Thank you very much for using RENESAS products.
We have prepared this documentation with regard to your approval of our switch to lead-free semiconductor products. The contents are listed below. Please examine the documentation thoroughly.

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  1.3 Evaluation of solderability by wetting balance method

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1. Solderability

Results for solderability of the combinations of lead-free plating, tin–lead (Sn-Pb) plating, lead-free Sn-Ag-Cu paste, and eutectic Sn-Pb paste.

1.1 Evaluation of solderability by wetting balance method

Pre-process condition: A: Stored for 4 hrs (105°C, 100%) B: Stored for 4hrs (100°C, 100%)

Sample	Plating	Solder	Pre-process condition	Wetting balance method Max.	Wetting balance method Min.	Wetting balance method Ave.	Wet area method
QFP1420-100-Fe	Sn-Cu	Sn-Ag-Cu (245°C)	A	0.4 s	0.3 s	0.36 s	95% and above
LQFP1414-100-Cu	Sn-Cu	Sn-Ag-Cu (245°C)	A	0.8	0.4	0.56	95% and above
QFP1420-100-Fe	Sn-Cu	Sn-Pb (230°C)	A	0.4	0.2	0.30	95% and above
LQFP1414-100-Cu	Sn-Cu	Sn-Pb (230°C)	A	0.8	0.4	0.50	95% and above
LQFP0707-48-Cu	Sn-Bi	Sn-Ag-Cu (245°C)	B	0.45	0.34	0.39	95% and above
LQFP0707-48-Cu	Sn-Bi	Sn-Pb (230°C)	B	0.53	0.38	0.48	95% and above
TSSOP-14-Cu	Ni/Pd/ Au	Sn-Ag-Cu (245°C)	B	0.44	0.40	0.43	95% and above
TSSOP-14-Cu	Ni/Pd/ Au	Sn-Pb (230°C)	B	0.49	0.45	0.47	95% and above
LQFP0707-48-Cu	Sn-Pb	Sn-Pb (230°C)	B	0.61	0.33	0.44	95% and above
			Evaluation	Equivalent to conventional specs.			Equivalent to conventional specs.

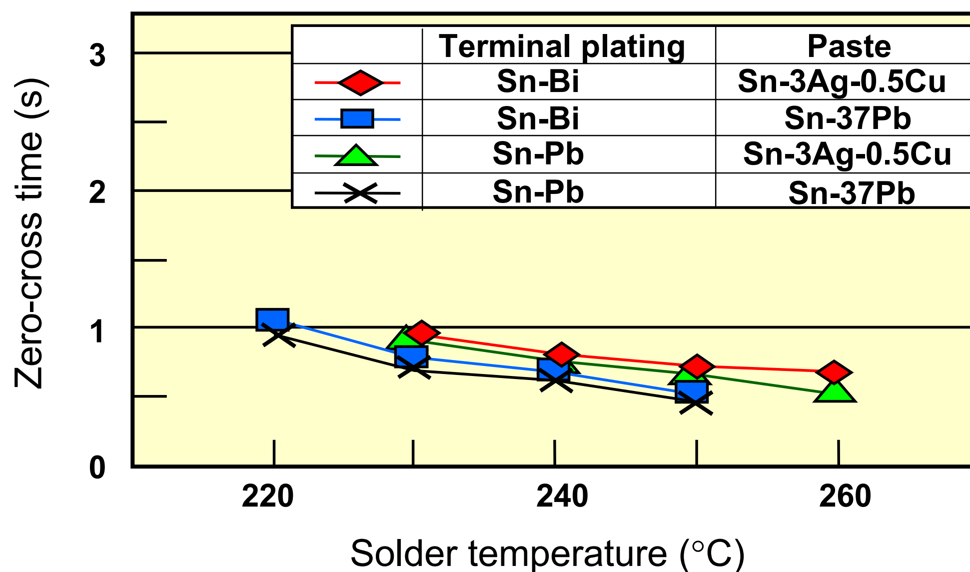
1.2 Evaluation of solderability by wetting balance method (rapid heating)

(1) Comparison of solderability for Sn-Bi and Sn-Pb plating

- Lead-frame material: 42 alloy
- Criteria:

  Sn-2Bi and Sn-Ag-Cu solders: 245°C, 3 s or less

  Sn-10Pb plating and Sn-37Pb plating: 210°C, 3 s or less



- Judgment:

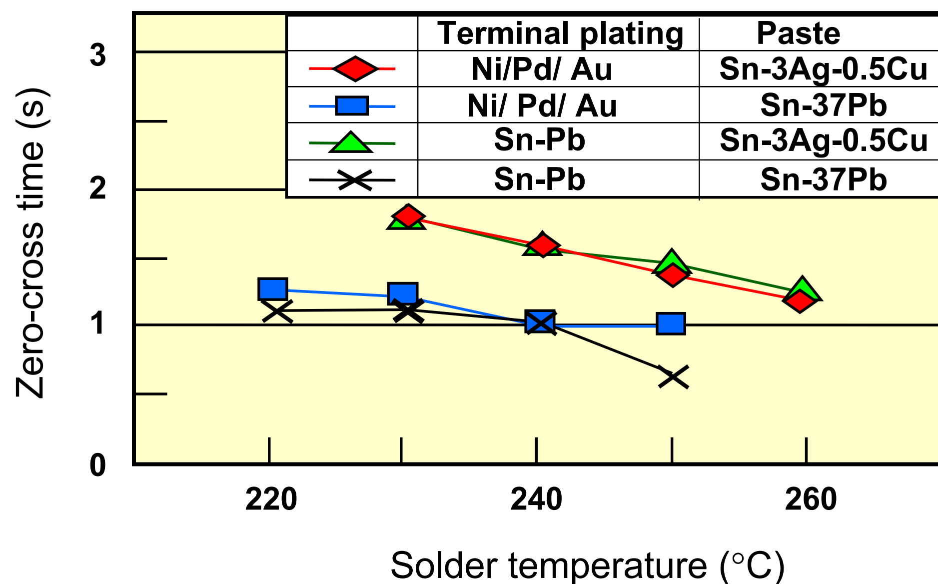
  Lead-free plating is equivalent to conventional one.

  The difference of ZCT seems to come from the difference of the solder pastes.

(ZCT: Zero-cross time)

(2) Comparison of solderability for Ni/Pd/Au and Sn-Pb plating

- Lead-frame material: Cu
- Criteria:
  Ni/Pd/Au plating and Sn-Ag-Cu solder: 245°C, 3 s or less
  Sn-10Pb plating and Sn-37Pb solder: 210°C, 3 s or less



- Judgment:
  Lead-free plating is equivalent to conventional one.
  The difference of ZCT seems to come from the difference of the solder pastes.

(ZCT: Zero-cross time)

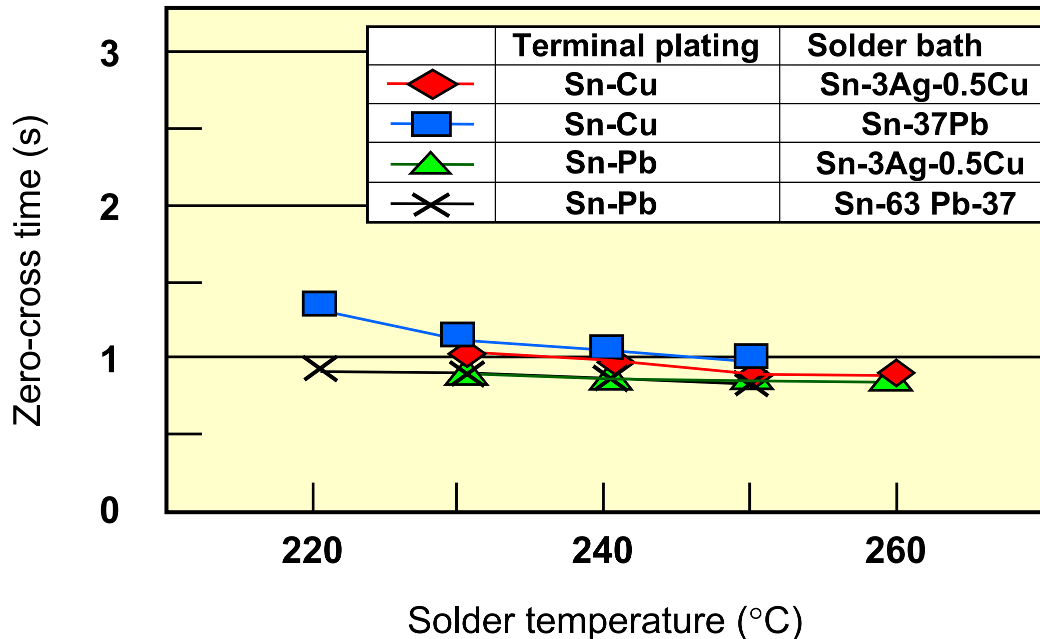
1.3 Evaluation of solderability by wetting balance method

Comparison of solderability for Sn-Cu and Sn-Pb dips

- Lead-frame material: Cu
- Criteria:

  Sn-Cu dip and Sn-Ag-Cu solder: 245°C, 3 s or less

  Sn-10P dip and Sn-37Pb solder: 210°C, 3 s or less



- Judgment:

  Although ZCT at 220 degree C is a little long due to high melting point of lead-free plating, ZCT itself satisfies sufficiently within 3 seconds. Solderability is equivalent to Sn-Pb plating.

(ZCT: Zero-cross time)

2. Mechanical strength of joints

2.1 Evaluation of terminal join strength for packages with leads

■Criterion: equivalent to or better than conventional materials (Sn-10Pb plating and Sn−37Pb solder)

