Design of Multiband Antenna for Mobile Applications

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***Abstract*— Today the world is moving towards minimization. We interested in things that are small in size. Mobile technology is a fast growing technology where thin shape of mobile phones are in trend so by reducing the number of antenna the device shape can be reduced. In this paper a microstrip antenna is designed to operate at multiple mobile bands starting from 2G to 4G. The antenna result was simulated by EMPro software and the results are analyzed and studied.**

Keywords*— *Mobile communication, Size reduction Multiband, Slot antenna

I. Introduction

Today the world is connected with wireless devices, in which mobile plays an important role for transfer the data. We are in need of miniaturized antennas that are comfortable for our handheld devices. Mobile phones are working in many wireless communication systems, so designing the antenna for multiple frequency can reduce the overall device size. A slot antenna consists of a metal surface, usually a flat plate, with one or more holes or slots cut out. When the plate is driven as an antenna by a driving frequency, the slot radiates electromagnetic waves in a way similar to a dipole antenna.

There are many antennas that can achieve multiband frequency such as, a printed monopole slot antenna achieve a compact size by bending its top ground portion to be orthogonal to the system ground plane of the mobile phone [1]. Slots in the ground plane are used to improve the bandwidth at both low and high frequencies without increasing the volume of the antenna [2]. A multiband inverted-F antenna for mobile handsets has a independent control on the resonant bands for UMTS, m- WiMAX and 5GHz WLAN. A current distribution on the radiator is the controlling parameter of the antenna [3]. The antenna with open end U- shaped slot covered the frequencies of 690 to 750 MHz and 1700 to 4200 MHz, enabling it for mobile phone system application [4]. The antenna with rectangular slot with *T*-shaped stub, and two *E*-shaped stubs covered the GPS, WLAN, and WiMAX systems [5]. Single folded monopole slot antenna achieves GSM850/900, GSM1800/1900/UMTS bands [9].

II. Antenna Design

First the basic microstrip rectangular antenna is calculated by the below formula then slots of same shape and different dimensions are introduced. By introducing slot we increase the path of current flow. When current flow is increased we get multiband and reasonable bandwidth that is suitable for mobile application.

The width of the rectangular micro strip patch antenna is approximated by equation (1),

$$W = \frac{C}{2f_r\sqrt{\frac{(\varepsilon_r+1)}{2}}} \tag{1}$$

Where, C is free space velocity of light, f_r is frequency of operation, ε_r is dielectric constant. Then the formula to calculate the effective length is given by equation (2), effective length is the extra length that comes into account when an antenna is radiating. They are known as fringing field that must be eliminated.

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \tag{2}$$

Where, ε_{reff} is the effective dielectric constant. Then the formula to calculate the effective dielectric constant is given in equation (3),

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-\frac{1}{2}} \tag{3}$$

Where, h is the height of dielectric substrate and w is the width of the patch. Then the formula to calculate the patch length extension is given in equation (4),

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)} \tag{4}$$

The formula to calculate the actual length of the patch is given in equation (5),

$$L = L_{eff} - 2\Delta L \qquad (5)$$

III. PROPOSED ANTENNA

The proposed antenna used FR-4 as a substrate with a dielectric constant of 4.4, a loss tangent of 0.02 and a substrate height of 1.57 mm. The substrate has good tensile strength than the other available substrate. The total volume of the radiator is 20.59*26.803mm^2, while the overall volume of the antenna including the ground plane is 30*35mm^2. Fig. 1 shows the microstrip patch antenna all the dimension is in mm. The size of the antenna is calculated from the above microstrip rectangular formula from equation (1) to equation (5). The total size of the antenna is reduced so that it is comfortable to be fit in the mobile phone. Since a single antenna can operate at multiple mobile frequency the number of antenna can be reduced that leads to device ministration.

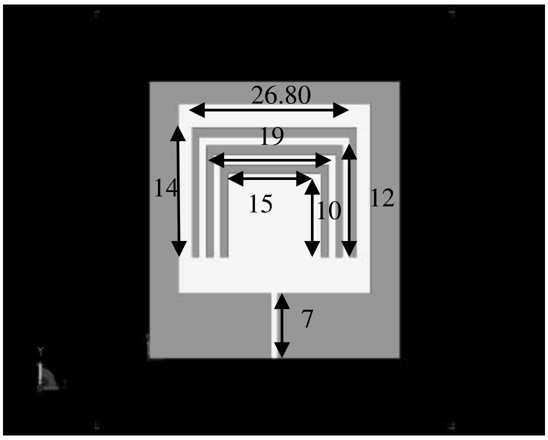

Fig. 1. Proposed Antenna

TABLE I Detailed Dimensions of the Proposed Antenna (In Millimeter)

Parameter	Dimension(mm)
L_p	20.59
W_p	26.803
L_s	7
W_s	1
SL_1	14
SW_1	23
SL_2	12
SW_2	19
SL_3	10
SW_3	15

The length and width of the three slots along with the patch and substrate dimensions are given in the table 1.The dimension of the ground plane is same as the substrate dimension.

IV. RESULTS AND DISCUSSIONS

This session discuss about the return loss and radiation pattern of the antenna. The proposed antenna is simulated using EMPro software.

Return loss is the parameter that describes the reflection coefficient of the antenna and the operating frequency of the antenna. Fig. 2 shows about the return loss. It has a multiband with return loss of -36.9 dB at 1.8 GHz is 3G frequency and -14 dB at 2.34 GHz which is 2G frequency and -13.15 at 4.5 GHz which is 4G frequency. It covers a three band of mobile communication from 2G to 4G so that three antennas can be replaced into a single antenna in a mobile that reduces the size of the mobile.

