TRANSACTIONS ON ELECTROMAGNETIC SPECTRUM

Bandwidth and Gain Enhancement of Parasitic Loaded Proximity Coupled Antenna for WLAN Applications

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Abstract: In this work, two different substrates were used for enhancing the bandwidth and gain of the designed antenna for the application of WLAN. The proposed design attained at 5.2 GHz frequency. The proposed structure consists of the five layers arranged in vertical direction. The lower layer is ground layer, fifth layer is the active patch, substrate one is FR-4, and substrate two is RT Duroid 5880 with equal height of 1.6 mm. The performance of the proposed antenna is improved by placing triangular slots on the patch. A non-contacting type proximity feed line method was proposed for excellent impedance matching. From the observation stage by stage, the radiating element enhances the bandwidth and gain. The proposed design simulated through CSTMW 2018. The measured S-parameters and radiation patterns results are observed from vector network analyzer and anechoic chamber. Finally, the proposed radiating element is well suited for WLAN applications.

Keywords: Proximity coupled, Parasitic element, Gain, Bandwidth, WLAN.

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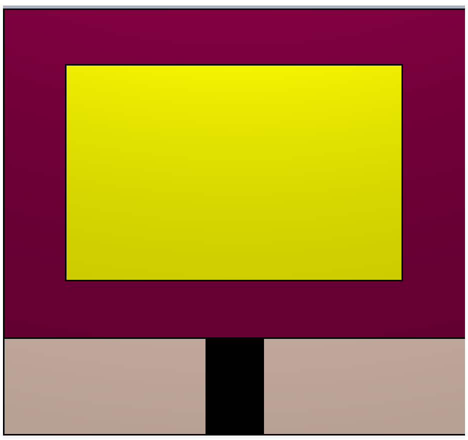
1. INTRODUCTION

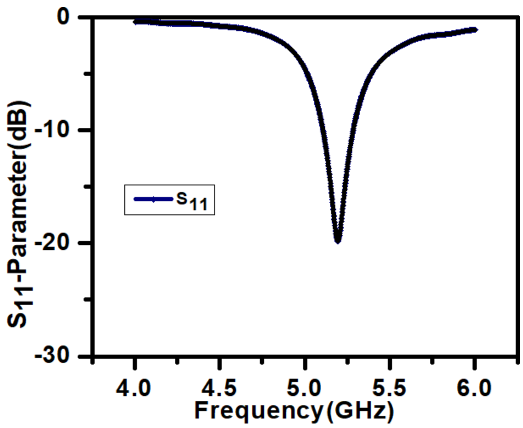
Now a day's wireless communication systems looking for high gain and broad bandwidths for sending high data rates between the communication systems. Generally, microstrip antennas are used for the wireless communication applications. However, the major limitation with microstrip patch antennas are narrow bandwidth and lower gains. Due to this effective communication is not possible. In order to overcome the most of the antenna designers proposing stacked antenna for the improvement of the bandwidth and gains. In [1] design and operation of the microstrip antenna was explained very clearly. In [2] stacked with aperture coupling was used for wide band impedance matching. In [3] a multiband dual layer micro strip antenna was designed for the improvement of bandwidth. In [4] and [5] for wide bandwidth and gain enhancement stacked and fractal techniques was used in the designing of 2×2 and 4×4 array. In [6] UWB antenna was designed with high impedance bandwidth in the range of 3.61 GHz to 14.93 GHz for UWB applications. In [7] a four layer microstrip antenna was designed for triband applications and for good impedance matching aperture coupling was used. In [8] and [9] the author designed stacked microstrip antenna for gain and bandwidth improvement and proximity coupling feeding technique also used for proper impedance matching for the WLAN and WiMAX applications. In [10] reconfigurable stacked antenna was designed for 60 GHz band applications. In [11] a probe fed stacked microstrip antenna was designed and verified experimentally for gain improvement. In [12] proximity coupled microstrip antenna was designed for enhancing the gain and for impedance matching. In [13-14] and [15] rectangular and circular stacked microstrip patch antenna was designed for gain and bandwidth improvement.

