

## DUAL BAND SQUARE MICROSTRIP ANTENNA EMBEDDED WITH A PLACARD SHAPED SLOT

G.S.Binoy, C.K.Aanandan, P.Mohanan and K.Vasudevan

Microwave Engineering Group  
Department of Electronics,  
Cochin University of Science & Technology  
Cochin-22, Kerala, India  
e-mail: [kv@doe.cusat.edu](mailto:kv@doe.cusat.edu)

### ABSTRACT:

By loading a placard shaped slot towards the centre of a square microstrip antenna, dual frequency design can be obtained using a single probe feed. The proposed antenna offers tunability of the frequency ratio between the two frequencies by adjusting the slot dimensions. This configuration also provides a size reduction up to ~51% and 35% for the two modes as compared to a square microstrip patch antenna.

### INTRODUCTION:

Microstrip antennas finds far reaching applications in the current communication scenario, due to its inherent advantages like light weight, low profile, low production cost, ease of fabrication etc. Many applications such as mobile communication systems, indoor communications or satellite systems often require dual frequency operations [1].

With regard to microstrip patch antennas, dual frequency behaviour can be obtained by using only a single radiating element loaded by reactive elements such as slots etched on the patch [2]. In this letter, we present a novel design of a square shaped microstrip antenna embedded with a square slot, with an arm extended giving dual frequency operation with the polarisation planes perpendicular to each other. This new design carrying a placard shaped slot exhibits reduction in antenna size for dual frequency operation compared to conventional microstrip antennas. By changing the dimensions of the arm of the slot, the ratio of the two operating frequencies can be adjusted. Details of the antenna design, impedance and radiation characteristics at the two resonant frequencies are described and experimental results are presented.

### ANTENNA DESIGN AND EXPERIMENTAL DETAILS:

Fig1 shows the proposed configuration of a dual frequency placard shaped slot microstrip antenna. The square microstrip patch has a side length  $L$  is fabricated on a substrate of thickness  $h$  and relative permittivity  $\epsilon_r$  [3]. The placard shaped slot is centered in the square microstrip patch antenna. It consists of a slot of equal side dimensions  $L_s=W_s$ , with an arm having length  $L_a$  and width  $W_a$  ( $L_a \gg W_a$ ) extending towards one of the edges of the square microstrip patch as shown in fig. 1.

When  $L_s$ ,  $L_a$ , and  $W_a$  are properly chosen, the excited patch surface current densities of the  $TM_{10}$  and  $TM_{01}$  modes are perturbed such that these two modes are excited for dual frequency

operation. Fig(2) shows the measured return loss for the two operating frequencies  $f_1$  and  $f_2$ . Here, the slot creates another resonance near the fundamental resonance of the antenna, which will result in dual frequency operation ( $TM_{01}$  and  $TM_{10}$ ) The fundamental resonance frequency of the conventional unslotted square patch is  $\sim 1.9\text{GHz}$ (f). With a square slot alone ( $L_a=0$ ), it is observed that the antenna is resonating at 1.6GHz, whereas the introduction of the slot arm initiates an additional resonance frequency at 1.4GHz. By changing the length of the slot arm ( $L_a$ ), the frequency ratio of the proposed antenna can be tuned in the range of about 1.06 to 1.2.

By comparing a case in which a regular rectangular patch is used to the present design ( $L_s=12\text{mm}$ ,  $L_a=10$  and  $W_a=1.5\text{mm}$ ), we see that the reduction in patch areas are 51% and 35% respectively for the first and second resonant frequencies. The variation of the two resonant frequencies and hence the frequency ratio of the antenna for different lengths of the slot arm is given in table I. The frequency ratio is found to vary from 1.06 to 1.2. From the table it can be seen that, by changing the slot arm dimensions we can merge or shift apart the resonating frequencies [4]. The percentage bandwidth remains almost invariant even when the slot arm dimensions are changed to reduce the operating frequency ratio ( $f_2/f_1$ ). Good cross polarisation radiation for both the operating frequencies is observed.

