Combination of advantages offered by selective and wave soldering in one machine

System purchase may reimburse quickly

Jürgen Friedrich, Ersa GmbH

Figure 3: Multi-wave soldering unit allows for higher throughput

Wherever possible, through-hole components on the board assemblies are selectively soldered. The classical wave-soldering technology is moving increasingly to the backseat, as the selective soldering approach offers significant advantages such as better solder-joint quality, minimized operating costs and defects.

Nevertheless, even in the most up-to-date electronics production lines, the classical wave soldering cannot be entirely replaced. There are still many applications that can be efficiently and cost-effectively processed with wave-soldering machines alone. As an answer to the afore mentioned development, in collaboration with leading customers, Ersa has developed its flagship soldering machine Versaflow Ultimate RSA.

Today, when manufacturers have to make strategic decisions on the verge of the transition to lead-free, the procedures have to be optimized in regard to quality, productivity and cost reduction. Due to the ever-increasing application of surface-mount devices on assemblies, it is difficult to find the appropriate balance between selective and wave-soldering processes. On the one hand, the demand for selective-soldering systems is increasing and, on the other hand, the relative extent of wave soldering is constantly decreasing, although nevertheless still needed. With the Versaflow Ultimate, all major wave-soldering processes are available in one machine. Thus, there is no need to invest in two different systems. Less floor space is required, operation is handled by one central controller, and service/maintenance is less than that required by two separate machines.

However, the herein implemented process technology also opens novel perspectives: an automated repair process is possible without human manual intervention. In addition to the classical wave process, the oven also offers selective soldering with multiple-waves for high throughput and a single wave for the highest level of flexibility. So, solder bridges that form, for example, in wave soldering because of critical layout conditions, can automatically be removed with the single-wave module immediately thereafter, in a reproducible manner.

System architecture

The machine has a sectional, horizontal conveyor mechanism that links all functional modules. This architecture provides the advantage that each module can independently process one assembly simultaneously, to achieve maximum throughput (figure 2). Moreover, the conveyor precisely positions the board assemblies in the fluxer unit and in the selective-soldering modules. For this purpose, the conveyor system is equipped with positioning and gripping devices. The working width of the machine is laid out for 400mm and a maximum assembly length of 500mm.

In the working sequence, the fluxer module comes first. It is equipped with a multi-drop precision fluxer for selective-soldering applications, as well as with a spray head for full-surface treatment. The pre-heater section begins next to the fluxer; it is factory-fitted with a standard IR radiation module. Two additional pre-heaters are available, operating from below. This first is directly adjacent to the standard pre-heater module, as this step can become a bottleneck depending on the cycle time of the two soldering modules (double and multi wave). In this case, expansion of the pre-heater section is useful in order to provide an additional pre-heat cycle. A second heater module (below) can be arranged upstream the single-wave unit. This pre-heater off-loads the other pre-heater upstream from the high-speed soldering modules in mixed operation.

In addition, a convection-heater module can be installed above each pre-heater and the single-wave soldering module, as the clearance above the assemblies is not limited by grippers. Such a top-side heater offers the advantage that high-mass assemblies or components can also be pre-heated effectively, uniformly and gently. Thus, soldering primarily with lead-free alloys and multi-layer assemblies can significantly be improved. The optional heater above the single-wave soldering module assures a constant assembly temperature, even for long processing cycles. Therefore, the assemblies will not cool down during the process, and all solder joints are formed under identical conditions.

The double wave-soldering module features a working width of 400mm. The solder-pump drives are of variable speed and can be monitored. The waves can be fitted with a nitrogen hood to minimize oxide formation and to minimize maintenance, as well as increase soldering quality. The sectional in-line conveyor is designed as finger system at the wave-soldering module. In horizontal position, the assembly is taken-over by the pre-heater transport mechanism. After completition the transport then stops, and the adjustment device automatically moves the conveyor into the specified angle. If the needed angle is attained, the conveyor is activated again, and the assembly is moved and soldered according to the soldering program. After soldering, the transport stops again, travels back into horizontal position and places the assembly at the next module.

Figure 1: Selective-soldering system with integrated wave-soldering module

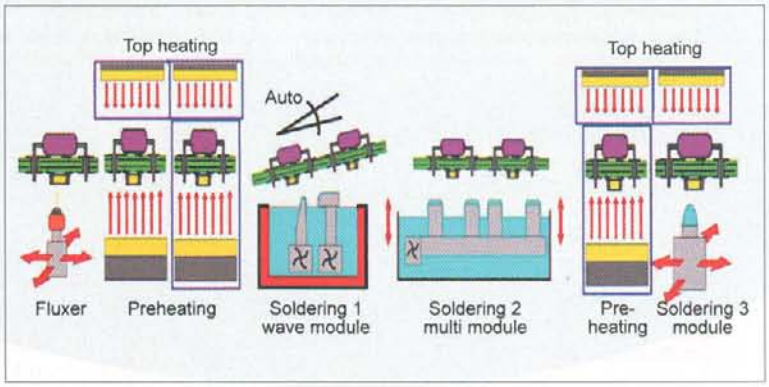

Figure 2: Parallel processing of multiple boards

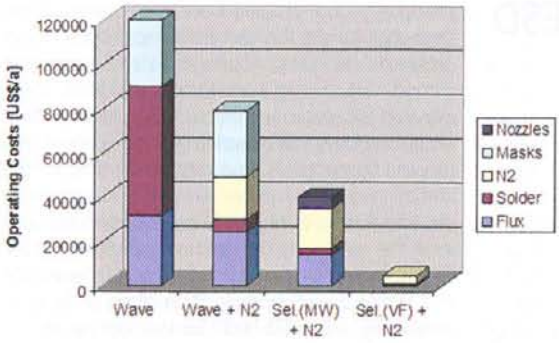

Figure 4: Cost comparison between wave process with and without nitrogen, selective multi-wave (MW) and selective single-wave