2. PROXIMITY COUPLED FED

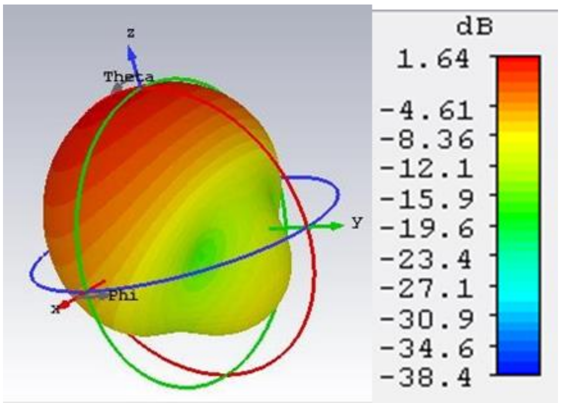
Initially the basic dual layer microstrip patch antenna was designed, it consists of five layers, the height of the ground layer is 0.035, above the ground the FR-4 substrate with height of 1.6 mm after that feed line is placed above the substrate with 3 mm and 10 mm length and width, then RT Duroid 5880 with 1.6 mm height is placed upon that active patch was placed. Because of the electromagnetic field coupling the patch radiate efficiently. The dimensions of proposed structure reported in the Table 1. Fig.1(a) shows the view of the basic dual layer rectangular antenna and the corresponding return loss is shown in Fig 1(b). The results of returns loss are attained at the desired band is -21dB between the 5.1 GHz - 5.3 GHz. The gain offered at the desired frequency is 1.64 dB and given in Fig1(c). For the improvement of the gain and the bandwidth, V-slots are cut from three sides of the active patch with radius of R1 (2 mm) which is shown in Fig. 2(a) and the corresponding return loss is shown in Fig. 2(b). Because of the slot cutting, the frequency shifting from 5.2 -5.4 GHz with bandwidth from 5.25-5.55. In order to main the desired frequency, for low return loss parasitic elements are placed around the patch results in low return loss -32dB, improved bandwidth from 4.8 GHz-5.4 GHz with 45%. The radiating element and the structure shows in Fig. 3(a) and 3(b). For further improvement bottom side of the patch is removed with slots S1 and S2. From that it was observed without shifting the desired frequency range, the proposed element improved their performance in terms of gain, bandwidth and low return loss. The gain is offered 6 dB, bandwidth is from 4.98-5.43(MHz) is improved, and obtained very low return loss at the 5.2 GHz with the -62dB.



