NC-SMQ® 230

Pb-Free Solder Paste

- Consistent fine-pitch deposition
- Unsurpassed response-to-pause printing
- Performs at peak temperatures as low as 229°C

INDIUM CORPORATION®

Product Information

NC-SMQ®230 Pb-Free Solder Paste

Benefits

- Minimum peak temperature 229°C
- Wide reflow process window
- Consistent fine pitch print deposition
- Excellent start-up after idle time
- Long stable tack life and open time

Introduction

NC-SMQ®230 is an air reflow, no-clean solder paste specifically formulated to accommodate the higher processing temperatures required by the Sn/Ag/Cu, Sn/Ag/Bi, Sn/Ag, and other Pb-free alloy systems favored by the electronics industry to replace conventional Pb-bearing solders. **NC-SMQ®230** formulation offers consistent, repeatable printing performance combined with long stencil and tack times to handle the rigors of today's high-speed, as well as high-mix surface mount lines.

Alloys

Indium Corporation manufactures low oxide spherical powder composed of a variety of Pb-Free alloys that cover a broad range of melting temperatures. The metal load required is application dependent and will vary with alloy density and mesh size. Type 3 (-325/+500 mesh) powder is standard, but other powder sizes are available. See Standard Product Specifications section for details on metal load and particle size.

Standard Product Specifications

Alloy	Metal Load	IPN
96.5Sn/3.0Ag/0.5Cu (SAC305)	88.5% Printing	83495
95.5Sn/3.8Ag/0.7Cu (SAC387)	88.5% Printing	82797

Packaging

Standard packaging for stencil printing applications includes 4 oz. jars and 6 oz. or 12 oz. cartridges. Packaging for enclosed print head systems is also readily available. For dispensing applications, 10cc and 30cc syringes are standard. Other packaging options may be available upon request.

Storage and Handling Procedures

Refrigerated storage will prolong the shelf life of solder paste. The shelf life of **NC-SMQ®230** is 6 months when stored at <5°C. Solder paste packaged in syringes and cartridges should be stored tip down.

Solder paste should be allowed to reach ambient working temperature prior to use. Generally, paste should be removed from refrigeration at least two hours before use. Actual time to reach thermal equilibrium will vary with container size. Paste temperature should be verified before use. Jars and cartridges should be labeled with date and time of opening.

Material Safety Data Sheets

The MSDS for this product can be found online at http://www.indium.com/techlibrary/msds.php .

Bellcore and J-STD Tests & Results

J-STD-004 (IPC-TM-650)	Result	J-STD-005 (IPC-TM-650)	Result
Flux Type Classification	ROL1	Typical Solder Paste Viscosity: Malcom (10rpm) SAC305 (Sn96.5/Ag3/Cu0.5, Type 3, 89.3%) SAC387 (Sn95.5/Ag3.8/Cu0.7, Type 3, 89.3%)	2100 poise
Flux Induced Corrosion: Copper Mirror	L		
Presence of Halide Silver Chromate Fluoride Spot Test	 Pass Pass	Thixotropic Index; SSF (ICA Test)	-0.475
		Slump Test	Pass
Post Reflow Flux Residue: ICA Test	42%	Solder Ball Test	Pass
Corrosion	Pass	Typical Tackiness	48 grams
SIR	Pass	Wetting Test	Pass
Acid Value	99.6	**Bellcore GR-78**	**Result**
		SIR	Pass
		Electromigration	Pass

All information is for reference only. Not to be used as incoming product specifications.

NC-SMQ®230 Pb-Free Solder Paste

Printing

Stencil Design:

Electroformed and laser cut/electropolished stencils produce the best printing characteristics among stencil types. Stencil aperture design is a crucial step in optimizing the print process. The following are a few general recommendations:

- Discrete components — A 10-20% reduction of stencil aperture has significantly reduced or eliminated the occurrence of mid-chip solder beads. The "home plate" design is a common method for achieving this reduction.
- Fine pitch components — A surface area reduction is recommended for apertures of 20 mil pitch and finer. This reduction will help minimize solder balling and bridging that can lead to electrical shorts. The amount of reduction necessary is process dependent (5-15% is common).
- For adequate release of solder paste from stencil apertures, a minimum aspect ratio of 1.5 is required. The aspect ratio is defined as the width of the aperture divided by the thickness of the stencil.

Printer Operation:

The following are general recommendations for stencil printer optimization. Adjustments may be necessary based on specific process requirement:

• Solder Paste Bead Size:	20-25mm diameter
• Print Speed:	25-50mm
• Squeegee Pressure:	0.018-0.027kg/mm of blade length
• Underside Stencil Wipe:	Once every 10-25 prints
• Solder Paste Stencil Life:	>8 hrs. @ 30-60% RH & 22°-28°C

Cleaning

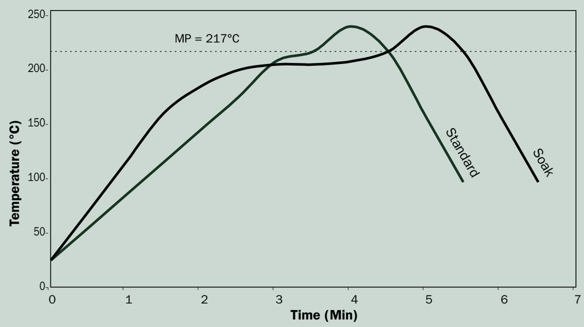
NC-SMQ®230 is designed for no-clean applications, however the flux can be removed if necessary by using a commercially available flux residue remover.
Stencil Cleaning is best performed using isopropyl alcohol (IPA) as a solvent. Most commercially available stencil cleaners work well.

