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RESEARCH ARTICLE

DESIGN AND SIMULATION OF MULTIBAND MICROSTRIP PATCH ANTENNA FOR WIRELESS 2 GHz TO 12 GHz BANDAPPLICATIONS WITH MICROSTRIP LINE FEEDING TECHNIQUE

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ABSTRACT-—In recent years many studies are concentrated on multiband micro strip antenna structures for important purposes in wireless communication systems, medical imaging, and radar sensor resolution. In this paper, we printed a circular radiator patch on FR4 substrate material. The relative dielectric constant was 4.4, and the thickness of the material was 1.6 mm. The patch was fed by a transmission line feeder, and there was a gap between the patch and the ground plane. Antenna design is simulated on electromagnetic (EM) simulation software HFSS and anechoic chamber with a network analyzer was used during the experimental tests. The simulated and measured results demonstrated that the proposed antenna achieved a wide impedance bandwidth from 2.0 GHz to 12.0 GHz with a return loss of less than -10 dB. The proposed antenna is easy to integrate with microwave circuitry for low manufacturing cost. The antenna structure is flat, and its design is simple and straightforward.

KEYWORDS - Patch antenna, partial ground plane, UWB antenna

I. INTRODUCTION

The commercial use of the frequency band 2.0 to 12.0 GHz for radar, positioning and data transmission has been released by the Federal Communication Commission (FCC) in 2002 [1]. In this UWB antennas have enormous attention in both academia and industry for applications in wireless transmission systems [2]. Impulse-Ultra wideband (I-UWB) is a carrier less short range communications technology in which its transmission occupies a bandwidth of more than 20% of its center frequency (>500 MHz)

[3].Wireless communication systems have developed rapidly in recent years, an antenna as a front component is required to have a wide band, good radiation performances and sometimes switchable ability [4].

From a systems point of view, the response of the antenna should cover the entire operating bandwidth, and the antenna should be non-responsive to signals outside the specified band [5]. UWB have wide applications in short range and high speed wireless systems, such as ground penetrating radars, medical imaging system, high data rate wireless local area networks (WLAN), communication systems for military and short pulse radars for automotive even or robotics. The antenna is one of the crucial components, which determine the performance of UWB system [6]. In the past, one serious limitation of the micro strip antenna was its narrow bandwidth characteristics, being 15 to 50% that of commonly used antenna elements such as dipoles, slots, and waveguides horns [7]. This limitation was successfully removed achieving a matching impedance bandwidth ratio it was necessary to increase the size, height, volume or feeding and matching techniques [8] Generally, UWB communication antennas require low voltage standing wave ratio (VSWR<2), constant phase center, constant group delay, and constant gain over entire operating frequency band [1].

II. ANTENNA CONFIGURATION AND DESIGN

For patch antenna the length and width are used as calculated from the equations. The expression for ε_{reff} is given by Balanis as [9]:

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

The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is given empirically by Hammerstad as:

$$\Delta L = 0.412h \; \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.2\right.}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + \right.} \qquad (2)$$

The effective length of the patch L_{eff} now becomes:

$$L_{eff} = L + 2\,\Delta L \qquad (3)$$

For a given resonance frequency f_o, the effective length is given by

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_r}} \qquad (4)$$

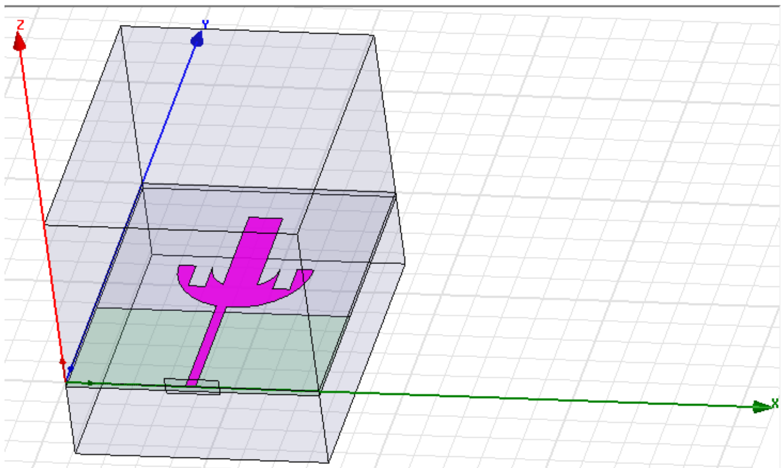
For a rectangular microstrip patch antenna, the resonance frequency for TM mn mode is given by James and Hall as:

$$f_o = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right] \qquad (5)$$

For efficient radiation, the width W is given by:

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon}{\ }}} \qquad (6)$$

The motivation of UWB antenna is to design a small and simple antenna that introduces low distortions with large bandwidth. The geometry of the antenna is as shown in Figure 1.



