Why Hybrid Rework?
Background to a new rework technology

by Jörg Nolte and Mark Cannon

ERSA GmbH, Europe's leading soldering specialist, presented the unique Hybrid Rework System HR 100 to specialists at the Productronica 2007 trade fair. 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 term? The following article gives a detailed explanation of these questions.

Looking back to the "leaded age"

When solders contained lead and SMT components were mostly wired, the unfortunate but unavoidable repair and reworking of electronic components could be undertaken without difficulty using contact heat (classical soldering station) or even contact-free heat transfer – e.g. hot air systems. The process security requirements for this first generation of reworking systems were not particularly high; the soldering processes were "good-natured".

Since the dissemination of component casing with covered soldering points, e.g. ball grid arrays (BGAs), non-contacting heating technologies are the only option for exchanging such components. To date electronics producers could choose between the widely-used hot air systems and, since the ERSA GmbH rework market launch in 1997, now also infra-red radiation for the repair. High quality systems with both technologies usually met and meet the requirements of repair tasks very well whereby mid-range infra-red devices are characterized by various kinds of heat contribution and flexibility for highly varied applications. Traditional convection systems bundle the heat energy more strongly using individual jets and thus achieve somewhat faster cycle times but without guaranteeing secure process control from the first repair.

New, lead-free components

Since that time electronics production has experienced enormous dynamism and is constantly producing new products, shapes and component sizes. The introduction of lead-free solders characterizes a milestone for the repair equipment requirements. The current rework systems are faced with the following tasks:

- Quick soldering in and out 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 concentrated a manner as possible without influencing or destroying neighboring parts and substrates.
- Creating reproducible, stable, documentable processes
- Simple but modular operating concept for new and professional users

The smaller process window and higher process temperatures for lead-free soldering make ever greater demands on a contemporary rework system. More output on the one hand in order to handle higher temperatures and more control for temperature-sensitive components on the other – which is an extremely difficult balance to strike. In particular

when it comes to hot air pistons there is increasingly the problem of unintentionally blowing away a small chip during the repair. On the other hand many large companies avoid contact heat with hot tweezers during repairs due to the possibility of thermal shock, e.g. for small ceramic condensers. What should a safe repair of 0402 and 0201 components now look like?

High technical requirements for a compact rework system workstation

The technical requirements can be divided into three groups: “absolutely essential”, “extremely practical” and “nice to have but not absolutely essential”. The requirements for “absolutely essential” include the speed of the rework cycle, low costs, small size, the option of implementing a repair in the casing, flexibility and process security. The requirements for “extremely practical” are process stability and repeatability, simple operation and effective user training. The “nice to have but not essential” requirements include software support, use of temperature profiles, documentation and traceability.

As the only producer of rework systems ERSA also produces high-end reflow systems and of course has a large amount of experience in producing convection soldering systems. The decision taken 10 years ago to use mid-wave infra-red radiation in place of hot air for reworking has paid off. The ERSA IR rework systems are now leaders on the global market with many thousand devices sold. But there has been a gap between the soldering pistons and unsoldering tweezers in the lower product range and the larger, more expensive semi-automatic rework systems in the upper segment that has now been filled. ERSA researched a solution to fit precisely and found the answer in combining two familiar technologies.

Hybrid – the best of both worlds

As already stated, both technologies – hot air and infra-red – have strengths and weaknesses. Using hot air you can reach temperature gradients (up to 10°C/s and more) very quickly, e.g. if the component to be soldered is already defective and if no smaller, neighboring components can be heated in the process. Such gradients are not permitted however for safe soldering. Mid-wave infra-red radiation reached to date a maximum temperature gradient of just around 2°C/s, which is safe but rather slow. A combination of hot air and mid-wave infra-red radiation therefore represents the perfect alternative.

