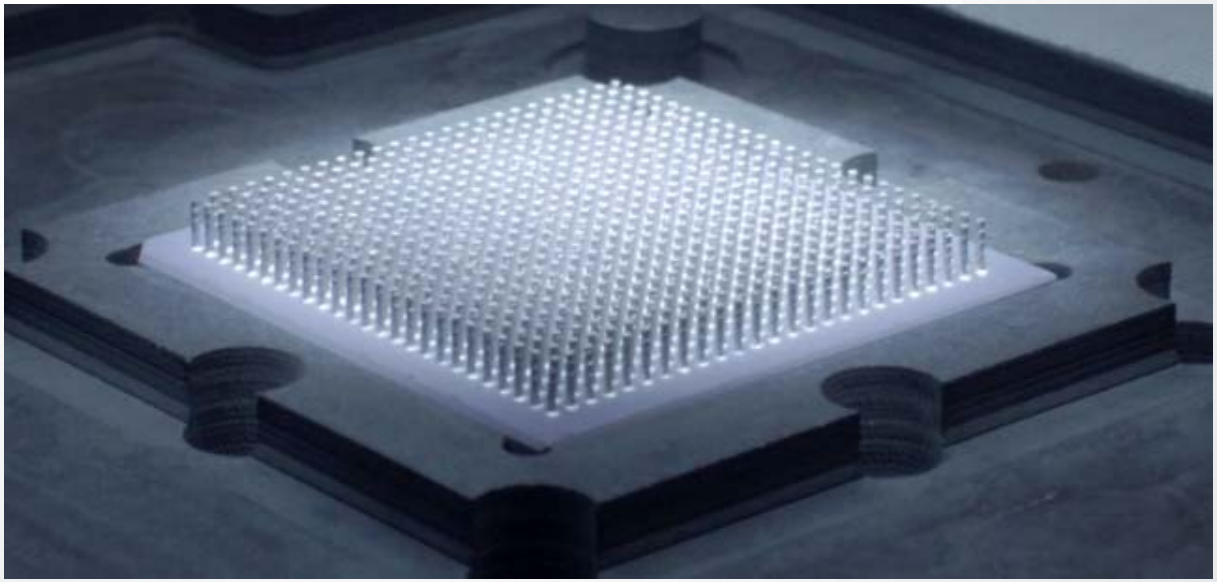
# ESA Contract N°. 4000107948/13/NL/CBi
# Columns Manufacturing & Assembly on Ceramic : Setup & Qualification

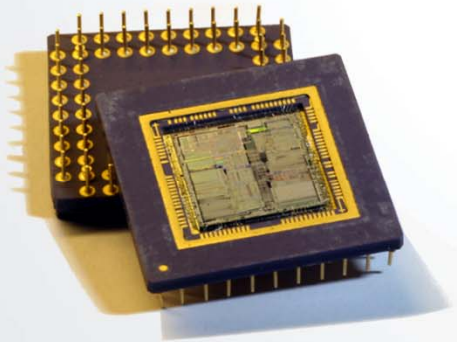


15th Dec 2015

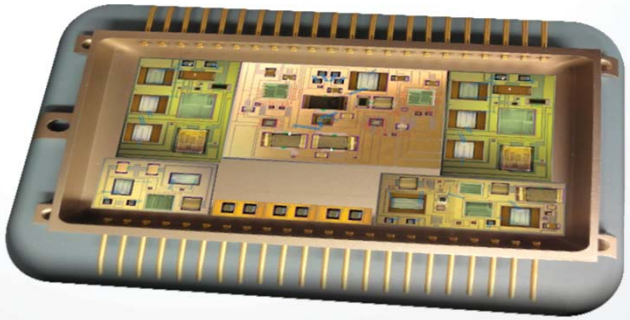
# Our Services

HCM.SYSTREL, as SERMA Group entity, produces high reliability components such as SCM, MCM & custom hermetic packages, serving Mil & Aerospace specifications.

With over 30 years' experience and an ISO 9001 quality system certified, we provide global back-end services **(wafer sawing, assemblies & tests) and thick films substrates (near Paris)** for a wide range of devices  and also address high-density mixed technologies.



**Digital ASIC (PGA)**



**Hybrid**

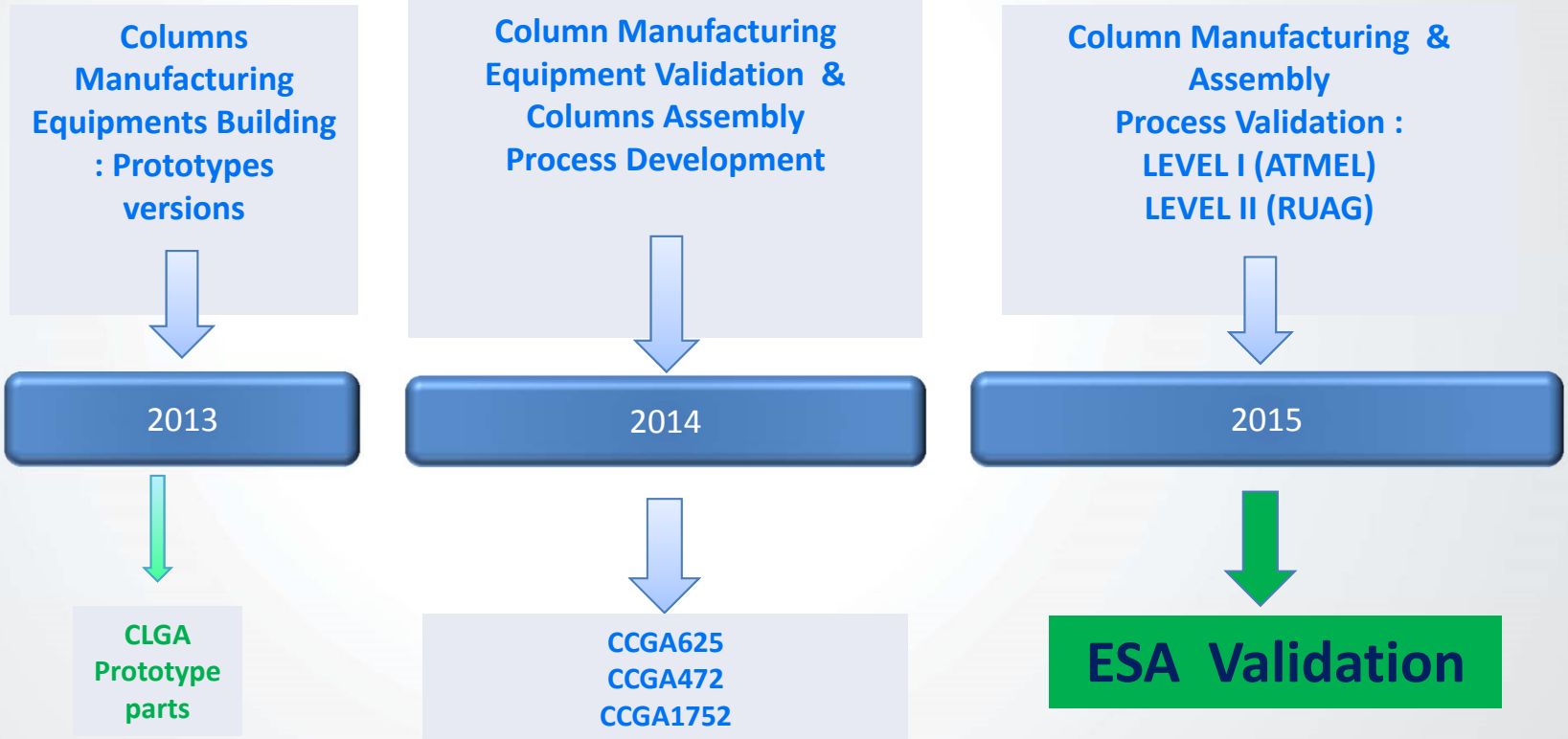
**CCGA**

For ECI 3, HCM.SYSTREL developed a **European Column Manufacturing & Attachment Process** in its facility in La Rochelle (France), in partnership with ATMEL (LEVEL I package provider) & RUAG (LEVEL II End-user) . This process use Sn/Pb as core material and **copper ribbon** as reinforcement. It had been fully validated by ESA and includes :

- ✓ The in-house **reinforced columns** manufacturing
- ✓ Column attach process (1 reflow & one tool) on ceramic substrates.
- ✓ Quality control ( Automatic Optical Inspection, Column pull-test, Solderability, Ionic contamination)
- ✓ Coplanarity , Pitch & Diameter measurements (using contactless metrology microscope) :