High throughput with minimized cycle times can also be gained with the multi-wave soldering unit (figure 3), working under nitrogen and arranged on second position after the wave module. For this application, a product-specific soldering tool is necessary. It features nozzles for several solder waves, with arrangement and sizes corresponding to the position of the selective solder joints on the respective board. The pump continuously keeps the solder flow through these various nozzles. This ensures stable energy transfer to the solder joints. And at the same time, impurities that may be present on the waves before the soldering process can be washed out by temporarily increasing the pump speed. For soldering, the assembly is immersed for 2 to 3 sec. in the waves and accordingly all solder joints are formed at the same time.

To meet requirements of higher flexibility, it is necessary to use a single-wave soldering module, which is installed downstream from the multi-wave unit. Flexibility is achieved through the 3D-programmable movement of the soldering unit on its XYZ-table, where the values of each solder joint can individually be set. The mini-soldering nozzles are available standard in various dimensions and can easily and quickly be replaced in operation. The electro-magnetic pump system does not depend on mechanically moved elements, so no bearings, motors, drive belts, pump shafts or impellers are present. Service and maintenance of such a system is reduced to cleaning the solder-bath surface, due to the nitrogen hood of the pot acquainted with very low efforts. Because of the high dynamics of the wave, the system is also especially suitable for solder joints featuring high thermal demand.

As already mentioned, this process also opens up new horizons. For the first time, this system enables an automated soldering-repair process without requiring human intervention. Solder bridges that form, for example, in the wave module because of critical layout situations, can automatically be removed with the single wave immediately thereafter, in a manner that is reproducible.

Cost considerations

An essential point, which unfortunately receives little attention much too often, is the financial aspect when using selective-soldering technology. Considering just the pure material costs, an enormous difference becomes evident between classical wave and selective-soldering technologies, as well as between the use of lead-free and lead-containing alloys. But the expenses for solder masks must also be added to the calculation as material costs, because without them selective wave-soldering is not possible. The service life of such a mask is of course limited.

Take, for example, a lead-free wave-soldering process under normal air and nitrogen atmosphere compared with single and multi-wave selective soldering. The data derived from these scenarios are based on three-shift operation, at about 300 days/year. Lead-free alloy SnAgCu (SAC) is used as solder. As shown in figure 4, the potential for material savings ranges from approximately 114,000 US$/year in the most favorable case, to about 38,000 US$/year. With this outlook, the purchase of a selective-soldering system may reimburse quickly.

www.ersa.de

ZUSAMMENFASSUNG

Mit einem System, das die Wellenlöttechnik mit dem Selektivlöten verbindet, lassen sich im direkten Arbeitsablauf der Fertigungslinien auch viele Vorteile aus diesen unterschiedlichen Applikationswelten zusammenbringen. Zwar wird die Mehrzahl aller Lötstellen auf Baugruppen zeit- und kostensparend im Reflow- oder Welllenlötverfahren hergestellt, doch gibt es immer auch einige Lötstellen, die speziell zu bearbeiten sind. Hat man hier früher noch manuell gelötet, so sind mittlerweile Automaten in der Lage, weitere Kosten- und Qualitätsvorteile zu offerieren.

RÉSUMÉ

Avec un système qui associe la technique du brasage à la vague au brasage sélectif, il est possible de réunir également beaucoup d'avantages provenant des différents domaines d'application dans le déroulement direct des opérations sur les lignes de production. Bien entendu, la plupart des brasages sur les modules sont réalisés avec économie de temps et de coûts en utilisant le procédé de brasage à la vague ou la refusion (reflow). Cependant, il y a toujours quelques brasures devant faire l'objet d'un traitement spécial. Si par le passé la brasure se faisait encore à la main, de nos jours des automates sont en mesure d'offrir d'autres avantages au niveau des coûts et de la qualité.

SOMMARIO

Con un sistema capace di unire i processi di saldatura ad onda con la saldatura selettiva in un diretto ciclo operativo nelle linee di produzione si possono combinare anche molti vantaggi per diversi mondi d'applicazione. Gran parte di tutti i punti di saldatura viene senz'altro realizzata su gruppi costruttivi risparmiando tempo e costi nel processo di saldatura a riflusso o ad onda, tuttavia, esistono ancora alcuni punti di saldatura che richiedono una lavorazione speciale. Mentre qui in passato una volta si saldava manualmente, nel frattempo sono disponibili diversi automatismi in grado di offrire ulteriori vantaggi di costi e qualità.