Why Hybrid Rework?
Background To a New Rework Technology

by Mark Cannon and Jörg Nolte

ERSA GmbH, Europe's leading soldering equipment supplier, presented the revolutionary Hybrid Rework System, HR 100 to the market at the recent Productronica 2007 trade fair in Munich, Germany. Which technical issues and market requirements are behind this new technology? How did this product come about and is "hybrid" more than just a fashionable marketing slogan? The following article addresses these questions and offers insight into this new, value added technology.

Looking back to the "leaded age"

During the days of tin-lead alloys where SMDs were externally leaded devices, the required rework and repair of such components could be undertaken without too much difficulty. Both contact heat systems such as soldering irons or heated tweezers and non-contact systems such as hot air guns were viable alternatives for bench top rework. The process control requirements for such systems were not particularly high as the soldering processes and components themselves were, for the most part "forgiving".

Since the introduction, however, of ball grid array (BGA) components, the rules for rework have changed completely. Non-contact heating technologies were the only option for exchanging such components and hot air systems were the accepted state of the art. In 1997, ERSA GmbH entered the BGA rework market with the launch of a completely new technology designed specifically for reworking area array devices. Rework specialists could now choose between the commonly-used hot air systems and ERSA's new, medium wavelength IR systems. Traditional convection systems bundle the heat energy more strongly via the hot air nozzle and thus achieve somewhat faster cycle times. Medium wavelength infrared radiation on the other hand, guarantees uniform heat distribution across the BGA package and is characterized as a slower and safer process.

New, lead-free components

The ever increasing demands on today's electronic assembly have not only targeted the components but also the alloys. The introduction of lead-free solders characterizes a milestone for both production and repair equipment requirements. The current rework systems are faced with the following challenges:

- Efficient soldering and desoldering of target components without damaging them (as per IPC requirements at a maximum temperature gradient of 4°C/s)
- Bringing the heat energy onto the target component in as focused a manner as possible without influencing or destroying neighboring parts and/or substrates
- Creating stable, reproducible and documentable processes
- Simple but modular operating concept for both beginner and professional users

The smaller process windows and higher process temperatures of lead-free soldering place ever greater demands on a contemporary rework system. More power on the one side (in order to handle higher temperatures) and more control for temperature-sensitive

components on the other is a paradox in itself and is an extremely difficult balancing act to manage. When it comes to hand held, hot air guns, there is the ever present problem of unintentionally overheating and blowing away an adjacent small chip during the repair. On the other hand, many large companies are banning contact heat methods with hot tweezers for rework due to the possibility of thermally shocking small ceramic condensers. Given these two extremes, how should or could a safe repair of 0402 and 0201 components now look like?

Today's technical requirements for a compact bench top rework system

The technical requirements can be divided into three groups: "absolutely essential", "highly practical" and "nice to have but not essential". The requirements for "absolutely essential" include: fast rework cycle, low cost of system and small size, option of implementing a repair in the unit housing, flexibility and process security. The requirements for "highly practical" are: process stability and repeatability, simple operation and simple operator training. The "nice to have but not essential" requirements include: software support, use of temperature profiles, documentation and traceability.

As the only manufacturer of both rework systems and high-end reflow systems worldwide, ERSA has a large amount of experience in the area of convection soldering with hot air or hot gas. The decision taken 10 years ago to use medium wavelength infrared radiation instead of hot air for rework, however, was well thought out and has paid off. Rework is a selective soldering process which has the more difficult task of uniformly heating only one component. For this reason, the limitations of hot air in a rework environment caused ERSA engineers to look for a more viable alternative. The solution was found in the infrared radiation technology and today, the ERSA IR rework systems are leaders on the global market with many thousands of systems sold.

ERSA soldering irons and hand tools have also been market leaders since their inception in 1921. Looking at the hand tool range of ERSA products with respect to rework, however, there has always been a large gap between the soldering irons and de-soldering tweezers in the lower-end product range and the larger, more expensive semi-automatic IR rework systems in the upper segment. ERSA had consequently researched a solution to not only fill this gap but also to address certain repair needs in today's lead-free rework environment. The answer was found in combining two familiar technologies.

Hybrid – the best of both worlds

As already stated, both technologies, hot air and medium wavelength infrared, have their strengths and weaknesses, depending on the application. With hot air, one can achieve high temperature gradients of up to 10°C/s and more, for example if the component to be desoldered is already defective and if no smaller, neighboring components can be over-heated in the process of removal. Such gradients are not permitted, however, for safe re-soldering as specified by IPC which specifies a maximum gradient of 4 °c/sec. ERSA's medium wavelength infrared radiation allows for a maximum temperature gradient of approx. 2°C/s (see fig. 1). While this technology is safe, it can be rather slow. A combination of hot air and medium wavelength infrared radiation offers a perfect alternative rework solution.

