

UL1

Antenna C-Test Report

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1 Introduction

To judge the performance of antennas inside notebook, we may want to know the impedance bandwidth, radiation pattern (2D/3D), antenna gain, and efficiency. In this report, we will systematically show all these values, and make constructive comments in the summary. With the information revealed in this report, we can better realize the properties of current antennas, and it's also helpful for optimization in future designs.

2 General description

Novel antennas attractive to fit in the internal space of a NB (Notebook computer) for WWAN (Wireless Wide Area Network) and WLAN (Wireless Local Area Network) operations are presented in the UL1 antenna test report. The proposed antennas have in common good impedance bandwidth.

For WWAN (diversity is required), their required frequency bands of operation are shown as follows.

Main antenna:

GSM850: 824MHz–894MHz;

GSM900: 880MHz–960MHz;

DCS1800: 1710MHz–1880MHz;

PCS1900: 1850MHz–1990MHz;

IMT-2000: 1920MHz–2170MHz;

Diversity antenna:

GSM850: 869MHz–894MHz;

PCS1900: 1930MHz–1990MHz;

IMT-2000: 2110MHz–2170MHz;

For WLAN, they can cover the dual-band WLAN operation in the 2412–2462MHz and 5150–5875MHz frequency bands.

For WWAN applications, the antenna design utilizes a dual-band PIFA as the driving element. The main antenna placement is located on the right side of the device and the aux antenna placement is located on the other (left side). In the next sections, the test results include WWAN and WLAN passive items such as VSWR (Voltage Standing Wave Ratio), antenna gain (efficiency, dB) and radiation pattern (2D/3D) of the build-in antennas will be presented.

WWAN and WLAN antennas are made carefully following the specification and lying under the antenna space in UL1. The locations and the placements of all antennas are shown below.



3 Antenna characteristics

3.1 WWAN antenna (3G antenna)

3.1.1 3G main antenna

3.1.1.1 Description

The 3G main antenna (including WCDMA I) in UL1 is a 68 x 11 x 0.8 mm³ PCB locating on the right side of the device, as shown below.

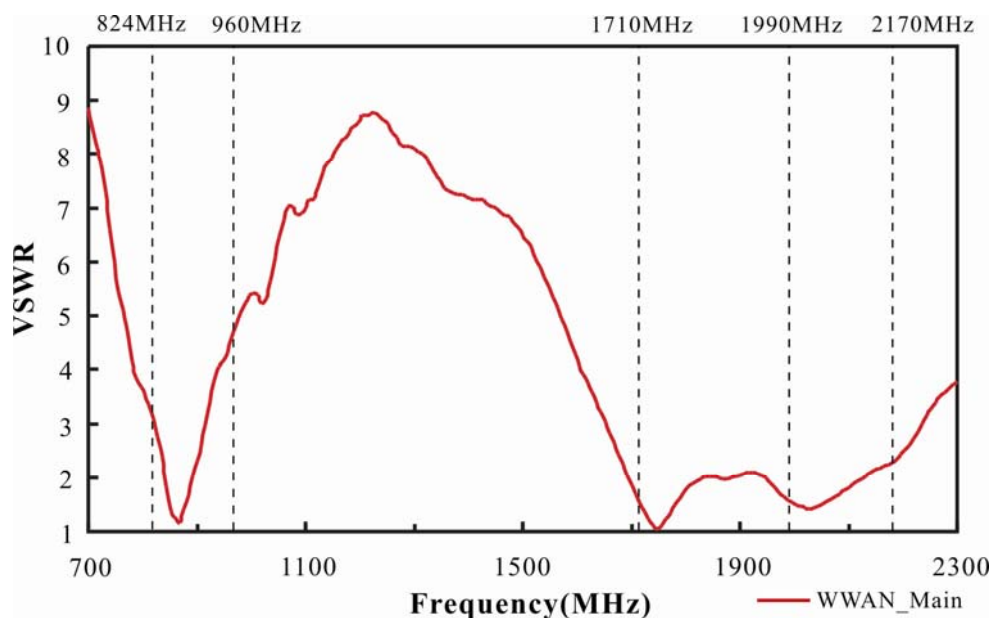


3.1.1.2 VSWR

For better impedance matching, we need to be sure that the antenna is totally in-band and holds a wide enough bandwidth. With the VSWR / Frequency relation, we can easily tell if the design meets the basic requirement. For measuring the return loss (VSWR) of an antenna, we need to apply an external cable at the feed point of this antenna. And to avoid interference from the other devices, we can simply cut off the connection between antennas and RF car-kits. By linking the antenna to a network analyzer (such as Agilent 8753ES) thorough the external cable, we can measure the return loss (VSWR) without difficulties.



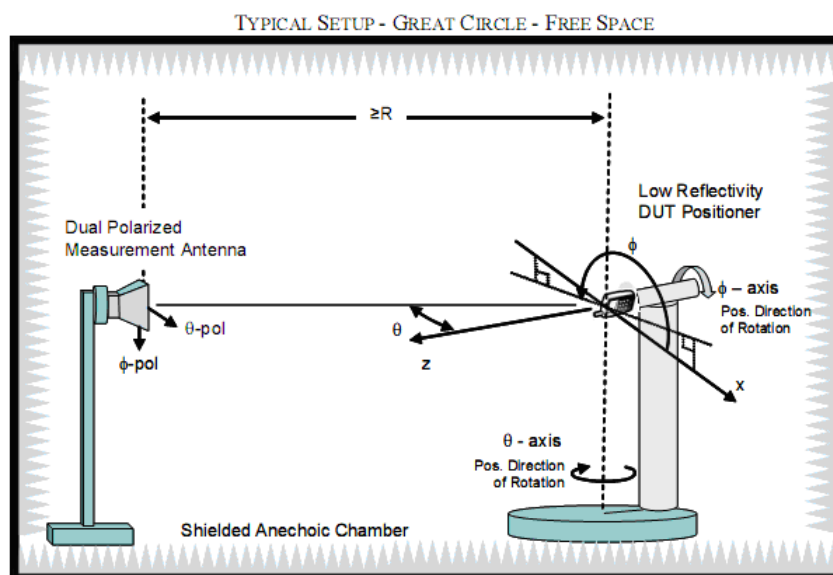
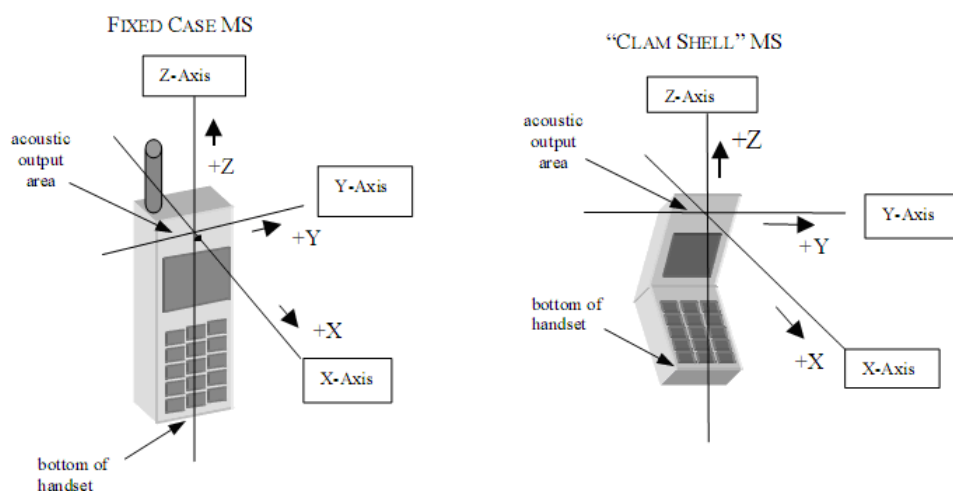
Figure 1 : Agilent 8753ES Network Analyzer



