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ECEN452 Ultra High Frequency
PreLab2

Q1. Since the matching network is a quarter-wave impedance, thus it's easy to calculate characteristic impedance which is $Z_0 = \sqrt{50 * 200} = 100\,\Omega$. With known characteristic impedance, electrical length of the matching network and operation frequency, microstrip line parameters can be calculated through online website shown as following (Assume microstrip line thickness can be neglected):

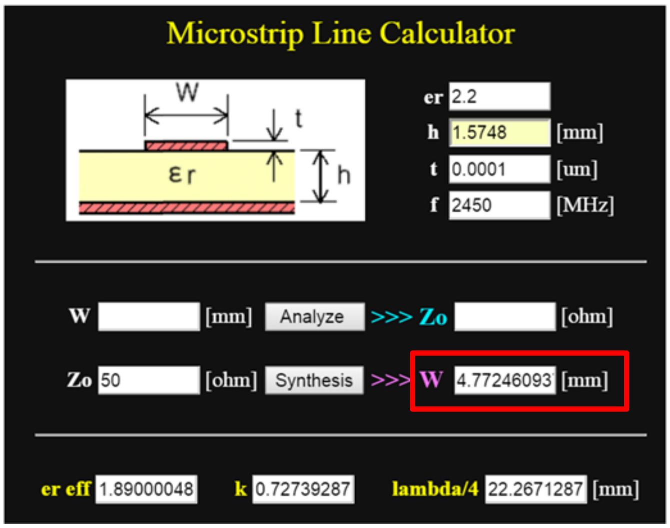

Figure 1. 50 Ω input microstrip line width calculation

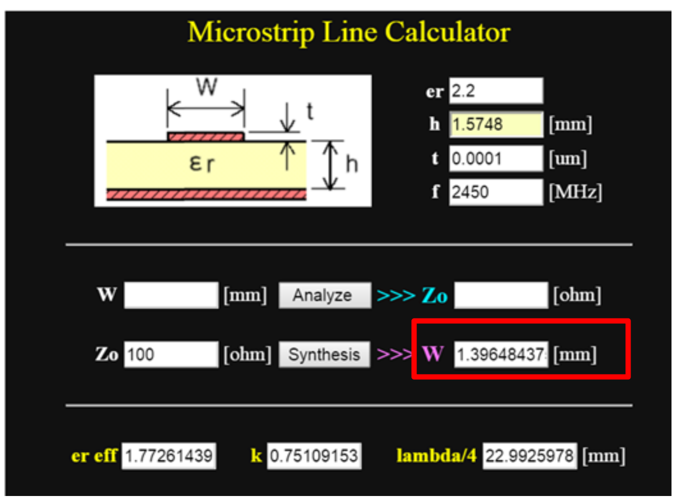

Figure 2. 100 Ω input microstrip line width calculation

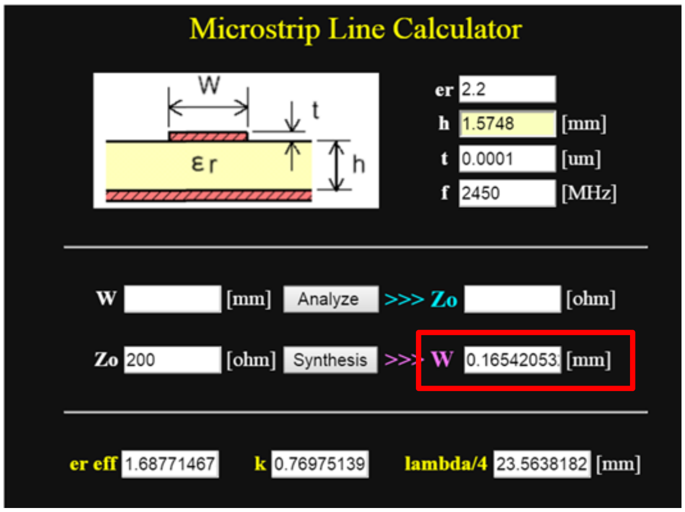

Figure 3. 200 Ω input microstrip line width calculation

Using circuit template file ECEN_452_PreLab2_1_Template.zov and run simulation in Z0lver, frequency starts with 2 GHz to 3 GHz. S11 parameter can achieve up to -68.5 dB at frequency about 2.448 GHz .The circuit model and simulation results are shown below:

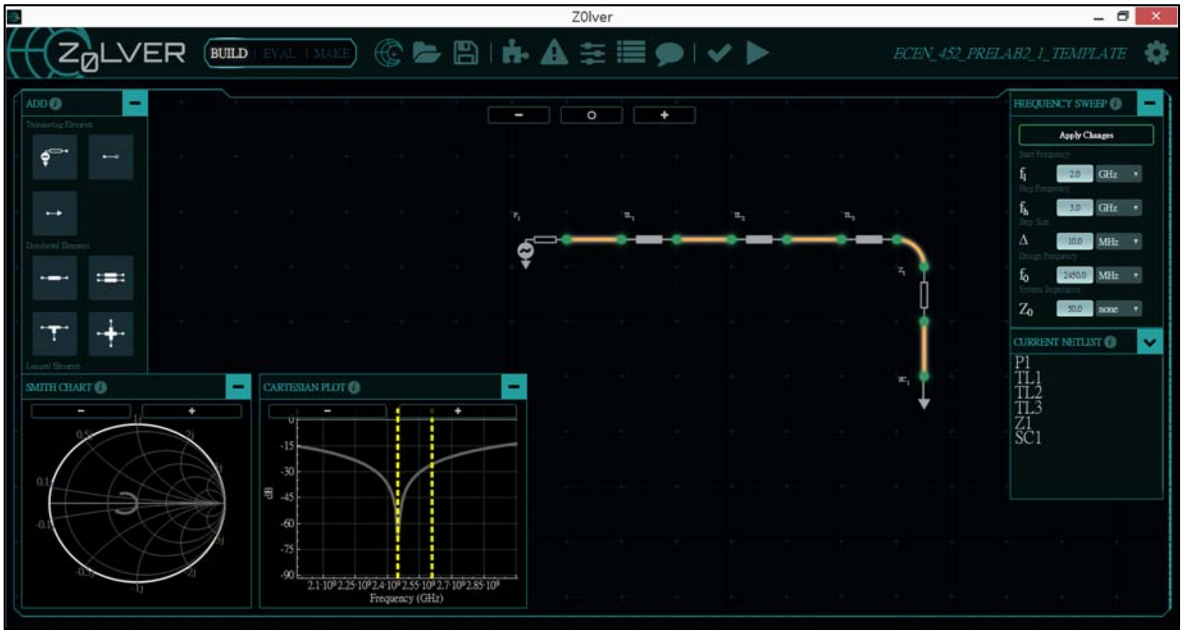

Figure 4. PreLab2_1 circuit model in Z0lver

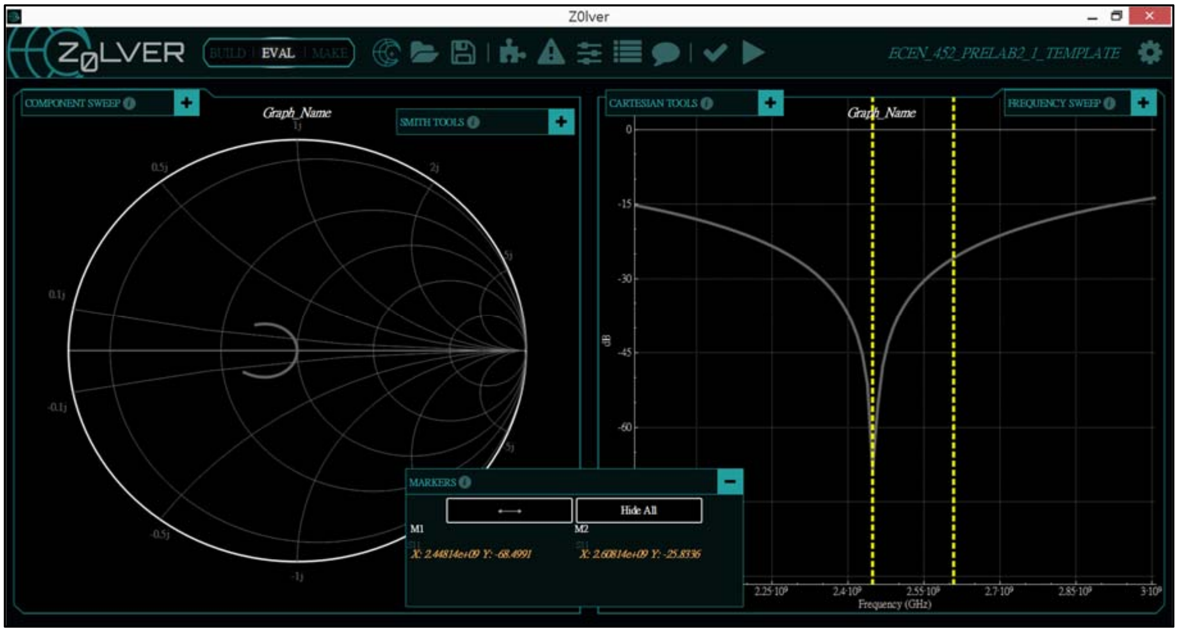

Figure 5. Simulation result of S11 and Smith Chart

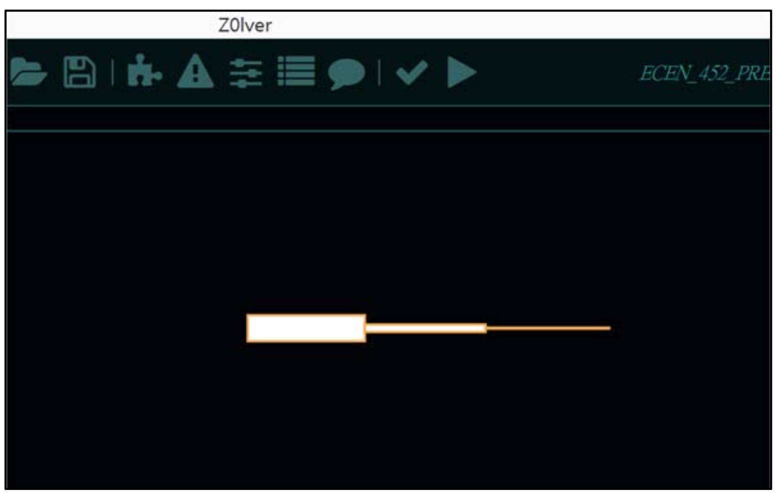

Figure 6. Circuit layout in Z0lver

Using template file ECEN_452_Lab2.hfss with same parameters, a simulation was conducted in ANSYS HFSS software. The model is almost the same as the result in Z0lver. S11 shows that the peak is about -82.03 dB at the frequency of 2.404 GHz.

