

ENVIRONMENTALLY FRIENDLY TECHNOLOGY

Approach to Lead Free Relays

Fujitsu Component Limited
Relay R&D department

1. Fujitsu Components' Guideline

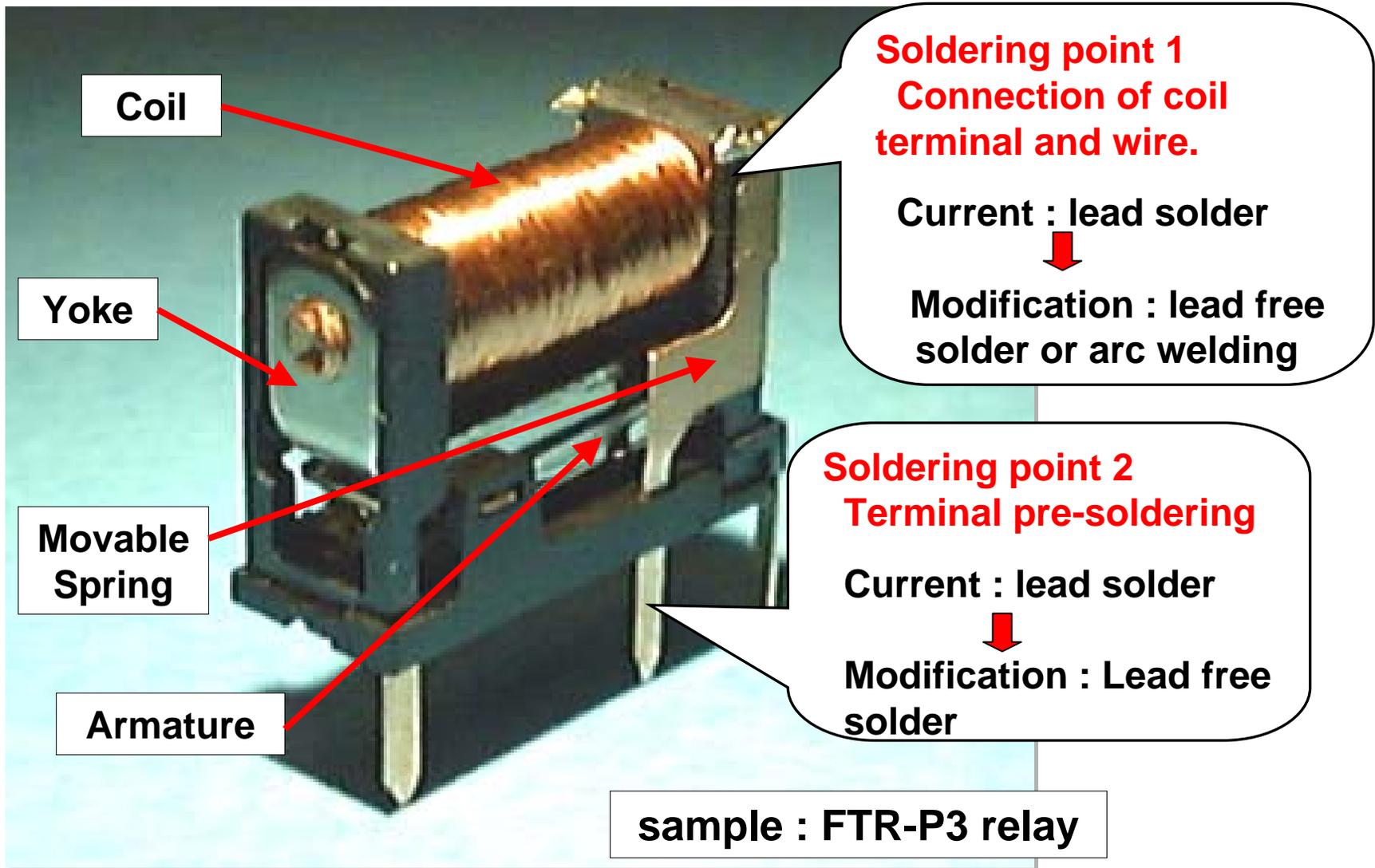
★ Schedule and Goal

Started to replace solder in each relay series with lead-free solder (SnAgCu) in April 2004 and will complete this conversion by March 2005.

★ Some exceptions

- 1. Difficult to convert automotive relays by March 2005**
- 2. SnCuNi will be used for FTR-B3 and B4 series from March 2005 instead of SnAgCu for more efficient production**

2. Soldered Parts in Relay



3. Choice of Lead Free Solder

Bottlenecks	Heat Resistance	Solderability	Connection Reliability	
	Melting Temperature	Solder Wettability	Connection Strength	Suitability for Lead Solder
Conventional Lead Solder	◎	◎	○	—
Sn Cu	△	△	○	○
Sn Ag Cu	○	○	○	○
Sn Ag Cu Bi	○	○	△	△
Sn Cu Ni	○	○	○	○

	Solder Composition	Melting Temperature
Conventional Lead Solder	Sn—37Pb	183 °C
SnCuNi	Sn- 3.0Cu-Ni	227 °C
SnAgCu	Sn- 3.0Ag- 0.5Cu	217-219 °C

Choose Sn-3.0Ag-0.5Cu & Sn-3.0Cu-Ni (only for FTR-B3,B4)

4.1 Recommended Lead Free Solder Profile

★ Recommended Solder Paste
Sn-3.0Ag-0.5Cu

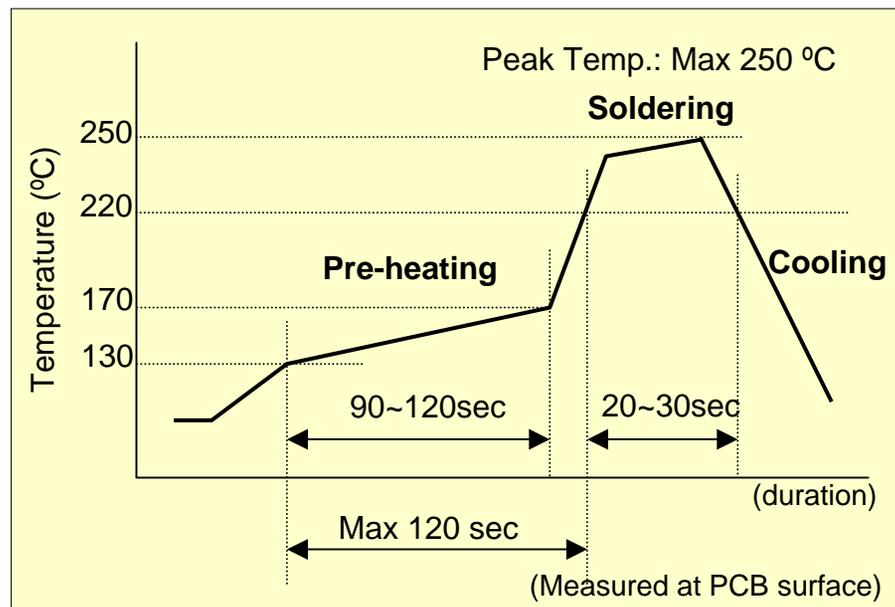
★ Flow solder conditions

Pre-heating: Max.120 °C
Soldering: Dip within 5 sec. at
260°C solder bath.

★ Solder by soldering iron

Soldering iron temperature
:Max. 360°C
Duration: Max. 3 sec.

