

# ***High-Temperature Soldering Requirements for Plug-In Power Surface-Mount Products***

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*PMP - Plug-In Power*

## **ABSTRACT**

The PTH, PTN, PTB, and PTMA series of lead-free (Pb-free), surface-mount, Plug-in Power (PIP) modules are designed to be compatible with industry-standard, Pb-free solder reflow processes and aqueous washes. High-temperature, Pb-free reflow compatible products are identified by the Z-suffix in PIP part numbers. This application report identifies requirements for soldering PIP modules to a host printed-circuit board with a Pb-free solder process.

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## **1 Soldering Requirements**

1. **High-Temperature Solder Process.** PIP modules must be attached to the host printed-circuit board (PCB) using industry-standard, Pb-free solder reflow processes. The solder paste should be an industry standard SAC alloy with a nominal melting point of 221°C.
2. **Quantity of Solder.** A minimum solder paste thickness of 0.006 inch is recommended for PIP modules with solder ball pins.
3. **Reflow Profile.** To avoid component damage and potential opens and shorts due to excessive temperature or internal solder reflow within the product, use the following maximum reflow parameters:
  - A. Preheat and cool-down ramps should not exceed 2°C/s to prevent internal component failures due to thermal stress.
  - B. Do not elevate the product's pin or component temperature above a peak of 260°C.
  - C. The pin or case temperature must exceed 235°C (with a maximum of 260°C) for at least 20 seconds, not to exceed 60 seconds.

## **2 Developing Your Own Reflow Profile**

A reliable profile for soldering power modules to a host PCB may be developed using at least three small-gauge (30 to 36 Awg) thermocouples, or other temperature measuring material, secured to the test unit in the following locations:

- Product power pin on the module's PCB
- Center of the module PCB
- Product ground pin near customers PCB

Monitor thermocouples as the unit passes through the oven to verify that the pin temperature exceeds 235°C (with a maximum of 260°C) for at least 20 seconds, not to exceed 60 seconds, and that the soldering requirements detailed herein are not exceeded. See a sample reflow profile on page 3 of this document.

### 3 Power Module Construction

PIP products are constructed on high-temperature laminate PCBs using surface-mount components. The components are soldered in place using 96.5% tin (Sn), 3.5% silver (Ag) high-temperature Pb-free solder. This solder has a melting temperature of  $221^{\circ}\text{C} \pm 4^{\circ}\text{C}$ .

The product pins are Pb-free; 100% matte tin (Sn) plating with a nickel (Ni) barrier. Typical pin plating is 300 to 500 micro-inches of 100% tin (Sn) over 100 to 200 micro-inches of nickel (Ni). The matte tin plating is reflowed during the assembly process of the module. All soldering surfaces meet and are routinely tested to the solderability requirements of ANSI/J-STD-002, Category 3.

The Z-suffix, Pb-free solder ball material is 96.5% tin (Sn), 3.0% silver (Ag), and 0.5% copper (Cu).

### 4 Surface-Mount Soldering Qualification

PIP surface-mount products are qualified to have no degradation from reflow/IR soldering and aqueous washing by verification through rigorous testing. Sample batches are subjected to three passes through a convection reflow oven and an aqueous wash cleaner, with a cool-down between passes to room temperature. The convection reflow oven is set to achieve  $245^{\circ}\text{C}$  to  $260^{\circ}\text{C}$  peak temperature on any pin or component. These parts are subsequently used for thermal shock, humidity, and life qualification testing. All products must pass this initial qualification testing with zero failures before being released to production.

