Antenna and Radio Propagation

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Experiment: 7

Design & Analysis of Broadband Circularly Polarized Microstrip Antenna

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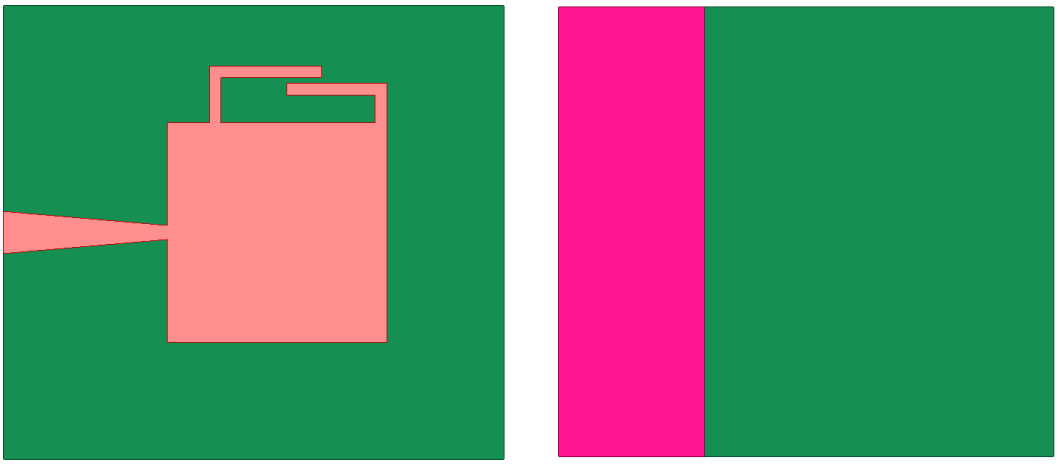
1 (a) Design & Analysis of Broadband Circularly Polarized Microstrip Antenna

This guide leads you step-by-step through creating, solving, and analysing the results of a microstrip patch antenna.

By following the steps in this guide, you will learn how to perform the following tasks in HFSS:

- Draw a geometric model.
- Modify a model's design parameters.
- Assign variables to a model's design parameters.
- Specify solution settings for a design.
- Validate a design's setup.
- Run an HFSS simulation.
- Create a 2D x-y plot of S-parameter results.
- Create a 2D x-y plot of gain, efficiency results.
- Create a 2D Polar/Rectangular plot of radiation pattern.
- Create a 3D plot of radiation pattern.
- Create a field overlay plot of results.

1 (b) Project overview



(a) (b)

Fig.1: Broadband circular polarized microstrip antenna. (a) Top view. (b) Bottom View.

Dimensions of the patch antenna. Units are in mm.

Properties

Name	Value	Unit	Evaluated...	Type
hs	1	mm	1mm	Design
hc	0.035	mm	0.035mm	Design
wp	18.8	mm	18.8mm	Design
lp	18.8	mm	18.8mm	Design
w	1.2	mm	1.2mm	Design
wt	3.6	mm	3.6mm	Design
lt	14	mm	14mm	Design
w0	1.4	mm	1.4mm	Design
h1	3.373	mm	3.373mm	Design
v1	7.6	mm	7.6mm	Design
d1	4.6	mm	4.6mm	Design
h2	5.335	mm	5.335mm	Design
v2	7.955	mm	7.955mm	Design
a	1.4	mm	1.4mm	Design

Substrate properties:

Material name: **FR4 Epoxy**

Dielectric constant: **4.4**

Substrate thickness: **1.0 mm**

Copper thickness: **0.035 mm**

Loss tangent: **0.02**

Microstrip antenna design in HFSS

Substrate:

Draw a box with starting position as **-wp/2-10mm ,-lp/2-lt ,0mm**

XSize: **wp+20mm**

YSize: **lt+lp+10mm**

ZSize: **hs**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateBox			
	Coordina...	Global			
	Position	-wp/2-10mm ,-lp/2-lt ,0mm		-19.4mm	
	XSize	wp+20mm		38.8mm	
	YSize	lt+lp+10mm		42.8mm	
	ZSize	hs		1mm	