**This process is also available for the rework of existing columned packages, and thick gold LGA, after degolding.**

# Program Progress



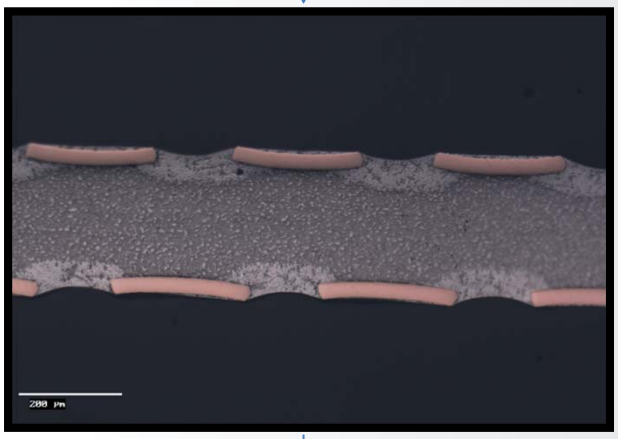
# Column manufacturing FlowChart

Core Material :
Sn15Pb85

Outer Material :
Sn63Pb37Tinned Cu

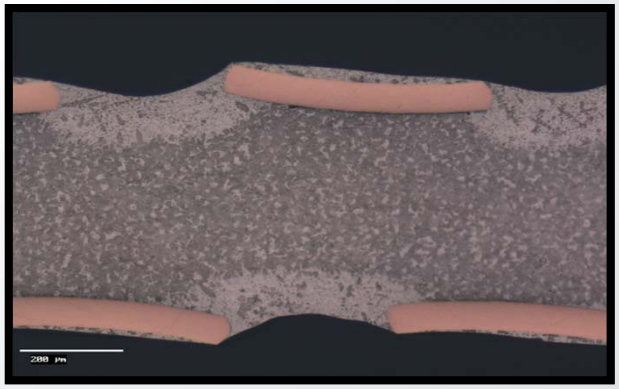
Flux bath
(ROL 0)

Sn63Pn37 Strand
Tinning



Intermediate Strand
Cutting

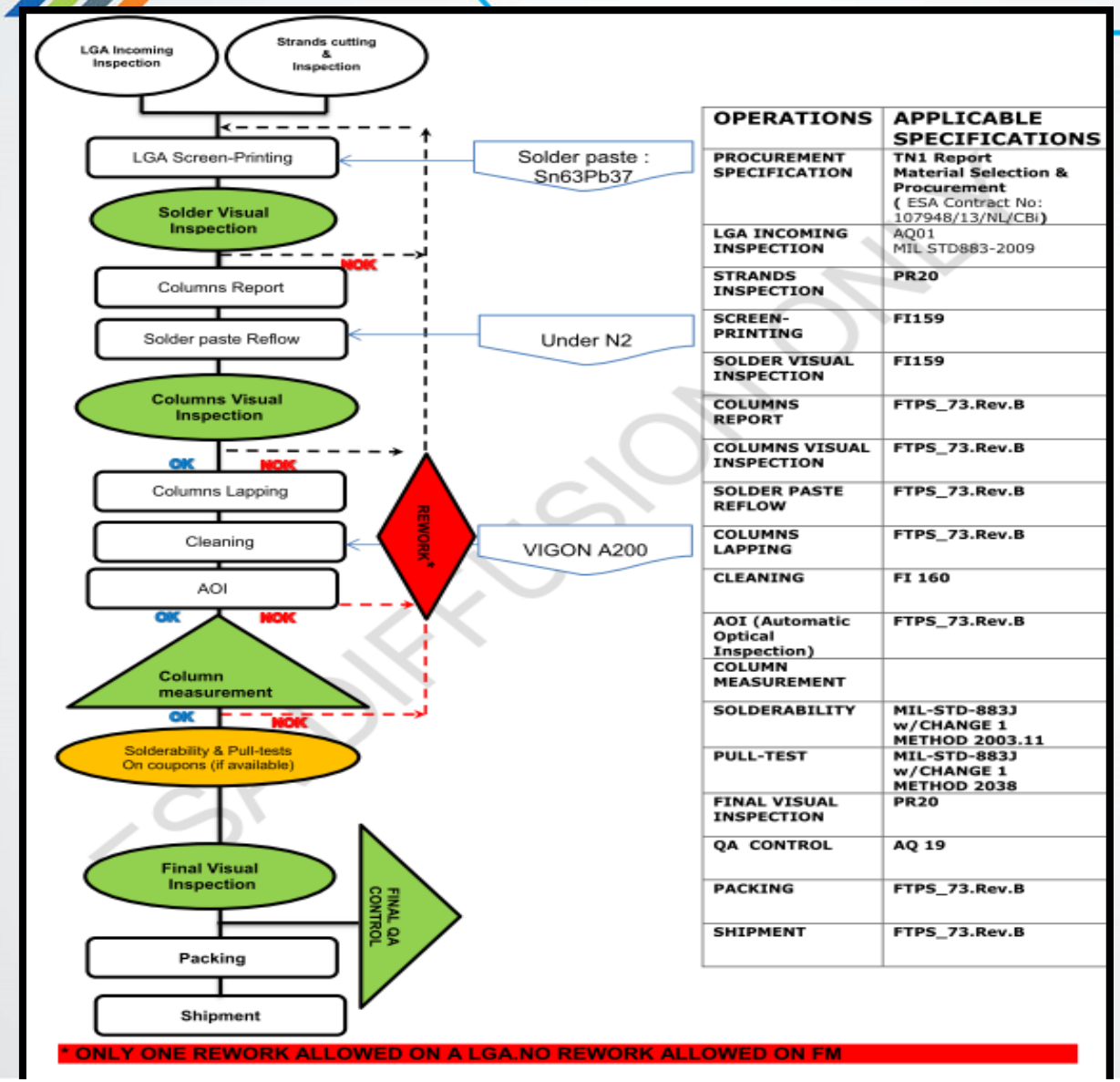
Strand cleaning



Strand Visual
inspection

Strand measurement
(winding step
& diameter)

# Column assembly on Ceramic FlowChart



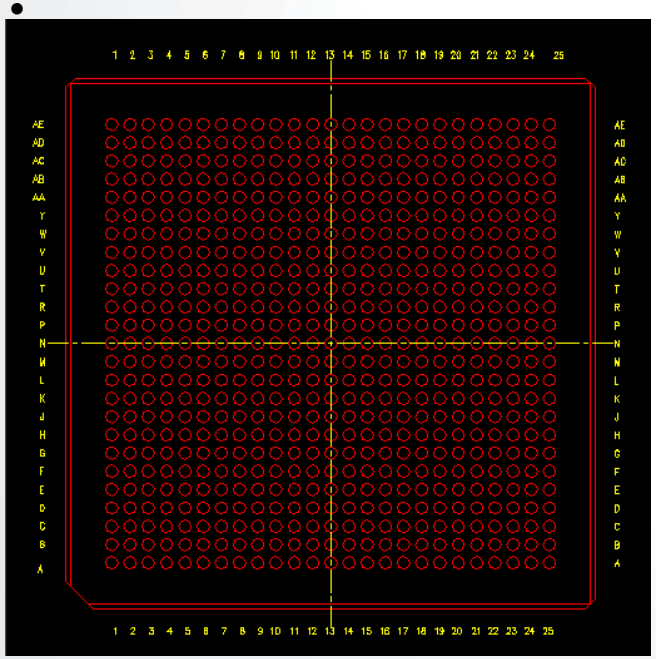

| OPERATIONS | APPLICABLE SPECIFICATIONS |
|---|---|
| PROCUREMENT SPECIFICATION | TN1 Report Material Selection & Procurement ( ESA Contract No: 107948/13/NL/CBi) |
| LGA INCOMING INSPECTION | AQ01 MIL STD883-2009 |
| STRANDS INSPECTION | PR20 |
| SCREEN-PRINTING | FI159 |
| SOLDER VISUAL INSPECTION | FI159 |
| COLUMNS REPORT | FTPS_73.Rev.B |
| COLUMNS VISUAL INSPECTION | FTPS_73.Rev.B |
| SOLDER PASTE REFLOW | FTPS_73.Rev.B |
| COLUMNS LAPPING | FTPS_73.Rev.B |
| CLEANING | FI 160 |
| AOI (Automatic Optical Inspection) | FTPS_73.Rev.B |
| COLUMN MEASUREMENT | |
| SOLDERABILITY | MIL-STD-883J w/CHANGE 1 METHOD 2003.11 |
| PULL-TEST | MIL-STD-883J w/CHANGE 1 METHOD 2038 |
| FINAL VISUAL INSPECTION | PR20 |
| QA CONTROL | AQ 19 |
| PACKING | FTPS_73.Rev.B |
| SHIPMENT | FTPS_73.Rev.B |