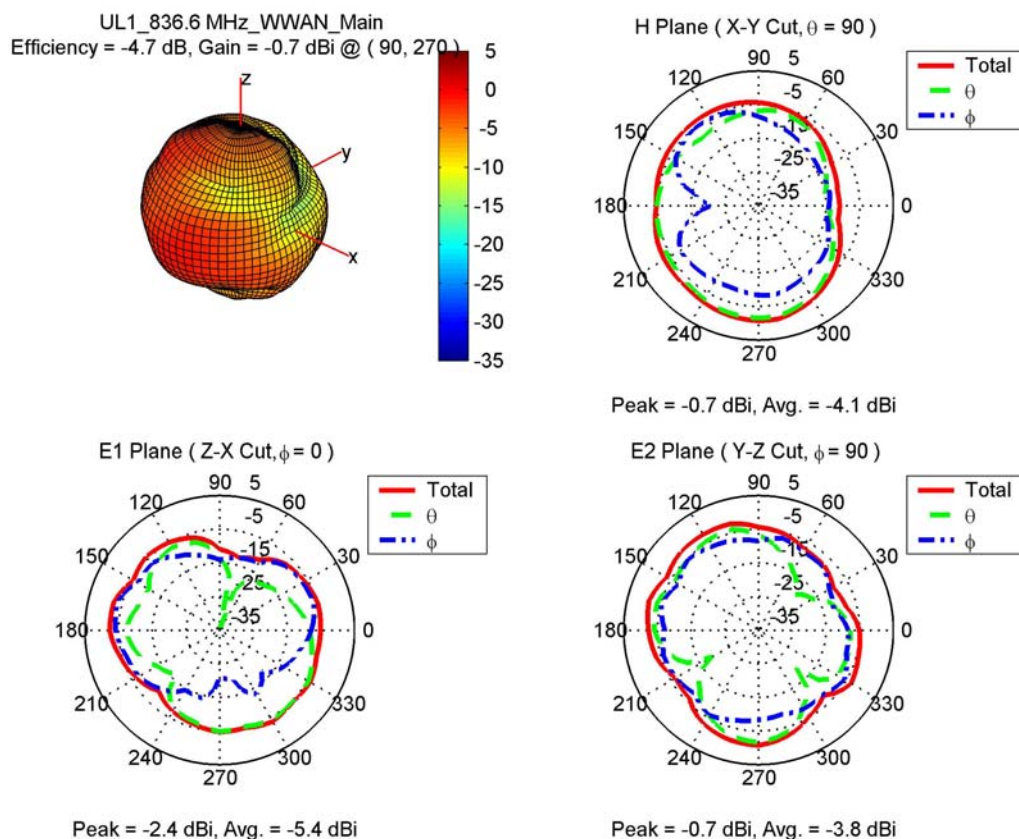
3.1.1.3 Passive

The antenna gain measurement we made here thoroughly follows **CTIA Test Plan for Mobile Station Over The Air Performance ver 2.2**. In the test plan, CTIA defines the total radiated power (TRP) and total isotropic sensitivity (TIS) measurements / specs in different modes (“free space”, “talk mode”, and “dial mode”) and different bands. The term TRP is, in fact, the spherical effective isotropic radiated power, which CTIA claims to be a better indication of mobile performance comparing to traditional peak effective isotropic radiated power (EIRP) in additional spatial coverage concern. Yet the term TIS is the spherical effective radiated receiver sensitivity. Just like TRP, TIS also includes the coverage concern. Following are the configurations for both “free space” and “talk mode” measurements.

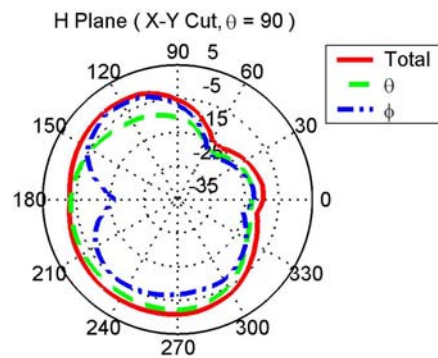
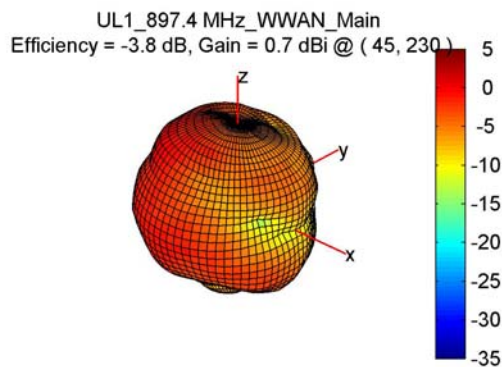
Free space configuration



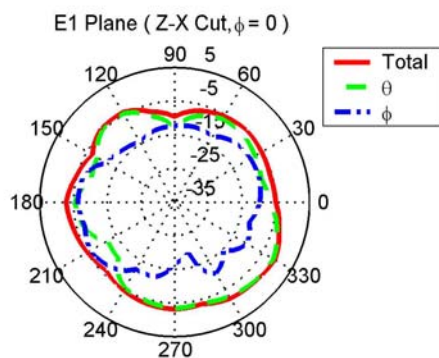
Following passive free space patterns are measured in the centre Tx channel of each band. Each graph contains 3D pattern, 2D (H, E1, E2) patterns, efficiency, and peak gain.



