Application Note

Pb-Free Solder Process Guidelines

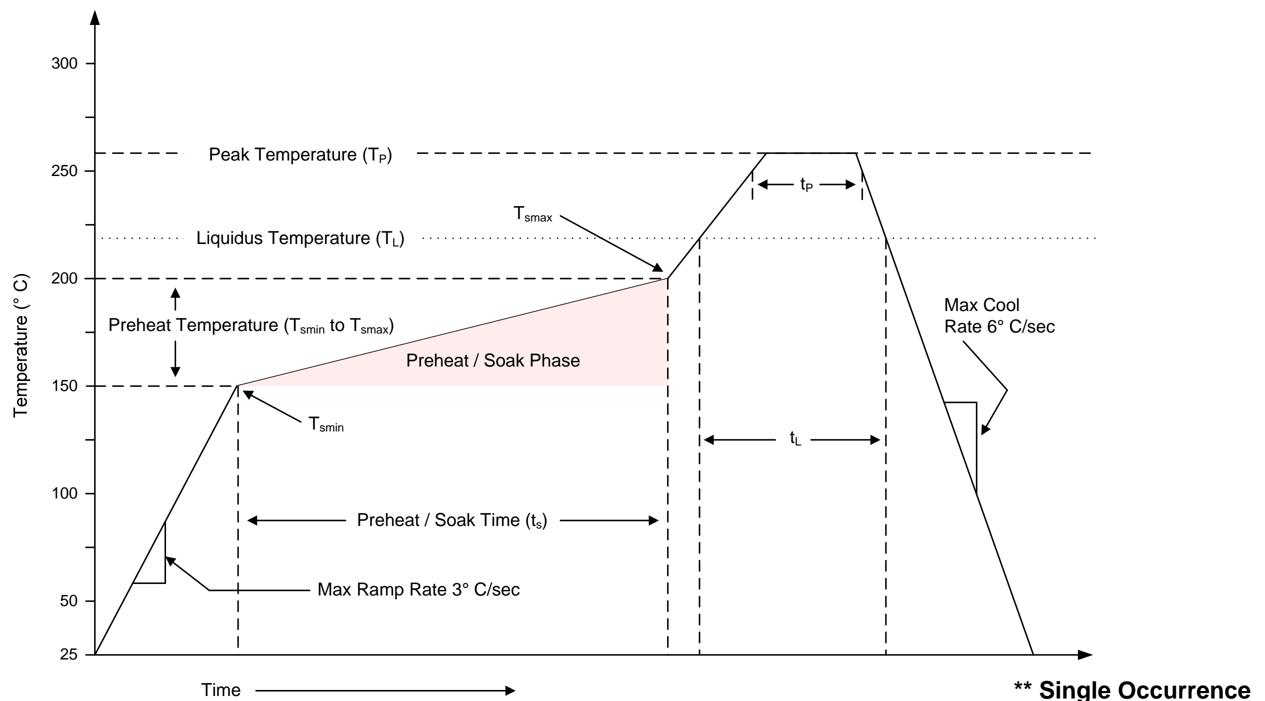
Introduction

The Solid State Optronics (SSO) product line consists of a broad range of optically isolated switching devices available in a wide assortment of packages. This application note provides SSO reference guidelines for various soldering methods and their recommended profiles.

Soldering Methods

Reflow Soldering

Reflow soldering is the most common way of attaching SMT (surface mount) devices to a circuit board. The process starts by temporarily attaching components to the circuit board with solder paste. The PCB assembly is then passed through an oven where the solder paste is heated, causing it to "reflow" and bond the joint between the component lead and PCB contact pad. The assembly is then cooled to complete the soldering process. A sample profile with recommended ranges for SSO products is shown below in Figure 01 with further discussion on the following page.



