

# Antenna Composite Gain Test Report

## 1. Test Information

Equipment	EMT
Brand Name	Nokia
Model Name	B24
Applicant	Nokia
Manufacturer	Nokia

## 2. Testing Location

Testing Location	
<b>AOT</b>	ADD: 289 Jinghua Road,Shipai, BachengTown, Kunshan City, Jiangsu Province

Test Condition	Test Engineer	Test Environment ( °C / %)	Test Date
Radiated	Changgan Lai	20-24 / 45-60	10.30.2023~10.30.2023

## 3. Test Frequency

Band (MHz)	Test Frequency (MHz)
2400-2500	2400/2450/2500
5500-5850	5500/5675/5825
5150-5400	5150/5250/5350

## 4. Antenna Information

Ant. Position	Brand Name	Model Name	Ant. Type	Connector
Antenna A (2.4G/5G-High)	Nokia		Dipole	I-PEX
Antenna B (2.4G/5G-High)	Nokia		Dipole	I-PEX
Antenna C (2.4G/5G-High)	Nokia		Dipole	I-PEX
Antenna D (2.4G/5G-High)	Nokia		Dipole	I-PEX
Antenna 1 (5G-Low)	Nokia		Dipole	I-PEX
Antenna 2 (5G-Low)	Nokia		Dipole	I-PEX
Antenna 3 (5G-Low)	Nokia		Dipole	I-PEX
Antenna 4 (5G-Low)	Nokia		Dipole	I-PEX

## 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 2 degree steps of phi and 10 degree of theta 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

**Antenna Peak Gain Table (Ant. Position: 2.4G Ant.A~D)**

Band (MHz)	2400-2500		
Frequency (MHz)	2400	2450	2500
Ant.A Max Gain (dBi)	3.14	2.71	3.14
Ant.B Max Gain (dBi)	2.67	2.34	1.82
Ant.C Max Gain (dBi)	3.44	3.27	3.71
Ant.D Max Gain (dBi)	1.82	2.17	2.25
Max Gain (dBi)	3.44	3.27	3.71

**Antenna Peak Gain Table (Ant. Position: 5G Ant.A~D)**

Band (MHz)	5500-5850		
Frequency (MHz)	5500	5675	5825
Ant.A Max Gain (dBi)	4.11	3.56	3.82
Ant.B Max Gain (dBi)	4.46	2.74	3.80
Ant.C Max Gain (dBi)	4.15	2.92	3.64
Ant.D Max Gain (dBi)	3.82	3.63	4.04
Max Gain (dBi)	4.46	3.63	4.04

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

Band (MHz)	5150-5400		
Frequency (MHz)	5150	5250	5350
Ant.1 Max Gain (dBi)	2.65	2.97	2.96
Ant.2 Max Gain (dBi)	2.96	4.09	5.09
Ant.3 Max Gain (dBi)	3.16	4.22	4.67
Ant.4 Max Gain (dBi)	3.20	3.85	3.75
Max Gain (dBi)	3.20	4.22	5.09

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 2 degree steps of phi and 10 degree of theta 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 D01F(2)(f)(ii) for CDD and KDB 662911 D01, F(2)(e)(ii) for TxBF.

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

Note :

KDB 662911 D01, F(2)(d)(i)

$$\text{Correlated Gain} = 10 \log \left[ \left( 10^{\frac{G_1}{20}} + 10^{\frac{G_2}{20}} + \dots + 10^{\frac{G_n}{20}} \right)^2 / N_{Ant.} \right] \text{ dBi}$$

KDB 662911 D01, F(2)(d)(ii)

$$\text{Uncorrelated Gain} = 10 \log \left[ \left( 10^{\frac{G_1}{10}} + 10^{\frac{G_2}{10}} + \dots + 10^{\frac{G_n}{10}} \right) / N_{Ant.} \right] \text{ dBi}$$

N<sub>Ant.</sub> : Number of antenna

G<sub>n</sub> : Gain of antenna

### Maximum Correlated / Uncorrelated Gain Calculation

#### (Ant. Position: 2.4G Ant.A~D)

Frequency (MHz)	2400	2450	2500
Ant.A Gain(dBi)	1.42	-4.95	-4.23
Ant.B Gain(dBi)	2.49	2.19	0.26
Ant.C Gain(dBi)	-4.95	-2.08	-0.84
Ant.D Gain(dBi)	-2.35	2.11	1.30
Phi (° )	20	70	64
Theta (° )	80	-80	-80
Beamforming	5.66	5.83	5.38
Non Beamforming (CDD MODE)	5.66	5.83	5.38

**(Ant. Position: 5G Ant.A~D)**

Frequency (MHz)	5500	5675	5825
Ant.A Gain(dBi)	-1.98	-1.95	0.93
Ant.B Gain(dBi)	2.13	2.68	-12.88
Ant.C Gain(dBi)	-0.42	-1.85	1.57
Ant.D Gain(dBi)	-0.92	0	1.75
Phi (° )	66	66	162
Theta (° )	-90	-90	90
Beamforming	5.86	5.95	5.49
Non Beamforming (CDD MODE)	5.86	5.95	5.49

**(Ant. Position: 5G Ant.1~4)**

Frequency (MHz)	5150	5250	5350
Ant.1 Gain(dBi)	-0.33	1.52	-5.52
Ant.2 Gain(dBi)	1.76	-2.99	-4.75
Ant.3 Gain(dBi)	-1.57	-0.36	4.34
Ant.4 Gain(dBi)	-1.63	0.24	1.25
Phi (° )	82	0	22
Theta (° )	100	-100	50
Beamforming	5.69	5.77	5.83
Non Beamforming (CDD MODE)	5.69	5.77	5.83

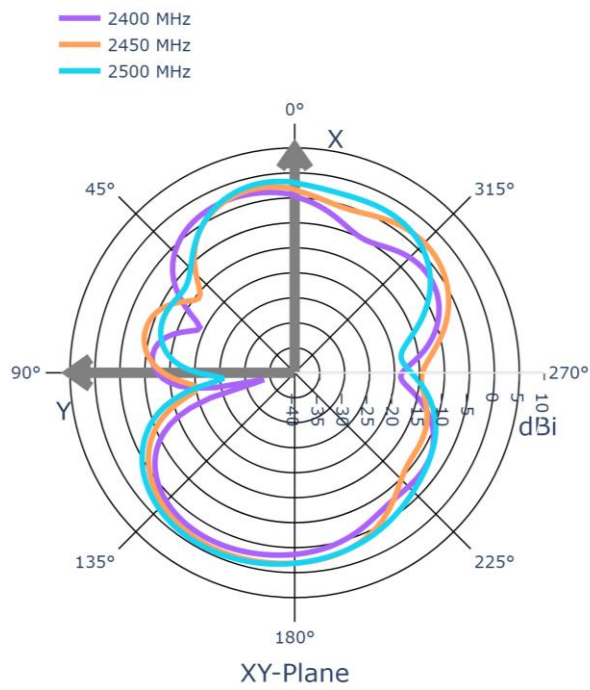
## Calculation example

$$10 \times \log\left\{\left[10^{(-0.33 \text{ dBi} / 20)} + 10^{(1.76 \text{ dBi} / 20)} + 10^{(-1.57 \text{ dBi} / 20)} + 10^{(-1.63 \text{ dBi} / 20)}\right]^2 / 4\right\} = 5.69 \text{ dBi}$$

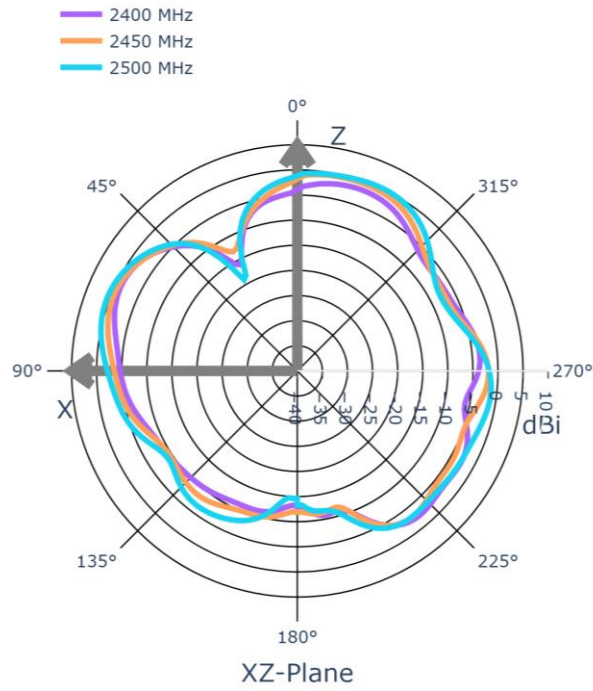
## 9. Radiation Pattern

Ant. Position: 2.4G Ant.A~D

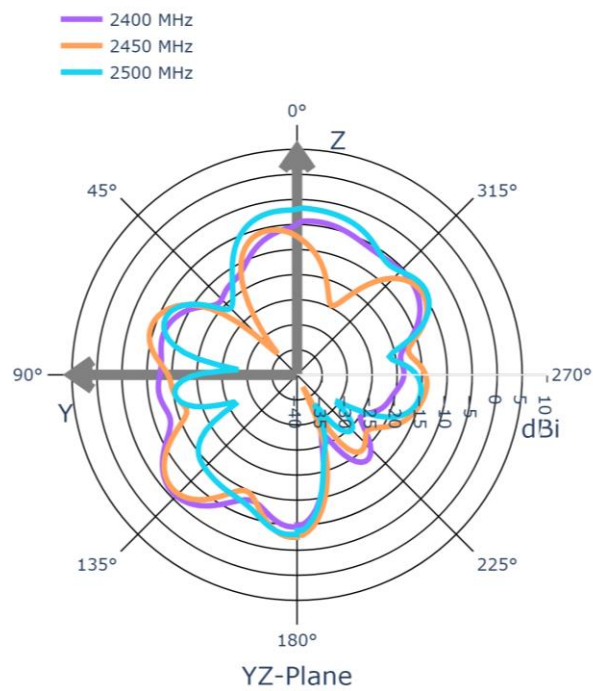
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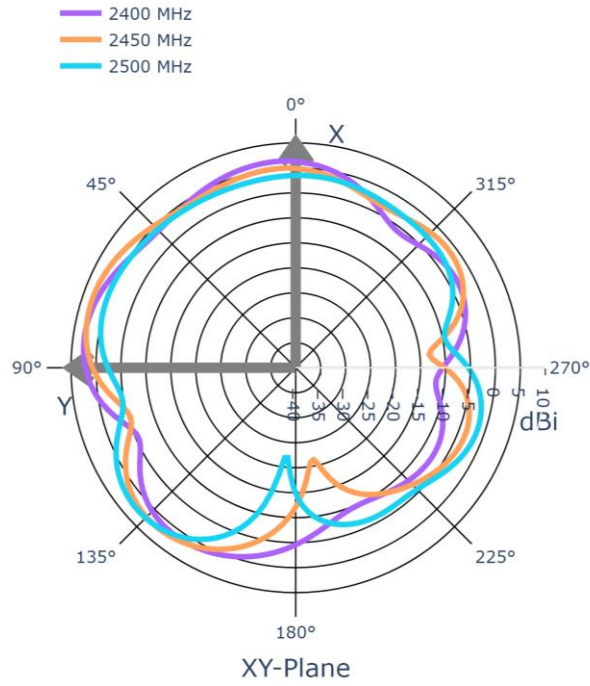
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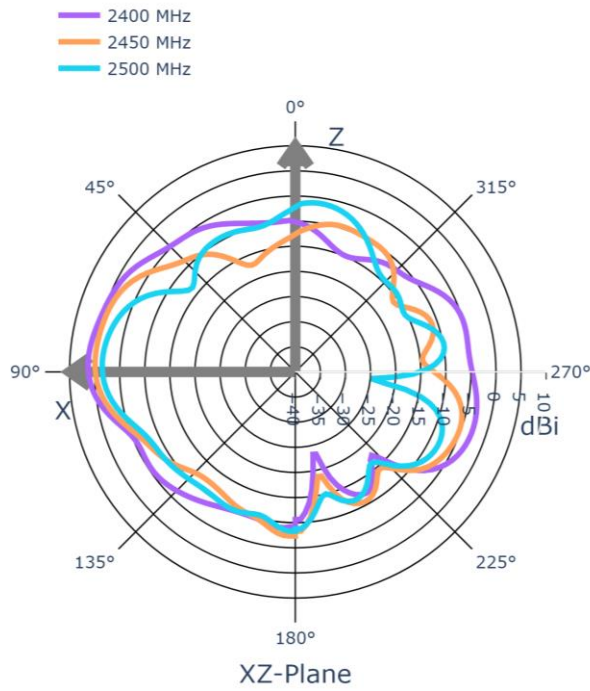
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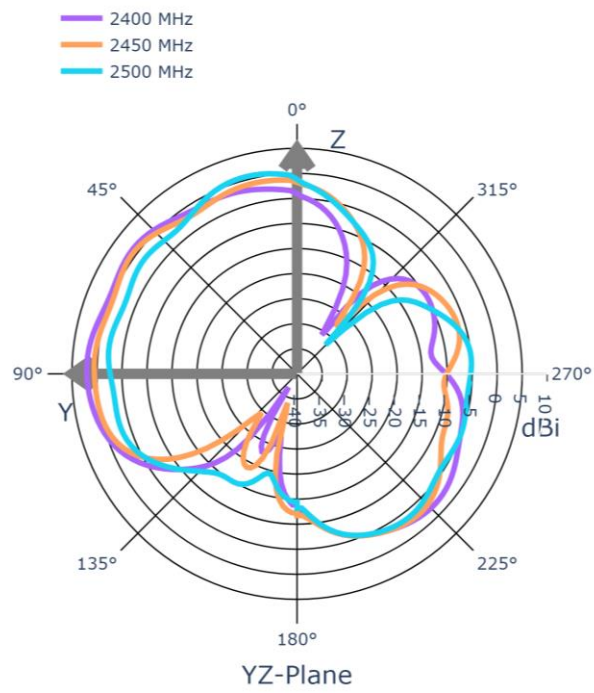
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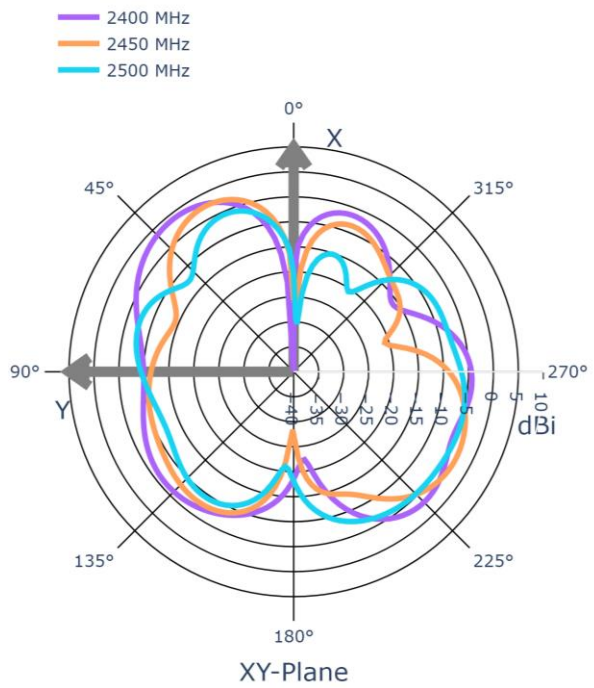
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**YZ\_Pol.\_Theta\_Ant.A@2.4G**

