ALPHA & OMEGA SEMICONDUCTOR

Application Note
PAC-005

Soldering Temperature Profile of AOS Product with Lead-free Solder

Purpose

This document defines the recommendation of soldering temperature profiles for all the Alpha and Omega Semiconductor (AOS) products. Using temperature and time duration not to exceed these conditions will prevent damage to the parts during the mounting processes and help ensure the quality and reliability of AOS parts.

Scope

This procedure applies to all AOS product/packages that are required to perform soldering on to PCB (Printed circuit board).

Reference Documents

JESD22-A113 Pre-conditioning of non-hermetic surface mount devices before reliability testing IPC/JEDEC J-STD-020D, moisture/reflow sensitivity classification for non-hermetic solid-state surface mount devices

General

The soldering profile is used in PCB assembly. Since different customer uses different system, different components, and different solder, the optimum soldering condition to ensure the solder integrity and reliability can only be determined by the user (customer).

The recommended soldering profiles reflect the common range used by the PCB assembly process, which has less thermal stresses than our reliability qualification precondition. This will ensure the long-term reliability of usage of AOS parts.

During the reliability qualification, AOS parts are subject to the very severe condition in accordance with the IPC/JEDEC J-STD-20D document (see profile in Appendix A), which involves one-week moisture absorption in 85 °C and 85% relative humidity followed by three solder reflows simulation for ≥30 sec at peak temperature between 255 °C and 260 °C. Using temperature and time duration not to exceed these recommended conditions will not damage AOS parts.

Recommended Soldering Profile

Reflow Soldering Profile

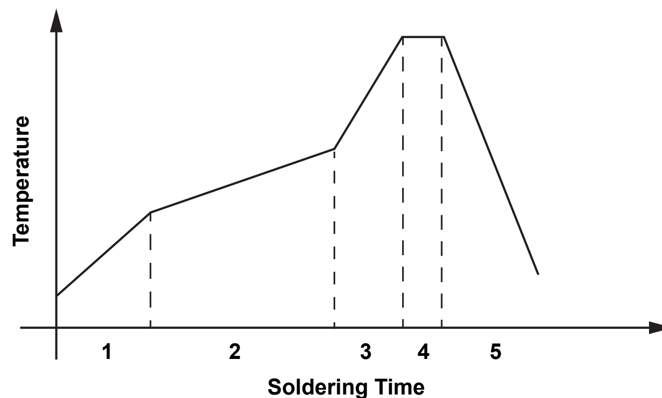

Figure 1. Recommended General Soldering Profile in PCB Assembly. Ranges 1 to 5 Correspond to Table 1.

Table 1. Recommended General Soldering Profile

Range	Profile Feature	Requirement
1	Ramp Up	1-4 °C/seconds
2	Soak	150 °C ~ 150 °C, 60-180 seconds
3	Ramp-up to Peak	1-4 °C/seconds
4	Peak to Soak(1)	245 °C ~ 260 °C, 10 seconds max.
5	Ramp-down Rate	1-6 °C/seconds max.

Note:

1. Maximum thermal excursion allowed during the reflow assembly is as follow:
   - Temperature: 255 °C ~ 260 °C
   - Duration at peak soak: 30 seconds
   - Number of reflow: 3

Table 2. Recommended Wave Soldering Profile

Range	Profile Feature	Recommended Condition
1	Preheat: Ramp-up Rate	1-7 °C/seconds
2	Soak:	
	Temperature	110 °C ramp to 140 °C
	Time	60-120 seconds
3	Ramp-up Rate	~150 °C/seconds
4	Peak:	
	Peak Package Body Temperature	245 °C ~ 260 °C
	Time	10 seconds max. For dual wave also.
5	Ramp-down Rate	1-7 °C/seconds

Wave Soldering Profile

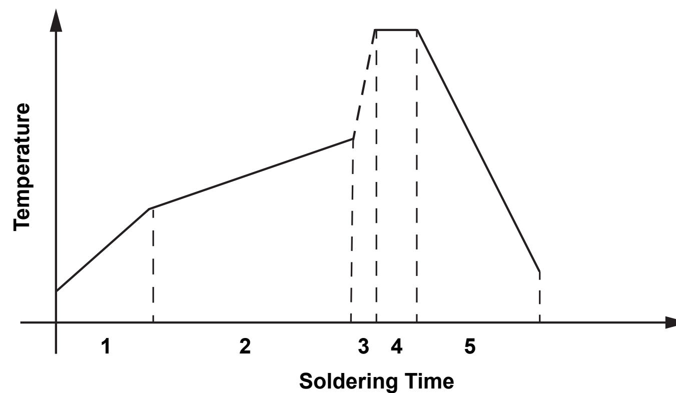

Figure 2. Recommended Wave Soldering by JEDEC Standard. Ranges 1 to 5 Correspond to Table 2.

Leadless Device Assembled on the Back Side of PCB

By and large, wave soldering is for through-hole device assemble. A leadless device is not recommended to be assembled on the backside of the PCB. In addition, all wave soldering must follow JEDEC standard temperature profile.

If the device is to be attached by surface mount reflow first on the backside, then the special holding fixture must be used to prevent the device from falling into the wave soldering bath.

If the device is attached on the backside with adhesive, it is the customer’s responsibility to ensure that it will not drop during the wave soldering process.

Surface Mount Device Package Apply in Wave Soldering

- MSL1 classified SMD package with gull wing leads can be used for IWS under JESD22-A111
- Package example but not limited to: SOT23, TSOP6, SOP-8, DPAK, D2PAK

Surface Mount Device Package Not for Wave Soldering

- MSL1 classified SMD package with flat leads cannot be used for IWS (red glue for gate floating concern)
- Package example but not limited to: DFN8x8, DFN5x6, DFN3x3, UltraSO8 (MSL1), TOLL (MSL1)
- AOS does not recommend any SMD packages with a MSL3 classification to be used for IWS board assembly process

Hand Soldering

Not recommended for mass production, an engineering project, or re-work, it is allowed. It should be used with caution.

