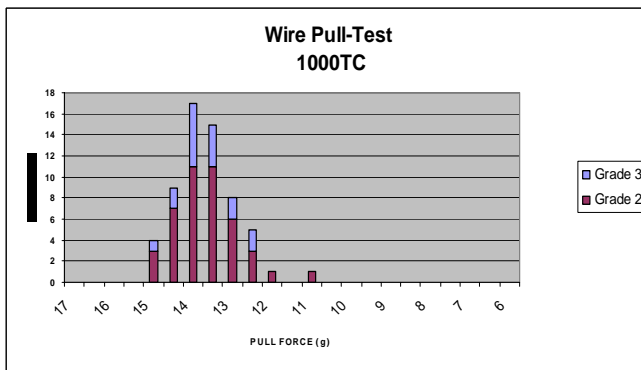
**TEST EQUIPMENT:** HITACHI S4500 (Scanning Electron Microscope)

TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55V*US10AA6	LQFP 32 7x7x1.4	996021	Wire pull-test

Wire type : Au, 1,2 mil  
 LSL (g) : 4,5

Sample size (pcs) : 5  
 Sample size (wires) : 60

Failure mode		1000TC (-50/+150°C)	1000h HTS@150°C
<b>2: BALL NECK</b> 	mean (g)	13,40	13,15
	stdev (g)	0,78	0,65
	min (g)	10,99	10,65
	max (g)	14,83	14,49
	occurrence	72%	85%
<b>3: LOOP CENTRE</b> 	mean (g)	13,46	13,55
	stdev (g)	0,61	0,51
	min (g)	12,25	12,53
	max (g)	14,65	14,14
	occurrence	28%	15%

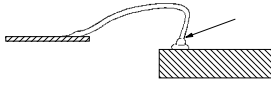
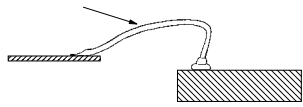


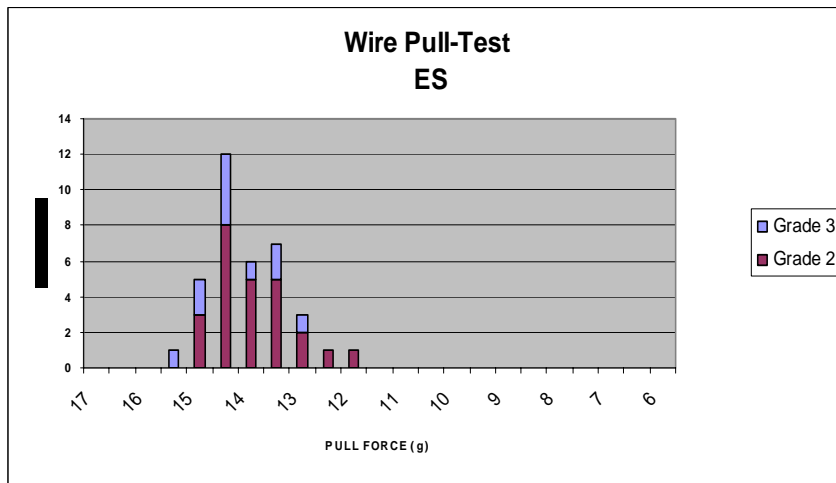
TEST EQUIPMENT: DAGE series 4000

<b>TECHNICAL CODE</b> A55V*US10AA6	<b>PACKAGE</b> LQFP 32 7x7x1.4	<b>LOT</b> 996021	<b>ANALYSIS ITEM</b> Wire pull-test
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Wire type : Au, 1,2 mil  
 LSL (g) : 4,5

Sample size (pcs) : 3  
 Sample size (wires) : 36

Failure mode	JL3+ES (100TC+96h PP)	
<b>2: BALL NECK</b> 	mean (g)	13,74
	stdev (g)	0,80
	min (g)	11,60
	max (g)	14,88
	occurrence	70%
<b>3: LOOP CENTRE</b> 	mean (g)	14,00
	stdev (g)	0,74
	min (g)	12,77
	max (g)	15,07
	occurrence	30%

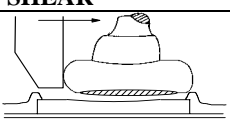
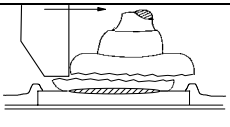


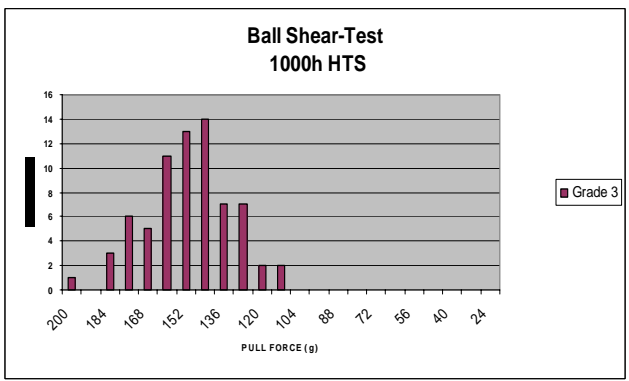
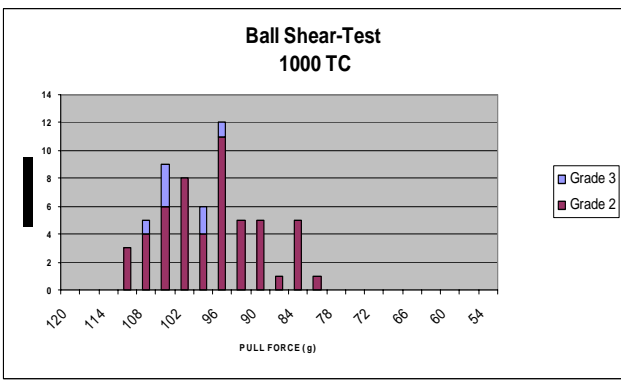
TEST EQUIPMENT: DAGE series 4000

