



Antenna Composite Gain Test Report

Equipment	Access Point
Brand Name	Extreme Networks
Model Name	AP5010
Applicant	Extreme Networks, Inc. 2121 RDU Center Drive Morrisville North Carolina United States 27560
Manufacturer	Extreme Networks, Inc. 2121 RDU Center Drive Morrisville North Carolina United States 27560
Sample Received	Dec. 01, 2021
Start Test Date	Dec. 01, 2021
Final Test Date	Dec. 15, 2021



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1. Operation Mode and Antenna Information

Antenna Position	WLAN 2.4GHz RF port	WLAN 5GHz RF port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
2G 5GAnt1	3	3	WNC	95XEAJ15.30	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~3
2G 5GAnt2	1	1	WNC	95XEAJ15.31	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~3
2G 5GAnt3	2	2	WNC	95XEAJ15.32	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~3
2G 5GAnt4	4	4	WNC	95XEAJ15.33	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~3

Note:

2.4GHz and 5GHz Operation Mode (1TX/4RX)

Only 2G 5GAnt2 can be used as transmitting antennas.

2G 5GAnt1~2G 5GAnt4 can be used as receiving antennas and can receive simultaneously.

2.4GHz and 5GHz Operation Mode (2TX/4RX)

2G 5GAnt2, 2G 5GAnt3 can be used as transmitting antennas and can transmit simultaneously.

2G 5GAnt1~2G 5GAnt4 can be used as receiving antennas and can receive simultaneously.

2.4GHz and 5GHz Operation Mode (4TX/4RX)

2G 5GAnt1~2G 5GAnt4 can be used as transmitting antennas and can transmit simultaneously.

2G 5GAnt1~2G 5GAnt4 can be used as receiving antennas and can receive simultaneously.

2. Test Frequency

The middle frequency of each bands are selected to represent each frequency bands.

Band [MHz]	Test Frequency [MHz]
2400-2483.5	2450
5150-5250	5200
5250-5350	5300
5470-5725	5600
5725-5850	5785

3. Testing Location

Testing Location		
<input checked="" type="checkbox"/>	HWA YA	ADD : No.13-1 & 14-1, Ln. 19, Wen 33rd St., Guishan Dist., Taoyuan City 333, Taiwan R.O.C.

Test Condition	Test Site No.	Test Engineer	Test Environment (°C / %)	Test Date
Radiated	05CH03-HY	Rex Liao	23-23.5 / 40-50	Dec. 01, 2021 ~ Dec. 15, 2021

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

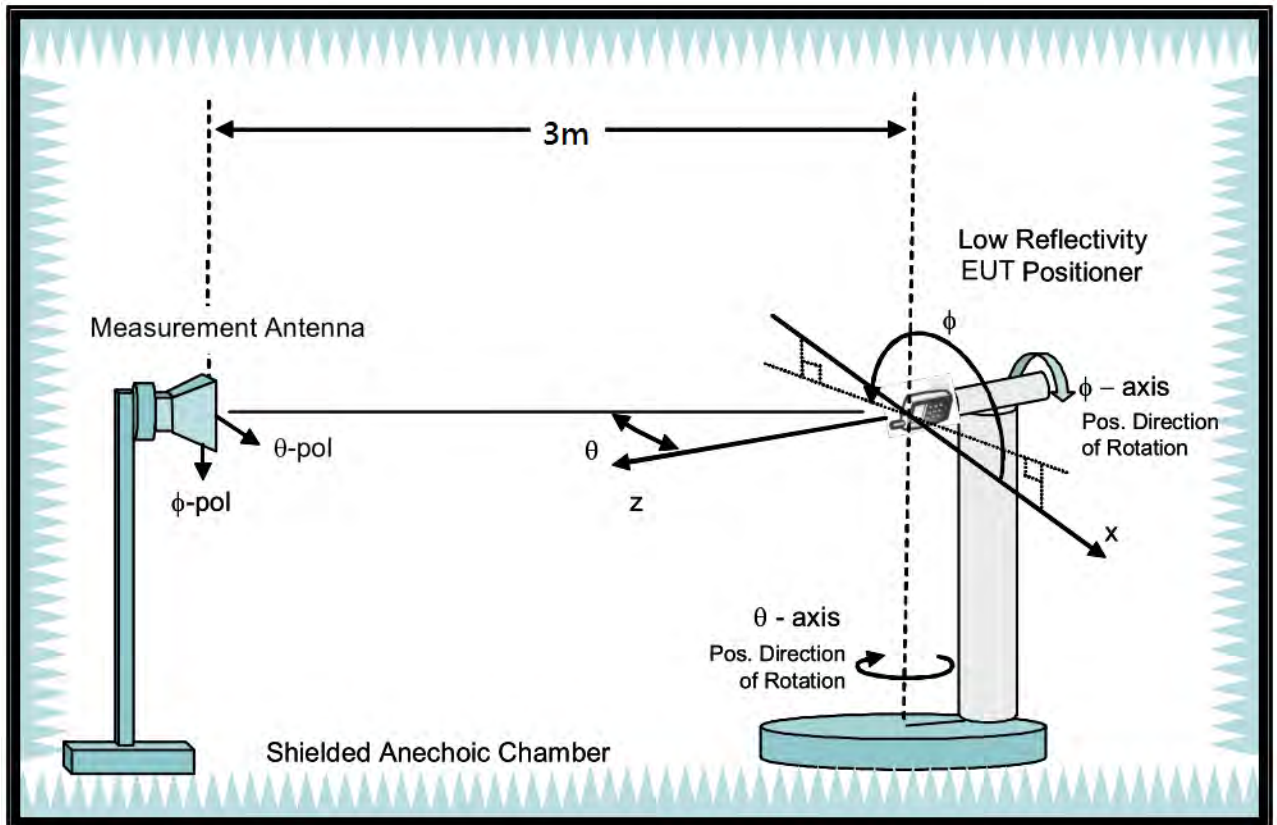
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Single Polarization Horn antenna calibrated according to ANSI C63.5.

