# A Low SAR WWAN Antenna Design

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***Abstract* – A low SAR WWAN antenna is presented in this paper. The proposed antenna structure constructed an IFA (inverter-F antenna) with a shorted loop structure for tablet device application with low SAR performance. The antenna elements are printed on a compact size and single layer FR4 substrate of size 51.2 × 8.2 × 0.4 mm$^3$ and fed by a 50 Ω coaxial cable with I-PEX connector. The proposed antenna can support triplet-bands (850/1900/2100) of WWAN communication system that covers 824~894 MHz, 1850~1990 MHz and 1920~2170 MHz and operate with around 40% radiation efficiency across these bands. The active performance of TRP we measured is about 28.5 dBm and 27.5 dBm in GRPS 850/1900 bands respectively and about 19.5~21.5 dBm in both WCDMA band II and band V. The SAR (specific absorption rate) performance of tablet back and tip side that we measured are less than 1.3 mW/g in low and high band which can meet FCC SAR limitation within 1.6 mW/g. All simulation data are simulated by SPEAG SEMCAD software tool [1] and SAR results are measured by SPEAG DASY5 SAR equipment.**

***Index Terms* — WWAN, Tablet, Shorted loop, Inverter-F, SAR.**

## I. Introduction

In recent years, personal wireless device of smart phone and tablet are vigorous development and getting more popular and rapidly booming in market. Most of multi nation telecommunications corporations had set up TRP/TIS level for transmit and receive performance certification, beside this performance certification, the country/area governments also have adopted limits for sage exposure to radio frequency energy. These limits are given in terms of a unit referred to as the specific absorption rate (SAR), which is measure of the amount of energy absorbed by the human body when using a personal wireless device, it became a big challenge that engineers need to design a high efficiency antenna but also with low SAR value. Most of country/area adopt U.S. FCC or E.U. CE SAR criterion to limit sage exposure to radio frequency energy, it request personal wireless device manufactures to ensure their product comply with these objective limits for safe exposure. Any personal wireless device at or below these SAR limitations is a safe product. The E.U. CE SAR limitation is 2.0 mW over 10 gram of tissue and the U.S. FCC SAR limitation is 1.6 mW over 1 gram of tissue, the request of U.S. FCC SAR is more difficult to satisfy than the one of E.U. CE request. In recent years, Auden devoted much resource to developing new antenna technologies for wireless device application [2]-[6] and so many introductions and solutions for SAR reduction had been proposed, those information arouse us to design a low SAR antenna structure for wireless device application. To gain full acceptance among consumer market, the design of anti-electromagnetic radiation and good communication quality are critical ingredients for personal wireless device.

## II. Antenna Design and Simulation Results

A low SAR WWAN antenna design is presented in this article. It has dimensions of 63 × 9 × 0.4 mm$^3$ and printed on a single layer FR4 substrate. The proposed antenna radiator is constructed an IFA antenna with a shorted loop structure and grounded to tablet's ground plane (195 × 115 mm$^2$) with a cooper foil as shown in Fig. 1. (a), and excited dual resonant modes covering 850/1900/2100 MHz bands and radiation efficiency can reach 55% above. Fig. 1. (b) shows the simulated tablet SAR test position, and the simulated VSWR and antenna efficiency are shown in Fig. 2.

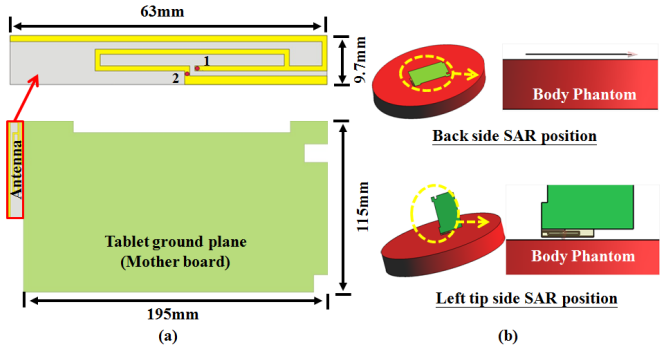



Fig. 1. (a) Geometry of proposed antenna and tablet ground plane; red point 1: antenna feeding point, red point 2: shorting part. (b) Tablet SAR test positions of back side and left tip side.

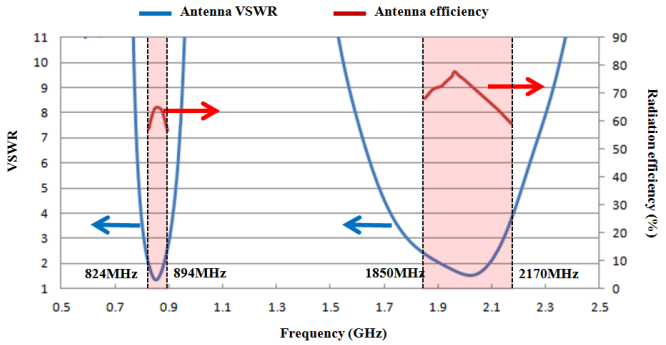



Fig. 2. The VSWR and efficiency plot of proposed antenna.

