Slit Loaded Dual Wideband Microstrip Patch Antenna

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Abstract- In this paper, slits loaded dual wideband microstrip patch antenna with coaxial probe feed has been proposed for wireless applications. For dual resonating behavior, the designed patch antenna has quite satisfactory linear radiation pattern and gain performance. Proposed antenna is designed, simulated by using a finite element method algorithm based tool HFSS electromagnetic solver. The results shows that the antenna operates for the lower frequency range of 594.5 MHz (5.0743–5.6688 GHz) and higher frequency range of 460 MHz (7.0200-7.4800 GHz),which make the structure suitable for WiMAX 2.5/3.5/5.5GHz,WLAN (2.4/5.2/5.8GHz) and C- band wireless applications.

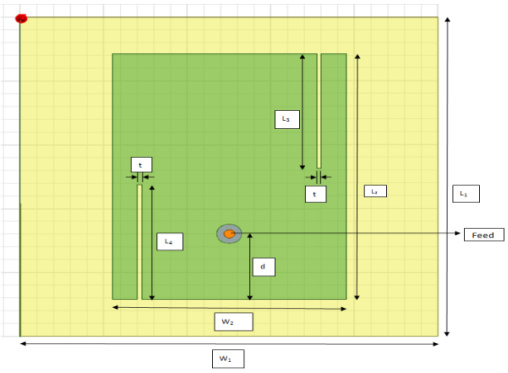
Index Terms- Microstrip Patch Antenna, HFSS, Dual Band, Slit, Radiation Pattern, Axial Ratio.

I. INTRODUCTION

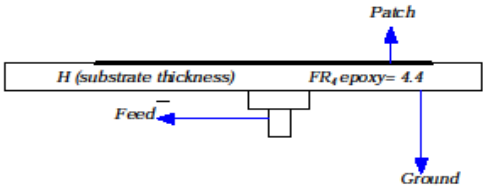
Microstrip patch antennas are prominent transmitting and receiving antennas for wireless communication due to their attractive features, such as compactness, low profile planar structure, light weight, and compatibility with thin film based integrated circuits [1-2]. Considerable problem of patch antenna is its narrower bandwidth operation, which is due to the resonant behavior of the conducting patch. Researchers have proposed various techniques to obtain dual band resonating behavior of patch antennas and for its bandwidth enhancement. Slot and notch loaded microstrip patch antennas for dual band operation in microwave communication are well reported in literature [3-7]. For applications in which the bandwidth enhancement is needed for antenna to operate at two separate sub-bands, an alternative approach to the broadening of total bandwidth is presented in this paper for dual-frequency patch antennas. Dual-band antennas exhibit a dual-resonant behavior in a single radiating patch structure and are reported in literature [8-10]. In this paper a microstrip patch antenna with rectangular slits structure has been designed and analyzed, which is make the structure dual resonating of 594.5 MHz (5.0743–5.6688 GHz) for lower frequency range and 460 MHz (7.0200-7.4800 GHz) for higher frequency range make it suitable for WLAN, WiMAX and other wireless applications .

II. SLIT LOADING

The effect of rectangular slits can be understand by the lumped element circuit equivalent in which inductor equivalent is placed in series with patch lumped equivalent circuit and capacitors are placed in parallel with patch circuit in the transmission line model for the patch antenna. As the slits are moved towards the radiating or non-radiating edges of the patch, in either direction, the resonant frequency rises symmetrically and the bandwidth increases for the desired range.



(a)



(b)

Fig. 1. Structure of the proposed patch antenna, (a) Top view (b) Side view.

III. DESIGN AND SPECIFICATION

The geometric configuration of the designed conductive patch antenna (top view and side view) fabricated on FR4 epoxy substrate having permittivity of 4.4 and loss tangent of 0.02 is shown in Figure 1(a) and 1(b). The dimensions of the epoxy substrate, conducting ground, coaxial probe feed location on the patch with respect to one edge of the patch, conducting rectangular patch structure and two slits made on the patch are shown in table I.

Table I. Dimensions of slits loaded coax probe feed patch antenna.

Parameters	Material and Dimensions (mm)
Substrate material	FR4 Epoxy
Relative permittivity of the substrate (εr)	4.4
Thickness of the dielectric substrate (H)	1.6 mm
Length of substrate and ground (L_1)	50 mm
Width of substrate and ground (W_1)	50 mm
Length of patch (L_2)	38.5 mm
Width of patch (W_2)	28 mm
Length of Slit 1 and Slit 2(L_3= L_4)	18 mm
Thickness of Slit 1 and Slit 2,t	0.5 mm
Feed distance (d) from one edge of antenna	10.25 mm

IV. RESULTS AND DISCUSSION

Proposed antenna is designed, simulated and analyzed by using a HFSS v13. From S-parameter analysis it has been observed that the impedance bandwidth (at -10 dB) of slit loaded dual wideband microstrip patch antenna are 594.5 MHz (5.0743–5.6688 GHz) and 460 MHz (7.0200-7.4800 GHz). Gain of the proposed antenna for lower frequency band and higher frequency band are greater than (>2 dB) and the value of VSWR are less than (<2) for desired operating frequency range. The axial ratio and radiation pattern of the patch antenna represents the linear polarization behavior for lower and upper frequency range. The results in terms of return loss, VSWR, radiation pattern, axial ratio and gain are shown in figures 2, 3, 4, 5 and 6 respectively.

