

Design of Reconfigurable Rectangular Patch Antenna Using Pin Diode Switches

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ABSTRACT: This project introducing a new technique for achieving reconfigurability of antennas. Basically antennas are designed for either transmitting or receiving the signals from distant locations. Mostly antennas are designed to operate at particular range of frequencies so that it could be used only for that specific applications so more number of antennas are required for operating different frequency ranges. These can be replaced by designing a reconfigurable antenna. Reconfiguration is used for reducing the antenna numbers a single antenna structure is sufficient to operate various frequency ranges. For achieving this type of reconfiguration is done by using the proper switching techniques to change over the frequencies. The proposed design uses the PIN diode switch for achieving the reconfigurability, which was used in wireless communications. The antenna design was analysed by HFSS.

KEYWORDS: Reconfigurable antenna, switches, frequency ranges, Microstrip patch

I.INTRODUCTION

The modern communication world requires portable devices with high performance so that the design of communicating devices are takes important role. Here the antenna could be designed by new technique which is used to perform a single antenna can operating at multiple frequencies. Generally reconfiguration can be achieved by various parameters such as frequency of operation, polarization, input voltages, radiation pattern, and compound pattern. Here the reconfiguration was achieved by changing or modifying the frequency of operations. That is modify the antenna dimensions electrically. The antenna dimensions are changed instantly by inserting switches in the antenna design .the MEMS switches are taken to examine how the reconfiguration was achieved. The micro electro mechanical systems are very small in size but it provides better concert. Because of its size only it can be chosen to design many wireless communicating equipment's. Very comfortable to use RF switches in any antenna design for achieving reconfiguration.

The microstrip patch antenna was designed to analysing the reconfiguration mechanism using the advanced design system software tool. Patch antennas are have less weight and small in size. Mostly the communicating equipment's prefers simple antenna design for reducing the space requirement so that the patch antenna was chosen to provide these specifications.to change the operating frequency is used to achieve the reconfiguration. Here we can use the HFSS tool for analysing the S parameter results. Minimum return loss that is less than -10db shows that the antenna was efficient enough. Tuning the operating frequency from one range to another by inserting the switches. If the switch is in on state it will operate one range of frequency if its in off state the antenna will operating at some other range of frequencies that is it will send and receive the information between these two frequency ranges.

The main reason for choosing P-i-n diode switches are they have high switching speed. The switch is designed to achieve high isolation with small input power. For better performance we will choose MEMS switches. These can be classified in to two types shunt and series switches, then Four type of actuation mechanisms are used to operate the switches. The cantilever bends when the voltage between the cantilever and the gate-electrode reaches pull-in voltage. The lever bends due to the electrostatic, piezoelectric, thermal or magnetic forces and forms an ohmic contact. In the OFF state the switch exhibits a moderate isolation. When shunt contact is closed, the isolation is improved. Theswitch is driven by a metal electrostatic actuator, which can generate large displacement and contact forces at lower

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temperatures. RF MEMS switches are used extensively in the wide frequency applications. These switches exhibit low insertion loss and better isolation at sufficiently high frequencies. Shunt switches can perform at both low and high frequency ranges, but the series switches are most suitable for high range of frequencies. The problem of MEMS switches was they have very low switching speed. so that we can prefer PIN diode switches to achieve reconfigurability. By comparing conventional antenna design with micro strip patch antenna, the patch antenna contains simple configuration setup and ease of fabrication. it contains dielectric layer and ground plane .above the dielectric layer the radiating patch could be placed. Generally the radiating patch could be designed in rectangular or circular shapes.

Patch antennas are required for many communicating equipment especially in mobile communications because of its size and weight. The basic microstrip patch antenna configuration was shown in given.

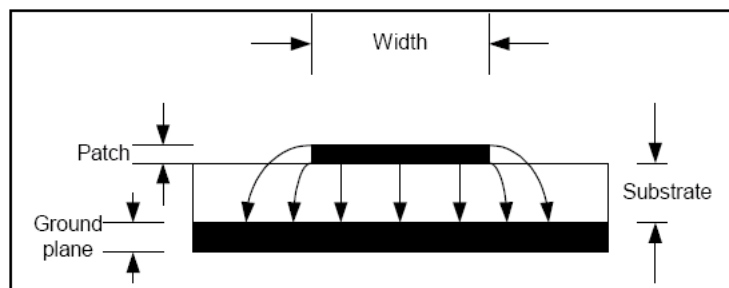


Figure 1. Basic Patch Antenna

A. Advantages

By comparing the microstrip antenna with conventional antenna the following advantages can be obtained

- Small in size and easily integrated with MIC
- Simple feeding mechanism
- Easy fabrication
- Low cost & volume

Patch antennas are required for many communicating equipment especially in mobile communications because of its size and weight.

