Penta-band Printed Antenna for Mobile Handset

Hemangi Patil
Dept. of Electronics and Telecommunication Engineering
SLRTCE, Mira Rd

Mrs. Manjiri Gogate
Assistant professor
Dept. of electronics and Telecommunication Engineering
SLRTCE, Mira Rd

Dr. S. S. Thakur
Dept. of Electronics and Telecommunication Engineering
VIT, Wadala, Mumbai.

***Abstract*—** There is rapid growth and development in the sector of wireless communication. The demand for high speed wireless communication for mobile phones is increasing day by day as LTE wireless standards promises of delivering high speed wireless communication for mobile phones and data terminals. To fulfil this the demand the requirements of printed antenna has increased due to their inherent properties of compact size, low cost, multiband, simple design and ease of fabrication. Proposed multiband printed antenna can cover GSM 850, GSM 900, DCS 1800, PCS 1900 and LTE 2300.

Key words: *penta-band antenna, mobile antenna, GSM, DCS, PCS, LTE.*

*****

I. INTRODUCTION

Antennas which can work properly in more than one frequency region either for transmitting or receiving electromagnetic (EM) waves are termed as Multi-band antennas. Such antennas are usually used for dual-band, tri-band, penta-band applications. Communication link reliability depends greatly on the performance of antenna employed and the challenges include link reliability, broad frequency bands, weight, scarcity of space, good impedance bandwidth, and good radiation performances and cost considerations.

Planar and printed monopole antennas are the good candidates for use in UWB wireless technology because of their wide impedance bandwidth and nearly Omni-directional azimuthally radiation pattern. Many shapes of planar, also known as planar disc, monopole antennas are reported, which yield very large bandwidth.

Printed monopole antennas (PMAs) are truly planar and have radiation patterns similar to that of a dipole antenna. These monopoles can be integrated with other components on printed circuit board, have reduced size on dielectric substrate, are without backing ground plane and are easy to fabricate. Printed antennas, commonly fabricated on FR4 substrate, are very cost effective, which is ideally suited for multiband technology-based low-cost systems [6].

Long-Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. The standard is developed by the 3GPP (3rd Generation Partnership Project) and is specified in its Release 8 document series, with minor enhancements described in Release 9. Y LTE is the upgrade same for carriers with both GSM/UMTS networks and CDMA2000 networks. The different LTE frequencies and bands used in different countries will mean that only multi-band phones will be able to use LTE in all countries where it is supported.

LTE stands for Long Term Evolution, and isn't as much a technology as it is the path followed to achieve 4G speeds. As it stands, most of the time when your phone displays the "4G" symbol in the upper right corner, it doesn't really mean it. When the ITU-R set the minimum speeds for 4G, they were a bit unreachable, despite the amount of money tech manufacturers put into achieving them. In response, the regulating body decided that LTE, the name given to the technology used in pursuit of those standards, could be labeled as 4G if it provided a substantial improvement over the 3G technology. Thus, LTE is marketed as 4G.

Currently in INDIA, 4G LTE band-40 having 2300 to 2400 MHz (TD-LTE) frequency range is active (online) and offered by the operators in Indian territory. The other LTE band in 1800 MHz (FDD-LTE) frequency is also auctioned by the INDIA government. But this LTE band is not offered for LTE by any telecom operators. This TD-LTE spectrum is cheaper to access and has less traffic.This 100MHz bandwidth of Band-40 from 2300MHz to 2400MHz is divided into downlink and uplink. Downlink refers to transmissions from ENB (i.e. base station) to UE (i.e. mobile user) and uplink refers to transmission from UE to ENB.

Recently, quad-band antennas for mobile phones and dual-band antennas for wireless local area network (WLAN) operations have been successfully designed. However, It is very challenging to design a single handset antenna to simultaneously cover all of the following communication standards, namely the GSM (Global System for Mobile communications, 880-960 MHz), DCS (Digital Communication System, 1710-1880 MHz), PCS (Personal Communication Services, 1850-1990 MHz), UMTS (Universal

Mobile Telecommunications System,1920-2170 MHz) and LTE(Long-Term Evolution 2300 MHz-2400 MHz).[1]

In this paper, we present a penta-band printed monopole antenna for mobile handset which can cover GSM 850, GSM 900, DCS 1800, PCS 1900 and LTE 2300. Here we are trying to achieve all the five frequencies by single antenna if possible.

