

# Engineering Manual

## LOCTITE GC 10 T3 Solder Paste

Suitable for use with: Standard SAC Alloys



**LOCTITE**<sup>®</sup>

GC 10 – The Game Changer



Excellence is our Passion

# Contents

1. Performance Summary
2. Introduction: Properties, Features & Benefits
3. Operating Parameters
  - Printing: Process Window
  - Printing: Continuous and Abandon Time Testing
  - Slump Testing
  - Tack-Life Force
  - Reflow Process Window
  - Reflow Performance Testing
  - Voiding Data
4. Reliability and Specification Testing
5. Operating Parameters: Storage
  - Printing & Reflow Performance
6. Product Summary

# Contents

## **1. Performance Summary**

### 2. Introduction: Properties, Features & Benefits

### 3. Operating Parameters

- Printing: Process Window
- Printing: Continuous and Abandon Time Testing
- Slump Testing
- Tack-Life Force
- Reflow Process Window
- Reflow Performance Testing
- Voiding Data

### 4. Reliability and Specification Testing

### 5. Operating Parameters: Storage

- Printing & Reflow Performance

### 6. Product Summary

# GC 10: Performance Summary

## Flux

- Halogen-free flux: passes IC with pretreatment IPC-TM-650 2.3.34/EN14582
- Halogen-free flux classification: ANSI/J-STD-004 Rev. B for a type ROL0 classification

## Paste

- Suitable for printing up to 125mm/s (5"/s)
- Optimized for long hot soak reflow profiles
- Excellent coalescence in air & nitrogen atmosphere
- Excellent humidity resistance
- Excellent solderability on challenging surface finishes, including CuNiZn
- Colourless residues for easy post-reflow inspection
- Long 12 month shelf-life when stored below 25°C

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  - Tack-Life Force
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# Introduction

## Basic Solder Paste Properties

|                                                             |           |
|-------------------------------------------------------------|-----------|
| Flux Description                                            | GC 10     |
| Alloy                                                       | SAC305    |
| Henkel Powder Size                                          | Type 3    |
| Powder Size range, $\mu\text{m}$                            | 45-25     |
| Metal Content, %                                            | 88.5      |
| Malcom Viscosity, 10rpm Pa.s                                | 207       |
| TI                                                          | 0.50      |
| IPC slump @182°C (0.33mm x 2.03mm)<br>first space no bridge | 0.15      |
| IPC Solder Balling                                          | preferred |

## GC 10 Features & Benefits

| Product Attribute | Process Benefit                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Halogen Free      | <ul style="list-style-type: none"><li>• No added halogen</li><li>• Measured &lt;900ppm chlorine and bromine and &lt;1,500ppm total by oxygen (O<sub>2</sub>) bomb test</li></ul>                                                                                                                                                                                                                                                   |
| Halide Free       | <ul style="list-style-type: none"><li>• Flux classification ROL0 in accordance to J-STD-004B</li></ul>                                                                                                                                                                                                                                                                                                                             |
| Application       | <ul style="list-style-type: none"><li>• Designed for printing and pin-in-paste</li><li>• Excellent wetting to a broad range of metallisations, even through long hot soak profiles in an air atmosphere</li><li>• Compatible with existing halogen free solutions</li><li>• Suitable for medium to large board assemblies</li><li>• Designed for long 12 month shelf-life stability without impact to printing or reflow</li></ul> |

## GC 10 Features & Benefits

| Product Attribute              | Process Benefit                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Technology Printing Advantages | <ul style="list-style-type: none"><li>• Wide process window for printing and minimal slump</li><li>• Abandon time of up to 2 hours; work life &gt; 16 hours</li><li>• Excellent print capability and reduction in print related defects</li><li>• Suited for high throughput production, where yield consistency on print deposits is key</li><li>• Improved paste transfer efficiency</li><li>• Allows on line paste utilisation protocols to be re-written</li></ul> |
| Technology Reflow Advantages   | <ul style="list-style-type: none"><li>• Optimised for long hot soak reflow processes</li><li>• Very shiny Pb-free solder joints over wide range of reflow</li><li>• Excellent coalescence</li><li>• Excellent humidity resistance</li><li>• Excellent solderability on challenging surface finishes (ENIG, Copper OSP, CuNiZn and Imm Ag)</li></ul>                                                                                                                    |
| Low Voiding                    | <ul style="list-style-type: none"><li>• Low void levels increases solder joint reliability</li><li>• New chemistries allow pursuit of class 3 void levels in accordance to IPC7095B on industry surface finishes: ENIG, Copper OSP, CuNiZn and Imm Ag</li><li>• Low voiding in CSP/BGA</li></ul>                                                                                                                                                                       |
| Residues                       | <ul style="list-style-type: none"><li>• Clear, transparent and colourless</li><li>• Pin testable after 4x reflows</li></ul>                                                                                                                                                                                                                                                                                                                                            |

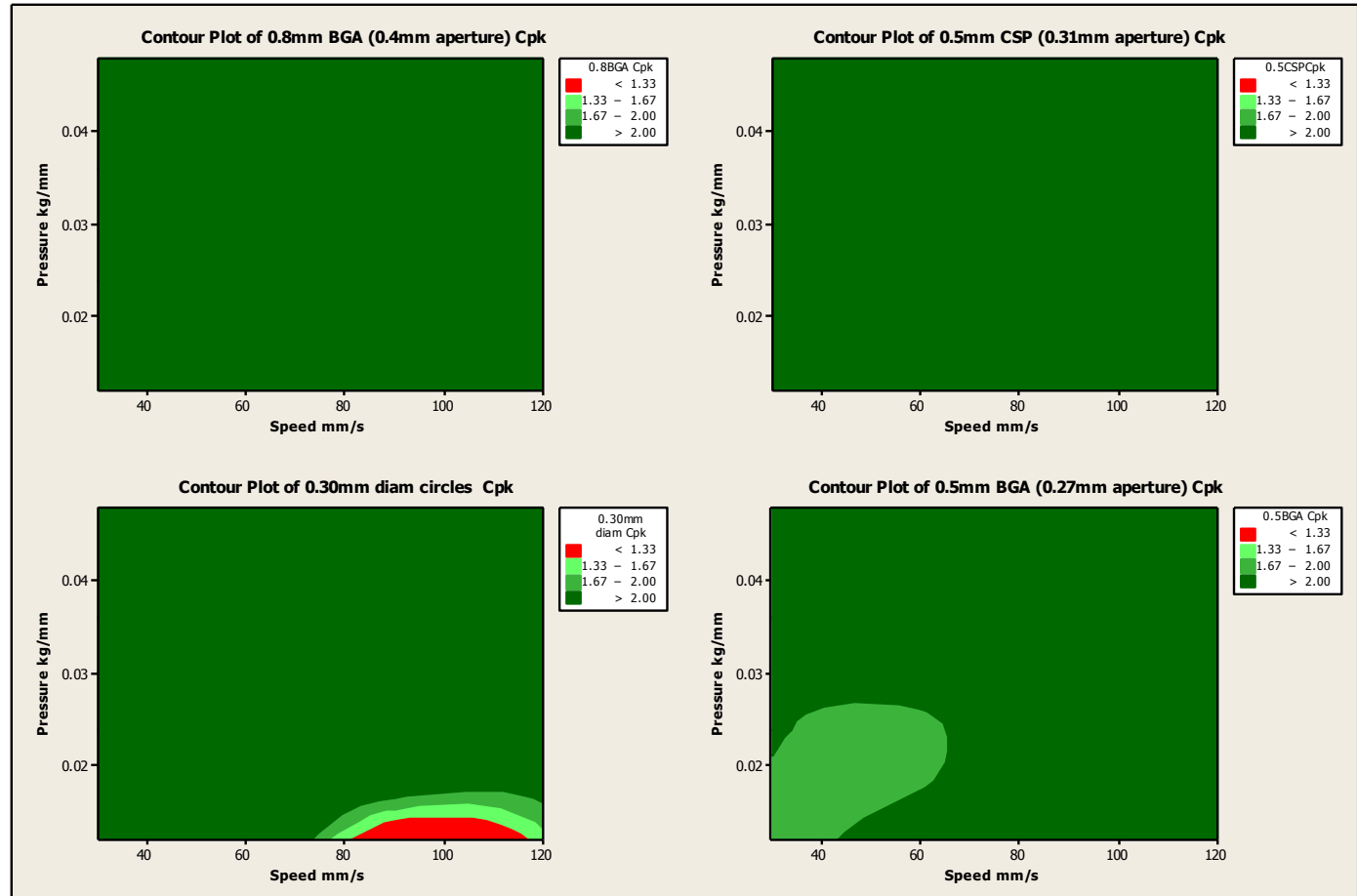
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# Operating Parameters

## Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- Excellent printing in the range 30 – 120mm/s, 0.4mm to 0.27mm round apertures

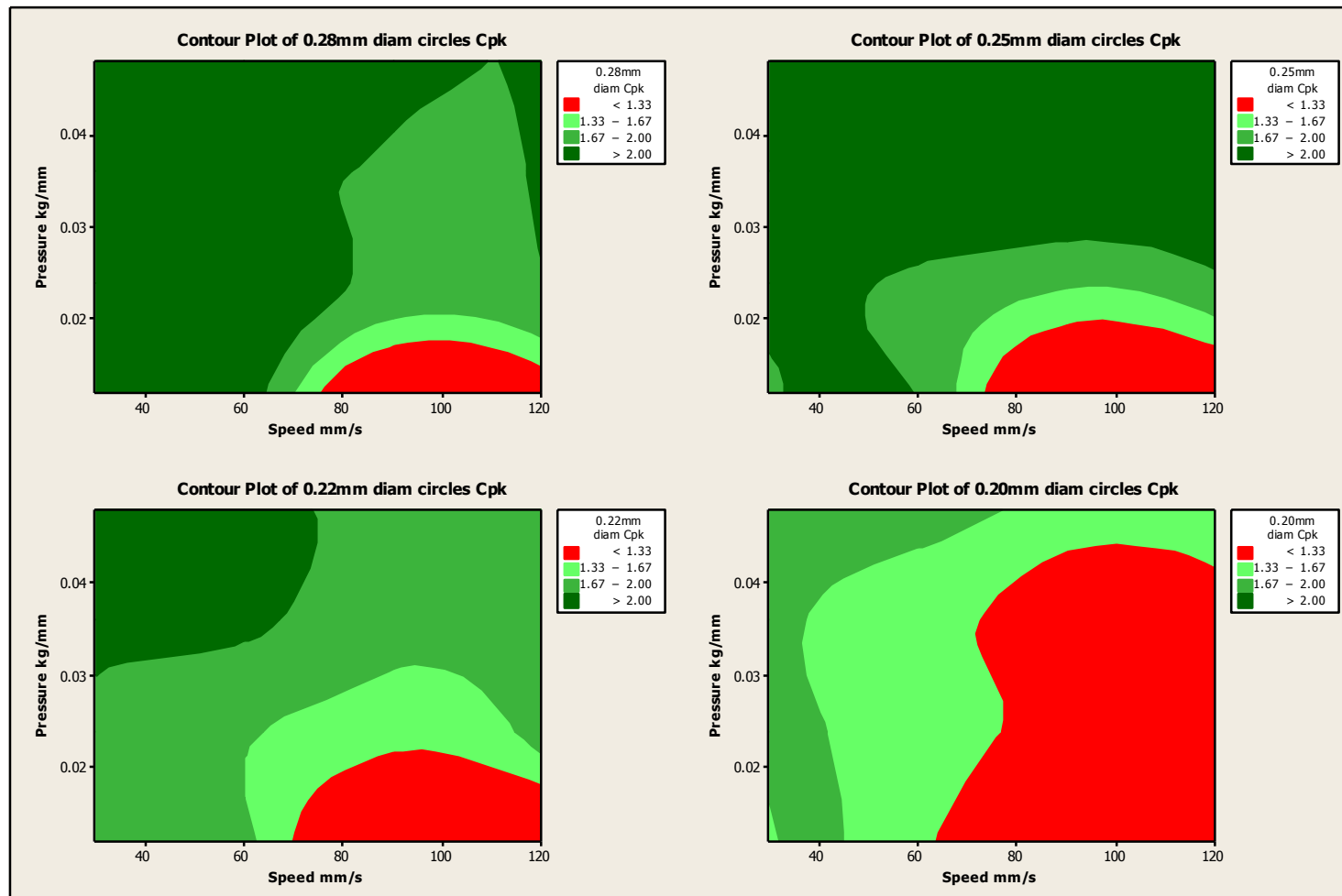


0.8mm, 0.5mm & 0.4mm pitch round apertures, (120µm stencil)

# Operating Parameters

## Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- Excellent printing in the range 30 – 120mm/s, 0.28-0.22mm round apertures
- Limited process window with 0.20mm apertures. GC 10 T4 may be required



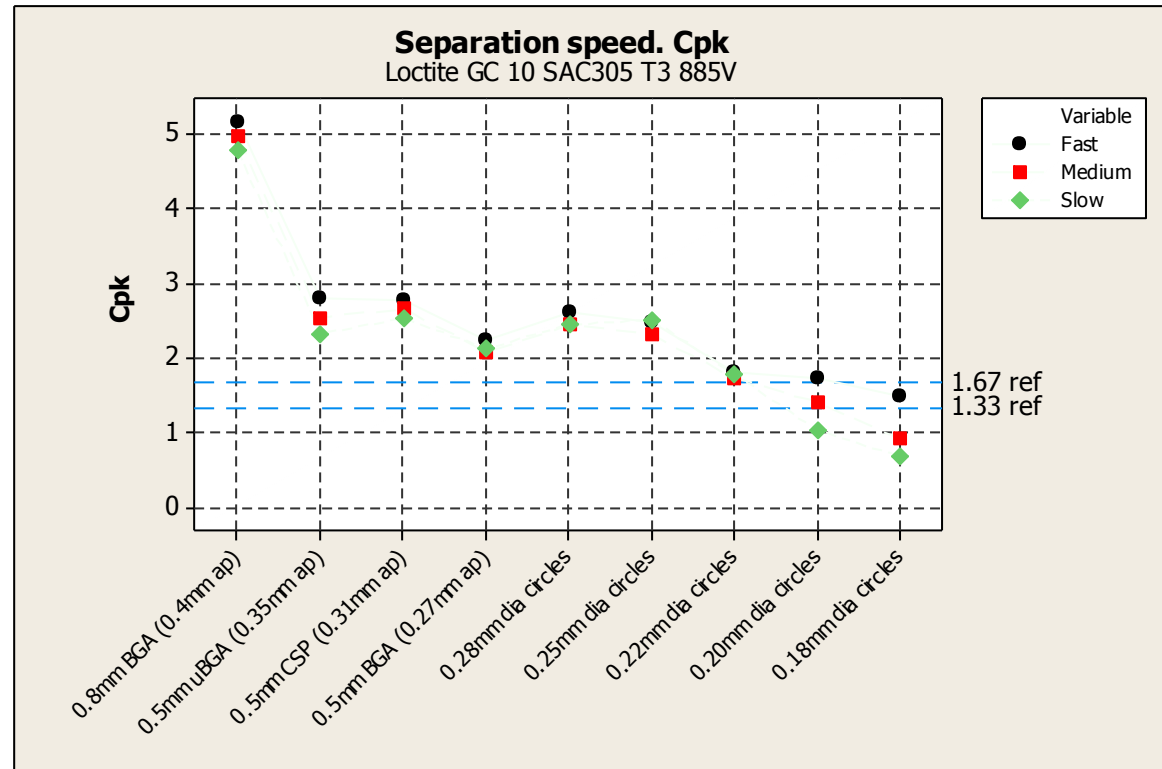
0.28mm – 0.20mm round apertures, (120µm stencil)

# Operating Parameters – Separation Speed

## Print Process Window

(LOCTITE GC 10 SAC305 T3 885V)

- Excellent printing in the range down to 0.22mm round apertures.
- Fast separation speed is preferable.

