A Tri-band Slot Antenna using Capacitive CPW and Meander Line Stub Technique

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Abstract - **This paper presents a tri-band slot antenna designed by using capacitive CPW for controlling the second and third harmonics as desired. The slot stub with meander line is employed for matching, resulting in return loss less than -10 dB at all three operating bands. Radiation patterns are omni-directional. Bandwidths of the proposed antenna are 360 MHz, 1200 MHz, and 1400 MHz at 1.9 GHz (1.81 GHz-2.24 GHz), 3.7 GHz (2.77 GHz-3.97 GHz) and 5.5 GHz (4.75 GHz- 6.22 GHz), respectively. These operating bands can be used for GSM, WiMAX and WLAN systems.**

Index Terms — **Capacitive CPW, Meander line, Slot antenna.**

1. Introduction

Nowadays antenna is one of the most important in wireless communication systems. For example, antennas are required for mobile and satellite communication systems. To use an antenna, several important characteristics are required such as small size to suit all conditions, lightweight as sometime it must be mounted on a wall or hung on a pole, low cost, ease of design and high efficiency. Microstrip is popularly used for antenna design because of simple structure compatible with print circuit board, low cost, and good performance. Therefore, several researchers have developed antennas to have more efficient than conventional such as the CPW slot antenna [1], the small antenna by using capacitive feed and interdigital capacitor with slot CPW [2] and the meander line rectangular loop antenna [3], however, their sizes are still large.

In this paper presents the compact microstrip antenna based on RF circuit techniques to operate at three bands of 1.9 GHz as the fundamental frequency, 3.7 and 5.5 GHz as the first and second harmonics, respectively. The details of antenna design will be presented in next section. Then, the implementation and measured results will be demonstrated in later section. Finally, conclusions and suggestion for future development will be given.

2. Antenna Design

This proposed antenna has been designed on the FR4 substrate with $\varepsilon r = 4.4$, loss tangent = 0.016 and thickness = 1.6 mm. Layout of a tri-band slot antenna using capacitive CPW and meander line stub, is shown in Fig.1. To design the antenna, IE3D program has been employed, resulting in parameters as follow: W1= 2.5 mm, W2= 1.8 mm, W3= 17.31 mm, W4= 8 mm, W5= 9.82 mm, W6= 2.42 mm, W7= 2.42 mm, W8= 2.4 mm, W9= 1 mm, W10= 1.25 mm, W11= 3.1425 mm, W12= 3 mm, W13= 0.4 mm, W14= 0.98 mm, W15= 0.3 mm, W16= 2 mm, W17= 1.7 mm, L1= 13.3 mm, L2= 24.2 mm, L3= 14.95 mm, L4= 28 mm, L5= 12.84 mm, L6= 21 mm, and L7= 4 mm, respectively. The antenna design is on a basis of slot antenna with λ/4 length connected with CPW feedline with λ/4 length, so total length is λ/2 as the structure shown on the left side of Fig.2. Then, the capacitive coplanar waveguide (CCPW) feed has been designed, resulting in size reduction to approximately λ/8 as shown on the right side of Fig.2. In addition, the meander line stub technique ahs been used to shift the second harmonics from 5 GHz to 5.5 GHz and to improve the return loss value less than -10 dB at all frequency bands.

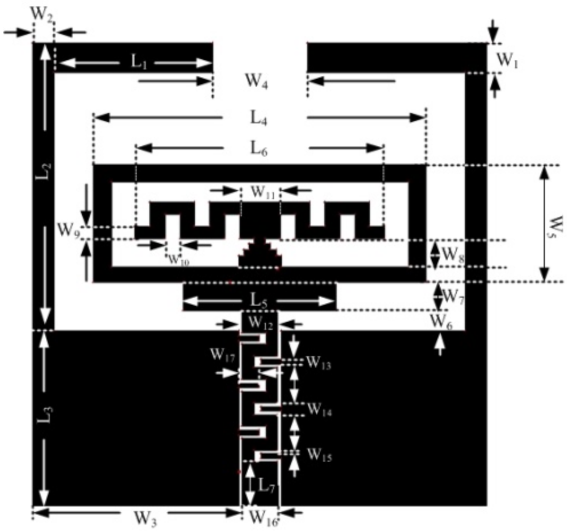


Fig. 1. Layout of the tri-band antenna.

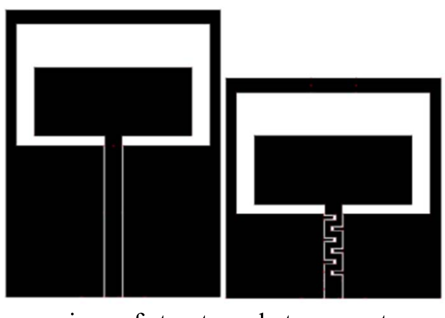


Fig. 2. Comparison of structures between antenna using CPW and CCPW feeds.

