

Antenna and Radio Propagation

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Experiment: 10

Design of a Patch Antenna For Ultra-Wide Band Applications



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Design of a Patch Antenna For Ultra-Wide Band Applications

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

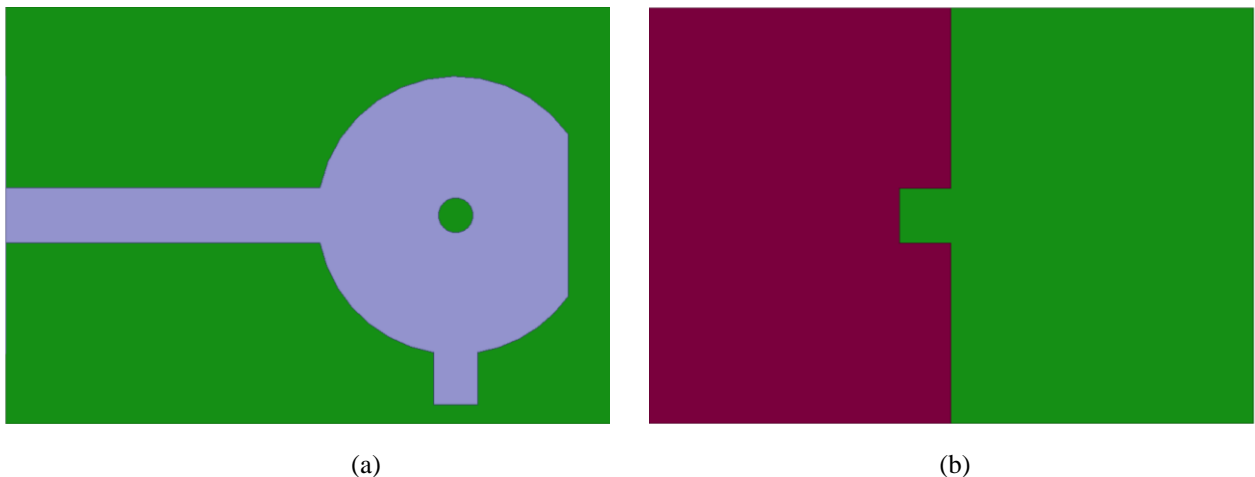


Fig.1: Ultra-wideband microstrip patch antenna. (a) Top view. (b) Bottom View.

Dimensions of the patch antenna. Units are in mm.

Properties				
Name	Value	Unit	Evaluated...	Type
hs	1.6	mm	1.6mm	Desian
wf	3.2	mm	3.2mm	Desian
lf	10	mm	10mm	Desian
Gd	10.4	mm	10.4mm	Desian
La	17.5	mm	17.5mm	Desian
h	0.5	mm	0.5mm	Desian
was	3.2	mm	3.2mm	Desian
las	3	mm	3mm	Desian
L	35	mm	35mm	Desian
W	24	mm	24mm	Desian
R2	8	mm	8mm	Desian
R1	1	mm	1mm	Desian
Lh	6.5	mm	6.5mm	Desian
Lrec	3	mm	3mm	Desian
Wrec	2.5	mm	2.5mm	Desian

Substrate properties:Material name: **FR4 Epoxy**Dielectric constant: **4.4**Substrate thickness: **1.6 mm**Loss tangent: **0.02****Microstrip antenna design in HFSS****Substrate:**Draw a box with starting position as **-W/2 ,0mm ,0mm**XSize: **W**YSize: **L**ZSize: **hs**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateBox			
	Coordina...	Global			
	Position	-W/2 .0mm .0mm		-12mm . 0...	
	XSize	W		24mm	
	YSize	L		35mm	
	ZSize	hs		1.6mm	

Airbox:Draw a box with starting position as **-W/2-10mm ,0mm ,-10mm**XSize: **W+20mm**YSize: **L+10mm**ZSize: **20mm**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateBox			
	Coordina...	Global			
	Position	-W/2-10mm .0mm .-10mm		-22mm . 0...	
	XSize	W+20mm		44mm	
	YSize	L+10mm		45mm	
	ZSize	20	mm	20mm	

GND:Draw a rectangle with starting position as **-Gd-wf/2 ,0mm ,0mm**XSize: **2*Gd+wf**YSize: **Lg**ZSize: **Z**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateRectangle			
	Coordina...	Global			
	Position	-Gd-wf/2 .0mm .0mm		-12mm . 0...	
	Axis	Z			
	XSize	2*Gd+wf		24mm	
	YSize	Ld		17.5mm	

