



## SOLDER REFLOW GUIDELINE FOR PACKAGES

### REVISION HISTORY

Revision	Effective date	Editor	Description
1.0	2006/10/27	Venice Lee	
2.0	2006/11/30	Venice Lee	Add rebaking condition and limitation.
3.0	2007/07/16	Albert Chang	Add TFBGA 14*14*0.89 (356), VFBGA 10*10*0.71(216), PBGA 27*27*1.73 (388), PBGA 31*31*1.73 (448)
4.0	2008/8/4	Albert Chang	Add PLCC44, QFP 10*10*2.0 (44), QFN 10*10*0.85 (72), QFN 4*4*0.85 (16/24), QFN 5*5*0.85 (24), QFN 6*6*0.85 (48), Add "(EDHS)" in BGA PKG type. Modify "MOISTURE SENSITIVITY LEVEL CLASSIFICATION PROCEDURE" reflow condition and diagram and notes.
5.0	2009/6/22	WilsonLin	Add QFN 3*3*0.85; QFN 4.5*6.5*0.85
6.0	2010/1/19	Wilson Lin	Add QFN 8*8*0.85
7.0	2010/3/16	Wilson Lin	Add T/LQFP 20*20
8.0	2010/8/12	Wilson Lin	Add DFN
9.0	2010/12/23	WilsonLin	Add WLCSP series
10.0	2011/5/4	WilsonLin	QFN 12*12*0.85 (164)
11.0	2011/10/12	WilsonLin	Add TFBGA 20*20*1.2 (448)
12.0	2011/10/24	WilsonLin	Add QFP 32*32*3.23 (296)
13.0	2012/03/01	WilsonLin	Add QFN 7*7 (56)
14.0	2013/5/15	WilsonLin	Add TFBGA 5.1x5.1(80)/ TFBGA 5.6x5.6(90)
15.0	2014/2/01	WilsonLin	Add manual soldering T>=350℃ </=5 secs
16.0	2014/05/28	WilsonLin	Add TFBGA 4.5x4.5(64)
17.0	2014/06/19	WilsonLin	WLCSP Level 1
18.0	2014/07/08	WilsonLin	Modify peak tempt , 260 +0 ℃ to 260 +0 /-5℃ 250 +0 ℃ to 250 +0 /-5℃ 245 +0 ℃ to 245 +0 /-5℃
19	2014/07/08	WilsonLin	Modify peak tempt , 260 +0 ℃ to 260 +0 /-5℃ 250 +0 ℃ to 250 +0 /-5℃ 245 +0 ℃ to 245 +0 /-5℃
20	2015/05/18	WilsonLin	Add TQFP 7x7 64
21	2016/4/18	WilsonLin	Add LQFP 14*20*1.4 (100/128/156)

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ABSTRACT	This document outlines the recommendation for conditions of soldering reflow.
SOLDERING REFLOW CONSIDERATIONS	<p>The optimal reflow profile should consider the solder paste/flux used and all the components used on the board. Temperature profile should be established for all new board designs using thermocouples at different location on the board.</p> <p>The solder reflow profile should refer to the recommendation of solder paste and flux supplier to makes sure good wetting and yielding. The recommendation profile from solder paste supplier is usually a time/temperature range, however, the maximum peak temperature and temperature ramping and cooling rate should not be worse than the definition in general JEDEC/IPC standard J-STD-020 specification.</p>
SMD DAMAGE DURING IMPROPER REFLOW	<p>The vapor pressure of moisture inside a nonhermetic package increases greatly when the package is exposed to the high temperature of solder reflow. Under certain conditions, this pressure can cause internal delamination of the packaging materials from the die and/or leadframe/substrate, internal cracks that do not extend to the outside of the package, bond damage, wire necking, bond lifting, die lifting, thin film cracking, or cratering beneath the bonds.</p> <p>In the most sever case, the stress can result in external package cracks. This is commonly referred to as the “popcorn” phenomenon because the internal stress causes the package to bulge and then crack with an audible “pop”.</p> <p>SMDs are more susceptible to this problem than through-hole parts because they are exposed to higher temperature during reflow soldering. The reason for this is that the soldering operation must occur on the same side of the board as the SMD device. For through-hole devices, the soldering operation occurs under the board that shields the devices from the hot solder.</p>
BAKING	<p>To avoid package damage during reflow, the moisture should be baked out of the package to remove all moisture from the package so that it will be dry. The worst-case condition is defined in J-STD-033 as following table.</p> <p>Since Realtek’s SMDs are classified as passing MSL level 3 <b>except WLCSP package</b>, the worst baking conditions defined in J-STD-033 are as following table. The baking time specified in the table are based on the worst-case condition, which can be reduced if technically justified.</p>

