Technology Focus

Reflow soldering—energy efficiency and economic efficiency in the focus

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For today's electronic production industry, "Green Electronics" is more than only a buzzword. Right next to the economic factors, it has firmly established itself as an important and integral element. For years now, policy guidelines such as WEEE, RoHS, EuP, ELV, REACH and battery directives determine, to an increasing degree, the processes of electronic production. Over the last few years, extensive and fundamental measures have been decreed by law, measures that are today considered as commonly accepted standards. It is for this reason that the developments of our industrial society, and here especially electronic products and tools, are characterized by an ever growing degree of sustainability.

In light of exploding prices for the base materials and for energy, and the finiteness of our fossil resources, our modern society is forced to utilize the resources available with much greater care than was done in the past. Especially for the European countries, where only limited sources of both raw material and fossil fuels are available, sustainable use of these precious materials is gaining in importance.

This importance is heightened further by a global shift of the cost of labor, of rising energy prices and foreign exchange risks, which together give rise to immense cost pressures and a subsequent reduction in profitability. And all this while demands on the quality of the electronic products manufactured are increasing.

To face these global challenges and to maintain the competitive edge, the manufacturing lines, and the reflow systems found therein, need to provide stable and reproducible operation and low resource consumption while at the same time maximizing the productive per square meter floor space.

Energy—as well as economic efficiency—is therefore the central points on which the purchaser of a system focuses, with the final goal being to minimize the total cost of manufacturing a printed circuit board.

It is for just these reasons that Ersa has invested in developing new reflow systems with a focus on improving process safety, raising the throughput and lowering the operating costs. In the standard version already, Ersa's reflow systems make available features improving energy efficiency that cannot be found by any system of the competition.

The success of the new reflow systems, which have come out of evaluations by numerous large EMS suppliers as the winner, are proof that the road taken by Ersa's drive towards heightened efficiency is setting new standards in its field of application.

Efficient reflow systems for maximum performance

The HF 3/20e – 3/14e are the newest reflow systems in the Hotflow family, delivering superior soldering results on account of their thermal performance and their excellent cross profile and optimal zone separation. The "e" in the name stands for "efficiency".

Parallel to the systems of the e-series, the premium models HOTFLOW 3/20 – 3/14 differ from the e-series in that they are laid out for the use of N_2, and have all features necessary integrated.

When designing the systems, the complete know-how and experience gained by Ersa during 25 years of successfully building reflow systems was incorporated. The HOTFLOWs of the e-series are therefore the result of an ideal combination of technological and economical solutions. The HOTFLOW "e" excites also on account of its very attractive purchase price, which, when considered together with its superior system uptime, ensures an excellent TCO (total cost of ownership) value as well as a quick ROI (return of investment)

Focus on low energy consumption—the basic system already is extremely economical

In the course of developing the system towards more energy efficiency, the reflow systems were equipped with a number of new functions. Some of these smart options are integrated into the standard versions of the systems and do not need to be ordered as additional options. Ersa is very proud of the fact that these options are setting new standards in the industry, since in comparable equipment of competitors they are presently not available.

As is the case with the PC, the systems can be placed in stand-by or in a dormant state. In stand-by mode, the temperature of a number of heaters and the RPMs of a number of drives is reduced, so that energy is conserved. Returning to the operating mode, the reduced temperatures and RPMs are raised again to the programmed values. All of this takes only very few minutes, and then the system is again ready for production. The stand-by mode is ideal for short downtimes—for example, when the line is set up for a new product or a malfunction in the line is being repaired. The dormant state is intended for extended downtimes. In it, some heaters and drives are shut down completely. In either case, the mode can be terminated at all times by a click of the mouse, and the system will return automatically to the program from which the energy saving function was initiated.

In addition to these measures, the units are also provided with very good thermal insulation. High quality insulation material reduces the temperate of the skin of the system, thereby reducing the emission of heat into the manufacturing area to a minimum. The AC of the production area is not tasked having to remove this additional heat.

