

DESIGN OF FREQUENCY RECONFIGURABLE ANTENNA FOR WIRELESS COMMUNICATIONS SYSTEMS

Rajeshwari.A¹, Dhanalakshmi.K.M²

¹PG Student, Department of ECE, ²Associate Professor, Department of ECE
S.A. Engineering College, Thiruverkadu, Chennai-600077, Tamil Nadu, India

¹rajeshwariannadurai@gmail.com, ²dhanalakshmikm@saec.ac.in

Abstract: This paper presents a reconfigurable antenna, which can be used for wireless communication systems. In order to improve the performance of the antenna, the simple reconfigurable antenna are proposed. The antenna operates at different frequencies upto 10 GHz, which effectively operates at different frequency bands and which also covers various wireless communications i.e.. Wi-Fi (wireless fidelity), Bluetooth, 1G (first generation), 2G (second Generation), 3G (third generation) and 4G (fourth generation) applications between this frequency range. The patch are designed by using FR-4 material and it is simulated by using a Advanced Design System (ADS) software. Wires are use between the slots, which performs the switching operations. The ON/OFF conditions of switches will allow the current distribution to the antenna surface and which causes antenna reconfigurability. The mobile phones contains nearly seven to eight antennas for each applications such as 2G, 3G, 4G, Wi-Fi (wireless fidelity)and Bluetooth etc. In this paper, a single reconfigurable antenna is used to cover these applications. The reconfigurable antenna will also improve the antenna performance in changing scenario and satisfy the changing operating requirements.

Keywords: Reconfigurable antenna, FR-4 substrate material and Patch.

1. Introduction

To enhance the execution of communication systems, a reconfigurable antenna is presented. The reconfigurable radio wire is a receiving wire which progressively change its conduct, for example, radiation pattern, polarization and recurrence because of the progressions occurring in nature. The radio wire is a specific transducer. It is an electrical gadget which has transmitting receiving wire and accepting reception apparatus changes over electrical current into radio waves and the other way around. The transmitting receiving wire changes over electrical current into radio waves and the electric field in the space

changes over the radio waves into electrical present, at that point the getting reception apparatus convey the electrical current to electronic types of gear [1]. In some circumstance, a few correspondence framework scope are made by utilizing numerous radio wires which are supported by a solitary reconfigurable antenna. The recurrence reconfigurability can be accomplished by physically or electrically altering the measurements of the receiving wire i.e., either by including or expelling parts of its length by utilizing switches or any tunable materials [2]. In evolving conditions, the size of the antenna vary and it will reconfigure and resonate at various frequency. The polarization reconfiguration dynamically changes their polarization modes such as linear, circular, vertical and horizontal. The utilization of wire material will divert the current in the antenna surface and wires utilized for tuning the frequency band [3].

The wire is connected at the top slot of the antenna, so the current flows to the top and middle slot of the antenna and which resonate at frequencies such as 1.6, 2.7, 4.1, 7.2, 8.2, 9.1, 0.14 GHz. Then the wire is placed at the bottom slot of the antenna, here current flows to the bottom and middle of the patch, the antenna resonate at frequencies such as 0.14 and 0.85 GHz. The wire is connected at the right slot of the antenna, so the current redirect to the right and middle slot of the antenna which resonate at frequencies such as 1.3, 7.6, 8.2 and 9.85 GHz. Finally, the wire is placed at the left slot of the antenna, the current flows to the left and middle slot of the antenna, which resonate at frequencies such as 0.5, 1.5, 3.6 and 9 GHz. The most important parameter of antenna is isolation. From a single antenna many designs can be done by taking a small portion of an antenna and connecting a wire in that particular portion between the antenna [4][5]. In this case, only when supply is given the wire should give continuity and when supply is not given, the wire should not give continuity. But in some cases, if supply is not given due to leakage the wire will provide continuity. So that the radiation pattern will be

modified, because every antenna have a specific frequency range and for every frequency range corresponding radiation pattern is produced [6]. Reconfigurable and multiband antenna are same because multiband means, it has more than one frequency and reconfigurable antenna also resonate at different frequency ranges by using a wire, so it is called as reconfigurable multiband antenna. Apart from foam, epoxy and RT duroid, Teflon substrate, the FR4 substrate is used. The patch antenna is proposed in this paper, has single substrate, low cost, compact and it is easy to fabricate. The manufacturing period of patch is less [7]. The patch and the ground plane are separated by dielectric material. Copper conductor is used because copper is a good conductor so that the current vigorously flows on the antenna surface.

