“SHENMAO” LEAD-FREE SOLDER PASTE TEST REPORT

TYPE:PF606-P

Alloy Composition：Sn96.5/ Ag3.0 / Cu0.5

.

Index

1、Introduction---3

2、Test Items and Results

【1】、Specification,Testing Methods, Measuring Devices and Relative Standards---4

【2】、Test Items and Results--7

(1)、 (Alloy composition impurity analysis)------------------- -- 7

(2)、 (Particle size and shape)----------------------------------- -- 9

(3)、 (Oxide)--- 11

(4)、 (Halide content)-- 13

(5)、 (Presence of halides, silver chromate method)-------- -- 17

(6)、 (Fluorides by spot test)--- 19

(7)、 (Flux induced corrosion, copper mirror method)--21

(8)、 (Corrosion)--- -----------------------------------23

(9)、 (Surface insulation resistance)(SIR)---------------------------------- --------------------------25

(10)、 (Electrochemical migration resistance)(ECM by HP test method)--------- -------------------28

(11)、 (Electrochemical migration resistance)(ECM by IPC test method)---------------------------33

(12)、 (Electromigration resistance)(EM by GR-78-CORE test method)----------------------------36

(13)、 (Cross-compatibility matrix)-- ---------------------------39

(14)、 (Viscosity)-------------------------------------- --44

(15)、 (Tack)--- ---46

(16)、 (Slump)--48

(17)、 (Solder ball test)--- -------50

(18)、 (Spread Test)---52

(19)、 (Cross Section)--- ------------54

(20)、 (Component Shear and IC Pull test)--58

(21)、 (Thermal Cycling test)-- --------------------------60

3、Conclusion---62

Annex (1)、 (Solder Paste Handing and storage Instruction)---------------------------- ------------63

Annex (2)、 (Labeling)-- ------64

Annex (3)、 (Quality Assurance Certificate of Analysis)-- ------65

Annex (4)、 (Temperature profile)---66

Annex (5)、 (MSDS)---67

1、INTRODUCTION:

Acording to 【HP Sn-Ag-Cu Solder Paste Specification, Document # 5982-0881EN】, all of the tests in this document follow IPC, JIS, Telcordia, ASTM and HP specs.

【IPC】

J-STD-003	Solderability Tests for Printed Boards
J-STD-004	Requirements for Soldering Fluxes
J-STD-005	Requirements & Test Methods for Solder Pastes
J-STD-006	Requirements & Test Methods for Soft Solder Alloys
IPC-TM-650	Test Methods Manual

【JIS】

JIS-Z-3197	Testing Method for Resin Type Soldering Flux
JIS-Z-3282	Soft Solder
JIS-Z-3284	Solder Paste

【Telcordia】

Telcordia	GR-78-CORE, Issue 1, 13.1.5

【ASTM】

ASTM	G3-89, G5-94

【HP】

HP	HP Flux ECM Test Method EL-EN861-00

.

2、Test Item and Results

【1】、Testing Methods, Measuring Devices and Relative Standards

The solder paste sample had been tested according to test items below. Table 1 lists the types of solder paste sample. Tabel 2 lists the solder paste specification. All the testing methods, measuring devices and standards followed are listed in Table 3.

【Table 1】

Manufacturer	Brand	Type 1
SHENMAO	FORMOSA	PF606-P

SHENMAO TECHNOLOGY INC.

.

【Table 2】

SPECIFICATIONS

(1)、Solder Paste Type----PF606-P

NO	Item	Specification	Standard
1	Appearance	Gray paste, No foreign, No Stiff	
2	Alloy ★	**Sn96.5/ Ag3.0 / Cu0.5**	J-STD-006A
3	Melting Point	217~219℃	DSC
4	Particle Size	+38μm 1% large, —20μm 10% less	J-STD-005
5	Powder Shape	Sphere	IPC-TM-650, 2.2.14
6	Flux Content	11 ± 0.5wt%	JIS-Z-3197, 6.1
7	Halide Content	0.05 ± 0.02wt% (in flux)	JIS-Z-3197, 6.5
8	Viscosity	200 ± 30 Pa.S (25±1℃)	JIS-Z-3284,Annex 6
9	Flux Type	ROL1	J-STD-004

ALLOY COMPOSITION

(Sn)	**(Ag)**	**(Cu)**	**(Ni)**	**(Ge)**	(Zn)	(Al)	(Sb)	(Fe)	(As)	(Bi)	(Cd)	(Pb)	(In)
REM.	**3±0.3**	**0.5± 0.2**	**0.01 MAX**	**0.01 MAX**	0.002 MAX	0.002 MAX	0.05 MAX	0.02 MAX	0.03 MAX	0.1 MAX	0.002 MAX	0.1 MAX	0.01 MAX

★Patent No.: Japanese Patent No. 3296289 U.S Patent No. 6179935B1.

Patent Alloy Composition: Sn； 0<Ag≦4, 0<Cu≦2, 0<Ni≦1, 0<Ge≦1

Physical Properties & Reliability Data			
No.	**Test Item**	**Test Result**	**Test Method**
1	Copper Plate Corrosion Test	PASS	JIS-Z-3197, 6.6.1
2	Spread Test	75% up	JIS-Z-3197, 6.10
3	Silver Chromate Test	PASS	IPC-TM-650, 2.6.33
4	Copper Mirror Test	PASS	IPC-TM-650, 2.6.32
5	S.I.R Test ▲	1×10^{9} up	JIS-Z-3284. Annex 3
6	Electro Migration Test ◆	PASS	JIS-Z-3284. Annex 14
7	Viscosity Test(25℃,10rmp)	200 ± 30 Pa.S	JIS-Z-3284. Annex 6
8	Tack Test (KN/m^2)	138.5(hr)	JIS-Z-3284. Annex 9
9	Slump Test	Less than 0.3mm	JIS-Z-3284. Annex 8
10	Solder Ball Test	PASS	JIS-Z-3284. Annex 11

▲S.I.R Test Conditions: 85℃, 85% RH ◆Electro Migration Test Conditions: 40℃, 95% RH

.

【Table 3】

NO.	Test Item	Measuring Device	Standard
1	(Alloy composition impurity analysis)	Spark Analyzer	J-STD-006A
2	(Particle size and shape)	3D Vision Measuring System	J-STD-004, J-STD-005, J-STD-006A
3	(Oxide)	--	HP Document 5982-0881EN Section 10
4	(Halide content)	--	IPC-TM-650 Method 2.3.38
5	(Presence of halides, silver chromate method)	Silver chromate paper	IPC-TM-650 Method 2.3.33
6	(Fluorides by spot test)	--	IPC-TM-650 Method 2.3.35.1
7	(Flux induced corrosion, copper mirror method)	Copper Mirror	IPC-TM-650 Method 2.3.32
8	(Corrosion)	Copper Plate Humidity Chamber	IPC-TM-650 Method 2.6.15
9	(Surface insulation resistance)	IPC-B-25 Test coupon Humidity Chamber	IPC-TM-650 Method 2.6.3.3
10	(Electrochemical migration resistance)	IPC-B-25 Test coupon Humidity Chamber	HP Flux ECM Test Method EL-EN861-00
11	(Electrochemical migration resistance)	IPC-B-25 Test coupon Humidity Chamber	IPC-TM-650 Method 2.6.14.1
12	(Electromigration resistance)	IPC-B-25 Test coupon Humidity Chamber	Telcordia GR-78-CORE, Issue 1, 13.1.5
13	(Cross-compatibility matrix)	IPC-B-25 Test coupon Humidity Chamber	HP Flux ECM Test Method EL-EN861-00
14	(Viscosity)	Viscosity Meter	JIS-Z-3284---Annex 6
15	(Tack)	Tack Tester	JIS-Z-3284---Annex 9
16	Slump	Printer and Oven	JIS-Z-3284---Annex 7,8
17	Solder ball test	Ceramic Plate and Heat Plate	IPC-TM-650 Method 2.4.43
18	Spread Test	Copper Plate and Heat Plate	JIS-Z-3197 , 6.10
19	Cross Section	SEM	Newly Established Standard
20	Component Shear and IC Pull test		Newly Established Standard
21	Thermal cycling test	Thermal cycling test Chamber	Newly Established Standard

【2】、Test Items and Results

(1)、Alloy Composition impurity analysis---(Test method)

a. Scope: To verify the ratio of alloy composition and impurity is conformed to the specification of standards.

b. Standards: **J-STD-006A**

c. Instruments: Spark Analyzer (as photo shown below)

d. Test Procedures:

(1) Take specimen approx. 250gm from solder paste, and clean the flux with solvent.
(2) Heat up the powder until it becomes nugget form
(3) Take the tin nugget as specimen and place onto Spark Spectrometer.
(4) Alloy composition report will be automatically printed out in about 30 seconds.

e. Determination: The ratio of alloy composition and impurity is required to conform to J-STD-006A standard specification.

SPARK Analyzer SPECTROMETER

SHENMAO TECHNOLOGY INC.

.

(1)、Alloy Composition impurity analysis ---(Results)

Sample / Metal Element	PF606-P
Sn	**96.39**
Ag	**3.014**
Cu	**0.542**
Ni	0.0007
Ge	0.0020
Fe	0.0016
Al	0.0003
Cd	0.0006
Sb	0.0227
As	0.0001
In	0.0025
Bi	0.0058
Zn	0.0011
Pb	**0.0160**

Program: SN-01 2004/03/08 04:46:02 PM
Comment: SN-ORIENTATION 10434/98
Single spark(s) Elements: Concentration

Sample No: SHENMAO Quality:
Sample Id: PF606-P

No	Sn	Sb	Cu	Bi	Zn	Fe	Al	Cd
	%	%	%	%	%	%	%	%
1	96.39	0.0227	0.542	0.0058	0.0011	0.0016	0.0003	0.0006

No	Ag	As	In	Ni	Pb	Ge
	%	%	%	%	%	%
1	3.014	<0.0001	0.0025	0.0007	0.0160	0.0020

(PF606-P)

.

(2)、 Particle Size and Shape ---(Test Method)

a. Scope: Well-rounded solder powder and well-distributed particle size would help.

b. Standards: **J-STD-005 3.3 Solder Powder Particle Size**
IPC-TM-650 2.2.14

c. Contents: As Table 4 & 5

(Table 4): % of Sample by Weight –Nominal Sizes

	Less Than 1% Larger Than	80% Minimum Between	10% Maximum Less Than
Type 1	150 µm	150-75 µm	20 µm
Type 2	75 µm	75-45 µm	20 µm
Type 3	45 µm	45-25 µm	20 µm

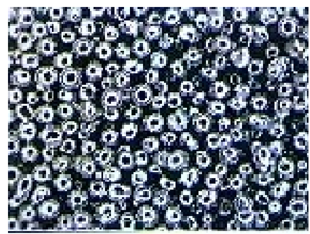
(Table 5): % of Sample by Weight-Nominal Sizes

	Less Than 1% Larger Than	90% Minimum Between	10% Maximum Less Than
Type 4	38 µm	38-20 µm	20 µm

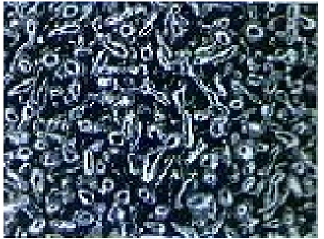
d. Measuring Device: 3D Vision Measuring System

e. Testing Method: Examine the appearance of solder powder by microscope. Randomly choose and measure solder powders' size and sphericality. Determine the particle size distribution.

Notes: This test is to make sure whether solder particle size distribution is of type 3 or type 4. Figures below indicate particle shapes.



Well-Rounded Shape

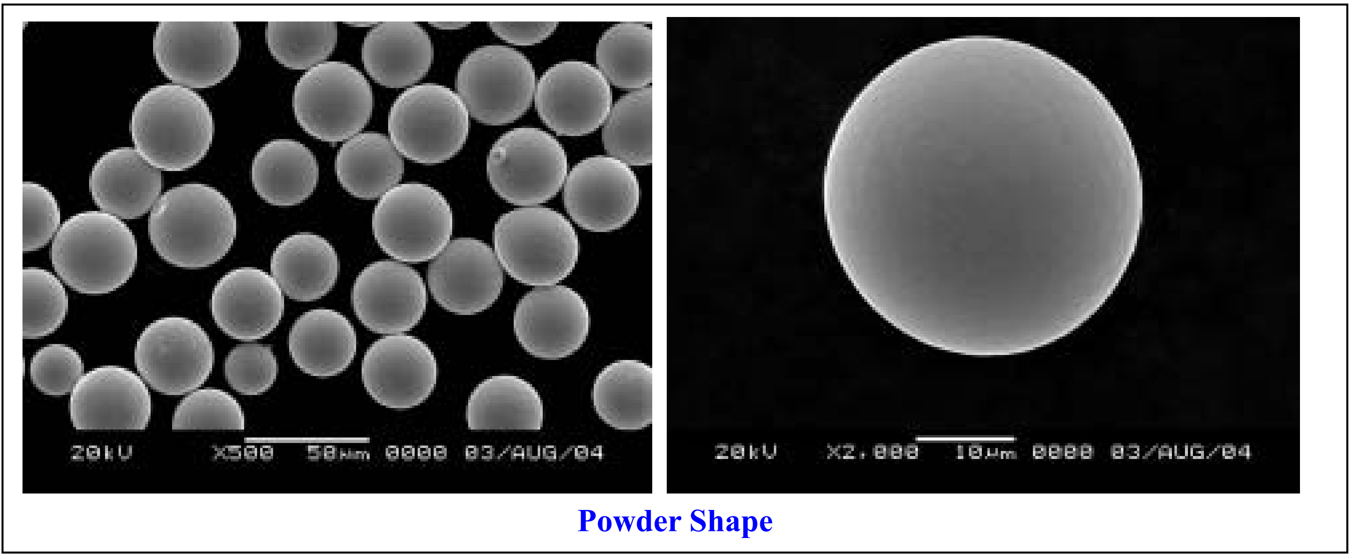


Irregular Shape

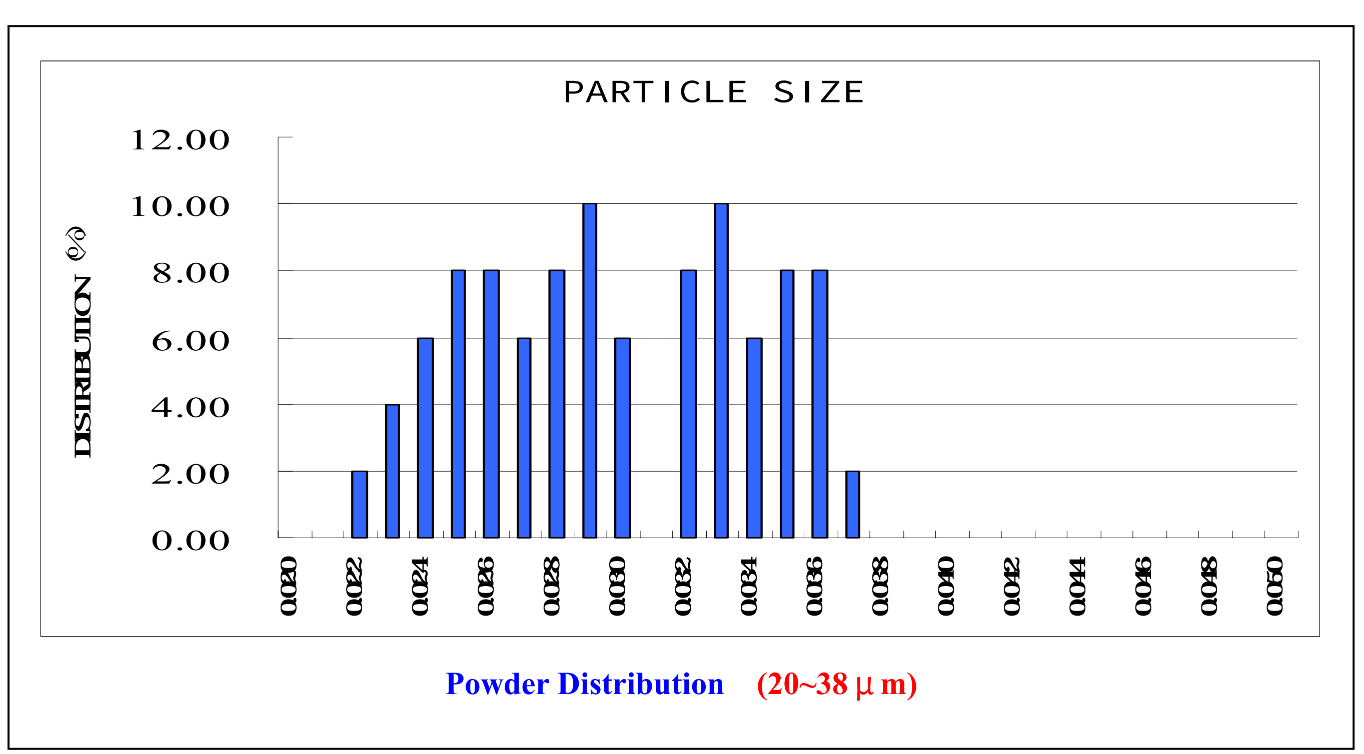
.