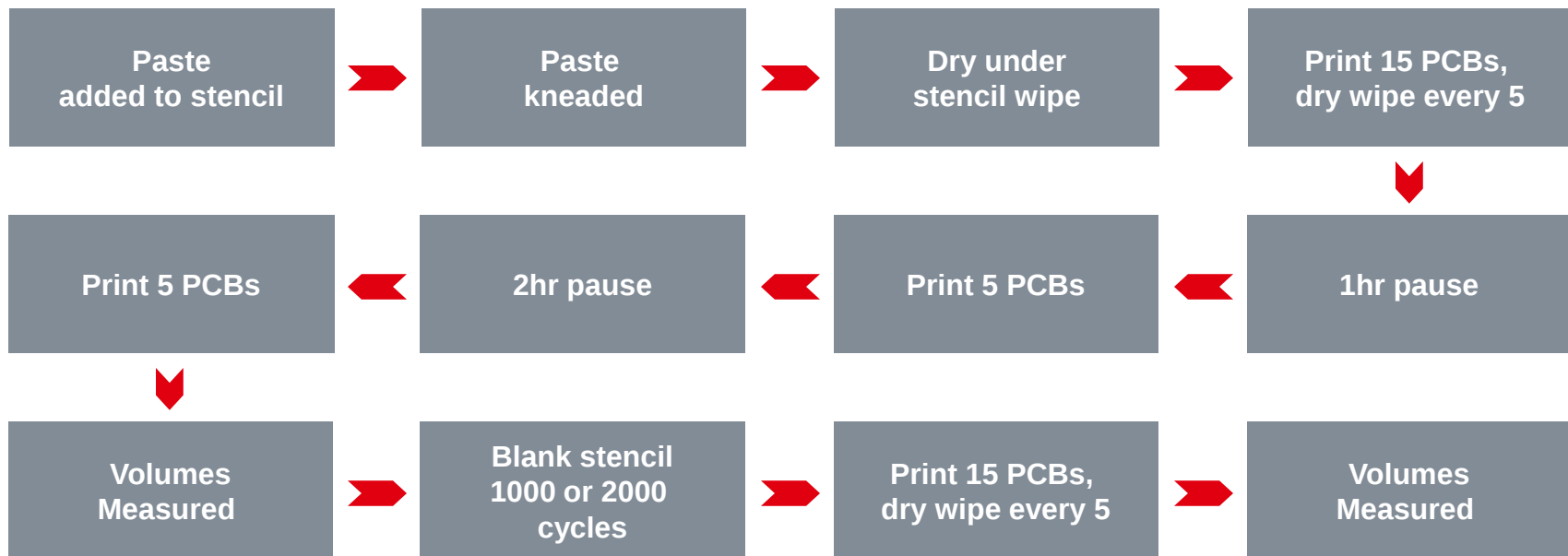


0.8mm BGA – 0.18mm round apertures, 120 $\mu$ m stencil thickness, 60mm/s, 10kg

# Operating Parameters

## Continuous Print and Abandon Stability Assessment

Henkel Board 0.8mm BGA to 0.18mm diameter circles Process flow for Henkel print test as shown below



- Printing
- DEK Europa
- Stainless steel, laser cut
- 120µm thickness
- Vacuum tooling

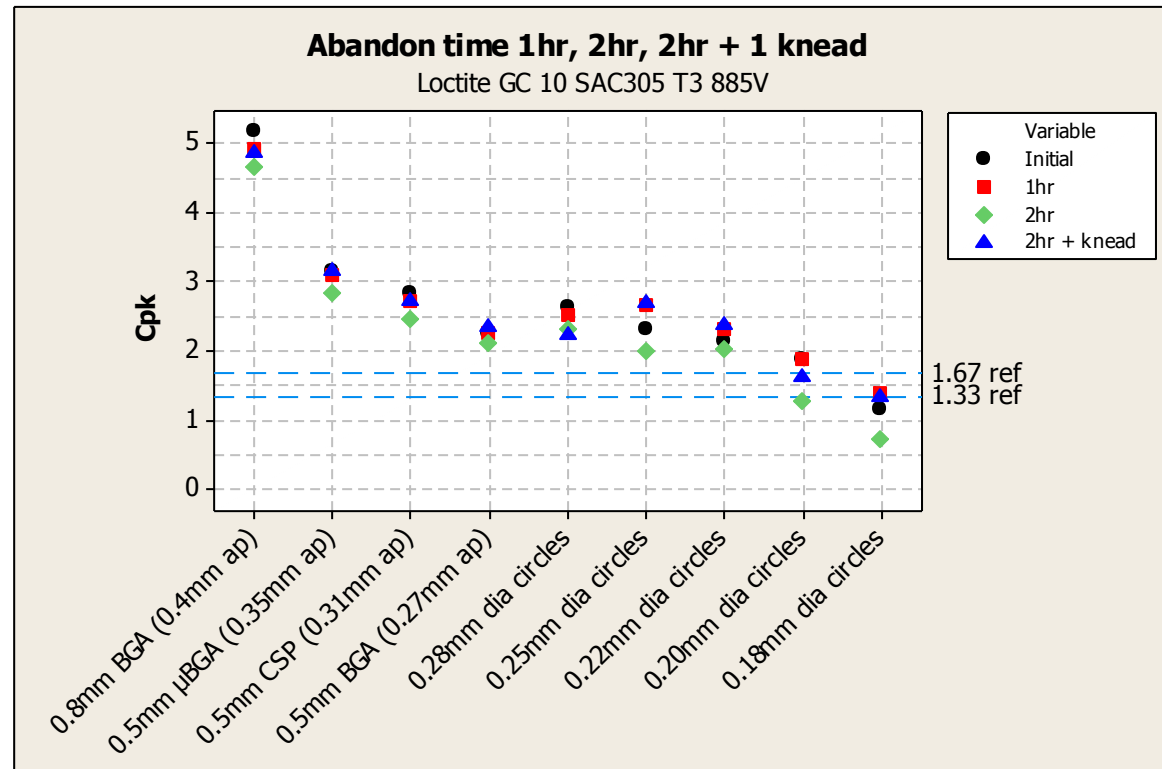
- 250mm, 60° squeegee
- 60mm/s squeegee speed
- Fast separation speed
- Conditions typical, 22C, 40% RH
- Koh Young KY-8020T volume measurement

# Operating Parameters

## – Abandon Stability 22°C/40%RH

Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- **Print Capabilities**
- Excellent printing in the range down to 0.22mm round apertures
- Single knead cycle required after 2hr abandon at 0.20mm round apertures



0.8mm BGA – 0.15mm round apertures

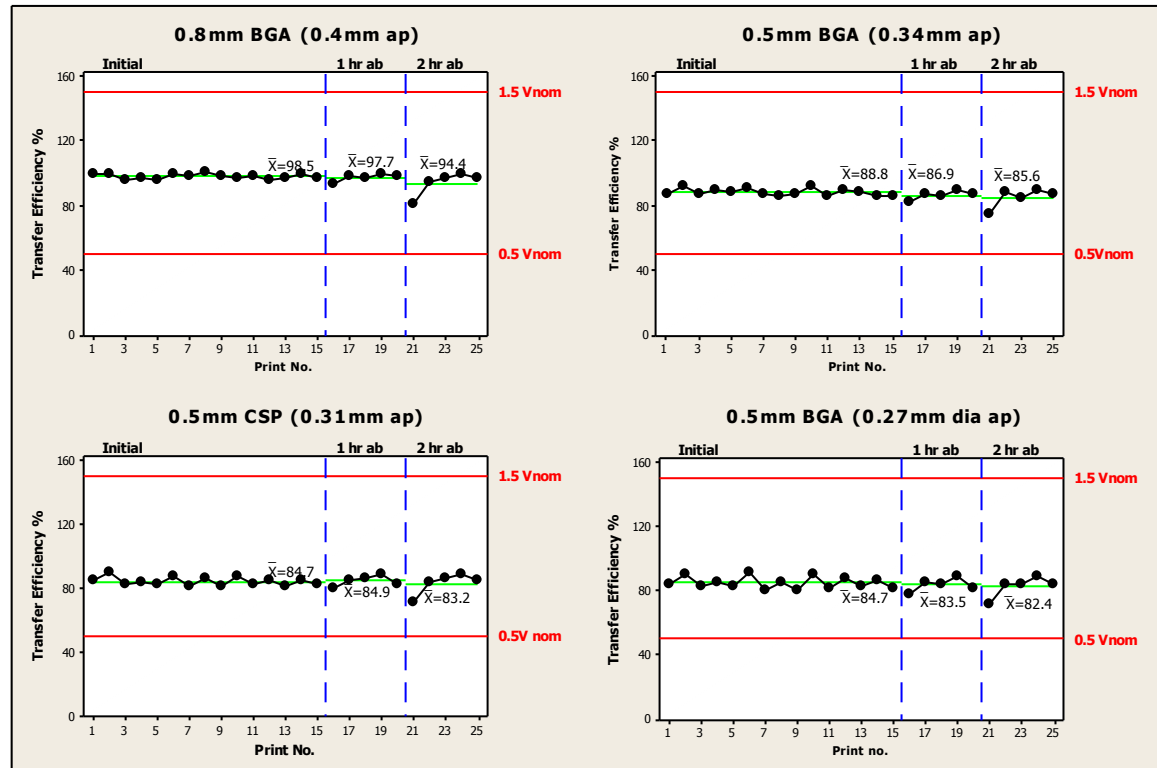
120µm stencil thickness, 60mm/s, fast separation, 250mm squeegee, 10kg

# Operating Parameters

## – Abandon Stability 22°C/40%RH

Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- Transfer Efficiencies
- Excellent printing in the range 0.40mm down to 0.27mm round apertures



0.8mm BGA – 0.5mm BGA round apertures

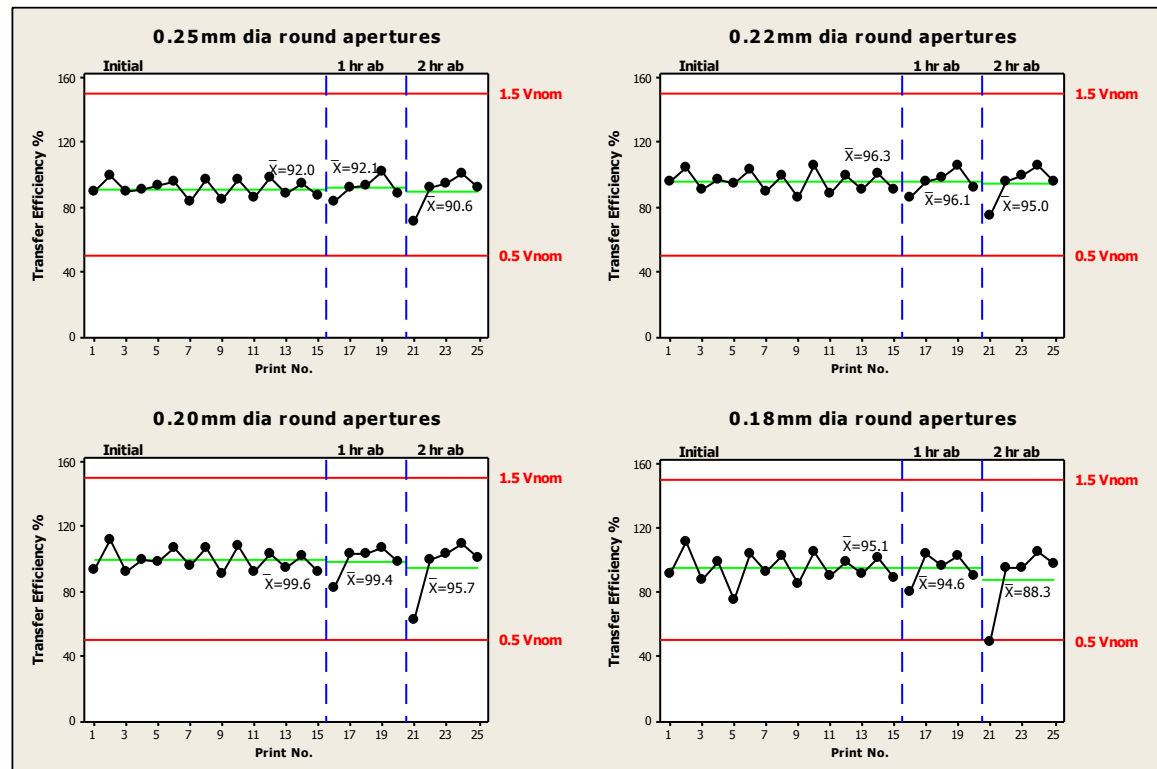
120µm stencil thickness, 60mm/s, fast separation, 250mm squeegee, 10kg

# Operating Parameters

## – Abandon Stability 22°C/40%RH

Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- **Transfer Efficiencies**
- Excellent printing in the range down to 0.22mm round apertures
- Single knead cycle for best results after 2hr abandon at 0.20mm round apertures and below



0.28mm – 0.20mm round apertures

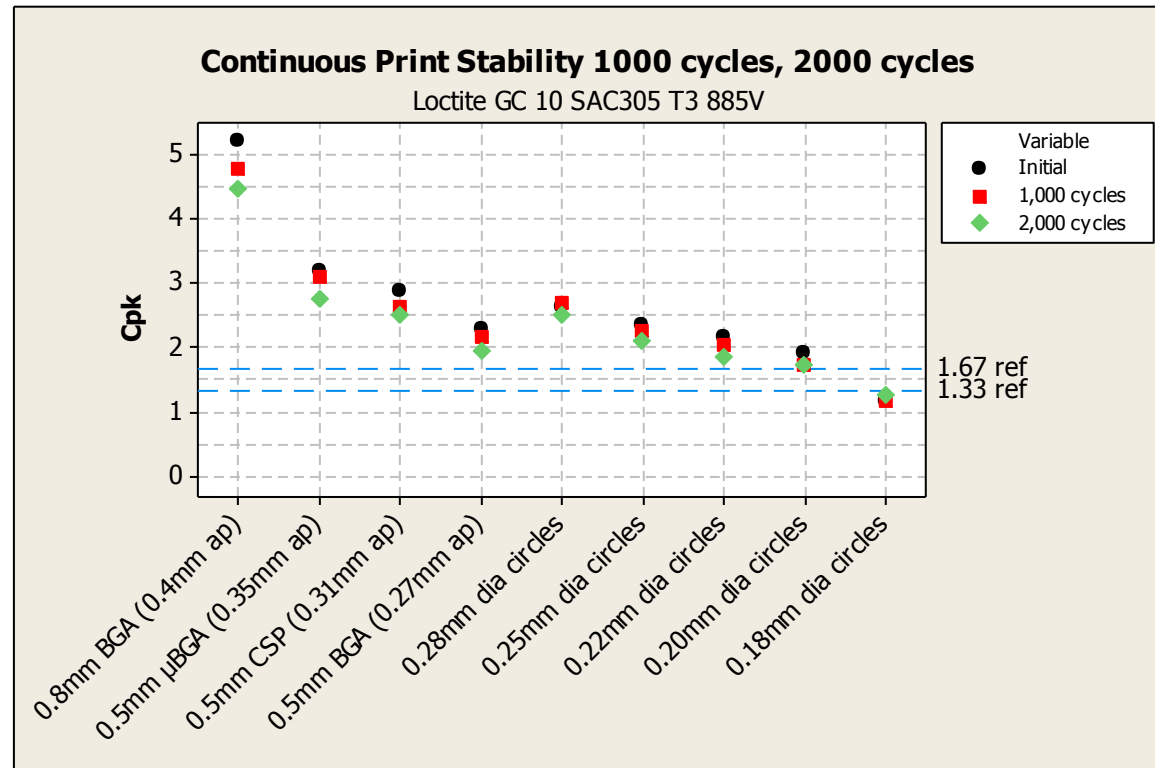
120 $\mu$ m stencil thickness, 60mm/s, fast separation, 250mm squeegee, 10kg

