Tri-Band Planar Inverted F-Antenna for GPS, UMTS and WLAN or Bluetooth Applications

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Abstract—*In this article, a Tri-band planar inverted-F antenna is proposed. The antenna is a planar inverted-F antenna with ground slot. The advantage of the designed antenna compared with patch antenna is that the antenna size can be also reduced 50% as PIFA antenna. 1st band covers The Global Positioning System (GPS) band, 2nd band covers the Universal Mobile Telecommunications System (UMTS) band and the 3rd band cover The Wireless Local Area Network (WLAN) or Bluetooth band.Also, another advantages of the designed antenna compared with monopole antenna as well as microstrip antenna are planar and no dielectric loss.*

Keywords: *GPS, UMTS, WLAN, Bluetooth, PIFA.*

I. INTRODUCTION

With the rapid progress of wireless communication systems which come in variety size ranging from small hand-held devices to wireless local area networks. The integration of different radio modules into the same piece of equipment has created a need for multi-band antenna. The antenna which can operate at two or more frequency bands is more desirable and convenient. Therefore, the design of compact and multi-band antenna becomes a critical technique.

In numerous antenna structures, microstrip patch antenna is widely applied to design the antenna in ISM band generally. It is because the advantages of the microstrip patch antenna are low profile, lightweight and low cost. Directly-fed microstrip patch antenna usually have limited bandwidth about 2~4%. High dielectric constant material is conducive to the reduction of antenna size, but the problem of the radiation efficiency and the limitation of the bandwidth will occur [1][2].

Therefore, on the consideration of the size and bandwidth of the antenna, the microstrip patch antenna structure is replaced with the PIFA (Planar Inverted F- Antenna) gradually. For PIFA antenna, the size and bandwidth of the antenna will be reduced 50% and improved by introducing one more shorting pin than microstrip patch antenna [3]. PIFA has reduced backward radiation towards the user‘s head, minimizing the electromagnetic wave power absorption (SAR) and enhance antenna performance. The feature of the PIFA antenna is its quarter wavelength of the resonant frequency. This advantage compared with monopole antenna as well as microstrip antenna is planar and no dielectric loss, respectively. Based on the above analysis, we present a novel triple band planar inverted-F antenna. The main feature of the antenna is the slot cut in the ground plane [4]. Its biggest advantage is not only realizing the work of a triple-band PIFA, but also meeting the requirements of bandwidth and small antenna.

II. ANTENNA DESIGN

The antenna has a simple structure fed by 0.5mm radius using probe feed technique. The dielectric material selected for the design is FR-4 which has dielectric constant of 4.4 and height of dielectric substrate (h) = 1.6 mm. A microstrip radiator of width L2= 2mm is designed in IE3D. The radiator is fed by a 50ohms microstripfeedline of width Wf = 3mm and placed Wd= 6mm from the antenna edge. It occupies a small area of Lr = 10mm X Wg= 40 mm, one end of the radiator is folded twice with L1= 3mm and W1 = 26mm to form the configuration shown in Figure 1. To form an inverted-F antenna, other end of the radiator is grounded through a via. This is to compensate the large capacitance introduced from the coupling of the folded arm to the ground. The gap between the Lg = 90mm X Wg = 40mm ground plane supporting the antenna and the feedline to the shorting strip *G* = 4mm are the other parametes . The chosen ground plane size is typical for many wireless transceivers such as a mobile phone.

Following the technique in [5], a slot is introduced in the ground. The ground slot is placed Ld = 5mm from the ground top edge and has a dimension of Ls = 3mm Ws = 26mm as shown in Figure 1. All final dimensions are achieved through optimization using parametric study in IE3D.

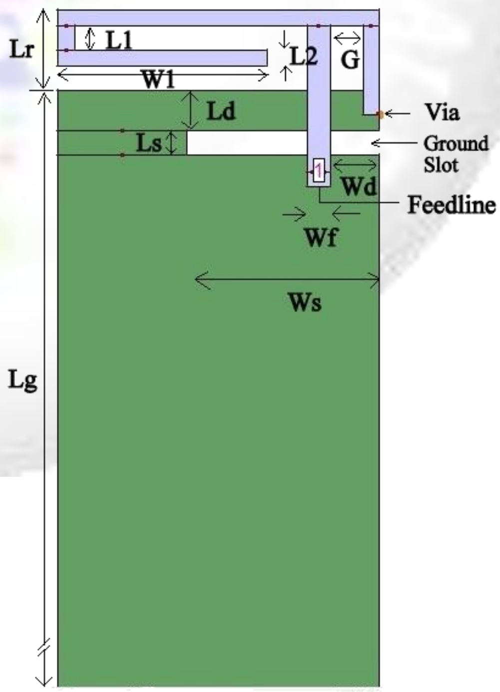

Fig. 1: Proposed Antenna

III. SIMULATION RESULTS

A. *Return loss:*

The practical circuit realization suffers with the mismatch between the available source power and the power delivered. This mismatch is known as return loss.