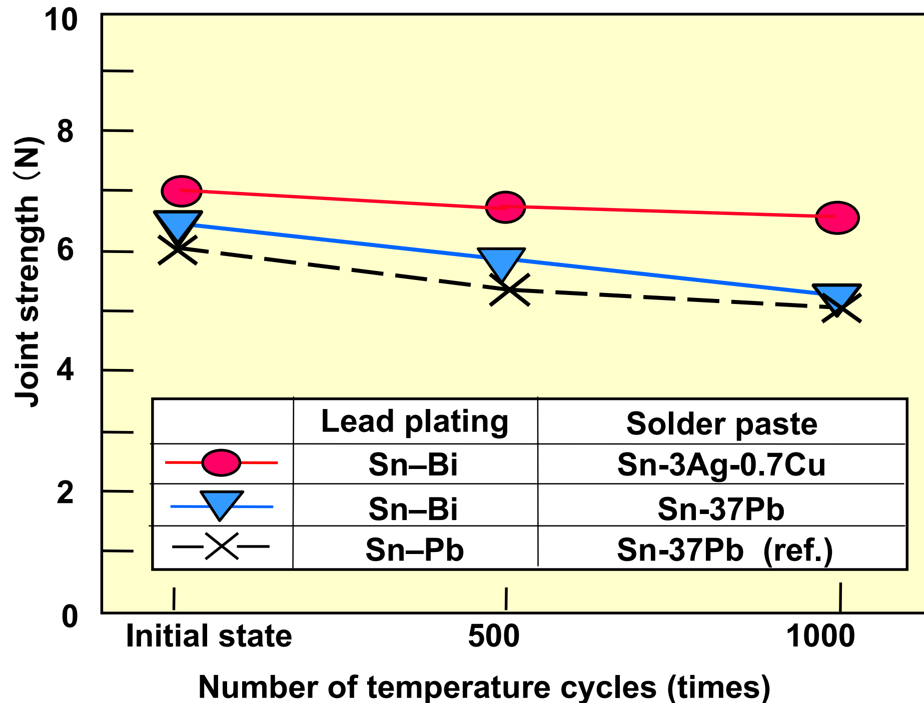
2.1.1 Sn-Bi plating evaluation

Package: QFP2828-208-0.5 (Fe-Ni)

Condition of temperature-cycling: -55/125°C 10 min./10 min.

Lead-Pulling Test (45°)

Temperature for joint formation: Sn-3 Ag-0.5Cu: 245°C, Sn-37Pb: 220 °C



■ Judgment:
It is equivalent to the conventional specification.

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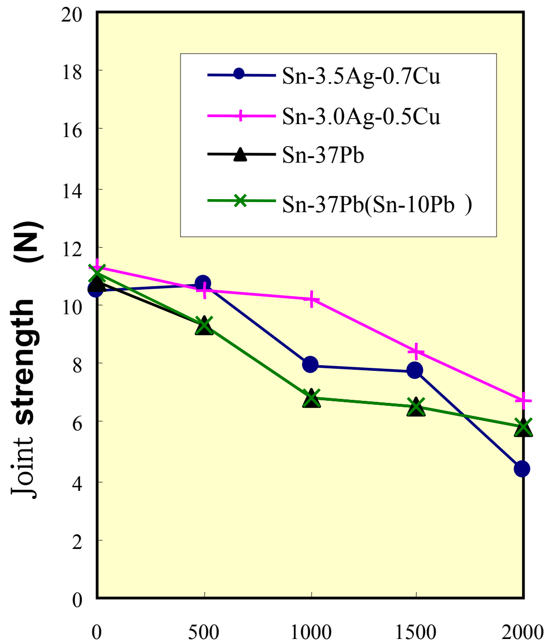
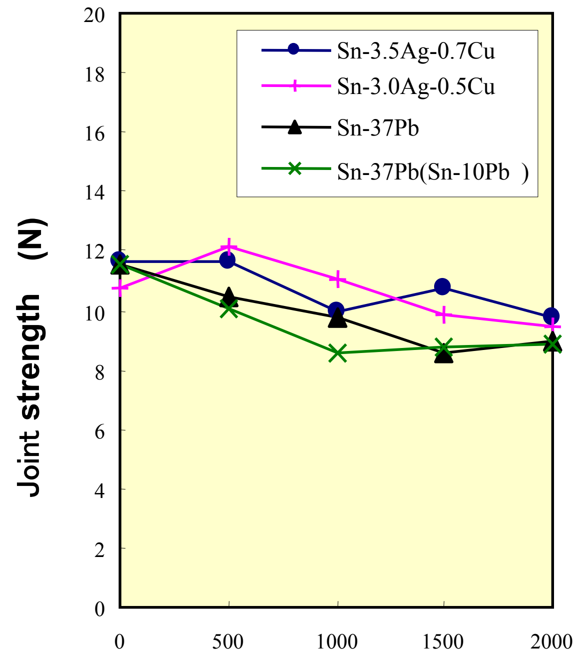
2.1.2 Sn-Cu plating evaluation

Package : QFP100pin (Fe-Ni)
Condition of temperature-cycling -40/125 °C 15min/15min



Package : LQFP100pin (Cu)
Condition of temperature-cycling -40/125 °C 15min/15min

