"What cannot be cleaned in a stencil cleaner?"

Prepared by

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The stencil cleaner can be one of the most versatile tools on the manufacturing floor. It can be used to clean electronic modules in various stages of the manufacturing process. In fact, an automated stencil cleaner can clean just about anything you come up against in your PCB assembly process.

Detailed in this paper are seven applications that were submitted to our applications lab providing support to the statement that there is very little that cannot be cleaned in a automated, vertical format, stencil cleaner.

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APPLICATION EXAMPLE #1:
Cleaning Stencils and Tools used to Screen Print SMT Solder Paste.

Test Protocol

A Client supplied our lab with one polished stainless stencil with solder paste residues pre applied. Two squeegees were also supplied along with a frame for holding the squeegees (see photos below).

Photo 1 Stencil as received

The squeegees were also received with solder paste applied. All samples were wrapped in plastic to prevent drying.

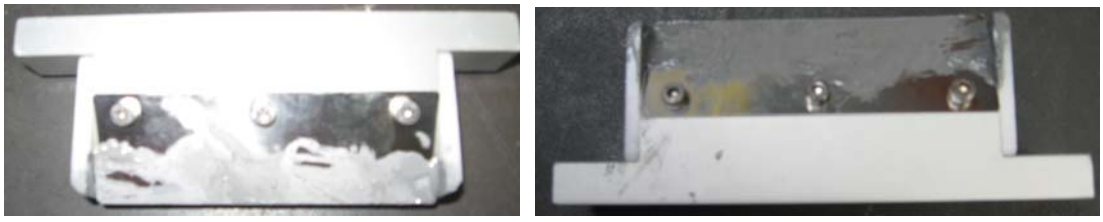

Photo 2 Squeegees as received

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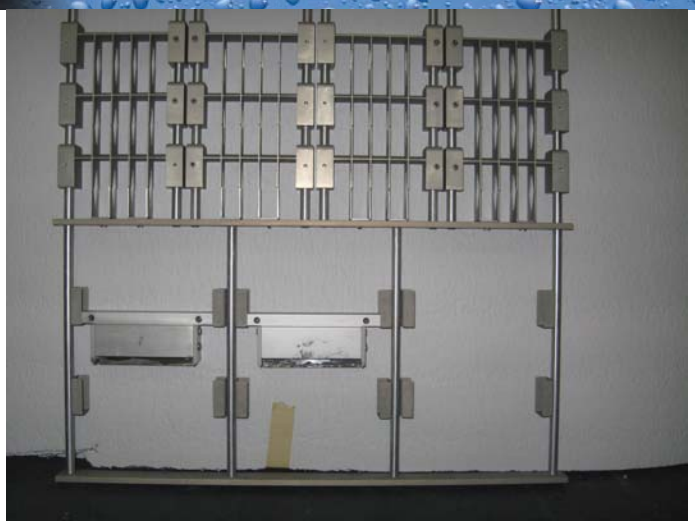

Photo 3 Squeegees in tool holding frame

The test samples were examined, as received, and primary areas of contamination were documented. The automatic stencil cleaner was set-up with Zestron SC200, a micro-emulsion Neutral pH aqueous cleaning agent. The model X-30 was set to run at ambient (no heat). Client supplied solder paste was applied to the other 3 printing patterns using a plastic squeegee.

The test samples were ran separately in sequential cycles following the recommendations of the Zestron product data sheet.

Test group	*Frame size*	*Concentration of SC-200*	*Wash temp/time*	*Rinse temp/time*
1 Stencil	23" X 23"	25%	75 F/5mins	68 F/5min
2 Tool insert w/Squeegees	20.5" X 23"	25%	75 F/5mins	68 F/5min
3 Tool insert w/Squeegees	20.5" X 23"	25%	75 F/5mins	68 F/10min

Table 1 Cleaning process parameters

Visually examine slides @ 10X for flux or solder ball remaining and note results.

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Photo 4 Test Set-up in Lab (squeegees loaded in tool holder)

Data or Results Summary: The stencil passed visual examination. The were areas in the areas etched on one side that gave the appearance of solder balls, but upon examination at 25X revealed them to be indentation in the surfaces (perhaps created previously by trapped solder balls).

Photo 5 Stencil pattern - before clean

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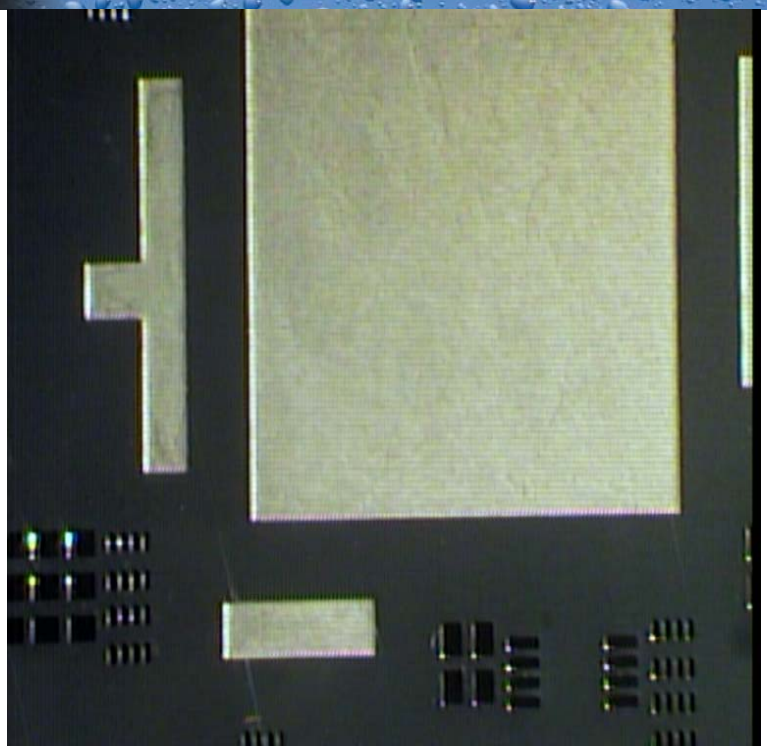

Photos 6 Stencil after clean

Conclusions: The automatic stencil cleaner will effectively remove solder paste from stencils and production tools in wash cycles ranging from 5-10 minutes.
The system proposed will not deteriorate or otherwise corrode the fixtures as solution is neutral pH water based cleaning agent. This will also simplify recycling and disposal. This system can be run closed loop wash and rinse or closed loop wash with a DI rinse to drain. We ran the latter in this test. The on-board transfer pump and filter transfers the rinse water to a remote drain. This configuration would meet the EPA standards for waste disposal to drain.

Recommendations: A standard automatic spray in air stencil cleaner with Zestron SC200 would meet the process requirements for this application. We do recommend a metering pump be purchased to enable the automatic chemical replenishment feature in the software. No heater is needed for this application all-though heating the cleaning agent would speed the process and if desired the unit should be purchased with a wash sump heater. The final equipment consideration is the heated dryer. The standard is an un-heated (room temp) vortex dry. We would recommend purchasing the heated vortex dryer option. The machine used for this test was an X30-A with a heated vortex dryer.