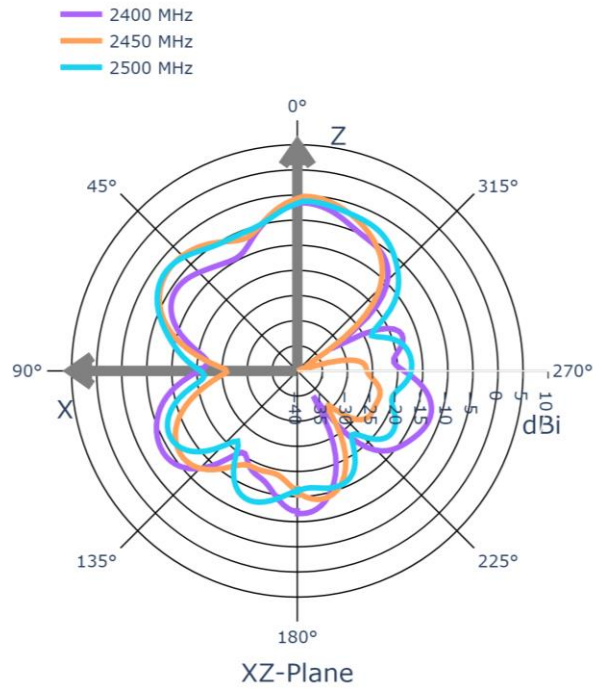


**XY\_Pol.\_Phi\_Ant.B@2.4G**

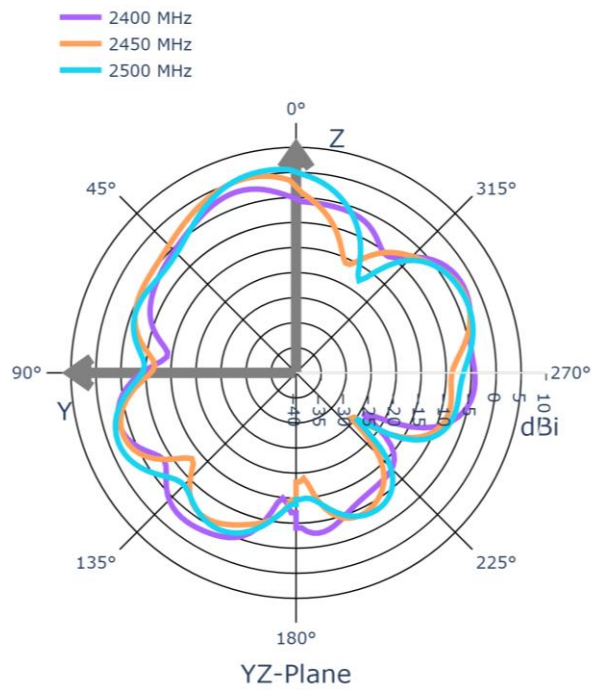


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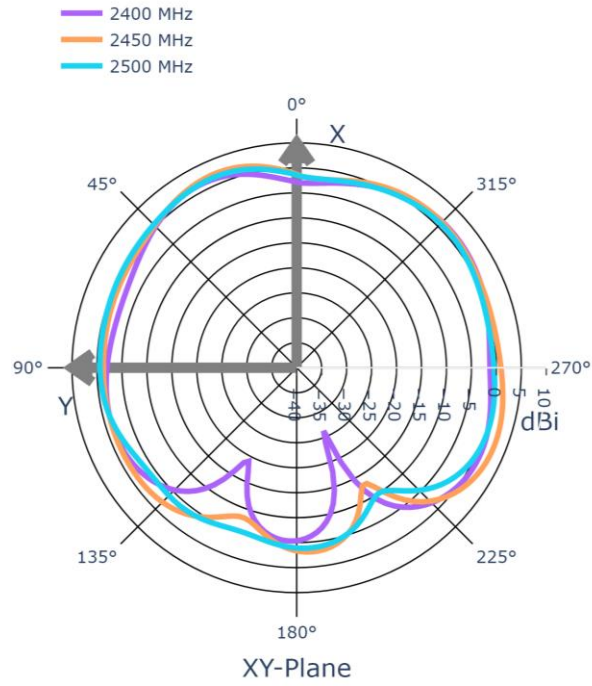




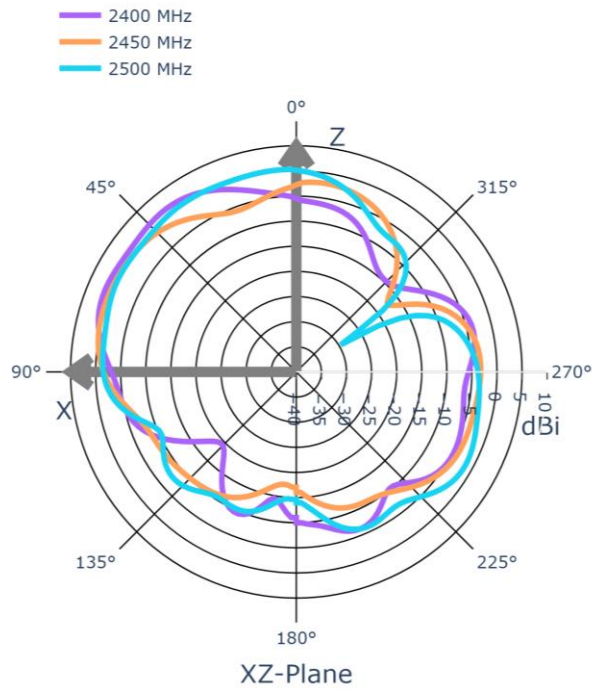
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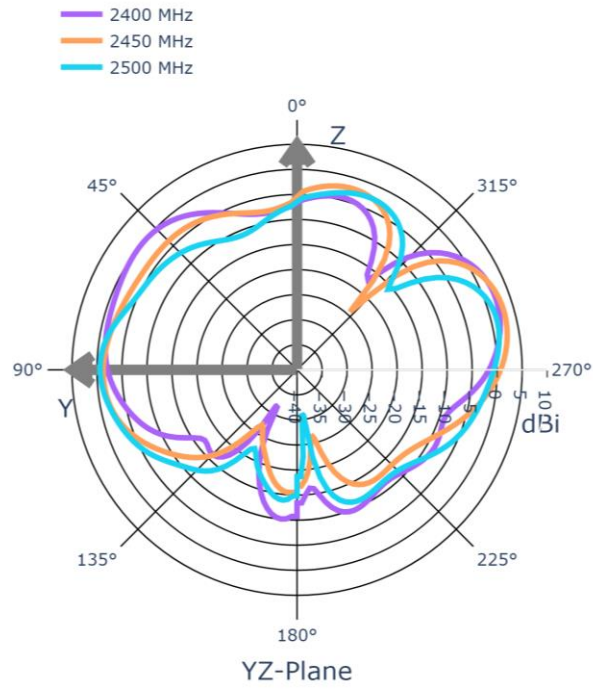
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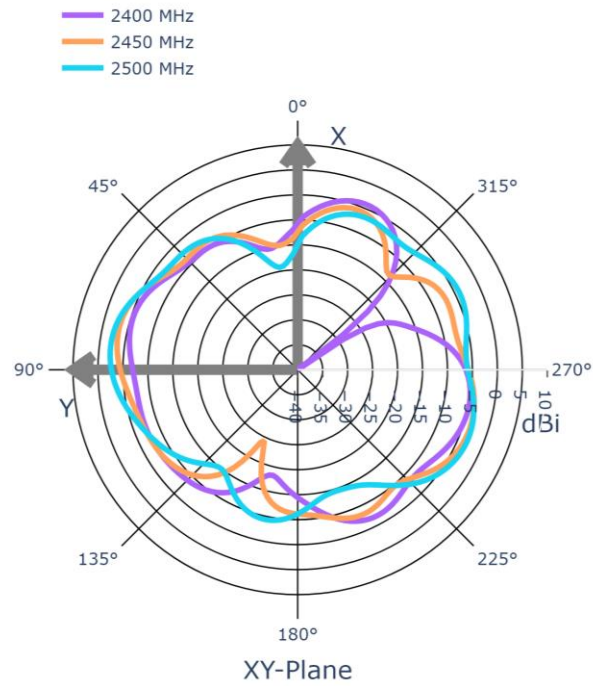
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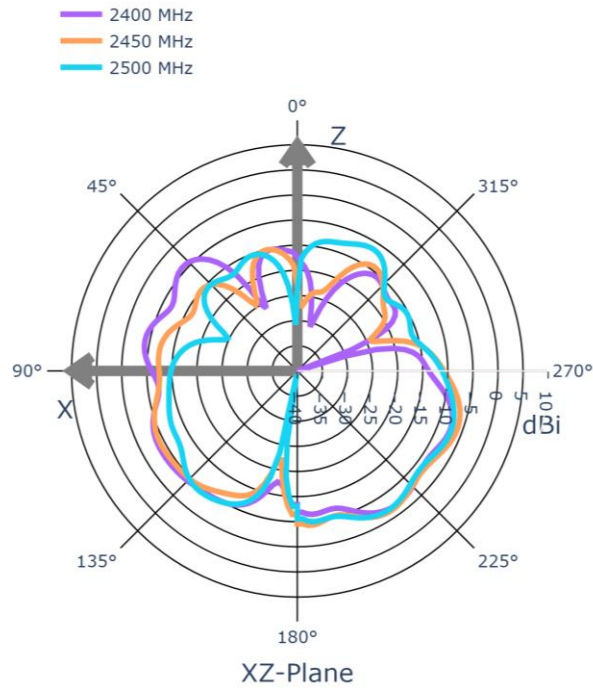
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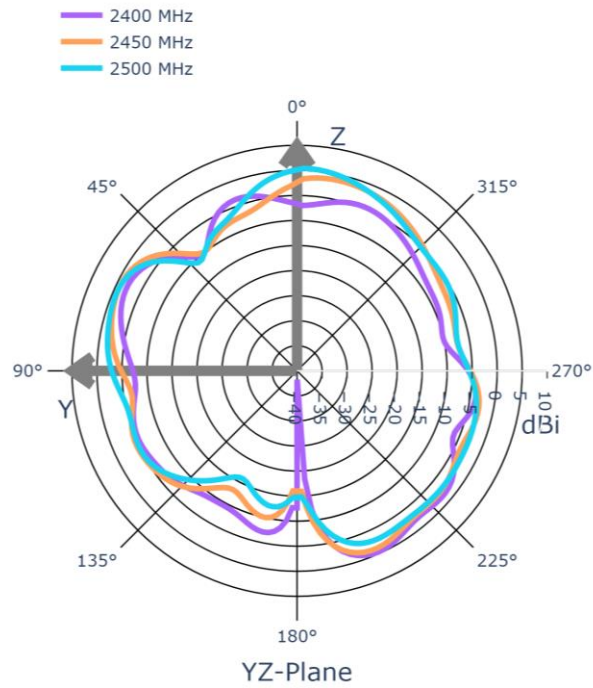
**XY\_Pol.\_Phi\_Ant.C@2.4G**



