Microwave Project

E-plane Tee Design

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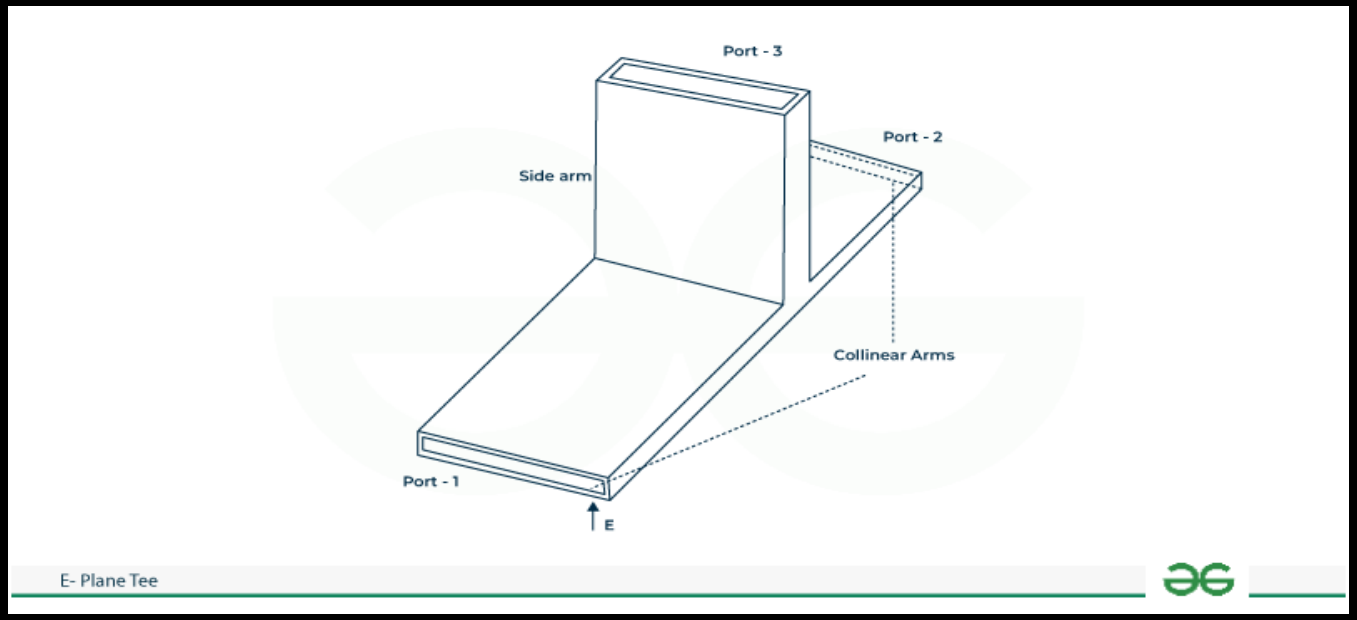
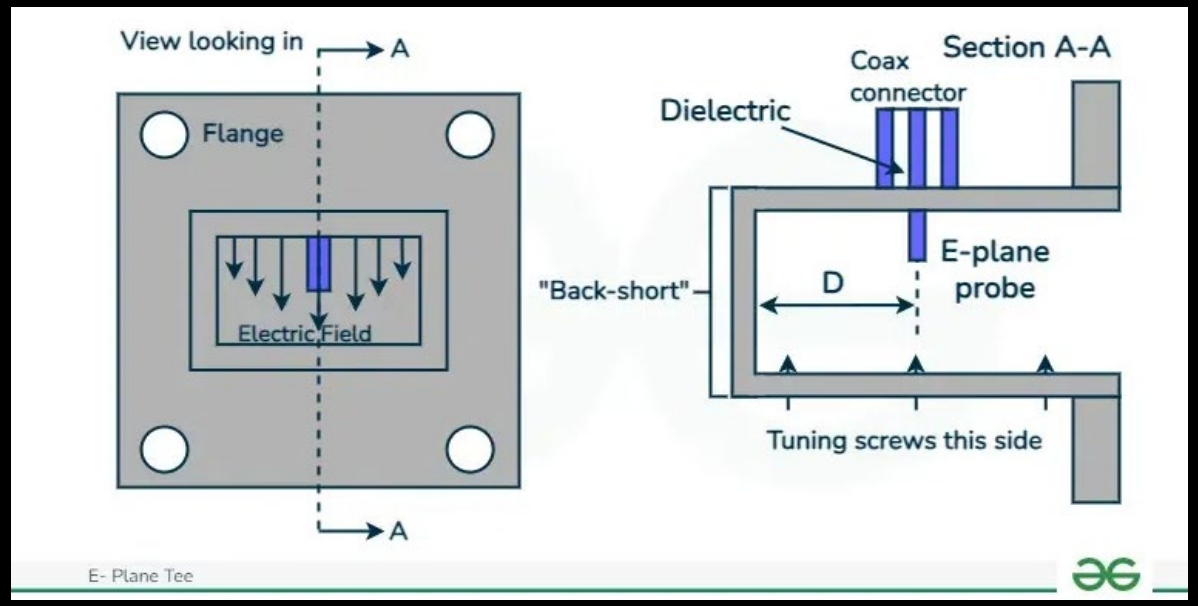
An E-Plane Tee also known as a waveguide Tee is a device made of two waveguides connected. It is made by joining a waveguide to another rectangular waveguide that already has two ports. Therefore, the shape of the whole device resembles the letter 'T' in the English alphabet, giving it the name 'Tee'. The figure given below represents a basic E-Plane Tee.