Turntable: Multi-axis positioner (Theta and Phi angle).

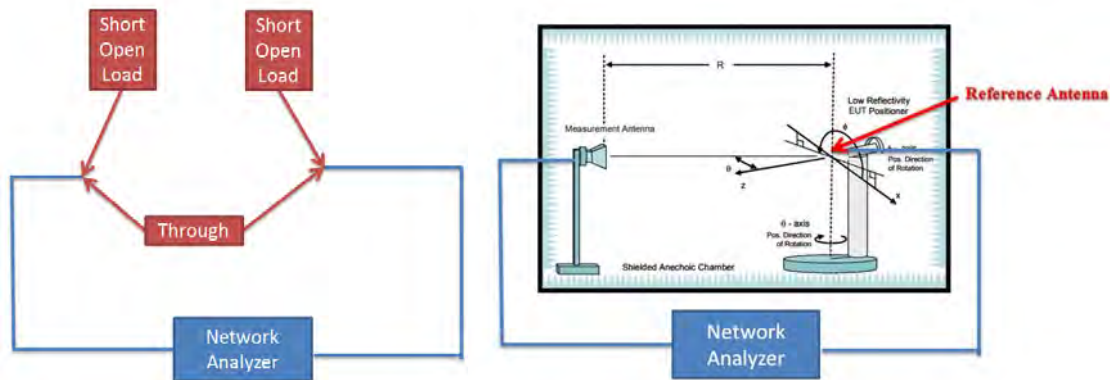
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



5. Reference Calibration

Connected cables to VNA calibration kit and use network analyzer internal function to do calibration. Do short, open and load to each side. Then connect through to both side and calibrate S21 values. The cable loss is calibrated and set inside the network analyzer.

Measurement Antenna is connected to port1 of Network analyzer and reference antenna connected to port 2 of Network Analyzer. Record S21 values and used with reference antenna gain to calculate gain factor.



Frequency (MHz)	2400	2450	2500	5150	5200	5300	5600	5750	5800	5900	6000	6500	7000	7500
S21 values (dBi)	-31.4	-31.4	-31.3	-31.3	-31	-30.7	-30.1	-30.5	-30.5	-30.8	-31.3	-32.8	-34.4	-35.4
Reference gain (dBi)	10.2	10.4	10.6	12.4	12.8	13.4	13.4	13.3	13.3	13.1	13.2	12.3	11.7	11.1
Factor (dB)	41.63	41.81	41.89	43.72	43.78	44.12	43.5	43.78	43.76	43.88	44.45	45.14	46.08	46.51



6. Test Method

EUT set on multi-axis positioner and adjust EUT's physical center to measurement reference center. Measurement antenna set at phi polarization and 1.5 meter height. Port 1 of Network analyzer connect to antenna 1 of EUT. Record S21 value every 15 degree from 0 to 345 degree on Phi angle and 0 to 180 on theta angle of multi-axis positioner. Then set measurement antenna to theta polarization and repeat process. Repeat process to each antenna of EUT.

DG steps:

1. Each Phi and Theta polarization antenna gain are measured for all test angles.
2. Composite Phi and Theta antenna gain are computed, using formula in KDB662911 D01 d) (i) and (ii), for all angles.
3. Composite antenna gain are examined for all angles to determine max gain and Phi/Theta position. Max gain and phi/theta position are listed in section 7 tables.

7. Measured Values and Calculation of Maximum Gain Positions

For 2TX

DG_1SS Max Value Position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 2 (dBi)	2.47	-1.15	-0.92	-2.03	-1.6
Ant. 3 (dBi)	3.37	4.38	4.4	2.73	3.04
DG [1SS] (dBi)	5.94	5.06	5.15	3.68	4.04
Polarization	Theta	Theta	Theta	Theta	Theta
θ (°)	60	75	75	75	75
φ (°)	75	135	135	135	135

Note: The DG 1SS max value position is the maximum value of section 11 table DG 1SS Result.

DG_1SS Max Value Position Calculation

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 2 [10 ^{^(G/20)}]	10 ^{^(2.47/20)}	10 ^{^(-1.15/20)}	10 ^{^(-0.92/20)}	10 ^{^(-2.03/20)}	10 ^{^(-1.6/20)}
Ant. 3 [10 ^{^(G/20)}]	10 ^{^(3.37/20)}	10 ^{^(4.38/20)}	10 ^{^(4.4/20)}	10 ^{^(2.73/20)}	10 ^{^(3.04/20)}
Ant. 2 [10 ^{^(G/20)}] value	1.329	0.876	0.899	0.792	0.832
Ant. 3 [10 ^{^(G/20)}] value	1.474	1.656	1.66	1.369	1.419
Sum All Antenna [Amax]	2.803	2.532	2.559	2.161	2.251
DG [10*log(Amax ² /Nant)]	5.94	5.06	5.15	3.68	4.04

Note:

Directional Gain (1SS) is the max value of every look angle. Each position value is calculated by KDB662911 D01 d) (i).

$$\text{Directional gain (1SS)} = 10 \cdot \log(10^{(G_{ant1}/20)} + 10^{(G_{ant2}/20)} + 10^{(G_{ant3}/20)} + 10^{(G_{ant4}/20)} + \dots)^2 / N_{ant}$$

DG_2SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 2 (dBi)	2.47	-1.15	-0.92	-2.03	-1.6
Ant. 3 (dBi)	3.37	4.38	4.4	2.73	3.04
DG [2SS] (dBi)	2.94	2.44	2.51	0.97	1.31
Polarization	Theta	Theta	Theta	Theta	Theta
θ (°)	60	75	75	75	75
φ (°)	75	135	135	135	135

Note: The DG 2SS max value position is the maximum DG 2SS value calculated from section 11 table Gain Result.

