

# Designing Multiband and Broadband Antenna for 3G Mobile Handsets

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**Abstract:** This paper concentrates on studying, designing and manufacturing a broadband microstrip antenna to be able to operate within many frequency bands. Antenna is used for 3G mobile handsets operating within GSM, UTMS, and WLAN bands. This antenna is made from FR4-epoxy substrate having  $\epsilon_r = 4.4$ ,  $h = 0.8$  mm (thickness). It is designed at 900 MHz and 2000 MHz frequencies. It has folded structure and includes three branches: two resonant branches and a tuning branch which are fed by 50  $\Omega$  microstrip line.

**Keywords:** Microstrip Antenna; Broadband Antenna; Multiband Antenna

## I. INTRODUCTION

In recent years, wireless communication has been developed so rapidly and requirement for the compact mobile handsets is high.

To satisfy the demands of reducing mobile handset size, antenna on the terminals needs to reduce as well. Microstrip antennas have many interesting advantages such as small dimensions, easy to attach on the terminals, and subsequently they will be the best choice to satisfy above designing demands.

Narrowband is an inherent property of microstrip antennas and broadband is normally a demand with real applications today, especially for 3G broadband mobile networks. Therefore, size reducing and broadband capability are two main design trends for real applications of microstrip antennas. These trends attract much attention of antenna's designers. Many

significant innovations in designing compact microstrip antennas with properties such as broadband, multiband, operating with both vertical polarization and horizontal polarization, circular polarization and higher gain have been reported during recent years.

In this paper, designing and manufacturing of planar monopole microstrip antenna with 2D structure [1] and [2] is concentrated. By selecting an antenna structure and carefully adjusting the parameters, we can achieve multi-resonant and broadband properties, which are able to satisfy designing demands of applications in 3G wireless network.

## II. DESIGNING AND SIMULATING ANTENNA

A planar monopole antenna [3] includes a rectangular radiator after being cut by a winding slot to make three branches, where two of which are resonant branches and the other one is a tuning branch. Antenna is printed on a FR4-epoxy substrate and is fed by a 50 Ohm microstrip line. This antenna can be used for GSM, UTMS and WLAN bands with VSWR below 2.5.

An overview of this antenna is as in Fig. 1. The antenna surface area is 75 x 36 mm<sup>2</sup>. The antenna structure includes three parts: radiator, broadband impedance matching component and 50  $\Omega$  microstrip line. Radiator has an area of 15 x 36 mm<sup>2</sup> printed on a surface of substrate. On the other surface

of substrate, ground plane (GND) is printed with an area of 60 x 36 mm<sup>2</sup>.

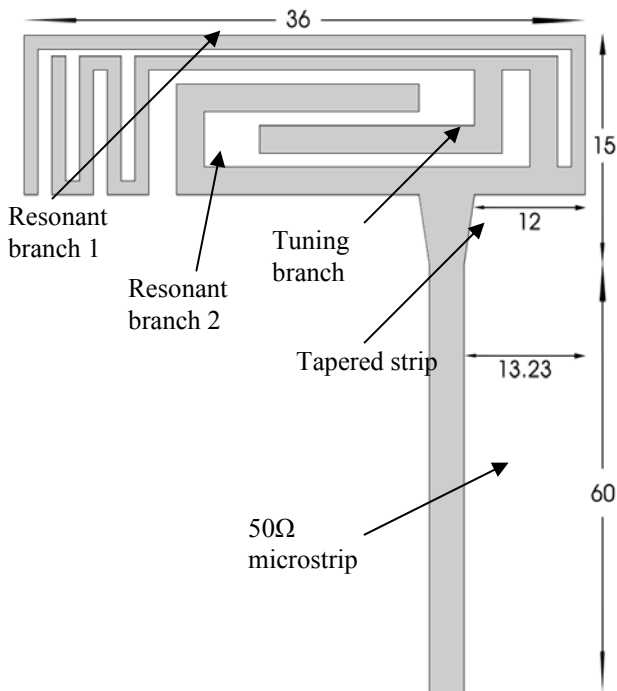


Figure 1: Overview of the antenna.

FR4-epoxy substrate is quite cheap material available on the market and is often used to make print circuit board.

Original radiator has rectangular shape fed by a 60 x 1.54 mm microstrip line. To achieve multi-resonant property, we cut a winding slot on original radiator to make three branches, where the first resonant branch is longer, the second is shorter and the tuning branch (third branch) with detail dimensions as in Fig 2.

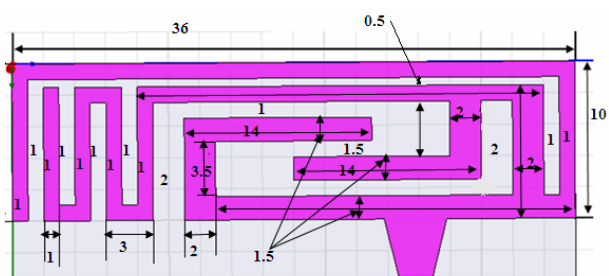


Figure 2: The radiator of the antenna.

