Design of low cost 5GHz Stacked Microstrip Patch Antenna for Broadband WLAN

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Abstract

One of the generally looked into range in communication field is wireless communications. The utilizations, applications and operation of various antennas must be known in investigation of wireless communications. Antennas equipped for keeping up superior over a wide range of frequencies, having light weight, minimized and modest are favored. Microstrip fix antennas are one of the antennas that satisfy the previously mentioned criteria. Henceforth in this paper the plan of a Microstrip patch antenna as a stacked antenna is produced for 5 GHz band to expand the exhibitions, for example, bandwidth, pick up and directivity. The Microstrip fix antenna has been outlined utilizing IE3D programming which is an commercially accessible electromagnetic simulator.

These microstrip antennas can be used for networking of routers / access points to obtain a private network. A password can be used to protect the network from being hacked or corrupted. These routers can be connected in bridge or repeater mode to enhance the coverage area. The throughput of 5GHz is much higher as compared to a 2.5GHz with a compromise in Beamwidth though.

Keywords—*Microstrip patch antenna, stacked antenna, bandwidth, gain, IE3D.*

INTRODUCTION

Microstrip antennas are widely used as its demand is increasing rapidly in wireless communication systems for microwave frequency range because they can be easily fabricated, small size, simple, low profile and weighs less. Nowadays, as microstrip patch antennas (MPA) are commonly used in wireless devices, it is very important to reduce the size of antenna which in turn would minimize the entire size of the communication system. Conventional microstrip patch antenna suffers from very narrow bandwidth, which is typically about 5% bandwidth with respect to the center frequency, excitation of surface waves, low power and relatively high level of cross polarization radiation which limits their applications. Number of numerical strategies has been created by researchers to facilitate the design procedure of microstrip antennas to meet broadband criteria.

LITERATURE SURVEY

A microstrip fix antenna is a position of safety antenna which is comparable to planar and non-planar surfaces. Microstrip antennas are straightforward and economical to manufacture utilizing

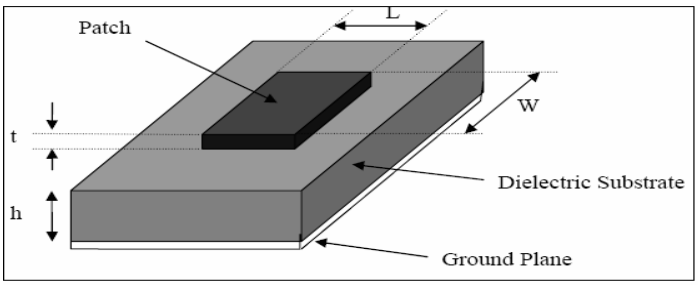
present day printed-circuit technology. Microstrip antenna is flexible as far as resounding recurrence, polarization, example, and impedance [1]. Numerous radar and communication frameworks lean toward antennas which has dual-polarization and double recurrence abilities for higher capacity data exchange [2]. A square microstrip antenna with aperture coupled feeding is selected in order to easily accommodate the requirement for two polarization states in arrayed microstrip patch. The antenna is fed through a small aperture on a separate ground plane and a feed point on conducting patch through power divider. The radiating patch and the feed lines are electrically and electromagnetically isolated through the ground plane. As the number of patch element increases the directivity of an antenna increases thereby reducing the beamwidth.

Microstrip patch antennas essentially started in 1953, it is proposed by Deschamps that microstrip feed lines can be utilized to sustain a variety of printed antenna components. The printed antenna components presented were really flared planar horns and not microstrip patches. A microstrip patch antenna for the most part comprises of a conducting Patch; this conducting patch can either be non-planar or planar in geometry on one side of the dielectric substrate and a ground plane on opposite side.

These types of microstrip patch antennas are popularly known as 'printed resonant antenna' and are used where semi-hemispherical coverage is required for narrow band wireless links [3].

Improvement of antenna performance using stacked microstrip patch antenna presented by Md. Bappy Hossain and Sham Datto. This paper deals with increasing the performance of microstrip antenna using stacked antenna. The author here used HFSS software as a simulator to simulate stacked microstrip antenna [4].

