To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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RENESAS

NEC Electronics

Power Management Discrete Lead-Free Products

RoHs Directive-Compliant Products

Power Management Devices Division

1. Introduction

Efforts related to restrictions of the use of certain hazardous substances (RoHS Directive), which began in the European Union, spread to Japan, leading to various regulations such as the Home Appliance Recycling Law (Law for Recycling of Specified Kinds of Home Appliances) and the Chemical Substances Control Law (Law Concerning the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.). This movement is also taking effect in China, where similar laws being established, and efforts to protect the Earth's environment continue to spread throughout the world these days.

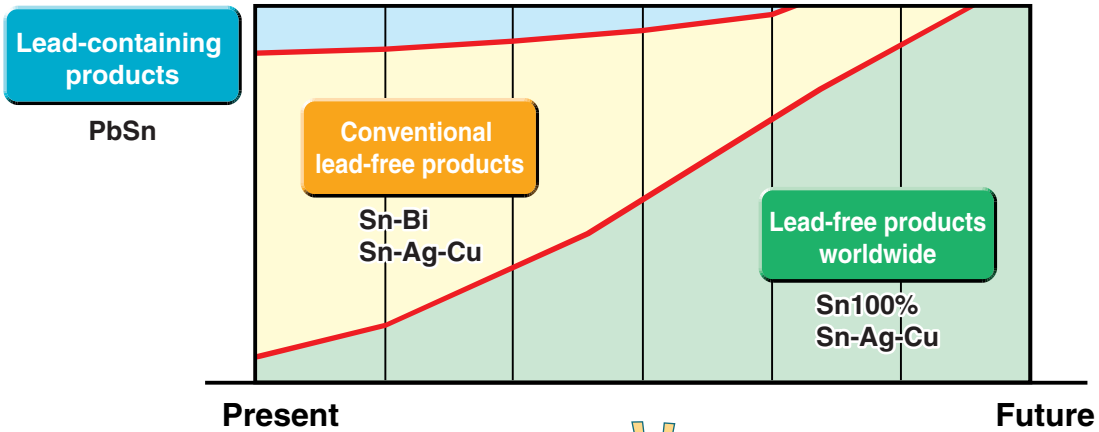
Power management discrete products manufactured by NEC Electronics are also in the process of complying with the global-scale movement to strengthen environment-related regulations. We are gradually changing over to pure tin as the lead-free material of our products. This policy applies to all of our products, including those for use in vehicles, produced in Japan and other countries. We have established measures for controlling tin whiskers[Note], which have heretofore been a barrier to the use of pure tin plating, and these measures are set to become standard specifications for pure tin plating. From now on we will therefore be able to deliver worldwide lead-free products using pure tin, in compliance with European standards.

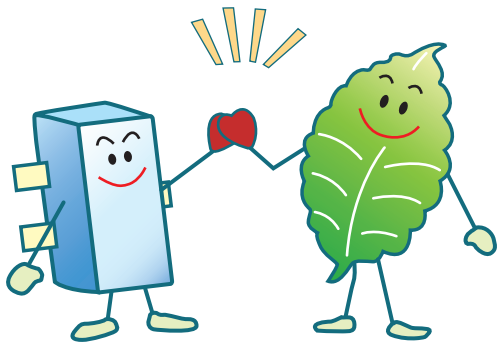
We ask for your understanding as we continue our active efforts to develop highly reliable environment-friendly products. We look forward to your continued patronage of power management discrete products (including regulators in the same package) made by NEC Electronics.

Note Diameters are a few microns and lengths are a few microns to a few millimeters.
Tin whiskers begin as monocrystals created by the re-crystallization of tin and grow under compression stress acting on plating films.
Once they have grown, tin whiskers pose the risk of electrical shorting by contact with other electrical circuits.

Power Management Devices Division
Display Driver and Power Management Device Operations Unit
NEC Electronics Corporation

Proportions of plating used for discrete products (except for optical-microwave products)





2. Target Packages (Current as of May, 2007)

2-1. Surface-mount type (SMD) products (1/2)