The length of the first resonant branch from feeding point to the its end is about 75 mm. This value

is approximate to ¼ of the wavelength at the 900 MHz in the free space [4] and [5].

We need to note that resonant frequency depends on both the length and the width of the end. In the same way, the length of the second resonant branch from feeding point to its end is about 35 mm, approximately to ¼ of the wavelength at the 2 GHz.

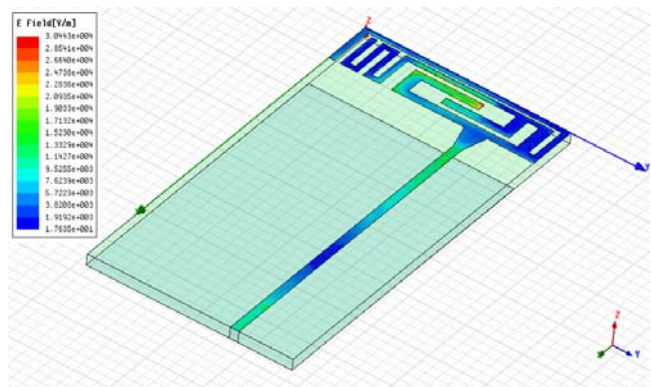


Figure 3: E field simulation.

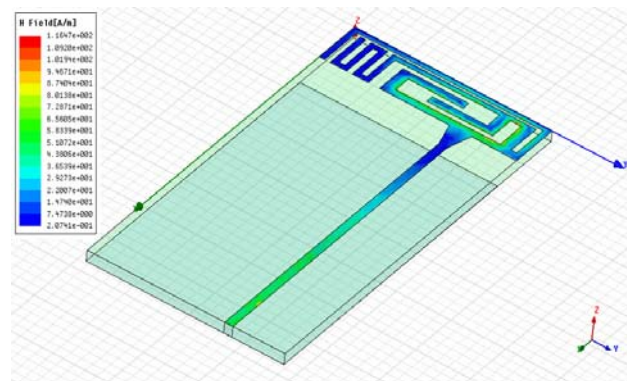


Figure 4: H field simulation.

The tuning branch is added to reach demanded bandwidth. By carefully tuning the dimensions and position of the tuning branch, the basic resonant modes and higher levels of the first resonant branch can be adjusted to demanded frequency.

As the simulation data, resonant frequency of the basic mode is reduced from 900 MHz to 850 MHz. With higher level mode, resonant frequency is changed from more than 3 GHz to about 2.3 GHz. As a result, antenna with all three branches can operate in all three bands: GSM, UTMS, and WLAN.

The broadband impedance matching component is a trapezium microstrip line with small bottom of 1.54 mm, big bottom of 4 mm and height of 5 mm. This is a triangular tapered line.

The simulation was carried out by Ansoft HFSS 9.1 software. The simulation results of E field and H field are shown in Fig. 3 and Fig. 4 respectively.

Figure 5 shows the result for simulated return loss  $S_{11}$  of antenna with all three branches.



Figure 5: Simulated return loss  $S_{11}$  (dB) of the antenna.

With return loss  $S_{11} = -8$  dB, similar to VSWR (Voltage Standing Wave Ratio) = 2.5, we can see that antenna with the tuning branch resonates around 850 MHz, 2160 MHz and 2380 MHz.

When having the third branch, the resonant frequency of the antenna is tuned to around the three above bands and bandwidth is nearly enough to cover all three bands' demand (GSM, UTMS, and WLAN).

Figure 6, 7, 8 below show the radiation patterns in XOY, YOZ, XOZ planes.

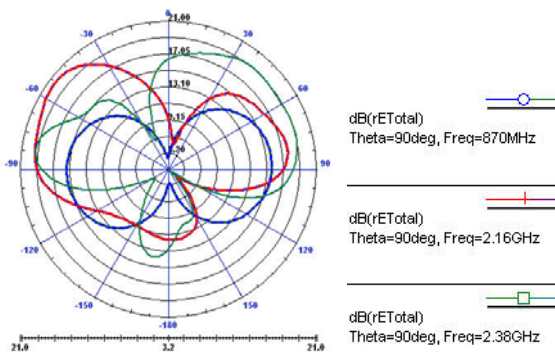


Figure 6: XOY plane of simulated radiation pattern.

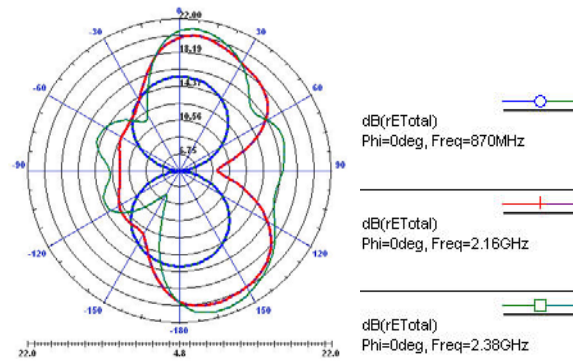


Figure 7: XOZ plane of simulated radiation pattern.