The main objective of this paper is to reduce the huge amount of antennas used in mobile phones for several applications. The major advantage of the proposed antenna can resonate at different frequencies ranging from upto 10 GHz by the use of electrical wires. The antenna covers 1G (first generation), 2G (second generation), 3G (third generation), 4G (fourth generation), Wi-Fi (wireless fidelity) and Bluetooth antenna applications. The patch is designed by the use of FR-4 substrate material (Flame Retardant 4), the material is sandwiched by copper conductor and air medium. The FR-4 substrate material spread its electromagnetic radiation in a high manner compare to other materials and it has induction on only one side. The various mobile phones are designed by using FR-4 substrate material. The results were simulated by using an Advanced Design System (ADS) software.

2. Antenna Configuration

The antenna is designed by using FR-4 substrate material of thickness h is 1.6mm, tangential loss is 0.02 and permittivity ϵ_r is 4.3. The simulations are made by using Advanced design systems (ADS). There are electrical wires were used, these wires are placed at the top, bottom, right and left slot of the patch antenna[8]. The values of thickness, tangential loss, width and permittivity ϵ_r are obtained from the equations. The equations are shown below.

For efficient radiation, the width, W is given by

$$W = \frac{c}{2f_0} \sqrt{2/(\epsilon_r + 1)} \quad (1)$$

An effective dielectric constant can be expressed by

$$\epsilon_{\text{reff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + 12h/w \right]^{-1/2} \quad (2)$$

The effective length of the resonant frequency is given by

$$L_{\text{eff}} = c / (2f_0 \sqrt{\epsilon_{\text{reff}}}) \quad (3)$$

The extended incremental length of the patch can be expressed by

$$L = 0.412h \frac{(\epsilon_r + 1)}{(\epsilon_r - 1)} \quad (4)$$

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

$$L_{\text{eff}} = L + 2\Delta L \quad (5)$$

A. Switch Design

The antenna can be switched to different frequency by using diode which causes reconfigurability. In an antenna, several designs can be done with the help of diode [8]. The reconfigurability is an multiband system which consist of different frequencies called as multiband frequency. There are wires are used in the antenna which causes the current to flow in the antenna surface. The changing conditions of the wire causes reconfigurability which operates at different frequencies [9]. The wires has four switching configurations. The wire W1 is located at the middle bottom of the slot and the wire W2 is located at the middle top of the slot, the wire W3 is placed at the middle right of the slot and the wire W4 is placed at the middle left of the antenna. There are four antenna designs each has single wire which is connected to the slot of the antenna [10]. Then the wire is placed at the bottom slot of the antenna, the current flows to the bottom and middle of the patch i.e., the feed is given to the lower section of the patch, so the antenna resonate at frequencies such as 0.14 and 0.85 GHz. The wire is connected at the top slot of the antenna, so the current flows to the top and middle slot of the antenna i.e., the part of the current is distributed to the top of the patch and which resonate at frequencies such as 1.6, 2.7, 4.1, 7.2, 8.2, 9.1, 0.14 GHz.

