A Reconfigurable H-Shape Antenna for Wireless Applications

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***Abstract*— This paper presents a novel H-Shaped reconfigurable microstrip patch antenna fed by a Grounded Coplanar Waveguide (GCPW) for wireless applications. The uniqueness in the presented antenna design relies in the ability to select the number of operating frequencies electronically by using a varactor diode. The antenna structure consists of coplanar waveguide (CPW) input with an H-shape printed on a PCB and a varactor diode for reconfigurability. By electronically varying the value of the diode capacitance, the antenna can operate in a single band mode to cover Global Position System (GPS), a dual band mode to cover GPS and Global System for Mobile communications (GSM1900) or a three-band mode to cover GPS, GSM1900 and Bluetooth or Wireless Local Area Networks (WLAN).**

***Index Terms*— Reconfigurable Antenna, Tri-band, Multiband Antenna, CPW, Tunable Antenna, H-Shape**

I. Introduction

There has been a significant interest in the field of reconfigurable antennas during the last few years. Due to the demand for thinner devices, the requirement for smaller antennas has increased. A reconfigurable antenna can be considered as one of the key advances for future wireless communication transceivers. The advantage of using a reconfigurable antenna is to operate in multiband where the total antenna volume can be reused and therefore the overall size can be reduced. Different reconfigurable antenna techniques have been reported in [1]. Reconfigurability can be achieved by using PIN diode switches [2] and [3] or by using Varactor diode [4] or by using MEMS switches [5]. An extensive study of a Planer Inverted-F antenna (PIFA) was presented in [6] to design three resonant frequencies to cover GSM, DCS and DMB applications and it was reported that two folded parts can be added to the main PIFA to create the three bands. Another design has been reported recently to design multiband independent antenna by cutting slots within the main radiated patch to introduce multiband operation [7]. Independent operations were achieved in the reported designs [6] and [7] by incorporating additional parts or by changing the physical size of the antenna.

In this paper, a novel technique to electrically introduce independent resonant frequencies by using a varactor diode is presented. The antenna has an H-shaped structure fed by a coplanar waveguide (CPW). Up to three resonant frequencies can be generated and controlled to be used for GPS, GSM and Bluetooth or WLAN applications.

II. Antenna Configuration

Fig.1 shows the structure of the proposed reconfigurable antenna. The main dimensions are listed in Table I. The antenna is designed with an area of 44.6 x 50 mm2 printed on a volume of 70 x 70 x 1.57 mm3 to make it better suited for compact wireless applications. The antenna consists of an H-shape CPW feed line and a varactor diode. The antenna is designed on a 1.57 mm-thick FR-4 substrate with a dielectric constant of 4.4. The varactor diodes selected for the design is a BB184 from NXP with a capacitance value ranging from 2 pF to 14 pF controlled by a DC bias voltage varying from 1v V to 16 V.

III. Simulations and Experimental Results

The simulated and measured input reflection coefficients (S_{11} in dB) of the proposed antenna for different varactor bias voltages are presented in Fig.2 (a)-(c). The antenna generates three independent resonant frequencies depending on the voltage applied to the varactor diode switch. The first resonance occurs at 1.88 GHz while the second and third resonances occur at 2.4 GHz and 1.57 GHz respectively. Fig.2

