DESIGN AND ANALYSIS OF U SHAPE MSP ARRAY ANTENNA FOR SATELLITE APPLICATIONS USING CST

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Abstract

Microstrip antenna arrays play important role in aircraft, Spacecraft and missile applications because of their lighter weight, low volume, low cost, low profile, smaller in dimensions besides easy installation and aerodynamic profile are constrains. The major considerations of this work are to enhance the bandwidth, efficiency, Directivity of a Microstrip patch antenna fabricated with corporate feed U shape patch array antenna. The resonant frequency is chosen at **4.5GHz** which is suitable for Wireless Communication Application. **CST** is used to the software environment to design and compare the performance of the antennas. Based on the result analysis, it is noted that corporate feed U shape patch array antenna offers higher bandwidth, higher radiation efficiency and directivity as compared with the U shape Microstrip antenna. In addition the U shape Microstrip antenna shows smaller than the return loss of corporate feed U shape microstrip patch array.

Keywords: U shape microstrip patch Array antenna, , FR4_Epoxy substrate material, CST tool.

I.Introduction to Rectangular Microstrip Patch Antenna:

A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. This concept was undeveloped until the revolution in electronic circuit miniaturization and large-scale integration in 1970. Various mathematical models were developed for this antenna and its applications were extended to many other fields. The number of papers, articles published in the journals for the last ten years, on these antennas shows the importance gained by them. The micro strip antennas are the present day antenna designer's choice. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configuration. Other configurations are complex to analyze and require heavy numerical computations. A microstrip antenna is characterized by its Length, Width, Input impedance, and Gain and radiation patterns. Various parameters of the microstrip antenna and its design considerations were discussed in the subsequent chapters. The length of the antenna is nearly half wavelength in the dielectric; it is a very critical parameter, which governs the resonant frequency of the antenna. There are no hard and fast rules to find the width of the patch.

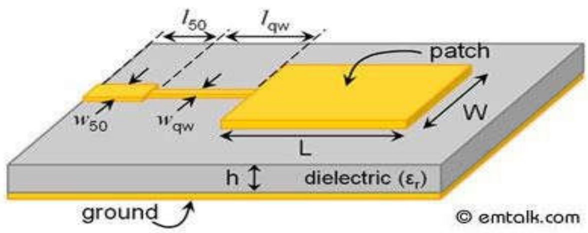

Fig (1a) Structure of a Microstrip Patch Antenna

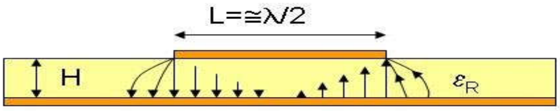

Fig. (1b) Side View

Microstrip antenna array design: The performance of microstrip antenna increases based on the count of patch elements placed on the substrate.