# Operating Parameters

## – Continuous Print Stability

### Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- **Print Capabilities**
- No impact on print performance after 8 hours (1000 cycles) and 16 hours (2000 cycles) printing



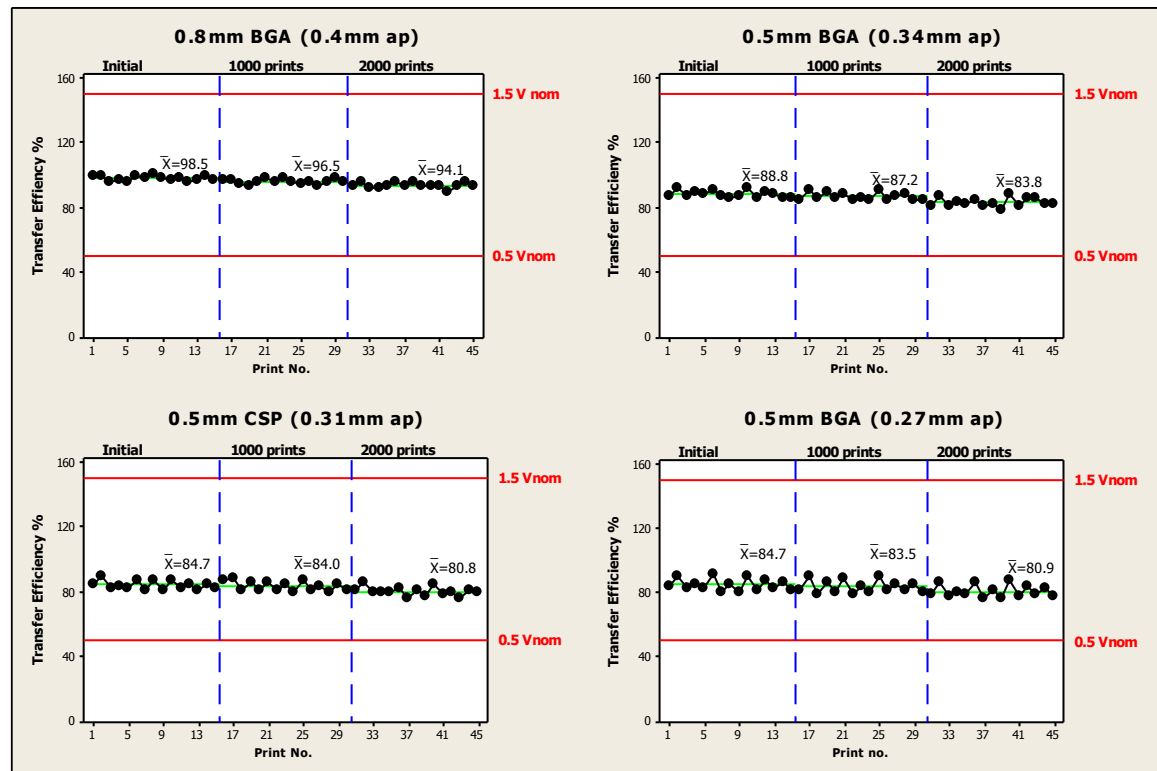
0.8mm BGA – 0.18mm round apertures, 120µm stencil thickness,  
60mm/s, Fast separation, 250mm squeegee, 10kg

# Operating Parameters

## – Continuous Print Stability

## Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

- **Transfer Efficiencies**
- No impact on print performance after 8 hours (1000 cycles) and 16 hours (2000 cycles) printing



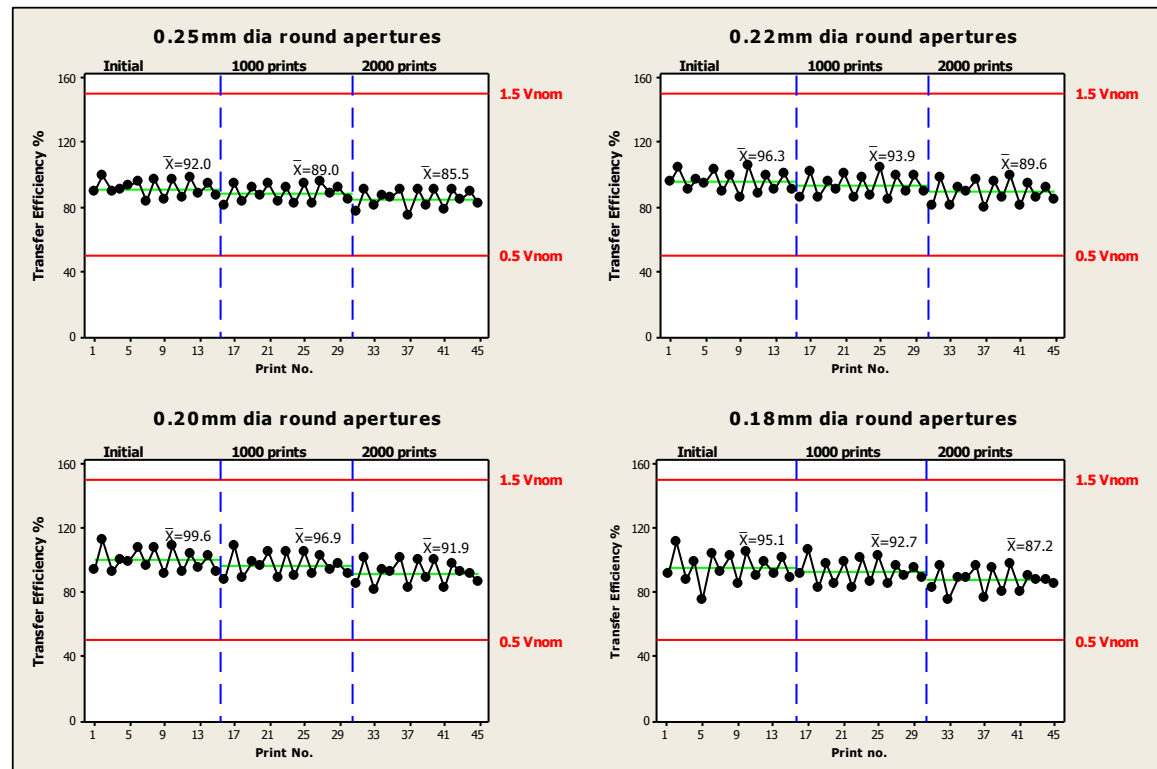
0.8mm BGA – 0.5mm BGA round apertures, 120 $\mu$ m stencil thickness,  
60mm/s, Fast separation, 250mm squeegee, 10kg

# Operating Parameters

## – Continuous Print Stability

## Print Process Window (LOCTITE GC 10 SAC305 T3 885V)

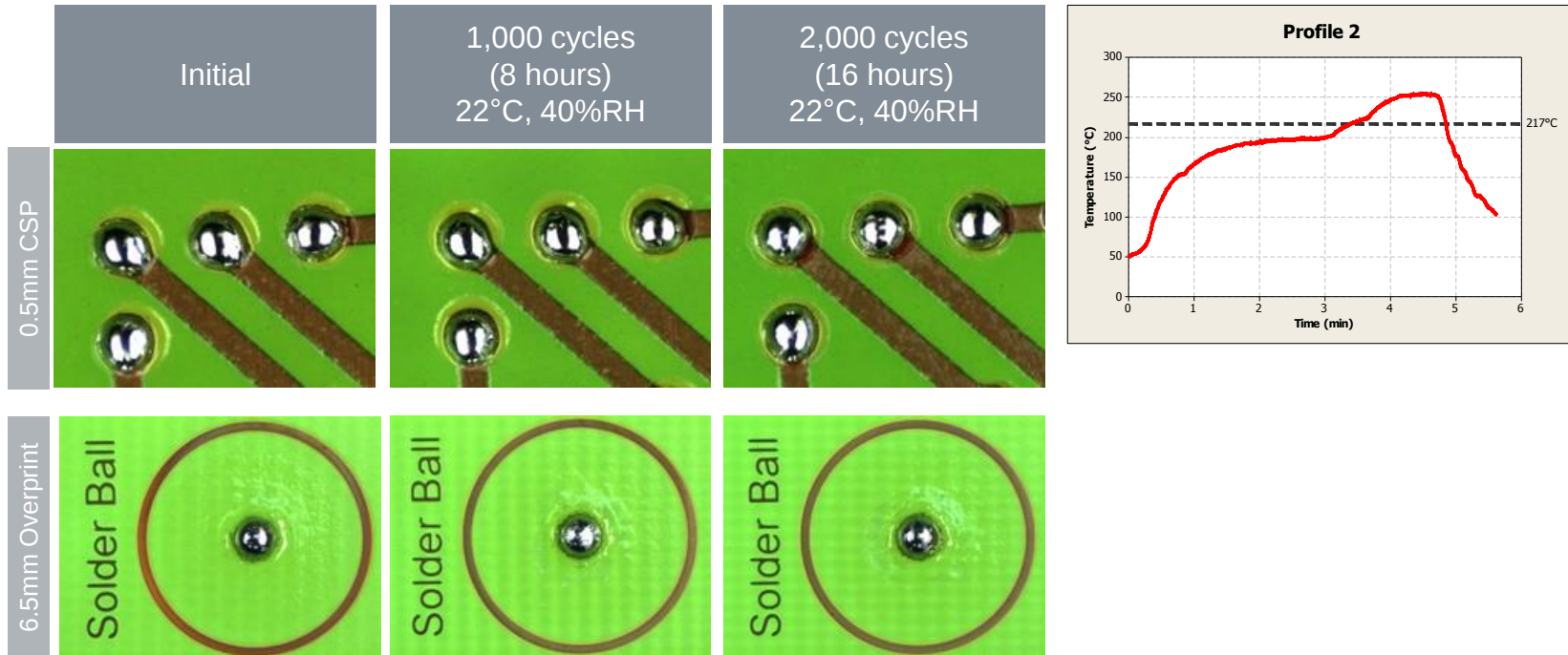
- Transfer Efficiencies
- No impact on print performance after 8 hours (1000 cycles) and 16 hours (2000 cycles) printing



0.28mm– 0.20mm round apertures, 120 $\mu$ m stencil thickness,  
60mm/s, Fast separation, 250mm squeegee, 10kg

# Operating Parameters (Reflow)

## Paste Properties After Continuous Printing



- No change to reflow performance after 16hours printing (2000 print cycles)

# Operating Parameters

## Slump

- Slump evaluation was performed in accordance with J-STD-005A, IPC-TM-650 2.4.35
- First spacing with no bridge recorded after 10 minutes at 182°C (35°C below melting point 217°C)

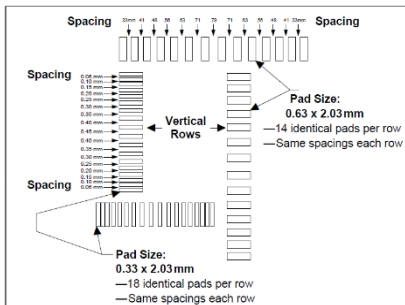


Figure 1: Slump test stencil, IPC-A-21

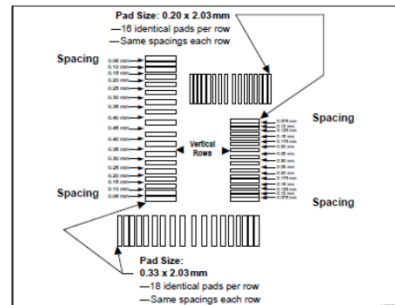
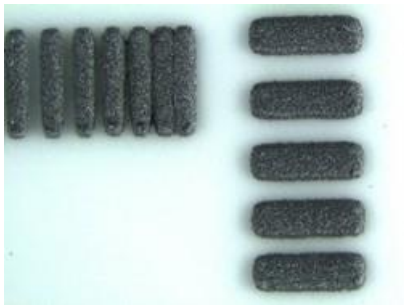
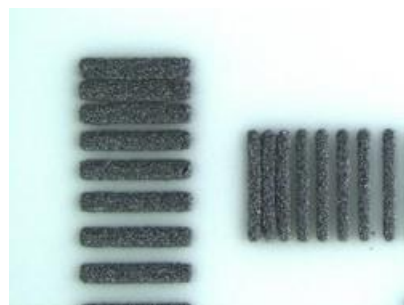


Figure 2: Slump test stencil, IPC-A-20



A21  
200μm



A20  
100μm

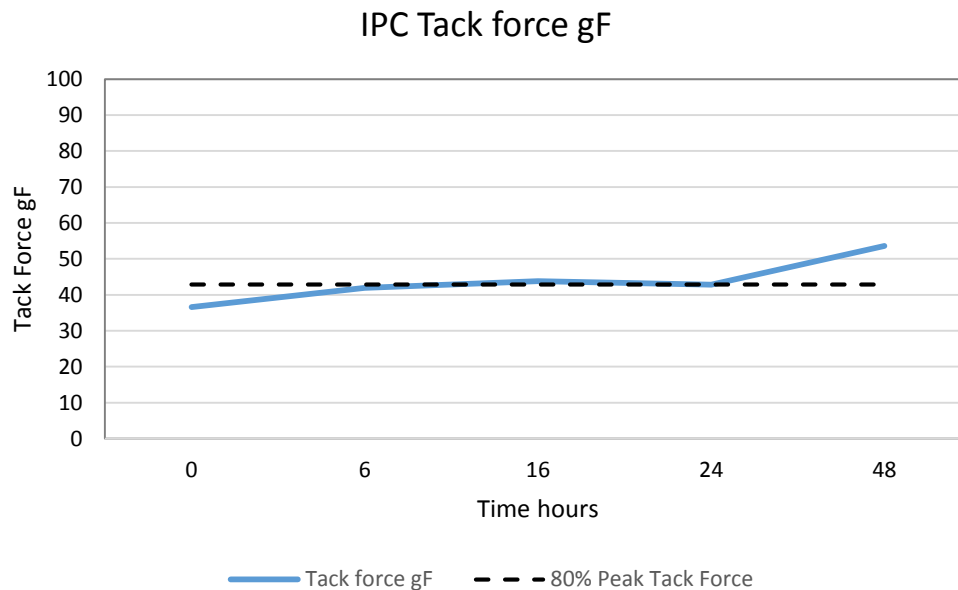
### Stencil Design/ thickness

| Stencil<br>Design/<br>thickness | A 21<br>200μm    |                  | A 20<br>100μm    |                  |
|---------------------------------|------------------|------------------|------------------|------------------|
|                                 | Aperture         | Pass mark        | GC 10<br>25°C    | GC 10<br>182°C   |
|                                 | 0.63 x<br>2.03mm | 0.33 x<br>2.03mm | 0.33 x<br>2.03mm | 0.20 x<br>2.03mm |
|                                 | 0.63mm           | 0.30mm           | 0.30mm           | 0.25mm           |
|                                 | 0.33mm           | 0.10mm           | 0.08mm           | 0.075mm          |
|                                 | 0.33mm           | 0.15mm           | 0.15mm           | 0.125mm          |

# Operating Parameters

## Tack Force

- Tackiness evaluation was performed in accordance with J-STD-005A, IPC-TM-650 2.4.44
- GC10 tack-life >48hours



Malcom TK1 Tackiness Tester

|                  |           |
|------------------|-----------|
| Preload          | 300g      |
| Preload time     | 5 secs    |
| Retraction Speed | 2.5mm/sec |
| Deposit diameter | 5.1mm     |
| Deposit height   | 0.25mm    |

