Dual band Microstrip Patch Radiator

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Abstract: *A rectangular patch antenna comprised of dielectric FR4 material having effective refractive permittivity of 4.4 and thickness of 1.6 mm is presented. Low cost and low profile antenna resonating at 3.5 GHz and 6.8 GHz frequency working at S band and C band applications is designed.*

Key Words: *Resonator, electrically small antenna, bandwidth, gain.*

1. INTRODUCTION:

Mirostrip patch antenna was first proposed by Deschamps in 1953. Presently, rapid increase of wireless devices for mobile communication, RFID, WLAN and Satellite applications demands surface mountable antennas. In recent of years radio frequency engineers are facing continued challenges of design of small volume, multiband and bandwidth or power efficient low weight and low cost systems designs [1-2]. A low profile small size antenna integrated with sufficient bandwidth is essential in wireless systems [3-8]. Microstrip patch antenna is useful due to its low profile and low fabrication cost and easy to feeding structure. Main drawback of microstrip patch antenna is narrow bandwidth of antenna and relatively large size [9-10].

The demand of a smaller antenna size often conflicts with the desired wide band or dual band, multiband antenna application. Electrically small antenna provides the possible solution and has attracted significant research efforts [11-14]. The antenna resonances with linear polarization; which is typically obtained by rectangular patch antenna comprised of matched feeding. This may be obtained by probe – fed configuration..

Mirostrip antennas are dividing into the four categories [1-2, 15-17]

- Mirostrip Patch antenna
- Mirostrip dipoles
- Printed slot antennas
- Microwave Travelling- wave antennas

Microstrip patch antenna has a very high quality antenna factor (Q), which is the loss associated with antenna, where a large Q will result in a narrow bandwidth and low efficiency [3]. The Q factor can be reduced by increasing the thickness of the dielectric substrate [18-20].
Other problems, such as low gain and the lower bandwidth capacity of capacity can be overcome by using a configuration for the array elements which is a set of similar antennas oriented similarly, to obtain greater directivity and gain in the desired direction. Patch is typically made of a conductive material such as copper or gold [5-6].

2. ANTENNA DESIGN:

Antenna substrate is made up of low cost FR4 material. Planar antenna enjoys the benefit of fabrication through printed circuit board printing technique. The standard FR4 substrate material with thickness of 1.6 mm is selected as it is readily available in market. Design of MSA antenna is presented in figure 1. The probe feeding technique has been utilized for impedance matching.

Fig. 1 Top view of Microstrip patch antenna

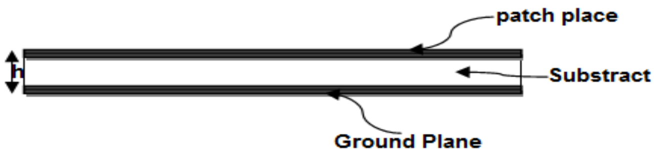

Fig: 2 side view of proposed antenna

Element	Dimensions (mm)
Patch (L)	20.3
Patch (w)	13.3
Height (h)	1.6
Substrate Length	24.2
Substrate Length	16.1

Table 1 Dimensions of Microstrip patch antenna

Typical rectangular microstrip antenna length and width calculation can be given as [3]:
The microstrip patch antenna width can be calculated as:

$$W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

ε_r = substrate dielectric constant
W = width of the patch
h = height of the substrate

$$\Delta L = 0.412h \frac{(\varepsilon_{eff} + 0.3).(\frac{W}{h} + 0.264)}{(\varepsilon_{eff} - 0.258).(\frac{W}{h} + 0.8)} \qquad (2)$$

Since the length was extended ΔL on each side rectangular patch, the effective length is given,

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{eff}}} \qquad (3)$$

$$L = L_{eff} - 2\Delta \qquad (4)$$

Equation 4 incorporates the variations due to fringing fields.