(2)、 Particle Size and Shape ---(Results)

Sample	PF606-P
Size Distribution	20~38 μ m
Shape	SPHERE



Powder Shape



Powder Distribution (20~38 μ m)

(3)、Oxide ---(Test Method)

a. Scope: The percent of metal oxide for the powder by mass shall be less than 0.15% to be measured as follows by vendor at powder manufacturing site for each lot.

b. Standards: **HP Test Method, Section 10.**

c. Instruments:

▒ Heat Plate Should be capable to heat to 370-400℃.

d. Test Method:

(1). Weigh a clean beaker to the nearest milligram. Add 25-30g solder powder weighed to the nearest milligram. Note the added weight of the powder.

(2). Add to the beaker sufficient stearic acid or other fluxing material capable of removing all metal oxide.

(3). Place sample on a hot plate between 370-400℃.

(4). After the powder totally melted, remove from the hotplate and allow sample to solidity.

(5). After sample cooled, remove the metal cap from the solution and clean with isopropyl alcohol. Allow alcohol to evaporate and weight solder to the nearest milligram. Note this value as the weight of the solder.

e. Calculation:

$$\%\ \text{metal oxide} = \frac{\text{weight of solder}}{\text{weight of powder}} \times 100$$

f. Evaluation Method: The percent of metal oxide for the powder by mass shall be less than 0.15%.

(3)、Oxide ---(Results)

Item \ Sample	Sample 1 PF606-P
Powder weight(g)	29.8362
Solder weight (g)	29.8168
Metal oxide (%)	99.93
Mass loss (%)	**0.07**

.

(4)、 Halide Content ---(Test Method)

a. Scope: This test method is designed to determine the halide content of fluxes attributable to chlorides and bromides. A sample of flux or flux extract is tritrated to an end-point and the percentage chloride is calculated.

b. Standards: **IPC-TM-650 No.2.3.35**

c. Instruments:

▧ Hot plate with magnetic stirrer.

▧ Pipet、Buret、100 ml beakers, Pyrex125 ml separatory funnel 125 ml Erlenmeyer flasks 1000 ml volumetric flasks.

▧ Reagents: 0.02 N $AgNO_3$、1M NaOH、0.2 M HNO_3、1M K_2CrO_4、0.03 M phenolphthalein solution (Reagent Grade)、Chloroform (Reagent Grade)、Deionized water.

d. Testing Method:

◎ **For Rosin/Resin Fluxes:**

(1). In a tared 100 ml beaker, accurately weigh about 3-5 g of flux sample on an analytical balance.

(2). Quantitatively transfer the flux sample to a 125 ml separatory funnel using three 10 ml aliquots of chloroform.

(3). Add 15 ml of deionized water to the funnel and shake the funnel for 10 seconds.

(4). Allow the funnel to stand until the layers completely separate.

(5). Draw off the bottom (chloroform) layer into a beaker and save for the next extraction.

(6). Transfer the top (water) layer to a 125 ml Erlenmeyer flask.

(7). Transfer the chloroform layer from the beaker to the funnel and repeat the extraction with 15 ml of water two more times, each time adding the water extract portion to the flask.

(8). Heat the water extract in the Erlenmeyer flask using a steam bath to expel any chloroform which may be present.

(9). Do not heat above 80°C. Allow for solution to cool to room temperature.

(10). Add 2 drops of 0.03 M phenolphthalein solution to the Erlenmeyer flask.

(11). Add 1 M sodium hydroxide until the solution turns red. Add 0.2 M nitric acid dropwise until the red color is just completely discharged.

(12). Dilute to about 60 ml with deionized water.

(13). Add 6 drops of 1 M potassium chromate and titrate with standardized 0.02 N silver nitrate to the red-brown end point.

e. Calculation:

$$\text{Halides, as \% chlorides} = \frac{3.55VN \times 100}{mS} \times 100$$

Where:

V is the volume of 0.02 N $AgNO_3$ in ml.
N is the normality of $AgNO_3$ solution.
m is the mass (weight) of flux sample in gram.
S is the percentage of solids (non-volatiles) of the flux.

f. Evaluation Method: Combined halides content (Cl) for non-clean materials < 0.5%.

Surface Organic Contaminant Detection Test ---(Test Method)

a. Scope: This test method is for use in determining if organic, non-ionic contaminants are present on bare printed wiring board, and completed assembly surfaces in the production area by limited technical personnel.

b. Standards: **IPC-TM-650 No.2.3.38**

c. Instruments:
- The test fluid: High Pressure Liquid Chromatography (HPLC) grade acetonitrile.
- Microscope slides, 25 mm x 75 mm, glass.
- Disposable glass medicine dropper with rubber squeeze bulb.
- 60 ml capacity rubber squeeze bulb fitted with glass medicine dropper tube.
- Lint free gloves.

d. Testing Method:

(1). Pre-clean microscope slide by rinsing the slide with test fluid, Evaporate the test fluid with a gentle stream of dry in a well-ventilated fume hood. Rapid evaporation of the test fluid must be avoided, to prevent evaporative cooling of the glass slide and subsequent moisture condensation from the air onto the slide.

(2). Hold the test specimen by the edges at an angle above the pre-cleaned microscope slide. The specimen should not touch the slide.

(3). Slowly drip 0.25 to 0.50 ml of test fluid onto the test specimen, allowing it to wash across a small area of the surface of the specimen and drip onto the microscope slide. Do not allow medicine dropper to touch test specimen. See Figure 1.

(4). Repeat until 3 ± 5ml of test fluid washings per10cm^2 of washed specimen surface area have been accumulated on the slide.

(5). Make a control slide.

e. Evaluation Method: Hold the test slide on the edges and tilt so over-head incident light is reflected from the surface. The residues (if present) washed from the test specimen will be readily visible.

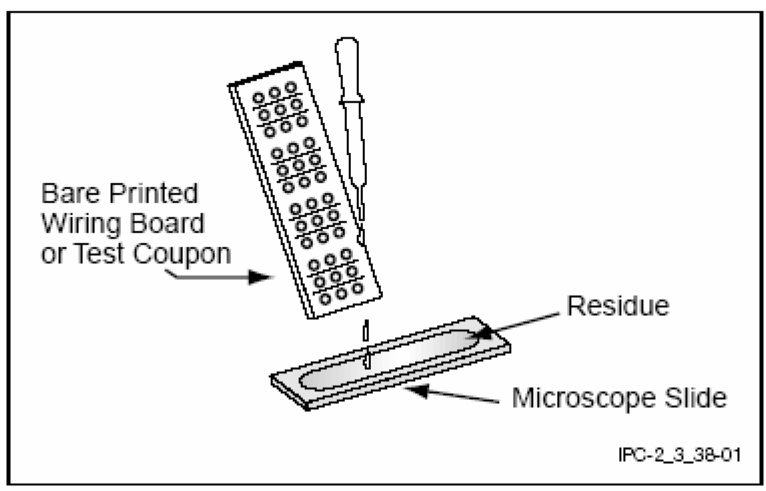


Figure 1 Contaminant Collection on Microscope Slide

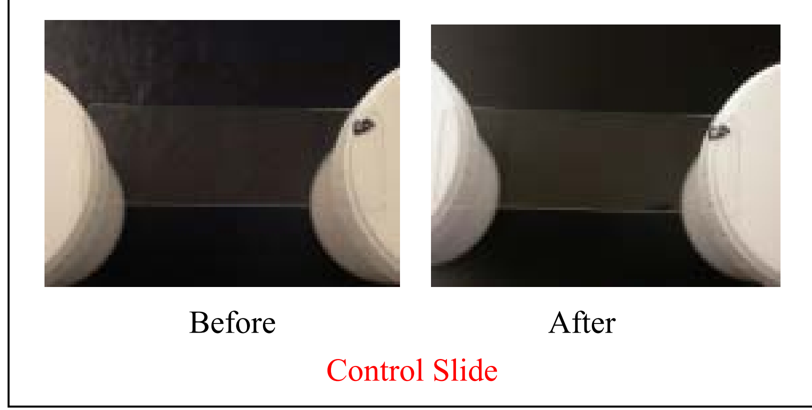
.

(4)、Halide Content ---(Results)(IPC-TM-650, 2.3.35)

Item \ Sample	Sample 1
Flux Weight(g)	4.517
0.02 N $AgNO_3$ (ml) (Factor = 0.9564)	4.00
Chloride Content(%)	**0.06**

Surface Organic Contaminant Detection Test ---(Results)(IPC-TM-650, 2.3.38)

Item \ Sample	Control Slide	SHENMAO PF606-P
Results	**PASS**	**PASS**



Before After

Control Slide

Before After

SHENMAO PF606-P

(5)、Presence of Halides in Flux, Silver Chromate Method ---(Test Method)

a. Scope: This test method is designed to determine the presence (if any) of chlorides and bromides in soldering flux by visual examination after placement on test paper.

b. Standards: **IPC-TM-650 No.2.3.33**

c. Instruments:

- Silver chromate test paper 51 mm x 51 mm
- 2-Propanol(reagent grade).

d. Testing Method:

(1). Clean a glass microscope slide with 2-propanol and air dry.

(2). Moisten a piece of silver chromate reagent paper of suitable size with deionized water.

(3). Apply the wet paper to the glass slide and remove the excess water with blotting paper.

(4). Using a spatula, apply a thin coating of the paste flux or solder paste flux directly to the moist reagent paper.

(5). Allow the paste flux or solder paste flux to remain in contact with the paper for 1 minute, then remove the flux with 2-propanol without disturbing the paper.

e. Evaluation Method : Carefully examine each test sheet for possible color change. A change to off-white or yellow-white indicates the presence of chlorides or bromides. See Figure 1.

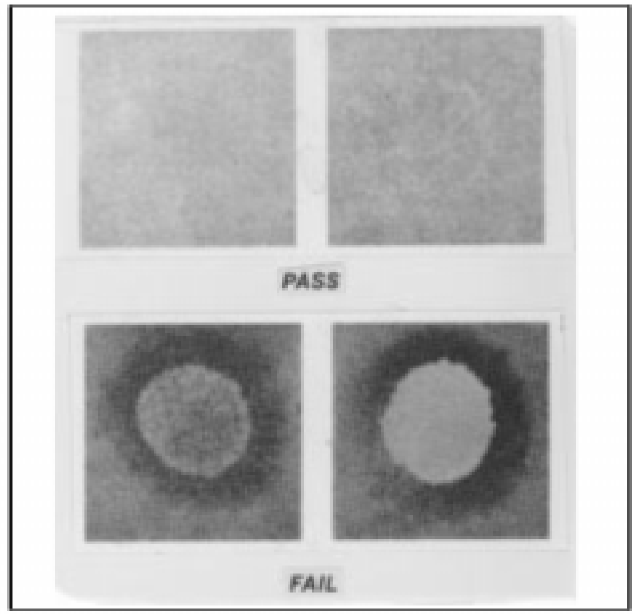
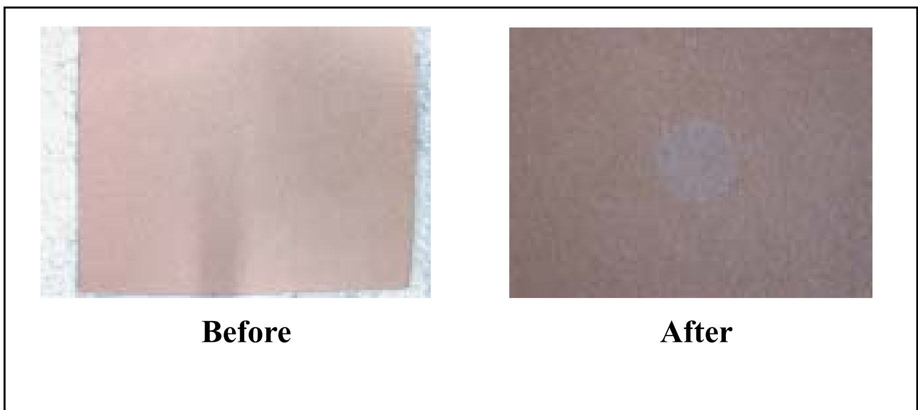


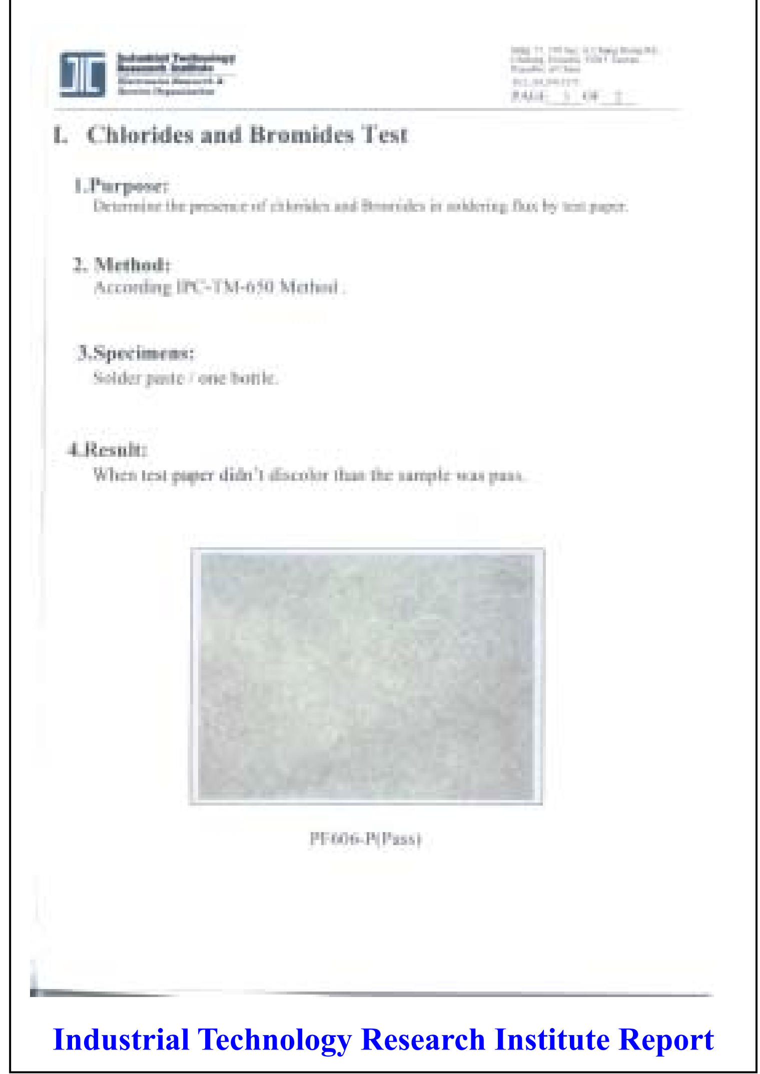
Figure 1 Chlorides and/or bromides test results

(5)、Presence of Halides in Flux, Silver Chromate Method ---(Results)

Item \ Sample	Sample 1
Results	PASS



Before　　　　After



I. Chloridesand Bromides Test

1.Purpose:
Determine the presence of chlorides and Bromides in soldering flux by test paper.

2. Method:
According IPC-TM-650 Method .

3.Specimens:
Solder paste / one bottle.

4.Result:
When test paper didn't discolor than the sample was pass.

PF606-P(Pass)

Industrial Technology Research Institute Report

(6)、Fluorides by Spot Test ---(Test Method)

a. Scope: This test method is designed to determine the presence (if any) of fluoride(s) in soldering flux by visual examination after placement of a drop of liquid test flux in a zirconium-alizarin purple lake.

b. Standards: **IPC-TM-650 No.2.3.35.1**

c. Instruments:

▩ White spot plate.
▩ Glass rods.
▩ Glass rods.
▩ Reagents: Zirconium nitrate solution、Sodium alizarin sulfate solution

d. Testing Method:

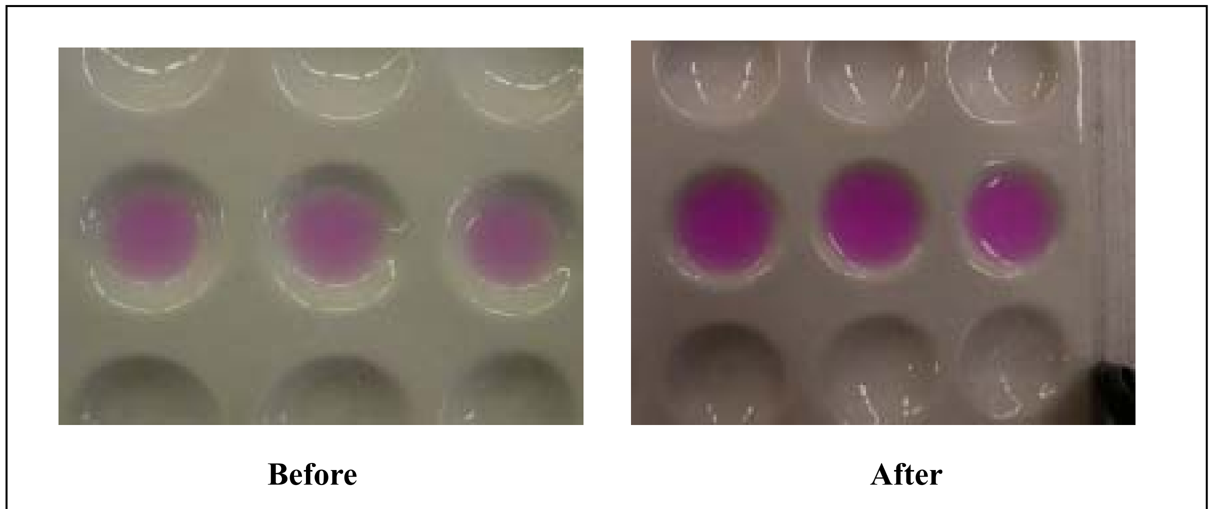
(1). Prepare a fresh zirconium - alizarin purple lake in three spots of the white spot plate by adding 1 drop each of zirconium nitrate and sodium alizarin sulfate solutions.
(2). Add one drop of the test flux to each of the spots.
(3). Mix each spot with a clean glass rod.
(4). Examine for any color change.

e. Evaluation Method: A change in color of the lake from purple to yellow is an indication of the presence of fluoride(s).

