OAW-AP1521
Antenna Test Report

Version:V1
2024-8-12

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1. Test Information

Equipment	E5071C and SATIMO microwave anechoic chamber
Applicant	Han-Networks
Manufacturer	T&W

2. Testing Location

Testing Location	
T&W	ADD: No. 2 Danzi North Road, Kengzi Street, Pingshan District, Shenzhen, Guangdong, China

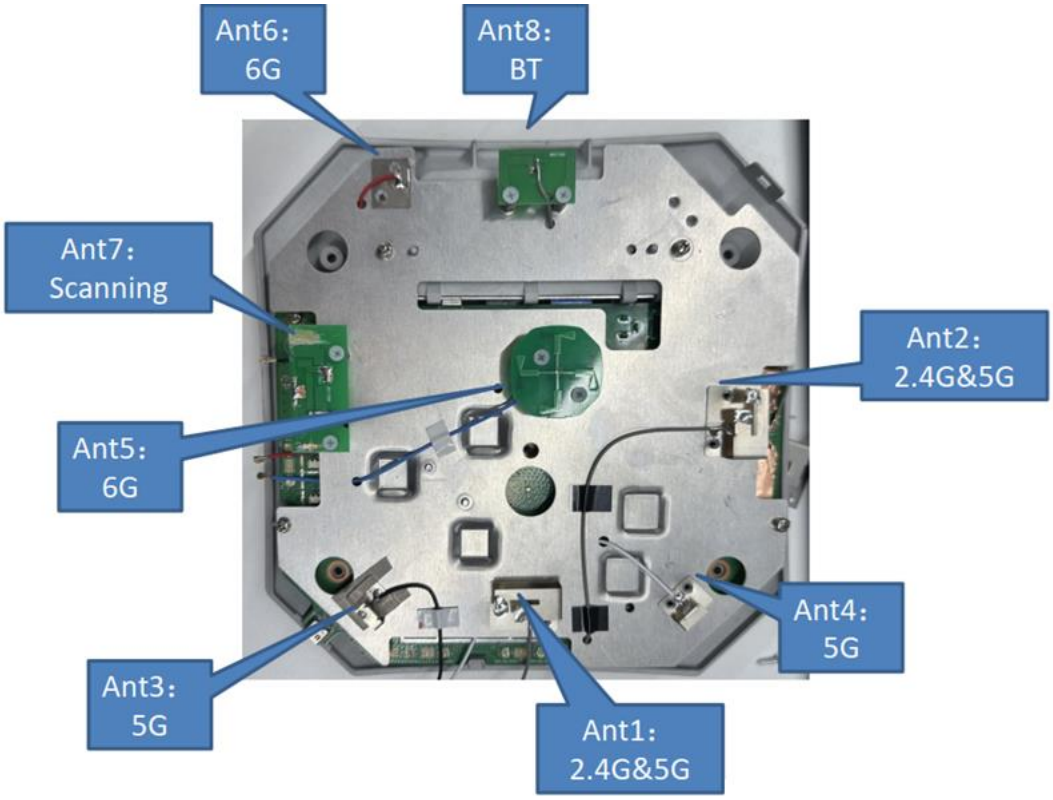
Test Condition	Test Engineer	Test Environment (°C / %)	Test Date
Radiated	Winty	22-26 / 45-60	7.20.2024~7.25.2024

3. Test Frequency

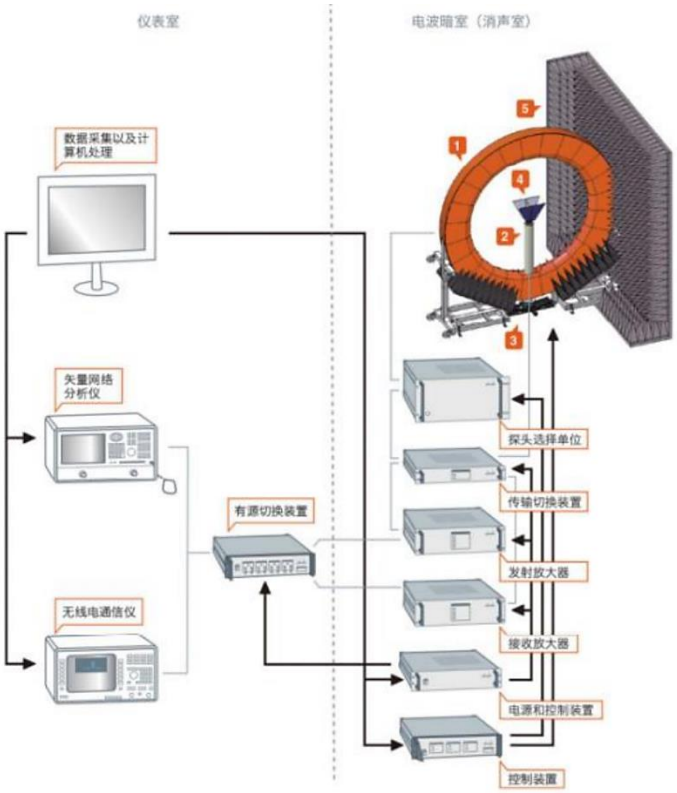
Band (MHz)	Test Frequency (MHz)
2400-2500	2450
5150-5850	5200/5300/5500/5850
5925-7125	6225/6525/6725/7025

