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Body-centric Wireless Communication (BCWC) Application Microstrip Patch Antenna

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Abstract**—** In this paper a simple and light weight microstrip patch antenna has been presented. This antena is designed on a FR-4 substrate with dielectric constant of 4.3 and 1.6 mm thickness. The designed antenna is simmulated and anyalized for Body-centric Wireless Communication (BCWC) application, which operates at 5.126 GHz Industrial, Scientific and Medical (ISM) Hyper Local Area Network (LAN) band. Antenna is designed with dimensions of 13.2x18.6x1.6 mm^3. A parametric study has been carried out which shows a return loss of -31 dB and gain of 3.8 dBi at the designed frequency. The software used for simulation of this antenna is IE3D HyperLynx Zeland. A probe fee is used to excite the antenna.

Keywords**—** ISM band, BCWC, patch antenna, coaxial feed.

I. INTRODUCTION

Microstrip antenna is mostly used for wireless commutations in these days due to their peculiar properties of light weight, small size and easy to install. For body wearable antennas a patch antenna is integrated in cloth of user and reduce the problem of security and increase the intelligence level. Due to good radiation property these antenna are used for on/off body communication [1]. It radiates in a desired direction and reduces the radiation on other direction which increases the gain of antenna and further helps to reduce the specification absorption rate (SAR) which play important role in antenna performance when deployed on body parts. Other types of technique like slot cut, different shapes and metamaterial loading are discussed in literature to increase the performance parameter of patch antenna. Due to low and flat profile of patch antenna their uses are extended to applications like spacecraft and airborne [2]. For feeding the antenna a lot of techniques are discussed. It is very important to select the proper feeding method depending upon the structure and requirement of antenna. Feeding play important role for impedance matching of antenna, if matching is proper and efficient maximum power can be introduce in the patch and return loss can be improved [3]. The effect of rain water and seawater is also analyzed by various authors. The performance parameter will change due to the moisture on the antenna. Due to the moisture dielectric constant will change which further alter the radiation and gain also [4]. Whenever antenna is integrated into garments antenna is subjected to bend which causes to change the gain and return loss of antenna [5].

II. DESIGN ANALYSIS

A coaxial feed microstrp patch antenna is designed and tuned to 5.126 GHz frequency. The dimensions of antenna are calculated using the standered equations [6][7]. Using these equation length and width of the patch are estimated to 13.2 mm and 18.6 mm respectively for a substrate of FR-4 having dielectric constant of 4.3. The thickness of substrate is taken as 1.6 mm. A Coaxial feed is used to feed the antenna being a simple and effective for better performance. The proposed antenna is shown in fig.1

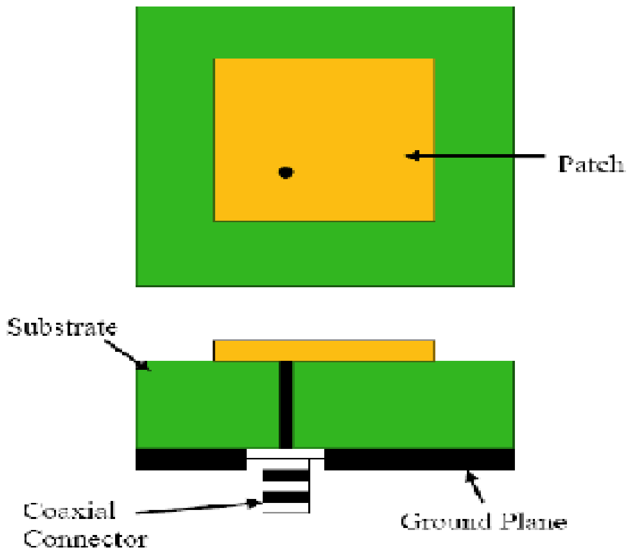

Fig.1 Coaxial feed patch antenna

The microstrip patch antenna design is accomplished by following steps

Step1: The width of patch is given by (1) $$w = \frac{c}{2f_0\sqrt{(\varepsilon_r+1)/2}} \quad (1)$$

Where, c is free space velocity of light. f_0 is resonant frequency in GHz for the current design. ε_r is dielectric constant of the substrate kept at 4.3. By using these values the width of the patch of antenna is found to be 18.6 mm.

Step 2: Calculation of effective dielectric constant

$$\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1 + 12\frac{h}{w}\right]^{-1} \quad (2)$$

Where, h is height of the substrate or thickness of the substrate given as 1.6 mm.

Step 3: Calculation of the length extension ΔL, which is given by

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)(\frac{w}{h}+0.264)}{(\varepsilon_{reff}-0.3)(\frac{w}{h}+0.8)} \quad (3)$$

Step 4: Now length of patch is given by

$$L = \frac{\lambda_0}{f_0\sqrt{\varepsilon_{reff}}} - 2\Delta L \quad (4)$$

Where the effective length of the patch L_{eff} is 13.2 mm and is calculated as:

$$L_{eff} = \frac{\lambda_0}{f_0\sqrt{\varepsilon_{reff}}}$$

III. RESULTS AND ANALYSIS

The analysis of coaxial feed antenna is done on the basis of return loss and radiation pattern at the design frequency 5.126 GHz. The return loss is realted to matching of feeding line and patch of antenna. So the feeding techniques and point should be selected carefully for better matching to aviod reflection. The return loss or S_{11} parameter is shown in the fig.2 which is -31 dB at designed frequency.