**Extracted from PID 11.Rev.B Column Manufacturing & Assembly**

# Qualified hermetic test vehicle for column assembly

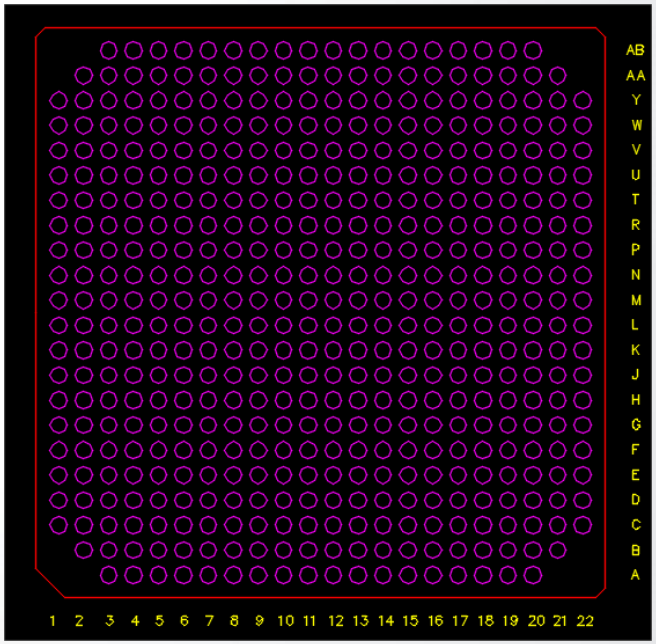
**3 test vehicles with gold thickness of 0.1µm from** NTK **:**

- CLGA625 29x29mm – **Pitch 1.0mm** – Lands diameter 0.68mm
- Daisy chain package
- Active ASIC package



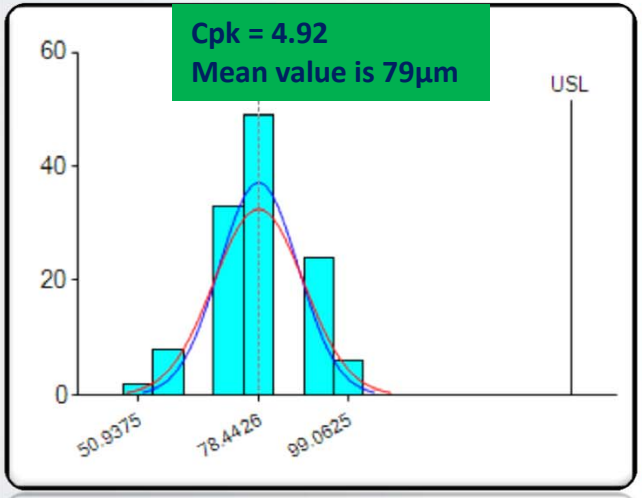
**CLGA625 Lands Matrix**

- CLGA472 29x29mm – **Pitch 1.27mm** – Lands diameter 0.86mm
- Daisy chain package

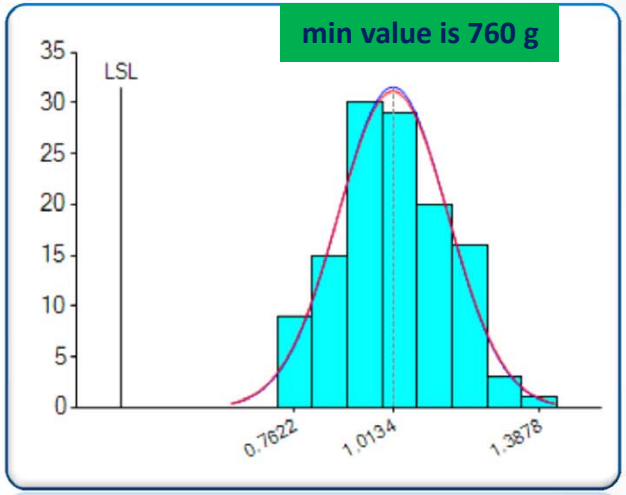


**CLGA472 Lands Matrix**

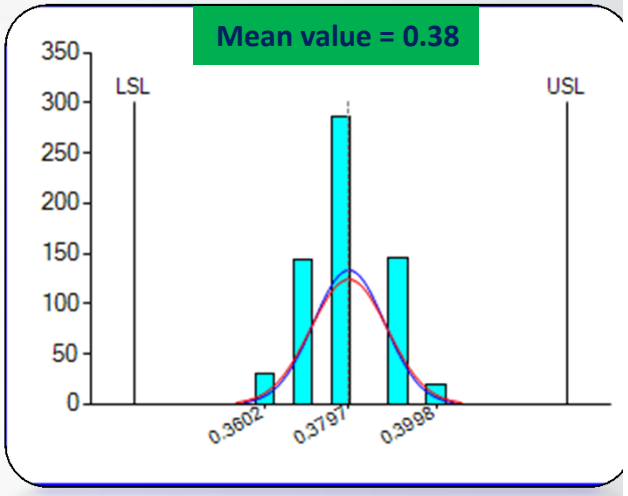
# Detailed production results (SPC)




**Coplanarity** target is <150µm
Per MIL-STD-883 Method 2009




**Pull-test** min value is 320g
Per MIL-STD-883 Method 2038

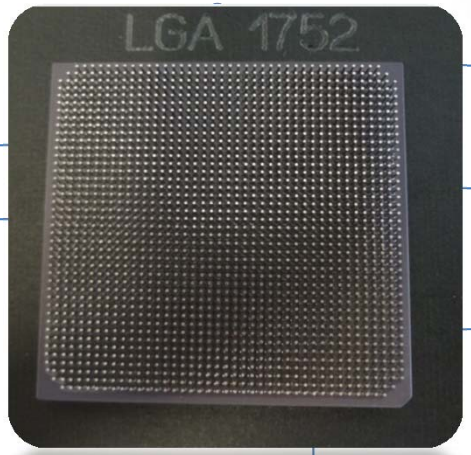



**Diameter** target is 0.38mm
(±0.05mm)

**All results are compliant with MIL STD 883J CCGA requirements**

# Key points of our technology

**Short Lead-Time:**
✓ 3 weeks for 50 pcs




**Column soldering**
✓ Max thermal stress : 210°C
✓ Only one Reflow

**Rework**

**In-House Columns Manufacturing**:
✓ Core wire is **Sn15Pb85**
✓ Reinforced Material is **Copper**
✓ Tinning material is **Sn63Pb37**