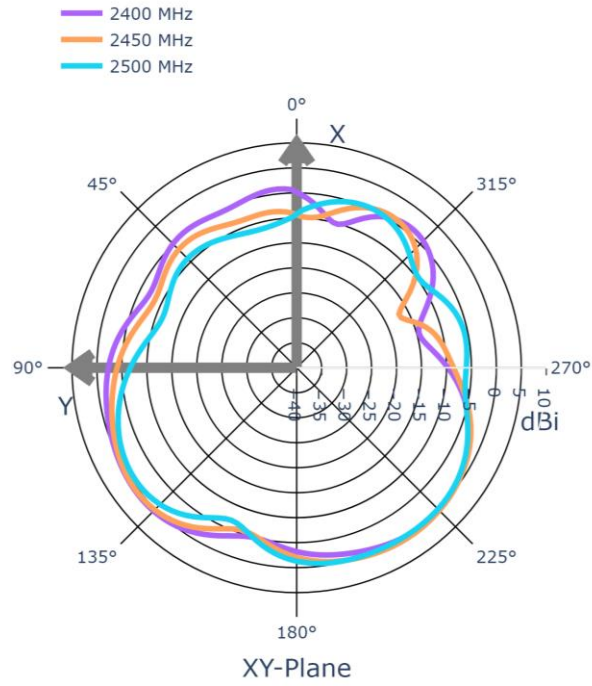
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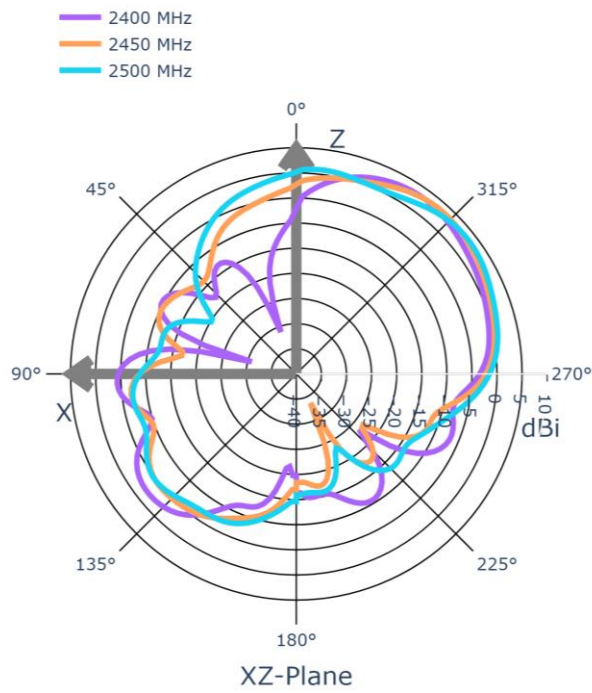
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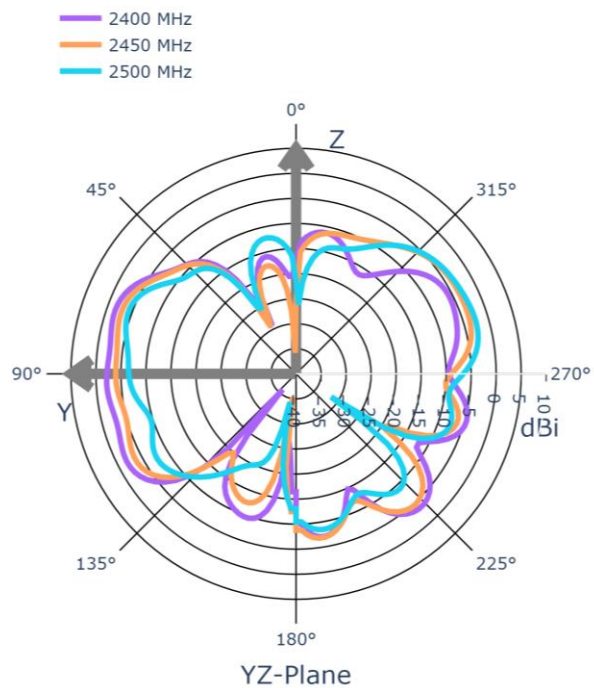
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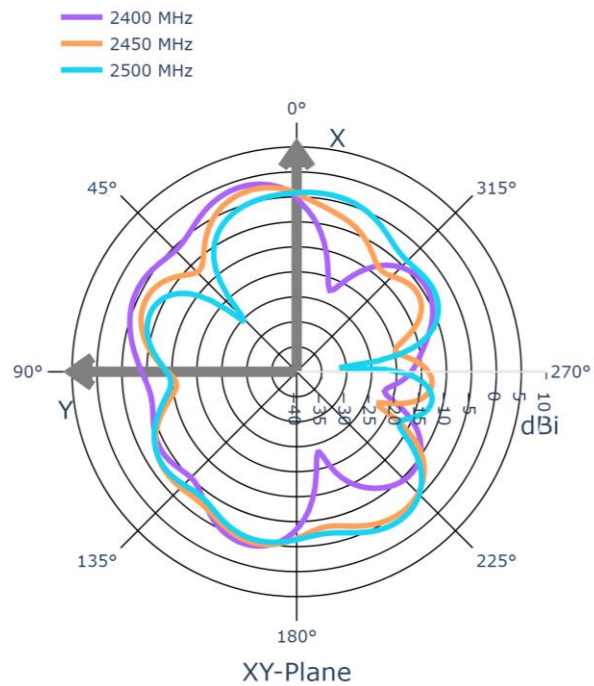
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**YZ\_Pol.\_Theta\_Ant.C@2.4G**

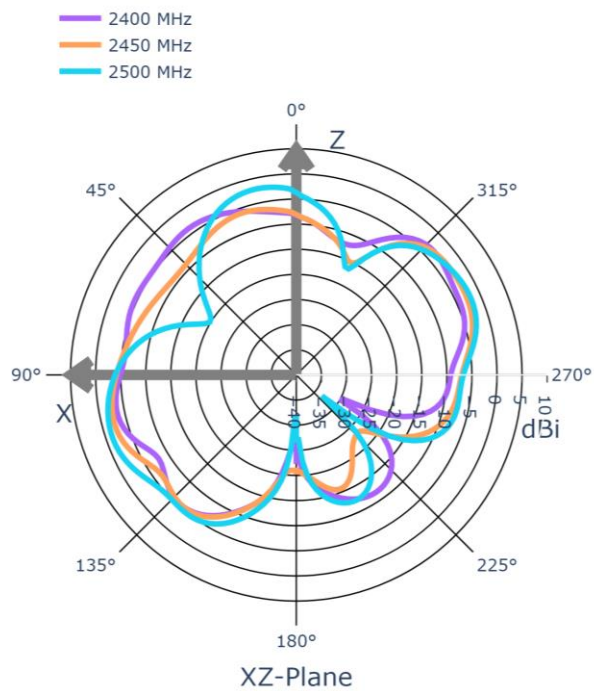


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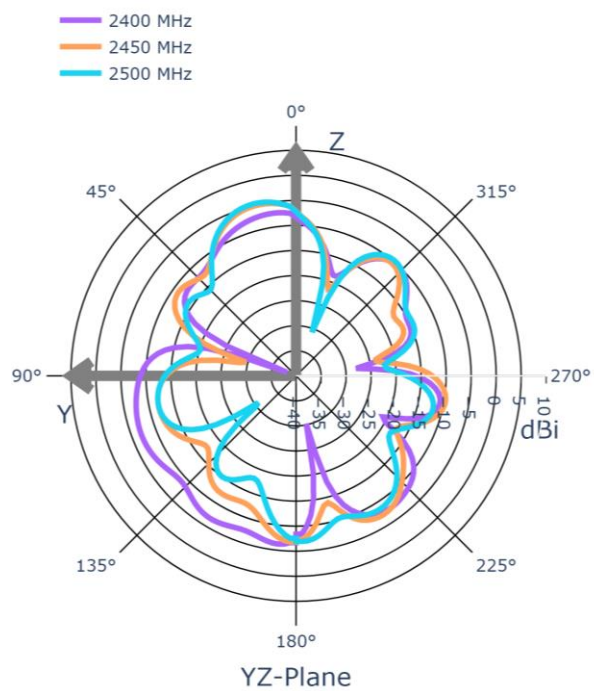


**XZ\_Pol.\_Phi\_Ant.D@2.4G**

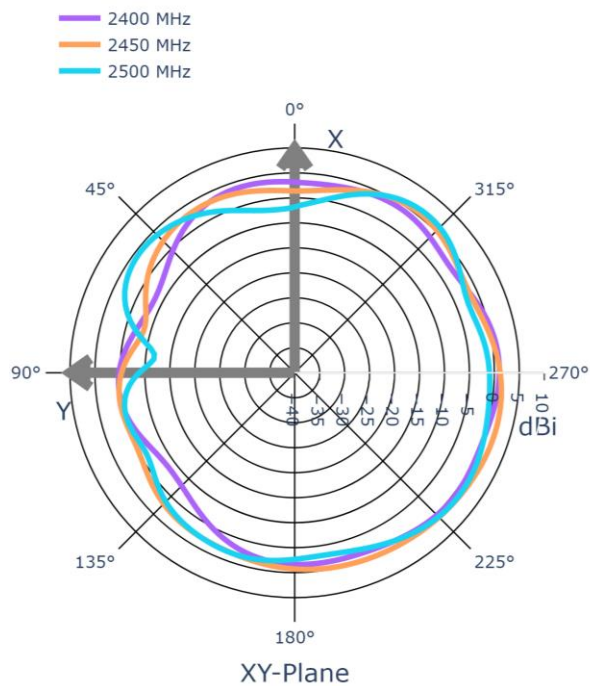




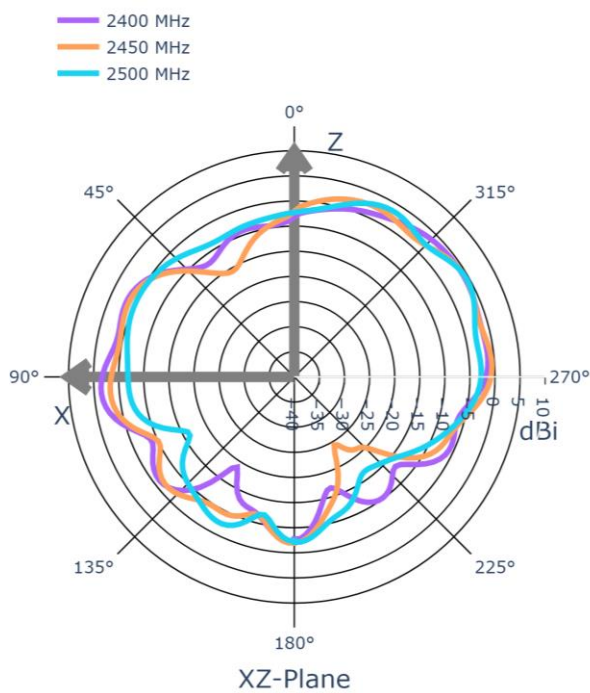
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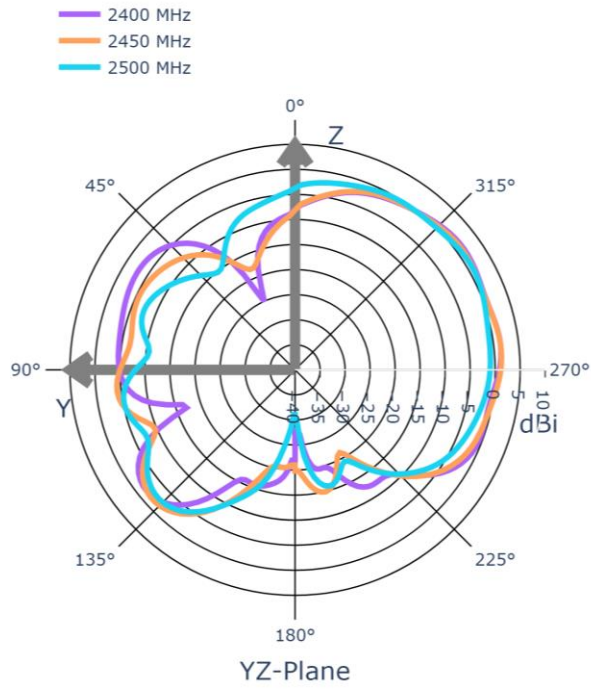


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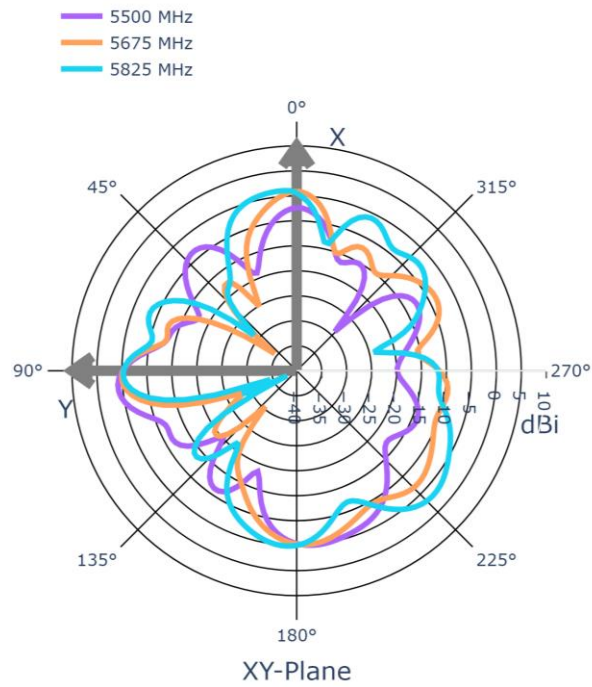
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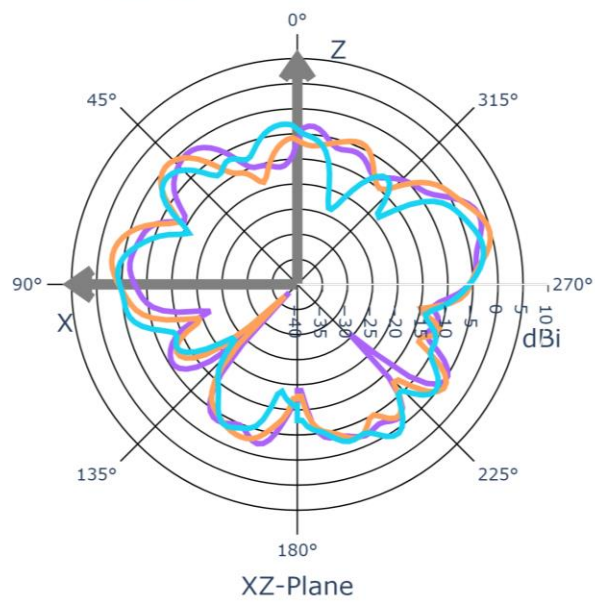
**Ant. Position: 5G-High Ant.A~D**

