ECO+PLUS series
Lead free SOLUTIONS you can TRUST

TECHNICAL INFORMATION

Lead Free No-clean Flux Cored Solder Wire

S03X7C-56M

KOKI COMPANY LIMITED

The alloy composition of the lead-free resin flux cored solder is now dominated by SnAg3.0Cu0.5, resulting in a much higher Sn content compared to SnPb wires. While soldering Sn enters the crevices between crystals on the plating surface of a soldering bit, dissolves and erodes Cu in the center of the soldering bit, and the Cu flows out from the bit.

As a corrective measure against such erosion of the soldering bit, simply thickening the bit plating (around 500µm) may be one option, though it cannot be the complete solution due to the properties of the metals utilized.
In the case of using **S03X7C–56M**, intermetallic compounds are formed over the plating surface while soldering in the same way as with the normal solders. Composition of such compounds is Sn/Fe/Co. Although these are compounds with a high melting point of over 500°C like Sn/Fe, they can spread thinly over the Fe plating surface thanks to Co relieving the high surface tension of Sn, allowing it to fill up the crevices between crystals. Subsequently, intrusion of solder into the bit center is restrained, and the erosion is diminished.

1. Features

- Helps prevent shortening of the soldering iron bit life.
- Solder wettability is greatly improved.
- Minimized solder/flux spattering.
- Compatible with various solder alloys.

2. Specifications

Product		**S03X7C-56M**
Alloy composition (%)		Sn Ag0.3 Cu0.7 Co0.03
Specific gravity		7.32
Melting point (°C)	Solidus	217
	Liquidus	227
Tensile length (N/mm2)		37.7
Elongation (%)		42.8
Vickers hardness (HV)		12.7
Flux content (%)		3.0
Halide content (%)		0.12
Wire diameter (mm dia.)		0.3, 0.5, 0.6, 0.8, 1.0, 1.2
Packaging		200gs/spool (0.3mm dia. only), 500gs/spool

This technical information has been prepared in accordance with JIS Z 3284.

3. Test Items

No.	Test item	Test standard
1	Chemical composition analysis of solder alloy	Complied with JIS Z 3910.
2	Flux content	Complied with JIS Z 3197. 8. 1. 2.
3	Dryness test	Complied with JIS Z 3197 8. 5. 1.
4	Halide content	Complied with JIS Z 3197 8. 1. 4. 2. 1.
5	Copper plate corrosion test	Complied with JIS Z 3197 8. 4. 1.
6	Copper mirror corrosion test	Complied with JIS Z 3197 8. 4. 2.
7	Aqueous solution resistivity test	Complied with JIS Z 3197 8. 1. 1.
8	Surface insulation resistance test	Complied with JIS Z 3197 8. 5. 3.
9	Electromigration test (Moisture proof test by applying DC voltage)	Complied with JIS Z 3197 8. 5. 4.
10	Solder spread factor	Complied with JIS Z 3197 8. 3. 1. 1.
11	Flux spattering	Complied with JIS Z 3197 8. 3. 2. 1.
12	Copper erosion test	(No relation to JIS standard.)
13	Creep test	(No relation to JIS standard.)
14	Heat cycle test	(No relation to JIS standard.)

3.1 Chemical composition analysis of solder alloy

Analysis method

Sn content is calculated by subtraction from total mass of Cu, which contains other analyzed properties.

With respect to analyzing impurities of 8 properties as given from Pb till Cd in the following analyzed result, our test conformed to the test method of JIS Z 3910 8.2 (solder analysis method), which shall be used by mixed acid A as adjusting test solution, and we executed quantitative analysis by using the plasuma-spectro analyzer.

Result

(%)

Cu	Co	Ag	Sn	Pb	Sb	Bi	Zn	Fe	Al	As	Cd
0.70	0.030	0.30	Rest	0.035	0.023	0.006	0.001	0.004	0.001	0.007	0.001