In an E-Plane Tee, the axis of the side arm is parallel to the Electric Field (E) of the collinear arms which is a critical property of this device. If we carefully observe, the E-plane Tee is a 3-port device. In general, the input is given at port 3 and then the signal is obtained from port 1 and port 2.

E-Plane Tee Circuit Model



•**Co-Axial Cable:** The ports of an E-Plane Tee are connected to other components of the circuit using a co-axial cable. Proper termination of co-axial cable is necessary to ensure impedance matching. The co-axial cable should be able to match the characteristic impedance of Tee. This is how cable ensures proper signal transmission.

•**E-Plane Tee:** The E-Plane Tee forms one essential component of the circuit. It performs the task of combining or splitting the input wave depending on the application it is being used for. The input is generally fed at port 3 and then the Tee splits the input to generate output at the two ports, port 1 and port 2.

•**Terminations:** At the end of each port reflections can occur and distort the signals therefore terminations are applied to minimize signal loss through reflections. This is how power is transmitted efficiently.

•**Signal Monitoring:** A probe can be used to measure the signal at certain points. The probe is connected in a way such that it helps to test the signal at a specific port without causing any trouble to the signal.

The difference between E-plane and H-plane

Aspect	E-Plane	H-Plane
Definition	The E-plane refers to the plane where the electric field ($\vec{E}$) is oriented. In this plane, the electric field is parallel to the waveguide's broad sides.	The H-plane refers to the plane where the magnetic field ($\vec{H}$) is oriented. In this plane, the magnetic field is perpendicular to the electric field and lies in the waveguide's narrow direction.
Field Orientation	The electric field is parallel to the broad walls of a rectangular waveguide.	The magnetic field is parallel to the narrow walls of a rectangular waveguide.
Waveguide Mode	The waveguide supports TE (Transverse Electric) modes, where the electric field lies in the E-plane.	The waveguide supports TM (Transverse Magnetic) modes, where the magnetic field lies in the H-plane.
Relationship to Each Other	The E-plane is perpendicular to the H-plane. These two planes are orthogonal to each other.	The H-plane is perpendicular to the E-plane, and they define the two fundamental planes of wave propagation in a waveguide.
Electric Field	The electric field is oriented in the E-plane. This is the primary field that governs the wave's behavior in this plane.	The electric field is perpendicular to the magnetic field in the H-plane, so the orientation of the electric field is not in the H-plane.
Magnetic Field	The magnetic field is perpendicular to the E-plane, forming the H-plane.	The magnetic field is oriented in the H-plane, and it plays a significant role in guiding waves through this plane.
Wave Propagation	The wave propagates in the direction that is perpendicular to the E-plane (i.e., along the waveguide). The electric field's interaction with the waveguide walls helps guide the wave.	The wave propagates in the direction that is perpendicular to the H-plane. The magnetic field's interaction with the waveguide walls helps guide the wave in the H-plane.

