

BW Enhancement of Slot Antenna with Application of Filter in MS Feed Line

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Abstract: A planar inverted L-slot antenna is proposed covering different bandwidth applications. The open slot antenna configuration for GSM/DCS/PCS/UMTS/WLAN bands is described. The inverted-L slot antenna system composed of filter circuit within microstrip feed line to enhance the bandwidth. For LC band pass filter, the value of inductor and capacitor is calculated parametrically. The antenna achieves frequency range 1710-2690 MHz for -10dB return loss. The S11 parameter for antenna with filter and without filter is discussed.

Index Terms— Personal Communications Service (PCS), slot antenna and Universal Mobile Telecommunication Standard (UMTS)

1. INTRODUCTION

The developments of tablet computer with metallic frame needs planar antenna which covers multiband operations. The slot antenna has various advantages such as simple structure, wide bandwidth and efficient radiation. By designing a slot of different shapes such as L or T-shaped slot in the ground plane the open slot antenna can be developed [1]. The length of the slot is to be quarter of the wavelength of its solution frequency at which antenna is operated [2]. The ground plane of the open slot antenna can be exploit to mount other device components. The installation of device components provides compact designs. Due to standing wave magnetic current distribution the inverted-L slot antenna yield linear polarization along the slot designed in the ground plane [3]. The impedance of the slot antenna can be varied by change in the slot dimensions i.e. width and length of the slot [4].

For three band operations, a monopole lateral extension is adjoined which gives rise to generate resonant mode to the slot antenna produces additional operating band [5]. The drawback of monopole lateral extension is the increase in size of the antenna. The frequency reconfigurable antenna provides multiband operations with the use of RF switch [6]. The large antenna dimension of the antenna and the switch makes the mobile devices bulky. Therefore an inverted-L shaped slot antenna with filter is proposed in the paper. The passive components of band pass filter provide wide bandwidth at -10 dB return loss.

The dual resonance behavior the capacitive microstrip feed line can be used [7]. These days the tablet computer comes with

metallic frame. To utilize the frame an inverted E- feed antenna excited by direct microstrip feed line of small dimension is proposed [8]. A planar inverted -T open slot antenna with two microstrip feed line is proposed [9]. This antenna designed on FR-4 Epoxy substrate of thickness 1.6 mm and loss tangent 0.02. The proposed inverted- L slot antenna system incorporates GSM1800/1900, DCS (1710-1880 MHz), Personal Communication Service (1850-1990 MHz), UMTS (1920-2170 MHz) and WLAN (2400-2480 MHz) bands.

2. ANTENNA CONFIGURATIONS

A. Antenna Design

Fig.1 shows the proposed inverted L- open slot antenna with band pass filter. An inverted L shape is dissected from the ground plane which is made of copper. Thus, the inverted L- open slot antenna is designed. The FR-4 substrate is used for this antenna system with 1.6 mm thickness and 0.02 loss tangent with 4.4 relative permittivity.

In tablet computer, metallic frame is surrounded by the side edges perpendicular to the ground plane. Thus, an opening of 4 mm equal to slot width is provided within the side metal frame.

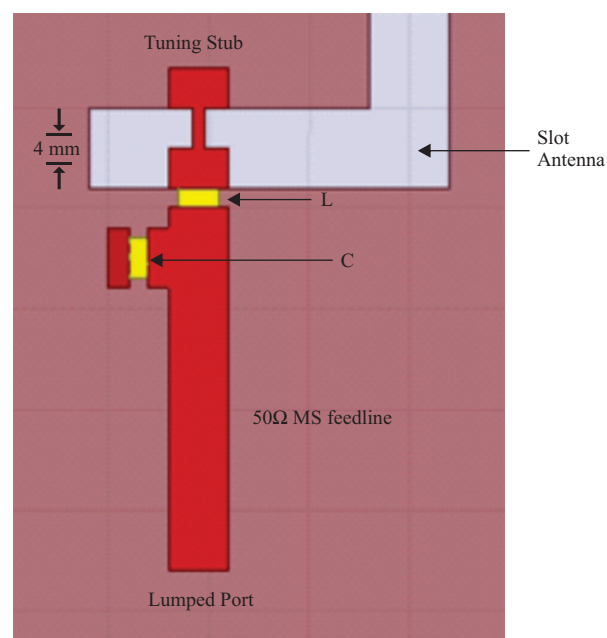


Fig.1 Dimensions of the proposed antenna

inverted-L slot has uniform width of 4mm, the total length of the open slot antenna is 22 mm which is only 0.16 times of the wavelength. The reduction in slot size from quarter of wavelength to 0.16 times of wavelength is because of FR-4 epoxy substrate induces loading effect.

For proper impedance matching of 50 Ω microstrip feed line the microstrip feed line is shifted from the center of the slot. The 0.5 mm MS line is used to feed the inverted L- slot antenna. In designing the MS linefeed the openings of 0.5 mm is left for soldering passive filter components i.e. chip capacitor in parallel and inductor in series. The microstrip line is evolved by the band pass filter composed of passive chip components (L= 4nH, C=1pF).