DG_2SS max value position Calculate

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 2 ((10 ^{^(G/20)}) ²)	1.766	0.7674	0.8091	0.6266	0.6918
Ant. 3 ((10 ^{^(G/20)}) ²)	2.1727	2.7416	2.7542	1.875	2.0137
Sum All Antenna	3.9387	3.5089	3.5633	2.5016	2.7056
DG [10*log(sum all/Nant)]	2.94	2.44	2.51	0.97	1.31

Note:

Directional Gain (2SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(S_{21}/20)}$$

Directional Gain (2SS) =

$$10 \cdot \log(((10^{(S_{21ant1}/20)})^2 + (10^{(S_{21ant2}/20)})^2 + (10^{(S_{21ant3}/20)})^2 + (10^{(S_{21ant4}/20)})^2 + \dots) / N_{ant})$$



For 4TX

DG_1SS Max Value Position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	0.16	-2.33	1.71	-1.09	-2.79
Ant. 2 (dBi)	2.47	-2.09	0.5	-2.03	-1.6
Ant. 3 (dBi)	3.37	4	-3.72	2.73	3.04
Ant. 4 (dBi)	-0.46	1.98	1.38	-1.62	-0.18
DG [1SS] (dBi)	7.55	6.83	6.24	5.74	5.92
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	60	75	75	75	75
Φ (°)	75	195	345	135	135

Note: The DG 1SS max value position is the maximum value of section 11 table DG 1SS Result.

DG_1SS Max Value Position Calculation

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 [10^(G/20)]	10^(0.16/20)	10^(-2.33/20)	10^(1.71/20)	10^(-1.09/20)	10^(-2.79/20)
Ant. 2 [10^(G/20)]	10^(2.47/20)	10^(-2.09/20)	10^(0.5/20)	10^(-2.03/20)	10^(-1.6/20)
Ant. 3 [10^(G/20)]	10^(3.37/20)	10^(4/20)	10^(-3.72/20)	10^(2.73/20)	10^(3.04/20)
Ant. 4 [10^(G/20)]	10^(-0.46/20)	10^(1.98/20)	10^(1.38/20)	10^(-1.62/20)	10^(-0.18/20)
Ant. 1 [10^(G/20)] value	1.019	0.765	1.218	0.882	0.725
Ant. 2 [10^(G/20)] value	1.329	0.786	1.059	0.792	0.832
Ant. 3 [10^(G/20)] value	1.474	1.585	0.652	1.369	1.419
Ant. 4 [10^(G/20)] value	0.948	1.256	1.172	0.83	0.979
Sum All Antenna [Amax]	4.77	4.392	4.101	3.873	3.956
DG [10*log(Amax^2/Nant)]	7.55	6.83	6.24	5.74	5.92

Note:

Directional Gain (1SS) is the max value of every look angle. Each position value is calculated by KDB662911 D01 d) (i).

$$\text{Directional gain (1SS)} = 10 \cdot \log(10^{(G_{ant1}/20)} + 10^{(G_{ant2}/20)} + 10^{(G_{ant3}/20)} + 10^{(G_{ant4}/20)} + \dots)^2 / N_{ant}$$

DG_4SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	0.16	-2.33	-2.79	-1.09	-2.79
Ant. 2 (dBi)	2.47	-2.09	-0.92	-2.03	-1.6
Ant. 3 (dBi)	3.37	4	4.4	2.73	3.04
Ant. 4 (dBi)	-0.46	1.98	-1.96	-1.62	-0.18
DG [4SS] (dBi)	1.67	1.22	0.72	-0.03	0.2
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	60	75	75	75	75
Φ (°)	75	195	135	135	135

Note: The DG 4SS max value position is the maximum DG 4SS value calculated from section 11 table Gain Result.

DG_4SS max value position Calculate

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 ((10^(G/20))^2)	1.0375	0.5848	0.526	0.778	0.526
Ant. 2 ((10^(G/20))^2)	1.766	0.618	0.8091	0.6266	0.6918
Ant. 3 ((10^(G/20))^2)	2.1727	2.5119	2.7542	1.875	2.0137
Ant. 4 ((10^(G/20))^2)	0.8995	1.5776	0.6368	0.6887	0.9594
Sum All Antenna	5.8758	5.2923	4.7261	3.9683	4.191
DG [10*log(sum all/Nant)]	1.67	1.22	0.72	-0.03	0.2

Note: Directional Gain (4SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(G/20)}$$

$$\text{Directional Gain (4SS)} = 10 \cdot \log((10^{(G_{ant1}/20)})^2 + (10^{(G_{ant2}/20)})^2 + (10^{(G_{ant3}/20)})^2 + (10^{(G_{ant4}/20)})^2 + \dots) / N_{ant}$$



8. Summary of Test Result

For 2TX

Frequency (Hz)	2.45G
Ant. 2 Max Gain (dBi)	2.69
Ant. 3 Max Gain (dBi)	3.74
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/195
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/90
Max Gain (dBi)	3.74
DG [1SS] (dBi)	5.94
DG [2SS] (dBi)	2.94

Note:

1. Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
2. The max gain is the max value of all antennas.

