JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Compact Microstrip Antenna for GSM Devices-Application

Rajesh Kumar Gupta*, Rajendra Kumar Mishra[@], Rajeev Kumar[%] ,K. S. Kushwaha[$] and D. K. Sahu[#]

*Department of Applied Sciences & Humanities, Dr Ambedkar Institute of Technology for Handicapped, Kanpur (U.P.)-208024
[@]Department of Physics, D.B.S. College, Kanpur (U.P.)-208014
[%] Department of Physics, D.A.V. College, Kanpur (U.P.)-208001
[$]Department of Physics, Pt. J.L.N. College, Banda (U.P.)-210001
[#]Department of Physics, R.S. Government PG College, Lalitpur (U.P.)-284403

Email: drrajesh.aith@gmail.com

ABSTRACT

There are already 150 million users globally to the cellular sector, which started 25 years ago. In the 1980s, people utilised clunky, hefty cellular phones. VLSI technological advancements have made it possible to reduce the size of the many microprocessors based signal processing chips. By employing more compact antennas, handset size may be decreased still another way. This paper's goal is to create a small antenna like that for usage in wireless and cellular devices. A ground plane is attached to the other side of a patch that has a dielectric substrate on one side. This is known as a microstrip patch antenna. A small microstrip patch antenna is intended to operate at 1.9 GHz in a mobile phone. The outcomes offer a practical antenna design that may be used in a mobile phone.

Keywords: communication design, GSM Band design, microstrip antenna, radiation mechanics.

Introduction

Guglielmo Marconi proved that radio could maintain constant communication with ships in 1897.after that, wireless communications has seen a number of advancements. Different researchers conducted a number of studies to use electromagnetic waves to transmit information [1].Metal constructions called antennas are used to transmit and receive electromagnetic radiation. A structure known as an antenna serves as a bridge between a guiding system (such as a waveguide or transmission line and free space [2]. According to Stutzman and Thiele [3], the official IEEE definition of an antenna is as follows: “component of a transmitting-receiving system intended to send and receive the electromagnetic information in the form of waves.”

The major causes of a conducting wire radiating are a changing current accelerating and decelerating specified amplitude signals strength charges. There is no current flow in a transmission line if there is no charge movement; there is no radiation [4]. Even if charges are travelling down a straight line at a constant speed, radiation won't happen. Radiation will, however, be produced by charges travelling down a wire that is curved or twisted at a consistent speed. According to Balanis [5], radiation can happen even down a straight wire if the charge is fluctuating over time.

The voltage source attached to a two-conductor forming a balance transmission line structure. a sinusoidal voltage with the specified amplitude is applied over the wire-line, where the electric lines of force terms as Electromagnetic field are tangential to the electric field are developed. A sinusoidal electric field results from this. The electric lines of force bunched together show "how strong the electric field is". The charges on the conductors are forced to move by the electric lines of force, and the current that comes from the movement of these charges produces a magnetic field *.E[1,6]*.

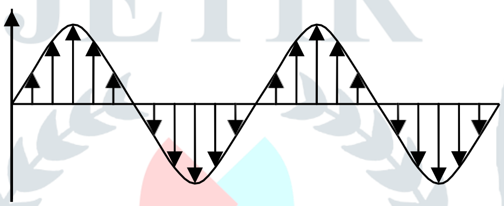

Figure 1: Radiation from an antenna

A Microstrip patch antenna, (Figure 2), consists of a radiating surface as patch developed or printed on one side of a dielectric substrate ranging from 4.0-12.30 and a ground plane as conducting ground plane on the other. The patch can have any form and is often constructed of conductive materials like copper or gold. The feed lines and radiating patch are etched on the dielectric substrate [6].