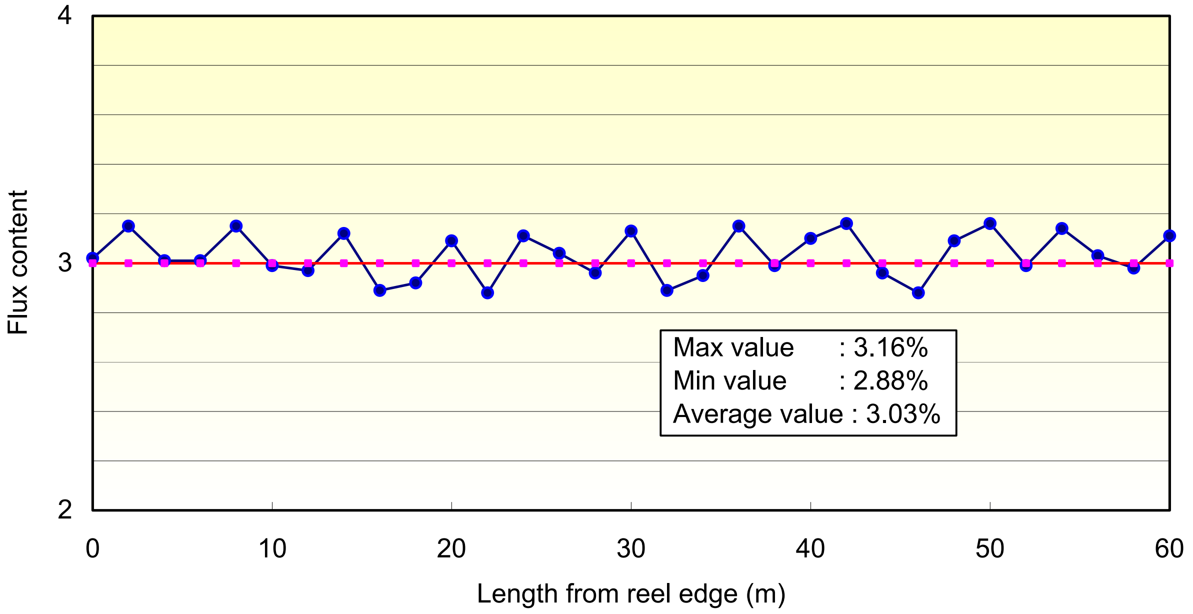
3.2 Flux content

Measuring method

Draw respectively flux-cored wire solders in length of 2m out of the reel edge and cut them in 2m length, then, measure them according to the test method of [resin-based flux used for soldering specified in JIS Z 3197, 8. 1. 2 (1)].

Measured results

Changes in flux content are exhibited as in the following graph.



3.3 Dryness test

Test method

After winding the flux-cored wire solder around the surface of a 2mm dia. metal rod and cutting it by one turn in a ring form to make the test piece, melt the test piece at 270°C for 5secs. Other test conditions shall be complied with JIS Z 3197, 8. 5. 1 (test method for resin-based flux for soldering).

Test results

Sprinkled chalk powders over the test piece was removed easily by a soft brush and remarkable adhesion of flux residue was not been observed.

3.4 Measuring halide content

Test method (Potentiometric titration method)

After cutting the flux-cored wire solder in 2mm length and making it into a chip state to obtain the test piece, mix the test piece with IPA, and apply ultrasonic to the test piece for extracting most of flux it to use as a test solution. Other test conditions followed JIS Z 3197, 8. 1. 4. 1. 2. 1 (Test method for resin-based flux for soldering). Then, we executed this test.

Measured result

(%)

Measured value				Average
0.12	0.11	0.13	0.12	0.12

3.5 Copper plate corrosion test

Test method

After winding the flux-cored wire solder around the surface of a 2mm dia. metal rod and cutting it by one turn in a ring form to make the test piece, melt the test piece at 270°C for 5 sec. and perform surface treatment to the test piece by 0.1N hydrochronic acid solution. Other test conditions followed to JIS Z 3197, 8. 4. 1 (Test method for resin-based flux for soldering). Then, we executed this test.

Test result

Compared with the standard test pieces so far, any propagating corrosions on the test piece used for this test could not be found at the bottom area of flux residue and the around. [Refer to the following photos.

Before humidification			
			

Before humidification			
			

3.6 Copper mirror corrosion test

Test method

After cutting the flux-cored wire solder in 2mm length and making it into a chip state to obtain the test piece, mix the test piece with IPA, and apply ultrasonic wave to the test piece for extracting almost amount of flux property from it to use as a test solution. Condense the test solution till to a 25% concentration by vacuum-desiccation for this test. Other test conditions followed JIS Z 3197, 8. 4. 2 (Test method for resin-based flux for soldering). Then, we executed this test.