GND:

Draw a rectangle with starting position as **-wp/2-10mm ,-lp/2-lt ,0mm**

XSize: **wp+20mm**

YSize: **lt-g**

ZSize: **Z**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateRectangle			
	Coordina...	Global			
	Position	-wp/2-10.6mm ,-lp/2-lt ,0mm		-20mm , -...	
	Axis	Z			
	XSize	wp+21.2mm		40mm	
	YSize	lt-g		12.6mm	

Airbox:

Draw a box with starting position as **-wp/2-20mm ,-lp/2-lt-10mm ,-10mm**

XSize: **wp+40mm**

YSize: **lt+lp+30mm**

ZSize: **20mm**

Name	Value	Unit	Evaluated...	Description
Command	CreateBox			
Coordina...	Global			
Position	-wp/2-20mm ,-lp/2-lt-10mm ,-10mm		-29.4mm	
XSize	wp+40mm		58.8mm	
YSize	lt+lp+30mm		62.8mm	
ZSize	20	mm	20mm	

Patch:

Draw a rectangle with starting position as **-wp/2 ,-lp/2 ,hs**

XSize: **wp**

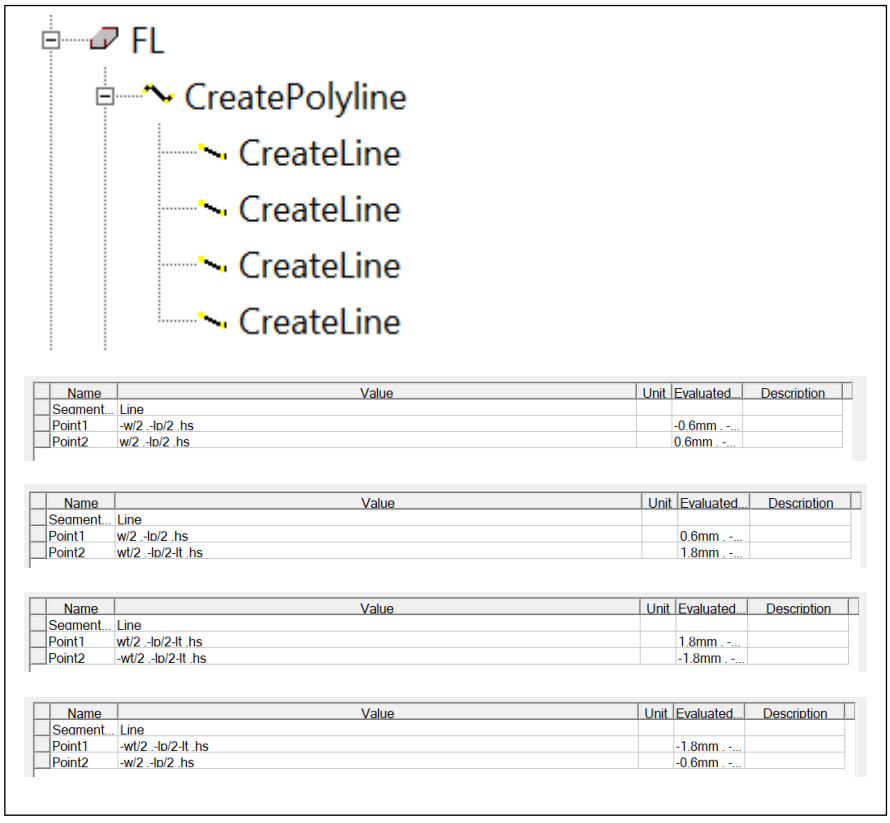
YSize: **lp**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	-wp/2 ,-lp/2 ,hs		-9.4mm , -...	
Axis	Z			
XSize	wp		18.8mm	
YSize	lp		18.8mm	

Feedline:

Draw a line:



Name	Value	Unit	Evaluated...	Description
Segment...	Line			
Point1	-w/2 ,-lp/2 ,hs		-0.6mm , -...	
Point2	w/2 ,-lp/2 ,hs		0.6mm , -...	

