Experiment No. - 2

Aim- Design and simulate Quarter Wave transformer at f = 1 GHz.

Software Required- CST studio

Theory

A quarter-wave impedance transformer, often written as λ/4 impedance transformer, is a transmission line or waveguide used in electrical engineering of length one quarter wavelength (λ), terminated with some known impedance. It presents at its input the dual of the impedance with which it is terminated.

The relationship between the characteristic impedance, Z0, input impedance, Zin and load impedance, ZL is:

Alternatives to the quarter-wave impedance transformer include lumped circuits that can produce the impedance inverter function, and stubs for impedance matching.

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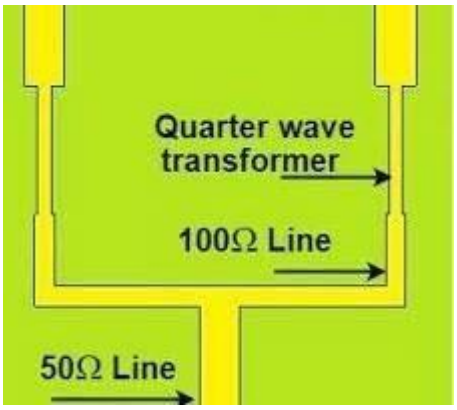
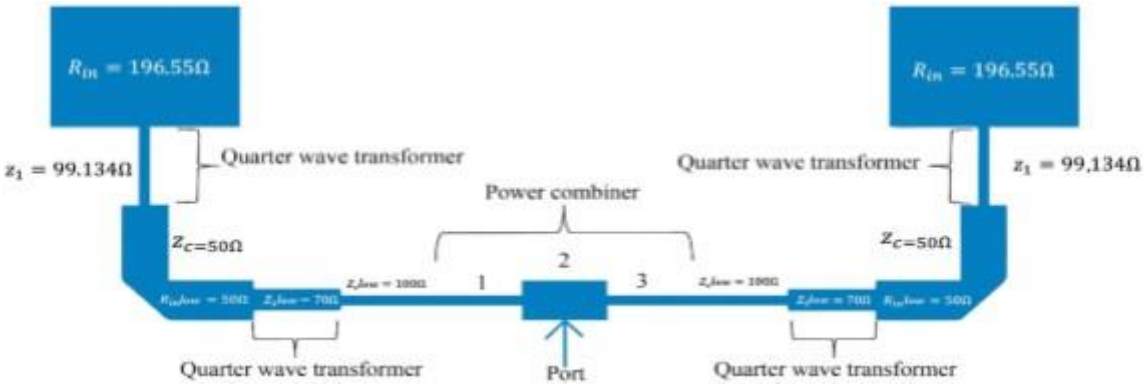


Fig- quarter wave transformer



Formula

A quarter-wave transformer is a transmission line segment that transforms the impedance at one end to a different impedance at the other end. The characteristic impedance (\(Z_0\)) of the quarter-wave transformer and the input and output impedances (\(Z_{\text{in}}\) and \(Z_{\text{out}}\)) are related by the following formula:

$$Z_0 = \sqrt{Z_{\text{in}} \cdot Z_{\text{out}}}$$

Where:
Z0 is the characteristic impedance of the quarter-wave transformer,
Zin is the input impedance,
Zout is the output impedance.

This formula assumes that the quarter-wave transformer is an ideal transmission line and that there are no losses in the line.

Procedure

Designing a Quarter Wave Transform using CST Microwave Studio (CST MWS) involves several steps. Below is a general procedure for designing Quarter Wave Transform, along with measurements you can perform in CST:

Step 1: Define Specifications

Determine the operating frequency (f0) is 2 GHz of the Quarter Wave Transform.
Design Substrate taking material, Rogger 5870(Lossy).
Design Ground with Copper(annealed) Material.
Choose the size and shape of the Quarter Wave Transform.