.

(6)、Fluorides by Spot Test ---(Results)

Sample / Item	Sample 1
Results	**PASS**



Before **After**

(7)、Flux induced corrosion, copper mirror method---(Test Method)

a. Scope: This test method is designed to determine the removal effect the flux has (if any) on the bright copper mirror film which has been vacuum deposited on clear glass.

b. Standard: **IPC-TM-650 (2.3.32)**

c. Test Method:

(1). Place the copper mirror test panel on a flat surface, mirror side up, and protect from dust and dirt at all times.

(2). Place one drop of test flux or extract to be tested (approximately 0.05 ml) on each copper mirror test panel. Do not allow the dropper to touch the test panel.

(3). Solder-paste shall be applied directly to the mirror without scratching the copper mirror, with a volume approximating a 0.5 mm thickness and 8 mm diameter. (It has been determined that significant variations from this quantity have little effect for most materials.)

(4). Immediately also place one drop of the control standard flux adjacent to the test flux. Do not allow drops to touch.

(5). Place test panels in a horizontal position in the dust free cabinet at 23 ± 2°C and 50 ± 5% relative humidity for 24 ± 1/2 hours. At the end of the 24 hour period, remove the test panels and remove the test flux and control standard fluxes by immersion in clean 2-propanol.

d. Evaluation:

(1). Carefully examine each test panel for possible copper removal or discoloration.

(2). If there is any complete removal of the copper film as evidenced by the background showing through the glass, the test flux has failed the L category. Complete removal of the copper only around the perimeter of the drop defines the flux as M. Complete removal of the copper places the flux in the H category. (See Figure 1).

(3). Discoloration of the copper film due to a superficial reaction or only a partial reduction of the copper film thickness is not considered a failure.

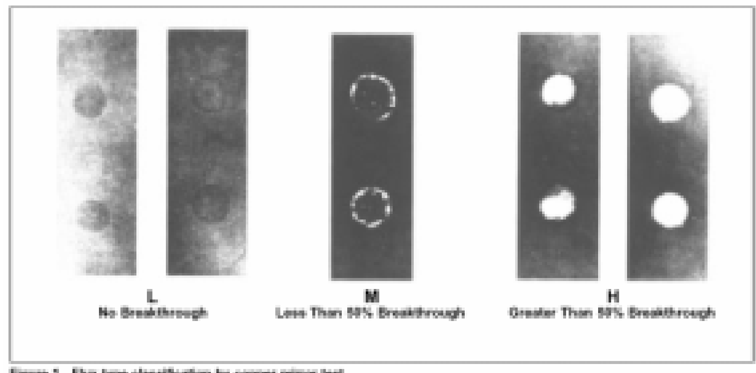


Figure 1 Flux type classification by copper mirror test

.

(7)、Flux induced corrosion, copper mirror method---(Result)

Item \ Sample	Sample 1
Results	**PASS**

PAGE 3 OF 3

II. Copper Mirror Test

1.Subject:
Copper Mirror Test.

2. Standard:
Copper Mirror Method, IPC-TM-650 Method 2.3.32.

3. Speciments :
Solder paste / one bottle.

4.Result:
Copper film was not removed copper showed that this test is pass.

PF606-P(Pass)

Industrial Technology Research Institute Report

(8)、Corrosion ---(Test Method)

a. Scope: This test method is designed to determine the corrosive properties of flux residues under extreme environmental conditions. The solder is then exposed to prescribed conditions of humidity and the resulting corrosion.

b. Standards: **IPC-TM-650 No.2.6.15**

c. Instruments:

- Hot plate.
- Humidity chamber capable of achieving 50 ±2°C and 95 ± 2% relative humidity.
- Microscope having 20X minimum.
- Copper plate : 51 x 51 x 0.50 ± 0.05 mm
- Chemicals: Ammonium persulphate (25% m/v in 0.5% v/v sulfuric acid)、Sulfuric acid (5% v/v)、Degreasing agent: Acetone、Deionized water.

d. Testing Method:

(1). Pre-treating Test Panels: Immediately before performing test, pretreat as follows using clean tongs for handling.

[1.1] Degrease with a suitable neutral organic solvent such as acetone, toluene, or petroleum ether.

[1.2] Immerse in 5% sulfuric acid (by volume) at 65 ±5°C for 1minute to remove the tarnish film.

[1.3] Immerse in a solution of 25% m/v ammonium persulphate (0.5% v/v sulfuric acid) at 23±2°C for 1 minute to etch the surface uniformly.

[1.4] Wash in running tap water for a maximum of 5 seconds.

[1.5] Immerse in 5% sulfuric acid (by volume) at 23 ±2°C for 1minute.

[1.6] Wash for 5 seconds in running tap water, then rinse thoroughly in demineralized water.

[1.7] Rinse with acetone.

[1.8] Allow to dry in clean air.

(2). Weigh 1.00 gram ±0.05 gram specimen of solder for each test and place in center of depression of each test panel.

(3). Heat solder pot so that solder bath stabilizes at 245 ±5°C.

(4). Carefully examine test specimen at 20X magnification for subsequent comparison after humidity exposure. Record observations, especially any discoloration.

(5). Preset humidity chamber to 40 ±1°C and 93 ±2% relative humidity.

(6). Suspend each test specimen vertically.

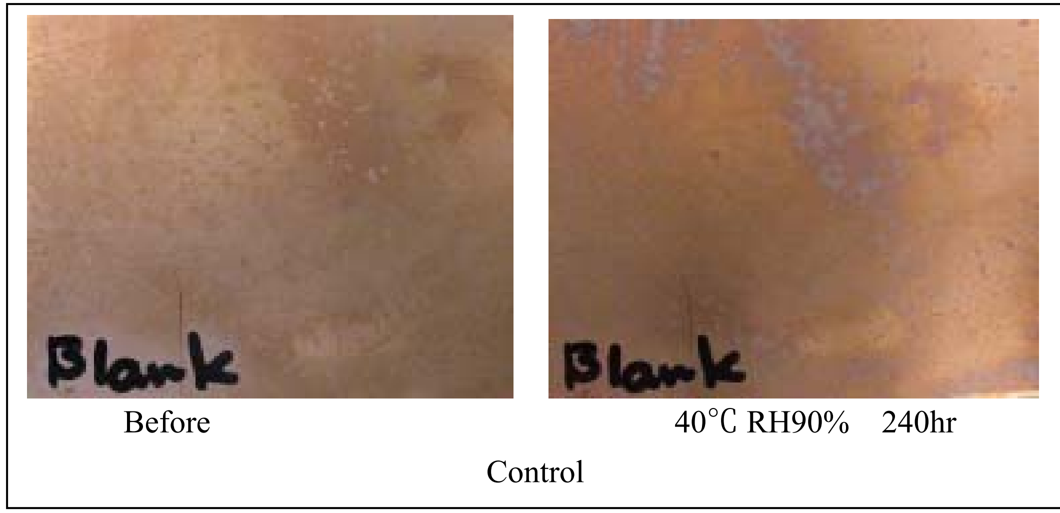
(7). Expose specimens to the above environment for 240 hours (10 days).

e. Evaluation Method: Carefully examine specimens prior to placing them in the environmental chamber. Note any discoloration.

.

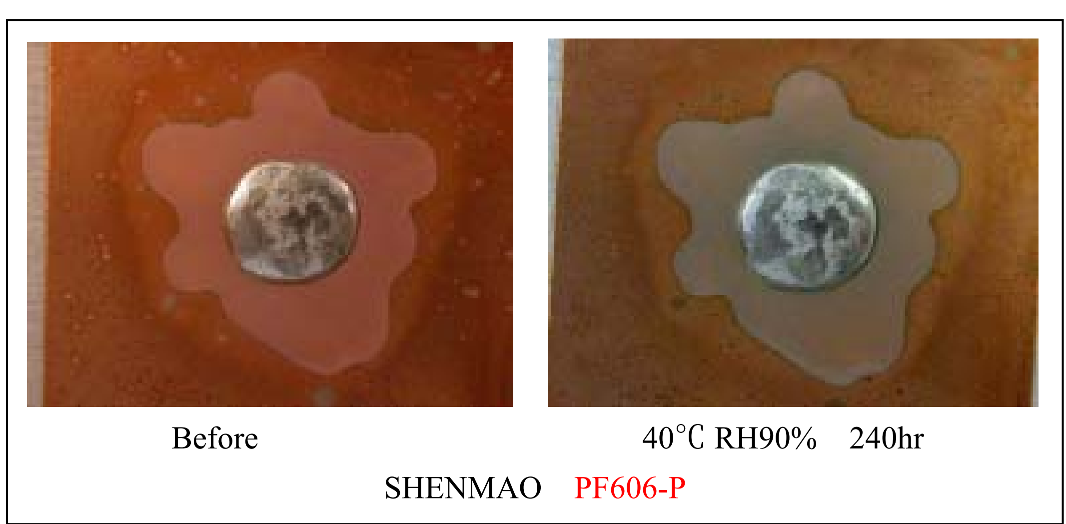
(8)、Corrosion ---(Results)

Item \ Sample	Sample 1
Results	**PASS**



Before 40°C RH90% 240hr

Control



Before 40°C RH90% 240hr

SHENMAO PF606-P

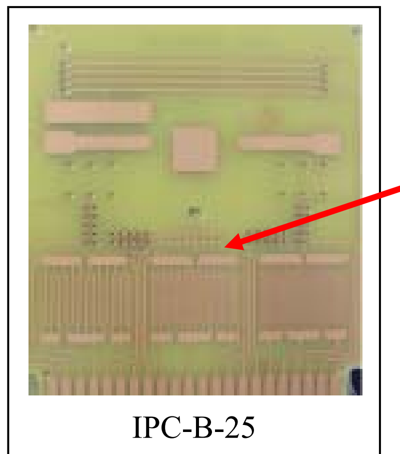
(9)、Surface Insulation Resistance ---(Test Method)

a. Scope: This test method is to characterize fluxes by determining the degradation of electrical insulation resistance of rigid printed wiring board specimens after exposure to the specified flux. This test is carried out at high humidity and heat.

b. Standards: **IPC-TM-650 No.2.6.3.3**

c. Instruments:

- IPC-B-25 Surface Insulation Resistance Test Board, using "B" Pattern
- A clean test chamber capable of programming and recording an environment of 25 +10/-2°C to at least 85 ±2°C and 85% ±2% relative humidity.
- A power supply capable of producing a standing bias potential of 45–50 volts DC with a tolerance of ±10%.
- A resistance meter capable of reading high resistance (10^{12}ohms) with a test voltage of 100 volts or an ammeter capable of reading 10^{-10} amps in combination with 100 volts DC power supply.
- Three 2000 ml beakers
- Exhaust ventilation hood.
- Metal tongs.
- Soft bristle brush
- Deionized or distilled water.
- Drying oven capable of maintaining at least 50°C.
- 2-propanol.



IPC-B-25

d. Testing Method:

◎ **For Solder Paste:**

(1). Clean the test coupon with deionized or distilled water and scrub with a soft bristle brush for a minimum of 30 seconds. Spray rinse thoroughly with deionized or distilled water.Rinse cleaned area thoroughly with fresh 2-propanol. An alternative cleaning method is to place the test coupon in an ionic contamination tester containing 75% 2-propanol, 25% deionized water and process the solution until all ionics have been removed. During the remainder of the specimen preparation, handle test specimens by the edges only, or use non-contaminating rubber gloves.

(2). There shall be 3 test coupons for each solder paste to be tested in the cleaned state (see Table 1).

(3). Solder Paste Stencil print the solder paste on to the comb pattern using a 0.2 mm thick stencil (the IPC-B-25 artwork contains the stencil design).

(4). The samples shall be run through a reflow soldering process using the temperature profile recommended by the vendor.

(5). Place the specimens in the environmental chamber in a vertical position such that the air flow is parallel to the direction of the board in the chamber. Set the chamber temperature at 85±2°C and humidity at 85% ±2%RH.

(6). Connect the 45–50v DC voltage source to the specimen test points to apply the bias voltage to all specimens.

(7). Measurements shall be made with test specimens in the chamber under the test conditions of temperature and humidity at 24, 96 and 168 hours. To take these measurements, the 45 - 50v DC bias voltage source must be removed from the test specimen and a test voltage of -100v DC shall be applied. (Test voltage polarity is opposite the bias polarity.)

Table 1. Coupons for SIR Testing

Sample Group	Flux/Solder	Clean	Number of Coupons
A	Yes	Yes	3
B	Yes	No	3
C	Yes	No	3
D	Yes	Yes	3
E	**Yes**	**No**	**3**
F	**No**	**No**	**2**

A = Pattern down/clean
B = Pattern down/no clean
C = Pattern up/no clean
D = Solder paste/reflow/clean
E = Solder paste/reflow/no clean
F = Control (precleaned, unprocessed)

e. Evaluation Method: No-clean solder paste resistance measurements must be great than 1.0 x $10^8 \Omega$, if resistance drops below 1.0 x$10^8 \Omega$ and is completely reversible when moisture is removed, it is not considered a failure. If a resistance drop reaches $10^6 \Omega$ at anytime during the test, it is a failure.

(9)、 Surface Insulation Resistance ---(Results)

Raw results from SIR /Log (Ω)

Brand	Cable No.		Environmental (85 ℃,85 %)		
	Blue	Red	24 hr	96 hr	168 hr
SHENMAO PF606-P	1	1	5.46×10^{9}	7.88×10^{9}	8.69×10^{9}
	1	2	5.32×10^{9}	3.24×10^{9}	5.35×10^{9}
	2	2	2.46×10^{9}	3.34×10^{9}	5.39×10^{9}
	2	3	3.66×10^{9}	6.49×10^{9}	5.42×10^{9}
SHENMAO PF606-P	3	4	5.01×10^{9}	8.62×10^{9}	1.02×10^{10}
	3	5	2.53×10^{9}	4.74×10^{9}	4.41×10^{9}
	4	5	2.49×10^{9}	4.70×10^{9}	4.40×10^{9}
	4	6	4.90×10^{9}	8.16×10^{9}	9.25×10^{9}
SHENMAO PF606-P	5	7	3.21×10^{9}	5.15×10^{9}	5.88×10^{9}
	5	8	1.36×10^{9}	2.04×10^{9}	2.09×10^{9}
	6	8	1.33×10^{9}	2.08×10^{9}	2.09×10^{9}
	6	9	2.93×10^{9}	5.39×10^{9}	4.26×10^{9}
Control (unprocessed)	7	10	1.00×10^{10}	1.04×10^{10}	9.53×10^{9}
	7	11	8.78×10^{9}	1.06×10^{10}	2.15×10^{9}
	8	11	9.01×10^{9}	9.36×10^{9}	8.35×10^{9}
	8	12	1.14×10^{10}	1.03×10^{10}	9.53×10^{9}
Control (precleaned)	9	13	1.11×10^{10}	9.87×10^{9}	9.26×10^{9}
	9	14	9.89×10^{9}	9.06×10^{9}	1.16×10^{10}
	10	14	1.00×10^{10}	9.48×10^{9}	1.25×10^{10}
	10	15	6.56×10^{9}	6.20×10^{9}	7.21×10^{9}

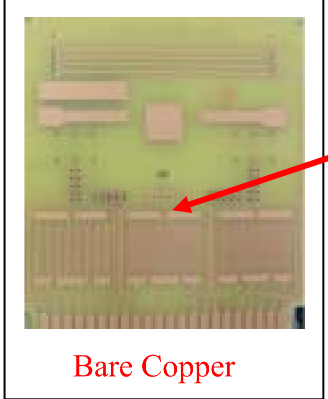
(10)、Electrochemical Migration Resistance ---(Test Method)

a. Scope: This document describes Hewlett-Packard Company's (HP's) electrochemical migration (ECM) test method for electronics-grade fluxes. This method must be employed when qualifying flux materials for use in HP products manufactured internally or externally.