★ Reflow solder conditions



We highly recommend confirmation using your actual solder conditions

4.2 Recommended Lead Free Solder Profile

★ Recommended Solder Paste
Sn-3.0Cu-Ni

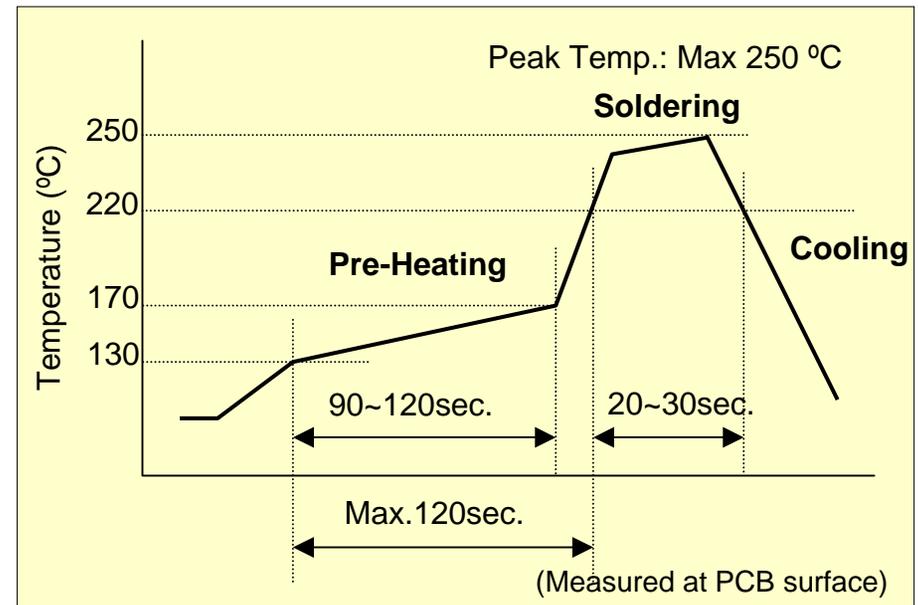
★ Flow Solder Conditions

Pre-heating: Max.120°C
Soldering: Dip within 5 sec.
at 260°C solder bath

★ Solder by Soldering Iron

Soldering iron temperature
: Max. 360 °C
Duration: Max.3 sec

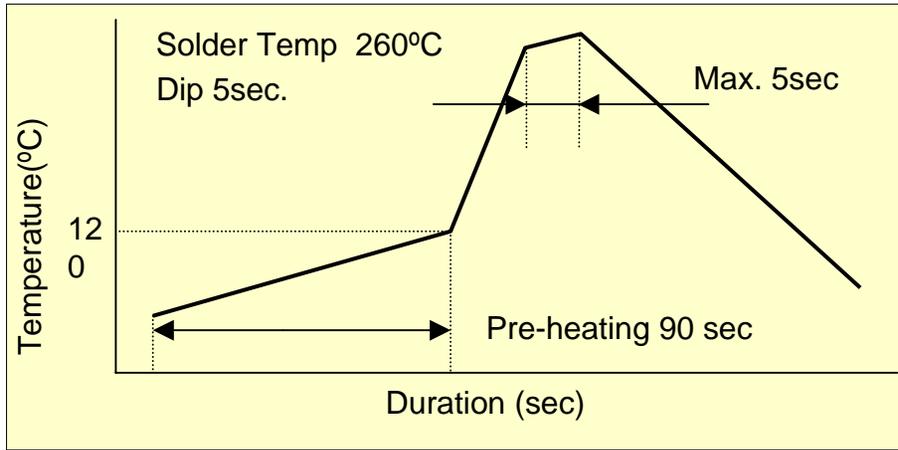
★ Reflow Solder Conditions



We highly recommend confirmation using actual solder conditions.