Design and advancement of Microstrip rectangular patch antenna with various feed techniques at 4 GHz displayed by Deepika J, A.M. Prasanna Kumar and Mohan Prasad P. This paper gives detail depiction about outline and advancement of microstrip rectangular patch antenna for wireless applications. There are different nourishing procedures for patch antenna, in this paper it was intended for two understood and broadly utilized feeding techniques, for example, Co-axial test sustain strategy and microstrip feed line method. The proposed antenna has reverberation recurrence (f0) at 4 GHz [5]. Band-rejection filter is necessary in UWB RF front-ends in order to provide pattern radiation stability, insertion-loss problem [6].



B.B.Tigadi, Namita Gokavi and V.R.Udupi presents Design and Development of Microstrip Patch antenna array with Improved Performance. Because of inherent advantages of Microstrip patch antenna, it is widely used in wireless communication .But it suffers from the limitations such as low bandwidth, low gain, less efficiency etc. In this paper author has constructed microstrip patch

antenna arrays which results in performance improvement in terms of parameter like gain, directivity, efficiency and bandwidth. Initially patch antenna is designed for bandwidth improvement, the C slot is introduced as C slot patch antennas are configured into an array to enhance the bandwidth [7]. Dual band characteristic can be achieved using U Slot in the conducting patch, conducting patch in the lower band could be attained using truncated corners [8].

Bandwidth Enhancement and modification of single band patch antenna into double band presented by Ranjeet Pratap Singh Bhadoriya and sumit Nigam. The attention for multiband antenna has grown drastically in last few years. To fulfill demand, multiband antennas have been developed to achieve operations at different frequencies by applying a single frequency as input over several wireless services. Requirement has always been that the capability of antenna should be to operate at different frequencies for simultaneous operations at multiple frequency bands. It is desirable that these antennas should present high returns loss, similar directivity at the operation frequencies and high bandwidth, compact size is also important to integrate these antennas into small devices [9].

Ramila Shreshtha, Dimitris E. Anagnoston, Stephen J.Horst and James P.Hoffman presents Dual-Frequency and Polarization Antenna Array for Satellite Deployment. The development of a microstrip dual-band and dual-polarization 6X6 antenna array using aperture coupled feed on RO4003C is presented. To provide dual frequency operation at 14 GHz and 35 GHz, the antenna array will have multilayer structure that consists of square microstrip elements, placed on each substrate layer. Two right-angled microstrip lines and two perpendicular slots to feed the antennas are used to achieve dual polarization. The microstrip feed line is orthogonally placed from the center of the slot between the substrates on the ground plane. The energy from the microstrip feed line is aperture coupled to each square antenna element through the slot. To enable the two different polarization states, two right-angled non-overlapping slots are used on each antenna. The antenna array has 35 GHz patches on the lower substrate layer and 14 GHz patches on the top substrate layer in order to maintain a similar percentage bandwidth [10]. The dualband behavior could be achieved by a shorting pin at 2.4GHz and 5.8GHz [11].

THE MICROSTRIP PATCH ANTENNA

Microstrip patch antenna consists of radiating element or a metal strip on one side of the dielectric substrate and ground plane on the other side. Because the shielding ground plane is spaced a few substrate thicknesses away the dielectric substrate retains most of the power. The radiating patch may be of different shapes such as square, rectangular, thin strip, circular, elliptical, triangular or any other configuration.

Fig. 1. Microstrip patch antenna.

A microstrip patch antenna consists of conducting element which is a radiating patch and ground plane between them is a dielectric medium called the substrate. This substrate has particular value of dielectric constant. The dimensions of a ground plane is larger than the radiating patch. Dimensions of a microstrip patch antenna i.e. radiating patch as well as ground plane depends on the resonant frequency and value of the dielectric constant.

Different shapes of Microstrip patch antenna

The Conducting patch is usually square, rectangular, circular, triangular, elliptical or other common shape as shown in Figure 2. The length L of the patch, for

rectangular patch is usually $0.3333\lambda o < L < 0.5\lambda o$, where λo is the free-space wavelength [4].

