

# Microwave Engineering (Lab)

## Lab 5: Design of Wilkinson Power Divider

### Part 1

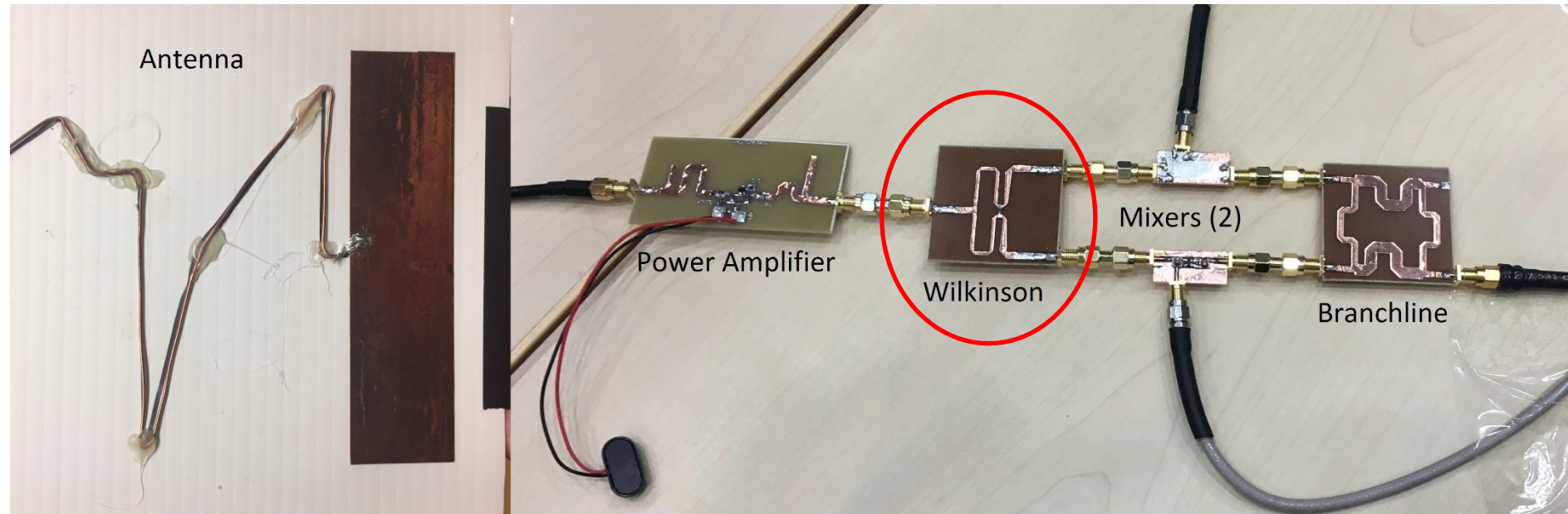
**DONG Yunyang**

**[dongyy@sustech.edu.cn](mailto:dongyy@sustech.edu.cn)**

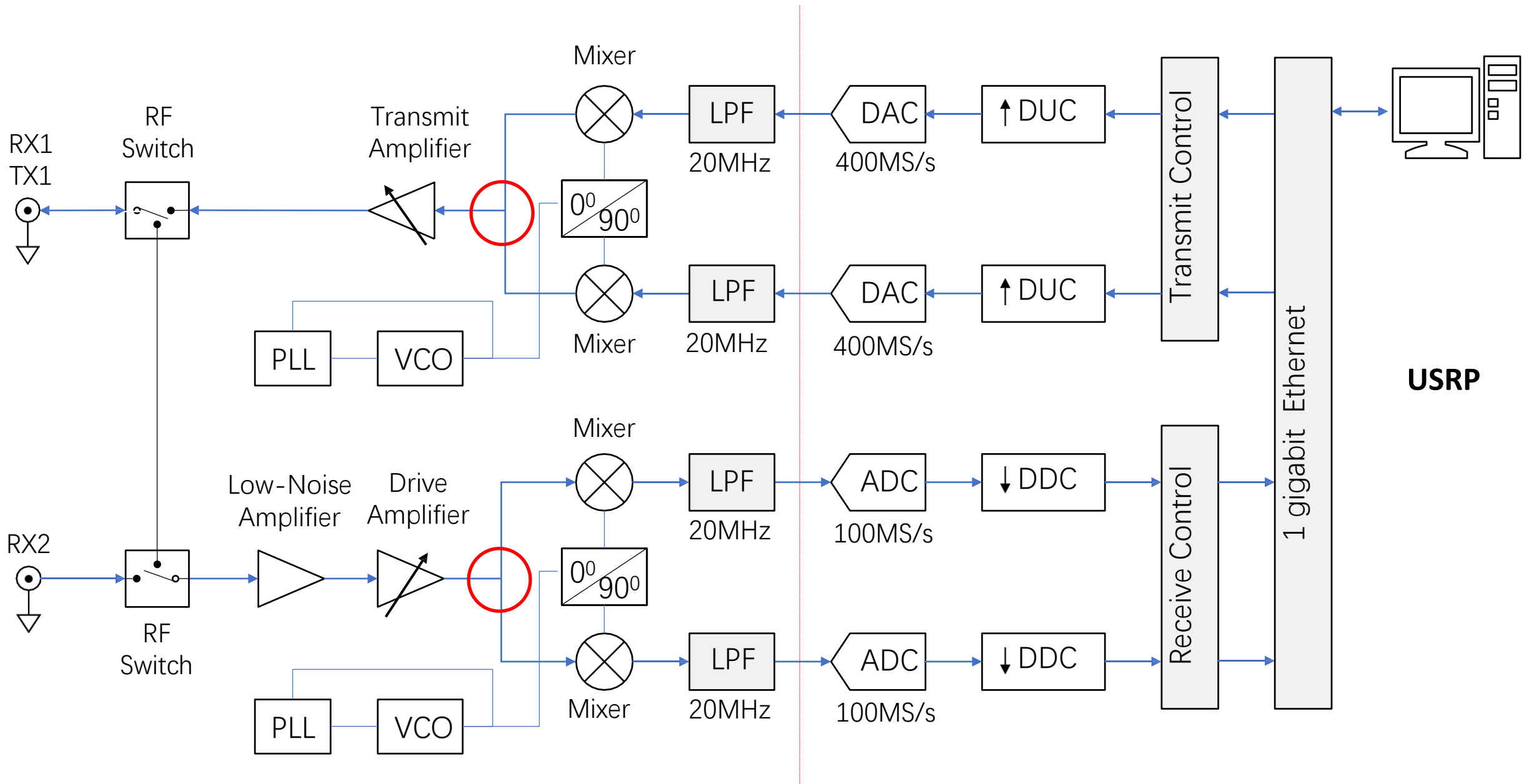
**411, No. 2, Hui Yuan**

**Tencent Meeting: 874-068-9694**

**Bits2Waves, a 1-day experience on building your own modern digital radio.**



<https://rickettslab.org/bits2waves/bits2waves-download/>





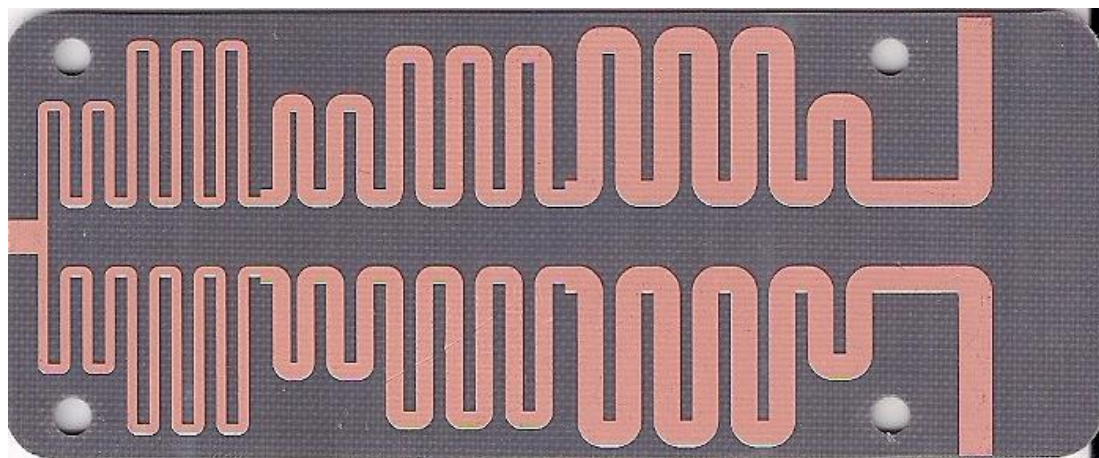
一分2功分器



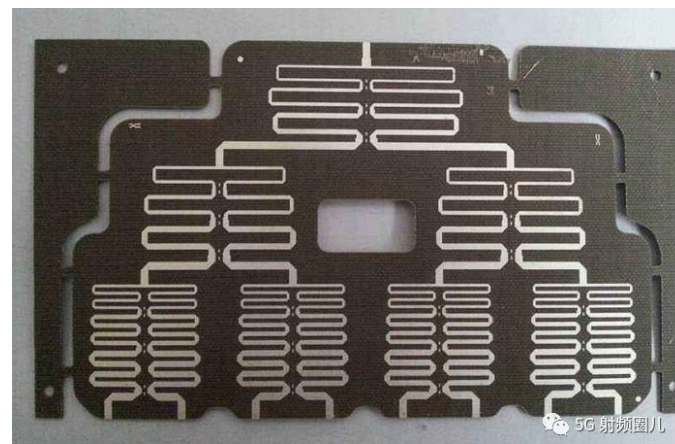
一分4功分器



一分8功分器



宽带一分2功分器



一分8功分器

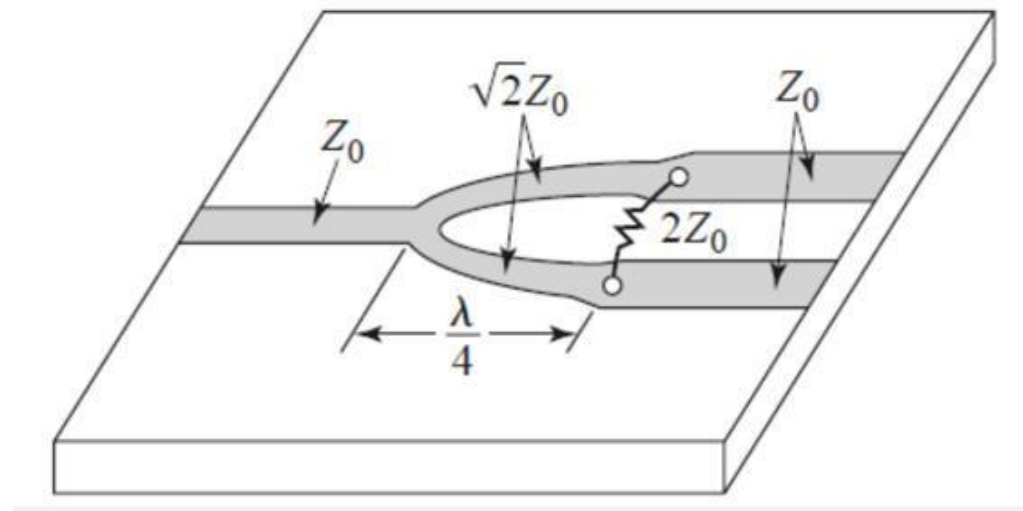
功分器：将输入功率分成相等或者不相等的几路输出功率的一种多端口微波网络。

理想情况下，各个输出端口的输出功率之和等于输入端口功率，由于实际中存在损耗，会造成输出端口输出功率之和小于输入端口的输入功率。

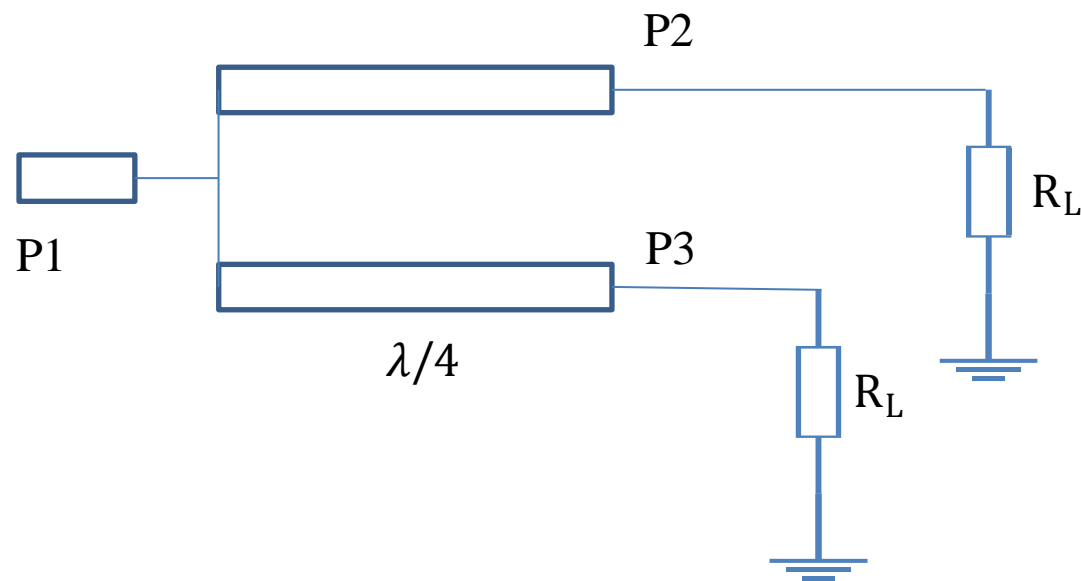
理想功分器的特点：

- 端口无反射
- 端口2、3输出功率比值为任意给定值 $1/k^2$

**Wilkinson功分器**：如果功分器 $k$ 等于1，两个端口输出的功率相等，这就是一个3dB Wilkinson功分器。



3dB Wilkinson功分器





Wilkinson功分器中，两段分支线的特性阻抗分别为，

$$Z_{01} = \sqrt{2}Z_0$$

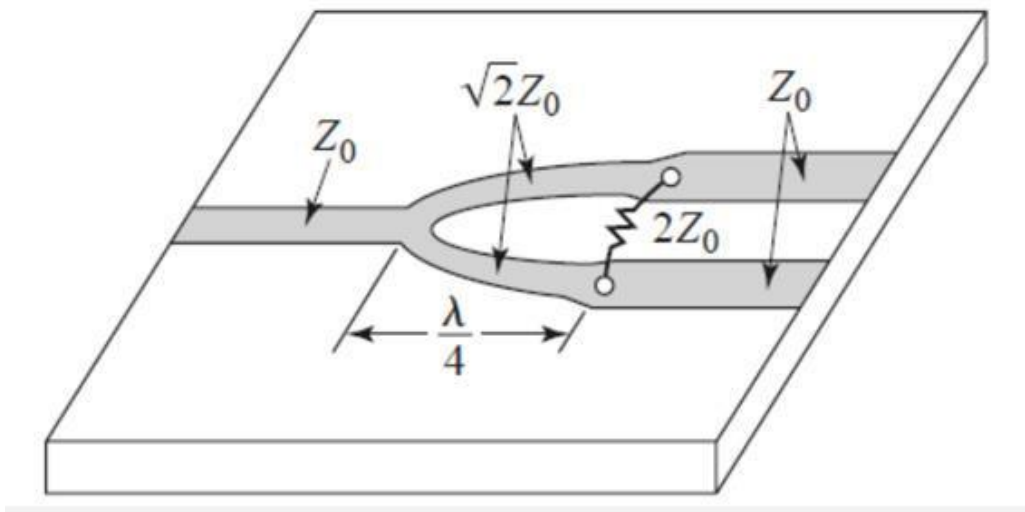
功率分配时，信号从合成端输入，由于两个输出链路是相同的，因此，通过隔离电阻的电流为0。

功率合成时，输入信号不仅会到达合成端，还会到达另一个输入端。

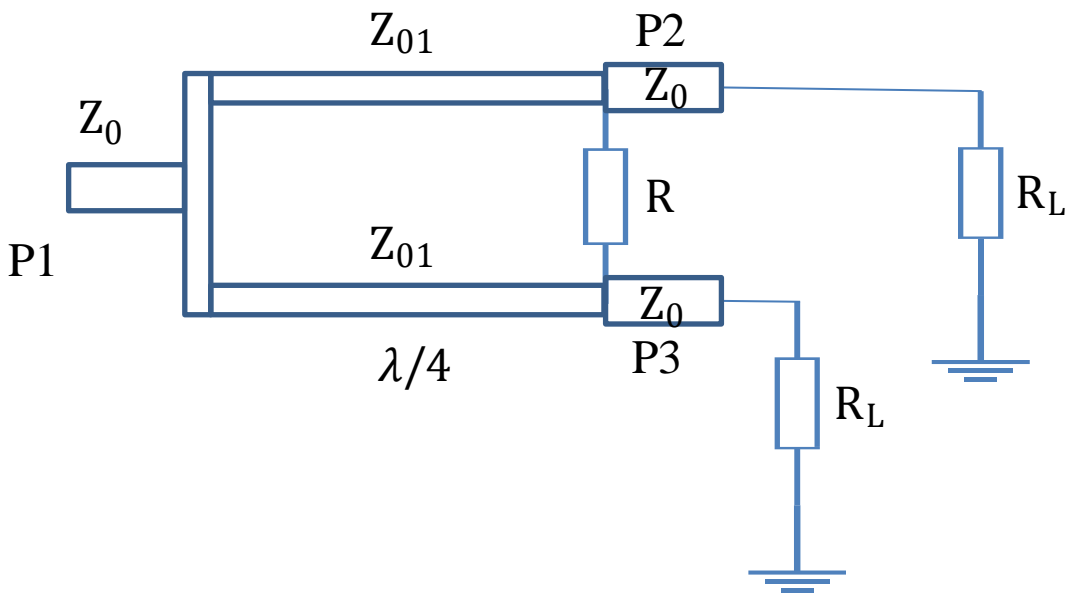
选择适当的隔离电阻，可以最大程度增加端口隔离度，减小相互耦合。

隔离电阻与特性阻抗关系式为：

$$R = 2Z_0$$



3dB Wilkinson功分器



设计指标:

频率: 0.9~1.1GHz

端口反射系数 $S_{11} < -20\text{dB}$ ,  $S_{22} < -20\text{dB}$

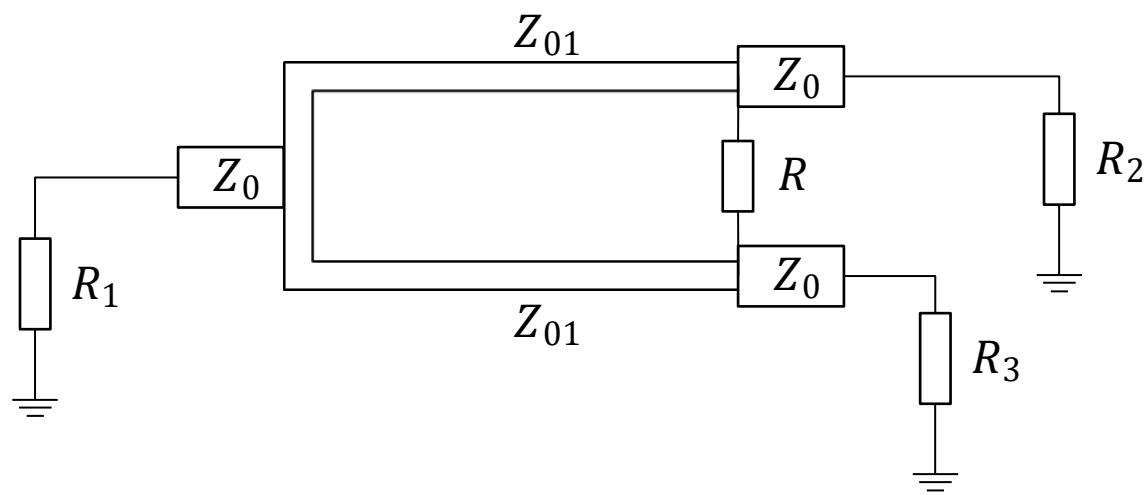
传输系数 $S_{21} > -3.3\text{dB}$

隔离度 $S_{32} < -25\text{dB}$

板材选择: FR4

厚度: 0.8mm

端口阻抗:  $50\Omega$



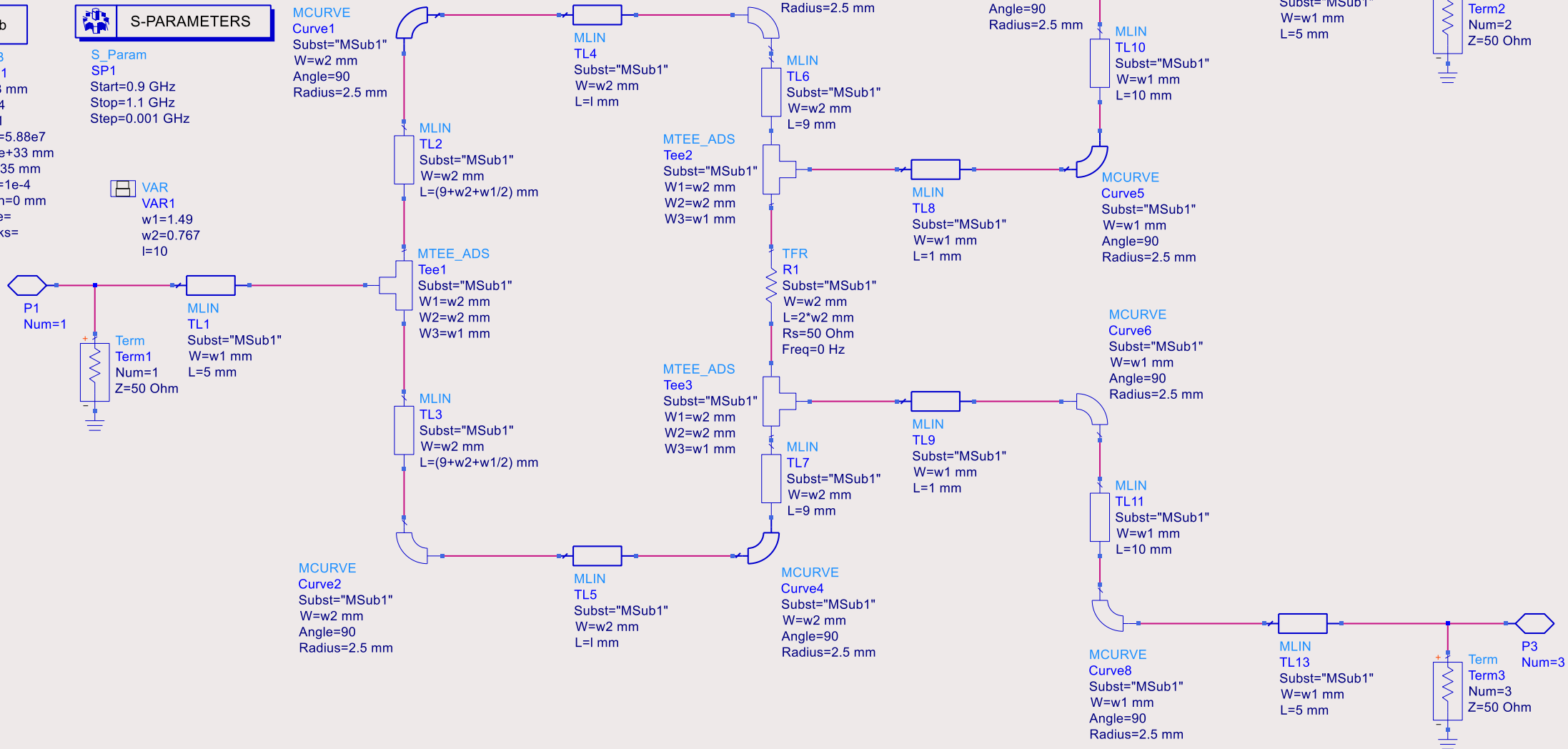
MSub

MSUB  
MSub1  
H=0.8 mm  
Er=4.4  
Mur=1  
Cond=5.88e7  
Hu=1e+33 mm  
T=0.035 mm  
TanD=1e-4  
Rough=0 mm  
Bbase=  
Dpeaks=

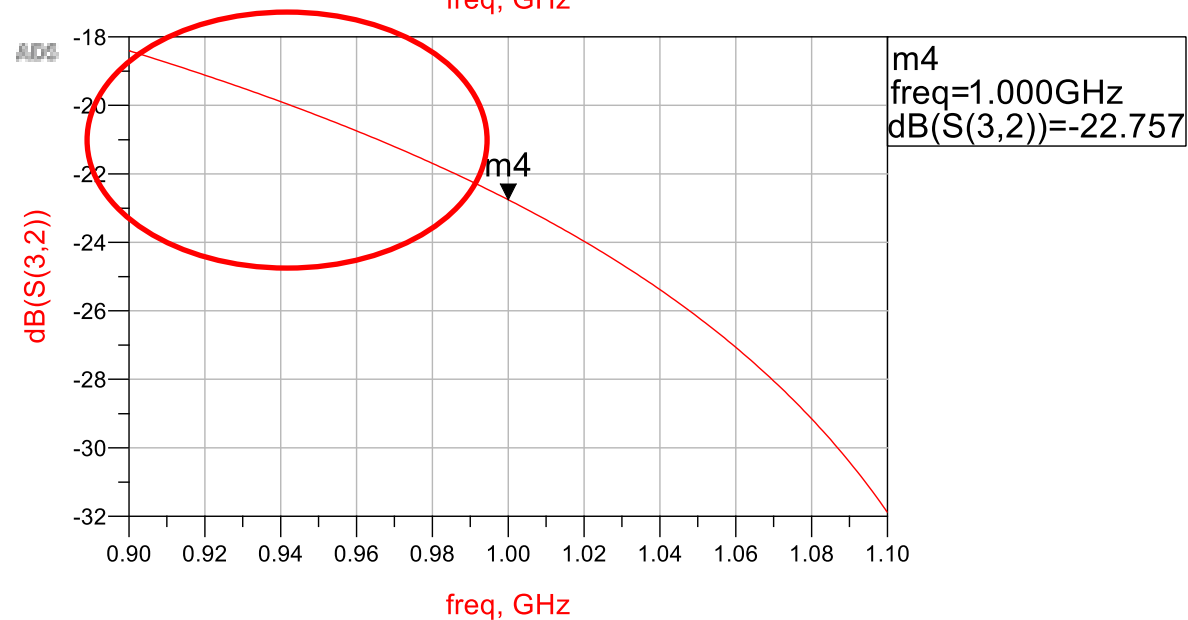
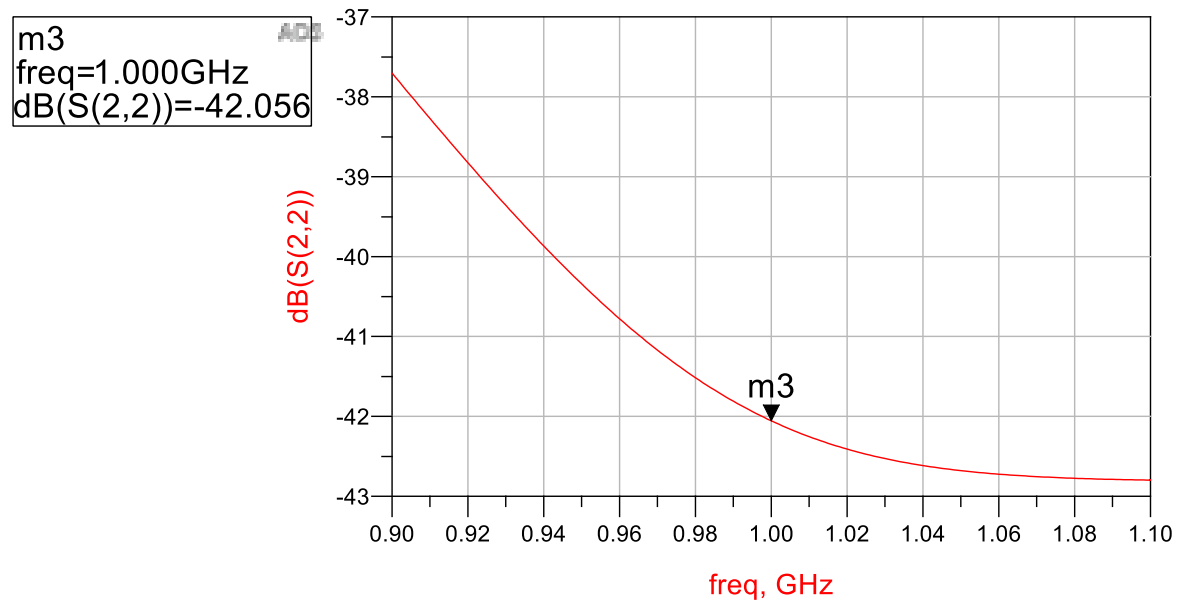
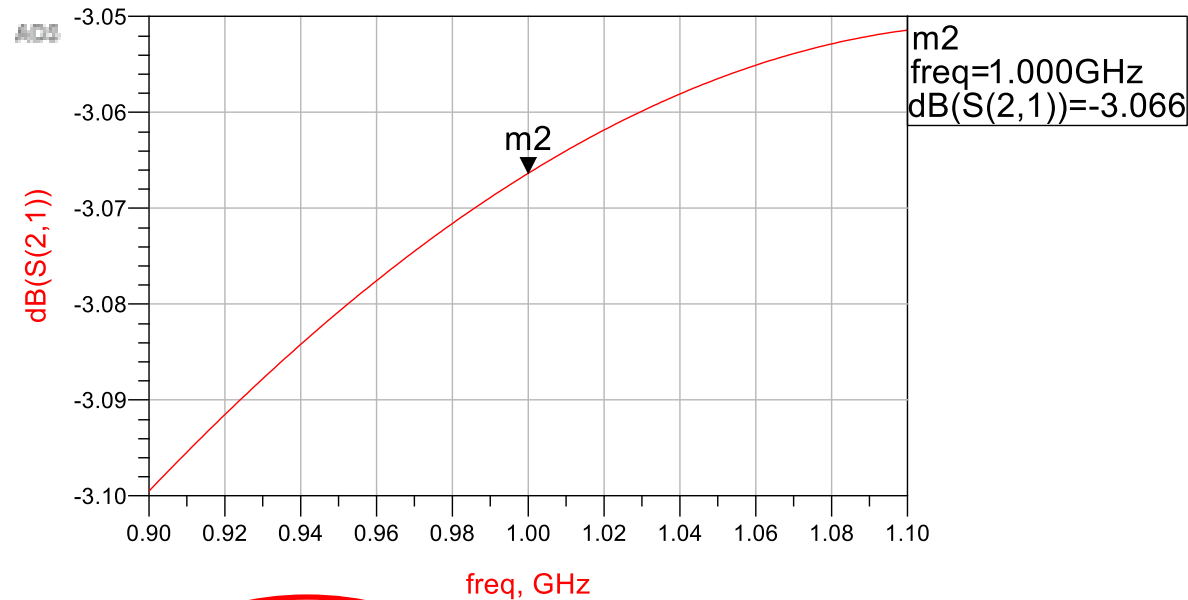
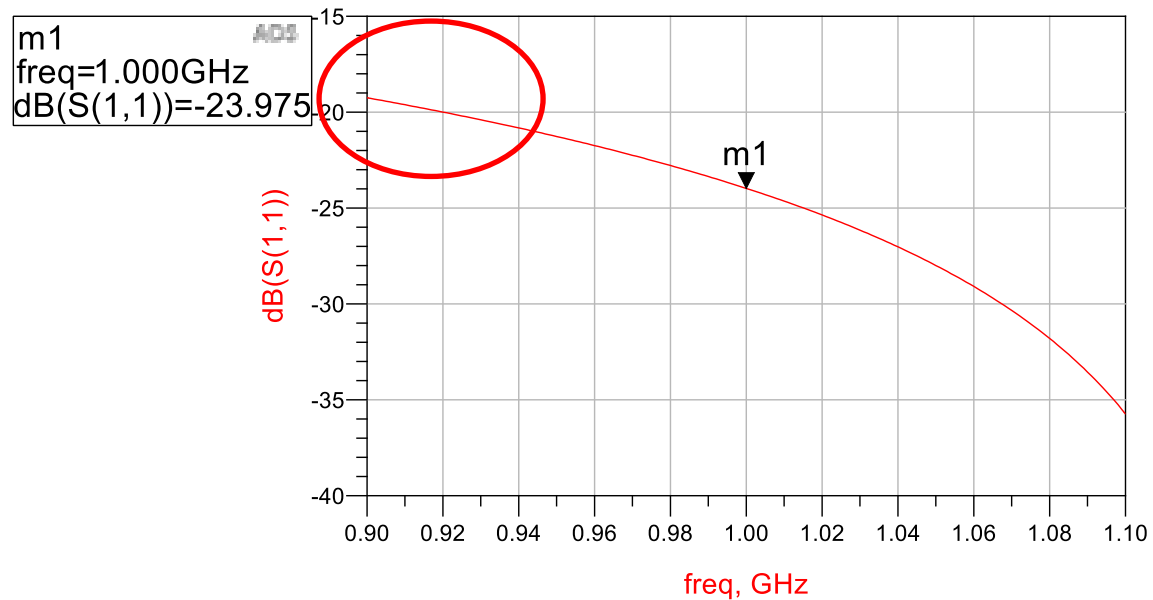
S-PARAMETERS