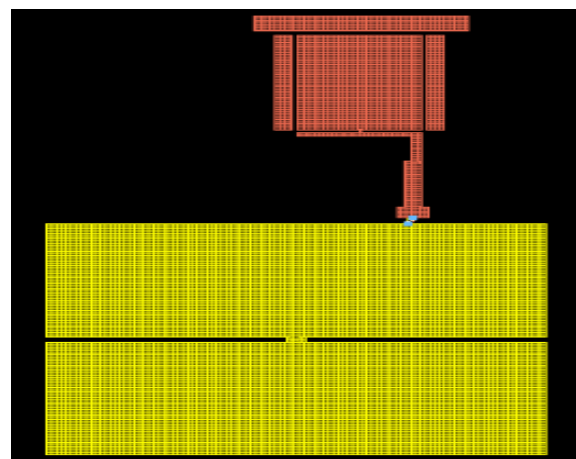


Figure 1. Current distribution at bottom slot

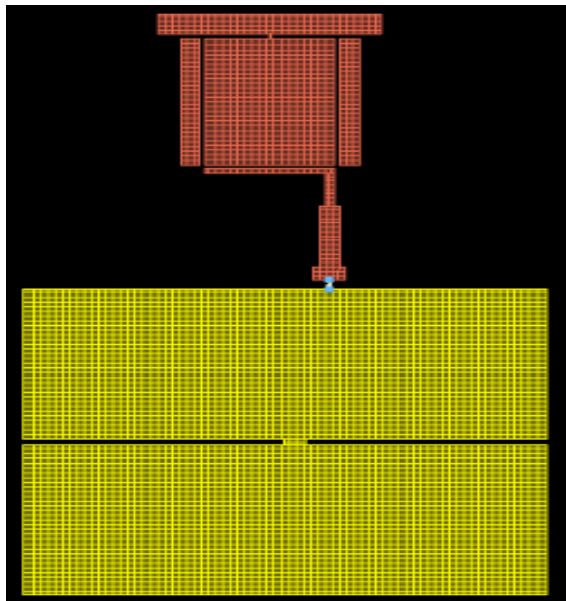


Figure 2. Current distribution at top slot

The above Fig. 1 & Fig. 2 shows the top and bottom layer of the antenna. The antenna layout is obtained by using Advanced Design system (ADS) software. The wire is connected at the right slot of the antenna which resonate at frequencies such as 1.3, 7.6, 8.2, and 9.85 GHz.

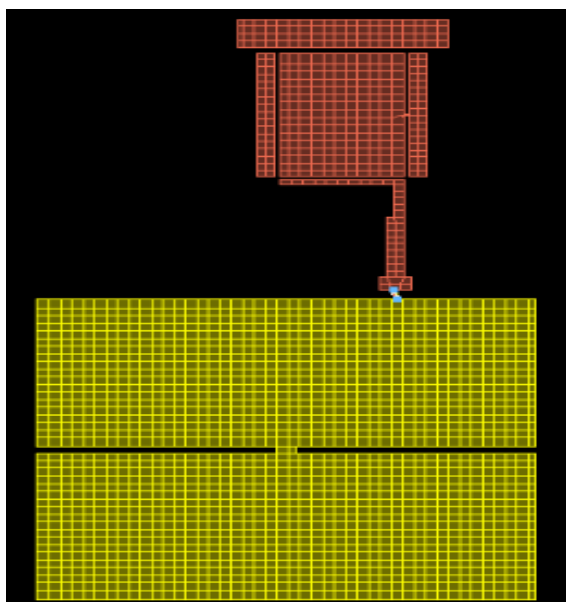


Figure 3. Current distribution at right slot

Finally, the wire is placed at the left slot of the antenna, the current flows to the left and middle slot of the antenna, which resonate at frequencies such as 0.5, 1.5, 3.6 and 9 GHz.

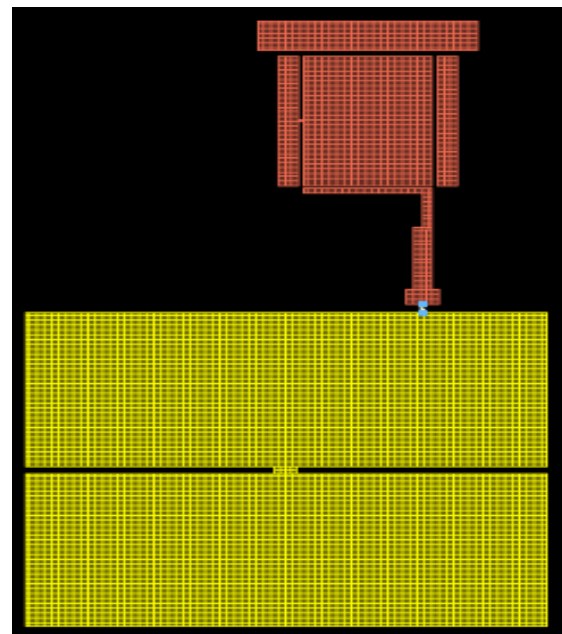


Figure 4. Current distribution at left slot

The proposed antenna is designed and simulated by using the commercial electro-magnetic (EM) field simulator. The FR-4 substrate is sandwiched by air medium. The design of patch antenna are used FR-4 material for 1G (first generation), 2G (second generation), 3G (third generation), 4G (fourth generation), Wi-Fi (wireless fidelity) and Bluetooth applications [11]. The simulation is done by using ADS software. The four configurations are used for WiMAX (Worldwide Interoperability for Microwave Access) applications and LTE (Long Term Evolution), UMTS (Universal Mobile Telecommunications System) for defense and security applications.

