Ducommun LaBarge Technologies (DLT) specializes in solutions - smart, innovative and reliable answers to customers' needs. Their full-service approach combines broad-based manufacturing capabilities and extensive value-added services, including professional engineering support and program management to help their customers achieve their goals. DLT draws upon best-in-class processes, their continuous improvement culture and a passionate commitment to excellence to deliver quality in everything they do.

DLT’s niche in the broad Electronics Manufacturing Services (EMS) industry is low-to-medium volume production of highly complex, high rate-of-change electronic and electromechanical products and systems. Their full-service EMS capabilities include cable assemblies and interconnect systems, printed circuit board assemblies, higher level electronic and electromechanical assemblies, system integration, engineering and design support, and program management.

As an established EMS provider with a proven track record for engineering expertise and product quality, DLT qualified their processes for numerous customers by consistently exceeding the cleanliness specification required; that is, a contamination level of less than 10µg/in² as per the IPC-TM-650 test method for Ionic Contamination. Now they had an opportunity to earn new business, however, the qualification process included an additional requirement, passing an SIR test.

Intrinsic to their SMT process, DLT used a chemistry assisted spray-in-air inline cleaning system that had proved satisfactory for their needs thus far. However, upon considering this new customer opportunity and proceeding through the qualification process, DLT found that with their current process, they were unable to meet the SIR hurdle, failing the test several times. Furthermore, the SIR test failure was traced to residual flux, particularly underneath components.

Initially, three qualification attempts were made in order to pass the SIR test. All three attempts failed the test. As each attempt was completed, process changes were implemented in the subsequent attempt, yet to no avail. Following the second failed attempt, DLT teamed with ZESTRON to assess their cleaning process and develop a Design of Experiment (DOE) that would define a process capable of meeting the new qualification standard.

INITIAL TEST PROCEDURE - QUALIFICATION ATTEMPTS
The new customer requirement was for Circuit Card Assemblies (CCA) to be fabricated with a no-clean solder paste and RMA liquid flux, each of which DLT had been using for products built for their existing customer base. Thus, DLT approached this new opportunity utilizing their existing process and fully expecting the product build to meet their customer’s specification including passing the required SIR test.
In order to qualify their process for this new customer, DLT used the IPC-B-36 test coupon and their current SMT procedures in the build process. The cleaning process test protocol followed for the initial three qualification attempts was as follows:

**Inline cleaner configuration:**
- Cleaning agent concentration: 12%
- Wash temperature: 145°F
- Inline belt speed: 1.6 ft/min
- Wash zone configuration:
  - Spray bars: 4
  - One hurricane jet
  - 10hp wash pump

As an additional check on product quality throughout the process, several Ionic Contamination analyses were conducted, even though these were not required for the qualification. These tests were conducted at DLT with results consistently meeting their quality standards. Following the completion of the assembly process, the board samples were sent to a certified lab for SIR analysis as required by the qualification standards.

Upon receiving the SIR test results from the first attempt, DLT was surprised to learn that none passed. Furthermore, the test results indicated that insufficient cleaning was the root cause of the failed test. DLT examined their cleaning process and for the second attempt, manually cleaned the boards as well as passed them through the inline cleaner four times. Once again, the SIR test failed.

For the third attempt, DLT utilized the IPC-B-52 test coupon. DLT felt that this coupon was more representative of typical production style components as compared to the IPC-B-36. On the IPC-B-52 coupon, the components have increased spacing between the component body and the PCB, and are therefore thought to be easier to clean and more likely to pass the SIR test. The previous process parameters for the inline cleaner were maintained, however, the cleaning agent concentration was increased to 16%.

Once again, the boards failed the SIR test. Additionally, due to the 16% concentration, compatibility issues surfaced as part of the markings were removed.

**DESIGN OF EXPERIMENT**
As the qualification testing attempts progressed, DLT realized that their current cleaning process may not yield a satisfactory result. Thus, they began to analyze all parts of the cleaning process including equipment process settings and cleaning chemistry selection. Seeking assistance with this process, DLT teamed with ZESTRON in order to evaluate their current process and create a DOE with the goal of identifying a process capable of producing CCAs that would pass the required SIR test and thus meet their new customer qualification standards.