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 2 Max Gain (dBi)	1.96	2.27	1.08	1.18
Ant. 3 Max Gain (dBi)	4.38	4.4	2.73	3.04
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/150	Theta/75/150	Theta/75/105	Theta/45/150
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/135	Theta/75/135	Theta/75/135	Theta/75/135
Max Gain (dBi)	4.38	4.4	2.73	3.04
DG [1SS] (dBi)	5.06	5.15	3.68	4.04
DG [2SS] (dBi)	2.44	2.51	0.97	1.31

Note:

1. Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
2. The max gain is the max value of all antennas.



For 4TX

Frequency (Hz)	2.45G
Ant. 1 Max Gain (dBi)	2.04
Ant. 2 Max Gain (dBi)	2.69
Ant. 3 Max Gain (dBi)	3.74
Ant. 4 Max Gain (dBi)	1.68
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/255
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/195
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/90
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/45/345
Max Gain (dBi)	3.74
DG [1SS] (dBi)	7.55
DG [2SS] (dBi)	4.55
DG [4SS] (dBi)	1.67

Note:

1. Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
2. Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
3. The max gain is the max value of all antennas.

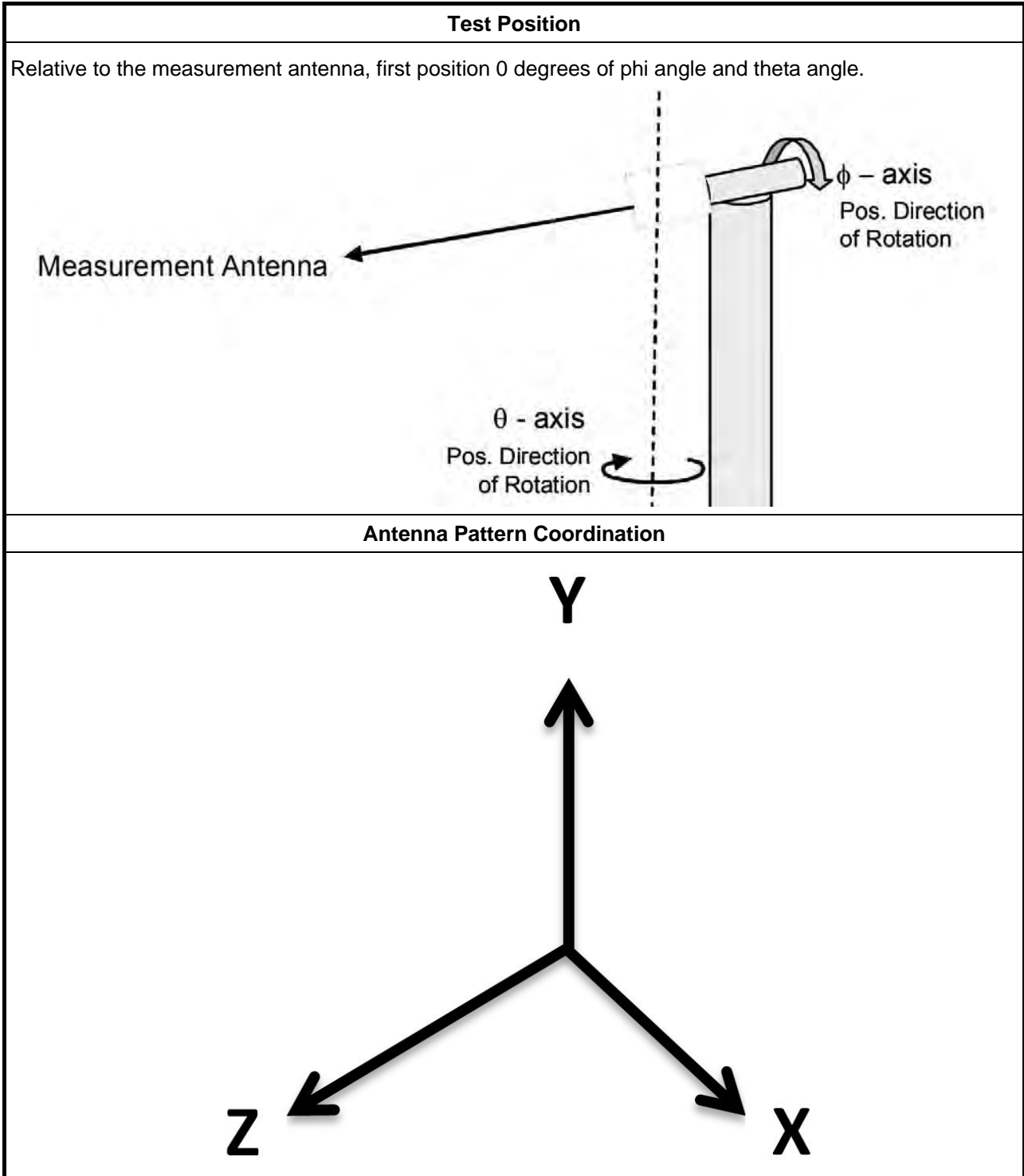


Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.99	3.18	2.9	1.52
Ant. 2 Max Gain (dBi)	1.96	2.27	1.08	1.18
Ant. 3 Max Gain (dBi)	4.38	4.4	2.73	3.04
Ant. 4 Max Gain (dBi)	2.83	3.02	2.16	1.69
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/0	Theta/75/0	Theta/75/0	Theta/75/0
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/150	Theta/75/150	Theta/75/105	Theta/45/150
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/135	Theta/75/135	Theta/75/135	Theta/75/135
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/240	Phi/75/240	Theta/75/270	Phi/75/270
Max Gain (dBi)	4.38	4.4	2.9	3.04
DG [1SS] (dBi)	6.83	6.24	5.74	5.92
DG [2SS] (dBi)	4.38	4.4	2.9	3.04
DG [4SS] (dBi)	1.22	0.72	-0.03	0.2

Note:

1. Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
2. Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
3. The max gain is the max value of all antennas.

9. Test Setup



Note:

Photos of Test Position: Please refer to the test photos in the appendix.



10. Test Equipment and Calibration Data

Instrument	Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date
Horn Antenna	SCHWARZBECK	BBHA9120D	BBHA 9120D-1292	1GHz~18GHz	Aug. 04, 2021	Aug. 03, 2022
Test Software	SPORTON	SENSE-RDG	V1.0.6	-	N.C.R.	N.C.R.

Note: Calibration Interval of instruments listed above is one year.

NCR means Non-Calibration required.



11. Test Results

Please refer to the appendix.

Appendix A – Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 2TX.....	Page 16
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Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 2 Max Gain (dBi)	2.69	1.96	2.27	1.08	1.18
Ant. 3 Max Gain (dBi)	3.74	4.38	4.4	2.73	3.04
Ant. 2 Polarization/ Θ (°)/ Φ (°)	Theta/60/195	Theta/60/150	Theta/75/150	Theta/75/105	Theta/45/150
Ant. 3 Polarization/ Θ (°)/ Φ (°)	Theta/60/90	Theta/75/135	Theta/75/135	Theta/75/135	Theta/75/135
Max Gain (dBi)	3.74	4.38	4.4	2.73	3.04
DG [1SS] (dBi)	5.94	5.06	5.15	3.68	4.04
DG [2SS] (dBi)	2.94	2.44	2.51	0.97	1.31



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 2TX

Appendix A

DG 1SS Result

Table with columns for Freq(Hz), DG(dB), and various Phi angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, and 5.3G. The table contains multiple rows of data for each frequency, showing gain values in dB across different angles.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 2TX

