

Solder Reflow Recommendation

Author: Ravi Sharma
Microchip Technology Inc.

INTRODUCTION

The electronic manufacturing industry is moving towards lead-free, environmentally safe assembly processes. Factors that should be considered when switching to lead-free soldering materials include:

- circuit board thickness
- fabrication complexity
- surface finish
- assembly process compatibility

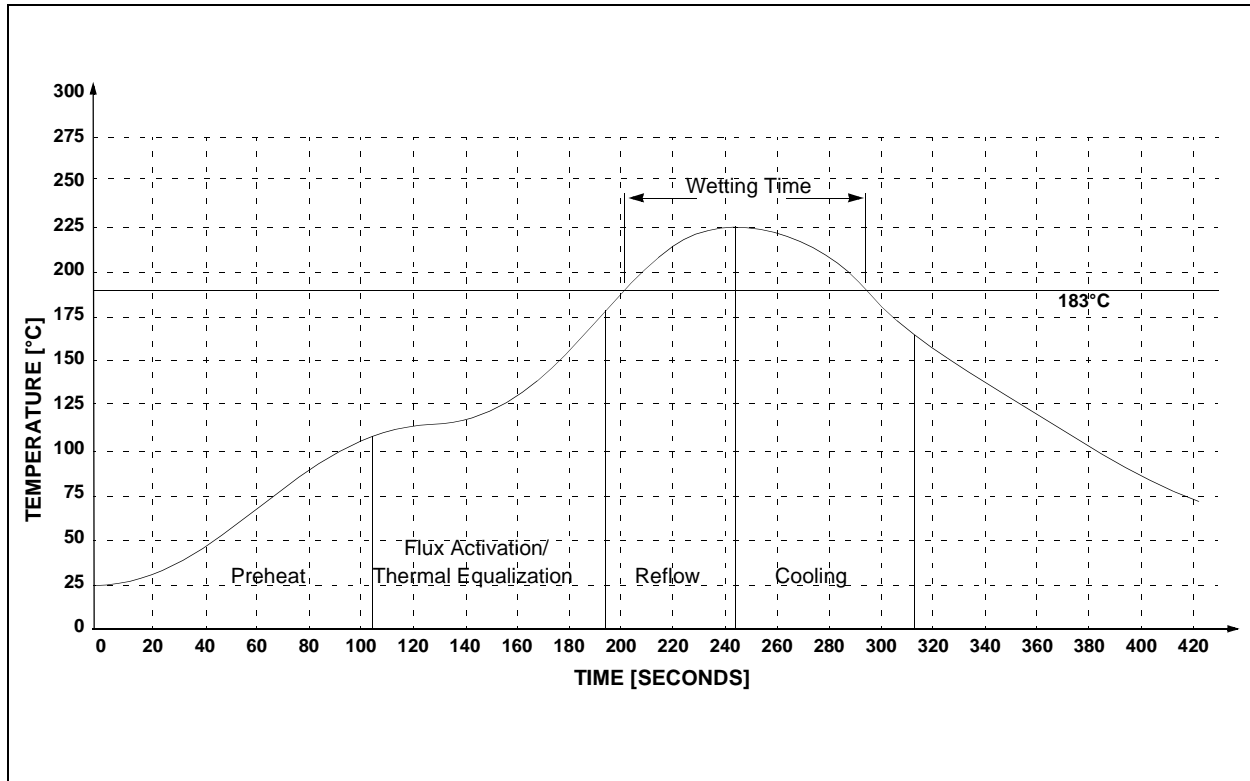
This Application Note focuses on solder reflow recommendation for packages with Matte Tin and Tin/Lead finishes.

BASICS OF THE REFLOW PROCESS

Lead-free soldering techniques have been available for some years. However, they do not always meet the same physical criteria for attachments as alloys containing lead. In the past, the most common alloy for joining electronic components was the mixture of 63% tin and 37% lead. This composition of tin and lead provided excellent bonding strength as well as enough elasticity to withstand the thermal stresses in the product's operating environment. As electronic manufacturers move away from this longtime standard PbSn alloy toward Pb-free solder alloys such as tin-silver-copper (Sn-Ag-Cu), melting and eutectic temperatures also change, requiring modification to the solder reflow profile.

As a starting point for a review of the basics of the reflow process, a typical thermal reflow profile is shown in Figure 1. The process typically undergoes five distinct transitions, as seen in the diagram.

FIGURE 1: Sn/Pb TYPICAL REFLOW PROFILE



AN233

The five transition periods for the typical reflow process are:

1. **Preheat** – Brings the assembly from 25°C to 80-150°C and evaporates solvents from the solder paste.
2. **Flux Activation** – Dried solder paste is heated to a temperature in which the flux will react with the oxide and contaminants on the surfaces to be joined.
3. **Thermal Equalization** – Achieves temperature equalization approximately 25-50°C below the reflow temperature. Actual time and temperature will depend on the mass and materials used.
4. **Reflow** – In this stage, the assembly is brought to the temperature sufficient to produce reflow of the solder. Note the “wetting time” is shown as the time the solder is in a liquid state around 183°C on the curve.
5. **Cool Down** – This is the final stage in the process where gradual cooling should be used. Slower cool down produces a finer grain structure in the solder joint, which will yield a more fatigue-resistant solder joint.

FIGURE 2: JEDEC REFLOW PROFILES FOR Sn-Pb AND Pb-FREE ASSEMBLIES

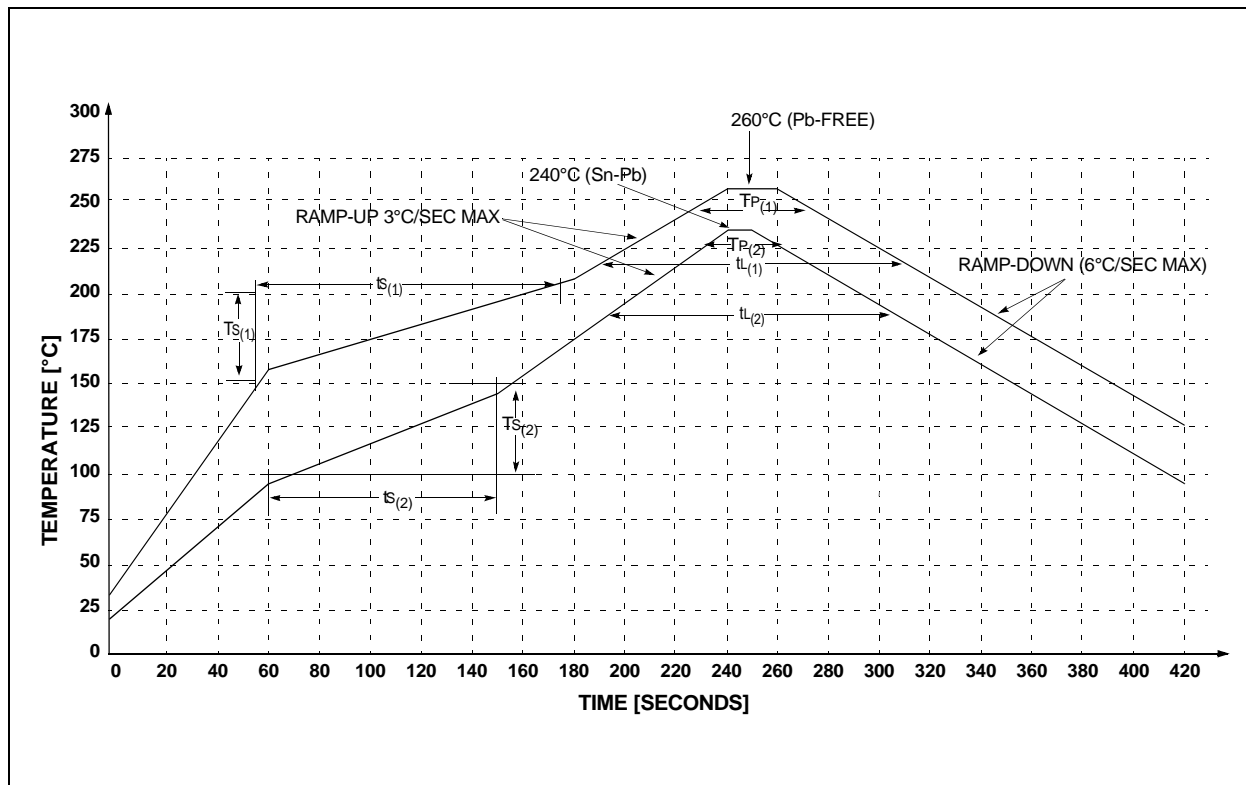


TABLE 1: TIME AND TEMPERATURE PARAMETRICS

Sym.	Min.	Max.	Units	Test Conditions
$T_{s(1)}$	150	200	°C	Pb-Free
$T_{s(2)}$	100	150	°C	Sn-Pb
$t_{s(1)}$	60	180	Sec	Pb-Free
$t_{s(2)}$	60	120	Sec	Sn-Pb
$t_{l(1)}$	60	150	Sec	Pb-Free
$t_{l(2)}$	60	150	Sec	Sn-Pb
$T_{p(1)}$	245	260	°C	Pb-Free
$T_{p(2)}$	225	240	°C	Sn-Pb

