## the product:

A world class lead free, high reliability no-clean solder paste with best in class in-circuit pin testability

# ALPHA® OM-338 PT Solder Paste

product guide

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# Welcome to the ALPHA® OM-338 PT Product Guide

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**Introducing ALPHA® OM-338 PT, a more pin testable variation of the OM-338 lead-free solder paste family.**

Cookson considered what you need from a lead free solder paste – high yield fine feature printing with a wide process window, excellent reflow yields with both straight ramp and soak profiles, high electrical reliability **AND world class in circuit pin testability.**

OM-338 PT passed every major Surface Insulation and Electrochemical Migration test, including Bellcore, IPC, JIS and the HP protocols.

With our local teams of technical experts, you can count on Cookson's complete support whenever and however you need us. It's the kind of support you would expect from a company that's remained dedicated to serving the needs of the Global circuit assembly market for over 50 years.

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# Performance Summary

| Process Benefit | OM-338 PT Benefit | Performance Capability |
| --- | --- | --- |
| Print Process Window | Fine Feature Print Definition | Excellent print definition and consistant volumetric performance to 0.25mm (10 mil) circles and 0.3mm (12 mil) pitch rectangular QFP pads. |
| | Tack Life | >24 hours |
| | Temperature Window | Capable of printing in temperatures from 20°C to ≥ 30°C (68°F to ≥ 86°F) |
| | Print Consistancy | Repeatable volume deposition and low volume variability (CpK > 2.0) on 0.25mm (10 mil) circles. |
| | Print Speed Range | 25mm/second to 150mm/second (1 inch/second to 6 inches/second) down to 0.25mm (10 mil) circles and .3mm (12 mil) pitch QFP pads. |
| Reflow Yield | Pin Testability | >98% Yield (<2% False Negatives) Best in Class |
| | Resistance to Voids | Exceeds requirements of IPC 7095 Class III using soak reflow profile. Class II with straight ramp profiles. |
| | Resistance to Hot and Cold Slump | Exceeds the requirements of IPC J-STD-005 and JIS-Z-3284 for hot and cold slump. |
| | Flux Residue Cosmetics | Clear, colorless residue. |
| Electrical Reliability | SIR | Meets/Exceeds JIS, IPC and Bellcore Requirements |
| | Electromigration Resistance | Meets/Exceeds JIS, Bellcore and HP EL-EN 861-00 Requirements |
| | J-STD-004A Classification | ROL0 |
| | Halide Content | Halide Free |

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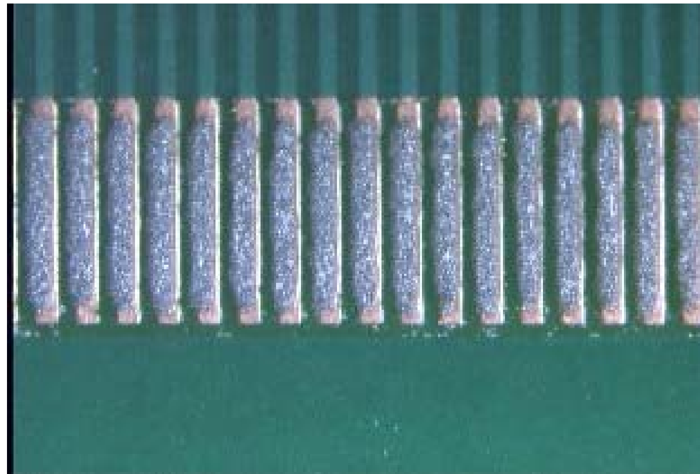
# Fine Feature Print Definition



**0.3mm (12mil) pitch QFPs* Using Type 3 Powder**

## Delivers High Fine Feature Print Yields

- Excellent print definition and consistent volumetric performance to 0.30mm (12mil) squares and 0.25mm (10mil) pitch circles
- Type 3 Powder Capable for Better Economy

*10 cm/sec (4in/sec), 0.26kg/cm (1.5 lbs/in) squeegee pressure, 0.125mm (5 mil) stencil



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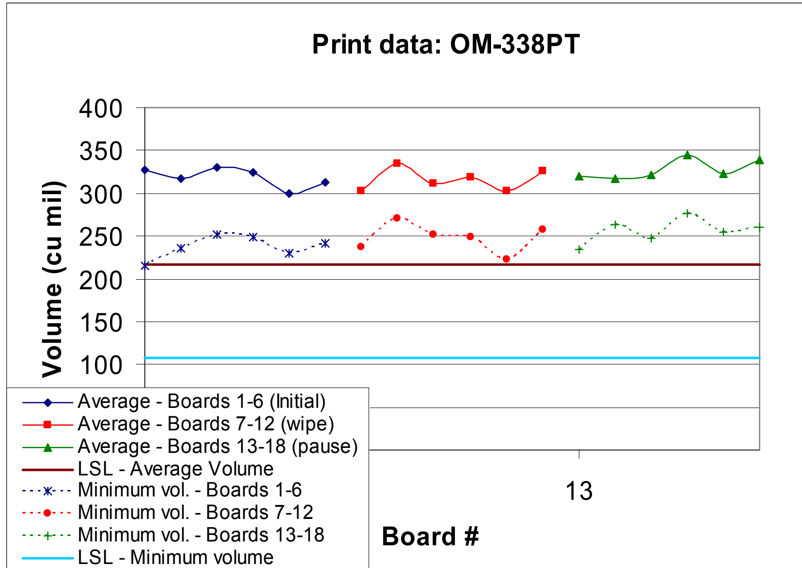
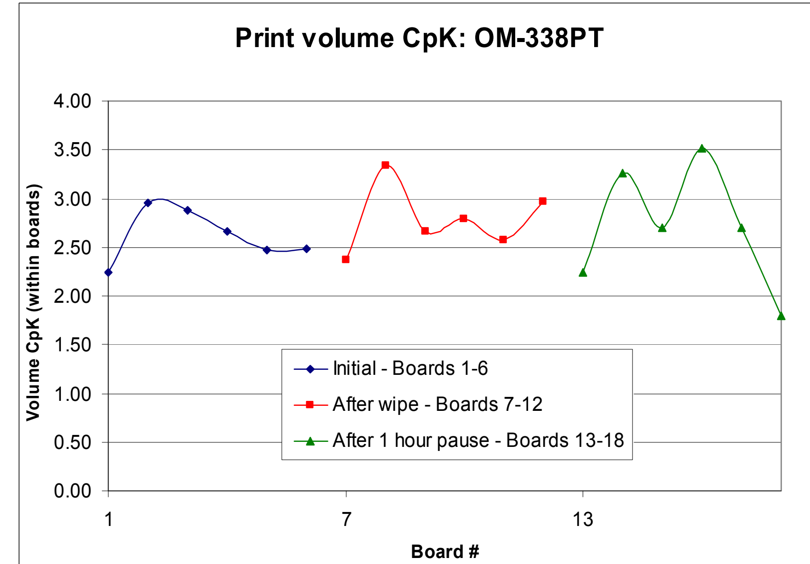
# OM-338 PT solder paste

