Multi-band Slot Antenna

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Abstract

A small-size printed antenna is developed for the application of mobile phones. The architecture of antenna bases on the concept of coplanar waveguide (CPW) feeding with slot design. The antenna is planned by an inverted triangular monopole structure with the overall size of 50 mm× 120 mm (shown in Fig. 1). The proposed antenna was fabricated on PCB with FR4 dielectric substrate. The substrate thickness is 1.6 mm with the relative permittivity of ~ 4.45. The slots are added to adjust resonance frequency and achieve characteristic of multi-band, which may cover the applications of GPS, GSM (Global System for Mobile Communications), UMTS (Universal Mobile Telecommunications System), and LTE (Long Term Evolution). By the trial of simulation to tune the design of slots, an optimum design of antenna can be obtained. Fig.2 presents the simulated and measured return loss of the antenna. Even though, there are few minor differences between the simulation and measured data. The measured and simulated results still can agree with each other. The achieved bandwidths are 0.54 to 1.01 GHz, 1.34 to 2.28 GHz, and 2.55 to 2.90 GHz, while the return loss ($|S_{11}|$) is limited more than 6 dB. This antenna is well suitable for the using of mobile phone applications.

Keywords: multi-band, coplanar waveguide (CPW), printed circuit board (PCB), return loss, slot antenna

1. Introduction

The rapid development of wireless communication leads to the more demands of the types, speed, and quality of wireless communication. The transmission and receiving antennas are the essential parts of wireless communication systems (such as GSM, GPS, UMTS, ISM, LTE, etc.). Therefore, the quality of antenna will greatly affect the emission and reception performances of system. In recent years, almost all the mobile devices are equipped with multi-band applications, so it requires multiple frequency characteristics of the antenna to transceiver the communication signals [1-2].

2. Method

A small-size printed antenna was designed for the multi-band requirements of mobile phones. The construction of antenna bases on the concept of coplanar waveguide (CPW) feeding with slot design. The antenna is planned by an inverted triangular monopole structure with the overall dimensions of 50 mm× 120 mm (shown in Fig. 1). The proposed antenna was fabricated on PCB with FR4 dielectric substrate. The substrate thickness is 1.6 mm with the relative permittivity of ~ 4.45.

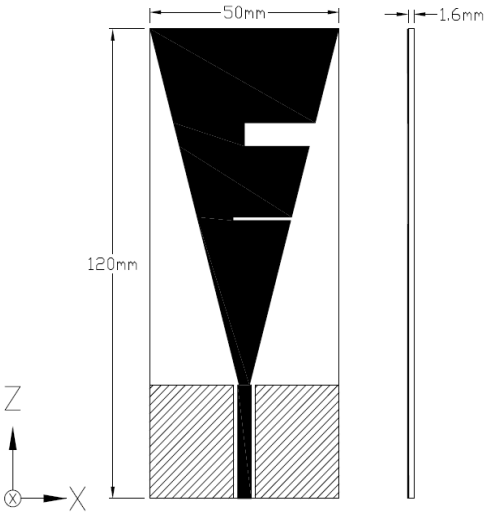

Fig. 1 Multi-band slot antenna

The original triangular structure of the antenna having a wideband characteristic, coupled with the use of the slots will destroy the wide band characteristic of the triangular structure, and then presenting a multi-frequency antenna characteristic. The slots were added to adjust

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resonance frequency and achieve characteristic of multi-band, which may cover the applications of GPS, GSM (Global System for Mobile Communications), UMTS (Universal Mobile Telecommunications System), and LTE (Long Term Evolution).

We used an electromagnetic simulation software to predict various important parameters of this proposed antenna. An actual sample of this antenna was fabricated based on the simulation results. Moreover, the measured data and simulated results of this proposed antenna was compared.

