The Institute for Interconnecting and Packaging Electronic Circuits
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# IPC-TM-650
# TEST METHODS MANUAL

| Number | |
|---|---|
| **2.2.13.1** | |
| Subject | |
| **Thickness, Plating in Holes Microhm Method** | |
| Date | Revision |
| **1/83** | **A** |
| Originating Task Group | |
| **Printed Board Test Methods Task Group (7-11d)** | |

## 1.0 Scope

**1.1** A nondestructive inspection method for determining the quality of plated-through connections in printed wiring boards. 1.2 Theory. Copper will display a resistivity of known value depending upon the geometry of the shell and the conductivity of the copper. If the shell is not uniform, defects such as cracks, voids, or thin spots in the copper will cause the measured resistance to be higher than the theoretical value. This value is computed by using the equation given in Fig. 1.

## 2.0 Applicable Documents

**IPC-TC-500** Specification for copper plated through hole, two-sided boards, rigid.

## 3.0 Test Specimen

**3.1 Description of Specimens.** The following types of specimens can be tested using the equipment specified herein:

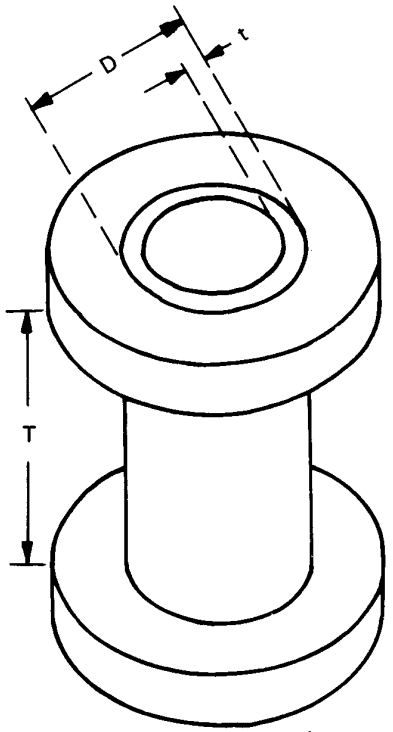
(1) Printed wiring boards, either two-sided or multilayer, which can fit properly within the neck of the test meter.

**NOTE:** *In testing of plated-through holes in two-sided or multilayer printed wiring boards, the measurement is the resistance of the plating in the hole only and is not related to any interconnected circuit terminating in that hole, unless there is an electrically parallel circuit, i.e., two or more holes located within 0.25" of each other.*

(2) Printed wiring boards up to 3/8'' in thickness.

(3) Plated-through connections of any diameter which can be spanned conveniently by the probes.

**3.2 Specimen Preparation.** Insulating materials such as flux, conformal coatings, encapsulating compounds, adhesives, mold release compounds, etc., shall be removed from the terminal areas to allow a positive metal-to-metal contact to be made between the probes and the plated-through hole terminal area. Closely spaced conductors shall be masked to prevent the probes from bridging between the terminal areas and adjacent conductors. Whatever material is used to mask the conductors shall be located in such a manner that the probes are not separated from the hole to be measured.




$$R = \frac{0.215348 \times 10^{-6}(T)}{Dt - t^2}$$

where:

R = resistance (ohms)
T = thickness of PWB (inches)
D = diameter of drilled hole (inches)
t = copper plating thickness in hole (inches)

*NOTES:*

1. It is assumed that the conductivity of the copper is 100 percent IACS.
2. To compute the value of t with known values of D, T, and R, use the following equation:

$$t = 0.5D - \left[0.25D - \frac{0.219T}{R}\right]^{1/2}$$

where

R = resistance (microhms) and D, T, and t are in inches.

**Figure 1 Resistance Calculation of Plated-Through Connection**

**3.3 Operating Conditions.** The evaluation of the plated-through holes shall be performed at room temperature (68° to 75° F) and the printed wiring boards to be evaluated shall be stabilized at that temperature for approximately one hour prior to evaluation.

**4.0 Apparatus**

**4.1 Description of Equipment.** The microhm resistance meter used in the nondestructive testing employs the standard four*probe technique. The equipment is portable and suitable for bench operation. The equipment consists of two essential parts:

(1) the mechanical portion for providing physical attachment with the test specimen and

(2) the electrical-electronic portion for providing the microhm readout of the through connection being measured

The probes are tension-suspended to ensure positive interfacial contact with the termination areas over a range of material thicknesses.

**4.2** The meter impresses a constant ac current into the through connection, and the voltage that develops across the, hole is sensed. This voltage is amplified and observed visually on a suitable meter or a digitized readout. See circuit diagram in Fig. 2A.