# Operating Parameters

## Solder Balling

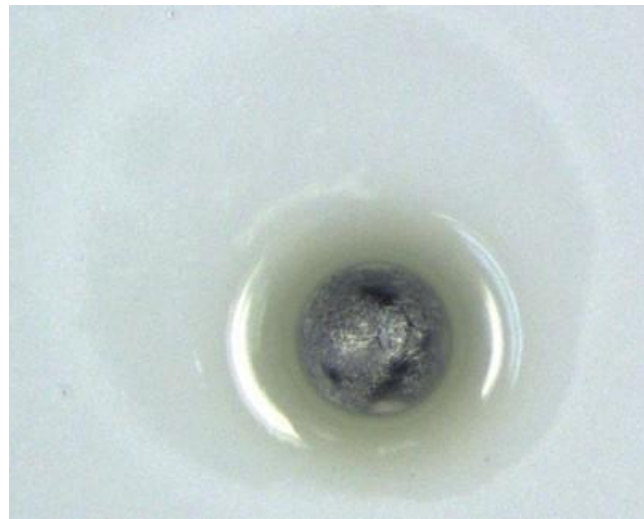
- Solder balling performance as been assessed in accordance with an extended version of IPC-TM-650 2.4.4.3
- Clear and colourless residues observed post-reflow

**Initial**



Preferred Pass

**24hrs 25°C 50% RH**

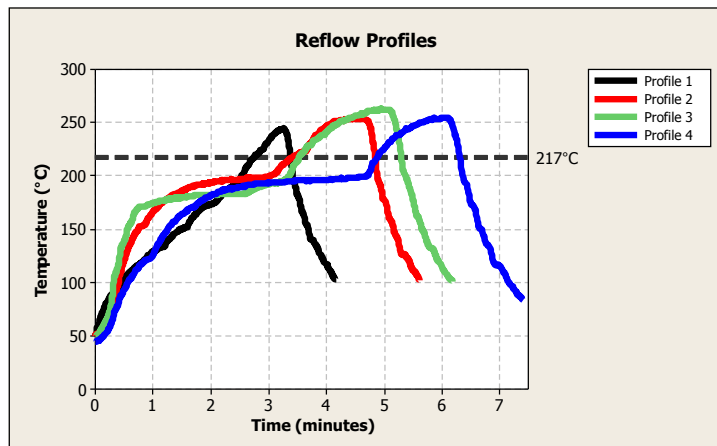


Preferred Pass

# Operating Parameters

## Reflow Process Window (Air)

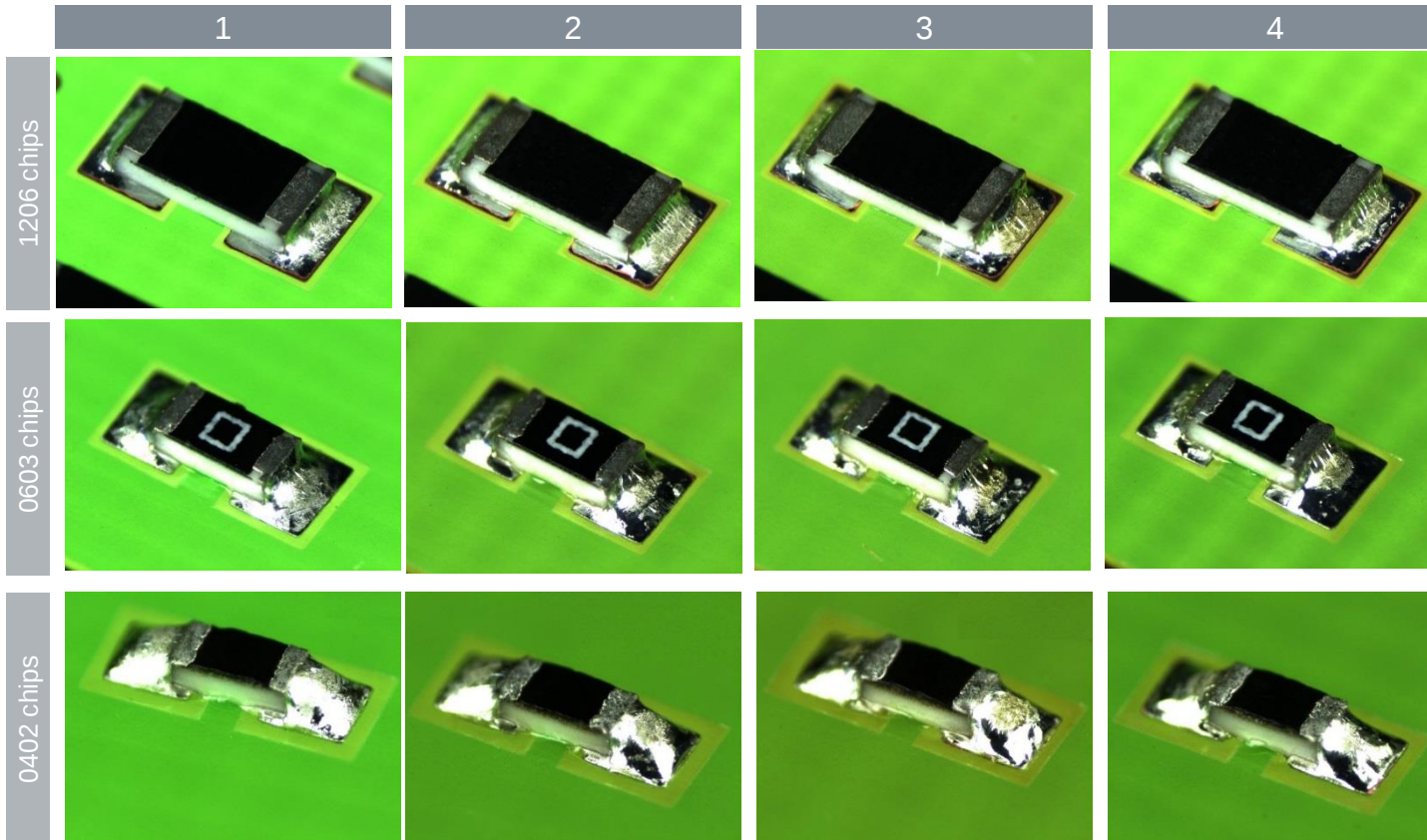
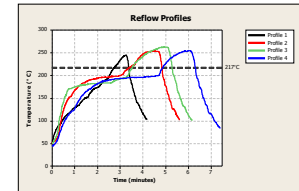
- LOCTITE GC 10 solder paste offers halogen containing reflow performance in a truly halogen free formulation
- GC 10 shows excellent coalescence onto a range of PCB and component finishes especially during long-hot profiles
- There is no single profile that works for all applications and each process should be assessed individually, under laboratory conditions the following profiles have been found to give good results
- These process window guidelines are suitable for Type 3 SAC powder



| Profile                     | 1                | 2    | 3     | 4    |
|-----------------------------|------------------|------|-------|------|
| Peak Temp (°C)              | 244              | 254  | 260   | 255  |
| Time to Peak (min)          | 3.3              | 4.5  | 5.1   | 6.0  |
| Soak Time (150-200°C) (min) | (No Soak)<br>1.0 | 2.35 | 2.80  | 3.44 |
| Time above Liquidus (min)   | 0.62             | 1.46 | 1.75  | 1.45 |
| Time above Liquidus (sec)   | 37.2             | 87.6 | 105.0 | 87.0 |

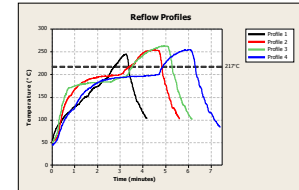
# Operating Parameters (Reflow)

Reflow Profile



# Operating Parameters (Reflow)

Reflow Profile



1

2

3

4

Overprinted  
Solder ball

Solder Ball

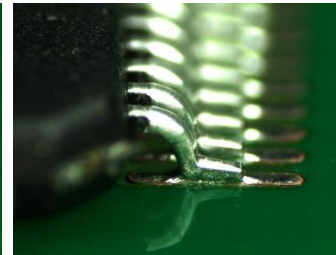
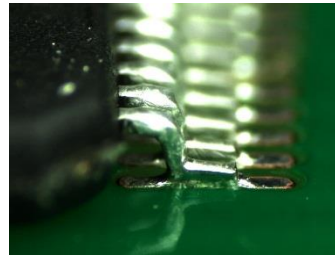
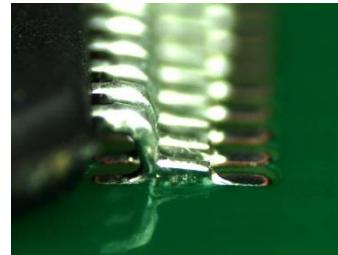
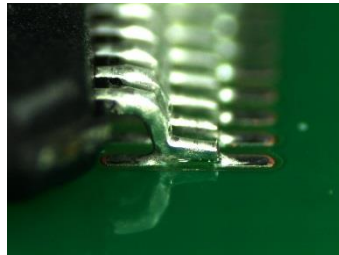
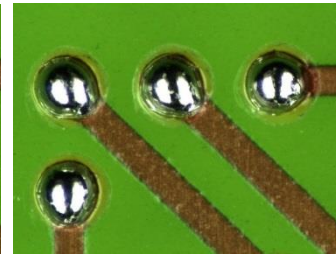
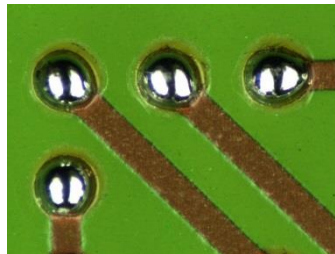
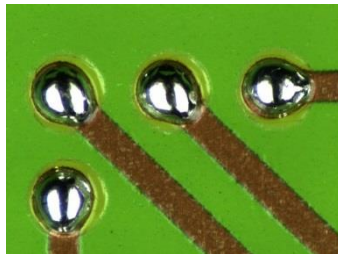
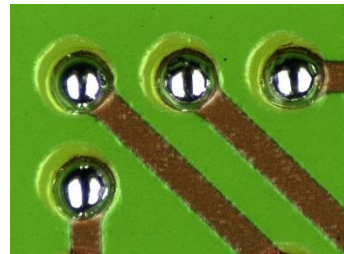
Solder Ball

Solder Ball

Solder Ball

0.5mm CSP56

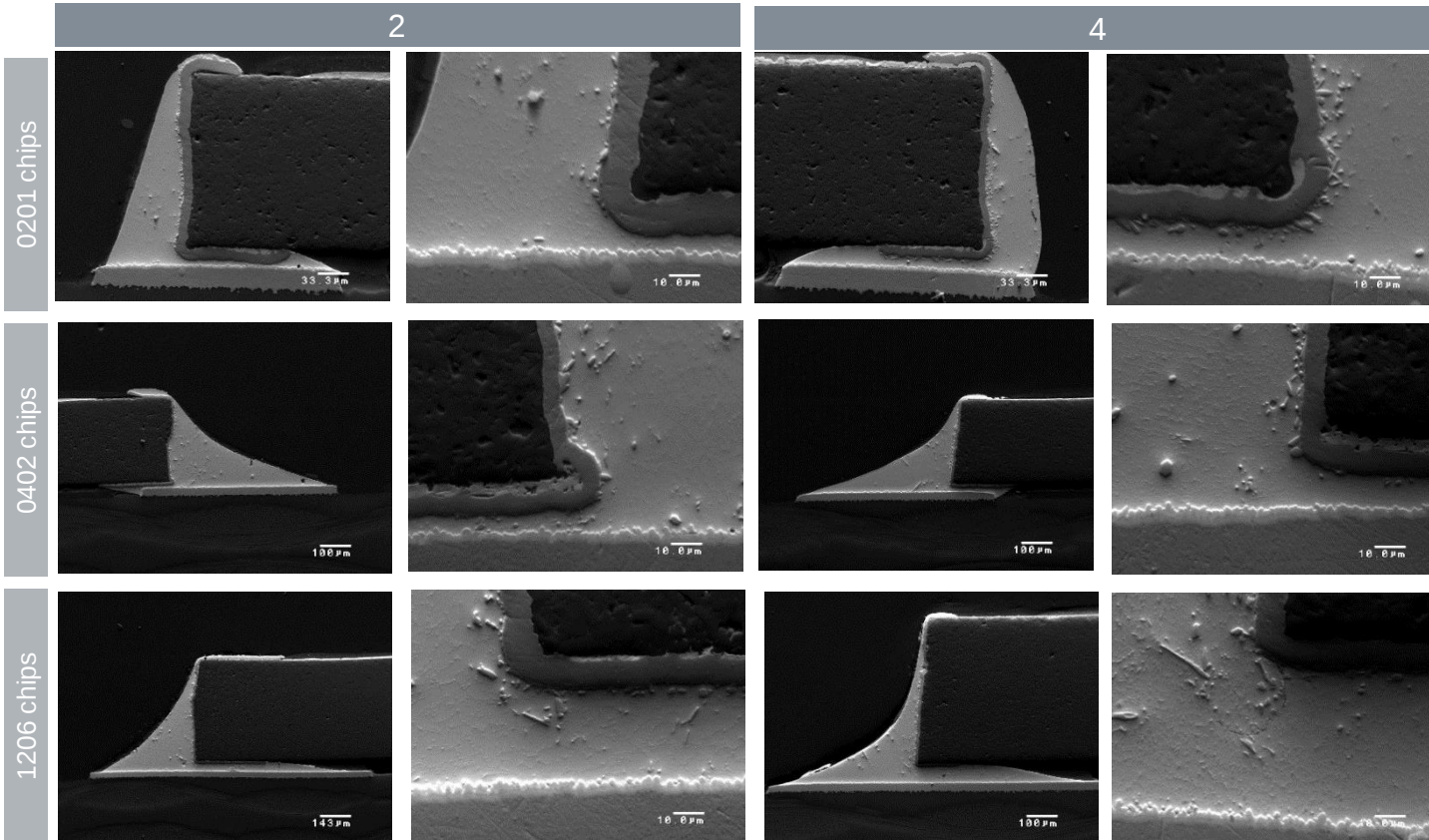
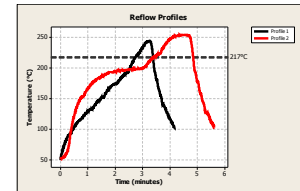
0.4mm TQFP120



# Operating Parameters (Reflow – GC10)

LOCTITE®

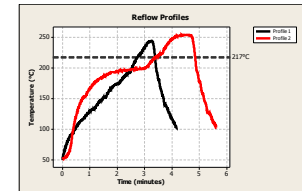
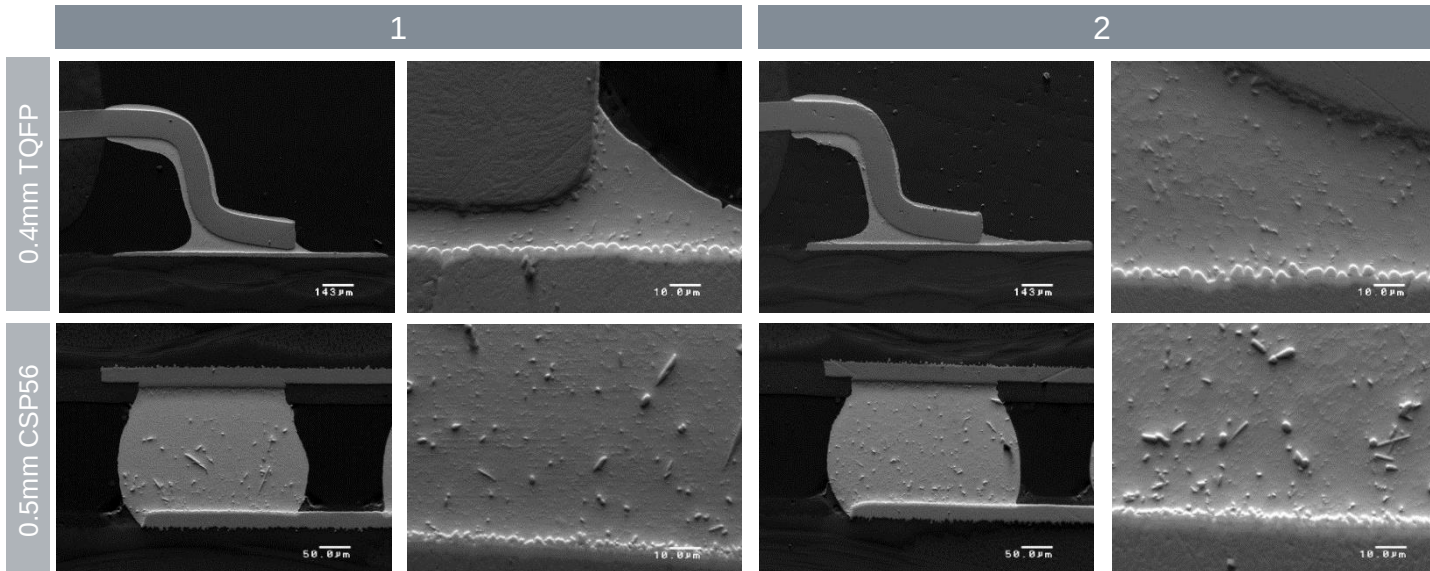
Reflow Profile