Type	Package				Product
	NECEL Name	JEDEC Name IPC Name	JEITA Name	Appearance	
Surface-mount type (SMD)	2pin XSOF	–	–		Diode
	3pin XSOF 03	–	–		Junction FET
	3pin XSOF 04	–	–		Junction FET
	5pin XSOF	–	–		Diode
	2pin Ultra Small Mini Mold	–	SC-78		Diode
	3pin Ultra Small Mini Mold	SOT-416	SC-75		Small-signal device, MOSFET, junction FET
	3pin Ultra Small Mini Mold (Thin-type)	–	SC-75		Junction FET
	2pin Super Small Package	SOD-323	SC-76		Diode
	3pin Super Small Package	SOD-323	SC-70		Small-signal device, MOSFET, junction FET, diode
	5pin Super Small Package	SOT-353	SC-88A		Small-signal device, MOSFET, diode
	6pin Super Small Package	–	SC-88		Small-signal device, MOSFET
	3pin Mini Mold	SOT-346	SC-59A		Small-signal device, junction FET, MOSFET, diode
	3pin Mini Mold(Thin-type)	–	SC-96		MOSFET
	5pin Mini Mold	SOT-457	SC-74A		Small-signal device, MOSFET, diode, (IC: Regulator)
	5pin Mini Mold(Thin-type)	–	SC-95_5P		MOSFET

2-1. Surface-mount type (SMD) products (2/2)

Type	Package				Product
	NECEL Name	JEDEC Name IPC Name	JEITA Name	Appearance	
Surface-mount type (SMD)	6pin Mini Mold	–	SC-74		Small-signal device, MOSFET
	6pin Mini Mold(Thin-type)	MO-193	SC-95		MOSFET
	6pin WSOF	–	–		MOSFET
	2pin Power Mini Mold	–	–		Diode
	2pin Small Power Mini Mold	–	–		Diode
	3pin Power Mini Mold	TO-243	SC-62		Small-signal device, MOSFET, diode, (IC: Regulator)
	6pin HWSON	–	–		MOSFET
	8pin TSSOP	MO-187	–		MOSFET
	8pin HVSON	–	–		MOSFET
	8pin SOP	–	SC-87		MOSFET
	8pin HSOP	–	SC-87		MOSFET
	MP-2	–	SC-84		Power transistor, MOSFET
	MP-3Z[Note]	TO-252	SC-63		Power transistor, MOSFET, (IC: Regulator)
	MP-25Z[Note]	TO-263	SC-83		Power transistor, MOSFET

Note Multiple packages are available. Contact an NEC Electronics sales representative for details.

2-2. Through-hole type (THD) products

Type	Package				Product
	NECEL Name	JEDEC Name IPC Name	JEITA Name	Appearance	
Through-hole type (THD)	TO-92	–	SC-43A		MOSFET, small-signal device
	SST	–	SC-72		MOSFET, small-signal device
	SP-8	–	–		MOSFET, small-signal device
	MP-3[Note]	TO-251	SC-64		MOSFET, power transistor
	MP-5	TO-126	–		MOSFET, power transistor
	MP-7	–	SC-53		MOSFET, power transistor
	MP-10	–	–		MOSFET, power transistor
	MP-25[Note]	TO-220AB	SC-46		MOSFET, power transistor
		TO-262	–		MOSFET, power transistor
	MP-45F	TO-220F	SC-91		MOSFET, power transistor
	MP-88	TO-3P	SC-65		MOSFET

Note Multiple packages are available. Contact an NEC Electronics sales representative for details.

3. Lead-Free Product Nomenclature

3-1. Identifying lead-free products by name

Each type of solder used is identified by a lead-free classification symbol suffixed to the product name.

Lead-Free Classification Symbol	Exterior Solder Material	Presence of Lead Used Internally
-A	Sn-Bi Sn-Ag-Cu	No
-AZ	Sn-Bi Sn-Ag-Cu	Yes[Note]
-AT	Sn	No
-AY	Sn	Yes[Note]

Note High-melting-point solder (85% lead, minimum) used, the solder being specified in RoHS directive-related documents as excluded from the directive.

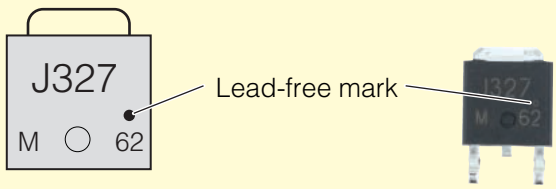
Example 2SJ327-ZK-E1-**AZ** Example of product internally using high-melting-point solder

Refer to **6. Package-Specific Standards** to check the displayed contents of each package.
Note that a few of the products do not follow the identification system. Contact an NEC Electronics sales representative for details.

3-2. Identifying lead-free products by product marking

Packages subject to lead-free marking are marked with an identifying dot ("●") (see **6. Package-Specific Standards**).

