SIMULATION OF U SLOT RECTANGULAR MICROSTRIP ARRAY ANTENNA

Mr.R.D.Mengade[1], Prof.A.S.Bhalerao[2]

[1] PG Student, E&Tc Department, JCOE, Kuran, Maharashtra, India
[2]Assistant Professor, E&Tc Department, JCOE, Kuran, Maharashtra, India

ABSTRACT

Now a day's wireless communication system antennas are the most important device for creating communication link between source and destination. Microsrtip antennas are used for mobile and other satellite communication application because of their light weight, low power handling capacity and low profile. The modern mobile communication system requires high gain, wide bandwidth and minimal size antennas that are capable of providing better performance over a wide range of frequency spectrum. This requirement leads to the design of microsrtip patch array antenna. This paper proposes the design of 4-Element microstrip patch antenna array which uses corporate feed technique for excitation. Low dielectric constant substrates are generally preferred for maximum radiation. Thus it prefers FR4 as a dielectric substrate. Desired patch antenna design is simulated by using high frequency simulation software and patch antenna is designed as per requirement. Antenna dimensions such as Length (L), Width (W), and substrate dielectric constant and parameters like Return Loss, Gain and impedance are calculated using CAD-FEKO. The antenna has been design to be operated in the range of 8-12GHz. Hence this antenna is highly suitable for X-band applications. For long distance communication we cannot use single element microstrip patch antenna. So for that purpose we are using microstrip patch array antenna. In this paper array stands for geometrical and electrical arrangements of patch elements. As number of patch elements goes on increasing, the performance is improved. A wide operating bandwidth for a single-layer corporate fed rectangular microstrip patch antenna can be obtained by cutting a U-shaped slot on the patch.

Keyword: *Microstrip patch array Antenna, Surface Current, VSWR, Radiation Pattern, Efficiency,gain.*

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1. INTRODUCTION

The microstrip antenna is also called as patch antenna. It contains metallic patch, dielectric substrate and ground plane. The dielectric substrate is sandwich between patch and ground plane. Low dielectric constant substrates are generally preferred for maximum radiation. So this patch is generally made up from various metals like silver, gold, zinc, etc. But here we have used copper metal because it is cheap and easily available in market. The patch metal may have different shapes Such as, rectangle, square, circle, triangle, circular ring. But Rectangular patch is commonly used because it is easy to use, fabricate and cheap. So we are using rectangular patch in this project. A microstrip antenna is characterized by its length, width, input impedance, and gain and radiation patterns. Numbers of single patch element are combined together to form an array antenna. The array increases the gain and performance of microsrtip antenna. The performance of microstrip antenna determines by using substrate material, dimension of antenna, feeding techniques. The four most popular feed techniques used are the line feeding, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes). Microstrip antennas consist of metallic patch on grounded substrate. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The rectangular patch is most popular because of ease of analysis, fabrication and attractive radiation characteristics, especially low cross polarization radiation.

The microstrip are low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to fabricate using modern printed-circuit technology and very versatile in terms of resonant frequency, polarization, pattern and impedance. This rectangular microstrip patch antenna is designed for wireless communication. These antennas can be mounted on surface of high performance aircraft, satellite, missiles, car and handheld mobile telephone.

2. DESIGN AND CALCULATIONS

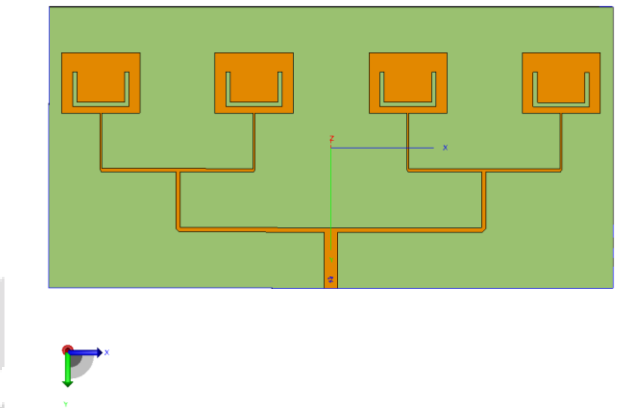


Fig-1: Structure of 4*1 U-Slot microstrip patch antenna

Design the patch of MSA. The U-slot is composed of two paralleled vertical rectangular slots and a horizontal rectangular slot. U-slot plays an important role to control the wideband behaviour of the coupled patch antenna. There are three parameters to characterize the slots, namely slot length, slot position, and slot width. During the process of the optimization, we can exhibit a wider bandwidth.For a rectangular patch, the length L of the element is usually $\lambda_0/3 < L < \lambda_0/2$, where $\lambda_0$is the free space wavelength. The patch is selected to be very thin such that $t << \lambda_0$(where t is the patch thickness). The height h of the dielectric substrate is usually $0.003\ \lambda_0 \leq h \leq 0.05\ \lambda_0$. There are numerous substrates that can be use for design of microstrip antennas, and their dielectric constants are usually in the range of $2.2 \leq \varepsilon_r \leq 12$.