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APPLICATION EXAMPLE #2:
Cleaning of Epibond 7275-1 Surface Mount Adhesive from DEK Pump Print Stencil

Purpose: The purpose of this test is to determine the effectiveness of cleaning Epibond 7275-1 Surface Mount Adhesive from a DEK Pump Print Stencil in a stencil cleaner utilizing Zestron Vigon SC-200 cleaning agent at 50% concentration and room temperature.

Background: A client supplied AAT with two DEK Pump Print Stencil inserts (see photo below). These inserts mount into frames. The frames were not supplied, so all test were preformed on the stencils without frames loaded into a standard AAT holder.

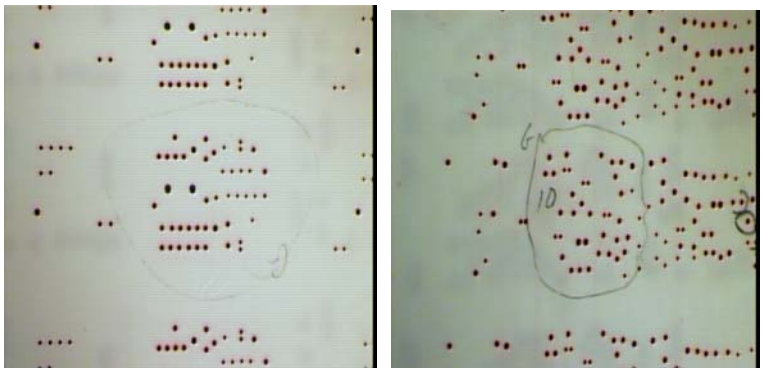

Photo 1 & 2 DEK Pump Print Stencils as supplied

The label of the adhesive used for this test is shown in photo #3.

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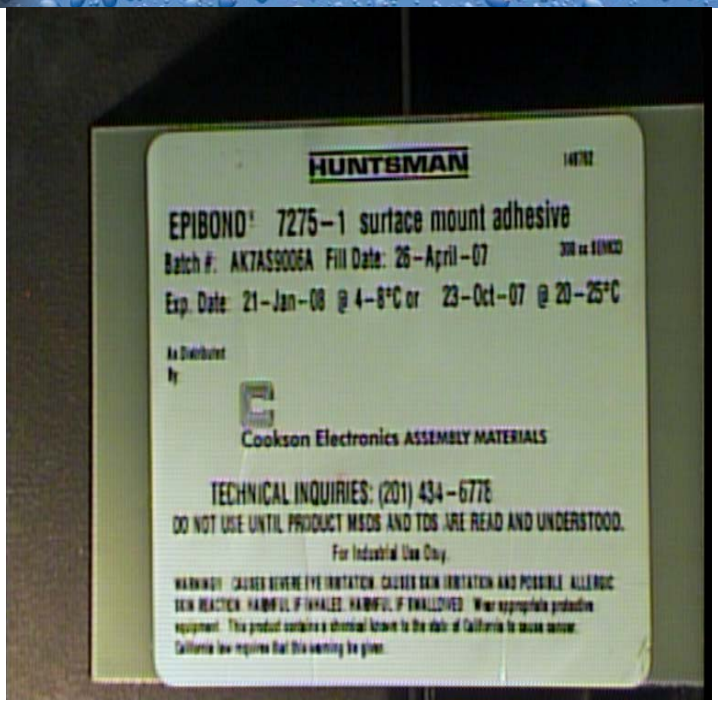

Photo 3 Adhesive label as supplied

Testing Protocol: The two test samples were examined, as received, and primary areas of contamination were documented. Each stencil was inspected for the areas of heaviest build up and blockage. Heaviest areas were assigned a name (block #) and that area was documented with a photograph for later comparison. The stencil cleaner was set-up with Zestron Vigon SC-200, a neutral pH aqueous cleaning solution at 50% concentration and cleaned in the stencil cleaner as defined in table 1:

Test group	Stencil size	Concentration of SC-200	Wash temp/time	Rinse temp/time
1 Stencil 42	22” X 22”	50%	RT (80 F)/2X8*mins	80 F/1min
2 Stencil 81	22” X 22”	50%	RT (80 F)/16mins	80 F/1min

Table 1 Cleaning process parameters * 8 two minute cycles – inspected each cycle

Apply adhesive to the stencil using a squeegee taking care to fill all holes.

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Photo #4 Adhesive application to fill pump cavities

Load the stencils into the standard stencil frame holder and activate the stencil cleaning cycle as per the parameter in table.
Visually examine slides @ 1-10X for adhesive blockage and over-all removal: note results.

Data or Results Summary: The stencils passed visual examination and showed no evidence of aperture blockage adhesive build-up following cleaning. The stencils appeared cleaner post clean than as received indicating removal of some cured adhesive. The 15 minute cycle produced a better result virtually cleaning all the new and old adhesive.

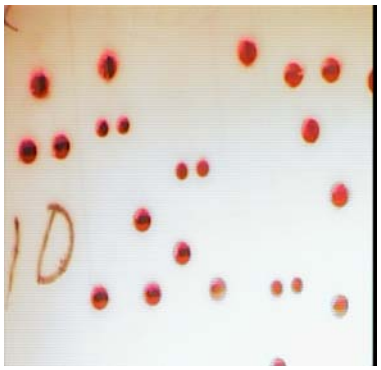

Photo 5 Stencil 42. cycle before clean

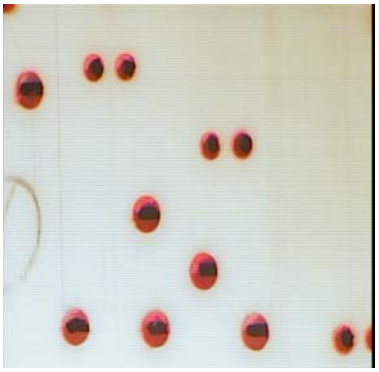

Photo 6 apertures after clean

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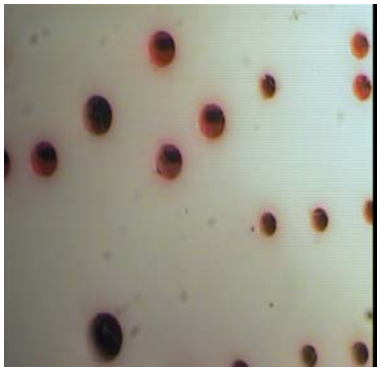

Photo 7 Stencil 81 cycle before clean

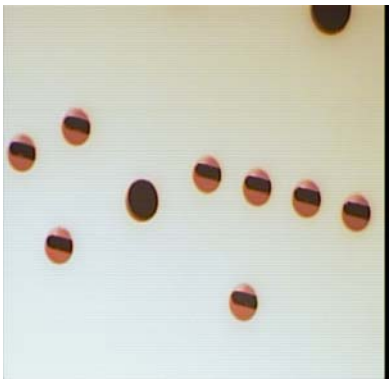

Photo 8 apertures after clean

It was noted that much of the adhesive was collected by the 10 micron cartridge filter as a solid.

