

# PI31xx Product Family Reflow Soldering Guidelines

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## Introduction

The Cool-Power® PI31xx family of very high density isolated DC-DC converters are intended for reflow soldering assembly. The information contained in this application note defines the processing conditions for successful installation of the product on to a printed circuit board (PCB). Failure to follow the guidelines established in this application note can lead to incorrect solder joints, aesthetic damage and/or failure of the module.

## Storage

The PI31xx family is rated at JEDEC MSL-6. All components in this family should remain in the dry vacuum bag they were shipped in during storage and prior to assembly. Exposure of the product to ambient environmental conditions for longer than four hours maximum requires a bake at 125°C for 24 hours to remove moisture from the device package.

## Solder Paste

### RoHS Compatible Lead Free Applications

#### 245°C Peak Case Temperature

SAC 305, either no-clean or water-washable solder paste is recommended. Other types of lead-free solder pastes can be used so long as the peak case temperature of 245°C is not exceeded during the reflow process.

### Leaded Applications

#### 225°C Peak Case Temperature

63/37 SnPb either no-clean or water-washable solder paste is recommended. Other types of SnPb solder pastes can be used so long as the peak case temperature of 225°C is not exceeded during the reflow process.

## PCB Considerations

### PCB Stencil Design

Figure 1 shows the recommended receiving pattern for the PCB with the dimensioned pad centers shown with respect to the center of the package. The recommended stencil aperture ratio should be 0.9:1 based on a 6mil-thick stencil, allowing for solder paste coverage of 90% of each pad 6mils thick.

## Pick And Place

The PI31xx should be placed within  $\pm 5$  mils of the center line. To maintain proper placement, the module should not be subjected to acceleration greater than  $500\text{in}/\text{sec}^2$  from the time it is placed until after it has been reflowed. All handling of the PI31xx through personnel and process must be done using proper ESD procedures.

## RoHS Compatible 245°C Reflow Guidelines

PI31xx modules that are approved for 245°C reflow are qualified per J-STD-020D for three reflows at a peak temperature of 245°C under MSL-6 conditions. The time out of bag (TOB) is four hours. The solder reflow information presented here is based on experiments performed on the PI31xx and do not represent exact conditions found at every factory. Information that is contained in this note is for guidance only. The actual process employed will likely require some optimization to account for various factors such as PCB thickness, oven type and the desired solder paste.

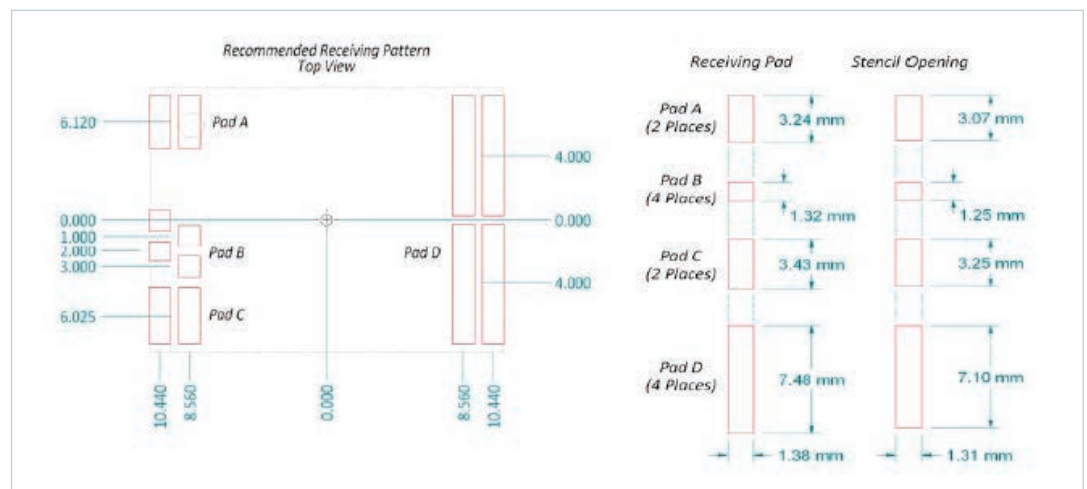
The two temperatures that are critical to the success of the reflow process are the solder joint temperature and the module case temperature. The solder joint temperature should reach 240°C while the module case temperature must not exceed 245°C at any time during the process. A forced-air convection oven is recommended for reflow soldering to limit the temperature rise of the module case. Ovens of this type transfer heat from the PCB to the J-lead rather than from the case to the J-lead. Other types of reflow ovens have not been qualified for use with PI31xx products and should be studied by the user to ensure they can provide a reflow profile in accordance with these guidelines before using. The thermal mass of the case slows the temperature rise of the case relative to the J-lead and receiving pads. Figure 2 shows the typical 245°C PI31xx reflow profile when soldering to a  $4.2\text{in}^2$  1oz Cu six-layer FR4 PCB.

