INTERNATIONAL STANDARD

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Solder wire, solid and flux cored — Specifications and test methods —

Part 3: **Wetting balance test method for flux cored solder wire efficacy**

Fils d'apport de brasage, pleins et à flux incorporé — Spécifications et méthodes d'essai —

Partie 3: Méthode d'essai à la balance de mouillage de l'efficacité des fils à flux incorporé

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12224-3 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 12, *Soldering and brazing materials*.

ISO 12224 consists of the following parts, under the general title *Solder wire, solid and flux cored — Specifications and test methods*:

— *Part 1: Classification and performance requirements*

— *Part 2: Determination of flux content*

— *Part 3: Wetting balance test method for flux cored solder wire efficacy*

Solder wire, solid and flux cored — Specifications and test methods —

Part 3:
Wetting balance test method for flux cored solder wire efficacy

1 Scope

This part of ISO 12224 specifies a wetting balance test method for measuring the flux efficacy of a cored solder wire for the electronics industry. The test is applicable to all classes of flux listed in ISO 9454-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9454-1, *Soft soldering fluxes — Classification and requirements — Part 1: Classification, labelling and packaging*

ISO 9455-16:1998, *Soft soldering fluxes — Test methods — Part 16: Flux efficacy tests, wetting balance method*

IEC 60068-2-54, *Environmental testing. Part 2: Tests. Test Ta: Soldering — Solderability testing by the wetting balance method*

3 Principle

A copper coupon and flux cored solder wire are simultaneously immersed in a bath of molten solder alloy that releases the flux to be tested by the coupon. It is subjected to a group of buoyancy forces due to Archimedian thrust and the different surface tensions at the alloy/flux/test specimen interfaces. Data are collected on wetting forces versus time which represent the meniscus, and therefore the wetting angle θ, the wetting speed and the total wetting performance, i.e. the efficacy of the flux cored solder wire.

4 Apparatus

4.1 Solder bath, containing the alloy capable of reaching test temperature (see Figure 1 and 6.3).

4.2 Wetting balance, and ancillary instrumentation, conforming to IEC 60068-2-54.

4.3 Stainless steel crucible (see Figures 1 and 2).

4.4 Additional attachments, to hold cored solder wire to be tested in accordance with the dimensions specified in Figure 3.

4.5 Copper sulfidation artificial reference (SAR) test specimens, of the following dimensions:

— width: (10 ± 0,1) mm for flux cored solder wire diameter ⩾ 1 mm; 10 × the flux cored solder wire diameter for flux cored solder wire diameter < 1 mm;

— length: constant between 15 mm and 30 mm, to suit the equipment used;

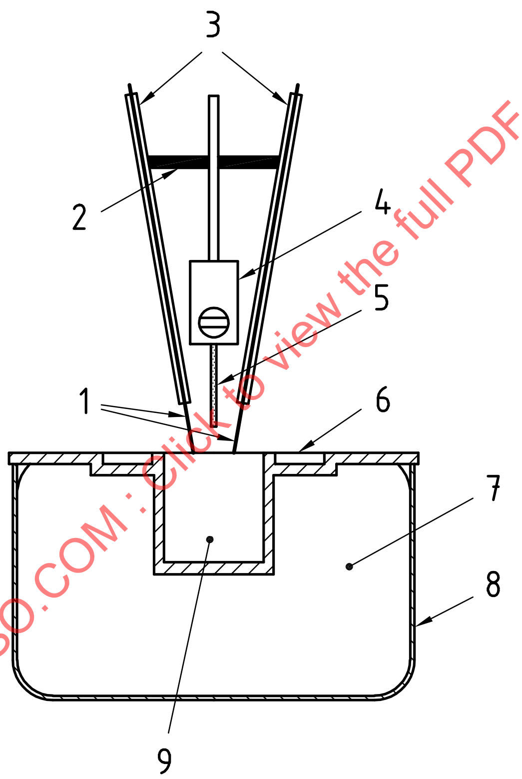
— thickness: either 0,1 mm ± 0,02 mm or 0,3 mm ± 0,05 mm.

4.6 Absorbent paper or lint free tissue.

4.7 Non-metallic, heat-resistant scraper.

5 Reagents

5.1 Acetone or methyl ethyl ketone.

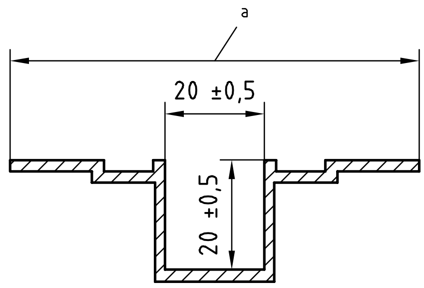


Key

1 solder wire to be tested
2 insulation
3 cored solder wire holder
4 wetting balance SAR coupon holder
5 SAR coupon
6 crucible
7 temperature controlled solder bath
8 wetting balance bath
9 alloy obtained from reflowed and fluxless cored solder wire to be measured

