

# Multiple and Wideband Antenna Consideration for Commercial Mobile Terminal

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**Abstract** - Most published paper have revealed novel single antenna design. It's important; however, another important topic is that there are many antennas for different communication systems inside a commercial phone. Hence, in this paper, we will talk about the consideration for practical application.

**Index Terms** — Multiple antennas, Wideband antenna, Commercial phone antenna, Tunable Antenna.

## I. INTRODUCTION

Recently, Long Term Evaluation (LTE) is more and more popular in the world. From Global Mobile Suppliers Association (GSA) [1] report in May, 2014, 288 LTE networks have now commercially launched in 104 countries; and firm commitments to deploy LTE networks have been made in 150 countries by 497 network operators

From antenna point of view, the main challenges from 2G/3G to 2G/3G/LTE are (1) multiple antennas are required for multi-input multi-output (MIMO) operation, and (2) much wideband operation requirement of each antenna. (3) Furthermore, the industry design and mechanism (ID/ME) favor, such as ultra-thin phone, metal ring, and metal back cover, raises antenna design challenge again.

Hence, in the paper, we will focus on the solutions for these practical issues.

## II. MULTIPLE ANTENNAS

Inside a commercial phone, there is not only cellular antenna, but also connectivity antenna. Especially for a 2G/3G/LTE phone, it would include main antenna (2G/3G/LTE), diversity antenna (2G/3G/LTE), BT/WiFi antenna, and GPS antenna. How we arrange the antenna placement will lead to overall wireless performance difference; hence, we need to come out a balance solution to meet all requirement.

Firstly, let's review the specification and regulation definition for a commercial phone worldwide.

(1) For over-the-air (OTA) specification: There are both free-space specification and user scenarios specification for 2G/3G/4G antenna and GPS antenna. Furthermore, diversity antenna has lower specification compared to main antenna.

(2) For specific-absorption-rate (SAR) specification: Both main antenna and BT/WiFi antenna have transmission power.

(3) For hearing-aid-compatibility (HAC) regulation: Main antenna with transmission power and voice function has to meet the regulation.

After considering above specification and regulation, the proposed antenna placement is shown in Fig. 1.

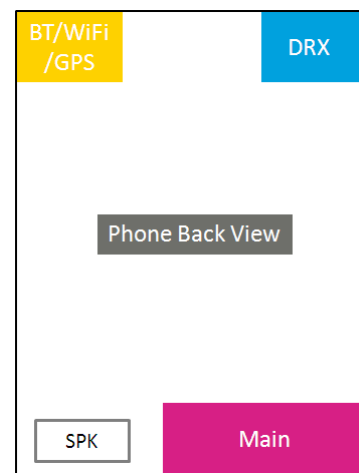


Fig. 1. Proposed Multiple Antenna Placement.

Let's explain the benefit and consideration of the proposed antenna placement.

(1) Main antenna: it has to meet wideband operation, and there is better clearance at bottom edge in most practical phone; it also needs to meet SAR and HAC, it means that the test point of HAC and the phantom head for SAR is far while antenna at bottom edge.

(2) Diversity antenna: it only have receiver path, hence, there is no SAR or HAC concern. Moreover, the OTA spec of diversity antenna is lower than main antenna in generally. Furthermore, while the main antenna and diversity antenna at the same long edge, the isolation would be better. Hence, we propose reserve the worse antenna space for diversity antenna compared to main antenna.

(3) BT/WiFi/GPS antenna: BT/WiFi has much lower transmission power compared to main antenna, hence, SAR is not a big issue while place it at top edge. And then, while GPS antenna is placed at top edge, upper hemisphere to lower hemisphere radiation pattern ratio would be better, especially while considering hand effect. Hence, better upper hemisphere isotropic sensitivity (UHIS) is expected.

### III. WIDEBAND OPERATION ANTENNA

In section II, we have proposed an antenna placement. And then, the next step is how we achieve the band operation for each antenna requirement. Let's focus on the main antenna here, because it needs to cover the widest bandwidth.

