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ELECTRONICS INDUSTRIES®

2215 Sanders Road
Northbrook, IL 60062-6135

Number	
2.4.14.2	
Subject	
Liquid Flux Activity, Wetting Balance Method	
Date	Revision
06/04	**A**
Originating Task Group	
Flux Specifications Task Group, (5-24a)	

IPC-TM-650
TEST METHODS MANUAL

1 Scope This test method assesses the relative activity of liquid fluxes using a wetting balance.

2 Applicable Documents

ISO 1634

IPC J-STD-004 Requirements for Soldering Fluxes

3 Test Specimen

3.1 The test specimen shall be a copper coupon complying with ISO 1634-CU-ETP Condition HA. The width shall be 6.0 ± 0.25 mm [0.236 ± 0.00984 in]; the length should be 25.0 ± 1.0 mm [0.984 ± 0.0394 in] or as appropriate to the test equipment. The thickness shall be 0.5 ± 0.05 mm [0.0197 ± 0.00197 in].

3.2 A minimum of 50 ml of the liquid flux to be tested.

4 Apparatus and Reagents

4.1 Apparatus (see Figure 1).

4.2 A meniscus force measuring device (wetting balance) which includes a temperature-controlled solder pot containing solder maintained at 245 ± 3 °C [473 ± 5.4 °F].

Note: Reaction rate is very sensitive at this temperature.

Solder composition shall be Sn60/Pb40 or Sn63/Pb37.

4.3 A chart recorder, data logger, or computer capable of recording force as a function of time with a minimum recorder speed of 10 mm/s [0.394 in].

4.4 A mechanical dipping device able to produce an immersion and emersion rate of 20-25 mm [0.787-0.984 in] per second to a depth of 6.0 ± 0.1 mm [0.236 ± 0.00394 in], with a dwell time of 5.0 ± 0.5 seconds.

5 Procedure

5.1 Preparation

5.1.1 Degrease the test coupon by immersing it in a suitable solvent. Use a 10 ± 1% fluoroboric acid dip to clean the coupon.

