

Reflow in any case - but what is economic?

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The ERSA Hotflow 2 series

ERSA sets new standards with its new HOTFLOW-2 series high-performance reflow ovens. The strategy of offering a convincing "added-value concept" consistently oriented to customer and market requirements has been a total success and has enabled the traditional company to assume a leading role in the intensely competitive reflow market. ERSA focuses primarily on extremely reliable machinery, absolute process safety and the lowest possible energy and nitrogen consumption rates for its customers. A concept which ERSA has been able to realize by being highly present on every market and in every market segment, together with effective communication with its customers. ERSA has succeeded in implementing this new machinery concept to such an extent that customers are able to enjoy significant financial benefits.

Since the introduction of the ROHS guidelines in 2006, the complexity of the reflow process has become evident to everybody. No other aspect of SMD technology involves combining such complex demands of a physical, chemical and temperature-related nature. The process windows are becoming smaller and smaller, and the performance specifications to be fulfilled by the machinery increasingly more demanding.

The main focus is directed towards accurate temperature profiles, precise reproducibility and minimal energy requirements in conjunction with the simplest possible handling and maximum throughput rates. Conventional reflow soldering systems have long been incapable of meeting all of these needs to the same extent.

Restrictions and limitations of conventional machinery in lead-free soldering

Due to the unsuitable process zone geometries or thermal conditions in conventional machinery, many operators creating lead-free soldering profiles are forced to either drastically reduce the throughflow speed, or must accept higher peak temperatures with a higher delta T and increased outflow temperatures. In addition to this, more exhaustive controlling measures are required to ensure that processes remain stable.

It is therefore hardly surprising that many operators are unsettled, and there are even renewed calls for alternative technologies such as reflow soldering. And this despite the fact that it is extremely difficult

to implement this technology in bulk processing systems, involving as it does considerable restrictions in process flexibility. Just thinking about converting to varying soldering and adhesive profiles or the curing of underfills makes this point very evident.

To provide a technically simple and economically practical solution to meet these requirements, ERSA decided to develop a totally new type of reflow machine.

Overview of the Hotflow 2/20

Machines from the ERSA HOTFLOW 2 series are very flexible all-rounders and are designed to handle the fastest possible throughflow rates. All the deployed and processed materials such as surfaces, motors, bearings, seals and heaters have been

carefully selected with regard to their enduring suitability for lead-free processes.

A HOTFLOW 2 is much more than just a simple reflow oven. This innovative generation has transformed soldering systems into adaptive reflow and know-how centers. They make it easier for the operator to master all the main process steps, with preliminary verification of the plausibility of defined specifications and parameters, and offer almost infinite flexibility for configuring profiles.

This becomes even more significant when one considers that currently there are no standardized regulations for solder paste, PCB and component manufacturers with regard to an ideal soldering profile. This means that made-to-order manufacturers in particular frequently have to fulfill widely varying specifications for their customers.

For this reason, ERSA has developed an extremely finely tuned range of products for the reflow segment. Above all, attention was paid to covering the broad spectrum of customer business fields and to satisfying all their requirements from small-scale series production runs through to 3-shift plants operating at full capacity. A prime concern of ERSA here is to give its customers exactly what they need so that they can achieve a fast return on their new customized investments.

The HOTFLOW 2 series – the ultimate reflow center

The zones are arranged so that the lengths of the preheating areas and the holding and reflow zones can be varied as required. Linear profiles with constantly rising temperature curves are possible, as are single or multi-stage profiles with homogenizing and holding areas. The prime goal is always to achieve the fastest possible throughput rate in conjunction with the smallest possible delta T.

As well as the staggered preheating zones for the different models, the machinery also features multisection, vertical reflow and cooling zones with upward and downward-facing cartridges. In each module, the temperature or air speed can be set individually, and the peak zone length can be varied in accordance with the PCB specifications. This allows even the most complex assemblies to be soldered at delta Ts of less than 5°C. Consequently, the peak temperature can also be kept at a very low level, i.e. below 240°C.

