

## ***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**

<b>FCC ID</b>	:	VUI-UPWL6013
<b>Product Name</b>	:	WIFI Module
<b>Model Name</b>	:	UPWL6013
<b>Frequency Range</b>	:	IEEE 802.11b/g/n Draft 1.0 20M: 2.412GHz ~ 2.462GHz
<b>Channel Spacing</b>	:	5MHz
<b>Support Channel</b>	:	IEEE 802.11b/g/n Draft 1.0 20M: 11 Channels
<b>Modulation Skill</b>	:	DBPSK, DQPSK, CCK, OFDM
<b>Power Type</b>	:	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 <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
<b>(A) Limits for Occupational/Controlled Exposure</b>				
0.3-3.0	614	1.63	100	6
3.0-30	1842/f	4.89/f	900/f <sup>2</sup>	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3-1.34	614	1.63	100	30
1.34-30	824/f	2.19/f	180/f <sup>2</sup>	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:

**Früis Transmission Formula:** 
$$S = \frac{PG}{4\pi R^2} = \frac{225.42 \times 3.74}{4\pi(20)^2} = 0.168mW / cm^2$$

**Estimated safe separation:** 
$$R = \sqrt{\frac{PG}{4\pi}} = \sqrt{\frac{225.42 \times 3.74}{4\pi}} = 8.191cm$$

**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/cm<sup>2</sup>)

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:

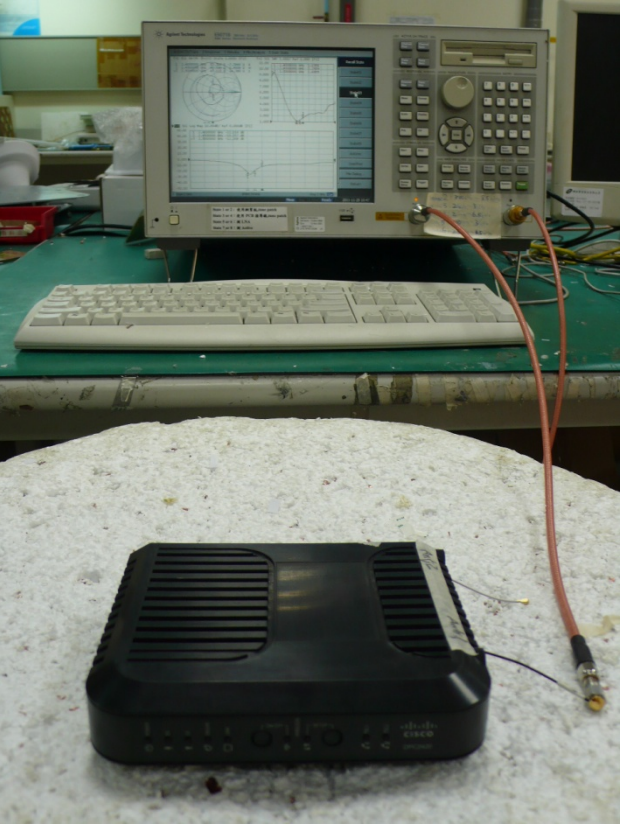
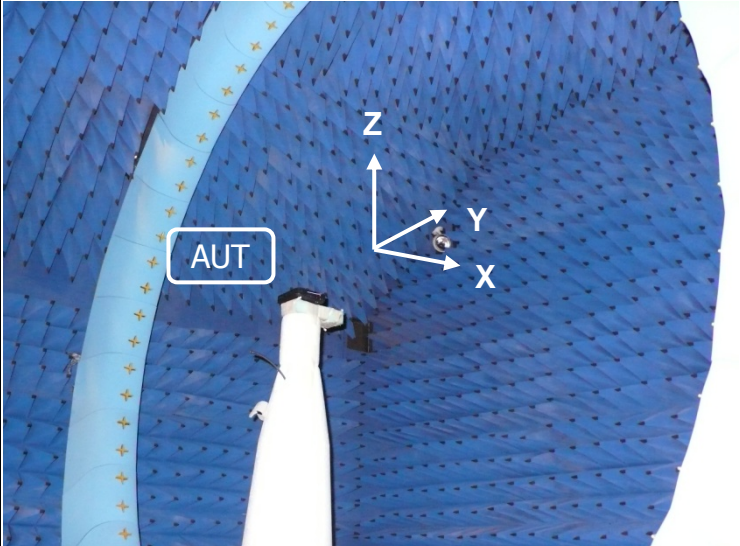
$$G = \text{Log}^{-1} ( dB \text{ antenna gain} / 10 )$$

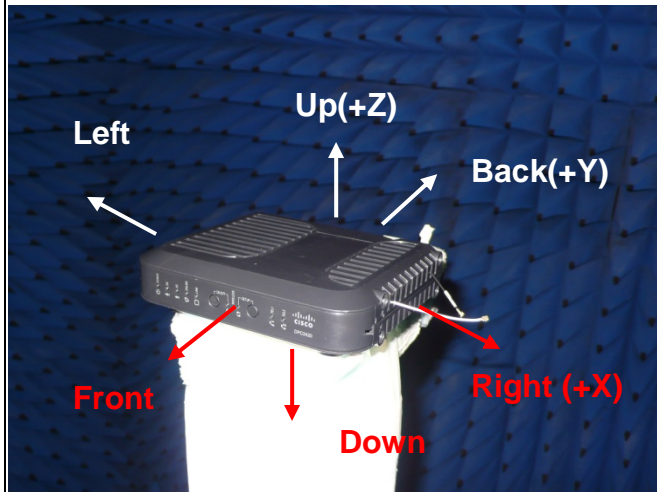
$$G = \text{Log}^{-1} ( 5.73 / 10 ) = 3.74$$

## *Appendix*

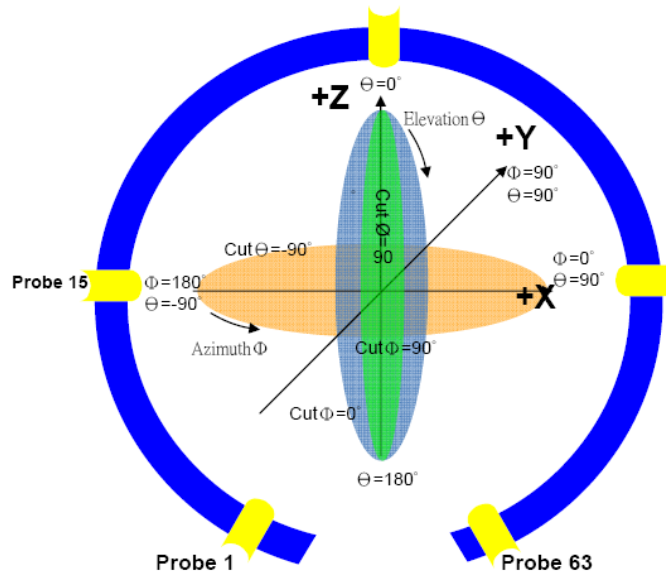
### **(Antenna #1      Antenna Specification                          C1335-520153-A & C1335-520154A)**