Conclusions: A standard automatic spray in air stencil cleaner with Zestron Vigon SC-200 chemistry will effectively remove Epibond 7275-1 Surface Mount Adhesive from DEK Pump Print Stencils as room temperature (no heat).
We would recommend a wash cycle of 15 minutes depending on the degree of cure of the adhesive.
The system proposed did not deteriorate or otherwise effect the pump stencil as solution is neutral pH water based cleaning agent. The stencil cleaner is set up to rinse with Zestron SC-200, thus close-looping the cleaning system. This will also simplify recycling and disposal. If used with a DI rinse, this system would meet the EPA standards for waste disposal to drain in the US.

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APPLICATION EXAMPLE #3:
Removing Solder Balls and Flux Residue from Re-balled BGA's

The automated stencil cleaner can also be used for BGA rework

Example 3; BGA re-balling --- The test vehicles as received from client were VIA CoreFusion 1.0GHz BGA assemblies post re-balling. Upon receipt, the ball grid arrays were covered in Alpha WS609 residue and numerous solder balls were observed on pre-test examination. Parts were required to meet a cleanliness criteria of no solder balls or flux residues at 20X magnification and pass ROSE testing.

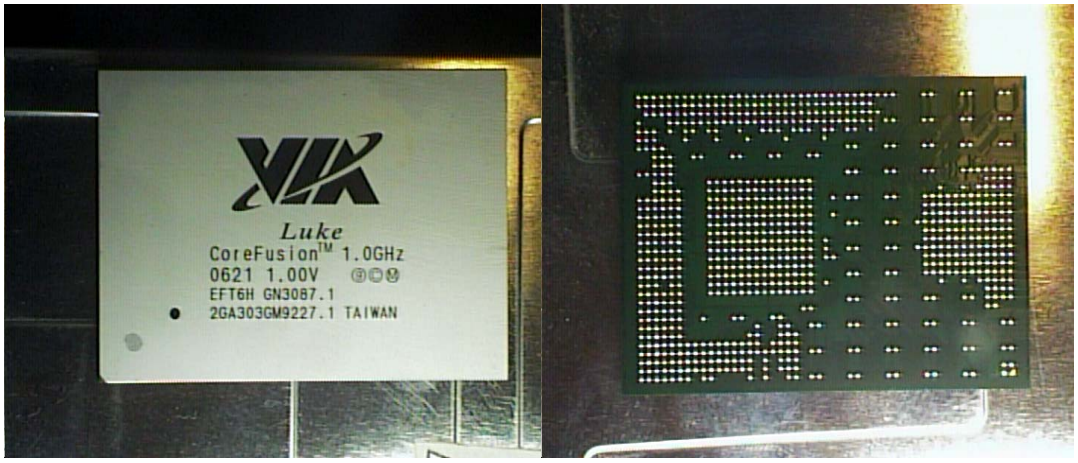

Photo 1: Overview of control test vehicle soldered w/ ws609.

BGA re-ball Cleaning – The test samples were loaded into a matrix tray and placed in the stencil cleaner. Water only, was selected as the cleaning agent as the flux was water soluble.
Process parameters – Process selection Board mode; Wash chemistry – water @55C, De-foamer – none required, DI water purity – greater than 2megohms.
Process Cycle - wash time 3 minutes, fixed DI rinse 60 sec, final rinse 1 cycle (up/down), dry 3minuutes = total cycle = 8 minutes
Results - All samples cleaned tested less than **2.8 micrograms/sq. in.** (limit <14 micrograms/sq. in.) No solder balls of flux residues were noted at 20X inspection.

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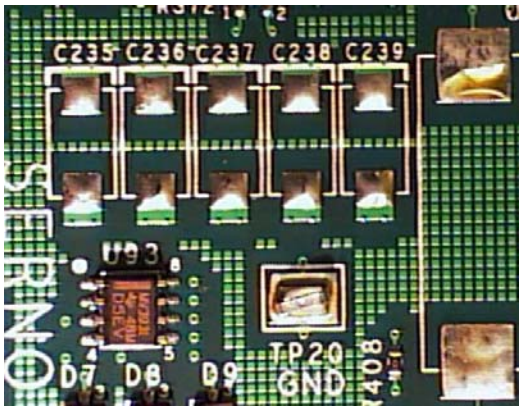
APPLICATION EXAMPLE #4: De-Fluxing SMT Glue & Wave Soldered Circuit Boards

Example 4; SMT glue and wave - Samples were cleaned in an automated stencil cleaner with water only on board cycle - side 2 (glue & wave) soldered with Alpha WS609 a (tested as defined by IPC protocol paragraph 8.3).

Process parameters – Process selection Board mode; Wash chemistry – water @55C, De-foamer – 3ml/cycle, DI water purity – greater than 2megohms.
Process Cycle - wash time 4 minutes, fixed DI rinse 60 sec, final rinse 2 cycle (up/down), dry 4minuutes = total cycle = 10 minutes



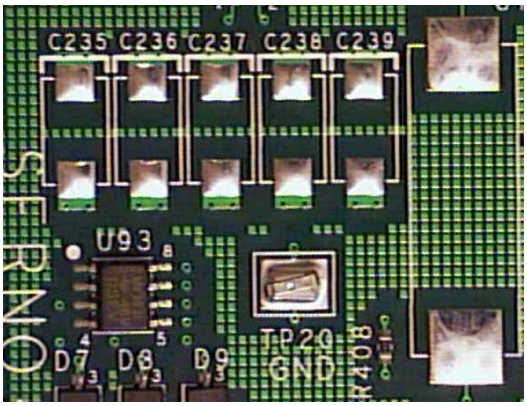


Photo 2 Before clean Photo 3 After clean in AAT X-30
Photo 2,3 Comparisons of before clean & after clean

Test Results for Ionic Cleanliness = **4.2 micrograms/in^2**

Example 3 Thru-hole wave soldering with WS 609, cleaned with water in stencil cleaner.
Process parameters – Process selection Board mode; Wash chemistry – water @50C, De-foamer – 3ml per cycle, DI water purity – greater than 2megohms.
Process Cycle - wash time 4 minutes, fixed DI rinse 60 sec, final rinse 2 cycle (up/down), dry 4minuutes = total cycle = 11 minutes

Test Data

	Visual Examination Results		Ionics Test
Sample/Group	Pre-clean inspection IPC J-STD- 001	Post-clean inspection IPC J-STD- 001	IPC J-STD- 001 Paragraph 8.3.6
Sample #1	100% flux coverage	Pass See photo #1	Ionics less than 2.2micrograms/in^2
Sample #1,2	100% flux coverage	Pass See photo #2	Ionics less than 2.2micrograms/in^2