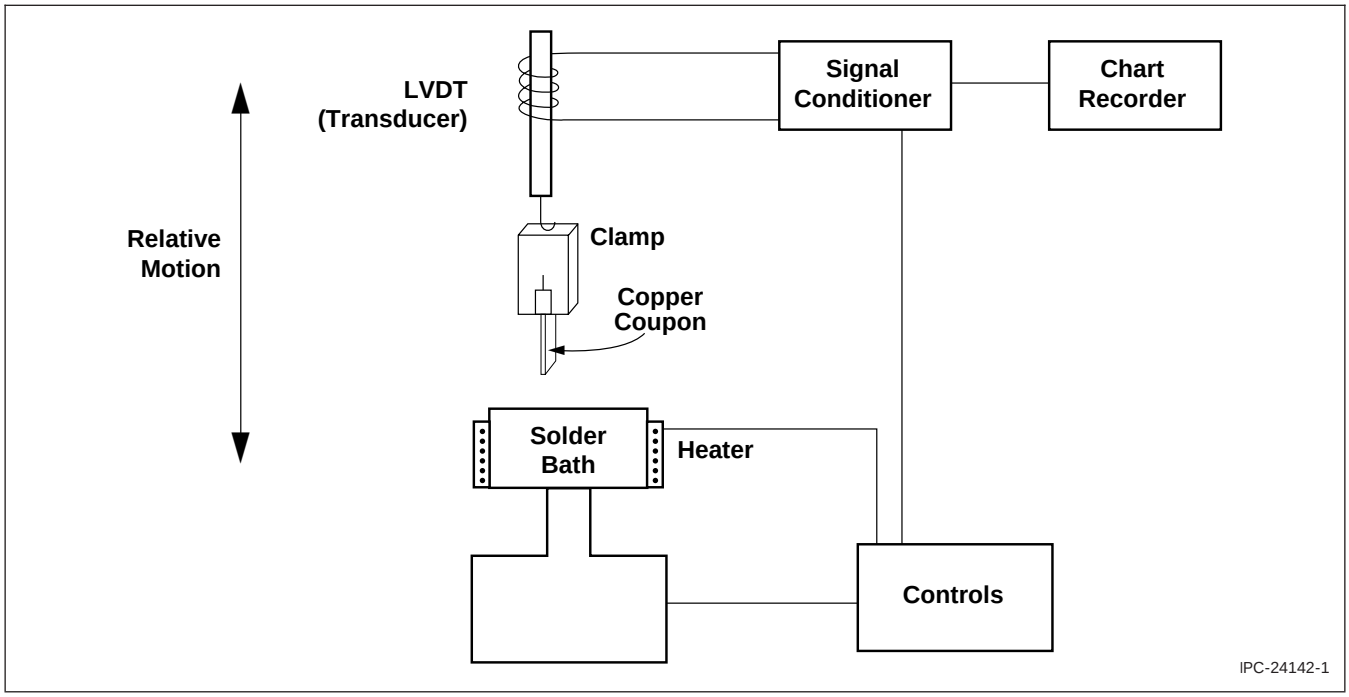

Figure 1 Wetting Balance Apparatus

5.1.2 Rinse the coupon with deionized water, then dry the coupon.

5.2 Test

5.2.1 Immerse the coupon in the liquid flux at room temperature to a minimum depth of 10.0 mm [0.394 in].

5.2.2 Immediately drain off excess flux by standing the specimen vertically on a clean filter paper for 1-5 seconds.

5.2.3 After partial drying, mount the coupon in the test equipment.

5.2.4 Skim (remove dross from) the surface of the molten solder just prior to immersing the specimen in the solder.

5.2.5 Hold the specimen 3.0 mm [0.118 in] above the solder pot for approximately 10 ± 1 seconds. Start the test. Immerse the specimen to a depth of 5.0 ± 0.1 mm [0.197 ± 0.00394 in], using an immersion and emersion rate of 20-25 mm [0.787-0.984 in] per second and a dwell time of 5.0 ± 0.5 seconds.

5.2.6 Record the wetting curve during the test.

5.3 Evaluation Use the wetting balance curve recorded during the test to determine the following flux activity parameters:

5.3.1 Tw, the wetting time. This is the time at which the wetting curve crosses the corrected zero axis, measured from the start of the test (see Figure 2).

