HIGH FREQUENCY TEST METHODS

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1 MHz TWO FLUID CELL METHOD

- Uses two fluids, air and silicone fluid
- Measures capacitance of air, air + sample, silicone fluid and silicone fluid + sample
- Measures conductance of silicone fluid and silicone fluid + sample
- DK and Df calculated from the above variables

1 MHz TWO FLUID CELL TEST METHOD

- Test fixture independent of thickness or DK
- Excellent reproducibility, very quick, helpful in “ball parking” DK and Df
- Eliminates/Minimizes operator error
- Excellent test method for PTFE-Laminates.

1 MHz Two Fluid Cell Test Method

$$\varepsilon_r = \frac{1.0058}{C1} * \left(C1 + \frac{(C3-C1)*(C2-C1)*C4}{(C3-C1)*C4-(C4-C2)*C3}\right)$$

$$\text{Tan}\delta = \frac{G2}{6.2832*C4} + \frac{(\varepsilon_r*0.99942*C1-C4)}{(C4-C2)} * \left(\frac{G2}{(6.2832*C4)} - \frac{G1}{(6.2832*C2}\right)$$

C1 = Capacitance of Air
C2 = Capacitance of Silicone Fluid
C3 = Capacitance of Air + Sample
C4 = Capacitance of Silicone Fluid + Sample

G1= Conductance of Silicone Fluid
G2 = Conductance of Silicone Fluid + Sample

1 MHz TWO FLUID CELL TEST METHOD (Contd.)

- Not suitable for non-pure PTFE products due to oil absorbance and dipolarization due to polar molecules and interfacial polarization due to inhomogeneities of the material.
- Not suitable if DK and Df of material is a function of frequency.