Compatible Products

- Rework Flux: **TACFlux® 023**
- Flux Pen: **FP-500**
- Wave Flux: **WF-7742, WF-9942**

Reflow

Recommended Profile:



The stated profile recommendations apply to most Pb-Free alloys in the Sn/Ag/Cu (SAC) alloy system, including SAC305 (96.5Sn/3.0Ag/0.5Cu). This can be used as a general guideline in establishing a reflow profile when using **NC-SMQ®230** Solder Paste. Deviations from these recommendations are acceptable, and may be necessary, based on specific process requirements, including board size, thickness & density.

Heating Stage:

A linear ramp rate of 0.5°- 2.0°C/second allows gradual evaporation of volatile flux constituents and helps minimize defects such as solder balling and/or beading and bridging resulting from hot slump. It also prevents unnecessary depletion of fluxing capacity when a high peak temperature and extended time above liquidus is used. A profile with a soak between 200°-210°C for up to 2 minutes can be implemented to reduce void formation on BGA & CSP type devices. A short soak of 20-30 seconds just below the melting point of the solder can help minimize tombstoning.

Liquidus Stage:

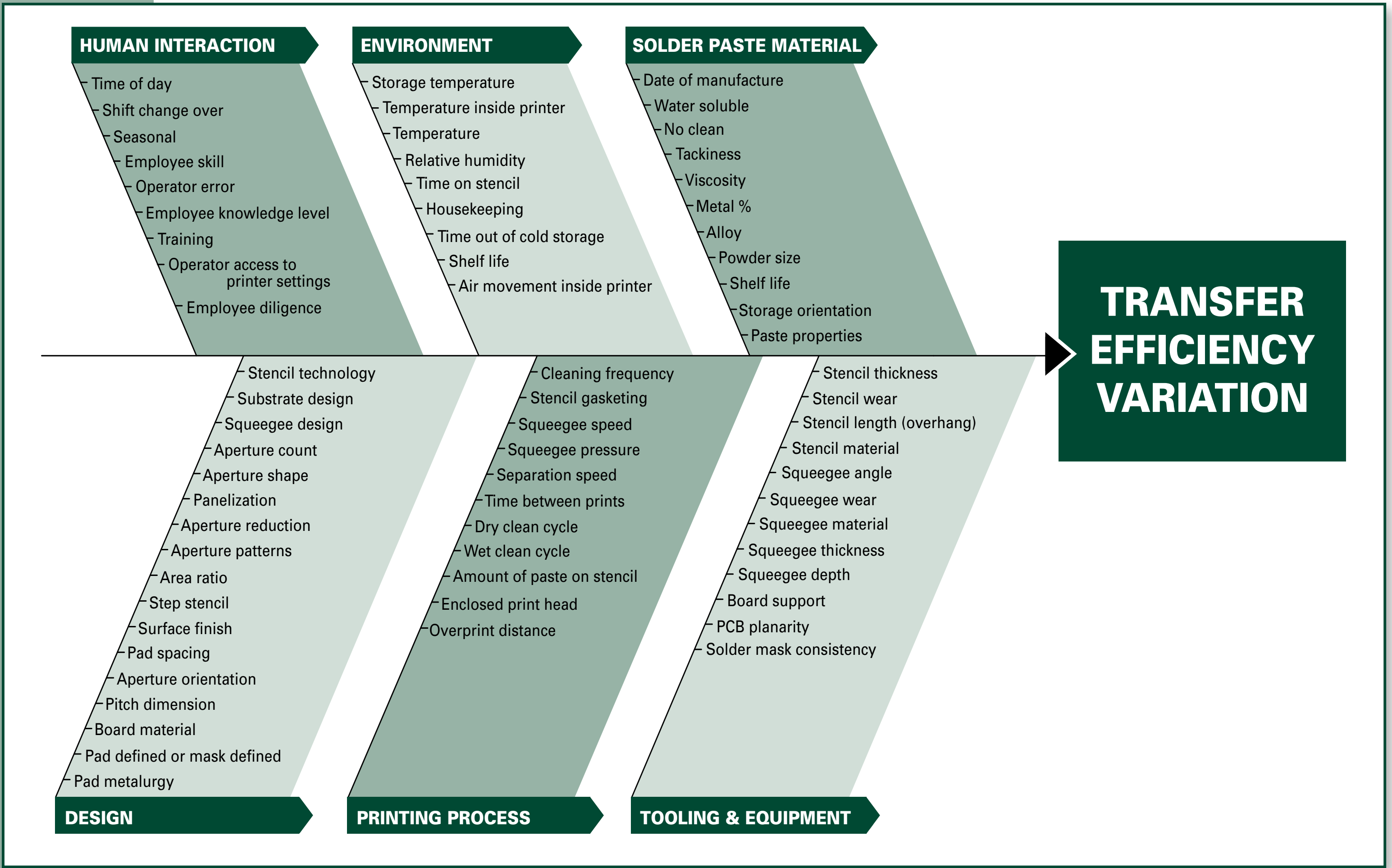
A peak temperature of 12° to 43°C above the melting point of the solder alloy is recommended to achieve acceptable wetting and form a quality solder joint. The time above liquidus (TAL) should be 30–90 seconds. A peak temperature and TAL above these recommendations can result in excessive intermetallic formation that can decrease solder joint reliability.

Cooling Stage:

A rapid cool down (4-6°C/second) is desired to form a fine grain structure. Slow cooling will form a large grain structure, which typically exhibits poor fatigue resistance.

This product data sheet is provided for general information only. It is not intended, and shall not be construed, to warrant or guarantee the performance of the products described which are sold subject exclusively to written warranties and limitations thereon included in product packaging and invoices.

