



Antenna Composite Gain Test Report

FCC ID	MSQ-RTBE6M00
Equipment	ROG Rapture GT-BE98 Pro BE30000 Quad-band Gaming Router
Brand Name	ASUS
Model Name	GT-BE98 Pro
Applicant	ASUSTeK COMPUTER INC. 1F., No. 15, Lide Rd., Beitou, Taipei City 112, Taiwan
Sample Received	Jun. 16, 2023
Start Test Date	Jun. 26, 2023
Final Test Date	Jun. 28, 2023

Approved by: Sam Chen

Sporton International Inc. Hsinchu Laboratory

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History of this test report

Report No.	Version	Description	Issued Date
AP321615-08	01	Initial issue of report	Jul. 01, 2024



1. Operation Mode and Antenna Information

Ant. Position	Port				Brand	Model Name			Antenna Type	Connector	Modes of Operation
	WLAN 2.4GHz	WLAN 5GHz	WLAN 6GHz UNII 5/6	WLAN 6GHz UNII 7/8		WLAN 2.4GHz / WLAN5GHz	WLAN 6GHz UNII 5/6	WLAN 6GHz UNII 7/8			
6GL Ant1	-	-	1	-	Whayu	-	C660-510595-AW1	-	Dipole	I-PEX	6GHz UNII 5~6
6GL Ant2	-	-	2	-	Whayu	-	C660-510596-AW1	-	Dipole	I-PEX	6GHz UNII 5~6
6GL Ant3	-	-	3	-	Whayu	-	C660-510597-AW1	-	Dipole	I-PEX	6GHz UNII 5~6
6GL Ant4	-	-	4	-	Whayu	-	C660-510598-AW1	-	Dipole	I-PEX	6GHz UNII 5~6
6GH Ant1	-	-	-	1	Whayu	-	-	C660-510595-AW2	Dipole	I-PEX	6GHz UNII 7~8
6GH Ant2	-	-	-	4	Whayu	-	-	C660-510596-AW2	Dipole	I-PEX	6GHz UNII 7~8
6GH Ant3	-	-	-	2	Whayu	-	-	C660-510597-AW2	Dipole	I-PEX	6GHz UNII 7~8
6GH Ant4	-	-	-	3	Whayu	-	-	C660-510598-AW2	Dipole	I-PEX	6GHz UNII 7~8
2G5G Ant1	4	1	-	-	Whayu	C660-510591-AW1	-	-	Dipole	I-PEX	2.4GHz, 5GHz UNII 1~3
2G5G Ant2	1	4	-	-	Whayu	C660-510592-AW1	-	-	Dipole	I-PEX	2.4GHz, 5GHz UNII 1~3
2G5G Ant3	2	3	-	-	Whayu	C660-510593-AW1	-	-	Dipole	I-PEX	2.4GHz, 5GHz UNII 1~3
2G5G Ant4	3	2	-	-	Whayu	C660-510594-AW1	-	-	Dipole	I-PEX	2.4GHz, 5GHz UNII 1~3

Note:

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

2G5GAnt1~4 can be used as transmitting/receiving antenna.

2G5GAnt1~4 could transmit/receive simultaneously.

6GHz Operation Mode (4TX/4RX) – UNII 5~6

6GL Ant1~4 can be used as transmitting/receiving antenna.

6GL Ant1~4 could transmit/receive simultaneously.

6GHz Operation Mode (4TX/4RX) – UNII 7~8

6GH Ant1~4 can be used as transmitting/receiving antenna.

6GH Ant1~4 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
5925-6425	6175
6425-6525	6475
6525-6875	6695
6875-7125	6995

3. Testing Location

Testing Location		
Sporton International Inc. Hsinhua Laboratory		
<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 / 40-50	Jun. 26, 2023~Jun. 28, 2023

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

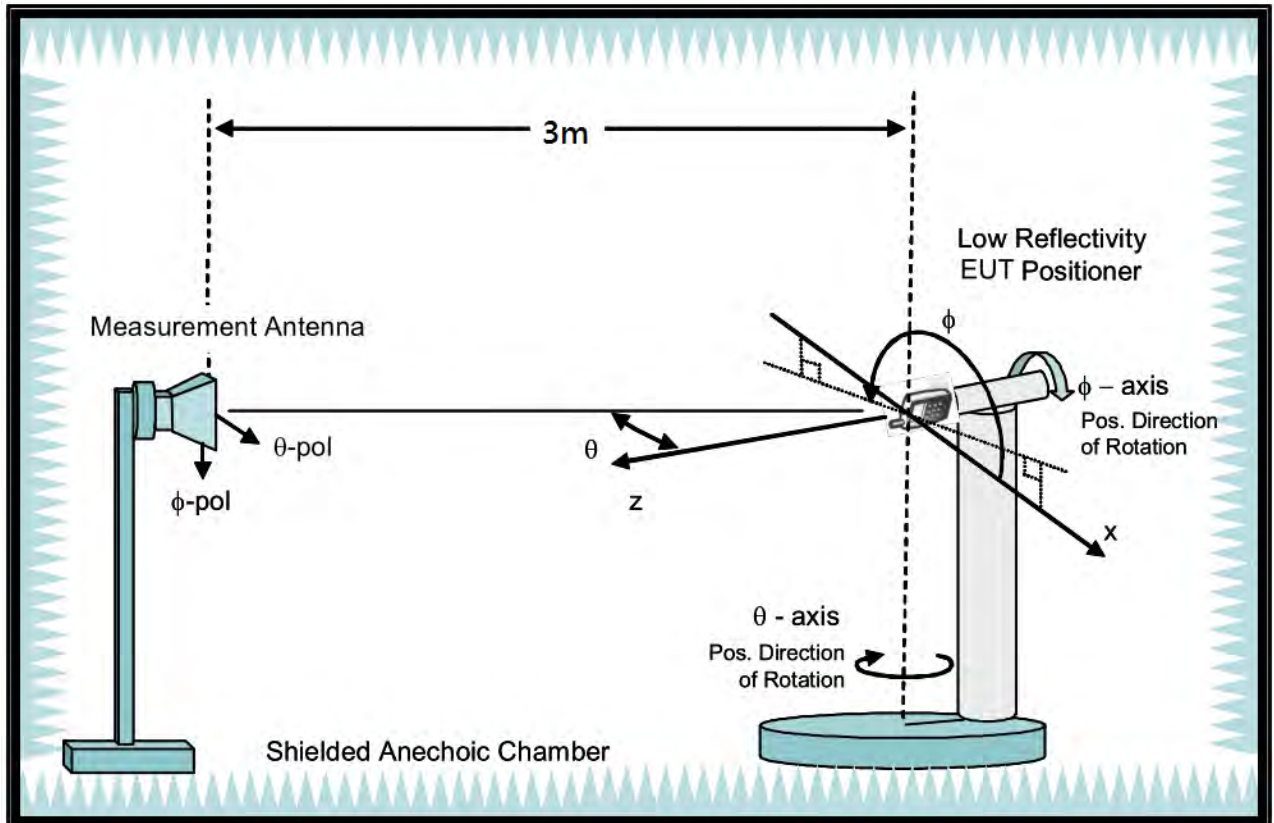
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

