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CPW-Fed Printed Slot Antenna for WLAN/WiMAX and UWB Applications

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***Abstract* - A CPW-fed printed slot antenna for WLAN/WiMAX and UWB applications is presented in this paper. By using beveled step on both sides of trapezoid slot and tapered central line of the CPW feed line for impedance matching improvement, the proposed antenna capably responds to extremely wide impedance bandwidth from 2.2-10.7 GHz covering the operation frequencies of WLAN/WiMAX and UWB systems. Having shown radiation patterns likely omni-directional in *xz* and *yz* plane, the proposed antenna capably been applied for various WLAN/WiMAX and UWB applications.**

***Index Terms* — Beveled step, printed slot antenna, extremely wide impedance bandwidth.**

I. Introduction

The operating frequencies between 2.4-6 GHz are occupied by several wireless communication systems including wireless local area network systems (WLANs) with IEEE802.11b/g/a (2.4-2.4835 GHz, 5.15-5.35/5.725-5.825 GHz) standards and worldwide interoperability for microwave access (WiMAX) with IEEE802.16e (2.5-2.69/3.3-3.7/5.2-5.8 GHz) standard. Also, the frequency range from 3.1-10.6 GHz or ultra-wideband (UWB) is determined for wireless personal area network (WPAN). Clearly, those operating bands have been close together and some bands are overlapping. As a result, antennas with extremely wide impedance bandwidth have been attracted. As apparently, the printed antennas are suitable to design operating for modern wireless devices due to exhibit many advantage properties such as low profile, light weight, various shapes for multi-mode resonant with compact size, low cost etc. Additionally, slot printed antenna is one of almost antenna usually designing for general wireless devices. Many techniques are employed to design slot printed antennas using for aforementioned systems. For example, the printed slot antennas based on square slots had been proposed for wideband [1]-[2] and ultra-wideband operations [3]-[4]. Although wideband and ultra-wideband are designed, the working bands are not covering entire WLAN/WiMAX and UWB systems. The antennas [5] and [6] can cover all WLAN/WiMAX and UWB frequencies, but they have large size. It is obviously that the compact slot printed antenna covering entire WLAN/WiMAX and UWB frequencies is attractively designed and strongly required.

In this paper, the CPW-fed slot antenna with extremely wide impedance bandwidth covering all frequencies is presented. Trapezoid slot on ground plane conductor is modified with beveled stepped-sides. A semicircle tuning stub on same side of FR4 substrate is also used. The tapered CPW-fed is applied for impedance matching improvement. The proposed antenna provides extremely wide bandwidth. All antenna design and measurement are as follows.

II. Antenna Design

A. Design Procedures

The software IE3D of Zeland is employed for simulation and optimization. The antenna structure is designed using single metallic side on FR4 substrate with the thickness of 1.6 mm, dielectric constant of 4.4, and loss tangent of 0.02. Firstly, the ground plane conductor is determined with dimensions of 34×36 mm^2 (≈0.43 λ_g). The trapezoid slot and the 50 Ω CPW feeding line with proper semi-circle exciting patch are used simultaneously. The first model capably generates five resonant modes covering impedance bandwidth of 2.2-10.9 GHz. However, the impedance matching at some frequencies as shown in Fig. 1 (a) is worse. Secondly, by applying both beveled stepped-structure and corner chamfered of conductor ground plane of CPW as shown in model 2, the impedance matching improvement at frequency range from 2.5-7.5 GHz is achieved. The slight contrary effect is found at exceed 7.5 GHz. Finally, the tapered central line of CPW is applied resulting in impedance matching is enhanced. Covering impedance bandwidth entire WLAN/WiMAX and UWB systems, the final model is chosen to propose. The simulation results of designed step and configuration of the proposed antenna are shown in Fig. 1 (a) and (b), respectively.

B. Parameter Studies

There are two major parameters effecting to characteristic of the proposed antenna, which are studied. The width of lower part of the slot (*W1*) can control lower edge frequency while the overall length of feeding line (*F1*) has more effect to impedance matching, as shown in Fig. 2. By adjusting *W1* of 25.5 mm which is proper size, the appropriate lower edge frequency is obtained, as shown in Fig. 2 (a). For other parameter, the simulation results when *F1* is altering are shown in Fig. 2 (b). The optimal impedance matching is achieved when the proper *F1* parameter is set to be 13.6 mm. It is seen that there is no effect to the other characteristics.