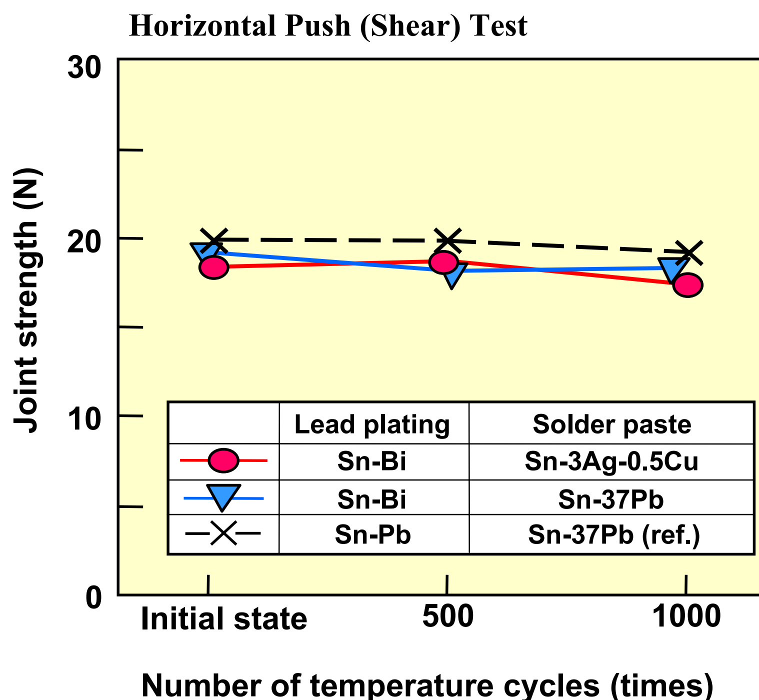


■ Judgment:
It is equivalent to the conventional specification.

2.1.3 Sn-Bi plating evaluation

Package: CMPAK-4 (Cu leads)
Condition of temperature cycling: -55°C/125°C

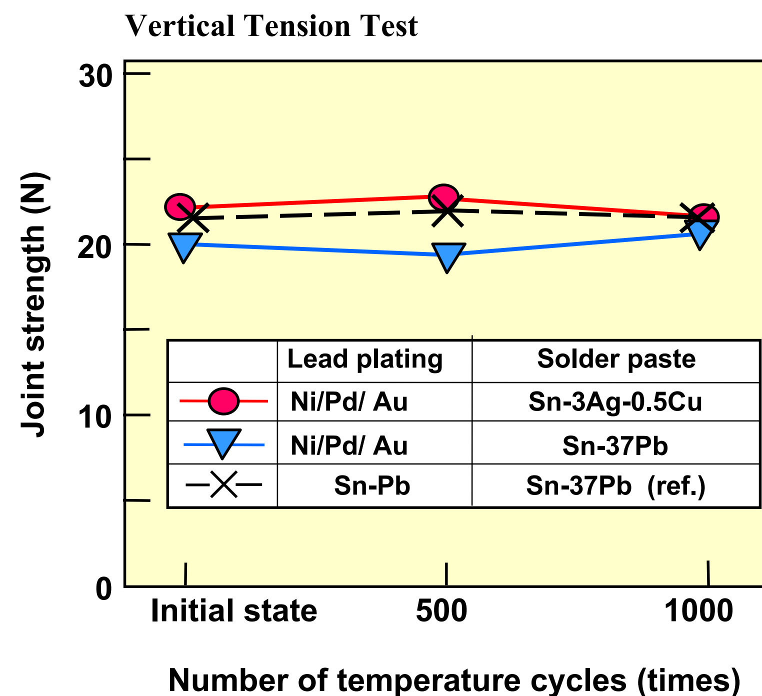
Temperature for joint formation:
Sn-3 Ag-0.5Cu: 245°C, Sn-37Pb: 220 °C



2.1.4 Ni/Pd/Au plating evaluation

Package: 20-pin SOP (Cu leads)
Condition of temperature cycling: -55°C/125°C

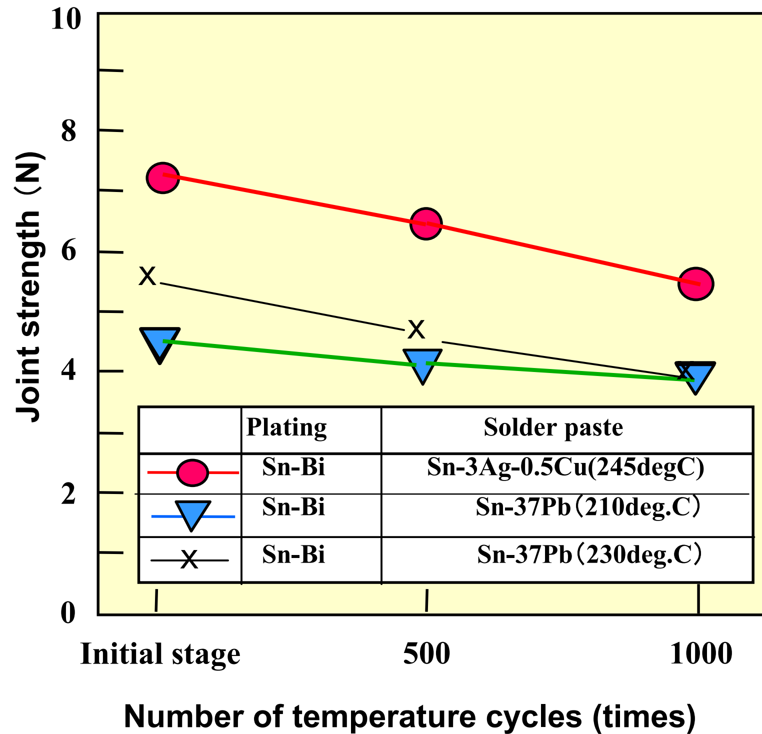
Temperature for joint formation:
Sn-3 Ag-0.5Cu: 245°C, Sn-37Pb: 220 °C



