

Measurement of Maximum Permissible Exposure

1. Foreword

In adopt with the Human Exposure IEEE C95.1, and according to the FCC 1.1310. The *Maximum Permissible Exposure (MPE)* is obligated to measure in order to prove the safety of radiation harmfulness to the human body.

The *Gain* of the antenna used is measured in an *Anechoic chamber*. The *maximum total power to the antenna* is to be recorded. By adopting the **Friis Transmission Formula** and the *power gain of the antenna*, we can find the distance right away from the product, where the limit of the MPE is.

2. Description of EUT

FCC ID	:	VUIUPWL6025
Product Name	:	WIFI module
Model Name	:	UPWL6025
Frequency Range	:	IEEE 802.11b/g/n Draft 1.0 20M: 2.412GHz ~ 2.462GHz IEEE 802.11n Draft 1.0 40M: 2.422GHz ~ 2.452GHz
Channel Spacing	:	5MHz
Support Channel	:	IEEE 802.11b/g/n Draft 1.0 20M: 11 Channels IEEE 802.11n Draft 1.0 40M: 7 Channels
Modulation Skill	:	DBPSK, DQPSK, CCK, OFDM
Power Type	:	Powered by PCI Express interface of client's device

3. Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Filed Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	100	6
3.0-30	1842/f	4.89/f	900/f ²	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	100	30
1.34-30	824/f	2.19/f	180/f ²	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

[The EUT is tested in transmit and receive modes and in the first, middle and the last channel separately.

The following shows only our observation have the greatest emissions.]

According to OET BULLETIN 56 Fourth Edition/August 1999, Equation for Predicting RF Fields:

$$\text{Friis Transmission Formula: } S = \frac{PG}{4\pi R^2} = \frac{606.09 \times 3.11}{4\pi(20)^2} = 0.374 \text{ mW/cm}^2$$

$$\text{Estimated safe separation: } R = \sqrt{\frac{PG}{4\pi}} = \sqrt{\frac{606.09 \times 3.11}{4\pi}} = 12.247 \text{ cm}$$

Note: "The safe estimated separation that the user must maintain from the antenna is at least 6.5cm"

Where: S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

The Numeric gain G of antenna with a gain specified in dB is determined by:

$$G = \log^{-1} (\text{dB antenna gain} / 10)$$

$$G = \log^{-1} (4.93 / 10) = 3.11$$

Appendix

Antenna Specification (Antenna #1 & #2 N2420DS & N2420DCS)

Airgain™)))))

UNIHAN DRG7908 Antenna solution Report

April 21, 2011

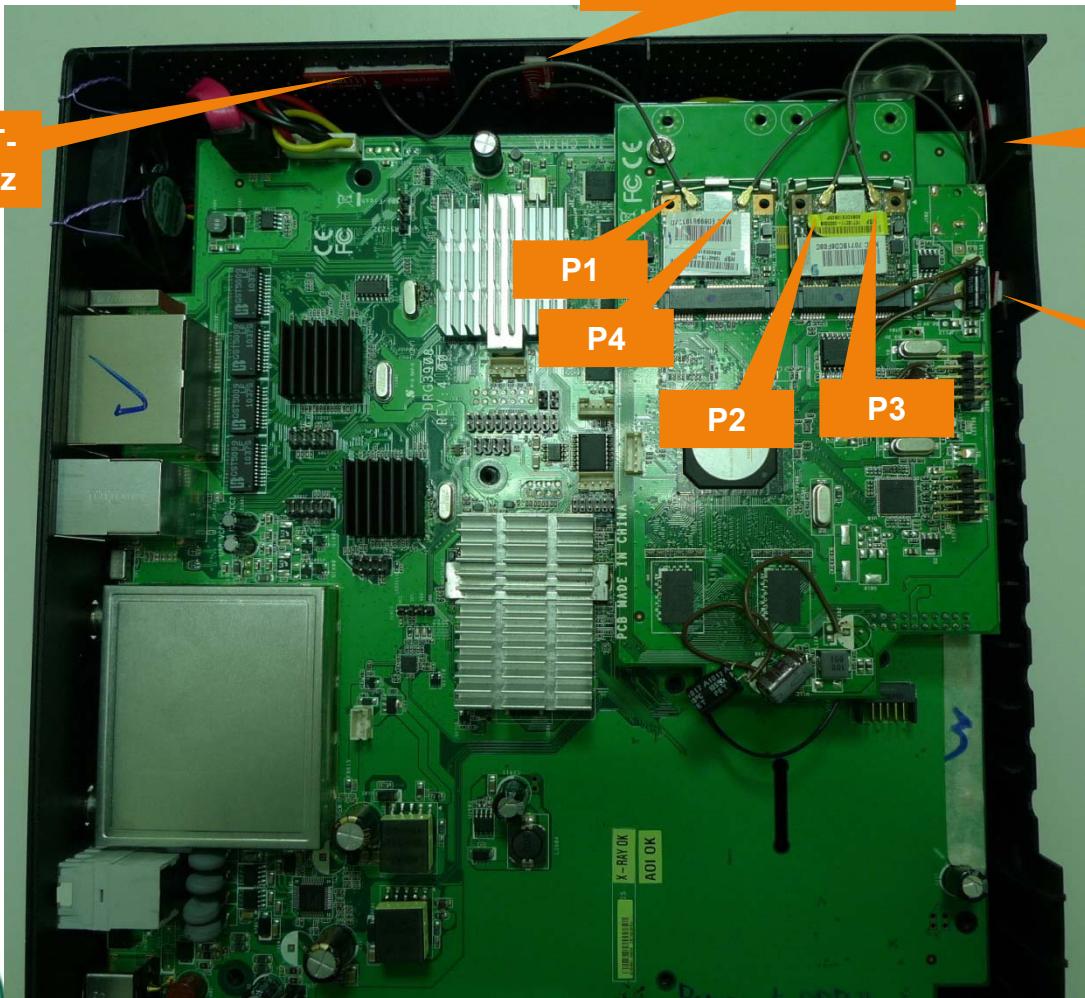
Antenna Installation method

P1_N2420DS-T-130U for 2.4GHz

P2_N5X20SC-T-130U
for 5GHz

P3_N5X20SC-T-130U for 5GHz

P4_N2420DCS-T-130U for 2.4GHz



N5X2oSC

3

■ Features

- Single-Band
- Single feed, low profile design
- Superior performance in both vertical and horizontal orientations
- Simple case mount accommodates easy integration in existing form factors

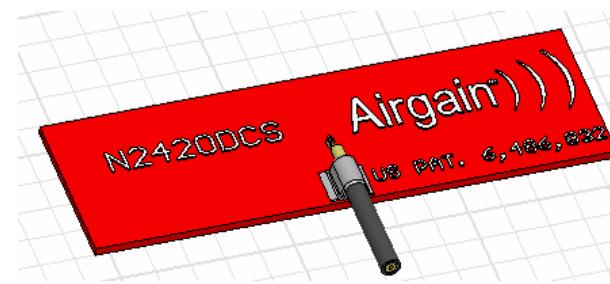


Standard	IEEE 802.11n and 802.11a
Frequency Range	4.9 to 5.9 GHz
Peak Gain	5.12dBi (With DRG7908)
VSWR	2:1
Feed Impedance	50 Ohms
Power Handling	30 dBm
Interface	50 ohm, 1.13mm diameter, micro coax cable, U.FL Compatible Plug
Antenna Dimensions (LxWxH)	21x8x0.5(mm)
Antenna type	PCB type

N2420DCS

■ Features

- Single feed, low profile design
- Superior performance in both vertical and horizontal orientations
- Simple case mount accommodates easy integration in existing form factors



Standard	IEEE 802.11n and 802.11 b/g
Frequency Range	2.4 to 2.49 GHz
Peak Gain	4.93 dBi (with DRG7908)
VSWR	2:1
Feed Impedance	50 Ohms
Power Handling	30 dBm
Interface	50 ohm, 1.13mm diameter, micro coax cable, U.FL compatible Plug termination
Antenna Dimensions (LxWxH)	30 x 9.5 x 1 (mm)
Antenna type	PCB type