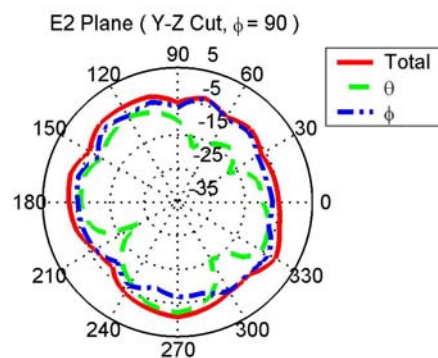
Band	Tx			Rx		
GSM850	824MHz	836.6MHz	849MHz	869MHz	881.6MHz	894MHz
Efficiency (dB)	-5.3	-4.7	-4.0	-3.2	-3.4	-3.6



Peak = -0.7 dBi, Avg. = -3.4 dBi



Peak = -0.7 dBi, Avg. = -4.2 dBi



Peak = -0.8 dBi, Avg. = -3.6 dBi

Band	Tx			Rx		
EGSM	880MHz	897.4MHz	915MHz	925MHz	942.4MHz	960MHz
Efficiency (dB)	-3.2	-3.8	-4.6	-5.4	-6.1	-6.1

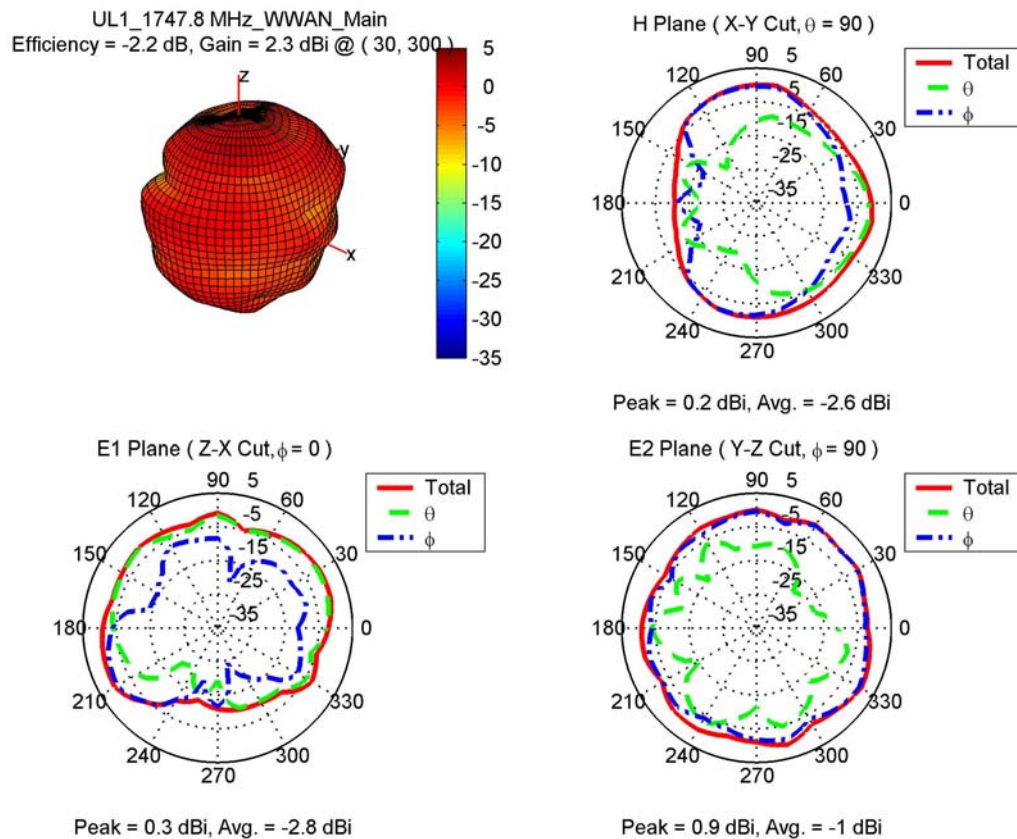
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Band	Tx			Rx		
DCS	1710MHz	1747.8MHz	1785MHz	1805MHz	1842.8MHz	1880MHz
Efficiency (dB)	-3.2	-2.2	-2.9	-3.4	-4.1	-4.2

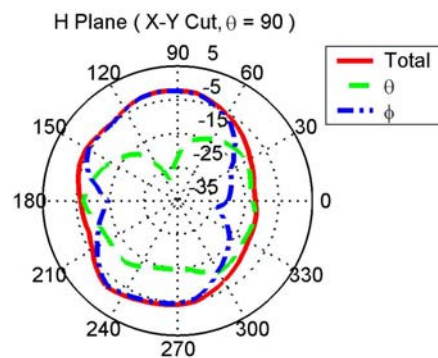
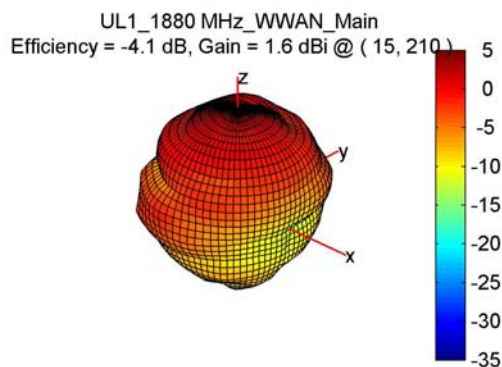
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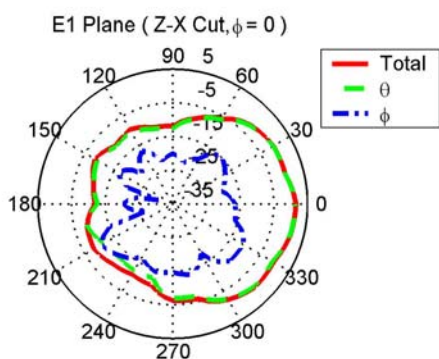
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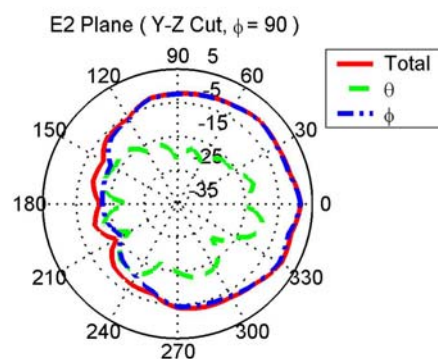
UL1



