ijcrr
Vol 04 issue 15
Category: Research
Received on:20/04/12
Revised on:11/05/12
Accepted on:29/05/12

ENHANCEMENT OF PARAMETERS FOR MULTI LAYER BRO MICROSTRIP PATCH ANTENNA

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ABSTRACT

In this paper, The proposed model for enhancing gain and return loss, which improves the performance of a conventional microstrip patch antenna. This paper presents a novel wideband probe fed inverted multiple slot microstrip patch antenna. This model adopts contemporary techniques; probe feeding, inverted patch structure and stacked UV-shaped slotted patch. In addition to the easy feeding, the proposed model possesses the advantages of being wide bandwidth, high gain and low return loss. The patch element has the peak gain 13.16 dBi and the return loss is -23.7dB.

Keywords- Broadband antenna; microstrip patch antenna; probe fed; Inverted patch.

INTRODUCTION

Microstrip antennas are the most rapidly developing field in the last few years. Currently these antennas have a large application in mobile radio systems, integrated antennas, satellite navigation receivers, satellite communications, direct broadcast radio, television, etc. The considerable interest in microstrip antennas is due to their advantages compared to conventional microwave antennas as low profile and light weight, easy to fabricate, conformable to mounting structures, and compatible with integrated circuit technology.

However, one of the most serious disadvantages of microstrip antennas is limited bandwidth [1]-[3]. To overcome this inherent limitation of narrow impedance bandwidth, low gain and cross-polarization many techniques have been suggested e.g., for probe fed stacked antenna, microstrip patch antennas on electrically thick substrate, slotted patch antenna and stacked shorted patches have been proposed [4]. Recently, there has been considerable interest in the two layer probe fed patch antenna consisting of a driven patch in the bottom and a parasitic patch [5], [6]. By stacking a parasitic patch on a Microstrip patch antenna, the antenna with high gain or wide bandwidth can be realized [7]. These characteristics of stacked microstrip antenna depend on the distance between a fed patch and a parasitic patch. When the distance about 0.1λ mm(wavelength) the stacked microstrip antenna has a wide bandwidth [7], [8].

Recently, aperture-coupled fed stacked patch antenna[9] have been investigated and bandwidths up to 69% have been reported, however, the major drawbacks are the level of back radiation due to use of a resonant aperture and the surface wave excitation. Other feeding techniques such as the use of L-shaped or F-shaped probes have also been proposed yielding to wide impedance bandwidths [10],[11], at the expense of increased complexity of the design and fabrication, especially of the probe. In [10], an L-probe fed stacked U-Slot patch antenna was proposed with a bandwidth up to 44.4% being achieved. V-slotted rectangular microstrip antenna with a stacked patch has been shown able to achieve bandwidths as high as 47% [12].

This paper proposes UV-shape slotted multiple stacked patch antenna with wide bandwidth, low return loss and high gain characteristics operating between 16.35-17.1 GHz. This employs contemporary techniques namely, the probe feeding, inverted patch, and stacked patch techniques to meet the design requirement.

ANTENNA MODEL

The geometry of the proposed antenna structure is shown in Fig. 1. The antenna is made-up of two UV-shaped stacked patches, two air layers, two Rogers substrates, and a vertical probe connected to the driven patch. The driven and parasitic patches supported by a low dielectric substrate with dielectric permittivity, ε_1 and thickness, h_1. The parasitic patch is stacked at the height h_2 above the lower substrate with permittivity ε_2 and thickness h_3. Two air-filled layers are used in between the lower substrate and ground plane with permittivity, ε_0 and thickness, h_0 and in between lower and upper substrates with permittivity, ε_0 and thickness, h_2 respectively.

The proposed two UV-shaped stacked patches are on two different radiating elements. The use of probe feeding technique, stacked multiple slotted patch with thick air filled substrates provide the gain enhancement. The UV-shaped slots for driven patch and parasitic patch are shown in Fig. 1(a). The driven patch is fed by a direct connected probe along the centreline (x-axis) of the patch as shown in Fig. 1(b).