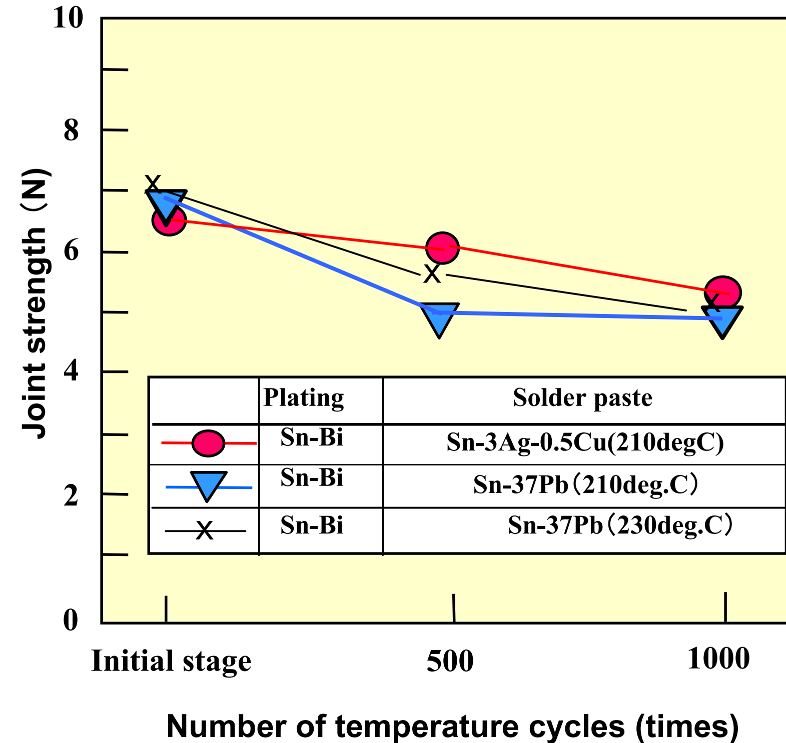
■ Judgment:
It is equivalent to the conventional specification.

2.1.5 Sn-Bi plating evaluation

Package: QFP1414-100-0.5 (Fe-Ni leads)
Condition of temperature cycling: -55°C/125°C
10 min./10 min.



Package: QFP1414-100-0.5 (Cu leads)
Condition of temperature cycling: -55°C/125°C
10 min./10 min.



■ Judgment:
It is equivalent to the conventional specification.

2.1.6 Sn-Cu dipping coat evaluation

Data on the joint strength of lead-insertion packages was not obtained because the force was beyond the limit for the machine used in the test.

2.2 Evaluation of terminal join strength for packages with balls

2.2.1 Evaluation of BGA-joint strength with temperature cycling

•Temperature-cycling stress: -55°C/125°C 10 min./10 min.
• Sample specifications/conditions:
  -Package: P-LFBGA1313-240 pins ("daisy-pattern" chip)
  -Ball pitch: 0.65 mm
  -Solder-ball materials: Sn-3Ag-0.5Cu (lead-free) and Sn-37 Pb (eutectic)
• Mount type: Single-side mounting

[Result]