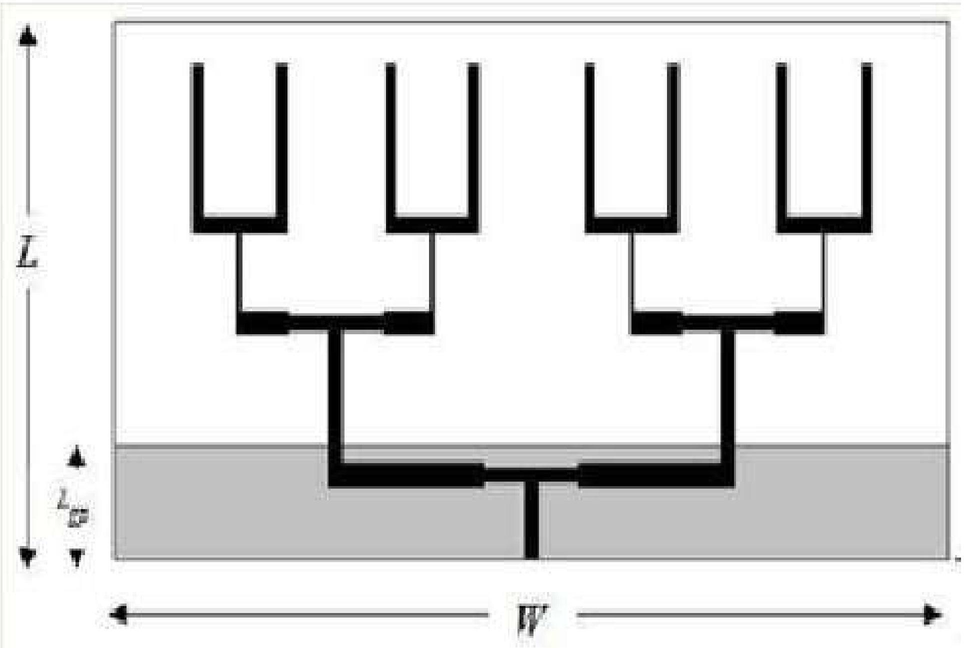

Fig. (1c) Microstrip array antenna

II.Designing of Rectangular Microstrip antenna:

To design a Rectangular microstrip patch antenna the Essential parameters are

1. The operating frequency (f_0).
2. Dielectric Constant of substrate (Ɛr).
3. The height of the dielectric substrate (h).

Rectangular microstrip antenna designed based on the following equations

1.To find the width (W).

$$\text{Width } (W) = \frac{}{2f_0\sqrt{\frac{(\varepsilon_r+1)}{2}}c}$$

2. To find the effective dielectric constant (ε_{eff}).

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

3. To find the fringing length (ΔL):

$$\Delta L = 0.412h \frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{}$$

$$W\ (\varepsilon_{eff} - 0.258)\ (\ h + 0.813)$$

4. To find the effective Length (L_{eff}):

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}}$$

5. To find the actual length (L):

$$L = L_{eff} - 2\Delta L$$

Table 1 Data sheet of microstrip antenna

S No.	Parameters	mm
1	F_0	4.5GHz
2	Ɛr	4.4
3	h	1.6
4	W	50
5	ΔL	0.5085
6	L_{eff}	42.72

III.Simulation Results of U Shape Patch Antenna

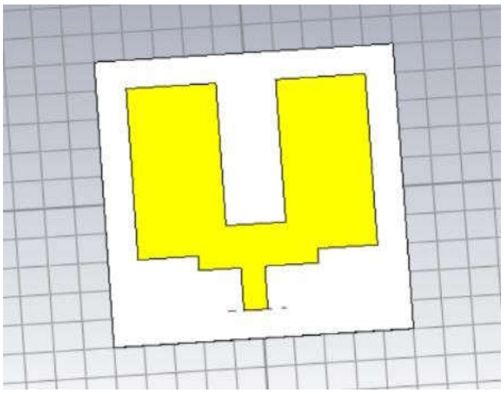

Fig. 2 Designed U shaped patch using CST

i). Return Losses: It is a parameter used to measure the power reflected by the antenna due to the mismatch of the transmission line and antenna. Lower value of the return loss provides the high efficiency of antenna.

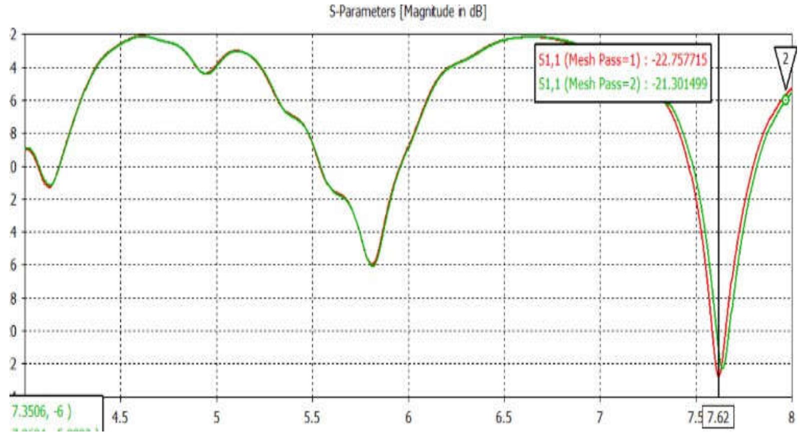

Fig. 2a Return losses for Single patch MSPA

ii). VSWR: VSWR stands for voltage standing wave ratio. It is defined as the ratio between the maximum value of standing wave voltage to its minimum value. The antenna with less VSWR has the better return loss compared to the other antenna