(a)

Figure 1: Geometry of micro strip patch antenna in 3-D view

III. ANTENNA DESIGN

The micro strip-fed UWB antenna's radiating patch is spade-shaped. The antenna is designed on a substrate with thickness of 1.6 mm and relative permittivity of 4.4. A semicircle structure is adapted in the front side of radiating patch, which results in a smooth transition from one resonant mode to another and ensures good impedance match over a broad frequency range. Two rectangles are cut off from bottom patch separately, which improve the characteristic of the high frequency band. The half-wavelength of the lowest resonant frequency in UWB band (f = 3.1 GHz) can be calculated with Expression (1).

$$\frac{\lambda p}{2} = \frac{\ }{2f} \qquad (7)$$

where, λp denotes the corresponding phase wavelength of the resonator; f represents frequency; ∊r is the effective dielectric constant of the substrate; c is the speed of the light in free space.

The radiating element occupies a size of 30 mm x 20 mm. The simulated return loss of the multi band antenna is presented in Figure 2. The -10 dB impedance bandwidth is from 2.0 GHz to 12.0 GHz,

IV. SIMULATION RESULTS

The simulated results are obtained using Ansoft simulation software high-frequency structure simulator (HFSS). The Six notch frequencies are obtaining at 2.2 GHz, 4.2GHz, 5.9GHz, 8.5GHz, 10.5GHz, and 12.0 GHz with -10dB return loss values shown in figure 2.

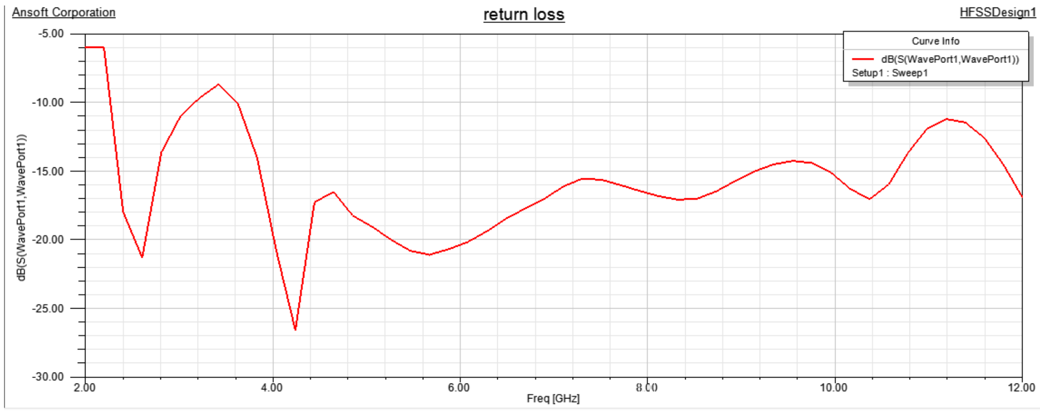


Figure 2: Return loss curves with Optimized length

Figure 3 shows the VSWR curve for multi band monopole Patch Antenna. The value of VSWR is less than 2 of the entire band of 2 GHz to 12 GHz wireless range.