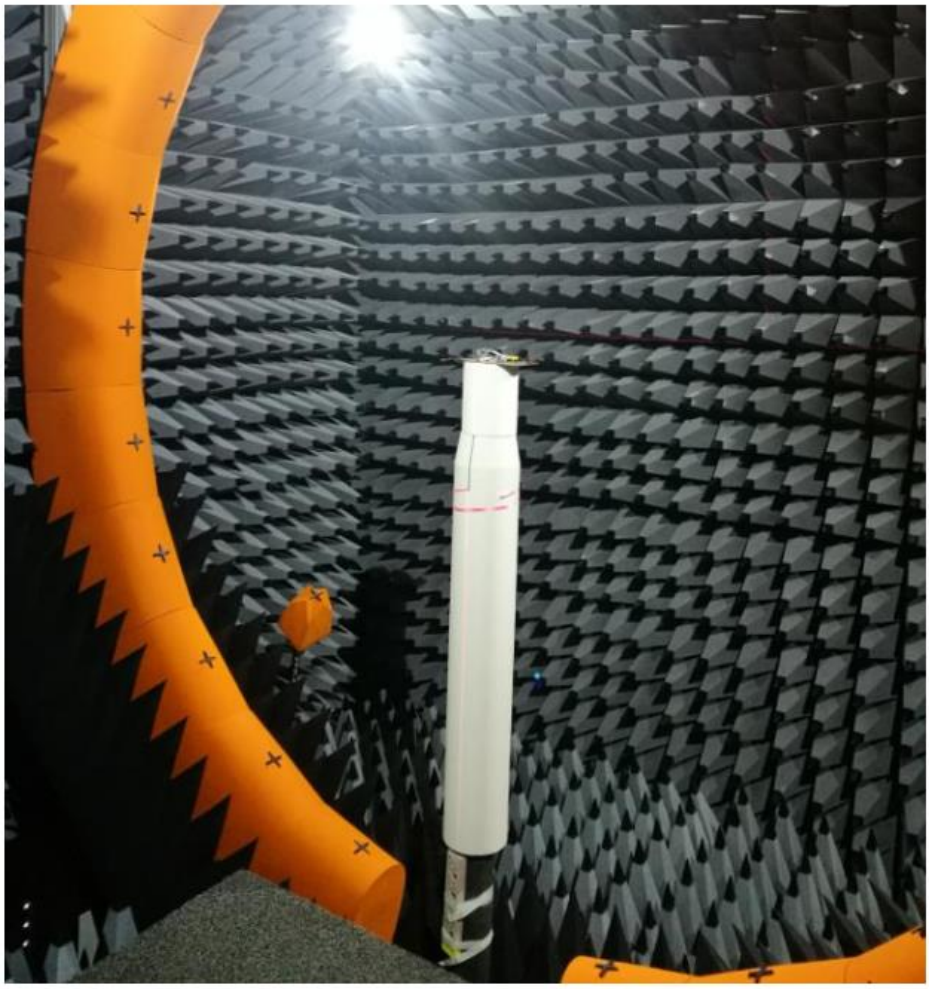
4. Antenna Information

	Frequency	Type	Size(L*W*H)	Cable Length(mm)	Polarization type
ANT1	WiFi 2+5G	PIFA	26*19*8	41	Vertical
ANT2	WiFi 2+5G	PIFA	26*19*8	152	Vertical
ANT3	WiFi 5G	PIFA	16.5*13.4*7	89	Vertical
ANT4	WiFi 5G	PIFA	16.5*13.4*7	131	Vertical
ANT5	WiFi 6G	Dipole	32.5*32.5*0.6	183	Horizontal
ANT6	WiFi 6G	PIFA	17*14*6.5	136	Vertical
ANT7	Scanning	Dipole	45*20*0.8	119	Horizontal
ANT8	BLE	Dipole	26+17.7*0.8	152	Horizontal

