Abstract— In this paper, Rectangular microstrip antenna (RMSA) is designed by creating three V-shaped slots operating at the resonant frequency 12.79 GHz. The patch is designed having thickness of 1.1 mm and dielectric constant of 2.4 yielding bandwidth of 900 MHz. Antenna Efficiency achieved is 84%. Direct broadcast satellite is a term used to refer to satellite television broadcast intended for home reception. DBS uses the upper portion of Ku band which ranges from 12 – 18 GHz. The analysis is done using the Zealand IE3D software based on method of moment.

Index Terms—Direct Broadcast System (DBS), IE3D simulator, Microstrip antenna, Patch length.

I. INTRODUCTION

A patch antenna is a type of radio antenna with a low profile, which can be mounted on a flat surface. Microstrip antennas consist of very thin patch placed at small fraction of a wavelength above the ground plane. The patch and ground plane are separated by dielectric sheet [1]. The specialty about these antennas is that they can be easily fabricated, light in weight, low cost, small in size [2]. Nowadays, microstrip patch antennas are becoming useful because they can be printed directly onto the circuit board. In this paper, analysis of microstrip antenna is done using Transmission –line model. Transmission –line model is the easiest of all, its gives god physical insight [1]. Microstrip antennas are widely used for wireless applications. Ku-band (12-18 GHz) is used for most satellite communication systems particularly satellite TV; Broadcasting Satellite (BSS); Fixed Satellite Systems (FSS); Direct Broadcast Satellite (DBS) [3]; VSAT system; Marine communication [4]. The Ku band is also used for high resolution mapping and satellite altimetry. The most important use of the Ku Band is tracking the satellite within the ranges roughly from 12.87 GHz to 14.43 GHz [5]. In this paper the microstrip patch antenna is designed for use in a DBS at 14 GHz. With its higher power and superior video and audio quality, Direct Broadcast Satellite (DBS) communications is proliferating worldwide. Many new DBS Systems are evolving and with the introduction of HDTV, DBS technology is predicted to become even more prevalent.

Design Parameters for the microstrip antenna: The return loss is at 12.79 GHz frequency. Bandwidth is 900 MHz. This design of three V-shaped patch antenna is having dielectric constant of 2.4 and center frequency of 12.79 GHz. VSWR is 1.2.

II. MATHEMATICAL ANALYSIS

To design a rectangular microstrip patch antenna following parameters such as dielectric constant ($\varepsilon_r$), resonant frequency ($f_0$), and height of the substrate (h) should be considered for calculating the length and the width of the patch [6].

Width of patch (w):

$$W = \frac{C}{2f_0\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

Effective dielectric constant of antenna:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{\frac{2}{\varepsilon_r - 1} + \sqrt{\frac{1}{1 + \frac{12h}{W}}}}$$

Effective dielectric length of antenna:
\[ L_{\text{eff}} = \frac{C}{2 f_0 \sqrt{\varepsilon_{\text{eff}}}} \]

The extended length of antenna (\( \Delta L \)):

\[ \Delta L = 0.421 h \left[ \left( \varepsilon_{\text{eff}} + 0.3 \right) \left( \frac{w}{h} + 0.264 \right) - \left( \varepsilon_{\text{eff}} - 0.258 \right) \left( \frac{w}{h} + 0.8 \right) \right] \]

The length is:

\[ L = L_{\text{eff}} - 2 \Delta L \]

### III. ANTENNA DESIGN

The antenna design shown in fig. 1 has three v shape rectangular microstrip patch antenna with the following dimensions: length=6.9832 mm, width =8.2174 mm and they are cut into the slots \( w_1=1 \) mm, \( w_2=1 \) mm.

The proposed antenna has:
- Patch length=6.9832 mm.
- Patch width=8.2174 mm.
- Cut width \( w_1=1 \) mm.

The proposed antenna simulated using IE3D simulator is best operated at frequencies 12.79 GHz.

### IV. RESULT AND DISCUSSION

The microstrip patch antenna is designed with center frequency 12.79 GHz; dielectric constant of 2.4 and thickness 1.1 mm. This antenna is simulated in IE3D Zealand software.

![Fig 2: V- shaped Microstrip Patch Antenna with feed](image)

![TABLE I: OPTIMISED ANTENNA PARAMETERS](image)

<table>
<thead>
<tr>
<th>ANENNA PARAMETERS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESONANT FREQUENCY</td>
<td>12.79 GHz</td>
</tr>
<tr>
<td>DIELECTRIC CONSTANT</td>
<td>2.4</td>
</tr>
<tr>
<td>THICKNESS(H)</td>
<td>1 mm</td>
</tr>
<tr>
<td>LENGTH(L)</td>
<td>6.9832 mm</td>
</tr>
<tr>
<td>WIDTH(W)</td>
<td>8.2174 mm</td>
</tr>
<tr>
<td>CUT WIDTH(W1)</td>
<td>1 mm</td>
</tr>
</tbody>
</table>

Return loss at 12.79 GHz = -20.65 dB.

2. **Return Loss:**

Return loss curve is shown in fig. 4 with the return loss of -20.65 dB at 12.79 GHz.

3. **VSWR:**

Fig. 5 Shows the VSWR value of 1.2 at frequency of 12.79. The VSWR value of microstrip antenna is between 1 and 2.

![Fig 3: Smith Chart of proposed antenna](image)

![Fig 4: Return Loss v/s Frequency](image)

![Fig 5: VSWR Vs Frequency for Proposed Antenna](image)

VSWR=1.2 at frequency 12.79 GHz.
4. **Axial Ratio:**

![Fig 6: Axial Ratio Vs Frequency of Proposed Antenna](image)

Axial Ratio at 12.79 GHz = 1.6 dB.

5. **RADIATION PATTERNS:**

**A. Elevation Pattern:**

![Fig 7: Elevation Pattern](image)

**B. Azimuth Pattern:**

![Fig 8: Azimuth Angle](image)

**V. CONCLUSION**

The research motivation of this paper is to design RMSA by creating 3 V-shaped slots for Direct Broadcast Satellite operating at resonant frequency 12.79 GHz. The proposed antenna provides the wide bandwidth of 900 MHz along with antenna efficiency of 84%. The axial ratio and VSWR of proposed antenna is 1.6 dB and 1.2. The antenna has been designed and simulated using IE3D software. Thus the proposed microstrip patch antenna is suitable for implementing it in the Direct Broadcast Satellite. Proposed Antenna is expected to have great potential usage in DBS system.

**REFERENCES**


