Tech Article

Modern PCBA Cleaning: Methods to Improve Reliability

Author: Emily Peck,
Senior Chemist at MicroCare, LLC
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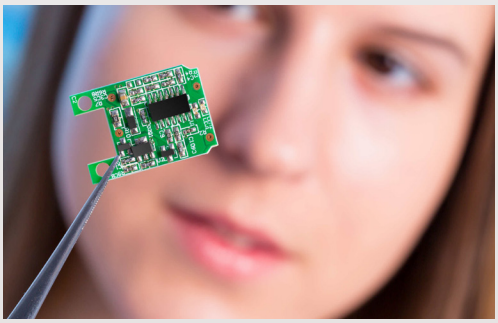

The use of miniaturized PCBAs (printed circuit board assembly) is making circuit board cleaning more difficult.

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Modern PCBA cleaning is a challenge. The drive towards miniaturization has long been a goal within the electronics industry. As more advanced electronic applications are designed, which require increased functionality in a smaller package, manufacturers are looking for production methods which will result in a reliable device.

The smaller, more densely populated circuit boards required for this new generation of technology are making the issue of managing faults, quality and product longevity highly challenging. The use of miniaturized PCBAs (printed circuit board assembly) is making circuit board cleaning more difficult. Cleaning is essential to ensure a trouble-free performance. If not cleaned effectively, contaminated PCBAs can fail in the field, resulting in malfunctioning devices, extensive product recalls and costly warranty replacements.

The risk of failure can be detrimental. Think critical applications like heart pacemakers or airbag sensors. If these do not work efficiently the consequences could be catastrophic. They need to operate reliably each and every time without exception. These PCBAs are also typically used in products that must endure challenging conditions over a long period of time. They need to work perfectly under any circumstances and withstand harsh conditions like persistent exposure to humidity, extreme temperatures and climates and continuous vibration.

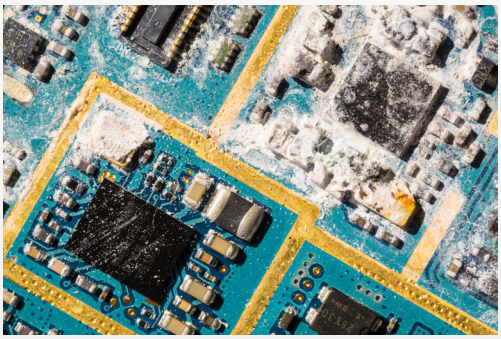
Furthermore, PCBAs are often used in applications where replacing the assembly can be difficult or nearly impossible. For example, electronics used in down-hole logging, a space station communication system, or implantable medical devices like the cochlear implant. These all require huge amounts of time, effort or expense to access, so it is therefore critical that these PCBAs function without fault.

Some PCBA failures occur intermittently. It can come off the manufacturing line in good working order only to lose some function or performance over a period of time. In some cases, the electronic product affected may be ‘throw-away’. A mobile phone for example is upgraded frequently therefore it is not as much of a problem. However, for other more long-lived devices, like a fetal monitor, an electric train motor or an elevator controller, the consequences of a failure are more of a concern.

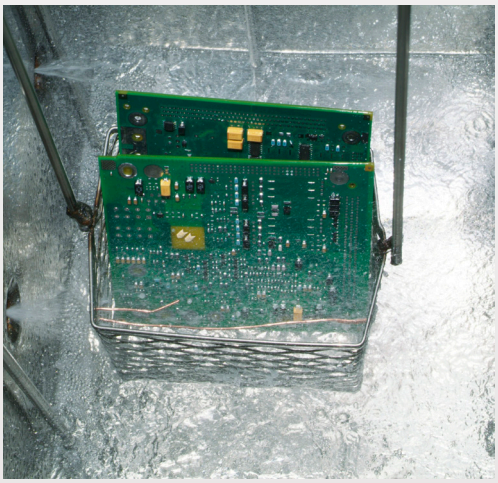
Modern PCBA Cleaning Increases Reliability

One of the main reasons for PCBA failure is contamination. The smallest contaminant can form a barrier between contacts and parts. Dirty PCBAs are susceptible to a whole host of problems from electrochemical migration and delamination to parasitic leakage, dendrite growth and shorting.

Modern PCBAs are small, multilayered, complex systems with bottom termination components such as BGAs, CSPs, MLFs, QFNs, and D-Paks. These new designs make effective cleaning a challenge. Being able to remove contaminant under and around tightly-spaced components is difficult. Add to this the low stand-off between conductors which can collect and trap contaminants like solder balls and the challenge increases.



Residue corrodes fragile circuits and enable dendrite growth.



Vapor degreasing uses an environmentally sustainable cleaning fluid to clean PCBs.

In many instances, active fluxes or flux residue may stay on the PCBA after reflow in wave machines or after hand-soldering. Let's also not forget there can be other contaminants like ink and fingerprints that require removal for optimal circuit board reliability.

One of the most common types of contamination directly impacting PCBA performance is ionic residue, typically in the form of flux left behind during the manufacture of a PCBA, or after the soldering process. Another contamination culprit is no-clean fluxes. Today, the need to clean no-clean flux residue is essential for long-term PCBA performance and functionality. Designed to stay on the board, no-clean flux can leave behind a white residue when the salt activators in the fluxes come in contact with heat or other chemicals. This residue can corrode fragile circuits and enable dendrite growth. This can potentially create noise on the board or interfere with signal transmission, particularly on high-voltage systems. Frustratingly, 'no-clean' flux is some of the most stubborn and difficult contamination to clean from PCBAs without the correct cleaning methods put in place.