Peak = -1.8 dBi, Avg. = -5.2 dBi



Peak = 1.6 dBi, Avg. = -3.8 dBi



Peak = 1.6 dBi, Avg. = -2.8 dBi

Band	Tx			Rx		
PCS	1850MHz	1880MHz	1910MHz	1930MHz	1960MHz	1990MHz
Efficiency (dB)	-4.2	-4.1	-4.2	-4.3	-4.5	-4.5

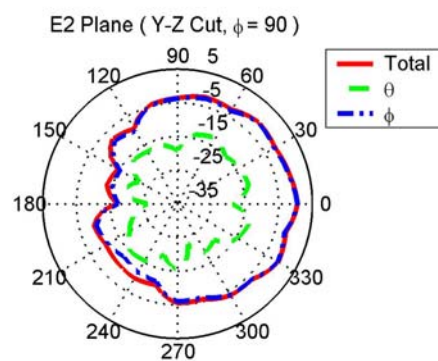
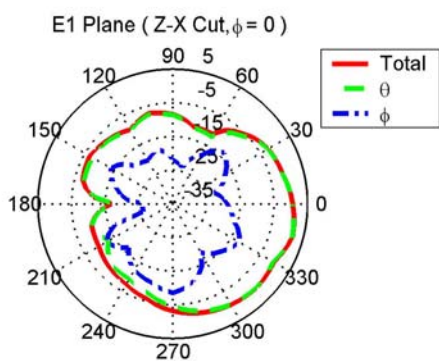
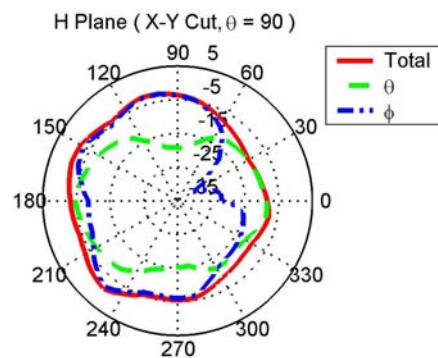
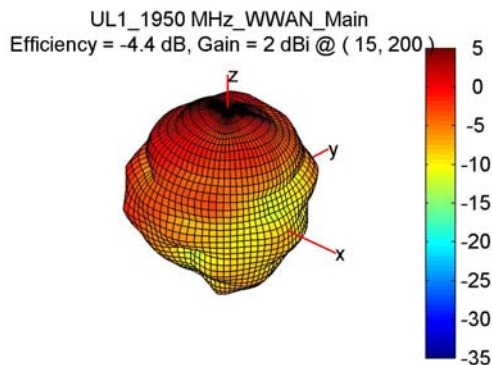
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Band	Tx			Rx		
WCDMA I	1920MHz	1950MHz	1980MHz	2110MHz	2140MHz	2170MHz
Efficiency (dB)	-4.2	-4.4	-4.5	-4.7	-5.3	-5.9

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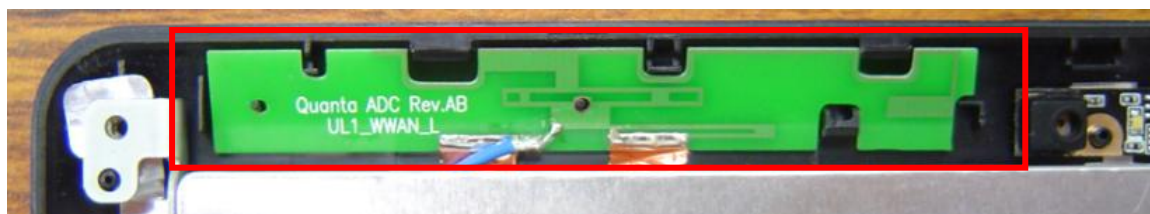
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3.1.2 3G diversity antenna

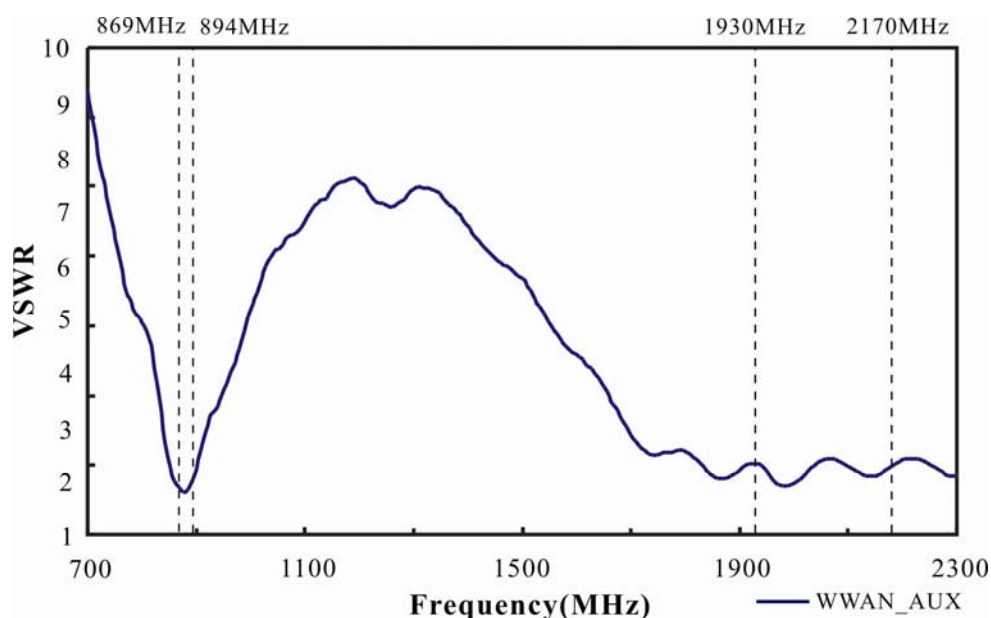
3.1.2.1 Description

The 3G diversity antenna (including WCDMA I) in UL1 is a 78 x 11 x 0.8 mm³ PCB locating on the left side of the device, as shown below.