(Example)



3-3. Identifying lead-free products by package label

"Pb-Free T." is printed on labels in order to identify lead-free products.

Sample label

4. Exterior Solder Material for Lead-Free Products

Package Classification	Exterior Solder Material	Solder Film Thickness	Relative Proportions
Surface-mount type	Sn-Bi, Sn	4 to 20 μm	Sn-2Bi, Sn100, Sn-3Ag-0.5Cu
Through-hole type	Sn-Ag-Cu, Sn-Bi, Sn		

Remark See **6. Package-Specific Standards** for details.

5. Recommended Soldering Conditions for Lead-Free Products

Recommended soldering conditions for each type of package should be checked in conjunction with **6. Package-Specific Standards**.

Meanings of condition symbols

IR60-00-3
① ② ③ ④

Description example: 260°C infrared reflow, up to 3 times
No baking required

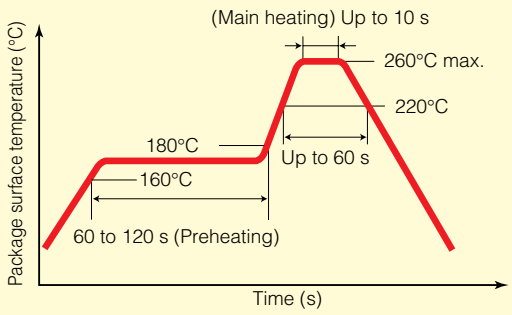
Number	Meaning
①	Soldering method
②	Peak temperature
③	Baking temperature/shelf life after unpacking
④	Number of times mountable

5-1. Infrared reflow (IR) method

Products listed in this document, for which infrared reflow may be applied, can withstand a peak temperature of 260°C.

Condition Symbol	Preheating		Main Heating		Peak Temperature		Number of Reflows
	Temperature	Time	Temperature	Time	Temperature	Time	
IR60-00-3	160 to 180°C	60 to 120 seconds	220°C or higher	60 seconds max.	260°C max.	10 seconds max.	3 times

Infrared reflow temperature profile



5-2. Wave soldering (WS) method

Condition Symbol	Preheating		Maximum Temperature		Count
	Package Surface Temperature	Time	Solder Bath Temperature	Time	
WS60-00-1	120°C max.	Unlimited	260°C max.	10 seconds max.	Once

5-3. Partial heating method

Maximum Temperature of Pins	
Temperature	Time
350°C max.	3 seconds max. (per pin row)

5-4. Flux

Rosin-based flux containing chlorine of up to 0.2 Wt% is recommended.

5-5. Other

Detailed technical information related to solder mounting is disclosed on the following NEC Electronics web site.
URL http://www.necel.com/pkg/en/mount/index.html

6. Package-Specific Standards

6-1. Surface-mount type lead-free products

Type	Package					Recommended Soldering Conditions			Lead-Free Mark
	NECEL Name	JEDEC Name IPC Name	JEITA Name	Product Weight [mg] (Reference)	Lead-Free Classification Symbol (Suffix)	IR	WS	Partial Heating [°C]	
Surface-mount type (SMD)	2pin XSOF	–	–	0.88	-A, -AT	IR60-00-3	WS60-00-1	350	No
	3pin XSOF 03	–	–	1.33	-A, -AT				No
	3pin XSOF 04	–	–	1.33	-A, -AT				No
	5pin XSOF	–	–	2.88	-A, -AT				No
	2pin Ultra Small Mini Mold	–	SC-78	2.3	-A, -AT				No
	3pin Ultra Small Mini Mold	SOT-416	SC-75	3	-A, -AT				No
	3pin Ultra Small Mini Mold (Thin-type)	–	SC-75	2	-A, -AT				No
	2pin Super Small Package	SOD-323	SC-76	4.8	-A, -AT				No
	3pin Super Small Package	SOD-323	SC-70	6	-A, -AT				No
	5pin Super Small Package	SOT-353	SC-88A	6	-A, -AT				No
	6pin Super Small Package	–	SC-88	6	-A, -AT				No
	3pin Mini Mold	SOT-346	SC-59A	12	-A, -AT				No
	3pin Mini Mold (Thin-type)	–	SC-96	11	-A, -AT				No
	5pin Mini Mold	SOT-457	SC-74A	13	-A, -AT				No
	5pin Mini Mold (Thin-type)	–	SC-95_5P	13	-A, -AT				No
	6pin Mini Mold	–	SC-74	13	-A, -AT				No
	6pin Mini Mold (Thin-type)	MO-193	SC-95	11	-A, -AT				No
	6pin WSOF	–	–	6.4	-A, -AT		–		No
	2pin Power Mini Mold	–	–	63	-AZ, -AY		WS60-00-1		No
	2pin Small Power Mini Mold	–	–	–	-AY		WS60-00-1		No
	3pin Power Mini Mold	TO-243	SC-62	48	-AZ, -AY		–		Yes
	6pin HWSON	–	–	18.6	-A, -AT		–		Yes
	8pin TSSOP	MO-187	–	40	-A, -AT		WS60-00-1		Yes
	8pin HVSON	–	–	100	-AZ, -AY		–		Yes
	8pin SOP	–	SC-87	80	-A, -AZ, -AT, -AY		WS60-00-1		Yes
	8pin HSOP	–	SC-87	80	-AZ, -AY		–		Yes
	MP-2	–	SC-84	90	-AZ, -AY		–		Yes
	MP-3Z[Note]	TO-252	SC-63	315	-AZ, -AY		–		Yes
	MP-25Z[Note]	TO-263	SC-83	1,390	-AZ, -AY		–		Yes

