Experiment No. - 8

Aim- To Design and Simulate Micro strip patch antenna at resonating frequency = 2 GHz.

Software Required-CST studio

Theory

The Micro strip Patch Antenna is a streamlined design comprising four essential elements: the patch, ground plane, substrate, and feeding part. Classified as a single-element resonant antenna, its characteristics are fixed once the frequency is determined. The patch, a slender metal strip or array, sits on one side of a non-conductive substrate, with the ground plane mirroring it on the other side. Typically crafted from thin copper foil coated with corrosion-resistant metals like gold or nickel, the patch can take various shapes, with rectangular and circular being the most prevalent. The substrate, crucial for spacing and support, is thin, with a thickness ranging from

0.01 to 0.05 of the free-space wavelength. High dielectric-constant materials are sometimes used to both support and reduce patch size. For employed.

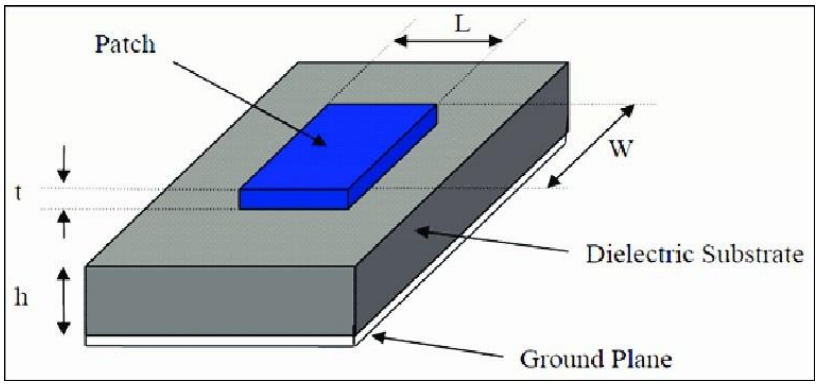


Fig5.1: Micro strip patch antenna

The frequency of operation of the patch antenna 1 is determined by the length L. The center frequency will be approximately given:

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0 \varepsilon_r \mu_0}}$$

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

$$W = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}$$

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

Substrate materials fall into three categories based on dielectric constants:

1. Those with a dielectric constant between 1.0 and 2.0, including air, polystyrene foam, or dielectric honeycomb.
2. Materials with εr in the range of 2.0–4.0, often composed mostly of fiberglass-reinforced Teflon.
3. Materials with a dielectric constant between 4 and 10, such as ceramic, quartz, or alumina.

Microstrip antennas offer advantages like compact size, low profile, and light weight, making them adaptable to planar and non-planar surfaces. They occupy minimal volume when mounted and are cost-effective to manufacture using contemporary printed-circuit technology. However, they come with drawbacks, notably low efficiency, a narrow bandwidth of less than 5%, and low RF power due to the limited separation between the radiation patch and the ground plane, making them unsuitable for high-power applied.

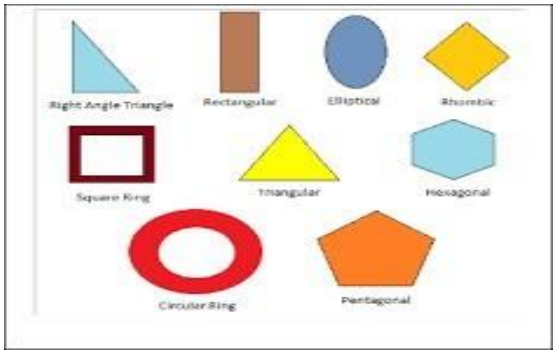


Fig 2: Most frequently encountered forms of patch antennas

Feeding Methods:

Various methods exist for feeding a micro strip antenna, with the most popular ones being:

1. Micro strip Line.
2. Coaxial Probe (coplanar feed).
3. Proximity Coupling.
4. Aperture Coupling.

Given that the antenna radiates from one side of the substrate, feeding can occur from the other side (ground plane) or from the side of the element. The paramount consideration is achieving maximum power transfer—ensuring the feed line matches the antenna's input impedance.