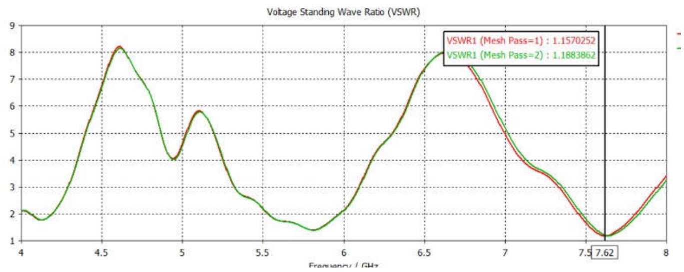

Fig.2b VSWR for Single patch MSPA

iii). Beamwidth:

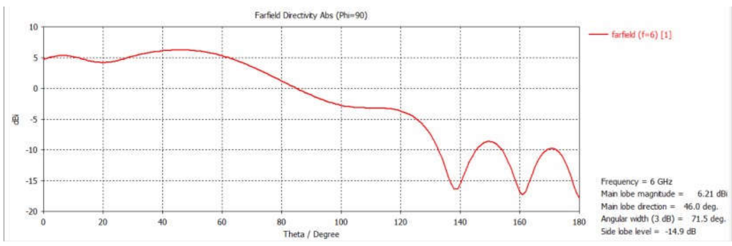

Fig. 2e Beamwidth for Single patch MSPA

iv). Directivity:

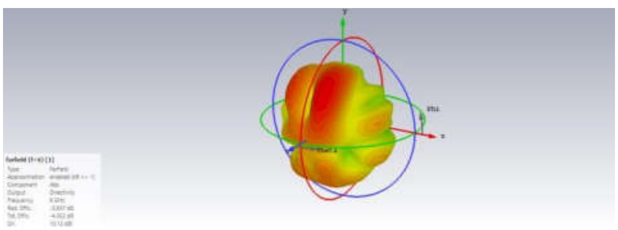

Fig. 2d Directivity for Single patch MSPA

v). Bandwidth:

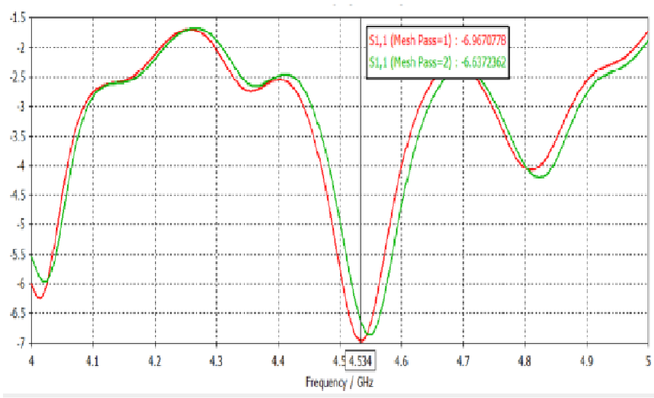

Fig. 2e Bandwidth for Single patch MSPA

IV. Simulation Results of Corporate feed U SHAPE Patch Array Antenna

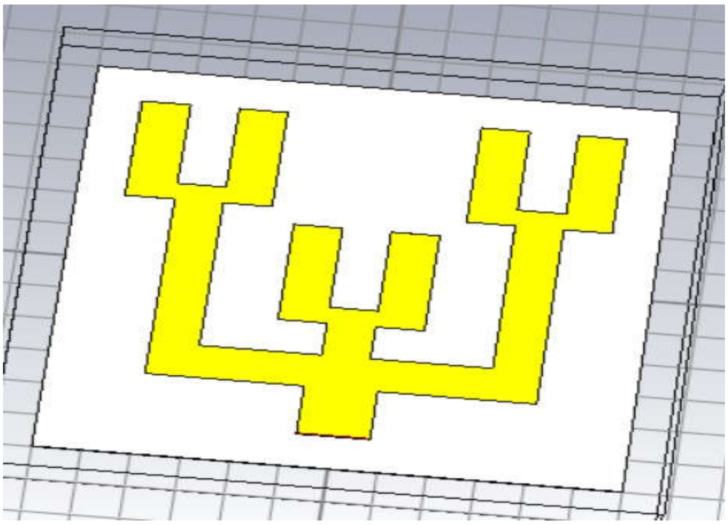

Fig. 3 Designed Corporate feed U Patch Array Antenna

i). Return Losses:

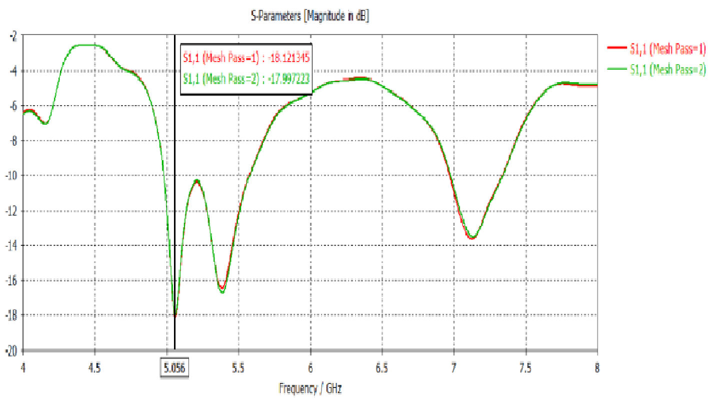

Fig. 3a Return losses for Microstrip Antenna Array

ii). VSWR:

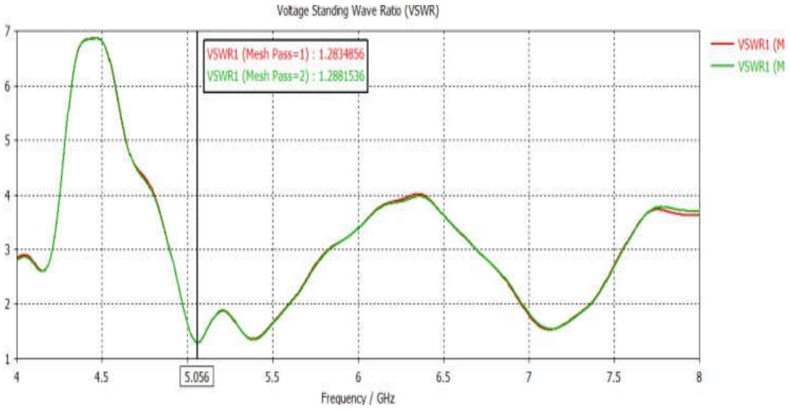

Fig. 3b VSWR for Microstrip Antenna Array

iii). Beamwidth:

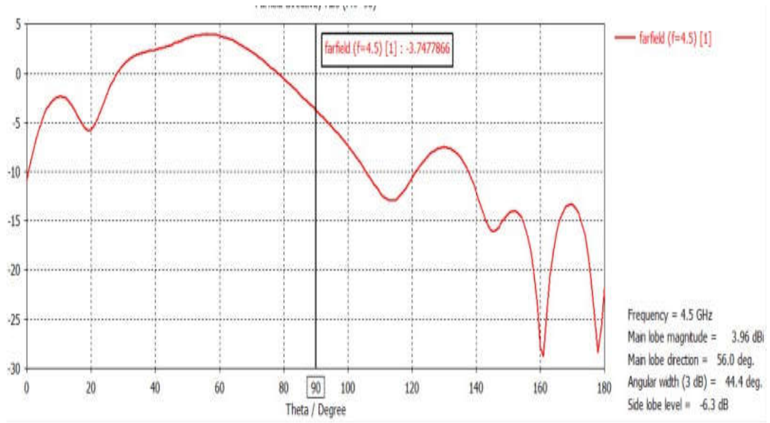

Fig. 3c Beamwidth for Microstrip Antenna Array

iv). Directivity:

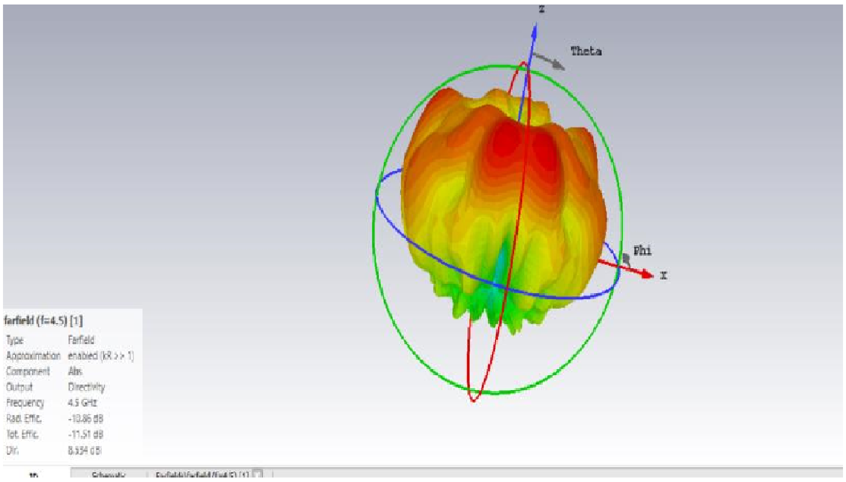

Fig. 3d Directivity for Microstrip Antenna Array

v). Bandwidth:

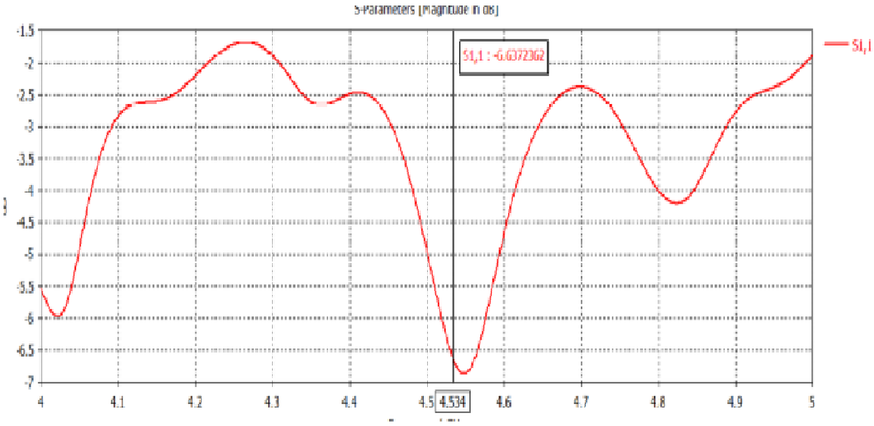

Fig. 3e Bandwidth for Microstrip Antenna Array

V. Results and Discussions

S. No	Type	Return Loss (in dB)	VSWR	Band width	Directivity	Angular width	Efficiency
1	Single substrate Single patch	-32.31	1.049	113.1 Mhz	9.84 dB	56.4 deg	74.18
2	Double substrate Single patch	-17.76	1.303	463 Mhz	7.653 dB	50.0 deg	64.68
3	Single substrate Double patch	-11.027	1.7814	376.7 Mhz	9.194 dB	51.5 deg	51.12
4	Double substrate Single patch	-22.75	1.15	618 Mhz	10.71 dB	21.9 deg	54.8
5	Single substrate Triple patch	-6.96	2.62	187 Mhz	8.916 dB	30.6 deg	91.96
6	Double substrate Triple patch	-16.01	1.05	541 Mhz	7.110 dB	43.3 deg	42.33
7	Double substrate Double patch	-18.12	1.283	250 Mhz	10.12 dB	71.5 deg	54.84
8	Double substrate Single patch	-16.73	1.37	778 Mhz	9.21dB	75.0 deg	24.53

9	Single substrate Single patch	-32.31	1.049	113.1Mhz	9.84 dB	56.4 deg	74.18
10	Single substrate Triple patch	-6.96	2.62	187 Mhz	8.916 dB	24.6 deg	91.96

Table 2 .Comparison of Microstrip antenna, U patch array antenna.

VII.Conclusion:

As per the results observed the beam width of the antenna increasing with increasing the number of the substrate layers. There is a trade of between the beam width and the directivity of antenna. Here the beam width increases for optimum value of the directivity. Rectangular substrate and U shaped patch, beam width of the antenna increasing with increasing the number of the substrate layers. Rectangular substrate and U shape patch, beam width of the antenna increasing with increasing the number of the substrate layers. The reduction in directivity of antenna w.r.t to increase in beam width is too.

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