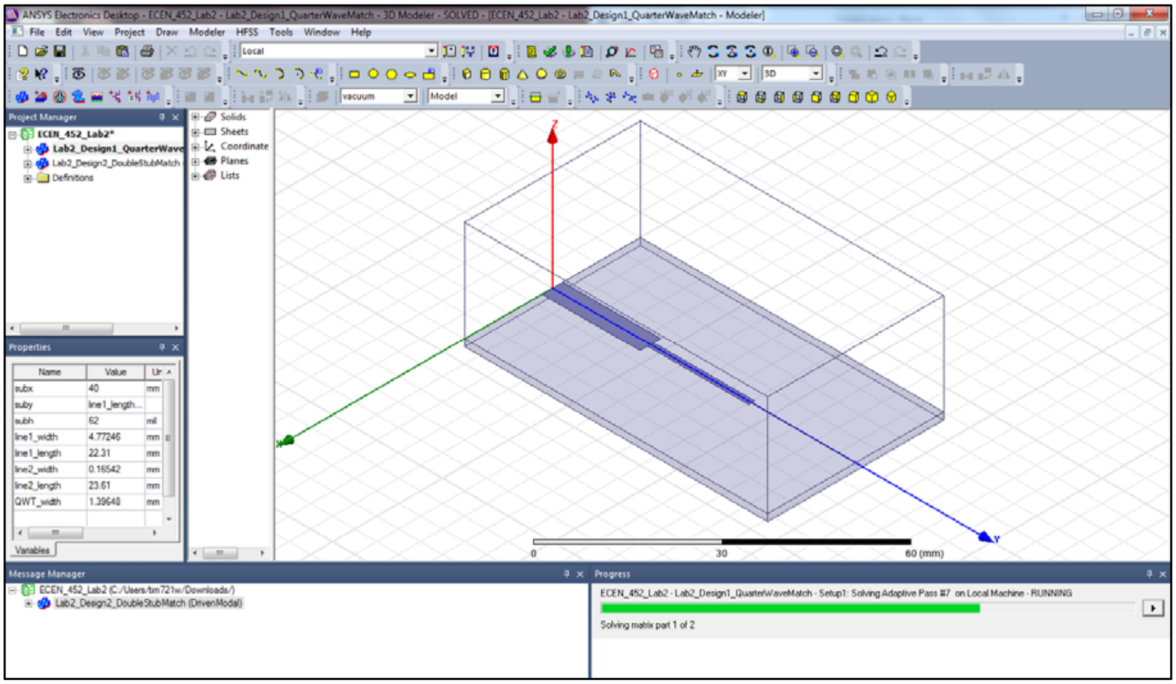

Figure 7. ANSYS HFSS model setup and simulation

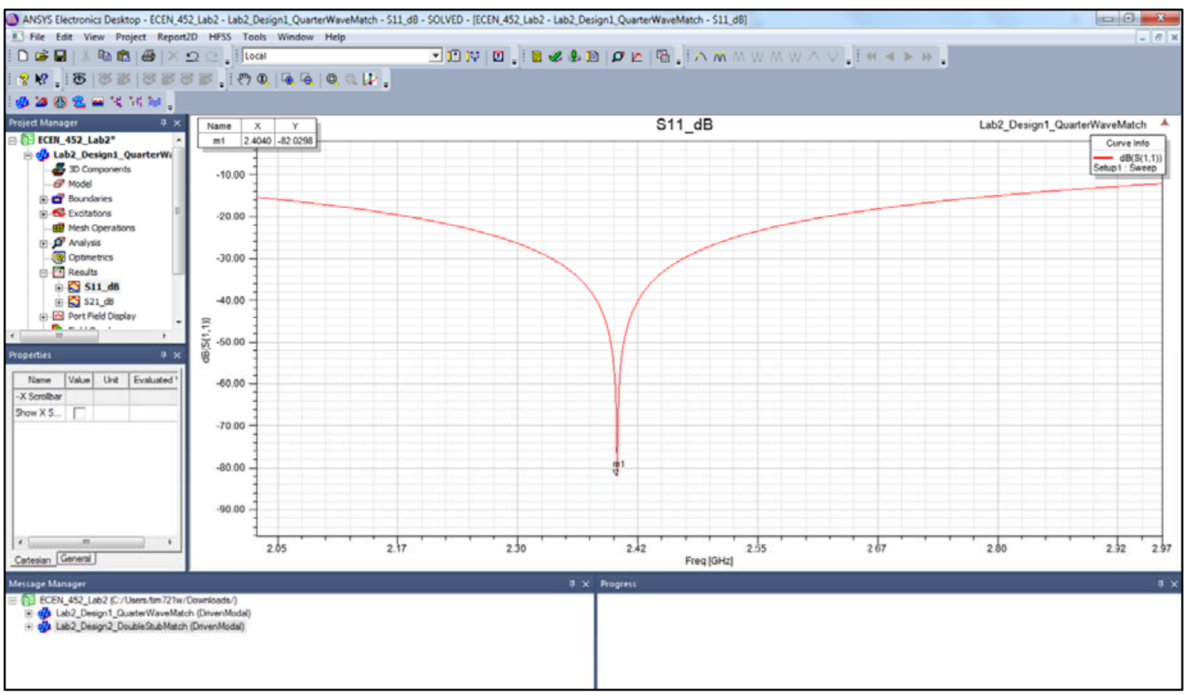

Figure 8. ANSYS HFSS S11 simulation result

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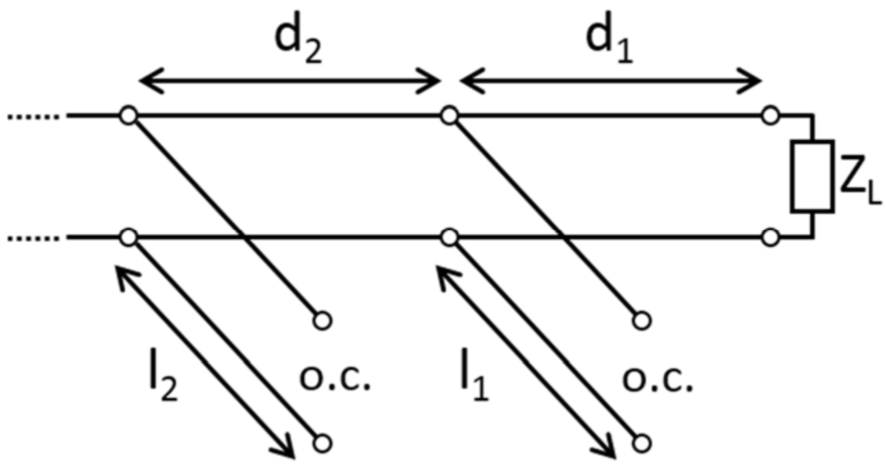
Q2. Double stub tuning structure are designed as below: (For simplicity, d_1 is chosen as 0.5 wavelengths and d_2 is chosen as 0.125 wavelengths)