TECHNICAL CODE	PACKAGE	LOT	ANALYSIS ITEM
A55V*US10AA6	LQFP 32 7x7x1.4	996021	Ball-shear test

Wire type : Au, 1,2 mil  
 LSL (g) : 35

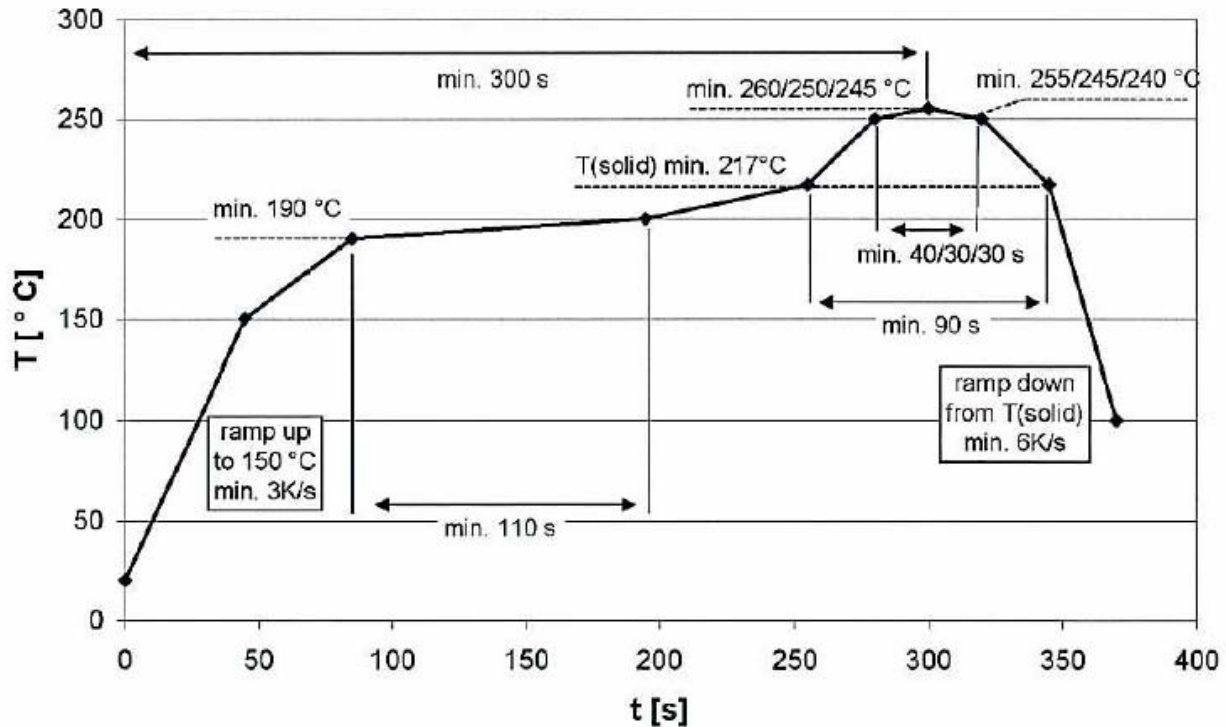
Sample size (pcs) : 5  
 Sample size (wires) : 60

Failure mode		1000TC (-50/+150°C)	1000h HTS 150°C
<b>2: PAD SHEAR</b> 	mean (g)	95,88	-
	stdev (g)	7,87	-
	min (g)	78,10	-
	max (g)	109,83	-
	occurrence	78%	-
<b>3: BALL SHEAR</b> 	mean (g)	101,34	147,03
	stdev (g)	3,91	17,64
	min (g)	95,51	108,63
	max (g)	105,17	192,58
	occurrence	12%	100%



TEST EQUIPMENT: DAGE series 4000

## ATTACHMENT 4: REFLOW PROFILE



Profile Features	Class1 (small)	Class 2 (large)	Class 3 (very large)
<b>preheat</b>			
ramp-up rate to 150 °C	min. 3 K/s (average value over 10 s)		
time from 190°C to 200°C	min. 110 s		
<b>peak</b>			
ramp-up rate from 200°C to $T_{peak}$	0,5 K/s - 3 K/s (average value over 10 s)		
time above $T_{solid,us}$ (min. 217 °C)	min. 90 s		
peak temperature $T_{peak}$	260 (- 0) °C	250 (- 0) °C	245 (- 0) °C
time above $T_{peak} - 5 K$	min. 40 s	min. 30 s	min. 30 s
<b>cooling</b>			
ramp-down rate: from $T_{solid,us}$ (min. 217 °C)	min. 6 K/s (average value over 10 s)		
<b>general</b>			
time 25 °C to $T_{peak}$	min. 300 s		

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