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Course Code:

Course Title: ***Sessional Based on*** ____________

Experiment No: 02

Experiment Name: Design a Micro Strip Patch Antenna at Resonant Frequency of f = 1.43 GHz (800+21*30 MHz) Using CST Studio Suite.

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Year:3rd Year EVEN Semester
Experiment Date:
Submission Date:

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Experiment Name: Design a Micro Strip Patch Antenna at Resonant Frequency of f = 1.43 GHz (800+21*30 MHz) Using CST Studio Suite.

2.1 Objectives:

1. To design an Microstrip Patch Antenna using CST Studio Suite.
2. To simulate the Microstrip Patch Antenna.
3. To observe the parameter of S parameter, return loss, gain, reference impedance & directivity of the antenna.

2.2 Theory:

The most common type of microstrip antenna is commonly known as patch antenna. Antennas using patches as constitutive elements in an array are also possible. A patch antenna is a narrowband, widebeam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common microstrip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible. Some patch antennas do not use a dielectric substrate and instead are made of a metal patch mounted above a ground plane using dielectric spacers; the resulting structure is less rugged but has a wider bandwidth. Because such antennas have a very low profile, are mechanically rugged and can be shaped to conform to the curving skin of a vehicle, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices.

Microstrip antennas are relatively inexpensive to manufacture and design because of the simple 2-dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonant frequency. A single patch antenna provides a maximum directive gain of around 6-9 dBi. It is relatively easy to print an array of patches on a single (large) substrate using lithographic techniques. Patch arrays can provide much higher gains than a single patch at little additional cost; matching and phase adjustment can be performed with printed microstrip feed structures, again in the same operations that form the radiating patches. The ability to create high gain arrays in a low-profile antenna is one reason that patch arrays are common on airplanes and in other military applications.

An advantage inherent to patch antennas is the ability to have polarization diversity. Patch antennas can easily be designed to have vertical, horizontal, righthand circular (RHCP) or lefthand circular (LHCP) polarizations, using multiple feed points, or a single feed point with asymmetric patch structures. This unique property allows patch antennas to be used in many types of communications links that may have varied requirements.

2.3 Measurements:

The most important three parameters considered for constructing a Microstrip patch antenna are given below.

- *Frequency of operation (f_0):* The antenna has been designed between the range of 1-2 GHz and 1.47 GHz is the default resonant frequency exclusive for this research arrangement.
- *Dielectric constant of the substrate ε_r:* Dielectric constant is one of the most important parameters in the Microstrip antenna and substrate is used. One ofthe most used materials is FR4, but it only supports the 2-4 GHz range. FR4 PCB is also not capable of handling high power at microwave frequencies. Its permittivity is 4.3.
- *Height of dielectric substrate (h):* Antennas used in phones are expected to be light in weight and small in size, which restricts their height. By substituting

c = 3108m/s, ε_r = 4.3 and f_0 = 1.43GHz, the values of antenna dimensions can easily be determined.

The following equations are used in designing the patch antennas,

$$Width = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}; \quad \varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$Length = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right)$$

Here,

C= The speed of light

ε_{eff}= The effective dielectric constant

h= The height of the substrate

Parameters	Values
Center Frequency	1.43 Ghz
Substrate	FR-4(Lossy)
Substrate Height	0.035 mm
Dielectric Constant	4.3
Length of Patch	49 mm
Width of Patch	62.5 mm
Substrate Length	100mm
Substrate Width	100mm
Width of Transmission Line	2.941mm
Dielectric Depth	1.5mm
Insite Width	1.5mm
Insite Length	5.16mm

Table: Measurement of different parameters.

2.4 Figure of An Antenna:

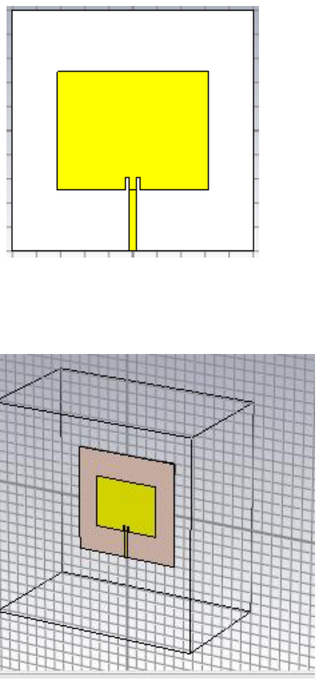

Fig 2.1: Microstrip Patch Antenna

2.5 Parameter Observation:

S-Parameter:

The simulated S-parameter versus frequency for the designed antenna at 1.43GHz. It is presented in below. It can be seen that the simulated center frequency is 1.43 GHz.