**** Single Occurrence**

Figure 01: *Pb-Free SMT Reflow Profile (not to scale)*

Profile Parameter	*Value*
Peak Reflow Temperature (T_P)	260°C
Time at Peak Temperature (t_{Pmax})	10 seconds
Time within 5°C of Peak Temperature(t_P)	30 seconds
Maximum Ramp Rate	3°C/s
Preheat Temperature Range (T_{smin}, T_{smax})	150C-200°C
Preheat/Soak Time (t_s)	90-120 seconds (120s maximum)
Liquidus Temperature of Solder (T_L)	~217°C
Time Above Liquidus (t_L)	60-150 seconds
Maximum Cool Ramp Rate	6°C/s
Maximum Device Surface Temperature	250°C

There are several steps in the reflow process and each is important in creating conditions for ideal solder joint bonding. The guidelines and recommendations discussed in this section follow industry standards as outlined in IPC/JEDEC J-STD-020D.1 (March 2008).

Sections below describe the various stages of the reflow solder process:

- Ramp Zone: The ramp zone is used to raise the temperature of the assembly to preheating levels. The critical parameter in this stage is the ramp rate, or rate at which the temperature rises. If the ramp rate is too low, solvents in in the solder paste may not evaporate completely leading to weak solder joints. If the temperature around the circuit board assembly rises too quickly, flux can splash causing bridges and shorts between leads or traces. A high ramp rate may also create thermal shock conditions in the assembly resulting in cracks or other physical damage.

  The usual ramp rate is between 1°C-3°C per second. SSO recommends a ramp rate between 2°C-3°C per second, with 3°C per second as a maximum.

  The assembly starts at room temperature (25°C) and should rise to a minimum preheat temperature of 150°C.

- Preheat Zone: During the preheating zone, flux components of the solder paste begin to activate and various components on the circuit board should reach a state of thermal equilibrium. This stage becomes more important as the number and size of components on the circuit board increase.

  SSO recommends a Preheat time of between 90 and 120 seconds.

- Reflow Zone: The purpose of the reflow zone is to melt the solder past and create the bond between the component leads and the circuit board. The liquidus temperature of solder paste is ~217°C and the assembly must reach a temperature of at least 230°C for ten (10) seconds in order for the solder joints to form properly.

  SSO's recommendations follow J-STD-020D and call for a maximum peak temperature of 255°C (±5°C) with a time of 30 seconds within 5°C of this peak temperature.

  The peak temperature at the terminals should not exceed 260°C, and the dwell time at the peak temperature should not exceed 10 seconds.

- Cooling Zone: This is the final zone of the reflow process and is where the gradual cooling of the assembly takes place. Solder joints harden during this phase and a faster rate is desired so that the grain structure of the solder joint is fine.

  The cool down rate should not exceed 6°C per second.

As a general rule, SSO recommends that the reflow process be monitored regularly and that temperatures are checked to ensure peak temperature limits are not violated.

Throughout the entire reflow process, the surface temperature of the device should never exceed 250°C.

SSO devices should undergo the reflow solder process only a single time.

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Wave Soldering

Wave soldering is used for PCBs that are populated by through-hole devices. Wave soldering is a process in which a single wave or continuous waves of molten solder are generated and a conveyor moves the circuit board assembly so that the top of the solder waves touch the underside of the circuit board, sticking to the solder pads and component leads.

A typical wave solder profile is shown below in Figure 02. Key parameters include a maximum preheat rate of 4°C/s, a maximum heat ramp rate of 200°C/s, a maximum time across both waves of 10 seconds, and a maximum cool down ramp rate of 5°C/s. At no point should a maximum temperature of 260°C be exceeded.

SSO devices should undergo the wave solder process only a single time.

