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Dual-Element Linearly Polarized Broadside Radiated Rectangular Microstrip Array Antenna

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Abstract: Linearly polarized and Broadside radiating dual element rectangular microstrip array antenna is presented for quad band operation. The antenna has a 3-Dimensional structure of 90 X 50 X 1.6 mm^3 and operates between the frequency range of 4.7 to 7.73 GHz giving a maximum impedance bandwidth of 13.3% with a peak gain of 5.1 dB. The microstripline feed in addition with power divider technique is used to excite 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, Wimax and lower X-band frequencies.

Key words: Dual-Element microstrip antenna array, gain, Quad band.

1. INTRODUCTION

The inherent properties like ease of manufacturing, low cost, compact size, and ease of integration with various planar circuit technologies, ruggedness, ease of installation. etc made the microstrip antennas (MSAs) to wide spread use in commercial and military communication systems. In various wireless and measurement application there is a need for a simple planar radiator with enhanced gain and good radiation characteristics. In this paper dual element array antenna having a simple microstripline feed with suitable power divider method is presented, which can radiate broad sided characteristics with linear polarization. This kind of antenna is rarely found in the literature.

2. ANTENNA DESIGN

The simple low cost modified glass epoxy substrate material of thickness h = 0.16 cm and ε_r = 4.2 is used to fabricate the Dual-element H-Slot rectangular microstrip array antenna (DEHSRMSAA). The art work of proposed antennas is sketched using AUTOCAD-7 software to achieve better accuracy. The antennas are etched using the photolithography method.

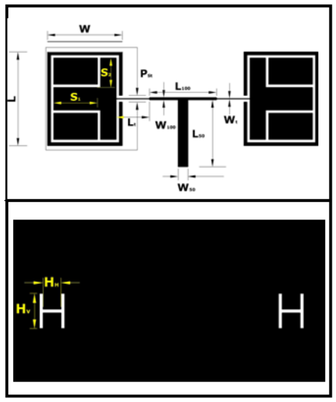

Figure -1: Geometry of DEHSRMSAA.

Figure 1 shows the geometry of DEHSRMSAA. 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 H-shaped slots of horizontal and vertical arm lengths H_H and H_V of 1 mm width which are 64.12 mm apart 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 3 mm are placed at two opposite. Figure 2 and Table 1 gives the photograph and design parameters of the DEHSRMSAA.

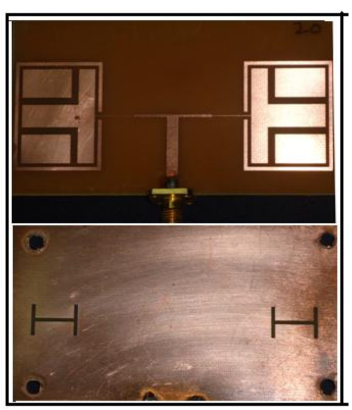

Figure-2: The photograph of DEHSRMSAA.

Table-1 Design details of DEHSRMSAA(mm)

Parameter	Dimension	Parameter	Dimension
A-Sub	90	H_V	9.4
B-Sub	50	S_H	9.15
W	26.6	S_V	14.3
L	20.4	L_{100}	2.18
L_t	10.92	W_{100}	0.7
W_t	0.3	L_{50}	21.8
H_H	4.8	W_{50}	3.2

3. RESULTS AND DISCUSSION

Vector Network Analyzer is used to measure the experimental return loss of DEHSRMSAA.

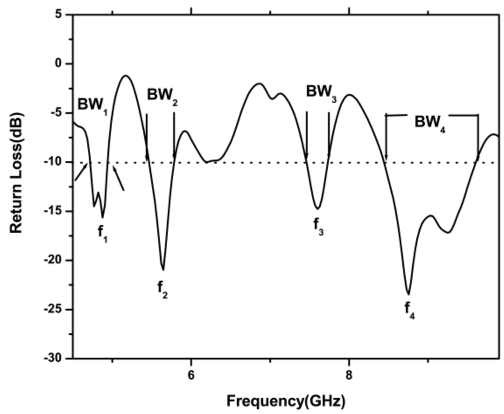

Figure-3: Variation of return loss versus frequency of DEHSRMSAA.

Figure 3 shows the variation of return loss versus frequency of DEHSRMSAA. It is clear from this figure that, the antenna resonates for four resonating modes f_1, f_2 f_3 and f_4 with their respective bandwidths BW_1=4.1%(4.9-4.7 GHz) BW_2=5.3%(5.78-5.48GHz) BW_3=3.4% (7.73-7.47 GHz) and BW_4=13.3 % (9.6-8.4 GHz) .The first resonating mode is due to the fundamental frequency of the antenna and the additional three modes are due to the combined effect of H-shaped slots present on the ground plane and the parasitic ring around the patches. Addtionally, a frequency ratio f_2/f_1 of about 1.14 in obtained which indicates the tuning property of the antenna.

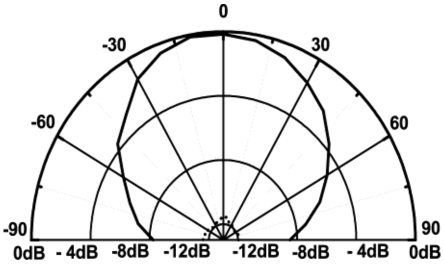

Figure-4: Radiation pattern of DEHSRMSAA measured at 5.63 GHz

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

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 DEHSRMSAA is measured in its operating frequency is found to be 5.1 dB.

4. CONCLUSION

From investigation it is concluded that, DEHSRMSAA gives the broad sided radiation characteristics that helps to cover the operating range of the antenna. The Quad bands between 4.7 to 7.73 GHz with a maximum bandwidth of about 13.3 % is achieved. The antenna exhibits broadside radiation characteristics with a peak gain of 5.1 dB with a frequency ratio of about1.14. The proposed antenna uses low cost substrate material with simple design and fabrication. This antenna may find applications for systems operating in WLAN, Wimax and lower X-band frequencies.

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