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Square Patch Antenna: A Computer Aided Design Methodology

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Abstract

A novel best results micro strip patch antenna is presented. Inset line feed is also designed. Design of micro strip patch antenna in L-band at 1.897 GHz frequency is reported in this research paper. It is shown that the design adopted for microstrip patch antenna is quite accurate. The proposed antenna are designed on the substrate of dielectric constant 4.4 and thickness 1.6mm, simulation is done by using the microwave software IE3D; to achieve the desired results. The antenna have minimum VSWR of 1.05 at a frequency of 1.897 GHz. Return loss is to be -30 dB at a frequency of 1.897 GHz. Substrate taken was glass dielectric constant 4.4 and loss tangent is 0.02. At frequency 1.897 GHz. Radiation efficiency is 89% and antenna efficiency is 89.9%. E total gain achieved is 0.203457 dBi.

Keywords: Micro strip patch, VSWR, Return Loss, radiation pattern; efficiency.

Introduction

In today's communication-centered market place cellular communication technology has generated awareness of the important role wireless service play. Due to this awareness there is growth in wireless communication. Hence there is advancement in antenna technology. An important example of this antenna technology is development of antenna inside and outside the handset.

The recent effort taken towards improving available personal communication services has generated an increased interest in the performance of compact antenna structures mounted on handheld device. The characterization of such antenna is dependent of simulation tools that can accurately model general topologies, including wires, dielectrics, conductors and lumped elements. In effort to meet these simulation needs attention, focused on the use of the finite difference time domain (FTTD) [1] [2] methodology for antenna analysis [3]- [4].

The increasing effort in miniaturization of mobile communication equipment has made the development of small, low profile antenna suitable for implementation in portable devices.

Early handset treated the antenna as a bolt- on item, but the current trend is to integrate the antenna to within the body of the handset. The handsets are becoming smaller or more functionally is being packing into these units. This leaves little room for the antenna.

A wide variety of antenna has been used on handset, but they can split in following categories:

- External helical antenna
- Printed helical antenna
- Printed inverted F type antenna
- L type antenna
- Circular, square, triangular, rectangular patch antenna
- Ceramic antenna
- Meander line antenna
- Dual planer inverted L type antenna

These antenna type have been given in numerous papers and books. For reader not familiar with above antenna, further reading suggested: [5] [6].

Conventional antenna theory uses an [5], image technique to allow for an infinite ground plane. This can not be used for electrically small ground planes. As all antennas mentioned above are affected to some extent by electrically small ground plane, the use of simulator is recommended to examine the current flow is the ground. The current distribution on the handset provides a useful insight into the positioning of coaxial feeds to the antenna and coupling into other assemblies on the handset.[7]

Micro strip patch antenna structure is a planar in configuration and enjoys all advantages of substrate technology. Micro strip antenna are used where size, weight, cost, better performance, compatibility with microwave and millimeter wave Integrated circuits (MMIC), robustness and ability to conform to planar and no planar surface is required. The impedance is a passive measurement that is a coaxial feed 3. Micro strip patch antenna supports both linear and as well as circular polarization. It is capable of dual and triple frequency operations. Low fabrication cost, hence can be manufactured in large quantities.

Most important application of microstrip patch antenna at present is in GPS system. It is also used in mobile communication; RFID; TAGS and WIFI applications [8].

Feed Network

Microstrip antenna can be fed by variety of methods.These methods can be classified into two categories – contacting and non-contacting. In contacting method, R.F.power is fed directly to the radiating patch using connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and radiating patch. The four most popular feed techniques used are the microstrip line, coaxial probe, aperture coupling and proximity coupling. Feed used to this antenna is inset line feed.

Computer aided Design of Antenna

First calculate the width (W) of Microstrip patch Antenna. Width of microstrip patch antenna is given by

$W= C/ C/2f_0\surd \epsilon r+1/2$

Substituting $C= 3*10^8$ m/sec; ϵr =4.4 and $f_0 = 1.9$ GHz We get W = 48.00 mm

Effective dielectric constant ($\epsilon reff$) is calculated as

$\epsilon_{reff =} \epsilon r+1/2 + \epsilon r-/2 \ [1+ 12h/W]^{1/2}$

where ϵ_r is relative dielectric constant

Substituting ϵ_r =4.4, W = 48mm and h =1.6 mm

We get $\epsilon_{reff =}$ 4.14

The effective length is given by

$L_{eff.=} C/2f_0\surd \epsilon_{reff}$

Substituting $\epsilon_{reff\ =4.14,}$ $C= 3*10^8$ m/sec; ϵr =4.4 and $f_0 = 1.9$ GHz We get Leff =38.8mm

The length extension is given by:

$\Delta L= 0.412h\ (\epsilon reff + 0.3)\ (W/h + 0.264)/\ (\epsilon reff – 0.258)\ (W/h + 0.8)$

ΔL= 0.75mm

The actual length is obtained by:

$L= L_{eff\ -}\ 2\ \Delta L$ Substituting the values

L=37.7 mm

By using above formulae we get

L = 37.3 mm and W = 48 mm

So, microstrip patch dimensions decided by using above formulae and L = 37.3 mm and W = 48 mm is calculated by taking these dimensions antenna is simulated [5] by using IE3D Software.

