



GYSEL POWER DIVIDER

Layout and EM simulation

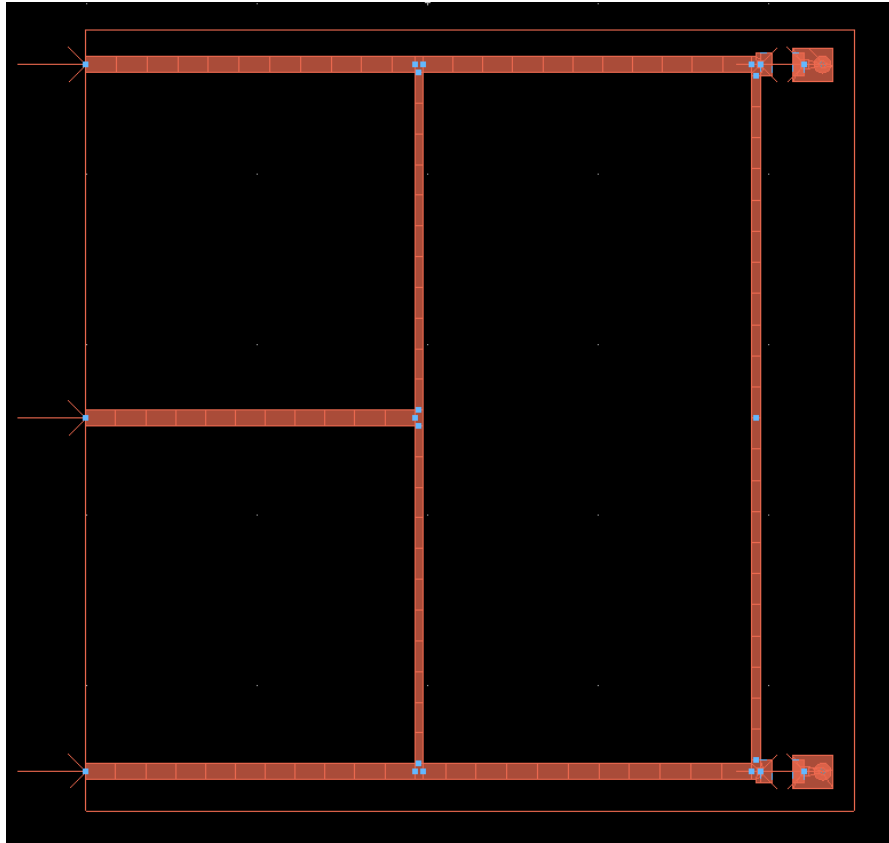


Presented By:

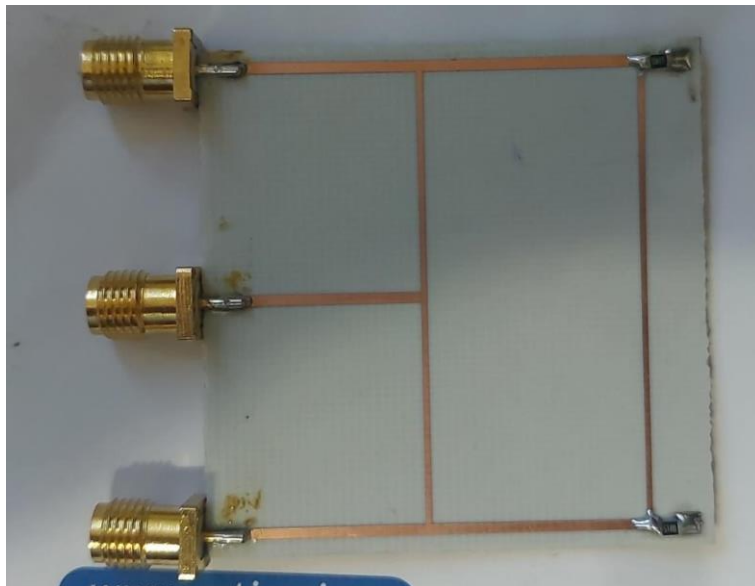
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Under Supervision:
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Layout Design