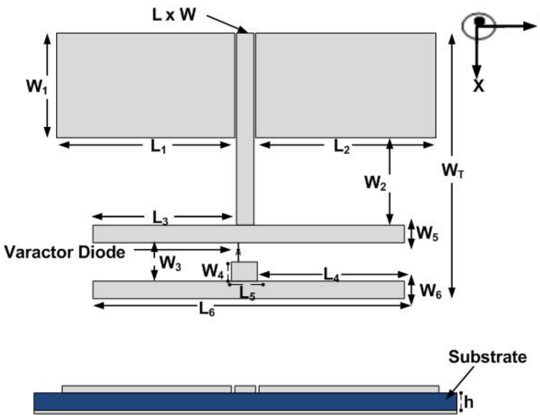
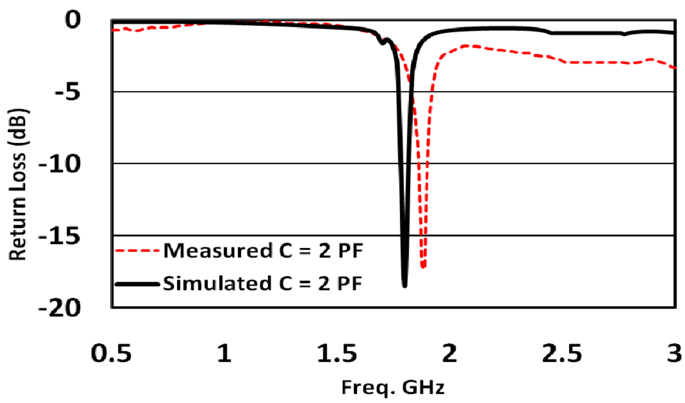


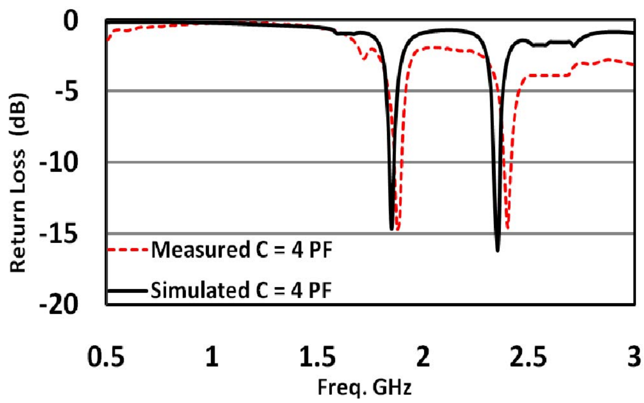
Fig. 1 Layout of the GCPW design

TABLE I
DIMENSIONS OF THE GCPW ANTENNA (UNITS IN MM)

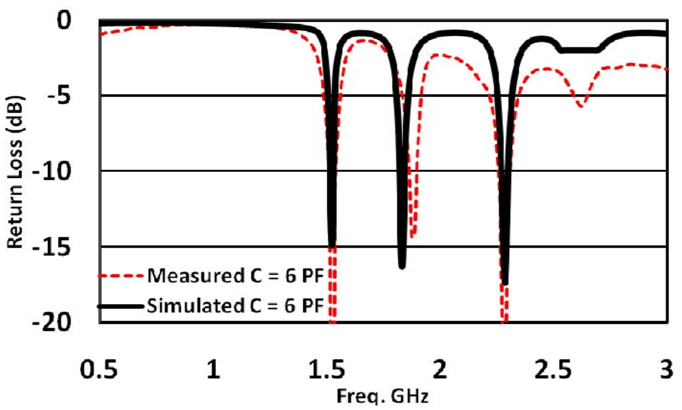
W	**W_1**	**W_2**	**W_3**	**W_4**
3	20	9.6	5	4
W_5 W_6	**W_T**	**L**	**L_1**	**L_2**
5	50	29.6	19.5	26.5
L_3	**L_4**	**L_5**	**L_6**	**h**
15	22	4	40	1.57



(a)



(b)

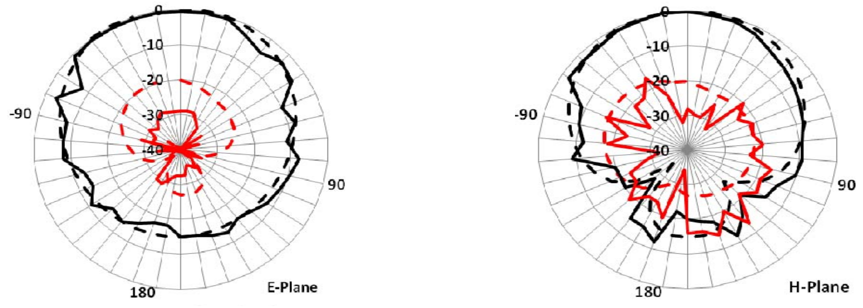


(c)