Print Performance

## Paste Volume, Repeatability- Room Temperature (25° C)




**Repeatable volumes after stencil wipe and 1 hour response to pause**

- Continuous monitoring of paste volume over time demonstrates ALPHA OM-338 PT's consistent printability

- **High Volume Deposits**
- **High Level of Volume Repeatability**

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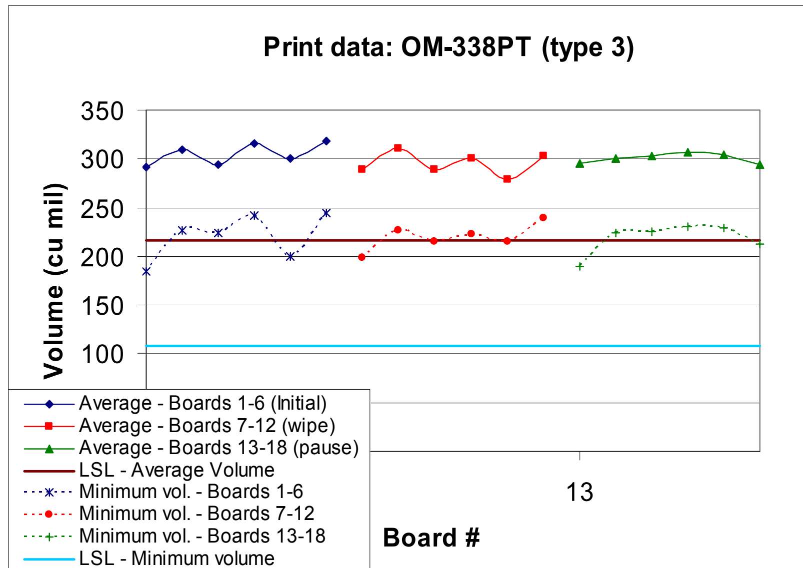
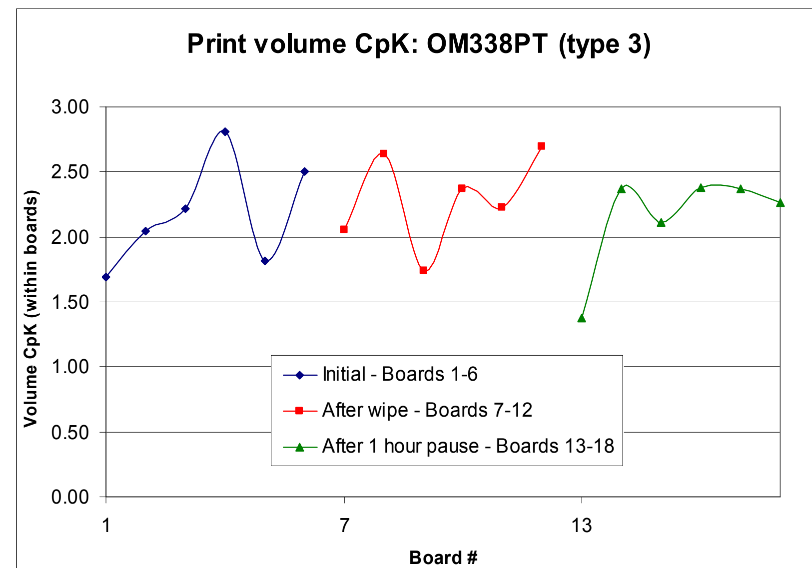
# OM-338 PT solder paste

Print Performance

## Paste Volume, Repeatability- Low Temperature (20° C)




**Repeatable volumes after stencil wipe and 1 hour response to pause**

- Continuous monitoring of paste volume over time demonstrates ALPHA OM-338 PT's consistent printability

·**High Volume Deposits**

·**High Level of Volume Repeatability**

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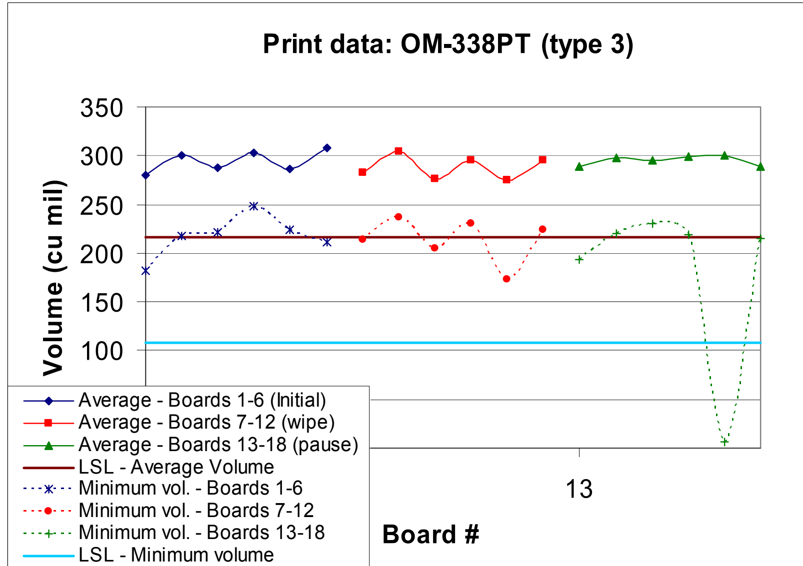
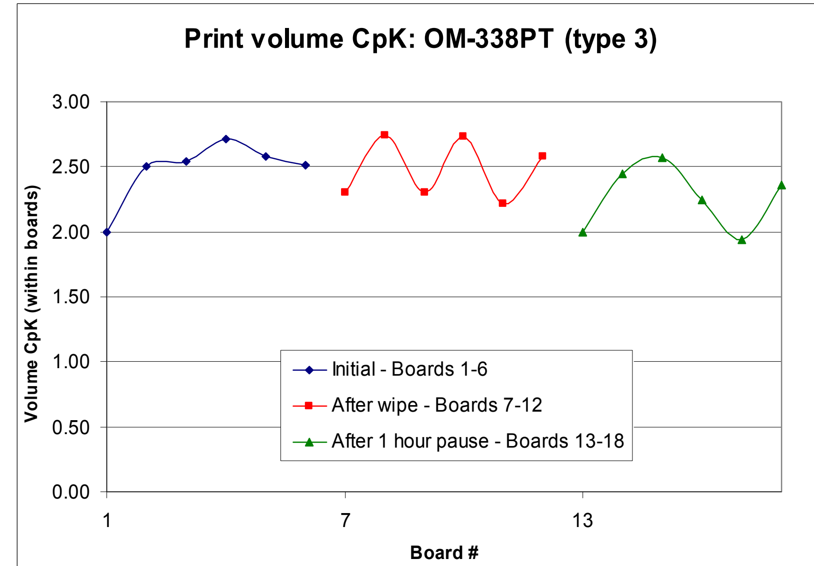
# OM-338 PT solder paste