Figure 1 — Apparatus for measuring wetting properties of cored solder wire

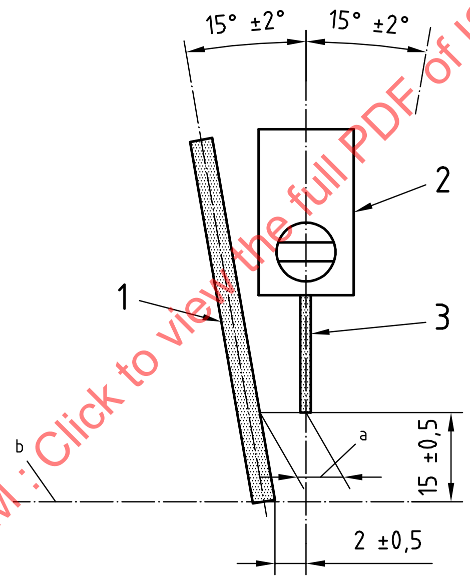
Dimensions in millimetres



a Dimension adapted to the solder bath or the wetting balance

Figure 2 — Detail of the crucible

Dimensions in millimetres



Key

1 solder to be tested
2 SAR coupon holder
3 SAR coupon

a (tan 15° × 22,5) mm = 6 mm
b level of the molten alloy in the crucible

Figure 3 — Relative position between the test coupon and the sample of the flux cored solder wire to be tested before the test

6 Procedure

6.1 Artificial reference sulfidation (SAR)

The controlled pollution shall be obtained in accordance with Annex B of ISO 9455-16:1998.

6.2 Calibration

The apparatus shall be calibrated in accordance with the manufacturer's instructions.

6.3 Preparation

Maintain the wetting balance (4.2) bath temperature at 50 °C ± 3 °C above the alloy liquidus temperature of the flux cored solder wire. Put the crucible (4.3) into the properly filled solder bath (4.1) in order to maintain sufficient heat transfer to the molten alloy. Completely fill the crucible with alloy of the same composition as the flux cored solder wire to be tested. When the alloy is fully molten, adjust the level of the molten alloy to the top of the crucible and clean the surface with the scraper (4.7).

Clean at least 20 cm of each of the two samples of the flux cored solder wire with acetone or methyl ethyl ketone (5.1) on absorbent paper or lint free tissue (4.6).

Place the cleaned solder wire in the solder wire holders (4.4) as shown in Figure 3.

6.4 Measurement

Before each test, adjust the level of the molten alloy to the top of the crucible; using the non-metallic scraper (4.7), remove the dross from the top of the crucible.

Set the two samples of the flux cored solder wire such that they are just in contact with the molten alloy in the crucible and fix them in position (see Figure 3).

Immediately following this:

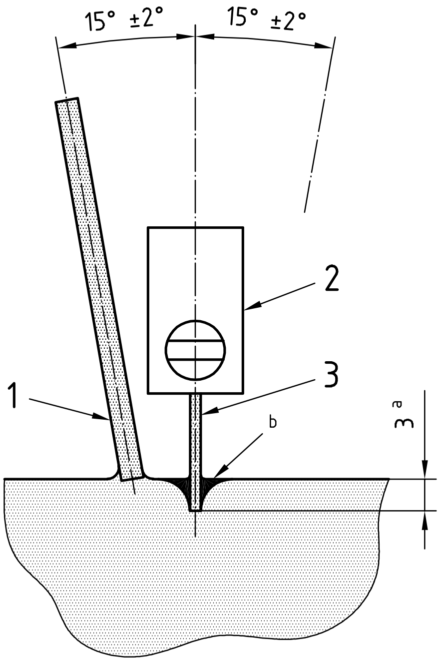
— suspend the test specimen on the sensor, set the test apparatus to zero (if necessary);

— immediately start the recorder (see 4.2) and dip the SAR coupon and the two flux cored solder wire samples into the molten alloy to a depth of 3 mm ± 0,2 mm at a rate of 20 mm/s ± 5 mm/s (see Figure 4); run the test for a duration of 10 s ± 1 s;

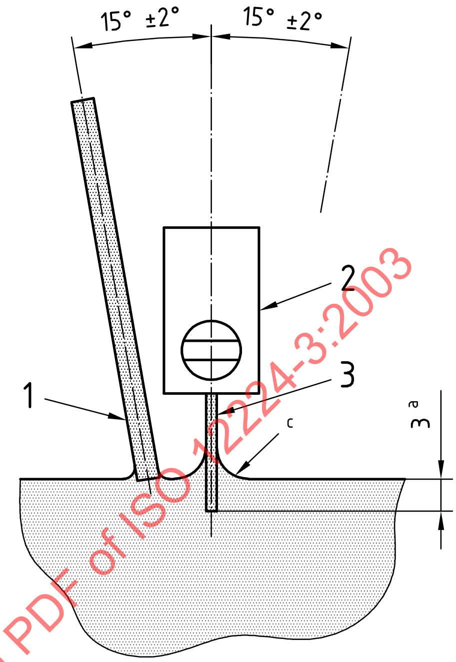
— stop the recording operation upon withdrawal of the test specimen if stopping is not automatic.

Take ten measurements and from them obtain an arithmetic mean.