Effective Modern PCBA Cleaning

PCBA malfunction is not an option in today's electronic devices. For this reason, it is crucial to ensure cleaning procedures are in place and work effectively to guarantee clean boards every time. There are several methods to reliably clean PCBAs whether it is in a vapor degreaser or at the benchtop. Whatever process you choose it's important to do it correctly.

Vapor degreasing is one of the most efficient and effective cleaning processes available to clean PCBAs. Vapor degreasing offers excellent performance when cleaning miniature components and uses an environmentally sustainable cleaning fluid, instead of water. PCBAs come out clean, dry, spot-free and cool enough for immediate coating or packaging.

Because vapor degreasers recycle and reuse the cleaning fluid for hundreds of hours before the fluid needs to be refreshed, it makes it a cost-effective and environmentally sound cleaning method.

Aqueous PCBA cleaning typically uses heated deionized water and a detergent in a series of washing and rinsing cycles which takes place in large machines. A second operation, using heat or air, dries the PCBAs. Aqueous systems are considered by many to be environmentally friendly however, they consume relatively large amounts of electricity, require continuous water monitoring and stringent wastewater management. As a result, cost implications are another point to investigate before use as operating costs can be high.

Benchtop Cleaning is necessary in some circumstances. For example, when manufacturing PCBAs occasionally there may be missing elements like surface mount components when the board comes off the line. These will be hand-soldered onto the PCBA at a later stage. Other times there may be a fragile or moisture-sensitive component that can only be hand-soldered in place after the initial PCB cleaning is completed to prevent damaging the component.

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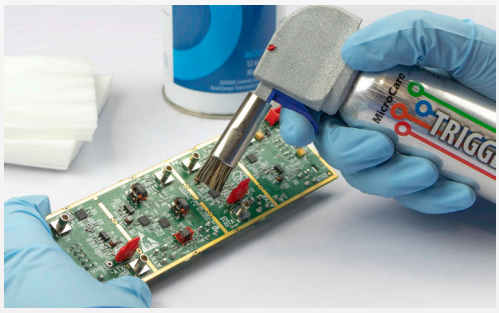

The TriggerGrip™ delivers faster and better benchtop cleaning, with less waste and more precision.

These selectively-soldered PCBAs will usually undergo a secondary “spot-cleaning” at the benchtop using a fast drying aerosol packaged flux remover and a brush. This method is only as reliable as the person undertaking the clean. Does the operator know how to manually clean PCBAs effectively? Have they been trained in the process, and are the tools they are using up to the job?

In an ideal world, the PCBAs are selectively-soldered without any surplus amount of flux. This helps to improve the chance of all the flux being completely heated and deactivated, resulting in as little residue left on the board as possible therefore making it easier to clean. This, however, is often not the case.

If an operator is well-trained, they will immediately choose to clean the entire selectively-soldered board, not just the hand-soldered area. Because flux can migrate, it can be residing under components near to where the hand-soldering has taken place and not obvious on first inspection. For this reason, cleaning the whole board is important to ensure it is contaminant-free.

Four Step Rule When “Spot Cleaning”

If flux residue and other contaminants must be removed manually from PCBAs it is important to ensure the operator is trained in the four steps of wet, scrub, rinse and dry. First, wet the board with a pure cleaning fluid. Scrub it using a good quality scrubbing brush. Next, rinse with more clean fluid and finally dry the board with a lint-free wipe, a high-quality air duster, or a combination of both.

This recognized manual process is effective at cleaning select PCBAs because it allows the operator to adjust the amount of cleaning fluid delivered, how much scrubbing and rinsing takes place and how well the boards are dried.

Controlled Cleaning

The ideal protocol after secondary-soldering takes place is to clean the whole PCBA. It is important to do this in a controlled manner to regulate the flow and volume of the cleaning fluid being used. The use of a dispensing system that attaches to the aerosol can is key to control. This method delivers faster and better cleaning, with less waste and more precision.

Sealed fluid dispensing systems are now replacing the pump bottles and brushes of old. Using a controlled dispensing system keeps the flux remover clean for each use and delivers more efficient cleaning. The cleaning power of the flux remover is amplified by the mechanical scrubbing action of the brushes. A secondary spray of the flux remover thoroughly rinses and washes away contaminants so they are not left on the board.

A quality dispensing system will deliver the right amount of fluid to wet the PCBA completely, but without overspray or waste, using 50-60% less fluid, therefore, cutting cleaning costs. Importantly through the use of a controlled dispensing system worker safety is increased as operators’ exposure to the flux remover is reduced.

For benchtop cleaning effectiveness and safety, a cleaning fluid dispensing system is a simple, yet effective way to help protect workers and deliver consistently clean circuit boards for long life and optimum reliability.

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Get Your Cleaning Processes Right

The increasing emphasis on miniaturization is set to continue. Designers are pushing the boundaries by incorporating technology into smaller packages. Electronic circuits and products are shrinking in order to accommodate this trend which brings with it reliability issues. Modern PCBA cleaning is a mission-critical process, if it is not completed effectively the device simply will not function reliably for the required life of the product.

Successful modern PCBA cleaning involves first identifying the contaminant and then selecting the best combination of cleaning fluid and method to effectively remove it. Balancing these factors properly can enhance PCBA reliability. To ensure reliability and implement the right cleaning procedures, it is recommended that PCBA manufacturers work with a knowledgeable cleaning partner that specializes in specific cleaning fluids for this task. These experts can help choose the best cleaning process and fluids to deliver quality cleaning results to help in the objective of achieving high reliability.

About the Author:
Emily Peck is a Senior Chemist at MicroCare which offers benchtop and vapor degreasing critical cleaning solutions. She has been in the industry more than 6 years and holds a MS in Chemistry from Tufts University. Peck researches, develops and tests cleaning-related products that are used on a daily basis in electronics, medical, fiber optic and precision cleaning applications.
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