The design parameters for this question are:

Parameters	1st Solution	2nd Solution
d_1	0.5 λ_g	0.5 λ_g
l_1	0 (0.5 λ_g can also be chosen)	0.161 λ_g
d_2	0.125 λ_g	0.125 λ_g
l_2	0.375 λ_g	0.199 λ_g

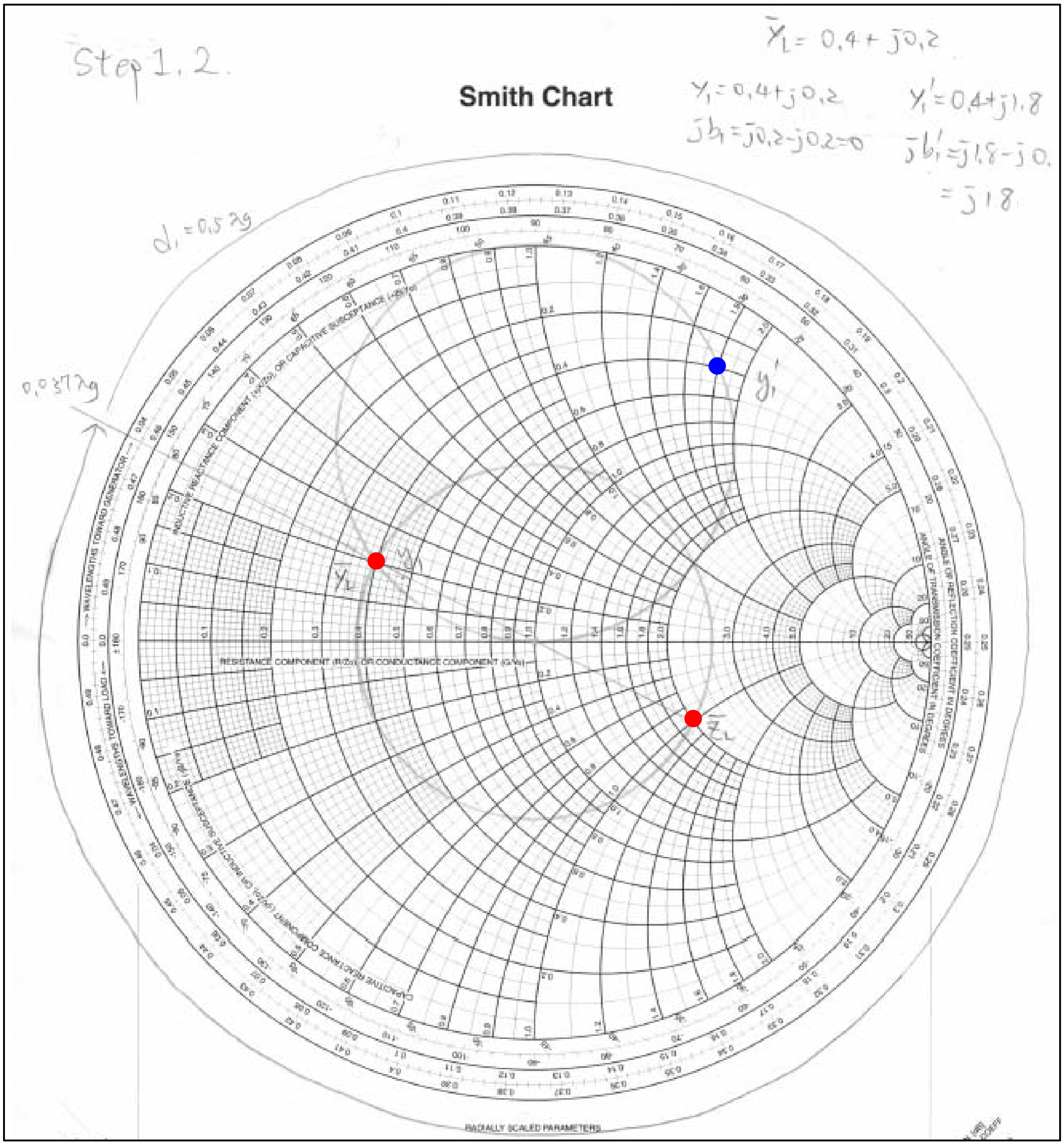
Step 1. Plot normalized impedance/admittance and rotate distance d_1 towards the generator.