The active cooling section is fitted with enclosed, water-operated cooling modules. This means that it is possible to configure a gentle but efficient cool-



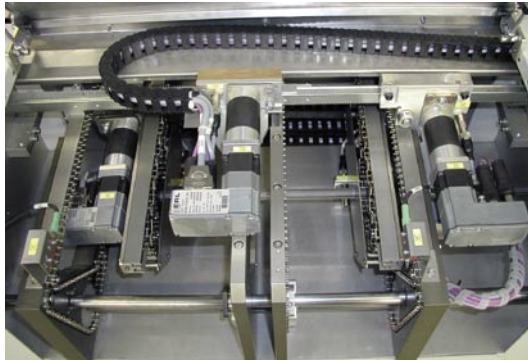
Open Hotflow with process tunnel

ing curve, a critical factor in particular with eutectic lead-free soldering. PCB exit temperatures of less than 40°C can be easily achieved.

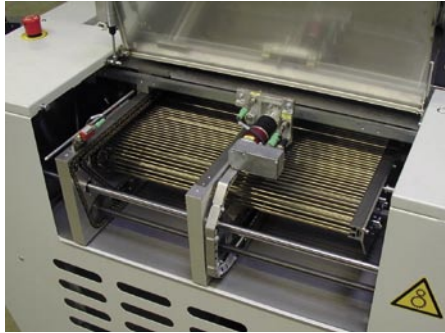
Here the customer can decide, depending upon the scale of the production process, whether he wants to let the machine do the cooling process, or if he would rather resort to an external cooler located outside of the production area. He can also combine both of these options. Particularly in warmer countries, or even with regard to the increasingly hotter summers here in Europe, the temperature factor in the manufacture of electronics is one that should not be neglected. A stable process can only be achieved with stable ambient conditions. With this system, it is possible to centrally assign the cooling of the machinery to an externally located cooling unit. Centralization of the cooling process enables the operator to achieve huge energy savings, and keeps heat emissions away from the production area. During the winter, this procedure can simply be reversed, and the cooling process can be "recalled" back into the manufacturing area with just a few mouse clicks in order to utilize the heat emitted by the cooling units as a source of heating for the production hall. - An intelligent energy-saving model for drastically cutting energy costs and keeping the operator's processes even more stable.

Leaded or lead-free, with or without nitrogen. This new machinery technology requires top-grade flexible systems that must be capable of handling almost all sorts of profiles. This technology incorporates clearly defined zones, separately controllable overhead and bottom heating, a clear homogenous heat distribution in both the width and the length, and above all an exact separation of the airflows. As a result of the increasingly larger and more complex assemblies, which also have an extremely high packaging density, no manufacturer can afford to allow cross-flows or low-pressure areas to occur on the board or run the risk of component displacement.

To counteract this, as well as to achieve an absolutely homogenous distribution of temperature and air to all the process zones, ERSA has developed the patented ERSA Multijet System. The primarily vertical interchange of air and its even distribution among the over 250 individual air jets in each zone ensures that there is no thermal variation at the various points on the assemblies. The directed air flows also guarantee a consistently stable separation of the zones, and the operator is able to exclude the risk of low-pressure areas and cross-flows, thereby assuring extremely stable manufacturing processes. To increase the flexibility of the manufacturing processes even further and to be able to cope with increasingly larger product mixes, ERSA has integrated a new optional function for quickly switching between different profiles. As the two factors "flexibility" and



Dual track conveyor



Dual Track conveyor



Condensation management - easy to maintain

"heat insulation" inevitably have a mutual bearing on one another in a machine concept, this fast change-over option allows the gas to be extracted from the process chamber to allow quick switching between the profiles. With this intelligent technology it is possible to rapidly switch between a soldering profile and an adhesion profile, for example.

