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A novel inverted U-Slot Two-Element Rectangular Microstrip Array Antenna for Dual Band operation

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Abstract: In this communication a novel design of inverted U-slot Two-element rectangular microstrip array antenna is presented for dual frequency operation. The antenna is has 3-Dimensional structure of 9 X 5 X 0.16 cm^3 and functions between the frequency range of 5.29 GHz to 8.0 GHz giving a maximum impedance bandwidth of 18.1 % with a peak gain of 3.56 dB. The microstripline feed in addition with equal power divider method is used to excite the antenna. The low cost modified glass epoxy substrate material is used to fabricate the antenna. The design detail of the antenna is described. The experimental results are presented and discussed. This antenna may find applications for systems operating higher C band and lower X-band frequencies.
Key words: Inverted U-Slot, Two-Element, Microstrip antenna array, gain.

1. INTRODUCTION

In todays communication era, the microstrip antennas have stood at the great place because of their inherent and challenging properties like ease of manufacturing, low cost, compact size, and ease of integration with various planar circuit technologies, ruggedness, ease of installation. etc. In various wireless communication application there is a need for a simple radiating element with comparable bandwidth.. In this paper the a novel inverted U-slot two element rectangular microstrip array antenna employing a simple microstripline feed with equal power divider method is presented, which can radiate linearly polarized and broad sided characteristics. This kind of antenna is rarely found in the literature.

2. ANTENNA DESIGN

The low cost modified glass epoxy substrate material of thickness h = 0.16 cm and relative permittivity $\varepsilon_r = 4.2$ is used to fabricate the inverted U-Slot two-element rectangular microstrip array antenna (NIUSTERMSAA). The art work of proposed antennas is sketched using autoCAD-7 computer software to achieve better accuracy. The antennas are etched using the photolithography process.

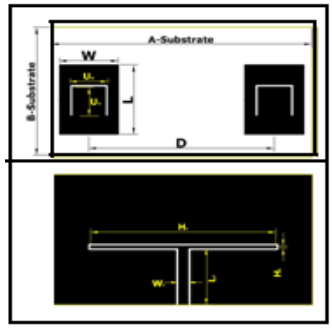

Figure -1: Geometry of NIUSTERMSAA.

Figure 1 shows the geometry of NIUSTERMSAA. The antenna has the radiating patch designed for the resonant frequency of 3.5 GHz, using the basic equations available in the literature [1-3]. Two inverted U-shaped slots of horizontal and vertical arm lengths U_H and U_V of 1 mm width which are 64.12 mm apart are placed on the radiating patch. The microstripline feed of length L_f and width W_f is used to feed the microwave energy to the antenna. The equal power divider of length H_f and width H_t is used to supply the microwave power to the antenna elements at the center. A gap of 1 mm is cut around the microstripline feed so as ensure better couple of the microwave power to the radiating patches of the array. A semi miniature-A (SMA) connector of 50**Ω** impedance is used at the tip of the microstripline to supply the microwave power from Vector Network Analyzer. Figure 2 and Table 1 gives the photograph and design parameters of the NIUSTERMSAA.

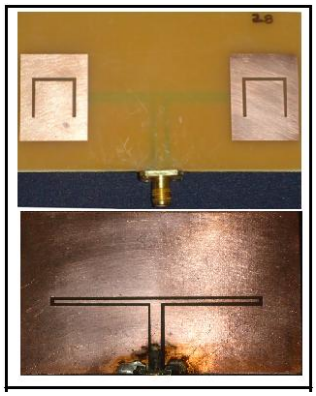

Figure-2: The photograph of NIUSTERMSAA.

Table-1 Design details of NIUSTERMSAA(mm)

Parameter	**Dimension**	**Parameter**	**Dimension**
A-Substrate	90	D	64.12
B-Substrate	50	L_f	21.84
W	26.6	W_f	3.2
L	20.4	U_H	14.8
H_t	0.74	U_V	13.1
H_f	64.12		

3. RESULTS AND DISCUSSION

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

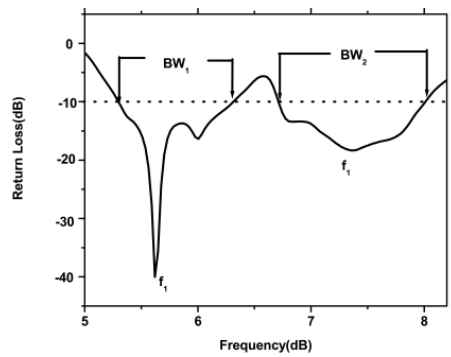

Figure-3: Variation of return loss versus frequency of NIUSTERMSAA.

Figure 3 shows the variation of return loss versus frequency of NIUSTERMSAA. It is clear from this figure that, the antenna resonates for three resonating modes f_1 and f_2 with their respective bandwidths BW_1=17.58 %(6.31-5.29 GHz) and BW_2=18.1%(8.0-6.1 GHz) The first resonating mode is due to the fundamental frequency of the antenna and the other mode is due to the presence of U-shaped slots on the radiating patch. Also, the antenna gives the frequency ratio f_2/f_1 of about 1.267 which indicates the tuning property of the antenna.

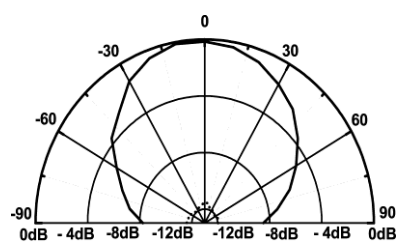

Figure-4: Radiation pattern of NIUSTERMSAA

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 proposed antenna is measured in its operating frequency is found to be 3.56 dB.

4. CONCLUSION

From this novel study it is concluded that, NIUSTERMSAA gives triple bands between 5.29 GHz to 8.0 GHz giving a maximum impedance bandwidth of 18.1 % with a peak gain of 3.56. The antenna exhibits linearly

polarized and broadsided radiation characteristics along with the frequency ratio of about 1.267. The proposed antenna uses commercially available low cost substrate material with simple design and fabrication process. This antenna may find applications for systems operating in higher C band and lower X-band frequencies.

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