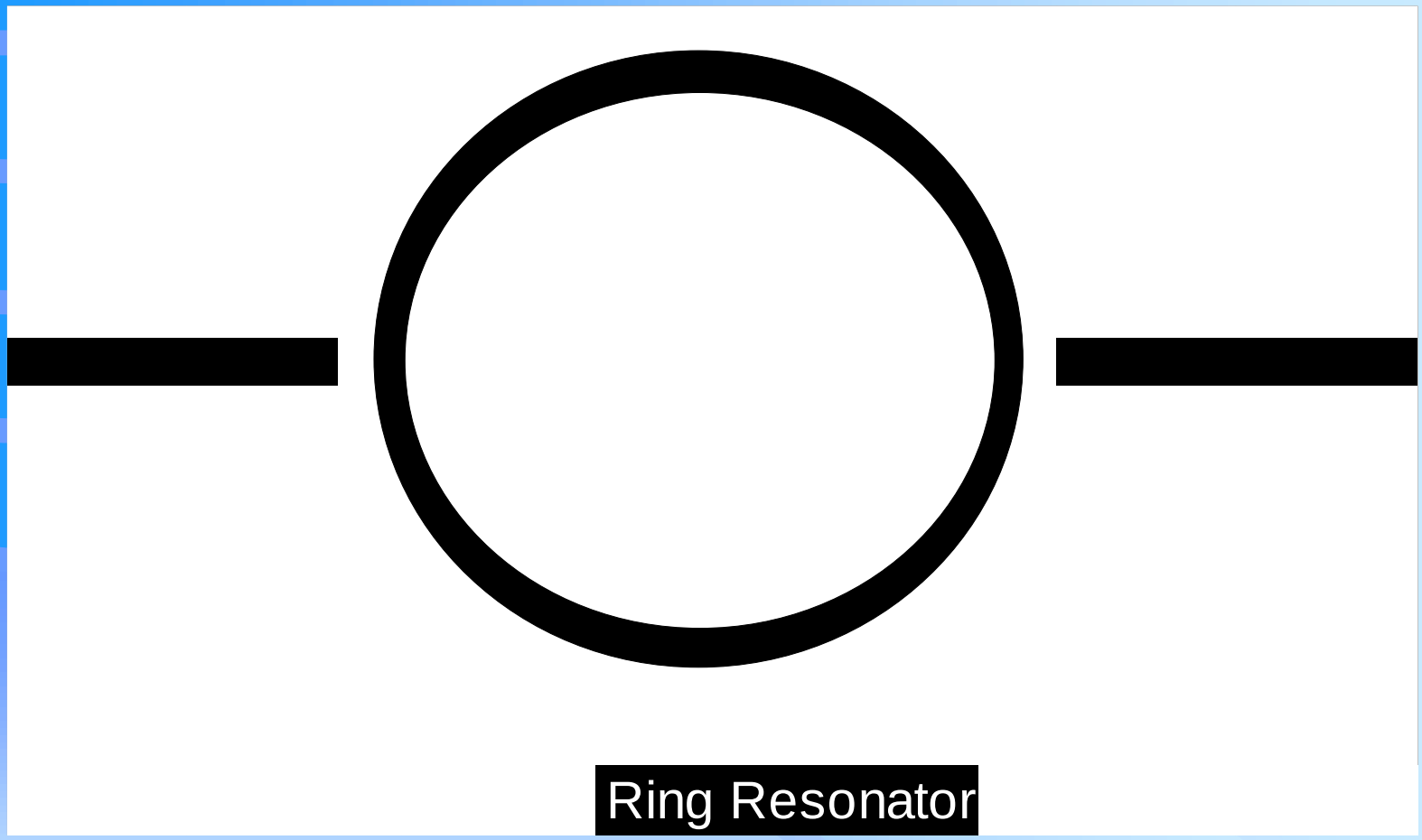
MICROSTRIP TESTING

End Coupled Resonator

MICROSTRIP TESTING

- Utilizes imaged resonator pattern on the actual material
- The dimensions of the pattern depend on DK, dielectric thickness, resonant frequency and impedance of the line (50 Ohms)
- The resonant frequency, bandwidth and the electrical length is used to determine DK and Df

MICROSTRIP TESTING



Ring Resonator

MICROSTRIP TESTING

- Excellent correlation between test results and actual application
- Only test capable of measuring insertion losses
- Capable of testing the effect of copper on electrical properties

MICROSTRIP TESTING (Contd)

- Separate artwork needed for each DT and DK
- Very time consuming and operator sensitive
- Probe gaps optimization is difficult

“BERESKIN” STRIPLINE TEST

- Very similar to modified stripline test
- Uses 50 ohms impedance probe lines
- Fixture independent of DK and DT
- Test not “artsy”
- Not suitable for <11 mil laminates

FULL SHEET RESONANCE (FSR)

- The entire metal clad dielectric is excited
- The dielectric behaves as a dielectric filled waveguide and the resonant frequency is measured
- The resonant frequency and dimensions of the panel is used to determine K`
- Radiation loss extremely high, hence cannot measure Df (or Q)

FSR TESTING

- Excellent QC Test for non-standard materials
- Quick, reliable and non-destructive
- Confirms intra-lot consistency and tests the complete laminate, rather than a small fraction of the laminate
- Excellent resolution of DK

FSR TESTING (Contd.)

- Not suitable for <15 mil laminates
- Cannot measure Df
- Testing performed at 100-300 MHz range
- Test data is a function of panel size

X-Band Stripline Resonator IPC-TM-650 2.5.5.5

- Resonator w/ length = 2wavelenghts @ 10GHz
- Minimal sample preparation
- Excellent reproducibility, simple equations to obtain DK and Df
- Can obtain value for Df of material
- Accepted industry standard

X-Band Stripline Resonator IPC-TM-650 2.5.5.5(Contd)

- Thickness of ground plane spacing set
- Can’t test heavy metal backed laminates
- Test set for freq. of 2.5, 5, 7.5 & 10 GHz

Modified Stripline Test Proposed IPC-TM-650 2.5.5.X

- 3” resonator such that resonances occur at intervals of at least 500 MHz
- Can measure Dk & Df from 500 MHz to 15 GHz
- Can test any thickness or heavy metal clad samples

Modified Stripline Test Proposed IPC-TM-650 2.5.5.X (Contd)

- Complicated setup and test procedure

Waveguide Perturbation Test Method

- Electric field perturbation that compares results from empty waveguide to that of sample under test
- Can test series of frequencies using multiple waveguides
- Can test anisotropy of material

Waveguide Perturbation Test Method (Contd)

- Requires precise sample size (control to 0.001”)
- Complicated algorithms to obtain Dk & Df

SO WHAT DO WE DO?

- No single test will be suitable for the entire range of products
- 1 MHz and 10 GHz test suitable for “standard” products
- Microstrip test suitable for special R & D projects
- FSR suitable for high Dk and non-binary products

SO WHAT DO WE DO? (Contd)

- Modified stripline or Bereskin test for non-teflon and “any material”QC testing, also for various frequencies testing
- For non-standard thin laminates (<10-15 mil), no test really gives an accurate result.