5.1 Flow Solder Heat Resistance Evaluation

★ Temperature profile for flow solder heat resistance test

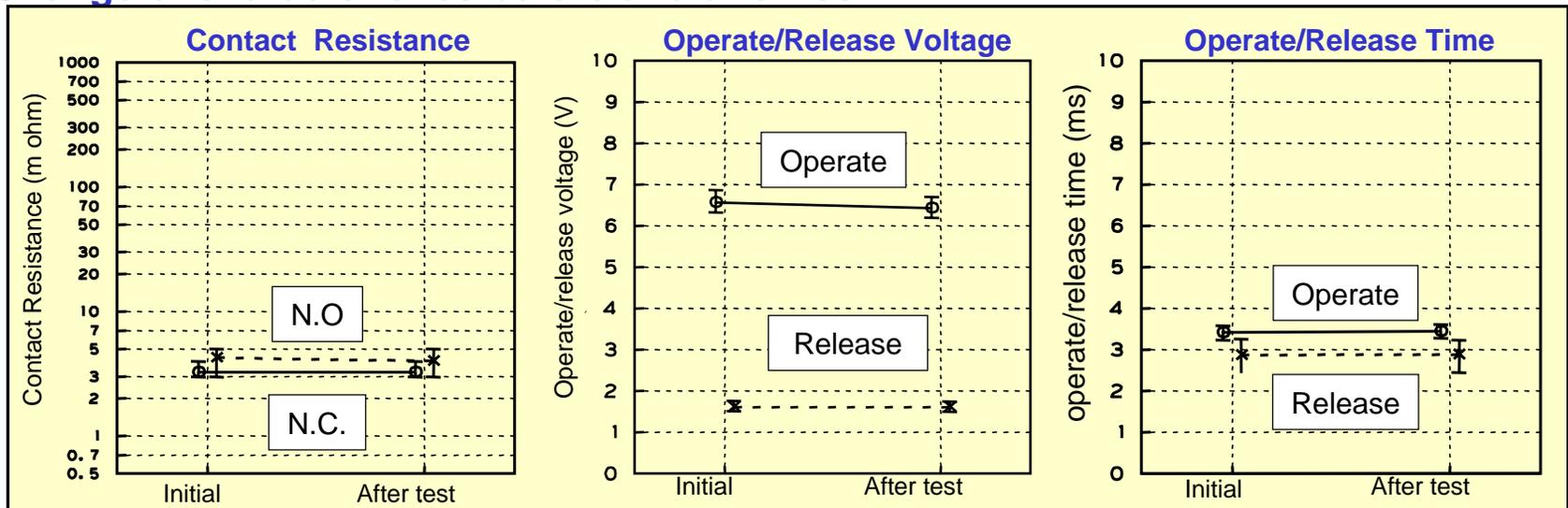


★ Sample FTR-P3 relay



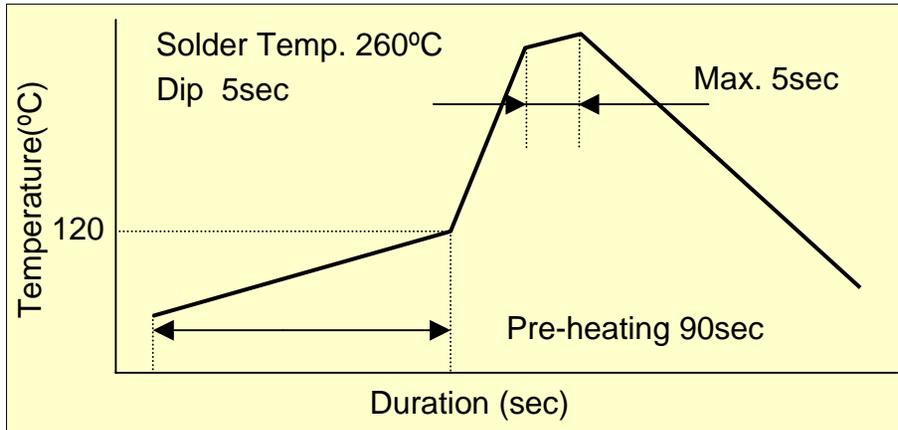
Lead free Solder
Sn-3.0Ag-0.5Cu

★ Change of characteristics before and after test

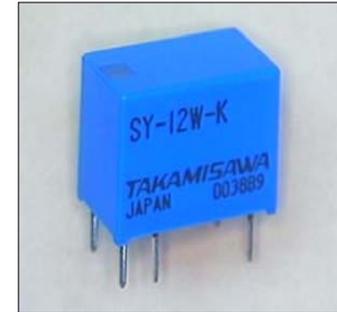


5.2 Flow Solder Heat Resistance Evaluation

★ Temperature profile for flow solder heat resistance test

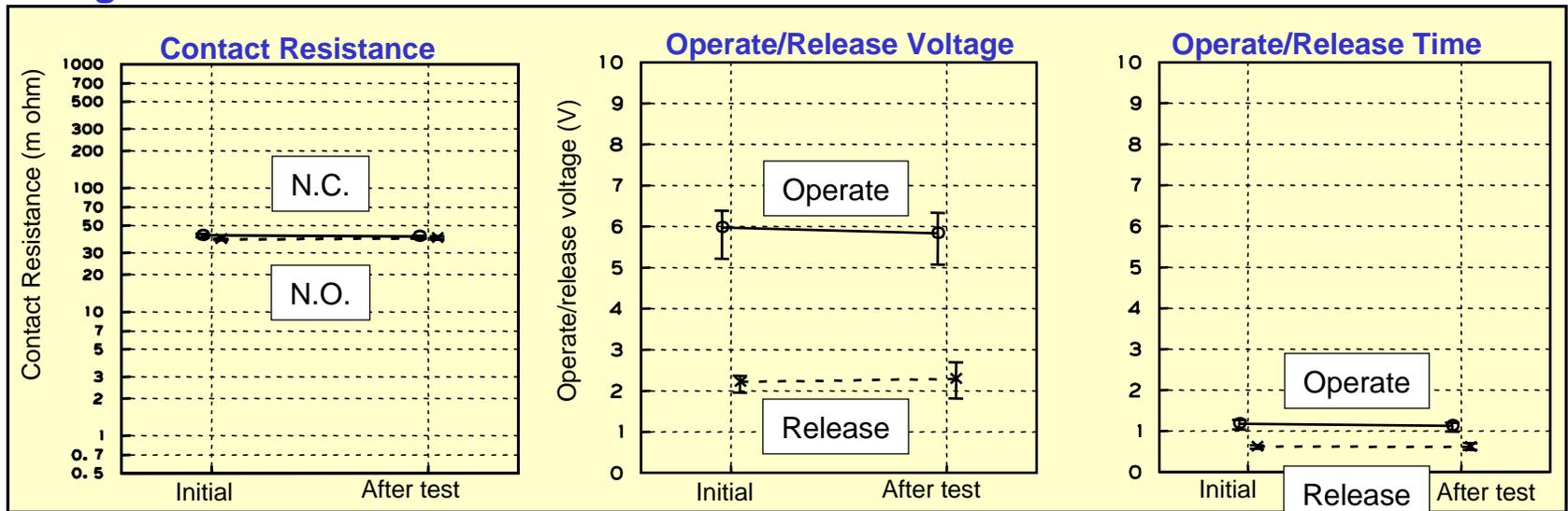


★ Sample SY relay



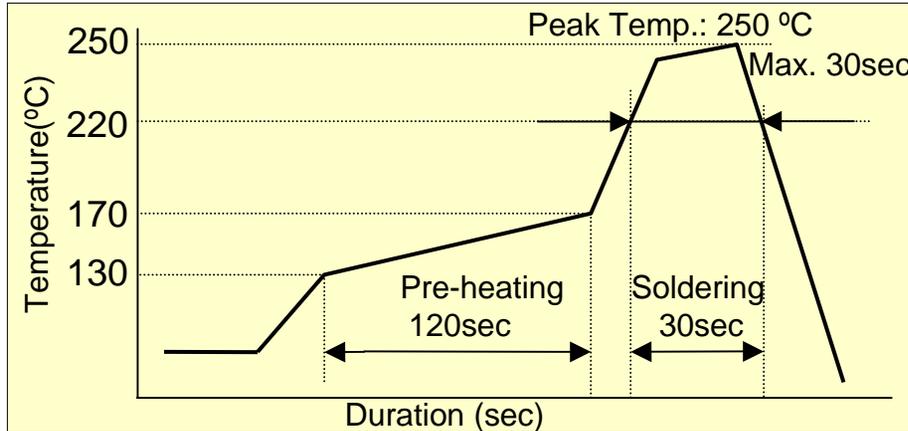
Lead free Solder
Sn-3.0Ag-0.5Cu

★ Change of characteristics before and after test

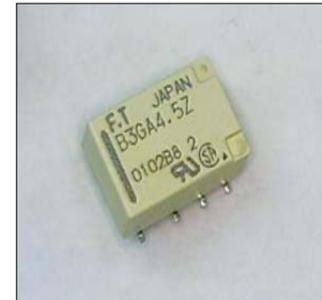


5.3 Reflow Solder Heat Resistance Evaluation