(a) Dual layer rectangular radiating element

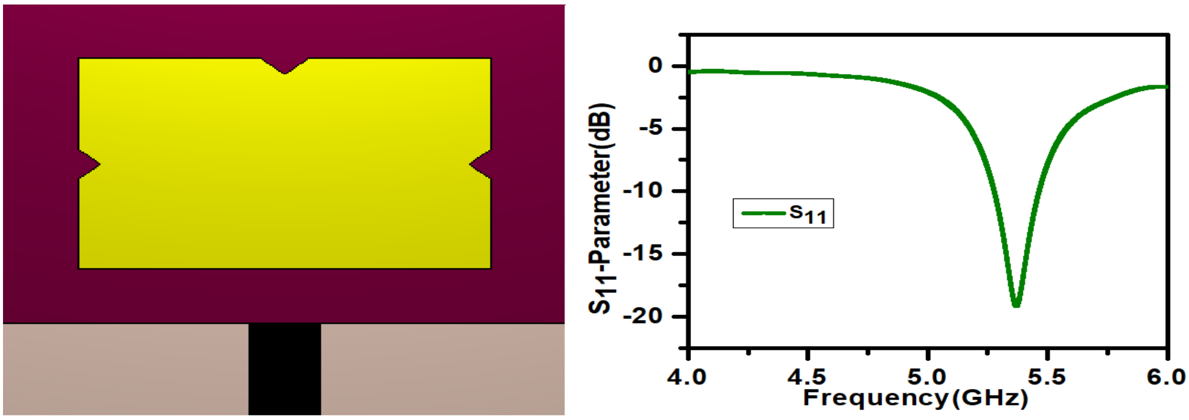


(b) S-Parameter



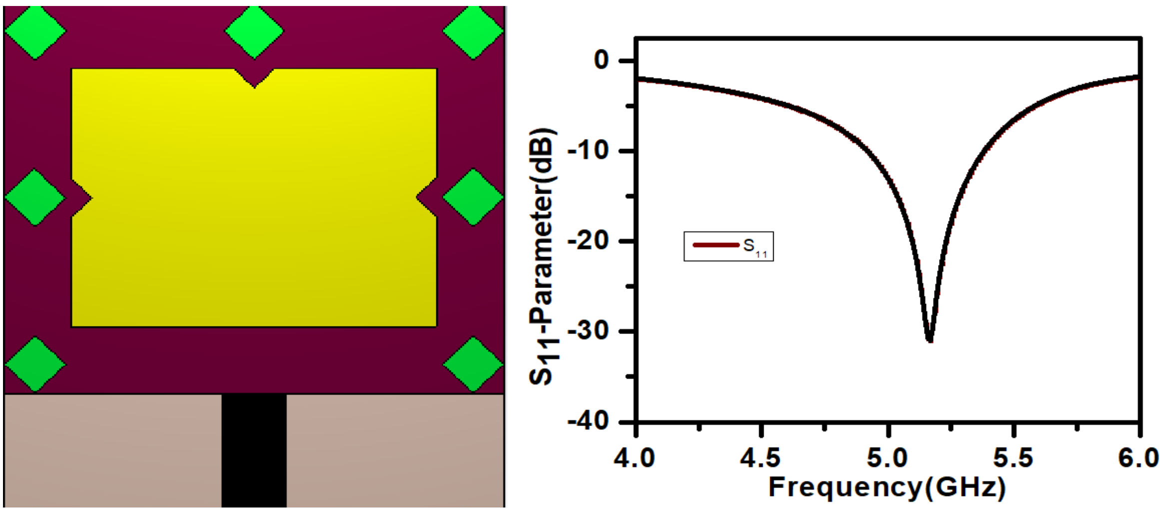
(c) 3D Gain plot

Figure 1. The basic dual layer rectangular antenna



(a) Slot cutting element *(b) S-parameter*

Figure 2. The cutting of the V-slots from three sides of the active patch



(a) Parasitic proposed element *(b) S-parameter*

Figure 3. The parasitic proposed element and its S- parameter

Table 1. The dimensions of the dual layer radiating element

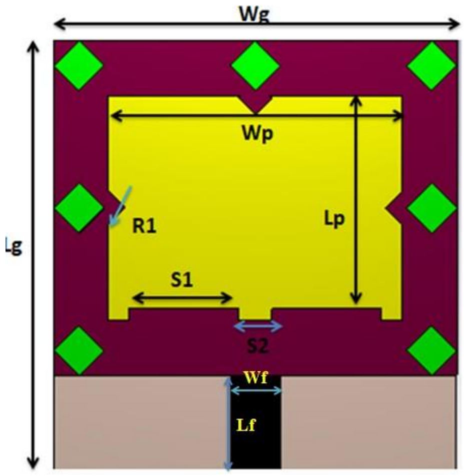
Parameter	Value (mm)
Wg	24
Lg	26
Wp	17
Lp	13
R1	2
S1	6
S2	2
Wf	3
Lf	10

3. RESULTS AND DISCUSSION

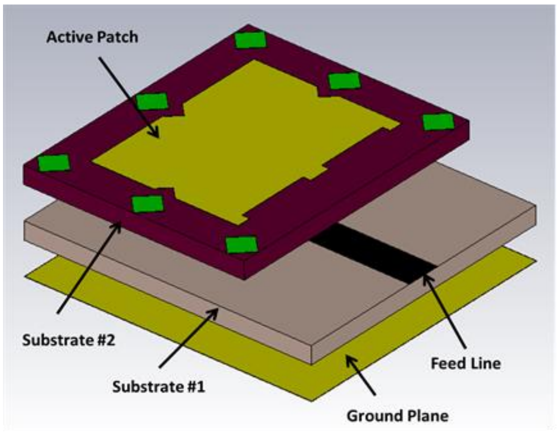
In this paper slot cutting and parasitic method was used for the improvement of the gain and the bandwidth. Stage by stage the radiating element shows the performance with improved instance. Compared to the basic dual layer structure, the multi slot and parasitic structure improve the results in terms of return loss, gain and bandwidth. Fig 4(a) shows the overall structure and corresponding dimensions. The corresponding graph for S-parameter shown in Fig 4(b). The gain of the proposed antenna at the resonant frequency is 6.02 dB and shown in Fig. 4(e) with the VSWR is less than 2. The measured s-parameters and radiation patterns of the proposed antenna are shown in Fig. 4(f) and 4(g). The measurement set-up of the proposed design shows at the network analyzer and anechoic chamber. From the simulated and measured graph of S-parameters, there is a deviation in the frequency due to the SMA connectors and soldering connections. Due to that the frequency is shifted from 5.2 GHz - 5.18 GHz. Table 2 shows the performance of the proposed structure step-by-step analysis.