**Degolding**

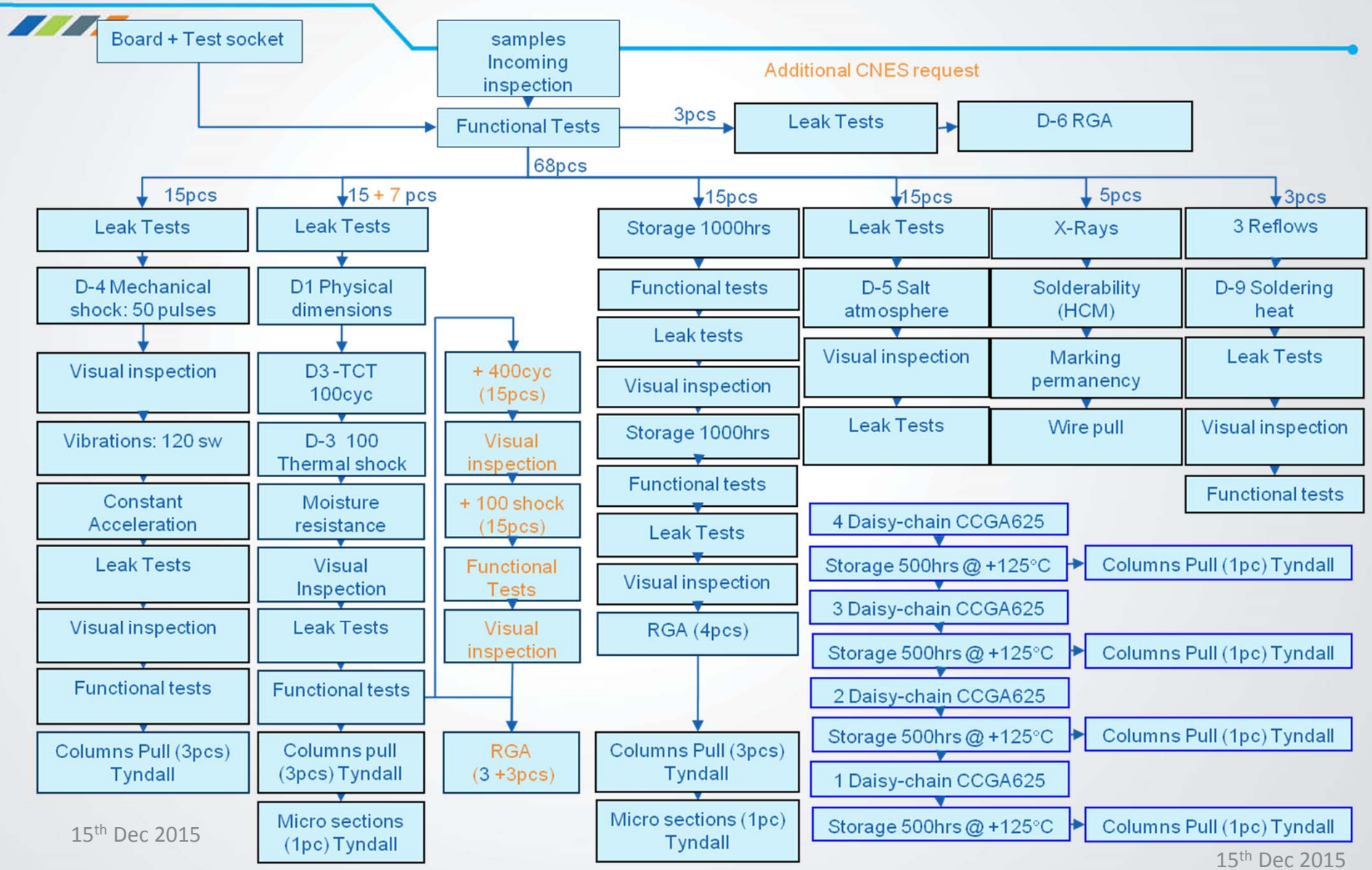
**Quality control :**
✓ 100% coplanarity control : Mean value is 80µm
✓ Mean Diameter value : 0.38 mm
✓ Visual Inspection per MIL-STD-883 :
no diameter reduction higher than 20%


# LEVEL 1 QUALIFICATION TEST PLAN

## PACKAGE LEVEL

15th Dec 2015

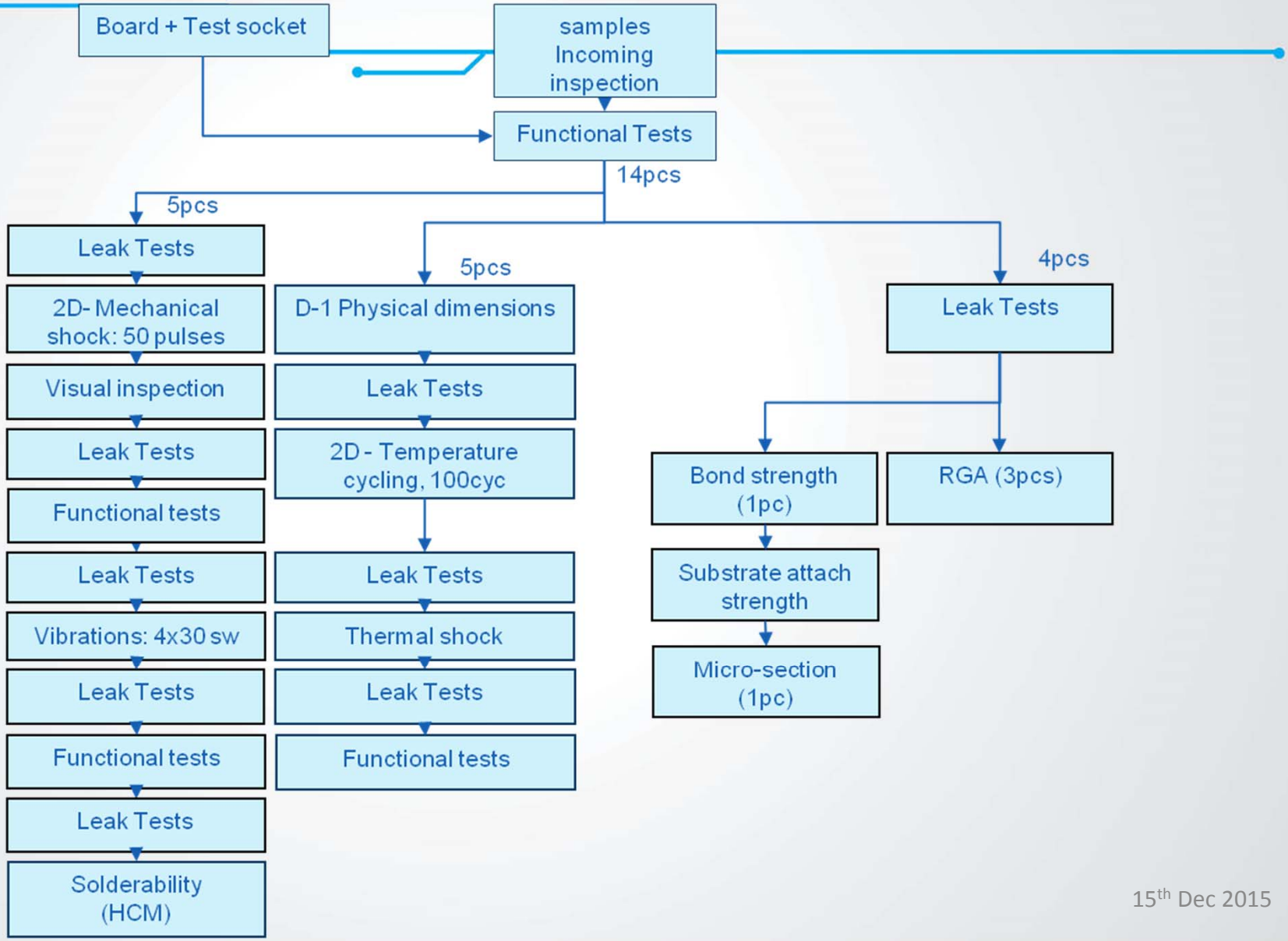
# Qualification test plan on CCGA625 & CCGA472: **NO DEFECT DETECTED**



