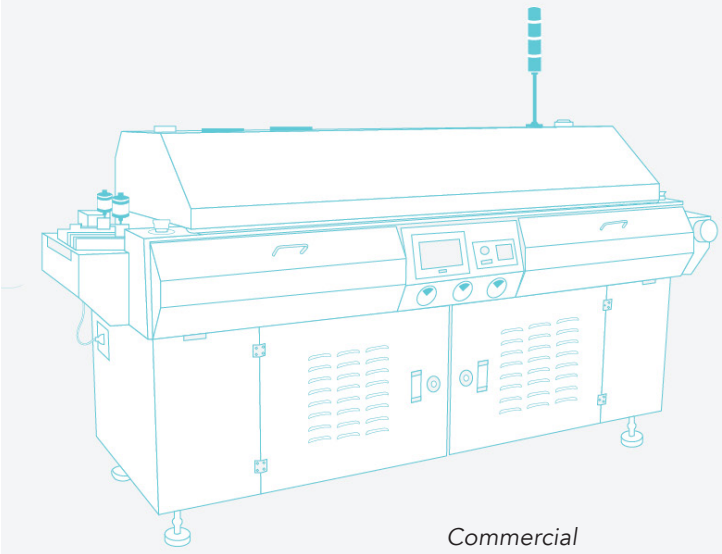
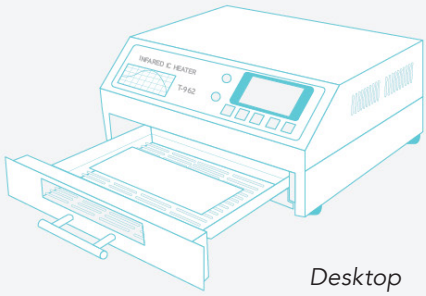
REFLOW SOLDERING
Better than Easy-Bake

Desktop or even home-made reflow ovens are becoming much more common in the tech world for both DIYers and small start-ups. The overall concept of reflow soldering is simple: put a pre-assembled board with some solder paste into an oven and bake it until the solder properly melts. As is true with many things in life, the actual application is a bit more complicated. When a board is reflowed, it typically is put through four different stages or zones of the reflow process. The difference between stages or zones is dependent on the reflow process. The smaller, do-it-yourself or prototyping-sized ovens do not move the boards, but rather change the internal temperature of the oven as needed. For larger, commercial-sized reflow ovens, the boards are moved through zones of different temperatures via a conveyor belt. These four different stages, and their settings, are crucial in achieving consistent results in the soldering process.



Commercial



Desktop

Advanced Assembly was founded to help engineers assemble their prototype and low-volume PCB orders. Based on years of experience within the printed circuit board industry, Advanced Assembly developed a proprietary system to deliver consistent, machine surface mount technology (SMT) assembly in 1-5 days. It's our only focus. We take the hassle out of PCB assembly and make it easy, so you can spend time on other aspects of your design.