Package body thickness	Bake @125°C ( hours)	Bake @150°C ( hours)
≤1.4mm	16	8
≤2.0mm	43	21
≤4.5mm	48	24

## REBAKING

The following table gives the conditions for rebake of SMD packages at the user site after the floor life has expired or other conditions have occurred to indicate excess moisture exposure. The following conditions are based on the definition of JEDEC J-STD-033B, and the MSL level for Realtek's devices are classified as MSL3 except WLCSP package.

Baking temperature : 125°C

THK : package body thickness

Exceeding floor life	>72 hours	≤72 hours	Package type
THK ≤ 1.4mm	9 hours	7 hours	QFN, LQFP, TQFP, TSSOP
1.4 < THK ≤ 2.0mm	27 hours	17 hours	SSOP
2.0 < THK ≤ 4.5mm	48 hours	48 hours	QFP
BGA package > 17 x 17 mm	96 hours	Note 1	BGA
Stacked die package	96 hours	Note 1	Stacked die

Note 1. As above per package body thickness.

For the other rebaking temperature lower than 125°C are not applicable due too long baking time, only 125°C baking conditions are listed. If baking temperature lower than 125°C is preferred, please refer to JEDEC J-STD-033B.

**WARNING** : For solderability consideration, the cumulative bake time at temperature greater than 90°C and up to 125°C should not exceed 96 hours. If the bake temperature is not greater than 90°C, there is no limit on bake time. Bake temperatures higher than 125°C are not allowed without solderability verification.

## FLOOR LIFE

The definition of floor life in IPC/JEDEC J-STD-033B defined as the allowable time period after remove from a moisture barrier bag, dry storage and dry bake and before the solder reflow process. The floor life of each moisture sensitivity level is listed in the following table. Within the time duration of floor life, SMD does not need re-bake before mounted to PCB.

The floor life will depend on the characterization of the package itself, and the classification procedure is described in next paragraph.

MSL level	Time	Humidity	Temperature
1	Unlimited	85	≤ 30°C
2	1 year	60	
3	168 hours		

The devices from Realtek **except WLCSP package** are classified as MSL 3, which could be opened seal to 30°C / 60% RH for 168 hours before soldering reflow without baking.

**The Device with WLCSP package from Realtek are classified as MSL1.**

MOISTURE  
SENSITIVITY LEVEL  
CLASSIFICATION  
PROCEDURE

The MSL (moisture sensitivity level) classification procedure follows the procedure defined in IPC/JEDEC J-STD-020.

The procedure is briefed as following:

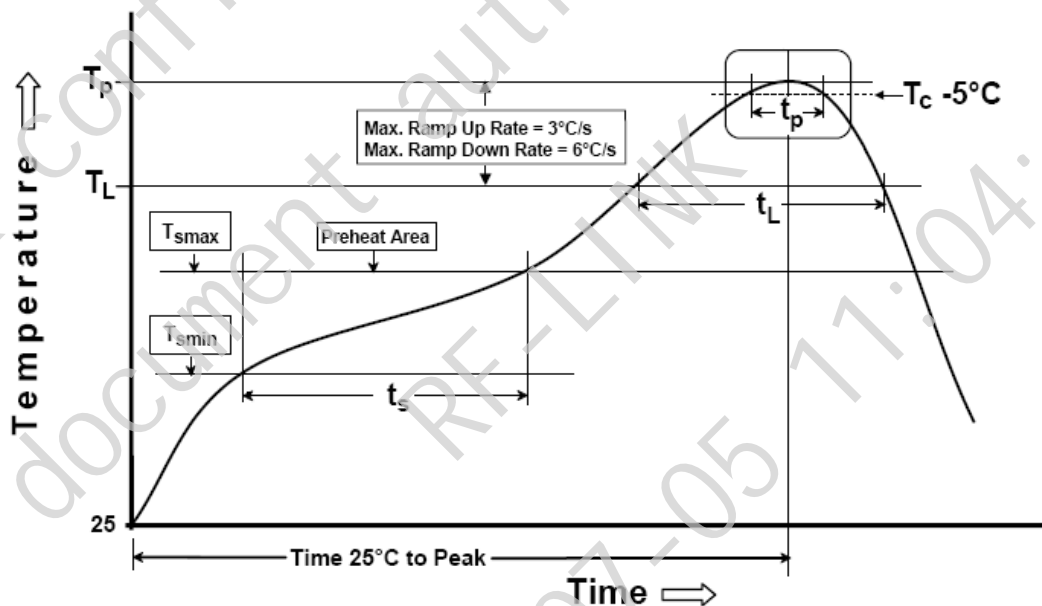
Step no	Check item	Detailed description
1	Initial check	Electrical test & external visual / acoustic microscope examination.
2	Bake	Bake for 24 hours @ 125+5/-0°C.
3	Soak	Moisture soak with the condition of its moisture sensitivity level
4	Reflow x 3 times	Not sooner than 15 minutes and not longer than 4 hours after removal from the soak chamber, subject the samples to 3 cycles of the appropriate reflow condition as defined in the follow section.
5	External crack check	Examine the devices using an optical microscope (40X) for external crack.
6	Electrical test	Perform the same electrical testing as step 1.

7	Acoustic check	Perform scanning acoustic microscope analysis on all devices.
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The sample will be judged to fail at the classification if failure defined in J-STD-020 found.

The reflow condition used in step 4 is defined in J-STD-020 as following table. All the temperature is measured on the topside of the package.

Stage	Note	Pb-free assembly
Average ramp-up rate	$T_L$ to $T_p$	3 °C / second max.
Preheat	Temperature min ( $T_{smin}$ )	150°C
	Temperature max ( $T_{smax}$ )	200°C
	Time ( $t_{smin}$ to $t_{smax}$ )	60 – 120 seconds
Time maintained above	Temperature( $T_L$ )	217°C
	Time ( $t_L$ )	60 – 150 seconds
Peak package body temperature ( $T_p$ )		See following table. $T_p$ must not exceed the specified classification temp in following table.
Time( $t_p$ ) within 5°C of the specified classification temperature ( $T_c$ )		30 seconds
Ramp-down rate ( $T_p$ to $T_L$ )		6 °C / seconds max.
Time 25°C to peak temperature		8 minutes max.



**Notice: The above reflow profile is for MSL classification only, not the recommendation for SMT process. Actual board assembly profiles should be developed based on specific process needs and board designs and should not exceed the parameter in above table.**

The peak temperature package can sustain depends on its volume and thickness. The reason is that, engineering studies have shown that, thin, small volume SMD packages reach higher body temperatures during reflow soldering to boards that have been profiled for larger packages. Therefore, technical and/or business issues normally require thin, small volume SMD packages to be classified at higher reflow temperatures.

The different peak temperature for different package volume / thickness is listed as following table:

## Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	Volume < 350 mm3	Volume 350 – 2000 mm3	Volume > 2000
< 1.6 mm	260 +0 /-5 °C	260 +0/-5 °C	260 +0 /-5 °C
1.6 – 2.5 mm	260 +0 /-5 °C	250 +0/-5 °C	245 +0/-5 °C
≥ 2.5 mm	250 +0 /-5 °C	245 +0/-5 °C	245 +0/-5 °C

The following table displays the dimension / volume for each package type for Realtek's product.