## Test Environment

Equipment	Description
Network Analyze 3D Chamber	<p>Network Analyze</p>  <p>3D Chamber</p> 

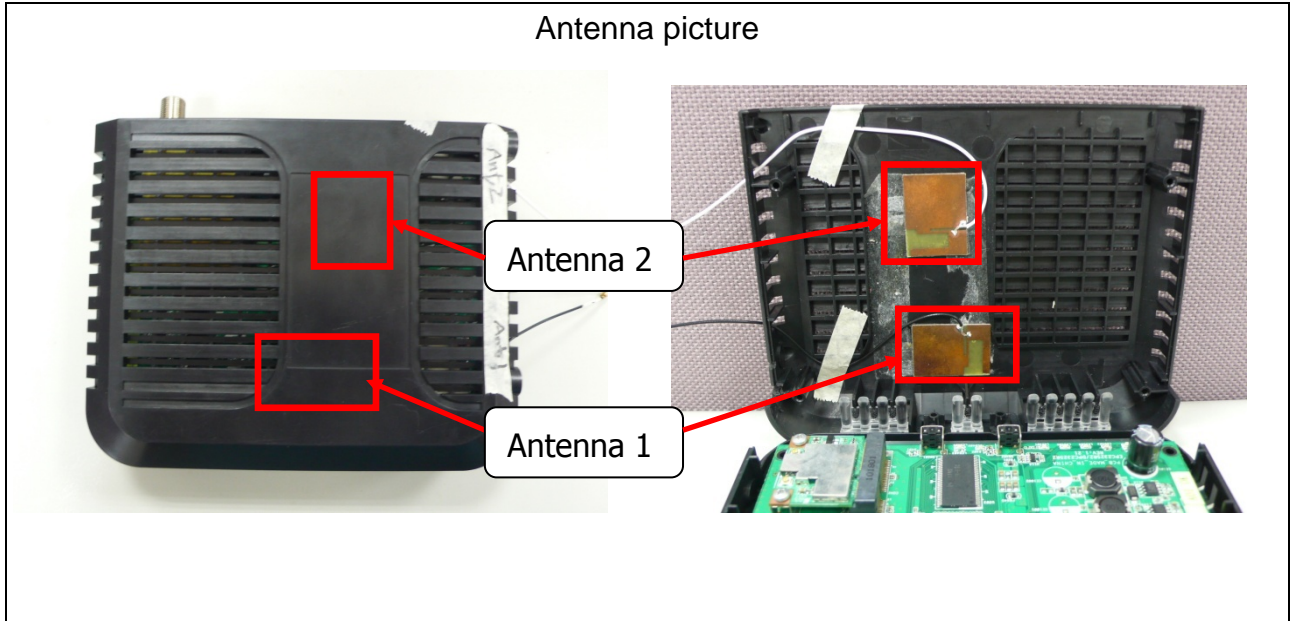


	XY	YZ	XZ
0°	Right	Up	Up
90°	Back	Back	Right
180°	Left	Down	Down
270°	Front	Front	Left



	$\theta$	$\phi$
Total angle	175°	360°
How many angle scan one point	5°	5°
Total scan point	36	73

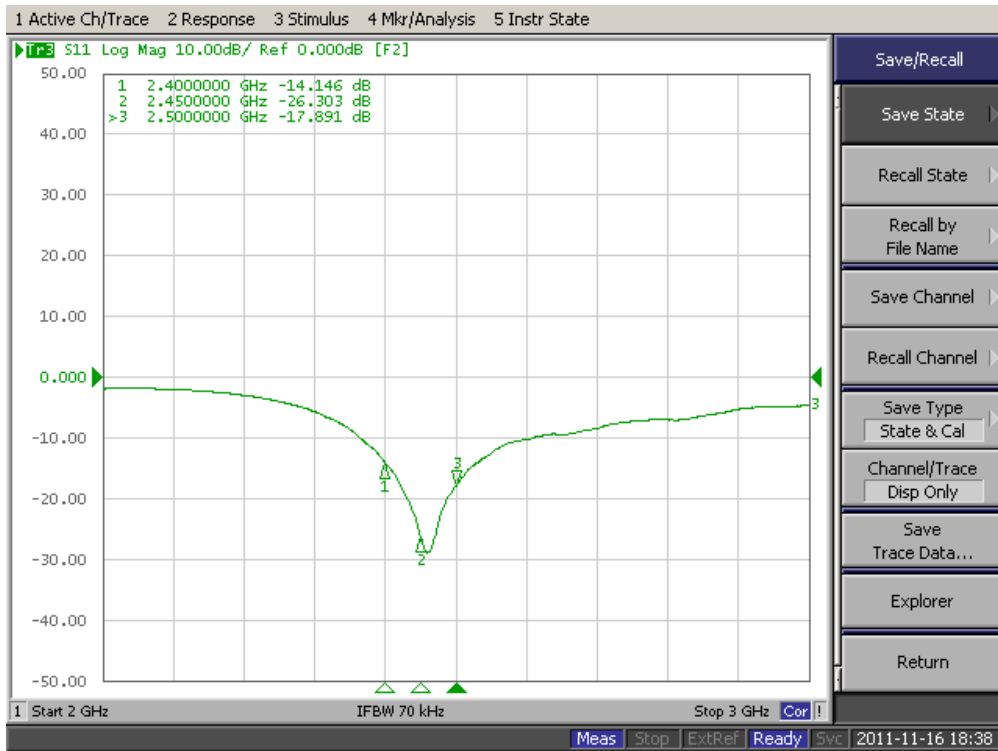
Antenna picture



### RF Antenna Assembly

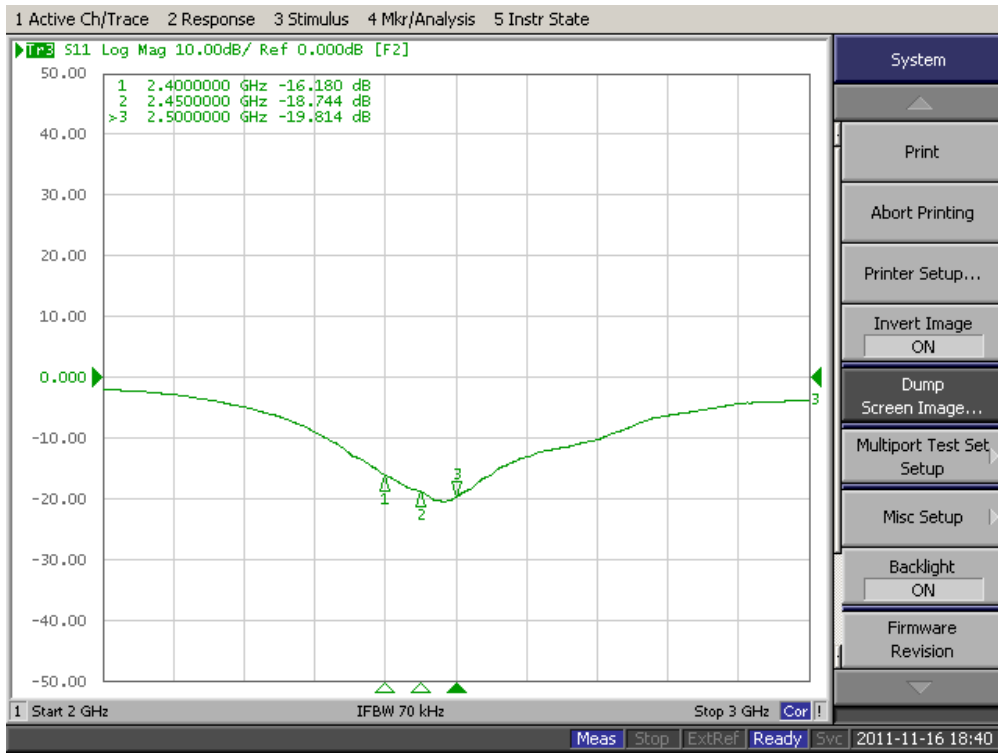
Antenna 1 P/NO : C1335-520153-A SPEC : 2.4~2.5 GHz

