SUSTech Southern University of Science and Technology

Microwave Engineering (Lab)

Lab 5: Design of Wilkinson Power Divider

Part 2

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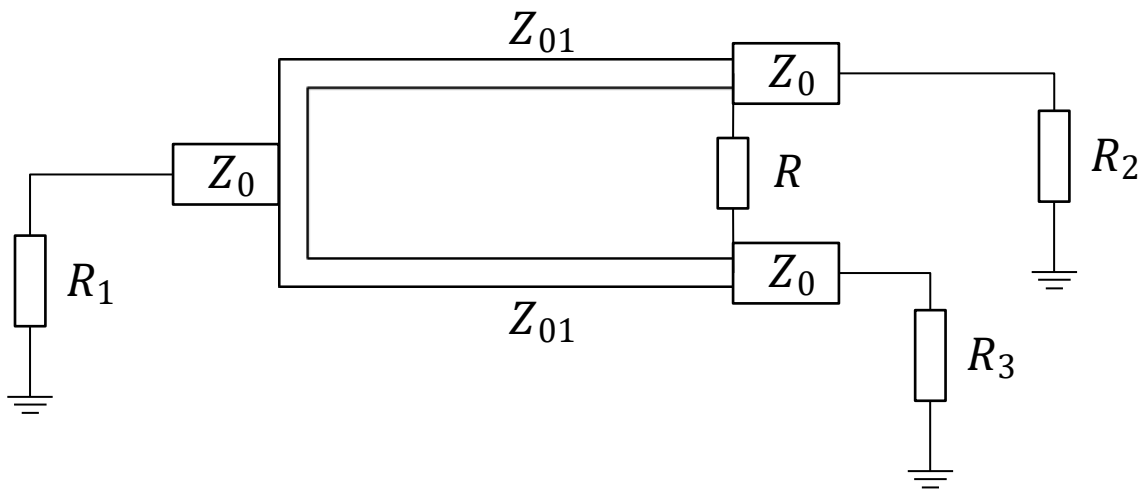
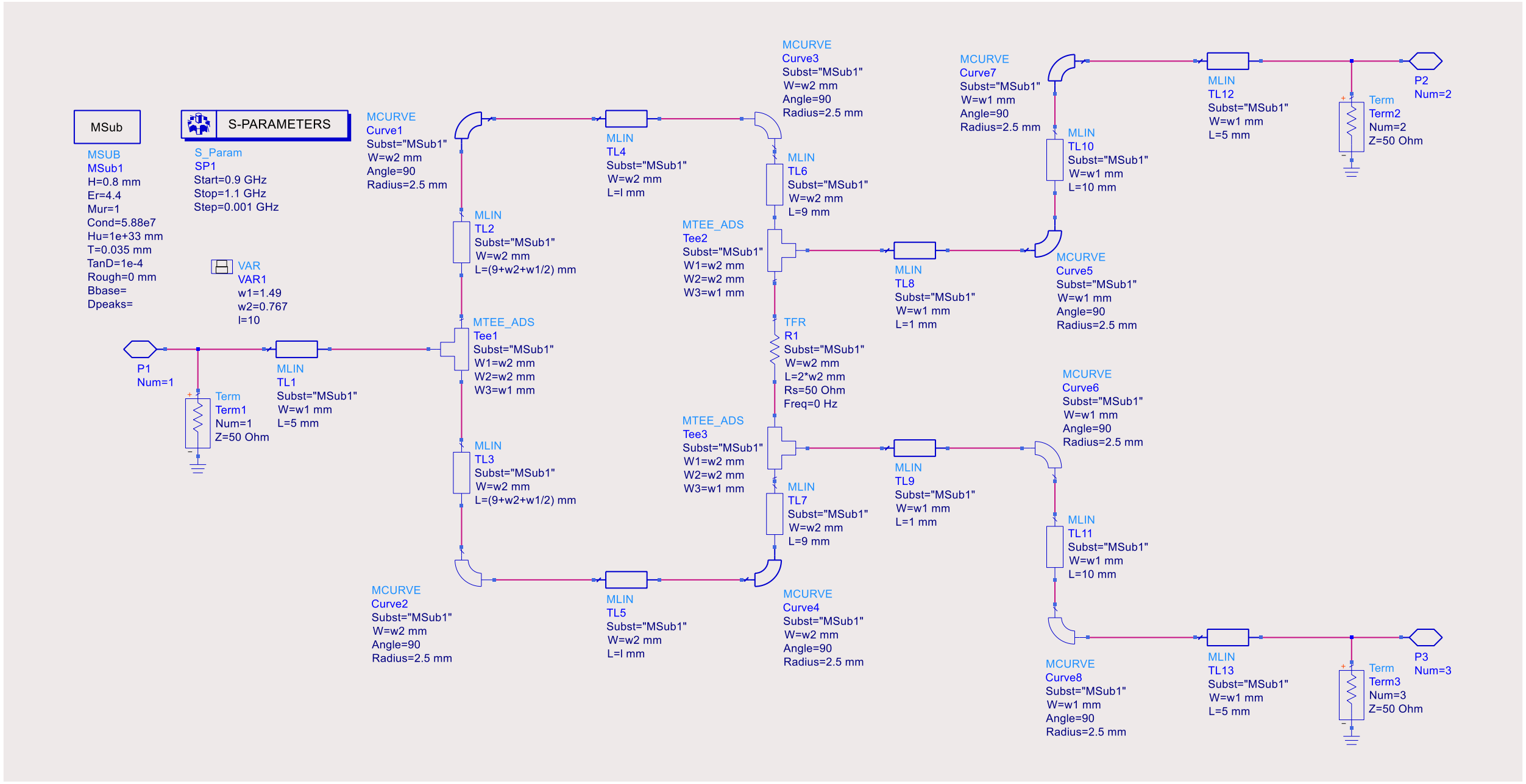
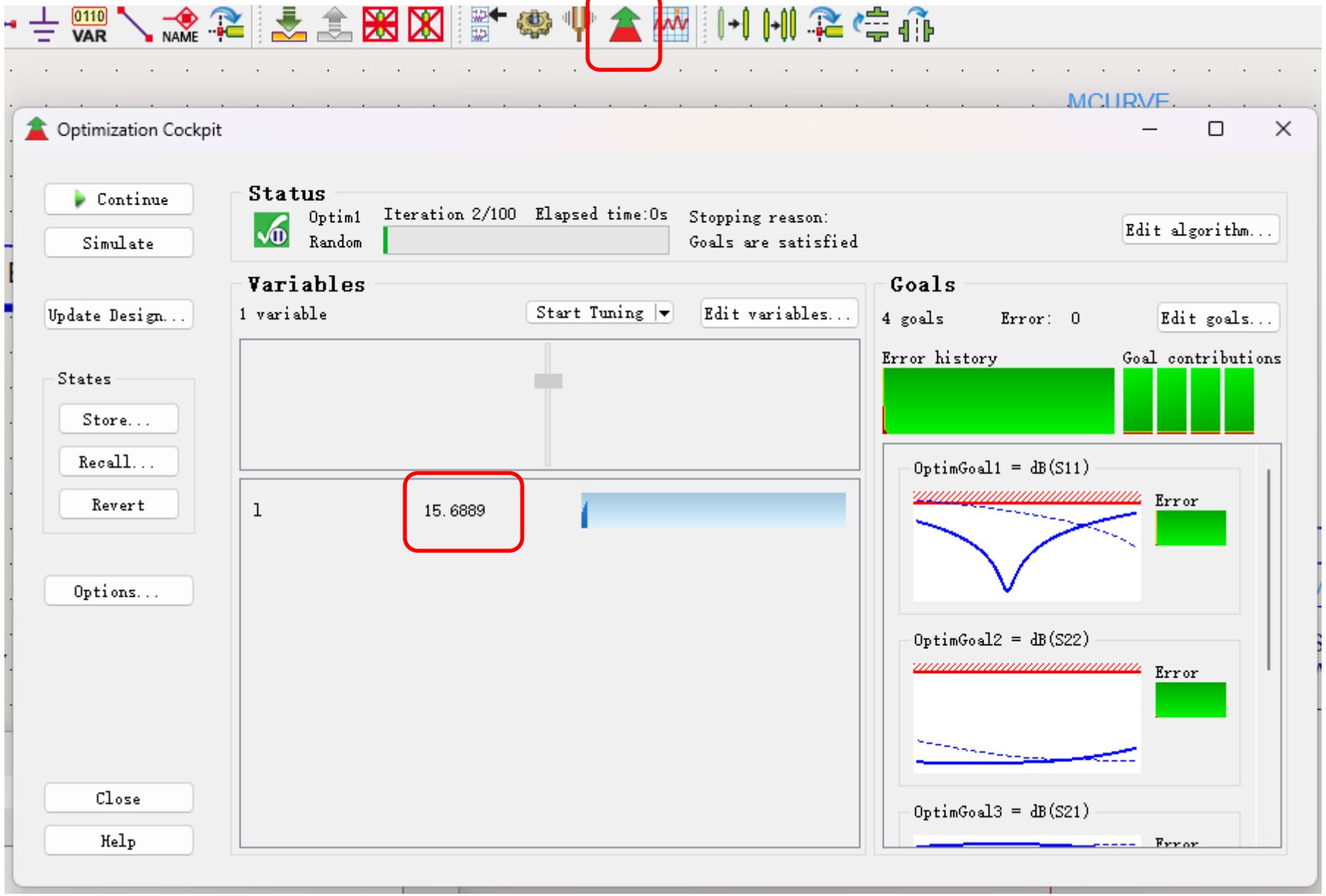
Tencent Meeting: 874-068-9694

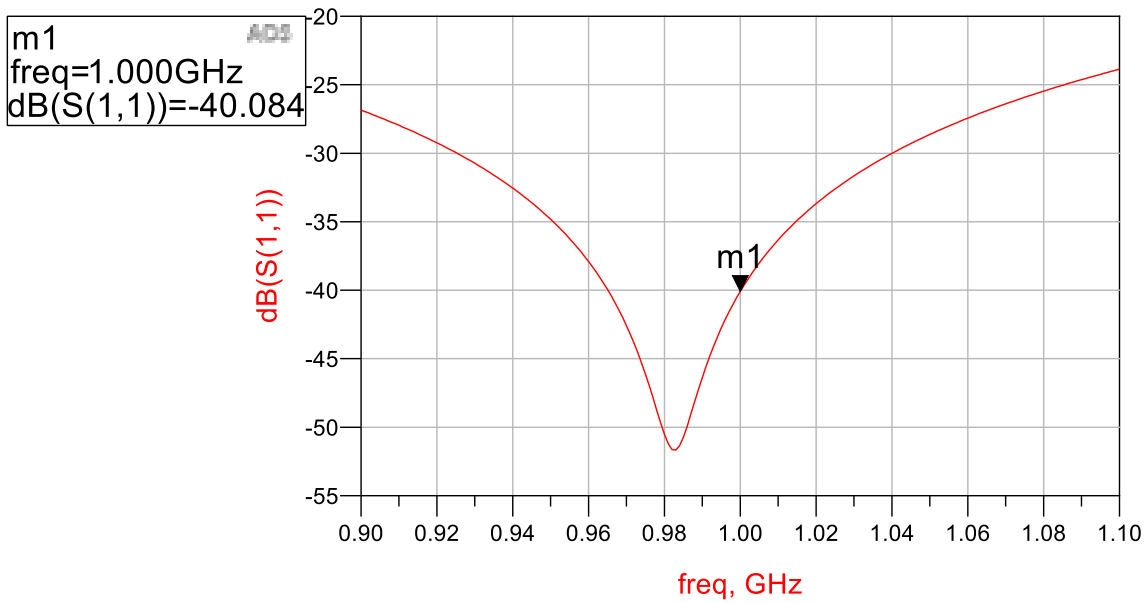
设计指标：
频率：0.9~1.1GHz
端口反射系数S11<-20dB，S22<-20dB
传输系数S21>-3.3dB
隔离度S32<-25dB

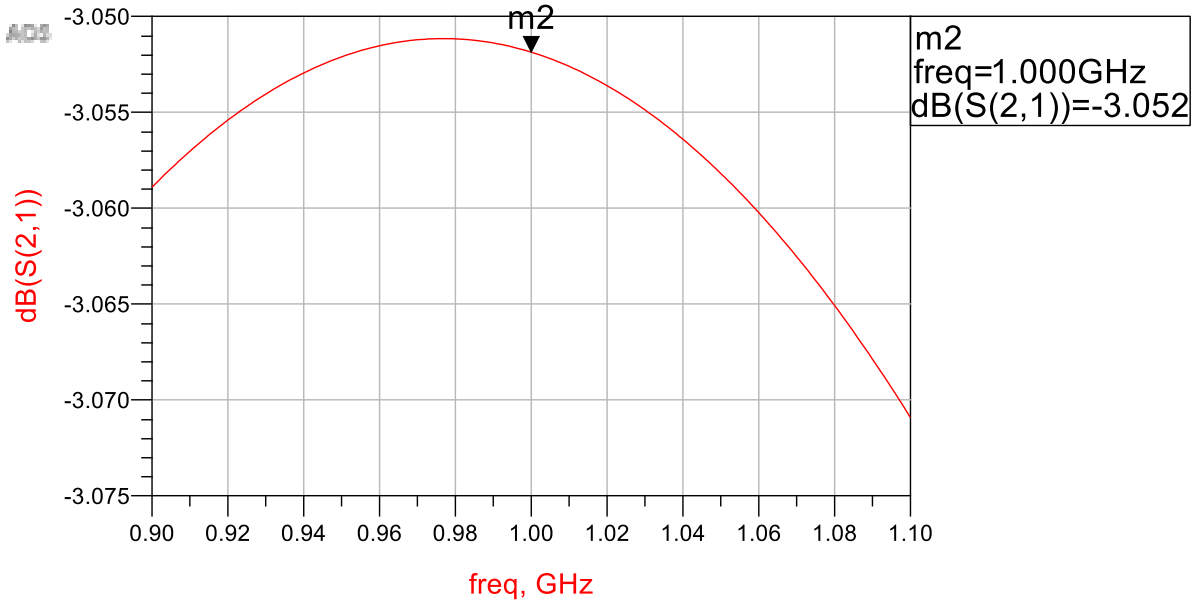
板材选择：FR4
厚度：0.8mm

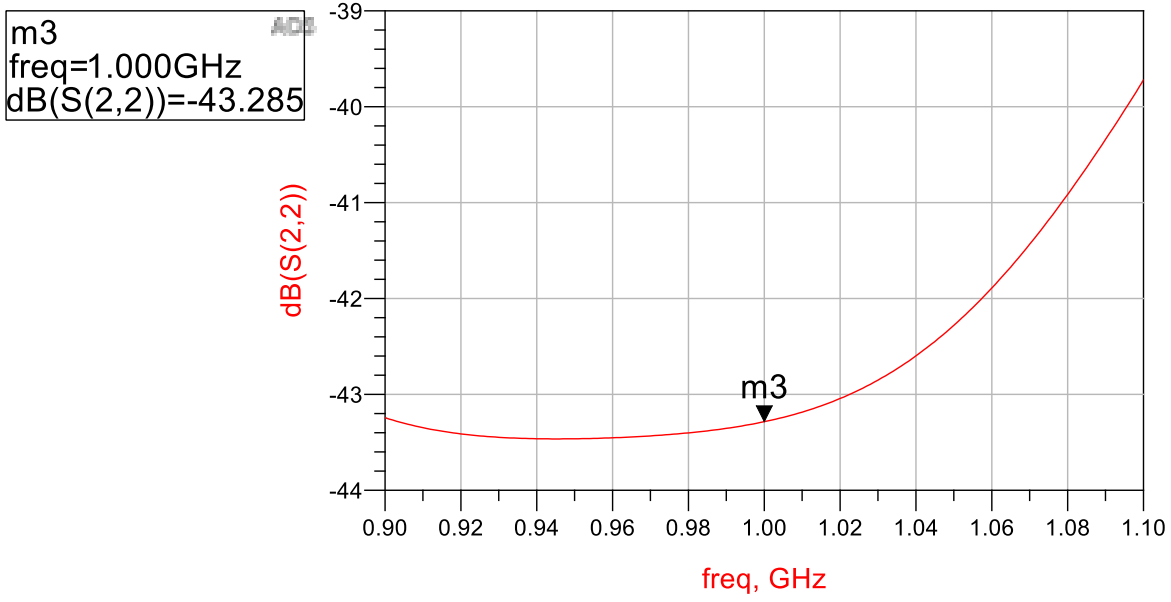


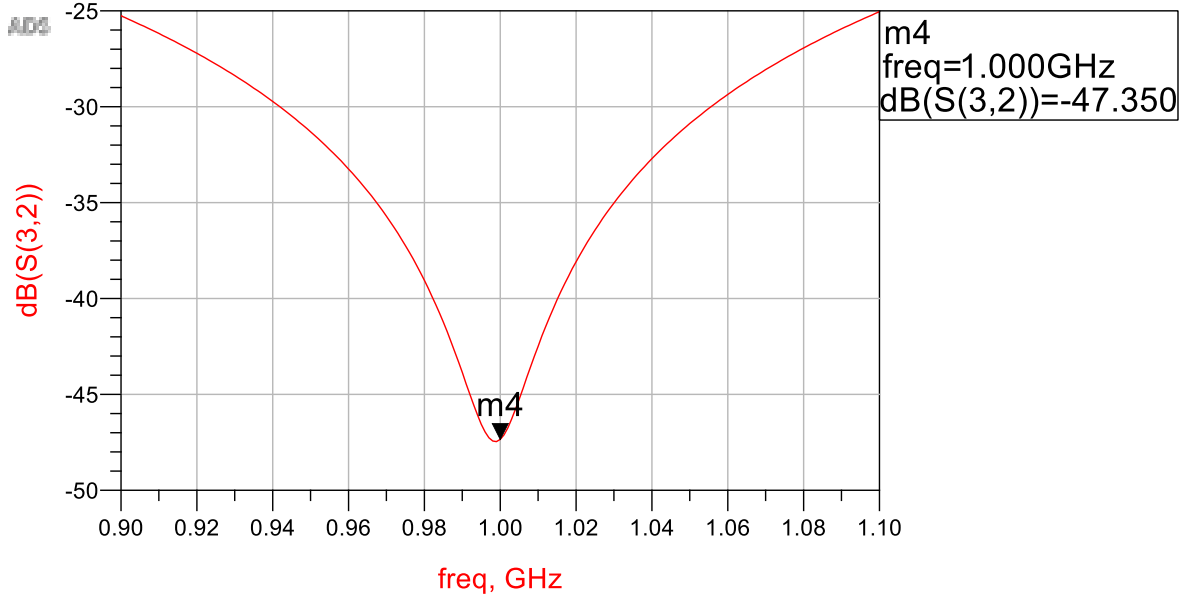

MSub
MSUB
MSub1
H=0.8 mm
Er=4.4
Mur=1
Cond=5.88e7
Hu=1e+33 mm
T=0.035 mm
TanD=1e-4
Rough=0 mm
Bbase=
Dpeaks=
S-PARAMETERS
S_Param
SP1
Start=0.9 GHz
Stop=1.1 GHz
Step=0.001 GHz
VAR
VAR1
w1=1.49
w2=0.767
l=10
P1
Num=1
Term
Term1
Num=1
Z=50 Ohm
MLIN
TL1
Subst="MSub1"
W=w1 mm
L=5 mm
MCURVE
Curve1
Subst="MSub1"
W=w2 mm
Angle=90
Radius=2.5 mm
MLIN
TL2
Subst="MSub1"
W=w2 mm
L=(9+w2+w1/2) mm
MTEE_ADS
Tee1
Subst="MSub1"
W1=w2 mm
W2=w2 mm
W3=w1 mm
MLIN
TL3
Subst="MSub1"
W=w2 mm
L=(9+w2+w1/2) mm
MCURVE
Curve2
Subst="MSub1"
W=w2 mm
Angle=90
Radius=2.5 mm
MLIN
TL4
Subst="MSub1"
W=w2 mm
L=l mm
MLIN
TL5
Subst="MSub1"
W=w2 mm
L=l mm
MCURVE
Curve3
Subst="MSub1"
W=w2 mm
Angle=90
Radius=2.5 mm
MLIN
TL6
Subst="MSub1"
W=w2 mm
L=9 mm
MTEE_ADS
Tee2
Subst="MSub1"
W1=w2 mm
W2=w2 mm
W3=w1 mm
TFR
R1
Subst="MSub1"
W=w2 mm
L=2*w2 mm
Rs=50 Ohm
Freq=0 Hz
MTEE_ADS
Tee3
Subst="MSub1"
W1=w2 mm
W2=w2 mm
W3=w1 mm
MLIN
TL7
Subst="MSub1"
W=w2 mm
L=9 mm
MCURVE
Curve4
Subst="MSub1"
W=w2 mm
Angle=90
Radius=2.5 mm
MLIN
TL8
Subst="MSub1"
W=w1 mm
L=1 mm
MLIN
TL9
Subst="MSub1"
W=w1 mm
L=1 mm
MCURVE
Curve5
Subst="MSub1"
W=w1 mm
Angle=90
Radius=2.5 mm
MCURVE
Curve6
Subst="MSub1"
W=w1 mm
Angle=90
Radius=2.5 mm
MCURVE
Curve7
Subst="MSub1"
W=w1 mm
Angle=90
Radius=2.5 mm
MLIN
TL10
Subst="MSub1"
W=w1 mm
L=10 mm
MLIN
TL11
Subst="MSub1"
W=w1 mm
L=10 mm
MCURVE
Curve8
Subst="MSub1"
W=w1 mm
Angle=90
Radius=2.5 mm
MLIN
TL12
Subst="MSub1"
W=w1 mm
L=5 mm
MLIN
TL13
Subst="MSub1"
W=w1 mm
L=5 mm
Term
Term2
Num=2
Z=50 Ohm
P2
Num=2
Term
Term3
Num=3
Z=50 Ohm
P3
Num=3


Optimization Cockpit
Continue
Simulate
Update Design...
States
Store...
Recall...
Revert
Options...
Close
Help
Status
Optim1
Random
Iteration 2/100
Elapsed time:0s
Stopping reason:
Goals are satisfied
Edit algorithm...
Variables
1 variable
Start Tuning
Edit variables...
1
15.6889
Goals
4 goals
Error: 0
Edit goals...
Error history
Goal contributions
OptimGoal1 = dB(S11)
Error
OptimGoal2 = dB(S22)
Error
OptimGoal3 = dB(S21)
Error

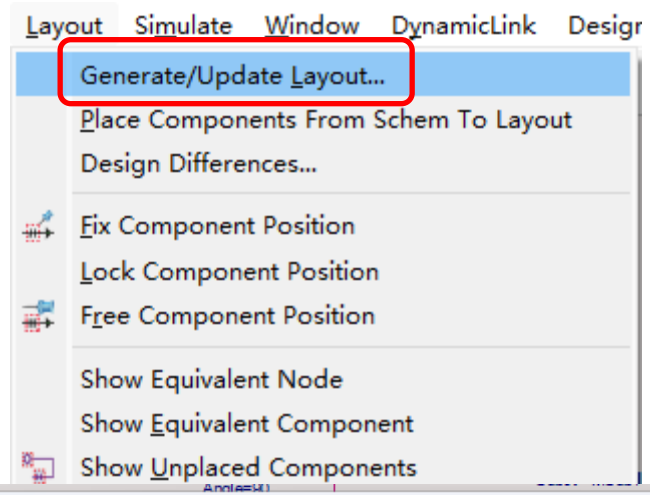

m1
freq=1.000GHz
dB(S(1,1))=-40.084
m1
dB(S(1,1))
freq, GHz
-20
-25
-30
-35
-40
-45
-50
-55
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
1.10