3. Proposed System

A simple reconfigurable multiband antenna is designed with wire for 1G (first generation), 2G (second generation), 3G (third generation), 4G (fourth generation), Wi-Fi (wireless fidelity) and Bluetooth antenna applications. The antenna design is simulated by using Advanced Design System (ADS) software. Different states of patches are accessible they are rectangular, square, and round shape and so on., among

these shapes the rectangular patch is the most prominent patch antenna. The microstrip patch is manufactured by utilizing Flame Retardant 4 (FR4) substrate. The proposed antenna is resonate at various frequencies. The patch antenna is smaller and exceptionally easy to create, the assembling time of patch antenna is less. The patch antenna has a solitary substrate.]

A. FR-4 Substrate

The FR-4 (Flame Retardant-4) substrate parts the high electromagnetic radiations and the induction is spread just one way. The FR remains for Flame Retardant which is a well known substrate is normally utilized as an electrical protector. The dielectric material is sandwiched between two copper directing layers [12]. The most regularly utilized dielectric material is FR-4 substrate material. It has a few properties, for example, warm, electrical, chemical and mechanical properties.

The antenna results are simulated by utilizing a product called Advanced Design System (ADS) programming. The Fig. 2 demonstrates the preparing of every last strides in ADS programming. The Advanced Design System programming is an electronic plan computerization programming framework is delivered by a unit of agilent advances. It likewise gives a coordinated outlines to the originators of RF items, for example, cell phones, radar frameworks, satellite correspondences, pagers and rapid information joins [13]. The ADS programming supports each progression of configuration process, for example, schematic catch, design, time area and recurrence space reenactment. The Advanced Design System programming is a modern circuit test system and it can require greatest measure of investment to learn the complex features. The ADS can be utilized as a part of different working frameworks (OS). ADS is the innovative and most popular software for wireless communications. It is the simplest software and easy to handle compare to other antenna software.

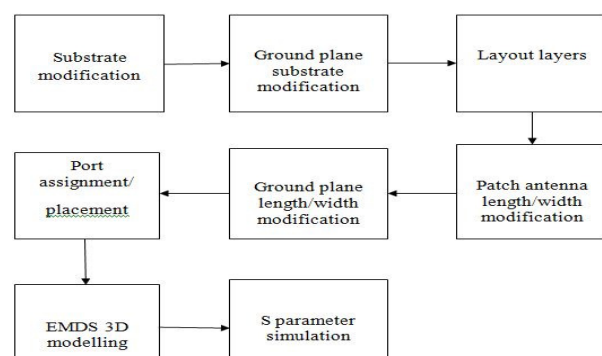


Figure 5. Processing of advanced design system

The Advanced Design System (ADS) programming has three distinctive recreation strategies they are immediate thick, iterative thick and direct packed techniques. Force is the piece of the Advanced Design System (ADS) programming which gives reproduction instruments to outline and assess the RF items [14]. The force is an electromagnetic solver which processes s-parameter for the planar circuits. The printed circuit boards (PCB) and multilayer communications circuits can be simulated in ADS programming. With the assistance of force device the execution of radio wire and coordinated circuits can be anticipated. The energy gives 3D (3-Dimensional) see for the client during simulation [15]. The radio wire configuration begins in ADS format window, the format window comprise of a few devices, for example file, options, edit, tools, EM, design guide, help, window, schematic, view, insert, select [16]. Tap on energy choosing substrate and moves to alter, a dialog box will be open in that, the kind of substrate, real and tangential loss value is selected. At that point moving to design layers, the medium and the portion of the conductor is chosen. The state of the patch is chosen and by choosing the patch, the height and width of the patch is altered [17]. Thus, the height and width of the ground plane is also altered, at that point the port is associated with the two sections of the circuit by choosing ports and manager in force which goes about as two port system. By choosing 3D EM review in energy gives the 3-Dimensional perspective of the patch antenna. The 3D review demonstrates the different perspectives of the patch antenna.