In the reflow step, the module and board assembly should be heated at a rate no faster than  $2^\circ\text{C}/\text{sec}$ . Once the assembly is above the liquidus temperature required to produce reflow of the solder, it should remain there between 60 and 90 seconds. In order to achieve the correct reflow temperature profile, the peak temperature and feeder speed of the oven must be based on the total mass of the assembly being soldered. The final stage is the cooling stage. The cool down rate should be no faster than  $3^\circ\text{C}/\text{sec}$ .

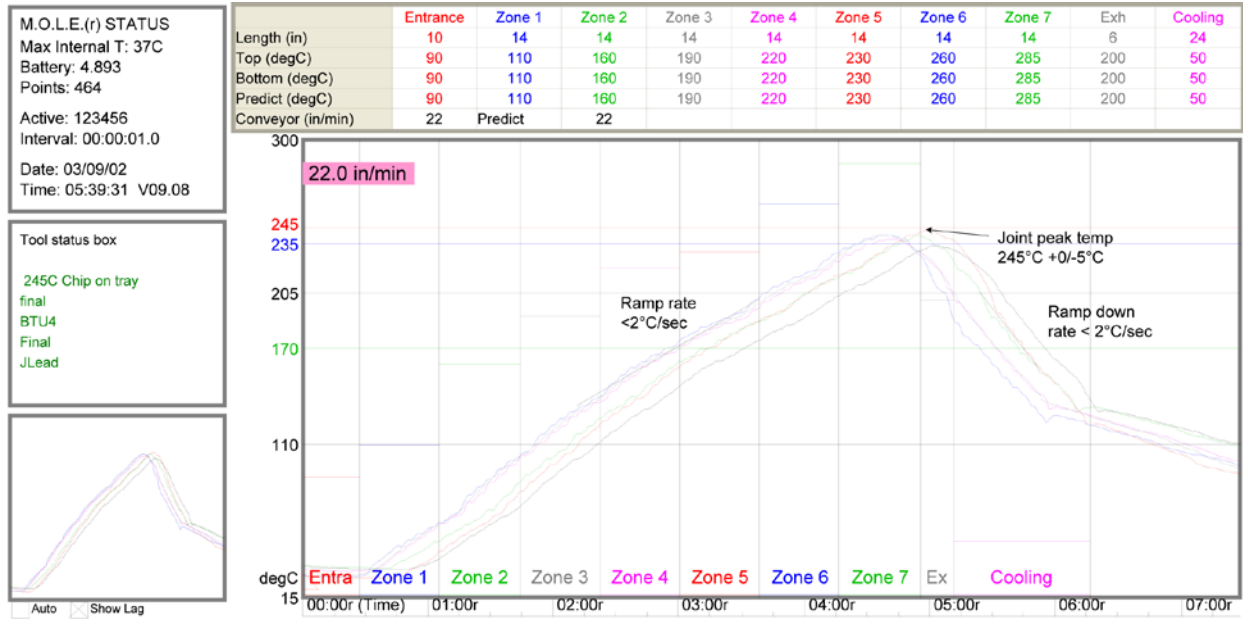
Following reflow, flux residue must be removed from and in between the PI31xx J-leads. Failure to remove this residue can cause it to become electrically conductive over time and create module failures.

PI31xx modules can be subjected to 245°C maximum case temperature reflow up to three times provided that in between each reflow, the same MSL6 handling procedures are followed. Exposure to ambient conditions for more than four hours requires a re-bake at 125°C for 24 hours prior to reflow.

