Qspeed™ semiconductor

AN-303 RoHS Compliant Soldering Considerations

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Abstract

All Qspeed Semiconductor device packages have lead-free, tin-plated leads that comply with RoHS and other environmental requirements. A typical wave soldering profile is described, which should ensure that good solder joints are made to Qspeed device leads, when lead-free solder is used. Hand soldering techniques, tips and precautions are provided. Lastly, printed circuit board (PCB) layout pads are shown and the maximum mounting screw torque and clamp pressures are also given.

Introduction

Lead-free solders have higher melting temperatures than lead-based solders do. Therefore, the soldering process subjects RoHS compliant, semiconductor packages to higher temperatures, for longer periods of time, than when lead-based solders were used. That has caused semiconductor device manufacturers to revisit their component packages, and to verify that they can withstand prolonged exposure to higher temperatures without damaging the parts, or reducing their long-term reliability.

Qspeed Semiconductor's component packages were originally designed to be soldered using lead-free solder on the leads, and extensive testing was done to ensure that the devices would not suffer any detrimental effects from the higher soldering temperatures.

Comparison of Wave Solder Profiles

Figures 1 and 2 show wave solder profiles for typical lead-based and lead-free solders. Standard wave soldering profiles include four distinct stages: pre-heat, thermal soak, soldering, and cool down. The longer exposure time and the higher soldering temperature are readily apparent. The thermal soak time of the lead-free solder profile is noticeably longer than the equivalent stage for the leaded solder. The longer soak time is required to ensure that the components to be soldered have reached their higher pre-solder temperature.

However, the most critical parameter of the four stages is the soldering stage temperature. The leads of all Qspeed devices must only make contact with the solder wave for a maximum duration of five to ten seconds, and should not be subjected to solder temperatures above 300 °C. A profile, similar to the one shown in Figure 2 should be used for soldering Qspeed devices into place on a PCB.

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Leaded Wave Solder Profile

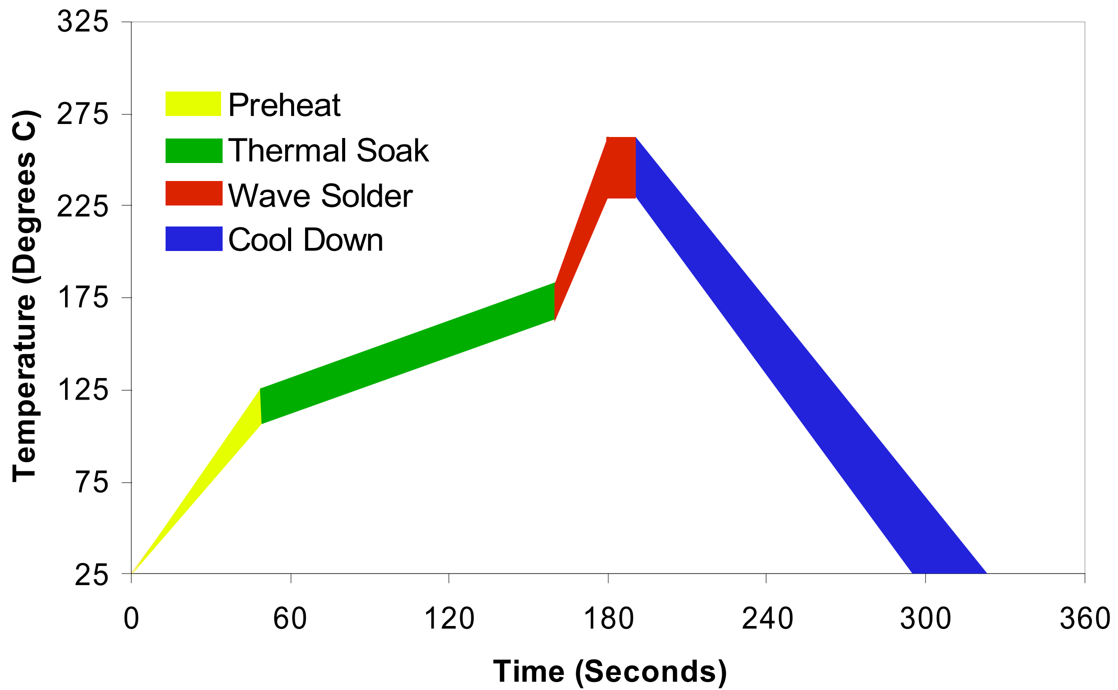

Figure 1: Wave solder profile for a typical lead-based solder.

