

# TECHNICAL INFORMATION

## *Lead Free No Clean* SOLDER PASTE

### *TS58-M301-3 series*

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## 1. FEATURES

- 1) Combination of a eutectic alloy composed of Tin and Silver, and Koki's unique halide free no-clean flux, realises soldering performances equivalent to conventional no-clean solder pastes including wetting performance.
- 2) Carefully selected thixotropic materials ensure excellent slump resistance and significantly reduce the occurrence of bridging and solder beading.
- 3) Specially developed 'heat resistant' flux system ensures both extremely high reliability and superior solder wetting.
- 4) Low colour flux residue offers a superior cosmetic appearance.

## 2. SPECIFICATION

### 1) Alloy

Item	Unit	TS58-M301-3	TS58-M301-3L	Remarks
Composition	%	Sn96.5Ag3.5		JIS E grade
Shape	--	Spherical		Microscope ×50
Particle size	μm	20 - 38		Laser microsizer
Melting point	°C	221		DSC method

### 2) Flux

Halogen content	%	0.0		Potentiometer
SIR* <sup>1</sup>	Initial value	$> 1 \times 10^{12}$		JIS comb type electrode type-II
	After humidification	$> 1 \times 10^{11}$		
Aqueous solution resistivity* <sup>2</sup>	Ωcm	$> 2 \times 10^4$		Conductivity
Flux type	-	ROL0		ANSI/J-STD-004

### 3) Solder paste

Flux content	%	12	12	By weight
Viscosity* <sup>3</sup>	Ps	1900 10%	1700 ± 10%	Malcom PCU-205
Copper plate corrosion* <sup>4</sup>	--	Passed		--
Solder spread factor	%	85		Copper plate
Tack time	hour	> 24		Malcom FG-1
Shelf life	month	6		Below 10°C

1. SIR ..... 40°C×95%RH×96Hr
2. Aqueous solution resistivity..... In accordance with MIL specifications.
3. Viscosity ..... Malcom spiral type viscometer, PCU-205 at 25°C 10rpm
4. Copper plate corrosion ..... In accordance with JIS

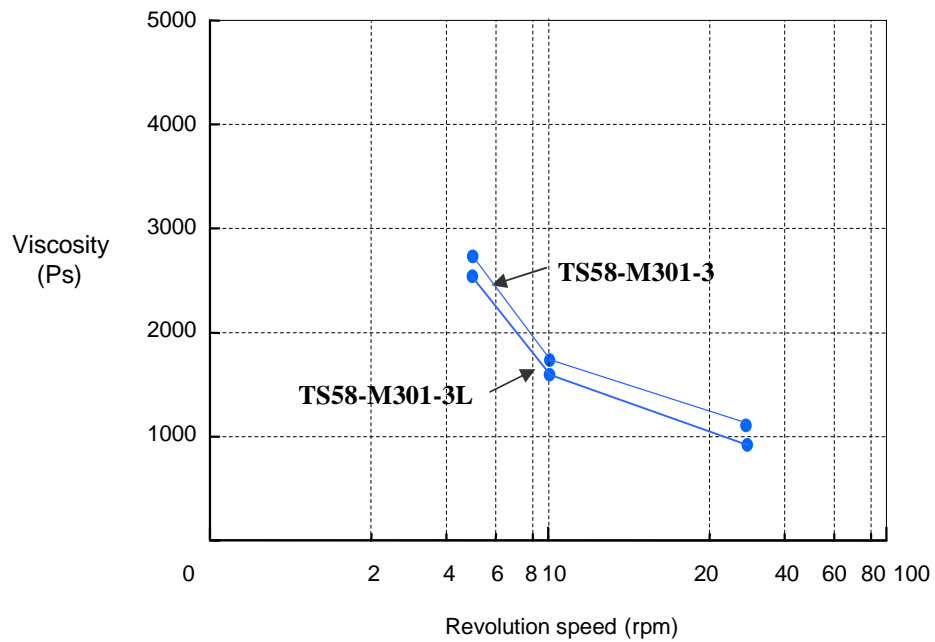
### 3. VISCOSITY CURVE

- Test method

Equipment : Malcom viscometer PCU-205

- Test result

Rotation speed (rpm)		5	10	30	10
Measurement time (min)		3	3	3	1
Viscosity (Ps)	<b>M301-3</b>	2871	1851	1040	1873
	<b>M301-3L</b>	2656	1736	991	1745



## 4. TACK FORCE

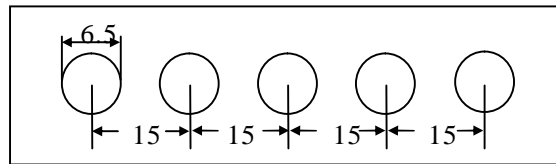
- Test method

Print the solder paste on an alumina plate with a 0.2mm thick stencil that has five 6.5mm dia. holes, to obtain the test piece.

