Solder plus Support

PROFILE SUPPLEMENT FOR WAVE SOLDERING PROCESS

This information is provided as a reference guideline only. Your temperature profile will depend upon many factors including customer requirements, component characteristics and restrictions, oven characteristics, board layout, etc. Ultimately, quality requirements should define the profile in use, not adherence to these guidelines.

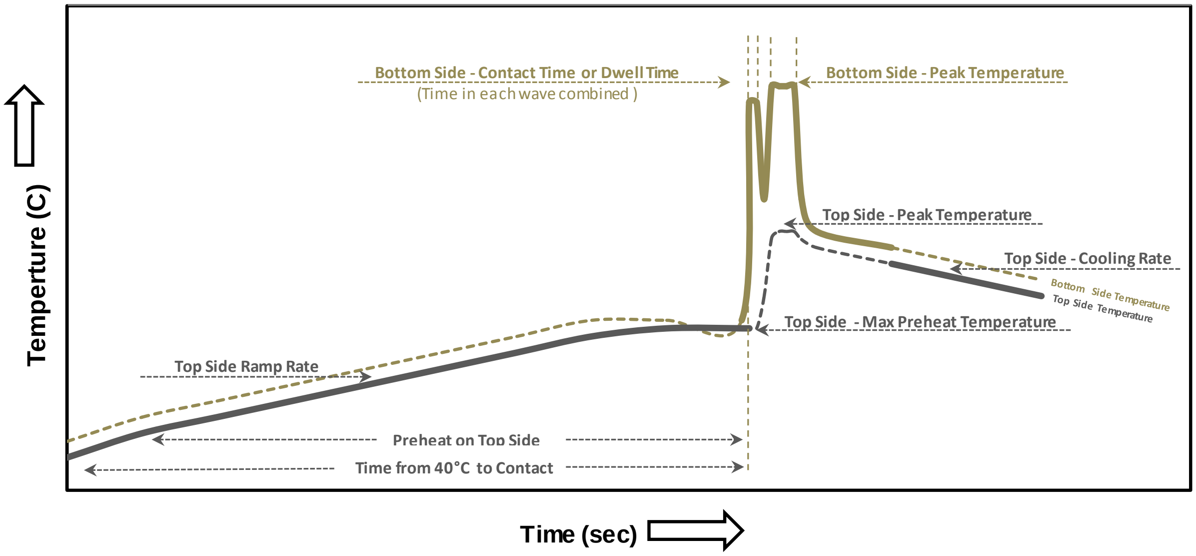
These reference guidelines follow the recommendations of the standards IPC-7530 for Temperature Profiling for Mass Soldering Processes, IPC-9502 PWB Assembly Soldering Process Guideline for Electronic Components, IPC/EIA J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies and IPC/JEDEC J-STD-020C Requirements for Small to Very Large Bodied Components.

Ideally, temperature profile measurements should be collected on a component populated assembly and recorded for each product being processed. IPC-7530 provides guidelines for the construction of profiling test vehicles and various techniques for wave soldering temperature profiling. It is common for the same profile settings to be used across multiple assemblies. It is recommended that profile data should be collected, analyzed and recorded for each assembly part number at the beginning of individual production runs for process verification and record keeping.

PROCESS GUIDELINES

Begin measuring a wave solder profile, using a minimum of three thermocouples. Attach one through the PCB to the bottom to measure the solder contact time and temperature, and the other two attached to the top side solder mask of the PCB according to IPC-7530. Flux can be applied by different methods including spray, foam, brush or dip. When spray fluxing is used, it is imperative that proper flux coverage and uniformity be achieved and maintained. Flux deposition of 500-1500 micrograms of flux per square inch is typical and is measured by dry or wet methods (later referenced in this supplement). Additional flux may be applied as the application dictates, but this may require additional tests to ensure post-soldering flux residue properties are as specified. It is important that the flux solvents be dry prior to making contact with the wave regardless of PCB temperature to avoid soldering issues. Smoke may occur and is considered normal if it is not excessive. Recommended contact time with the wave is dependent on wave configuration, pot temperature, alloy type and thermal mass of the assembly.