2.1. Theoretical design

Step 1: Calculation of the Width (*W*):

The width of the Microstrip patch antenna is given as:

Where;

c - Free space velocity of light, 3×10^8 m/s

fr - Frequency of operation

ε_r - Dielectric constant

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

The effective dielectric constant is:

Where;

ε_r - Dielectric constant

h - Height of dielectric substrate

W - Width of the patch

Step 3: Calculation of the Effective length (L_{eff}):

The effective length is:

Where;

c - Free space velocity of light, 3 x 10^8 m/s

f_r - Frequency of operation

ε_{reff} - Effective dielectric constant

Step 4: Calculation of actual length of patch (L):

The actual length is obtained by:

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

Where,

L-Actual length of patch.

L_{eff} -Effective length.

ΔL-Small difference between length.

2.2. Design Values

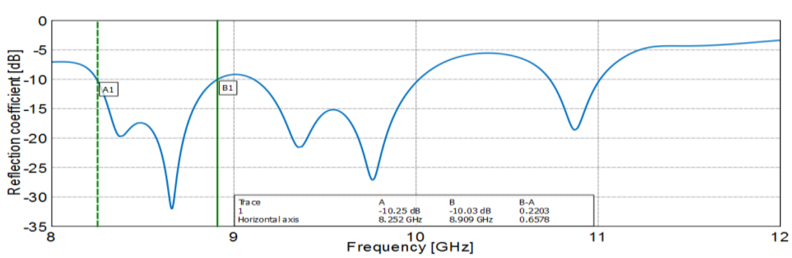
Table -1: Dimensions

Patch Shape	Rectangular
Frequency	8GHz-12GHz
Dielectric constant of substrate	4.4
Height of substrate	1.6mm
Feeding method	Corporate Feed
Polarization	Linear

3. SIMULATION RESULTS

The simulated results of antenna are measured using CAD-FEKO version 7.0. As we know for proper transmission of signal by antenna, the S11 parameter of antenna should be less than -10dB and VSWR Should be less than 2.