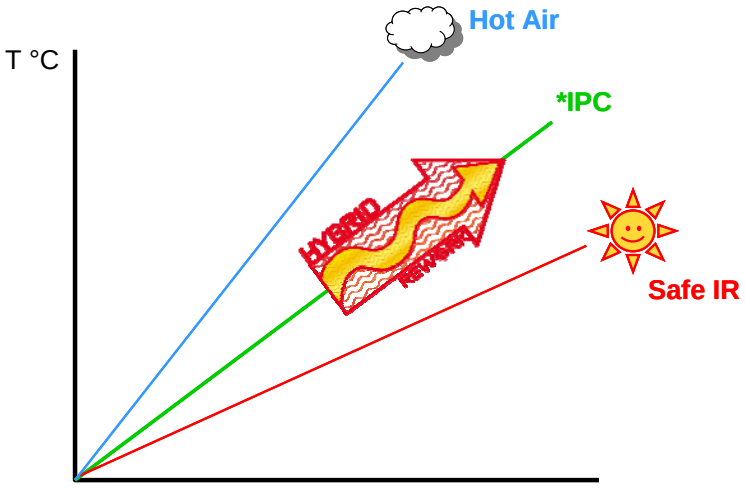
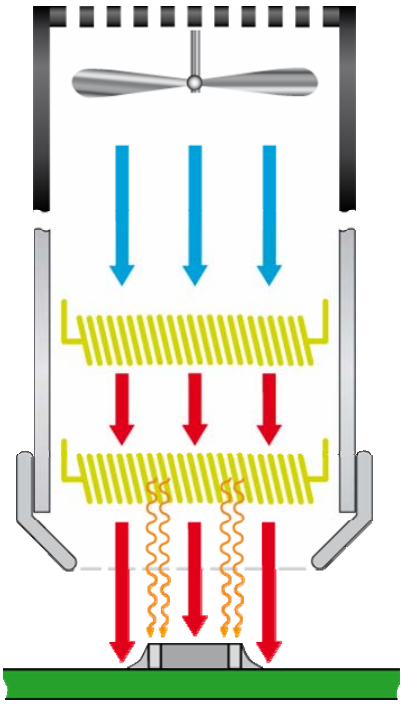


Figure 1: Graphical depiction of the temperature gradients for various heating technologies

Profiting from their experience with both infrared rework systems and convection reflow soldering machines, ERSA GmbH has now combined both heating technologies into one revolutionary system. The patented ERSA Hybrid Rework System HR 100 combines infrared and convection heating in a hand-held device for safely soldering and desoldering densely packed SMDs (see figs. 2 & 3). IR radiation heat transfer is combined and enhanced via a precise amount of hot air. This unique hybrid tool can uniformly, safely and rapidly heat components ranging from 0201s up to SMD sizes of 20 x 20 mm and even larger. Three exchangeable hybrid adapters (available standard) focus up to 200 W of heating power from the hybrid heating element in a targeted manner whilst neighboring components remain protected from overheating and blowing away.



Figures 2 & 3: Schematic diagram of the hybrid heating technology & hybrid tool

Homogenous heat radiation in the medium wavelength IR range, paired with gentle but concentrated convection, provides a unique mix for efficient rework soldering. For the small surfaces of modern CSP, QFN or MLF components, this combination of heating technologies provides ideal conditions for efficient heat transfer. The convective portion is so reduced as to avoid an over heating and “blowing away” of adjacent chips. When compared to ERSA’s larger IR systems, the surface area size of the radiation is quite small. Due to the shortened working distance to the component and the convective portion, however, the efficiency of the hybrid heat transfer is now comparable or even superior to the semi-automated IR machines (see fig. 4). Efficient and safe rework with the temperature gradients recommended by IPC (up to 4°C/s) is now possible with this bench top unit.

