



# Antenna Composite Gain Test Report

Equipment	802.11ax 6E Wireless Access Point
Brand Name	Juniper
Model Name	AP34
Applicant	Juniper Networks, Inc. 1133 Innovation Way Sunnyvale, California 94089 USA
Manufacturer	Juniper Networks, Inc. 1133 Innovation Way Sunnyvale, California 94089 USA
Sample Received	Mar. 22, 2022
Start Test Date	Mar. 23, 2022
Final Test Date	Mar. 23, 2022



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### 1. Operation Mode and Antenna Information

Antenna Position	RF Port		Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
	2.4GHz	5GHz					
2G 5GAnt1	1	2	Juniper	AP34	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~3
2G 5GAnt2	2	1	Juniper	AP34	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~3

Note:

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

2G 5GAnt1~2 can be used as transmitting/receiving antenna.

2G 5GAnt1~2 could transmit/receive simultaneously.

### 2. Test Frequency

The listed 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	23.5-24.5 / 50-55	Mar. 23, 2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m\*6m\*6m

Characteristic: Fully Anechoic Chamber

#### 4. Test Facility and Configuration

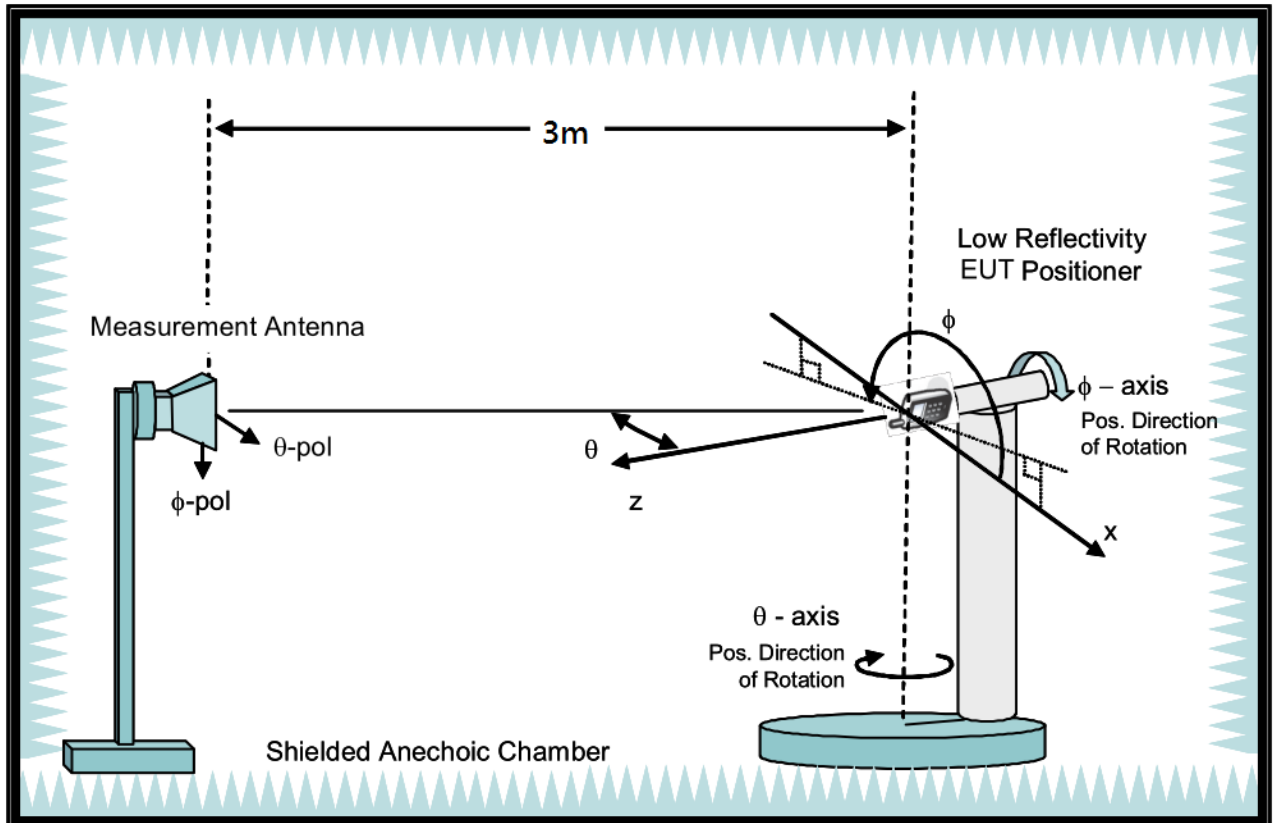
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

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

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

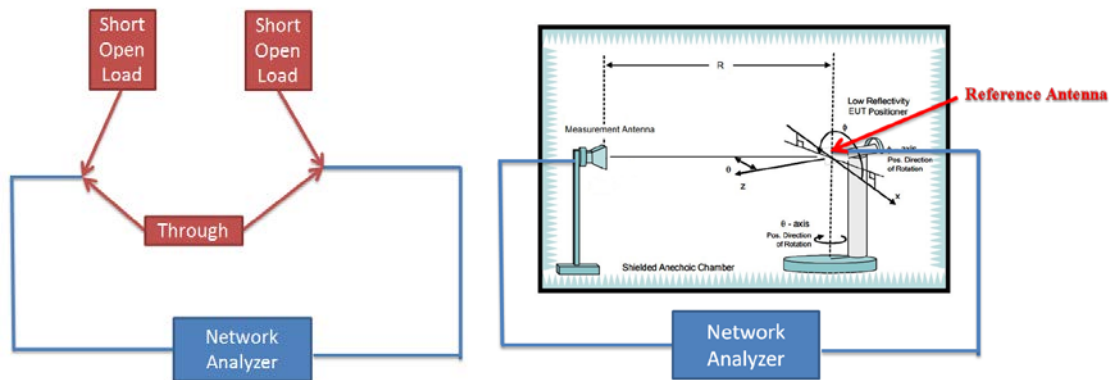
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