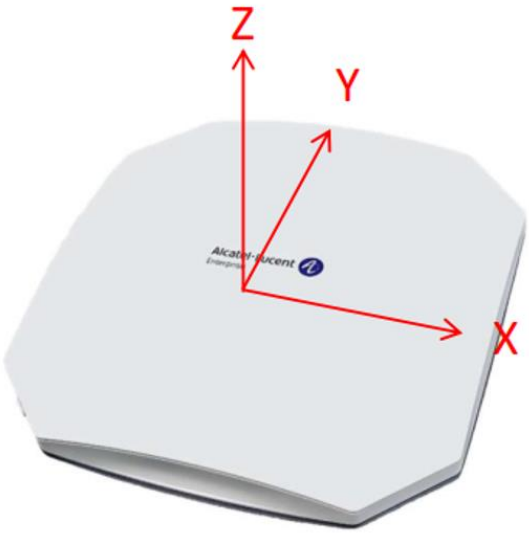


5. Test Configuration

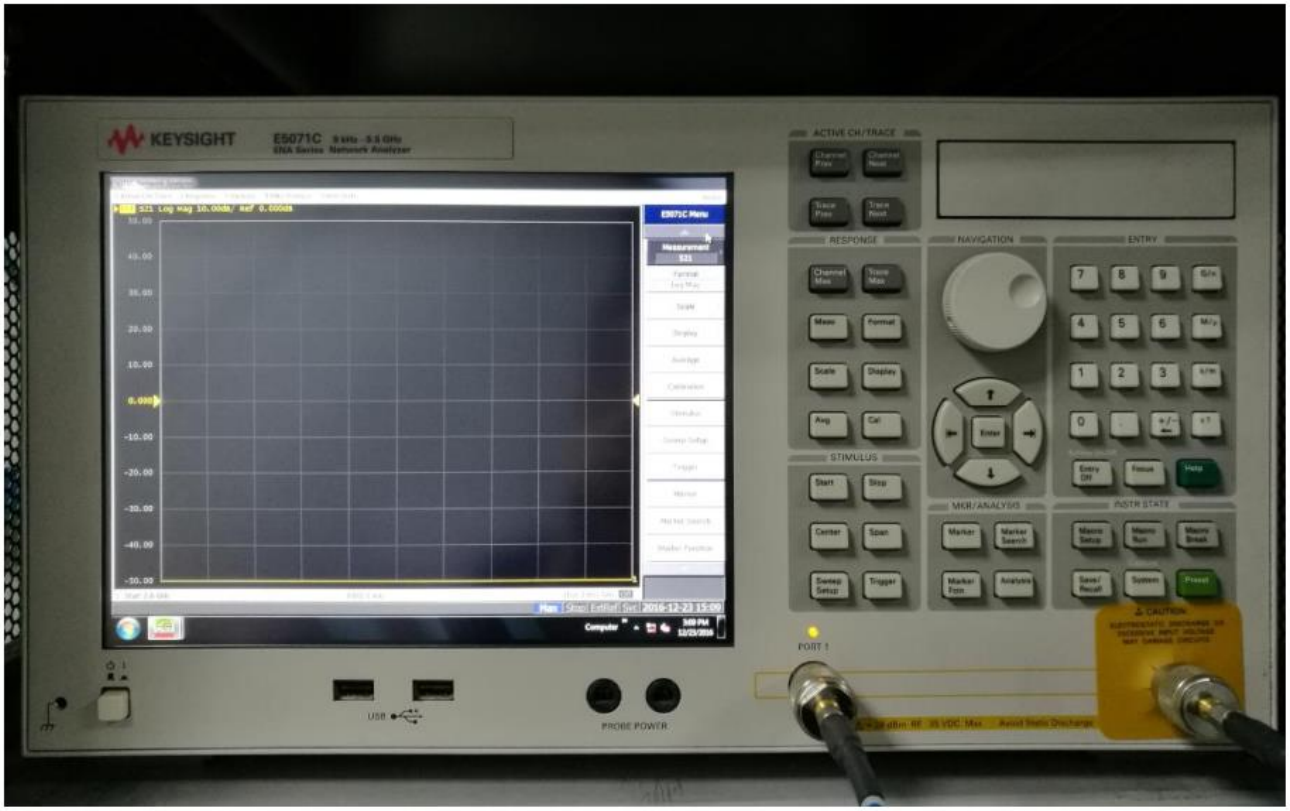




Microwave anechoic chamber



6. Reference Test



The network Analyzer

7. Test Method

The “great circle” cut method, whereby the Measurement Antenna remains fixed and the EUT is rotated about two axes in sequential order. The radiated RF performance of the Equipment Under Test (EUT) is measured by sampling the radiated transmit power of the mobile at various locations surrounding the device. A three-dimensional characterization of the 'transmit' performance of the EUT is pieced together by analyzing the data from the spatially distributed measurements.

Data points taken every 2 degrees in the theta and in the phi axes are deemed sufficient to fully characterize the EUT's Far-Field radiation pattern and total radiated power All of the measured power values will be integrated.

8. Measured Values and Calculation of Correlated / Uncorrelated Gains

Summary of Antenna Peak Gain

Antenna Peak Gain Table (Ant. Position：2.4G Ant.1~2)

Band (MHz)	2400-2500
Ant.1 Max Gain (dBi)	3.7
Ant.2 Max Gain (dBi)	4.6

Antenna Peak Gain Table (Ant. Position：5G Ant.1~4)

Band (MHz)	5150 ~ 5250	5250 ~ 5350	5470 ~ 5725	5725 ~ 5850
Ant.1 Max Gain (dBi)	4.8	5.3	5.8	4.7
Ant.2 Max Gain (dBi)	4.2	4.8	4.4	4.8
Ant.3 Max Gain (dBi)	4.9	4.6	5.9	5.7
Ant.4 Max Gain (dBi)	4.8	4.9	4.2	4.9

Antenna Peak Gain Table (Ant. Position：6G Ant.5~6)

Band (MHz)	5925 ~ 6425	6425 ~ 6525	6525 ~ 6875	6875 ~ 7125
Ant.5 Max Gain (dBi)	3.2	3.5	3.2	2.2
Ant.6 Max Gain (dBi)	5.7	6.4	6.3	4.7

Antenna Peak Gain Table (Ant. Position：Scanning Ant.7)

Band (MHz)	2400-2500			
Ant.7 Max Gain (dBi)	4.8			
Band (MHz)	5150 ~ 5250	5250 ~ 5350	5470 ~ 5725	5725 ~ 5850
Ant.7 Max Gain (dBi)	6.3	6.1	6.2	6.3
Band (MHz)	5925 ~ 6425	6425 ~ 6525	6525 ~ 6875	6875 ~ 7125
Ant.7 Max Gain (dBi)	5.0	4.3	2.9	4.9

Antenna Peak Gain Table (Ant. Position：BLE/Zigbee Ant.8)

Band (MHz)	2400-2500
Ant.8 Max Gain (dBi)	5.3

Result for Uncorrelated Gain and Correlated Gain

Maximum Correlated Gain Calculation

Because the antennas are fixed in location within the device the directional antenna gain for MIMO is calculated over a sphere using the raw spatial data taken at 10 degree steps of theta and 10 degree of theta phi for each antenna using the equations from KDB 662911 D01. The raw antenna data is located in the appendix of this report.

The correlated antenna gain was calculated using KDB 662911 D01 F(2)(d)(i).

$$\text{Directional gain} = 10\log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}]\ \text{dBi}$$

The uncorrelated antenna gain was calculated using KDB 662911 D01 F(2)(d)(ii)

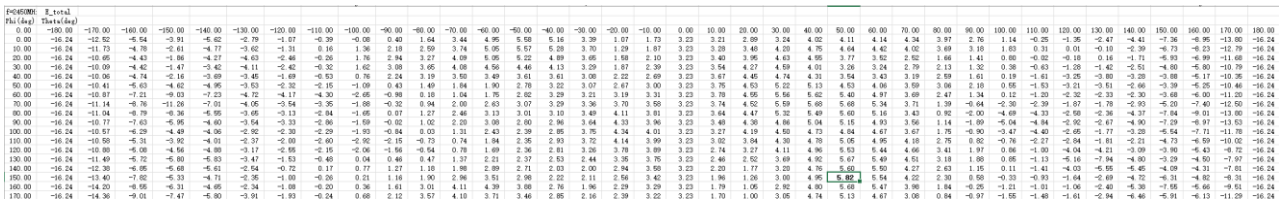
$$\text{Directional gain} = 10\log[(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})/N_{ANT}]\ \text{dBi}$$

The correlated gains were calculated for each point in the spatial data and the highest values reported.

Correlated Directional Gain for 2.4GHz (Ant. Position：2.4G Ant.1~2)

Frequency (MHz)	2450
Directional Gain	5.82

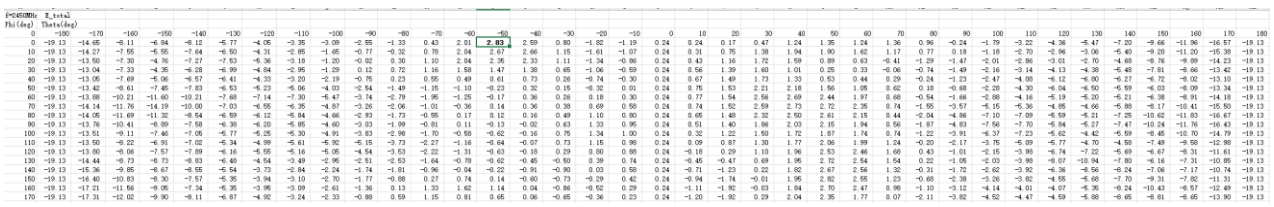
Ant.1~2 @2.45GHz



Uncorrelated Directional Gain for 2.4GHz (Ant. Position：2.4G Ant.1~2)