Microstrip Patch Antenna Configuration

Antenna has a length of 37.7 mm and width of 48 mm and thickness of 1.6 mm. Total size of antenna will be substrate is 49 mm * 49 mm square. It has provided feed type is inset Line feed.

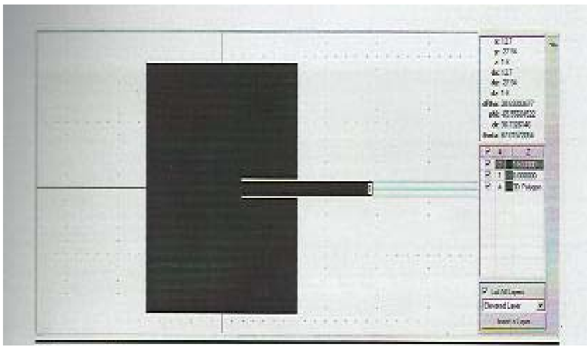

Figure 1.a

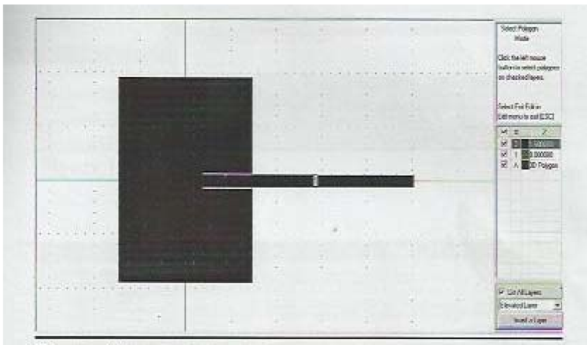

Figure 1.b

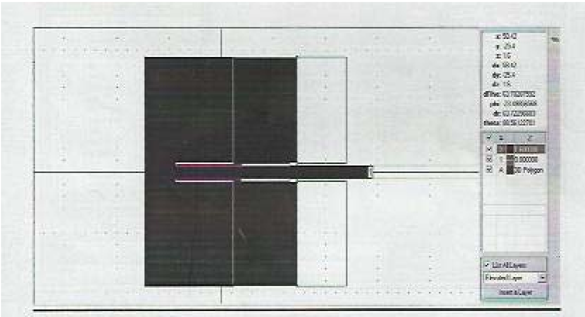

Figure 1.c

Figure 1. Micro strip patch antenna various configuration

Results and Analysis

Micro strip patch antenna simulated by using IE3D Software then following results is presented.

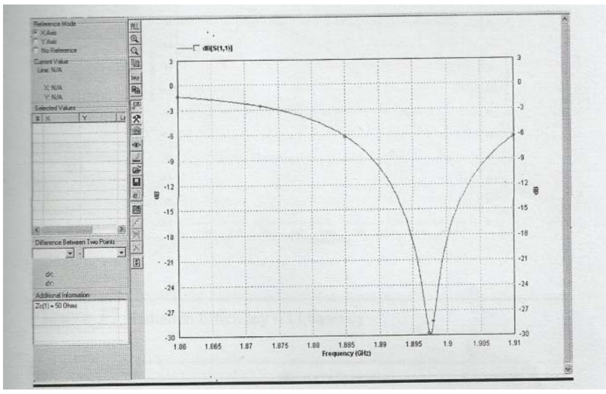

Figure 2: Return Loss

Historically the return loss or impedance of antenna was the main parameter considered. The return loss is still a key parameter to be measured. In case of micro strip patch antenna there is matching of impedance between inset feed and probe, hence return loss is -30 dB at a frequency of 1.897 GHz. Needs careful consideration to ensure that the coaxial line does not significantly alter current distribution on the ground. It is recommended that the current distribution on the ground is examined to determine the optimum connection point between feed and ground.

Different handset manufactures use different specifications for return loss, but aiming to achieve -6dB return loss for conditions i-v listed above would be good starting point.