# Operating Parameters (Reflow – GC10)

**LOCTITE®**

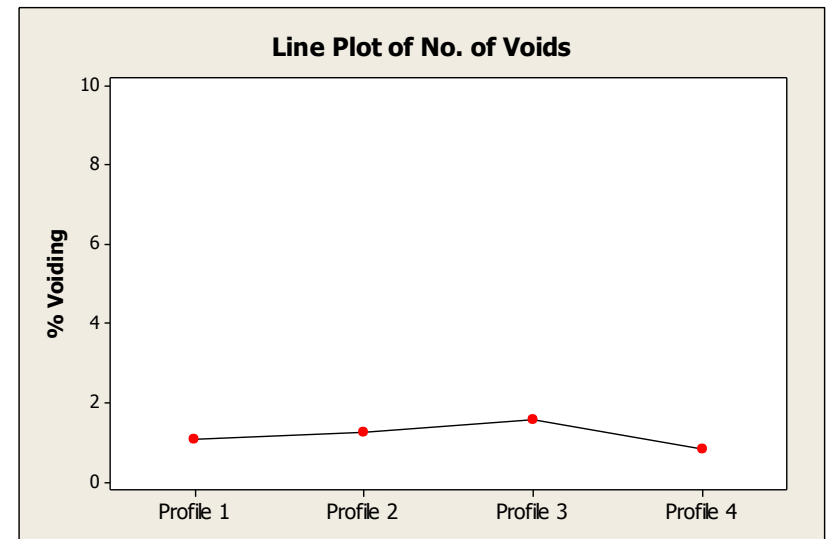
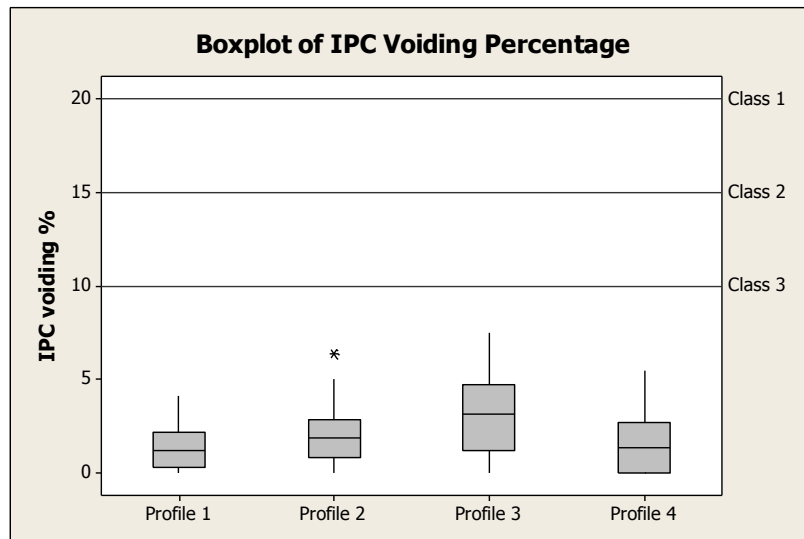
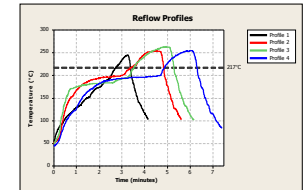
Reflow Profile



# Operating Parameters

## Voiding

- Void performance assessed using 4 different reflow profiles.
- 0.5mm CSP, 120µm stencil
- With component, 0.5mm CSP, SAC305 balls
- GC 10 shows low levels of voiding over a range of profiles
- Void Percentage analysed in accordance with IPC7095B

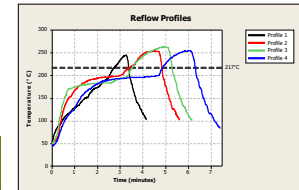
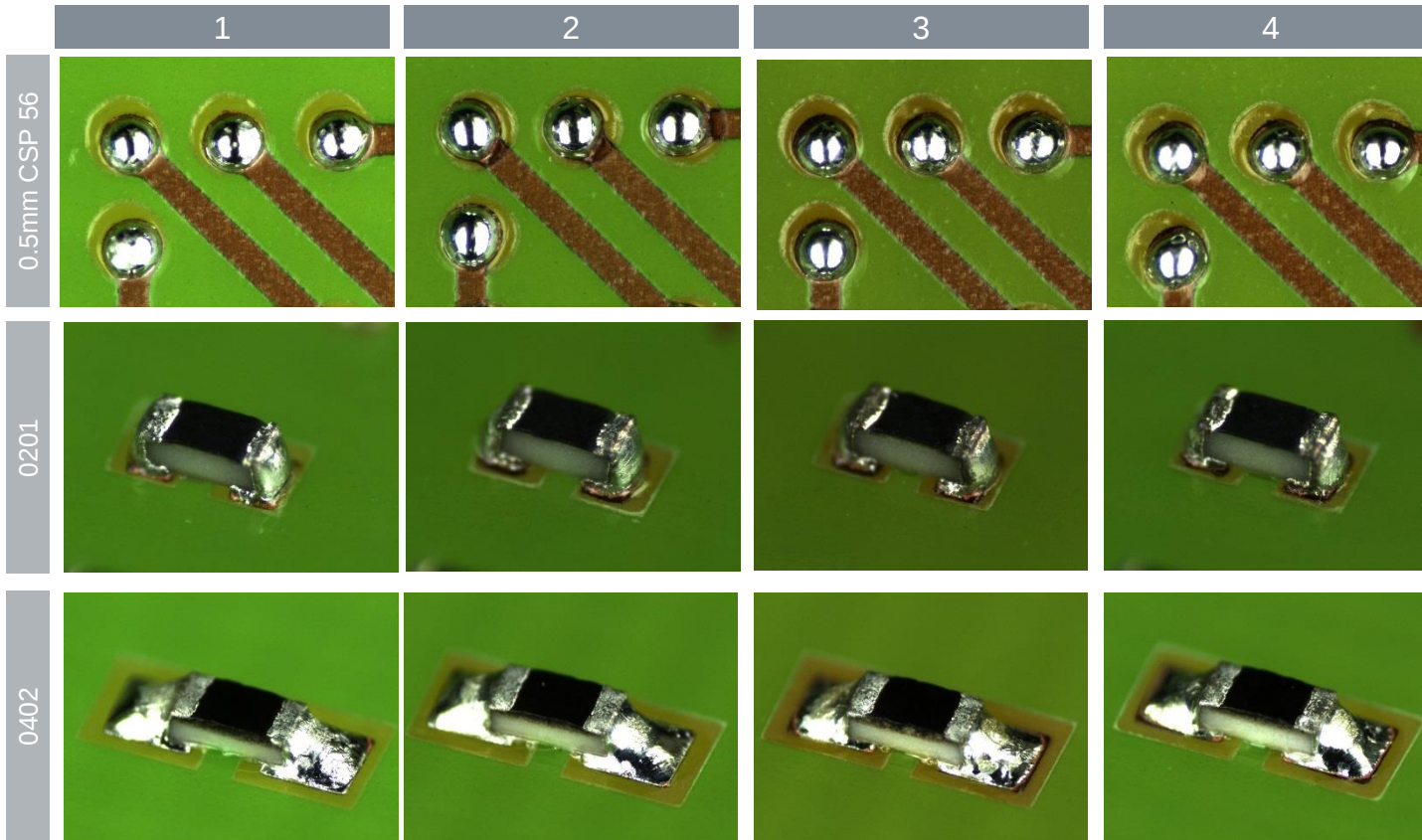


**GC 10 meets IPC7095B class 3**

# Operating Parameters

## 2<sup>nd</sup> side reflow

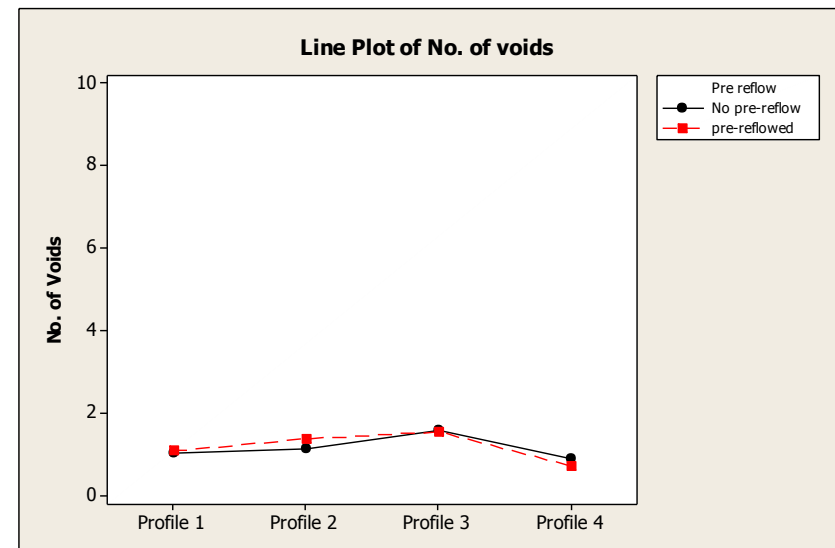
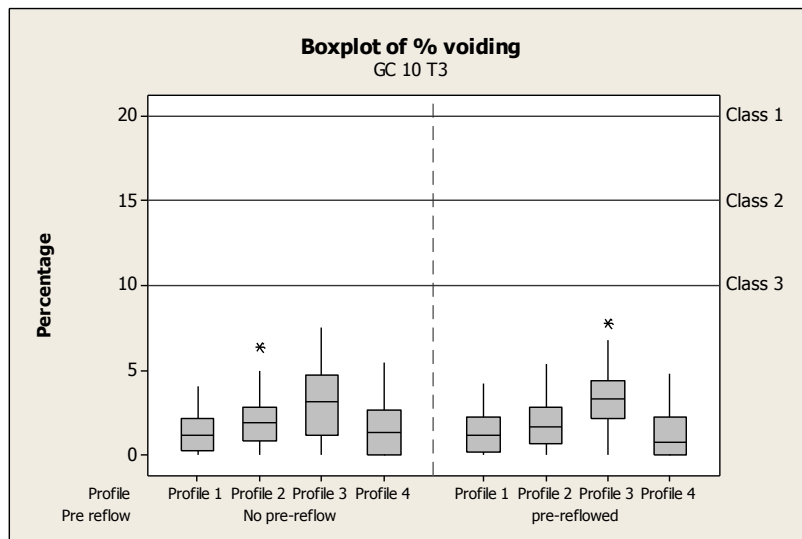
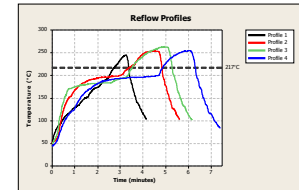
2<sup>nd</sup> second side reflow profile



# Operating Parameters

## Voiding after 2<sup>nd</sup> side reflow

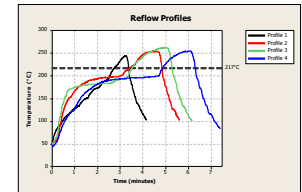
- Void performance assessed using 4 different reflow profiles.
- 0.5mm CSP, 120µm stencil
- With component, 0.5mm CSP, SAC305 balls
- GC 10 shows no deterioration in voiding with pre reflowed boards



**GC 10 meets IPC7095B class 3**

# Operating Parameters

## Pin Testing

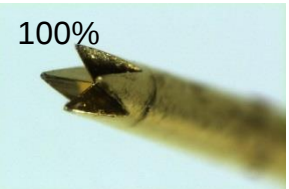
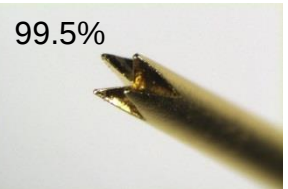
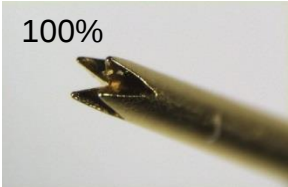
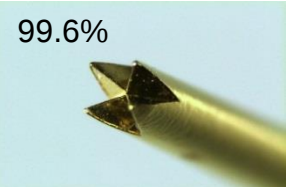
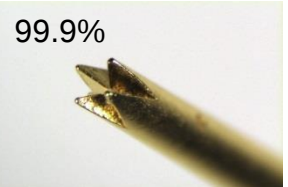
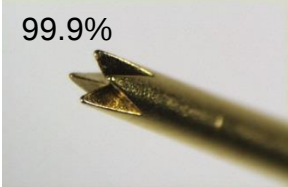
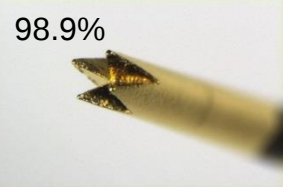
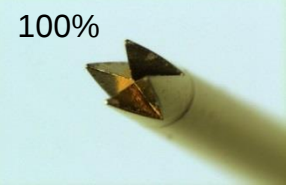
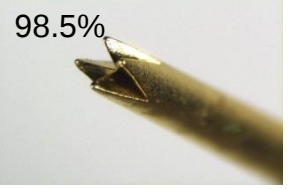


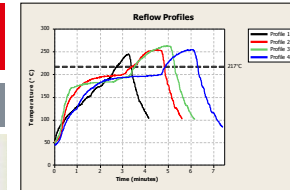
|                   |                                                                |
|-------------------|----------------------------------------------------------------|
| Board             |                                                                |
| Stencil           | 100μm                                                          |
| Pads              | 500 pads per board, 2 boards tested                            |
| Probe             | 0.9mm 4 point plain crown light spring probe 100g spring force |
| Profiles          | 4 reflow profiles                                              |
| No. of reflow     | 1, 2, 3 & 4 passes through oven                                |
| Atmosphere        | Air & 1000ppm O <sub>2</sub>                                   |
| Time after reflow | 1 day, 1 week                                                  |

# Operating Parameters

## Pin Testing

Reflow Profile (% after 1000 tests)

