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Multiband Printed Monopole Slot Antenna For Mobile Phone

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Abstract:

We formed a new internal multiband mobile phone antenna by cutting two printed monopole slots of different lengths at the edge of the system ground plane of the mobile phone.It will generate one wide band centered at about 1850 and 2170 MHz to cover the PCS/UMTS bands.The antenna occupies a small area of 11.4x40 mm^2 only,hence it has a simple planar structure.We will be able get good radiation characteristics over the wide operating bands.

Key words: *Internal mobile phone antennas, mobile antennas,monopole slot antennas, multiband antennas, printed antennas.*

1.Introduction

Recently, it has been demonstrated that by cutting the printed slot at the edge of the ground plane, a quarter wavelength or monopole slot antenna can be obtained.With comparison to the general slot antenna that is operated as a half-wavelength resonant structure the monopole slot antenna has an attractive feature of compact in size for a fixed operating frequency. The compact size makes it promising for application in the mobile devices. In addition, the monopole slot antenna has a simple planar structure and is suitable to be printed on the system circuit board of the mobile device, which makes it easy to fabricate at low cost for practical applications. This is an advantage over the internal patch antennas that have been applied in many mobile phones.In this paper, we are going to present a promising design of the monopole slot antenna for dual band operation in the mobile phone. The proposed antenna is to be placed at the top portion of the system ground plane of the mobile phone, different from the reported design of placing the slot at the center of the ground plane .In that case, maximum coupling to the low-Q chassis dipole type resonance can be obtained, providing sufficient bandwidth and efficiency to cover the 1.850~2.170 GHz frequency range.However, the reported design in complicates the circuit floor planning and signal line routing. The proposed antenna is formed by two monopole slots of different lengths and is fed in series by using a microstrip feedline, different from the parallel-feeding arrangement described in for dual-band WLAN operation. The series-feeding arrangement allows the two monopole slots to be closely spaced with a small spacing (1mm here), which is helpful for the antenna to occupy a smaller board space in the system circuit board of the mobile phone.In addition, the antenna is capable of multiband (dual-band) operation covering the PCS (1850~1990 MHz), and UMTS (1920~2170 MHz) for mobile communication. With multiband operation achieved in this study, however, the proposed printed monopole slot antenna requires a small area of on the system circuit board of the mobile phone. Design considerations of the antenna are described in detail in the paper, and results for the constructed prototype are presented and discussed. Effects of various parameters on the antenna performances are also analyzed.

2.Design Considerations And Simulation Of Monopole Slot Antenna

Fig.1 shows geometry of the monopole slot antenna for mobile phone application. The antenna is printed on the top portion of the system circuit board of the mobile phone, whose Fig.1 shows the geometry of the proposed printed dimensions are selected to be

100 mm in length and 40 mm in width. The selected dimensions are reasonable for general mobile phones, and in this study the circuit board is fabricated using a 0.8-mm-thick FR4 substrate of relative permittivity 4.4 and loss tangent 0.0245. The printed metal on the FR4 substrate has a conductivity of $5.8x10^7$S/m . The circuit board is also enclosed by a 1-mm-thick plastic housing with relative permittivity 3.5, whose dimensions are shown in Fig.1The outer thickness of the housing is 12 mm, which is about the size of thin mobile phones that are attractive for many mobile users recently.The antenna consists of two monopole slots of different lengths cut at the edge of the ground plane printed on the system circuit board. Detailed dimensions of the two monopole slots are shown in Fig.1 Monopole slot 1 has a length of 19.95 mm monopole slot 2 has a length of 25.45 mm Note that owing to the presence of the FR4 substrate on one side of the printed monopole slot, which decreases the resonant frequency of the antenna , the required length for the monopole slot to operate as a quarter-wavelength resonant structure is decreased. For this reason, the lengthsS_1 andS_2 in this study are smaller than one-quarter wavelength. The two monopole slots are chosen to have a wide width of 3.2 mm, which is helpful for widening the bandwidths for the antenna. However, in order to reduce the occupied area of the antenna, the spacing between the two monopole slots is chosen to be 1 mm only. On the other hand, the top ground portion requires a wide width of 4mm to achieve good excitation of the antenna.