There are many wideband antenna design is published [2] - [4]. However, due to much wideband operation and ID/ME favor, even metal ID/ME. We need to come out a solution to solve above issues. Compared to passive antenna, one of feasible technology is Tunable Radio.

Firstly, let's explain what the concept of Tunable Radio is. It's well known that antenna bandwidth is limited by antenna space, ground type, and nearby components and so on. Furthermore, it's also well known that we can use matching circuit to help to design antenna. Hence, an idea to solve the wideband challenge is using different matching circuit states for one physical antenna, and it will lead to different antenna resonant modes. Finally, these different antenna resonant modes can be treated as a wideband operating antenna.

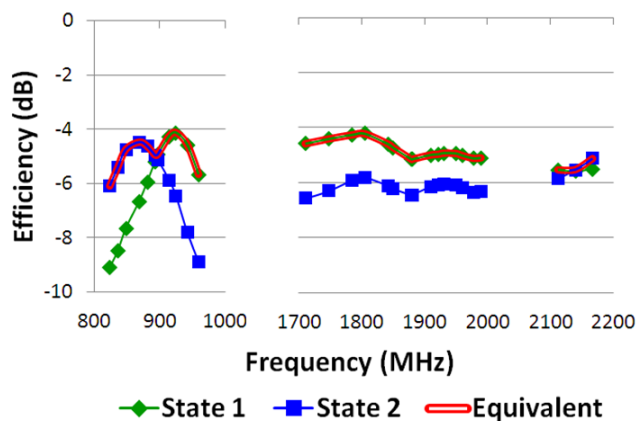


Fig. 2. Concept of Tunable Radio.

Secondly, how we implement Tunable Radio? Basically, there are two main types of RF components could be used for Tunable Radio. One is switch, another one is digital tunable capacitor (DTC).

The general usage methodology of switch for Tunable Radio is to change the matching component type and value. Please refer to Fig 3, for example, we can connect one single-port-four-throw (SP4T) switch to an antenna radiation structure. Because there are four throws, it means that we can use 4 different states. As shown in Fig 3, state 1 is open; state 2 is connected to an inductor, state 3 is grounded; state 4 is connected to a capacitor.

About DTC, basically, DTC is mainly for different capacitance values. Furthermore, DTC can provide 5-bits capacitance values in generally. 5-bits DTC means it has 32 states capacitance. Assume the DTC capacitance range is

from 0.5 to 8 pF. It means that the capacitance step is about 0.235 pF. Hence, we can change more precise capacitance by using DTC compared to switch.

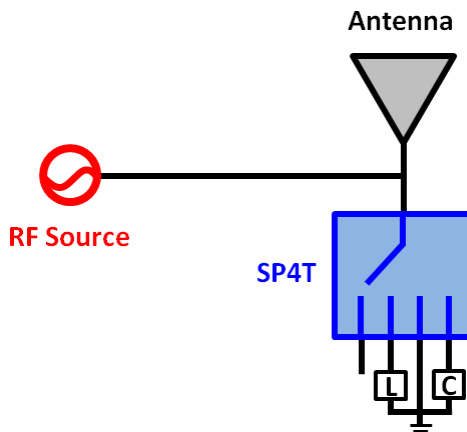


Fig. 3. Example of Tunable Radio by using SP4T.

Both of switch and DTC has their own benefits. Use which one to implement Tunable Radio is heavily depends on the antenna design concept.

Furthermore, antenna efficiency includes radiation efficiency and mismatching loss. It means that if radiation efficiency itself is bad, the final antenna efficiency will be limited. Hence, even for Tunable Radio, an good antenna design itself is still the key to achieve good wireless performance.

### IV. CONCLUSION

In the paper, we draw an image about what's the commercial phone challenge and what's the possible solution to meet the requirement. The one is antenna placement, how to have a balance and feasible antenna placement is based on many different specifications and regulations. And the other one is Tunable Radio; it's a feasible method to release single wideband antenna issue.

### REFERENCES

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