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Design and Estimation of Various Parameters of Rectangular Micro strip Patch Antenna

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ABSTRACT
Micro strip Patch antenna has been widely used in wireless communication applications. As the antenna used in these applications should be low profile, light weight, low volume and wide bandwidth are required. For a good antenna design and performance various other parameters like Return loss, Voltage standing Wave Ratio, Bandwidth and Input Impedance are equally important, so these parameters are discussed in this paper

Keywords—Return loss, VSWR, Bandwidth and Input impedance.

1. INTRODUCTION

A micro strip antenna is characterized by its length, width (W), height (h) and dielectric constant. Length (L) of patch controls the resonant frequency (f) of operation as seen from equation (1.1).In cell phones, compact antennas are required. One technique is to use a substrate with high permittivity(ε_r)as higher value of permittivity allows shrinking of patch antenna.

$$f = \frac{c}{(2L\sqrt{\varepsilon_r}\ )} \qquad (1.1)$$

Decreasing the value of permittivity increases antenna bandwidth from equation (1.2).The efficiency is also increased with low value of permittivity. Height of substrate controls the bandwidth. Increasing the height increases bandwidth (B) as seen from equation (1.2).

$$B \ \alpha \ \frac{(\varepsilon_r - 1)}{\varepsilon_r^2} \frac{W}{L} h \qquad (1.2)$$

For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation
However, such a configuration leads to a larger antenna size. In order to design a compact Microstrip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a compromise must be reached between antenna dimensions and antenna performance

Parameters of Micro strip Patch Antenna

1.1 Return Loss.

Return loss [1] is the reflection of signal power from antenna to the source of power. Mathematically, it is expressed as ratio of reflected power to the transmitted signal power.
Return loss (RL) is calculated using equation given below:

$$RL = 10 \ log \frac{P_r}{P_i} \qquad (1.11)$$

P_i- Power supplied by the source.
P_r - Power reflected by the antenna

If $V_i$is the amplitude of incident wave and $V_r$is the amplitude of the reflected wave then return loss can be expressed in terms of the reflection coefficient as:
RL=$-20 log \|\|$

The reflection coefficient is expressed as given by Equation (1.12)

$$= \frac{V_r}{V_i} \quad (1.12)$$

If =0 dB, then all the power is reflected from the antenna and nothing is radiated. For an antenna to radiate effectively, the reflection coefficient should be less than −10 dB.

1.2 Voltage Standing Wave Ratio.

Voltage standing wave ratio (VSWR), also known as the standing wave ratio (SWR), is used to describe the performance of an antenna [2] when attached to a probe feed (generally a 50ohm feed line). It is a measure of how well the antenna input impedance is matched to the characteristic impedance of the feed. Specifically, the VSWR is the ratio of the maximum to the minimum RF voltage along the feed line MHz).

If the antenna input impedance is equal to the characteristic impedance of the feed line, then the antenna and feed line are said to be matched. It indicates that none of the signal energy sent to the antenna will be reflected from its terminals. In this case, VSWR has a value of one. However, if the antenna and feed line are not matched, then some fraction of the signal energy sent to the antenna is reflected back along the feed line. In this case, the VSWR has a value greater than one. VSWR of 1.5 is considered excellent, while a value of 1.5 to 2.0 is considered good and values higher than 2.0 may be unacceptable.

1.3 Bandwidth.

The bandwidth [3] of an antenna is defined as the range of frequency within which characteristics of antenna have acceptable values. VSWR is a useful and practical way to specify an antenna bandwidth. VSWR bandwidth of antenna is defined as the range of frequency over which it is matched to that of feed line within specified limits. Usually, bandwidth is specified as the range of frequency over which VSWR is less than 2.

For broadband antennas, the bandwidth is usually expressed as the ratio of the upper to lower frequencies of acceptable operation. However, for narrowband antennas, the bandwidth is expressed as a percentage of the bandwidth [4].

1.4 INPUT IMPEDANCE.

Input impedance is defined as the ratio of voltage to current at the connections of the antenna (the point where the feed line is connected). The most efficient coupling of energy between an antenna and its feed line occurs when the characteristic impedance of the feed line and the input impedance of the antenna are same. When this is the case, antenna is considered to be matched to the line. Matching usually requires that the antenna be designed so that it has input impedance of about 50 ohms or 75 ohms to match the common values of available coaxial cable.

2.SIMULATION AND RESULTS

To model and simulate the proposed micro strip patch antenna SONNET 13.52 and MATLAB software have been used. SONNET is an electromagnetic simulator based on the method of moments. It has been widely used in the design of every kind of planar structures like micro strip, strip line or coplanar circuits such as stubs, patch antenna. It can be used to calculate return loss plot, VSWR, current distributions, radiation patterns etc.