N2420DS

5

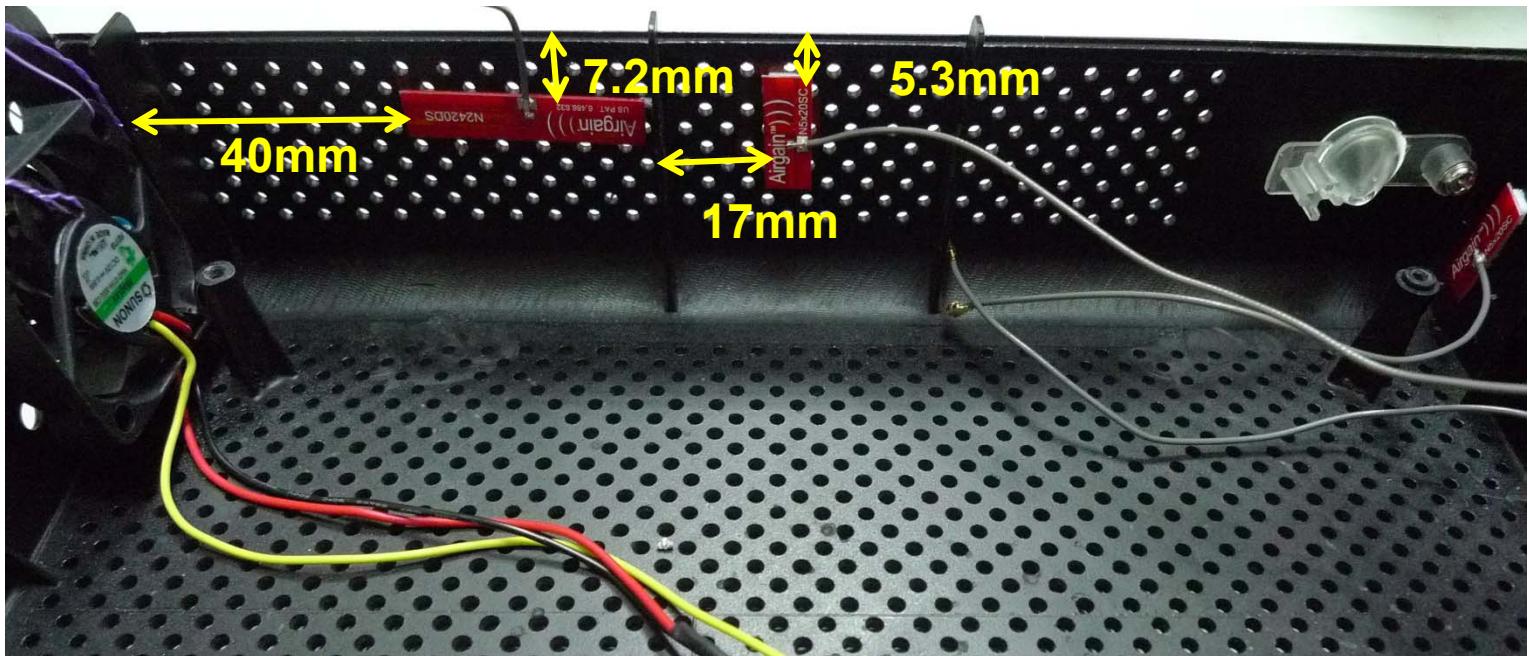
■ Features

- Single feed, low profile design
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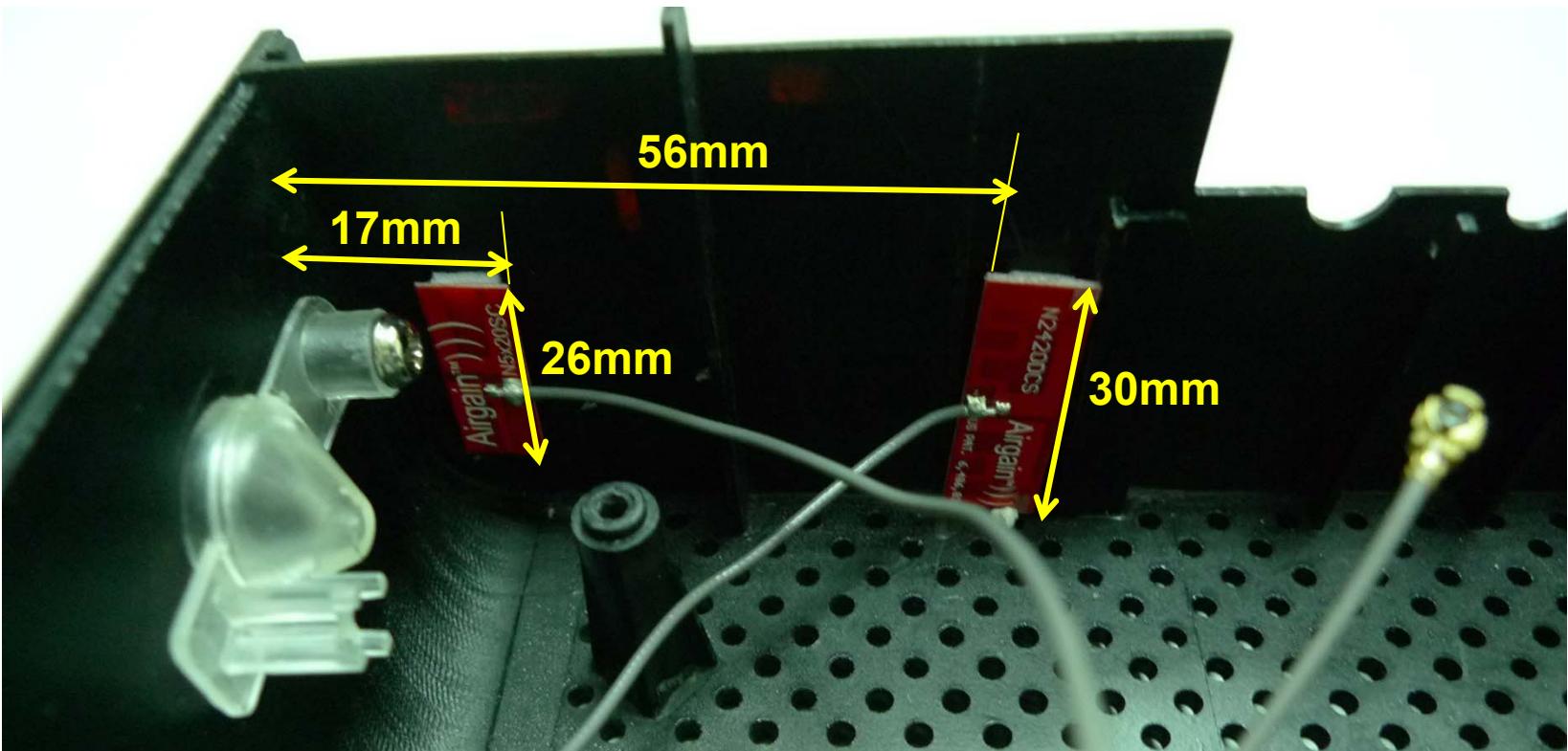


Standard	IEEE 802.11n and 802.11 b/g
Frequency Range	2.4 to 2.49 GHz
Peak Gain	4.36 dBi (with DRG7908)
VSWR	2:1
Feed Impedance	50 Ohms
Power Handling	30 dBm
Interface	50 ohm, 1.13mm diameter, micro coax cable, U.FL compatible Plug termination
Antenna Dimensions (LxWxH)	40 x 8 x 1 (mm)
Antenna type	PCB type

Antenna location (P1 & P2)



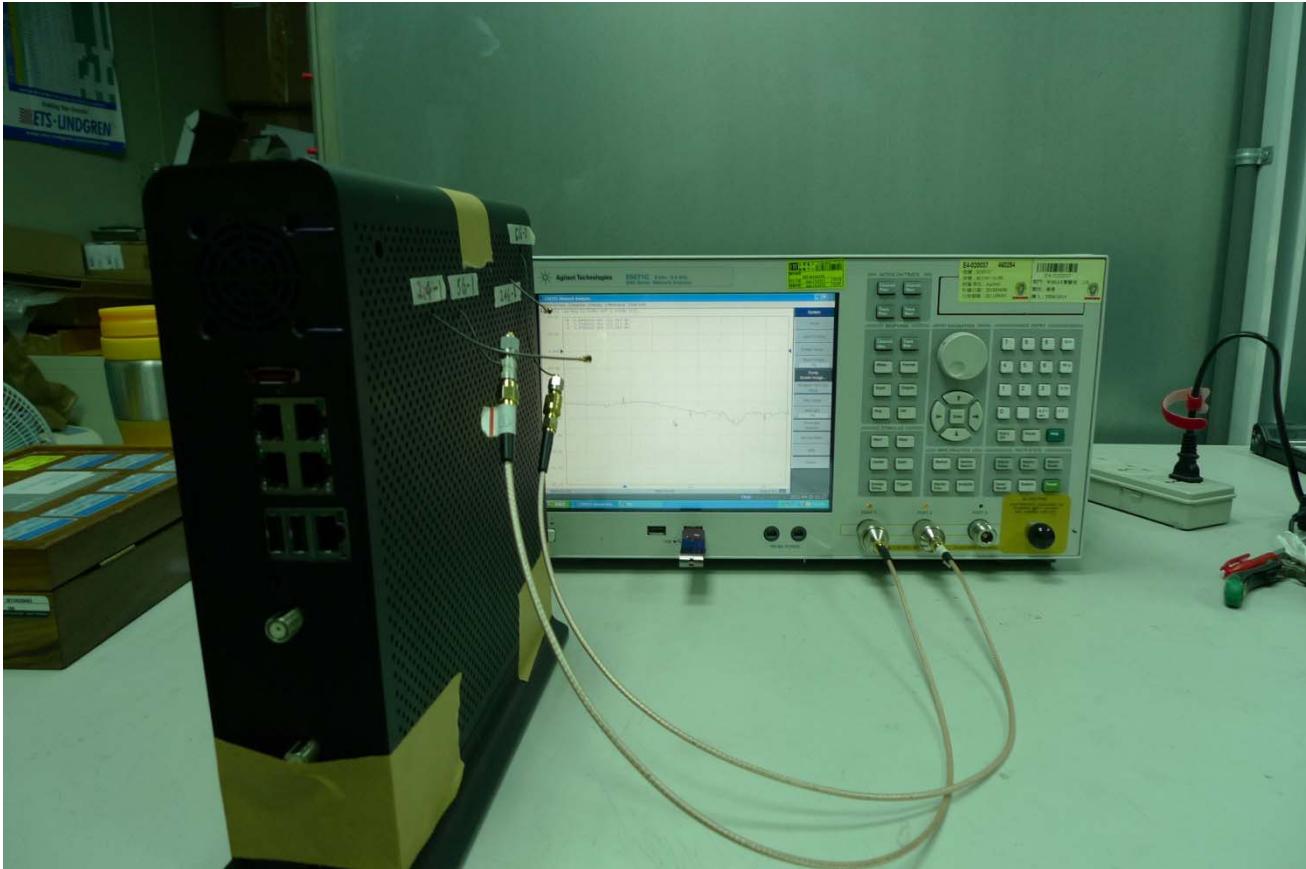
Antenna location (P3 & P4)