- *The main difference between E-Plane and H-Plane Tee is the difference in their configuration and direction of the dominant electric field component. In E-plane tee, the electric field vector is parallel to the plane of the junction, and in H-plane tee, the magnetic field vector is parallel to the plane of the junction.*

Advantages of E-Plane Tee

- E-Plane Tee provides us with the combined features of a tee and a waveguide therefore it offers a variety of features like **combining and splitting** the original signal depending on our needs.

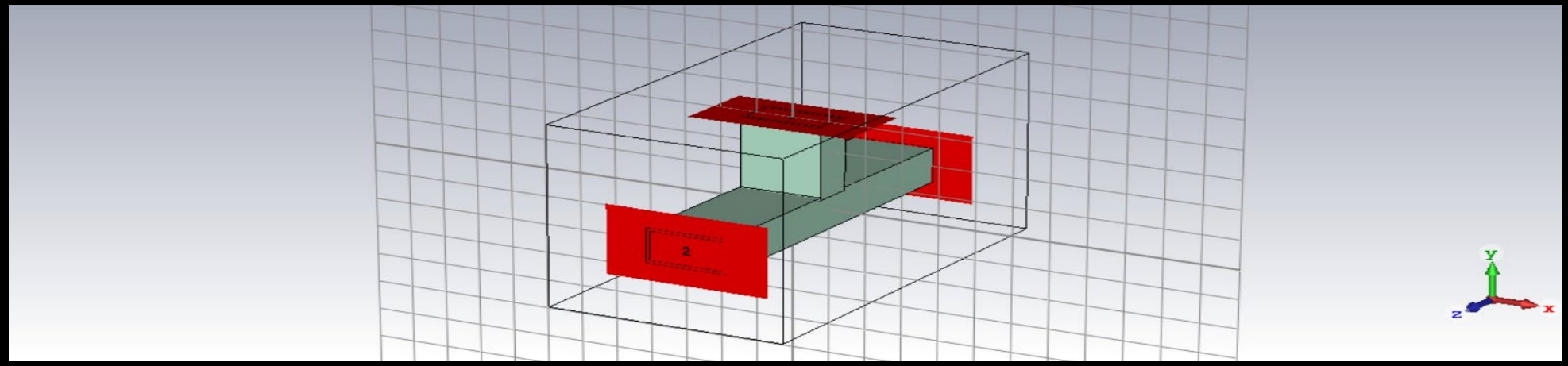
- One major advantage of the E-Plane Tee is the **low-cross coupling** between the arms. Due to the configuration of the E-Plane Tee, the coupling between any two arms is minimal which is important for isolation.

- The **symmetrical configuration** of the E-Plane Tee simplifies the design of the tee. The output generated is the same irrespective of the port used for input. This helps to generate consistent output irrespective of the port.

- The **small size and compact design** of the E-Plane Tee is useful since it allows using this tee in microwave circuits that are largely affected by the dimensions of the device.