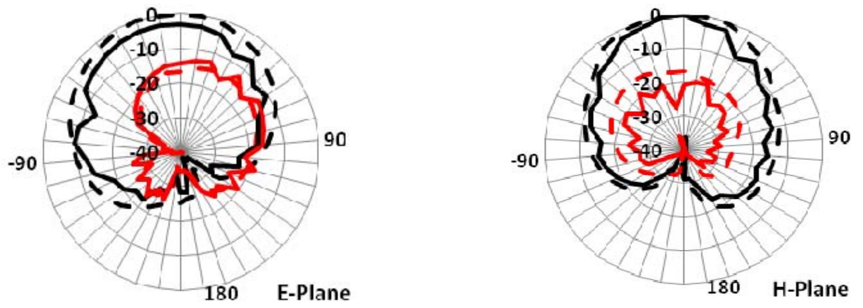
Fig. 2 Simulated and measured return loss for the three resonant frequencies at (a) Single band at 1.88GHz (b) Dual band at 1.88 GHz and 2.4 GHz (c) Tri-band at 1.57 GHz, 1.88 GHz and 2.4 GHz

(a) shows the simulated and measured single band response generated from the antenna when the varactor diode is set to be 2 pF, the antenna generates a single band at 1.88 GHz serving GSM1900 (1850–1910 MHz) applications.

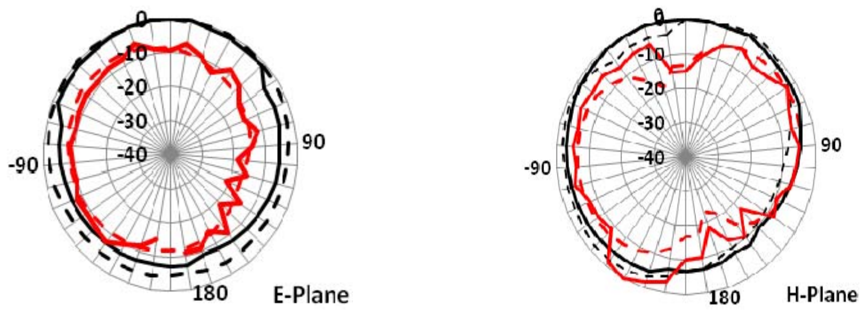
If the capacitance of the diode further increases to 4 pF, the antenna can resonate at an additional band at 2.4 GHz serving Wireless Local Area Network (WLAN) and Bluetooth applications while the resonant frequency of GSM1900 band



(a) 1.88GHz



(b) 2.4 GHz



(c) 1.57GHz

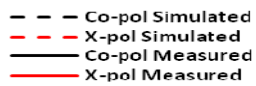


Fig. 3 Simulated and measured E-Plane and H plane Co-pol and X-pol radiation patterns for the three bands (a) 1.88GHz (b) 2.4 GHz (c) 1.57GHz

is still supported as shown in Fig.2 (b). In a similar way, if the capacitance is further increased to 6 pF, a third band can be obtained at 1.57 GHz for Global Position Systems (GPS) (1575 MHz) applications, while the GSM1900 and the WLAN/Bluetooth bands are still supported as shown in Fig.2 (c). The measured and simulated S_{11} results are in good agreement.

(NPL) was used to measure the performance of the proposed antenna. The measured and simulated far field radiation patterns for the single, dual and three bands are observed as shown in Fig.3 (a) - (c).

IV. CONCLUSIONS

A novel reconfigurable microstrip patch antenna to electrically introduce multiple bands fed by CPW is presented for single, dual and three band applications. The generated bands can be easily controlled by varying the capacitance of the varactor diode. The antenna design targeted GSM, GPS and WLAN/Bluetooth frequency bands. The performances of the proposed antenna were measured and are in good agreements with simulated results.

ACKNOWLEDGMENTS

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