A stable process requires a stable conveyor system

The structure of the hardened chain pin conveyor system is mounted on surface-hardened aluminum profiles. These have an extremely low mass and are thermally stable and smooth running. The tracks are

mounted 700 mm apart on encased toothed racks and have a parallel tolerance over the entire length of the machinery of less than +/- 1 mm. The maximum processing width is 500 mm and can be mechanically variably adjusted.

But the future no longer lies in single-track transport systems. ERSA has developed not only a dual track system, but even a triple track system, allowing operators to run up to 3 boards simultaneously through the plant. Not only does this save valuable space in productions areas, but the significant savings in energy and nitrogen obviously have

to be taken into consideration as well. Consequently the operator is able to triple throughput rates without any increase in energy and nitrogen costs.

A tripling of the throughput rate obviously also results in a correspondingly higher gas emission from the pastes, PCBs, etc. In turn, this naturally means that a machine must have an extremely effective process gas management system. Lengthy servicing periods are not permissible. - The machinery manufacturer clearly needs to find effective solutions.

Here, ERSA relies on a completely new condensation management system in which the gas passes through a multi-stage purification process. The volatile substances and particles are extracted from the process tunnel right at the intake section of the machinery. The air is fed through suspended solid particle filters to a heat exchanger for extracting the condensation, purified using further coarse and fine filters, and finally fed back into the process chamber.

This procedure is repeated between the reflow and cooling zones. Here, an additional active unit consolidates the condensation extraction process and the purified air is used to cool the PCBs.

The most effective results can be achieved by coordinating the airflow with the accordingly calibrated heat exchanger and filter systems.

The metal filters are reusable and can be removed from the machine without stopping it. The heat exchangers can be extracted for cleaning and are coupled with quick-release catches.

The residual condensation is fed into an easily removable collector.

It goes without saying that this system has to function absolutely reliably. ERSA has already unreservedly demonstrated that this is the case with its de-

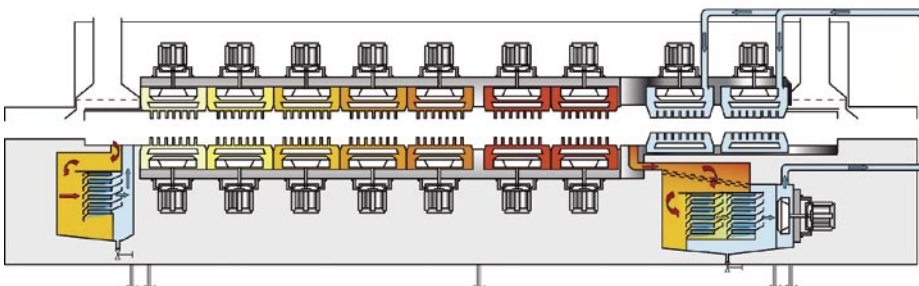


Diagram of the condensation management system

ERSA - "think globally, act locally"

Ever since its foundation in 1921, ERSA has been a driving force behind innovations in soldering technology. Together with the Kurtz Group, to which ERSA has belonged since 1993, the company has a global service and sales network at its disposal. More than 70 subsidiaries and trading partners guarantee a local presence and first-class international customer support. ERSA speaks the same language world-wide as ERSA product users and provides a 24/7 service. Customers are even able to perform soldering tests at ERSA application centers located throughout Europe, Asia and the United States. Highly qualified service technicians, a fast-reacting marketing network and permanent communication with the technology center in Wertheim round off the global customer care package. This has enabled ERSA to develop a market awareness to which the company is able to react quickly and flexibly with new developments.