S-parameter

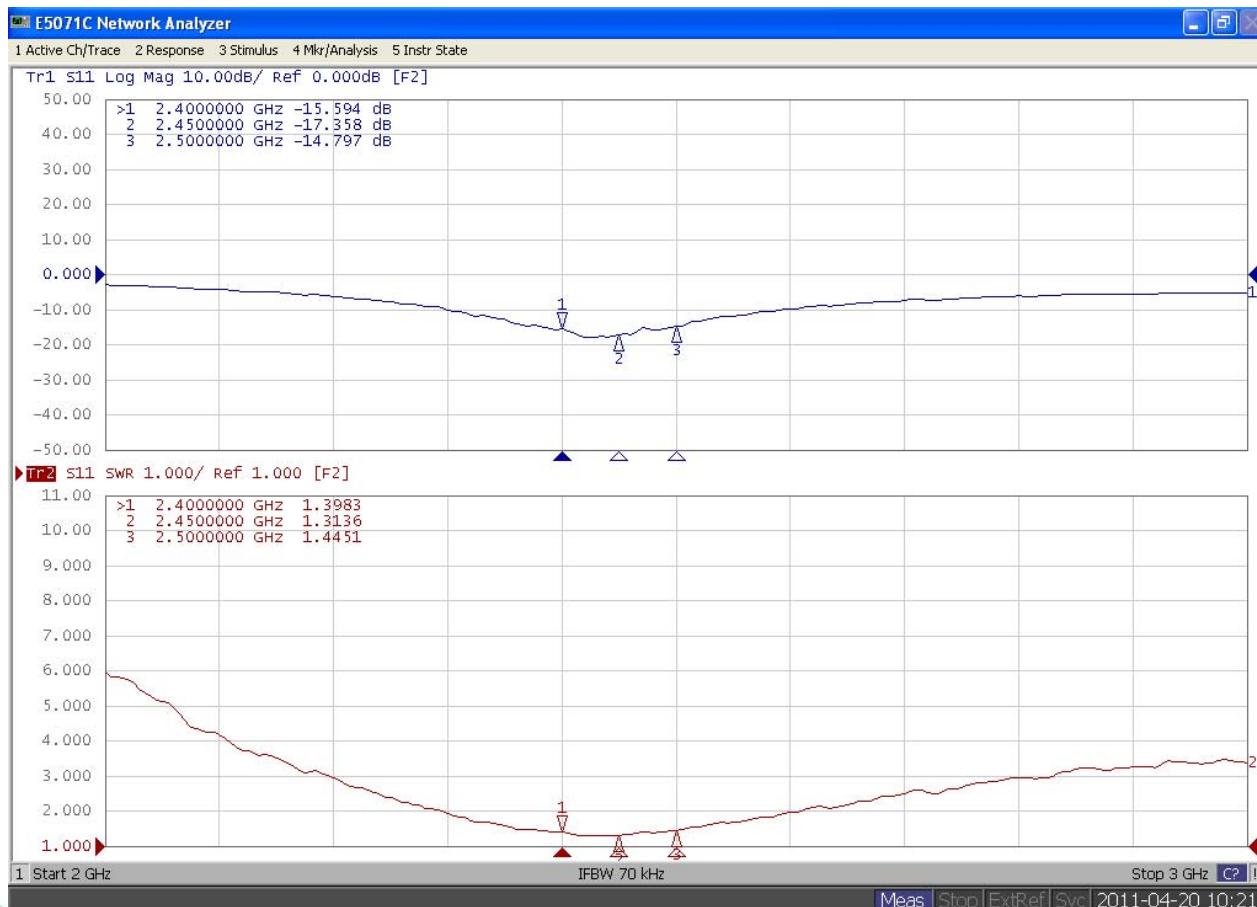
3

■ Measurement Method



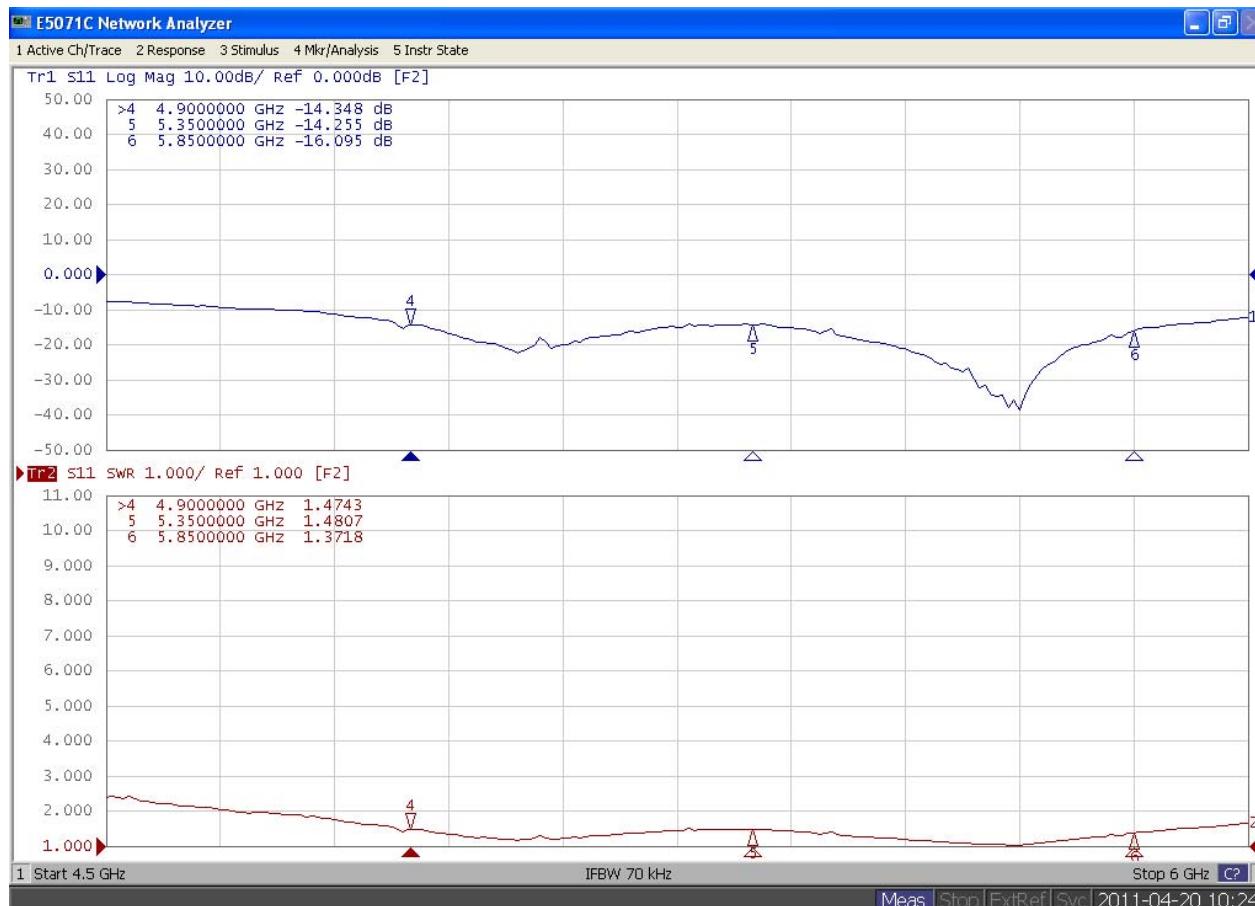
S-parameter

■ P1_N2420DS-T-130U for 2.4GHz



S-parameter

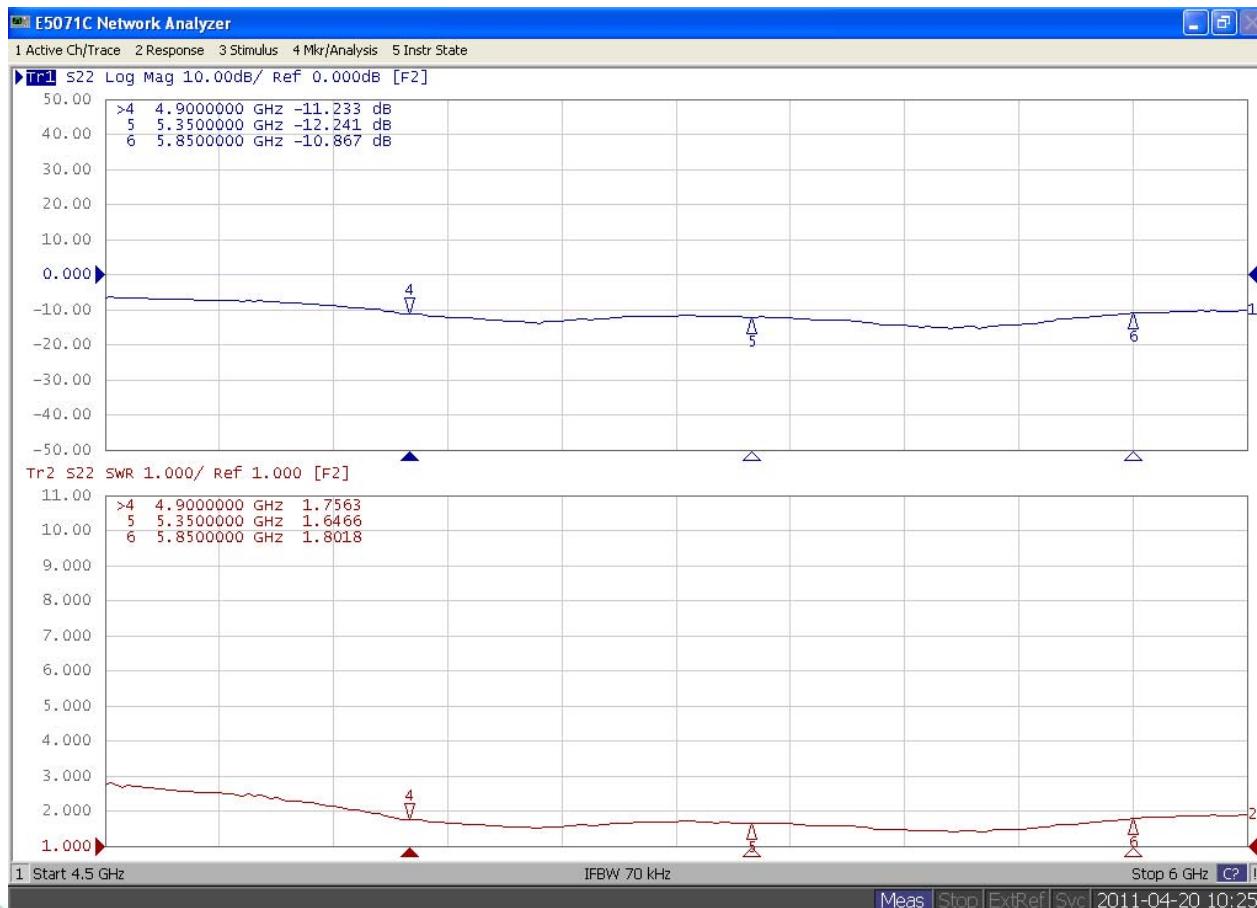
■ P2_N5X20SC-T-130U for 5GHz



S-parameter

1

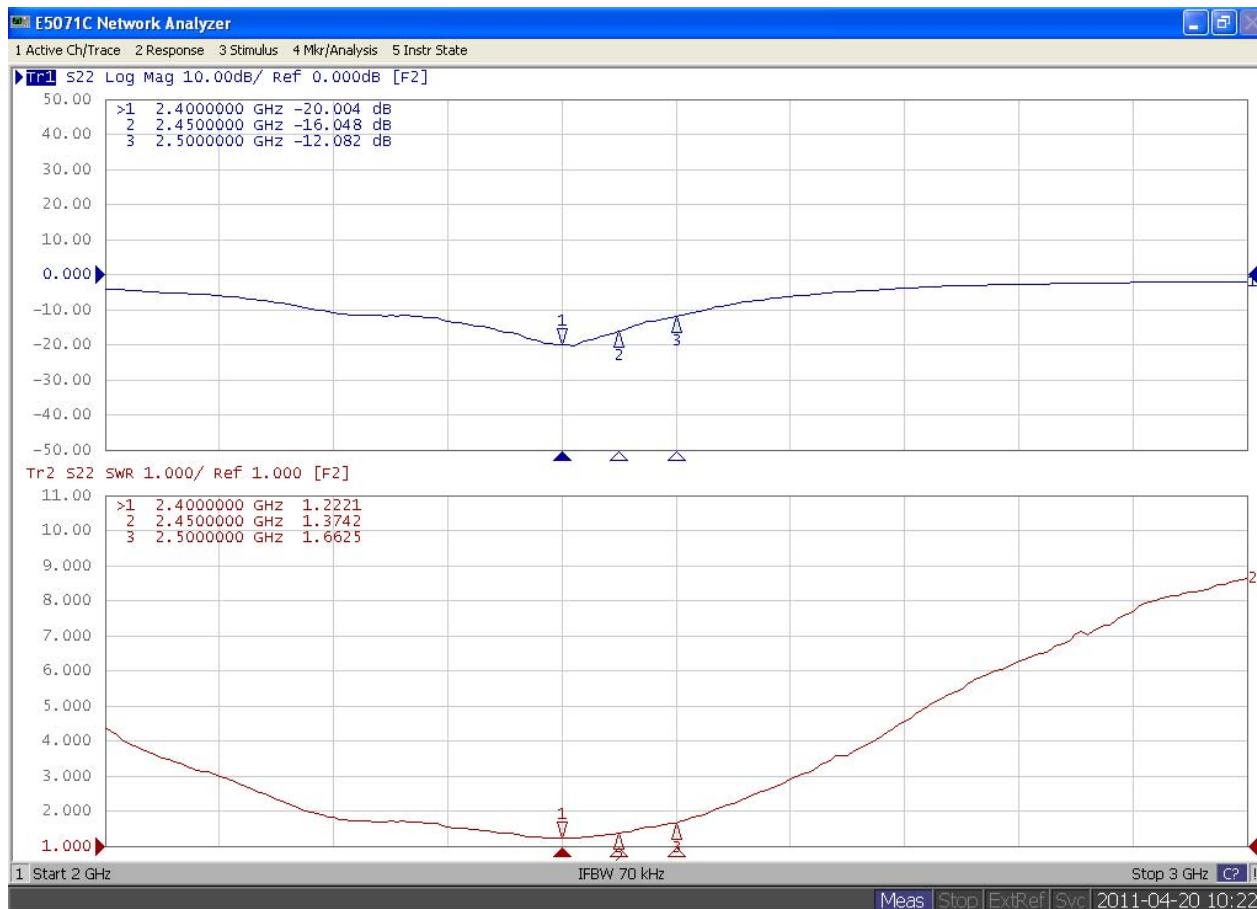
■ P3_N5X20SC-T-130U for 5GHz



S-parameter

2

■ P4 _N2420DS-T-130U for 2.4GHz



S-parameter

3

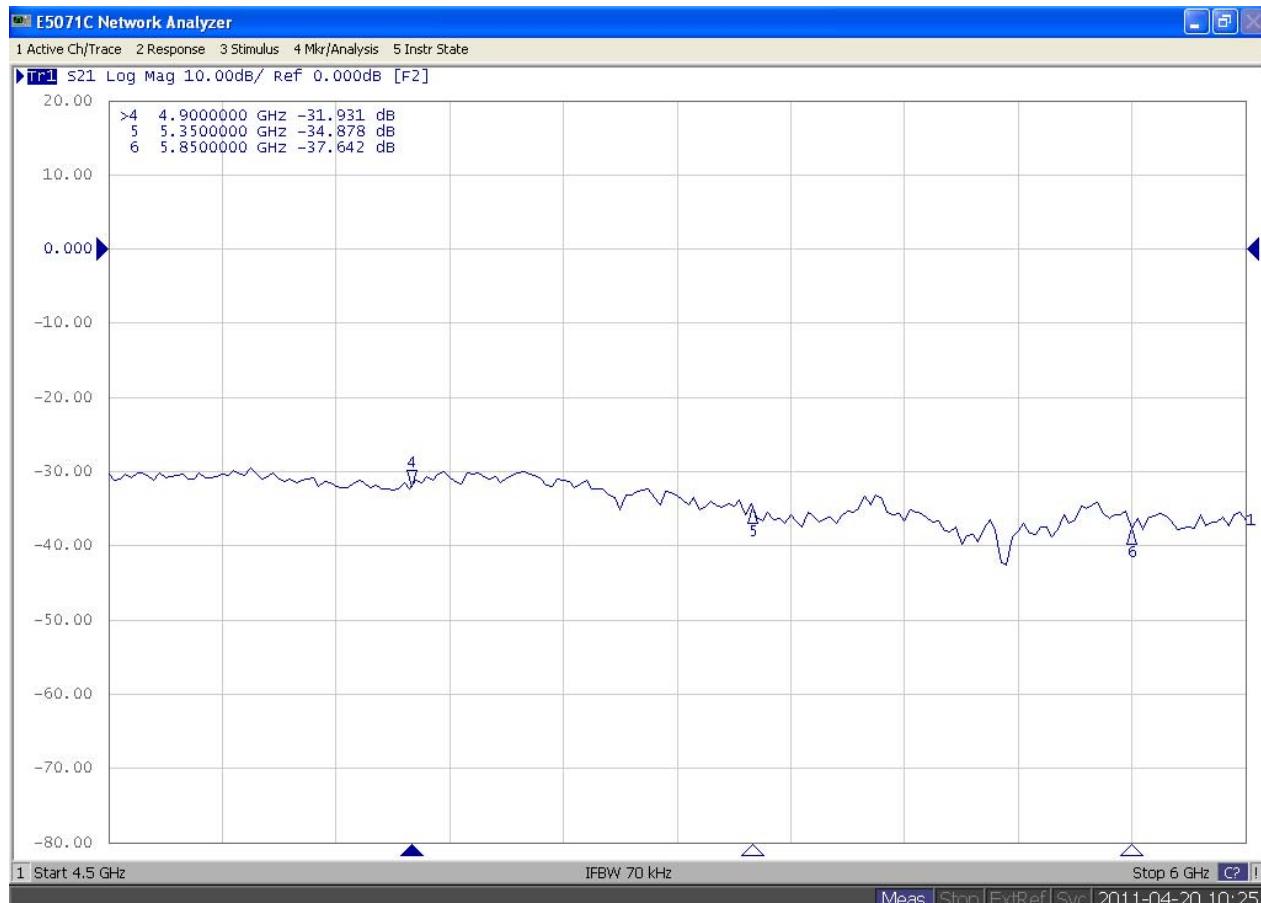
■ Isolation between 2.4GHz antenna



S-parameter

4

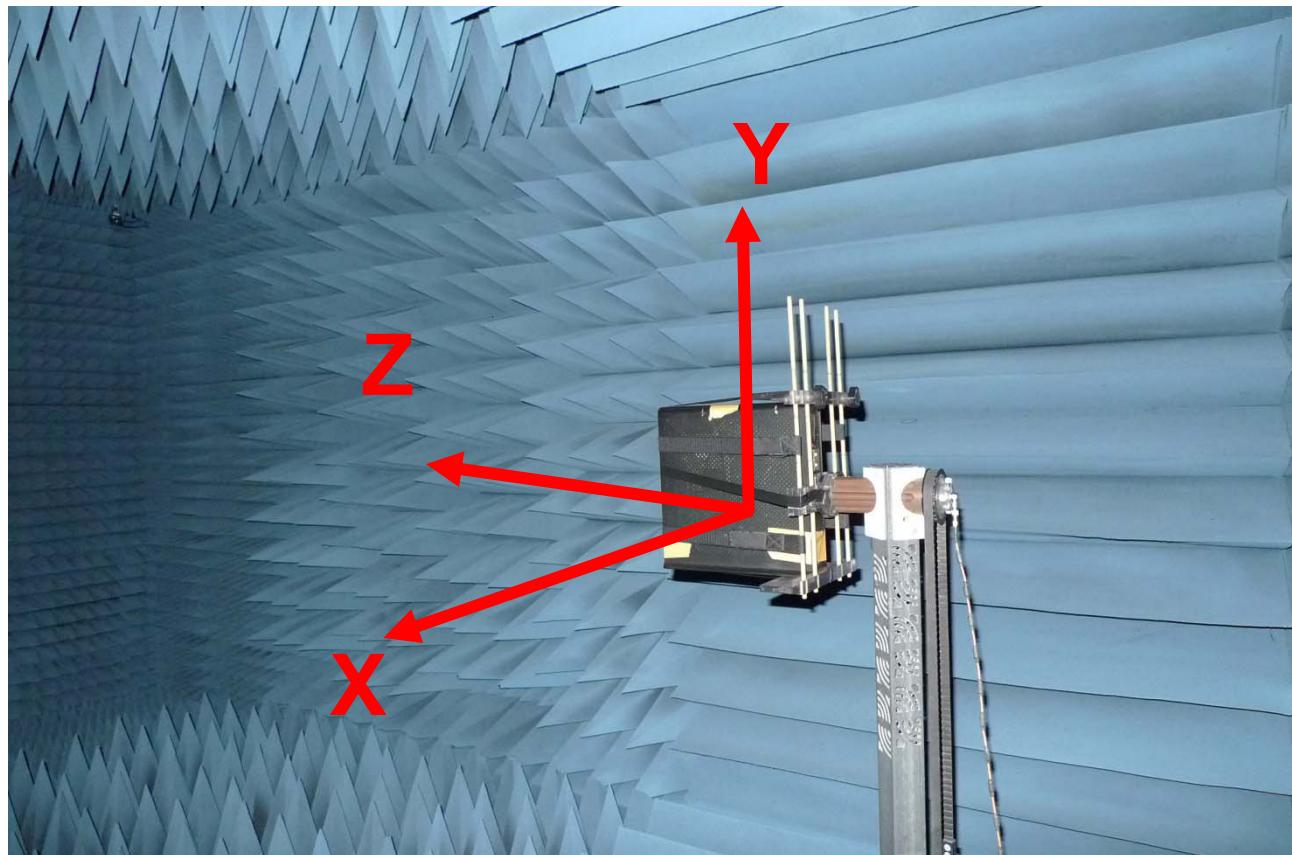
■ Isolation between 5GHz antenna



Radiation pattern

5

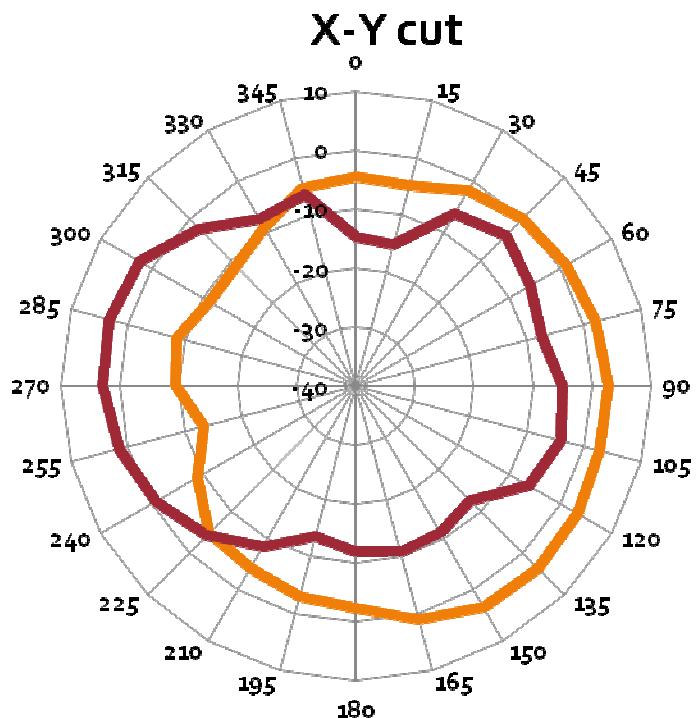
■ Chamber Orientation



Radiation pattern

6

- 2.452GHz (X-Y cut)

