

# **RoHS**

# **Quick Guide**



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**Renesas Technology Europe**

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# Introduction to RoHS

The RoHS Directive 2002/95/EC (Removal of Hazardous Substances) comes into force on 1<sup>st</sup> July 2006 and restricts the use of certain hazardous substances in the manufacture of various types of electronic & electrical equipment.

There are six restricted substances listed below:

Hazardous Substance	Allowed PPM Level
Cadmium (Cd)	100ppm (0.01%)
Lead (Pb)	1000ppm (0.1%)
Mercury (Hg)	1000ppm (0.1%)
Hexavalent Chromium (CrVI)	1000ppm (0.1%)
Polybrominated Biphenyls (PBBs)	1000ppm (0.1%)
Polybrominated Diphenyl Ethers (PBDEs)	1000ppm (0.1%)

Renesas Technology has always carried out research and development into environmentally safe products, already ensuring the successful eradication of five of these hazardous materials a number of years ago. Renesas is now at a very advanced stage in the switch over from traditional tin/lead plating on package terminals to lead free alternatives such as Sn-Cu, Sn-Bi, Ni/Pd and Ni/Pd/Au. So for Renesas, and other semiconductor manufacturers, the RoHS Directive is also more commonly known as the “Lead Free Directive”.

By the end of December 2005, 90% of Renesas’ European shipments will be lead-free devices, with the exception of some specific applications which are not yet covered by this legislation, e.g. automotive applications.

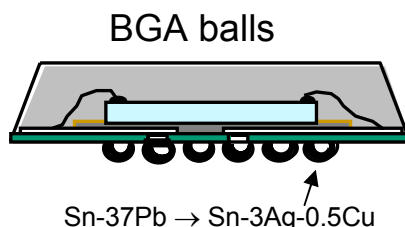
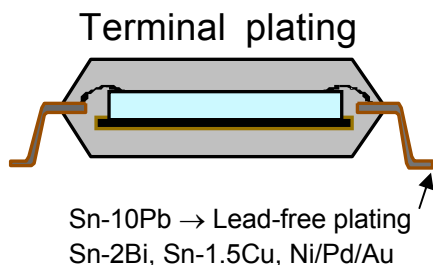
Identification of a Renesas lead-free device consists of the original leaded part number plus a specific lead-free suffix. Full details of lead-free device part numbers, suffixes and shipping labels can be found on the Renesas European RoHS Website. All the latest RoHS information available from Renesas is published on the Website, so regular visits are always recommended. A list of useful Renesas RoHS Website links are provided in the “Further Information” section.

# Renesas RoHS Terminal Platings

The major change in semiconductor packaging required to meet RoHS compliance is the change from the traditional Sn-Pb terminal plating to non-lead based platings. Renesas have implemented several types of lead free terminal platings, depending on the packaging type.

The terminal platings and external ball materials used for lead-free conversion are as follows:

- Terminal plating materials: Sn-2Bi, Sn-1.5Cu, and Ni/Pd/Au
- Solder dipping material: Sn-0.7Cu
- External ball material: Sn-3Ag-0.5Cu



The table below details the terminal platings available for the different package types:

Applicable Packages			RoHS Materials				
			Sn-Bi	Sn-Cu	Ni/Pd/Au	Sn-Cu Dipping	Sn-Ag-Cu
Surface Mount (SMD)	IC, LSI	QFP, TQFP, LQFP, HQFP	✓	✓	✓		
		SOP, TSSOP, TSOP(1), TSOP(2)	✓	✓	✓		
		HSOP					
		QFJ, SOJ	✓	✓			
		P-VQFN	✓	✓	✓		
		BGA, TFBGA, HBGA	✓				✓
	Transistor & Diode	UPAK, SOT-89, DPAK(S), MP-3	✓				
		LDPAK(S), TO-220S					
		MPAK, SOT-23mod	✓				
		URP, UFP	✓				
Insertion (THD)	IC, LSI	DIP, SDIP	✓	✓	✓	✓	
		ZIP	✓	✓			
	Transistor & Diode	TO-92, TO-220, TO-3P				✓	
		DO-34, DO-35				✓	
		DPAK-L, LDPAK-L	✓				

Although some packages appear to have multiple options for lead free platings, in fact each specific device has only one type, depending on the particular family. For example, the H8 and SH Micon families use Sn-2Bi plating, whereas the 740, R8C, M16C & M32C Micon families use Sn-1.5Cu plating.

