Self Complementary Rectangular Microstrip Antenna for Modern Communication Systems

Malipatil Shivashankar A1 and Nagraj Kulkarni2
1Assistant Professor in Electronics, Sharanbasweshwar College of Sc., Kalaburgi, Karnataka, India
2Assistant Professor in Electronics, Government College, Kalaburgi, Karnataka, India
Principal Author e-mail: malipatilsa@rediffmail.com

Abstract: In this paper the self complementary rectangular microstrip slot antenna is presented for modern communication system. The antenna is housed in a volume of 5X3X0.16cm³. The low cost modified glass epoxy substrate material is used for the fabrication of the antenna. The design concept is presented. The proposed antenna gives a maximum bandwidth of 23.36 GHz. The antenna shows broadside and linear radiation characteristics with a peak gain of 4.2dB in its operating range of frequency. The experimental and simulated results are compared. This antenna may find its applications in X-band range communication systems.

Key Words: Rectangular, bandwidth, gain, radiation pattern.

1. Introduction

In recent era the use of microstrip antenna in communication system has increased because of its inherent properties like light weight, loss cost, ease of installation, planar in configuration, etc. In modern communication systems the microstrip antenna has proved a good tool for effective communication. The use of dual, triple and multiband antennas are finding the wide applications in communication application for transmit/receive purposes(1-5). The antenna with radiating slots on the patch is designed to achieve dual and triple bands with better radiation characteristics. This kind of antenna is rarely found in the literature.

2. Design considerations

The AUTOCAD software is used to do the artwork of self complementary rectangular microstrip slot antenna (SCRMSA). The low cost modified glass epoxy substrate material of relative permittivity \( \varepsilon_r = 4.2 \) and loss tangent of 0.01 is used for the fabrication of the antenna. The antenna operates in X-band frequency range. The antenna uses a substrate of length \( L = 5 \) cm and width \( W = 3 \) cm. The horizontal slots of length \( L_s = 1.6 \) cm and width \( W_s = 0.2 \) cm are used on the top of the antenna. The microstripline feed of length \( L_f = 4.69 \) cm and width \( W_f = 0.9535 \) cm is used on the bottom side for exciting the antenna. The distance \( d \) and \( d' \) is maintained constant at 0.575 cm and 0.89 cm respectively to obtain better return loss. The separation between the slots is taken as \( D \) which act as the varying factor for the performance evaluation of the antenna. Figure -1 shows the structure of the SCRMSA.
Figure 1: Structure of SCRMSA

Figure 2: Variation of Return loss versus Frequency of SCRMSA when D=0.2cm
3. Result and Discussion

The Vector Network Analyser is used to measure the return loss and the Smith chart of the antenna. The HFSS software is used to simulate the SCRMSA.

From figure-2 it is clear that the antenna shows two resonant modes \( f_1 \) and \( f_2 \) with respective bandwidths \( BW_1 = 5.91\% \) \((8.8 \text{ GHz} - 8.29 \text{ GHz})\) \( BW_2 = 20.29\% \) \((12 \text{ GHz} - 9.79 \text{ GHz})\). The minimum reflection coefficient at both the resonance is found to be -17.028 and -26.722 dB respectively.

Figure-3 Variation of Return loss versus Frequency of SCRMSA when \( D=0.4\text{cm} \)

Figure-3 Shows the variation of return loss with frequency. It is clear from this figure that, the antenna shows three resonant modes \( f_3 \), \( f_4 \) and \( f_5 \) with respective bandwidths \( BW_3 = 2.36\% \) \((8.67 \text{ GHz} - 8.27 \text{ GHz})\), \( BW_4 = 7.51\% \) \((10.46 \text{ GHz} - 9.77 \text{ GHz})\) and \( BW_5 = 9.79\% \) \((12 \text{ GHz} - 11.15 \text{ GHz})\). The minimum reflection coefficient at each resonance is found to be -28.810, -16.738 and -15.767 dB respectively.

Figure-4 Variation of Return loss versus Frequency of SCRMSA when \( D=0.6\text{cm} \)

From figure-4 it is clear that, the antenna exhibits two resonant modes \( f_6 \) and \( f_7 \) with respective bandwidths \( BW_6 = 5.1\% \) \((8.65 \text{ GHz} - 8.22 \text{ GHz})\) and \( BW_7 = 23.36\% \) \((12 \text{ GHz} - 9.52 \text{ GHz})\). The minimum reflection coefficient at both the resonance is found to be -17.028 and -26.722 dB respectively. The minimum reflection coefficient at both the resonance is found to be -17.041 and -34.543 dB respectively.
Figure-5 Radiation pattern of SCRMSA(D=0.2 cm)  
Figure-6 Radiation pattern of SCRMSA(D=0.4 cm)  
Figure-7 Radiation pattern of SCRMSA(D=0.6 cm)  
Figure-8 Smith Chart typical antenna  
Figure-9 Experimental and Simulated results
Figures 5 to 7 show the radiation patterns of the proposed antenna in their operating frequencies it can be seen that, the patterns are broadside and linearly polarised with no side and back lobes. Figure – 8 shows the Smith chart of the typical antenna. From this figure it is clear that, the circles are concentrated at the centre of the graph which indicates the good impedance matching of the antenna. It is seen from Figure -9 that the experimental and simulated results are in good agreement with each other. Figure 10 shows the photograph of the SCRMSA.

4. Conclusion:
The proposed antennas are light weight and handy in nature. These antennas exhibit broadside and linearly polarised radiation patterns. The antenna operates in X-band of frequencies. The maximum bandwidth of 23.36 GHz and over all bandwidth of 74.32 GHz is obtained which is very useful in SAR and X-band communication systems.

References