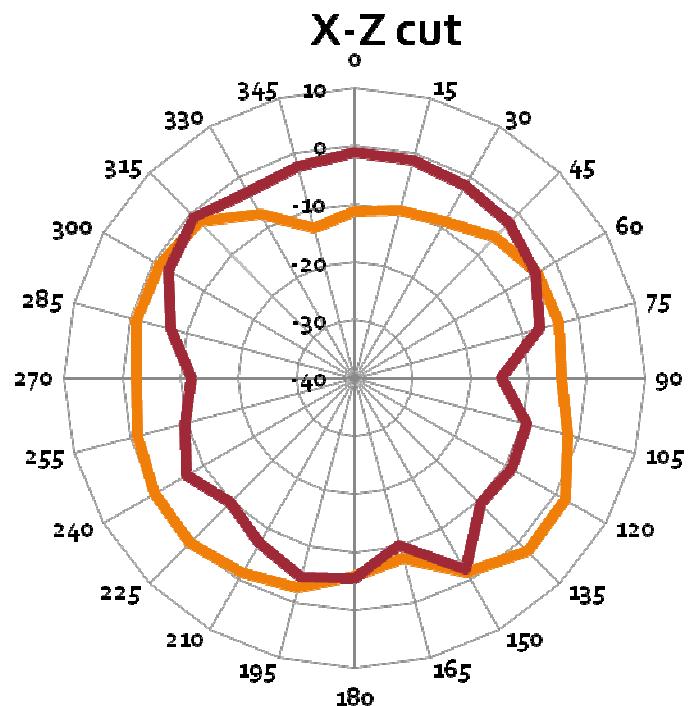


- P1_N2420DS-T-
130U for 2.4GHz
- P4_N2420DS-T-
130U for 2.4GHz

Radiation pattern

7

- 2.452GHz (X-Z cut)



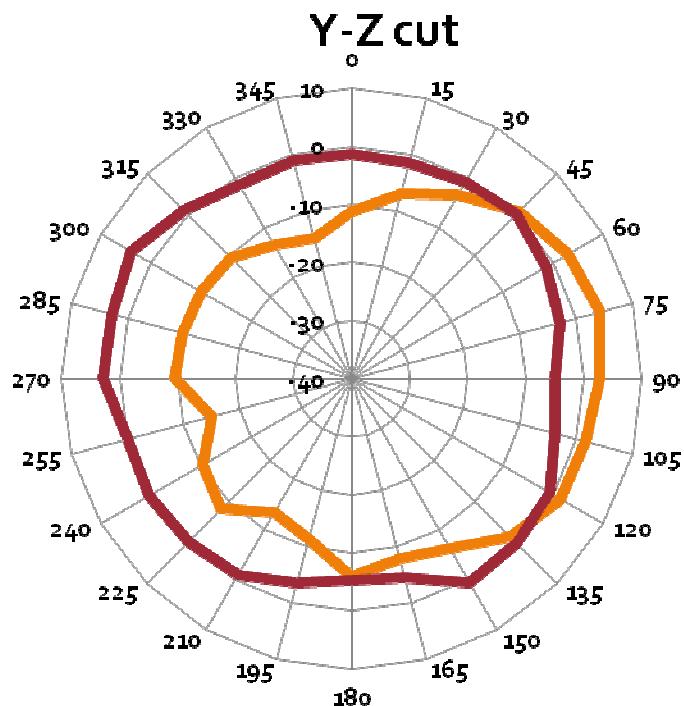
P1_N2420DS-T-
130U for 2.4GHz

P4_N2420DS-T-
130U for 2.4GHz

Radiation pattern

8

- 2.452GHz (Y-Z cut)



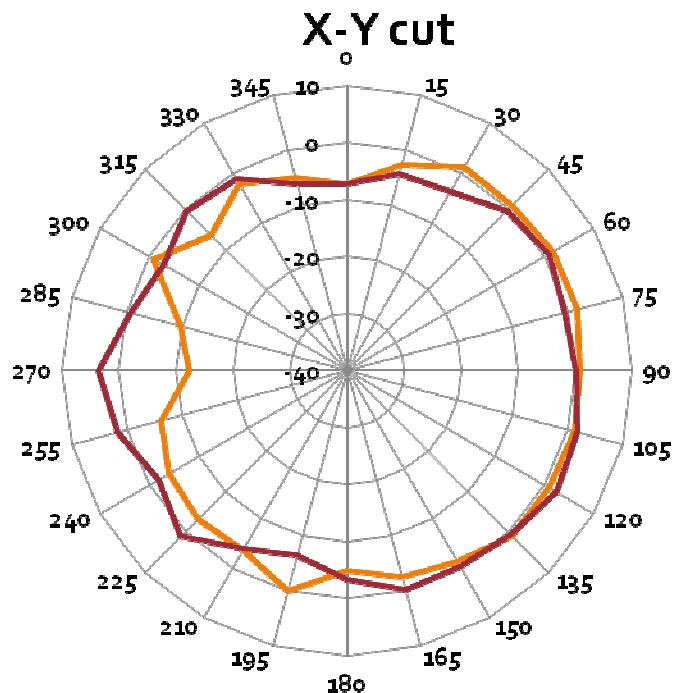
— P1_N2420DS-T-
130U for 2.4GHz

— P4_N2420DS-T-
130U for 2.4GHz

Radiation pattern

9

■ 5.5GHz (X-Y cut)

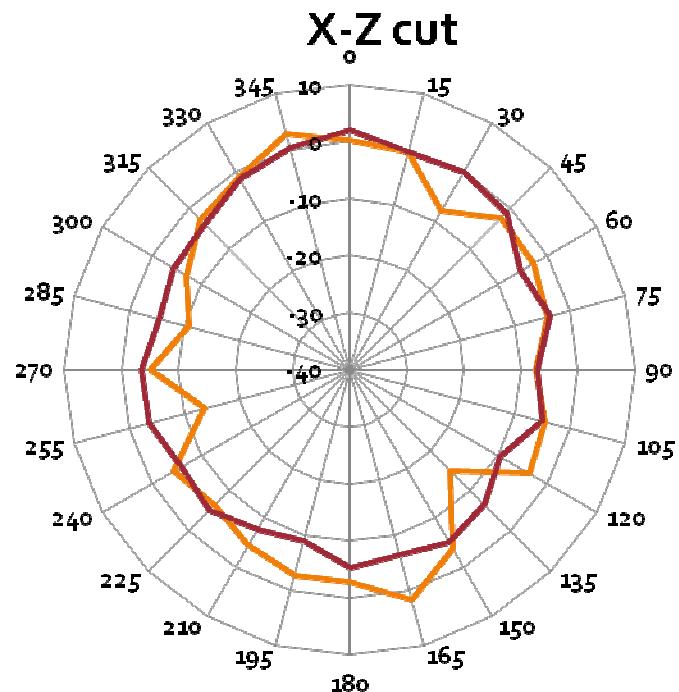


P2_N2401D-T-
130Ufor 5GHz

P3_N2401D-T-
100Ufor 5GHz

Radiation pattern

■ 5.5GHz (X-Z cut)



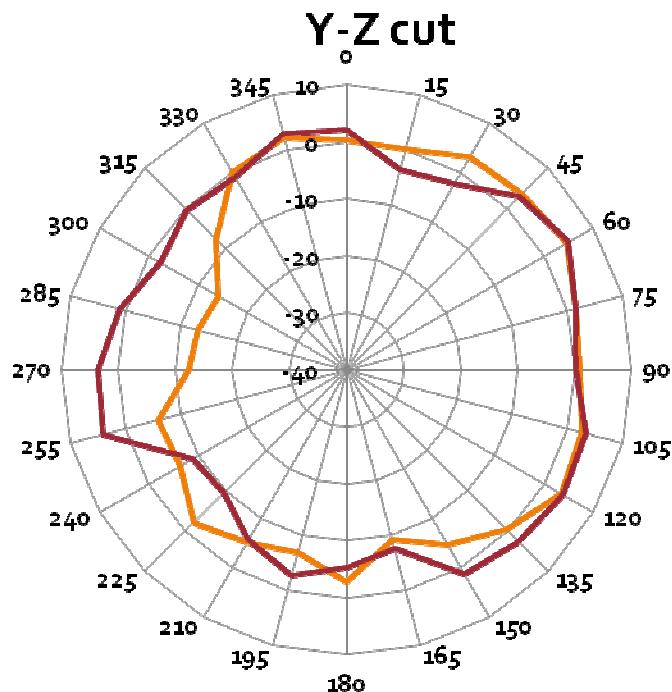
P2_N2401D-T
130Ufor 5GHz

P3_N2401D-T
100Ufor 5GHz

Radiation pattern

1

■ 5.5GHz (Y-Z cut)