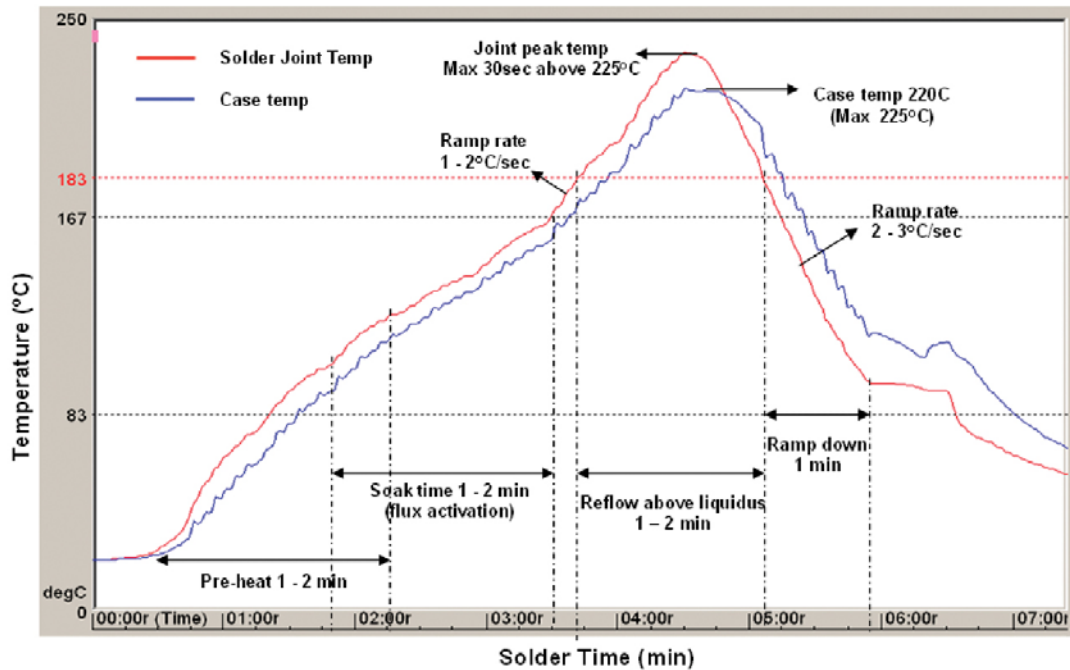
**Figure 1**  
PCB Receiving Pattern  
for PI31xx Products



**Figure 2**  
 Typical 245°C Reflow Profile  
 for a Lead Free Application  
 PI31xx Product MSL6



**Figure 3**  
 Typical 225°C Reflow Profile  
 for a Leaded Application  
 PI31xx Product MSL6



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## Leaded 225°C Reflow Guidelines

PI31xx modules that are approved for 225°C reflow are qualified per J-STD-020D for three reflows at a peak temperature of 225°C under MSL-6 conditions. The time out of bag (TOB) is four hours. The solder reflow information presented here is based on experiments performed on the PI3101 and do not represent exact conditions found at every factory. Information that is contained in this note is for guidance only. The actual process employed will likely require some optimization to account for various factors such as PCB thickness, oven type and the desired solder paste.

The two temperatures that are critical to the success of the reflow process are the solder joint temperature and the module case temperature. The solder joint temperature is allowed to reach 225°C for 30 seconds, while the module case temperature must not exceed 225°C at any time during the process. A forced-air convection oven is recommended for reflow soldering to limit the temperature rise of the module case. Ovens of this type transfer heat from the PCB to the J-lead rather than from the case to the J-lead. Other types of reflow ovens have not been qualified for use with

PI310X products and should be studied by the user to ensure they can provide a reflow profile in accordance with these guidelines before using. The thermal mass of the case slows the temperature rise of the case relative to the J-lead and receiving pads.

Figure 3 shows the typical 225°C PI31xx reflow profile when soldering to a 4.2in<sup>2</sup> 1oz Cu six-layer FR4 PCB.