S\_Param  
SP1  
Start=0.9 GHz  
Stop=1.1 GHz  
Step=0.001 GHz

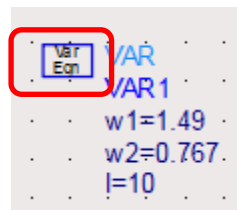
VAR  
VAR1  
w1=1.49  
w2=0.767  
l=10



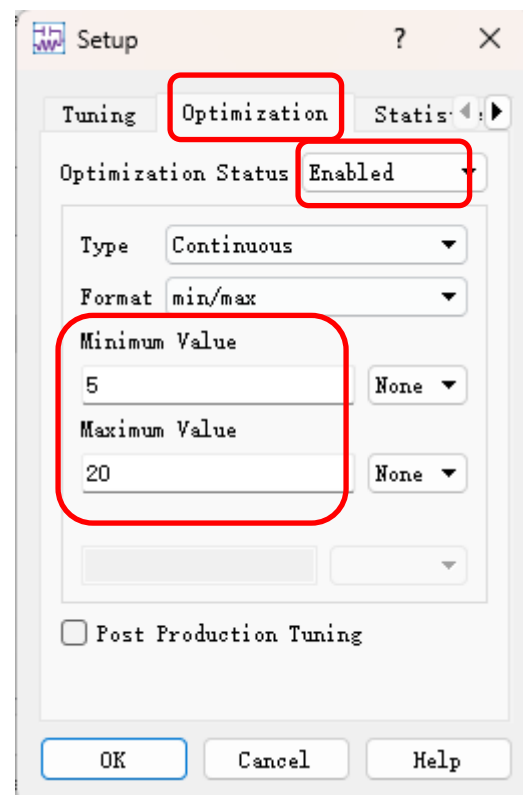
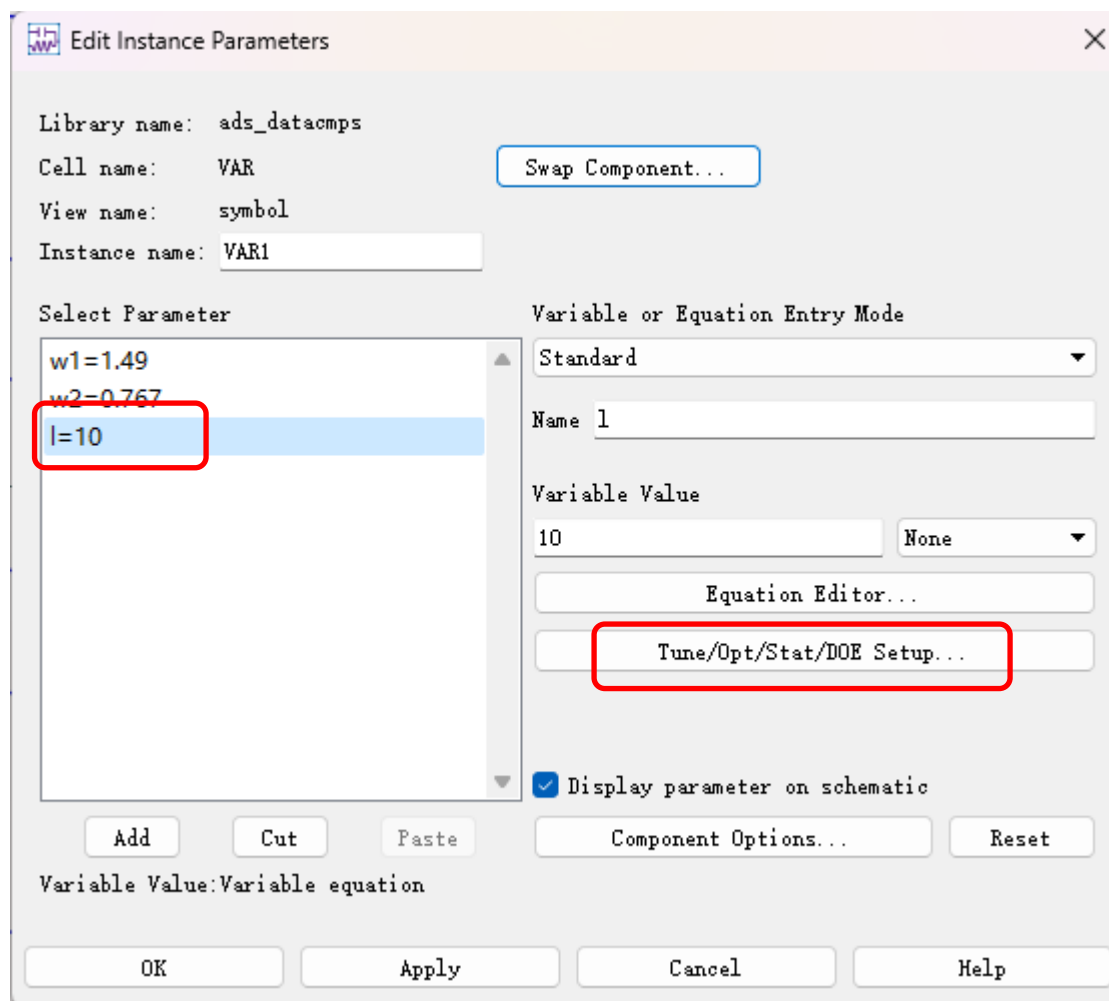




## 优化I值



double  
click →



Optim Goal Input:1

ads\_simulation:Goal Instance Name

OptimGoal1

Goal Information

Display

Expression: dB(S11) ▾

Help on Expressions

Analysis: SP1 ▾

Weight: 1.0

Sweep variables: freq

☒ freq

☐ time

Edit...

Limit lines

	Name	Type	Min	Max	Weight	freq min	freq max
1	limit1	<		-20	1.0		

Add Limit

Delete Limit

Move Up

Move Down

OK

Apply

Cancel

Help

GOAL

Goal  
OptimGoal1  
Expr="dB(S11)"  
SimInstanceName="SP1"  
Weight=1.0  
IndepVar[1]="freq"  
LimitMin[1]=  
LimitMax[1]=-20  
Indep1Min[1]=  
Indep1Max[1]=

GOAL

Goal  
OptimGoal2  
Expr="dB(S22)"  
SimInstanceName="SP1"  
Weight=1.0  
IndepVar[1]="freq"  
LimitMin[1]=  
LimitMax[1]=-20  
Indep1Min[1]=  
Indep1Max[1]=

GOAL

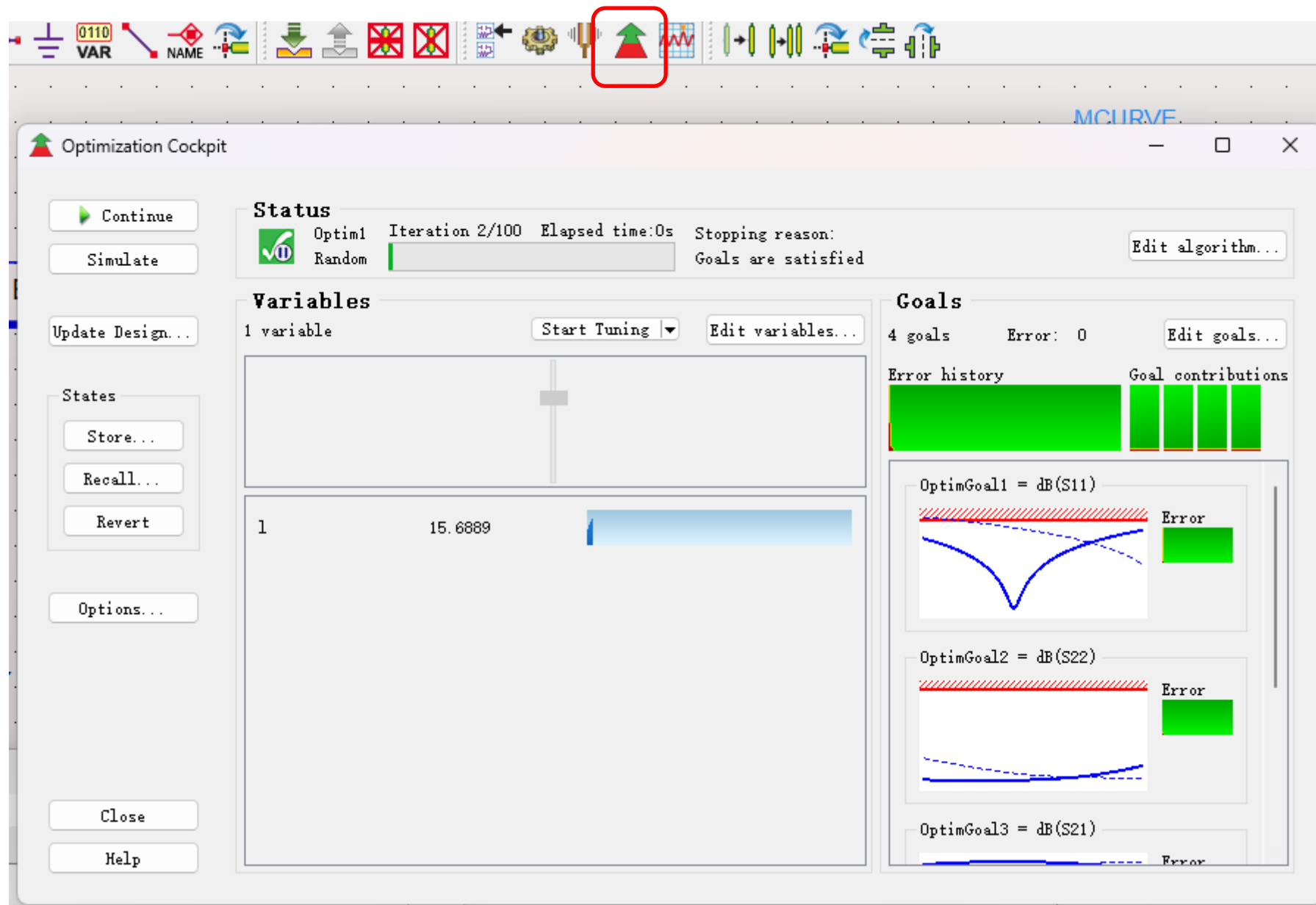
Goal  
OptimGoal3  
Expr="dB(S21)"  
SimInstanceName="SP1"  
Weight=1.0  
IndepVar[1]="freq"  
LimitMin[1]=-3.3  
LimitMax[1]=  
Indep1Min[1]=  
Indep1Max[1]=

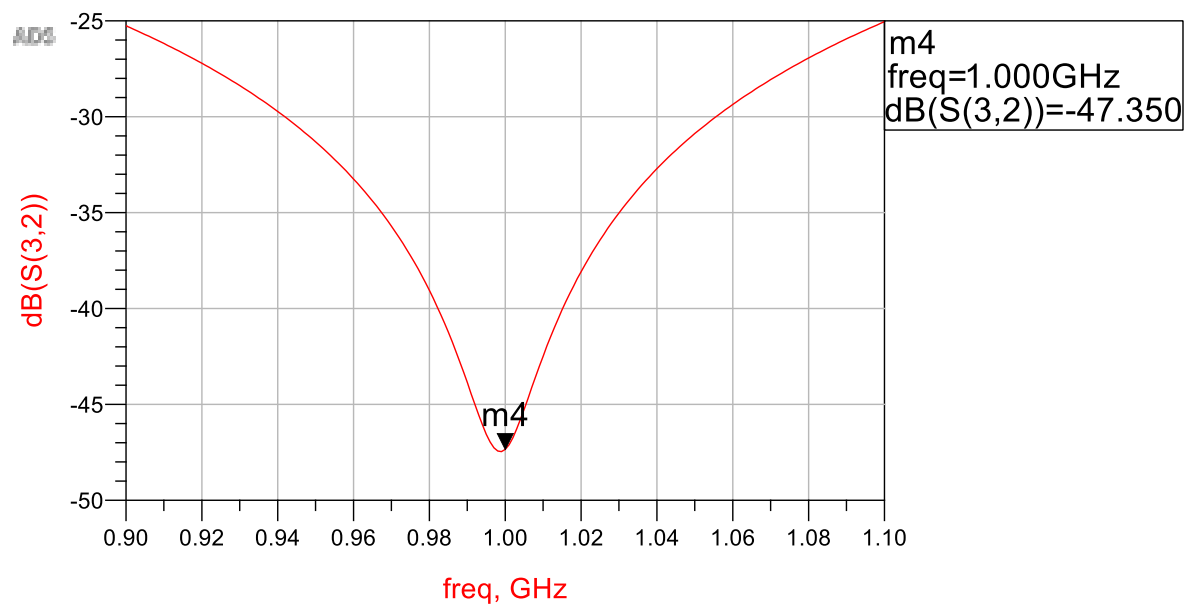
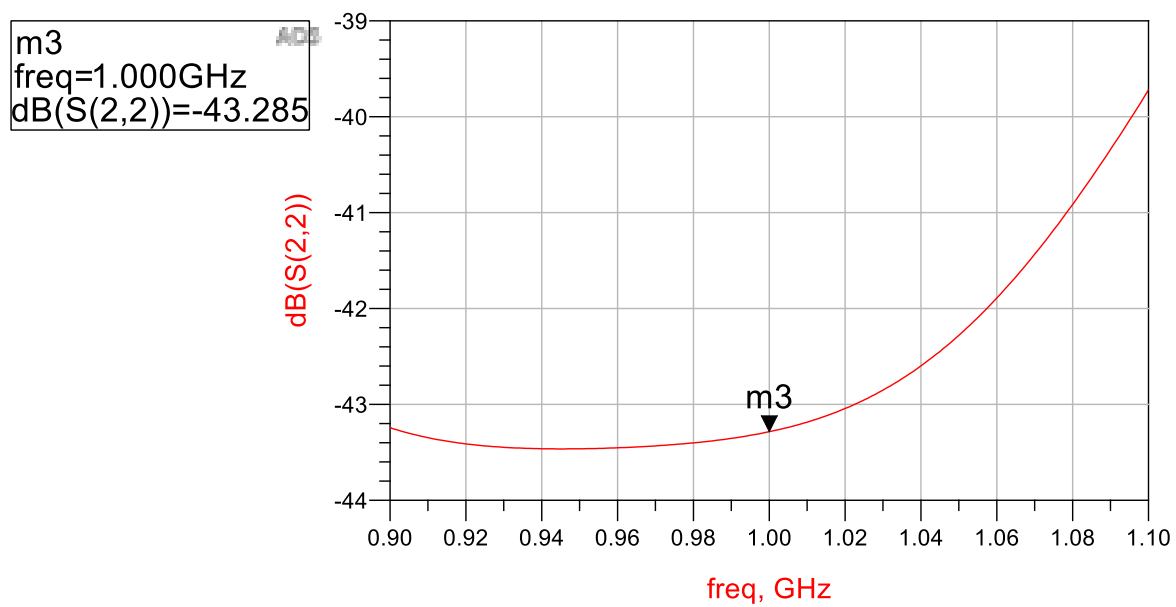
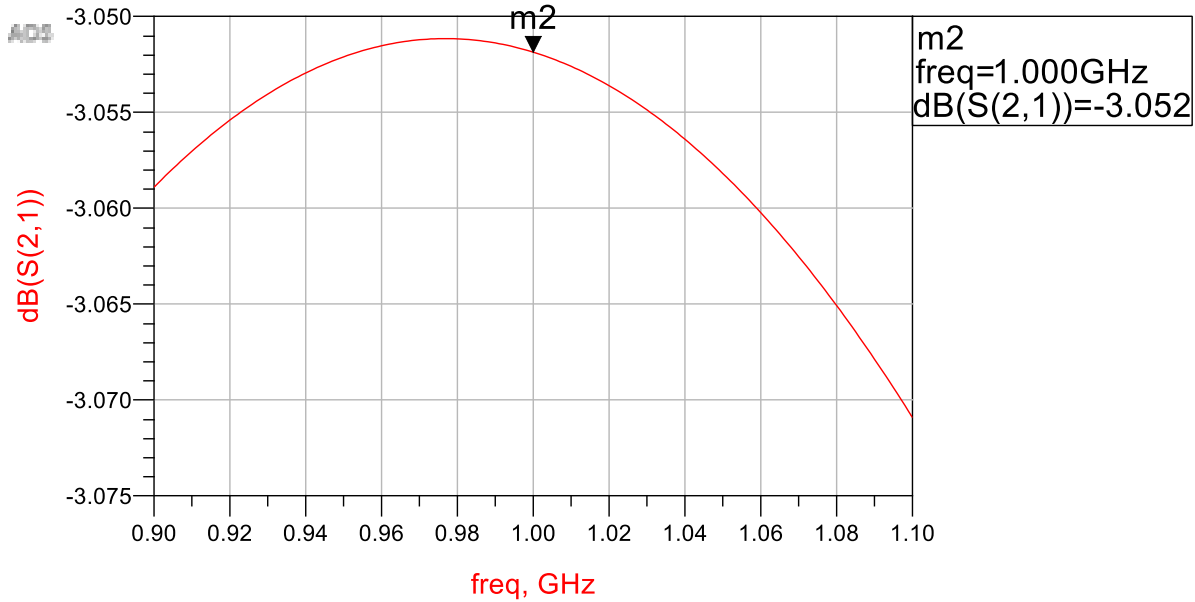
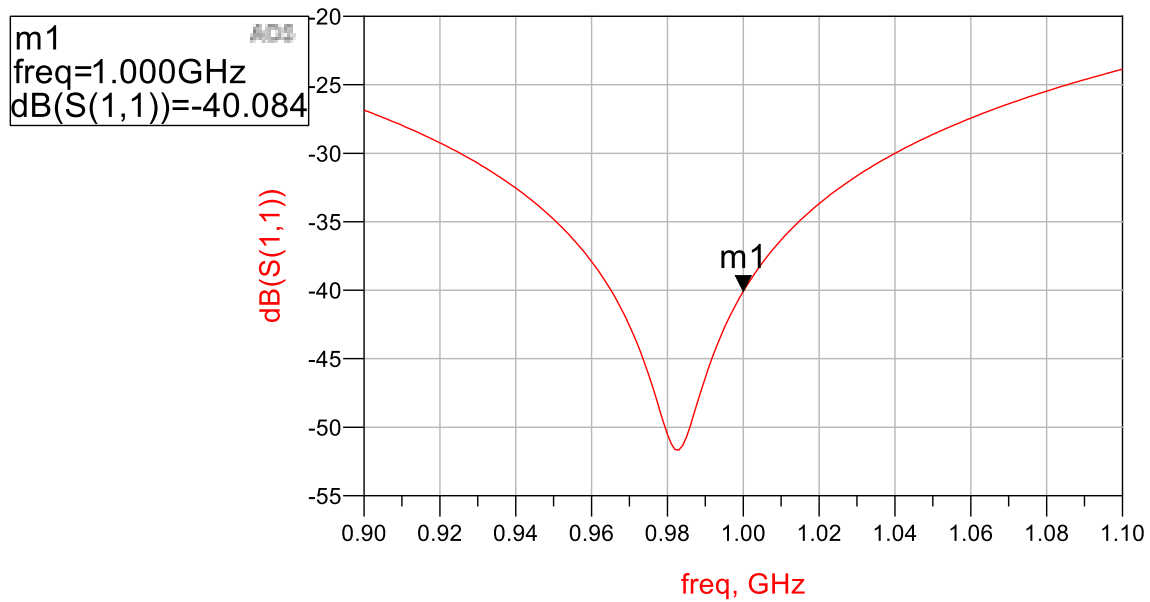
GOAL

Goal  
OptimGoal4  
Expr="dB(S32)"  
SimInstanceName="SP1"  
Weight=1.0  
IndepVar[1]="freq"  
LimitMin[1]=  
LimitMax[1]=-25  
Indep1Min[1]=  
Indep1Max[1]=

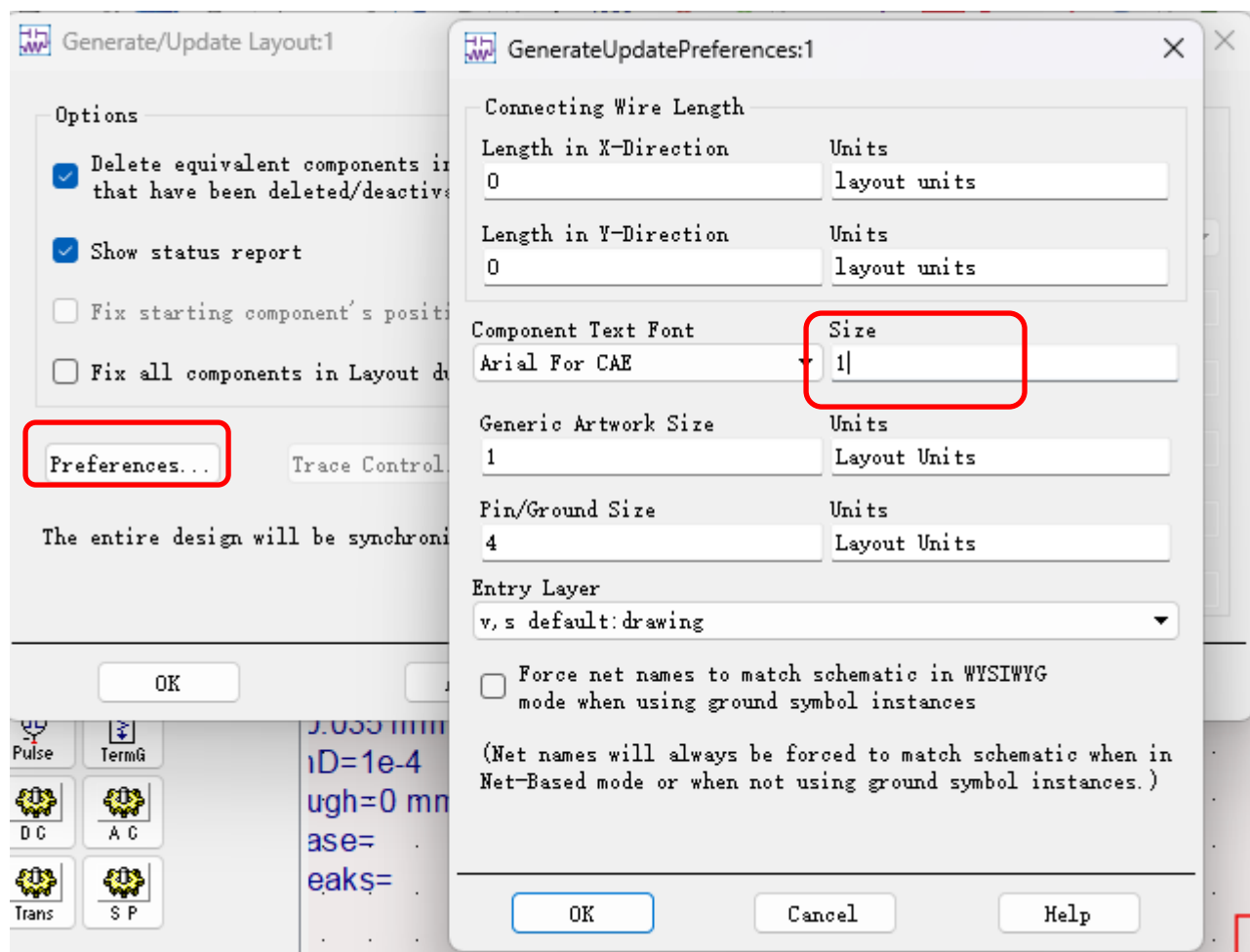
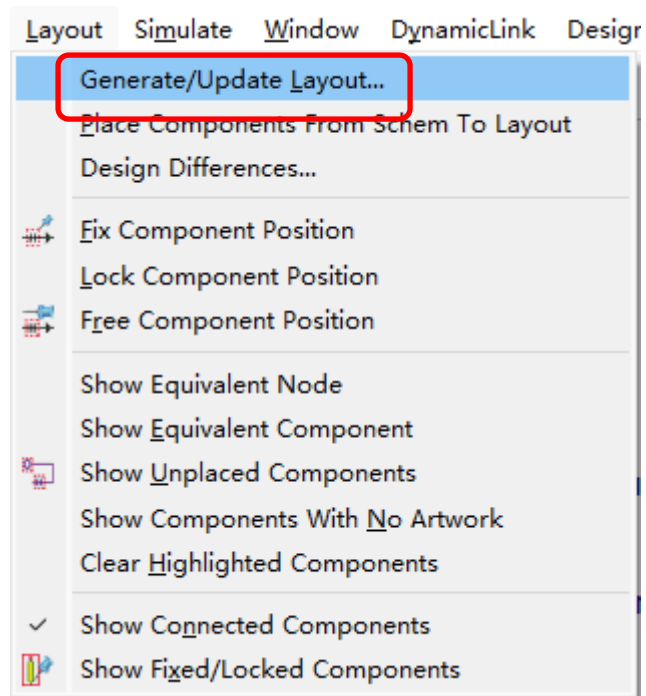
OPTIM

Optim  
Optim1  
OptimType=Random  
MaxIters=100  
DesiredError=0.0  
StatusLevel=4  
FinalAnalysis="None"  
NormalizeGoals=yes  
SetBestValues=yes  
Seed=  
SaveSolns=yes  
SaveGoals=yes  
SaveOptimVars=no  
UpdateDataset=yes  
SaveNominal=no  
SaveAllIterations=no  
UseAllOptVars=yes  
UseAllGoals=yes  
SaveCurrentEF=no  
EnableCockpit=yes  
SaveAllTrials=no

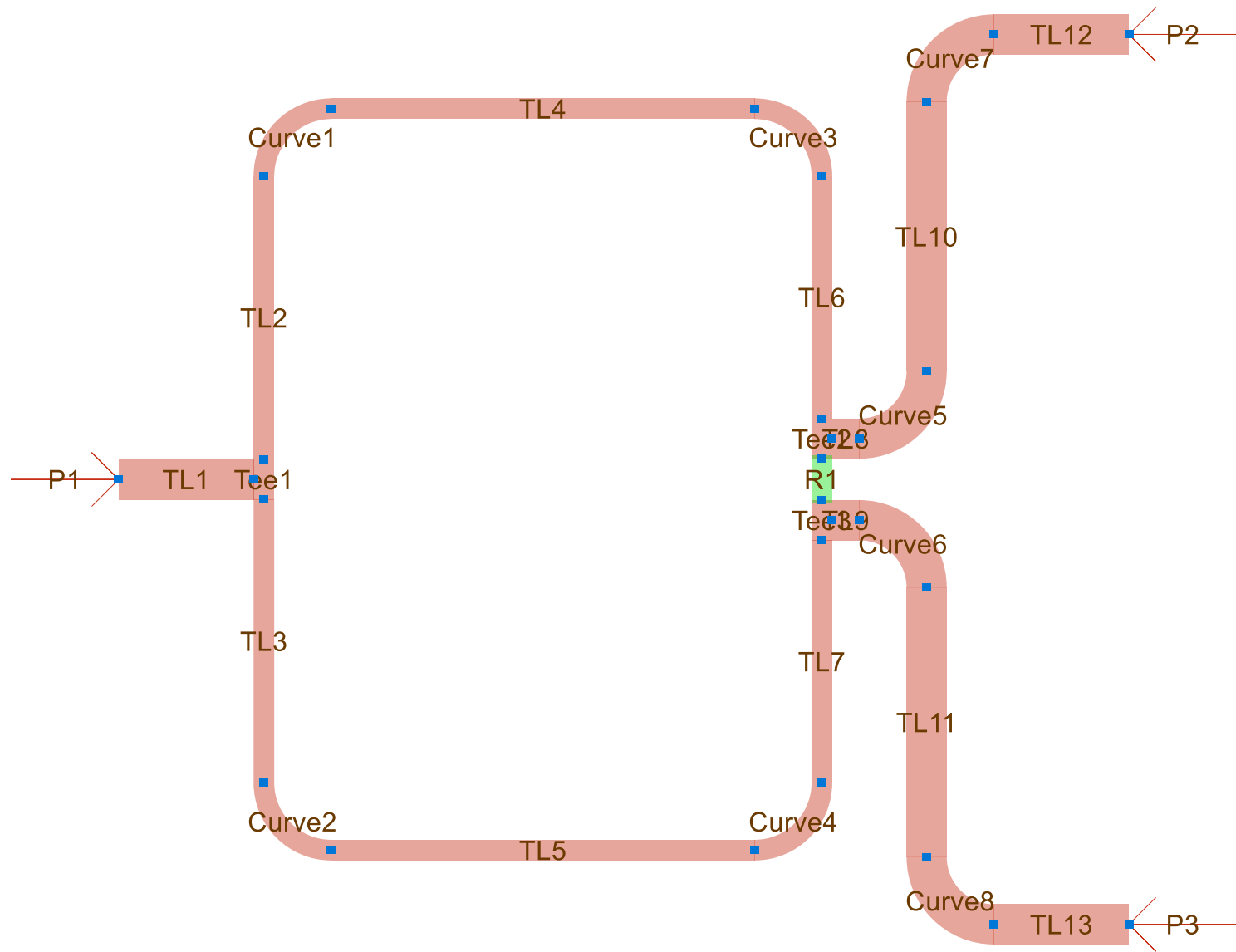




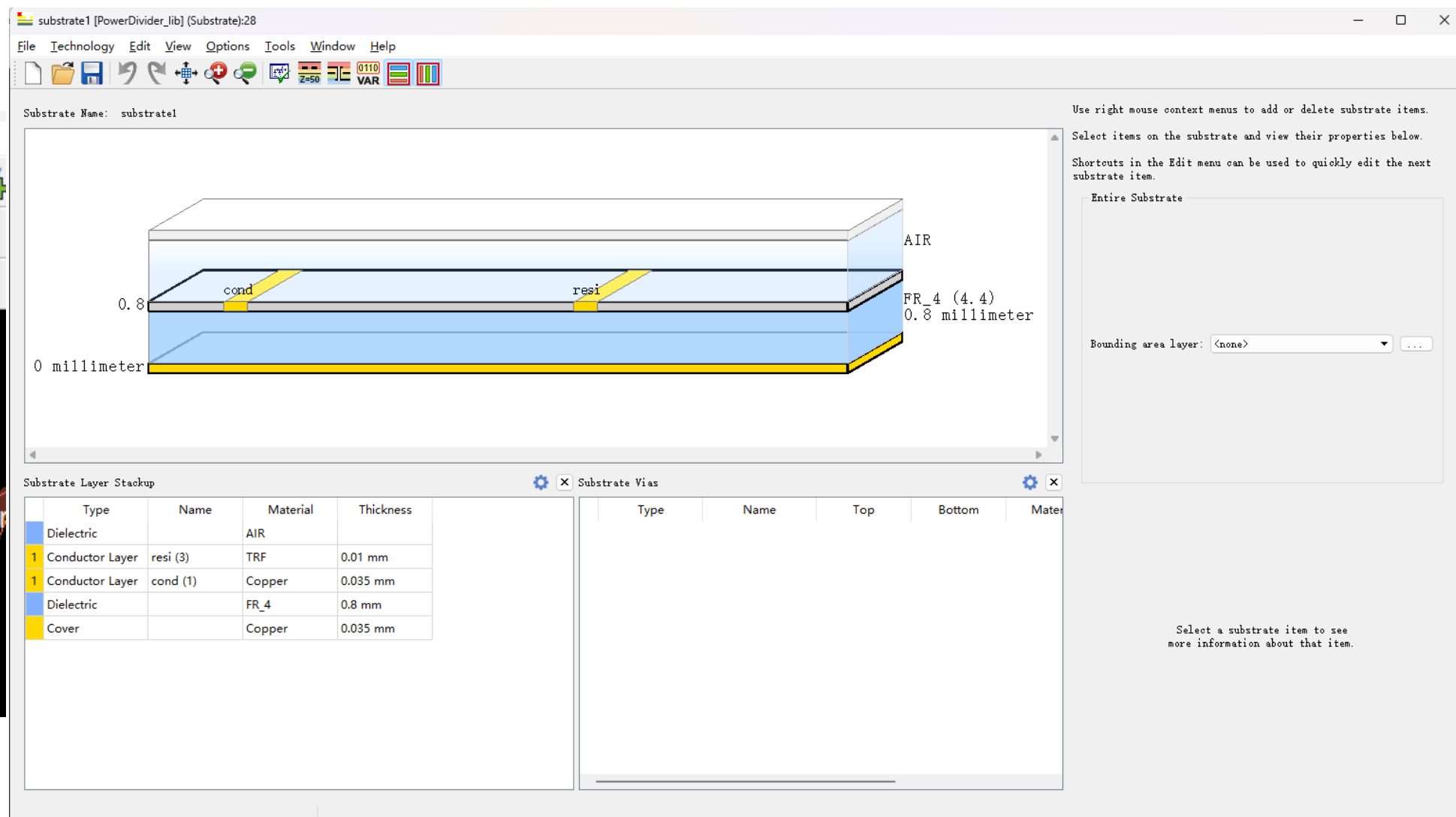
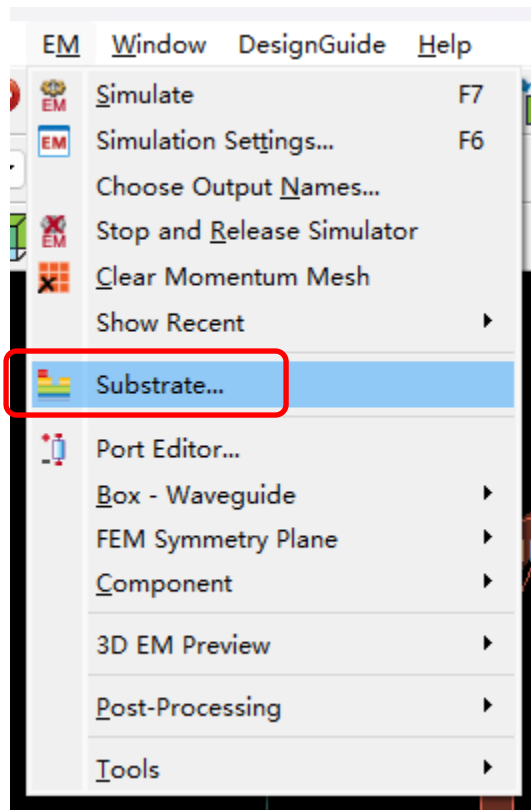
## 生成版图

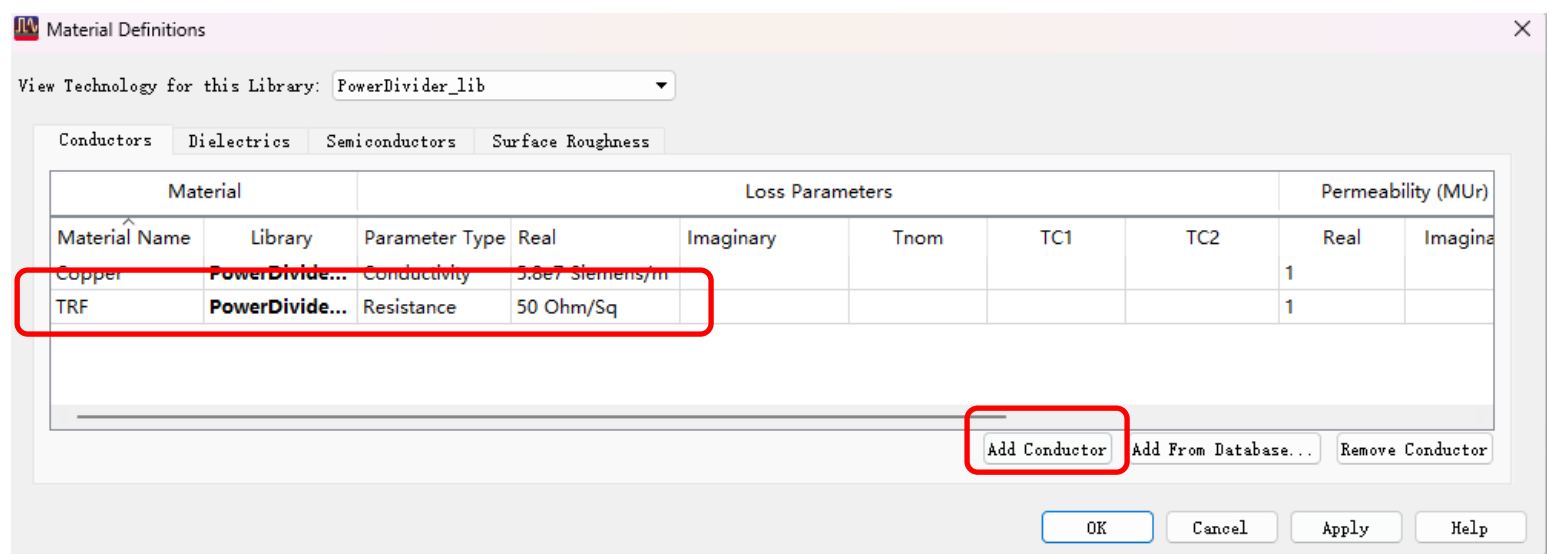