Kostenvergleich Maschinenstillstand zu verlorenem Umsatz			
		ERSA HOTFLOW2	Vergleichs-Maschine
Boards / Tag	5.000		
Kosten / Board	300,00 €		
Produktionsstunden / Tag	16,00		
Maschinenstillstandszeit / Wartung [h/Jahr]		20,00	50,00
Entgangener Umsatz	€	1.875.000,00	4.687.500,00
Entgangener Umsatz durch längere Maschinenstillstandszeit		€	2.812.500,00

Illustration: Lost turnover due to non-availability of machinery

Kostenvergleich Strom- und Stickstoffverbrauch			
		ERSA HOTFLOW 2	Vergleichsmaschine
Betriebszeit/Jahr [h]	6000		
Stromverbrauch	Kosten/kWh	Stromverbrauch/h [kWh]	Stromverbrauch/h [kWh]
	0,25 €	15,00	30,00
Stromkosten		22.500,00	45.000,00
Stickstoff	Kosten/m ³	N ₂ -Verbrauch/h [m ³]	N ₂ -Verbrauch/h [m ³]
	0,20 €	13,00	25,00
Kosten für Stickstoff pro Jahr		15.600,00	30.000,00
Gesamtbetriebskosten pro Jahr		€ 38.100,00	€ 75.000,00
Kosteneinsparung pro Jahr		€	36.900,00

Illustration: Comparison of energy consumption

ployment in semi-conductor systems, where clean process tunnels are a fundamental prerequisite. Because of these requirements, increasingly more attention is being paid to the service aspect. The servicing intervals should be as long as possible, and service times kept down to a minimum. The following calculation illustrates the extent of the economic impact of these factors: Assuming a throughput of 1,500 boards at an average price of €300 per day, 1 hour's servicing costs €18,750!

Leading manufacturers in the telecommunications sector, for example, produce 25,000 boards per production line and day. They no longer calculate in hours, but in minutes. - Here it is clearly obvious that service-friendliness and accessibility have absolute priority. Ersa has successfully put this into practise with the ASP feature of its HOTFLOW 2 series, and its machinery has been certified as achieving a consistent availability rate of over 99%.

If there is any one variable that expresses the performance of a machine better than any other, then it is the machinery availability rate (uptime). In practise, this means that the plant must function without malfunctioning and that servicing can be performed quickly and easily. In the event of a failure, it must be possible for the defective parts to be replaced in the fastest possible time (Mean Time To Repair), ideally by the machine operator himself.

Uptimes in excess of 99% and MTTRs of less than 15 minutes are the standard Ersa has set itself for the design concept of the HOTFLOW 2 series.

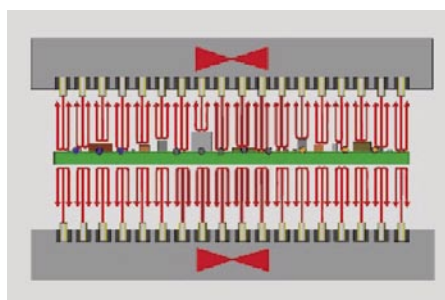
To achieve this, Ersa has developed the ASP (Advanced Service and Performance) package. This provides for fast access to the heating and cooling modules via the hinged cowling mounted on top of the machinery. The heaters, fan motors, turbines and thermal elements are mounted on flange plates. The connector cables are fitted with plug connectors.



Extracted multijets, opened heater module



Extracted multijets



Multijet diagram / principle of airflow

The entire unit can be removed by releasing four snap fasteners. In the bottom modules, the fan motors are arranged vertically and can be easily tilted forwards for servicing. The jet plates in the heating and cooling cartridges can be pulled out without the use of tools. In a worst case scenario, all the other components such as the motors, bearings, seals or electrical parts can be replaced in less than 15 minutes. Replacing the filters and heat exchangers takes under 5 minutes and can also be completed without using any tools.

N₂ atmosphere to a minimum. This means that the machine is capable of attaining a steady operating status very quickly. The intelligent nitrogen regulation makes the system with this constellation particularly stable, as it is able to immediately register the slightest fluctuations in the process parameters and react accordingly.

Additional insulating plates on the heater and cooler modules prevent any unnecessary ambient heat dissipation. The surface temperature does not exceed 40°C anywhere on the machinery.

All of these factors contribute to the machinery's outstanding energy consumption despite its enormous performance capability. Both the connected load values, as well as the actual energy and N₂ consumption, mean that consumption levels are distinctly lower than those of either its predecessors or any comparable machines available on the market today.

