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Design And Implementation Of Rectangular Spiral Patch Antenna By Using Coaxial Feed

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Abstract

This paper presents design, simulation, fabrication and measurement of spiral patch antenna in rectangular spiral form by using coaxial feed. Spiral antennas are coming under class of frequency independent antennas. In the fabrication of this antenna FR-4 substrate with relative permittivity 4.4 is used. The parameters like resonant frequency, directivity, VSWR are measured at various frequencies ranging from 2GHz to 9.5 GHz, and the experimental results shows that antenna has better radiation pattern and is capable to operate at various GHz frequencies. These rectangular spiral patch antennas with coaxial feed can be used for Satellite Communications. Simulation has been realized by using Ansoft HFSS software, and Antenna parameters like Reflection coefficient and VSWR are measured using Combinational Analyser.

Keywords: *Hamming code; Encryption; Decryption; EC-reversible logic;*

1. Introduction

By way of speedy growth of contemporary communication a good kind of wireless services are bring in throughout the world now a days. Ultra band (UWB) is one such technology, which guarantees very elevated transmission rates for a really small distance, high capability and less power consumption. Antenna acts a key role in any wireless communication. A finely designed antenna reduces the difficulty and gives better performance at the receiver. The dimension, type and the pattern of the antenna relies on the appliance and the operating frequency. In microstrip patch antennas, 3 types of analysis are determined such as; transmission line model, cavity model, and full wave model[1]. Within the limits of operating frequency range , the antenna must have stable response in of impedance matching, gain, radiation pattern polarization etc. Mean while it must be having the less size, less cost and without difficulty it must be integrated into the RF circuits. Spiral antennas are coming under class of frequency independent antennas [2]. In the fabrication of antenna FR-4 substrate with relative permittivity 4.4 can be used as it is less costly.

2. Antenna Design Procedure

The geometrical configuration of the proposed rectangular spiral shaped patch antenna consists of 3 turns. In every turn the microstrip increases in length regularly. The total length of the turned microstrip is 55.5 cm. FR-4 is used as substrate with a dielectric constant of 4.4. The spiral shaped patch antenna is fed by a coaxial feeding technique as it is depicted in Figures 1(a) and 1(b). The antenna is designed and simulated using Ansoft HFSS. The geometry of the proposed antenna is shown in figures 1(a) and 1(b). The fabricated antenna is shown in the figures 2 and 3

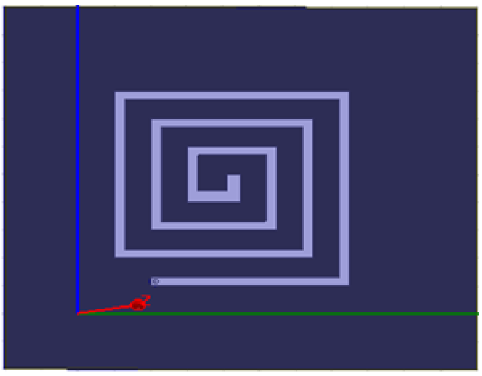

Figure 1(a) Simulated structure of rectangular spiral patch antenna by using coaxial feed (top view)

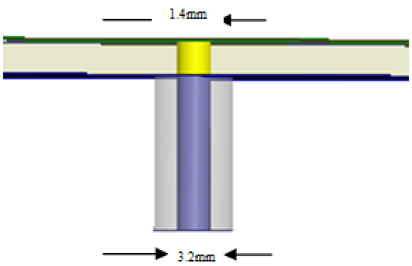

Figure 1(b) Simulated structure of rectangular spiral patch antenna by using coaxial feed (Side View)

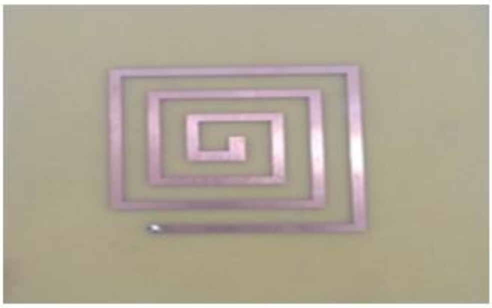

Figure 2: Fabricated rectangular spiral patch antenna by using coaxial feed (front view)

Figure 3: Fabricated rectangular spiral patch antenna by using coaxial feed (side view)

3. Results and Discussion

The antenna parameters like reflection coefficient, resonant frequency, directivity and VSWR are calculated [3-4]. Figure 3.1 is the experimental set up for measuring the antenna characteristics parameters like reflection coefficient and VSWR of recatngular spiral patch antenna by using Coaxial Feed.