★ Temperature profile for reflow solder heat resistance test

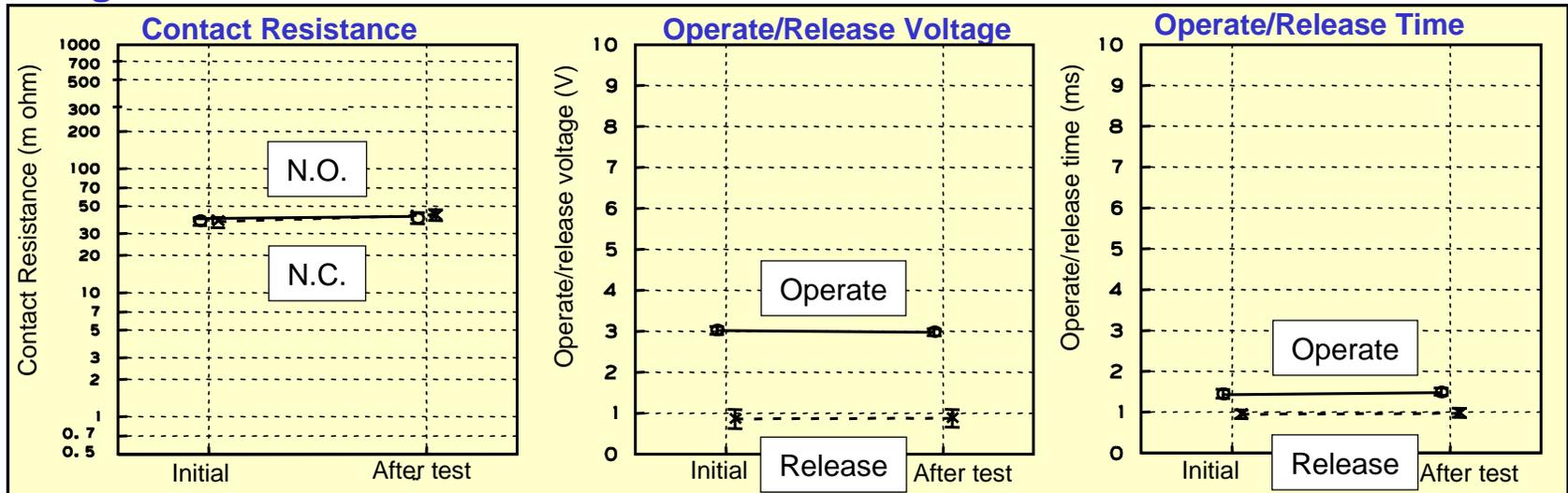


★ Sample FTR-B3 relay



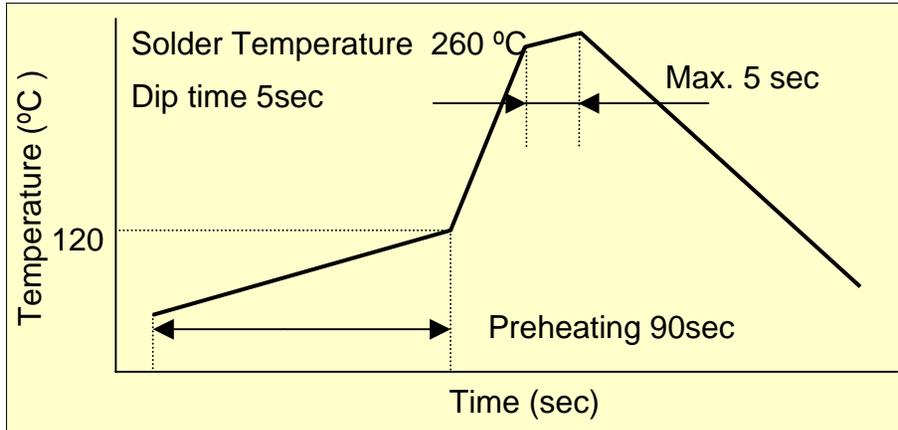
Lead free Solder
Sn-3.0Ag-0.5Cu

★ Change of characteristics before and after test

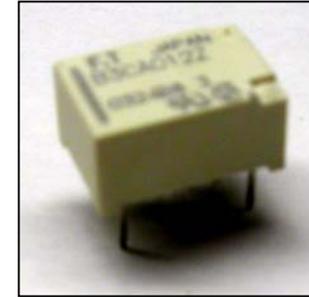


5.4 Flow Solder Heat Resistance Evaluation

★ Temperature profile for flow solder heat resistance test

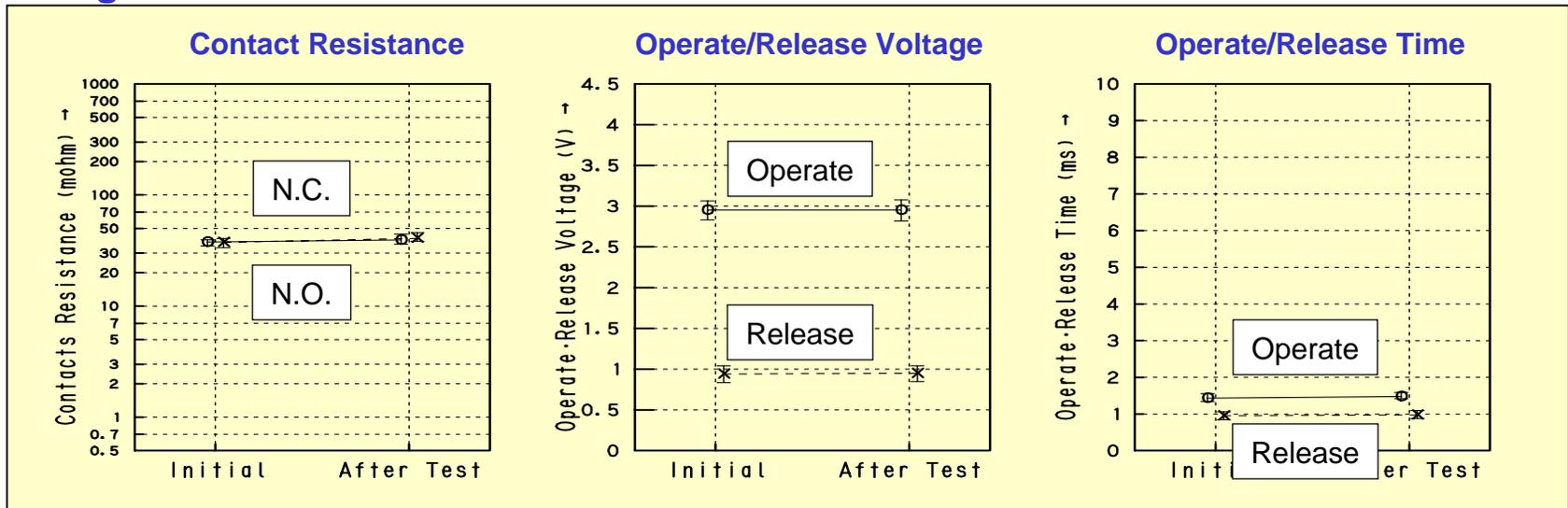


★ Sample FTR-B3 Relay



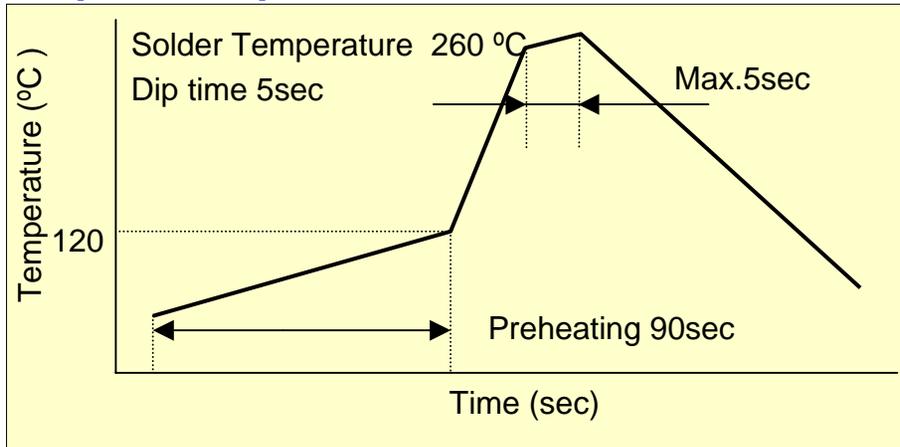
**Lead free Solder
Sn-3.0Cu-Ni**

★ Change of characteristics before and after test

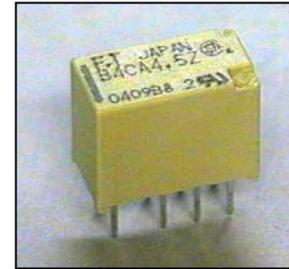


5.5 Flow Solder Heat Resistance Evaluation

★ Temperature profile for flow solder heat resistance test