Defect criterion: Change in resistance ≥100%

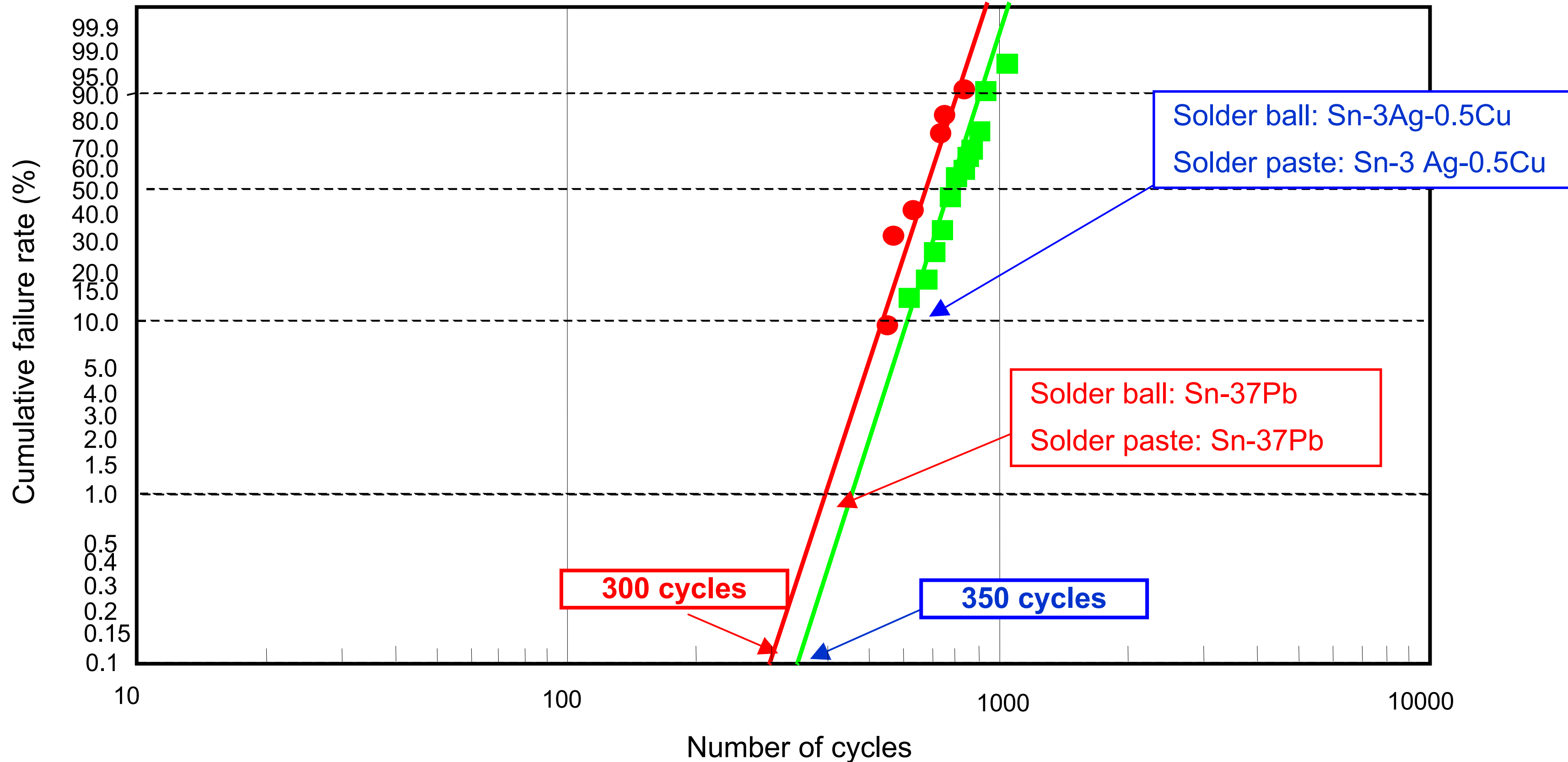
Number of defects (pieces)

Solder ball	Solder paste	No. of samples	500 cycles	1000 cycles	1200 cycles
Sn-3Ag-0.5Cu	Sn-3Ag-0.5Cu	25	0	0	0
Sn-37Pb	Sn-37Pb	25	0	0	0

■ Judgment:
It is equivalent to the conventional specification.

2.2.2 Reliability of mounting on one-layer board (175FBGA)

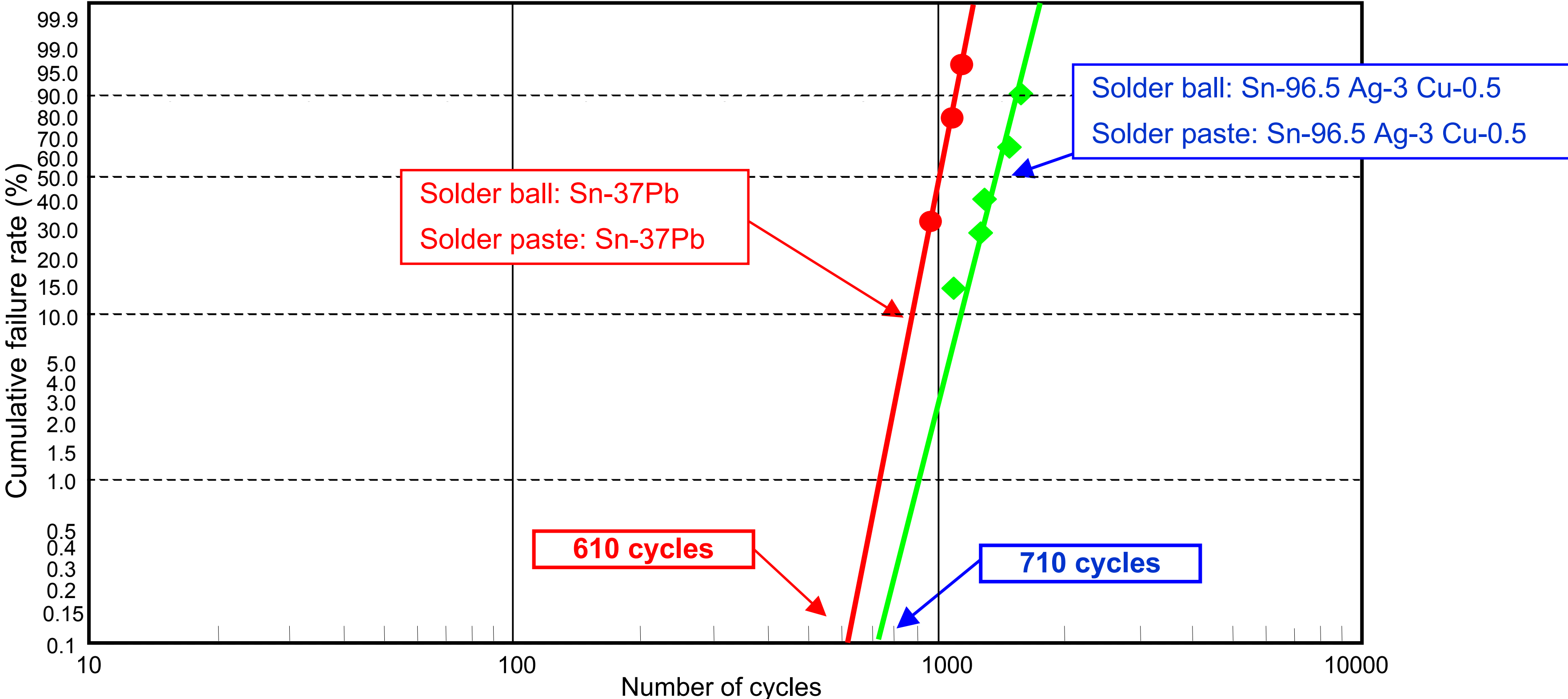
- Condition of temperature cycling: -25/125°C, 10 min./10 min.
- Package: 175FBGA, 13-mm square, ball pitch = 0.8 mm
- Board material: FR-4
- Total number tested: 30 boards