PCB



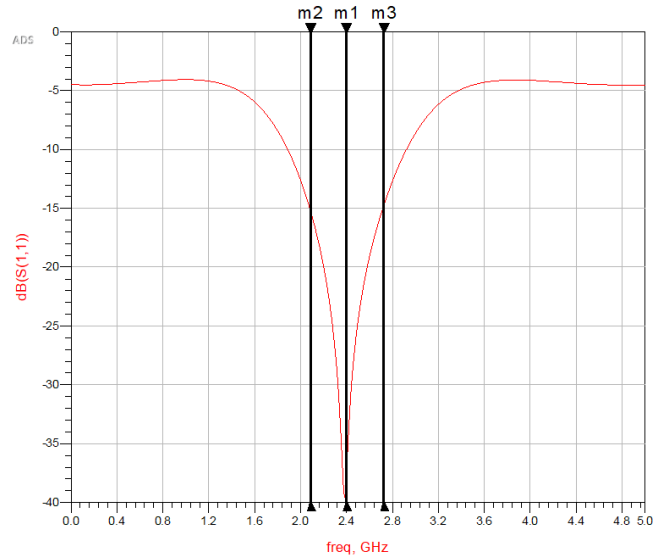
EM simulation results

S11

m3
freq=2.725GHz
dB(S(1,1))=-14.695

m2
freq=2.087GHz
dB(S(1,1))=-15.284

m1
freq=2.400GHz
dB(S(1,1))=-37.495

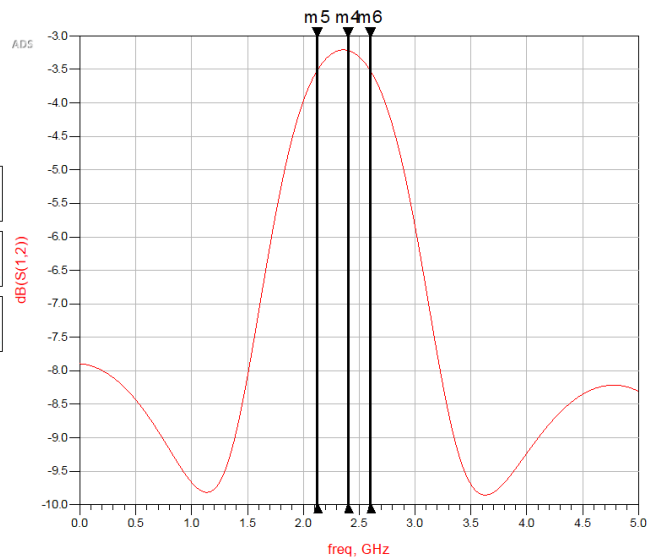


S12

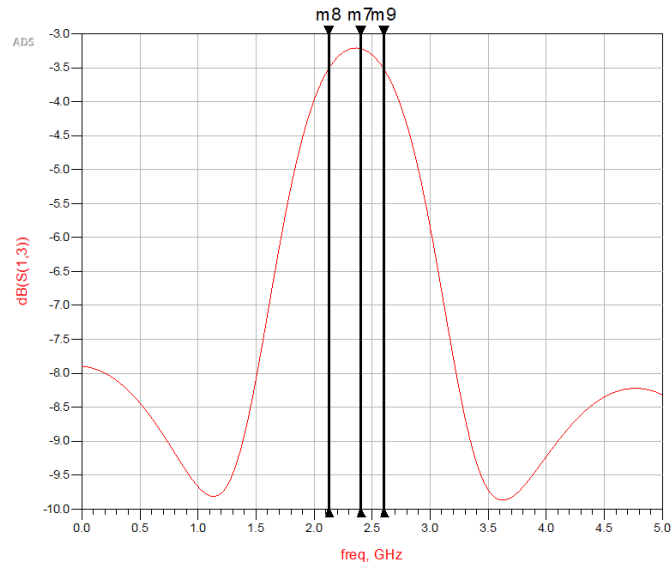
m6
freq=2.600GHz
dB(S(1,2))=-3.520

m5
freq=2.125GHz
dB(S(1,2))=-3.506

m4
freq=2.400GHz
dB(S(1,2))=-3.216



S13

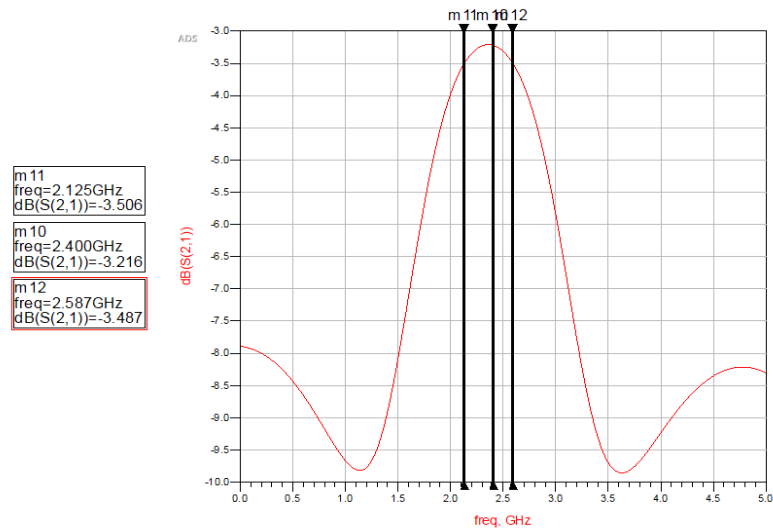


m9
freq=2.600GHz
dB(S(1,3))=-3.515

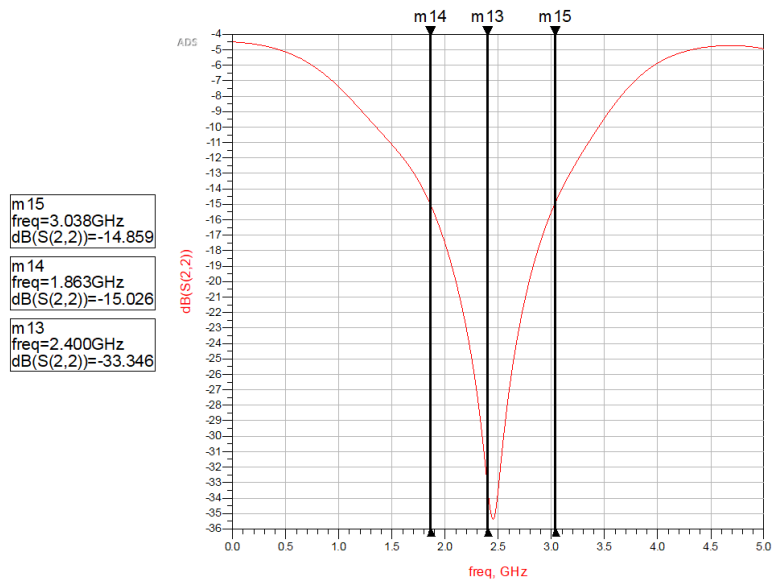
m8
freq=2.125GHz
dB(S(1,3))=-3.510

m7
freq=2.400GHz
dB(S(1,3))=-3.216

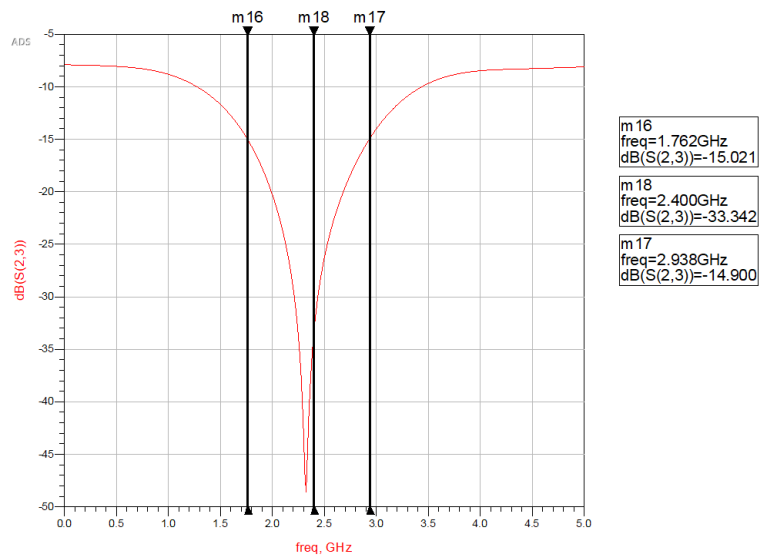
S21



S22



S23

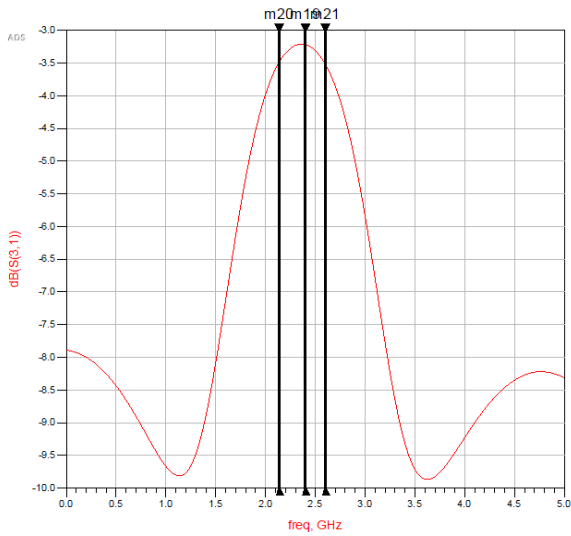


S31

m19
freq=2.400GHz
dB(S(3,1))=-3.216

m20
freq=2.138GHz
dB(S(3,1))=-3.477

m21
freq=2.600GHz
dB(S(3,1))=-3.515

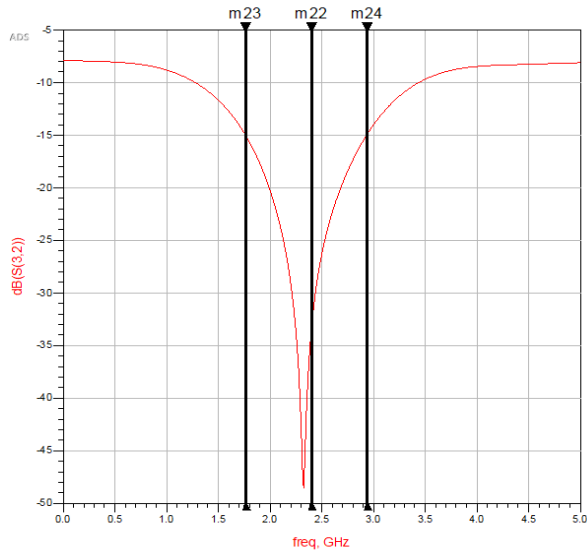


S32

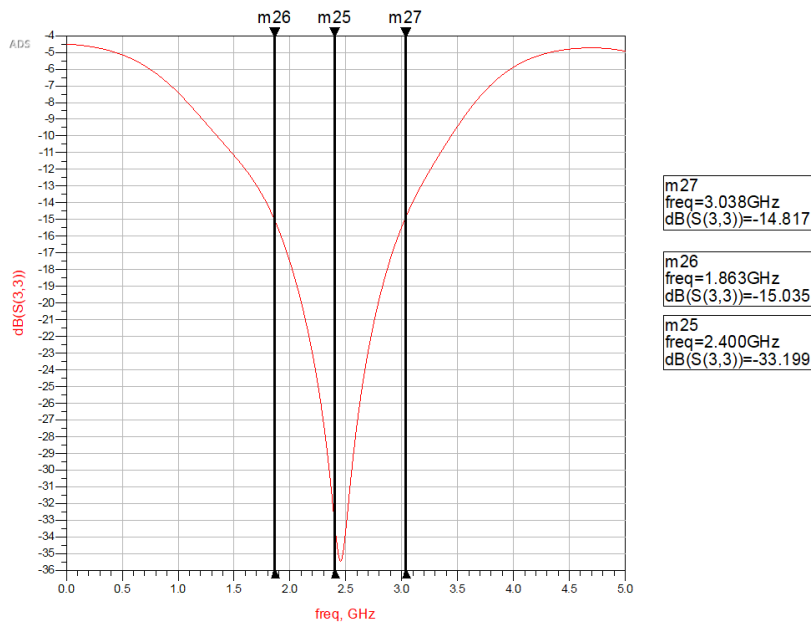
m23
freq=1.762GHz
dB(S(3,2))=-15.021

m22
freq=2.400GHz
dB(S(3,2))=-33.342

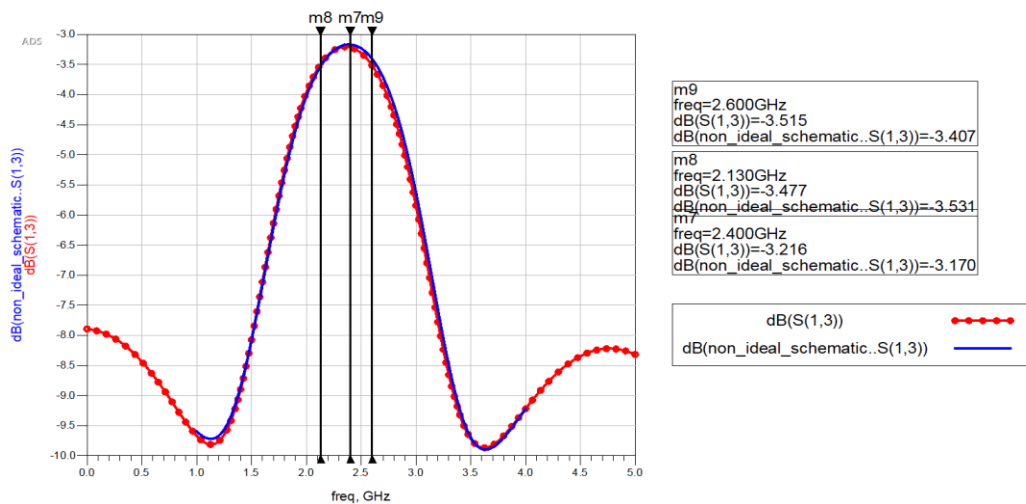
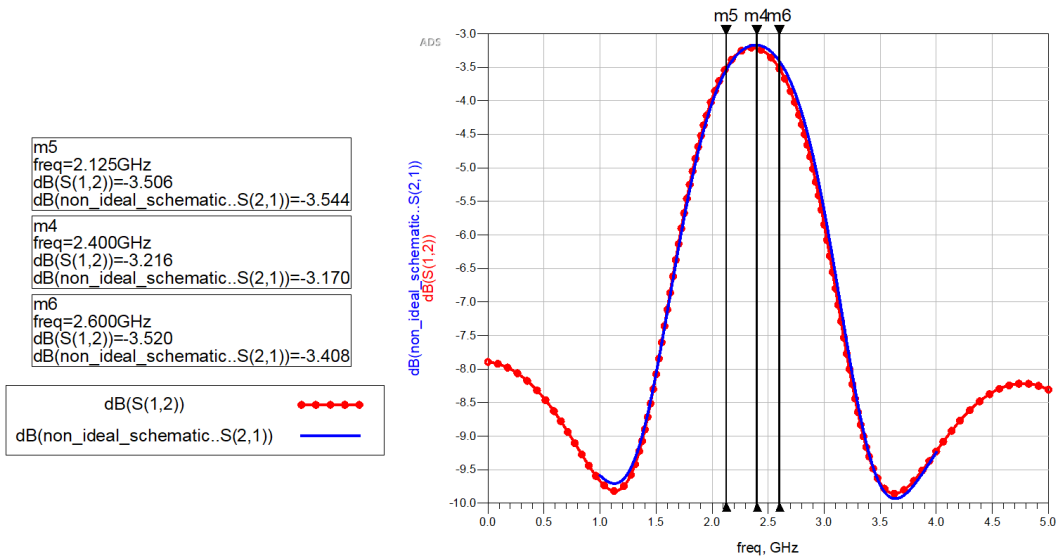
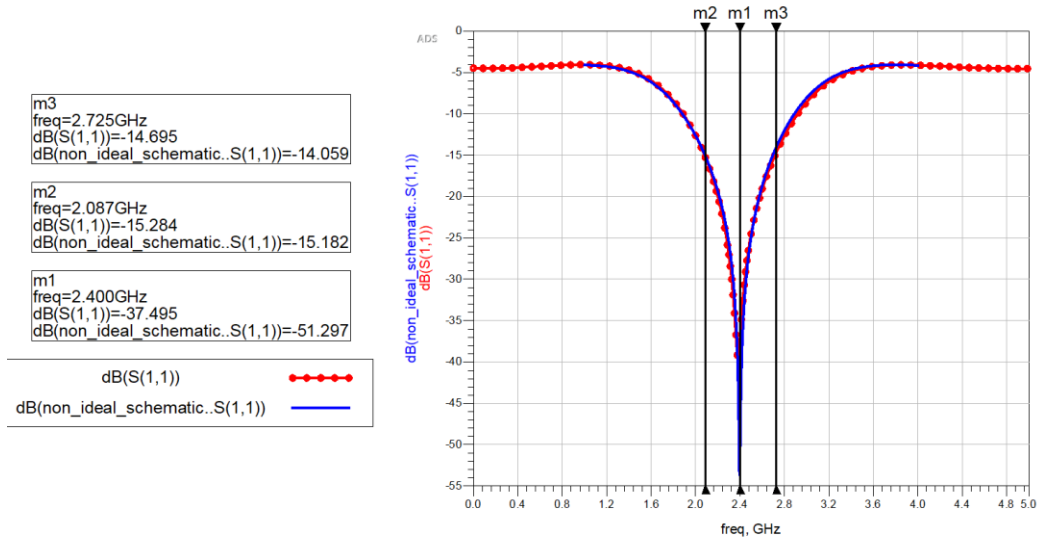