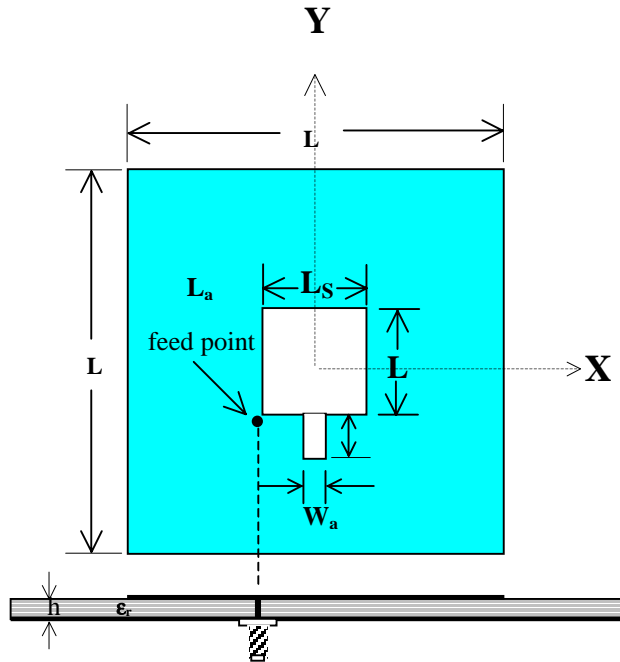
From the transmission characteristic ( $S_{21}$ ) we can infer that the polarisation planes of the two resonant frequencies are orthogonal to each other [5]. Radiation patterns for the proposed antenna for two tuning stubs are shown in fig. 3.

## CONCLUSION:

A novel design of a dual frequency dual polarized square microstrip antenna embedded with a placard shaped slot is demonstrated. The proposed design uses the fundamental  $TM_{10}$  mode as well as the new resonant mode  $TM_{01}$  excited due to the slot for the dual frequency operation. The frequency ratio of the two frequencies can be made as low as 1.06, which makes the proposed antenna suitable for applications where a low frequency ratio is required. The proposed antenna shows a patch size reduction of up to  $\sim 51\%$  and  $35\%$  for the two modes.

## REFERENCES:

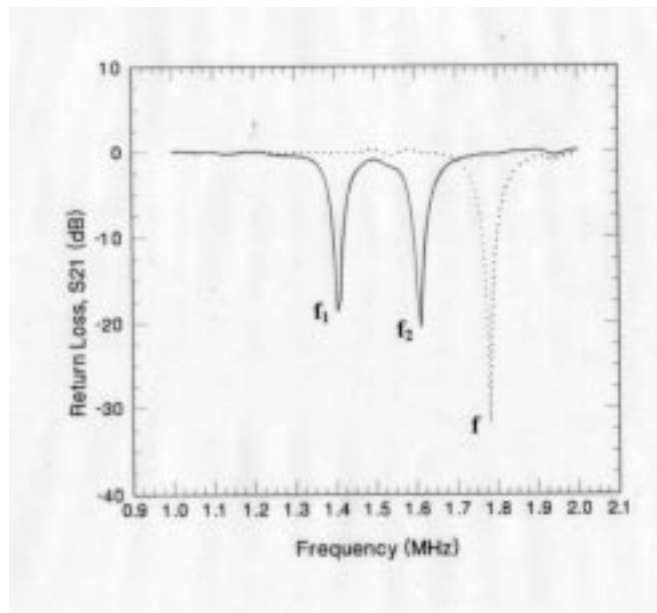
1. Kin-Lu-Wong and Jia-Yi-sze,: 'Dual Frequency slotted rectangular microstrip antenna', *Electronics Letters*,1998, **34**, (14), pp 1368-1370
2. S.Maci, G.Biffi Gentili, P.Piazessi, and C. Salvador,"Dual Band slot loaded patchantenna," Proc. Inst. Elect. Eng., Microwaves, antennas, propagation1995,Vol. **142**, No3, pp 225-232.
3. J.R.James AND P.S.Hall: '*Handbook of microstrip antennas*', Peter Peregrinus, London,1989.U.K.,: IEE, 1989
4. Jui-Han-Lu and Kin-Lu-Wong,.'Dual frequency rectangular microstrip antenna with embedded spur lines and integrated reactive loading', *Microwave and Optical Technology Letters*, 1998, **21**, (4), pp.272-275.
5. Chan -Kun\_wu,Kin Lu Wong, and Wen\_shyang Chen," Slot coupled meandered microstrip antenna for compact dual frequency operation",*Electronics letters*,1998,**34**, (11),pp 1047-1048