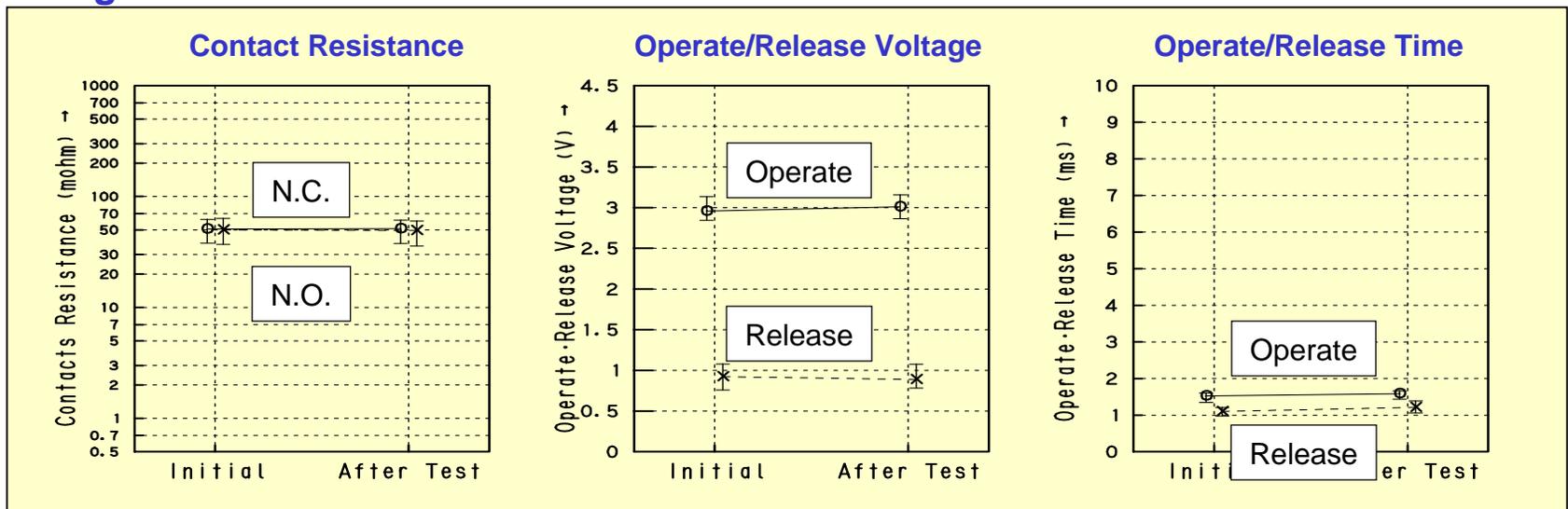


★ Sample FTR-B4 Relay



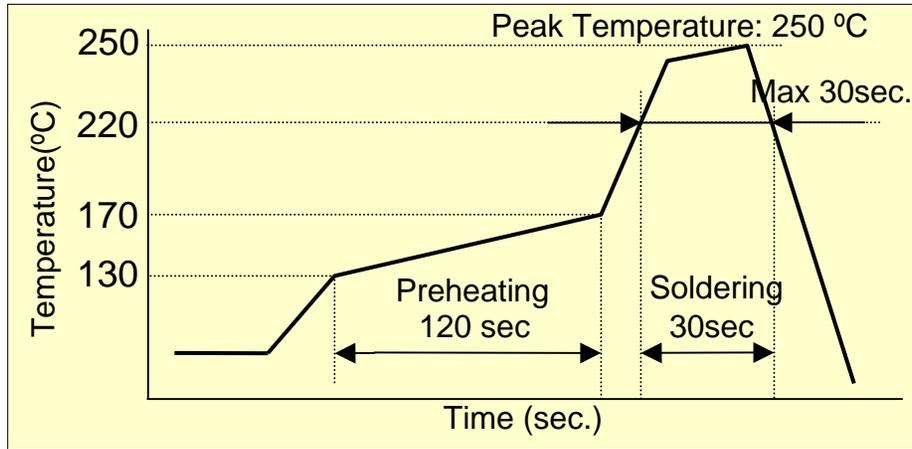
Lead free Solder
Sn-3.0Cu-Ni

★ Change of characteristics before and after test

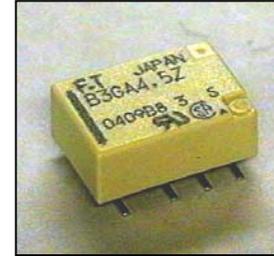


5.6 Reflow Solder Heat Resistance Evaluation

★ Temperature profile

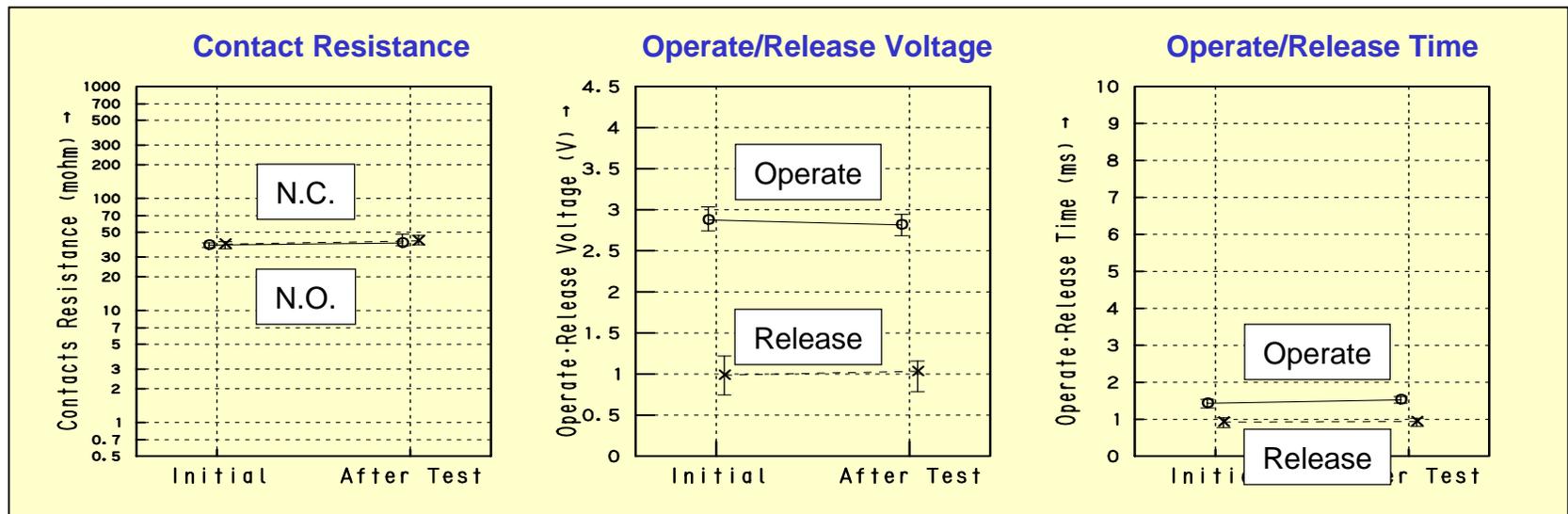


★ Sample FTR-B3 Relay



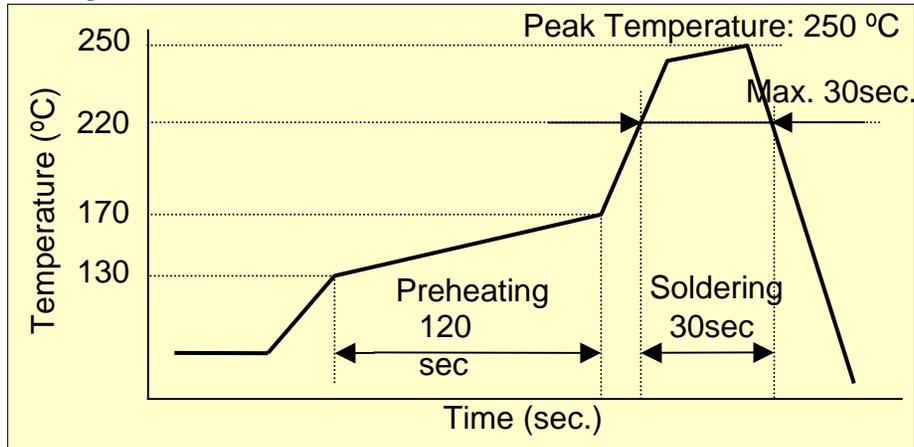
Lead free Solder
Sn-3.0Cu-Ni

★ Change of characteristics before and after test

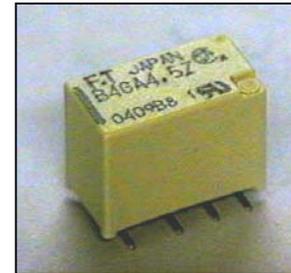


5.7 Reflow Solder Heat Resistance Evaluation

★ Temperature Profile

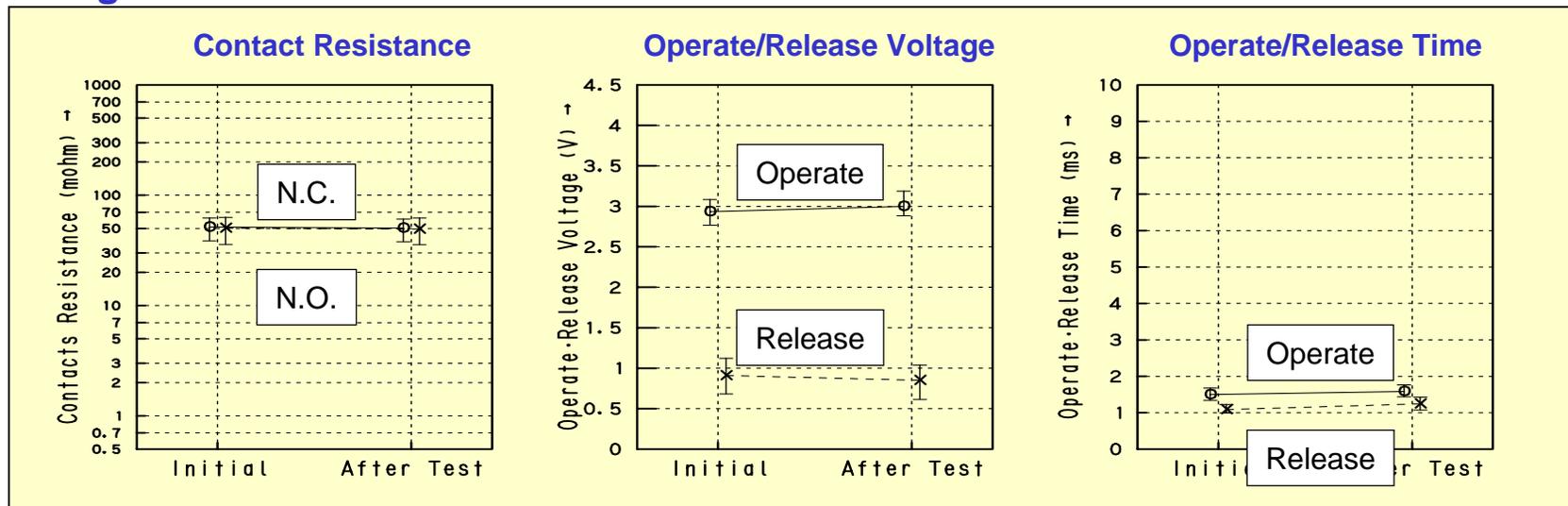


★ Sample FTR-B4 Relay



**Lead free Solder
Sn-3.0Cu-Ni**

★ Change of characteristics before and after test