Test result

No evidence (break through of copper mirror) of copper corrosion was observed.

3.7 Aqueous solution resitivity

Measurement method

After cutting the flux-cored wire solder in approx. 2mm length and making it into a chip state to obtain the test piece, mix the test piece with IPA, and apply ultrasonic wave to the test piece for extracting most of flux to use as a test solution. Condense the test solution till to a 25% concentration by vacuum-desiccation for this test. Other test conditions followed JIS Z 3197, 8. 1. 1 (Test method for resin-based flux for soldering).

Test result

(Ω▪m)

Measured value				Average
700	770	720	730	730

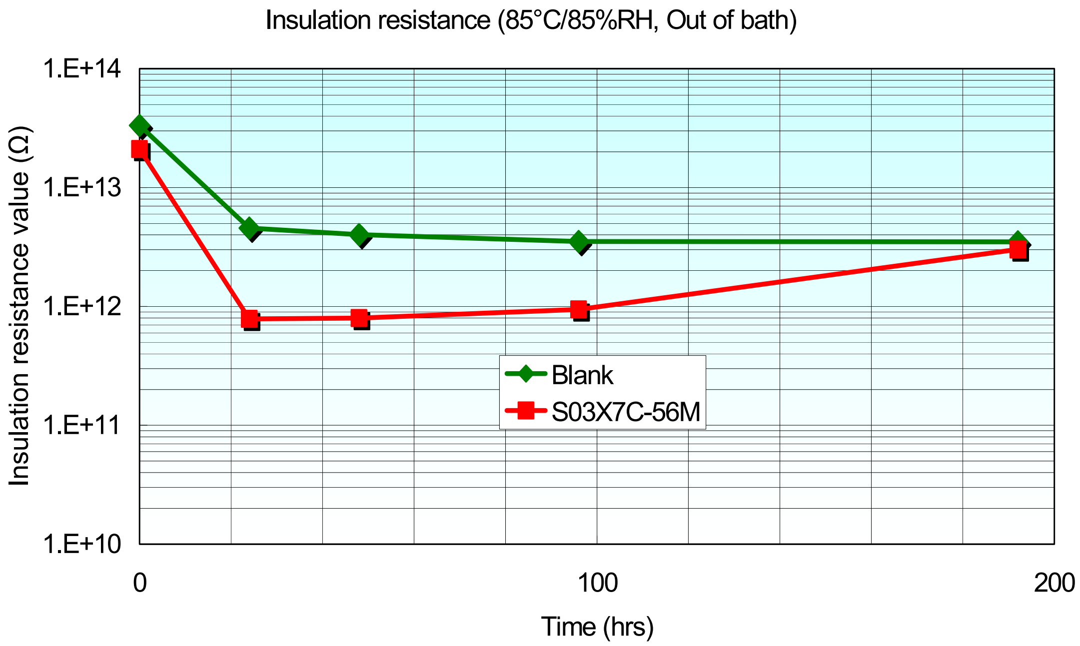
3.8 Surface insulation resistance test

Test method

As a test piece, use the comb type electrode of the glass fiber-based copper-clad, epoxy-resin FR-4 specified in JIS Z 3197, 8. 5. 3 (Test method for resin-based flux for soldering).

After cutting the flux-cored wire solder in approx. 2mm length and making it into a chip state to obtain the test piece, mix the test piece with IPA, and apply ultrasonic to the test piece for extracting most of flux to use as a test solution. Other test conditions followed JIS Z 3197, 8. 5. 3 (Test method for resin-based flux for soldering).