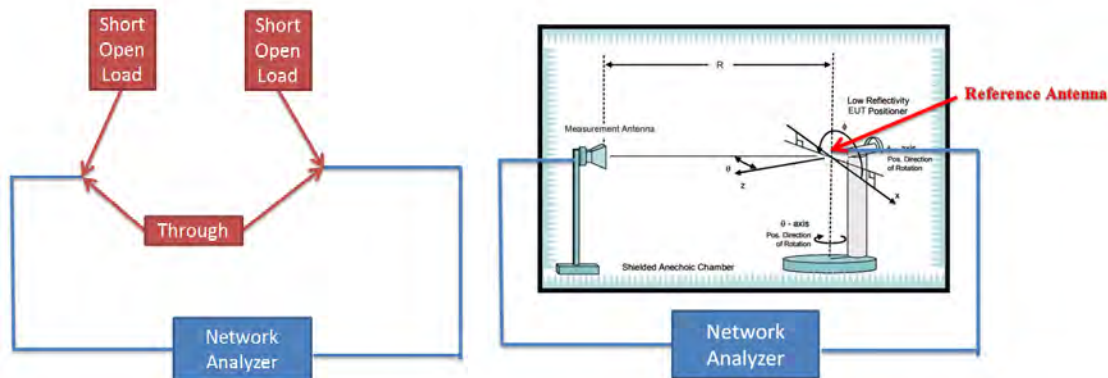
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



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 G 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 G 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	7200
G(theta) reading (dB)	-33.75	-33.64	-32.91	-32.21	-32.45	-32.33	-32.57	-32.94	-32.78	-33.35	-32.91	-33.81	-34.54	-35.64
G(phi) reading (dB)	-33.19	-32.12	-32.48	-32.51	-32.64	-31.68	-32.24	-32.45	-32.45	-32.85	-32.45	-33.62	-34.48	-35.24
Reference gain (dBi)	10	10.4	10.6	12.3	12.5	13.3	13.3	13.2	13.1	13	13.2	12.4	11.8	11.1
Factor(theta) (dB)	43.75	44.04	43.51	44.51	44.95	45.63	45.87	46.14	45.88	46.35	46.11	46.21	46.34	46.74
Factor(phi) (dB)	43.19	42.52	43.08	44.81	45.14	44.98	45.54	45.65	45.55	45.85	45.65	46.02	46.28	46.34

Note:

$$G \text{ reading (dB)} = 20 \cdot \log(V2/V1) = 10 \cdot \log(P2/P1)$$

V2 is the voltage of VNA port2 is measured, V1 is the voltage of VNA port1 is the reference source.

P2 is the power of VNA port2 is measured, P1 is the power of VNA port1 is the reference source.

$$\text{Factor} = \text{gain factor} + \text{power gain conversion} = (\text{Reference antenna gain}) - (G \text{ reading})$$



Frequency (MHz)	2400	2450	2500	5150	5200	5300	5600	5750	5800	5900	6000	6500	7000	7200
G(theta) reading (dB)	-33.55	-33.38	-32.91	-32.29	-32.48	-32.25	-32.33	-32.85	-32.67	-33.37	-32.53	-33.75	-34.72	-35.33
G(phi) reading (dB)	-33.11	-32.68	-32.48	-32.45	-32.85	-31.35	-32.76	-32.68	-32.57	-32.81	-32.85	-33.62	-34.33	-35.29
Reference gain (dBi)	10.3	10.3	10.1	11.1	11.3	11.7	12.1	11.5	11.2	11.1	11.3	11	11.1	10.5
Factor(theta) (dB)	43.85	43.68	43.01	43.39	43.78	43.95	44.43	44.35	43.87	44.47	43.83	44.75	45.82	45.83
Factor(phi) (dB)	43.41	42.98	42.58	43.55	44.15	43.05	44.86	44.18	43.77	43.91	44.15	44.62	45.43	45.79

Note:

$$G \text{ reading (dB)} = 20 \cdot \log(V2/V1) = 10 \cdot \log(P2/P1)$$

V2 is the voltage of VNA port2 is measured, V1 is the voltage of VNA port1 is the reference source.

P2 is the power of VNA port2 is measured, P1 is the power of VNA port1 is the reference source.

$$\text{Factor} = \text{gain factor} + \text{power gain conversion} = (\text{Reference antenna gain}) - (G \text{ reading})$$



6. Test Method

EUT set on multi-axis positioner and adjust EUT's physical center to measurement reference center. 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 G value every 7.5 degree from 0 to 352.5 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.