6.1 Solderability Evaluation

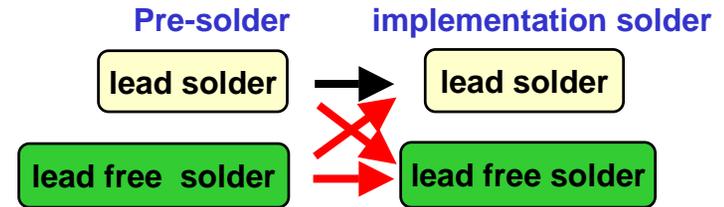
★ Test Condition

Item	Condition
Solder Temp	245 °C (*1)
Dip speed	2 mm/sec
Dip depth	2 mm

*1) FCL's recommended minimum temperature for lead soldering

- **Sample (terminal) pretreatment**
PCT(105 °C, 100%RH, 1.22×10^5 Pa, 8 hours)
- **Solderability tester**
RHESCA CO., Ltd.
Solder checker SAT-5100

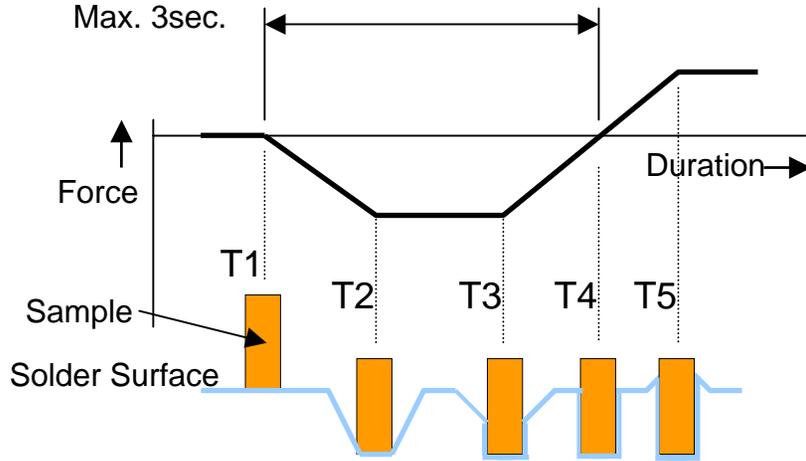
★ Suitability between pre-soldering and implementation soldering



★ Criterion for evaluation

Criterion: Soldering duration (T1~T4)

Max. 3sec.



T1: Contact with solder

T2: Dip

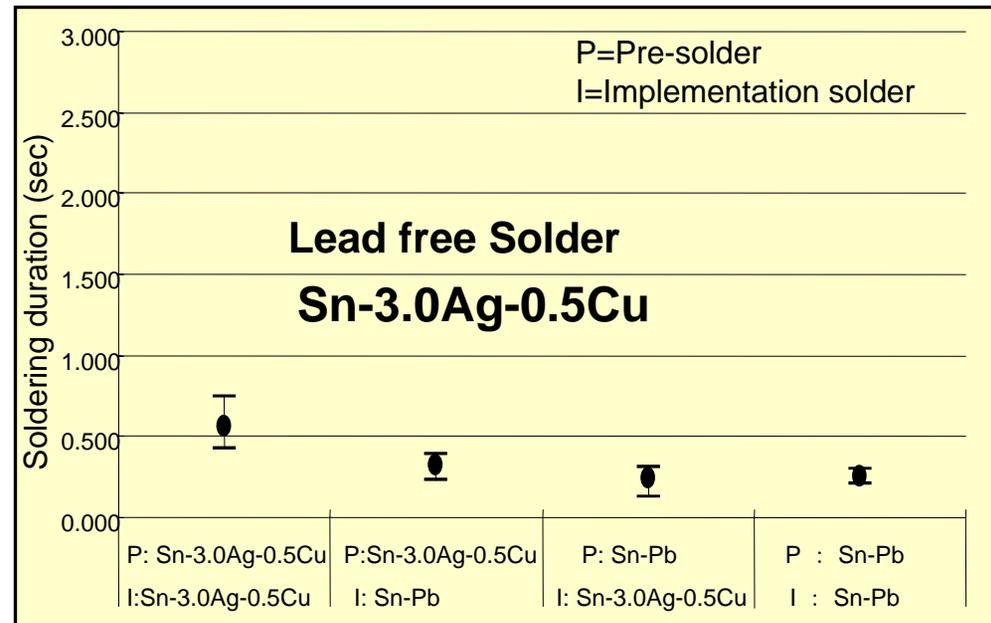
T3: Start wetting

T4: 0 equilibrium point

T5: wetting in counterpoise

★ Test Result

[Sample: C5191]