### 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 e) (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

#### DG\_1SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	2.63	1.77	1.49	-0.39	2.02
Ant. 2 (dBi)	2.11	1.26	-0.45	1	-1.88
DG [1SS] (dBi)	5.38	4.53	3.58	3.34	3.3
Polarization	Theta	Theta	Theta	Theta	Theta
$\Theta$ (°)	60	60	75	60	75
$\Phi$ (°)	270	135	315	90	15

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 [ $10^{(G/20)}$ ]	$10^{(2.63/20)}$	$10^{(1.77/20)}$	$10^{(1.49/20)}$	$10^{(-0.39/20)}$	$10^{(2.02/20)}$
Ant. 2 [ $10^{(G/20)}$ ]	$10^{(2.11/20)}$	$10^{(1.26/20)}$	$10^{(-0.45/20)}$	$10^{(1/20)}$	$10^{(-1.88/20)}$
Ant. 1 [ $10^{(G/20)}$ ] value	1.354	1.226	1.187	0.956	1.262
Ant. 2 [ $10^{(G/20)}$ ] value	1.275	1.156	0.95	1.122	0.805
Sum All Antenna [Amax]	2.629	2.382	2.137	2.078	2.067
DG [ $10 \cdot \log(A_{max}^2/N_{ant})$ ]	5.38	4.53	3.58	3.34	3.3

Note:

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

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





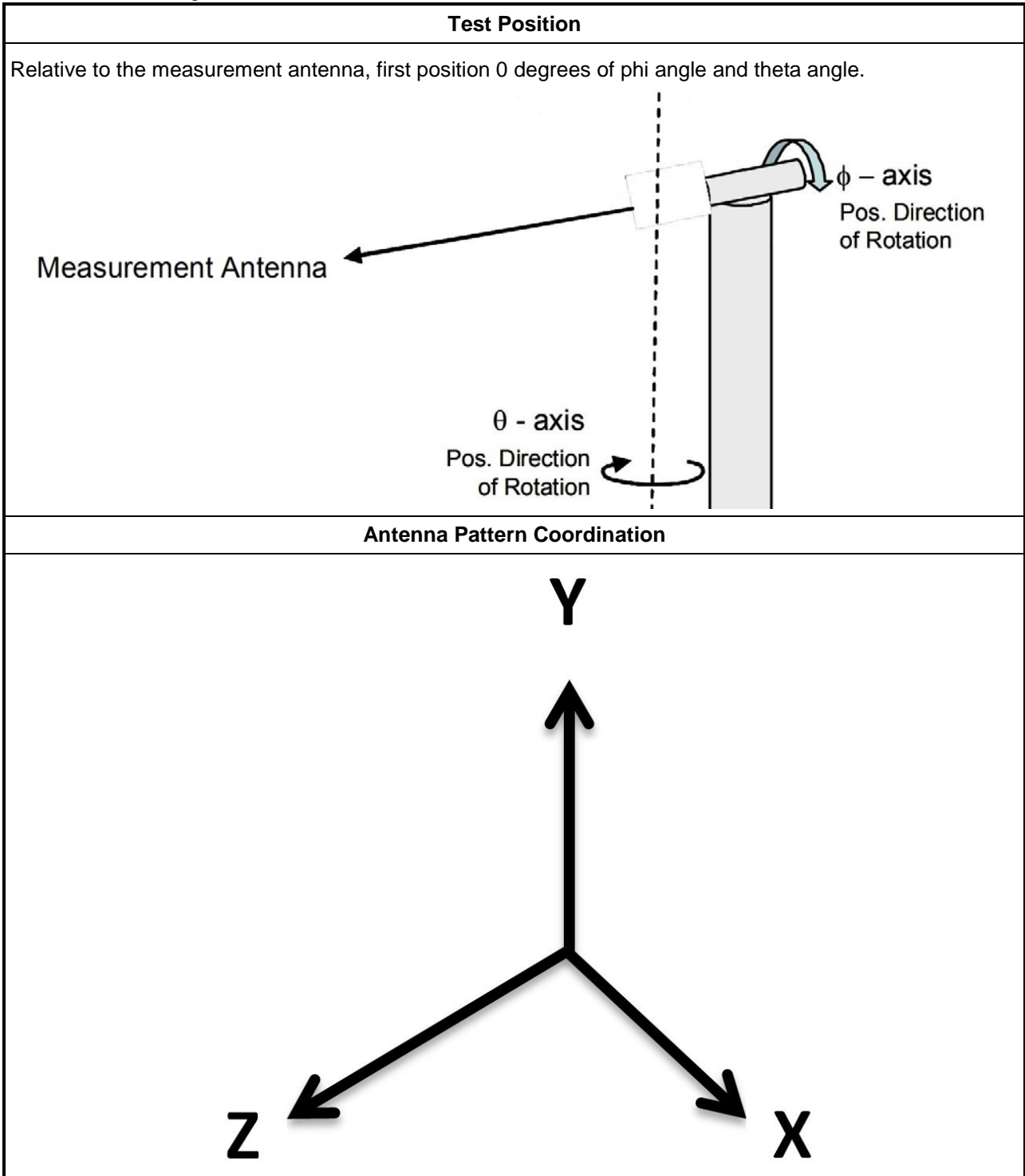
### 8. Summary of Test Result

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.63	2.4	2.13	2.25	2.02
Ant. 2 Max Gain (dBi)	2.11	2.38	2.2	2.33	2.07
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/60/270	Theta/60/180	Theta/75/15	Theta/75/15	Theta/75/15
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/60/90	Theta/60/0	Theta/75/165	Theta/75/195	Theta/60/285
Max Gain (dBi)	2.63	2.4	2.2	2.33	2.07
DG [1SS] (dBi)	5.38	4.53	3.58	3.34	3.3
DG [2SS] (dBi)	2.63	2.4	2.2	2.33	2.07

Note:

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

### 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
ENA Series Network Analyzer	AGILENT	E5071C	MY46419201	100kHz~8.5GHz	Feb. 21, 2022	Feb. 20, 2023
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 and 5GHz U-NII 1 and U-NII 3.....Page 14  
Appendix B – Antenna Pattern of 2.4GHz and 5GHz U-NII 1 and U-NII 3.....Page 20  
Appendix C – Test Photos..... Page 24



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.63	2.4	2.13	2.25	2.02
Ant. 2 Max Gain (dBi)	2.11	2.38	2.2	2.33	2.07
Ant. 1 Polarization/ $\Theta$ (°)/ $\Phi$ (°)	Theta/60/270	Theta/60/180	Theta/75/15	Theta/75/15	Theta/75/15
Ant. 2 Polarization/ $\Theta$ (°)/ $\Phi$ (°)	Theta/60/90	Theta/60/0	Theta/75/165	Theta/75/195	Theta/60/285
Max Gain (dBi)	2.63	2.4	2.2	2.33	2.07
DG [1SS] (dBi)	5.38	4.53	3.58	3.34	3.3
DG [2SS] (dBi)	2.63	2.4	2.2	2.33	2.07



DG 1SS Result

Table with columns: Freq(Hz), 2.45G, Pol., Phi, and 24 directional gain values (Phi(0°) to Phi(345°)). Multiple sections for 2.45G, 5.2G, and 5.3G frequencies.



Radiated Composite Gain

Appendix A

Θ(180°)	-5.08	-5.2	-7.6	-9.15	-12.22	-15.37	-14.3	-15.25	-11.77	-8.85	-7.36	-5.55	-5.89	-6.42	-7.88	-10.88	-12.19	-14.57	-15.68	-14.2	-12.46	-9.11	-7.46	-5.65
Freq(Hz)	5.6G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	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°)	-13.98	-11.5	-5.84	-4.55	-1.81	-2.11	-1.73	-2.77	-2.81	-5.36	-7.57	-14.13	-14.48	-11.73	-5.49	-4.09	-2.44	-2.35	-2.33	-2.97	-3.44	-6.39	-9.29	-15.27
Θ(15°)	-15.02	-14.48	-6.23	-4.42	-3.68	-1.79	-0.66	-2.65	-5.24	-6.56	-9.58	-13.79	-14.32	-11.91	-6.19	-4.12	-3.64	-3.73	-1.96	-1.3	-2.45	-4.28	-6.85	-11.68
Θ(30°)	-14.74	-11.28	-7.27	-5.52	-3.44	-1.2	-4.06	-3.06	-5.24	-4.39	-7.74	-10.26	-15.52	-10.09	-6.19	-3.88	-4.07	-3.92	-3.72	-3.26	-2.77	-5.32	-8.82	-15.7
Θ(45°)	-9.67	-14.73	-15.35	-9.58	-4.16	-2.64	-2.25	-5.33	-4.05	-10.53	-14.95	-10.67	-15.27	-10.25	-13.1	-7.12	-4.86	-3.59	-4.1	-2.97	-3.83	-11.16	-15.07	-11.23
Θ(60°)	-14.22	-15.79	-8.54	-8.03	-5.08	-5.45	-2.92	-3.83	-3.19	-8.53	-8.44	-12.04	-14.76	-12.04	-9.88	-7.17	-4.84	-3.69	-3.65	-4.91	-9.02	-8.02	-5.67	-12.02
Θ(75°)	-15.06	-13.12	-13.83	-10.08	-4.05	-9.18	-8.31	-5.75	-5.05	-11.54	-11.69	-11.19	-15.09	-10.68	-12.59	-10.08	-5.3	-5.6	-5.47	-3.74	-5.45	-12.51	-8.39	-11.84
Θ(90°)	-15.64	-12.01	-14.88	-6.71	-5.26	-7.54	-11.2	-9.21	-4.21	-6.58	-14.38	-10.58	-15.09	-12.49	-14.7	-5.88	-3.56	-9.66	-10.41	-4.67	-4.88	-10.84	-10.45	-15.32
Θ(105°)	-15.21	-13.56	-15.46	-7.96	-6.56	-7.7	-8.18	-9.66	-5.26	-7.84	-13.02	-15.67	-14.2	-14.35	-14.62	-5.49	-10.56	-11.1	-4.86	-7.66	-8.85	-10.51	-14.95	-15.77
Θ(120°)	-14.86	-9.86	-10.16	-10.65	-9.9	-7.78	-5.4	-7.44	-9.99	-12.06	-11.72	-15.12	-15.12	-13.57	-14.19	-11.56	-7.32	-9.71	-3.87	-7.88	-8.99	-9.68	-11.18	-15.38
Θ(135°)	-12.56	-12.22	-11.96	-11.82	-13.1	-10.15	-8.53	-12.71	-10.69	-9.8	-10.89	-13.01	-15.22	-15.78	-11.59	-10.45	-15.35	-10.5	-8.93	-9.07	-13.25	-10.84	-8.79	-15.61
Θ(150°)	-15.38	-14.55	-12.56	-11.22	-8.16	-9.97	-8.35	-9.34	-7.93	-11.95	-13.81	-15.79	-14.98	-14.27	-13.36	-12.97	-13.29	-13.13	-12.6	-11.49	-11.41	-13.64	-13.81	-15.03
Θ(165°)	-15.86	-15.29	-15.84	-15.2	-15.43	-13.67	-8.5	-13.31	-14.79	-15.28	-15.15	-15.43	-15.81	-15.31	-14.94	-10.88	-10.06	-10.11	-11.28	-12.71	-11.86	-12.43	-14.23	-15.38
Θ(180°)	-15.08	-14.16	-12.92	-11.29	-11.04	-11.24	-10.89	-10.19	-11.4	-14.05	-13.71	-15.19	-15.51	-15.74	-15.8	-13.66	-11.2	-10.93	-11.12	-12.23	-12.41	-10.56	-12.33	-13.01
Freq(Hz)	5.6G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	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°)	-2.38	-2.44	-3.43	-6.1	-8.33	-14.44	-14.82	-10.62	-6.42	-4.29	-2.34	-1.34	-2.1	-2.6	-3.93	-5.26	-10.12	-14.9	-15.22	-9.56	-6.26	-3.57	-2.14	-1.81
Θ(15°)	-1.41	-1.24	-1.53	-3.42	-5.81	-6.47	-6.9	-6.25	-5.71	-3.38	-1.68	-1.75	-1.77	-1.77	-2.13	-3.5	-6.79	-8.63	-9.42	-7.35	-5.1	-2.69	-1.45	-0.97
Θ(30°)	-1.57	-0.52	-0.28	-1.61	-3	-3.86	-4	-3.65	-3.89	-0	-0.34	-1.09	-1.07	-0.9	-1.02	-0.69	-2.17	-4.8	-5.61	-4.69	-3.2	-0.43	-1.03	-0.81
Θ(45°)	1.67	2.28	1.85	-0.27	-1.27	-1.3	-0.8	-2.6	-0.67	-0.01	0.68	1.46	1.81	1.55	1.45	-1.86	-2.38	-2.12	-2.18	-2.59	-2.15	-1.58	0.87	0.58
Θ(60°)	0.03	2.46	-0.88	1.9	0.37	1.69	3.34	2.37	1.98	1.79	-0.16	2.23	0.42	2.13	0.29	0.24	-0.42	0.16	0.48	0.85	-0.7	1.03	0.31	2.27
Θ(75°)	0.31	3.18	0.93	1.62	-1.19	1.92	1.45	1.71	2.26	1.92	1.28	2.58	1.61	3.08	0.88	0.68	0.35	1.45	2.84	0.96	-0.52	1.3	2.08	2.48
Θ(90°)	-2.4	0.46	-1.3	-1.14	-3.25	-0.75	-1.82	-1.94	-1.55	-1.98	-0.6	0.64	-0.4	-0.55	-2.01	-0.8	-1.12	0.17	1.65	-2.02	-1.71	0.25	-1.73	1.04
Θ(105°)	-6.29	-2.17	-5.63	-4.64	-7.6	-7.57	-7.83	-9.76	-5.7	-4.79	-4.77	-2.62	-5.45	-2.87	-4.41	-6.07	-5.37	-7.43	-6.41	-7.21	-7.31	-5.71	-3.46	-2.7
