A COMPACT FREQUENCY RECONFIGURABLE SLOT ANTENNA FOR WLAN APPLICATIONS

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Abstract: A Novel compact four–port reconfigurable multiple-input multiple-output (MIMO) antenna design. This focuses on the design of multiband antenna intended for existing wireless services including GPS, GSM, PCS, DCS, GPS, UMTS, bands. The present techniques available in the open literature include the modification of the main radiator via bending, folding, meandering and wrapping. Each approach offers different advantages, depending on the required application. The introduction of a ground slot in a finite antenna ground plane can be further extended to include reconfigurable features. Therefore, such antennas that are compact and have multiband capability can be promising candidates for many wireless applications.

I. INTRODUCTION

A compact frequency reconfigurable slot antenna containing A U-shaped slot with short ends and an L-shaped slot with open ends are etched in the ground plane to realize dual-band operation. By inserting two PIN diodes inside the slots, easy reconfigurability of three frequency bands over a frequency ratio of 2.62:1 can be achieved. Simulated and measured results show that the antenna can switch between two single-band modes (2.3 and 5.8 GHz) and two dual-band modes (2.3/4.5 and 4.5/5.8 GHz). Also, stable radiation patterns are obtained. Reconfigurability, when used in context of antennas, the capacity to change an individual radiators fundamental operating characteristics through electrical, mechanical, or some other means. Therefore under this definition, the traditional phasing of signals between elements in an array to achieve beam forming and beam steering doesn't make the antenna "reconfigurable" because the antennas basic operating characteristics remain unchanged in this particular case. basically, reconfigurable antennas should altering their operating frequencies, impedance bandwidths, polarizations, and the radiation patterns independently to accommodate changing operating requirements. However, the development of these antennas poses significant challenges to both antenna and system designers. These challenges will lie not only in obtaining desired levels of antenna functionality but also in integrating this functionality into a complete system to arrive at efficient and cost-effective solutions. In many cases of technology development, most of the system cost will not come from the antenna but from the surrounding technologies that enables reconfigurability.

EXISTING ANTENNA SYSTEMS:

Antennas used previously were capable of working on particular frequency applications. Where quarter wavelength radiators used were subjected to the miniaturization which will affect to form limited bandwidth and also low radiation efficiency.

DRAW BACKS:

Antennas used before were of less frequency with large size but now its high frequency with small size, narrow bandwidth and lower gain.

PROPOSED ANTENNA SYSTEM:

It is capable of working in 4 frequency bands and for 3 applications as per built in by one antenna. The miniaturization which is done in various inverted-U-shaped radiator with the additional I-shaped and L-shaped strips that are designed optimistically to achieve the minimal return loss over the four bands of the frequency spectrum.
Such as

- 2.4/5.3/5.8 GHz WLAN
- 3.5 GHz WI-Max

DESIGN SIMULATOR:

- ANSOFT HFSS 13.0
- Rogers RT/duroid 5880(tm)
- MATLAB HFSS API

APPLICATIONS:

- Mobile equipment.
- Vehicles area communications.
- Cognitive radio applications.
- High data applications.
- Detecting Skin Cancer
- Space applications

I. LITERATURE SURVEY

MEMS RECONFIGURABLE OPTIMIZED E-SHAPED PATCHANTENNA DESIGN FOR COGNITIVE RADIO

Reconfigurable antennas offer attractive potential solutions to solve the challenging antenna problems related to cognitive radio systems using the ability to switch patterns, frequency, and polarization. In this paper, a novel frequency reconfigurable E-shaped patch design is proposed for possible applications in cognitive radio systems. This paper provides a methodology to design reconfigurable antennas with radio frequency micro-electro-mechanical system (RF-MEMS) switches using particle swarm optimization, a nature-inspired optimization technique. By adding RF-MEMS switches to dynamically change the slot dimensions, one can achieve wide bandwidth which is nearly double the original E-shaped patch bandwidth. Utilizing an appropriate fitness function, an optimized design which works in the frequency range from 2 GHz to 3.2 GHz (50% impedance bandwidth at 2.4 GHz) is obtained. RF-MEMS switch circuit models are incorporated into the optimization as they more effectively represent the actual switch effects. A prototype of the final optimized design is developed and measurements demonstrate good agreement with simulations.

DRAWBACKS:

- The E-shaped patch antenna has strong fringing fields within these slots, which can be problematic due to strong interactions between the patch and the bias lines.

III. A FREQUENCY RECONFIGURABLE HALF ANNULAR RING SLOT ANTENNA DESIGN

The design of a switchable micro strip-fed half annular ring slot antenna for multi-frequency operation is proposed. By incorporating three switches along the meandered tuning stub that is loaded on top of the half circular patch located within the circular slot, easy re-configurability of four frequency bands over a frequency ratio of approximately 1.7:1 can be achieved. Furthermore, the proposed antenna structure does not require additional DC biasing circuit. Simulation and measurement results have demonstrated that the four frequency bands can exhibit good impedance matching, stable radiation patterns and desirable gains.

DRAWBACKS:

- It requires 2 additional switches as compared to the proposed antenna.

