ECE 546: ANSYS HFSS Tutorial Simulate and Analyze an Example of Trace and Via

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Problem Description

Getting Started Create the 3D model Analysis Setup Plot S-parameters vs. Frequency

Trace and Via



Problem Description

Getting Started Create the 3D model Analysis Setup Plot S-parameters vs. Frequency

Nominal Design



- Trace: length=10mm, width=1mm, thickness=0.1mm
- Via: radius=0.5mm, height=0.9mm
- Ground: thickness=0.1mm
- Board: thickness=0.9mm, relative permittivity $\epsilon_r=1$

Getting Started

1. Launch HFSS:

 $\begin{array}{l} \mbox{Start button} \Rightarrow \mbox{All Programs} \Rightarrow \mbox{ANSYS Electromagnetics} \Rightarrow \mbox{HFSS 15.0} \\ \Rightarrow \mbox{Windows 64-bit} \Rightarrow \mbox{HFSS 15.0} \end{array}$

2. Set HFSS options:

 $\mathsf{Tools} \Rightarrow \mathsf{Options} \Rightarrow \mathsf{HFSS} \ \mathsf{Options} \ \Rightarrow \mathsf{General} \ \mathsf{Tab}$

- check $\checkmark \mbox{Use Wizards}$ for data input when creating new boundaries
- check \checkmark Duplicate boundaries/mesh operations with geometry
- click OK

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Getting Started

3. Set Modeler options:

 $\begin{array}{l} {\sf Tools} \Rightarrow {\sf Options} \Rightarrow {\sf Modeler} \; {\sf Options} \; \Rightarrow \\ {\sf Operation} \; {\sf Tab} \end{array}$

- check $\checkmark\mbox{Automatically cover closed polylines}$
- $\bullet\,$ check $\checkmark\,Select$ last command on object select

Drawing Tab

• check \checkmark Edit properties of new primitives

Click OK

Getting Started

- 4. New Project
 - A new project called Project 1 is created by default, or you can create a new project from File \Rightarrow New
 - Right click on Project 1 and select Rename (F2), you can rename the project as helloHFSS
- 5. New HFSS Design
 - Right click on helloHFSS \Rightarrow Insert \Rightarrow Insert HFSS Design
 - Rename the HFSS Design as *via_and_trace*

Hello HFSS!

Now you should have a workspace as below



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Creating the 3D model

1. Set solution type: HFSS \Rightarrow Solution Type \Rightarrow Driven Terminal \Rightarrow OK

MANSYS HFSS - helloHFSS - via_and_trace - 3D M	odeler - [helloHFSS - via_and_trace - Modeler]
E File Edit View Project Draw Modeler	HFSS Tools Window Help
🗋 🖬 🖬 🕷 📾 🕷 🗡 고요 🛛	8 2 9 🖂 🔍 🖬 🚺 🚺 🛛 🖉 🖉 🖉 🖉
😵 №? 🗆 O O O 📥 Ø 🖯 🗊	▲ ● ● ■ ◎ № 0 • # XY ▼ 3D ▼ 1 G @
🤣 🚯 🔹 🛠 🛰 🖻 🖉 🖉 🖉	
Project Manager	Solution Type: helloHFSS - via_and_trace
□ ① helloHFSS ⊕ ② via_and_trace (DrivenTerminal) ⊕ ② Definitons	Diriven C Model C Terminal Transiert C Exectation Network Analysis C Eigennode
Project Properties	OK Cancel

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Creating the 3D model

2. Set model unit:

 $\mathsf{Modeler} \Rightarrow \mathsf{Units} \Rightarrow \mathsf{Select} \ \mathsf{mm} \Rightarrow \mathsf{OK}$

ANSYS HFSS - helloHFSS - via_and_trace - 3D N	Iodeler - [helloHFSS - via_and_trace - Modeler]
File Edit View Project Draw Modeler	HFSS Tools Window Help
🗋 🖬 🖬 🕼 📾 🕼 🗮 🗙 요 요	a 🗘 🔍 🛋 👟 📓 🚺 👯 💌
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🐠 🛞 🐟 🛠 🛰 🗇 💞 🖑	
Project Manager	 × E Z Coordinate Systems
e 📑 helloHFSS	Set Model Units
⊕ ∰ via_and_trace (DrivenTeminal) ⊕- ⊇ Definitions	Select units: mm
Project Properties	

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Creating the 3D model

3. Set default material:

Open material tool bar \Rightarrow type pec in the Search by Name field \Rightarrow Click OK

Open material tool bar



Creating the 3D model

type pec in the Search by Name field

pec Petrona Pe	Search Oteas C by Property Show Project definitions T Postove Premitively -				
/ Name	Location	Origin	Relative Permittivity	Relative Permeability	Bulk ^ Conduct
palladium	SysLibrary	Materials	1	1.00082	9300000siemen
pec		Materials			1e+030siemens
perfect conductor	SysLibrary	Materials	1	1	1e+030siemens
platinum	SysLibrary	Materials	1	1	930000siemen
plexiglass	SysLibrary	Materials	3.4	1	0
polyamide	SysLibrary	Materials	4.3	1	0
polyester	SysLibrary	Materials	3.2	1	0
polyethylene	SysLibrary	Materials	2.25	1	0
Polyfion Copper-Clad ULTEM (tm)	SysLibrary	Materials	3.05	1	0
Polyflon CuFlon (tm)	SysLibrary	Materials	2.1	1	0
Polyflon Polyguide (m)	SysLibrary	Materials	2.32	1	0
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Creating the 3D model

Click Ok and the default material has been changed to pec



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Create Trace

There are multiple ways to specify the position and dimensions of a trace, or any shape in general

- One way is to enter the information in the **coordinate entry fields**. Variables are not allowed in the coordinate entry fields.
- Another way is to draw an arbitrary box first and modify its position and dimensions with **variables**.
- Using variables is encouraged as it is easier for changes to be made on the designs.
- Here, we first create a box in the 3D modeler window and then redefine its position and dimensions with variables.

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Create Trace

1. Define variables

 $HFSS \Rightarrow Design Properties \Rightarrow add w_trace = 1 mm, l_trace = 10 mm,$ and $t_trace = 0.1 mm$ as local variables; w_trace, l_trace, and t_trace represent the width, length, and thickness of the trace, respectively

Value	C Optimization	'n	C Tuning	C Sensitivity	C Statistics		
Name	Value	Unit	Evaluated Value	Туре	Description	Read-only	Hidden
w_trace	1	mm	1mm	(esign			
Ltrace	10	mm	10mm	(<mark>l</mark> esign			
t_trace	0.1	mm	0.1mm	lesign			Г
				-			
· "							

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Create Trace

2. Draw a box

 $\mathsf{Draw} \Rightarrow \mathsf{Box}$



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- 3. Click three times in the 3D modeler window to create an arbitrary box
 - first click to define the position of the box
 - second click to specify the lateral dimensions
 - third click to create the height of the box

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Create Trace

4. Specify the dimensions and position with variables



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Create Trace

5. Change the attributes

Double click on Box1 for the attribute menu, change the name to trace, color to red, and set the transparency to 0.5.

perties:	helloHFSS - via	and_trace - Modeler				
ttribute						
	Name	Value	Unit	Evaluated Value	Description	Read-only
	Name	trace				
	Material	"pec"		"pec"		
	Solve Inside					
	Orientation	Global				
	Model	v				
	Display Wirefra					
	Color					
	Transparent	0.56				
					⊏ s⊧	iow Hidden
						OK Canc

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Create Trace

6. View the information of the created trace

Double click on **Create Box** under **trace**, one is able to see the Position, XSize, YSize, and ZSize of the created trace in the figure below

E @ Solids D @ pec E @ Cylinder1 B @ GND 1 D @ GND 1 D @ trace Comma	s: helloHFSS - via	a_and_trace - Modeler	Ž	4		×	
⊕ Unite ⊕ Dupite ⊕ Dupite ⊕ DupiteateAround ⊕ ⊕ trace_1 ⊕ ⊕ Via	Name Command Coordinate Sys.	Value CreateBox Global	Unt	Evaluated Value	Description		
 B → Vacuum B → Sheets B → L, Coordinate Systems B → Planes 	XSize YSize ZSize	w_trace I_trace t_trace		1mm -10mm 0.1mm			
<u>B</u> -€ L1515			1			-	
X					☐ Show Hidden		
<	~~	0	~	~~~	ОК 15	Cancel	

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- 7. Fit the view in the 3D modeler window CTRL + D
- 8. Done with the trace!

Try the two useful tricks in the 3D modeler window

- Shift + Mouse left
- Alt + Mouse left

What did you find?

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Create Via Pad

1. Define variables

 $HFSS \Rightarrow Design Properties \Rightarrow add r_pad = 0.75 mm, t_pad = 0.1 mm,$ as the radius and the thickness of the via pad, respectively.

Prope	ertie	: helloHFSS - via	_and_trace	-					×
Loc	al Va	ariables							
	e١	/alue C	Optimization		C Tuning	C Sensitivity	C Statistics		
		Name	Value	Unit	Evaluated Value	Туре	Description	Read-only	Hidden
		w_trace	1	mm	1mm	Design			
		l_trace	10	mm	10mm	Design			
		t trace	01	mm	0.1mm	Design			
		r_pad	0.75	mm	0.75mm	Design			
		t_pad	0.1	mm	0.1mm	Design			
	•			1				Show H	⊧
-		Add	Add Array	<i></i>	Edit	Remove		ОК	Cancel
_	-						×	1000	

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2. Draw a cylinder

- Draw \Rightarrow Cylinder
- Again, three clicks in the 3D modeler window: the first click to specify the center of the cylinder, the second click to define the radius, and the third click for the height

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Create Via Pad

3. Position and Dimensions

Enter the position and the dimensions of the created cylinder as shown in the figure below.

Proper	rties:	helloHFSS - via	and_trace - Modeler				<
Com	mano	4					
		Name	Value	Unit	Evaluated Value	Description	
		Command	CreateCylinder				
		Coordinate Sys	Global				. 1
		Center Position	0,0,0	mm	Omm , Omm , Omm		
		Axis	Z				
		Radius	r_pad		0.75mm		
		Height	t_pad		0.1mm		
		Number of Seg	0		0		
	Г						
						Show Hidden	
							_
	_					OK Cancel	H

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Create Via Pad

4. Change the attributes

Double click on **Cylinder 1** for its attribute menu, change the name to Via_pad and color to **red**, and set the transparency to 0.5.

	Name	Value	Unit	Evaluated Value	Description	Read-only
F	Name	Via_pad				Г
F	Material	"pec"		"pec"		
Γ	Solve Inside					
Г	Orientation	Global				
	Model	~				
	Display Wirefra					
	Color					
	Transparent	0.5				

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Create Via Pad

- 5. Unite trace and pad
 - Edit \Rightarrow Select All Visible or CTRL+A
 - $\bullet \ \ \mathsf{Modeler} \Rightarrow \mathsf{Boolean} \Rightarrow \mathsf{Unite}$



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Create Ground Plane

1. Define variables

HFSS \Rightarrow Design Properties \Rightarrow add $t_plane = 0.1 \text{ mm}$, $w_plane = 20 \text{ mm}$, $l_plane = 40 \text{ mm}$, and $t_dielectric = 0.1 \text{ mm}$

•	Value	Optimization	n	C Tuning	C Sensitivity	C Statistics			
Γ	Name	Value	Unit	Evaluated Value	Туре	Description	Read-only	Hidden	*
ſ	Ltrace	10	mm	10mm	Design				
ľ	t_trace	0.1	mm	0.1mm	Design				
ľ	r_pad	0.75	mm	0.75mm	Design				
ľ	t_pad	0.1	mm	0.1mm	Design				
1	t_plane	0.1	mm	0.1mm	Design		Γ		Е
Т	w_plane	20	mm	20mm	Design				
ľ	l_plane	40	mm	40mm	Design				
ľ	t_dielectric	0.1	mm	0.1mm	Design				
1		· · · ·							-
	•							•	
					1		Show H	idden	

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Create Ground Plane

- t_plane, w_plane, and l_plane denote the thickness, the width, and the length of the plane, respectively;
- *t_dielectric* denotes the thickness of the dielectric layer between the trace and its neighboring ground;
- the lateral dimensional of the dielectric layer is chosen as the same as that of the ground plane.

Create Ground Plane

2. Draw a box

 $\mathsf{Draw} \Rightarrow \mathsf{Box}$

¢	Value	C Optimization	'n	C Tuning	C Sensitivity	C Statistics		
Г	Name	Value	Unit	Evaluated Value	Туре	Description	Read-only	Hidden
h	I_trace	10	mm	10mm	Design			
h	t_trace	0.1	mm	0.1mm	Design			
h	r_pad	0.75	mm	0.75mm	Design			
F	t_pad	0.1	mm	0.1mm	Design			
ſ	t_plane	0.1	mm	0.1mm	Design			
Τ	w_plane	20	mm	20mm	Design			
ľ	I_plane	40	mm	40mm	Design			
	t_dielectric	0.1	mm	0.1mm	Design			
	•							÷
			1		1	1	Show H	lidden

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- 3. Similar to creating the trace, click three times in the 3D modeler window for an arbitrary box
 - first click to define the position of the box
 - second click to specify the lateral dimensions
 - third click to create the height of the box

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Create Ground Plane

4. Specify the dimensions and position with variables

Prope	rties:	helloHFSS - via	and_trace - Modeler				×
Con	mark	1					
		Name	Value	Unit	Evaluated Value	Description	
		Command	CreateBox				
		Coordinate Sys	Global				
		Position	-w_plane/2 .1_plane/2 .1_dielectric1_plane		-10mm , -20mm		
		XSize	w_plane		20mm		
		YSize	I_plane		40mm		
		ZSize	t_plane		0.1mm		
						Show Hidden	
-							
						ОК	Cancel

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Create Ground Plane

5. Change the attributes

Double click on **Box 1**, rename it as **GND**, set the color to **green**, and modify the transparency to 0.7.

Nar	ne	Value	Jnit	Evaluated Value	Description	Read-only
Name	GND					
Material	"pec"			"pec"		
Solve In:	ide					
Orientatio	in Global					Γ
Model		~				Γ
Display \	Virefra					Γ
Color						
Transpar	ent	0.7				

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Create Ground Plane

Side-view of the ground plane and the trace(pad)



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Create Ground Plane

3D-view of the ground plane and the trace(pad)



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Create Anti-Pad

1. Define variables

 $\label{eq:HFSS} HFSS \Rightarrow \text{Design Properties} \Rightarrow \text{add } r_{-antipad} = 1 \ \text{mm}, \ \text{the height of the} \\ \text{anti-pad should be identical to the thickness of the ground plane}$

• V	alue	C Optimization	1	C Tuning	C Sensitivity	C Statistics		
	Name	Value	Unit	Evaluated Value	Type	Description	Read-only	Hidden 🔺
	t_trace	0.1	mm	0.1mm	Design			
	r_pad	0.75	mm	0.75mm	Design			
	t_pad	0.1	mm	0.1mm	Design			
	t_plane	0.1	mm	0.1mm	Design			
	w_plane	20	mm	20mm	Design			
	Lplane	40	mm	40mm	Design			
	t_dielectric	0.1	mm	0.1mm	Design			
	r_antipad	1	mm	1mm	Design			
•								+

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Create Anti-Pad

2. Draw a cylinder

 $Draw \Rightarrow Cylinder and specify the dimensions with variables.$

Propert	ies: helloHFSS - via	and_trace - Modeler			1		×
Comm	hand						
	Name	Value	Lint	Evaluated Value	Deec	notion	
	Command	CreateCylinder	one		0000	-puon	
	Coordinate Sys	Global					
	Center Position	0mm .0mm .t_dielectric.t_plane		0mm , 0mm , -0			
	Axis	Z					
	Radius	r_antipad		1mm			
	Height	t_plane		0.1mm			
	Number of Seg	0		U			
							_
					Show	Hidden	
					ОК		Cancel

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Create Anti-Pad

3. Change the attributes

Double click on Cylinder 1 for its attribute and rename it as Antipad



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Create Anti-Pad

4. Boolean Operation

- $\bullet~\mathsf{Edit} \Rightarrow \mathsf{Select} \Rightarrow \mathsf{By}~\mathsf{Name} \Rightarrow \mathsf{select}~\mathsf{GND}$ and Antipad
- Modeler \Rightarrow Boolean \Rightarrow Subtract \Rightarrow Bland parts: GND; Tool parts: Antipad \Rightarrow Click OK

Subtract			
Blank Parts		Tool Parts	
GND	>	Antipad	
	<		
	-		
Clone tool object	s before (operation	
OK	1	Cancel	
	_		

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Create Anti-Pad





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Assign Excitation

1. Draw Rectangle

- $\bullet \ \ \mathsf{Modeler} \Rightarrow \mathsf{Grid} \ \mathsf{Plane} \Rightarrow \mathsf{XZ}$
- Draw \Rightarrow Rectangle
- Specify the dimensions as the figure below

nma	es: helloHFSS - via, and	and_trace - Modeler			
Γ	Name	Value	Unit	Evaluated Value	Description
	Command	CreateRectangle			
	Coordinate Sys	Global			
	Position	-w_trace/2 .1_trace .4_dielectric		-0.5mm , -10mm	
	Axis	Y			
	XSize	w_trace		1mm	
IΓ	ZSize	t_dielectric		0.1mm	
				Г	Show Hidden
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Assign Excitation

2. Rename as source

Double click on Rectangle 1 and rename it as source



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Assign Excitation

3. Assign lumped port

- Edit \Rightarrow Select \Rightarrow By Name \Rightarrow select source \Rightarrow HFSS \Rightarrow Excitations \Rightarrow Assign \Rightarrow Lumped port
- Set the lumped port as shown in the picture: Port name to 1; select conductor GND and check ✓ Use as Reference; check ✓ Highlight selected conductors ⇒ Click OK

Assign Excitation

R R	eference Conductors for Ter	minals 💌
P. T	ort Name: 1 eminal Naming	tors Inuckion a
p	art must all be connected in the	plane of the port.
	Conductor	Use as Reference
	GND	
4	Highlight selected conductors	Cancel

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Assign Excitation

- 4. Renormalizing impedance
 - In the Project Manager, expand Excitations and rename *trace_T1* as **T1**
 - The renormalizing impedance of the lumped port is by default 50 Ohms

			* ×	🗆 🖉 Solids
⊨	race (Driv	en Terminal)		Terminal
🗃 Bounda ⊕ 🚭 Excitatio	ries Ins			General Defaults
i⊟- 1 i…∲	T1		=	Name: T1
👪 Mesh O 🔊 Analysia	perations			Port Name: 1
- 🧑 Optimet	ics			Terminal Renormalizing Impedance
Project			-	Resistance: 50 ohm 💌
operties			• ×	
Name Value	Unit	Evaluated Value	•	
Name T1				Har Defende
Type Terminal				Use Derauts
Terminal R 50	ohm	50ohm		·
				OK Cancel

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Assign Excitation

5. Highlight the lumped port

Again under Excitations in the Project Manager, if you click on 1, the lumped port is highlighted.



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Image: A mathematical states and a mathem

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Create Multilayers by Duplication

1. Define variables

 $HFSS \Rightarrow Design Properties \Rightarrow add t_separate = 0.45 mm$

•	Value	Optimization		C Tuning	C Sensitivity	C Statisti
Г	Name	Value	Unit	Evaluated Value	Туре	Descri; 🔺
	t_dielectric	0.1	mm	0.1mm	Design	
	r_antipad	1	mm	1mm	Design	
- F	t_seperate	0.45	mm	0.45mm	Design	
	r_via	0.5	mm	0.5mm	Design	
- F	t_via	21_separate		0.9mm	Design	
	w_air	30	mm	30mm	Design	
- F	Lair	50	mm	50mm	Design	E
	t air	10	mm	10mm	Design	
	t_separate	0.45	mm	0.45mm	Design	*
	(

Create Multilayers by Duplication

2. Create Offset Coordinate System

 $\mathsf{Modeler} \Rightarrow \mathsf{Coordinate} \ \mathsf{System} \Rightarrow \mathsf{Create} \Rightarrow \mathsf{Relative} \ \mathsf{CS} \Rightarrow \mathsf{Offset}$



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Create Multilayers by Duplication

3. Set the Offset Coordinate System

Click on the 3D modeler window and set the Relative CS1 as shown in the figure

Type Name Referen	Relative RelativeCS1			
Name Referen	Relative(CS1			
Referer	The fail we could be			
- Incruice	ice CS Global			
Origin	Omm ,Omm ,t_si	parate	0mm , 0mm , -0	
X Axis	1.0.0	mm	1mm , 0mm , 0mm	
Y Point	0,1,0	mm	Omm , 1mm , Omm	

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Create Multilayers by Duplication

4. Perform the Duplication

- $\bullet \ \ \mathsf{Edit} \Rightarrow \mathsf{Select} \ \mathsf{All} \ \mathsf{Visible} \ \mathsf{or} \ \mathsf{CTRL} + \mathsf{A}$
- Modeler \Rightarrow Coordinate System \Rightarrow Set Working CS \Rightarrow RelativeCS1
- $\bullet \ \ \mathsf{Edit} \Rightarrow \mathsf{Duplicate} \Rightarrow \mathsf{Around} \ \mathsf{Axis}$
- Set the duplication parameters as shown in the picture in the next page

Create Multilayers by Duplication

4. Perform the Duplication

Duplicate Arour	id Axis			23
Axis:	ΘX	OY OZ	2	
Angle:	180	💌 deg	•	
Total number:	2	·		
Attach To Origi	nal Object:			
NOTE: When face/edge assi on duplicates w consistency, w	Attach to 0 gnments (e. rill be lost, ti nen 'Total N	Iriginal Objec g. boundarie o ensure moo lumber' is ed	t' is select s/excitatio lel ited.	ed, ons)
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Create Multilayers by Duplication

Side-view of the multilayered structure



Create Multilayers by Duplication

3D-view of the multilayered structure



Create Via

- 1. Define variables
 - \bullet Modeler \Rightarrow Coordinate System \Rightarrow Set Working CS \Rightarrow RelativeCS1
 - HFSS \Rightarrow Design Properties \Rightarrow add $t_via = 2 * t_separate$ and $r_via = 0.5 \text{ mm}$

Г	Name	Value	Unit	Evaluated Value	Туре	Descrit A
F	t_dielectric	0.1	mm	0.1mm	Design	
F	r antipad	1	mm	1mm	Design	
E		0.45		A 15		
H	r via	0.5	mm	0.5mm	Design	
H	t via	21 separate		0.9mm	Design	
h	w_air	30	mm	30mm	Design	
F	l_air	50	mm	50mm	Design	1
F	t_air	10	mm	10mm	Design	
F	t_separate	0.45	mm	0.45mm	Design	
1						

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Create Via

2. Draw a cylinder

 $\mathsf{Draw} \Rightarrow \mathsf{Cylinder}$ and specify the dimensions and position as the figure below

Properties	helloHFSS - via_	and_trace - Modeler				×
Comman	d					
	Name	Value	Unit	Evaluated Value	Description	
	Command	CreateCylinder				_
	Coordinate Sys	Global				
	Center Position	0mm .0mm21_seperate		0mm , 0mm , -0		
	Axis	Z				
	Radius	r_via		0.5mm		
	Height	t_via		0.9mm		
	Number of Seg	0		0		
					C Show Hidden	
					ОК С	ancel

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Create Via

3. Change attributes

Double click on Cylinder 1 and rename it as Via

_						
	Name	Value	Unit	Evaluated Value	Description	Read-only
	Name	Via				
	Material	"pec"		"pec"		
Г	Solve Inside					
Г	Orientation	Global				
Г	Model	~				
	Display Wirefra					
Г	Color					
	Transparent	0.5				
					⊏ sr	iow Hidden

Image: A image: A

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Create Dielectric Layer

1. Select material

Use 3D modeler materials toolbar, choose vacuum



3.5

Create Dielectric Layer

2. Draw Box

 $\mathsf{Draw} \Rightarrow \mathsf{Box}$ and specify the dimensions and position as the figure below

Command CheckeBax Condrate Sys, Global Global Poston w_plane (2, 1)pare/2, 21_separate XSta w_plane VSta w_plane ZSta 21_separate	-10mm , -20mm 20mm 40mm	
Coolinne Sys. Gobal Poston w plane/2 , johne/2 , 21_separate XSte w plane YSte Lafare ZSte 21_separate	-10mm , -20mm 20mm 40mm	
Postion wybine?2./21_seperate XSte wybine YSte Lptere ZSte 21_seperate	-10mm , -20mm 20mm 40mm	
Xite w_plane YSite Uplane ZSite Z1_separate	20mm 40mm	
VSte Lplane ZStre 21_seperate	40mm	
ZSize 21_seperate		
	0.9mm	

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Create Dielectric Layer

3. Change attributes Rename it as board

Г	Name	Value	Unit	Evaluated Value	Description	Read-only
	Name	board				
	Material	"vacuum"		"vacuum"		
	Solve Inside	v				
Г	Orientation	Global				
Г	Model	~				
	Display Wirefra					
	Color					
	Transparent	0.7				

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Create Airbox

1. Define variables

Define $w_air = 30 \text{ mm}$, $l_air = 50 \text{ mm}$, and $t_air = 10 \text{ mm}$

¢	Value	Optimization	,	C Tuning	C Sensitivity	C Statistics		
Г	Name	Value	Unit	Evaluated Value	Туре	Description	Read-only	Hidden 🔺
ľ	t_dielectric	0.1	mm	0.1mm	Design			
ľ	r_antipad	1	mm	1mm	Design			
h	t_seperate	0.45	mm	0.45mm	Design		Г	
h	r_via	0.5	mm	0.5mm	Design		Г	
	1			0.0	n		-	
ŀ	w air	30	mm	30mm	Design			
ŀ	l_air	50	mm	50mm	Design		Г	
È	t_air	10	mm	10mm	Design			
1	•			m				÷
						- 1	Show H	idden

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Create Airbox

2. Draw Box

 $\mathsf{Draw} \Rightarrow \mathsf{Box}$ and specify the dimensions and position as the figure below

Properties	: helloHFSS - via	and_trace - Modeler			_	×
Comman	d					
	Name	Value	Unit	Evaluated Value	Description	
	Command	CreateBox				
	Coordinate Sys	Global				
	Position	<pre>w_air/2 .4_air/2 .4_air/2</pre>		-15mm25mm		
	XSize	w_air		30mm		
	YSize	l_air		50mm		
	ZSize	t_air		10mm		
					Show Hidden	
					ОК	Cancel

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Create Airbox

3. Change attributes

Rename it as air

	Name	Value	Unit	Evaluated Value	Description	Read-only	
Г	Name	air					
	Material	"vacuum"		"vacuum"			
Г	Solve Inside	~					
	Orientation	Global					
Г	Model	~					
	Display Wirefra	~					
	Color						
Г	Transparent	1					

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- 4. Assign perfect-H boundary
 - $\bullet \ \mathsf{Edit} \Rightarrow \mathsf{Select} \Rightarrow \mathsf{By} \ \mathsf{Name} \Rightarrow \mathsf{air} \Rightarrow \mathsf{Click} \ \mathsf{OK}$
 - $\bullet \ \mathsf{HFSS} \Rightarrow \mathsf{Boundaries} \Rightarrow \mathsf{Assign} \Rightarrow \mathsf{Perfect} \ \mathsf{H} \Rightarrow \mathsf{Click} \ \mathsf{OK}$
- 5. Override Material
 - HFSS \Rightarrow Design Settings \Rightarrow Enable Material Override
 - check \checkmark Enable Material Override
 - click OK

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Create an Analysis Setup

1. Create an Analysis

 $\mathsf{HFSS} \Rightarrow \mathsf{Analysis} \; \mathsf{Setup} \Rightarrow \mathsf{Add} \; \mathsf{Solution} \; \mathsf{Setup} \Rightarrow \mathsf{General} \; \mathsf{tab}$

- Solution Frequency: 10 GHz
- Maximum number of passes: 20
- maximum Delta S: 0.02

Driven Solution Setup	
General Options Advanced Expres	sion Cache Derivatives Defaults
Setup Name: Setup1	
🔽 Enabled	C Solve Ports Only
Solution Frequency: 10	GHz 💌
Adaptive Solutions	
Maximum Number of Passes:	20
Maximum Delta S	0.02
C Use Matrix Convergence	Set Magnitude and Phase.
Uee C	efsuite
	OK Cancel

Create an Analysis Setup

2. Options tab

Initial Mesh Ontions	ion coune Dein	dives Deladic			
Do Lambda Refinement		lefault Value	1		
Use Free Space Lambda	10 000 0				
Adaptive Options					
Maximum Refinement Per Pass:	30	74			
Maximum Refinement:	1000000				
Minimum Number of Passes:	1				
Minimum Converged Passes:	2				
Solution Options					
Order of Basis Functions:	Zero Order	-			
Enable Iterative Solver	·				
Relative Residual:	0.0001				
Enable Use of Solver Domains					
Use De	faults				

Create an Frequency Sweep

3. HFSS \Rightarrow Analysis Setup \Rightarrow Add Frequency Sweep \Rightarrow Edit the sweep as the figure below \Rightarrow click OK

weep Name: Sweep			🔽 En	abled
weep lype: Fast				
Trequency Setup	[#	Frequency	-
Type: LinearCount 💌		1	0.1GHz	
Start 0.1 GHz V	Display >>	2	0.11GHz	
		3	0.12GHz	
Stop 10 GHz -		4	0.13GHz	
Count 991	ĺ	5	0.14GHz	
		6	0.15GHz	
Time Domain Calculation		7	0.16GHz	
		8	0.17GHz	
3D Fields Save Ontions		9	0.18GHz	
Save Belde		10	0.19GHz	
		11	0.2GHz	
Generate fields at ealure time		12	0.21GHz	
(All Frequencies)		13	0.22GHz	-
		_		Ŧ

Validation Check and Analyze All

- 4. HFSS \Rightarrow Validation Check
 - click Close if all pass
 - Use Message Manager to view any warning or error message

Validation Check: helloHFSS - via_and_trace	X
Via_and_trace Validation Check completed	Design Settings 3D Model Boundaries and Excitations Mesh Operations Analytis Setup
Abort Close	 Optimetrics Radiation

5. HFSS \Rightarrow Analyze all

Plot S-parameters vs. Frequency

- 6. HFSS \Rightarrow Results \Rightarrow Create Terminal Solution Data Report \Rightarrow Rectangular Plot
 - Solution: Setup1:Sweep1
 - Domain: Sweep
 - Category: Terminal S Parameters
 - Quantity: St(T1,T1), St(T1,T2)
 - Function: dB

Plot S-parameters vs. Frequency

Report: helloHFSS - via_and_trace - New Report - New Trace(s)								
Solution: Setup 1 : Sweep	Trace Families Families Display Primary Sweep: Freq X: I Default Freq	/ - Al	<u> </u>					
Update Report	Y: (B(St(T1,T1)); B(St(T1, Category: Variables Catant Vanables Example Stanmeter Terminal Parameter Terminal Parameter	T2)) Quantity: St(T1,T1) St(T2,T2) St(T2,T2)	Range Function: crone> ang_red ang_red cang_deg cang_deg cang_deg cang_deg cang_deg cang_deg cang_deg cang_red d82 mag normalze re					
Output Variables Options	New Report Apply Trace	Add Trace	Close					

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Plot S-parameters vs. Frequency



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