Press the flat tip of the cylindrical probe of a Malcom Solder Checker FG-1 onto the printed solder paste with a pressure of 50gs for 0.2mm sec. and pull it back up at a speed of 10mm/sec. to measure the maximum tensile strength needed to separate the probe from the paste.

Evaluate the tackiness of the solder paste from the obtained tack force and time after printing.

\*Ambient condition : 25°C 50±10%RH



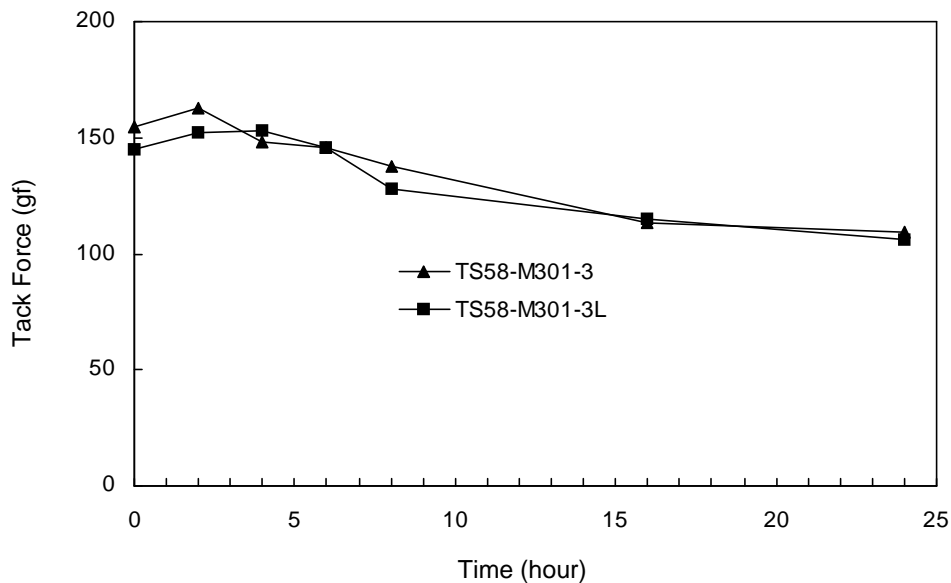
\*Unit : mm

Stencil used

Time (hour)		0	2	4	6	8	16	24
Tack force (gf)	<b>M301-3</b>	155	163	148	146	138	113	109
	<b>M301-3L</b>	145	152	153	146	128	115	106

\*Unit : (gf) Average of n = 5

**Tackiness data**

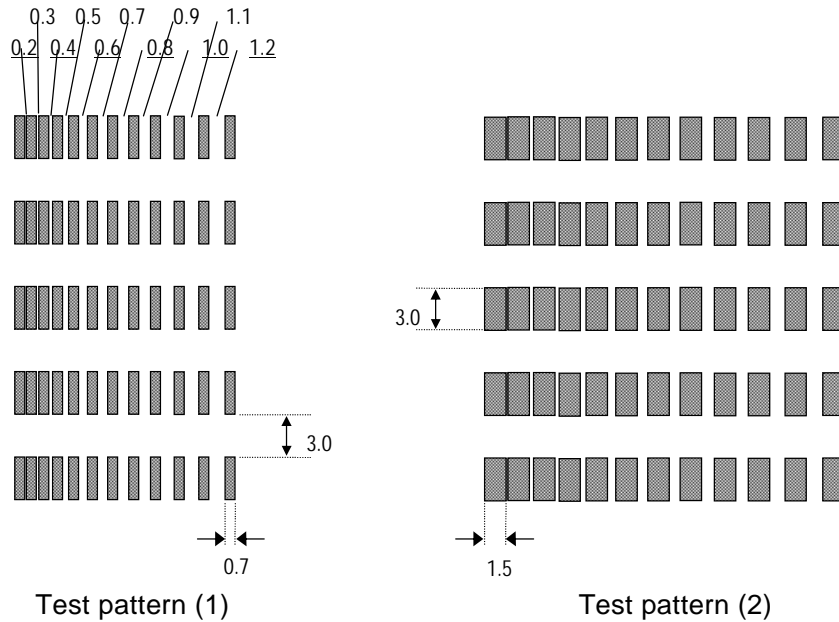


## 5. SLUMP

### • Test method

Using a 0.2mm thick stainless steel stencil with two patterns of apertures, (1)3.0mm×0.7mm, (2)3.0mm×1.5mm arranged as grids with the spacing between the apertures varying from 0.2mm to 1.2mm in steps of 0.1mm, print the solder paste on 1.6mm thick copper clad laminate plate to obtain the test pieces.

- (1) Observe the slump behaviour after leaving the test pieces at room temperature for 1 hour.
- (2) Observe the minimum spacing across which the paste has not merged after storing the test pieces at room temperature for 1 hour, and heating it for 20 minutes at 100°C in the thermostatic oven.
- (3) Observe the minimum spacing across which the paste has not merged after storing the test pieces at room temperature for 1 hour, and heating it for 5 minutes at 150°C in the thermostatic oven.