Note: Antenna gain = G reading + factor, The factor of chapter five includes reference antenna gain factor and power gain conversion.



7. Measured Values and Calculation of Maximum Gain Positions

For 2G5G Ant1~4:

DG_1SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	-2.98	1.02	-3.23	-0.13	-1.08
Ant. 2 (dBi)	-2.37	0.48	-0.22	1.93	1.97
Ant. 3 (dBi)	3.25	-0.11	1.31	-0.88	-1.2
Ant. 4 (dBi)	1.41	-2.18	0.47	-1.67	-1.08
DG [1SS] (dBi)	6.24	5.9	5.76	5.94	5.78
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	60	97.5	90	90	82.5
Φ (°)	352.5	255	352.5	285	277.5

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^(-2.98/20)	10^(1.02/20)	10^(-3.23/20)	10^(-0.13/20)	10^(-1.08/20)
Ant. 2 [10^(G/20)]	10^(-2.37/20)	10^(0.48/20)	10^(-0.22/20)	10^(1.93/20)	10^(1.97/20)
Ant. 3 [10^(G/20)]	10^(3.25/20)	10^(-0.11/20)	10^(1.31/20)	10^(-0.88/20)	10^(-1.2/20)
Ant. 4 [10^(G/20)]	10^(1.41/20)	10^(-2.18/20)	10^(0.47/20)	10^(-1.67/20)	10^(-1.08/20)
Ant. 1 [10^(G/20)] value	0.71	1.125	0.689	0.985	0.883
Ant. 2 [10^(G/20)] value	0.761	1.057	0.975	1.249	1.255
Ant. 3 [10^(G/20)] value	1.454	0.987	1.163	0.904	0.871
Ant. 4 [10^(G/20)] value	1.176	0.778	1.056	0.825	0.883
Sum All Antenna [Amax]	4.101	3.947	3.883	3.963	3.892
DG [10*log(Amax^2/Nant)]	6.24	5.9	5.76	5.94	5.78

Note:

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

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



For 6G Ant1~4:

DG_1SS max value position

Frequency (Hz)	6.175G	6.475G
Ant. 1 (dBi)	0.37	1.69
Ant. 2 (dBi)	-2.97	-2.72
Ant. 3 (dBi)	-0.28	-0.12
Ant. 4 (dBi)	0.96	0.82
DG [1SS] (dBi)	5.66	6.09
Polarization	Theta	Theta
Θ (°)	82.5	82.5
Φ (°)	15	7.5

Frequency (Hz)	6.695G	6.995G
Ant. 1 (dBi)	-0.72	-2.1
Ant. 2 (dBi)	-2.28	-1.04
Ant. 3 (dBi)	-0.28	2.39
Ant. 4 (dBi)	0.82	-0.33
DG [1SS] (dBi)	5.48	5.92
Polarization	Theta	Theta
Θ (°)	82.5	75
Φ (°)	52.5	195

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)	6.175G	6.475G
Ant. 1 [10^(G/20)]	10^(0.37/20)	10^(1.69/20)
Ant. 2 [10^(G/20)]	10^(-2.97/20)	10^(-2.72/20)
Ant. 3 [10^(G/20)]	10^(-0.28/20)	10^(-0.12/20)
Ant. 4 [10^(G/20)]	10^(0.96/20)	10^(0.82/20)
Ant. 1 [10^(G/20)] value	1.044	1.215
Ant. 2 [10^(G/20)] value	0.71	0.731
Ant. 3 [10^(G/20)] value	0.968	0.986
Ant. 4 [10^(G/20)] value	1.117	1.099
Sum All Antenna [Amax]	3.839	4.031
DG [10*log(Amax^2/Nant)]	5.66	6.09

Frequency (Hz)	6.695G	6.995G
Ant. 1 [10^(G/20)]	10^(-0.72/20)	10^(-2.1/20)
Ant. 2 [10^(G/20)]	10^(-2.28/20)	10^(-1.04/20)
Ant. 3 [10^(G/20)]	10^(-0.28/20)	10^(2.39/20)
Ant. 4 [10^(G/20)]	10^(0.82/20)	10^(-0.33/20)
Ant. 1 [10^(G/20)] value	0.92	0.785
Ant. 2 [10^(G/20)] value	0.769	0.887
Ant. 3 [10^(G/20)] value	0.968	1.317
Ant. 4 [10^(G/20)] value	1.099	0.963
Sum All Antenna [Amax]	3.757	3.952
DG [10*log(Amax^2/Nant)]	5.48	5.92

Note:

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

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



8. Summary of Test Result

For 2G5G Ant1~4:

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.22	2.16	1.26	2.44	3.08
Ant. 2 Max Gain (dBi)	3.31	2.91	2.84	2.86	4.2
Ant. 3 Max Gain (dBi)	4.09	4.07	3.99	3.62	3.02
Ant. 4 Max Gain (dBi)	1.94	2.3	2.28	2.41	3.66
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/97.5/345	Theta/97.5/262.5	Theta/75/45	Phi/172.5/180	Phi/165/195
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/105/202.5	Theta/60/67.5	Theta/105/247.5	Theta/82.5/247.5	Theta/180/75
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/52.5/352.5	Theta/60/0	Theta/60/7.5	Theta/60/0	Theta/90/202.5
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/67.5/337.5	Theta/90/187.5	Theta/90/150	Theta/97.5/187.5	Theta/82.5/187.5
Max Gain (dBi)	4.09	4.07	3.99	3.62	4.2
DG [1SS] (dBi)	6.24	5.9	5.76	5.94	5.78
DG [2SS] (dBi)	4.09	4.07	3.99	3.62	4.2

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. Refer to KDB662911D01 (F) (2) (e) (ii)