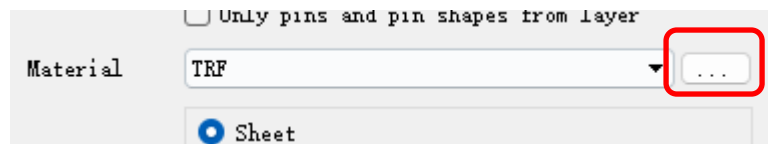
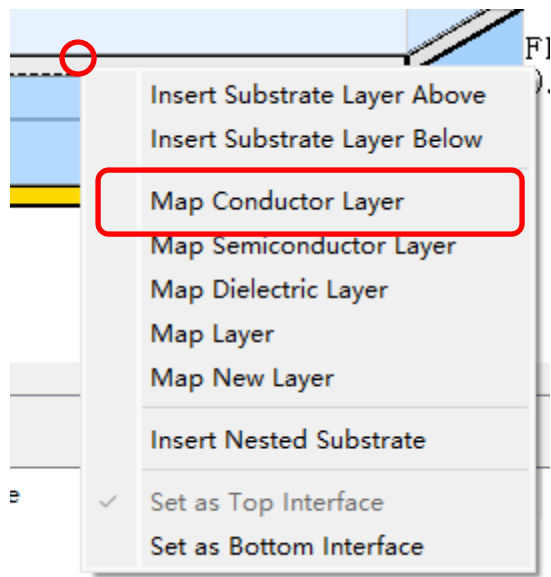


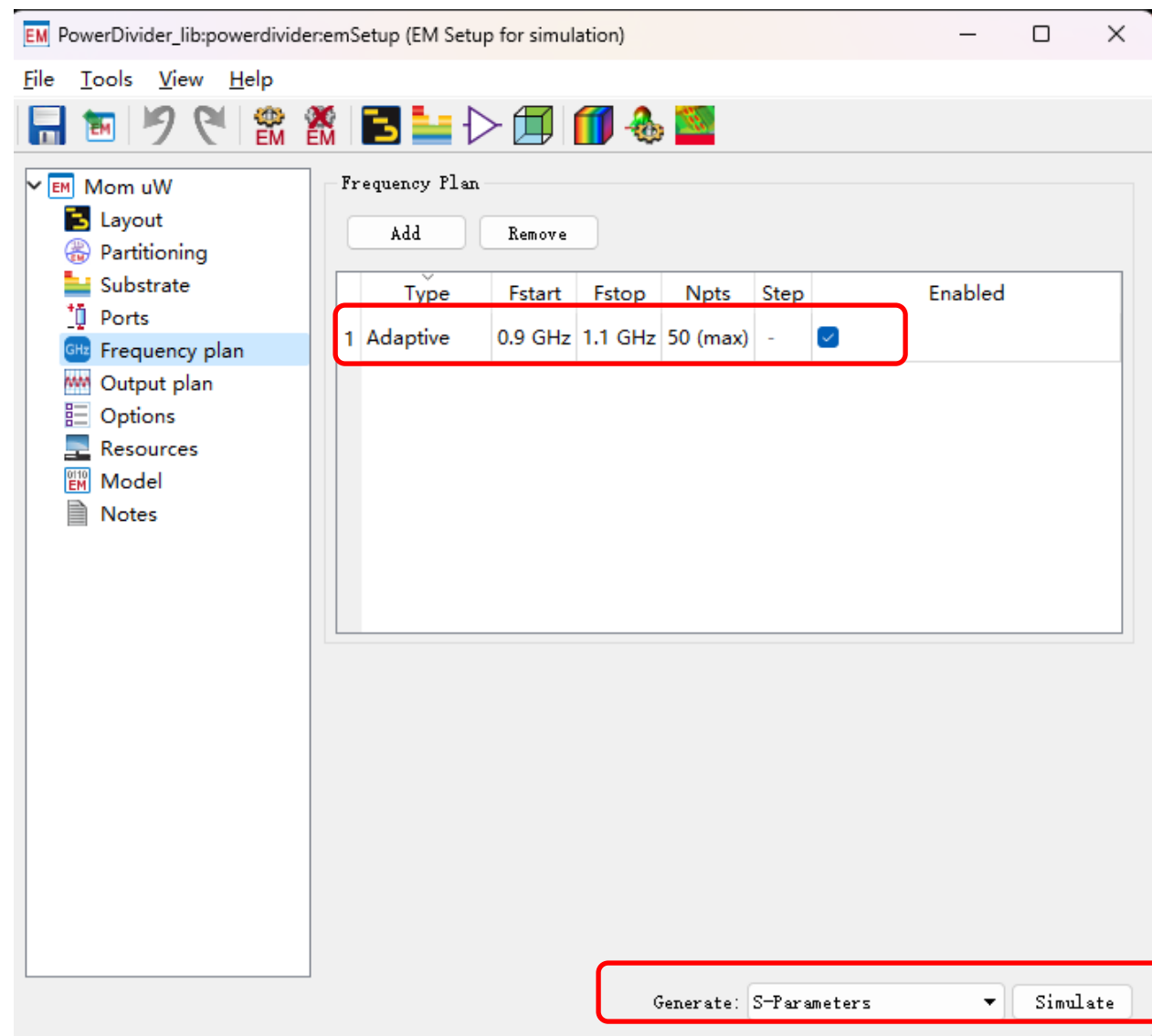
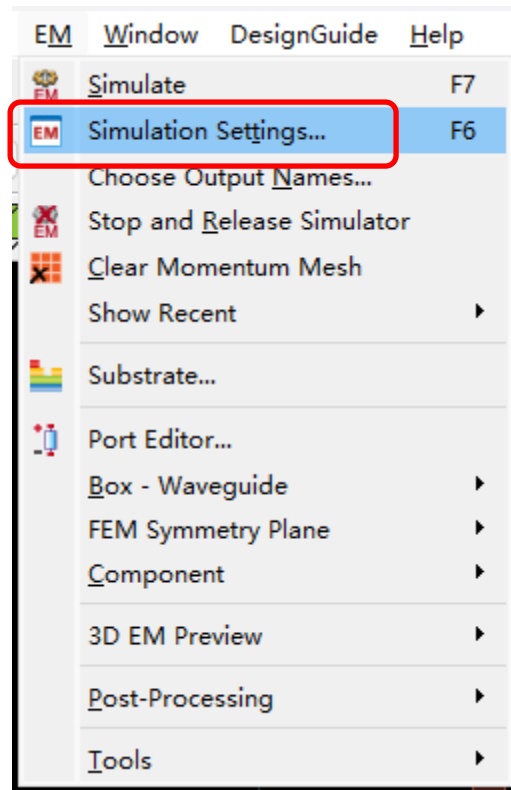