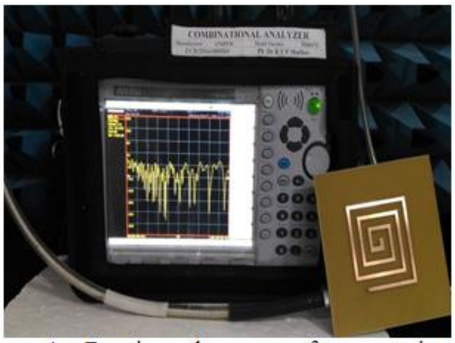

Figure 4: Experimental set up for measuring the characteristics parameters of rectangular spiral patch antenna by using Coaxial Feed

The antenna resonates at multiple frequencies and some of the antenna parameters like reflection coefficient, VSWR and Directivity are calculated at the resonating frequencies [5-6].

The simulated and measured reflection coefficient plots of this antenna are shown in the figures 4.4 and 4.5 respectively. The antenna is resonated at 2 GHz, 2.7 GHz, 3 GHz, 3.2 GHz, 3.7 GHz, 3.9 GHz, 4.2 GHz, 5.2 GHz, 5.5 GHz, 6.4 GHz, 6.8 GHz, 8.2 GHz and 9.5 GHz resonating frequencies, the observed reflection coefficient (S_{11}) at the corresponding resonated frequencies are -10.48 dB, -12.47 dB, -13.69 dB, -14.63 dB, -10.38 dB, -11.49 dB, -17.7 dB, -10.13 dB, -21.29 dB, -10.93 dB, -13 dB, -18.31 dB and -13.88 dB.

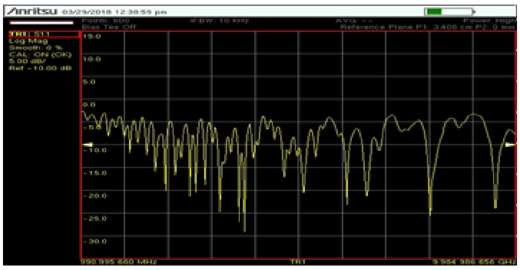

Figure 5: Measured Reflection coefficient of rectangular spiral patch antenna by using Coaxial feed.

The simulated and measured VSWR plots for this antenna are shown in the figures 4.6 and 4.7 respectively. The observed VSWR at the obtained resonating frequencies are 1.8, 1.62, 1.52, 1.45, 1.86, 1.72, 1.29, 1.9, 1.18, 1.79, 1.57, 1.27 and 1.5.

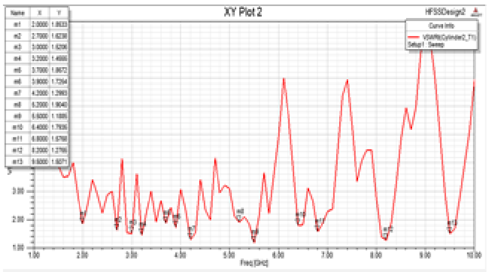

Figure 6: Simulated VSWR of rectangular spiral patch antenna by using Coaxial feed

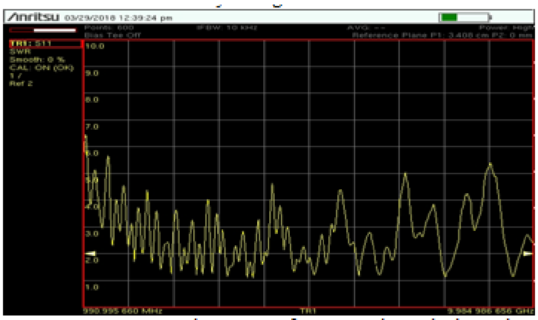

Figure 7: Measured VSWR of rectangular spiral patch antenna by using Coaxial feed

The 3D Directivity polar plots at the antenna resonting frequencies are shown from figures 3.5(a) to 3.5(l) at frequencies 2GHz,3.2GHz, 3,3GHz, 3.7GHz, 3.9GHz, 4.2GHz, 5.2GHz, 5.5GHz, 6.4GHz, 6.8GHz, 8.2GHz, 9.5GHz. respectively and the corresponding directivity values are 6.07 dB, 8.08 dB, 6.54 dB, 9.36 dB, 6.32 dB, 5.79 dB, 9.09 dB, 9.4 dB, 9.55 dB, 6.59 dB, 8.09 dB, 8.14 dB and 7.45 dB respectively.