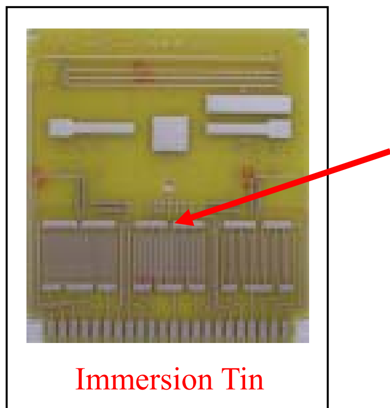
b. Standards: **HP Flux ECM Test Method EL-EN861-00**

c. Instruments:

- Chamber
- Power supply
- Resistance meter capable of reading and recording high resistance ($10^{12}\Omega$) with a test voltage of 5 volts or an ammeter capable of reading 10^{-10} amps in combination with 5 volts DC power supply. Continuous monitoring should be done using a chart recorder, event detector, or rapid scanning SIR meter and appropriate data acquisition software.
- Solder pastes and paste fluxes require a reflow oven profiled by using a coupon, thermocoupled on the top side with a high temperature solder or a thermally conductive epoxy, to adjust the reflow oven to the vendor recommended reflow profile. Profiling coupons may not be used as test specimens.
- Liquid fluxes require a wave solder machine profiled by using a coupon, thermocoupled on the top side with a high temperature solder or a thermally conductive epoxy, to adjust the preheat zones such the coupon is exposed to the vendor recommended thermal profile. Profiling coupons may not be used as test specimens.
- Pen fluxes and cored wire require a calibrated soldering iron rated to at least 60W, and capable of producing tip temperatures of at least 480°C.
- 2-propanol (isopropyl alcohol, IPA, isopropanol)
- Deionized water
- Stiff-bristle, non-contaminating, plastic brush
- Exhaust ventilation hood
- Drying oven capable of maintaining 45°C to 50°C



Bare Copper



Immersion Tin

d. Testing Method:

(1). Cleaning

Gloves should be worn from this point on whenever the coupons are handled.

Soak the coupons for a minimum of five minutes in a solution of 75% 2-propanol and 25% DI water. Brush the coupons, using a stiff-bristle, non-contaminating, plastic brush, parallel to the comb pattern for one minute. The brush may be dipped in the soaking solution to aid in the removal of debris. Rinse the coupons in 100% 2-propanol and dry them in a clean oven at 45°C to 50°C for 1 hour. During the remainder of the test, only handle specimens by the edges while wearing non-contaminating gloves.

(2). Solder paste and paste fluxes should be screened onto the comb pattern using a 6 mil or 150 µm stencil.

(3). Single-sided reflow specimens must be exposed to one reflow with combs face up. Double-sided reflow specimens must be exposed to one reflow with the combs face up. Then solder paste must be applied to the second side and exposed to another reflow with the newly applied solder paste on the combs face up.

(4). Fluxed coupon inspection

After fluxing (and activation, if required), visually inspect all combs with a microscope (10 to 50X magnification) and test with an ohmmeter to verify that the patterns are free of shorts. Discard any combs with bridging of conductors.

(5). Wiring

The coupons should be vertically placed in the sample trays that will go into the chamber. It is best to have the card edge on the side so that when the wires are being soldered, the soldering iron is not above the comb pattern.

The specimens need to be wired as follows:

- Individual wires from a ribbon cable should be attached to each coupon.
- Use water white rosin to solder Teflon insulated wires to the connection points of the specimens. Do not attempt to remove the flux residues.
- A bus wire should be used to connect all of the ground wires on the coupons.
- A list should be kept detailing the coupon identity, flux, activation method and channel number.
- The comb pattern should be covered during all soldering processes to ensure that the pattern is not contaminated by flux spatter.

(6). Chamber thermal stabilization

Set the chamber temperature for rosin fluxes to 50°C at 20%RH and allow it to stabilize for 3 hours.

(7). Chamber humidity stabilization

Slowly ramp the chamber to 90%RH over a minimum of 15 minutes. Allow the specimens to come to equilibrium for at least 8 hours before applying the bias voltage to begin the test.

(8). Measurements

Once the temperature and humidity stabilize, connect the 5 volt DC bias to all specimens and begin continuous monitoring. Resistance measurements must be made with test specimens in the chamber under the test conditions without removing the bias.

(9). Ramp down

After the samples have been exposed and monitored for 28 days, slowly ramp the chamber to 20%RH over a minimum of 15 minutes. Ramp down temperature and remove specimens for evaluation.

e. Evaluation

(1). Resistance measurements

Each comb pattern on each test specimen shall be evaluated by the resistance obtained (over the duration of the test). If the control coupon readings are less than 1000 M., a new set of test coupons must be obtained and the entire test repeated. All resistance readings shall stabilize above 100 M. and less than two decades below the control. The reading in the first part of the test may fall below 100 M. provided it recovers by 96 hours, but any reading less than 1 M. is unacceptable. Resistance values shall not degrade by more than one decade at any time between start of test (after temperature/humidity stabilizes) and the end of the test.

(2). Inspection

Within 24 hours of completing the test, all specimens shall be visually inspected for dendrites and corrosion using a microscope at 30 to 50X. Use a light source under the coupons to identify electrochemical migration, a light above the sample to verify that an issue is a defect as opposed to debris on the pattern, and a polarized light to identify corrosion.

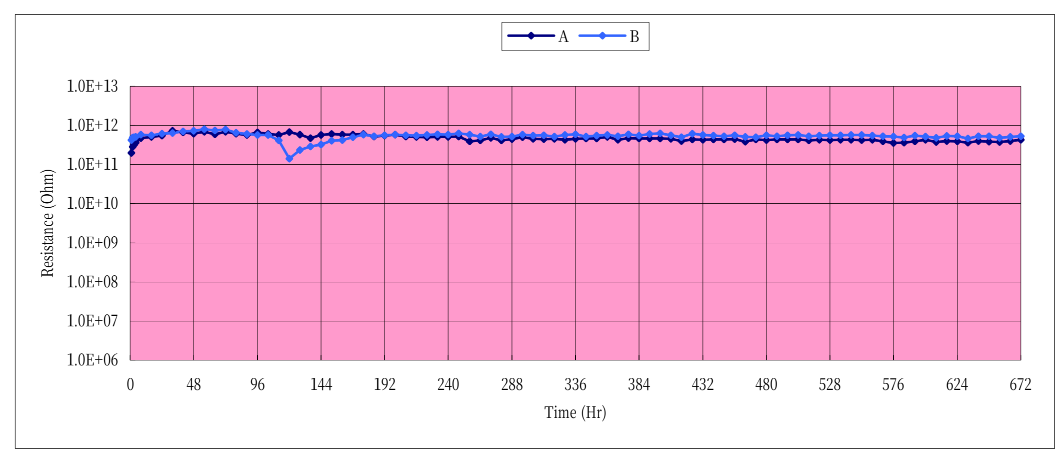
There shall be no visual evidence of metallic dendrites or corrosion that exceeds 20% of the conductor spacing at the end of the test.

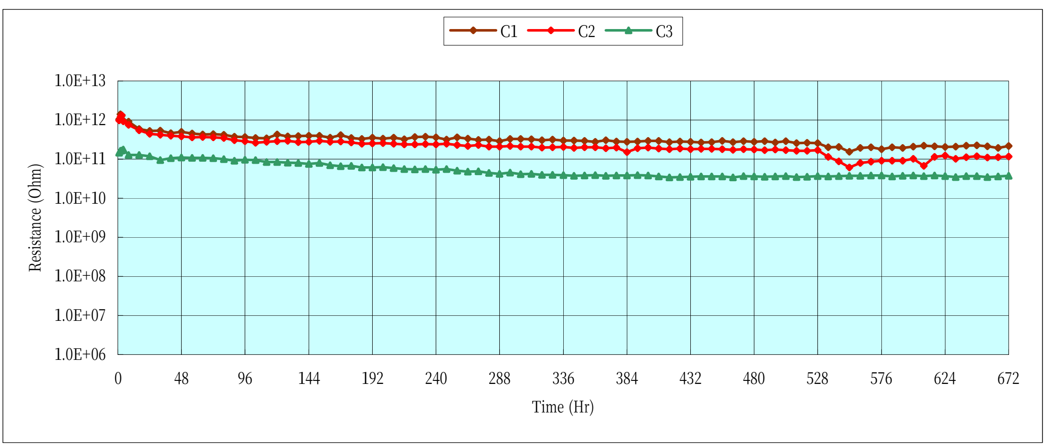
SHENMAO TECHNOLOGY INC.

.

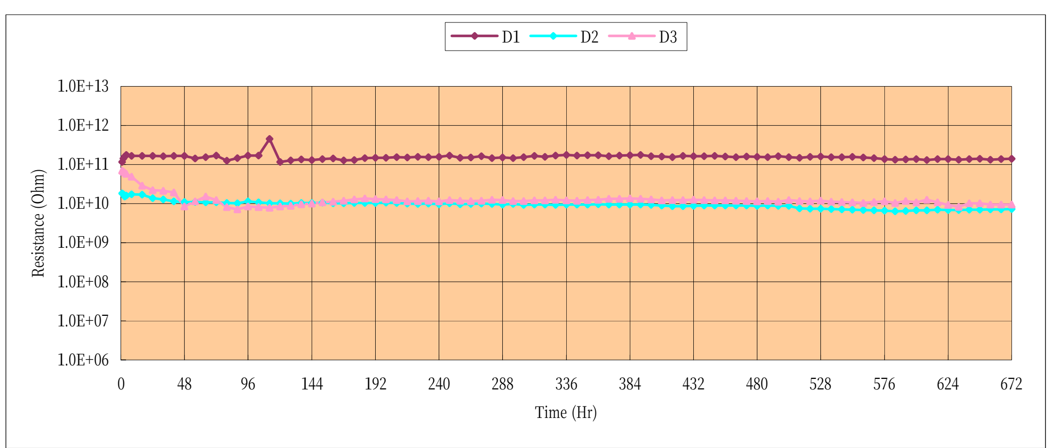
(10)、Electrochemical Migration Resistance ---(Results)

Sample group	Surface Finish	Bare Coupon Cleaned	Test Material	Number of Coupons	Number of Measurments
A (as-received control)	**Bare Copper**	**NO**	**None**	**1**	**1**
B (clean control)	**Bare Copper**	**YES**	**None**	**1**	**1**
C (single-sided reflow)	**Bare Copper**	**YES**	**PF606-P**	**3**	**3**
D (double-sided reflow)	**Bare Copper**	**YES**	**PF606-P**	**3**	**3**
E (as-received control)	**Immersion Tin**	**NO**	**None**	**1**	**1**
F (clean control)	**Immersion Tin**	**YES**	**None**	**1**	**1**
G (single-sided reflow)	**Immersion Tin**	**YES**	**PF606-P**	**3**	**3**
H (double-sided reflow)	**Immersion Tin**	**YES**	**PF606-P**	**3**	**3**

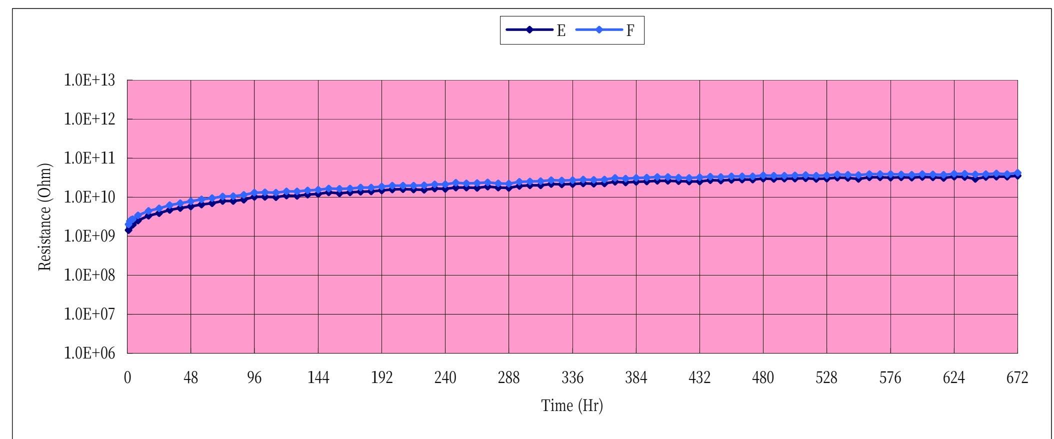




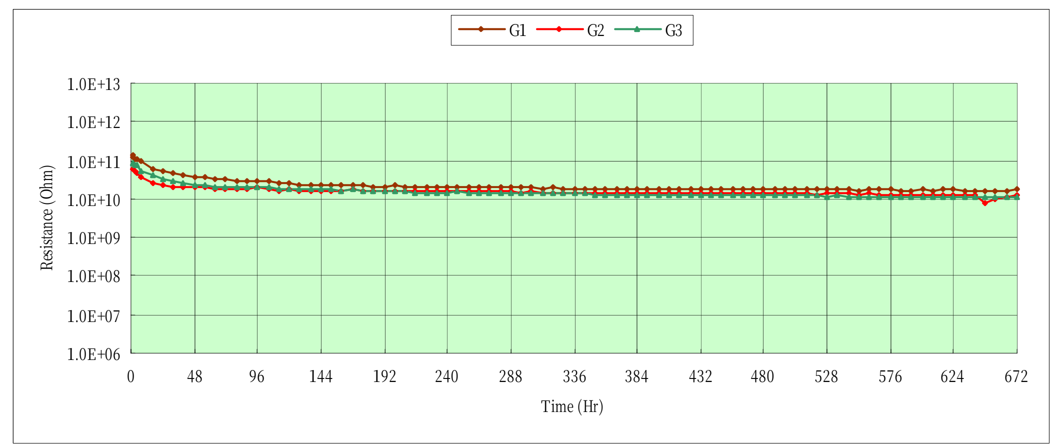
.



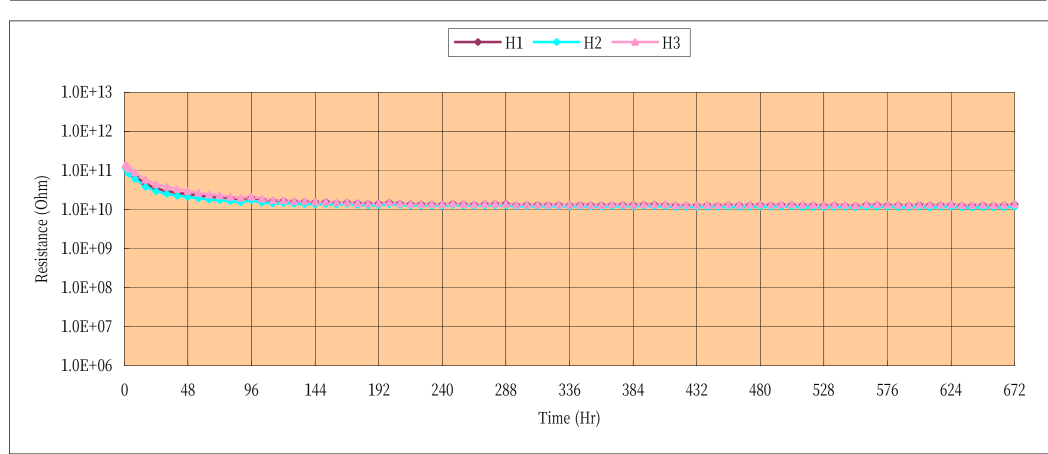
D1
D2
D3
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
Resistance (Ohm)
0 48 96 144 192 240 288 336 384 432 480 528 576 624 672
Time (Hr)



E
F
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
Resistance (Ohm)
0 48 96 144 192 240 288 336 384 432 480 528 576 624 672
Time (Hr)



G1
G2
G3
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
Resistance (Ohm)
0 48 96 144 192 240 288 336 384 432 480 528 576 624 672
Time (Hr)



H1
H2
H3
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
Resistance (Ohm)
0 48 96 144 192 240 288 336 384 432 480 528 576 624 672
Time (Hr)

(11)、Electrochemical Migration Resistance ---(Test Method)

a. Scope: This test method provides a means to assess the propensity for surface electrochemical migration. This test method can be used to assess soldering materials and/or processes.

b. Standards: **IPC-TM-650 No.2.6.14.1**

c. Instruments:

▒ IPC-B-25 Multipurpose Test Board

▒ Conductor line widths and spacings of 0.318 mm [0.01250 in].

▒ A temperature/humidity chamber capable of producing an environment of 65℃± 2°C and 85%± 2%.

▒ High resistance measuring equipment, with a range up to 10^{12}ohm and capable of yielding an accuracy of ± 5% at 10^{10}ohm with an applied potential of 100 VDC (10% tolerance).

▒ Power Supply: Equipment capable of providing 10VDC at 100 μA, with a 10% tolerance.

d. Testing Method:

◎ **For Solder Paste:**

(1). A squeegee or screen printer shall be used with a stencil imaged with the test pattern. It should be noted that the Telcordia GR-78 pattern requires a minimum stencil thickness of 0.20 mm [7.9mil]. Due to the fact that the minimum stencil thickness is often dependent on the pitch or trace width and spacing, a smaller stencil thickness may be used for fine features and shall be agreed upon between the tester and customer for the purpose of this test method. Reflow the printed specimens using convection, infrared, or vapor phase reflow equipment using a reflow profile representative of production. Equivalent methods may be used if such equipment is not available.

(2). Place the rack approximately in the center of the test chamber. Route the wires to the outside of the chamber; dress the wiring away from the test patterns. Ensure that drops of condensation cannot fall on the specimens.