Appendix A

Θ(180°)	-8.09	-8.23	-7.02	-7.78	-9.4	-11.65	-11.49	-13.88	-16.32	-17.41	-12.52	-11.42	-11.55	-10.73	-9.03	-7.78	-8.79	-10.22	-13.5	-12.87	-10.44	-9.6	-10.48	-9.58
Freq(Hz)	5.6G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dB)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-8.2	-9.41	-5.96	-6.86	-5.91	-6.11	-8.04	-9.19	-14.2	-16.86	-11.1	-9.09	-7.21	-6.32	-7.45	-5.24	-6.37	-8.78	-8.73	-10.32	-12.78	-13.26	-13.38	-10.99
Θ(15°)	-6.2	-6.69	-5.17	-5.09	-5.8	-8.76	-11.61	-11.43	-9.71	-11.83	-14.1	-9.81	-6.86	-6.47	-6.35	-4.73	-7.52	-6.52	-8.73	-9.31	-6.79	-6.21	-7.01	-6.78
Θ(30°)	-7.24	-6.04	-12.11	-14.39	-13.17	-8.32	-5.04	-5.79	-6.3	-9.35	-5.54	-6.63	-9.03	-3.48	-8.43	-4.88	-7.07	-4.94	-10.05	-10.45	-11.02	-7.85	-6.9	-6.36
Θ(45°)	-5.99	-10.29	-9.77	-15.47	-18.63	-9.89	-8.71	-8.42	-6.08	-5.32	-7.25	-9.11	-5.15	-6.08	-2.37	-13.34	-4.24	-13.95	-4.94	-6.95	-13.31	-9.96	-6.82	-6.07
Θ(60°)	-8.4	-9.44	-11.18	-11.06	-14.08	-8.93	-9.47	-11.82	-9.15	-6.51	-9.27	-5.01	-5.15	-3.5	-3.78	-7.9	-5.13	-10.89	-7.43	-15.36	-8.92	-7.88	-9.61	-7.52
Θ(75°)	-7.38	-13.44	-11.56	-9.52	-8.25	-10.14	-7.51	-9.99	-8.17	-4.75	-5.58	-4.92	-3.31	-5.75	-7.53	-11.29	-4.77	-7.65	-16.51	-8.77	-19.28	-10.5	-6.29	-7.82
Θ(90°)	-6.56	-9.98	-9.52	-8.85	-7.38	-11.34	-8.79	-12.36	-7.69	-6.55	-5.17	-6.32	-6.85	-8.63	-10.2	-13.6	-6.5	-9.31	-8.9	-10.06	-13.67	-9.36	-8.97	-9.9
Θ(105°)	-8.53	-8.22	-9.09	-7.71	-8.06	-11.37	-9.64	-11.85	-8.51	-5.44	-5.35	-8.08	-5.32	-6.61	-12.13	-11.93	-8.77	-17.72	-7.7	-10.97	-8.78	-9.22	-9.5	-9.93
Θ(120°)	-10.97	-10.33	-8.05	-7.69	-10.98	-11.87	-10.34	-11.31	-10.12	-9.17	-6.08	-6.95	-9.23	-9.64	-13.03	-11.01	-9.32	-18.92	-11.27	-13.25	-12.83	-8.29	-10.88	-8.79
Θ(135°)	-10.02	-7.14	-7.83	-9.69	-9.82	-14.69	-20.44	-16.32	-9.52	-8.22	-11.45	-10.27	-11.45	-10.32	-13.11	-8.44	-14.25	-12.17	-7.93	-17.15	-9.82	-11.57	-11.13	-10.9
Θ(150°)	-11.36	-10.14	-11.6	-10.82	-11.48	-17.63	-18.43	-14.75	-14.68	-7.64	-10.23	-12.27	-7.49	-8.34	-16.21	-18.79	-13.33	-18.18	-14.6	-14.77	-15.07	-15.62	-14.39	-9.97
Θ(165°)	-12.19	-12.15	-14.77	-13.34	-16.54	-14.91	-15.69	-18.05	-16.58	-11.99	-9.71	-11.62	-17.02	-13.71	-16.89	-16.93	-17.6	-15.51	-12.33	-12.23	-13.45	-14.74	-14.94	-11.08
Θ(180°)	-13.36	-12.64	-11.64	-11.68	-12.33	-13.05	-12.94	-10.32	-10.34	-10	-11.97	-16.05	-15.92	-18.88	-12.09	-13.05	-10.44	-10.6	-7.8	-8.23	-8.65	-8.67	-9.5	-10.47