m24
freq=2.938GHz
dB(S(3,2))=-14.900



S33



The comparison between EM simulation and non-ideal simulation



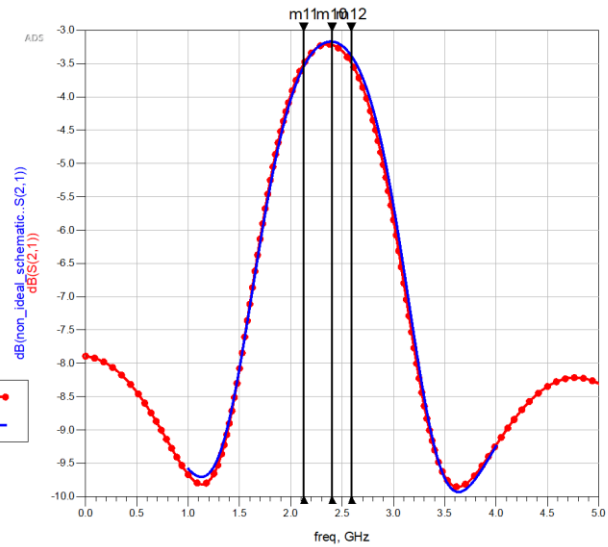
m11
freq=2.125GHz
dB(S(2,1))=-3.506
dB(non_ideal_schematic..S(2,1))=-3.544

m10
freq=2.400GHz
dB(S(2,1))=-3.216
dB(non_ideal_schematic..S(2,1))=-3.170

m12
freq=2.590GHz
dB(S(2,1))=-3.520
dB(non_ideal_schematic..S(2,1))=-3.385

dB(S(2,1))

dB(non_ideal_schematic..S(2,1))



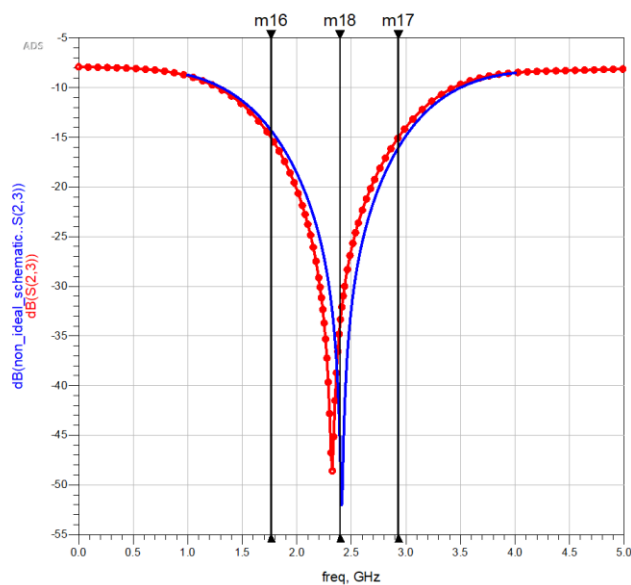
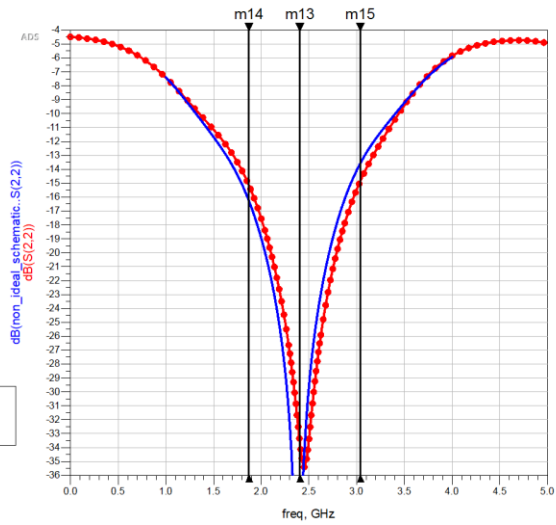
m15
freq=3.038GHz
dB(S(2,2))=-14.859
dB(non_ideal_schematic..S(2,2))=-13.550

m14
freq=1.870GHz
dB(S(2,2))=-15.224
dB(non_ideal_schematic..S(2,2))=-16.263

m13
freq=2.405GHz
dB(S(2,2))=-34.124
dB(non_ideal_schematic..S(2,2))=-43.608

dB(S(2,2))

dB(non_ideal_schematic..S(2,2))



m16
freq=1.762GHz
dB(S(2,3))=-15.021
dB(non_ideal_schematic..S(2,3))=-14.324

m18
freq=2.395GHz
dB(S(2,3))=-33.342
dB(non_ideal_schematic..S(2,3))=-46.110

m17
freq=2.930GHz
dB(S(2,3))=-14.900
dB(non_ideal_schematic..S(2,3))=-16.038

dB(S(2,3))

dB(non_ideal_schematic..S(2,3))