(3). Close the chamber and allow all samples to stabilize or 96 hours at the specific temperature and humidity (65 ± 2°C, RH 88.5 ± 3.5%). After the 96-hour stabilization period, the initial insulation resistance measurements shall be made using voltage in the range of 45VDC to 100 VDC. Due to polarity, measurements should be made between terminals 1 and 2, 3 and 2, 3 and 4, and 5 and 4, at the specific temperature and humidity with the current limiting resistors placed in series with the test circuit. Terminals 2 and 4 shall be at one potential, and terminals 1, 3, and 5 at the opposite potential.

(4). Connect the samples to the power supply with the current limiting resistors placed in series with the test circuit, and apply 10 VDC for the duration of the test. The test polarity shall be the same as the measurement polarity used in section (3).

.

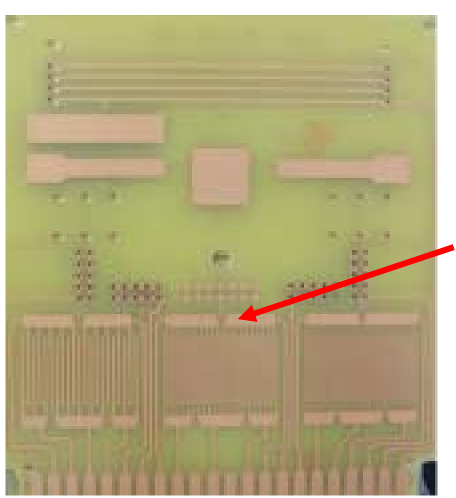
(5). After 500 hours of applied bias (596 hours total), disconnect the power supply and repeat the measurements per section (3) with the specimens under test conditions.

e. Data Handling: The average (geometric mean) insulation resistance (IR_{avg}) is calculated from:

$$IR_{avg} = 10^{\left[\frac{1}{N}\sum_{1}^{N}\log IR_i\right]}$$

where,
N = number of test points (10 minimum),
IRi = individual insulation resistance measurements

Where an assignable cause of low insulation resistance, which is properly attributable to the materials of construction or to the process used to produce the test board, can be found, then such a value can be excluded from calculating the average.



IPC-B-25

(11)、Electrochemical Migration Resistance ---(Results)

Raw results from ECM /Log (Ω)

Initial electromigration results (after 96 hours at test conditions, no bias)		Final electromigration results (after 500 hours at test conditions, 10V DC bias)	
	SHENMAO PF606-P		SHENMAO PF606-P
1	3.43×10^9	1	8.76×10^9
2	6.41×10^9	2	8.56×10^9
3	7.07×10^9	3	8.63×10^9
4	5.05×10^9	4	8.49×10^9
5	4.12×10^9	5	8.90×10^9
6	5.24×10^9	6	8.99×10^9
7	5.29×10^9	7	8.91×10^9
8	1.91×10^9	8	8.78×10^9
9	3.18×10^9	9	8.59×10^9
10	2.18×10^9	10	8.23×10^9
11	2.15×10^9	11	7.98×10^9
12	3.04×10^9	12	8.17×10^9
	Control (Ω)		Control (Ω)
1	9.87×10^9	1	1.15×10^9
2	1.30×10^9	2	7.14×10^9
3	1.36×10^9	3	7.43×10^9
4	3.78×10^8	4	3.84×10^9

Mean results for ECM /Log (Ω)test

	Control	SHENMAO PF606-P
Initial (96h) Mean	**3.23×10^9**	**4.09×10^9**
Final (500h) mean	**4.89×10^9**	**8.58×10^9**

(12)、Electromigration Resistance ---(Test Method)

a. Scope: This test method provides a means to assess the propensity for surface electrochemical migration. This test method can be used to assess soldering materials and/or processes.

b. Standards: **Telcordia GR-78-CORE, Issue 1, 13.1.5**

c. Instruments:

- IPC-B-25 Multipurpose Test Board
- Conductor line widths and spacings of 0.318 mm [0.01250 in].
- A temperature/humidity chamber capable of producing an environment of 65℃± 2°C and 85%± 2%.
- High resistance measuring equipment, with a range up to 10^{12}ohm and capable of yielding an accuracy of ± 5% at 10^{10}ohm with an applied potential of 100 VDC (10% tolerance).
- Power Supply: Equipment capable of providing 10VDC at 100 μA, with a 10% tolerance.

d. Testing Method:

(1). A squeegee or screen printer shall be used with a stencil imaged with the test pattern. It should be noted that the Telcordia GR-78 pattern requires a minimum stencil thickness of 0.20 mm [7.9mil]. Due to the fact that the minimum stencil thickness is often dependent on the pitch or trace width and spacing, a smaller stencil thickness may be used for fine features and shall be agreed upon between the tester and customer for the purpose of this test method. Reflow the printed specimens using convection, infrared, or vapor phase reflow equipment using a reflow profile representative of production. Equivalent methods may be used if such equipment is not available.

(2). Place the rack approximately in the center of the test chamber. Route the wires to the outside of the chamber; dress the wiring away from the test patterns. Ensure that drops of condensation cannot fall on the specimens.

(3). Close the chamber and allow all samples to stabilize or 96 hours at the specific temperature and humidity (65 ± 2°C, RH 85 ± 3.5%). After the 96-hour stabilization period, the initial insulation resistance measurements shall be made using voltage in the range of 45VDC to 100 VDC. Due to polarity, measurements should be made between terminals 1 and 2, 3 and 2, 3 and 4, and 5 and 4, at the specific temperature and humidity with the current limiting resistors placed in series with the test circuit. Terminals 2 and 4 shall be at one potential, and terminals 1, 3, and 5 at the opposite potential.

(4). Connect the samples to the power supply with the current limiting resistors placed in series with the test circuit, and apply 10 VDC for the duration of the test. The test polarity shall be the same as the measurement polarity used in section (3).

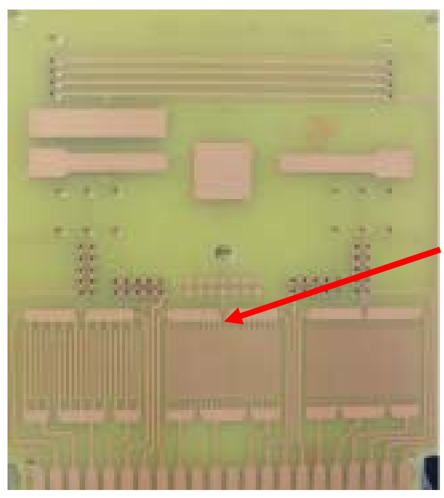
(5). After 500 hours of applied bias (596 hours total), disconnect the power supply and repeat the measurements per section (3) with the specimens under test conditions.

e. Data Handling: The average (geometric mean) insulation resistance (IR_{avg}) is calculated from:

$$IR_{avg} = 10^{\left[\frac{1}{N}\sum_{1}^{N}\log IR_i\right]}$$

where,
N = number of test points (10 minimum),
IRi = individual insulation resistance measurements

Where an assignable cause of low insulation resistance, which is properly attributable to the materials of construction or to the process used to produce the test board, can be found, then such a value can be excluded from calculating the average.



IPC-B-25

(12)、Electromigration Resistance ---(Results)

Raw results from ECM /Log (Ω)

Initial electromigration results (after 96 hours at test conditions, no bias)		Final electromigration results (after 500 hours at test conditions, 10V DC bias)	
	SHENMAO PF606-P		SHENMAO PF606-P
1	3.57E+09	1	8.45E+09
2	2.85E+09	2	8.14E+09
3	4.36E+09	3	8.64E+09
4	7.45E+09	4	8.85E+09
5	5.15E+09	5	8.04E+09
6	3.84E+09	6	8.54E+09
7	2.57E+09	7	8.16E+09
8	4.58E+09	8	8.36E+09
9	6.12E+09	9	8.45E+09
10	3.18E+09	10	8.71E+09
11	4.41E+09	11	8.42E+09
12	6.04E+09	12	8.76E+09
	Control (Ω)		Control (Ω)
1	9.87E+09	1	4.16E+09
2	7.15E+09	2	6.03E+09
3	6.53E+09	3	5.10E+09
4	1.33E+10	4	7.13E+09

Mean results for ECM /Log (Ω)test

	Control	SHENMAO PF606-P
Initial (96h) Mean	**8.85E+09**	**4.30E+09**
Final (500h) mean	**5.50E+09**	**8.46E+09**

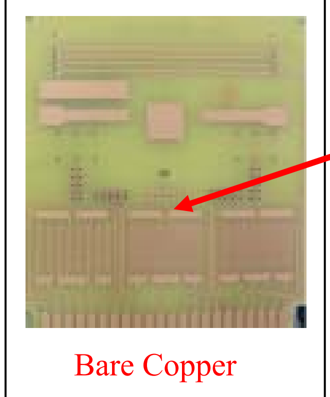
(13)、Cross-compatibility Matrix ---(Test Method)

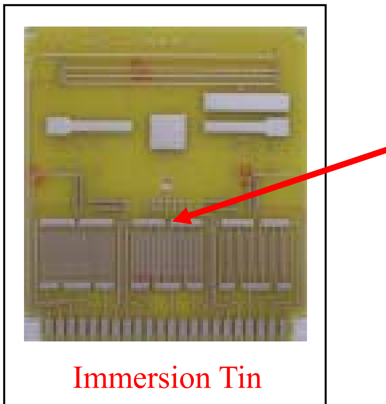
a. Scope: This document describes Hewlett-Packard Company's (HP's) electrochemical migration (ECM) test method for electronics-grade fluxes. This method must be employed when qualifying flux materials for use in HP products manufactured internally or externally.

b. Standards: **HP Flux ECM Test Method EL-EN861-00**

c. Instruments:

- Chamber
- Power supply
- Resistance meter capable of reading and recording high resistance ($10^{12}\Omega$) with a test voltage of 5 volts or an ammeter capable of reading 10^{-10} amps in combination with 5 volts DC power supply. Continuous monitoring should be done using a chart recorder, event detector, or rapid scanning SIR meter and appropriate data acquisition software.
- Solder pastes and paste fluxes require a reflow oven profiled by using a coupon, thermocoupled on the top side with a high temperature solder or a thermally conductive epoxy, to adjust the reflow oven to the vendor recommended reflow profile. Profiling coupons may not be used as test specimens.
- Liquid fluxes require a wave solder machine profiled by using a coupon, thermocoupled on the top side with a high temperature solder or a thermally conductive epoxy, to adjust the preheat zones such the coupon is exposed to the vendor recommended thermal profile. Profiling coupons may not be used as test specimens.
- Pen fluxes and cored wire require a calibrated soldering iron rated to at least 60W, and capable of producing tip temperatures of at least 480°C.
- 2-propanol (isopropyl alcohol, IPA, isopropanol)
- Deionized water
- Stiff-bristle, non-contaminating, plastic brush
- Exhaust ventilation hood
- Drying oven capable of maintaining 45°C to 50°C


Bare Copper


Immersion Tin

d. Testing Method:

(1). Cleaning

Gloves should be worn from this point on whenever the coupons are handled.

Soak the coupons for a minimum of five minutes in a solution of 75% 2-propanol and 25% DI water. Brush the coupons, using a stiff-bristle, non-contaminating, plastic brush, parallel to the comb pattern for one minute. The brush may be dipped in the soaking solution to aid in the removal of debris. Rinse the coupons in 100% 2-propanol and dry them in a clean oven at 45°C to 50°C for 1 hour. During the remainder of the test, only handle specimens by the edges while wearing non-contaminating gloves.

(2). Solder paste and paste fluxes should be screened onto the comb pattern using a 6 mil or 150 µm stencil.

(3). Single-sided reflow specimens must be exposed to one reflow with combs face up. Double-sided reflow specimens must be exposed to one reflow with the combs face up. Then solder paste must be applied to the second side and exposed to another reflow with the newly applied solder paste on the combs face up.

(4). Fluxed coupon inspection

After fluxing (and activation, if required), visually inspect all combs with a microscope (10 to 50X magnification) and test with an ohmmeter to verify that the patterns are free of shorts. Discard any combs with bridging of conductors.

(5). Wiring

The coupons should be vertically placed in the sample trays that will go into the chamber. It is best to have the card edge on the side so that when the wires are being soldered, the soldering iron is not above the comb pattern.

The specimens need to be wired as follows:

- Individual wires from a ribbon cable should be attached to each coupon.
- Use water white rosin to solder Teflon insulated wires to the connection points of the specimens. Do not attempt to remove the flux residues.
- A bus wire should be used to connect all of the ground wires on the coupons.
- A list should be kept detailing the coupon identity, flux, activation method and channel number.
- The comb pattern should be covered during all soldering processes to ensure that the pattern is not contaminated by flux spatter.

(6). Chamber thermal stabilization

Set the chamber temperature for rosin fluxes to 50°C at 20%RH and allow it to stabilize for 3 hours.

(7). Chamber humidity stabilization

Slowly ramp the chamber to 90%RH over a minimum of 15 minutes. Allow the specimens to come to equilibrium for at least 8 hours before applying the bias voltage to begin the test.

(8). Measurements

Once the temperature and humidity stabilize, connect the 5 volt DC bias to all specimens and begin continuous monitoring. Resistance measurements must be made with test specimens in the chamber under the test conditions without removing the bias.

(9). Ramp down

After the samples have been exposed and monitored for 28 days, slowly ramp the chamber to 20%RH over a minimum of 15 minutes. Ramp down temperature and remove specimens for evaluation.

e. Evaluation

(1). Resistance measurements

Each comb pattern on each test specimen shall be evaluated by the resistance obtained (over the duration of the test). If the control coupon readings are less than 1000 M., a new set of test coupons must be obtained and the entire test repeated. All resistance readings shall stabilize above 100 M. and less than two decades below the control. The reading in the first part of the test may fall below 100 M. provided it recovers by 96 hours, but any reading less than 1 M. is unacceptable. Resistance values shall not degrade by more than one decade at any time between start of test (after temperature/humidity stabilizes) and the end of the test.

(2). Inspection

Within 24 hours of completing the test, all specimens shall be visually inspected for dendrites and corrosion using a microscope at 30 to 50X. Use a light source under the coupons to identify electrochemical migration, a light above the sample to verify that an issue is a defect as opposed to debris on the pattern, and a polarized light to identify corrosion.

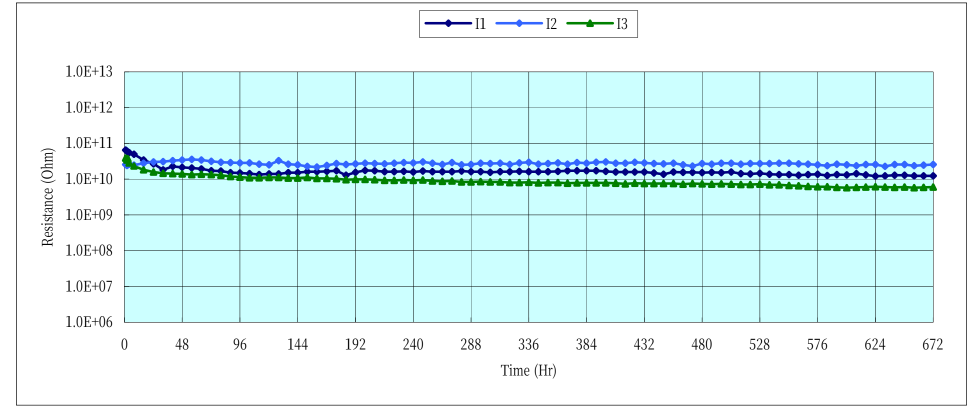
There shall be no visual evidence of metallic dendrites or corrosion that exceeds 20% of the conductor spacing at the end of the test.

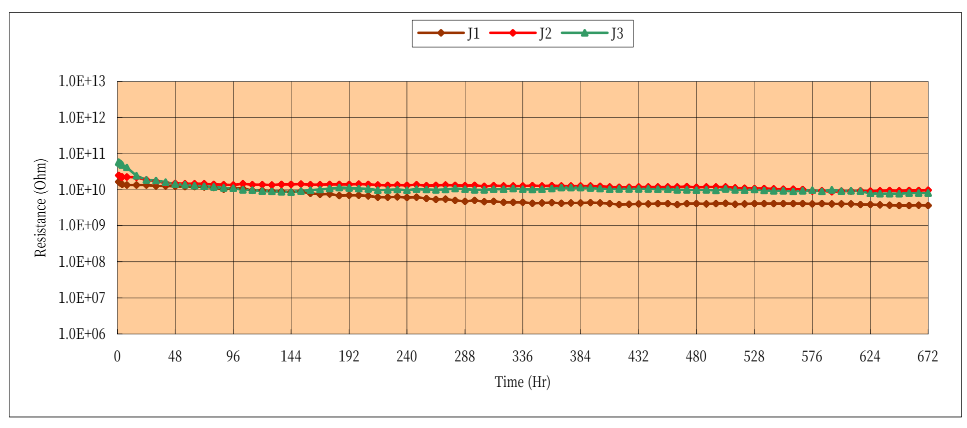
SHENMAO TECHNOLOGY INC.

.