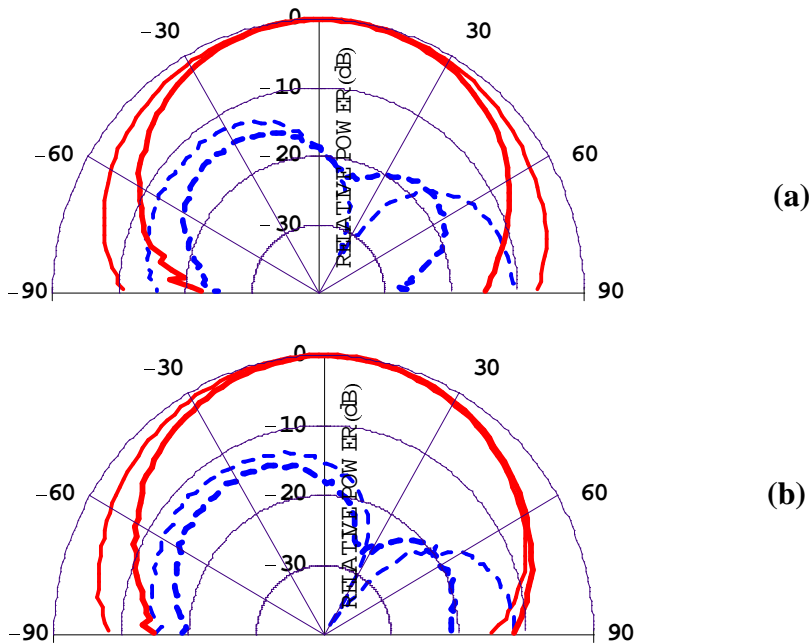


**Fig. 1** Geometry of a Dual frequency square microstrip antenna with a placard shaped slot

**Fig. 2.** The measured return loss( $S_{11}$ ) for the proposed dual frequency dual polarised microstrip antenna having slot arm length  $L= 10\text{mm}$ .

—  $S_{11}$  of the slot antenna ( $L=10\text{mm}$ )      .....  $S_{11}$  of Standard Square patch  
 $h = 1.6\text{mm}$ ,  $\epsilon_r = 4.5$ ,  $L_p = 40\text{mm}$ ,  $L_s = 12\text{mm}$ ,  $L_a = 10\text{mm}$ ,  $W_a = 1.5\text{mm}$





**Fig.3.** Measured E-plane and H-plane radiation patterns for the proposed antenna  
**(a)= 1.411 GHz (b) = 1.611 GHz**

—      - - -      E-Plane  
- - -      —      H-Plane

Tuning Slot Length in mm	First resonance frequency, $f_1$ in MHz	Percentage bandwidth	Second resonance frequency $f_2$ in MHz	Percentage bandwidth	Frequency Ratio $f_2/f_1$
2	1507	1.61	1611	1.63	1.068
4	1480	1.68	1610	1.67	1.081
6	1450	1.73	1592	1.79	1.118
8	1433	1.81	1604	1.94	1.124
10	1411	1.74	1611	2.08	1.141
12	1390	1.68	1618	1.96	1.160

Table I: Dual-frequency performance for proposed antenna with a shaped slot with various slot arm lengths

Antenna parameters are given in fig. 2