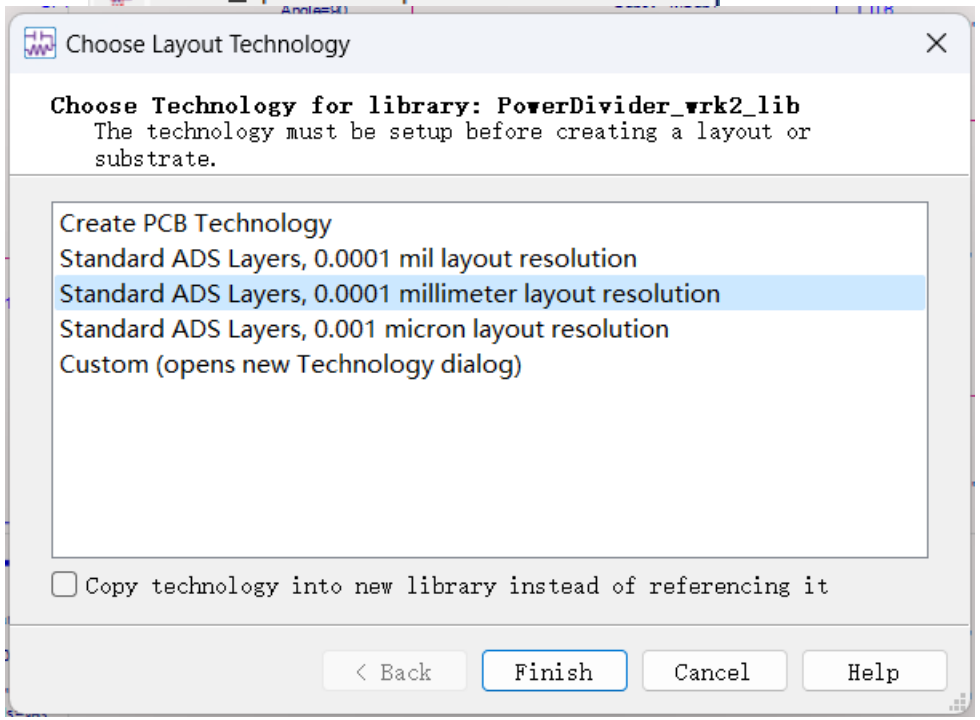

m2
freq=1.000GHz
dB(S(2,1))=-3.052
m2
dB(S(2,1))
freq, GHz
-3.050
-3.055
-3.060
-3.065
-3.070
-3.075
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
1.10

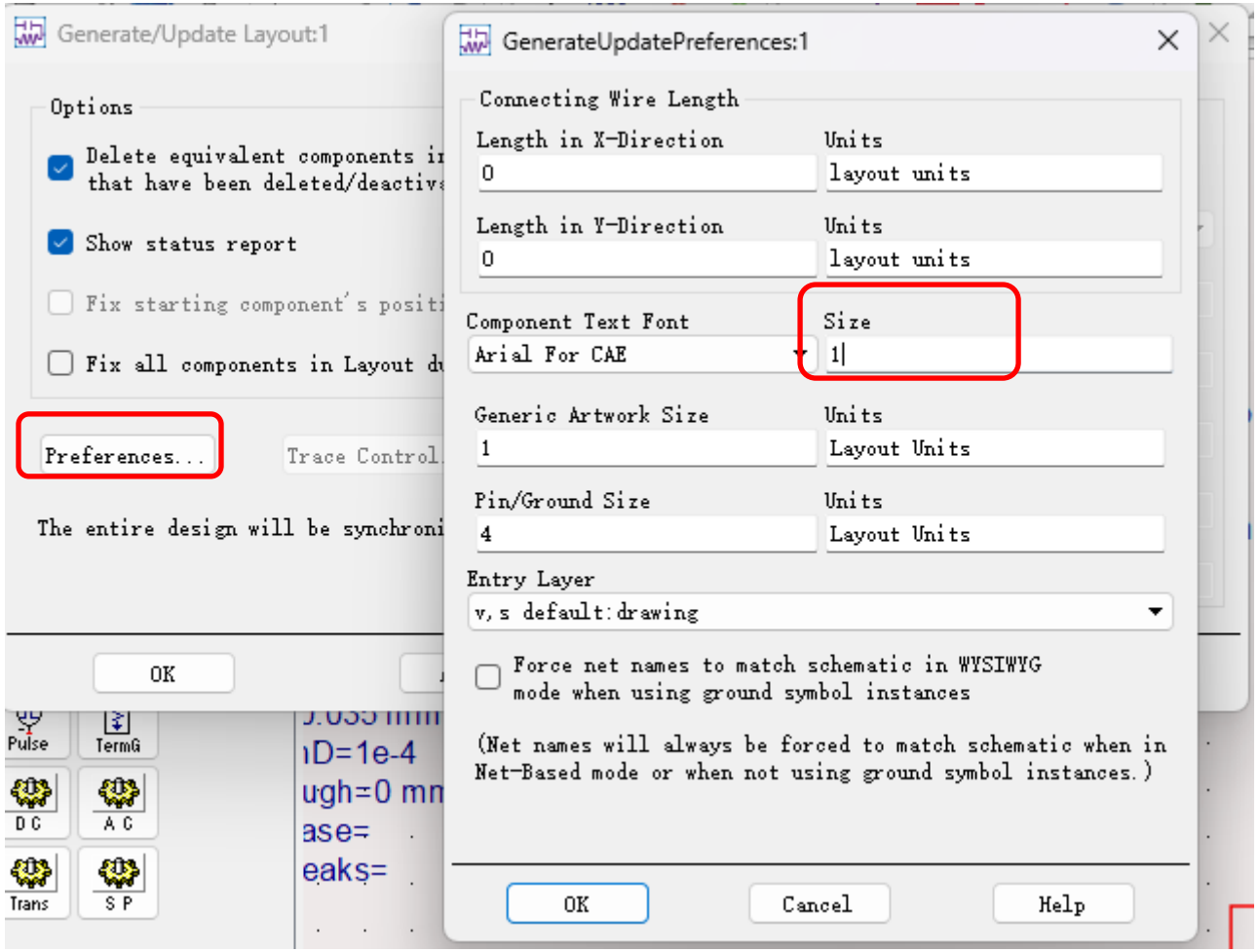

m3
freq=1.000GHz
dB(S(2,2))=-43.285
m3
dB(S(2,2))
freq, GHz
-39
-40
-41
-42
-43
-44
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
1.10

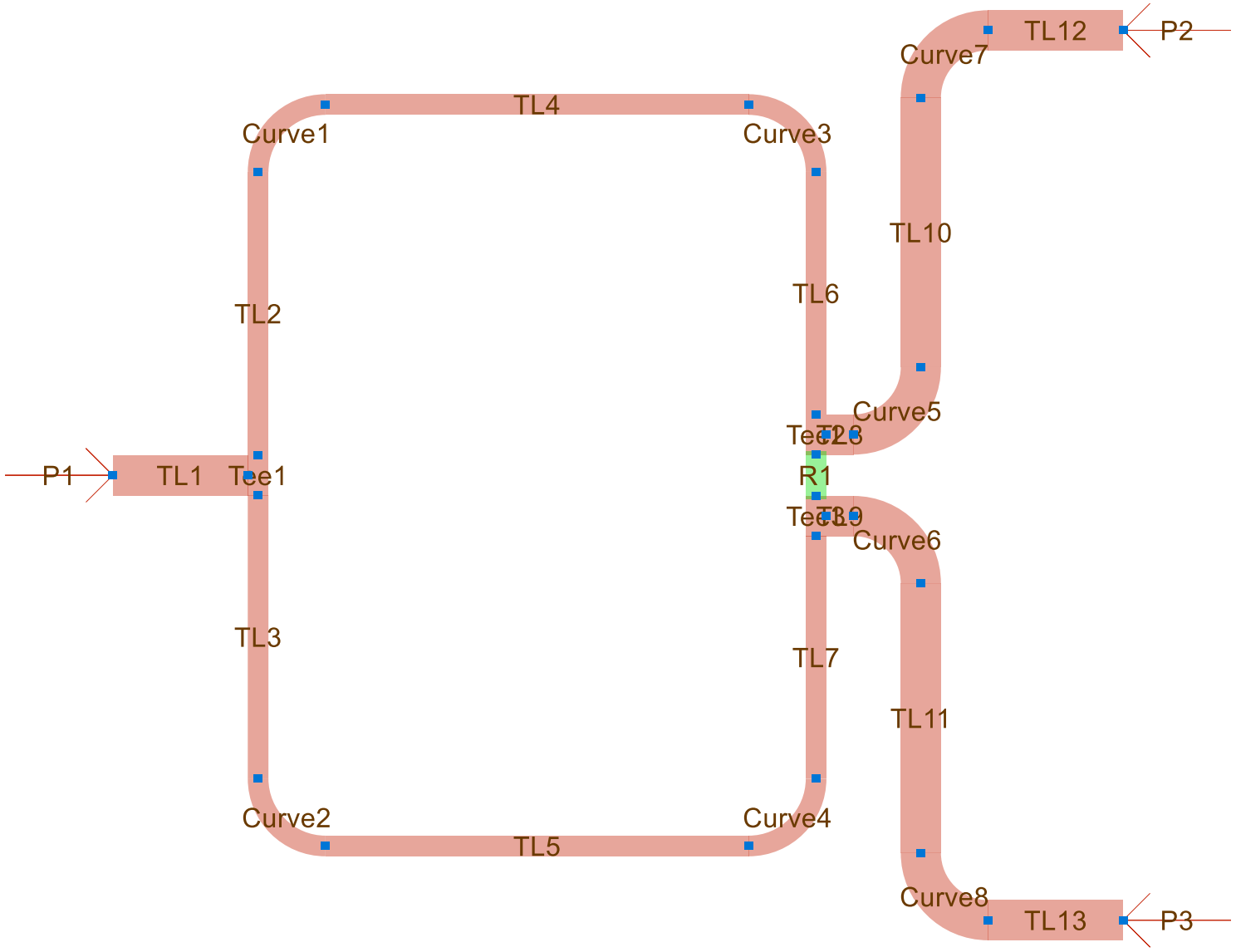

m4
freq=1.000GHz
dB(S(3,2))=-47.350
m4
dB(S(3,2))
freq, GHz
-25
-30
-35
-40
-45
-50
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
1.10

Generate Layout

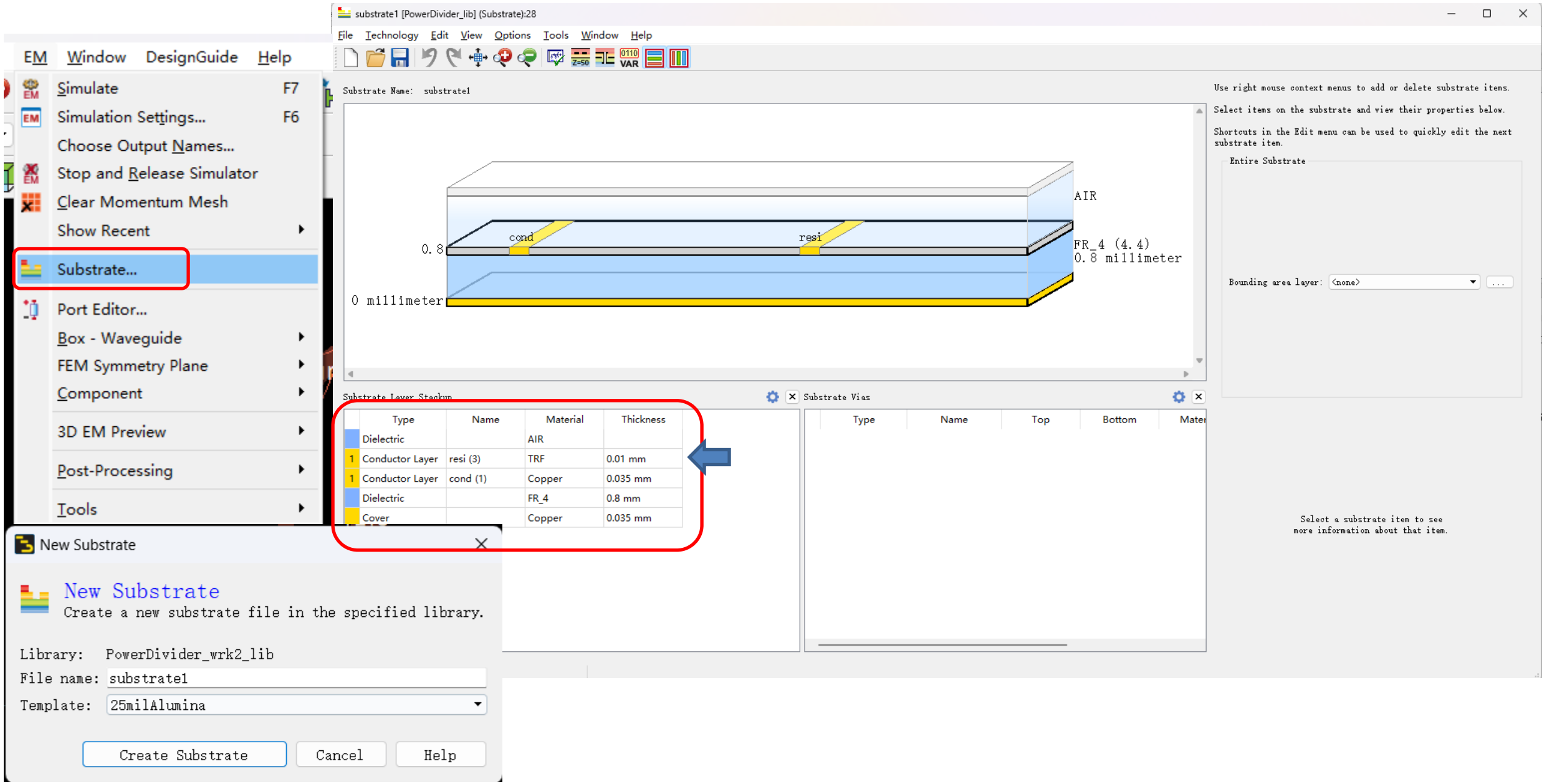


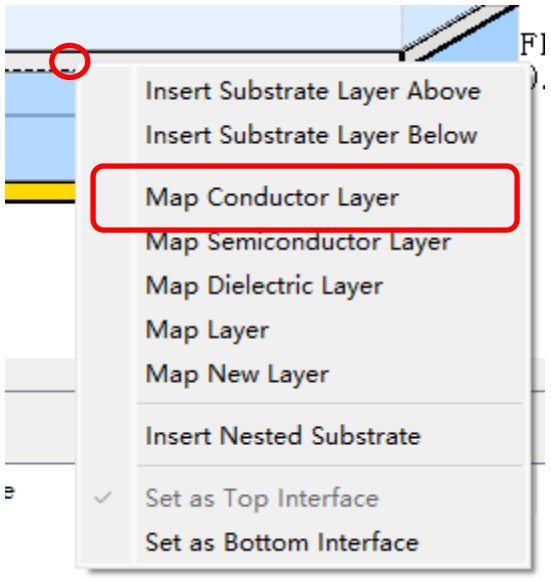


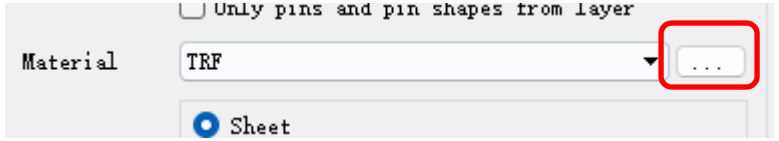


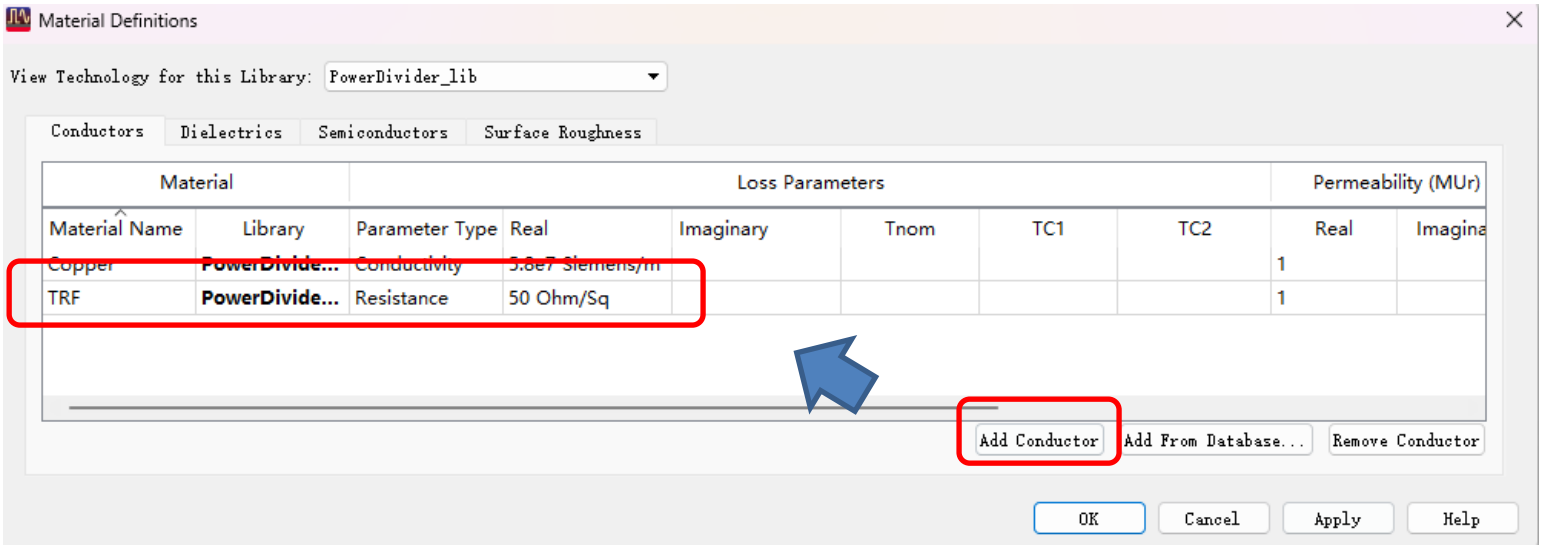

TL12
P2
Curve7
TL4
Curve1
Curve3
TL10
TL6
TL2
Curve5
P1
TL1
Tee1
R1
Curve6
TL3
TL7
TL11
Curve2
Curve4
TL5
Curve8
TL13
P3

Substrate Definition

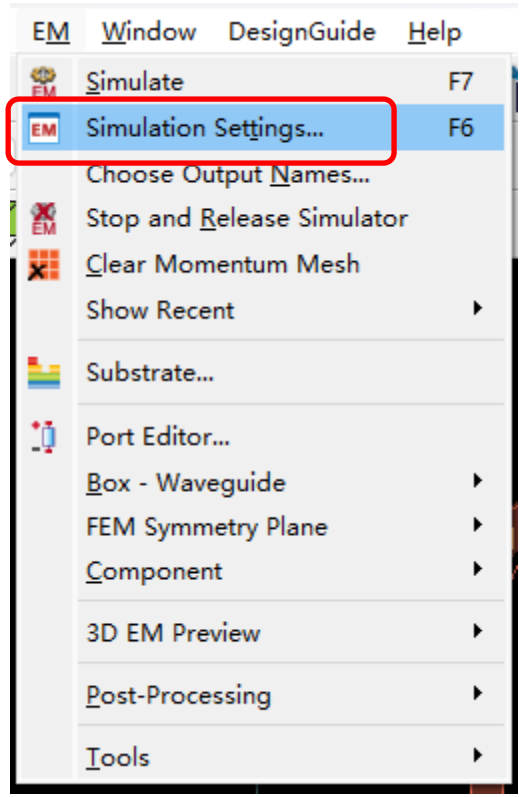


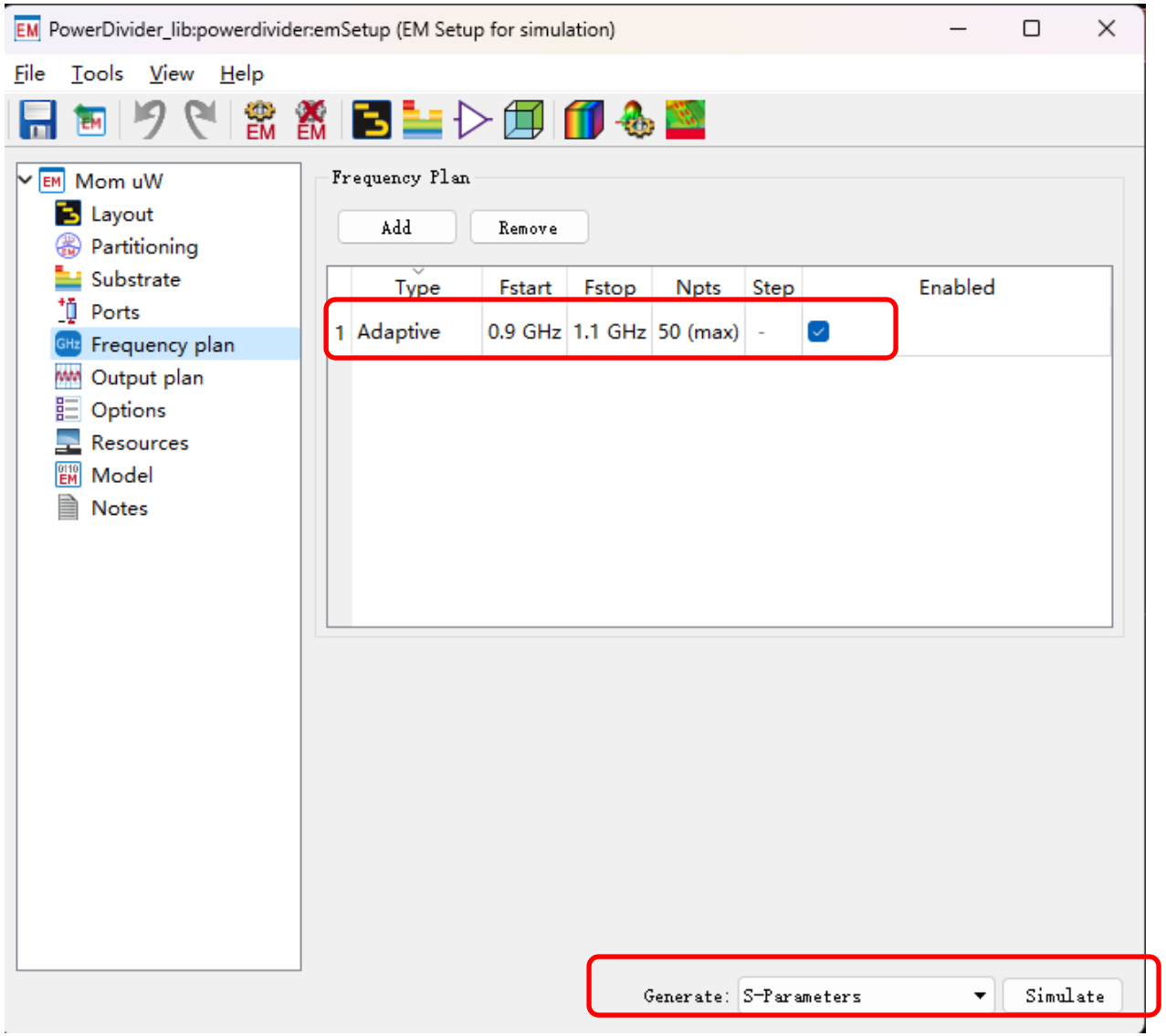

Insert Substrate Layer Above
Insert Substrate Layer Below
Map Conductor Layer
Map Semiconductor Layer
Map Dielectric Layer
Map Layer
Map New Layer
Insert Nested Substrate
Set as Top Interface
Set as Bottom Interface

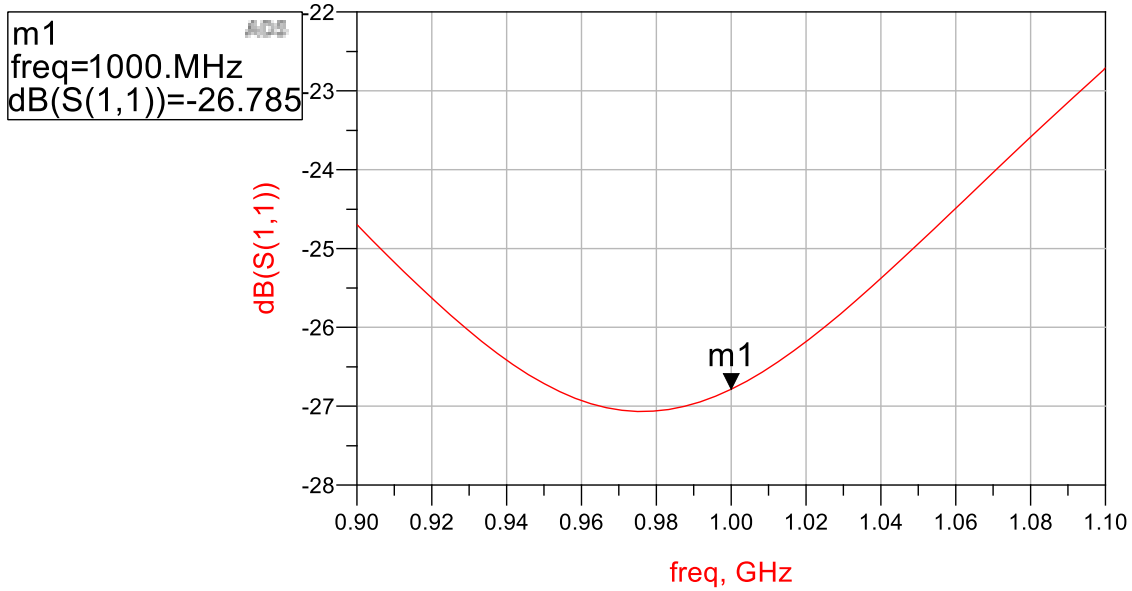

Only pins and pin shapes from layer
Material
TRF
...
Sheet

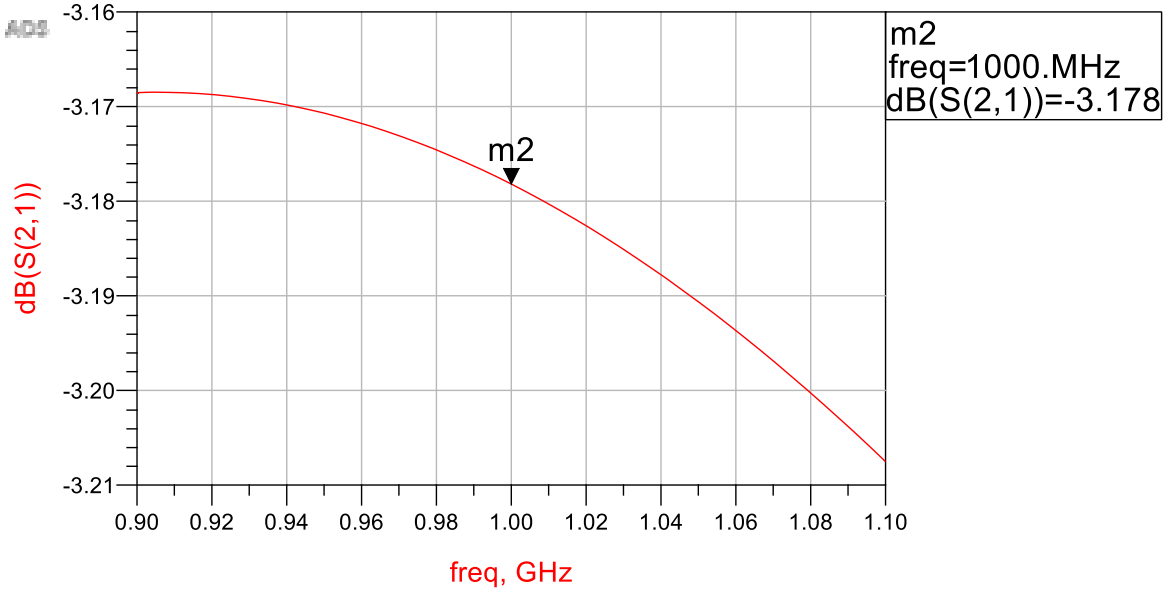

Material Definitions
View Technology for this Library: PowerDivider_lib
Conductors
Dielectrics
Semiconductors
Surface Roughness
Material
Loss Parameters
Permeability (MUr)
Material Name
Library
Parameter Type
Real
Imaginary
Tnom
TC1
TC2
Real
Imagina
Copper
PowerDivide...
Conductivity
5.8e7 Siemens/m
1
TRF
PowerDivide...
Resistance
50 Ohm/Sq
1
Add Conductor
Add From Database...
Remove Conductor
OK
Cancel
Apply
Help