Remark : Numeral in brackets is lead counts or ball counts.

## Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	Volume < 350 mm3	Volume 350 – 2000 mm3	Volume > 2000
< 1.6 mm	TSSOP 240mil (56/64) T/LQFP 7*7*1.4 (32/48/64) LQFP 10*10*1.4 (44/64) LQFP 12*12*1.4 (30) LQFP 14*14*1.4 (100/128) TQFP 14*14*1.0 (128) DFN/QFN 3*3*0.85 (8/12) QFN 4*4*0.85 (16/24) QFN 4.5*6.5*0.85 (46) QFN 4*6 (40) QFN 5*5*0.85 (24/32/40) QFN 6*6*0.85 (48) QFN 7*7*0.85 (48/56) QFN 8*8*0.85 (68) QFN 9*9*0.85 (64/76) QFN 10*10*0.85 (72/88) QFN 12*12*0.85 (164) TFBGA 5*5 (65) TFBGA 4.5*4.5 (64) TFBGA 5.1x5.1(80) TFBGA 5.6x5.6(90) TFBGA 6x6(96) TFBGA 15*15*0.89 (233) TFBGA 14*14*0.89 (356) TFBGA 17*17*0.89 (292) VFBGA 10*10*0.71 (216) WLCSP series	LQFP 14*20*1.4 (100/128/156) LQFP 24*24*1.4 (216) LQFP 28*28*1.4 (256) LQFP 20*20*1.4 (176) TQFP 20*20*1.0 (176) TFBGA 20*20*1.2 (448)	NA
1.6 – 2.5 mm	SOP 150mil (8/14/16) SOP 300mil (16/18/20) SSOP 209mil (20/28) SSOP 300mil (48/56) QFP 10*10*2.0 (44)	PBGA(EDHS) 27*27*1.73 (388/702) PBGA(EDHS) 31*31*1.73 (448)	NA
≥ 2.5 mm	NA	PDIP 300mil (16/20) QFP 14*20*2.85 (100/128) PLCC44	QFP 28*28*3.23 (208) QFP 32*32*3.23 (296)

**All the devices from Realtek complied with MSL level 3 passed MSL classification procedure which has IR reflow three times with peak temperature defined per its volume as described in this section.**

REFLOW CONDITION RECOMMENDATION FOR SMT PROCESS	<p>In SMT process, the reflow temperature profile for manufacturing should be recommended by solder paste supplier, and the peak temperature should not be higher than the lowest peak temperature used for the MSL classification for the components on board.</p> <p>The reflow temperature profile defined for MSL classification in J-STD-020 is not recommended to be used for real SMT process unless approved by solder paste supplier. Basically, the reflow profile used for MSL classification is for classification only and regardless of the solder paste itself. Thus the temperature profile is only to “simulate” the reflow process in real case, but not a recommendation for that. The real case still depends on solder paste itself.</p>
MULTIPLE REFLOW PASSES	<p>If more than one reflow pass is used, care must be taken to ensure that no moisture sensitive SMD package (mounted or unmounted) have exceeded their floor life prior to the final pass.</p> <p>If any component on the board has exceeded its floor life, the board needs to be baked prior to the next flow. (Reference to J-STD-033B).</p> <p>J-STD-033 Clause 6 should be referenced for the baking of populated board.</p> <p>For cavity packages in which water may be entrapped, water clean process after the 1<sup>st</sup> reflow can be an additional source of moisture. This may present an additional risk, which should be evaluated.</p>
MAXIMUM REFLOW PASSES	A maximum of three reflow passes is allowed per components. (Reference to J-STD-020).
MANUAL SOLDERING	$T \leq 350^{\circ}\text{C}$ $\leq 5$ secs