Note Multiple packages are available. Contact an NEC Electronics sales representative for details.

6-2. Through-hole type lead-free products

Type	Package					Recommended Soldering Conditions			Lead-Free Mark
	NECEL Name	JEDEC Name IPC Name	JEITA Name	Product Weight [mg] (Reference)	Lead-Free Classification Symbol (Suffix)	IR	WS	Partial Heating [°C]	
Through-hole type (THD)	TO-92	–	SC-43A	260	-A, -AZ	–	WS60-00-1	350	Yes
	SST	–	SC-72	120	-A				Yes
	SP-8	–	–	540	-AZ				Yes
	MP-3[Note]	TO-251	SC-64	320	-AZ				Yes
	MP-5	TO-126	–	705	-AZ				Yes
	MP-7	–	SC-53	1,400	-AZ				Yes
	MP-10	–	–	1,530	-AZ				Yes
	MP-25[Note]	TO-220AB	SC-46	1,900	-AZ, -AY				Yes
		TO-262	–	1,800	-AZ, -AY				Yes
	MP-45F	TO-220F	SC-91	2,200	-AZ				Yes
	MP-88	TO-3P	SC-65	4,980	-A				Yes

Note Multiple packages are available. Contact an NEC Electronics sales representative for details.

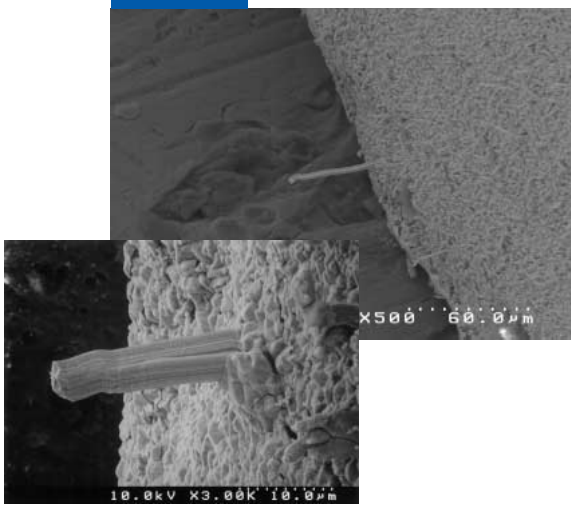
7. Mounting Reliability Evaluation Data

Examples of whiskers and mounting strength evaluations are presented below.
Note that an NEC Electronics sales representative should be consulted for detailed evaluation results of individual products.