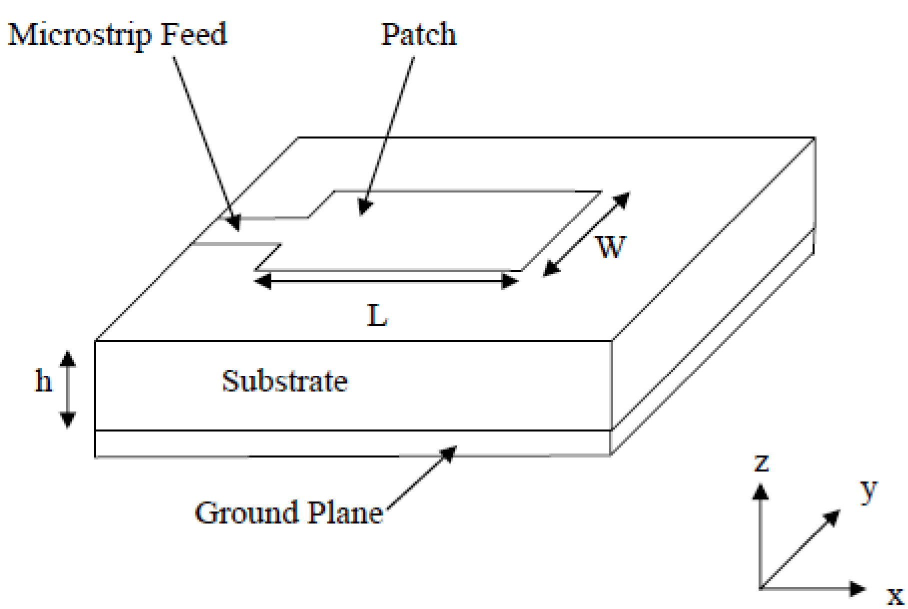

Figure 2: microstrip antenna design

To make analysis and performance prediction the design is develop in such way that mass the patch design is frequently square, rectangular, circular, triangular, elliptical, or any other common shape,. Usually, the length L of a rectangular patch is equal to 0.3333λ<λ< c, where c is the wavelength of free space [7]. The patch is made of a thin conductive material such that microstrip patch antennas radiate some sort of charge in the form of wave as a result fringing fields that exist between the patch surfacce, dielectric and the ground plane. The best antenna performance is achieve with the thick a thick and high dielectric substrate loss constant to provides applicable bandwidth efficiency, a directive bandwidth, and nearly isotropic radiation [5].

The size of the antenna is increased by this configuration, though. To make a small Microstrip patch antenna, higher dielectric constants result in a narrower bandwidth. As a result, it's necessary to strike a compromise between antenna size and performance. Microstrip patch antennas may be fed in a number of different ways. These approaches come in two flavours: contacting and non-contacting forming the LCR circuits resonating at given frequency. In these technique, balance and unbalance way of current the generate RF power in the radiating patch through a metal conductor element like a microstrip line. Power is transferred between the microstrip line and the radiating patch system is connected using electromagnetic field coupling [8].

To operate in the TM10 mode of electromagnetic radiation, the patch's length must be just about λ/ 2 and λ/4. The length of the field fluctuates by half a cycle while the patch's width remains constant in the TM10 mode. The microstrip patch antenna is shown as two slots that are open circuited at both ends and divided by an L-length transmission line in the diagram below. Over the patch's width, the voltage magnitude is highest and the current is magnitude lowest due to the open ended non terminated transmission line. The fields strength at the boundaries of the ground plane can be divided into normal and tangential components [9].

They therefore balance each other out in a broadside orientation. The combined fields provide the highest radiated field normal to the structure's surface because the tangential components are in phase. The width can radiate slots at λ/ 2 apart elements since they are stimulated in phase above the ground plane [10-12]. Electrically speaking, the patch of the microstrip antenna seems bigger than its true size due to the radiating slots along the breadth of the fringing fields that may be modelled. As calculated empirically by Hammerstad [13], a distance L has now been added to each end of the patch's dimensions along its length.

RESULTS

This section explains the design step involved in creating a rectangular microstrip patch antenna in rectangular shaped antenna for cell phones is created. The outcomes of the simulations are presented in the end.