The radiation pattern describes the behavior of antenna direction and directivity at resonant frequencies [7].

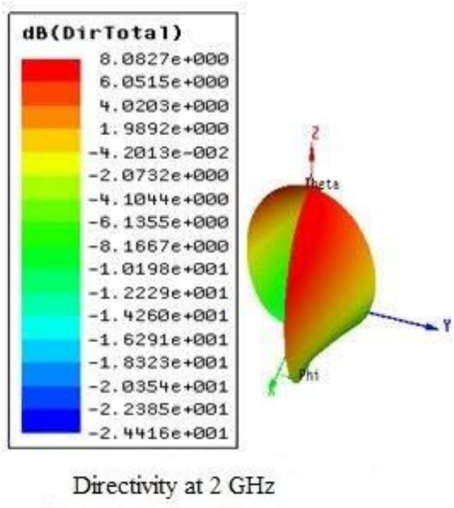

Figure 8(a) Directivity at 2 GHz

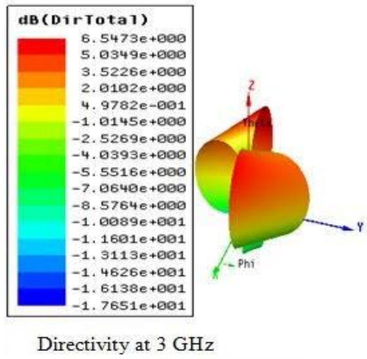

Figure 8(b) Directivity at 3 GHz

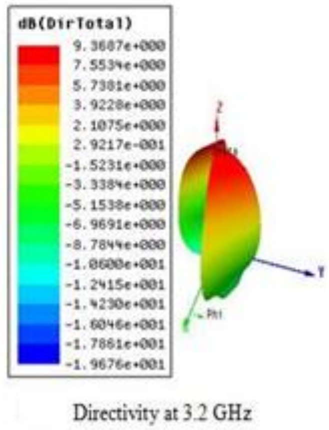

Figure 8(c) Directivity at 3.2 GHz

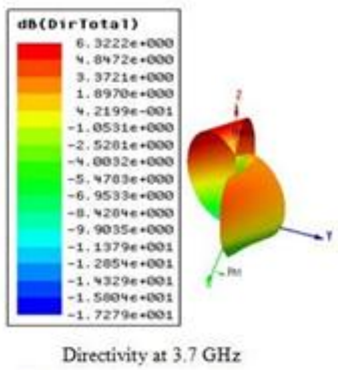

Figure 8(d) Directivity at 3.7 GHz

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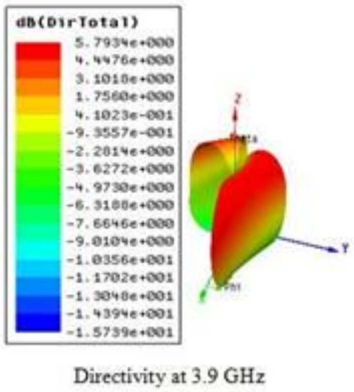

