



Antenna Composite Gain Test Report

Equipment	Cable Modem
Brand Name	ARRIS
Model Name	TG6452, DG6450
Applicant	ARRIS 3871 Lakefield Drive Suite 300 SUWANEE Georgia United States 30024
Manufacturer	ARRIS 3871 Lakefield Drive Suite 300 SUWANEE Georgia United States 30024
Sample Received	Mar. 22, 2022
Start Test Date	Apr. 15, 2022
Final Test Date	May 31, 2022



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History of this test report

Report No.	Version	Description	Issued Date
AP232223AA	01	Initial issue of report	Jul. 20, 2022



1. Operation Mode and Antenna Information

Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
Ant1	1	Wanshih	BBGWIFI0038A	PCB	I-PEX	2.4GHz, 5GHz UNII 1~3
Ant2	2	Wanshih	BBGWIFI0038A	PCB	I-PEX	2.4GHz, 5GHz UNII 1~3
Ant3	3	Wanshih	BBGWIFI0038A	PCB	I-PEX	2.4GHz, 5GHz UNII 1~3
Ant4	4	Wanshih	BBGWIFI0038A	PCB	I-PEX	2.4GHz, 5GHz UNII 1~3

Note:

2.4GHz Operation Mode for IEEE802.11b (1TX/4RX)

The EUT supports the Ant1~Ant4 with TX diversity function.

Ant1~Ant4 can be used as receiving antennas.

Ant1~Ant4 could receive simultaneously.

2.4GHz Operation Mode for IEEE802.11g/n/ax (4TX/4RX)

Ant1~Ant4 can be used as transmitting/receiving antenna.

Ant1~Ant4 could transmit/receive simultaneously.

5GHz Operation Mode for IEEE802.11a (1TX/4RX)

The EUT supports the Ant1~Ant4 with TX diversity function.

Ant1~Ant4 can be used as receiving antennas.

Ant1~Ant4 could receive simultaneously.

5GHz Operation Mode for IEEE802.11n/ac/ax (4TX/4RX)

Ant1~Ant4 can be used as transmitting/receiving antenna.

Ant1~Ant4 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	Jay Lo	24.1-24.6 / 63-65	Apr. 15, 2022~May 31, 2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

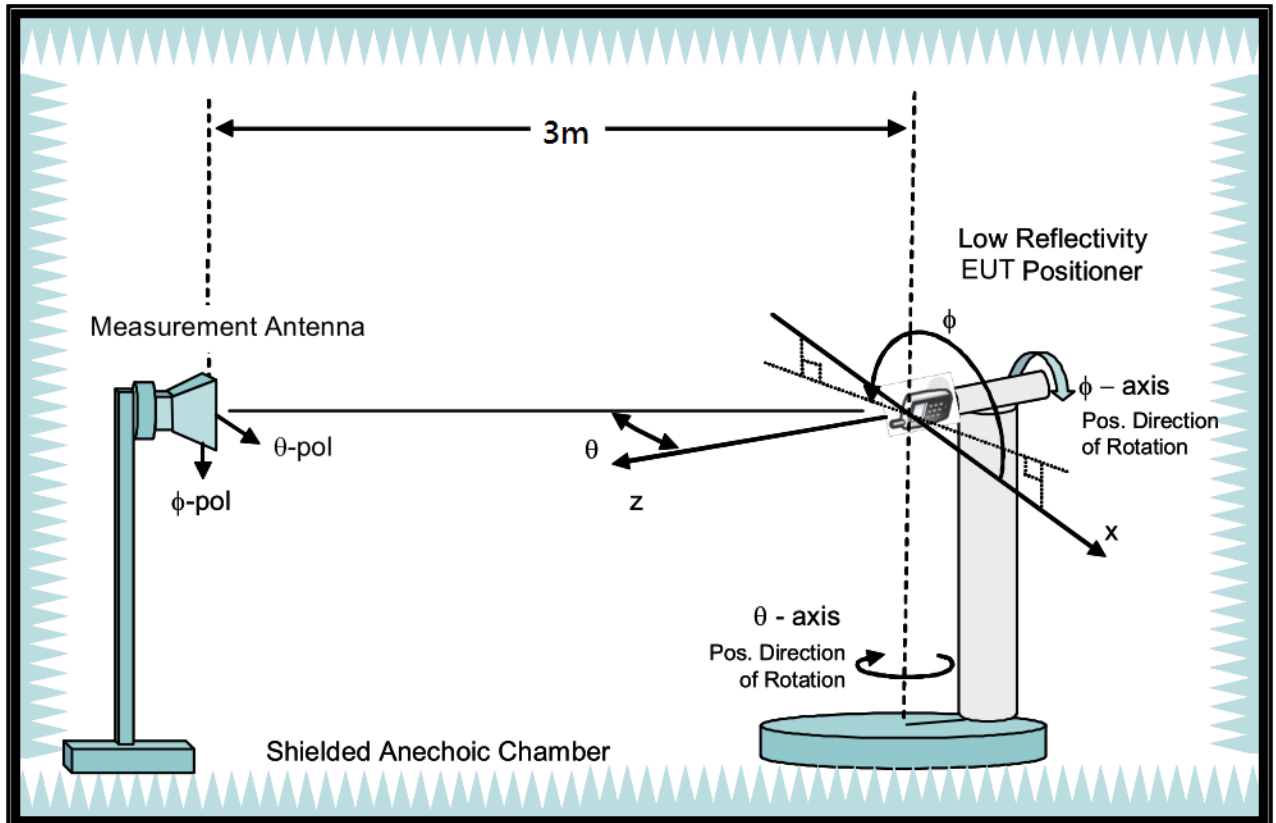
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

