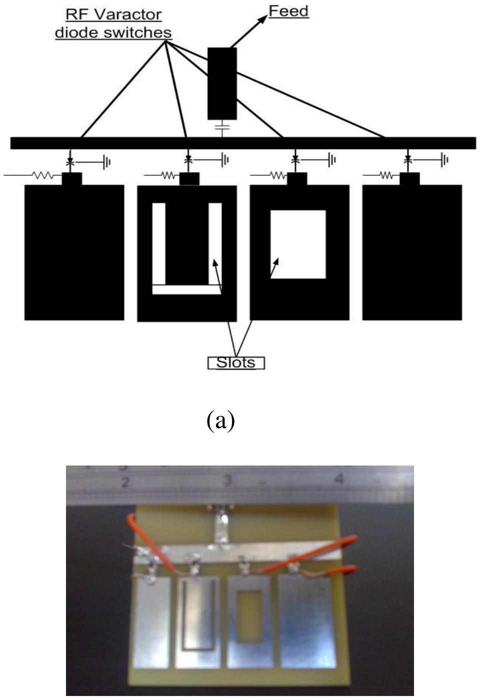
European Conference on Antennas and Propagation 2010, 12-16 April 2010, Barcelona

A FREQUENCY RECONFIGURABLE MULTIBAND PATCH ANTENNA FOR WIRELESS APPLICATIONS

H. F. AbuTarboush[1], R. Nilavalan[1], K. M. Nasr [2], H. S. Al-Raweshidy[1] and D. Budimir[3]
[1]Wireless Networks and Communications Center (WNCC), School of Engineering and Design, Brunel University, West London, UB8 3PH, UK
[2]National Physical Laboratory (NPL), Teddington, TW11 0LW, UK
[3] Wireless Communications Research Group, School of Electronic & Communication Engineering, University of Westminster, W1W 6UW, U.K
Hattan.AbuTarboush@brunel.ac.uk

Introduction: The aim of tuning the frequency of the antenna is to have a single multifunctional antenna within a small wireless terminal supporting multiple standards and services. A reconfigurable multiband patch antenna was reported in [1] using pin diodes. Other related works includes a reconfigurable dual-band antenna for wireless applications [2] with a wide tunable range and a single band antenna using varactor diode to tune between 2.15 to 2.8 GHz [3].

This paper presents a reconfigurable five-band single fed microstrip patch antenna capable of operating between 0.9GHz to 3 GHz for different cellular and wireless radio frequency applications. This antenna has a simple structure fed by 50-ohm microstrip line as shown in Fig.1. The antenna consists of four sub-patches connected to one line by four switches (varactor diodes). Each sub-patch generates a single band. By placing a variable capacitor and an inductor at the antenna input, the impedance matching frequency of the antenna can be varied. The fabricated prototype antenna achieves a tunable frequency range from 0.9 to 3 GHz. The designs are verified through both numerical simulations and measurement of the experimental prototype.



(a)

(b)

Fig. 1. (a) The structure of the reconfigurable 5 band antenna and the fabricated prototype (b)

Design procedure and main results

Varactor diodes are commonly used to tune the operating frequencies of RF front-end applications. A microstrip antenna is a resonant element. Its resonance frequency can be determined by its lumped element equivalence. Therefore, the variation of the reactive loading of the patch results in changing the resonance frequency of the antenna. Varactor diodes (Philips type BB184) were used for the presented antenna. The capacitance of the diode can be changed from 2pF (10V) to 14pF (1V). The diode has an inductance of 0.6nH and a resistance of 0.65 ohm.

The varactor diodes and the lumped capacitor were located at specific positions to reconfigure the band generated from the radiated patch. Fig.1(a) shows the structure of the presented reconfigurable antenna along with the biasing network. Fig.1(b) shows the prototype which was fabricated on FR-4 substrate material with a relative permittivity of 4.4 and substrate thickness of 1.57mm. Four switches, 10 pF capacitor and 1K-ohm resistance were attached to the positions shown in Fig.1 (a) with help of an optical microscope and a hot pad. The chosen 10pF capacitor is located between the feed and the horizontal line for DC isolation.

The 1K-ohm resistance was placed to provide low frequency terminations. If the antenna is not supplied with a bias voltage (i.e passive), five fixed bands will be generated as shown in Fig. 2.

The components were connected to the DC supply to generate different voltages varying from 1V to 10V while the antenna was connected to a vector network analyzer to measure the return loss for various tuning voltages with different values of capacitances.

The measured reflection coefficients S11 of the antenna across the frequency range between 0.9 and 3.0 is shown in Fig.3. Examples of the measured and simulated co- and cross polar far field E-plane (y-z Plane) and H-plane (x-z plane) radiation patterns at 0.92, 1.7, 1.95, 2.4 and 2.9 GHz at 0V are presented in Fig.4. Further details and results will be presented in the full version of the paper.