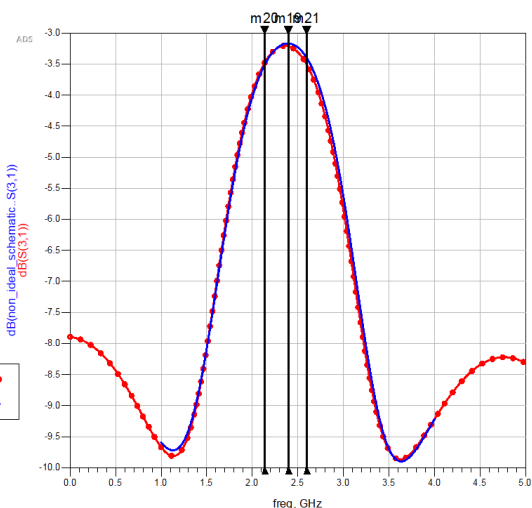
m19
freq=2.395GHz
dB(S(3,1))=-3.216
dB(non_ideal_schematic..S(3,1))=-3.170

m20
freq=2.135GHz
dB(S(3,1))=-3.477
dB(non_ideal_schematic..S(3,1))=-3.517

m21
freq=2.595GHz
dB(S(3,1))=-3.515
dB(non_ideal_schematic..S(3,1))=-3.395

dB(S(3,1))

dB(non_ideal_schematic..S(3,1))



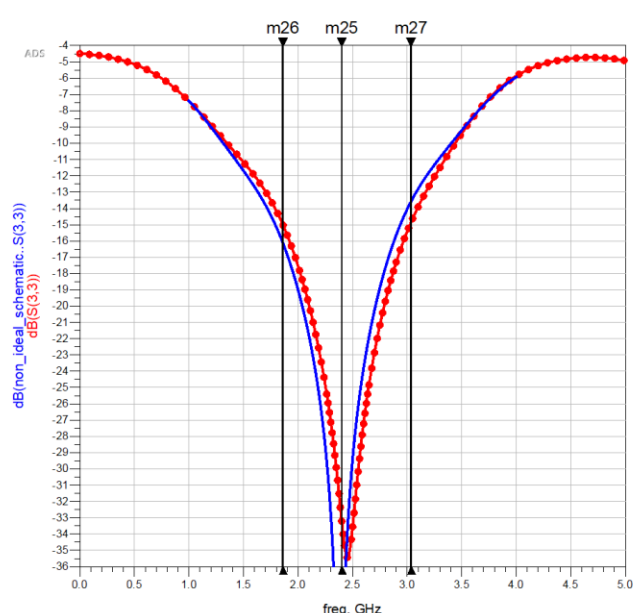
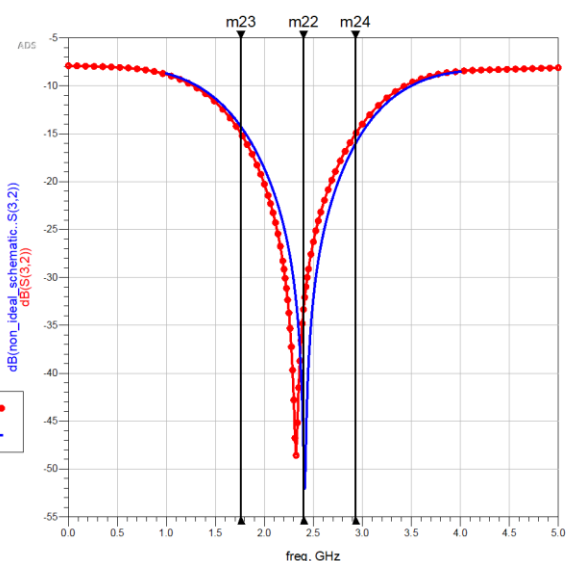
m23
freq=1.760GHz
dB(S(3,2))=-15.021
dB(non_ideal_schematic..S(3,2))=-14.252

m22
freq=2.400GHz
dB(S(3,2))=-33.342
dB(non_ideal_schematic..S(3,2))=-48.337

m24
freq=2.930GHz
dB(S(3,2))=-14.900
dB(non_ideal_schematic..S(3,2))=-16.038

dB(S(3,2))

dB(non_ideal_schematic..S(3,2))



m27
freq=3.035GHz
dB(S(3,3))=-14.817
dB(non_ideal_schematic..S(3,3))=-13.582

m26
freq=1.860GHz
dB(S(3,3))=-15.035
dB(non_ideal_schematic..S(3,3))=-16.114

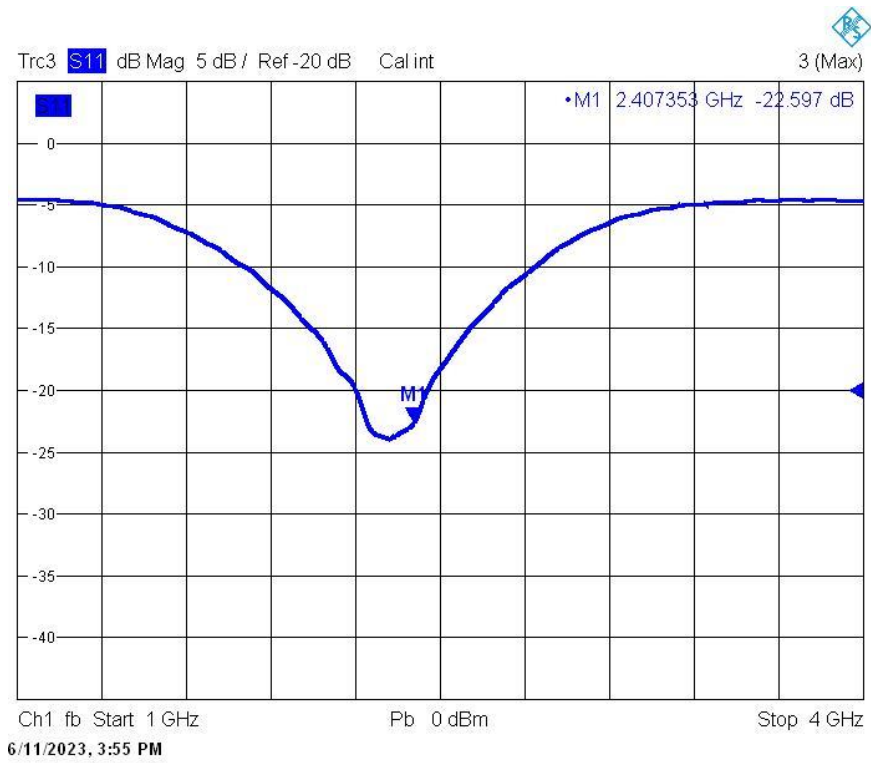
m25
freq=2.400GHz
dB(S(3,3))=-33.199
dB(non_ideal_schematic..S(3,3))=-44.358

dB(S(3,3))

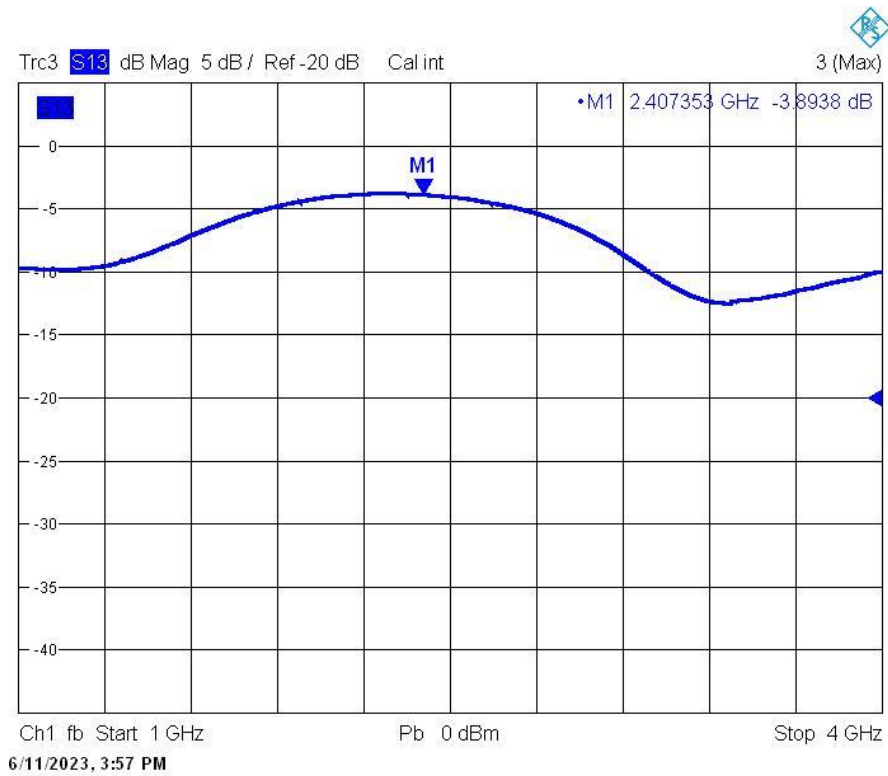
dB(non_ideal_schematic..S(3,3))

