Virtual Lab 5 – Microwave Resonator

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# EEL4436C Microwave Engineering

Section 0012

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1. (20 pts) Report the results using Method 1. You need to present your own versions of structure drawing, field plots, convergence table, etc.

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Microstrip Resonator Structure

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Q after 20 Passes

A screenshot of a calculator

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Q after 25 Passes

A screenshot of a calculator

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Q after 30 Passes

A diagram of a blue line

Description automatically generated with medium confidence

Mode

A diagram of a wire fence

Description automatically generated with medium confidence

Mode

A diagram of a blue and green structure

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Mode

A diagram of a structure

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A diagram of a grid with arrows

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Mode

A table of numbers with numbers

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1. (20 pts) Report the results using Method 2 with all necessary details.

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Description automatically generated with medium confidence

Microstrip Resonator Structure with Feeding lines

In the second method, we use Modal Network mode to simulate the resonator. The resonator has two feeding microstrip lines (50 ) with a 3 mm gap to prevent lowering the resonant frequency. The microstrip lines. The dielectric material is Rogers RO4003 with loss tangent. To determine the we must first find using the following equation, , and afterwards, we can use the S21 plot to determine with the following equation,

A graph with red lines and numbers

Description automatically generated

S21 dB Plot

Using the previously mentioned equations, we find that and

1. (20 pts) Report the results using Method 3 with all necessary details.

A graph with red lines and yellow text

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S21 dB Plot for Metal Loss Only

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S21 dB Plot for Dielectric Loss Only

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S21 dB Plot for Radiation Loss Only

1. (10 pts) Report the Q factors due to three loss mechanisms. When you combine all three unloaded Q factors in parallel, does it agree with the total unloaded Q factor with Method 3?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Loss Method |  |  |  |  |  |  |
| Metal |  |  |  |  |  |  |
| Dielectric |  |  |  |  |  |  |
| Radiation |  |  |  |  |  |  |
| All |  |  |  |  |  |  |

When combing only metal and dielectric, which is about 9.6% off from method 2, however, when combining all three losses, , which is about 38% off from method 2. This is expected to happen because in method 2 we did not simulate radiation loss.

1. (10 pts) In Method 4, you will use analytical formulas to calculate the *f0* and *Qu*. By today’s standard, it is no longer considered accurate. However, it is beneficial for you to see how things were done in the past and how accurate/inaccurate this method is. Find the effective dielectric constant of the microstrip line using the formula in the textbook and use it to estimate the resonant frequency of the half-wavelength resonator. This frequency is typically higher than the HFSS simulation results. The difference is due to the fringing field effect at the two ends of the resonator. The actual resonator is equivalent to an ideal transmission line loaded with two identical capacitors at both ends. Calculate the capacitance. In addition, you can find the using Pozar’s methods for the attenuation and the propagation constant. Follow example 6.2 in Pozar’s book. It is noted that radiation losses are not considered in this case.

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1. (10 pts) You can also find the effective dielectric constant, attenuation and the propagation constants in HFSS Ports-only simulations. Report *f0* and using this method (Method 5)?

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Metal Loss Only

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Dielectric Loss Only

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Radiation Loss Only

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Metal, Dielectric, and Radiation Loss

1. (10 pts) Compare the *f0* and by all 5 methods in a table and comment.

|  |  |  |
| --- | --- | --- |
| Method |  |  |
| 1 | 5.12 GHz | 348.9 |
| 2 | 5.09 GHz | 359.9 |
| 3 | 5.08 GHz | 247.4 |
| 4 | 5.62 GHz | 196.82 |
| 5 | 5.00 GHz | 307.3 |

Method 1,2,5 and relatively close in Q measurement. Method 3 could be more accurate if I had lowered the max S delta and increased the pass count, however, that would have cause longer simulation time. The Pozar’s method (4) provided decent accuracy considering the level of approximation and simplicity of equations. Method 5 shows that the majority of inaccuracies of the Pozar’s equations are in loss computation. Overall, I would use method 1 (eigenmode) to compute Q due it’s speed and simplicity.