### • Test result

Product	Pattern	Stored at room temperature for 1 hour		
		Room temp.	150°C × 5min.	180°C × 5min.
TS58-M301-3	(1)	0.2	0.3	0.4
	(2)	0.2	0.3	0.4
TS58-M301-3L	(1)	0.2	0.3	0.4
	(2)	0.2	0.3	0.4

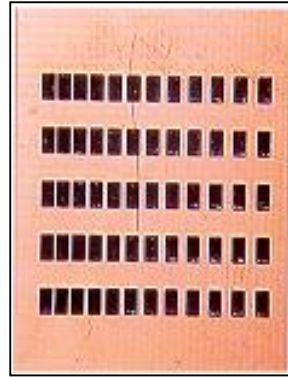
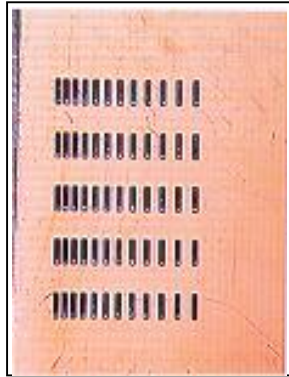


\*Store at room temperature for 1 hour.

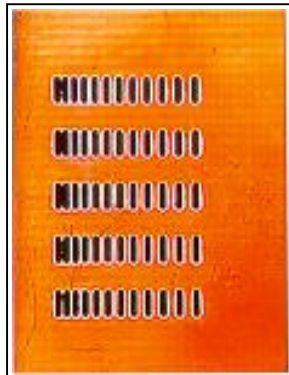
**Product : TS58-M301-3**

Room temperature (no heating)

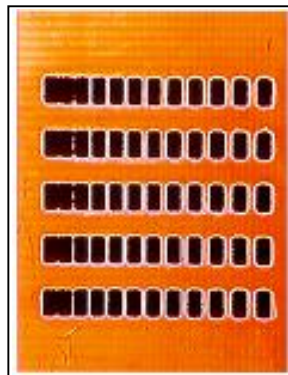
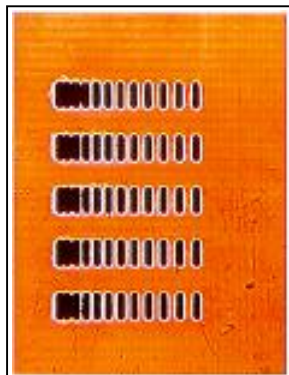
+



150°C × 5min.



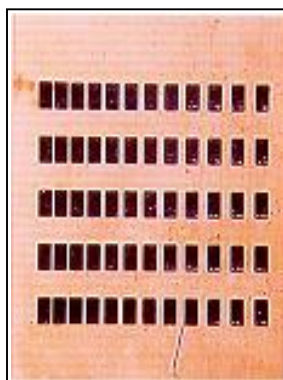
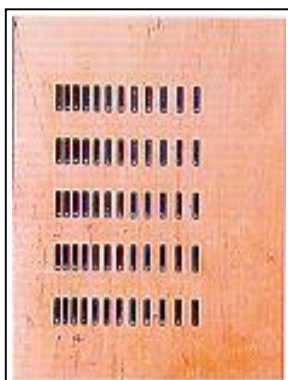
180°C × 5min.



\*Store at room temperature for 1 hour.

**Product : TS58-M301-3L**

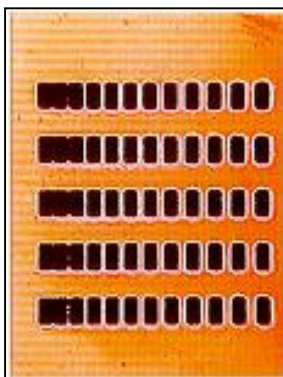
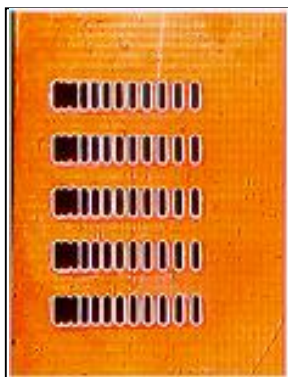
Room temperature (no heating)



150°C × 5min.



180°C × 5min.



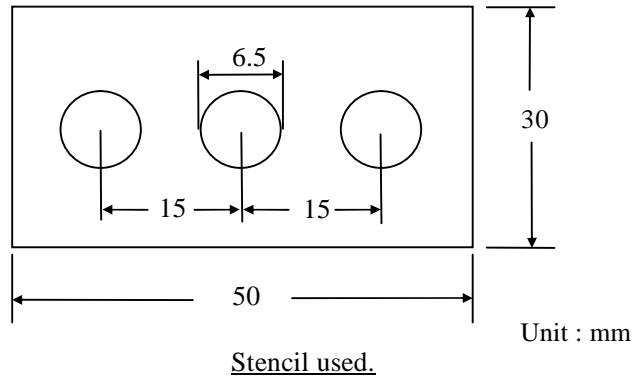
## 6. SOLDER BALLING

- Test method

Prepare two test pieces by printing the paste on each alumina plate (50×50×0.8mm) with a 0.2mm thick stencil provided with three 6.5mm diameter apertures with a distance between centres of 15mm.