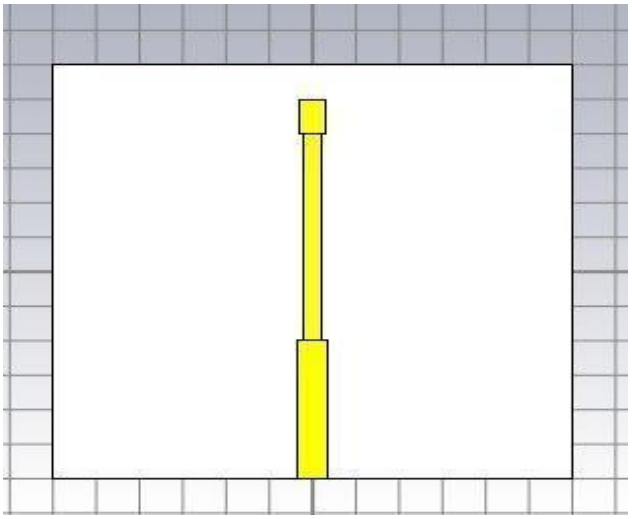
Step 2: Initial Design

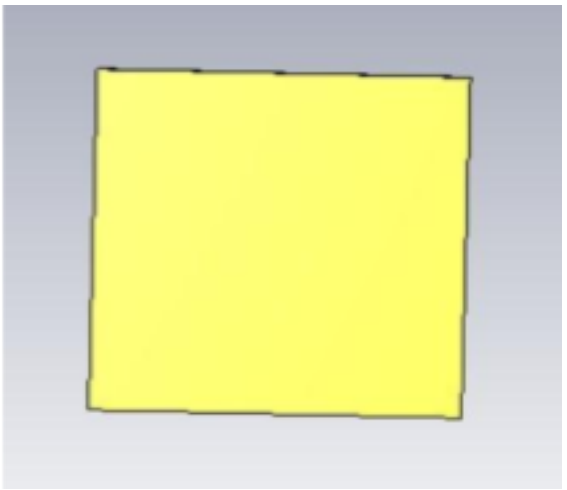
Create a new project in CST MWS.
Choose the Time Domain solver and set up the simulation environment.
Start with an initial design of the Quarter Wave Transform based on given

specifications. Step 3: Simulation and Optimization

Simulate the initial design to obtain the radiation pattern, impedance matching, and other relevant characteristics.
Use the optimization tools in CST to fine-tune the Quarter Wave Transform (e.g., size, shape) to meet your specifications.
Iterate the optimization process until the desired antenna performance is achieved.

DESGIN:

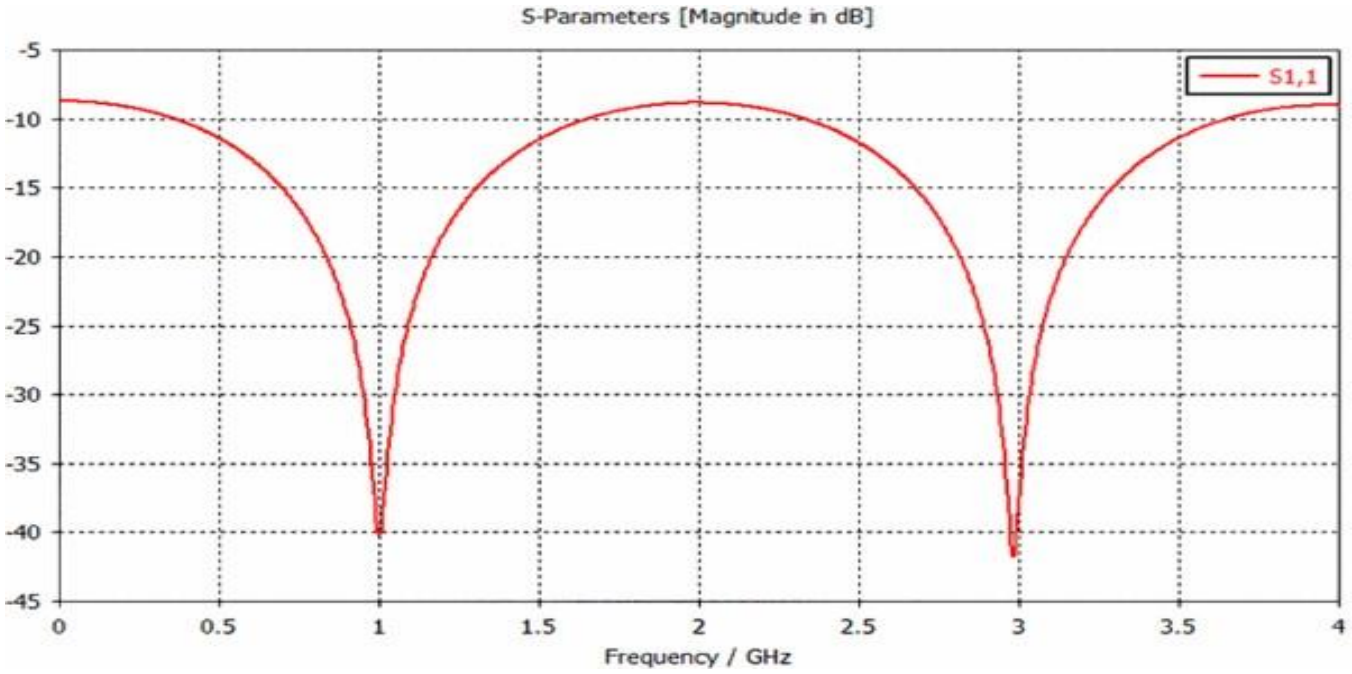




Parameters table:

Parameter	Value	Description
h	0.787 mm	Substrate thickness
t	0.035 mm	Metallization thickness
eps_r	4.3	Substrate permittivity
Z0	50 Ω	System characteristic impedance
RL	100 Ω	Load impedance
W50	2.35 mm	50 Ω line width
W70	1.23 mm	70.71 Ω line width
l70	24.5 mm	Transformer length

RESULT:



Conclusion:

A quarter-wave transformer is a simple impedance transformer which is commonly used in impedance matching in order to minimize the energy which is reflected when a transmission line is connected to a load. The quarter-wave transformer uses a transmission line with different characteristic impedance and with a length of one-quarter of the guided-wavelength to match a line to a load and we simulate and get the result.