Return loss = -20log (Ʈin)

Where 'Ʈin' is input reflection coefficient. The return loss of the antenna is obtained as -14.75 dB at 1.5GHz, -16.52 dB at 2.1GHz and -19.40 dB at 2.4 GHz. So the designed antenna offers good gain and minimum losses at the specified frequency. It has a bandwidth of 70MHz, 110MHz and 200MHz respectively. The return loss of the antenna is shown in Fig 2.

B. *Radiation pattern:*

A microstrip patch antenna (PIFA) radiates normal to its patch surface. The elevation pattern for Φ=0 and Φ=90 degrees would be important. Figure below (see 3.a, 3.b, 3.c) show the 2D radiation pattern of the antenna at the desired frequency of 1.5GHz, 2.1GHz and 2.4GHz for Φ=0 and Φ=90 degrees in polar plot.

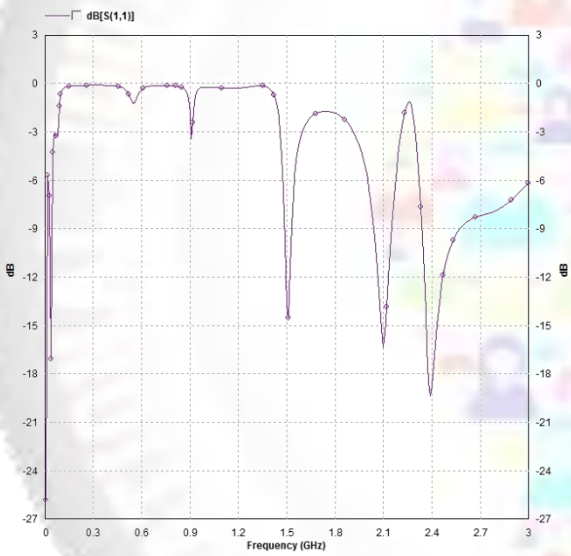

Fig. 2: Return loss

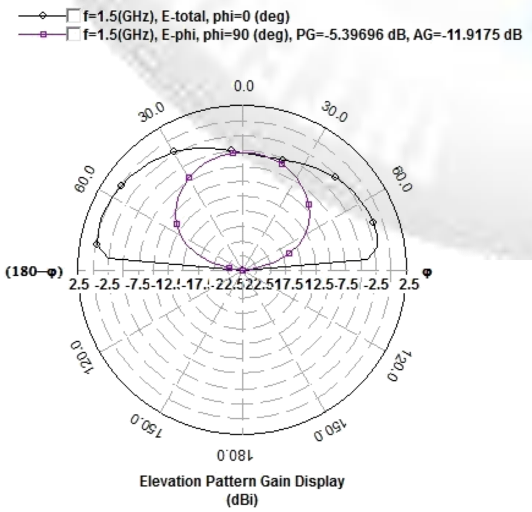

Fig. 3(a): Elevation pattern gain display (dBi) at 1.5GHz

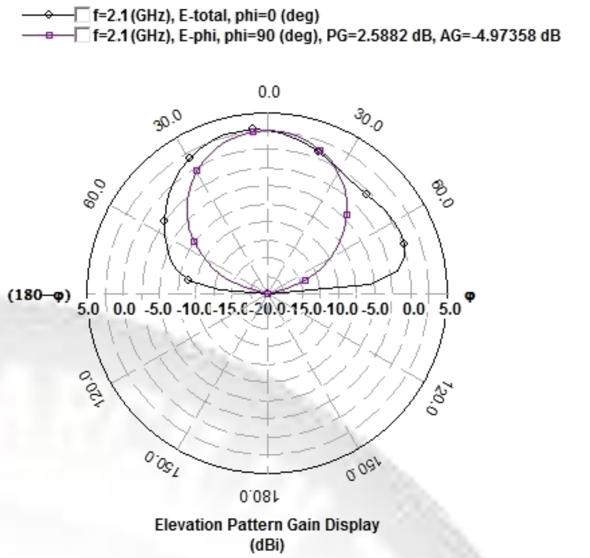

Fig. 3(b): Elevation pattern gain display (dBi) at 2.1GHz.

