Antenna and Radio Propagation

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Experiment: 11

Design of a Dual-Band Patch Antenna For WLAN/WiMAX Band Applications

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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.
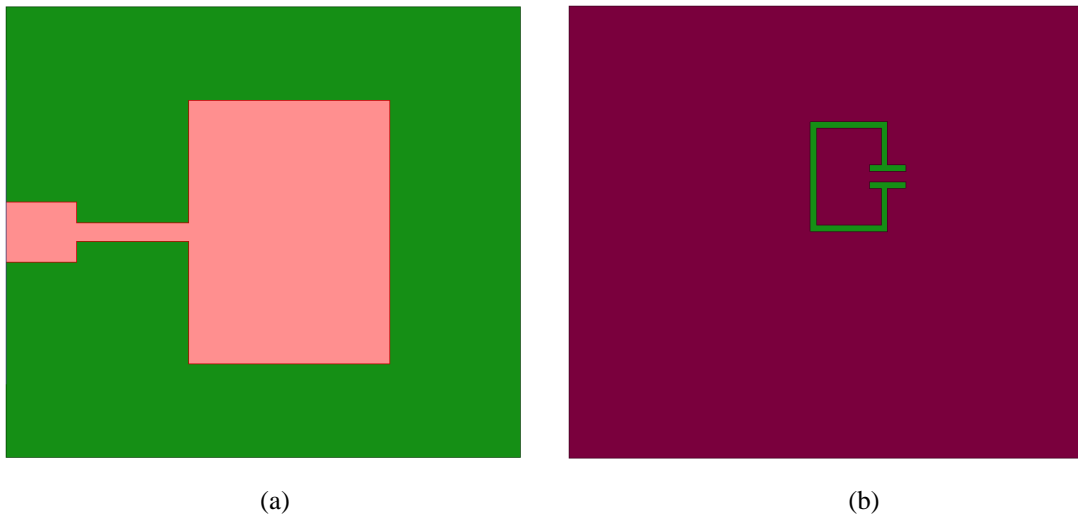- ❖ Create a field overlay plot of results.

1 (b) Project overview

(a)   (b)

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

Dimensions of the patch antenna. Units are in mm.

Name	Value	Unit	Evaluated...	Type
hs	1.57	mm	1.57mm	Design
W	35	mm	35mm	Design
L	40	mm	40mm	Design
wf	4.73	mm	4.73mm	Design
Lf	5.5	mm	5.5mm	Design
w1	1.42	mm	1.42mm	Design
l1	8.72	mm	8.72mm	Design
wᴅ	20.5	mm	20.5mm	Design
lᴅ	15.6	mm	15.6mm	Design
d1	10.2	mm	10.2mm	Design
d2	4.5	mm	4.5mm	Design
a	8.5	mm	8.5mm	Design
a1	0.45	mm	0.45mm	Design
b	6	mm	6mm	Design
d	0.8	mm	0.8mm	Design
c	2.8	mm	2.8mm	Design

Substrate properties:

Material name: **Rogers RT Duroid-5880 substrate**

Dielectric constant: **2.2**

Substrate thickness: **1.57 mm**

Loss tangent: **0.0009**

Microstrip antenna design in HFSS

Substrate:

Draw a box with starting position as **0mm ,0mm ,0mm**

XSize: **W**

YSize: **L**

ZSize: **hs**

Name	Value	Unit	Evaluated...	Description
Command	CreateBox			
Coordina...	Global			
Position	0 ,0 ,0	mm	0mm , 0m...	
XSize	W		35mm	
YSize	L		40mm	
ZSize	hs		1.57mm	

Airbox:

Draw a box with starting position as **-10mm ,0mm ,-10mm**

XSize: **W+20mm**

YSize: **L+10mm**

ZSize: **20mm**

Name	Value	Unit	Evaluated...	Description
Command	CreateBox			
Coordina...	Global			
Position	-10 ,0 ,-10	mm	-10mm , 0...	
XSize	W+20mm		55mm	
YSize	L+10mm		50mm	
ZSize	20	mm	20mm	

GND:

Draw a rectangle with starting position as **0 ,0 ,0**

XSize: **W**

YSize: **L**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	0 ,0 ,0	mm	0mm , 0m...	
Axis	Z			
XSize	w		35mm	
YSize	l		40mm	

Slot1:

Draw a rectangle with starting position as **w/2-wp/2+d1 ,lf+l1+d2 ,0mm**

XSize: **a**

YSize: **g1**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1 ,lf+l1+d2 ,0mm		17.45mm ...	
Axis	Z			
XSize	a		8.5mm	
YSize	g1		0.45mm	

Slot2:

Draw a rectangle with starting position as **w/2-wp/2+d1 ,lf+l1+d2 ,0mm**

XSize: **g1**

YSize: **b**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1 ,lf+l1+d2 ,0mm		17.45mm ...	
Axis	Z			
XSize	g1		0.45mm	
YSize	b		6mm	

Slot3:

Draw a rectangle with starting position as **w/2-wp/2+d1+a ,lf+l1+d2 ,0mm**

XSize: **-g1**

YSize: **b**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1+a .lf+l1+d2 .0mm		25.95mm ...	
Axis	Z			
XSize	-a1		-0.45mm	
YSize	b		6mm	

Slot4:

Draw a rectangle with starting position as **w/2-wp/2+d1+a/2-d/2 ,lf+l1+d2+b-c/2 ,0mm**

XSize: **-g1**

YSize: **c**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1+a/2-d/2 .lf+l1+d2+b-c/2 .0mm		21.3mm	
Axis	Z			
XSize	-a1		-0.45mm	
YSize	c		2.8mm	

Slot5:

Draw a rectangle with starting position as **w/2-wp/2+d1+a/2+d/2 ,lf+l1+d2+b-c/2 ,0mm**

XSize: **g1**

YSize: **c**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1+a/2+d/2 .lf+l1+d2+b-c/2 .0mm		22.1mm	
Axis	Z			
XSize	a1		0.45mm	
YSize	c		2.8mm	

Slot6:

Draw a rectangle with starting position as **w/2-wp/2+d1+a/2-d/2 ,lf+l1+d2+b ,0mm**

XSize: **-a/2+d/2**

YSize: **-g1**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1+a/2-d/2 ,lf+l1+d2+b ,0mm		21.3mm	
Axis	Z			
XSize	-a/2+d/2		-3.85mm	
YSize	-g1		-0.45mm	

Slot7:

Draw a rectangle with starting position as **w/2-wp/2+d1+a/2+d/2 ,lf+l1+d2+b ,0mm**

XSize: **a/2-d/2**

YSize: **-g1**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2+d1+a/2+d/2 ,lf+l1+d2+b ,0mm		22.1mm	
Axis	Z			
XSize	a/2-d/2		3.85mm	
YSize	-g1		-0.45mm	

- ➢ **Unite all Slots from SL1 to SL7.**
- ➢ **Subtract Slots from GND.**

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	

Patch:

Draw a rectangle with starting position as **w/2-wp/2 ,lf+l1 ,hs**

XSize: **wp**

YSize: **lp**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wp/2 ,lf+l1 ,hs		7.25mm , ...	
Axis	Z			
XSize	wp		20.5mm	
YSize	lp		15.6mm	

FL:

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

XSize: **wf**

YSize: **lf**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-wf/2 ,0 ,hs		15.135m...	
Axis	Z			
XSize	Wf		4.73mm	
YSize	Lf		5.5mm	

TL:

Draw a rectangle with starting position as **w/2-w1/2 ,lf ,hs**

XSize: **w1**

YSize: **l1**

ZSize: **Z**

Name	Value	Unit	Evaluated...	Description
Command	CreateRectangle			
Coordina...	Global			
Position	w/2-w1/2 ,lf ,hs		16.79mm ...	
Axis	Z			
XSize	w1		1.42mm	
YSize	l1		8.72mm	

➢ **Unite FL and TL with Patch.**
➢ **Select GND and Patch ➡ Right click ➡ Go to Assign Boundary ➡ Select Perfect E**