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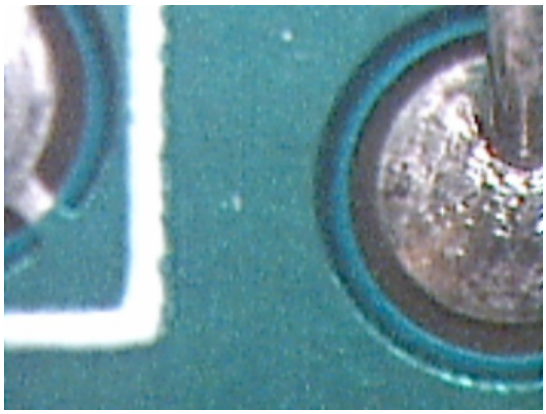
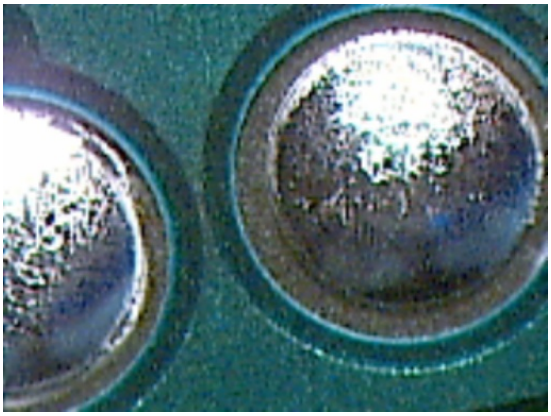


Component side



Solder side

Photo #4 Group #1 cleaned

CONCLUSION

The stencil cleaner has in many installations consistently removed the water soluble flux residue from post soldered assemblies to exceed IPC cleanliness requirements. The vertical format and high energy "spray in air" format with closely place nozzles are effective for removing water soluble fluxes used in conjunction with SMT adhesives. This is a robust process which is constantly renewed with fresh DI water which replenishes the wash purity each cycle keeping flux from building up in the wash tank keeping a steady state process.

APPLICATION EXAMPLE #5:

De-Fluxing Critical Assemblies Assembled with High Temp Solder

De-fluxing circuits assembled with high temperature solder can be a real challenge. RMA fluxes in general become increasingly more difficult to clean with high soldering temperatures and longer reflow profiles. The following example shows the results of de-fluxing "down hole" oil field sensors assembled with both RMA and water soluble fluxes and cleaned in a stencil cleaner

PROCESS TESTING

The test assembly pictured below was sent for testing.
Sections – 1-4 are fluxed and reflowed by client with RMA, 5-8 fluxed with water soluble fluxes as indicated below

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Photos #1 & 2: top and bottom of assembly submitted for testing

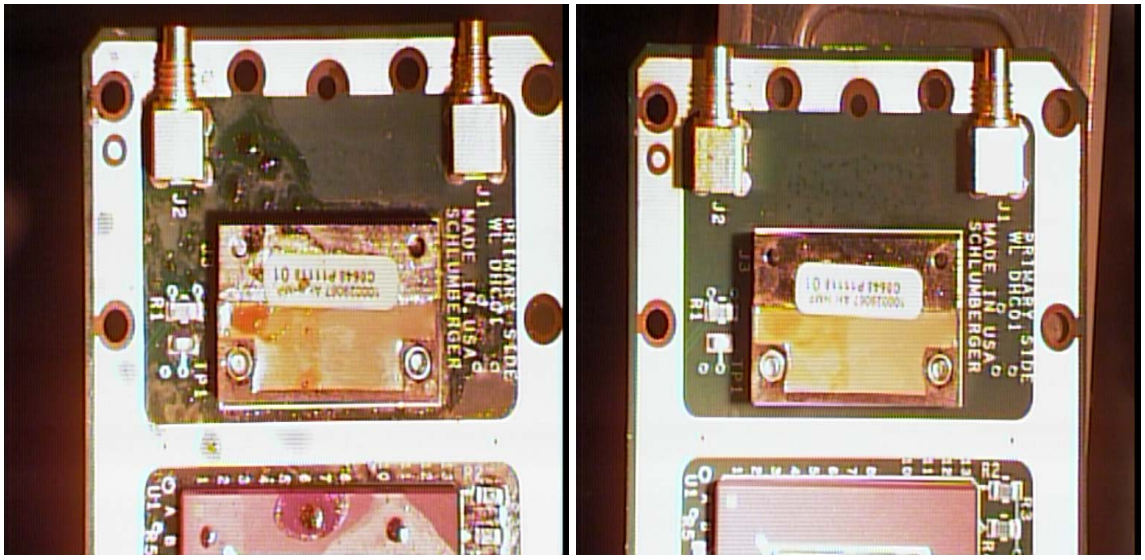
Testing Protocol

1. Take before cleaning photos of each section of the test board to document starting conditions.
2. Clean the test board in the X-30 cleaner using Zestron Vigon A200 @ 10% concentration at 150F for a 15 minute wash followed by a 2 minute DI rinse and 140F heated dry.
3. Remove the test board from the cleaner and re-inspect test board, Take new photos of sections documented earlier.

PROCESS RESULTS

Cleanliness Results

The cleaning process described above removed all flux residues (20X inspection).



Photos 3 & 4: Section 8 top side before and after clean

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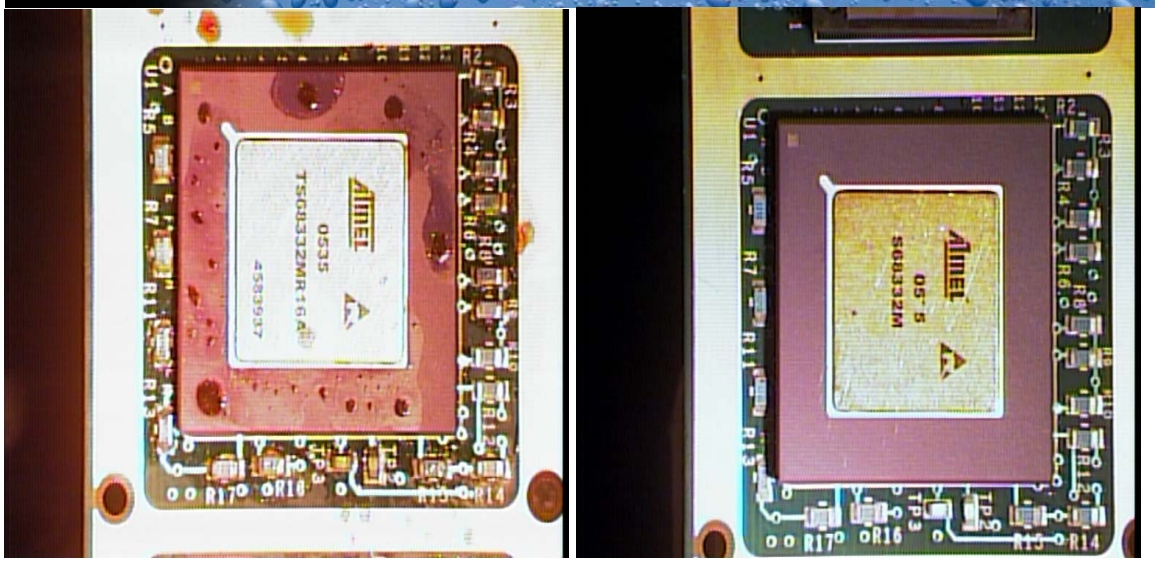
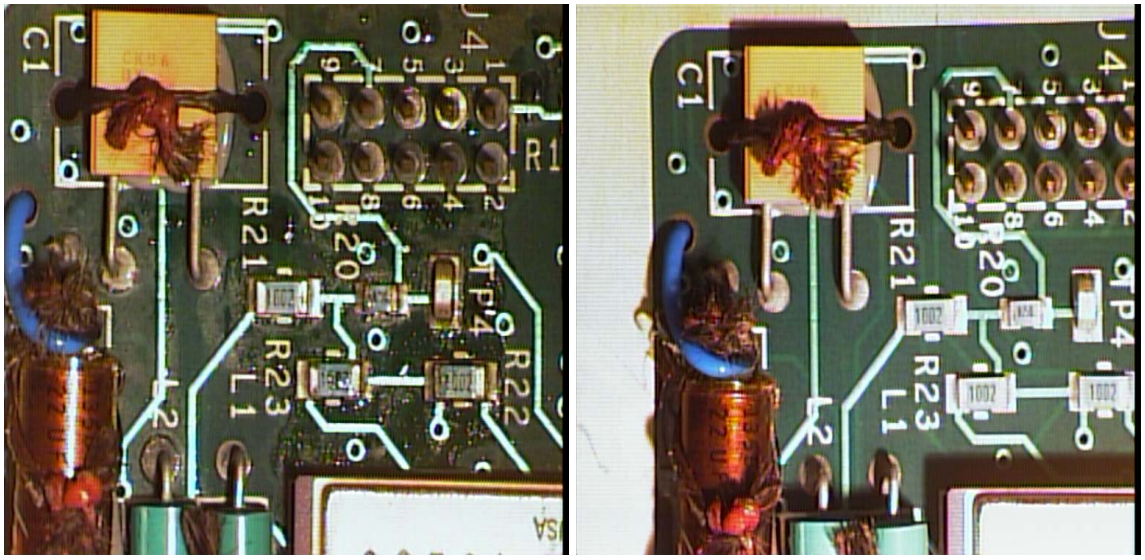