Freq(Hz)	5.6G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dB)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-9.16	-10.33	-12.69	-14.88	-17.26	-11.41	-8.22	-6.83	-6.36	-5.98	-6.84	-7.31	-9.01	-12.5	-16.51	-16.32	-13.16	-10.33	-9.59	-8.53	-7.3	-5.88	-6.54	-6.83
Θ(15°)	-6.32	-4.98	-3.32	-2.49	-2.04	-1.99	-2.88	-4.71	-5.42	-5.68	-6.26	-10.01	-12.71	-11.56	-10.68	-10.41	-13.39	-11.6	-6.42	-5.94	-5.9	-5.67	-6.48	-7.28
Θ(30°)	-2.97	-2.27	-1.82	-0.86	-0.21	0.11	-0.75	-2.49	-1.49	-0.81	-0.75	-0.3	-1.15	-1.46	-6.67	-7.35	-4.76	-2.43	-3.8	-5.47	-5.33	-7.56	-2.31	-2.94
Θ(45°)	-0.53	-0.33	0.96	-0.21	1.06	0.5	-0.59	-0.29	1.28	1.53	2.74	1.44	-0.6	-1.69	-3.51	-1.61	0.78	-1.15	-2.21	-2	-3.65	-3.54	-1.34	-1
Θ(60°)	-1.46	-1.02	-1.78	1.06	0.71	1	1.69	-0.56	1.49	2.34	2.91	0.28	1.88	-0.32	-0.07	0.45	0.46	-4.08	-0.54	-1.89	-0.31	-2	-3.31	-1.41
Θ(75°)	-1.43	-0.98	-0.41	0.27	0.71	1.64	2.56	1.71	0.01	3.68	2.78	2.07	3.18	0.9	-1.5	0.54	1.41	1.66	0.42	1.08	-1.85	-4.22	-4.82	-1.37
Θ(90°)	-2.36	-2.33	-1.17	-2.52	-0.8	0.51	1.65	-0.8	-2.83	0.78	1.18	0.72	1.43	0.48	-1.57	-2.14	1.32	-0.21	1.11	-0.11	-4.27	-2.78	-4.72	-1.25
Θ(105°)	-1.98	-2.88	-3.38	-3.56	-1.25	-0.71	-0.68	-1.45	-2.17	-1.44	-1.66	-3.16	-2.45	-2.84	-6.34	-3.45	-5.1	-3.94	-3.8	-5.37	-4.89	-4.19	-5.52	-4.94
Θ(120°)	-7.84	-4.61	-4.6	-5.95	-4.31	-2.93	-2.25	-3.55	-6.12	-2.4	-4.85	-7.33	-12.7	-7.43	-7.67	-6.7	-9.8	-4.07	-4.97	-7.9	-10.4	-8.86	-7.44	-6.73
Θ(135°)	-11.05	-10.14	-8.37	-8.05	-5.29	-6.81	-5.28	-5.85	-8.63	-8.12	-6.28	-6.8	-11.8	-12.73	-9.93	-8.67	-13.19	-14.63	-7.47	-9.16	-10.5	-12.49	-10.19	-15.47
Θ(150°)	-16.91	-11.6	-10.17	-11.26	-8.14	-7.16	-8.57	-9.58	-10.5	-11.67	-11.88	-10.1	-14.39	-18.23	-14.21	-13.02	-10.33	-13.51	-16.33	-17.47	-13.33	-12.76	-18.83	-10.83
Θ(165°)	-15.63	-13.68	-12.05	-15.61	-13.06	-10.98	-10.92	-11.34	-11.25	-10.28	-14.09	-15.98	-25.23	-11.76	-9.61	-10.57	-12.03	-11.91	-12.12	-13.27	-12.15	-14.87	-17.06	-17.6
Θ(180°)	-10.35	-7.58	-7.45	-7.96	-9.12	-10.31	-11.71	-13.42	-13.76	-13.75	-11.03	-10.26	-9.38	-9.13	-8.34	-7.72	-7.52	-8.71	-10.44	-11.54	-10.61	-10.85	-11.91	-13.28
Freq(Hz)	5.785G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dB)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-7.62	-7.13	-5.62	-6.68	-6.46	-6.49	-8.54	-8.72	-9.61	-8.99	-7.64	-5.91	-6.02	-4.19	-5.5	-4.19	-6.46	-7.79	-9.7	-11.21	-10.58	-8.99	-9.68	-10.71
Θ(15°)	-5.31	-7.41	-5.84	-5.57	-5.6	-6.67	-8.75	-7.4	-8.23	-5.94	-6.7	-9.51	-6.73	-5.59	-5.98	-8.59	-5.06	-4.21	-5.43	-5.13	-6.06	-6.56	-6.88	-6.38
Θ(30°)	-6.73	-5.1	-9.72	-14.6	-13.74	-8.84	-5.48	-6.44	-6.02	-7.72	-3.99	-4.99	-7.46	-2.35	-6.91	-6.14	-5.71	-5.84	-9.14	-9.48	-8.25	-5.13	-5.67	-6.16