Print Performance

## Paste Volume, Repeatability- High Temperature (30° C)




**Repeatable volumes after stencil wipe and 1 hour response to pause**

- Continuous monitoring of paste volume over time demonstrates ALPHA OM-338 PT's consistent printability

- **High Volume Deposits**
- **High Level of Volume Repeatability**

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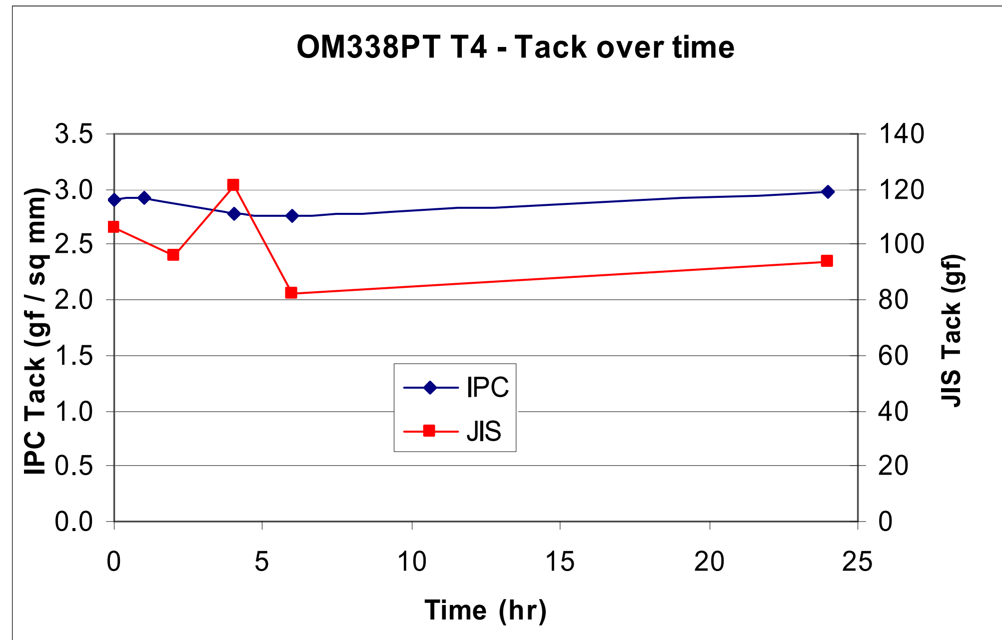
# Stencil Life – Tack Life




**Maintains consistent tack strength over 24 hours**

JIS Classification

- 80 gf and above at 24 hours

IPC Classification

- Less than 1 unit change in tack when tested at a humidity range of 25% - 75% RH measured over a 8 hour period

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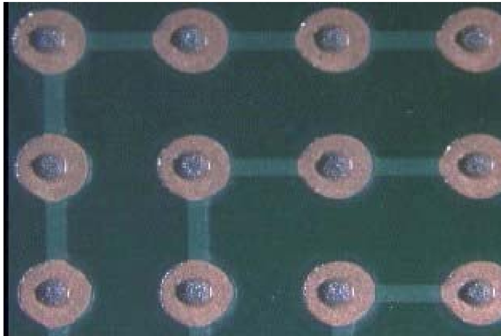
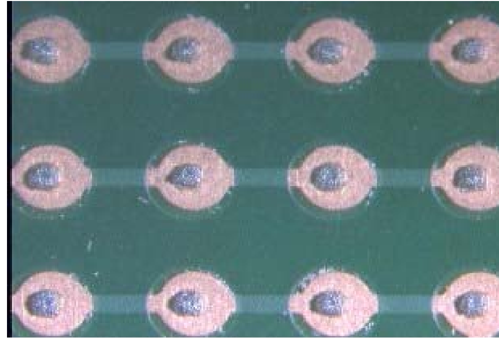
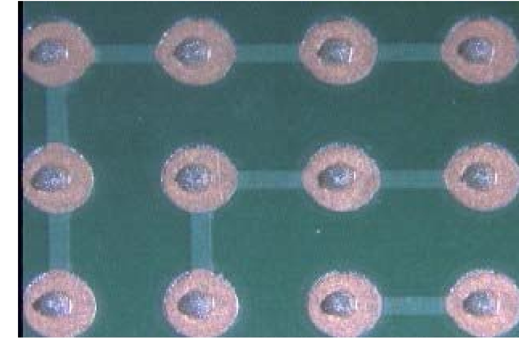
# Print Consistency Over Range of Print Speeds-.010” (.25mm) Circles



**Print speed = 1 in./sec (25.4mm/sec)**
**Squeegee pressure = 1 lb/linear in. (0.18 Kg/cm)**



**Print speed = 4 in./sec (100mm/sec)**
**Squeegee pressure = 1.25lb/linear in. (0.22 Kg/cm)**



**Print speed = 6 in./sec (150mm/sec)**
**Squeegee pressure = 1.5 lb/linear in. (0.26 Kg/cm)**

**Wide print speed capability allows for maximum throughput**

- Repeatable volume deposition and low variability based on theoretical aperture volumes
- Faster print speed reduces print cycle time
- This allows printer to perform secondary functions without affecting SMT line beat rate
  - Under stencil wipe
  - 2D vision inspection

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# OM-338 PT solder paste

Print Performance

## Print Consistency Over Range of Print Speeds-.012" Pitch (.30mm) QFP Pads

**Print speed = 1 in./sec (25.4mm/sec)**
**Squeegee pressure = 1 lb/linear in.**
**(0.18 Kg/cm)**

**Print speed = 4 in./sec (100mm/sec)**
**Squeegee pressure = 1.25lb/linear in.**
**(0.22 Kg/cm)**

**Print speed = 6 in./sec (150mm/sec)**
**Squeegee pressure = 1.5 lb/linear in.**
**(0.27 Kg/cm)**

**Wide print speed capability allows for maximum throughput**

- Repeatable volume deposition and low variability based on theoretical aperture volumes
- Faster print speed reduces print cycle time
- This allows printer to perform secondary functions without affecting SMT line beat rate
  - Under stencil wipe
  - 2D vision inspection