The presented antenna has a novel balance shorted loop structure design, the total length of shorted loop part arranged as 65 mm (from feed to shorted point) to generate the resonant mode at high frequency. The shorted loop structure can induce a more uniform surface current distribution in high band that can effectively reduce SAR value in 1900 MHz band, shown in Fig. 3. In general, back side and tip side SAR have to be considered for tablet SAR evaluation. All of the detail simulated SAR results are listed in Table I.

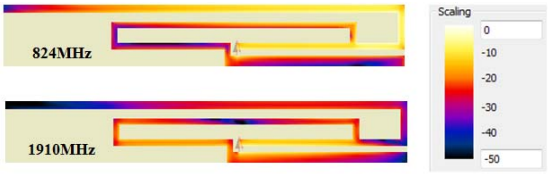


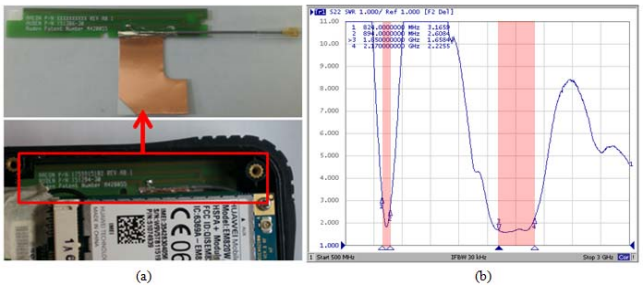

Fig. 3. Simulated surface current distribution of proposed antenna at 824MHz and 1910MHz.

TABLE I
SUMMARY OF SIMULATED SAR VALUES

| Frequency. (MHz) | 824 | 849 | 1850 | 1910 |
|---|---|---|---|---|
| Input Power (dBm) | 24 | 24 | 24 | 24 |
| Back Side 1g SAR (mW/g) | 1.08 | 1.14 | 1.56 | 1.51 |
| Left Tip Side 1g SAR (mW/g) | 0.87 | 0.89 | 1.47 | 1.58 |

## III. ANTENNA MEASURED PERFORMANCE

The proposed antenna is realized in an industrial tablet device, the antenna elements are printed on a single layer FR4 substrate with a small size of 51.2 × 8.2 × 0.4 $mm^3$ and fed by a 50 Ω coaxial cable with I-PEX connector. The antenna shorting part is connected to device ground plane with a copper foil as shown in Fig. 4. (a). The Fig. 4. (b) shows the measured VSWR that bandwidth can cover frequency in 824~894 MHz and 1850~2170 MHz for tri-band WWAN system application. The antenna efficiency can obtain above 40% in all bands.



(a) (b)

Fig. 4. (a) The Photograph of proposed antenna and realized in industrial tablet device. (b) The measured VSWR of proposed antenna.

The Fig. 5. shows the back and left tip side SAR measured by using SPEAG DASY5 equipment. The proposed antenna back side and left tip side SAR test results are all less than 1.6 mW/g in both WCDMA BII/BV and GPRS 850/1900. All the detail of active measured results and SAR data are shown in Table II, it is clearly observed this low SAR antenna can fulfill FCC body SAR limitation and also has good OTA performance.

TABLE II
SUMMARY OF TRP & SAR RESULTS

| Band | WCDMA B5 | WCDMA B2 | GPRS 850 | GPRS 1900 |
|---|---|---|---|---|
| Channel | 4183 | 9400 | 190 | 661 |
| Input Power | 24dBm | 24dBm | 33dBm | 30dBm |
| TRP | 19.53dBm | 21.76dBm | 28.42dBm | 27.61dBm |
| 1g Back SAR | 0.686mW/g | 1.22mW/g | 0.725mW/g | 0.903mW/g |
| 1g Tip SAR | 0.803mW/g | 0.874mW/g | 0.943mW/g | 1.21mW/g |

Fig. 5. The tablet back side and tip side SAR test setting.

## IV. CONCLUSION

A low SAR WWAN antenna for tablet device application has been demonstrated in this paper. The antenna can effectively make surface current distribution more uniform in high band by using an IFA design with a balance shorted loop structure that it can achieve lower SAR performance. The bandwidth of proposed antenna can cover 850/1900/2100 MHz bands requirement and furthermore good radiation performance has also been obtained. More detailed results will be described in the presentation.

## REFERENCES

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