Table 2.1 Design Parameter Specifications of Rectangular Microstrip Patch Antenna [5] [6]

Frequency of operation	**3-18 GHz**
Dielectric constant of the substrate	**2.4 (Duroid)**
Loss tangent	**0.0012**
Substrate thickness	**1.578mm**
Feeding method	**Probe feed**
VSWR	**2:1**

3. RESULTS

The particle swarm optimization is used to find the optimal parameters of the rectangular Microstrip Antenna using MATLAB and SONNET 13.52. Table 4.2 depicts the design parameters obtained by earlier work done by [5] [6]. For optimization of design parameters [5] and [6] have used the Particle swarm optimization algorithm for frequency range 3 GHz to 18 GHz. But in this paper result are shown only for frequency 3 GHz and 4 GHz.

Table 3.1 Optimized Design Parameters using PSO [5] [6]

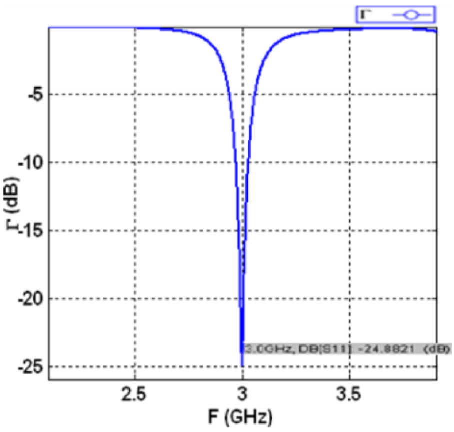
Frequency (In Ghz)	Optimize Patch length (in mm)	Optimize Patch width (in mm)	Probe Offset (in mm)	Return Loss (In db)	Band Width (%)
3	30.5	55.6	8	-17	4
4	23	42	6.5	-21	4.5
5	18	33	5.75	-25	5
6	15	25.1	3.9	-36	6
7	12.5	20.7	3.2	-28	7.8
8	11.1	20	4.3	-29	9
9	9.8	17.5	3.6	-28	10
10	8.65	15	`2.7	-39	12
11	7.85	13	2.2	-44	13.5
12	7.3	12	2.3	-32	14
13	7.2	10.8	2.8	-30	15
14	6.6	8.8	1.8	-35	20
15	6.6	7.6	1.8	-37	22
16	2.6	5.1	0.6	-16	24
17	2.5	4.8	0.58	-42	24.11
18	2.4	4.7	0.1	-23	27.5

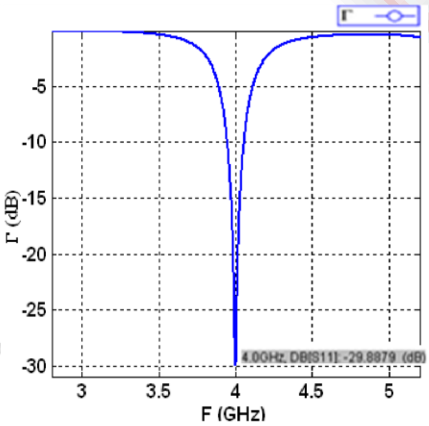
Table 3.2 Optimized Design Parameters using PSO

Frequency (In Ghz)	Optimize Patch length (in mm)	Optimize Patch width (in mm)	Probe Offset (in mm)	Return Loss (In db)	Band Width (%)
3	30.7	40.9	9.5	-24.8	1.9
4	22.7	30.7	6.7	-29.8	2.8
5	18	24.58	4.8	-26	4
6	14.9	20.48	3.45	-29.7	4.8
7	12.8	17.5	2.24	-19	5.8
8	11.03	15.36	2.3	-29.8	6.4
9	9.54	13.66	2.33	-12.05	4.38
10	8.32	12.29	2.2	-7.9	0.001
11	7.36	11.17	1.99	-5.6	0.001
12	6.63	10.24	1.79	-5.08	0.001
13	6.02	9.46	1.67	-4.4	0.001
14	5.52	8.78	1.55	-3.9	0.001
15	5.17	8.19	1.53	-3	0.001
16	5.14	7.68	1.84	-1.3	0.001
17	5.38	7.23	1.87	-1.5	0.001
18	5.34	6.83	2.16	-1.1	0.001

Comparing Table 4.1 with Table 4.2, it is observed that at 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 GHz, area has decreased by 28%, 25%, 20%, 13%, 24%, 24%, 21%, 19%, 22%, 27%, 17% and 16% respectively as compared to earlier design [5][6]. Thus, miniaturized patch design has been obtained for frequency ranging from 3-15 GHz.

4. **RESULT FOR RETURN LOSS**

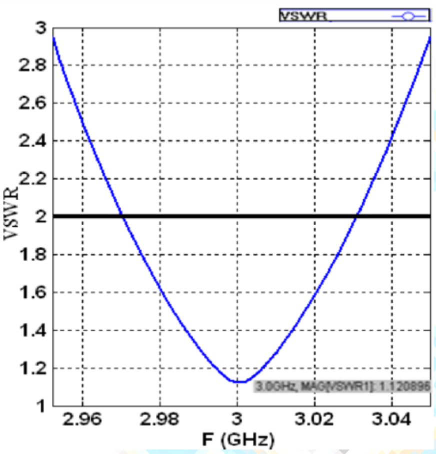




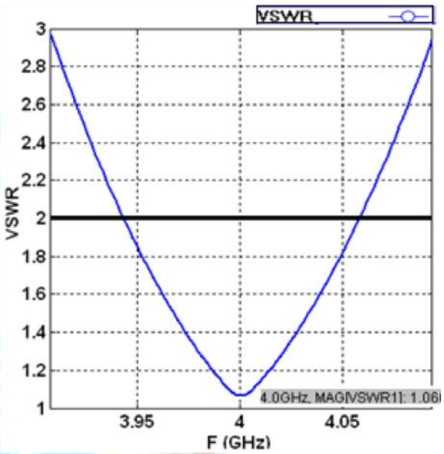
Return loss at 3 GHz **Return loss at 4 GHz**