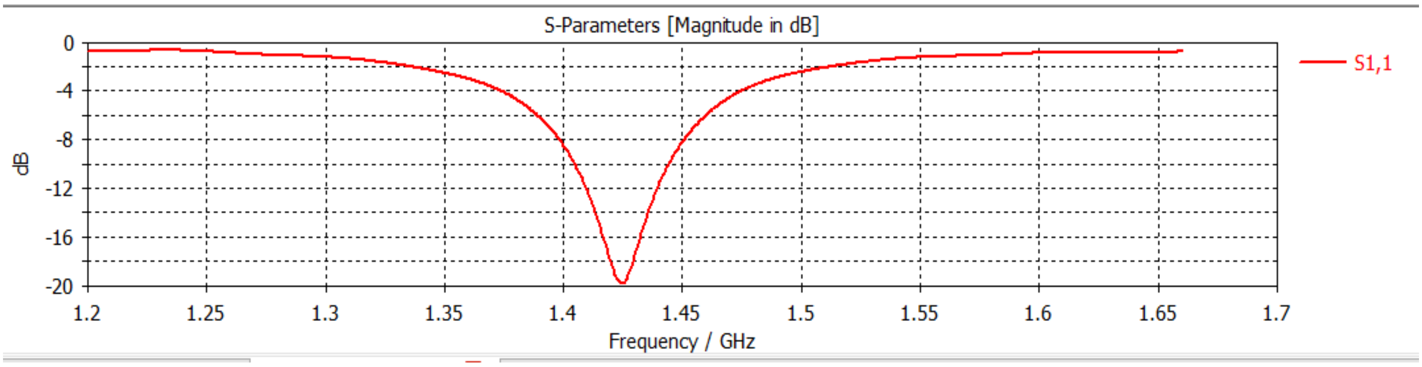

Fig 2.2: S_{11} Parameter.

Gain & Directivity:

The proposed antenna's gain at 2.03GHz is 2.536dBi, as shown in Fig. 2.3.1
In order to transmit or receive power, it is preferable to maximize the radiation pattern of the antenna response in a fixed direction. Similarly, the directivity is solely influenced by the radiation pattern's shape. According to Fig.2.3.2, the designed antenna's realized directivity at 1.43 GHz is 6.48 dBi.

