Small and internal UWB chip antenna for mobile handset

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1. Introduction

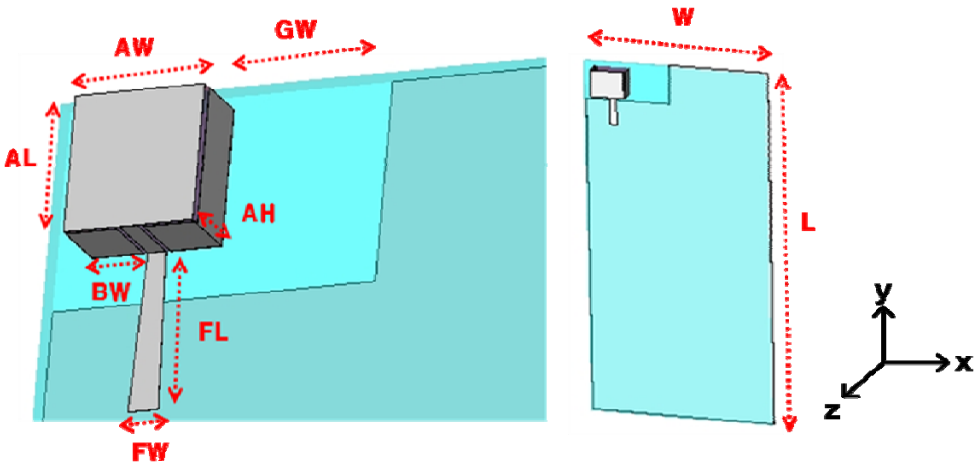
Ultra-wideband (UWB) technique has become one of the most fascinating technologies with various antennas. It has the merits of high speed transmission rate, low power consumption and simple hardware configuration over conventional wireless communication systems. The research and development of the UWB systems including antennas have been widely performed [1-5]. Recently, UWB systems have focused on USB dongles and wireless USB for mobile handsets with development of mobile communications [6-7]. In order to transmit and receive UWB signals, antennas for various terminals of mobile handsets using UWB technique is required. However, previous UWB antennas for USB dongles or wireless USB for mobile handsets have large size or high height to be inserted in terminals of mobile handsets [6-8].

In this paper, we propose a small and internal UWB chip antenna for wireless USB of mobile handsets. Various coupling among radiators is used to achieve wide band characteristic and miniaturization of the proposed antenna. A tapered feed line and folded feed line is also used to obtain an enhanced impedance matching characteristic. After all, it has very compact size as all radiators are is 6.4 x 6 x 3 mm^3 and the antenna clearance is 14 x 16 mm^2. The proposed antenna can cover ultra wide bandwidth of 3.1 ~ 10.2 GHz for VSWR less than 2. It also achieves good radiation and gain performance across the operating bandwidth. All simulations are in this work were carried out using CST Microwave Studio and a design example of the proposed antenna is demonstrated.

2. Antenna Design

The configuration of the proposed antenna is shown in Fig. 1. This antenna is fabricated on the FR4 substrate with dielectric constant 4.5 and height of 1mm. It is mounted on the top portion of the PCB of handset. The optimum design parameters are: AW = 6.4 mm, AL = 6 mm, AH = 3 mm, GW = 8 mm, BW = 2.6 mm, FL = 7 mm, FW = 1.5 mm, W = 35 mm, L = 80 mm. The size of the radiator is 6.4 x 6 x 3 mm^3 and the antenna clearance is 14 x 16 mm^2. It has very compact size and low profile. The PCB size is 35 x 80 x 1 mm^3 where other RF circuits can be integrated with the proposed antenna and it is considered dimensions of some practical size of mobile handsets.

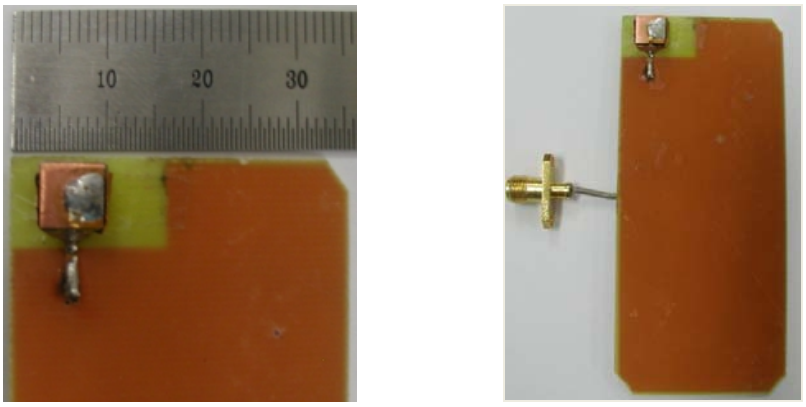
The proposed antenna is composed of a rectangular radiator, parasitic radiators on both right and left sides of a rectangular radiator, partial ground planes, a folded feed line and a tapered feeding point. A rectangular radiator and parasitic radiators is fabricated on the TLY-5A-0075-C1C1 substrate with dielectric constant 10 and height of 3mm. A rectangular radiator has similar characteristic to general planar monopoles [4]. Parasitic radiators operate as another radiator by using coupling with rectangular radiator and a folded feed line. Under and side ground planes of a radiator are partially removed and those can operate as another radiator by using coupling between parasitic radiators and ground planes. Moreover, Tapered feed line of the proposed antenna is also used for enhancing impedance matching and a folded feed line used for miniaturization of the proposed antenna. Therefore, an enhanced impedance matching and miniaturization of the proposed antenna can be realized.