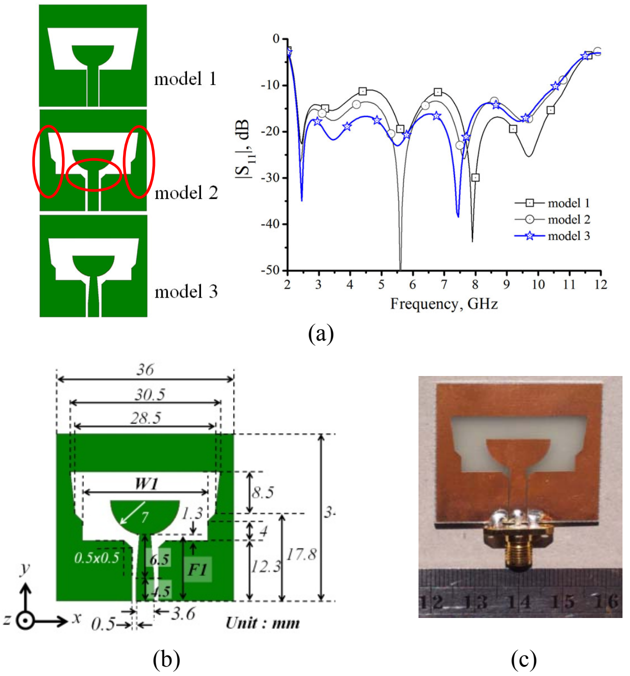

Fig. 1. (a) Configuration, (b) simulation results on designed step, and (c) prototype antenna.

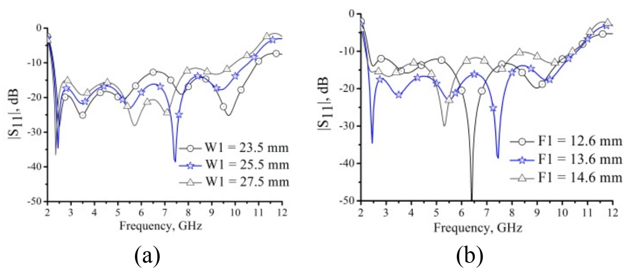

Fig. 2. Simulation results when (a) W1 and (b) F1 are varying.

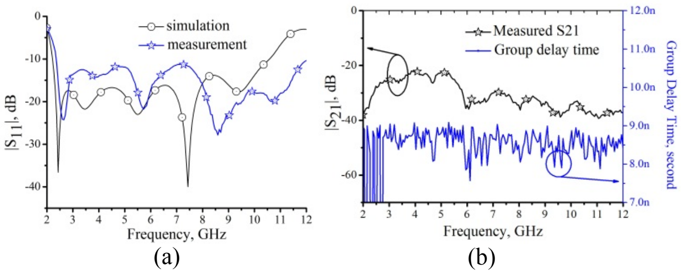

Fig. 3. (a) The S_{11} results and (b) time domain: S_{21} and delay time.

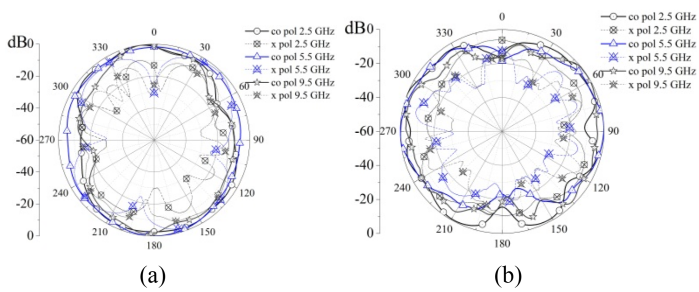

Fig. 4. Measured radiation patterns in (a) *xz* and (b) *yz* planes.

III. Implementation and Measurement Results

The prototype antenna shown in Fig. 1 (c) is implemented by chemical etching. Then, the impedance bandwidth is measured by network analyzer. A comparison $|S_{11}|$ from simulation and measurement results is shown in Fig. 3 (a). It is found that the resonant modes are agreement. However, the measured lower edge frequency is slightly shifted to higher due to the fabrication tolerance and discontinuous between the SMA and CPW. The measured impedance bandwidth shows 2.2-10.7 GHz. By setting two identical antennas with distance of 30 cm, the measured delay time and transfer function $|S_{21}|$ are obtained and shown in Fig. 3 (b). It is shown that the $|S_{21}|$ shows constant at entire band and the average delay time is about 8.5 ns with deviation of 3 ns, which good enough and suitable to use for impulse transmitting in UWB applications.

The measured radiation patterns results in *xz* and *yz* planes are shown in Fig. 4 (a) and (b), respectively. At lower frequency, the radiation pattern shows likely omni-directional in *xz* plane while slightly shown bi-directional at higher frequency. In *yz* plane, nearly bi-directional radiation pattern is given by the proposed antenna at entire band. The high cross polarization at whole band is found because the current paths on conductor ground plane around slot are orthogonal.

IV. Conclusion

The extremely wide impedance bandwidth printed slot antenna is presented in this paper. By modifying trapezoid slot with beveled stepped-structure on two sides of slot and applying gradual tapered central signal line of CPW for feeding the signal to semi-circle exciting patch, the proposed antenna capably operates covering frequency from 2.2-10.7 GHz. Nearly bi-directional radiation pattern in *yz* plane is given by the proposed antenna. The time domain shows nearly constant which suitable to use for the UWB system. Therefore, the proposed antenna is a good candidate to use for WLAN/WiMAX and UWB applications.

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