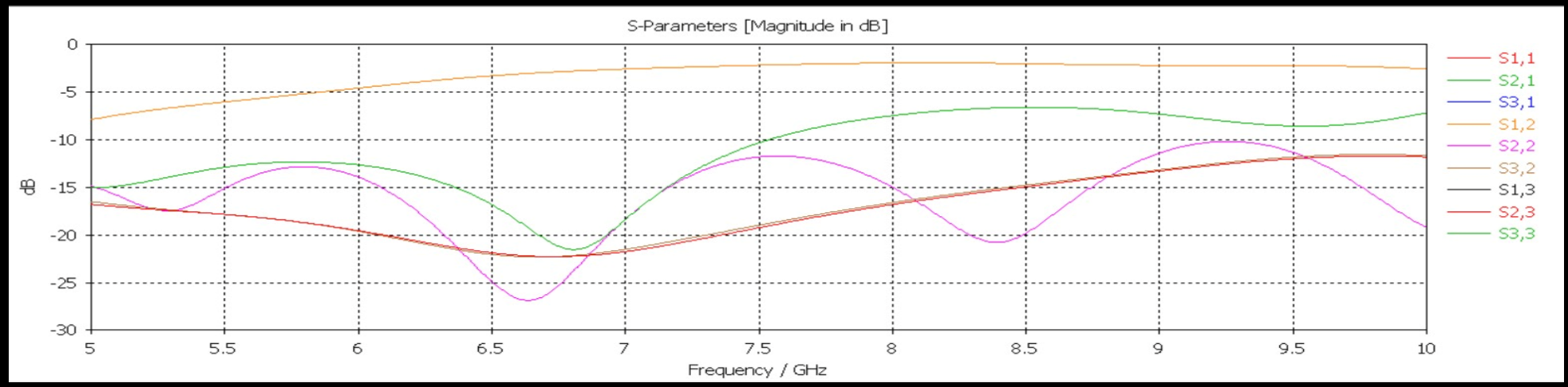
- E-Plane Tees are **versatile** since they can be used over a large frequency range.