Table 3. Hand Soldering Parameters

Parameters	Recommended Condition
Tip Temperature	350 ± 10 °C
Time(2)	3 seconds

Note:

2. Maximum duration in 5 seconds.

Appendix A

Reflow soldering profile per IPC/JEDEC J-STD-020E, Table 5.2, Figure 5.1 and Note 1 to 4.

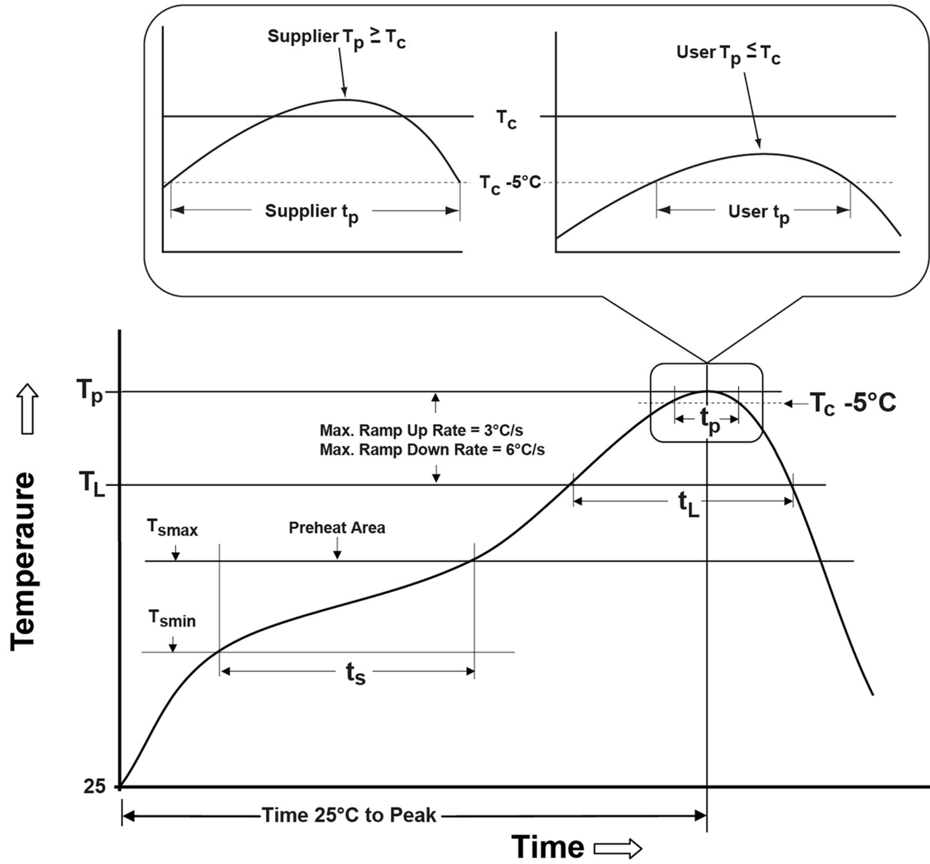

Figure 3. Recommended Reflow Profile per J-STD-020E

Table 4. Recommended Reflow Parameters per J-STD-020E(3,4,5,6)

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Temperature Min (T_{smin})	100 °C	150 °C
Temperature Max (T_{smax})	150 °C	200 °C
Time (t_s) from (T_{smin} to T_{smax})	60-120 seconds	60-120 seconds
Ramp-up Rate (T_L to T_p)	3 °C/seconds max.	3 °C/seconds max.
Liquidous Temperature (T_L)	183 °C	217 °C
Time (t_L) maintained above T_L	60-150 seconds	60-150 seconds
Peak Package Body Temperature (T_p)	For users T_p must not exceed the Classification temp. in Table 4-1. For suppliers Tp must equal or exceed the Classification temp in Table 4-1.	For users T_p must not exceed the Classification temp. in Table 4-2. For suppliers Tp must equal or exceed the Classification temp in Table 4-2.
Time (t_p)* within 5 °C of Specified Classification Temperature (T_C)	20* seconds	30* seconds
Ramp-down Rate (T_p to T_{smax})	6 °C/seconds max.	6 °C/seconds max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.
*Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum.		

Notes below are from the JSTD020E-01 document:

3. All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow (e.g., live-bug). If parts are reflowed in other than the normal live bug assembly reflow orientation (i.e., dead-bug), Tp shall be within ± 2 °C of the live bug T_p and still meet the T_c requirements, otherwise, the profile shall be adjusted to achieve the latter. To accurately measure actual peak package body temperatures, refer to JEP140 for recommended thermocouple use.
4. Reflow profiles in this document are for classification/preconditioning and are not meant to specify board assembly profiles. Actual board assembly profiles should be developed based on specific process needs and board designs and should not exceed the parameters in this table.

   For example, if T_c is 260 °C and time T_p is 30 seconds, this means the following for the supplier and the user:

   For a supplier: The peak temperature must be at least 260 °C. The time above 255 °C must be at least 30 seconds.

   For a user: The peak temperature must not exceed 260 °C. The time above 255 °C must not exceed 30 seconds.
5. All components in the test load shall meet the classification profile requirements.
6. SMD packages classified to a given moisture sensitivity level by using Procedures or Criteria defined within any previous version of J-STD-020, JESD22-A112 (rescinded), IPC-SM-786 (rescinded) do not need to be reclassified to the current revision unless a change in classification level or a higher peak classification temperature is desired.

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