Microwave Engineering Lab

Experiment: 6

Design of branch line coupler with 3 dB power division

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Task-1:

Design of branch line coupler with 3 dB power division

Objective

• Design of circuit model of the branch-line coupler with 3 dB power division using ADS.
• Full-wave simulation of branch-line coupler using HFSS.

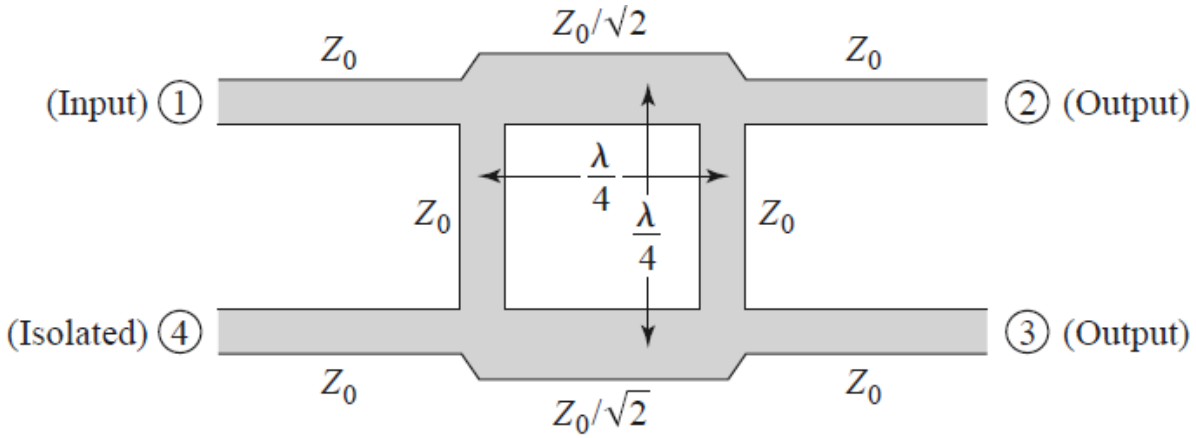


Fig. 1. Branch-line coupler. Here $Z_0 = 50\ \Omega$.