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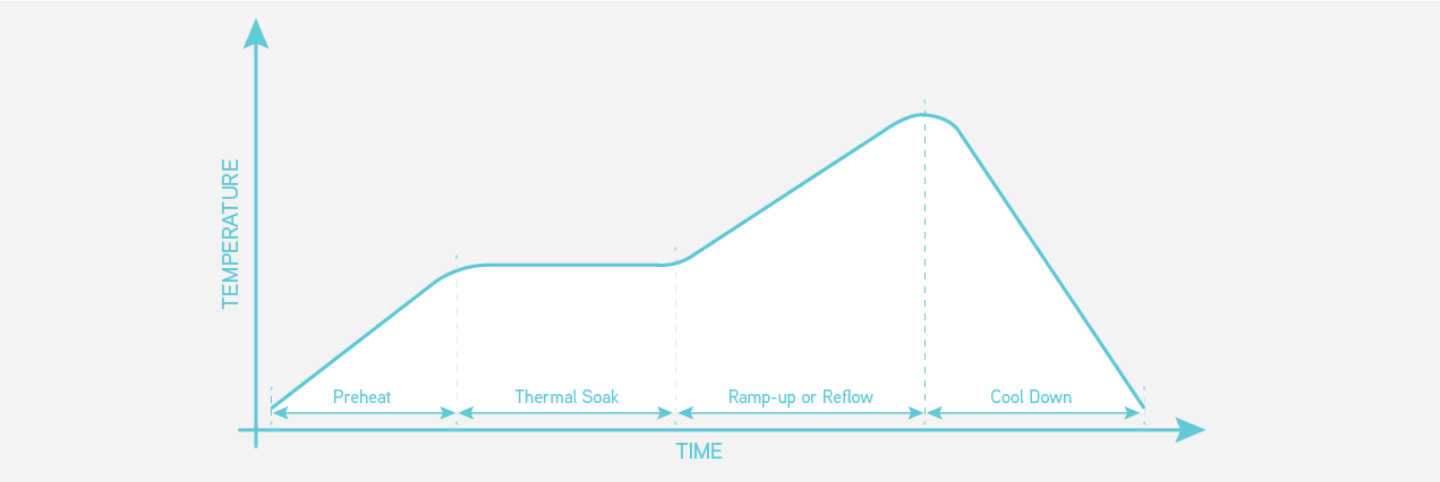

General soldering profile

The first zone is the preheat, where the temperature is brought up slowly. This must be done slowly to allow all portions of the board to heat up at the same time and to minimize thermal shock. This is also the stage where the solvents within the solder paste start to evaporate. If the board is heated up too quickly, it can expand in certain parts and crack, the copper can separate from the laminate, and the internal portions of integrated circuits can even break. Slowing the heating process also lets the integrated circuits gently release any moisture in them, preventing "popcorning" when the IC literally pops as the minute amounts of water in the IC turn to steam. The average ramp-rate is 3 degrees Celsius per second, but can vary significantly. This portion of the profile is unaffected by the use of leaded or lead-free solder. However the temperature-change rate can be modified to accommodate the different devices on a board, their sizes and heat masses.

After the temperature has been brought up to a specific temperature, typically around 155 degrees Celsius, the board enters the second zone called the thermal soak zone. At this point, the temperature increase is either stopped completely or slowed down to 1 degree Celsius or less per second. This typically takes about 90 seconds. Whether it is a leaded or lead-free process will dictate the maximum temperature reached in this zone. Here, the board should equalize in temperature and the solvents in the solder paste finish evaporating while the flux activates.

Once the board temperature has equalized, it is then passed to the ramp-up or reflow zone. This zone requires a delicate balance as this is where the solder is quickly brought to the eutectic point—the temperature where the solder melts. This temperature needs to be high enough and held long enough to provide the solder ample time to melt, joining the board and components. However, if the temperature is too hot or held too long it can cause damage to sensitive components or make the solder joints brittle. The melting point for lead-free solder is also significantly higher than lead solder, which makes the balance even more challenging. While there are different recommendations, the max temperature needs to be at least 5 to 10 degrees Celsius higher than the eutectic point and held anywhere from 10 seconds up to 60 seconds.

The final zone of the reflow process is the cooling zone, where the board is brought back down to room temperature. The temperature change is much quicker than the preheat and thermal-soak zones, taking around 3 minutes. It is recommended to keep the change less than 10 degrees Celsius per second, with the average change being significantly less than that. This stage is important as this is when the solder cools, forming the mechanical structure of the solder. This part of the reflow process starts inside the oven but usually ends outside of the oven, as the boards will still be extremely hot when they are done and will still need time to cool down.

While not as simple as tossing boards into a convection oven and hoping for the best, reflow soldering is an achievable process that can yield consistent, high-quality results. Understanding the steps can help you if you need to reflow your own boards or discuss your custom needs when working with an assembly house. ■