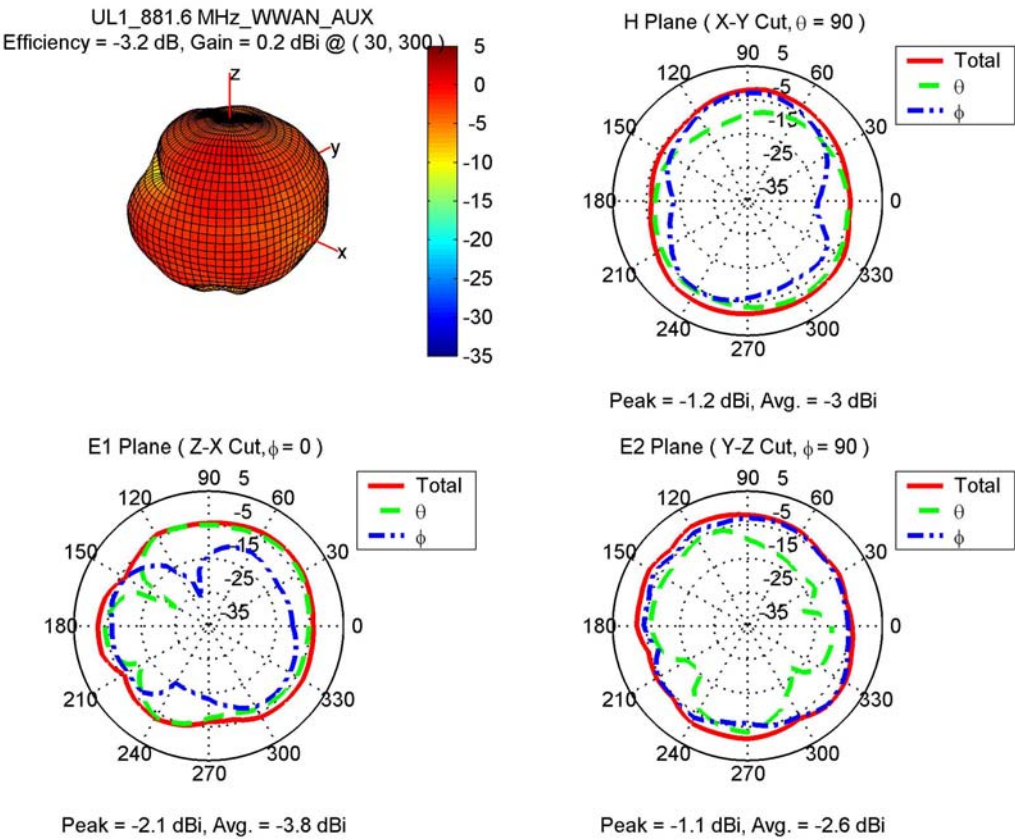
3.1.2.2 VSWR

For better impedance matching, we need to be sure that the antenna is totally in-band and shows a wide enough bandwidth. With return loss (or VSWR), we can easily tell if the design meets the basic requirement. To measure the return loss, we need to cut the connection between antenna feed-in and RF car-kit, and attach a coaxial cable at the feed-in point. Then, by click the coaxial cable onto a network analyzer (such as Agilent 8753ES), we can measure the return loss without difficulties.

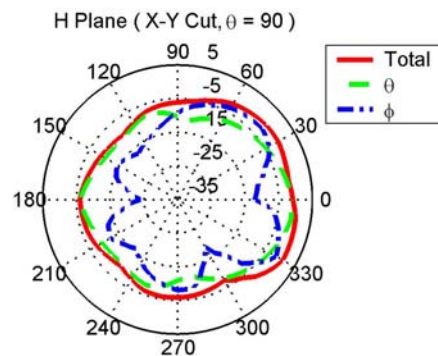
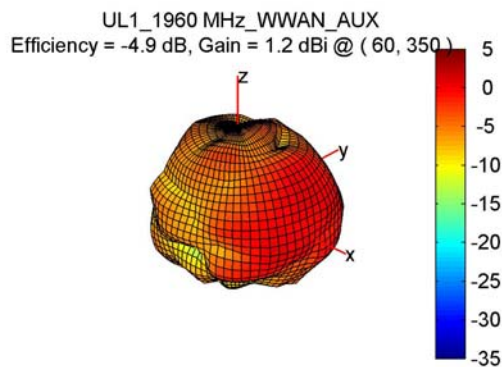


3.1.2.3 Passive

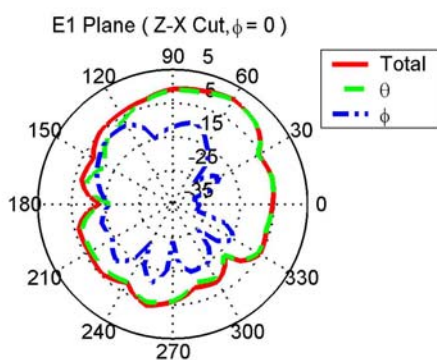
Following passive free space patterns are measured in the centre Rx channel of each band. Each graph contains 3D pattern, 2D (H, E1, E2) patterns, efficiency, and peak gain.



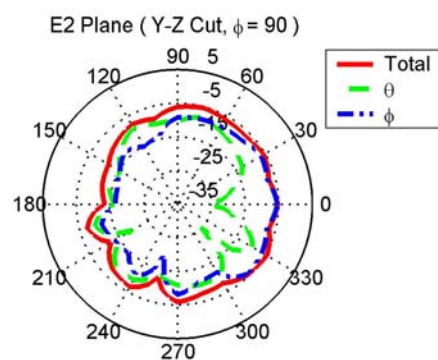
Band	Rx		
	WCDMA V	869MHz	881.6MHz
Efficiency (dB)	-3.4	-3.2	-3.5