P2_N2401D-T-
130Ufor 5GHz

P3_N2401D-T-
100Ufor 5GHz

P1&P4 Peak Gain & Efficiency

2

	P1		P4	
	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)
2.412GHz	4.93	77.24	4.36	67.57
2.417GHz	4.81	76.05	4.31	66.13
2.422GHz	4.75	75.55	4.25	65.20
2.427GHz	4.68	75.16	4.23	64.37
2.432GHz	4.67	74.87	4.19	63.78
2.437GHz	4.70	74.95	4.18	63.86
2.442GHz	4.69	74.59	4.14	63.30
2.447GHz	4.62	73.89	4.13	63.06
2.452GHz	4.69	75.04	4.21	64.25
2.457GHz	4.61	74.39	4.19	63.80
2.462GHz	4.55	73.91	4.15	63.45
2.467GHz	4.56	74.47	4.21	64.10
2.472GHz	4.43	73.03	4.17	63.13

P2&P3 Peak Gain & Efficiency

3

	P2		P3	
	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)
5.180GHz	4.92	75.59	5.04	77.21
5.200GHz	4.87	72.79	4.83	74.76
5.250GHz	4.79	74.36	4.62	73.10
5.300GHz	4.10	71.70	4.23	68.50
5.350GHz	4.61	77.43	4.41	77.94
5.400GHz	4.71	75.75	4.67	77.33
5.450GHz	4.98	71.58	4.58	73.09
5.500GHz	4.64	69.01	4.91	70.90
5.550GHz	4.45	70.54	5.08	75.72
5.600GHz	4.65	69.36	4.96	75.73
5.650GHz	4.90	72.62	4.59	75.48
5.700GHz	4.97	71.24	4.26	71.29
5.750GHz	5.12	76.00	4.90	76.70
5.800GHz	4.85	71.62	4.55	71.42
5.806GHz	4.95	73.27	4.60	73.19

Appendix

Antenna Specification (Antenna #3 WPB208 & WPB209)

納入仕様書

《新規。變更》

客戶

UNIHAN

制 定	2011 年 04 月 21 日
部品番號	1415-01UE000
品 名	WPB208 2.4GHz Antenna with MHF L150mm(F5B)
公司番號	UC3WFI0043

〔驗收印欄〕

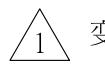
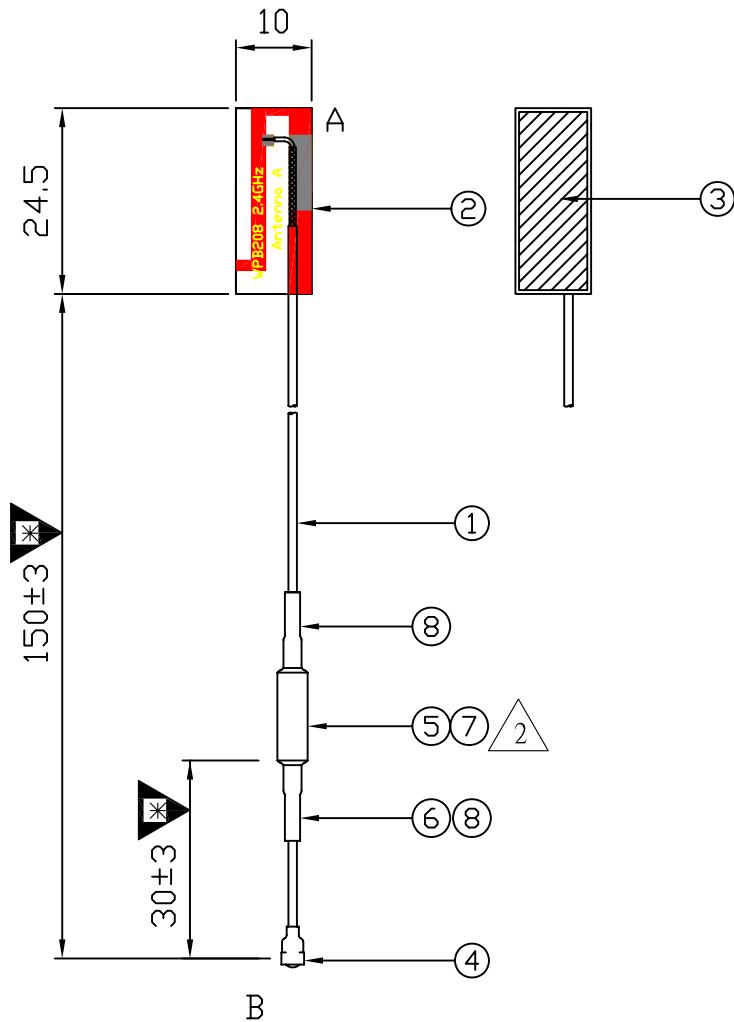
蘇州萬旭電子元件有限公司
江蘇省蘇州市相城區望亭鎮問渡路168號
PC:215155

TEL:86-512-66381105
FAX:86-512-65381104

作 成	檢 圖	確 認	核 準
曹 吉	沈天華	邢丽芬	邢胜华

1 2 3 4 5 6 7

一般未注公差(mm)	
X	±1.0
X.X	±0.5
X.XX	±0.3
ANGULAR	±5.0°
成品单重(g):	X.Xg

客户
签名客户
承认图面

加工注意项：

1. 天线组立依据天线组立作业指导书规定製作。
依据QC管理工程图，执行品质管制。

第3角法	圖面不用實測				机种料号	1415-01UE000		
單位: mm	作 成 檢 圖 確 認 核 准				品 名	WPB208 2.4GHz Antenna with MHF L150mm(F5B)		
比例: FREE					产品分类	<input checked="" type="checkbox"/> A成品	<input type="checkbox"/> B半成品	<input type="checkbox"/> C样品
11年04月20日	曹 吉 沈天华 邢丽芬 邢胜华				图面编号	UC3WFI0043		
S.Z成品编号：UC3WFI0043A	T.W成品编号：				文件编号：RD-4-037A	页次：1/2		

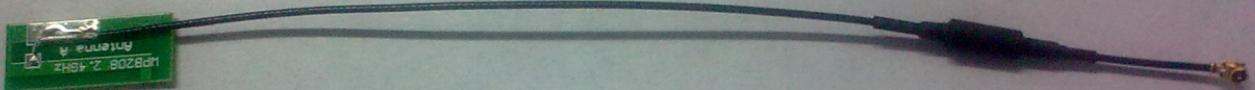


蘇州萬旭電子元件有限公司

1	2	3	4	5	6	7						
变更内容履历简述 REVISIONS DESCRIPTION				版次 REV.	年月日 DATE	變更切換方式	作成					
A	△ 增加CORE;原外露200mm变更为150mm		A2 2011.04.22				曹吉					
	△ F5B T 8*4*4 变更为F5B RH 4*10*2		A3 2011.04.25				曹吉					
	△ 3											
A												
B												
C												
D												
E												
F												
G												
H	8	热缩套管	CB 无卤套管2.5 黑			HF 黑	2					
	7	热缩套管	CB 无卤套管4.0 黑			HF 黑	1					
	6	热缩套管	CB 无卤套管 1.5 黑			HF 黑	1					
	5	CORE	F5B RH 4*10*2			HF 黑	1					
	4	MHF Connector	20278-112R-13			HF 金	1					
I	3	泡棉胶带	3M 4945压克力泡棉胶带 W9mm*H1.1mm*L23.5mm			HF	1					
	2	PCB	WPB208			HF	1					
	1	MINI.13 Coaxial Cable	MINI RG OD:1.13 黑色 HF-Sn			HF 黑	1					
J	NO.	材料名稱	廠商	零件規格			顏色 切斷尺寸& 備註 用量					
	第3角法		圖面不用實測			机种料号	1415-01UE000					
	單位: mm		作成	檢圖	確認	核准	品名 WPB208 2.4GHz Antenna with MHF L150mm(F5B)					
	比例: FREE		曹吉	沈天华	邢丽芬	邢胜华						
	11年04月20日						产品分类 <input checked="" type="checkbox"/> A成品 <input type="checkbox"/> B半成品 <input type="checkbox"/> C样品					
	S.Z成品編號 : UC3WFI0043A		T.W成品編號 :		圖面編號		UC3WFI0043					
	文件編號 : RD-4-037A											
	頁次: 2/2											

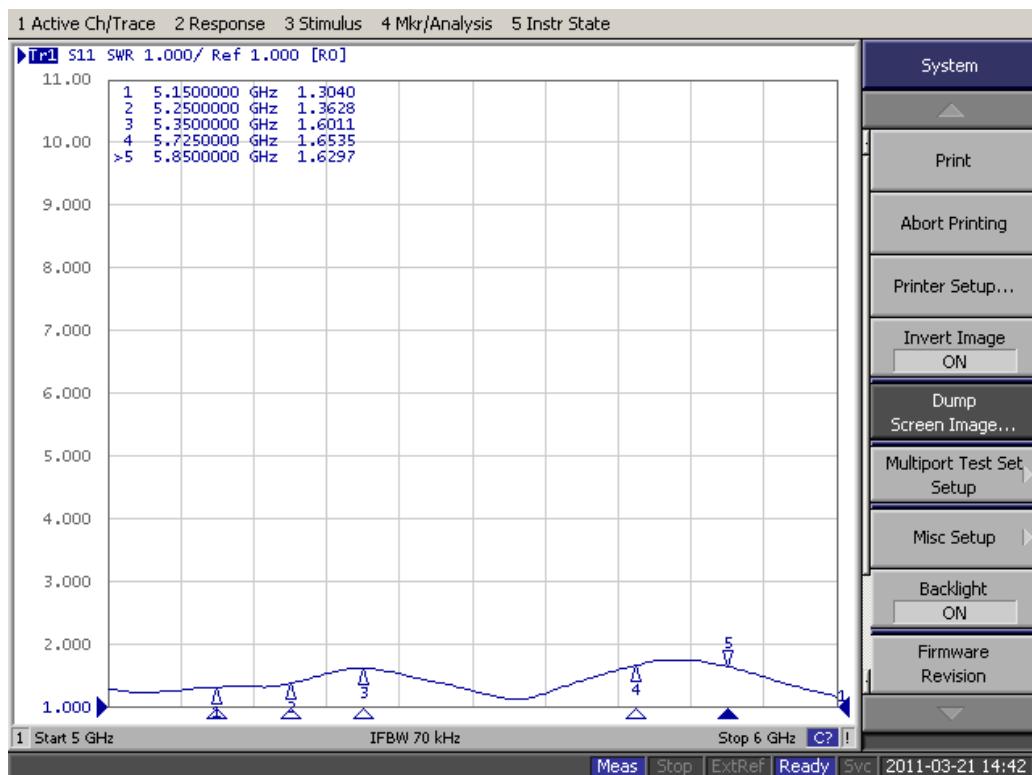
SPECIFICATION

- a. Description : WPB208 2.4GHz Antenna with MHF
L150mm(F5B)
- b. Customer : 永碩聯合國際股份有限公司
- c. Part No. : 1415-01UE000
- d. Model No. : DRG7908
- e. Standard : IEEE 802.11 b/g Wireless LAN
- f. Antenna Profile : 24.5*10*0.8 mm
- g. Lead Length : 150 mm
- h. Electrical Characteristics
 - Operating Frequency : 2.4~2.5 GHz
 - Antenna Type : PCB
 - Polarization Type : Linear
 - Impedance : 50 Ohm nominal
 - Antenna Peak Gain : 4.27 dBi
- i. Mechanical Characteristics
 - Connector : MHF
 - Core : F5B 4*10*2
- j. Raw Material
 - Coaxial Cable : Mini 1.13



