Bandwidth Enhancement of Rectangular Ring Antenna for On-body Communication System

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Abstract— In this modern mobile and wireless communication era, the demand of smaller and compact antenna has been increasing. The printed monopole antennas are popular for these applications and also applicable for body centric communication because of its low cost and process simplicity. Here the proposed antenna is a rectangular ring antenna operating at 2.45GHz. In this configuration the rectangular slot cut inside the patch resulting the ring and in this ring cut the C-shape slot. so simple and compact micro strip-fed printed monopole antenna is proposed in this design. The size of partial ground plane is 20x9mm and the dimension of substrate FR4 used is 20x40mm with thickness 1.6mm, dielectric permittivity is 4.7 and tangent loss is 0.019.The size of patch is 12x26 with ring width of 2mm and width of C-shape slot is 1mm.HFSS 13.0 is used for simulation and after he simulation it is found that the antenna operates well at 2.45GHz.The antenna covers bandwidth from 2.28GHz to 2.78GHz which is 20.40%.

Key words: Bodycentric communication, printed antenna, microstrip feed, HFSS13.0

I. INTRODUCTION

As applications increase in personal communication system. The demand of wireless system also increases. At the present time the on-body wireless communication has become major field of interest for researchers [2]. In various research it is found that the compact printed monopole antenna are suitable because of its compact size, omnidirectional radiation patters, wide matching characteristics and high radiation efficiency [1-8].there are many facts which are taken in mind of researchers when they design the on-body communication antenna such as reliable and efficient link between devices and body and it provide comfort after wearing it. In this paper, antenna is proposed for on-body communications that is a rectangular ring antenna fed by 50 ohm micro strip feed line. The performance of designed antenna is simulated by HFSS13.0 software.

II. DESIGN PARAMETERS

Mainly the design of Micro strip patch antenna depends upon three parameters, dielectric constant of substrate, thickness of the substrate and resonant frequency. Depending on the dimension, the operating frequency, radiation efficiency, directivity, return loss are influenced. For the calculation of geometrical dimensions it should be taken in the mind that for a micro strip patch the electrical dimensions are larger than geometrical dimensions This is due to the existence of fringing field beyond the limit, given by the geometrical dimensions of the micro strip patch. For a rectangular patch, the patch length L is usually $0.3333\lambda 0 < L < 0.5\lambda 0$, where $\lambda 0$ is the free-space wavelength. The thickness of patch is selected in such a way that $t << \lambda 0$ (where t is the patch thickness). The height h of the dielectric is usually $0.003\lambda 0 \leq h \geq 0.05\lambda 0$. Thus, a rectangular patch of dimension 6.12mm×30.14mm is designed on one side of an FR4 substrate of thickness 1.6mm and relative permittivity 4.4 and the ground plane is located on the other side of the substrate with dimension 45.80mm x 39.80mm. The antenna plate is fed by standard coaxial of 50_ at feeding location of 0.2mm by 20.286mm on the patch. This type of feeding scheme can be placed at any desired location inside the patch in order to match with the desire input Impedance and has low spurious radiation.

Various designing parameters are as follows:

Width of patch is given by:-

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

Effective dielectric constant is given by:

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

Effective length of patch:-

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

Due to fringing fields present extension of length is calculated by:-

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

Effective length of patch is given by:-

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

2.6 Ground plane dimensions are calculated by:-

$$L_g = 6h+L$$
$$W_g = 6h+W$$

Representations used are as follows:

ϵ_{reff} = Effective dielectric constant

ϵ_r = Dielectric constant of substrate

h= Height of dielectric substrate

f_0 = Resonant frequency

l_g = Length of ground plane

w_g = Width of ground plane

c = Velocity of light

III. ANTENNA GEOMETRY

The geometry of proposed antenna is given below. The overall size of antenna is 20x40 mm. The radiator and ground plane are etched on the opposite sides of FR4 substrate (ϵ =4.7 and 1.6mm in thickness).The radiator size is 12mm x 26mm and a rectangular notch cut from radiator that formed the rectangular ring The dimension of ring is given bellow figure 1. The C-shape slot cut from the ring which width 0.5mm. The width of micro strip feed line is 2.4mm and 12mm length located at the center with a 3mm feed gap. Figure 1 shows the dimensions of proposed antenna.