Advantages of Microstrip Antennas:

- Low profile (can even be “conformal,” i.e. flexible to conform to a surface).
- Easy to fabricate (use etching and photolithography).
- Easy to feed (coaxial cable, microstrip line, etc.).
- Easy to incorporate with other microstrip circuit elements andintegrate into systems.
- Patterns are somewhat hemispherical, with a moderate directivity (about 6-8 dB is typical).
- Easy to use in an array to increase the directivity.

Disadvantages of Microstrip Antennas :

- Low bandwidth (but can be improved by a variety of techniques). Bandwidths of a few percent are typical. Bandwidth is roughly proportional to the substrate thickness and inversely proportional to the substrate permittivity.
- Efficiency may be lower than with other antennas. Efficiency is limited by conductor and dielectric losses*, and by surface-wave loss**.
- Only used at microwave frequencies and above (the substrate becomes too large at lower frequencies).
- Cannot handle extremely large amounts of power (dielectric breakdown).

Antenna Design and its Dimensions:

The proposed antenna geometry containing of a dielectric substrate, patch along with microstrip feed line, is shown in Fig 1. The rectangular patch is separated from the ground plane with FR-4 Epoxy Dielectric substrate with the above-shown dimensions.

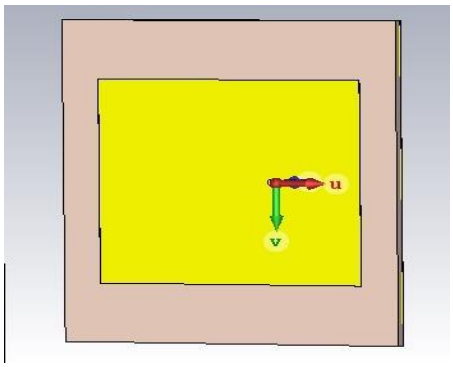
Parameters Values (in mm)

substrate	length		60	
	width		60	
	height		1.6	
patch	length		47	
	width		38	
	height		0.035	
ground	length		60	
	width		60	
	height		0.035	
εr			2.33	
εeff			2.13	
L			38	
h			1.6	
w			48	
feeding	Inner conductor	radius	Outer	0.6
			inner	0
		width	Wmin	-2*.035-1.6
			Wmax	Add=0.5
	Outer conductor	radius	Outer	2.1+.035
			inner	2 .1
		width	Wmin	0
			Wmax	Add=0.5
	teflon	Radius	outer	2.1
			inner	0.6
		width	Wmin	-0.035
			Wmax	Add=0.5

Table-1Proposed Antenna Dimensions

All the dimension of designed parameters of MPA is shown above in Table 1(All coordinates are drawn from center origin). The figure beneath shows a structure of a rectangular microstrip patch antenna. It consists of a dielectric substrate (R-5870), patch, and ground plane.

In this experiment we have designed microstrip patch antenna at 2.4 GHZ from above formula for which Width will be 49.25mm and effective permittivity 2.22 and length effective will be 41.94mm.



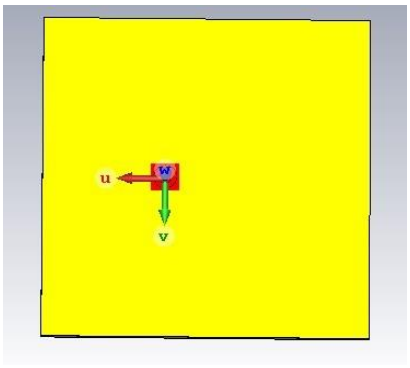
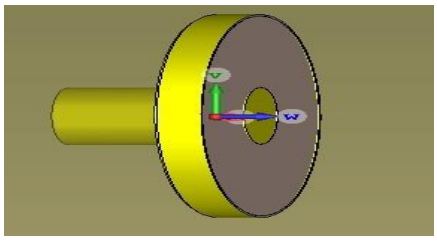