**XY\_Pol.\_Phi\_Ant.A@5G**



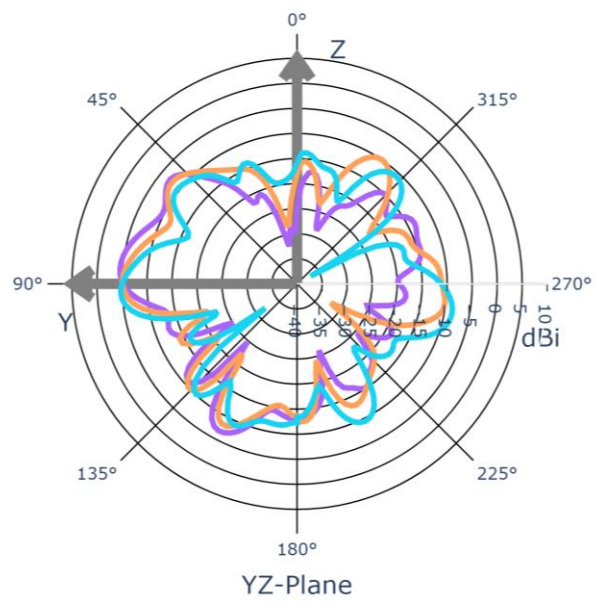
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- 5500 MHz
- 5675 MHz
- 5825 MHz

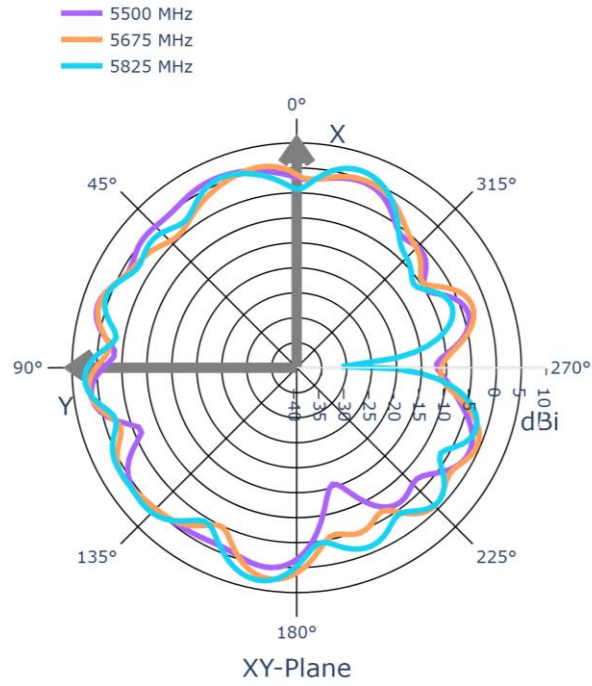


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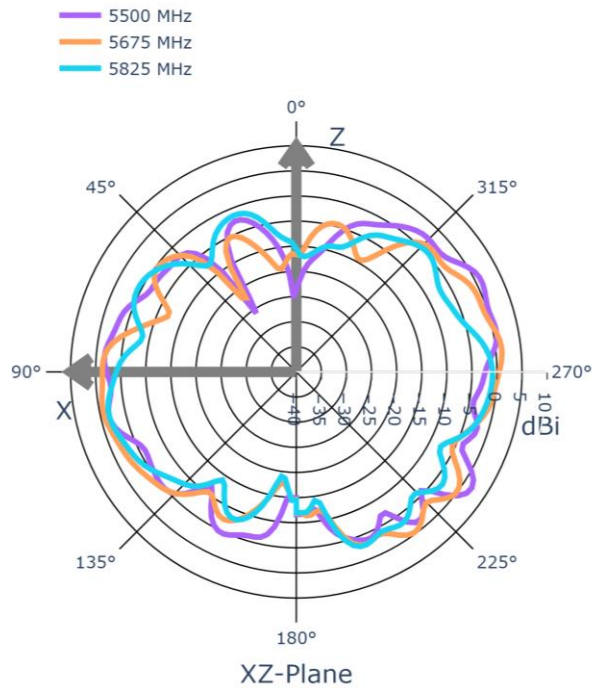
- 5500 MHz
- 5675 MHz
- 5825 MHz



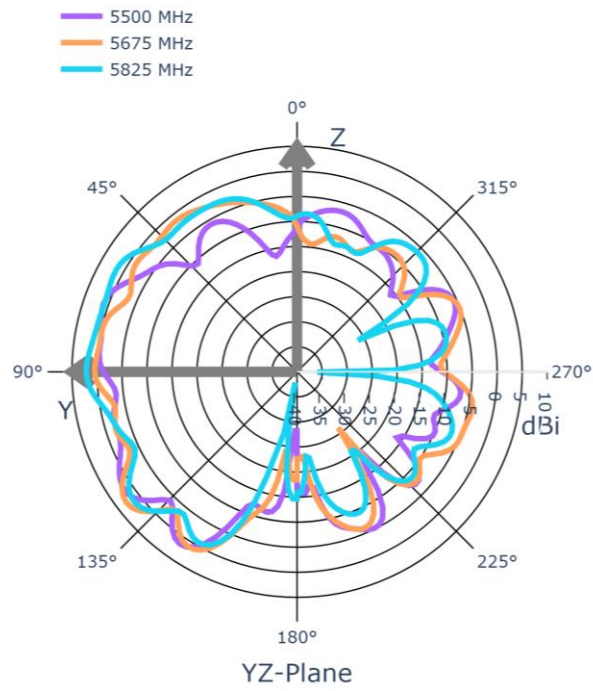
### XY\_Pol.\_Theta\_Ant.A@5G



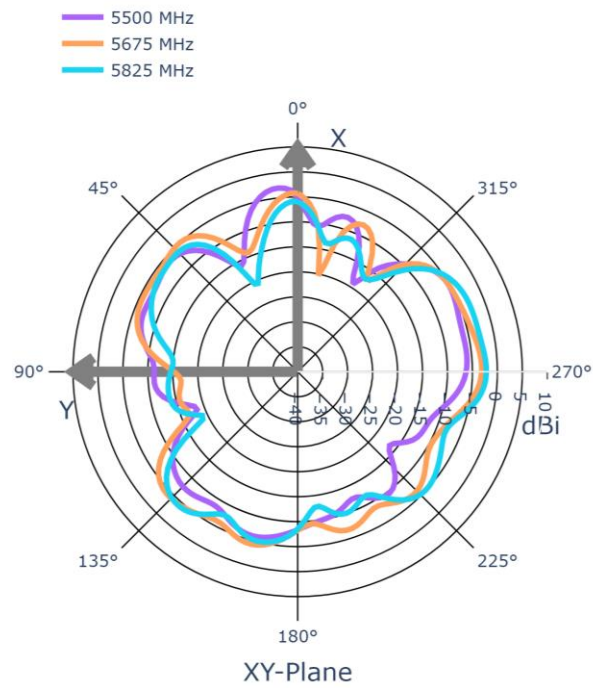
**XZ\_Pol.\_Theta\_Ant.A@5G**



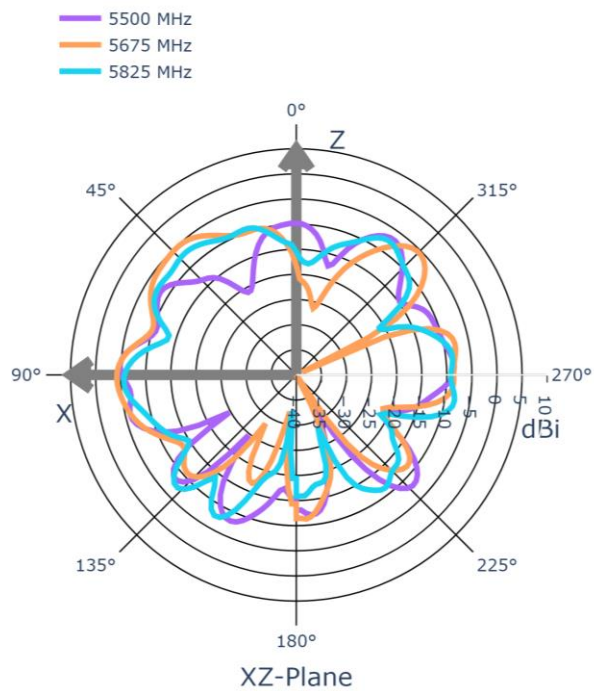
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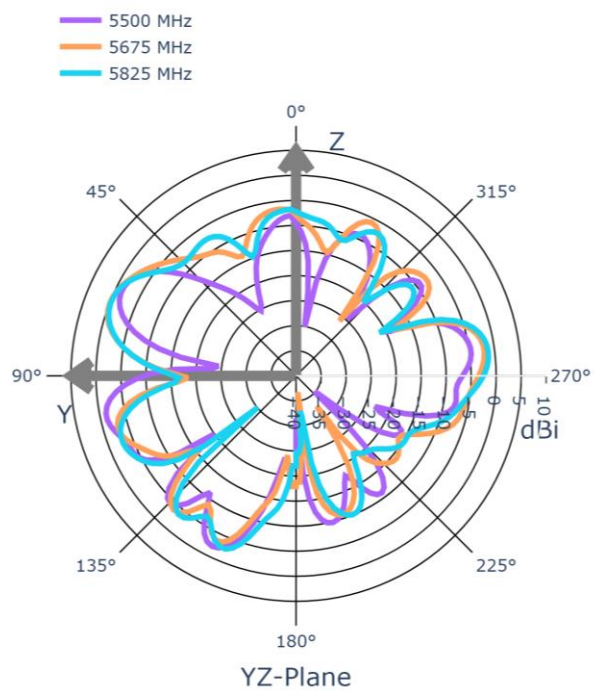
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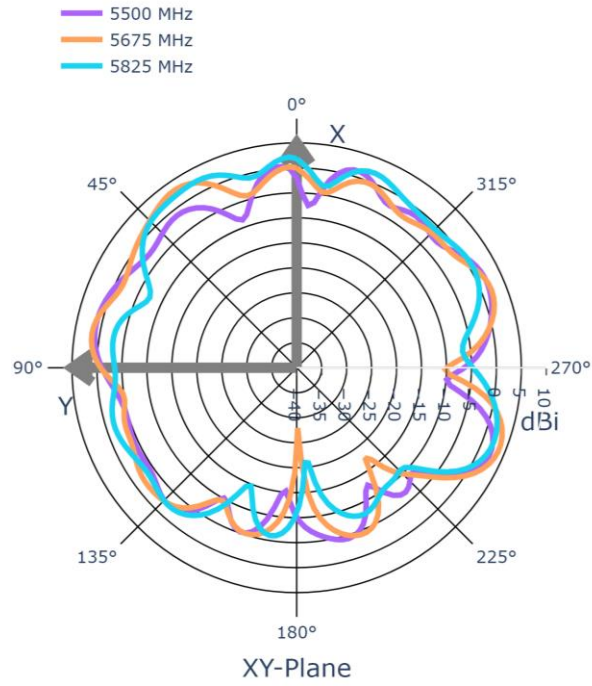
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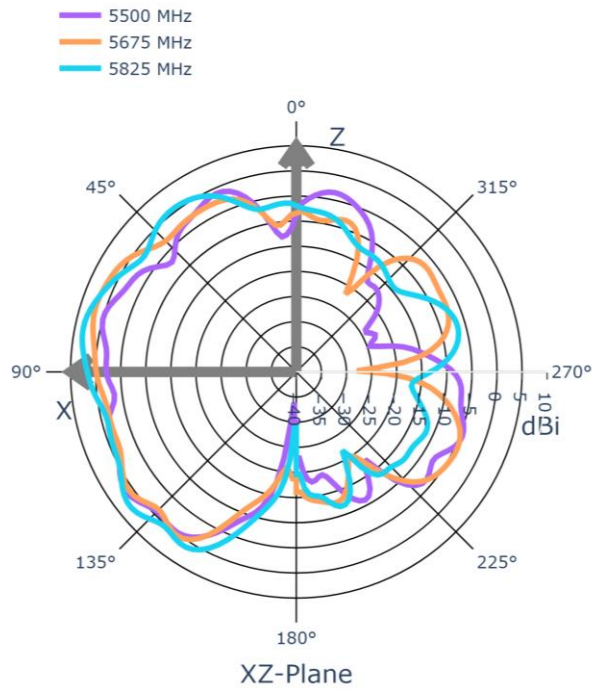
### YZ\_Pol\_Phi\_Ant.B@5G