**5.0 Procedure**

**5.1 Calibration of Equipment.** In order to provide valid resistance measurements, the equipment must be calibrated as specified in the manufacturers' instruction manual

**5.2 Test Steps.** The steps to be performed in evaluating the quality of plated-through holes in printed wiring board~ are as follows:

**5.2.1** Calibrate the equipment.

**5.2.2** Prepare and condition the specimen(s) to be inspected per 3.2.

**5.2.3** Position the printed wiring board between the probes as shown in Fig. 2B.

**5.2.4** Depress the upper probes until they Awes. come locked over the plated-through hole.

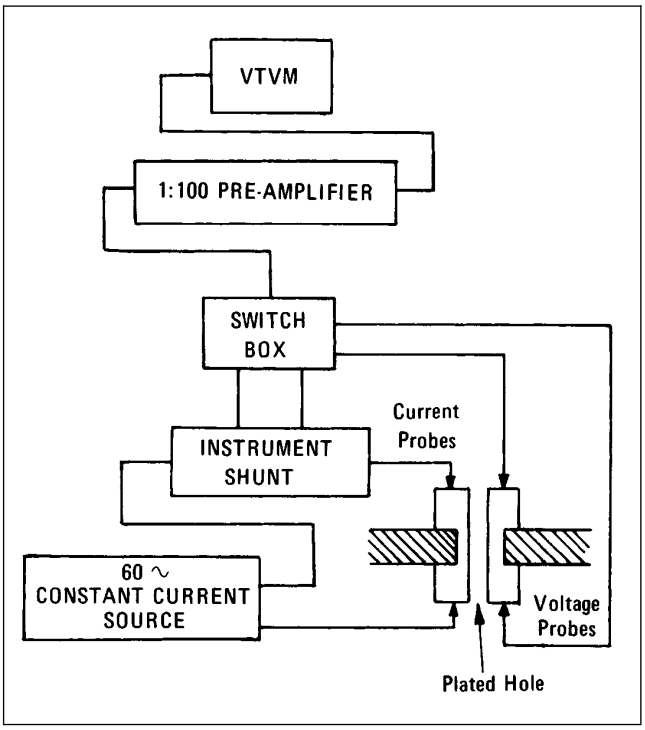



**Figure 2A Circuit for Resistance Measurements**

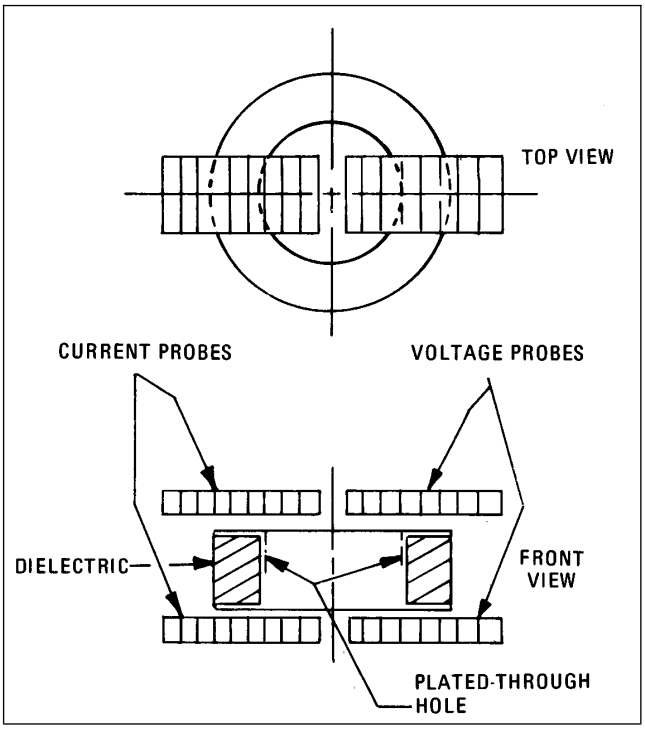



**Figure 2B Ideal Probe Placement on Pad**

**NOTE:** *A steady reading indicates that the probes am making good contact. Trial settings to obtain the minimum resistance value will indicate when the probes are properly located over the interconnection.*

**5.2.5** If poor electrical contact is evidenced, relocate the probes until a minimum resistance is indicated.

**NOTE:** *During the microscopic inspection (30X) of the edges of the plated-through hole and the adjacent areas on the terminal area, there shall be no detectable damage to the surfaces by contact with the probes during testing. In the absence of such surface defects, the microhm testing can assuredly be considered nondestructive.*

**5.2.6** Read and record the microhm value.

**5.2.7** Compare the microhm value with the plating thickness of the standardization curve as illustrated in Fig. 3. The theoretical curves shown in Fig. 3 indicate to within 0.2-rail thickness the plating in the through connection and for all practical purposes are representative of the resistance-plating thickness relationships encountered in practice.