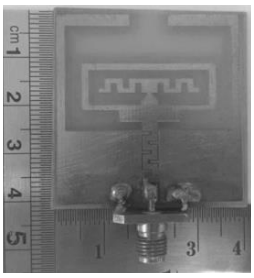


Fig. 3. A photograph of the proposed antenna.

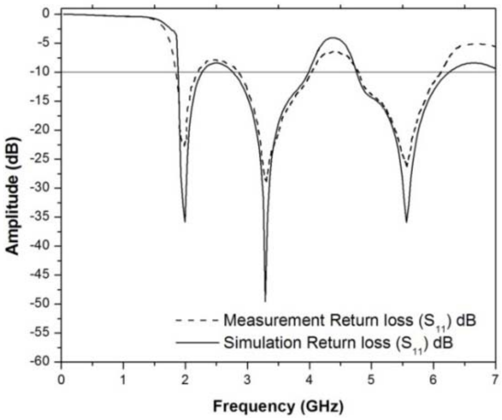


Fig. 4. Comparison of simulation and measurement results.

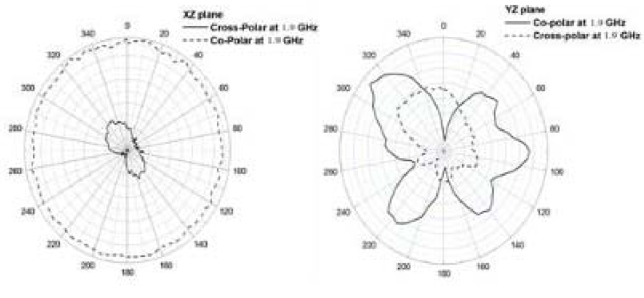
3. Implementation and Measurement Results

After designing the proposed tri-band antenna by techniques as mentioned in prior section, the size is 3.8×3.9 cm2 as shown in Fig.2. It was taken into measurement by the Agilent 8791ES network analyzer. The comparison of simulation and measurement results of this proposed antenna is shown in Fig. 3. There are three resonant frequencies at 1.9 GHz, 3.7 GHz, and 5.5 GHz. The simulated results of return losses (S11) are -36 dB, -50 dB, and -36 dB, respectively. The bandwidths are 1.81-2.24 GHz at GSM band, 2.77-3.97 GHz at Wi-MAX frequency range, and 4.75-6.22 GHz at WLAN frequency. The measured results of return losses are -23 dB, -28 dB, and -26 dB, respectively, while the measured bandwidths are 1.9-2.2 GHz at GSM band, 2.78-3.98 GHz at Wi-MAX frequency range, and 4.75-6.19 GHz at WLAN frequency. It is found that the measured results agree very well with simulation expectation. The patterns are Omni directional as shown in Fig. 4.

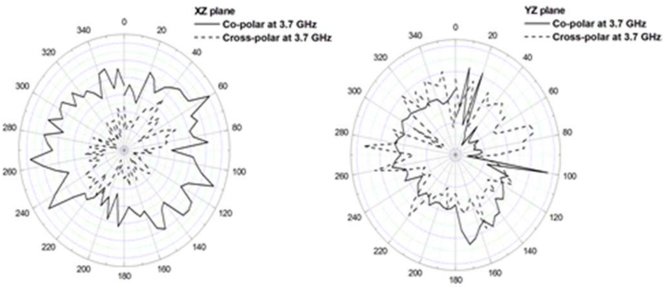
4. Conclusion

The tri-band open slot antenna using CCPW with meander line stub has been proposed to operate for GSM, Wi-MAX and WLAN systems. The CCPW technique can reduce size of CPW from λ/2 to λ/4 and can control the second and third harmonics as desired.

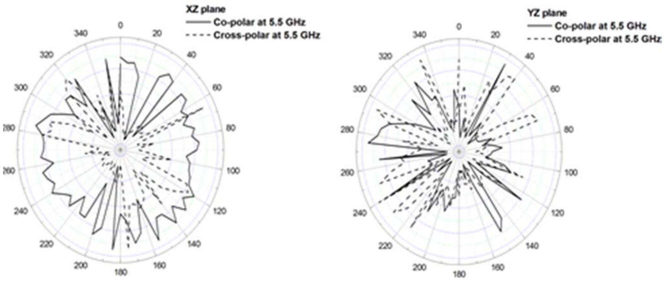
In addition, the meander line technique can be used to control high harmonic frequency as desired and to match at all resonance frequencies. The proposed antenna has compact size and the results show good agreement between simulation and measurement with return loss less than 10 dB at all frequency bands. The antenna also demonstrates good performances suitable for such systems.



(a)



(b)



(c)

Fig. 5 Patterns of the proposed antenna.
(a)XZ and YZ plane at 1.8 GHz
(b)XZ and YZ plane at 3.7 GHz
(c)XZ and YZ plane at 5.5 GHz

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