Ultra-Fine Pitch Printing



Solder Powder Reference

Solder Powder Size			Stencil Printing				Dispensing		
J-STD-005 Designation	Diameter Range (microns)		Aperture Width		Particles to Span Width		Needle Size		# of Large Particles
			Microns	Inches	Smallest	Largest	Gauge	ID (microns)	
3	25	45	250	0.010	10.00	5.60	22	410	9.1
4	20	38	225	0.009	11.25	6.00	23	330	8.6
5	15	25	200	0.008	13.30	8.00	25	250	10.0
6	5	15	175	0.007	35.00	11.67	27	200	13.3

To ensure that a consistent volume of solder paste is printed onto the board, it is essential to design the stencil according to industry guidelines:

Area Ratio ≥ 0.66
Minimum number of solder particles spanning an aperture should be at least 4-5

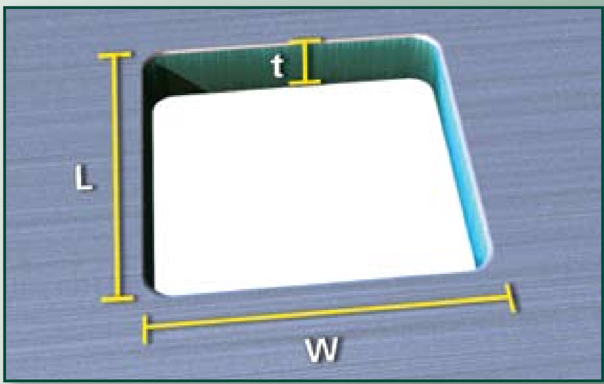
Area Ratio For Square/ Rectangular Apertures

$$\text{Area Ratio} = \frac{\text{Area Opening}}{\text{Area Walls}}$$

$$\text{Area Opening} = L \times W$$

$$\text{Area Walls} = 2t\,(L + W)$$

$$\text{Area Ratio} = \frac{L \times W}{2t\,(L + W)}$$



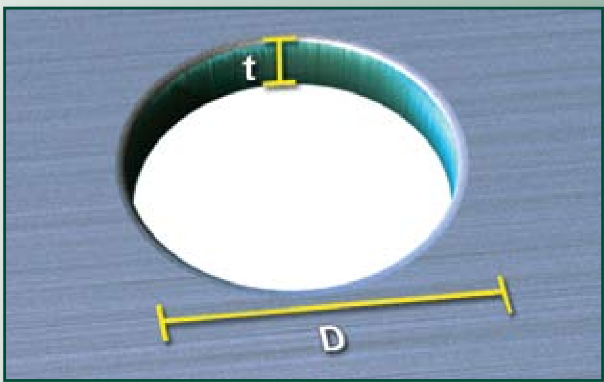
Area Ratio For Circular Apertures

$$\text{Area Ratio} = \frac{\text{Area Opening}}{\text{Area Walls}}$$

$$\text{Area Opening} = \frac{\pi D^2}{4}$$

$$\text{Area Walls} = \pi D t$$

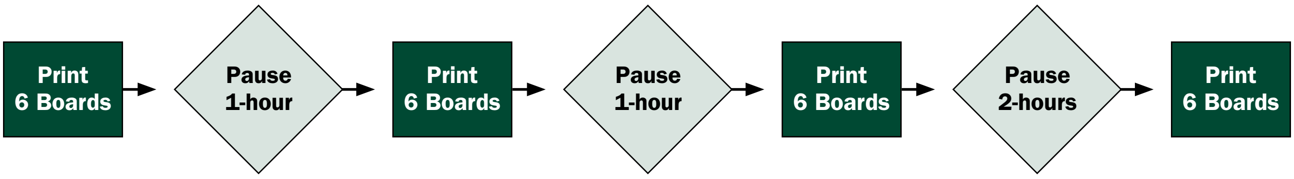
$$\text{Area Ratio} = \frac{D}{4t}$$



Sample Area Ratio Chart

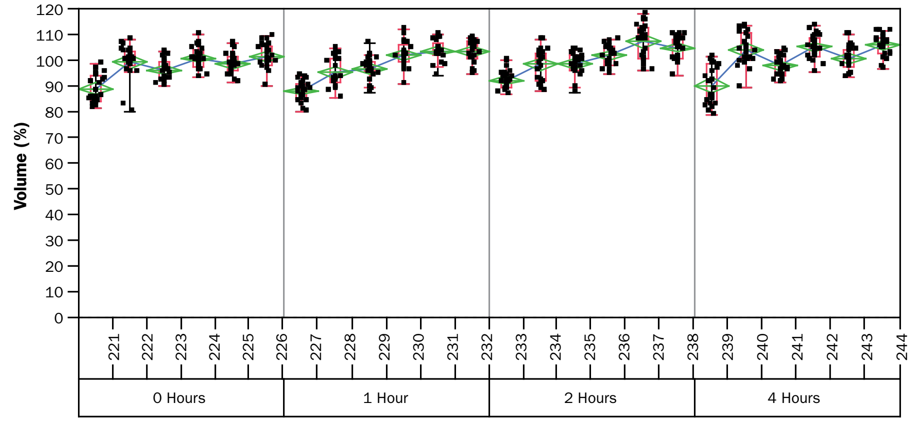
Pad Size (mm)	0.05	0.10	0.15	01005	0.20	0.25	0201	0.30	0.35	0.40	0.45	0.50
Aperture Width (mil)	**2.0**	**3.9**	**5.9**	**7 x 8**	**7.9**	**9.8**	**10 x 12**	**11.8**	**13.8**	**15.7**	**17.7**	**19.7**
Stencil Thickness (5.0 mil)	0.10	0.20	0.30	0.37	0.39	0.49	0.55	0.59	0.69	0.79	0.89	0.98
Stencil Thickness (4.5 mil)	0.11	0.22	0.33	0.41	0.44	0.55	0.61	0.66	0.77	0.87	0.98	1.09
Stencil Thickness (4.0 mil)	0.12	0.25	0.37	0.47	0.49	0.62	0.68	0.74	0.86	0.98	1.11	1.23
Stencil Thickness (3.5 mil)	0.14	0.28	0.42	0.53	0.56	0.70	0.78	0.84	0.98	1.12	1.27	1.41
Stencil Thickness (3.0 mil)	0.16	0.33	0.49	0.62	0.66	0.82	0.91	0.98	1.15	1.31	1.48	1.64
Stencil Thickness (2.5 mil)	0.20	0.39	0.59	0.75	0.79	0.98	1.09	1.18	1.38	1.57	1.77	1.97

