The Institute for Interconnecting and Packaging Electronic Circuits
2215 Sanders Road • Northbrook, IL 60062-6135

IPC-TM-650
TEST METHODS MANUAL

Number	
2.3.10.1	
Subject	
Flammability of Soldermask on Printed Wiring Laminate	
Date	Revision
8/98	
Originating Task Group	
N/A	

1 Scope This test method is intended to evaluate the relative flame resistance characteristics of a permanent solder mask coating on specified printed wiring laminates. It is intended for use on laminate 0.5 mm thick and greater. It should indicate to what degree, if any, that the coating may diminish the flammability of the laminate. The performance level of a material by these methods should not be assumed to correlate with its performance in end-use applications.

2 Applicable Documents

IPC-TM-650 Test Method Manual

2.3.6 Etching, Ammonium Persulfate Method

2.3.7 Etching, Ferric Chloride Method

2.3.7.1 Cupric Chloride Etching Method

3 Test Specimen

3.1 Test specimens shall be prepared using vendor recommendations or manufacturers' production process and fabricated parallel to either the warp or the fill direction as convenient.

3.2 Test specimens shall be 130 mm ± 5 mm in length and 13 mm ± 0.5 mm in width by the thickness being tested. Metal cladding shall be removed by etching, using lPC-TM-650, Test Method 2.3.6, 2.3.7, or 2.3.7.1.

3.3 The solder mask coating shall be applied evenly at both the minimum and maximum anticipated coating thickness over both the minimum and maximum laminate thickness desired.

3.4 All of these specimen sets, as well as one specimen set of uncoated laminate, for each laminate thickness, should come from the same laminate lots. In addition, if other solder masks are to be compared, all should be applied to the same lots, or results can vary widely. Pretesting of laminate lots is recommended.

3.5 Edges may be smoothed after fabrication, providing that any radius imparted to the corners does not exceed 12.5 mm.

3.6 Five specimens shall be prepared for each condition required (two conditions—see specimen conditioning). Reserve duplicates of five specimens are also required in the event a retest is necessary. Total specimens per set are therefore equal to 20. Total sets required, including uncoated substrate, would be six.

Note: Additional coatings tests would not have to include the uncoated sets if the laminate lots are the same and submitted simultaneously.

4 Apparatus

4.1 Test Chamber A laboratory hood, totally enclosed, with a heat resistant glass window for observing the test, shall be used. The exhaust fan shall be turned off during the test, but may be turned on periodically to clear out the fumes and carbonized airborne particles between tests.

4.2 Clamping Devices A clamping device, adjustable for vertical positioning of the test specimen, shall be provided within the test chamber so the specimen will hang with its length in a vertical position approximately coincident with the central vertical axis of the test chamber.

4.3 Laboratory Burner A Bunsen or Tirrell Burner shall be used having a tube length of 100 mm and an inside diameter of 9.4 mm ± 1.5 mm. The burner shall not be equipped with end attachments.

4.4 Gas Supply The gas supply shall be regulated and metered for uniform flow. The standard gas shall be technical grade methane. Natural gas having a nominal heat content of 1000 BTU per cubic foot may be substituted. Other fuel gases, such as butane, propane, and acetylene may be used; however, technical grade methane will be used for referee testing.

4.5 Timing Device A stop watch or other suitable timing device with a precision of 0.5 seconds minimum

4.6 Desiccator A desiccator containing dried silica gel or calcium chloride

4.7 Circulating Oven A conditioning oven of circulating draft type capable of maintaining 70°C ± 1°C

4.8 Flame Gauging Device A thin steel scale template for gauging flame height

4.9 Burner Base A block support for use as a burner base with a 20° incline for proper positioning of the burner flame under the sample

5 Procedure

5.1 Specimen Conditioning

5.1.1 Specimen sets should first be brought to room temperature (23°C ± 2°C) for 24 hours prior to being thermal shocked within the specifications of both the laminate and solder mask being tested.

5.1.2 Specimen sets shall then be divided into two groups of 10 each. The first group shall be conditioned prior to testing by exposure to standard laboratory conditions of 23°C ± 2°C and RH of 50% ± 5% for a minimum of 48 hours.

