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SLITS LOADED EQUILATERAL TRIANGULAR MICROSTRIP ANTENNA FOR TRIPLE BAND OPERATION

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ABSTRACT

This paper presents the design and development of a slits loaded equilateral triangular microstrip antenna for triple band operation. The antenna has a volume of 8 X 5 X 0.16 cm^3 and operates between the frequency range of 5.37 to 9.26 GHz giving a maximum impedance bandwidth of 3.83% with a peak gain of 3.14 dB. The simple glass epoxy substrate material is used to fabricate the antenna. The microstripline feed arrangement is incorporated to excite the antenna. The antenna shows linearly polarized broadside radiation characteristic. The design detail of the antenna is described. The experimental results are presented and discussed. This antenna may find applications in IEEE 802.11a and for systems operating in C- band frequencies.

Key words: Triangular Microstrip Antenna, Notch, Slits, Triple Band.

1. INTRODUCTION

In today's communication scenario the microstrip antennas have become attractive aids for transmit/receive purpose in emerging communication applications like WLAN, WiMax and 4G mobile systems, radar communication systems, because of their numerous inherent features like low profile, low fabrication cost, integrability with MMICs and ease of installation [1]. The triple and multiple band antennas are realized by many methods such as, slot on the patch, arrays, monopoles [2-4] etc. But in this study a simple equilateral triangular microstrip antenna with slits placed on the patch is used to achieve triple band operation with notch band. This kind of antenna is found to be rare in the literature.

2. ANTENNA DESIGN

The conventional equilateral triangular microstrip antenna (CETMSA) and the slit loaded equilateral triangular microstrip antenna (SETMSA) are fabricated on low cost glass epoxy substrate material of thickness h = 0.16 cm and $\varepsilon_r = 4.2$. The art work of proposed antennas is sketched using auto-CAD software to achieve better accuracy. The antennas are etched using the photolithography process.

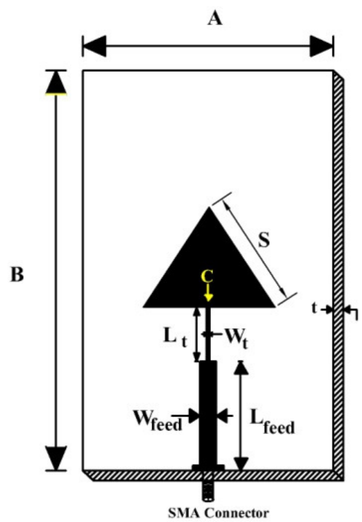

Figure 1: Top view geometry of CETMSA

Figure 1 shows the top view geometry of CETMSA. The radiating patch of side S is designed for the resonant frequency of 3.5 GHz, using the basic equations available in the literature [5]. A quarter wave transformer of length L_t and width W_t is used between C_P along the width of the patch and microstripline feed of length L_{feed} and width W_{feed} for matching their impedances. A semi miniature-A (SMA) connector of 50**Ω** impedance is used at the tip of the microstripline to supply the microwave power.

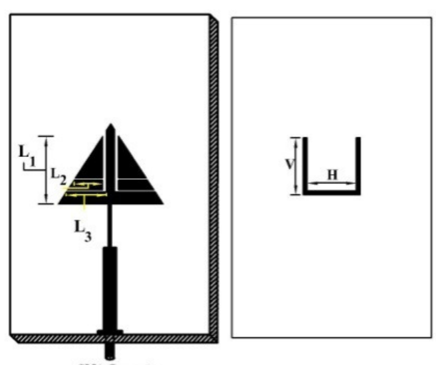

Figure 2: Top and bottom view geometry of SETMSA

Figure 2 shows the top and bottom view geometry of SETMSA. The three slits of lengths L_1, L_2 and L_3 each of width 1 mm are placed on either side of the equilateral triangular radiating patch taking the middle perpendicular as reference. The U shaped slot of width 1 mm having horizontal and vertical arm lengths H and V is placed on the ground plane such that the middle point of this slot coincides with the center of the radiating patch. The dimensions L_1, L_2, L_3, H and V are taken in terms of λ_0 , where λ_0 is a free space wave length in cm corresponding to the designed frequency of 3.5 GHz. Table 1 shows the design parameters of CETMSA and SETMSA.

Table 1: Design parameters of CETMSA and SETMSA(cm).