Response-to-Pause Procedure

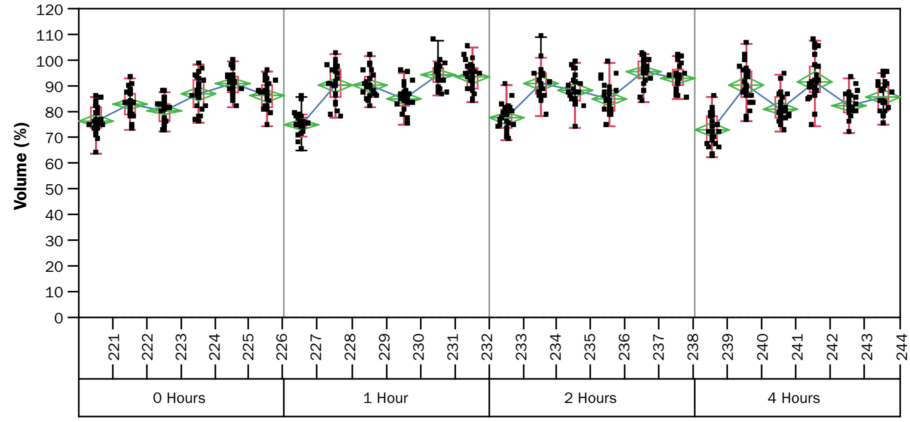


NC-SMQ230

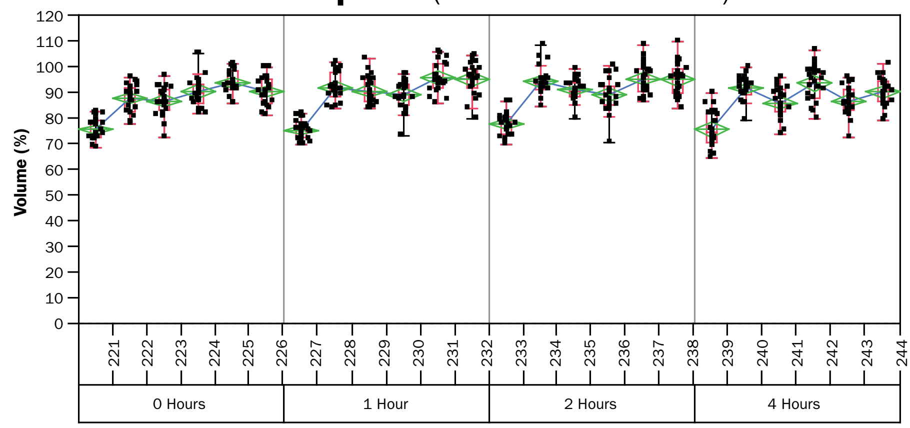
9mil x 50mil (Non-solder Mask Defined)



12mil Circle (Solder Mask Defined)



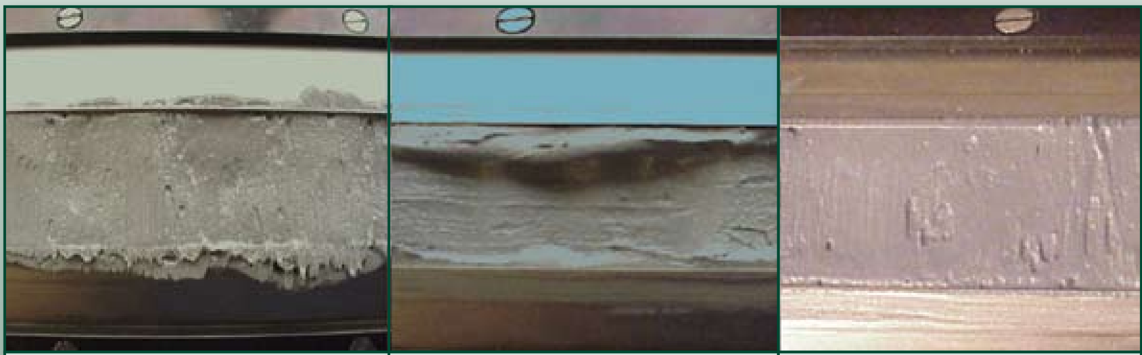
12mil Square (Solder Mask Defined)