Dimensions in millimetres



a) before wetting



b) after wetting

Key

1 solder wire to be tested

2 SAR coupon holder

3 SAR coupon

a Immersion depth.

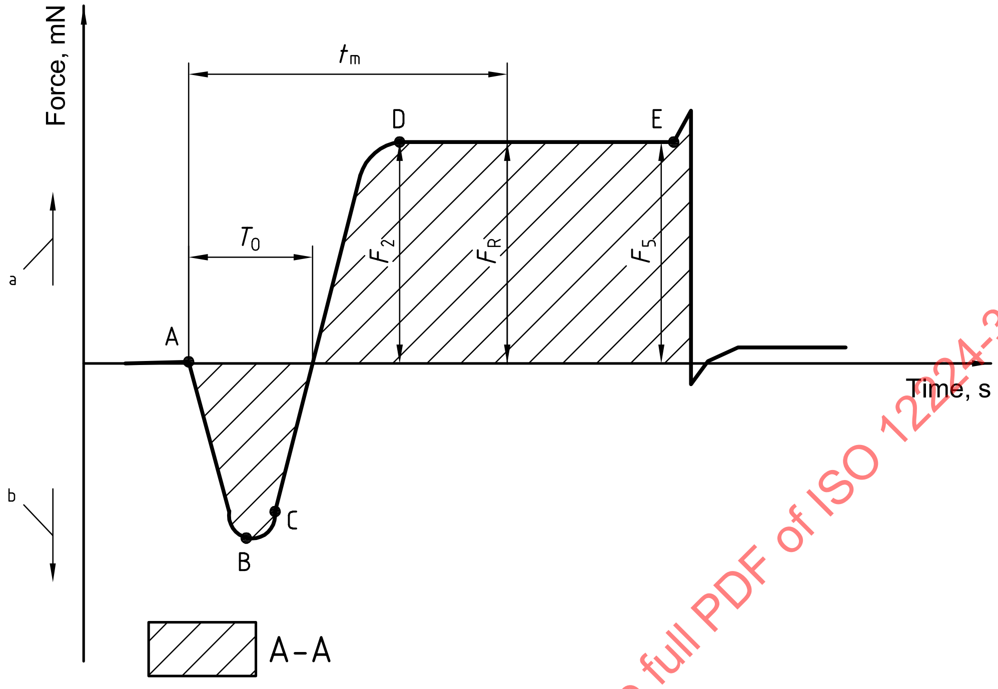
b Condition of maximum repelling force.

c Condition of maximum wetting force.

Figure 4 — Relative positions, during the test, between the SAR coupon and the sample of the flux cored solder wire to be tested

7 Interpretation of resultant curves

The appearance of an ideal curve is shown in Figure 5.



a Attraction

b Repulsion

— A-B represents the penetration of the molten alloy by the test specimen (repelling force due to Archimedian thrust and to the vertical component of the surface tensions).

— B represents the end of test specimen immersion [maximum repelling force, see Figure 4 a)].

— C represents the beginning of wetting (the repelling force applied to the test specimen is gradually compensated for by the force of attraction due to the variation of the surface tension vertical component).

— D represents the achievement of maximum wetting force, F_R [see Figure 4 b)].

— E represents the test specimen beginning to exit from the molten alloy.

— A-A represents the integrated value of area of the wetting curve from the start of the test.

— T_0 represents the time to buoyancy corrected to zero.

— F_2 represents the wetting force at 2 s from start of test.

— F_5 represents the wetting force at 5 s from start of test.

NOTE In practice the recorder curve may be slightly different in shape to the theoretical form of Figure 5 owing to a perturbation in the wetting process, but this has no influence on the expression of the results.

Figure 5 — Ideal curve of the resultant wetting force

The flux cored solder wire efficacy shall be determined from the curve of the recorded resultant wetting force by either of the following two methods.

a) By calculating a wetting angle θ, expressed in degrees, given by the equation:

$$\cos\theta = \frac{F_R + \rho \times v \times g}{\gamma_{LV} \times l}$$

where

F_R is the maximum force after time, t_m, in newtons;

t_m is the time to maximum force in seconds;

ρ is the density of the solder in kilograms per cubic metre;

v is the immersed volume in cubic metres;

g is acceleration due to gravity;

γ_{LV} is liquid/vapour surface tension newtons per metre;

l is the periphery of the test specimen in metres.

b) By comparing with a reference curve F_{REF} = f(t) according to different criteria, e.g.:

1) the time at which wetting begins;

2) the time at which the force reaches 2/3 of the maximum force;

3) the time at which the maximum wetting force is obtained;

4) a dewetting coefficient $\Delta F/F_R$ i.e.

$$\frac{\text{Maximum force reached} - \text{Force on completion of measuring}}{F_R}$$

5) the scatter of the family of obtained curves;

6) the area under the curves, calculated using appropriate methods.

8 Test report

The test report shall include the following information:

a) identification of the test sample (flux cored solder wire);

b) test method used (reference to this part of ISO 12224, i.e., ISO 12224-3);

c) test specimen dimensions and material;

d) SAR grade of the test specimen, as defined in annex B of ISO 9455-16:1998;

e) depth of immerson of the test specimen in the molten alloy;