Given load impedance and feed line impedance, $z_L = 2 - j$ can be calculated. Then, rotating 0.25 wavelengths to find $y_L = 0.4 + j0.2$.

Step 2. Since d_2 is chosen as 0.125 wavelengths, we have to rotate 1+jb circle and find jb_1 and jb_1'.

$y_L = 0.4 + j0.2$

$y_1 = 0.4 + j0.2$	$y_1' = 0.4 + j1.8$
$jb_1 = j0.2 - j0.2 = 0$	$jb_1' = j1.8 - j0 = j1.8$



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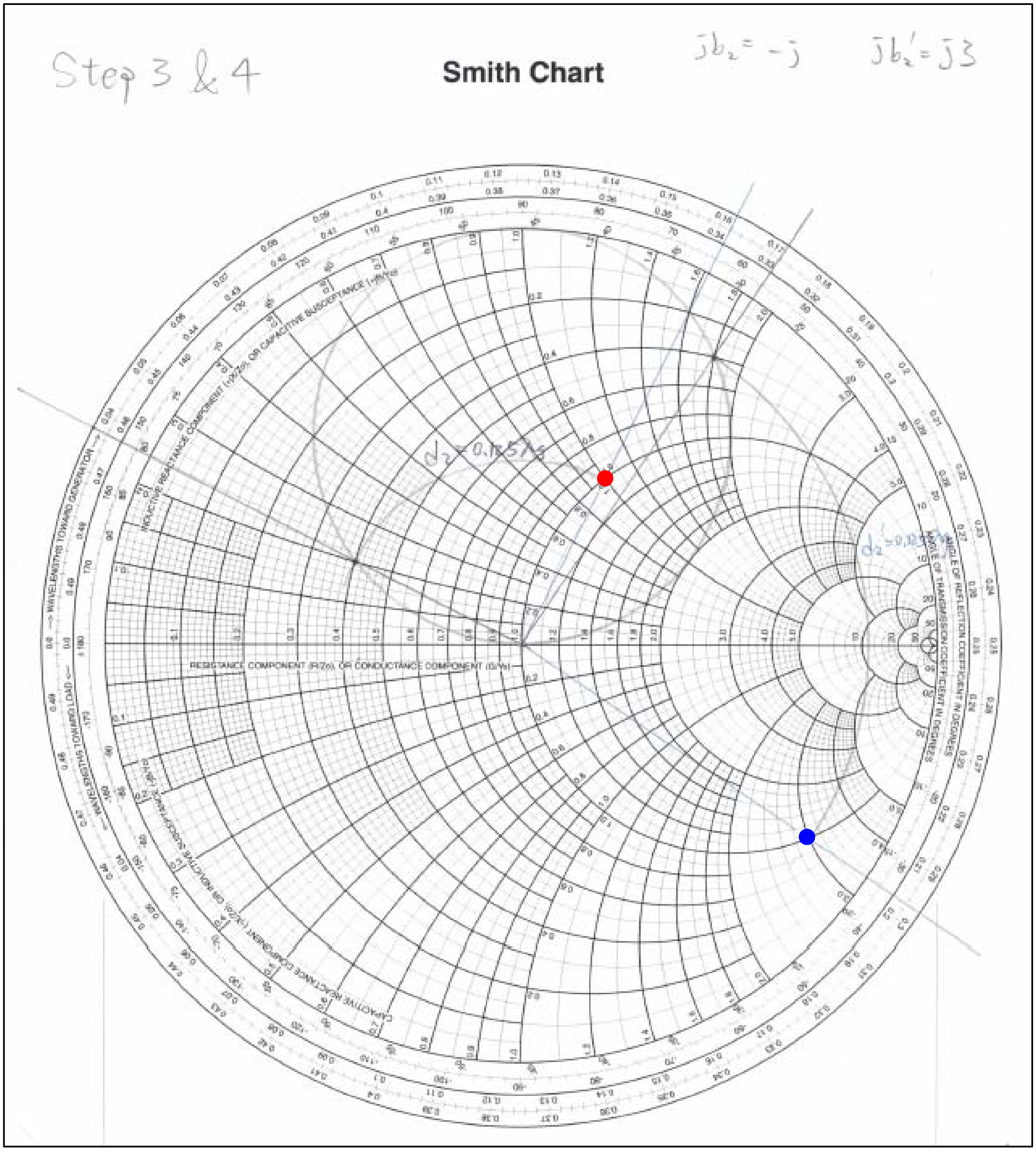
Step 3. Rotate distance d_2 (0.125 wavelengths) towards the generator.

Step 4. Find the negative of jb on the 1+jb circle.