Figure 8(e) Directivity at 3.9 GHz

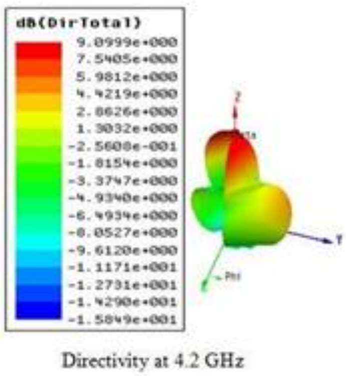

Figure 8(f) Directivity at 4.2 GHz

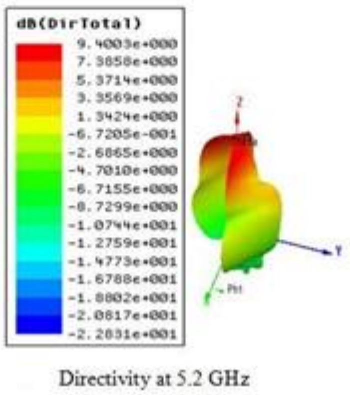

Figure 8(g) Directivity at 5.2 GHz

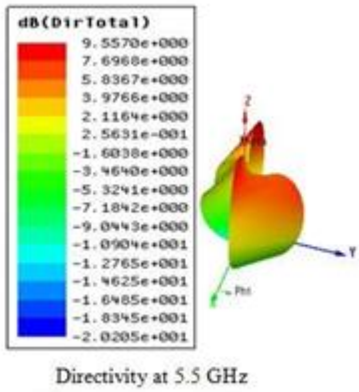

Figure 8(h) Directivity at 5.5 GHz

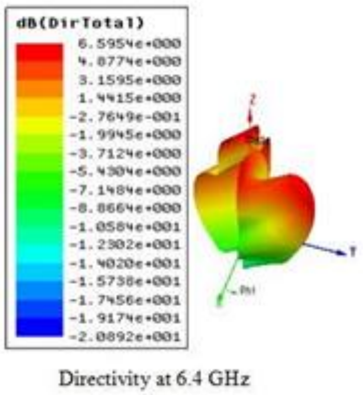

Figure 8(i) Directivity at 6.4 GHz

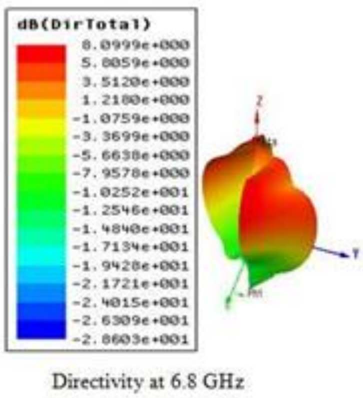

Figure 8(j) Directivity at 6.8 GHz

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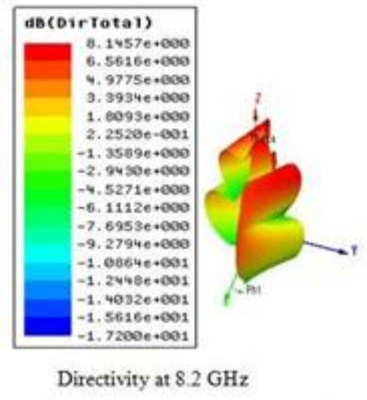

Figure 8(k) Directivity at 8.2 GHz

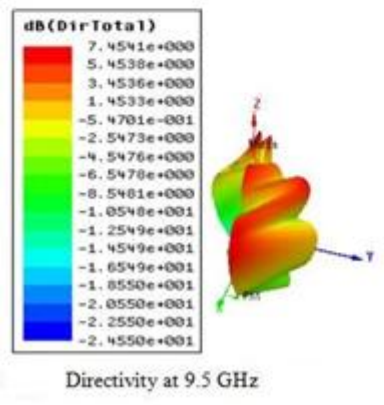

Figure 8(l) Directivity at 9.5 GHz

Figures 8(a) to 8(l) shows directivity at frequencies 2GHz,3.2GHz, 3,3GHz, 3.7GHz, 3.9GHz, 4.2GHz, 5.2GHz, 5.5GHz, 6.4GHz, 6.8GHz, 8.2GHz, 9.5GHz. respectively.

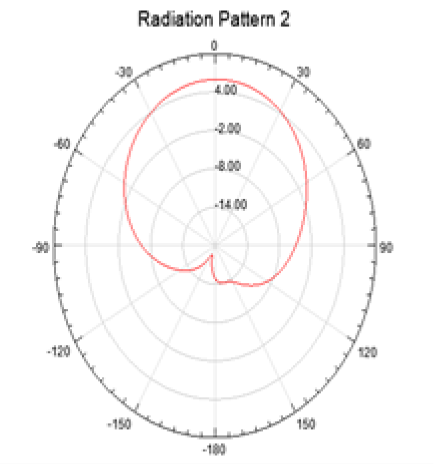

Figure 9(a) Radiation pattern at 2 GHz

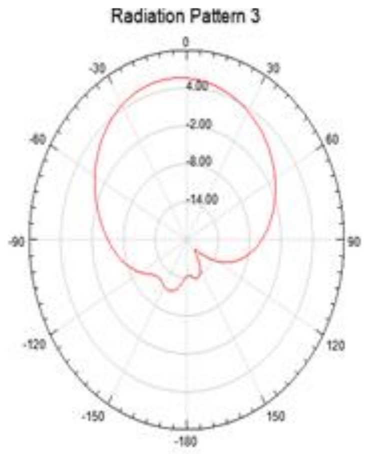

Figure 9(b) Radiation pattern at 2.7GHz.