Peak = 1.1 dBi, Avg. = -3.7 dBi



Peak = 1 dBi, Avg. = -4.3 dBi



Peak = -4.4 dBi, Avg. = -7.2 dBi

Band	Rx		
WCDMA II	1930MHz	1960MHz	1990MHz
Efficiency (dB)	-4.6	-4.9	-4.8

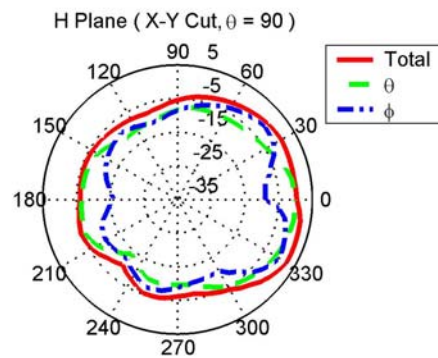
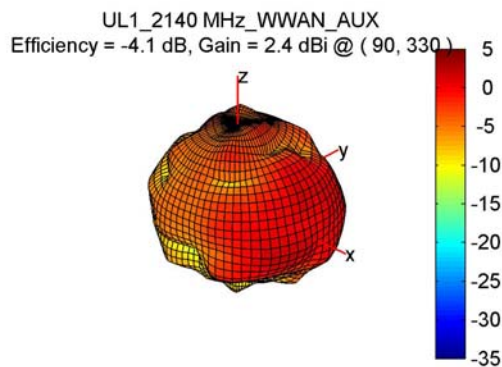
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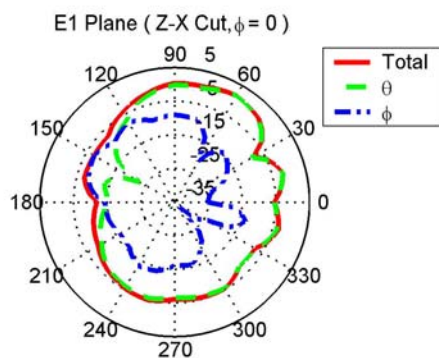
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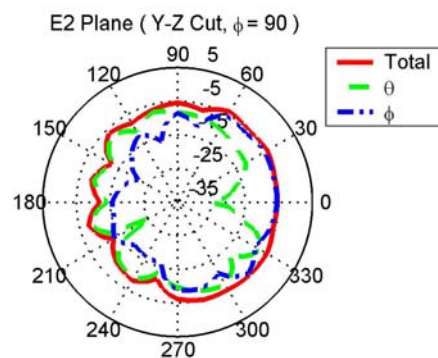
UL1



Peak = 2.4 dBi, Avg. = -2.5 dBi



Peak = 1.6 dBi, Avg. = -3.7 dBi



Peak = -3.9 dBi, Avg. = -6.4 dBi

Band	Rx		
WCDMA I	2110MHz	2140MHz	2170MHz
Efficiency (dB)	-4.1	-4.1	-4.7

3.2 WLAN antenna (WIFI antenna)

3.2.1 WIFI main antenna

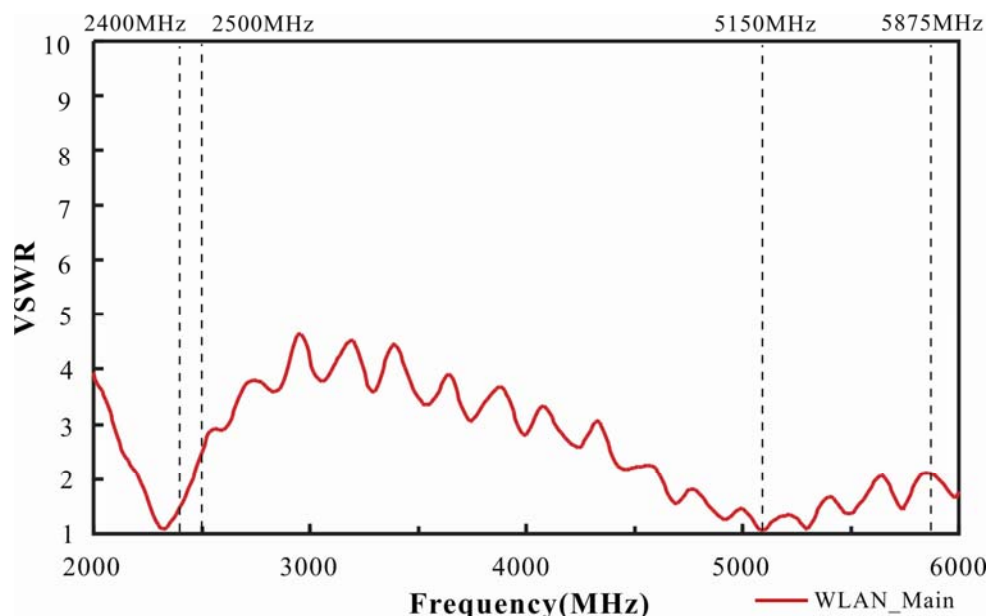
3.2.1.1 Description

The WIFI main antenna (including 802.11.a/b/g) in UL1 is a $45 \times 7 \times 2 \text{ mm}^3$ metal sheet locating on the right side of the device, as shown below.



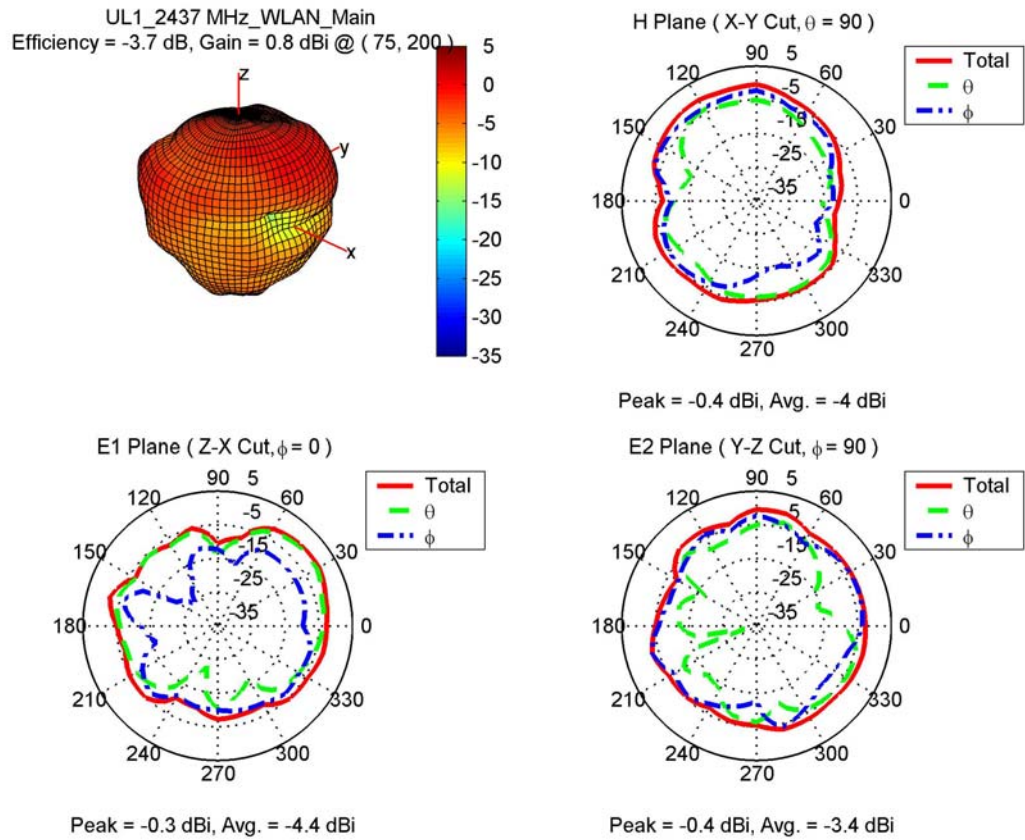
3.2.1.2 VSWR

For better impedance matching, we need to be sure that the antenna is totally in-band and shows a wide enough bandwidth. With return loss (or VSWR), we can easily tell if the design meets the basic requirement. To measure the return loss, we need to cut the connection between antenna feed-in and RF car-kit, and attach a coaxial cable at the feed-in point. Then, by click the coaxial cable onto a network analyzer (such as Agilent 8753ES), we can measure the return loss without difficulties.