B. Characteristics of Patch Antenna

- It has very thin profile
- Both linear and circular polarization are possible
- Easy of fabrication mechanism
- Flexibility with any shape of radiating patch
- Operating at dual frequencies

II. DESIGN

Initially we have to select the proper substrate material for designing a microstrip patch reconfigurable antenna. Most commonly four types of substrates are used those are duroid, alumina, quartz and honey comb. If we want to increase our radiated power, then we have to choose low value of dielectric constant. That is the substrate value should be less than 2.5. Duroid & alumina has low dielectric constant value so these are normally chosen. If we are increasing the substrate thickness which reduces the dielectric constant values also the thicker substrate can improve the input impedance and decrease the conductor loss.

For proper excitations we can choose the patch length should be greater than the width of the patch. Fundamental properties of an antenna are tested here by using HFSS (High Frequency Structure Simulator) software tool. In present case the design of antenna using the following values

Length of the radiating surface is given by,

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$$l = \frac{c}{2f} \sqrt{E_r}$$

Width of the radiating surface is given by,

$$w = \frac{c}{2f} \sqrt{E_r}$$

By using this formulas we can design the simple patch antenna with the frequency range of 2.4 GHz to varying the input frequency ranges by means of switches. Here we can choose the HFSS software for simulating the antenna design. Less than -10dB of return loss shows the optimization of an antenna. The microstrip antennas are most preferred for wireless systems requirements. These antennas are widely used on the base stations as well as handsets. They have variety of configurations mostly rectangular patch was chosen by the designer in the electronic environment. The proposed antenna structure was shown in given figure.

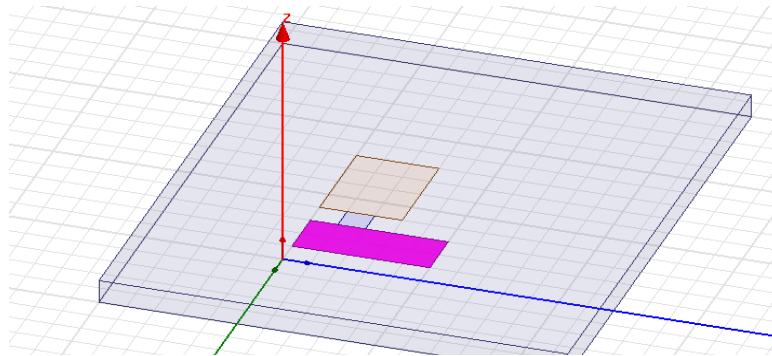


Fig. 2 Antenna design using hfss

The desired frequency of operation and the allowed bandwidth is the foremost design consideration any designer will have to deal with. With the rapid growth of wireless applications and systems, frequency spectrum has found its limitations in terms of available frequency bands. In this case, broadband devices have definitely an upper hand over narrow-band devices. Use of broadband devices eliminates the cost of up gradation in case of the requirement for the system to be used for higher frequency range. Rectangular patch antenna design using pin diode switch for reconfiguration was enclosed inside the air container using the hfss software tool. The given figure represents the proposed antenna structure.

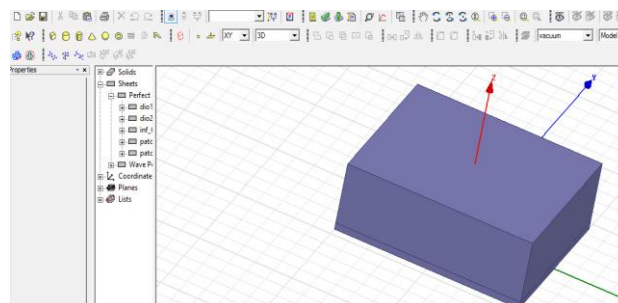


Fig. 3 The proposed antenna design with enclosed air container

The simulated results are in good agreement with the measured results. The results can be further improved by increasing the fabrication accuracy of the designed antenna. The peak gains of the antenna at different frequencies are between 2.4 and 3 dB in different switching states. The simulated radiation efficiency of the antenna in the ON-ON state ranges from 60% to 70%.