IV. FREQUENCY-RECONFIGURABLE LOW-PROFILE CIRCULAR MONOPOLAR PATCH ANTENNA

A novel frequency-reconfigurable antenna is presented based on a circular monopolar patch antenna. The antenna comprises of a center-fed circular patch surrounded by four sector-shaped patches. Eight varactor diodes are introduced to bridge the gaps between the circular patch and the sectorshaped patches. By changing the reverse bias voltage of the varactor diodes, the antenna can be switched in the operating frequency. A fully functional prototype is developed and tested, which exhibits a continuously tunable frequency band from 1.64 GHz to 2.12 GHz. The measured efficiency rises from about 45% to about 85% as the operating frequency increases from 1.64 GHz to 2.12 GHz. Stable monopole like radiation patterns are achieved at all operating frequencies. In addition, the antenna owns a low-profile structure (0.04 free-space wavelengths at 1.9 GHz). The frequency selective feature and stable radiation patterns make the antenna potentially suitable for future wireless communication systems, such as cognitive radio.

DRAWBACKS:

- As the capacitance of the actual varactor can only be tuned within certain range, the practical frequency tuning range is only some part within the theoretical range.

V. RECONFIGURING UWB MONOPOLE ANTENNAFOR COGNITIVE RADIO APPLICATIONSUSING GAAS FET SWITCHES

A novel ultra wideband (UWB) micro strip monopole antenna with reconfigurable multiband function is presented. Re-configurability is achieved by using GaAs field effect transistor (FET) switches to connect multiple stubs of different lengths to the main feed line of the monopole. The antenna is compact and flexible in terms of the availability of different reconfiguration bands and, most importantly, the simple biasing of the GaAs FET switches will not have a severe effect on the antenna performance. Using GaAs FET switches did not degrade the antenna radiation patterns due to the simple biasing technique and the few external biasing components needed, besides these switches did not degrade the antenna gain and efficiency due to their low insertion loss and low ON resistance. When the antenna was reconfigured from UWB to work into multiple frequency bands, the total peak gain improved by 20% compared to the UWB case. In addition, the total efficiency of the antenna has not been significantly reduced in any reconfigured band, whereas the out-of-band total efficiency is hugely reduced, which highlights the filtering role of the reconfiguration process. The total dc power consumption of the antenna switches is still very low W, and this will lead to simple integration of the antenna in some portable communication systems or future cognitive radio front ends.

DRAWBACKS:

- There are some distortions on the measured curves; these ripples are caused by the feed connector, the coaxial cable, and the dc biasing cables that are attached to the biasing micro-strip lines on the antenna board.

A. A COMPACT FREQUENCY-RECONFIGURABLE NARROWBANDMICRO-STRIP SLOT ANTENNA

A frequency-reconfigurable micro-strip slot antenna is proposed. The antenna is capable of frequency switching at six different frequency bands between 2.2 and 4.75 GHz. Five RF p-i-n diode switches are positioned in the slot to achieve frequency reconfigurability. The feed line and the slot are bended to reduce 33% of the original size of the antenna. The biasing circuit is integrated into the ground plane to minimize the parasitic effects toward the performance of the antenna. Simulated and measured results are used to demonstrate the performance of the antenna. The simulated and measured return losses, together with the radiation patterns, are presented and compared.

DRAWBACKS:

- The biasing circuits might degrade the performance of the antenna.

VI. PROBLEM FORMULATION

From the literature survey analysis, the study reveal that existing work shows the increased return loss, and VSWR. Gain total is also considerably needed to be increased. Frequency coverage is only for three frequency bands are generated.

The drawbacks present in the available antennas can be identified as Less reception of due to high return loss due to single patch antenna are used for each individual device.

Not compatible for future multiband antenna system applications. Each antenna requires each of them a separate processor to execute the particular data reception operation.

OBJECTIVE

- To design a Reconfigurable antenna for wireless communication bands.
- To achieve less VSWR, to obtain optimum return loss and radiation pattern.
- To determine and compare the performance of micro-strip patch antennas with two switches.

VII. ORGANISATION OF THE PROJECT REPORT

It deals with the overview of the project, literature survey, problem formulation, objective of the project.

This presents the basic theory of patch antenna, including the basic structure, feeding techniques and characteristics of the patch antenna. Then the performance parameters with its expressions to compare the various antenna structures have been discussed. Finally to find the dimensions of the conventional slot antenna using MIMO techniques are presented.

In details about the slotted micro-strip patch antenna for multiband applications. The simulation results about the slot antenna using ANSOFT High Frequency Simulation Software have been discussed. Then about Hardware description also discussed.

Chapter 4 concerts on the concluding remarks with the scope of future work.

VIII. MICRO-STRIP PATCH ANTENNA

A micro-strip antenna consists of a metallic pattern on one side of a dielectric substrate and ground plane on the other side of the substrate. In this project I have focused on making a micro-strip patch antenna. Figure 2.1.1 shows a micro-strip patch on the dielectric substrate.

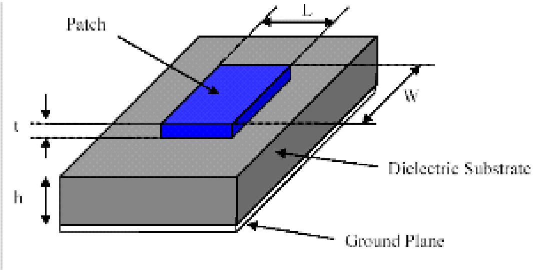

Figure: 2.1.1 Structure of a micro-strip patch antenna

The antenna patch can have different shapes, but is most likely rectangular. In order to make performance predictions the rectangular patch antenna has the following parameters, where λ_0 is the wavelength in vacuum also called the free-space wavelength. *Length(L)*:$0.3333\lambda_0<L<0.5\lambda_0$, *Height(h)*: $0.003\lambda_0 \leq h \leq 0.05\lambda_0$, *Thickness (t)* : $t <<\lambda_0$, *Dielectric constant ()*: $2.2 \leq \leq 12$, In electromagnetic radiation λ is often given instead of $\lambda_0$as the speed of light in vacuum is very close to the speed of light I air.