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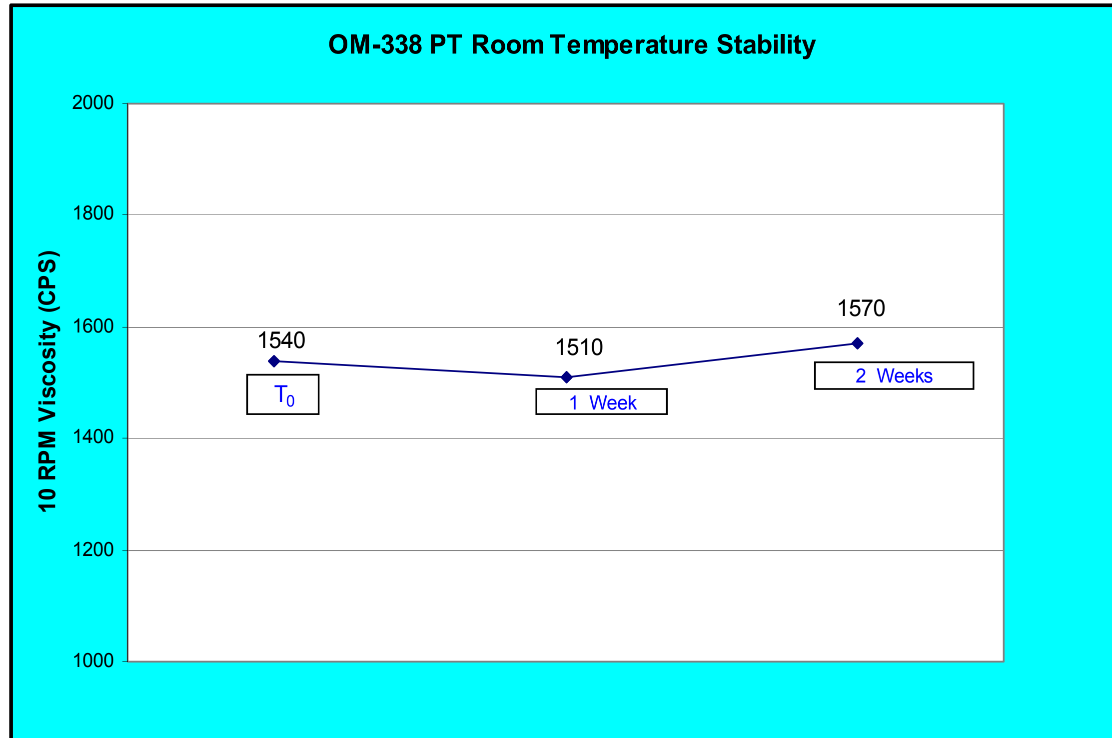
Print Performance

## Viscosity Stability




2 Weeks Room Temperature Stability (25°C; 77°F)

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# OM-338 PT solder paste

Post-Reflow Cosmetics

## Pin Testability

**High first pass strike rate (>98%) under demanding conditions**

- Pin Tip: Sharp Chisel
- Pin Force: 6.5 oz (0.18 Kg)
- Point 1: 0.040” (1.01mm) pad
- Point 2: 0.028” (0.71mm) pad
- Pad Finishes: HASL and Entek® OSP

| Resistance (Ω) | Point 1 | Point 2 |
|---|---|---|
| < 5 | 1000 | 990 |
| 5 – 10 | 0 | 2 |
| 10 – 20 | 0 | 0 |
| 20 – 50 | 0 | 0 |
| 50 – 100 | 0 | 0 |
| 100 – 200 | 0 | 0 |
| 200 – 500 | 0 | 0 |
| 500 – 1000 | 0 | 0 |
| 1000 - 2000 | 0 | 0 |
| > 2000 | 0 | 8 |

**Performance Indicator**

- Minimal residue contamination of pins helps to eliminate false negatives.

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# Reflow Process Guidelines

| *Parameter* | *Guideline* | *Additional Information* |
|---|---|---|
| Atmosphere | **Air or $N_2$** | Mass production verification both in air and $N_2$. |
| SnAgCu alloy melting ranges.<br>Lower temperature=solidus;<br>higher temperature = liquidus | **SAC305: 217 – 220 ℃**<br>**SAC405: 217 – 225 ℃**<br>**SAC387: 217 – 220 ℃** | Use for reflow above liquidus setting |
| | | |
| ***Profile General Guideline (Typical for SAC305)*** | | |
| **Setting Zone** | **Optimal Dwell Period** | **Extended window** |
| 40$^{o}$C to 220$^{o}$C | **3 min – 3:15** | < 3:30 min. |
| 130$^{o}$C to 220$^{o}$C | **1:30 to 1:40** | < 2:15 min. |
| 170$^{o}$C to 220$^{o}$C | **1 min.** | < 1:30 min. |
| TAL (220$^{o}$C) | **45 - 90 sec.** | 30-90 sec. |
| Peak temp. | **< 240$^{o}$C for OSP finish** | No limit to other surface finish |
| Joint cool down rate from 170C | **> 3$^{o}$C – 8$^{o}$C** | Recommended to prevent surface cracking issue. |

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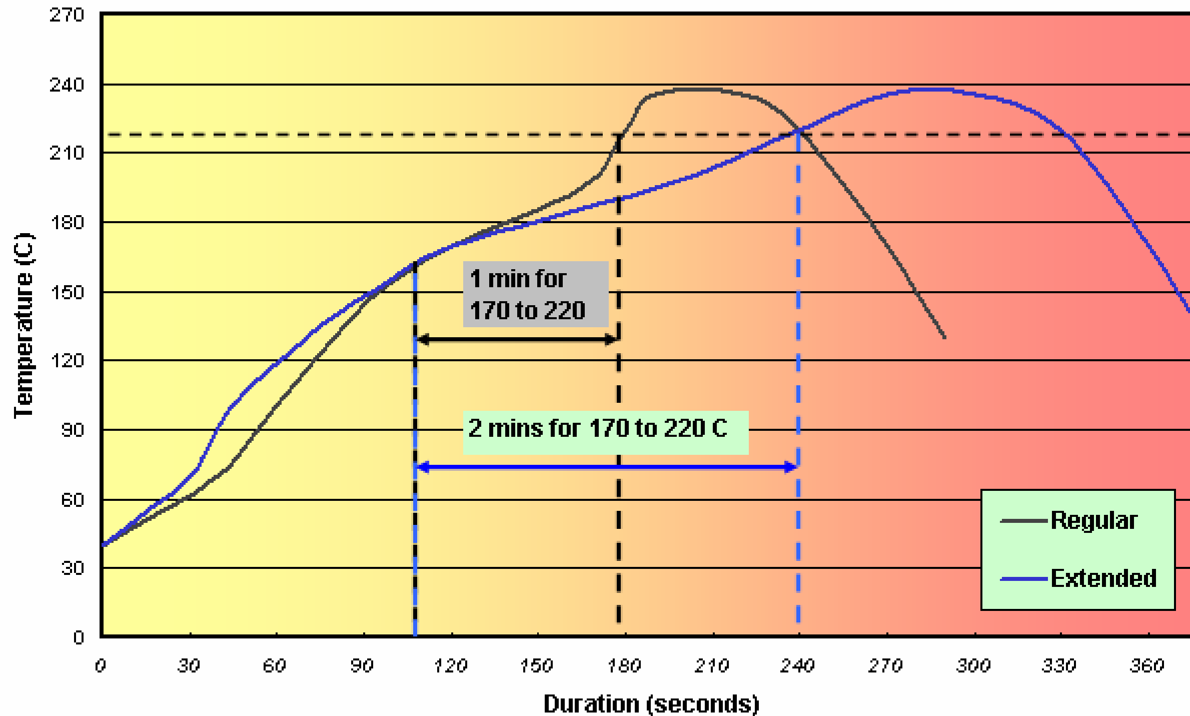


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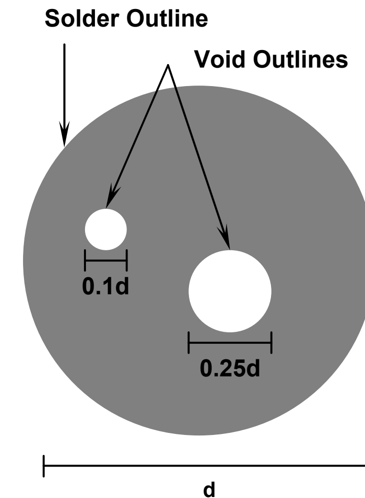
# Reflow Yield: Application Note

## Definition of Voiding Performance

| Location of Void | Class I | Class II | Class III |
|---|---|---|---|
| Void in Solder (Solder Sphere) | 60% of diameter = 36% of Area | 42% of diameter = 20.25% of Area | 30% of diameter = 9% of Area |
| Void at interface of Solder (Sphere) and Substrate | 50% of diameter = 25% of Area | 25% of diameter = 12.25% of Area | 20% of diameter = 4% of Area |




**Example:**
**Total Void Diameter**
**0.10d +0.25d = 0.35d**

### IPC Criteria for Voids in BGAs, IPC 7095 7.4.1.6

The IPC criteria provide three classes of acceptance for both the solder sphere and the sphere-pad interface.

Where multiple voids exist, the dimensions will be added to calculate total voiding in the joint.



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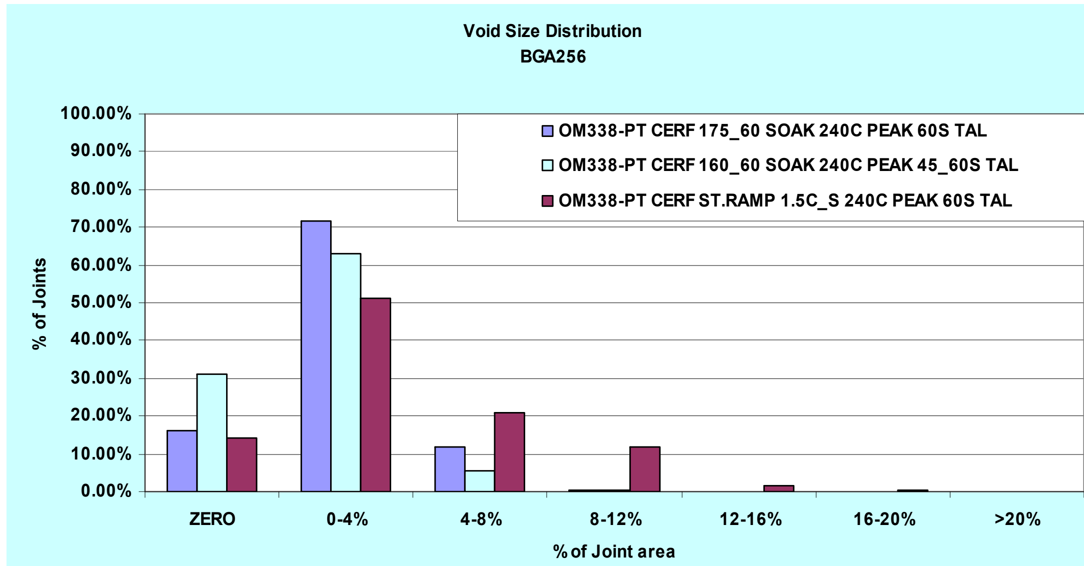
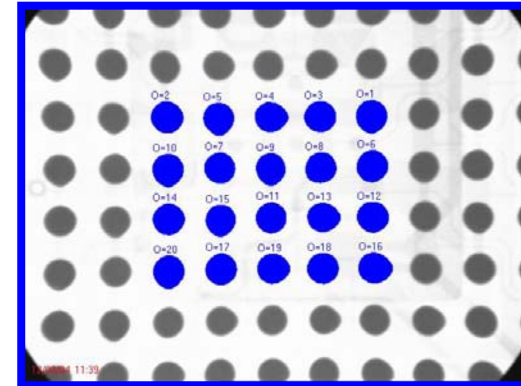
Reflow Performance

## Voiding Performance



**Excellent, low voiding performance**

- Meets IPC 7095 Class III Requirements with Soak Reflow Profile
- Meets IPC 7095 Class II Requirements with Straight Ramp Reflow Profile

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## Cold & Hot slump performance

**No bridging after 3 minute soak at 170°C using JIS-Z-3284 Appendix 8 test pattern**

**Meets Hot & Cold Slump Requirements per IPC J-STD-005**

| | Cold Slump 25˚C / 50% / 75% RH | | Hot Slump Oven 150˚C 10 minutes | |
|---|---|---|---|---|
| **Pad Size** | **0.63 x 2.03mm** | **0.33 x 2.03mm** | **0.63 x 2.03mm** | **0.33 x 2.03mm** |
| Largest Gap Bridged | No Bridges | 0.1 | 0.48 | 0.2 |
| IPC max gap bridge allowed | 0.48 | 0.2 | 0.56 | 0.25 |
| | **Pass** | **Pass** | **Pass** | **Pass** |