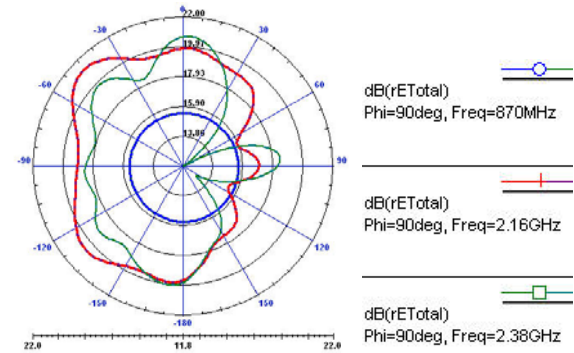


Figure 8: YOZ plane of simulated radiation pattern.

### III. MEASUREMENT RESULTS

Figure 9 shows measurement results for return loss.

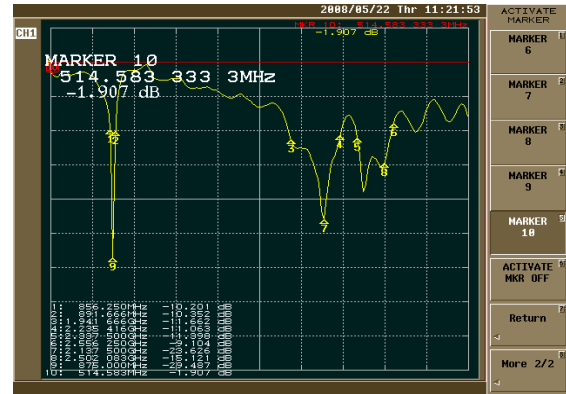


Figure 9: Measured return loss  $S_{11}$  (dB) of the antenna.

Band	Resonant frequency	Bandwidth VSWR = 2.5
GSM	850 MHz	825 – 926 MHz
UMTS	2160 MHz	1530 – 2530 MHz
WLAN	2380 MHz	

Table I: The results of the simulation

With  $S_{11} = -8$  dB, VSWR is similar to 2.5, bandwidth from Network Analyzer for respectively bands are as follow Table II.

Band	Frequency range	Bandwidth
GSM	830 – 915 MHz	85 MHz
UMTS	1941 – 2235 MHz	294 MHz
WLAN	2337 – 2556 MHz	219 MHz

Table II: Band width as measurement

Figure 10 shows measurement result and simulation result. The measurement result and simulation result are quite agreeable to each other. However the achieved bandwidth has not completely covered all three demanded bands, especially for GSM band.

Figure 11 shows the real shape of the antenna. It is very compact with the size of the model 3G mobile handset.

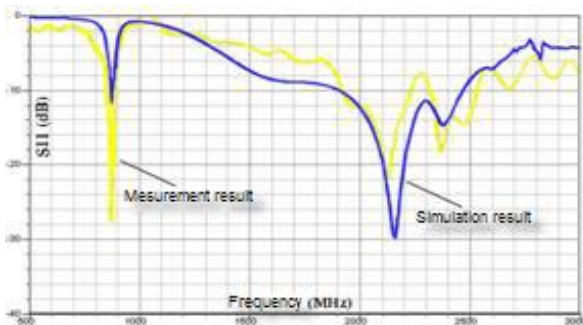


Figure 10: Measurement result and simulation result

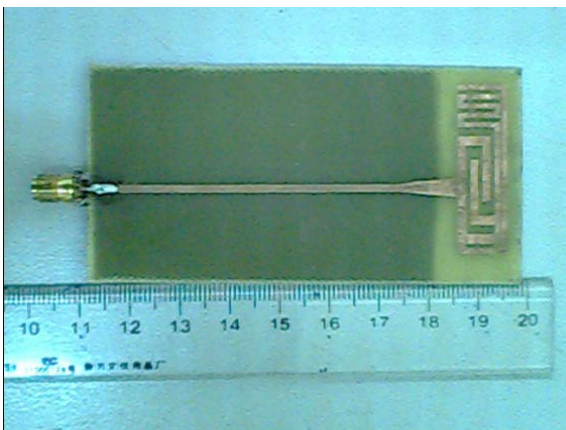


Figure 11: The real shape of the antenna.

#### IV. CONCLUSION

The designed antenna can completely be able to apply for 3G (operating on multiband and broadband) in GSM, UMTS and WLAN bands. However, in the future, some parameters of the antenna should be adjust so that it has better performance in term of the bandwidth.

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**Tran Minh Tuan** (Ph.D) was born in Hanoi – Vietnam in 1970. He received the B.E degree and M.E degree in Satellite Communications from Moscow Institute of Technology in Russia in 1994 and in 1995, respectively. In 2004, he received Ph.D degree in antenna and radiowave propagation in Hanoi University of Technology, Vietnam. Now he is working in National Institute of Information and Communications Strategy, Ministry of Information and Communications of Vietnam.

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