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Microstrip Patch Antenna Design for SAR Reduction in Human Head Using Slotting Technique

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ABSTRACT- In this paper a new type of mobile handset antenna is designed to reduce the specific absorption rate (SAR) in human head using the slotting technique. In order to reduce SAR multiple slots have been etched on various places on the radiating patch. The new design for low SAR will be operating at multiband frequencies due to multiple slots. Apart from the SAR reduction various antenna parameters are also considered to be better in the proposed antenna. The proposed design obtained a return loss of -16db at 2.5 GHz, -12dB at 4GHz, -15dB at 5.4 GHz, -15dB at 7.4 GHZ and -14dB at 8GHz. In the proposed model the value of average SAR was reduced to 0.061732 W/kg over 10 g at the centre frequency 2.5 GHz. HFSS software is used to simulate the design.

Keywords: *- Handset antenna, Human head, Radiating patch, Slotting technique, Specific Absorption Rate (SAR).*

I. INTRODUCTION

Electromagnetic radiation from the mobile phones is increasing day by day with the rapid growth in the use of mobile handsets. These electromagnetic radiations are affecting the human head at a greater extent day by day [1]. As per the government rules and regulations the accepted SAR value for each and every mobile handset should be of 1.6 W/kg and below. So mobile handset antenna designers are concentrating more on SAR reduction compared to other antenna parameters and SAR value for a proposed antenna should be of less than 1.6 W/kg and much more less [2]. SAR is a defined measure to evaluate the power absorbed by biological tissue.

$$\text{SAR}= \frac{\sigma E^2}{\rho} = C\frac{dT}{dt}$$

Where, σ= Electrical conductivity
ρ= Mass density
C =specific absorption rate
dT/dt= changing rate of the temperature in body tissue.

SAR value is influenced by radiated power, radiation patterns of the antenna and antenna positions relative to human body [3]. Reducing the power radiated towards the human head by mobile antenna reduces the SAR in life tissues [4]. To reduce radiation towards the human head lots of working is going on to find different ways. Use of RF shields was suggested by initial works which is not a convenient solution for mobile applications [5]. By using slotting technique on the radiating patch the power radiation can be reduced, by which SAR can be reduced. In general, on account of health effects in living beings, the SAR value needs to be reduced greatly.

II. ANTENNA STRUCTURE

The proposed design is shown in figure 1. It is designed to work at 2.5GHz. RT Duroid is used as substrate material that has relative permittivity 2.2, loss tangent 0.0009 and thickness of 1.6mm. The dimensions for the proposed structure are listed in table No.1. The feed used here is inset feed and the input given has an input impedance of 50 ohms. On the radiating patch four slots are equally spaced with length 12mm and width 2.6mm at the centre. Three slots have been used at the three edges of radiating patch as shown in figure 2, with length 11.5mm and width 0.5mm. These slots not only reduce the SAR value but also allow the antenna to work at multiband frequencies.

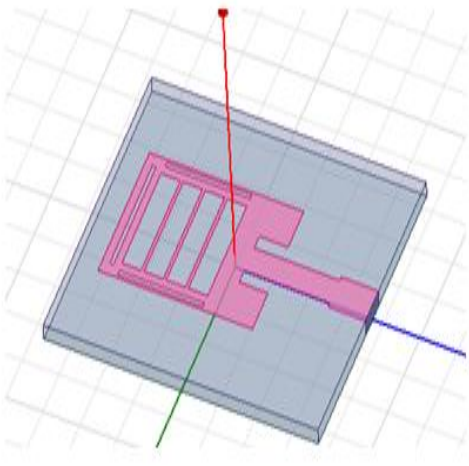

Fig 1:- Proposed microstrip patch antenna

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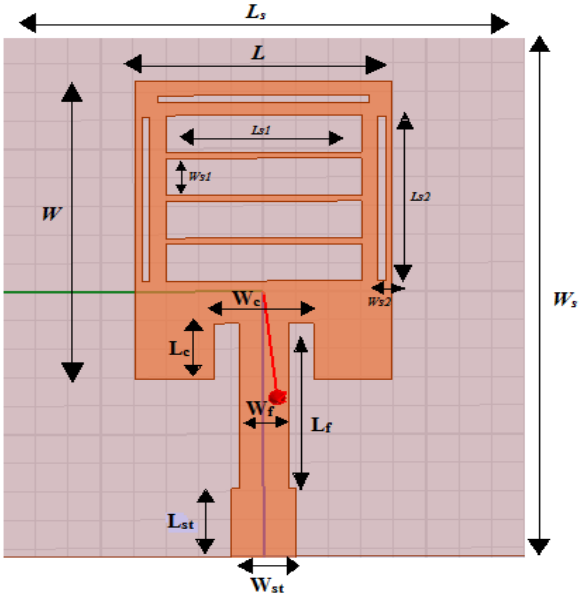

Fig 2:- Top side view of proposed antenna

Table No.1 dimensions of proposed antenna

PARAMETER	DIMENSIONS	PARAMETER	DIMENSIONS
L_S	33.2mm	W_{st}	4.059mm
W_S	37.14mm	L_c	4mm
L	15.74mm	W_c	6.2mm
W	11.75mm	L_{s1}	12mm
L_f	11.81mm	W_{s1}	2.6mm
W_f	3.059mm	L_{s2}	11.5mm
L_{st}	5mm	W_{s2}	0.5mm

III. SIMULATION RESULTS AND DISCUSSION

A. Return Loss

Return loss is defined as loss of power in the signal reflected by a discontinuity in a transmission line. Discontinuity can be due to mismatch with the terminating load. For the proposed design the S11 plot obtained has multiband frequencies with better return loss. Totally seven frequency bands are obtained in the plot, for the resonating frequency 2.5GHz the return loss obtained is -16dB and for all the remaining bands return loss is below -10dB. The return loss plot is shown in figure 3.