Design Requirements

The following three factors must be taken into account while designing a rectangular Microstrip Patch Antenna: The antenna's resonance frequency needs to be properly chosen. The frequency band between 1785,1850,1975, and 1990,2150 MHz is used by the Personal Communication System (PCS). As a result, the antenna must be able to function at frequency range. My design's chosen resonance frequency is 1.9,1.85,2.15 GHz

$$.f_0 = \frac{C}{2\sqrt{\varepsilon_{reff}}}[(\frac{m}{L})^2 + (\frac{n}{W})^2]^{1/2}$$

The antenna designing are employ with the basic formulas in the line model scheme, where the specific dimension of microstrip metallic part are design as [1]

Step 1: Width (W_0): The width of the Microstrip patch antenna is calculated using equation:

$$W_0 = \frac{C}{\sqrt{\frac{\varepsilon_r + 1}{2}} 2f_0}$$

Step 2: Effective dielectric constant (ε_{reff}): the effectivedielectric constant

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1+12\frac{h}{W}]^{1/2}$$

Step 3: Effective length (L_{eff}): The effective length

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_r}}$$

Step 4: Length extension (ΔL): the length extensionas:

$$\Delta L = 0.412h\frac{(\varepsilon_r + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_r - 0.258)(\frac{W}{h} + 0.8}$$

Step 5: Length of patch (L): The actual length is obtained by re-writing as: $L_{eff} = L + 2\Delta L$

Step 6: Calculation of the ground plane dimensions (L_g and W_g):

Infinite Electronic band ground planes may use the balance unfermented transmission line concept. However, a limited ground plane is necessary due to practical reasons. It has been demonstrated by [9] the size of the ground plane is bigger than the patch dimensions by around six times of thickness all around the periphery, equivalent results for finite and infinite ground planes may be produced. Therefore, the ground plane dimensions for this design with the following equation [13]:

$$L_g = 6h + L$$

$$W_g = 6h + W$$

Step 7: feed point location (X_f ,Y_f):

The feed point position in this design is established using the coordinates (X_f, Y_f) from the patch's centre as the origin. The feed is to be of the coaxial probe type. The input impedance for the resonant frequency is set at 50 ohms, so that it must be located the patch's feed point. As a result, the feed point is discovered through a process of trial and error. A number of feed point locations' are compared, and the feed site with the worst losses is picked. According to [5], there is a spot where the radiation loss is least prominent along the length of the patch microstrip line.

Simulation Setup and Results

Zeland Inc.'s IE3D software is used to develop the compact microstrip patch antenna for wireless device. Electromagnetic response simulator built using the method of moments is called IE3D. It examines single and multilayer with three-dimensional form structures. It has been extensively employed in the design of RF antennas, patch antennas, and wire antennas. The antenna performance is ploted the radiation patterns, VSWR, current distributions, and S11 parameters. Results for this thesis were obtained using an assessment version of the programmed [1,14-16].

Return Loss and Antenna bandwidth calculation

To obtain the findings given in the table below, the feed position was change along the length of the patch, from the center of the patch centre. By design, the coaxial probe feed used has a radius of 0.5 mm. A frequency range of 1.7-2.1 GHz and 301 frequency points are selected within this range in order to obtain exact results. Table displays the computed results for various feed sites.

Table 1: Effect of feed point location

No.	Feed Location (X_f ,Y_f) mm	Center Frequency (GHz)	Return Loss (RL) (dB)	Bandwidth (RL > -9.5dB) (MHz)
1	(1,0)	1.9153	-1.1384	-
2	(2,0)	1.92	-4.5967	-
3	(3,0)	1.927	-10.9502	9.97
4	(3.25,0)	1.933	-13.5696	25.32
5	(3.5,0)	1.927	-16.3242	28.84
6	(3.75,0)	1.927	-21.1769	31.43
7	(4,0)	1.920	-31.7585	33.28
8	(4.25,0)	1.9127	-28.9068	34.40
9	(4.5,0)	1.9127	-21.4952	35.16
10	(4.75,0)	1.920	-17.5845	35.23
11	(5,0)	1.920	-15.2523	34.30
12	(6,0)	1.987	-10.4521	33.57

A centre frequency of 1.9120 GHz, which is extremely near to the required GSM band design frequency, is obtained by calculating the antenna's, radiation loss, radiation directivity, and bandwidth for this feed point position to be 24.28 MHz. The chart shows that the centre frequency starts to significantly drop when the feed point is moved farther from the patch's centre. The largest bandwidth is found at (X_f,Y_f) = (3, 0), despite the fact that the biggest return loss is found at this location (3.75, 0)[1].