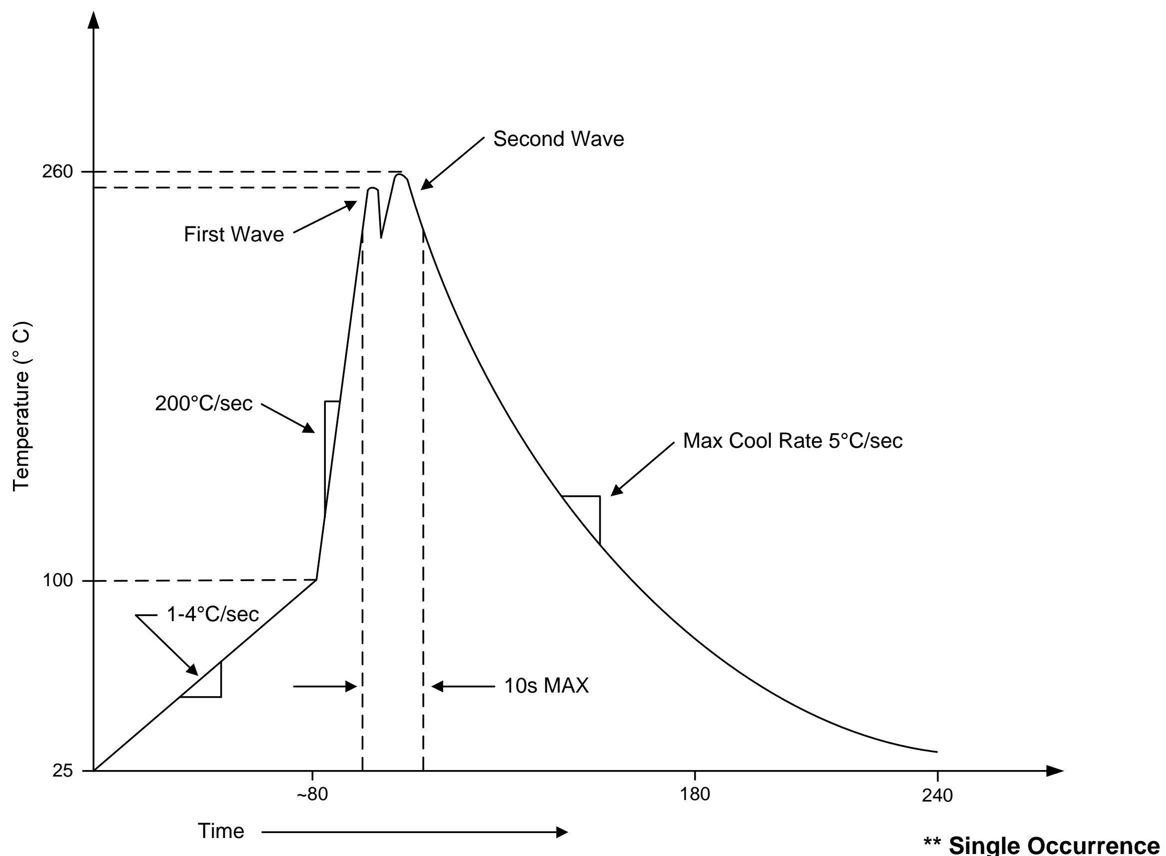

Figure 02: *Pb-Free Double Wave Solder Profile (not to scale)*

Profile Parameter	*Value*
Peak Wave Temperature	260°C
Maximum Time across Both Waves	10 seconds
Maximum Preheat Ramp Rate	4°C/s
Maximum Heat Ramp Rate	200°C/s
Maximum Cool Ramp Rate	5°C/s
Maximum Device Surface Temperature	250°C

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Hand (Manual) Soldering

This is a manual process using a soldering iron. It requires a fairly high level of skill and dexterity, is time-intensive and is typically suited to prototype or short run builds.

If used, this soldering method comes with the following SSO recommendations:

- Maximum Temperature: 350°C (at iron tip)
- Maximum Time: 3s

SSO devices should undergo the manual solder process only a single time.

Conclusion

SSO provides Customers with high quality optically isolated switching products designed to withstand the stresses of various soldering methods. SSO regularly subjects its devices to a battery of reliability tests. Included in these reliability tests are solderabilty evaluations to the latest industry standards. SSO Customers can be confident they are using components able to meet the demands of modern manufacturing solder techniques.

Visit www.ssousa.com or contact your local sales agent to learn more.

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