PCB results

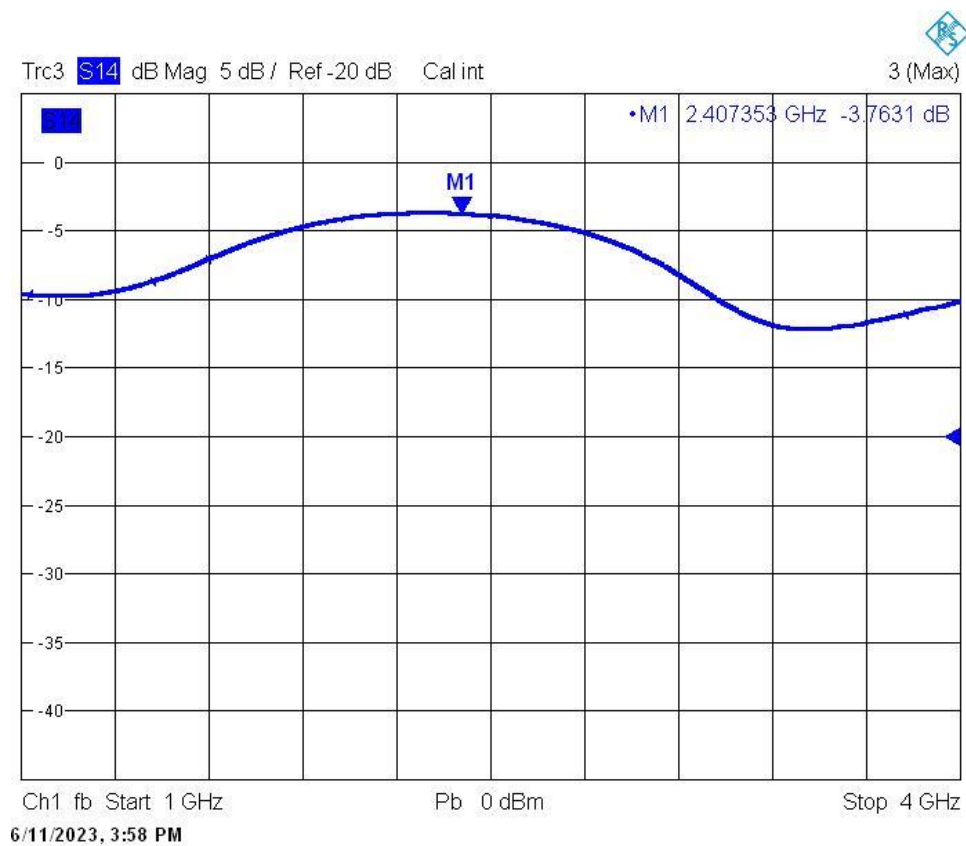
S11



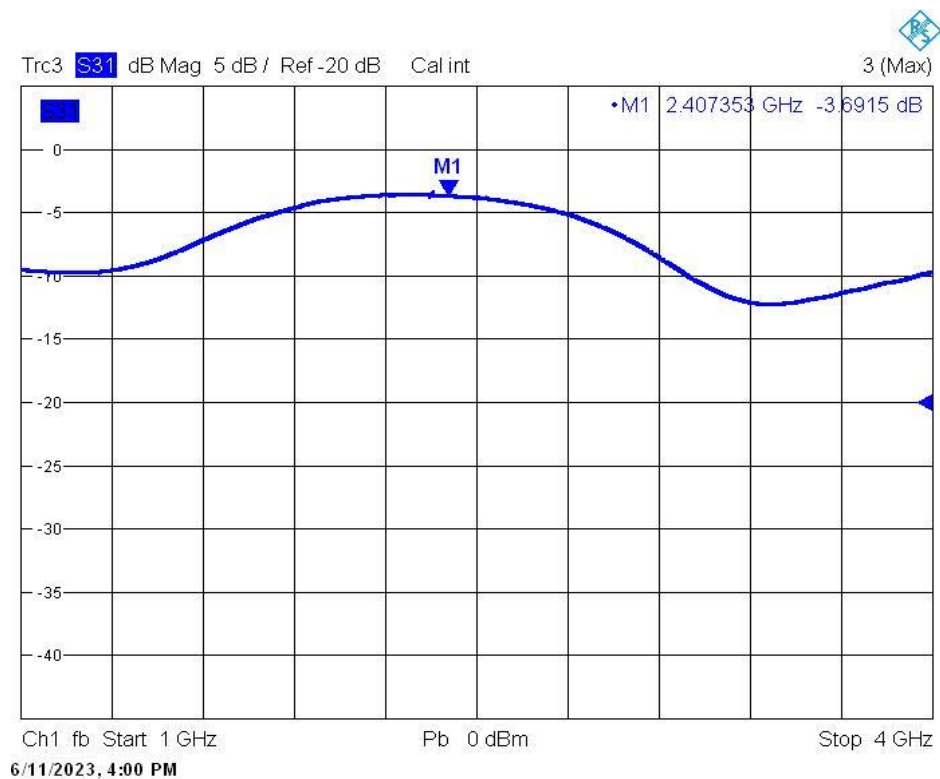
S12



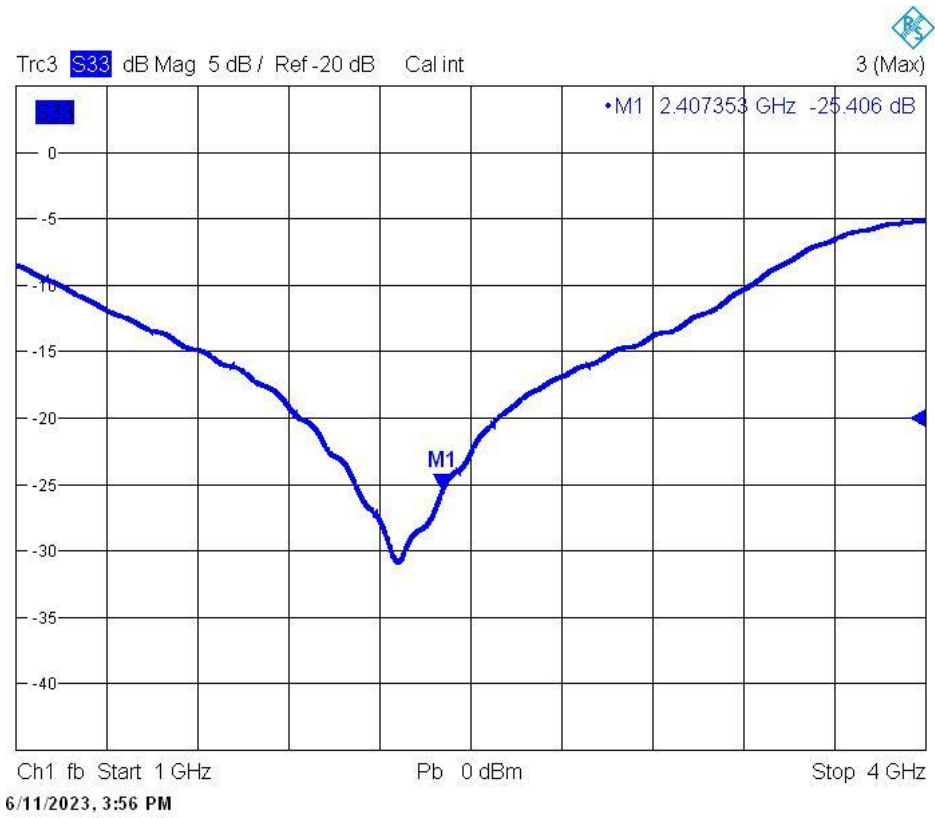
S31



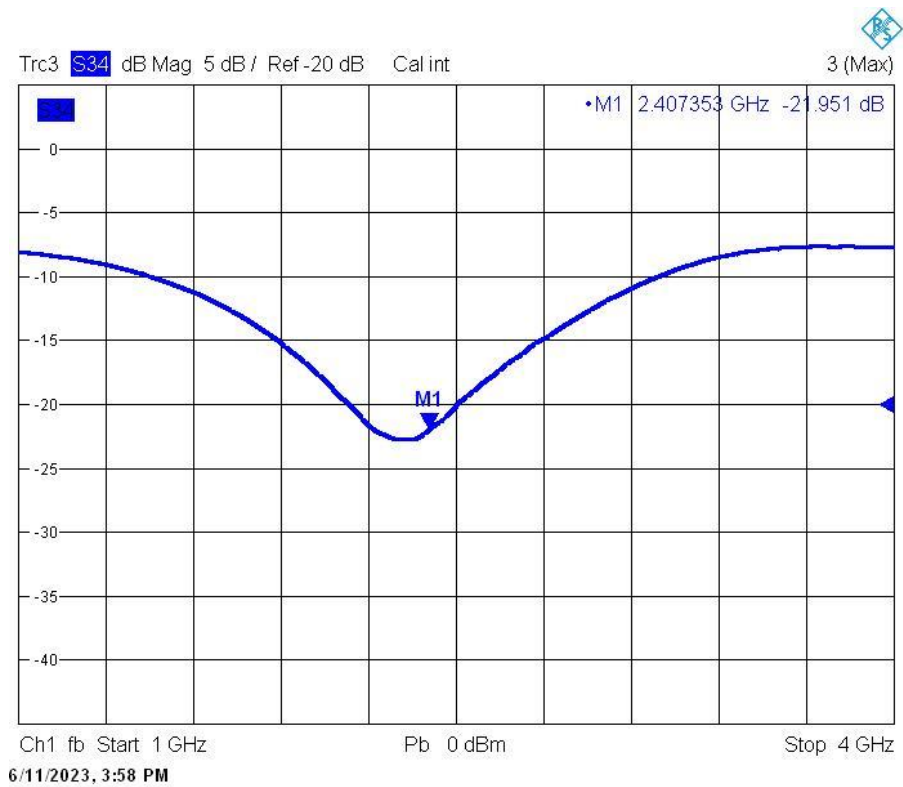
