

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 Field 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:

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

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

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:

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

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

Appendix

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

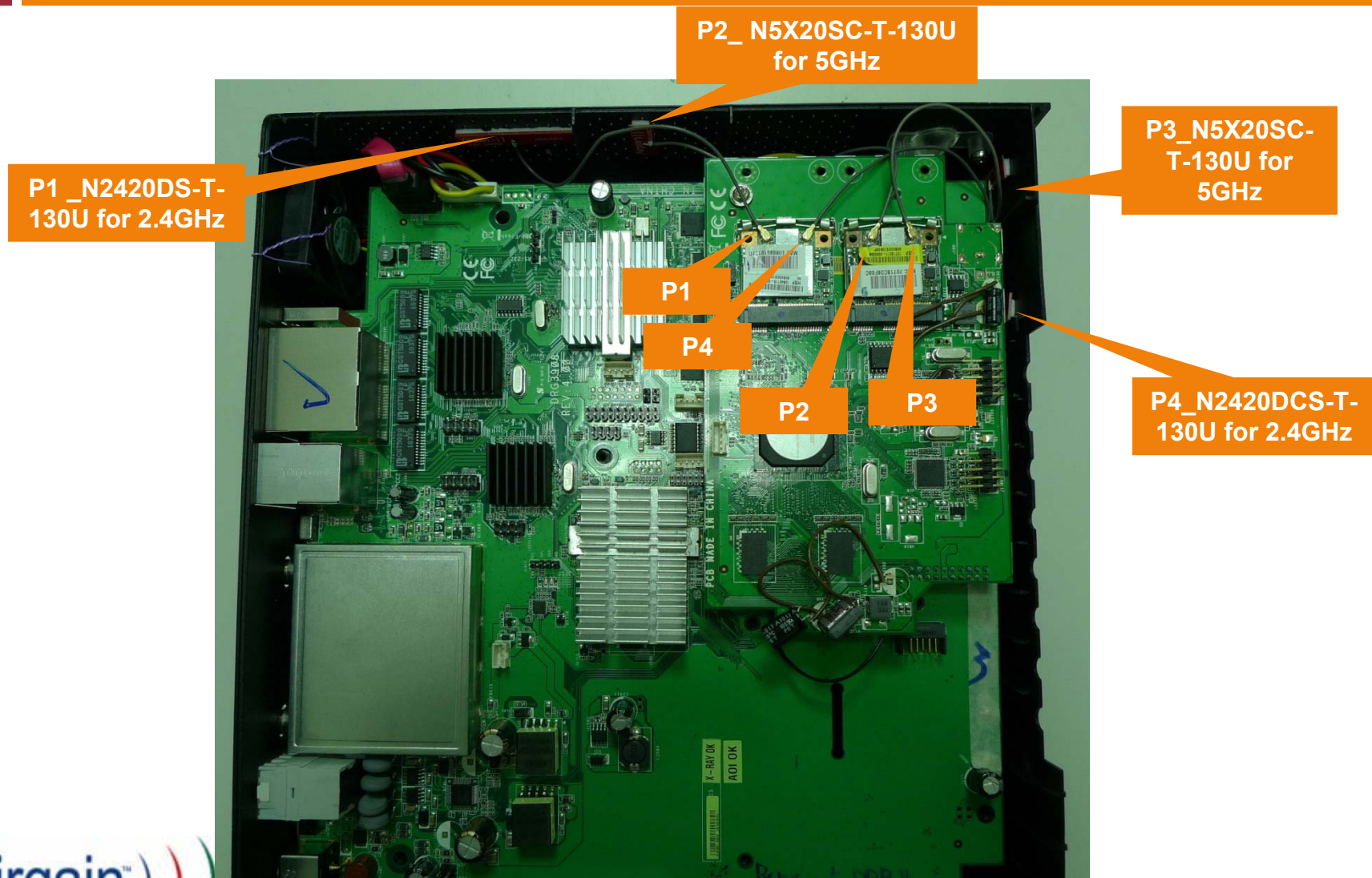


UNIHAN DRG7908 Antenna solution Report

April 21, 2011

Antenna Installation method

2



N5X20SC

■ 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

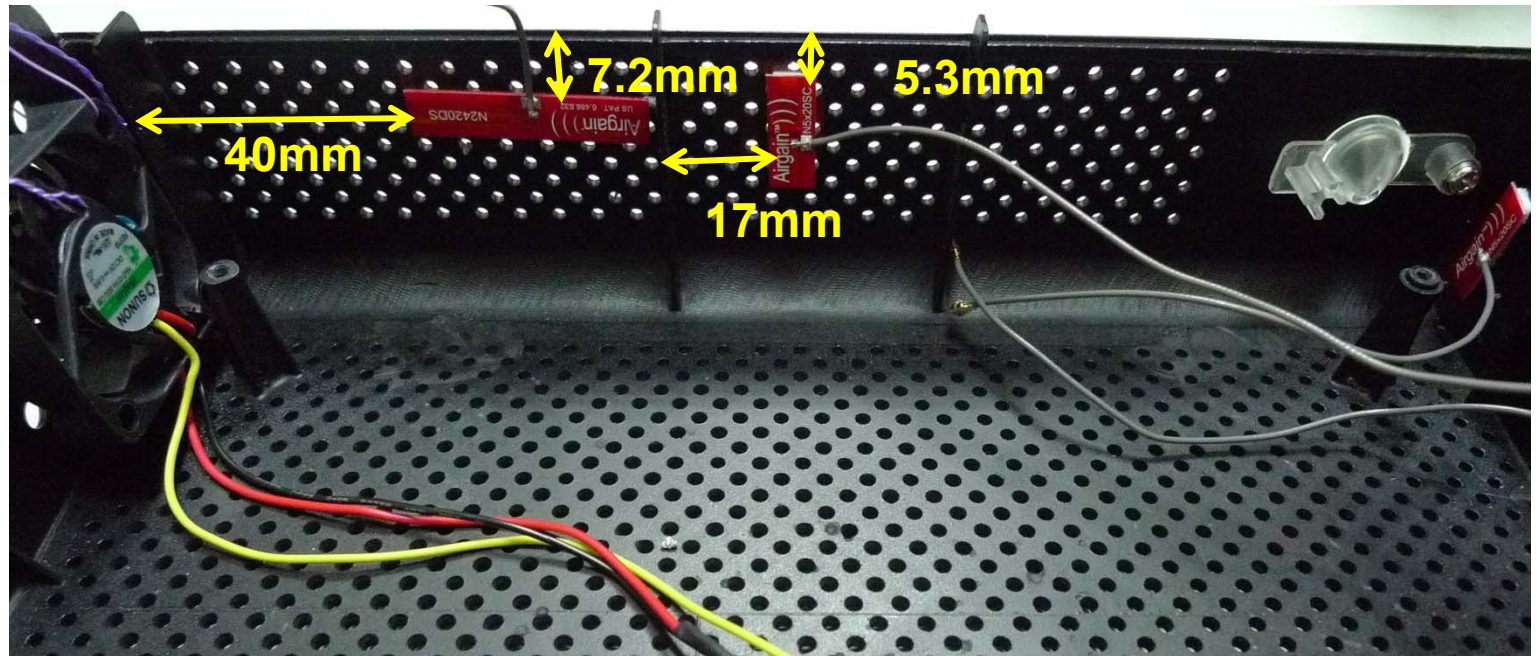
■ Features

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

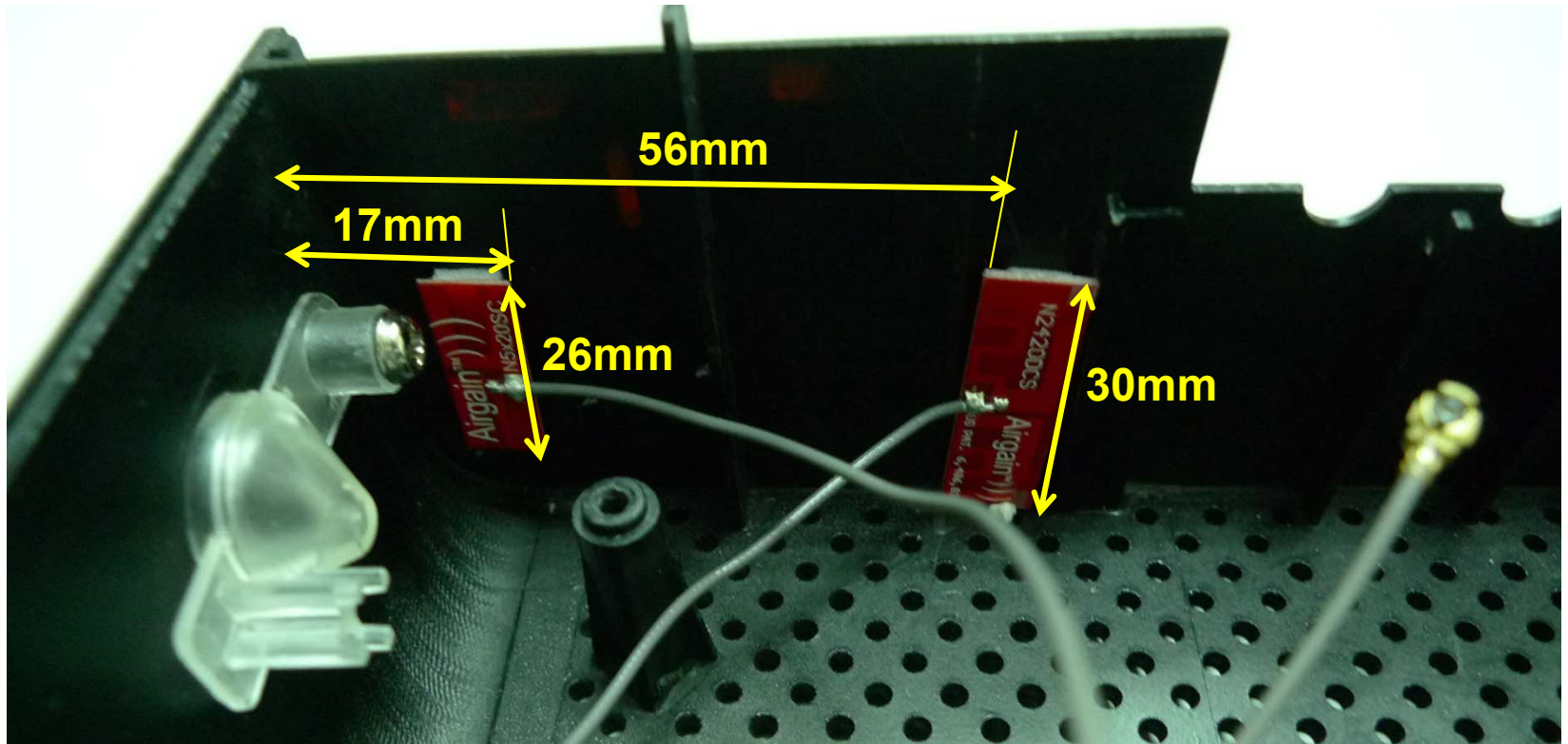


Standard	IEEE 802.11n and 802.11 b/g
Frequency Range	2.4 to 2.49 GHz
Peak Gain	4.36 dBi (with DRG7908)
VSWR	2:1
Feed Impedance	50 Ohms
Power Handling	30 dBm
Interface	50 ohm, 1.13mm diameter, micro coax cable, U.FL compatible Plug termination
Antenna Dimensions (LxWxH)	40 x 8 x 1 (mm)
Antenna type	PCB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

Antenna location (P₁ & P₂)

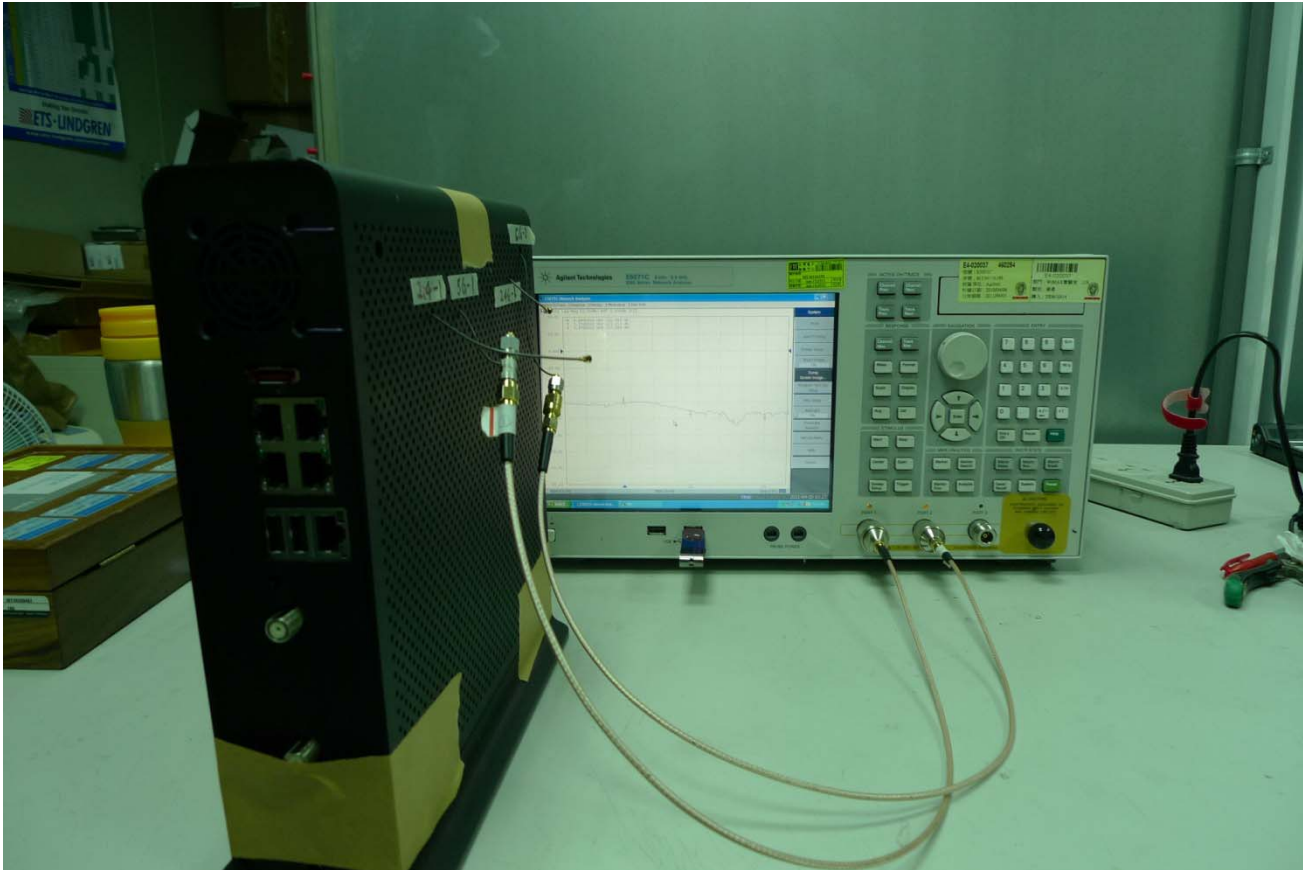


Antenna location (P₃ & P₄)



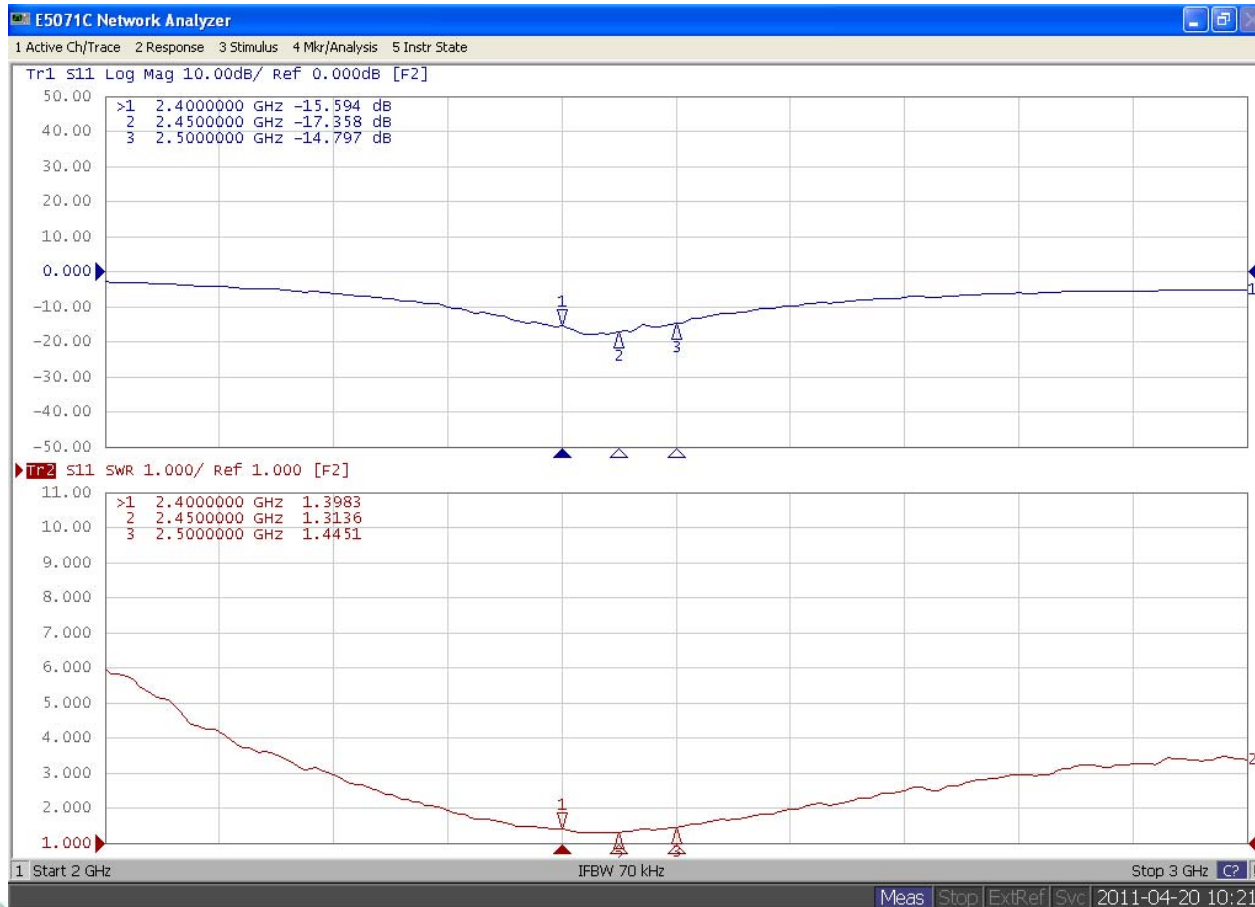
S-parameter

■ Measurement Method



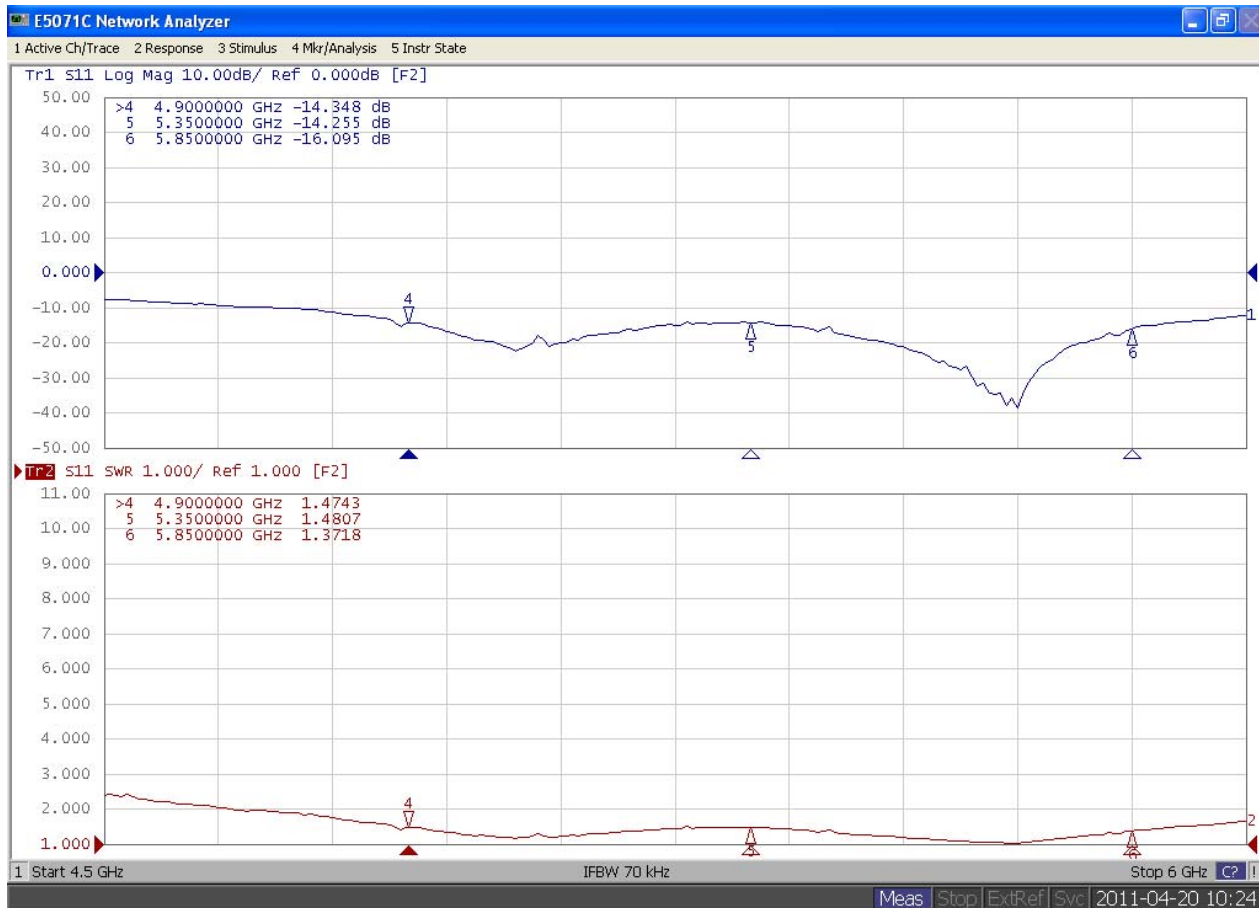
S-parameter

■ P1 _N2420DS-T-130U for 2.4GHz



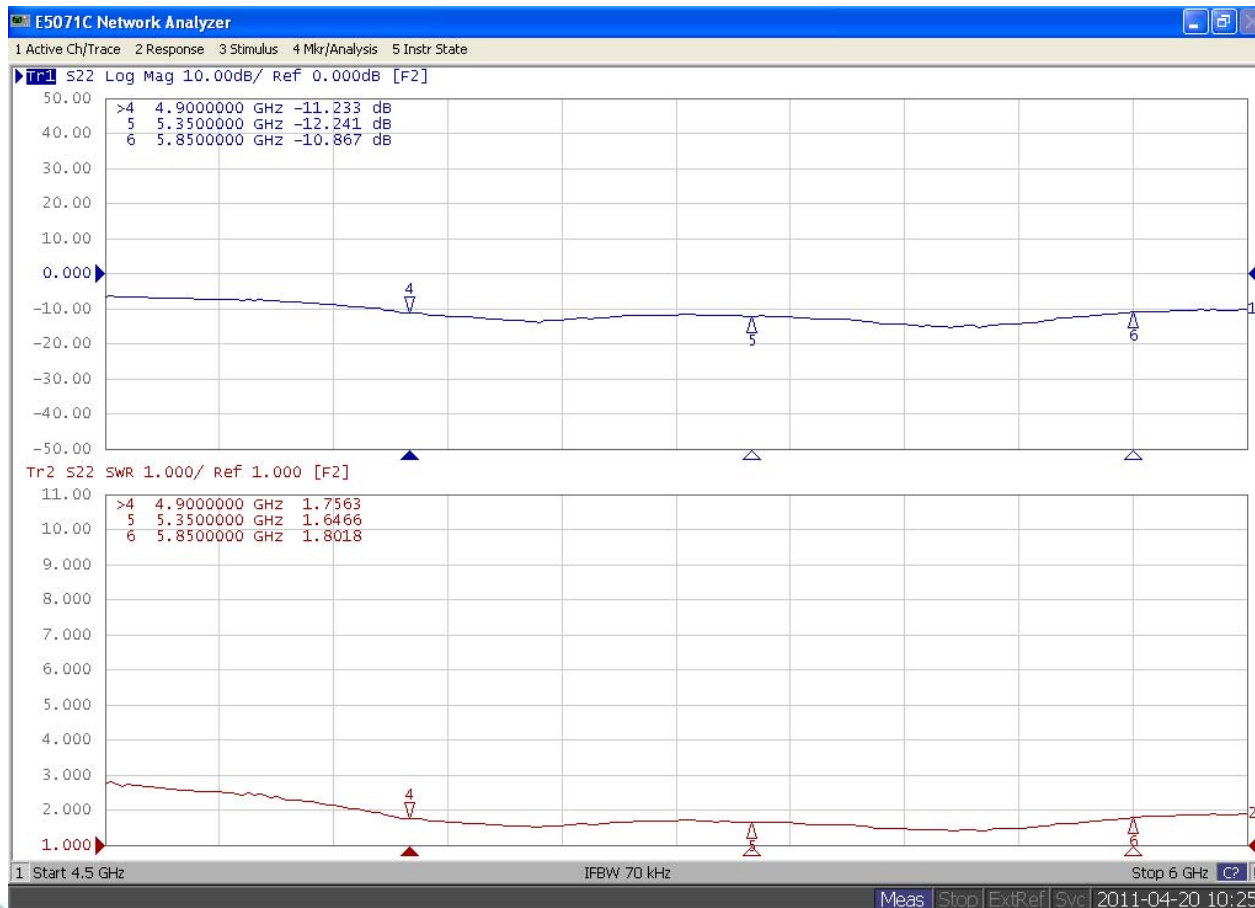
S-parameter

■ P2_ N5X20SC-T-130U for 5GHz



S-parameter

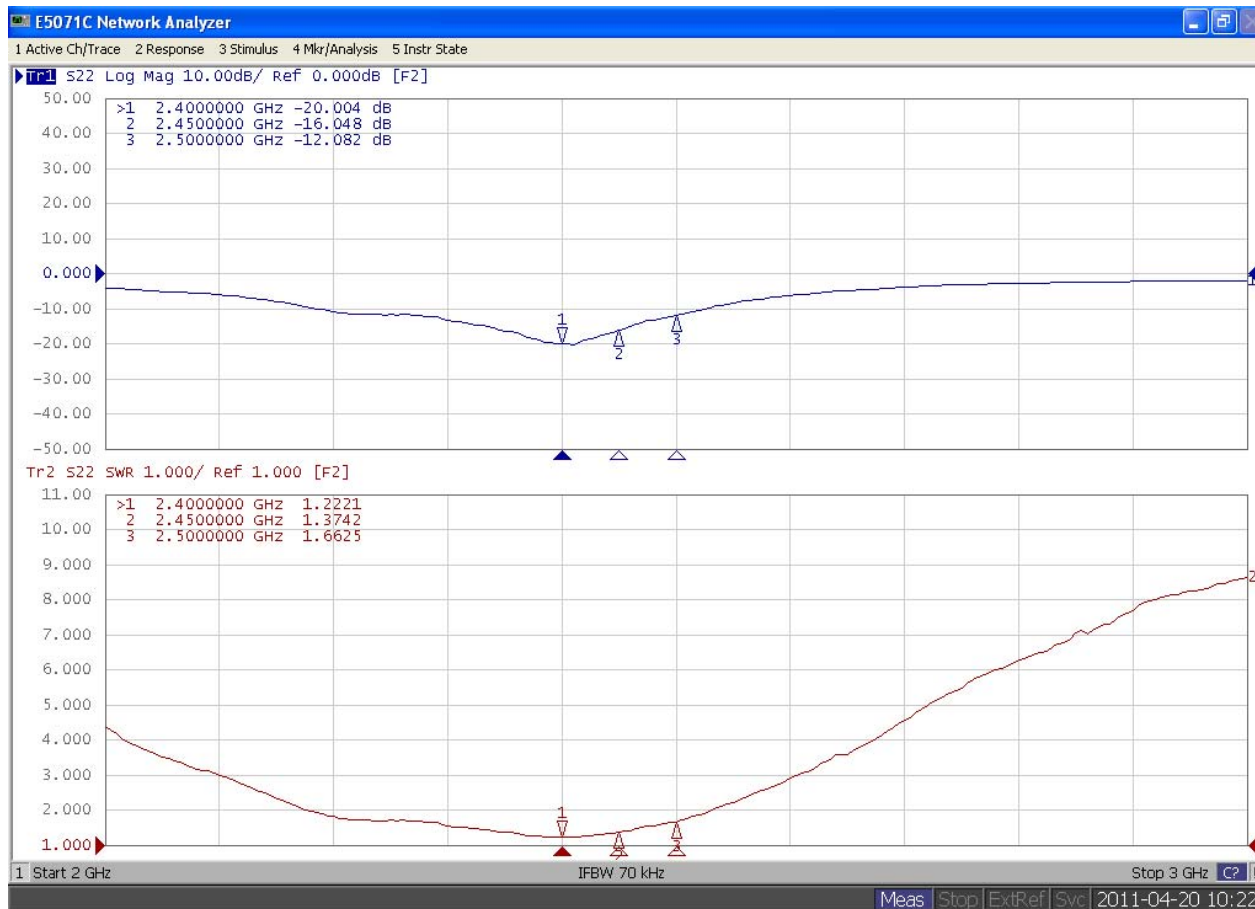
■ P3_ N5X20SC-T-130U for 5GHz



S-parameter

2

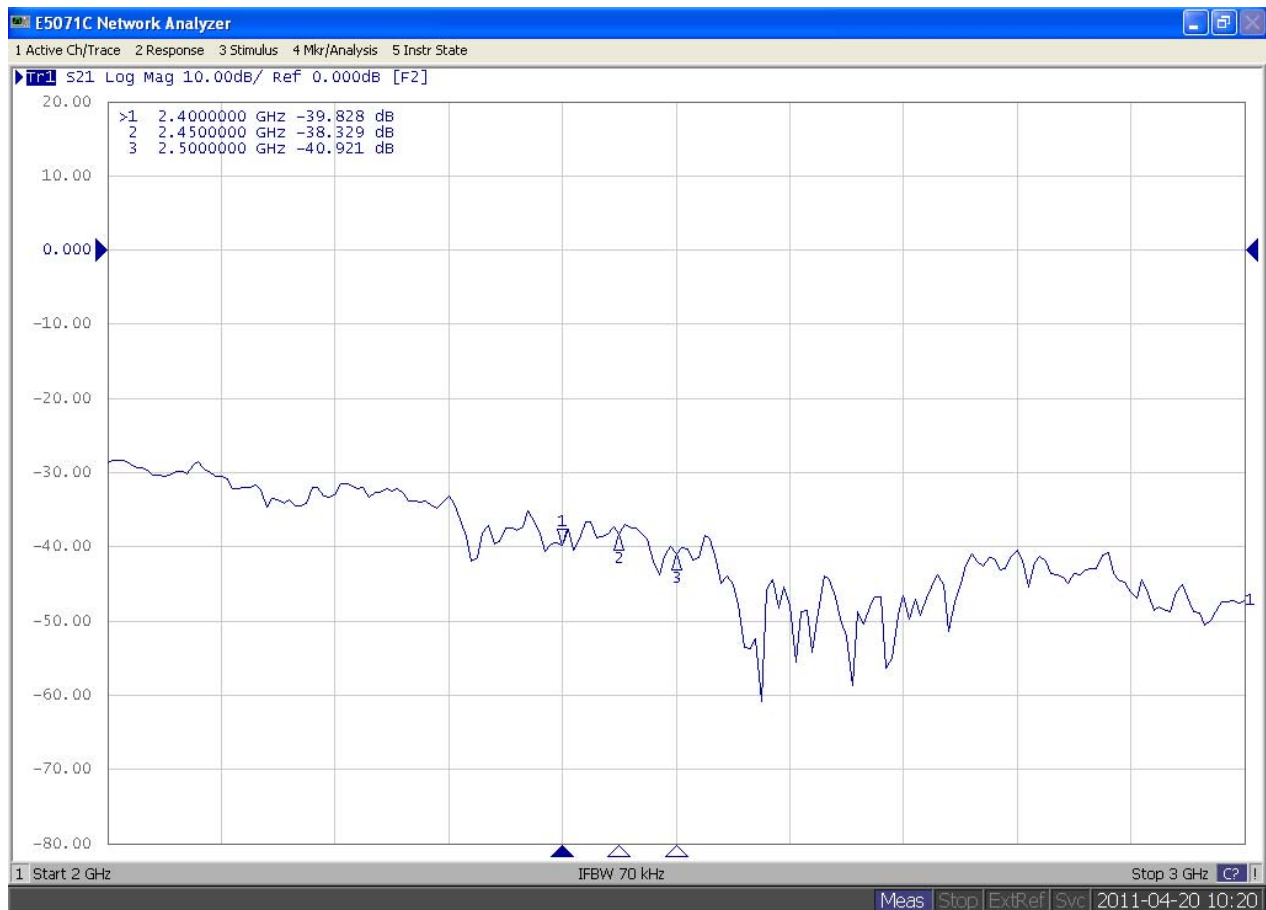
■ P4 _N2420DS-T-130U for 2.4GHz



S-parameter

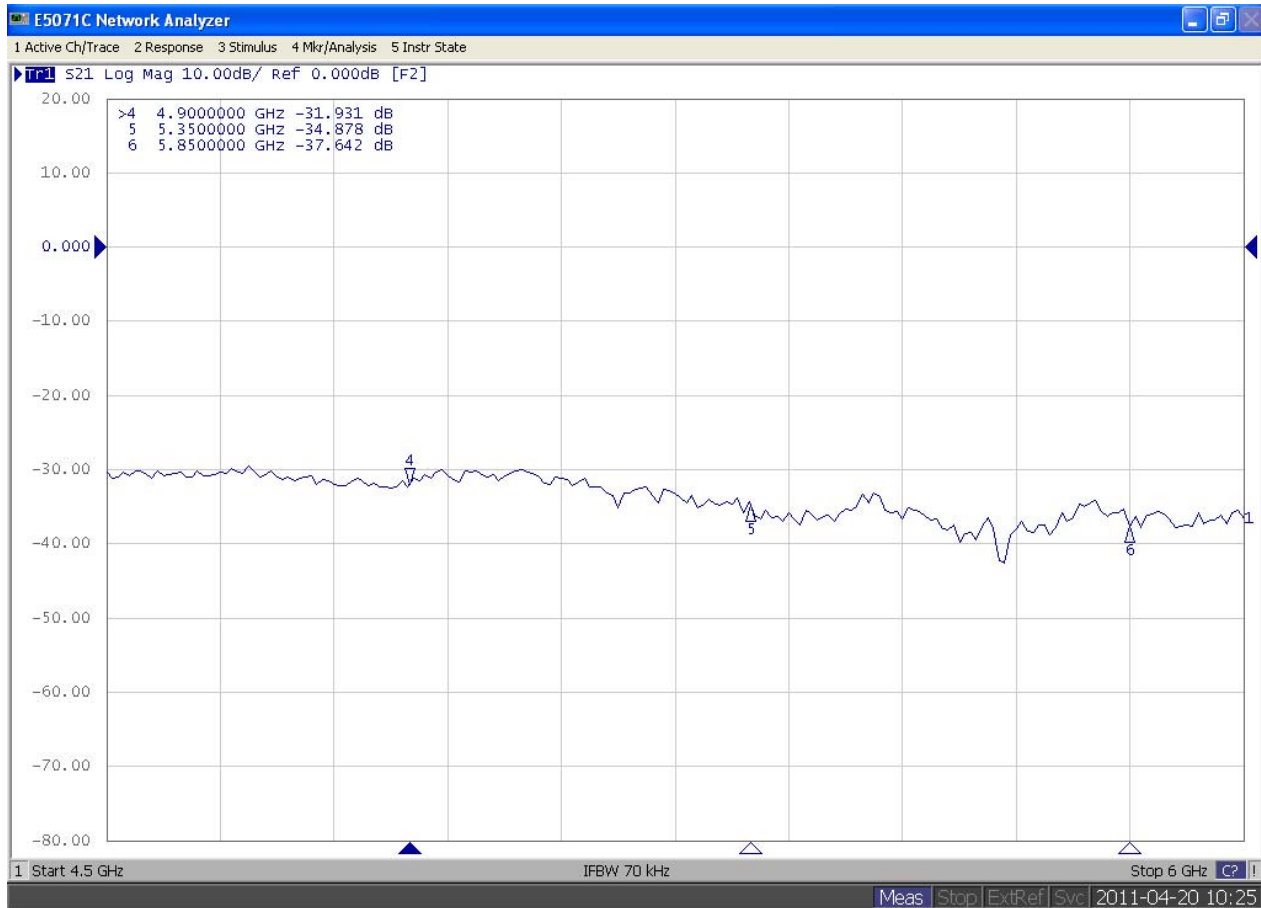
3

■ Isolation between 2.4GHz antenna



S-parameter

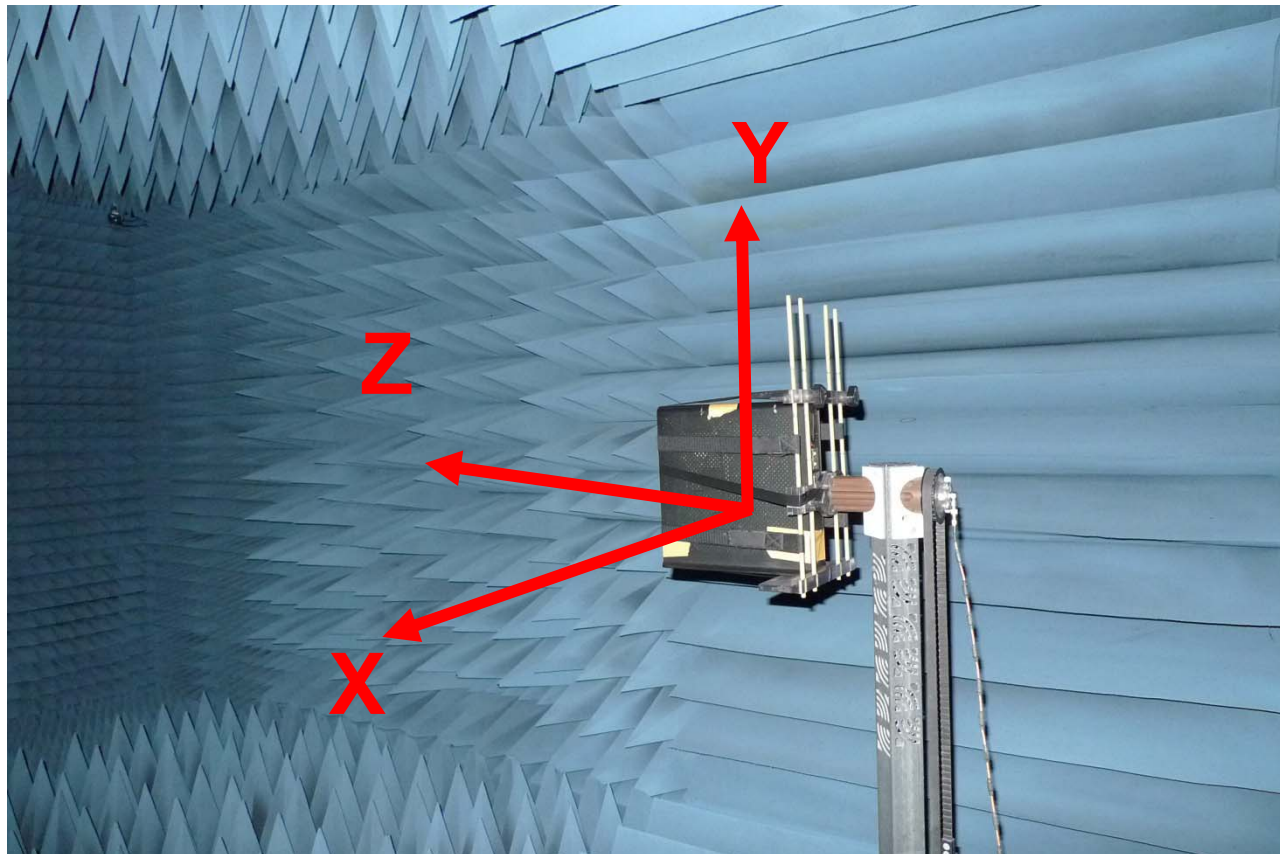
■ Isolation between 5GHz antenna



Radiation pattern

5

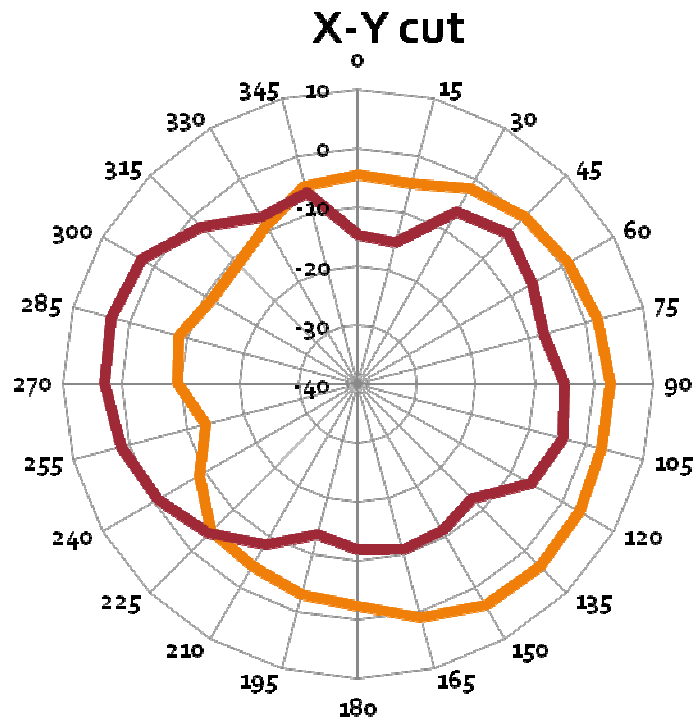
■ Chamber Orientation



Radiation pattern

6

■ 2.452GHZ (X-Y cut)

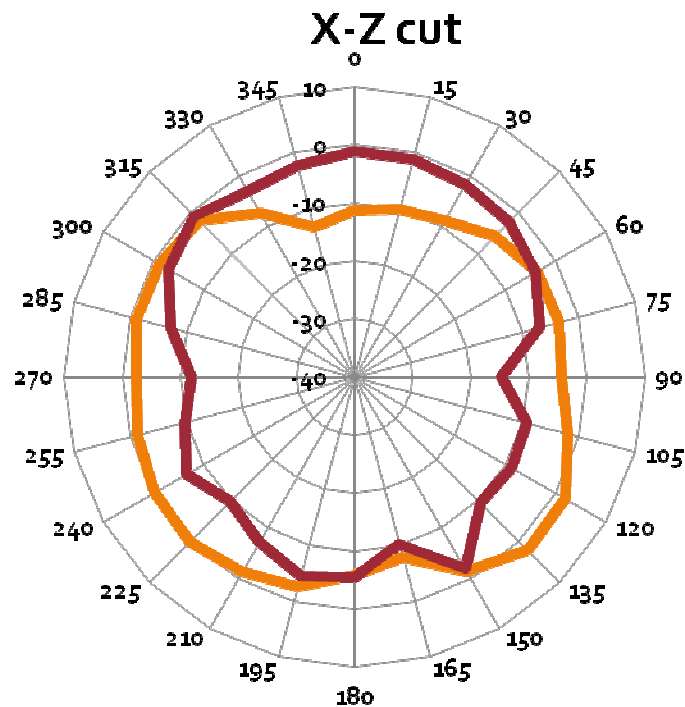


— P1_N2420DS-T-130U for 2.4GHz

— P4_N2420DS-T-130U for 2.4GHz

Radiation pattern

■ 2.452GHZ (X-Z cut)



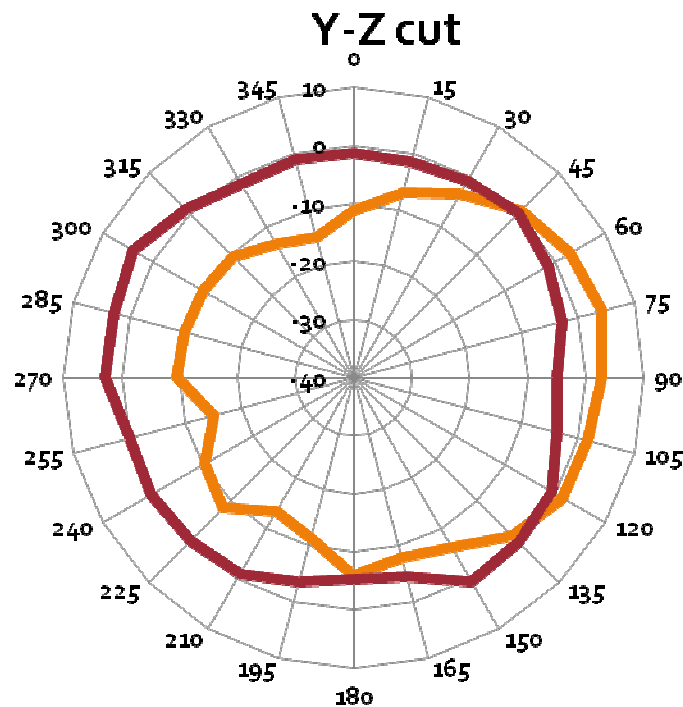
— P1_N2420DS-T-130U for 2.4GHz

— P4_N2420DS-T-130U for 2.4GHz

Radiation pattern

8

■ 2.452GHZ (Y-Z cut)



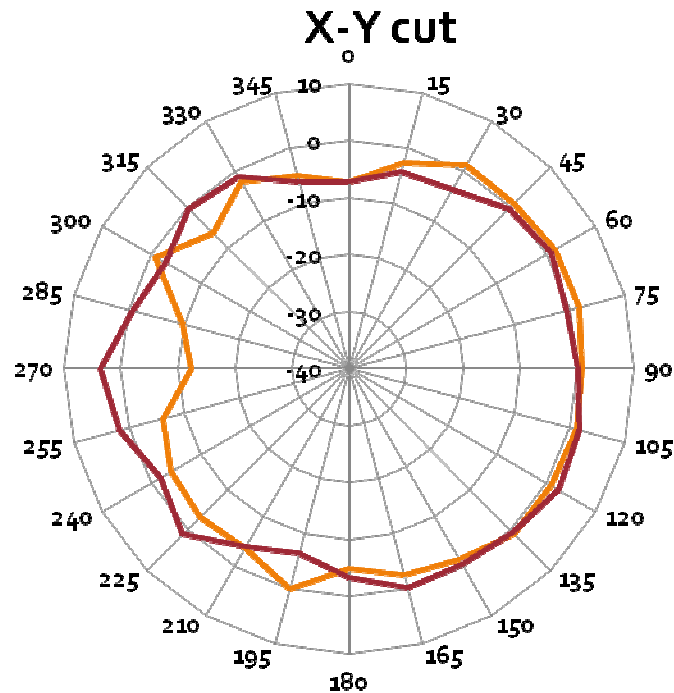
— P1_N2420DS-T-130U for 2.4GHz

— P4_N2420DS-T-130U for 2.4GHz

Radiation pattern

9

■ 5.5GHZ (X-Y cut)

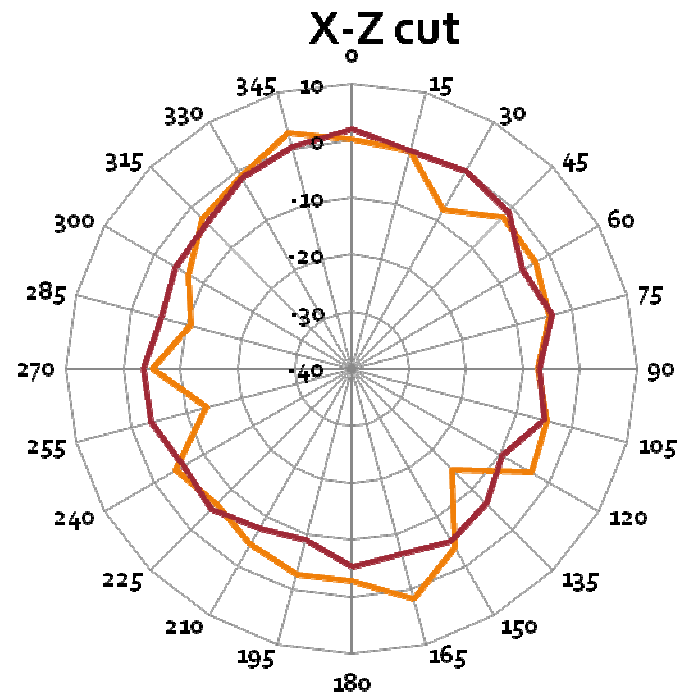


— P2_ N2401D-T-130U for 5GHz

— P3_ N2401D-T-100U for 5GHz

Radiation pattern

■ 5.5GHZ (X-Z cut)



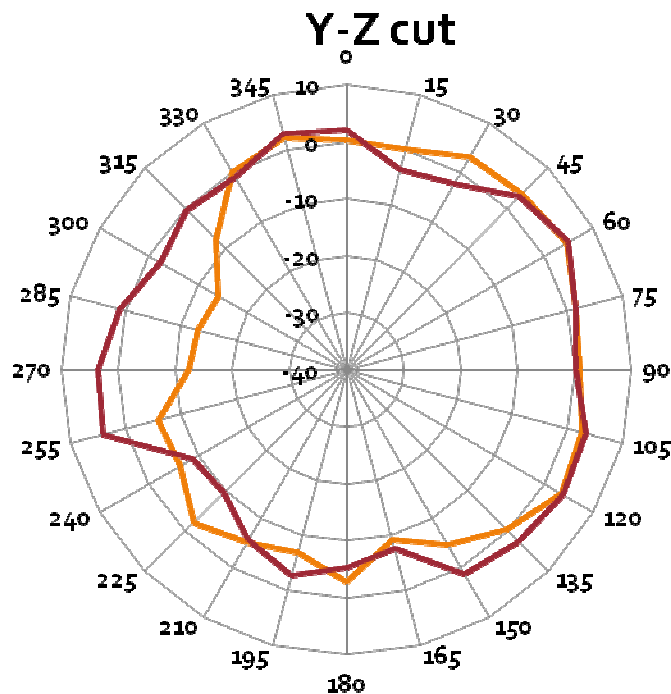
— P2_ N2401D-T-130Ufor 5GHz

— P3_ N2401D-T-100Ufor 5GHz

Radiation pattern

1

■ 5.5GHZ (Y-Z cut)



— P2_ N2401D-T-130U for 5GHz

— P3_ N2401D-T-100U for 5GHz

P₁&P₄ Peak Gain & Efficiency

2

	P ₁		P ₄	
	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~~》

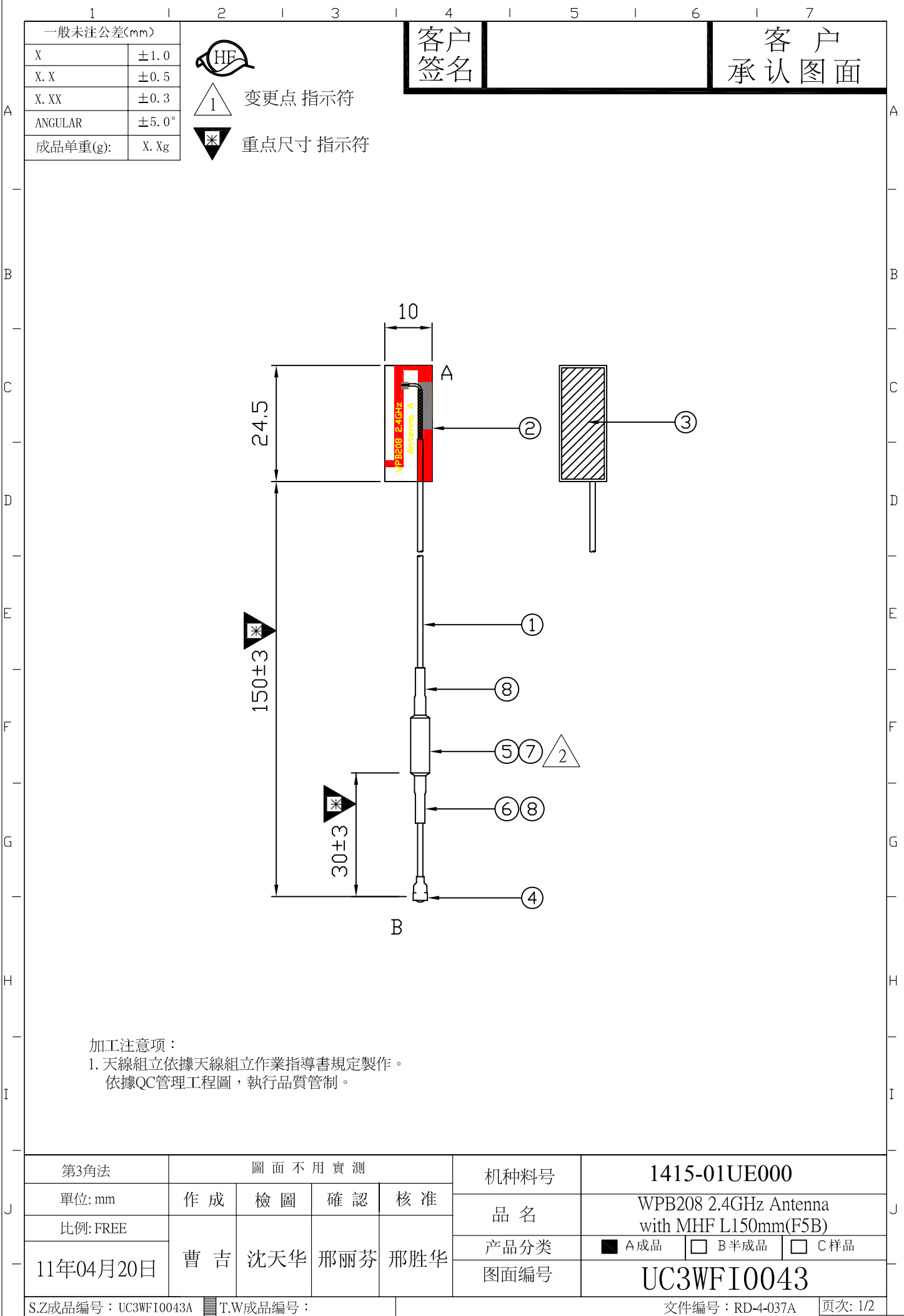
客戶 UNIHAN

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 〕

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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	邢麗芬	邢胜华



	1	1	2	1	3	1	4	1	5	1	6	1	7	
	變更內容履歷簡述 REVISIONS DESCRIPTION					版次 REV.	年月日 DATE	變更切換方式			作成			
	△	增加CORE;原外露200mm變更為150mm					A2	2011.04.22				曹吉		
	△	F5B T 8*4*4 變更為F5B RH 4*10*2					A3	2011.04.25				曹吉		
A	△													
	HF												A	
B													B	
C													C	
D													D	
E													E	
F													F	
G													G	
H	8	熱縮套管		CB 無鹵套管2.5 黑					HF	黑		2		
	7	熱縮套管		CB 無鹵套管4.0 黑					HF	黑		1		
	6	熱縮套管		CB 無鹵套管 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		
	3	泡棉膠帶		3M 4945壓克力泡棉膠帶 W9mm*H1.1mm*L23.5mm					HF			1		
I	2	PCB		WPB208					HF			1		
	1	MINI.13 Coaxial Cable		MINI RG OD:1.13 黑色 HF-Sn					HF	黑		1		
	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				機 种 料 号		1415-01UE000					
J	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	产品分类		☒ A 成品	☐ B 半成品	☐ C 样品			
	11年04月20日						圖面编号		UC3WFI0043					
	S.Z成品编号: UC3WFI0043A				T.W成品编号:				文件编号: RD-4-037A				页次: 2/2	



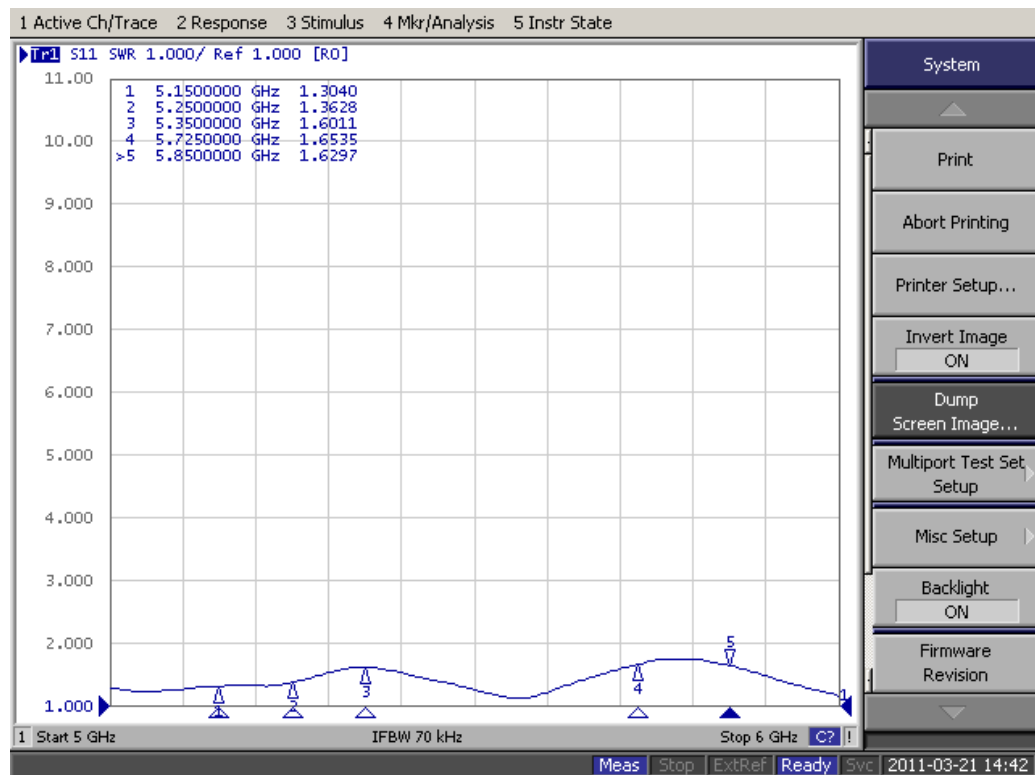
SPECIFICATION

- 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



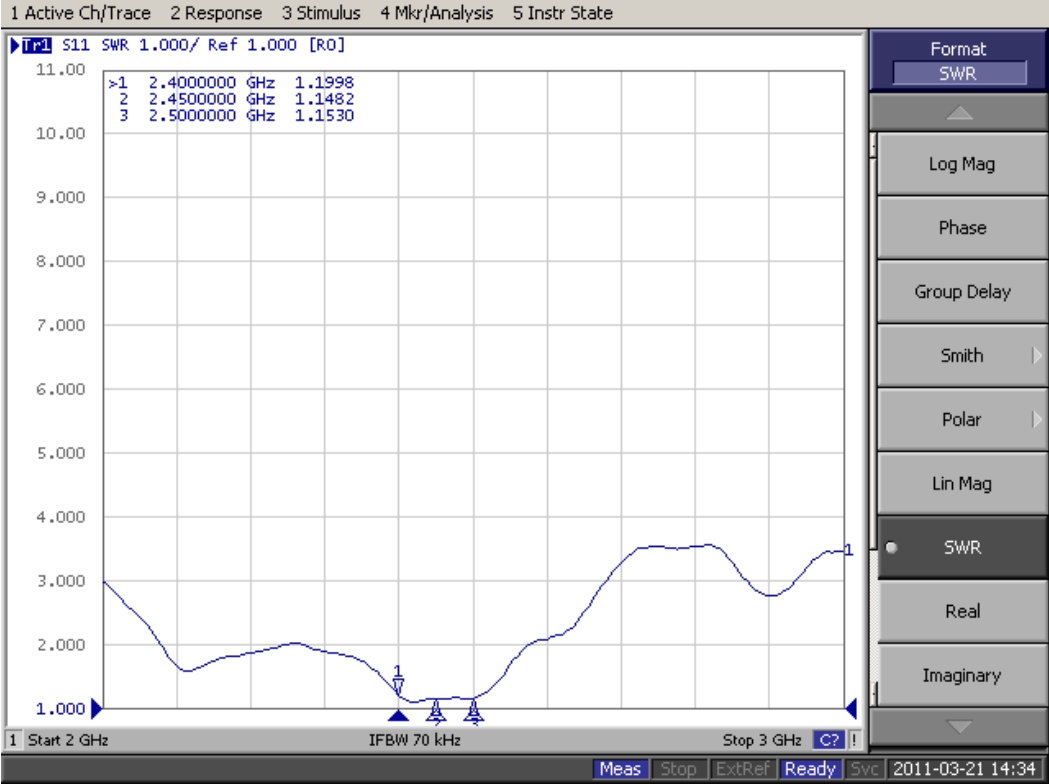
Radiation Pattern

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

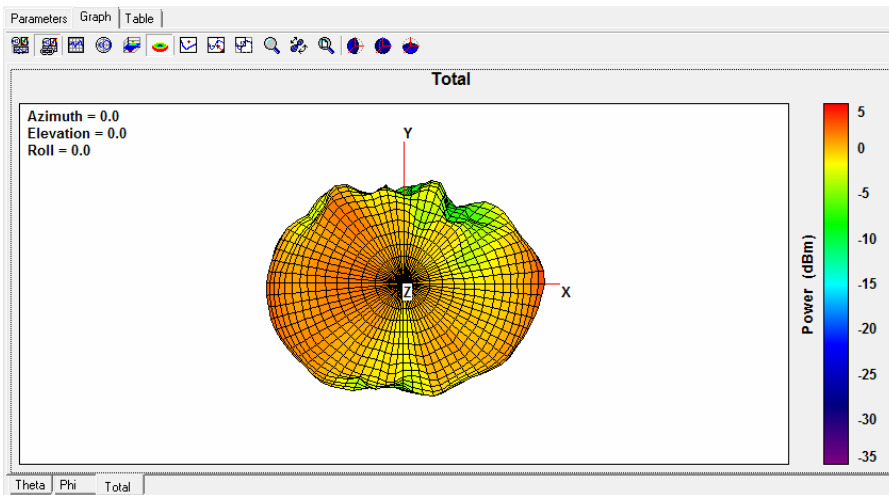


Radiation Pattern

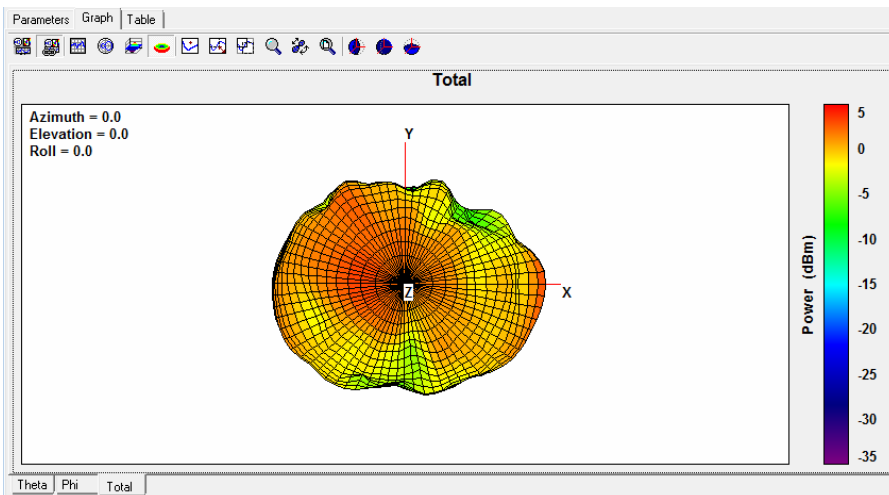
Antenna 1(2.4GHz)

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

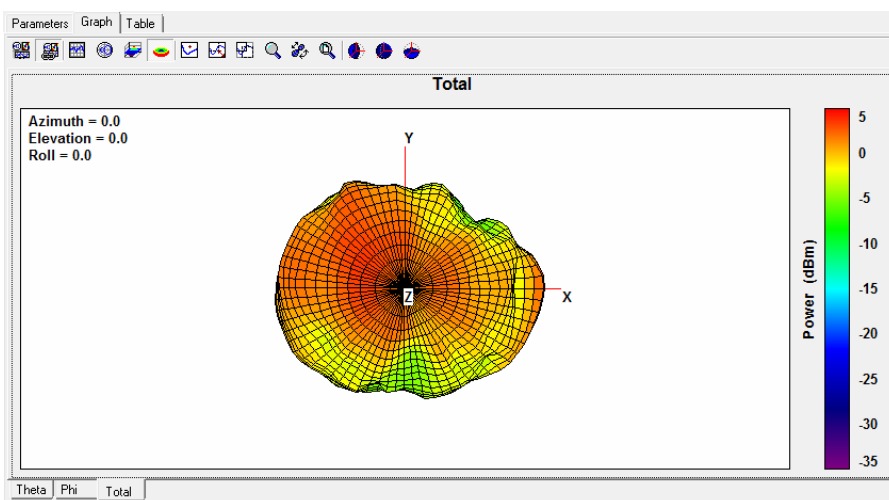
5.15GHz



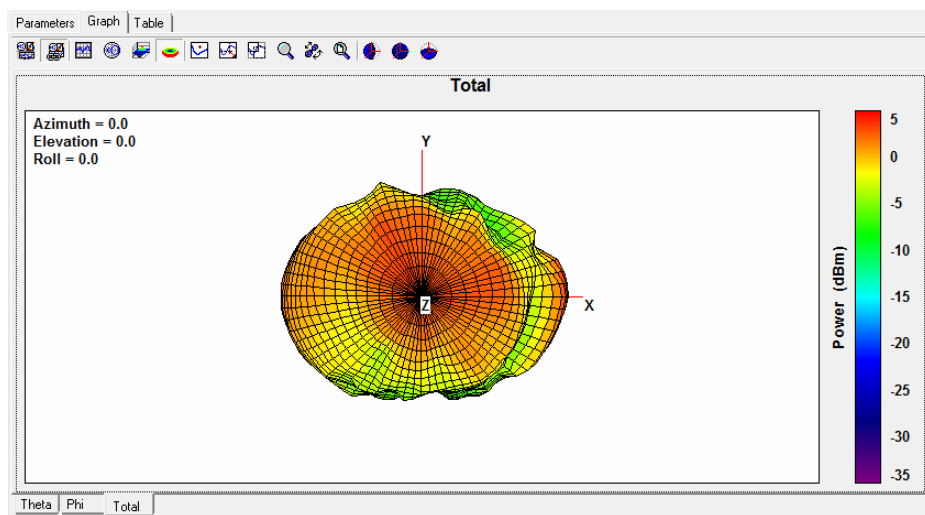
5.25GHz



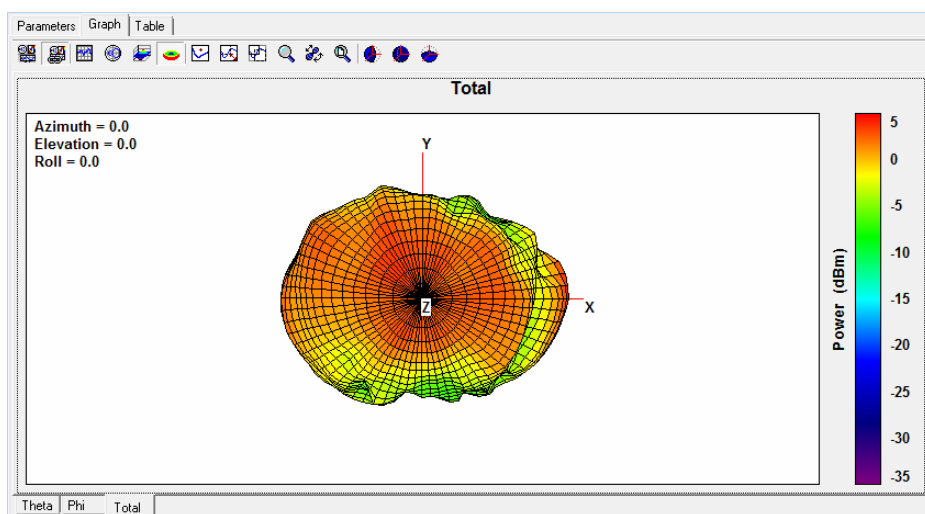
5.35GHz



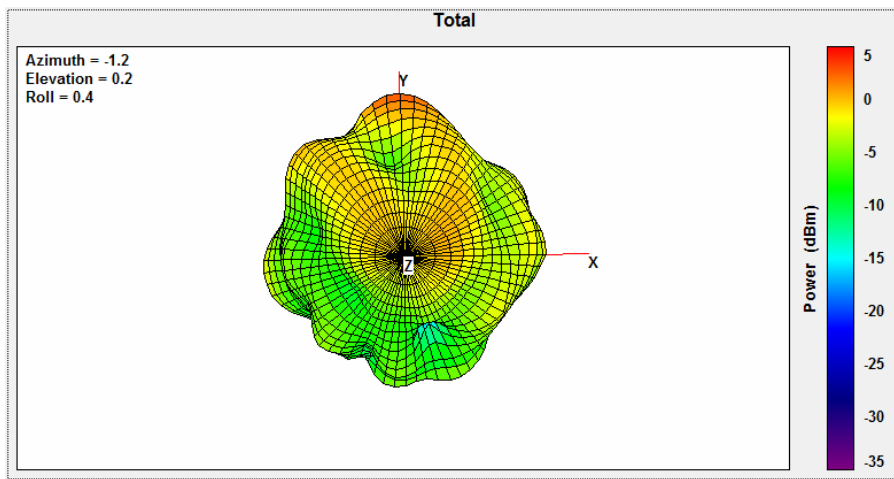
5.725GHz



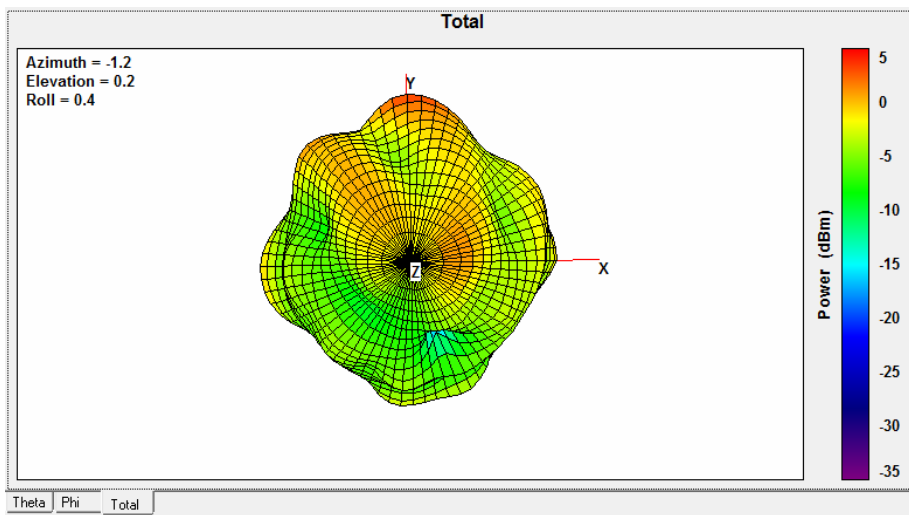
5.85GHz



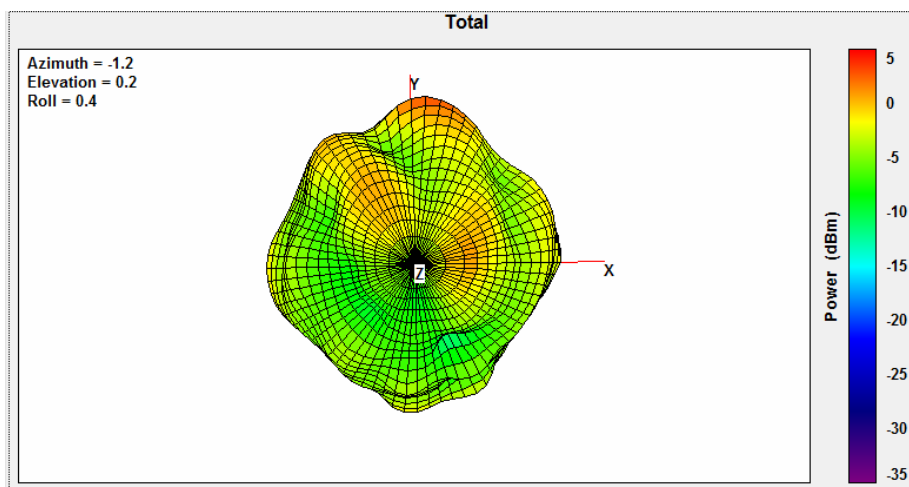
2.4GHz



2.45GHz



2.5GHz



納入仕様書

《新規・変更》

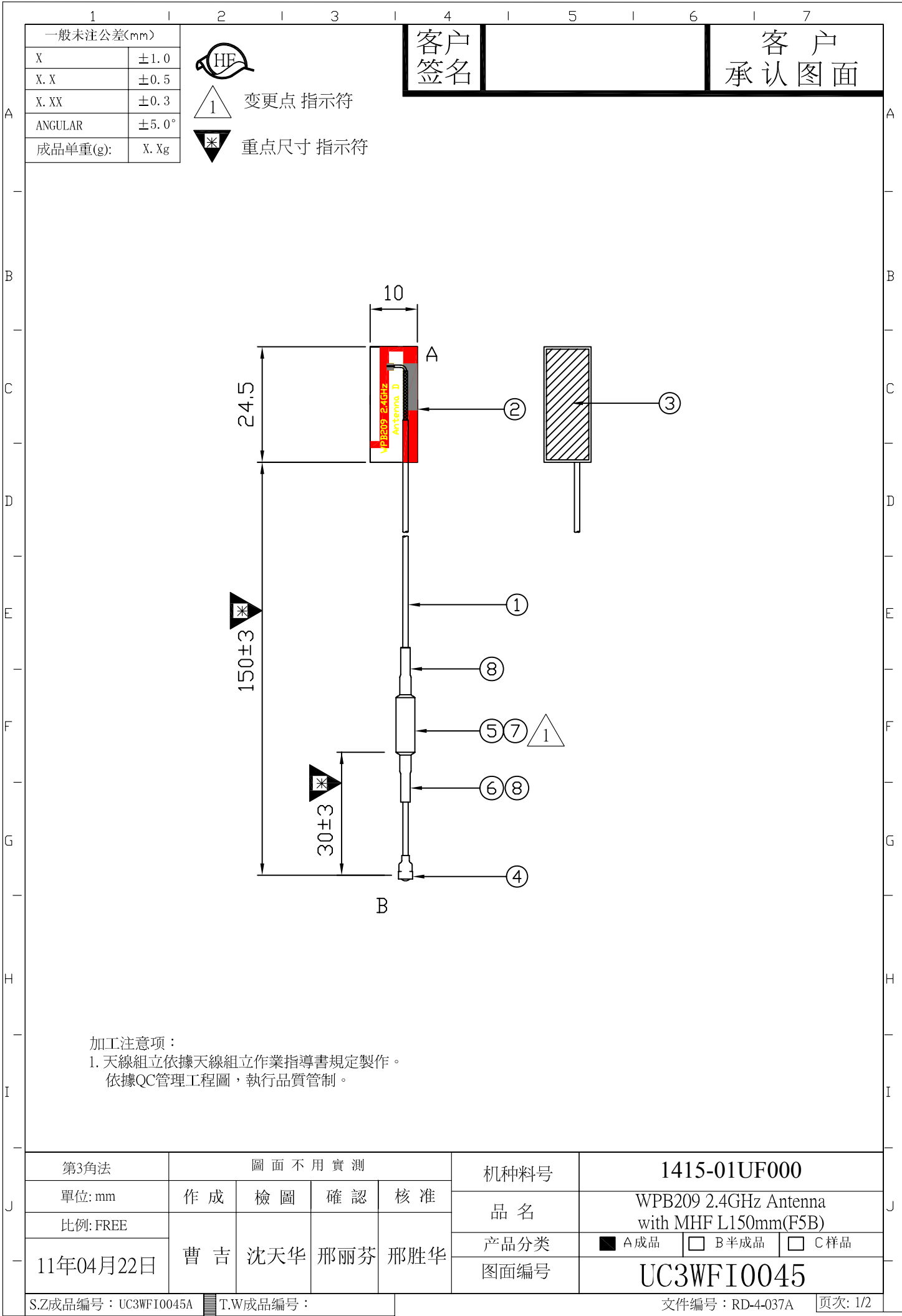
客 戸 UNIHAN

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
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FAX:86-512-65381104

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曹 吉	沈天華	邢丽芬	邢胜华



1		2		3		4		5		6		7	
變更內容履歷簡述 REVISIONS DESCRIPTION								版次 REV.	年月日 DATE	變更切換方式			作成
△ F5B T 8*4*4 變更為F5B RH 4*10*2								A3	2011.04.25				曹吉
△													
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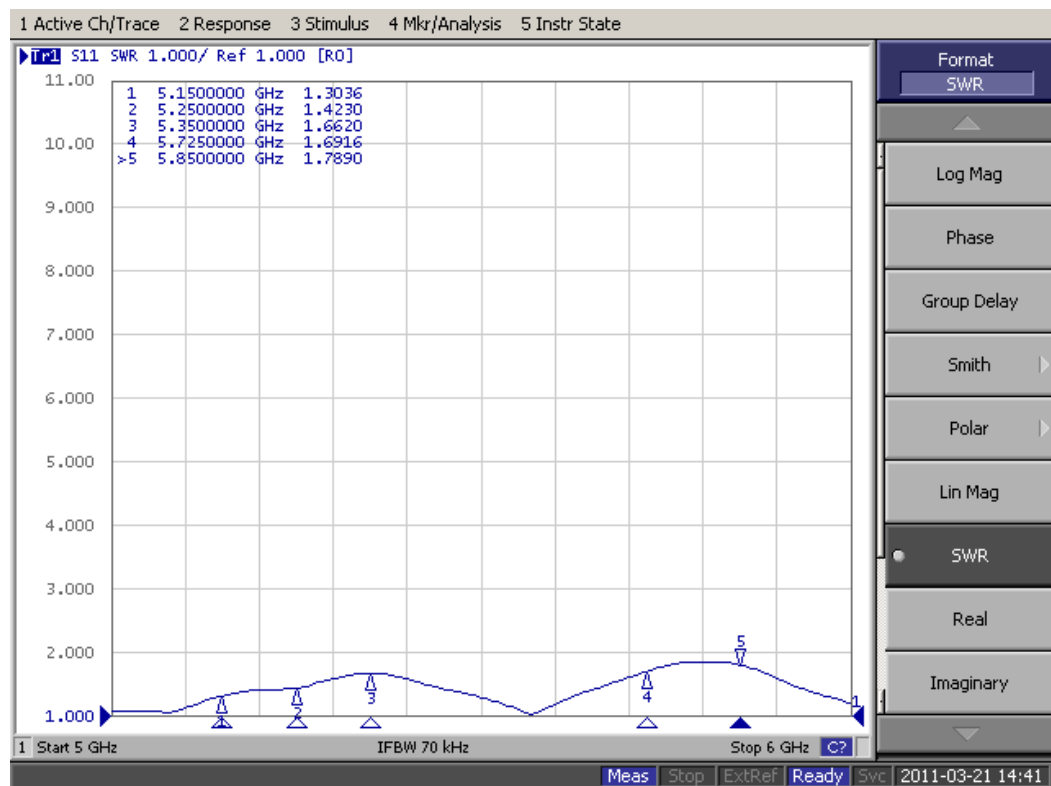
SPECIFICATION