Θ(120°)	-5.74	-5.88	-8.26	-8.55	-13.11	-12.78	-11.59	-13.3	-14.2	-7.38	-8.11	-5.08	-5.53	-3.81	-6.39	-8.77	-8.77	-12.39	-10.95	-15.86	-11.36	-5.82	-7.85	-4.02
Θ(135°)	-10.31	-6.98	-8.96	-12.63	-10.57	-13.2	-15.36	-14.83	-12.94	-13.81	-10.16	-9.22	-9.44	-8.24	-7.96	-12	-11.4	-12.33	-10.71	-15.59	-12.69	-13.93	-6.98	-7.19
Θ(150°)	-11.71	-7.06	-9.26	-14.27	-15.47	-14.17	-15.71	-14.55	-13.59	-13.76	-10.8	-7.28	-10.25	-9.8	-13.43	-13.53	-15.74	-14.53	-14.7	-15.78	-15.37	-11.19	-10.68	-8.55
Θ(165°)	-9.84	-9.47	-10.18	-14.29	-14.58	-15.23	-15.59	-16.11	-15.32	-15.59	-10.52	-10.42	-11.21	-12.27	-12.11	-14.13	-15.22	-13.39	-15.75	-14.5	-13.55	-10.78	-10.8	-12.69
Θ(180°)	-6.66	-6.8	-9.06	-10.94	-13.01	-15.59	-15.1	-15.75	-14.7	-13.7	-11.7	-8.52	-7.24	-8.52	-11.67	-12.02	-15.13	-15.87	-14.92	-15.06	-15.6	-12.21	-9.73	-7.92
Freq(Hz)	5.785G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	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°)	-15.04	-12.24	-8.1	-5.61	-3.95	-3.89	-3.42	-3.32	-4.47	-7.7	-9.46	-13.92	-14.88	-11.59	-8.23	-5.2	-3.74	-2.71	-2.9	-3.49	-4.88	-6.88	-9.6	-15.6
Θ(15°)	-14.56	-12.7	-6.84	-4.12	-3.29	-1.7	-1.48	-2.61	-5.02	-8.32	-10.56	-14.96	-14.42	-11.65	-7.06	-4.94	-3.86	-2.11	-1.2	-1.54	-3.4	-4.37	-6.7	-12.02
Θ(30°)	-15.12	-12.04	-7.16	-6.23	-3.96	-3.31	-3.46	-4.47	-4.73	-4.3	-7.87	-12.25	-15.6	-14.28	-5.13	-3.89	-3.01	-3.99	-3.72	-3.92	-3.17	-5.52	-10.35	-15.17
Θ(45°)	-9.53	-14.08	-16.02	-10.21	-4.47	-2.42	-3.02	-4.37	-3.83	-10	-15.4	-12.05	-15.74	-11.77	-13.23	-9.36	-4.68	-4.34	-5.97	-4.46	-4.63	-8.55	-13.71	-9.46
Θ(60°)	-13.6	-14.47	-10.59	-8.16	-5.31	-3.88	-4.18	-4.38	-4.92	-8.05	-11.75	-15.8	-15.36	-16.25	-9.95	-7.64	-5.72	-3.22	-5.06	-5.82	-11.17	-10.15	-7.28	-10.38
Θ(75°)	-14.96	-15.48	-14.16	-11.57	-5.82	-7.6	-9.54	-8.74	-3.51	-10.8	-11.93	-15.13	-16.02	-12.11	-13.38	-11.59	-5.75	-6.77	-5.81	-4.82	-5.55	-11.47	-7.54	-14.01
Θ(90°)	-15.6	-14.3	-12.96	-6.37	-5.8	-10.63	-14.03	-9.34	-4.05	-5.73	-14.27	-12.1	-15.91	-12.71	-15.29	-5.96	-6.13	-11.42	-15.05	-7.01	-5.74	-9.07	-11.94	-14.9
Θ(105°)	-15.73	-14.3	-14.2	-8.77	-7.98	-8.82	-9.17	-9.26	-6.93	-8.25	-14.44	-13.78	-15.7	-14.81	-14.49	-6.14	-10.15	-10.99	-7.88	-11.19	-8.9	-8.92	-14.03	-15.11
Θ(120°)	-15.76	-11.38	-15.2	-13.47	-8.92	-9.19	-7.95	-8.34	-10.75	-15.39	-13.84	-15.61	-14.85	-14.82	-13.27	-12.35	-8.32	-9.9	-5.24	-9.44	-8.66	-11.47	-12.85	-15.65
Θ(135°)	-11.92	-15.39	-13.36	-13.12	-11.31	-10.52	-12.57	-12.14	-13.52	-10.93	-11.61	-13.93	-15.06	-14.43	-15.78	-11.79	-13.1	-8.89	-7.03	-9.85	-13.47	-13.42	-11.54	-15.47
Θ(150°)	-15.66	-15.64	-12.35	-11.04	-8.06	-10.25	-12.47	-11	-10.73	-10.98	-15.12	-13.1	-14.21	-13.98	-13.03	-13.98	-15.35	-13.31	-12.49	-12.03	-14.9	-15.79	-13.23	-15.59
Θ(165°)	-15.22	-15.91	-14.8	-14.82	-16.04	-12.13	-8.83	-10.52	-11.99	-14.37	-15.3	-14.74	-15.65	-15.94	-15.99	-13.57	-12.19	-9.91	-9.81	-11.72	-11.88	-13.71	-14.56	-15.13
Θ(180°)	-16.3	-14.87	-13.3	-13.58	-13.42	-12.39	-13.21	-12.47	-14.27	-14.87	-15.15	-15.23	-14.85	-15.72	-15.49	-13.01	-13.5	-14.55	-15.11	-13.21	-13.51	-14.14	-13.69	-15.68
Freq(Hz)	5.785G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	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°)	-2.83	-3.22	-4.76	-7.2	-10.7	-14.23	-15.64	-11.45	-7.33	-5.36	-3.79	-2.68	-3.17	-3.63	-5.06	-7.31	-10.24	-14.89	-15.47	-10.67	-7.27	-4.93	-3.59	-2.8
Θ(15°)	-1.88	-1.64	-1.84	-3.1	-6.17	-7.21	-6.64	-7.04	-5.94	-4.05	-2.86	-2.17	-2.39	-1.45	-1.32	-3.8	-7.73	-8.21	-8.73	-7.45	-4.62	-2.62	-1.28	-1.66
Θ(30°)	-2.62	-0.09	-0.38	-1.66	-3.87	-3.93	-3.47	-4.63	-3.22	-1.7	-0.26	-0.23	-1.44	-0.77	-1.11	-2.79	-3.64	-5.04	-5.16	-5.49	-3.95	-1.14	0.04	-1.05
Θ(45°)	0.72	1.77	0.91	-0.65	-0.37	-1.98	-0.13	-1	-0	-1.86	-0.55	1.71	1.3	1.42	1.33	-1.23	-0.75	-2.23	-0.81	-1.68	-2.51	-1.47	0.87	1.03
Θ(60°)	-0.23	2.21	0.24	1.37	0.98	0.5	2	1.91	2.2															