The radiation design is utilized to see the directivity of the based on the major lobe, the graphical portrayal of radiation is referred as radiation pattern of the patch antenna. The radiation pattern can also be characterized as far as directivity, the antenna spreads the electromagnetic waves specifically where the span of real projection is vast. The antenna works adequately in the major lobe direction is alluded to as directivity of the radio wire. A few plans should be possible with a solitary patch antenna by utilizing wires. Each plan has specific frequency range, every frequency range has a particular radiation pattern. The radiation pattern changes for each frequency range. By registering the radiation pattern menu bar in the format window, the radiation pattern is shown. The Fig. 6 demonstrates the radiation pattern of the antenna.

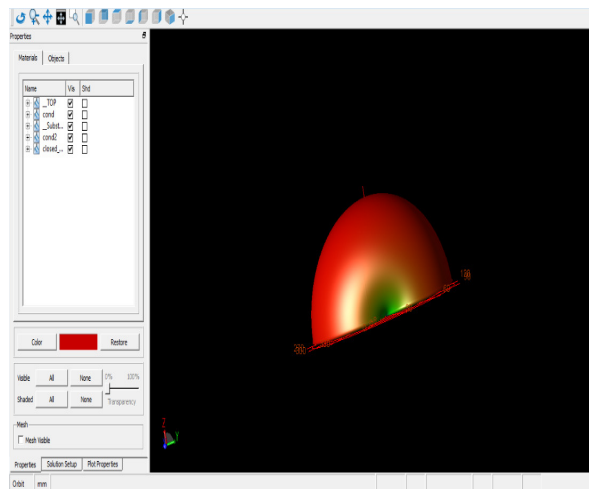


Figure 6. Radiation pattern of the patch

At that point by choosing simulate and s-parameter in the momentum, at long last the simulated results are shown i.e., the phase and magnitude of the plot, the frequency reaction and s-parameter chart are appeared. To fulfill the necessities of 1G (first generation), 2G (second generation), 3G (third generation), 4G (fourth generation), Wi-Fi (wireless fidelity) and Bluetooth, the patch antenna is outlined and simulated using Advanced Design System (ADS) programming.

B. Advantages

The significant preferred standpoint of proposed paper is the space involved by the antenna are moderated. The antenna resonate at diverse frequency. Radio wires are utilized. The wires are minimal effort, have faster exchanging speed, great separation and simple to create for ideal execution. The wire additionally offers a decent linearity and it is successfully utilized for high frequency and high power applications. The patch antenna is suitable for most of the wireless communication systems.

4. Existing System

A minimal triple band two component MIMO antenna is utilized to cover 2.2-6 GHz frequency range. The three groups which are taken from this frequency ranges are 2.37-2.64GHz, 3.39-3.58GHz and 4.86-6.98GHz. At the point when segregation is not great between two receiving wire, the present stream in the antenna surface so the frequency range changes and radiation pattern gets influenced [18]. The cell phones contains almost seven to eight antennas for different applications, for example, 2G (second era), 3G (third era) UMTS guidelines, 4G

(Fourth Generation) LTE Advanced benchmarks, Bluetooth, WIFI (Wireless Fidelity) and so on. Some cell phones contains about twelve antennas moreover. So the vast number of antennas in the cell phones involves extensive space [19]. A few changes were utilized to divert the present stream, so the wire involves substantial space and Method of Moments (MoM) approaches are used which is expensive for two parameters one is matrix filling and another is matrix inversion. Now and again, the antenna execution cannot be enhanced without changing the structure of the antenna. In order to enhance the execution of the antenna, the antenna measurements are altered either physically or electrically or by enhancing the execution of parameters.

