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Two Element Slit loaded Rectangular Microstrip Array Antenna

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Abstract: The new design of two element slit loaded rectangular microstrip array antenna is presented for tripleband and high gain operations. The antenna is housed in a volume of 9 X 5 X 0.16 cm^3 and operates between the frequency range of 5.3 to 9.8 GHz giving a maximum impedance bandwidth of 17 % with a peak gain of 5.21 dB. The microstripline feeding technique with efficient power dividers are used to energize the antenna. The low cost modified glass epoxy substrate material is used to fabricate the antenna. The antenna shows linearly polarized broadside radiation characteristics. The design detail of the antenna is described. The experimental results are presented and discussed. This antenna may find applications for systems operating in WLAN and lower X-band frequencies.

Key words: microstrip antenna array, gain triple band.

1. INTRODUCTION

Microstrip antennas have the attractive features of low profile, light weight, easy fabrication process, and conformability, but these antennas inherently suffer from the narrow bandwidth. Today the world is going wireless and modern advancements in communication technology and significant growth in the wireless communication, the smaller and reliable antennas is the need of the hour. In the present communication systems, the microstrip antennas and arrays have found numerous applications in over a wide range of frequencies because of their numerous advantages like ease of manufacturing, low cost, compact size, and ease of integration with various planar circuit technologies[1]. In this study a simple two element slit loaded rectangular microstrip antenna is presented for triple band and high gain operations. This kind of antenna is found to be rare in the literature.

2. ANTENNA DESIGN

The low cost modified glass epoxy substrate material of thickness h = 0.16 cm and $\varepsilon_r = 4.2$ is used to fabricate the two element slit loaded rectangular microstrip array antenna (TESLRMSAA). The art work of proposed antennas is sketched using AUTOCAD-2007 software to achieve better accuracy. The antennas are etched using the photolithography process.

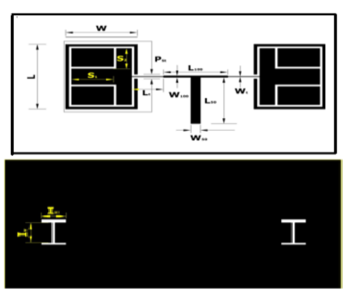

Figure -1: Geometry of TESLRMSAA.

Figure 1 shows the geometry of TESLRMSAA. The antenna has the radiating patch designed for the resonant frequency of 3.5 GHz, using the basic equations available in the literature [2-3]. A quarter wave transformer of length L_t and width W_t is used for matching the impedances. Two I shaped slots of horizontal and vertical arm lengths I_H and I_V of 1 mm width are placed on the ground plane such that the center of these slots coincide with the center of the radiating patch. The parasitic ring P_{st} of width 1 mm and length $\lambda_0/13$, where λ_0 is a free space wave length in cm corresponding to the designed frequency of 3.5 GHz is used around the radiating patches. The microstripline feed of length L_{50} and width W_{50} is used to feed the microwave energy to the proposed antenna. The power divider of 100 Ω impedance with its length L_{100} and width W_{100} is used to supply the microwave power to the antenna elements at the center. A semi miniature-A (SMA) connector of 50**Ω** impedance is used at the tip of the microstripline to supply the microwave power from VNA. The Slits of horizontal and vertical lengths S_H and S_V of width 1 mm are placed at two opposite. Figure 2 and Table 1 gives the photograph and design parameters of the TESLRMSAA.

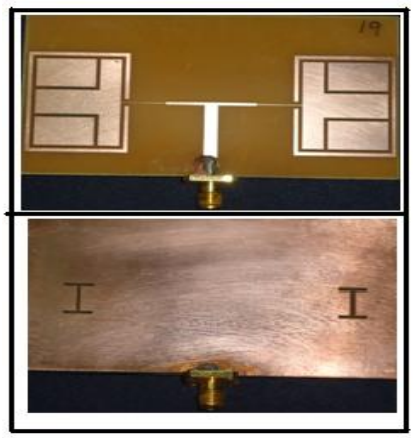

Figure-2: The photograph of TESLRMSAA.

Table-1 Design details of TESLRMSAA(cm)

Parameter	Dimension	Parameter	Dimension
A-Sub	9	S_H	0.915
B-Sub	5	S_V	1.43
W	2.66	L_{100}	2.18
L	2.04	W_{100}	0.07
L_t	1.092	L_{50}	2.18
W_t	0.03	W_{50}	0.32
I_H	0.68		
I_V	0.74		

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3. RESULTS AND DISCUSSION

Vector Network Analyzer (The Agilent N5230A: A.06.04.32) is used to measure the experimental return loss of TESLRMSAA.

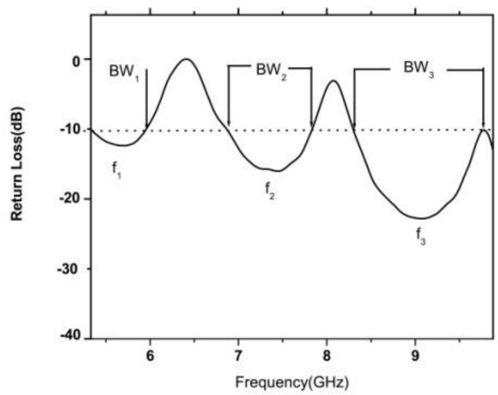

Figure-3: Variation of return loss versus frequency of TESLRMSAA.

Figure 3 shows the variation of return loss versus frequency of TESLRMSAA. It is clear from this figure that, the antenna resonates for three resonating modes f_1, f_2 and f_3 with their respective bandwidths BW_1= 11.2% (5.93-5.3 GHz) BW_2= 13.4% (7.84-6.85GHz) and BW_3=17% (9.8- 8.3 GHz) The minimum return loss of -22 dB is obtained at 9.0 GHz. The first resonating mode is due to the fundamental frequency of the antenna and the additional two modes are due to the I-shaped slots present on the ground plane.

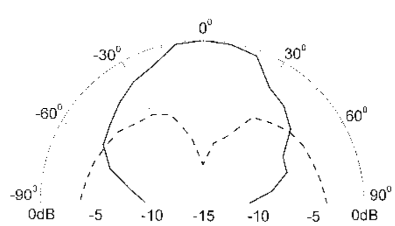

Figure-4: Radiation pattern of TESLRMSAA measured at 9.0 GHz

The far field co-polar and cross-polar radiation patterns of the proposed antenna is measured in its operating band is shown in Fig.4 From this figure it is observed that, the pattern is broadsided and linearly polarized. The gain of the proposed antenna is calculated using absolute gain method given by the relation, $G\,(dB) = 10 \log\left(\frac{P_r}{P_t}\right) - (Gt)\,dB - 20 \log\left(\frac{\lambda_0}{4\pi R}\right) dB$

where, P_t and P_r are transmitted and received powers respectively. R is the distance between transmitting antenna and antenna under test. The peak gain of TESLRMSAA is measured in its operating frequency is found to be 5.21 dB.

4. CONCLUSION

From this study it is concluded that, TESLRMSAA gives wideband between 5.3 to 9.8 GHz with a maximum bandwidth of about 17 %. The antenna exhibits broadside radiation characteristics with a peak gain of 5.21 dB. The proposed antenna uses low cost substrate material with simple design and fabrication. This antenna may find applications for systems operating in WLAN and lower X-band frequencies.

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