(13)、Cross-compatibility Matrix ---(Results)

Sample group	Surface Finish	Bare Coupon Cleaned	Test Material	Number of Coupons	Number of Measurments
I (Matrix)	**Bare Copper**	**YES**	**PF606-P & PF606-R**	**3**	**3**
J (Matrix)	**Bare Copper**	**YES**	**PF606-P & SM-816 & PF606-R & SMF-2**	**3**	**3**
K (Matrix)	**Immersion Tin**	**YES**	**PF606-P & PF606-R**	**3**	**3**
L (Matrix)	**Immersion Tin**	**YES**	**PF606-P & SM-816 & PF606-R & SMF-2**	**3**	**3**





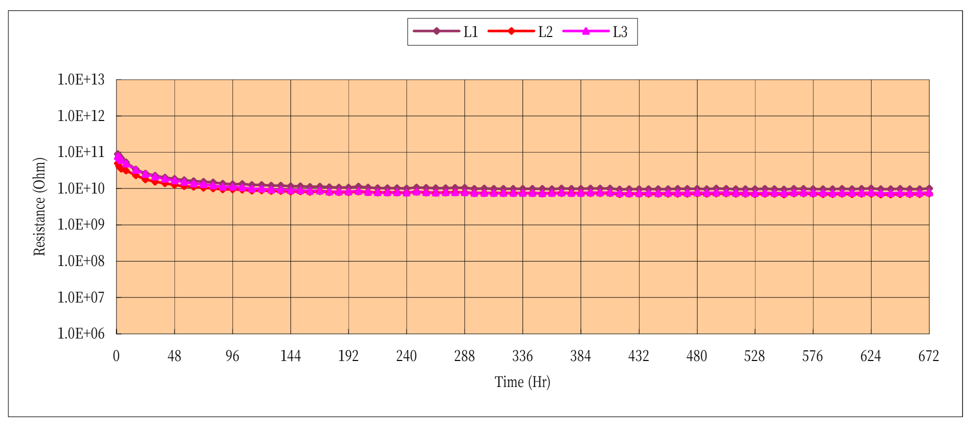
K1 K2 K3

1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06

Resistance (Ohm)

0 48 96 144 192 240 288 336 384 432 480 528 576 624 672

Time (Hr)



.

(14)、 Viscosity ---(Test Method)

a. Scope: To verify printing quality by testing printability of solder paste.

b. Standards: **JIS-Z-3284, Annex 6 (4.1)**

c. Instruments:

▩ Viscosity Meter (Malcom PCU –203)

d. Testing Method:

(1)Leave the solder paste as it is for 2h to 3h at the room temperature or at 25℃

(2)Open the lid of the container for the solder paste, and stir the solder paste carefully with a spatula for 1 min to 2 min while avoiding the air to be mixed therein.

(3)Put the container for solder paste into the thermostat chamber

(4)Adjust the rotational speed at 10 RPM, set the temperature at 25℃ Checking that the solder paste sucked by the rotor is discharged out of the discharge port after about three min, the rotor is stopped and leave the solder paste until the temperature becomes constant.

(5)Adjust the speed at 10 RPM after completing the temperature adjustment, and read the viscosity value after 3 min

(6)Then, set the rotational speed at 3 RPM, and leave it for 6 min in the rotating condition

(7)Read the viscosity value after 6 min

(8)Change the rotational speed to 3→4→5→10→20→30→10RPM， and read the respective viscosity values at 3, 10, 30, 10RPMThe respective reading time is 6, 3, 3, 3, 1 to 3, 1 to 3, and 1 min

e. Evaluation Method: To see if the test result is under product specification

Viscosity Meter Malcom PCU 203

(14)、 Viscosity ---(Results)

Item \ Sample	Sample 1	Sample 2	Sample 3
10 rpm, 3 min	200.6	201.2	197.8
03 rpm, 6 min	379.5	389.3	401.7
04 rpm, 3 min	325.4	330.0	336.3
05 rpm, 3 min	289.2	289.7	294.4
10 rpm, 3 min	202.0	201.7	200.0
20 rpm, 1 min	145.5	145.0	143.0
30 rpm, 1 min	119.4	120.8	119.2
10 rpm, 1 min	193.2	198.6	197.8
(Take 10rpm, 3min)	**202.0**	**201.7**	**200.0**

```
·PCU-203
2004-05-05
12:47
FORMAT: JIS

START
10     RPM
6.0    S-1
3      min
24.6   °C
200.6  Pa.S

03     RPM
1.8    S-1
6      min
24.6   °C
379.5  Pa.S

04     RPM
2.4    S-1
3      min
24.6   °C
325.4  Pa.S

05     RPM
3.0    S-1
3      min
24.6   °C
289.2  Pa.S

10     RPM
6.0    S-1
3      min
24.6   °C
202.0  Pa.S

20     RPM
12.0   S-1
1      min
24.6   °C
145.5  Pa.S

30     RPM
18.0   S-1
1      min
24.7   °C
119.4  Pa.S

10     RPM
6.0    S-1
1      min
24.7   °C
193.2  Pa.S
```

Sample 1

```
·PCU-203
2004-05-06
15:39
FORMAT: JIS

START
10     RPM
6.0    S-1
3      min
24.7   °C
201.2  Pa.S

03     RPM
1.8    S-1
6      min
24.7   °C
389.3  Pa.S

04     RPM
2.4    S-1
3      min
24.7   °C
330.0  Pa.S

05     RPM
3.0    S-1
3      min
24.7   °C
289.7  Pa.S

10     RPM
6.0    S-1
3      min
24.7   °C
201.7  Pa.S

20     RPM
12.0   S-1
1      min
24.7   °C
145.0  Pa.S

30     RPM
18.0   S-1
1      min
24.8   °C
120.8  Pa.S

10     RPM
6.0    S-1
1      min
24.8   °C
198.6  Pa.S

STOP
```

Sample 2

```
·PCU-203
2004-05-06
16:32
FORMAT: JIS

START
10     RPM
6.0    S-1
3      min
24.7   °C
197.8  Pa.S

03     RPM
1.8    S-1
6      min
24.7   °C
401.7  Pa.S

04     RPM
2.4    S-1
3      min
24.7   °C
336.3  Pa.S

05     RPM
3.0    S-1
3      min
24.7   °C
294.4  Pa.S

10     RPM
6.0    S-1
3      min
24.7   °C
200.0  Pa.S

20     RPM
12.0   S-1
1      min
24.7   °C
143.0  Pa.S

30     RPM
18.0   S-1
1      min
24.7   °C
119.2  Pa.S

10     RPM
6.0    S-1
1      min
24.7   °C
197.8  Pa.S

STOP
```

Sample 3

(15)、 Tack ---(Test Method)

a. Scope: The method to measure and evaluate the degree of the tackiness of the solder paste.

b. Standards: **JIS-Z-3284, Annex 9**

c. Instruments:

▒ Tackiness measuring device.

▒ Metal mask: the metal mask shall be 0.2 mm in tackiness, and have four holes of 6.5 mm in diameter.

▒ Slide glass plate (75*25*1 mm)

▒ Solvent: 2-propanol.

d. Testing Method:

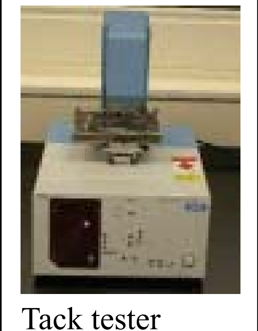
(1). The solder paste is printed on the glass plate by using the metal mask, and four circular solder pastes of 6.5 mm in diameter and of 0.2mm in thickness shall be made.

(2). The test specimen prepared in the above procedures shall be kept under the conditions of the temperature of 25 ± 2℃ and the relative humidity of (50 ± 10%) until the test is carried out.

(3). The test specimen shall be placed under the probe, and the probe is set to center of one of the three printed patterns. The probe shall be lowered into the printed paste at the speed of 2.0 mm/s, and pressurized at the specified pressure of 50 ± 5g. After pressurization, the probe is pulled upward out of the solder paste at the speed of 10 mm/s within 0.2 s, and the maximum load required for the separation is recorded. Five measurements shall be carried out under the same condition, and the measured values shall be averaged. Then, the tackiness strength (KN/m^2) shall calculated from these load values.

(4). The relationship between the elapsed time after printing the solder paste and the tackiness strength shall be obtained with the above procedures.

d. Evaluation Method: The tackiness of the solder paste shall be evaluated by the 0、4、8、12、24 hours after printing the solder paste and the tackiness strength.

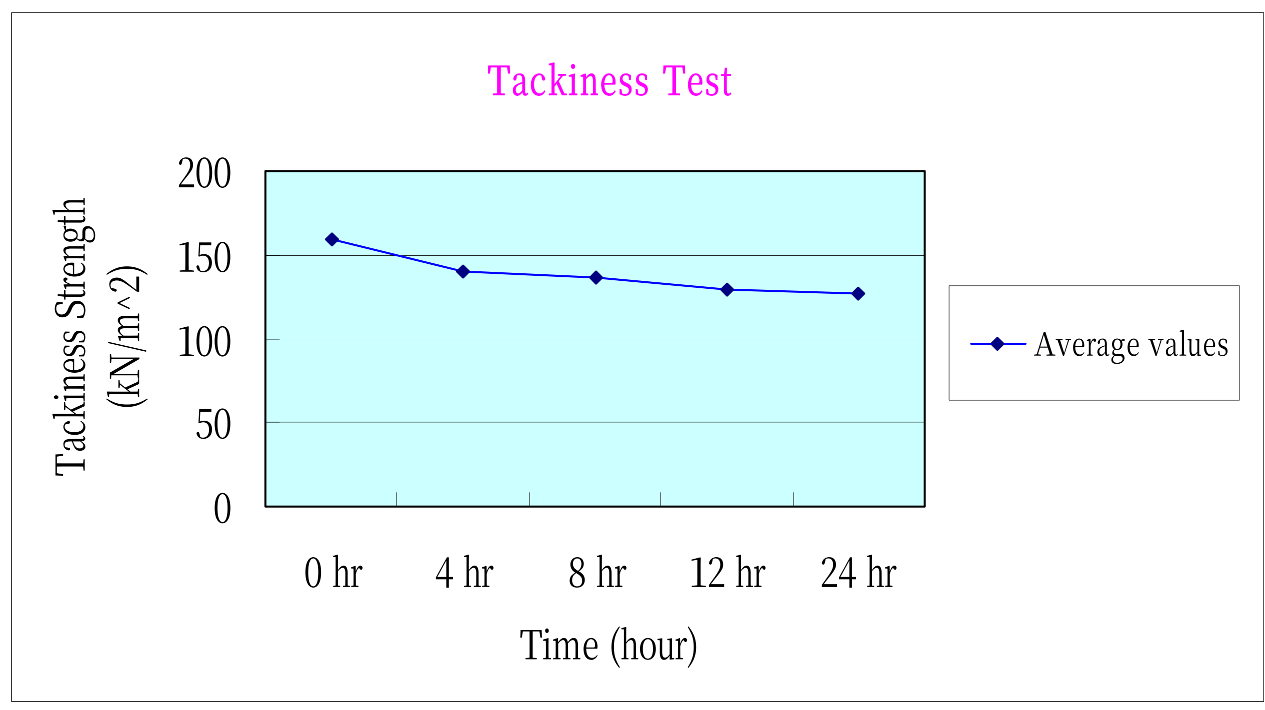


Tack tester

(15)、 Tack ---(Results)

Raw results from tackiness strength /Log (KN/m^2)

Sample / Item	SHENMAO PF606-P (KN/m^2)					
	1	**2**	**3**	**4**	**5**	**Average**
0 hr	167.3	161.5	153.3	155.8	158	**159.2**
4 hr	137.5	138.5	140.3	141.3	143.5	**140.2**
8 hr	138.8	136.3	134.3	135	136.5	**136.2**
12 hr	129.5	137.8	122.8	126.8	127.8	**128.9**
24 hr	134.5	125.3	120.3	124.8	128.8	**126.7**



(16)、Slump ---(Test Method)

a. Scope: The method to evaluate the slump behavior after printing of the solder paste and immediately before heating of the reflow process.

b. Standards: **JIS-Z-3284, Annex 7、8**

c. Instruments:

▒ Stainless steel plate of 0.20 + 0.001 mm in thickness having two kinds of pattern holes of (I) 3.0*0.7 mm and (Ⅱ) 3.0*1.5 mm.

▒ Copper-clad laminated plate (80*60*1.6 mm)

▒ Hot plate (heating temperature: 200℃ or over).

▒ 2-propanol.

d. Testing Method:

◎ **Annex 7. Slump— in —printing test :**

(1). Clean the copper-clad laminated plate with 2-propanol.

(2). Place a stencil on the copper-clad laminated plate and print the solder paste by using an appropriate squeegee. Then, remove the stencil.

(3). Keep the test plate at the room temperature for one hour.

(4). Measure and record the minimum interval where no printed solder pastes are integrated out of 5 rows of two kinds.

◎ **Annex 8. Slump— in— heating test :**

(1). Clean the copper-clad laminated plate with 2-propanol.

(2). Place a stencil on the copper-clad laminated plate and print the solder paste by using an appropriate squeegee. Then, remove the stencil.

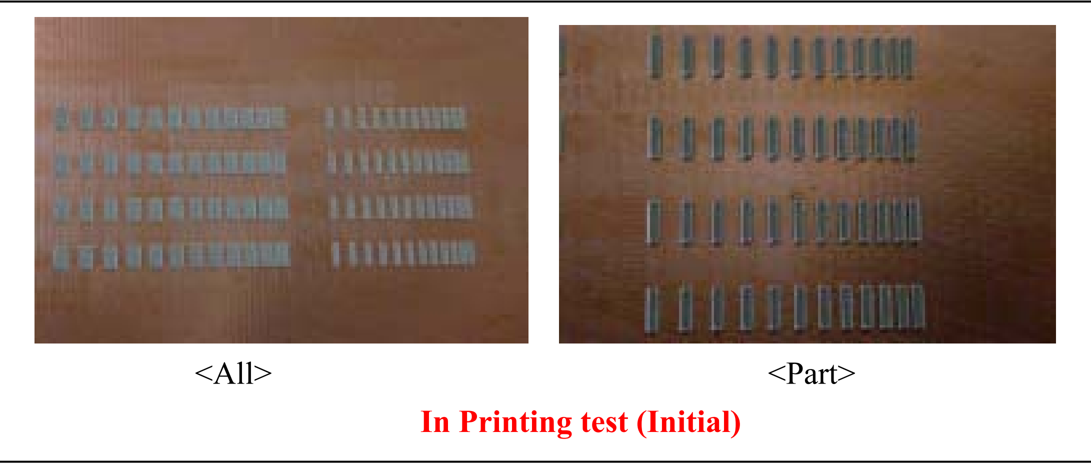
(3). Heat the printed test plate for 1 min at 150℃ in the case of the eutectic solder, or at the temperature of the solidus temperature -10℃ in the case of the low melting point solder paste respectively in the hot plate.

(4). Measure and record the minimum interval where no printed solder pastes are integrated out of 5 rows of two kinds.

e. Evaluation Method: Evaluation is made by the minimum interval where no printed solder pastes are integrated out of 5 rows of patterns of two kinds.