With housing



Antenna 2 P/NO : C1335-520154-A SPEC : 2.4~2.5 GHz

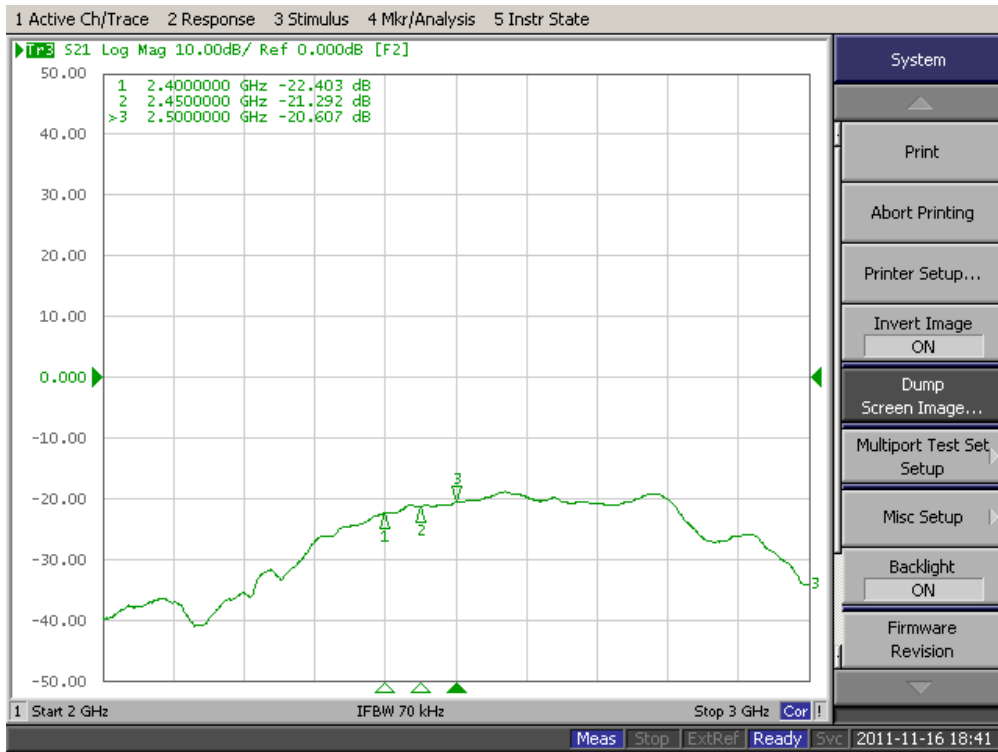
With housing



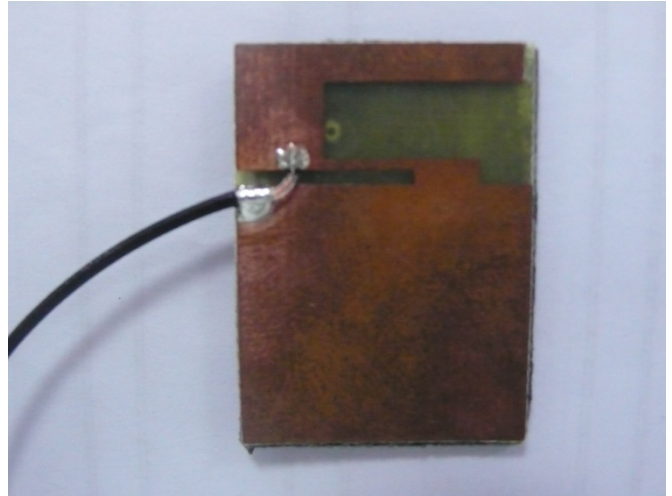
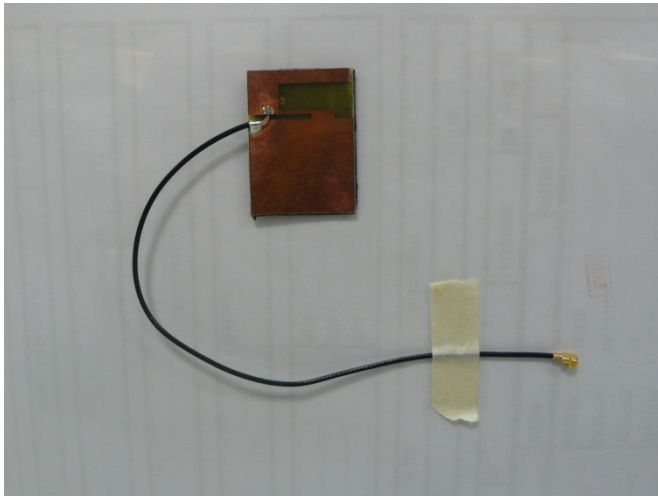
Isolation Test Results