Antenna Test Data

Antenna4 (5GHz) VSWR



Radiation Pattern

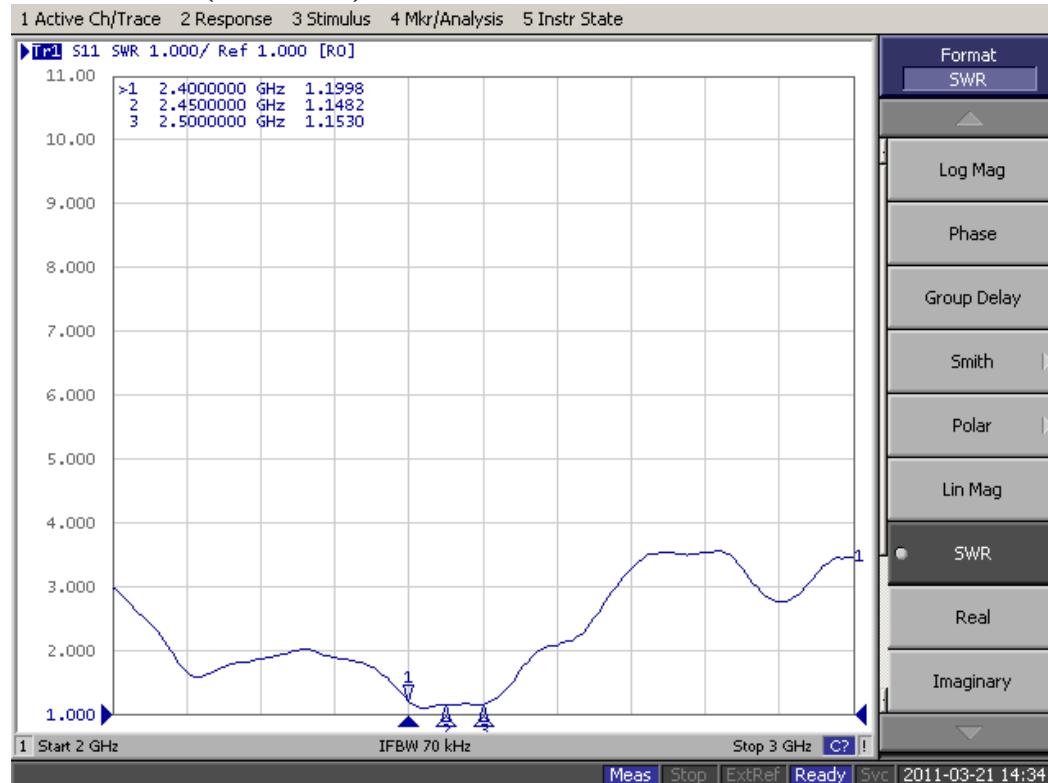
Antenna 4(5GHz)

Antenna 4 Gain

Frequency	Peak Gain (dBi)	Average Gain(dB)	Efficiency %
5.15GHz	3.55	-2.15	60.92
5.25GHz	3.76	-1.86	65.12
5.35GHz	3.87	-1.86	65.21
5.725GHz	4.56	-1.96	63.69
5.85GHz	4.71	-1.69	67.75

Antenna Test Data

Antenna 1(2.4GHz) VSWR

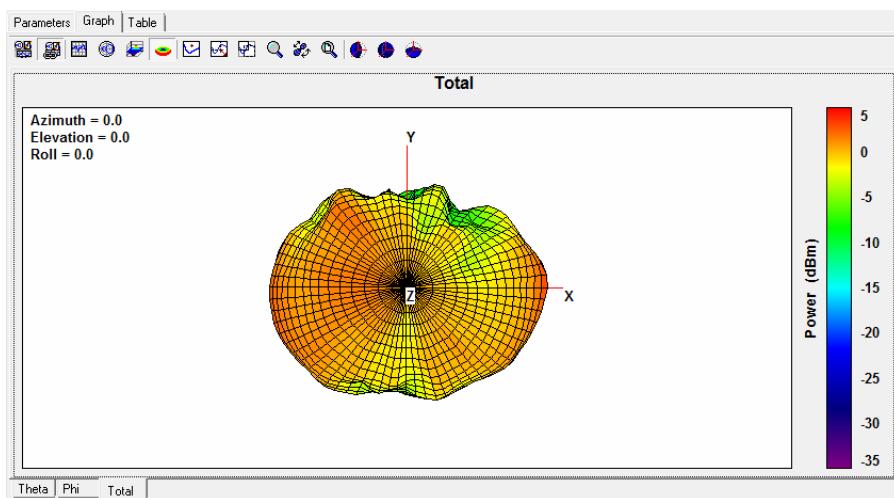


Radiation Pattern Antenna 1(2.4GHz)

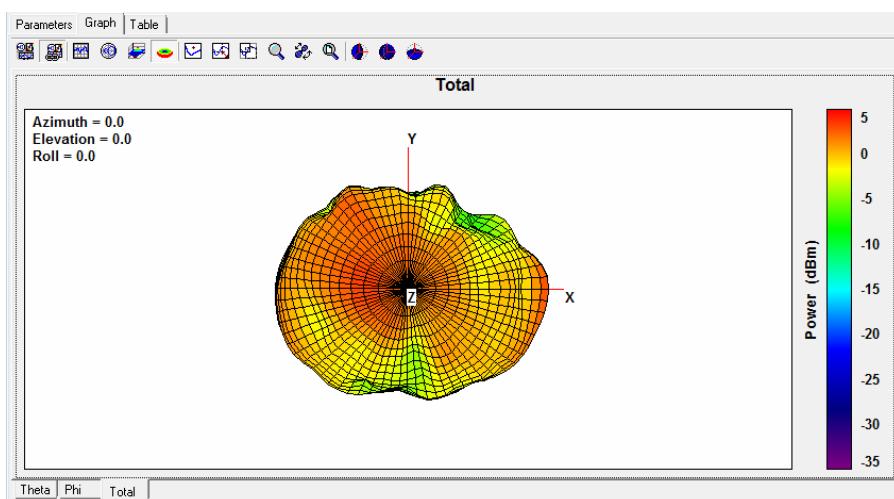
Antenna A1Gain

Frequency	Peak Gain (dBi)	Average Gain(dB)	Efficiency %
2.40GHz	3.81	-2.80	52.49
2.45GHz	4.27	-2.11	61.58
2.50GHz	3.92	-2.20	60.21

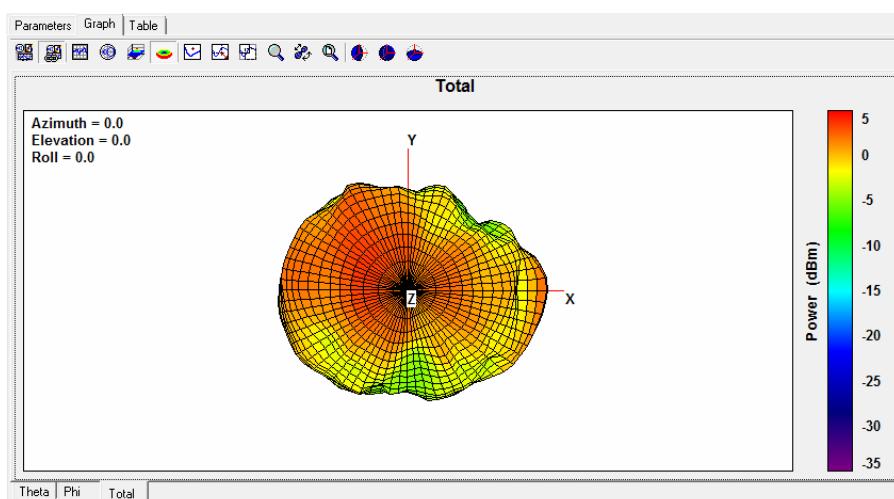
5.15GHz



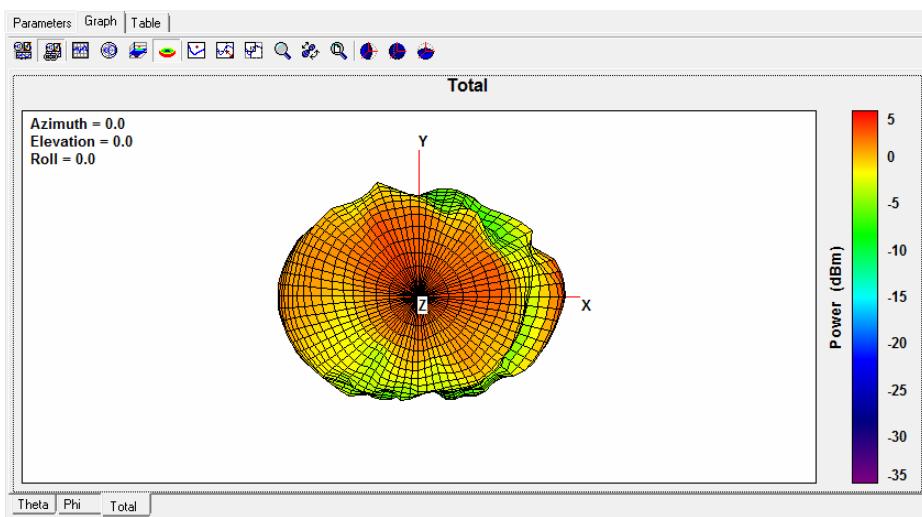
5.25GHz



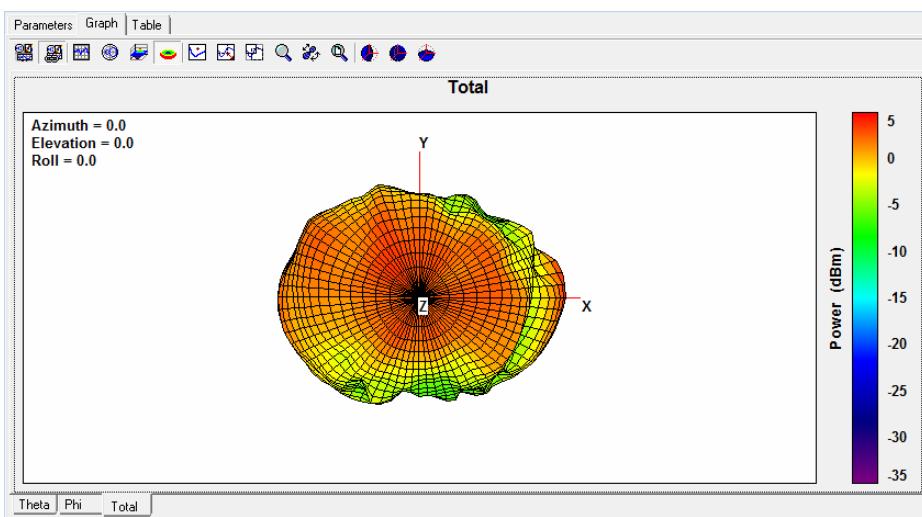
5.35GHz



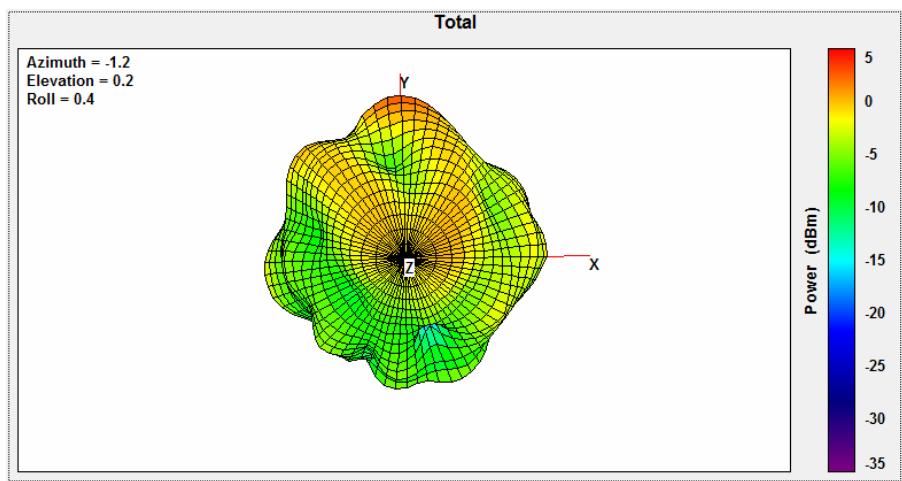
5.725GHz



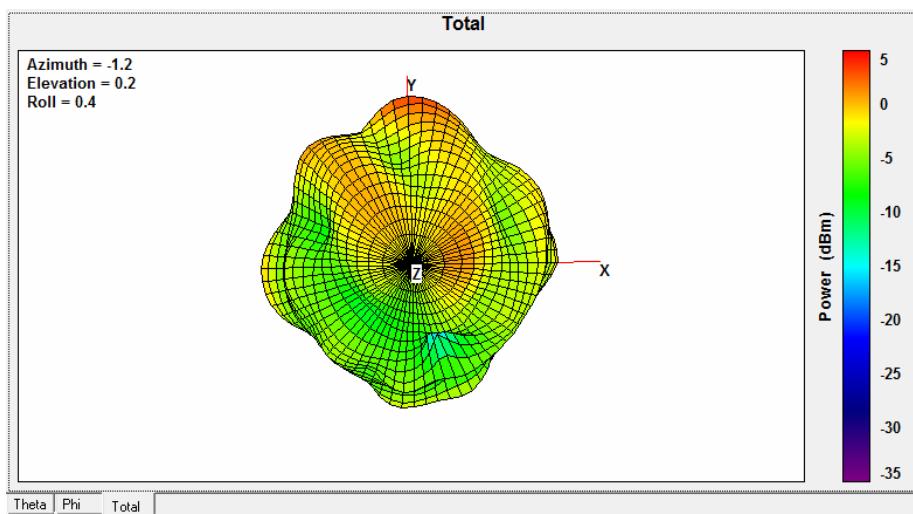
5.85GHz



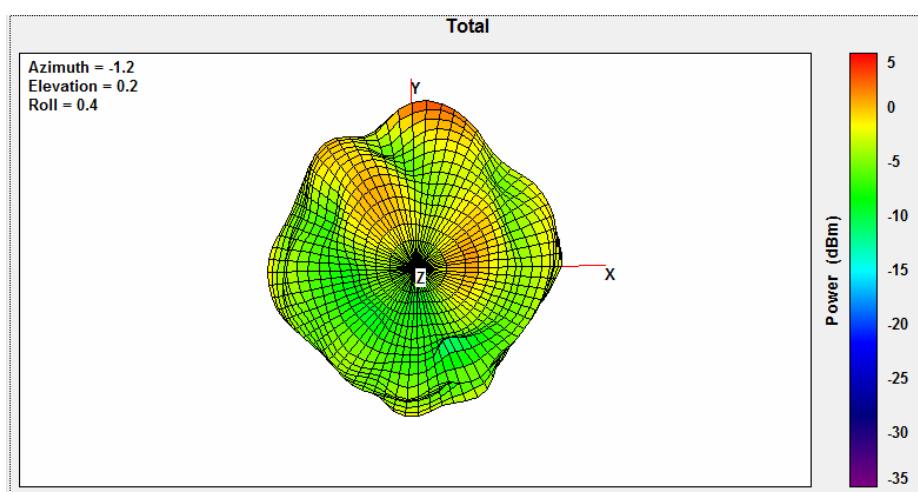
2.4GHz



2.45GHz



2.5GHz



納入仕様書

《新規。變更》

客戶

UNIHAN

制 定	2011 年 04 月 23 日
部品番號	1415-01UF000
品 名	WPB209 2.4GHz Antenna with MHF L150mm(F5B)
公司番號	UC3WFI0045