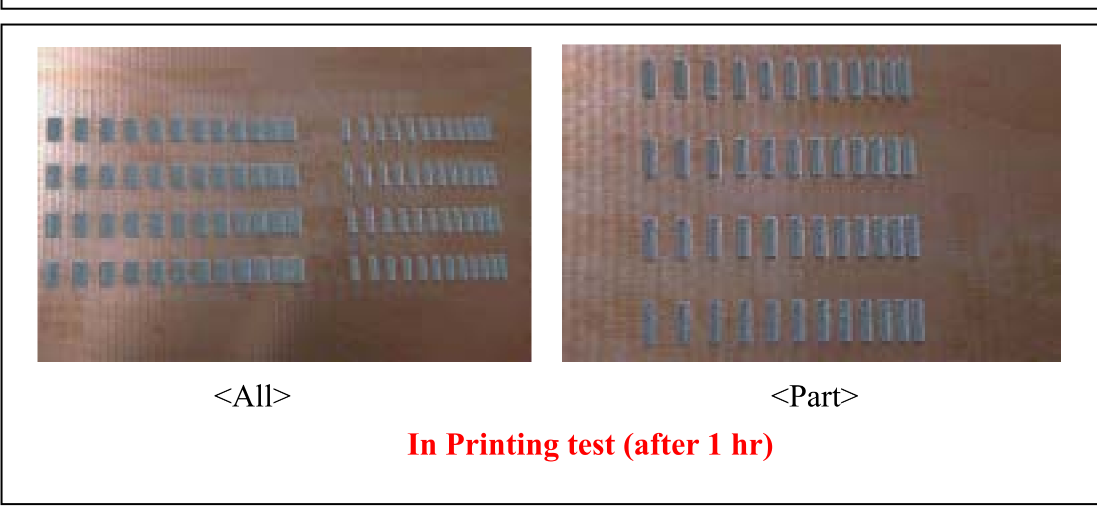
(16)、 Slump ---(Results)

Item \ Sample	Sample 1	Sample 2	Sample 3
Result	Less than 0.2 mm	Less than 0.2 mm	Less than 0.3 mm



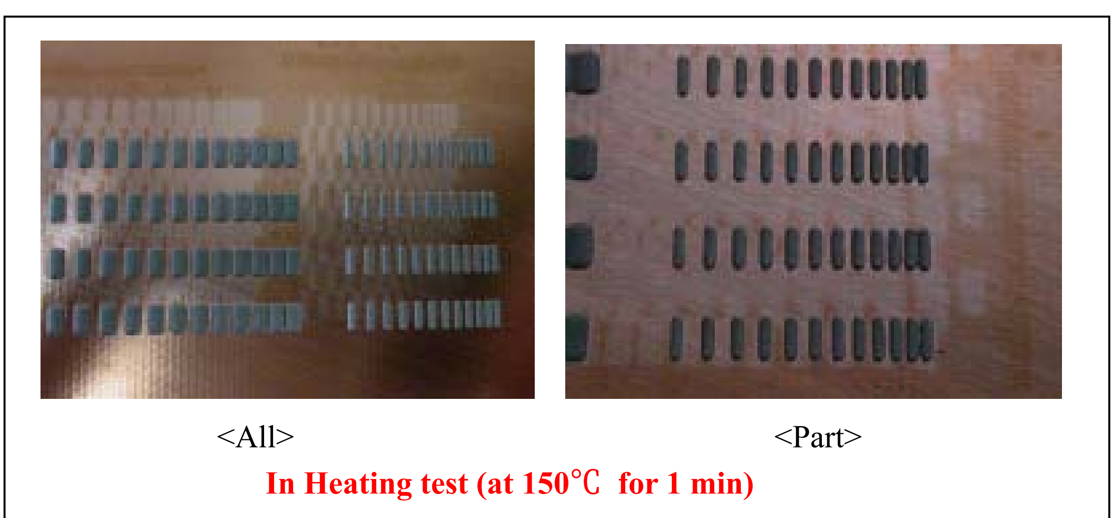
<All> <Part>

In Printing test (Initial)



<All> <Part>

In Printing test (after 1 hr)



<All> <Part>

In Heating test (at 150℃ for 1 min)

(17)、 Solder Ball Test ---(Test Method)

a. Scope: This method to measure and evaluate the degree of generation of the solder balls in the reflow of the solder paste.

b. Standards: **IPC-TM-650 No.2.4.43**

c. Instruments:

- Test Specimen **:** Frosted glass microscope slide with a thickness of 0.60 to 0.80 mm and a minimum length and width dimension of 76 mm and 25 mm.
- Metal Stencils Stencil for Type 1-4 Stencil 76 mm x 25 mm x 0.2mm provided with at least 3 round holes of 6.5 mm diameter apertures with a minimum distance between centers of 10mm.
- Hot plate.
- Surface temperature thermometer.
- Magnifying glass with a 10 to 20 times magnification.

d. Testing Method:

(1). Homogenize the solder paste by hand stirring with a spatula, condition the paste to uniform temperature of 25° C ± 2°C.

(2). Prepare test specimens stencils with Type 1-4 Stencil 76 mm x 25 mm x 0.2mm, the solder paste should be squeeged with the spatula to fill and level each hole.

(3). Test Conditions:

[3.1] Test one specimen within 15 ±5 minutes after placement of solder paste on test coupon.

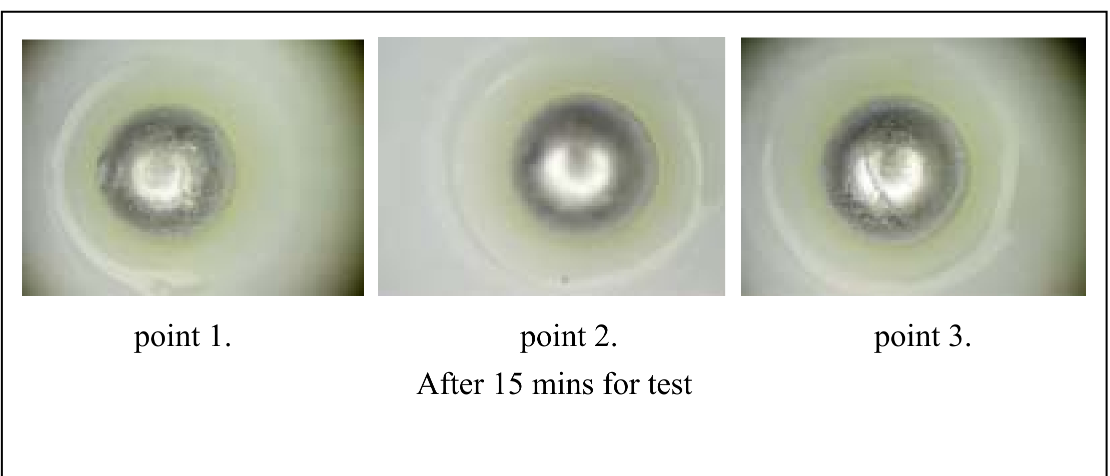
[3.2] Test the second specimen 4 hours +/–15 minutes after placement of solder paste on test coupon. Storage for 4 hours shall be at 25°C ±3°C and 50 ±10% RH.

(4). Place the substrate on the hot plate that temperature is 245°C ±3°C . As soon as the solder has melted, withdraw the substrate from the hot plate maintaining a horizontal position. The reflow shall occur within 20 seconds after the specimen is placed in contact with the hot plate.

e. Evaluation Method: Examine the reflowed specimens under 10X to 20X magnification.

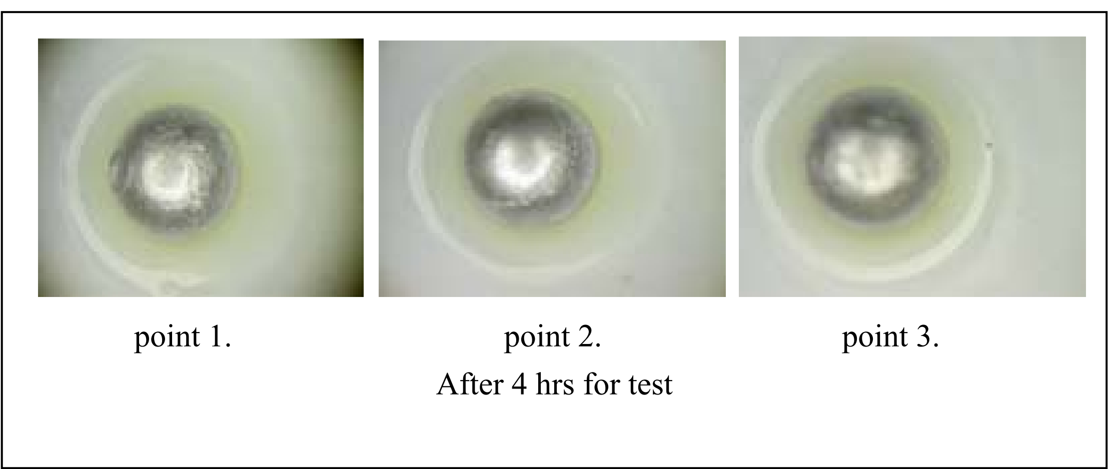
(17)、Solder Ball Test ---(Results)

Item \ Sample	Sample 1 15 min	Sample 2 4 hrs
Results	**PASS**	**PASS**



point 1. point 2. point 3.

After 15 mins for test



point 1. point 2. point 3.

After 4 hrs for test

(18)、Spread Test---(Test Method)

a. Scope：To examine the solderability and the ability to clean oxidation.

b. Standard：JIS-Z-3197 (6.10)

c. Instrument：

■Copper Plate：Size 0.3 x 50 x 50 mm.

■Heat Plate：Should be capable to heat to 220-230℃.

■micrometer：Shall be measure with a micrometer specified in JIS B 7502 or with a measuring apparatus equivalent or superior to it.。

d. Test Method：

Subject the test plate to oxidizing treatment in an electric furnace maintained at about 150℃ for 1h. The heating of test plate shall be done by means of an adequate heating apparatus. Place the sample on the test plate and heat it at the temperatures 40 to 50℃ higher than the liquidus temperature of solder,melt it for about 30 sec after reaching the said temperature and spread the flux over the plate. After cooling it at ordinary temperature, remove the residual flux with alcohol, and measure the area covered by solder with a planimeter or measure the height of solder and calculate the rate of spread form the formula.

e. Calculation：

$$\text{Rate of spread}(\%) = \frac{D - H}{D} \times 100$$

Where H：height of spread solder (mm)；

D：diameter when the solder used is assumed to be a sphere（mm）；

$$D = 1.24V^{1/3}$$

V：mass/specific gravity

f. Evaluation Method： 70% up

.

(18)、 Spread Test---(Results)

Sample No.	Result
Sample 1	76.54
Sample 2	75.86
Sample 3	76.26
Average (%)	**76.22**

SHENMAO-PF606-P

(19)、 Cross Section---(Test Method)

a. Scope：Examine the interconnection of BGA and solder paste to ensure soldering quality.

b. Test Conditions：

【1】、 Reflow under non-nitrogen environment.

【2】、 Pilot run for 50 pcs.

【3】、 Test Sample: Below

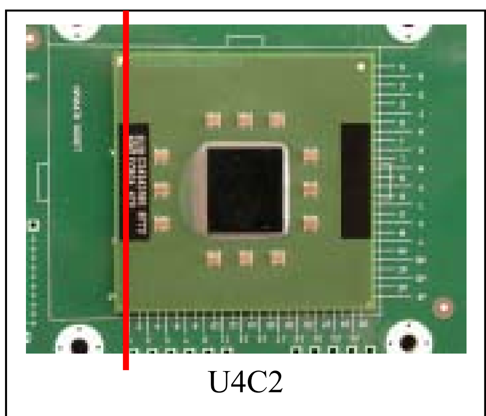
c. Evaluation Standard：

【1】、 Use SEM to check the cross section after reflow.

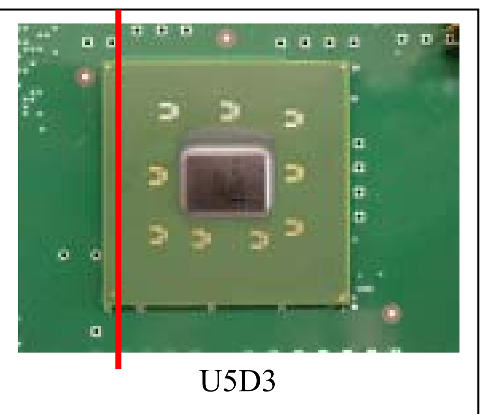
【2】、 Void area should not excess 20% of solder sphere cross area.

【3】、 IMC should be found.

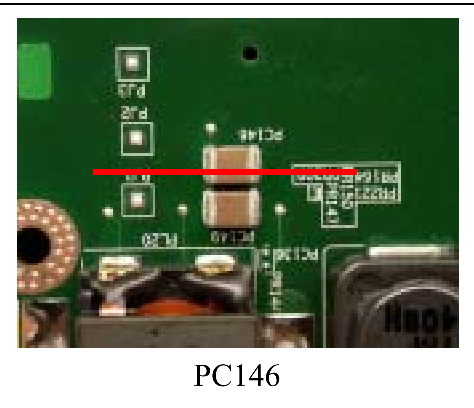
【4】、 No cracks and Open are allowed.



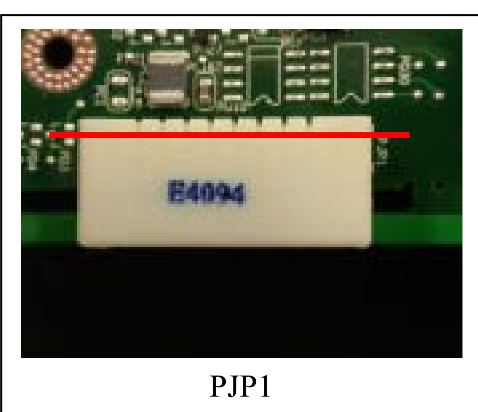
U4C2



U5D3



PC146



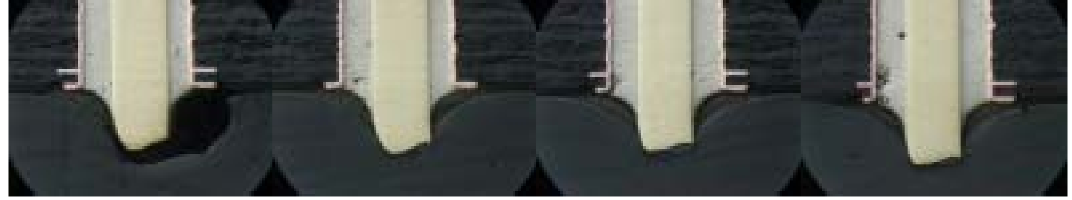
PJP1

(19)、Cross Section---(Result)

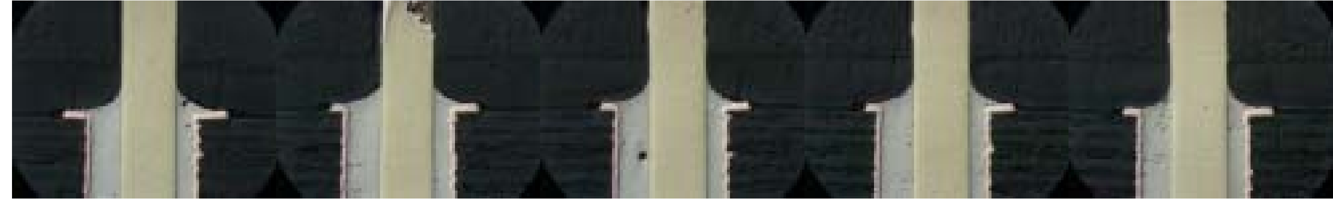
C-13

.

PC146



Down



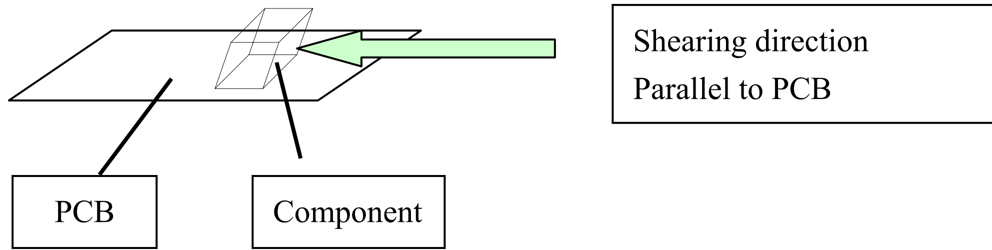
UP

(20)、Component Shear and IC pull Test---(Test Method)

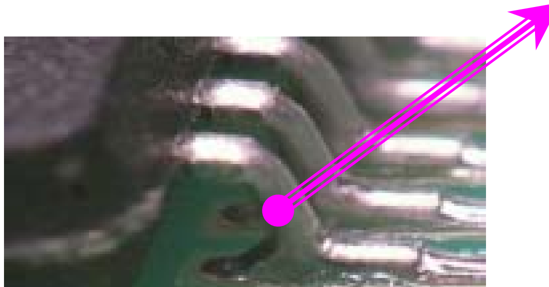
a. Scope：To Test the Strength of Solder Joint

b. Testing Method

(1) Shear Test: Measure the stress strength with shear/pull gauge as shown in the figure below.



(2) Pull Test: Measure the stress strength with shear/pull gauge as shown in the figure below.



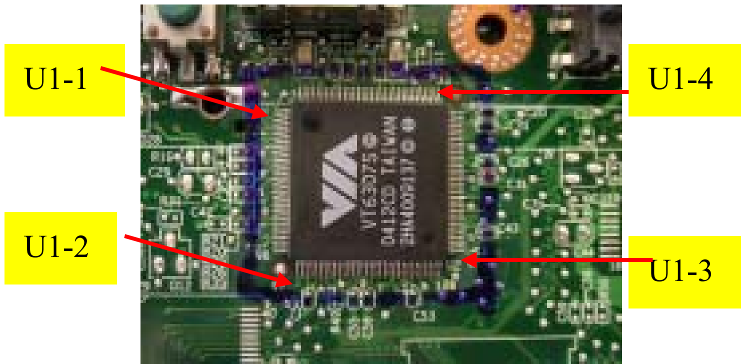
Pulling direction
45 degree upward PCB

SHENMAO TECHNOLOGY INC.

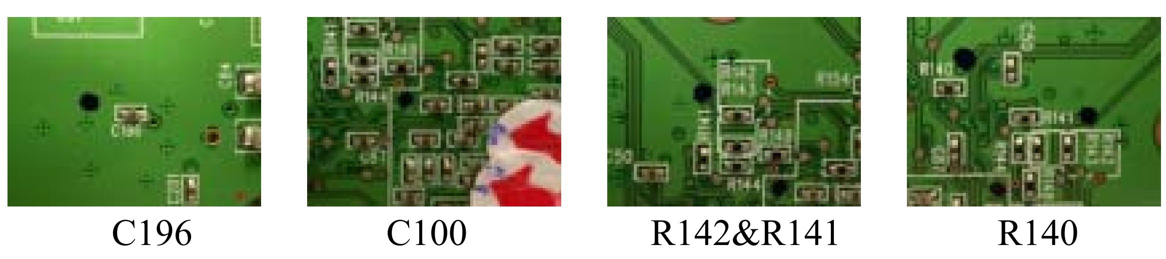
.

