SKYWORKS

APPLICATION NOTE

Measuring SRF and Q of Coaxial Resonators

Introduction

Skyworks coaxial resonators are ceramic-filled transmission lines that support Transverse Electro-Magnetic (TEM) waves. Accurate characterization of these microwave resonators is essential for effective use. The following lists the important parameters required to fully describe a resonator:

- Self Resonant Frequency = SRF
- Coupling coefficient = β
- Quality factor = Q

Although several measurement methods are possible, this Application Note describes a reflection technique using the impedance locus on the Smith Chart. A small slotted brass slug can be used to capacitively couple to the coaxial resonator.

One side of the slot acts as a plate of the coupling capacitor, and the resonator's tab acts as the other plate. The complete fixture is constructed using a Sub-Miniature A (SMA) panel mount connector and an aluminum block (as shown in Figure 1).

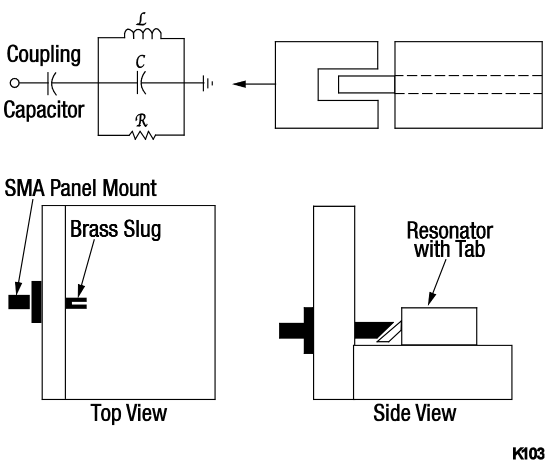

Figure 1. Coupling Capacitor using an SMA and Aluminum Block

Procedure

1. Find the approximate SRF using the following equation.

   $$SRF = \frac{c}{4\ell\sqrt{\varepsilon R}} = \text{Quarter-Wave Shorted}$$

   or

   $$SRF = \frac{c}{2\ell\sqrt{\varepsilon R}} = \text{Half-Wave Open}$$

   Where:

   C = Speed of light

   εR = 38.5 (8800 materials) or 88.5 (9000 material)

2. Set the network analyzer to measure:
   - S_{11}
   - Center frequency = SRF
   - Span = 80 MHz
   - Number of points = 801
   - Format = Smith Chart
3. Connect the cable from the network analyzer to the fixture, and then perform an open response calibration to the fixture setup without the resonator.
4. Insert the resonator's tab into the brass slot until critical coupling (b = 1, R = Z_0) is achieved (as shown in Figure 2).

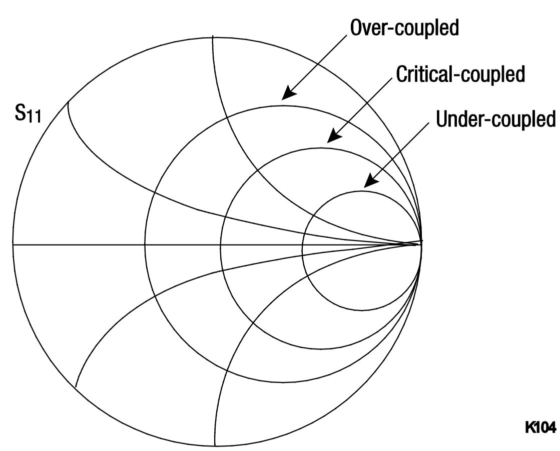

Figure 2. Smith Chart Coupled Responses

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5. Define the resonant frequency at the critical coupled condition or at the point of maximum return loss (as shown in Figure 3).

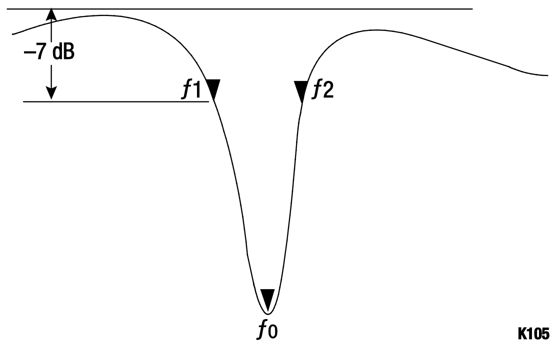

Figure 3. Self Resonant Frequency (SRF)

6. Because the half power bandwidth corresponds to the –7 dB return loss points (R = ± X), the Quality factor (Q) can be found using the following equation.

$$Q = \frac{f0}{f2 - f1}$$