As described later in this chapter the length of the patch is very important when it comes to the radiation. Looking at the parameters of the length, the length is slightly less than $\lambda/2$. That is because the micro-strip patch antenna is constructed on the theory based on one-half wavelength.

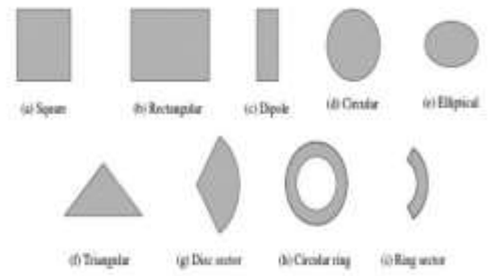

Figure: 2.1.2 typical patch shapes

IX. CHARACTERISTCS

Micro-strip patch antenna are used as embedded antennas in handheld wireless devices such as cellular phones, and also employed in Satellite communication. Some of their principal advantages are given below

- Light weight and low fabrication cost
- Support both linear as well as circular polarization.
- Can be easily integrated with microwave integrated circuits.
- Capable of dual and triple frequency operations.
- Mechanically robust when mounted on rigid surfaces.
- Easy integration with microwave integrated circuits(MIC)

X. ADVANTAGES AND DISADVANTAGES

Micro-strip antennas are becoming more and more popular every day. And with a more modern world where the internet and Wi-Fi are delivered in many stores, more and more gadgets are using micro-strip antennas. Some of the advantages are:

- Light weight.
- Low volume.
- Easy in fabrication.

On the other hand, micro-strip antennas also features some disadvantages compared to conventional antennas:

- Narrow band width.

- Low efficiency.
- Low gain.
- Extra radiation from feeds and junction.
- Surface waves.
- Low power handling capacity.

XI. FEEDING TECHNIQUES

Micro-strip patch antennas can be fed by a variety of methods. These methods can be classified into two categories contacting and non-contacting. In the contacting method, RF power is fed directly to the radiating patch using a connecting element such as micro-strip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the micro-strip line and radiating patch. The four most popular feed techniques used are the micro-strip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

XII. MICRO-STRIP LINE FEED

In this type of feed technique, a conducting strip is connected directly to the edge of the micro-strip patch shown in the figure 2.4.1. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planer structure. The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation.

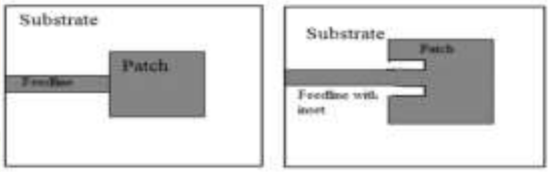

Figure:2.4.1 Micro-strip Line Feed

Coaxial Feed

The coaxial feed or probe feed is a very common technique used for feeding Micro-strip patch antennas. As seen from Figure 2.4.2, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be place at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, its major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates ($h > 0.02\lambda_0$). Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the micro-strip line feed and the coaxial feed suffer from numerous disadvantages. The non-contacting feed techniques discussed below, solve these problems

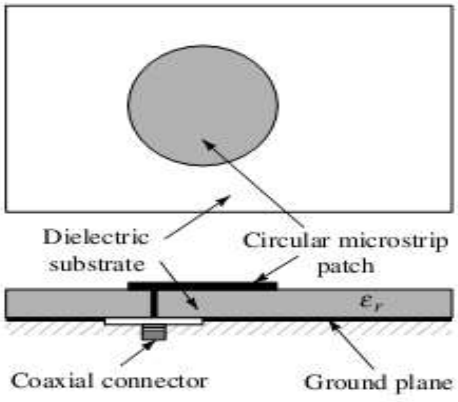

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Figure:2.4.2 Coaxial Feed

Aperture Coupled Feed

In this type of feed technique, the radiating patch and the micro-strip feed line are separated by the ground plane shown in Figure 2.4.3. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane

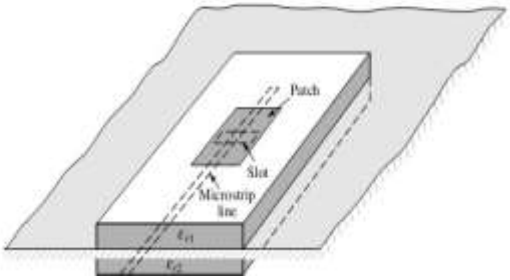


Figure:2.4.3 Aperture Feed

The coupling aperture is usually centered under the patch, leading to lower cross polarization due to symmetry of the configuration. The amount of coupling from the feed line to the patch is determined by the shape, size and location of the aperture. Since the ground plane separates the patch and the feed line, spurious radiation is minimized. Generally, a high dielectric material is used for the bottom

Substrate and a thick, low dielectric constant material is used for the top substrate to optimize radiation from the patch. The major disadvantage of this feed technique is that it is difficult to fabricate due to multiple layers, which also increases the antenna thickness. This feeding scheme also provides narrow bandwidth.

Proximity Coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. As shown in Figure, two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%), due to overall increase in the thickness of the micro-strip patch antenna. This scheme also provides choices between two different dielectric media, one for the patch and one for the feed line to optimize the individual performances.