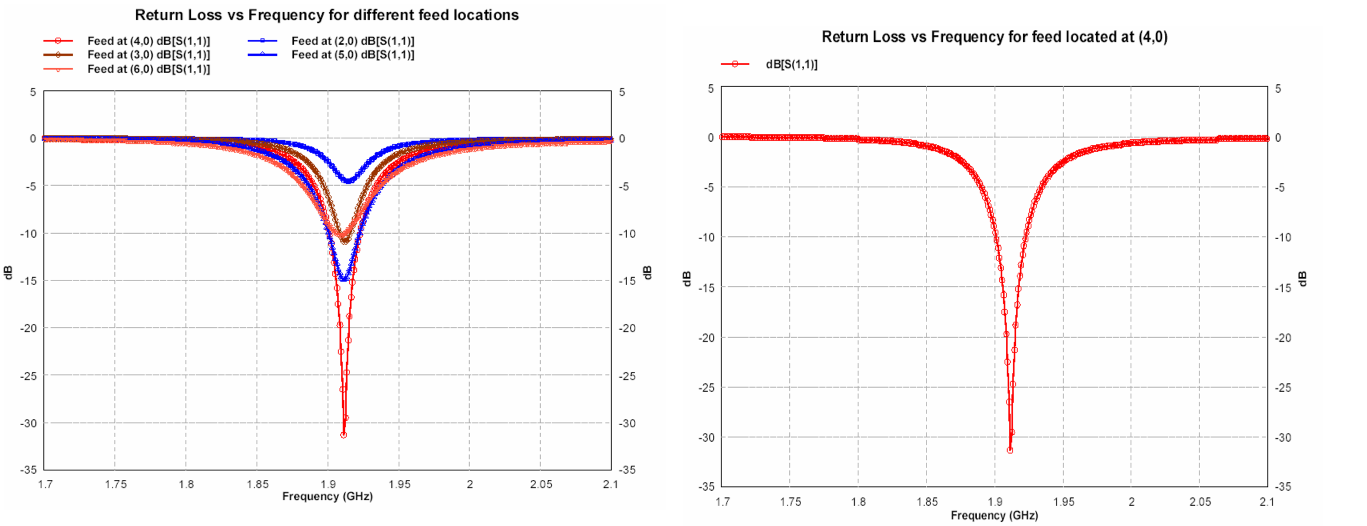

Figure 3: return loss with feed pattern and location

Since a microstrip patch antenna radiates to its patch surface, the elevation pattern for ϕ = 0 and ϕ = 90^0 would be important at 1.9120 GHz .