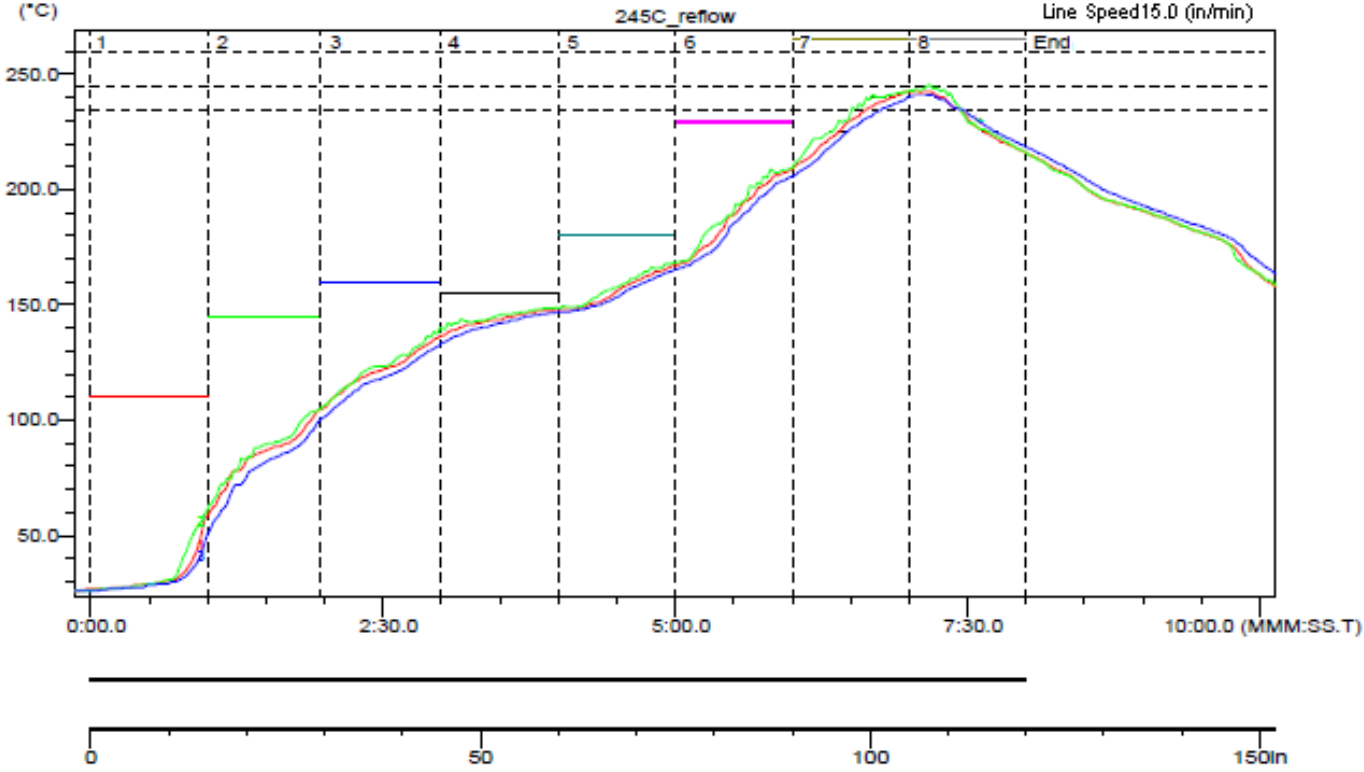
### 5 Additional Considerations

Each host PCB and PIP module assembly may be physically different. Each assembly should be individually verified to be within these soldering requirements.

The PIP modules are designed to be thermally efficient in transferring heat from their components through convection, conduction, and radiation. During soldering, heat therefore flows easily into the power module. As a result, the module's components and solder joints may heat at different rates than the host PCB and its SMT components.

The Pb-free, surface-mount products have a moisture sensitivity level (MSL) classification of level 3 /  $260^{\circ}\text{C}$ .

# Sample Reflow Profile



Zone	#1	#2	#3	#4	#5	#6	#7	#8
Upper	110	145	160	155	180	230	265	265
Lower	110	145	160	155	180	230	265	265

Probe	Max Temp	Reached Max Temp	Time Above 235°C	Reached 235°C	Time Above 245°C	Reached 245°C	Time Above 260°C	Reached 260°C
pcb	242.5	6:58	0:49	6:39	0:00	-	0:00	-
pin	245.5	7:10	0:55	6:31	0:02	7:10	0:00	-
inductor	241.0	7:09	0:42	6:44	0:00	-	0:00	-

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