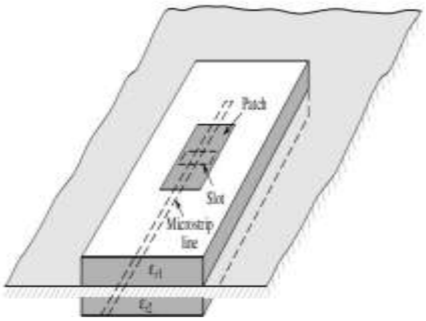


Figure:2.4.4 Proximity Coupled Feed

Matching can be achieved by controlling the length of the feed line and the width-to-line ratio of the patch. The major disadvantage of this feed scheme is that it is difficult to fabricate because of the two dielectric layers which need proper alignment. Also, there is an increase in the overall thickness of the antenna.

It uses a two-layer substrate with a micro-strip line on the lower substrate, terminating in an open stub below the patch which is printed on the upper substrate. It is a type of non- contacting feed. Proximity coupling has the advantage of allowing the patch to exist on a relatively thick substrate for improved bandwidth; on the contrary the feed line is on an effectively thin substrate, which reduces spurious radiation and coupling.

XIII. METHODS OF ANALYSIS

The most popular models for the analysis of Micro-strip patch antennas are the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method). The transmission line model is the simplest of all and it gives good physical insight but it is less accurate. The cavity model is more accurate and gives physical insight but is complex in nature.

The full wave models are extremely accurate, versatile and can treat single elements, finite and infinite arrays, stacked elements, arbitrary shaped elements and coupling.

It must be noted that our project is centered on the transmission line model and uses all of the empirical equations this model is based on for simulations. The cavity model is not at the center of our project and is hence explained very briefly. The method of moments is explained in detail as it is used by several field solvers (such as IE3D) for simulations.

Transmission Line Model

This model represents the micro-strip antenna by two slots of width W and height h, separated by a transmission line of length L. The micro-strip is essentially a non-homogenous line of two dielectrics, typically the substrate and air. Figure 3.8 illustrates this

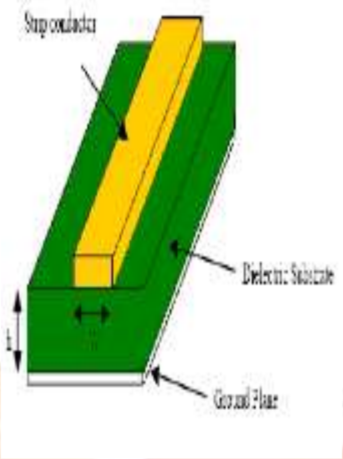


Figure:2.5.1 Micro-strip patch line

As seen from Figure, most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse electric-magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate.

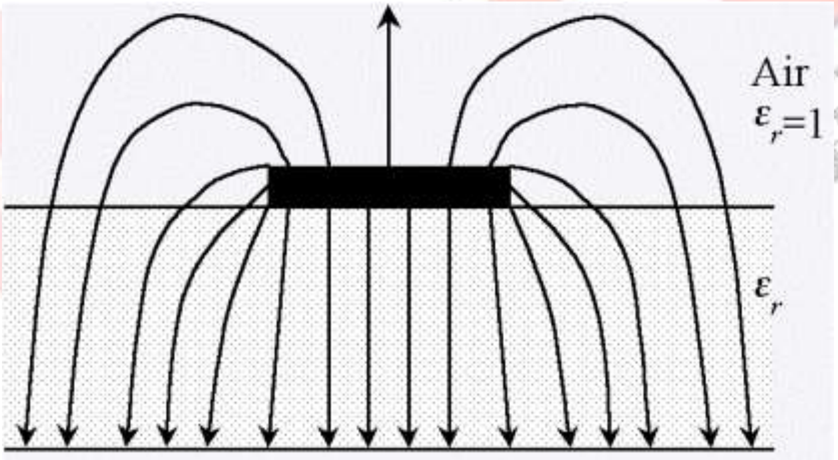


Figure:2.5.2 Electric Field Line

Instead, the dominant mode of propagation would be the quasi-TEM mode. Hence, an effective dielectric constant (ε_{reff}) must be obtained in order to account for the fringing and the wave propagation in the line. The value of ε_{reff} is slightly less then ε_r because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air as shown in Figure 2.5.2.

ε_{reff}=Effective dielectric constant
ε_r=Dielectric constant of substrate
h=Height of dielectric substrate
W=Width of the patch