6.2 Solderability Evaluation

★ Test Condition

Item	Condition
Solder Temp.	245°C (*1)
Dip Speed	2 mm/sec
Dip Depth	2 mm

*1)FCL's recommended minimum temperature for soldering

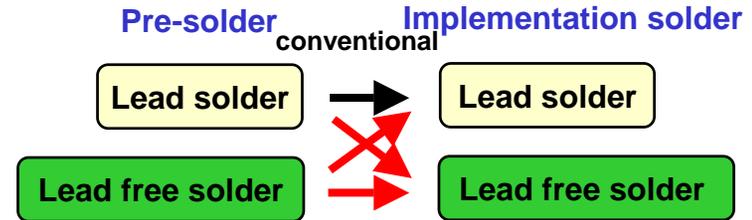
• Sample (terminals) pretreatment

PCT(105°C, 100%RH,
1.22×10⁵Pa, 8Hours)

• Solderbility Tester

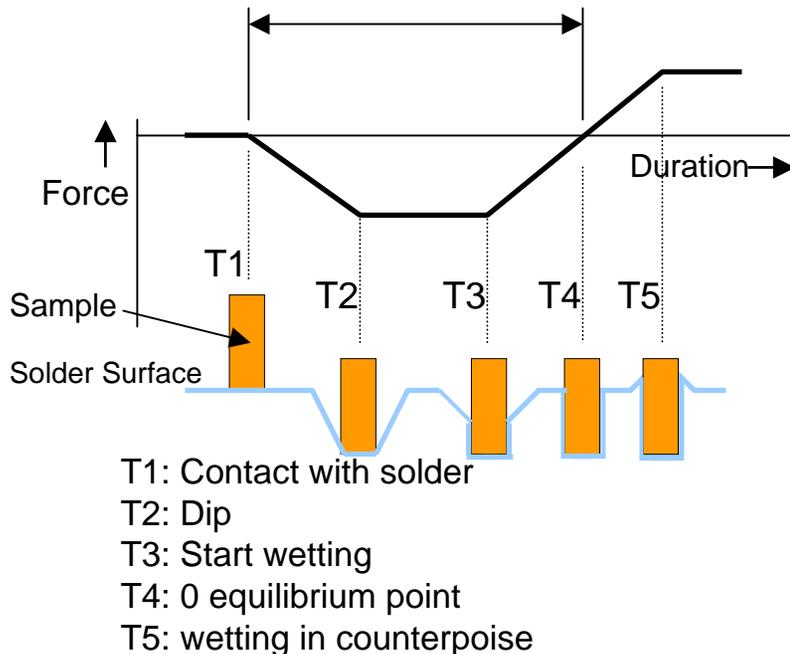
Rhesca Co.,Ltd. :SAT-5100

★ Suitability between pre-soldering and implementation soldering

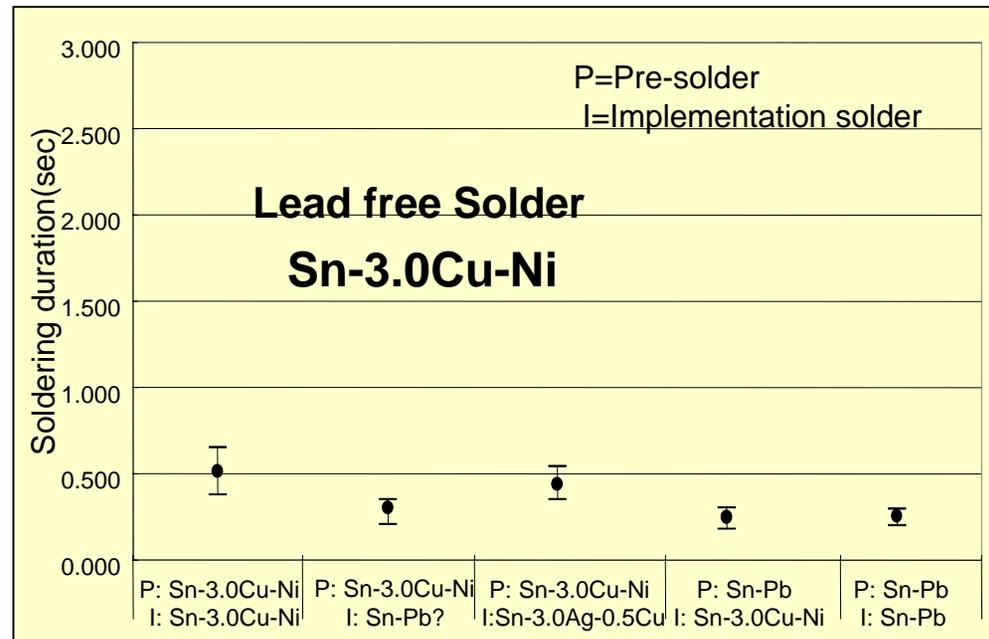


★ Criterion for Evaluation

Criterion: Soldering Duration(T1~T4), Max.3ms

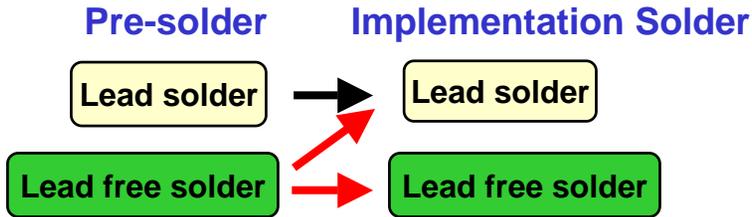


★ Test Result [Sample: C5191]



7.1 Connection Reliability Evaluation

★ **Sample** (Combination of pre-soldering and implementation soldering)

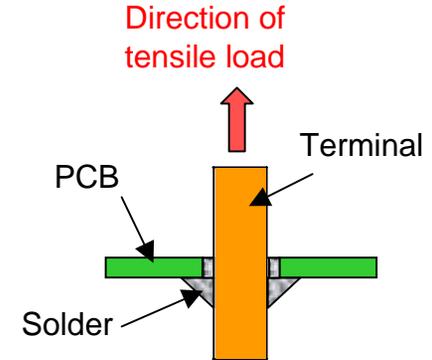


• **Sample (terminal) pre-treatment**
 PCT (105°C, 100% RH, 1.22×10^5 Pa, 8 hours)