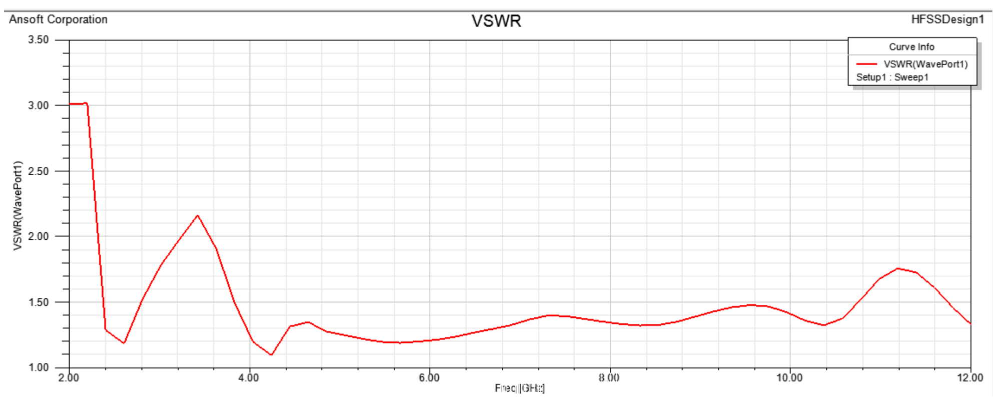


Figure 3: VSWR curve with Optimized length

The other antenna parameters like gain, directivity, peak gain, and radiated gain, accepted power, incident power, and radiation efficiency, front to back ratio, E field and H field are also simulated in figure4, figure5, figure6, figure7, figure8, figure9, figure10, figure11, and figure12 respectively.