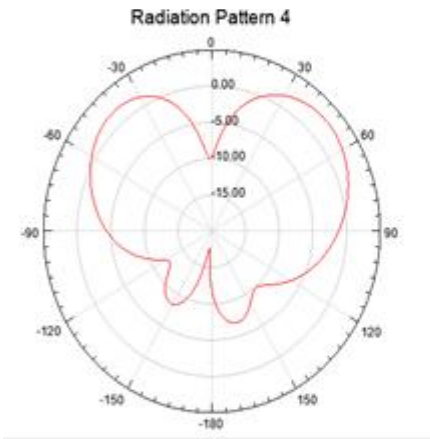

Figure 9(c) Radiation pattern at 3 GHz

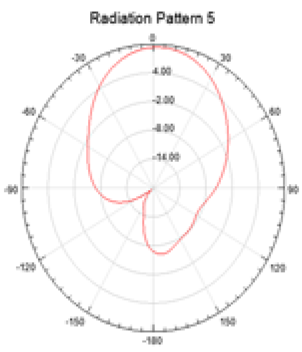

Figure 9(d) Radiation pattern at 3.2 GHz

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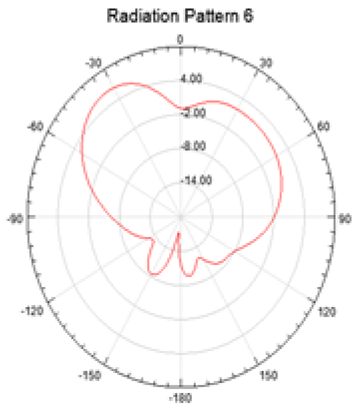

Figure 9(e) Radiation pattern at 3.7 GHz

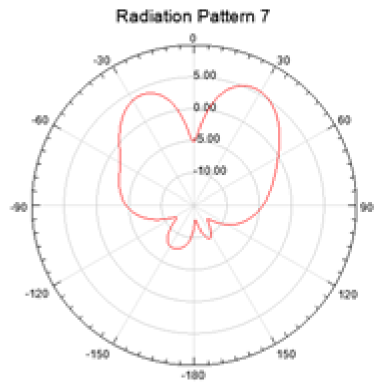

Figure 9(f) Radiation pattern at 3.9 GHz

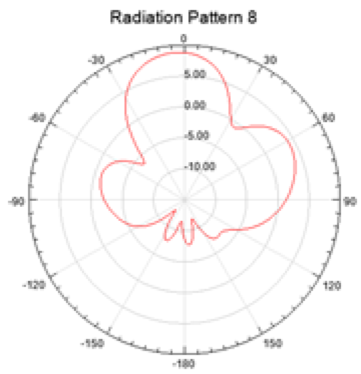

Figure 9(g) Radiation pattern at 4.2 GHz

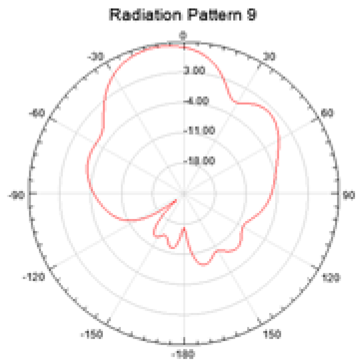

Figure 9(h) Radiation pattern at 5.2 GHz

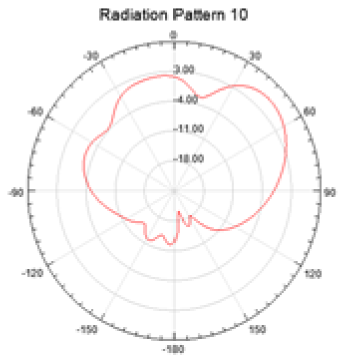

Figure 9(i) Radiation pattern at 5.5 GHz

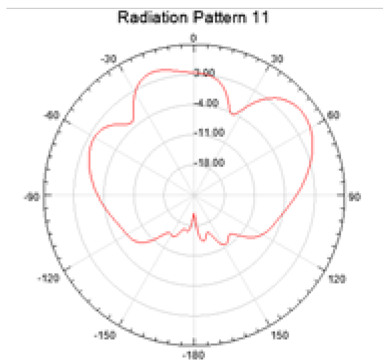

Figure 9(j) Radiation pattern at 6.4GHz

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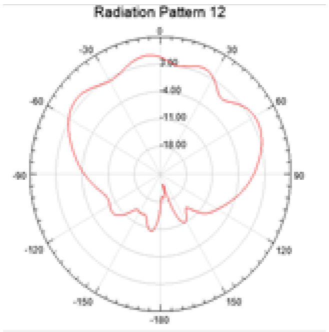