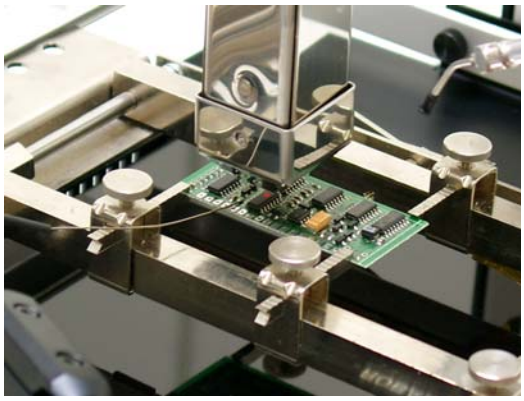


Figure 4: HR 100 directs heat energy very close to the SMD

With this innovative technology, ERSA has now bridged the gap between “tools” and “machines” with respect to rework. In general, bench top rework applications are conducted by operators using a variety of hand held tools in order to complete their work quickly and safely. A hot air gun is frequently one of these tools found on bench tops around the globe. Such tools offer on the one hand quick and simple heating of SMDs, but on the other hand hide the serious risk of blowing away neighboring chips. The hybrid tool offers all the advantages of a hand held hot air gun without the disadvantages. Flexibility combined with safety and process control is the value added benefits of this new technology.

With the help of an integrated laser pointer in the ergonomic handle, the user focuses the hybrid heat energy to the component being worked without damaging the assembly housing. Even demanding repairs or component exchanges, for example, if the board is still inserted in the assembly housing, can be carried out without difficulty and safely with the hybrid tool (see figs. 5 & 6). This results in tremendous time savings for operators as they are no longer required to remove the PCB from its housing in order to perform rework!

Figure 5 and 6: Problem-free and safe reworking on boards that are still installed in the assembly housings.

Unlike hot air guns which require a myriad of different nozzles, the hybrid tool only needs three adapters and these are included standard with the system (see fig. 7). No additional nozzles are required! Components ranging from the smallest 0201 chips up to SMDs of 20 x 20 mm and even larger can be handled with the system. The visible count down timer on the HR 100 offers operators the simplest form of process control which can be expanded upon to include closed loop temperature profiling with an optional thermal couple (see fig. 8).

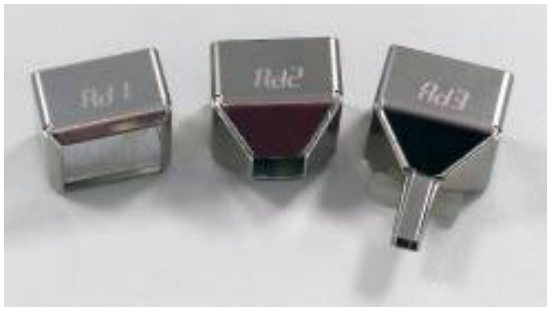


Figure 7: Three hybrid adapters are available for various component sizes

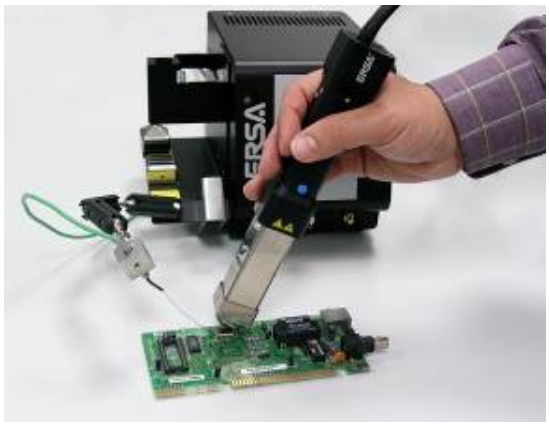
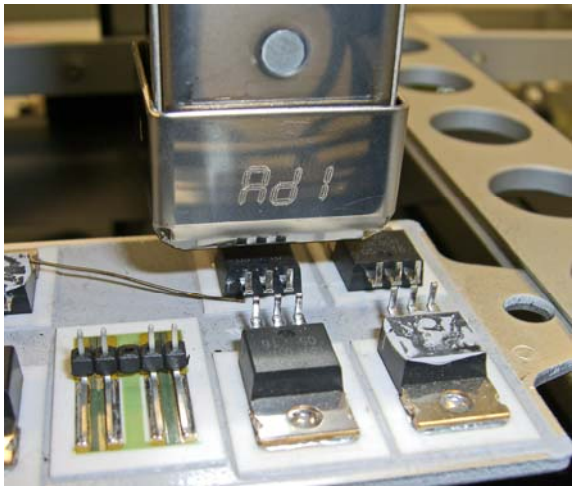
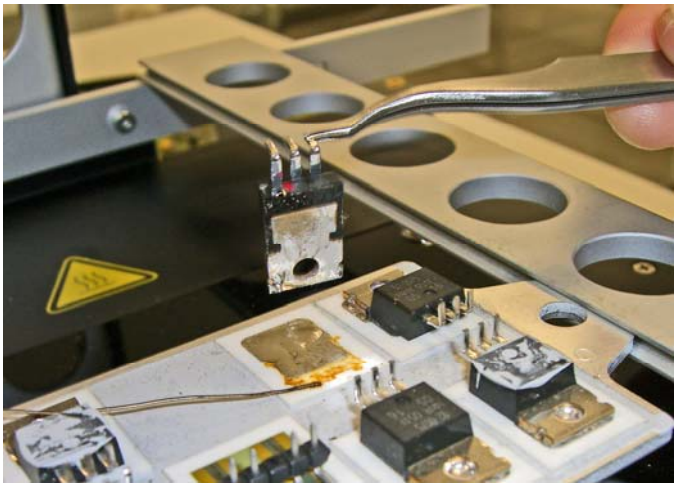


