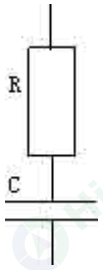
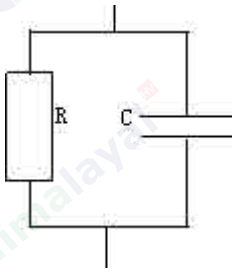
HCL2840 Dielectric Loss Tester Working Model and Instrument Calibration

1. Capacitor test object model

Any capacitor with dielectric loss can be simulated into two ideal models of RC cascade and parallel:

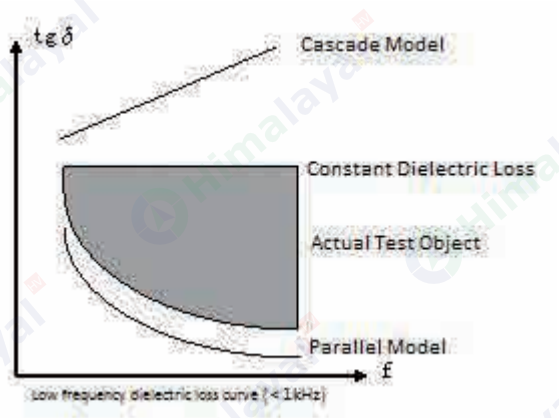


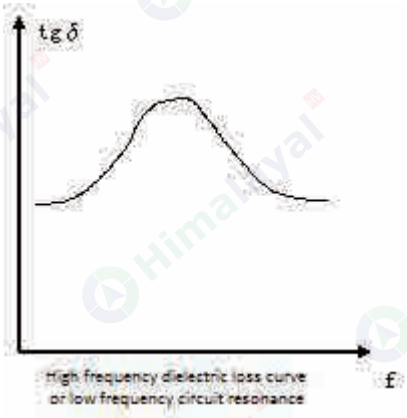
Cascade model



Parallel model

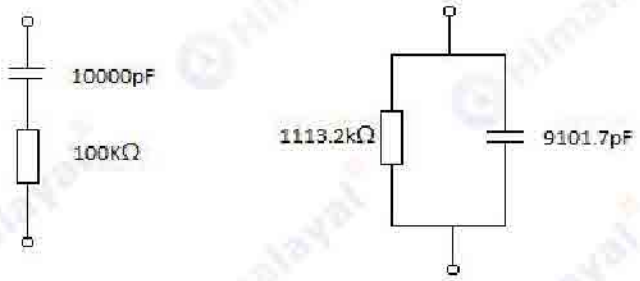
Theoretical cascade model tgδ=2πfRC, parallel model tgδ=1/(2πfRC), R and C basically stay the same, f is a variate. Substitute 45Hz, 50Hz, 55Hz respectively into the formula, draws the conclusion that tgδ turns proportional and inverse over frequency f. As shown on the diagram below, f has greater impact on fully proportional and fully inverse model.





2. Working model applied to HCL2840 dielectric loss tester

Actual capacitor test object can be signified via cascade model as well as parallel model under a fixed frequency. For instance two circuits below shows exact same characteristics under 50Hz:



tg δ =31.4% Z=100-318j kΩ

Dielectric loss of the two test objects remains 31.4% measured with different tan delta bridge, yet capacitance measured by Schering bridge(2801, QS1 and QS37) is 10000pF, capacitance measured by current comparator bridge(for example HCL2876) is 9101.7pF. This is because 2801 tan delta bridge assumes test object dielectric loss as cascade model, HCL2876 assumes test object to be parallel model. Actually capacitance difference is minor on condition of dielectric loss below 10%.

Actual capacitor applies hybrid model, through mass experiment and theoretical calculation, actual power capacitor mostly accord with parallel model, this is due to active current flow through insulation layer, more like loss resistance parallel between electrodes, electrode resistance is zero therefore no loss. For instance CT, bushing and equalizing capacitor, tgδ usually decreases as frequency increases.

Thus HCL2840 is adaptable to both parallel model and cascade model while measuring capacitor dielectric loss.

3. HCL2840 dielectric loss tester calibration

During dielectric loss tester laboratorial calibration, QSJ3 calibration console perform more accurate calibration. Range and accuracy of dielectric loss tester can be tested precisely. However, QSJ3 requires more complicated operation, calibrate with standard dielectric loss tester if requirement is not too strict.

Standard loss tester normally applies a three-electrode standard capacitor and multiple précised parallel resistance, ranging 0-10%, with multiple gears. Standard loss tester is a classic cascade model. Therefore adjust working model to cascade model when using

HCL2840 as standard loss tester, this way actual value of all gears can be fully corresponded.

Sometimes when measuring standard loss tester, measured capacitance decreases as dielectric loss increases, whereas actual standard capacitance is fixed, this is due to incorrect model selection. Calibrate with formula below:

$$C_{Calibration}=C_{Reading}(1+tg2\delta)$$

During calibration, connect dielectric loss tester to test object with full shielding standard plug, exposed electrode can cause major error.

Note: schering bridge is adaptable to both tangent and inversed wiring serving as three electrode structure(high voltage pole, low voltage pole and shielding pole) standard loss tester. Whereas M type dielectric loss tan delta bridge adapts to only tangent instead of inversed wiring, otherwise it will cause standard loss tester burnout.