Test result



3.9 Electromigration test result (Moisture proof test by applying DC voltage)

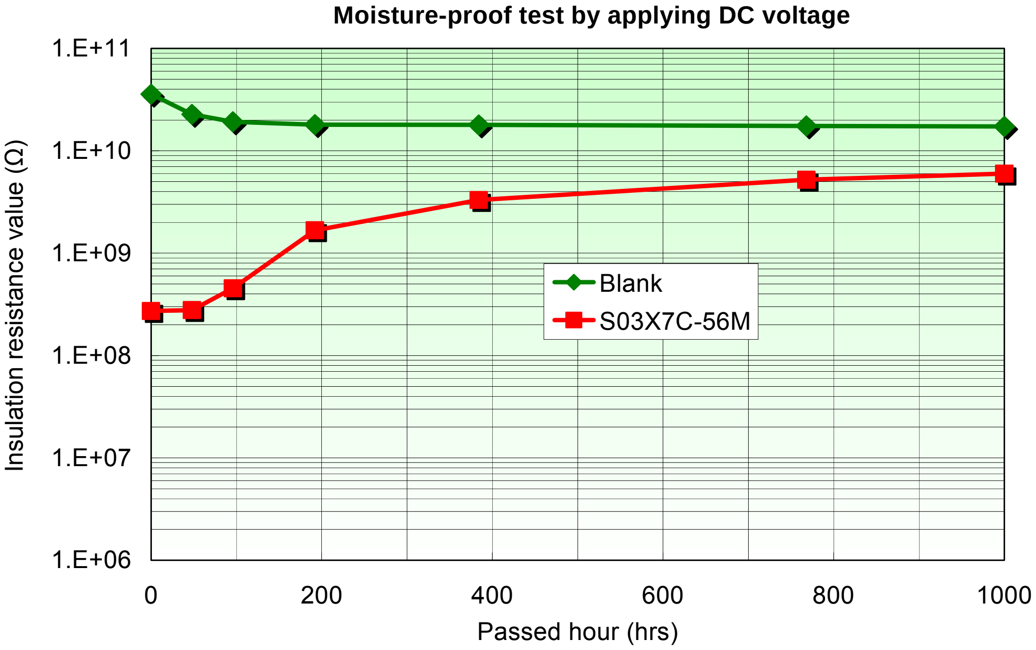
Test method

As a test piece, use the comb type electrode of the glass fiber-based copper-clad, epoxy-resin FR-4 specified in JIS Z 3197, 8. 5. 3 (Test method for resin-based flux for soldering).

After cutting the flux-cored wire solder in approx. 2mm length and making it into a chip state to obtain the test piece, mix the test piece with IPA, and apply ultrasonic wave to the test piece for extracting most of flux to use as a test solution, and then, condense the solution to 25% concentration through vacuum treatment. After applying this test solution onto the above electrode, carry out this migration test. Other test conditions to use specified humidifying atmosphere and applying DC voltage followed JIS Z 3197, 8. 5. 3 (Test method for resin-based flux for soldering). Then under these conditions, we measured insulation resistances under humidified states at each stage during 1000 hours time span.

Test result

The test result shown as below was carried out under the conditions of 85%×85%RH.



3. 10 Solder spread factor

Test method

According to JIS Z 3197, 8. 3.1. 1 (Test method for resin-based flux for soldering).

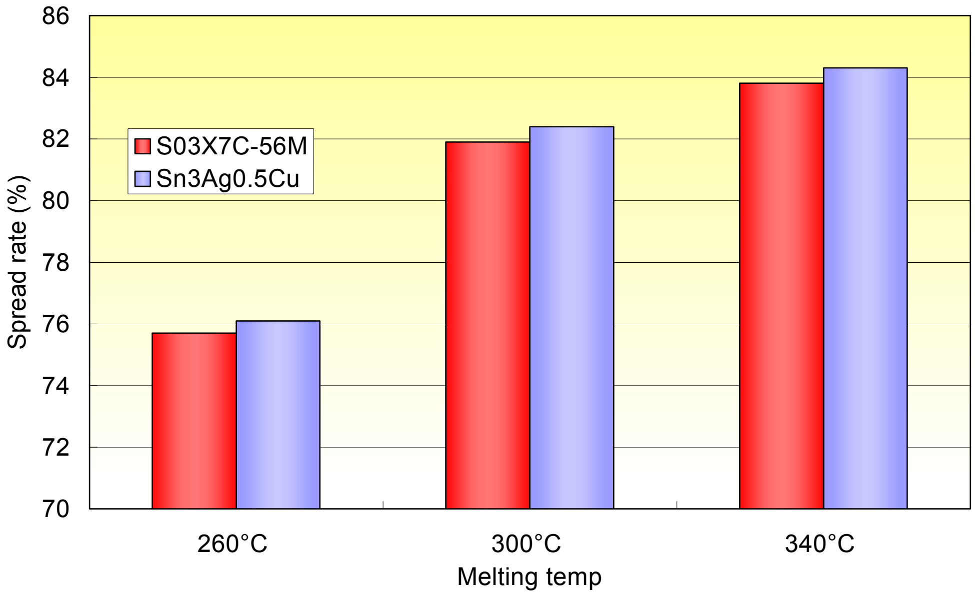
After weighing precisely 0.3g of the flux-cored wire solder, place it on to the copper plate (30 x 30 x 0.3mm thickness) to obtain the test piece. Heat the test piece floating in a molten solder for 5 seconds.