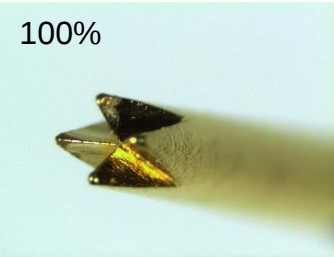
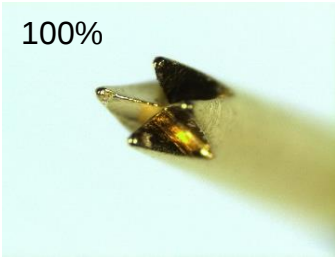
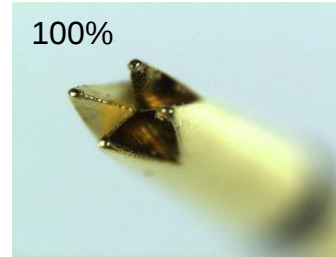
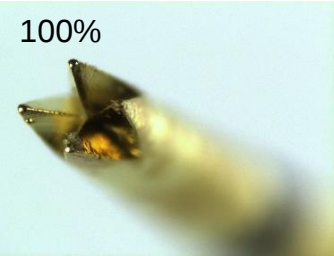
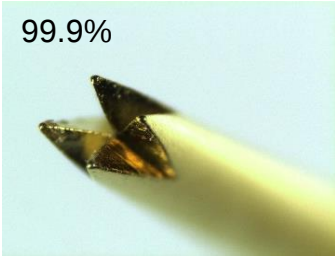
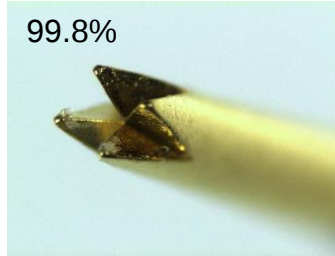
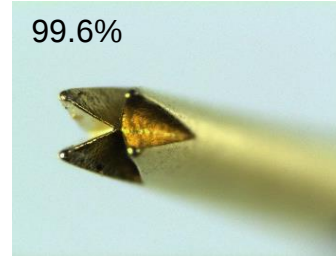
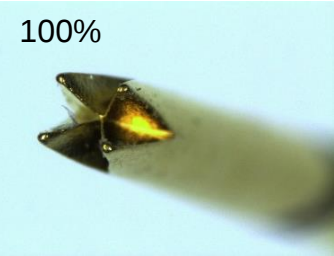
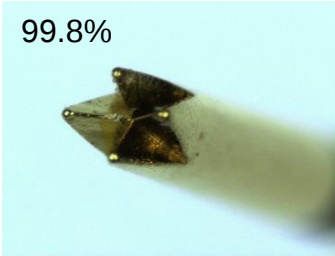
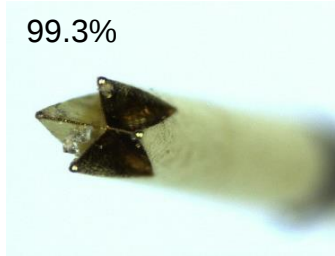
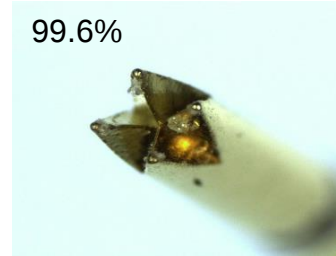
|           | 1                                                                                            | 2                                                                                           | 3                                                                                            | 4                                                                                              |
|-----------|----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| 1 reflow  | 100%<br>    | 100%<br>   | 100%<br>   | 99.5%<br>   |
| 2 reflows | 100%<br>    | 100%<br>   | 99.6%<br>  | 99.9%<br>   |
| 3 reflows | 99.9%<br>  | 100%<br>  | 100%<br>  | 98.9%<br>  |
| 4 reflows | 99.9%<br> | 100%<br> | 100%<br> | 98.5%<br> |

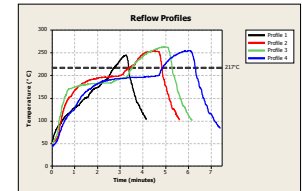


# Operating Parameters

## Pin Testing

Reflow Profile (% after 1000 tests)

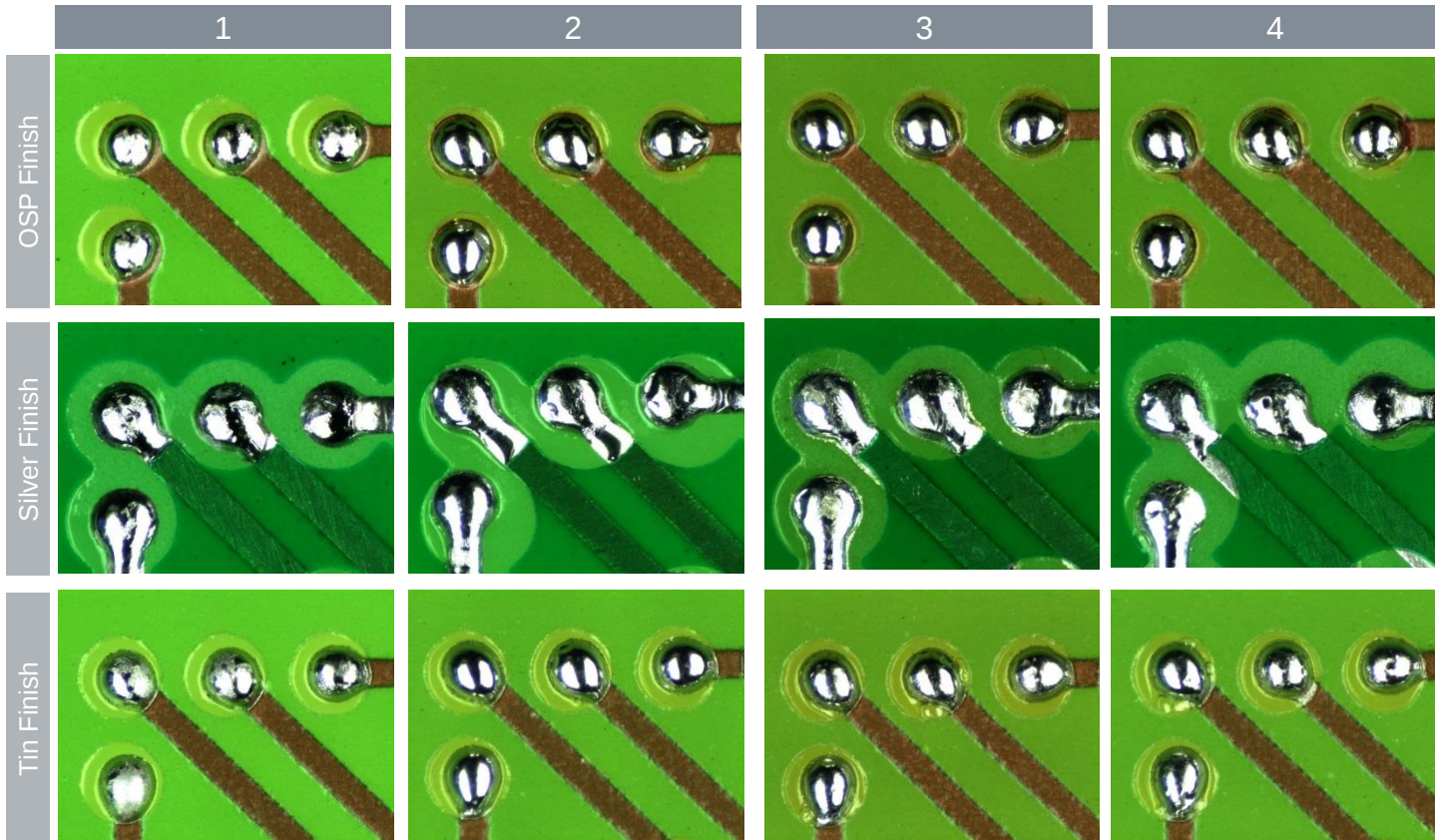
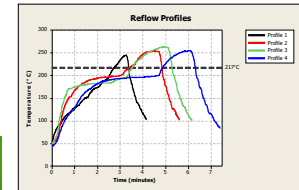
|                            | 1                                                                                          | 2                                                                                           | 3                                                                                            | 4                                                                                             |
|----------------------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Reflowed in N <sub>2</sub> | 100%<br>  | 100%<br>   | 100%<br>   | 100%<br>   |
| 1 day after reflow         | 100%<br>  | 99.9%<br>  | 99.8%<br>  | 99.6%<br>  |
| 1 week after reflow        | 100%<br> | 99.8%<br> | 99.3%<br> | 99.6%<br> |



# Operating Parameters

## Surface Finish

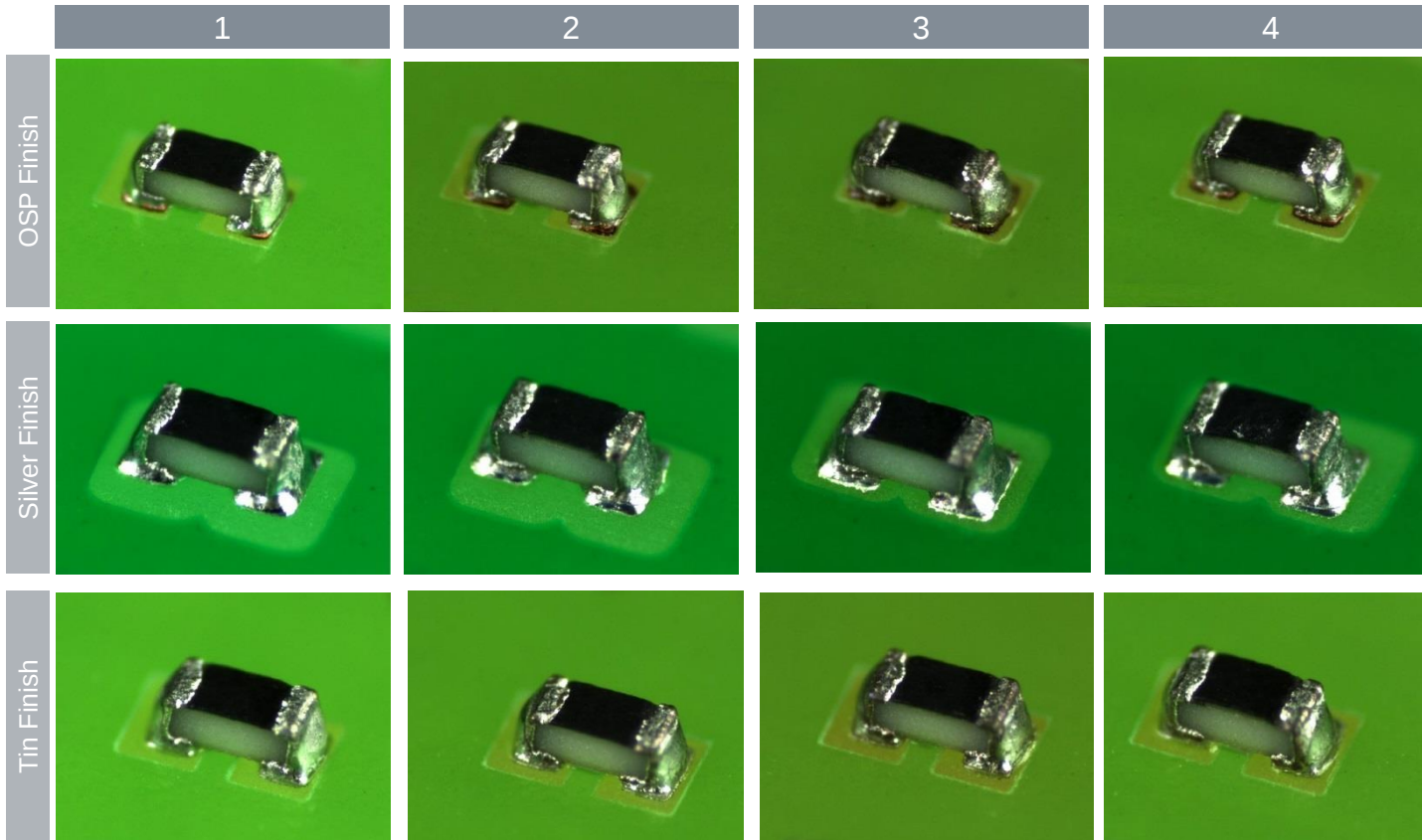
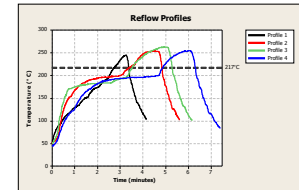
Reflow Profile (0.5mm CSP56)



# Operating Parameters

## Surface Finish

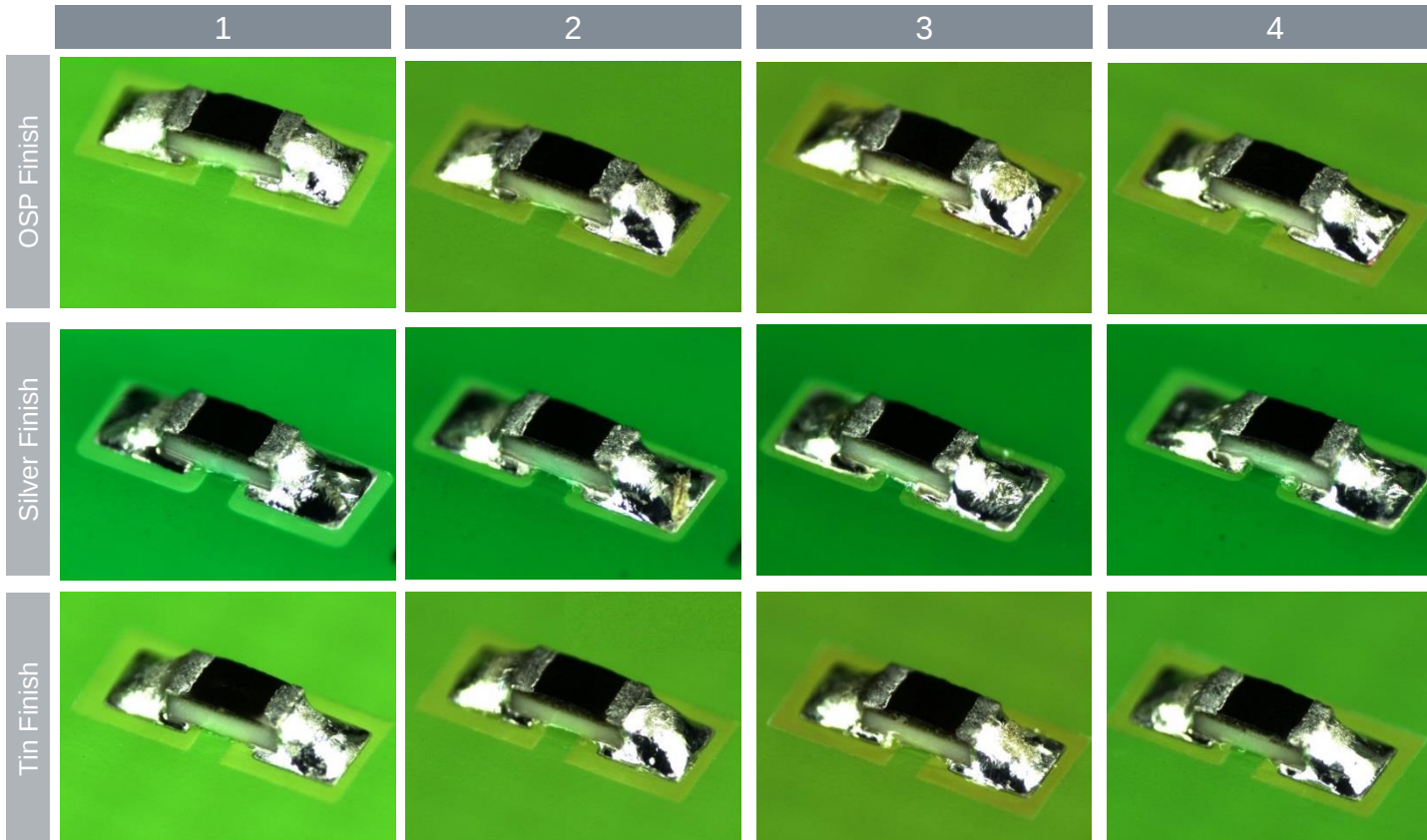
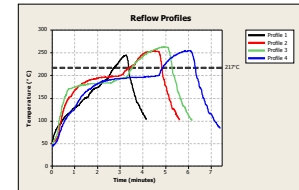
Reflow Profile (0201)