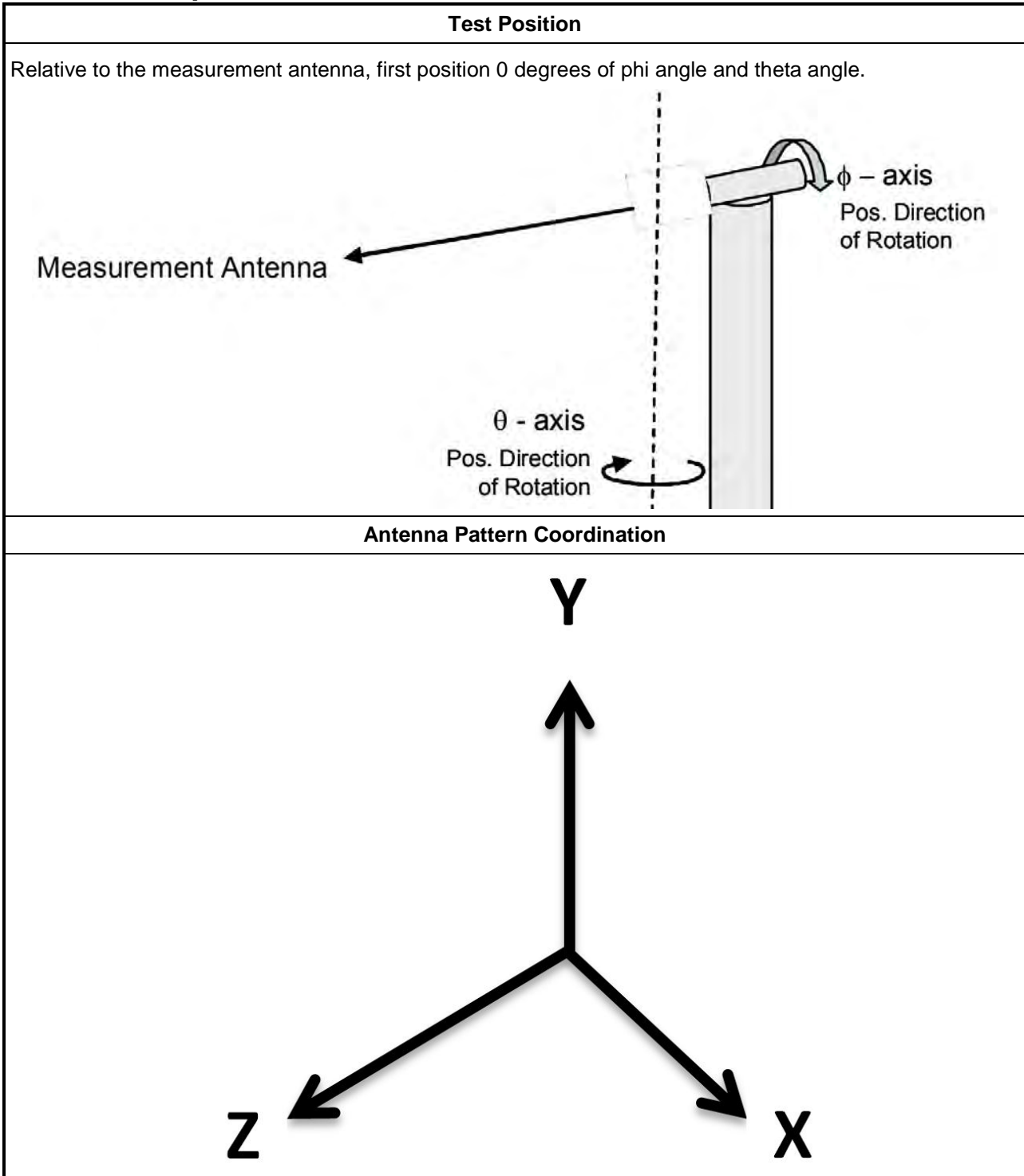
For 6G Ant1~4:

Freq(Hz)	6.175G	6.475G	6.695G	6.995G
Ant. 1 Max Gain (dBi)	1.8	1.69	1.38	1.91
Ant. 2 Max Gain (dBi)	1.95	1.21	2.3	3.01
Ant. 3 Max Gain (dBi)	1.82	1.56	3.5	3.51
Ant. 4 Max Gain (dBi)	1.74	2.31	3.29	2.92
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/82.5/127.5	Theta/82.5/7.5	Theta/82.5/120	Theta/105/97.5
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/90/60	Theta/82.5/97.5	Theta/97.5/352.5	Theta/97.5/7.5
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/195	Theta/82.5/352.5	Theta/120/307.5	Theta/67.5/142.5
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/150	Theta/120/232.5	Theta/82.5/300	Theta/82.5/247.5
Max Gain (dBi)	1.95	2.31	3.5	3.51
DG [1SS] (dBi)	5.66	6.09	5.48	5.92
DG [2SS] (dBi)	2.66	3.09	3.5	3.51

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. Refer to KDB662911D01 (F) (2) (e) (ii)

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-1543	1GHz~18GHz	May 11, 2023	May 10, 2024
Horn Antenna	SCHWARZBECK	BBHA9120D	BBHA 9120D-1531	1GHz~18GHz	Dec. 20, 2023	Dec. 19, 2024
Dual Polarization Horn Antenna	Sporton	S0209DP	S0209DP-001	2GHz~9GHz	N.C.R.	N.C.R.
ENA Series Network Analyzer	AGILENT	E5071C	MY46419477	100kHz~8.5GHz	Jul. 20, 2022	Jul. 19, 2023
VNA Calibration Kit	TS RF	TS85033E-F	-	DC~9GHz	N.C.R.	N.C.R.
Multi-axis positioner	Sporton	MAPS01	MAPS01-001	Theta / Phi axis	N.C.R.	N.C.R.
Test Software	SPORTON	SENSE-RDG	V1.0.8	-	N.C.R.	N.C.R.