Enclosed Print Head Compatibility

DEK ProFlow

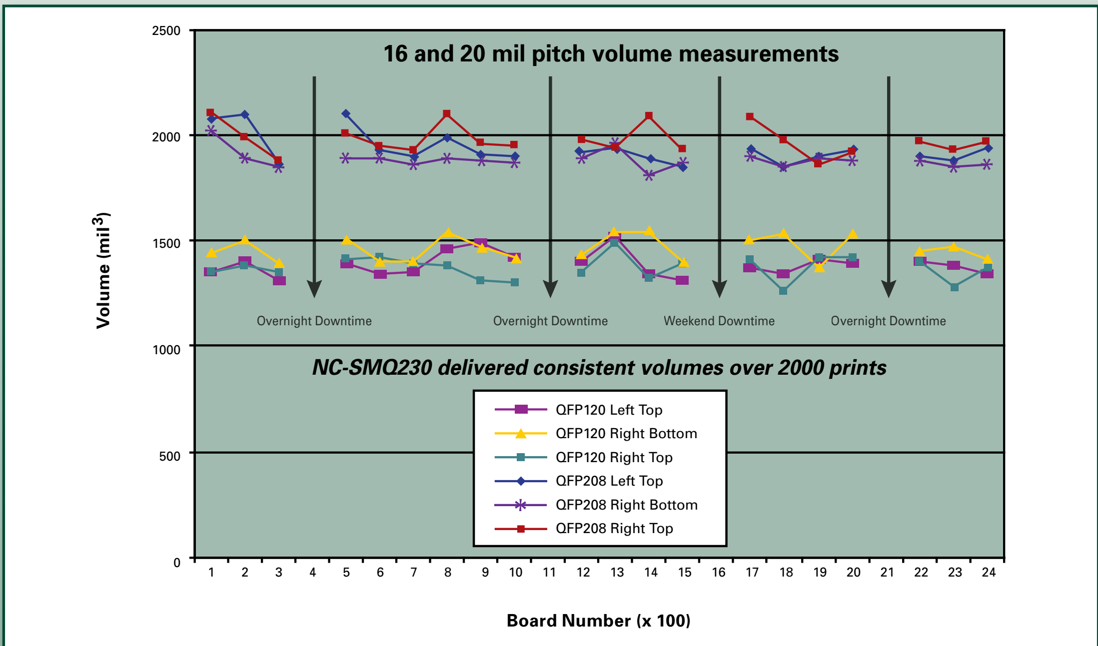
Optimized Settings	
Proflow System Pressure	4 kg
Separation Speed	5 mm/sec
Print Speed	130 mm/sec
Proflow Paste Pressure	2 Bar



Following Compaction	Material Removed	After Priming/Printing

Speedline RheoPump

Optimized Settings	
Print Speed	75 mm/sec
Total System Force	20 lbs
Charge Pressure	10 psi
Print Pressure	6 psi



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Wide Reflow Process Window

Section #1 – Preheat:

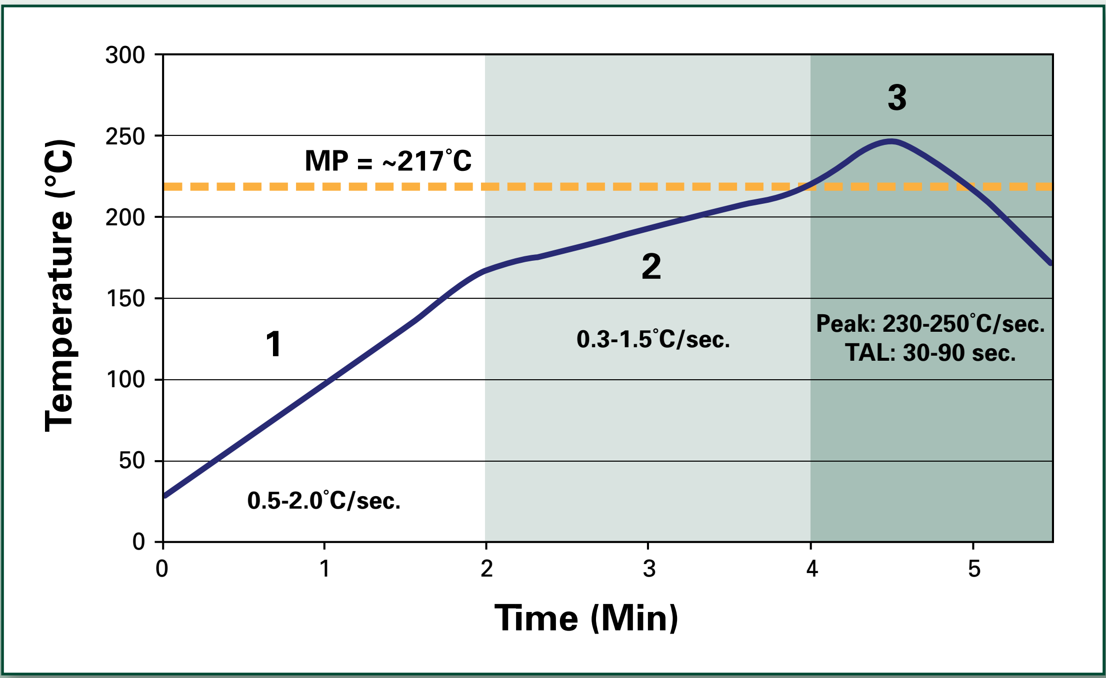
- **Slow Ramp Rate** – Minimizes paste slump and flux spattering. Fewer shorts, solder balls, and solder beads.
- **Fast Ramp Rate** – Minimizes additional oxidation on parts and boards. May help soldering of highly oxidized components.

Section #2 – Soak:

- **Short Soak Time** – Minimizes oxidation and provides best opportunity for good wetting and shiny solder joints.
- **Long Soak Time** – Minimizes tombstoning and voiding. Could negatively impact wetting.

Section #3 – Time Above Liquidus (TAL)/Peak:

- **Short TAL/Low Peak** – Minimizes voiding and thermal damage to components/substrates.
- **Long TAL/High Peak** – Improves solder coalescence but could result in dewetting if too long/high.



NC-SMQ230 Product Level Testing

Copper Mirror (Test #2.3.32)

Objective: The purpose of this test is to determine the corrosive (free-halide) properties of a flux.

Procedure: Flux is applied to a copper-coated glass slide and sits in a controlled environment for 24 hours. The flux is cleaned and the copper inspected for corrosion.