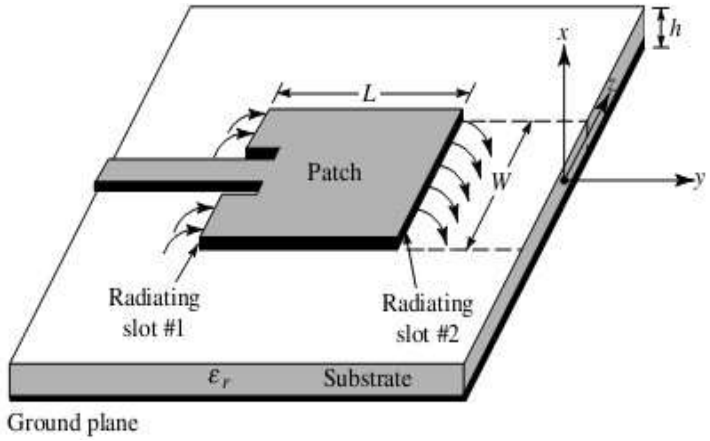


Figure:2.5.3 Micro-strip patch Antenna

Figure 2.5.3 shows a rectangular micro-strip patch antenna of length L, width W resting on a substrate oh height h. The co-ordinate axis is selected such that the length is along the x direction, width is along the y direction and the height is along the z direction. In order to operate in the fundamental TM mode, the length of the patch must be slightly less than where is the wavelength in the dielectric medium and is equal to $_0$/ $_{reff}$) where $_0$ is the free space wavelength. The TM mode implies that the field varies one /2 cycle along the length, and there is no variation along the width of the patch. In figure 3.11 the micro-strip patch antenna is represented by two slots, separated by a transmission line of length L and open circuited at both the ends. Along the width of the patch, the voltage is maximum and current is minimum due to the open ends. The fields at the edges can be resolved into normal and tangential components with respect to the ground plane.

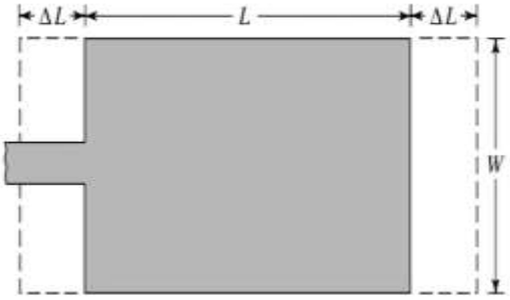
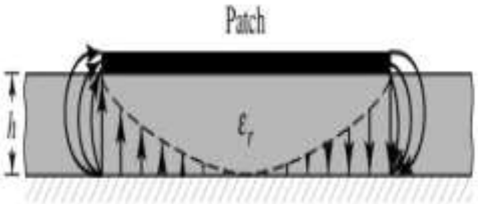


Figure:2.5.4 Top view of Antenna



It is seen from figure 2.5.4 that the normal components of the electric field at the two edges along the width are in opposite directions and thus out of phase since the patch is /2 long and hence they cancel each other in the broadside direction. The tangential components, which are in phase, means that the resulting fields combine to give maximum radiated field normal to the surface of the structure. Hence the edges along the width can be represented as two radiating slots, which are /2 apart and excited in phase and radiating in the half space above the ground plane.

The fringing fields along the width can be modeled as radiating slots and electrically the patch of the micro-strip antenna looks greater than its physical dimensions.

Although the transmission line model discussed in the previous section easy to use, it has some inherent disadvantages. Specifically, it is useful for patches of rectangular design and it ignores field variations along the radiating edges. These disadvantages can be overcome by using the cavity model. In this model, the interior region of the dielectric substrate is modeled as a cavity bounded by electric walls on the top and bottom. The basis for this assumption is the following observations for thin substrates (h<<λ).

- Since the substrate is thin, the fields in the interior region do not vary much in the z direction, i.e. normal to patch.

- The electric field is z directed only, and the magnetic field has only the transverse components $H_x$andH_y in the region bounded by the patch metallization and the ground plane. This observation provides for the electric walls at the top and the bottom.

XIV. PERFORMANCE PARAMETERS

The performance of an antenna can be measured by a number of parameters. The following are the critical ones:

2.6.1 Radiation pattern

The antenna pattern is a graphical representation in three dimensional of the radiation of the antenna as the function of direction. It is a plot of the power radiated from an antenna per unit slid angle which gives the intensity of radiations from the antenna. If the total power radiated by the isotropic antenna is P, then the power is spread over a sphere of radius r, so that power density S at this distance.

Isotropic antennas are not realizable in practice but can be used as a reference to compare the performance of practical antennas. The radiation pattern provides information on the antenna beam width, side lobes and antenna resolution to a large extent.

The E plane pattern is a graphical representation of antenna radiation as a function of direction in a plane containing a radius vector from the center of the antenna to the point of maximum radiation and the electric field intensity vector. Similarly the H plane can be drawn considering the magnetic field intensity vector.

2.6.2 Gain

Antenna gain the ratio of maximum radiation intensity at the peak of main beam to the radiation intensity in the same direction which would be produced by an isotropic radiator having the same input power. Isotropic antenna is considered to have a gain of unity. The G is the power radiated per unit solid angle in the direction P and W_t is the total radiated power. Micro-strip antennas because of the poor radiation efficiency poor gain. Numerous researches have been conducted in various parts of the world in order to obtain high gain antennas.

2.6.3 Directivity

If a three dimensional antenna pattern is measured, the ratio of normalized power density at the peak of the main beam to the average power density is called the directivity.

2.6.4 Bandwidth

It is defined as "The range of usable frequencies within which the performance of the antenna, with respect to some characteristics, conforms to a specified standard". The bandwidth can be the range of frequencies on either side of the centre frequency where the antenna characteristics like input impedance, radiation pattern, beam width, polarization, side lobe level or gain, are close to those values which have been obtained at the centre frequency.

2.6.5 Effective area or aperture

The effective area or effective aperture of a receiving antenna expresses the portion of the power of a passing electromagnetic wave which it delivers to its terminals, expressed in terms of an equivalent area. Since the receiving antenna is not equally sensitive to signals received from all directions, the effective area is the function of the direction to the source. Due to reciprocity (discussed above) the gain of an antenna used for transmitting must be proportional to its effective area when used for receiving. Consider an antenna with no loss, that is, one whose electrical efficiency is 100%. It can be shown that its effective area averaged over all directions must be equal to$^2/4\pi$, the wavelength squared divided by 4π. Gain is defined such that the average gain over all directions for an antenna with 100% electrical efficiency is equal to 1.