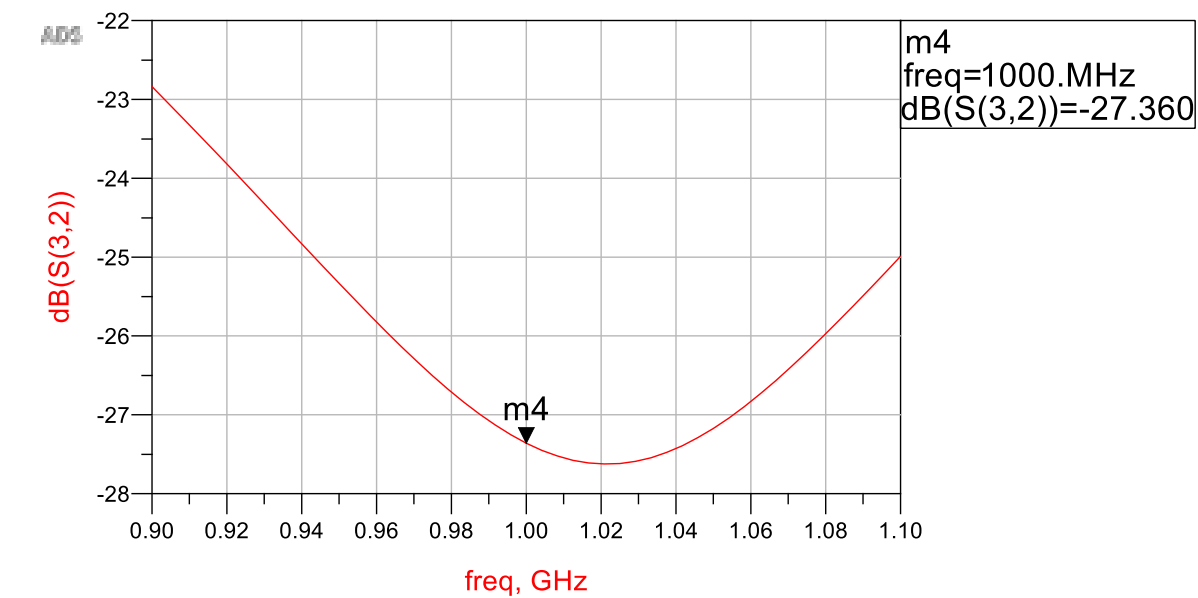
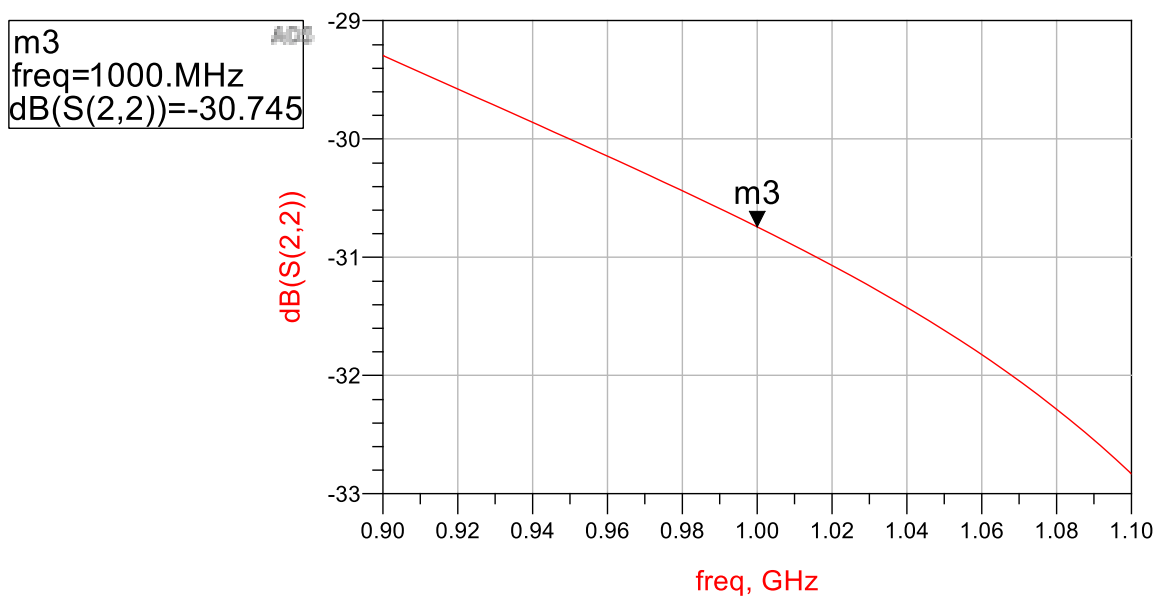
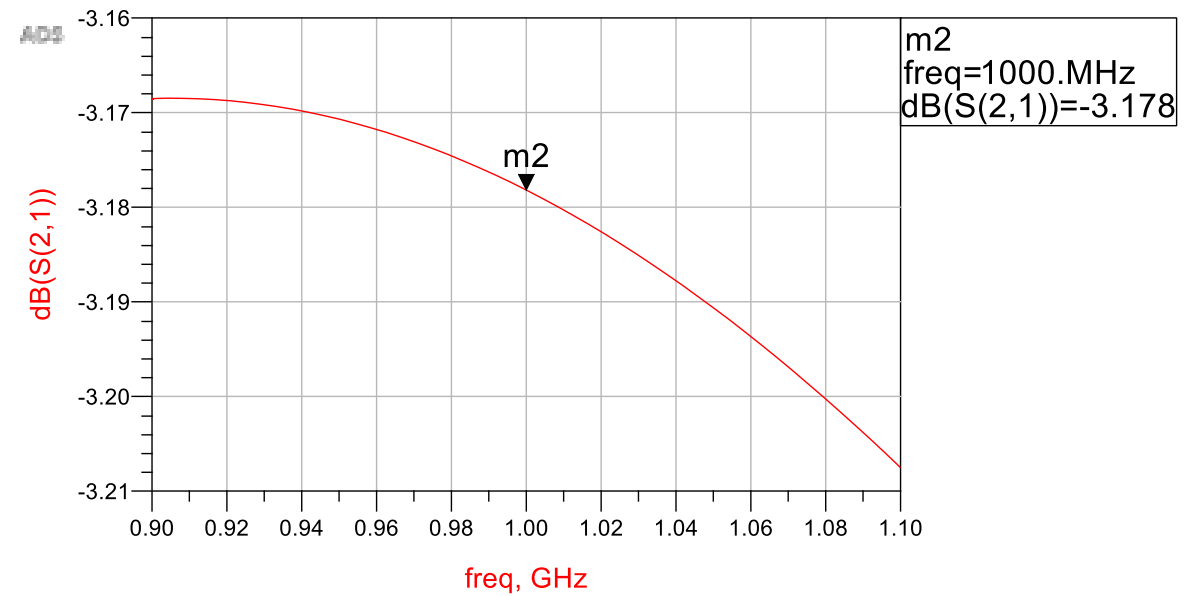
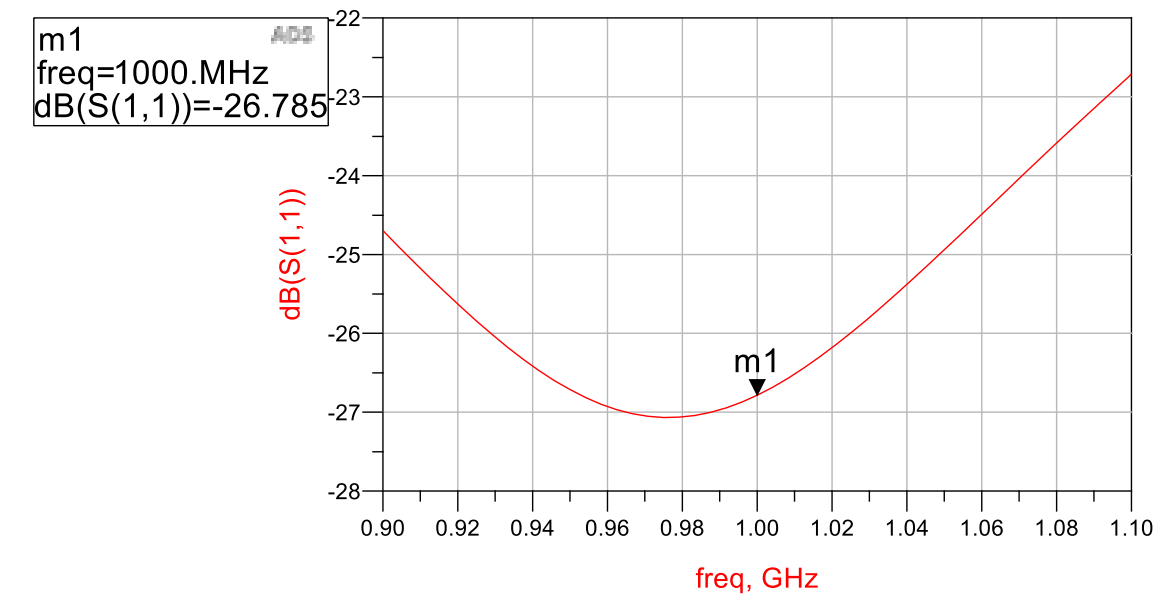


# 版图仿真









# Homework

- Wilkinson Power Divider design in ADS
- Freq. 2.4 GHz
- Bandwidth: 200MHz
- Substrate: FR4, thickness: 1.6mm
- S11, S21, S22 and S32
- Optimization