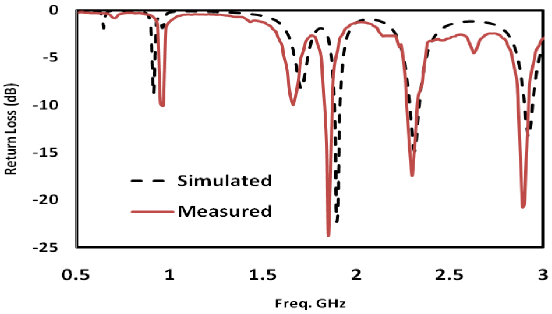


Fig. 2 The measured (solid) and simulated (dashed) return loss (S11) when the antenna is not biased (i.e. V=0)

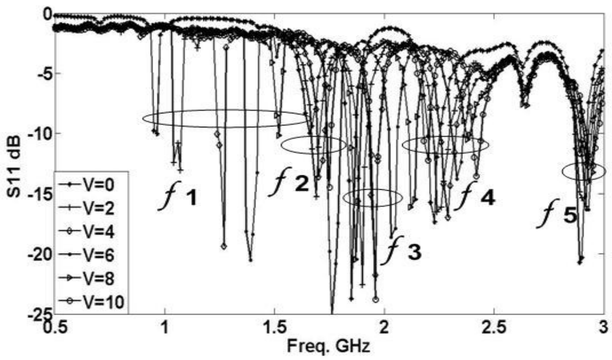
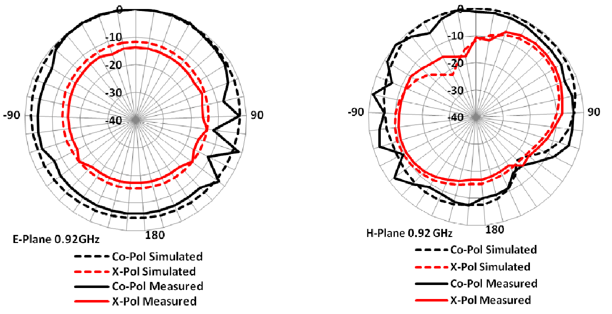
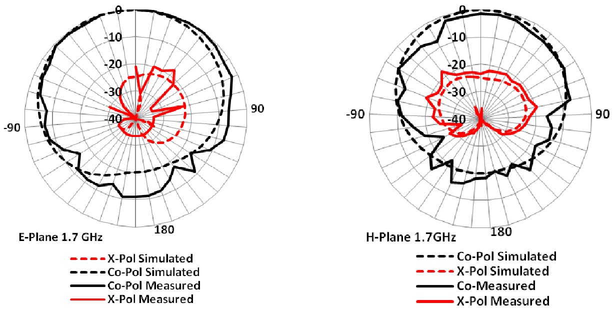


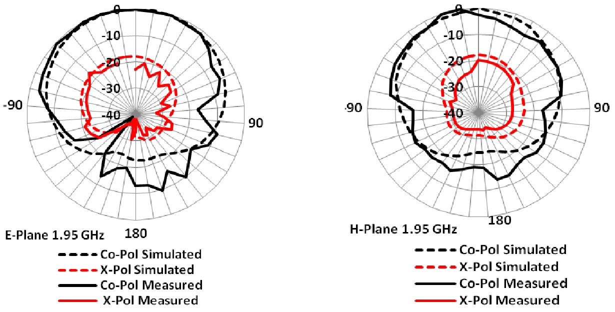
Fig. 3. The measured return loss S11 when applying different voltages to the four switches



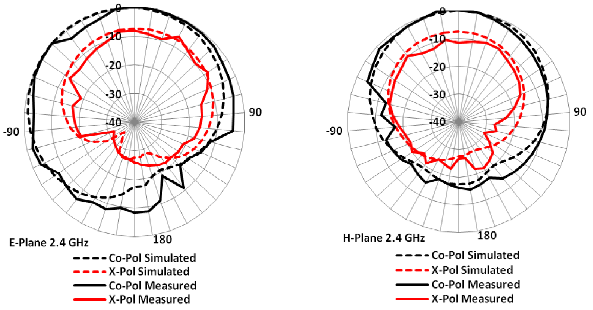
(a) 0.92 GHz



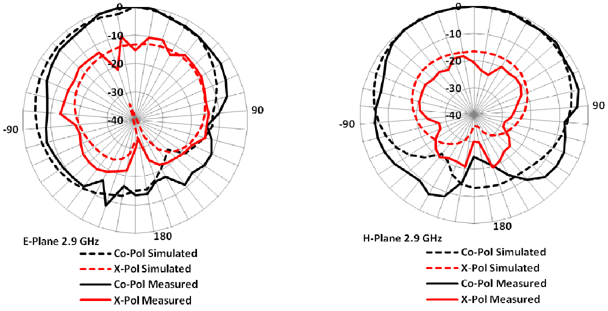
(b) 1.7GHz



(c) 1.95GHz



(d) 2.4GHz



(e) 2.9GHz

Fig.4. Measured versus simulated Co-Pol and X-Pol radiation patterns for E and H planes when all switches set to be 0V at (a) 0.92 GHz (b) 1.7 GHz (c) 1.95 GHz (d) 2.4 GHz and (e) 2.9 GHz

ACKNOWLEDGMENTS

The measurements at the NPL SMART chamber were supported by the Measurements for Innovators (MFI) program and the National Measurement Office, an Executive Agency of the Department for Business, Innovation and Skills.

REFERENCES

[1] D. Ressiguier, J. Costantine, Y. Tawk, and C. G. Christodoulou, “A Reconfigurable Multi-Band Microstrip Antenna based on open ended microstrip lines”, EUCAP09, Berlin, pp.792-795, March 2009.

[2] N. Behdad and K. Sarabandi, "Dual-band reconfigurable antenna with a very wide tunability range," IEEE Transactions on Antennas and Propagation, vol. 54, pp. 409-416, 2006.

[3] M. I. Lai, T. Y. Wu, J. C. Hsieh, C. H. Wang and S. K. Jeng, "Design of reconfigurable antennas based on an L-shaped slot and PIN diodes for compact wireless devices," IET Microwaves, Antennas & Propagation, vol. 3, pp. 47-54, 2009.