The height of solder shall be measured with a micrometer specified in JIS-B-7502 or with a measuring apparatus equivalent or superior to it.

$$\text{Rate of spread (\%)} = \frac{D - H}{D} \times 100 \text{ ....(3)}$$

H : Height of spread (mm)
D : Diameter when the solder used assumed to be a sphere 8mm)
$D = 1.24V^{1/3}$
V : Mass/specific gravity

Test result

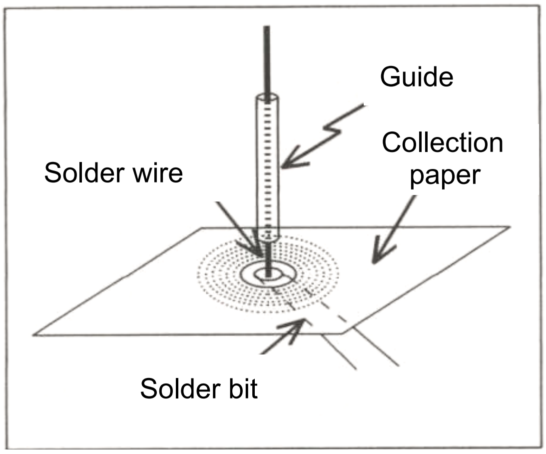


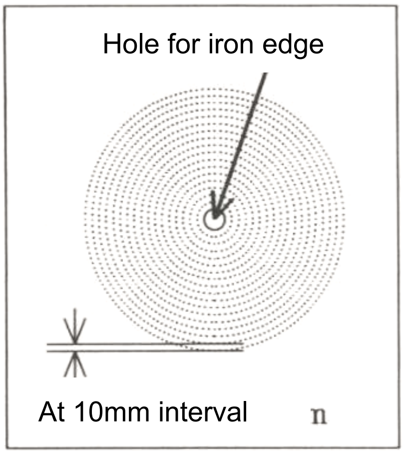
3.11 Measuring flux dispersal

Measurement method

Cut the flux-cored wire solder to approx. 20cm length and straiten as a test piece. Melt the test piece up to 10cm with the solder iron, of which temperature is set at 350°C, at the feeding speed of 1cm/sec above the spattering collection paper with concentric circles drawn at 1cm interval.

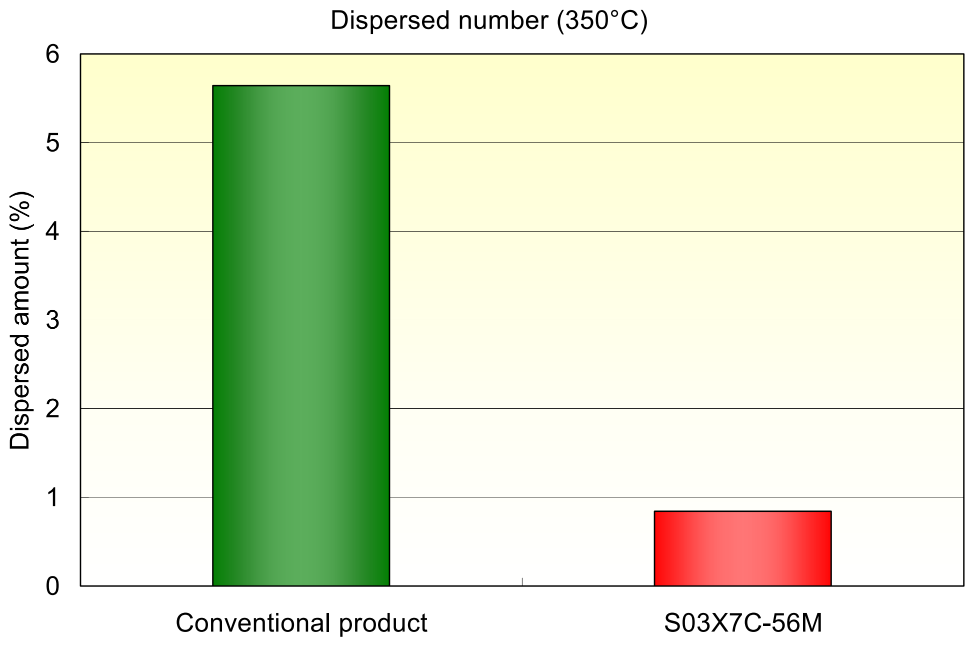
Other test conditions are according to JIS Z 3197, 8. 3. 2. 1 (Test method for resin-based flux for soldering).