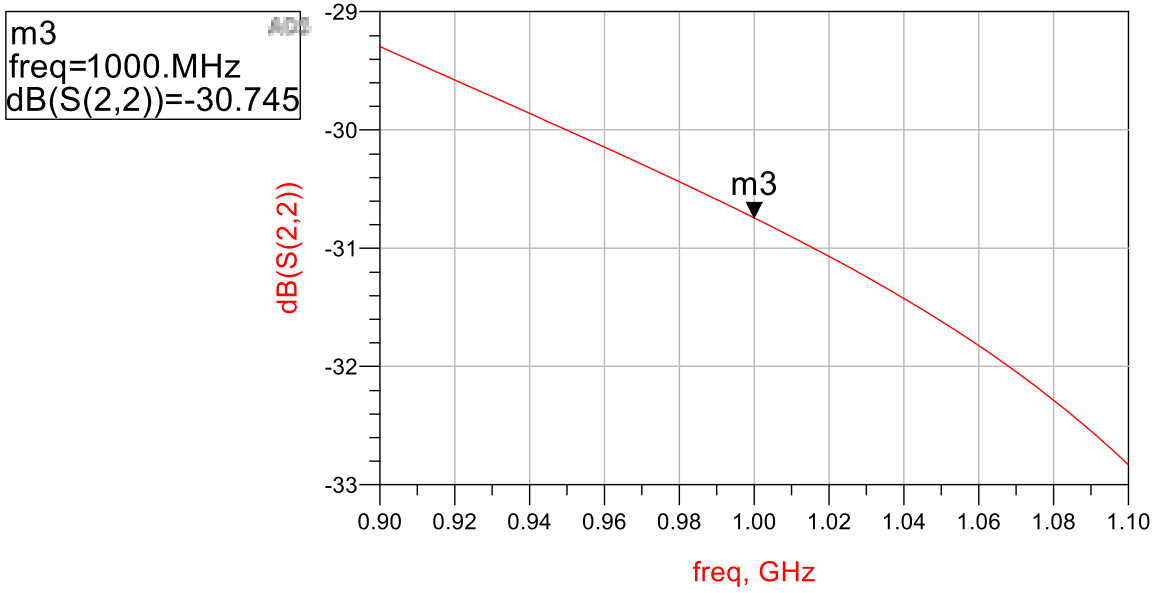
Layout Simulation

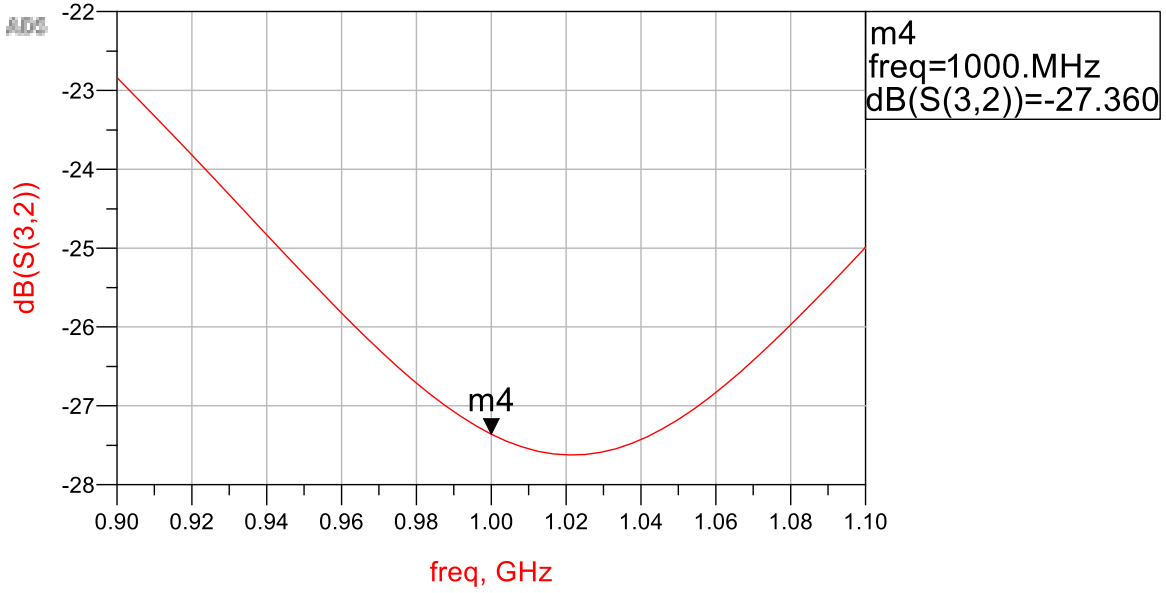




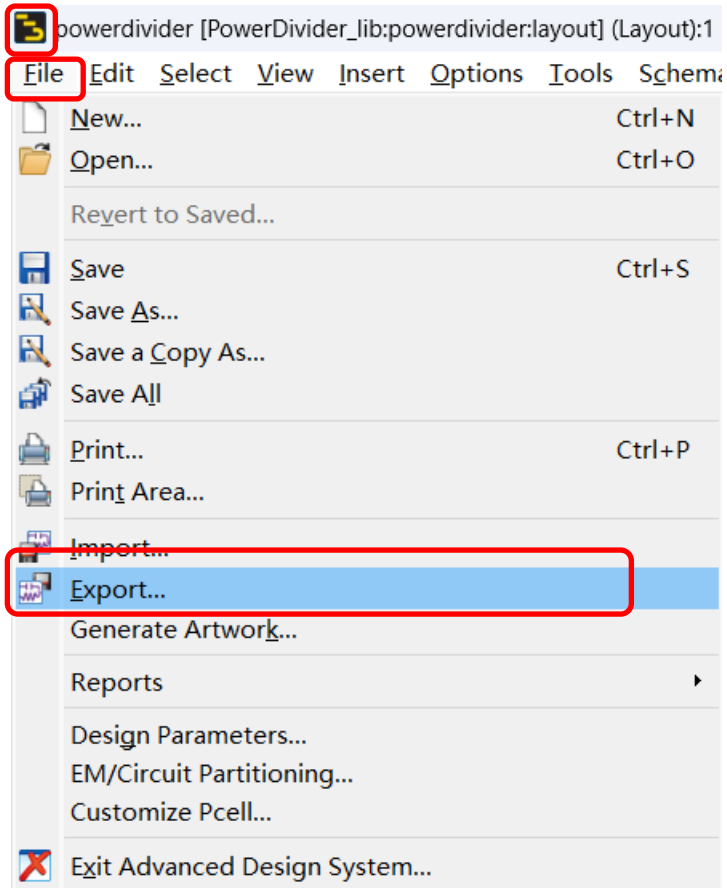

m1
freq=1000.MHz
dB(S(1,1))=-26.785
dB(S(1,1))
freq, GHz
m1

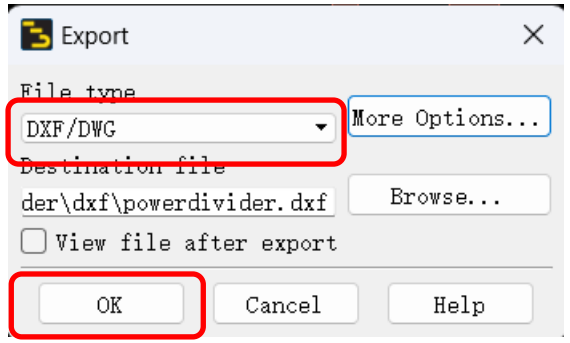

m2
freq=1000.MHz
dB(S(2,1))=-3.178
dB(S(2,1))
freq, GHz
m2


m3
freq=1000.MHz
dB(S(2,2))=-30.745
dB(S(2,2))
freq, GHz
m3

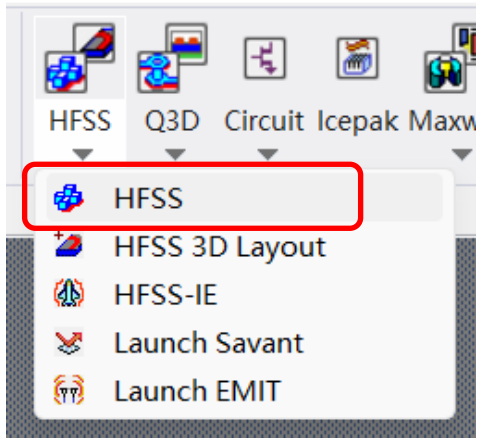

m4
freq=1000.MHz
dB(S(3,2))=-27.360
dB(S(3,2))
freq, GHz
m4

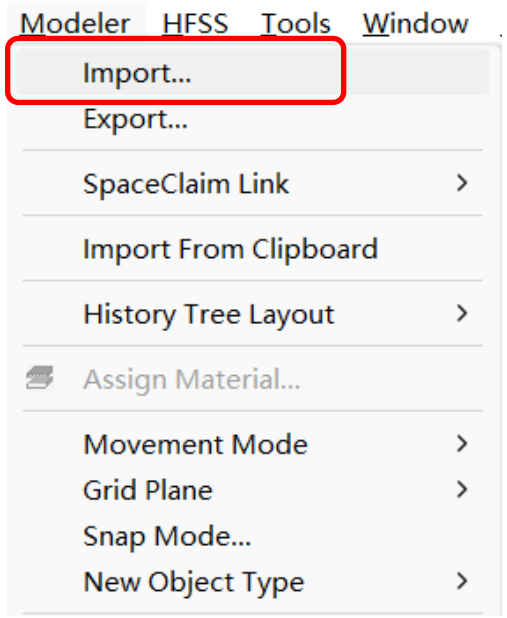
Export to HFSS

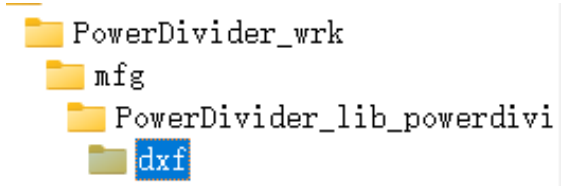


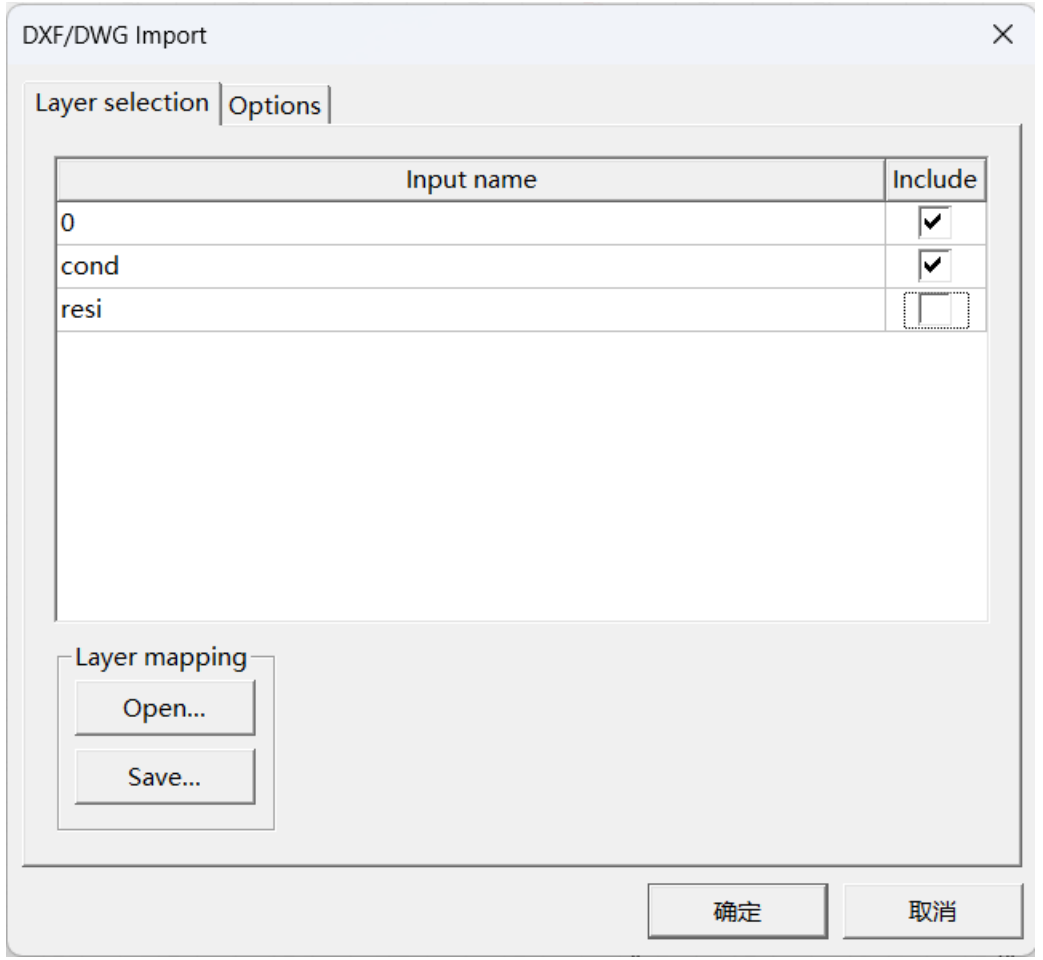


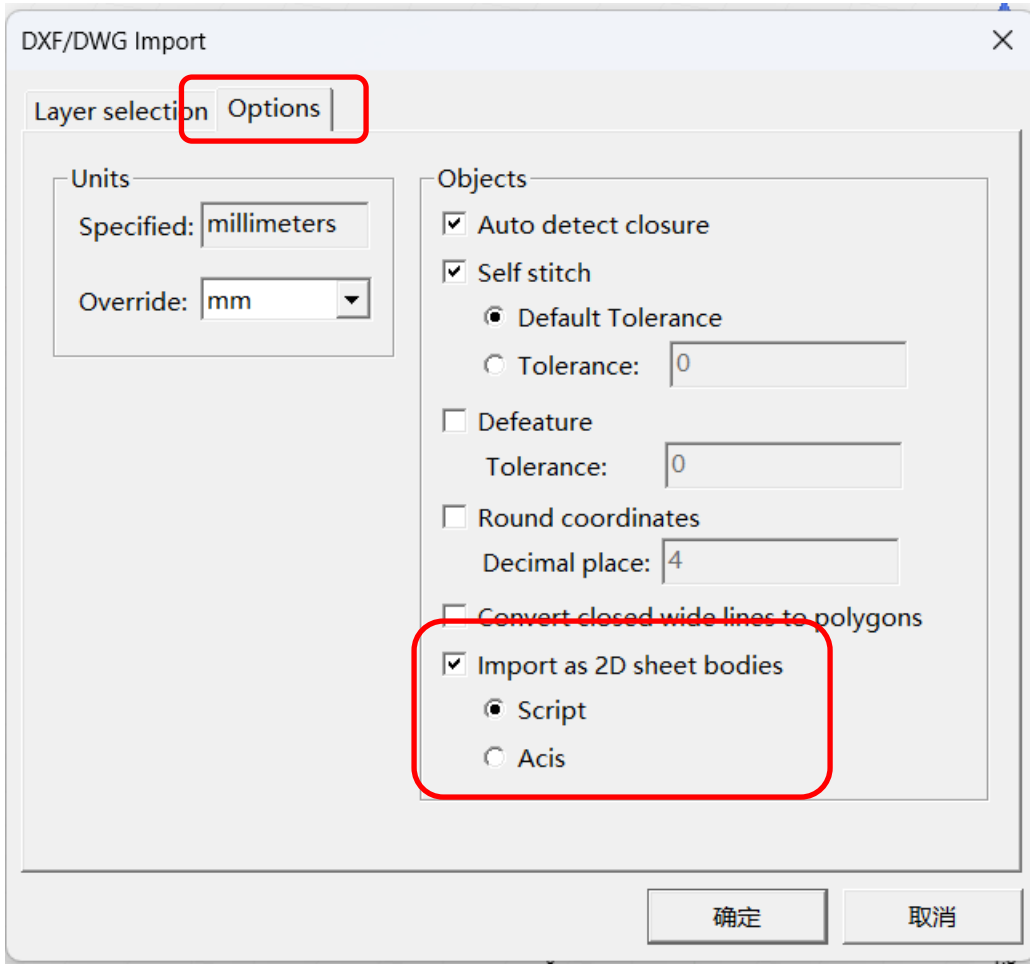
In HFSS import model

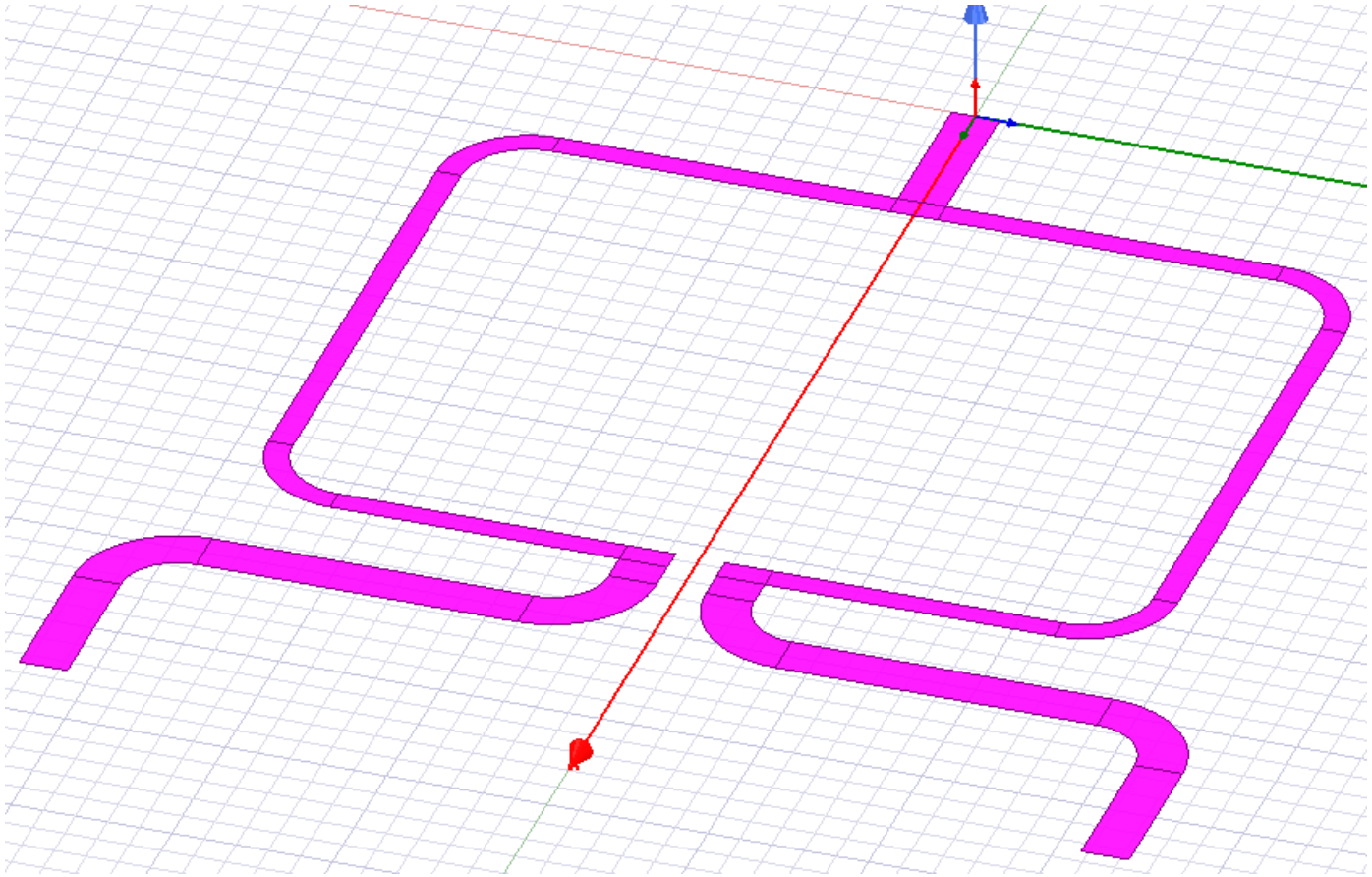




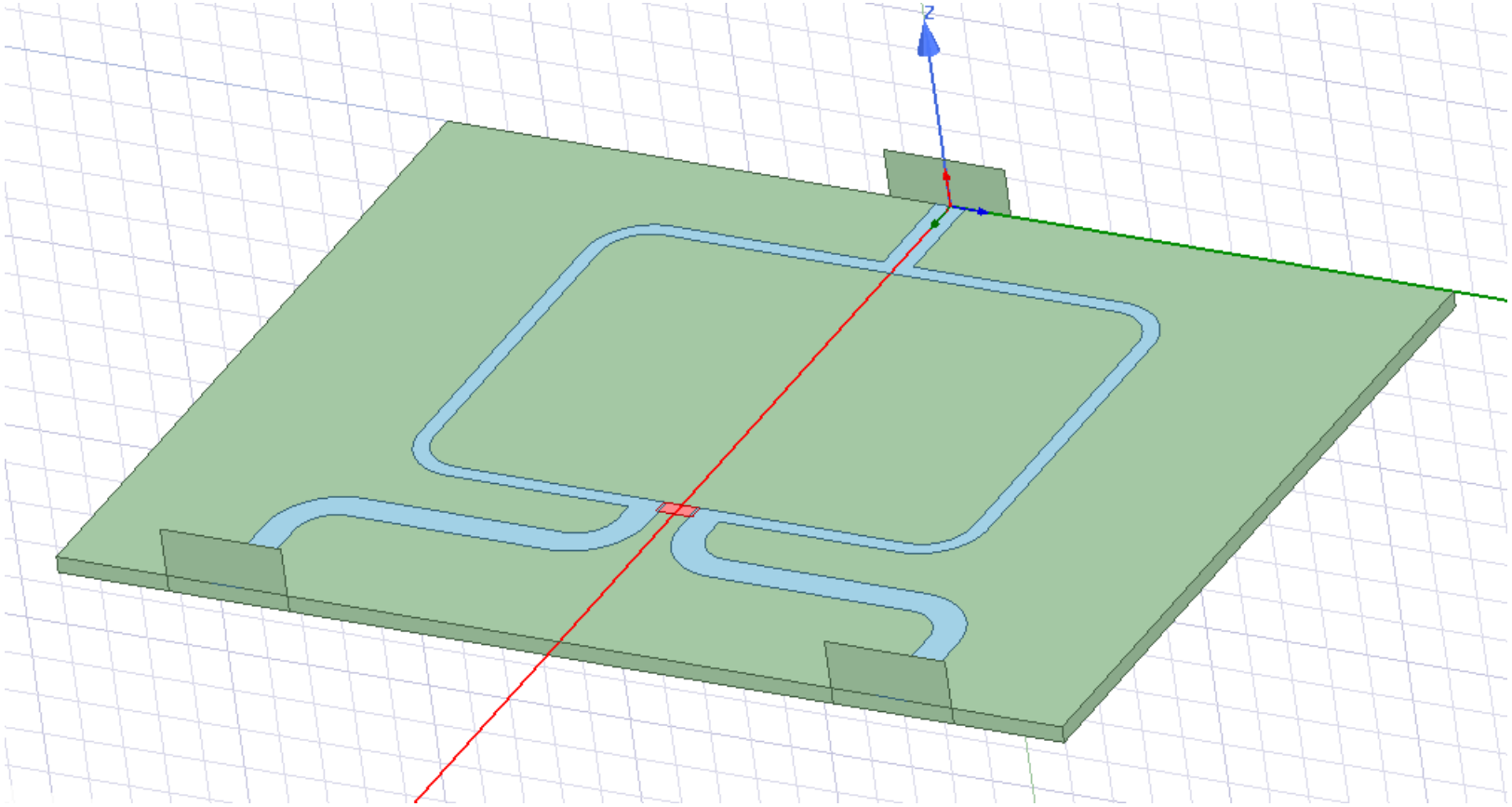





DXF/DWG Import
Layer selection
Options
Units
Specified:
millimeters
Override:
mm
Objects
Auto detect closure
Self stitch
Default Tolerance
Tolerance:
0
Defeature
Tolerance:
0
Round coordinates
Decimal place:
4
Convert closed wide lines to polygons
Import as 2D sheet bodies
Script
Acis
确定
取消

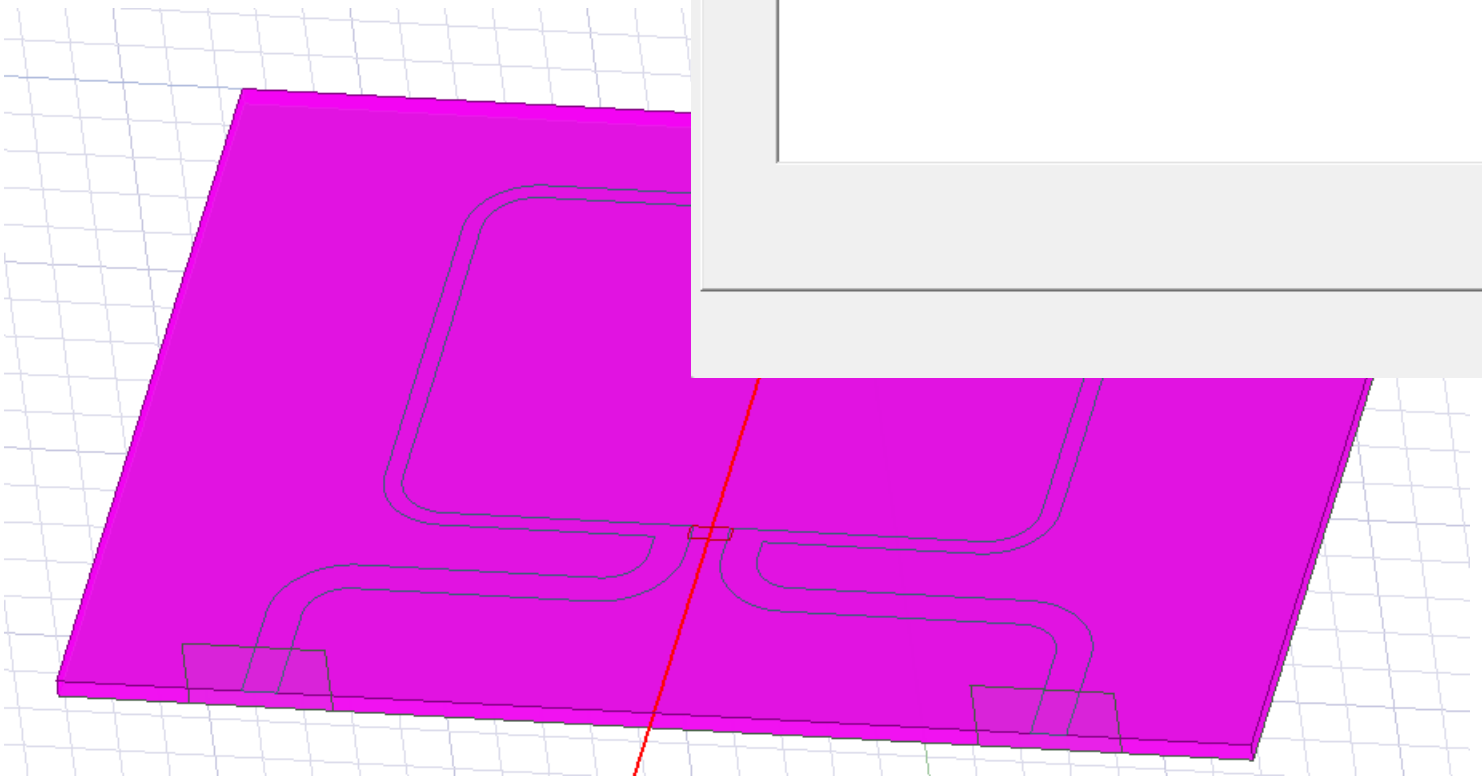


Draw Boxes and Rectangles



All Models

Substrate



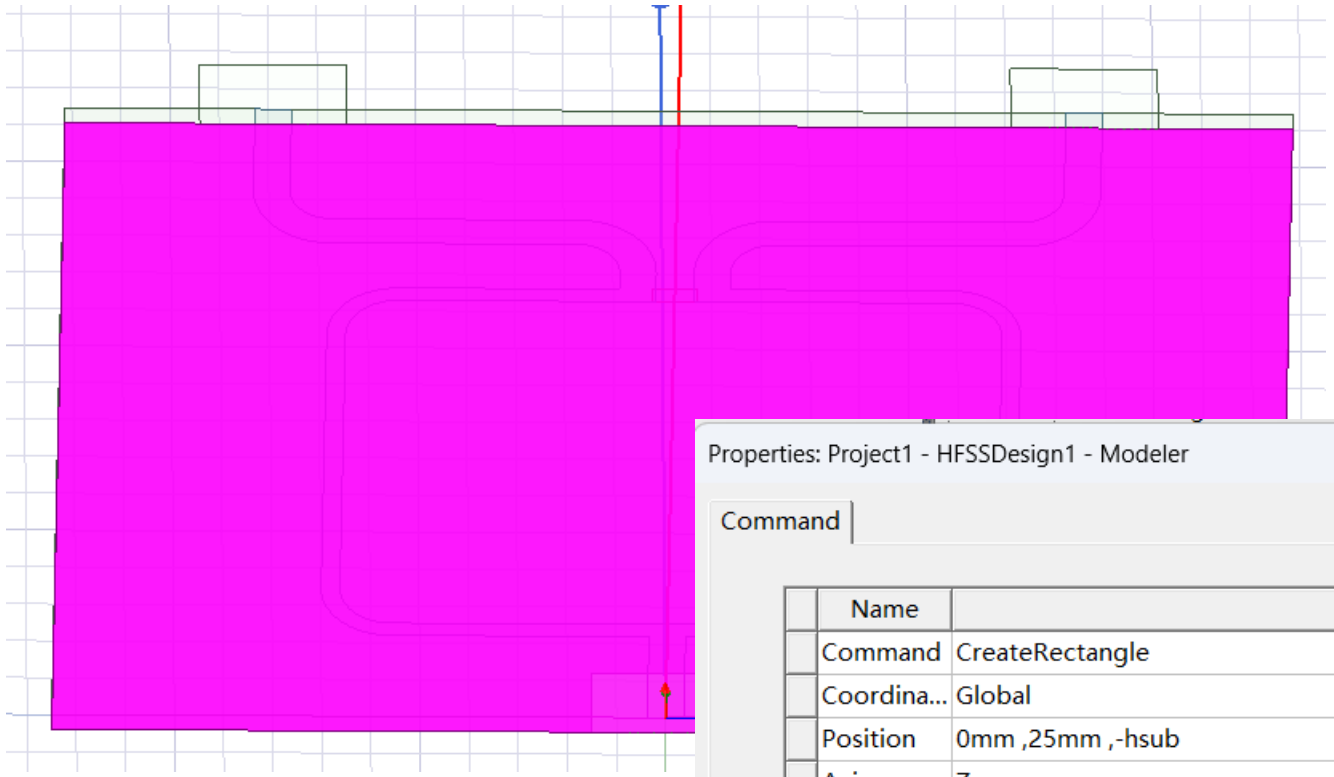
Properties: Project1 - HFSSDesign1 - Modeler

Command

	Name	Value	Unit	Evaluated...	Description
	Command	CreateBox			
	Coordina...	Global			
	Position	0 ,-25 ,0	mm	0mm , -2...	
	XSize	37.4559	mm	37.4559m...	
	YSize	50	mm	50mm	
	ZSize	-hsub		-0.8mm	

Show Hidden

确定 取消 应用(A)



GND

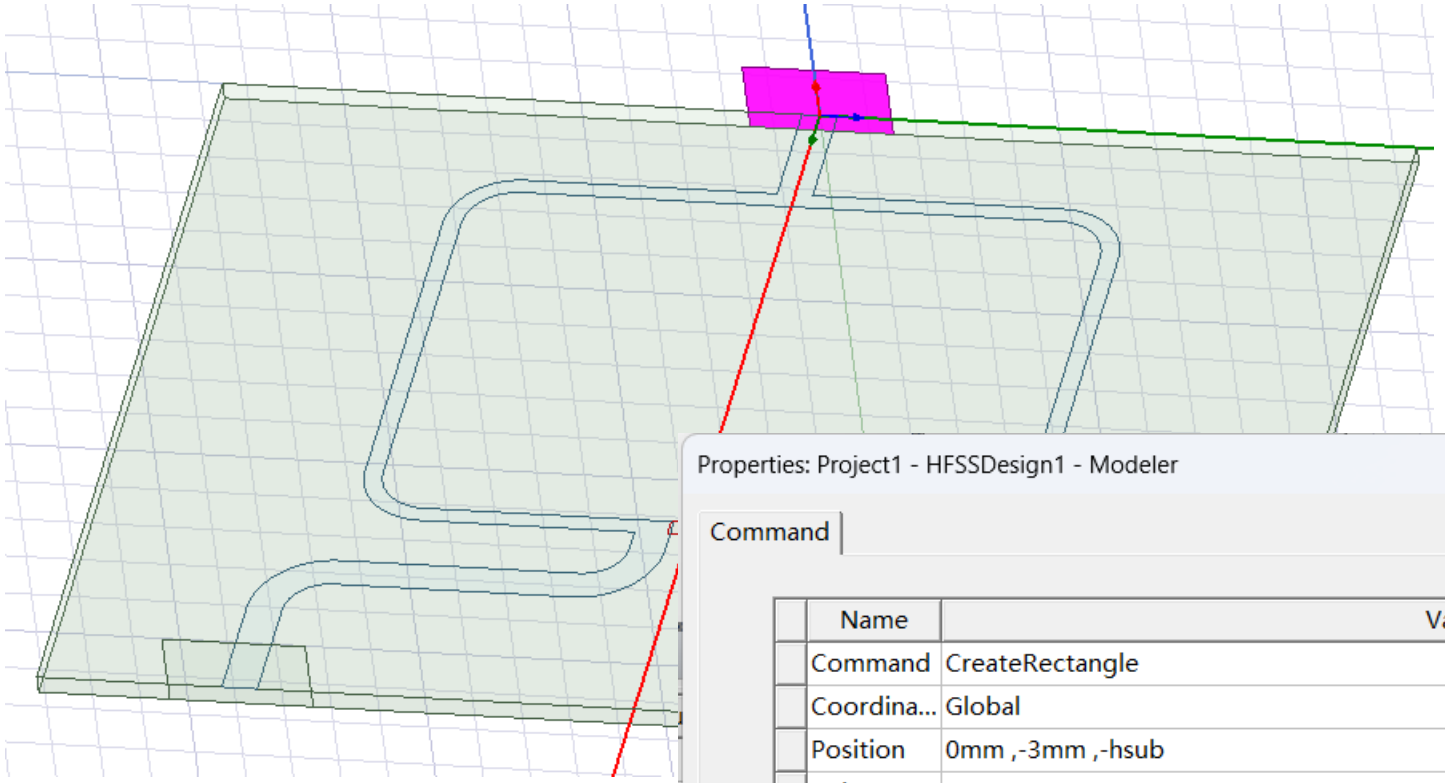
Properties: Project1 - HFSSDesign1 - Modeler

Command

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	0mm ,25mm ,-hsub		0mm , 25...	
Axis	Z			
XSize	37.4559	mm	37.4559m...	
YSize	-50	mm	-50mm	

Show Hidden

确定 取消 应用(A)



Port 1

Properties: Project1 - HFSSDesign1 - Modeler

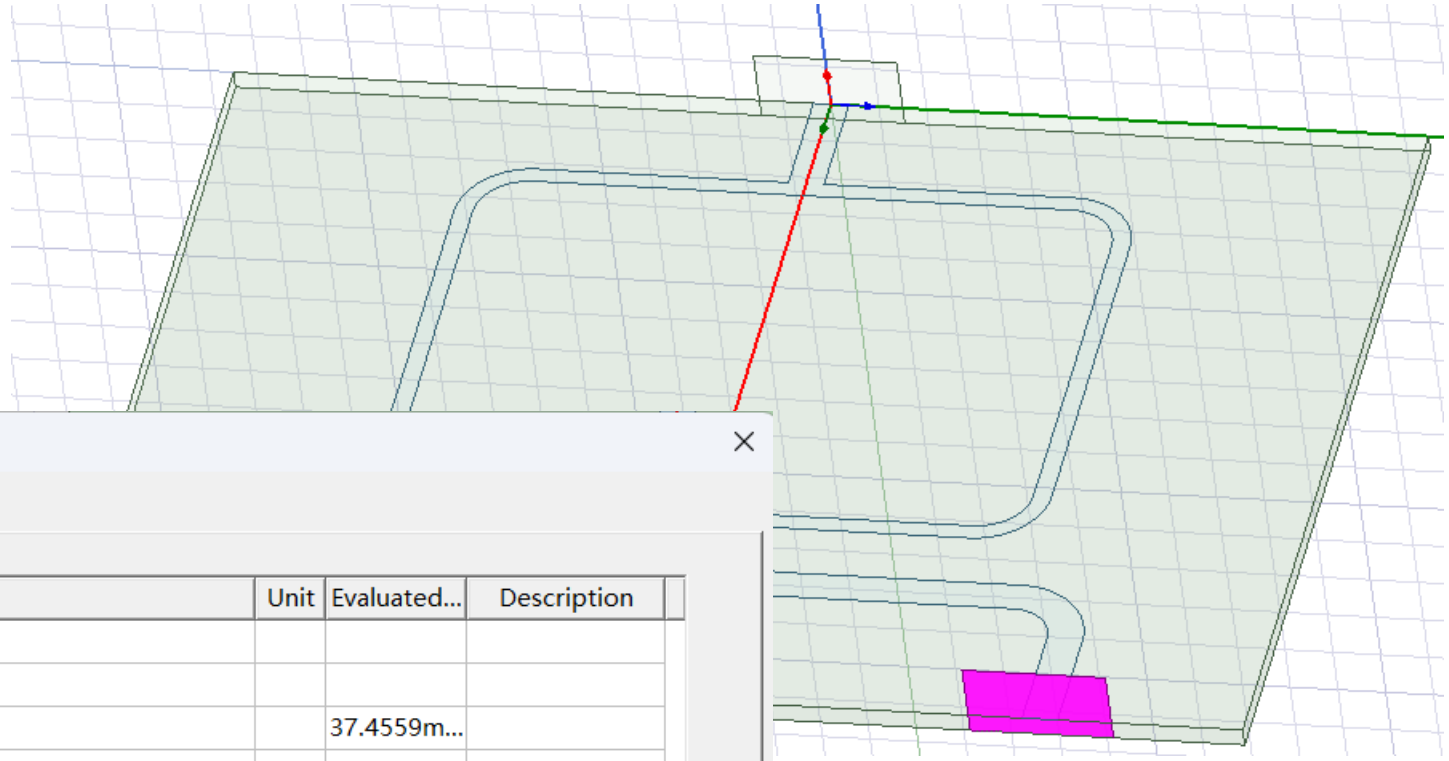
Command

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	0mm ,-3mm ,-hsub		0mm , -3...	
Axis	X			
YSize	6	mm	6mm	
ZSize	4*hsub		3.2mm	

Show Hidden

确定 取消 应用(A)