Slot1:

Draw a rectangle with starting position as **-wgs/2 ,Lg ,0mm**

XSize: **wgs**

YSize: **-lgs**

ZSize: **Z**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateRectangle			
	Coordina...	Global			
	Position	-was/2 .La .0mm		-1.6mm	
	Axis	Z			
	XSize	was		3.2mm	
	YSize	-las		-3mm	

➤ **Subtract Slot1 from GND.**

Circle1:

Draw a circle with starting position as **-0mm ,Lg+h+R2 ,hs**

Axis: **Z**

Radius: **R2**

Number: **0**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateCircle			
	Coordina...	Global			
	Center P...	-0mm .La+h+R2 .hs		-0mm . 26...	
	Axis	Z			
	Radius	R2		8mm	
	Number ...	0		0	

Circle2:

Draw a circle with starting position as **-0mm ,Lg+h+R2 ,hs**

Axis: **Z**

Radius: **R1**

Number: **0**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateCircle			
	Coordina...	Global			
	Center P...	-0mm .Lg+h+R2 .hs		-0mm . 26...	
	Axis	Z			
	Radius	R1		1mm	
	Number ...	0		0	

Rectangle1:

Draw a rectangle with starting position as **-5mm ,Lg+h+R2+Lh ,hs**

XSize: **10mm**

YSize: **2mm**

ZSize: **Z**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateRectangle			
	Coordina...	Global			
	Position	-5mm .Lg+h+R2+Lh .hs		-5mm . 32...	
	Axis	Z			
	XSize	10	mm	10mm	
	YSize	2	mm	2mm	

➤ **Subtract Circle2 and Rectangle1 from Circle1.**

FL:

Draw a rectangle with starting position as **-wf/2 ,0mm ,hs**

XSize: **wf**

YSize: **lg+h+0.2mm**

ZSize: **Z**

	Name	Value	Unit	Evaluated...	Description
	Command	CreateRectangle			
	Coordina...	Global			
	Position	-wf/2 .0mm .hs		-1.6mm	
	Axis	Z			
	XSize	wf		3.2mm	
	YSize	lg+h+0.2mm		18.2mm	

Rectangle2:

Draw a rectangle with starting position as **R2-0.1mm ,Lg+h+R2-Wrec/2 ,hs**

XSize: **Lrec**

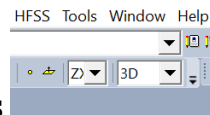
YSize: **Wrec**

ZSize: Z

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	R2-0.1mm .Lq+h+R2-Wrec/2 .hs		7.9mm . 2...	
Axis	Z			
XSize	Lrec		3mm	
YSize	Wrec		2.5mm	

- **Unite FL and Rectangle2 with Circle1.**
- **Select GND and Circle1 → Right click → Go to Assign Boundary → Select Perfect E**

Wave port:



Draw a rectangular in **ZX axis** with starting position as **-2.5*wf ,0mm ,0mm**

Axis: Y

YSize: **5*wf**

ZSize: **4.2*hs**

Assign Excitation:

Select wave port → right click on wave port → go to new line → choose X: 0
Y: 0, Z: 0 → enter → put dX: 0, dY: 0, dZ: 1.6

Assign Boundary:

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

Analysis setup:

Driven Solution Setup

General

Options

Advanced

Expression Cache

Derivatives

Defaults

Setup Name:

☒ Enabled ☐ Solve Ports Only

Solution Frequency: GHz

Adaptive Solutions

Maximum Number of Passes:

☒ Maximum Delta S

☐ Use Matrix Convergence

Edit Frequency Sweep

General

Defaults

Sweep Name: ☒ Enabled

Sweep Type:

Frequency Sweeps [451 points defined]