Photos 5 & 6: Section 7 top side before and after clean



Photos 7 & 8: Section 6 top side before and after clean

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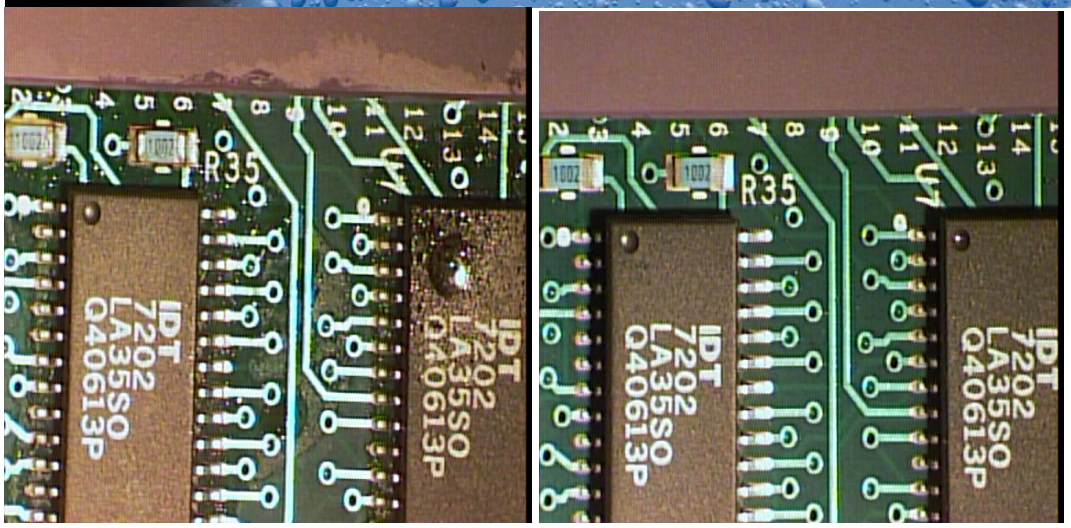
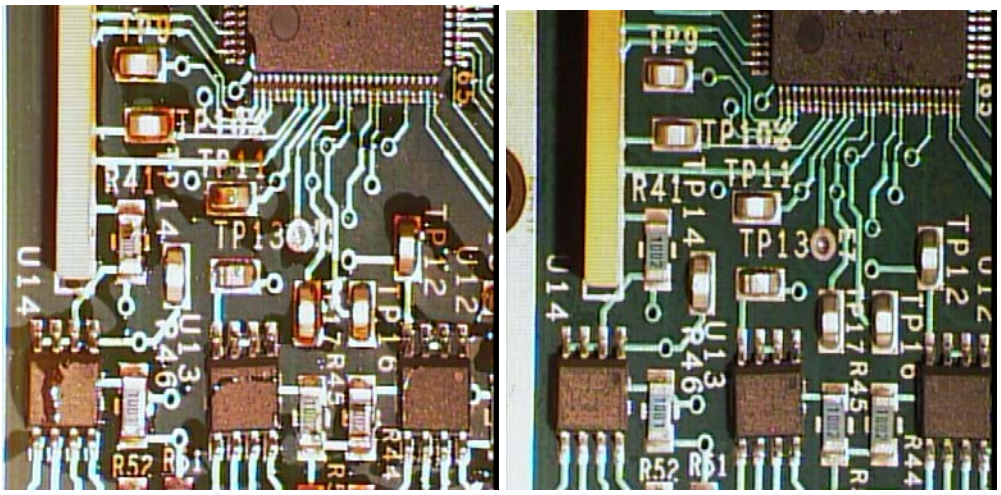


Photos 9 & 10: Section 5 top side before and after clean



Photos 11 & 12: Section 4 top side before and after clean

Process Cycle - wash time for high temp de-fluxing was 15 minutes, fixed DI rinse 2 minutes, dry 3minuutes = total cycle = 20 minutes.
Stencils would require a 3 minute wash with a total cycle around 8 minutes.
Mis-printed boards – a 5 minute wash (10 minute cycle).

RESULTS and RECOMMENDATIONS

The automated stencil cleaner with Zestron Vigon A200 did completely clean the reflowed RMA and water soluble fluxes supplied to 20X visual standards.

We recommend the purchase of an automatic stencil cleaner with a dual programming switch, a heated vortex dryer, and a spring loaded work board holder to hold the assembly in the cleaning process. The spring loaded board holder is easy to load and can hold multiple boards. It loads just like a stencil.

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APPLICATION EXAMPLE #6:
Subject: Cleaning of flux and conformal coating from assembly fixtures

Background: A Client supplied AAT with one wave soldering pallet with removable insert and one conformal coat fixture with manufacturing residues (see photo below). The wave solder pallet frame was constructed from aluminum extrusions and stainless steel and the insert appeared to be a high temperature (black) glass filled epoxy composite with stainless hardware. There was dried flux residue on the insert and the frame.

