



# The User Benefits of a Supplier Partnership

EQUIPMENT SUPPLIERS HAVE BECOME A RESOURCE FOR PROCESS CONTROL EXPERTISE, EVEN IN THE REFLOW OPERATION.

**By Bjorn Dahle and Marc Peo**

In the industry's ongoing drive to reach higher levels of quality in surface mount assembly, electronics manufacturers have focused on process control. Establishing and maintaining performance limits for each assembly process has been viewed as critical to achieving output that is consistent, requires minimal rework and has few or, ideally, zero defects.

To meet the quality challenge, equipment suppliers have designed machines that perform with greater accuracy and repeatability. Software has been developed to define and monitor a tight process window, ensuring that output remains within stated limits. The outcome can be seen in modern assembly systems that incorporate process control concepts in their mechanical operations, and in computer programs that manage and document each system's adherence to process parameters.

As a result, equipment suppliers have become resources for process control expertise, particularly in assembly procedures with numerous variables, such as screen printing and component placement. However, process control for reflow has received less attention from the industry. This has occurred in spite of — or perhaps

because of — the fact that modern forced convection reflow ovens have evolved into highly reliable systems that are routinely capable of maintaining precise temperature profiles and producing consistent output.

Growing numbers of electronics manufacturers have found that incorporating process control measures into the reflow operation can contribute significantly to the overall quality of an assembly line. The question then becomes how best to apply process control to reflow. One effective answer has been the creation of a close working relationship between Heller Industries, an oven supplier, and KIC Thermal Profiling, a profiling system supplier. Over the past eight years, the companies have worked in partnership to incorporate profiling software as a standard feature on reflow ovens.

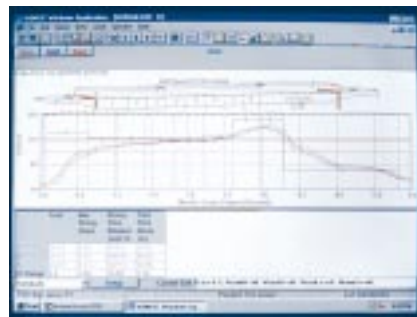
While each company's products are available independently in the marketplace, customizing them to each other's systems can create solutions that benefit users in several ways. Initially, the profiling software helps oven users save a significant amount of time in the process development stage, by optimizing

reflow profiles quickly. When integrated into the oven, the software also provides the foundation for a variety of process control options that can be implemented, as needed, to monitor and manage the productivity of the reflow operation. Finally, profiling software serves to validate the reliability of the reflow oven.

The initial challenge in customizing the profiling program and integrating it into the oven control software involved interprogram communications. Different operating systems for the two programs required that a second computer be installed on the production floor alongside the computer controlling the oven.

The first stage in the modification process allowed both programs to operate on a single computer, saving factory floor space. Users were able to toggle back and forth between the two independent systems to enter and display data. After further refinement, the thermal profiling software was fully integrated into the oven controller software. Temperatures entered into the controller software are now downloaded automatically to the profiling software, creating seamless communication between the two programs.

The thermal profiling software operates in conjunction with any conventional trailing



**Figure 1.** Thermal profiling software records events taking place during the thermal process and displays them for immediate viewing or stores them for later recall and analysis.

wire profiler. These are provided by most oven manufacturers and are also available in the marketplace. As a test board is passed through the oven and the temperatures are recorded, the profiling software translates the data, in real time, into a graph illustrating the profile. This provides immediate feedback on the thermal process as it progresses (Figure 1).

Using the program's forecasting algorithm, the graph can also be manipulated to simulate an optimal profile and determine the parameters that will achieve it. By eliminating the need to send the board back for repeated profiling runs, as is required by conventional profilers, this feature provides time-saving benefits. The user needs only to conduct a second, and final, validation run.

A survey of a number of electronics manufacturers using the customized combination of the two products — profiling software and reflow ovens — indicates a wide range of benefits. The initial advantage (the saving in time made possible by the profiling software) is particularly significant in a high-mix production environment.