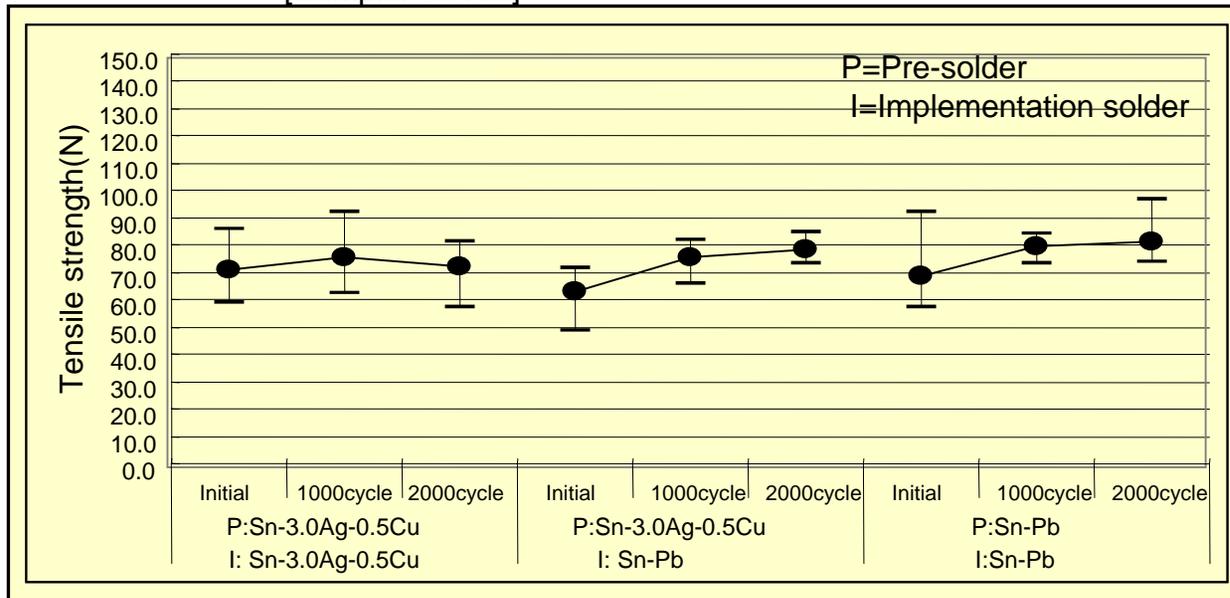
★ **Heat cycle test conditions**

Item	Condition
Min. storage temp.	-35 °C
Max. storage temp.	+105°C
Holding	15min.
Test cycle	1000, 2000

★ **Tensile test**



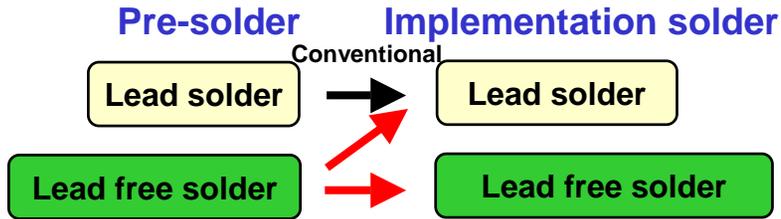
★ **Test Result** [Sample: C5191]



Lead free Solder
Sn-3.0Ag-0.5Cu

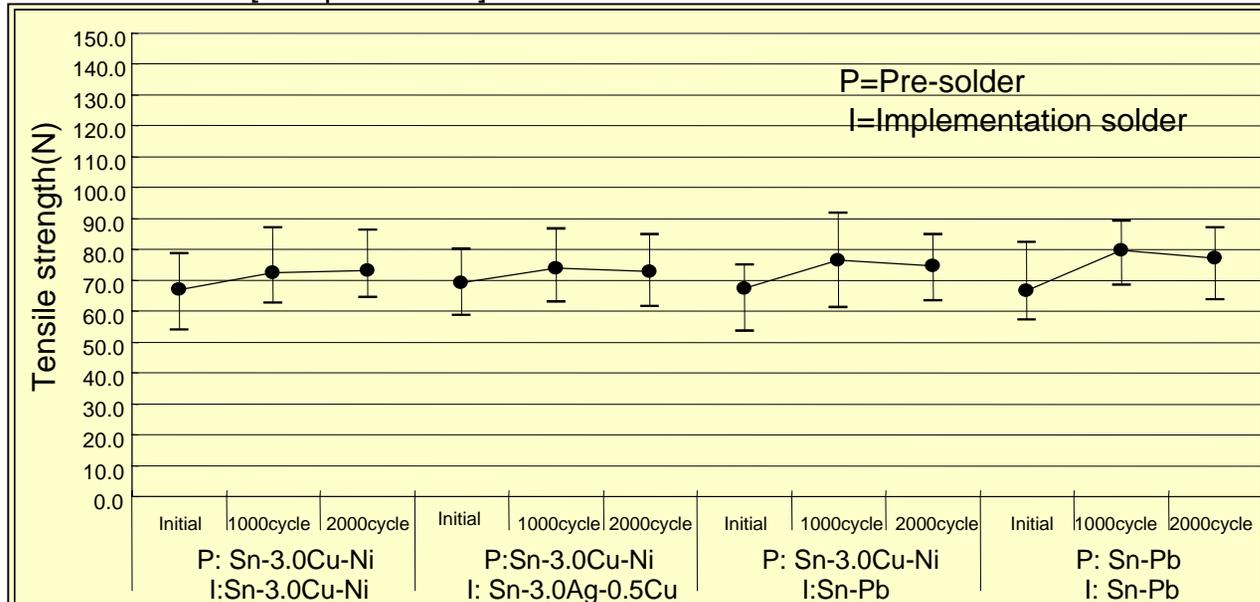
7.2 Connection Reliability Evaluation

★ Sample (Combination of pre-soldering and implementation soldering)



- Sample (Terminals) pre-treatment
PCT(105 °C, 100%RH, 1.22×10^5 Pa, 8hours)

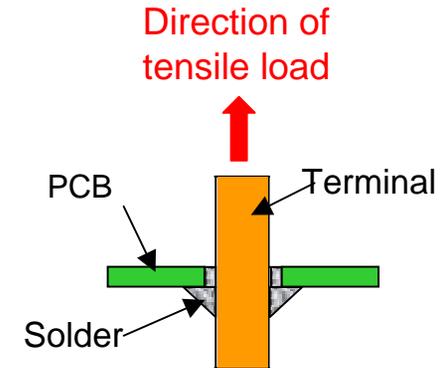
★ Test result [Sample: C5191]



★ Heat cycle test conditions

Item	Condition
Min.storage temp.	-35 °C
Max.storage temp.	+105 °C
Holding	15min.
Test cycle	1000, 2000

★ Tensile test



**Lead free Solder
Sn-3.0Cu-Ni**

8. Summary

★ Transition Time Line

Started fin April 2004 but actual transition time depends on each relay

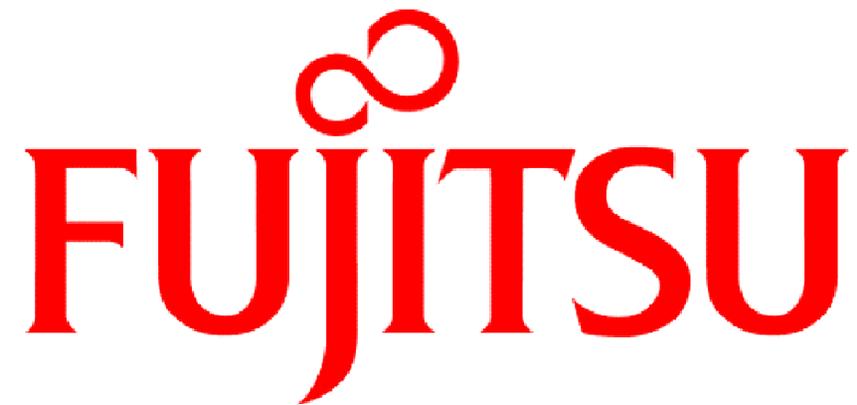
★ Lead free solder material

Sn – 3.0Ag – 0.5Cu

Sn-3.0Cu-Ni from March 2005 for only FTR-B3 and B4 series

★ Lead free soldering evaluation results

- Heat resistance  **Good**
(FCL's recommended lead free soldering condition)
- Solderability  **Good**
- Connection reliability  **Good**



THE POSSIBILITIES ARE INFINITE