In addition to machine reliability and energy requirements, Ersa was also uncompromising in its choice of materials, only being satisfied with the very best quality for its parts and components.

Particularly in the lead-free process, machinery components are subjected to increasing greater stress levels. The solder pastes are far more aggressive than conventional leaded pastes, and therefore cause greater wear and tear. For this reason, great N₂ atmosphere to a minimum. This means that the machine is capable of attaining a steady operating status very quickly. The intelligent nitrogen regulation makes the system with this constellation particularly stable, as it is able to immediately register the slightest fluctuations in the process parameters and react accordingly.

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The concept of center supports is another totally innovative feature. With its low-mass carrier system, PCBs are fully supported and work in the X, Y and



Center support and conveyor

Z positions absolutely precisely. The center support folds down during the return pass to reduce the distance between the heater and the board and assure an optimum heat transfer. Lubrication of the chains takes place fully automatically in all profiles and can be adapted to accommodate varying throughput rates.

ERSA has also taken a new path with its new plant control system and innovative machine software concept, EPOS. The main goals are:

- Simplest possible operation of the machinery
- Total process monitoring and visualization
- Reduction in the time required for configuring the parameters and searching for profiles
- Complete process and product data management
- Documentation and archiving of all relevant information
- Collation of all process-related steps in a software module

The customer can enter this data using either a touchscreen PC or a laptop.

The specially developed EPOS software platform unites the following three standalone software packages into one single solution:

ERSA Autoprofiler saves all the temperature-related readings for the machinery itself, the various PCB materials and the components. This allows the ideal soldering parameters to be configured, analyzed and optimized offline, whereby the operator is able to enter the relevant specifications and run a plausibility check on them. The system then makes suggestions for optimizing the processes, which may be throughput or delta T-oriented. Alternatively, the operator can also change the parameters manually. The results of the entered data are visualized in the form of the probable temperature profile, the cycle

times and the PCB throughput. Once the operator has found the ideal parameters, he can import them directly into the ERSAsoft machinery software. This almost completely eliminates the need for the time-consuming searching of soldering parameters at the machine using temperature recorders, which is then only necessary for counterchecking purposes.

ERSAsoft itself controls, verifies and visualizes all the soldering programs and machine data. It makes sure that all the parameters remain within their tolerances and indicates the position of the different assemblies in the machine. The process zone temperature and its impact on the assemblies are monitored independently of the temperature measure-



ASP (Advanced Service and Performance) option reduces MTTR



**Flux management:
Excellent accessibility and easy maintenance**

ments taken in the single zones. This ensures that the processes can be controlled and documented to the greatest possible degree.

The Ersa Imagedoc quality assurance software is the most extensive imagery and video database on soldering technology available today. In order to judge the soldering results, the operator can refer to the reference images in the database, or even add imagery, comments and quality criteria for his own products. Ersa ImageDoc also provides information on the causes of soldering and process faults and offers sound solutions for correcting them and optimizing the processes. This allows the operator to store all the process steps, data and imagery relating to a certain product under the same project name such as the soldering program, profile diagram and the associated analyses.

In this way, EPOS develops into a know-how and documentation center for the entire SMD process. It is always accessible to all authorized users, and presents an overview of all the essential product and process information in a matter of seconds.

With all the additional features incorporated in the new HOTFLOW 2 and EPOS generation of machinery, Ersa provides the operator with tangible and calculable added values with regard to machine availability, energy consumption and time savings. This lends a completely new dimension to the reflow machinery.

Closing comments

With its HOTFLOW 2 series, Ersa has realized a machinery concept that offers the customer definite benefits. Economic viability calculations clearly demonstrate that the deployment of low-cost systems with an apparently favorable purchase price only represent a good decision at first glance. The rising costs of energy and raw materials have long ago established operating costs and machine reliability as being the decisive cost factors. This is why systems such as the Ersa HOTFLOW 2, which can score points with an efficient energy budget, convenient features and the greatest possible machine reliability, clearly represent a better choice for the successful operator.

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