Return loss plots show that return loss at 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 GHz is -24.8, -29.8, -26, -29.7, -19, -29.8, -12.05, -7.9, -5.6, -5.08, -4.4, -3.9, -3,1.31, -1.5 and -1.1dB respectively. So, for frequency ranging from 3-9 GHz, the return loss is less than -10dB (-10 dB is the acceptable valued return loss).

4.1 **VSWR (VOLTAGE STANDING WAVE RATIO)**



VSWR at 3 GHz

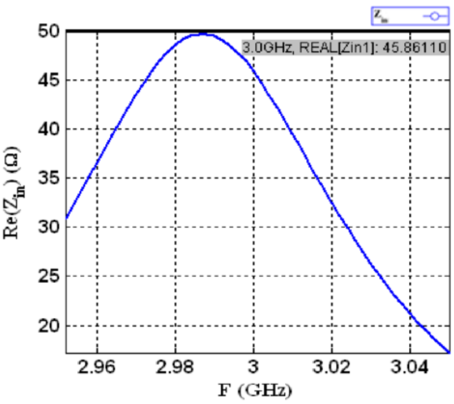


VSWR at 4 GHz

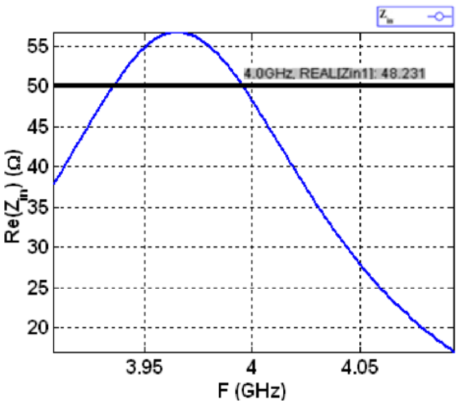
VSWR result for 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 GHz are 1.1, 1, 1.1, 1, 1.2, 1, 1.6, 2.3, 3.1, 3.5, 3. 9, 4.4, 5.8, 13.2, 11.1 and 15.3 respectively. It is seen that VSWR for frequency ranging from 3-9 GHz is lying in the acceptable range

4.2 **INPUT IMPEDANCE**

We expect pure real impedance at frequencies where the patch is designed to radiate. In addition, one needs to match the input resistance with the characteristic impedance of the feed line. The input impedance plot for 3 to 18 GHz patch antenna is shown in Fig



Input impedance at 3 GHz



Input at 4GHz

Input impedance of antenna at 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 GHz are 45.8, 48.2, 52.1, 50.7, 49.4, 50, 49.3, 49.7, 50.2, 48.5, 49.6, 49.4, 45.12, 21.4, 27.7 and 25.7 ohm obtain respectively.

4.5 CONCLUSION

It is concluded that at 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 GHz, area has decreased 28%, 25%, 20%, 13%, 24%, 24%, 21%, 19%, 22%, 27%, 17% and 16% respectively as compared to earlier design [7][6]. Thus, miniaturized patch design is obtained for frequency ranging from 3-15 GHz. Gain is achieved within 5-8dB (typical value of gain for patch antenna) for frequency ranging from 3-15 GHz but VSWR and return loss is acceptable for frequency ranging from 3-9 GHz. So, PSO/SONNET for antenna design is found suitable for frequency ranging from 3-9 GHz which is covering frequencies used for mobile communication systems.

REFERENCES

1. K.D. Prasad, “Antenna and Wave Propagation”, second edition, 1985.
2. C.A. Balanis, “Advanced Engineering Electromagnetics”, John Wiley & sons, New York, 1989.
3. Girish Kumar, K. P. Roy, “Broadband Microstrip Antennas”,Artech House, 2003.
4. Constantine. A. Balanis, “Antenna Theory, Analysis and Design,” John Wiley & Sons, New York, 2005.
5. Malay Gangopadhyaya, Pinaki Mukherjee and Bhaskar Gupta, “Resonant Frequency Optimization of Coaxially Fed rectangular Microstrip Antenna Using Particle Swarm Optimization Algorithm”, Annual IEEE India Conference (INDICON), pp.1-3,2010.
6. Shibaji Chakraborty, Uddipan Mukherjee, “Comparative Study of microstrip patch line feed and coaxial feed antenna design using genetic algorithms”, International Conference on Computer and Communication Technology, pp.203-208, 2011.
7. Shibaji Chakraborty, Uddipan Mukherjee, “Micro-strip antenna optimization using Genetic Algorithms”, International Conference on Computer and Communication Technology, pp.635-640, 2010