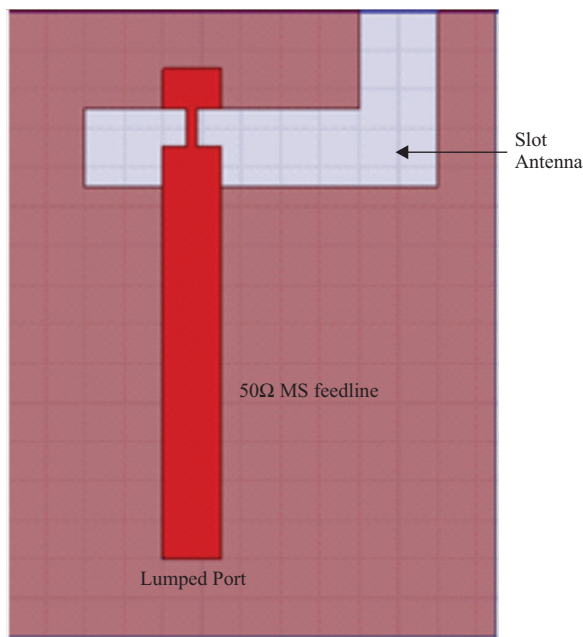


Fig.2 Antenna design without filter

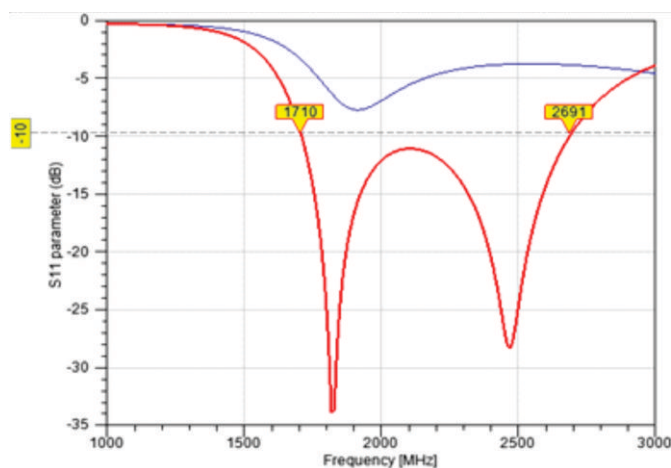


Fig.3 Scattering parameter S11 of Antennawithout band pass filter and with band pass filter (L,C)

By incorporating band pass filter in the microstrip line feed of open L-slot antenna the bandwidth of 1710-2690 MHz bandwidth is attained at -10 dB return loss. The return loss of -34

dB is obtained at 1800 MHz.

Thus, by the application of filter it is observed that the bandwidth can be enhanced as well as return loss can be minimized for a particular bandwidth application.

3. WORKING PRINCIPLE

The inverted-L open slot antenna system is shown in Fig.1. The excitation is provided at the lumped port on microstrip line feed of width 3 mm. The inverted L-slot is fed by 0.5 mm width microstrip line. The impedance of the slot antenna is zero at the center and maximum at the side edges of the slot. Therefore, for impedance matching of 50 Ω microstrip line the feed is to be shifted towards the left from the center of the slot antenna. The slot antenna is simple the complimentary dipole antenna. The impedance of the slot antenna is given by Booker's extension of Babinet's Principle [4]

$$Z_s = \frac{Z_0^2}{4Z_d}$$

Where, Z_s = impedance of the slot antenna
 Z_d = impedance of the diode
 Z_0 = impedance of the ambience medium

For proper impedance matching a tuning stub of 2 mm × 3 mm is used at the other end of MS feed line of width 0.5 mm. The microstrip line of 3 mm width incorporates band pass filter. The values of filter components are obtained by parametric analysis by ANSYS Electromagnetic Suite 17.1. The optimum values of L=4nH and C= 1pF is used to get the required bandwidth.

4. RESULTS

The Scattering parameter S11 for antenna with filter and antenna without filter is shown in Fig.3. The results shown are simulated by ANSYS Electromagnetic Suite 17.1. It is observed that by applying filter to the MS line the bandwidth is enhanced as well as return loss is decreased. The proposed inverted L-slot antenna with band pass filter covers GSM1800/1900, DCS (1710-1880 MHz), Personal Communication Service (1850-1990 MHz), UMTS (1920-2170 MHz) and WLAN (2400-2480 MHz at -10dB return loss.

5. CONCLUSION

A planarinverted L-slot antenna with band pass filter for GSM1800/1900, DCS, PCS, UMTS and WLAN2400 bands is proposed and studied. The antenna is planar, compact and covers wide bandwidth appropriate for tablet computer.

In future, the dimensions of the handheld devices such as tablet computer requires antenna with very small dimension as well as wide bandwidth applications. The slot antenna gives wide bandwidth as well as very good efficiency. The ground of the slot antenna can be used for mounting other electronic components gives rise to concise design of the antenna.

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