Reflow one of them 1 hour after printing and the other after storing it at 25±2°C 60±20%RH for 24 hours, on a hot plate at 250°C. Remove the test pieces from the hot plate after 5 seconds once the solder paste has melted completely and cool them down to room temperature.

Inspect the degree of reflow referring to the ‘Solder balling evaluation standard’ using a ×10 magnifying glass.



- Solder balling evaluation standard

Category	Status of coalescence of solder	Illustration (ex.)
1	The molten solder from the paste has melted into one solder ball.	
2	The molten solder from the paste has melted into one large solder ball with no more than three isolated small solder balls with a diameter less than 75µm.	
3	The molten solder from the paste has melted into one large solder ball surrounded by more than three solder balls with diameters less than 75µm which do not form a semi-continuous halo.	
4	The molten solder from the paste has melted into one ball accompanied by a large number of smaller solder balls which may form a semi-continuous halo, or has melted to form a number of similarly sized balls.	

• Test result

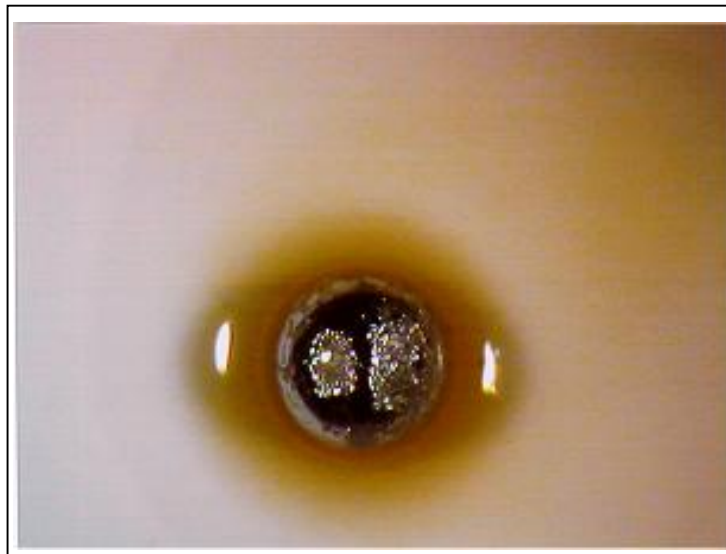
**Product : TS58-M301-3**

Test piece	1 hour after print	24 hours after print
a	Category 2	Category 2
b	2	2
c	2	2

1 hour after printing



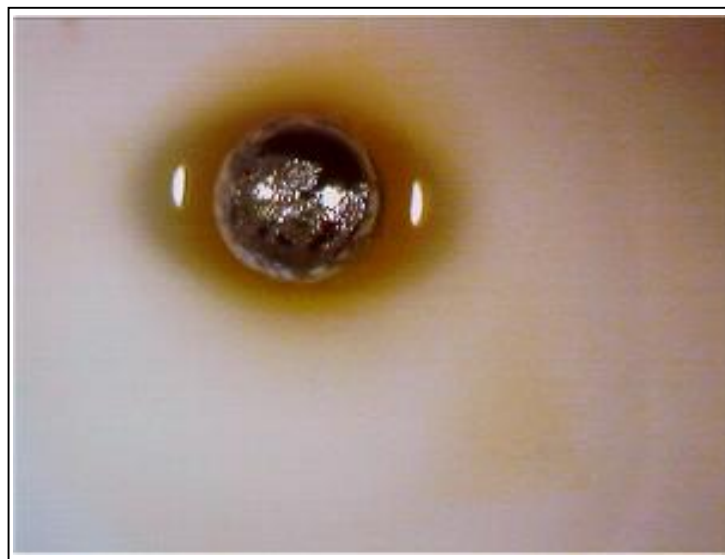
24 hour after printing



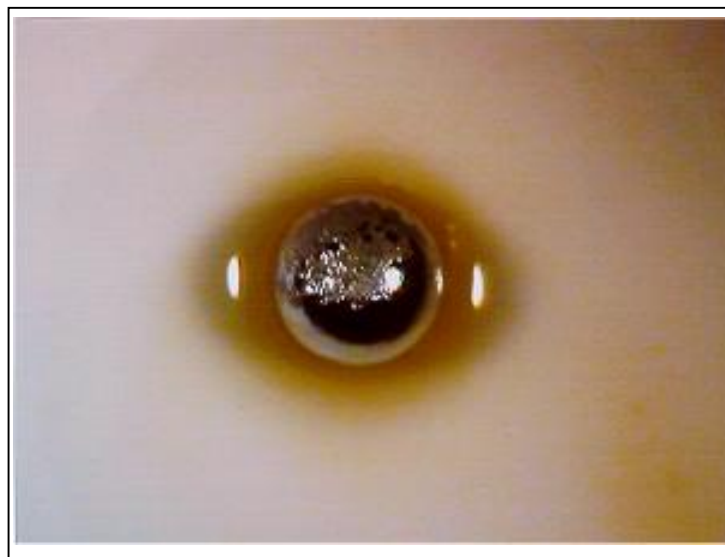
**Product : TS58-M301-3L**

Test piece	1 hour after print	24 hous after print
a	Category 2	Category 2
b	2	2
c	2	2

