

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).

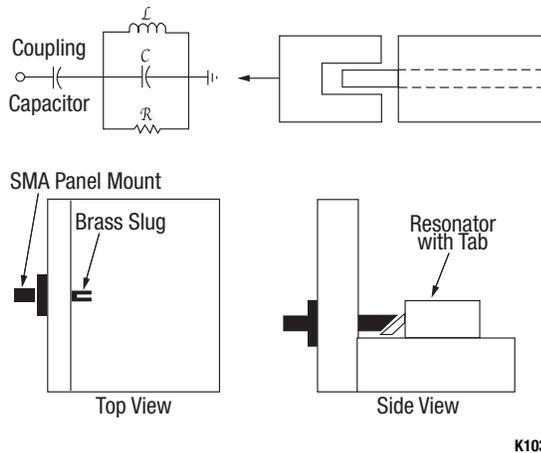


Figure 1. Coupling Capacitor using an SMA and Aluminum Block

Procedure

1. Find the approximate SRF using the following equation.

$$SRF = \frac{C}{4t\sqrt{\epsilon R}} = \text{Quarter-Wave Shorted}$$

or

$$SRF = \frac{C}{2t\sqrt{\epsilon R}} = \text{Half-Wave Open}$$

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).

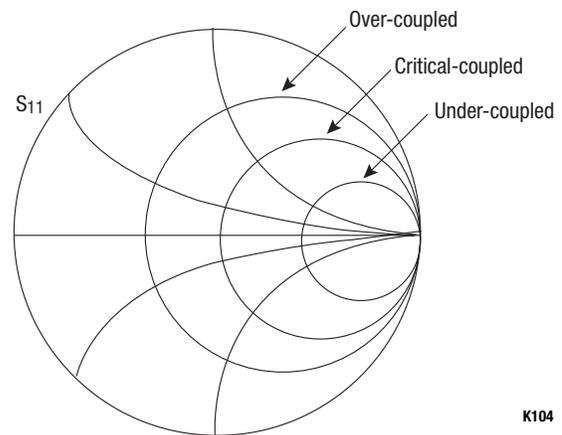


Figure 2. Smith Chart Coupled Responses

APPLICATION NOTE • MEASURING SRF AND Q OF COAXIAL RESONATORS

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

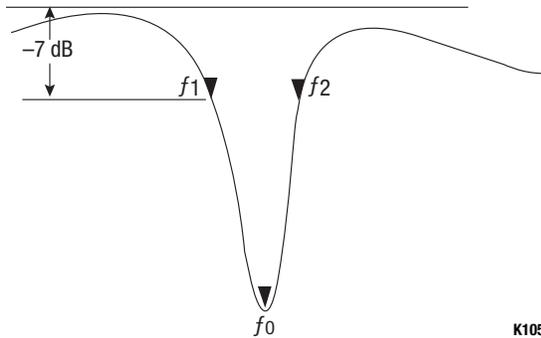


Figure 3. Self Resonant Frequency (SRF)

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

$$Q = \frac{f_0}{f_2 - f_1}$$

Copyright © 2013, 2017 Trans-Tech Inc., All Rights Reserved.

Information in this document is provided in connection with Trans-Tech, Inc. ("Trans-Tech"), a wholly-owned subsidiary of Skyworks Solutions, Inc. These materials, including the information contained herein, are provided by Trans-Tech as a service to its customers and may be used for informational purposes only by the customer. Trans-Tech assumes no responsibility for errors or omissions in these materials or the information contained herein. Trans-Tech may change its documentation, products, services, specifications or product descriptions at any time, without notice. Trans-Tech makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Trans-Tech assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Trans-Tech products, information or materials, except as may be provided in Trans-Tech Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS, AND INFORMATION ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY, OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. TRANS-TECH DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS, OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. TRANS-TECH SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Trans-Tech products are not intended for use in medical, lifesaving, or life-sustaining applications, or other equipment in which the failure of the Trans-Tech products could lead to personal injury, death, or physical or environmental damage. Trans-Tech customers using or selling Trans-Tech products for use in such applications do so at their own risk and agree to fully indemnify Trans-Tech for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Trans-Tech products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Trans-Tech assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Trans-Tech products outside of stated published specifications or parameters.

Skyworks and the Skyworks symbol are trademarks or registered trademarks of Skyworks Solutions, Inc., in the United States and other countries. Third-party brands and names are for identification purposes only, and are the property of their respective owners.