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TRIPLEBAND MICROSTRIP PATCH ANTENNA

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ABSTRACT

A microstrip patch antenna is designed having symmetrical slots in four quadrants to yield triple frequency of 2.5 GHz, 3.8 GHz and 4.7 GHz using FR4 substrate having dielectric constant of 4.4. The bandwidth obtain are 250MHz, 15MHz and 140MHz respectively. This antenna can be used for various wireless communication applications such as mobile communication, satellite, WLAN and WPAN. The antenna is based on transmission line model and is simulated using Zealand Inc.'s IE3D software which works on the principle of method of moments.

Keywords: Tripple band, symmetric pattern, microstrip patch,IE3D, wireless communication

INTRODUCTION

The emerging trends in wireless and mobile communication have necessitated the need of low return loss and good bandwidth antenna designs for effective communication. The antenna proposed in this paper is operating at three different frequency band (2.4GHz, 3.8GHz, 4.7GHz) having return loss upto -35dB and a VSWR of 1.18 making it suitable for applications such as mobile communication, satellite, WPAN, various IEEE standards such as IEEE 802.11 in the WLAN at 2.4 GHz (2.4GHZ -2.5 GHz) and IEEE 802.16 WiMAX at 3.17 GHz to 4.2 GHZ bands.

A microstrip patch antenna has a conducting patch that is made up of metals such as copper or gold, printed on a grounded dielectric substrate [1]. Compared with conventional antennas, Microstrip antennas have more advantages and better prospects. These antennas are low profile, simple and inexpensive to manufacture using modern printed circuit technology [2]. When a particular patch shape is selected they are very versatile in terms of resonant frequency, polarization, pattern and impedance. A large variety of patch antennas are being designed for various wireless applications having different shapes such are rectangle, square, pentagon, circle, spiral etc. [2].

Wireless local area network (WLAN) is raising its application in wireless communications. Antennas for portable WLAN device require broad band, high gain and compact design. As a result of these parameters multiband antenna techniques have attracted more attentions. The

antenna designed in this paper is triple band symmetric antenna having a high bandwidth of upto 260MHz. Performance stimulation of the patch antenna is done using IE3D stimulator which is based on method of moments [3].

antenna geometry

The basic structure of an antenna consists of a rectangular patch having a height h = 1.6mm, width w = 38.036mm, length l= 29.184mm. The given patch consists of symmetric pattern in all four quadrants. The length and the width of the patch are calculated using the following formula at 2.4 GHz and $\in_r = 4.4$ [4].

$$W = \frac{c}{2f\sqrt{(\in_r + 1)/2}}$$

$$\in_{reff} = \frac{\in_r + 1}{2} + \left(\frac{\in_r - 1}{2}\left(1 + \frac{12h}{W}\right)^{-0.5}\right)$$

$$L_{eff} = \frac{c}{2f\sqrt{\in_{reff}}}$$

$$\Delta L = \frac{h}{\sqrt{\in_{reff}}}$$

$$L = L_{eff} - 2\Delta L$$

Where

c = Velocity of light in free space

f= Operating resonant frequency

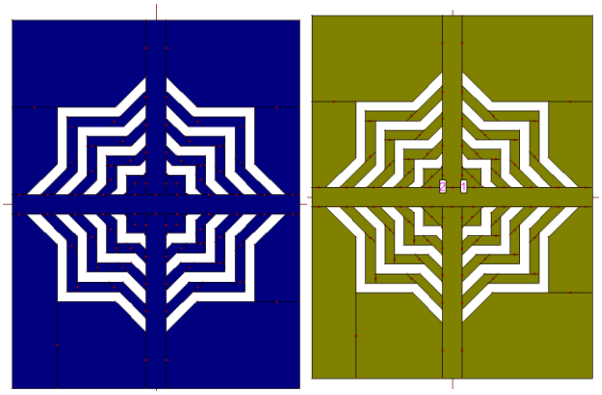
$\in_r$ = Relative dielectric constant

$\in_{reff}$ = Effective dielectric constant of the substrate

L_{eff} = effective length

h = Height of the substrate

W = Width of the substrate



(a) (b)

