KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (KIIT)

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LABORATORY RECORD – AUTUMN 2020

MICROWAVE ENGINEERING LAB (EC 3015)

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ROLL NO: 1804373

Section: ETC-06

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Experiment Number	01
Date of Experiment	12/08/2020
Date of Submission	16/08/2020
Name of the student	Debagnik Kar
Roll Number	1804373
Section	ETC – 06

Aim of The Experiment :-

To design a quarter wave transformer for matching a 50 Ω microstrip line with a load of 173Ω

Equipment / Software Required:-

CST Studio Suite 2019 (Student Edition)

Theory:

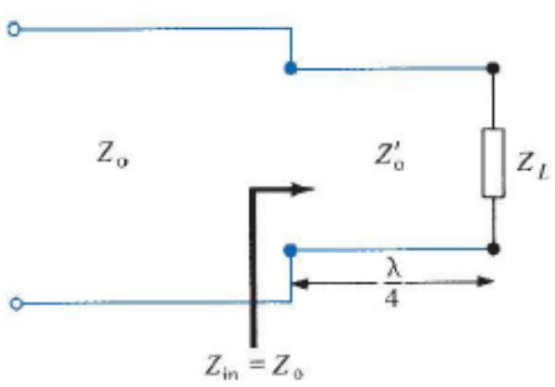

Fig 1: Load matching using a quarter wave transformer

When $Z_0 \neq Z_L$, the load is said to be mismatched and a reflected wave exist. So we use quarter wave transformer for impedance matching.

When $l = \frac{\lambda}{4}$,

$$Z_{in} = Z_0 \left[\frac{Z_L + \frac{jZ_0 \tan\pi}{2}}{Z_0 + \frac{jZ_L \tan\pi}{2}}\right] = \frac{Z_0^2}{Z_L}$$

(1)

A mismatched load can be properly matched to a line (with characteristic impedance Z_0) by inserting prior to the transmission line λ/4 long (with characteristic impedance Z_0') as depicted in Fig.1.

From (1), Z'_0 is selected such that (Z_{in}=Z_0)

Therefore,

$$Z_0^{|} = \sqrt{Z_0 Z_L} \quad (2)$$

Note: When microstrip line is used, then guided wavelength must be used ,i.e,

$$\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{eff}}}$$

(3)

where, λ_g= guided wavelength.

When $Z_0 \neq Z_L$, the load is said to be mismatched and a reflected wave exist. So we use quarter wave transformer for impedance matching.

When $l = \frac{\lambda}{4}$,

$$Z_{in} = Z_0 \left[\frac{Z_L + \frac{jZ_0 \tan\pi}{2}}{Z_0 + \frac{jZ_L \tan\pi}{2}}\right] = \frac{Z_0^2}{Z_L}$$

(1)

A mismatched load can be properly matched to a line (with characteristic impedance Z_0) by inserting prior to the transmission line λ/4 long (with characteristic impedance Z'_0) as depicted in Fig.1.

From (1), Z'_0 is selected such that (Z_{in}=Z_0)

Therefore,

$$Z_0^{'} = \sqrt{(Z_0 Z_L)}$$

Z_0 = 50

Z_L = 173

$Z_0' = \sqrt{(50 \times 173)}$

$Z_0^{'} = 93.01\ \Omega$ (2)

Note: When microstrip line is used, then guided wavelength must be used ,i.e,

$$\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{eff}}} \quad (3)$$

where, λ_g= guided wavelength.

Substrate: FR4 (Lossless) ($\varepsilon_r = 4.3$)

Width of the substrate is 50 mm and the length is 100 mm

h = 1.6 mm

t = 0.2 mm

W = 2.93 mm (determined using Analysis and synthesis of transmission lines)

$\mathcal{E}_{eff}$ = 3.204

$Z_0^{'} =$ 93.01 Ω length = 17 mm

Therefore, width of the quarter wave line is 0.87mm

Design:

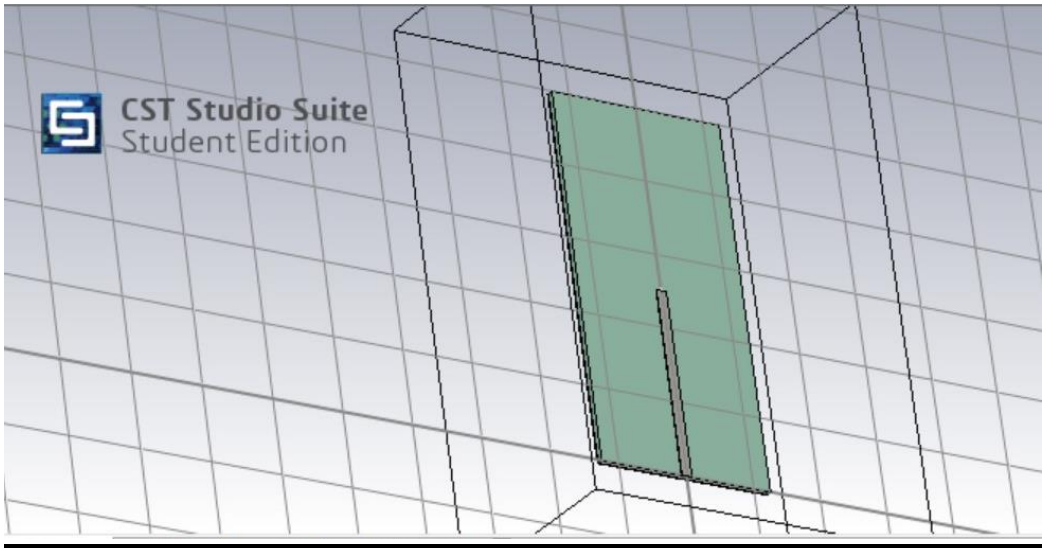

Fig 2: Design of microstrip line terminated with the desired load.