SPEC : 2.4~2.5 GHz

With housing



## Antenna1 (C1335-520153-A)

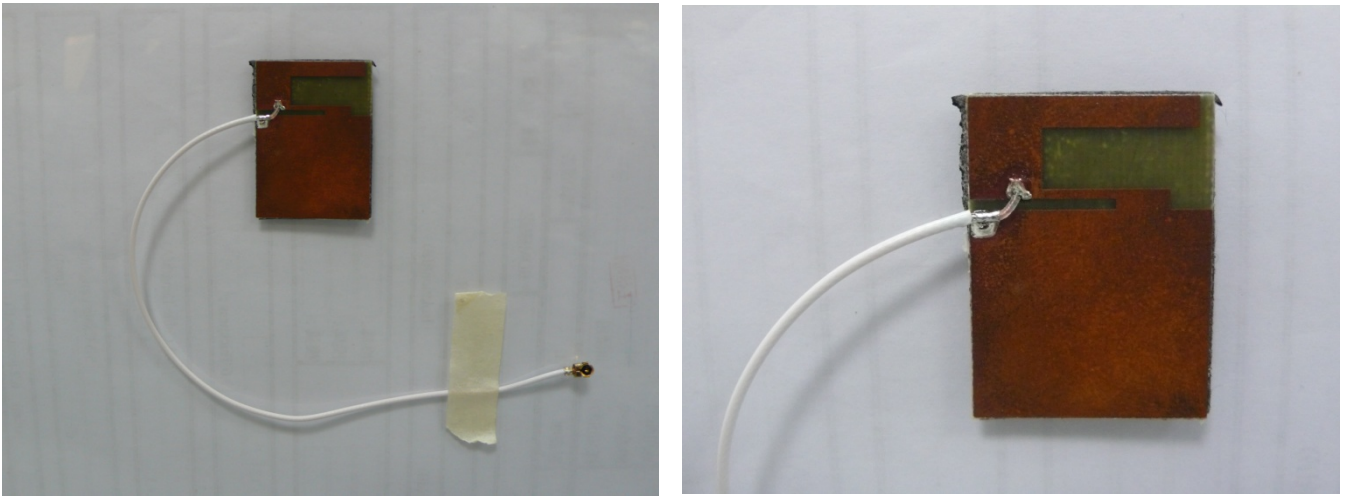


### Antenna1 Passive Efficiency in Free Space

Model name	CISCO DPC2325	Band	802.11 b/g/n		
Date	2011/11/24	Frequency(MHz)	2400	2450	2500
		Specification(%)	40	40	40
Antenna type	PIFA type	Avg Gain(dBi)	-2.61	-2.23	-2.52
		Peak Gain(dBi)	5.18	5.73	5.14
		Efficiency(%)	55	60	56
Antenna	Antenna 1 (C1335-520153-A)	Average Efficiency(%)	57		
		Peak Gain of Operation band(dBi)	5.73		



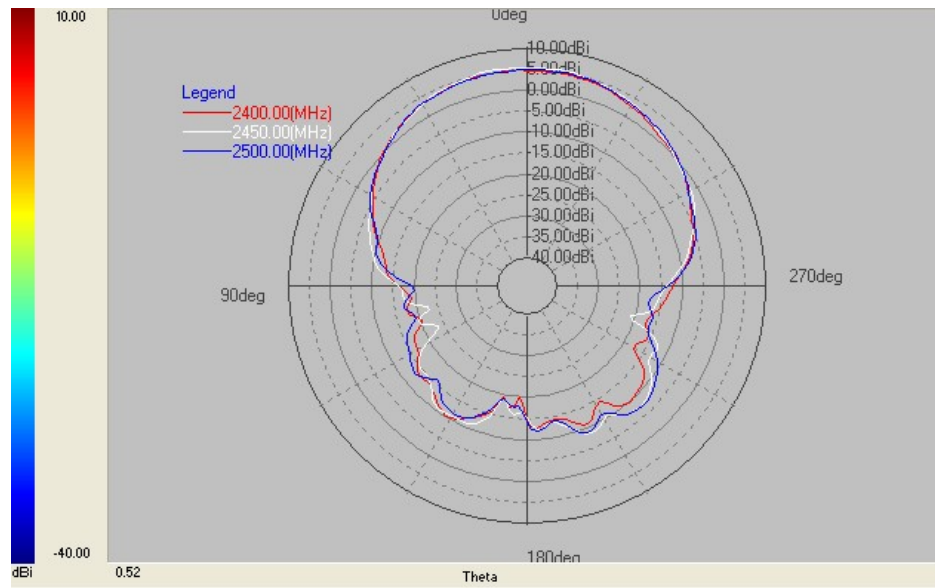
## Antenna2 (C1335-520154-A)



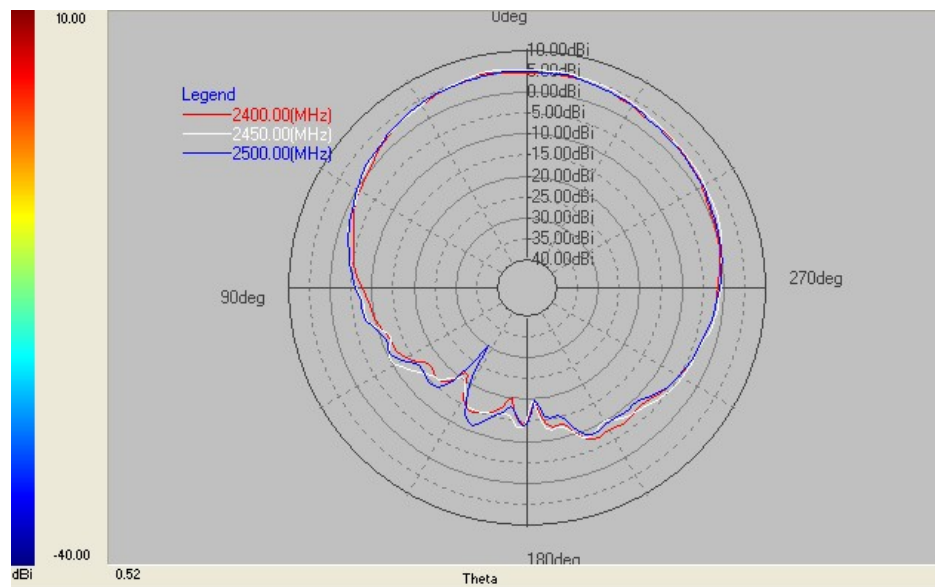
### Antenna2 Passive Efficiency in Free Space

Model name	CISCO DPC2325	Band	802.11 b/g/n		
Date	2011/11/24	Frequency(MHz)	2400	2450	2500
		Specification(%)	40	40	40
Antenna type	PIFA type	Avg Gain(dBi)	-2.58	-2.51	-2.70
		Peak Gain(dBi)	4.55	4.84	3.92
		Efficiency(%)	55	56	54
Antenna	Antenna 2 (C1335-520154-A)	Average Efficiency(%)	55		
		Peak Gain of Operation band(dBi)	4.84		

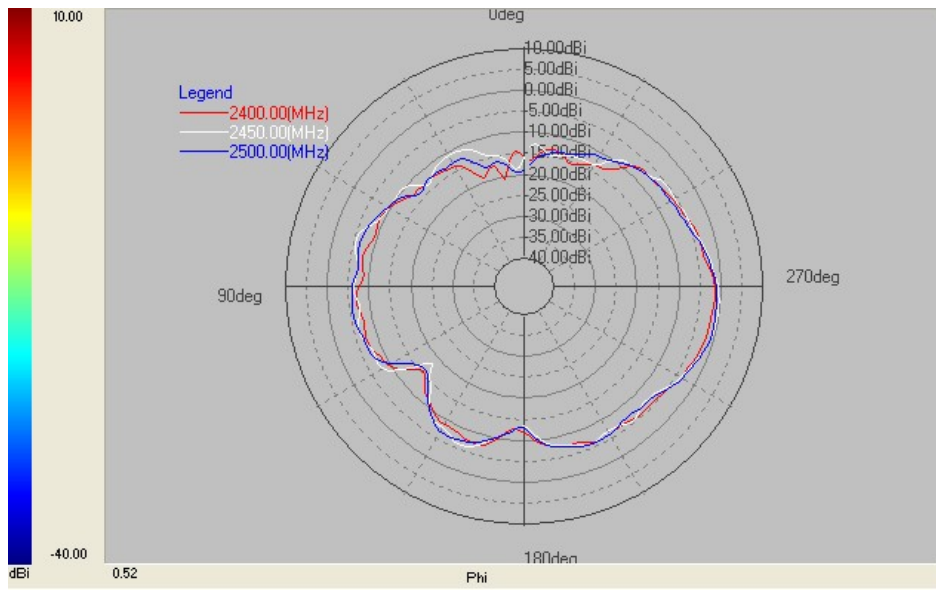
Antenna 1- 802.11 b/g/n band 2D polar plots  
(C1335-520153-A)