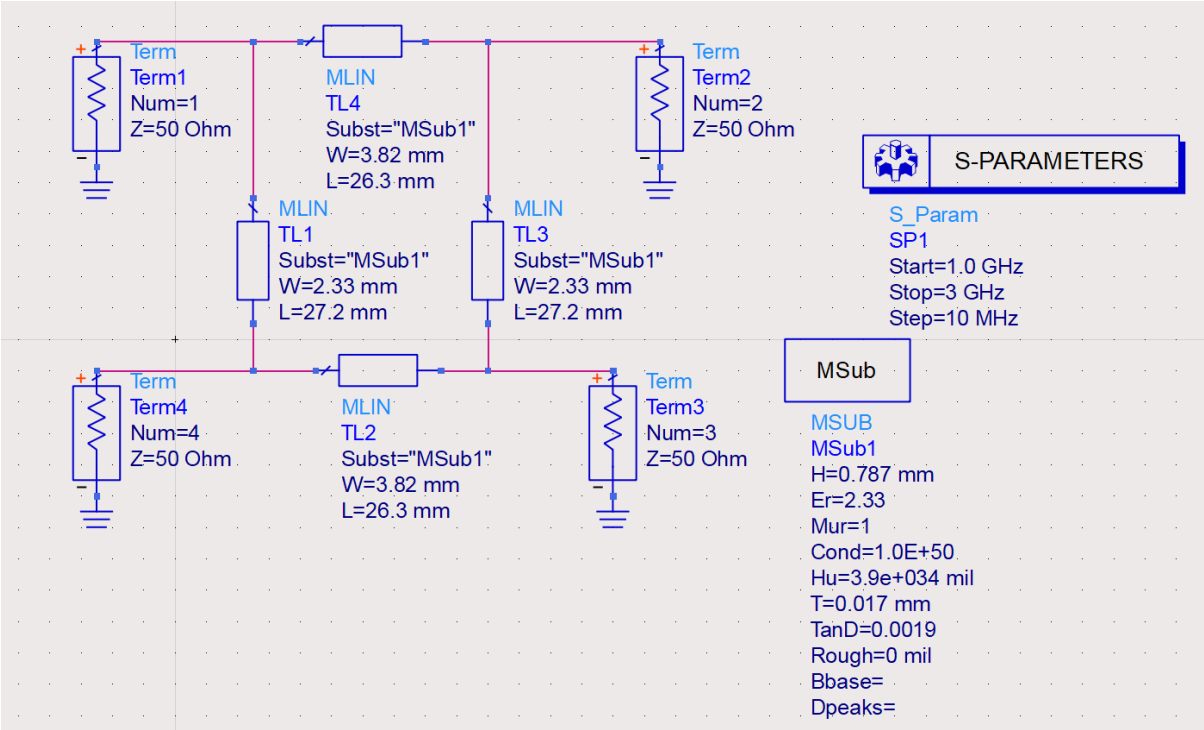
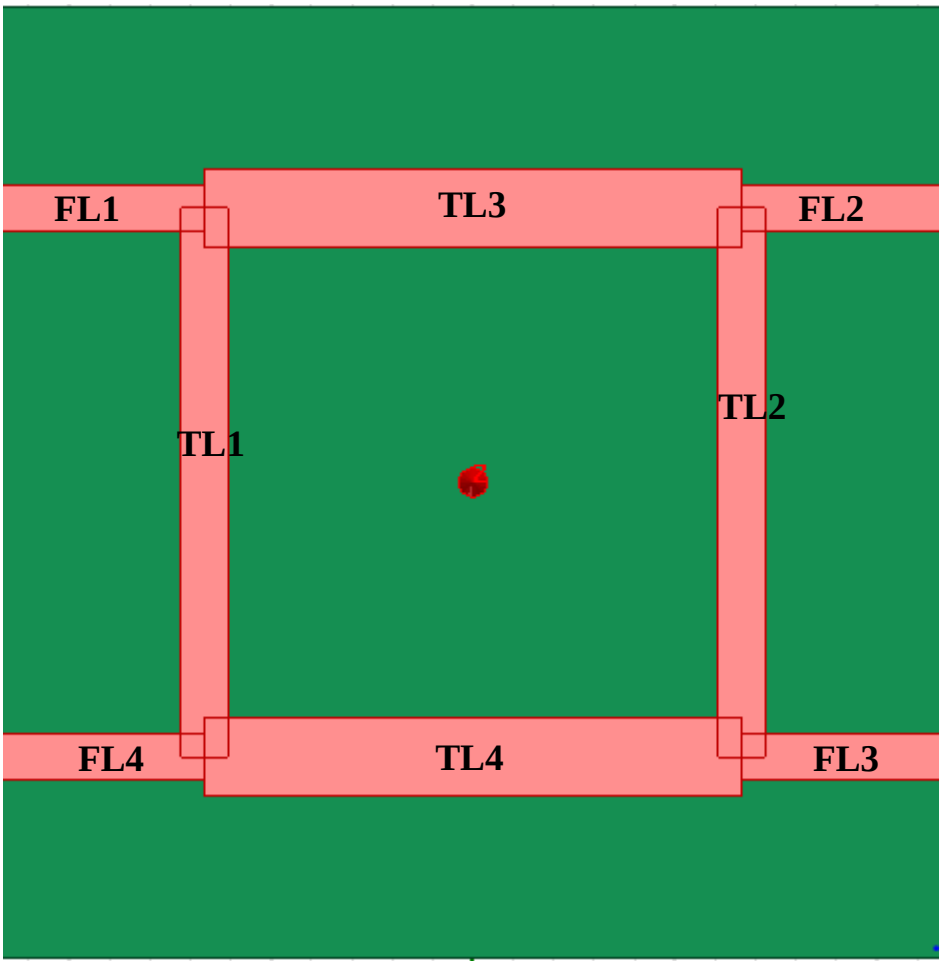
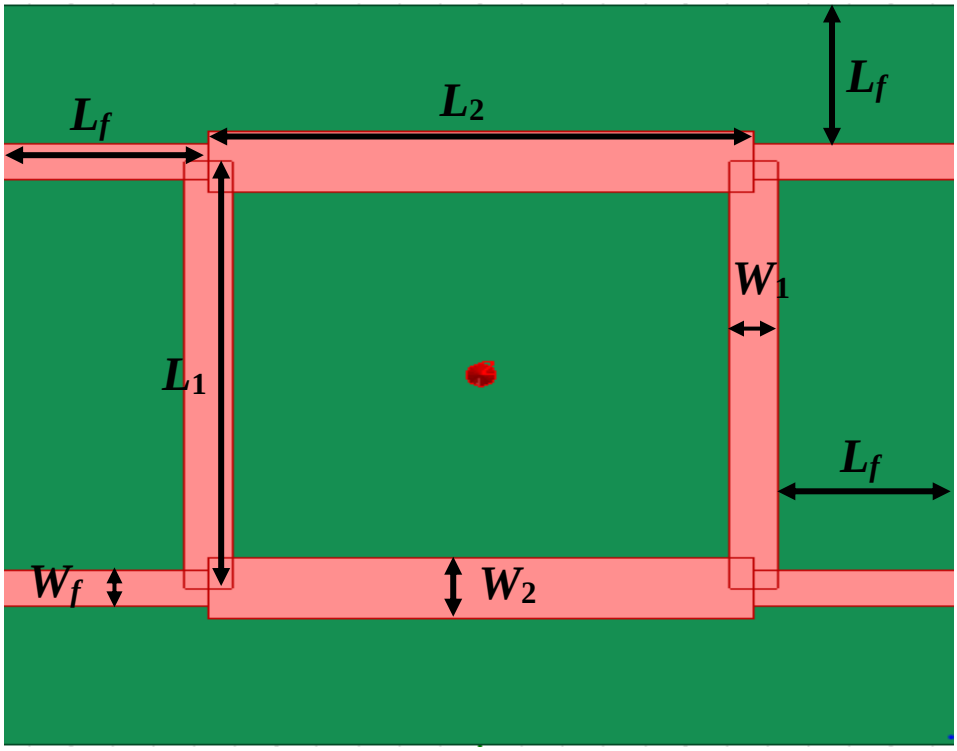


