IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 5, May 2016

Analysis of Specific Absorption Rate (SAR) of Microstrip Patch Antenna for Wireless Applications

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Abstract: In this paper the Specific Absorption Rate (SAR) of a microstrip antenna is presented which can be used for 4G mobile wireless communications.The proposed antenna geometry describes a inset feed rectangular patch printed over a FR4 substrate of thickness 1.6 mm and Permittivity $\varepsilon_r = 4.3$. The antenna is designed with slot and simulated in CST microwave Studio electromagnetic simulation tool. The simulated antenna shows -25dB of return loss, 69.13MHz bandwidth for 2.3GHz,-30 dB of return loss, 91.55MHz for 3.5GHz and -25 dB of return loss, 102.774MHz for 4.46GHz and VSWR is less than 2. Head model is developed to calculate the SAR value. The head model is kept at a distance of 50 mm from the antenna and SAR is calculated. The SAR value is 0.06399 W/Kg for 10 gram of tissue which is well within the value specified by the FCC. So there is a 96.80 % reduction compared to the value set by FCC.

Keywords: Specific Absorption Rate (SAR), Microstrip patch antenna, Return Loss, FCC.

I. INTRODUCTION

As the world care about the development of wireless communication and with the really huge goals they have achieved on the other hand we should consider the human health and the risk which is effect negatively in the human health.This paper investigates health concerns from human exposure to RF communication antennas. This indicates that mobile devices are required to support different technologies and operate in different frequency bands. So, the LTE (long term evolution) is a new high-performance air interface standard for cellular mobile communication systems. It is the 4th generation (4G) of radio technologies to increase the capacity and speed of mobile telephone networks operating at 2.3 GHz. Exposure is usually measured in terms of the specific absorption rate (SAR). The SAR limit specified in IEEE C95.1:1999 is 1.6W/Kg in a SAR1gm averaging mass while that specified in IEEE C95.1: 2005 has been updated to 2W/Kg in a 10 gm averaging mass SAR is the most appropriate metric for determining EM effect exposure in the very near field of a Radio Frequency (RF) source.

Specific Absorption Rate (SAR):

SAR is a value describing how much power absorbed in biological tissue when the Body is exposed to electromagnetic radiation. The mathematical definition is

$$SAR = \frac{\sigma eff \times Erms^{2}}{\rho} \quad \text{W/Kg}$$

Microstrip Antenna

Microstrip patch antennas are more popularly used now a days due to its various advantages such as light weight, low volume, compatibility with integrated circuits, easy to install on the rigid surface and low cost. Microstrip patch antennas are design to operate in dual-band and multi-band application either dual or circular polarization. These antennas are used in different hand held communicating devices.

The simple Microstrip patch Antenna consists of a dielectric substrate having fixed dielectric constant. Radiating patch is present on one side of a dielectric substrate and a ground plane is present on other side of a substrate. The metallic patch may take any geometrical shapes like rectangular, triangular, circular, helical, ring, elliptical etc. The dimensions of the patch are corresponds to the resonant frequency of antenna. most of the applications which uses Microstrip antenna in communication systems like mobile hand held communicating devices require smaller antenna size. Different advance tools to the design of very compact Microstrip patch antennas have been introduced over the last few years.

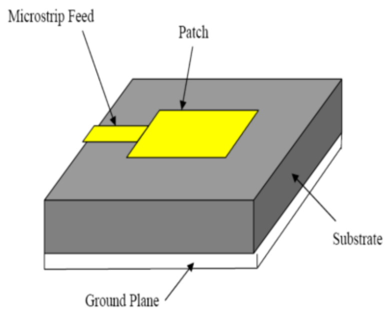

Fig.1 Structure of micro strip patch antenna

DOI 10.17148/IJARCCE.2016.5555

ISSN (Online) 2278-1021
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International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 5, May 2016

Where

L: Element length	W: Element width
h: Thickness	fr: Resonate frequency
$\in_r$: Dielectric Constant	C: Velocity of light
ΔL : Extension length	$\in_{eff:}$ Effective Dielectric Constant

II. ANTENNA DESIGN

Microstrip Patch antenna is known to be a low profile radio antenna, which can be mounted on a flat surface. It is basically designed with radiating patch on one side of a dielectric substrate and on the other side of this dielectric substrate, a ground plane is fixed. The patch is usually made up of various conducting materials such as copper or gold and can be produced in any possible shape. Electric fringing fields between the edges of the conductor element and the ground plane behind it are the primary source of the antenna's radiation. The antenna's radiation depends upon various properties of antenna such as dielectric constant, height (h) of the substrate, the patch dimensions and the frequency. The Microstrip patch antenna is designed with the slot to operate at 2.3 GHz frequency. The rectangular patch reception apparatus is manufactured on glass epoxy substrate ϵ_r = 4.3 with thickness (h) of 1.6 mm, width of the patch is W=40.062 mm and length L=31.092 mm and the dimensions of the the slot are W=21mm and L=mm and 15mm above from the origin as shown in the figure 2. Then power is fed to the antenna through inset fed.