Note: Calibration Interval of instruments listed above is one year.
N.C.R means Non-Calibration required.



11. Test Results

Please refer to the appendix.

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Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.22	2.16	1.26	2.44	3.08
Ant. 2 Max Gain (dBi)	3.31	2.91	2.84	2.86	4.2
Ant. 3 Max Gain (dBi)	4.09	4.07	3.99	3.62	3.02
Ant. 4 Max Gain (dBi)	1.94	2.3	2.28	2.41	3.66
Ant. 1 Polarization/ θ (°)/ Φ (°)	Theta/97.5/345	Theta/97.5/262.5	Theta/75/45	Phi/172.5/180	Phi/165/195
Ant. 2 Polarization/ θ (°)/ Φ (°)	Theta/105/202.5	Theta/60/67.5	Theta/105/247.5	Theta/82.5/247.5	Theta/180/75
Ant. 3 Polarization/ θ (°)/ Φ (°)	Theta/52.5/352.5	Theta/60/0	Theta/60/7.5	Theta/60/0	Theta/90/202.5
Ant. 4 Polarization/ θ (°)/ Φ (°)	Theta/67.5/337.5	Theta/90/187.5	Theta/90/150	Theta/97.5/187.5	Theta/82.5/187.5
Max Gain (dBi)	4.09	4.07	3.99	3.62	4.2
DG [1SS] (dBi)	6.24	5.9	5.76	5.94	5.78
DG [2SS] (dBi)	4.09	4.07	3.99	3.62	4.2



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

DG 1SS Result

Table with columns for Frequency (Freq/Hz), Polarization (Pol), and various antenna gain configurations (Phi, Theta). Rows include data for 2.45GHz and 5.2GHz, with values ranging from -11.99 to 5.51. Includes a 'Theft' column for 5.2GHz.



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

Gain Result

Gain	Phi0°(7.5°)	Phi15°(22.5°)	Phi30°(37.5°)	Phi45°(52.5°)	Phi60°(67.5°)	Phi75°(82.5°)	Phi90°(97.5°)	Phi105°(112.5°)	Phi120°(127.5°)	Phi135°(142.5°)	Phi150°(157.5°)	Phi165°(172.5°)	Phi180°(187.5°)	Phi195°(202.5°)	Phi210°(217.5°)	Phi225°(232.5°)	Phi240°(247.5°)	Phi255°(262.5°)	Phi270°(277.5°)	Phi285°(292.5°)	Phi300°(307.5°)	Phi315°(322.5°)	Phi330°(337.5°)	Phi345°(352.5°)
Gain	Phi0°(7.5°)	Phi15°(22.5°)	Phi30°(37.5°)	Phi45°(52.5°)	Phi60°(67.5°)	Phi75°(82.5°)	Phi90°(97.5°)	Phi105°(112.5°)	Phi120°(127.5°)	Phi135°(142.5°)	Phi150°(157.5°)	Phi165°(172.5°)	Phi180°(187.5°)	Phi195°(202.5°)	Phi210°(217.5°)	Phi225°(232.5°)	Phi240°(247.5°)	Phi255°(262.5°)	Phi270°(277.5°)	Phi285°(292.5°)	Phi300°(307.5°)	Phi315°(322.5°)	Phi330°(337.5°)	Phi345°(352.5°)
Theta(7.5°)	-17.78/-18.29	-17.26/-16.29	-15.71/-15.67	-15.44/-16.64	-17.69/-18.92	-18.4/-16.13	-14.63/-15.3	-18.25/-19.09	-17.43/-18.51	-18.76/-18.13	-18.17/-17.34	-18.38/-18.76	-17.28/-19.22	-18.39/-16.35	-15.63/-15.65	-16.51/-17.71	-19.18/-18.45	-17.32/-17.97	-18.54/-18.8	-16.41/-15.52	-19.59/-19.37	-17.35/-13.54	-13.71/-16.71	-18.63/-17.63



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

θ (2.5°)	θ (5°)	θ (7.5°)	θ (10°)	θ (12.5°)	θ (15°)	θ (17.5°)	θ (20°)	θ (22.5°)	θ (25°)	θ (27.5°)	θ (30°)	θ (32.5°)	θ (35°)	θ (37.5°)	θ (40°)	θ (42.5°)	θ (45°)	θ (47.5°)	θ (50°)	θ (52.5°)	θ (55°)	θ (60°)	θ (65°)	θ (70°)	θ (75°)	θ (80°)	θ (85°)	θ (90°)	θ (92.5°)	θ (95°)	θ (97.5°)	θ (100°)	θ (102.5°)	θ (105°)	θ (107.5°)	θ (110°)	θ (112.5°)	θ (115°)	θ (120°)	θ (125°)	θ (130°)	θ (135°)	θ (140°)	θ (145°)	θ (150°)	θ (155°)	θ (160°)	θ (165°)	θ (170°)	θ (175°)	θ (180°)	θ (182.5°)	θ (185°)	θ (187.5°)	θ (190°)	θ (192.5°)	θ (195°)	θ (200°)	θ (205°)	θ (210°)	θ (215°)	θ (220°)	θ (225°)	θ (230°)	θ (235°)	θ (240°)	θ (245°)	θ (250°)	θ (255°)	θ (260°)	θ (265°)	θ (270°)	θ (275°)	θ (280°)	θ (285°)	θ (290°)	θ (295°)	θ (300°)	θ (305°)	θ (310°)	θ (315°)	θ (320°)	θ (325°)	θ (330°)	θ (335°)	θ (340°)	θ (345°)	θ (350°)	θ (355°)	θ (360°)	θ (362.5°)	θ (365°)	θ (367.5°)	θ (370°)	θ (372.5°)	θ (375°)	θ (377.5°)	θ (380°)	θ (382.5°)	θ (385°)	θ (387.5°)	θ (390°)	θ (392.5°)	θ (395°)	θ (397.5°)	θ (400°)	θ (402.5°)	θ (405°)	θ (407.5°)	θ (410°)	θ (412.5°)	θ (415°)	θ (420°)	θ (425°)	θ (430°)	θ (435°)	θ (440°)	θ (445°)	θ (450°)	θ (455°)	θ (460°)	θ (465°)	θ (470°)	θ (475°)	θ (480°)	θ (485°)	θ (490°)	θ (495°)	θ (500°)	θ (502.5°)	θ (505°)	θ (507.5°)	θ (510°)	θ (512.5°)	θ (515°)	θ (520°)	θ (525°)	θ (530°)	θ (535°)	θ (540°)	θ (545°)	θ (550°)	θ (555°)	θ (560°)	θ (565°)	θ (570°)	θ (575°)	θ (580°)	θ (585°)	θ (590°)	θ (595°)	θ (600°)	θ (602.5°)	θ (605°)	θ (607.5°)	θ (610°)	θ (612.5°)	θ (615°)	θ (620°)	θ (625°)	θ (630°)	θ (635°)	θ (640°)	θ (645°)	θ (650°)	θ (655°)	θ (660°)	θ (665°)	θ (670°)	θ (675°)	θ (680°)	θ (685°)	θ (690°)	θ (695°)	θ (700°)	θ (702.5°)	θ (705°)	θ (707.5°)	θ (710°)	θ (712.5°)	θ (715°)	θ (720°)	θ (725°)	θ (730°)	θ (735°)	θ (740°)	θ (745°)	θ (750°)	θ (755°)	θ (760°)	θ (765°)	θ (770°)	θ (775°)	θ (780°)	θ (785°)	θ (790°)	θ (795°)	θ (800°)	θ (802.5°)	θ (805°)	θ (807.5°)	θ (810°)	θ (812.5°)	θ (815°)	θ (820°)	θ (825°)	θ (830°)	θ (835°)	θ (840°)	θ (845°)	θ (850°)	θ (855°)	θ (860°)	θ (865°)	θ (870°)	θ (875°)	θ (880°)	θ (885°)	θ (890°)	θ (895°)	θ (900°)	θ (902.5°)	θ (905°)	θ (907.5°)	θ (910°)	θ (912.5°)	θ (915°)	θ (920°)	θ (925°)	θ (930°)	θ (935°)	θ (940°)	θ (945°)	θ (950°)	θ (955°)	θ (960°)	θ (965°)	θ (970°)	θ (975°)	θ (980°)	θ (985°)	θ (990°)	θ (995°)	θ (1000°)
Gain	Φ(0°)Φ(7.5°)	Φ(15°)Φ(22.5°)	Φ(30°)Φ(37.5°)	Φ(45°)Φ(52.5°)	Φ(60°)Φ(67.5°)	Φ(75°)Φ(82.5°)	Φ(90°)Φ(97.5°)	Φ(105°)Φ(112.5°)	Φ(120°)Φ(127.5°)	Φ(135°)Φ(142.5°)	Φ(150°)Φ(157.5°)	Φ(165°)Φ(172.5°)	Φ(180°)Φ(187.5°)	Φ(195°)Φ(202.5°)	Φ(210°)Φ(217.5°)	Φ(225°)Φ(232.5°)	Φ(240°)Φ(247.5°)	Φ(255°)Φ(262.5°)	Φ(270°)Φ(277.5°)	Φ(285°)Φ(292.5°)	Φ(300°)Φ(307.5°)	Φ(315°)Φ(322.5°)	Φ(330°)Φ(337.5°)	Φ(345°)Φ(352.5°)																																																																																																																																																																																																																												
Gain	Φ(0°)	Φ(7.5°)	Φ(15°)	Φ(22.5°)	Φ(30°)	Φ(37.5°)	Φ(45°)	Φ(52.5°)	Φ(60°)	Φ(67.5°)	Φ(75°)	Φ(82.5°)	Φ(90°)	Φ(97.5°)	Φ(105°)	Φ(112.5°)	Φ(120°)	Φ(127.5°)	Φ(135°)	Φ(142.5°)	Φ(150°)	Φ(157.5°)	Φ(165°)	Φ(172.5°)	Φ(180°)	Φ(187.5°)	Φ(195°)	Φ(202.5°)	Φ(210°)	Φ(217.5°)	Φ(225°)	Φ(232.5°)	Φ(240°)	Φ(247.5°)	Φ(255°)	Φ(262.5°)	Φ(270°)	Φ(277.5°)	Φ(285°)	Φ(292.5°)	Φ(300°)	Φ(307.5°)	Φ(315°)	Φ(322.5°)	Φ(330°)	Φ(337.5°)	Φ(345°)	Φ(352.5°)																																																																																																																																																																																																				
Gain	Φ(0°)	Φ(7.5°)	Φ(15°)	Φ(22.5°)	Φ(30°)	Φ(37.5°)	Φ(45°)	Φ(52.5°)	Φ(60°)	Φ(67.5°)	Φ(75°)	Φ(82.5°)	Φ(90°)	Φ(97.5°)	Φ(105°)	Φ(112.5°)	Φ(120°)	Φ(127.5°)	Φ(135°)	Φ(142.5°)	Φ(150°)	Φ(157.5°)	Φ(165°)	Φ(172.5°)	Φ(180°)	Φ(187.5°)	Φ(195°)	Φ(202.5°)	Φ(210°)	Φ(217.5°)	Φ(225°)	Φ(232.5°)	Φ(240°)	Φ(247.5°)	Φ(255°)	Φ(262.5°)	Φ(270°)	Φ(277.5°)	Φ(285°)	Φ(292.5°)	Φ(300°)	Φ(307.5°)	Φ(315°)	Φ(322.5°)	Φ(330°)	Φ(337.5°)	Φ(345°)	Φ(352.5°)																																																																																																																																																																																																				