S21



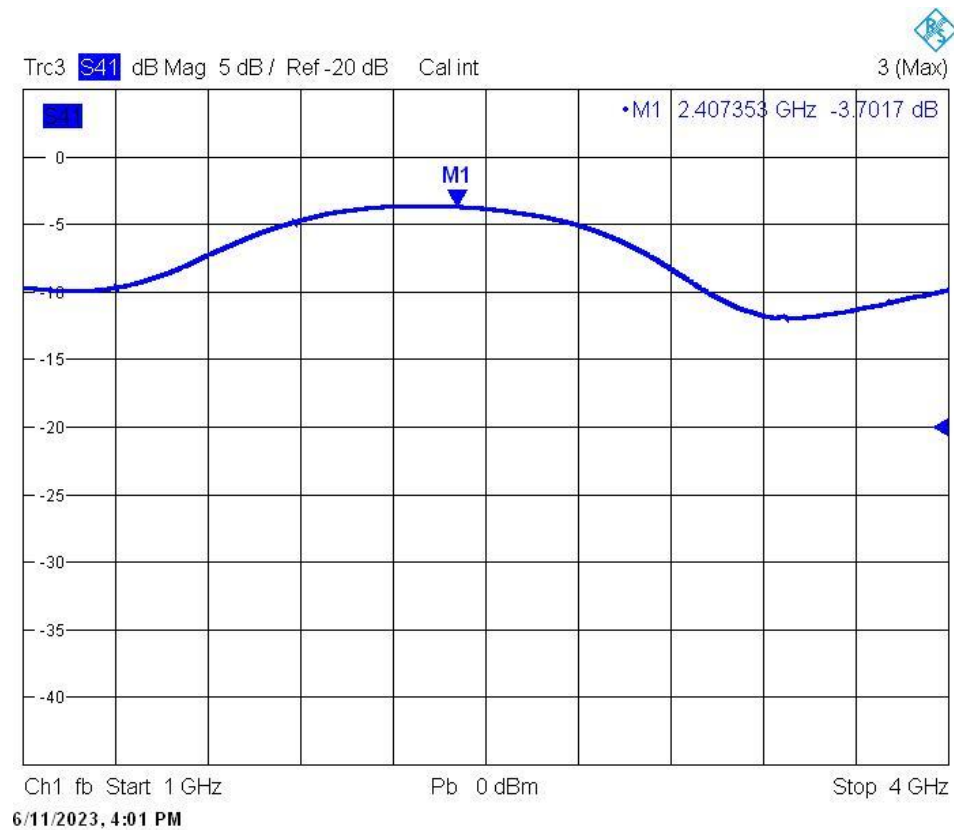
S22



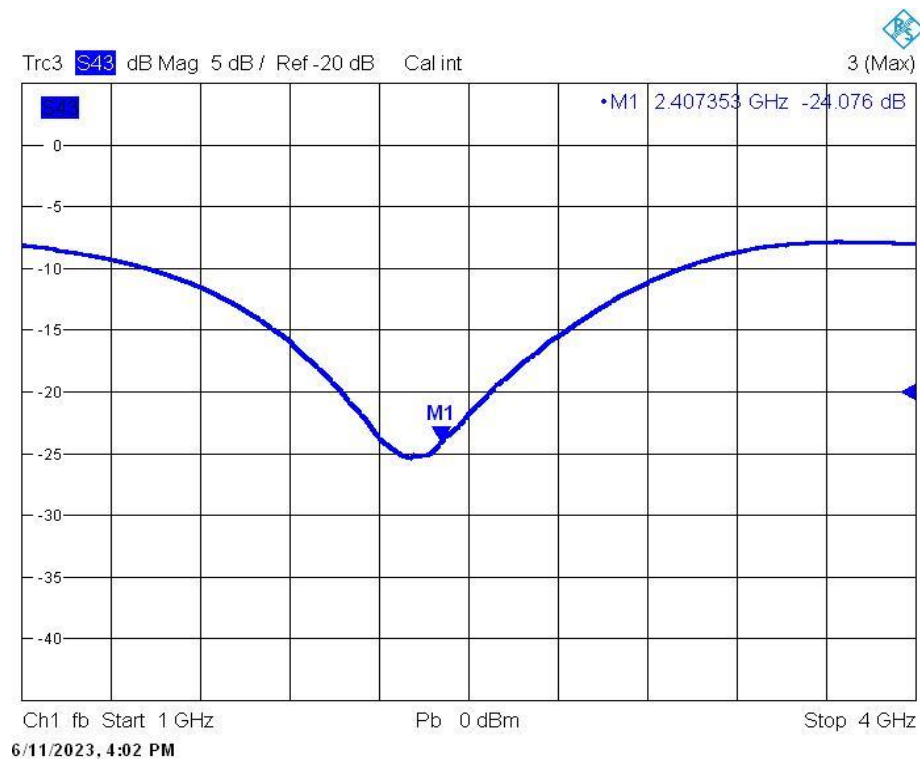
S23



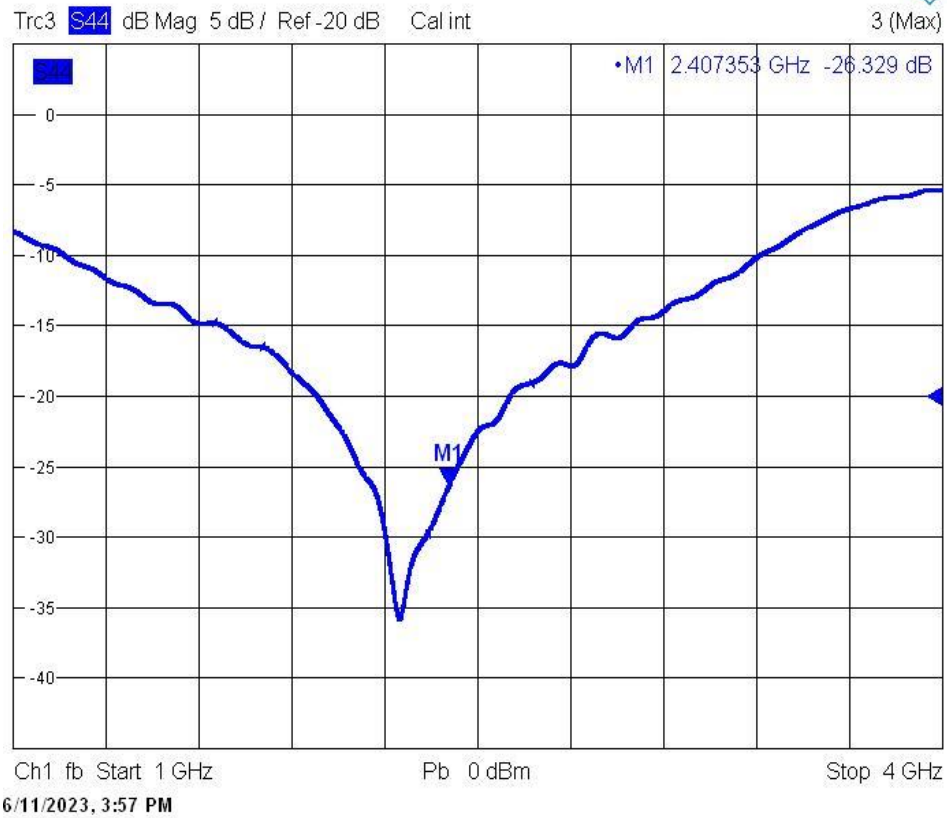
S31



S32



S33



Note:

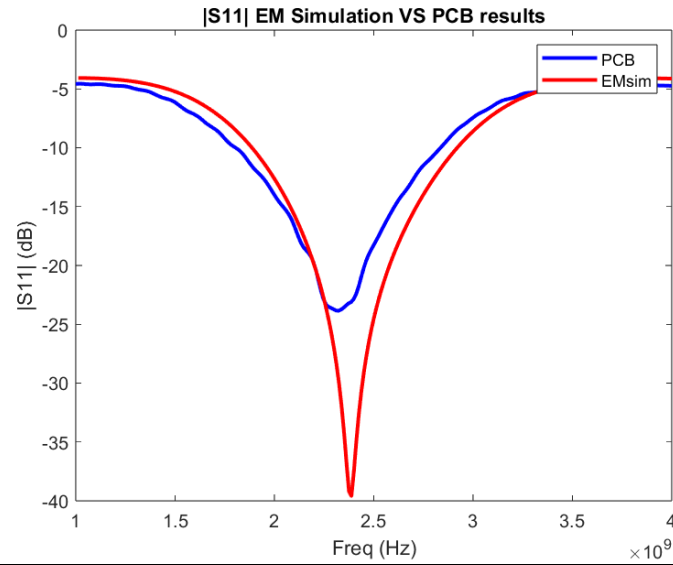
Differences between electromagnetic (EM) simulation and actual measurements of microstrip PCB can arise due to several factors like, fabrication tolerances, environmental effects, modeling assumptions, measurement setup and calibration techniques.

Despite these factors, the PCB has achieved satisfactory performance as shown in tables 1,2.

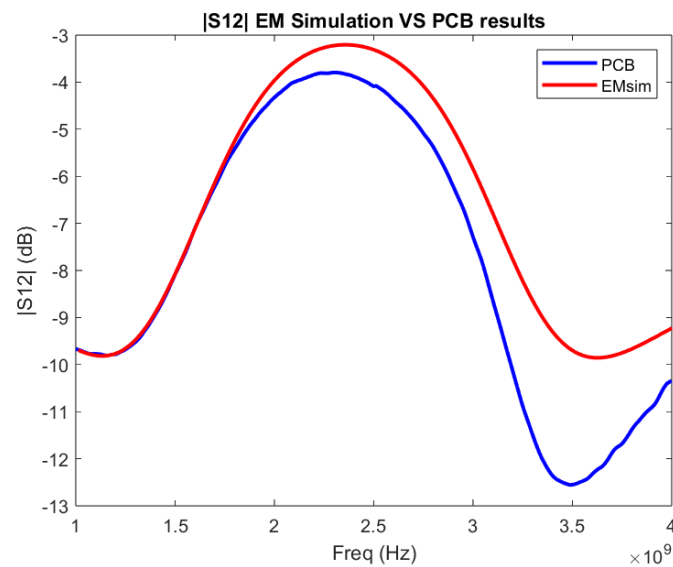
@2.4GHz	S ₁₁ dB	S ₁₂ dB	S ₁₃ dB	S ₂₁ dB	S ₂₂ dB	S ₂₃ dB	S ₃₁ dB	S ₃₂ dB	S ₃₃ dB
Ideal TL	-325.64	-3.01	-3.01	-3.01	-331.66	-322.42	-3.01	-331.66	-331.66
Microstrip schematic	-51.297	-3.17	-3.17	-3.17	-50.342	-48.33	-3.17	-48.33	-50.342
EM simulation	-37.495	-3.216	-3.216	-3.216	-33.345	-33.342	-3.216	-33.342	-33.199
PCB Measurements	-22.814	-3.884	-3.758	-3.683	-25.77	-22.044	-3.635	-23.416	-26.435

PCB compared to EM simulation.

