A COMPARATIVE STUDY OF VARIOUS PATCH ANTENNAS FOR WLAN APPLICATIONS

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ABSTRACT

In this communication a comparative study is carried out on various microstrip patch antennas for single band operation. The proposed antennas are constructed with a volume of 80 X 50 X 1.6 mm\(^3\). The simple commercially available glass epoxy substrate material is used to fabricate the antennas. The microstripline feed arrangement is employed to excite the patches. These antennas show linearly polarized broadside radiation characteristics. The design detail of the antennas is described. The experimental results are presented and compared. These antennas may find applications in WLAN.

Key words: Square Patch, Circular Patch, Equilateral Triangular Patch.

1. INTRODUCTION

The microstrip antennas have become good candidates for transmission and reception purpose in modern communication application like WLAN, WiMax and 3G - 4G mobile communication systems, because of their numerous inherent advantages like low profile, low fabrication cost, integrability with MMICs, ruggedness and ease of installation [1]. The broadband antennas are realized by many methods such as, slot on the patch [2-4] etc. But in this paper a comparative study is carried out to on square, circular and triangular patch antennas to suit for a particular application. This kind of study is found to be rare in the literature.

2. ANTENNA DESIGN

The low cost glass epoxy substrate material of thickness h = 0.16 cm, loss tangent = 0.01 and \(\varepsilon_r = 4.2\) is used to fabricate the square, circular and equilateral triangular microstrip patch antennas. The artwork of proposed antennas is sketched using the computer software AUTO CAD to achieve better accuracy. The antennas are etched using the photolithography process.
Figure 1: Top view geometry of SMSA, CMSA and ETMSA.

Figure 1 shows the top view geometries of square microstrip antenna [SMSA: Fig. 1(a)], circular microstrip antenna [CMSA: Fig. 1(b)] and equilateral triangular microstrip antenna [ETMSA: Fig. 1(c)]. The SMSA has radiating patch of equal length (L) and width (W), CMSA has radiating patch of radius R and ETMSA has a radiating patch of side S. All the antennas are designed for the resonant frequency of 3.5 GHz, using the basic equations available in the literature [1, 2, 5]. A quarter wave transformer of length $L_t$ and width $W_t$ is used between the lower edge of the patch and microstripline feed of length $L_f$ and width $W_f$ for matching their impedances. A semi miniature-A (SMA) connector of 50Ω impedance is used at the tip of the microstripline to supply the microwave power. Table 1 gives the design parameters of SMSA, CMSA and ETMSA.

Table 1: Design parameters of SMSA, CMSA and ETMSA.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>L</th>
<th>W</th>
<th>$L_f$</th>
<th>$W_f$</th>
<th>$L_t$</th>
<th>$W_t$</th>
<th>A</th>
<th>B</th>
<th>S</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMSA</td>
<td>2.04</td>
<td>2.04</td>
<td>2.18</td>
<td>0.32</td>
<td>1.09</td>
<td>0.06</td>
<td>5</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CMSA</td>
<td>-</td>
<td>-</td>
<td>2.18</td>
<td>0.32</td>
<td>1.097</td>
<td>0.07</td>
<td>5</td>
<td>8</td>
<td>-</td>
<td>1.227</td>
</tr>
<tr>
<td>ETMSA</td>
<td>-</td>
<td>-</td>
<td>2.135</td>
<td>0.31</td>
<td>1.71</td>
<td>0.05</td>
<td>5</td>
<td>8</td>
<td>2.82</td>
<td>-</td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSION

Vector Network Analyzer (The Agilent N5230A: A.06.04.32) is used to measure the experimental return loss of SMSA, CMSA and ETMSA.

Figure 2: Variation of return loss versus frequency of SMSA, CMSA and ETMSA.
Figure 2 shows the variation of return loss versus frequency of SMSA, CMSA and ETMSA. The experimental bandwidth of SMSA, CMSA and ETMSA is calculated by the formula,

\[
\text{Bandwidth (\%) } = \frac{f_2 - f_1}{f_c} \times 100
\]

where, \( f_2 \) and \( f_1 \) are the upper and lower cut off frequencies of the resonated band when its return loss reaches -10dB and \( f_c \) is a centre frequency between \( f_1 \) and \( f_2 \).

The figures 3 to 5 show the far field radiation patterns of SMSA, CMSA and ETMSA measured in their operating bands. It clear from these figures that all the three antennas show the broad side and linearly polarized radiation characteristics.
The gain of the proposed antennas is calculated using absolute gain method given by the relation,

$$G (\text{dB}) = 10 \log \left( \frac{P_t}{P_r} \right) \cdot (\text{Gt}) \text{ dB} - 20 \log \left( \frac{\lambda_0}{4\pi R} \right) \text{ dB}$$

where, $P_t$ and $P_r$ are transmitted and received powers respectively. R is the distance between transmitting antenna and antenna under test.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>Designed Frequency</th>
<th>Resonating Frequency</th>
<th>Bandwidth (%)</th>
<th>Gain (dB)</th>
<th>HPBW (Degrees)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMSA</td>
<td>3.5 GHz</td>
<td>3.43GHz</td>
<td>2.94</td>
<td>0.8</td>
<td>59</td>
<td>WLAN and S-band</td>
</tr>
<tr>
<td>CMSA</td>
<td>3.5 GHz</td>
<td>3.1GHz</td>
<td>3.0%</td>
<td>0.91</td>
<td>57</td>
<td>WLAN and S-band</td>
</tr>
<tr>
<td>ETMSA</td>
<td>3.5 GHz</td>
<td>3.3GHz</td>
<td>1.8</td>
<td>0.72</td>
<td>56</td>
<td>WLAN and S-band</td>
</tr>
</tbody>
</table>

4. CONCLUSION

From this study it is concluded that, the comparative data of the antennas help the antenna designer to choose the suitable antenna for particular applications. All the antennas exhibits broadside radiation characteristics. The proposed antennas use low cost substrate material with simple design and fabrication. These antennas may find applications in WLAN.

REFERENCES

BIO-DATA

Dr. Nagraj K. Kulkarni received his M.Sc, M.Phil and Ph. D degree in Applied Electronics from Gulbarga University Gulbarga in the year 1995, 1996 and 2014 respectively. He is working as an Assistant professor and Head, in the Department of Electronics Government Degree College Gulbarga. He is an active researcher in the field of Microwave Electronics.