Geometry of the antenna:

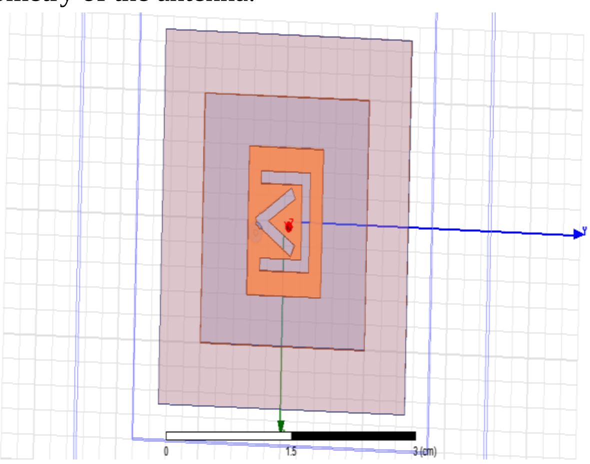

Fig 1:proposed antenna model top view

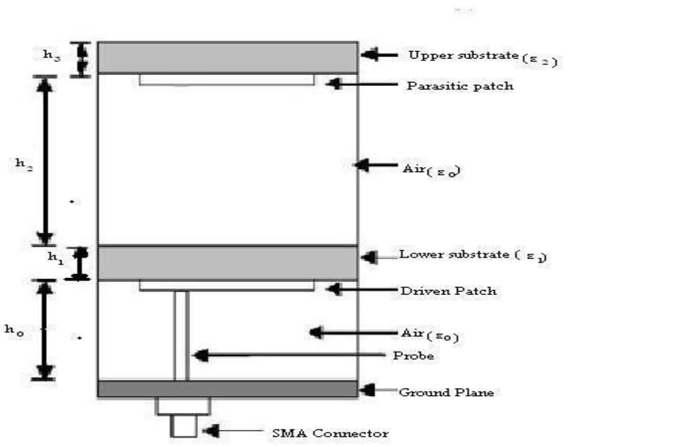

Fig 1:proposed antenna model side view

Figure 1. The geometry of the proposed patch antenna: (a) Top view driven and parasitic patch (b) side view

RESULTS

The resonant properties of the proposed antenna have been predicted and optimized using a frequency domain three dimensional full wave electromagnetic field solver (Ansoft HFSS).

Return loss:

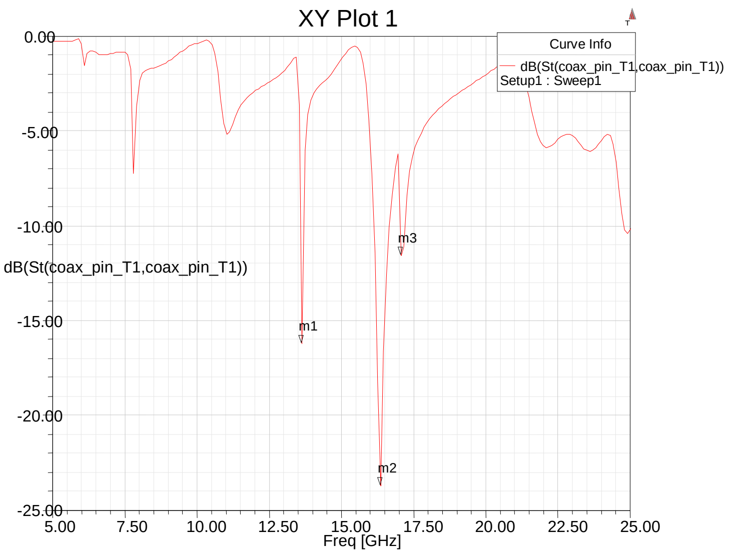

Fig 2. Simulated return loss of the proposed patch antenna

The above figure shows the return loss graph for the proposed antenna. It can be seen that the minimum value is obtained at 16.35 GHz and the minimum value obtained is -23.7 dB. Hence the antenna works well at that frequency and there are wide applications for patch antennas at that frequency.