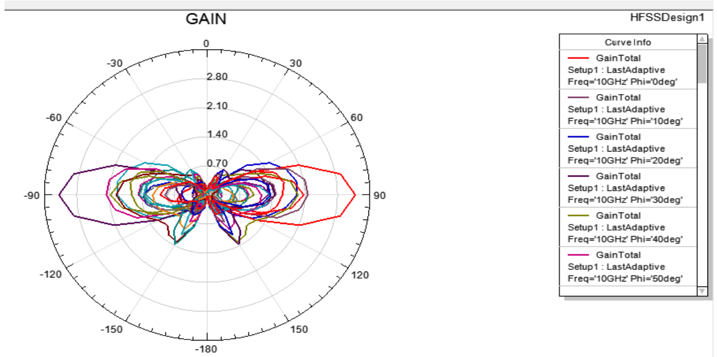


Figure 4: Plot of Gain at frequency 7.5 GHz

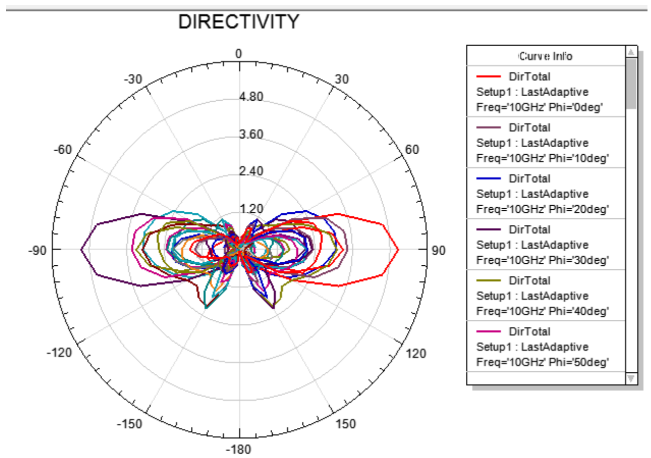


Figure 5: Plot of Directivity at frequency 7.5 GHz

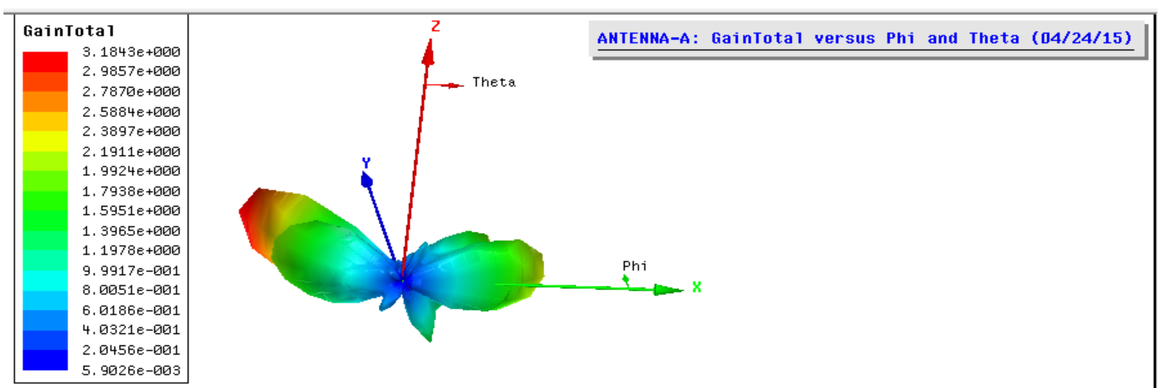


Figure 6: Plot of Gain at 10GHz

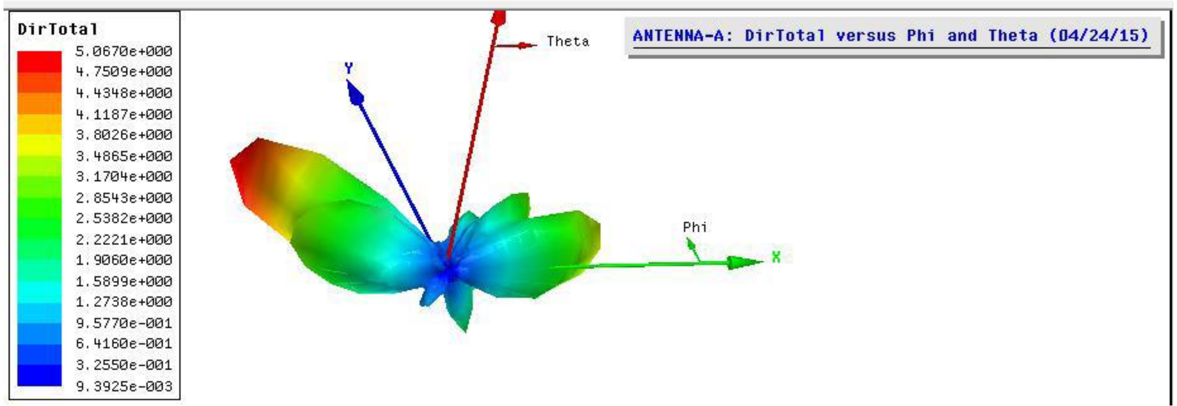


Figure 7: Plot of Directivity at 10 GHz

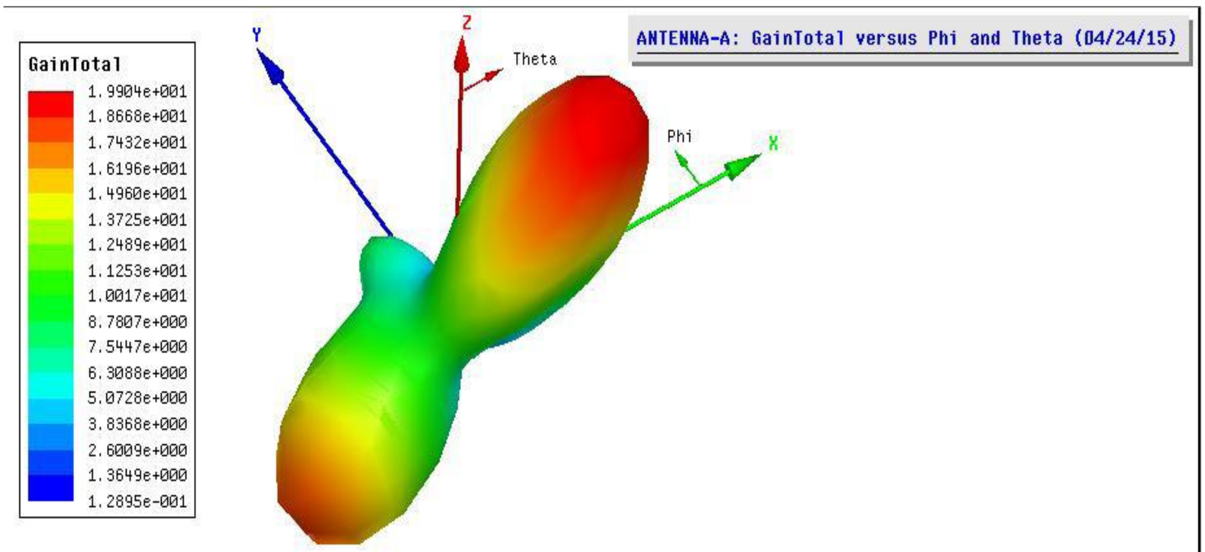


Figure 8: Plot of Gain at 10 GHz

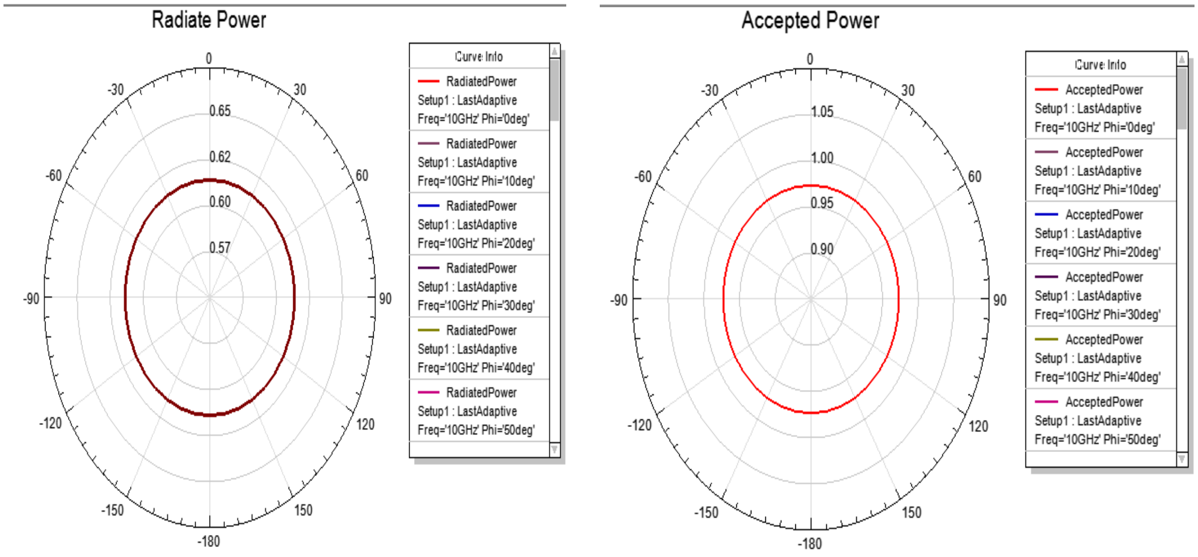


Figure 9: Plot of Radiate and Accepted Power at 10 GHz

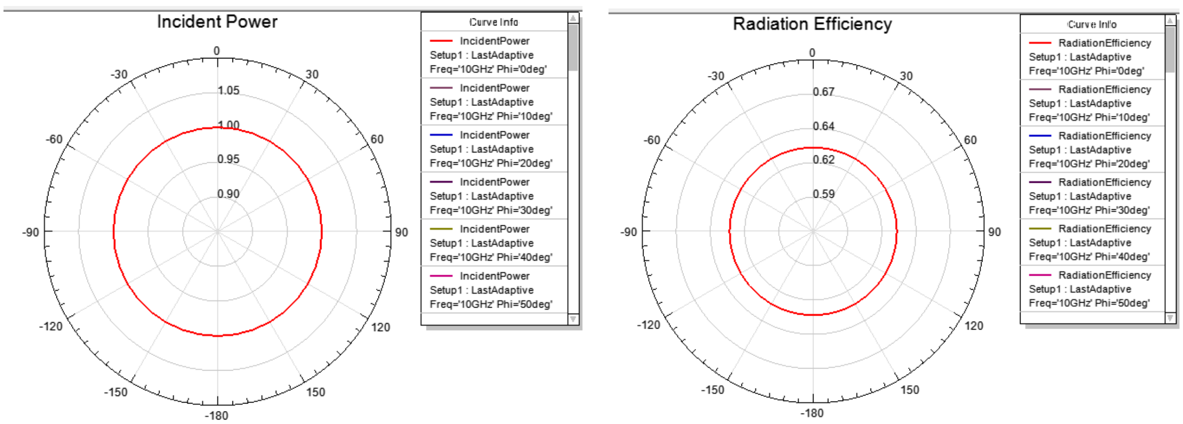


Figure 10: Plot of incident power and Radiation Efficiency at 10 GHz

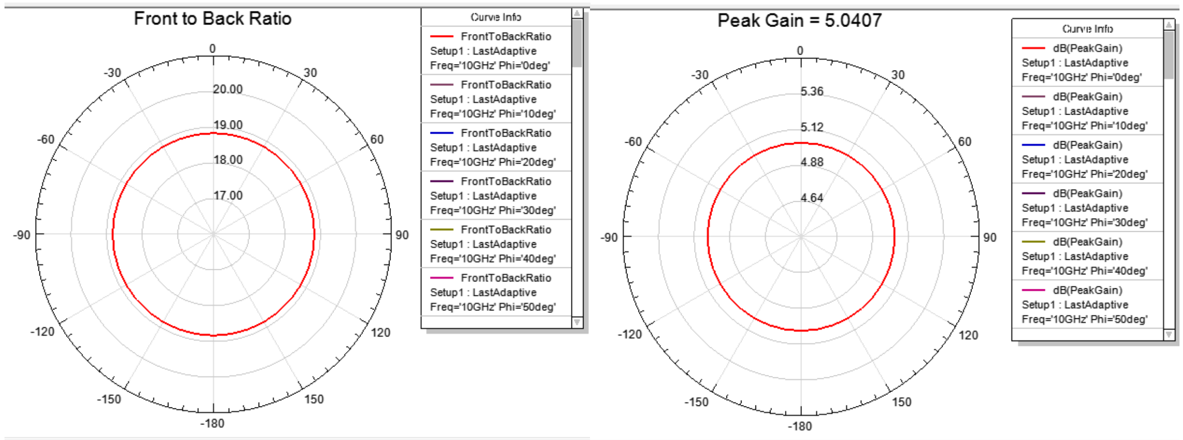


Figure 11: Plot of front to back and Peak Gain at 10 GHz

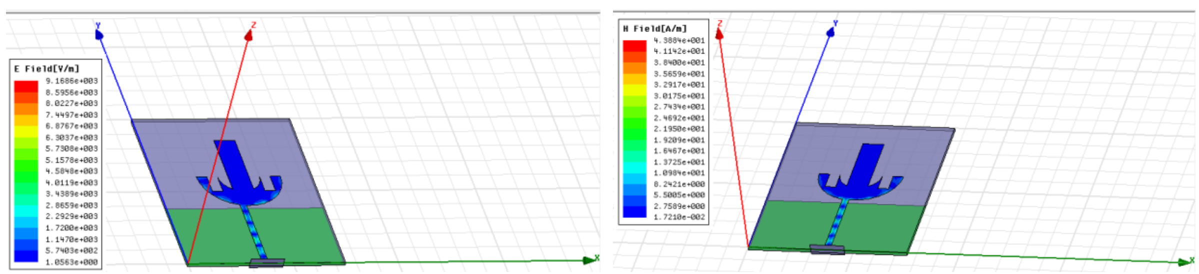


Figure 12: Plot of E-H field at 10 GHz