Mike McMonagle, process engineering supervisor at K-Tec Electronics, said, "The predictive profiling makes it very easy, as a contract manufacturer, to be able to profile a board rapidly to an optimum profile with very little time involvement." He added that the system is accurate, usually coming within 5° of the actual temperature. "Other systems I have worked with have sometimes varied up to 50° or more from actuals."

K-Tec reported further benefits from the partnership in terms of installation and service. "When we purchase an oven, the profiling hardware and software ships along with it," said McMonagle. "Within a short time frame, the oven supplier installs and commissions the equipment, then the profiling supplier is in-house to do their installation and commissioning." Support is available to users directly from each company, making the OEM relationship transparent to the customer.

Beyond the basic profiling software supplied with each oven, users can implement more extensive process control by adding thermal profiling or thermal management as options, either when the oven is purchased or as a retrofit. Steve Castillo, a member of the senior maintenance technical support team at Honeywell, uses a nine-channel thermal profiler that utilizes radio transmission to provide real-time results without trailing wires.\* This system either logs thermal data internally for later download or transmits the data directly to a personal computer in real time for display, storage and recall.

Castillo said that the system "adds to our safety, as far as running correct profiles.

Without it, you could damage a lot of components. The thermal profiler is part of our quality program." This facility's processes include both reflow and curing for many different products on two nitrogen-inerted ovens.

In another application, a reduction in board size provided the impetus for adding the wireless thermal profiler to a nitrogen-inerted oven. According to Jeff Peterson,



**Figure 2.** The combination of integrated thermal profiling software with an advanced reflow oven provides electronics manufacturers with superior efficiency in thermal processing.

electrical/mechanical technician for SMT at Seagate, when the cards being processed became smaller, and the oven rails were adjusted to accommodate them, "we went to the wireless profiler because it fit and was easier to handle in the oven than a conventional trailing wire profiler. We can tailor the profile and setup of the oven exactly to the specific card type."

In other cases, challenging SMT applications have led users to require continuous monitoring of the reflow process, using a new thermal management program.\*\* This full-featured system uses 30 or more thermocouples placed along the conveyor at board level to acquire, deliver and display process data in real time on a personal computer. The thermal management system's extensive documentation, storage and recall capabilities support ongoing process control, SPC analysis, quality documentation and product traceability.

Karl Bethsold, a process engineer at Honeywell, is running double-sided SMT boards with fine-pitch and large gate arrays. The copper-invar-copper board is a dense, heavy substrate. He relies on the thermal management system "to give the baseline. Once you've established the limits, the operator knows that the process won't start unless the oven is in control. You get real-time monitoring of the baseline you've established."

While the facility's nitrogen-inerted reflow oven has functioned properly since 1995, Bethsold said that the thermal management

system has alerted operators to occasional problems in the exhaust system. In addition, he has run tests to determine that the system would detect any deviations from the normal flow of nitrogen through the oven, should they occur during a production run.

McMonagle has also begun using the virtual profiling feature of the thermal management system to monitor and log the profile of each board as it is processed, in conjunction with product bar coding. This combination provides real-time defect tracking and individual product traceability. "We warranty our assembly quality in the field for 12 months. Therefore, it's extremely important to us to have a validation system so that, if a customer has a problem, we can demonstrate that our process was in control when a given board was being processed," he explained.

A manufacturer's confidence in the stability of a thermal process, as documented by profiling software, is also critical for users of long-term cure ovens. For these applications, the thermal management system has been customized as an option for use in vertical-format cure ovens.

Trailing wire profiling is difficult and inefficient in vertical ovens, for two reasons: the up-across-and-down configuration of the oven and the length of most cure cycles. Conventional profiling of a cycle lasting several hours can easily consume an entire shift, during which no production can take place. Thermal management, with real-time profiling and virtual profiling capabilities, provides the tight process control required for semiconductor operations and other procedures involving long-term curing.

Whether a reflow or cure oven is used with any level of thermal profiling, from standard to the most sophisticated, the interaction of thermal equipment and profiling software creates a synergy that benefits the customer (Figure 2). With equipment reliability a given in today's competitive marketplace, incorporating a system to validate that reliability, at no extra cost, enhances its value. The added ability to implement process control measures also gives the user the opportunity to monitor and improve overall line productivity. SMT

\* Slim-KIC™

\*\* Prophet™

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