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

Number	
2.5.5.4	
Subject	
Dielectric Constant and Dissipation Factor of Printed Wiring Board Material-Micrometer Method	
Date	Revision
10/85	**—**
Originating Task Group	
N/A	

1.0 Scope The purpose of this test method is to provide a usable test procedure to determine the dielectric constant and dissipation factor of printed wiring materials at various frequencies (from 22kHz to 70mHz).

2.0 Applicable Documents None

3.0 Test Specimens Each specimen shall be between 38 and 55 mm in diameter by thickness of substrate material. The copper-clad must be completely removed, using standard commercial procedures. Three specimens are required for this test.

4.0 Equipment/Apparatus

4.1 Meter A Hewlett-Packard Q Meter, model 4342A or equivalent.

4.2 Test Fixture Hewlett-Packard model number 16451A test adapter or equivalent.

4.3 Inductor A reference inductor capable of resonating at the desired measurement frequency.

5.0 Procedure

5.1 Depress the appropriate frequency range button and set frequency dial control for the desired measurement frequency.

5.2 Connect desired reference inductor to 4342A measurement coil (HI and LO) terminals.

5.3 Adjust L/C dial and ΔC dial controls for a maximum Q meter deflection. Note sum of the C dial and ΔC dial readings as C_1 and panel meter reading as Q_1.

5.4 Let the reference inductor remain in place (as is) and attach the 16451A to 4342A measurement capacitor (HI and GND) terminals.

5.5 Set 16451A electrode spacing as desired. However, if possible, it is best to set the electrode spacing dimension to about the same as the thickness of the material to be measured.

5.6 Again resonate the measurement circuit by adjusting the L/C and ΔC dial controls. Note C dial and Δ dial readings as C_2 and panel meter reading Q_2.

5.7 Depress ΔQ button and adjust ΔQ zero (course and fine) controls so that meter pointer indicates zero (full scale) on ΔQ scale.

Note: Press ΔQ button to release ΔQ function and recheck for current resonance. Again depress the ΔQ button and recheck for ΔQ zero indication.

5.8 Place the sample material between 16451A electrodes. The sample material should be in close contact with electrodes. Note 16451A micrometer reading TX (as thickness of sample).

5.9 Again adjust the L/C and ΔC dial controls for resonance. Note sum of the C dial and ΔC dial readings as C_3 and panel meter ΔQ reading. If meter pointer scales out at the left end of the scale (ΔQ full scale), reset the function for normal Q measurement. The difference in Q is calculated from the two Q values as $\Delta Q = Q_2 - Q_3$.

5.10 Remove the sample material from between the 16451A electrodes.

5.11 Let the L/C and ΔC dial settings remain as is, and reduce space between the 16451A electrodes until resonance again occurs. Note the micrometer reading too.

6.0 Calculations The Dielectric Constant shall be calculated as follows:

$$\text{D.C.} = \frac{TX}{TO} \times 8.855 \times 10^{-12}\ (\text{F/M})$$

Where:

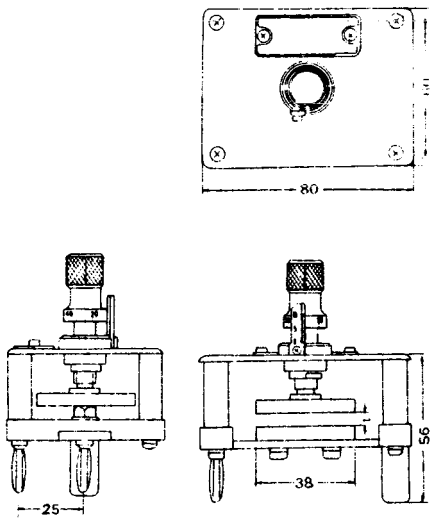
D.C. = Dielectric Constant
TX = Micrometer reading (thickness of sample)
TO = Micrometer reading at resonance after reduction of spacing between test fixture electrodes.
(F/M) = Farads per meter

The Dissipation Factor shall be calculated as follows:

$$D.F. = C_1 \text{ TO } \frac{\Delta Q}{C_2 (Q_2 - Q)} \times 100$$

Where:

D. F. = Dissipation Factor
C_1 = Capacitance reading without fixture or sample (in picofarads)
TO = Micrometer reading at resonance after reduction of spacing between test fixture electrodes
Q_2 = Q reading with test fixture attached (no sample)
ΔQ = $Q_2 - Q_3$



TEST FIXTURE

IPC-2554