3.1. Reflection Coefficient-1



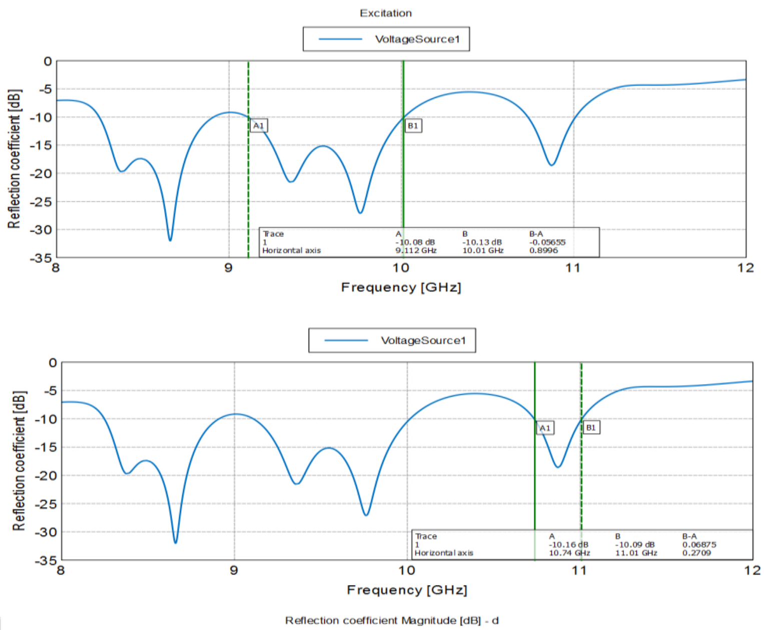


Fig.2: Reflection Coefficient

3.2. Gain-2

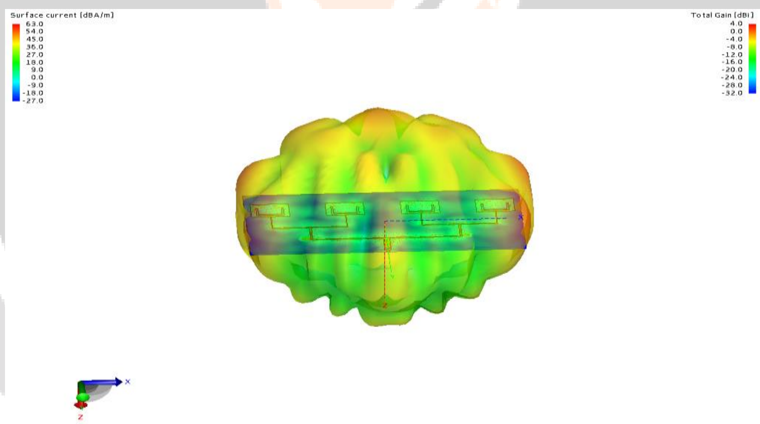


Fig.3: Gain

3.3. Efficiency-3

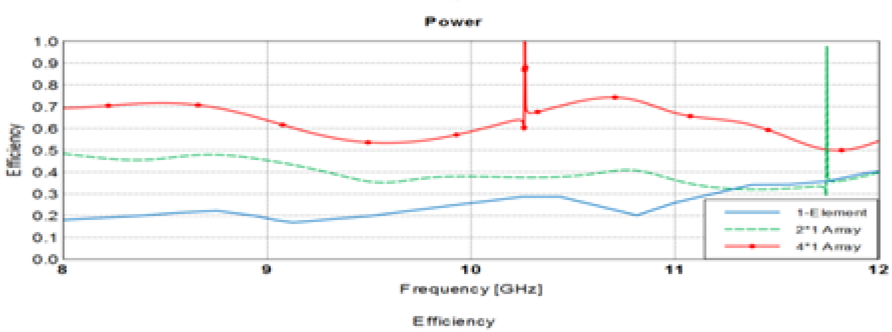


Fig.4: Efficiency

3.4. Radiation pattern-4

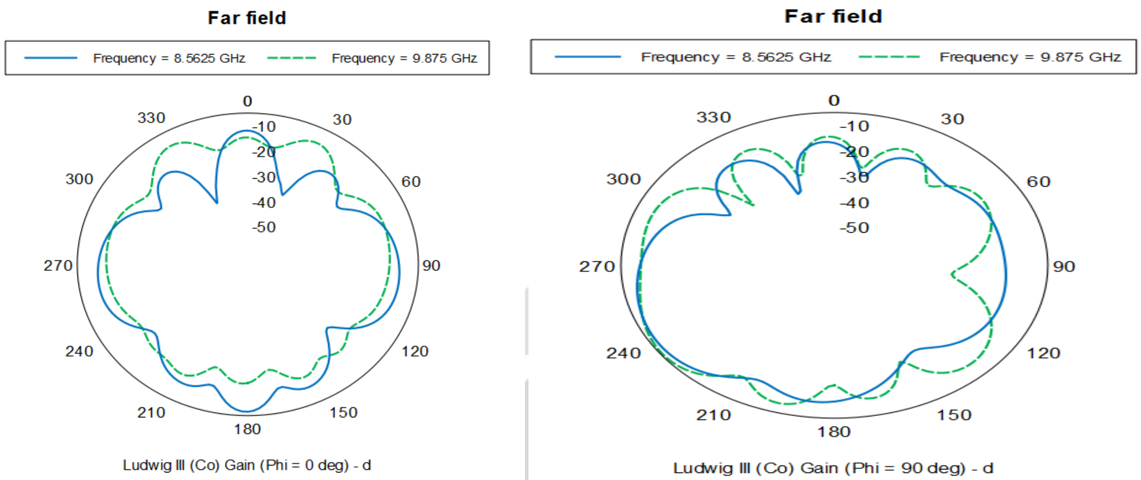


Fig.5: Radiation Pattern

3.5. Surface Current-5

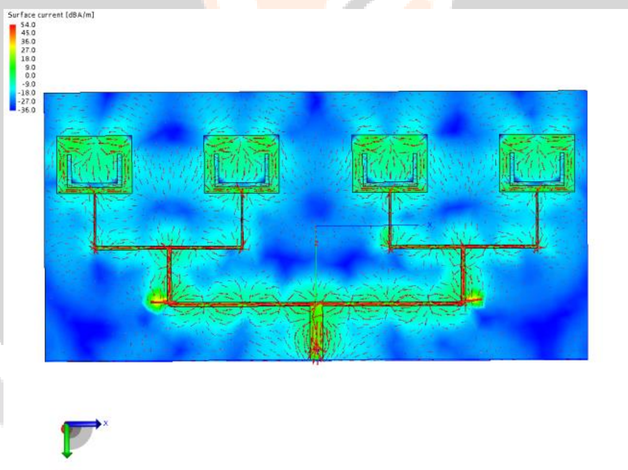


Fig.6: Surface Current

3.6. Smith chart-6

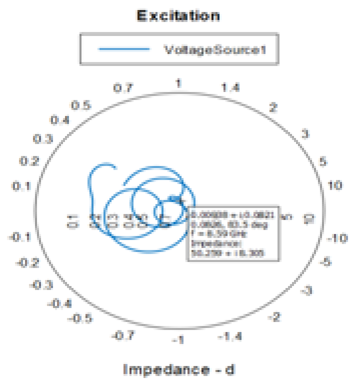


Fig.6: Smith Chart

3.7. VSWR -6

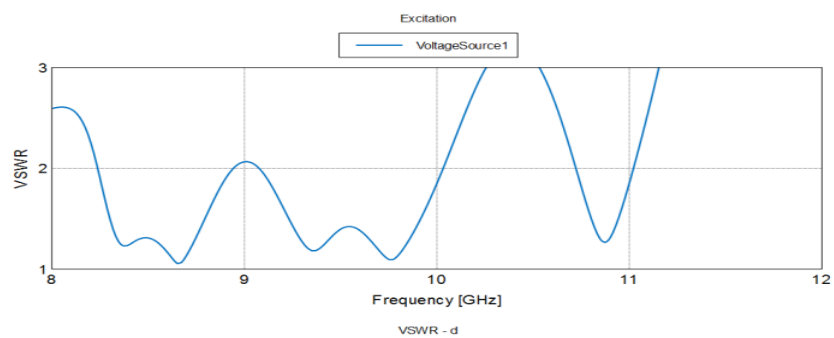


Fig.7: VSWR

4. COMPARATIVE STUDY OF SIMULATION RESULTS

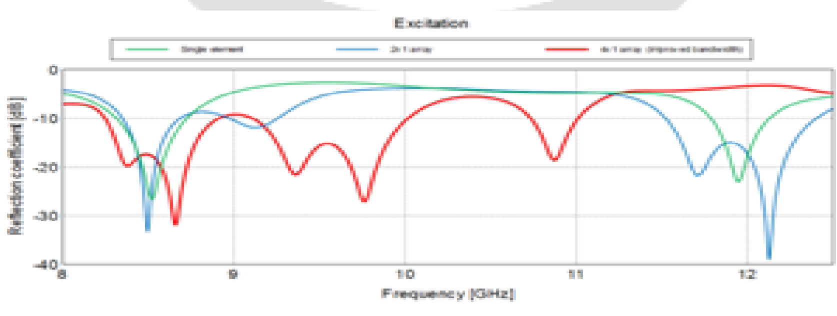


Fig.8: Comparison between single element and array

5.APPLICATION

The microsrtip antenna is used in RFID, Wi-Max applications. It is widely usedin satellite and aircraft communication. It also used in the WLAN as well as Bluetooth communication. And also in 3G communication system and for mobile communication this antenna is widely used.The microstrip patch array antenna used for GPS as well as RADAR

6. CONCLUSION

The microsrtip antenna can be simulated by using different high frequency simulation software. The proposed antenna can be operated in different frequency band. A wide operating bandwidth for a single-layer corporate fed rectangular microstrip patch antenna can be obtained by cutting a U-shaped slot on the patch. By using U slot on the patch antenna can be operated in two or three bands at different frequency. There are different parameters that affect the performance of antenna. Dimensions, selection of the substrate, feed technique and also the operating frequency can take their position in effecting the performance of microsrtip antenna. We can vary the parameters like bandwidth and gain of microsrtip antenna by varying different antenna parameter.

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BIOGRAPHIES

Author is pursuing M.E. (Signal processing) in JCOE KURAN, Pune, under the guidance of Prof. A.S. Bhalerao and Prof. V.M. Dhede.