Effects of dielectric substrate material microstrip antenna for limited band applications

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Abstract. In this paper, an analysis of dual frequency resonance antenna is achieved by OM-shape microstrip patch antenna. The proposed antenna is analyzed using IE3D simulation software. The analysis of proposed structure is done by varying the dielectric constants and height of the substrate as well as gain and radiation pattern of the antenna is obtained. It observed that on varying the dielectric substrate the effect on proposed antenna is very effective.

1. Introduction
With the rapid development of micro electronics devices and the wireless communication equipment has led the way toward miniaturization, broadband and multifunction. This increasing demands of wireless communication system show that the communication terminal antennas are required to be compatible with multiband operation and satisfactory coverage of the required frequency band. A number of designs have been reported focusing on multiband small antennas in which various experimental techniques were utilized [1-6]. These reported papers are fabricated on different dielectric materials. Thus, it is desirable to understand behavior of dielectric material for microstrip patch antenna. There few researchers paper have been reported on these features of microstrip patch antenna such as L-shaped multi-band patch antenna on a polymer [7], compact square loop patch antenna on high dielectric [8]. Compact notch loaded half disk patch antenna for dualband operation [9], F-shape microstrip line fed dualband antenna for WLAN applications [10-12]. In these papers, they have shown the variation of dielectric substrate as well as for height of dielectric substrate but these papers are focus on microstrip patch not on material or substrate used.

In this paper, novel microstrip patch antenna is design to study the behavior of dielectric substrate and height of the substrate on the proposed microstrip patch. The complete design of antenna, discussion of results and conclusion are discussed in next sections.

2. Antenna Radiating Geometry
The proposed antenna is designed as a combination angular ring is shown in Figure 1. The antenna structure can be analysis in three parts. The first section is of semi angular ring with rectangular strip, second and third section is of semi- angular ring attached with at one end and at that attached end quarter angular ring is also attached whereas on another end of both the sections a rectangular
microstrip is attached. The complete description of antenna design is given Table 1. The current distribution is shown Figure 2 at 7.12 GHz of the proposed geometry.

**Figure 1.** Proposed antenna geometry.

**Figure 2.** Current distribution of proposed geometry.

**Table 1.** Design Specification of proposed antenna

| Antenna dimensions                           |       |
|---------------------------------------------|-------|
| Outer radius of angular ring $R_1$ (Section I-III) | 7 mm  |
| Inner radius of angular ring $R_2$ (Section I-III) | 5 mm  |
| Length of microstrip of section I($L_2$)    | 5 mm  |
| Width of microstrip of section I($W_2$)     | 1 mm  |
| Length of microstrip of section II($L_1$)   | 2.5 mm|
| Width of microstrip of section II($W_1$)    | 0.5 mm|
| Length of microstrip of section II($L_3$)   | 5 mm  |
| Height of the dielectric substrate          | 1.6 mm|
| Feeding point ($x,y$)                       | (1, 8)|
| Relative permittivity of the substrate ($\varepsilon_\text{r}$) | 1.07  |
3. Discussion & Results

The simulated result of proposed antenna is shown in Fig 3. It is observed that, the bandwidth of proposed antenna is 114 MHz at 7.12 GHz. This antenna has been simulated on IE3D. Antenna can be utilized for satellite communication and armature radio.

From Fig. 4, it is observed that on increase the dielectric constant of the antenna from 1.07 to 4.7 bandwidth shifts toward left side as well as multi band is obtained at 4.7. It is observed that antenna has given good result at 7.12 GHz below 10 dB i.e. air as dielectric constant. Further, it is observed that antenna has given multi band for Bakelite, RT Duroid and Glass epoxy.

Figure 3. Simulated result of frequency versus return loss (dB) of proposed antenna
From Figure 5 it is observed that on decreasing height from 1.6 mm to 0.1 mm single band behavior vanishes and dual band obtained. This happens due to the dielectric behavior of the antenna as dielectric constant changes the its total input impedance of antenna varies. Similarly, when height is changed capacitance developed across the antenna start varying which in turn varies the behavior of antenna. Figure 6 shows the gain of the antenna it is observed that it gain is 6.1 dBi and
Figure 6. Gain of the proposed antenna.

Figure 7 shows the radiation pattern for $E_{\theta}$ and $E_{\phi}$. It is observed that antenna has 60˚ 3 dB beam width at $E_{\theta}$ plane in broadside direction while 23˚ two beam are observed at $E_{\phi}$ plane.

Figure 7. Radiation pattern at 7.025 GHz.
4. Conclusion

From the above analysis it is inferred that the frequency ratio of the antenna depends on the height of the substrate H and dielectric constant. The gain of antenna is obtained to 6.1 dBi. The proposed antenna can be utilized for 7.12 GHz having bandwidth 114 MHz this band can be for satellite communication and armature radio.

5. References

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