Result

The following graph represents correlation between dispersal distance and dispersed number of solder balls according to our test.



3.12 Copper erosion test

Test method

Set two copper plates of 10×120×1mm on the stirring paddles of a mixer. Dip 20mm from the tip into the solder bath of 255°C. Stir at 30rpm for 30 minutes. Measure a decrease in weight of the copper plates and represent the figures as the quantities of copper erosion.

.

Test result

Tested sample	Alloy composition	Copper loss by erosion (g)
Compared sample (1)	Sn3.0Ag0.5Cu	2.60
Compared sample (2)	Sn0.3Ag0.7Cu	2.04
Compared sample (3)	Sn0.7Cu	1.98
S03X7C-56M	**Sn0.3Ag0.7Cu0.03Co**	**0.04**

Note) Complete erosion of the dipped part is 3g.

3.13 Creep test

Test method

1. Test PCB for lead wire

*Glass-epoxy PCB (FR4) (30mm x 30mm x 1.6mmt) with one through hole arranged at the center part of the PCB.

*Through hole dia.: 1.1mm dia.

Pad diameter : 3.0mm

Pad width: 18μm

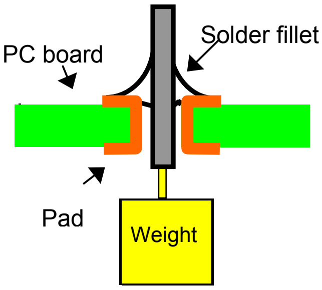
2. Lead wire

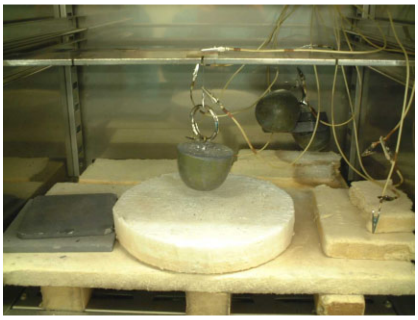
*1.0mm dia. Sn-plated copper wire

3. Test method

*Preparation of test sample

Insert the lead wire through the through hole of the test PCBs and apply RMA type flux thereon. Next, heat the PCB for preheat treatment at 100 – 110°C and, contact it with molten solder kept at 255°C for 10 seconds in the solder bath (except for exclusively given 240°C to ordinal solder formulated in Sn37Pb) to make it soldered.

