



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS Z 3198-3 : 2003
(JWES)

**Test methods for lead-free solders—
Part 3 : Methods for spread test**

ICS 25.160.50

Reference number : JIS Z 3198-3 : 2003 (E)

PROTECTED BY COPYRIGHT

5 S

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 of establishing a Japanese Industrial Standard from The Japan Welding Engineering Society (JWES), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Soldering is called HANDAZUKE (Japanese), a technique to be used for mounting electronic and electrical machinery and apparatus, communication equipment and the like and its use field is wide and expectation for high reliability of the connection is large.

Though there are standards inside and outside Japan as well as International Standards like IEC or ISO, this Standard uses results of "standardization of test methods and the like necessary for solder connection corresponding to the reduction of an environmental load" based on the research and development by contract of New Energy and Industrial Technology Development Organization.

This Standard concerns the methods for spread test of lead-free solders which are environmentally friendly and is positioned as a standard for considering environment.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

JIS Z 3198 includes the following 7 parts with the general title *Test methods for lead-free solders*

Part 1 : Methods for measuring of melting temperature ranges

Part 2 : Methods for testing of mechanical characteristics—tensile test

Part 3 : Methods for spread test

Part 4 : Methods for solderability test by a wetting balance method and a contact angle method

Part 5 : Methods for tensile tests and shear tests on solder joints

Part 6 : Methods for 45° pull test of solder joints on QFP lead

Part 7 : Methods for shear strength of solder joints on chip components

Date of Establishment: 2003-06-20

Date of Public Notice in Official Gazette: 2003-06-20

Investigated by: Japanese Industrial Standards Committee
Standards Board

Technical Committee on Welding

JIS Z 3198-3:2003, First English edition published in 2003-12

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2003

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Definitions	1
4 Outline of test	1
5 Material and reagents	1
6 Apparatus and equipment	2
7 Procedure of test.....	3
7.1 Pretreatment of copper sheet	3
7.2 Shape of sample solder	3
7.3 Flux (Halogen-activated rosin flux)	4
7.4 Test	4
8 Calculation of spread rate	4

Test methods for lead-free solders— Part 3 : Methods for spread test

Introduction This Japanese Industrial Standard specifies the method for spread test for evaluation of wettability of lead-free solders based on occupational results by contract of New Energy and Industrial Technology Department Organization concerning “the standardization of test methods and the like necessary for solder connection corresponding to the reduction of an environmental load” carried out in 2000 and 2001.

1 Scope This Standard specifies the method of spread test of lead-free solder to be used principally for wiring connection, parts connection and the like of electrical machinery and apparatus, electronic apparatus, communication equipment and the like.

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

JIS B 7502 *Micrometer callipers*

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

JIS K 5902 *Colophonium*

JIS K 8034 *Acetone*

JIS K 8839 *2-Propanol*

JIS R 3503 *Glass apparatus for chemical analysis*

JIS Z 3001 *Welding terms*

JIS Z 3284 *Solder paste*

3 Definitions For the purposes of this Standard, the definitions given in **JIS Z 3001** and the following definitions apply:

- a) **lead-free solder** It is the generic term of “a tin based solder” not containing lead as an alloy component. It is “a solder not containing lead” for a use corresponding to that of “a tin-lead based solder”, which is used for mounting an electrical, electronic, communication equipment and the like.

4 Outline of test Place a lead-free solder (hereafter referred to as “solder”) sample and a flux on a copper plate. After melting by heating for a specific time, evaluate wettability of the solder by measuring the spread rate of the solder.

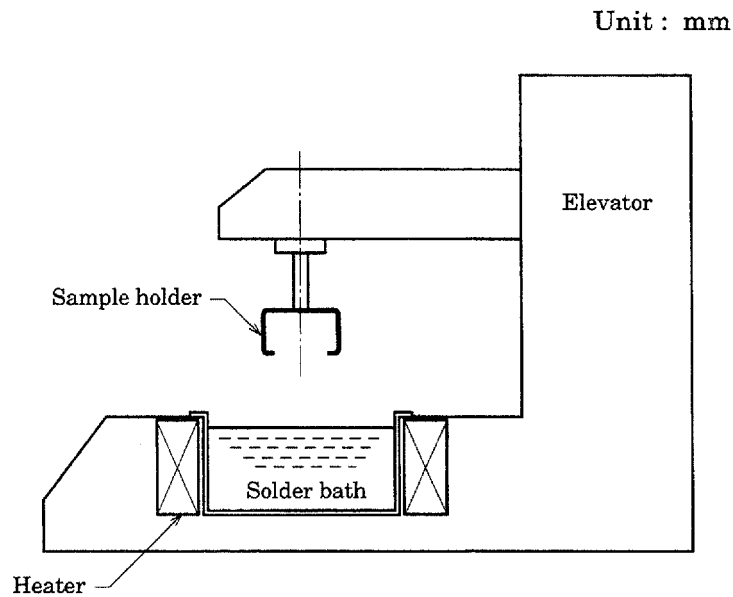
5 Material and reagents Material and reagents shall be as follows:

- a) **Copper sheet** Phosphorus-deoxidized copper sheet C1220P or C1201P specified in **JIS H 3100** of which the size is 30 mm × 30 mm × 0.3 mm.
- b) **Rosin** Rosin of class 2 specified in **JIS K 5902**.