3. RESULTS:

The rectangular patch antenna shown in figure 1 resonates at dual bands. The reflection coefficients are illustrated in figure 3. The reflection coefficient at 3.5 GHz is around -14 db. Impedance bandwidth of 5% was achieved. At 6.8GHz resonance reflection coefficient of around -12 db was achieved. At 6.8 GHz bandwidth of around 2% was achieved. Figure 4 and 5 illustrates E-plane and H-plane radiation patterns.

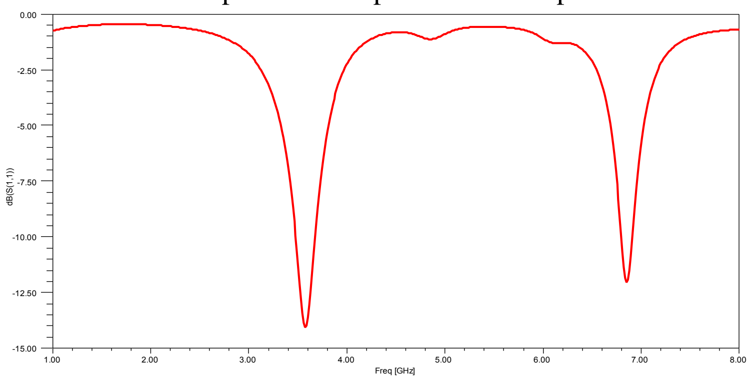

Fig 3: Radiation pattern of the antenna

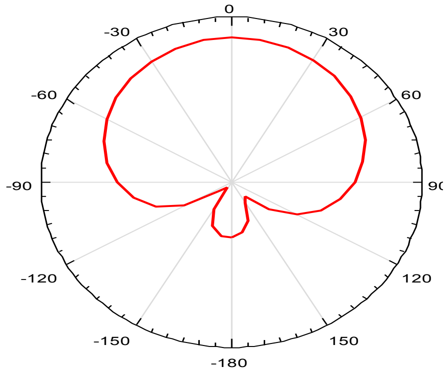

Fig 4(a) : E-plane Pattern at 3.5 GHz

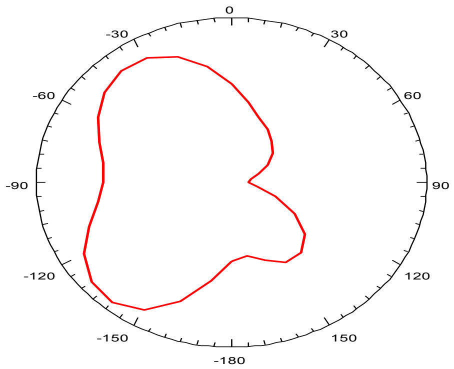

Fig 4(b) : E-plane Pattern at 6.8 GHz

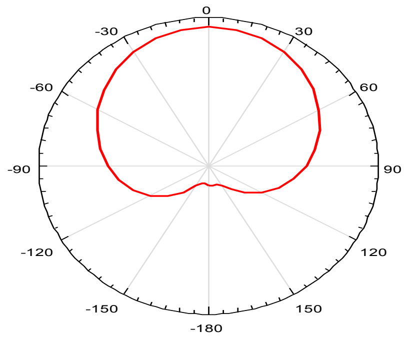

Fig 5(a): H-plane Pattern at 3.5 GHz

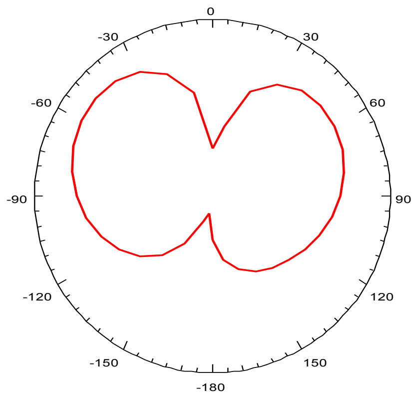

Fig 5(b): H –plane Pattern at 6.8 GHz

4. CONCLUSION:

Dual band planar resonator is presented. Patch antenna suffers from low bandwidth. Due to utilization of low cost FR4 substrate gain of antenna is significantly suffered. Antenna can be utilized for S and C band band wireless communications.

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