Fig1. (a) patch (b)patch with dual feed

stimulation and result

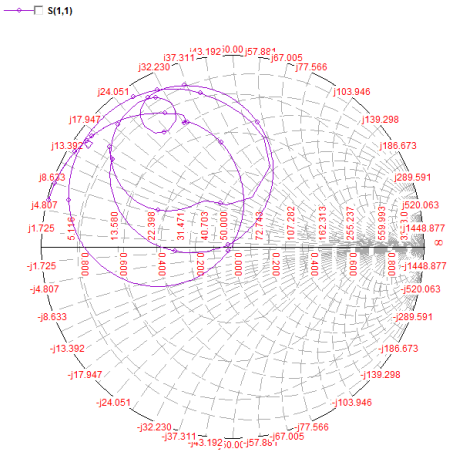


Fig 2.Smith chart

Fig 2 shows that the patch antenna operates at three different frequency bands, which lies inside the stable region of the smith chart. Therefore the operation of the patch antenna is stable for the three frequency bands.

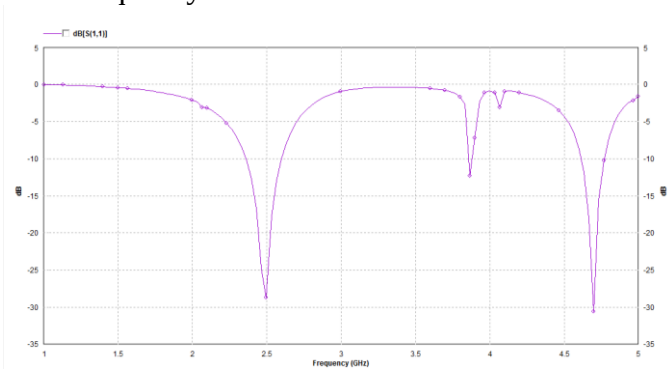


Fig 3.S-parameter versus frequency (return loss)

Return loss at 2.5GHz = -29dB

Return loss at 3.8GHz = -13dB

Return loss at 4.7 GHz = -31dB

The above figure shows the return loss at three different bands which is less that -10dB. The maximum return loss with the patch antenna is -31dB which makes it suitable for various wireless applications as the reflected energy is very less that which causes more amount of energy to be radiated.

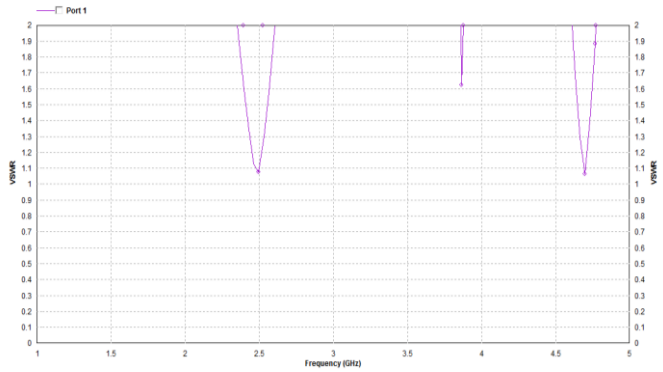


Fig 4.VSWR versus frequency
VSWR at 2.5GHz = 1.19
VSWR at 3.8GHz = 1.6
VSWR at 4.7GHz = 1.18

Fig 4shows that the VSWR at the three operating frequency bands is less than 2. The least obtained VSWR is 1.18, the three frequencies thus provides good impedance matching condition as the reflected energy is less at all these frequencies. Because of the less amount of energy reflectedback the return loss also reduces to a greater extent.