# Operating Parameters

## Surface Finish

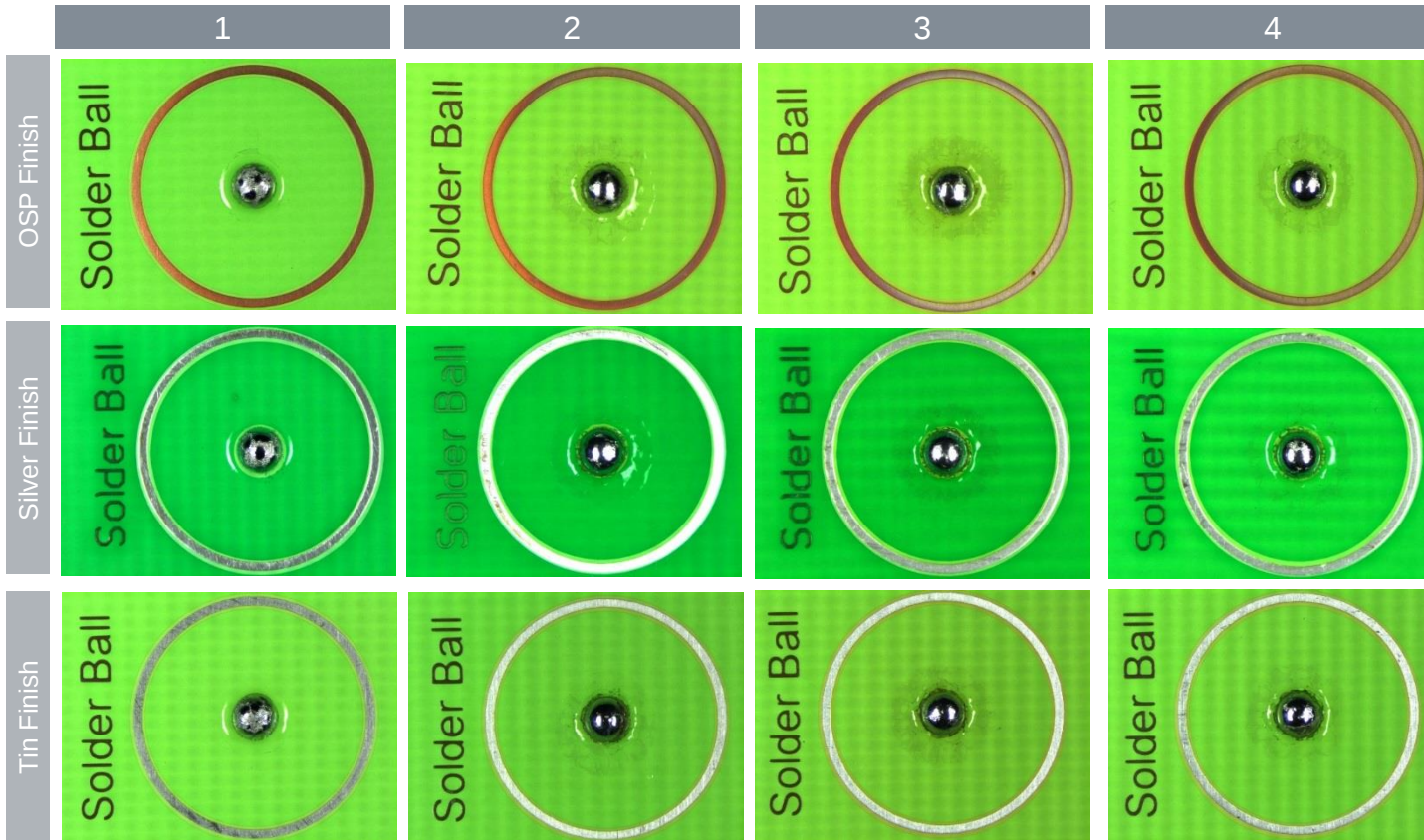
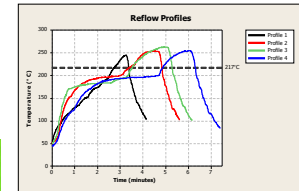
Reflow Profile (0402)



# Operating Parameters

## Surface Finish

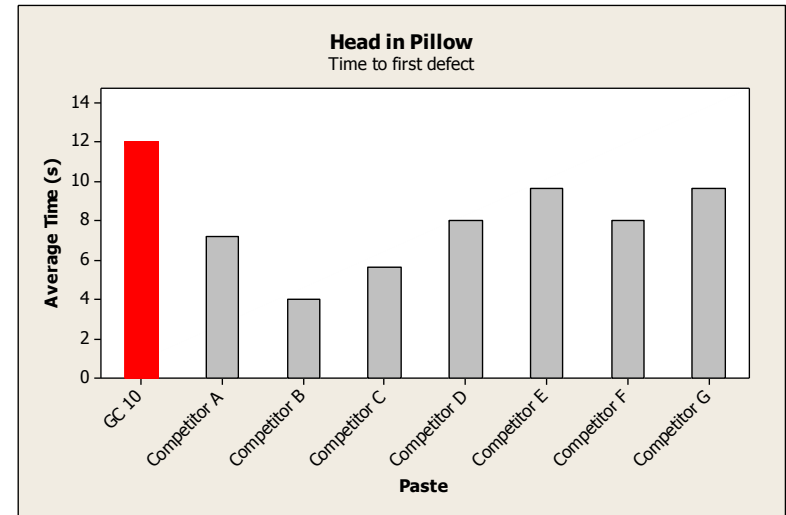
Reflow Profile (6.5mm overprinted solder ball)



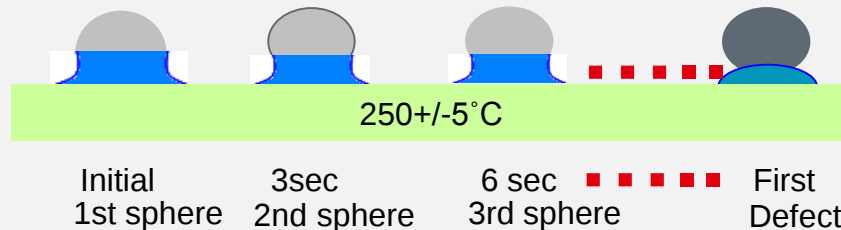
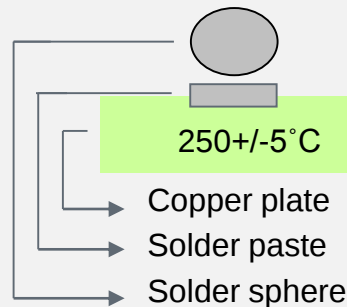
# Reliability and Specification Testing

## Head in Pillow Test

- Print solder paste on a Cu plate, 0402 pad, stencil thickness 125µm.
- When the solder paste starts to melt, place a solder sphere (SAC305, 0.76mm diameter) on the printed solder paste
- Place another sphere after 3sec, 6 sec, 9sec... until the solder sphere no-longer coalesces
- Flux activity at elevated temperatures – up to 20% longer than industry standard – helping to reduce HiP



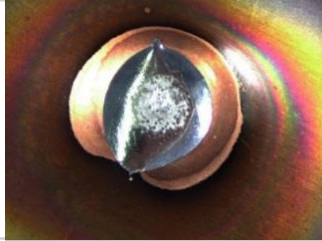
Place a solder sphere onto printed paste



# Reliability and Specification Testing

## J-STD- 004B

**LOCTITE®**

| Standard            | Test                          | Result |                                                                                     |
|---------------------|-------------------------------|--------|-------------------------------------------------------------------------------------|
| ANSI/<br>J-STD-004B | Cu Corrosion                  | Pass   |  |
|                     | Cu Mirror                     | Pass   |  |
|                     | Halogen                       | Pass   | (no added halogen)                                                                  |
|                     | Surface Insulation Resistance | Pass   | $6.0 \times 10^{11}$ Ohms after 7days                                               |
|                     | Electromigration              | Pass   | $5.0 \times 10^{10}$ Ohms after 21days                                              |

**GC 10 J-STD-004B classification ROL0**

# Reliability and Specification Testing

## 3<sup>rd</sup> Party Testing

- SGS report for GC 10
- Sample reflowed flux residue
- Reference EN14582/IC Analysis
- To meet halogen free requirements
- Br<900ppm, Cl <900ppm, and combined <1500ppm

- Halogen – Fluorine - ND
- Halogen – Chlorine - ND
- Halogen – Bromine – ND
- Halogen – Iodine – ND



### Test Report

No. : CE/2015/61413

Date : 2015/06/12

Page: 2 of 4

HENKEL CORPORATION  
14000 JAMBOREE ROAD, IRVINE, CALIFORNIA, 92606 U.S.A.



#### Test Result(s)

PART NAME No.1 : GRAY PASTE

| Test Item(s)                                   | Unit  | Method                                                            | MDL | Result |
|------------------------------------------------|-------|-------------------------------------------------------------------|-----|--------|
|                                                |       |                                                                   |     | No.1   |
| <b>Halogen</b>                                 |       |                                                                   |     |        |
| Halogen-Fluorine (F)<br>(CAS No.: 14762-94-8)  | mg/kg | With reference to BS EN 14582:2007. Analysis was performed by IC. | 50  | n.d.   |
| Halogen-Chlorine (Cl)<br>(CAS No.: 22537-15-1) | mg/kg |                                                                   | 50  | n.d.   |
| Halogen-Bromine (Br)<br>(CAS No.: 10097-32-2)  | mg/kg |                                                                   | 50  | n.d.   |
| Halogen-Iodine (I)<br>(CAS No.: 14362-44-8)    | mg/kg |                                                                   | 50  | n.d.   |

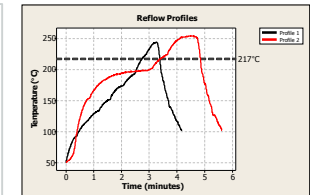
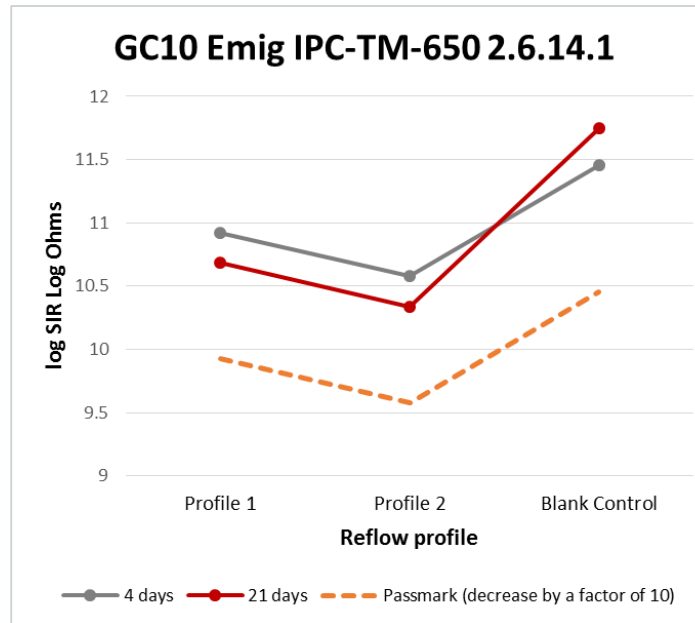
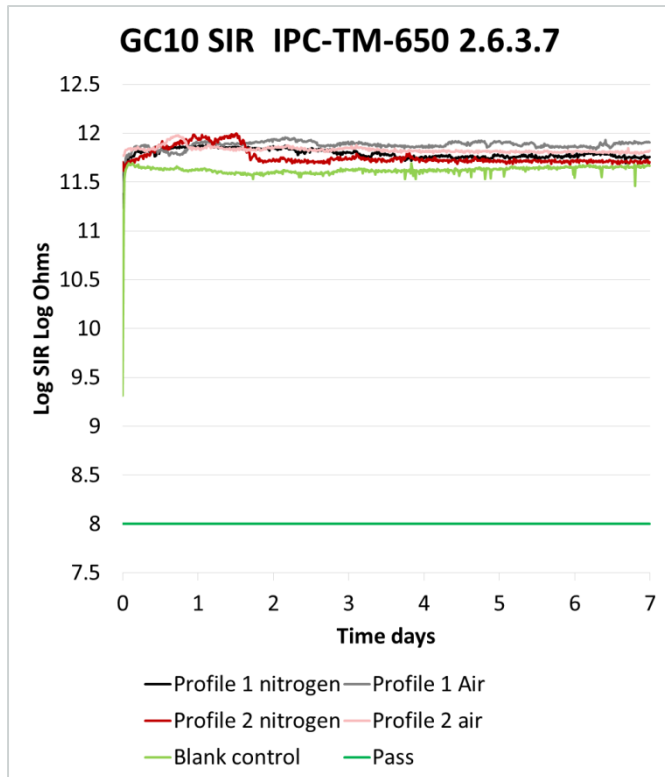
#### Note :

1. mg/kg = ppm; 0.1wt% = 1000ppm
2. n.d. = Not Detected
3. MDL = Method Detection Limit

**GC 10 has no detectable halogen and is designated as halogen free**

# Reliability and Specification Testing

## IPC J-STD 004B



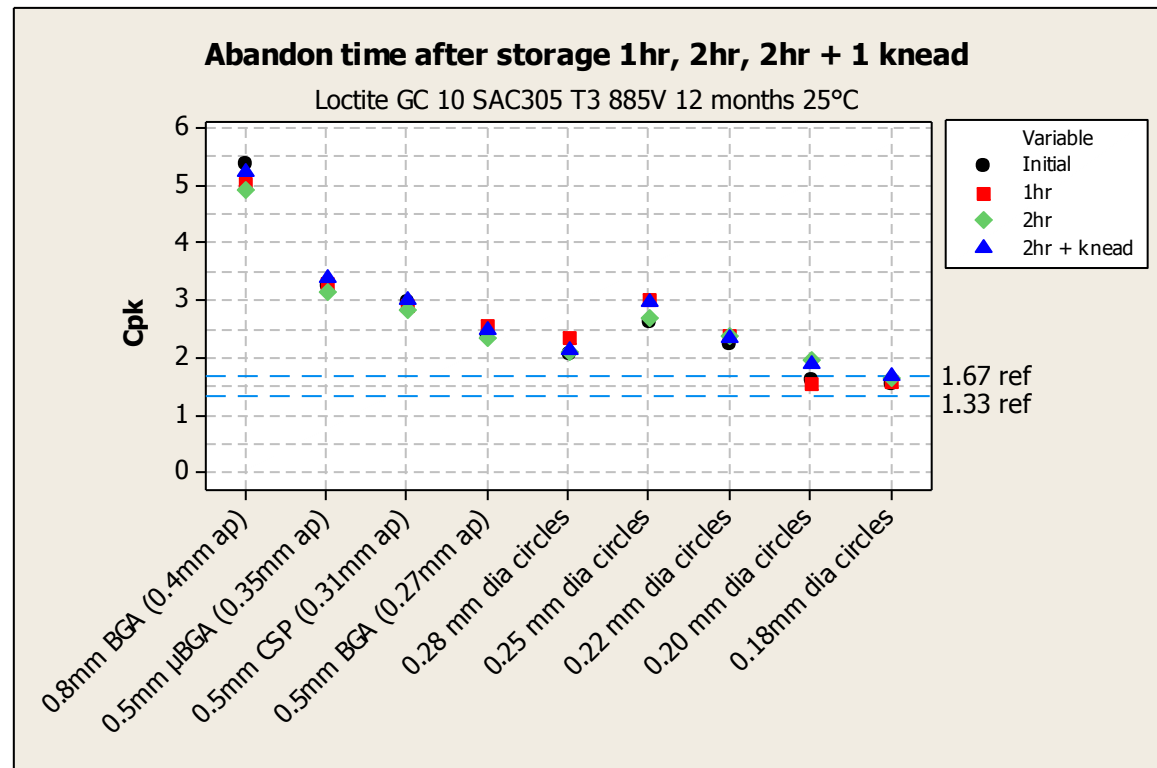
# Contents

1. Performance Summary
2. Introduction: Properties, Features & Benefits
3. Operating Parameters
  - Printing: Process Window
  - Printing: Continuous and Abandon Time Testing
  - Slump Testing
  - Tack-Life Force
  - Reflow Process Window
  - Reflow Performance Testing
  - Voiding Data
4. Reliability and Specification Testing
- 5. Operating Parameters: Storage**
  - Printing & Reflow Performance
6. Product Summary