Name	Value	Unit	Evaluated...	Description
Segment...	Line			
Point1	w/2 ,-lp/2 ,hs		0.6mm , -...	
Point2	wt/2 ,-lp/2-lt ,hs		1.8mm , -...	

Name	Value	Unit	Evaluated...	Description
Segment...	Line			
Point1	wt/2 ,-lp/2-lt ,hs		1.8mm , -...	
Point2	-wt/2 ,-lp/2-lt ,hs		-1.8mm , -...	

Name	Value	Unit	Evaluated...	Description
Segment...	Line			
Point1	-wt/2 ,-lp/2-lt ,hs		-1.8mm , -...	
Point2	-w/2 ,-lp/2 ,hs		-0.6mm , -...	

Create line-1

Point-1: **-w/2 ,-lp/2 ,hs**

Point-2: **w/2 ,-lp/2 ,hs**

Create line-2

Point-1: **w/2 ,-lp/2 ,hs**

Point-2: **wt/2 ,-lp/2-lt ,hs**

Create line-3

Point-1: **wt/2 ,-lp/2-lt ,hs**

Point-2: **-wt/2 ,-lp/2-lt ,hs**

Create line-4

Point-1: **-wt/2 ,-lp/2-lt ,hs**

Point-2: **-w/2 ,-lp/2 ,hs**

TL1:

Draw a rectangle with starting position as **-wp/2 ,lp/2 ,hs**

XSize: **-h1**

YSize: **-w0**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	-wp/2 ,lp/2 ,hs		-9.4mm , ...	
Axis	Z			
XSize	-h1		-3.173mm	
YSize	-w0		-1.3mm	

TL2:

Draw a rectangle with starting position as **-wp/2-h1 ,lp/2-w0 ,hs**

XSize: **w0**

YSize: **-v1**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	-wp/2-h1 ,lp/2-w0 ,hs		-12.573m...	
Axis	Z			
XSize	w0		1.3mm	
YSize	-v1		-8.6mm	

TL3:

Draw a rectangle with starting position as **-wp/2 ,-lp/2+d1 ,hs**

XSize: **-h2**

YSize: **-w0**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	-wp/2 ,-lp/2+d1 ,hs		-9.4mm , -...	
Axis	Z			
XSize	-h2		-4.85mm	
YSize	-w0		-1.3mm	

TL4:

Draw a rectangle with starting position as **-wp/2-h2 ,-lp/2+d1 ,hs**

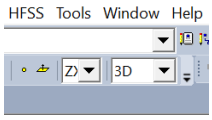
XSize: **w0**

YSize: **v2**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	-wp/2-h2 ,-lp/2+d1 ,hs		-14.25mm...	
Axis	Z			
XSize	w0		1.3mm	
YSize	v2		8.6mm	

Lumped port:

Draw a rectangular in **ZX axis** 

with starting position as **-wt/2 ,-lp/2-lt ,0mm**

Axis: **Y**

YSize: **wt**

ZSize: **hs**

Assign Excitation:

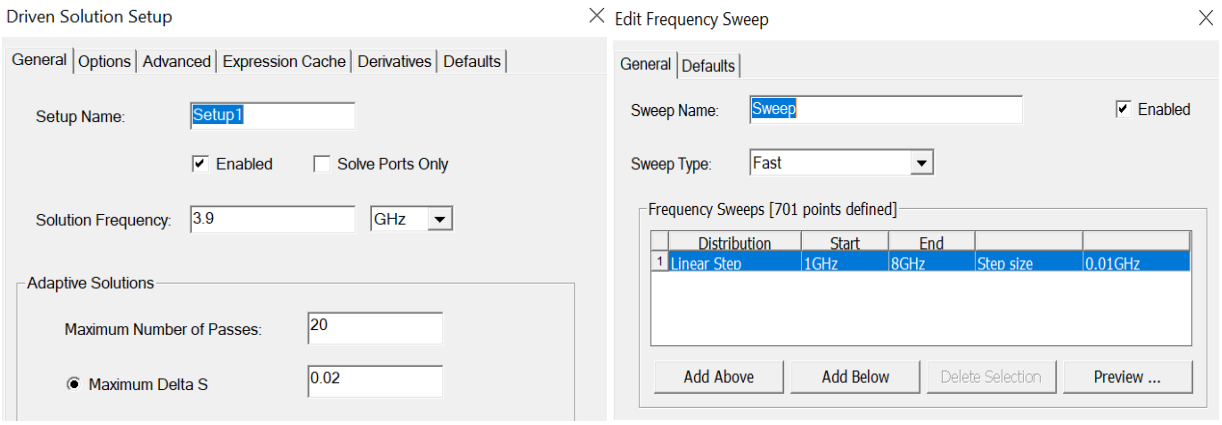
Select lumped port ⟶ right click on lumped port ⟶ go to new line ⟶ choose X: 0 Y: -23.4, Z: 0 ⟶ enter ⟶ put dX: 0, dY: 0, dZ: 1

Unite ALL:

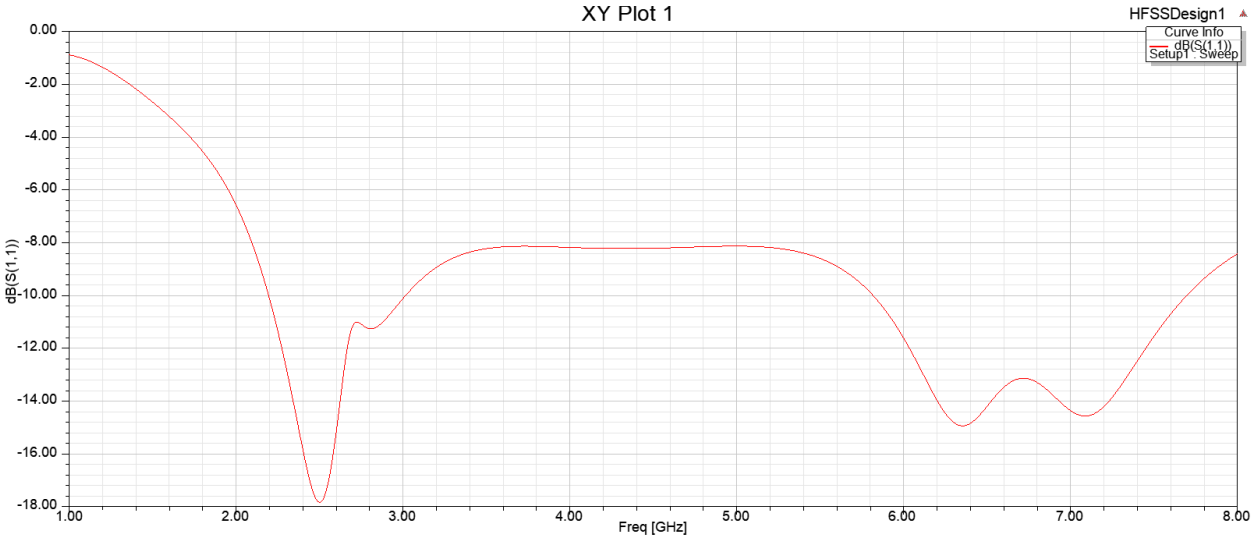
Assign Boundary:

Select airbox ⟶ right click on airbox ⟶ go to assign boundary ⟶ choose radiation ⟶ enter

Analysis setup:



Result Analysis:



Radiation Pattern