(a) Proposed antenna (b) Proposed antenna with PCB
Figure 1: Configuration of the proposed antenna

3. Results and Discussions

Based upon the design dimensions shown in Fig.1(a) and (b), the proposed antenna is constructed and optimized to operate at all UWB band of 3.1 ~ 10.2 GHz for VSWR less than 2 and have a compact size. The photos of the proposed antenna with and without PCB are shown in Fig.2 (a) and (b). In practical, the feeding point of the antenna can be connected to the RF circuit on the reverse side of the PCB. Therefore, feeding point is connected with the use of a via. It can be seen that the proposed antenna has a very compact size.



(a) Proposed antenna (b) Proposed antenna with PCB
Figure 2: Fabricated antenna

The measured return loss of the proposed antenna in free space is shown in Fig. 3. It is examined by the Agilent Vector Network Analyzer. It shows that the impedance bandwidth for VSWR less than 2 is from 3.15 GHz to 10.4 GHz. The measured impedance bandwidth reaches 7250 MHz and it covers all UWB band.

As shown in Fig. 4, the measured radiation patterns on XZ plane are represented at 3.2 GHz and 7.5 GHz for the proposed antenna respectively. The solid line means the measured radiation pattern at 3.2 GHz and the dotted line means the measured radiation pattern at 7.5 GHz. Table 1 shows measured maximum gain of the proposed antenna. The gain varies from 1.5 dBi to 1.6 dBi on XZ plane.

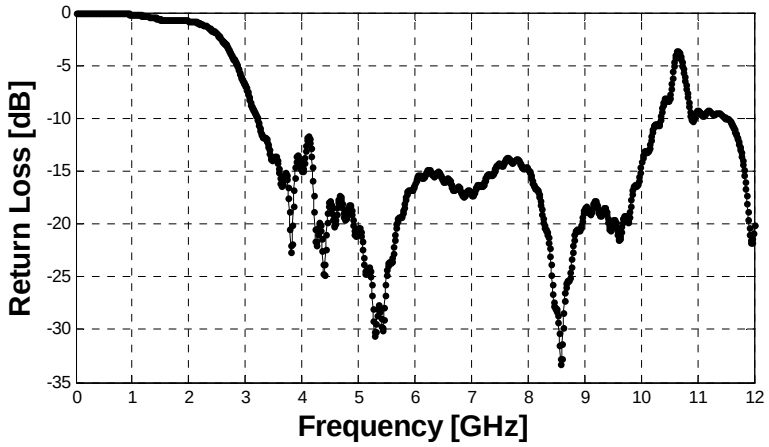


Figure 3: Measured return loss of the proposed antenna

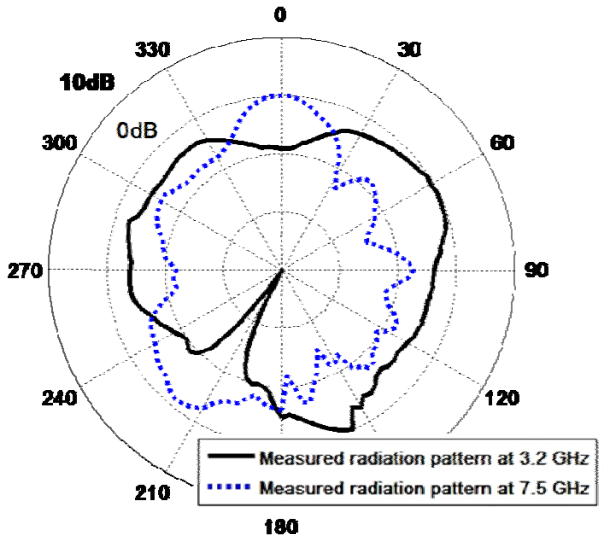


Figure 4: Measured radiation pattern of the proposed antenna

Table 1: Measured gain of the proposed antenna

$Gain_{peak}$ (dBi)	
3.2 GHz	**7.5 GHz**
1.5	1.6

4. Conclusion

The small and internal UWB chip antenna for mobile handsets is proposed to operate for all UWB band. A rectangular radiator has similar characteristic to general planar monopoles and parasitic radiators can be used to operate as another radiator by using coupling with rectangular radiator and a folded feed line. Under and side ground planes are partially removed to operate as another radiator by using coupling between parasitic radiators and ground planes. Moreover, a tapered feed line and folded feed line is also used to obtain an enhanced impedance matching characteristic. Therefore, an enhanced impedance matching and miniaturization of the proposed antenna can be realized. After all, the proposed antenna has very compact size as all radiators are is 6.4 x 6 x 3 mm^3 and the antenna clearance is 14 x 16 mm^2 .Moreover, it can covers all UWB band for VSWR less than 2. Good radiation characteristics for the proposed antenna over the UWB band

have also been achieved. The proposed antenna is very easy to implement by bending a simple metal plate into a compact structure. It will have strong potential for next generation of convergence between UWB system and mobile handsets.

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