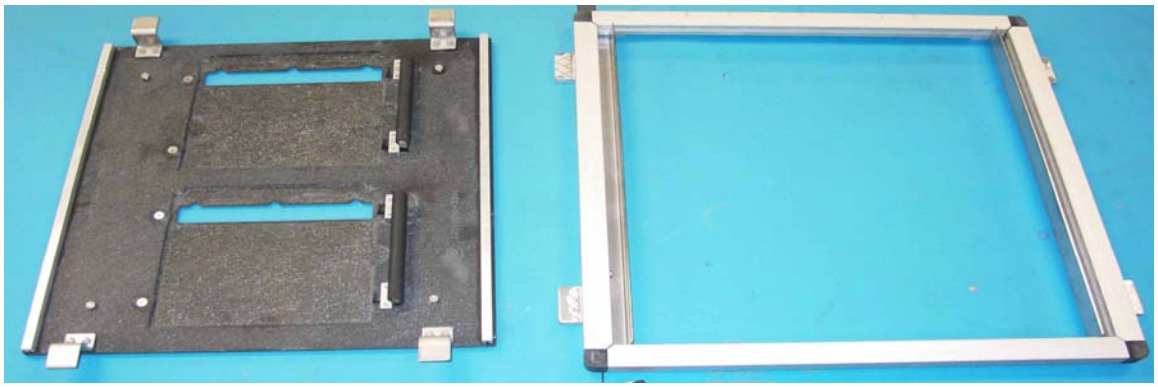

Photo 1 Wave solder pallet and insert

The conformal coat fixture was fabricated from what appeared to be standard fiberglass laminate ~ 0.25" thick with stainless hardware. The conformal coat fixture had substantial build-up of cured acrylic conformal coating. It was particularly thick around the stainless capture hardware.

Photo 2 Conformal coat fixture

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Testing Protocol: The two test samples were examined, as received, and primary areas of contamination were documented. The stencil cleaner was set-up with Petroferm SP-50, a neutral pH aqueous cleaning solution as defined in table 1

Test group	Frame size	Concentration of SP-50	Wash temp/time	Rinse temp/time
1 Wave pallet	18" X 18"	25%	130 F/5mins	120 F/1min
2 Wave insert	17" X 17"	25%	130 F/5mins	120 F/1min
3 C. coat pallet	17" X 16"	25%	130 F/15mins	120 F/1min

Table 1 Cleaning process parameters

Visually examine slides @ 25X for flux or water residue and note results.

Data or Results Summary: The Wave solder pallets (WSP) passed visual examination and showed no evidence of flux, conformal coating, or water residue following cleaning.

Photo 3 WSP before clean

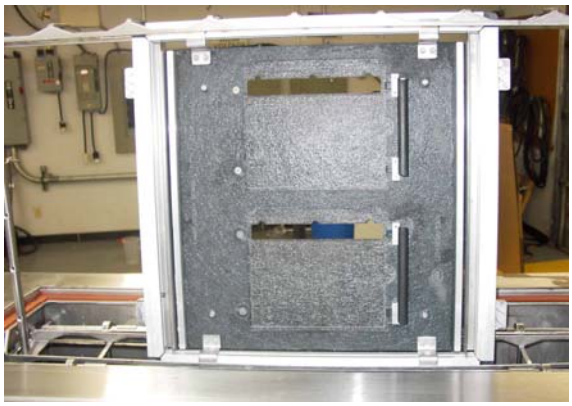

Photo 4 WSP after clean

The conformal coat pallet was first washed in a 25% solution of Petroferm Hydrex SP-50 for 5 minutes. The top surface of the pallet was clean of residues. The inside of the picture frame and areas in the cut out around the capture hardware had residue remaining. The pallet was cleaned an additional 10 minutes and upon examination was residue free in these areas (see photo 5)

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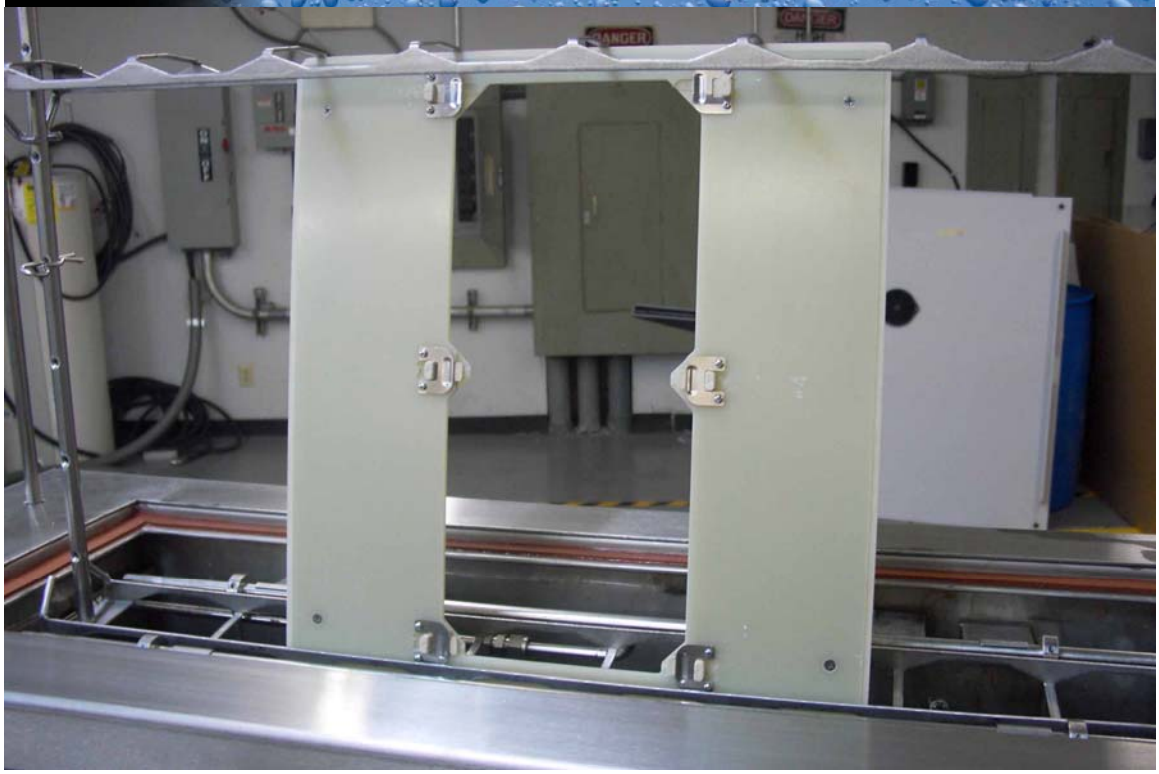

Conclusions: The standard automatic stencil cleaner will effectively remove flux and conformal coating from production fixtures in wash cycles ranging from 5-15 minutes. This cycle time could be further shortened by raising the wash temperature from 130F to 140-150F or increasing the concentration of the SP-50 cleaning agent.

The system proposed will not deteriorate or otherwise effect the fixtures as solution is neutral pH water based cleaning agent. This will also simplify recycling and disposal. This system would meet the EPA standards for waste disposal to drain.