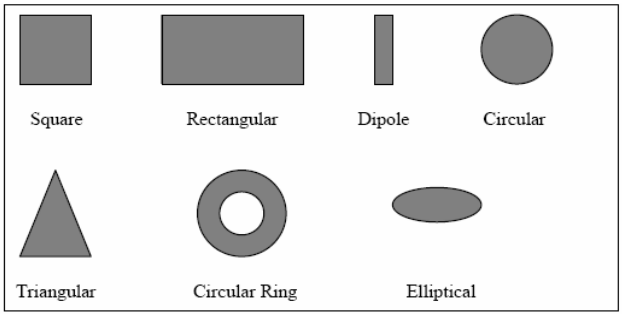


Fig. 2. *Different shapes of Microstrip patch antenna.*

The conducting patch is selected to be very thin such that $t << \lambda o$ (where t is the patch thickness). The height (h) of the dielectric substrate is usually $0.003\ \lambda o \leq h \leq 0.05\ \lambda o$. The dielectric constant of the substrate (εr) is typically in the range $2.2 \leq \varepsilon r \leq 12$.

FEEDING TECHNIQUE

To make antenna structure so that it can operate at full power of transmission feeding technique is most important in designing the antenna. Designing the feeding techniques is a difficult process for high frequency [12]. This is because the input loss of feeding increases depending on frequency and finally give huge effect on overall design. Few feeding techniques that can be used to design MPA are:

- Microstip line feeding
- Coaxial probe feeding
- Aperture coupled feeding
- Proximity coupled feeding
- CPW feeding

THE STACKED PATCH ANTENNA

The stacked antenna is built like a multilayer printed circuit board by vertically stacking two patches i.e. one conducting patch is placed on top of the other. It is also called as multilayer antenna or dual patch antenna. The top patch is referred as radiating patch and bottom patch is referred to as feeding patch. The radiating patch is fed or excited via an electromagnetic coupling from the feeding patch [4].

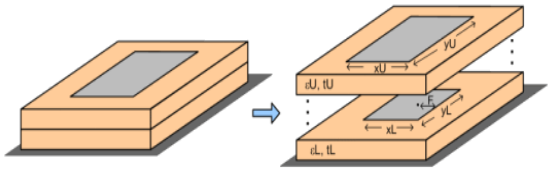


Fig. 3. *Stacked microstrip patch antenna.*

There are three ways to connect to stacked antenna as given below:

- Providing input to both patches individually (dual band)
- Providing input to the upper patch only: series fed (dual band)
- Providing input to the lower patch only: shunt fed (wide band)

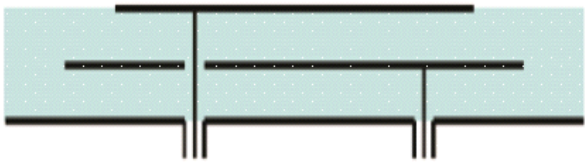


Fig 4. *Shows this three connection.*

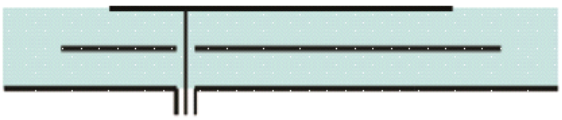


Fig 4(b). *Series Feed.*

Fig. 4(c). Shunt feed.

ANTENNA DESIGN

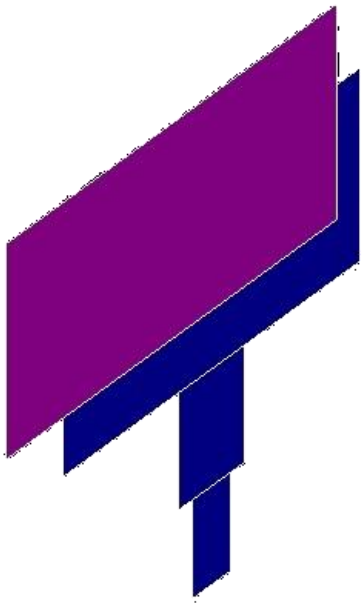


Fig. 5(a). *Isometric view of stacked microstrip patch antenna.*

The design parameters of the proposed antennas are given below-

Stacked Antenna with Microstip line feed:

- Ground : L=36 mm, W=34 mm
- Lower substrate : (Taconic, Dk = 3.0)
- L = 36 mm, W = 34 mm, H (Height) = 0.8 mm
- Upper substrate:(FR4, Dk = 4.4)
- L=36 mm, W=34 mm, H=0.5 mm
- Feeding patch : L=15 mm, W=13.3 mm
- Radiating patch : L=21.5 mm, W=18.4 mm

RESULTS AND DISCUSSION

The performance of proposed antenna has been observed in terms of the return loss, VSWR and radiation pattern. By using the method of design of variables, the optimization is gained.