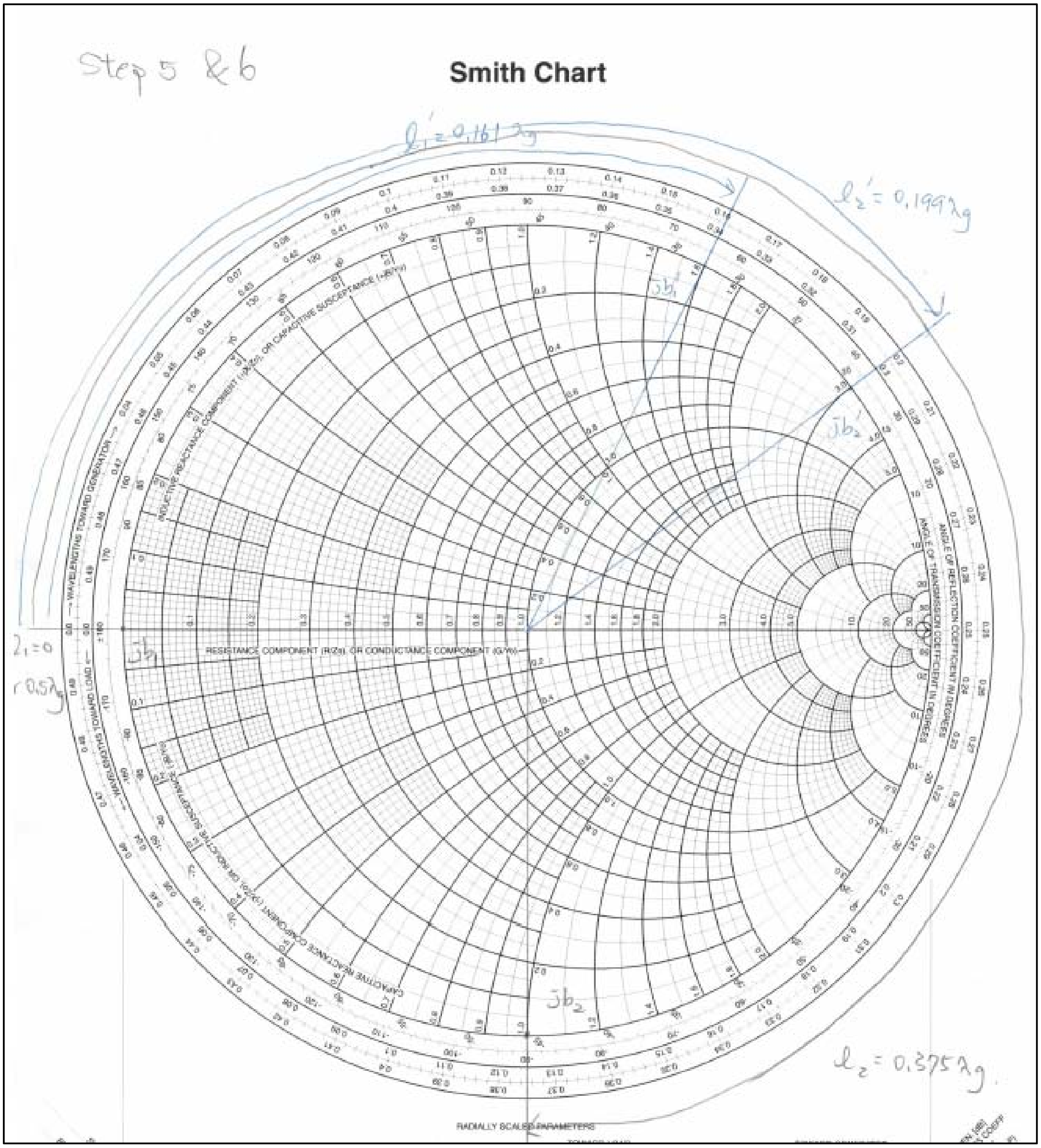
$jb_2 = -j$ $jb_2' = j3$



Step 5. Determine the length of the first stub and second stub.

Since we found out $jb_1 = 0$ and $jb_1' = j1.8$, it's easy to get the stub length on smith chart from open-circuit to these points. Therefore, two solutions for first stub are $l_1 = 0$ and $l_1' = 0.161\ \lambda_g$.

Second stub length can be determined through $jb_2 = -j$ and $jb_2' = j3$ using the same way above. Thus, $l_2 = 0.375\ \lambda_g$ and $l_2' = 0.199\ \lambda_g$.



Using circuit template file ECEN_452_PreLab2_2_Template.zov and run simulation in Z0lver, frequency starts with 2 GHz to 3 GHz. S11 parameter can achieve up to -81.2 dB at frequency about 2.45 GHz .The circuit model and simulation results are shown below:

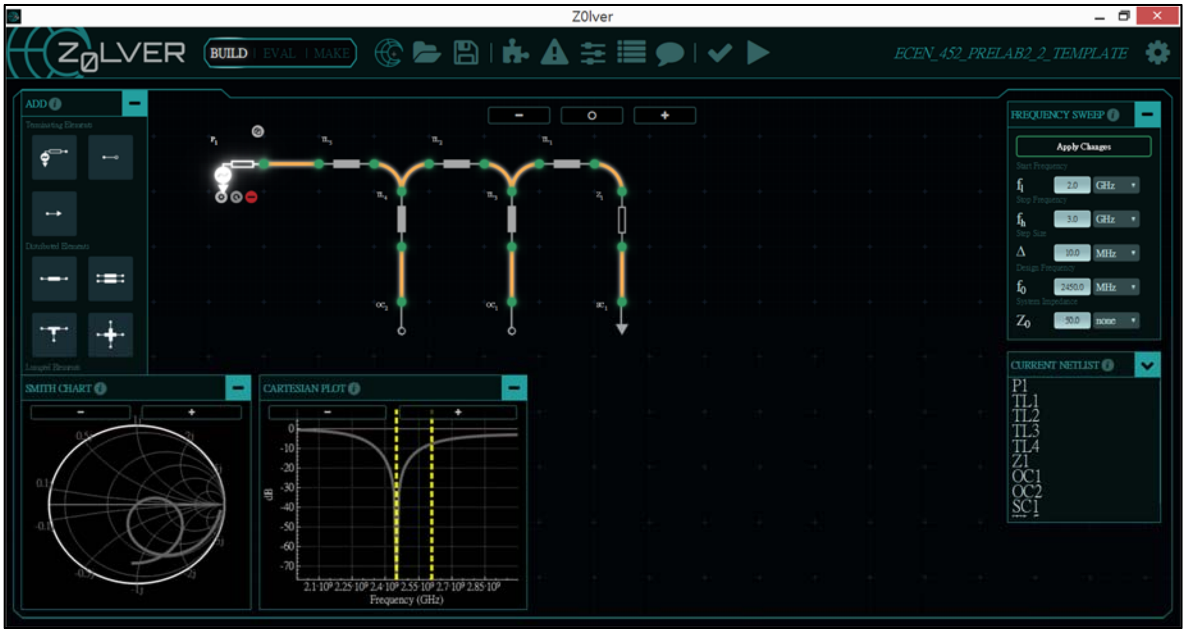


Figure 9. PreLab2_2 circuit model in Z0lver

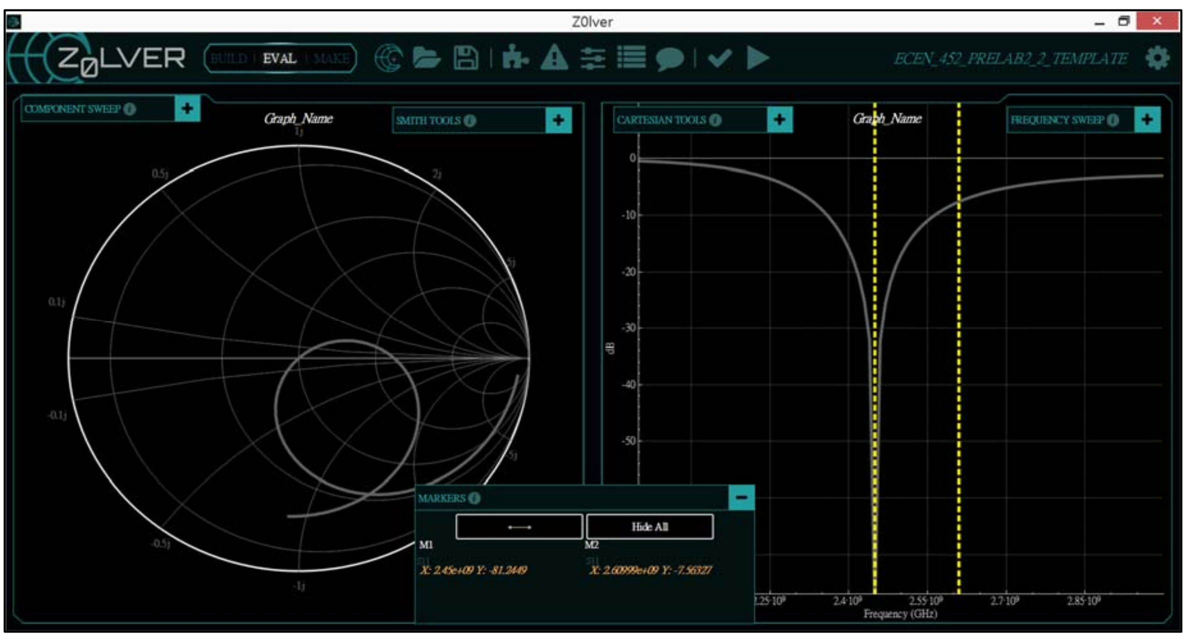


Figure 10. Simulation result of S11 and Smith Chart

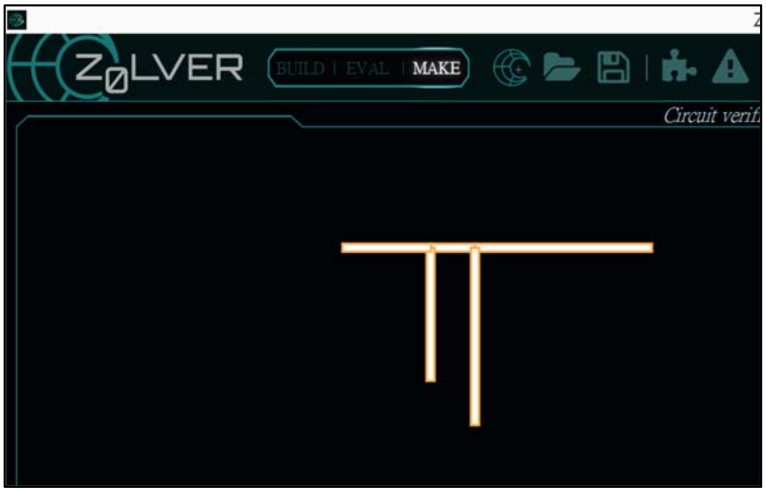


Figure 11. Circuit layout in Z0lver

Using template file ECEN_452_Lab2.hfss with same parameters, a simulation was conducted in ANSYS HFSS software. S11 shows that the peak is about -23.11 dB at the frequency of 2.432 GHz.