WAVE SOLDER GENERAL PROFILE



Document Rev #1

WWW.AIMSOLDER.COM INFO@AIMSOLDER.COM
USA +1 401-463-5605 CANADA +1 514-494-2000 MEXICO +52 656-630-0032 ASIA +86 755-2993-6487 EUROPE +48 42-663-60-04

Solder plus Support

RECOMMENDED PARAMETERS FOR SOLDER POT TEMPERATURE

Profile Feature	General Profile IPC/JEDEC[1]	AIM (Recommended starting point)[2]
Tin-Lead Alloys	230 – 260 °C	230 – 260 °C
Lead-Free Alloys	260 – 290 °C	260 – 300 °C

RECOMMENDED PARAMETERS FOR IPA-BASED FLUXES – MEDIUM TO HIGH SOLIDS >4.0% TYPICAL*

Profile Feature	General Profile IPC/JEDEC[1]	Tin-Lead Alloys (Recommended starting point)[2]	Lead-Free Alloys (Recommended starting point)[3]
Top Side Ramp Up Rate	< 3 °C/ Sec.	1 - 3 °C/ Sec.	1 - 3 °C/ Sec.
Top Side Max Preheat Temperature	< 150 °C	75 – 130 °C	80 – 140 °C
Bottom Side Contact Time	< 10 Sec.	< 5 Sec.	< 8 Sec.
Top Side Cooling Rate	< 3 °C / Sec.	< 3 °C / Sec.	< 3 °C / Sec.
Time from 40°C to Contact	60 – 180 Sec.	60 – 180 Sec.	60 – 180 Sec.

* Modern low-solid fluxes including AIM “FX” series may be used with medium to high solids parameters for improved performance.

RECOMMENDED PARAMETERS FOR IPA-BASED FLUXES – LOW SOLIDS <3.0% TYPICAL

Profile Feature	General Profile IPC/JEDEC[1]	Tin-Lead Alloys (Recommended starting point)[2]	Lead-Free Alloys (Recommended starting point)[3]
Top Side Ramp Up Rate	< 3 °C/ Sec.	1 - 3 °C/ Sec.	1 - 3 °C/ Sec.
Top Side Max Preheat Temperature	< 150 °C	75 – 110 °C	80 – 120 °C
Bottom Side Contact Time	< 10 Sec.	< 5 Sec.	< 8 sec.
Top Side Cooling Rate	< 3 °C / Sec.	< 3 °C / Sec.	< 3 °C / Sec.
Time from 40°C to Contact	60 – 180 Sec.	60 – 90 Sec.	60 – 90 Sec.

RECOMMENDED PARAMETERS FOR VOC-FREE

Profile Feature	General Profile IPC/JEDEC[1]	Tin-Lead Alloys (Recommended starting point)[2]	Lead-Free Alloys (Recommended starting point)[3]
Top Side Ramp Up Rate	< 3 °C/ Sec.	1 - 3 °C/ Sec.	1 - 3 °C/ Sec.
Top Side Max Preheat Temperature	< 150 °C	90 – 120 °C	90 – 140 °C
Bottom Side Contact Time	< 10 Sec.	< 5 sec.	< 8 Sec.
Top Side Cooling Rate	< 3 °C / Sec.	< 3 °C / Sec.	< 3 °C / Sec.
Time from 40°C to Contact	60 – 240 Sec.	60 – 180 Sec.	60 – 180 Sec.

[1] The general profile data are the parameters allowable by IPC/JEDEC, and are added only as a reference.
[2] This data guideline applies to common tin-lead alloys (i.e. Sn63/Pb37, Sn62/Pb36/Ag2).
[3] This data guideline applies to common lead-free alloys (i.e. AIM REL Alloys, SAC, SN100C et.al.).

WAVE SOLDER TROUBLESHOOTING

This defect information addresses common issues related to the wave soldering process. Soldering defects can be caused by a myriad of other process/material variables. However there are three main inputs to forming a high quality solder joint and control is critical; flux, heat and solder. Controlling these main inputs and their interaction will provide a wide process window and optimal results. Use of profiles which are outside of the recommended parameters of this supplement due to component temperature restrictions, use of board fixtures/pallets, or thermally massive assemblies is acceptable practice. Please contact AIM Technical Support for targeted process and profiling assistance.

WWW.AIMSOLDER.COM INFO@AIMSOLDER.COM
USA +1 401-463-5605 CANADA +1 514-494-2000 MEXICO +52 656-630-0032 ASIA +86 755-2993-6487 EUROPE +48 42-663-60-04