Frequency (MHz)	2450
Directional Gain	2.83

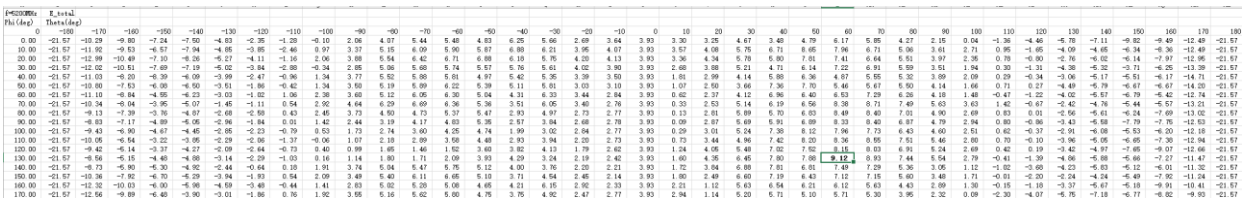
Ant.1~2 @2.45GHz



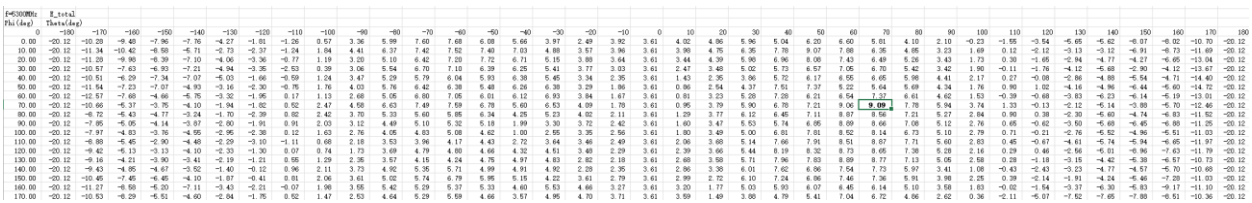
Correlated Directional Gain for 5GHz (Ant. Position：5G Ant.1~4)

Frequency (MHz)	5200	5300	5500	5800
Directional Gain	9.12	9.09	8.95	8.69

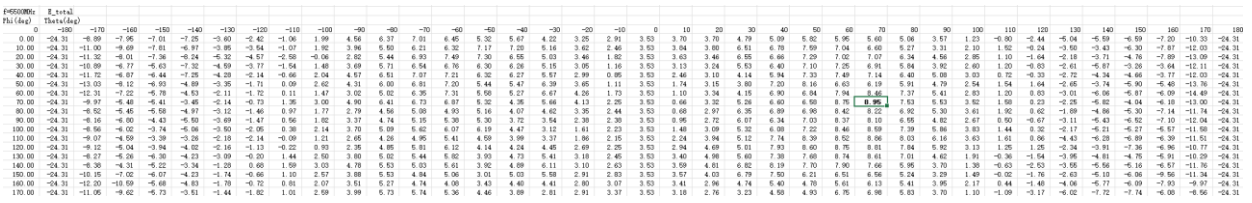
Ant.1~4 @5.2GHz



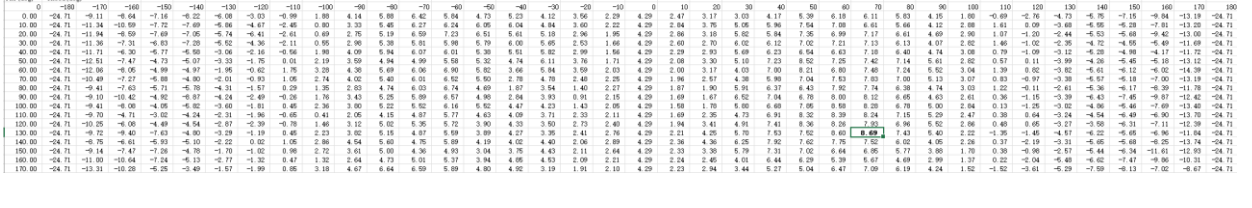
Ant.1~4 @5.3GHz



Ant.1~4 @5.5GHz



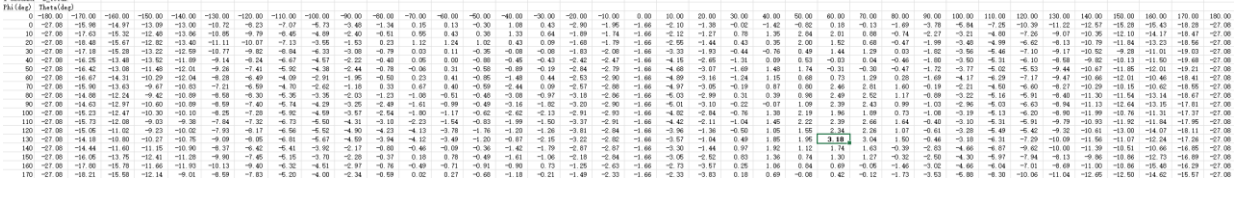
Ant.1~4 @5.8GHz



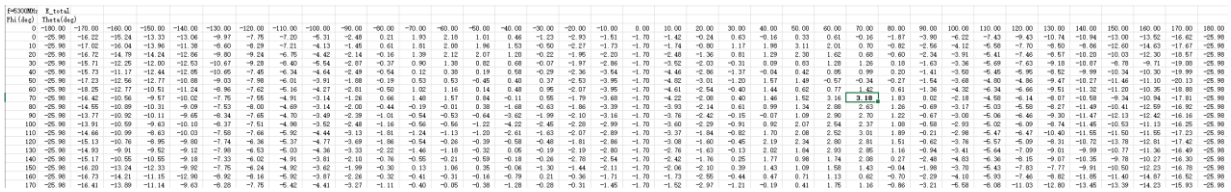
Uncorrelated Directional Gain for 5GHz (Ant. Position：5G Ant.1~4)

Frequency (MHz)	5200	5300	5500	5800
Directional Gain	3.18	3.18	3.16	3.08

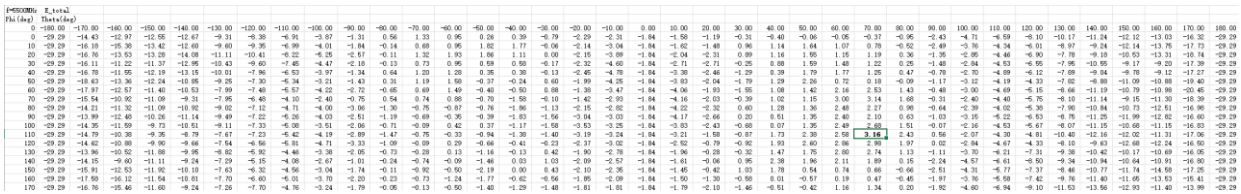
Ant.1~4 @5.2GHz



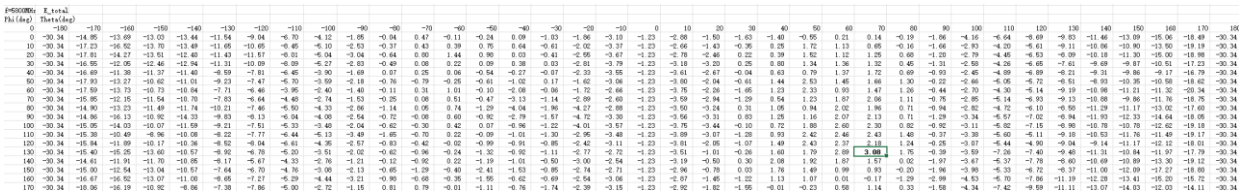
Ant.1~4 @5.3GHz



Ant.1~4 @5.5GHz



Ant.1~4 @5.8GHz

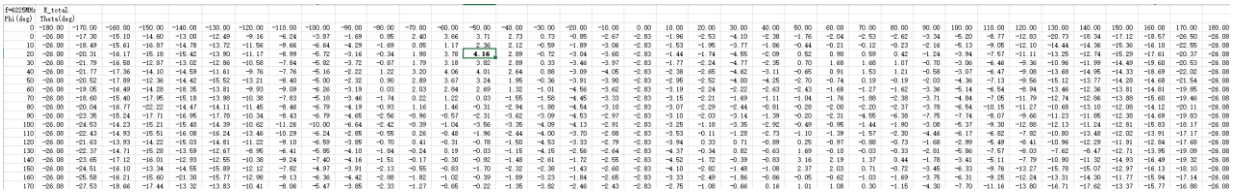


Correlated / Uncorrelated Directional Gain for 6GHz (Ant. Position：6G Ant.5~6)

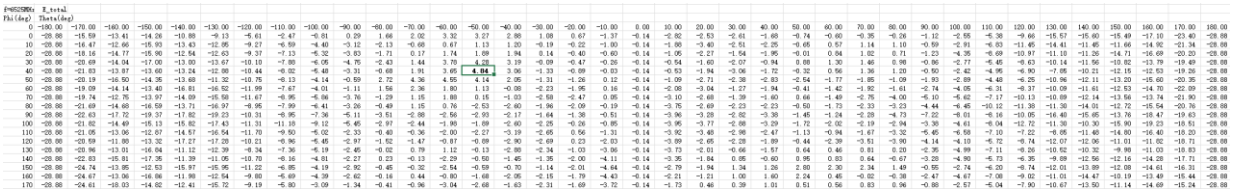
Frequency (MHz)	6225	6525	6725	7025
Directional Gain	4.16	4.84	4.09	2.91

Note: Two 6GHz outputs drive a cross-polarized pair of linearly polarized antennas. Therefore, the results are the same for correlated and uncorrelated gains.

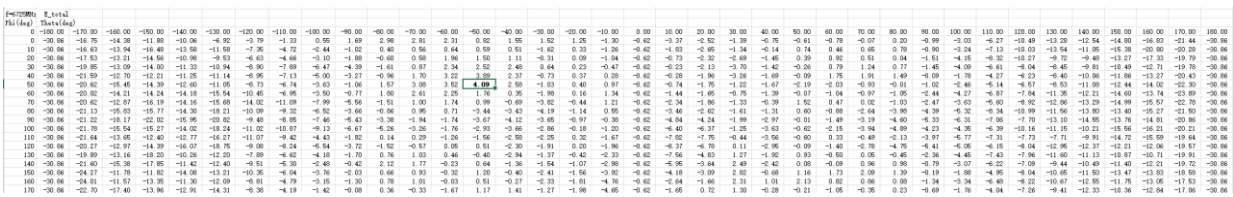
Ant.5~6 @6.225GHz



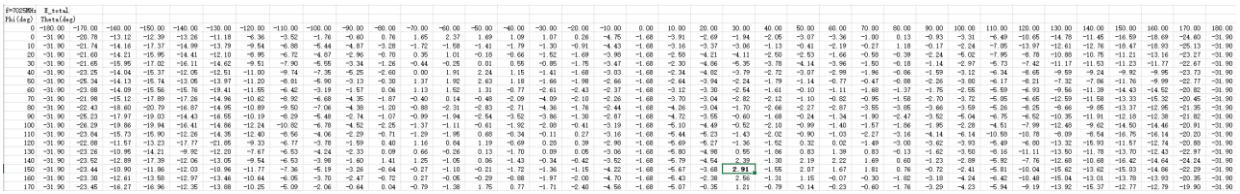
Ant.5~6 @6.525GHz



Ant.5~6 @6.725GHz

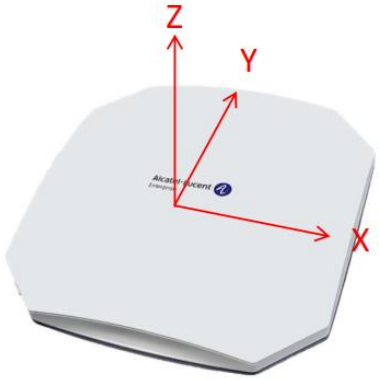


Ant.5~6 @7.025GHz



9. Radiation Pattern

Ant. Position：2.4G Ant.1



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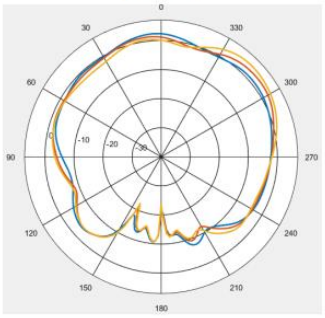

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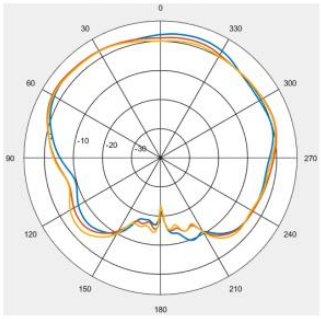

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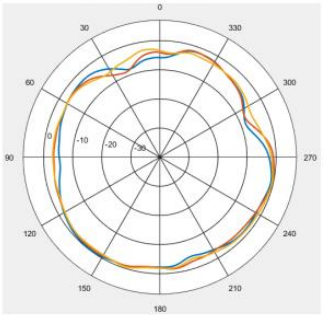
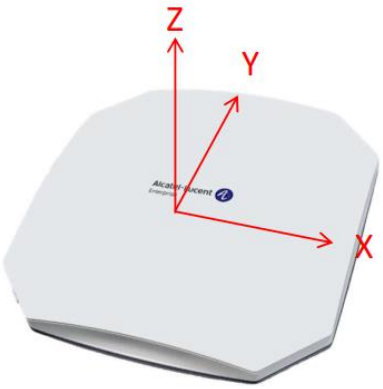
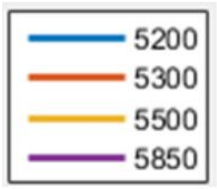


Ant. Position：5G Ant.1





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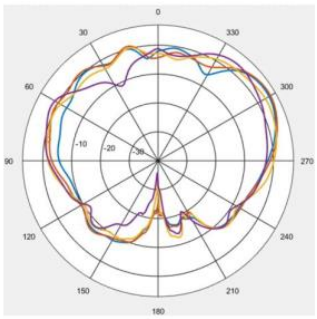

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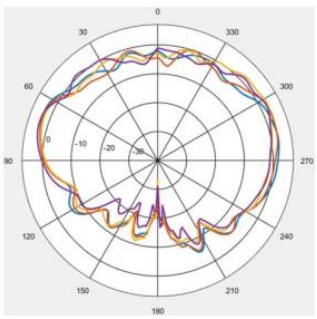

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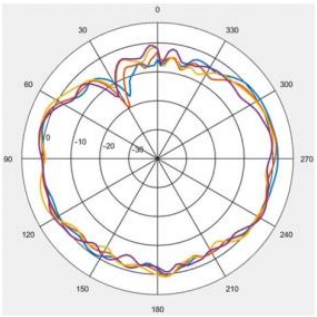
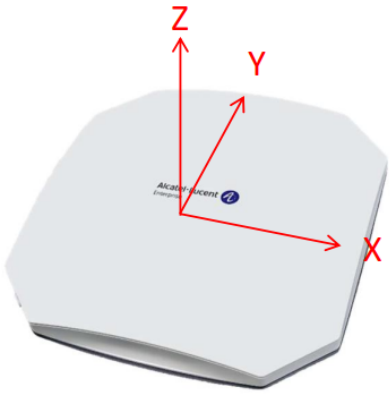
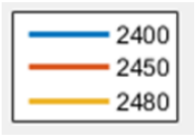


Ant. Position：2.4G Ant.2





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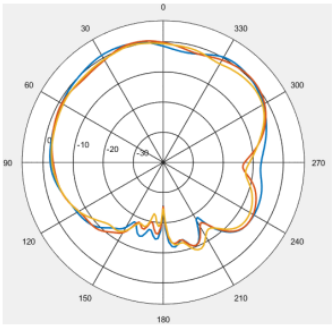

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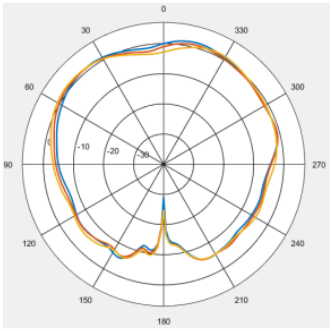

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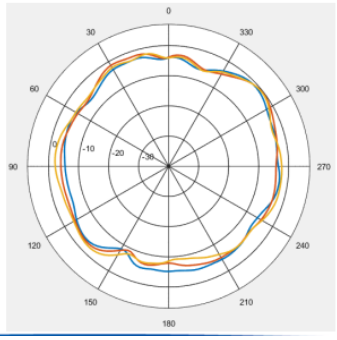
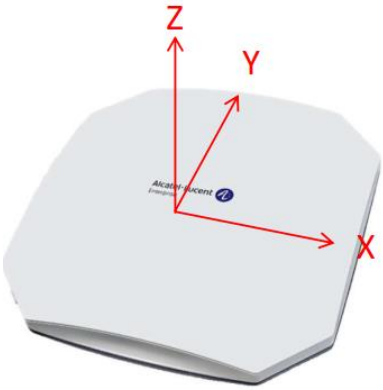
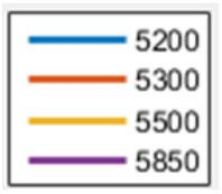


Ant. Position：5G Ant.2





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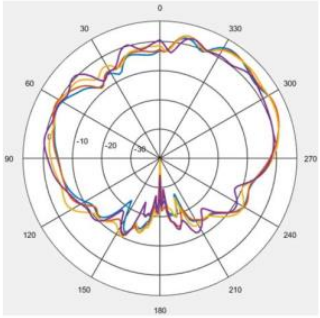

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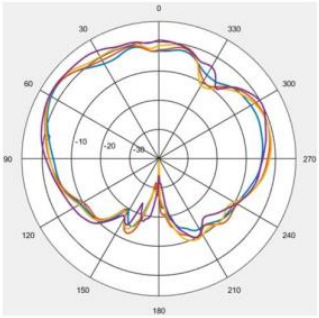

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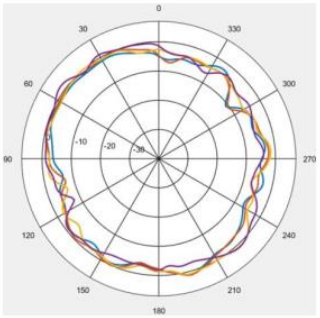
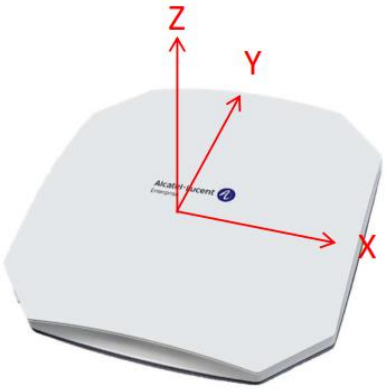
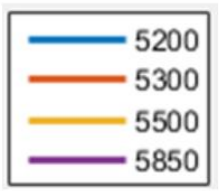


Ant. Position：5G Ant.3





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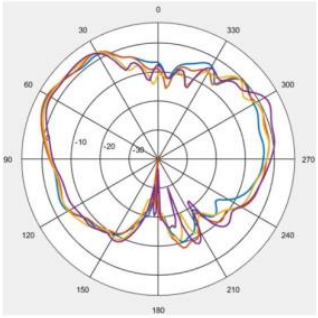