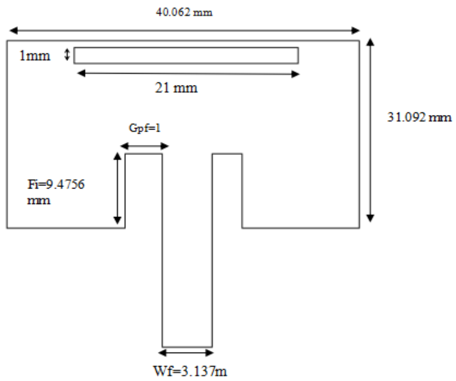

Fig.2 Geometry of the patch

Table1: Parameters

Parameters	Mm
Width(W)	40.062
Length(L)	31.092
F_i	9.4756
W_f	3.137
G_{pf}	1
Ground Length(Lg)	2*L
Ground Width (Wg)	2*W
Height of the conductor(h_t)	0.035
Substrate thickness(h_s)	1.6

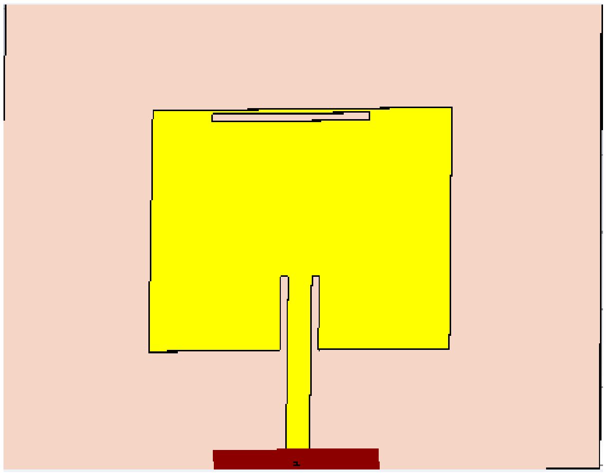

Fig. 3: Designed Microstrip antenna

III. RESULTS

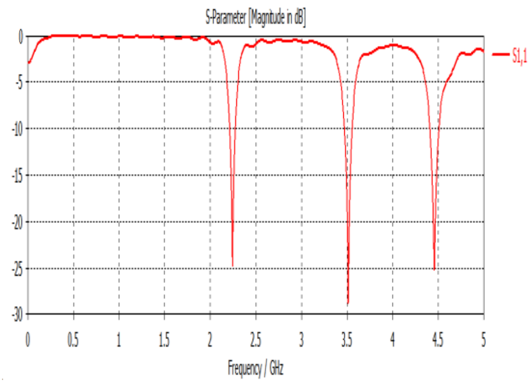

Fig.4: Return loss of designed Microstrip patch antenna with slot

IV. SAR CALCULATIONS

Head model is developed to calculate the SAR value. The head model is kept at a distance of 50 mm from the antenna and SAR is calculated. The SAR value is 0.06399W/Kg for 10 gram of tissue. Figure 5 shows the antenna and head model designed in the tool.

Table 2: results

Frequency = 2.3 GHz	Return loss in dB	Bandwidth MHz	VSWR	SAR W/Kg For 10 gm of tissue
With slot	1st Band -25 2nd Band -30 3rd Band -25	1st Band 69.13 2nd Band 91.55 3rd Band 102.77	1st Band 1.1563 2nd Band 1.109 3rd Band 1.109	0.064

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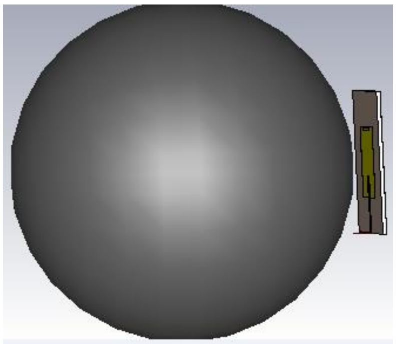

Fig.5: SAR of head model before simulation

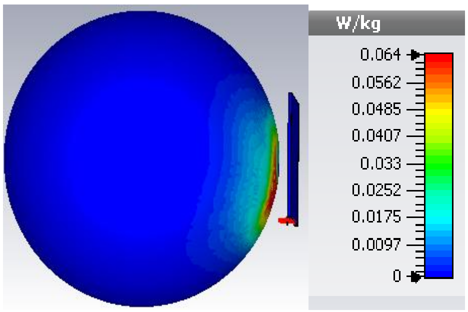

Fig.6: SAR value after simulation

Figure 6 shows the SAR value after the simulation has carried out. The red colour shows the area of the brain tissue which absorbed electromagnetic radiations transmitted from the antenna.

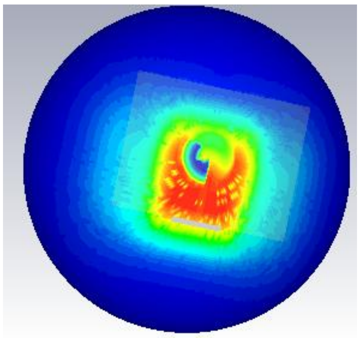

Fig.7: SAR Effect on head tissue

IV. CONCLUSION

Microstrip patch antenna is designed and its SAR value is analysed by considering the head model designed in CST MWS tool. The simulated SAR result of the proposed antenna is 0.06399 for 10gm of tissue, 96.80 % reduction compared to the standard value. The antenna was simulated using the CST simulator. The designed slotted antenna has -25dB of return loss, 69.13MHz bandwidth for 2.3GHz,-30 dB of return loss, 91.55MHz for 3.5GHz and -25 dB of return loss, 102.774MHz for 4.46GHz

ACKNOWLEDGMENT

I express my sincere gratitude to my guide, **Rajendra Soloni** and **Dr.Chandrappa. D.N** Dept. of Electronics and Communication Engineering, G M Institute of Technology, Davanagere, Karnataka for the consistence support in successful completion of this paper.

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