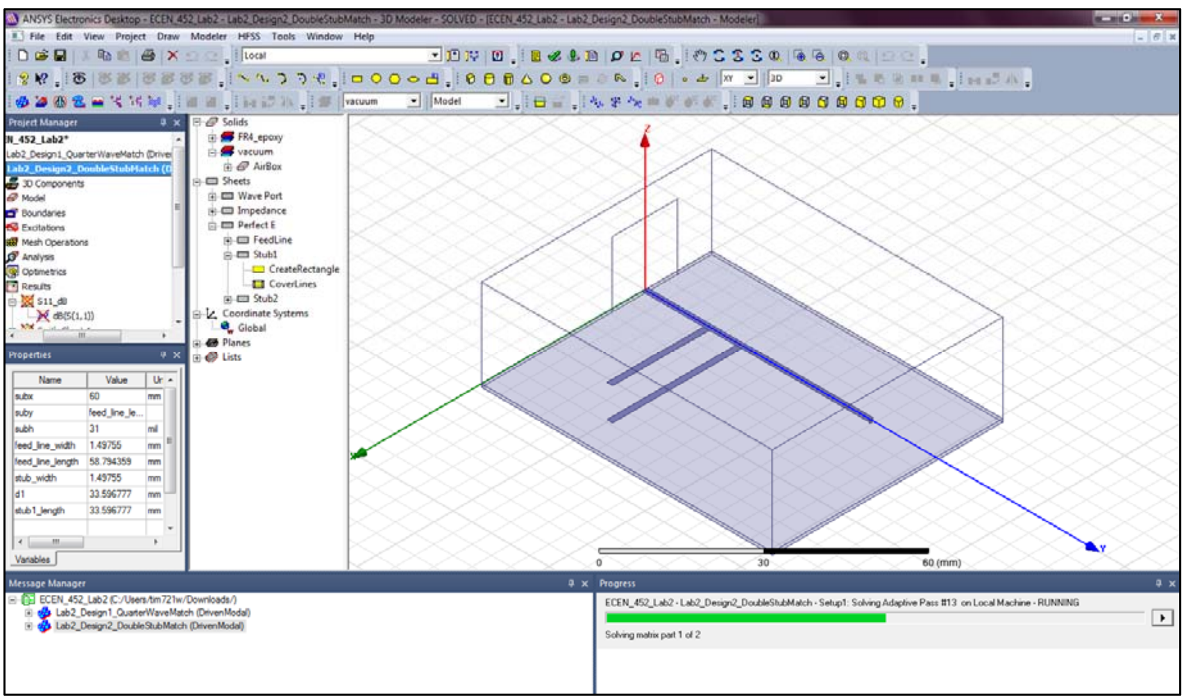


Figure 12. ANSYS HFSS model setup and simulation

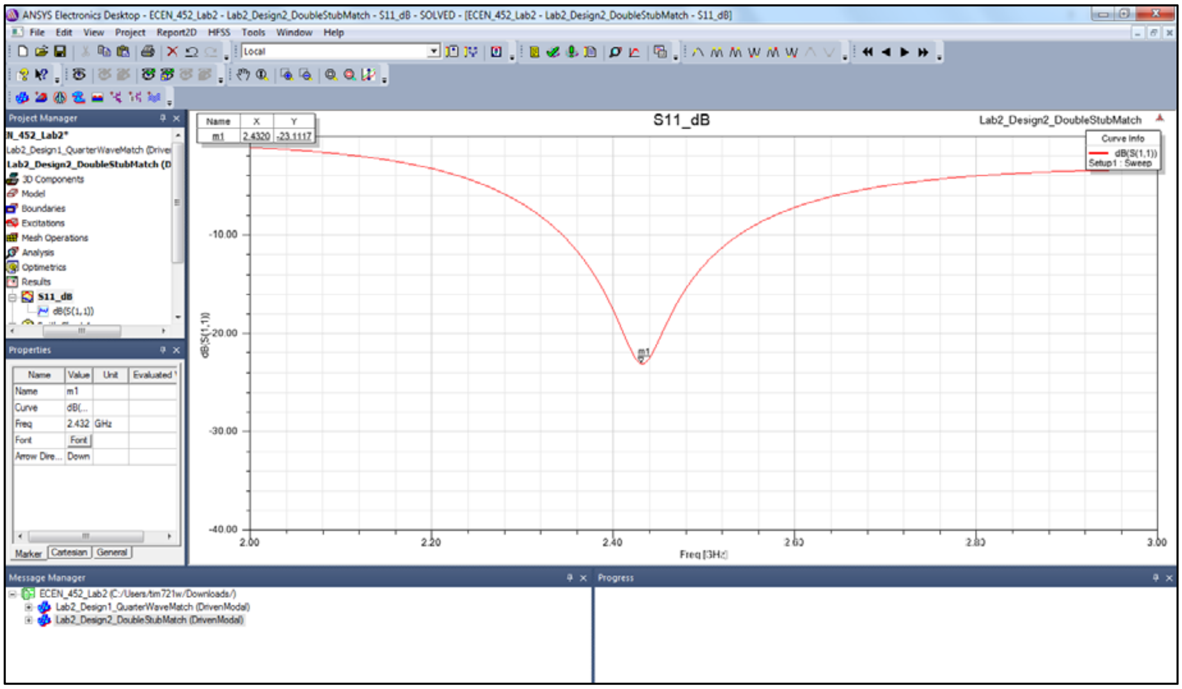


Figure 13. ANSYS HFSS S11 simulation result

Q3. Familiarize with the basic operation of the Keysight FieldFox portable network analyzer. Already done basic operation such as frequency sweep setup, resolution chosen, one-port calibration and data store in Lab.