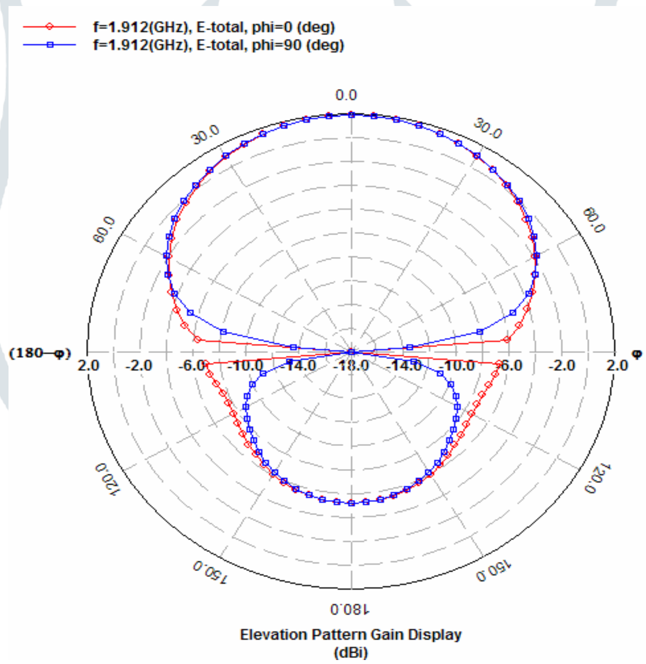

Figure 4: radiation resistance based n Pattern for ϕ = 0 and ϕ = 90^0

The broadside direction yields the highest gain, which is measured at 1.87 dBi. The back lobe radiation for the figure above is measured to be -5.24dBi, which is a tiny enough value. Since less electromagnetic radiation flows towards the user's head when utilizing this antenna in a cell phone, this reduced back lobe radiation provides an additional benefit. When the developed microstrip patch antenna is installed in a mobile phone, it is oriented so that the z axis is parallel to the earth's surface. The 3D radiation pattern maps for this instance are shown in Figure.4 Gain = 1.4717 dBi, Directivity = 5.26 dBi, Antenna Efficiency = 57.77% ,3 dB Beamwidth = (116.85, 120.24) degrees[17].

CONCLUSIONS

a small microstrip patch antenna with a 1.91 GHz centre frequency has been successfully created. The patch antenna's ground plane is meant to be 29 mm by 38 mm in size, while the patch itself is 20 mm by 30 mm. As a result, the developed antenna is small enough to fit within a normal cell phone. Plots of the radiation pattern for the appropriate antenna orientation have been obtained. Since less electromagnetic energy is emitted towards the user's head when back lobe radiation is reduced, this is a benefit for the application of the antenna in cellular phones. The results showed a gain of 1.4717 dBi and a directivity of 5.26 dBi. Since TDMA and GSM, the bandwidth obtained is 24.88 MHz, which should be adequate range.

REFERENCES

[1] A. P.Bhat, Development of smarat instrumention technology for nanostructured antenna and solar sell , RTM Nagpur University, Nagpur , Ph.D. Thesis, ch3, 2018, 123-160

[2] Rappaport, Theodore S., Wireless Communications: Principles and Practice, Prentice Hall Communications Engineering and Emerging Technologies Series, 1999.

[3] www.wirelessadvisor.com

[4] http://web.bham.ac.uk/eee1roj8/websites_demo

[5] Stutzman, W.L. and Thiele, G.A., Antenna Theory and Design, John Wiley & Sons, Inc,1998.

[6] Balanis, C.A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, 1997.

[7] Makarov, S.N., Antenna and EM Modeling with MATLAB, John Wiley & Sons, Inc, 2002.

[8] Ulaby, F.T., Fundamentals of Applied Electromagnetics, Prentice Hall, 1999.

[9] Saunders, S.R., Antennas and Propagation for Wireless Communication Systems, John Wiley& Sons, Ltd, 1999.

[10] Kumar, G. and Ray, K.P., Broadband Microstrip Antennas, Artech House, Inc, 2003.

[11] Garg, R., Bhartia, P., Bahl, I., Ittipiboon, A., Microstrip Antenna Design Handbook, Artech House, Inc, 2001.

[12] Qian, Y., et al., "A Microstrip Patch Antenna using novel photonic bandgap structures", Microwave J., Vol 42, Jan 1999, pp. 66-76.

[13] Balanis, C.A., Advanced Engineering Electromagnetics, John Wiley & Sons, New York,1989

[14] Hammerstad, E.O., "Equations for Microstrip Circuit Design," Proc. Fifth European Microwave Conf., pp. 268-272, September 1975.

[15] James, J.R. and Hall, P.S., Handbook of Microstrip Antennas, Vols 1 and 2, Peter Peregrinus, London, UK, 1989.

[16] Bahl, I.J. and Bhartia, P., Microstrip Antennas, Artech House, Dedham, MA, 1980.

[17] Richards, W.F., Microstrip Antennas, Chapter 10 in Antenna Handbook: Theory Applications and Design (Y.T. Lo and S.W. Lee, eds.), Van Nostrand Reinhold Co., NewYork, 1988.

[18] Newman, E.H. and Tylyathan, P., "Analysis of Microstrip Antennas Using Moment Methods," IEEE Trans. Antennas Propag., Vol. AP-29, No. 1, pp. 47-53, January 1981.

[19] Harrington. R.F., Field Computation by Moment Methods, Macmillan, New York, 1968.

[20] Kantorovich, L. and Akilov, G., Functional Analysis in Normed Spaces, Pergamon, Oxford,pp. 586-587, 1964.

[21] IE3D 10.0, Zeland Software Inc., Fremont, CA.