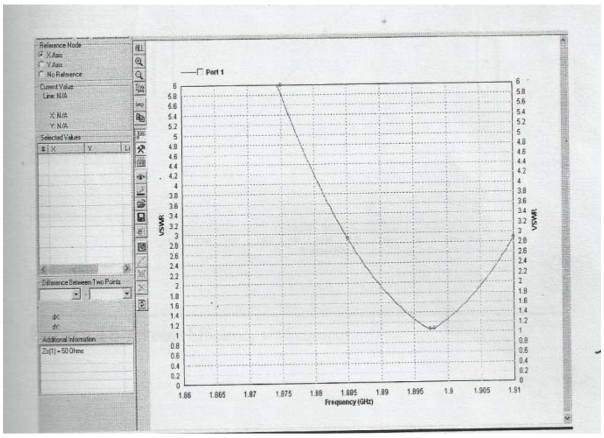

Figure 3 V.S.W.R

Simulated V.S.W.R shown in Fig.3. from Fig.3 it is seen that, V.S.W.R is 1.05 at a frequency of 1.897 GHz and resulting bandwidth of 17 MHz.

Radiation efficiency versus frequency plot shown in Fig.4. From Fig.4 it is observed that at a frequency of 1.897 GHz, radiation efficiency is 89%.

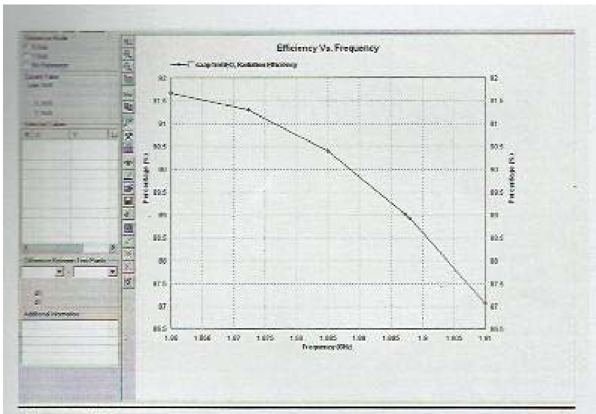

Figure 4 radiation efficiency versus frequency

On the other hand, antenna efficiency shown in Fig.5. From Fig.5 antenna efficiency is 89.9%.

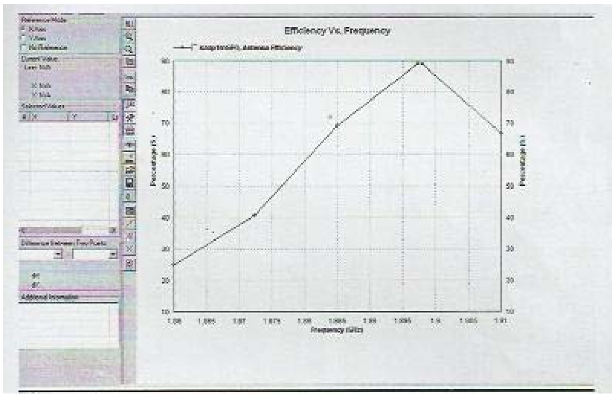

Fig:5 Antenna efficiency v/s frequency

Lastly 3-dimensional radiation pattern shown in Fig.6. From Fig.6 it is seen that E totsl gain achieved is 0.203457 dBi.

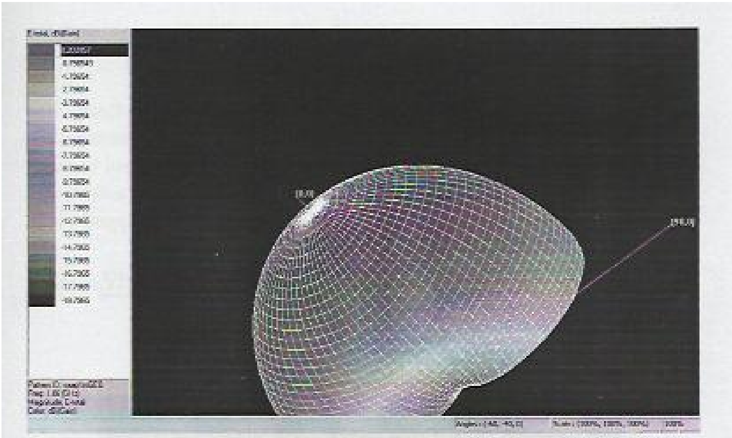

Figure 6 3D Radiation Pattern.

Conclusion

It can be seen that the design adopted for micro strip patch antenna in this research paper are accurate. This antenna can be used at 1.897 GHz mobile communication application. The proporsed antenna have return loss -30 dB at a frequency 1.897 GHz. It has V.S.W.R. 1.05 and bandwidth 17 MHz. radiation efficiency is 89%, antenna efficiency is 89.9% and E total gain achieved is 0.203457 dBi.

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