Figure 8: Closed loop temperature of PCB during rework

Figure 9: ERSA HR 100 and ERSA IRHP 100 set with Lap top (not included)

The HR 100 is a very flexible, low-cost solution for both beginners and advanced operators. When combined with the optional IRHP 100 (see fig. 9), however, this bench top system can be expanded to offer many of the features seen only in the larger and more expensive rework machines. The Z-axis, height-adjustable tool holder for the hybrid tool and the X-Y PCB holder offer repeatable, machine like results. The powerful and highly reactive 800 W infrared heating plate guarantees safe, bottom side, closed loop heating of the assembly during rework. This additional power from the bottom combined with the efficient Hybrid heating technology allows operators to handle the most difficult, heavy mass rework applications where hot air fails. Figures 10 & 11 depict a heavy mass SMD with a ground plane which has been easily de-soldered from a ceramic plate attached to an aluminum carrier!





Figures 10 & 11: Ultra heavy mass ceramic and aluminum SMD removal

Via a mini USB port, it is now possible to connect the HR 100 to the tried and trusted ERSA IRSoft rework software platform which is used for all ERSA rework machines. This opens up new possibilities for operating this bench top system.

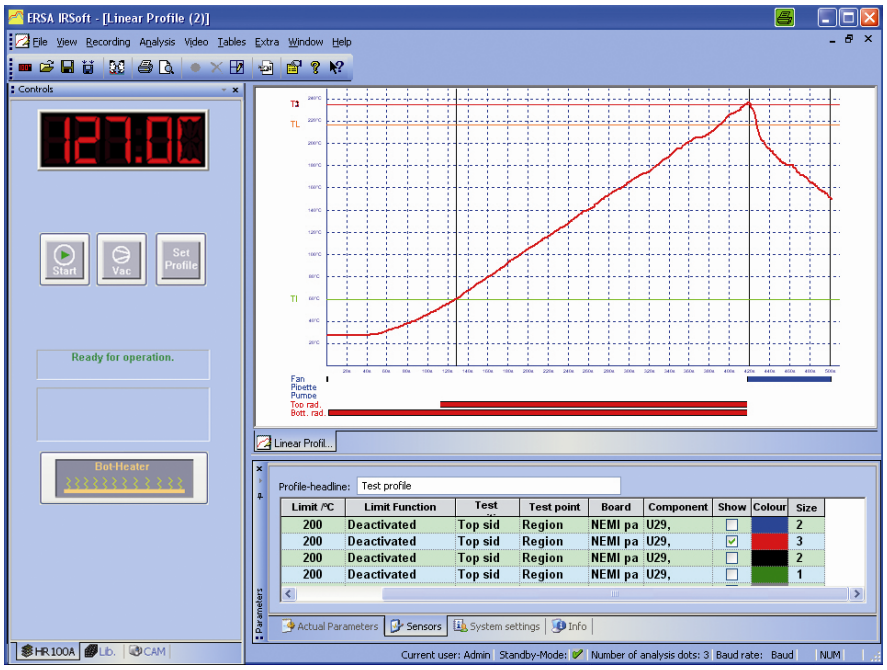


Figure 12: IRSoft Rework Software for HR 100

The hybrid system now bridges the gap between rework tools and rework machines. In the same way as for the larger rework systems, the HR 100 can run a closed loop, temperature-controlled process and document this completely via the IRSoft and PC interface (see fig. 12). Individual parameter settings, ramp-guided temperature profiles, 2-channel temperature recording and process documentation are now possible. Finally, password lockout and user administration rights offer a level of process safety never before seen with hand held or bench top rework units.

Conclusion

Hybrid rework is not simply a fancy marketing slogan but rather the start of a new era for bench top rework. The patented ERSA Hybrid Rework System HR 100 combines infrared and convection heating in a hand-held device for safely soldering and de-soldering densely packed SMDs. Simplicity, flexibility, process control and documentation are the four pillars upon which this new technology is based. In its continuous effort to offer value added innovations for its customers, ERSA has once again proven its ability to address the markets needs with truly innovative solutions.

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