L_{sub}	40 mm
W_{sub}	20 mm
L	26 mm
W	12 mm
L_g	9 mm
L_{feed}	12 mm
g	3 mm
d	2.4 mm
h	1.6 mm

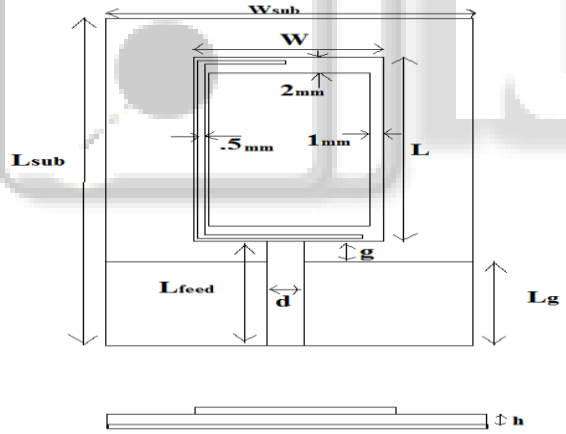

Fig. 1: Antenna Configuration

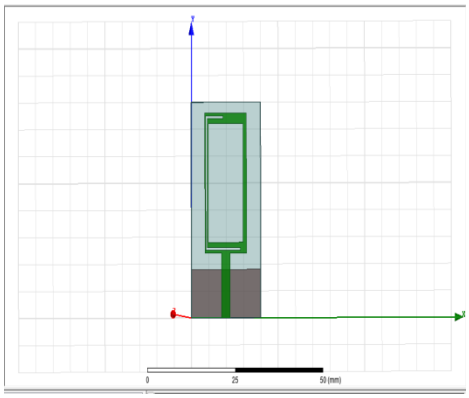

Fig. 2: Antenna structure in HFSS13.0

IV. RESULT

The overall simulation is performed using HFSS13.0 software. By the cutting of C-shape slot in rectangular ring, it is analyzethat the bandwidth is increased. To adjust the impedance matching, both feed gap and position of feed point can be used. The length of the ground plane was optimized to achieve a miniaturized design with good impedance matching.

Figure 3 shows the return loss of simulated antenna. It can be seen that the simulated antenna is excited at 2.45 GHz with a -10dB impedance bandwidth of 500MHz (2.28GHz to 2.78GHz).

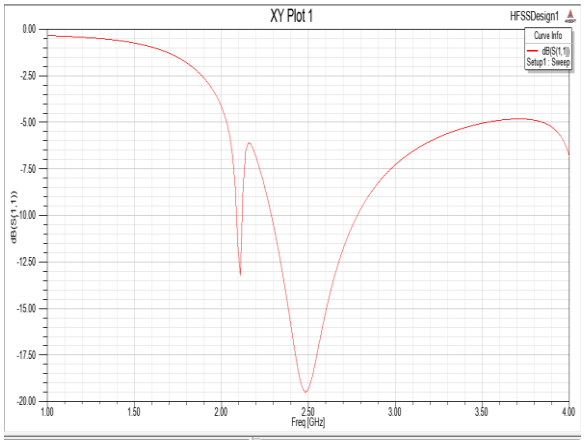

Fig. 3: Return Loss for Antenna

Figure 4 shows the VSWR of simulated antenna. It can be seen thatthe rang of VSWR is 2.09 to 1.90 in frequency band 2.28GHz to 2.78GHz respectively.

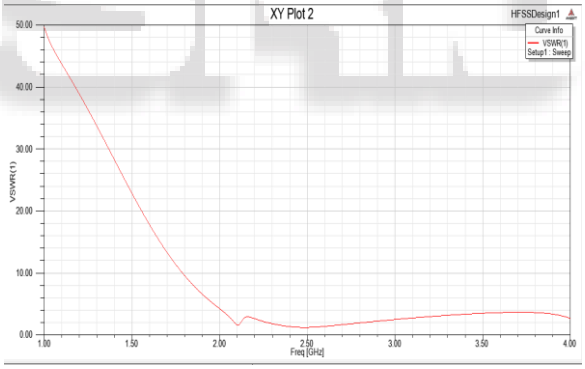

Fig. 4: VSWR for Antenna

V. CONCLUSION

A C-slot rectangular monopole ring antenna fed by micro strip line is presented in this paper. The proposed antenna was successfully design to operate at 2.45GHz frequency for on-body communication. The corresponding bandwidth of 20.40%.This frequency band belongs to S- band or short wave band so it also used by weather radar, communication satellites and surface ship radar system.

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