- Judgment:
  It is equivalent to the conventional specification.

2.2.3 Reliability of mounting on two-layer board (240FBGA)

- Condition of temperature cycling: -25/125°C, 10 min./10 min.
- Package: 240FBGA, 15-mm square, ball pitch = 0.8 mm
- Board material: FR-4
- Total number tested: 20 boards



- Judgment:
  It is equivalent to the conventional specification.

3. Whisker Evaluation

3.1 Sn-Bi plating: The minimal effect of low Bi concentration on whisker formation

Test conditions	Package	Bi conc. (wt%)	Cu lead frame	Fe-Ni lead frame
85°C/85% RH Storage for 500 hrs	QFP 14x14 100 pins 0.5-mm pitch	0.5	0/500 leads	0/500 leads
		1	0/500	0/500
		2	0/500	0/500
		3	0/500	0/500
		4	0/500	0/500
		5	0/500	0/500
With temperature cycling: -55°C/125°C 10 min./10 min. 500 cycles	QFP 14x14 100 pins 0.5-mm pitch	0.5	0/500 leads	0/500 leads

Criterion: whisker length ≧ 50 μm

Observation: stereoscope (40x)

3.2 Formation of whiskers on Sn-Bi plating stored at room-temperature

Package	Lead-frame material	No. of samples	Storage time	Result
QFP2828-208-0.5	Cu	3 pcs	13000 hrs	0/624 leads
LQFP0707- 48-0.5	Cu	22	13000	0/1056
TSSOP -16-0.65	Cu	114	13000	0/1824
TQFP1414-120-0.4	Fe-Ni	14	13000	0/1680
LQFP0707- 48	Cu	100	14500	0/4800
LDPAK 3 pins	Cu	100	9500	0/300
CMPAK 4 pins	Cu	100	23000	0/400

Note: No whisker is detected.

Criterion: whisker length ≧ 50 μm

Observation: stereoscope (40x)

3.3 Formation of whiskers on Sn-Cu plating stored at room-temperature

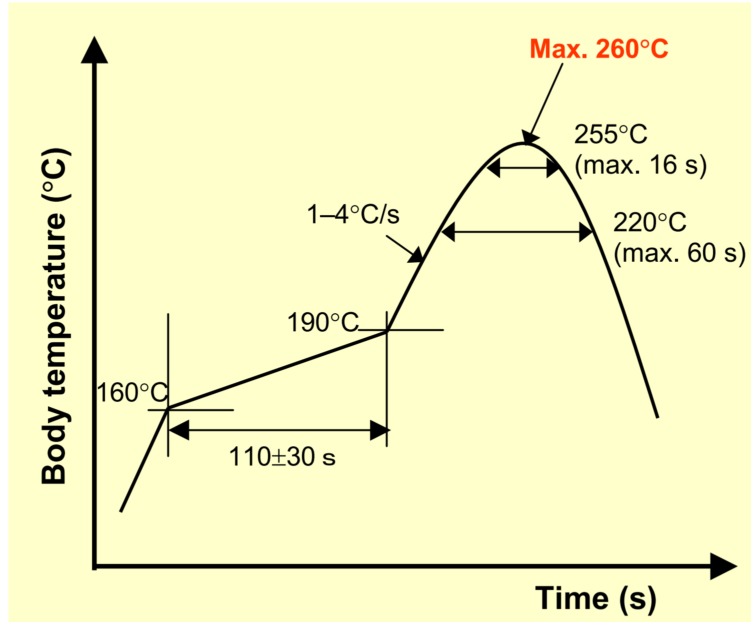
Package	Lead-frame material	No. of samples	Storage time	Result
QFP - 100	Cu	5 pcs	4000 hrs	0/500 leads
QFP - 100	Cu	5	4000	0/500
QFP - 100	Fe-Ni	5	8800	0/500
QFP - 216	Cu	5	14500	0/1080
QFP - 100	Cu	5	15900	0/500
QFP - 80	Cu	5	12750	0/400
SOP - 20	Cu	5	12750	0/100
SOP - 20	Fe-Ni	5	12300	0/100
QFP - 48	Cu	5	12700	0/240

Note: No whisker is detected.