3. Simulation and Result

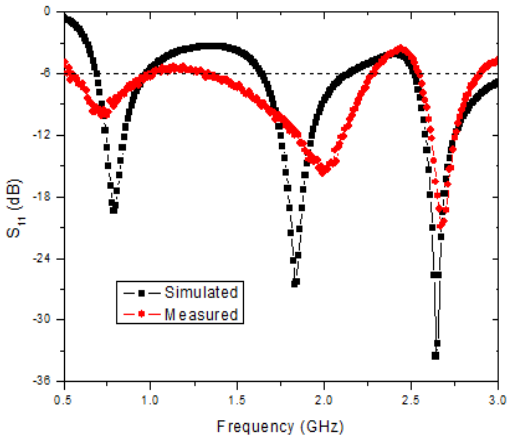

Fig. 2 The measured and simulated data of S11 of the multi-band slot antenna

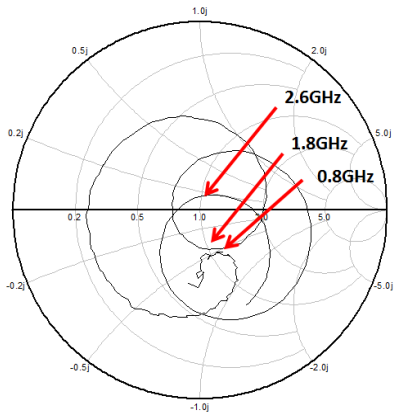

Fig. 3 The measured smith chart of the multi-band slot antenna

Fig. 2 shows the measured and simulated data of $|S_{11}|$ of the multi-band slot antenna. There are few minor differences between the simulation and measured data. The measured and simulated results still can agree with each other. The achieved bandwidths are 0.54 to 1.01 GHz, 1.34 to 2.28 GHz, and 2.55 to 2.90 GHz, while the return loss $|S_{11}|$ is limited more than 6 dB.

The measured smith chart of the multi-band slot antenna is presented in Fig. 3. From which it is apparent that the impedances of this antenna at 0.7, 1.8, and 2.6GHz band are very close to 50 ohms.

The test results of bandwidths, gains and radiation efficiencies are listed in Table 1. The values of accomplished bandwidths are those we mentioned before. Via parameter adjustment, the gain of slot antenna was greater than -2.54dBi, radiation efficiency was higher than 25%.

Table 1 The test results of bandwidths, gains and radiation efficiencies of the multi-band slot antenna

Operating Freq. (GHz)	0.8GHz Band (0.7-0.96)	1.9GHz Band (1.7-2.17)	2.6GHz Band (2.56-2.7)
Simulated BW (GHz) (S_{11} < -6dB)	0.69 - 0.97	1.64 - 2.14	2.52 - 3.0
Measured BW (GHz) (S_{11} < -6dB)	0.54 - 1.01	1.34 - 2.28	2.55 - 2.9
Gain (dBi)	-2.5 - -0.3	2.3 - 3.9	1.8 - 3
Efficiency (%)	25.2 - 46.9	52.5 - 77.5	44.8 - 47.3

4. Conclusions

A slot antenna used in 2G, 3G, 4G and GPS frequency band is proposed. The Applications bands of the slot antenna cover GPS, GSM850 / 900/1800/1900, UMTS, LTE700 / 800/850/900 and LTE 1700/1800/1900/2100/2600. The antenna was planned by an inverted triangular monopole structure with the design of slots, and the overall size is 50 mm×120 mm. This antenna was fabricated on PCB with FR4 dielectric substrate. The substrate thickness is 1.6 mm with the relative permittivity of ~ 4.45. The achieved bandwidths are 0.54 to 1.01 GHz, 1.34 to 2.28 GHz, and 2.55 to 2.90 GHz, while the return loss $|S_{11}|$ is limited more than 6 dB. Via parameter adjustment, the gain of slot antenna was greater than -2.54dBi, radiation efficiency was higher than 25%. This antenna is well suitable for the using of mobile phone applications.

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