Results:
Pass, (L)

Silver Chromate (Test #2.3.33)

Objective: The purpose of this test is to determine the corrosive (free-halide) properties of a flux.

Procedure: Flux is applied to Silver Chromate-impregnated paper and inspected for color change.

Results:
Pass
(No Color Change)

Quantitative Halides (Cl, Br, Fl) (Test #2.3.28.1)

Objective: The purpose of this test is to determine the total halide concentration of a flux.

Procedure: Flux is dissolved to a pre-determined concentration. Extracted solutions are then analyzed using an Ion Chromatograph with 3 to 5 level calibration. Total halide content is calculated and reported at Cl^- equivalent.

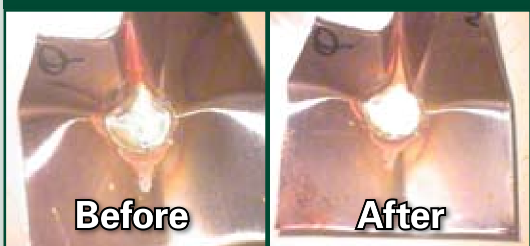
Results:
Total Halides <
0.5% Cl^- Equivalent

Qualitative Corrosion (Test #2.6.15)

Objective: The purpose of this test is to determine the corrosive properties of the flux residues under extreme environmental conditions.

Procedure: Solder paste is reflowed onto a sheet of copper and exposed to 40°C and 93% RH for 10 days. The coupon is then investigated for any signs of Cu corrosion.

Results and Image: Pass



NC-SMQ230 Product Level Testing

Surface Insulation Resistance (Test #2.6.3.3)

Objective: The purpose of this test is to determine the Surface Insulation Resistance (SIR) of the flux residue after paste reflow.

Procedure: Paste is stenciled onto the test board and reflowed. The un-cleaned board is then sent to an outside laboratory for testing.

Results: Pass

Surface Insulation Resistance (SIR), IPC-TM-650 Method 2.6.3.3 Results

Coupon	Pattern	Initial	24 Hours	96 Hours	168 Hours	Final
1	A	1.05E+13	1.41E+13	1.51E+13	7.59E+11	8.2E+12
1	B	1.12E+13	7.76E+09	6.46E+09	1.82E+09	7.6E+12
1	C	1.07E+13	1.48E+13	1.51E+13	3.02E+09	8.2E+12
1	D	1.07E+13	1.48E+13	6.46E+09	2.69E+09	7.5E+12
2	A	1.12E+13	1.48E+13	4.47E+09	2.95E+09	9.1E+12
2	B	1.20E+13	5.75E+09	5.89E+09	5.75E+09	7.5E+12
2	C	1.20E+13	8.51E+09	3.55E+09	4.37E+09	7.0E+12
2	D	1.26E+13	7.94E+09	3.31E+09	3.72E+09	2.4E+12
3	A	1.05E+13	1.38E+10	4.57E+09	3.63E+09	9.5E+12
3	B	1.07E+13	1.82E+10	6.46E+09	5.25E+09	8.7E+12
3	C	1.10E+13	1.66E+10	7.24E+09	6.17E+09	8.6E+12
3	D	1.10E+13	1.15E+10	3.55E+09	2.88E+09	9.1E+12
Control 1	A	1.10E+13	9.12E+09	8.13E+09	8.71E+09	1.7E+13
Control 1	B	1.10E+13	9.12E+09	7.59E+09	8.51E+09	4.8E+13
Control 1	C	1.10E+13	1.02E+10	6.92E+09	7.76E+09	4.3E+12
Control 1	D	1.10E+13	1.12E+10	7.59E+09	8.13E+09	1.8E+13
Control 2	A	1.10E+13	1.00E+10	8.13E+09	8.71E+09	1.2E+13
Control 2	B	1.10E+13	1.20E+10	7.76E+09	8.51E+09	1.6E+12
Control 2	C	1.12E+14	1.32E+10	7.94E+09	8.51E+09	8.6E+12
Control 2	D	1.12E+13	1.32E+10	8.51E+09	8.91E+09	2.1E+12

Note: add rows for coupons as needed.

Electrochemical Migration (Test #2.6.14.1)

Objective: The purpose of this test is to determine the Electrochemical Migration and SIR of the flux residue after paste reflow.

Procedure: Paste is stenciled onto the test board and reflowed. The un-cleaned board is then sent to an outside laboratory for testing.

Results: Pass

Electrochemical Migration Resistance, IPC-TM-650 Method 2.6.14.1 Results

Test Sample	Initial resistance value after 96 hour stabilization with no bias (Ohm)	Final resistance value after 500 hours at test conditions (Ohm)
1	1.97E+11	9.40E+10
2	2.24E+11	9.83E+10
3	1.30E+11	5.49E+10
4	6.58E+09	4.44E+09
5	2.70E+11	5.80E+10
6	2.68E+11	4.68E+10
7	2.38E+11	3.48E+10
8	1.88E+11	2.92E+10
9	5.84E+10	1.79E+10
10	5.92E+10	1.63E+10
11	1.88E+09	4.97E+09
12	3.95E+10	1.75E+10
Geometric Mean (IR_{avg})	10.49E+10	2.71E+10
Control	**Initial resistance value after 96 hour stabilization with no bias (Ohm)**	**Final resistance value after 500 hours at test conditions (Ohm)**
1	3.24E+10	8.62E+10
2	3.92E+10	9.25E+10
3	3.96E+10	8.65E+10
4	3.92E+10	7.40E+10
5	4.58E+10	9.93E+10
6	4.94E+10	1.04E+11
7	4.63E+10	9.74E+10
8	4.07E+10	8.48E+10
9	2.35E+10	5.81E+10
10	3.09E+10	6.49E+10
11	3.07E+10	6.37E+10
12	2.25E+10	5.54E+10
Geometric Mean (IR_{avg})	3.57E+10	2.44E+11

Note: add rows for coupons as needed.