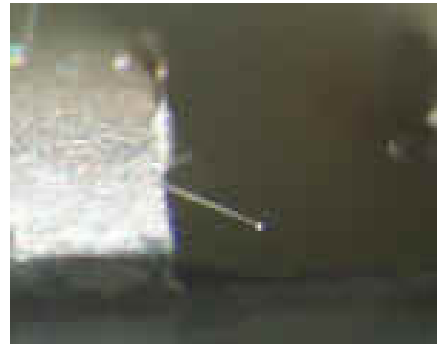
# Renesas RoHS Device Reliability

## Solderability and Mechanical Strength

Extensive solderability and solder joint mechanical strength testing has been carried out for all major device packages. Test results were compiled for various combinations of leaded and lead-free plated devices, with both leaded and lead-free solder pastes. This evaluation data is posted on the Renesas RoHS Website.

## Whiskers

Tin whiskers are electrically conductive, crystalline structures of tin that sometimes grow from surfaces where tin (especially electroplated tin) is used as a final finish. Tin whiskers have been observed to grow to lengths of several millimetres and in rare instances to lengths up to 10 mm. Numerous electronic system failures have been attributed to short circuits caused by tin whiskers that bridge closely-spaced circuit elements maintained at different electrical potentials.



**Example of a Tin Whisker**

The evaluation process for lead-free terminal platings included extensive whisker growth tests under multiple conditions. The evaluation criteria set for confirmation of the presence of a whisker was a growth of 50  $\mu\text{m}$ . No whisker growths were detected during the evaluations.

## Overall conclusions for RoHS device reliability

As a result of the various device and package evaluations, lead-free plated products and conventional lead plated products were found to be equivalent. For all devices the specification (functionality and AC/DC characteristics) and existing data sheets will not change, except for the plating composition and associated properties.

# Renesas RoHS Device Soldering

## Lead Free Solder Paste (Alloys)

Many possible lead free alloys have been proposed and evaluated but the most widely used are based on tin, silver and copper and are often referred to as SAC alloys ( **S**n (tin) **A**g (silver) **C**u (copper) ).

The major differences between the SAC alloys and traditional Sn-Pb solders are:

- Higher melting point ( typically 40°C higher than Sn-Pb)
- Inferior wetting characteristics
- Form harder solder joints
- Solder joints may appear dull (similar to a poor Sn-Pb joint)

The last three characteristics have already been previously addressed in the section on RoHS device reliability. This section will now focus on the changes to PCB manufacturing reflow soldering profiles, resulting from the higher melting point of SAC solder pastes.

Before examining the details of RoHS reflow soldering profiles, one area to be considered is the inter-changeability of leaded and lead-free solder pastes with leaded and lead-free plated devices.

## Soldering RoHS Devices with Sn-Pb Reflow Soldering Profile

All Renesas products available with lead-free plating (with the exception of BGA packages) can be soldered with a “conventional leaded” soldering process using a leaded soldering paste. However, the solderability and reliability of joints must be verified during prototype manufacture, before finalising the soldering conditions. For lead-free BGA packages, Renesas recommends the use of lead-free pastes only.

