Design and Analysis of Reconfigurable Microstrip Antenna for Dual Band Operation in Wireless Applications

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Abstract— This paper gives a portrayal for design and development of a reconfigurable multi-slotted antenna by inserting a slot on the patch with a lumped capacitor (or varactor) located on the edges at slot. The proposed antenna suits for various wireless applications which include 4G, Bluetooth. This antenna is an attractive candidate for important applications like wireless communication such as WLAN, WiMax. Microstrip feeding technique is used to feed the antenna. The proposed antenna enhances the return loss of -19.17dB at 2.34GHz frequency. The reconfigurability of the proposed antenna is achieved using capacitors. This paper manages a method for planning a reconfigurable multi-space receiving wire by stacking an opening on patch with a lumped capacitor situated on the edges of the space. With a settled capacitor area along the opening reductions the capacitance which brings about expansion the full recurrence of the space radio wire. The designs are verified through numerical simulations.

Key words: Microstrip Patch Antenna, Return Loss, Wireless Applications, Frequency Reconfigurable Antenna

I. INTRODUCTION

Antennas are crucial and fundamental portions of any correspondence framework. Utilizing the idea of frequency reconfiguration a solitary reception apparatus can be utilized to work at numerous frequencies. There are some mechanisms for changing the resonant frequency of an antenna by changing its effective length. Among those mechanical and electrical mechanisms are popular. Frequency-reconfigurable antennas using electrical mechanism are of two types- continuous and switched tuning type. Continuous tuning can be achieved by using varactor diodes whereas, switched tuning can be achieved by using PIN diodes, RF- MEMS switches etc., to operate at distinct frequency bands [1].

Reconfigurable receiving wires, that are fit for resonating at various frequencies and have phase tuning ability utilizing distinctive structures, are attractive at various applications. Present radio wire necessity ought to be empowered with various capacity like route and battle applications. A recurrence reconfigurable receiving wire gives the capacity to the reception apparatus to be worked just the craved recurrence range while dismissing neighbouring ones. This lessens obstruction which will therefore build S/N proportion, along these lines channel limit or power effectiveness. For a reception apparatus to be equipped for covering a large portion of the applications (recurrence groups, stage tuning, example and polarization reconfiguration) and thorough wideband modes are fancied and some such outlines are currently displayed. By applying distinctive patch size extensive variety of stage change can be acquired in reflect exhibit antenna. Naturally, when the number of components required for a system increases, possibility of shortcomings increases proportionally. These shortcomings may be related with interference, cost, maintainability, reliability, weight, etc. Arising above all these shortcomings, multifunctional antennae provides solution to problems such as supporting multiple functions in a single antenna unit by supporting more than one frequency or radiate in different patterns, etc [3].

Reconfigurable receiving wire have been considered in the past ten years for a blended sack of employments however every one of them have made use or something to that impact of a trading instrument. Once these radio wire are constructed and put on a specific stage, they can be reconfigured remotely without expecting to replicate the reception apparatus or the stage whereupon the receiving wire structure is mounted.

II. ANTENNA DESIGN CONSIDERATIONS

Small scale strip patch reception apparatus is known not a position of safety radio receiving wire, which can be mounted on a level surface. It is essentially composed with emanating patch on one side of a dielectric substrate and on the opposite side of this dielectric substrate, a ground plane is altered. The patch is normally comprised of different directing materials, for example, copper or gold and can be created fit as a fiddle. Electric bordering fields between the edges of the channel component and the ground plane behind it are the essential wellspring of the radio wire's radiation. The radio wire's radiation relies on different properties of receiving wire, for example, dielectric consistent, tallness (h) of the substrate, the patch measurements and the recurrence.

![Fig. 1: Structure of micro strip patch antenna](image)

Where,

- L: Elemental length
- W: Elemental Width
- h: Thickness
- f₀: Resonate frequency
- c: Dielectric Constant
- v: Velocity of Light
- Δ: Extension Length
- ε_e: Effective Dielectric Constant

The geometry and path of the proposed microstrip antenna is shown in Fig. 2. The dimensions of the path are determined using the frequency with the help of available standard equations listed below:

### A. Elemental Width

The width of the rectangular microstrip antenna is given by:

\[
W = \left[\frac{c}{(2f_0)}\right]\left[(\varepsilon_r + 1)/2\right]^{-1/2}
\]

(1)
Where, \( f_r \) represents the resonant frequency, \( \varepsilon_r \) represents dielectric constant, \( c \) is the velocity of light.