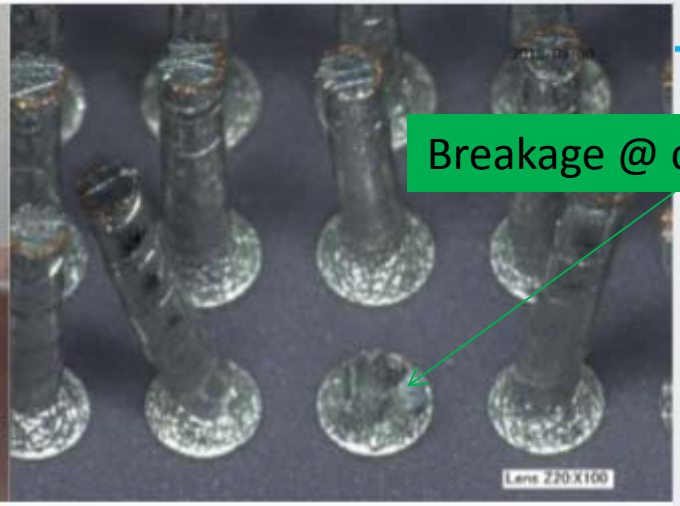



15th Dec 2015

# Qualification test plan on reworked CCGA625:
## NO DEFECT DETECTED



# Global Pull test results on qualification lot



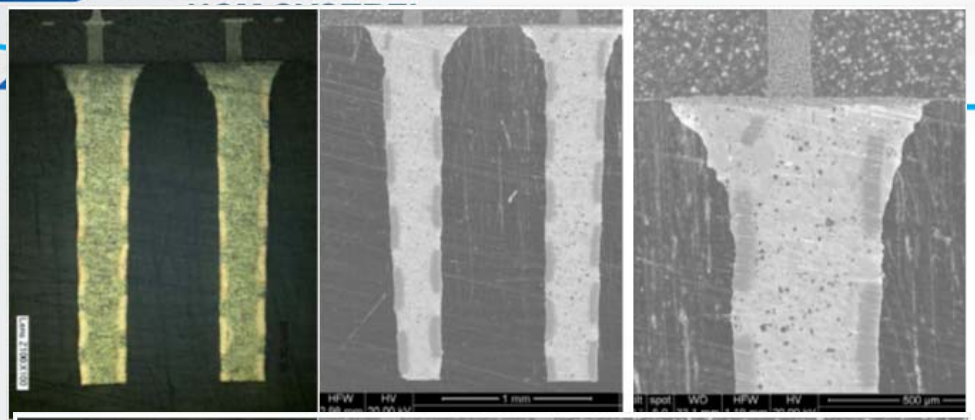
Breakage @ column level

| | 100 Thermal Cycling + 100 Thermal Shocks | | | Mechanical Shocks + Vibration + Acceleration | | | 2000hrs @ +125°C | | | 500 to 2000hrs @ +125°C | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 500 hrs | 1000 hrs | 1500 hrs | 2000 hrs |
| Part # | 02 | 04 | 07 | 21 | 22 | 25 | 30 | 31 | 27 | 12 | 14 | 15 | 17 |
| Min (N) | 6.87 | 6.42 | 6.33 | 6.46 | 7.12 | 6.64 | 6.33 | 6.07 | 6.76 | 6.47 | 6.46 | 6.45 | 5.81 |
| Max (N) | 8.11 | 9.22 | 8.83 | 9.55 | 9.50 | 9.20 | 9.08 | 9.14 | 8.45 | 9.13 | 7.72 | 7.97 | 7.71 |
| Mean (N) | 7.59 | 8.04 | 7.51 | 7.93 | 8.34 | 7.52 | 7.75 | 7.51 | 7.79 | 7.26 | 6.84 | 7.15 | 7.02 |
| Std. Dev (N) | 0.36 | 0.76 | 0.72 | 0.76 | 0.65 | 0.74 | 0.91 | 1.01 | 0.50 | 0.68 | 0.34 | 0.47 | 0.47 |

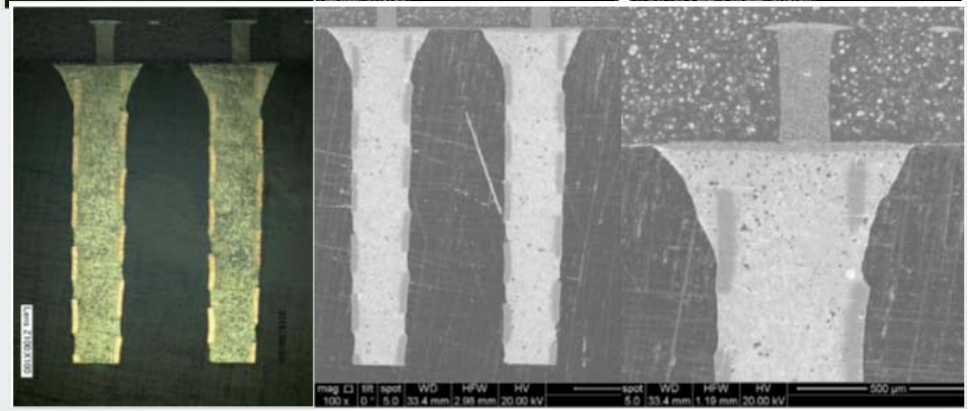
Stable behavior

**Columns pull test**
**Per MIL883 – TM2038, min value to 0.38mm column diameter is 320g (3N).**

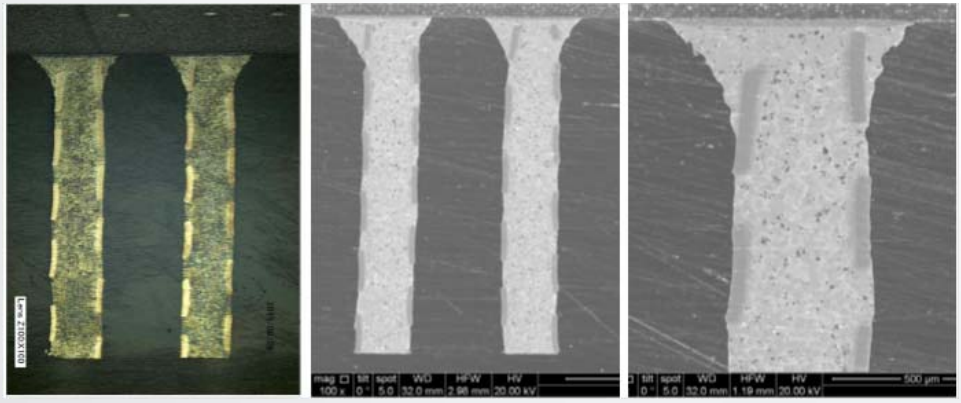
# Thermal cycling typical cross-sections



**Cross-section @ T0**



**Reworked parts cross-section @ T0**



**Cross-section after 2000hrs**

No defect (voids, gouges) detected with these cross sections, whatever the reliability test applied.


# LEVEL 2 QUALIFICATION TEST PLAN

## BOARD LEVEL

15th Dec 2015

# Test boards & packages

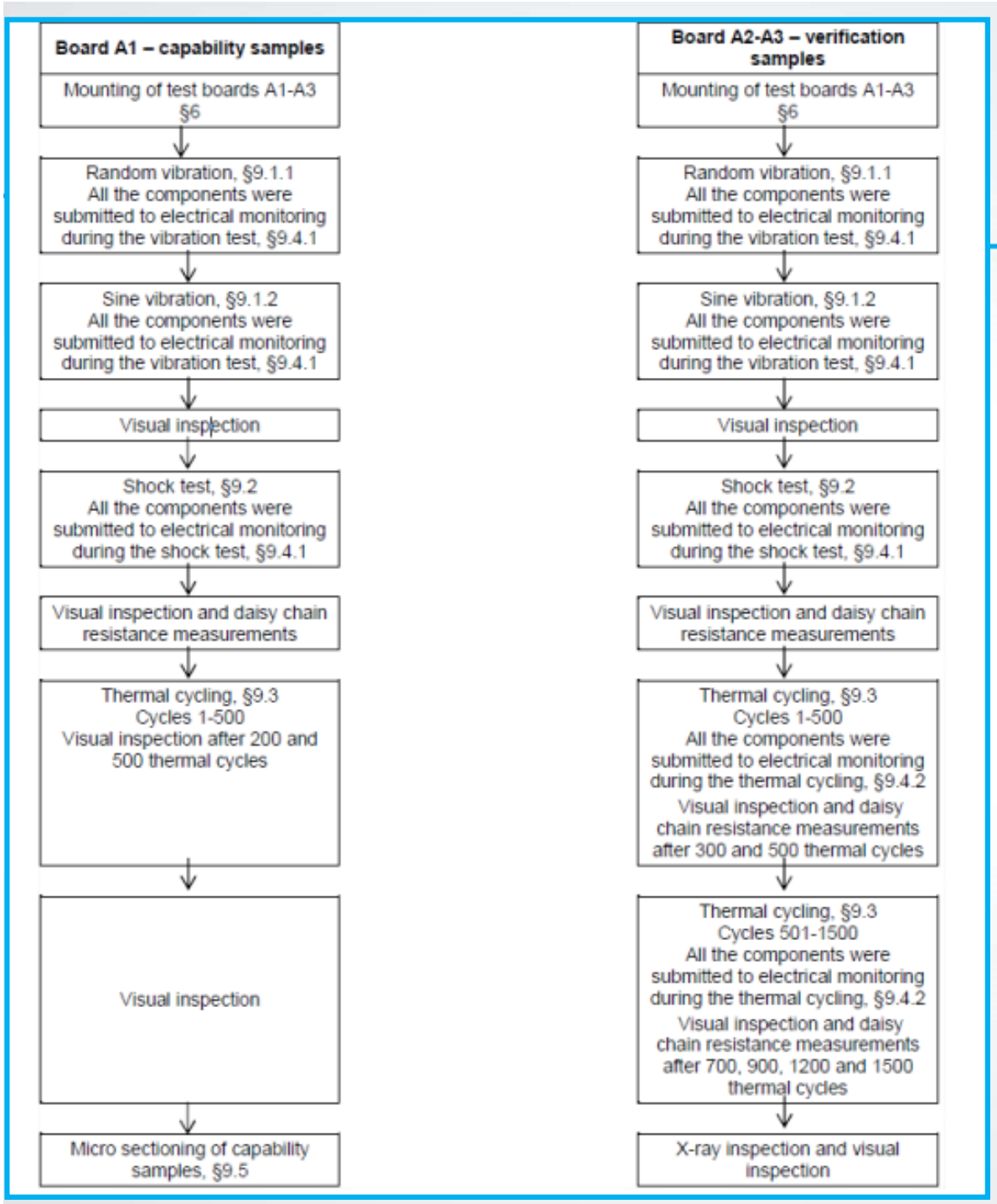
10 CCGA625 and 8 CCGA472 were used to validate the Board Assembly level, in compliance with on ECSS-Q-ST-70-38 & TEC-QT-2009/1059/CV specifications

Test boards were 16 layers glass reinforced polyimide.