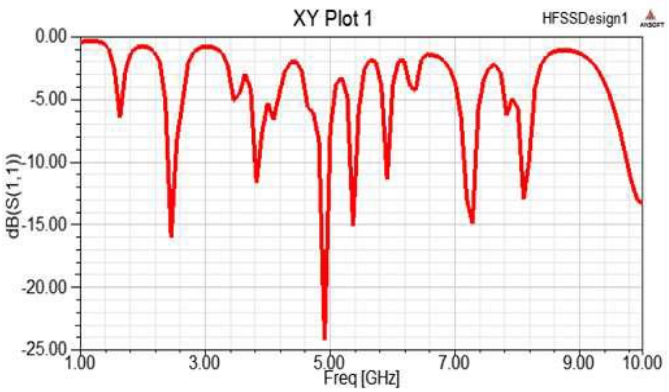

Fig 3:- Return loss plot

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B. 3 D Radiation Pattern

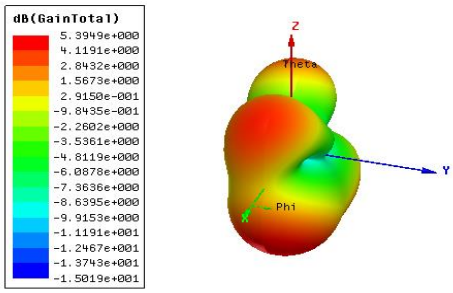


Fig 4:- 3-D Radiation Pattern

The 3-Dimensional radiation pattern of the proposed antenna is shown in figure 4 and it represents the directional capabilities of the antenna. From the figure it can be concluded that the antenna has Omni directional radiation pattern and the value obtained is 5.3949 dB.

C. SAR (Specific Absorption Rate)

Since SAR has greater effect on living beings its value should be reduced as much as possible to a greater extent [6]. The SAR value obtained for the proposed design is 0.0611732 W/kg and it is shown in the figure 2. The above SAR result shows that the absorption rate has been decreased to a greater extent. From the above figure circled with red mark it can be observed that the minimum SAR value is 0.0249907 W/kg and maximum value is 0.0611732 W/kg. The difference between these two values is 0.0361825 W/kg. It can be said that proposed antenna will not cause any effect on living beings.

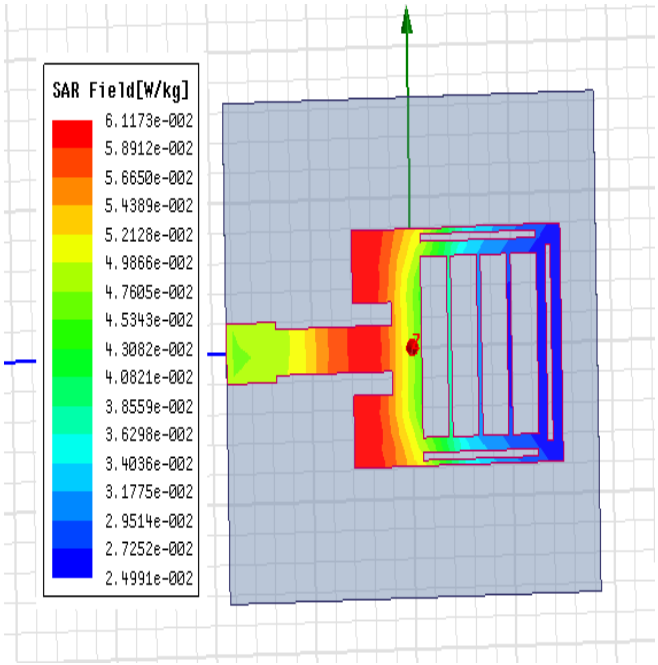
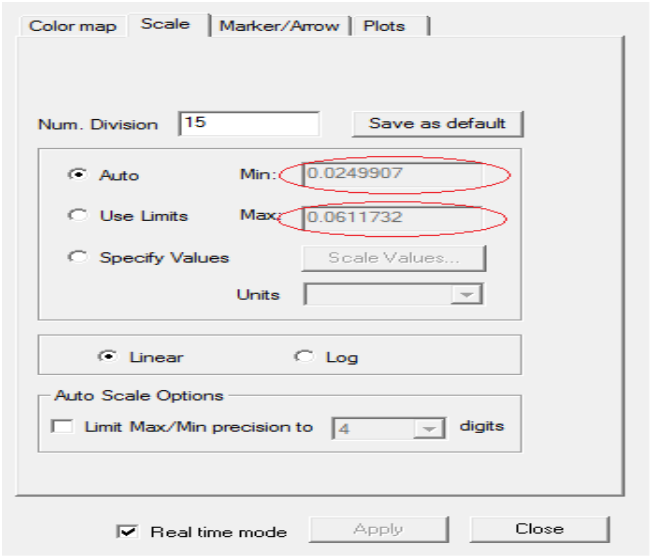


Fig 5:- SAR Plot



IV. CONCLUSION

Low SAR antenna was effectively designed by using slotting technique. In the proposed model the value of the averaged SAR over 10 g was reduced to 0.0611732 W/kg at the centre frequency 2.5 GHz. Along with SAR reduction minimum return loss was also obtained at different frequencies. In addition, this antenna is suitable for WLAN, WI-MAX, Satellite applications. The designed antenna operates at 2.5 GHz and has an Omni directional radiation pattern. It was also observed that more the number slots on the radiation element lesser the SAR value will be obtained. Finally it can be concluded that since the proposed antenna gave a very minimum SAR value it does not shows any effect on the living beings.

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