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(JWES)

**Solder paste — Part 4: Test methods for
wettability, solderball and spread**

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by The Japan Welding Engineering Society (JWES) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Consequently **JIS Z 3284**:1994 has been withdrawn and partially replaced with this Standard.

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JIS Z 3284 series consists of the following 4 parts under the general title “*Solder paste* —”:

Part 1: Kinds and quality classification

Part 2: Test methods for solder particle shape, surface condition judgment, and particle size distribution

Part 3: Test methods for printability, viscosity, slump and tackiness

Part 4: Test methods for wettability, solderball and spread

Solder paste — Part 4 : Test methods for wettability, solderball and spread

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of IEC 61189-5 published in 2006 with some modifications of the technical contents in order to reflect the current situation in Japan.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the flux efficacy and de-wetting test, solderball test, spread test, wetting balance test and displacement detection wetting test of the solder paste for soldering used for the wiring connection, connection of parts, etc. of electric equipment, electronic equipment, communication equipment, etc.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

IEC 61189-5 : 2006 *Test methods for electrical materials, interconnection structures and assemblies — Part 5 : Test methods for printed board assemblies* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 0099 *Environmental testing : Tests — Test : Test methods for solderability of surface mounting devices (SMD) by wetting balance using lead-free solder paste*

JIS H 3100 *Copper and copper alloy sheets, plates and strips*

JIS K 8034 *Acetone (Reagent)*

JIS K 8180 *Hydrochloric acid (Reagent)*

JIS K 8839 *2-Propanol (Reagent)*

JIS R 6252 *Abrasive papers*

JIS Z 3001 (series) *Welding and allied processes — Vocabulary*

JIS Z 3197 *Test methods for soldering fluxes*

JIS Z 3284-1 *Solder paste — Part 1 : Kinds and quality classification*

NOTE : Corresponding International Standard : IEC 61190-1-2 : 2007 *Attachment materials for electronic assembly — Part 1-2 : Requirements for soldering pastes for high-quality interconnects in electronics assembly (MOD)*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS Z 3001** (series) and **JIS Z 3284-1**, and the following apply.

3.1 acting force area

area obtained with a sign by the integration of the interval from the reference point of measurement of time until the start of pulling-up to the acting force applied to a test specimen

4 Test methods

4.1 Flux efficacy and de-wetting test

The method to measure and evaluate the flux efficacy of the solder paste is specified herein. The test shall be as follows.

- a) **Outline of test** The degree of the spread on a flat substrate of the solder in solder paste which is in the molten state is measured under the specified conditions.
- b) **Reagent** The reagent shall be as follows.

2-Propanol as specified in JIS K 8839.

- c) **Equipment and instruments** The equipment and instruments shall be as follows.

- 1) **Test plate** either of phosphorous deoxidized copper plate of C1201P or C1220P, or brass plate of C2680P specified in **JIS H 3100** of 50 mm × 50 mm × 0.5 mm in dimensions.
- 2) **Abrasive paper** of P600 (waterproof) specified in JIS R 6252.
- 3) **Metal mask** of 0.20 mm in thickness having a hole of 6.5 mm in diameter.
- 4) **Spatula**
- 5) **Squeegee**
- 6) **Dryer** of an air-circulating type having the performance capable of setting and holding the temperature at 150 °C ± 3 °C.
- 7) **Solder bath** of a cylindrical container of 40 mm or more in depth and 120 mm or larger in diameter, or a rectangular parallelepiped container of 30 mm or more in depth and 100 mm × 150 mm or larger in sides. It shall be capable of being filled with the solder of which the liquidus temperature is 220 °C or under (for example,

Sn96.5Ag3Cu0.5) and having a temperature controller which can control the temperature at $250\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ or at the higher temperature than the liquidus temperature of solder used for the test by $35\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.

- 8) **Tongs or other suitable tools** suitable for picking up a test specimen horizontally from the surface of the solder bath.
 - 9) **Scrubber** capable of removing the solder oxide film of the solder bath easily.
- d) **Test procedure** The test procedure shall be as follows.
- 1) **Pretreatment of test plate** Clean the surface of the test plate with 2-Propanol. After polishing one side of the copper plate using an abrasive paper while dropping 2-Propanol, wash dirt on the surface with 2-Propanol and dry enough at the room temperature.

In order to make handling by tongs easy, one corner of the test plate may be bent.
 - 2) In the case where the solder paste has been stored in a cool and dark place, take it out, and leave it as it is with the container sealed until it reaches the room temperature. Open the lid of the container, and stir the solder paste with a spatula to make it uniform. Within 1 h after polishing the surface of the test plate, apply the solder paste to the centre of the copper plate using a metal mask and take it as a test specimen.
 - 3) When preliminary drying is specified, dry the test plate to which the solder paste is applied for 1 min in a dryer at $150\text{ }^{\circ}\text{C}$.
 - 4) Clean the surface of the solder bath with a scrubber.
 - 5) Heat the test specimen by floating it on the solder bath set at the higher temperature than the liquidus temperature of solder used for the test by $35\text{ }^{\circ}\text{C}$ and hold it for 5 s after the solder is melted. In the case of Bi58Sn42 solder, the preset temperature of the solder bath shall be $235\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

After that, pull up the test specimen from the solder bath keeping it horizontally and cool it to the room temperature. Remove the flux residues with a suitable solvent such as 2-Propanol.
 - 6) Examine the degree of spread.
 - 7) For the results, record them in accordance with Annex A.
- e) **Evaluation method** The degree of spread shall be classified according to the state of spread shown in Table 1.