Wave port:
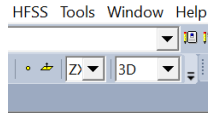
Draw a rectangular in **ZX axis** with starting position as **w/2-2.5*wf ,0mm ,0mm**
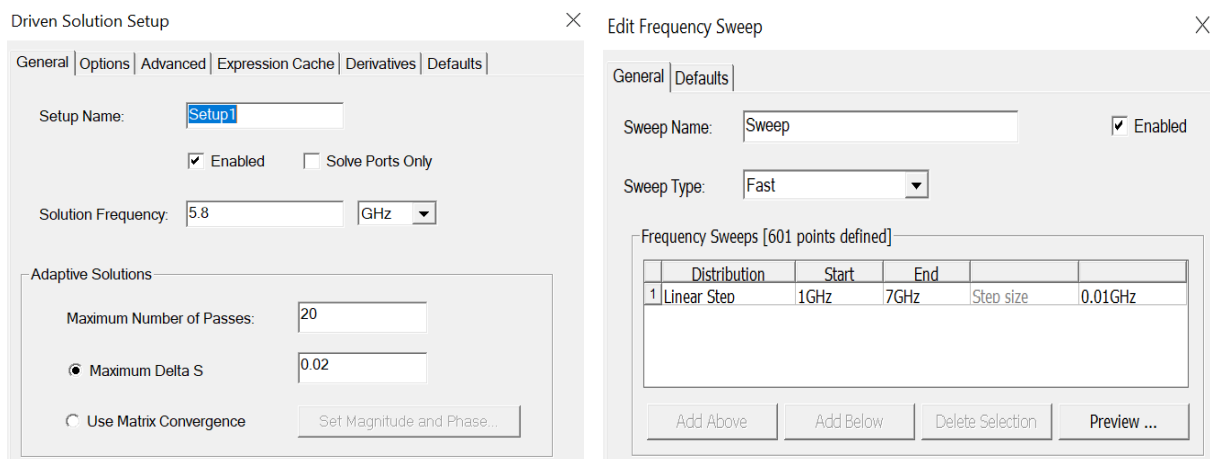
Axis: **Y**

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: 1.57

Assign Boundary:

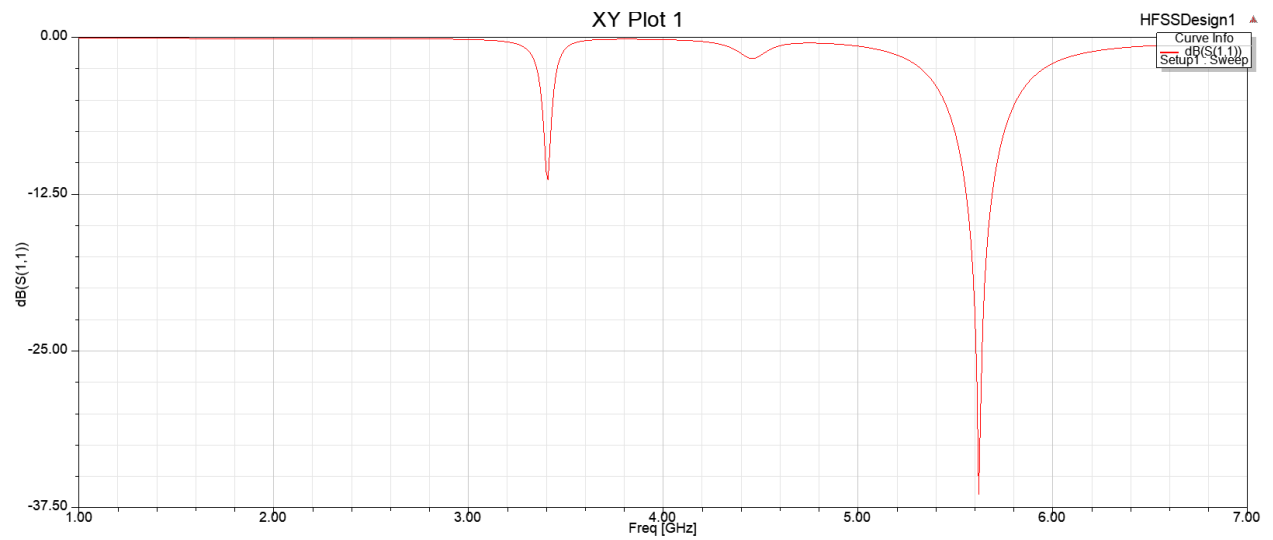Select airbox ⟶ right click on airbox ⟶ go to assign boundary ⟶ choose
radiation ⟶ enter