Metal Content (Test #2.2.20)

Objective: The purpose of this test is to determine the weight percent of metal in the solder paste. The percentage should not deviate more than +/- 1% from the solder paste specification.

Procedure: A known weight of solder paste is reflowed in a glass beaker. A "button" of solder is formed from the coalescence of the solder. The "button" is cleaned and weighed. The ratio of "button" weight to original solder paste weight is the metal percent.

Sample Results

Lot	Metal % (Type 3)
Sample 1	89.25
Sample 2	89.18
Sample 3	89.03
Sample 4	89.13
Sample 5	89.10

Viscosity (Test #2.4.34.2)

Objective: The purpose of this test is to determine the viscosity of a specific lot of solder paste. Viscosity testing is a fundamental test that ensures consistent performance from lot-to-lot.

Procedure: Approximately 500g of solder paste is stabilized at 25 +/- 1°C and the viscosity is measured using a Malcom spiral pump viscometer at 5rpm's. The results are measured and compared to the nominal value. Solder paste lots with values outside the expected variation (USL and LSL) need to be investigated for possible performance related issues.

Sample Results

Lot Number	Mfg Date	Test Date	10 rpm (3 min)	3 rpm (6 min)	4 rpm (3 min)	5 rpm (3 min)	10 rpm (3 min)	20 rpm (1 min)	30 rpm (1 min)	10 rpm (1 min)	SSF
Sample 1	4/28	4/28	2072	4107	3511	3083	2146	1599	1365	2061	.4784
Sample 2	5/3	5/3	2202	4142	3466	3097	2207	1667	1409	2107	.4683
Sample 3	5/3	5/3	2165	4168	3506	3091	2175	1656	1399	2083	.4741
Sample 4	5/9	5/9	2190	4391	3770	3325	2287	1709	1462	2192	.4776
Sample 5	5/11	5/11	2147	4225	3606	3190	2215	1678	1447	2135	.4654

Solder Ball (Test #2.4.43)

Objective: The purpose of this test is to validate soldering performance of a specific lot of solder paste. Solder ball testing is a fundamental test that ensures consistent performance for lot-to-lot.

Procedure: Three small deposits of solder paste are printed onto a ceramic coupon and reflowed at a temperature of approximately 240°C (for Sn/Ag/Cu alloys). The coupon is then inspected to ensure complete coalescence of the solder paste, and that there are no extraneous solder balls in the flux pool. Results are compared to images in the J-STD-005 to determine whether it passes or fails.

Typical Result and Image: Pass, Preferred

NC-SMQ230 Product Level Testing

Slump (Test #2.4.35)

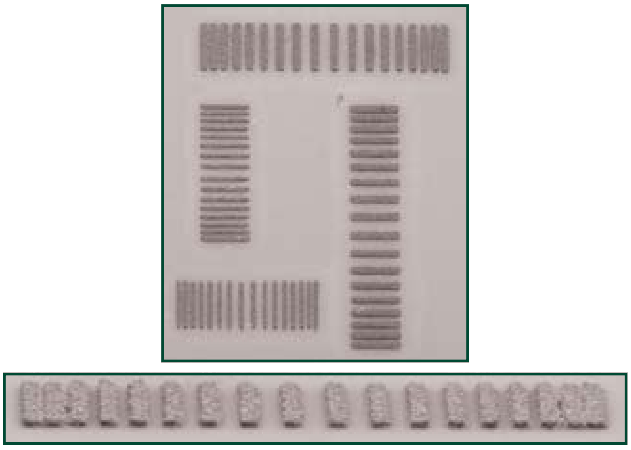
Objective: The purpose of this test is to determine the potential for slumping with a given solder paste.

Procedure: For cold slump, solder paste is printed using an IPC-A-20 stencil on an alumina substrate and examined for maximum spacing bridged. Samples are stored at 47% relative humidity at room temperature (approx. 25 +/- 5°C) for 20 minutes. Samples are then re-examined for maximum spacing bridged. For hot slump, samples are again printed with an IPC-A-20 stencil on an alumina substrate and examined for maximum spacing bridged. Samples are then heated to 180°C for 15 minutes and allowed to cool. Samples are re-examined immediately, and again after 2-hours and 4-hours, for maximum spacing bridged.

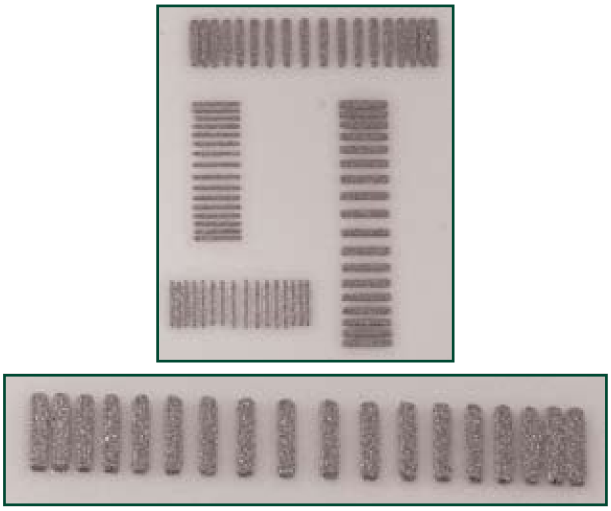
Result: Pass

Solder Paste - Slump Test (IPC-TM-650 2.4.35)

180°C



Room Temperature



Wetting (Test #2.4.45)

Objective: The purpose of this test is to ensure that the solder paste has sufficient capability to wet to a copper substrate.