- 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



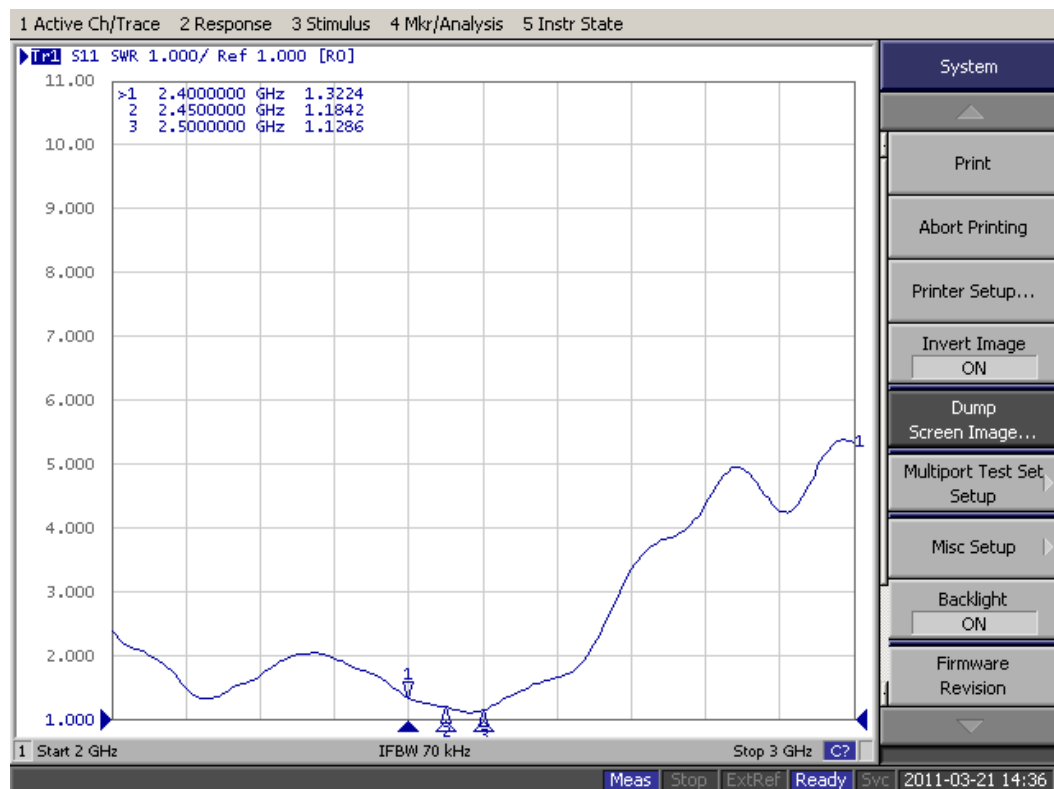
Radiation Pattern

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

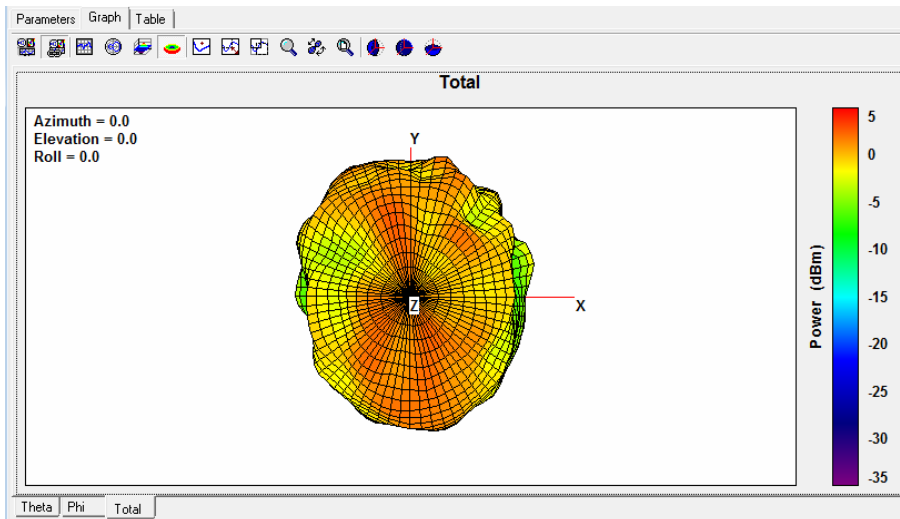
Antenna 3(2.4GHz) VSWR



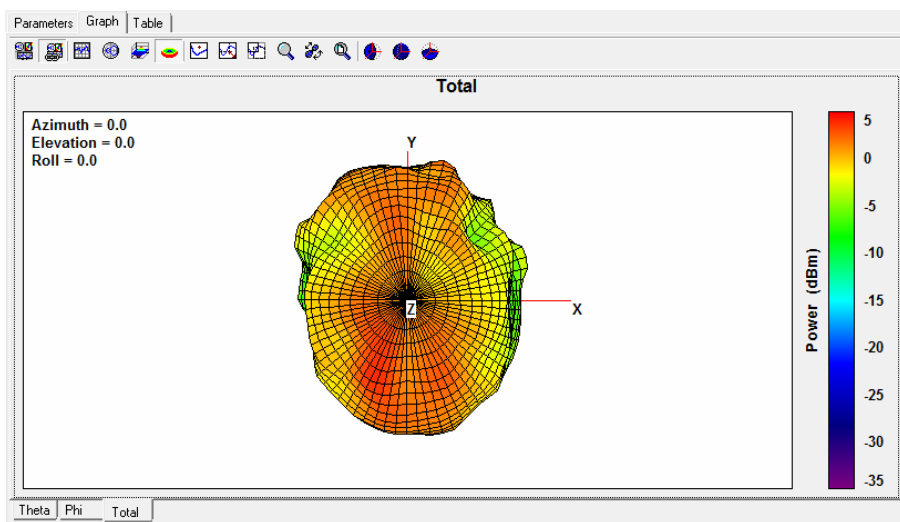
Radiation Pattern Antenna 3(2.4GHz)

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

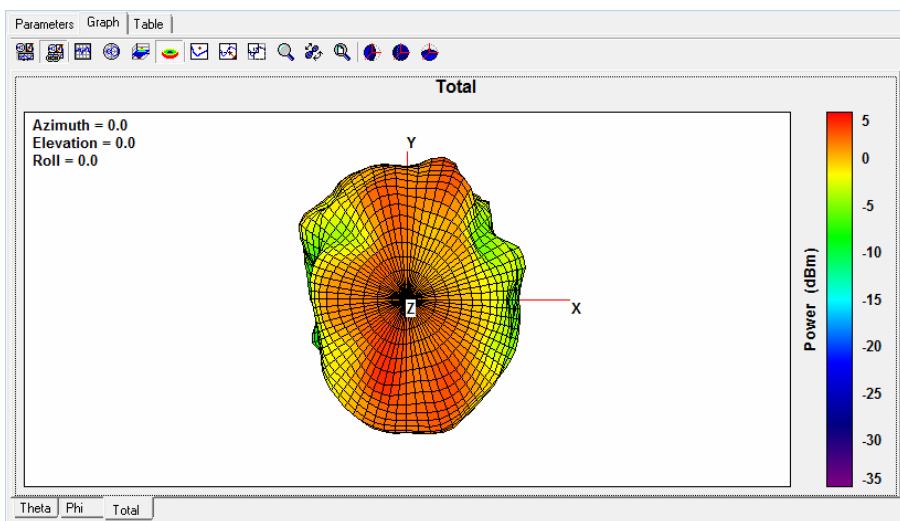
5.15GHz



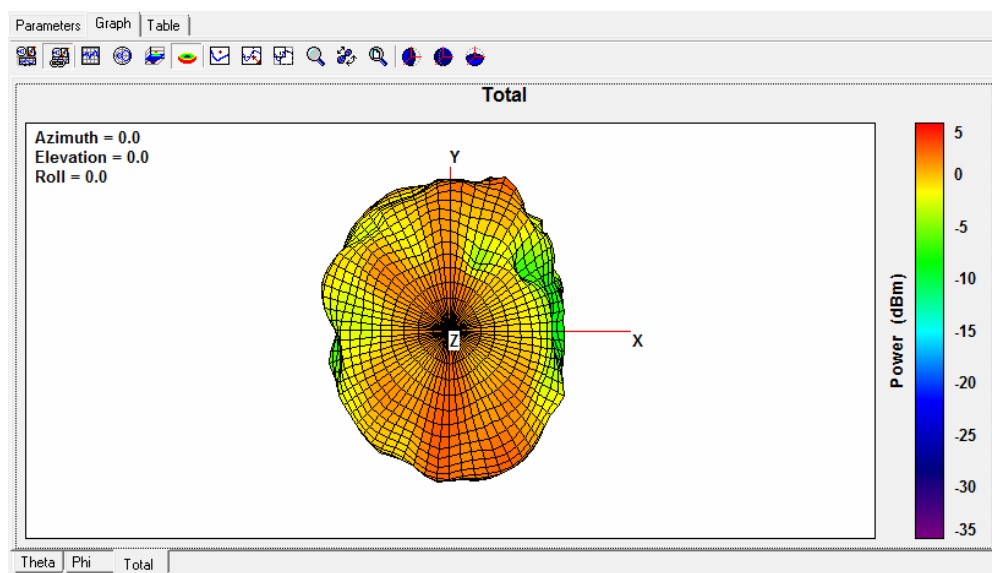
5.25GHz



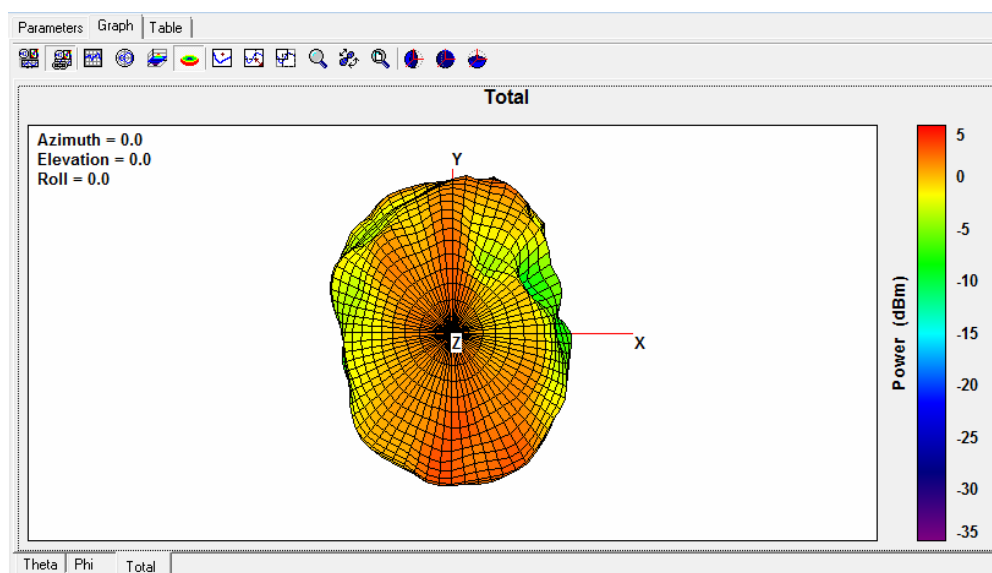
5.35GHz



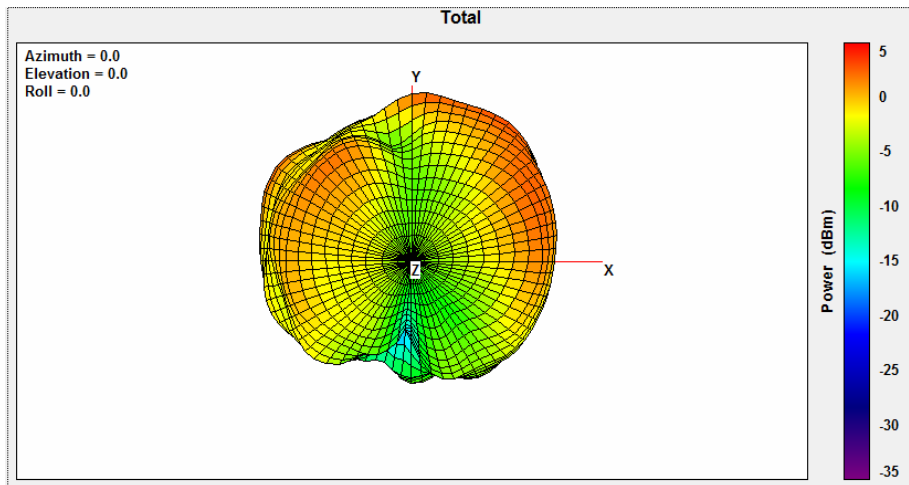
5.725GHz



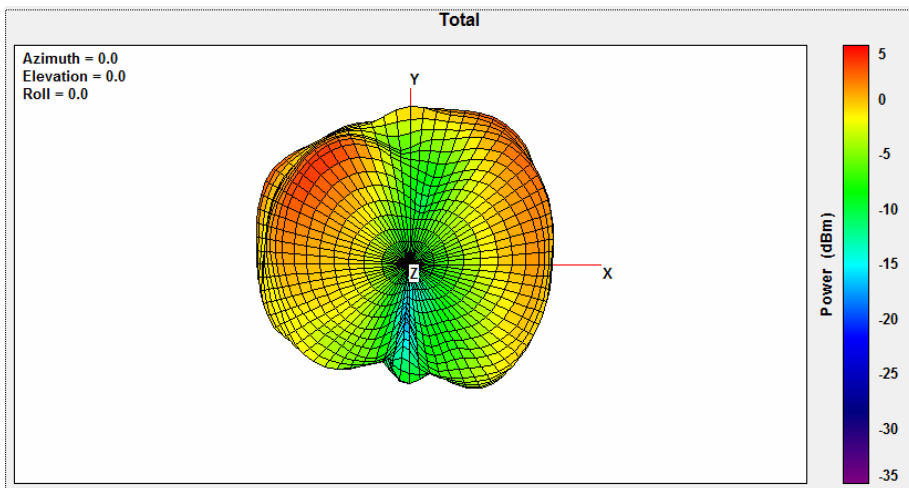
5.85GHz



2.4GHz



2.45GHz



2.5GHz