Analysis setup:

Driven Solution Setup   ✕

| General | Options | Advanced | Expression Cache | Derivatives | Defaults |

Setup Name: Setup1

        ☑ Enabled   ☐ Solve Ports Only

Solution Frequency: 5.8   GHz ▼

Adaptive Solutions

    Maximum Number of Passes: 20

    ⦿ Maximum Delta S   0.02

    ◯ Use Matrix Convergence   Set Magnitude and Phase...

Edit Frequency Sweep   ✕

| General | Defaults |

Sweep Name: Sweep   ☑ Enabled

Sweep Type: Fast ▼

Frequency Sweeps [601 points defined]

Distribution	Start	End		
1 Linear Step	1GHz	7GHz	Step size	0.01GHz

    Add Above   Add Below   Delete Selection   Preview ...
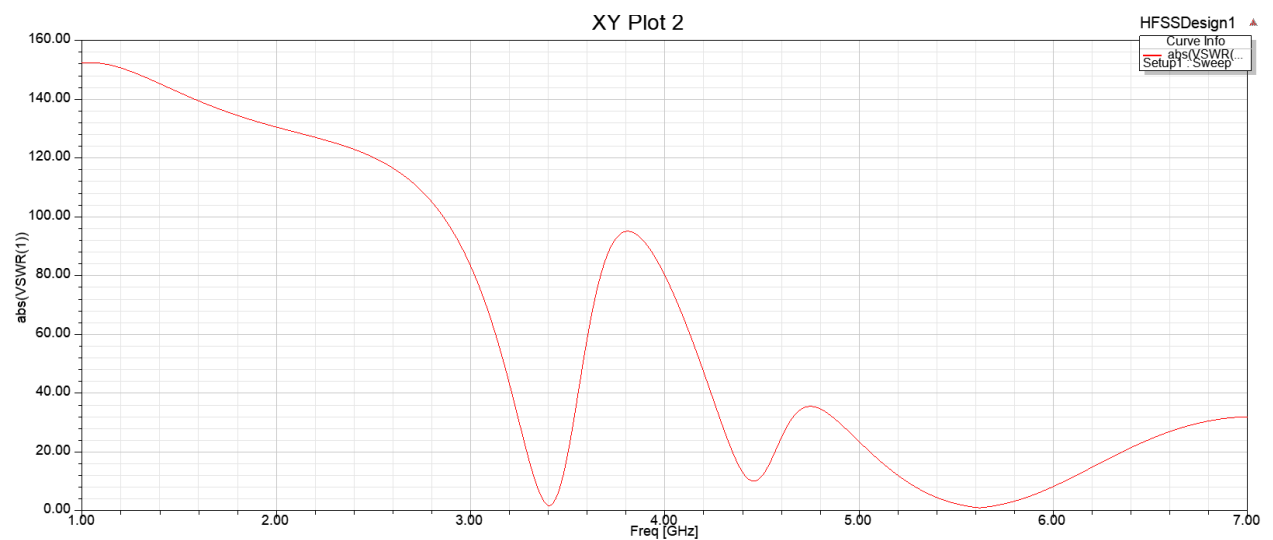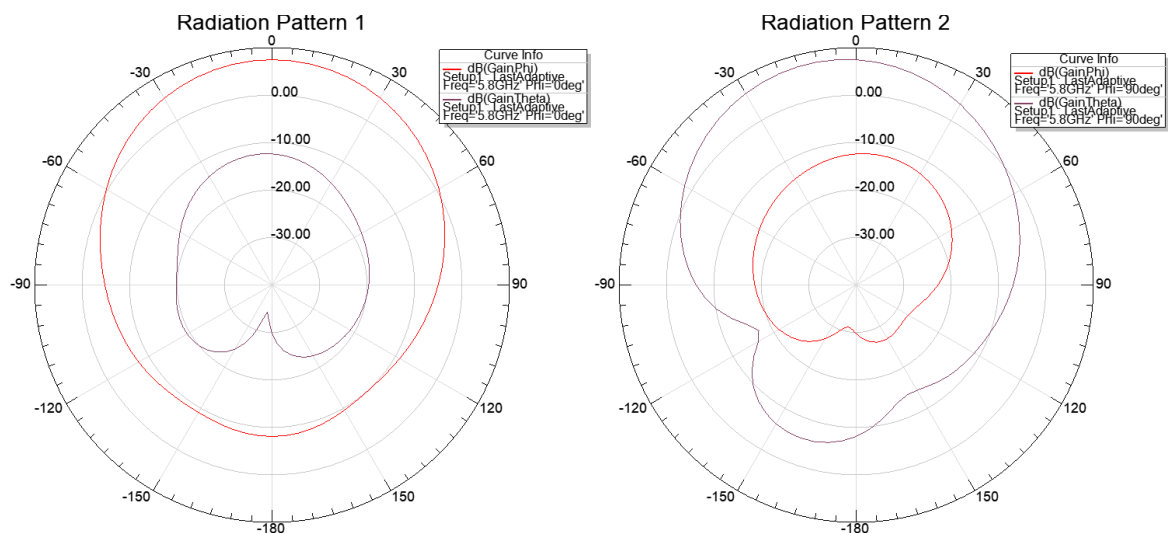
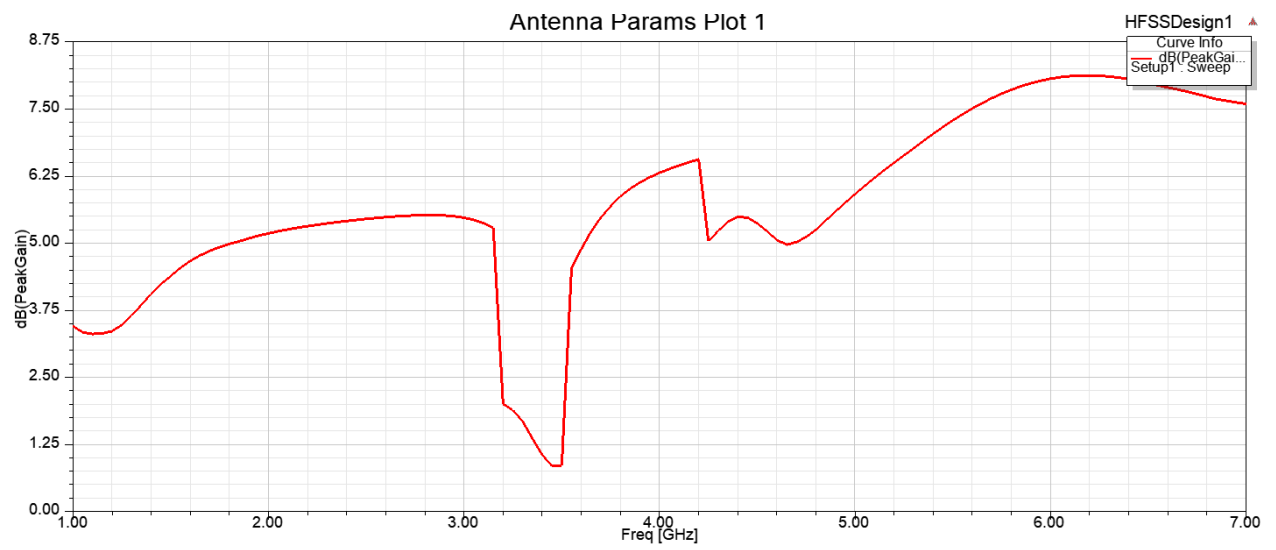# Result Analysis:

Return loss:

VSWR:

Radiation Pattern:

Peak Gain:

Radiation Efficiency: