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The Evolution of Cleaning Methods in PCB Rework

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The rework process has long consisted of three steps: removal of the inoperative component, cleaning of residual solder from the ball grid assembly (BGA) pads which held the component in place, and replacement with a new component to create a viable, working PCB. The first and third steps have been automated, and are completed on rework machines with operator assistance. Cleaning, the second step, and arguably the most sensitive and vital when it comes to reclaiming a damaged board, is often done manually by a skilled technician. Cleaning is performed with hand tools, usually a wicking braid and soldering iron, using standard or specialized tips. Obviously, the effectiveness of the operation is highly dependent on the skill of the operator, which makes board damage a frequent occurrence.

One common scenario in manual cleaning is the destruction of a pad due to sticking, when the heat of the soldering iron momentarily dissipates through the board, causing the pad to stick to the wick and be chipped or to lift off the board entirely when the operator pulls his tool back. This is a highly undesirable result since destruction of a pad results in a

wasted PCB that has just become scrap.

In the drive for greater functionality, manufacturers are creating thicker PCBs with multiple inner layers of copper.



Open via and solder resist damage.

These, unfortunately, also cause heat to dissipate more quickly when using hand-held cleaning tools, ensuring that sticking challenges will become even more of a problem.

Other problems may include molten solder flowing into electrical connections and into vias which causes shorts in the board. Further, solder may be removed inconsistently among the pads which results in poor adhesion of the new components, or portions of the

solder resist can be inadvertently removed by the wick which causes solder to flow into electrical connections when the board is put back into the rework machine, leading to bridges and shorts.

Perhaps an even more insidious issue is that while many manual cleaning problems can be caught in the inspection process, and the board, which is now expensive scrap is kept from getting to market, another common source of damage is not discernible by visual — or even X-ray — inspection. Pad craters can be created in the fiberglass substrate under the pad due to the stresses caused by the mechanical pressure of operators pressing a little too hard with the soldering iron, or by excessively heated tips held slightly too long against the board. With this kind of damage, the pad and the solder balls are still connected to each other, but the pad is not fully anchored to the circuit board, leaving it vulnerable to the smallest jolt by the consumer — and the end product brand vulnerable to consumer dissatisfaction.

The smaller the pads, the more susceptible they are to hidden cracking, which means that the situation has been

and will become more common as pad size continues to decrease.

Manual Cleaning Gets Tougher

Over the years, pad size and pitch size have been reduced significantly. Many devices now use pads as small as 0.25mm (0.0098-in.), spaced at intervals of 0.5mm (0.02-in.). New chips are scheduled to be released in the next two or three years that call for pad sizes as small as 0.1mm (0.004-in.) with a 0.3mm (0.012-in.) pitch. Avoiding hitting the parts with the wick during

The problem stems from the fact that two different types of solder are used in manufacturing, with melting points of 183 and 302°C (361 and 575°F) respectively. Improper manual cleaning can change the melting temperature of the solder on the pads so the temperature may not be high enough to form a connection, resulting in a dry joint.

In addition, many Package-on-Package (PoP) chips cannot be confidently cleaned with manual methods due to the threat of melting the bottom package. A highly advanced component,

flowing into the wrong areas.

All-in-One Designs

Until recently, contact-less cleaning could only be performed on very large, high-end machines, or as an optional, retrofittable add-on that would allow the cleaning function to become part of the removal and replacement steps on a single rework machine. Stand-alone contact-less cleaning machines present a substantially lower capital investment and other benefits.

Perhaps most significantly, stand-alone machines can offer great throughput. They can be run by a single operator, and when used next to a standard rework machine, offer the opportunity for the establishment of an assembly line operation to increase speed.

These stand-alone machines offer the opportunity for manufacturers to flexibly add contact-less capability to their operations. If they have more recently invested in a standard rework machine lacking a scavenger add-on, they can readily add a contact-less cleaning machine to work side-by-side with their current system. This is a useful option if suddenly the manufacturer is forced to quickly add the capability because of customer demand.

Scavenging can eliminate the risks that come with manual cleaning. As chip sizes shrink, and production struggles to keep up with an ever-expanding demand for smaller and more powerful electronics, rework processes must develop as well.

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manual cleaning will likely become impossible for even the most skilled technician.

Another challenge for traditional cleaning methods is presented by PCBs with advanced chip technologies. For example, one new technology is providing outstanding improvements in security, making it nearly impossible for criminals to access data stored on the processor. However, due to factors such as differing pad sizes and uneven solder volumes, manual cleaning can be a challenge.

Ceramic ball grid array, a specialty process used in aerospace, military and other high-reliability applications, is another example. These boards, which use individual components costing tens of thousands of dollars and themselves, with PCBs that can cost half a million dollars or more, are notoriously hard to successfully clean manually and rework, and usually have to be scrapped if faulty.

the Invensas BVA PoP holds the solder balls on with fishhook shaped connectors 50µ wide and 90µ high, barely visible to the unaided eye, and spaced at 0.2mm (0.008-in.) intervals.

Contact-Less Cleaning

Contact-less cleaning — also called scavenging — can alleviate the challenges associated with manual cleaning, and will supplant it entirely in many applications. For example, there is no contact made with the pad or board, reducing the risk of mechanical damage. Precision controlled tips can clean pads too small and too close together for human operators to reasonably attempt. The software and equipment continually control thermal profiles.

Also, the vacuum collection nozzle automates the task of solder removal, for more consistent and complete removal, and with less chance of molten solder