(20)、 Component Shear and IC pull Test---(Result)

Pull Test Location



Shear Test Location



C196 C100 R142&R141 R140

Result

	Pull Test					Shear Test					
	U1-1	U1-2	U1-3	U1-4	AVG	C196	C100	R142	R140	R141	AVG
Result	1.78	1.61	1.51	1.68	1.65	1.59	1.87	2.00	3.28	2.90	2.33

(21)、Thermal Cycling Test---(Method)

a、Scope：To Test the Quality and Reliability of Solder Joint

b、Test Equipment and Test Condition：

Test Equipment:

THERMOTRON SML-1500-25-25 Temperature Cycling Test Chamber(See below)
Temperature range: -73°C ~ +177°C
Temperature change rate: 1°C ~ 15°C /minute
Inside dimension: 157(W)* 208(D)* 239(H)/cm

Inspection Condition:

Test temperature: -40°C ~ +125°C.
Dwell : 15 minutes.
Ramp Rate : 10°C ~20°C / minute
Number of cycle: 1000 cycles (Check Interval / 200 cycles)

Test Equipment

.

(21)、Thermal Cycling Test---(Result)

Item	ID	S/N	Testing Result
39	3-14	1029888200046	After 200 cycles test T331 can be found whiskers growth. Their length is less than 50 um after 1000 cycles OM inspection. No cracks occur from OM image.
40	3-15	1029888200063	After 200 cycles test T331 can be found whiskers growth. Their length is less than 50 um after 1000 cycles OM inspection. No cracks occur from OM image.
37	3-16	1029888200081	After 200 cycles test T331 can be found whiskers growth. Their length is less than 50 um after 1000 cycles OM inspection. No cracks occur from OM image.

3、Conclusion

The final results of test of Shenmao's solder paste are shown below：

NO.	Test Item	Results
1	Alloy composition impurity analysis	**PASS**
2	Particle size and shape	**PASS**
3	Oxide	**PASS**
4	Halide content	**PASS**
5	Presence of halides, silver chromate method	**PASS**
6	Fluorides by spot test	**PASS**
7	Flux induced corrosion, copper mirror method	**PASS**
8	Corrosion	**PASS**
9	Surface insulation resistance	**PASS**
10	Electrochemical migration resistance	**PASS**
11	Electrochemical migration resistance	**PASS**
12	Electromigration resistance	**PASS**
13	Cross-compatibility matrix	**PASS**
14	Viscosity	**PASS**
15	Tack	**PASS**
16	Slump	**PASS**
17	Solder ball test	**PASS**
18	Spread Test	**PASS**
19	Cross section	**Submitted**
20	Component Push and IC Pull test	**Submitted**
21	Thermal Cycling test	**PASS**

Annex (1)

Solder Paste Handing and Storage Instruction

1. Storage

(1) Keep in 0~10℃ temperature.

(2) Expiration period: 6 months from production date (sealed condition).

(3) Keep out of direct sunlight.

2. Operation Manual (Sealed)

(1) Keep solder paste in room temperature (25 ± 2℃) for 3~4 hours. Do not use any heater to raise temperature.

(2) Kindly mixed averagely for 2~4 minutes according to necessity.

3. Operation Manual (Opened)

(1) At first, add 2/3 can of solder paste onto the stencil, do not add more than 1 can of which.

(2) Add solder paste a little at a time according to production procedure.

(3) To maintain the solder paste quality, please make sure not to storage the opened can with sealed can.

(4) Use new opened solder paste at the beginning of the next day. Mix opened solder paste with sealed one at ratio 1:2, add a little at a time during printing.

(5) Soon after printing, please make sure all components to be mount on printed circuit board between 4~6 hours.

(6) Please withdraw solder paste from stencil and seal kindly if printing progress would pause for more than 1 hour.

(7) After continuously printing for 24 hours, kindly withdraw printed solder paste and follow step (4).

(8) It is recommended to clean both side of stencil every 4 hours manually to ensure printing quality.

(9) Kindly keep room temperature between 22~28℃, room humidity RH 30~60% is recommended.

(10) To clean up the defect printed board, kindly use isoprophyl alcohol , IPA or YC336.

.

Annex (2)

Labeling

FORMOSA

Lead-Free Solder Paste

TYPE :

LOT NO. :

ALLOY :

FLUX :

PRODUCED DATE :

METAL % :

EXPIRATION DATE :

NET :

SHENMAO TECHNOLOGY INC.

No 12-1, Gongye 2nd Rd, Guanyin Township
Taoyuan country 328, Taiwan

Tel: +886-3-4160177
Fax:+886-3-4160133

Japanese Patent No. 3296289

U.S. Patent No. 6179935B1

CAUTION !

1) Wear protective gloves or glasses, when use paste
2) Wipe off the paste with ethanol when it adheres to your skin
3) Wash hands well after treating solder paste
4) Store between 0~10C
5) Read technical data and MSDS before using
6) Shelf life:
   6 months from produced date.

SHENMAO TECHNOLOGY INC.

.

Annex (3)

Quality Assurance Certificate of Analysis

Product Code	**PF606-P**
Alloy Composition	Sn96.5 / Ag3.0 / Cu0.5 /
Product Date	Apr 01,2004
Expiration Date	Jan 31. 2005
Lot No.	1686
Net Quantity	500g
Storage temperature range	0~10℃
Customer's name	COMPAL
HP Purchase order number	
HP part number	

RESULT OF ANALYSIS

Solder paste classification	No Clean					
Appearance	Gray Smooth Paste, No Impurities					
Nitrogen requirement						
Melting point	217~219℃					
Flux designation	ROL1					
Metal percent	91%					
Chloride content	0.05 % (in flux)					
Hazard rating	Health	1	Flammability	1	Reactivity	0
Powder class	Type 4		+38 μm +38~20 μm −20 μm		0.24 % 97.53 % 2.23 %	
Viscosity	200 Pa.s/25℃ (MALCOM Viscometer)					
Solder ball acceptance level	LEVEL 1					
Alloy & Impurity Composition	Element	Spec.	Result	Element	Spec.	Result
	Sn	Remainder		Sb	≦0.05	
	Ag	3.0± 0.3%		Fe	≦0.02	
	Cu	0.5± 0.2%		As	≦0.03	
	Ni	≦0.01		Bi	≦0.05	
	Ge	≦0.01		In	≦0.01	
	Zn	≦0.002		Cd	≦0.002	
	Al	≦0.002		Pb	≦0.1	
Remark						

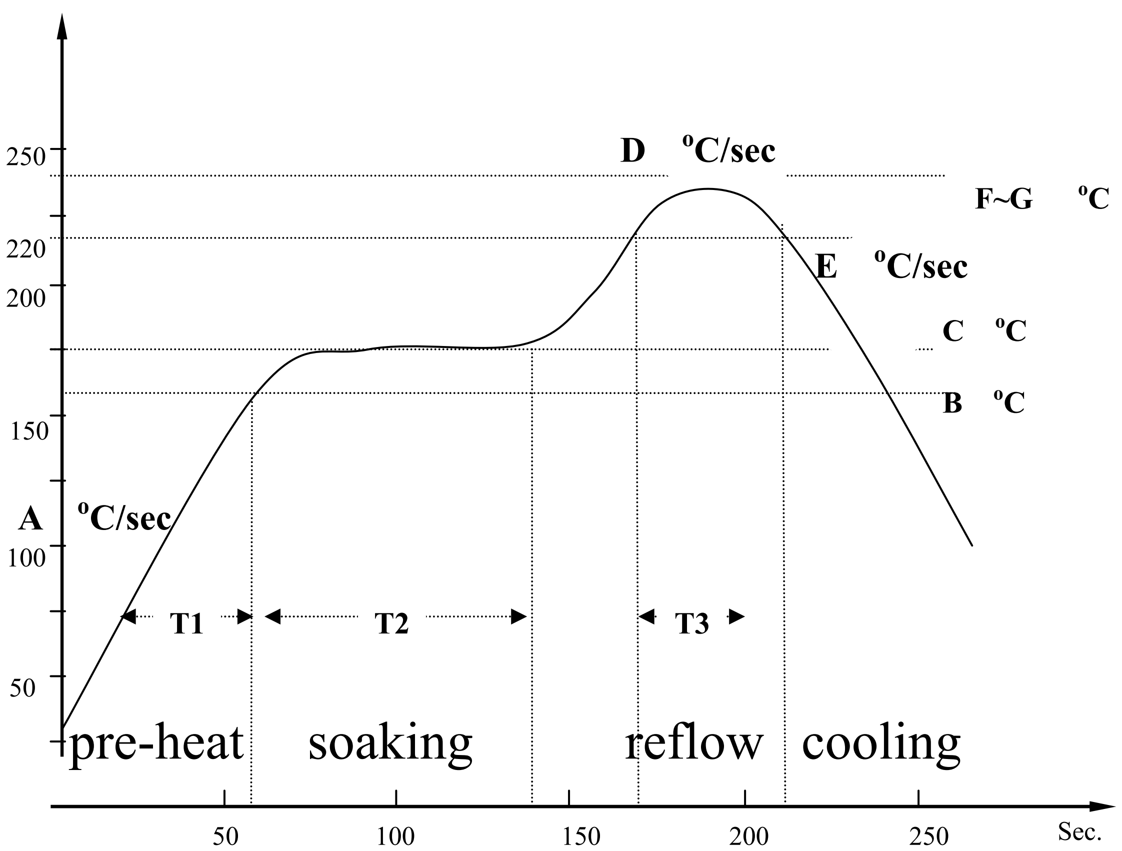
Inspector

Quality control manager

SHENMAO TECHNOLOGY INC.

.

Annex (4)



A: ramp up rate during preheat: **1.5~3.0 oC/sec**
B~ C : soaking temperature: **155~185 oC**
D: ramp up rate during reflow: **1.2~2.3 oC/sec**
E: ramp down rate during cooling: **1.7~2.2 oC/sec**
F~G : peak temperature: **230~250 oC**
T1: preheat time: **50~80 sec**
T2 : dwell time during soaking: **60~120 sec**
T3 : time above 220 oC : **40~70 sec**

SHENMAO TECHNOLOGY INC.

.

Annex (5)

MATERIAL SAFETY DATA SHEET

1、CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

CHEMICAL PRODUCT NAME：PF606-P
COMPANY INFORMATION：
NAME OF MANUFACTURER：SHENMAO TECHNOLOGY INC.
NAME OF SECTION：QUALITY ASSURANCE DEPARTMENT
ADDRESS：51-6 Bei Tau Ri, Tanshui 251, Taiwan R.O.C.
TELEPHONE NUMBER: 886-2-26217627
FAX NUMBER: 886-2-2622-7326

2、COMPOSITION, INFORMATION OR INGREDIENT

Components-Chemical Name	wt.%	CAS No.
Rosin	3.5-5.8	8050-09-7
Wax	1.2-2.6	(Secret)
Solvent	2.8-3.7	(Secret)
Additive	1.3-1.6	(Secret)
Tin (Sn)	85.89	7440-31-5
Silver (Ag)	2.67	7440-22-4
Copper (Cu)	0.45	7440-50-8
PS. Sn/Ag/Cu: 96.5%/3.0%/0.5%		

3、HAZARDS IDENTIFICATION

ADVERSE HUMAN HEALTH HAZARD：①Vapors may irritate eyes, respiratory system and skin. ②Harmful by inhalation.
ENVIRONMENTAL EFFECTS：Not available
PHYSICAL AND CHEMICAL HAZARDS：Vapors may catch fire

4、FIRST AID MEASURES

EYE CONTACT： Gently rinse the affected eyes with clean water for at least 15 minutes. Arrange for transport to the nearest medical facility for examination and treatment by a physician as soon as possible.
SKIN CONTACT： Remove all contaminated clothing, shoes and socks from the affected areas as quickly as possible, cutting them off if necessary. Wash the affected area under tepid running water using a mild soap. If irritation persists, arrange for transport to the nearest medical facility for examination and treatment by a physician as soon as possible.
INHALATION： Remove the victim from the contamination immediately to flesh air. If breathing is week, irregular or has stopped, open his airway, loosen his collar and belt and administer artificial respiration.
INGESTION： Give the person one or two glasses of water or solution of salt, try to get the victim to vomit. Arrange for transport to the nearest medical facility for examination and treatment by a physician as soon as possible.

5、FIRE FIGHTING MEASURES

EXTINGUISH MEDIA： Use alcohol resistant foam, carbon dioxide or dry chemical extinguishing agents.
FIRE-FIGHTING INSTRUCTIONS： Shut off fuel to fire if possible to do so without hazard. Evacuate area and fight fire from a safe distance. Apply water from a safe distance to cool and protect surrounding area. Firefighters should wear proper protective equipment.
FLASH POINT：Not applicable
EXPLOSION LIMIT：Not available

6、ACCIDENTAL RELEASE MEASURES

Shut out all sources of ignition; No flare, smoking or flames in area.
Wear proper protective equipment.
For spills, wipe and scrape away with cloth or paper, take up and store in a sealed container.

7、HANDLING AND STORAGE

HANDLING：
Do not use fire near storage area. Wear proper protective equipment.
STORAGE：
Keep away from heat or sunlight. Store in a cool (0-10℃) place in closed containers.

8、EXPOSURE CONTROLS AND PERSONAL PROTECTION

ENGINEERING MEASURES：
Use only with adequate ventilation and in closed systems. Make available emergency shower and eye wash in the work area.
EXPOSURE GUIDELINES：
ACGIH TLV: $0.1mg/m^3$ (Silver) $2mg/m^3$ (Tin)
PROTECTIVE EQUIPMENT：
RESPIRATORY PROTECTION：Industrial canister gas masks.(Heating) EYE PROTECTION：Safety goggles. HAND, SKIN AND BODY PROTECTION： Rubber gloves. Selection of specific items such as boots, apron or full-body suit will depend on operation.

9、PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE	Gray paste
BOILING POINT	>200℃ (Flux)
VAPOR PRESSURE	<0.01mmHg(20℃)
MELTING POINT	217~219℃ (Solder)
SPECIFIC GRAVITY	$7.4g/cm^3$ (Solder, 20℃)
SOLUBILITY (IN WATER)	Almost Insoluble

10、STABILITY AND REACTIVITY

CHEMICAL STABILITY：
Stable, hazardous polymerization will not occur.
INCOMPATIBILITY WITH OTHER MATERIALS：
Strong oxidizing agents, strong bases and strong acids.
HAZARDOUS DECOMPOSITION PRODUCTS：
Carbon oxide on burning.
HAZARDOUS POLYMERIZATION：
Will not occur.

11、TOXICOLOGICAL INFORMATION

CORROSIVE AND IRRITANT PROPERTIES：Not available
ALLERGENIC AND SENSITIZING EFFECTS：Not available
ACUTE TOXICITY：Not available
SUB-ACUTE TOXICITY：Not available
CHRONIC TOXICITY：Animal drink water containing 0.18mg/L of lead may get lead poisoning. Rats ingested the 0.005mg/Kg of lead showed evidence of CMS disturbances.
CARCINOGENIC EFFECTS：Not available
MUTAGENIC EFFECTS：Not available
EFFECTS ON THE REPRODUCTIVE SYSTEM：Not available
TERATOGENIC EFFECTS：Not available

12、ECOLOGICAL INFORMATION

BIODEGRADABILITY：Not available
BIOACCULATION：Not available
FISH TOXICITY：Not available
OTHER INFORMATION：Not available

13、DISPOSAL CONSIDERATIONS

Dispose in compliance with local regulations.
Do not discharge into the environment.

14、TRANSPORT INFORMATION

UN CLASS：Not applicable UN NUMBER：Not applicable
Keep in a cool(0-10℃)place. Follow all regulations in your country.

15、REGULATORY INFORMATION

JAPAN STATUS EXISTING CHEMICAL SUBSTANCES(MITI)：Listed
US STATUS TSCA INVENTORY：Not Listed
EU STATUS EINECS：Not Listed (Polymer exemption)

LABELING ACCORDING TO EEC DIRECTIVES：
HAZARD SYMBOL：T-Toxic
RISK PHRASES：R 61-62-20/22-33
SAFETY ADVICES：S 53-45

Regulatory information with regard to this substance in your country or in your region should be examined by your own responsibility.

16、OTHER INFORMATION

<table>
<tr><td colspan="4">REFERENCE:
AIR PRODUCTS MSDS、INTERNATIONAL MARITIME DANGEROUS GOODS CODE</td></tr>
<tr><td>HAZARDOUS</td><td>NFPA</td><td>HMIS</td><td rowspan="4">LEVEL：0~4：From least to serious
NFPA：National Fire protection Association rating identifies hazards during a fire emergency.
HMIS：Hazardous Materials Identification System rating applies to process as packaged.</td></tr>
<tr><td>HEALTH</td><td>1</td><td>1</td></tr>
<tr><td>FLAMMABILITY</td><td>1</td><td>1</td></tr>
<tr><td>REACTIVITY</td><td>0</td><td>0</td></tr>
</table>

The information herein is given in good faith, but no warranty, express or implied, is made.
Please consult the SHENMAO TECHNOLOGY INC. for further information.