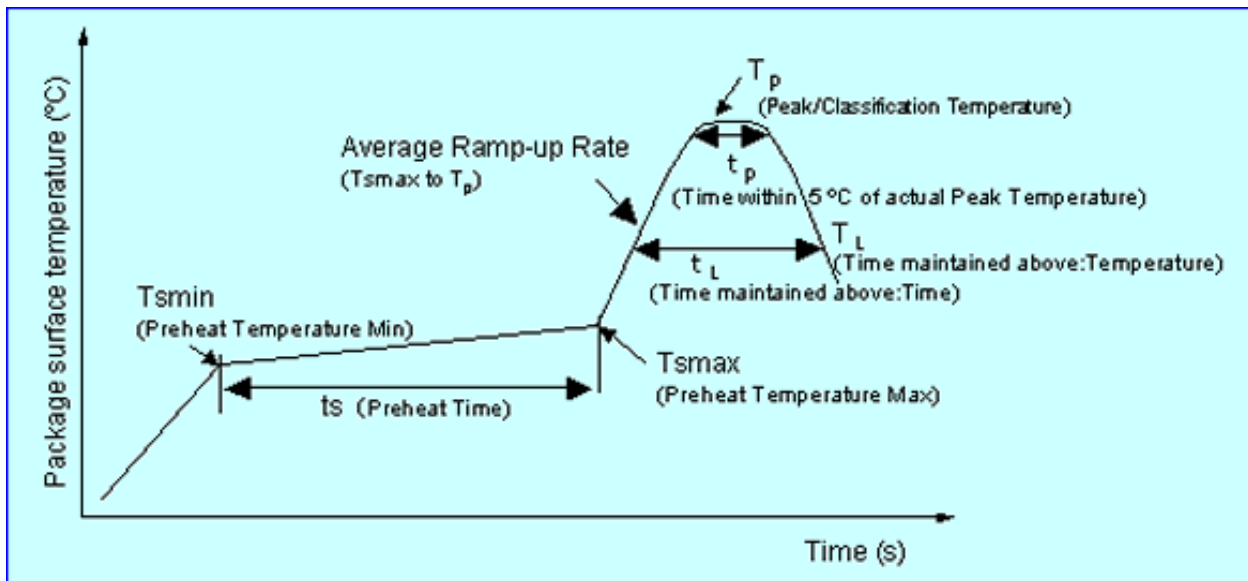
## Soldering Sn-Pb Plated Devices with RoHS Reflow Soldering Profile

This is dependent on the heat resistance of the particular device. For H8, SH, and MPP family devices, with Sn-Pb terminal plating, this is acceptable. For R8C, M16C, M32C, 7xx family devices this is not consistently valid. These devices, with Sn-Pb terminal plating, may have problems to withstand the higher lead-free soldering temperatures. Please contact Renesas sales representatives for final confirmation. However, it is not recommended to mix leaded devices in a lead-free process.

# Renesas RoHS Device Soldering

## Reflow Soldering Profile for RoHS Solder Pastes

The recommended reflow soldering profile for RoHS manufacturing is defined by the IPC/JEDEC J-STD-020C standard below.



Profile Feature	Value
Average Ramp-up Rate (T <sub>smmax</sub> to T <sub>p</sub> )	3°C/second max
Preheat Time (t <sub>s</sub> )	60-180 seconds
Temperature Min (T <sub>smmin</sub> )	150°C
Temperature Max (T <sub>smmax</sub> )	200°C
Time maintained above: Temperature (T <sub>l</sub> )	217°C
Time maintained above: Time (t <sub>L</sub> )	60-150 seconds
Peak/Classification Temperature (T <sub>p</sub> )	See Table on Page 8
Time within 5°C of actual Peak Temperature (t <sub>p</sub> )	20-40 seconds <b>(See Note 1)</b>
Ramp-down Rate	6°C/second max
Time 25°C to Peak Temperature	8 minutes max

# Renesas RoHS Device Soldering

## IPC/JEDEC J-STD-020C Reflow Peak/Classification Temperature (Tp)

Package Thickness \ Volume	< 350 mm <sup>3</sup>	350-2000 mm <sup>3</sup>	> 2000 mm <sup>3</sup>
< 1.6 mm	260°C	260°C	260°C
1.6 mm – 2.5 mm	260°C	250°C	245°C
> 2.5mm	250°C	245°C	245°C

The Table below details the specific Renesas RoHS packages and their relevant Tp value.

## Renesas Packages Reflow Peak/Classification Temperature (Tp)

Renesas Package Type	Tp Value
HQFP (> 28 mm <sup>2</sup> )	240°C
QFP (> 28 mm <sup>2</sup> ), QFJ, DPAK, LDPAK, HSOP	245°C
QFP (< 28 mm <sup>2</sup> ), HQFP (< 10 mm <sup>2</sup> ), LQFP, TQFP SOP, TSOP, BGA MPAK, URP, UFP	260°C

### Note 1.

All Renesas RoHS compliant devices meet the minimum 20s tp time of J-STD-020C. The H8 and SH families meet the full 20-40s tp specification, with the exception of the HQFP package. The HQFP package includes an in-built heat sink and has a tp of 20s.