Another feature rests with the operating modes of the cooling unit to cool down the printed circuit boards in the cooling zone. Through a click of the mouse, a selection is possible between an internal and an external cooling aggregate. During those months where the production area has to be heated, the waste heat of the internal cooling unit can be used to heat the factory environment. During times with high outside temperatures, when cooling the air of the production area with an AC unit is necessary, the reflow system can be switched over to the external cooling unit. The waste heat of the board assemblies is transported directly to the outside, and does not increase the load on the AC system. Additional heat exchangers in the exhaust ducts support these measures.

View into the process zone.

As a rule, power consumption of a reflow system depends on the option level. The sum of the measures realized to increase the energy efficiency has led to a remarkable level of energy saving.

Energy consumption of a system with a connected power of 50 kW, operating in the steady state mode, could be reduced to 5–7 kW.

To further lower the costs of the electrical infrastructure, an intelligent power management system has been added to the software, which allows reducing the power draw of the system during start-up. The power draw can be substantially reduced.

Heating technology—a measurable advantage

An extensive evaluation of reflow systems presently on the market was performed by a customer. In the evaluation, complex power electronics boards with high heat capacity were used. Profiling these boards showed very minor temperature differences between solder joints with high and low heat capacity. The HOTFLOW from Ersa was able to provide this customer with the largest process window for his assemblies. His decision on which system to purchase was therefore made easy – he ordered the HOTFLOW.

In the reflow process, the efficiency of the heat transfer has a deciding influence on all quality-, productivity- and operating cost aspects, which, taken together, directly influence the profitability. The effective rate of heat transfer of the HOTFLOW's ensures a minimal ΔT while requiring only a small amount of energy for the operation of the heaters and the fan motors.

One of the measurable advantages of the Ersa Multijet-Convection technology is the smallest ΔT in the cross-the-belt profile (over the full process width of max. 580 mm), which is within the range of the measuring tolerances of the thermocouples.

Process stability regardless of the load factor as well as between systems

The highly efficient reflow heating system ensures reproducibility at the highest level regardless of the load factor. The improved Multijet heating technology does not require that a gap of a certain length between boards be maintained, regardless of the type, size and mass of the assemblies, so that absolute process stability is

"Quatro Track" quadruples throughput.

achieved. The type of loading, whether sporadically or continuously, does not influence the long-term process stability of the system, even in three-shift operation.

Ersa reflow soldering systems are build conformist. That means that all systems possess the same temperature characteristics. Whenever a product is moved from one line to another, there is be need to adapt solder programs and temperature settings. With Ersa reflow they can be transferred 1 to 1.

Maximized production volume per m² floor space.

Early on, Ersa's designer realized that a multitrack option would be the future for mass production. Multitrack systems open up the possibility for a new line layout, since now a number of lines/pick-and-place units can feed into one reflow system with multiple, independently operating conveyors.

The successful advancement in the heating technology, as well as the company's long-standing experience with dual track conveyors, enables integration of a maximum of four separate conveyors into the process tunnel without experiencing any detrimental impact on the thermal characteristics of the systems. Productivity increases of up to 400%, when compared to customary systems, can be achieved. Different products, of different sizes and at different conveyor speeds, can be processed in one and the same reflow system.

The length of the process zone of the HF 3/20 allows conveyor speeds of up appr. 140 cm/min. Then the throughput of a product of 200 mm length in a three-shift operation is, with a single conveyor, 8,000 assemblies. With a dual track conveyor it rises to 16,000 assemblies, and with a "Quatro" track it is 32,000 assemblies in 24 hours.

This ensures not only that the highest throughput is achieved, but it also maximizes cost effectiveness and flexibility per m².

Ultra-low mass center support

The new, ultra-low mass center support (protection of industrial design granted) offers a mechanically stable, continuous support of the assemblies over the whole length of the process zone. It allows to transport also very thin PCBs through the process tunnel. The specially developed, ultra-low mass support elements automatically tuck themselves under for the return to the infeed section, so that the distance of the lower heating zones to the underside of the board is kept at a minimum. In this manner, the maximum possible heat transfer from the lower heater cassettes is being achieved. Additional substantial advantages are the high mechanical stability at a minimum space requirement and that there is no impact on the thermal characteristics in the process zone.