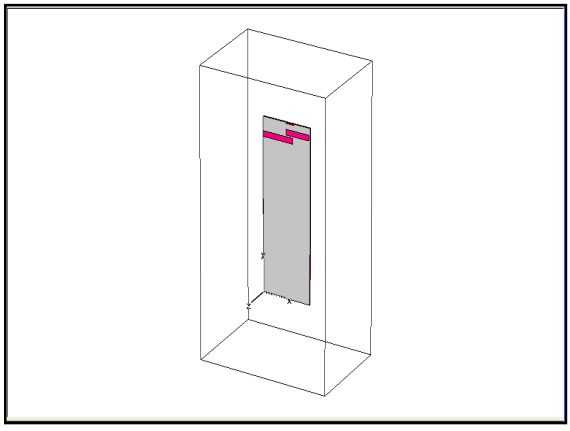

Figure 1: Geometry of the antenna

To excite the two monopole slots, a 50Ω microstrip feed line printed at the location of 23 mm away from the edge of the ground plane or the open ends of the two monopole slots is used. The tuning-stub length of the feed line is chosen to be the same as that of the top

ground portion to simplify the design consideration. For the location 23 mm, it has a large effect on the impedance matching.

Effects of the ground plane length L on the performance of the antenna are generally are smaller than those of the conventional internal mobile phone antennas.

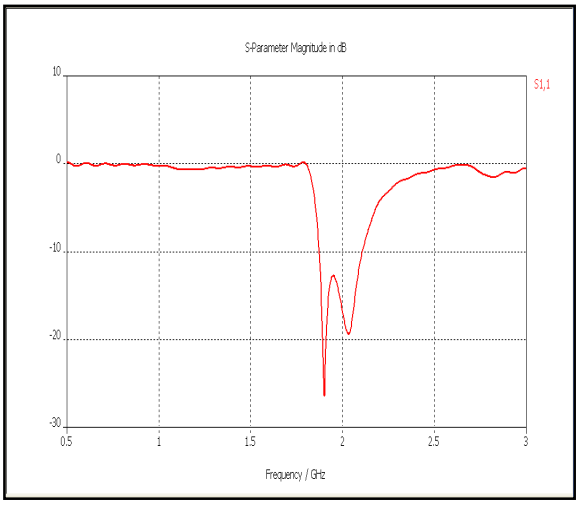

Figure 2: Simulated return loss

3.Fabrication And Measurement

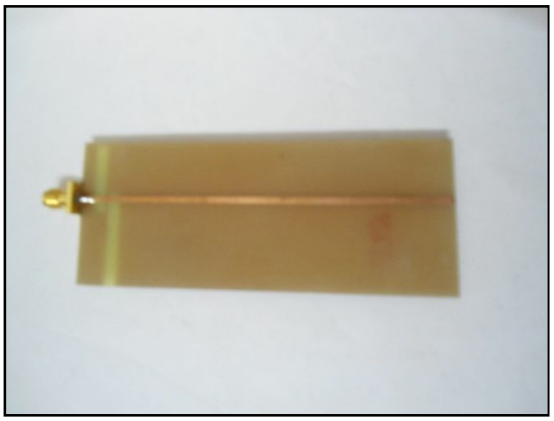

Figure 3: Front view of antenna

Here fig.1 and fig.2 show fabricated antenna in which front side show the location of transmission line which is 50Ω microstrip feedline which use to excite the two monopole slots antenna.It is 23 mm away from the edge of the ground plane or open ends of the two monopole slot antenna.

Back view of antenna is also shown.In back side,on ground plane,we cut two different length of slots.we keep spacing between these two antenna is 1mm.