WAVE SOLDER TROUBLESHOOTING

POTENTIAL CAUSES MECHANISM OR FAILURES, INDIVIDUALLY OR IN COMBINATION

POTENTIAL FAILURE MODE BY THE PROFILE OR PROCESS VARIABLES

	Potential Failure Mode & Causes	Bridging	Insufficient solder - Top side - PTH Fill	Insufficient solder - Bottom side	Grainy solder	Disturbed solder	Solder spattering	Random solder balls	Solder pin holes, voids or outgassing	Solder skips or missing solder	Excessive solder	De-wetting	Non-wetting	Excessive flux residue	Dark residue	Component damaged	Excesive solder dross	Delaminate / Discoloration
PROFILE	Top side - Preheat time too long	✓		✓						✓					✓			
PROFILE	Top side - Preheat time too short		✓				✓	✓	✓				✓	✓				
PROFILE	Top side - Max preheat temp too high	✓		✓						✓		✓			✓			
PROFILE	Top side - Max preheat temp too low		✓				✓	✓	✓				✓	✓				
PROFILE	Bottom side - Contact time too long	✓										✓			✓	✓		✓
PROFILE	Bottom side - Contact time too short	✓	✓	✓					✓	✓	✓		✓					
PROCESS	Solder pot temperature too high						✓	✓				✓			✓	✓	✓	✓
PROCESS	Solder pot temperature too low	✓	✓	✓		✓			✓	✓	✓		✓					
PROCESS	Solder wave height high	✓									✓					✓	✓	✓
PROCESS	Solder wave height low	✓	✓	✓						✓			✓	✓				
PROCESS	Solder contaminated	✓	✓	✓	✓	✓				✓	✓	✓	✓				✓	
PROCESS	Flux contaminated	✓	✓	✓					✓	✓		✓	✓		✓		✓	
PROCESS	Flux application excessive						✓	✓						✓				✓
PROCESS	Flux application too low	✓	✓	✓				✓		✓		✓	✓					
PROCESS	PCB wrong design	✓	✓	✓						✓	✓							
PROCESS	PCB handling improper		✓	✓		✓				✓		✓	✓					
PROCESS	PCB lands contaminated		✓	✓	✓		✓		✓	✓		✓	✓					
PROCESS	PCB defective solder mask							✓	✓									✓
PROCESS	PCB humidity						✓	✓	✓									
PROCESS	PCB not seated well	✓	✓	✓		✓				✓		✓	✓					
PROCESS	Component contamination			✓	✓		✓	✓	✓	✓		✓	✓					
PROCESS	Component leads too long	✓									✓							
PROCESS	Compoenent leads too short									✓			✓					
PROCESS	Pallet too hot	✓	✓	✓				✓	✓		✓	✓	✓					✓
PROCESS	Pallet wrong design	✓	✓	✓						✓	✓	✓	✓					
PROCESS	Pallet defective or damaged	✓	✓	✓						✓	✓	✓	✓			✓		✓
PROCESS	Pallet humidity						✓											
PROCESS	Pallet dirty	✓	✓	✓						✓							✓	
PROCESS	Conveyor vibration	✓				✓				✓								
PROCESS	Conveyor angle	✓	✓							✓		✓	✓					
PROCESS	Conveyor speed too fast	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓				
PROCESS	Conveyor speed too slow	✓		✓		✓			✓			✓			✓	✓		✓
PROCESS	Excessive solder dross				✓	✓		✓		✓		✓	✓		✓			

WWW.AIMSOLDER.COM INFO@AIMSOLDER.COM
USA +1 401-463-5605 CANADA +1 514-494-2000 MEXICO +52 656-630-0032 ASIA +86 755-2993-6487 EUROPE +48 42-663-60-04

FLUX DEPOSITION MEASURING METHODS

The convenient and acceptable way to check flux deposition is by weighing the product (PCB) before and after fluxing, then calculating the flux amount by the area of the PCB and the weight change.

The results may be affected by the evaporation of flux solvent, the accuracy of weighing techniques, and operator's experience. Therefore, results may vary depending on the flux type, technique/equipment and operator inputs.

The two common weight test methods are wet and dry techniques. The wet method is recommended for water-based (VOC-Free) fluxes and the dry method is recommended for alcohol-based (VOC containing) fluxes. Each method requires the weight measurements to be calculated using a high accuracy laboratory scale/balance capable of measuring grams to three decimal places .001 – and the capacity to measure the full weight of the board.

WET METHOD

- When using the wet method, a sample board and re-sealable bag capable of accommodating the PCB is weighed prior to fluxing.
- The PCB is then fluxed and, following the last spray stroke, the PCB is immediately removed from the machine, placed into a re-sealable bag, closed, and weighed again.
- The before and after weights are measured, and along with the TDS given percent of solid content, the flux deposition is then calculated using the board size to calculate the total board area.
- Formula of flux deposition by wet method:

Flux in µg/area = ((weight after – weight before) x (% flux solids/100)) x1,000,000/Area

Note: The solids content and flux type is commonly showed on the flux Technical Data Sheet.