In the reflow step, the assembly is preheated to a temperature between 100°C and 150°C and held there for one minute to evaporate solvents from the solder paste. The next zone is the soak zone, where the flux activation occurs and the flux reacts with the oxide and contaminants on the surfaces to be joined. The assembly is raised above the 183°C liquidus temperature to produce reflow of the solder and held there for between 60 and 90 seconds. In order to achieve the correct reflow temperature profile, the peak temperature and feeder speed of the oven must be based on the total mass of the assembly being soldered. The final stage is the cooling stage. The cool down rate should be no faster than 3°C/sec.

Following reflow, flux residue must be removed from and in between the PI31xx J-leads. Failure to remove this residue can cause it to become electrically conductive over time and create module failures.

PI310X modules can be subjected to 225°C maximum case temperature reflow up to three times provided that in between each reflow, the same MSL6 handling procedures are followed. Exposure to ambient conditions for more than four hours requires a re-bake at 125°C for 24 hours prior to reflow.

## Solder Joint Inspection Guidelines

Both a module package and solder joint inspection should be performed following the reflow procedure and the guidelines below cover both leaded and lead free soldering.

The module package should show no evidence of:

- Solder extrusion from the PI31xx package
- J-lead separation from the module body
- J-lead damage or delamination
- Any evidence of the above indicates that the PI31xx module package was subjected to excessive temperature during the reflow process

J-lead solder joints should conform to IPC 12.2 to include:

- Properly wetted fillet must be evident per Figure 4. Heel fillet height must exceed lead thickness plus solder thickness

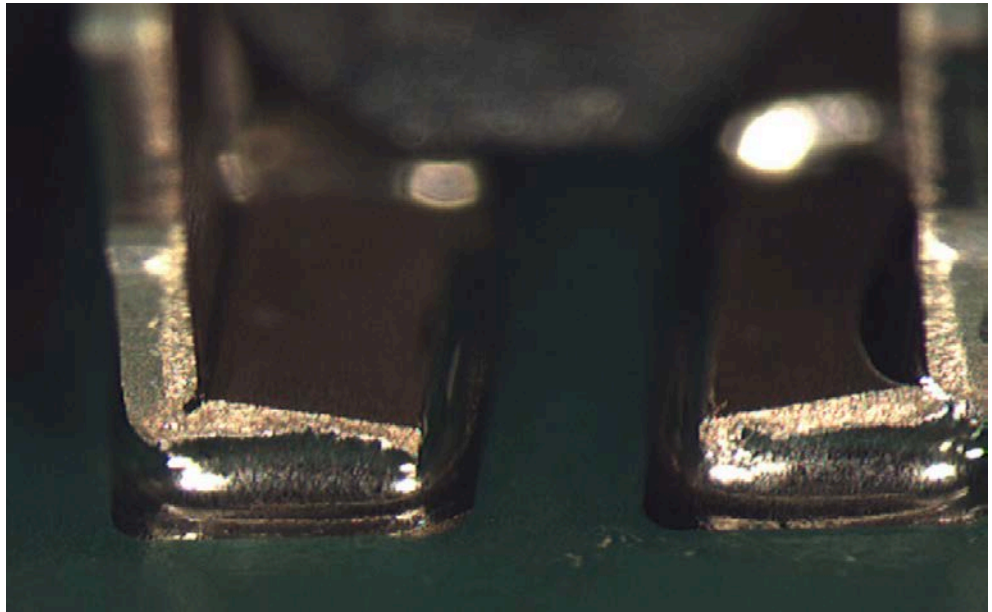
Note that J-leads do not sit flat on the PCB surface. The solder fillet forms underneath the heel and does not necessarily extend up the side of the J-lead after successful reflow.

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## Rework Guidelines

For rework purposes, the PI31xx family of converters can be removed from the PCB using specialized hot air tools such as those made by [Air-Vac at air-vac-eng.com/index.html](http://air-vac-eng.com/index.html). These tools heat a very localized region of the PCB while providing tensile force in the form of a vacuum. Prior to heating the solder joint, the PCB should be preheated to 100°C using either a bench oven or hot plate to reduce the time required to flow the solder and also to prevent warping of the PCB. If there are adjacent moisture sensitive components, a bake may be necessary to prevent damaging them. Follow those components MSL guidelines. Removal using hot air tools with an uncontrolled temperature profile may damage the PI31xx and it should not be reused under those circumstances.

**Figure 4**  
*Typical Example of  
Wetted Fillet J-lead Connection  
Using PI31xx*



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