Criterion: whisker length ≧ 50 μm
Observation: Scanning electron microscope (60–85x)

4. Heat resistance (temperature profile)

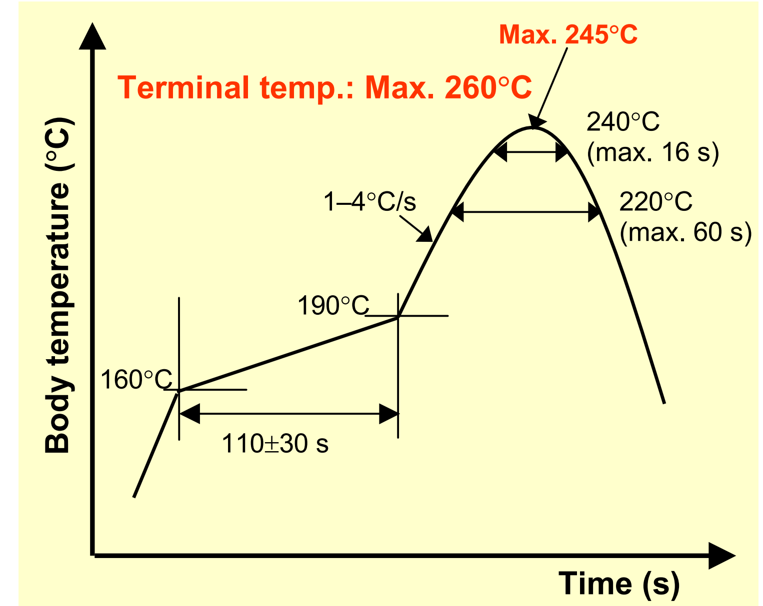
Reflow condition 1



Applicable to these packages:

QFP (less than 2000 cubic mm), LQFP, TQFP, SOP, QFN, TSOP, TSSOP, BGA, CSP (FBGA), LGA, HQFP (10-mm square)
MPAK, CMPAK SRP, URP, UFP, TEFP,SFP, UPAK, LFPAK, etc.

Reflow condition 2



Applicable to these packages:

QFP with a large volume more than 2000 cubic mm, QFJ, DPAK, LDPAK

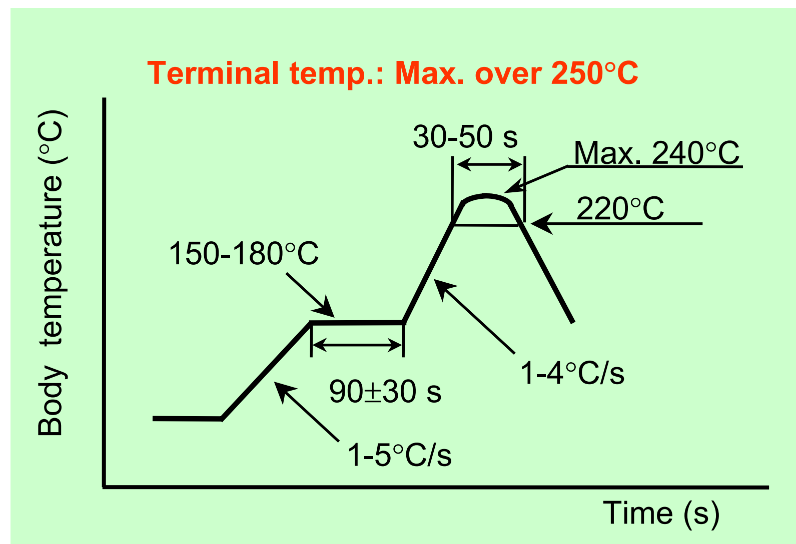
Heat-tolerance criteria

- Plating appearance: No voids or cracks
- Inspection with ultrasonic waves: No exfoliation
- Electrical characteristics

Supplementary note

Reflow condition to support the lead-free HQFP (28-mm square and larger) packages available for some former Hitachi products is 240°C at the peak, with the 30–50 s time range at above 220°C .

Reflow condition 3



Heat tolerance criteria:

- Solder appearance: No voids or cracks
- Inspection with ultrasonic waves: No exfoliation
- Electrical characteristics

Applicable to this package:
HQFP (28 mm square or more)

5. Heat resistance for flow soldering and soldering iron

The flow soldering condition for lead-free packages is the same as the condition for solder that contains lead.

(1) Conditions for lead-insertion-type packages such as DIPs :

Maximum of 260°C , 10 seconds

- Conditions for surface mount type packages such as QFP :

Maximum of 260 °C , 7 seconds

* When the respond condition for a product is different from the above, the condition described at the delivery specification of the device is available.

The condition for soldering iron is the same as the condition for solder that contains lead:

Maximum of 350°C , 3 seconds

* If this condition is exceeded, please make sure that the pin temperature does not rise above 260°C and that time at this temperature is within 3 seconds.

* There are some packages which are available for conditions over 350°C , 3 seconds.

For example: QFP, LQFP, a part of SOP, TQFP, DIP and etc.

380°C, 3s for former Hitachi products

370°C, 5s for former Mitsubishi products