### XY\_Pol\_Theta\_Ant.B@5G

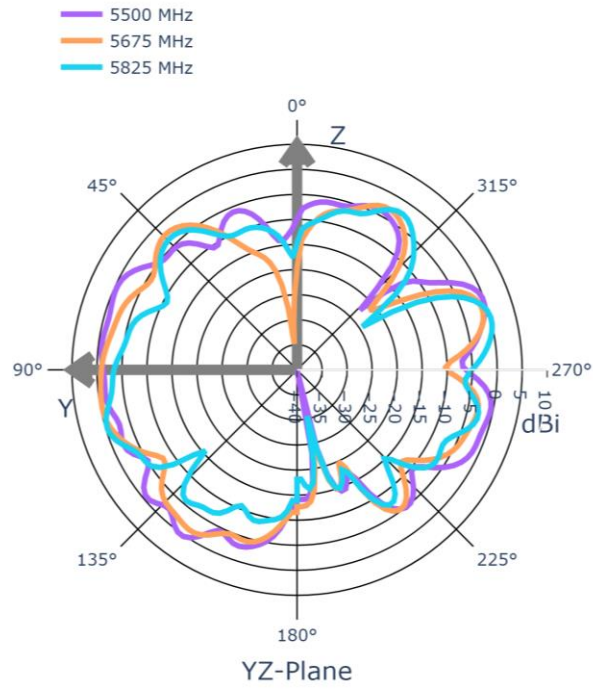


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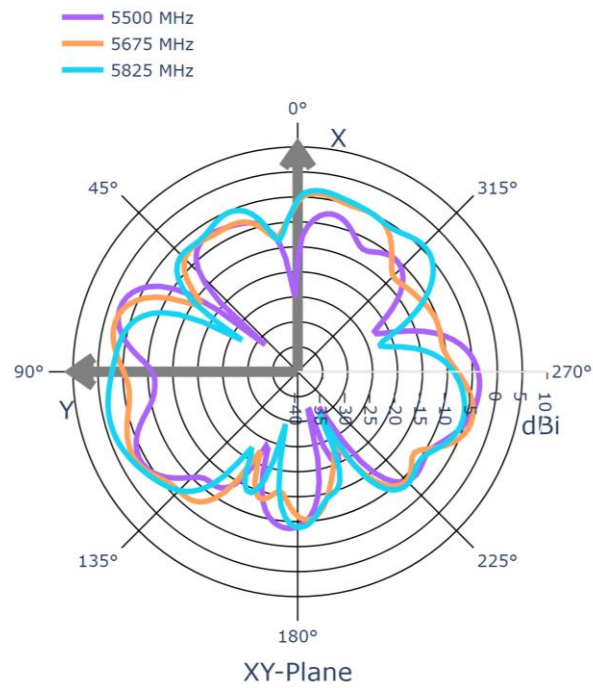


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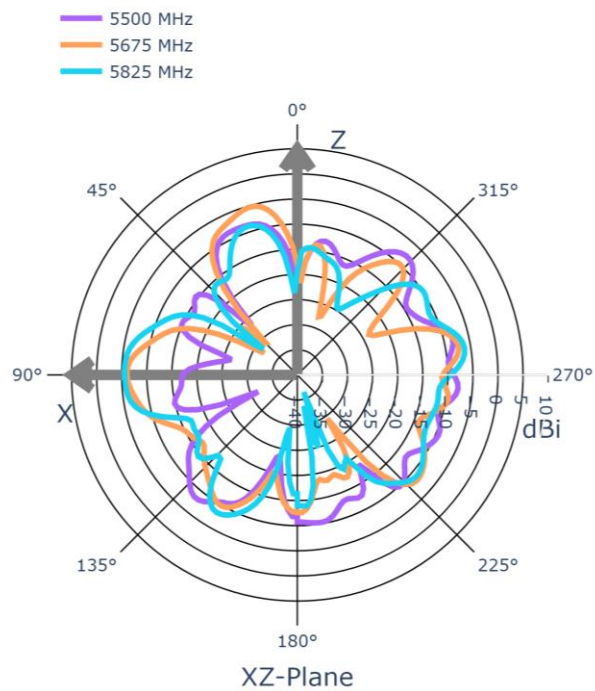




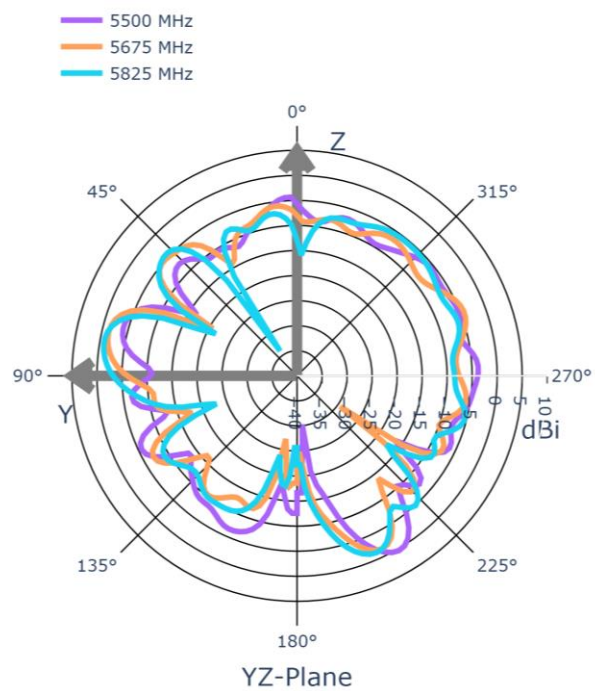
**XY\_Pol.\_Phi\_Ant.C@5G**



**XZ\_Pol.\_Phi\_Ant.C@5G**

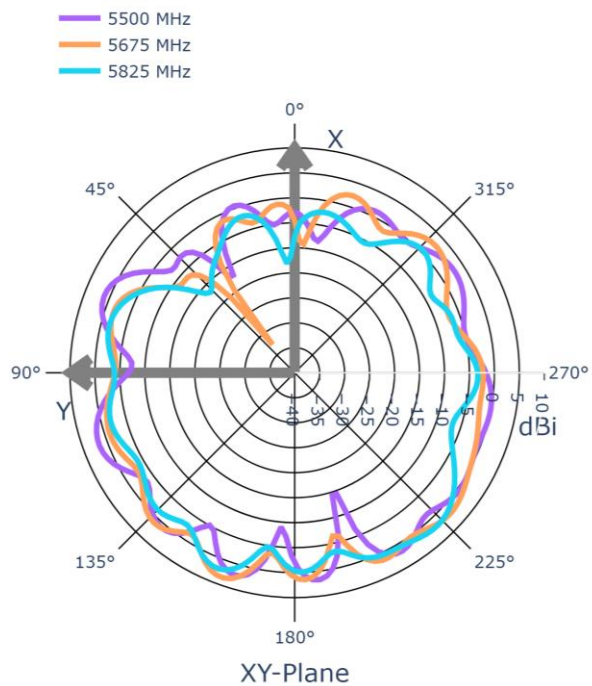


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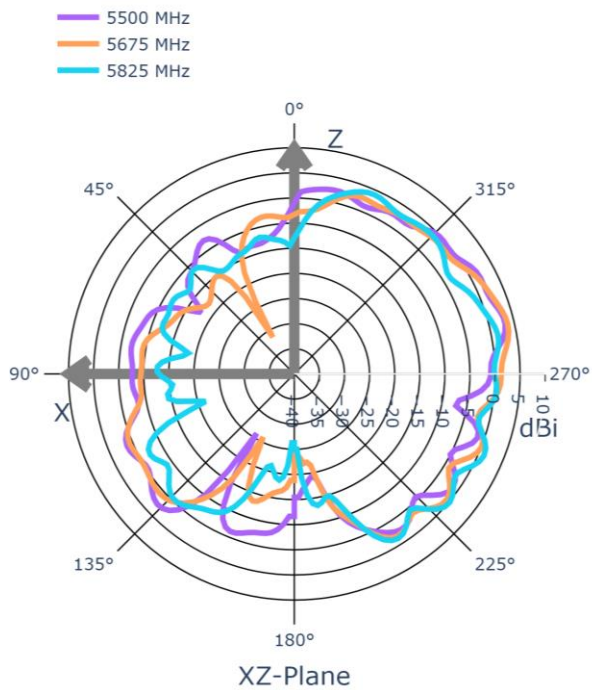


**XY\_Pol.\_Theta\_Ant.C@5G**

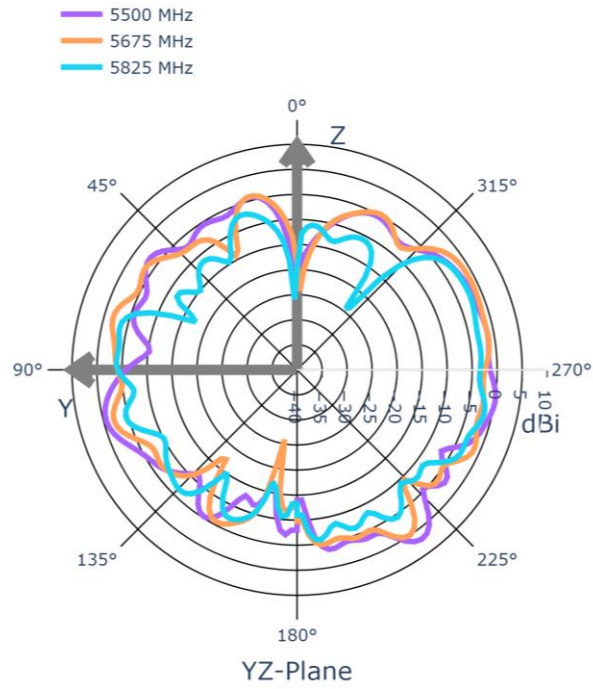




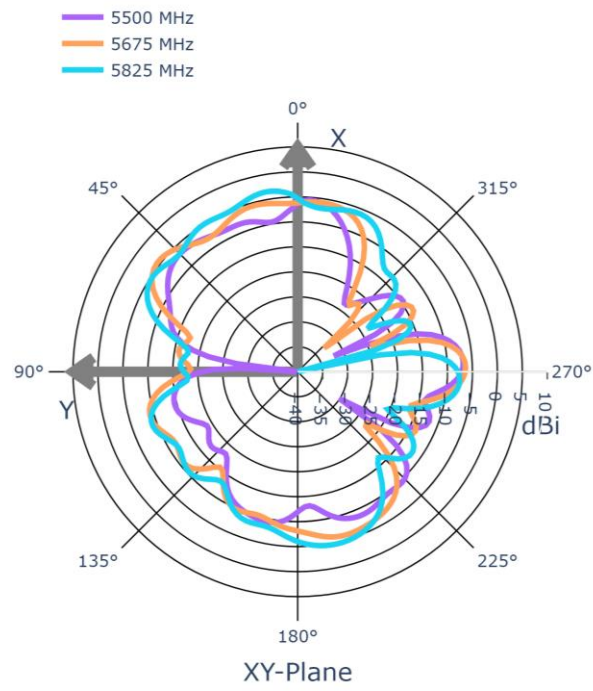
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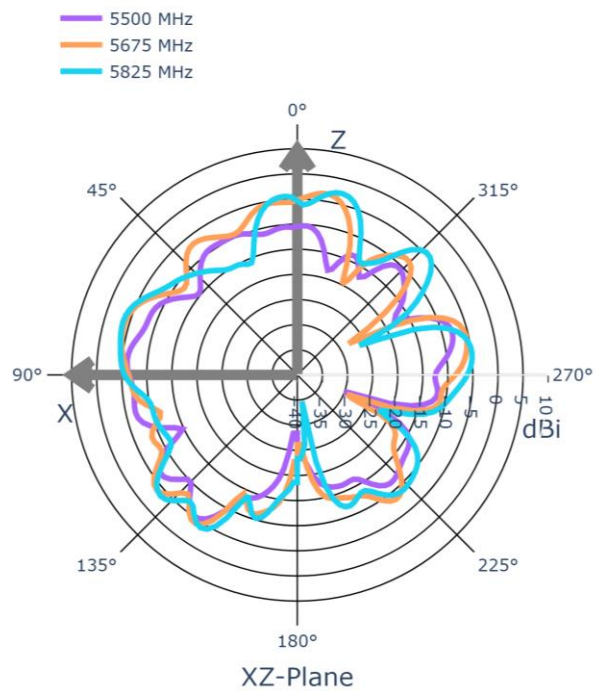
**YZ\_Pol.\_Theta\_Ant.C@5G**