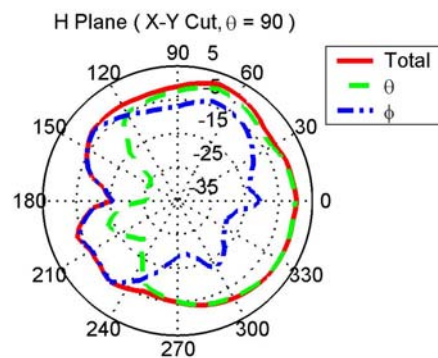
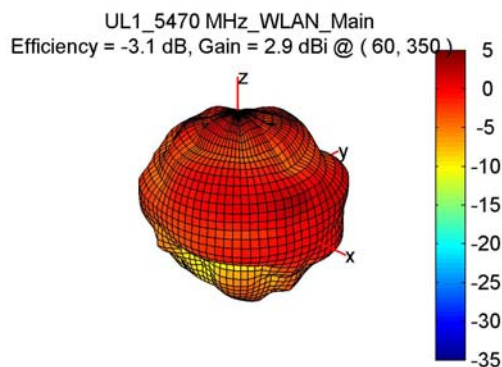


3.2.1.3 Passive

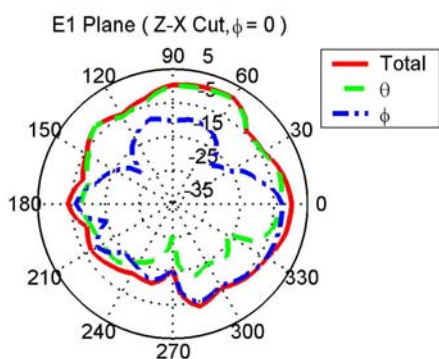
Following passive free space patterns are measured in the centre channel of each band. Each graph contains 3D pattern, 2D (H, E1, E2) patterns, efficiency, and peak gain.



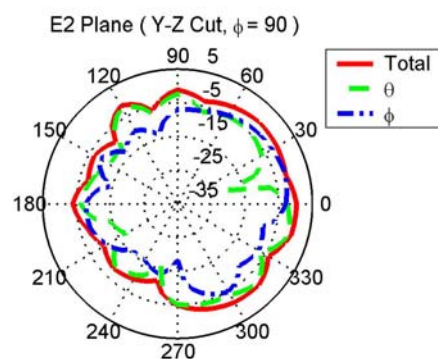
	Tx / Rx		
Frequency	2412MHz	2437MHz	2462MHz
Efficiency (dB)	-3.7	-3.7	-3.8



Peak = 1.8 dBi, Avg. = -1.9 dBi



Peak = 1.2 dBi, Avg. = -3 dBi



Peak = 0.3 dBi, Avg. = -3.1 dBi

	Tx / Rx				
Frequency	5150MHz	5350MHz	5470MHz	5725MHz	5875MHz
Efficiency (dB)	-2.5	-2.9	-3.1	-3.9	-4.4

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3.2.2 WIFI aux antenna

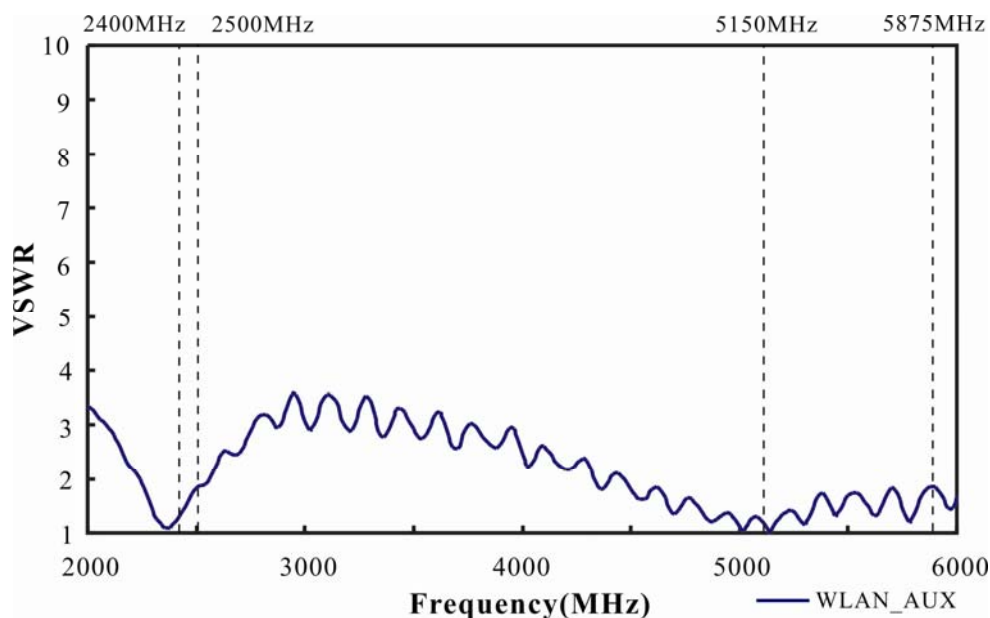
3.2.2.1 Description

The WIFI aux antenna (including 802.11.a/b/g) in UL1 is a 45 x 7 x 2 mm³ metal sheet locating on the left side of the device, as shown below.