〔驗收印欄〕

蘇州萬旭電子元件有限公司
江蘇省蘇州市相城區望亭鎮問渡路168號
PC:215155

TEL:86-512-66381105
FAX:86-512-65381104

作 成	檢 圖	確 認	核 準
曹 吉	沈天華	邢丽芬	邢胜华

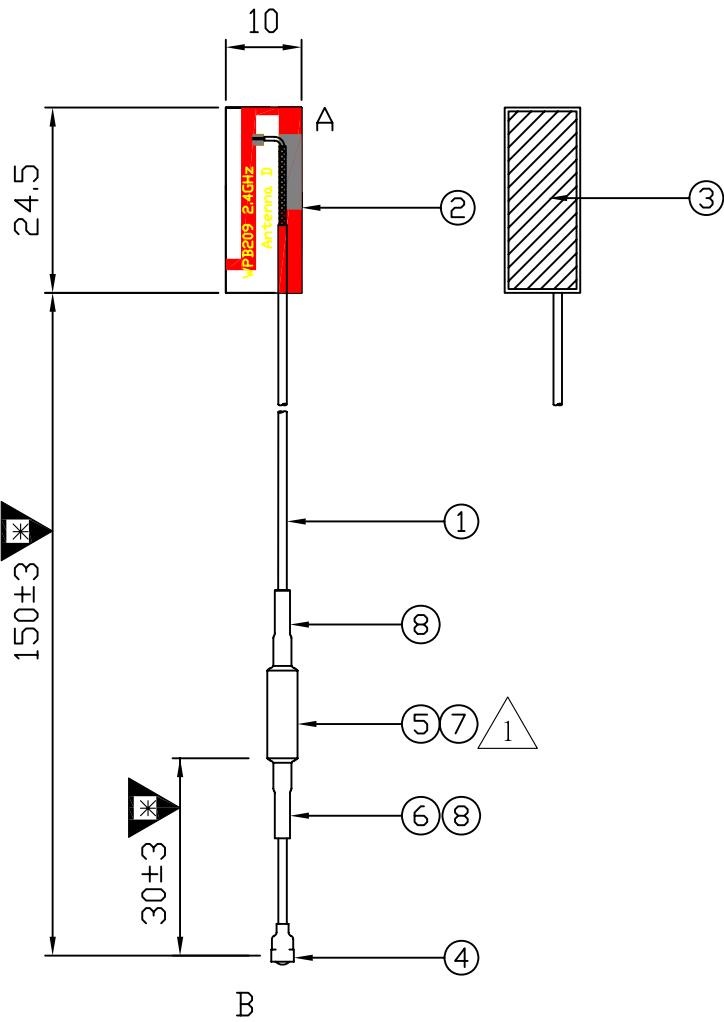
1	2	3	4	5	6	7
一般未注公差(mm)			客户 签名			客户 承认图面
X	±1.0					
X.X	±0.5					
X.XX	±0.3					
ANGULAR	±5.0°					
成品单重(g):	X.Xg					



变更点 指示符



重点尺寸 指示符



加工注意项：

- 天線組立依據天線組立作業指導書規定製作。
依據QC管理工程圖，執行品質管制。

第3角法	圖面不用實測				机种料号	1415-01UF000		
單位: mm	作 成 檢 圖 確 認 核 准				品 名	WPB209 2.4GHz Antenna with MHF L150mm(F5B)		
比例: FREE					产品分类	<input checked="" type="checkbox"/> A成品	<input type="checkbox"/> B半成品	<input type="checkbox"/> C样品
11年04月22日	曹 吉 沈天华 邢丽芬 邢胜华				图面编号	UC3WFI0045		
S.Z成品编号：UC3WFI0045A	T.W成品编号：	文件编号：RD-4-037A 页次：1/2						

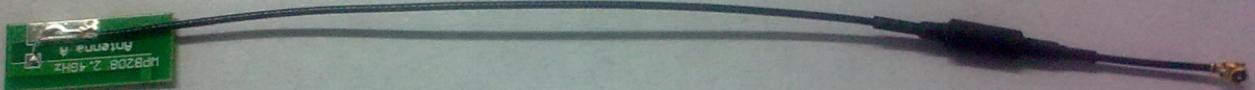


苏州万旭电子元件有限公司

1	2	3	4	5	6	7					
变更内容履历简述 REVISIONS DESCRIPTION				版次 REV.	年月日 DATE	變更切換方式	作成				
A	△ F5B T 8*4*4 变更为F5B RH 4*10*2				A3	2011.04.25					
	△										
	△										
A											
B											
C											
D											
E											
F											
G											
H	8	热缩套管	CB 无卤套管 2.5 黑			HF 黑					
	7	热缩套管	CB 无卤套管 4.0 黑			HF 黑					
	6	热缩套管	CB 无卤套管 1.5 黑			HF 黑					
	5	CORE	F5B RH 4*10*2			HF 黑					
I	4	MHF Connector	20278-112R-13			HF 金					
	3	泡棉胶带	3M 4945压克力泡棉胶带 W9mm*H1.1mm*L23.5mm HF								
	2	PCB	WPB209			HF					
	1	MINI.13 Coaxial Cable	MINI RG OD:1.13 黑色 HF-Sn			HF 黑					
J	NO.	材料名稱	廠商	零件規格			顏色 切斷尺寸 & 備註 用量				
	第3角法		圖面不用實測			机种料号	1415-01UF000				
	單位: mm		作成	檢圖	確認	核准	品名				
	比例: FREE		曹吉	沈天华	邢丽芬	邢胜华	WPB209 2.4GHz Antenna with MHF L150mm(F5B)				
	11年04月22日						产品分类 <input checked="" type="checkbox"/> A成品 <input type="checkbox"/> B半成品 <input type="checkbox"/> C样品				
	S.Z成品编号: UC3WF10045A		T.W成品编号:		图面編號		UC3WF10045				
					文件編號: RD-4-037A						
					頁次: 2/2						

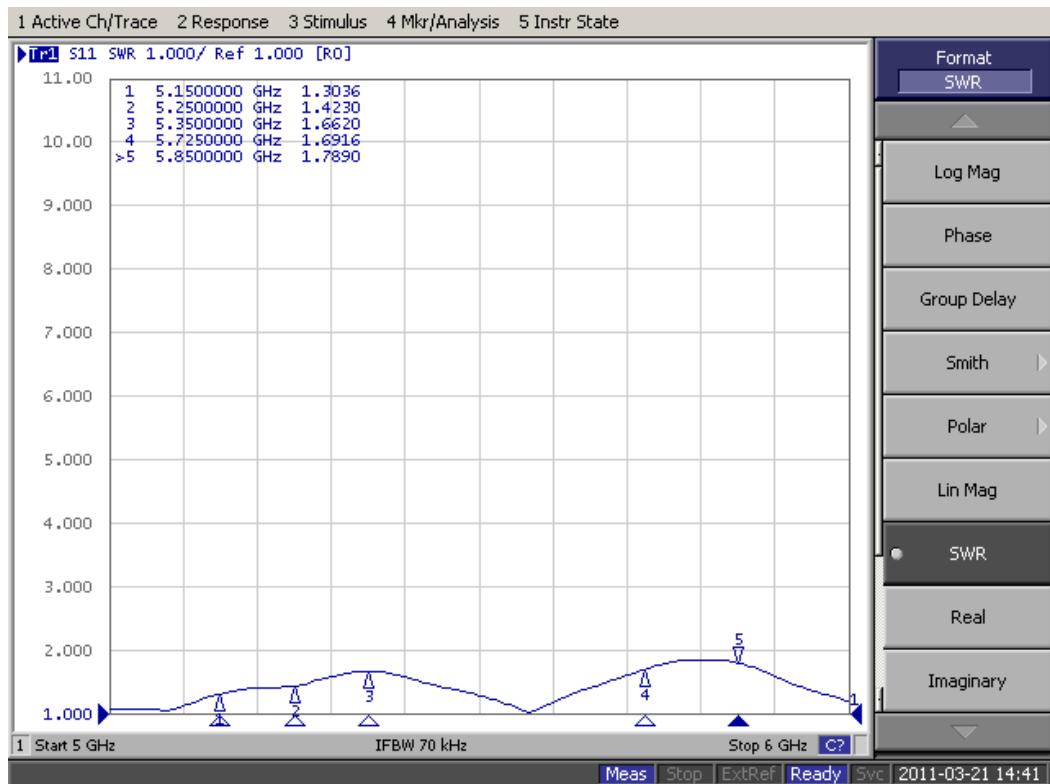
SPECIFICATION

- a. Description : WPB209 2.4GHz Antenna with MHF
L150mm(F5B)
- b. Customer : 永碩聯合國際股份有限公司
- c. Part No. : 1415-01UF000
- d. Model No. : DRG7908
- e. Standard : IEEE 802.11 b/g Wireless LAN
- f. Antenna Profile : 24.5*10*0.8 mm
- g. Lead Length : 150 mm
- h. Electrical Characteristics
 - Operating Frequency : 2.4~2.5 GHz
 - Antenna Type : PCB
 - Polarization Type : Linear
 - Impedance : 50 Ohm nominal
 - Antenna Peak Gain : 4.04 dBi
- i. Mechanical Characteristics
 - Connector : MHF
 - Core : F5B 4*10*2
- j. Raw Material
 - Coaxial Cable : Mini 1.13



Antenna Test Data

Antenna 2(5GHz) VSWR



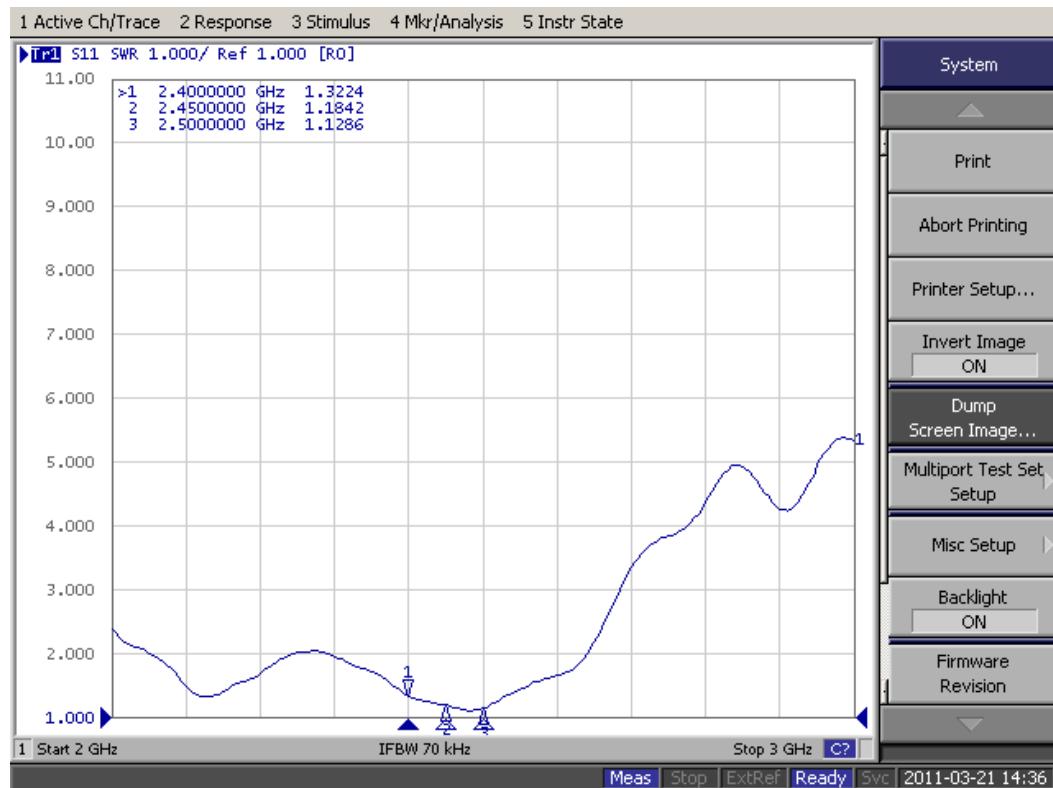
Radiation Pattern

Antenna 2(5GHz)