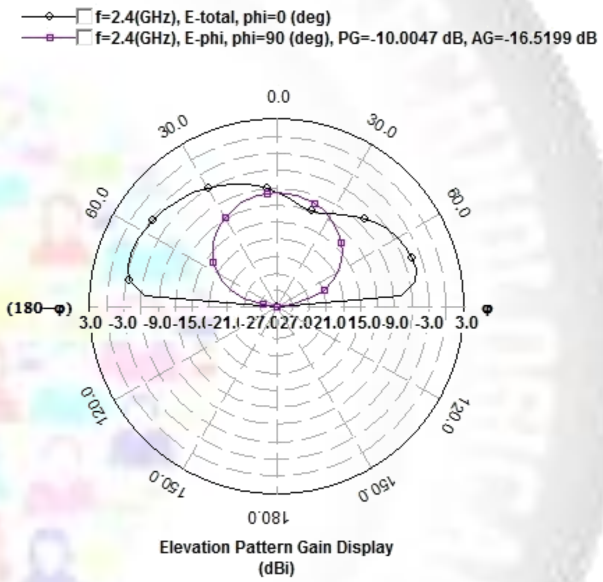

Fig. 3(c): Elevation pattern gain display (dBi) at 2.4GHz.

C. *Voltage standing wave ratio:*

VSWR is a function of reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is given by Ʈ, then the VSWR is defined as

VSWR = (1 + Ʈ) / (1 - Ʈ)

As shown in fig 5, the VSWR of 1.16, 1.29 and 1.05 was achieved for 1.5GHz, 2.1GHz and 2.4GHz respectively from simulation results.

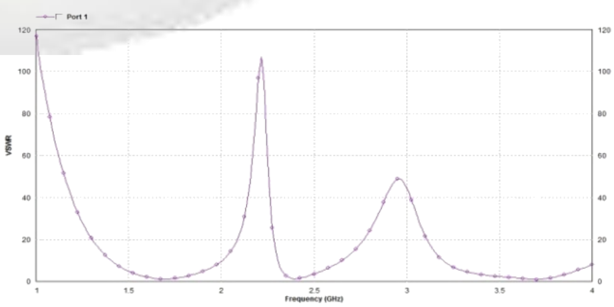

Fig. 4: Plot of VSWR v/s Frequency.

IV. CONCLUSION

A Novel compact Tri-band Polar Inverted-F Antenna has been designed and simulated to independently control GPS, UMTS and WLAN/Bluetooth bands. The antenna can be used as singleband or as multiband. Although the antenna has been design to operate in GPS, UMTS and WLAN/Bluetooth, it would also be possible to design the bands to any other system by changing the parameters of the top patch and by varying the length and width of the slots. This design also has a provision for tuning only the frequencies by varying the dimensions of the ground slot.

REFERENCES

[1] Zhan Li, YahyaRahmat-Samii, TeemuKaiponenz, “Bandwidth study of a dual band PIFA on a fixed substrate for wireless communication,” IEEE 2003Transactions on Antennas and Propagation, Vol 1, pp 435-438, June 2003.

[2] C. A. Balanis, Antenna theory: analysis and design, chapter 14, John Wiley & Sons, 1997.

[3] R. Chair, K.M. Luk and K.F. Lee., “Simulation of Bandwidth Enhancement on the Quarter-Wave Shorted Patch By Adding a Shorting Pin,” IEEE 2001International Symposium of Antennas and PropagationSociety, Vol 1, pp 82-85, July 2001.

[4] Razali, A. R. and M. E. Bialkowski, “Coplanar inverted-F antenna with open-end ground slots for multiband operation," IEEE Antennas Wireless Propag. Lett., Vol. 8, 1029{1032, 2009.

[5] Broadband Microstrip Antennas by Girish Kumar and K. P. Ray.

[6] H. F. AbuTarboush1, R. Nilavalan1, H. S. Al Raweshidy1 and D. Budimir2,”Design of Planar Inverted-F Antennas (PIFA) for Multiband Wireless Applications”.