The first set shall be referred to as ''as received'' specimen.

5.1.3 The second group shall be conditioned for a duration of 168 hours (seven days) at 70°C ± 1°C and then cooled in a desiccator over anhydrous calcium chloride for at least four hours at room temperature (23°C ± 2°C) prior to testing.

This second set shall be referred to as ''conditioned'' specimen.

5.1.4 From each of these groups, one half (five specimens) will be burned for the evaluation, with the remaining five specimens being held in reserve for retest if needed.

Note: See 5.6 to determine if and when the reserve sets will be needed.

5.2 Adjustment of Test Flame The burner is ignited and adjusted to produce a blue flame 19 mm high. The correct flame is obtained by adjusting the gas supply and the air ports of the burner until a blue flame with a yellow tipped outer cone 19 mm high is produced. The air supply is increased slightly by opening the air ports until only the yellow tip just disappears and it forms completely blue inner and outer flame cones. The flame is remeasured to assure correct height. The procedure is repeated as necessary until all conditions are met. The burner tube is vertical during the adjustment and measuring (see Figure 1).

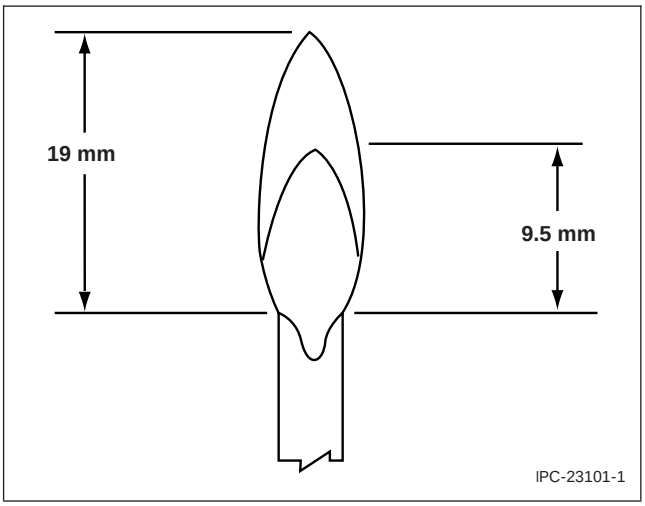

Figure 1 Burner Flame

5.3 Specimen Mounting Each specimen is mounted in the test fixture with its longitudinal axis vertical. The clamp used shall cover no more than the upper 6.5 mm of the specimen. The vertical position of the test fixture/specimen assembly is adjusted so that the lower end of the specimen is 9.5 mm above the top of the burner tube (see Figure 2).

5.4 Flame Test The test flame is placed centrally under the lower end of the specimen. Timing begins immediately for 10 ± 0.5 seconds. The burner is withdrawn at least 152 mm away from the specimen. If active combustion ceases prior to the specimen being completely consumed, the test flame is to be immediately placed under the specimen again for an additional 10 ± 0.5 seconds, then withdrawn as before.

5.5 Data to be Observed and Recorded The following test data is to be recorded:

a. Duration of specimen burning to the nearest second after the first test flame application for each specimen

b. Duration of specimen burning to the nearest second after the second test flame application for each specimen

c. Duration of specimen burning plus glowing to the nearest second after the second test flame application for each specimen, only if required by the specification

d. If any specimen burns up to the holding clamp on any ignition

e. If any specimen drips flaming particles, and if they ignite the dry absorbent surgical cotton located 305 mm below the test specimen