Table 1 Degree of spread

Classification of degree of spread	State of spread
1	State where molten solder spreads not less than the area to which solder paste is applied, and wets the test plate.
2	State where the whole area to which solder paste is applied is wetted by solder.
3	State where almost the entire area to which solder paste is applied is wetted by solder (including de-wetting).
4	State where no solder seems wetted, and the molten solder becomes one or more solderballs (non-wetting).
— On the brass plate, the solder may be sometimes expanded to the outward of major spread area along the file groove due to the capillary effect. This excessive spread need not be evaluated. — Although a small solderball may be found, this shows that the degree of reflow is insufficient, and it need not be evaluated.	

4.2 Solderball test

The method to measure and evaluate the degree of generation of solderballs in the reflow process of the solder paste is specified herein. The test shall be as follows.

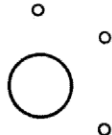
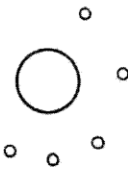
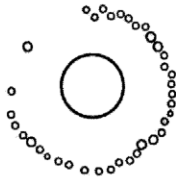
- a) **Outline of test** The solder paste is melted on the substrate whose surface cannot be wetted with the solder, and the performance that the solder particles in the solder paste are aggregated is measured under the specified conditions.
- b) **Reagent** The reagent shall be as follows.
 - 1) **2-Propanol** as specified in JIS K 8839.
- c) **Equipment and instruments** The equipment and instruments shall be as follows.
 - 1) **Ceramic plate** of 25 mm × 50 mm × 0.2 mm in dimensions.
 - 2) **Metal mask** of 25 mm × 50 mm × 0.2 mm in dimensions having a hole of 6.5 mm in diameter at the centre. The metal mask specified in 4.5 c) 2) of JIS Z 3284-3 may be used.
 - 3) **Solder bath** of a cylindrical container of 40 mm or more in depth and 120 mm or larger in diameter, or a rectangular parallelepiped container of 30 mm or more in depth and 100 mm × 150 mm or larger in sides. It shall be capable of being filled with the solder of which the liquidus temperature is 220 °C or under (for example, Sn96.5Ag3Cu0.5) and having a temperature controller which can control the temperature at 250 °C ± 3 °C or at the higher temperature than the liquidus temperature of solder used for the test by 35 °C ± 3 °C.
 - 4) **Tongs or other suitable tools** suitable for picking up a test specimen horizontally from the surface of the solder bath.
 - 5) **Spatula**

- 6) **Magnifier** capable of setting the observation magnification to $\times 10$ to $\times 20$ (for full view observation) or $\times 50$ (for solderball observation).
- d) **Test procedure** The test procedure shall be as follows.
- 1) In the case where the solder paste has been stored in a cool and dark place, take it out, and leave it as it is with the container sealed until it reaches the room temperature. Open the lid of the container, and stir the solder paste with a spatula to make it uniform.
 - 2) Apply the solder paste to the centre of the ceramic plate using a metal mask and take it as a test specimen.
 - 3) Place the metal mask on the ceramic plate. After printing using a squeegee, remove the mask, check the sizes of 6.5 mm in diameter and 0.2 mm in thickness, and take it as a sample. Prepare two samples.
 - 4) Melt one sample under the condition a and the other sample under the condition b on two plates by heating according to the procedure of 5). Preheat them for 1 min at $150\text{ }^{\circ}\text{C}$ as necessary.

Condition a Within 1 h after printing

Condition b After being left for 24 h at relative humidity $(60 \pm 20)\%$ and temperature of $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ after printing
 - 5) Clean the surface of solder with a scrubber in the solder bath set at the higher temperature than the liquidus temperature of solder by $35\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, place the sample on the liquid solder surface horizontally, take the test specimen out from the liquid solder surface horizontally 5 s after the solder paste is melted, and leave it as it is to cool it until the solder of sample is solidified.
 - 6) For the results, record them in accordance with Annex A.
- e) **Evaluation method** The full view of the solidified solder (spread shape of solder-ball) shall be observed by using a magnifier of $\times 10$ to $\times 20$, and the particle size and the number of solderballs shall be observed by using a magnifier of $\times 50$, and the evaluation shall be made according to the aggregated state of the solder particles shown in Table 2.

Table 2 Aggregated state of solder particles

Degree of aggregation of solder	Explanation of aggregated state of solder particles	Illustrated example
1	Solder (powder) is melted to make a large ball, and no solderballs are found around it.	
2	Solder (powder) is melted to make a large ball, and three or under solderballs whose diameter is 75 μm or under are found around it.	
3	Solder (powder) is melted to make a large ball, and four or more solderballs whose diameter is 75 μm or under are found around it, but they are not arranged in a semi-continuous annular form.	
4	Solder (powder) is melted to make a large ball, and a number of small balls are found arranged in a semi-continuous annular form.	
5	Other than the above	

4.3 Spread test

The test method of the spreading characteristics of solder paste is specified herein, which shall be in accordance with **JIS Z 3197**.

4.4 Wetting balance test

4.4.1 Temperature rise method by rapid heating

The test method in which various solder pastes are melted by rapid heating with a heating device in a short time is specified herein. The solder wettability of the test specimen at that time is measured and the solder paste wettability is evaluated, which shall be as follows.

- a) **Outline of test** This test is performed in such a way that the solder paste is melted by rapid heating with a heating device in a short time, the solder wettability of the sample product at that time is measured, and the solderability is evaluated. The test specimen shall be immersed before heating the solder paste.
- b) **Reagents and materials** The reagents and materials shall be as follows.
 - 1) **Pickling agent** 5 g of hydrochloric acid (guaranteed) specified in **JIS K 8180** diluted with 95 g of deionized water (about 1.75 % for concentration of hydrochloric acid).
 - 2) **Acetone** as specified in **JIS K 8034**.