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APPLICATION EXAMPLE #7:
Subject: Cleaning Solder Paste from Mis-printed Circuit Cards

Subject: Selecting an Aqueous Chemistry for Removal of Alpha 6106 Paste from Mis-printed Circuit Cards

Purpose:
To determine an acceptable aqueous based cleaning method for removing Alpha 6106 solder paste from stencils and misprinted circuit cards.

Testing Protocol:
Part one – Screening Tests: Test samples were prepared by coating sample boards with a uniform layer of solder paste ~ 10-20 mils thick using a hand squeegee. Each sample was immersed and agitated for one minute in the test solution. Visual inspections were performed at 15 second intervals.
Cleaning solutions selected for screening
A) Water only (base line)
B) Isopropyl Alcohol (base line)
C) Alpha 2110 saponifier
D) Kyzen 4520
E) Petroferm Hydrex SP50
F) Zestron A200

Part two – Panel Tests: A customer supplied sample panel was coated as indicated in part one above, and cleaned with the best performer found in the screening test.

Data or Results Summary: Results of the screening test (part one)

Group	Cleaning agent	{%}	Wash Time	Wash temp	% removed		pH
A	Water	100%	2 minutes	130 F	0%	fail	8
2	IPA	100%	2 minutes	80 F	100%	pass	7
3	Hydrex SP50	25%	2 minutes	130 F	100%	pass	6
4	Hydrex SP50	10%	2 minutes	130 F	100%	pass	6
5	Kyzen 4520	25%	2 minutes	130 F	100%	pass	10.5
6	Kyzen 4520	10%	2 minutes	130 F	75%	fail	10
7	Zestron 200A	25%	2 minutes	130 F	0%	fail	10
8	Alpha 2110	10%	2 minutes	130 F	100%	pass	11

Results of machine test
Machine testing was performed with the Hydrex SP 50 cleaning agent using a 3 minute wash cycle at 130F using the panel supplied by Tellabs. The board was examined at 20X magnification and passed. No significant solder paste residue was noted around pads or in via holes.

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Conclusions: Based on the test results AAT would recommend the use of 10% aqueous solution of Hydrex SP 50 from Petroferm in a stencil cleaner with a PCB/Stencil program selector, PCB water knife, and a hot vortex dryer. Hydrex is a pH neutral cleaning agent.

Stencil cleaning parameters for SP-50 recommended – wash 130F for 4 minutes, drip time 90 seconds, 60 second ambient water rinse (DI preferred), Hot vortex dry for 90 sec.
Total cycle ~ 8 minutes

Misprint cleaning parameters - wash 130F for 4 minutes, drip time 90 seconds, 60 second ambient water rinse (DI preferred), water knife rinse (up-down DI required), Hot vortex dry for 120 sec.
Total cycle ~ 10 minutes

Waste Management – Based on the chemistry recommended AAT recommends pumping the rinse water to drain through an external HMR chelation bed to removed dissolved heavy metals. You may want to add a carbon bed to remove organics as well. Corresponding photos are below.

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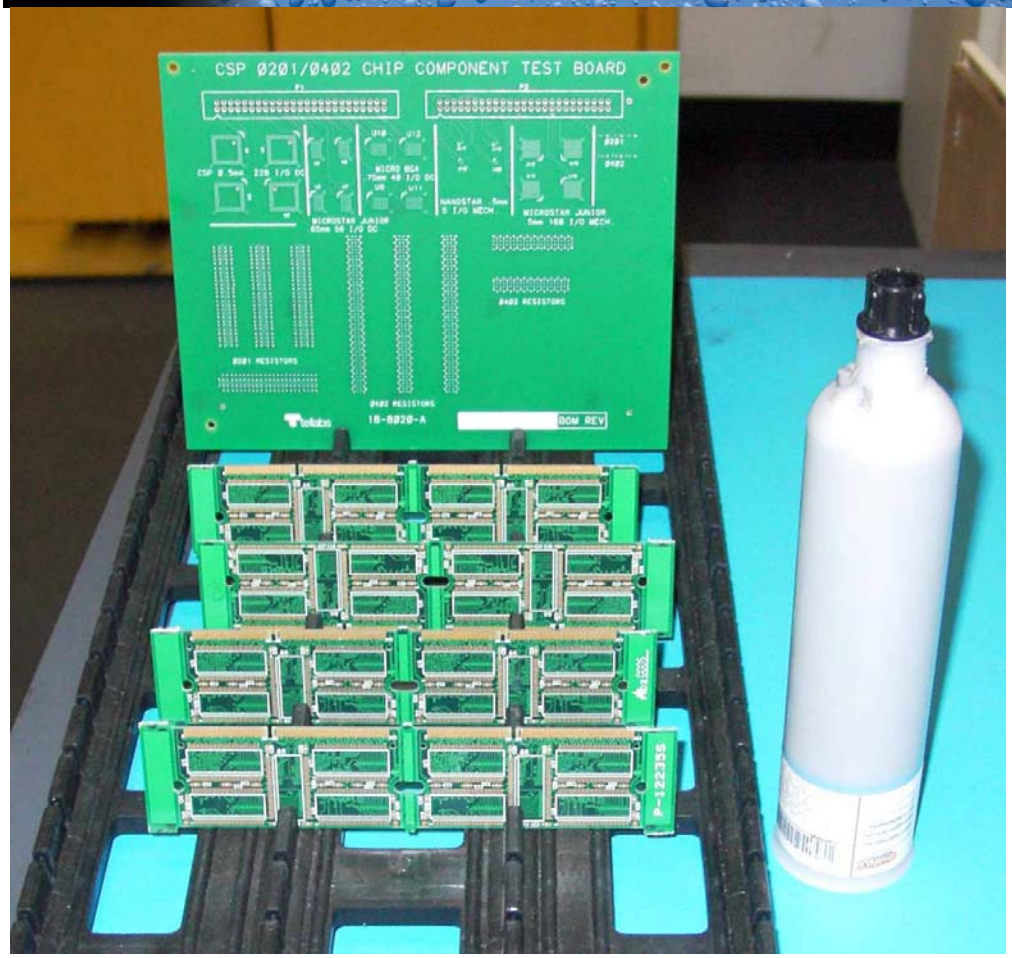
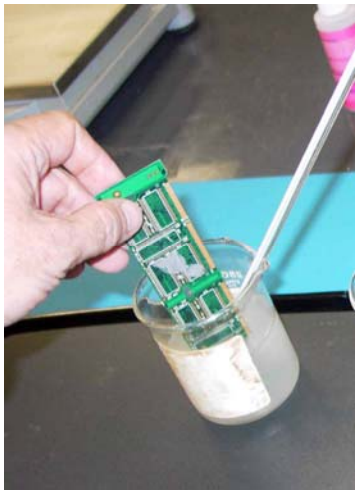