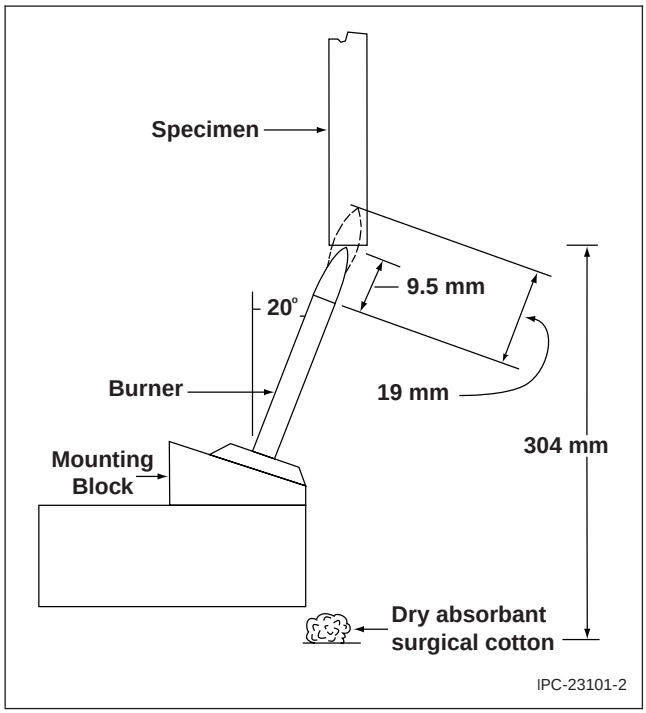

Figure 2 Specimen Mounted in the Test Fixture

f. Calculation of the total specimen burning time or the average specimen burning time as applicable based on 10 ignitions per set of five specimens (see Figure 3)

g. Calculation of the glowing time for each specimen if required by the specification

5.6 Evaluation and Reporting The material shall be considered to be out of compliance with the specification if:

a. More than one specimen per set burns up to the holding clamp on any ignition

b. More than one specimen per set burns for a period of time longer than allowed by the specification for a single specimen

c. The total specimen burning time as applicable exceeds the maximum allowed by the specification and is beyond the tolerance specified in 5.6.2

d. More than one specimen glows for a period of time greater than allowed by the specification (when applicable)

e. More than one specimen drips flaming particles, which ignite the dry absorbent surgical cotton

5.6.2 Reporting Each test condition is reported separately. The parameters outlined in 5.6 are to be reported only as applicable.

5.6.3 Retests If only one specimen per set (five) fails to comply with the requirements, the reserve set of specimen shall be tested. In the case of total and/or average specimen burning time, the reserve set shall be tested only if these calculated values exceed the specification maximum by five seconds or less. All specimens, their total, and their average from the reserve set shall comply with the requirements.

6 *Notes*

6.1 The inside of the burner barrel should be cleaned frequently. Specimen combustion by-products can collect around and inside the barrel tip. These deposits can be flushed out during burner ignition and flame adjustment, resulting in a false yellow flame tip. Proper flame adjustments then become very difficult if allowed to remain.

6.2 When the flame is correct and the specimen's end is at the proper height above the burner (9.5 mm), the inner blue cone of the flame will just meet the end of the specimen. The hottest area of the flame will then ignite the specimen.

6.3 Accurate centering of the flame under the specimen is essential for consistent test results.

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Solder Mask _____ **Color** _____ **Vendor** _____ **Lot** _____ **Coated Thickness–Nm** **Min:** **Max:**	**Laminate (ANSI type)** _____ **Color** _____ **Vendor** _____ **Lot** _____ **Substrate Thickness–(mm)** **Min:** **Max:**

Solder Shock Parameters	**Check One**
Time (seconds) _____ Temperature _____ °C	Actual Solder ☐ Fluidized Alumina ☐

Conditioning: ≥48 Hours @ 23°C ± 2°C & 50% ± 5% RH										
Specimen Number	**Total Thickness**	**Time of Combustion or Combustion & Glowing**						**Total Flaming Time/ea.**	**Total Flaming & Glowing**	**Within (W) or Exceeds (E) Spec. Limits**
		1st Flame Appli.		**2nd Flame Application**						
		Flame (sec.)		**Flame (sec.)**		**Glowing (sec.)**				
1										
2										
3										
4										
5										

Conditioning: 168 ± 2 Hours @ 70°C ± 1°C Desiccator Cooled										
Specimen Number	**Total Thickness**	**Time of Combustion or Combustion & Glowing**						**Total Flaming Time/ea.**	**Total Flaming & Glowing**	**Within (W) or Exceeds (E) Spec. Limits**
		1st Flame Appli.		**2nd Flame Application**						
		Flame (sec.)		**Flame (sec.)**		**Glowing (sec.)**				
1										
2										
3										
4										
5										

Figure 3 Vertical Burn Flammability Data