Software implementation



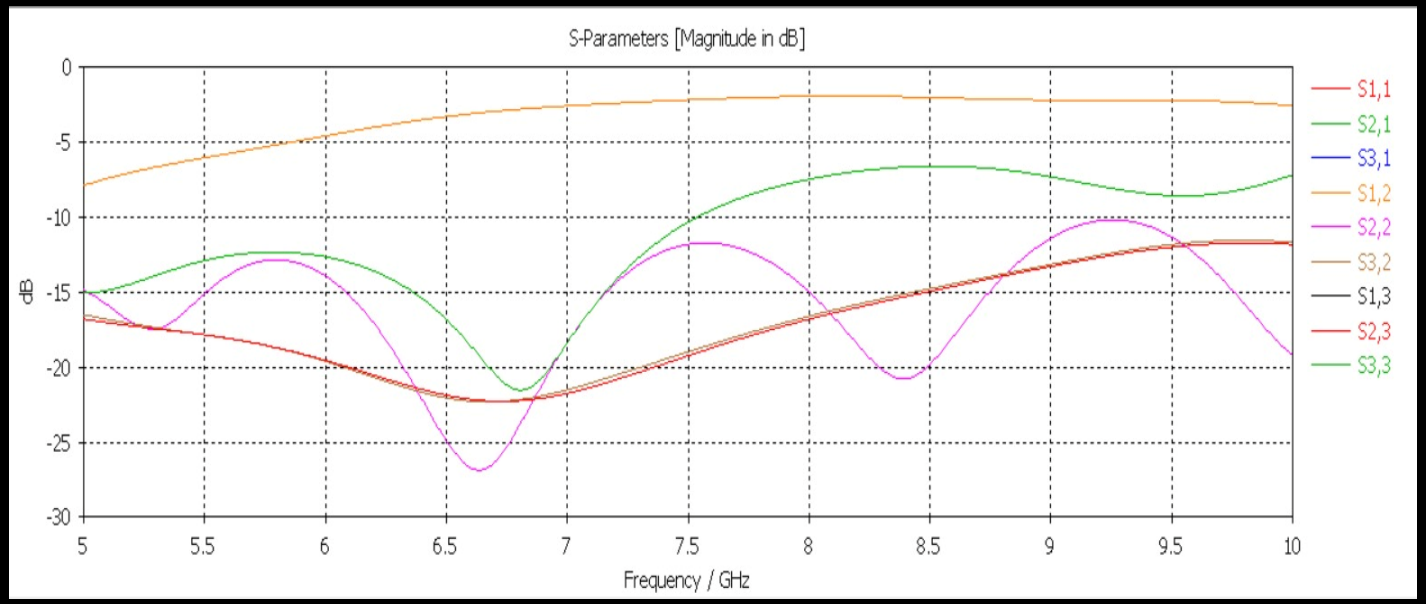
Parameter List

Name	Expression	Value	Description
a	= 11	11	width
b	= 6	6	heigth
c	= 50	50	depth
d	= 11	11	half dis between xmin,xmax
e	= 12.5	12.5	half dis between ymax,ymin
f	= 6	6	half dis between zmax,zmin



Result and visualization

Frequency	S1,1 input	S1,1phase	Ref input	RefPhase
Frequency	S1,1 [Mag	S1,1 [Pha	Ref.Imp. [	Ref.Imp. [Pha in deg.]
5	0.180911	94.05651	244.7112	0
5.005	0.18006	93.93882	244.7112	0
5.01	0.179188	93.8264	244.7112	0
5.015	0.178296	93.71969	244.7112	0
5.02	0.177385	93.61905	244.7112	0
5.025	0.176455	93.52492	244.7112	0
5.03	0.175508	93.43769	244.7112	0
5.035	0.174544	93.35778	244.7112	0
5.04	0.173563	93.28563	244.7112	0
5.045	0.172568	93.22164	244.7112	0
5.05	0.171558	93.16624	244.7112	0
5.055	0.170535	93.11985	244.7112	0
5.06	0.169499	93.0829	244.7112	0
5.065	0.168452	93.05582	244.7112	0
5.07	0.167395	93.03903	244.7112	0
5.075	0.166329	93.03297	244.7112	0
5.08	0.165255	93.03804	244.7112	0
5.085	0.164174	93.05467	244.7112	0
5.09	0.163088	93.08329	244.7112	0
5.095	0.161999	93.12429	244.7112	0
5.1	0.160907	93.1781	244.7112	0
5.105	0.159814	93.24509	244.7112	0
5.11	0.158721	93.32564	244.7112	0
5.115	0.15763	93.42016	244.7112	0



machine learning and pre processing

- https://colab.research.google.com/drive/1lZqQOYl7-S3kCj-YSzm7wt0yW0R3VNmQ?usp=sharing

END POINT

- At the end of the E-plane and Tee Design project, we were able to effectively bridge the gap between theoretical learning and practical experience. This project has opened our eyes to a whole new world of knowledge and skills that we didn't even imagine before. Here's how it helped us:

- 1.Designing with CST: When I designed the system on CST and set specific parameter values, I was able to visually observe their impact on the output. This allowed me to directly connect power and frequency, and understand how they interact in real-world applications.

- 2. Data Analysis: After generating the data file, I was able to study the relationship between the input and output, which helped me understand the specific characteristics of the E-plane Tee design more deeply.

- 3. Working with Machines: By working with the machines, I gained valuable experience in data preparation and processing before entering it into the model, ensuring the accuracy of our simulations.

- 4. Data Visualization and Model Selection: When I viewed the processed data, I was able to select the right model based on data visualization, making more informed decisions that aligned with the data.

- This project was truly eye-opening and provided us with a deeper understanding of how theory and practical application can work together. It has significantly expanded our technical knowledge and skills, and we feel much more confident in tackling complex engineering challenges in the future.

Thank you for listening