Fig. 2 Circuit simulation of branch-line coupler in ADS.


FL1
TL3
FL2
TL1
TL2
FL4
TL4
FL3


L_f
L_2
L_f
W_1
L_1
L_f
W_f
W_2

Name	Value	Unit	Evaluated...	Type
hs	0.787	mm	0.787mm	Design
hc	0.017	mm	0.017mm	Design
Lf	10	mm	10mm	Design
Wf	2.33	mm	2.33mm	Design
L1	27.22	mm	27.22mm	Design
W1	2.33	mm	2.33mm	Design
L2	27	mm	27mm	Design
W2	3.82	mm	3.82mm	Design

Dimensions for 3 dB branch-line coupler

Design procedure of branch-line coupler:

1. **Substrate:**
   Create a box with the below properties.
   Assign material: Right Click>Assign Material>Rogers/Select RT Duroid 5870

Command

Name	Value
Command	CreateBox
Coordina...	Global
Position	-Lf-L1/2 ,-Lf-L2/2 ,0mm
XSize	2*Lf+L1
YSize	2*Lf+L2
ZSize	hs

Name	Value
Name	Sub
Material	"Rogers RT/duroid 5870 (tm)"
Solve Insi...	☑
Orientation	Global
Model	☑
Display ...	☐
Color	
Transpar...	0

2. **Ground:**

Create a box with the below properties.

Assign material: Right Click>Assign Material>Rogers/Select Copper

Command

Name	Value
Command	CreateBox
Coordina...	Global
Position	-Lf-L1/2 .-Lf-L2/2 .0mm
XSize	2*Lf+L1
YSize	2*Lf+L2
ZSize	-hc

Attribute

Name	Value	Un
Name	GND	
Material	"copper"	
Solve Insi...	☐	
Orientation	Global	
Model	☑	
Display ...	☐	
Color		
Transpar...	0	

3. **AirBox:**

Create a box with the below properties.

Assign material: Right Click>Assign Material>Select Air

Command

Name	Value
Command	CreateBox
Coordina...	Global
Position	-Lf-L1/2-10mm .-Lf-L2/2 .-10mm
XSize	2*Lf+L1+20mm
YSize	2*Lf+L2
ZSize	20

Attribute

Name	Value
Name	Airbox
Material	"air"
Solve Insi...	☑
Orientation	Global
Model	☑
Display ...	☐
Color	
Transpar...	1

4. **FL1:**

   Create a box with the below properties.
   Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	Value
Command	CreateBox
Coordina...	Global
Position	-L1/2-Wf/2 .-L2/2 .hs
XSize	Wf
YSize	-Lf
ZSize	hc

5. **FL2:**

   Create a box with the below properties.
   Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	
Command	CreateBox
Coordina...	Global
Position	-L1/2-Wf/2 .L2/2 .hs
XSize	Wf
YSize	Lf
ZSize	hc

6. **FL3:**

   Create a box with the below properties.
   Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	Value
Command	CreateBox
Coordina...	Global
Position	L1/2+Wf/2 .L2/2 .hs
XSize	-Wf
YSize	Lf
ZSize	hc

7. **FL4:**

   Create a box with the below properties.
   Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	
Command	CreateBox
Coordina...	Global
Position	L1/2+Wf/2 .-L2/2 .hs
XSize	-Wf
YSize	-Lf
ZSize	hc

8. **TL1:**

   Create a box with the below properties.
   Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	
Command	CreateBox
Coordina...	Global
Position	-L1/2 .-L2/2-W1/2 .hs
XSize	L1
YSize	W1
ZSize	hc

9. **TL2:**

Create a box with the below properties.

Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	
Command	CreateBox
Coordina...	Global
Position	-L1/2 .L2/2+W1/2 .hs
XSize	L1
YSize	-W1
ZSize	hc

10. **TL3:**

Create a box with the below properties.

Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	
Command	CreateBox
Coordina...	Global
Position	-L1/2+W2/2 .-L2/2 .hs
XSize	-W2
YSize	L2
ZSize	hc

11. **TL4:**

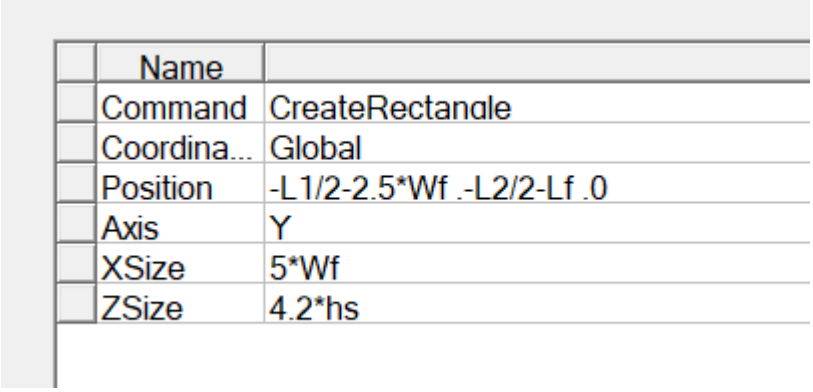
Create a box with the below properties.