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III.SIMULATION RESULTS

The simulation of reconfigurable dual- band patch antenna by using High frequency structure simulator. The reconfigurable result is achieved by ON/OFF PIN diode on vertical slot. The different position of PIN diode is making different resonant frequencies, the suitable position of PIN switch for proposed antenna is shows at $p=12\text{mm}$. When PIN diode is in OFF mode the resonant frequencies measured at 2.4 and 3.5 GHz with return loss -22 & -27dB and bandwidth 65 and 50MHz respectively. When PIN diode is in ON mode the resonant frequency measured at 2.4 GHz with return loss -20 and bandwidth 65MHz as illustrated in Figure.

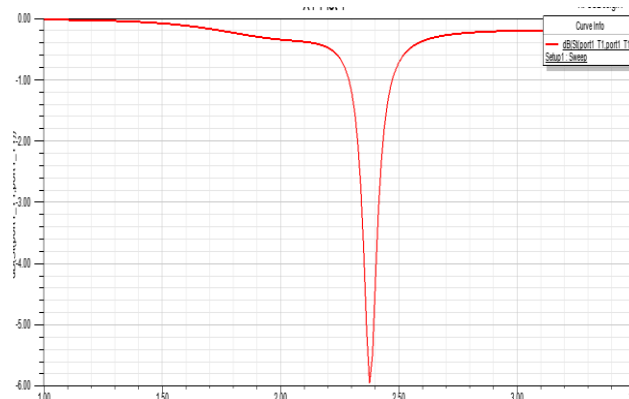


Fig.5 Result of S11 Parameter

The measured gain shows that the antenna with reflector has a higher gain than the antenna without reflector, while the front to back ratio shows that the antenna with reflector has a higher value than the antenna without reflector at all frequency bands. As can be seen, an increment of gain up to 3 dB is achieved after the introduction of the reflector. The radiation pattern and the VSWR of the antenna structure was shown in given figure.

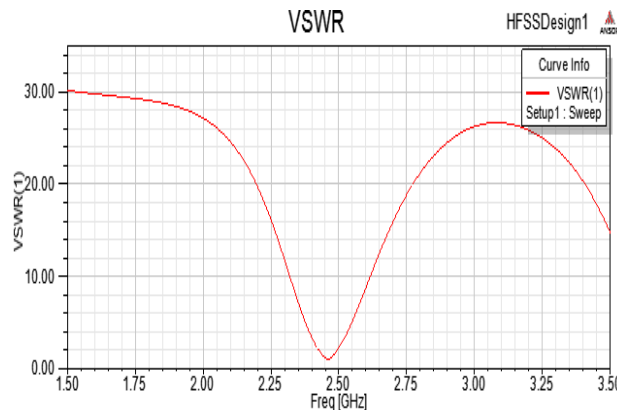


Fig. 6 Result Of VSWR For Proposed Antenna Design

The antenna is having return loss of -29.6925 dB at 2.4GHz .This designed antenna is simulated on HFSS software.For this antenna, a sufficient band-width was achieved byutilizing microstrip line technique, the desired frequency of2.4GHz is achieved, likewise the VSWR value of 1.2 isachievable. The designed microstrip antenna is optimized tocover multiband applications. The proposed antenna is very compact, veryeasy to fabricate, and is fed by a 50Ω microstrip line whichmakes it very attractive for current and future wireless systems applications.

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IV.CONCLUSION

The antenna is having return loss of -10.6925 dB at 2.4GHz. This designed antenna is simulated on HFSS software. For this antenna, a sufficient band-width was achieved by utilizing microstrip line technique, the desired frequency of 2.4GHz is achieved, and likewise the VSWR value of 1.2 is achievable. The designed microstrip antenna is optimized to cover WLAN. The proposed antenna is very compact, very easy to fabricate, and is fed by a 50Ω microstrip line which makes it very attractive for current and future multiband applications.

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