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

Gain	Φ(0°)Φ(7.5°)	Φ(15°)Φ(22.5°)	Φ(30°)Φ(37.5°)	Φ(45°)Φ(52.5°)	Φ(60°)Φ(67.5°)	Φ(75°)Φ(82.5°)	Φ(90°)Φ(97.5°)	Φ(105°)Φ(112.5°)	Φ(120°)Φ(127.5°)	Φ(135°)Φ(142.5°)	Φ(150°)Φ(157.5°)	Φ(165°)Φ(172.5°)	Φ(180°)Φ(187.5°)	Φ(195°)Φ(202.5°)	Φ(210°)Φ(217.5°)	Φ(225°)Φ(232.5°)	Φ(240°)Φ(247.5°)	Φ(255°)Φ(262.5°)	Φ(270°)Φ(277.5°)	Φ(285°)Φ(292.5°)	Φ(300°)Φ(307.5°)	Φ(315°)Φ(322.5°)	Φ(330°)Φ(337.5°)	Φ(345°)Φ(352.5°)
Gain	Φ(0°)Φ(7.5°)	Φ(15°)Φ(22.5°)	Φ(30°)Φ(37.5°)	Φ(45°)Φ(52.5°)	Φ(60°)Φ(67.5°)	Φ(75°)Φ(82.5°)	Φ(90°)Φ(97.5°)	Φ(105°)Φ(112.5°)	Φ(120°)Φ(127.5°)	Φ(135°)Φ(142.5°)	Φ(150°)Φ(157.5°)	Φ(165°)Φ(172.5°)	Φ(180°)Φ(187.5°)	Φ(195°)Φ(202.5°)	Φ(210°)Φ(217.5°)	Φ(225°)Φ(232.5°)	Φ(240°)Φ(247.5°)	Φ(255°)Φ(262.5°)	Φ(270°)Φ(277.5°)	Φ(285°)Φ(292.5°)	Φ(300°)Φ(307.5°)	Φ(315°)Φ(322.5°)	Φ(330°)Φ(337.5°)	Φ(345°)Φ(352.5°)
Gain	Φ(0°)Φ(7.5°)	Φ(15°)Φ(22.5°)	Φ(30°)Φ(37.5°)	Φ(45°)Φ(52.5°)	Φ(60°)Φ(67.5°)	Φ(75°)Φ(82.5°)	Φ(90°)Φ(97.5°)	Φ(105°)Φ(112.5°)	Φ(120°)Φ(127.5°)	Φ(135°)Φ(142.5°)	Φ(150°)Φ(157.5°)	Φ(165°)Φ(172.5°)	Φ(180°)Φ(187.5°)	Φ(195°)Φ(202.5°)	Φ(210°)Φ(217.5°)	Φ(225°)Φ(232.5°)	Φ(240°)Φ(247.5°)	Φ(255°)Φ(262.5°)	Φ(270°)Φ(277.5°)	Φ(285°)Φ(292.5°)	Φ(300°)Φ(307.5°)	Φ(315°)Φ(322.5°)	Φ(330°)Φ(337.5°)	Φ(345°)Φ(352.5°)



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

Table with columns for frequency (5.2GHz, 5.3GHz), gain (Theta), and various polarization angles (Phi). Each cell contains numerical gain data. Includes a legend for gain symbols and a footer with 'Sporton International Inc. Hsinchu Laboratory'.



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

Table with columns for Frequency (MHz), Power (dBm), and Gain (dBi) for various antenna configurations. The table is organized into multiple sections based on frequency bands (5.6GHz, 5.785GHz) and antenna types (Theta, Phi, Gain).



Radiated Composite Gain Data of 2.4GHz and 5GHz UNII 1~3

Appendix A

Table containing radiated composite gain data for various frequency ranges and antenna configurations. The table is organized into multiple sections, each with a frequency range (e.g., (127.5°) to (172.5°)) and a sub-section for 2.45GHz and 5.2GHz. Each section includes a Gain column and a Phi/Ant. 4 column, followed by columns for various antenna configurations (e.g., Phi(0°)Phi(7.5°) to Phi(345°)Phi(352.5°)).



Freq(Hz)	6.175G	6.475G
Ant. 1 Max Gain (dBi)	1.8	1.69
Ant. 2 Max Gain (dBi)	1.95	1.21
Ant. 3 Max Gain (dBi)	1.82	1.56
Ant. 4 Max Gain (dBi)	1.74	2.31
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/82.5/127.5	Theta/82.5/7.5
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/90/60	Theta/82.5/97.5
Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/60/195	Theta/82.5/352.5
Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/60/150	Theta/120/232.5
Max Gain (dBi)	1.95	2.31
DG [1SS] (dBi)	5.66	6.09
DG [2SS] (dBi)	2.66	3.09



Radiated Composite Gain Data of 6GHz UNII 5 and UNII 6

Appendix B

Theta (°)	-19.2	-18.2	-17.2	-16.2	-15.2	-14.2	-13.2	-12.2	-11.2	-10.2	-9.2	-8.2	-7.2	-6.2	-5.2	-4.2	-3.2	-2.2	-1.2	0	1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2									
Theta (°)	-19.2	-18.2	-17.2	-16.2	-15.2	-14.2	-13.2	-12.2	-11.2	-10.2	-9.2	-8.2	-7.2	-6.2	-5.2	-4.2	-3.2	-2.2	-1.2	0	1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2									
Theta (°)	-19.2	-18.2	-17.2	-16.2	-15.2	-14.2	-13.2	-12.2	-11.2	-10.2	-9.2	-8.2	-7.2	-6.2	-5.2	-4.2	-3.2	-2.2	-1.2	0	1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2									
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)°	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)°
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)°	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)°

