



ASSOCIATION CONNECTING  
ELECTRONICS INDUSTRIES®

---

# IPC-7530

## Guidelines for Temperature Profiling for Mass Soldering Processes (Reflow & Wave)

**IPC-7530**

May 2001

A guide developed by IPC

# Table of Contents

<b>1 INTRODUCTION</b> .....	1	6.3 Setup and Base Lining.....	7
1.1 Scope .....	1	6.4 Process Control .....	7
1.2 Background.....	1	<b>7 TECHNIQUES AND PROCEDURES FOR IN-LINE PROCESSES</b> .....	7
1.3 Purpose .....	1	7.1 Pre-Heating Limits .....	7
<b>2 REFERENCES</b> .....	1	7.2 Profiling Frequency.....	7
2.1 IPC .....	1	7.3 Thermocouple Definition/Selection .....	7
2.2 Joint Industry Standard .....	1	7.3.1 Thermocouple Type.....	7
<b>3 GENERIC PROCESS PROFILES</b> .....	1	7.3.2 Thermocouple Wire Gauge.....	8
3.1 Wave Soldering .....	1	7.3.3 Insulation .....	8
3.2 Reflow Soldering.....	1	7.3.4 Wire Length.....	8
<b>4 TEMPERATURE PROFILING EQUIPMENT</b> .....	3	7.5 Thermocouple Junction .....	8
4.1 Profiler Types .....	3	7.6 Life Expectancy/Deterioration (Sample Board as well as Thermocouple).....	8
4.1.1 Product Profilers.....	3	7.7 Calibration and Test .....	8
4.1.2 Machine Profilers .....	4	7.8 Thermocouple Positioning .....	8
4.1.3 Continuous Real-Time Thermal Profile Monitoring .....	4	7.8.1 Wave Solder .....	8
4.1.4 Profiling Equipment Data Display and Analysis .....	4	7.8.2 Reflow/Cure.....	8
<b>5 THEORY OF PROFILING EQUIPMENT OPERATION</b> .....	4	7.9 Thermocouple Attachment .....	8
5.1 Basic Concepts .....	4	7.9.1 Hi-Temperature Solder .....	9
5.2 Data Output .....	5	7.9.2 Adhesives.....	9
5.3 Interpretation of Results.....	5	7.9.3 Polyimide Tape.....	9
5.4 Predictive Capability .....	5	7.9.4 Aluminum Tape.....	9
5.4.1 Automated Prediction Tools.....	6	7.9.5 Embedded Thermocouple .....	9
5.5 External Impacts.....	6	7.9.6 Mechanical Attachment.....	9
<b>6 EQUIPMENT ANALYSIS WITH MACHINE PROFILING</b> .....	6		
6.1 Issues .....	6		
6.2 Control.....	6		
6.2.1 Reasons of Decreased Control.....	6		
6.2.2 Assessment of Soldering Process .....	6		
6.2.3 Characteristics of Equipment Analysis.....	7		
6.2.4 Solutions .....	7		

**Figures**

Figure 3-1	Dual-Wave Solder Profile	
Figure 3-2	Reflow Profile.....	2
Figure 3-3	Curing Profile .....	3
Figure 7-1	Thermocouple Attachment (Solder Method) .....	9
Figure 7-2	Thermocouple Attachment (Adhesive Method).....	9
Figure 7-3	Thermocouple Attachment (Tape Method).....	9

# Guidelines for Temperature Profiling for Mass Soldering Processes (Reflow & Wave)

## 1 INTRODUCTION

**1.1 Scope** This guideline document addresses the issues pertinent to temperature profiling of electronic assemblies for mass soldering processes (reflow and wave).

**1.2 Background** During mass soldering, it is important that all solder joints reach the minimum soldering temperature. The minimum soldering temperature is the minimum temperature necessary to assure metallurgical bonding of the solder alloy and the base metals to be soldered. Metallurgical bonding requires that both surfaces to be soldered, as well as the solder, reach this minimum soldering temperature for a sufficient time to allow the wetting of the solder surfaces and the formation of a layer(s) of intermetallic compound(s) of some of the base metal(s) with one or more constituents of the solder alloy. As a practical matter, the minimum soldering temperature is somewhat (~25°C) above the melting temperature (Liquidus temperature) of the solder alloy. The solder joint on a given assembly that reaches the minimum soldering temperature last (typically on or underneath one of the most massive components) has to be the one that determines the temperature profile setting for a given assembly and a given soldering process/machine.

Mass soldering requires controlled rates of heating and subsequent cooling. However, too rapid a heating rate can damage printed wiring boards (PWBs) as well as components. High cooling rates can damage components and can result in temperature gradients of sufficient magnitude to warp PWBs and larger components and may fracture solder joints.

It is for these reasons that appropriate temperature profiling is essential to assure solder joints of high quality.

**1.3 Purpose** This document provides guidelines for the construction of appropriate profiling test vehicles and various techniques and methodologies for temperature profiling.

## 2 REFERENCES

### 2.1 IPC<sup>1</sup>

**IPC-T-50** Terms and Definitions for Interconnecting and Packaging Electronic Circuits

**IPC-CA-821** General Requirements for Thermally Conductive Adhesives

**IPC-9501** PWB Assembly Process Simulation for Evaluation of Electronic Components

**IPC-9502** PWB Assembly Soldering Process Guideline for Electronic Components

**IPC-9504** Assembly Process Simulation for Evaluation of Non-IC Components (Preconditioning Non-IC Components)

### 2.2 Joint Industry Standard<sup>1</sup>

**IPC/EIA J-STD-001** Requirements for Soldered Electrical and Electronic Assemblies

## 3 GENERIC PROCESS PROFILES

**3.1 Wave Soldering** When profiling assemblies for wave soldering, the following areas shall be monitored as seen in Figure 3-1.

*Ramp Up:* The rate of temperature increase is controlled to ensure the PWB, components and flux have sufficient time to reach soldering temperatures without degradation.

*Thermal Spike:* Thermal spike is measured to ensure components are not exposed to excessive shock that can result in damage.

*Dwell Time:* Dwell time is measured to ensure excessive time in the solder does not occur which could result in damage to components and degrade flux.

*Maximum Topside Temperature:* Maximum topside temperature is monitored to ensure solder joints formed by reflow do not revert to a liquid state.

**3.2 Reflow Soldering** When profiling assemblies for solder reflow and adhesive cure, the following areas shall be monitored as seen in Figure 3-2 for solder paste.

**Note:** An example of adhesive, underfill or other material curing profile is shown in Figure 3-3.

*Ramp:* This is the portion of the profile where the assembly is heated from ambient temperature at a predetermined rate. Controlling the ramp is necessary to prevent component damage. It also allows the flux solvents to evaporate prior to the flux being fully active.

1. IPC, 2215 Sanders Road, Northbrook, IL 60062