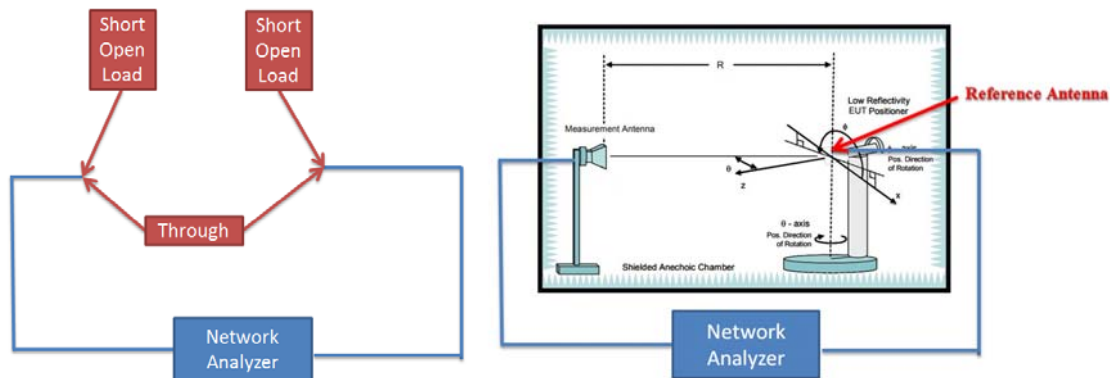
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



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	7500
G reading (dB)	-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)	41.34	41.55	41.68	43.24	43.56	43.68	43.79	43.91	43.99	44.43	44.49	45.24	46.12	46.31

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. 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 10 degree from 0 to 350 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

DG_1SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	0.28	-7.11	-1.6	-7.84	-3.22
Ant. 2 (dBi)	-2.75	2.39	0.69	-7.23	3.37
Ant. 3 (dBi)	4.09	-3.61	-6.02	1.25	-8.49
Ant. 4 (dBi)	-6.07	0.64	0.06	2.86	0.96
DG [1SS] (dBi)	5.71	4.85	4.66	4.57	5.24
Polarization	Phi	Theta	Theta	Theta	Theta
Θ (°)	70	60	90	30	90
Φ (°)	280	200	0	150	0

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 [$10^{(G/20)}$]	$10^{(0.28/20)}$	$10^{(-7.11/20)}$	$10^{(-1.6/20)}$	$10^{(-7.84/20)}$	$10^{(-3.22/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-2.75/20)}$	$10^{(2.39/20)}$	$10^{(0.69/20)}$	$10^{(-7.23/20)}$	$10^{(3.37/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(4.09/20)}$	$10^{(-3.61/20)}$	$10^{(-6.02/20)}$	$10^{(1.25/20)}$	$10^{(-8.49/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(-6.07/20)}$	$10^{(0.64/20)}$	$10^{(0.06/20)}$	$10^{(2.86/20)}$	$10^{(0.96/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.033	0.441	0.832	0.406	0.69
Ant. 2 [$10^{(G/20)}$] value	0.729	1.317	1.083	0.435	1.474
Ant. 3 [$10^{(G/20)}$] value	1.601	0.66	0.5	1.155	0.376
Ant. 4 [$10^{(G/20)}$] value	0.497	1.076	1.007	1.39	1.117
Sum All Antenna [Amax]	3.86	3.494	3.421	3.385	3.657
DG [$10^{*\log(Amax^2/Nant)}$]	5.71	4.85	4.66	4.57	5.24

Note:

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

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



8. Summary of Test Result

Frequency (Hz)	2.45G
Ant. 1 Max Gain (dBi)	3.21
Ant. 2 Max Gain (dBi)	3.33
Ant. 3 Max Gain (dBi)	4.48
Ant. 4 Max Gain (dBi)	4.51
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/130/160
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/300
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/90/270
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/80
Max Gain (dBi)	4.51
DG [1SS] (dBi)	5.71
DG [2SS] (dBi)	4.51
DG [4SS] (dBi)	4.51

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.
4. Directional Gain (4SS) = Directional Gain (1SS) – 6dB. If directional gain is less than max gain, use max gain as directional gain.