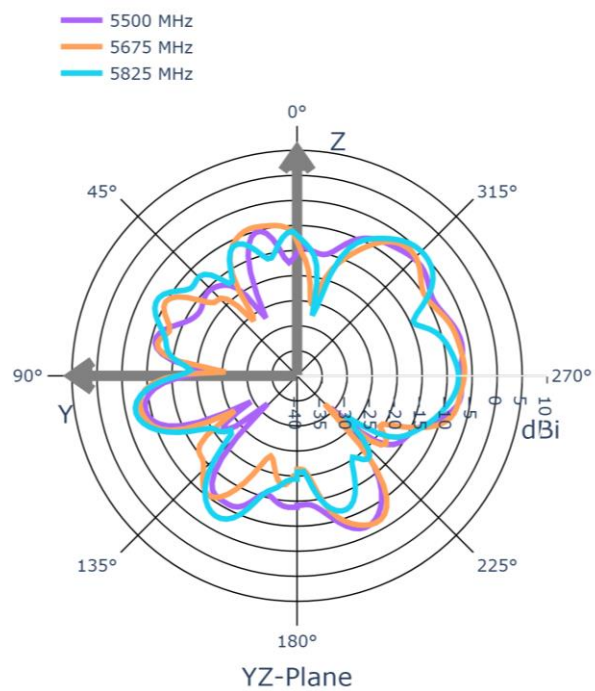
**XY\_Pol.\_Phi\_Ant.D@5G**



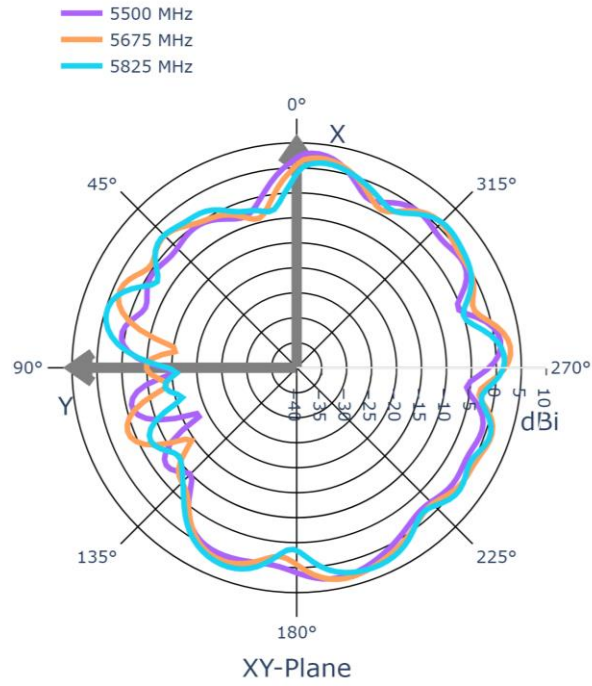
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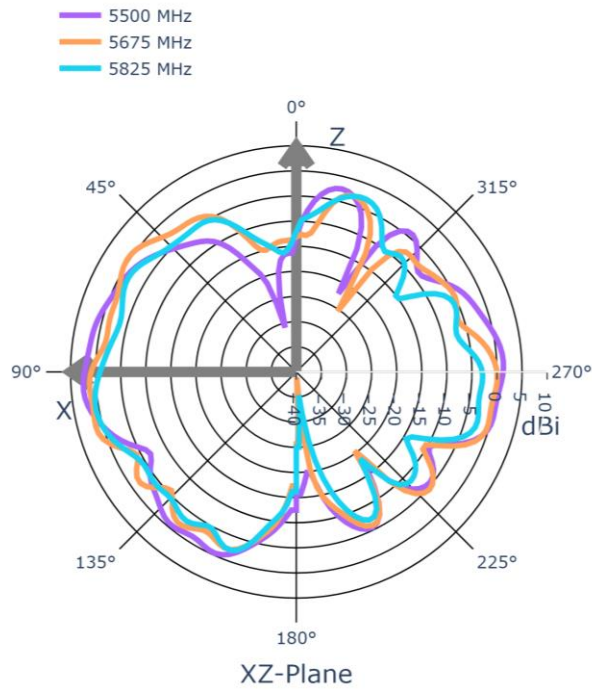
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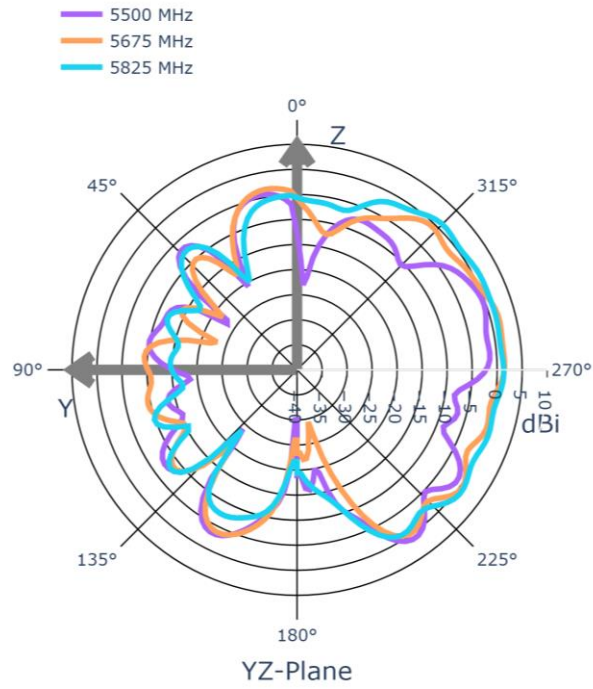
### XY\_Pol\_Theta\_Ant.D@5G



**XZ\_Pol.\_Theta\_Ant.D@5G**

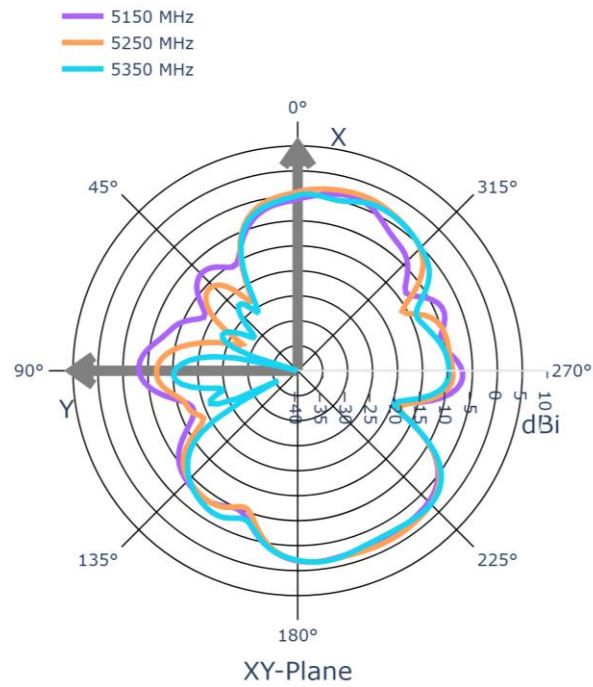


**YZ\_Pol.\_Theta\_Ant.D@5G**

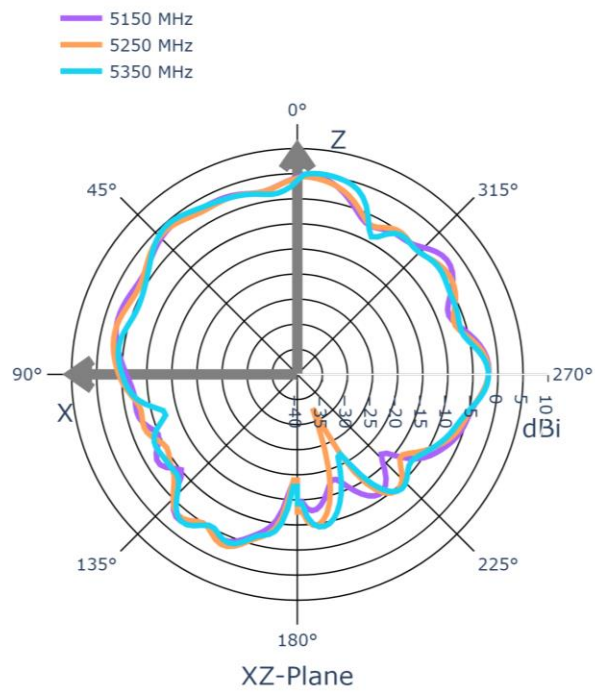


**Ant. Position: 5G-Low Ant.1~4**

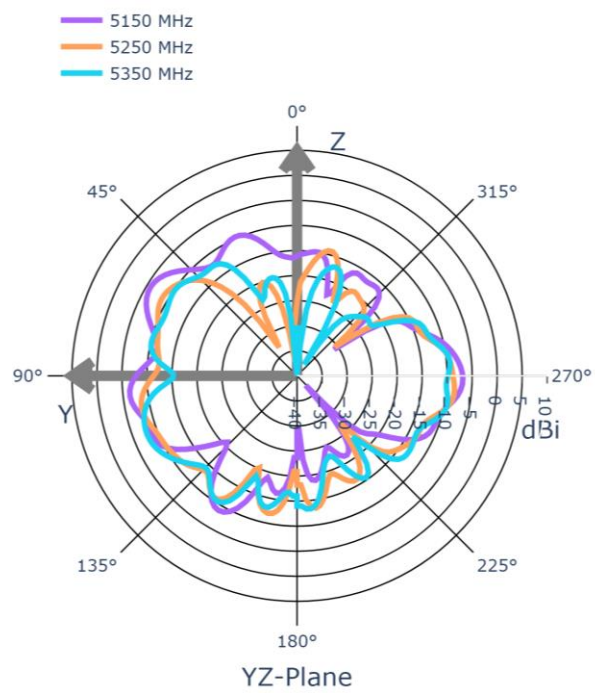
**XY\_Pol.\_Phi\_Ant.1@5G**



### XZ\_Pol.\_Phi\_Ant.1@5G

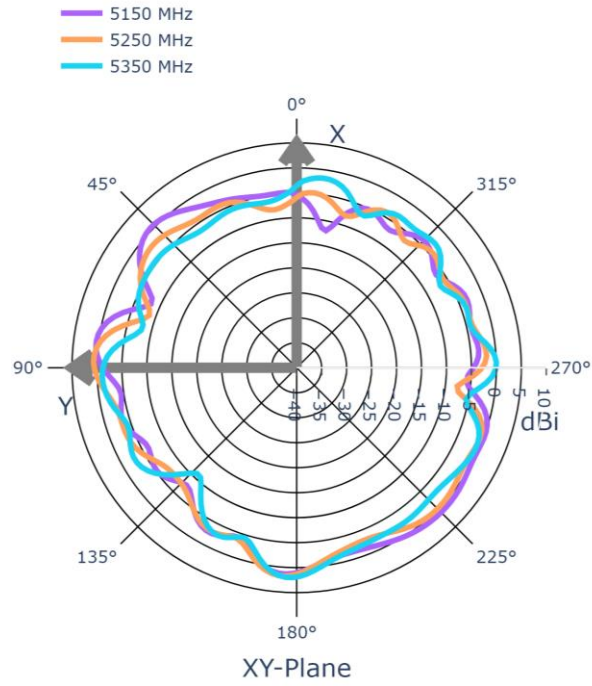


### YZ\_Pol.\_Phi\_Ant.1@5G

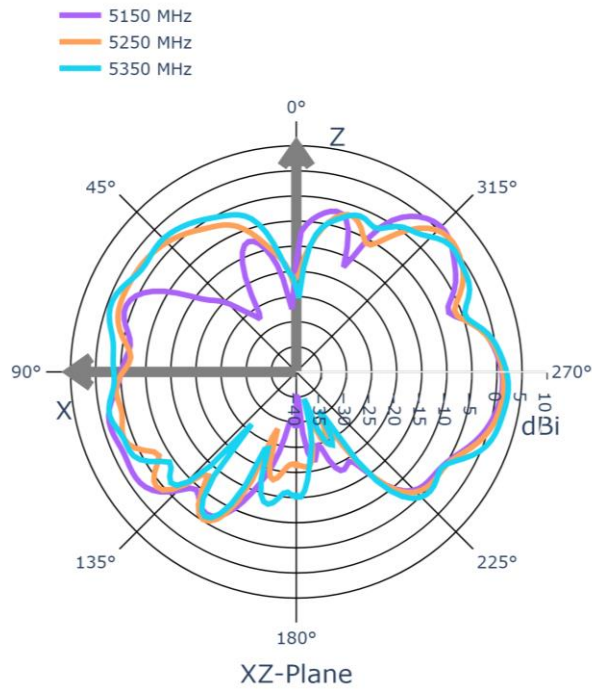


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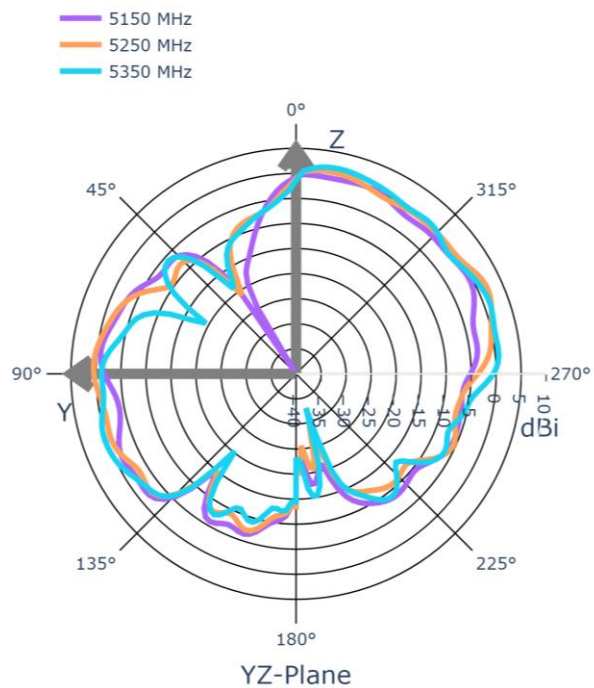