Gain Result

Table with columns: Freq(Hz), Pol., Phi, Ant. 1, and Gain for various angles (Theta) and frequencies (2.45G, 5.2G, 5.3G, 5.6G). Rows include Gain, Theta (0 to 120 degrees), and Freq(Hz) for each frequency band.





Radiated Composite Gain

Appendix A

Table with columns for Frequency (5.6G, 5.785G, 2.45G, 5.2G), Polarization (Pol.), Phase (Theta), Antenna (Ant. 1, 2), and Gain (Phi(0) to Phi(345)).



Radiated Composite Gain

Appendix A

Table with columns for frequency (5.3G, 5.6G, 5.785G), polarization (Pol.), phase (Phi), antenna (Ant. 2), and gain for various angles (Theta and Phi) from 0 to 180 degrees.



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

Appendix B

Total Gain Data

Table with columns for Freq(Hz), Pol., Total, and Ant. 1-2, and rows for Gain and various theta angles (0 to 120 degrees) across multiple frequency bands (2.45G, 5.2G, 5.6G, 5.785G).



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

Appendix B

Θ(135°)	-6.44	-12.45	-10.18	-8.24	-7.81	-7.00	-7.53	-9.66	-8.94	-13.52	-8.74	-8.13	-13.17	-9.19	-10.81	-9.14	-10.97	-8.39	-6.63	-6.89	-8.48	-7.05	-10.21	-8.08
Θ(150°)	-7.24	-10.49	-16.14	-8.68	-9.86	-9.25	-13.43	-11.47	-13.33	-12.75	-14.89	-14.06	-13.92	-13.12	-13.37	-14.36	-15.54	-12.74	-11.01	-9.52	-13.38	-12.48	-15.66	-9.21
Θ(165°)	-9.41	-10.96	-12.01	-13.22	-9.71	-9.83	-12.88	-13.26	-12.75	-15.43	-15.30	-15.52	-15.32	-10.60	-9.66	-8.90	-11.21	-15.48	-13.01	-9.68	-9.93	-11.94	-8.17	-7.95
Θ(180°)	-7.31	-7.30	-8.38	-9.01	-10.02	-11.64	-11.85	-11.50	-12.00	-9.96	-9.48	-9.96	-7.93	-8.26	-7.39	-8.54	-8.29	-7.72	-8.15	-8.15	-8.03	-7.75	-6.59	-6.28
Freq(Hz)	5.3G	Pol.	Total	Ant. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gain	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°)	-4.32	-5.01	-4.86	-5.28	-4.81	-5.01	-4.35	-4.62	-4.30	-4.39	-4.57	-4.46	-4.65	-4.40	-5.00	-4.69	-5.31	-4.54	-4.50	-4.60	-4.90	-4.20	-4.75	-5.33
Θ(15°)	-0.32	-1.43	-4.14	-4.87	-3.86	-3.38	-5.73	-8.29	-8.00	-5.56	-4.02	-4.99	-6.32	-6.27	-5.45	-4.50	-5.21	-4.95	-4.50	-3.93	-4.04	-2.21	-1.43	-0.84
Θ(30°)	0.98	-0.32	-2.79	-2.62	-1.58	-0.95	-3.74	-3.69	-4.99	-3.74	-3.00	-5.40	-7.41	-6.28	-2.51	-3.60	-2.60	-3.86	-3.07	-0.56	-3.19	-1.13	-3.25	-0.92
Θ(45°)	-1.52	-2.05	-2.71	-0.30	0.16	-0.63	-2.22	-3.24	-2.22	-3.89	-4.40	-0.05	-2.66	0.50	-3.34	-1.36	-3.03	-2.08	-1.19	-0.37	-0.10	1.02	-2.24	-2.07
Θ(60°)	1.42	-2.14	-0.67	0.97	-0.01	0.16	1.04	0.35	0.40	0.08	-1.24	0.98	-3.36	0.07	0.24	-0.37	-2.25	-1.73	-1.68	-2.64	-0.99	0.32	-1.99	-3.09
Θ(75°)	-2.22	-5.31	-1.47	-1.16	-0.46	0.47	0.32	-1.07	-0.36	0.18	0.15	2.56	-1.47	1.93	-0.20	0.36	-2.06	0.37	0.80	-1.25	-5.10	-0.34	-1.98	-4.45
Θ(90°)	-2.25	-6.44	-2.98	-3.57	-2.94	-1.57	-3.17	-4.89	-2.97	-2.31	-4.38	-0.78	-4.67	-2.15	-3.27	-2.64	-2.40	-3.10	-1.14	-3.37	-6.86	-1.56	-3.60	-6.30