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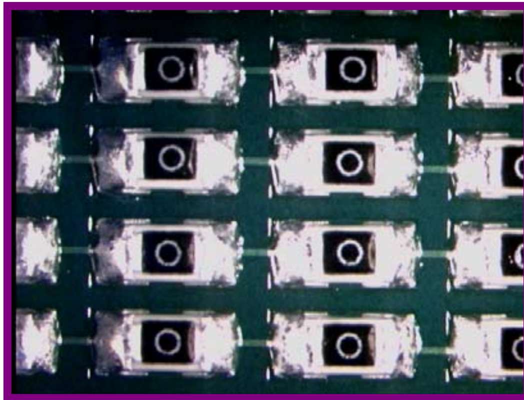
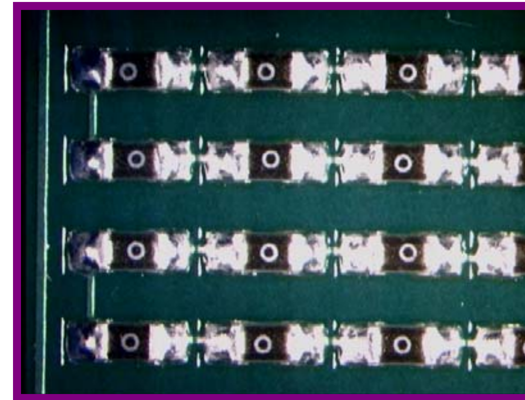
## Flux Residue Cosmetics



0805 Components



0603 Components

### Location and appearance

- No flux bridging between two terminations at intentional 10% overprint on 0805 and 0603
- Thin, consistent flux residue on top of joints
- Clear colorless flux residue on all devices

**Performance Indicator**

- Products that do not deliver clear residues can lead to inconsistent flux cosmetics, increasing the difficulty of visual inspection.

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# Summary Table

| Chemical | | |
|---|---|---|
| Cu Corrosion | IPC J-STD 004A | Pass |
| Cu Mirror | IPC J-STD 004A | Pass |
| Ag Chromate | IPC J-STD 004A | Pass |

Paste is ROL-0 per IPC

| Electrical | | | |
|---|---|---|---|
| SIR (IPC) | 7 day 85˚C/85% RH | 4.1 X $10^{9}$ ohm | > $10^{8}$ = Pass |
| SIR (Bellcore) | 96 hours @ 35˚C/85% RH | 8.4 X $10^{11}$ ohm | > $10^{11}$ = Pass |
| SIR (JIS) | 7 day, 40°C, 93% RH | 1.4 x $10^{11}$ ohm | > $10^{11}$ = Pass |
| Electromigration (Bellcore) | 500 hours, 65° C, 85% RH | Initial: 1.2 X $10^{10}$<br>Final: 5.1 X $10^{9}$ | Pass<br>Final > Initial/10 |
| Electromigration (JIS) | 1000 hours, 85°C, 85% RH | 1.0 x $10^{10}$ ohm | Pass<br>> 1.0 X $10^{8}$ ohm |
| Electromigration (HP EL-EN861-00) | 28 day, 50°C, 90% RH, 5V, Readings Every 10 minutes | Test Report Available Upon Request | Pass |

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# Electrical Reliability Data

**Passes IPC SIR Test**

SIR TEST REPORT - IPC

Test #.0527-2i T/H/B:85/85/-48
Tested by:.K. Tellefsen Report Pass/Fail Limit 1.0 E+8Ω
CONDITION
MATERIAL TESTED/
OM338 PT
PNC0513A (PT817-2) sac 305

| | | 1 Day SIR | 4 Day SIR | 7 Day SIR | Comments |
|---|---|---|---|---|---|
| | Reflowed Paste, Uncleaned | 2.90E+09 | 3.70E+09 | 4.30E+09 | Visually OK |
| | | 3.10E+09 | 3.40E+09 | 3.40E+09 | |
| | | 8.60E+08 | 8.10E+08 | 9.80E+08 | |
| | | 3.30E+09 | 4.40E+09 | 5.20E+09 | |
| | | 3.90E+09 | 5.50E+09 | 6.50E+09 | |
| | | 3.00E+09 | 4.50E+09 | 4.90E+09 | |
| | | 2.50E+09 | 3.20E+09 | 3.70E+09 | |
| | | 2.50E+09 | 1.50E+09 | 2.20E+09 | |
| | | 3.00E+09 | 3.90E+09 | 4.60E+09 | |
| | | 2.60E+09 | 2.40E+09 | 4.20E+09 | |
| | | 2.80E+09 | 4.80E+09 | 7.40E+09 | |
| | | 3.30E+09 | 1.70E+09 | 1.90E+09 | |
| | | | | | |
| Arithmetic mean | | 2.80E+09 | 3.30E+09 | 4.10E+09 | |

| | | 1 Day SIR | 4 Day SIR | 7 Day SIR |
|---|---|---|---|---|
| | Control Boards | 4.40E+09 | 6.10E+09 | 6.90E+09 |
| | | 2.40E+09 | 3.00E+09 | 3.40E+09 |
| | | 2.60E+09 | 3.20E+09 | 3.40E+09 |
| | | 4.70E+09 | 6.20E+09 | 7.10E+09 |
| | | 5.30E+09 | 6.40E+09 | 7.10E+09 |
| | | 1.70E+09 | 4.10E+09 | 4.10E+09 |
| | | 4.10E+09 | 4.50E+09 | 4.80E+09 |
| | | 4.50E+09 | 5.20E+09 | 5.00E+09 |
| | | 1.10E+10 | 9.40E+09 | 9.40E+09 |
| | | 8.20E+09 | 6.50E+09 | 6.50E+09 |
| | | 6.90E+09 | 5.50E+09 | 5.70E+09 |
| | | 6.70E+09 | 6.00E+09 | 6.30E+09 |
| | | | | |
| Arithmetic mean | | 5.20E+09 | 5.50E+09 | 5.80E+09 |

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# Electrical Reliability Data

**Passes Bellcore SIR Test**

SIR TEST REPORT - BELLCORE
(per GR-78-CORE Issue 1, Sept 97)