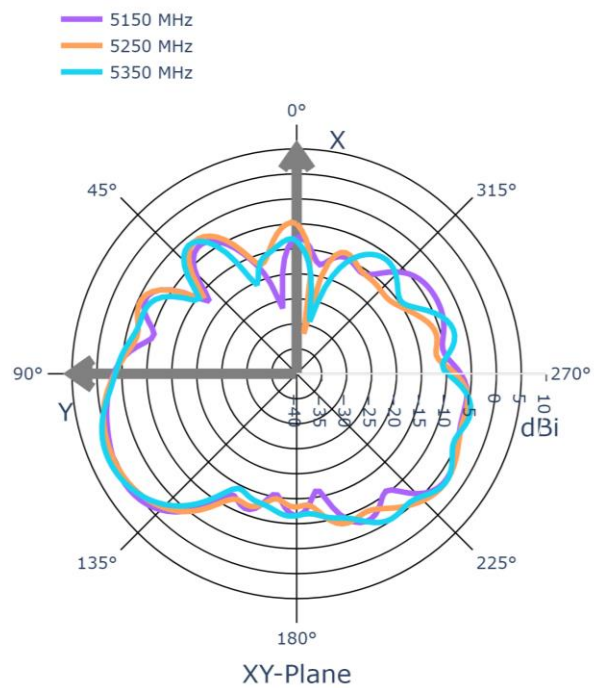
**XZ\_Pol.\_Theta\_Ant.1@5G**



**YZ\_Pol.\_Theta\_Ant.1@5G**

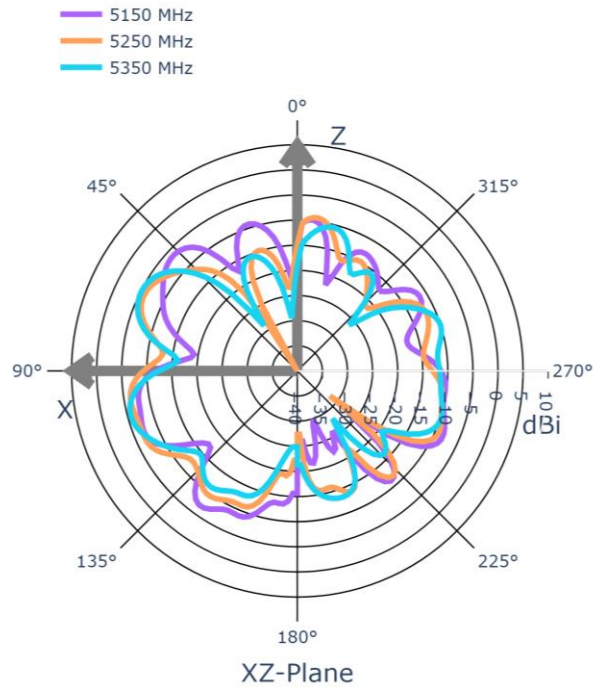


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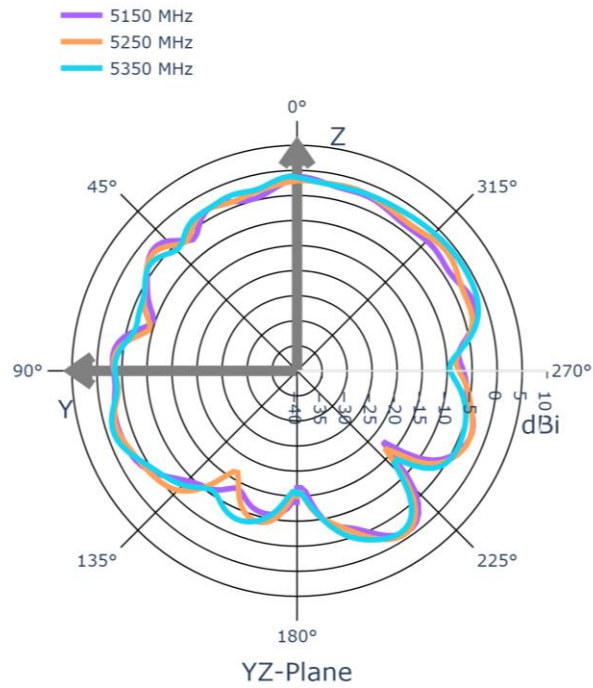