2D Gain:

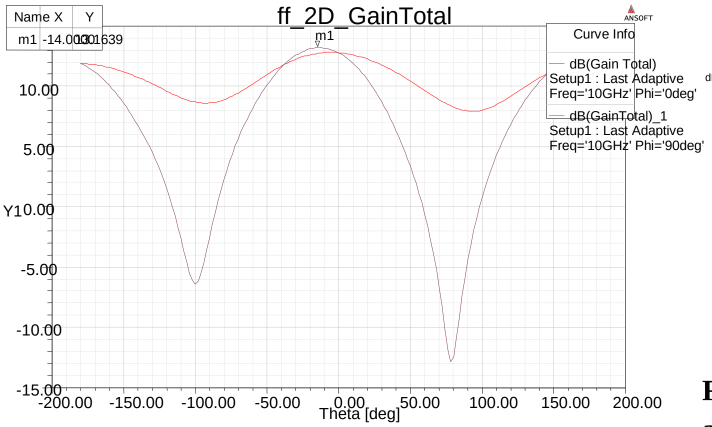

Fig 3 Simulated 2D-gain of the proposed patch antenna at different frequencies

The simulated gain of the proposed patch antenna at various frequencies is shown in Fig. 3. As shown in the Fig.3, the maximum achievable gain is 13.16 dBi at the frequency of 16.35 GHz, which is greater than [13],[14] .

3D Gain:

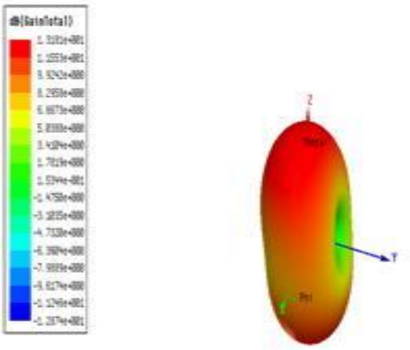

Fig 4. Simulated 3D-gain of the proposed patch antenna

The 3 dimensional pattern of the gain indicates that a high directional beam of radiation is produces and hence the antenna performs well as a good endfire radiator. The peak gain of the antenna is obtained as 13.16 dBi which is a good value for the antenna to behave well.

VSWR:

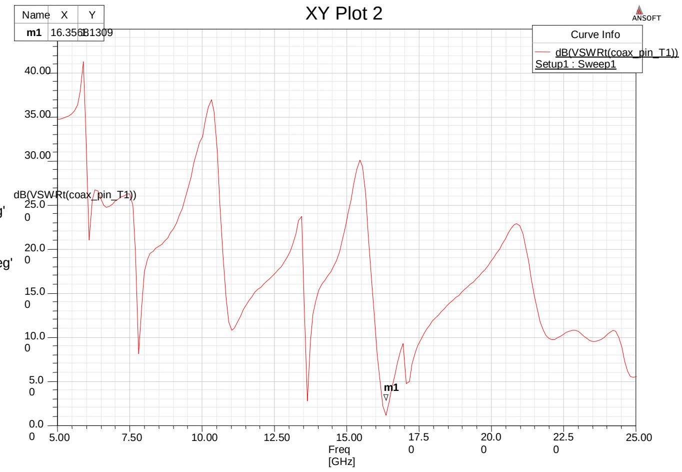

Fig 5. Simulated VSWR of the proposed patch antenna

Radiation patterns

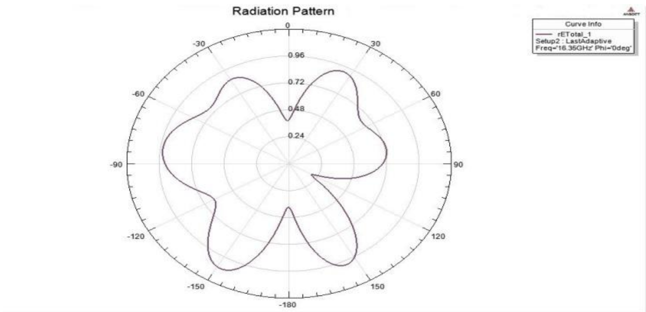

Fig.6(a)Radiation pattern of the proposed patch antenna at resonance frequency 16.35 GHz for ϕ =0^{0}

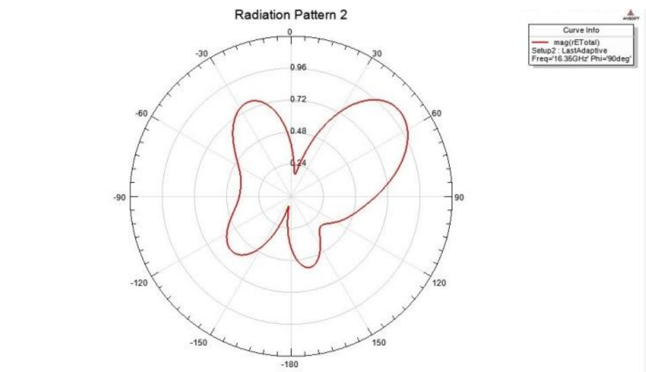

Fig 6(b). Radiation pattern of the proposed patch antenna at resonance frequency 16.35 GHz for ϕ =90^{0}