The antenna components are based on liquid crystal technology has multilayer substrate, about it contains six substrates and it is hard to create. It requires critical measure of investment to fabricate the antenna [20]. The radiation pattern is the most imperative parameter of antenna which differs in view of sort of antenna utilized. The distinctive kinds of antenna has diverse radiation designs [21]. At the point when a several antennas are utilized more space will be involved, due to inappropriate detachment the frequency range changed and radiation design gets influenced. The antenna is developed in order to overcome the problems and to provide a satisfactory solutions to the wireless communications. The antenna is produced so as to conquer the issues and to give an agreeable answers for the remote correspondences. So MIMO (Multiple Input Multiple Output) frameworks are presented which comprise of a few transmitting and receiving antennas. It is primarily utilized for server to server association in order to provide wide transfer speed. Therefore large number of antennas were utilized as a part of cell phones for every single applications, so it involves huge zone in cell phones and the device turns out to be vast in size. In order to overcome the issues, the various antennas are replaced by single reconfigurable antennas. The reconfigurable antenna is appropriate for various applications.

5. Results and Discussions

The simulation of patch antenna has been outlined and described utilizing Advanced Design System (ADS) programming. The figure demonstrates the impacts of the wires on the simulated antenna in various exchanging states with various full frequencies. A few frequencies are accomplished by utilizing wires at the spaces. The below Fig. 7a & b portrays the resonating frequency of proposed patch antenna. The patch and the ground plane are disconnected by a dielectric material. The patch is outlined with FR4 (Flame Retardant 4) substrate material.

The patch is outlined with FR4 (Flame Retardant 4) substrate material. The substrate is sandwiched with two copper transmitters and the external layer of the conveyor is secured with air medium. The antenna was recreated utilizing Advanced Design System (ADS) programming. The ADS programming is basic and simple to deal with contrast with other receiving wire software.

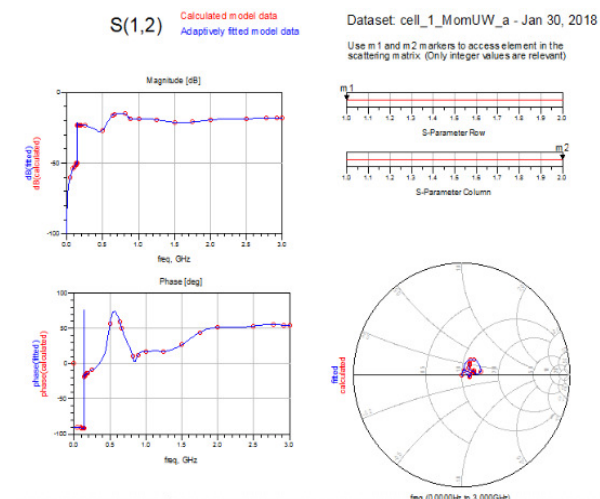


Figure 7. a Frequency response graph of wire connected at bottom slot

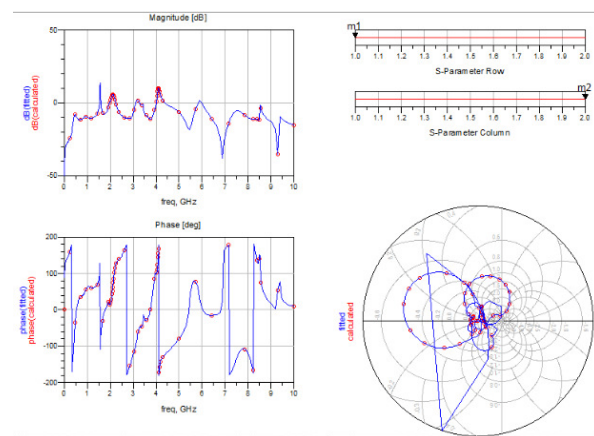


Figure 7. b Frequency response graph of wire connected at top slot

When high recurrence is given, the electrons in the link are surpass out of the link. At high recurrence, how much the electrons are gone out from the link are appeared in the Fig. 7 given above. The other two graph are similar to the the above garaph, where fig 7a and 7b depicts the wire connected at bottom and top slot, the

other two graph consist of wire connected at right and left slot.

6. Conclusion

The reconfigurable multiband antenna is designed using Advanced Design System (ADS) software. The single reconfigurable antenna is designed with wires top, bottom, right and left. The use of wire connection allow the current to flow in the antenna surface, which resonate at different frequency upto 10GHz frequency range and it satisfies the requirements of 1G (first generation), 2G (second generation), 3G (third generation), 4G (fourth generation), Wi-Fi (wireless fidelity) and Bluetooth antenna applications.

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