Active cooling

The newly developed "Power Cool" system offers, for the first time, the feature best described as controlled adjustable cooling gradients. In it, the temperature of the first cooling zone is actively controlled to maintain a nominal value as stored in the soldering program. If desired, cooling gradients of over 6 K/s are possible. This high cooling capacity permits that assemblies are cooled down to a temperature of lower than 40 °C. The need to install additional, external cooling units is eliminated.

Returning the assembly to a temperature as close as possible to the ambient temperature can be of great importance. In the following AOI system, for example, the pseudo defect rate will drop, and functional tests of the assembly or the programming of memory modules can only be performed at these lower temperatures.

Condensate management—maintenance with production stop

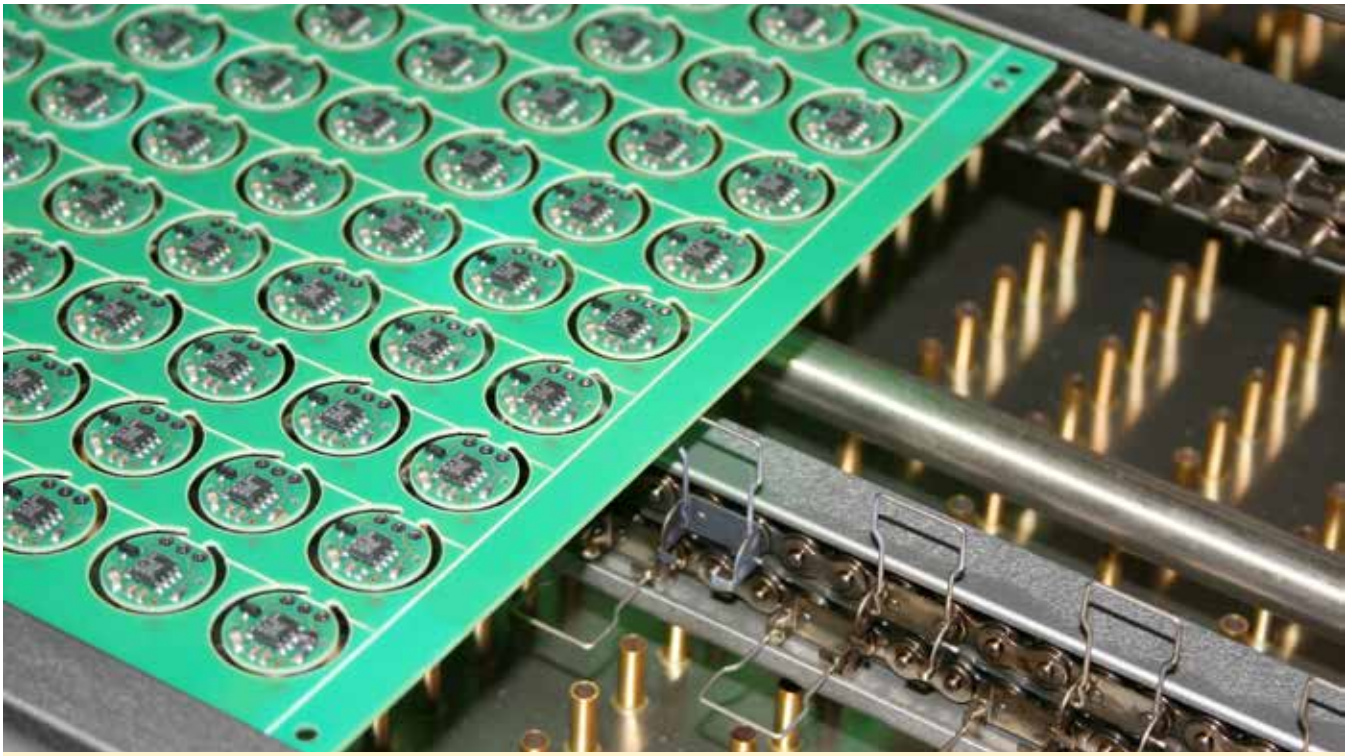
Maintenance implies normally nothing else but a system downtime and the stoppage of production. Not so with the HOTFLOWs from Ersa.