Photo 1 Test board, test strips and solder paste as received



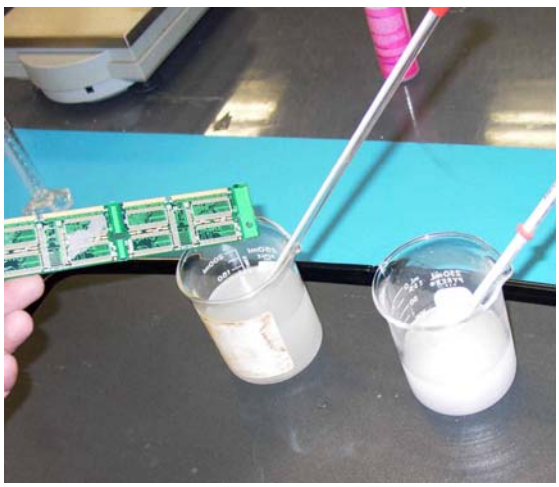


Photo 2 and 3 Screening tests

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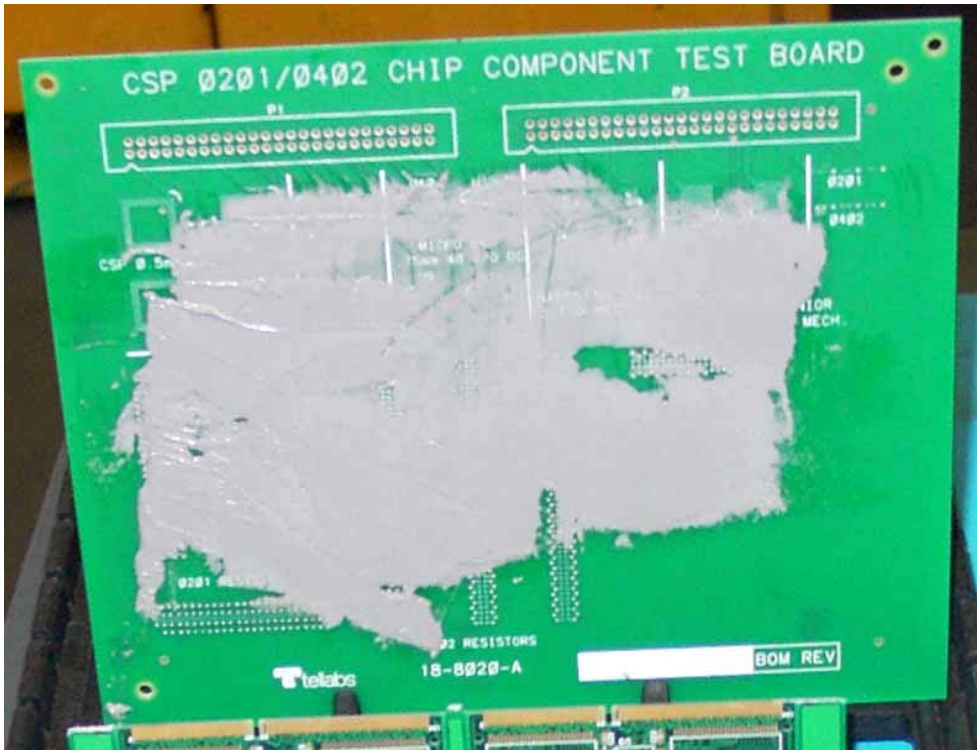

Photo 5 Test panel with solder paste applied

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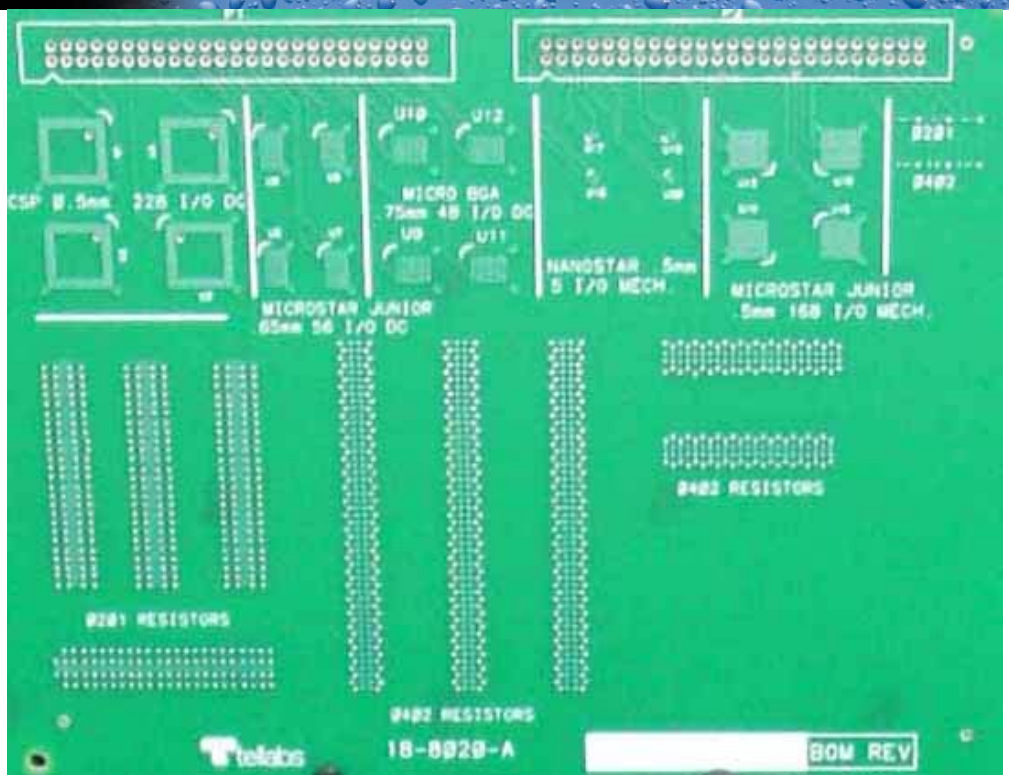

Photo 6 Board after machine clean

Cleaning misprinted boards ---- Very early in the development of the X-Series cleaner a mis-print option was developed for reclaiming circuit cards not printed properly. Boards misprinted in the solder paste printing process can be cleaned of remaining solder paste for reprinting. A special option, referred to as the "mis-print option" adds a second rinse and provides a longer dry time for circuit assemblies. Both mis-prints and final clean boards are held in an easy to load "spring loaded work board holder" as shown in the photo below

Photo: X-30 configured with the spring loaded board holder

The high impingement "Spray in Air" cleaning system is very effective in removing solder paste from either 1st or 2nd side mis-prints. The selection of the mis-print cycle is made on the selector switch on the front panel prior to starting the cycle. Many applications have proven this approach to be superior to ultrasonic cleaners.

Other Cleaning Applications not show with application examples

Large format board cleaning ---- The X40 can clean back panels and other very large boards up to 36" X 40". An accomplishment no other cleaner can match.

Photolithography etching, developing, and stripping ---- The x-series has seen service in developing and stripping photo sensitive films.

Conclusion: As demonstrated in the many applications shown, the AAT X-Series vertical format automated batch cleaner can be used for many manufacturing cleaning operations. Its flexibility allows many solvent selections and the X-Series can be used to clean most materials used in electronic assembly. This truly sets it apart from any other cleaning system.

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