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Design of Compact Microstrip Antenna with High Gain & Bandwidth for LTE System

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Abstract: ***This paper proposes the compact microstrip antenna with high gain and broad bandwidth by using Bi-polar mechanism. In this mechanism the surface is increased and the losses are reduced. This antenna uses the MATLAB simulator to calculate the parameters and from results it is found that the bandwidth is wider by using this mechanism. This antenna is used for C-Band application, which is the part of our daily life. The Microstrip Patch Antenna (MPA) is used for daily need communication system and for prolongs communication with anyone in the world. By study of few years' literature it is found that the research on MPA is focused only on the narrow bandwidth of antenna. In this we have high gain and efficiency with low losses. In any case, naturally MPA have thin data transmission so to upgrade transfer speed different strategies are locked in.***

Keywords: Microstrip Patch Antenna (MPA), Microstrip feed, Patch, Printed Antenna, LTE.

1. Introduction

In order to meet the requirements in spacecraft or aircraft applications where size, weight, cost, performance and a low profile antenna are required. Antenna is one of the critical components in any wireless communication system. The word „antenna" is derived from Latin word „antenna." Since the first demonstration of wireless technology by Heinrich Hertz and its first application in practical radio communication by Guglielmo Marconi, the antenna has been a key building block in the construction of every wireless communication system. IEEE defines an antenna as "a part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves."

Micro-strip Antenna

Micro-strip antenna is one of the most popular types of printed antenna. It plays a very significant role in today's world of wireless communication systems. A microstrip antenna in its simplest form is a layered structure with two parallel conductors separated by a thin dielectric substrate and the conductor. The upper portion is termed as patch that is responsible for radiation and lower portion acts as a ground plane. Micro-strip patch antenna consists of a radiating patch on one side of a dielectric substrate (FR4) that has a ground plane (Cu) on the other side as shown in Figure 1.

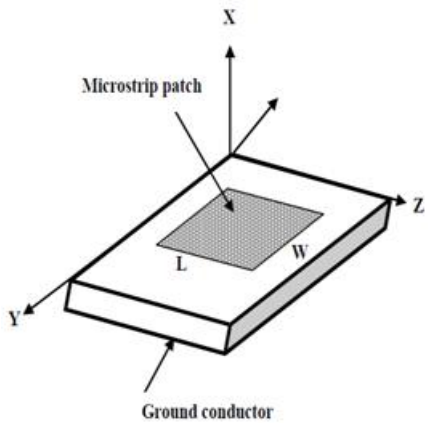

Figure 1: Physical Geometry of Microstrip Antenna.

A rectangular Microstrip antenna consists of very thin radiating metallic patch placed at small height in one side of dielectric substrate which other plane is grounded. Generally, an Microstrip consists of rectangular radiating patch element fed with a coaxial line in which length is most critical dimension and slightly less than half wavelength in the dielectric substrate. The radiating patch of Microstrip antenna are of different shapes such as rectangular, circular, elliptical, square, annular ring etc.

There are many advantages of Micro-strip patch antenna like low cost, compact size, straightforward structure and similarity with incorporated hardware. It has tremendous applications in military, radar systems or mobile communications, global positioning system (GPS), remote detecting and so on. A microstrip radio wire fused with a solitary shorting post at legitimate position and size is found to give lessening in general region with deference to an ordinary patch receiving wire. Additionally, the minimal roundabout spellbound patch receiving wires can be accomplished by space stacking on patch. The heap of the spaces or openings in the emanating patch can cause wandering of the energized patch surface current Paths furthermore, bring about bringing down of the full recurrence of the reception apparatus, Which relates to a decreased radio wire size for such a reception apparatus, contrasted with a routine circularly spellbound microstrip radio wire at the same working recurrence. For outline smaller and broadband microstrip patch receiving wire here shorting strategy utilized with conductive vias [1] for proposed and broke down. This sort of receiving wire had wide data transfer capacity and radiation design like a monopole and this receiving wire was developed on a round patch radio wire [1] that was shorted concentrically with an arrangement of conductive vias. The receiving wire was examined through depression model. Here mono-polar patch receiving wire was using two modes (TMo1 and TMo2 modes) and both modes give monopole like radiation design.

2. Antenna Parameters

For design a micro-strip patch antenna following parameters such as dielectric constant ($\epsilon_r = 4.3$), resonant frequency ($f_{0=8\,GHz}$), and height *(h=1.6mm)* are considered for calculating the width, effective dielectric constant and the length of the patch.