Port 2



Properties: Project1 - HFSSDesign1 - Modeler

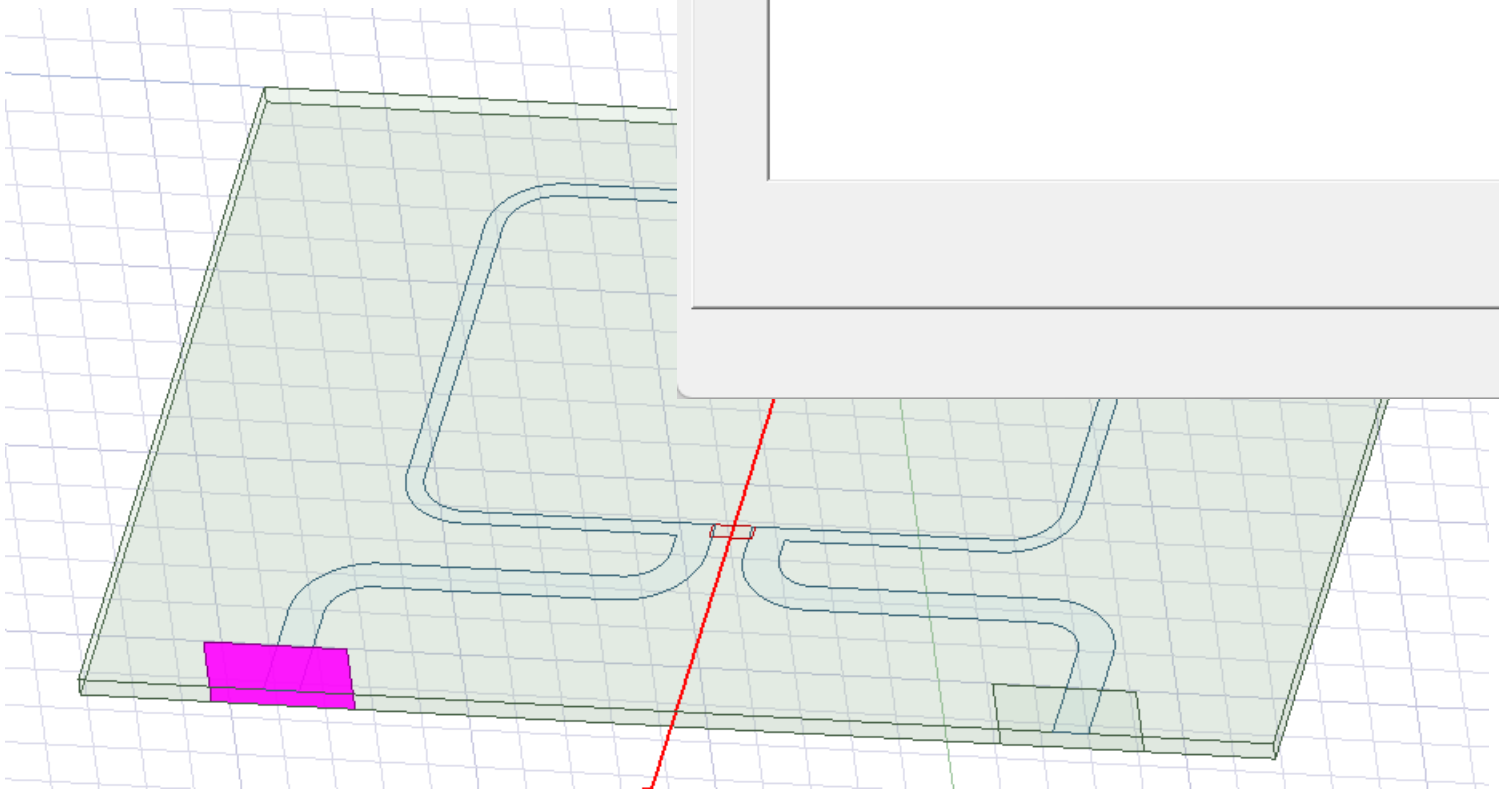
Command

	Name	Value	Unit	Evaluated...	Description
	Command	CreateRectangle			
	Coordina...	Global			
	Position	37.4559mm ,16.512mm-3mm ,-hsub		37.4559m...	
	Axis	X			
	YSize	6	mm	6mm	
	ZSize	4*hsub		3.2mm	

Show Hidden

确定 取消 应用(A)

Port 3



Properties: Project1 - HFSSDesign1 - Modeler

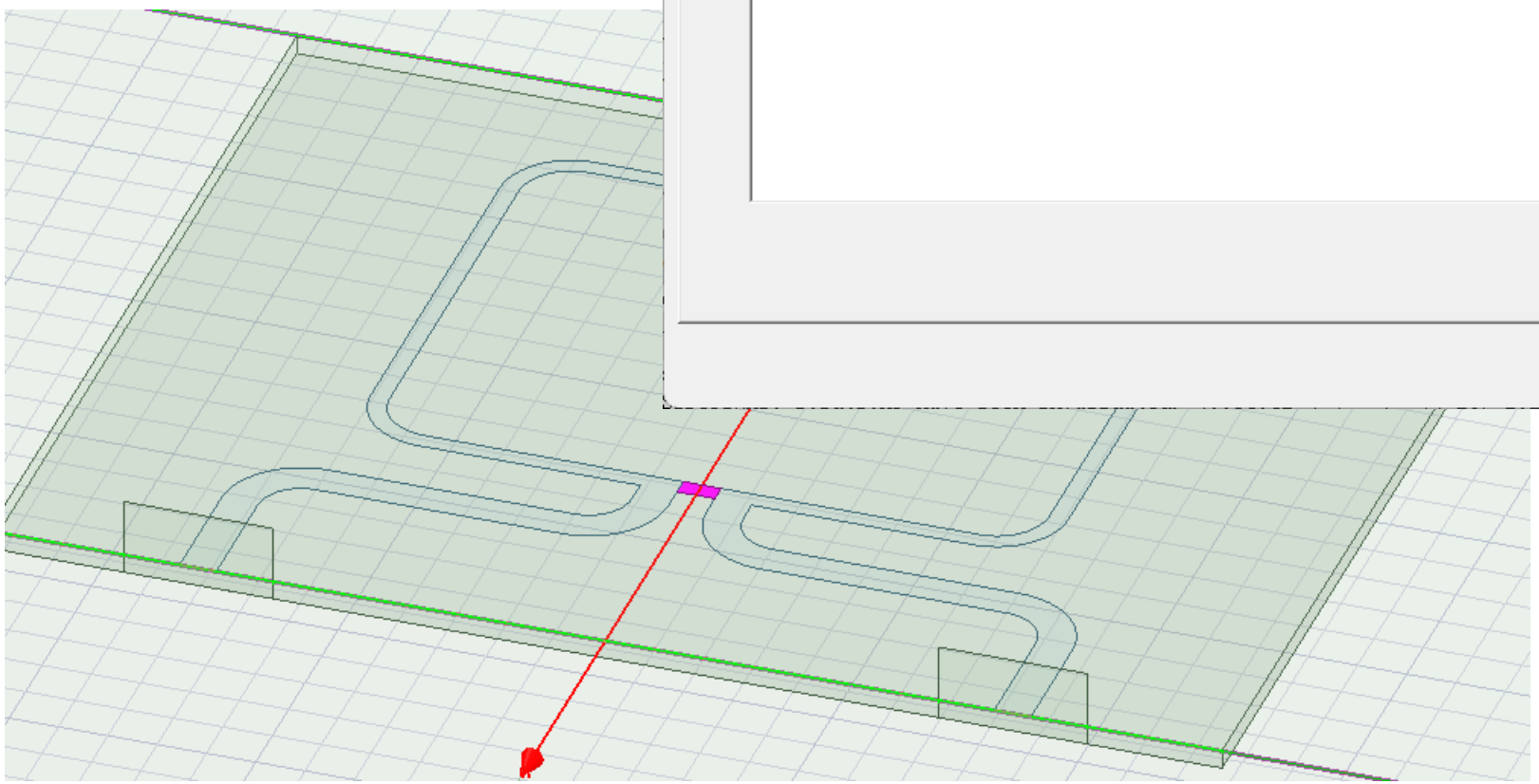
Command

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	37.4559mm ,-16.512mm-3mm ,-hsub		37.4559m...	
Axis	X			
YSize	6	mm	6mm	
ZSize	4*hsub		3.2mm	

Show Hidden

确定 取消 应用(A)

Resi



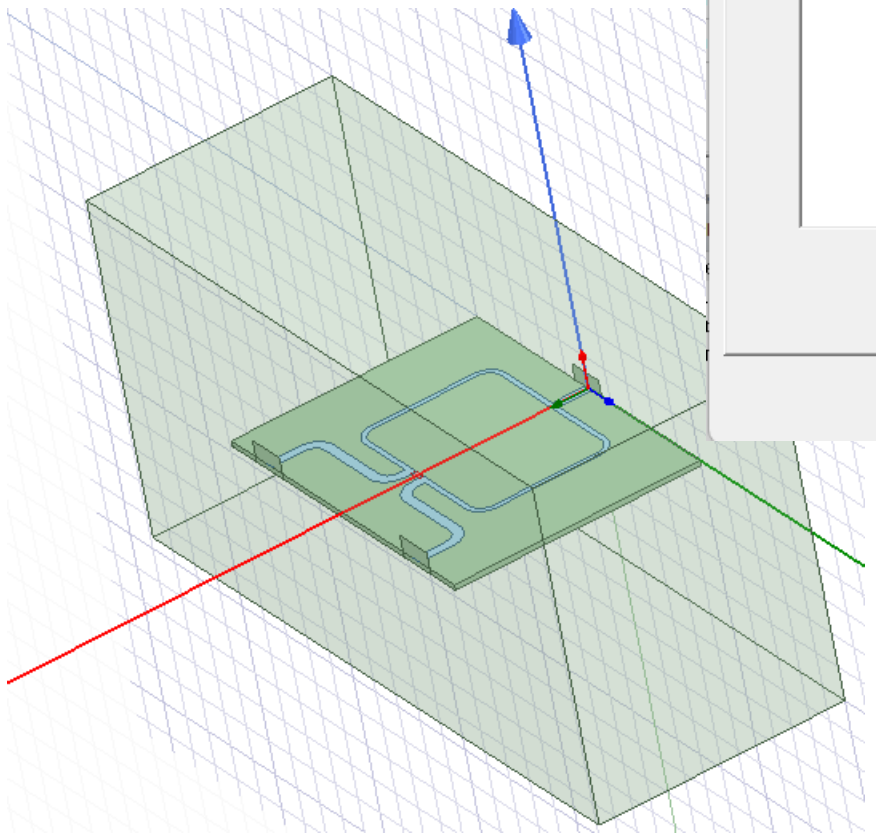
Properties: PowerDivider - HFSSDesign1 - Modeler

Command

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	25.6889 ,-0.767 ,0	mm	25.6889m...	
Axis	Z			
XSize	0.767	mm	0.767mm	
YSize	1.534	mm	1.534mm	

Show Hidden

确定 取消 应用(A)



Properties: PowerDivider - HFSSDesign1 - Modeler

Command

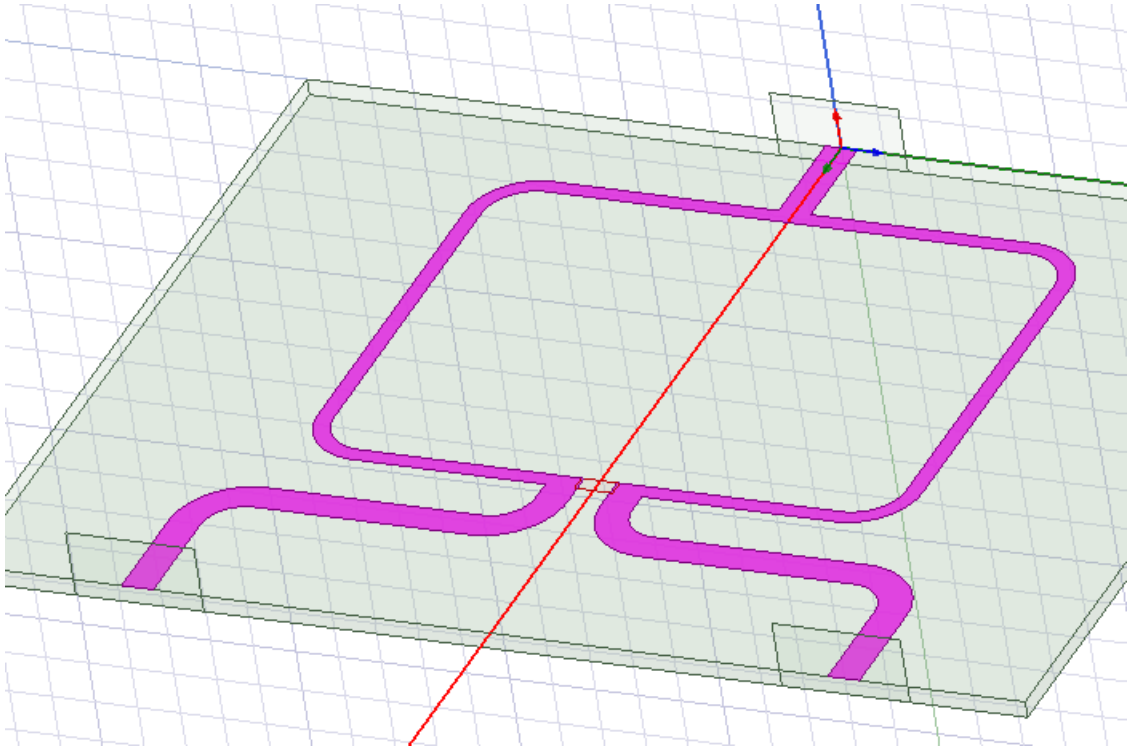
	Name	Value	Unit	Evaluated...	Description
	Command	CreateBox			
	Coordina...	Global			
	Position	0 ,-50 ,-25	mm	0mm , -5...	
	XSize	37.4559	mm	37.4559m...	
	YSize	100	mm	100mm	
	ZSize	50	mm	50mm	

Show Hidden

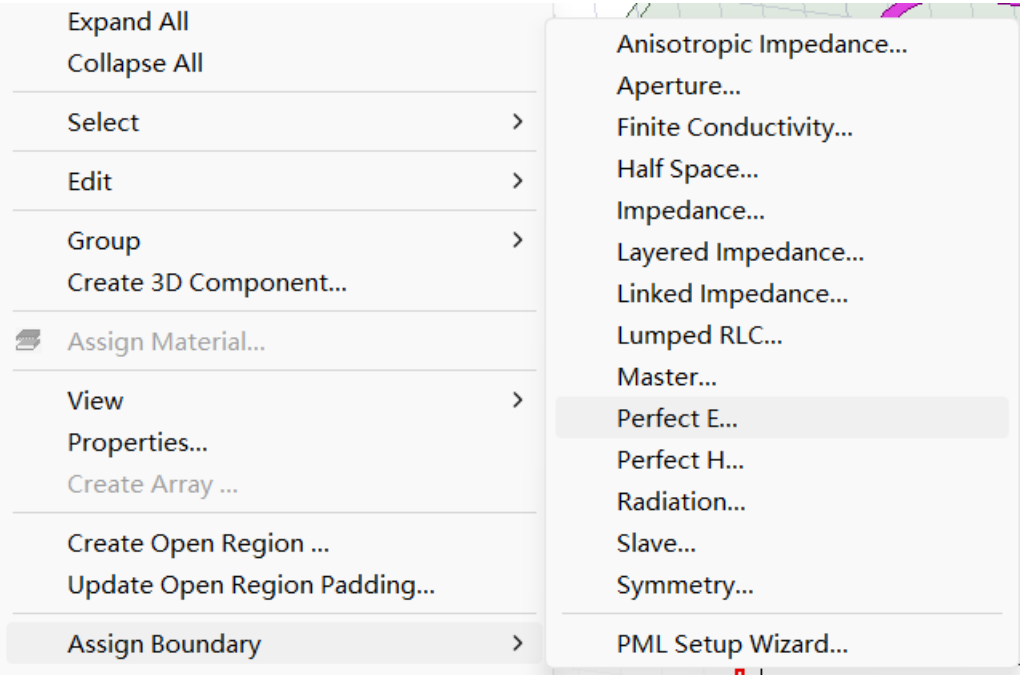
确定 取消 应用(A)