Antenna 2 Gain			
Frequency	Peak Gain (dBi)	Average Gain(dB)	Efficiency %
5.15GHz	3.49	-1.88	64.91
5.25GHz	4.11	-1.82	65.70
5.35GHz	4.31	-1.79	66.21
5.725GHz	3.90	-2.09	61.48
5.85GHz	4.40	-1.93	64.06

Antenna Test Data

Antenna 3(2.4GHz) VSWR

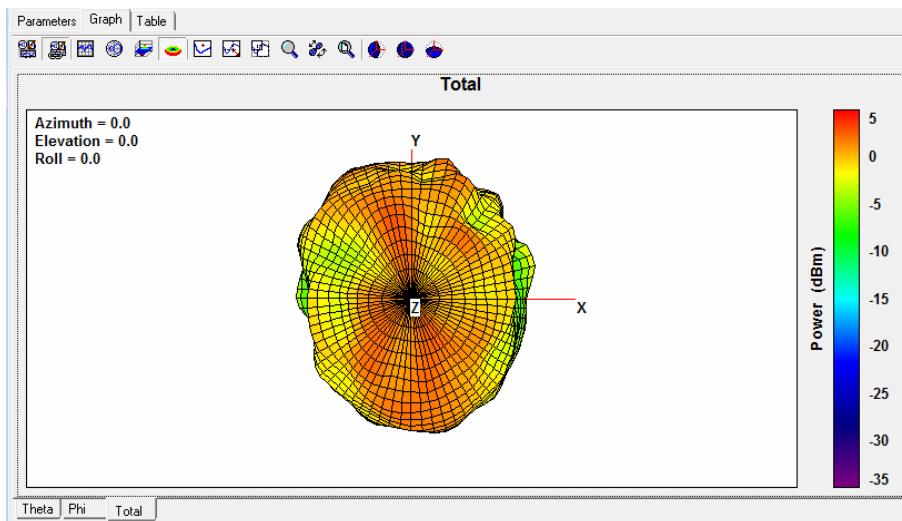


Radiation Pattern Antenna 3(2.4GHz)

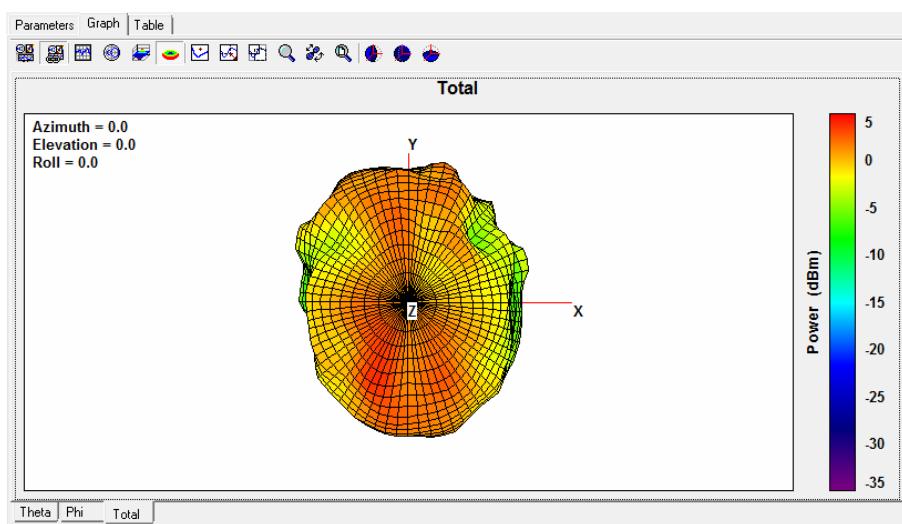
Antenna 3 Gain

Frequency	Peak Gain (dBi)	Average Gain(dB)	Efficiency %
2.40GHz	3.26	-2.39	57.70
2.45GHz	4.04	-2.15	60.98
2.50GHz	3.66	-2.33	58.54

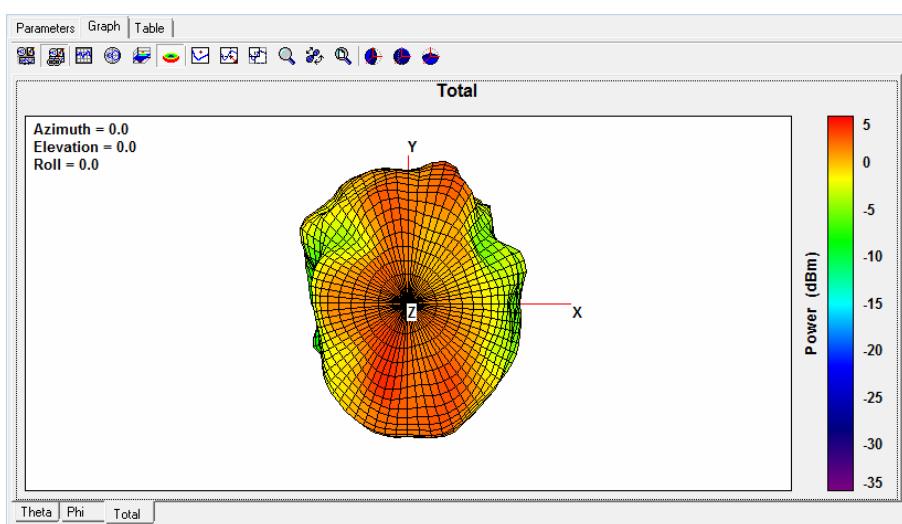
5.15GHz



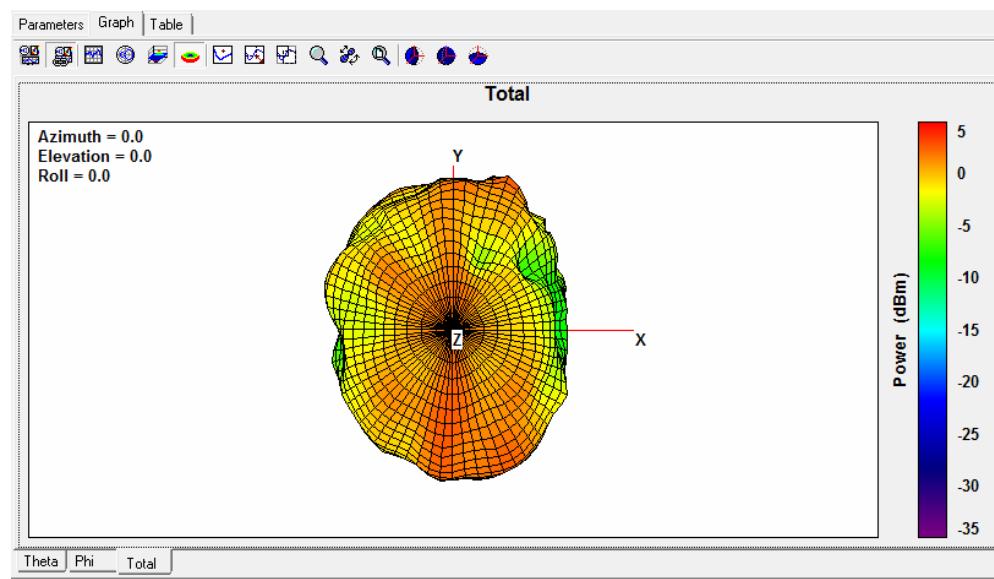
5.25GHz



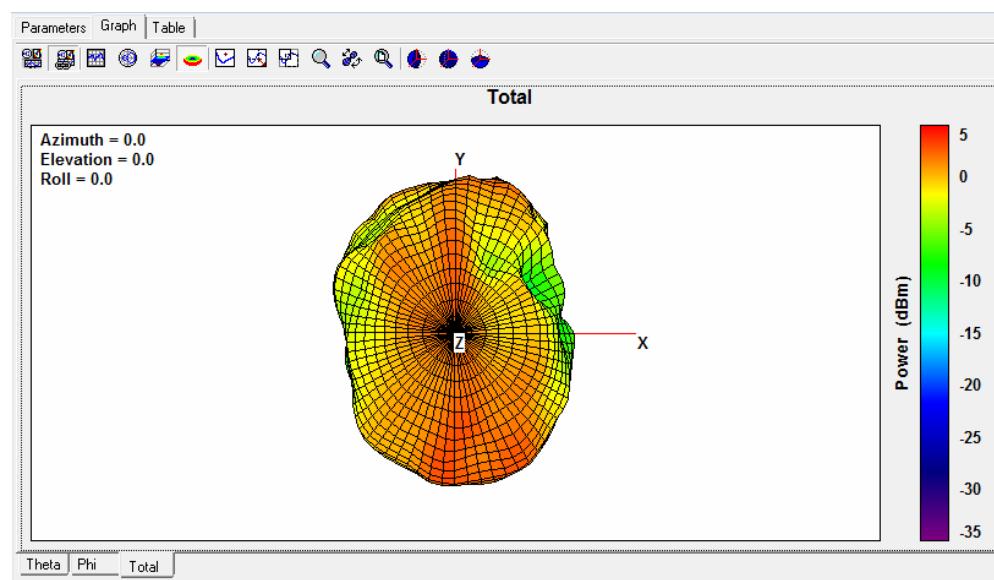
5.35GHz



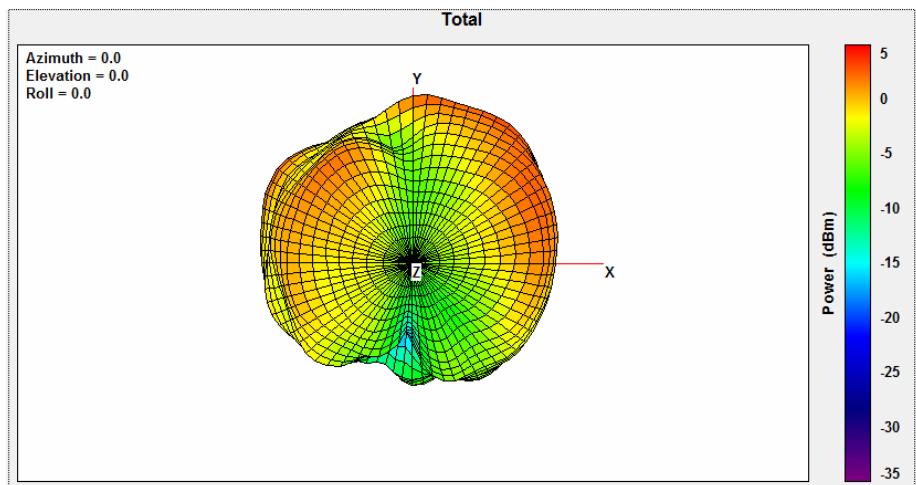
5.725GHz



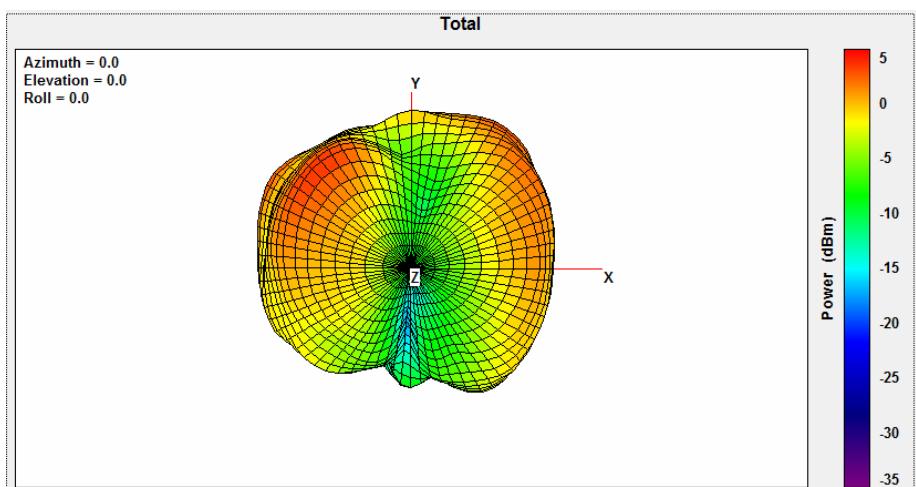
5.85GHz



2.4GHz



2.45GHz



2.5GHz