For reference, reflow conditions from IPC/JEDEC J-STD-020C are reproduced in Figure 2 and Table 1.

Solder Reflow Recommendations

Figure 3 shows Microchip's recommended profiles for Pb-free devices. These devices are plated with matte Tin (Pure Sn) and contain no lead. They can be used in standard tin-lead (SnPb) applications, using a profile that is equal to or above the lower line in the plot, or in Pb-free solder such as Tin-Silver-Copper (Sn-Ag-Cu) with profiles up to and including the upper line on the plot.

Figure 4 shows Microchip's recommended profiles for standard devices with 63%/37% tin-lead (Sn-Pb) solder finish. The reflow profile for these devices can be anywhere between the upper and lower curves shown in Figure 4. Please note that the peak temperature is lower than that of the Pb-free devices.

FIGURE 3: REFLOW PROFILE RECOMMENDATION (Pb-FREE)

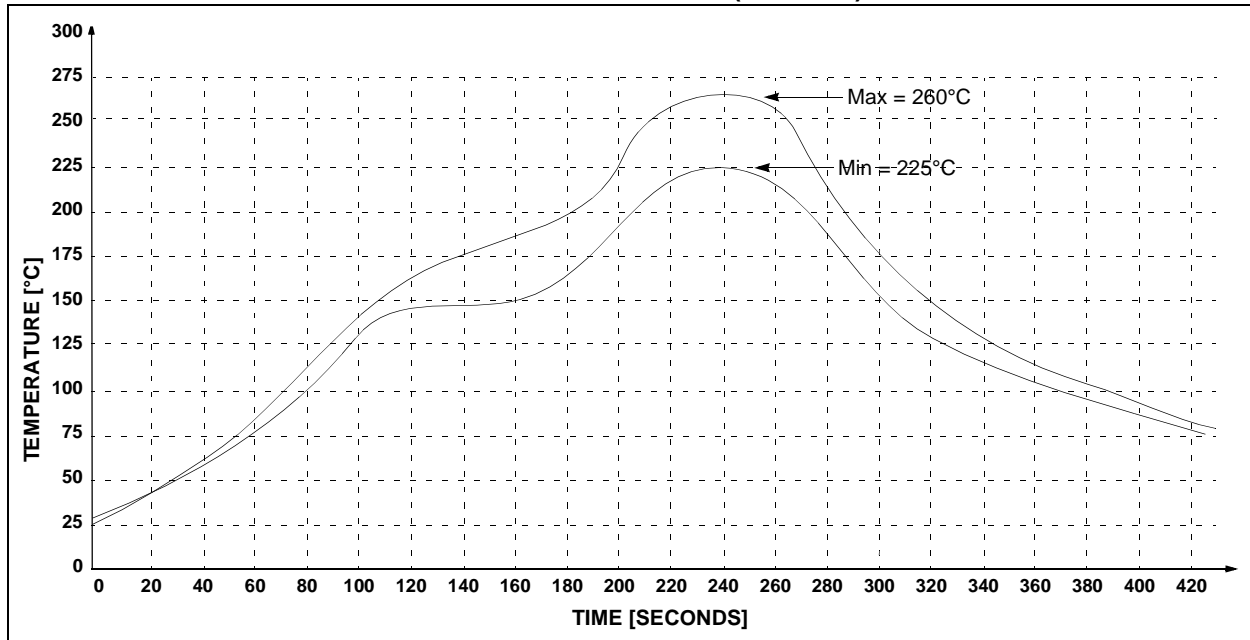
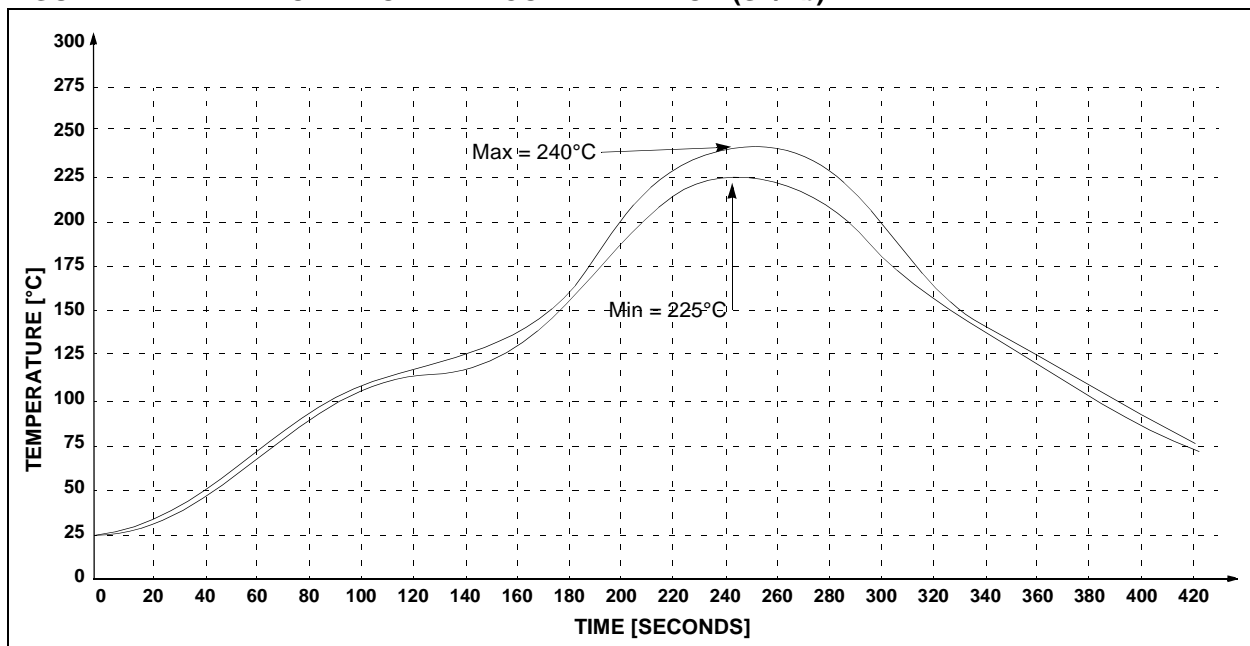