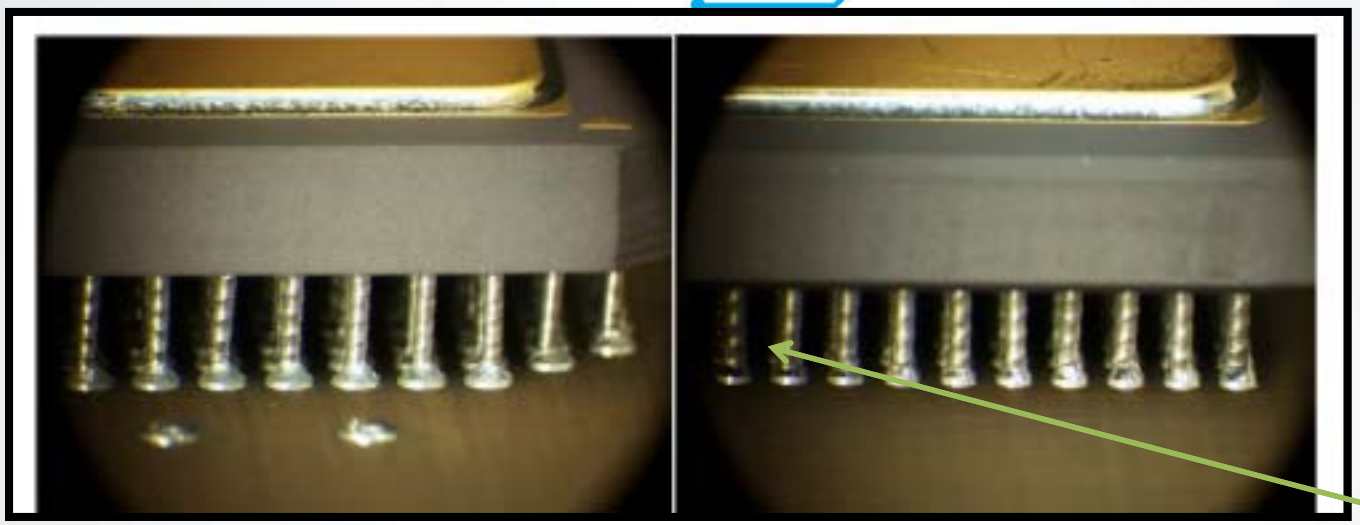
| Test board | Board material | Number of components mounted | | Number of components repaired | | Electrical monitoring to 1500 cycles | | Micro sectioning after 500 cycles (Capability samples) | |
|---|---|---|---|---|---|---|---|---|---|
| | | CCGA-472 | CCGA-625 | CCGA-472 | CCGA-625 | CCGA-472 | CCGA-625 | CCGA-472 | CCGA-625 |
| A1 | Polyimide (§5.1) | 2 | 2 | 1 | 1 | None | | 2 | 2 |
| A2 | Polyimide (§5.1) | 2 | 2 | 1 | 1 | 2 | 2 | None | |
| A3 | Polyimide (§5.1) | 2 | 2 | None | | 2 | 2 | None | |

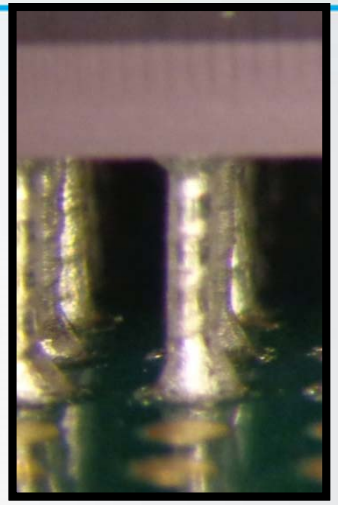
Test Configuration Table

# Capability and verification test plan



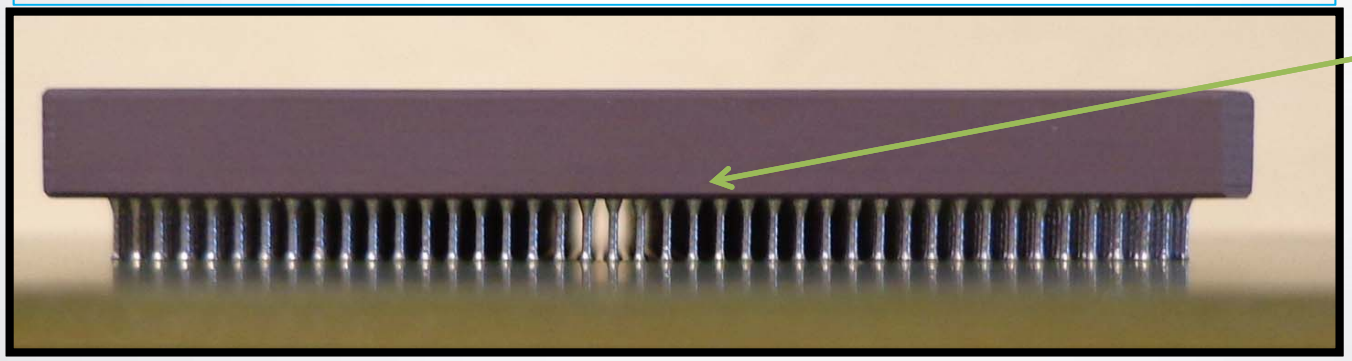
# CCGA assembly on PCB





Solder joints examples : Left CCGA625/Right CCGA472

Comply with MIL-STD-883 Method 2003 : solderability



**Capability Domain : CCGA1752 on PCB**

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# Electrical Measurement

- Continuous electrical measurement was applied with interrupts >5µs survey during vibration and shocks tests.
  No interrupts have been detected.

During thermal cycling, total resistance value (voltage) was recorded with 1000ms sampling time. With >5µs interrupts survey.

| Test board | Pos. | After shock [Ω] | After 300 TC [Ω] | After 500 TC [Ω] | After 700 TC [Ω] | After 900 TC [Ω] | After 1200 TC [Ω] | After 1500 TC [Ω] | Daisy chain resistance increase [%] |
|---|---|---|---|---|---|---|---|---|---|
| A2 | IC01 | 28.3 | 28.4 | 28.7 | 28.8 | 28.8 | 28.7 | 28.7 | 1.4 |
| A2 | IC02 | 27.1 | 27.2 | 27.3 | 27.5 | 27.6 | 27.6 | 27.6 | 1.8 |
| A3 | IC01 | 26.2 | 26.2 | 26.4 | 26.5 | 26.5 | 26.6 | 26.6 | 1.5 |
| A3 | IC02 | 26.6 | 26.3 | 26.9 | 27.0 | 27.0 | 26.9 | 26.9 | 1.1 |