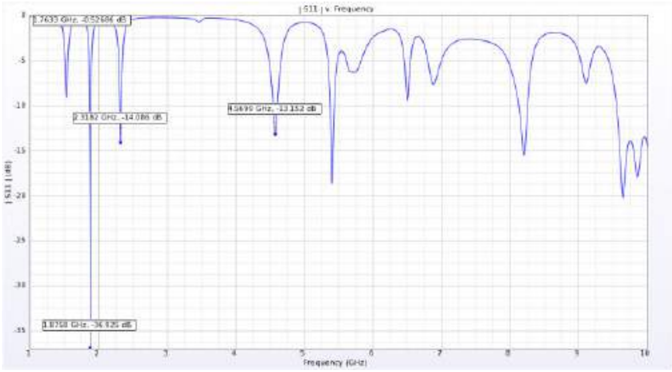

Fig.2. Return loss

Radiation pattern describes gain of the antenna at a specific direction. Also we can find the directivity of the given antenna. For mobile application antenna must have a Omni directional radiation pattern with equal gain at all frequency. Fig. 3 shows the radiation pattern of the antenna. It is a Omni directional radiation pattern that is suitable for mobile communication. The gain of the antenna is 3 dBi.

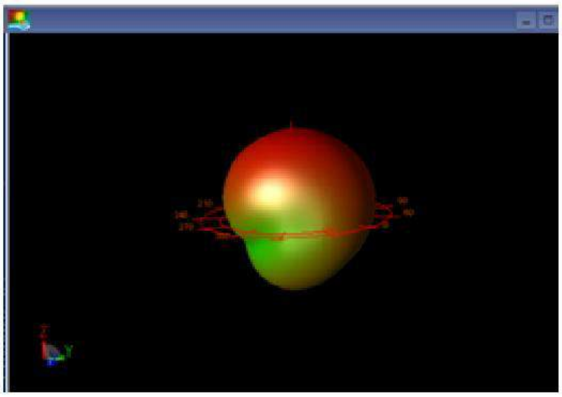

Fig. 3. Radiation Pattern

IV. CONCLUSION AND FUTURE WORK

The proposed Microstrip slot antenna is designed by using EMPro software. From the simulation result it is noted that the designed antenna works at multiple mobile frequency as 1.8 GHz for 2G, 2.31 GHz for 3G and 4.5 GHz for 4G.These frequency have desirable return loss and gain in the three mobile frequencies that is obtained in the simulation. By using this proposed antenna three antennas can be replaced by a single antenna. The total size of the antenna is very small so that the device size can still be reduced. Further the antenna can be modified to achieve more frequency for ISM Band application. And since it an antenna designed for mobile application we have to achieve a SAR rate as per the value specified for mobile antenna. So next we have to calculate the SAR for the proposed antenna. And introduce technique to minimize the SAR rate.

REFERENCES

[1] Chun-I Lin and Kin-Lu Wong, "Printed Monopole Slot Antenna for Internal Multiband Mobile Phone Antenna," IEEE Transactions on Antennas and Propagation. vol.55, no. 12, pp. 3690-3696, December 2007.

[2] Arnau Cabedo, Jaume Anguera, Cristina Picher, Miquel Ribó, and Carles Puente, "Multiband Handset Antenna Combining a PIFA, Slots, and Ground Plane Modes," IEEE Transactions on Antennas And Propagation, vol. 57, no. 9, pp. 2526-2533, September 2009.

[3] Hattan F. AbuTarboush, R. Nilavalan, Thomas Peter, and S. W. CheungCheung, "Multiband inverted-F antenna with independent bands for small and slim cellular mobile handsets," IEEE Transactions on Antennas and Propagation, vol. 59, no. 7, pp.2636-2645, July2011.

[4] Cho-Kang Hsu and Shyh-Jong Chung, "Compact Antenna With U-Shaped Open-End Slot Structure for Multi-Band Handset Applications," IEEE Transactions on Antennas and Propagation, vol. 62, no. 2, pp. 929-932, February 2014.

[5] Y. F. Cao, S. W. Cheung, T. I. Yuk, "A Multiband Slot Antenna for GPS/WiMAX/WLAN Systems," IEEE Transactions on Antennas and Propagation, vol. 63, no. 3, pp. 952-958, March 2015.

[6] X. L. Sun, S. W. Cheung, and T. I. Yuk, "Dual-band monopole antenna with compact radiator for 2.4/3.5 GHz WiMAX applications", Microw. Opt. Tech. Lett., vol. 55, no. 8, pp. 1765–1770, Aug. 2013.

[7] X. L. Sun, S. W. Cheung, and T. I. Yuk, "Dual-band monopole antenna with frequency tunable feature forWiMAX applications," IEEE Antennas Wireless Propag. Lett., vol. 12, pp. 100–103, Mar. 2013.

[8] Youngtaek Hong, Jinpil Tak, Jisoo Baek, Bongsik Myeong, and Jaehoon Choi," Design of a Multiband Antenna for LTE/GSM/UMTS Band Operation," International Journal of Antennas and Propagation, volume 2014, pp. 1-9, May 2014.

[9] Fang-Hsien Chu and Kin-Lu Wong," Simple Folded Monopole Slot Antenna for Penta-Band Clamshell Mobile Phone Application," IEEE Transactions On Antennas And Propagation, Vol. 57, no. 11, pp.3680-3684, November 2009.

AUTHOR DETAILS

Karthika K pursuing her Post Graduation in Communication Systems from Mepco Schlenk Engineering College, Sivakasi, Tamil Nadu, India. She had completed B.E. Degree in Electronics and Communication Engineering from Infant Jesus College of Engineering, Thoothukudi, Tamil Nadu, India, in 2015. She is specialized in Antenna Design. She had good academic response.