**NOTE:** *This comparison shall indicate if the plating thickness of the through connection meets the acceptable thickness requirements*

**5.2.8** When this method is used, any reading above the specified allowable microhm reading shall be reason for further investigation of the defect for conformance to the requirements of the applicable fabrication specification.

**5.2.9** Plating thickness curves shall be generated by the user.

**6.0 Resistance Curves**

**6.1** Curves for the resistances of plated-through holes of three different diameters in 1/16'' printed wiring boards are presented in this test method (Fig. 3). Over coatings of gold, tin-lead, etc., can have an effect on the micro-ohm readings depending on the electrical resistance relative to the copper. Resistivity of tin-lead is approximately ten times that of copper, while gold is of the same resistivity.

**6.2** To eliminate material and equipment variables, the user should develop thickness-resistance curves for his particular condition based on metallographic cross-section measurements (TM-650 Method 2.2.13). These curves may be used as guides for acceptance of product.

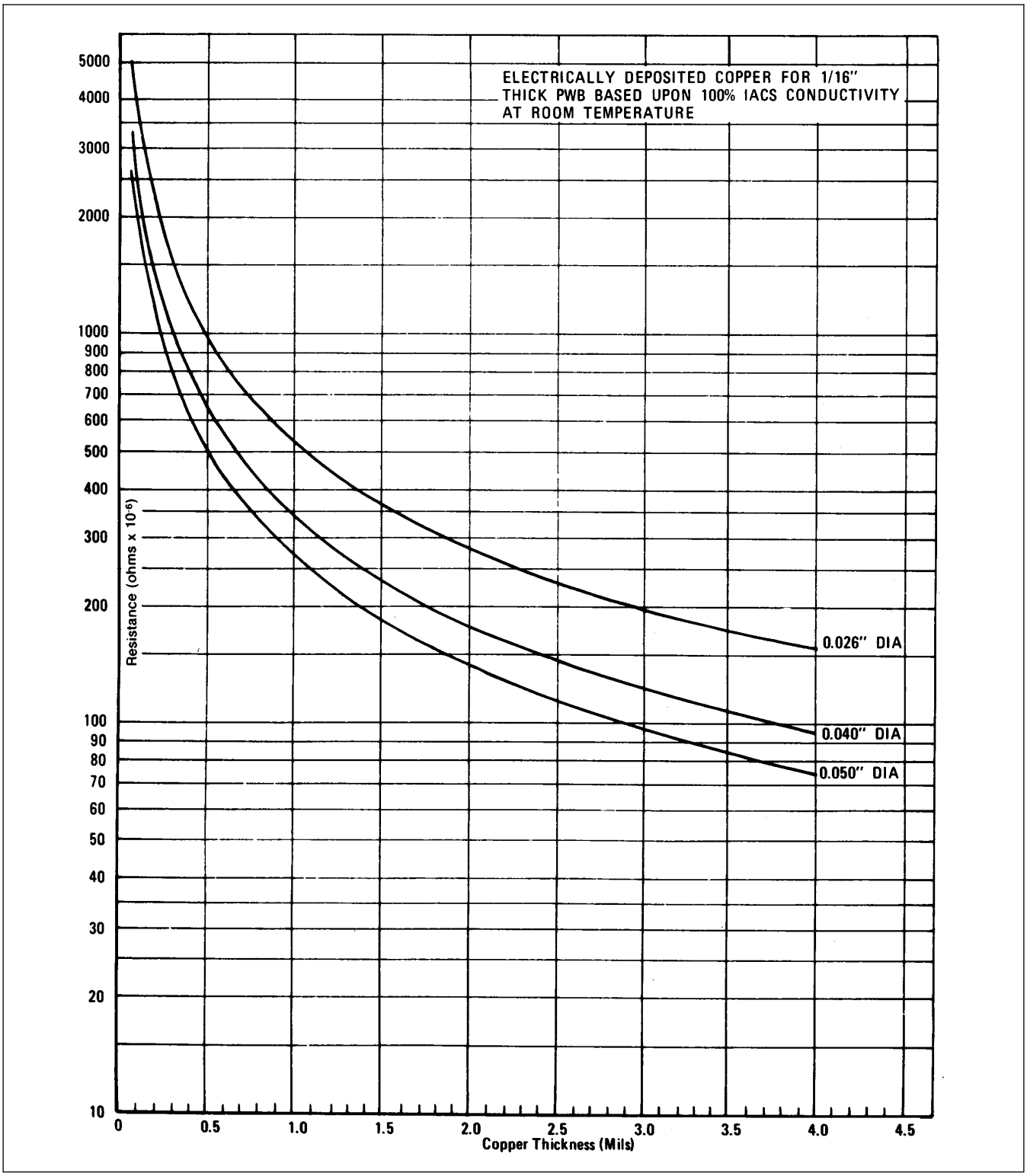



**Figure 3 Microhm Meter Calibration Curves**