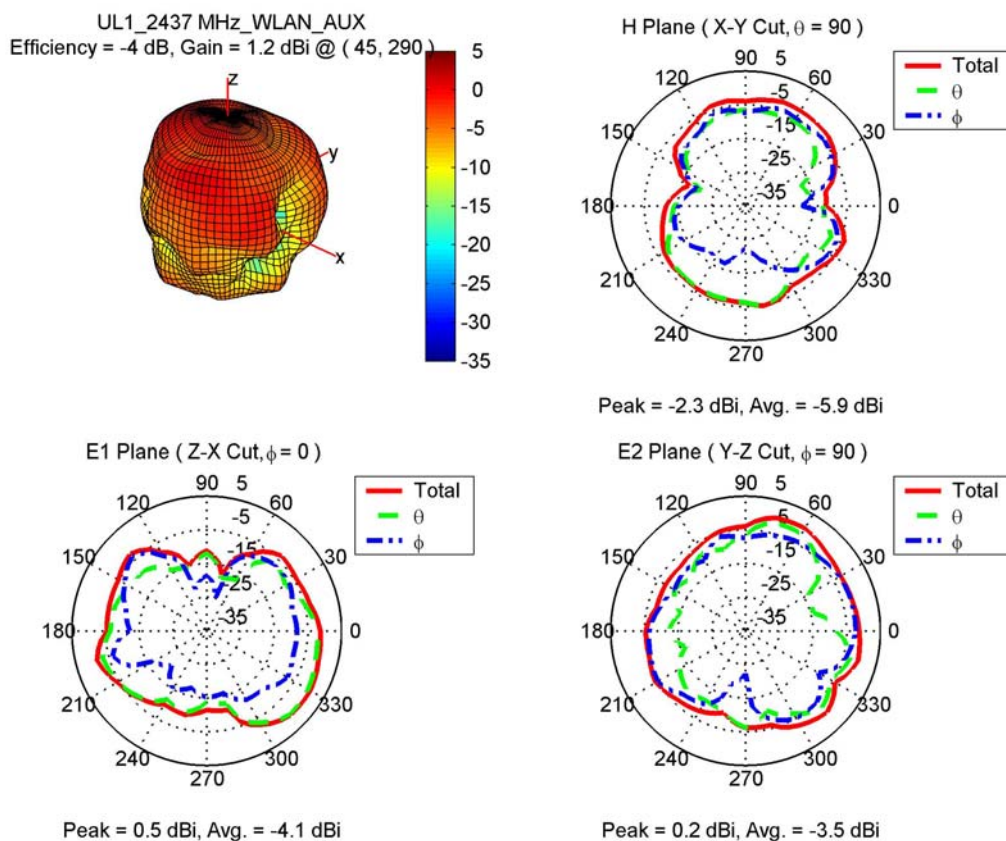
3.2.2.2 VSWR

For better impedance matching, we need to be sure that the antenna is totally in-band and shows a wide enough bandwidth. With return loss (or VSWR), we can easily tell if the design meets the basic requirement. To measure the return loss, we need to cut the connection between antenna feed-in and RF car-kit, and attach a coaxial cable at the feed-in point. Then, by click the coaxial cable onto a network analyzer (such as Agilent 8753ES), we can measure the return loss without difficulties.

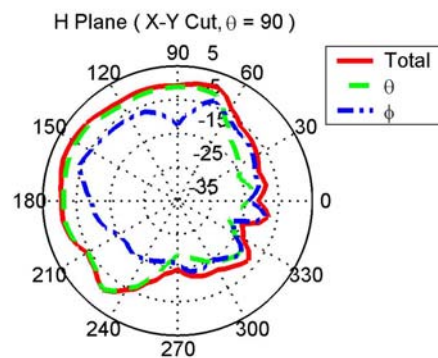
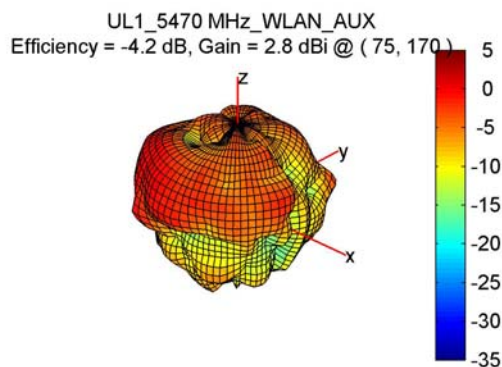


3.2.2.3 Passive

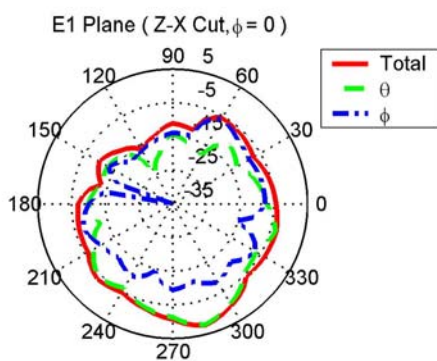
Following passive free space patterns are measured in the centre channel of each band. Each graph contains 3D pattern, 2D (H, E1, E2) patterns, efficiency, and peak gain.



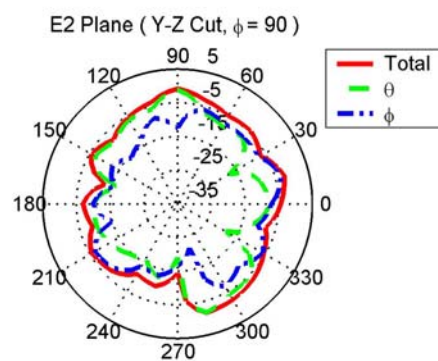
	Tx / Rx		
Frequency	2412MHz	2437MHz	2462MHz
Efficiency (dB)	-4.0	-4.0	-4.1



Peak = 1.1 dBi, Avg. = -3 dBi



Peak = 2.4 dBi, Avg. = -4.4 dBi



Peak = -0.8 dBi, Avg. = -5 dBi

	Tx / Rx				
Frequency	5150MHz	5350MHz	5470MHz	5725MHz	5875MHz
Efficiency (dB)	-3.7	-3.8	-4.2	-4.9	-5.0

4 Summary

The UL1 antenna passive design report, a novel WWAN and WLAN antenna, having a simple structure and being easy to construct with low cost, is presented. The operating bandwidths of the proposed antennas can cover all desired frequency bands. For WWAN, the main antenna efficiency is between -3.2 to -6.1dB in the GSM850/900 band and -2.2 to -5.9dB in the DCS1800/PCS1900/IMT-2000 bands, the aux antenna efficiency is -3.3 to -4.9dB in the GSM850/PCS1900/IMT-2000 receiver bands.

For WLAN, the low band (802.11.b/g) efficiency is between -3.7 to -4.1dB, and the high band (802.11.a) efficiency is between -2.5 to -5.0dB.