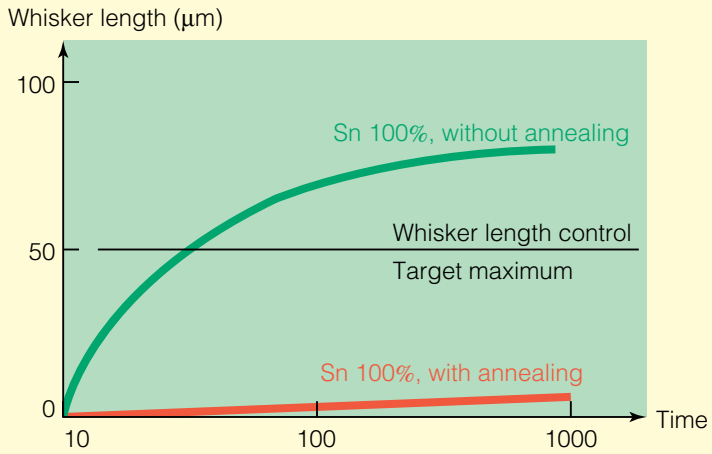
7-1. Whiskers

A tin whisker is a phenomenon resulting from the re-crystallization of tin (Sn) monocrystals.
The main source of tin whiskers is said to be stress arising within tin, with stress such as that due to the application of stress and linear expansion having been suggested as the cause of the stress.
As countermeasures, the most general method is the addition of an appropriate amount of bismuth (Bi), and, for products plated with pure tin, a method of relaxing stress through the effect of high-temperature storage annealing.
NEC Electronics, too, controls the growth of tin whiskers by annealing all pure tin-plated products for one hour at 150°C.

Whisker



Effects of controlling whiskers



Remark Example of experiments using high-temperature, high-humidity storage

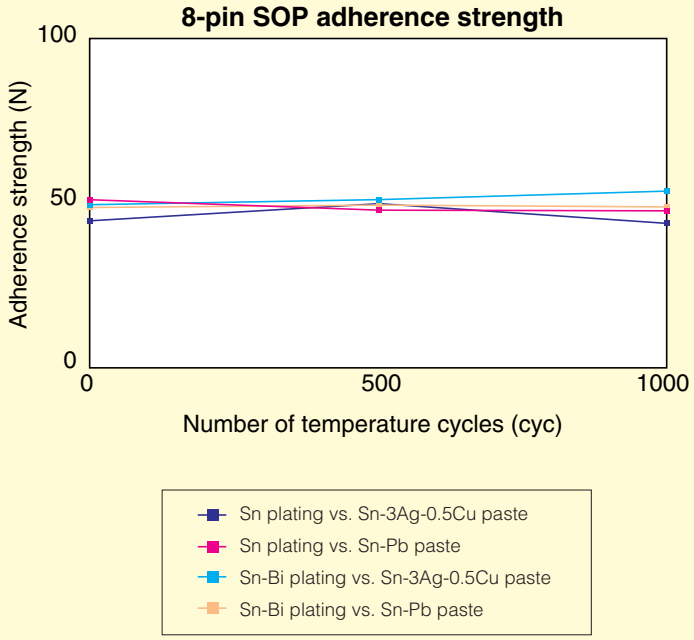
Whisker experiment examples

Item	Experiment Conditions
High-temperature, high-humidity storage	85°C, 85% relative humidity, 1000 hours
Temperature cycles	–40 to +125°C, 500 cycles

7-2. Joint strength of lead-free products

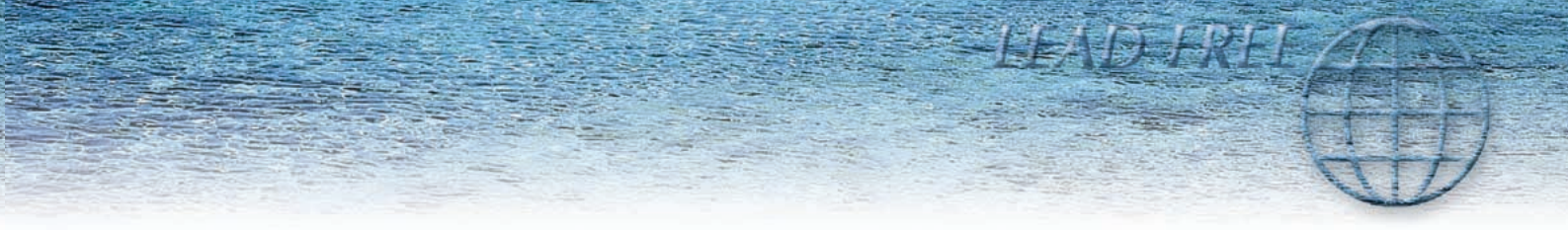
A comparative example of joint strength when mounting solder paste is combined with lead-free plating. No large plating specification-related differences were found.

8-pin SOP evaluation



Evaluation conditions

- **Lead material:** Cu
- **Exterior plating:** Sn/Sn-Bi
- **Mounting solder:** Sn-3Ag-0.5Cu/Sn-Pb
- **Mounting board:** FR-4 (1.6 mmt)
- **Mask thickness:** 150 µm
- **Reflow temperature:** 245°C, peak
- **Temperature cycles:** –40 to +125°C, 10 min. each



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