Antenna	S	L_{feed}	W_{feed}	L_t	W_t	L_1	L_2	L_3	H	V
CETMSA	2.82	2.135	0.31	1.71	0.05	-	-	-	-	-
SETMSA	2.82	2.135	0.31	1.71	0.05	$\lambda_0/4.3$	$\lambda_0/11.2$	$\lambda_0/7.5$	$\lambda_0/6$	$\lambda_0/7$

3. RESULTS AND DISCUSSION

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

Figure 3 shows the variation of return loss versus frequency of CETMSA. From this figure it is seen that, the CETMSA resonates at 3.30 GHz of frequency which is close to the designed frequency of 3.5 GHz. The experimental bandwidth is calculated using the formula,

$$\text{Bandwidth } (\%) = \frac{f_2 - f_1}{f_c} \times 100$$

where, f_2 and f_1 are the upper and lower cut off frequencies of the resonated band when its return loss reaches -10dB and f_c is a centre frequency between f_1 and f_2. The bandwidth of CETMSA is found to be 1.8 %.

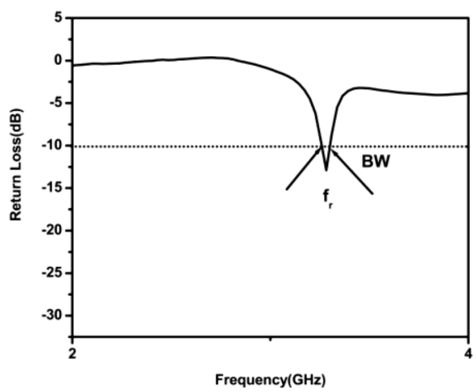

Figure 3: Variation of return loss versus frequency of CETMSA

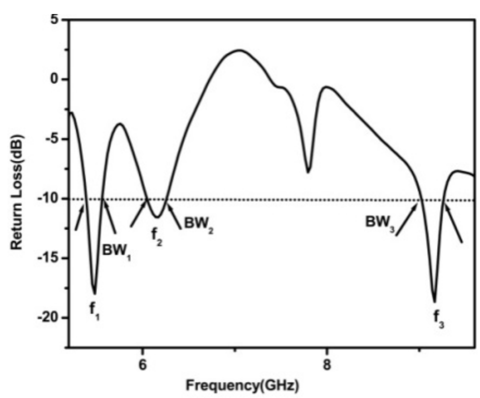

Figure 4: Variation of return loss versus frequency of SETMSA

Figure 4 shows the variation of return loss versus frequency of SETMSA. It is clear from this figure that, the antenna operates for three bands BW_1 = 3.83 % (5.37-5.58 GHz), BW_2 =3.5 % (6.03-6.25 GHz) and BW_3 = 2.6 % (9.02-9.26 GHz) for the resonating modes of f_1, f_2 and f_3 respectively. The BW_1 is due to the fundamental resonance of the patch. The bands BW_2 and BW_3 are due to the slits present on the patch. Further it can be noted that, the insertion of the U shaped slot on the ground plane, the notch band of (9.14-6.14 GHz) is obtained, and this property is very much useful to reject the unwanted bands in the spectrum. Also, the SETMSA gives the frequency ratio of about 1.12 which indicates the flexibility to design dual and triple bands.

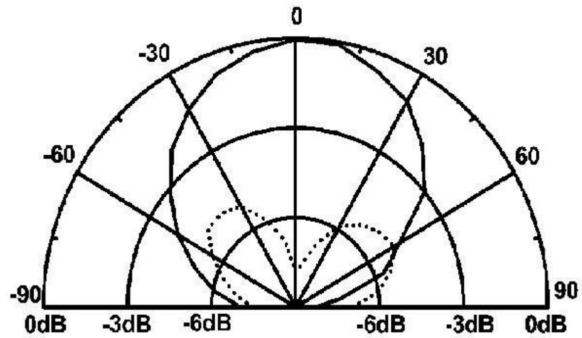

Figure 5: Radiation pattern of SETMSA measured at 5.475 GHz

The far field co-polar and cross-polar radiation patterns of the proposed antenna is measured in its operating band. The typical radiation pattern of SETMSA measured at 5.475 GHz is shown in Fig. 5. 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 SETMSA measured in BW_1 is found to be 3.14 dB.

4. CONCLUSION

From this study it is concluded that, SETMSA gives triple bands with a maximum bandwidth of about 3.83 % and a frequency ratio of 1.12. The SETMSA gives a notch band from 9.14 to 6.14 GHz which is useful to reject the unwanted bands. The antenna exhibits broadside radiation characteristics with a peak gain of 3.14 dB. The proposed antenna uses low cost substrate material with simple design and fabrication. This antenna may find applications in IEEE 802.11a and for systems operating in C -band frequencies.

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BIO-DATA

Dr. Nagraj K. Kulkarni received his M.Sc, M.Phil and Ph. D degree in Applied Electronics from Gulbarga University Gulbarga in the year 1995, 1996 and 2014 respectively. He is working as an Assistant professor and Head, in the Department of Electronics Government Degree College Gulbarga. He is an active researcher in the field of Microwave Electronics.