Following ZESTRON's recommendations and utilizing the newly selected cleaning agents, the DOE was developed and implemented in two phases at ZESTRON’s Technical Center in Manassas, VA. Phase 1 was designed to replicate the current DLT cleaning process and through various parameter adjustments, potentially improve the cleaning results. If the Phase 1 trials yielded positive results, the Phase 2 trial would then be executed. This trial was designed to clean boards for SIR testing using the optimum process settings from the Phase 1 trials.

For Phase 2, the boards were soldered at DLT and shipped overnight to ZESTRON. These boards were cleaned within 24 hours of reflow.

**DOE RESULTS**

**PHASE 1 TEST PARAMETERS:**
- Inline cleaner configuration:
  - ATRON® AC 205 and VIGON® A 201
  - Concentration: 10% and 15%
- Wash temperature: 140°F, 150°F and 155°F
- Inline belt speed: 1.6 ft/min, 1 ft/min, 0.8 ft/min and 0.6 ft/min
- Wash zone configuration:
  - Spray bars: 4, 8 and 16
  - One hurricane jet
  - 15hp wash pump

**Process protocol:**
- ESD procedures followed throughout
- Test coupon: Eleven IPC-B-36 single-sided coupons populated with four LCC-68 components
- All coupons were passed through the inline cleaner one time

The test results and process parameters are indicated in Table 1.

Figures 1, 2 and 3 are representative pictures of boards prior to cleaning.

Figures 4, 5 and 6 are representative pictures to illustrate the different ratings used for evaluating board cleanliness.

As represented by boards 7, 8, 9, and 10, both ATRON® AC 205 and VIGON® A 201 cleaned over 95% of the flux residues from underneath the components in a single pass.

**Coupon pictures before cleaning:**

**Coupon pictures after cleaning:**

**Figure 1:** Flux residues around the leads of the component

**Figure 2:** Flux residues underneath the component

**Figure 3:** Flux residues on the underside of the component

**Figure 4:** Visual inspection observation: <75% clean

**Figure 5:** Visual inspection observation: >75% clean

**Figure 6:** Visual inspection observation: +: >95% clean

**Table 1**

<table>
<thead>
<tr>
<th>Test coupon</th>
<th>IPC-B-36</th>
<th>IPC-B-52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test results</td>
<td>Passed</td>
<td>Passed</td>
</tr>
<tr>
<td>Process parameters</td>
<td>10hp wash pump</td>
<td>15hp wash pump</td>
</tr>
</tbody>
</table>

Thus, the optimum inline parameters were determined to be as follows:
- Cleaning agent concentration: 10%
- Wash temperature: 155°F
- Inline belt speed: 0.6 ft/min
- Wash zone configuration:
  - Spray bars: 16
  - 15hp wash pump

Due to the positive results from ZESTRON in the Phase 1 trials of the DOE, DLT agreed to proceed with Phase 2. However, for this trial, it was decided to select VIGON® A 201 due to its ability to filter out contaminants.

Refer to Table 2 for Phase 2 inline operating parameters.
PHASE 2 TEST PARAMETERS:
DLT supplied twelve IPC-B-36 test boards to ZESTRON. Of these, ten boards were populated with four LCC-68 components (Figure 7) and the remaining two were left unpopulated and maintained as control boards.

PHASE 2 SIR TEST RESULTS:
DLT sent five of the IPC-B-36 coupons to a certified lab for SIR testing. All boards passed the Comb Pattern, Perimeter Pattern and Daisy Chain Pattern Resistance measurements (Figures 8, 9 and 10).

QUALIFICATION PROCESS
Based on the results of the DOE and particularly the SIR results from the Phase 2 trial, DLT qualified their process for the new customer. Additionally, this process demonstrated that the cleanliness level for their existing product lines would be greatly improved by adopting the Phase 2 process parameters including the cleaning agent change. However, most of their customers are military and as such, their production process and specifically, the cleaning process, would have to be re-qualified. DLT presented all the data from the Phase 2 study to their customer base and in the ensuing weeks gained the approval from all to change the operating parameters of their cleaning process including the use of a new cleaning agent. As stated by Ken Van Zill, Senior Quality Engineer, DLT,

"The hardest thing to do with the industry we are in is to get all of our primes to agree to allow a major process change. Although this took some time and many conference calls to answer any outstanding questions or concerns, we did finally get everyone of our customers to approve this change."

Thus, with the mechanical improvements made to DLT’s inline cleaner and process parameters used as defined in Phase 2 of the DOE, VIGON® A 201 was implemented, the new customer business was secured and overall quality was improved throughout the DLT product line. Material compatibility reports were also submitted to DLT which proved the compatibility of all major board materials with VIGON® A 201.

CONCLUSIONS
In addition to achieving improved product quality, the new process provided many benefits to DLT in terms of reduced costs that were realized in the ensuing months following implementation. These are:

<table>
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<tr>
<th>Board #</th>
<th>Chemistry</th>
<th>Concentration (%)</th>
<th>Temperature (°F)</th>
<th>Belt Speed (ft/min)</th>
<th>Results</th>
<th># of spray bars</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>-</td>
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<tr>
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<td>1</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>ATRON® AC 205</td>
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<td>150</td>
<td>0.8</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
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<td>0.6</td>
<td>++</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
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<td>155</td>
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<td>++</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
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<td>++</td>
<td>0</td>
</tr>
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<tr>
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<tr>
<td>11</td>
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<td>15</td>
<td>155</td>
<td>0.6</td>
<td>++</td>
<td>+</td>
</tr>
</tbody>
</table>

++: 100% clean  +: >95% clean  0: >75% clean  -: <75% clean

Table 1 - Test Results and Process Parameters

Table 2 - Inline Operating Parameters

Cleaning Process | Inline
--- | ---
VIGON® A 201 Concentration | 10%
Conveyor Belt Speed | 0.6 ft/min
Wash Pressure (Top/Bottom) | 55 PSI / 30 PSI
Wash Hurricane Pressure (Top) | 0 PSI
Cleaning Temperature | 155°F / 68°C

Rinse
Rinsing Agent | DI-water
Rinse Pressure (Top/Bottom) | 85 PSI / 80 PSI
Rinse Hurricane Pressure (Top/Bottom) | 85 PSI
Rinsing Temperature | 150°F / 65°C
Final Rinse Flow Rate | 2 gal/min
Final Rinse Temperature | Room Temperature

Drying
Drying Method | Hot Circulated Air
Drying Temperature | 140°F-160°F 60°C-71°C

Figure 7: Populated IPC-B-36 Coupon
Figure 8: Comb Pattern Resistance Measurements
Figure 9: Perimeter Pattern Resistance Measurements
Figure 10: Daisy Chain Pattern Resistance Measurements
ASIA UPDATE

ZESTRON Opens Japan Headquarters and Technical Center

ZESTRON Japan, located in Kanagawa, opened in December 2012. This expansion represents the 4th Asian Technical Center and the 6th in ZESTRON’s worldwide footprint.

Mr. Daido Sawairi, General Manager, with over 20 years of extensive experience in international industrial equipment sales and new business development and management, leads the team.

This investment enables ZESTRON to introduce leading edge aqueous based cleaning agents within this market as an environmentally sound alternative to the many solvent based cleaning products currently used.

AMERICAS UPDATE

ZESTRON America Sales Team

ZESTRON America supports its customers with four regional sales managers in coordination with a dynamic group of sales representatives as well as key distributors in Canada, Mexico, Brazil, and Argentina.

National Sales Manager

Effective January 1, 2013, Richard Burke was promoted to National Sales Manager. In this position, Richard is responsible for national sales while he continues to manage his Northeast territory. In addition to serving ZESTRON for three years, Richard has more than 23 years of professional experience within the electronics manufacturing industry including technical sales and marketing as well as product and program management.

Midwest Sales Manager

In December of 2012, John Neiderman joined the ZESTRON Sales team as the Midwest Regional Sales Manager. John brings to ZESTRON over 13 years of sales and technical experience within the precision cleaning industry complementing our customer focused Sales and Application Technology Team.

ZESTRON Academy

Are you looking for learning opportunities to enhance your knowledge about high precision cleaning? ZESTRON @cademy launched the 2013 free of charge cleaning webinar series in January. ZESTRON’s accredited application engineers as well as featured leading industry experts will present the webinars. ZESTRON will also host workshops throughout the year. For a complete list of webinar topics, workshop opportunities and registration information, please visit www.zestron.com or email infousa@zestron.com.

Cleaning Questions? ZESTRON Has Answers.

AMERICA | EUROPE | JAPAN | EAST CHINA | SOUTH CHINA | SOUTH ASIA