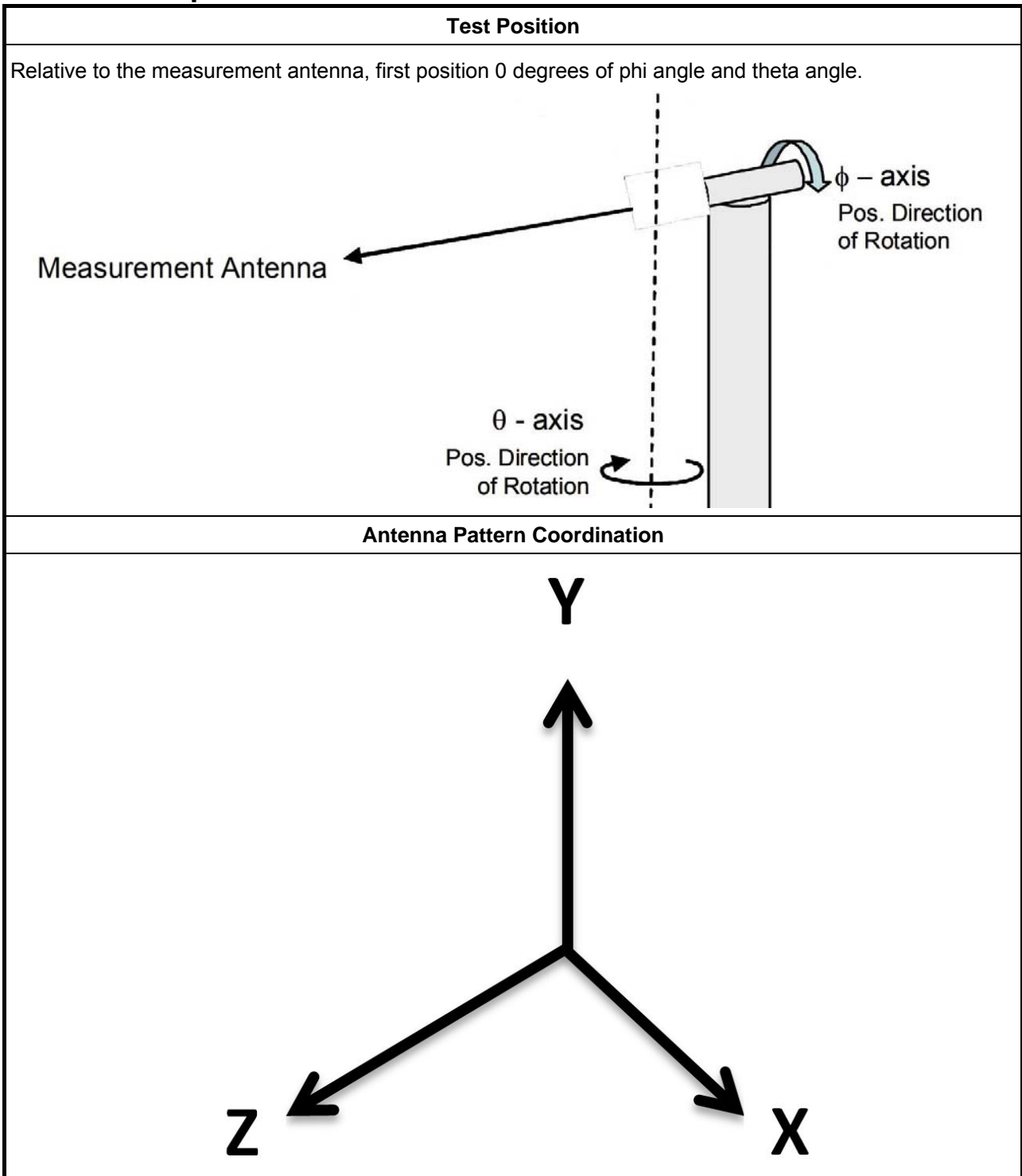


Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.34	2.39	3.23	3.3
Ant. 2 Max Gain (dBi)	3.53	2.83	2.83	3.93
Ant. 3 Max Gain (dBi)	2.9	3.39	2.64	2.86
Ant. 4 Max Gain (dBi)	3.93	4.55	3.74	4.25
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/130/160	Phi/50/160	Phi/40/150	Phi/20/10
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/300	Theta/70/200	Theta/70/200	Theta/70/350
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/90/270	Phi/40/240	Phi/10/230	Phi/40/240
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/80	Theta/100/130	Theta/60/160	Theta/60/160
Max Gain (dBi)	3.93	4.55	3.74	4.25
DG [1SS] (dBi)	4.85	4.66	4.57	5.24
DG [2SS] (dBi)	3.93	4.55	3.74	4.25
DG [4SS] (dBi)	3.93	4.55	3.74	4.25