Θ(105°)	-2.88	-7.95	-4.78	-5.68	-5.00	-5.44	-5.02	-7.56	-7.83	-6.73	-7.65	-4.69	-13.72	-4.88	-9.73	-5.67	-11.12	-7.11	-4.47	-11.16	-6.82	-4.12	-4.94	-9.10
Θ(120°)	-3.36	-10.07	-6.96	-5.91	-9.71	-7.04	-7.66	-5.74	-13.00	-10.33	-7.40	-6.61	-11.10	-6.33	-12.15	-7.72	-8.21	-8.87	-7.36	-8.58	-8.67	-4.73	-7.77	-10.05
Θ(135°)	-5.49	-12.95	-15.26	-8.85	-6.71	-9.12	-10.19	-9.71	-8.07	-15.49	-8.62	-8.95	-12.66	-10.46	-13.21	-11.32	-11.70	-9.28	-5.93	-8.24	-10.08	-7.63	-11.27	-8.36
Θ(150°)	-7.68	-8.06	-14.42	-10.84	-9.66	-10.35	-14.26	-10.16	-13.52	-12.95	-13.37	-12.07	-15.01	-14.49	-15.10	-14.91	-15.16	-13.48	-11.36	-10.19	-11.38	-14.30	-15.18	-10.99
Θ(165°)	-9.07	-9.55	-9.68	-12.58	-12.15	-10.05	-10.43	-12.33	-12.60	-14.09	-12.58	-13.12	-15.28	-11.80	-9.93	-10.90	-14.64	-15.55	-12.82	-13.36	-13.91	-11.38	-8.28	-7.64
Θ(180°)	-7.22	-6.98	-8.65	-8.37	-10.17	-11.14	-11.32	-12.69	-11.41	-10.23	-9.87	-8.97	-9.09	-8.56	-7.75	-8.10	-7.40	-6.66	-7.68	-8.54	-9.41	-7.07	-7.15	-6.38
Freq(Hz)	5.6G	Pol.	Total	Ant. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gain	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°)	-6.07	-5.76	-5.34	-5.85	-3.75	-5.73	-5.48	-6.57	-6.08	-5.99	-5.34	-5.02	-5.75	-6.39	-6.51	-5.39	-5.92	-6.56	-5.77	-5.79	-5.60	-5.83	-5.32	-5.70
Θ(15°)	-2.50	-2.70	-2.29	-3.50	-2.89	-2.81	-3.69	-6.19	-7.84	-6.44	-6.18	-6.90	-7.32	-5.76	-5.53	-4.61	-5.65	-7.13	-3.44	-1.84	-1.62	-1.89	-1.65	-1.90
Θ(30°)	-1.63	-0.91	-1.01	-1.85	-2.32	-1.54	-3.76	-6.11	-2.62	-2.79	-6.23	-8.10	-5.98	-2.95	-2.93	-3.85	-5.04	-3.05	-2.50	-1.68	-0.26	-1.80	-0.60	
Θ(45°)	-0.34	-0.84	0.63	-1.23	-0.57	-1.01	-0.15	-4.07	-3.93	-4.54	-3.05	-1.64	-3.27	-0.88	-2.43	-4.73	-4.63	-2.62	-3.07	-3.15	-0.72	-2.61	-0.26	-2.67
Θ(60°)	-1.55	-0.37	-3.08	-0.08	0.15	1.22	2.02	-0.39	0.78	-0.84	-2.23	-0.05	-3.00	0.02	-2.23	-1.92	-3.11	-2.48	-0.64	0.13	-2.03	-1.38	-1.35	-0.42
Θ(75°)	-3.04	-2.46	-2.38	-0.99	-2.12	0.95	-0.54	-1.09	0.03	0.07	0.05	1.86	-1.05	2.53	-1.17	-1.83	-1.59	-0.60	0.24	0.60	-1.84	-3.20	-1.66	-2.86
Θ(90°)	-3.52	-3.80	-2.62	-3.01	-2.75	-1.54	-4.06	-5.21	-3.09	-3.07	-3.71	-1.43	-4.55	-1.94	-5.24	-2.20	-0.76	-2.39	-0.67	-2.01	-3.12	-5.00	-3.68	-3.57
Θ(105°)	-6.26	-5.68	-4.98	-5.04	-4.81	-6.36	-8.25	-12.32	-6.13	-5.74	-10.16	-4.42	-11.19	-5.66	-9.02	-6.30	-9.02	-10.94	-4.68	-5.61	-5.95	-7.34	-5.19	-4.98
Θ(120°)	-6.67	-8.76	-8.25	-6.37	-9.35	-8.87	-7.64	-10.47	-15.18	-10.27	-9.22	-8.30	-9.96	-5.21	-12.61	-9.27	-12.59	-12.26	-5.94	-8.82	-9.33	-10.21	-9.59	-8.17
Θ(135°)	-10.17	-8.32	-11.34	-9.81	-11.00	-9.70	-10.59	-13.47	-12.05	-10.95	-11.98	-10.18	-12.78	-10.40	-12.89	-15.63	-10.64	-13.52	-10.86	-14.54	-11.26	-10.09	-8.51	-9.51