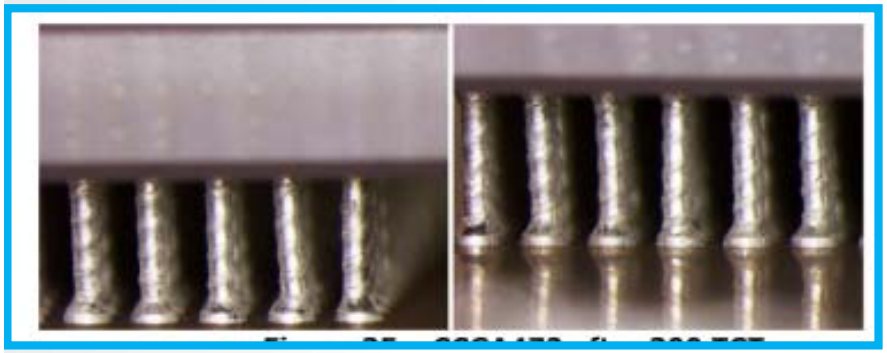
**CCGA625/Resistance measurement**

| Test board | Pos. | After shock [Ω] | After 300 TC [Ω] | After 500 TC [Ω] | After 700 TC [Ω] | After 900 TC [Ω] | After 1200 TC [Ω] | After 1500 TC [Ω] | Daisy chain resistance increase [%] |
|---|---|---|---|---|---|---|---|---|---|
| A2 | IC21 | 28.6 | 28.7 | 29.0 | 29.0 | 29.0 | 29.0 | 29.1 | 1.7 |
| A2 | IC22 | 29.7 | 29.7 | 29.8 | 30.1 | 30.2 | 30.2 | 30.2 | 1.7 |
| A3 | IC21 | 27.4 | 27.4 | 27.5 | 27.7 | 27.8 | 27.8 | 27.8 | 1.5 |
| A3 | IC22 | 27.8 | 27.7 | 27.9 | 28.1 | 28.2 | 28.2 | 28.3 | 1.8 |

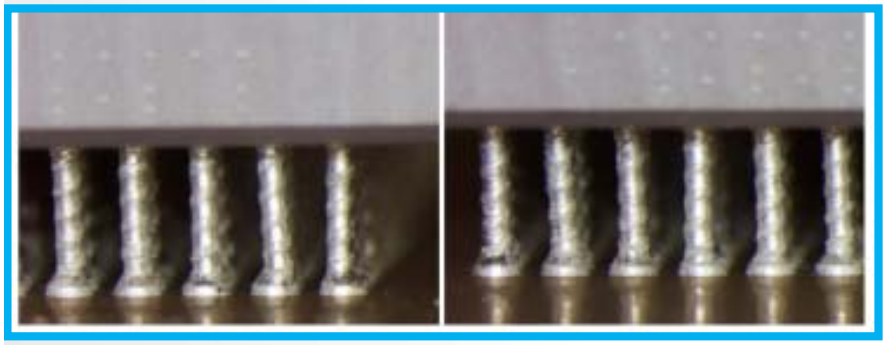
**CCGA472/Resistance measurement**

# Vibration / mechanical Shocks Thermal Cycles

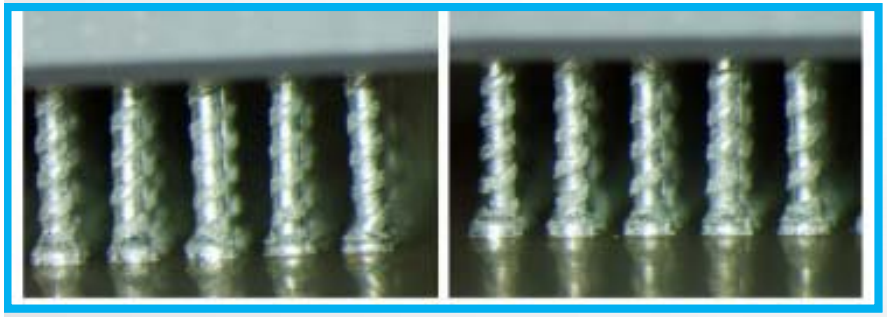
**Visual Inspections have been performed after Vibrations + Mechanical shocks + 300, 500 and 1500 cycles (-55/+100°C)**



**CCGA472 after 300 Thermal cycles : OK**

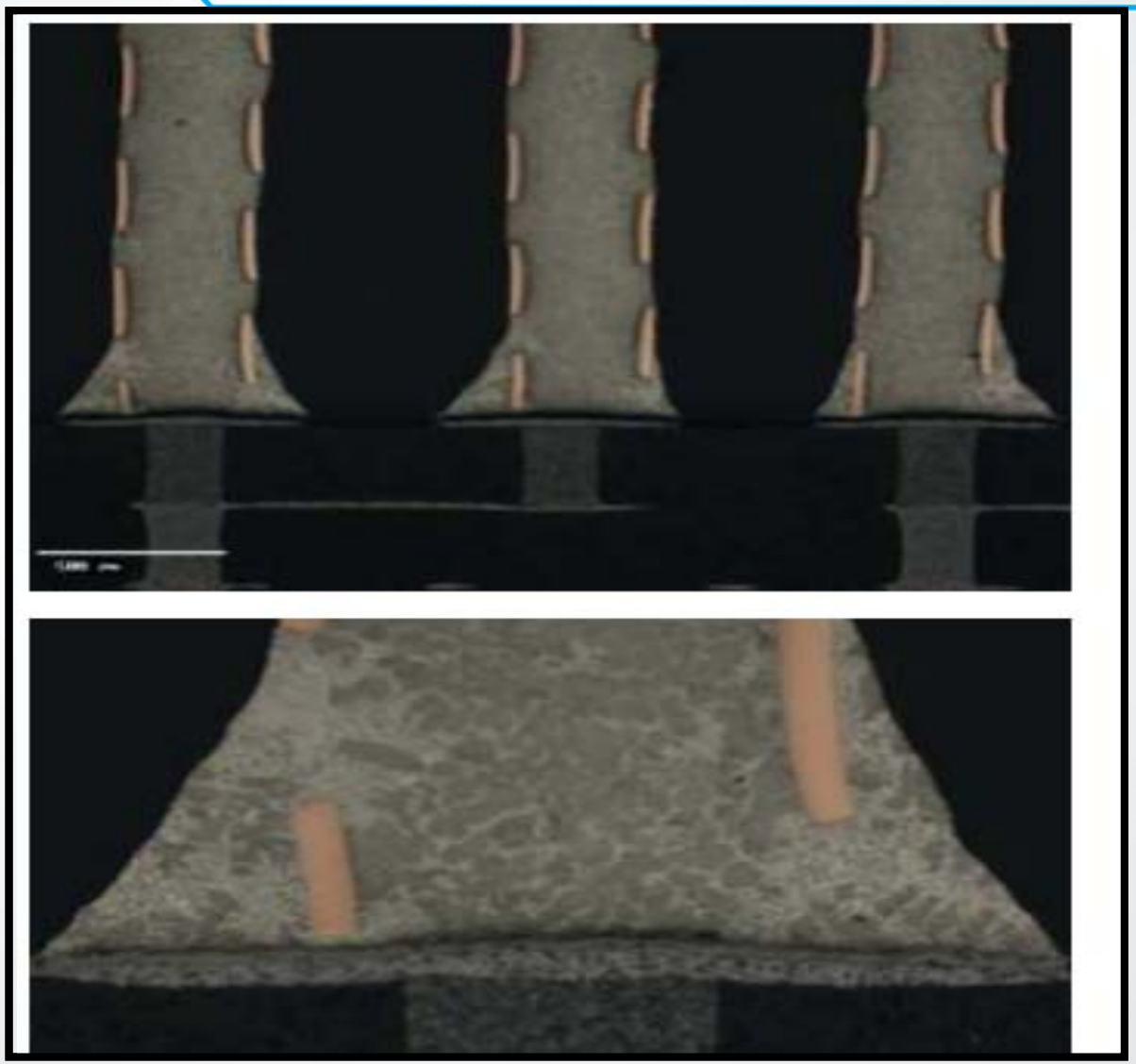


**CCGA472 after 500 Thermal cycles : OK**



**CCGA472 after 1500 Thermal cycles : OK**

# Cross-sections after thermal cycles



# ❑ ESA validated Domain for HTCC Hermetic Packages

- **Columns Raw materials**

  Core Materials : Cu & Pb85/Sn15
  Solder paste : Pb37/Sn63
  Column Winding step is 0.432 mm
  Column Ribbon thickness is 0.038 mm
  Column Ribbon width is 0.254 mm