Effective dielectric constant of antenna(ϵ_{reff}):

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2}$$

$$\varepsilon_{reff} = 4.2965$$

Width of patch (w):

$$w = \frac{c}{2f_0\sqrt{\frac{\epsilon_r + 1}{2}}}$$

$$w = 11.518$$

Effective electric length of antenna:

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

$$L_{eff} = 0.009mm$$

The extended length of antenna (ΔL):

$$\frac{\Delta L}{h} = \frac{0.412\left(\epsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\epsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)}$$

$$\Delta L = 0.0019$$

The length of the patch is:

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

$$L = 0.9008$$

The width of ground plane is:

$W_g = 6h + w$

$$W_g = 21.12$$

The length of ground plane is:

$L_g = 6h + L$

$$L_g = 18.61$$

3. Proposed Work

In this research the bi-polar mechanism is used for increase the efficiency and gain of the micro-strip antenna (MPA). In this mechanism dual polarity is introduced, surface current is induced. More will be the surface current induced, maximize the radiation pattern.

For design the antenna we use the MATLAB software. We take the FR-4 material with 4-8 GHz frequency, height between ground and patch is 1.6mm and the dielectric constant is taken as 4.3.

This mechanism is reducing the losses and improves the efficiency and radiation pattern. For LTE system there is low loss, high gain, less insertion loss, good VSWR.

By using Bi-polar mechanism the bandwidth is enhanced, it is 90% in the frequency range 5 – 7 GHz and the efficiency is 99% with high gain of 16.66 dBi.

4. Simulation Results

All the results are calculated by MATLAB software by using bi-polar mechanism. Fig. shows the frequency range and antenna bandwidth. For the proposed antenna the return loss is -20.5dB from 5.0 to 6.5 GHz and by bandwidth formula and return loss is approximately – 48 dB in 6.7 GHz.

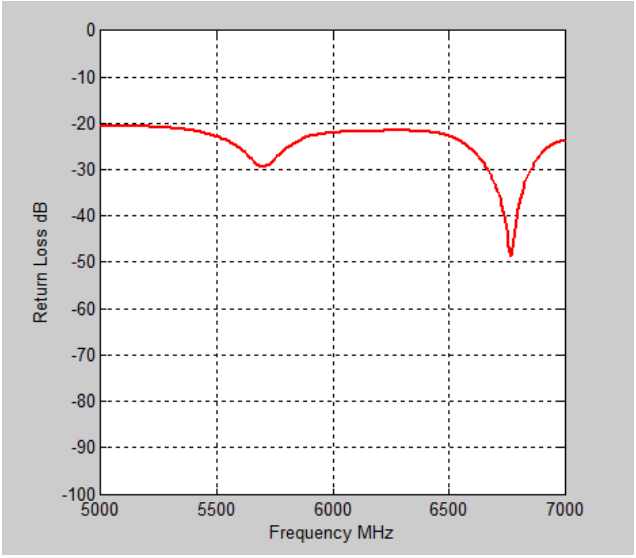

Figure: Frequency range and antenna bandwidth

The bandwidth of antenna is also improved about 90% in the range of 5 to 7 GHz and return loss is -48dB at 6.7 GHz. The gain for this frequency is 16.66 dB.

By using this mechanism the efficiency achieved at 6.7GHz is 99%. The efficiency of antenna is calculated in the range of 4 – 8 GHz and it is better at 6.7 GHz and the VSWR is also good. The measured value of VSWR should be less than 2 for a better performance. At 6.7 GHz the VSWR is 1.2.

5. Conclusion and Future Scope

The micro-strip patch antenna is implemented and simulated by MATLAB software; it is based on rectangular patch antenna by using bi-polar mechanism. A compact antenna is implemented for high gain and better antenna performance. The high efficiency is the aim of design such type of antenna by using bi-polar mechanism. Bi- polar mechanism is used to increase the surface current due to the inductance and therefore the efficiency and return loss is improved. This antenna achieved 90% bandwidth in the frequency range of 5 – 7 GHz and the efficiency of antenna is 99%. The gain of this antenna is 16.66 dB at 6.7 GHz and VSWR is less than 2(it is 1.2) with -48dB return loss. Therefore the antenna has better performance with high gain, wide bandwidth and better efficiency. So this antenna has very useful in satellite communication by using C- Band. The proposed antenna is electronically tunable. Hence this antenna is also programmed by using microcontroller. Furthermore for

better efficiency the artificial intelligence (AI) techniques are used.

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