With the "maintenance-on-the-fly" option, the condensate management systems can be cleaned with the system still in full operation. This means that there is no system downtime and therefore no loss of production because of the need to maintain the system. The "maintenance-on-the fly" concept of the HOTFLOW series reduces the actual downtime of the system to an absolute minimum.

The condensation management system of the HF 3/20 is designed as a multi-stage system. Preheat- and Peak zone have separated systems, which effectively clean the process atmosphere and deposit the contaminants in the filter, thereby reducing the contamination in of the atmosphere in the process zone.

Nitrogen controls with N_2 consumption display

The advantages of soldering in a nitrogen atmosphere are absolutely convincing, but nevertheless, the N_2 consumption, and therefore the cost, has to be kept as low as possible. An improved N_2 consumption monitoring and control system, that incorporates a controlled N_2 consumption monitoring system with display and alarm function, can effectively reduce the N_2 consumption. When controlling the rest oxygen value of the atmosphere, the system takes into account the load factor present as well as actual conveyor width of the reflow unit. To monitor the stability of the atmosphere, a number of monitoring points are located in the process zone. In combination with the very efficient Multijet technology, an extremely low N_2 consumption can be achieved.



Ultra low mass center support offers a mechanically stable, continuous support of assemblies over the full length of the process zone.

The innovative Ersa process control system (EPC)

For the first time in the history of the reflow technology, Ersa applies in the HOTFLOW series the revolutionary Ersa process control system (EPC). This control system for the heat transfer monitors not only the temperature of the individual heated zones, but also the convection. This way, the system can monitor and display the value, in real time, the actual heat transfer in the individual heating zones in the process tunnel. The result is a continuously monitored reflow process, which ensures the necessary heat transfer independent of the load factor, the thermal mass and running time of the system.

The Ersa process control system EPC (patent pending) open the door to completely new reflow process monitoring and control.

Process visualization and data management

The user-friendly system software offers a new process control program, a process data recorder as well as the Ersa Auto-profiler for a quick offline programming. This software package simplifies the operation of the system, it offers a complete process monitoring and visualization, a reduction in the time required for configuring of process parameters as well as the search for profiles, complete process- and product data administration as well as documentation and archiving of all process- and system relevant data for future tracing.

An interface for the integration of a traceability system as per ZVEI standards is present, as is the possibility to connect to a commonly used MES (manufacturing executive system).

Off-line profiling increases productivity

The AutoProfiler is an Ersa-specific software tool, which substantially reduces the effort to find the correct temperature profile. It is based on a comprehensive data base, in which the thermal behavior of typical components and of board material in relation to the reflow system is being calculated. With it, it is possible to generate a "virtual board" and send this through a "virtual oven"—all fully off-line. The accuracy of the prediction lies above 90%. The downtime of the system due to profile generation is therefore drastically reduced. Customers report that with generally only one or two temperature profile runs need to be performed, to control and optimize the simulation result.

Summary

In the era of green electronics, the measures undertaken to improve the energy efficiency of the HOTFLOW series reflow units serve actively reduce of the emission of greenhouse gas. Ersa views it as its responsibility to offer to its customers equipment that exceed the norms set by laws, that satisfy the drive government policy and industry for increased environmental awareness.

Today, the economics of a soldering system are no longer defined by an apparently low purchase, but primarily over low operating costs and a high system uptime. This is the reason why energy efficient system with low energy consumption, high flexibility in the generation of profiles and a high uptime are the first choice when looking for a system to install in electronic production departments.

Under these conditions, process stability and reproducibility of RoHS conform process can be ensured for a broad spectrum of boards. High quality of the processed electronic assemblies, and low operating costs are the key to successfully counter the worldwide cost pressures, to ensure profitability and to maintain a competitive edge.

The HOTFLOW reflow soldering systems from Ersa are an active contribution for a raised environmental awareness, since they assist its user when following the goal to save resources and to protect the environment.