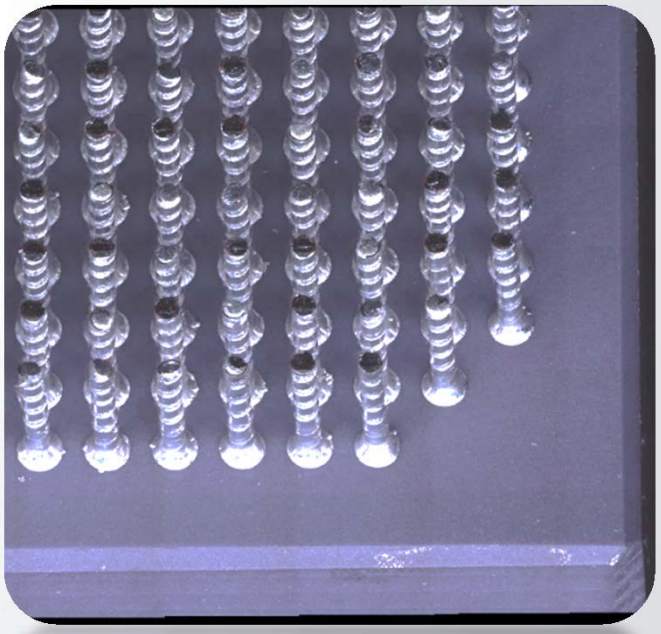
- **Columns Specifications**

  Diameter: **0.38mm ( ± 0.05mm)** according to **HCM.SYSTREL PID 11**
  Columns Length: 2.21mm ± 0.20mm according to **HCM.SYSTREL PID 11**

- **CLGA Packages Specifications**

  Package pin count: Up to 625
  Package Lands Diameter: 0.68 to 0.86mm
  Package Body Size: Up to 45x45mm
  Packages Pitches : 1.00 – 1.27mm
  Gold thickness : 0.1µm
  Coplanarity = 150µm max

- 1 **Rework** allowed on EM **.**For FM, no rework allowed unless customer authorization



## ❑ APPLICABLE STANDARDS & SPECIFICATIONS

❖ **For level I validation :**

- Columns Assembly per **HCM.SYSTREL PID 11**
- Columns External Visual Inspection per **MIL-STD-883 Method 2009/HCM.SYSTREL PID 11**
- Columns Coplanarity per **MIL-STD-883 Method 2009**
- Columns Pull-test per **MIL-STD-883 Method 2038**
- Column Solderability Test **per MIL-STD-883 Method 2003**

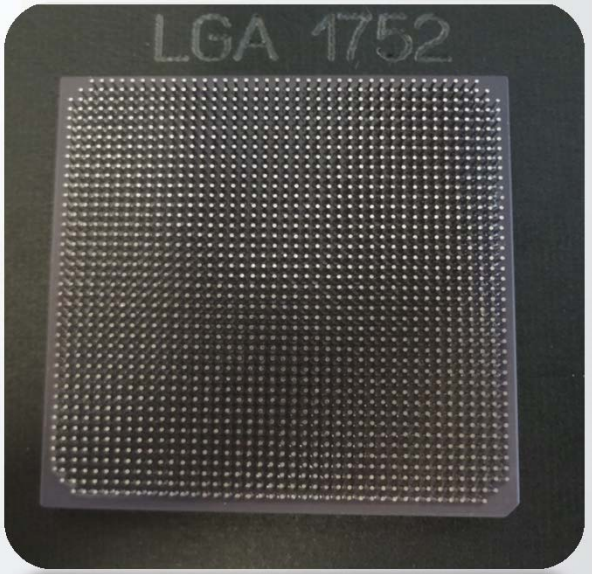
❖ **For level II validation (PCB Assembly):**

- **ECSS-Q-ST-70-38C**
- **TEC-QT-2009/1059/CV s.**

❖ **For FM, we deliver Pull-test & Solderability results( as per MIL-PRF-38535 K), using 2 dummies CLGA from the customer.**

# ❑Capability Domain for HTCC Hermetic Packages

- ✓ Columns count : from 192 to 1752 pins
- ✓ Min columns diameter : 0.33mm
- ✓ Min columns pitch : 0.80mm
- ✓ Gold thickness > 0.1 µm (for Au thickness higher than 0,3µm, degolding process is available)
- ✓ Columns Length < 2.21mm or > 2.4mm



# ESA validation letter

SERMA
HCM.SYSTREL

→ SERVING EUROPEAN COOPERATION AND INNOVATION

HCM. SYSTREL
Ave. Joliot Curie
ZI de Perigny
17137 PERIGNY
France

Att.: Mr. J. Guilbaud

**Noordwijk**, 14th December 2015

your ref. / *votre réf.*
our ref. / *notre réf.* D/TEC-QT/2015/LM

Subject/objet: **Development of Column Manufacture and Attach Processes**

Dear Sir,

We are pleased to confirm the completion of the planned activities in creating and demonstrating a high reliability, column grid array fitting process. The equipment and facilities for the production and fitting of the columns are located at:

HCM. SYSTREL,
Ave. Joliot Curie
ZI de Perigny
17137 PERIGNY
France

The processes described in Document: HCM PID 11 issue B, have been demonstrated to be satisfactory, and are considered suitable for inclusion as part of formal product qualifications for space flight components.

This certificate does not serve as formal qualification, however, it is expected that certification will be granted following the issue of a suitable ESCC requirements specification.

Yours faithfully

W. Veith
Head of The Product Assurance
And Safety Department

*European Space Agency*
*Agence spatiale européenne*

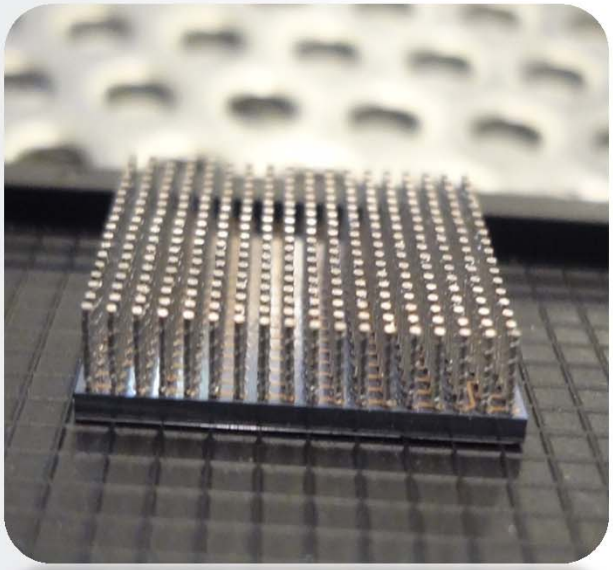
" The processes described in Document: HCM PID 11 issue B, have been demonstrated to be satisfactory, and are considered suitable for inclusion as part of formal product qualifications for space flight components"

SERMA
HCM.SYSTREL

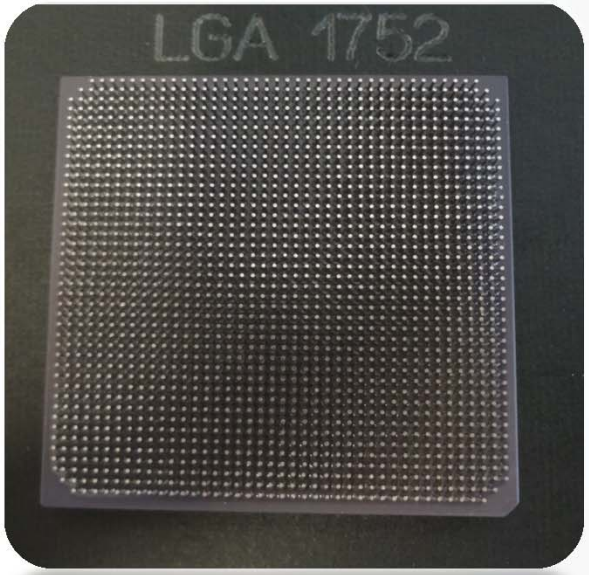
# SOME PICTURES / INFORMATION

15th Dec 2015

# Column attach examples



324 Columns on Si dies with a pitch of **0.8mm & thickness of 400 µm**




1752 Columns on Ceramic package with a **pitch of 1mm**

**625** Columns on Ceramic package with a pitch of 1mm

# Next Steps

- A **global communication** towards all potential users of this technology has been initiated by SERMA business development team

- HCM.SYSTREL applied for a Lab Suitability and the technology have been submitted to a **QML-V qualification** by our partner ATMEL for Q4/2016-Q1/2017

- CCGA1752 had been developed and is being evaluated in 2016 ( 95% of good yield so far

- The current **production forecast** is around 500 000 columns for 2016

# Contact points

- For any technical question on this technology, please contact:
  - Wilfried AKLAMAVO – Project leader – w.aklamavo@serma.com
  - Patrick BARBOT – C.T.O. – p.barbot@serma.com

- For any request for quotation or sales information, please contact:
  - Maxence LEVEQUE – Area Sales Manager – m.leveque@serma.com / +336.84.95.75.99

## THANK YOU FOR YOUR ATTENTION