Technical Article

Selective Soldering – the constant struggle for short cycle time and high flexibility

Selective soldering systems for the assembly of electronic products established in today's market are based, to the most part, on equipment featuring miniaturized solder waves. But to attempt to respond to the dual demands of high throughput and high flexibility, system concepts following different principles are also available on the market.

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Ersa VERSAFLOW– the flexible platform for the most varied demands

Systems working on a sequential basis offer to the user a high level of flexibility, with which even products in batch size 1 can be economically manufactured. High throughput, on the other hand, is obtained on systems using the simultaneous soldering process, with which cycle times in the range of the classical wave soldering process can be achieved.

The selection of the most suitable process for their applications is not always easy for the user, and for this reason, Ersa GmbH actively assists its customers during the selection process and offers advice on the configuration of the systems. This ensures that the best economical solution for the customer to optimize his quality, cost and delivery service is found.

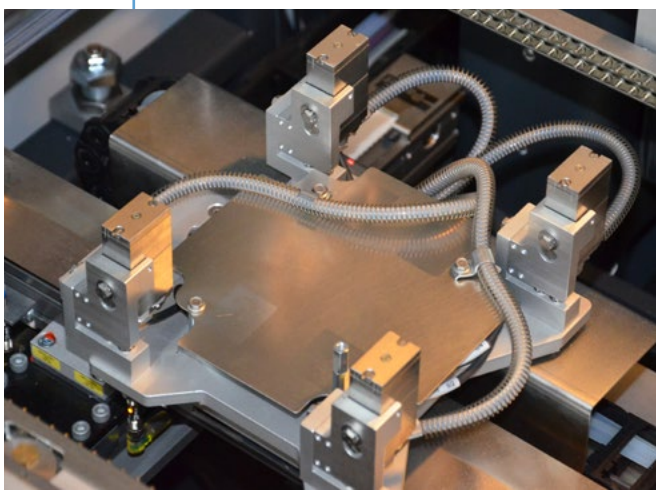
No longer are selective soldering systems reserved for an exclusive circle of customers, since today, they are available in a broad selection. Therefore, mid-sized companies, EMS contract assembly houses as well large multi-nationals can and will all use this modern soldering technology to solder PCB's. Regardless, though, of the system eventually chosen, the common demand for the lowest cost of ownership (TCO) and a high degree of economic efficiency, all the while obtaining a high FPY, is maintained. This implies that the systems have to have a high availability for production, which can only be achieved by reducing the down time to an absolute minimum.

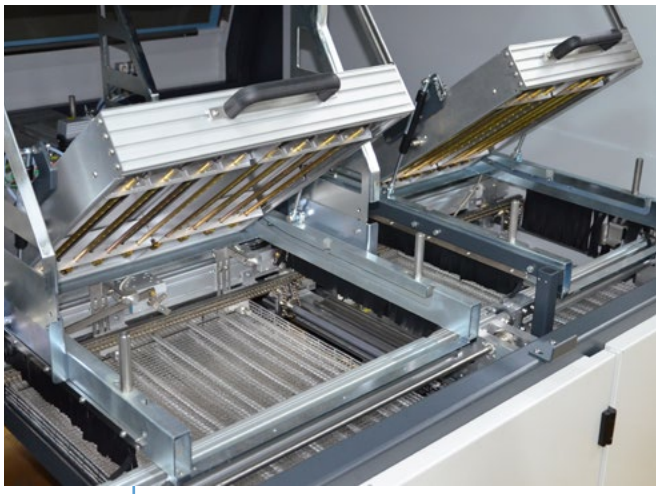
Today, state-of-the-art systems autonomously monitor the selective soldering process, and ensure the stability and reproducibility of the process. The design of modern systems allows performing maintenance and repair expending a minimal amount of time, which again assists the drive towards a high uptime.

MINI- AND MULTI WAVE SELECTIVE SOLDERING SYSTEMS

The large range of through-hole components, which still needs to be processed despite the preponderance of SMT components, which are the standards of today, drives the continuous advancement of the selective soldering technology. A number of alternative technologies are available, such as the press-fit technology for connectors,

Flux module with four multi-drop fluxing heads





Preheat module with top-side preheater

but none of them has so far been able to break through on a substantial level. Soft soldering is therefore still the preferred method to connect electronic components to a printed circuit board. As a rule, selective soldering is applied on boards that have already been reflow soldered on one or both sides. This additional process, though, should not become the bottle neck in the board assembly process.

The throughput of the selective soldering system therefore has to be attuned to the capacity and cycle time of the full production line, so as to ensure a continuous production flow. Only then can the need for a temporary storage of assemblies waiting to be soldered be prevented, and the capital tied-up in work-in-process be minimized.

To be able to realize in high-volume manufacturing cycle times in the range of 20 – 30 seconds, the decision as to which selective soldering process to use falls almost exclusively on dip soldering. If, on the other hand, high flexibility at small batch sizes is called for, soldering with mini waves is the first choice.