Table 2. The comparison of the proposed structure

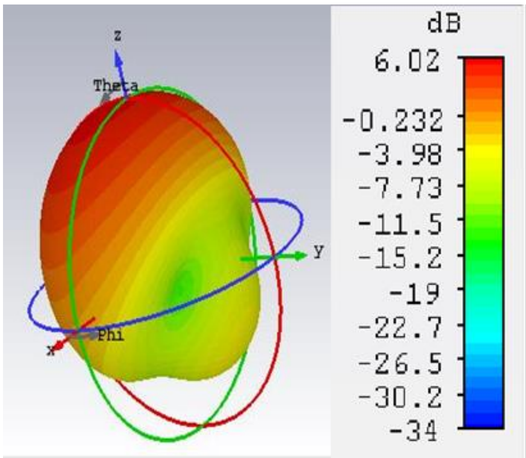
Parameter	S_{11}Parameter	Bandwidth (MHz)
Simulated Results	-60 dB (5.23GHz)	453
Measured Results	-50 dB (5.2GHz)	440



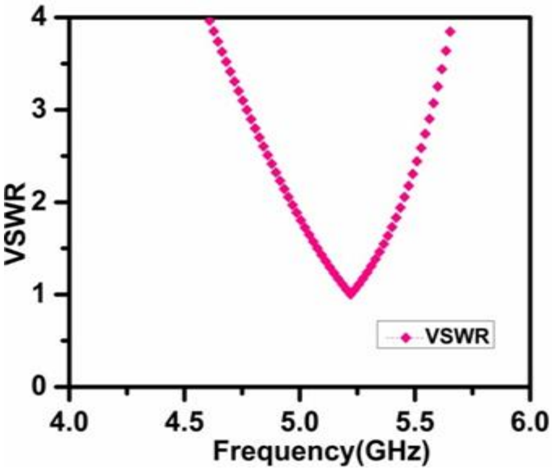
(a) Slot cutting element proposed antenna



(b) side view of proximity coupled antenna

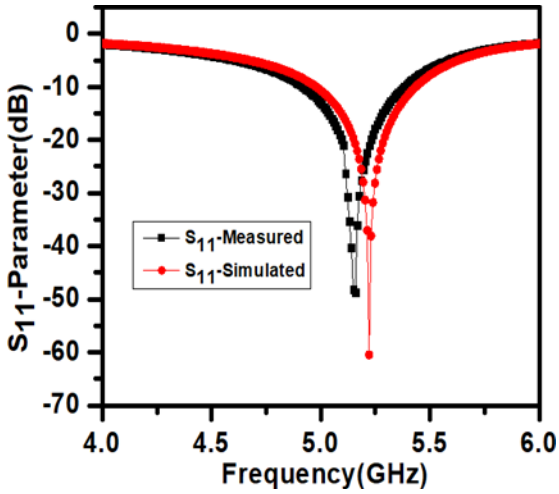


(c) 3D gain plot

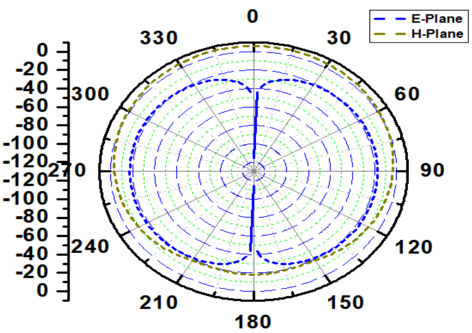


(d) VSWR Plot

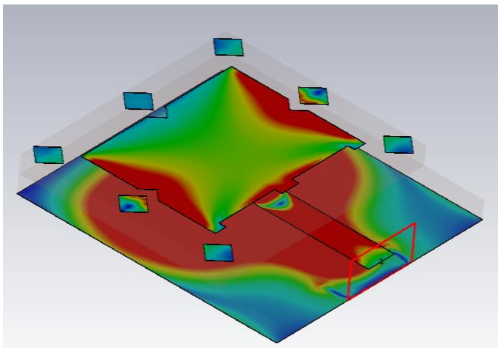
(e) The measurement view



(f) The simulated and measured S_{11}



(g) The radiation pattern



(h) Electrical field of the antenna

Figure 4. The graphics of the proposed antenna

Table 3. The comparison of the proposed structure stage by stage

Sl.no	Frequency (GHz)	S_{11} (dB)	Bandwidth (MHz)	Gain(dB)
Antenna-1	5.2	-20	200	1.64
Antenna-2	5.35	-19	210	2
Antenna-3	5.2	-30	412	4.7
Antenna-4	5.23	-60	453	6.02

4. CONCLUSION

In present scenario, wireless communication systems need huge data rates for enhancing the system capacity, for that improvement of the bandwidth and gain both are the major parameter for system improvement. This work is for bandwidth and gain enhancement for WLAN applications. For that improvement slot cutting and parasitic elements techniques are proposed. By step by step observation the final proposed structure with slot cutting and bandwidth were improved 4.98.25-5.43(MHz), gain is 6.02 dB from stage one to final stage. Finally, the proposed structure is well suited for WLAN applications.

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