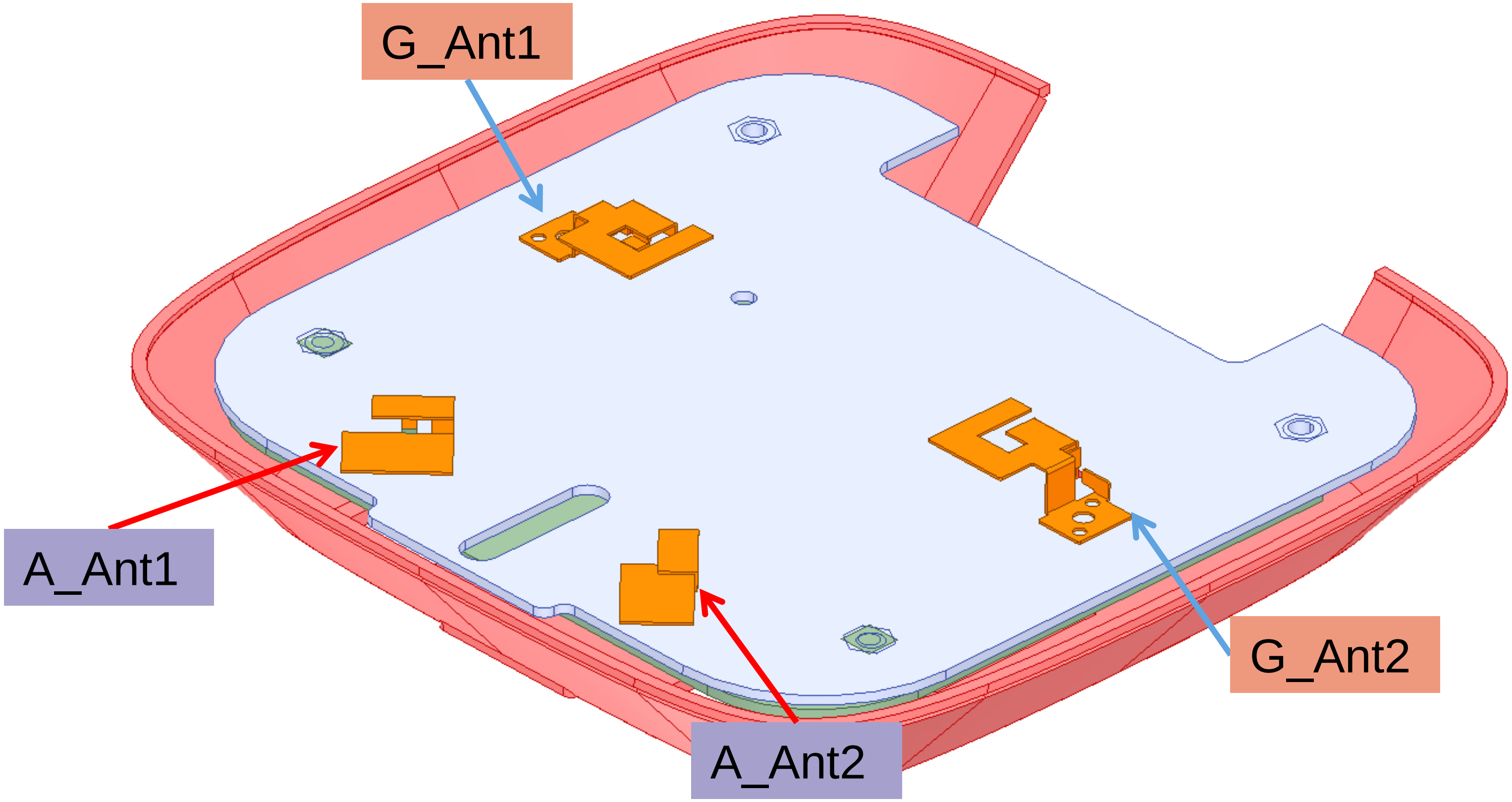
Cambium XV2-21X Antenna Test Report Vt00d DVT Report

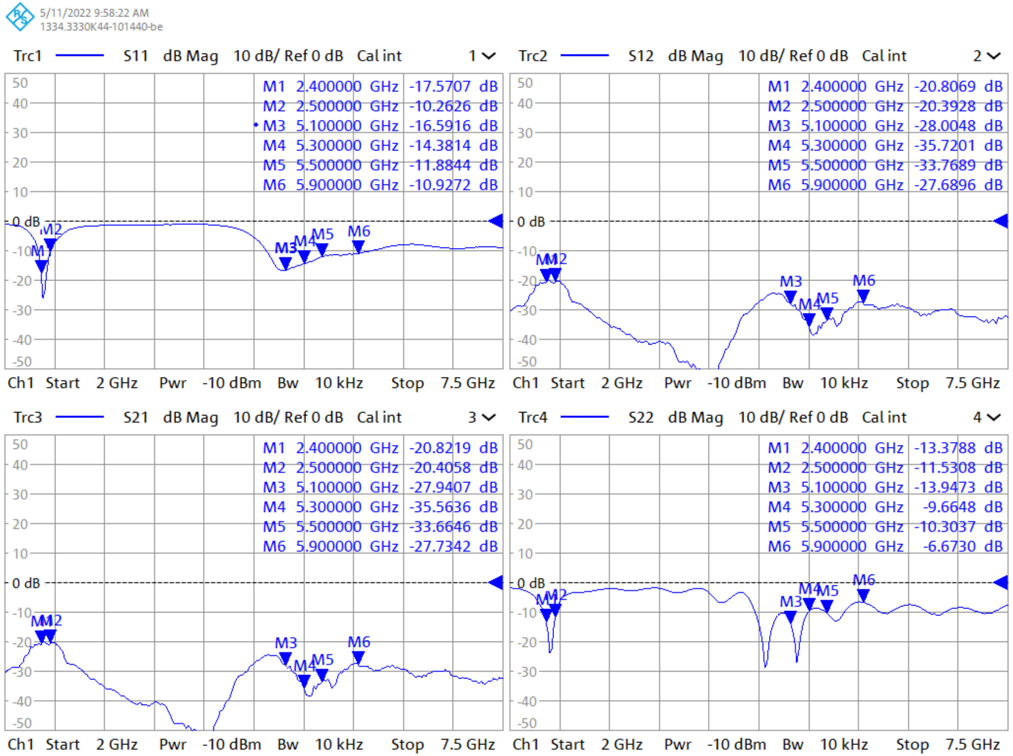
Antenna Team
December 27, 2022

Antenna Set Definition



G Band Antenna Return Loss & Isolation

G_Ant2



G_Ant1

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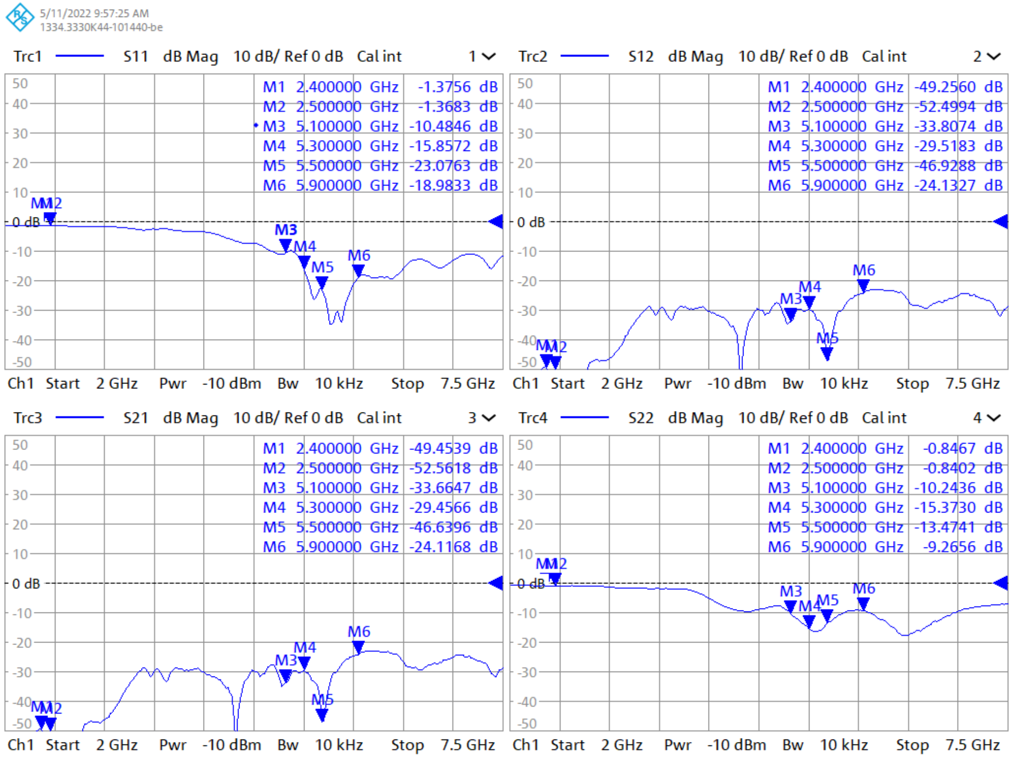
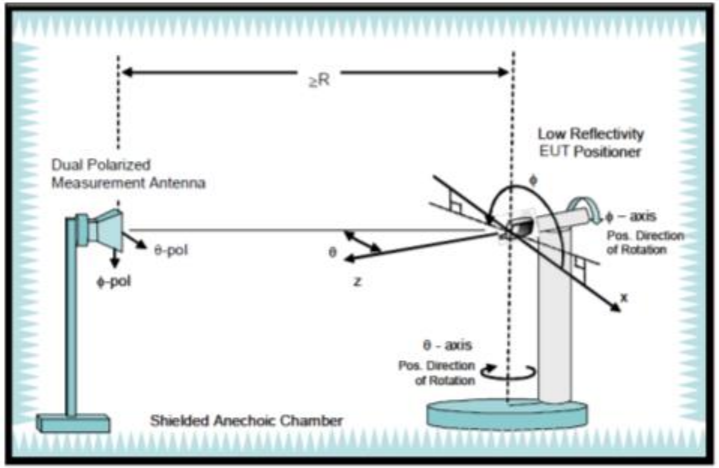
A Band Antenna Return Loss & Isolation

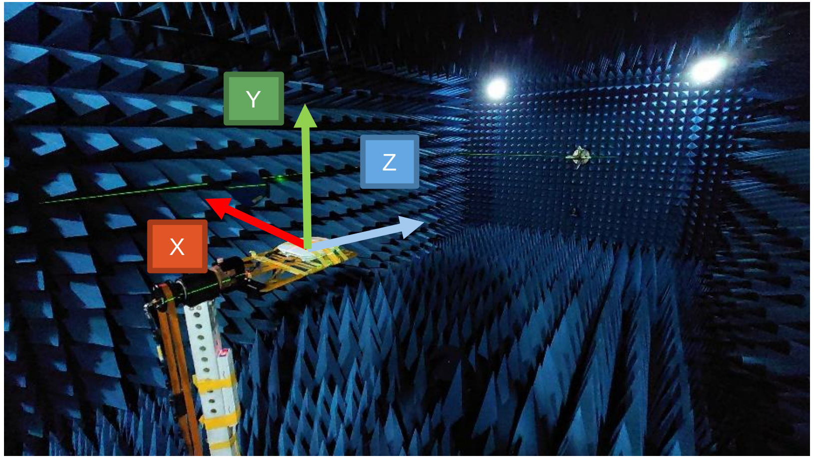
A_Ant2



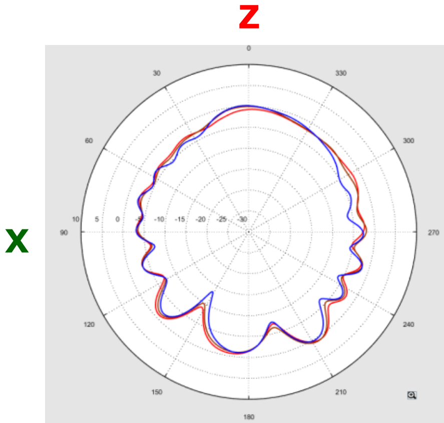
A_Ant1

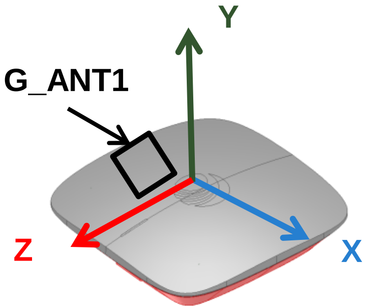
Antenna Coordinate System Definition

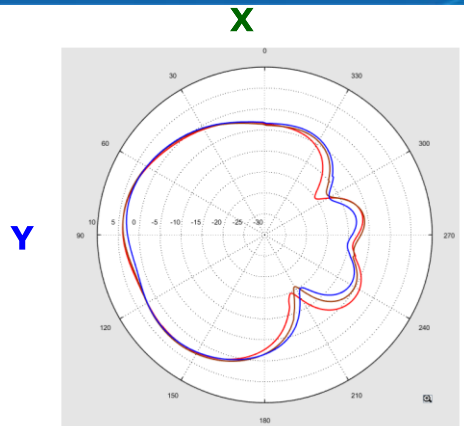


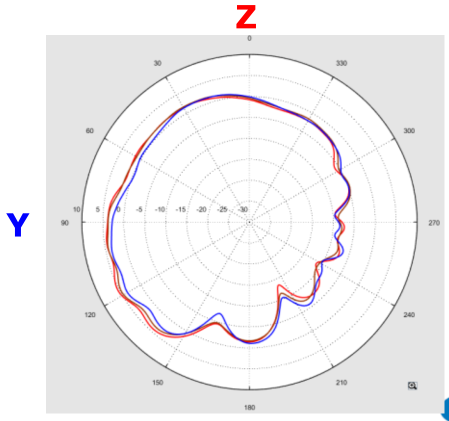


G_ANT1 Gain Total (dBi) Pattern



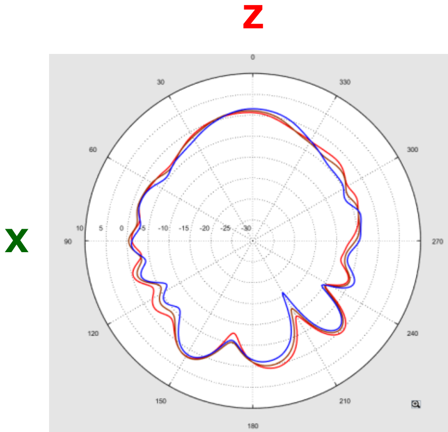


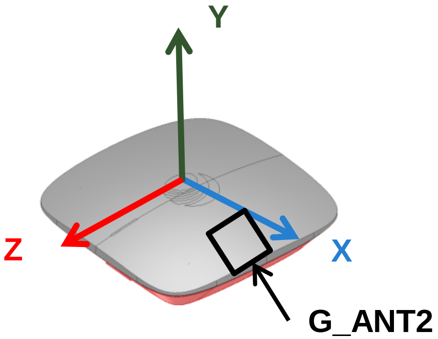




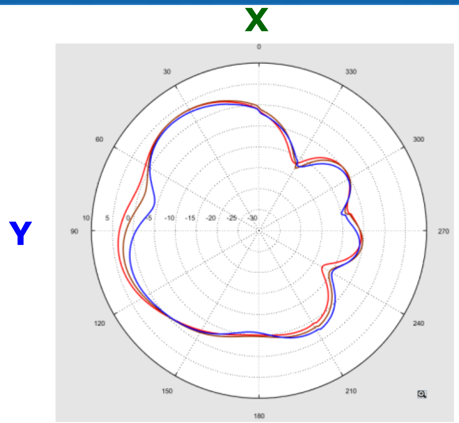
2400MHz
2450MHz
2500MHz

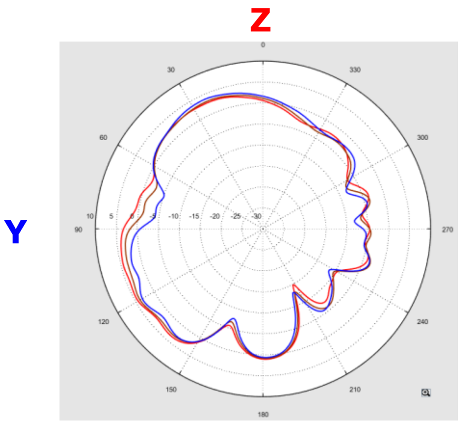
G_ANT2 Gain Total (dBi) Pattern





2400MHz
2450MHz
2500MHz





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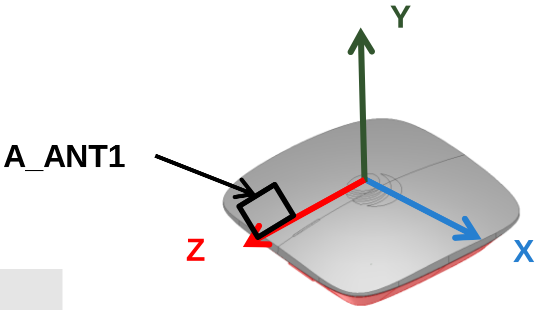
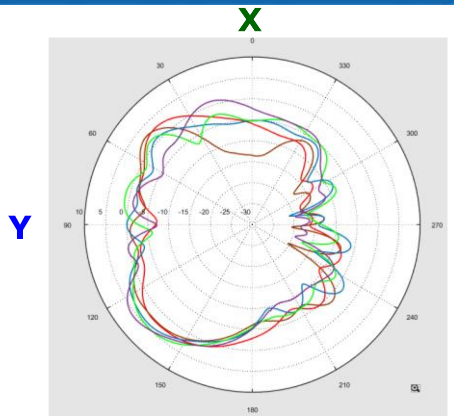
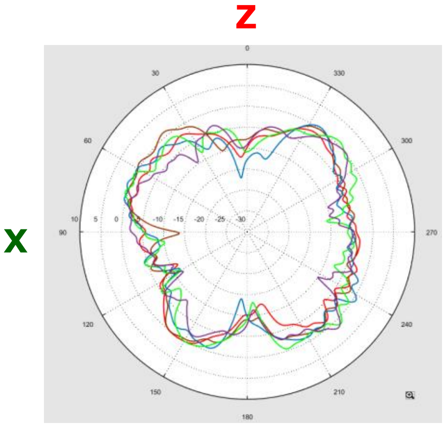
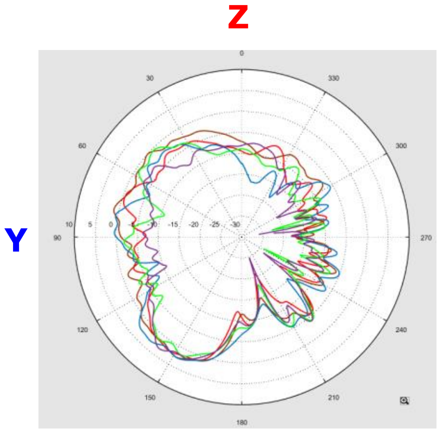
A_ANT1 Gain Total (dBi) Pattern



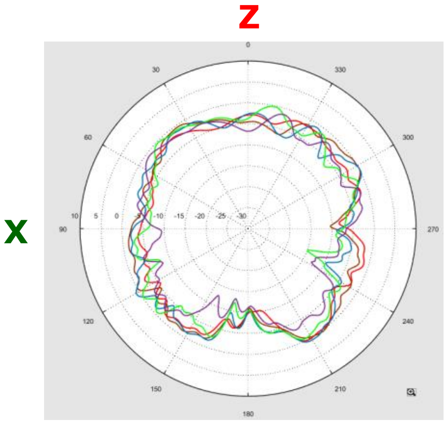


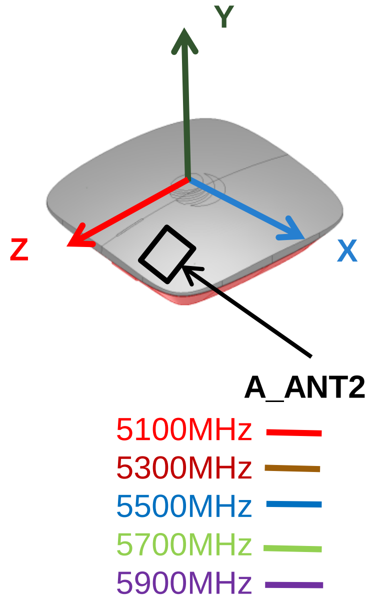


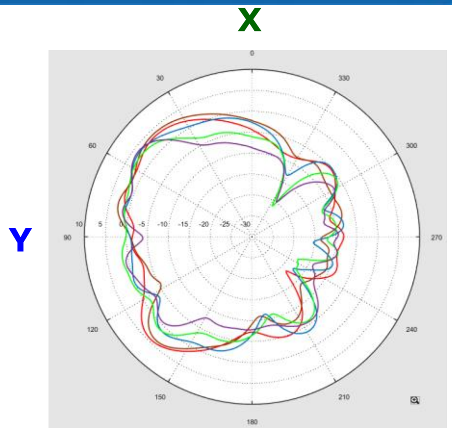


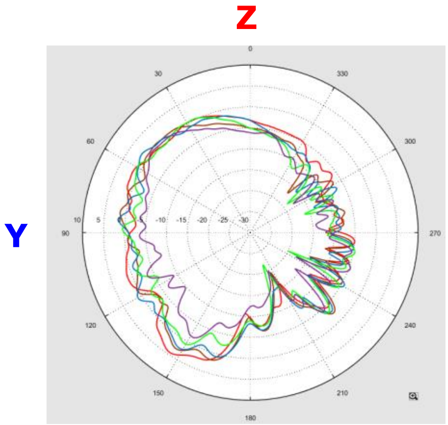
5100MHz
5300MHz
5500MHz
5700MHz
5900MHz

A_ANT2 Gain Total (dBi) Pattern









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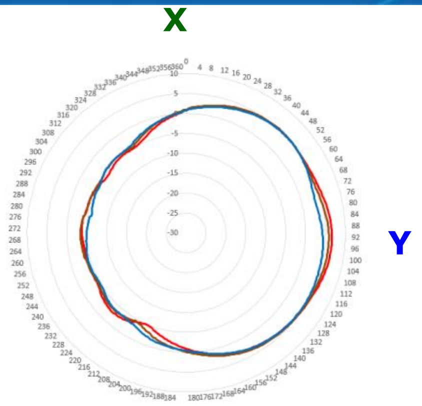
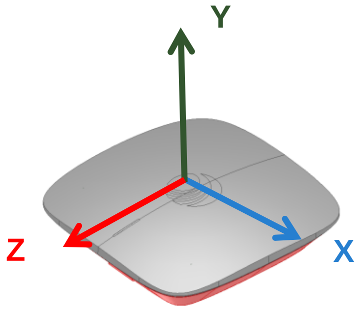
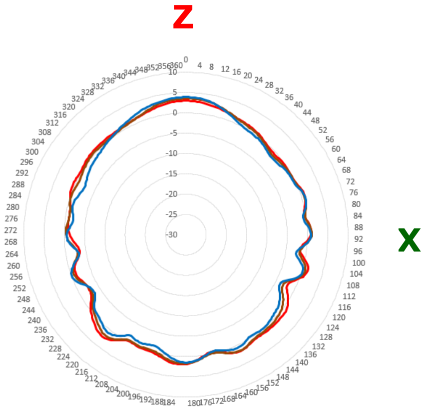
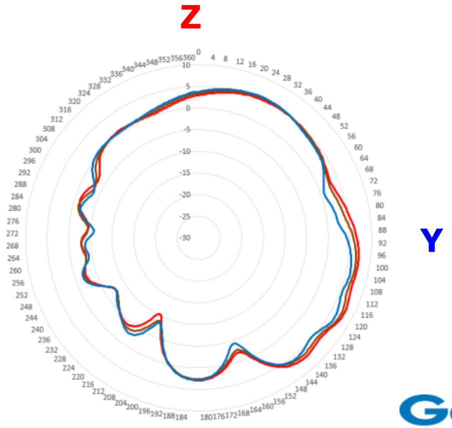
G_ANT Composite Gain Total (dBi) Pattern







2400MHz
2450MHz
2500MHz



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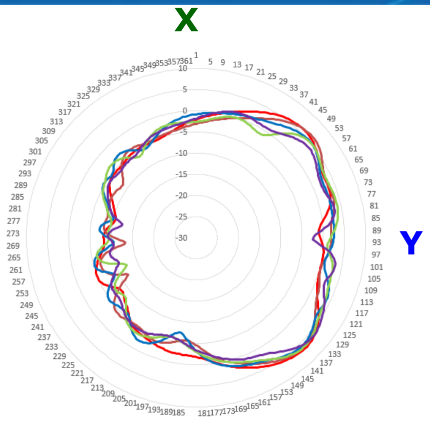
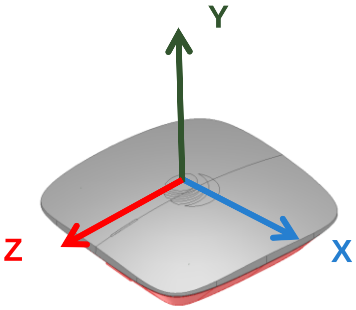
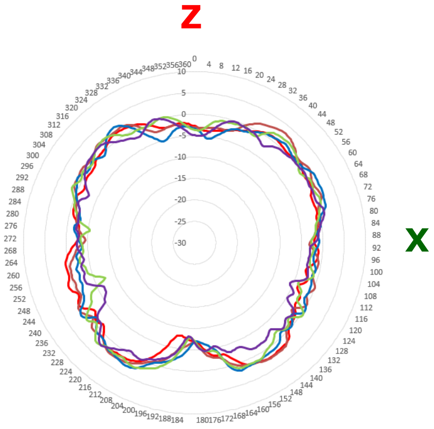
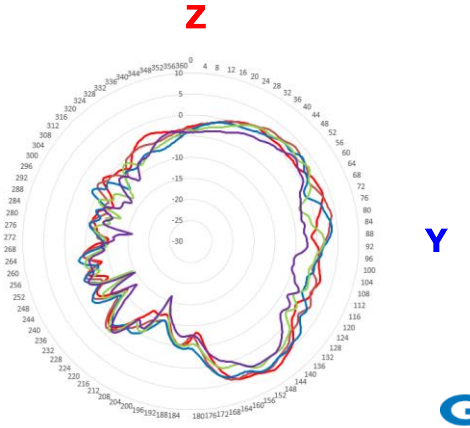
A_ANT Composite Gain Total (dBi) Pattern









5100MHz
5300MHz
5500MHz
5700MHz
5900MHz

Antenna 2.4G /5G Efficiency

WIFI G Band Antenna Efficiency (%)			
Frequency (MHz)	2400	2450	2500
G_ANT1 (Cable Loss : 0.6dB)	83.7	79.3	77.4
G_ANT2 (Cable Loss : 0.35dB)	80.1	77.4	66.4

WIFI A Band Antenna Efficiency (%)					
Frequency (MHz)	5100	5300	5500	5700	5900
A_ANT1(Cable Loss : 0.9 dB)	70	80.3	84	86	81
A_ANT2(Cable Loss : 0.4 dB)	81.5	86.5	82.4	79.4	60.7

Noted: The antenna gain excludes the cable loss, Cable Loss is refer to D1.13 low loss cable datasheet, the attenuation at 5GHz is 4.5 dB per meter.(including IPEX PLUG)

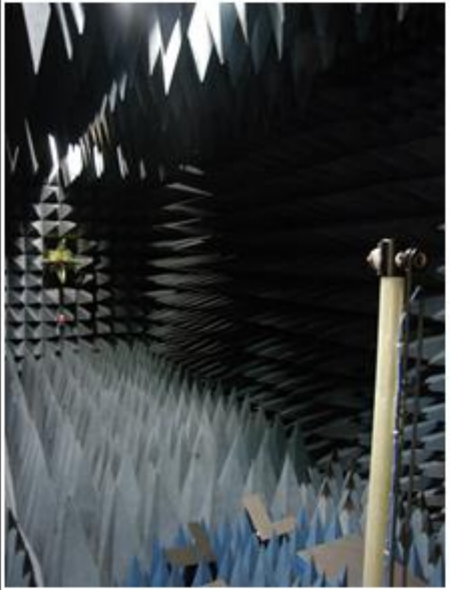
Antenna (2.4G/5G) Peak gain

WIFI G Band Antenna Peak Gain (dBi)			
Frequency (MHz)	2400	2450	2500
G_ANT1 (Cable Loss : 0.6dB)	5.65	5.17	4.3
Peak Gain @	Theta:120/Phi:90	Theta:120/Phi:75	Theta:105/Phi:90
G_ANT2 (Cable Loss : 0.35dB)	5	4.43	4.47
Peak Gain @	Theta:105/Phi:90	Theta:120/Phi:105	Theta:120/Phi:120

WIFI A Band Antenna Peak Gain(dBi)					
Frequency (MHz)	5100	5300	5500	5700	5900
A_ANT1(Cable Loss : 0.9 dB)	6.32	7.2	6.57	7.76	7.79
Peak Gain @	Theta:135/Phi:45	Theta:135/Phi:45	Theta:135/Phi:45	Theta:150/Phi:60	Theta:105/Phi:125
A_ANT2(Cable Loss : 0.4 dB)	6.92	6.89	8.16	8.15	7.48
Peak Gain @	Theta:135/Phi:135	Theta:135/Phi:135	Theta:150/Phi:135	Theta:150/Phi:135	Theta:150/Phi:135

Noted: The antenna gain excludes the cable loss, Cable Loss is refer to D1.13 low loss cable datasheet, the attenuation at 2.4GHz is 3.2dB per meter.(including IPEX PLUG)

Measurement Environment

<table>
<tr><td>Chamber type</td><td>Operation Band: 700 MHz ~ 18 GHz
Chamber Size: 7m(L) * 3.5m(W) * 3.5m(H)
</td></tr>
<tr><td>Antenna type</td><td>Types of measurement antennas (Frequency Range)</td></tr>
<tr><td>Test Equipment</td><td><table><tr><td>Instrument</td><td>Brand</td><td>Model No.</td></tr><tr><td>VNA</td><td>ROHDE & SCHWARZ</td><td>ZNB8</td></tr></table></td></tr>
</table>

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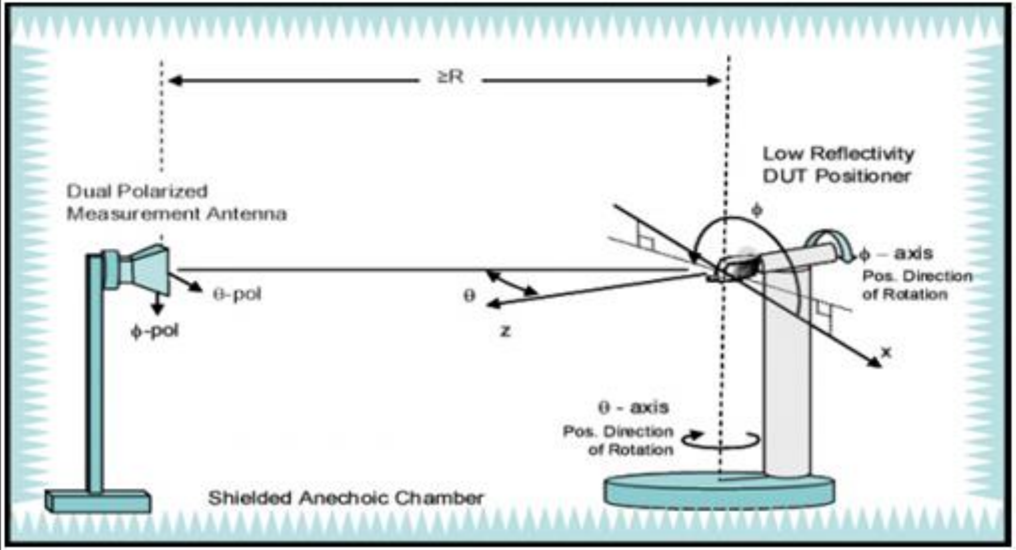
Measurement Environment (cont'd)

Coordinate difinition	

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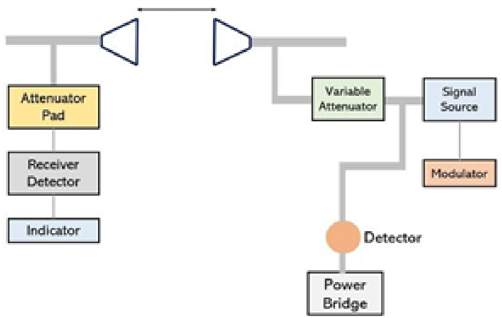
Test method / Test Procedure

- Measurement Method

Absolute gain



Suppose the two antennas (transmitting and receiving) are separated at a distance r. Here, P_t and P_r represent the transmitted and received power respectively. While A_{et} and A_{er} are the effective apertures of transmitting and receiving antennas.

As the two antennas are identical. Therefore, $A_{et} = A_{er} = \frac{G_0\lambda^2}{4\pi}$

By Friis's transmission equation, $\frac{P_r}{P_t} = \left(\frac{A_{et}A_{er}}{\lambda^2 r^2}\right) = \left(\frac{G_0\lambda^2}{4\pi}\right)\left(\frac{G_0\lambda^2}{4\pi}\right)\frac{1}{\lambda^2 r^2}$

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Test method / Test Procedure (cont'd)

$$\frac{P_r}{P_t} = \left(\frac{G_0 \lambda}{4\pi r}\right)^2$$

$$\sqrt{\frac{P_r}{P_t}} = \frac{G_0 \lambda}{4\pi r}$$

Thus, $G_0 = \frac{4\pi r}{\lambda}\sqrt{\frac{P_r}{P_t}}$

While if we consider the effect of direct and indirect rays in case of ground reflection then, $G_0 = \frac{4\pi r}{\lambda F}\sqrt{\frac{P_r}{P_t}}$

: F is the propagation constant due to interference.

$$Gain = \frac{Maximum\ amount\ of\ power\ received\ from\ subject\ antenna}{Maximum\ amount\ of\ power\ received\ from\ reference\ antenna}$$

Hence, $G = \frac{P_1}{P_2}$

The calibration data for the test environment

Antenna G_{Total} Calculation

- G_{Theta} **or** G_{Phi} =S21(VNA reading value) – Path Loss
- $Antenna\ G_{Total}$

Step1: Each angle Gain(G_{Theta} **and** G_{Phi}) transfer to linear data：10^(G /10)

Step2: Each angle total linear = G_{Theta} linear +G_{Phi} linear

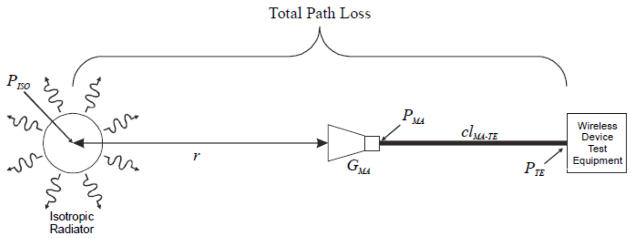
Step3: data transfer dB scale：G_{Total} =10*LOG10(Each angle total linear)

The calibration data for the test environment (cont'd)

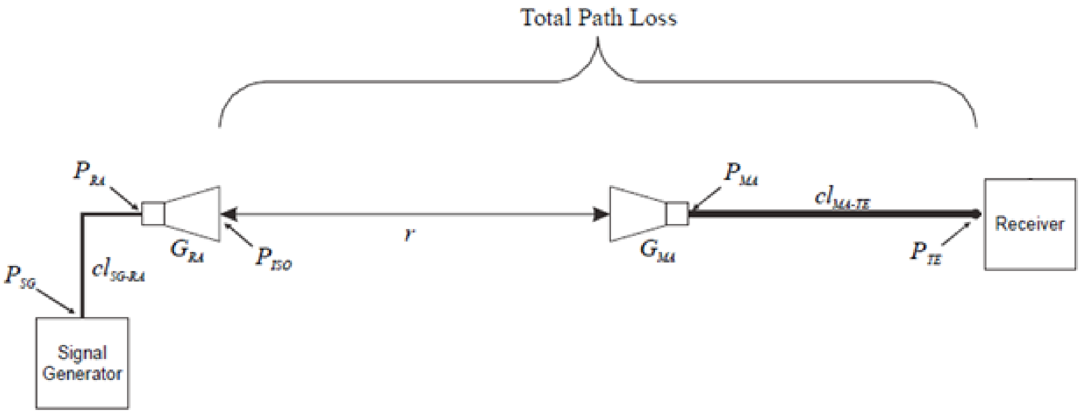
- **Path Loss Calculation**

- PL：Path Loss，P_{ISO}：Isotropic power，P_{TE}： Receive power from VNA

$$PL = P_{ISO} - P_{TE}$$



- G_{RA}：Gain from reference antenna，P_{SG}：Power from Signal Generator ，Cl_{SG-RA}：Cable Loss from Signal Generator to reference antenna



$$P_{ISO} = (P_{SG} - Cl_{SG-RA}) + G_{RA}$$

$$P_{RA} = P_{SG} - Cl_{SG-RA}$$

$$PL = (P_{RA} + G_{RA}) - P_{TE}$$

Antenna Information

Antenna PN: 180-100-1491R

- Antenna factory address:

  蘇州市相城區陽澄湖鎮岸山開發區田多裡路號

  An shan Development Zone , Yang chenghu Town , Xiangcheng District , Suzhou City , Jiangsu province

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