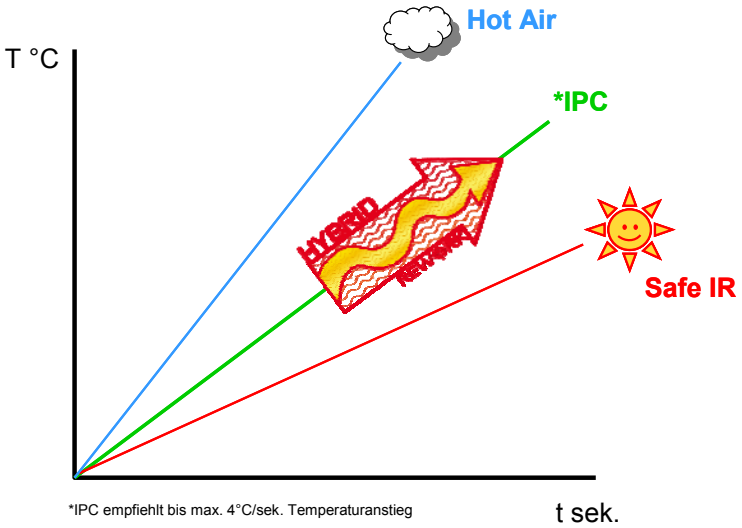

Image 1: Graphical depiction of the temperature increase for various heating technologies

Thanks to its experience with infra-red reworking and convection reflow soldering systems, ERSA GmbH has combined both heating technologies into a unique system. The patented ERSA Hybrid Rework System HR 100 combines infra-red and convection heating in a hand-held device to solder and remove tightly set SMT elements. Via the IR radiation with soft hot air, this hybrid tool can heat construction elements from a size of 0201 to 20 x 20 mm evenly whilst protecting them. Standard available, exchangeable hybrid adapters guide up to 200 W heating power to the element in a targeted manner whilst neighboring components remain protected from blowing away.

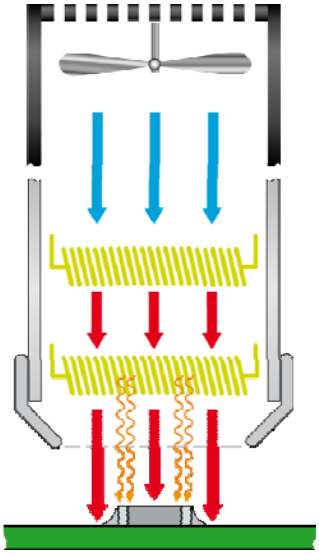

Image 2: Schematic diagram of the hybrid heating technology
Image 3: The hybrid tool

Homogenous radiation heat in the mid-wave IR range, paired with gentle but concentrated convection, provides a special mix for efficient repair soldering. For the small surfaces of

modern CSP, QFN or MLF components, this combination of heat sources provides ideal conditions for energy transfer.
The hot air ratio is reduced until the dreaded unsoldering and movement of neighboring chips is avoided. Although the hybrid tool has low radiation areas compared with the familiar ERSA IR systems, the radiation energy is also transferred very well due to the shortened work distance to the component. This enables efficient and safe work with the temperature gradients recommended by the IPC – up to 4°C/s.

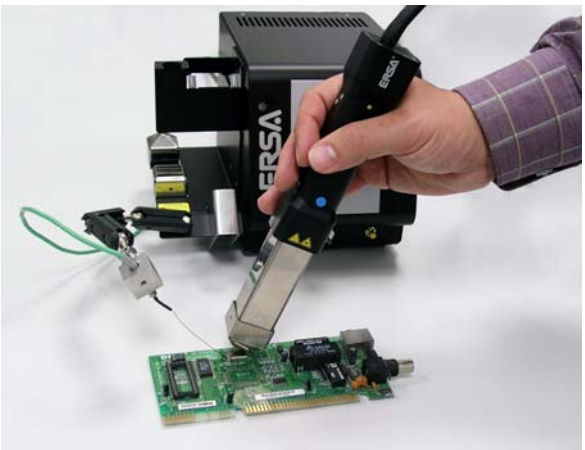

Image 4: Typical use of the HR 100

In addition, with this repair device ERSA has successfully built bridges with the tried and trusted ERSA soldering stations. As is known from the soldering stations, the hybrid tool is firstly a manually guided instrument for flexible working with components. In order to complete their work quickly and safely, the user has available various tools at almost any manual workstation. A hot air gun is frequently one of these tools. Such tools offer on the one hand quick and simple work but on the other also hide serious risks, e.g. the risk of blowing away neighboring chips. The hybrid tool has many advantages of such a “tool” but without having its faults and thus enables safe and user-friendly reworking.