For an antenna efficiency with an less than 100%, both the effective area and gain are reduced by that same amount. Therefore the above relationship between gain and effective area still holds. These are thus two different ways of expressing the same quantity. A_{eff} is especially convenient when computing the power that would be received by an antenna of a specified gain.

2.6.6 Efficiency

Efficiency of a transmitting antenna is the ratio of power actually radiated (in all directions) to the power absorbed by the antenna terminals. The power supplied to the antenna terminals which is not radiated is converted into heat. This is usually through loss resistance in the antenna's conductors, but can also be due to dielectric or magnetic core losses in antennas (or antenna systems) using such components. Such loss effectively robs power from the transmitter, requiring a stronger transmitter in order to transmit a signal of a given strength.

2.6.7 Polarization

The polarization of an antenna refers to the orientation of the electric field (E plane) of the radio wave with respect to the Earth's surface and is determined by the physical structure of the antenna and by its orientation; note that this designation is totally distinct from the antenna's directionality. Thus, a simple straight wire antenna will have one polarization when mounted vertically, and a different polarization when mounted horizontally. As a transverse wave, the magnetic field of a radio wave is at right angles to that of the electric field, but by convention, talk of an antenna's "polarization" is understood to refer to the direction of the electric field.

Reflections generally affect polarization. For radio waves, one important reflector is the ionosphere which can change the wave's polarization. Thus for signals received following reflection by the ionosphere (a sky wave), a consistent polarization cannot be expected. For line of sight communication or ground wave propagation, horizontally or vertically polarized transmissions generally remain in the about the same polarization state at the receiving location. Matching the receiving antenna's polarization to that of the transmitter can make a very substantial difference in received signal strength.

Polarization is predictable from an antenna's geometry, although in some cases it is not at all obvious. An antenna's linear polarization is generally along the direction (as viewed from the receiving location) of the antenna's currents when such a direction can be defined. For instance, a vertical or Wi-Fi antenna vertically oriented will transmit and receive in the vertical polarization. Antennas with horizontal elements, such as most roof top TV antennas, are horizontally polarized (broadcast TV usually uses horizontal polarization). Even when the antenna system has a vertical orientation, such as an array of horizontal dipole antennas, the polarization is in the horizontal direction corresponding to the current flow. The polarization of a commercial antenna is an essential specification.

Polarization is the sum of the E-plane orientations over time projected onto an imaginary plane perpendicular to the direction of motion of the radio wave. In the most general case, polarization is elliptical, meaning that the polarization of the radio waves varies over time. Two special cases are linear polarization (the ellipse collapse into a line) as we have discussed above, and circular polarization (in which the two axes of the ellipse are equal). In linear polarization the electric field of the radio wave oscillates back and forth along one direction; this can be affected by the mounting of the antenna but usually the desired direction is either horizontal or vertical polarization. In circular polarization, the electric field and magnetic field of the radio waves rotates at the radio frequency circularly around the axis of propagation. Circular or elliptically polarized radio waves are designated as right handed rule from the one used by radio engineers.

It is the best for the receiving antenna to match the polarization of the transmitted wave for optimum reception. Intermediate matching will lose some signal strength, but not as much as a complete mismatch. A circularly polarized antenna can be used to equally well match vertical or horizontal linear polarizations. Transmission from a circularly polarized antenna received by a linearly polarized antenna (or vice versa) entails a 3dB reduction in signal to noise ratio as the received power has there by been cut in half.

2.6.8 Impedance matching

Maximum power transfer requires matching the impedance of an antenna system (as seen looking into transmission line) to the complex conjugate of the impedance of the receiver or transmitter. In the case of a transmitter, however, the desire matching impedance might not correspond to the dynamic output impedance of the transmitter as analyzed as a source impedance but rather the design value (typically 50 ohms) required for efficient and safe operation of the transmitting circuitry. The intended impedance is normally resistive but transmitter (and some receivers) may have additional adjustments to cancel a certain amount of reactance in order to "tweak" the match. When the transmission line is used in between the antenna and the transmitter (or receiver) one generally would like an antenna system whose impedance is resistive and near the characteristic impedance of that transmission line in order to minimize the standing wave ratio (SWR) and the increase in transmission line losses it entails, in addition to supplying a good match at the transmitter or receiver itself. In some cases this is done in a more extreme manner, not simply to cancel a small amount of residual reactance, but to resonate an antenna whose resonance frequency is quite different than the intended frequency of operation. For instance, a "whip antenna" can be made significantly shorter than ¼ wavelength long, for practical reasons, and then resonated using a so-called loading coil. This physically large inductor at the base of the antenna has an inductive reactance which is the opposite of the capacitive reactance that such a vertical antenna has at the desired operating frequency. The result is pure resistance seen at the feed point of the loading coil; unfortunately that resistance is somewhat lower than would be desired to match commercial.

So an antenna tuning generally refers to cancellation of any reactance seen at the antenna terminals, leaving only a resistive impedance which might or might not be exactly the desired impedance (that of the transmission line). Although an antenna may be designed to have a purely resistive feed point impedance (such as a dipole 97% of a half wavelength long) this might not be exactly true at the frequency that it is eventually used at. In some cases the physical length of the antenna can be "trimmed" to obtain a pure resistance. On the other hand, the addition of a series inductance or parallel capacitance can be used to cancel a residual capacitive or inductive reactance, respectively.