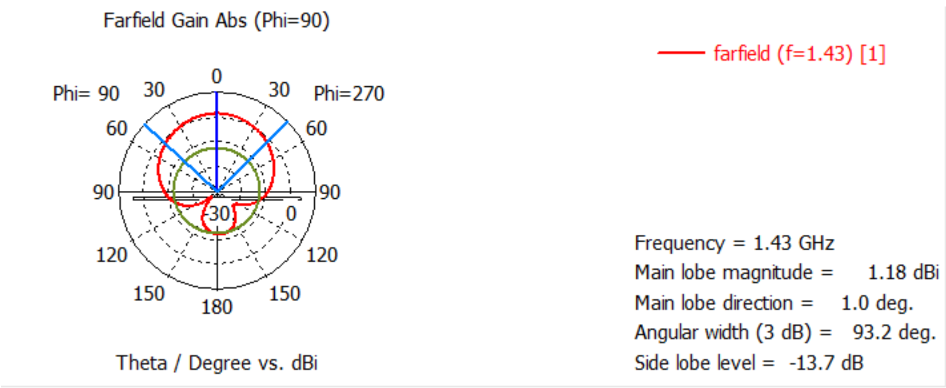

Fig 2.3.1: Gain

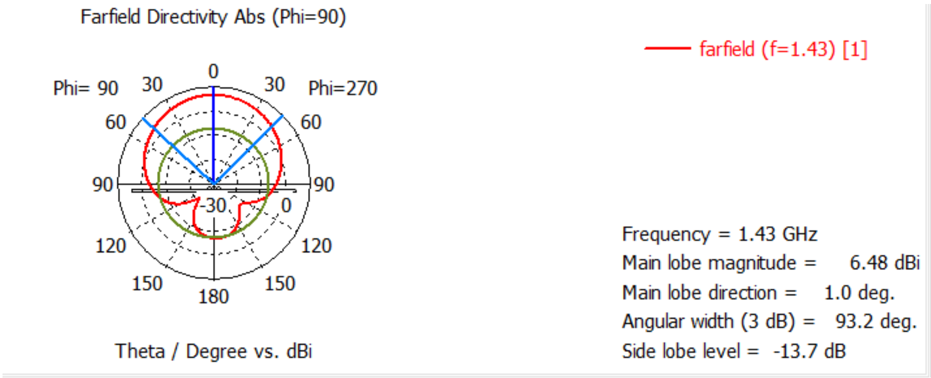

Fig 2.3.2: Directivity

Smith Chart:

The suggested antenna's smith chart is displayed in Fig. 2.5. It is a graphicdepiction of the characteristic impedance that has been normalized. The most practical graphical tool for high frequency circuit applications is the Smith chart.

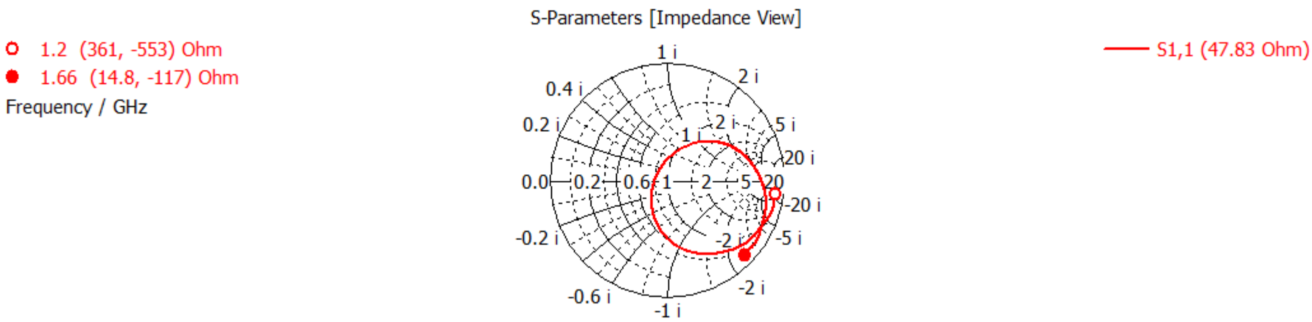

Fig 2.4: Smith Chart

Radiation Pattern:

The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna as a function of space. That is, the antenna's pattern describes how the antenna radiates energy out into space (or how it receives energy). Fig. 2.6 shows the radiation pattern of the simulated antenna

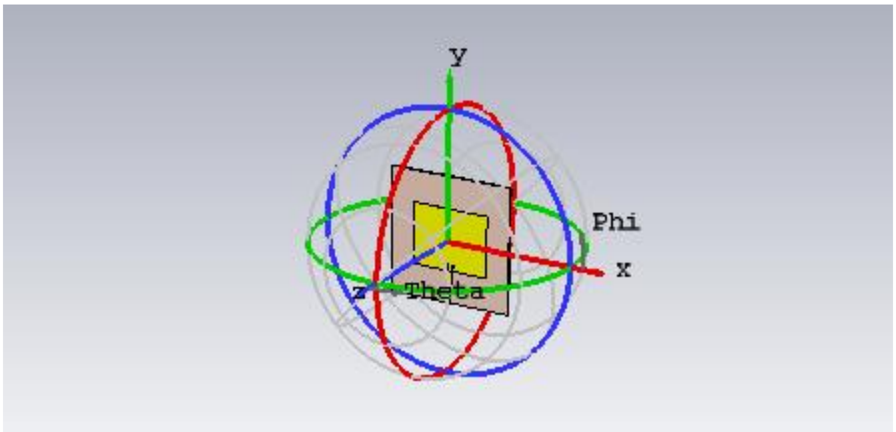

Fig 2.5: Radiation Pattern 3D

Input Impedance:

The input impedance of an antenna is the impedance (resistance and reactance) that the antenna presents to the source of the radio frequency energy. It is measured at the point where the transmission line is connected to the antenna