II. ANTENNA DESIGN

Various shaped printed monopole antennas such as printed square monopole antenna (PSMA), printed rectangular monopole antenna (PRMA), printed hexagonal monopole antenna (PHMA), printed triangular monopole antenna (PTMA), printed circular monopole antenna (PCMA), and printed elliptical monopole antenna (PEMA) for different feed positions can be deisgned. These antennas are generally fabricated on FR4 substrate (εr =4.4, h = 0.16 cm and tan δ = 0.01) with backing ground plane removed.

If is the height of the planar monopole antenna in cm, which is taken same as that of an equivalent cylindrical monopole, and in cm is the effective radius of the equivalent cylindrical monopole antenna, which is determined by equating area of the planar and cylindrical monopole antennas, then the lower band-edge frequency is given as [3].

$$f_L = \frac{c}{\lambda} = \frac{7.2}{(L+r+p)} \text{ GHz} \quad (1)$$

Where, $f_{L=}$ lower edge frequency.
L= Length of antenna.
r= radius of equivalent monopole antenna.
P= feed length (0.3cm).
Λ= wavelength.
c= speed of light.

Where p is the length of the 50 Ω feed line in cm. Unlike the planar disc monopole antennas, the printed configuration has dielectric layer on one side of the monopole. This dielectric material increases the effective dimensions of the monopole leading to reduction in the lower band-edge frequency. This is also confirmed by simulation studies. Hence, more appropriate equation for the lower band-edge frequency is given as

$$f_L = \frac{c}{\lambda} = \frac{7.2}{(L+r+p)\times k} \text{ GHz} \quad (2)$$

Where, k= correction factor (1.15).

With reference to various configurations shown in Figure 1, L and W are calculated.

$$r = W/(2\pi) \quad (3)$$

Where, W= width of antenna.

Where r is calculated by,

$$F= (L/r)/ (1 + L/r) = L/ (L+ r) \quad (4)$$

Where F is calculate by,

$$F = L/0.24\ \lambda \quad (5)$$

III. CONCLUSION

The proposed idea says that, a single printed monopole antenna can be designed which will resonant at five frequencies: 800 MHz (GSM), 900 MHz (GSM), 1800 MHz (DCS), 1900 MHz (PCS) and 2300 MHz (LTE) for mobile hand-set. Design of antenna is done in both ways mathematically and graphically. Mathematically it is done by using all formulas mention above and graphically by simulating the design of antenna using IE-3D software.

Before buying 4G LTE phones in INDIA one has to know which LTE frequency bands in INDIA are available and supported by the Indian telecom operators. As currently only TD-LTE 2300 band is online. Thus, the proposed idea can overcome the issue of buying only 4G LTE mobile handset to access 4G LTE speed.

References

[1] Mohamed Mamdouh M. Ali 1; Andrew M. Azmy1; Osama M. Haraz, "Design and Implementation of Reconfigurable Quad-Band Micro Strip Antenna for MIMO Wireless Communication Applications," *31st National Radio Science Conference*, (NRSC2014) 14.

[2] Naixiao He; Yuan Yao; Youbo Zhang; Junsheng Yu; and Xiaodong Chen, "Design of An Internal Penta-band Monopole Antenna for Mobile Handset," *Antennas & Propagation (ISAP)*, 2013.

[3] Nayyer Fazal; Shahid Bashir, "Penta Band Micro Strip Patch Antenna," *International Conference on Robotics and Artificial Intelligence*, January 2013.

[4] Bin ZhOU; Raj Mittra and Guizhen LU, "A Systematic Design Procedurefor a Penta-band Antenna for Mobile Handsets," *Antennas and Propagation Society International Symposium*, 2009. APSURSI '09. IEEE

[5] Usama Shameem 1; Masood Ur-Rehman 1; Qammer Hussain Abbasi 2; and Khalid Qaraqe 2, "A Low Profile Penta-band Antenna For Portable Devices," *2016 International Workshop on Antenna Technology (iWAT)*, 978-1-5090-0267-2/16 ©2016 IEEE

[6] K.P. Ray "Design Aspect of Printed Monopole Antennas for Ultra-Wide Band Application," *Hindawi Publishing Corporation, International journal of antennas and propagation*, Vol. 2008, Article ID 713858.