Θ(150°)	-12.10	-10.13	-9.27	-12.34	-10.64	-11.46	-11.66	-11.74	-13.14	-13.99	-13.63	-10.74	-14.76	-13.89	-13.52	-14.58	-14.33	-14.77	-14.61	-14.64	-10.92	-10.97	-10.32	-9.82
Θ(165°)	-12.20	-9.33	-12.83	-14.39	-15.26	-15.29	-10.83	-14.24	-15.28	-15.60	-13.78	-12.68	-11.32	-13.04	-11.65	-10.61	-14.42	-12.65	-10.73	-12.07	-13.34	-12.69	-12.10	-12.43
Θ(180°)	-9.30	-9.66	-13.44	-11.42	-14.80	-15.99	-15.05	-13.87	-14.13	-14.24	-14.69	-12.05	-10.00	-10.93	-12.26	-12.93	-13.42	-11.45	-10.73	-11.49	-12.32	-11.57	-10.37	-10.03
Freq(Hz)	5.785G	Pol.	Total	Ant. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gain	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°)	-5.76	-5.95	-7.00	-6.67	-6.25	-7.75	-6.58	-6.17	-6.07	-6.92	-6.46	-6.28	-6.34	-6.42	-6.24	-6.22	-6.32	-5.60	-6.35	-5.71	-5.54	-5.30	-5.02	-5.77
Θ(15°)	-3.13	-2.84	-1.81	-2.14	-3.23	-3.65	-4.00	-5.74	-8.58	-9.25	-8.44	-7.45	-7.22	-5.25	-5.43	-6.56	-8.17	-5.28	-3.57	-2.50	-1.39	-1.06	-1.27	-2.53
Θ(30°)	-2.28	-0.82	-0.23	-1.98	-2.67	-2.73	-2.85	-4.51	-5.92	-3.82	-3.81	-6.59	-7.67	-4.41	-3.40	-4.84	-4.59	-4.80	-3.13	-3.95	-1.64	-0.75	0.09	-1.17
Θ(45°)	-2.14	-0.30	-0.89	-0.83	-0.66	-0.84	-0.72	-3.74	-2.59	-5.57	-5.74	-2.97	-2.43	-1.53	-2.67	-6.10	-3.46	-4.03	-2.31	-2.42	-2.32	-1.55	-0.48	-1.34
Θ(60°)	-2.73	-0.40	-1.71	-0.90	-0.26	-0.43	0.50	-0.84	0.41	-1.07	-3.60	-0.34	-2.61	-0.69	-2.16	-2.27	-3.63	-2.90	-1.42	2.27	-1.63	-2.02	-0.94	0.01
Θ(75°)	-3.23	-1.79	-1.83	-0.85	-2.59	-1.37	-1.51	-3.64	0.29	-0.76	0.25	0.41	-0.44	0.35	-1.30	-2.28	-1.63	-2.37	-0.32	-0.76	-1.34	-4.29	-2.63	-1.47
Θ(90°)	-4.98	-4.61	-4.44	-3.11	-3.95	-3.02	-6.01	-7.62	-2.80	-4.91	-3.48	-3.31	-2.81	-2.23	-5.45	-1.42	-1.96	-5.48	-1.60	-3.25	-3.32	-3.91	-4.52	-3.31
Θ(105°)	-7.55	-7.02	-6.21	-5.85	-5.79	-5.11	-7.84	-11.10	-6.83	-7.39	-9.39	-4.90	-9.30	-5.71	-11.53	-5.12	-9.02	-13.92	-5.35	-7.62	-5.05	-6.70	-6.90	-6.03
Θ(120°)	-10.82	-8.11	-10.47	-7.73	-7.53	-9.92	-10.91	-12.01	-15.76	-12.85	-10.68	-7.64	-10.48	-5.36	-14.93	-9.75	-15.00	-10.81	-7.69	-9.34	-8.26	-10.04	-9.18	-7.22
Θ(135°)	-8.80	-8.61	-10.45	-10.68	-11.18	-10.05	-13.94	-11.92	-12.08	-13.00	-14.05	-9.01	-13.24	-7.47	-13.98	-15.48	-11.06	-13.01	-9.90	-12.49	-13.40	-13.04	-9.58	-8.70
Θ(150°)	-14.76	-14.57	-9.88	-13.62	-9.73	-10.91	-14.97	-12.60	-14.85	-14.24	-15.66	-12.08	-14.22	-12.01	-14.26	-15.57	-15.21	-15.74	-14.86	-15.22	-14.11	-12.83	-12.46	-14.74
Θ(165°)	-15.94	-15.50	-13.63	-14.69	-15.33	-13.68	-10.42	-11.68	-14.23	-16.03	-11.94	-12.57	-10.11	-12.14	-13.14	-14.83	-15.70	-10.53	-8.82	-11.06	-12.00	-10.03	-12.07	-12.74
Θ(180°)	-12.23	-13.36	-15.51	-16.24	-15.76	-14.98	-14.59	-13.26	-14.47	-15.15	-14.79	-14.35	-12.06	-11.79	-13.61	-12.80	-14.80	-15.24	-14.98	-13.57	-13.32	-14.85	-12.72	-13.79

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  $\Theta(0-180)\Phi(270)$