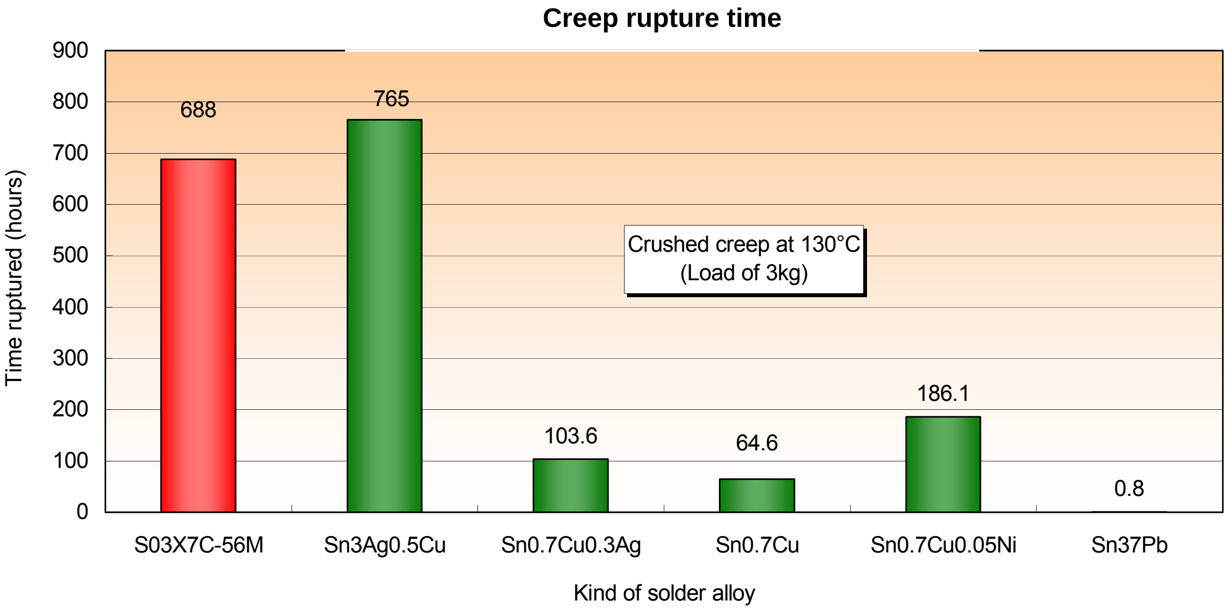




Test result

The following graph represents the test results.

This flux cored wire solder newly doped with Co exhibited as strong creep strength as Sn3Ag0.5Cu.



3.14. Heat cycle test

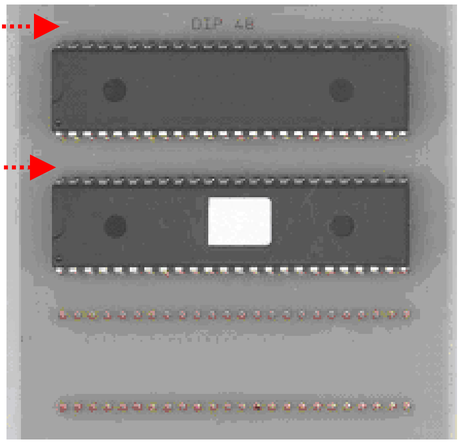
Test method

(1) Heat cycle test PCB

- Test PCB

  Glass-epoxy PCB (FR4) allowing to be inserted with three works of DIP-48pins:

  73mm × 100mm × 1.6mm^2



SnPb-plated component

SnPb-plated component

- Through hole

Through hole diameter :	0.9mm dia.
Annular pad diameter :	1.4mm dia.
Pad thickness :	18μm

- Component

  DIP-48pins

Plated lead :	Sn-Pb
	Sn-Bi (Center-inserted)

(2) Preparation for test PCB

*Insert the components (each of DIP-48pin respectively plated with SnBi & SnPn) into the test PCB.

*Apply flux (KOKI RMA type) to the PCB.

*Using the hot plate, preheat the soldering side of the board to 100 – 110°C.

*Using the test solders, perform dip-soldering to the PCB in static state molten solder (constant at 255°C).

Dip-temperature: SnPb-based solder --- 235°C
SnCu-based solder --- 255°C

(3) Heat cycle test equipment and test condition

Test equipment:

Cool/heat thermal shock tester, NT1020W (WINTECH AIR-series by KUSUMOTO KASEI)

Cycle schedule: -40°C for 45min →120°C

Number of test cycles: 0, 100, 200, 500, 700, 1000, 1200 and 1500 cycles

(4) Evaluating method

Using the binocular-stereo microscope (real image microscope), observe the fillets state and, evaluate their heat cycle characteristics with referring the standards specified in the following table.

Table of evaluating standard for crack

Rank	Surface state of fillet	Evaluated score
A	Random deformation (Wrinkle, roughness)	0.1
B	Concentrated wrinkle (Less than 1/8 of circumferential length.)	0.2
C	Concentrated wrinkle (More than 1/8 of circumferential length.)	0.3
D	Crack (Less than 1/8 of circumferential length.)	0.4
E	Crack (More than 1/8 of circumferential length.)	0.5

*Occurrence frequency of cracking

R = ∑ (Evaluated score of each rank) / n × 100

*Number of cycle of R=50%

Occurrence frequency of cracking is plotted on each cycle test cycle and R=50% is indicated from the plotted graph.

Test result

S03X7C-56M indicated as high anti-thermal fatigue property as Sn/3Ag/0.5Cu.