	Distribution	Start	End		
1	Linear Step	3GHz	12GHz	Step size	0.02GHz

3D Fields Save Options

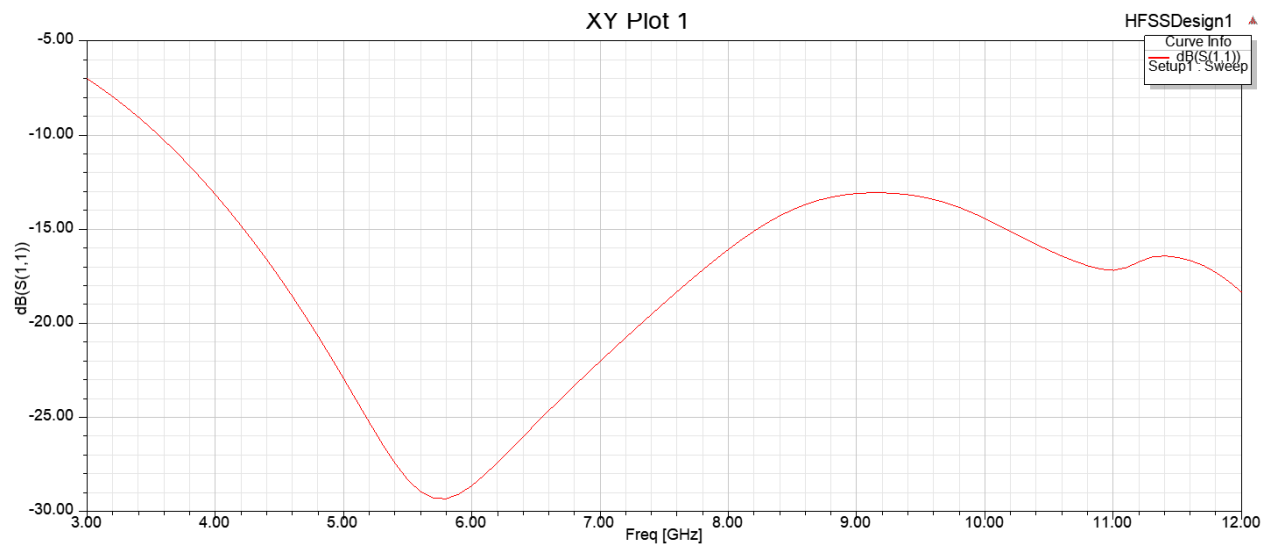
☒ Save Fields

☐ Save radiated fields only

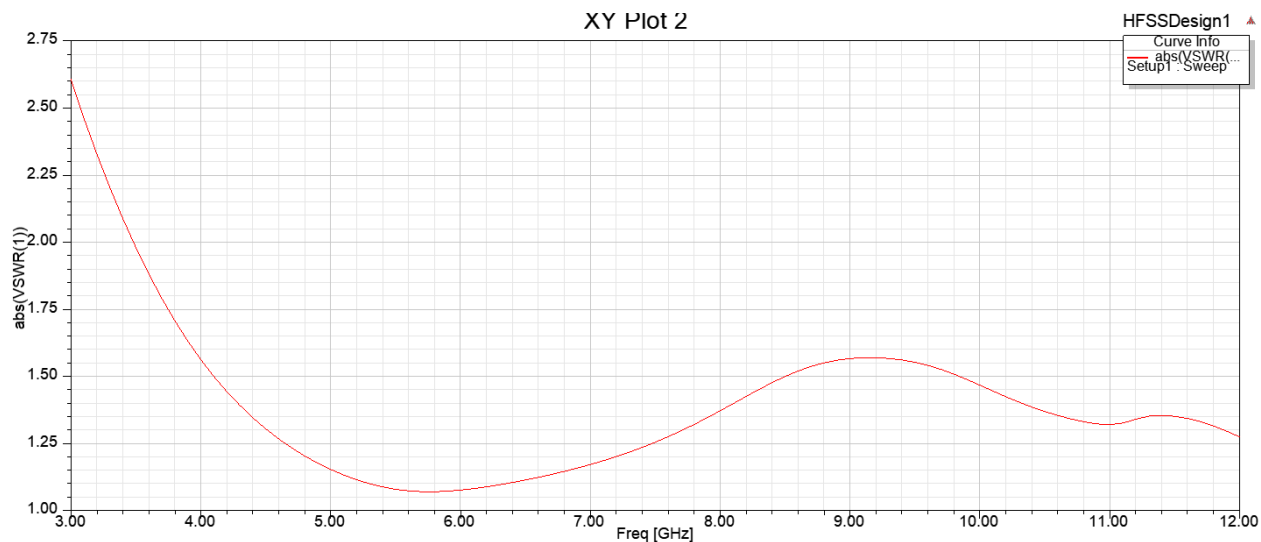
☐ Generate fields at solve time (All Frequencies)

Result Analysis:

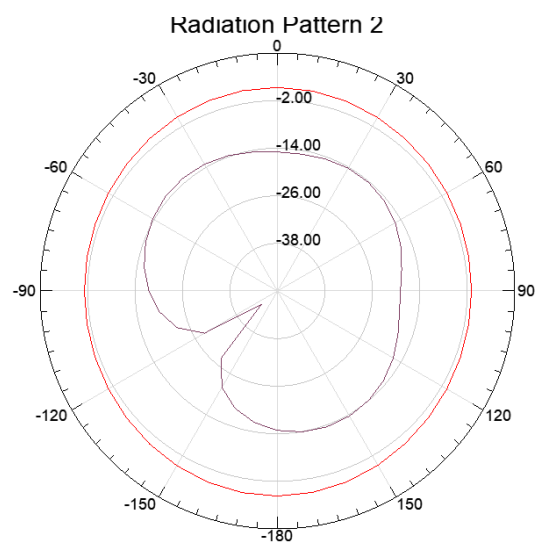
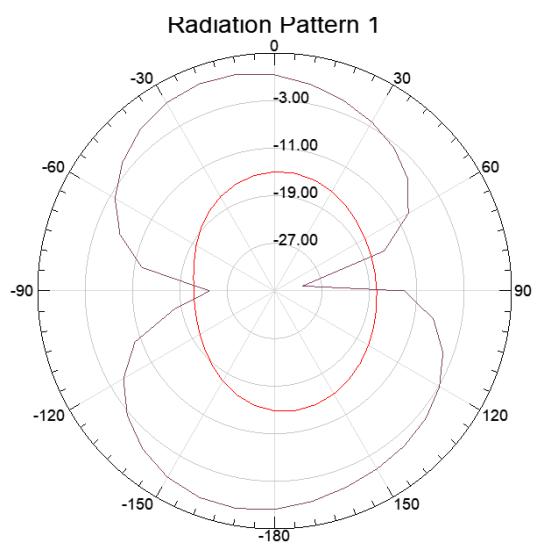
Return loss:



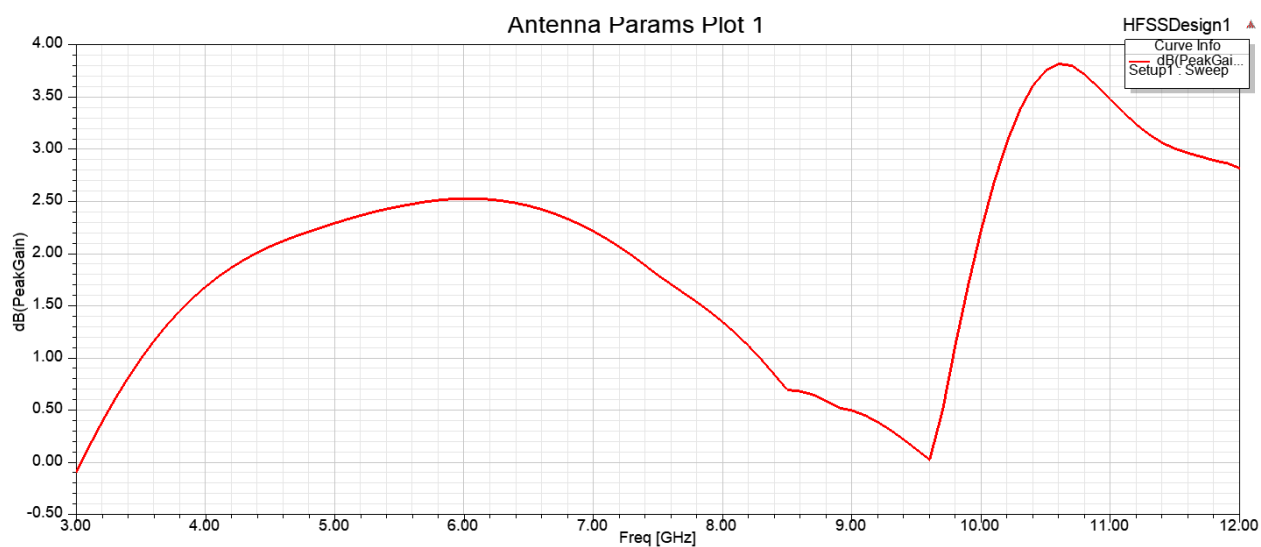
VSWR:



Radiation Pattern:



Peak Gain:



Radiation Efficiency:

