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Design of C-Shaped Microstrip Patch Antenna for Various Wireless Applications Using HFSS

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ABSTRACT

Usage of cellular phones for long duration generates heat which leads to reduced data/talk time. To overcome this constrain supply voltage for the RF power amplifier in CDMA/WCDMA cellular phones is controlled which can also improve PA efficiency. For bandwidth enhancement a C Shaped antenna is used which is fed by mini-coaxial cable along with a thin printed ground-line that protrudes from ground-plane to be a balance-feed structure. Prototype of the antenna with length 25 mm, height 30 mm and width 5 mm has been designed. The human's hand effect on impedance bandwidth and radiation characteristics of the antenna is studied. A prototype is designed to cover hex-band: CDMA (8.24–8.94 GHz), GSM (8.8–9 GHz), DCS (1.71–1.88 GHz), PCS (1.85–1.99 GHz) and WCDMA (1.92–2.17 GHz), GPS (2.18-2.2 GHz). To verify the theoretical work, experimental results are shown.

Keywords: Wireless Networks, C-Shaped, VSWR

I. INTRODUCTION

Wireless products in recent days are expected to be small, lightweight and curvy. Designing an integrated antenna with multi-band operation is difficult to satisfy the bandwidth requirements. Optimizing the performance of the integrated antenna for wireless products is characterized by large bandwidth, omnidirectional radiation pattern and low power consumption. Dielectric-loading effects are expected when cellular phones are used in close proximity to human head. A novel hex-band antenna comprising a metal-wire-cutting bended monopole antenna (BMA) fed by mini-coaxial cable along with a thin printed ground-line to operate at hex-band: CDMA, GSM, DCS, PCS, WCDMA, GPS bands. Balance-feed structure of the antenna is provided by a printed thin ground-line that protrudes from ground-plane is like a sleeve-balun for BMA which overcome the interaction between the antenna and human body. This antenna combines Omni-directional; balance-feed structure, broad bandwidth and low profile in an easy to fabricate structure and the design details of the prototype are discussed below.

The combination of low PA efficiency and continuous PA operation causes the battery to drain quickly and the resulting internal power dissipation can also make the phone overheat. PA runs continuously until the data transmission is complete, which leads to phone heating. Power dissipation was a major problem for the early WCDMA handsets that supported high-speed data-transmission services.

It forced designers to include larger area heat sinks, more airflow for cooling, and larger capacity (bigger) batteries. Had they not overcome the issue of power dissipation, today's handsets would be bulky and heavy. Fortunately, the past few years have alleviated this problem by providing a dramatic improvement in PA power efficiency for CDMA/WCDMA cell phones.

II. ANTENNA STRUCTURE AND DESIGN

Antenna impedance is used to measure as return loss or VSWR and the parameter is analyses using Network Analyzer. Antenna gain and radiation patterns are used to measure as Anechoic Chamber. The anechoic environment eliminates all reflections and allows precise and repeatable measurements to be made. Reference antennas under test are typically rotated 360 degrees in multiple orientations for various different directions to determine the shape of the radiation pattern. Reference antennas are used to measure the impedance measurements, gain and radiation patterns. Efficiency is used to calculate the calibrated gain and radiation pattern measurement. In recent years, monopole antennas are the focus of microstrip antenna. Several monopole microstrip antennas for various structures, such as circular, square, elliptical, pentagonal and hexagonal have been proposed.

A suitable microstrip antenna should be capable of operating frequency over a bandwidth as allocated by the Federal Communications Commission. Efficiency and radiation pattern properties over the entire frequency range are also necessary. Microstrip patch antenna is a used for wireless communication and Global Positioning system nowadays. A microstrip antenna made up of a dielectric substrate, with a ground plane on the other side. Patch antenna such as low profile planer configuration, low weight, low manufacture cost and integrated circuit technology, the microstrip patch antenna is very well suited for applications such as wireless communication system, cellular phone, radar system, signal processing, network analysis and satellite communication system. Patch antenna is used to operate both in dual and triple frequency operations. After the study of several structures, C-slot microstrip antenna provides bandwidth up to 30% while various patch antenna can increase bandwidth above 30% .C-shaped microstrip patch antenna is used to optimize the base design in to obtain higher bandwidth.

C-Shaped antenna is placed on the top of the ground-plane i.e. the system circuit board. Antenna is made up of metal-wire-cutting BMA fed by mini-coaxial cable along with a thin printed ground-line which protrudes from ground-plane. The feed and ground points are connected to a 50 RG-178 coaxial-cable of length 10 cm, with a SMA connector. Dimension of antenna is 38mm: 40mm: 6mm.

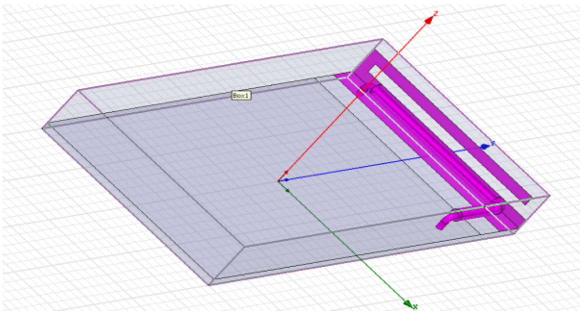

Figure 1: Proposed Structure for C-Shaped Antenna

Reduced electrical length of antenna and high upper and lower operating band width is caused due to the effect of reactive loading element. Total shape and dimension of resonant frequency is designed to occur at about 892MHz and 1800MHz. Quarter-wave length at the resonance frequencies helps in finding the length of radiating elements. Good impedance matching and extended band width is achieved by selecting appropriate dimensions of antenna structure. Printed ground line structure helps to obtain wider impedance band width in lower operating band. Small antenna element enhances the handset antenna's performance and enlarged antenna dimensions increase gain and bandwidth of the system. Hence ground-plane dimension plays key role in determining proper parameters to achieve desired band width of proposed design.

III. RADIATION CHARACTERISITICS OF PROPOSED ANTENNA

By the simulation of conventional structures and proposed structure using HFSS the C shaped structure shown in the figure 1 reduce radiation rapidly and also plot the graph XY shown in figure 2. C-Shaped Antenna pattern reduce the radiation -22.45 dB. To improve VSWR in the range of 1.47 are shown in the figure 4 and the typical power amplifier for CDMA/WCDMA cell phones structure are shown in the figure 1. The antenna should be small in order to be mounted in the limited space provided by the mobile handsets.

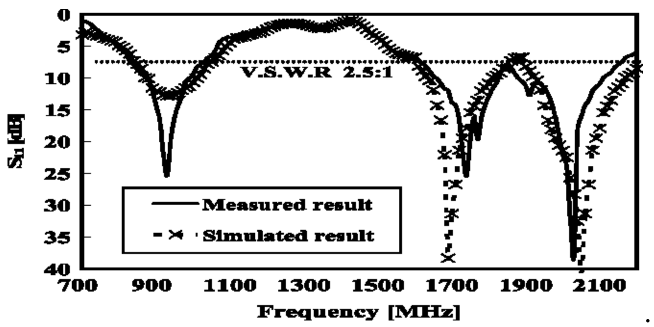

Figure 2: VSWR of C-Shaped Antenna

The desired radiation pattern should be primarily omni-directional in the horizontal plane. In addition, it should be noted that the ground-plane dimension could also affect the resonant frequency and operating bandwidth of the lower operating band. Use of the handset body as a part of the radiator is beneficial particularly when a small antenna element is used. The radiation pattern ZX plane shown in figure 3.

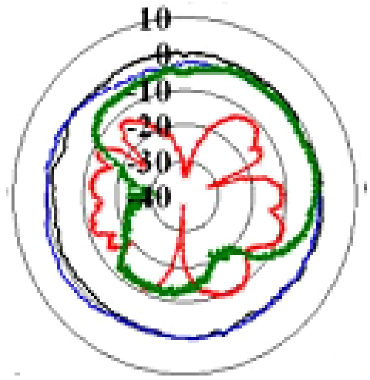

Figure 3: Radiation Pattern for C-Shaped Antenna

It enhances the handset antenna performance, as the handset body is usually larger than the antenna element and effectively enlarges the antenna dimensions so that the gain and the bandwidth of the antenna system are increased.

IV.SIMULATION RESULTS AND DISCUSSION

The dimension of proposed antenna is 40mm: 5mm: 6 mm and is mounted on the topside portion of an FR4 substrate (thickness of 1.5 mm, loss tangent of 0.023, relative permittivity of 4.3, and dimension is 80mm: 40 mm, front- and back-side is shorted by via hole), which can be treated as the circuit board of a practical mobile handsets. Effects of the space-distance between antenna and ground plane on the antenna operating bandwidth can be adjusted by varying the space-distance which is 5mm and the measured radiation patterns at 960 MHz and 1880 MHz for free space in the xy and zx-plane.

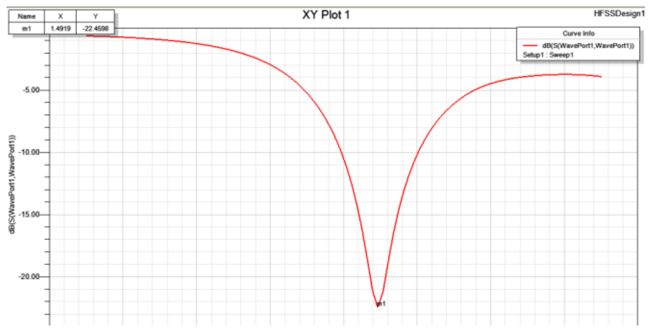

Figure 4. S- Parameters of C Shaped Antenna Design

V. CONCLUSION

By controlling supply voltages for the RF power amplifier in a CDMA/WCDMA cellular phone, PA efficiency is improved, heat is minimized, and phone's data/talk time dramatically extended. This antenna helps to implement a simple and low profile antenna for practical mobile handsets application. Experimental result shows that the structure offers very broad bandwidth characteristics. The design and implementation of a C-Shaped antenna along with controlled supply voltage for RF power amplifier is integrated in mobile handsets, which enhances the system performance. The balance-feed antenna system can overcome the interaction between human's hand effect and mobile handset is proved. More detail analysis for proposed antenna on mobile handsets such as Specific Absorption Rate (SAR) and Hearing Aid Compatibility (HAC) are the next subjects for research.

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