2.6.9 Return loss

Return loss or reflection loss is the reflection of signal power from the insertion of a device in a transmission line or optical fiber. It is expressed as ratio in dB relative to the transmitted signal power.

2.6.10 VSWR

A standing wave in a transmission line is a wave in which the distribution of current, voltage or field strength is formed by the superimposition of two waves of same frequency propagating in opposite direction. Then the voltage along the line produces a series of nodes and antinodes at fixed positions.

XIV. CONCLUSION

In this chapter, the procedure for designing a micro-strip patch antenna for multiband application is explained. Next, a compact micro-strip patch antenna is defined for use in multiband wireless applications. Finally the results obtained from the simulations are demonstrated.

1. DESIGN SPECIFICATIONS

The three essential parameters for the design of a slotted micro-strip patch are given below.

Frequency of operation (f_0): The resonant frequency of the antenna must be selected appropriately. For multiband operation the frequency range selected is from 2-7 GHz. Hence the antenna designed must be able to operate in this high frequency range. The resonant frequency selected for my design are between 2GHz and 7GHz.

Dielectric constant of the substrate (ε_r): The dielectric material selected for our designRO4350Bwhich has a dielectric constant of 3.48. A substrate with a low dielectric constant has been selected. Since it increased the bandwidth of the antenna.

Height of dielectric substrate (h): For the micro-strip patch antenna to be used in multi band applications, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 0.8mm. Hence, the essential parameters for the design are

Frequency of operation (f_0)= 2GHz to 7GHz.
Dielectric constant of the substrate(ε_r)= 3.48
Height of the dielectric substrate (h) = 0.8mm

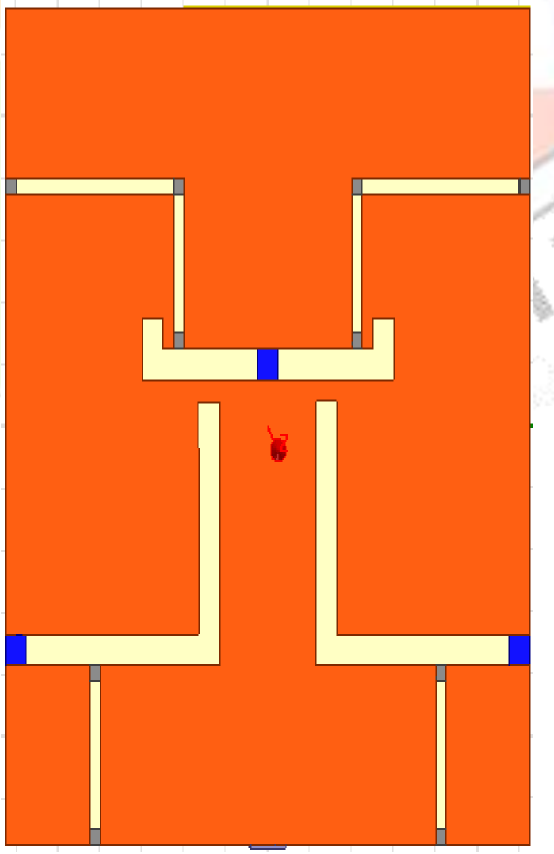


Figure:3.1 PROPOSED ANTENNA

Figure 3.1 shows the proposed antenna which indicates the radiator fed with micro-strip feed line. The radiator consists of slot along with the feed in the in the radiating edge. These slot with the feed reduce the return loss to a greater extent.

The proposed antenna is designed by cutting single slot in patch to make it a slotted antenna. Cutting of slots in antenna increases the current path which increases the current intensity, as a result efficiency is increased. The basic structure of antenna consists of ground plane, substrate, patch and feed line. The transmission line is the preferred method of analysis for calculating the various dimensions of the slotted micro-strip patch antenna.

The transmission line model is applicable to infinite ground planes only. However, for practical considerations it is essential to have a finite round plane. It has been shown by that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater the patch dimensions by approximately six times the substrate thickness all-round the periphery.

2. SIMULATION RESULTS

The software used to model and simulate the micro-strip patch antenna in ANSOFT HFSS is a high performance full wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modelling that takes advantages of the familiar micro soft graphical user interface.

ANSOFT HFSS can be used to calculate parameters such as S-parameters, Resonant frequency and Fields. ANSOFT HFSS is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. Ansoft pioneered the use of the Finite Element Method(FEM) for EM simulation by developing or implementing technologies such as tangential vector finite elements, adaptive meshing and Adaptive LancozosPade Sweep(ALPS).

It has been widely used in the design of RFICs, patch antennas, wire antennas and other RF or wireless antennas. It has been used to calculate and plot the S11 parameters, VSWR, current distributions as well as the radiation pattern

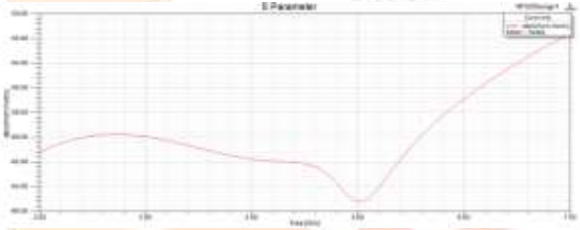


Figure:3.3 Return loss of d1-OFF,d2-OFF & d3-ON

Return loss or reflection loss is the loss of signal power resulting from the reflection cost at a discontinuity in a transmission line or optical fiber.

