Application Report
SLVA840–January 2017

Power Module MSL Ratings and Reflow Ratings

ABSTRACT

All semiconductor devices, including power modules that have a moisture sensitivity level (MSL) rating and a peak reflow classification, which provides needed information when manufacturing with the device. This application report helps to explain these ratings.

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1 Introduction

The MSL rating and peak reflow information is displayed on the "Quality & packaging" tab (see Figure 1) of the device's product folder on www.ti.com. Likewise, the information can also be found on the device reel and packing box. Figure 2 shows an example of a device's box label that also includes the MSL and peak reflow information.

Quality & environmental data

Part #	Eco Plan*	Lead / Ball Finish	MSL Rating / Peak Reflow
LMZ31704RVQR	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

Figure 1. Component MSL Rating and Peak Reflow on ti.com

Figure 2. MSL Rating and Peak Reflow Labeling on Box

2 Applying the Moisture Sensitivity Level (MSL)

The MSL rating of a device determines its floor life, or the amount of time that a device can be removed from its anti-static, dry pack bag before being reflowed. Once the dry pack bag is opened, moisture from the ambient air gets into the device. If the floor life is exceeded and too much moisture gets into the device during reflow, the moisture can expand and damage the device.

IPC/JEDEC J-STD-033C is the electronics industry standard for defining MSL ratings versus floor life at 30°C, as shown in Table 1.

Table 1. Factory Floor Life @ 30°C

MSL	Floor Life	Moisture Relative Humidity
1	Unlimited	85% RH
2	1 year	60% RH
2a	4 weeks	
3	168 hours	
4	72 hours	
5	48 hours	
5a	24 hours	
6	Bake before use and reflow within time on label	

Most TI power modules are rated MSL 3 or higher. The MSL rating is given after product qualification and determined by the materials used in its packaging and assembly process, assuming a constant 30°C and 60% relative humidity. The absorption of moisture into an IC package is proportional to temperature and relative humidity. Exposing the device to higher humidity conditions or higher temperatures potentially shortens the floor life.

The *Recommended Equivalent Total Floor Life* table in IPC/JEDEC J-STD-033C provides guidance on floor life for differing temperatures (20°C to 35°C) and a range of relative humidity (5% to 95%) for different package types and thicknesses.

If the floor life is exceeded, the device must be baked prior to reflow. Consult IPC/JEDEC J-STD-033C for baking times based on the thickness of the device, the MSL rating of the device, and the baking temperature. Devices in tape and reel, trays, or tubes may not be baked at any temperature higher than 40°C.

3 Reflow Profile for Lead-Free Soldering

When reflowing TI power modules, the peak reflow rating of the device must be observed and applied. A reflow profile that meets the temperature and time requirements defined in J-STD-020D.1 is shown in Figure 3. Figure 3 illustrates the key temperature and times associated with the different reflow oven zones.

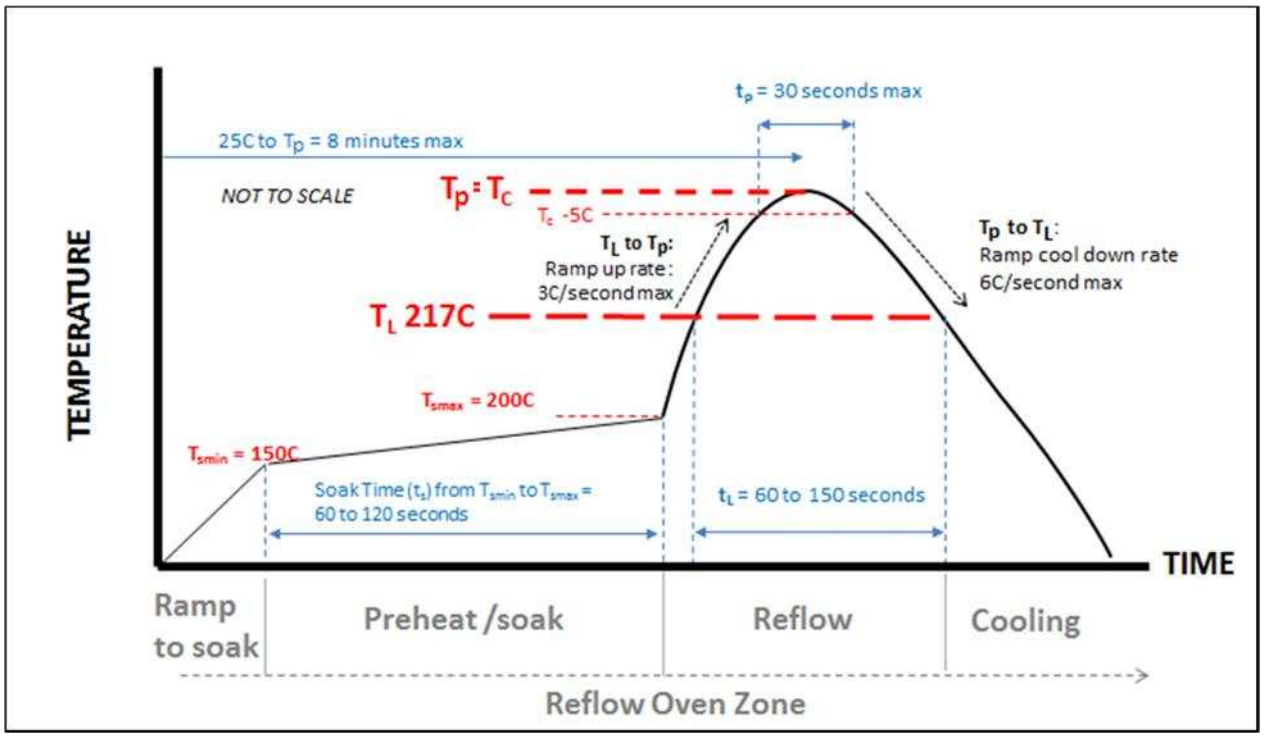

Figure 3. TI Representation of a J-STD-020D.1 Lead-Free Reflow Profile

The *Classification Reflow Profiles* table from J-STD-020D.1 defines the industry standard for a lead-free reflow profile that applies to TI power modules during manufacturing as shown in Figure 3.

Important items defined in J-STD-020D.1 that can impact IC reliability are:

- Soak time: t_s
- Soak temperatures: minimum (T_{smin}) and maximum (T_{smax})
- Liquidous temperature (T_L) for lead-free soldering; this is approximately 217°C. This varies according to the alloy.
- The peak temperature (T_p) for reflow at top of the package.
  - For users, T_p must not exceed the specified classification temperature (T_c).
- The maximum time (t_p) that the temperature is within 5°C of T_c.
- Ramp up rate from T_L to T_p
- Cool down rate from T_p to T_L

NOTE: J-STD-020D defines a broad standard for reflow profile. For specific recommendations or limitations on reflow ramp rates and times, see the solder paste manufacturer's data sheet.

4 References

- **IPC/JEDEC J-STD-033C**: Joint IPC/JEDEC standard for handling, packing, shipping, and use of moisture and reflow sensitive surface-mount devices
- **J-STD-020D.1**: Joint IPC/JEDEC standard for moisture and reflow sensitivity classification for nonhermetic solid state surface-mount devices

Both documents are available on JEDEC.ORG

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