Θ(45°)	-6.98	-6.82	-7.56	-20.8	-8.56	-7.31	-5.62	-7.3	-4.48	-5.66	-6.02	-7.27	-2.89	-6.63	-1.71	-11.32	-5.78	-11.84	-6.85	-8.31	-10.57	-6.75	-5.38	-6.05
Θ(60°)	-9.19	-10.42	-7.37	-11.21	-6.61	-6.69	-4.87	-10.47	-7.95	-6.1	-8.73	-5.49	-6.47	-3.44	-3.1	-9.99	-7.67	-9.28	-5.84	-14.34	-8.83	-8.44	-8.18	-6.28
Θ(75°)	-6.36	-13.28	-8.09	-10.61	-4.97	-10.53	-6.62	-10.18	-8.68	-3.7	-3.6	-5.88	-5.52	-5.4	-7.46	-9.85	-5.73	-9.17	-10.61	-8.2	-15.89	-9.55	-6.15	-8.16
Θ(90°)	-7.64	-12.32	-7.55	-10.85	-6.89	-12.82	-8.95	-11.69	-7.48	-9.14	-3.87	-7.02	-10.18	-9.29	-10.27	-13.32	-8.04	-9.33	-7	-10.43	-12.56	-11.37	-8.48	-11.07
Θ(105°)	-9.53	-7.83	-7.93	-8.75	-8.25	-13.52	-9.72	-10.99	-9.91	-6.02	-5.42	-9.15	-6.29	-8.2	-11.65	-15.65	-10.98	-12.89	-7.94	-17.42	-10.07	-11.03	-10.28	-8.65
Θ(120°)	-9.37	-8.35	-8.6	-9.1	-12.51	-10.46	-11.81	-11.1	-13.1	-10.52	-6.69	-7.31	-10.68	-7.34	-12.53	-14.11	-9.45	-14.77	-18.37	-16.8	-14.39	-9.41	-10.88	-8.22
Θ(135°)	-9.75	-9.83	-9.68	-9.55	-12.47	-13.87	-16.98	-10.89	-10.45	-10.94	-12.86	-8.66	-8.62	-9.01	-13.17	-7.46	-10.9	-10.9	-13.58	-15.86	-13.16	-16.16	-11.81	-9.85
Θ(150°)	-12.24	-10.76	-11.58	-13.33	-12.63	-16.17	-19.63	-13.32	-20.54	-7.11	-12.09	-10.81	-7.88	-9.09	-19.31	-18.39	-14.58	-19.32	-19.31	-16.61	-14.91	-18.38	-14.28	-9.98
Θ(165°)	-14.44	-13.38	-13.33	-14.67	-14.38	-15.03	-19.42	-18.26	-11.68	-13.23	-11.53	-10.19	-10.84	-15.96	-11.55	-16.35	-18.06	-12.89	-12.9	-14.03	-18.02	-14.11	-14.08	-10.8
Θ(180°)	-13.27	-12.82	-11.81	-14.59	-14.45	-15.76	-14.11	-12.63	-10.24	-10.93	-13.96	-20.92	-23.91	-16	-12.46	-12.71	-13.41	-14.9	-12.4	-13.85	-11.82	-9.31	-11.4	-12.09
Freq(Hz)	5.785G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dB)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-7.74	-8.45	-8.87	-9.44	-8.99	-7.84	-6.14	-5.08	-4.98	-5.32	-6.12	-7.23	-7.95	-8.49	-10.37	-9.46	-7.67	-6.44	-6.69	-6.45	-6.21	-6.16	-6.74	-8.22
Θ(15°)	-5.27	-4.84	-3.16	-2.14	-1.7	-2.07	-2.04	-3.16	-5.9	-6.44	-6.05	-9.1	-13.09	-14.99	-10.9	-8.35	-13.7	-7.83	-4.92	-5.06	-5.95	-5.49	-6.65	-6.78
Θ(30°)	-1.55	-1.13	-1.03	0.28	-0.03	-0.88	-1.51	-1.15	-0.89	-0.75	-1.42	-0.27	-2.52	-3.46	-5.88	-7.41	-4.57	-2.75	-5.73	-4.77	-5.03	-5.3	-2.5	-3.77
Θ(45°)	-2.56	-1.18	-1.24	0.89	1.47	1.61	0.47	0.64	0.73	1.59	3.04	0.59	-0.18	-1.25	-1.86	-3.11	-0.63	-0.69	-2.59	-1.99	-1.28	-1.54	-1.29	-3.14
Θ(60°)	-1.69	-1.18	-2.99	1.35	1.45	1.33	1.65	-1.04	1.17	0.82	2.22	-0.66												