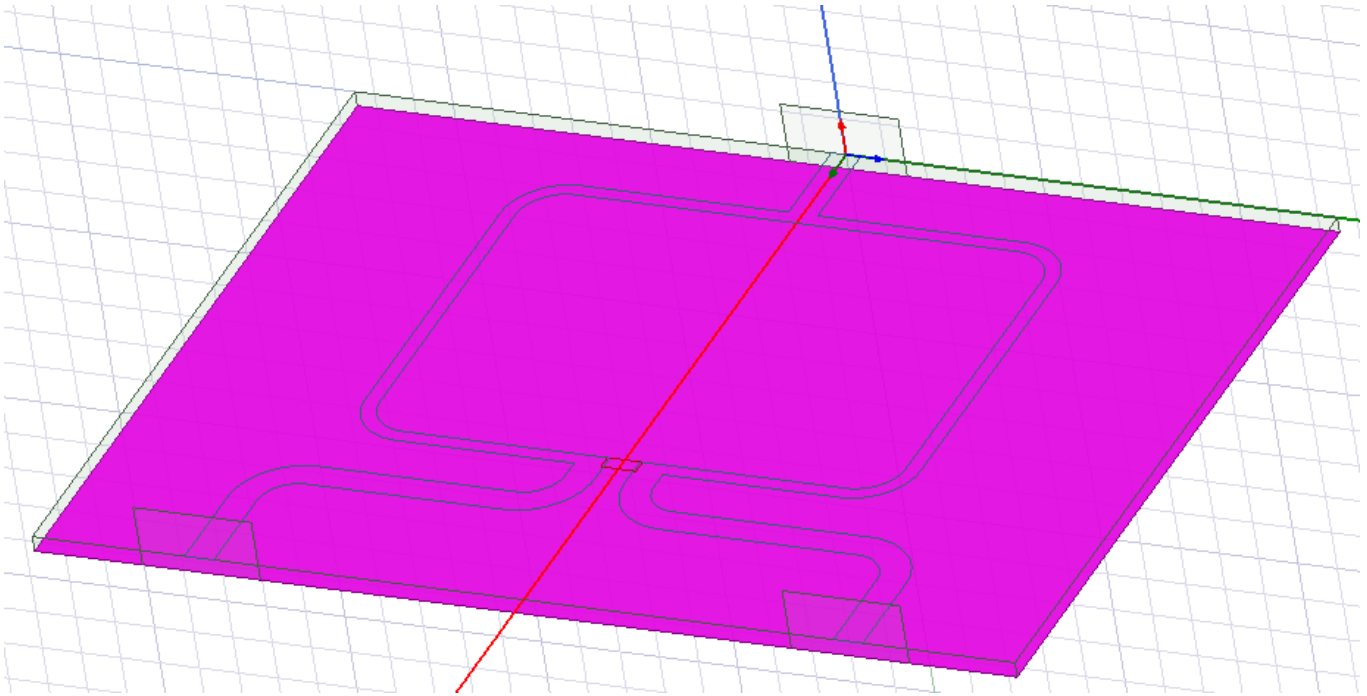
Radiation Box

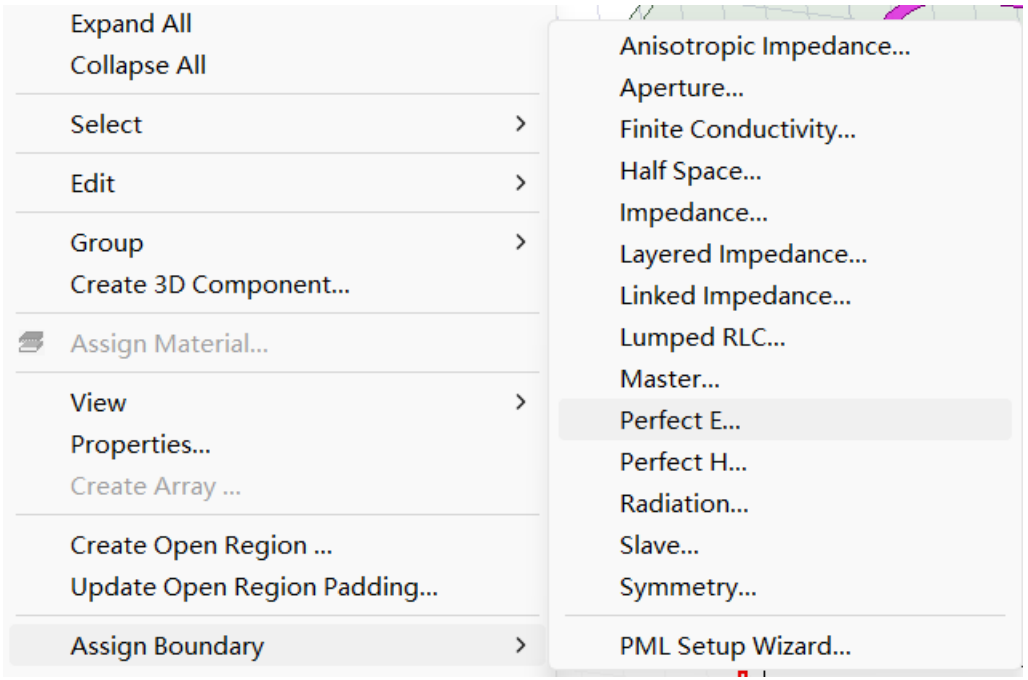
Assign Material, Port and Boundary



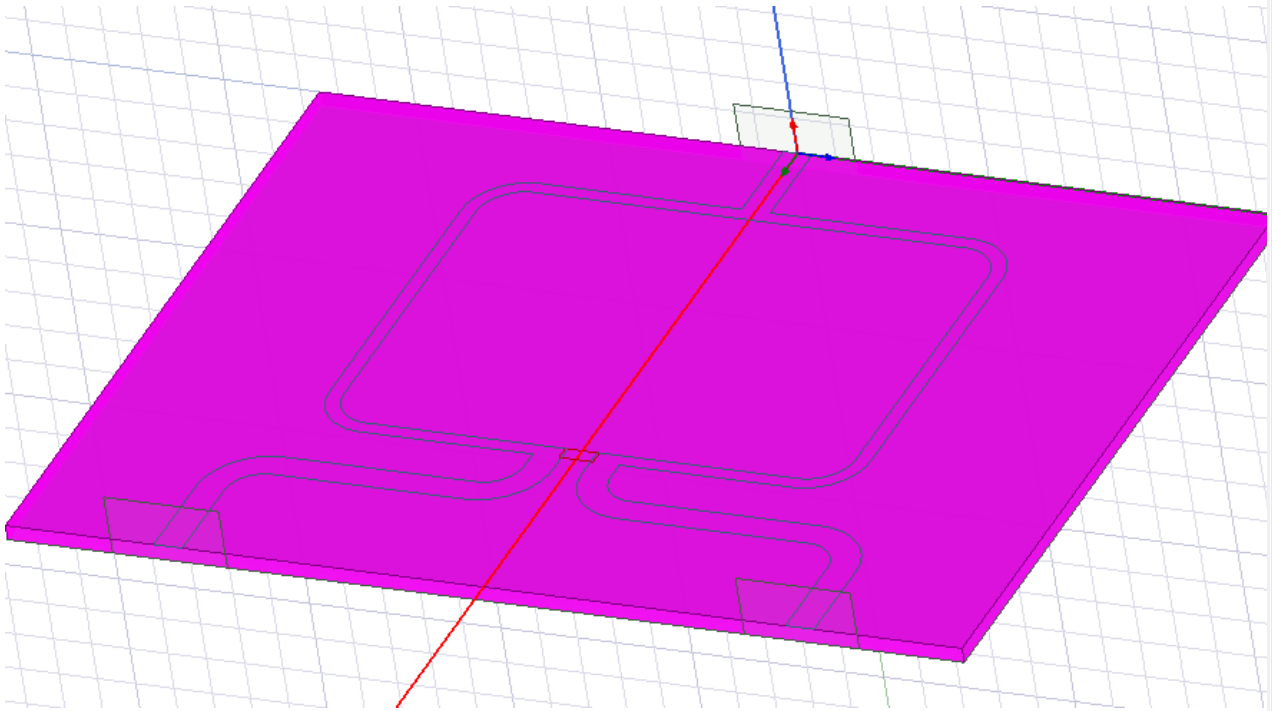
MicrostripLine

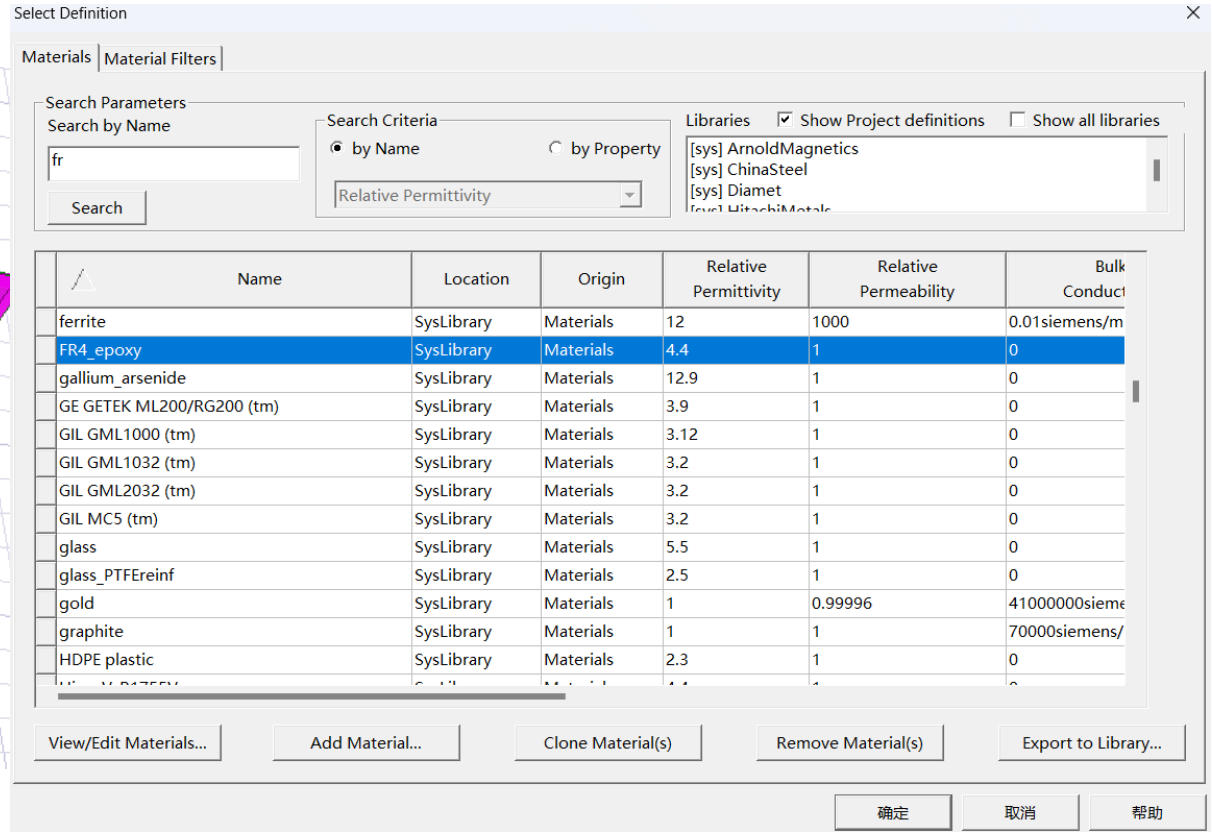




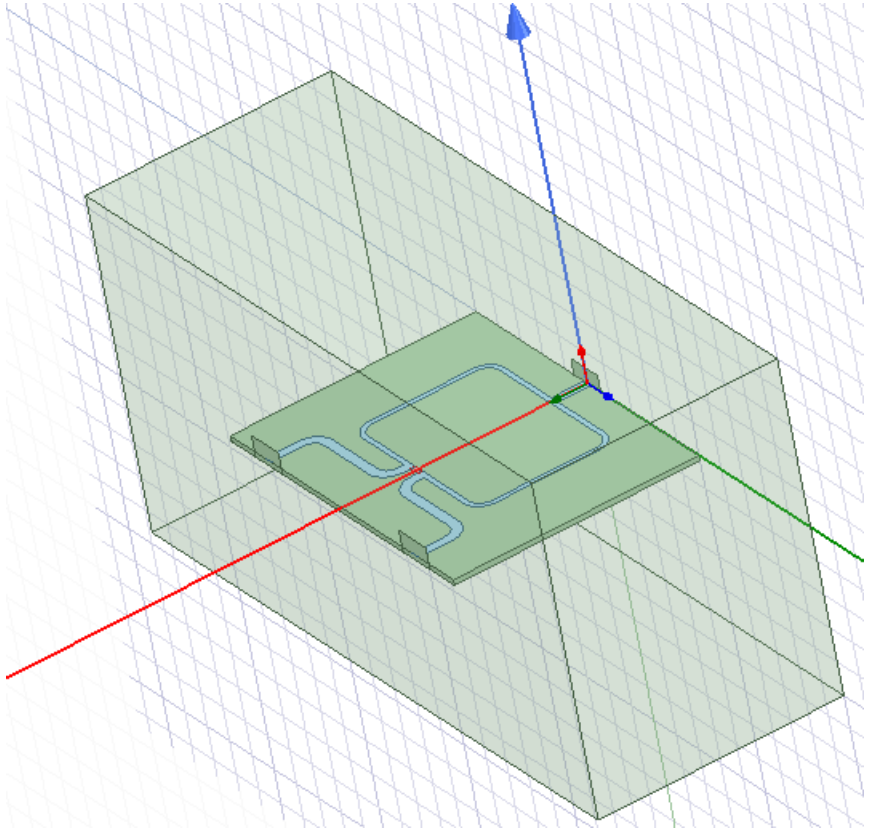

Expand All
Collapse All
Select
Edit
Group
Create 3D Component...
Assign Material...
View
Properties...
Create Array ...
Create Open Region ...
Update Open Region Padding...
Assign Boundary
Anisotropic Impedance...
Aperture...
Finite Conductivity...
Half Space...
Impedance...
Layered Impedance...
Linked Impedance...
Lumped RLC...
Master...
Perfect E...
Perfect H...
Radiation...
Slave...
Symmetry...
PML Setup Wizard...

GND

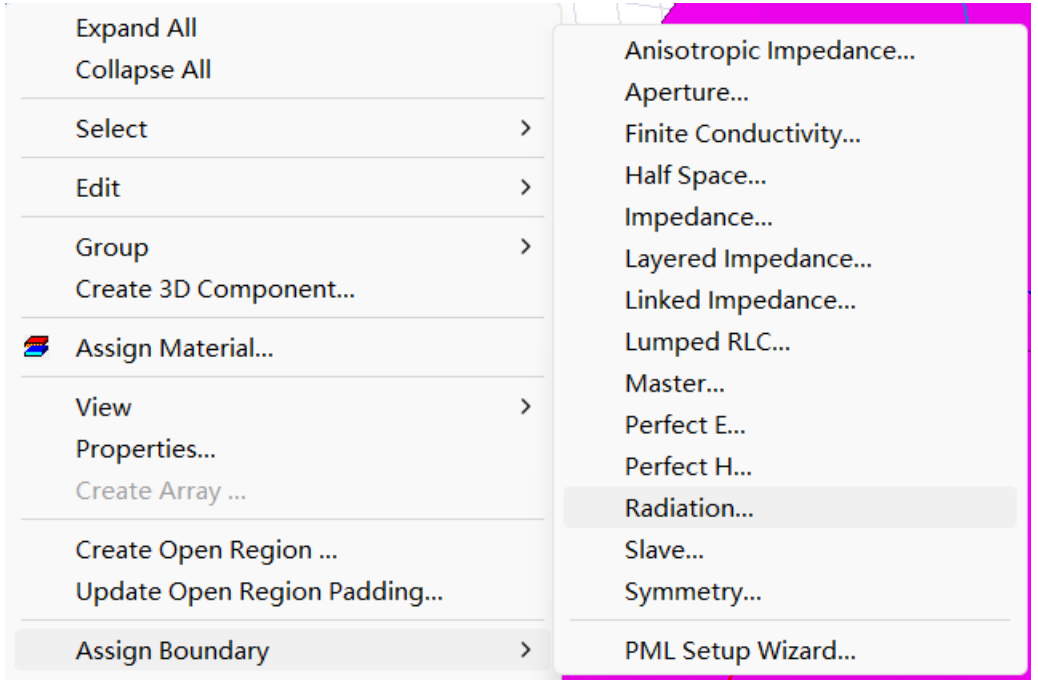


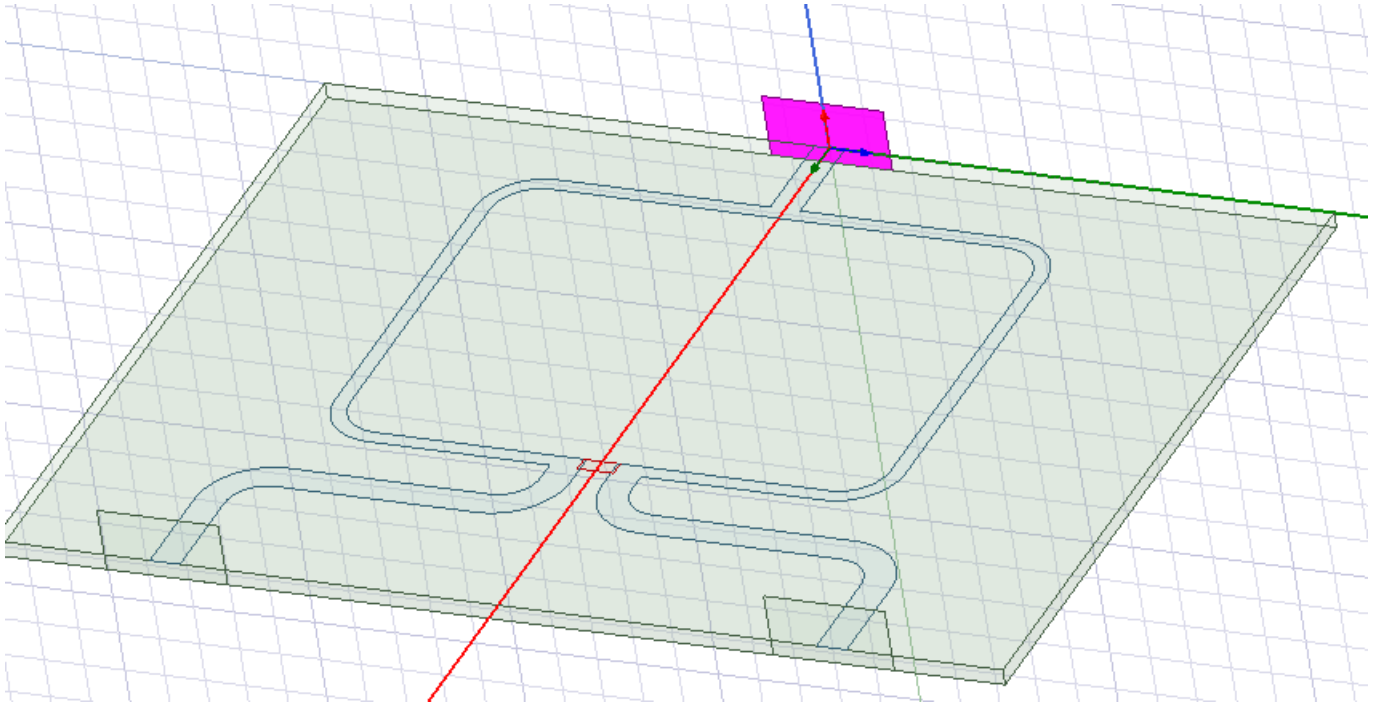

Select Definition
Materials
Material Filters
Search Parameters
Search by Name
fr
Search
Search Criteria
by Name
by Property
Relative Permittivity
Libraries
Show Project definitions
Show all libraries
[sys] ArnoldMagnetics
[sys] ChinaSteel
[sys] Diamet
Name
Location
Origin
Relative Permittivity
Relative Permeability
Bulk Conduct
ferrite SysLibrary Materials 12 1000 0.01siemens/m
FR4_epoxy SysLibrary Materials 4.4 1 0
gallium_arsenide SysLibrary Materials 12.9 1 0
GE GETEK ML200/RG200 (tm) SysLibrary Materials 3.9 1 0
GIL GML1000 (tm) SysLibrary Materials 3.12 1 0
GIL GML1032 (tm) SysLibrary Materials 3.2 1 0
GIL GML2032 (tm) SysLibrary Materials 3.2 1 0
GIL MC5 (tm) SysLibrary Materials 3.2 1 0
glass SysLibrary Materials 5.5 1 0
glass_PTFEreinf SysLibrary Materials 2.5 1 0
gold SysLibrary Materials 1 0.99996 41000000sieme
graphite SysLibrary Materials 1 1 70000siemens/
HDPE plastic SysLibrary Materials 2.3 1 0
View/Edit Materials...
Add Material...
Clone Material(s)
Remove Material(s)
Export to Library...
确定
取消
帮助

Substrate

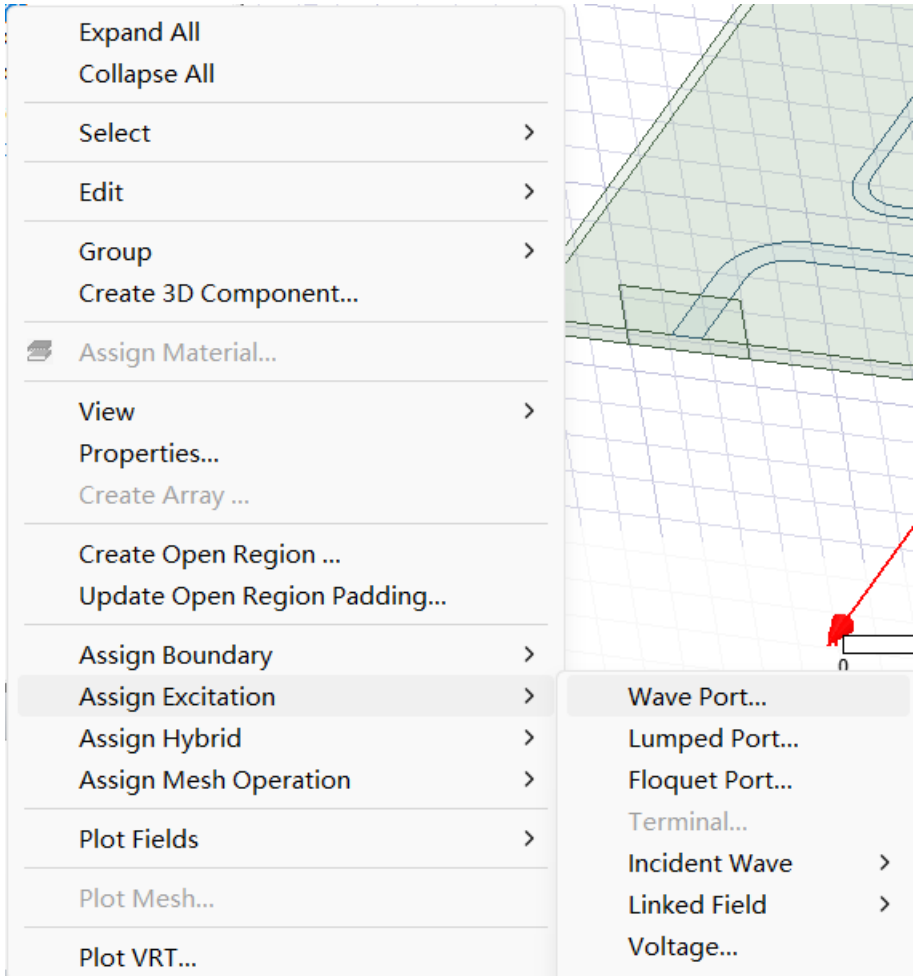


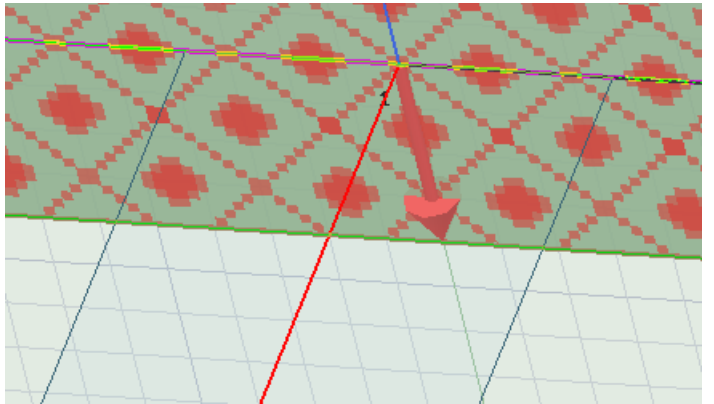
Radiation Box

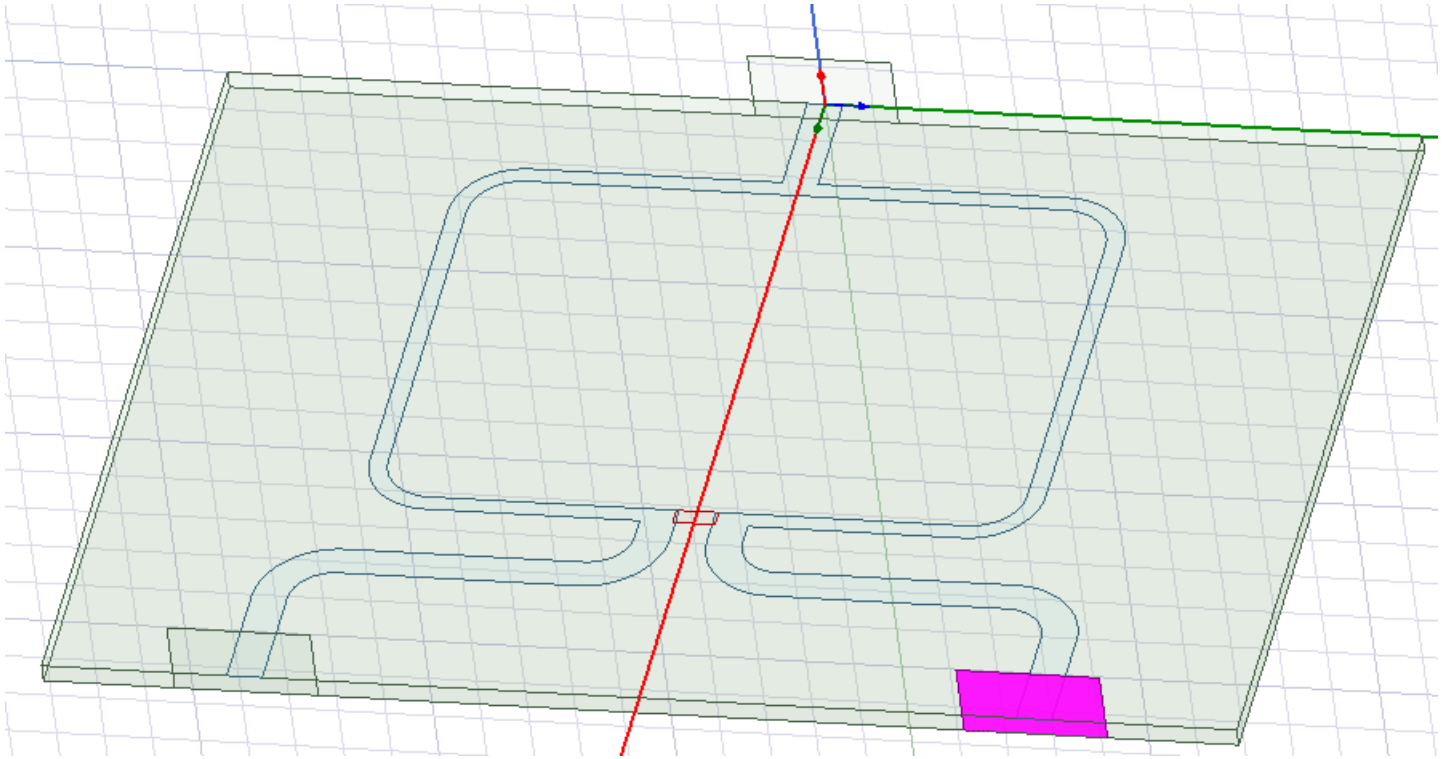




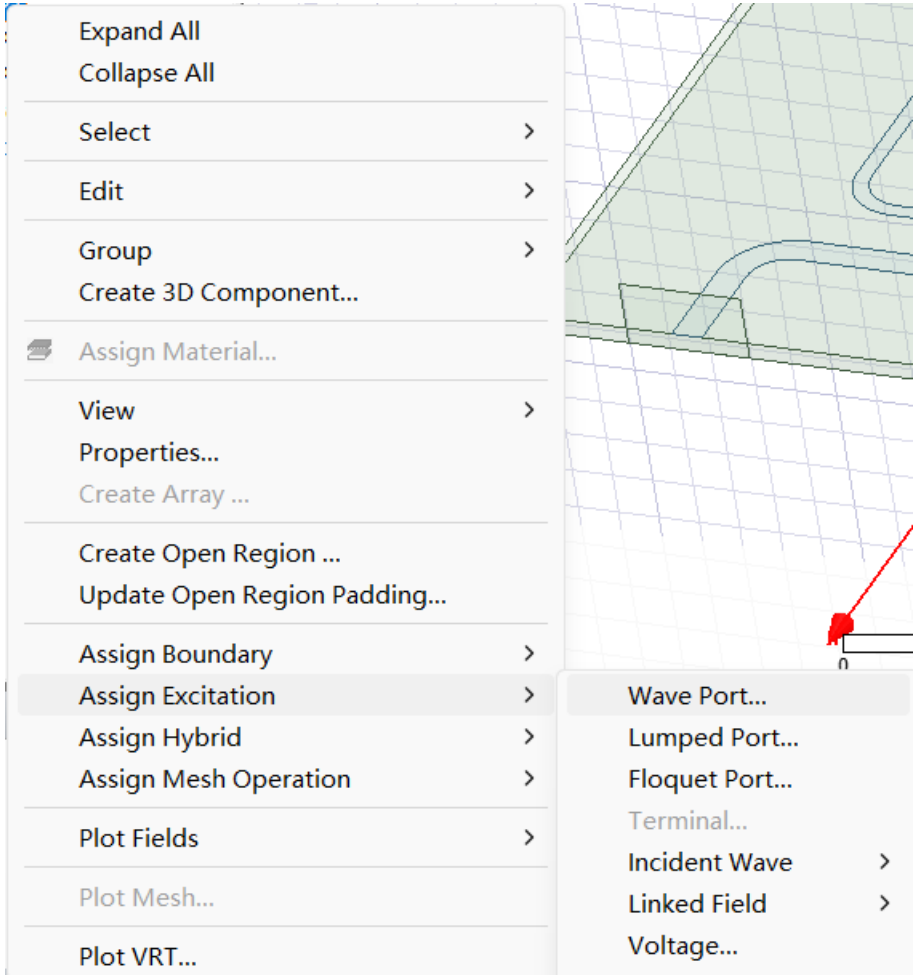
Port 1

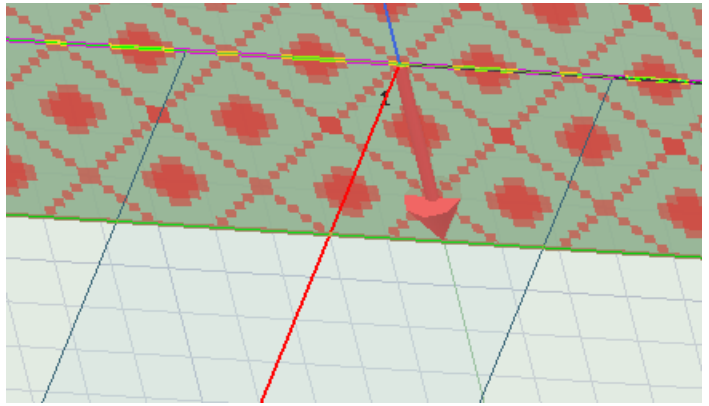

Expand All
Collapse All
Select
Edit
Group
Create 3D Component...
Assign Material...
View
Properties...
Create Array ...
Create Open Region ...
Update Open Region Padding...
Assign Boundary
Assign Excitation
Assign Hybrid
Assign Mesh Operation
Plot Fields
Plot Mesh...
Plot VRT...
Wave Port...
Lumped Port...
Floquet Port...
Terminal...
Incident Wave
Linked Field
Voltage...