FIGURE 4: REFLOW PROFILE RECOMMENDATION (Sn/Pb)



CONCLUSIONS

Many new lead-free alloy compositions are being released. When testing the alternative solder compositions the user must consider several issues:

- Is the material selected going to be compatible with the plating on the component leads or the finish specified on the circuit board?
- Will the material chosen compromise product performance, reliability or manufacturability?
- What is the residual effect of the higher temperature required for soldering lead-free alloys on the semiconductor packages, the passive components, and the board itself?

This Application Note addresses the use of Matte Tin and Tin/Lead finishes, and recommends staying within the limits shown in Figure 3 and Figure 4. However, factors such as circuit board thickness, size, package type, and reflow equipment may affect the total profile time.

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELoQ, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, PowerSmart, rfPIC, and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AmpLab, FilterLab, MXDEV, MXLAB, PICMASTER, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, rLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2004, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

**QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949:2002 ==**

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELoQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://support.microchip.com
Web Address:
www.microchip.com

Atlanta
Alpharetta, GA
Tel: 770-640-0034
Fax: 770-640-0307

Boston
Westford, MA
Tel: 978-692-3848
Fax: 978-692-3821

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

San Jose
Mountain View, CA
Tel: 650-215-1444
Fax: 650-961-0286

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8676-6200
Fax: 86-28-8676-6599

China - Fuzhou
Tel: 86-591-750-3506
Fax: 86-591-750-3521

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Shunde
Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

China - Qingdao
Tel: 86-532-502-7355
Fax: 86-532-502-7205

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-2229-0061
Fax: 91-80-2229-0062

India - New Delhi
Tel: 91-11-5160-8631
Fax: 91-11-5160-8632

Japan - Kanagawa
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Taiwan - Hsinchu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

EUROPE

Austria - Weis
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark - Ballerup
Tel: 45-4420-9895
Fax: 45-4420-9910

France - Massy
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Ismaning
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

England - Berkshire
Tel: 44-118-921-5869
Fax: 44-118-921-5820