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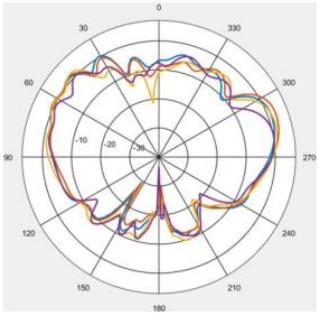

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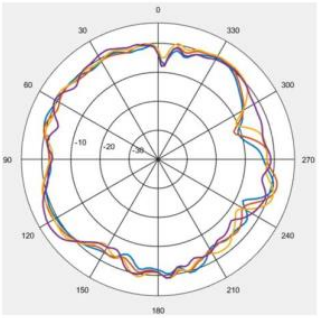
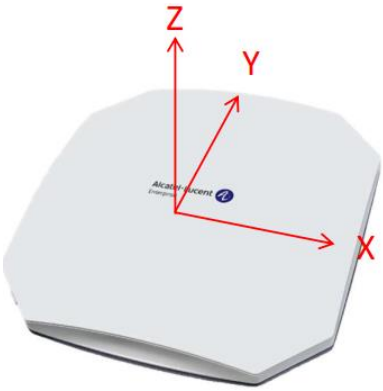
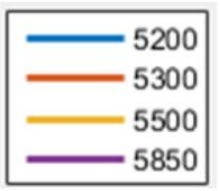


Ant. Position：5G Ant.4





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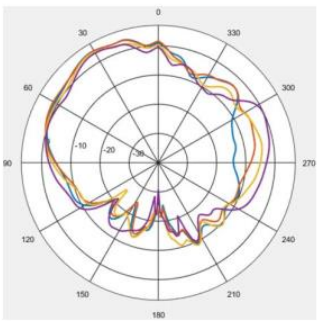

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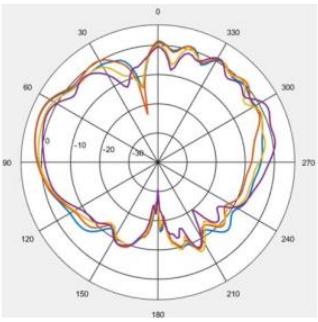

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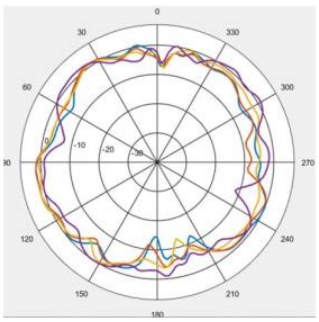
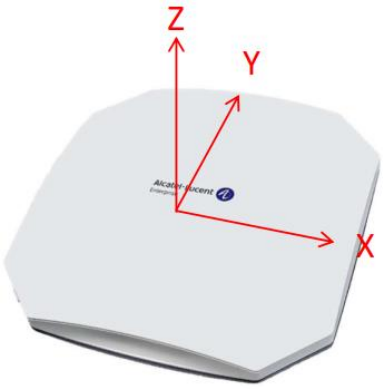
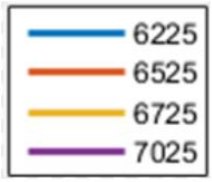
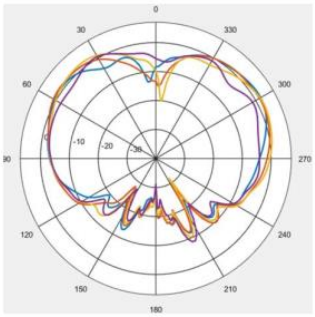


Ant. Position：6G Ant.5

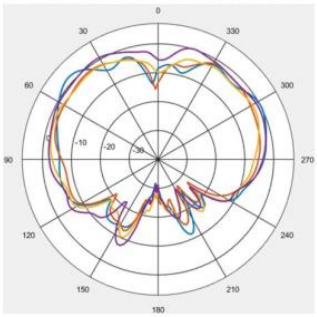




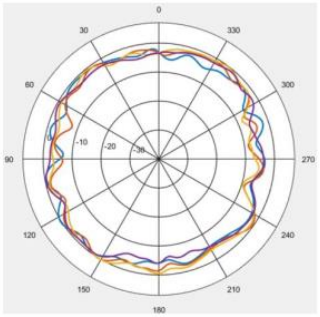
phi=0°



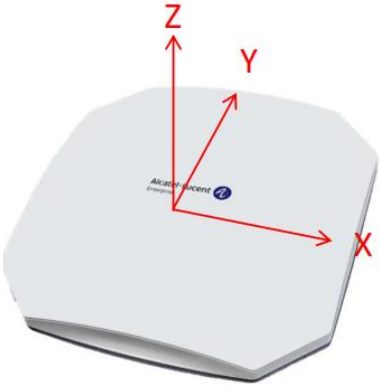
phi=90°

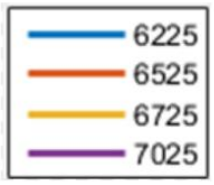


theta=90°

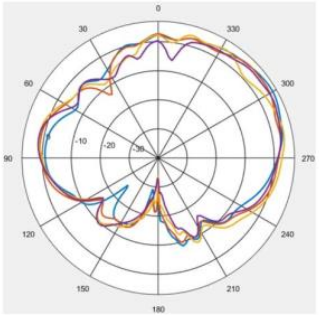


Ant. Position：6G Ant.6

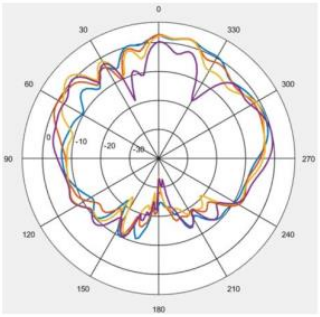




phi=0°



phi=90°



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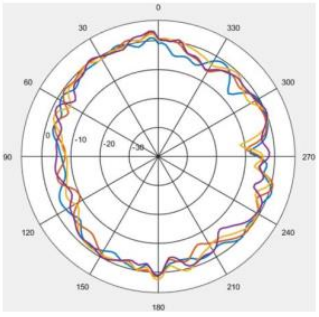
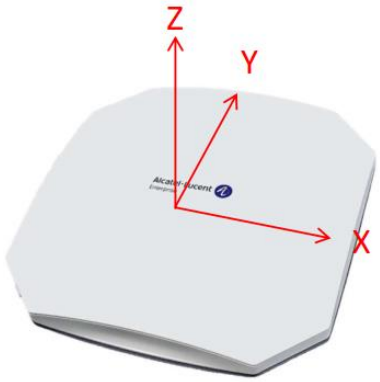
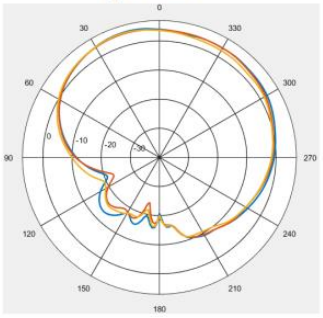