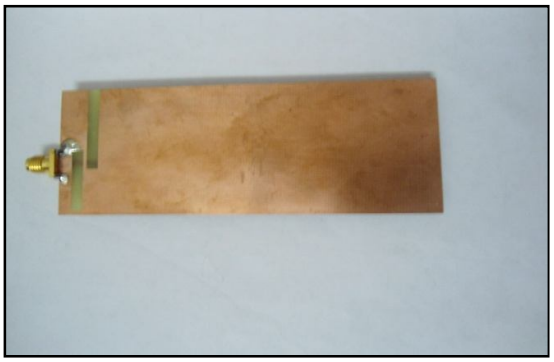

Figure 4: Back view of antenna

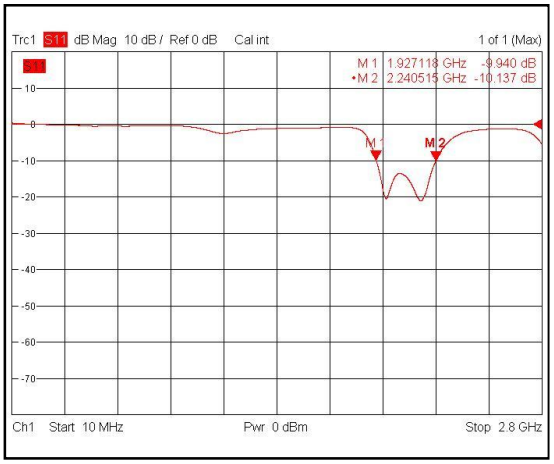

Figure 5: Measured result

4.Results And Discussion

Based on the design dimensions given in Fig.1 the antenna was fabricated and tested. Fig.5 and Fig.2 shows the measured and simulated return loss of the fabricated prototype. The simulated results are obtained from CST Microwave studio.

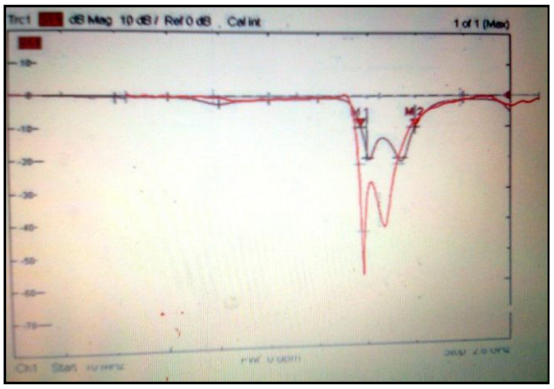

Figure 6: Measured and simulated result

The dual-resonance behavior is obtained largely because, for the microstripline-fed slot, the microstrip line can function as a virtual short-circuiting across the slot. This leads to the generation of an additional resonance with a frequency slightly higher than that of the original resonance. It can concluded that the antenna band are mainly generated by monopole slots 1 and 2,respectively.

4.1.Parametric Study Of The Antenna

Results indicate that the presence of the top ground portion is important for achieving good impedance matching over the antenna's lower and upper bands. Acceptable bandwidths are obtained when the length of the top ground portion is at least 4mm. This length adds to the total length (11.4 mm here) of the proposed antenna. By fixing to be 4 mm, effects of the variations in are studied. this case, the total length of the antenna is fixed to be 11.4 mm, Thus, with varied, the width of the spacing or ground portion between monopole slots 1 and 2 is varied. Indicating that a wider slot width can lead to an increased bandwidth.. In order to minimize the total length of the antenna, the width is selected to be 1 mm as the preferred dimension.

Fig.2 shows the simulated return loss for the antenna.In the latter case, the total length of the antenna is 11.5mm , different from that in the former case.

4.2.Radiation Characteristics Of The Antenna

Radiation characteristics of the constructed prototype Studied.

4.3.User's Hand And Head Effects

Also note that the user's hand and head will cause large effects on the mobile phone antenna, and related issues of the user's hand effects have been studied. For the proposed antenna here, its radiation efficiency with the presence of the user's hand and head is studied using the SEMCAD simulation software. The simulation model with the studied antenna embedded in the plastic housing. Radiation efficiency decrease more in presence of users hand and head both.

5.Conclusion

For internal multiband mobile phone, a printed monopole slot antenna has been proposed. It has a simple structure and is easy to be printed on an area of 11.4x40 mm^2 in the top portion of the system circuit board. In addition it can generate wide bands, covering the PCS/UMTS operation., and good radiation characteristics over the operating bands. The proposed printed monopole slot antenna is especially suitable for application in the modern thin mobile phones as an internal antenna. In future, we can modify it by increasing its efficiency or adding some extra features like changing its operating bands. Means, it can work for different band or for more than two bands.

6.Reference

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