# Renesas RoHS Device Soldering

## Moisture Sensitivity Level (MSL)

If devices are not handled correctly, in accordance with their MSL conditions, then they will start to naturally absorb moisture. When heated rapidly during reflow soldering, the moisture turns to steam. If it cannot escape quickly enough the pressure built up may damage the component by cracking the package moulding, an effect known as “Popcorning”

IPC/JEDEC J-STD-020C also defines device MSLs as part of the specification. MSL Level 3 is used as the standard for dry packed products and MSL Level 1 for products supplied without moisture proof packaging. The majority of Renesas products have an MSL Level of 3 or below, however there are some exceptions. The MSL for a particular device is indicated on the shipping box label.

The Table below details the MSL Levels and conditions defined by J-STD-020C

MSL	Floor Life Time	Floor Conditions
1	Unlimited	$\leq 30^{\circ}\text{C}/ 85\% \text{ RH}$
2	1 Year	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$
2a	4 Weeks	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$
3	168 Hours	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$
4	72 Hours	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$
5	48 Hours	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$
5a	24 Hours	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$
6	Time on Label	$\leq 30^{\circ}\text{C}/ 60\% \text{ RH}$

# Renesas RoHS Device Soldering

## Wave (Flow) and Hand Soldering

**Flow soldering** conditions for lead-free and leaded solder are the same.

- (1) Insertion-type package such as DIP  
260 °C max., 10 s max.
- (2) Surface-mount package such as QFP  
260 °C max., 7 s max.

**Hand soldering** conditions for lead-free and leaded solder are the same.

Iron tip 350 °C, 3 s max.

If the conditions above are exceeded, ensure the terminal temperature is kept within 260°C for 3 s. (Some packages such as QFP, LQFP, some SOP, TQFP, DILP, can withstand 380 °C for 3 s or 370 °C for 5 s)

# Further Information

The Renesas Websites are regularly updated with new information as it becomes available. Below are links to the key areas of the Renesas RoHS Websites.

## **Renesas European RoHS Home Page**

[http://eu.renesas.com/fmwk.jsp?cnt=lead\\_free\\_landing.jsp&fp=/support/environmental\\_activity/lead\\_free/](http://eu.renesas.com/fmwk.jsp?cnt=lead_free_landing.jsp&fp=/support/environmental_activity/lead_free/)

## **Renesas RoHS Converted Part Numbers and Suffix Lists**

[http://eu.renesas.com/fmwk.jsp?cnt=eu\\_converted\\_products.jsp&fp=/support/environmental\\_activity/lead\\_free/converted\\_products/&title=EU%20Converted%20Products%20and%20Identification](http://eu.renesas.com/fmwk.jsp?cnt=eu_converted_products.jsp&fp=/support/environmental_activity/lead_free/converted_products/&title=EU%20Converted%20Products%20and%20Identification)

## **Renesas RoHS FAQs**

[http://eu.renesas.com/fmwk.jsp?cnt=faq\\_landing.jsp&fp=/support/environmental\\_activity/lead\\_free/FAQ/&title=EU%20FAQs](http://eu.renesas.com/fmwk.jsp?cnt=faq_landing.jsp&fp=/support/environmental_activity/lead_free/FAQ/&title=EU%20FAQs)

## **Renesas Technical Information Home Page**

[http://eu.renesas.com/fmwk.jsp?cnt=lead\\_free\\_category\\_landing.jsp&fp=/products/lead\\_free/&title=Technical%20Info%20\(Global%20Lead-Free%20Pages\)](http://eu.renesas.com/fmwk.jsp?cnt=lead_free_category_landing.jsp&fp=/products/lead_free/&title=Technical%20Info%20(Global%20Lead-Free%20Pages))

## **Renesas RoHS Terminal Evaluation Data**

[http://eu.renesas.com/fmwk.jsp?cnt=technical\\_information.htm&fp=/products/lead\\_free/child\\_folder/&title=Evaluation%20Data%20of%20Lead-Free%20Terminal%20Plating](http://eu.renesas.com/fmwk.jsp?cnt=technical_information.htm&fp=/products/lead_free/child_folder/&title=Evaluation%20Data%20of%20Lead-Free%20Terminal%20Plating)



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