1 hour after printing



24 hour after printing

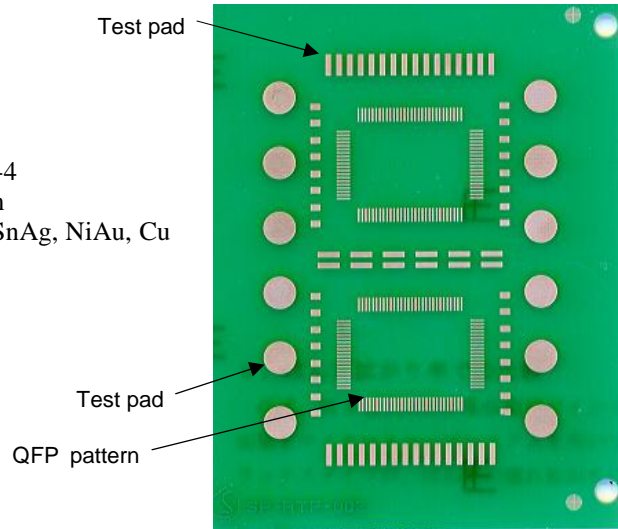


## 7. SOLDER SPREAD FACTOR & WETTING

• Test method

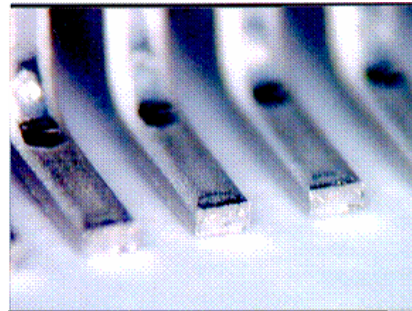
1. Test board

Model : SP RTP-002  
 Material : Glass epoxy FR-4  
 Dimension : 80×100×1.6mm  
 Surface treatment : OSP, SnAgCu, SnAg, NiAu, Cu  
 Pad size (round pad) : 6.0mm



2. QFP tested

PC board : Glass epoxy FR-4  
 Component : QFP 0.65mm pitch 100 pins  
 Lead wire : Cu with Sn/Pb plating



3. Print condition

Stencil thickness : 0.150mm (laser cut)  
 Printer : Model MK-880SV (Minami Kogaku)  
 Stencil aperture : 4.2mm diameter

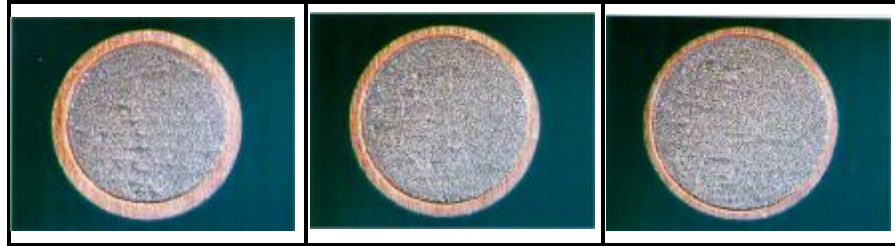
4. Reflow condition

Heat source : Far infrared + Hot air convection  
 Zone structure : 3 pre-heat zones + 1 reflow zone  
 Atmosphere : Air  
 Temperature profile :

Profile	Pre-heat zones	Peak temp.	Time over 220°C
Profile	165 - 180°C × 80 sec.	240°C	55sec.