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 2TX

Appendix A

Gain Result

Table with columns for Freq(Hz), Pol., Phi, Ant. 2, and Gain for various angles (Theta) and frequencies (2.45G, 5.2G, 5.3G, 5.6G). The table contains multiple rows of data for each frequency and angle combination.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 2TX

Appendix A

Table with columns for frequency (5.6G, 5.785G, 2.45G, 5.2G), gain, and various angles (Theta, Phi) from 0 to 180 degrees. The table contains numerical data for each combination of frequency and angle.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 2TX

Appendix A

Table with columns for frequency (5.3G, 5.6G, 5.785G), polarization (Pol.), phase (Phi), antenna (Ant. 3), and gain for various angles (Theta) and azimuths (Phi). Values range from -23.3 to -1.98 dB.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4TX

Appendix B

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.04	3.99	3.18	2.9	1.52
Ant. 2 Max Gain (dBi)	2.69	1.96	2.27	1.08	1.18
Ant. 3 Max Gain (dBi)	3.74	4.38	4.4	2.73	3.04
Ant. 4 Max Gain (dBi)	1.68	2.83	3.02	2.16	1.69
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/255	Theta/75/0	Theta/75/0	Theta/75/0	Theta/75/0
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/195	Theta/60/150	Theta/75/150	Theta/75/105	Theta/45/150
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/90	Theta/75/135	Theta/75/135	Theta/75/135	Theta/75/135
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/45/345	Theta/75/240	Phi/75/240	Theta/75/270	Phi/75/270
Max Gain (dBi)	3.74	4.38	4.4	2.9	3.04
DG [1SS] (dBi)	7.55	6.83	6.24	5.74	5.92
DG [2SS] (dBi)	4.55	4.38	4.4	2.9	3.04
DG [4SS] (dBi)	1.67	1.22	0.72	-0.03	0.2



DG 1SS Result

Table with columns for Freq(Hz), DG(dB), and various Phi angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, and 5.3G. The table contains multiple rows of data for each frequency, showing gain values in dB.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4TX

Appendix B

Table with columns for frequency (5.6G, 5.785G), polarization (Phi, Theta), and gain values for various angles (0 to 180 degrees) across multiple frequency bands.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4Tx

Appendix B

Gain Result

Table with columns for Freq(Hz), Gain, and various Phi and Theta angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, and 5.3G. The table contains multiple rows of numerical data representing gain values in different directions.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4Tx

Appendix B

Table with columns for frequency (5.6G, 5.785G, 2.45G, 5.2G), gain, and various angles (Theta, Phi) from 0 to 180 degrees. The table contains numerical data for each combination of frequency and angle.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4Tx

Appendix B

Table with columns for frequency (5.3G, 5.6G, 5.785G), polarization (Pol), phase (Phi), and antenna (Ant. 2, 3). Rows list gain values for various angles (Theta) and phases (Phi) from 0 to 345 degrees.



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4Tx

Appendix B

Table with columns for frequency (2.45G, 5.2G, 5.3G, 5.6G), polarization (Pol.), theta angle, and gain values for various phi angles (0 to 345 degrees).



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4Tx

Appendix B

Table with columns for frequency (5.785G, 2.45G, 5.2G), polarization (Phi), and gain values for various angles (Theta) and azimuthal angles (Phi). Includes sub-headers for Gain, Phi(0), Phi(15), Phi(30), Phi(45), Phi(60), Phi(75), Phi(90), Phi(105), Phi(120), Phi(135), Phi(150), Phi(165), Phi(180), Phi(195), Phi(210), Phi(225), Phi(240), Phi(255), Phi(270), Phi(285), Phi(300), Phi(315), Phi(330), Phi(345).



Radiated Composite Gain of 2.4GHz 5GHz U-NII 1~U-NII 3 4Tx

Appendix B

Table with columns for frequency (5.3G, 5.6G, 5.785G), polarization (Phi), and antenna (Ant. 4), and rows for gain at various angles (Theta) from 0 to 180 degrees.



Total Gain Data

Table with columns for Freq(Hz), Pol., Total, Ant. 1, and various azimuth angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, 5.3G, 5.6G, 5.785G, and 5.2G. Each cell contains a numerical gain value.



Antenna Pattern of 2.4GHz 5GHz U-NII 1~U-NII 3

Appendix C

Table with columns for frequency (5.3G, 5.6G, 2.45G, 5.2G, 5.3G, 5.6G), gain, and various angles (0 to 180 degrees). It contains numerical data for antenna patterns across multiple frequencies and gain levels.



Antenna Pattern of 2.4GHz 5GHz U-NII 1~U-NII 3

Appendix C

Table with columns for frequency (5.785G, 2.45G, 5.2G, 5.3G, 5.6G, 5.785G), polarization (Pol.), total gain, antenna number (Ant. 3, 4), and azimuth/elevation angles (Theta and Phi) from 0 to 180 degrees. Values represent gain in dB.

E1(XY plane) – $\Theta(90)\Phi(0-360)$
 E2(XZ plane) – $\Theta(0-180)\Phi(0)$ and $\Theta(0-180)\Phi(180)$
 E3(YZ plane) – $\Theta(0-180)\Phi(90)$ and $\Theta(0-180)\Phi(270)$