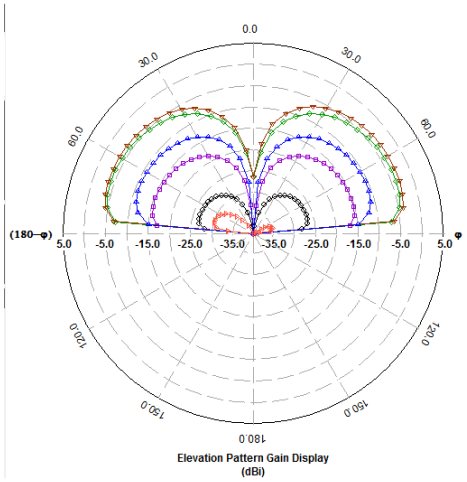


Fig 5.Radiation pattern at frequencies 2.5 GHz, 3.8 GHz, 4.7 GHz

Fig 5 shows the radiation pattern at the different operating frequencies, indicating a bidirectional radiation pattern at these frequencies.

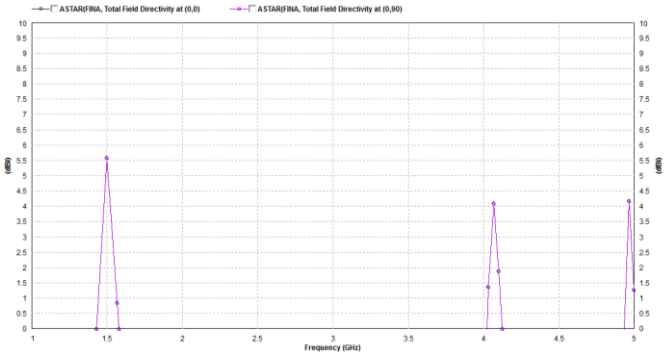


Fig 6.Directivity versus frequency
Directivity at 2.5GHz = 5.5dBi
Directivity at 3.8GHz = 4.2 dBi
Directivity at 4.7GHz = 4.2dBi

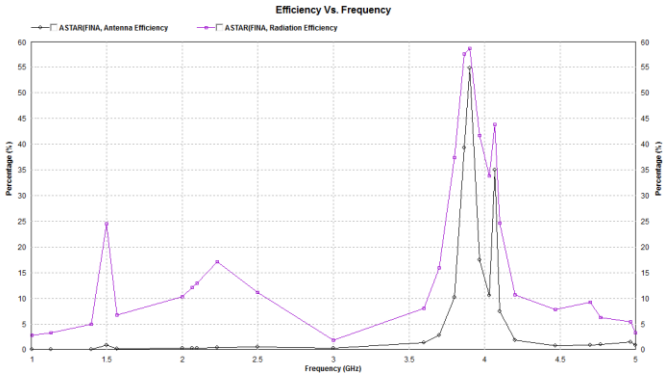


Fig 7. Efficiency versus frequency at 2.5 GHz, 3.8 GHz, 4.7 GHz

The other important parameters such as directivity, efficiency, are also stimulated for the symmetric antenna. The directivity of an antenna should always be greater than 1, and it is relative to "figure of merit" which gives an indication of the directional properties of the antenna [2]. The maximum directivity for the antenna proposed in this paper is 5.5dBi. The radiation efficiency as shown in fig 7 is 58% and the antenna efficiency is 55%.

Table I .Summary of antenna parameters at three operating frequency

Antenna Parameters	**Operating Frequencies**		
	2.5 GHz	***3.8GHz***	***4.7 GHz***
Return loss	-29 dB	-13 dB	-31 dB
VSWR	1.19	1.6	1.18
Bandwidth	250 MHz	15MHz	140MHz
Directivity	5.5 dBi	4.2 dBi	4.2 dBi

CONCLUSION

A compact triple band microstrip patch antenna having a symmetric pattern etched enables triple band operation having a wide band width.A bandwidth of 260MHz and 140MHz obtained at 2.5 GHz and 4.7GHz respectively, enables it to be used for WiMAXapplications. The simulated antenna designed has a return loss less that -10dB hence it can provide satisfactory performance. Thereby it can be used for applications such as mobile communication, satellite communication and WLAN. The simulated results are in good agreement. The designed antenna is capable of receiving multiple services introduced by different wireless technology networks.

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