TEXAS INSTRUMENTS

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MSL Ratings and Reflow Profiles

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ABSTRACT

This application reports explains the relationship of MSL rating to floor life and surface mount reflow temperatures for TI semiconductors.

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1 Introduction

All TI surface mount ICs have a moisture sensitivity level and peak reflow classification. This information is displayed on http://www.ti.com (see Figure 1) and on the reel and box packing. Figure 2 shows an example of a box label.

Quality & environmental data

Part #	Eco Plan*	Lead / Ball Finish	MSL Rating / Peak Reflow
TMS320F28035PAGQ	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

Figure 1. Example of Component MSL Rating and Peak Reflow of ti.com

Figure 2. MSL Rating and Peak Reflow Labeling on Box

2 Applying the Moisture Sensitivity Level (MSL)

The MSL rating of an IC determines its floor life before the board mounting once its dry bag has been opened.

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 semiconductor products are rated MSL3 or higher. MSL 1 is the highest rating where it is considered as being not moisture sensitive even at 85% RH and components rated MSL1 do not require dry packing.

The MSL rating is given after product qualification and determined by the materials used in its IC packaging and assembly process is based on a constant 30°C and constant relative humidity. In practice, the absorption of moisture into an IC package is proportional to temperature and relative humidity.

Therefore, floor life can generally be increased with exposure to temperatures lower than 30°C or lower humidity levels than 60% RH.

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Similarly, exposing it 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.

Products that exceed their floor life can be re-worked with a bake to drive out residual moisture. IPC/JEDEC J-STD-033C provides guidance about the baking procedure and where you should take care to ensure that the plastic housing (trays, tape and reel or tubes) can withstand the temperatures being considered.

3 Peak Reflow Temperature

Table 2. Peak Reflow Classification (Tc) Based on Package Dimensions

Package Thickness	Volume < 350 mm3	Volume 350 – 2000 mm3	Volume >2000 mm3
< 1.6 mm		260°C	
1.6 mm – 2.5 mm	260°C	250°C	245°C
>2.5mm	250°C	245°C	

Table 2 is an extract from the *Pb-Free Process - Classification Temperatures (T_c)* table in J-STD-020D.1 peak reflow temperatures for a lead-free soldering operation.

Three peak temperatures are defined based on package thickness and volume where the tolerance for peak temperature is +0/-5°C.

4 Reflow Profile for Lead-Free Soldering

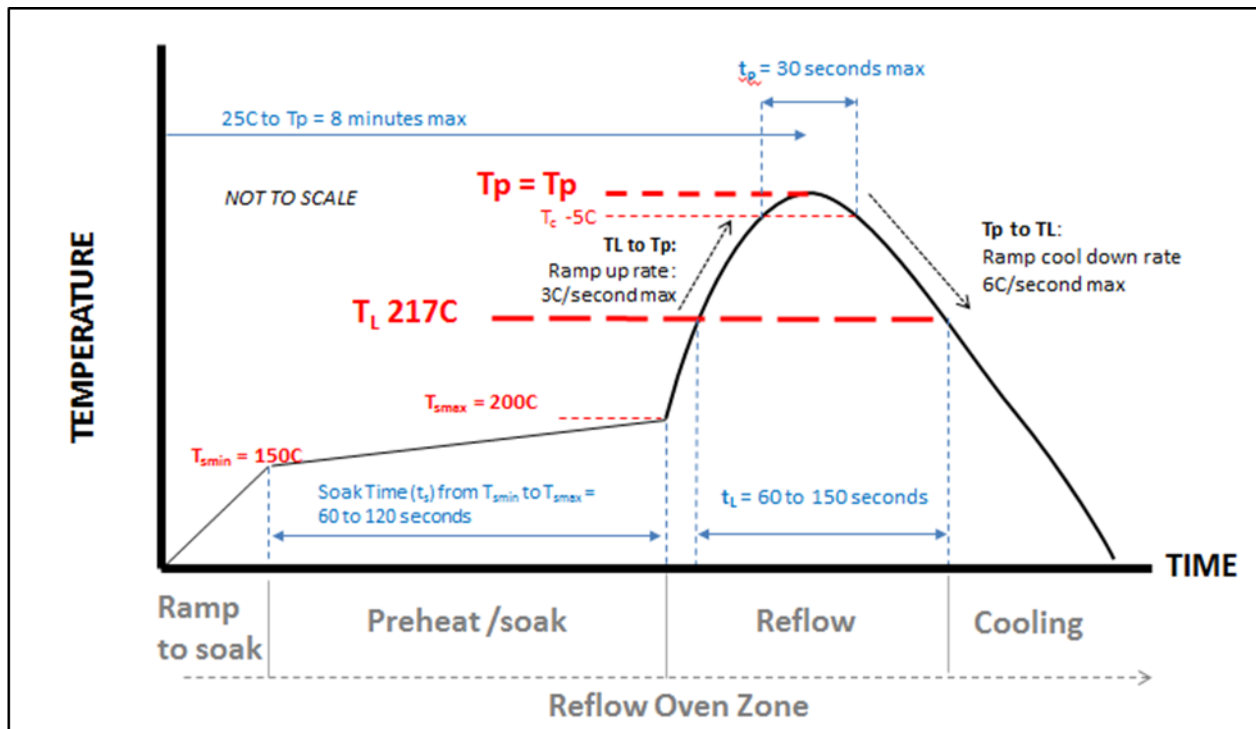

Figure 3. TI Representation of a J-STD-020D.1 Lead-Free Reflow Profile

The *Classification Reflow Profiles* table from J-STD-020D.1 defines the industry standard for a lead-free reflow profile that TI components are capable of being manufactured with.

Figure 3 illustrates the key temperature and times associated with the different Reflow oven zones.

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

- Soak time ts
- Soak temperatures: min(T_{smin}) and max (T_{smax})
- Luquidous (Liquidus) temperature (TL) for lead-free soldering; this is approximately 217°C. This varies according to the alloy.
- The Peak temperature (Tp) for reflow at top of the package.
  - For a user, Tp should not exceed Tc
  - Time that defines the peak temperate (tp) starts -5°C below Tc.
- Ramp up rate from TL to TP
- Cool down rate from TP to TL

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

5 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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