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.
4. Directional Gain (4SS) = Directional Gain (1SS) – 6dB. 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
Dual Polarization Horn Antenna	Sporton	S0209DP	S0209DP-001	2GHz~9GHz	N.C.R.	N.C.R.
ENA Series Network Analyzer	AGILENT	E5071C	MY46419201	100kHz~8.5GHz	Feb. 21, 2022	Feb. 20, 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	V1.0.6	-	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.

Appendix A – Radiated Composite Gain of 2.4GHz, 5GHz U-NII 1~U-NII 3.....	Page 15
Appendix B – Antenna Pattern of 2.4GHz, 5GHz U-NII 1~U-NII 3.....	Page 23
Appendix C – Test Photos.....	Page 28



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.21	2.34	2.39	3.23	3.3
Ant. 2 Max Gain (dBi)	3.33	3.53	2.83	2.83	3.93
Ant. 3 Max Gain (dBi)	4.48	2.9	3.39	2.64	2.86
Ant. 4 Max Gain (dBi)	4.51	3.93	4.55	3.74	4.25
Ant. 1 Polarization/ θ (°)/ ϕ (°)	Phi/130/160	Phi/50/160	Phi/40/150	Phi/20/10	Phi/20/0
Ant. 2 Polarization/ θ (°)/ ϕ (°)	Theta/100/300	Theta/70/200	Theta/70/200	Theta/70/350	Theta/80/350
Ant. 3 Polarization/ θ (°)/ ϕ (°)	Phi/90/270	Phi/40/240	Phi/10/230	Phi/40/240	Phi/100/260
Ant. 4 Polarization/ θ (°)/ ϕ (°)	Theta/100/80	Theta/100/130	Theta/60/160	Theta/60/160	Theta/60/160
Max Gain (dBi)	4.51	3.93	4.55	3.74	4.25
DG [1SS] (dBi)	5.71	4.85	4.66	4.57	5.24
DG [2SS] (dBi)	4.51	3.93	4.55	3.74	4.25
DG [4SS] (dBi)	4.51	3.93	4.55	3.74	4.25



DG 1SS Result

Table with 30 columns labeled 'Model' and 48 rows of numerical data. The data is organized into blocks corresponding to different frequencies: 2.4GHz, 5GHz, and U-NII 1~3. Each block contains a 'Model' column and a 'Gain' column with values ranging from approximately -150 to 150 dBm.



Radiated Composite Gain_2.4GHz, 5GHz U-NII 1~U-NII 3

Appendix A

Table with multiple columns containing numerical data for various frequencies and gain measurements across different test configurations.



Antenna Pattern_2.4GHz, 5GHz U-NII 1~U-NII 3

Appendix B

Total Gain Data

Table with columns for Frequency (Freq), Polarization (Pol), Total Antenna Gain (TotalAnt. 1), and directional gain values for various angles (Theta) and azimuths (Phi).



Antenna Pattern_2.4GHz, 5GHz U-NII 1~U-NII 3

Appendix B

Angle	Gain	Phi(0°)Phi(10°)	Phi(20°)Phi(30°)	Phi(40°)Phi(50°)	Phi(60°)Phi(70°)	Phi(80°)Phi(90°)	Phi(100°)Phi(110°)	Phi(120°)Phi(130°)	Phi(140°)Phi(150°)	Phi(160°)Phi(170°)	Phi(180°)Phi(190°)	Phi(200°)Phi(210°)	Phi(220°)Phi(230°)	Phi(240°)Phi(250°)	Phi(260°)Phi(270°)	Phi(280°)Phi(290°)	Phi(300°)Phi(310°)	Phi(320°)Phi(330°)	Phi(340°)Phi(350°)
Theta(0°)	0.35/0.28	-0.12/1.82	-3.25/3.28	-3.56/3.94	-3.19/2.14	-1.24/0.62	-1.08/2.69	-4.08/3.99	-3.07/2.17	-1.69/1.89	-2.15/2.09	-2.03/1.95	-1.53/0.37	0.65/1.24	1.72/2.23	2.45/2.02	0.88/0.46	1.25/1.15	

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

