Optimizing PCB Cleaning By Process Control

by Michael Schneider, Rohde & Schwarz

Rohde & Schwarz, one of the leading global manufacturers of measuring and communications technology, qualified the Zestron Bath Analyzer as the monitoring method for its assembly cleaning process. The company offers unique solutions, which enhance efficiency, quality and reliability in electronic testing and measuring technologies as well as communications. The portfolio ranges from applications in the field of test/measuring technology, wireless communications, HF and microwave, audio, video and broadcast radio to general electronics applications and services. The products are used in the development of mobile transmission equipment, flight safety systems for both, civilian and military use, encryption systems, terrestrial transmitters as well as video processing systems. Highest quality, consistency and reliability are thus a standard at Rohde & Schwarz.

The company's largest manufacturing plant is located in Memmingen, Germany, with a main focus on manufacturing equipment and entire systems, microelectronics and assemblies/modules. The process of PCB manufacturing may be subdivided into the steps illustrated in Figure 1.

After soldering, a cleaning process is incorporated in order to ensure the successful completion of further processing steps. Additionally, the entire manufacturing process is controlled by a quality assurance program and testing procedures, including temperature and climate tests of the completed assembly.

Reasons for bath monitoring

When assemblies are cleaned, the removed flux residues remain in the cleaning bath. Depending on the flux type and volume, they can affect the bath life significantly. Additionally, the bath life is influenced by numerous process parameters including the cleaning agent concentration, temperature, filtration efficiency and the bath volume. These parameters are the key to a stable and reliable process and thus need to be continuously monitored. With the exception of the concentration level, all these process parameters can be controlled by the cleaning machine and adjusted if necessary.

Poor and irregular process monitoring can lead to process imbalance resulting in quality inconsistencies in the cleaning results. Insufficient cleaning can negatively impact subsequent processes such as wire bonding and conformal coating, as the required surface cleanliness cannot be guaranteed. This in turn can have a crucial effect on the functional capabilities and the reliability of the assemblies in the field. Electrochemical migration, leakage currents and insufficient adhesion of the coating are a few examples of failures, which may result from an insufficient cleaning process.

Cleanliness requirements

In cooperation with Zestron, a manufacturer of cleaning agents for the SMT and Semiconductor Backend industry, Rohde & Schwarz evaluated a Vigon product as a suitable agent for assembly cleaning. The water-based, slightly alkaline MPC cleaning agent can be used in various cleaning machines featuring spray-in-air or spray-under-immersion agitation. Due to the subsequent coating process, Rohde & Schwarz places extremely high requirements on the surface cleanliness, so that a reliable and stable cleaning process is crucial. However, the clean-

Figure 1 – Simplified process of PCB manufacturing

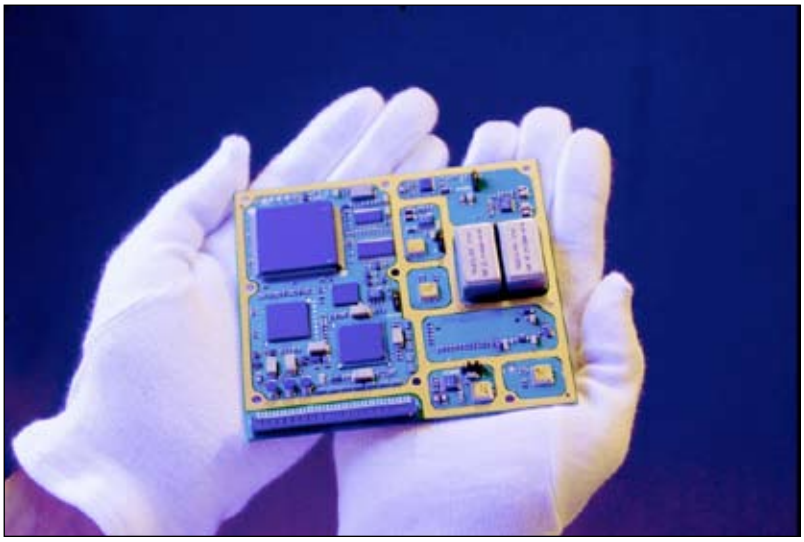

Figure 2 – Completed assembly after cleaning

ing bath concentration varies, as drag-out and dilution of the cleaning agent cannot be avoided. For this reason, a continuous, process-specific bath monitoring solution is essential to ensure the stability and reliability of the cleaning process. A suitable method minimizes costly and avoidable interruptions in the production process as well as serious problems arising down the line due to poor cleaning results. An accurate method of monitoring the cleaning agent's concentration is therefore fundamental to maintaining consistent cleaning results in automated processes.