Figure 9(k) Radiation pattern at 6.8 GHz

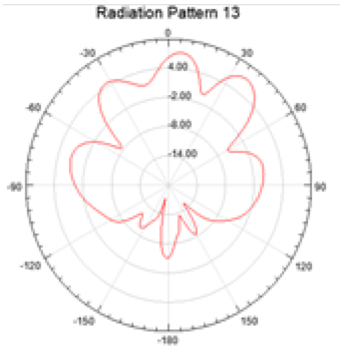

Figure 9(l) Radiation pattern at 8.2 GHz

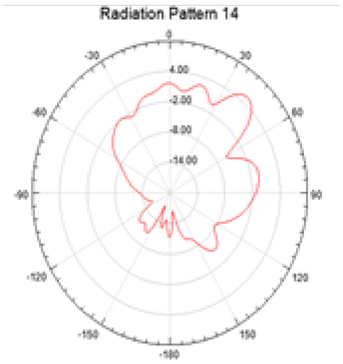

Figure 9(m) Radiation pattern at 9.5 GHz

Figures 9(a) to 9(m) shows the radiation pattern of the rectangular spiral antenna using coaxial feed at 2GHz, 2.7GHz, 3 GHz, 3.2GHz, 3.7GHz, 3.9GHz, 4.2GHz, 5.2GHz, 5.5 GHz, 6.4 GHz, 6.8 GHz, 8.2 GHz, and 9.5 GHz respectively.

Antenna parameters like Reflection coefficient and VSWR are measured using Combinational Analyser. The simulated and measured values are noted and summarized. The fabricated antenna resonates at more number of frequencies than compared with the simulated results. But only the resonant frequencies corresponding to the simulated results are taken into consideration. Both the simulated and measured results at corresponding frequencies are shown in the Table-I.

TABLE-I: SIMULATION AND MEASURED RESULTS OF RECTANGULAR SPIRAL PATCH ANTENNA

Resonant freq. (GHz)		Reflection Coefficient (dB)		VSWR		Simulated Directivity (dB)
Simulated	Measured	Simulated	Measured	Simulated	Measured	
2	1.95	-10.48	-18.5	1.8	1.3	6.07
2.7	2.65	-12.47	-19	1.62	1.3	8.08
3	2.95	-13.69	-17.5	1.52	1.4	6.54
3.2	3.2	-14.63	-23	1.45	1.3	9.36
3.7	3.7	-10.38	-28	1.86	1.2	6.32
3.9	3.9	-11.49	-13	1.72	1.2	5.79
4.2	4.15	-17.7	-10	1.29	1.8	9.09
5.2	5.2	-10.13	-19	1.9	1.3	9.4
5.5	5.5	-21.29	-12	1.18	1.7	9.55
6.4	6.45	-10.93	-20	1.79	1.2	6.59
6.8	6.8	-13	-11	1.57	1.25	8.09
8.2	8.15	-18.31	-25	1.27	1.3	8.14
9.5	9.5	-13.88	-23	1.5	1.35	7.45

Simulated and measured results of Resonant frequency, Reflection Coefficient, VSWR and Simulated Directivity in dB of Rectangular spiral patch antenna using rectangular feed are tabulated in the table-I.

4. Conclusion

From the experimental results it can be concluded that the rectangular spiral patch antenna by using coaxial feed is designed and experimentally verified. From the results it is observed that the controlling parameter has different dimensions like number of turns, width of the turn, space between the turns, shape of the turns and also depends on the type of feeding technique used. The designed antenna resonated at 2 GHz, 2.7 GHz, 3 GHz, 3.2 GHz, 3.7 GHz, 3.9 GHz, 4.2 GHz, 5.2 GHz, 5.5 GHz, 6.4 GHz, 6.8 GHz, 8.2 GHz and 9.5 GHz. The corresponding directivities at these frequencies are 6.07 dB, 8.08 dB, 6.54 dB, 9.36 dB, 6.32 dB, 5.79 dB, 9.09 dB, 9.4 dB, 9.55 dB, 6.59 dB, 8.09 dB, 8.14 dB and 7.45 dB. The developed multibands are useful in various wireless communication systems like GPS, Radionavigation, Space Research , DCS, PCS, ISM and WiMAX.

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