Here, today's flexibility extends so far that even batch sizes of only one assembly can be economically processed. For both types of soldering methods, safe guarding the success of the future process starts already during the design of the assembly.

To assist its customers, Ersa makes available to the designers a publication containing layout recommendations for the assemblies. Only if minimum distances between adjacent components are maintained, will the process window be large enough for a safe process.

THE FLUXING SYSTEMS

Flux deposition during the selective soldering process has to be locally well defined. On areas of the printed circuit board which will not be contacted by flowing solder, no flux is allowed to be deposited. To ensure this requirement, multi-drop flux heads are being employed, which have their primary application in the ink jet printing technology.

The advantage of this technology is found in the fact that the flux is not vaporized, but that, in the form of small drops, the flux drops are aimed directly and precisely at the point to be soldered. To achieve this, the flux heads are mounted on an x-y axes system, which, program controlled, moves around under the printed circuit board, which is fix-mounted in the conveyor.

To match the cycle times of the fluxing sequence to the short cycle times of the soldering process, flux modules of the multi wave systems can be equipped with up to 4 fluxing head, those of the mini wave systems with up to 2

fluxing heads.
A number of options to monitor the precision of the flux deposition are available for both soldering systems. For example, the position of where the flux is to be deposited can be automatically, the actual volume deposited can be continuously monitored.

PREHEATING

Preheat modules with short wave IR emitters and hybrid convection preheaters are available for Ersa selective soldering systems. To preheat the assemblies from below, IR emitters are being employed, the optional top-side preheaters are hybrid-convection preheaters. The top-side preheaters can be installed in the preheat module as well as in the solder module.

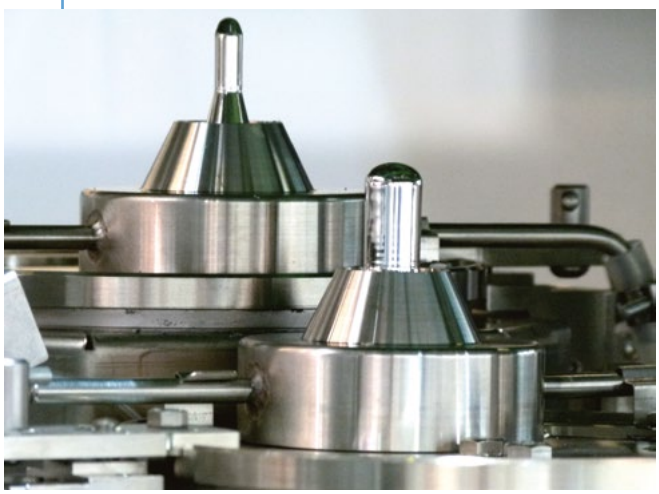
The size of the preheat modules is standardized and conforms to the maximum board size the system can handle. If only small assemblies are to be processed on the unit, the heating module can be segmented by a second printed circuit board stopper. This will double the capacity of the preheat module and cut the cycle time of the assemblies in half.

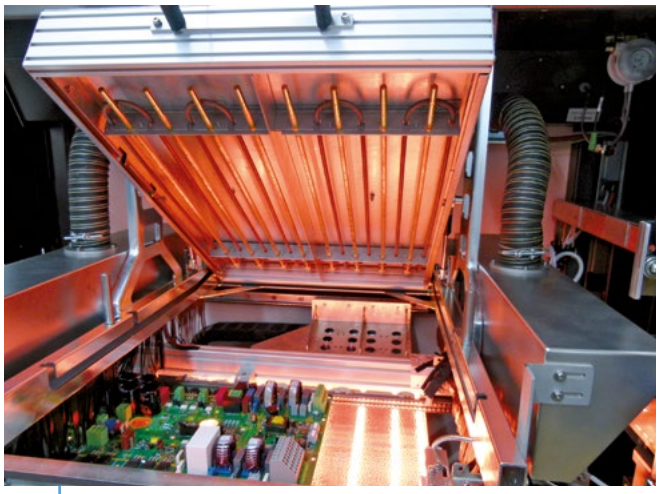
THE MINI-WAVE SOLDER AGGREGATE

The high flexibility of the Mini-wave soldering aggregate is achieved through the programmable movement of the solder bath on an x-y axes system, which moves the bath underneath the board, which is fix-mounted in the conveyor. This freely programmable motion sequence allows that individual process parameters for each solder joint can be applied.

The solder bath itself is optimized to expose the smallest possible surface, and to hold a very small amount of solder. It is flooded with nitrogen, so as to reduce the oxidization of the solder to a minimum. When exiting the solder bath, the nitrogen is concentrated on the solder wave and forms an optimal cover gas protection for the solder process.