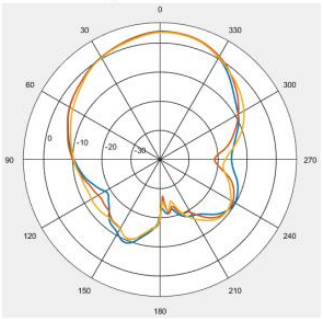
Ant. Position：2.4G Ant.7



phi=0°



phi=90°



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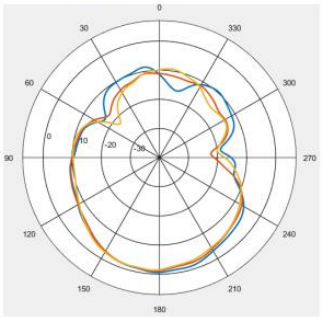
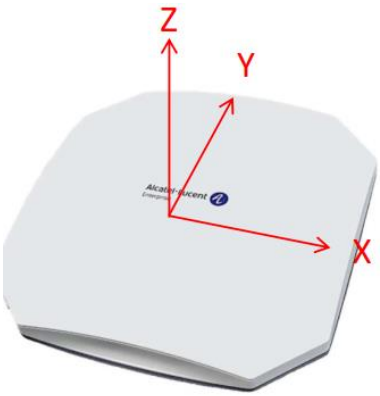
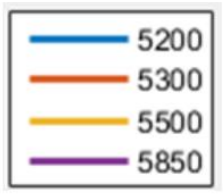
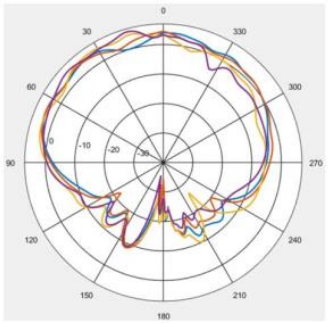


Ant. Position：5G Ant.7

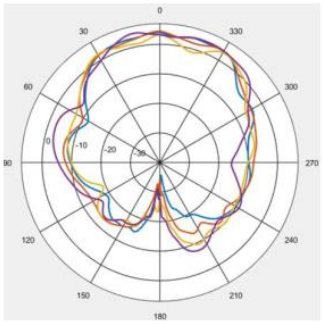




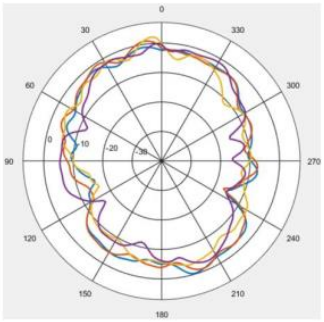
phi=0°



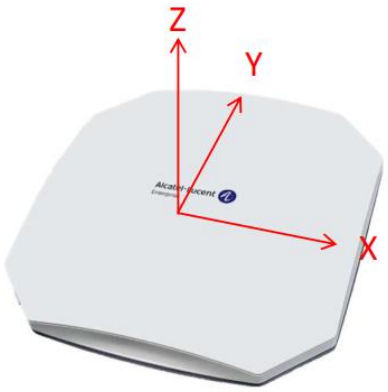
phi=90°

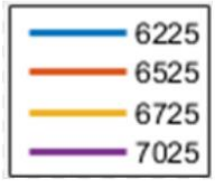


theta=90°



Ant. Position：6G Ant.7





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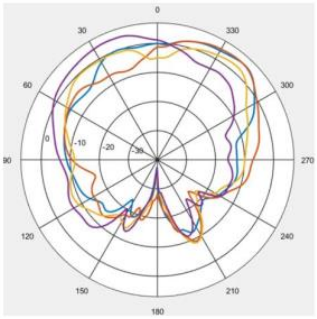
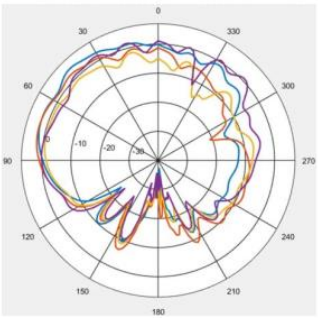
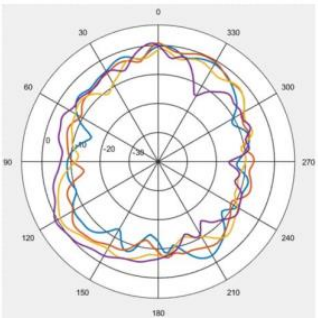


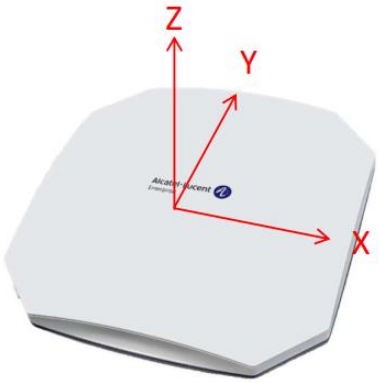
phi=90°



theta=90°



Ant. Position：BLE Ant.8



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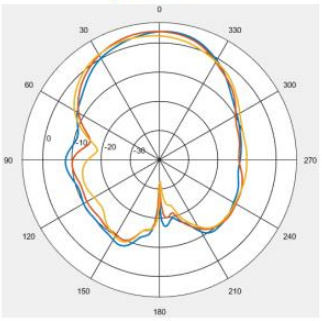
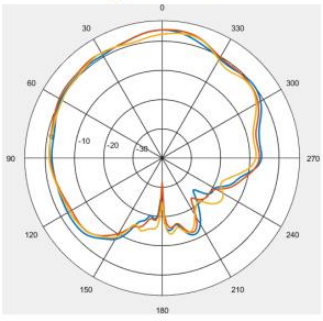


phi=90°



theta=90°