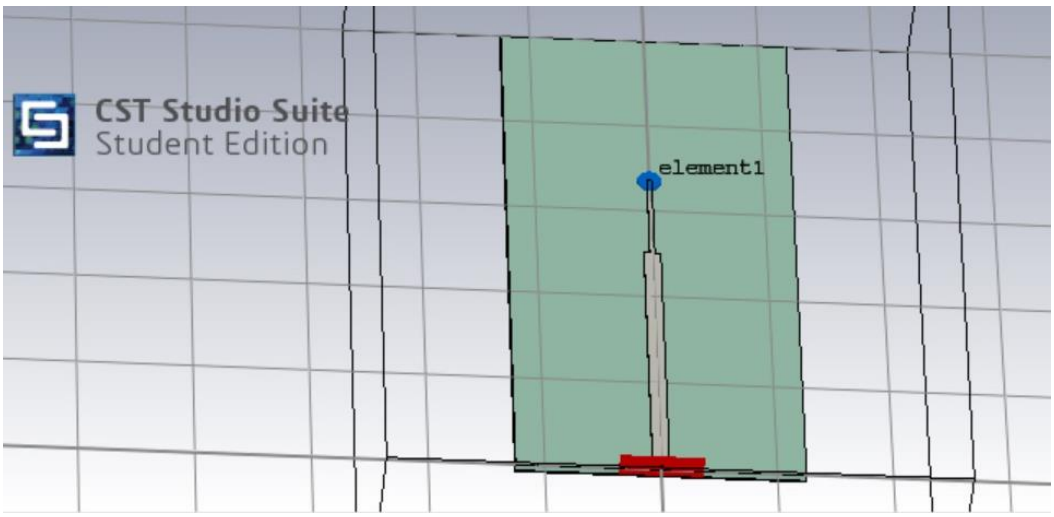

Fig 3: Design of microstrip line terminated with quarter wave line and desired load

Output/Graph:-

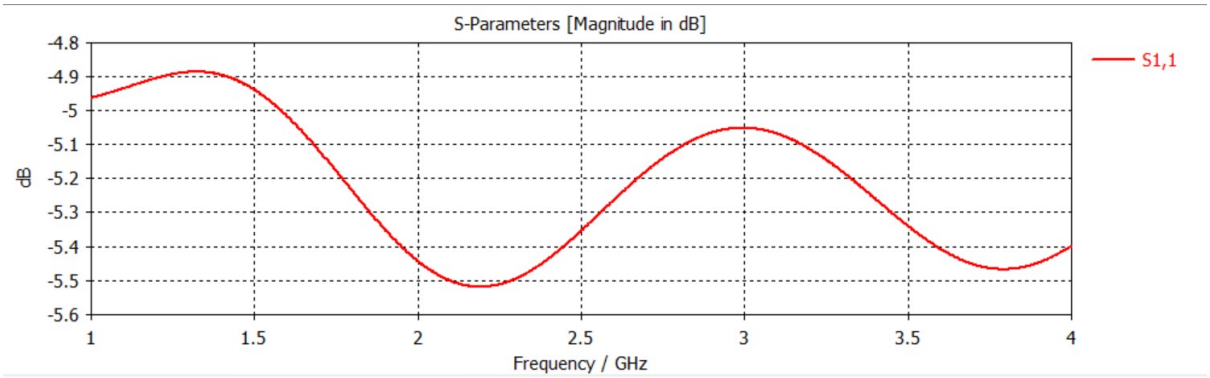

Fig 4: Result of the design of the microstrip line

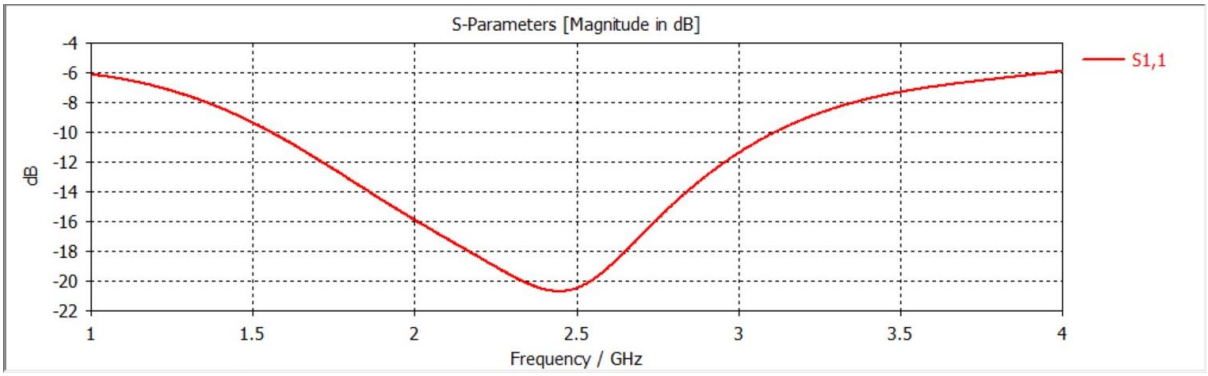

Fig 5: Result of the design of the microstrip line terminated by quarter wave line.

Observation of the experiment:

- For fig 4, No resonance is observed around 2.4 GHz which implies impedance mismatch.
- For fig 5, an impedance is achieved at 2.4 GHz by using a quarter wave transformer.

Conclusion:-

The designing of a quarter wave transformer for matching a 50 Ω microstrip line with a load od 173 Ω is successfully achieved.