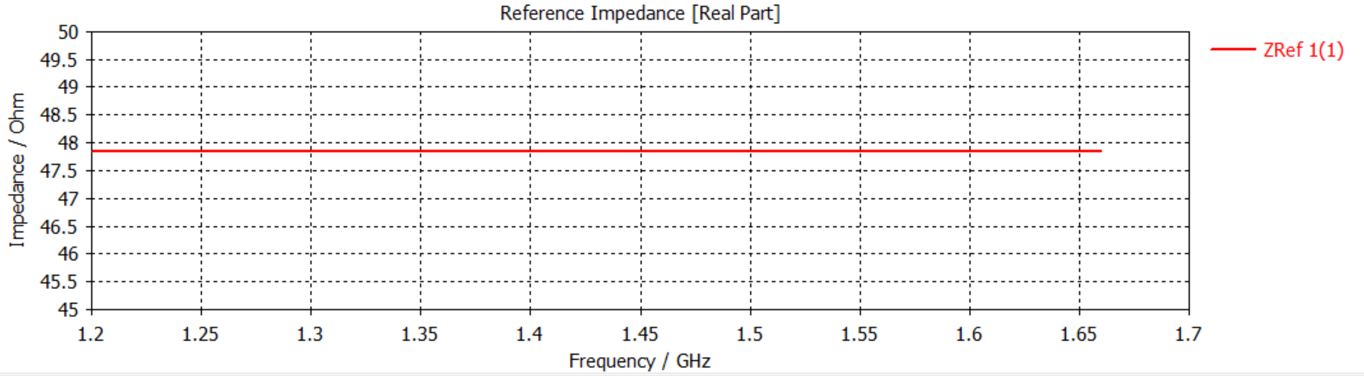

Fig 2.6: Input Impedance

VSWR:

The calculation of impedance mismatch is Known as VSWR (Voltage Standing Wave Ratio). It is a ratio of the maximum amplitude to the minimum amplitude of the standing wave on the transmission line. The VSWR ratio of proposed antenna is found as 1.3128721 as showing Fig.2.7

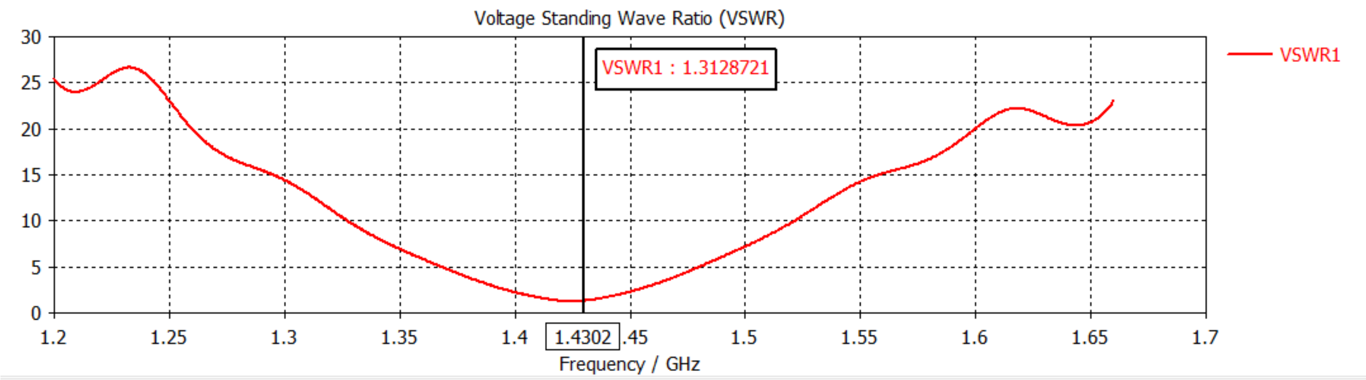

Fig 2.7: VSWR

Discussion and Conclusion:

For this experiment, a microstrip rectangular patch antenna operating at 1.43 GHz resonance frequency was developed. The width and length of the patch were initially calculated using a micro strip patch antenna calculator. The patch was half as long and wide as the ground and substrate. The substrate used was made of the lossy Flame Retardant 4 (FR4) material and had a dielectric constant of 4.3. The best conductor of electricity is ground and patched copper that has been annealed. The patch was cut into pieces with a nickel for feeding. The port stood out for its power distribution in the far field. The input impedance was then estimated after various parameters of the antenna simulation were examined.