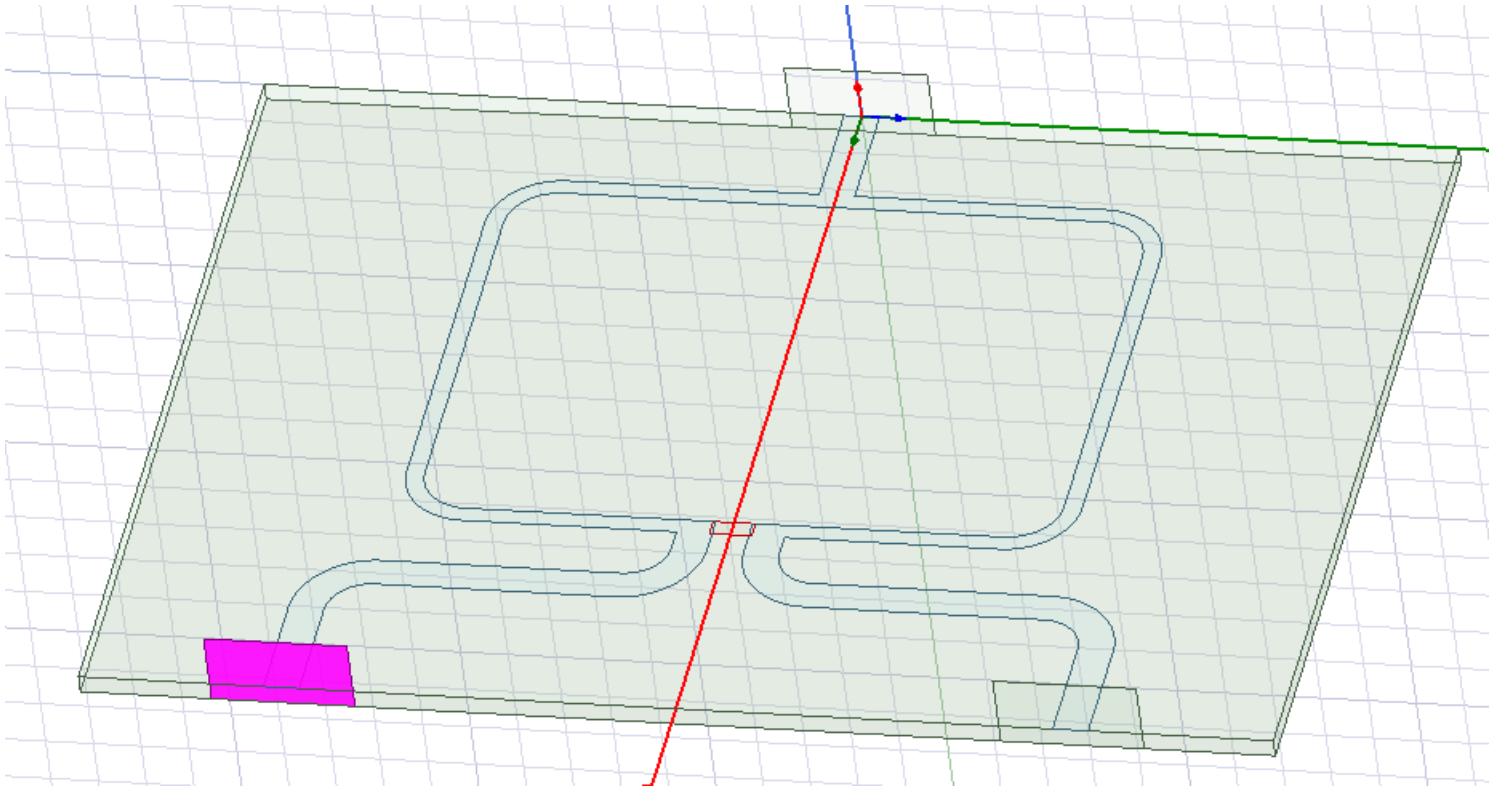




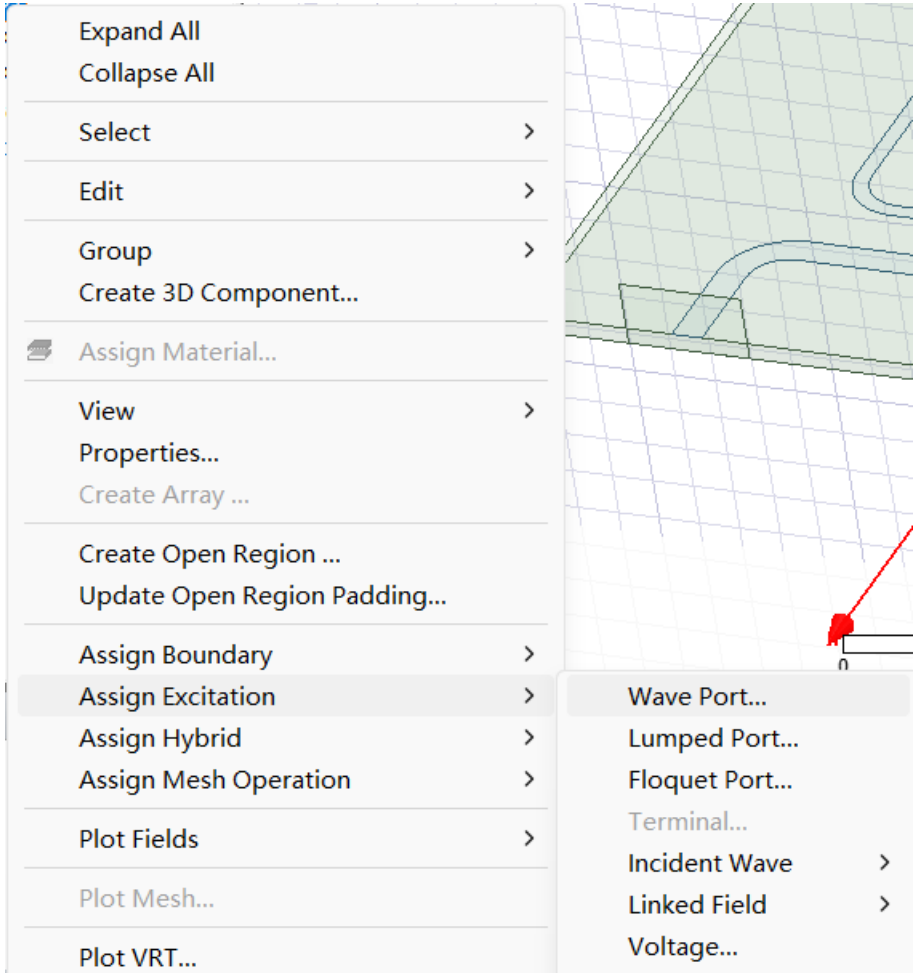
Port 2

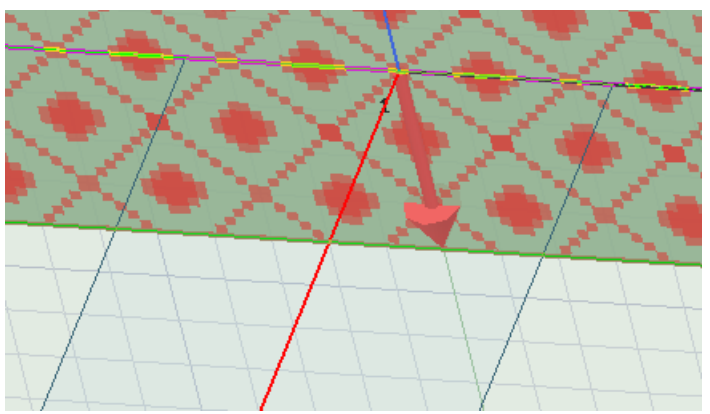

Expand All
Collapse All
Select
Edit
Group
Create 3D Component...
Assign Material...
View
Properties...
Create Array ...
Create Open Region ...
Update Open Region Padding...
Assign Boundary
Assign Excitation
Assign Hybrid
Assign Mesh Operation
Plot Fields
Plot Mesh...
Plot VRT...
Wave Port...
Lumped Port...
Floquet Port...
Terminal...
Incident Wave
Linked Field
Voltage...

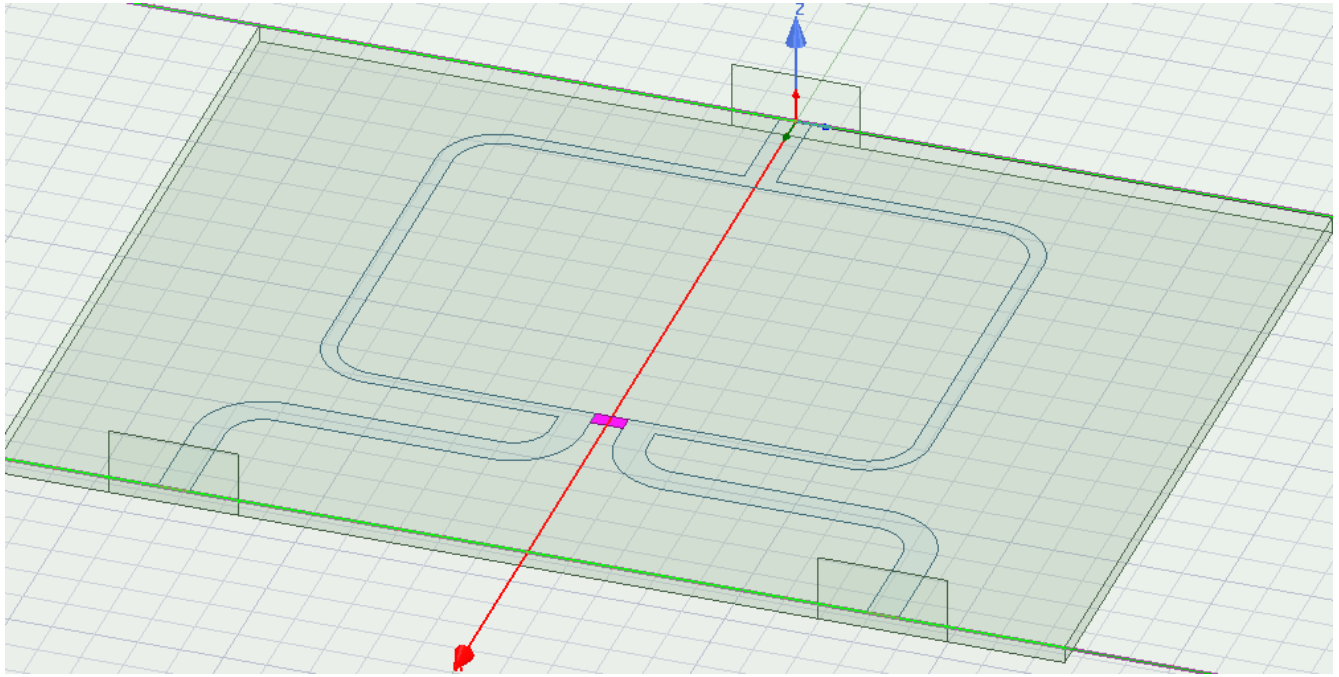


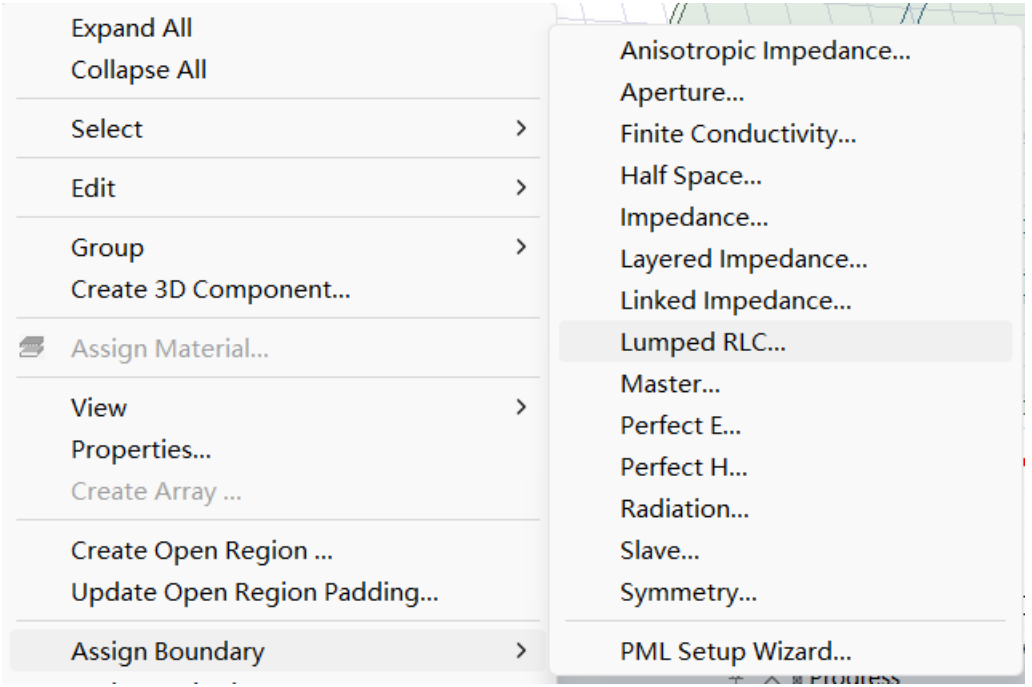


Port 3

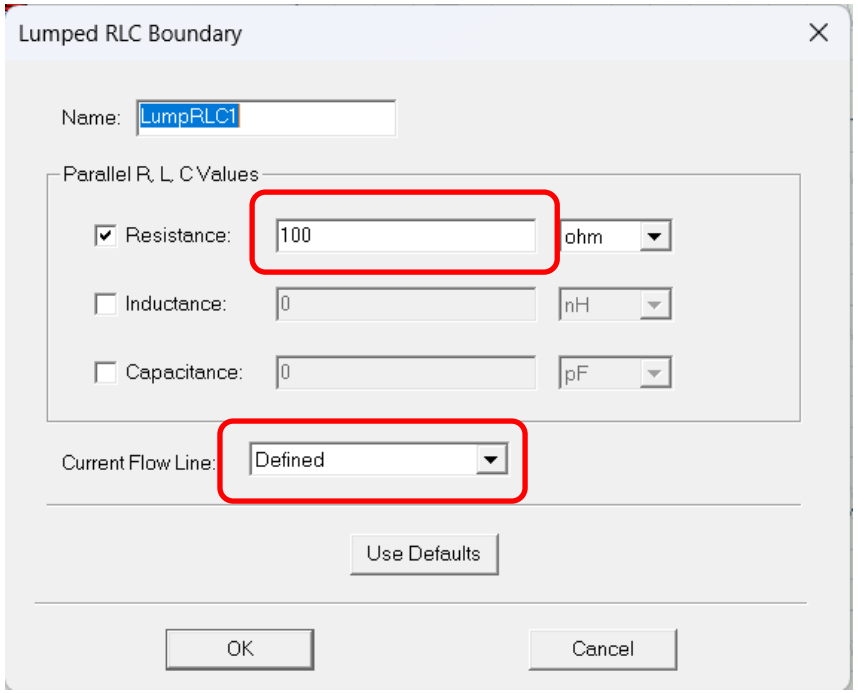

Expand All
Collapse All
Select
Edit
Group
Create 3D Component...
Assign Material...
View
Properties...
Create Array ...
Create Open Region ...
Update Open Region Padding...
Assign Boundary
Assign Excitation
Assign Hybrid
Assign Mesh Operation
Plot Fields
Plot Mesh...
Plot VRT...
Wave Port...
Lumped Port...
Floquet Port...
Terminal...
Incident Wave
Linked Field
Voltage...

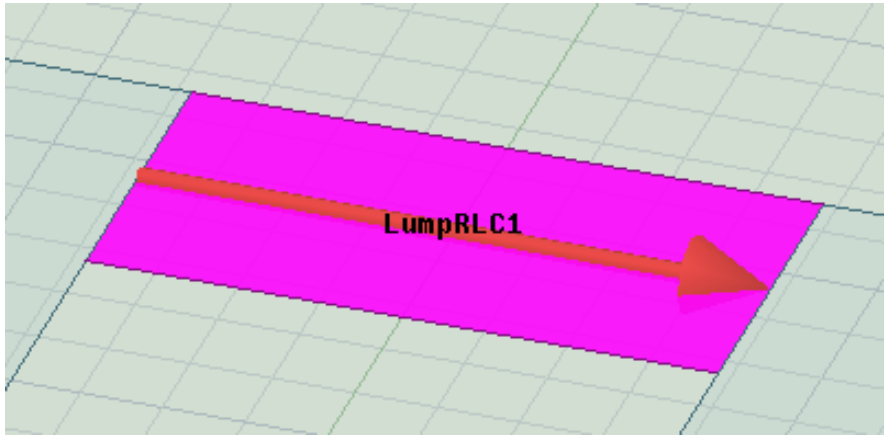




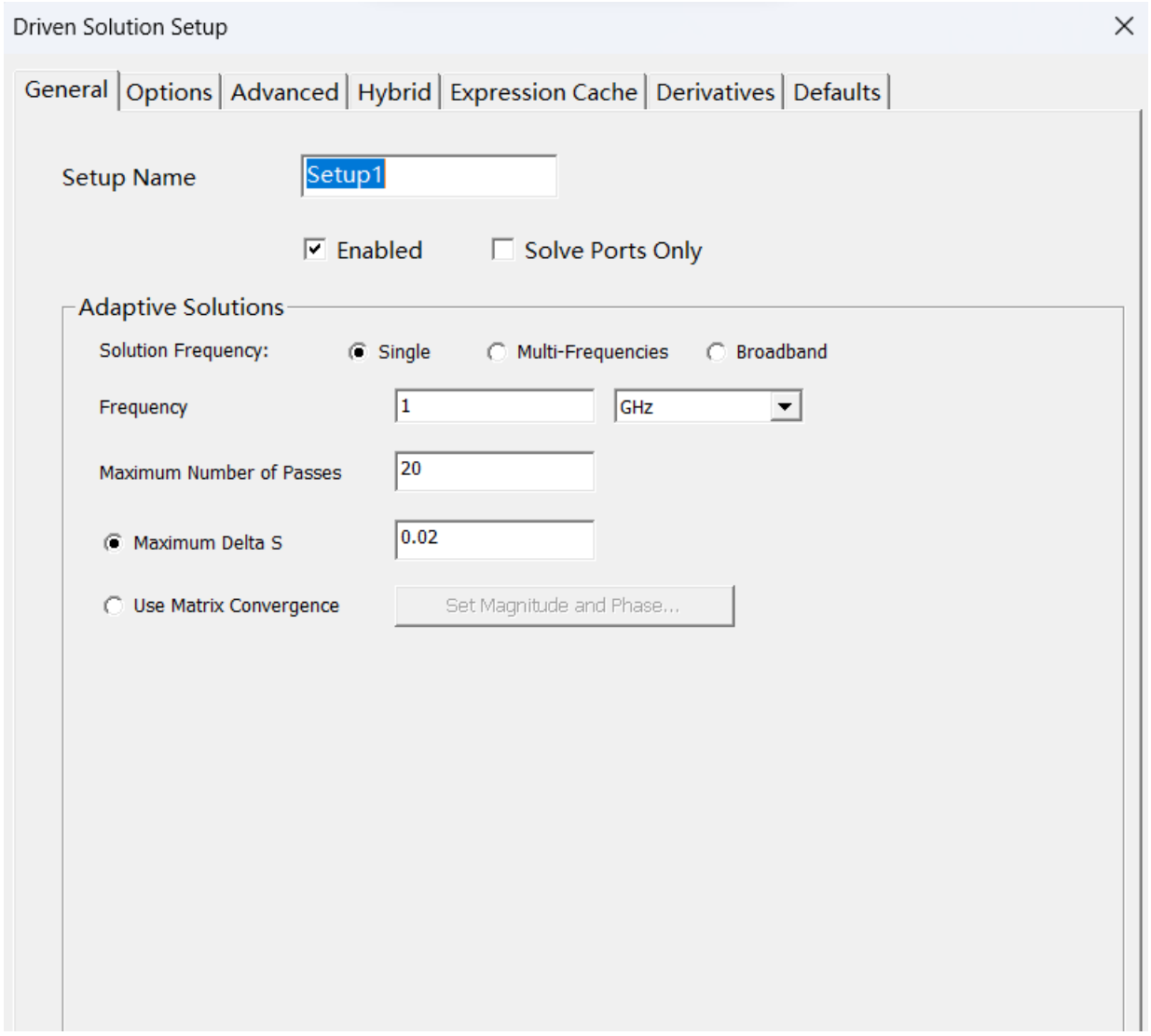

Expand All
Collapse All
Select
Edit
Group
Create 3D Component...
Assign Material...
View
Properties...
Create Array ...
Create Open Region ...
Update Open Region Padding...
Assign Boundary
Anisotropic Impedance...
Aperture...
Finite Conductivity...
Half Space...
Impedance...
Layered Impedance...
Linked Impedance...
Lumped RLC...
Master...
Perfect E...
Perfect H...
Radiation...
Slave...
Symmetry...
PML Setup Wizard...