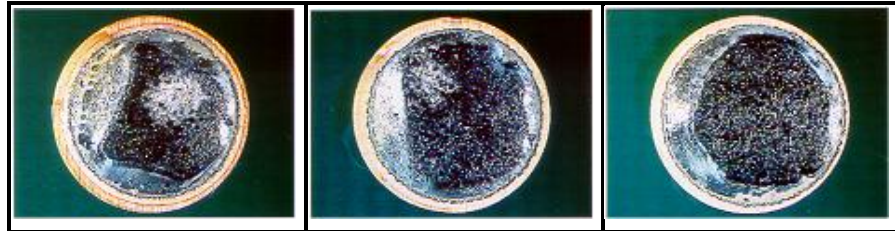
• Result

**1. Solder spread**



After reflow

**Product : TS58-M301-3**

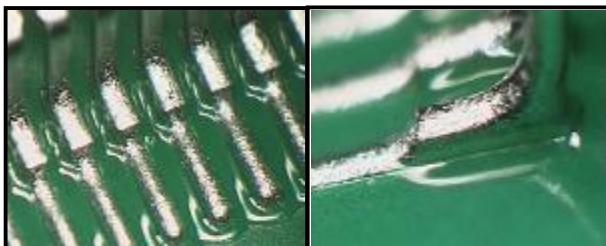


**Product : TS58-M301-3L**

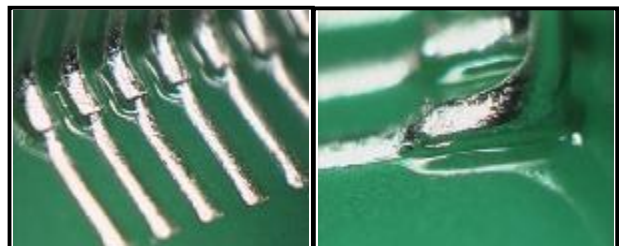


**2. Wetting**

**Product : TS58-M301-3**



**Product : TS58-M301-3L**



## 8. BONDING STRENGTH (Product : TS58-M301-3)

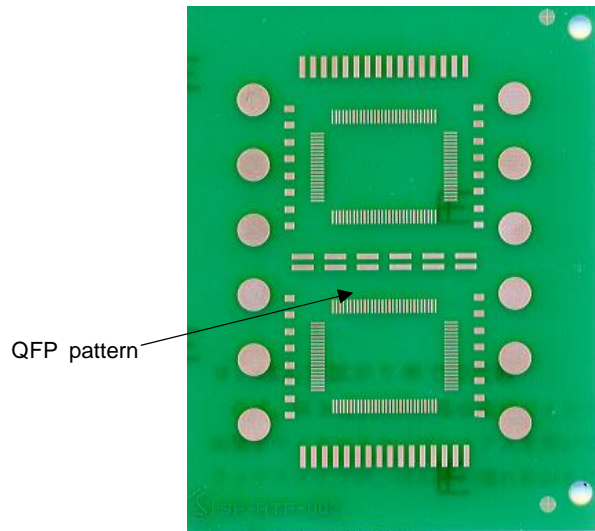
• Test method

Solder 0.65mm pitch QFP on test board and determine bonding strength of solder joints both before and after thermal shock treatment, by peel off test.

• Test conditions

1. Test board

Model : SP RTP-002  
 Material : Glass epoxy FR-4  
 Dimension : 80×100×1.6mm  
 Surface treatment : None (bare copper)  
 Pad size: 0.3×2.5mm



2. QFP tested

PC board : Glass epoxy FR-4  
 Component : QFP 0.65mm pitch 100 pins  
 Lead wire : Cu with Sn/Pb plating

3. Print condition

Stencil thickness : 0.150mm (laser cut)  
 Printer : Model MK-880SV (Minami Kogaku)  
 Stencil aperture : 4.2mm diameter

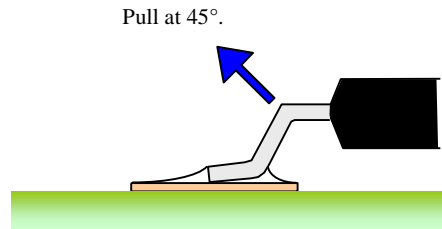
4. Reflow condition

Heat source : Far infrared + Hot air convection  
 Zone structure : 3 pre-heat zones + 1 reflow zone  
 Atmosphere : Air  
 Temperature profile :

Profile	Pre-heat zones	Peak temp.	Time over 220°C
Profile	165 - 180°C ×80 sec.	240°C	55sec.

5. Bonding strength measurement condition

Measurement equipment : Model SS-30WD  
Number of measurement : 60 pins per item  
Pull speed : 1.0mm/sec.



6. Thermal shock test condition

- 30°C ~ +85°C (30 cycles per condition) × 500 cycles

• Test results

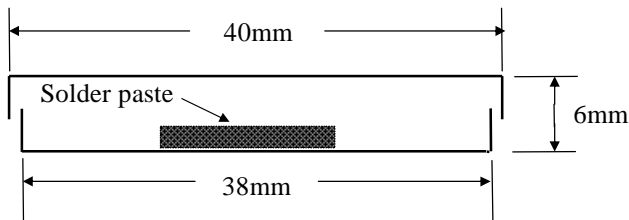
**Peel-off strength test**

Initial value (no thermal shock)	After thermal shock treatment
2.15kg	1.91 kg

## 9. COPPER PLATE CORROSION

- Test method

Prepare 6 pcs. of phosphorus deoxidized copper plate of 50×50×0.5mm in size (JIS-H-3100). Bend 3 of them at right angles at 5mm (copper plate A), and the rest at 6mm (copper plate B) from both edges to form three open ended boxes.



After removing grease from the both copper plate A and B with acetone, soak them in 5% sulfuric acid for 1 minute and in ammonium persulfate solution (solution which contains 25% of ammonium persulfate in 0.5% of sulfuric acid) for 1 minute to etch the surface uniformly. After washing them with running water, soak in 5% sulfuric acid for 1 minute and rinse thoroughly with running tap water and demineralised water. Then finally, rinse them with acetone and dry.