Assign material: Right Click>Assign Material>Rogers/Select Copper

Name	
Command	CreateBox
Coordina...	Global
Position	L1/2-W2/2 .-L2/2 .hs
XSize	W2
YSize	L2
ZSize	hc

12. Port1:

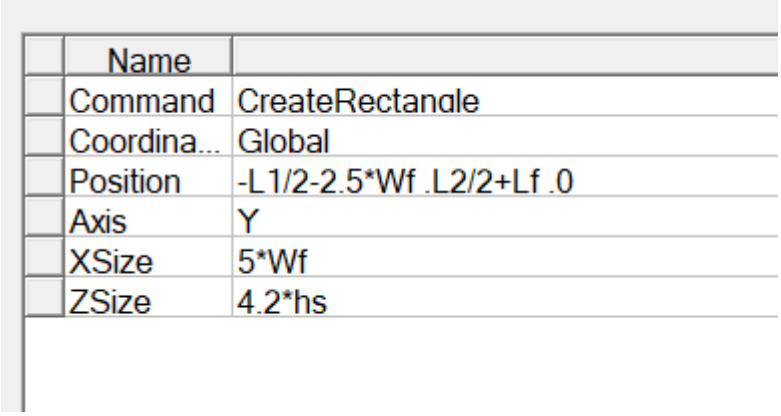
Create a rectangle in ZX-plane with the below properties.



Name	
Command	CreateRectangle
Coordina...	Global
Position	-L1/2-2.5*Wf .-L2/2-Lf .0
Axis	Y
XSize	5*Wf
ZSize	4.2*hs

13. port2:

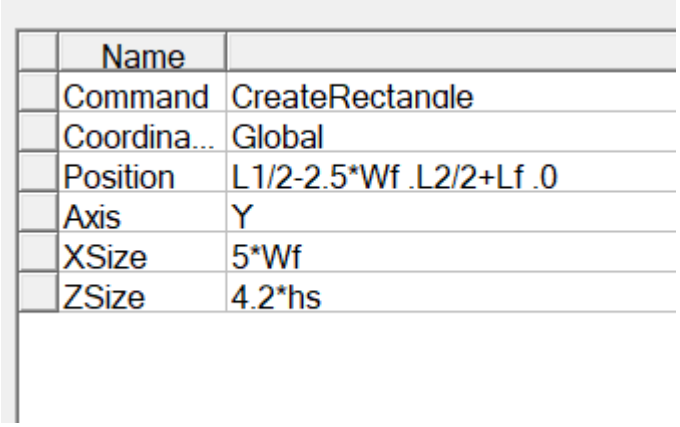
Create a rectangle in ZX-plane with the below properties.



Name	
Command	CreateRectangle
Coordina...	Global
Position	-L1/2-2.5*Wf .L2/2+Lf .0
Axis	Y
XSize	5*Wf
ZSize	4.2*hs

14. Port3:

Create a rectangle in ZX-plane with the below properties.



Name	
Command	CreateRectangle
Coordina...	Global
Position	L1/2-2.5*Wf .L2/2+Lf .0
Axis	Y
XSize	5*Wf
ZSize	4.2*hs

15. Port4:

Create a rectangle in ZX-plane with the below properties.

Name	
Command	CreateRectangle
Coordina...	Global
Position	L1/2-2.5*Wf .-L2/2-Lf .0
Axis	Y
XSize	5*Wf
ZSize	4.2*hs

Analysis

- Assign boundary to airbox: Right Click on Airbox>Go to Assign Boundary> select Radiation.
- Assign ports: **Click HFSS>Excitations>Assign>Wave Port**.
- Define integral lines for each port.
- Point to analysis Setup and add solution setup.

  Solution Frequency: 2 GHz
  Max number of passes: 20
  Max Delta S per passes: 0.002
  Frequency Sweep: 1 GHz – 3 GHz
  Sweep type: Fast
- Validate your model and analyze.
- Generate a graph for S_{11}, S_{21}, S_{31} and S_{41} vs. frequency. Also plot the phase response between two output ports.

Report

1. Format should include title, objective, analysis/discussion, results, and conclusion
2. Include all relevant graphs and outputs from ADS and HFSS with detailed design procedure for HFSS
3. Compare the results for obtained from ADS and HFSS.