The above figure shows radiation pattern. As shown in fig.6 the designed antenna displays good broadside radiation patterns for both resonance frequencies when ϕ=0^{0} and ϕ=90^{0}. It can be seen that 3-dB beam widths of 58^{0} and 60^{0} are at resonance frequencies of 16.35 GHz and 17.1 GHz.

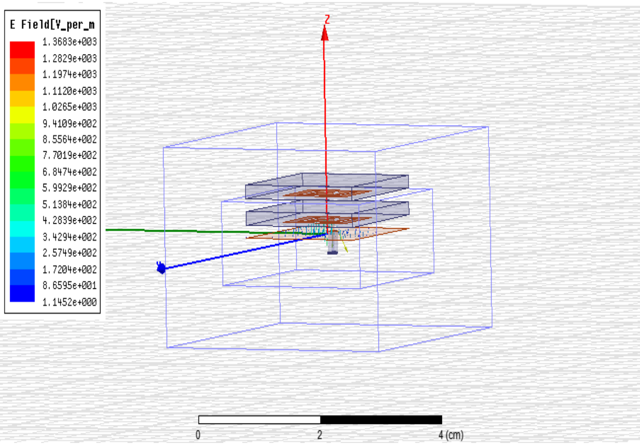

Fig 7. E-field vector distribution of the proposed patch antenna

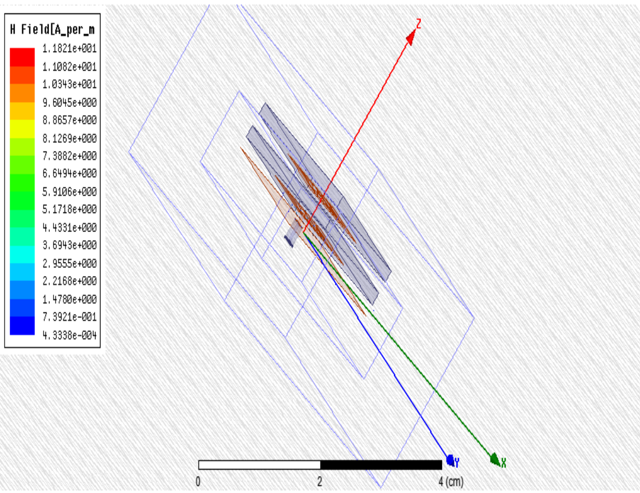

Fig 8. H-field vector distribution of the proposed patch antenna

MeasuredData:

Quantity	Value	Units
Max U	0.0018656	W/sr
Peak Directivity	2.3906	
Peak Gain	2.3978	
Peak Realized Gain	2.3686	
Radiated Power	0.0098067	W
Accepted Power	0.0097775	W
Incident power	0.0098979	W
Radiation Efficiency	1.003	
Front to Back Ratio	2.1778	
Decay Factor	0	

Tabe.1Proposed Patch Antenna parameters at 16.35GHz

CONCLUSION AND DISCUSSION

A UV-shaped slotted patch antenna has been designed for high gain and low return loss. A newly technique for enhancing gain and low return loss of microstrip patch antenna is successfully designed in this research. Simulation results of a wideband microstrip patch antenna covering 16.35 to 17.1 GHz frequency have been presented. Techniques for microstrip broad-banding, gain enhancement and low return loss are applied with significant improvement in the design by employing proposed slotted patch shaped design, inverted patch and probe feeding.

The proposed microstrip patch antenna achieves a bandwidth of 16.35 to 17.1 GHz at -23 dB return loss and the maximum achievable gain of the antenna is 13.16 dBi. The design has demonstrated that stacked patch with UV-shape slots and probe fed can be used to form an antenna with very low return loss further more due to its high gain and broad bandwidth more applications can be anticipated.

ACKNOWLEDGMENT

The authors like to express their thanks to the department of ECE and the management of K L University for their support and encouragement.

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