Obtain the test pieces by printing solder paste on the copper plate B with a 0.2mm thick stencil provided with a 6.5mm diameter aperture.

Place all three copper plates A over the copper plates B and lower each box in a horizontal position onto the surface of the solder bath at a temperature of  $235\pm 2^{\circ}\text{C}$  and maintain the test pieces in this position for 5 seconds.

Remove each test piece from the solder bath and allow it to cool in a horizontal position down to room temperature. Place all three boxes in the thermohygrostat under the condition of  $40\pm 2^{\circ}\text{C}$ , 90~95%RH for 72 hours.

Remove the boxes from the thermohygrostat and inspect the inside surfaces of the boxes (including the lid) for possible corrosion.

- Test result

Solde paste	n	Copper plate A	Copper plate B
<b>TS58-M301-3</b>	1	No corrosion	No corrosion
	2	No corrosion	No corrosion
	3	No corrosion	No corrosion
<b>TS58-M301-3L</b>	1	No corrosion	No corrosion
	2	No corrosion	No corrosion
	3	No corrosion	No corrosion

## 10. SURFACE INSULATION RESISTANCE

- Test method

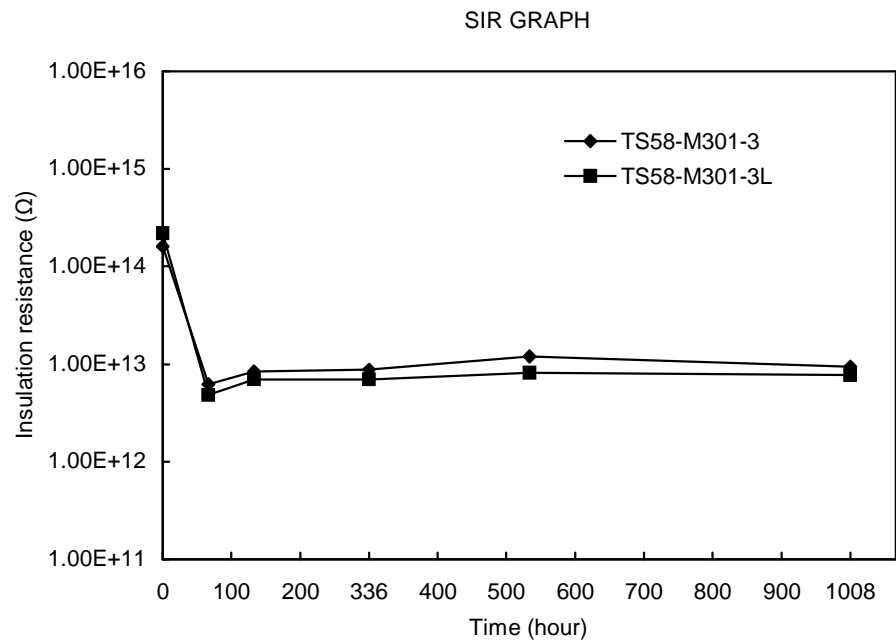
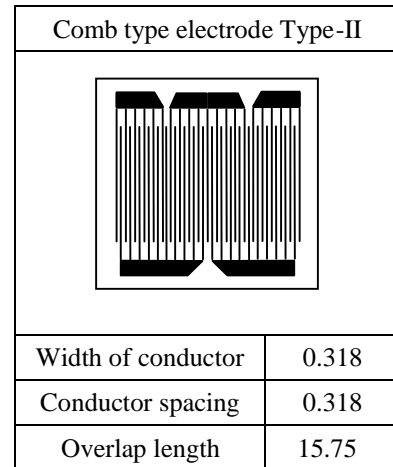
Print the solder paste with a 0.1mm thick stencil on a comb type electrode type-II specified in JIS-Z-3197: 1999 8.5.3 and reflow them to obtain the test piece.

Put the test piece in a thermohygrostat under the conditions of  $85\pm 2^{\circ}\text{C}$  and  $85\pm 2\% \text{RH}$ .

Measure the insulation resistance at every specific time taking the test pieces out of the thermohygrostat. DC100V for the measurement.

- Test result

Time (hour)	S.I.R. Value ( $\Omega$ )	
	TS58-M301-3	TS58-M301-3L
Initial value	$1.6 \times 10^{14}$	$2.2 \times 10^{14}$
96	$6.2 \times 10^{12}$	$4.8 \times 10^{12}$
168	$8.4 \times 10^{12}$	$7.0 \times 10^{12}$
336	$8.8 \times 10^{12}$	$7.0 \times 10^{12}$
504	$1.2 \times 10^{13}$	$8.1 \times 10^{12}$
1008	$9.4 \times 10^{12}$	$7.7 \times 10^{12}$



## 11. VOLTAGE APPLIED SIR (Electromigration Test)

• Test method

Print the solder paste with a 0.1mm thick stencil on a comb type electrode Type-II specified in JIS-Z-3197: 1999 8.5.4 and reflow them to obtain the test pieces.