**XZ\_Pol.\_Phi\_Ant.2@5G**

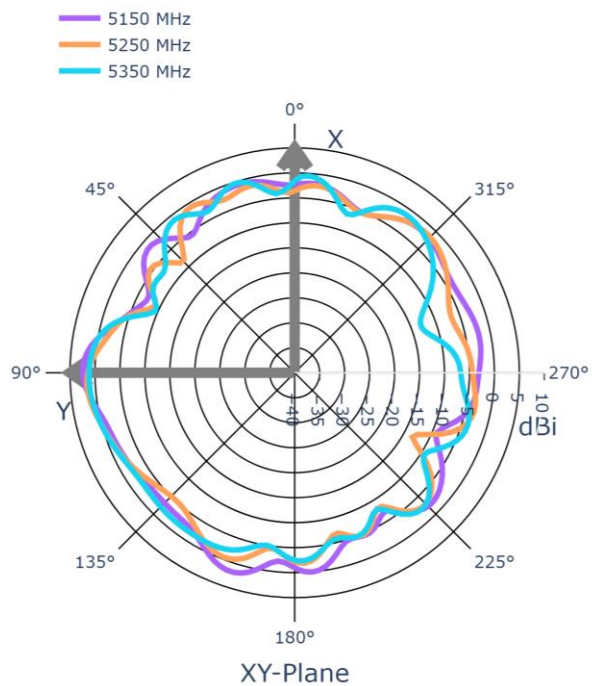




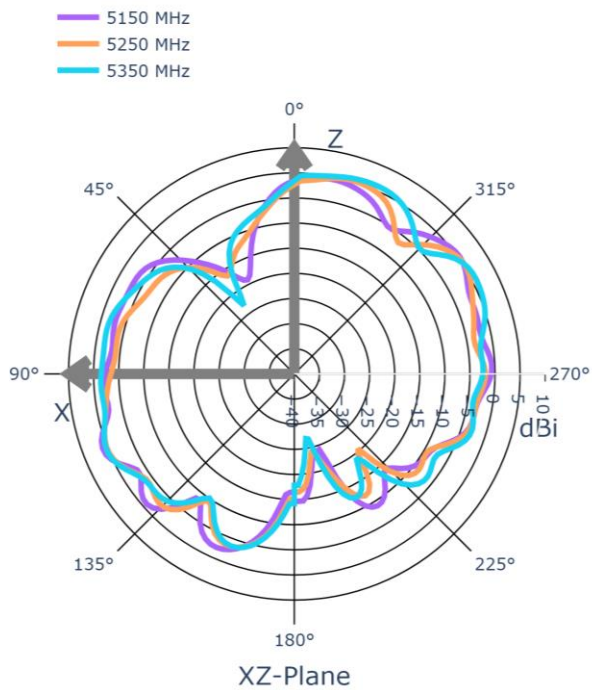
**YZ\_Pol.\_Phi\_Ant.2@5G**



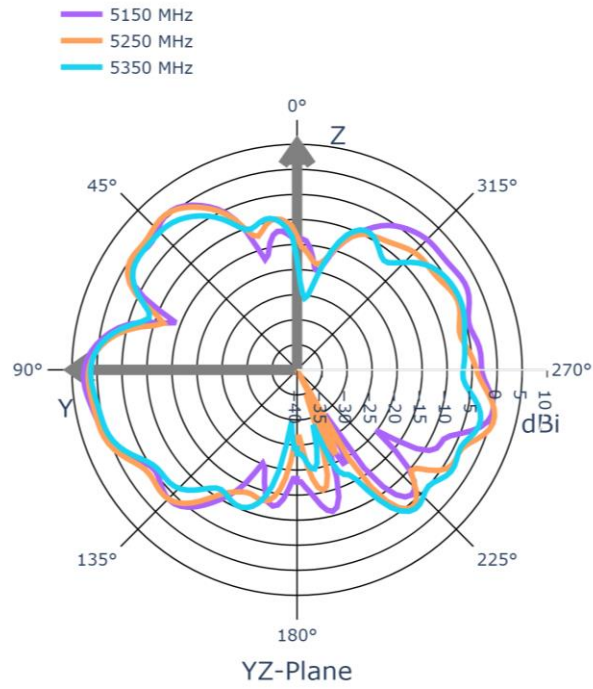
**XY\_Pol.\_Theta\_Ant.2@5G**



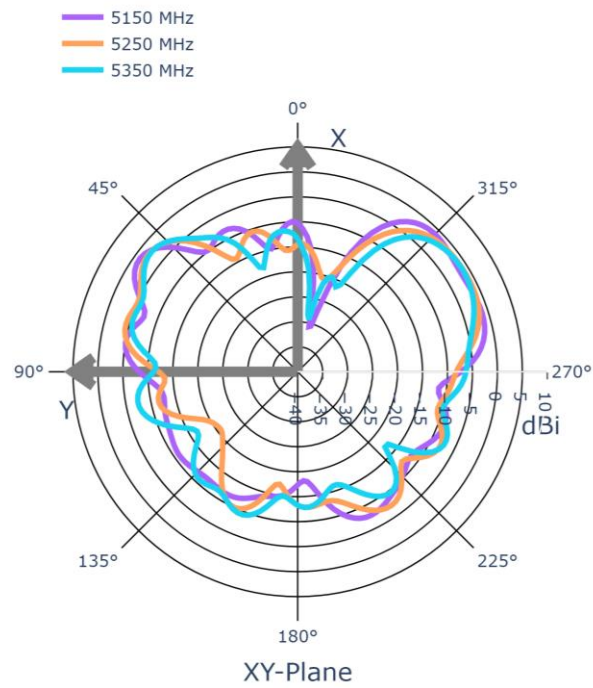
**XZ\_Pol.\_Theta\_Ant.2@5G**



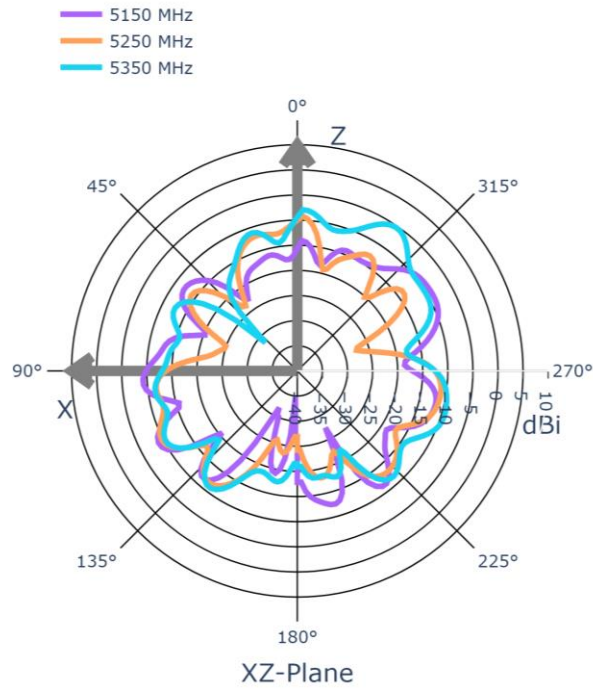
**YZ\_Pol.\_Theta\_Ant.2@5G**



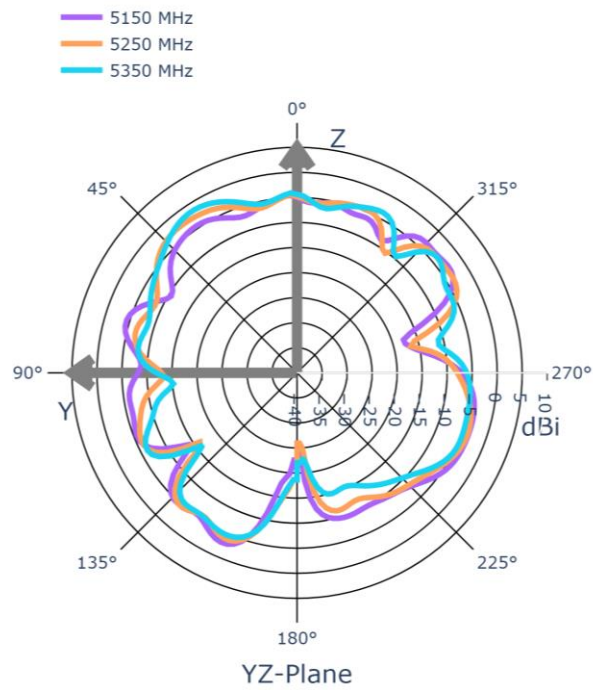
### XY\_Pol.\_Phi\_Ant.3@5G



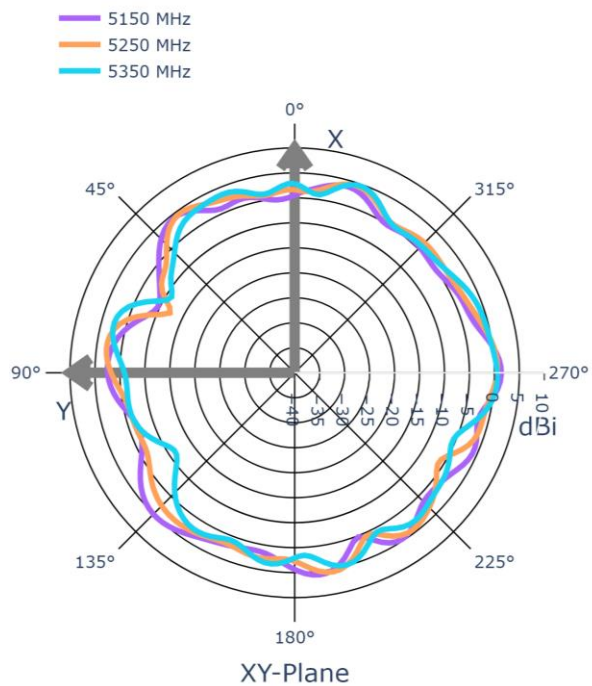
### XZ\_Pol.\_Phi\_Ant.3@5G



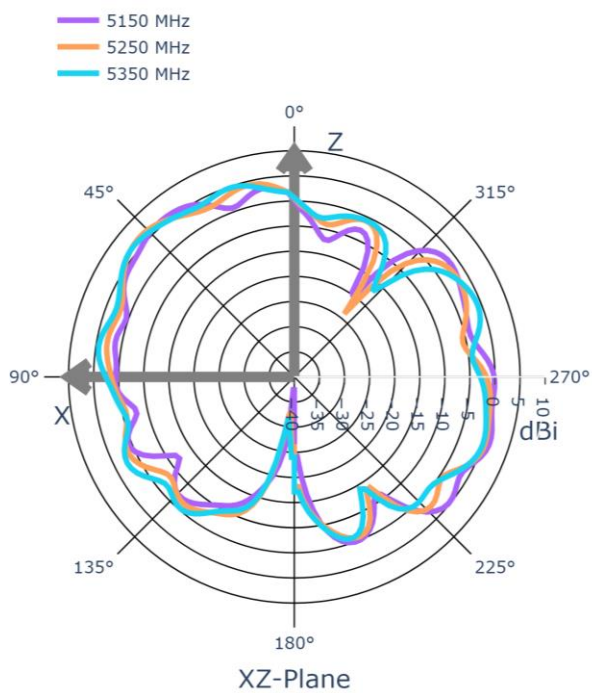
**YZ\_Pol\_Phi\_Ant.3@5G**



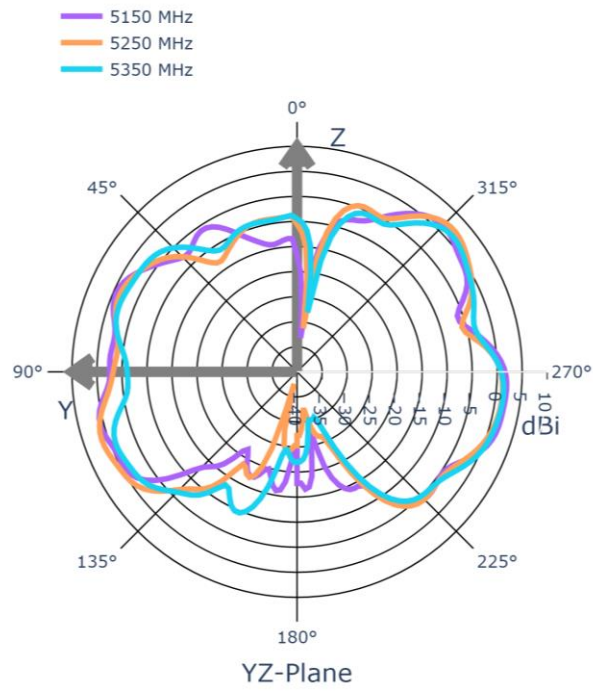
**XY\_Pol\_Theta\_Ant.3@5G**



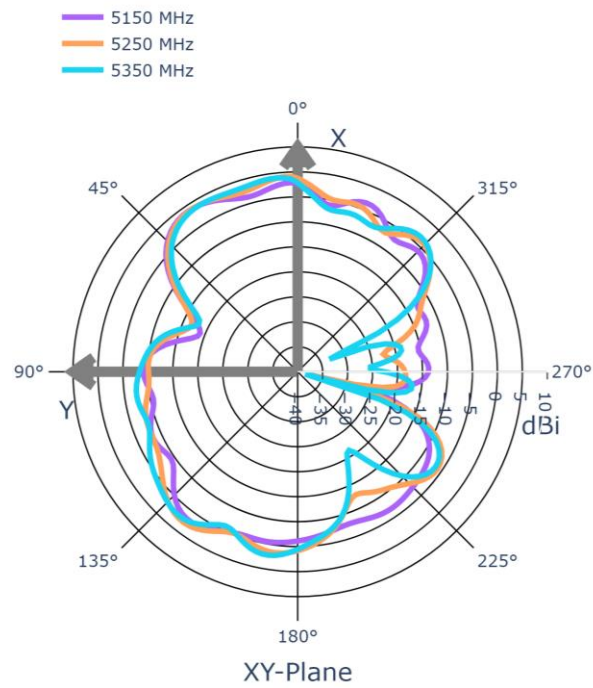
**XZ\_Pol.\_Theta\_Ant.3@5G**



**YZ\_Pol.\_Theta\_Ant.3@5G**

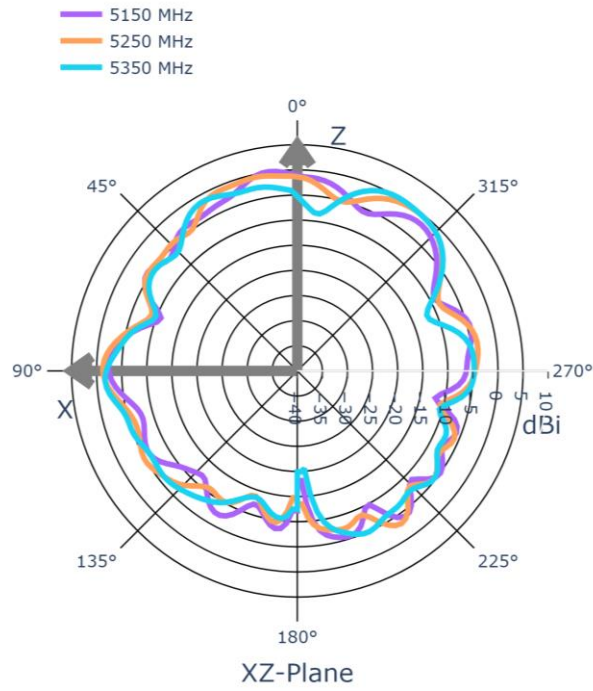


**XY\_Pol.\_Phi\_Ant.4@5G**

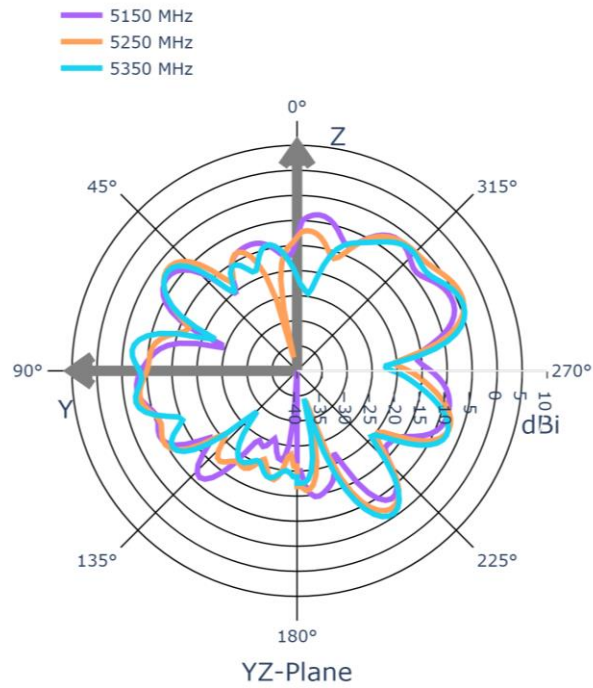


**XZ\_Pol.\_Phi\_Ant.4@5G**

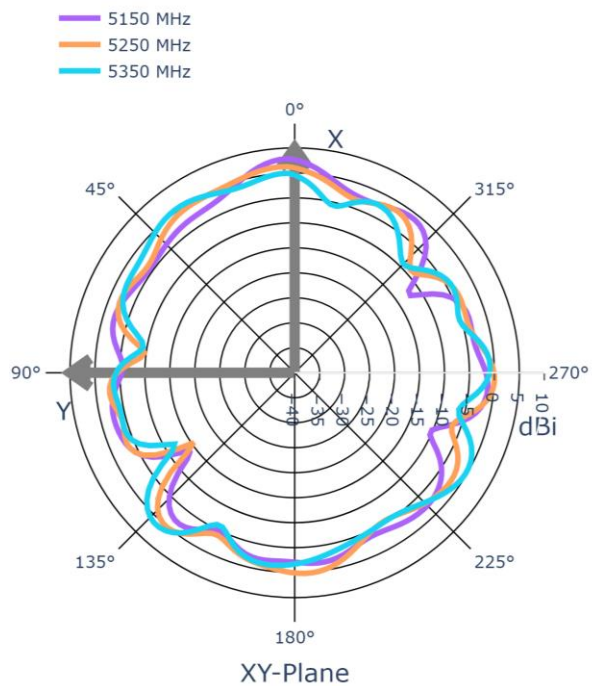




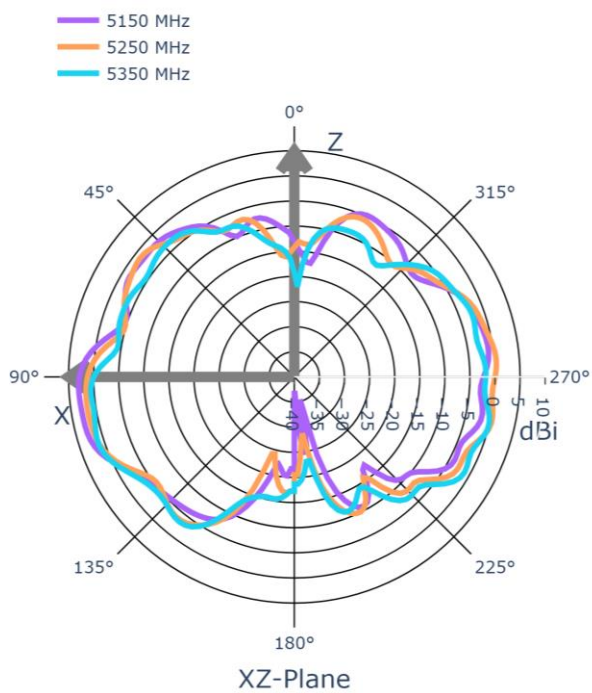
**YZ\_Pol\_Phi\_Ant.4@5G**



**XY\_Pol\_Theta\_Ant.4@5G**

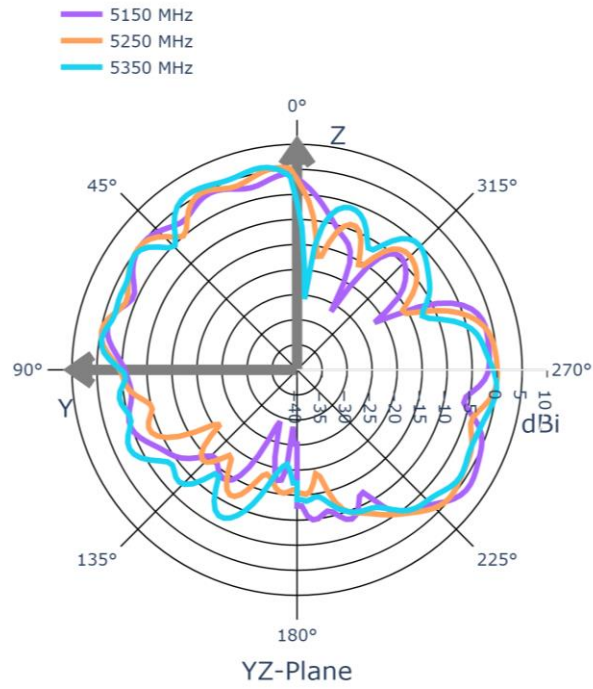


### XZ\_Pol.\_Theta\_Ant.4@5G



### YZ\_Pol.\_Theta\_Ant.4@5G





## Appendix \_Radiated Total Gain Result

Ant. Position: 2.4G Ant.A\_GAIN PHI

Table with columns: Frequency, EIRP, Ant. 1, Ant. 2, Ant. 3, Ant. 4, Ant. 5, Ant. 6, Ant. 7, Ant. 8, Ant. 9, Ant. 10, Ant. 11, Ant. 12, Ant. 13, Ant. 14, Ant. 15, Ant. 16, Ant. 17, Ant. 18, Ant. 19, Ant. 20, Ant. 21, Ant. 22, Ant. 23, Ant. 24, Ant. 25, Ant. 26, Ant. 27, Ant. 28, Ant. 29, Ant. 30, Ant. 31, Ant. 32, Ant. 33, Ant. 34, Ant. 35, Ant. 36, Ant. 37, Ant. 38, Ant. 39, Ant. 40, Ant. 41, Ant. 42, Ant. 43, Ant. 44, Ant. 45, Ant. 46, Ant. 47, Ant. 48, Ant. 49, Ant. 50, Ant. 51, Ant. 52, Ant. 53, Ant. 54, Ant. 55, Ant. 56, Ant. 57, Ant. 58, Ant. 59, Ant. 60, Ant. 61, Ant. 62, Ant. 63, Ant. 64, Ant. 65, Ant. 66, Ant. 67, Ant. 68, Ant. 69, Ant. 70, Ant. 71, Ant. 72, Ant. 73, Ant. 74, Ant. 75, Ant. 76, Ant. 77, Ant. 78, Ant. 79, Ant. 80, Ant. 81, Ant. 82, Ant. 83, Ant. 84, Ant. 85, Ant. 86, Ant. 87, Ant. 88, Ant. 89, Ant. 90, Ant. 91, Ant. 92, Ant. 93, Ant. 94, Ant. 95, Ant. 96, Ant. 97, Ant. 98, Ant. 99, Ant. 100. The table contains a dense grid of numerical data points for each frequency and antenna combination.

**Ant. Position: 2.4G Ant.A\_GAIN THETA**



Ant. Position: 2.4G Ant.B\_GAIN PHI







**Ant. Position: 2.4G Ant.B\_GAIN THETA**



Ant. Position: 2.4G Ant.C\_GAIN PHI

Table with columns: Frequency (MHz), Power (dBm), and various numerical parameters. The table contains a dense grid of data points for regulatory purposes.

Ant. Position: 2.4G Ant.C\_GAIN THETA



Table with columns: Inspeccion/Phases, Ethern, A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The table contains a dense grid of numerical data points across approximately 1000 rows and 26 columns.



Ant. Position: 2.4G Ant.D\_GAIN PHI



Ant. Position: 2.4G Ant.D\_GAIN THETA