Freq(Hz)	6.695G	6.995G
Ant. 1 Max Gain (dBi)	1.38	1.91
Ant. 2 Max Gain (dBi)	2.3	3.01
Ant. 3 Max Gain (dBi)	3.5	3.51
Ant. 4 Max Gain (dBi)	3.29	2.92
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/82.5/120	Theta/105/97.5
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/97.5/352.5	Theta/97.5/7.5
Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/120/307.5	Theta/67.5/142.5
Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/82.5/300	Theta/82.5/247.5
Max Gain (dBi)	3.5	3.51
DG [1SS] (dBi)	5.48	5.92
DG [2SS] (dBi)	3.5	3.51



Radiated Composite Gain Data of 6GHz UNII 7 and UNII 8

Appendix C

Gain Result

Freq(Hz)	6.695GHz Pol.	Phi(Ant. 1)	Phi(0°)	Phi(7.5°)	Phi(15°)	Phi(22.5°)	Phi(30°)	Phi(37.5°)	Phi(45°)	Phi(52.5°)	Phi(60°)	Phi(67.5°)	Phi(75°)	Phi(82.5°)	Phi(90°)	Phi(97.5°)	Phi(105°)	Phi(112.5°)	Phi(120°)	Phi(127.5°)	Phi(135°)	Phi(142.5°)	Phi(150°)	Phi(157.5°)	Phi(165°)	Phi(172.5°)	Phi(180°)	Phi(187.5°)	Phi(195°)	Phi(202.5°)	Phi(210°)	Phi(217.5°)	Phi(225°)	Phi(232.5°)	Phi(240°)	Phi(247.5°)	Phi(255°)	Phi(262.5°)	Phi(270°)	Phi(277.5°)	Phi(285°)	Phi(292.5°)	Phi(300°)	Phi(307.5°)	Phi(315°)	Phi(322.5°)	Phi(330°)	Phi(337.5°)	Phi(345°)	Phi(352.5°)
Gain	Phi(0°)	Phi(7.5°)	Phi(15°)	Phi(22.5°)	Phi(30°)	Phi(37.5°)	Phi(45°)	Phi(52.5°)	Phi(60°)	Phi(67.5°)	Phi(75°)	Phi(82.5°)	Phi(90°)	Phi(97.5°)	Phi(105°)	Phi(112.5°)	Phi(120°)	Phi(127.5°)	Phi(135°)	Phi(142.5°)	Phi(150°)	Phi(157.5°)	Phi(165°)	Phi(172.5°)	Phi(180°)	Phi(187.5°)	Phi(195°)	Phi(202.5°)	Phi(210°)	Phi(217.5°)	Phi(225°)	Phi(232.5°)	Phi(240°)	Phi(247.5°)	Phi(255°)	Phi(262.5°)	Phi(270°)	Phi(277.5°)	Phi(285°)	Phi(292.5°)	Phi(300°)	Phi(307.5°)	Phi(315°)	Phi(322.5°)	Phi(330°)	Phi(337.5°)	Phi(345°)	Phi(352.5°)		
Theta(°)	0	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120	127.5	135	142.5	150	157.5	165	172.5	180	187.5	195	202.5	210	217.5	225	232.5	240	247.5	255	262.5	270	277.5	285	292.5	300	307.5	315	322.5	330	337.5	345	352.5		
Gain	Phi(0°)	Phi(7.5°)	Phi(15°)	Phi(22.5°)	Phi(30°)	Phi(37.5°)	Phi(45°)	Phi(52.5°)	Phi(60°)	Phi(67.5°)	Phi(75°)	Phi(82.5°)	Phi(90°)	Phi(97.5°)	Phi(105°)	Phi(112.5°)	Phi(120°)	Phi(127.5°)	Phi(135°)	Phi(142.5°)	Phi(150°)	Phi(157.5°)	Phi(165°)	Phi(172.5°)	Phi(180°)	Phi(187.5°)	Phi(195°)	Phi(202.5°)	Phi(210°)	Phi(217.5°)	Phi(225°)	Phi(232.5°)	Phi(240°)	Phi(247.5°)	Phi(255°)	Phi(262.5°)	Phi(270°)	Phi(277.5°)	Phi(285°)	Phi(292.5°)	Phi(300°)	Phi(307.5°)	Phi(315°)	Phi(322.5°)	Phi(330°)	Phi(337.5°)	Phi(345°)	Phi(352.5°)		
Theta(°)	0	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120	127.5	135	142.5	150	157.5	165	172.5	180	187.5	195	202.5	210	217.5	225	232.5	240	247.5	255	262.5	270	277.5	285	292.5	300	307.5	315	322.5	330	337.5	345	352.5		
Gain	Phi(0°)	Phi(7.5°)	Phi(15°)	Phi(22.5°)	Phi(30°)	Phi(37.5°)	Phi(45°)	Phi(52.5°)	Phi(60°)	Phi(67.5°)	Phi(75°)	Phi(82.5°)	Phi(90°)	Phi(97.5°)	Phi(105°)	Phi(112.5°)	Phi(120°)	Phi(127.5°)	Phi(135°)	Phi(142.5°)	Phi(150°)	Phi(157.5°)	Phi(165°)	Phi(172.5°)	Phi(180°)	Phi(187.5°)	Phi(195°)	Phi(202.5°)	Phi(210°)	Phi(217.5°)	Phi(225°)	Phi(232.5°)	Phi(240°)	Phi(247.5°)	Phi(255°)	Phi(262.5°)	Phi(270°)	Phi(277.5°)	Phi(285°)	Phi(292.5°)	Phi(300°)	Phi(307.5°)	Phi(315°)	Phi(322.5°)	Phi(330°)	Phi(337.5°)	Phi(345°)	Phi(352.5°)		
Theta(°)	0	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120	127.5	135	142.5	150	157.5	165	172.5	180	187.5	195	202.5	210	217.5	225	232.5	240	247.5	255	262.5	270	277.5	285	292.5	300	307.5	315	322.5	330	337.5	345	352.5		