Return Loss and Bandwidth

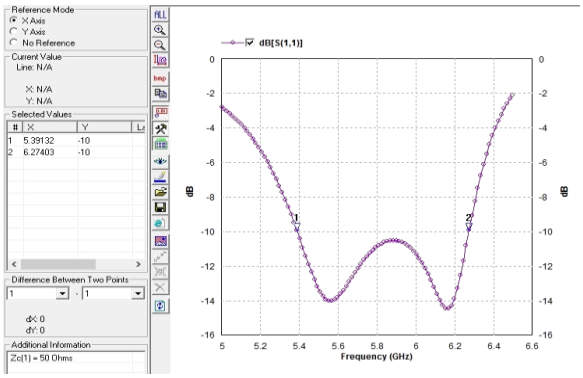


Fig 6. *illustrates the return loss plot of the stacked antenna with microstrip line feed. The return loss and bandwidth have been increased by this technique of stacking.*

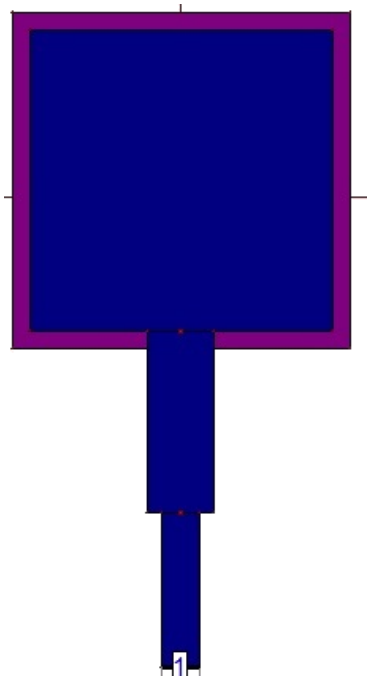
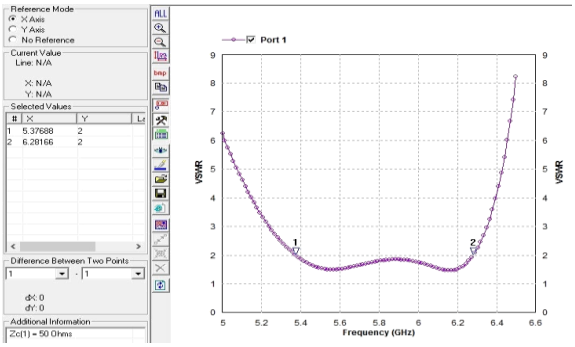


Fig. 6. *Return loss of stacked microstrip patch antenna.*



VSWR

Fig. 7. *VSWR of stacked microstrip patch antenna.*

Radiation Pattern

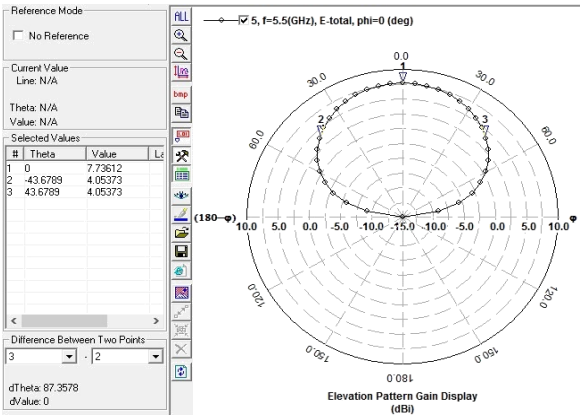


Fig. 8. *Radiation pattern of stacked microstrip patch antenna.*

CONCLUSION

Gain enhancement and size reduction are few of the major design requirements for practical applications. Many techniques have been used to achieve high gain as well as to reduce the size of the antenna. In this paper, stacking technique is used to enhance the gain of the antenna. Study of size reduction techniques is as well studied. By stacking a 1 element patch at 5GHz band, the gain can be increased with a compromise in beamwidth though. The size of the antenna can be substantially reduced using Taconic laminates which has low substrate losses at higher frequencies. Further the single patch design can be upgraded either to a dual polarized antenna array or a single polarized high gain array. Both the antenna arrays, if developed have vast and promising applications in the ISM / WLAN industry globally.

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