Test #.0527-2b T/H/B:35/85/-48
Tested by:.K. Tellefsen Report limit:1E11 Ohms
CONDITION
MATERIAL TESTED/
OM338 PT
PNC0513A (PT817-2) sac 305

| Condition | 1 Day SIR | 4 Day SIR | Comments |
|---|---|---|---|
| Reflowed Paste, Uncleaned | 2.20E+12 | 5.50E+12 | Visually OK |
| | 5.80E+12 | 1.50E+12 | |
| | 1.60E+12 | 5.30E+11 | |
| | 2.30E+12 | 1.00E+12 | |
| | 2.10E+12 | 1.90E+12 | |
| | 5.30E+12 | 4.10E+11 | |
| | 1.60E+12 | 1.50E+12 | |
| | 2.60E+12 | 8.20E+11 | |
| | 6.80E+11 | 1.20E+12 | |
| | 8.50E+12 | 1.60E+11 | |
| | 6.30E+11 | 1.90E+11 | |
| | 2.10E+12 | 8.60E+11 | |
| Geometric mean: | 2.20E+12 | 8.40E+11 | |
| Control Boards | 2.70E+12 | 2.10E+11 | |
| | 1.30E+12 | 8.00E+11 | |
| | 9.00E+12 | 4.10E+11 | |
| | 6.80E+12 | 7.00E+11 | |
| | 1.50E+12 | 5.20E+11 | |
| | 1.30E+12 | 4.50E+11 | |
| | 1.70E+12 | 1.80E+12 | |
| | 8.00E+12 | 3.60E+11 | |
| | 3.30E+12 | 8.00E+11 | |
| | 1.10E+12 | 6.10E+11 | |
| | 5.00E+12 | 4.00E+11 | |
| | 8.10E+12 | 2.40E+11 | |
| Geometric mean: | 3.10E+12 | 5.10E+11 | |

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# Electrical Reliability Data

## Passes JIS ECM Test

Test #:0527-2je Start date: 9/12/2005 bias = 50 V T/ H: 85/85

Tested by: K. Tellefsen Reported by: K. Tellefsen

| MATERIAL TESTED/ CONDITION | SIR ohms initial | SIR 24 hrs | SIR 96 hrs | SIR 168 hrs | SIR 200 hrs | SIR 400 hrs | SIR 600 hrs | SIR 800 hrs | SIR 1000 hrs |
|---|---|---|---|---|---|---|---|---|---|
| OM338 PT | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- |
| PNC0513A (PT817-2) | >1.0E12 | 2.50E+09 | 8.60E+09 | 6.50E+09 | 5.10E+09 | 3.30E+09 | 1.50E+09 | 1.20E+09 | 1.10E+09 |
| IPC-B-25 pattern B | >1.0E12 | 4.80E+09 | 8.10E+09 | 6.20E+09 | 5.20E+09 | 7.90E+09 | 1.40E+10 | 1.60E+10 | 2.20E+10 |
| 0.318 mm lines and spaces | >1.0E12 | 3.10E+09 | 8.20E+09 | 7.10E+09 | 5.00E+09 | 7.20E+09 | 1.20E+10 | 1.30E+10 | 1.60E+10 |
| Reflowed paste | >1.0E12 | 3.00E+09 | 1.20E+10 | 6.90E+09 | 5.00E+09 | 7.60E+09 | 1.20E+10 | 1.30E+10 | 1.80E+10 |
| uncleaned | >1.0E12 | 2.70E+09 | 7.90E+09 | 7.10E+09 | 4.60E+09 | 3.30E+09 | 3.30E+09 | 3.10E+09 | 3.40E+09 |
| | >1.0E12 | 2.60E+09 | 1.00E+10 | 8.20E+09 | 6.40E+09 | 5.40E+09 | 8.10E+09 | 8.40E+09 | 1.20E+10 |
| | >1.0E12 | 2.30E+10 | 6.80E+10 | 8.20E+10 | 9.00E+10 | 1.10E+11 | 1.20E+11 | 1.40E+11 | 7.90E+10 |
| Passed electrical | >1.0E12 | 2.00E+10 | 8.40E+10 | 9.10E+10 | 1.20E+11 | 1.40E+11 | 1.40E+11 | 2.00E+11 | 1.30E+11 |
| and visual | >1.0E12 | 3.80E+09 | 1.10E+10 | 7.20E+09 | 6.10E+09 | 4.30E+09 | 4.40E+09 | 4.60E+09 | 5.80E+09 |
| requirements | >1.0E12 | 5.20E+09 | 1.40E+10 | 8.50E+09 | 7.90E+09 | 6.00E+09 | 6.30E+09 | 6.70E+09 | 7.90E+09 |
| no evidence of | >1.0E12 | 2.30E+09 | 9.00E+09 | 7.10E+09 | 6.70E+09 | 5.00E+09 | 5.00E+09 | 4.40E+09 | 6.10E+09 |
| electrochemical | >1.0E12 | 2.80E+09 | 1.10E+10 | 7.20E+09 | 5.90E+09 | 2.40E+09 | 1.60E+09 | 1.60E+09 | 1.70E+09 |
| migration | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- |
| Geometric mean: | >1.0E12 | 4.30E+09 | 1.40E+10 | 1.10E+10 | 9.30E+09 | 8.40E+09 | 9.00E+09 | 9.50E+09 | 1.00E+10 |
| Controls | >1.0E12 | 9.00E+09 | 2.30E+10 | 3.90E+10 | 4.70E+10 | 9.00E+10 | 1.70E+11 | 1.70E+11 | 1.60E+11 |
| IPC-B-25 pattern B | >1.0E12 | 1.00E+10 | 2.30E+10 | 4.00E+10 | 4.80E+10 | 3.10E+10 | 3.90E+10 | 2.90E+10 | 6.00E+10 |
| | >1.0E12 | 1.20E+10 | 2.50E+10 | 3.70E+10 | 4.40E+10 | 3.10E+10 | 3.90E+10 | 3.60E+10 | 6.10E+10 |
| | >1.0E12 | 7.90E+10 | 5.10E+10 | 3.90E+10 | 4.70E+10 | 4.90E+10 | 5.70E+10 | 6.60E+10 | 7.40E+10 |
| | >1.0E12 | 8.80E+10 | 3.50E+10 | 3.40E+10 | 4.10E+10 | 4.10E+10 | 4.10E+10 | 4.80E+10 | 5.90E+10 |
| | >1.0E12 | 7.40E+10 | 5.00E+10 | 3.60E+10 | 4.20E+10 | 4.90E+10 | 5.20E+10 | 5.90E+10 | 6.80E+10 |
| | >1.0E12 | 3.60E+10 | 3.80E+10 | 3.40E+10 | 4.00E+10 | 4.00E+10 | 4.40E+10 | 5.10E+10 | 6.40E+10 |
| | >1.0E12 | 8.60E+09 | 1.60E+10 | 3.20E+10 | 3.80E+10 | 2.50E+10 | 3.00E+10 | 3.40E+10 | 4.20E+10 |
| | >1.0E12 | 1.10E+11 | 5.90E+10 | 3.10E+10 | 3.80E+10 | 5.60E+10 | 6.10E+10 | 6.90E+10 | 8.80E+10 |
| | >1.0E12 | 9.60E+10 | 1.00E+11 | 3.20E+10 | 3.90E+10 | 5.40E+10 | 6.10E+10 | 6.90E+10 | 8.20E+10 |
| | >1.0E12 | 8.60E+10 | 9.20E+10 | 3.00E+10 | 3.60E+10 | 5.00E+10 | 5.60E+10 | 6.40E+10 | 7.90E+10 |
| | >1.0E12 | 1.30E+10 | 2.80E+10 | 2.90E+10 | 3.60E+10 | 4.20E+10 | 5.00E+10 | 5.90E+10 | 7.40E+10 |
| | ----- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- |
| Geometric mean: | >1.0E12 | 3.40E+10 | 3.90E+10 | 3.40E+10 | 4.10E+10 | 4.40E+10 | 5.20E+10 | 5.60E+10 | 7.20E+10 |