Procedure: Solder paste is printed onto a clean copper coupon and reflowed using the manufacturer's recommended reflow profile. The coupon is then inspected to ensure uniform wetting and no evidence of de-wetting or non-wetting.

Results and Image: Pass

Example of Certificate of Analysis and Conformance for Solder Powder Products

PRODUCT CERTIFICATION

Alloy Integrity

Major Elements:				
	Sn	96.390 %	*Reported by:*	*LAZ*
	Ag	3.068 %	*Test Method(s):*	*AC*
	Cu	0.507 %		

RoHS Compliance:	*Actual*	*RoHS Max*
Pb	*0.0132%*	*0.1000%*
Cd	*Not Detected*	*0.0100%*
Total Cr	*Not Detected*	*0.1000%*
Hg	*Not Detected*	*0.1000%*

Indium certifies that this product meets RoHS requirements if Pb or Cd is not a part of the alloy constituency. Any product that is <99.9% pure is not certified to be RoHS compliant. Review ROHS directive for any applicable exemptions. Indium does not use any flame retardant in its product.

Impurities

0.0021%	Bi
0.0026%	Fe
0.003%	In
0.0132%	Pb
0.0118%	Sb

Total: 0.0327% (327 PPM) >99.9% Pure

Powder Size Distribution:

+270	-	0%
-270/+325	-	1.1%
-325/+400	-	36.1%
-400/+450	-	31.5%
-450/+500	-	30.5%
-500/+635	-	0.6%
-635	-	0%

Reported by: PR
Test Method(s): SA

Oxide: 0.069 %

Reported by: KMB
Test Method(s): BD

Visual Inspection: ☑ Acceptable

Reported by: KMB
Test Method(s): MS @ 100x

Comments:

CONFORMANCE STATEMENT

Indium Corporation of America certifies that all the material used in the manufacture of this order has been made in accordance with its standard procedures and practices. Test reports to substantiate the same are retained in Indium Corporation's files and are available for your examination during the agreed upon time.

William A. Jacobs

Director, Corporate Quality

APPROVING OFFICER

Nicole A. Palma

Nicole A. Palma
Quality Technician

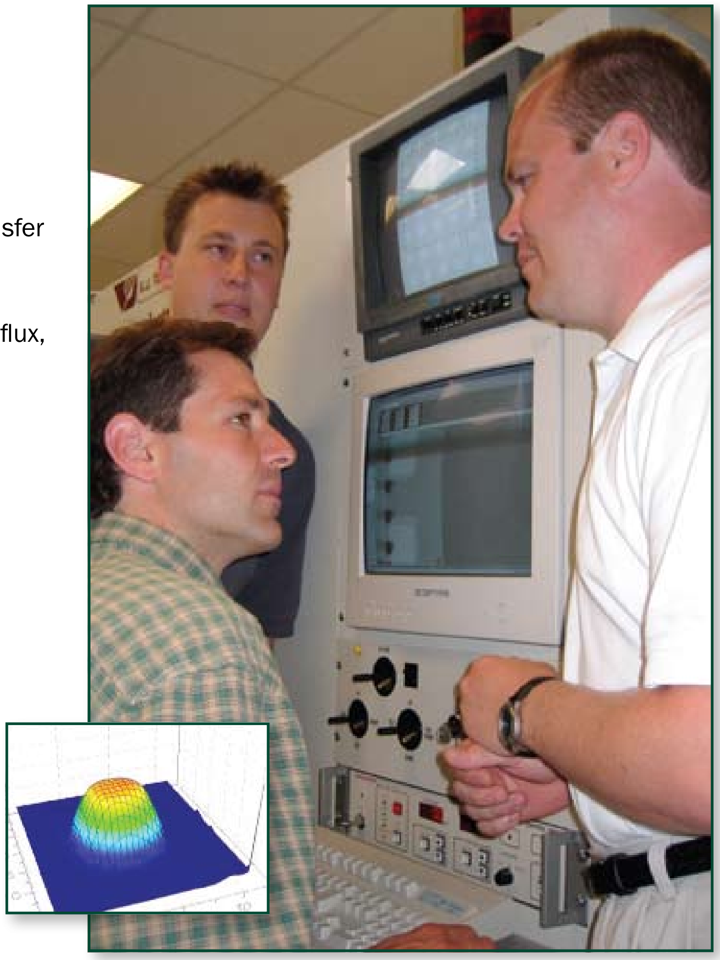
This signature was created electronically

Technical Support

Indium's Process Simulation Lab

provides Applications Engineers with the tools to work with you and industry partners on designed experiments to fully characterize SMT assembly materials and their use in leading-edge technology applications, including:

- Solder paste response-to-pause testing and transfer efficiency calculations
- Voiding analysis and characterization on BGA and CSP components using solder paste, epoxy flux, and no-flow underfill materials in micro via-in-pad applications
- Feasibility studies for new technologies and materials
- Reflow profile optimization



Indium's Process Simulation Lab Capabilities:

- Stencil printing
- Precision syringe dispensing
- Fully automated 3D solder paste inspection
- Component placement
- Forced air convection and infrared reflow
- Wave soldering
- X-ray analysis
- Acoustic microscope inspection
- Temperature-humidity-bias testing (SIR & ECM)
- Mechanical strength testing
- TG/DTA & DSC analysis
- Wetting balance testing
- Thermal cycling
- And more...

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- **Metals & Specialty Chemicals**
- **Metal Thermal Interface Materials**
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We develop, manufacture, and market soft solders, electronics assembly and packaging materials, indium alloys, and inorganic compounds.

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Increase our customers' productivity and profitability through premium design, application, and service using advanced materials.

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- *Technical and customer service*
- *Cutting-edge material research and development*
- *Extensive product range*
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