Fig- 5.3 front view Fig-5.4 back view



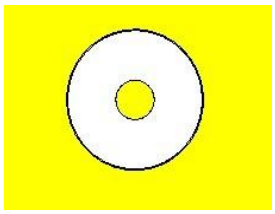
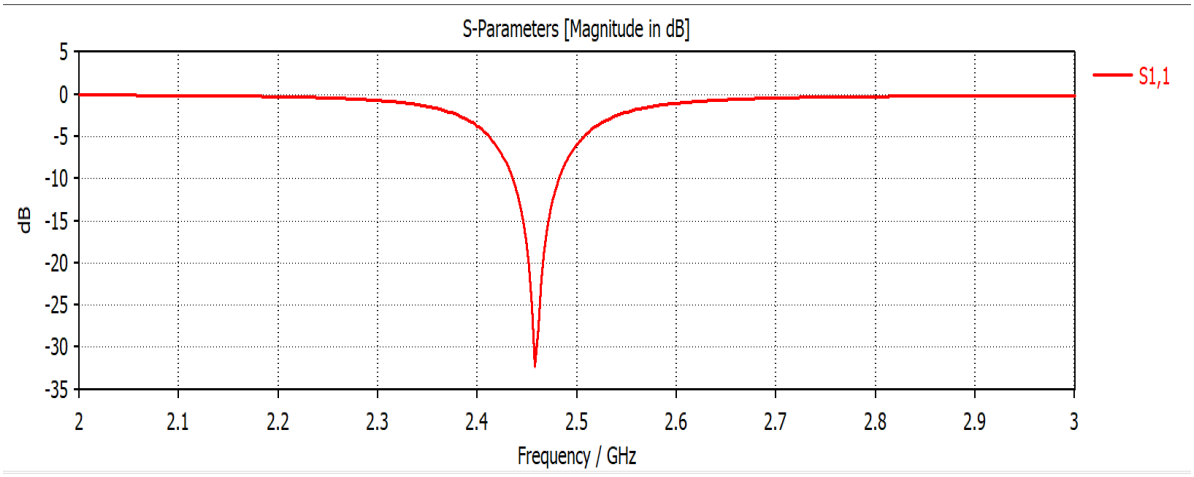
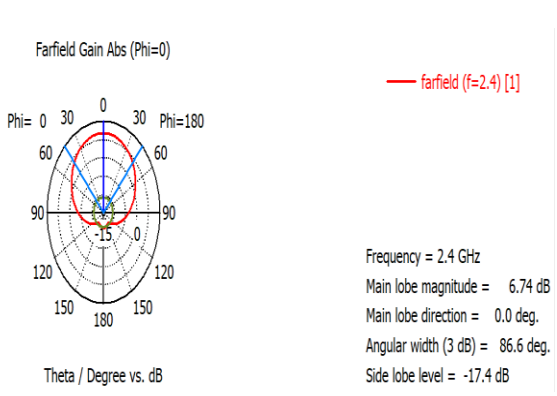
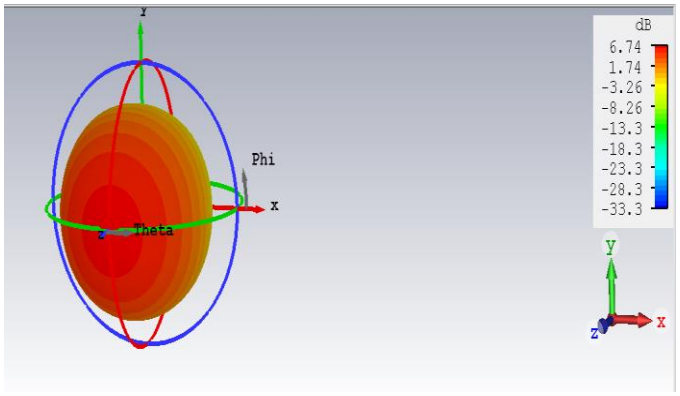


fig- 5.5 claxial feesing(side view) fig 5.6 coaxial feeding(front view)

RESULT:







Cconclusion-

The micro strip patch antennas are most preferable antennas due to its inherent advantages like small size and weight, low cost, printed directly on the circuit board, low profile and easy to fabrication.