Monitoring method demands

Rohde & Schwarz therefore required a manual measurement method offering the following features:

- a simple and fast way to measure the concentration level
- precise and reliable measurement results irrespective of the bath loading
- ensuring stable and consistently good cleaning results
- documentation and reliability of results that can be confirmed by comparative measurements

These selection criteria should also be the basis for a further optimization of the cleaning process that will be reflected in defined intervals for bath changes and respectively reduce labor and operating costs.

Selecting the optimal method

A number of bath monitoring methods were developed by Zestron, all contributing to a reliable process control. In response to the demands set by Rohde & Schwarz, the Zestron Bath Analyzer 20 was proposed as the most suitable method for monitoring the cleaning bath concentration.

The Bath Analyzer 20 and/or Bath Analyzer 10 are mobile tests that can be conducted in a few easy steps and operated within the SMT manufacturing environment without extensive training. These test kits allow the quick and precise determination of the concentration level in fresh and loaded cleaning baths. By means of a test fluid, a color-based phase separation develops in a cylinder, enabling the operator to read of the concentration level (Figure 3). The test kit is suitable for checking alkaline (Bath Analyzer 10) and especially pH-neutral cleaning agents (Bath Analyzer 20).

Over an extended period of testing, the Bath Analyzer 20 was confirmed as a suitable test procedure for determining the concentration level of the cleaning bath. During the test phase, random measurements were taken by both Rohde & Schwarz and Zestron. The samples taken by Rohde & Schwarz were analyzed at the plant in Memmingen, while the samples taken by Zestron were analyzed at their Technical Center. The comparison of the results confirmed the measurements at Rohde & Schwarz. At the same time, possible reasons for differing results and thus potential problems, such as an insufficient mixed cleaning bath at sampling, could also be detected and solved by regular exchange of experience.

Figure 3 – Example of measuring with the Bath Analyzer 20 at Rohde & Schwarz: 1. Pouring cleaning bath sample into cylinder, 2. Adding test fluid, 3. Shaking the cylinder, 4. Brief wait, followed by determination of concentration level according to phase separation

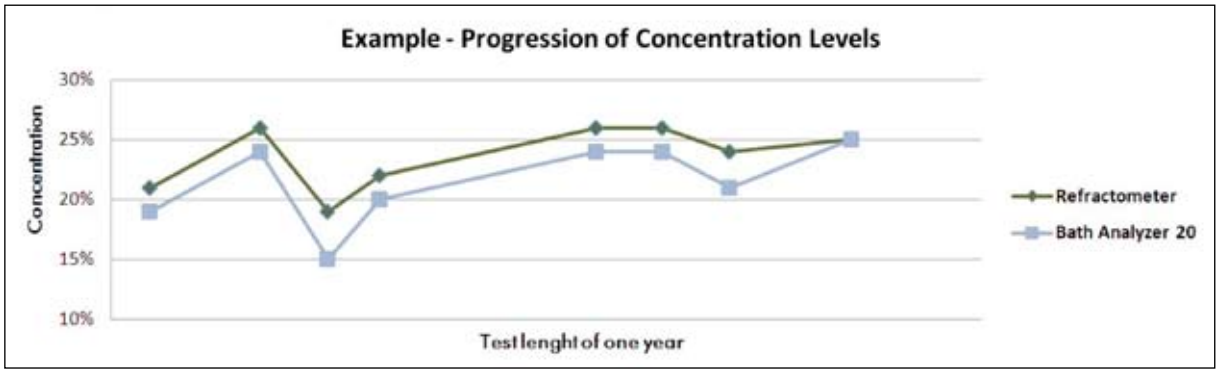

Figure 4 – Excerpt of measurements by Rohde & Schwarz - progression of concentration levels

By using the test kit, Rohde & Schwarz is now able to determine the cleaning agent concentration directly at the cleaning machine without the need for additional equipment. The test procedure is quick and efficient enabling real time analysis and monitoring of the bath concentration (Figure 4). Thus it allows for the short term adaption of the process, if necessary.

Unaffected by impurities

The test represents a reliable concentration monitoring method for Rohde & Schwarz, since the indicated result is not affected by impurities such as flux and is generally not impacted by the bath load. These are definite advantages in comparison to other concentration measurement techniques utilizing parameter such as refractive index and pH value. Hence, concentration levels in both, freshly prepared or used cleaning baths, can be determined with precision and reliability.

However, parameter such as pH value, refractive index and conductibility, serve to increase information on the state of the cleaning bath. Together with the concentration level, they offer valuable clues to the bath load and remaining bath life. At Rohde & Schwarz, the pH value and refractive index are taken into account as supplementary process indicators.

Since the Vigon cleaning agent used is slightly alkaline, the progression of the pH value is an indicator of current cleaning performance and thus remaining bath life. The refractive index (obtained by use of a refractometer) provides additional information on flux load (Figure 5). Additional concentration measurements at an external lab confirmed the results of the Bath Analyzer 20 and therefore the reliability of the test method and its handling.

As indicated in Figure 5, the Bath Analyzer reflects the actual concentration level of the cleaning agent within the scope of precision measurement. The values of the refractometer reflect the sum of the cleaning agent concentration and the level of contamination, which is underlined by the seemingly higher readings. Thus, when compared with the Bath Analyzer results, an assessment of the amount of contamination becomes feasible.

The Bath Analyzer 20 has met all requirements defined and effectively supports the high and increasingly demanding quality standards set by Rohde & Schwarz. This method ensures reliable and stable values, which are crucial for process transparency and traceability of the products as far as accountability is concerned. In addition, the continuous bath monitoring helped to reduce the cost of the cleaning process since unnecessary bath changes are avoided.

Figure 5 – Excerpt of concentration values by Refractometer and Bath Analyzer 20

	Concentration levels of the cleaning bath	
Date	Refractometer	Bath Analyzer 20
27.01.2011	21%	19%
25.03.2011	26%	24%
29.04.2011	19%	15%
26.05.2011	22%	20%
15.09.2011	26%	24%
19.10.2011	26%	24%
23.11.2011	24%	21%
25.01.2012	25%	25%

New Tilt Universal Prober Launched For NPI Testing

Everett Charles Technologies (ECT) has announced that its Fixture and Service Group (FSG) has released the new Tilt Tester, a faster NPI test with the lowest overall cost of test. The Tilt Tester features superior test and diagnostic capabilities, faster test times and improved fault coverage compared to flying probers. It is capable of testing printed circuit board assemblies up to 25 x 31 inches with up to 10,000 nets. Tilt Tester fixtures and test programs average 33 percent of the cost of conventional ICT and can be delivered in less than half the time normally required for conventional ICT programs and fixtures. Additionally, test access is increased with the ability to test 0.38 mm) targets on 0.6 mm) spacing. Backplanes also can be tested. ECT is a subsidiary of Dover Corporation a manufacturer of electrical test products and services, including Pogo test contacts, semiconductor test products, bare-board automatic test systems, and bare and loaded PCB test fixtures. ECT manufacturing, service, and support facilities are ISO registered and the company has been awarded numerous patents and participates actively in developing industry standards.

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Semi-Automatic X-ray Inspection Offers High Performance Verification Linkage

Viscom has announced the launch of the X8011 PCB with HARAN – a brand new linkage to the verification station for X8011 PCB X-ray inspection systems. Now, analysis results can be verified with ease and unspecified defects can be automatically pinpointed and re-examined in detail, says the company. Viscom's line of optical and X-ray inspection solutions covers all examination needs in the SMD production sector. The company's portfolio encompasses highly efficient AOI systems as well as high-resolution systems for X-ray inspection – from fully automatic in-line solutions (AXI X7056) to manual and semi-automatic X-ray inspection with the X8000-series systems. The X8011 PCB X-ray inspection system was specifically developed for assembly inspection, providing maximum granularity and highest image quality. The XMC analysis software allows for convenient operation, containing several automatic analyses such as BGA, QFN and inspection, as well as void calculation.

The new verification terminal link with XMC is identical to the in-line system's standard issue. Hereby, detected defects are vividly represented and the operator can verify them precisely assisted by diverse high-resolution views. All data and images of the type of defect can be stored and, when needed, called up over the traceability system. This ensures even higher process security and alleviates inspection verification, i.e. by audits. A feature of the system is that defects that evade conclusive identification can be directly and automatically pinpointed for detailed examination, i.e. with an inclined view or zoom enlargements.

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