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# OM-338 PT solder paste

Summary

## Delivers excellent print volume and consistancy

- Prints .3mm pitch QFP's , .25mm circles with Type 3 Powder
- Print Temperature window 20°C to ≥30°C
- Excellent post print tack life
- Wide print speed process window (25mm/sec to 150mm/sec)
- Stable viscosity

## High Post Reflow Yields

- 99% In Circuit Pin Test Yields
- IPC Class III Voiding Performance (Using Soak Reflow Profile)
- Resistance to cold and hot slump
- Clear, colorless flux residue

## Electrical Reliability

- IPC SIR
- Bellcore SIR
- JIS SIR
- Bellcore Electromigration
- JIS Electromigration
- HP EL-EN861-00 Electromigration

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# OM-338 PT solder paste

Summary

Leading Products:

No Clean, SnPb

- ALPHA OM-6106
- ALPHA OM-5100

No Clean, Lead-free

- ALPHA OM-338 T
- ALPHA OM-338 PT
- ALPHA OM-350

Water Soluble, SnPb

- ALPHA WS-809

Water Soluble, Lead-free

- ALPHA WS-819

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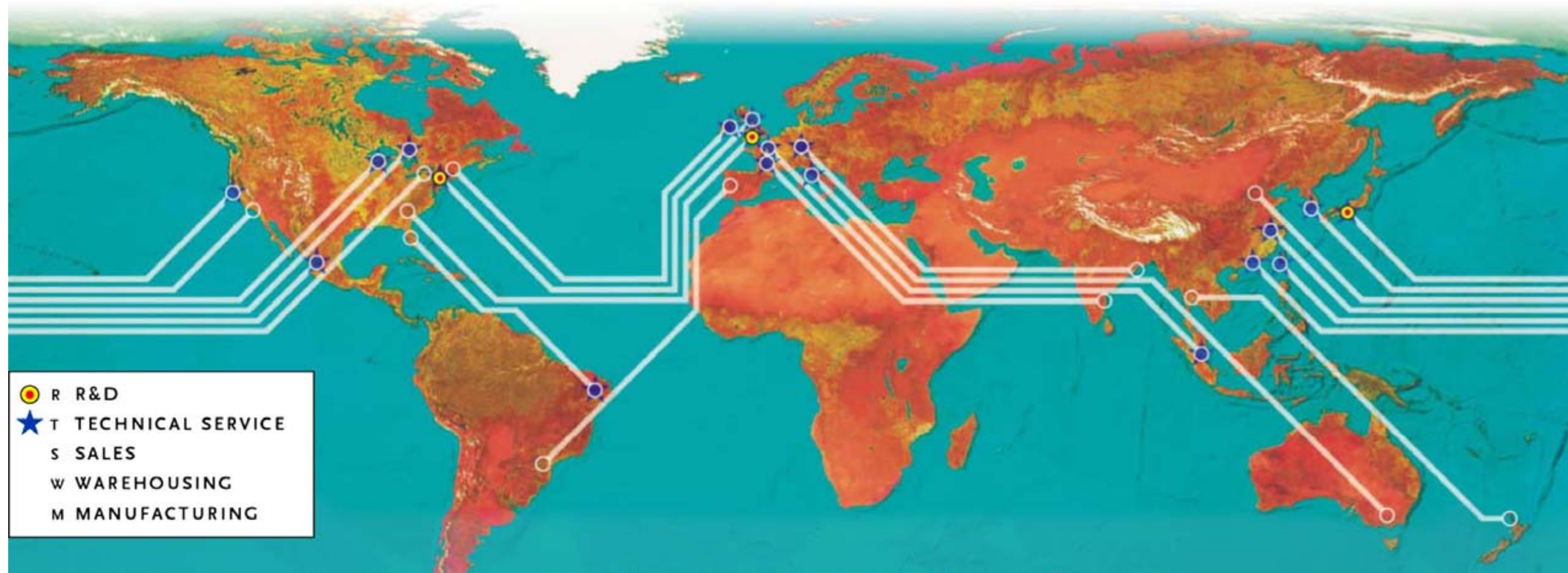
# OM-338 PT solder paste

## Summary




| NORTH AMERICA | |
|---|---|
| California, USA | TSM |
| Florida, USA | M |
| Georgia, USA | SWM |
| Illinois, USA | TSWM |
| New Jersey, USA | RTSWM |
| New York, USA | M |
| Ontario, Canada | TS |
| Guadalajara, Mexico | TSWM |

| SOUTH AMERICA | |
|---|---|
| Capital Federal, Argentina | SW |
| Manaus, Brazil | WM |
| Sao Paulo, Brazil | TSWM |

| EUROPE | |
|---|---|
| Woking, England | TS |
| Ashford, England | WM |
| Turnhout, Belgium | SWM |
| Paris, France | TSW |
| Lagenfeld, Germany | TS |
| Budapest, Hungary | TSWM |
| Dublin, Ireland | TSWM |
| Milan, Italy | TSW |
| Naarden, Netherlands | TSWM |
| East Kilbride, Scotland | TSWM |
| Madrid, Spain | S |

| ASIA PACIFIC | |
|---|---|
| Hong Kong, China | TSWM |
| Beijing, China | TSWM |
| Chengdu, China | S |
| Nanjing, China | S |
| Shanghai, China | TSW |
| Shenzhen, China | TSWM |
| Xiamen, China | SW |
| Chennai, India | SWM |
| Hiratsuka, Japan | RTSWM |
| Sihung City, Korea | TSWM |
| Penang, Malaysia | TSW |
| Muntinlupa, Philippines | S |
| Singapore, Singapore | TSWM |
| Lu-Chu Hsiang, Taiwan | TSWM |
| Kaohsiung, Taiwan | SW |
| Bangkok, Thailand | SW |
| Melbourne, Australia | S |
| Auckland, New Zealand | SW |

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