5.3.2 The maximum wetting force, Fmax, with the zero axis corrected for buoyancy (see 6.2 and Figure 2).

6 Notes This test method can be useful in requalifying materials that have exceeded the recommended shelf life. In

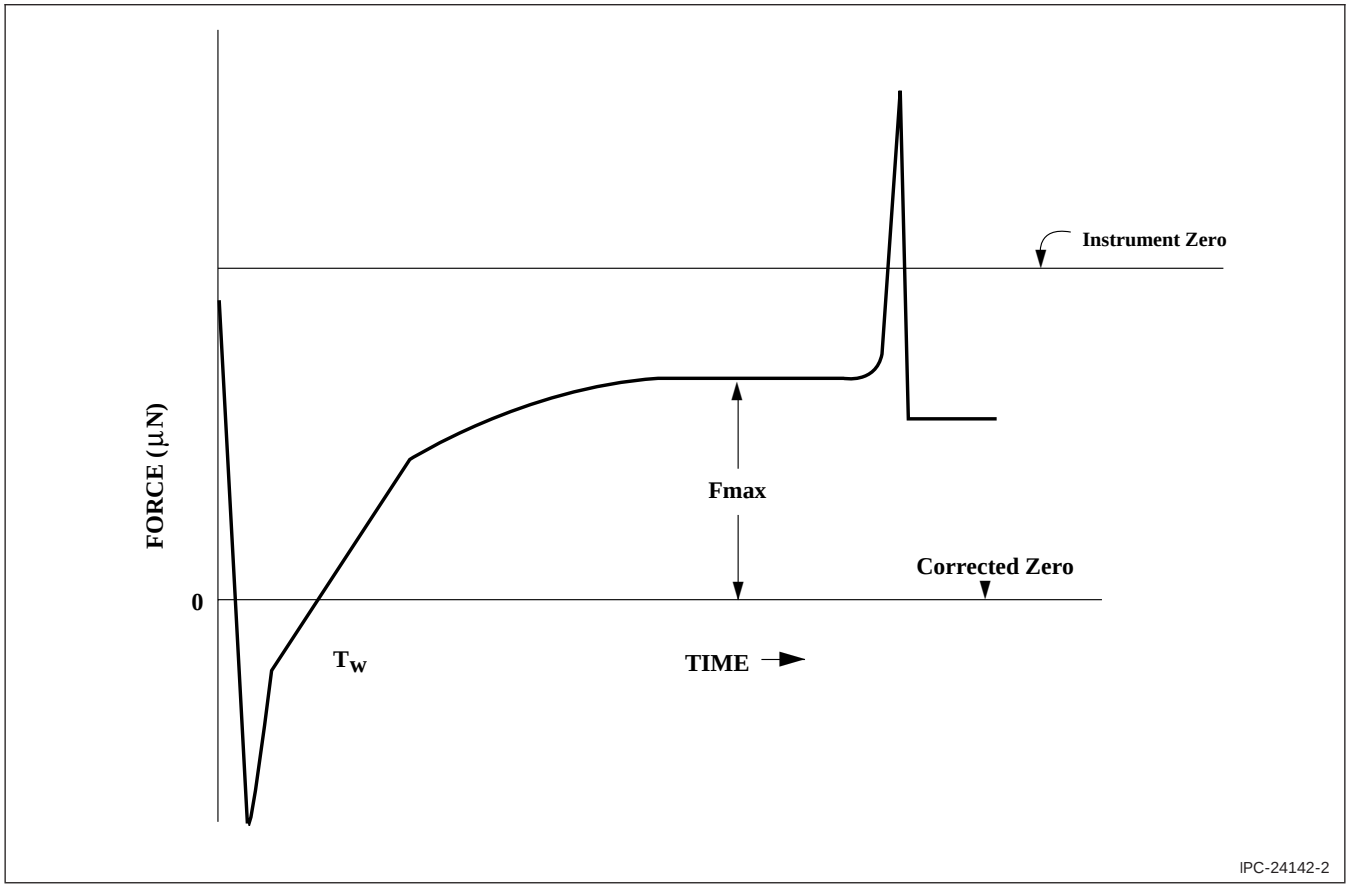

Figure 2 Wetting Balance Curve

addition, the method can help evaluate fluxing power on critical applications prior to manufacturing operations.

6.1 Safety Observe all appropriate precautions on MSDS for chemicals involved in this test method.

6.2 Correction for Buoyancy For the results from different wetting balance tests to be relatable, it is necessary to correct for the variability in specimen sizes. This is done by correcting the zero axis for the buoyant force produced by the volume of sample immersed in the solder. (The instrument zero corrects for the weight of the specimen.) The following formula is used to calculate the magnitude of the buoyant force correction, P_b, in µN: $P_b = \rho\ gV$

Where:

ρ = Density of solder @ 245°C (8.15g/cm^3)*
g = Acceleration of gravity (9810 mm/s^2 [386.220 in/^{2}])
V = Immersed volume of coupon (cm^3)
v = width x thickness x immersion depth)

*For Sn60/Pb40 Alloy

The calculated buoyancy force must be used to correct the zero axis. This correction is required to obtain correct values of wetting times as well as wetting forces. All measurements of wetting times and wetting forces must be made from the corrected zero axis. In the case of an upright (tensile force) curve, the corrected zero axis will be below the instrument zero, as shown in Figure 2.

Note: The vertical (tensile) force measured by the wetting balance consists of three forces – the weight of the specimen, the buoyancy force, and the wetting force caused by the surface tension of the solder and its interaction with the fluxed coupon.

The weight of the specimen is constant, and is included in the instrument zero axis.

The buoyancy force is equal to the weight of the solder displaced when the specimen is immersed. It changes as the specimen is lowered into and removed from the solder, but may be considered constant during the dwell time.

The only changing force during the dwell time is the wetting force. Changes in this force are caused by the contact angle changing from initial nonwetting to wetting, as the specimen solders. The corrected zero (buoyancy) line is the force when the contact angle is 90°, or when the bath surface has returned to horizontal, having been initially depressed by the immersed sample. When the contact angle is 90°, the contribution of the wetting force to the total vertical force is 0.

The wetting balance curve is centered on the corrected zero (buoyancy) line, since the only parameter that changes during the test dwell time is the contact angle, θ. The measured vertical tensile force, F, in µN (omitting the constant weight of the specimen, which is zeroed out by the instrument), is given by:

$F = \gamma\ \rho \cos\theta - g\ \rho v$

Where:

γ = Surface tension of molten solder (400 µN/mm)
p = Specimen perimeter in mm
θ = Contact angle
g = Gravitational acceleration (9.81 x 10^3 mm/s^2)
ρ = Solder density (~8000 µg/mm^3)
v = Immersed volume in mm^3

The buoyancy is the value of F when θ is 90° ($\cos\theta = 0$):

Buoyancy = $-g\rho v$

The corrected zero line (buoyancy) is the fixed reference point for wetting force and wetting time measurements.

Altering the specimen dimensions changes the immersed volume and hence the buoyancy, and so alters the position of the corrected zero line; but the wetting curve still remains centered on this line. Similarly, any change in immersion depth will also alter the immersed volume, with the same effect on the buoyancy.

Although use of the corrected zero line will cancel small variations in the specimen immersed volume and the immersion depth, large changes will affect the rate of heat transfer into the specimen, which will affect both Tw, the time to recross the corrected zero (buoyancy) line, and the time to reach Fmax.