Lead-Free Wave-solder Profile

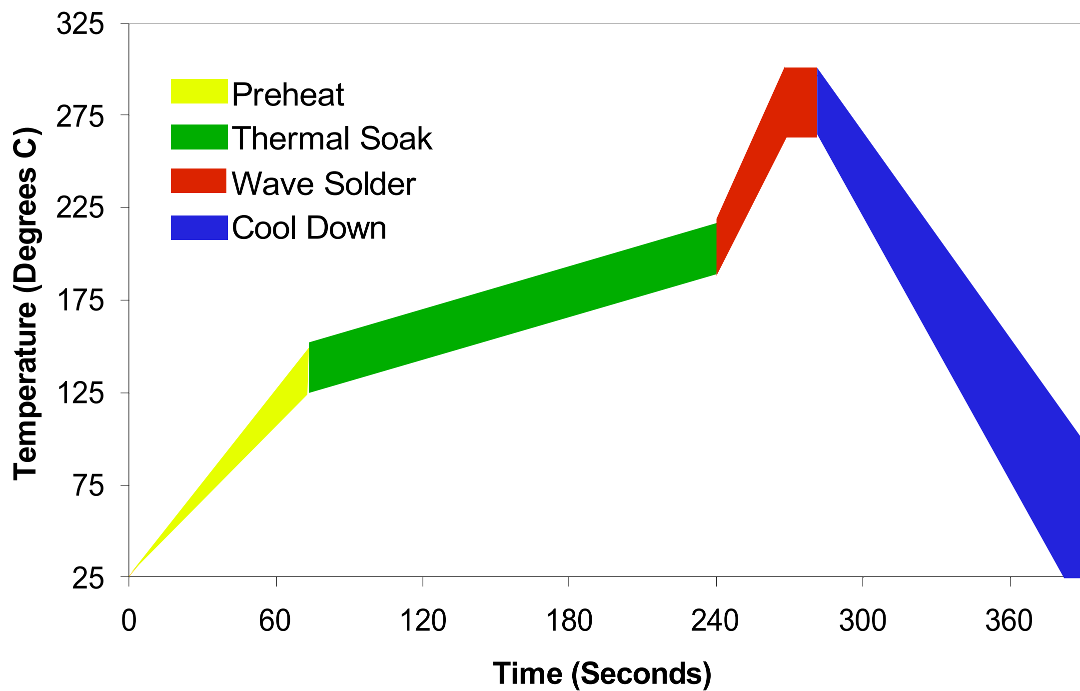

Figure 2: Wave solder profile for a typical lead-free solder.

Table I gives the upper and lower control limits for the times and temperatures of the preheat, thermal soak, solder and cool down stages of the profile that should be used for soldering Qspeed devices into a PCB, when a wave solder machine is used.

Table I: Wave Solder Time and Temperature Profile for Using Lead-free Solder

Phase	Start Temperature	End Temperature	Total Time
Preheat	25 °C	125-150 °C	60-80 Seconds
Thermal Soak	125-150 °C	190-220 °C	150-175 Seconds
Wave Solder	190-220 °C	275-300 °C	5-10 Seconds*
Cool Down	275-300 °C	25 °C	100-150 Seconds

*Note: Qspeed devices must not be subjected to 300 °C solder for more than 10 seconds, max.

Correct PCB Pads and Layout and Mounting Torque/Clamping Pressure

In order to ensure a good solder connection, double-sided PCBs with plated-through holes are recommended. However, (even if single-sided boards are used), PCB solder pads, similar to the size and shape of those shown in Figure 3, should be used to ensure that solder can properly adhere to the device leads.

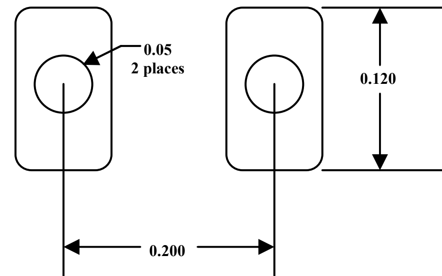

Figure 3: Typical TO-220 PCB pad layout

If the Qspeed device is to be secured to a heatsink, using a screw that passes through the mounting hole in the tab of the package, a maximum torque of 1 Newton Meter (nm) or 8.8 inch-pounds (lb-in.) should be used to tighten the screw.

If an external clamp is used to press the plastic case of the device against the heatsink, the maximum pressure that the clamp should apply to the case is 12.3 kilogram-force per square centimeter (kgf/cm^2) or 175 foot-pounds per square inch (lbf/in^2).

Hand Soldering Techniques, Tips and Precautions

Hand soldering of electronic components is not usually recommended, due to concerns about solder joint quality and reliability. However, Qspeed devices may be soldered by hand, as long as a few simple guidelines are followed (see Table II). First, soldering equipment–that has a tip with sufficient thermal mass and adequate heating capability–should be used, to ensure fast soldering of the device leads to the PCB. Second, a fixture that holds the device rigidly to the PCB, during soldering and cool-down is critical for producing a long-lasting solder joint. Third, a robust solder connection can only be achieved with a process that minimizes contaminants.

Table II: Guidelines for Hand Soldering with Lead-free Solder

Guiding Principle	Reason or Description of Requirements
Soldering iron tip size and heating ability	Tip of iron must have enough thermal mass
Immobilization fixture or Gig	Prevents device movement while soldering
Minimize presence of contaminants	Weakens joint and extends soldering time
Clean PCB pads and package leads	Allows fast heat transfer and a solid joint
Maximum heating time and temperature	10 seconds at 300 °C, maximum

Not only do contaminants weaken the finished solder joint, but they also restrict heat transfer during the soldering process. This can cause soldering to take longer than it would otherwise, which increases the likelihood of damaging the device by overheating it. Clean PCB pads and package leads allow for fast heat transfer and improve the likelihood of producing a solid solder joint.

Lastly, the maximum duration of elevated lead temperatures must be adhered to. No Qspeed devices should be subjected to lead temperatures greater than 300 °C, and should not be kept at that soldering temperature for more than 10 seconds.

Summary

Soldering Qspeed Semiconductor devices should not present any special challenges compared with other diodes in similar packages, as long as the duration of exposure to elevated temperatures is not violated. Standard wave solder profiles, used within the electronics industry, should provide good results, without modification. Specific Qspeed Semiconductor datasheets should be consulted for the latest, most up-to-date information on each device (see http://www.qspeed.com/Tech-Info/Technical-Information.cfm).

References

1. Various articles by Bob Willis, http://www.leadfreesoldering.com.
2. Karl Seelig, *"Considerations for Lead-Free Wave Soldering"*, AIM, June, 2005. http://www.aimsolder.com/techarticles/Considerations%20for%20Lead-Free%20Wave%20Soldering.pdf
3. IPC J-STD-006B, Joint Industry Standard, *"Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications"*, http://www.ipc.org/4.0_Knowledge/4.1_Standards/Free/IPCJ-STD-006BAmendment1.pdf

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