Even demanding repairs or component exchanges, e.g. if the board is still inserted in the casing, can be carried out without difficulty and safely with the hybrid tool. With the help of an integrated laser pointer in an ergonomic handle, the user guides the hybrid soldering energy to the component being worked even if the board is still installed.

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

With each of the three exchangeable adapters, the most varied components can be processed from the very smallest to a size of 20 x 20 mm and sometimes even larger. Simple time control helps the user achieve a safe process.

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

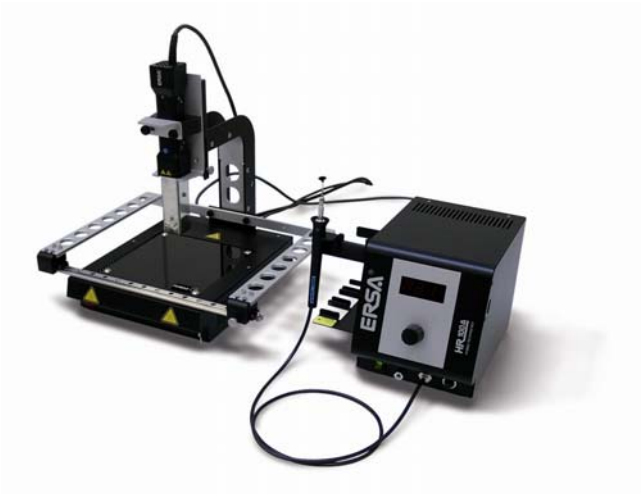

Image 8: ERSA HR 100 and ERSA IRHP 100 set

The HR 100 is a very flexible low-cost solution for new and industrial users. With the optional IRHP 100 infra-red heating plate (800 W) this table-top device offers powerful, quickly reactive and safe IR underside heating and a height-adjustable Z-axis tool receptacle for the hybrid tool and an X-Y board holder. Via a mini USB port it is possible to connect the HR 100 to the tried and trusted ERSA IRSoft rework software. This opens up various functions for operating the system – process parameters can be set and saved, and all soldering and unsoldering processes can be documented.

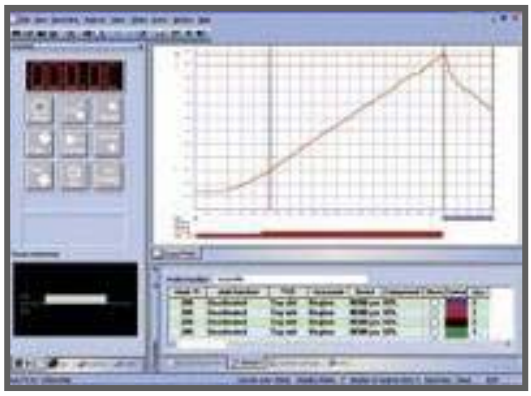

Image 9: IRSoft Rework Software for HR 100

In the same way as for larger systems, the HR 100 can run a temperature-controlled cycle and document this completely via the PC interface. Individual parameter setting, ramp-guided profiles, process recording and documentation,
User administration and 2-channel temperature recording and IPC-conformant temperature increases (maximum 4°C/S) for regulated heating output from top to bottom round off the HR 100's range of performance. Such flexibility and expandability was not possible to date for tools of this type.

Conclusion

Hybrid rework is not simply a key word but rather the start of a new era for reworking. Combined infra-red and convection heating for ideal heat transfer on small areas and the variable use of a handy tool or firmly installed system, hybrid rework is the start of a new generation of systems for repairing electronics components. The hybrid technology saves money, is safe, user-friendly and fits on any workbench! Thus ERSA underlines its own claim to understand its customers' complete production process.

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