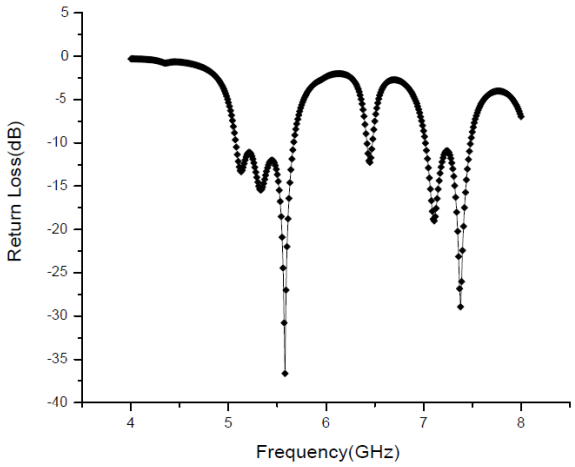


Fig. 2. Return loss of patch antenna.

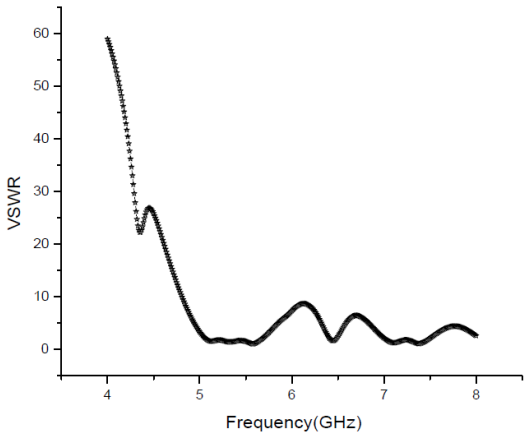
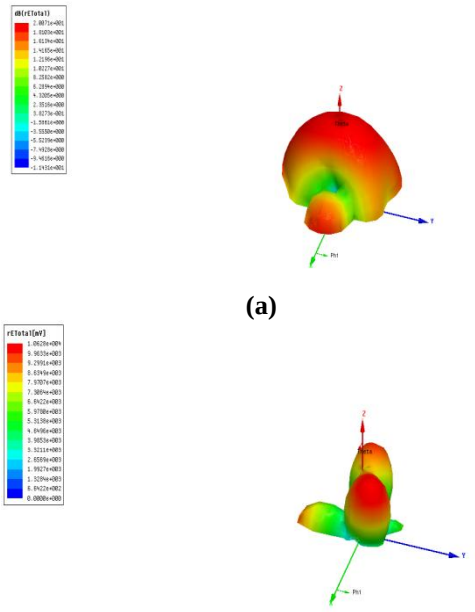


Fig. 3. VSWR of patch antenna.



(a)

(b)

Fig. 4. Radiation Pattern antenna at (a) 5.58 GHz (b) 7.38 GHz.

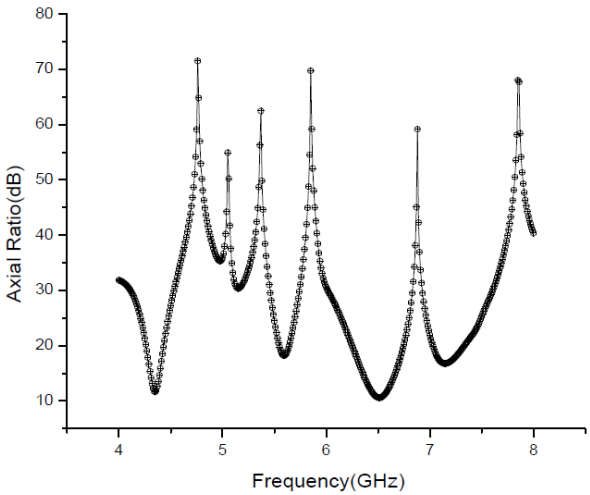


Fig. 5. Axial Ratio of the patch antenna.

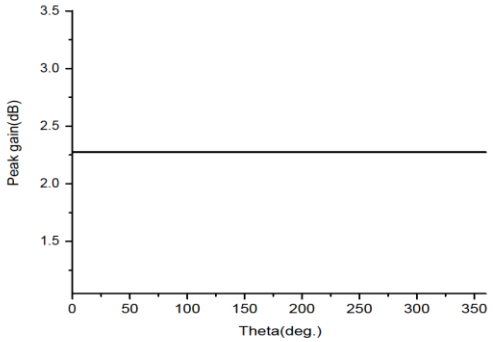


Fig. 6. Peak Gain of the patch antenna.

IV. CONCLUSIONS

A novel design of dual-wideband antenna has been studied that consists of a single layer conducting patch with two narrow rectangular slits close to the radiating edges. The lower operating frequency range of the patch make it suitable for WLAN and WiMAX application for 5.2/5.4/5.5 GHz operation while the upper frequency range can be used for C- band wireless applications. Slit loading provides a tuning over the resonance frequency range as an alternative to enhance the bandwidth of the patch antenna. The simulated results represents the satisfactory patch antenna behavior.

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