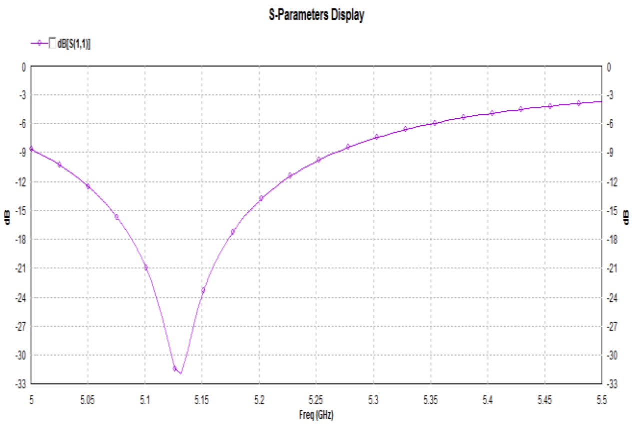

Fig.2 S_{11} parameter of coaxial feed microstrip patch antenna

Fig 3(a) and 3 (b) shows the elevation and azimuth gain pattern of antenna which is 3.8 dBi at the 5.126 GHz frequency.

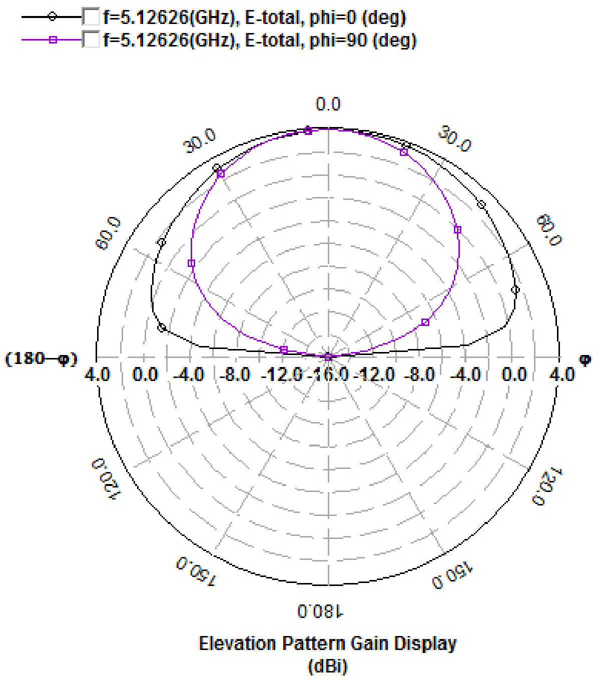

Fig.3(a) Elevation pattern gain at 5.126 GHz

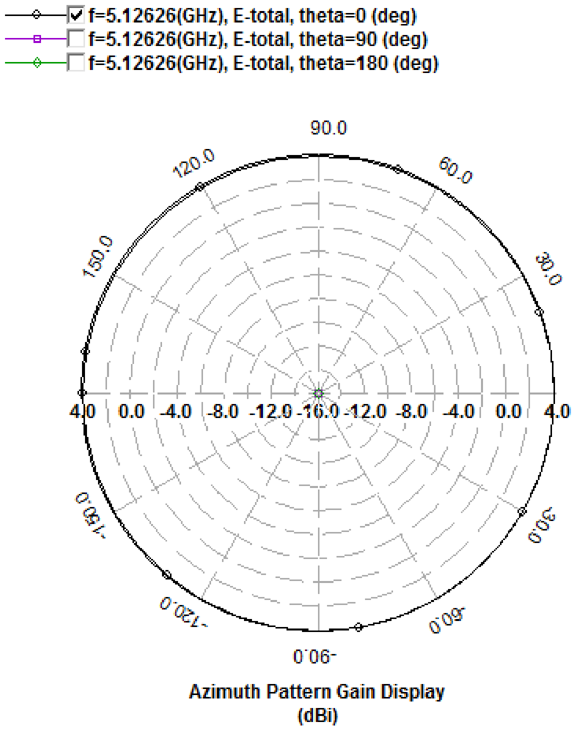

Fig.3(a) Azimuth pattern gain at 5.126 GHz

IV. CONCLUSION

The design antenna is tuned to frequency of 5.126 GHz. The return loss of antenna is -31 dBi which is good for perfect matchinf of feeding and patch but gain of antenna is only 3.8 dBi. So gain of this antenna may be increase by using some gain and directivity enhancement techniques like arrays of antennas. further by using slot cut and metamaterial a wide band of frquency can be achieved.

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