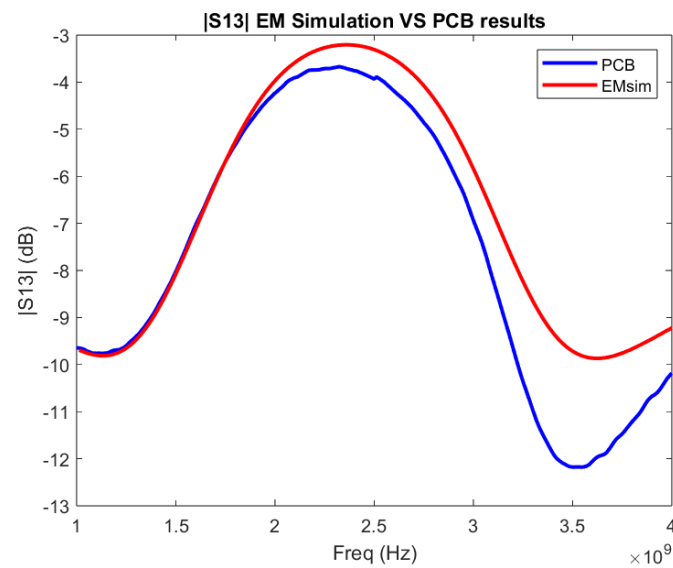
S11



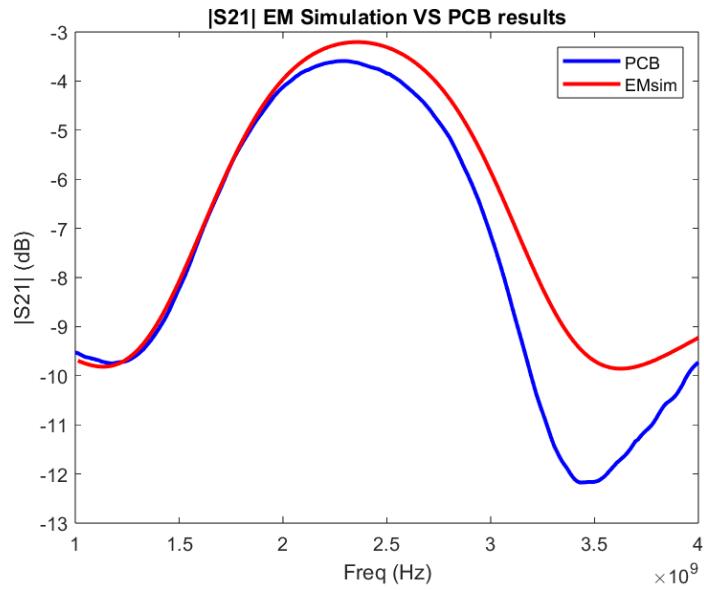
S12



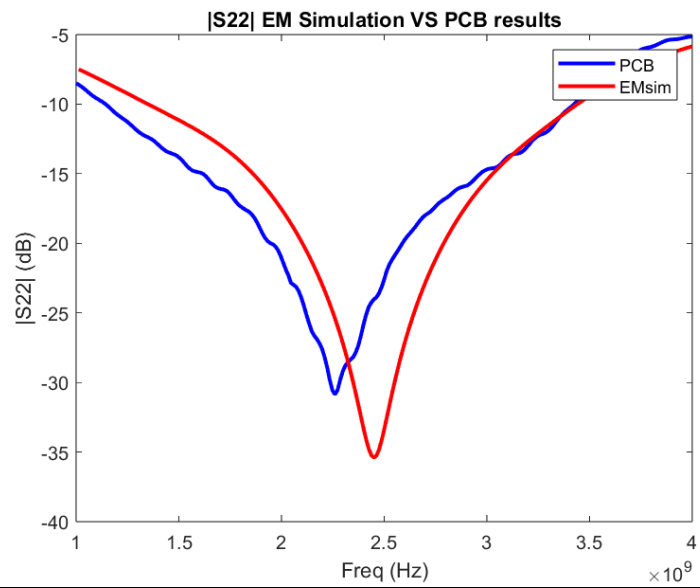
S13



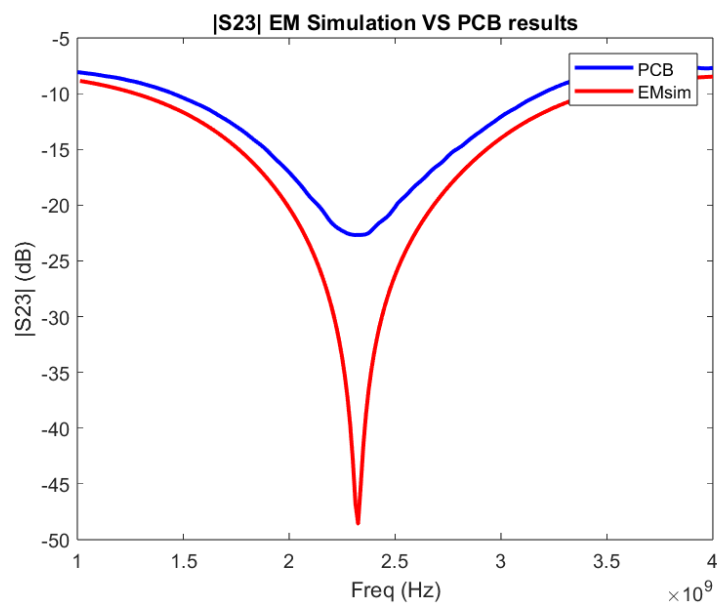
S21



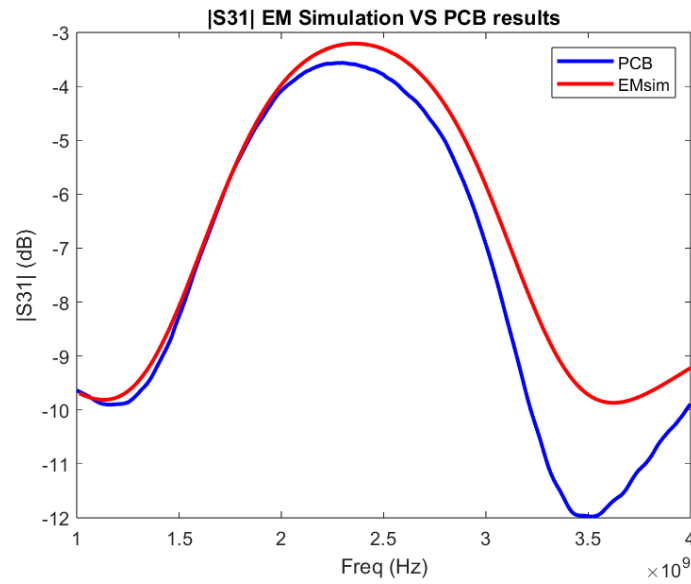
S22



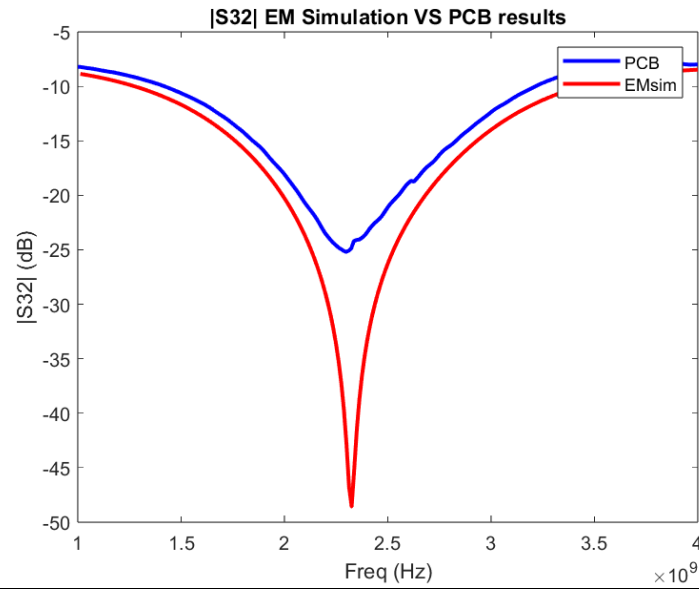
S23



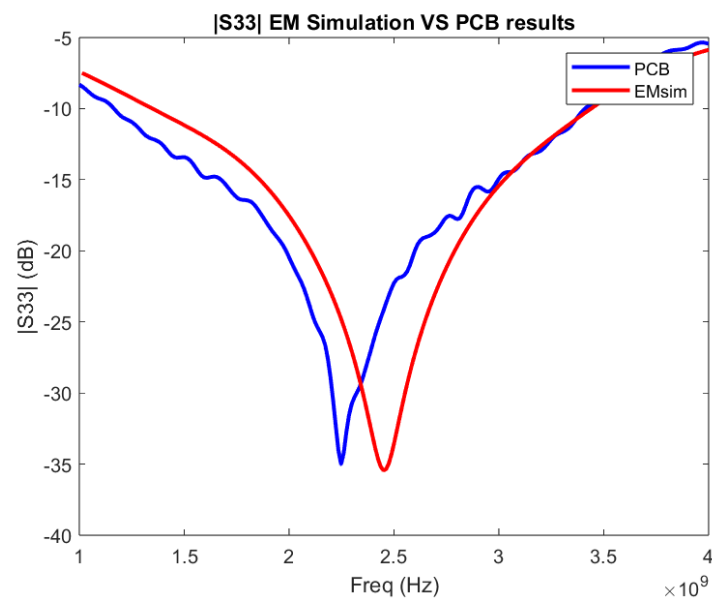
S31



S32



S33



Summary

@2.4 GHz	Return loss	Excess loss	Isolation loss
Ideal transmission line	325 dB	0.01 dB	322.42 dB
Microstrip schematic	51.29 dB	0.17 dB	48.33 dB
EM simulation	37.495 dB	0.216 dB	33.3 dB
PCB	22.814 dB	0.683 dB	23 dB

@2.4GHz	S ₁₁ dB	S ₁₂ dB	S ₁₃ dB	S ₂₁ dB	S ₂₂ dB	S ₂₃ dB	S ₃₁ dB	S ₃₂ dB	S ₃₃ dB
Ideal TL	-325.64	-3.01	-3.01	-3.01	-331.66	-322.42	-3.01	-331.66	-331.66
Microstrip schematic	-51.297	-3.17	-3.17	-3.17	-50.342	-48.33	-3.17	-48.33	-50.342
EM simulation	-37.495	-3.216	-3.216	-3.216	-33.345	-33.342	-3.216	-33.342	-33.199
PCB Measurements	-22.814	-3.884	-3.758	-3.683	-25.77	-22.044	-3.635	-23.416	-26.435

Code example

%Simulation data and variables

```
Simulation_data = importdata('S parameters.xlsx');
```

```
S = xlsread('S parameters.xlsx', 'Sheet1');
```

```
Freq_Sim=S(:,1);
```

```
Freq_Sim_after=Freq_Sim(202:end);
```

```
S11_Sim=S(:,2);
```

```
S11_Sim_after=S11_Sim(202:end);
```

```
S12_Sim=S(:,5);
```

```
S12_Sim_after=S12_Sim(202:end);
```

```
S13_Sim=S(:,8);
```

```
S13_Sim_after=S13_Sim(202:end);
```

```
S21_Sim=S(:,11);
```

```
S21_Sim_after=S21_Sim(202:end);
```

```
S22_Sim=S(:,14);
```

```
S22_Sim_after=S22_Sim(202:end);
```

```
S23_Sim=S(:,17);  
S23_Sim_after=S23_Sim(202:end);  
S31_Sim=S(:,20);  
S31_Sim_after=S31_Sim(202:end);  
S32_Sim=S(:,23);  
S32_Sim_after=S32_Sim(202:end);  
S33_Sim=S(:,26);  
S33_Sim_after=S33_Sim(202:end);
```

%PCB_data for s11 and variables

```
PCB_data1 = load('s11.dat');  
Freq_PCB=PCB_data1(:,1);  
downsample_factor = ceil(length(Freq_PCB)/240);  
Freq_PCB_smoothed=Freq_PCB(1:downsample_factor:end);  
Freq_PCB_smoothed_after=Freq_PCB(4000:end);  
S11_PCB=PCB_data1(:,5);  
S11_PCB_smoothed=S11_PCB(1:downsample_factor:end);  
S11_PCB_smoothed_after=S11_PCB(4000:end);
```

%PCB_data for s12 and variables

```
PCB_data2 = load('s12.dat');  
S12_PCB=PCB_data2(:,5);  
S12_PCB_smoothed=S12_PCB(1:downsample_factor:end);  
S12_PCB_smoothed_after=S12_PCB(4000:end);
```