Elevation,  $\Phi=0$

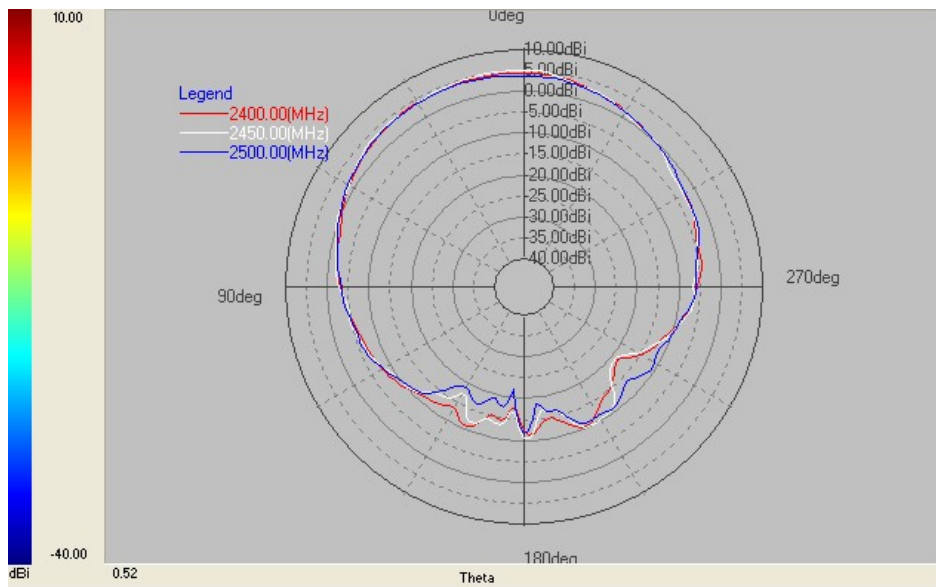


Elevation,  $\Phi=90$

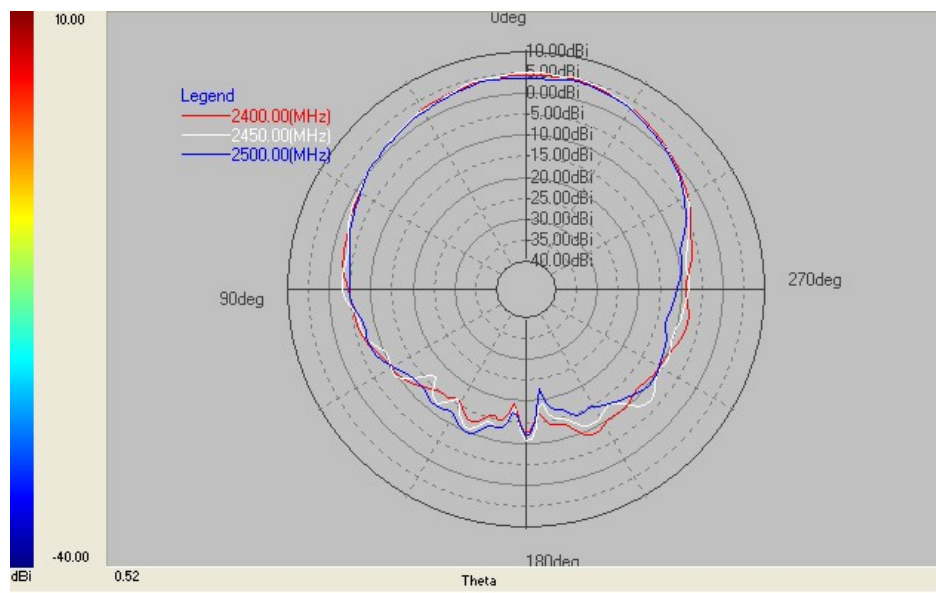


Azimuth

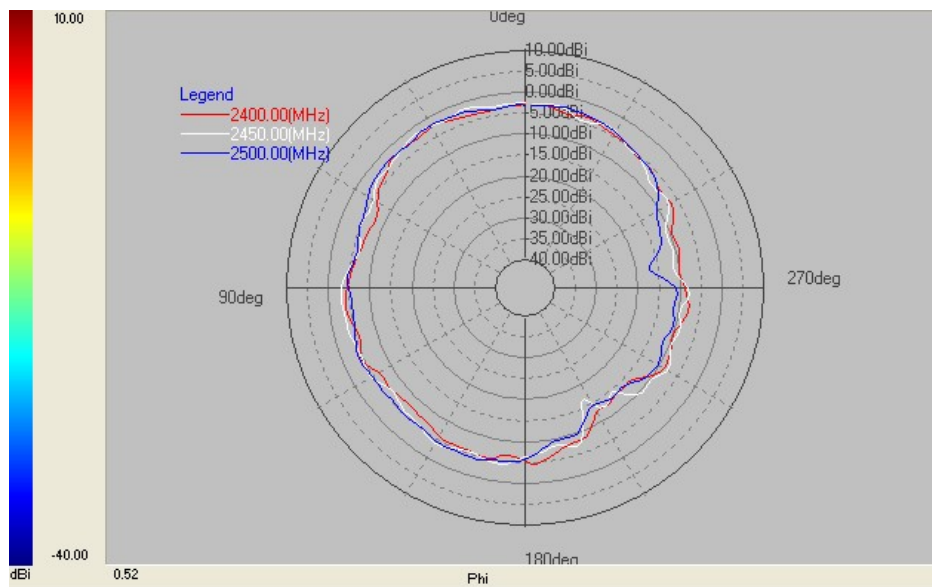
Antenna 2- 802.11 b/g/n band 2D polar plots  
(C1335-520154-A)



Elevation, Phi=0



Elevation, Phi=90



Azimuth

## *Appendix*

### **Antenna Specification (Antenna #2 260-23197 & 260-23198)**



客户名称：(CUSTOMER)

**Unihan**

产品名称

APPELLATION :

**PCB 天線**

产品型号

MODEL :

**DPC2420 、EPC2325 、 DPC2320**

客户料号

No. :

泓淋料号

No. :

**260-23197**

<b>生 产 方</b>	工艺审核 TECHNICAL	品质审核 QUALITY	项目审核 PROJECT	开发审核 DEVELOPING

<b>客 户 方</b>	设计工程师 Engineer	主管审批 Approval	研发体系 R & D System



承認書目錄(簡易版)

- 一. 天線規格表
- 二. 測試報告
- 三. 成品圖



## 一. 天线规格表

### Specification

#### 1. Electrical Properties

- 1.1 Frequency Range----- 2.4GHz~2.5GHz
- 1.2 Impedance----- 50 Ω
- 1.3 VSWR----- 1.92:1
- 1.4 Return Loss----- -10dB or Less
- 1.5 Peak Gain----- 2.34dBi
- 1.6 Admitted Power----- 1W
- 1.7 Cable----- Ø1.13 (Gray)
- 1.8 Connector----- 特諾
- 1.9 Antenna Type----- PIFA type

#### 2. Physical Properties

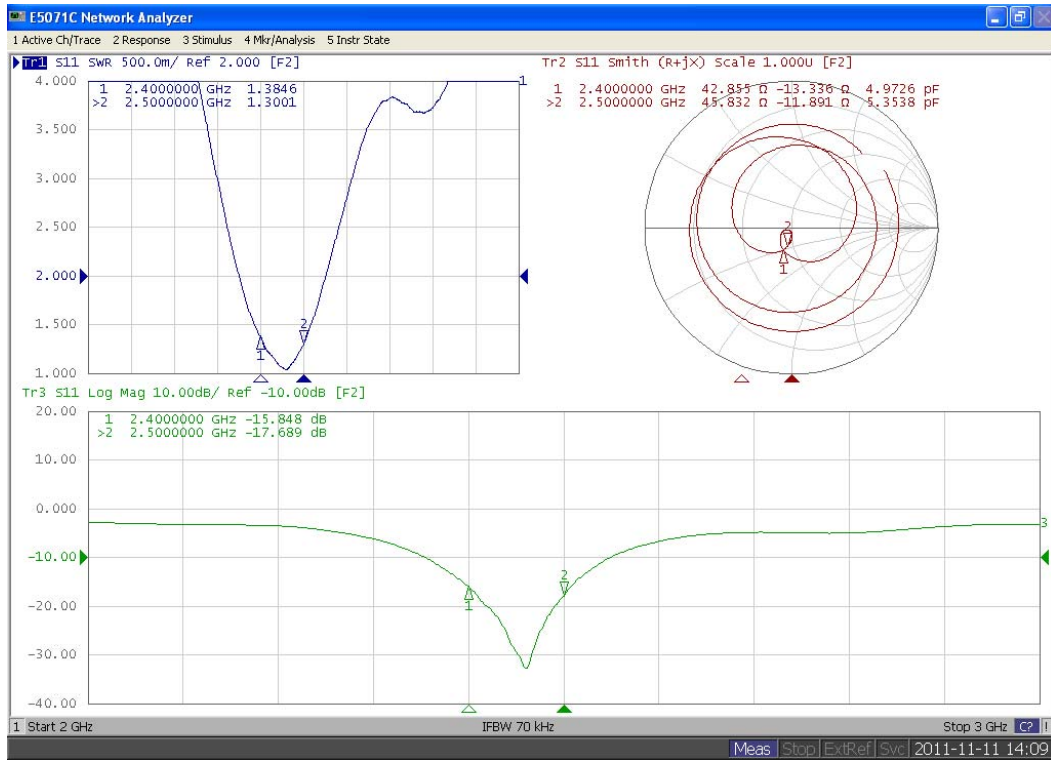
- 2.1 Antenna Body-----FR4
- 2.2 Operating Temp----- -10°C~+60°C
- 2.3 Storage Temp----- -10°C~+70°C





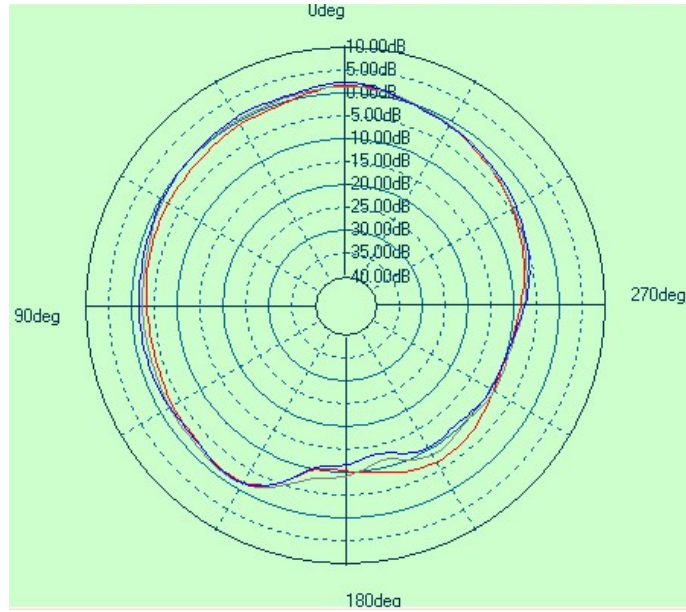
## 二. 測試報告

### Return loss and VSWR

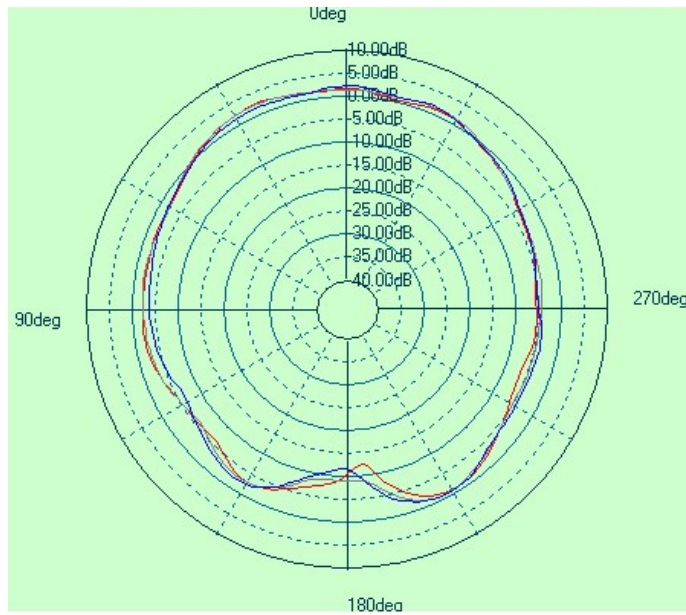




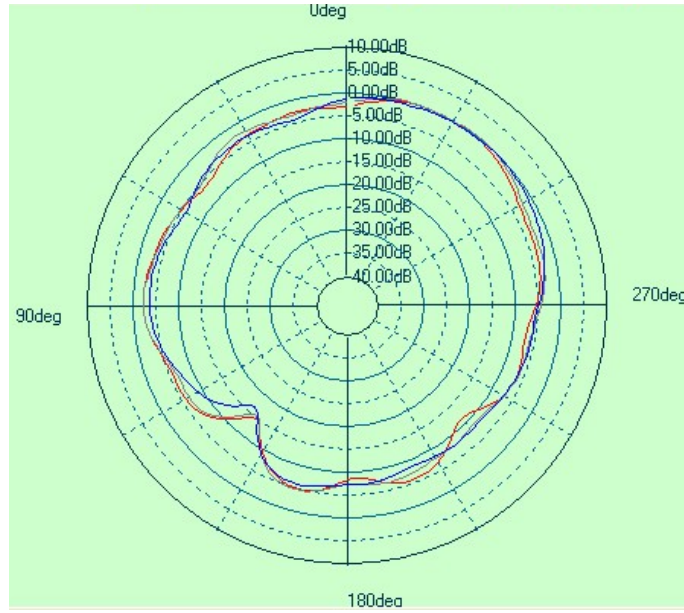
### Radiation Pattern



(X-Z Plane)



(Y-Z Plane)



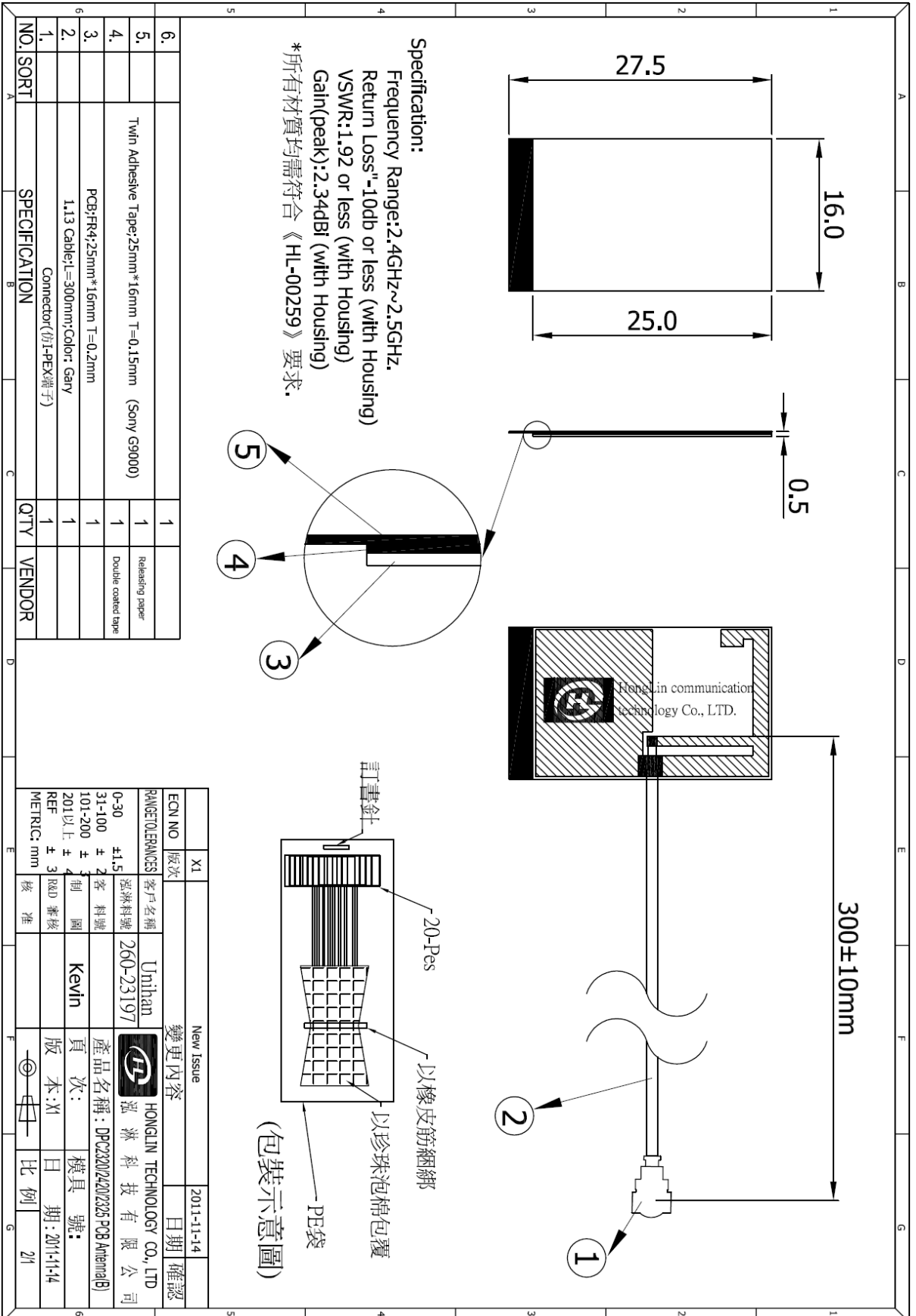
(X-Y plane)

Gain Table

Frequency (MHz)	X-Z plane Phi=0		Y-Z plane Phi=90		X-Y plane theta=90		E-total (dBi)	Efficiency (%)
	Peak Gain	Average Gain	Peak Gain	Average Gain	Peak Gain	Average Gain		
2400	1.40	-3.79 dB	2.23	-2.48	-0.08	-4.68	2.34	60
2450	1.20	-3.31 dB	2.17	-2.21	0.04	-4.31	2.21	64
2500	1.97	-3.25 dB	1.97	-2.41	-0.14	-4.41	2.08	63



三. 成品圖





客户名称：(CUSTOMER) Unihan

产品名称

APPELLATION: PCB 天線

产品型号

MODEL: DPC2420 、EPC2325 、 DPC2320

明瑞料号

No.:

泓淋料号

No.:

260-23198

生产方	工艺审核 TECHNICAL	品质审核 QUALITY	项目审核 PROJECT	开发审核 DEVELOPING

客户方	设计工程师 Engineer	主管审批 Approval	研发体系 R & D System



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### Specification

#### 1. Electrical Properties

- 1.1 Frequency Range----- 2.4GHz~2.5GHz
- 1.2 Impedance----- 50  $\Omega$
- 1.3 VSWR----- 1.92:1
- 1.4 Return Loss----- -10dB or Less
- 1.5 Peak Gain----- 2.94dBi
- 1.6 Admitted Power----- 1W
- 1.7 Cable-----  $\varnothing$ 1.13 (Black)
- 1.8 Connector----- 特諾
- 1.9 Antenna Type----- PIFA type