Figure3.3 shows the proposed reconfigurable patch antenna with slot using micro-strip feed line as a feeding technique, which gives the return loss or reflection coefficient value as -65.2 dB in the frequency range of 5 GHz.

The transmission feed used in design to have a frequency range of 2GHz to 7GHz is selected and frequency points are selected over this range to obtain accurate results.

The most common case for measuring and examining VSWR is when installing and tuning transmitting antennas. When a transmitter is connected to an antenna by a feed line, the impedance of the antenna and feed line must match exactly for maximum energy transfer from the feed line to the antenna to be possible.

Graphical representation of the spatial distribution of the radiation from an antenna is represented as a function of angle. The proposed antenna is showing Bi directional pattern.

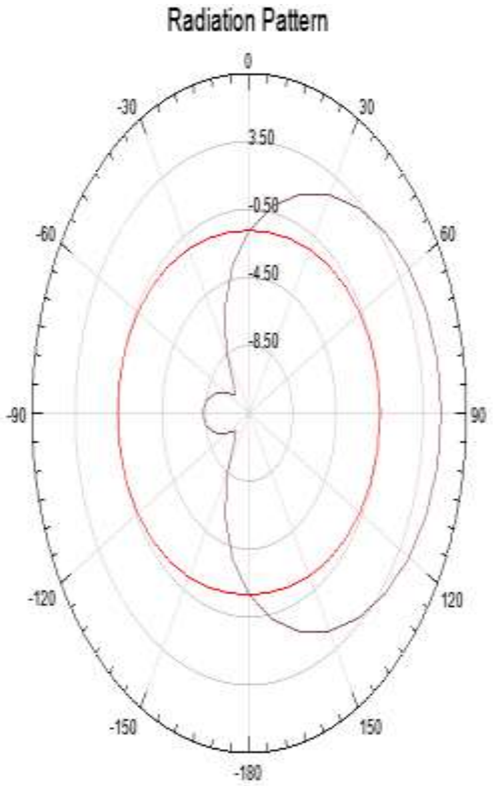


Figure: 3.5 2D Radiation Pattern

The radiation field of the slotted micro-strip patch antenna is shown in figure 3.5 which is determine using either an "electric current model" or a "magnetic current model". In the electric current model, the current in is used directly to find the far field radiation pattern.

If the substrate is neglected (replaced by air) for the calculation of the radiation pattern, the pattern may be found directly from image theory. If the substrate is accounted for and is assumed infinite, the reciprocity method may be used to determine the far-field pattern.

It can be shown that the electric and magnetic current models yield exactly the same results for the far-field pattern, provide the pattern of each current is calculated in the presence of the substrate at the resonant frequency of the patch cavity model. Figure 3.5 shows that at 2GHz to 7GHz a graphical representation in polar coordinates of spatial distributions of fabricated antenna is shown.

3. Discussions

In every antenna design, simulation is always an important step. All the study of parameter can be predicted before it is to make changes.

Simulation is done using ANSOFT HFSS. All of the shapes shown in this section are simulated. The simulated results are compared. The results investigated in this section for the design are return loss, VSWR and radiation pattern. By varying these widths of the slot, length of the slot, feed and feed position of S-parameter variation is studied for the slotted patch antenna.

The characteristics of proposed antennas have been investigated through different parametric studies using ANSOFT HFSS simulation software. The proposed antenna have achieved stable radiation pattern and satisfied return loss. This antenna design can be used for multiband applications.

XV. SOFTWARE DESCRIPTION

ANSOFT HFSS SOFTWARE:

The antenna is designed and simulated in ANSOFT HFSS design software. HFSS is a commercial finite element method solver for electromagnetic structures. The acronym originally stood for high frequency structural simulator. It is one of several commercial tools used for antenna design, and the design of complex RF electronic circuit elements including filters, transmission lines, and packaging. HFSS offers accurate, efficient computational solutions for electromagnetic design and analysis. Our 3D EM simulation software is user friendly and enables you to choose the most appropriate method for the design and optimization of devices operating in a wide range of frequencies. It is based on Finite Element Method (FEM).

FEM has its origin in the field of structural analysis. It is a more powerful and adaptable numerical technique for handling programs involving complex 24 geometries. In mathematics, FEM is a numerical technique for finding approximate solutions to boundary value problems. It uses variational methods (the Calculus of variations) to decrease an error function and produce a steady solution. As we know that joining many tiny straight lines can approximate a larger circle, FEM involves all the methods for connecting many simple element equations over many small subdomains, named finite elements, to approximate a more complex equation over a larger domain. FEM analysis of any problem involves basically four steps Passive microwave and RF component design is a major application of ANSOFT HFSS and supporting it is one of ANSOFT HFSS's core competencies. ANSOFT HFSS MWS offers a broad range of solver technologies, operating in both the time and frequency domain and capable of using surface meshes as well as Cartesian and tetrahedral volume meshes. An antenna array allows us to achieve high gain with multiple radiating elements and a phased array in addition offers the possibility to shape and steer the beam without changing the array geometry.

DESIGN PROCEDURE FOR THE SIMULATION:

There are six main steps to create and solve a proper ANSOFT HFSS simulation. They are:
1. Create model/geometry
2. Assign boundaries
3. Assign excitations
4. Setup the solution
5. Solve
6. Post process the results

In brief, the adaptive solution process is the method by which ANSOFT HFSS guarantees that a final answer to a given EM problem is the correct answer. It is a necessary part of the overall solution process and is the key reason why a user can have extreme confidence in ANSOFT HFSS's accuracy.