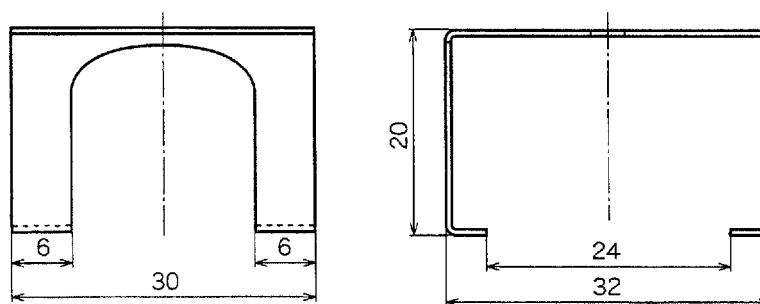
- c) **2-Propanol** 2-Propanol specified in **JIS K 8839**.
- d) **Cleaning solvent** A solvent suitable for removing a flux residue after soldering.
- e) **0.5 mass % ammonium persulfate solution** Dissolve 250 g of ammonium persulfate in water and carefully add 5 ml of concentrated sulfuric acid (1.84 in specific gravity). Thereafter, stir, cool and dilute to 1 l. Prepare this solution each use.
- f) **5 mass % sulfuric acid** Carefully add 50 ml of concentrated sulfuric acid (1.84 in specific gravity) to 400 ml of water. Stir, cool and dilute to 1 l with water.
- g) **Acetone** Acetone specified in **JIS K 8034**.
- h) **Refined water** Distilled water or ionexchanged water of $\geq 5 \text{ k}\Omega \cdot \text{m}$ in specific resistance at 20 °C.

6 Apparatus and equipment The apparatus and equipment shall be as follows:

- a) **Solder bath** The solder bath is provided by filling solder $\leq 200 \text{ }^{\circ}\text{C}$ in liquidus line temperature (for example, Sn-58Bi solder) in a solder tank $\geq 30 \text{ mm}$ in depth and $\geq 100 \text{ mm} \times 150 \text{ mm}$ in width and is equipped with a temperature regulator capable of controlling at a test temperature ($250 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$) specified in **7.4 c**).
- b) **Dryer** The dryer is of an air circulation type, which can be set at $100 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$ and held.
- c) **Elevator** The elevator is suitable for bringing a test piece to a horizontal contact with a molten solder surface of a solder bath and horizontally pulling up the test piece (see Fig. 1).



a) Basic structural figure



b) Sample holder

Fig. 1 Basic structural figure and sample holder

- d) **Scrubber** A scrubber which can easily remove a surface solder oxidized film of a solder bath.
- e) **Micrometer** A micrometer which is specified in **JIS B 7502** or has a measuring precision at least equivalent in quality thereto.
- f) **Microsyringe or micropipette** A microsyringe or a micropipette capable of a measurement to 0.02 ml.
- g) **General experimental implement** All glass implements to be used for this test shall be specified in **JIS R 3503**.

7 Procedure of test

7.1 Pretreatment of copper sheet A copper sheet is pretreated by the method specified in 4 (2) of Annex 4 of **JIS Z 3284**.

7.2 Shape of sample solder A solder sample is provided by being machined in a disc plate shape 6.5 mm ϕ in diameter and 1.24 mm in height (0.041 cm³ in volume).

7.3 Flux (Halogen-activated rosin flux) A flux is prepared in accordance with the following procedure:

- a) Add $25 \text{ g} \pm 0.1 \text{ g}$ of a rosin specified in class 2 of **JIS K 5902** to $75 \text{ g} \pm 0.1 \text{ g}$ of 2-propanol, quietly dissolve by heating, make it uniform solution by stirring, add $0.39 \text{ g} \pm 0.01 \text{ g}$ of diethylamine hydrochloride⁽¹⁾ and dissolve by quietly stirring.
- b) After cooling, weigh and add the evaporated amount of 2-propanol. This flux⁽²⁾ contains 0.5 g of a chlorine amount for every rosin content.

Notes ⁽¹⁾ For the diethylamine hydrochloride, that dried at $110^\circ\text{C} \pm 2^\circ\text{C}$ for 2 h is used.

⁽²⁾ The flux is put in a hermetically sealed container and stored in a cold dark place.

7.4 Test The test shall be as follows:

- a) Drip 0.02 ml of flux onto the centre of a copper sheet by using a microsyringe or a micropipette and place a solder sample thereon so as to be positioned at the centre of the copper sheet.
- b) Heat this at $100^\circ\text{C} \times 2 \text{ min}$ in a drier, evaporate a solvent in the flux and make a test piece therefrom. Make 5 test pieces.
- c) Set a solder temperature of the solder bath at $250^\circ\text{C} \pm 3^\circ\text{C}$.
- d) Bring the test piece to a horizontal contact with the molten solder of the solder bath by using an elevator. Remove the oxidized film on the surface of the molten solder with a scrubber just before bringing the test piece to a contact with it.
- e) After the test piece comes in contact with the molten solder, hold it under that state for 30 s, and let the solder sample spread on the copper sheet.
- f) Pull up horizontally the test piece from the solder bath with the elevator and naturally cool it to a room temperature.
- g) Remove the flux residue with a suitable cleaning solvent.

8 Calculation of spread rate Measure the height of the solder spread by measuring with a micrometer or other suitable implement. Calculate the spread rate according to the following formula. Repeat this operation for five sheets, obtain the average value and take it as the spread rate of the sample.

$$S_R = \frac{D - H}{D} \times 100$$

where, S_R : spread rate (%)

H : height of spread solder (mm)

D : diameter when the solder used for a test is considered as a ball (mm)

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

V : mass/density of the solder sample used for the test

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:
Standardization Promotion Department, Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN
TEL. 03-3583-8002 FAX. 03-3583-0462

100% Recycled paper

PROTECTED BY COPYRIGHT