DRY METHOD

- When using the dry method a sample board is weighed prior to fluxing.
- The board is fluxed and removed immediately from the machine **without passing** through the preheat zones.
- Place the board **flux side up** on a table to allow all of the solvent to evaporate off the board (typically 5-10 minutes @ 78°F 50% Rh).
- After the alcohol has completely evaporated, weigh the board.
- The before and after weights are measured and the flux deposition is calculated using the board area.
- Formula of flux deposition by dry method:

Flux in µg/area = ((weight after – weight before) x 1,000,000)/Area

Note: Anything remaining on the board will represent a deposit of only flux solids.

Flux quantity recommendations on Technical Data Sheets are often a broad range due to the wide variety of variables in a wave solder process. To obtain optimal soldering results, it may be necessary to adjust the amount of flux applied to the PCB. This is accomplished by adjusting the flow rate and/or the traverse speed of the flux head.

WWW.AIMSOLDER.COM INFO@AIMSOLDER.COM
USA +1 401-463-5605 CANADA +1 514-494-2000 MEXICO +52 656-630-0032 ASIA +86 755-2993-6487 EUROPE +48 42-663-60-04

Solder plus Support

TERMS AND DEFINITIONS

Allowable temperature: The temperature range that an electronic circuit or component can withstand during assembly.

Bridging: The unwanted formation of a conductive path of solder between conductors.

Component: An individual part or combination of parts that, when together, perform a design function(s).

Contact time: The amount of time a lead or PCB is in contact with the solder wave.

Cold solder / Grainy solder: A solder connection that exhibits poor wetting and that is characterized by a grayish, porous appearance caused by insufficient application of heat during the soldering process.

Disturbed solder joint: A solder connection that is characterized by the appearance that there was motion between the metals being joined when the solder was solidifying.

De-wetting: Retreating of solder from some or all parts of a substrate that was initially wetted.

Delamination: A separation between plies within a base material, between a base material and a conductive foil, or any other planar separation with a printed board.

Flux: A chemically and physically active compound that, when heated, promotes the wetting of a base metal surface by molten solder by removing minor surface oxidation and other contaminates and by protecting the surfaces from re-oxidation during a soldering operation.

Flux residue: A flux-related material that is present on or near the surface of a solder connection after soldering.

IPA: Isopropyl alcohol, also called isopropanol or dimethyl carbinol

Liquidus: The temperature at which solder reaches its fully molten or liquid state.

Lead-free alloys: All alloys that do not contain lead (Pb), usually with a high tin (Sn) base.

Non-wetting: A surface that has contacted but rejected molten solder.

Outgassing: The gaseous emission from a laminate printed board or component when the board or the printed board assembly is exposed to heat or reduced air pressure, or both.

Packages: The container for a circuit component, or components that is used to protect its contents and to provide terminals for making connections to the rest of the assembly.

Peak temperature – Bottom side: Peak temperature on the bottom side is the maximum temperature recorded by the thermocouple attached on the bottom side of the board and has contact with the solder.

Peak temperature – Top side: Peak temperature on the top side is the maximum temperature recorded by the thermocouple attached on the top side of the board.

WWW.AIMSOLDER.COM INFO@AIMSOLDER.COM
USA +1 401-463-5605 CANADA +1 514-494-2000 MEXICO +52 656-630-0032 ASIA +86 755-2993-6487 EUROPE +48 42-663-60-04

Pin holes: Small holes formed on the solder surface related to outgassing.

Popcorning: Eruptions in an IC during wave soldering, normally the result of moisture absorption.

Solder pot: Vessel for melted solder.

Preheat rate: The time/temperature relationship of the assembly during the initial stage of wave soldering. This portion of the wave profile creates thermal equilibrium of the assembly, drives off volatile ingredients within the flux and allows the flux to remove/reduce surface oxides.

Preheat temperature max – Top side: Maximum temperature of the assembly the instant before contacting the solder wave.

Solder balls: Tiny spheres of solder usually located around a solder joint or randomly around the board.

VOC-free: Flux not containing volatile organic compounds (VOC).

Voids: Pockets devoid of solder within a solder joint. Voids are usually formed from outgassing of PCB laminate during wave soldering due to improperly fabricated PCB.

Wave soldering: A process where an assembled printed board is brought in contact with the surface of a continuously flowing and circulating mass of solder and soldered en masse.

Wave solder profile: The time vs. temperature graph of a PCB as it is processed through a wave solder machine as a heat source.

Wetting: The formation of an intermetallic allowing the spread of molten solder over a base metal.

Wicking solder: Wicking is a redistribution of solder caused by molten solder surface tension.

This document applies to all AIM solder products that reference it on the TDS.

WWW.AIMSOLDER.COM INFO@AIMSOLDER.COM
USA +1 401-463-5605 CANADA +1 514-494-2000 MEXICO +52 656-630-0032 ASIA +86 755-2993-6487 EUROPE +48 42-663-60-04