Mini-wave soldering aggregate with wettable nozzle





Detail of a nozzle plate with challenging nozzle geometry

Small solder bath surfaces present very little of the molten, lead-free solder to come in contact with the surrounding air, thus keeping down oxidization, and the small solder volume of approximately 12 kg required to fill the bath means, that refilling the bath with the expensive lead-free solder represents a small investment only. The solder pump is designed to continuously deliver very small solder volumes and works inductively, without any moving mechanical parts.

Maintenance of the solder bath is therefore very simple and restricted to a bare minimum. Solder nozzles are available with different diameters. They

are mounted on a magnetic base and can very easily and quickly be exchanged. The nozzle surfaces are wettable, bringing with it important advantages in regards to solder quality and a reduction of the keep-out requirements, i.e. the distances to adjacent components required around the joint to be soldered. The solder level of the bath is constantly being monitored, and should solder be missing, the solder wire feeder installed will automatically add the missing amount.

On the axis system of the solder module, two solder baths can optionally be installed. Exercising this option, either the distance between the nozzles relative to each other is adjustable, or the two baths can, in turns, be raised respectively lowered. In the first case, it is possible to simultaneously solder two assemblies, whereas with the second option it is possible to either switch between two nozzles of different size or to solder with two different solder alloys.

Soldering aggregate in the maintenance and set-up position

THE MULTI-WAVE SOLDERING AGGREGATE

The demand for short cycle times calls most of the times for the use of multi wave solder baths and simultaneous dip soldering. At the heart of this solder module is the product specific soldering tool: the nozzle plate.

It consists of a massive base plate, on which nozzles are mounted whose size and position corresponds to the board assembly to be soldered. Aside from the installation of standard nozzle types, the geometry of the nozzles will frequently have to be adapted to reflect special circumstances found on the lower side off the assembly.

These nozzles are designed with the aid of 3D-CAD, and they are subsequently machined from a solid block of steel. Many years of experience at Ersa in designing solder nozzles is assurance for the stability of the solder results, the high uptime of the system and the excellent quality of the solder joint.

The new generation of Ersa Multi-wave solder aggregates is equipped with electromagnetic solder pumps, which contain no movable parts and are therefore maintenance free. The output of the pump is infinitely adjustable, so that the height of the solder waves can be set very precisely. The pumps are suitable for all solder alloys commonly in use today.

A hood flooded with nitrogen is installed above the solder aggregate. It encloses the complete solder area as well as the conveyor system, so that a stable nitrogen atmosphere during soldering can be ensured. Within this hood, optional component hold-downs can be integrated, which support components that may dislodge, tilt or fall during the soldering process.

These component hold-down systems are required only once and can be, just as the solder nozzle plate, exchanged very quickly. Expensive workpiece carriers in large numbers with integrated component hold-downs are no longer required.

A second soldering aggregate can be installed, so that the uptime of the system on account of the change-over to a new product does not suffer. Ersa developed - for the second, not in operation solder module - an "on the fly" changeover and set-up feature that is being implemented while production on the first module continues. As a result, the changeover between products can take place without any down time. Solder level control and a solder bar feeder are standard features for the solder modules.

The solder programs can be written off-line with the Ersa CAD-Assistant, a graphical programming interface which uses scanned photos or DFX data of the board for programming.
All system specific data as well as all data relevant to the manufacture of the specific board assembly is being stored in the controller of the soldering system and is made available for the MES/ERP system via the trace interface. Traceability and quality assurance of the board assembly is therefore ensured at all times.

All selective soldering systems offer the possibility to interlock the process. With this feature, it is possible to avoid defects due to an incorrect set-up of the system. Prior to process release given by the MES to the soldering system, the higher level system verifies whether the set-up and the selected solder program for the product coincide. With a positive result the process release is given and the soldering system will commence to produce. In case the data is erroneous, the process remains locked.

CONCLUSION

Modern selective soldering technology offers its users a stable and reproducible process, and a choice between short cycle times and high flexibility. Extensive technical features allow for an economical operation with low operating costs, high uptime of the system and high quality joints on the PCB assembly. Continuous process monitoring and continuous process data storage not only make it possible to process boards on the systems without an operator attendant, but they also are the base for the traceability feature of the finished products.

As systems supplier, Ersa offers a wide range of selective soldering systems. The scope reaches from the simple, manual to load ECOSELECT 1 up to the family of VERSAFLOW's, a flexible modular platform of inline selective soldering systems with up to 6 solder bath and dual track conveyor system. The combination of dip soldering and mini wave in one system offers to the user superior flexibility at a minimum of floor space required and with a low cycle time.

Another large advantage of Ersa selective soldering systems is the exchangeability between manufacturing sites of the process parameters and manufacturing experiences. All selective soldering systems from Ersa work reliably on the same software platform, world-wide and under the most varied demands and conditions. And that very often in three shift operation, 7 days a week! ■

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