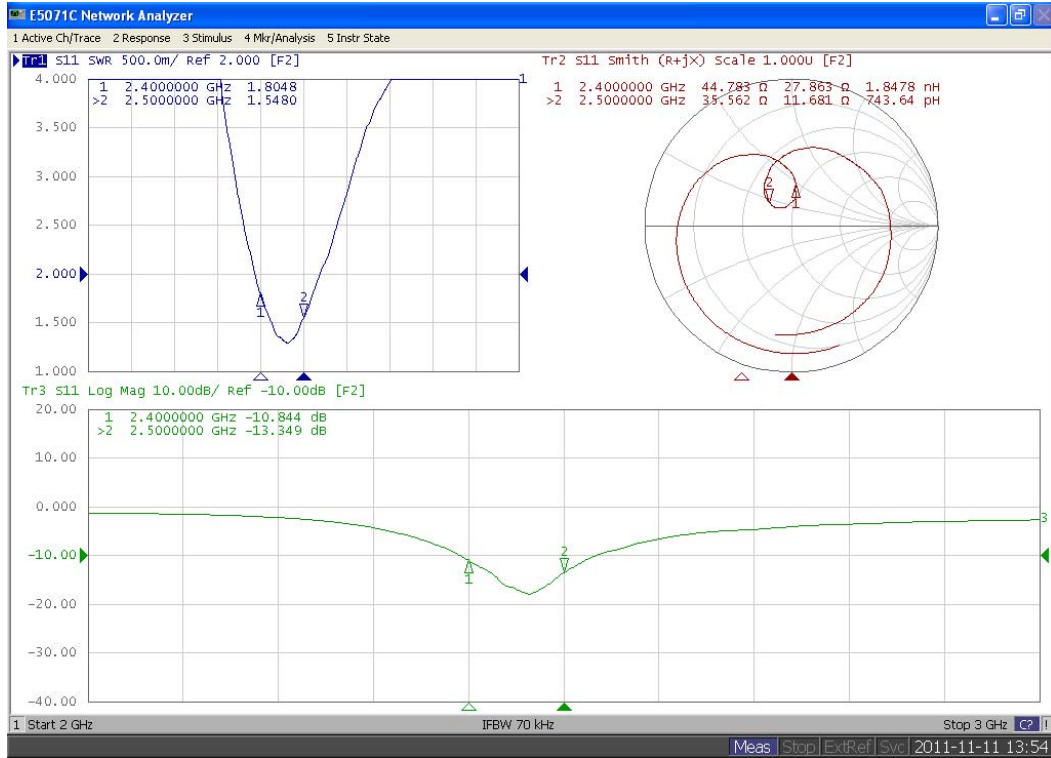
#### 2. Physical Properties

- 2.1 Antenna Body-----FR4
- 2.2 Operating Temp----- -10 $^{\circ}$ C~+60 $^{\circ}$ C
- 2.3 Storage Temp----- -10 $^{\circ}$ C~+70 $^{\circ}$ C



## 二. 測試報告

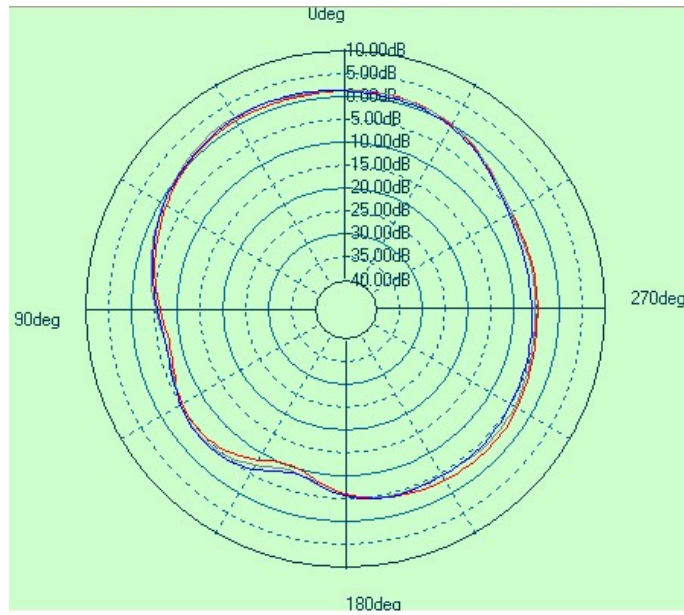
### Return loss and VSWR



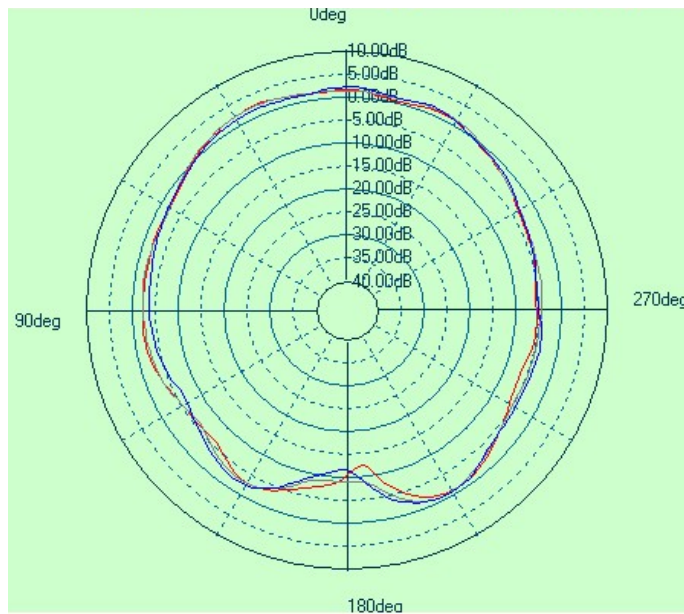




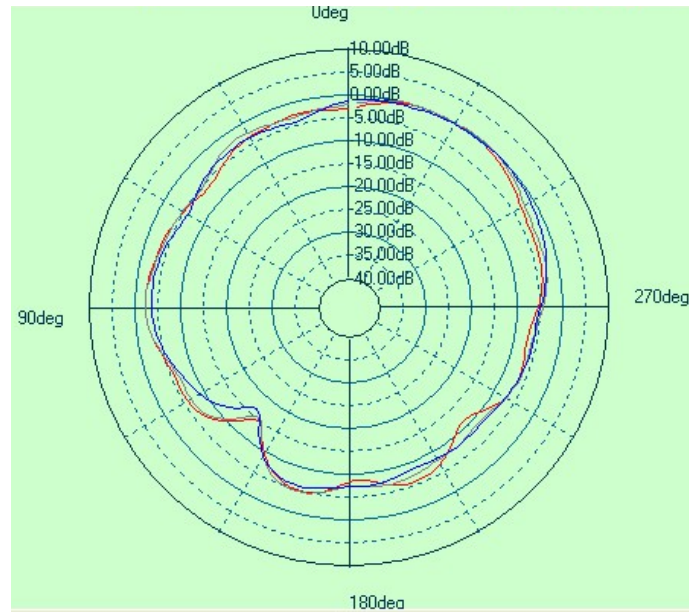
### Radiation Pattern



(X-Z Plane)



(Y-Z Plane)



(X-Y plane)

Gain Table

Frequency (MHz)	X-Z plane Phi=0		Y-Z plane Phi=90		X-Y plane theta=90		E-total (dBi)	Efficiency (%)
	Peak Gain	Average Gain	Peak Gain	Average Gain	Peak Gain	Average Gain		
2400	2.14	-2.68	2.47	-2.73	-0.60	-4.95	2.51	60
2450	2.58	-2.45	2.74	-1.99	0.05	-4.08	2.94	64
2500	2.23	-2.69	2.63	-2.00	0.17	-4.31	2.68	63



三. 成品圖