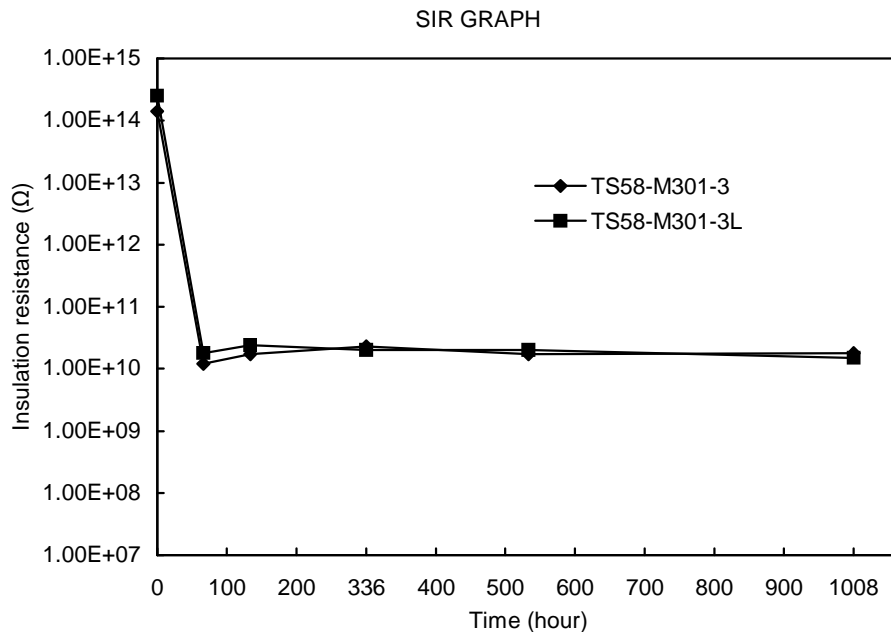
Put the test pieces in a thermohygrostat under the conditions of 85±2°C and 85±2%RH.

Measure the insulation resistance at every specific time keeping the test pieces in the thermo hygrostat and apply DC50V. Apply 100V for the measurement.

• Test result

Time (hour)	Place measured	Average (Ω)	
		TS58-M301-3	TS58-M301-3L
Initial value	Out thermohygrostat	$1.4 \times 10^{14}$	$2.5 \times 10^{14}$
96	In thermohygrostat	$1.2 \times 10^{10}$	$1.8 \times 10^{10}$
168	In thermohygrostat	$1.7 \times 10^{10}$	$2.4 \times 10^{10}$
336	In thermohygrostat	$2.3 \times 10^{10}$	$2.0 \times 10^{10}$
504	In thermohygrostat	$1.7 \times 10^{10}$	$2.0 \times 10^{10}$
1008	In thermohygrostat	$1.8 \times 10^{10}$	$1.5 \times 10^{10}$

\*There was no evidence of electromigration.



## 12. USE OF KOKI SOLDER PASTE

In order to optimise the use of KOKI SOLDER PASTE, please refer to the following guidelines carefully before use.

### 1. Preparation for printing

#### 1) Temperature

After taking the solder paste from the refrigerator, in which the temperature is controlled to between 5 - 10°C, allow the paste temperature to return to ambient.

\*Caution : Do not open the jar while it is cold, as it causes condensation moisture on the paste, and could be the cause of poor performance, such as an increase in viscosity, solder balling etc.

Do not under any circumstances heat the paste prior to use.

#### 2) Stirring

By using a stainless steel or chemically resistive plastic spatula, fold the paste before use.

It is recommended to fold it for at least 1~2 min. to obtain a uniform and stable viscosity.

\*Caution : When automatic stirring equipment is used, do not stir the paste for longer than 4 min.

### 2. Printing

#### 1) Recommended printing parameters

##### (1) Squeegee

1. Kind : Flat
2. Material : Rubber or metal blade
3. Angle : 80~90°(rubber) or metal blade
4. Pressure : Lowest.
5. Squeegee speed : 10~100mm/sec.

##### (2) Stencil

1. Thickness : 200~120µm for 0.65~0.4mm pitch pattern
2. Snap-off distance : 0~0.5mm

\*Although on-contact (0mm snap-off) is normally recommended for fine pitch printing, if the printing equipment is not provided with a stencil separation speed control system, proper snap-off distance is necessary to ensure smooth and gradual separation of the stencil from the substrate to ensure good solder paste deposits.

3. Fixing method of substrate : It is recommended to have a fixture or vacuum system to hold the substrate in position during printing to prevent movement of the PC board and to have a good separation from the stencil.

4. It is strongly recommended to set the stencil separation speed as slow as possible.

##### (3) Ambient

1. Temperature : 25 ± 5°C
2. Humidity : 40~60%RH
3. Climate control : Air flow seriously affects stencil life and tack performance of solder pastes.

\*Caution : When local air conditioner is equipped, make sure it is not enhancing the drying out of the solder paste.