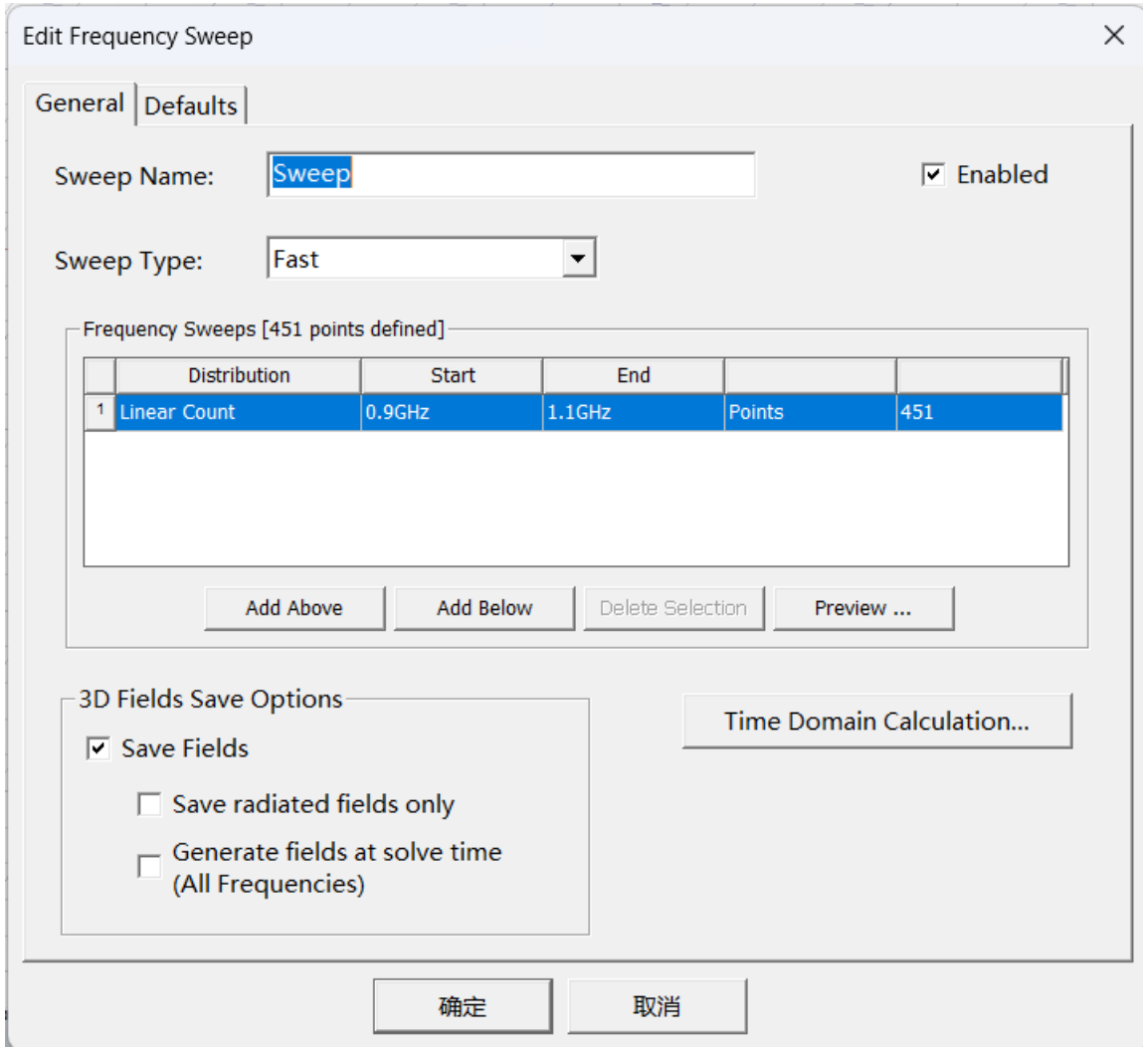
Resi

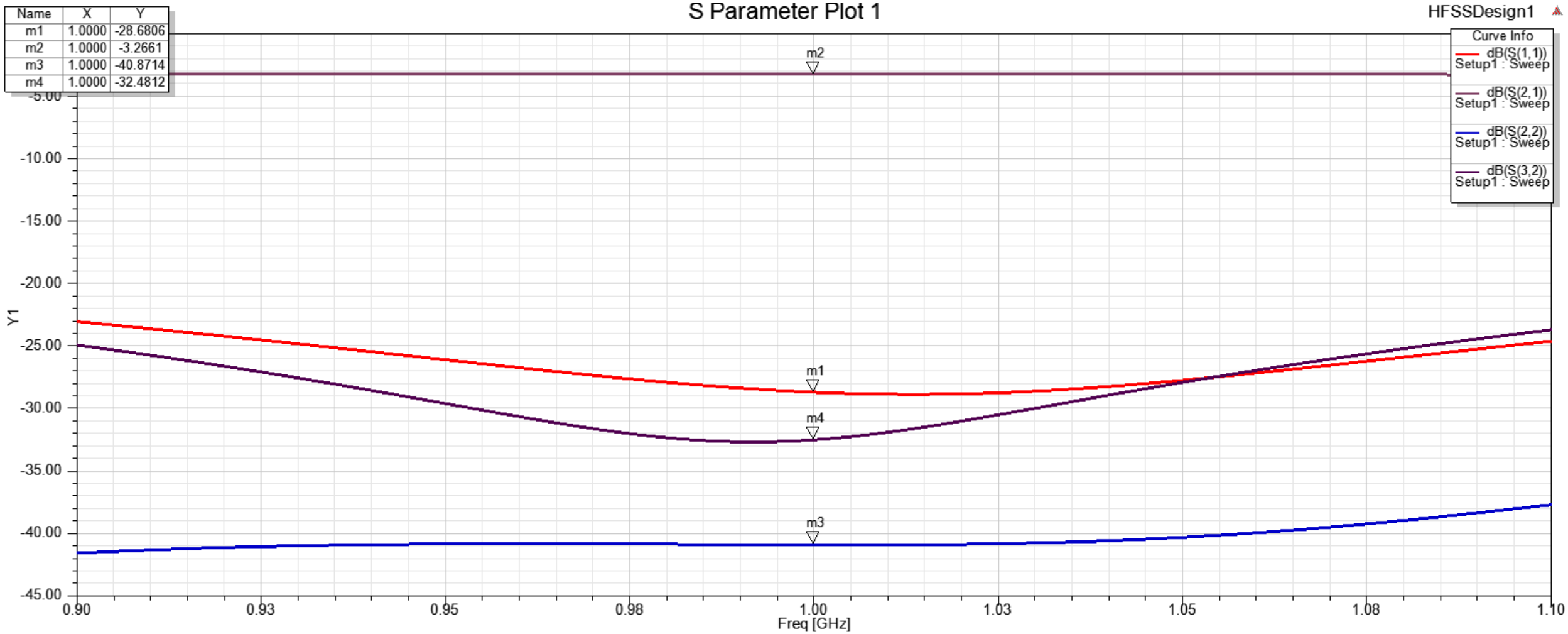

Lumped RLC Boundary
Name: LumpRLC1
Parallel R, L, C Values
Resistance: 100 ohm
Inductance: 0 nH
Capacitance: 0 pF
Current Flow Line: Defined
Use Defaults
OK
Cancel


LumpRLC1

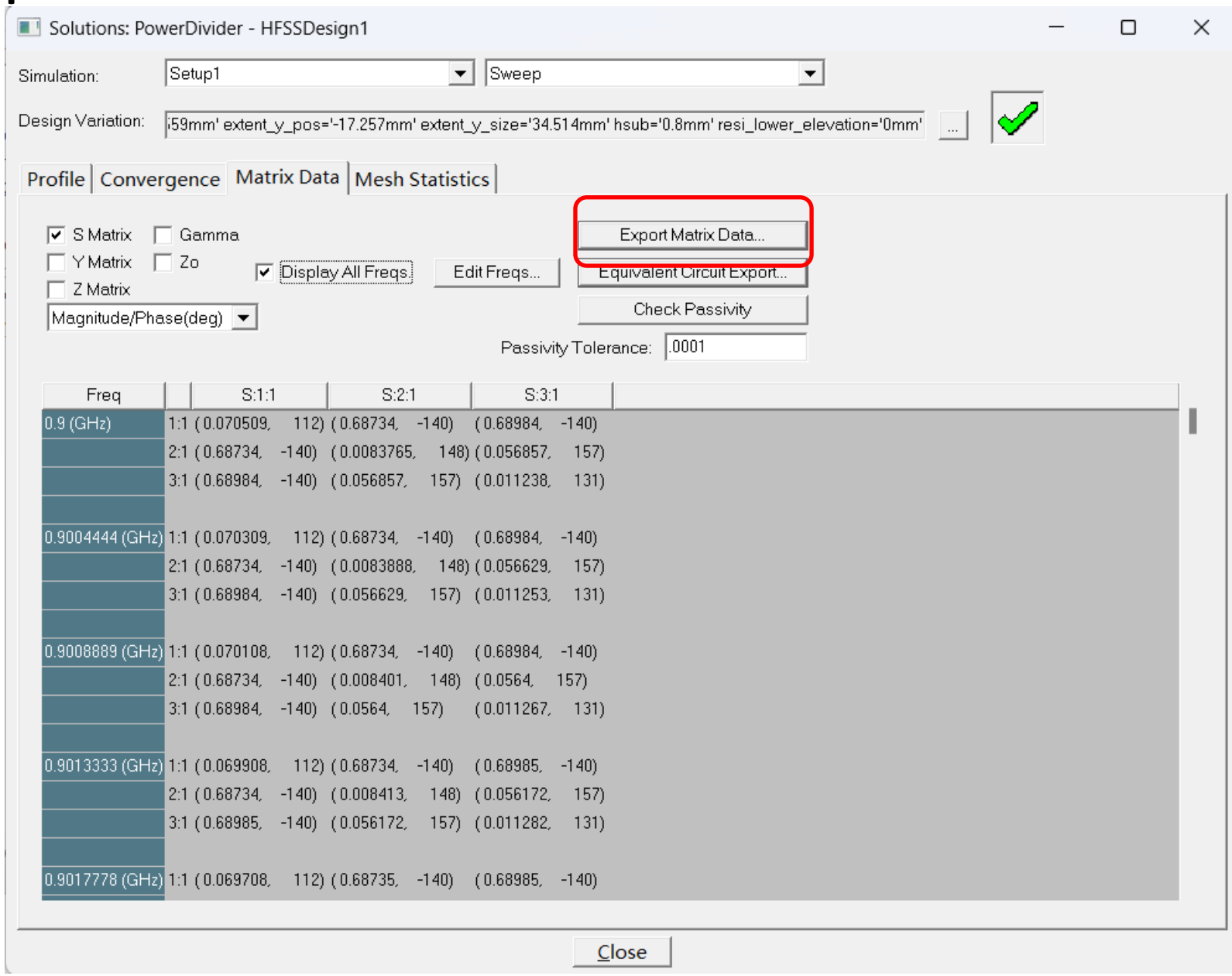
Analysis and Results

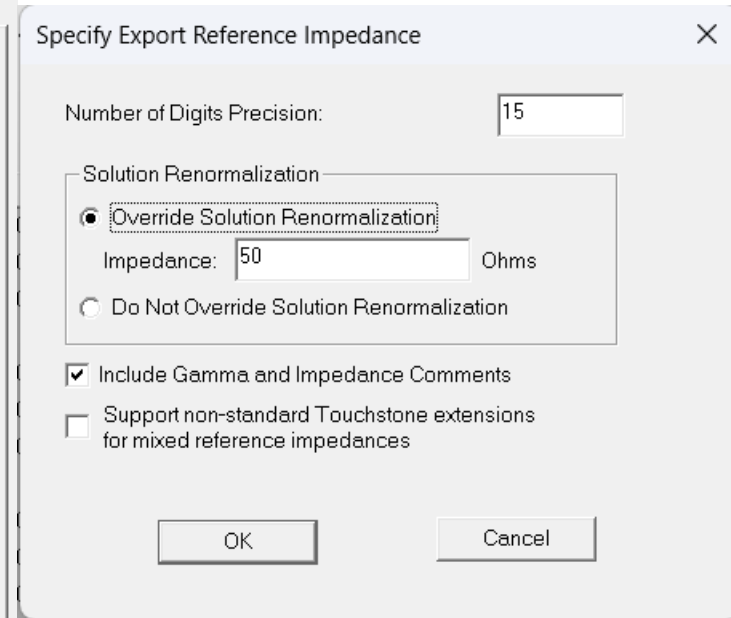




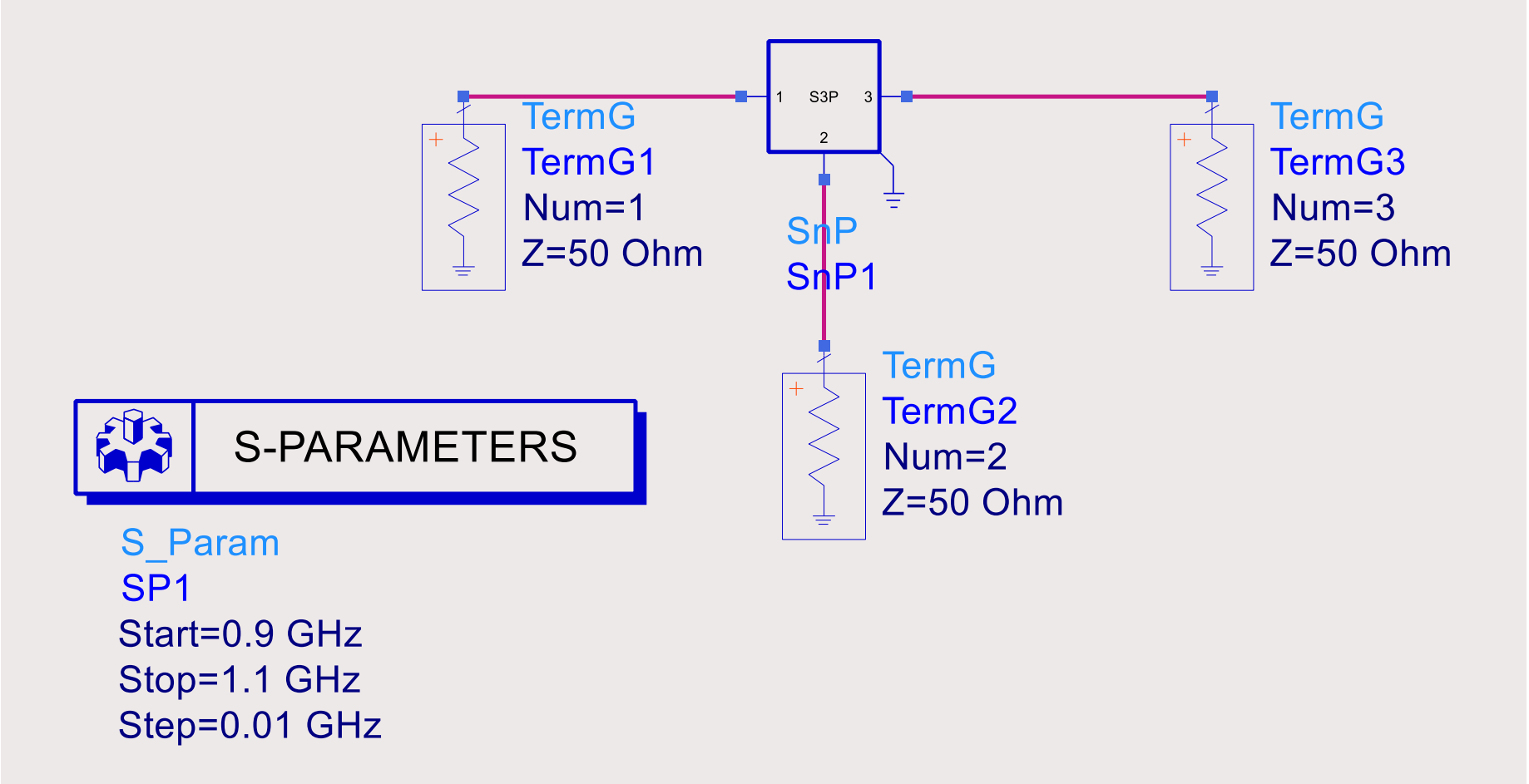

S Parameter Plot 1
HFSSDesign1
Name X Y
m1 1.0000 -28.6806
m2 1.0000 -3.2661
m3 1.0000 -40.8714
m4 1.0000 -32.4812
Curve Info
dB(S(1,1)) Setup1 : Sweep
dB(S(2,1)) Setup1 : Sweep
dB(S(2,2)) Setup1 : Sweep
dB(S(3,2)) Setup1 : Sweep
Y1
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
0.90
0.93
0.95
0.98
1.00
1.03
1.05
1.08
1.10
Freq [GHz]

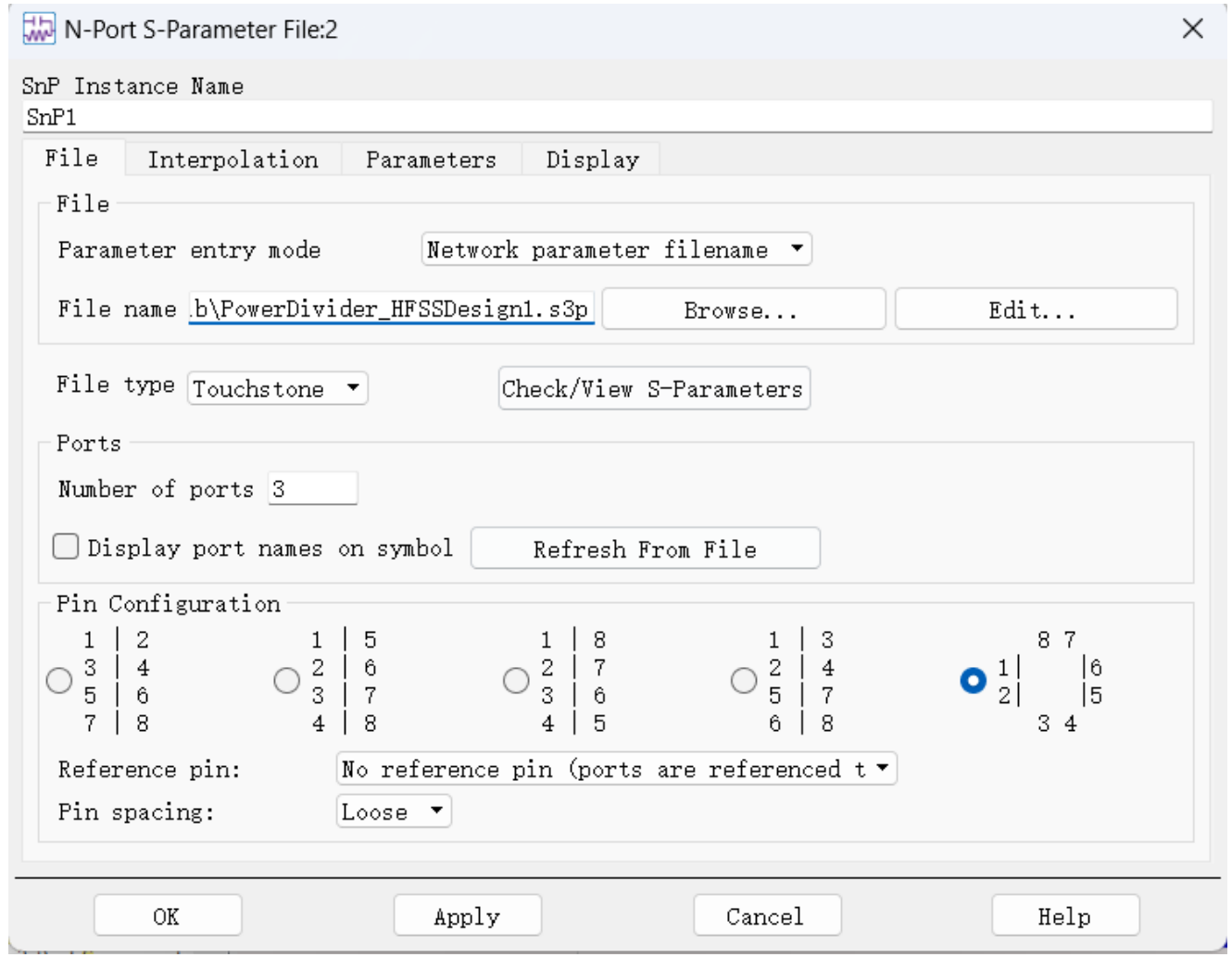
Export SNP data

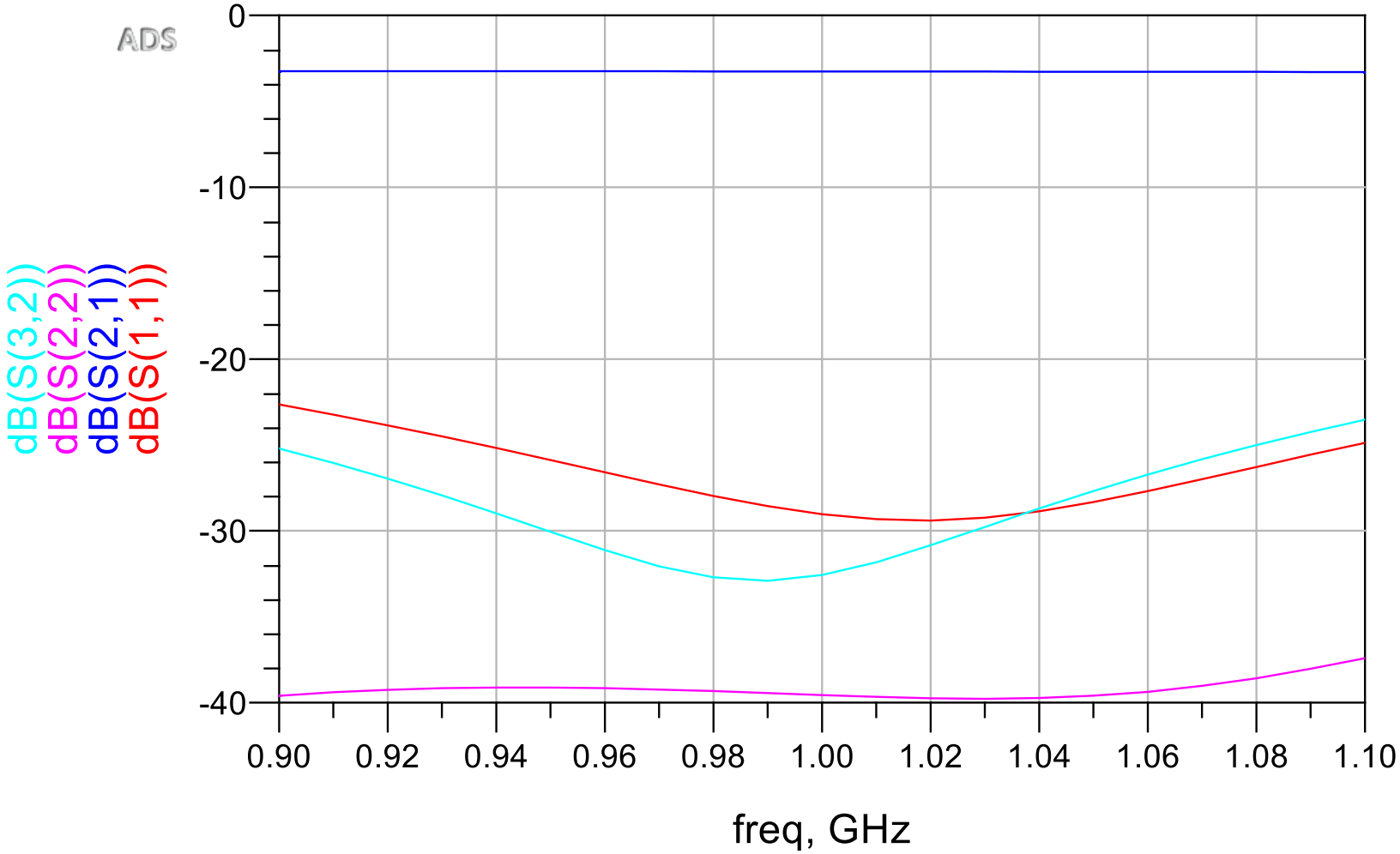




SNP data simulation in ADS




N-Port S-Parameter File:2
SnP Instance Name
SnP1
File
Interpolation
Parameters
Display
File
Parameter entry mode
Network parameter filename
File name
.b\PowerDivider_HFSSDesign1.s3p
Browse...
Edit...
File type
Touchstone
Check/View S-Parameters
Ports
Number of ports
3
Display port names on symbol
Refresh From File
Pin Configuration
1 | 2
3 | 4
5 | 6
7 | 8
1 | 5
2 | 6
3 | 7
4 | 8
1 | 8
2 | 7
3 | 6
4 | 5
1 | 3
2 | 4
5 | 7
6 | 8
8 7
1 | | 6
2 | | 5
3 4
Reference pin:
No reference pin (ports are referenced t
Pin spacing:
Loose
OK
Apply
Cancel
Help


ADS
0
-10
-20
-30
-40
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
1.10
freq, GHz
dB(S(3,2))
dB(S(2,2))
dB(S(2,1))
dB(S(1,1))

Homework

- Wilkinson Power Divider design in ADS and HFSS
- Freq. 2.4 GHz
- Bandwidth: 200MHz
- Substrate: FR4, thickness: 1.6mm
- S11<-20dB, S21>-3.3dB, S22<-20dB and S32<-25dB
- Optimization