V. RESULT AND DISCUSSION

The various designing parameters like return loss, VSWR, gain, directivity, total gain, radiate power, acceptant power, incident power, radiation efficiency front to back ratio, peak gain, E-field and H-field are calculated with the help of simulation software. All the calculated values are shown in table 1.

TABLE 1 SUMMARIZED SIMULATED RESULTS

S.NO.	PARAMETER	SIMULATED VALUE
1	S11 OR RETUN LOSS	17 DB TO 26 DB IN THE ENTIRE BAND OF 2 GHZ TO 12 GHZ
2	VSWR	LESS THEN 2
3	GAIN	3.184

4	DIRECTIVITY	5.60
5	TOTAL GAIN IN DB	3.184
6	RADIATE POWER	61.25
7	ACCEPTED POWER	97.68
8	INCIDENT POWER	100.00
9	RADIATION EFFICIENCY	62.94
10	FRONT TO BACK RATIO	18.80
11	PEAK GAIN	5.04
12	E FIELD AND H FIELD	9.16 AND 4.388

VII. CONCLUSION

In this paper, the radiation performance of a monopole multiband patch antenna designed on glass epoxy FR4substrate. The antenna is capable of providing enhanced bandwidth to cover Wi MAX, Wi Fi and Bluetooth operations at Absolute Bandwidth (GHz) Below -10 db is 2 GHz to 12 GHz allotted by IEEE 802.16 working group for Wi MAX and UWB applications.

Radiation performance of circular patch antenna is also presented in this paper. The simulated results indicate that this antenna increase the Maximum Fractional Bandwidth up to 45%, 14%, 20% can be designed by cutting a slots in a complete circular patch. The radiation efficiency, S11, VSWR, incident power radiated power and front to back ratio also be calculated for this design using High frequency structure simulator (HFSS).

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