Do you like news and articles like this?

Then, get it from the **ORIGINAL** source ... ***PCB UPdate*** ...
the semi-monthly e-mail newsletter produced by ***Circuits Assembly***
and ***PCD&M*** and circulated to over 40,000 readers.

CLICK HERE TO READ THE ARTICLE YOU REQUESTED

Phil Zarrow

Reflow Profiling for Fun and Profit

Save time and gain accuracy by tweaking your profiling process.

FOR INDIVIDUAL USE ONLY
CIRCUITS ASSEMBLY PROHIBITS COMMERCIAL
PUBLICATION AND DISTRIBUTION

Profiling is the process by which we determine the proper time/temperature durations a printed circuit board assembly (PCBA) must sustain throughout the reflow cycle. It is dictated by such solder paste characteristics as solder alloy, solder sphere size, metal content and chemistry. The setpoints of the emitters and conveyor speed setting of the oven for a particular assembly are affected by the mass, surface geometry complexity and substrate conductivity of that assembly, as well as the oven's capability to impart sufficient heat energy. The oven's heat transfer efficiency and the operator's experience affect just how much of a trial and error process profiling will be.

Reflow soldering is complicated, but it is not rocket science. The time/temperature duration information is supplied by the solder paste manufacturer for the specific formulation being used and can, hopefully, be found on the data sheet. The paste is their formulation, and the manufacturer should mandate what is required to adequately reflow their solder paste.

The maximum temperature the assembly can withstand is dictated by the component or material on the assembly with the lowest thermal threshold of pain. Subtract a buffer of 5°C from this temperature to determine the most vulnerable component (MVC) temperature and do not exceed this temperature.

The maximum gradient across the assembly is the MVC minus the temperature at which the liquidicity of the molten alloy is ideal for wetting— which is usually 15 to 20° above the melting point of the solder alloy and conveniently obtained from the solder paste manufacturer's wonderfully comprehensive data sheet. With Sn63/Pb37 and Sn62/Pb36/Ag2 alloys, this temperature is typically 205 to 210°C. With the current vogue lead-free alloy, SnAgCu, it is around 235°C. And do not forget to attain the shortest time above liquidus as well.

You really should profile each application that you are going to reflow. Take a sample board and obtain the proper profile for that application. If you have PCBA applications that are very similar in size, mass and surface geometry, you can likely get away with using the same profile. But no matter how heat-transfer efficient the reflow oven is (or the salesman says it is), one profile does not do all.

Although reflow profiling is not difficult, it is monotonous. Reflowing in a convection oven is a very unexciting process: The assembly disappears down a dark tunnel and emerges about four minutes later. One oven manufacturer has valiantly experimented with boroscopic cameras to allow observation of the melting solder.

Properly attaching the thermocouple to the assembly is very important. Do not attach the thermocouple with Kapton tape because you will not make consistent contact with the solder joint you are monitoring. Rather, you will likely measure a combination of air temperature, tape temperature and, if you are lucky, perhaps joint temperature. Instead, attach the thermocouples with a high temperature solder alloy or a conductive epoxy. You may have to sacrifice an assembly to the profile gods, but you will have a tool with which you can periodically check the accuracy and repeatability of the profile for that board in your oven. If you have very low quantities and a high mix of boards, non-destructive, reusable contacting probes are useful.

Unless you are reflow soldering a bare board, do not profile with an unpopulated board. Thermocouples should be attached at interconnections that represent, at least, the warmest and coolest points on the board. The warmest point will typically be a low mass component, such as a passive, located near a corner or edge of the board. The coolest point will likely be an interconnect of a high-mass component, such as a quad flat pack (QFP) or ball grid array (BGA) near the center of

No matter how heat-transfer efficient the reflow oven is (or the salesman says it is), one profile does not do all.

Phil Zarrow *used to hallucinate reflow profiles before becoming president and surface-mount process consultant for ITM Inc., Durham, NH; (603) 868-1754; www.ITMConsulting.org.*

the board. Place other thermocouples at heat sensitive components like the MVC to assure they see sufficient heat.

When using a previously soldered assembly, remove the solder from the interconnects where you attach thermocouples. As the board was likely soldered with Sn63/Pb37 and you might use Sn10/Pb90, you could wind up with a mystery alloy that will not sustain the multiple thermal excursions required of the test board. Therefore, the existing solder at the interconnect must be removed using solder-wick. Also, remove the solder when using conductive adhesive to attach the thermocouple; otherwise, it will reflow underneath the adhesive.

Since profiling is a tedious process, nothing is worse than losing a thermocouple during a run and having to do it over again. The assembly I use for evaluating reflow systems was instrumented in this fashion and has seen at least 150 reflow cycles without losing one thermocouple attachment. The rest of the board does not look so good, but the thermocouples are intact.

After removing the old solder, apply a small amount of flux and use a soldering iron to apply a small but sufficient amount of the high temperature solder.

Use Type K, 30 AWG thermocouple wires, preferably prewelded. After attachment, route the thermocouple leads toward the rear (in terms of direction) of the PCBA. Some people prefer to terminate the thermocouple lead at the trailing edge of the PCB with a connector. The lead from the measuring device can then be quickly connected and disconnected. Use Kapton tape to provide hold-down and strain relief to the thermocouple leads at appropriate locations on the PCB.

Most reflow machines are equipped with on-board profiling software, allowing thermocouple leads be tracked on the system monitor screen. Many people prefer using a data-recorder device, such as K.I.C., M.O.L.E or DataPaq, that travels through the oven with the test assembly and records the temperature from multiple thermocouples at programmable time intervals. With either type of data recorder system, be sure to have it periodically calibrated by the manufacturer.

Now that you have established the proper profile for the application, use it. Conscientious practitioners confirm the profile by running the instrumented PCBA and data recorder through the oven before committing the oven to production each time a setup occurs. Other operators doing high-volume, low-mix assembly confirm that the oven is set up with a profile confirmation check at the beginning of the production day. The best of the best log in the profiles on a control chart.

Today's ovens have powerful heat transfer efficiency, translating to greater ease of profiling and fewer profiles required among similar boards. By taking care in the profiling process, time can be saved and greater accuracy attained. Remember, we're all in this together. ■

CIRCUITS ASSEMBLY PROHIBITS COMMERCIAL DUPLICATION AND DISTRIBUTION
FOR INDIVIDUAL USE ONLY