B. Extension Length (\( \Delta l \)):
The extension length is given by:

\[
\Delta l = 0.412 \left( \frac{\varepsilon_r + 0.3}{\varepsilon_r - 0.258} \right) \left( \frac{W}{h} \right) + 0.264
\]

Where, \( \varepsilon_e \) is the effective dielectric constant. It is calculated using the formula,

\[
\varepsilon_e = \left[ \frac{\varepsilon_r + 1}{2} \right] \left[ \frac{\varepsilon_r + 1}{2} \right] \left( 1 + \frac{12\varepsilon_r}{W} \right)^{-\frac{1}{2}}
\]

C. Elemental Length (L)
Once the essential width (w), augmentation length (\( \Delta l \)) and powerful dielectric consistent (\( \varepsilon_e \)) are resolved utilizing the above comparisons then the basic length is found by utilizing the mathematical statement,

\[
L = \left[ \frac{c}{2f(e_\varepsilon - \frac{1}{2})} \right] - 2\Delta l
\]

The routine patch antenna is intended for 2.45 GHz frequency. The rectangular patch reception apparatus is manufactured on glass epoxy substrate \( \varepsilon_r = 4.4 \) with thickness (h) of 1.6 mm, width of the patch is \( W = 28.82 \)mm and length \( L = 37.26 \)mm.

Multi openings on customary antenna are outlined by considering the estimations of the width of the considerable number of slots are 1mm. The proposed antenna as shown in Fig.2, can be tuned by changing the geometry of the antenna. The reconfigurability of the proposed antenna is accomplished by using the capacitors. In this paper, to make the proposed antenna reconfigurable, capacitors C1 and C2 with dimensions of 1mm and 1mm each are used respectively. Then power is fed to the antenna through microstrip line feed.

Fig. 4: Geometry of reconfigurable antenna

Fig. 5: Return loss of reconfigurable microstrip patch antenna with capacitor

Fig. 6: Practical results of the proposed antenna

Fig. 7: Radiation pattern for frequency, \( f_r \)- 1.02GHz
III. RESULTS

In this paper, it is planned the reconfigurable small scale strip antenna by considering the fitting estimations of the considerable number of parameters.

The return loss graph of the proposed reconfigurable antenna as shown in Fig. 5 depicts the various return loses at distinctive frequencies namely -19.17 dB at 2.34GHz, -16.5 dB at 1.02 GHz. The radiation pattern is also shown in figure 7 and 8. The simulated results of proposed reconfigurable antenna are in good agreement with each other and results are summarised in Table 1.

![Radiation Pattern](image)

![Return Loss Graph](image)

<table>
<thead>
<tr>
<th>Type of Antenna</th>
<th>Frequency (GHz)</th>
<th>Return Loss (dB)</th>
<th>BW (GHz)</th>
<th>Size Reduction (%)</th>
<th>VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Antenna</td>
<td>2.36</td>
<td>-16.5</td>
<td>0.3</td>
<td>7.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Antenna with 1 Capacitor</td>
<td>2.34</td>
<td>-19.03</td>
<td>0.1</td>
<td>3.6</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>-12.51</td>
<td>0.0</td>
<td>9</td>
<td>2.12</td>
</tr>
<tr>
<td>Antenna with 2 Capacitors</td>
<td>1.02</td>
<td>-16.5</td>
<td>0.0</td>
<td>3.6</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td>2.34</td>
<td>-19.17</td>
<td>0.1</td>
<td>8</td>
<td>1.28</td>
</tr>
</tbody>
</table>

Table 1: Simulated results of proposed antenna

IV. CONCLUSION

The simulated results on proposed micro strip antennas show that return loss at the centre frequency for 2.34GHz is suitable for Wireless LAN, Wi-Max and Wi-Fi applications. The micro strip patch antenna for applications requires a low profile multitasking antenna that takes up less space. That single antenna can be used for different purposes (reconfigurable antenna) proving it to be more cost and space efficient. Hence in this paper, a single antenna is designed for wireless applications with return loss of -19.17dB. The main concern of this paper is to design an antenna for wireless applications and consolidate it as a multiband antenna for various purposes.

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REFERENCES