# Wideband MIMO Antenna Array Design for Future Mobile Devices Operating in the 5G NR Frequency Bands n77/n78/n79 and LTE Band 46

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## 1 Introduction

The 5G New Radio (5G NR) is a brand new air interface specially developed for future 5G operation. An air interface can be considered as the technology used for the communication link between mobile devices and the base station within a cellular network. Recently, the 3rd Generation Partnership Project has released its new specification (released 15) and has approved the following new spectrums for future 5G NR working below the Sub-6 GHz frequency bands, namely Band n77 (3300–4200 MHz), Band n78 (3300–3800 MHz), and Band n79 (4400–5000 MHz), and they can completely cover the future 5G NR spectrums catered for U.S. (3550–4200 MHz), China,EU, and Japan (3600–4200 MHz and 4400–4900 MHz). As the above-mentioned 5G NR spectrum may not be sufficient for the upcoming 5G multiband communication, another unique unlicensed spectrum known as the LTE Band 46 (5150–5925 MHz) has also been discussed recently to further support the Sub-6 GHz frequency bands[1].

## 2 ANTENNA GEOMETRY AND DESIGN

### 2.1 Geometry of Single Array Element

As shown in Fig.1, the system ground of a smartphone has a planar size of 134 mm × 64.4 mm printed on a 0.8 mm thick FR4 substrate (136 mm × 68 mm), allowing 1 mm ground clearance between the ground edge and the outer circumference of the substrate. Along the two longer edges of the ground substrate are two standing FR4 substrates (136 mm×6.2 mm) of thickness 0.8 mm that work as the smartphone frame, and the proposed antenna array is printed on its inner surface.

### 2.2 Design Evolution of Proposed Antenna Element

The evolutionary design steps of the proposed array element and its corresponding S11 are shown in Fig.2. Ref.1 is a simple monopole with double-step feeding structure that can cover the LTE Band 46 by exciting two resonances at approximately 5.2 GHz (f2) and 6.05 GHz (f4). By loading a shorting inverted-L branch adjacent to Ref. 1 that forms the Ref. 2, an additional resonance at 3.54 GHz (f1) is excited without affecting f3 and f4. The current distribution at f1 along Ref.2 is also depicted in Fig.2 (left bottom corner). One can see that the energy is coupled from the driven element to the inverted-L branch that exhibits a guided quarter-wavelength current distribution. As for the excitation of f2, by further observing the current

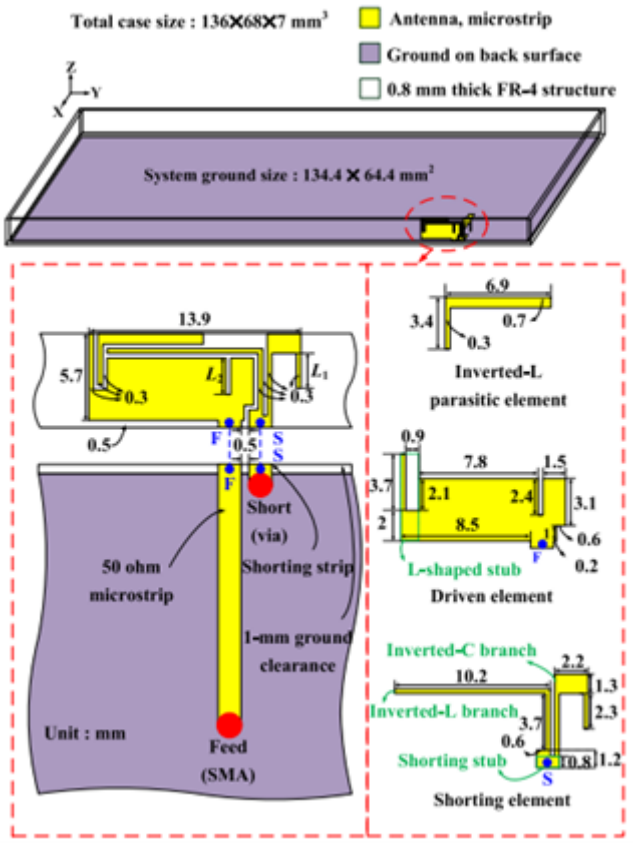


Figure 1: Geometry and dimensions of the proposed array element

distribution diagram for Ref.1 at 5.2 GHz in Fig.2, it is obvious that f2 is simply a guided quarter-wavelength current distribution along the driven element. For brevity, the excitation of f4 will not be discussed further.

# 3 Conclusion

A novel eight-antenna array design for future 5G smartphone applications has been successfully investigated. The proposed MIMO antenna has exhibited very wideband operation of >50% that can cover the entire 5G NR Band (n77/n78/n79) and LTE Band 46. Besides demonstrating good ECC of <0.1, it can yield desirable efficiency and peak channel capacity of more than 41% and 39 b/s/Hz. Therefore, the proposed MIMO antenna may be able to support the future 5G NR networks, such as NR/NR, NR/LTE, and NR/WiFi.

# References

[1] Hang Xu, Hanyang Wang, Steven Gao, Hai Zhou, Yi Huang, Qian Xu, and Yujian Cheng. A compact and low-profile loop antenna with six resonant modes for lte smartphone. *IEEE Transactions on Antennas and Propagation*, 64(9):3743–3751, 2016.