# Operating Parameters: Storage

## Printing After Storage 12 months 25°C

- **Print Capabilities**
- Excellent print capability after storage for 12 months @ 25°C
- No knead cycle required after 2hrs abandon down to 0.22mm round apertures

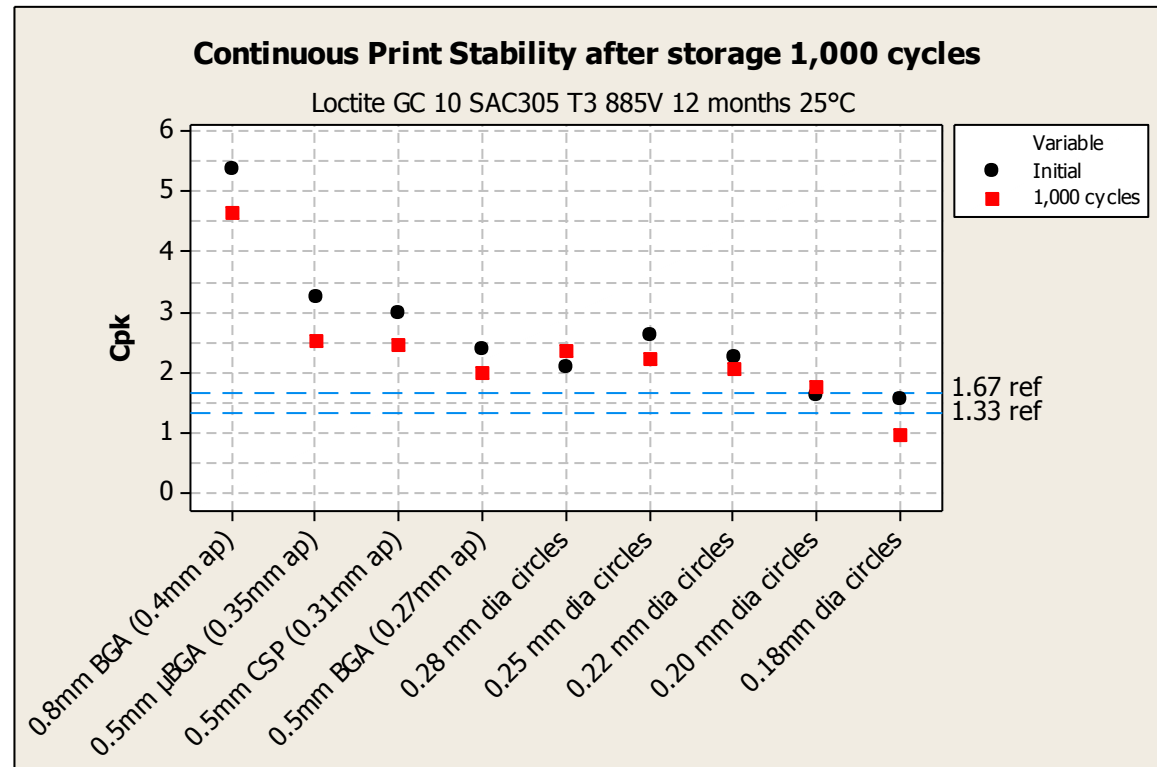


0.8mm BGA – 0.18mm round apertures, 120µm stencil thickness, 60mm/s,  
Fast separation, 250mm squeegee, 10kg

# Operating Parameters: Storage

## Printing After Storage 12 months 25°C

- **Print Capabilities**
- Excellent print capability after storage for 12 months @ 25°C
- Excellent print performance after 1000 cycles down to 0.22mm round apertures

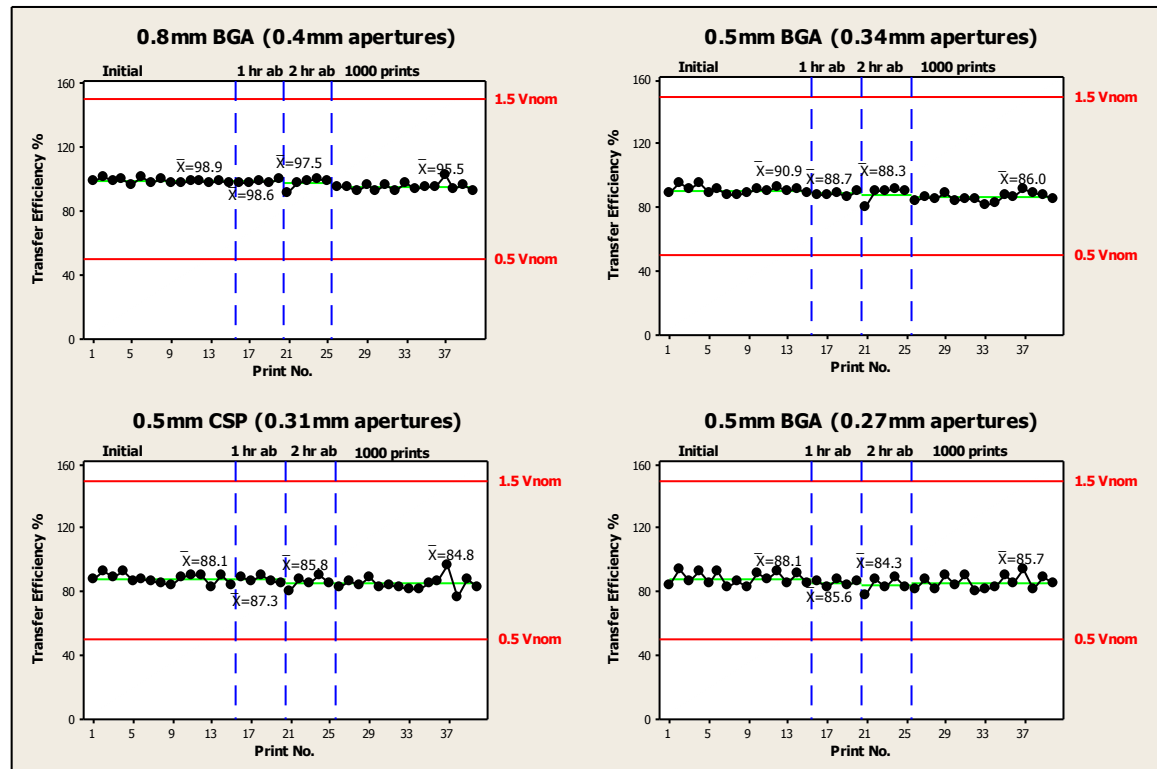


0.8mm BGA – 0.18mm round apertures, 120µm stencil thickness, 60mm/s,  
Fast separation, 250mm squeegee, 10kg

# Operating Parameters: Storage

## Printing After Storage 12 months 25°C

- **Transfer Efficiencies**
- Excellent print capability after storage for 12 months @ 25°C
- No knead cycle required after 2hrs abandon
- Excellent print performance after 1000 cycles

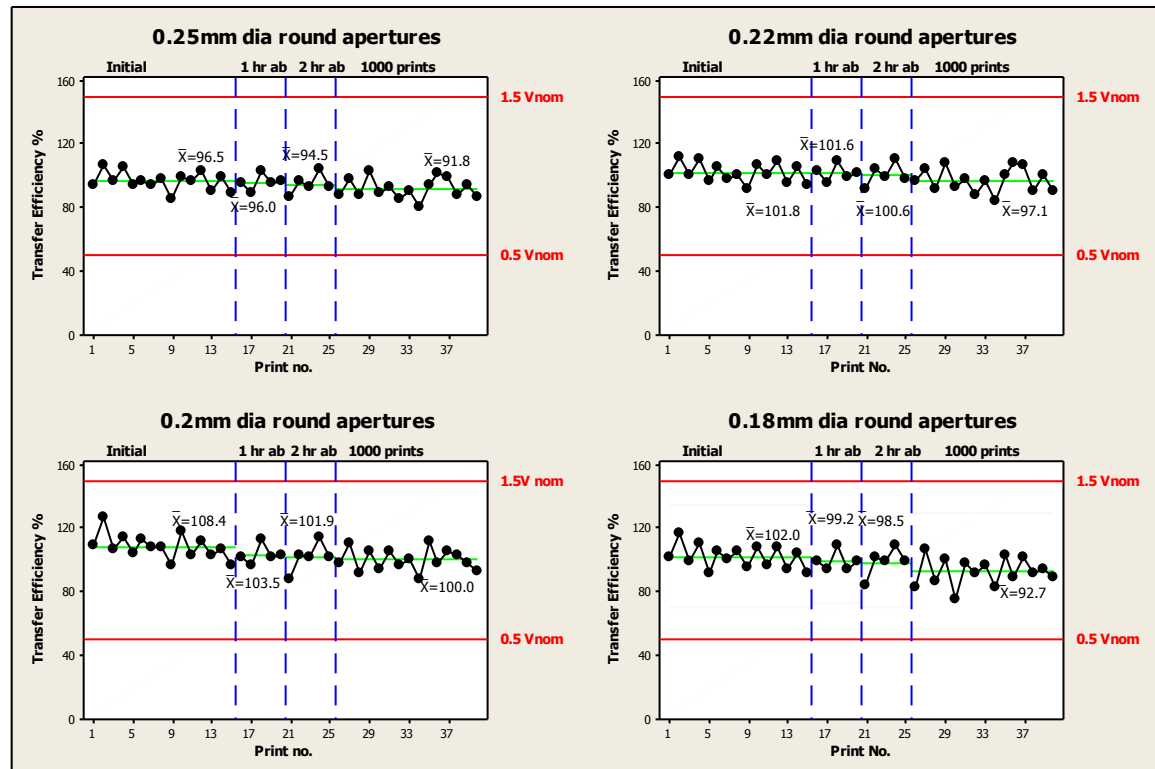


0.8mm BGA – 0.5mm BGA, 120 $\mu$ m stencil thickness, 60mm/s,  
Fast separation, 250mm squeegee, 10kg

# Operating Parameters: Storage

## Printing After Storage 12 months 25°C

- **Transfer Efficiencies**
- Excellent print capability after storage for 12 months @ 25°C
- No knead cycle required after 2hrs abandon
- Excellent print performance after 1000 cycles

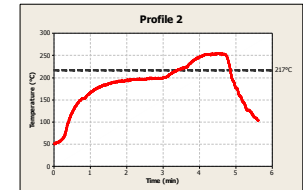
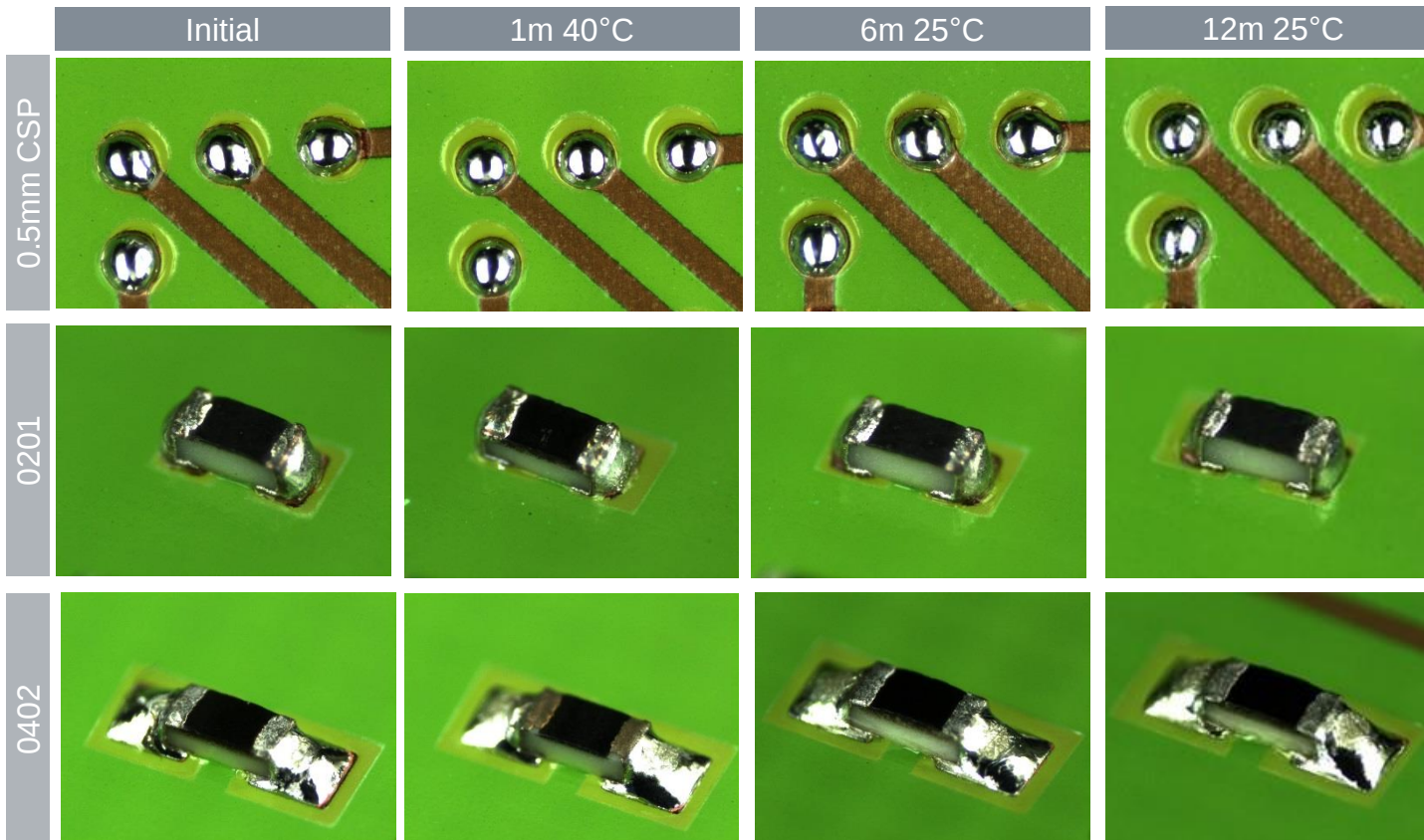


0.25mm – 0.18mm round apertures, 120 $\mu$ m stencil thickness, 60mm/s,  
Fast separation, 250mm squeegee, 10kg

# Operating Parameters: Storage

## Reflow After Storage to 12months 25°C

After Paste storage



# Contents

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  - Reflow Performance Testing
  - Voiding Data
4. Reliability and Specification Testing
5. Operating Parameters: Storage
  - Printing & Reflow Performance
- 6. Product Summary**

# GC 10: Performance Summary

## Flux

- Halogen-free flux: passes IC with pretreatment IPC-TM-650 2.3.34/EN14582
- Halogen-free flux classification: ANSI/J-STD-004 Rev. B for a type ROL0 classification

## Paste

- Suitable for printing up to 125mm/s (5"/s)
- Optimized for long hot soak reflow profiles
- Excellent coalescence in air & nitrogen atmosphere
- Excellent humidity resistance
- Excellent solderability on challenging surface finishes, including CuNiZn
- Colourless residues for easy post-reflow inspection
- Long 12 month shelf-life when stored below 25°C

# Thank you!



**LOCTITE®**



Excellence is our Passion